NorthMet Project

Water Modeling Data Package
Volume 1 - Mine Site

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Acronyms, Abbreviations, and Units

Acronym / Abbreviation	Stands For
CEC	Continuation of Existing Conditions
CPS	Central Pumping Station
DEIS	Draft Environmental Impact Statement
DO	dissolved oxygen
ET	evapotranspiration
FEIS	Final Environmental Impact Statement
HELP	Hydrologic Evaluation of Landfill Performance
HRL	health risk limit
KM	Kaplan-Meier
LCS	laboratory control spike
LCSD	laboratory control spike duplicate
LTVSMC	LTV Steel Mining Company
MCL	maximum contaminant level
MDNR	Minnesota Department of Natural Resources
MPCA	Minnesota Pollution Control Agency
MS	matrix spike
MSD	matrix spike duplicate
MSL	mean sea level
NPDES	National Pollutant Discharge Elimination System
NTS	Northeast Technical Services, Inc.
NWS	National Weather Service
OSLA	Overburden Storage and Laydown Area

Acronym / Abbreviation	Stands For
OSP	Ore Surge Pile
P	precipitation
P10	lower 10th percentile model result
P50	median or 50th percentile model result
P90	upper 90th percentile model result
Pace	Pace Analytical
redox	Oxidation-reduction
QA/QC	quality assurance and quality control
RMSE	root-mean-squared error
RO	runoff
RPD	relative percent difference
RTH	Rail Transfer Hopper
SDEIS	Supplemental Draft Environmental Impact Statement
SDS	State Disposal System
sMCL	secondary maximum containment level
UPL	upper prediction limit
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
UTL	upper tolerance limit
VBA	Visual Basic for Applications
WWTF	Mine Site Waste Water Treatment Facility
WWTP	Plant Site Waste Water Treatment Plant

Unit	Description
cfs	cubic feet per second
gpd	gallons per day
gpm	gallons per minute
in/yr	inches per year
L/kg	liters per kilogram
m/day	meters per day
mg/L	milligram per liter
mi2	square mile
ng/L	nanograms per liter
µg/L	micrograms per liter

1.0 Introduction

This document describes the water data for the Poly Met Mining Inc. (PolyMet) NorthMet Project (Project) Mine Site. It presents the regulatory basis, modeling framework and baseline data, describes the probabilistic modeling used to estimate Project water balances and water quality impacts, and reports model results.

Several Project Management Plans use the Mine Site water data from this report, including the Water Management Plan – Mine (Reference (1)) the Mine Plan (Reference (2)), the Rock and Overburden Management Plan (Reference (3)), and the Adaptive Water Management Plan (Reference (4)).

Water data for the Plant Site are available in the NorthMet Project Water Modeling Package Volume 2 – Plant Site (Reference (5)). The geochemical properties of Mine Site materials are described in NorthMet Project Waste Characterization Data Package (Reference (6)). When this report references a supporting document, it provides a general description of the supporting document.

1.1 Outline

The outline of this document is:

Section 2.0 Describes the regulatory basis for the water management plan at the Mine Site.

Section 3.0 Describes the modeling framework for water quantity and quality modeling at the Mine Site.

Section 4.0 Describes the baseline data used in water quantity and quality modeling at the Mine Site.

Section 0 Describes the modeling approach for water quantity and quality modeling at the Mine Site.

Section 6.0 Describes the water quantity and quality model results for the Mine Site.

This document is intended to evolve through the environmental review, permitting (National Pollutant Discharge Elimination System (NPDES) / State Disposal System (SDS), Water Appropriations and Permit to Mine), operations, reclamation and long-term closure phases of the Project. A Revision History is included at the end of the document. The Revision History includes revisions to the single, comprehensive water modeling package (prior to splitting the package into volumes in June 2011) and revisions to this document following that split.

2.0 Regulatory Basis

2.1 Minnesota Groundwater Standards

Groundwater in Minnesota is protected for use as an actual or potential source of drinking water (Class 1 Waters). The State of Minnesota has adopted the U.S. Environmental Protection Agency (USEPA) primary and secondary drinking water quality standards (40 CFR parts 141 and 143) as its groundwater quality standards (Minnesota Rules, chapter 7060). Minnesota Rules, parts 4717.7100 to 4717.7800, identify health risk limits/standards (HRLs) as appropriate cleanup levels for managing groundwater contamination and risk to human receptors in compliance with Minnesota Rules, chapter 7060. Although not promulgated as rule, the Minnesota Department of Health (MDH) has developed Risk Assessment Advice values when available toxicity data do not meet the requirements necessary for development of a HRL or Health Based Value.

It should be noted that Minnesota Rules, part 7060.0600 also has a provision that states:

"The groundwater may in its natural state have some characteristics or properties exceeding the standards for potable water supplies. Where the background level of natural origin is reasonably definable and is higher than the accepted standard for potable water and the hydrology and extent of the aquifer are known, the natural level may be used as the standard."

Groundwater quality standards for the constituents being evaluated are summarized in Large Table 1. The lower of the groundwater standards referenced above was selected as the target groundwater criteria used in this evaluation. The exception to this are the standards based on the secondary maximum contaminant level (sMCL) for aluminum, iron, and manganese, consistent with guidance provided by the Lead Agencies. Local groundwater already exceeds the sMCLs, which is consistent with concentrations seen elsewhere along the Iron Range and in northeastern Minnesota. The sMCLs were established for treated rather than natural water and were established only as guidelines by the USEPA to assist public water systems in managing their drinking water for aesthetic considerations such as taste, color, and odor. sMCLs and are not based on risk to human health. Aluminum, iron and manganese will be modeled, but estimated concentrations above the sMCLs will not be considered exceedances of the groundwater evaluation criteria.

Because measurements show high natural baseline concentrations of beryllium, thallium and manganese at the Mine Site, site-specific evaluation criteria were developed for these constituents, consistent with the provisions of Minnesota Rules, part 7060.0600. The development of the site-specific evaluation criteria is presented in Section 4.3.4.2 and the values are summarized in Large Table 1.

2.2 Minnesota Surface Water Quality Standards

Minnesota Rules, chapter 7050 defines surface water quality standards applicable to all surface waters of the State. Surface water quality standards vary in the state of Minnesota based on the

use classification of the water body. Minnesota Rules, part 7050.0140 describes the following use classifications: Class 1 waters (domestic consumption), Class 2 waters (aquatic life and recreation), Class 3 waters (industrial consumption), Class 4 waters (agriculture and wildlife), Class 5 waters (aesthetic enjoyment and navigation), Class 6 waters (other uses and protection of border waters), and Class 7 waters (limited resource value waters). These classes are further divided into subclasses with letter designations. Water bodies can receive multiple designations. In these cases, the applicable water quality standards usually will be the most restrictive standards from the water's listed classifications. Minnesota Rules, part 7050.0470 lists waters that are specifically classified. All waters that are not specifically listed have a default classification as specified in Minnesota Rules, part 7050.0430.

Minnesota Rules, chapter 7052 establishes additional surface water quality standards for water bodies within the Lake Superior Basin, which includes the Mine Site. These Lake Superior Basin water quality standards relating to aquatic life, human health and wildlife (Class 2 only) can differ from the water quality standards for the same substances, characteristics, or pollutants in Minnesota Rules, chapter 7050. Where different, the 7052 standards supersede the 7050 standards, even if Minnesota Rules, chapter 7052 rules are less stringent. For substances, characteristics, or pollutants not listed in Minnesota Rules, chapter 7052, the standards from Minnesota Rules, chapter 7050 apply.

In the Mine Site area, in-stream surface water quality standards for the Partridge River are Class 2B (recreational purposes and aquatic life; cold or warm water sport or commercial fish; not protected as a source of drinking water), Class 3C (industrial cooling and materials transport), Class 4A (irrigation use), Class 4B (livestock and wildlife use), Class 5 (aesthetic enjoyment and navigation), and Class 6 (other uses), which is the default designation for unlisted waters. All other streams and lakes in the Mine Site area have the default classification except Colby Lake, which is designated as Class 1B (treated with simple chlorination for domestic consumption) and 2Bd (cool or warm water sportfish and drinking water), as well as Class 3C, 4A, 4B, 5, and 6; and Wyman Creek which is also designated as Class 1B, as well as Class 2A, 3B, 3C, 4A, 4B, 5 and 6. Large Table 2 presents the surface water quality standards for the stream classifications applicable to the Project for constituents included in the probabilistic model. Minnesota Rules, part 7050.0224 subpart 2 also addresses water quality as it relates to wild rice. This standard and its applicability to the Project are discussed in Section 2.3.

Discharges, either direct or indirect, must not cause violation of water quality standards in the immediate receiving waters, but also must not cause exceedances in downstream waters that may have more stringent water quality standards.

The surface water quality standards applicable to surface waters in the Plant Site Project area are described in Section 2.1 of Reference (5).

2.2.1 Hardness-based Standards

Per Minnesota Rules, chapters 7050 and 7052, surface water quality standards for the following constituents are calculated as a function of the hardness in the receiving water:

- copper
- cadmium
- lead
- nickel
- zinc

The MPCA has indicated that Project discharges will be required to meet applicable water quality standards at end of pipe and, for the metals that have a hardness-based standard, the hardness of the discharge itself will be used to set the effluent targets for EIS modeling. Actual discharge limits will be determined as part of permitting. The Mine Site probabilistic modeling results for surface waters (Section 6) include comparison of constituent concentrations to applicable standards, including hardness-based standards. Hardness-based standards are calculated at each model evaluation location and each model time step.

Following MPCA guidance, hardness-based standards at all model evaluation points, except SW004 and SW004a, are determined using the model-estimated hardness at that evaluation point. For these locations, hardness-based standards are calculated at each model time step based on the instantaneous, mixed water quality. Hardness-based water quality standards at SW004 and SW004a are based on the median hardness measured (not modeled) in the receiving stream.

2.3 Wild Rice Standard

Minnesota Rules, part 7050.0224 includes a Class 4A standard of 10 mg/L for sulfate "applicable to water used for production of wild rice during periods when the rice may be susceptible to damage by high sulfate levels." Additional Minnesota Pollution Control Agency (MPCA) staff guidance has been issued regarding the seasonal application of this water quality standard (Reference (7)). This guidance states:

> *To be conservative, and to take into account variability associated with annual climatic variations, geographic locations and individual stand variability the MPCA staff recommendation is that the 10 mg/L sulfate standard is applicable for portions of the Partridge and Embarrass River systems used for the production of wild rice from April 1 through August 31. This timeframe applies at the specific reaches of these river systems that have been determined to be waters used for the production of wild rice; the travel and*

residence time of the river system from the point of discharge to the location of wild rice will need to be considered when evaluating a specific discharge.

None of the water bodies downstream of the Project are specifically designated as Wild Rice Waters in Minnesota Rules, chapter 7050. However, MPCA staff guidance identified waters used for the production of Wild Rice downstream of the Mine Site (Large Figure 1) and determined that this standard will apply to the Partridge River within the reach shown in (Large Figure 1). SW005 represents the model evaluation location were compliance with the wild rice standard will be assessed.

PolyMet is not asking for application of the seasonal aspect of the rule. For the evaluation presented in this document, it is assumed that the sulfate standard applies year-round at SW005.

2.4 Water Appropriations

A water use (appropriations permit) is required from the Minnesota Department of Natural Resources (MDNR) Ecological and Water Resources Division for all users withdrawing more than 10,000 gallons of water per day, or 1 million gallons per year (Minnesota Rules, part 6115.0620). There are several exceptions to water appropriation permit requirements: domestic uses serving less than 25 persons, test pumping of a groundwater source, reuse of water already authorized by a permit, or certain agricultural drainage systems. Permits for water appropriation for mining shall be in agreement with provisions of Minnesota Statutes 2014, section 130G.297. An appropriations permit will be needed for process water withdrawal from Colby Lake and for mine pit dewatering.

A new appropriations permit will be needed for dewatering from the mine pits during operations. The estimation of the amount of withdrawal that will be needed is discussed in Section 6.0.

See Volume 2 for discussion of water appropriations at the Plant Site.

2.5 NPDES / SDS Permitting

As authorized by the Clean Water Act, the National Pollutant Discharge Elimination System (NPDES) permit program regulates point source discharges to waters of the United States. The NPDES permit program in Minnesota is administered by the MPCA. Industrial facilities in Minnesota may be required to obtain coverage from the MPCA under a NPDES permit and/or a Minnesota State Disposal System (SDS) permit. These permits establish specific limits and requirements on the amount and quality of discharges to surface waters and monitor the effects of industrial facilities on surrounding surface waters and groundwater. Permits are enforced through a combination of self-reporting (reports to the MPCA, USEPA or both) and compliance monitoring.

The only water entering the environment from the Mine Site during operations and reclamation will be very small amounts from liner leakage (or infiltration in the case of the Overburden

Storage and Laydown Area), and stormwater, which will be covered under an industrial stormwater permit. All other water will be collected, treated, and pumped to the Plant Site: there will be no direct discharge to surface water at the Mine Site during operations and reclamation. During long-term closure, West Pit and Category 1 Waste Rock Stockpile water will be pumped to the Mine Site Waste Water Treatment Facility (WWTF) as needed to prevent the West Pit from overflowing. An NPDES/SDS permit will be required to discharge WWTF effluent to the Partridge River during long-term closure via the unnamed creek downstream of the West Pit overflow.

Other current NPDES/SDS permit holders in the Partridge River watershed include Northshore Mining Company (Northshore), which discharges from the Peter Mitchell Pit to the headwaters of the Partridge River from several discharge locations under NPDES/SDS permit number MN0046981.

See Volume 2 for discussion of NPDES/SDS permitting at the Plant Site.

3.0 Modeling Framework

3.1 Monte Carlo Simulation Background

Monte Carlo simulation is a statistical method for quantifying the uncertainty in a model's results. It is one form of ***probabilistic analysis***, a type of analysis that is fundamentally different from the ***deterministic analysis*** that was applied to the water quality modeling for the NorthMet Project Draft Environmental Impact Statement (DEIS). This section includes a basic introduction to the concepts and rationale involved with probabilistic analysis in general and Monte Carlo simulation in particular, and is derived from Appendix A of Reference (8).

Many of the features and processes which influence the behavior of a complex system, such as the water quality impacts from a proposed mining project, cannot be known with certainty. Uncertainties exist regarding the true values of model parameters (e.g., baseflow to a river segment), the occurrence of future extreme events (e.g., a flood or drought), and the conceptual model of physical processes (e.g., the interactions that control river flow at a particular location). Because of these underlying uncertainties, the resulting behavior of the system itself is also uncertain.

In order to understand and quantify the uncertainty in a model's results, the uncertainty in the model inputs must be quantified or otherwise addressed. Probabilistic analysis includes explicit representations of the uncertainty in the parameters, events and processes discussed above and propagating the uncertainty through the model.

Uncertainty is quantified in terms of ***probability distributions***. "A probability distribution is a mathematical representation of the relative likelihood of an uncertain variable having certain specific values," (Reference (8)). Familiar probability distributions include the normal, lognormal, and uniform distributions; there are many other types of probability distributions used in various applications of probabilistic analysis. Probability distributions can be determined by fitting distributions to available data or by using subjective experience and/or professional judgment to define a distribution's bounds or shape. It is important to note that the goal for defining probability distributions is to ***accurately and honestly reflect the uncertainty*** in the various aspects of the model system.

Uncertainty in parameter values is primarily due to two causes: ***inherent variability*** and ***lack of complete knowledge***. These types of uncertainty are sometimes referred to as *aleatory* and *epistemic* uncertainty, respectively. Aleatory uncertainty results from the fact that many parameters are inherently variable in space and/or time. For example, the flow rate in a river at a given location is temporally variable and cannot be defined by a single number, even in the presence of perfect knowledge of the system. Epistemic uncertainty results from insufficient data or incomplete knowledge of the system to characterize it with complete certainty. For example, a true value for the roughness coefficient in a river reach exists, but the available data may not be sufficient to define it exactly. Uncertainty due to insufficient data can be reduced or eliminated

by gathering more information, but uncertainty due to inherent variability can only be represented statistically.

In order to quantify the uncertainty in the model outcome in terms of a probability distribution, it is necessary to translate the input uncertainties into uncertainty in the model results. This can be accomplished analytically for models that are linear or are defined by single equations, but becomes unworkable for highly non-linear and complex models. ***Monte Carlo simulation*** is one method for translating uncertainties; this method relies on repeated simulation of uncertain systems rather than numerical solutions to determine output probability distributions.

In a Monte Carlo simulation, the entire modeled system is simulated a large number of times (hundreds or thousands). Each individual simulation represents one equally-likely possible performance of the system in which all uncertain parameters are sampled from the defined probability distributions. Each individual simulation results in a single value (or a time history of values) for each model output. The results of these many simulations are then assembled into probability distributions of the possible model outcomes. The resulting distributions represent the uncertainty in the model output resulting from the uncertainty and variability in the model input parameters and their complex interactions with one another.

The output of a Monte Carlo simulation is therefore a probability distribution that describes the likely performance of a given model result. This is distinctly different from the output of deterministic analysis, which is a single model result with no characterization of uncertainty. A deterministic analysis may be intended to represent “best guess” or “worst case” conditions, but is fundamentally unable to answer the question, “How likely is the model result?” In a Monte Carlo simulation, if the uncertainty and variability of relevant input parameters are defined to accurately and honestly capture the likelihood of potential values and events, the model output explicitly describes the likelihood associated with each model result.

3.2 Probabilistic Model Selection

This section documents the selection of a probabilistic modeling platform for the SDEIS water quality modeling. The same modeling platform is used for the FEIS water quality modeling.

3.2.1 Project Modeling Needs

The first step in selecting a modeling platform is to identify the modeling needs of the project. There are often several different modeling platforms available, each with their own capabilities, operational characteristics and limitations. It is important that the most appropriate modeling tool(s) is (are) selected for the problem being evaluated, given the project specific requirements with respect to modeling. Modeling tool selection is somewhat subjective, and care needs to be taken such that familiarity with a particular tool does not lead to an attempt to force-fit the conceptual model or the study objectives into the mold of a pre-chosen tool.

The essential model capabilities for the Project that were considered when selecting a modeling platform are presented below:

- Probabilistic model – In order to address uncertainty in key model inputs, it was determined that the SDEIS modeling should be probabilistic. As such, the selected modeling platform needs to be able to perform probabilistic simulations, including generating random numbers from defined probability distributions and performing statistical analysis on the output of many simulation runs.

- Ability to handle large quantities of data – The complexity of the system being modeled (the number of solutes being modeled, the number of locations being evaluated, the number of contaminant sources and the time frame being evaluated) requires that the modeling platform be capable of handling large quantities of data. This is especially true for a probabilistic simulation that will run the same model hundreds or thousands of times.

- Flexibility to simulate a variety of different processes – The modeling platform needs to be able to including the key controlling factors related to the geochemical release of solutes, the performance of engineered systems, solute transport through the aquifer, and flow in surface waters.

- Transparency – The SDEIS model will need to be reviewed by numerous different lead and cooperating agencies; the selected modeling platform needs to allow for easy review. If a proprietary modeling tool is considered, it must have a mechanism for model review that does not require a purchase (i.e., there must be a way for reviewers to review the model for free).

Additional model capabilities were considered, but were not deemed essential in the selection of a modeling platform.

3.2.2 Model Platforms Considered

Based on the experience of the modeling team, two modeling platforms were identified that meet the essential model capabilities: Microsoft Excel with Microsoft Access, and GoldSim. In both platforms standard Monte Carlo simulation is the basis for implementing probabilistic modeling.

3.2.2.1 Microsoft Excel with Microsoft Access

Much of the previous water quality modeling was conducted using Microsoft Excel, including the limited uncertainty analysis that was conducted for the DEIS. Excel is widely used in business and government for a nearly infinite range of applications, and is a familiar tool for virtually all model developers and reviewers. Excel contains a limited set of tools for probabilistic modeling (basic random number generators and statistical functions) and is extensible through the use of Visual Basic for Applications (VBA).

For the SDEIS modeling, the number of model runs associated with a probabilistic simulation of multiple mine and natural features and a number of chemical constituents would exceed the data-management capabilities of Excel alone. To handle the large quantities of data that would be

needed for this modeling exercise, Microsoft Access would need to be used in conjunction with Excel. Access is also widely used for database management, although it is less familiar to many technical professionals compared to Excel.

In order to perform the SDEIS modeling in Excel/Access as efficiently as possible, proprietary VBA code would be written to execute looping calculations, generate random numbers, and compile output statistics. The proprietary code would be a mixture of code written for previous modeling efforts for the Project and new code written expressly the SDEIS water quality modeling. VBA is included as a standard part of the Microsoft Office package and is available to all users of Excel/Access; however, review and debugging of VBA code requires knowledge of the coding language and its use in the specific application.

3.2.2.2 GoldSim

Another modeling platform with the capabilities for the probabilistic SDEIS modeling is the off-the-shelf software package GoldSim. GoldSim is a simulation engine that functions as a visual programming language, with objects linked graphically and equations written in a manner similar to Excel. GoldSim is as flexible as Excel, allowing users to create models ranging from mine water balances to factory throughput analyses to financial planning and risk analyses. GoldSim does not require knowledge of any programming language, and models can be reviewed, fully explored, and run with minimal specialized training through the free downloadable GoldSim Player.

In the GoldSim model framework, users define probability distributions for all uncertain and variable input parameters using the same input information as an Excel-based model. Because GoldSim is designed expressly for probabilistic simulation, it also functions as an efficient data-management tool for the output of large and complex models. GoldSim includes built-in features for compiling output statistics and generating graphical output, and allows selected data to be exported to other programs (e.g., Excel) for further analysis or presentation. GoldSim also includes the optional Contaminant Transport Module, which contains specialized tools to facilitate modeling of contaminant transport through engineered and natural systems.

3.2.2.3 Other Options

PolyMet and its consultants are not aware of any other probabilistic modeling platform with the visually programmed object-oriented configuration capability and ease of use for reviewers offered by GoldSim. Other modeling tools execute Monte Carlo simulations but they are not integrated into an overall package that provides ease of use (including review), transparency and features such as the Contaminate Transport Module that are designed for some of the specific systems that must be modeled for the Project.

3.2.3 Selection of Model Platform

GoldSim was selected for use for the SDEIS and FEIS water quality modeling for the following reasons:

- it met all of the essential model criteria identified for the Project (identified above)
- it is widely used in the industry for conducting water and chemical balances for mining applications
- it has the capability for internal documentation, organization and dimensional consistency (built-in unit conversions) that can minimize the potential for input error and aid model debugging and review
- it is object-oriented and graphical, which enables faster and more accurate model construction as well as easier model debugging and review
- it does not require knowledge of a particular programming language or purchase of a specific software product for reviewers
- it enables users and reviewers to examine intermediate results that may not be presented in the modeling summary report
- it includes tools for simulating contaminant transport and enforcing conservation of mass
- it is well-documented and the developers (GoldSim Technology Group) provide responsive and capable technical support

3.3 GoldSim Model Platform Overview

GoldSim Version 10.5, a product of GoldSim Technology Group is used to perform the probabilistic analysis of the Project water quality impacts. The software is designed as a simulation engine that functions as a visual programming language, allowing users to create models that address an infinite range of issues. Models are often time-dependent (i.e., have a specified duration and time step length), although they can also be fixed in time. The software does not require knowledge of any programming language, and models can be reviewed and explored with minimal specialized training.

In the GoldSim model framework, users define probability distributions for all uncertain and variable input parameters. The software includes a library of built-in distribution functions (normal, lognormal, beta, log-Pearson, etc.) and allows users to define custom distributions from available data. Correlation between uncertain parameters can be included, if necessary, to ensure that each simulation accurately reflects real-world conditions. Probability distributions can be sampled once per simulation (e.g., aquifer saturated hydraulic conductivity) or more frequently within a simulation, as appropriate (e.g., annual precipitation, sampled once per year).

GoldSim also includes the optional Contaminant Transport Module, which contains specialized tools to facilitate contaminant transport through engineered and natural systems. These tools

include definition of the characteristics of the contaminant "species" of concern and the fluid and solid media through which they are transported. The pathways through which contaminants move are represented by specialized model elements that solve the differential equations to define flow through mixing cells at each model time step. GoldSim contaminant transport elements can simulate the processes of precipitation and adsorption, and they enforce conservation of contaminant mass throughout the system. The contaminant transport features of GoldSim are used extensively in the water quality model of the Project to simulate the sources of constituent loading (waste rock stockpiles, tailings deposits, etc.), containment and treatment systems (stockpile liners, collection ponds, treatment facilities, etc.), groundwater transport (surficial and bedrock flow paths) and surface water transport (stream reaches and lakes).

The water quality model in GoldSim was run for a duration of 200 years using a monthly time step. The duration was chosen in order to capture the expected peak impacts to groundwater (a function of groundwater transport times) and the return towards steady-state conditions. Modeling will confirm whether this duration is sufficient for the systems in question. A monthly time step was chosen to ensure model stability for annually-changing values (e.g., stockpile rock mass), to capture intra-annual fluctuations in the pit and tailings basin water balances, and to allow simulation of the water quality in surface waters at any time of the year. Model output may be summarized by time step (e.g., average annual, maximum annual) as appropriate for evaluation relative to the determined impact criteria.

3.4 Model Scenarios

Mine Site water modeling includes two scenarios; the Continuation of Existing Conditions Scenario Model and the Project Model.

3.4.1 Continuation of Existing Conditions

The Continuation of Existing Conditions Scenario Model for the Mine Site represents future conditions at the Mine Site in the absence of the Project. At the Mine Site, this is equivalent to a model of existing conditions, with the additional assumption that the discharge from the Peter Mitchell Pit stops in approximately year 2070. The Continuation of Existing Conditions Scenario Model simulates many possible futures, rather than simulating specific periods of recent history that correspond to periods of observed water quality. Possible futures are simulated using distributions of input parameters such as precipitation and groundwater quality. Background watershed runoff quality parameters are calibrated to achieve model results similar to mean observed water quality, which is discussed further in Section 5.2.4.7.

3.4.2 Project Model

The Project Model adds Project features described in the Project Description (Reference (9)). Non-project related model inputs are identical to those used for the Continuation of Existing Conditions Scenario Model. The Project Model includes the Mine Pits, the waste rock stockpiles, and other mining infrastructure, along with engineering controls such the Category 1 Waste Rock Stockpile Groundwater Containment System, temporary stockpile liner systems to collect

stockpile drainage, the Category 1 Waste Rock Stockpile Cover to reduce infiltration, and the WWTF to treat Mine Site process water.

4.0 Baseline Data - Mine Site

4.1 Climate

The mean annual precipitation for the study area is 28.7 inches for the period 1981-2010, which corresponds is the climate normal period as defined by the Climate Prediction Center of the National Weather Service (NWS). This value is based on monthly NWS data collected closest to the Mine Site and Tailings Basin, retrieved using the Minnesota Climatology Working Group dataset (Reference (10)). Approximately 75% of the annual precipitation occurs between May and October, whereas approximately 9% of the annual precipitation corresponds to the water equivalent of snowfall between December and February.

The results of the statistical analysis of precipitation data representative of the long-term climatic conditions in the Partridge River watershed are presented in Appendix B of Reference (11). These results were used to confirm that periods of water quality monitoring in the study watershed included wet and dry weather/flow conditions; precipitation (rather than flow) is used as a proxy to determine wet and dry conditions because available flow data for the Partridge River (Section 4.4) do not necessarily cover the same periods of water quality monitoring.

The mean annual evaporation (from open water surfaces) for the study area was modeled as 20.0 inches in Reference (12). Pan evaporation measurements from Hoyt Lakes for the period 1966-1983 give no evaporation in the winter months, with a yearly total evaporation of 20.8 inches when a pan correction factor of 0.78 is used. No evaporation is considered during the winter. Results from the hydrologic/hydraulic model of the Partridge River watershed (Reference (12) and Reference (13)) indicate that the actual total evapotranspiration from the study watershed (including evaporation from open water surfaces) is 16.8 inches per year. This value is very similar to the mean evapotranspiration of 16 inches per year suggested by Reference (14).

4.2 Land Use

The Partridge River watershed is a mix of upland and marshland, with little development. Land use patterns were determined using 2001 National Land Cover Dataset, the National Wetlands Inventory dataset, and the U.S. Geological Survey (USGS) Gap Analysis Program dataset. The Partridge River watershed is dominated by upland forests (approximately 50%) and wetlands (approximately 40%). A detailed description of the available land use data sets for the Partridge River watershed is included in Reference (12).

4.3 Geology/Hydrogeology

4.3.1 Summary of Previous Hydrogeologic Investigations

Since 2005, a number of subsurface investigations have been conducted at the Mine Site to develop and refine the hydrogeologic and geologic models of the site. The following sections provide a chronological summary of the investigations, along with a brief discussion of the

objectives of each study and the work completed. The results of each study are not summarized in detail in these sections; however, relevant results from the studies are discussed and referenced as needed in the sections describing the site geology and hydrogeology.

4.3.1.1 Hydrogeologic Investigation – Phase I

The objectives of the Phase I investigation (conducted in March 2005) were to provide information regarding the ability of the Duluth Complex rocks and the unconsolidated deposits (glacial drift, mostly till) at the Mine Site to transmit water into the proposed NorthMet pits (i.e., the transmissivity of the units), to evaluate the quality of the groundwater within the Duluth Complex and the unconsolidated deposits at the Mine Site, and to conduct a preliminary evaluation of the geotechnical characteristics of the unconsolidated deposits (Reference (15)). Field activities for the Phase I investigation included advancing ten shallow rotasonic borings through the unconsolidated deposits to bedrock to characterize the material via visual inspection and aquifer performance testing. Three of the shallow borings were converted to permanent monitoring wells, aquifer tests were completed to obtain hydraulic conductivity estimates, and groundwater samples were collected. Temporary wells were installed in the remainder of the borings and aquifer tests were completed. Soil boring and monitoring well locations are shown on Large Figure 2 and boring logs are included in Attachment A. Soil samples were collected for geotechnical analysis from the borings located beneath or near the proposed waste rock stockpiles. In addition, aquifer performance tests were conducted in ten boreholes in the Duluth Complex. The locations of these boreholes are shown on Large Figure 2. Groundwater samples were also collected from two of these boreholes, as well as from the water supply well at the Mine Site, which penetrates the Duluth Complex and terminates in the Virginia Formation.

4.3.1.2 Hydrogeologic Investigation – Phase II

The objectives of the Phase II investigation (conducted in November 2005 – January 2006) were to provide information on the hydrogeologic characteristics of the Virginia Formation at the Mine Site and the chemical characteristics of the groundwater within the formation, because the Virginia Formation is anticipated to make up a portion of the north wall of the East Pit. Field activities included installing four pumping wells (P-1 through P-4) and six observation wells (Ob-1, Ob-2, Ob-3, Ob-3a, Ob-4, and Ob-5) targeting the Virginia Formation along the north boundary of the East Pit (Reference (16)). A number of these boreholes (Ob-1, Ob-2, Ob-3, Ob-3a, P-1, and P-2) also intersected and are open to portions of the Duluth Complex. With the exception of wells Ob-1 and Ob-2 (which were not used to develop estimates of hydraulic conductivity), the pumping and observation wells terminate in the Virginia Formation. The well locations are shown on Large Figure 2 and boring logs are included in Attachment A. At P-1, P-2, and P-4, the pumping phase of the aquifer tests had a duration of 36-hours. A 96-hour pumping test was completed at P-3. A groundwater sample was collected from each pumping well to assist in the evaluation of mine pit dewatering water quality.

4.3.1.3 Phase I Geotechnical Investigation

Golder Associates Inc. conducted a Phase I geotechnical investigation at the Site in April 2006 (Reference (17)). The purpose of the investigation was to evaluate soil conditions to support waste stockpile design recommendations. As part of this investigation, 15 test trenches were advanced, the characteristics of the unconsolidated deposits were logged, and samples were collected for analytical testing. The test trenches were excavated to depths ranging from 3.5 to 20 feet below ground surface and were terminated at bedrock or the maximum reach of the excavator. Trench locations are shown on Large Figure 2.

4.3.1.4 Hydrogeologic Investigation – Phase III

The objectives of the Phase III investigation (conducted October – November 2006) were to evaluate the possible effects of mine dewatering on the wetland areas in the vicinity of the Mine Site, to gather additional specific capacity data from wells completed in the Virginia Formation, and to gather additional water-quality data for groundwater within the unconsolidated deposits, the Virginia Formation, and the Duluth Complex (Reference (18)). The investigation consisted of conducting a 30 day pumping test in well P-2. Water levels during the pumping test were monitored in five wetland piezometers located north of the pumping well at distances ranging from approximately 150 to 1,500 feet (Large Figure 2). In addition, specific capacity tests were conducted at wells P-3 and P-4, which are open exclusively to the Virginia Formation. To isolate the upper portion of the borehole from the lower portion, a packer was installed approximately halfway down each borehole. Each test consisted of pumping the upper portion of the borehole at varying rates and monitoring water levels above and below the packer during the pumping and recovery phases of the test.

4.3.1.5 Overburden Geochemical Characterization Investigation

The objective of this investigation (conducted in January 2008) was to collect data to assist in geochemical characterization of the unconsolidated material at the Mine Site. Additional geotechnical data were also collected during this investigation (References (19), (20), (21), and (22)). Rotasonic and hand auger soil borings were completed at a total of 20 locations and were advanced into bedrock where possible. Boring locations are shown on Large Figure 2 and boring logs are included in Attachment A. Detailed soil logging was completed on the rotasonic core samples including lithologic identification of clastic material, pebble counts, and field rinsate testing. Additional detailed observations of the occurrence of mottles, discoloration, and secondary mineralization were also noted. The rotasonic cores were also sampled for geochemical analysis (Reference (6)).

4.3.1.6 Exploratory Borehole Sump Logging and Sampling

To collect additional geologic and geochemical data on unsaturated overburden, a total of seventeen sumps that were dug in March 2010 to contain drilling water used for exploration drilling were logged prior to their use (Reference (22)). Sump locations are shown on

Large Figure 2. Samples for geochemical analysis were collected from nine of the sumps. The samples were subjected to acid digestions and Meteoric Water Mobility Procedure testing in a similar fashion to the January 2008 samples.

4.3.1.7 Additional Monitoring Well Installation

The primary objective of additional monitoring well installation (conducted October 2011-February 2012) was to collect additional groundwater quality data at the Mine Site. The additional wells also provide information on vertical gradients and site geology. Field activities included advancing rotasonic borings through the unconsolidated deposits to bedrock at a total of 26 locations to characterize the surficial deposits via visual inspection. Monitoring wells were installed at 21 locations. Soil boring and monitoring well locations are shown on Large Figure 2 and boring logs are included in Attachment A. Groundwater samples were collected monthly from these monitoring wells following installation through August 2012. An additional round of groundwater samples was collected in October 2012 and groundwater sampling will be completed quarterly, with the exception of the winter (first) quarter.

4.3.1.8 Additional Field Activities

In addition to the investigations summarized above, a number of other field activities have been completed, including: collecting soil samples for analysis of site-specific sorption parameters, measuring groundwater elevations in numerous boreholes to evaluate groundwater flow directions, and periodic sampling of monitoring wells completed in the unconsolidated deposits and bedrock to collect background groundwater quality data. The sorption sampling locations and exploratory boreholes are shown on Large Figure 2.

4.3.2 Geology

The following section describes the geology in the Mine Site area, incorporating data collected during field investigations described above, as well as previously published material. The Mine Site area geology is described in further detail in Section 2 of Reference (9). A series of cross-sections have been developed based on the information from the field investigations described above and the top-of-bedrock surface developed using data from the exploration drilling program. Cross-section locations are shown on Large Figure 3 and the cross-sections are shown on Large Figure 4 through Large Figure 10. Due to the scale of these cross-sections and the large distances between borings, the lithology shown in the unconsolidated deposits has been generalized compared with the level of detail shown on the boring logs. The primary intent of these cross-sections is to illustrate the ground surface and top-of-bedrock topography, the thickness of the unconsolidated deposits, and the general nature of the lithologies present.

4.3.2.1 Unconsolidated Deposits

Glacial deposits in the Mesabi-Vermillion Iron Range region generally consist of four main till units and associated glaciofluvial sediments deposited during southwest advancements of the Rainy Lobe of the Laurentian ice sheet approximately 14,000 to 16,000 years ago, although

some of the till units may have been deposited during glacial activity occurring as early as 25,000 to 50,000 years ago (Reference (23)). Regionally, the four major till units include (in stratigraphic order from bottom to top): a basal unit, a bouldery till unit, a brown silty till unit, and a surficial till unit. The bouldery till unit is the dominant unit at the Mine Site with the possibility of surficial till identified near the western end of the site (Reference (24)). In a regional project covering the Iron Range at a scale of 1:100,000, Jennings and Reynolds (Reference (25)) classified the majority of the till deposits at the Mine Site as a generally unsorted sandy loam mixture with pebbles, cobbles, and boulders (Large Figure 11).

Based on data collected during site-specific investigations, the unconsolidated deposits across the Mine Site are relatively heterogeneous, ranging from very dense clay to well-sorted sand. Although predominantly sandy deposits have been encountered in various intervals in some borings, these deposits do not appear to be laterally extensive or continuous. On a local scale, the unconsolidated deposits are typically poorly sorted and contain numerous cobbles and boulders (Reference (15)) and can generally be classified as till, consistent with previously published interpretations of the glacial stratigraphy of the area (e.g., References (24), (23), and (25)). The unconsolidated material at the Mine Site area can generally be subdivided into two till units (the "lower till" and "upper till"), peat deposits in topographic lows, scattered topsoil and/or alluvium, and a clayey till unit that does not appear to be laterally continuous across the Site. The lower and upper till units are differentiated by color, stratigraphic sequence, and mineralogical differences of sand fractions. Based on drilling, geophysics, and outcrop mapping, the depth to bedrock across the property averages less than 14 feet, and ranges from 0 to 59 feet (Large Figure 12). The thickest unconsolidated deposits are generally associated with wetland areas, which tend to fill the pre-existing depressions in the bedrock.

4.3.2.2 Bedrock

The bedrock geology in the vicinity of the Mine Site is shown on Large Figure 13 (modified by PolyMet after References (26), (27), (28), and (29)). The NorthMet deposit is located in the Duluth Complex, a large mafic intrusion that was emplaced into flood basalts along a portion of the Middle Proterozoic Midcontinent Rift System (1.1 billion year old). The deposit is situated along the northwestern edge of the Complex within the Partridge River intrusion, which has been subdivided into a least seven igneous stratigraphic units in drill core. These units exhibit a shallow dip (10º-25º) to the south-southeast, which grossly parallels the dip of the underlying sedimentary units. Below the Duluth Complex at the Mine Site is the sedimentary Lower Proterozoic (1.8 billion year old) Virginia Formation, which, in turn, is underlain by the Biwabik Iron-Formation. The Biwabik Iron-Formation will not be intersected by mining; the Virginia Formation will be intersected only along the north wall of the East Pit.

Bedrock geology is relevant to the hydrological model mostly in terms of bedrock surface geometry, contact locations, unit relations, and nature of fractures. Data support for the geological model is high and is based on outcrop mapping, over 311,000 feet of exploration drilling in 395 drill holes, rock mass quality testing, about 40,000 multi-element assays, whole

rock chemistry, mineral analysis, and geophysics. Additional information on the bedrock at the Mine Site can be found in Reference (30).

4.3.3 Hydrogeology

4.3.3.1 Unconsolidated Deposits

Saturated conditions exist within the unconsolidated deposits at the Mine Site and the depth to groundwater is typically less than 10 feet. The water table is generally a subdued replica of the land surface, with groundwater divides in the area expected to roughly coincide with surface water divides. Recharge to the unconsolidated deposits occurs primarily via direct infiltration of precipitation.

Because of the thin nature of the surficial aquifer (Large Figure 12), groundwater flow paths are generally thought to be short. Shallow groundwater flow is also interrupted by bedrock outcrops, which force local deviations in the flow field (Reference (31)). Based on topography, bedrock surface relief, and groundwater elevation measurements in Mine Site monitoring wells, groundwater flow in the surficial aquifer is generally toward the Partridge River, which represents a sink for shallow groundwater flow (Large Figure 14). The bouldery till of the Rainy Lobe that covers the majority of the Mine Site has an estimated hydraulic conductivity range of 0.1 to 30 feet/day (Reference (31)). Lab permeameter tests on the silty sand from drill core and test trenches at the Mine Site found the hydraulic conductivity values to be 0.00043 to 0.0081 feet/day; note that these tests were specifically targeting low-permeability material and are not considered representative of the Mine Site deposits as a whole. Field testing of the various unconsolidated deposits found a range of hydraulic conductivity values from 0.012 to 31 feet/day (Reference (15)). Ultimately, the ability of the surficial aquifer to transmit water is proportional to the thickness of the sediments (References (32) and (31)).

Groundwater elevations measured at Mine Site monitoring wells are shown on Large Figure 15. Note that the vertical and horizontal scales vary for each of the individual plots shown on Large Figure 15. The magnitude of temporal groundwater elevation fluctuation varies by well across the Mine Site, but the overall range of water levels observed at a single well is typically less than four feet. In general, lower water levels are observed in winter and early spring, water levels rise in spring and early summer in response to snowmelt and rainfall, and then decline in late summer and fall.

The following three nested well pairs allow for an evaluation of vertical hydraulic gradients within the unconsolidated deposits: MW-6S/MW-6D (screened 1571.6 to 1561.6 feet MSL in sandy silt with gravel and 1559.5 to 1554.5 feet MSL in silty sand with gravel, respectively), MW-8S/MW-8D (screened 1604.8 to 1594.8 feet MSL in sandy silt and sand with silt and gravel and 1580.1 to 1575.1 feet MSL in sand with silt and gravel and silty gravel with sand, respectively), and MW-10S/MW-10D (screened 1547.2 to 1537.2 feet MSL in silty sand, clayey sand with silt, and silty sand with gravel and 1524.8 to 1519.8 feet MSL in silty sand with gravel, respectively). The groundwater elevations at each well pair and the calculated vertical hydraulic

gradients are shown on Large Figure 16. Note that the vertical scale varies for each plot shown on Large Figure 16. At MW-6S/6D, the vertical gradient is upward, with the exception of one set of measurements in November 2011, which indicated a downward gradient. The average magnitude of the upward gradient at MW-6S/6D is approximately 0.02 feet/feet. At MW-8S/8D, the vertical gradient has been primarily downward, with the exception of measurements in February 2011 and August 2011. The average magnitude of the downward gradient at this well nest is approximately 0.02 feet/feet. At MW-10S/10D, the vertical gradient is downward. MW-10S was dry from February through May 2012, so vertical gradients cannot be estimated for these months. The average vertical gradient at MW-10S/10D is approximately 0.1 feet/feet, nearly an order of magnitude larger than the gradients at the other nested wells. Although the water levels in MW-10S and MW-10D appear to follow similar trends, the large vertical hydraulic gradient between them suggests that the hydraulic connection between the upper and lower portions of the unconsolidated deposits in this area may be more limited than at the other well nests. A silty layer is located between the shallow and deep well screens at MW-10S/10D, which may act to restrict the vertical flow of groundwater in this area.

4.3.3.2 Bedrock

The bedrock units have low primary hydraulic conductivity and groundwater flow is primarily through fractures (i.e., secondary porosity features). The Biwabik Iron-Formation is generally considered to be the most permeable unit, with the Virginia Formation and Duluth Complex being less permeable (Reference (31)). Recharge to the bedrock is by infiltration of precipitation in outcrop areas and seepage from the overlying surficial aquifers (Reference (31)). Groundwater in the upper portions of the bedrock is thought to be hydraulically connected with the overlying surficial aquifers to some degree, resulting in similar flow directions. Groundwater elevation measurements from boreholes indicated that groundwater in the bedrock flows generally to the south, similar to the surficial aquifer (Reference (33)). Groundwater elevations measured in monitoring wells Ob-1 through Ob-5 indicate that the bedrock piezometric surface is typically present within a few feet of the bedrock-unconsolidated interface and is often located below the top of bedrock. A piezometric surface below the top of bedrock could indicate that either: (1) there is no saturated unconsolidated material (surficial aquifer) above the bedrock and the bedrock piezometric surface represents the water table or (2) that there may be an unsaturated zone between the surficial deposits and bedrock present in some portions of the site, which would suggest a minimal degree of hydraulic connection between the surficial aquifer and bedrock. Data collected during a 30-day pumping test at P-2 showed a small amount of drawdown in the nearest deep wetland piezometer, but no detectable drawdown at other water table or deep wetland piezometers, indicating that the connection between the bedrock and surficial aquifer may be relatively weak (Reference (18)). PolyMet geologists report that Duluth Complex bedrock is exceptionally competent and only rarely deeply fractured near surface (Section 2.11 of Reference (9)).

Aquifer tests were conducted at the Mine Site to evaluate the hydraulic properties of the Duluth Complex and the Virginia Formation. Four pumping tests were conducted in wells constructed within the Virginia Formation. The hydraulic conductivity values measured in these wells ranged

from 0.0024 to 1.0 feet/day, with a geometric mean of 0.17 feet/day (Reference (16)). Data from specific capacity tests conducted in Virginia Formation wells P-3 and P-4 indicate that the upper portion of the Virginia Formation is more permeable than the lower portion (Reference (18)). This is consistent with what has been reported for the Duluth Complex, where the upper 200 to 300 feet of the formation is reported to be more extensively fractured and jointed, potentially resulting in increased permeability (Reference (31)).

Single well aquifer tests were also conducted within ten exploratory boreholes completed within the Duluth Complex. Hydraulic conductivity values measured in these boreholes ranged from 0.00026 to 0.041 feet/day (Reference (16)). Five of the tests were conducted in boreholes near the contact with the Virginia Formation, where the hydraulic conductivity is believed to be affected by the characteristics of the contact. The five remaining tests were located south of the proposed mine pits, where the Virginia Formation contact is at a greater depth. While hydraulic conductivity estimates from borehole tests are scale-dependent (i.e., due to heterogenity of the fracture network, fracture flow to the borehole may be greater or less than fracture flow of the aquifer at a larger scale), the depth range of the Duluth Complex tested in the five boreholes further from the Virginia Formation contact was, for the most part, the entire thickness of the bedrock unit (4 out of 5 borings intersecting the top of the Virginia Formation). The Co-lead Agencies consider the results from these five tests to be more representative of conditions being evaluated in the GoldSim model (Reference (34)). Assuming the bedrock has a uniform hydraulic conductivity with depth, the geometric mean of the hydraulic conductivity from these five tests is 0.00046 feet/day. If it is assumed that the uppermost approximately 50 feet (or 15 meters) of bedrock transmit the majority of the water, then the geometric mean of the hydraulic conductivity from the five borehole tests would be 0.0075 feet/day.

4.3.4 Groundwater Quality

Groundwater quality at the Mine Site is assessed via a network of monitoring wells completed in the unconsolidated surficial aquifer and bedrock. The locations of the wells are shown on Large Figure 2. Three monitoring wells were installed in the surficial aquifer at the Mine Site in 2005 (Reference (15)) and were sampled occasionally from 2005 through 2011. Twenty-one additional wells were completed in the surficial aquifer between October 2011 and February 2012. A monthly groundwater sampling program for the surficial monitoring wells was initiated in November 2011 and continued through August 2012. Quarterly sampling began in October 2012 and data collected through October 2013 is referenced in this document. The Mine Site also contains nine monitoring wells completed in bedrock that have been sampled for groundwater quality characterization. Five observation wells (OB-1 through OB-5) were installed in the upper 100 feet of the bedrock and have been sampled at least eleven times each from 2006 through October 2013. Four larger diameter bedrock wells were completed to depths ranging from 485 to 610 feet below grade and were sampled during aquifer testing in 2005 and 2006. Finally, a water supply well completed in bedrock was sampled in 2005. Groundwater quality data at the Mine Site from wells in the surficial aquifer and bedrock are summarized in Large Table 3 and Large Table 4.

Laboratory analyses of the groundwater samples were performed either by Northeast Technical Services Inc., (NTS) (prior to March 2011) or by Pace Analytical (after March 2011) located in Virginia, Minnesota with the exception of methyl mercury, palladium, platinum, low-level mercury, and cyanide. When methyl mercury was not performed by NTS or Pace, analyses were completed by Frontier Geosciences, Inc. located in Seattle, Washington or ALS Environmental (formerly Columbia Analytical Services), located in Kelso, Washington. The palladium and platinum analyses were performed by Pace Analytical (Pace), located in Minneapolis, Minnesota or Braun Intertec Co., located in Minneapolis, Minnesota. The low-level mercury analyses were performed by NTS or Pace in Virginia, MN or Pace Minneapolis in 2011-2012. Minnesota Valley Testing Laboratories, located in New Ulm, Minnesota, or Pace Minneapolis performed the cyanide analyses.

4.3.4.1 Baseline Groundwater Quality

Groundwater quality statistics for the data set as a whole are presented in Large Table 5 (surficial aquifer) and Large Table 6 (bedrock). These tables contain the total number of samples analyzed for each constituent as well as the number of detected and non-detected results, the percent non-detects, and the minimum, maximum, and mean concentrations. The mean concentrations were calculated using parametric and non-parametric methods, depending on the number of detected values, using the statistical program ProUCL 4.1 (Reference (35)). Parametric statistics were calculated when a sample set contained all detected concentrations. When a sample set contained at least one non-detect concentration and more than six detected concentrations, non-parametric statistics were calculated. In these cases, a non-parametric Kaplan-Meier mean was calculated. If a sample set contained at least two samples and less than six detected concentrations, a parametric mean was calculated (with all values less than the reporting limit converted to zero). For these instances, using zero is more conservative than using the detection limit, ultimately resulting in a lower compliance target for performance monitoring. The statistics presented here are intended to facilitate data comparison and evaluation and are not necessarily the same statistics that are used to develop the distributions used in the GoldSim model.

In the following discussion, constituent concentrations are compared between the samples from wells screened in the surficial aquifer and the samples from the bedrock wells. They are also compared to potentially applicable water quality standards (Section 2.1).

4.3.4.1.1 Field and Physical Parameters

Field-measured parameters are indicated in Large Table 3 and Large Table 4. Water quality samples were collected with a pump. The pH, specific conductance, and dissolved oxygen (DO) were analyzed in the field using a flow-through cell attached to a multi-parameter water quality monitoring device (Hydrolab MS-5) prior to exposure to the atmosphere.

Measurements of pH in samples collected from wells screened in the surficial aquifer and those of samples from bedrock wells range from 4.9 to 10.4 and 5.6 to 10.4 standard units,

respectively. However, 83% and 74% of the groundwater samples from the surficial and bedrock wells have a pH between 6 and 8 standard units.

Specific conductance measurements from samples collected in wells screened in the surficial aquifer are very similar to samples collected from the bedrock wells, with mean values of 137.7 µmhos/cm and 155.2 µmhos/cm, respectively. The concentrations of total dissolved solids measured in samples collected from wells screened in the surficial aquifer are slightly higher than those in samples from the bedrock wells.

The concentration of DO in samples collected from wells completed in surficial aquifer and bedrock are similar, with means of 4.38 mg/L and 3.89 mg/L, respectively. Oxidation-reduction (redox) potential, a variable that reflects the oxidative state of groundwater (and that correlates with dissolved oxygen concentrations), also indicates little difference between groundwater in the surficial aquifer and the bedrock, with mean redox potential of 300.5 mV and 265 mV, respectively.

In the surficial aquifer, redox potential ranges widely from -196 to 712 mV, indicating variability in the redox state of shallow groundwater. High dissolved iron and manganese concentrations are generally associated with lower DO concentrations (between 0 and 5 mg/L, although low dissolved iron concentrations are associated with a wide range of DO concentrations). There are exceptions, however, in the case of manganese, with some of the highest dissolved manganese concentrations (>1000 µg/L) being associated with high DO concentrations (6-10 mg/L). The highest concentrations of dissolved iron and dissolved manganese in samples from wells screened in the surficial aquifer are associated with lower redox values (0-400 mV). The general relationships between dissolved iron and manganese with DO and redox reflects the redox sensitivity of these elements.

4.3.4.1.2 Major Ions

Major ions are generally present in groundwater in concentrations greater than 1 mg/L. The majority of samples from the Mine Site indicate Ca-HCO_3 as the dominant ions in groundwater. Calcium (the dominant cation) and potassium concentrations in samples collected from wells screened in the surficial aquifer are similar to concentrations in samples collected from the bedrock wells. Magnesium and sodium concentrations, however, are slightly higher in samples collected from wells screened in the bedrock than in the surficial aquifer, with mean concentrations of 9.26 mg/L and 6.82 mg/L, respectively (for magnesium), and 8.09 mg/L and 5.43 mg/L, respectively (for sodium). Similarly, chloride and fluoride concentrations were higher in the samples collected from wells screened in the bedrock than those screened in the surficial aquifer.

Total alkalinity is similar in the groundwater samples collected from wells in the surficial aquifer and the bedrock. Given the dominant Ca-HCO_3 present in most of these samples, and the generally circumneutral pH measured in these samples, the bicarbonate ion likely makes up most of the alkalinity in groundwater.

Sulfate concentrations were higher in samples collected from the wells screened in the bedrock than samples collected from wells screened in the surficial aquifer, with mean concentrations of 45.7 mg/L and 9.1 mg/L, respectively. The highest concentration of sulfate (1200 mg/L) was detected at P-1 (a well completed in the bedrock) on 1/5/2006. The second highest concentration of sulfate was detected in a well screened in the surficial material (104 mg/L at MW-13 on 10/21/2013). If the 1200 mg/L sample is not included in the mean, the mean sulfate concentration in samples from the bedrock wells is 18.3 mg/L, still higher than the mean concentration collected from wells screened in the surficial aquifer (9.1 mg/L). At P-1, both the Duluth Complex and Virginia Formation bedrock were intersected. Due to the drilling methods used (air rotary), detailed stratigraphic and mineralogical information are not available for the wells. Therefore, it is difficult to isolate the specific factors that might lead to the elevated sulfate at P-1, but it may be related to localized mineralogy of the bedrock. The USEPA sMCL for sulfate in groundwater is 250 mg/L; the sample from P-1 on 1/5/2006 is the only groundwater sample that exceeded the standard.

4.3.4.1.3 Trace Constituents

Trace constituents are normally present in groundwater in concentrations less than 1 mg/L. Select constituents are discussed here, generally in order of relative abundance.

Iron

Dissolved iron concentrations in samples collected from wells screened in the surficial aquifer were slightly higher than those in samples from the bedrock wells, but total iron concentrations are generally similar between the two populations. In general, mean total iron concentrations were almost an order of magnitude higher than dissolved iron concentrations in the groundwater samples (Large Table 5and Large Table 6). These differences are likely due to field filtration of the dissolved metals samples, and indicate that iron may be present as suspended solid in the groundwater samples. The USEPA sMCL for iron in groundwater is 0.3 mg/L; dissolved iron samples collected from the surficial aquifer and the bedrock exceeded this standard 30.2% and 32.0% of the time, respectively, whereas total iron samples exceeded this standard 81.5% and 73.5% of the time, respectively. The maximum dissolved concentrations were 25.6 mg/L and 3.2 mg/L for wells screened in the surficial aquifer and the bedrock, respectively, and the maximum total concentrations were 44.4 mg/L and 44.3 mg/L for wells screened in the surficial aquifer and the bedrock, respectively. It is important to note that for wells screened in the surficial aquifer, total iron concentrations were analyzed on samples collected only from MW-05-02, MW-05-08, and MW-05-09. As discussed above, iron concentrations are likely strongly controlled by the redox state of groundwater.

Aluminum

Dissolved aluminum concentrations in samples collected from wells screened in the surficial aquifer were similar to those from bedrock wells, with mean concentrations of 0.07 and 0.05 mg/L, respectively. However, total aluminum concentrations were almost an order of magnitude higher in samples collected from wells screened in the surficial aquifer compared to those

collected from the bedrock wells. In samples from the surficial wells, the mean dissolved aluminum concentration is 0.07 mg/L, but the mean total aluminum concentration is 5.75 mg/L, nearly two orders of magnitude greater (Large Table 5 and Large Table 6). Like iron, this difference indicates that aluminum may be present as suspended solid in the unfiltered groundwater samples. The USEPA sMCL for aluminum in groundwater is 0.05-0.2 mg/L. In the wells screened in the surficial aquifer, 28.1% of the dissolved samples and 96.3% of the total samples exceeded the standard of 0.05mg/L and 10.0% of the dissolved samples and 81.5% of the total samples exceeded the 0.2 mg/L standard. As for the wells screened in the bedrock, 10.2% of the dissolved samples and 61.2% of the total samples exceeded the standard of 0.05mg/L and none of the dissolved samples and 40.8% of the total samples exceeded the 0.2 mg/L standard. The maximum dissolved concentrations were 0.9 mg/L and 0.1 mg/L for wells screened in the surficial aquifer and the bedrock, respectively, and the maximum total concentrations were 32.3 mg/L and 6.9 mg/L for wells screened in the surficial aquifer and the bedrock, respectively. It is important to note that for wells screened in the surficial aquifer, total aluminum concentrations were analyzed on samples collected only from MW-05-02, MW-05-08, and MW-05-09.

Manganese

Total and dissolved manganese concentrations in samples collected from wells screened in the surficial aquifer were slightly higher than those in samples from the bedrock wells. The MDH HRL and USEPA sMCL for manganese in groundwater are 0.1 mg/L and 0.05 mg/L, respectively. The HRL was exceeded in 49.5% of the dissolved and 59.3% of the total samples collected from wells screened in the surficial aquifer and 40% of the dissolved and 40.8% of the total samples collected from wells screened in the bedrock. The sMCL was exceeded in 64.3% of the dissolved and 81.5% of the total samples collected from wells screened in the surficial aquifer and 40.0% of the dissolved and 51.3% of the total samples collected from wells screened in the bedrock. The maximum dissolved concentrations were 3.3 mg/L and 0.2 mg/L for wells screened in the surficial aquifer and the bedrock, respectively, and the maximum total concentrations were 1.8 mg/L and 0.4 mg/L for wells screened in the surficial aquifer and the bedrock, respectively. It is important to note that for wells screened in the surficial aquifer, total manganese concentrations were analyzed on samples collected only from MW-05-02, MW-05-08, and MW-05-09. As discussed above, manganese concentrations may be controlled by the redox state of groundwater.

Copper

Dissolved and total copper concentrations in groundwater sampled from wells screened in the surficial aquifer are similar to those in groundwater sampled from the bedrock wells. Mean total copper concentrations are an order of magnitude higher than dissolved copper concentrations (Large Table 5and Large Table 6). Similar to iron and aluminum, this difference may be due to the presence of copper associated with suspended solids in the groundwater samples. The USEPA sMCL for copper in groundwater is 1 mg/L; none of the copper samples exceeded this standard. The spatial distribution of dissolved copper is displayed in Large Figure 17.

Nickel

The mean dissolved nickel concentration in samples collected from wells screened in the surficial aquifer is approximately an order of magnitude lower than that in samples collected from the bedrock wells. Total nickel concentrations in samples collected from wells in the surficial aquifer were also slightly lower than those in samples collected from the bedrock wells. Similar to iron and aluminum, dissolved nickel samples are an order of magnitude smaller than total nickel in wells screened in the surficial aquifer (Large Table 5and Large Table 6), which may be due to the presence of nickel associated with suspended solids in the groundwater samples. The MDH HRL for nickel in groundwater is 0.1 mg/L; none of the nickel samples from the surficial wells exceeded the standard, however 14.3% of dissolved and 18.4% of the total nickel samples collected in the bedrock do exceed the standard. The spatial distribution of dissolved nickel is displayed in Large Figure 18.

Beryllium

Beryllium was rarely detected in the groundwater samples. Beryllium concentrations in samples collected from wells screened in the surficial aquifer were, on average, an order of magnitude higher than those in samples from the bedrock wells. None of the beryllium samples collected exceeds the USEPA MCL (0.004 mg/L); however, the reporting limit for beryllium in these samples exceeds the MDH HRL (0.00008 mg/L).

Thallium

Thallium was detected in concentrations exceeding the laboratory's reporting limit in 5%of the samples from wells screened in the surficial aquifer and never in samples from the bedrock wells. The reporting limit of thallium can be as high as 0.002 mg/L in this data set, equal to the USEPA MCL (0.002 mg/L), and exceeding the MDH HRL (0.0006 mg/L).

4.3.4.1.4 Comparison to Regional Data

In general, the results of water quality monitoring at the Mine Site are consistent with the conclusions of the regional Copper-Nickel Study, a study of regional hydrology and water quality (Reference (31), data presented in Large Table 7) and the MPCA baseline water quality assessment developed by the Ground Water Monitoring and Assessment Program (GWMAP) (Reference (36), data presented in Large Table 8). One of the objectives of the Copper-Nickel Study was to evaluate the chemical quality of groundwater for use as baseline data in the evaluation of impacts associated with the development of a mine within the study region. The objectives of the groundwater data collection discussed above are similar, with respect specifically to the Mine Site.

The Copper-Nickel study found that water within the glacial till is moderately hard to very hard, with mean values of major dissolved constituents higher than those observed in sand and gravel deposits in the region. It was also demonstrated that iron is occasionally observed at anomalously high concentrations, most likely related to reducing conditions in the aquifer system. Similarly, the results of sampling and analysis of groundwater at the Mine Site indicates that groundwater

in the surficial aquifer and the shallow bedrock is circumneutral, moderately hard, calcium-bicarbonate water, with less than 250 mg/L total dissolved solids. Common trace constituents in the groundwater include iron, aluminum, manganese, copper, nickel, cobalt, chromium, and arsenic. Redox appears to play an important role in controlling the concentrations of several trace constituents, such as iron and/or manganese. Cadmium, lead, beryllium, vanadium, selenium, boron, thallium, and zinc were rarely detected in the groundwater samples. Concentrations of several of these constituents, including aluminum, beryllium, iron, manganese, nickel, sulfate (in bedrock only), and thallium exceed potentially applicable water quality standards promulgated by federal and state agencies.

The Copper-Nickel study found that concentrations of copper and nickel in water from the surficial aquifer are higher near the contact between the Duluth Complex and the underlying formations. At the Mine Site, groundwater quality appears to be spatially variable. In general, the monitoring stations for the NorthMet Mine Site are all located in the general area of higher copper and nickel concentrations identified by the Copper-Nickel study.

The GWMAP, which developed baseline water quality for the surficial quaternary water table aquifer in the Northeast Region, indicates that the quality of shallow groundwater within the crystalline bedrock reflects groundwater interaction with the overlying unsaturated zone and buried drift aquifers. At the Mine Site, the groundwater quality within the shallow bedrock is similar to that in the overlying unconsolidated surficial deposits at the Mine Site, consistent with that finding.

4.3.4.2 Site-Specific Evaluation Criteria

Natural background (un-impacted) groundwater concentrations of beryllium, manganese, and thallium at the Mine Site are greater than the applicable groundwater standards (Section 2.1 for a summary of the applicable standards). Groundwater standards include primary and secondary drinking water standards and the HRL. Minnesota Rules, part 7060.0600, subpart 8 states that "where the background level of natural origin is reasonably definable and is higher than the accepted standard for potable water and the hydrology and extent of the aquifer are known, the natural level may be used as the standard."

The same data set that is used to define natural background water quality for use in the water quality impact modeling (Section 5.2.3.8) is used to develop site-specific evaluation criteria for use in the environmental review process.

The MPCA, the agency responsible for regulating groundwater quality, does not have a standard method for defining a site-specific groundwater standard based on natural background concentrations. Upper Prediction Limits (UPLs) or Upper Tolerance Limits (UTLs) are commonly used to develop compliance limits, or not-to-exceed values, in federally-lead programs (Reference (35)). USEPA guidance on the statistical analysis of environmental data recommends using the 95% UPL for developing not-to-exceed values, such as natural background concentrations. The 95% UPL is used for the analysis presented here when there is

sufficient detected data. For datasets with left-censored data (non-detects), the Kaplan-Meier (KM) method is used for the calculation of the 95% UPL. The ProUCL guidance documents recommend using the Kaplan Meier method for datasets with left-censored data, particularly if it is highly skewed. When there are limited data or few detected concentrations, the first or second highest measured concentration (depending on number of samples and number of detected values) is recommended as an appropriate background concentration (Reference (37)).

The background data for each constituent and location are presented below, along with the statistical measures of 95% UPL and the second highest concentration.

4.3.4.2.1 Beryllium

At the Mine Site, 320 background beryllium groundwater samples were collected from the surficial aquifer and 49 samples were collected from the bedrock. Of the samples from the surficial aquifer, 295 (92%) were recorded below the detection limit with 25 detected concentrations as shown in Figure 4-1. For samples from the bedrock, 46 (94%) were recorded below the detection limit with only three detected concentrations, as shown in Figure 4-2.

Although there are a high percentage of non-detected concentrations for the surficial aquifer samples, the ProUCL Guidance indicates there are a sufficient number of detected concentrations to use non-parametric methods to calculate background statistics (page 124 of Reference (35)). The non-parametric estimate of the 95% UPL using the KM method is presented in Table 4-1. The 95% UPL, 0.39 µg/L, is used as the beryllium evaluation criterion for the surficial aquifer at the Mine Site.

Table 4-1 Summary Statistics for Background Beryllium Concentrations in the Surficial Aquifer at the Mine Site

	Second Highest Detected Concentration	95% UPL
Total Beryllium, Surficial Aquifer (µg/L)	0.84	0.39

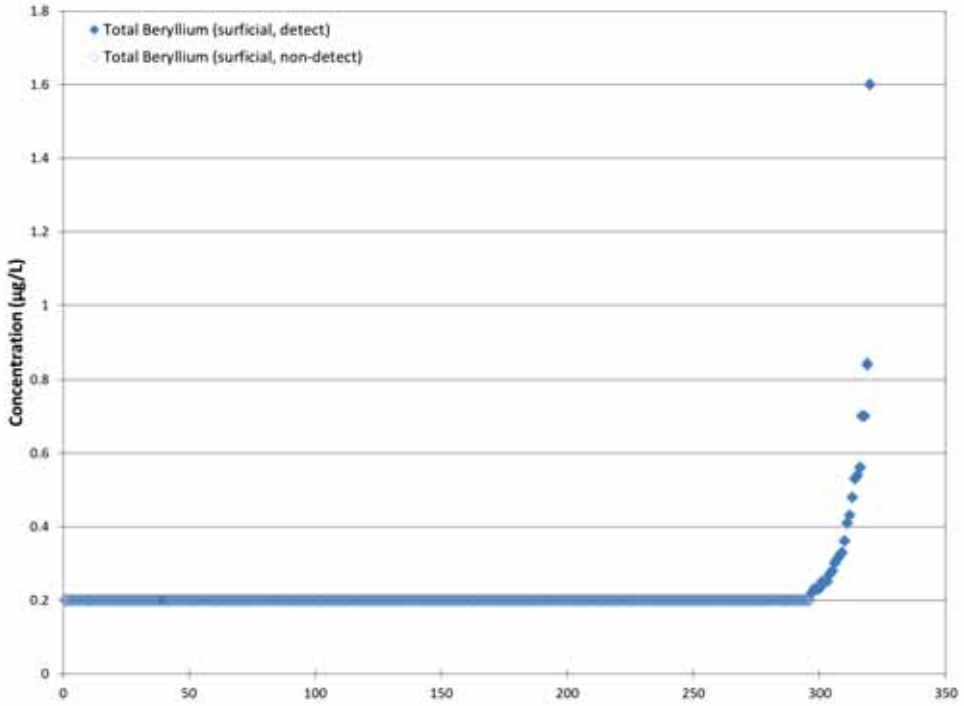


Figure 4-1 Background Total Beryllium Concentrations Measured in the Mine Site Surficial Aquifer (Non-detects Plotted at the Detection Limit)

Because there are only three bedrock samples with detected beryllium concentrations and two of the detected concentrations were at the detection limit of 0.2 µg/L (Figure 4-2), the detection limit of 0.2 µg/L is used as the beryllium evaluation criterion for the bedrock at the Mine Site.

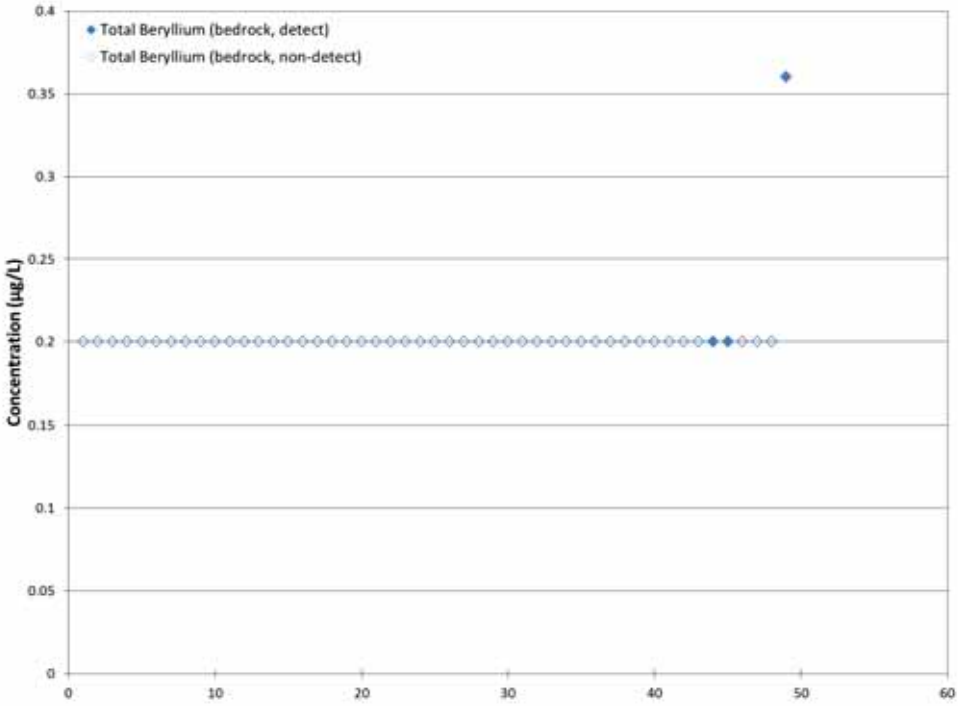


Figure 4-2 Background Total Beryllium Concentrations Measured in the Mine Site Bedrock (Non-detects Plotted at the Detection Limit)

4.3.4.2.2 Manganese

At the Mine Site, 311 background manganese groundwater samples were collected from the surficial aquifer and 49 background manganese samples were collected from the bedrock. Of the samples from the surficial aquifer, five (2%) were recorded below the detection limit and 306 (98%) samples had detected concentrations (Figure 4-3), whereas of the bedrock samples, three (6%) were recorded below the detection limit and 46 (94%) samples had detected concentrations (Figure 4-4).

Because the surficial aquifer data did not follow a normal distribution (based on Shapiro-Wilk tests at a 5% significance level, and seen in Figure 4-3 by the non-linear shape of the graph), non-parametric methods were used to compute the background statistics. The second highest detected value and the non-parametric estimate of the 95% UPL using the KM method are shown in Table 4-2. The 95% UPL, 1002 µg/L, is used as the dissolved manganese evaluation criterion for the surficial aquifer samples at the Mine Site.

Table 4-2 Summary Statistics for Background Manganese Concentrations at the Mine Site

	Second Highest Detected Concentration	95% UPL
Dissolved Manganese, Surficial Aquifer (µg/L)	2400	1002
Total Manganese, Bedrock (µg/L)	366	307

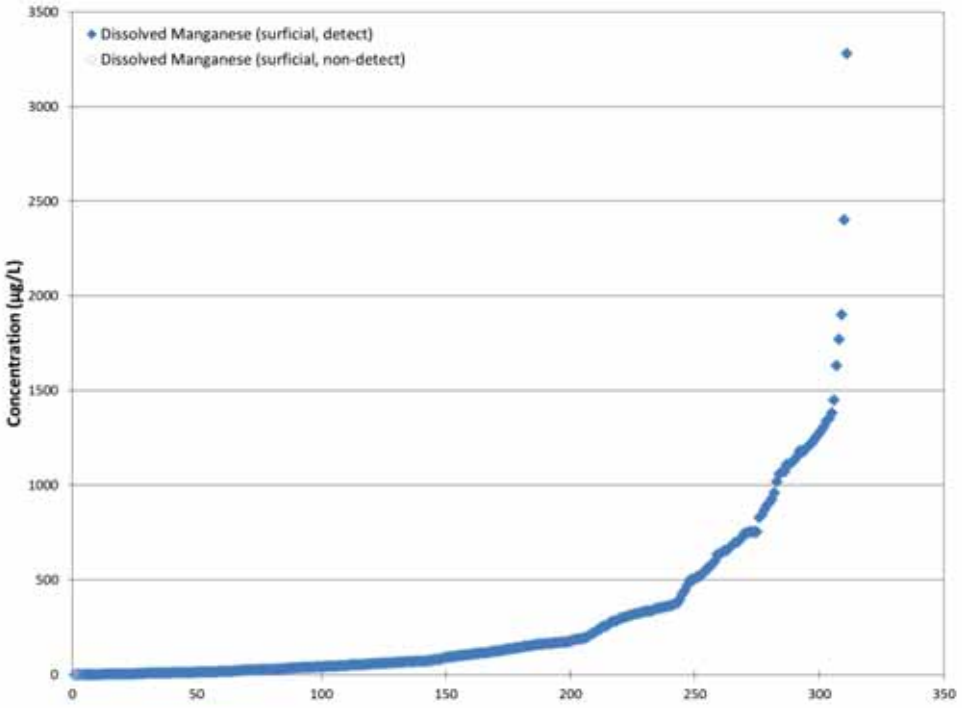


Figure 4-3 Background Dissolved Manganese Concentrations Measured in the Mine Site Surficial Aquifer (Non-detects Plotted at the Detection Limit)

For the bedrock samples, non-parametric methods were used to compute the background statistics because the data does not follow a normal distribution (based on Shapiro-Wilk tests at a 5% significance level, and as can be seen in Figure 4-4 by the non-linear shape of the graph). The second highest detected value and the nonparametric estimates of the 95% UPL using the KM method are shown in Table 4-2. The 95% UPL (307 µg/L), is used as the total manganese evaluation criterion for the bedrock at the Mine Site.

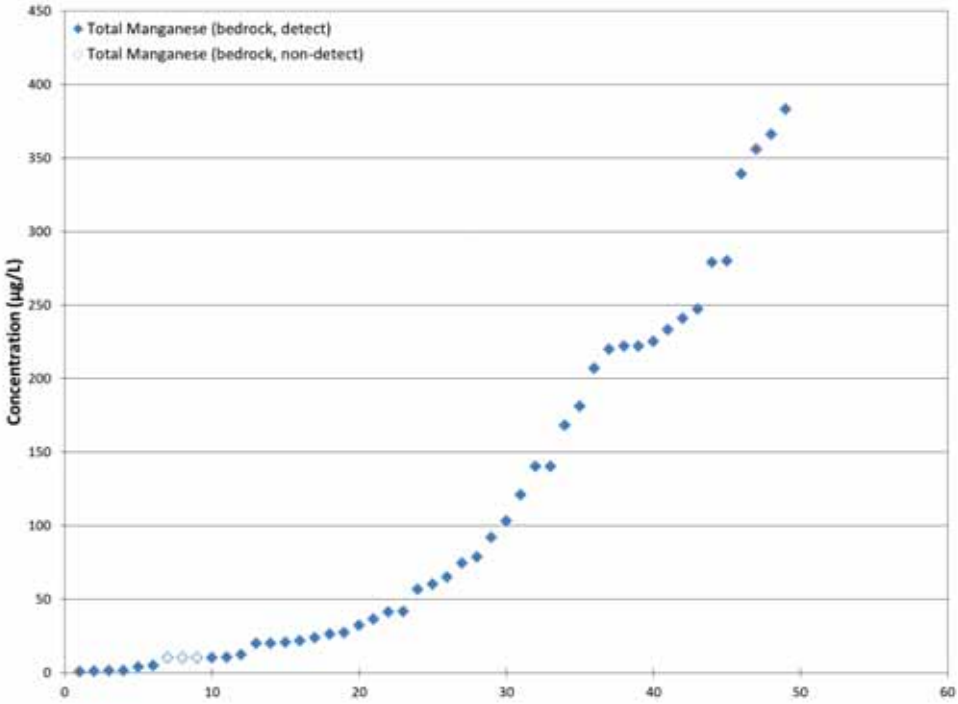


Figure 4-4 Background Total Manganese Concentrations Measured in the Mine Site Bedrock (Non-detects Plotted at the Detection Limit)

4.3.4.2.3 Thallium

At the Mine Site, 49 background thallium samples were collected from the bedrock, all of which measured below the detection limit, which ranged from 2.0 to 0.2 µg/L (Figure 4-5). With no detected concentrations, it is not advisable to perform parametric statistical analysis of the data (Reference (37)). The highest and second highest detection limits were 2.0 µg/L. Given the high percent of non-detected concentrations one half of the highest detection limit is used as the thallium evaluation criterion (i.e., natural background level) for the bedrock at the Mine Site.

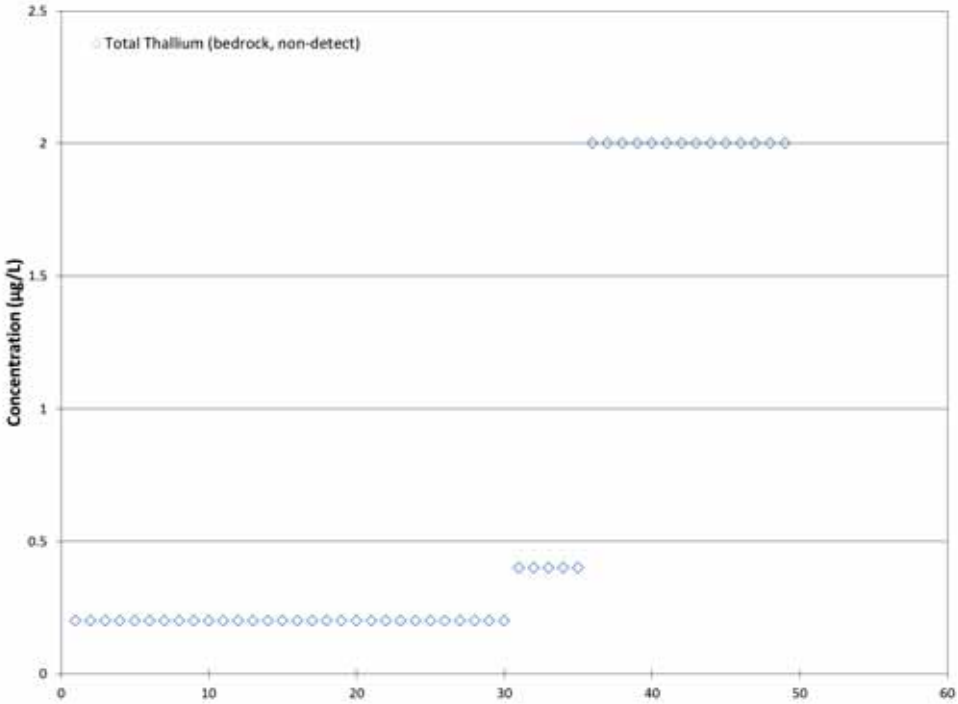


Figure 4-5 Background Total Thallium Concentrations Measured in the Mine Site Bedrock (Non-detects Plotted at the Detection Limit)

4.3.4.3 Data Validation and Reduction

Field and laboratory groundwater quality data were subjected to a series of quality assurance and quality control (QA/QC) procedures, several tests of reliability, and ongoing analysis of intra-well temporal variability.

4.3.4.3.1 Quality Assurance/Quality Control (QA/QC) Review

QA/QC procedures were generally performed on the laboratory analytical results for the sampling events from 2005 through 2007 and 2009 through 2013. The QA/QC procedures were performed in accordance with The National Functional Guidelines for Inorganic and Organic Data Review (Reference (38) and Reference (39)). In general, the QA/QC procedures address USEPA recommended holding times and preservation, blank sample analyses, accuracy data, precision data, and an overall assessment of data quality.

Technical holding times were evaluated for each sample and target parameter, based on the USEPA recommendations listed in 40 CFR SW846 Test Methods for Evaluating Hazardous Waste (Reference (40)). The technical holding times were met for the samples submitted to the laboratories during these sample events with the exceptions qualified (h) as estimated concentrations based on holding time exceedances in Large Table 3 and Large Table 4.

Blank evaluation was conducted to determine the existence and magnitude of target analyte contamination as a result of activities in the field during collection and transport, or from inter-laboratory sources. Analyte concentration detections in laboratory, field or trip blank samples were compared against project sample analyte concentrations. Any sample concentration within five times of the blank sample detection concentrations was qualified (b) in the data summary tables and the database, and should be considered a potential false positive concentration.

The accuracy and precision data review included evaluation of laboratory control spike (LCS), laboratory control spike duplicate (LCSD), matrix spike (MS), matrix spike duplicate (MSD), and duplicate sample data. Accuracy was evaluated by comparing laboratory percent recoveries from LCS, LCSD, MS, and MSD samples to laboratory acceptance criteria. Precision was evaluated by calculating the relative percent difference (RPD) of the LCS/LCSD sample pairs, MS/MSD sample pairs, and duplicate samples. The RPD formula is as follows:

$$RPD = \frac{D_1 - D_2}{(D_1 + D_2)/2} \times 100$$ **Equation 4-1**

Where:

D_1 = concentration of the sample
D2 = concentration of the duplicate sample

An LCS is a sample of analyte-free media spiked with known concentrations of the target analyte that is carried through the same sample preparation and analytical procedures as the project samples. LCS recoveries are used to estimate overall analytical method accuracy independent of sample matrix effects. Review of the LCS/LCSD sample pairs indicated the following:

- In 2005, one or more sample pairs had lower recoveries than the laboratory acceptance criteria. This affected monitoring well samples MW-05-02, MW-05-08, and MW-05-09 for molybdenum, and these results are (*) qualified as estimated values (Large Table 3).

- The total zinc pairs analyzed for the 3/17/2009 data did not meet the laboratory acceptance criteria, and are (*) qualified as estimated values (Large Table 3).

A matrix spike is a project sample spiked with a known concentration of the target analyte that is carried through the sample preparation and analysis procedures in order to assess the accuracy of a method in a given sample matrix. Review of the MS/MSD sample pairs indicated there were percent recoveries and/or RPD for one or more MS/MSD samples that exceeded the laboratory limits for multiple target parameters. The associated project sample data whose MS/MSD percent recoveries and/or RPD exceeded the laboratory acceptance criteria for accuracy, generally, by 5% or more, were (*) qualified (Large Table 3).

Laboratory duplicate samples were evaluated, when required, and the RPD for alkalinity (total as $CaCO_3$) in sample MW-7 (8/20/2012) exceeded laboratory criteria and was qualified as estimated (*) (Large Table 3).

A field duplicate sample was collected over the course of these sampling events approximately once every day. Field duplicate sample pairs with calculated RPDs greater than 30% are qualified as estimated concentrations (*). This affected multiple field duplicate sample pairs for metals and general parameters. The RPD exceedances were not qualified if the parameter concentrations were at or near the reporting limit, which exaggerates the RPD value, and is not necessarily indicative of poor precision.

The laboratory (Pace) noted in 2013 the instances when, during the analysis of 5-day biological oxygen demand for the bedrock wells, the oxygen usage was less than 2.0 for all dilutions set for a particular sample. The reported value was calculated from the dilution using the largest amount of sample and is considered an estimated “less than” value and was qualified (*).

The groundwater data met the Project requirements and is deemed acceptable for the purposes of this Project with the above mentioned qualifications. Qualified data were used in the calculations presented in this document except as noted in Section 4.3.4.3.2.

4.3.4.3.2 Outlier Identification

Consultation with the co-lead agencies included assessment of the adequacy of the number of samples in the groundwater quality data set needed for modeling certain water quality parameters (Reference (41)). During this assessment, it was determined that the size of the standard deviations for the aluminum and chloride data sets, relative to their respective means, indicated that the presence of outliers may be skewing the standard deviations. Based on visual analysis and comparison with other wells, two samples collected from MW-18 and one sample from MW-2 were flagged as potential outliers (“BQS”) and are not used in developing distributions of background groundwater quality (Section 5.2.3.8).

4.4 Partridge River Watershed

The Mine Site is located within the Partridge River watershed approximately 17 river miles upstream of Colby Lake (Large Figure 19). Creeks and streams tributary to the Partridge River above Colby Lake include Wetlegs Creek, Colvin Creek, Longnose Creek, Yelp Creek, Wyman Creek, Stubble Creek, and the South Branch of the Partridge River.

Above Colby Lake, the Partridge River watershed covers approximately 103 square miles (including portions of the Peter Mitchell Pits). Construction of the Peter Mitchell Pit reduced the drainage area of the Partridge River above Colby Lake by approximately 6 square miles (Large Figure 19) and resulted in pit dewatering discharge to the headwaters of the Partridge River (Section 4.4.1.2).

The Partridge River watershed upstream of Colby Lake was divided into 75 subwatersheds for the purposes of hydrologic modeling (Section 5.2.4.3 and Large Figure 20). Delineation of the subwatersheds was based on a preliminary version of the Minnesota Lake Watershed Delineation (Lakeshed) Project delineation of the St. Louis River watershed. These watersheds were delineated by MDNR staff using custom software developed in ESRI ArcView 3.3 and ESRI ArcInfo, on a hydrologically corrected DEM. The Lakeshed Project watersheds were further subdivided at the approximate location of culverts and bridges, confluence of streams, and within the Mine Site boundary. Detailed sub-watersheds within the Mine Site boundary were derived using watershed delineation tools in the ESRI ArcMap 9.1 Spatial Analyst extension and the DEM referred to in Reference (12). The two sets of sub-watersheds were combined manually using ESRI ArcMap software. Subwatershed delineations were also visually inspected.

4.4.1 Hydrology

Daily flow data is available for the Partridge River from USGS gage 04015475 – Partridge River above Colby Lake at Hoyt Lakes, Minnesota (Large Figure 19). The period of record includes water years 1979 through 1988 (i.e., October 1, 1978 through September 30, 1988). During this period, hydrology was affected by periodic and variable dewatering of the Peter Mitchell Pits located at the headwaters of the Partridge River. Flow statistics characterizing the hydrology of the Partridge River (Section 6.4.1) were calculated for the observed flows (Table 4-3).

Table 4-3 Hydrologic Statistics Calculated for the Partridge River (USGS Gage 04015475)

Statistic (cfs)	Water Year										
	1979-1988	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Annual Daily Mean	87.7	107.2	47.8	78.4	100.1	110.8	101.3	94.6	101.3	83.9	51.2
October Mean	124.4	36.9	34.1	81.1	138.3	330.6	242.8	63.9	211.4	83.4	22.0
November Mean	63.2	23.5	75.2	43.2	44.0	195.5	87.2	36.4	45.6	64.1	17.1
December Mean	20.3	17.1	15.1	10.8	12.8	39.4	39.6	16.2	21.5	22.1	8.2
January Mean	7.5	2.1	5.2	2.5	4.9	14.5	19.2	2.6	9.4	11.8	3.1
February Mean	6.4	1.3	1.9	3.4	3.3	13.4	21.6	1.6	6.7	8.9	1.5
March Mean	15.9	8.8	1.8	18.7	3.7	25.1	23.8	10.7	9.1	54.7	2.2
April Mean	241.6	454.0	146.4	377.6	236.1	194.5	297.7	161.5	326.7	85.2	136.5
May Mean	219.7	397.4	46.3	198.4	345.6	168.6	196.9	182.7	247.7	264.3	148.9

Statistic (cfs)	Water Year										
	1979-1988	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
June Mean	104.6	198.6	38.4	109.1	48.2	98.7	183.4	222.3	75.8	56.8	14.8
July Mean	103.6	42.0	9.8	73.5	163.8	118.3	69.4	218.5	81.6	254.5	4.4
August Mean	55.4	40.4	14.7	18.4	89.0	67.0	19.1	45.8	51.2	30.9	177.9
September Mean	86.9	64.2	190.3	4.2	103.6	58.2	16.1	170.8	125.3	60.2	76.3
Annual Max 1-day Mean	1960	1960	312	600	602	775	613	635	628	874	480
Annual Max 3-day Mean	1840	1840	301	595	582	767	595	616	603	839	462
Annual Max 7-day Mean	1446	1446	274	572	523	709	535	515	508	749	390
Annual Max 30-day Mean	710	710	190	422	458	340	329	278	357	300	215
Annual Max 90-day Mean	362	362	104	231	243	214	229	245	219	200	102
Annual Min 1-day Mean	0.54	1.30	1.60	0.96	2.70	6.50	6.60	1.50	6.50	8.00	0.54
Annual Min 3-day Mean	0.65	1.30	1.60	0.97	2.73	7.33	6.97	1.50	6.50	8.03	0.65
Annual Min 7-day Mean	0.79	1.30	1.60	1.07	2.74	9.60	8.63	1.50	6.50	8.17	0.79
Annual Min 30-day Mean	1.21	1.32	1.60	1.55	2.90	13.27	12.54	1.56	6.50	8.74	1.21
Annual Min 90-day Mean	2.23	2.96	2.95	3.70	4.00	17.08	20.30	3.48	7.94	12.84	2.23

4.4.1.1 Validation of Partridge River gage data relative to climate normal period

Data from USGS gage 04015475 – Partridge River above Colby Lake exists for water years 1979 through 1988. While this data is over twenty years old, the following analysis will examine climate trends and flow in a similar watershed to demonstrate the data is applicable to the present

climate normal period and appropriate for assessing potential Project impacts. This section will present information demonstrating:

- the Partridge River and Kawishiwi River watersheds are similar with regard to expected flow response associated with climate variation
- the Partridge River and Kawishiwi River watersheds have experienced similar climate for the last two climate normal periods and the time when USGS gage 04015475 was active
- the Kawishiwi River flow expressed as average annual and minimum 30-day average did not change for the above periods

The logical conclusion of the above is that, with regard to climate change, 1979-1988 Partridge River gage data can be used to represent current flow in the Partridge River.

4.4.1.1.1 Existing Data Limitations

The USGS gage 04015475 – Partridge River above Colby Lake was maintained from September 1978 through October 1988. There is no continuous flow data within the Partridge River watershed from more recent periods that is directly comparable to the historical data at USGS gage 04014575. The MDNR established a continuous flow gage (MDNR gage H03155002) at monitoring location PM-3/SW003 in 2011 (see Large Figure 19). Data collected at MDNR gage H03155002 is not directly comparable to the historical USGS data due to the distance between the gages, and therefore the large difference in tributary areas. The evaluation of Partridge River baseflow described in Section 4.4.1.3.2. Point (i.e., non-continuous) flow data was collected during water quality sampling on the Partridge River in 2004-2010. Point flow data is not sufficient to draw comparisons between recent and historical hydrologic patterns because the point measurements do not encompass all the potential variability in flows.

The Kawishiwi River near Ely (USGS gage 05124480) has a dataset extending from 1966 to the present and is unaffected by mining or any other non-natural discharges. The Kawishiwi River is located in the Rainy River drainage basin and flows into Birch Lake from the east. The drainage area upstream of USGS gage 05124480 is 254 square miles, or approximately two and a half times the drainage area of the Partridge River above USGS gage 04015475.

In this section the Kawishiwi River and Partridge River watersheds refer to the watersheds of these rivers above the gages mentioned.

4.4.1.1.2 Similarity between Partridge River and Kawishiwi River Watersheds

The Kawishiwi River and Partridge River watersheds are mostly undeveloped with no mining associated impact (other than the dewatering discharge from the Peter Mitchell Pit by Northshore to the Partridge River, which is discussed elsewhere in this document).

The Kawishiwi River watershed is more than twice the area of the Partridge River watershed. The Partridge River watershed yield (0.84 cfs per square mile) is similar to the Kawishiwi River watershed (0.77 cfs per square mile). The coincident monthly flow data for the 1979-1988 period for the two river gages is presented in Figure 4-6. The watersheds show similar behavior (Figure 4-6) as evidenced by a correlation coefficient (R) of 0.65 at a monthly time step. The daily data (and to a lesser extent the monthly data) show flashier peaks in the Partridge River while the trailing edge of the hydrograph is typically longer in the Kawishiwi River (probably owing to its larger catchment area and larger percentage of lakes in the watershed). Overall, the similarities in the development and character of the land within the watershed, watershed yield, and hydrograph shape (Figure 4-6) show the two watersheds will exhibit similar flow responses to climate variability.

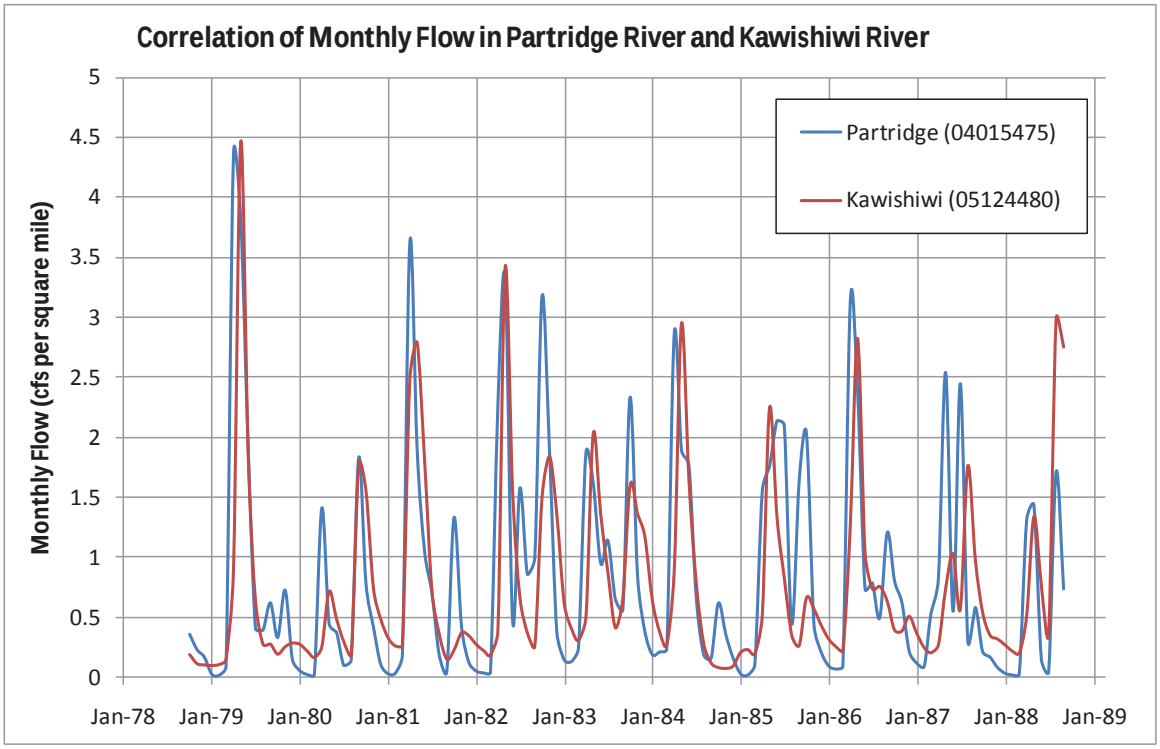


Figure 4-6 Correlation of Monthly Flow in the Partridge River and Kawishiwi River

The Kawishiwi River and Partridge River watersheds both experienced similar precipitation and temperature (Table 4-4) for the periods under study.

Table 4-4 Comparison of Average Climate Data over Periods of Analysis

Time Period (Water Years)	Average Annual Temperature (F)(1)		Average Annual Precipitation (in)(1)	
	Partridge River Watershed	Kawishiwi River Watershed	Partridge River Watershed	Kawishiwi River Watershed
1979-1988	38.6	38.5	29.4	28.7
1971-2000	37.4	37.9	29.1	29.1
1981-2010	36.9	38.3	29.2	29.5

(1) based on Minnesota Climatology Working Group HiDen network

4.4.1.1.3 Kawishiwi River (USGS gage 05124480) – Flow During the Study Period

Average annual flows at the Kawishiwi River gage are presented in Figure 4-7. The long-term average flows for the periods 1979-1988, 1971-2000, and 1981-2010 are also included in Figure 4-7. These periods were chosen because they represent or approximate the climate normal period used in the DEIS (1971-2000), the current climate normal period (1981-2010), and the period for which flow data on the Partridge River is available (water years 1979-1988). All annual data is presented as water years (e.g., 1982 includes data from October 1981 through September 1982). The data shows a decrease in average annual flow since 2000, reflected in the difference between the 1971-2000 climate normal average of 196.4 cfs and the 1981-2010 climate normal average of 178.6 cfs. The 1979-1988 period (average flow 195.3 cfs) is very similar to the 1971-2000 period. The average flow in the Kawishiwi River over its entire period of record (1966-2010) is 190.8 cfs.

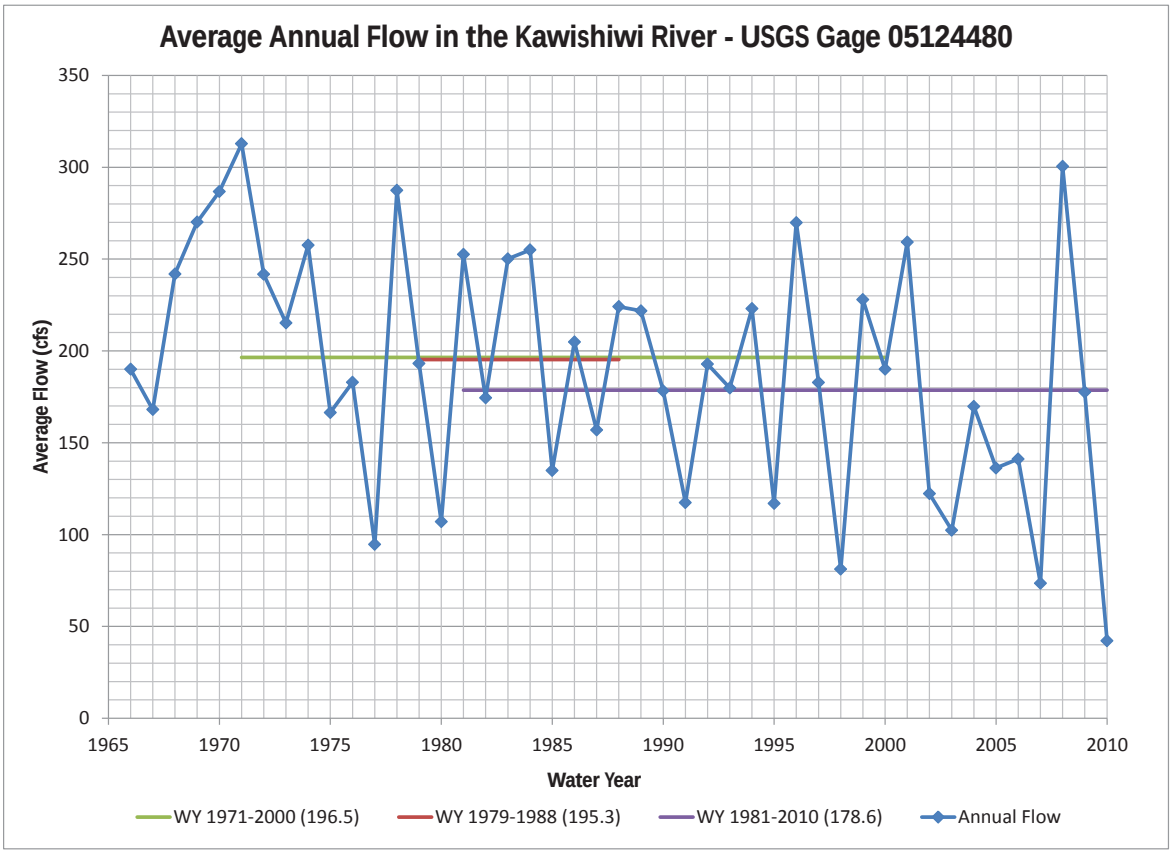


Figure 4-7 Time-Average Annual Flows in the Kawishiwi River – USGS Gage 05124480

Low flow data is of particular relevance to future water quality impact analysis (i.e., low flows provide the least amount of dilution of load from mining features). The annual minimum 30-day average flows in the Kawishiwi River are presented in Figure 4-8. The data shows large variability from year to year. The long-term averages of the annual minimum 30-day average flow are similar between all three periods analyzed, ranging from 37.5 cfs for the period from 1981-2010 to 40.0 cfs for the period from 1979-1988. The average annual 30-day low flow in the Kawishiwi River over its entire period of record (1966-2010) is 38.2 cfs.

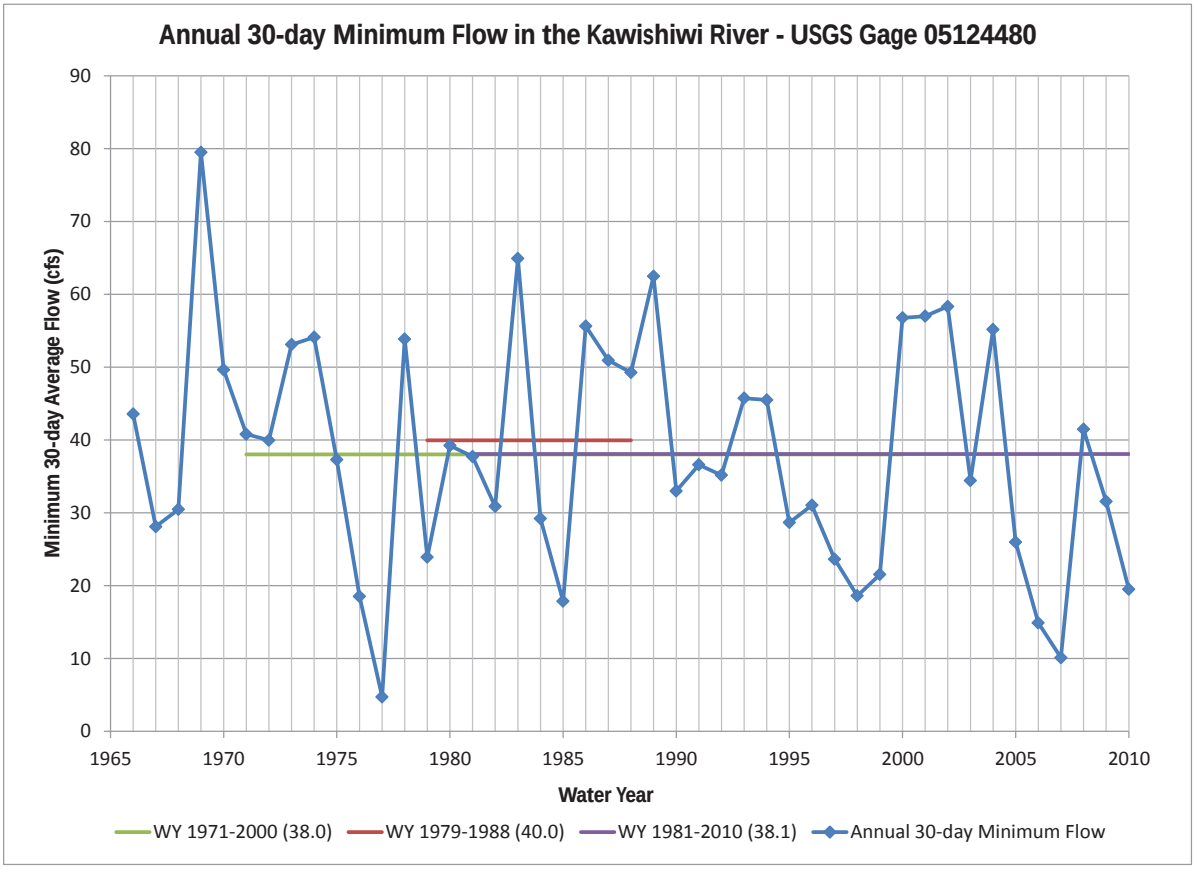


Figure 4-8 Time-Average 30-day Minimum Flows in the Kawishiwi River – USGS Gage 05124480

4.4.1.1.4 Differences in Historical Flow Data

Visual inspection of the average flows shown in Figure 4-7 suggests that average annual flow has decreased recently. Figure 4-8 shows no distinct trends in low flows, although the average for the most recent period (1981-2010) is less than the averages calculated over other time periods. Statistical tools can be used to quantify the level of certainty that flow means are different among the different time periods.

The boxes in Figure 4-9 indicate the 90% confidence interval of the average of each period, as determined using a two-tailed Welch's T-test. The overlap of the boxes indicates that at this level of confidence (90%), the true average of each data set could be the same. Similarly, a plot of the 90% confidence intervals on the average 30-day minimum flows reveals that the means are essentially indistinguishable given the variability in the data (Figure 4-10). As indicated by the overlap in the confidence intervals in Figure 4-9 and Figure 4-10, the Welch's T-test indicates that the averages of annual flow and minimum 30-day average flow cannot be differentiated between the time periods with a 90% confidence (i.e., the resulting p-value is greater than 0.10).

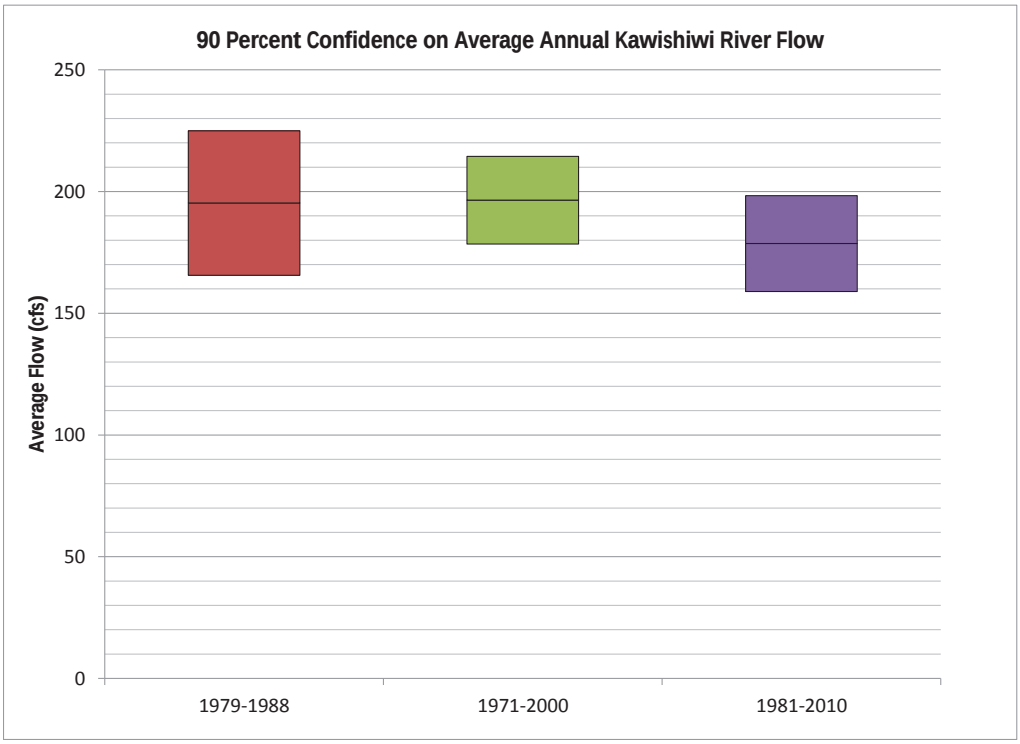


Figure 4-9 90 Percent Confidence Intervals on Average Annual Kawishiwi River Flow

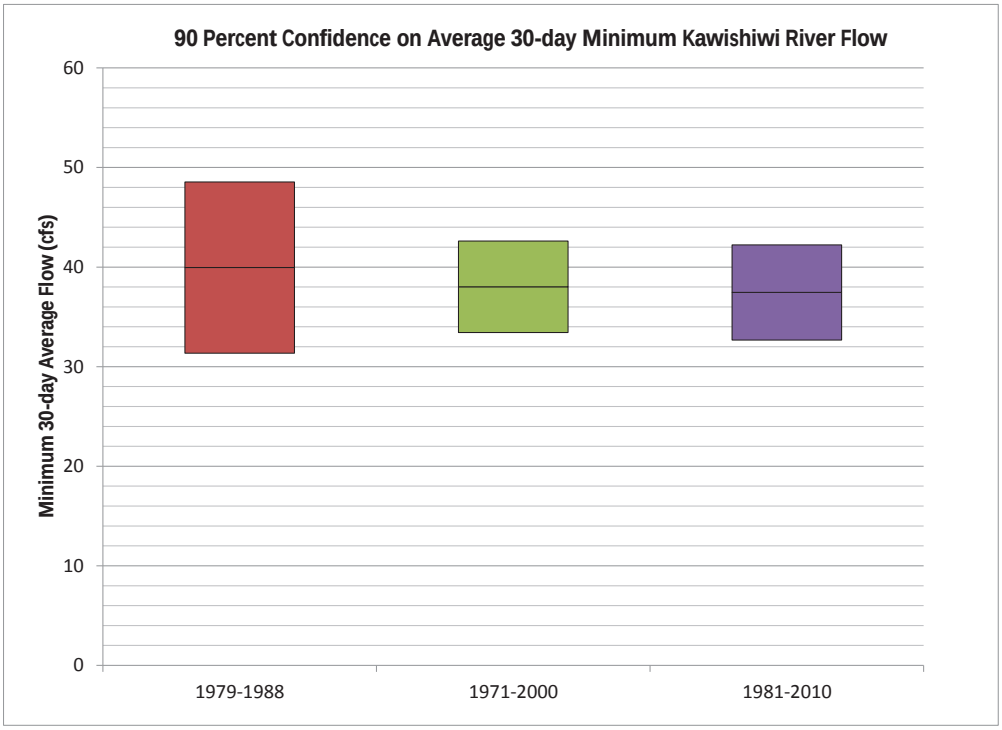


Figure 4-10 90 Percent Confidence Intervals on Average 30-day Minimum Kawishiwi River Flow

4.4.1.1.5 Conclusions

This analysis does not claim or assume that the hydrology of the Kawishiwi River is identical to that of the Partridge River. The shape of the hydrograph, watershed yield, location, and similarity in land use of both watersheds, however, suggest a similar flow response to climate variability. Both watersheds are subject to similar climatic factors, as the climate for both watersheds was similar during the periods of the study.

The Kawishiwi River flow data shows a decrease in average annual flow between the 1979-1988 and the period 1981-2010 (in the order of 10%). Statistical analysis, however, shows that the average annual flow between the period 1979-1988, the 1971-2000 climate normal period, and the period 1981-2010 (the current climate normal period) cannot be differentiated with 90% confidence. Statistical analysis also indicates that at the 90% confidence level, the minimum 30-day average flows cannot be differentiated for the three time periods evaluated.

Given the inability to differentiate average flow as well as low flow in the Kawishiwi River between the three periods analyzed and the similarity between the Kawishiwi River and Partridge River climate and watersheds, it is recommended that the Partridge River 1979-1988 flow data be used to evaluate current existing conditions (as represented by the most recent climate normal period) without quantitative adjustment for climatic factors. Other factors that may have affected the 1979-1988 period relative to the present (i.e., discharge from the Peter Mitchell Pit) must still be evaluated.

4.4.1.2 Adjustment of Partridge River gage data for Peter Mitchell Pit dewatering

During the period for which Partridge River flow data exists (1979-1988), the Peter Mitchell Pit at the headwaters of the Partridge River was being dewatered by Reserve Mining Company which is now Northshore. This activity resulted in flow at the gage that was not necessarily correlated with natural precipitation and runoff patterns in the Partridge River watershed. It is therefore possible that the 1979-1988 USGS gage data does not accurately represent future flow conditions in the Partridge River should the dewatering of the Peter Mitchell Pit cease (the Peter Mitchell Pit is currently being dewatered). This section details methods that could be used to minimize or eliminate the impact of Peter Mitchell Pit dewatering on the observed flow record.

4.4.1.2.1 Historical Peter Mitchell Pit dewatering data

When the XP-SWMM hydrologic/hydraulic model of the Partridge River watershed (Section 3.0 of Reference (12)) was being developed, dewatering data for the Peter Mitchell Pit was not available. After development, calibration and use of this model to evaluate potential hydrologic and water quality impacts associated with the Project, monthly dewatering volumes from the Peter Mitchell Pit to the Partridge River were provided by Northshore. The data is based on pumping records and was provided as monthly volumes from 1976 through 1986, after which dewatering ceased. The data (converted to monthly average flows in cfs) is presented in

Table 4-5 and shown in Figure 4-11. The dewatering ranges from zero dewatering in the winter of 1985 and 1986 to over 30 cfs in the spring of 1979. The average dewatering rate during the 8 year period in which dewatering records are coincident with observed flow data at USGS gage 04015475 (before dewatering stopped) was 11.8 cfs, or approximately 13% of the average flow recorded at USGS gage 04015475 during that period. The average dewatering rate during low flow months (January and February) during that period was 3.7 cfs, compared to observed flow at the gage of 7.4 for those same months.

There is limited detail regarding the accuracy of the dewatering data. The data for 1976 through 1984 are provided as total monthly volumes (gallons) summarized from pumping records (data is most likely based on pumping rates and times). Data from 1985 is estimated from instantaneous flow rates at the time of NPDES sampling integrated over the sampling interval (assumed to be 15 days). Data for 1986 is based on the 1987 MDNR Water Appropriations Report, and includes values "based on 1985 figures". There are potential inaccuracies throughout the dataset, in addition to the added uncertainty of distributing monthly totals to a smaller time step.

Table 4-5 Monthly average Peter Mitchell Pit Dewatering Flows (cfs) Discharged to the Partridge River

Month	Peter Mitchell Pit dewatering flow (cfs) by Month and Year										
	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
January	1.7	0.6	4.3	2.0	1.6	0.9	10.9	7.8	1.6	0.0	5.3
February	5.0	0.6	2.2	0.6	4.6	4.4	9.4	4.1	3.3	0.0	2.4
March	11.0	3.6	4.5	4.4	5.0	7.4	9.7	11.5	7.0	5.8	3.8
April	23.2	7.6	17.3	30.4	18.7	30.0	19.7	14.2	13.5	10.4	5.5
May	9.9	7.9	8.4	38.4	7.0	21.9	19.2	12.1	11.5	19.7	9.2
June	10.3	15.8	19.8	18.7	8.3	15.0	11.6	11.2	11.2	3.1	5.5
July	7.4	9.0	14.9	10.6	10.5	21.3	16.0	12.2	10.6	9.7	5.0
August	2.9	7.0	14.0	19.3	19.2	21.3	19.5	10.5	11.2	20.0	15.8
September	1.8	18.8	15.0	16.0	35.0	6.5	15.1	11.2	26.3	25.0	20.8
October	2.9	15.1	9.4	15.3	26.6	18.9	23.0	13.4	21.9	21.1	0.0
November	2.4	16.7	16.6	19.0	15.8	9.9	13.4	7.1	9.7	0.0	0.0
December	2.2	14.2	10.3	3.4	2.1	8.9	13.3	5.1	11.3	0.0	0.0
Annual Average	6.7	9.7	11.4	14.9	12.9	13.9	15.1	10.0	11.6	9.6	6.1

4.4.1.2.2 Partridge River gage data – USGS 04015475

The USGS gage 04015475 – Partridge River above Colby Lake was maintained from September 1978 through October 1988. Monthly average Peter Mitchell Pit dewatering data exists for the entire Partridge River flow record period (although dewatering ceased in 1986). Monthly average flows in the Partridge River gage record range from a low of 1.3 cfs in February 1979 to a maximum of 377.6 cfs in April 1981. The monthly average flow is 87.5 cfs over the entire period of record. The average flow is 92.6 cfs during the period of Peter Mitchell Pit discharge (water years 1979-1986), and 67.1 cfs after dewatering ceased (water years 1987-1988). Monthly average flows in the Partridge River are plotted in Figure 4-11.

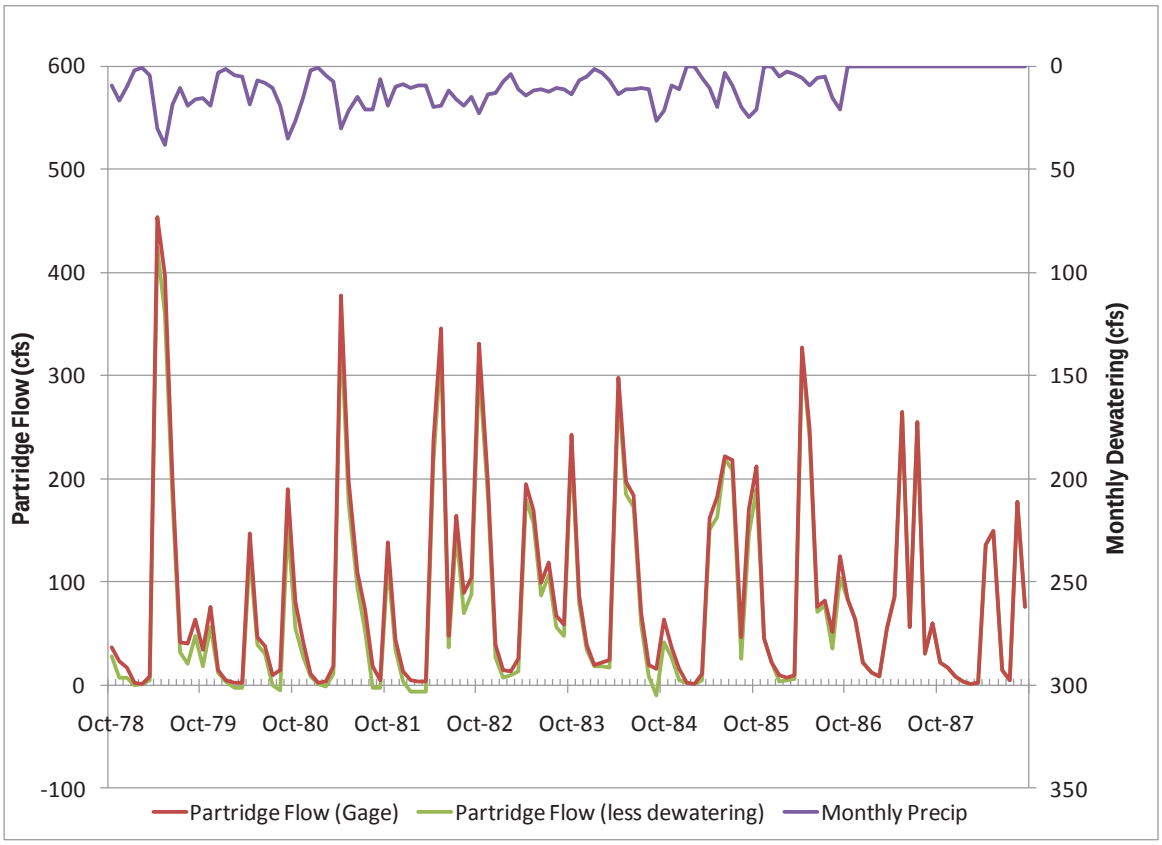


Figure 4-11 Monthly Partridge River Flow Data and Peter Mitchell Pit Dewatering Estimates

4.4.1.2.3 Subtracting Dewatering Rates from USGS Gage Data

The simplest and most straightforward way to estimate Partridge River flows without dewatering is to subtract the dewatering rates from the historical data. At a monthly time step (the Peter Mitchell Pit dewatering data are presented as total monthly volumes), the resulting Partridge River streamflow is plotted in Figure 4-11. During 11 of the 96 months for which concurrent USGS gage data and Peter Mitchell Pit dewatering records exist, the reported Peter Mitchell Pit dewatering volume is greater than the observed monthly streamflow, resulting in negative

residual flows. Point flow data taken along the length of the Partridge River as part of the 2004-2007 baseline monitoring and the November 2008 measurements of the MDNR shows Partridge River flows increasing throughout the stream length. Potential reasons for the apparent overestimation of dewatering volumes may include loss in ice pack in winter, evaporative loss in wetlands south of the Peter Mitchell Pit, retention in wetlands or behind beaver dams, or inaccuracies in the historical dewatering data. Regarding the latter, it is possible that the bi-weekly instantaneous measurements are biased toward high (or low) values and do not offer a good representation of monthly average values.

During the months when Peter Mitchell Pit dewatering is greater than observed streamflow, the average difference between the Peter Mitchell Pit dewatering and USGS gage record is 4.2 cfs, or approximately 36% of the average dewatering rate during those months. The average gaged streamflow during these months is 64% of the reported dewatering values. The frequency of these occurrences suggests that the dewatering estimates may be biased high (i.e., the actual volume dewatered is less than the reported value). This is supported by the fact that no periods of zero flow in the Partridge River occur in water years 1987 and 1988, after dewatering ceased. While this is only apparent during months with low flows in the Partridge River, it is likely that if such a bias exists, it is systemic (i.e., it will be present throughout the year).

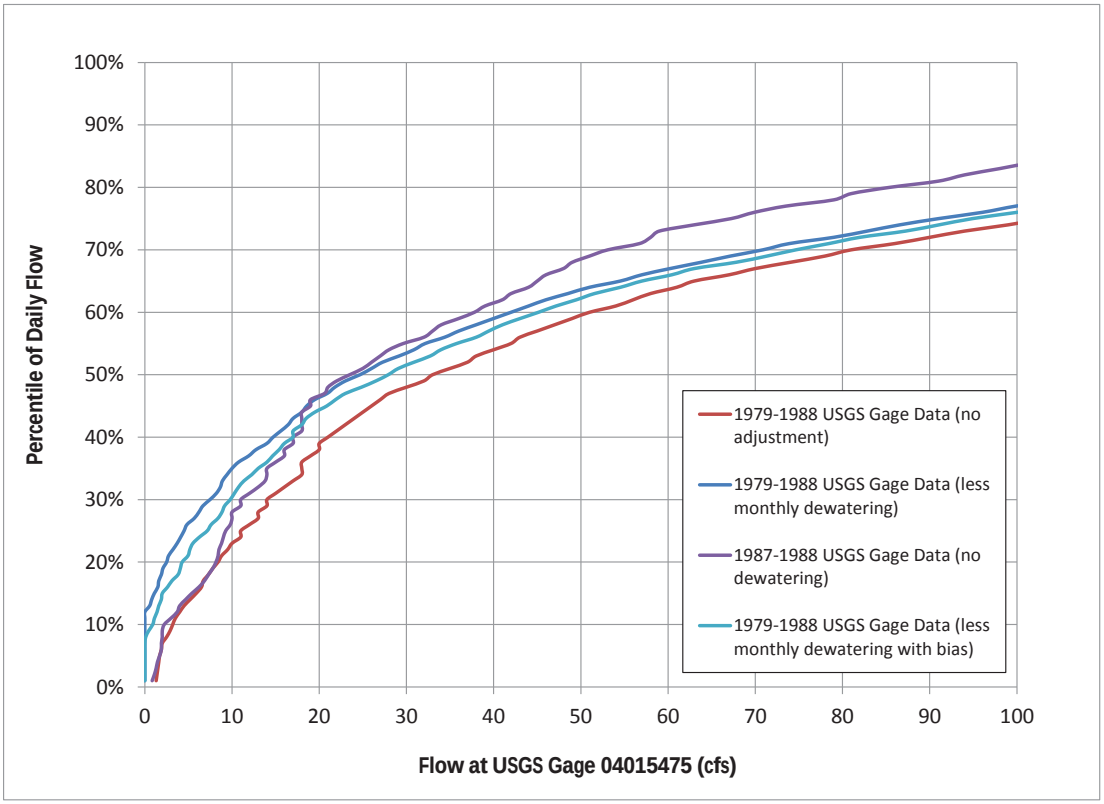


Figure 4-12 Daily Flow Percentiles for Observed and Dewatering-Adjusted Gage Data

Two methods were used to develop percentiles of daily flow (also known as flow-duration curves) by subtracting the dewatering data from the USGS gage record. First, the monthly average dewatering rates were subtracted from the Partridge River daily gage data and any resulting negative values were set equal to zero. Second, the monthly average dewatering rates were reduced to 64% of the reported value (the potential average bias as described above), subtracted from the USGS data, and any remaining negative values set equal to zero. The resulting daily flow percentile curves are plotted in Figure 4-12, along with a curve developed for the raw gage data and a curve for water years 1987 through 1988 (no dewatering). All flows were considered in developing the curves shown in Figure 4-12; the figure only shows flows less than 100 cfs for illustrative purposes (the impacts of dewatering are diminished at higher flows). It should be noted that the median flow is less than the average flow for all curves due to the non-normal distribution of flow (i.e., the highest flows are much higher than the mean than low flows are lower).

4.4.1.2.4 Calculating Daily Flow Percentiles Without Peter Mitchell Pit Dewatering

The method of simply subtracting dewatering data from the USGS gage data is not sufficient for development of a flow-duration curve, as it results in extended periods of zero flow in the river (approximately 12% of the year, see Figure 4-12). Such periods of zero flow are not expected, based on the 1987-1988 data with no dewatering, which shows no periods of zero flow despite periods of very low flow. Precipitation during these years (average 28 inches) is similar to the long-term average (29 inches). Thus, subtracting the dewatering data from the observed gage data at a monthly time step does not provide the necessary resolution of low flow data. Alternatively, the 1987-1988 data may be used to develop a flow-duration curve. The primary limitations in this approach are 1) the limited period of record (2 years) and 2) the average flow for those years of 67.1 cfs is less than the average flow of the entire period of record adjusted for dewatering (with or without bias). Given the limitations of the dewatering data and observed gage data, it is proposed that a flow-duration curve be developed using a combination of the 1987-1988 gage data and the dewatering-adjusted 1979-1988 gage data (subtracted with bias) as shown in Figure 4-13.

For the purposes of probabilistic water quality modeling (Section 5.2.4.3.5) it is necessary to develop flow percentiles for each month, as opposed to the annual distribution shown in Figure 4-13. The same method described above can therefore be applied to monthly data, although fewer data points will be available to develop each distribution. The resulting monthly distributions are presented in tabular form alongside the annual distribution in Section 5.2.4.3.5.

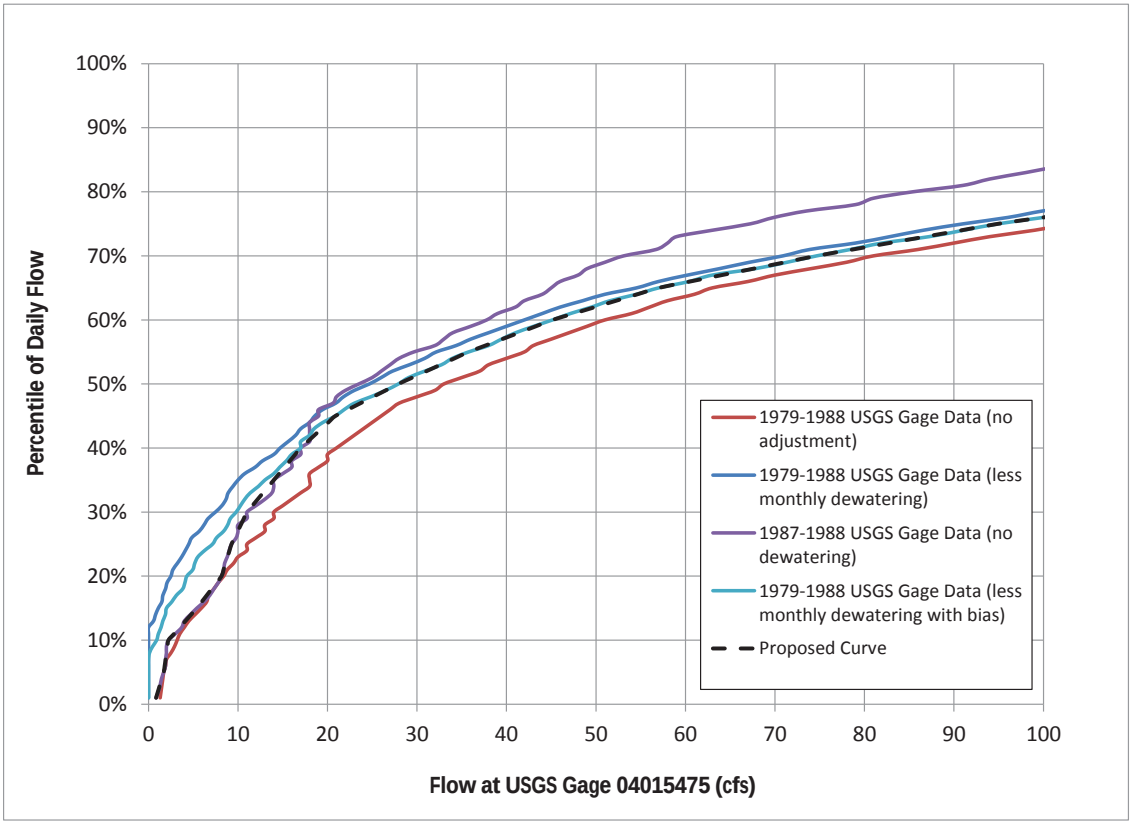


Figure 4-13 Proposed Daily Flow Percentiles for Dewatering-Adjusted Data

4.4.1.2.5 Implications for Hydrologic/Hydraulic Modeling

For the DEIS, an XP-SWMM hydrologic/hydraulic model of the Partridge River was developed to estimate flows upstream of the USGS gage (Section 2.1.1 of Reference (13)). The model was calibrated to gage data from water year 1985 and validated against the 1979-1988 observed flow record. No correction was made for Peter Mitchell Pit dewatering in the DEIS model calibration, as dewatering data was not available at the time.

The XP-SWMM model was used to estimate relative impacts to hydrologic statistics (i.e., Richter statistics, Section 3.2 of Reference (13)) at various locations along the Partridge River. These impacts were then converted to flows by scaling the model results at each location by the ratio of the model results at the USGS gage to the observed gage data. Because the observed gage data includes Peter Mitchell Pit dewatering, these scale factors implicitly included the impacts of dewatering.

Efforts to eliminate or at least reduce the impact of Peter Mitchell Pit dewatering on hydrologic/hydraulic modeling are described in this section.

4.4.1.2.6 Assessment of Model Calibration

DEIS model calibration was performed using water year 1985 (October 1984 – September 1985) and validated using water years 1979-1988 without adjusting the gage data for dewatering. Although the Peter Mitchell Pit was being dewatered during the calibration year, the Peter Mitchell Pit was not dewatered during January and February of 1985, the period of lowest flow during the calibration year. It is therefore possible that the model calibration is not adversely affected by the Peter Mitchell Pit dewatering, especially with respect to low flows.

To test this, the model fit statistics used to validate the XP-SWMM model for the DEIS (Section 5.1 of Reference (12)) were calculated using the dewatering-adjusted gage data (adjusted by subtracting 64% of the monthly average Peter Mitchell Pit dewatering flows from the Partridge River daily flow and replacing any resulting negative flow values with zero, see discussion above). Three statistics were used to quantify the model calibration:

Deviation of Runoff Volume: $$D_v = 100^* \left(\frac{V_{obs}-V_{mod}}{V_{obs}}\right)$$ **Equation 4-2**

Coefficient of Efficiency: $$E = \left[\left[\frac{\sum_{i=1}^{N}\left(Q_{obs}^{i}-Q_{mod}^{i}\right)^2}{\sum_{i=1}^{N}\left(Q_{obs}^{i}-\bar{Q}\right)^2}\right]\right]$$ **Equation 4-3**

Root Mean Square Error: $$RMSE = \frac{1}{\bar{Q}}\sqrt{\frac{\sum_{i=1}^{N}\left(Q_{obs}^{i}-Q_{mod}^{i}\right)^2}{N}}$$ **Equation 4-4**

The first two statistics were applied to all daily model results, but are not appropriate for evaluating calibration of the model to low flows (Section 5.1 of Reference (12)). The third root mean square error (RMSE) was used solely to evaluate model performance with respect to low flow periods, quantified in this analysis as the annual 30-day minimum average flow. Smaller RMSE values indicate a better fit. Table 4-6 shows the model goodness of fit statistics computed using the USGS data without any adjustment for dewatering (Table 9 of Reference (12)) and computed using the USGS data with the monthly dewatering data subtracted (with bias) from the gage data.

Table 4-6 DEIS Model Calibration Statistics with and without Adjustment for Dewatering

Water Year	Deviation in Volume (D_v)		Coefficient of Efficiency (E)		RMSE (30-day low flow)	
	Gage Data	Adjusted Data	Gage Data	Adjusted Data	Gage Data	Adjusted Data
1979-1988	33.1	28.1	0.24	0.25	1.15	2.01
1979	76.6	74.4	0.09	0.12	0.68	1.28
1980	23.6	10.1	-0.19	-0.30	3.05	--(1)
1981	24.4	14.6	0.17	0.17	6.65	8.95
1982	31.0	24.7	0.47	0.49	0.32	--(1)
1983	28.2	22.8	0.42	0.42	0.45	0.67
1984	25.2	20.3	0.37	0.38	0.75	13.08
1985	16.1	9.1	0.23	0.24	3.08	3.08
1986	38.6	35.4	-0.03	-0.01	0.04	0.88
1987	41.0	41.0	0.39	0.39	0.27	0.27
1988	1.8	1.8	0.15	0.15	5.98	5.98

(1) RMSE cannot be calculated when observed value is zero (divide by zero)

The results indicate that the existing model calibration provides an equal or better fit in the calibration year (1985). Overall, the model goodness of fit to the dewatering-adjusted flow data is similar to the fit to the unadjusted flow data (due in part to the underestimation of observed flows in the earlier model calibration). The deviation of volume is better (smaller) between the dewater-adjusted flows and the model results, while the coefficient of efficiency is nearly identical. The RMSE of the annual 30-day low flows for the entire dataset is higher than the original calibration (2.0 versus 1.2). The RMSE for water years 1980 and 1982 could not be computed because the dewatering-adjust observed flow is zero (the denominator becomes zero in the calculation). Based on the goodness of fit statistics, lack of a detail in Peter Mitchell Pit dewatering data, and additional correction applied to model results (see scale factor discussion below) further calibration of the XP-SWMM model will not be conducted (Reference (42)).

4.4.1.2.7 Model results and extrapolation (Scale Factors)

The XP-SWMM model as developed was not intended to calculate instantaneous flows in the Partridge River, but to allow evaluation of hydrologic changes in relative terms (Section 3.3 of Reference (13)). Therefore, ratios of observed flows to model results (at the location of the USGS gage), referred to as scale factors, were instead used to convert model results for future scenarios and additional locations along Partridge River to expected flow values (versus percent

impact). For the DEIS, scale factors were calculated using the entire 1979-1988 USGS record, thereby implicitly including Peter Mitchell Pit dewatering.

The USGS gage data adjusted for dewatering by subtraction (with bias) may not be used to determine scale factors because the monthly time step is insufficient to calculate hydrologic statistics with shorter durations (e.g., 1-, 3-, and 7-day maximum and minimum average flows). Instead, the scale factors will be based solely on observed data during periods of no dewatering (October 1986 through September 1988). The resulting scale factors are presented in Table 4-7.

Table 4-7 Water Year 1987-1988 Observed and Modeled Flow Statistics and Scale-up Factors

Statistic (cfs)	USGS Data (1987-1988)	XP-SWMM Model (1987-1988)	Scale Factor
Annual Daily Mean	67.6	51.4	1.31
October Mean	52.7	19.3	2.73
November Mean	40.6	22.9	1.77
December Mean	15.1	6.6	2.29
January Mean	7.5	6.2	1.20
February Mean	5.2	6.4	0.82
March Mean	28.4	144.6	0.20
April Mean	110.9	60.2	1.84
May Mean	206.6	134.2	1.54
June Mean	36.8	11.7	3.05
July Mean	129.5	54.7	2.37
August Mean	104.4	114.0	0.92
September Mean	68.2	29.3	2.33
Annual Max 1-day Mean	677.0	949.0	0.71
Annual Max 3-day Mean	650.8	835.1	0.78
Annual Max 7-day Mean	569.7	663.8	0.86
Annual Max 30-day Mean	257.6	251.4	1.02
Annual Max 90-day Mean	150.8	128.1	1.18

Statistic (cfs)	USGS Data (1987-1988)	XP-SWMM Model (1987-1988)	Scale Factor
Annual Min 1-day Mean	4.3	3.0	1.42
Annual Min 3-day Mean	4.3	3.2	1.37
Annual Min 7-day Mean	4.5	3.4	1.33
Annual Min 30-day Mean	5.0	5.1	0.97
Annual Min 90-day Mean	7.5	6.3	1.19

4.4.1.2.8 Summary

The USGS record of Partridge River flows for water years 1979-1988 is impacted by the dewatering of the Peter Mitchell Pit. For the impact analysis to be included in the SDEIS and FEIS, the following adjustments will be made to minimize or eliminate the impact of Peter Mitchell Pit dewatering in the observed flow record:

The Partridge River flow percentiles (flow-duration curve) used for water quality impact analysis (Monte Carlo simulations) will be based on water years 1987-1988 (no Peter Mitchell Pit dewatering) and water years 1979-1986 with monthly average dewatering rates subtracted (with bias) from the observed flow record (Figure 4-13).

XP-SWMM model calibration will not be updated, as the goodness of fit to the dewatering-adjusted data is sufficient and dewatering data had no impact on calibration of model to low flows (no dewatering in the winter of 1984-1985). Scale factors to convert relative impacts to flows will be based on water years 1987-1988 (no Peter Mitchell Pit dewatering).

These actions will reduce the impact of Peter Mitchell Pit dewatering on Project impact analysis performed as part of the SDEIS and FEIS. It should be noted, however, that adjusting the flow record by subtracting the monthly average dewatering rates is not an ideal solution. The frequent occurrence of monthly dewatering rates greater than average monthly streamflow indicates discontinuity between the data sets. The methods described in this section represent a good faith effort to account for the Peter Mitchell Pit dewatering to the maximum practicable extent given the available data.

4.4.1.3 Estimating Partridge River Baseflow

Estimating the flow in the Partridge River contributed by groundwater is necessary for modeling of future impacts, as groundwater and surface runoff chemistries differ (Sections 4.4.4 and 4.3.4). The flow contribution from groundwater is referred to as baseflow. While there is generally some variability in baseflow, it represents a relatively constant source of water to the river, especially as compared to surface runoff. The MDNR evaluated the potential range of

baseflow values in its analysis of upper Partridge River gage data (Reference (44), Reference (45)).

Because baseflow is a constant source of water to the Partridge River even during periods of little or no surface runoff, low flows observed in winter months are a reasonable estimate of baseflow. As noted in Section 4.4.1.2, dewatering of the Peter Mitchell Pit from 1976 to 1986 limits the use of the USGS gage data (Gage ID 04015475) to establish average winter low flows. Winter dewatering rates (Table 4-5) cannot simply be subtracted from observed data for reasons discussed in Section 4.4.1.2, including loss of dewatering flow to ice formation upstream of the gage.

The final two years of the USGS gage record (water years 1987 and 1988) do not include any mine pit dewatering, and may therefore be used to estimate winter low flows. The minimum 30-day average flow is used here as a surrogate statistic for baseflow. The minimum 30-day average flow during each water year was selected as an appropriate time scale to represent baseflow conditions because it is long enough to obtain a reasonable average flow but short enough to avoid inclusion of runoff events caused by winter snowmelt. In addition to water years 1987 and 1988, observed winter low flow data from January and February of 1985 (water year 1985) may be used, as no dewatering occurred during these months (Table 4-5). The minimum 30-day average flow (occurring between January and February of each year) for the three years of available data averages 3.8 cfs (1,700 gpm) at the USGS gage (Table 4-8).

Table 4-8 USGS Gage Record – Minimum 30-Day Average Flows

Water Year	Minimum 30-day Average Flow	Month of Occurrence	Mine Pit Dewatering
1979	1.3	Jan – Feb	Yes
1980	1.6	Feb – Mar	Yes
1981	1.6	Jan – Feb	Yes
1982	2.9	Jan – Feb	Yes
1983	13.3	Feb – Mar	Yes
1984	12.5	Aug – Sep	Yes
1985	1.6	Jan – Feb	No
1986	6.5	Feb – Mar	Yes
1987	8.7	Jan – Feb	No
1988	1.2	Feb – Mar	No
Average(1)	3.8	--	No

(1) Average of years without mine pit dewatering (1985, 1987, 1988)

The above approach calculates observed baseflow at the USGS gage, at the downstream end of the watershed. Average baseflow values under current conditions were estimated for upstream locations (as necessary for water quality impact modeling) using the same method as described in Section 4.4.1.2: upstream values estimated using the XP-SWMM model were multiplied by the scaling factors presented in Table 4-7. It should be noted that the scaling factors are based on water year 1987-1988 observed and modeled data. These factors do not include water year 1985 data because much of that data, excluding the 30-day low flow, are affected by Peter Mitchell Pit dewatering.

4.4.1.3.1 Comparison of Modeled Baseflow to MDNR Winter Observations

In the winter of 2011, the MDNR performed point (i.e., instantaneous) flow measurements at several locations in the Partridge River watershed. The results of these measurements are summarized in Reference (43). This section compares the results of that gaging effort to the low flows in the Partridge River from Barr's XP-SWMM model (Section 5.2.4.3).

Reference (43) reports an average winter flow of 7.8 cfs at CR666 (the location of surface water monitoring location SW006). The average 30-day low flow (used as a proxy for baseflow) estimated by XP-SWMM at this location is 5.5 cfs. The XP-SWMM baseflow values are scaled by 0.97 to account for differences in the observed flow data and the XP-SWMM-modeled data from concurrent periods (i.e., water years 1987-1988, see Section 4.4.1.2). The adjusted baseflow at SW006 as estimated by the XP-SWMM model is 5.3 cfs. The XP-SWMM-estimated baseflow values for other locations along the Partridge River are presented in Table 4-9.

Table 4-9 Comparison of Partridge River Winter Gaging and XP-SWMM Model Results

Location Name	Tributary Area (mi^2)	MDNR Measured Flows					XP-SWMM[1]
		Nov 24-26, 2008	Dec 15-16, 2010	Jan 25-26, 2011	Feb. 15-16, 2011	Mar. 15-16, 2011	30-day Low Flow
		Q (cfs)	Q (cfs)	Q (cfs)	Q (cfs)	Q (cfs)	Q (cfs)
Partridge River near Babbitt, RR tracks	--	0	9.1	0	4.3	3.7	0.1
Partridge River near Babbitt, 0.9mi upstream of Dunka Rd	13.7	7.6	0.4	5.5	5.1	4.2	0.4
Partridge River near Babbitt, Dunka Rd	16	10.2	--	4.1	4.2	6.6	0.5

Location Name	Tributary Area (mi²)	MDNR Measured Flows					XP-SWMM(1)
		Nov 24-26, 2008	Dec 15-16, 2010	Jan 25-26, 2011	Feb. 15-16, 2011	Mar. 15-16, 2011	30-day Low Flow
		Q (cfs)	Q (cfs)	Q (cfs)	Q (cfs)	Q (cfs)	Q (cfs)
Partridge River near Babbitt, 4mi downstream of Dunka Rd	22.3	14.1	--	--	--	--	0.9
Partridge River at Hoyt Lakes, CR666	104.1	41.9	--	9.1	7.3	6.9	5.3
Wyman Creek at Hoyt Lakes, CR666	10.9	5.7	--	1.5	1.6	1.1	--
Longnose Creek near Hoyt Lakes, FR117	4.8	2	--	0.3	0.5	0.4	0.3
South Branch Partridge River near Babbitt, CR680	13.7	6.1	--	0.2	0.2	0.4	0.7

(1) XP-SWMM model results are scaled by ratio of observed/modeled results as described in Section 4.4.1.2.

The difference between the MDNR measured and XP-SWMM estimated baseflows increases in the upstream direction. The average measured baseflow at Dunka Road (at surface water monitoring location SW003) is 5.0 cfs, compared to a value of just 0.5 cfs as estimated by the XP-SWMM model. Some of this disparity is attributed to the fact that the measured flow immediately downstream of Northshore's pit dewatering discharge ranged from 0 to 9.1 cfs (note that Reference (43) refers to the Northshore discharge as Northshore Mining, Cliffs and Cliffs Erie) which indicates that Northshore could have been discharging for some of the measurements. The XP-SWMM model assumes no Northshore pit dewatering discharge at the Partridge River headwaters. The average gain in baseflow between the Northshore discharge and CR666 measured from January to March (5.1 cfs) is similar to the increase in baseflow estimated by the XP-SWMM model (5.2 cfs). Average baseflows measured by the MDNR along Longnose Creek (0.4 cfs) and the South Branch of the Partridge River (0.3 cfs) are similar to those estimated by the XP-SWMM model (Table 4-9).

At all locations along the main stem of the Partridge River, the XP-SWMM-estimated baseflow is less than or similar to the MDNR-measured baseflow. The XP-SWMM model provides a reasonable estimate of Partridge River baseflow for the purposes of modeling water quality impacts.

4.4.1.3.2 Comparison of Modeled Partridge River Baseflow to Gage Data at SW003

Recent (2011-present) flow data near the Mine Site is available from MDNR gage H03155002, located on the Partridge River at the Dunka Road crossing (monitoring location SW003, see Large Figure 19). The MDNR performed baseflow analyses on data from this gage collected from June 2011 through December 2012, as well as on data from other regional gages to compare to estimates of observed baseflow to values modeled using XP-SWMM (Reference (44), Reference (45)).

The XP-SWMM modeling estimates baseflow of 5.3 cfs for the Partridge River near Hoyt Lakes (USGS #04015475) under natural flow conditions without augmentation from upstream dewatering activities (Section 5.2.4.3.5). The MDNR's base flow analysis of the historical USGS flow record showed the 30-day minimum base flow of 5.5 cfs and 7.2 cfs in water years 1986 and 1987, respectively (Reference (45)). This is comparable to the 5.3 cfs estimated from the XP-SWMM model. A historical comparison of flows and climatic conditions for the region shows water years 1986 and 1987 to be normal to wet years climatically and the average winter flow at three rivers in the region were close to normal compared to the long-term historical record for each stream gage. In contrast, flows and climatic conditions showed a severe drought condition affecting the region in 2011-2012.

The MDNR's baseflow analysis of the 2011-2012 Dunka Road stream gage (gage H03155002) indicated a 30-day minimum base flow of 1.3 to 1.8 cfs (Reference (44)). Although the data suggest some of the dewatering volume from the Peter Mitchell Pit was still in the system, the flows in December and February of 1.6 cfs and 1.8 cfs are similar and may be a close approximation of natural flows for 2011-2012. Comparatively, the XP-SWMM model estimates a baseflow value of approximately 0.5 cfs at this location. The MDNR memo notes that the XP-SWMM may have underpredicted base flow conditions for the average minimum winter conditions. Alternatively the base flow analysis of 2011-2012 may have overestimated base flows due to flow augmentation (i.e., pit dewatering) during the time period examined.

In the summer of 2014, the MDNR repeated this analysis using 2013 and partial 2014 data from gage H03155002 (Reference (46)). This analysis returned similar results, with estimated baseflows of 2.7 cfs in 2013 and 1.9 in 2014 (although the 2014 flow record was incomplete, it included data from January through March, during which the lowest flows typically occur).

Based on these combined analyses, the Co-Lead Agencies have recommended that the baseflow values provided by the XP-SWMM modeling be retained as the best estimate of Partridge River baseflow for use in the FEIS (Reference (47)). The Co-Lead Agencies have requested that a range of possible baseflow values informed by the gage H03155002 data be evaluated in a sensitivity analysis of the Partridge River model (Reference (48)).

4.4.2 Past and Current Point Discharges

The Partridge River watershed contains several past and current point discharges. The sources have impacted and continue to impact the hydrology and water quality of surface waters within the watershed. Significant point sources are discussed in the following sections.

4.4.2.1 Northshore Peter Mitchell Pit

One source of impacts in the Partridge River watershed is Northshore, which began mining operations in the Peter Mitchell Pit located north of the Mine Site (Large Figure 19) around 1956. Discharges from the Peter Mitchell Pit to the headwaters of the Partridge River have occurred periodically since 1956, with limited pumping records available (Section 4.4.1.2). Figure 19 of Reference (12)) shows the approximate locations of past and current Northshore water appropriations from and discharges into the Partridge River. Inactive portions of the Peter Mitchell Pit have been allowed to flood with water, but pumping from active mining areas and discharges to the Partridge River currently continue. MDNR water appropriation permit 822097 authorized Northshore to withdraw up to 29,700 gallons per minute (gpm) (66.2 cfs) for mine dewatering (referred to as "water level maintenance") in the Peter Mitchell Pit. This permit applies to discharges to both the Partridge River and the Dunka River.

Mine pumping records from the Peter Mitchell Pit from 1976 through 1987 were provided by Northshore. The MNDR has dewatering records beginning in 1988. Dewatering records beginning in 1998 are available from the MPCA records (Reference (49)). Water quality data has been collected by PolyMet in the Partridge River immediately downstream of the Northshore discharge (location SW001, also identified as PM-1) in 2004, 2006, and 2008. Baseline water quality data collected in the Partridge River is summarized in Section 4.4.4.1. Additional water quality data for a limited number of constituents is available from Northshore's NPDES monitoring (location SD009). Data from location SD009 is presented in Large Table 9.

Following closure of the Peter Mitchell Pit, pit dewatering to the Partridge River watershed will cease as the pit is allowed to flood with water. After the pit lake is flooded, the pit will discharge towards the Dunka River, effectively removing the pit watershed (an area of approximately 6 square miles) from the Partridge River watershed. Closure of the Peter Mitchell Pit is assumed to occur in approximately 2070.

4.4.2.2 City of Hoyt Lakes Wastewater Treatment Plant

There are municipal discharges from the Wastewater Treatment Plant of the City of Hoyt Lakes (WWTP-Hoyt Lakes) into Whitewater Reservoir, in the Partridge River watershed (Large Figure 1 for location of Whitewater Reservoir). The WWTP-Hoyt Lakes has an installed, operative capacity to treat up to 665,000 gallons per day (gpd) (1.03 cfs), and with a modest amount of maintenance and repair work the treatment capacity could be increased to 1,000,000 gpd (1.55 cfs). The currently treated average flow is 250,000 gpd (0.39 cfs). The installed, operative capacity of 665,000 gpd is considered sufficient to meet foreseeable future needs

derived from projected population growth. Water quality data for metals is not available for the WWTP-Hoyt Lakes effluent.

4.4.2.3 LTV Steel Mining Company (LTVSMC)

Erie Mining Company (predecessor to LTVSMC) began mining taconite in the Partridge River watershed in the 1950's. Three former LTVSMC mine pits (Pit 5S, Pit 3, and Pit 2WX) are located within the watershed tributary to Colby Lake (Reference (32)). Pit 5S and Pit 3 are currently overflowing to Wyman Creek and are thus implicitly represented in the baseline water quality collected in Colby Lake (Large Table 10) (discussion in Section 4.4.4). Pit 2WX is located within the watershed of an unnamed creek that enters Colby Lake near the lake outlet (Large Figure 19).

Reference (32) estimates that Pit 2WX will begin to overflow sometime between 2013 and 2017. Based on the small portion of the Colby Lake watershed tributary to Pit 2WX, it is unlikely that the pit will have an impact on Colby Lake water levels or the management of Whitewater Reservoir.

The unnamed creek is likely to have little impact on Colby Lake water quality based on the location of its outlet to Colby Lake and the bathymetry of the lake itself. The unnamed creek that will receive water from the watershed including Pit 2WX enters Colby Lake less than 1,000 feet from the lake outlet to the Partridge River. At this location, the lake is narrow and shallow. Combined with an average hydraulic residence time of less than one month (based on the average flow in the upstream Partridge River of 87.1 cfs and an approximate lake volume of 5,300 acre-feet), the local bathymetry will most often result in flushing of these inflows downstream and inhibit mixing in Colby Lake.

While diversions from Colby Lake to Whitewater Reservoir will increase the average hydraulic residence time of the Colby Lake-Whitewater Reservoir system, diversions to Whitewater Reservoir occur only during periods of high flow, when inputs from the unnamed creek will be flushed downstream regardless of the diversion. Because of this, potential future inputs from Pit 2WX are not included in the water quality modeling of Colby Lake.

4.4.3 Other Area Streams

Several small streams are tributary to the main stem of the Partridge River downstream of the Mine Site (Large Figure 19 and Large Figure 20). Several of these tributaries may be directly or indirectly impacted by the Project, including:

- Unnamed Creek downstream of the proposed West Pit Overflow
- Wetlegs Creek
- Longnose Creek

- Wyman Creek

The Unnamed Creek downstream of the proposed West Pit overflow location will be directly impacted by the Project. The watershed tributary to this creek will be reduced as the West Pit is developed (Large Figure 21 through Large Figure 27). During mining and pit flooding, flows will likely be reduced in this creek due to the reduced watershed area. In closure, after the West Pit is flooded, flow in the Unnamed Creek will include discharge from the WWTF, directly impacting hydrology and water quality in the Unnamed Creek. Modeling methodology for the West Pit overflow and Unnamed Creek is described in Section 5.2.4.5.

Wetlegs Creek is located southwest of the Mine Site. Less than 5% of the Wetlegs Creek watershed is located within the Mine Site; this small hydrologic alteration will not result in significant environmental impacts (Reference (42)). There is no anticipated groundwater flow between mining features and Wetlegs Creek (Large Figure 28 and Large Figure 29). Water quality in Wetlegs Creek may be impacted by potential spillage of ore from rail cars that pass over the creek. Impacts from rail car spillage are discussed qualitatively in Reference (50).

Similar to Wetlegs Creek, Longnose Creek and Wyman Creek may be impacted from potential spillage of ore from rail cars at the railroad crossing. These impacts are discussed in Reference (50). The watershed areas tributary to Longnose Creek and Wyman Creek are not impacted by the Project, nor is groundwater flow between the Mine Site and these surface water features anticipated (Large Figure 28 and Large Figure 29).

4.4.4 Water Quality

Several locations within the Partridge River watershed have been monitored for water quality since 2004. These locations are shown in Large Figure 19 and include seven monitoring locations on the Partridge River above Colby Lake, two locations along Wyman Creek, three locations along tributaries to the Partridge River, and two locations in Colby Lake and Whitewater Reservoir. The results of baseline monitoring upstream of Colby Lake is presented in Large Table 11. Baseline monitoring data collected in Colby Lake and Whitewater Reservoir is presented in Large Table 10. The frequency and extent of monitoring vary by location. Monitoring conducted from 2004 through 2008 generally includes a wider parameter list to characterize the baseline conditions within the watershed. Monitoring from 2008 through 2010 generally focused on a smaller list of constituents and locations to address specific issues (e.g., ratio of dissolved to total aluminum, inadequate thallium detection limits). It should be noted that all concentrations discussed in Section 4.4.4 refer to total concentrations unless otherwise noted.

4.4.4.1 Partridge River Watershed Data

Seven surface water locations along the Partridge River have been monitored at some point since 2004 (Large Figure 19 and Large Table 11). Location PM-1/SW001, located downstream of the discharge from the Peter Mitchell Pit, was sampled 10 times from 2004 to 2008. Location PM-2/SW002 was sampled 29 times from 2004 through 2013. Location PM-3/SW003,

PM-16/SW004, and PM-4/SW005 were each sampled at least 51 times from 2004 through 2013. Locations SW004a and SW004b, located downstream of the Partridge River confluence with the South Branch of the Partridge River and Colvin Creek, respectively, were each sampled 25 times from 2010 through 2013. Location PM-5 on Wyman Creek was sampled 34 times from 2004 through 2013; location PM-6 on Wyman Creek was sampled four times in 2004 and once in 2013. Partridge River tributaries Wetlegs Creek (location WL-1), Longnose Creek (location LN-1), and the creek south of the proposed West Pit where the WWTF will discharge in long-term closure (location WP-1) were sampled 24 times, 23 times, and 15 times, respectively, between 2010 and 2013.

Baseline water quality monitoring results in the Partridge River watershed upstream of Colby Lake were assessed relative to applicable water quality standards. Constituent concentrations collected with concurrent flow measurements are presented in Large Figure 30 through Large Figure 36 for select constituents. The data reveal some existing exceedances of applicable surface water quality standards (Large Table 2). These exceedances are discussed in the following section by constituent.

4.4.4.1.1 Aluminum

Total aluminum exceeded the standard of 125 µg/L in 44 of 199 samples (22%) along the main stem of the Partridge River; dissolved aluminum exceeded 125 µg/L in 14 of 139 samples (10%). The average observed ratio of dissolved to total aluminum was approximately 70%, as calculated from samples in which both dissolved and total aluminum were detected. All but three aluminum exceedances occurred downstream of monitoring location PM-3/SW003. One of 23 samples in Longnose Creek exceeded the aluminum standard. Eight of 23 samples in Wetlegs Creek also exceeded 125 µg/L for total aluminum; three of those samples also exceeded 125 µg/L for dissolved aluminum. Fifteen of 15 samples from the location of the proposed West Pit overflow (location WP-1) exceeded 125 µg/L for total aluminum; 14 of these samples also exceeded 125 µg/L for dissolved aluminum.

4.4.4.1.2 Cobalt

Three of 215 observations of cobalt in the main stem of the Partridge River exceeded the 5 µg/L water quality standard (1%). Six of 23 samples collected in Wetlegs Creek (location WL-1) exceeded the water quality standard (26%). The average concentrations of dissolved and total cobalt in Wetlegs Creek are 3.3 µg/L and 3.6 µg/L, respectively. Total and dissolved cobalt exceeded the water quality standard in one of 15 samples collected at location WP-1.

4.4.4.1.3 Lead

Lead exceeded the 3.2 µg/L surface water quality standard in one of 51 samples taken at PM-4/SW005. The measured lead concentration was 12.3 µg/L; lead was not detected in the upstream location (PM-16/SW004) sampled on the same date.

4.4.4.1.4 Mercury

In the Partridge River upstream of Colby Lake, 172 of 235 samples (73%) exceeded the 1.3 ng/L mercury standard. Mercury exceedances occurred in at least 50% of samples at any given location in the main stem of the Partridge River. The average mercury concentration along the main stem of the Partridge River was 3.5 ng/L (including non-detections as half the detection limit). Mercury exceeded the 1.3 ng/L mercury standard in all 13 samples taken in Wetlegs Creek (average concentration of 5.2 ng/L), 12 of 13 samples taken in Longnose Creek (average concentration of 3.5 ng/L) and all seven samples taken from the location (WP-1) of the proposed West Pit overflow (average concentration of 13.4 ng/L).

4.4.4.1.5 Sulfate

Sulfate along the main stem of the Partridge River was sampled 233 times from 2004 through 2013. Sixty-seven percent of the samples (or 156 samples) exceeded the 10 mg/L standard applicable in areas of wild rice production. At PM-4/SW005, 25 of 51 samples (49%) exceeded 10 mg/L; the average concentration at PM-4/SW005 is 10.0 mg/L. All samples collected at location PM-1/SW001, downstream of the Peter Mitchell Pit discharge, exceeded 10 mg/L for sulfate. None of the 25 samples from Longnose Creek exceeded 10 mg/L of sulfate. Two of 24 samples taken from Wetlegs Creek (WL-1) and two of 16 samples taken from the proposed West Pit overflow (WP-1) exceeded 10 mg/L of sulfate.

4.4.4.1.6 Selenium

Selenium was detected at the water quality standard of 5 µg/L once in the main stem of the Partridge River (out of 175 samples). The next highest detection was 1.6 µg/L. Including these detections, selenium has been detected in only 13 of 175 samples. Selenium was detected in one of 20 samples in Longnose Creek (LN-1), zero of 20 samples in Wetlegs Creek (WL-1), and two of 13 samples in the proposed West Pit overflow (WP-1).

4.4.4.1.7 Thallium

Thallium was detected at a concentration greater than the 0.56 µg/L water quality standard once at location PM-1 in 2004 (0.63 µg/L). Several additional samples in 2004 were analyzed with detection limits above standard. Excluding the detection at PM1/SW001 in 2004, thallium was detected in 74 of 180 samples along the main stem of the Partridge River; these 74 detections have an average concentration of 0.011 µg/L and a maximum concentration of 0.053 µg/L (PM1/SW001).Thallium was detected in Longnose Creek (LN-1) in four of 22 samples with no exceedances. Thallium was detected in 11 of 22 samples in Wetlegs Creek (WL-1) with no exceedances and in 10 of 14 samples in the proposed West Pit overflow (WP-1) with no exceedances.

4.4.4.2 Wyman Creek Data

Wyman Creek crosses the rail line connecting the Mine Site and Plant Site before joining the Partridge River just upstream of Colby Lake (Large Figure 19). Two locations on Wyman Creek

(PM-5 and PM-6) were sampled a total of eight times each in 2004. Monthly sampling of PM-5 was restarted in 2011 and continued through 2013. The data is summarized in Large Table 11. Wyman Creek is specifically listed in Minnesota Rules, chapter 7050 as subject to Class 1B, 2A, and 3C water quality standards (Large Table 2). The baseline water quality data from Wyman Creek was assessed relative to these standards. Note that although sulfate regularly exceeds 10 mg/L in Wyman Creek, it is not discussed below because Wyman Creek is not a wild rice water.

4.4.4.2.1 Aluminum

Total aluminum in Wyman Creek exceeded 125 µg/L in six of 65 samples (9%). One of eight samples taken in Wyman Creek in 2004 exceeded 125 µg/L for total aluminum; dissolved aluminum was not measured in 2004. Five of the remaining 57 samples (all taken since 2011) exceeded the 125 µg/L water quality standard. Dissolved aluminum exceeded 125 µg/L in one sample taken since 2011.

4.4.4.2.2 Cobalt

One of eight cobalt samples collected in 2004 at location PM-5 in Wyman Creek (7.8 µg/L) exceeded the 5 µg/L surface water standard. No exceedances were observed in the 57 additional samples collected since 2011.

4.4.4.2.3 Mercury

Mercury concentrations exceeded 1.3 ng/L in 23 of 53 samples in Wyman Creek. The average mercury concentration in Wyman Creek is 1.5 ng/L (including non-detections as half the detection limit).

4.4.4.3 Colby Lake and Whitewater Reservoir Data

Colby Lake was sampled once in fall of 2008 at five locations, six times in 2010 at two locations (LCy-1 and LCy-2 in Large Figure 19), and again seven times in 2013 at the same locations sampled in 2010. Whitewater Reservoir was sampled six times at two locations in 2010 (LWr-1 and LWr-2 in Large Figure 19). Data from these sampling events is summarized in Large Table 10. As an unlisted water, the same standards applicable to the Partridge River are applicable to Whitewater Reservoir. Colby Lake, however, is listed in Minnesota Rules, chapter 7050 as subject to Class 1B, 2Bd, and 3C standards. Baseline water quality monitoring results from Colby Lake and Whitewater Reservoir were assessed relative to the applicable water quality standards (Large Table 2).

All sampled constituents in Whitewater Reservoir were less than the applicable water quality standards. Exceedances of applicable water quality standards in the Colby Lake baseline data are summarized below by constituent.

4.4.4.3.1 Aluminum

All five locations in Colby Lake sampled in November 2008 exceed the 125 µg/L water quality standard in total and dissolved aluminum concentrations. In contrast, none of the five samples taken at either location LCy-1 or LCy-2 (collected in 2010) exceeded the surface water quality standard in dissolved or total form. Two of seven samples collected in 2013 (in July and August) at both LCy-1 and LCy-2 exceeded 125 µg/L for both dissolved and total aluminum. The average ratio of dissolved to total aluminum in Colby Lake is 81% based on 31 samples in which both dissolved and total aluminum were detected.

4.4.4.3.2 Arsenic

Arsenic was sampled a total of 33 times in Colby Lake between 2008 and 2013. Total arsenic exceeded the 2 µg/L water quality standard in one sample (2.1 µg/L) and was detected at 2 µg/L in one other sample; both samples were collected in July 2013. Dissolved arsenic was below 2 µg/L in all 14 samples analyzed for dissolved arsenic. The average arsenic concentration based on 33 samples in Colby Lake is 0.95 µg/L. The ratio of dissolved to total arsenic is 95% based on 11 samples in which both dissolved and total arsenic were reported above the detection limit.

4.4.4.3.3 Iron

All 33 samples of total iron and all 19 samples of dissolved iron taken in Colby Lake exceed the secondary water quality standard of 300 µg/L for iron. The ratio of dissolved to total iron (based on 19 samples collected in 2008 and 2013) is 70%. Dissolved iron was not sampled in 2010.

4.4.4.3.4 Mercury

All five samples taken in November 2008 exceed the 1.3 ng/L mercury standard. Mercury was not monitored in 2010. Mercury was sampled four times in 2013. The average mercury concentration based on nine samples is 6.0 ng/L.

4.4.4.3.5 Manganese

Manganese exceeded the secondary water quality standard of 50 µg/L at one location in November 2008, with an average concentration of 44 µg/L among the five sampled locations. In 2010, manganese exceeded the secondary standard in c8 of 12 samples, with an average concentration of 75 µg/L among all 2010 samples. Both total and dissolved manganese were sampled 14 times in 2013. Total manganese exceeded 50 µg/L in all 2013 samples; dissolved manganese exceeded 50 µg/L in 12 of 14 samples. The average total manganese concentration in 2013 was 155 µg/L. The average ratio of dissolved to total manganese was 83% among 2013 samples.

4.4.4.3.6 Thallium

Thallium samples in 2008 were analyzed with a detection limit above the applicable Class 1B water quality standard of 0.28 µg/L. Four of the five 2008 samples were non-detect, with one

detection of 0.46 µg/L, exceeding the water quality standard. Analysis in 2010 was performed with a lower detection limit. No thallium samples in 2010 exceeded the water quality standard; the average concentration observed in 2010 was 0.032 µg/L (including non-detects at half the detection limit). The maximum observed concentration in 2010 was 0.066 µg/L.

4.4.4.4 Quality Assurance/Quality Control (QA/QC) Review

A QA/QC review was performed on the analytical results for the surface water sampling events for 2008, 2010, 2011, 2012, and 2013. This review was performed in accordance with the Barr Engineering Standard Operating Procedure for routine data evaluation, which is based on The National Functional Guidelines for Organic and Inorganic Data Review (Reference (38) and Reference (39)). Most analyses were performed either by NTS (prior to March 2011) or by Pace Analytical (after March 2011) located in Virginia, Minnesota. There were additional laboratories utilized throughout these sampling events as appropriate.

In general, the areas covered by the validation process are: USEPA recommended holding times and preservation, blank sample analyses, accuracy data, precision data, and an overall assessment of data quality.

Technical holding times were evaluated for each sample and target parameter, based on the USEPA recommendations listed in 40 CFR SW846 Test Methods for Evaluating Hazardous Waste. The technical holding times were met for the samples submitted to the laboratories during these sample events.

Field blank samples were collected and analyzed during the course of the sampling events. In these samples multiple target parameters were observed in the field blank samples. If the corresponding detections were small enough (less than five times the field blank value) to potentially be a “false positive” then that data was (b) qualified.

Method blank samples were analyzed and provided for the majority of the reports. In those reports, one or more method blank samples had minor detections of metals and general parameters, however, few data was qualified from these method blank sample detections because most corresponding samples were either five times this concentration amount or non-detect. No other qualifiers were applied based on blank data.

The accuracy and precision data review included evaluation of LCS, LCSD, MS, MSD, and duplicate sample data. Accuracy was evaluated by comparing laboratory percent recoveries from LCS, LCSD, MS, and MSD samples to laboratory acceptance criteria. Precision was evaluated by calculating the relative percent difference (RPD) of the LCS/LCSD sample pairs, MS/MSD sample pairs, and duplicate samples.

The LCS/LCSD pairs were evaluated and all met laboratory acceptance criteria and/or deviations were considered minor. A review of the MS/MSD sample pairs indicated there were percent recoveries and/or RPD for one or more MS/MSD samples that exceeded the laboratory limits for

multiple target parameters. The associated project sample data whose MS/MSD percent recoveries and/or RPD exceeded the laboratory acceptance criteria for accuracy, generally, by 5% or more, were (*) qualified.

Laboratory duplicate samples were evaluated, when required. Laboratory duplicates that were analyzed for thallium from Partridge River sample location PM-4 during the June 2012 sampling event and from PM-16 during the March 2013 sampling event had a calculated RPD that exceeded the acceptance criteria. The corresponding sampling data was qualified (*) as estimated. There were no other instances where the calculated RPD value of a project sample exceeded laboratory acceptance criteria and/or deviations were considered minor.

A field duplicate sample was collected for approximately one in five to ten samples. Field duplicate sample pairs with calculated RPDs greater than 30% are (*) qualified as estimated concentrations. This affected multiple field duplicate sample pairs for metals and general parameters. The RPD exceedances were not qualified if the parameter concentrations were at or near the reporting limit, which exaggerates the RPD value, and is not necessarily indicative of poor precision.

The field measurement of dissolved oxygen at Partridge River location PM-16 in February 2013 was noted as potentially suspect by the field technician and the data was qualified (BQS) to represent this.

The data met the Project requirements and is deemed acceptable for the purposes of this Project with the above mentioned qualifications.

5.0 Modeling Approach

This section presents the conceptual model for the Mine Site and provides details on the modeling methodology and input values.

5.1 Conceptual Model

Conceptual models for the main components of the Mine Site, including components of the Continuation of Existing Conditions Scenario Model and the Project Model, are presented below. This includes the waste rock and overburden stockpiles, mine pits, haul roads, Rail Transfer Hopper (RTH), and WWTF. Additional notes are made where the conceptual model differs from the modeling in the DEIS (Reference (51)) and SDEIS (Reference (52)).

The conceptual model for the Mine Site was presented in the approved Work Plan. The Work Plan presents the conceptual model for each mine feature in the probabilistic model and explains how the mine features are interrelated. The Work Plan text has been incorporated below to provide a coherent description of the modeling approach.

The following paragraphs describe individual conceptual model components.

5.1.1 Continuation of Existing Conditions Scenario Model

At the Mine Site, the Continuation of Existing Conditions Scenario is equivalent to the existing conditions. The only modeled source of constituent loading to the groundwater or surface water that does not represent background sources is the Peter Mitchell Pit discharge to the Partridge River. The background conditions in groundwater and surface water are described below.

5.1.1.1 Groundwater Flow Conceptual Model

The groundwater flow conceptual model is based on the baseline hydrogeologic conditions described in Section 4.3.3. Within the Mine Site boundary, existing groundwater flow is primarily to the south, with both water from the surficial aquifer and water in bedrock assumed to discharge to the Partridge River. Average groundwater quality is assumed to be constant through time in the Continuation of Existing Conditions Scenario Model and reflective of natural conditions as defined by Mine Site monitoring data (Section 4.3.4). Solute transport through the groundwater is not simulated in the Continuation of Existing Conditions Scenario Model.

5.1.1.2 Surface Water Conceptual Model

Water from the Mine Site flows to the Partridge River. The surface water conceptual model includes flows and loads in the Partridge River, based on the baseline surface water conditions described in Section 4.4.

The Partridge River flow is assumed to be a combination of groundwater baseflow and surface water. Constituent loading to the river is modeled by combining constituent loads from

groundwater and surface water with other source of water to the river, specifically the discharge from the Peter Mitchell Pit. Flow and chemical load from the discharge from the Peter Mitchell Pit is assumed to be of known quantity and quality and constant through time until ceasing in approximately 2070 (assumed to be equal to Mine Year 55). The discharge from the Peter Mitchell Pit is to the headwaters of the Partridge River at SW001. The concentrations resulting from loading to the Partridge River are calculated based on a cumulative probability density function of daily flow in the Partridge River, which is additive to the discharge from the Peter Mitchell Pit (Section 4.4.1 and Section 5.2.4.3.5). The Partridge River flow cumulative probability density function is re-sampled at each model time step of each realization. This allows water quality impacts to be computed over a wide range of estimated flows in the Partridge River. The results of this approach are analogous to the probability of exceeding a given concentration on a randomly selected sampling date.

Water from the Partridge River flows into Colby Lake. For modeling purposes, it is assumed that the sources of flow and load to Colby Lake are the flow and load from the Partridge River, the flow and load from the remainder of the lake's watershed (surface water and groundwater, assumed to reflect natural conditions), and an additional constant load to the lake, added for the FEIS modeling and determined during calibration (Section 5.2.4.8). Colby Lake is assumed to be well mixed.

5.1.2 Project Model

The Project Model includes the Waste Rock Stockpiles, the Ore Surge Pile (OSP), the Overburden Storage and Laydown Area (OSLA), the Mine Pits, the Haul Roads, the RTH and the WWTF. It estimates the effects of Project features on flows and constituent loading to surface water and groundwater during operations, reclamation, and long-term closure.

The Project that is modeled is described in the Project Description (Reference (9)). Large Figure 37, Large Figure 38, and Large Figure 39 show simple block diagrams of the conceptual model for the Mine Site in operations, reclamation, and long-term closure, respectively. The conceptual model includes water available, constituent sources, flow paths, attenuation of select constituents, dilution, engineered features (liners, covers), existing conditions, etc. Timelines of the significant changes to mine features are included as Large Figure 40 and Large Figure 41.

5.1.2.1 Waste Rock Stockpiles

The waste rock stockpiles (Category 1, Category 2/3, and Category 4 Waste Rock Stockpiles) and the OSP will be developed during operations as material is excavated from the mine pits.

The amount of each category of waste rock, ore, and saturated overburden that will be added to each stockpile in every month of operations is determined from the annual Mine Plan (Section 2.1 of Reference (3)). Saturated overburden will be placed in the temporary Category 2/3 and Category 4 Waste Rock Stockpiles along with the waste rock. This material is assumed

to behave chemically the same as the waste rock that is in the stockpile (Section 7 of Reference (6)).

The Category 1 Waste Rock Stockpile will be the only permanent stockpile. It will be reclaimed with an engineered geomembrane cover system constructed incrementally from Mine Year 14 through Mine Year 21. The Category 1 Waste Rock Stockpile will be surrounded by a containment system that will collect drainage (Section 5.1.2.1.1).

The Category 2/3 and Category 4 Waste Rock Stockpiles and the OSP will be temporary mine features. Each of these stockpiles will be constructed with a geomembrane liner and a drainage collection system (Section 5.1.2.1.2). Starting in Mine Year 11, the temporary Category 2/3 and Category 4 Waste Rock Stockpiles will be relocated to the East and Central Pits, after mining in each pit is completed. The Category 4 Waste Rock Stockpile will be completely removed by the end of Mine Year 11 and the Category 2/3 Waste Rock Stockpile will be completely removed by the end of Mine Year 19. The OSP will be removed at the end of operations with the ore transported to the Plant Site for processing.

It is assumed that each stockpile's water balance and constituent loading is a function of the climate data, the stockpile size and composition, the stockpile reclamation plan, and the containment system and/or liner system properties. The properties of each type of stockpiled rock are modeled based on the test results reported in Reference (6). The water balance and constituent loading for each stockpile is modeled by determining how much precipitation infiltrates the stockpile and how much runs off or evaporates. Inputs include the volume of water available at the top of the stockpile, which is a function of the monthly precipitation, the evaporation, runoff, and infiltration characteristics of the stockpile, and the designed stockpile footprint area. The water storage within the waste rock itself is assumed to be unchanging. At the bottom of the stockpile, the majority of the percolating water is collected as drainage by either a geomembrane liner (Category 2/3, Category 4, and OSP) or the containment system (Category 1). Drainage is routed to the WWTF. For the temporary stockpiles, once the stockpiled rock and the underlying liner systems are removed, the footprint areas for these temporary mine features no longer contribute water to the WWTF. Runoff from the temporary stockpile footprint areas returns to the natural watershed (Partridge River) once the stockpiles are removed.

The amount of water that is not collected (leakage) from the stockpile is determined from the liner/containment system design and effectiveness (Section 5.2.2.1). The leakage water from each stockpile is assumed to flow either to the mine pits or to the Partridge River via groundwater flow through the surficial aquifer, depending on the stockpile location. Water not collected by the Category 1 Waste Rock Stockpile Containment System will flow into the nearby West Pit or temporarily to the East Pit or deep bedrock (stockpile modeling in Attachment E of Reference (3) indicates negligible flow to the north); liner leakage from the Category 4 Waste Rock Stockpile will flow into the nearby East Pit. Liner leakage from the other lined stockpiles (Category 2/3 and OSP) will percolate to the surficial aquifer and flow to the Partridge River. Once these temporary stockpiles (Category 2/3 and OSP) are removed, recharge to groundwater from the stockpile footprint areas returns to the natural background recharge rate.

5.1.2.1.1 Category 1 Waste Rock Stockpile Groundwater Containment System

A containment system will completely surround the Category 1 Waste Rock Stockpile. Consisting of a cutoff wall (a low permeability hydraulic barrier) combined with a drainage collection system, the containment system will collect stockpile drainage and convey it to the WWTF. By drawing down the water table on the stockpile side of the cutoff wall and maintaining an inward gradient, the containment system will minimize the potential for stockpile drainage to pass through the cutoff wall. The conceptual model of the containment system is based on the design and operation plans detailed in Section 2.1.2 of Reference (3).
Large Figure 42 shows the footprint of the Category 1 Waste Rock Stockpile Groundwater Containment System. It is assumed that a small amount of stockpile drainage will flow permanently under the southern portion of the containment system through bedrock and into the West Pit. Based on the modeling of the containment system for the FEIS presented in Reference (3), is also assumed that during operations small amounts of stockpile drainage will flow through bedrock into the East Pit and into deep bedrock beneath the mine pits. The flow into deep bedrock is assumed to combine with the outflow from the West Pit to bedrock (Section 5.2.3.1). It is assumed that no groundwater from outside the containment system will be captured by the containment system.

5.1.2.1.2 Waste Rock Stockpile Geomembrane Liners Systems

An engineered geomembrane liner system will underlie all temporary stockpiles. Liner system design is based on the classification of the stockpiled rock and the existing topography. Consisting of an underdrain, an impermeable geomembrane, and an overliner drainage layer, the liner systems will collect stockpile drainage and convey it to the WWTF. The Mine Site Water model estimates the potential leakage through each stockpile liner based on liner properties as described in Section 2.1.3 of Reference (3).

5.1.2.2 Overburden Storage and Laydown Area (OSLA)

The OSLA will be used to screen, sort, and temporarily store Peat and Unsaturated Overburden for future use. This overburden is assumed to have the same hydrologic properties as a reclaimed stockpile. The OSLA is an unlined area, so the infiltration rate through the surface is assumed to be equal to the seepage rate into groundwater below the OSLA. The infiltration through the OSLA surface percolates to the surficial aquifer and flows away from the Mine Site to the Partridge River. The results of the Meteoric Water Mobility Procedures test for peat and unsaturated overburden material are used to model water quality for the water leaving the OSLA (Section 7 of Reference (6)). Runoff from the OSLA is assumed to have the same water quality as the infiltrating water; runoff is collected and pumped to the Central Pumping Station (CPS) pond for transport to the Plant Site.

5.1.2.3 Mine Pits

The water balance for each mine pit is modeled by determining the water volume reaching the bottom of the pit, which is a function of the monthly precipitation and evaporation, the runoff

from pit walls and outside-pit contributing areas, the groundwater inflows to the pit, and the designed pit footprint area (Section 5.2.2.6). There will be a limited amount of runoff into the pits during operations as pit rim dikes, seepage control measures, and perimeter dikes will be constructed to minimize the amount of runoff that will enter the pit (Reference (1)). These inflows will be collected in sumps, which will be pumped to the WWTF. This flow will be treated at the WWTF, then conveyed to the Plant Site via the Treated Water Pipeline from the CPS.

The footprint area of the pits will change over time as the pits are developed, which controls the total amount of precipitation that falls on each pit. The groundwater inflows will increase during the mine life, as the pits deepen. The amount of rock in the pit wall is held constant over time to simplify the model construct, equal to that in the final pit shell.

Constituent loading to pit water will be contributed by the pit walls, the in-pit inventory of blasted ore, groundwater inflow, and waste rock placed in the East and Central Pits as backfill when mining is completed (Section 5.1.2.1). The backfill rock will add constituent mass resulting from oxidation in the rock while in the temporary stockpiles and continues to generate constituent mass as long as it is above the water level. To maintain circumneutral pH conditions, the pH in the backfill and porewater will be adjusted as needed, as discussed in Section 2.2.1.1 of Reference (4). The backfill pH control is assumed for the water quality modeling to not add any constituent mass to the East Pit.

The mine pits will be flooded when mining is completed. In Mine Year 11, East Pit flooding will begin via groundwater inflow to the pit, supplemented with effluent from the WWTF as needed. As waste rock stockpiles are relocated into the pit, all but the upper few feet of backfill rock will be submerged at any time. During the later years of East Pit flooding, the water level will be maintained via pumping at a greater depth below the top of the backfilled rock in order to allow for safe mining in the Central Pit; once mining in the Central Pit is complete the combined East/Central Pit will be fully backfilled and flooded as quickly as possible. West Pit flooding will begin once the ore is exhausted (Mine Year 20). Flooding via natural sources (groundwater inflow to the pit and precipitation) will be supplemented with effluent from the WWTF and the WWTP. It is assumed that both pits will be well mixed, but that the East Pit will be divided into upper and lower zones representing the effects of a low-conductivity soil layer placed at approximately the bedrock rim of the pit.

The groundwater inflow and amount of exposed rock in the pit walls will decrease as the pits flood with water. The East Pit will overflow to the West Pit shortly after Mine Year 20. During the backfilling period the WWTF will treat any water pumped out of the East Pit to remove the constituents added with the relocated rock. After the East Pit is full (during the reclamation period) the WWTF will continue to pump and treat the backfill water as long as necessary to meet water quality goals, while returning most of the treated water to the pit to maintain subaqueous conditions for the backfilled waste rock.

The West Pit will not be allowed to overflow. Once the West Pit reaches a water level several feet below its natural overflow elevation the WWTF will pump water out of the West Pit for treatment and discharge to a small watercourse that flows into the Partridge River.

There have been several changes to the modeling of constituent release from the wall rock compared to the DEIS modeling. Similar to the waste rock stockpiles, constituent generation rates for most metals are now based on waste rock metal to sulfur ratios rather than humidity cell release rates. The long-term decay in sulfate release rates from the exposed wall rock is now based on both MDNR long-term test data and NorthMet humidity cell data; the DEIS modeling used only MDNR test data. Scaling from laboratory to field constituent release rates now accounts for both solar heating of the south-facing wall rock and the smaller depth of reactive rock anticipated in the pit rim set back areas around both mine pits.

Other changes to the conceptual model of the mine pits relative to the DEIS include:

- explicit accounting for the volume of the saturated overburden material added to the East Pit backfill
- consideration of the flow of groundwater over the pit walls with respect to the potential for wall rock runoff reaching concentration caps
- the application of empirical concentration caps to the water in both mine pits during flooding

5.1.2.4 Haul Roads and Rail Transfer Hopper (RTH)

The water collected from surface runoff of the haul roads and the RTH will be stored in process water ponds and routed to the WWTF. For the purposes of estimating the water quality of the runoff from the haul roads, it is assumed the road material will have the same properties as Category 1 waste rock (Section 8 of Reference (6)) with an assumed one foot depth of crushed rock top dressing. For the purposes of estimating the water quality of runoff from the RTH, it is assumed that there will be one foot depth of spilled fine ore using the same methods proposed to evaluate impacts of spilled ore along the transport corridor (Section 8.4.3 of Reference (6)). In both cases, the material is modeled as having the same particle size distribution as the crushed material in the NorthMet humidity cell tests (i.e., there is no scaling for particle size). The liner leakage quantity from the double-lined RTH sump and the lined haul road process water ponds (which only hold water during storm events) is assumed to be negligible and is not included in the model.

5.1.2.5 Wastewater Treatment Facility (WWTF)

The WWTF is designed to treat the influent water as required to manage the Flotation Tailings Basin (FTB) Pond water quality (operations), the East Pit backfill and West Pit water quality (reclamation), and the discharge to the Partridge River (long-term closure). The water quantity

and quality delivered to the WWTF are estimated based on the quantity and quality of the water collected from the waste rock stockpiles, mine pits, haul roads, and RTH. The Mine Site WWTF also receives water and constituent loading in the reject concentrate transported from the Plant Site WWTP during operations and reclamation. Water effluent target concentrations are modeled as constants for each modeling period (operations, reclamation, and long-term closure).

The quantity and quality of water leaking through the pond liners from the WWTF ponds is determined by the liner design and effectiveness and the amount of water assumed to be ponded on the liner. Liner leakage from WWTF ponds percolates to the surficial aquifer and flows away from the Mine Site to the Partridge River.

5.1.2.6 Groundwater Flow and Solute Transport

Eight groundwater flow paths have been defined as the pathways for drainage/leakage from the various mine features to the Partridge River: five in the surficial aquifer and three in the bedrock. In general, groundwater flows to the south and southeast from the Mine Site toward the Partridge River.

The Mine Site groundwater flow paths originate at mine features (pits, stockpiles, WWTF equalization basins) and extend downgradient to the Partridge River, which represents the discharge area for groundwater in the surficial aquifer and shallow bedrock (Large Figure 28 and Large Figure 29). Groundwater contours for the unconsolidated deposits and bedrock are the primary source of information used to delineate the flow path areas. The groundwater contours are from the Mine Site MODFLOW model, which was calibrated using measured groundwater elevations at the Mine Site (Attachment B). For the flow paths that originate from features that will only influence the surficial aquifer (OSLA flow path, WWTF flow path, and OSP flow path), the flow path boundaries were delineated by extending lines generally perpendicular to the groundwater contours from the outer edges of the feature to the Partridge River. For the surficial aquifer flow paths that originate at the pits, top of bedrock elevations in the area adjacent to the pits were used to determine the upgradient width of the flow paths. The flow paths include areas where the average long-term pit water elevation is higher than the bedrock elevation near the pit, because these represent areas where groundwater outflow to the surficial aquifer is likely to occur. The bedrock groundwater flow paths were delineated using groundwater contours. Liner leakage from the OSP, WWTF ponds, OSLA, and temporary Category 2/3 Waste Rock Stockpile is assumed to reach the Partridge River between monitoring locations SW003 and SW004. Groundwater outflow from the flooded East Pit (surficial and bedrock flow paths) is also assumed to reach the Partridge River between monitoring locations SW003 and SW004. Groundwater outflow from the flooded West Pit is assumed to reach the Partridge River between monitoring locations SW003 and SW004 (portion of bedrock flow path) and between SW004 and SW004a (surficial flow path and a portion of the bedrock flow path). The majority of stockpile drainage from the Category 1 Waste Rock Stockpile is collected by the containment system and is routed to the WWTF, with a small portion flowing beneath the containment system into the West Pit, the East Pit, or deep bedrock. Liner leakage from the temporary Category 4

Waste Rock Stockpile is assumed to be drawn into the nearby East Pit until the stockpile is removed and the ground beneath it excavated to form the Central Pit.

The flow of water along each groundwater flow path is dependent on the amount of recharge applied to the aquifer from non-stockpile areas, the time-varying liner leakage from stockpile areas, and the groundwater flow discharging from the mine pits (after the pits have flooded). The recharge rate from non-stockpile areas is calculated at the initial time step of each realization based on the hydraulic conductivity along the flow path and the average hydraulic gradient along the flow path, both of which are uncertainty inputs to the model. Hydraulic conductivity and the recharge rate applied to non-stockpile areas are then be held constant for each realization. The gradient is allowed to vary during the simulation to account for changes in the discharge from the flow path to the river due to temporal changes in liner leakage rates and pit inflow rates, with the assumption that the head in the river is constant. Flow from the Mine Site pits is calculated in the GoldSim model based on the calculated recharge to non-stockpile areas, the selected hydraulic conductivity, and an estimated hydraulic gradient which takes into account the long-term pit water elevation.

Each source of water to the aquifer has dissolved constituents which are added to the aquifer and transported via advection and dispersion. Attenuation due to sorption to the aquifer matrix is simulated in the surficial aquifer for selected constituents. The GoldSim model provides estimates of the water flow and dissolved concentrations at specified locations within each groundwater flow path (Section 5.2.3).

For the analysis presented in the DEIS, groundwater transport was simulated using MODFLOW/MT3D models that represented the groundwater flow paths between mining features and the Partridge River. For the current modeling (both SDEIS and FEIS modeling), the groundwater flow paths are incorporated into the GoldSim model using the GoldSim Contaminant Transport (CT) module (Section 5.2.3). The NorthMet model uses a set of the GoldSim CT “cell pathways” linked in series for this process. The setup is essentially a finite-difference or finite-volume analysis which is similar to MODFLOW/MT3D and many other contaminant transport models.

The groundwater flow paths transport mass using a mix of analytical and numerical solution methods. In short, the flow equation is solved analytically and is an exact solution to the idealized representation of the aquifer; the transport equation is solved numerically using a series of well-mixed cells of known volume and flow characteristics. The solution to the network of cells is not explicit in a sense that one cell is solved, then the next, then the next, etc. The entire coupled system of cells is solved at once using a set of matrices.

5.1.2.7 Surface Water

The flow of water and dissolved constituents exiting each of the groundwater flow paths replaces a portion of the expected groundwater inflow (baseflow) to the Partridge River in the Project Model. The total amount of baseflow to the Partridge River changes slightly due to Project-

related changes to the total area contributing recharge to groundwater (i.e., development of mine pits and temporary stockpiles). Of the remaining baseflow, a portion of the groundwater originates from background watershed recharge only (no change from the Continuation of Existing Conditions Scenario Model) and a portion originates from the modeled groundwater flow paths from the Mine Site. Otherwise, there is no change in the conceptual model for surface water between the Continuation of Existing Conditions Scenario Model and the Project Model.

5.2 Mine Site Model Construct

Modeling of the estimated impacts to surface and groundwater quality at the selected evaluation locations is performed as a probabilistic Monte Carlo simulation using the GoldSim simulation software (Section 3.1 and Section 3.3).

The model time period, calculation time steps, and output parameters are the same for the Continuation of Existing Conditions Scenario Model and the Project Model. The Project Model adds Project features to the Continuation of Existing Conditions Scenario Model. The difference between Continuation of Existing Conditions Scenario Model results and Project Model results represents the estimated effect of the Project.

The model inputs that are known or have very small uncertainty (as either time-series or constant through time) are termed *deterministic inputs*. Typical deterministic inputs are engineering design parameters (stockpile dimensions, WWTF effluent concentrations), operational parameters (mining rate, pit flooding rate) and physical characteristics (flow path dimensions, stream segment length, topographical elevations, etc.).

The model inputs that have uncertainty in their true values or temporal or spatial variability at any point in the life of the project are termed *uncertain inputs*. These uncertain inputs may be constant through time or vary through mine operation, reclamation and long-term closure. Typical uncertain inputs represent natural variability (annual precipitation and evaporation, stream flow, etc.), environmental parameters (average aquifer hydraulic conductivity, average recharge water quality, etc.), geochemical parameters (constituent generation rates, scale factors, concentration caps, etc.) and performance of engineered systems (cover effectiveness, etc.). Each uncertain input has a defined probability distribution, frequency of sampling and correlation coefficients (if appropriate).

Table 1-1 of Attachment C contains a complete list of all deterministic and uncertain inputs to the Mine Site water quality models (Project and Continuation of Existing Conditions Scenario), including parameters to define all probability distributions. Tables 1-2 through 1-40 of Attachment C provide additional detailed input information for selected model inputs.

For both models, the model outputs are continuous from Mine Year 0 (the start of mining) through Mine Year 200, with calculations performed on a monthly time step and results summarized as monthly or annual values as appropriate. Mine Year 200 is when the Project

Model reaches approximately steady state long-term closure conditions. Steady state long-term closure conditions are defined as:

- the West Pit is flooded and discharging (via the WWTF) with constant or decreasing concentrations
- the groundwater concentrations at the furthest evaluation locations (i.e., Partridge River) have peaked and are declining towards an approximate steady state

The probabilistic water quality model was executed for 500 realizations (runs). For each realization, the uncertain inputs are randomly sampled based on the defined probability distributions. During each realization the deterministic inputs may vary as a function of time and the uncertain inputs may be sampled according to a defined frequency (e.g., precipitation sampled every year).

The construct of the Project Model is shown in Large Figure 43 through Large Figure 46. This section documents methods, assumptions, and the development of model inputs for the Continuation of Existing Conditions Scenario Model and Project Model that are not discussed in other documents. The Continuation of Existing Conditions Scenario Model construct and the Project Model construct are described concurrently rather than in separate sections. Because the Mine Site is currently undeveloped, this structure is eliminates repetition, especially in description of the groundwater and surface water modeling.

5.2.1 Climate Model Inputs

5.2.1.1 Precipitation

The probabilistic modeling approach samples a distribution of annual rainfall each year at the beginning of the year (i.e., it is a probabilistic, time-variable parameter). From this value, monthly precipitation values are calculated based on a deterministic ratio of monthly precipitation to annual precipitation. The sum of the ratios for all twelve months is 1. The distribution of annual rainfall and the ratio of monthly precipitation to annual precipitation are discussed in this section.

The average annual precipitation for the Mine Site calculated over the most recent climate normal periods (1981-2010) is approximately 28.7 inches; this value was calculated from NWS sites closest to the Mine Site using the Minnesota Climatology Working Group's High Density Network (HiDen) (Section 4.1 and Reference (53)). The distribution is based on annual precipitation from this 30-year period. The probability distribution for annual precipitation is a normal distribution with a cubic root transformation, like that used for the uncertainty analysis performed for the DEIS (Reference (54)). The resulting cumulative distribution function for annual precipitation at the Mine Site has a mean of 3.05 ($in^{1/3}$) and a standard deviation of 0.16 ($in^{1/3}$). The distribution is presented in Figure 5-1 and Table 1-1 of Attachment C. In order to

maintain a consistent model water balance, the same value for precipitation is applied to all components of the Mine Site model.

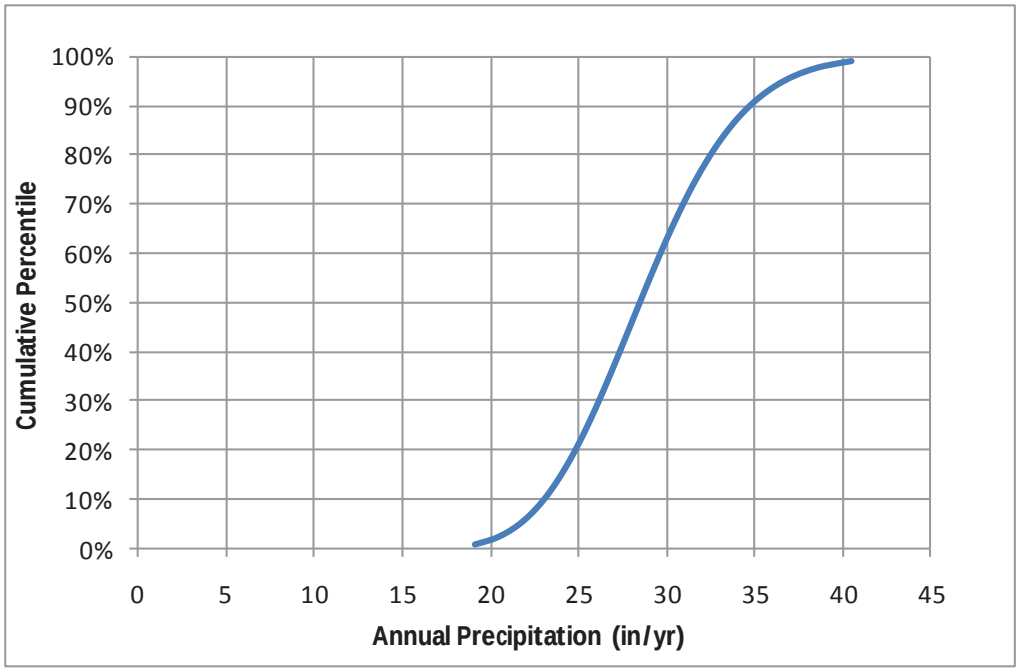


Figure 5-1 Distribution of Annual Mine Site Precipitation (1981-2010)

From the 1981-2010 precipitation record, monthly precipitation was calculated as a percentage of annual precipitation for each year and the average percentage over the entire period of record was calculated (Table 5-1 and Table 1-11 of Attachment C). The sum of the percentages for the twelve months is 100%. The percent of annual precipitation occurring in each month is treated as deterministic and constant within the probabilistic model.

Table 5-1 Monthly Distribution of Mine Site Annual Precipitation (1981-2010)

Period	NWS Precipitation (inches)	Percent of Annual
January	0.81	2.8%
February	0.68	2.4%
March	0.88	3.1%
April	1.87	6.5%
May	3.34	11.6%
June	4.03	14.0%
July	4.01	14.0%
August	4.00	13.9%

Period	NWS Precipitation (inches)	Percent of Annual
September	3.88	13.5%
October	2.75	9.6%
November	1.46	5.2%
December	0.96	3.3%
Annual	28.7	100%

5.2.1.2 Evaporation (Open Water)

Pan evaporation data from Hoyt Lakes collected from 1966 to 1983 yields an average annual open water evaporation of 20.8 inches when a 0.78 pan coefficient is used (Section 4.1 and Reference (14)). This data included no evaporation for winter months. Open water evaporation varies by year due to climatic conditions. The Thornthwaite method is a simple way to calculate annual evaporation at a monthly time step. This method was used to estimate annual open water evaporation from 1981-2010 using Equation 5-1, returning an average value of 20.8 inches per year and a standard deviation of 1.33.

$$E = 0.63\left(\frac{10T_a}{I}\right)^a$$ **Equation 5-1**

Where:

E is evaporation in inches/month

T_a is the average air temperature

I is an index and a function of mean monthly air temperatures throughout the year, and a is a polynomial function of I (Reference (55) and Reference (56)).

A normal distribution for annual open water evaporation was developed from these values (mean 20.8, standard deviation 1.33 (Table 1-1 Attachment C) and is sampled every year in the probabilistic model. The monthly evaporation is calculated as a fraction of the annual evaporation based on the monthly distribution of evaporation included in the 1966-1983 Hoyt Lakes dataset (Reference (14)). That distribution is presented in Table 5-2 and Table 1-11 of Attachment C.

Table 5-2 Monthly Distribution of Mine Site Annual Open Water Evaporation (1981-2010)

Period	Open Water Evaporation (inches)	Percent of Annual
January	0.0	0.0%
February	0.0	0.0%
March	0.0	0.0%
April	0.97	4.7%
May	3.85	18.5%
June	4.38	21.0%
July	4.91	23.6%
August	3.92	18.8%
September	2.27	10.9%
October	0.51	2.4%
November	0.0	0.0%
December	0.0	0.0%
Annual	20.8	100%

5.2.1.3 Runoff from Undisturbed Areas

Stormwater runoff produced from natural undisturbed and reclaimed areas (including the reclaimed Category 1 Waste Rock Stockpile) within the Mine Site is collected and routed to the Partridge River following existing drainage patterns wherever possible. Runoff from these areas is incorporated in to the Partridge River XP-SWMM model developed as described in Section 5.2.4.3. Runoff generated from other areas that is input to various Mine Site water balances is described in this section. The stormwater chemistry does not differ from the existing background water chemistry of the natural runoff in the Partridge River watershed (Section 5.2.4.7). Therefore, stormwater flows routed to the Partridge River do not represent a significant change to the existing water quality and are not specifically addressed as part of this water quality assessment.

The Partridge River flow record (USGS gage 04015475) is described in Section 4.4.1.2 and covers a watershed area of 103.4 square miles. The flow record was adjusted to account for the dewatering of the Peter Mitchell Pit (Section 4.4.1.2). Because the adjusted flow record removes discharge from the Peter Mitchell Pit, the drainage area tributary to those pits is subtracted from the total, reducing the tributary area for the adjusted flow record to 97.0 square miles. Based on the adjusted flow record and watershed area, the annual runoff is 41% of the annual precipitation, ranging from a minimum of 21% to a maximum of 59% within the 1978-1987

period of analysis. A normal distribution (mean of 0.41, standard deviation of 0.117) was assumed for the distribution of runoff as a percent of precipitation in the Partridge River watershed.

The percent runoff from the open water period was calculated using the above process applied only to the months June through November. April and May are excluded from the analysis because the runoff observed in those months is a mixture of melting snowpack and rainfall precipitation. The average open water period runoff was 30% with a standard deviation of 0.092, assuming a normal distribution. It is assumed that this distribution is applicable to precipitation falling in the month of April and May.

The average percent of winter (December through March) precipitation that becomes runoff in April (the snowmelt month assumed in probabilistic modeling) was calculated from the average annual runoff and open water period runoff using Equation 5-2:

$$\%RO_{annual} = \frac{4}{12}\%RO_{winter} + \frac{8}{12}\%RO_{open\ water} \qquad \textbf{Equation 5-2}$$

From Equation 5-2, the average percent runoff for the winter period is 63% of the precipitation during that period. That is, 63% of the cumulative precipitation becomes runoff during snowmelt. The variance for the percent of winter precipitation becoming runoff was calculated from the variance of the open water runoff fraction *($\%RO_{open\ water}$)* and the variance of the annual runoff fraction *($\%RO_{annual}$)* using basic probabilistic identities. The resulting standard deviation is 0.27, assuming a normal distribution. The distribution for $\%RO_{winter}$ is truncated with a minimum of 0 and a maximum of 1 (i.e., there cannot be negative runoff, nor can there be more runoff than the total winter precipitation). The seasonal fractions of precipitation that become runoff are each year within the probabilistic model but remain constant throughout that year.

During winter months, no runoff is generated, and a fraction of the monthly precipitation is accumulated as snowpack ($\%RO_{winter}$) to become runoff during the spring melt month (April). During the open water period (April through November) a fraction of the monthly precipitation ($\%RO_{open\ water}$) is immediately available as runoff. Over repeated iterations, the distribution of annual runoff fraction as calculated from the winter and open water runoff fractions closely matches the distribution of annual runoff fraction calculated directly from the annual flow data. Thus, the seasonal distributions are adequate for this analysis.

5.2.2 Project Features

Project features are represented in the Project Model and omitted from the Continuation of Existing Conditions Scenario Model. The engineered characteristics of many Mine Site features are considered to be known in the water quality model. Many of these characteristics are not constant but change through time as the mine is developed and eventually reclaimed. The quantities (e.g., stockpile waste rock) and timing (e.g., placement in stockpiles) of these variables

are considered to be deterministic. The engineered deterministic variables in the water quality model include those shown in Table 5-3.

Table 5-3 Engineered Mine Site Variables

Feature	Variable	Time Dependence	Source
Waste Rock Stockpiles	Dimensions	Time-variable	Section 2.1 of Reference (3)
	Waste rock quantity	Time-variable	Section 2.1 of Reference (3)
	Reclamation area	Time-variable	Section 2.1 of Reference (3)
	Watershed divides	Time-variable	Large Figure 21 - Large Figure 27
Mine Pits	Dimensions	Constant at maximum extents	Section 3.0 of Reference (2)
	Wall rock area (by category) with depth	Constant at maximum extents	Section 2.4 of Attachment A of Reference (3)
	Backfill waste rock quantity	Time-variable	Section 2.1 of Reference (3)
	Runoff tributary area	Constant at maximum extents	Large Figure 21 - Large Figure 27
	Overflow elevation	Constant at closure	Section 6.2.5 of Reference (2)
Waste Water Treatment Facility	Pond dimensions	Constant during mining	Reference (1)
	Maximum dewatering rate	Constant	Reference (1)

5.2.2.1 Waste Rock Stockpiles

The GoldSim model estimates how precipitation falling on the waste rock stockpiles is allocated between evaporation, runoff, and infiltration. It also estimates how the characteristics of the material in each stockpile contribute to constituent loading in runoff and drainage.

5.2.2.1.1 Stockpile Water Balance Modeling

Accurate characterization of stockpile water balances is necessary in an integrated model to prevent under- or over-counting of water and pollutant mass from each component of the model. Each stockpile must have an explicit water balance in which inflows equal outflows. This section

details the methods for modeling the hydrology of waste rock stockpiles within the probabilistic model approach. This section references climate inputs described in Section 5.2.1.

The conceptual model for the water balance of a waste rock stockpile is straightforward:

$$P = Runoff + ET + Infiltration + \Delta Storage \qquad \textbf{Equation 5-3}$$

Precipitation (*P*) is modeled for each monthly time step based on the method described in Section 5.2.1.1. Evapotranspiration (*ET*) and runoff from each modeled time step are estimated based on the methods described in Sections 5.2.2.1.2 and 5.2.2.1.4, respectively. Previous technical discussions have indicated that there is unlikely to be significant net storage of water within the waste rock stockpiles during their initial construction, although there is not universal agreement on this point (Reference (57)). With respect to the long-term performance of the stockpiles, it is agreed that the annual net change in water storage within the stockpiles is likely to be minimal. This analysis assumes that the water storage of the waste rock stockpiles does not change from year to year, effectively removing storage from the water balance equation. The water balance then becomes:

$$P = Runoff + ET + Infiltration \qquad \textbf{Equation 5-4}$$

In the case of bare rock stockpiles, infiltration is the residual unknown. For portions of the Category 1 Waste Rock Stockpile reclaimed with a geomembrane cover and vegetated, infiltration is estimated from a known distribution (Section 5.2.2.1.3) and runoff is then solved for as the unknown. For all stockpiles, the water that enters the stockpile in the form of infiltration is assumed to pass within the same time step to the stockpile base, where it encounters the stockpile liner or containment system. The water balance for this water at the bottom of the stockpile is:

$$Infiltration = Containment + Leakage \qquad \textbf{Equation 5-5}$$

The portion of the infiltrating water that is contained is routed elsewhere in the Mine Site for treatment or to flood the mine pits. The leakage water enters groundwater flow paths leading to off-site evaluation locations or, in the case of the Category 1 Waste Rock Stockpile, is routed directly to the West Pit. Estimation of stockpile leakage is detailed in Section 5.2.2.3.

5.2.2.1.2 Evapotranspiration (Waste Rock Stockpiles)

Evapotranspiration from non-stockpile areas is not used as a model input. Evapotranspiration from stockpiles is used as an input to the stockpile water balance and is described in this section. Data on evapotranspiration for hydrologic studies are often gathered indirectly, with evapotranspiration as the residual (unmeasured) term in the water balance. This is the case for data collected on test piles (some reclaimed and some bare rock) for rock generated by the AMAX exploratory shafts, located near the Mine Site. The values shown in Table 5-4 represent the fraction of annual rainfall that was either measured as surface runoff or collected from the

geomembrane liners beneath the test piles. The remaining (uncollected) water is assumed to be lost to the system as evapotranspiration. This assumes negligible losses via liner leakage.

This data is used to develop probability distributions for evapotranspiration for bare rock and reclaimed stockpiles. Because the distribution is used to represent the mean fractional evapotranspiration for the stockpiles throughout time and across the entire stockpile footprint, the analysis aims to develop a distribution for the uncertainty in the mean of the entire population of data (as opposed to the uncertainty in the range of possible observed values). Conceptually, it is expected that the true mean of the population of stockpile evapotranspiration throughout time can be known with less uncertainty than the evapotranspiration for any given year.

The uncertainty in the population mean is estimated with the jackknife method, in which each of n observations is sequentially removed from the data set to develop n different estimates of the true mean. These estimates of the mean are then compared to the mean of the entire data set to determine the range of uncertainty in estimating the true mean. The uncertainty in the mean is assumed to be normally distributed. The results of the jackknife analysis for the AMAX test pile evapotranspiration data are shown in Table 5-5. Not surprisingly, the standard deviation for the estimate of the population mean is less than the standard deviation of the data set as a whole.

Table 5-4 Stockpile Hydrology Data

Year	Precip. (in)	Natural W'sheds	Bare Rock Stockpiles				Reclaimed Stockpiles (soil & vegetation cover)	
			FL1	FL3[1]	FL4	FL6	FL2	FL5
		Fraction of Precipitation Collected as Runoff or on Liners (original data)						
1978	27.4	0.43	0.50	0.54	0.50	0.65	0.36	– [2]
1979	24.9	0.49	0.45	0.45	0.35	0.58	0.34	– [2]
1980	23.1	0.26	0.32	0.35	0.28	0.45	0.16	– [2]
1981	25	0.4	0.45	0.49	0.53	0.64	0.31	0.27
1982	34.1	0.44	0.48	0.50	0.53	0.66	0.35	0.37
1983	27.9	0.42	0.43	0.36	0.47	0.47	0.24	0.26

Year	Precip. (in)	Natural W'sheds	Bare Rock Stockpiles				Reclaimed Stockpiles (soil & vegetation cover)	
			FL1	FL3(1)	FL4	FL6	FL2	FL5
		Fraction of Precipitation as Evapotranspiration (1 - original data)						
1978	27.4	0.57	0.50	0.46	0.50	0.35	0.64	– (2)
1979	24.9	0.51	0.55	0.55	0.65	0.42	0.66	– (2)
1980	23.1	0.74	0.68	0.65	0.72	0.55	0.84	– (2)
1981	25	0.6	0.55	0.51	0.47	0.36	0.69	0.73
1982	34.1	0.56	0.52	0.50	0.47	0.34	0.65	0.63
1983	27.9	0.58	0.57	0.64	0.53	0.53	0.76	0.74

Source: Reference (58); additional data collected from 1984-1993 not considered for the purposes of this evaluation because stockpiles FL4 and FL3 were removed from the study.
(1) Stockpile FL3 was reclaimed with 34 cm of vegetated coarse sand, but did not show differences in performance from the bare rock stockpiles. It is treated here as a bare rock stockpile.
(2) Stockpile FL5 was reclaimed in 1980. Only data for the reclaimed time period are presented here.

Table 5-5 Jackknife Method Results for Evapotranspiration as a Fraction of Precipitation

Stockpile Condition	Sample Mean	Sample Range	Sample St. Dev.	St. Dev. of Mean(1)	Coefficient of Variation
Bare Rock	0.524	0.34 - 0.72	0.099	0.020	0.039
Reclaimed (soil & veg. cover)	0.704	0.63 - 0.84	0.069	0.023	0.033

(1) Estimated using jackknife method.

The mean and standard deviation shown in Table 5-5 define a normal distribution for the stockpile mean evapotranspiration as a fraction of annual precipitation. In the GoldSim model for the Mine Site, this normal distribution is used to generate a single value for evapotranspiration throughout each model realization (i.e., mean evapotranspiration does not vary annually). Note that the mean evapotranspiration developed here for the reclaimed stockpile is similar to the expected average annual potential evapotranspiration at the Mine Site (21" *ET* from 28.7" precipitation or 73% *ET*). When combined with the distribution for annual rainfall shown in Figure 5-1 the resulting annual evapotranspiration distributions is as shown in Figure 5-2.

In the GoldSim model, the distribution for bare rock *ET* in Table 5-5 is used to estimate the *ET* from the temporary waste rock stockpiles and the bare Category 1 Waste Rock Stockpile. The distribution for reclaimed *ET* in Table 5-5 is used to estimate the *ET* from the reclaimed Category 1 Waste Rock Stockpile and the OSLA.

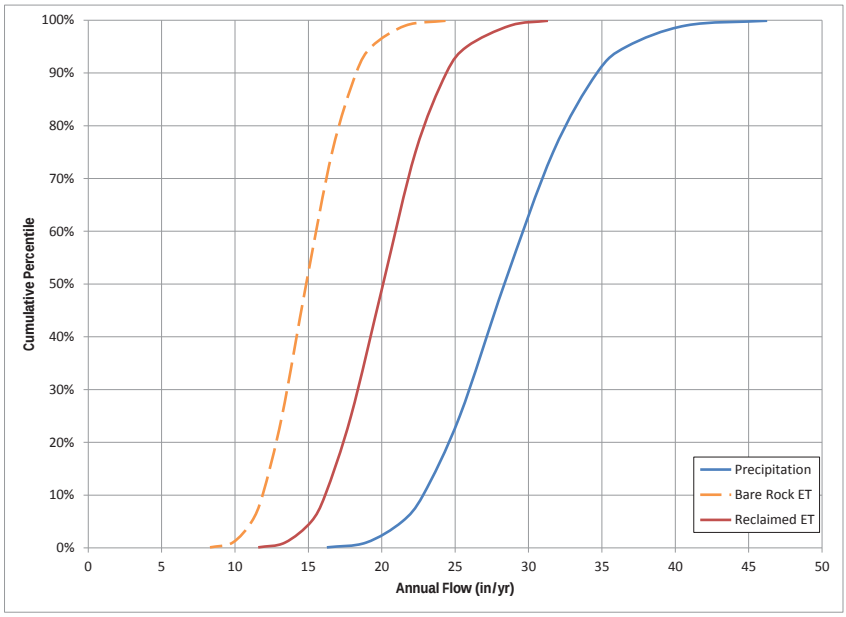


Figure 5-2 Cumulative Distribution Functions for Annual Evapotranspiration

5.2.2.1.3 Infiltration (Percolation)

Bare stockpiles are assumed to have zero runoff (Section 5.2.2.1.4). Thus, infiltration through stockpiles is calculated at each model time step as precipitation (P) minus evapotranspiration (ET) as shown in Equation 5-6.

$$Infiltration = P - ET \qquad \textbf{Equation 5-6}$$

During reclamation, the vegetated geomembrane cover on the Category 1 Waste Rock Stockpile greatly reduces the amount of infiltration into the stockpile. The characteristics and engineering design of the geomembrane cover system are described in Reference (4). The geomembrane cover system is incorporated into the probabilistic model with the following assumptions:

- The stockpile remains bare (no cover) until the geomembrane is installed.
- The stockpile footprint area increases slightly as the stockpile is re-graded for geomembrane installation.
- Geomembrane installation begins at the beginning of Mine Year 14 and is completed 8 years after it begins (end of Mine Year 21).
- Percolation through the geomembrane is modeled as an uncertain variable with a lognormal distribution, similar to the modeling for the geomembrane liners on the temporary stockpiles (Section 5.2.2.3). The percolation rate (as a percent of precipitation) is randomly-selected once per realization and remain constant for the remainder of the realization.

The Hydrologic Evaluation of Landfill Performance (HELP) Model was used to estimate percolation from the base of the cover into the stockpile (i.e., infiltration). Development of the model input distribution is described in detail in Section 3 of Reference (4). The resulting distribution fits multiple potential defect scenarios, and is shown in Figure 5-3. The resulting distribution has a 10th percentile percolation rate of 0.1% of precipitation (0.03 in/yr), a mean of 0.53% of precipitation (0.146 in/yr) and a 90th percentile percolation rate of 1.1% of precipitation (0.30 in/yr). Using this modeled mean value, the mean total percolation through the stockpile during long-term closure corresponds to approximately 4 gpm.

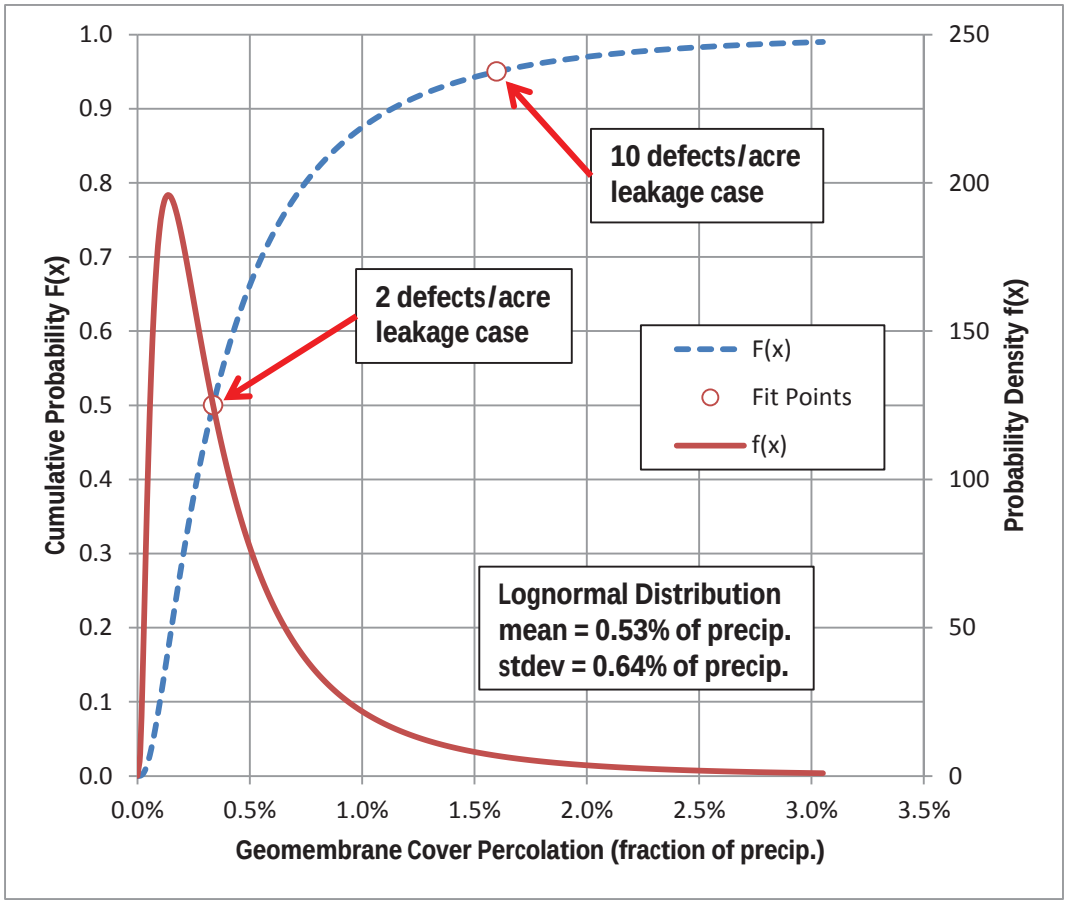


Figure 5-3 Cumulative Distribution Functions for Reclaimed Stockpile Percolation/Infiltration

5.2.2.1.4 Runoff from Waste Rock Stockpiles

Bare rock (active) stockpiles are assumed to have zero surface runoff because of their coarse particle sizes and the safety berms that are placed around the stockpile perimeter which promote ponding and infiltration of precipitation.

Runoff from reclaimed portions of the Category 1 Waste Rock Stockpile is calculated as the residual of precipitation, less evapotranspiration and infiltration through the geomembrane cover, as shown in Equation 5-7.

$$Runoff = P - ET - Infiltration$$ **Equation 5-7**

5.2.2.1.5 Constituent Loading

The waste rock and ore stored in the stockpiles generates constituent loading during each model time step that is dependent on the mass of material within each stockpile. The generated constituent load is calculated based on laboratory constituent generation rates and whole rock metals concentrations (Section 8.1 of Reference (6)) and is scaled to account for lab/field differences in temperature, rock size, water contact, and pH (Section 8.2 of Reference (6)). The concentration of each constituent in the drainage water is capped by defined concentration caps, which are an uncertain input to the model (Section 8.3 of Reference (6)). Any constituent mass that cannot be leached due to concentration caps is retained in the stockpile as precipitated mass, available for leaching in the future. Any constituent mass that cannot be leached due to a lack of water contact (temporary stockpiles only) is retained in the stockpile for flushing when the waste rock is moved to the East Pit and flooded.

In contrast to the DEIS modeling, constituent generation rates for most metals are now based on waste rock metal to sulfur ratios indicated in the NorthMet drill core database (Section 8.1 of Reference (59)). The DEIS modeling used only humidity cell results. This change is because the laboratory data indicated that concentration caps in the test cells may be influencing the apparent laboratory release rates.

Other changes to the stockpile modeling include the consideration of the potential constituent loading from the saturated overburden material in the temporary stockpiles and the consistent water balance that is performed on each of the waste rock stockpiles. The DEIS modeling did not account for any constituent loading from the saturated overburden; the DEIS modeling also did not include accurate partitioning of the total water reaching the bottom of each stockpile but rather assumed worst-case conditions for both liner leakage and the water collected and routed to the WWTF.

As directed by the Lead Agencies in 2012, the lab to field scale-up factor for the Category 1 Waste Rock Stockpile is based on factors developed by MDNR from the Dunka Mine data rather than the first-principles method used in the DEIS modeling (Section 8.2.8 of Reference (6)).

5.2.2.2 Category 1 Waste Rock Groundwater Containment System

Water that enters the Category 1 Waste Rock Stockpile in the form of infiltration is assumed to pass within the same time step to the stockpile base, where it encounters the containment system. MODFLOW modeling of the Category 1 Waste Rock Groundwater Containment System indicates that the containment system is capable of capturing 91% to more than 99% of the

drainage from the Category 1 Waste Rock Stockpile over the life of the mine and during long-term closure (Reference (3)). The capture percentage of the containment system varies through time due to the influence of the mine pits on the groundwater gradients in the vicinity of the stockpile. The majority of the drainage not captured in the containment system eventually flows to the mine pits. A small percentage, less than 1% to 2% (<0.01-6 gpm) during operations and less than 1% (<0.01 gpm) during reclamation and long-term closure, is not captured in the containment system or the mine pits and is estimated to flow off site.

The Mine Site GoldSim model assumes that 90% to 94% of the drainage from the Category 1 Waste Rock Stockpile is collected in the containment system and directed to the WWTF, with the capture percentage varying through time as indicated by the MODFLOW modeling. A constant 6% of the drainage is assumed to flow directly (without a time lag or consideration of sorption) into the West Pit. The drainage that is not captured in the containment system or the West Pit is assumed to temporarily flow to the East Pit or to deep bedrock. Flows to the East Pit go from <1% (or <1 gpm) in Mine Year 1 to 2% (or 6 gpm) in Mine Year 10 back down to <1% in Mine Year 20. During reclamation and long-term closure, flows to the East Pit are negligible (<0.01 gpm) and are not included in the model. The flow from the Category 1 Waste Rock Stockpile to deep bedrock is represented in the GoldSim model as contributing to the upstream end of the bedrock flow paths leaving the West Pit, which begin to transport flow and load when the water in the West Pit reaches the bedrock rim elevation. This flow is assumed by be <1% (or <0.1 gpm) at Mine Year 1, 2% (or 6 gpm), at Mine Year 10, and <1% (or <0.01 gpm) in Mine Year 20. During reclamation and long-term closure, uncaptured flows are negligible (<0.01 gpm) and are not included in the model.

5.2.2.3 Geomembrane Liner Systems

Water that enters the Category 2/3 and Category 4 Waste Rock Stockpiles and OSP in the form of infiltration is assumed to pass within the same time step to the stockpile base, where it encounters the geomembrane liner system. Percolating water above the liner is collected in the model and sent to the WWTF where mass is removed through treatment. Water that leaks through the stockpile liner and the load that it transports is sent to the appropriate groundwater flow path.

DEIS probabilistic modeling of leakage through geomembrane liners used first-order second-moment analysis (FOSM, also referred to as Gaussian uncertainty analysis) to develop a distribution for the fraction of water reaching the liner that leaks (Reference (60)). This method makes two important simplifying assumptions in order to develop probability distributions from limited data or complex models:

- the model output is a linear function of all input variables near the mean (sum of random inputs); and
- the input variables are independent of one another (covariances equal zero)

These simplifying assumptions imply that the uncertainty in the model output can be approximated with a normal (Gaussian) distribution. The aim of FOSM analysis is to determine the variance of the normal distribution of model output without performing a complete Monte Carlo simulation.

Closer examination of the model used to calculate liner leakage (the HELP model) indicates that liner leakage is more properly understood as a product of random inputs than a sum. An alternative form of FOSM analysis is available for this products-of-powers model under the assumption that the uncertainty in the model output can be approximated with a lognormal distribution.

A lognormal model for liner leakage was developed, based on the method in Reference (61). The mean model output (the output resulting from all input variables at their mean or expected values) can be determined from a single model run, and is the mean of the lognormal distribution for modeling uncertainty. The aim of FOSM analysis is to determine the variance of the lognormal distribution of model output without performing a complete Monte Carlo simulation. The additional information about each input variable necessary to develop the variance of the model output includes:

- the power to which each input variable is raised in the products-of-powers model
- the variance of each input variable

This information can be developed by performing relatively few model runs to evaluate the effective power on each input variable and by using engineering judgment or available data to define variances.

DEIS discussions on probabilistic modeling of liner leakage focused on whether the resulting distribution for liner leakage was properly understood as the uncertainty in the leakage rate for each individual unit of a stockpile (i.e., each acre or construction patch) or for the stockpile as a whole. In order to remove this issue from the discussion, modeling liner leakage on an acre-by-acre basis has not been included in the probabilistic water quality modeling for the SDEIS and FEIS.

However, it must be understood that for the liner leakage modeling to realistically estimate the uncertainty in the average liner leakage rate over the entire stockpile footprint, the input variable variances must be defined relative to their expected variation over the entire stockpile footprint. For example, it is realistic to assume that some portions of the stockpile may have a higher-than-acceptable frequency of undetected (and thus uncorrected) liner defects, while other areas may be essentially defect-free. These high- and zero-defect areas, however, are more indicative of spatial variability within the stockpile than uncertainty in the typical rate of defects across the stockpile as a whole. Because the FOSM analysis results are applied over the entire stockpile footprint, variance in the rate of defects must be defined relative to the uncertainty in the stockpile-average rate. This uncertainty can only be estimated with reference to the proposed

design and construction quality assurance and quality control methods, which specify allowable levels of variation from the proposed design values. The same reasoning applies to defining the variance for other input variables.

5.2.2.3.1 Input Variable Uncertainty

The three input variables proposed for the uncertainty analysis of liner leakage with the HELP model are liner slope, subgrade permeability, and frequency of liner defects. The volume of water contacting the liner (total infiltration) is also a factor in the HELP model, but DEIS analysis has shown that the liner leakage factor (portion of the water at the top of the liner that leaks) is essentially independent of infiltration except at very low infiltration levels. This analysis assumes that this independence applies at the expected infiltration rates.

Stockpile liner design and construction were addressed in a 2009 memo from Barr staff to PolyMet and MDNR (Reference (62)). Discussion of the input variables discussed here draws from the expected stockpile conditions outlined in the 2009 document. In addition, records for recently-constructed geomembrane liner systems in Minnesota (as-built survey and soil test data) are used to develop the expected variance for each variable.

5.2.2.3.2 Liner slope

The design liner slope varies between and within stockpiles because of the varying topography of the Mine Site. Each stockpile is not designed as a flat "sheet" with a consistent slope from one side to the other; rather the liner will have hills and valleys to facilitate drainage and to follow natural topographic features and minimize earthwork quantities. One source of uncertainty in the average liner slope is primarily due to the potential for differential settlement of the liner under the load of stockpiled waste rock. Such settlement is expected to have an equal probability of increasing and decreasing the slope in any given location, and therefore its effect on the average liner slope is negligible and can be ignored. Another source of uncertainty in the average liner slope is due to deviation from the specifications during construction. Because modern surveying and construction methods result in highly accurate establishment of specified grades, this deviation is typically very small.

As-built survey data from a geomembrane liner constructed in northeastern Minnesota in 2010 (Reference (63)) was analyzed to determine the deviation from design stockpile slopes. Transects were selected at random along the primary flow directions (n = 35) and the as-built slope was compared to the design slope. As shown by the blue bars in Figure 5-4, the as-built deviation between any two points is typically within ± 0.2% (0.002 feet/feet) of the design slope.

As discussed above, the intent of this analysis is to quantify the uncertainty in the stockpile average slope, not the possible range of deviation at any given point on the liner. Because there is no systematic bias towards higher- or lower-than-specified slope evident from the as-built data, the uncertainty in the stockpile-average slope is expected to be much less than the deviation from design slope at a given point. To develop an estimate of the uncertainty in the stockpile average slope, ten transects from the as-built dataset were selected at random and the average

slope deviation was computed. This process was repeated 1,000 times (bootstrap method) to develop a histogram of the average slope deviation, shown by the red bars in Figure 5-4. As expected there is much less variation in the average slope; the standard deviation from the bootstrap method is 0.04% (0.0004 feet/feet).

The standard deviation for stockpile-average slope developed here is used as the uncertainty in the geomembrane liner slope for the Project, relative to the design minimum slopes for each stockpile. The resulting distributions for the Category 2/3 Waste Rock Stockpile, the Category 4 Waste Rock Stockpile, and the OSP are shown in Figure 5-5. Note that the "base case" or mean slope used in this analysis is assumed to be the design minimum slope (0.50% or 0.75%). Each of these stockpiles has significant areas that are designed to be more steeply sloped, resulting in the actual stockpile median slope values shown in Table 5-6. Because higher slopes cause water to drain more rapidly off the liner and decrease the average head on the geomembrane, the use of the design minimum slope is a conservative assumption.

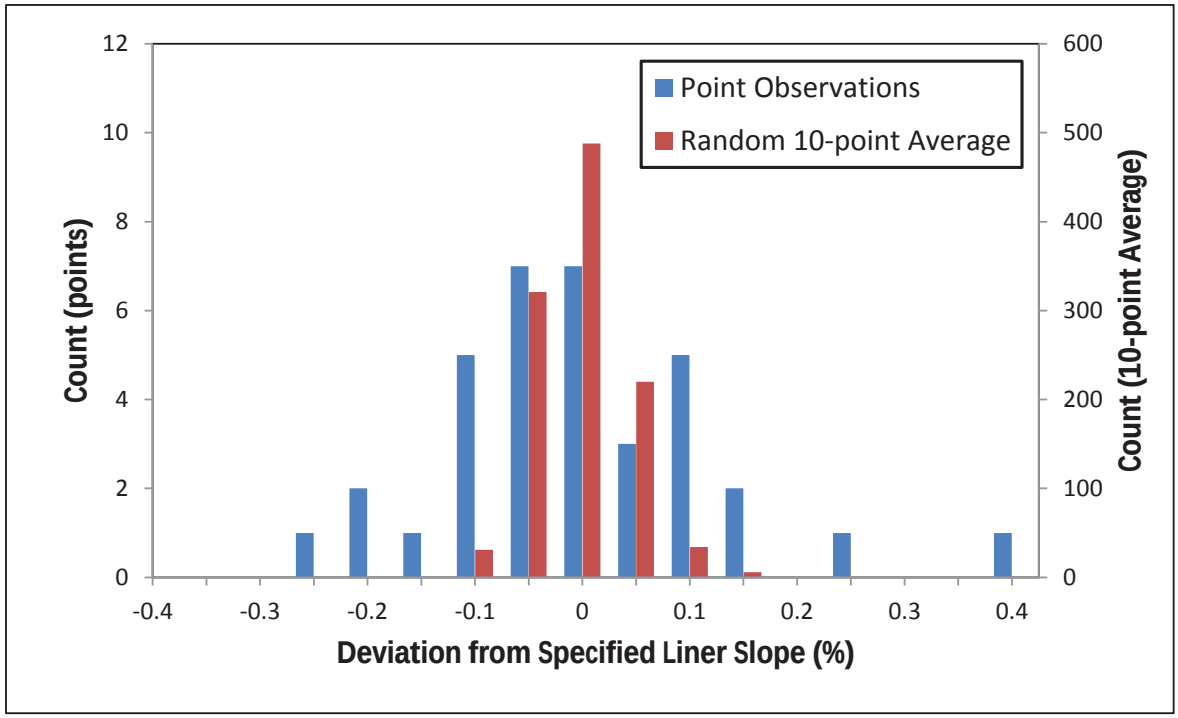


Figure 5-4 Analysis of Liner As-built Slope Data

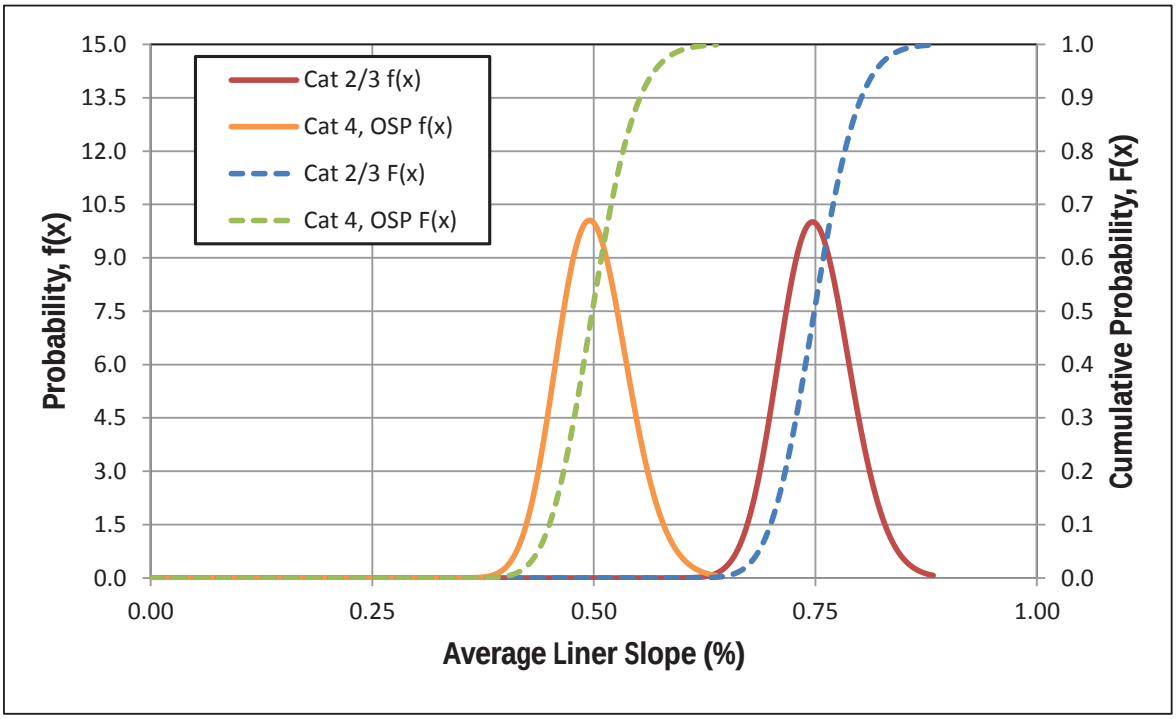


Figure 5-5 Distributions for Stockpile Average Liner Slope

5.2.2.3.3 Subgrade permeability

Subgrade soils beneath geomembrane liners will be constructed as secondary containment systems and have specified shear strength, compaction and hydraulic conductivity requirements. The subgrade soils will be tested throughout construction to ensure that the in-place soils meet or exceed specifications. The majority of tests must be satisfactory (i.e., specified or lower hydraulic conductivity) in order for the subgrade preparation to be considered acceptable, so the effective average permeability is expected to be lower (i.e., better) than the specified value.

In-place soil test data from multiple liners constructed in Minnesota between 1994 and 2010 were analyzed to determine the deviation from design subgrade permeability (References (63), (64), (65), and (66)). These data indicate that construction practices for soil liners are highly effective in meeting the specified permeability, given an acceptable material source and proper construction QA/QC. Out of the 39 tests of in-place permeability referenced, only 2 were above (i.e., worse than) the specified permeability, and one of these was determined to be the result of laboratory error. In most cases, the measured permeability was approximately one order of magnitude below (i.e., better than) specified, and the average permeability across each site was always below the specified value.

Rather than take credit for the high probability that the permeability of the subgrade material is expected to be better than specified, this modeling assumes that the specified permeability is achieved exactly across each stockpile. No uncertainty is modeled for subgrade permeability,

reflecting the negligible potential for higher-than-specified average permeability. The design subgrade permeability for each stockpile used in this analysis is shown in Table 5-6.

5.2.2.3.4 Liner defects

Industry standards (and permit requirements) for the installation of geomembrane liners require rigorous testing to ensure that the number of defects remaining in the liner after installation of cover soils is within acceptable limits. Good construction quality control and testing addresses the primary uncertainty surrounding this portion of the liner system. Once overliner material (2' of free-draining soils) has been placed to protect the geomembrane there is little potential for additional damage. Because the geomembrane liners proposed for the Mine Site are for temporary (less than 20 year) waste rock stockpiles, there is no additional uncertainty regarding long-term (i.e., more than 500 to 1,000 years) degradation of the geomembrane. The uncertainty in the rate of liner defects is evaluated using the literature values discussed in Reference (62). Industry-standard QA/QC programs result in an approximate average of 2 defects per acre (over the entire stockpile), and most installations have less than 4 defects per acre (over the entire stockpile).

The rate of liner defects is modeled as a lognormal distribution with a mean of 2 defects per acre and a 90th percentile value of 4 defects per acre. See Figure 5-6 for the resulting distribution, with a standard deviation of 1.82 defects per acre.

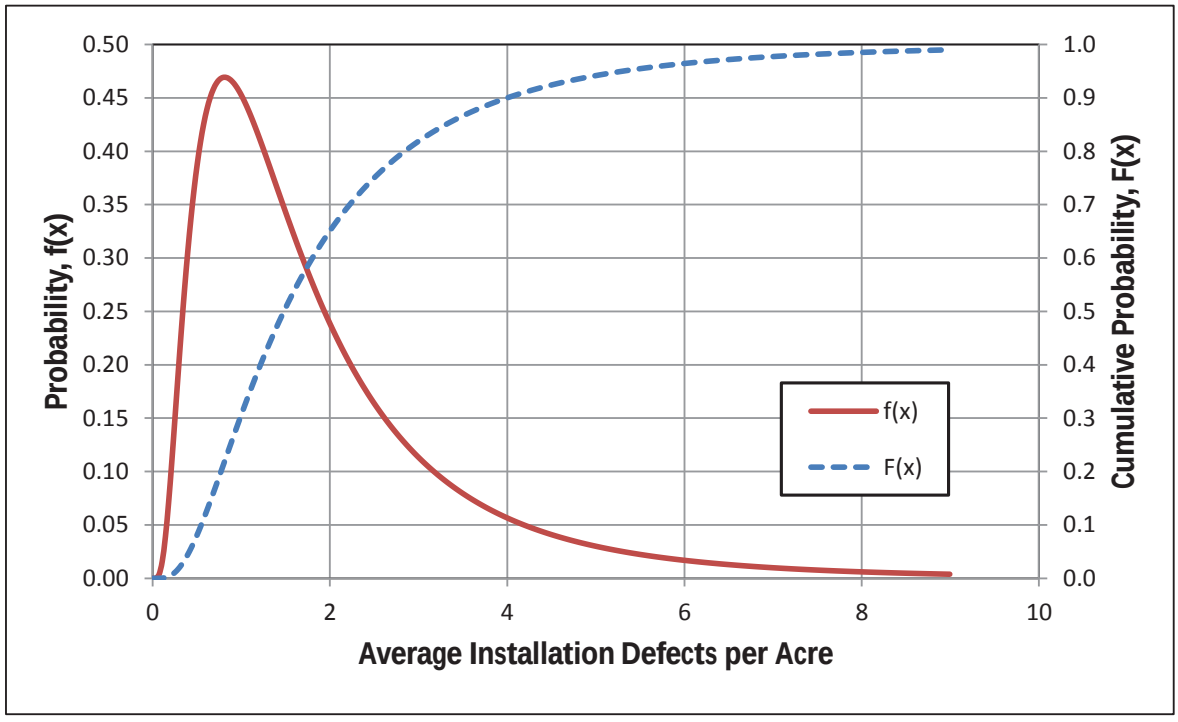


Figure 5-6 Distribution for Liner Defect Rate

5.2.2.3.5 Liner Leakage Distribution

Using the values shown in Table 5-6 to define the base case (average) condition, the HELP model was run several times in order to determine the effective power relationship between the uncertain variables (slope and defect rate) and the model output (liner leakage fraction). The results of this analysis for the Category 2/3 Stockpile are shown as an example in Figure 5-7. Modeled liner leakage fraction is a nearly linear function of the number of liner defects (power ≈ 1), and is inversely related to the slope of the liner (power ≈ -1).

Based on the analysis shown in Figure 5-7, the following equation for the liner leakage fraction as calculated by the HELP model is assumed:

$$LLF = A \cdot S^{.0906} \cdot D^{.0996} \qquad \textbf{Equation 5-8}$$

where *LLF* is the fraction of the water contacting the liner that leaks (dimensionless), *S* is the liner slope (%), *D* is the rate of installation defects (defects per acre), and *A* is a factor that encompasses all other model variables, including the subgrade permeability. The powers on *S* and *D* were determined as the average from the analysis of the Category 2/3 and Category 4 Waste Rock Stockpiles.

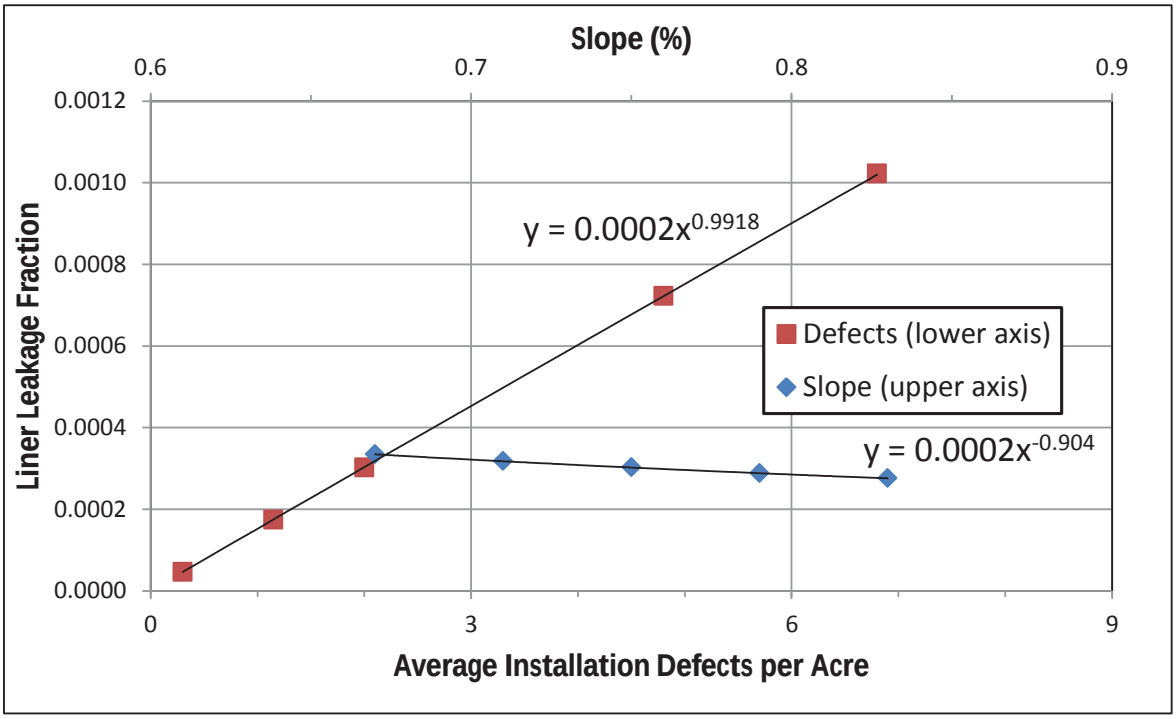


Figure 5-7 Example Liner Leakage Uncertainty Analysis (Category 2/3 Waste Rock Stockpile)

As discussed above and developed in Reference (61), the expected or mean value for *LLF* (denoted *E[LLF]*) can be approximated as the result of the model evaluated at the mean of each

input variable. The mean *LLF* is shown in Table 5-6 for each stockpile. Assuming that the input variables are independent (no covariance), the variance for *LLF* can be approximated using the mean and variance of each input variable and the square of the power on each input variable:

$$\frac{Var[LLF]}{E[LLF]^2} = (-0.906)^2 \frac{Var[S]}{E[S]^2} + (0.996)^2 \frac{Var[D]}{E[D]^2} \qquad \textbf{Equation 5-9}$$

The computed standard deviation (square root of the variance) of *LLF* for each stockpile is shown in Table 5-6. The resulting lognormal probability distributions for the liner leakage fraction from the Category 2/3 Water Rock Stockpile, Category 4 Waste Rock Stockpile, and OSP (same as the Category 4 Water Rock Stockpile) are shown in Figure 5-8. Note that the 95th percentile values from these distributions (0.0008 for the Category 2/3 Water Rock Stockpile and 0.0002 for the Category 4 Water Rock Stockpile and OSP) are approximately the same as the liner leakage fraction that will be expected from a stockpile with the mean slope and permeability and a defect frequency of 6 defects per acre.

Table 5-6 Liner Leakage Uncertainty Analysis Parameters

Model Variable	Units	Parameter	Category 2/3 Stockpile	Category 4 Stockpile	Ore Surge Pile
Design stockpile-wide slope	%	Median	1.48	1.15	3.99
Design minimum slope	%	Mean	0.75	0.50	0.50
		Std. Dev.	0.042	0.042	0.042
Subgrade permeability	cm/s	Mean	10^{-5}	10^{-6}	10^{-6}
		Std. Dev.	--	--	--
Liner defect rate	holes/acre	Mean	2	2	2
		Std. Dev.	1.82	1.82	1.82
Liner leakage fraction	--	Mean	0.00030	0.000081	0.000081
		Std. Dev.	0.00027	0.000073	0.000073

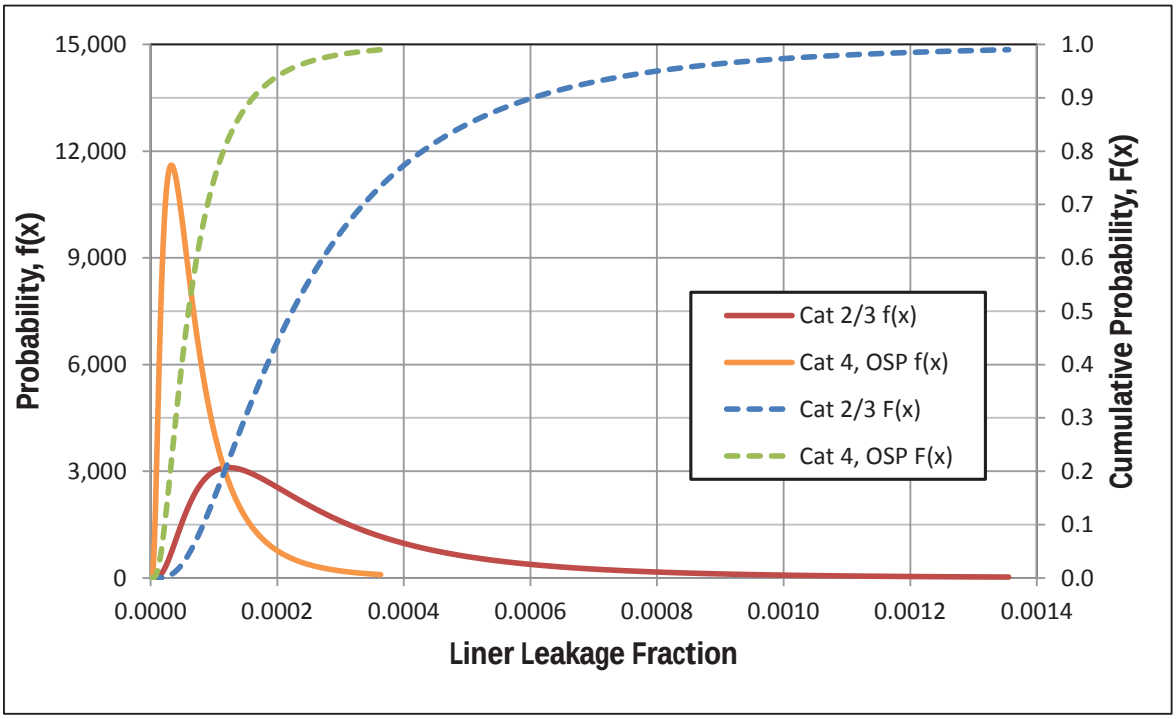


Figure 5-8 Probability Distributions for Stockpile Liner Leakage Fraction

The liner leakage value, as a percent of water that has infiltrated through the stockpile, is used in the groundwater transport modeling to determine the likely steady state water table profile. The liner leakage becomes the variable Q_s in Equation 5-13 of Section 5.2.3.1. If liner leakage was randomly determined as 1% of infiltrated water, then the variable S would be 1% of the median infiltration rate (because the most likely steady state profile is being modeled).

5.2.2.4 Stockpile Sumps

Stockpile sumps collect water from the stockpile liner systems before it is pumped to the WWTF. These areas are small and contain double geomembrane liner systems. Assuming six feet of head on the liner, the estimated liner leakage rate from the sumps will be 0.008 gallons/acre/day (Reference (67)). This is less than 3% of the median unit area liner leakage rate from the Category 2/3 Water Rock Stockpile (based on the precipitation distribution in Figure 5-1, the *ET* distribution in Figure 5-2 and the liner leakage fraction distribution in Figure 5-8). Because the area of the sumps is small relative to the area of each stockpile, the additional leakage from the sumps is negligible (<1%) compared to the liner leakage from the entire stockpile footprint. Leakage from the sumps is therefore not included in the GoldSim model.

5.2.2.5 Overburden Storage and Laydown Area (OSLA)

Runoff from the OSLA mimics that of a reclaimed stockpile because the OSLA includes natural overburden from the site. The water balance data for the reclaimed AMAX test piles

(Section 5.2.2.1.2) is used as a basis for developing distributions for the OSLA. Because the AMAX study does not distinguish between surface runoff and infiltration, additional information beyond the raw AMAX test pile data is necessary. The AMAX data indicates that on average 29.6% (0.296 = 1 - 0.704) of annual precipitation becomes either infiltration or runoff for the reclaimed stockpiles. This value represents a reduction in total stockpile infiltration plus surface runoff of 38% from the bare rock case (runoff of 0.476 = 1 – 0.524), entirely due to increased evapotranspiration.

A separate study of stockpile capping hydrology (Reference (68)) estimated reductions in infiltration of 49% to 58% for waste rock stockpiles covered with compacted native soils and vegetated. If a reduction in infiltration of 55% is assumed based on this information, the average infiltration for the waste rock stockpiles covered with compacted native soils and vegetation can be calculated as 21.4% of annual precipitation (0.214 = 0.476 * (1 - 0.55)). The difference between this value and the measured total stockpile infiltration plus surface runoff from the AMAX study is assumed to be surface runoff from the reclaimed stockpile with an average value of 8.2% of precipitation (0.082 = 0.296 - 0.214). The uncertainty in the average stockpile runoff coefficient is assumed to be normally distributed with the same coefficient of variation as the evapotranspiration distribution for the reclaimed stockpile shown in Table 5-5. The resulting distribution for runoff is shown in Figure 5-9.

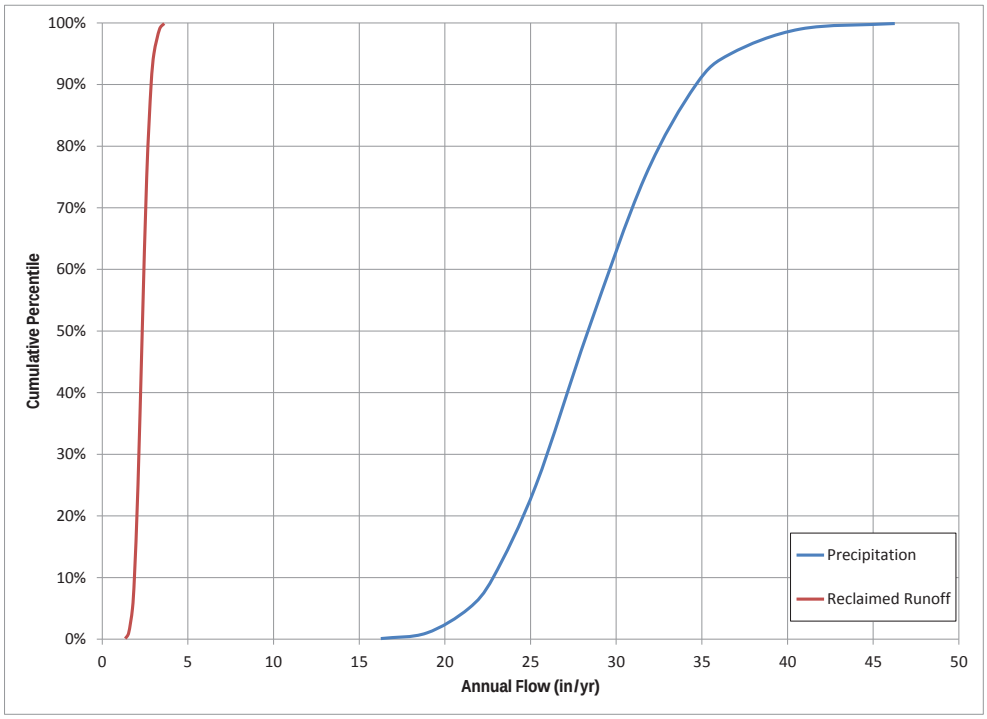


Figure 5-9 Cumulative Distribution Function for Annual Runoff from an Overburden Stockpile

Because the OSLA is an unlined area, the infiltration rate through the surface is assumed to be equal to the percolation rate into groundwater below the OSLA. Therefore, the infiltration rate is the variable Q_s in the groundwater flow path modeling (described in Section 5.2.3.1). The results of the Meteoric Water Mobility Procedures test leachate for peat and unsaturated overburden material are used to estimate water quality for the groundwater flow from the OSLA (Section 7 of Reference (6)). Runoff from this facility is assumed to have the same water quality as the infiltrating water; runoff is collected and pumped to the CPS pond for transport to the Plant Site.

5.2.2.6 Mine Pits

5.2.2.6.1 Mine Pit Water Balance Modeling

The generic water balance for the East and West Mine Pits is shown in Equation 5-10.

$$Storage = (P + RO_{wall} + RO + GW_i) - (E + GW_o) - Q_{pump} \qquad \textbf{Equation 5-10}$$

In Equation 5-10, *Storage* is the volume of water in the pit. During operations, this is the relatively small volume of water in the pit sump. During and after closure, it is the volume of water in the pit as it is flooding. P is precipitation on the water surface, RO_{wall} is runoff from the walls of the pit, RO is runoff from the contributing watershed, GW_i is groundwater inflow to the pits, E is evaporation from the water surface in the pit, GW_o is groundwater outflow from the pits, and Q_{pump} is the necessary pumping rate to meet the desired water volume. Note that the sign on Q_{pump} indicates it is water being pumped out of the pit. Q_{pump} has a negative value if water is being pumped *into* the pit.

5.2.2.6.2 Climate Inputs

Annual precipitation and open-water evaporation for all features on the Mine Site are selected from uncertainty input distributions and distributed among months using deterministic factors (i.e., percent of annual) (Section 5.2.1). Runoff factors (i.e., percent of precipitation) for the pit walls and contributing areas outside of the pits are selected from uncertainty input distributions for both winter and open-water periods (Section 5.2.1.3). The total groundwater inflow is divided between inflow from the surficial aquifer and bedrock (Section 5.2.2.6.3).

Monthly precipitation (Section 5.2.1.1) is applied to the area of the water surface at a monthly time step. In the case of operations when the pit is supposed to remain dry, precipitation is applied to the area of the pit sump. Precipitation generated in winter months (December – March) is stored in the model as snowpack and added to the precipitation in the first month of "spring" (April). The total precipitation in April therefore includes the precipitation calculated for that month based on the methods described in Section 5.2.1.1 as well as the cumulative precipitation from December – March.

Runoff tributary to the Mine Pits includes runoff from the pit walls (ROwall) and runoff from contributing non-pit watersheds (RO).

Runoff from the pit walls (ROwall) includes both the pit rim set back areas and the exposed pit walls. Runoff from pit walls is calculated by multiplying the monthly precipitation value by a runoff fraction and by the pit wall area (plan view). Runoff from the exposed pit walls is assumed to range from 40% to 60% of annual precipitation (uniform distribution), reflecting the impervious nature of the pit wall rock. Pit wall runoff is subject to the same snow pack analysis as described in Section 5.2.1.3.

RO is calculated by multiplying the fraction of precipitation resulting in runoff (%RO) as described in Section 5.2.1.3 by the contributing watershed area. Both runoff inputs to the pit water balance also go through the snow pack analysis as mentioned above for precipitation. The watershed and stockpile areas tributary to the East Pit and West Pit were delineated using GIS software and are presented in Table 5-7.

Table 5-7 Watershed Areas Tributary to Mine Pits in Closure

Watershed	Watershed Area (acres)	
	During West Pit Flooding	After West Pit Flooding
Category 1 Waste Rock Stockpile to West Pit	279	--(1)
Upland to West Pit	291	--(1)
West Pit Lake	320	320
Category 1 Waste Rock Stockpile to East Pit	--	--
Upland to East Pit	83	83
East Pit Lake	206	206

(1) After pit flooding, drainage is altered to minimize the area tributary to the West Pit.

Open water evaporation removes water from the mine pits. Open water evaporation losses are calculated using the rates described in Section 5.2.1.2 and an applicable surface area. While either of the pits is flooding, the applicable surface area is the water surface area. When the pits are dry, the area applied to the evaporation rate is the surface area of the pit sump.

While backfilling is ongoing in the East Pit, the surface of the waste rock backfill is typically above the level of the porewater (Section 5.2.2.6.5). When this condition exists, evaporation losses from the pit surface are calculated using the methods described in Section 5.2.2.1.2 for a bare rock stockpile.

5.2.2.6.3 Groundwater

The expected rate of groundwater inflow (GW_i) to the East and West Pits is estimated from the updated MODFLOW modeling described in Section 5.2.3.7 and Attachment B. The output of this modeling is a table relating groundwater flow rate to the current water elevation in each of the pits, as well as the fraction of the groundwater flow that originates from the surficial aquifer. Outflows from the pits are estimated using the methods described in Section 5.2.3.1 and compared to the MODFLOW modeling results to check reasonableness. The groundwater inflow from the surficial aquifer is assumed to receive constituent load generated by both the pit walls and the pit rim set back. The groundwater inflow from bedrock is assumed to receive constituent load generated by the pit walls (but not the pit rim set back).

As in the DEIS and SDEIS probabilistic modeling (Reference (54)), the uncertainty in the groundwater inflow rate is represented with a probability distribution that scales the model-estimated inflow values. This log-normal distribution is defined such that the mean is the model-estimated value (scaling factor of 1.0) and the 95% confidence interval extends from approximately 0.75 to 2.0. This log-normal distribution is shifted away from zero such that the generated value will never be lower than 0.75 (instead of a minimum value of zero in a typical log-normal distribution). See Figure 5-10 for an illustration of the distribution.

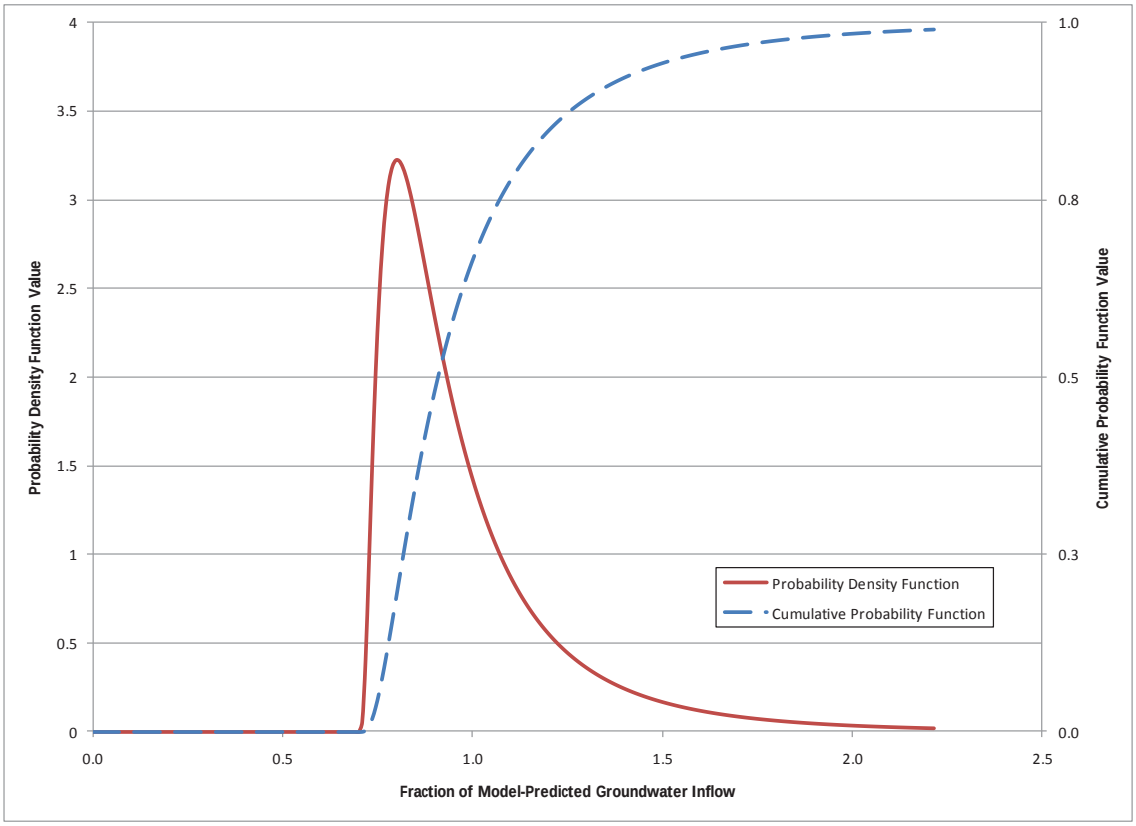


Figure 5-10 Probability Distributions for Uncertainty in Groundwater Inflow to Pits

Section 5.2.3.1 describes the modeled groundwater flow paths that transport mass from the pits to the Partridge River.

5.2.2.6.4 Pit Pumping

The pumping rate of water out of or into the pits is determined in the model based on the desired water volume in each pit. During operations, the pits are to be kept dry so that the only storage volume is the volume of water in the sump. During backfilling of the East Pit, the water level is maintained 5 feet below the surface of the backfilled waste rock (provided that enough water is available from the WWTF) except when the water level is maintained lower to provide for safe working conditions in the Central Pit. During reclamation, the West Pit is flooded with water as fast as possible to minimize pollutant loading. Therefore, water is no longer pumped out of the pit but is instead directed to the pit from available sources (such as the WWTF, free drainage from overflow of the East Pit, and collected seepage water and treated water from the Plant Site). The maximum dewatering rates for each pit are defined by the design of the process water pump system.

5.2.2.6.5 Pit Water Quality

Constituent loading to pit water is contributed by the pit walls, the in-pit inventory of blasted ore, groundwater inflow, and waste rock placed in the pits when mining is completed. The constituent loading from the pit walls is modeled using a similar method as for the waste rock loading within the stockpiles (Sections 9.1 through 9.4 of Reference (6)). The available constituent mass is mixed with the volume of water that is runoff from the pit walls (including groundwater flowing over the walls) to calculate the estimated concentration in the water in the pit wall runoff, which is capped by defined concentration caps (Section 9.5 of Reference (6)). Any constituent mass that cannot be leached due to concentration caps or due to limited water contact is retained on the pit walls as soluble mass, available for flushing in the future during pit flooding. The total dissolved constituent mass is mixed with the water at the bottom of the pit to calculate the estimated concentration in the water at the bottom of the pit.

The constituent loading from the in-pit inventory of blasted ore is calculated in the same manner as for the OSP (Section 5.2.2.1) and is combined with the load from the pit walls and other sources during operations. The inventory of blasted ore is assumed to be continuously refreshed with new nonacidic rock and is entirely removed by the end of operations.

Once the East Pit ore is exhausted (by the middle of Mine Year 11), the material in the temporary Category 2/3 and 4 Waste Rock Stockpiles begins to be relocated to the East Pit and all Category 2, 3 and 4 waste rock mined after that point is placed directly to the East Pit. Additional Category 1 waste rock mined after the Category 1 Waste Rock Stockpile reaches its design capacity is also placed in the East Pit beginning in Mine Year 13. The relocated rock adds constituent mass resulting from oxidation in the rock while in the temporary stockpiles and continues to generate constituent mass as long as it is above the water level in the East Pit. The East Pit is flooded with water as this backfill rock is added, with all but the upper few feet of backfill rock submerged at any time provided enough water is available from the WWTF. During

the later years of pit flooding, the water level is maintained at a greater depth below the top of the backfilled rock in order to allow for safe mining in the Central Pit; once mining in the Central Pit is complete the combined East/Central Pit is fully backfilled and flooded as quickly as possible. The groundwater inflow and amount of exposed rock in the pit wall decrease as the pit floods with water. The East Pit overflows to the West Pit as soon as the backfill placed in the final year of mining is completely flooded. During the backfilling period the WWTF treats any water pumped out of the East Pit to remove the constituents added with the relocated rock; the porewater pH is adjusted as needed to remain circumneutral conditions (see Section 2.2.1.1. of Reference (4)). The porewater pH control is assumed for the water quality modeling to not add any constituent mass to the East Pit. After the East Pit is full (during the reclamation period) the WWTF continues to pump and treat the backfill water as long as necessary to meet water quality goals, while returning most of the treated water to the backfill so as to maintain subaqueous conditions and an inward groundwater gradient.

5.2.2.6.6 Pit Mixing

During and after pit flooding, the East and West Pits behave differently from one another with respect to the degree of mixing of the pit water and the potential for stratification.

Ultimately, the East Pit is mostly filled with backfilled waste rock, with water in the pore spaces of the rock, and a relatively shallow constructed wetland near the surface. The wetland is separated from the waste rock backfill by a layer of compacted overburden material that serves as a hydraulic barrier between the two zones. The quantity of water flowing through this barrier layer is minimal because the hydraulic head is expected to be approximately equal on both sides of the barrier. The shallow East Pit wetland, therefore, has water quality that is largely independent of the quality of the water in the backfill pore spaces. In the probabilistic water quality modeling the separation between the two zones is assumed to occur at the elevation at which the porewater begins to contact the surficial deposits surrounding the pit. Outflow from the East Pit to the surficial aquifer, therefore, is only from the upper zone that includes the wetland and a small amount of backfilled waste rock.

The West Pit, in contrast, becomes a 600-foot deep lake flooded with nothing but water. The water in the West Pit may become chemically or thermally stratified during and after flooding, and any stratification may be permanent or seasonal (with semi-annual “turn over”). In the probabilistic water quality modeling, the West Pit is to be assumed to behave as a well-mixed system.

5.2.2.7 Haul Roads and Rail Transfer Hopper (RTH)

Surface runoff from the haul roads and the RTH is stored in process water ponds (Section 5.2.2.9) and routed to the WWTF along with the water collected from the waste rock stockpile sumps and the mine pit sumps. Water quality of runoff from the haul roads is calculated from the Category 1 waste rock properties (Section 8 of Reference (6)) with an assumed one foot depth of crushed rock top dressing. Water quality of runoff from the RTH is

calculated from an estimated one foot depth of spilled fine ore using methods proposed to evaluate impacts of spilled ore along the transport corridor (Section 8.4.3 of Reference (6)). Similar to the exposed pit walls (Section 5.2.2.6.2), runoff from the haul roads and RTH is assumed to vary from 40% to 60% of annual precipitation, due to the highly compacted surface material of these travel ways. The liner leakage quantity from the double-lined RTH sump and the lined haul road process water ponds (which only hold water during storm events) is negligible and is not included in the model.

5.2.2.8 Wastewater Treatment Facility (WWTF)

The water quantity and quality delivered to the WWTF from the various mine features are estimated is described in Sections 5.2.2.1 through 5.2.2.4 and 5.2.2.6 through 5.2.2.7. The Mine Site WWTF also receives water and constituent loading in the reject concentrate transported from the Plant Site WWTP during operations and reclamation. During operations, the effluent from the WWTF is mixed with the runoff collected from the OSLA (Section 5.2.2.5) in the CPS pond. The effluent is pumped from the CPS pond either to the Plant Site or for use in flooding the backfilled East Pit.

During the reclamation period, the WWTF operates primarily to treat the backfill water in the East Pit as long as necessary to bring the sulfate concentration in the backfill water below 250 mg/L. The WWTF also receives water and constituent loading from the collected drainage from the Category 1 Waste Rock Stockpile (Section 5.2.2.2) and reject concentrate from the Plant Site WWTP. The effluent is primarily returned to the East Pit, with any excess used to accelerate flooding of the West Pit. The reclamation period ends when water quality goals are met in the East Pit backfill.

The closure period for the WWTF begins when the water in the West Pit reaches a level several feet below the natural overflow elevation. This may occur while treatment of the East Pit porewater is ongoing in the reclamation WWTF. The quantity of water treated during closure is adjusted to manage the water level in the West Pit and to prevent uncontrolled overflow. During closure, the WWTF receives water and constituent loading only from the Category 1 Waste Rock Stockpile drainage and from the flooded West Pit. Effluent from the WWTF is discharged to an intermittent stream that flows to the Partridge River near SW004a (Section 5.2.4.5).

Target effluent concentrations from the WWTF and CPS Pond (Table 1-34 of Attachment C) are based on the anticipated level of treatment (to be finalized in permitting) and are model constants, and may be different between the different model periods as the treatment technology used changes. The constituent mass removed by the treatment process is removed from the model as chemical precipitation within the WWTF or CPS Pond.

5.2.2.9 Process Water Overflow Ponds / WWTF Equalization Basins / Central Pumping Station (CPS) Pond

Process water ponds store excess runoff from stockpiles resulting from storm events larger than the 10-year event and up to the 100-year event. There are a total of four process water overflow ponds. Two ponds receive water from the Category 2/3 Waste Rock Stockpile, one pond receives water from the Category 4 Waste Rock Stockpile, and one pond receives water from the OSP. The process water ponds vary in size and have a depth of six to twelve feet (designed based on the 100-year event). The process water overflow ponds contain a single geomembrane liner system. The unit area liner leakage rate estimated for such liner systems ranges from 5 to 12 gallons/acre/day for heads ranging from 6 to 12 feet (Reference (67)). Assuming the ponds are full during the 100-year event and are pumped down over the course of one month, the total leakage from the ponds will be approximated by the following formula:

$$Vol = \left(\frac{Q_{initial} + Q_{final}}{2}\right) At \qquad \textbf{Equation 5-11}$$

where $Q_{initial}$ is the initial unit area leakage rate based on an average depth of 9 feet (8.5 gallons/acre/day), Q_{final} is zero, A is the pond area, and t is the duration the pond contains water (30 days). For the Category 2/3 Waste Rock Stockpile (total combined pond area of about 5 acres), the resulting leakage volume during the month of storage is approximately 640 gallons. This compares to an average annual stockpile liner leakage of 20,400 gallons from the fully developed Category 2/3 Waste Rock Stockpile. Thus, during a year containing the 100-year event, the additional leakage is about 3% of the annual yield. The additional leakage will be less for smaller, more frequent events. Because the increase in leakage is small and these events occur infrequently, the additional load from process water overflow ponds has been omitted from the probabilistic model. The RTH process water pond and haul road process water ponds are similarly omitted from the probabilistic model, due to the small leakage volumes and relative infrequency of large storm events.

The WWTF equalization basins store water from the Category 1 Waste Rock Stockpile Groundwater Containment System, pit dewatering, and the liner yield from the other stockpiles. The WWTF equalization basins have a single geomembrane liner system similar to that described for the process water overflow ponds. Water is typically stored in the basins only during the summer months and during snowmelt events; in the winter any collected stockpile drainage and pit dewatering water is pumped directly to the WWTF. The WWTF equalization basins are included in the probabilistic model as two ponds; one receives water from the Category 1 Waste Rock Stockpile Groundwater Containment System, pit dewatering, and the RTH and haul road runoff; and one receives liner yield from the temporary stockpiles. The constituent concentrations of each basin are calculated in the probabilistic model based on the inflows to each pond. During the summer months (April through September) it is assumed the ponds are filled with 6 feet of head on the liner. The resulting liner leakage rate is 5 gallons/acre/day (Reference (67)), which is treated as a deterministic value in the model. The leakage from these basins is transferred to the appropriate groundwater flow path

(Section 5.2.3.1). During the remainder of the year, the leakage from the WWTF equalization basins is assumed to be zero.

The CPS Pond stores the WWTF effluent and collected runoff from the OSLA before it is pumped for use at the Tailings Basin. The liner and operations of the CPS Pond are similar to those described above for the WWTF basins, and it is included in the probabilistic model with the same liner leakage rate contributing water to the same groundwater flow path. Because the CPS Pond will contain treated water year-round, the liner leakage rate is assumed to be constant whenever the operations or reclamation WWTF is active.

5.2.3 Groundwater

Potential groundwater impacts are evaluated at evaluation distances located within groundwater flow paths that include the surficial aquifer and bedrock (Large Figure 28 and Large Figure 29, respectively). In contrast to the water quality modeling completed for the DEIS, the surface water and groundwater components in the SDEIS and FEIS models are fully coupled within GoldSim. The groundwater flow paths encompass areas to fully account for the pollutant load entering the river.

5.2.3.1 Groundwater Flow Path Modeling

The links between the surface water and groundwater systems need to be internally consistent to ensure mass conservation. The groundwater and surface water systems are linked using the following assumptions:

- The baseflow in a given reach of the Partridge River is due to aquifer recharge in the undisturbed contributing watershed area that discharges to the Partridge River. This forms a simple one-to-one relationship between baseflow and recharge (Equation 5-12).

$$R = \frac{Q}{A_w} \qquad \textbf{Equation 5-12}$$

where Q is baseflow in the river [Length^3/Time], A_w is the total contributing watershed area from the right and left banks [L^2], and R is the recharge rate [L/T]. The area of mining features such as stockpiles and pits were removed from the contributing area in the XP-SWMM model for the estimation of baseflow in the Partridge River during the Project (Section 5.2.4.3.5).

- The stage (h_2) in the river at the end of each flow path (Figure 5-11) is assumed to be known and remains constant throughout the simulation. In reality, river stage varies through time, but at the scale being considered this fluctuation can be ignored.

- The aquifer is assumed to have a uniform thickness along the length of the aquifer.

- The discharge quantity (Q_o) at the downstream end of each groundwater flow path is defined in Equation 5-13.

$$Q_o = RA_f + Q_u + Q_s \qquad \textbf{Equation 5-13}$$

where A_f [L^2] is the total undisturbed plan-view area of the groundwater flow path, Q_u [L^3/T] is any flow into the flow path at the upstream end, and Q_s [L^3/T] is liner leakage from any stockpile along the flow path (if applicable). In most cases Q_u is zero because the upstream end of the flow path is located at or near a groundwater divide and the contribution from upgradient areas can reasonably be assumed to be small. However, in closure, the flow paths that originate at the mine pits are receiving groundwater when the mine pits are full of water.

Figure 5-11 illustrates these assumptions. In the figure on the left, the green areas show the right and left bank contributing areas, the blue area in the middle is the river flowing top to bottom with a baseflow rate Q, and the brown area is the aquifer flow path. In the figure on the right the head in the river is h_2.

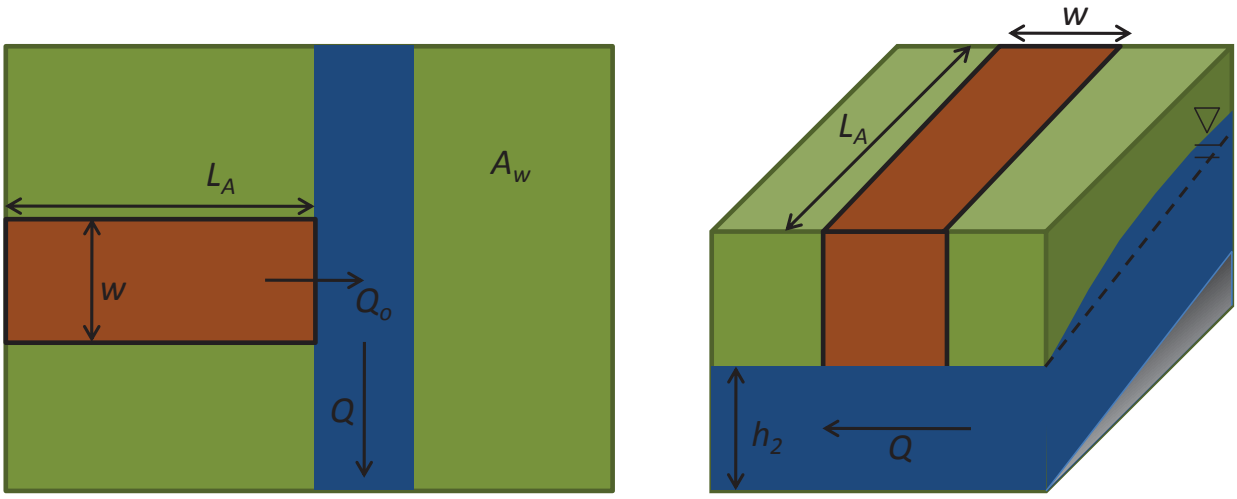


Figure 5-11 Simplified Schematic of a Flow Path within a Watershed Contributing to Baseflow in a River Reach

The groundwater modeling method makes use of the fundamental governing equations that define groundwater flow. Consider a one-dimensional aquifer of uniform width and thickness, with recharge distributed uniformly along the length of the aquifer. This is shown conceptually on Figure 5-12. The piezometric surface in an aquifer receiving recharge is parabolic in shape and the saturated thickness varies somewhat along the flow path. For the current modeling, the aquifer is assumed to have a uniform thickness of 5 meters, consistent with the DEIS groundwater flow path models. Compared with allowing the aquifer thickness to vary as a function of position (calculated based on the piezometric surface and aquifer bottom elevations),

the assumption of a uniform aquifer thickness results in a smaller aquifer area to accommodate flow and faster groundwater velocities. Faster groundwater velocities result in less dilution from recharge and higher concentrations observed at the evaluation points. An additional advantage to assuming a uniform aquifer thickness is that the governing equation can be readily solved as outlined below. Although solutions for an unconfined aquifer with a sloping bottom are available (e.g., Reference (69)), they are highly complex and integrating them into the GoldSim model framework would not be feasible.

As shown on Figure 5-12, the bedrock is assumed to act as an impermeable boundary, effectively separating the surficial aquifer flow paths from the bedrock flow paths in the model. As discussed below in Section 5.2.3.2, the hydraulic conductivity of the bedrock is substantially lower than that of the surficial aquifer, which results in significantly slower groundwater velocities and longer travel times within the bedrock flow paths. By separating the surficial aquifer and bedrock flow paths in the model, constituent mass entering the model from stockpiles does not enter the bedrock flow paths, which results in mass reaching the evaluation points more quickly than in the DEIS models, where the surficial aquifer and bedrock were connected and some stockpile mass could enter the bedrock. As discussed in Section 4.3.3.2, available data indicates that, although the surficial aquifer and bedrock are likely hydraulically connected to some degree, the connection is believed to be weak or non-existent in many areas of the Mine Site.

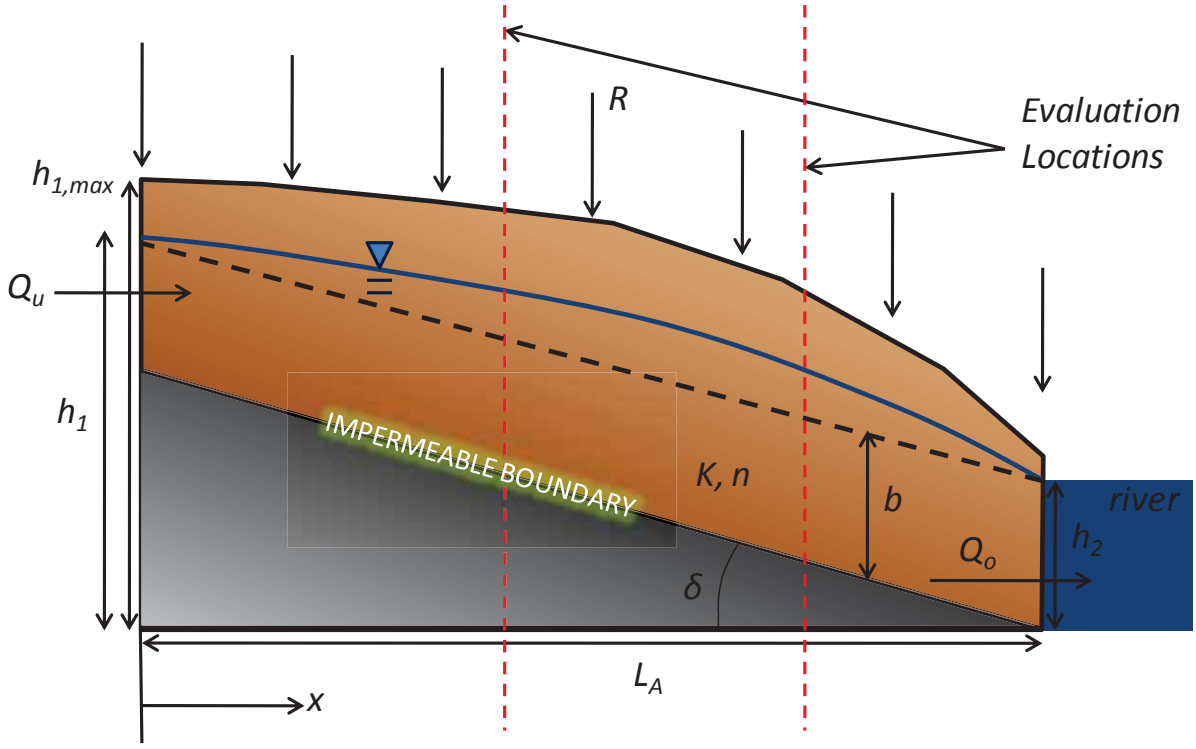


Figure 5-12 Detailed Schematic of a One-dimensional, Homogeneous, Isotropic Aquifer with Uniform Recharge and a Sloping, Impermeable Bed

Darcy's law applied to the aquifer shown in Figure 5-12 is presented in Equation 5-14.

$$Q(x) = Q_u + Rwx = -Ki(x)A = -Ki(x)wb \quad \textbf{Equation 5-14}$$

where *i* is the hydraulic gradient [L/L] at any location x along the flow path, *K* is the isotropic hydraulic conductivity [L/T], and *A* is the cross-sectional flow area defined by the uniform width multiplied by the uniform thickness [L^2]. The ordinary differential equation used to enforce continuity is shown in Equation 5-15 (e.g., Reference (70)).

$$\frac{d^2h}{dx^2} = -\frac{R}{Kb} \quad \textbf{Equation 5-15}$$

where h is the hydraulic head at any location x along the flow path [L].

The general solution to the above differential equation is:

$$h(x) = -\frac{R}{2Kb}x^2 + C_1x + C_2 \quad \textbf{Equation 5-16}$$

where *x* is any location along the flow path [L] and C_1 and C_2 are unknown coefficients defined by the boundary conditions. To solve the two unknown values, the following two boundary conditions are applied.

$$h(x = 0) = h_1 \ \therefore \ C_2 = h_1 \quad \textbf{Equation 5-17}$$

$$h(L_A) = h_2 \ \therefore \ C_1 = \frac{h_2 - h_1}{L_A} + \frac{RL_A}{2Kb} \quad \textbf{Equation 5-18}$$

These boundary conditions are the known heads at each end of the flow path. Assuming a function for *i*-bar (Equation 5-19), and taking the derivative of Equation 5-15 yields an equation for the hydraulic gradient *i(x)* along the flow path (Equation 5-20). Inserting Equation 5-20 into Equation 5-14 and solving for recharge results in Equation 5-21.

$$\bar{\imath} = \frac{h_2 - h_1}{L_A} \quad \textbf{Equation 5-19}$$

$$\frac{dh}{dx} = i(x) = -\frac{R}{Kb}x + \left(\bar{\imath} + \frac{RL_A}{2Kb}\right) \quad \textbf{Equation 5-20}$$

$$R = -\frac{2(Kbw\bar{\imath} + Q_u)}{L_Aw} \quad \textbf{Equation 5-21}$$

In the probabilistic model, *R* is calculated at the initial time step of each model realization. At that time, all groundwater flow paths originate at a groundwater divide or a no-flow boundary. Therefore, when *R* is calculated at the initial time in the model, Q_u is considered zero and the relationship between *R*, *K* and *i*-bar is defined by Equation 5-22.

$$\frac{R}{K\bar{\imath}} = -\frac{2b}{L_A} \qquad \textbf{Equation 5-22}$$

Operationally, b and L_A are known physical characteristics of each flow path. The flow path thickness b is assumed to equal 5 meters for the surficial flow paths and 15 meters for the bedrock flow paths (Reference (34)). The average hydraulic gradient, i-bar, is generated from its defining distribution, which is based on the river elevation at the downstream end of each flow path and the hydraulic head at the upstream end of the flow path estimated by the Mine Site MODFLOW model. Hydraulic conductivity (K) is also generated randomly at the beginning of each model realization based on its defining distribution. However, the randomly generated K value may be limited such that the resulting R values for each flow path are reasonable. Reasonable values of R range from 0.36 in/yr to 1.8 in/yr (approximately 50% to 250% of the estimated watershed-wide recharge value; see Section 5.2.4.3.5).

The groundwater flow relationship defined in Equation 5-21 applies to an aquifer with homogeneous recharge along its entire length. In the Mine Site model the recharge along several of the surficial flow paths is discontinuous because the liner leakage rates for the temporary stockpiles are much lower than natural recharge in the Partridge River watershed. The method presented above is used to develop a relationship between R, K and i-bar in these cases by solving Equation 5-14 and Equation 5-21 for multiple continuous zones, using the average liner leakage rate as the recharge for the zone beneath the stockpile.

In closure, the East and West Pits flood and ultimately discharge a small amount of water into the aquifer. When this occurs during the simulation, the hydraulic gradients are generated again (from a separate distribution) to more accurately capture the hydraulic gradient once the pit is full. The recharge value R and hydraulic conductivity value K remain unchanged from the values selected at the beginning of the realization. Using the new value of i-bar, Equation 5-14 and Equation 5-21 are used to calculate the rate of discharge from the pit to the groundwater flow path (Q_u). Ultimately, the flow leaving the pit determines the rate at which dissolved pollutants enter the flow path from the pits.

5.2.3.2 Groundwater Solute Transport

Within the GoldSim probabilistic model, a series of Cell Pathways simulate dissolved solute transport via groundwater from the mine features to the Partridge River. In other words, the 1D transport methods used to model groundwater (as described in Section 5.2.3.1) are entirely within the GoldSim platform. This eliminates the need to pass inputs and results back and forth between models where loss of information could potentially occur. The Cell Pathways are connected using advective fluxes so that flow leaving Cell A enters Cell B (the next downstream Cell) and transports mass from Cell A to Cell B.

The groundwater flow field and discharge through each cell in the network is determined using the analytical solutions for steady-state 1D flow in an aquifer of uniform thickness with recharge as described in Section 5.2.3.1. Mass is transported from one cell to the next at the estimated

flow rate from the analytical flow solution. Mass is also introduced to Cell Pathways either due to mass loading from recharge, from the stockpile liner leakage, or from the groundwater outflow from the pits. This mass loading is accounted for by setting appropriate boundary conditions for each cell. Groundwater quality is evaluated by reporting the water quality of the mixing cells that end nearest to a given evaluation location (evaluation distances shown in Large Figure 28 and Large Figure 29). Generally the evaluation locations are at Dunka Road and the nearest intersection with the Property Boundary or Partridge River for the surficial flow paths and the Property Boundary for the bedrock flow paths. For the flow path originating at the Overburden Storage and Laydown Area, the evaluation location was determined using a previous representation of the Property Boundary; the location has not been revised because it is conservatively close to the Mine Site.

The final or most downstream Cell Pathway in the series of cells representing a groundwater flow path must discharge to another pathway; otherwise it continually builds up constituent mass. The groundwater flow paths are connected to the 1D Partridge River portion of the model using an advective flux. The discharge flow rate from the groundwater flow paths transport constituent mass from the groundwater flow path to the Partridge River at the specified flow rate. During low-flow conditions, the discharge from groundwater flow paths to the river is adjusted as described in Section 5.2.4.4.

5.2.3.3 Hydraulic Conductivity

As discussed above, the aquifer along each groundwater flow path is assumed to be homogeneous and isotropic. Therefore, all material properties (porosity, hydraulic conductivity, etc.) of the aquifer are assumed to be representative of the entire aquifer area included in the flow path. Section 4.3.3.1 details the properties of the unconsolidated deposits, citing ranges in hydraulic conductivity from about 0.01 feet/day to about 30 feet/day. These values show the heterogeneity in the aquifer, and represent the range of values possible at any given location. The spatial average of hydraulic conductivity is a more appropriate value to use to represent a homogeneous aquifer. Therefore, the ranges on the distributions of hydraulic conductivity used in the GoldSim model are not as large as in the range presented in Section 4.3.3.1 because it represents uncertainty in the spatial average hydraulic conductivity rather than heterogeneity.

Hydraulic conductivity is an uncertain input to the probabilistic model and the values for the surficial and bedrock flow paths are selected from probability distributions once per realization. Example probability distribution functions for hydraulic conductivity are shown in Figure 5-13 and Figure 5-14. Triangular distributions are used with the mode value for the surficial aquifer flow paths determined using the average hydraulic gradient for each flow path and the estimated watershed-wide recharge value from the XP-SWMM model (0.74 inches/year, Section 5.2.4.3.5). See Equation 5-22 for the relationship between hydraulic conductivity, gradient, recharge, and the aquifer characteristics. For the bedrock flow paths, the mode value is the hydraulic conductivity of the Duluth Complex provided by the Co-Lead Agencies (3.0×10^{-3} m/day, see Reference (34)).

The limits of the hydraulic conductivity distribution values for the surficial aquifer flow paths were selected so that the calculated value of recharge for each flow path does not fall outside of the limits discussed in Section 5.2.3.1 (approximately 50% to 250% of the estimated watershed-wide recharge value). Using Equation 5-21, hydraulic conductivity (K) is maximized when recharge (R) is maximized and the gradient (i-bar) is minimized. Alternatively, K is minimized when R is minimized and i-bar is maximized. The limits on K for the surficial aquifers were determined using the reasonable limits on i-bar (Table 1-15 of Attachment C) and R (Table 1-1 of Attachment C).

The limits of the hydraulic conductivity distribution values for the bedrock flow paths were provided by the Co-Lead Agencies (Reference (34)). These limits allow for the values to range a total of one log cycle centered on the mode value. Hydraulic conductivity distribution values are shown in Table 5-8

Porosity is an input to the GoldSim model and is used to calculate groundwater velocities along the flow paths. Deterministic values of 0.3 and 0.05 were assumed for the porosity of the surficial deposits and bedrock, respectively. These values are within the ranges for surficial deposits (sand and gravel) and bedrock (fractured plutonic rocks) presented in Reference (71).

Table 5-8 Hydraulic Conductivity Distribution Values

Flow Path	Lower Bound K (m/day)	Mode K (m/day)	Upper Bound K (m/day)
West Pit - Surficial Aquifer	0.39	1.31	4.73
Overburden Storage and Laydown Area	2.06	3.55	6.17
Waste Water Treatment Facility	0.41	0.88	2.20
Ore Surge Pile	0.24	0.52	1.31
East Pit & Category 2/3 Stockpile	0.82	1.94	5.49
Bedrock Flow Paths	0.001	0.003	0.01

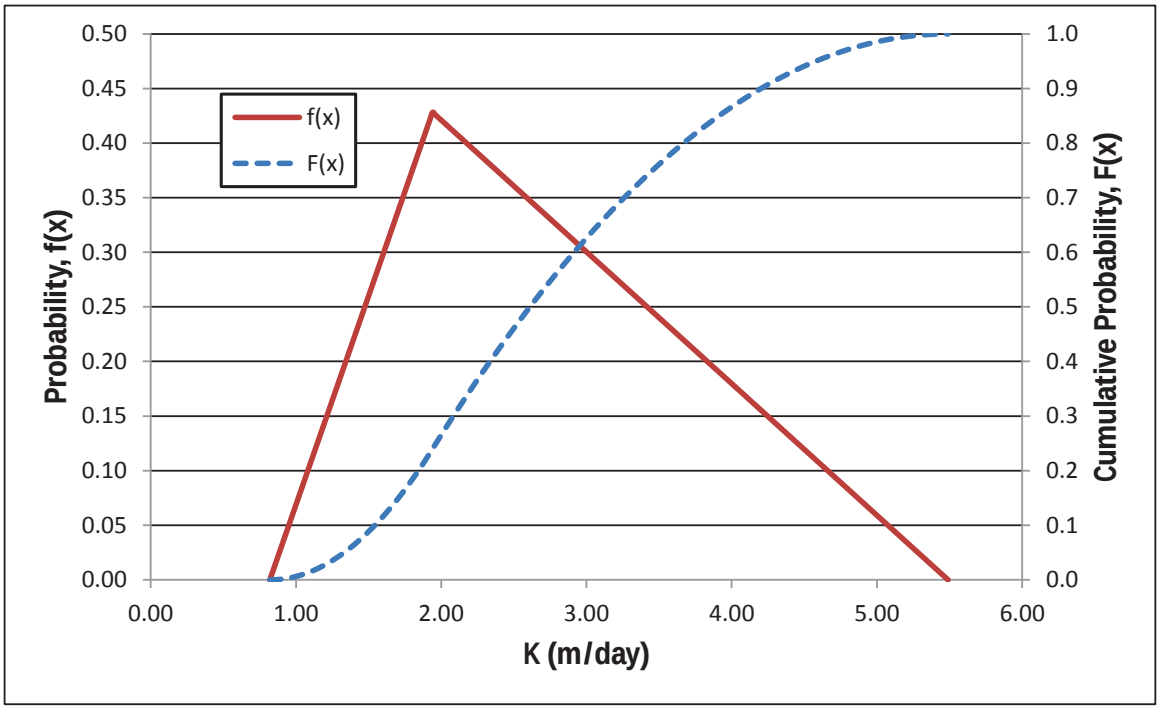


Figure 5-13 Hydraulic Conductivity Distribution of the East Pit and Category 2/3 Stockpile Flow Path

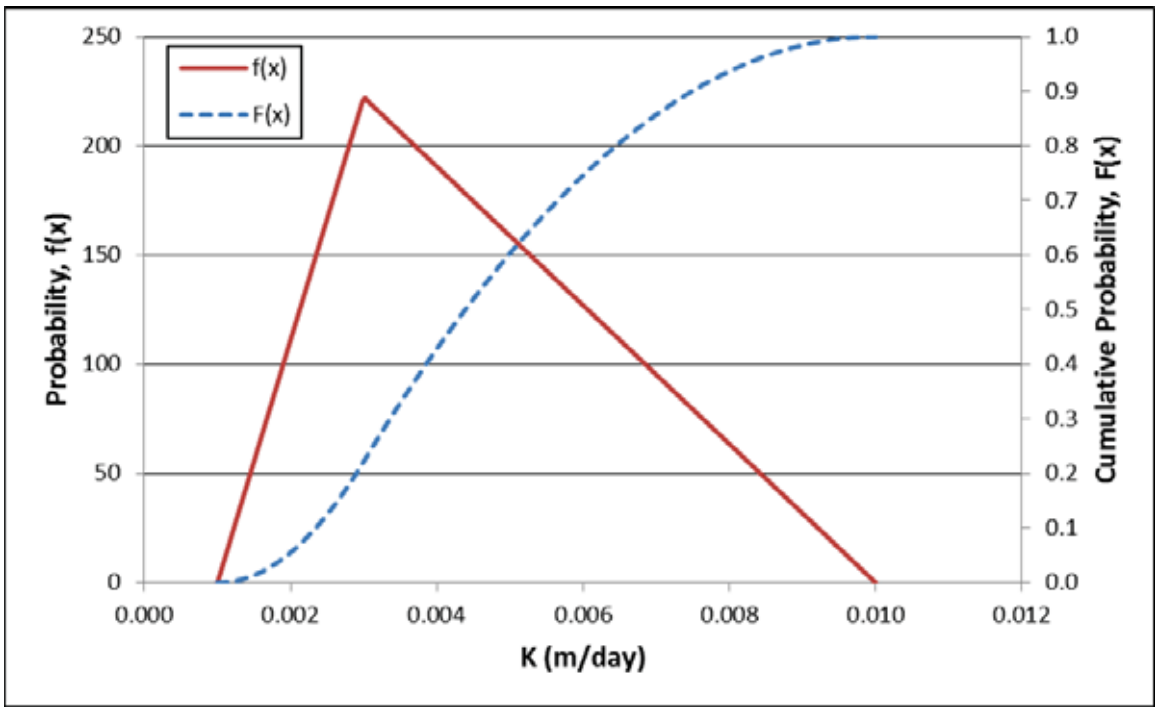


Figure 5-14 Hydraulic Conductivity Distribution of the Bedrock at the Mine Site

5.2.3.4 Recharge

The recharge rate applied to non-stockpile areas of the flow path is assumed constant and is calculated based on the estimated baseflow in the Partridge River and the contributing flow path area at that time during the simulation (Section 5.2.4.3.5 for discussion of estimating baseflow in the Partridge River). The recharge to the groundwater flow paths from stockpile areas (liner leakage) varies for each flow path during operations according to each stockpile's footprint area and water balance (Section 5.2.2.1.1). Therefore, the groundwater flow equations (Equation 5-14 and Equation 5-21) are solved for recharge at each model time step to account for temporal changes in liner leakage. In closure, liner leakage is replaced by natural recharge in areas formerly occupied by stockpiles. For example, the Category 2/3 Waste Rock Stockpile is removed at the end of operations, so the recharge rate to the area of the groundwater flow path formerly occupied by the stockpile is set equal to the recharge rates for non-stockpile areas. The calculated recharge values for each flow path are limited to a defined range from 0.36 in/yr to 1.8 in/yr (approximately 50% to 250% of the estimated watershed-wide recharge value; see Section 5.2.4.3.5).

The bedrock flow paths are modeled as disconnected from the surficial aquifer and therefore experience no recharge.

5.2.3.5 Sorption

Sorption is simulated for the surficial flow paths in the model using an empirical method by defining distribution coefficients (K_d). This method reflects the amount of sorption that can occur without reference to a particular sorption mechanism, and its use is valid if the environments from which the K_d values are determined are geochemically similar to the environment where they are applied. Water quality modeling for the DEIS used USEPA K_d screening values for arsenic, copper, and nickel. To evaluate the appropriateness of these K_d values with respect to the aquifer, a field-based investigation characterized relevant geochemical parameters in the soil at the NorthMet site (Reference (72)). The results of this work indicated that the field pH of soils at the site ranges from 5.4 to 7.2. The total organic carbon at the site was 1.73% in the shallowest sample and 0.11 to 0.48% in samples collected at greater than 10 feet. The unconsolidated overburden soils contain approximately 2% total iron and soil samples contained between 5 and 9% iron oxide, suggesting that most, but not all of the iron is present as iron oxide.

In comparison, the USEPA screening values were developed by modeling sorption at three different values of pH: 4.9, 6.8, and 8.0; and three different values of iron oxide content: 0.01%, 0.31%, and 1.11%. The pH values at the NorthMet site fall within the range of pH considered in the development of the USEPA screening values. The iron oxide content at the NorthMet site is higher. Because iron oxide promotes sorption, use of the USEPA screening values is conservative. The organic carbon content considered for the development of the screening values was 0.2%, approximately the median of the range observed in the surface at the NorthMet site.

Site-specific sorption factors for arsenic, copper, nickel and antimony were also estimated experimentally using representative aquifer material from the Mine Site and Plant Site. The pH of the site-specific tests ranged from 6.9 to 8.6, similar to the range observed in groundwater at the Mine Site. The results of the site-specific test work confirmed the conservatism of using the USEPA screening values for arsenic, copper and nickel (site-specific sorption values were larger than the screening values for these solutes). The results for antimony were lower than the USEPA screening value, but were consistent with the findings of Reference (73) and Reference (74).

The same USEPA screening values for arsenic, copper, and nickel that were used in the DEIS are used as deterministic values for the SDEIS and FEIS water quality modeling of the surficial flow paths. The sorption factor for antimony is treated as a probabilistic input (acknowledging uncertainty in the actual amount of sorption that may occur at the site) using a triangular distribution. The minimum K_d value is based on the lowest value reported in a USEPA literature review (Reference (74)). The mean and maximum K_d values are based on the lowest two values from the site-specific sorption test work (conducted using Mine Site and Plant Site aquifer samples) (Table 5-9). No sorption is simulated for the bedrock flow paths.

Table 5-9 Sediment Sorption Factor (K_d)

Pollutant	Deterministic K_d	Probabilistic K_d (triangular distribution)		
	L/kg	Minimum (L/kg)	Mean (L/kg)	Maximum (L/kg)
Arsenic	25	--	--	--
Antimony	--	1.3	1.6	6.1
Copper	22	--	--	--
Nickel	16	--	--	--

During the January 2008 Overburden Geochemical Characterization Investigation (Section 4.3.1.5), secondary pyrite mineralization was observed in the saturated overburden at a total of six boreholes and, in general, sulfur concentrations in the fine-grained soil fraction tended to increase with decreasing redox potential (Reference (22)). Hydrogen sulfide odors were also noted when some portions of the cores were subjected to hydrochloric acid. These field observations suggest that geochemical conditions in some portions of the surficial aquifer may be favorable for the occurrence of both sulfate reduction and precipitation of sulfides. Where they operate, these processes could act as attenuation mechanisms for both sulfate and metals in groundwater.

The aquifer bulk density is a required input to the GoldSim model for sorption calculations. A deterministic value of 1,500 kg/m3 was used for bulk density, a representative value from the USDA St. Louis County Soil Survey database for soil types present at the Mine Site.

5.2.3.6 Dispersion

Dispersion of contaminants within a groundwater flow path (aquifer) is a known naturally occurring process. For the DEIS, dispersion was incorporated into the MODFLOW/MT3D modeling used to evaluate solute transport. However, the current solute transport modeling in GoldSim does not allow for direct input of dispersion to the mass transport model. Instead, physical dispersion is simulated in the groundwater flow paths using controlled numerical dispersion using the approach recommended in the GoldSim Contaminant Transport Module User's Guide (Reference (75)). Numerical dispersion occurs as part of the numerical method used to solve the system of coupled differential equations in GoldSim. It occurs because mass is transported through a series of *well-mixed* cells. For example, if the aquifer was represented with 1 cell, in the first time step, some of the mass entering the cell will be seen leaving the cell because when mass entered the cell, it was instantly "dispersed" throughout the cell, all the way to the other end (due to the cell's length). On the other hand, if the same length of aquifer was represented using 1 billion cells, dispersion will have a much smaller effect. As mass enters one of the 1 billion "tiny" cells, it will be mixed throughout the entire cell, but the mixing length is so minute that it's almost as if mass was not dispersed at all. Therefore, there is a relationship between the dispersion length and the number of cells used to represent the aquifer. Using well-mixed cells to represent advection-dispersion transport, the dispersion length is equal to one-half the cell length (page 124 of Reference (75)).

For the GoldSim model, the aquifer flow paths were discretized such that the same dispersion relationship that was used in the modeling for the DEIS (Equation 5-23) is matched as closely as possible.

$$D = 0.83 * [\log(L)]^{2.414} \qquad \textbf{Equation 5-23}$$

For example, if the aquifer length is 1000 meters, then the desired dispersion length from Equation 5-23 is 11.8 meters. Then, because the dispersion length is equal to one-half the cell length, the cell lengths should be approximately 23.6 meters. Given the aquifer length and the optimal cell length, the aquifer will be represented using 42 cells to obtain the desired degree of dispersion.

5.2.3.7 Groundwater Inflow to Mine Pits

For the DEIS modeling, a MODFLOW model of the Mine Site was used to calculate groundwater inflow rates to the pits during operations and the expected head distribution and groundwater flow directions during reclamation and long-term closure (Reference (33)). The groundwater flow rates to the pits were used to develop the water balances for the pits, which directly affect the water quality within the pits. The distribution of heads in closure was used to establish the groundwater flow paths that were used in the MT3D models to evaluate dissolved solute transport and potential groundwater impacts associated with the Project (Reference (11)).

For the SDEIS modeling, a similar approach was used; however, several modifications were made to the DEIS MODFLOW model to incorporate new information. A brief discussion of the changes to the model for the SDEIS is included here. The DEIS MODFLOW model was calibrated to a baseflow estimate of 1.43 cfs at monitoring station SW004. Revisions to the XP-SWMM model subsequent to the DEIS modeling (Section 5.2.4.3) resulted in different baseflow estimates for the Partridge River. The MODFLOW model was re-calibrated for the SDEIS using target baseflow values of 0.41, 0.51, and 0.92 cfs at SW002, SW003, and SW004, respectively. In addition, groundwater elevations measured at Mine Site monitoring wells MW-1 through MW-18 were included as targets in the updated calibration. The automated-inverse modeling code PEST (Reference (76) and Reference (77)) was used to complete the model calibration.

At the direction of the Co-lead Agencies, additional changes were made to the MODFLOW models for the FEIS. Attachment B contains detailed documentation of the MODFLOW models for the FEIS; a brief summary of the changes relative to the SDEIS models is included here. The most significant change was updating the calibration head targets to incorporate new groundwater elevation data collected since the SDEIS. In addition, constraints were added to the calibration to:

- minimize the occurrence of simulated heads above the ground surface
- keep the hydraulic conductivity of the Duluth Complex as close as possible to the value recommended by the Co-lead Agencies (Reference (34))
- keep the hydraulic conductivity of the other bedrock units as close as possible to the DEIS values, which were estimated using available published information

The revised model calibration resulted in different optimized values for the horizontal hydraulic conductivity of the surficial aquifer and bedrock, which are used to establish the distribution of values used for the probabilistic groundwater flow path modeling (Section 5.2.3.1). During the MODFLOW model calibration process, the hydraulic conductivity of the Duluth Complex was kept as close as possible to 4.5×10^{-4} feet/day, the value recommended by the co-lead Agencies (Reference (34)). Details of the MODFLOW model calibration process are included in Attachment B.

To calculate groundwater inflow rates to the pits during operations, MODFLOW simulations were developed using the same methods as those used for the SDEIS modeling. (Details regarding the simulation setup and results are included in Attachment B. The estimates of groundwater inflow rates to the pits were used for the overall water balance of the pits in the probabilistic model (Section 5.2.2.6.3).

5.2.3.8 Background Groundwater Quality

Background groundwater quality is used in the Continuation of Existing Conditions Scenario Model, and also in the Project Model to represent the constituent load in groundwater not originating from mining features.

5.2.3.8.1 Surficial Aquifer

The concentrations of constituents in groundwater not originating from mining features are used in the Project Model to calculate the groundwater load to the Partridge River and mine pits. In addition, Mine Site source terms are diluted by recharge along specific flow paths (Section 5.2.3.2); the water quality of that recharge is assumed to be equivalent to groundwater not originating from mining features (i.e., background groundwater quality). Background surficial aquifer groundwater quality data for the Mine Site is summarized in Large Table 3.

As discussed in Section 4.3.4, the available groundwater quality data demonstrates spatial and temporal variability. Thus, there is uncertainty in the average background concentrations of constituents in groundwater within the watershed and along any specific flow path. To utilize the probabilistic model's ability to consider uncertainty, distributions of the mean groundwater concentration were developed for each constituent. Use of mean groundwater concentrations is appropriate because groundwater sources cover a wide area and groundwater travel times are relatively slow. Thus, loading from groundwater can be expected to reflect the integration of the spatial and temporal variability observed in the baseline data.

Distributions of average surficial aquifer groundwater concentrations were developed based only on data collected by PolyMet Mining, Inc. at the Mine Site, including data collected through December 2013. Additional regional data available from the USGS and MPCA were not included in developing the groundwater distributions as originally proposed due to the addition of new data collected at the Mine Site, as directed by the Co-lead Agencies. In order to create the distributions, the collected data was adjusted according to the following rules:

- The cut-off date utilized was December 2013, based on correspondence with the Co-lead Agencies.
- All non-detected concentrations were assumed to be half the detection limit.
- Three outlier samples (for all constituents) were removed for locations MW-2 on 11/9/2011, MW-18 on 2/23/2012, and MW-18 on 3/27/2012 based on correspondence with the Co-lead Agencies.
- The collected values at location MW-05-09 on 6/1/2012 utilized both a 0.1µm filter and a 0.45µm filter. The values obtained from the 0.1µm filter were not used to create the distributions.
- Any duplicate samples were averaged.

After the data set was adjusted, probability distributions were defined using a program written by Dr. Randal Barnes at the University of Minnesota in the MATLAB programming language. This program infers the distribution parameters that describe the uncertainty in the mean background concentration, using the adjusted data set. The population of the background concentration data was assumed to be log-normally distributed; therefore the uncertainty in the mean concentration was also assumed to follow a log-normal distribution.

These distributions were generated using the method described above and are presented for modeled constituents in Attachment D. Individual groundwater measurements are also plotted on the figures in Attachment D, although it should be noted that the distributions described above represent the uncertainty in the mean groundwater concentration and are not intended to represent the variability observed among the full population of individual measurements.

Contrary to the previous calibration efforts and the method discussed in the IAP process, the groundwater distributions developed from the PolyMet data were not calibrated to observed concentrations in the Partridge River during low-flow events. Reasons for this include the addition of new groundwater data at the PolyMet Mine Site and the limited amount of concurrent flow and concentration data available in the Partridge River during low-flow conditions.

The groundwater distributions developed from the Mine Site groundwater data are defined by three parameters: α, β, and α_{stdev}. The parameter α represents the mean of the log-transformed groundwater data; β represents the variability of the log-transformed groundwater data; and α_{stdev} is a parameter describing the uncertainty in the true mean value of the log-transformed groundwater data. In the probabilistic modeling, background groundwater quality is estimated by first randomly sampling a mean value in log-transformed space (normally distributed with parameters α and α_{stdev}), and then transforming the value using the parameter β. The mean of a distribution in a real or un-transformed space, μ, is shown in Equation 5-24.

$$\mu = e^{\left(\alpha + \frac{\beta^2}{2}\right)} \qquad \textbf{Equation 5-24}$$

Table 5-10 (see also Table 1-12 of Attachment C) presents the input parameters that define the groundwater distribution for each constituent.

Table 5-10 Summary of Surficial Groundwater Distribution Input Parameters

Constituent	Model input parameters (log-transformed)			Un-transformed values	
	α (log mean)	α_{stdev} (log mean std. error)	β (log std. dev.)	μ (population mean, µg/L)	σ (population std. dev., µg/L)
Ag[2]	-2.24E+00	1.56E-02	2.79E-01	1.11E-01	3.15E-02
Al[2]	3.27E+00	6.72E-02	1.20E+00	5.40E+01	9.69E+01
Alkalinity	1.09E+01	3.51E-02	6.28E-01	6.46E+04	4.49E+04
As[2]	-6.96E-01	4.86E-02	8.51E-01	7.16E-01	7.38E-01
B	3.27E+00	1.26E-02	2.26E-01	2.70E+01	6.18E+00
Ba	3.05E+00	5.00E-02	8.93E-01	3.14E+01	3.46E+01
Be	-2.20E+00	2.13E-02	3.80E-01	1.19E-01	4.70E-02
Ca	9.49E+00	3.14E-02	5.60E-01	1.54E+04	9.37E+03
Cd[2]	-2.29E+00	9.90E-03	1.77E-01	1.03E-01	1.83E-02
Cl	6.22E+00	4.00E-02	7.15E-01	6.52E+02	5.33E+02
Co[2]	-1.03E+00	7.71E-02	1.32E+00	8.52E-01	1.85E+00
Cr[2]	-2.84E-01	3.66E-02	6.55E-01	9.33E-01	6.82E-01
Cu[2]	3.23E-01	6.07E-02	1.08E+00	2.49E+00	3.72E+00
F	4.17E+00	2.64E-02	4.72E-01	7.26E+01	3.63E+01
Fe[2]	4.90E+00	1.24E-01	2.17E+00	1.43E+03	1.51E+04
Hardness	NA[1]	NA[1]	NA[1]	NA[1]	NA[1]
K	7.33E+00	2.45E-02	4.37E-01	1.69E+03	7.74E+02
Mg	8.67E+00	3.29E-02	5.88E-01	6.95E+03	4.47E+03
Mn[2]	4.38E+00	1.12E-01	1.96E+00	5.51E+02	3.75E+03
Na	8.41E+00	3.28E-02	5.86E-01	5.34E+03	3.41E+03
Ni[2]	9.40E-02	6.16E-02	1.10E+00	2.01E+00	3.09E+00
Pb	-9.18E-01	5.12E-02	9.14E-01	6.07E-01	6.93E-01
Sb[2]	-1.38E+00	5.80E-03	9.98E-02	2.53E-01	2.53E-02
Se[2]	-6.75E-01	1.30E-02	2.32E-01	5.23E-01	1.23E-01
SO_4	8.92E+00	3.94E-02	7.04E-01	9.58E+03	7.68E+03

Constituent	Model input parameters (log-transformed)			Un-transformed values	
	α (log mean)	α_{stdev} (log mean std. error)	β (log std. dev.)	μ (population mean, µg/L)	σ (population std. dev., µg/L)
Tl	-2.33E+00	3.90E-02	6.97E-01	1.24E-01	9.77E-02
V(2)	1.18E+00	2.71E-02	4.64E-01	3.62E+00	1.77E+00
Zn(2)	1.34E+00	2.81E-02	5.02E-01	4.34E+00	2.32E+00

(1) Hardness is calculated from other modeled constituents
(2) Constituents with distributions developed from dissolved concentrations, all others total.

It should be noted that the thallium groundwater data included some non-detections with a detection limit of 2 µg/L. The only detection had a concentration of 0.26 µg/L. The non-detections of thallium with a detection limit of 2 µg/L were removed from the dataset prior to developing a groundwater distribution.

5.2.3.8.2 Bedrock

Similar to the groundwater quality in the surficial aquifer, groundwater concentrations in the bedrock must be determined to calculate loading to the mine pits and water quality along bedrock flow paths (Section 5.2.3.2). The modeling approach utilizes mean bedrock groundwater concentrations that are homogenous across the modeled area and are constant through time, as was done for the surficial aquifer. Use of mean groundwater concentrations is appropriate because groundwater sources cover a wide area and groundwater travel times are very slow. The method discussed in Section 5.2.3.8.1 for developing distributions for the surficial aquifer is used to develop distributions for the average water quality in the bedrock. Table 5-11 (Table 1-12 of Attachment C) presents the input parameters that define the groundwater distribution for each constituent.

Table 5-11 Summary of Bedrock Groundwater Distribution Input Parameters

Constituent	Model input parameters (log-transformed)			Un-transformed values	
	α (log mean)	α_{stdev} (log mean std. error)	β (log std. dev.)	μ (population mean, µg/L)	σ (population std. dev., µg/L)
Ag(2)	-1.87E+00	1.04E-01	7.23E-01	2.01E-01	1.66E-01
Al(2)	2.70E+00	8.97E-02	6.28E-01	1.81E+01	1.26E+01
Alkalinity	1.07E+01	1.22E-01	8.47E-01	6.41E+04	6.57E+04
As	1.57E-01	1.55E-01	1.08E+00	2.10E+00	3.13E+00

Constituent	Model input parameters (log-transformed)			Un-transformed values	
	α (log mean)	α_{stdev} (log mean std. error)	β (log std. dev.)	μ (population mean, µg/L)	σ (population std. dev., µg/L)
B	3.56E+00	1.05E-01	7.33E-01	4.58E+01	3.87E+01
Ba	1.40E+00	1.45E-01	1.02E+00	6.83E+00	9.19E+00
Be	-2.24E+00	3.32E-02	2.33E-01	1.09E-01	2.58E-02
Ca	9.46E+00	7.81E-02	5.47E-01	1.49E+04	8.78E+03
Cd(2)	-2.22E+00	5.10E-02	3.54E-01	1.15E-01	4.20E-02
Cl	6.86E+00	1.61E-01	1.11E+00	1.78E+03	2.78E+03
Co	-3.67E-02	2.02E-01	1.42E+00	2.63E+00	6.68E+00
Cr(2)	-6.66E-01	1.96E-02	1.36E-01	5.19E-01	7.08E-02
Cu(2)	2.63E-02	1.07E-01	7.51E-01	1.36E+00	1.19E+00
F	4.68E+00	1.23E-01	8.52E-01	1.55E+02	1.60E+02
Fe	7.44E+00	3.03E-01	2.12E+00	1.60E+04	1.50E+05
Hardness	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)
K	7.33E+00	4.80E-02	3.36E-01	1.61E+03	5.56E+02
Mg	8.84E+00	1.16E-01	8.09E-01	9.58E+03	9.20E+03
Mn	3.77E+00	2.49E-01	1.74E+00	1.98E+02	8.85E+02
Na	8.47E+00	1.56E-01	1.09E+00	8.60E+03	1.30E+04
Ni	2.05E+00	2.72E-01	1.90E+00	4.72E+01	2.84E+02
Pb	-8.65E-01	9.47E-02	6.63E-01	5.25E-01	3.90E-01
Sb	-7.93E-01	1.15E-01	8.04E-01	6.25E-01	5.95E-01
Se(2)	-5.05E-01	4.49E-02	3.11E-01	6.33E-01	2.02E-01
SO4	9.67E+00	1.37E-01	9.51E-01	2.50E+04	3.03E+04
Tl	-1.57E+00	1.46E-01	1.02E+00	3.53E-01	4.79E-01
V	1.18E+00	2.71E-02	4.64E-01	3.62E+00	1.77E+00
Zn(2)	2.00E+00	1.44E-01	1.00E+00	1.21E+01	1.59E+01

(1) Hardness is calculated from other modeled constituents
(2) Constituents with distributions developed from dissolved concentrations, all others total.

5.2.3.8.3 Correlations in Background Water Quality

In natural waters, the concentrations of some constituents are often correlated to one another

for a variety of reasons. For example, Mine Site groundwater samples with relatively high iron concentrations often have high manganese concentrations. Such correlations exist in the background water quality data used for the water quality modeling.

As a modeling simplification, correlation between constituent concentrations in groundwater is not simulated in the NorthMet model. Each constituent is modeled separately. This simplification could lead to unrealistic estimates of the total groundwater quality in any particular realization, such as a water with high iron and low manganese concentrations at the same time. Because the impact assessment for the Project compares modeled concentrations to the applicable water quality standard on a constituent-by-constituent basis, however, this simplification is appropriate as long as the modeled distribution for each individual constituent is realistic.

5.2.4 Surface Water

5.2.4.1 Partridge River

The Partridge River is subdivided into seven reaches bracketed by monitoring locations from PM-1/SW001 to SW006 (Large Figure 20). Each reach is modeled as a separate cell element (i.e., a volume on which a mass balance is calculated). The Partridge River evaluation points shown in Large Figure 20 represent the downstream limit of each model cell (i.e., all inputs to that reach are included at the evaluation point). The volume of each cell is based on the length of the reach (Table 1-17 Attachment C) and cross-sectional area of the reach, determined from the stream geomorphology surveys performed on the Partridge River (Reference (78)). The volume of each river cell has a minimal effect on the probabilistic modeling, as the volumes are small enough that even low flows result in flushing each cell completely over the monthly time step.

Inflows to each cell include the outflow from the upstream river reach, surficial groundwater inflow from non-project areas tributary to that reach, surface runoff tributary to that reach, and any inflows from Project sources (e.g., groundwater, WWTF discharge). The contribution from bedrock groundwater is considered negligible. As discussed in Section 4.3.3.2, the hydraulic connection between the surficial aquifer and the bedrock appears to be relatively weak. Further, the bedrock has much lower hydraulic conductivity than the surficial aquifer and is not expected to transmit significant quantities of water to the Partridge River (Reference (43)). Constituent concentrations are calculated at each time step for the surface water evaluation points shown in Large Figure 20.

The generic water balance for any given reach (i.e., model node) of the Partridge River is shown in Equation 5-25.

$$Q_o = Q_{gw} + Q_{seep} + Q_{ro} + Q_{PMP} \qquad \textbf{Equation 5-25}$$

$$Q_{total} = Q_0 + Q_{WWTF} \qquad \textbf{Equation 5-26}$$

In Equation 5-25, Q_o is the flow leaving a given reach less any discharge from the WWTF in closure, Q_{gw} is the incremental surficial groundwater flow from non-mining sources contributing to flow at a given node, Q_{seep} is the flow from Mine Site sources and any additional recharge occurring along the flow path, Q_{ro} is the incremental surface runoff contributing to flow at a given node, and Q_{PMP} represents discharge from the Peter Mitchell Pit upstream of SW001 (Table 1-1 of Attachment C). Q_o differs from Q_{total} in that Q_{total} also includes Q_{WWTF}, which represents the WWTF discharge in closure (Equation 5-26). Q_o is distinguished from Q_{total} because the distributions of Partridge River flow used to develop the other inputs listed above (Section 5.2.4.3.5) are based on modeling that excludes the watershed area tributary to the WWTF.

Not all components of the water balance shown above are applicable to every surface water evaluation location. Figure 5-15 shows the modeled surface water evaluation locations in the Continuation of Existing Conditions Scenario Model, how they are connected hydraulically, and the sources of flow and load to each location.

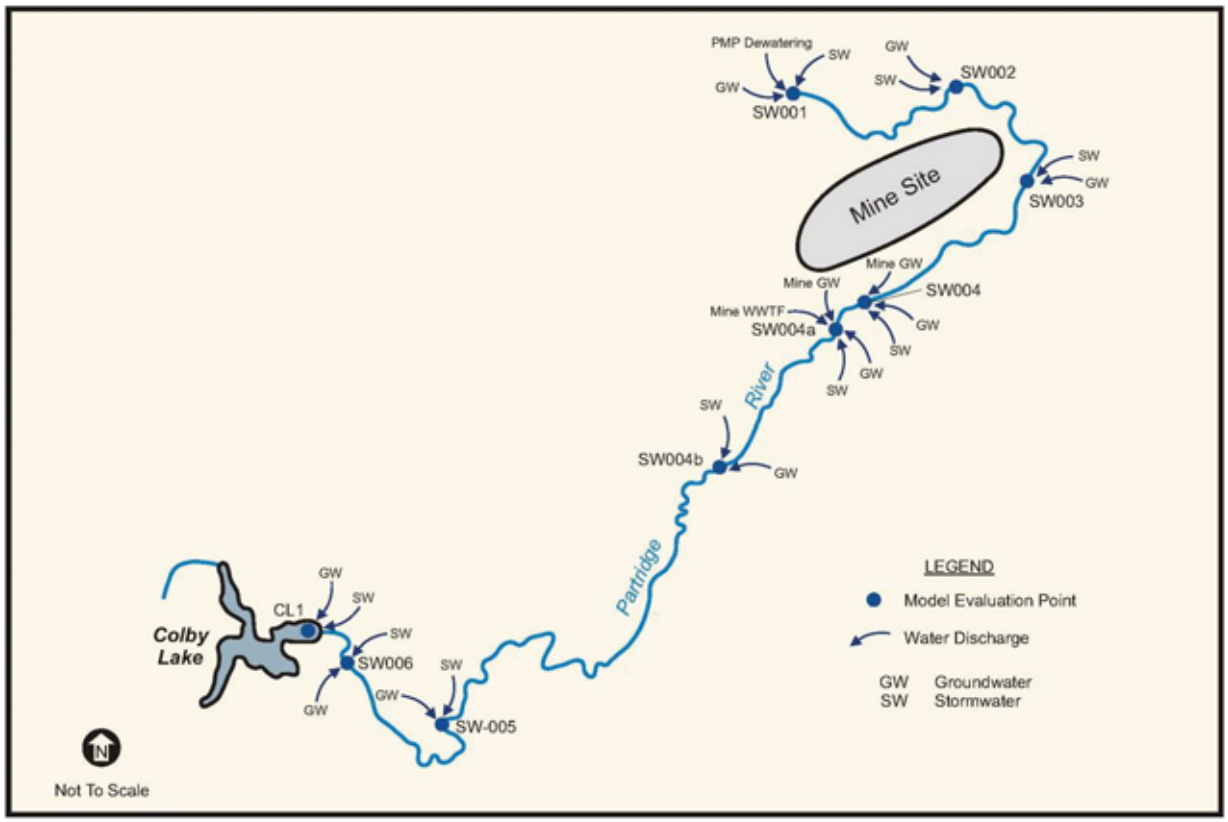


Figure 5-15 Schematic Showing Surface Water Evaluation Locations, Hydraulic Connectivity, and Sources to Each Location for the Project Model

Within each model realization, a flow (Q_o) at location SW006 is sampled from a distribution at each monthly time step. The flow is sampled from a distribution unique to that month. From the sampled flow at SW006, upstream incremental inflows to each river reach are calculated (Section 5.2.4.3.5). As noted in Section 5.2.4.3.5, the sum of Q_{seep} and Q_{gw} is equal to the incremental groundwater inflow to a given model node. The component of surface runoff in the Partridge River flow (Q_{ro}) is calculated as the residual in Equation 5-25.

5.2.4.2 Colby Lake and Whitewater Reservoir

A water balance around Colby Lake is a necessary component of the probabilistic water quality modeling. Colby Lake, Whitewater Reservoir, and their tributary areas are not included in the XP-SWMM model developed for the Partridge River (Section 5.2.4.3). To estimate monthly inflow into Colby Lake from the directly tributary area, the estimated flow in the Partridge River at SW006 (sampled from the distribution of daily flows unique to each month, see Section 5.2.4.3.5) was scaled by the ratio of tributary areas. The watershed tributary to Colby Lake is approximately 19 square miles, compared to a tributary area upstream of SW006 of

approximately 97 square miles (excluding those subwatersheds tributary to the Peter Mitchell Pit, see Large Figure 20).

Thus, the tributary area to Colby Lake is 20% of the tributary area to SW006. For the purposes of water quality modeling, it is assumed that the inflow to Colby Lake is 20% of the flow at SW006 under existing conditions. It is assumed that the seasonal distribution of runoff is similar at SW006 and Colby Lake.

Similarly, the groundwater inflow to Colby Lake occurring downstream of SW006 is assumed to be proportional based on tributary area. Thus, the additional groundwater inflow to Colby Lake is 20% of the existing conditions groundwater inflow to SW006, or 1.055 cfs (Section 5.2.4.3.5).

In the GoldSim model, Colby Lake is modeled as a cell element with a volume of 5,300 acre-feet. As a cell, water quality is calculated in Colby Lake assuming continuously mixed conditions. The water quality in Colby Lake at any given model time step may depend on the water quality of previous time step(s) depending upon the inflow to the lake relative to the lake volume. During low flow periods in the Partridge River, the residence time of Colby Lake can range from 2-5 months. The impact of pumping from Whitewater Reservoir to Colby Lake during low flow periods (an anticipated condition of the NPDES permit) is not considered in the probabilistic model. This is because Whitewater Reservoir water quality data is similar or better than Colby Lake water quality data (Large Table 10). Therefore, additional inflow from Whitewater Reservoir will not negatively impact Colby Lake water quality.

Whitewater Reservoir is not included in the water quality modeling for two reasons: 1) existing conditions water quality data demonstrates that Whitewater Reservoir water quality is better than Colby Lake for most parameters of concern, and 2) transfer of water from Colby Lake to Whitewater Reservoir occurs during spring snowmelt and the associated high flows, when parameter concentrations are diluted by large amounts of runoff.

5.2.4.3 XP-SWMM

PolyMet developed a hydrologic/hydraulic model for the Partridge River upstream of Colby Lake using XP-SWMM software. The development of the model, identification of input data, and calibration to existing gage data are presented in Reference (12). That model was updated to reflect changes in the Mine Plan (e.g., pit and stockpile design). This section discusses the changes made to the model and results of the revised model. Only those elements of the modeling that have changed since model development are discussed in this document.

5.2.4.3.1 Model Parameters and Components

Topography and Watershed Delineation

The topographic data used in the development of the model is described in Reference (12). To this data, LiDAR elevation data collected for Mine Site in 2010 was added. Watershed delineation was based on the 75 subwatersheds previously delineated and updated to reflect the

addition of the LiDAR data at the Mine Site. Watershed delineation was performed in ArcGis 9.3 GIS software. Several existing subwatershed boundaries within the Mine Site were altered relative to the previous analysis described in Reference (12). Existing conditions subwatersheds at the Mine Site are presented in Large Figure 21.

Watersheds delineated for existing conditions were adjusted for future conditions (with Project) based on the proposed Mine Plan. Watershed areas contributing process water (i.e., water that requires water quality treatment) such as mine pits, haul roads, and open stockpiles are removed from the area tributary to the Partridge River, as the treated process water is routed to the Plant Site and/or used to backfill Mine Pits. Reclaimed portions of the Category 1 Waste Rock Stockpile are considered as areas contributing surface runoff only. Mine Site watersheds delineated for Mine Years 1, 2, 11, 20, during West Pit flooding, and in long-term closure (after the West Pit is flooded) are shown in Large Figure 22 through Large Figure 27.

Other modifications to the Partridge River watershed include the removal of the Peter Mitchell Pit watersheds from the area tributary to the river. The Peter Mitchell Pit is currently being mined by Northshore; this action is expected continue until approximately 2070 (Mine Year 55). Dewatering of the pit is routed to the Partridge River and Dunka River. To reflect this condition, these watersheds (Large Figure 20) are turned off in the XP-SWMM model (i.e., they do not contribute runoff or infiltration). Instead, an assumed dewatering volume is added to the river (Section 5.2.4.6.1) in the probabilistic model. This was done to prevent modification to the XP-SWMM model should the dewatering practices at the Peter Mitchell Pit change substantially.

Land Use/Land Cover and Soils

Land use/land cover and soils data presented in Reference (12) were used to update the XP-SWMM model. No changes were made to the land cover and soil inputs for the majority of subwatersheds. For those subwatersheds within or near the Mine Site that were redelineated based on new topographic data, the model inputs were calculated using the same procedure presented in Reference (12), but applied to the new area. All area-based calculations were performed using ArcGis 9.3

Climate Inputs

Climate inputs used in the updated XP-SWMM modeling are identical to those presented in Reference (12). Climate inputs used in the XP-SWMM model are based on the period from 1978-1988, as opposed to the most recent climate normal period. The disparity in periods is expected to have a negligible impact on modeling results based on analysis presented in Section 4.4.1.1. The reason for this difference is that the XP-SWMM model is used to estimate river flow for a specific time period (water years 1979-1988). This period was selected because continuous USGS gage data exists for these years (Section 4.4.1). The XP-SWMM model is designed to estimate relative impacts to streamflow, as opposed to calculating future flows (Reference (12)). That is, future flows are estimated based on observed flows scaled by the relative difference between an existing conditions (i.e., 1978-1988) XP-SWMM model and a

future conditions XP-SWMM model. The use of 1978-1988 data to represent existing conditions is discussed in Section 4.4.1.1.

5.2.4.3.2 Model Calibration and Validation

Reference (12) presents the calibration of the original XP-SWMM model. The model was originally calibrated to USGS gage data from water year 1985 and validated against the remainder of the 1978-1988 gage period. Since the initial model calibration, the USGS gage data has been modified to account for augmentation due to historical mine pit dewatering (Section 4.4.1.2). The impact of this correction on model calibration and validation is discussed in Section 4.4.1.2 and does not warrant recalibration of the XP-SWMM model.

5.2.4.3.3 Model Outputs and Hydrologic Parameters

As presently constructed, the XP-SWMM model returns flow at each model conduit (reach) every 144 minutes. The model outputs are averaged to daily flow to develop a continuous hydrograph for the ten year modeled period. A benefit of using the XP-SWMM model is that it allows estimation of upstream hydrologic parameters, as model output can be generated from any conduit (or reach) within the model. Model outputs are reported at the following locations (Large Figure 20).

- SW002
- SW003
- SW004
- SW004a
- SW004b
- SW005
- SW006 (location of former USGS gage 04015475)

From the model output hydrographs, several hydrologic parameters were calculated (Section 6.4.1). These hydrologic statistics are key parameters used to define the degree of hydrologic alteration due to watershed changes (Reference (79)). These statistics are described in greater detail in Reference (13).

The XP-SWMM models of the Partridge River are intended to estimate changes in hydrologic parameters relative to another modeled condition (e.g., existing conditions). Thus, model output is not directly equivalent to estimated streamflow. Estimation of streamflow requires multiplying the flow parameter by a factor calculated by comparing the 1978-1988 model to the USGS gage data (Section 4.4.1.2). The scaling factors are presented in Table 4-7.

Streamflow statistics were estimated for each of these locations by multiplying the model output by the scaling factor for that hydrologic parameter (Table 4-7). The resulting existing conditions flow parameters for the above locations are presented in Section 6.4.1.

5.2.4.3.4 Modeling Future Conditions

XP-SWMM models were developed and run for key stages in future Mine Site development. These stages include:

- Mine Year 1
- Mine Year 2
- Mine Year 11
- Mine Year 20
- West Pit Flooding
- Closure (after the West Pit is flooded)

The primary difference between future conditions XP-SWMM models is the total tributary area to the Partridge River, as Mine Site development alters subwatershed divides and diverts runoff for treatment. The total watershed area tributary to each model output location during future conditions is presented in Table 5-12.

Table 5-12 Incremental XP-SWMM Tributary Area to Evaluation Points by Mine Year

Evaluation Point	Tributary Area (square miles) by Mine Year						
	Mine Year 0	Mine Year 1	Mine Year 2	Mine Year 11	Mine Year 20	West Pit Flooding	Closure[1]
SW001	1.05	1.05	1.05	1.05	1.05	1.05	1.05
SW002	6.00	5.68	5.68	5.62	5.96	5.93	5.93
SW003	1.63	1.63	1.63	1.62	1.62	1.63	1.63
SW004	7.84	7.30	7.30	7.20	7.20	7.65	7.65
SW004a	31.24	30.99	30.84	29.90	30.28	29.59	30.48
SW004b	23.61	23.61	23.61	23.61	23.61	23.61	23.61
SW005	20.94	20.94	20.94	20.94	20.94	20.94	20.94

Evaluation Point	Tributary Area (square miles) by Mine Year						
	Mine Year 0	Mine Year 1	Mine Year 2	Mine Year 11	Mine Year 20	West Pit Flooding	Closure(1)
SW006	4.67	4.67	4.67	4.67	4.67	4.67	4.67
Total Area to SW006	96.96	95.86	95.71	94.59	95.32	95.05	95.94
Percent of Mine Year 0	100%	98.9%	98.7%	97.6%	98.3%	98.0%	98.9%

(1) Areas tributary to West Pit are not included in closure model (modeled separately, Section 5.2.4.1)

Hydrologic parameters estimated from the XP-SWMM modeling results for locations SW002 through SW006 were calculated for each stage of Mine Site development and are presented in Section 6.4.1. Results for location SW001 are not included, as the location is not affected by the Project. For the models representing flooding of the West Pit and long-term closure, areas tributary to the West Pit were excluded from the model. Flow generated from these areas are estimated separately (Section 5.2.4.1) and added to the river flow in long-term closure (after the West Pit is flooded).

5.2.4.3.5 Developing Probabilistic Model Inputs (Flow Distributions)

To estimate constituent concentrations in the receiving waters, the GoldSim model must generate a flow at each river evaluation point during each model time step. Because the XP-SWMM model was not developed to accurately calculate future instantaneous flows (Reference (13)), observed flow (adjusted for Peter Mitchell Pit dewatering, see Section 4.4.1.2) were used to develop distributions of daily flow for each month at location SW006 under existing conditions. The distributions are presented in Table 5-13 and represent the temporal variability of daily flows; they are not intended to represent uncertainty in monthly average flow. It should be noted that the median (50%) flows in Table 5-13 are less than the respective monthly and annual average flows. This is because the high flows observed in each month may be very high relative to the average flows, resulting in a non-normal distribution.

Table 5-13 Distributions of Daily Flow at SW006 by Month

%tile	Daily flow by month (cfs)												Daily Flow (cfs) Annual[1]
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Min	1.7	1.0	0.6	4.0	17.0	6.0	0.5	0.7	5.3	17.0	13.0	5.3	0.5
5%	1.9	1.1	0.9	18.8	25.2	8.5	1.8	2.5	6.3	17.0	14.0	6.2	1.7
10%	2.0	1.2	1.1	41.7	43.6	10.0	4.1	11.0	7.0	17.1	14.0	6.7	2.2
25%	2.4	1.5	1.9	59.6	67.7	32.6	10.2	16.3	23.3	28.0	18.2	7.8	9.3
50%	8.0	2.0	6.6	168	172	74.9	46.3	37.0	61.9	62.2	37.4	14.0	27.9
75%	11.8	9.0	27.0	341	318	129	101	169	109	118	62.0	21.7	94.9
90%	15.2	14.2	91.9	498	590	200	555	269	167	263	130	31.5	232
95%	17.6	19.8	142	576	742	284	742	404	214	377	181	41.6	363
Max	22.0	23.9	209	1940	874	566	866	480	367	760	459	86.5	1940

(1) Annual distribution is shown as the "Proposed Curve" in Figure 4-13.

The Continuation of Existing Conditions Scenario (i.e., without Project) XP-SWMM model results for the various Partridge River evaluation points were compared to calculate the flow at each location as a percent of the flow at SW006, unique to each month. A single scaling factor was selected for each upstream location, based on the ratio of average monthly flow, rather than develop a distribution of flows unique to each evaluation point and each month of the year. The resulting flow percentages for each calendar month are presented in Table 5-14.

Table 5-14 Partridge River Flows as a Percent of Flow at SW006 (Existing Conditions)

Eval-uation Point	Total flow at upstream locations (Percent of SW006 Flow)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
SW001	1.1%	1.2%	1.5%	1.1%	1.2%	1.5%	1.5%	1.8%	1.1%	1.2%	1.5%	1.1%
SW002	7.0%	7.9%	8.9%	7.4%	6.8%	8.5%	7.4%	8.8%	7.0%	7.9%	8.9%	7.4%
SW003	9.0%	9.5%	10.6%	9.0%	8.4%	10.0%	8.8%	10.5%	9.0%	9.5%	10.6%	9.0%
SW004	16.9%	17.9%	19.2%	17.4%	16.2%	18.9%	16.8%	18.8%	16.9%	17.9%	19.2%	17.4%
SW004a	48.7%	49.1%	52.7%	48.9%	45.4%	50.1%	44.2%	49.2%	48.7%	49.1%	52.7%	48.9%
SW004b	73.7%	73.6%	77.5%	73.2%	69.9%	74.8%	67.8%	73.0%	73.7%	73.6%	77.5%	73.2%

Eval-uation Point	Total flow at upstream locations (Percent of SW006 Flow)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
SW005	95.3%	94.8%	94.1%	95.1%	95.2%	94.6%	94.4%	93.8%	95.3%	94.8%	94.1%	95.1%
SW006	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Colby Lake(1)	120%	120%	120%	120%	120%	120%	120%	120%	120%	120%	120%	120%

(1) Colby Lake flow are extrapolated based on average Partridge River flow per unit area (Section 5.2.4.1)

In addition to varying by reach along the length of the Partridge River, flow in the river varies as a function of Mine Site development (i.e., time) as mine features occupy a larger footprint of the watershed and reduce the area tributary to the Partridge River. The results of the XP-SWMM models for future conditions were compared to calculate the reduction at each evaluation point through time. To reduce model complexity, the reduction at each evaluation point at a point in time is considered uniform regardless of month of year or percentile of flow. This is a reasonable approximation because the reduction in flow is due to reduced tributary area to each evaluation point, as opposed to factors that vary with season or flow. The reduction for each location and time is based on the average annual flow; the remaining portion of flow relative to the existing conditions is presented in Table 5-15.

Table 5-15 Fraction of Existing Conditions Flow Through Time by River Location

Mine Year	Flow at upstream locations (%), based on average annual flows								
	SW001	SW002	SW003	SW004	SW004a	SW004b	SW005	SW006	Colby Lake(1)
0	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
1	100.0%	95.8%	98.8%	96.7%	98.4%	99.3%	99.5%	99.7%	99.7%
2	100.0%	95.9%	98.9%	96.8%	98.1%	99.1%	98.6%	99.5%	99.6%
11	100.0%	95.1%	98.1%	95.7%	95.6%	97.4%	98.1%	98.3%	98.6%
20	100.0%	100.4%	102.5%	98.1%	97.4%	98.5%	98.9%	99.2%	99.3%
Pit Flooding	100.0%	100.0%	102.3%	100.8%	96.8%	98.2%	98.6%	98.9%	99.1%
Closure	100.0%	100.0%	102.3%	100.8%	98.8%	99.5%	99.7%	99.9%	99.9%

(1) Colby Lake flow are extrapolated based on average Partridge River flow per unit area (Section 5.2.4.1)

The XP-SWMM model results described in this section represent total non-Peter Mitchell Pit flow in the river at each evaluation point, with the exception that areas tributary to the WWTF

are not included in the model. Discharge from the WWTF to the Partridge River in long-term closure is therefore not represented in these distributions and must be added when applicable (Equation 5-25).

Incremental Inflows to Evaluation Points

The GoldSim model uses the incremental surface runoff inflow and groundwater inflow to each model node to calculate mass loading. Thus, it is necessary to partition the above flows between groundwater inflow and surface runoff by evaluation location. The incremental flow into each model evaluation point during select modeled mine years was calculated for each month as a fraction of the existing conditions flow at SW006 using the data presented in Table 5-14 and Table 5-15. The resulting factors are presented for each month in Tables 1-20a through 1-20l of Attachment C.

For the purposes of modeling, it is assumed that groundwater inflows (a.k.a. baseflow) to each model node (i.e., river reach) are constant. The total flow in the river (and thus the incremental flows into each model node) varies with each model time step. The surface runoff component of the incremental inflow to each model node is the difference between the total incremental inflow to that node and the estimated incremental groundwater inflow (see Groundwater Inflow section below). Because the modeled baseflow is an average, it is possible that the expected groundwater inflow could exceed the total incremental inflow to the river for a particular model time step (e.g., if the randomly-generated incremental flow is less than the defined baseflow). In such instances, there is assumed to be zero surface runoff, and all of the incremental inflow is assumed to be groundwater inflow. A detailed accounting of such low-flow conditions is provided in Section 5.2.4.4.

Groundwater Inflow

The GoldSim model uses the incremental surface runoff inflow and groundwater inflow to each model node to calculate mass loading. Thus, it is necessary to partition the above flows between groundwater inflow and surface runoff by evaluation location. The minimum annual 30-day average flow is considered an approximation of baseflow (Reference (13)). The XP-SWMM model results were used to estimate this flow for each evaluation point under existing and future conditions. The model results were then multiplied by a scaling factor based on the ratio of observed flows to modeled flows, as described in Section 4.4.1.2. The scaling factor for the minimum annual 30-day flow is 0.97 (i.e., observed flow is less than the modeled flow). Estimated groundwater inflows are presented as the incremental groundwater inflow to each evaluation point in Table 5-16.

Table 5-16 Incremental Groundwater Inflow to each Evaluation Point

Mine Year	Incremental Groundwater Inflow (cfs)								
	SW001	SW002	SW003	SW004	SW004a	SW004b	SW005	SW006	Colby Lake(1)
0	0.065	0.341	0.104	0.405	1.528	1.369	1.097	0.365	1.055
1	0.065	0.322	0.100	0.376	1.515	1.367	1.103	0.363	1.055
2	0.065	0.322	0.101	0.376	1.500	1.369	1.059	0.408	1.055
11	0.065	0.318	0.100	0.371	1.441	1.369	1.108	0.363	1.055
20	0.065	0.338	0.100	0.370	1.459	1.370	1.105	0.365	1.055
Pit Flooding	0.065	0.336	0.101	0.393	1.420	1.370	1.106	0.364	1.055
Closure	0.065	0.336	0.101	0.393	1.469	1.371	1.102	0.366	1.055

(1) Incremental groundwater inflow to Colby Lake is based on tributary area (Section 5.2.4.2)

It should be noted that the incremental groundwater flow into location SW004a includes groundwater from the entire watershed between SW004 and SW004a, excluding the footprint of mining features (e.g., pits, stockpiles). This includes areas that provide recharge along the groundwater flow paths modeled from the Mine Site (Section 5.2.3.1). The infiltration along these flow paths is accounted for in the groundwater modeling of the Mine Site (Section 5.2.3). To avoid double-counting of the water (and associated constituent mass) that infiltrates along these flow paths, the incremental groundwater inflow listed in Table 5-16 is reduced by the amount equal to the total recharge along the flow paths within the watershed tributary to SW004a when calculating the total flow in the river at a given model location. Thus, in modeling the flow in the Partridge River at location SW004a, the sum of the groundwater inflow from non-mining areas and the groundwater inflow (i.e., recharge) from the modeled flow paths equals the values listed in Table 5-16.

The total existing conditions groundwater inflow to SW006 is 5.3 cfs (sum of SW001 through SW006 for Mine Year 0 in Table 5-16). Based on a watershed area of approximately 97 square miles, the existing conditions baseflow equates to a watershed-wide average recharge of 0.74 inches per year.

XP-SWMM model results were used to estimate groundwater inflow upstream of Colby Lake. The amount of groundwater inflow to Colby Lake downstream of SW006 was estimated by extrapolating the total existing conditions groundwater inflow to SW006 (5.3 cfs) to the Colby Lake watershed based on the ratio of the Colby Lake tributary watershed area to the cumulative watershed tributary to SW006 (approximately 20%). It is assumed that the resulting incremental groundwater inflow to Colby Lake is constant throughout the Project timeline (Table 5-16).

5.2.4.4 Adjustment for Low Flow

As discussed in Section 4.4.1.3, the baseflow for the Partridge River is estimated as the minimum 30-day average flow from the 10-year record at USGS gage 04015475. It is assumed that the minimum 30-day average flow represents conditions without precipitation or surface runoff, when all stream flow is derived from groundwater recharge. The observed baseflow at the USGS gage is extrapolated upstream according to the XP-SWMM model results and scaling factor described in Section 4.4.1.2. The upstream baseflow contributions are used to determine the *incremental* baseflow, or the groundwater contribution to stream flow within a given stream reach.

For each model time step, a single value for daily flow in the Partridge River is selected from the cumulative flow distribution for the applicable year of mining (Section 5.2.4.3.5). Note that this flow distribution represents only watershed-derived flows (groundwater and surface runoff) and is additive to any upstream discharges (Peter Mitchell Pit and WWTF discharges). If this simulated flow value is *greater* than baseflow, the excess flow is assumed to be entirely surface runoff. However, because baseflow is determined from a 30-day average of daily flows, there are time steps with simulated daily flow *less* than the baseflow. During these low flow periods all watershed-derived water in the Partridge River is assumed to originate as groundwater contributions to the stream (i.e., there is no surface runoff). In order to avoid over-estimating the pollutant mass loading from groundwater, the incremental baseflow during these periods ($Q_{i,GW}$, Equation 5-27 is scaled to match the simulated incremental stream flow (Q_i), resulting in an adjusted incremental baseflow ($Q_{i,GW,adj}$):

if $Q_i < Q_{i,GW}$:

$$Q_{i,GW,adj} = Q_{i,GW} \frac{Q_i}{Q_{i,GW}} \qquad \textbf{Equation 5-27}$$

This adjustment is illustrated for an example 10-year period in Figure 5-16. The baseflow for this stream segment is decreased whenever modeled watershed-derived stream flows are below approximately one cfs.

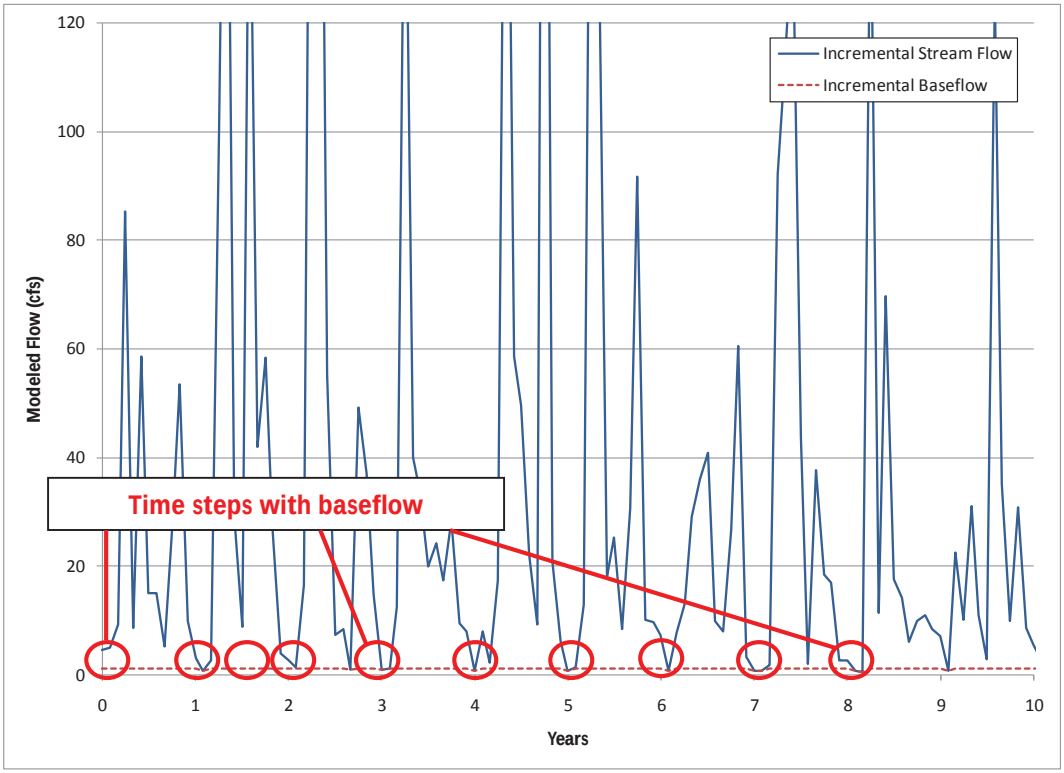


Figure 5-16 Baseflow Adjustment Example

The groundwater contribution to the stream is divided among that originating from undisturbed or non-project watershed areas and mining sources of groundwater. The groundwater modeling for the Mine Site (Section 5.2.3) assumes that the flow paths transporting contaminants from the Mine Site experience similar recharge as the remainder of the watershed (i.e., non-project watershed areas). Because the additional flow from Mine Site sources (i.e., liner leakage) is small, these flow paths are assumed to contribute the same flow per unit area to the Partridge River baseflow as natural areas. Therefore it is necessary to reduce the flows from the Mine Site flow paths during low-flow periods in a similar manner to the watershed as a whole in order to avoid over-estimating the pollutant mass loading from the Mine Site sources. The estimated flow path contribution to the Partridge River ($Q_{i,fp}$) is scaled by the same ratio as the natural contributions to baseflow as shown in Equation 5-28.

if $Q_i < Q_{i,GW}$:

$$Q_{i,fp,adj} = Q_{i,fp} \frac{Q_i}{Q_{i,GW}} \qquad \textbf{Equation 5-28}$$

This adjustment does not affect the calculation of contaminant transport through the surficial aquifer (Section 5.2.3), which assumes constant recharge and continuous outflow. Rather, the contaminant mass that does not enter the Partridge River can be understood as being "held back" just before the river because of the temporary low-flow conditions as shown in Figure 5-17.

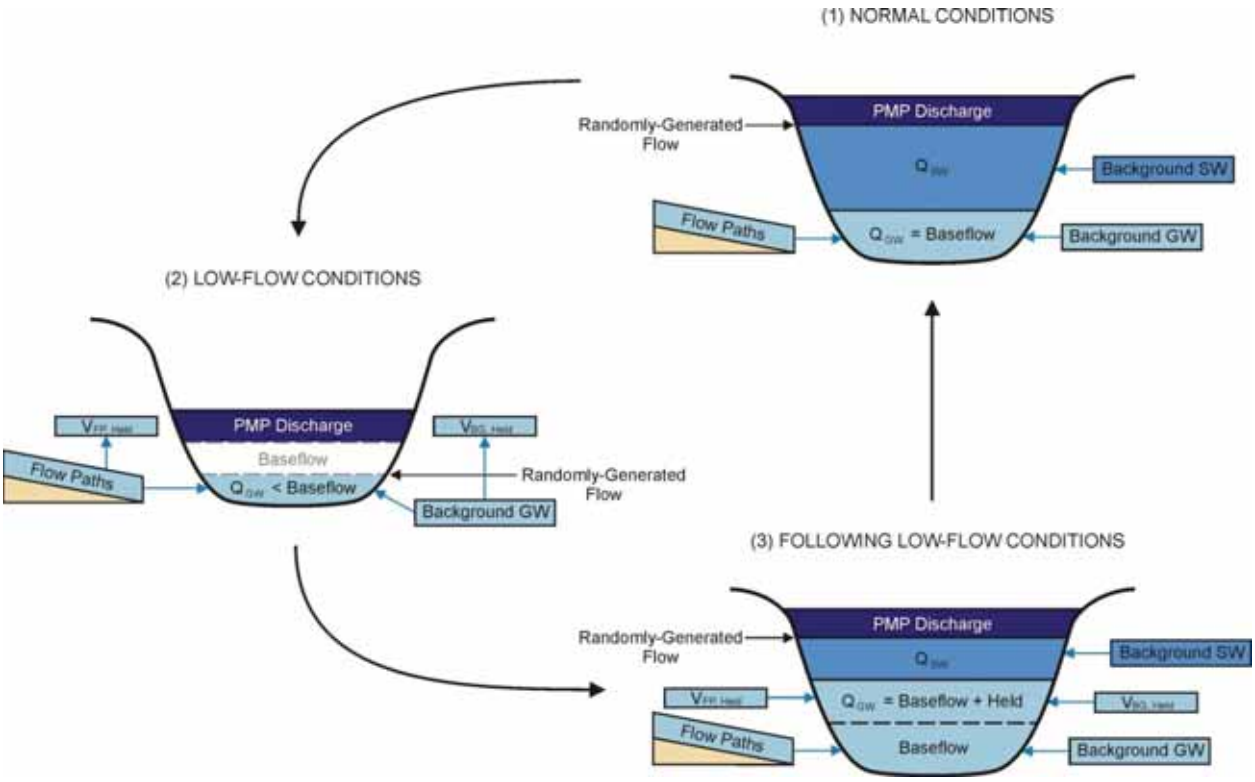


Figure 5-17 Baseflow Adjustment Schematic

The "held back" volume in low-flow conditions ((2) in Figure 5-17) will be calculated from Equation 5-29 for each river node and from Equation 5-30 for the flow paths contributing to each node, with the ratio between flow path outflow and baseflow taken as the 12-month running average.

if $Q_i < Q_{i,GW}$:

$$V_{i,GW,held} = \left(Q_{i,GW} - Q_{i,GW,adj}\right) \times 1\ month \qquad \textbf{Equation 5-29}$$

if $Q_i < Q_{i,GW}$:

$$V_{i,fp,held} = \left(Q_{i,GW,held}\left[\frac{Q_{i,fp}}{Q_{i,GW}}\right]_{avg}\right) \times 1\ month \qquad \textbf{Equation 5-30}$$

In the next time step ((3) in Figure 5-17), if the flow in the river is high enough to accommodate all of the expected groundwater contributions, the flow and contaminant mass that was temporarily "held back" is added to the steady-state loading to the river. No contaminant mass is removed from the system because of this low-flow adjustment, only the timing of its addition to the river is affected. The flow from the background groundwater and the flow paths to the river will be in addition to the regular baseflow contributions to the river and will be calculated from Equation 5-31 and Equation 5-32.

if $Q_i > Q_{i,GW}$ and $V_{i,GW,held} \neq 0$:

$$Q_{i,GW,extra} = min\left(Q_i - Q_{i,GW}, \frac{V_{i,GW,held}}{1\ month}\right) \quad \textbf{Equation 5-31}$$

if $Q_i > Q_{i,GW}$ and $V_{i,fp,held} \neq 0$:

$$Q_{i,GW,extra} = min\left(Q_i - Q_{i,GW}, \frac{V_{i,GW,held}}{1\ month}\right)\left[\frac{Q_{i,fp}}{Q_{i,GW}}\right]_{avg} \quad \textbf{Equation 5-32}$$

The difference between the total watershed-derived river flow and the total groundwater contributions (baseflow plus "held back" flow returned to the river) will consist of surface runoff. For example, assume the defined incremental baseflow value at a particular location is 1.0 cfs. During one month of very low-flow conditions, the simulated incremental river flow could be 0.5 cfs, resulting in 0.5 cfs "held back" for a month's time (30.2 acre-feet). If the simulated incremental river flow in the second month were to be 1.7 cfs, the river flow would consist of 1.0 cfs (natural baseflow) plus 0.5 cfs ("held back" baseflow) plus 0.2 cfs (surface runoff). If incremental river flow in the third month were to again be 1.7 cfs, the river flow would consist of 1.0 cfs (natural baseflow) plus 0.7 cfs (surface runoff) because the "held back" groundwater volume would be zero.

In all cases any flow from the Peter Mitchell Pit or the WWTF discharge would add to the watershed-derived flow described above. There is no "holding back" of Peter Mitchell Pit or WWTF discharge flow; the total flow in the river is never less than the discharge.

5.2.4.5 Wastewater Treatment Facility Discharge (WWTF)

The only surface water discharge from the Mine Site to the Partridge River is the discharge of treated Category 1 Waste Rock Stockpile drainage and West Pit water via the Mine Site WWTF in long-term closure. This discharge is modeled as occurring during each model time step that the West Pit is fully flooded. The rate of treatment is based on the water balance for the West Pit and the Category 1 Waste Rock Stockpile. The only loss of water from the long-term closure WWTF is 5% of the total inflow that is lost in WWTF evaporator. The treated effluent is pumped to an unnamed tributary to the Partridge River located south of the West Pit and Dunka Road. This discharge is included in the GoldSim model at location SW004a (Large Figure 20). The XP-SWMM model estimates an average annual flow of 1.2 cfs at the approximate location of the WWTF discharge under existing conditions. The estimated average annual flow at this location in long-term closure is increased to 1.4 cfs (due to changes in upstream watershed areas and the addition of the WWTF discharge, see Section 6.4.1.2).

5.2.4.6 Other (Non-Project) Loads

5.2.4.6.1 Northshore Peter Mitchell Pit

Northshore discharges from the Peter Mitchell Pit to the headwaters of the Partridge River approximately at location PM-1/SW001. In the probabilistic model, this load is tributary to the

river upstream of the first reach. This load is unrelated to the Project but affects downstream water quality. This discharge is implicitly included in the observations of baseline data (Section 4.4.4). Surface water quality observed at locations PM-1/SW001, PM2/SW002, and SD009 were used as a surrogate for the discharge quality from the Peter Mitchell Pit for the FEIS; only data from PM-1/SW001 was used to represent the Peter Mitchell Pit discharge quality for the DEIS and SDEIS modeling. The constituent concentrations associated with this discharge are deterministic and constant within the probabilistic models, and are based on the average constituent concentration calculated using data from all three sources (Table 1-13 of Attachment C). Non-detect data are included in the distributions as one-half the detection limit. Note that non-detects with high detection limits (i.e., higher than the maximum detection or other non-detections) were omitted when calculating the average constituent concentration in the Peter Mitchell Pit discharge. Omitted values include:

- 8 of 23 antimony non-detects with a detection limit of 3 µg/L
- 2 of 28 selenium non-detects with a detection limit of 10 µg/L
- 2 of 25 silver non-detects with a detection limit of 1 µg/L
- 17 of 38 thallium non-detects with a detection limit of 0.2 µg/L or greater

In reality, the dewatering rate from the Peter Mitchell Pit to the Partridge River is variable and depends upon a number of factors not easily replicated in a probabilistic model. Therefore, the discharge from the Peter Mitchell Pit is included in the probabilistic model as a constant value applied at each model time step until closure of the Peter Mitchell Pit in Mine Year 55, when dewatering permanently ceases. The constant value of the Peter Mitchell Pit discharge rate was calibrated prior to the calibration of runoff water quality using the Continuation of Existing Conditions Scenario Model and a mass balance method described below. The resulting value for the Peter Mitchell Pit discharge used in the probabilistic models is 2.6 cfs; this value becomes 0 cfs when the Peter Mitchell Pit is closed in 2070 (Mine Year 55). The flow from the Peter Mitchell Pit, when present, is additive to the probabilistically-generated flows described in Section 5.2.4.3.5.

Peter Mitchell Pit Discharge Rate Calibration

Calibration was performed based on sulfate concentrations, as was done in the DEIS and SDEIS. Other constituents (Al, Cl, Fe, Mn, and hardness) were initially considered but several resulted in unreasonable Peter Mitchell Pit discharge values (i.e., large negative values). Calibration was performed for individual dates (monitoring events) where the following observed data exist:

- constituent concentration at SW001
- constituent concentration at one or more downstream location (SW002, SW003, SW004, SW005)

- flow at one or more downstream location (SW002, SW003, SW004, SW005)

All surface water monitoring data (concentration and flow) used in the calibration were collected from 2004 through 2006. The calibration method requires concurrent concentration and flow data (see above) which are limited to the 2004-2006 monitoring period. Thus, no data from monitoring locations SW004a or SW004b are included in this calibration.

Equation 5-33 was used to calculate constituent load in the river resulting from Peter Mitchell Pit flow, surface runoff, and groundwater sources:

$$Q_{river}C_{river} = Q_{PMP}C_{PMP} + Q_{Runoff}C_{Runoff} + Q_{GW}C_{GW} \qquad \textbf{Equation 5-33}$$

In this analysis, the groundwater inflow at each river location (Q_{GW}) is taken from the GoldSim model and the groundwater concentrations (C_{GW}) are median values from the distributions of the mean groundwater concentrations presented in Attachment C. Flow and concentration in the river (Q_{river} and C_{river}) are based on observed data at each monitoring location downstream of SW001. Constituent concentration in the Peter Mitchell Pit flow (C_{PMP}) is the observed concentration at SW001. Flow from the Peter Mitchell Pit (Q_{PMP}) is the unknown variable to be solved for. As this calibration is performed prior to the calibration of surface runoff concentrations (Section 5.2.4.7), the concentration of sulfate in runoff is also unknown. To avoid a circular calibration process, the average sulfate concentration observed at monitoring location SW005 of 4.8 mg/L was assumed as the average concentration in runoff for this calibration. Flow from runoff (Q_{runoff}) is calculated as the flow in the river, minus the groundwater inflow and Peter Mitchell Pit flow (but not less than zero).

Equation 5-33, rewritten to solve for Q_{PMP} based on known or assumed variables, is shown as Equation 5-34.

$$Q_{PMP} = \frac{Q_{river}C_{river} - Q_{GW}C_{GW} + C_{runoff}(Q_{GW} - Q_{river})}{(C_{PMP} - C_{runoff})} \qquad \textbf{Equation 5-34}$$

On each monitoring date where the required input data exist, Equation 5-34 was solved for monitoring locations downstream of SW001 (i.e., SW002, SW003, SW004, and SW005)

This process resulted in 34 individual values of Peter Mitchell Pit discharge, ranging from -86 cfs to +41 cfs. A total of 16 of the 34 values were negative, with twelve of those less than -1 cfs. Figure 5-18 shows a histogram of the 34 individually calculated Peter Mitchell Pit discharges. An average Peter Mitchell Pit discharge was computed from these omitting the two highest values as unrealistic (16 cfs and 41 cfs) and considering negative values using three methods:

1. All negative values are set equal to zero and included in the average,
2. Values between 0 and -1 cfs are set equal to zero and included in the average, and
3. All negative values are omitted from the average (i.e., average is based only on positive values).

The resulting average values of Q_{PMP} are 1.7 cfs (method 1), 2.7 cfs (method 2) ad 3.4 cfs (method 3). All three values are greater than the 1 cfs used in the SDEIS modeling. The mean of these values is 2.6 cfs, as is the mid-point of the highest and lowest values. Thus, a value of 2.6 cfs is used as the constant, deterministic value to represent the contribution from the Peter Mitchell Pit to the Partridge River in the probabilistic models while the Peter Mitchell Pit is in operation (i.e., until Mine Year 55).

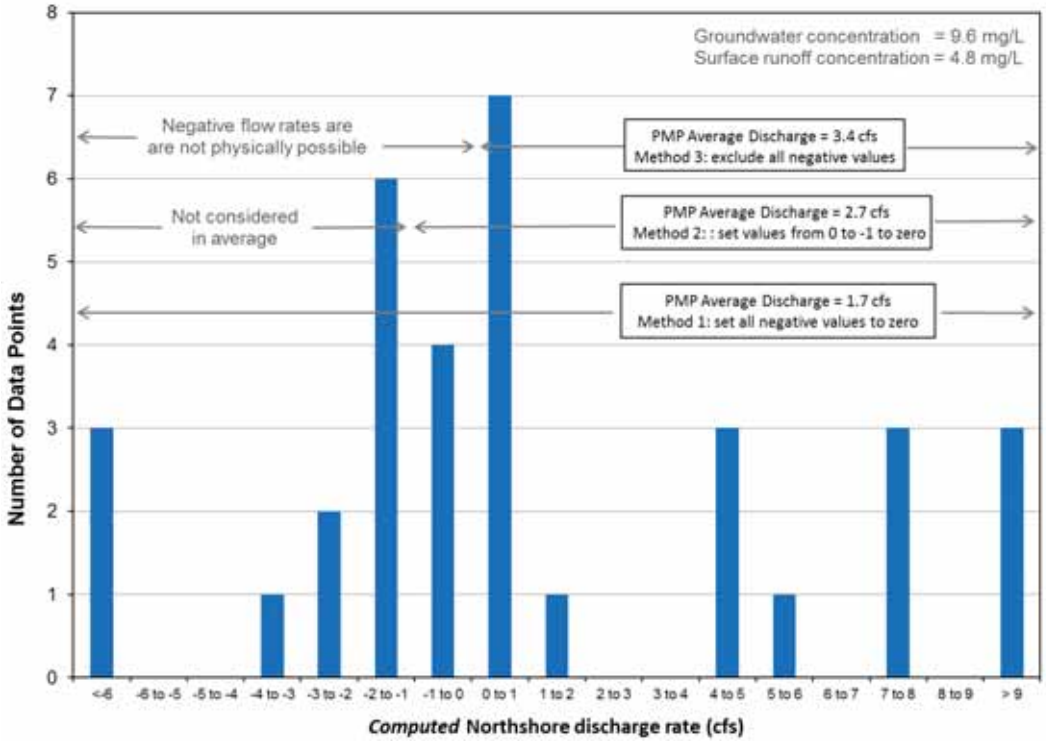


Figure 5-18 Peter Mitchell Pit Discharge Calculated based on Observed Sulfate Data

5.2.4.6.2 City of Hoyt Lakes Wastewater Treatment Plant

The Wastewater Treatment Plant of the City of Hoyt Lakes (WWTP-Hoyt Lakes) currently discharges into Whitewater Reservoir and is implicitly included in the water quality data for that

waterbody (Large Table 10). The City of Hoyt Lakes has no plans to change or to modify the WWTP-Hoyt Lakes for the next 25 years (Reference (80)). Therefore, future cumulative impact from this source relative to the Continuation of Existing Conditions condition is not anticipated. This load is not included in the GoldSim model, because Whitewater Reservoir is not included in the GoldSim model (Section 5.2.4.2).

5.2.4.6.3 LTV Steel Mining Company (LTVSMC)

These loads are discussed in Section 4.4.2.3 and represent possible cumulative impacts and are not explicitly included in the GoldSim model. Changes in the rate or quality of pit discharge, due to natural conditions or future industrial activity (e.g., pit dewatering) may impact water quality in Colby Lake.

5.2.4.7 Background Surface Runoff Quality

Direct runoff water quality data are unavailable for the Mine Site. Estimated distributions of runoff water quality were developed through calibration of the Continuation of Existing Conditions Scenario Model to observed water quality data in the Partridge River, following the flow chart shown in Figure 1 of Attachment E. Note that the Continuation of Existing Conditions Scenario Model used for calibration is a pre-curser to the final Continuation of Existing Conditions Scenario Model and was run for a smaller duration and number of iterations. Groundwater concentration distributions described in Section 5.2.3.8 were used as input into the calibration model. An initial surface runoff concentration distribution for each constituent was selected based on the mean concentration and standard deviation observed in the Partridge River between monitoring locations SW003 and SW005 (monitoring locations SW001 and SW002 were omitted because they are highly impacted by the Peter Mitchell Pit discharge and are located upstream of any Project constituent loading). Note that previous calibrations for the DEIS and SDEIS included data from SW002 in the calibration data set for the Partridge River; for the FEIS these data have been used to characterize the Peter Mitchell Pit discharge and are not included in the calibration data set for the Partridge River. The observed data were used to develop the initial distributions because surface runoff accounts for most of the flow in the Partridge River (Section 4.4.1). There is insufficient concurrent flow and concentration data to limit the analysis to high flow observations (i.e., when the surface runoff chemistry has the greatest influence on river chemistry).

All constituent concentrations are simulated with log-normal distributions. Field duplicate samples were averaged prior to inclusion in the calibration dataset. All samples in which the constituent was reported above the detection are included in the analysis. Non-detect data are included in the distributions as one-half the detection limit. It should be noted that some non-detections with higher detection limits were omitted from analysis (both in developing initial distributions and evaluating model fit). Those non-detections omitted from analysis include:

- silver (Ag) – 12 of 71 samples with 1 µg/L detection limit

- cobalt (Co) – 2 of 179 samples with 25 µg/L detection limit
- fluoride (F) – 6 of 79 samples with 1 µg/L or greater detection limit
- antimony (Sb) – 12 of 83 samples with 3 µg/L detection limit
- selenium (Se) – 1 of 137 samples with 10 µg/L detection limit
- thallium (Tl) – 27 of 143 samples with 0.4 µg/L or greater detection limit

The mean and standard deviation of the distribution were determined by minimizing the error in the 10th percentile, 50th percentile, and 90th percentile between measured and modeled constituent concentrations in the Partridge River between monitoring locations SW003 and SW005. Error of the mean is calculated as the normalized RMSE, which is defined in Equation 5-35.

$$RMSE' = \frac{1}{\overline{C}_{obs}} \sqrt{\frac{\sum_{i=1}^{N} \left(\overline{C}_{i,obs} - \overline{C}_{i,model} \right)^2}{N}}$$

Equation 5-35

Where:

$\overline{C}_{obs}$ is the average concentration in the observed data set
N is the number of model result percentiles evaluated.

In this case, the percentiles (i) included in the model fit evaluation include:

- 10th percentile
- 50th percentile (median)
- 90th percentile

Using the normalized RMSE goodness of fit, increased accuracy in model calibration is represented by smaller normalized RMSE values, with a perfect fit equaling a normalized RMSE of zero. The mean concentration and variance of each constituent in surface runoff was varied to minimize the normalized RMSE. In some cases, normalized RMSE was minimized with a variance of zero (representing constant runoff concentrations). For all constituents, the minimum standard deviation was set equal to 1% of the mean to allow for some variability.

Figure 1 of Attachment E shows that the mean of each constituent was calibrated prior to the calibration of the standard deviation. For some constituents, this method resulted in standard

deviations several orders of magnitude greater than the mean and did not represent realistic distributions. For the following constituents, mean concentration and standard deviation were calibrated simultaneously: aluminum, alkalinity, manganese, and zinc.

5.2.4.7.1 Surface Runoff Calibration Results

The method described in Section 5.2.4.7 was applied to all modeled constituents. The resulting mean and standard deviation of each constituent in surface runoff is presented in Table 5-17 and Table 1-13 of Attachment C. The Continuation of Existing Conditions Scenario Model calibration results are plotted against observed water quality in the Partridge River in Figure 2 through Figure 55 in Attachment E. For each constituent, the figures in Attachment E present the model calibration results against all Partridge River observed data between SW003 and SW005, as well as against the observed data collected at each individual model evaluation location at the Partridge River and within Colby Lake (Section 5.2.4.8). Specific results for individual or groups of constituents are described in this section. In the case of thallium, the best fit occurred with a surface runoff concentration of zero; a nominal mean value of 0.001 µg/L was selected instead, and the standard deviation set to 1% of the mean.

Table 5-17 Summary of Calibrated Runoff Concentrations and Distributions by Constituent

Constituent	Runoff Mean (mg/L)	Runoff Standard Deviation (mg/L)	Normalized RMSE
Ag	1.01E-04	5.80E-06	6.6%
Al	1.42E-01	1.20E-01	6.0%
Alk	6.50E+01	6.80E+01	2.1%
As	9.60E-04	2.00E-03	12%
B	7.30E-02	1.30E-01	23%
Ba	2.50E-03	1.20E-03	18%
Be	9.60E-05	9.60E-07	3.5%
Ca	1.68E+01	1.60E+01	5.6%
Cd	7.20E-05	6.90E-05	26%
Cl	6.30E+00	1.30E+01	20%
Co	4.20E-04	1.60E-03	1.7%
Cr	6.30E-04	5.90E-04	26%
Cu	1.36E-03	1.60E-03	17%
F	8.80E-02	1.00E-01	11%
Fe	2.30E+00	3.30E+00	11%

Constituent	Runoff Mean (mg/L)	Runoff Standard Deviation (mg/L)	Normalized RMSE
K	1.80E+00	2.40E+00	4.2%
Mg	7.50E+00	4.80E+00	3.8%
Mn	4.00E-02	6.50E-01	9.4%
Na	4.70E+00	1.10E+01	22%
Ni	1.48E-03	3.50E-03	7.1%
Pb	3.80E-04	3.30E-03	14%
Sb	2.50E-04	2.50E-07	0.3%
Se	6.40E-04	6.90E-04	30%
SO_4	7.60E+00	8.00E+00	1.1%
Tl	1.00E-06	1.00E-08	341%
V	9.70E-04	9.70E-06	28%
Zn	9.00E-03	2.10E-02	16%

The method results presented in Table 5-17 and Table 1-13 of Attachment C provide a reasonable model fit for all constituents The normalized RMSE is less than 10% for twelve constituents: Ag, Al, alkalinity, Be, Ca, Co, K, Mg, Mn, Ni, Sb, and SO_4. Another eight constituents have normalized RMSEs between 10% and 20%: As, Ba, Cl, Cu, F, Fe, Pb, and Zn. Predictably, the normalized RMSE for thallium is large (greater than 300%) due to the selection of a non-zero mean.

The Continuation of Existing Conditions Scenario Model calibration overestimates the maximum concentration for several constituents relative to observed concentrations. This is in part due to the selection of the 10th, 50th, and 90th percentiles as the criteria to calculate RMSE and evaluate fit. Selecting the 99th percentile, for example, will provide a better fit of peak concentrations; however, model fit between the 50th and 99th percentile would be compromised.

Select constituents are discussed in greater in the following sections. Constituents are discussed if the calibration model results include any exceedances of applicable water quality standards (Al, B, Cu, sulfate, and Zn) or if the calibration model underestimates maximum concentrations for constituents subject to a surface water quality standard (regardless if exceedances have or have not been observed) (Co, Pb, and Se). Thallium is also discussed because the model overestimates concentrations regardless of the surface runoff calibrated value.

Aluminum (Al)

The Continuation of Existing Conditions Scenario Model fit for aluminum is presented in Figure 4 and Figure 5 of Attachment E. Both the model results and observed data show aluminum exceedances of the 125 µg/L surface water quality standard. The model results exceed the standard between the 70th and 80th percentile, as does the observed data. The model results closely match the observed data at the 90th percentile (191 µg/L in the model versus 199 µg/L in the observed data) and through the 95th percentile (254 µg /L versus 241 µg/L); above the 95th percentile, the model slightly underestimates aluminum concentrations observed in the Partridge River.

Boron (B)

The Continuation of Existing Conditions Scenario Model fit for boron is presented in Figure 10 and Figure 11 of Attachment E. The model shows exceedances of the 500 µg/L surface water quality standard above the 99th percentile of model results. No exceedances have been observed in the Partridge River.

Cobalt (Co)

The Continuation of Existing Conditions Scenario Model fit for cobalt is presented in Figure 22 and Figure 23 of Attachment E. The model results show a maximum estimated concentration of about 11 µg/L, versus the maximum observed value of 8.5 µg/L. The 99th percentile of the model results (3.2 µg/L) is equal to the 99th percentile of the observed data (µg/L). The modeled and observed data represent a similar exceedance frequency (less than 1%).

Copper (Cu)

The Continuation of Existing Conditions Scenario Model fit for copper is presented in Figure 26 and Figure 27 of Attachment E. The model results above the 99th percentile exceed the water quality standard (based on a hardness of 100 mg/L). The observed data does not include any exceedances of the water quality standard (based on a hardness of 100 mg/L). Overall, model results are well fit to the observed data, with a slight overestimation of copper concentrations between the 93rd and 98th percentiles. The maximum observed value in the surface water data is 9.1 µg/L, which corresponds to approximately the 99.5th percentile of the model results.

Lead (Pb)

The Continuation of Existing Conditions Scenario Model fit for lead is presented in Figure 42 and Figure 43 of Attachment E. The model results exceed the water quality standard with a value of 12.8 µg/L at the 99.9th percentile. The modeled lead concentration at the 99th percentile is 3.2 µg/L. The observed data show one exceedance of the lead water quality standard with an observed value of 12.3 µg/L (out of 146 observations); the next highest observed value is 2.4 µg/L. The model results demonstrate a good fit at the 90th percentile, and overestimate the lead concentrations from the 90th percentile to the 99th percentile. The model slightly underestimates lead concentrations below the 50th percentile (approximately 10% of the water quality standard).

Selenium

The Continuation of Existing Conditions Scenario Model fit for selenium is presented in Figure 46 and Figure 47 of Attachment E. The selenium observed data include one measurement of 5.0 µg/L, which is equivalent to the water quality standard in the Partridge River. The model results underestimate the maximum selenium value, with a 99th percentile value of 4.8 µg/L. The next highest observed selenium detection is 1.6 µg/L. All other detections were below 0.5 µg/L. Overall, selenium was detected in only 13 of 137 samples. The model results for selenium slightly underestimate the 90th percentile and 10th percentile, while overestimating the 50th percentile. The awkward fit of the model results is due in part to the nature of the observed data, in which all but two data points above the 10th percentile are non-detects and the majority of observed data is below the 10th percentile.

Sulfate (SO4)

The Continuation of Existing Conditions Scenario Model fit for sulfate is presented in Figure 48 and Figure 49 of Attachment E. The model results match the data very well at the 10th, 50th, and 90th percentiles. The model slightly underestimates the sulfate concentrations between the 90th and 98th percentile, and overestimates the maximum observed concentrations. Both the model results and observed data exceed 10 mg/L (the surface water quality standard applicable in wild rice production waters) approximately 65% of the time.

Thallium (Tl)

The Continuation of Existing Conditions Scenario Model calibration overestimates thallium in the Partridge River (Figure 50 and Figure 51 of Attachment E). A calibrated mean concentration of zero provided the lowest RMSE during calibration; rather than use a value of zero, however, a nominal mean of 0.001 µg/L was selected. The overestimation of observed data is due in part to the discharge from the Peter Mitchell Pit at the headwaters of the Partridge River in the Continuation of Existing Conditions Scenario Model. The concentration of thallium assumed for the Peter Mitchell Pit discharge is approximately 0.03 µg/L (Attachment C). Although this load is diluted along the Partridge River in the model, the resulting model concentrations downgradient of the discharge are above the average observed concentration in the Partridge River of 0.007 µg/L. The overestimation of the model is also due in part to higher thallium groundwater concentrations. The cumulative result of higher thallium concentrations in groundwater and the Peter Mitchell Pit discharge is that the model results overestimate the thallium concentrations throughout the dataset.

Zinc (Zn)

The Continuation of Existing Conditions Scenario Model fit for zinc is presented in Figure 54 and Figure 55 of Attachment E. The calibration for Zinc shows an acceptable fit at the 10th and 90th percentiles and a slight overestimation of zinc concentration at the 50th percentile. The model results, however, overestimate the peak concentrations of zinc. The model results include exceedances of the 105 µg/L standard (based on an assumed hardness of 100 mg/L) above the

99th percentile of model results. The observed data includes a maximum value of 83 µg/L. The resulting distribution is shown in Figure 28 of Attachment E.

5.2.4.8 Additional Loading to Colby Lake

For the modeling performed as part of the SDEIS, runoff tributary to Colby Lake was assumed to have the same constituent concentrations as runoff tributary to the Partridge River. This assumption resulted in a poor fit between modeled and observed concentrations in Colby Lake for some constituents. This is problematic for constituents with a lower water quality standard in Colby Lake than is applicable in the Partridge River (i.e., arsenic, thallium). To achieve a better model fit to observed data in Colby Lake, an additional mass loading to Colby Lake was added in the modeling for the FEIS. There is no transport medium (i.e., water) associated with this mass loading. The mass loading term is constant and deterministic for each model time step.

A mass load of zero kg/year was initially assumed for all constituents. Where the model overestimates constituent concentrations in Colby Lake with a mass load of zero, the mass load is left as zero (i.e., no constituent mass is removed from Colby Lake, regardless of model fit). Where the probabilistic model would otherwise underestimate constituent concentrations in Colby Lake, a non-zero mass is added to Colby Lake. The mass to be added was calculated by calibrating the model to the observed mean concentration in Colby Lake (similar to the calibration of surface runoff, but using the mean as the target, rather than the 10th, 50th, and 90th percentiles). Mass is added for the following constituents:

- arsenic (As)
- barium (Ba)
- beryllium (Be)
- calcium (Ca)
- cadmium (Cd)
- copper (Cu)
- magnesium (Mg)
- manganese (Mn)
- sodium (Na)
- nickel (Ni)
- lead (Pb)
- antimony (Sb)
- sulfate (SO4)
- thallium (Tl)
- vanadium (V)

The mass added to Colby Lake for each constituent is presented in Table 1-13 of Attachment C. The resulting normalized RMSE is less than one percent for all constituents.

5.2.4.9 Correlations in Background Water Quality

In natural waters, the concentrations of some constituents are often correlated to one another for a variety of reasons. For example, Mine Site groundwater samples with relatively high iron concentrations often have high manganese concentrations. Such correlations exist in the background water quality data used for the water quality modeling.

As a modeling simplification, correlation between constituent concentrations in surface water is not simulated in the NorthMet model. This simplification could lead to unrealistic estimates of the total surface water quality in any particular realization, such as a water with high iron and low manganese concentrations at the same time. Because the impact assessment for the Project compares modeled concentrations to the applicable water quality standard on a constituent-by-constituent basis, however, this simplification is appropriate as long as the modeled distribution for each individual constituent is realistic.

5.2.4.10 Correlation of Flow and Water Quality

In the probabilistic model, surface runoff concentration (whether a constant value or a distribution) is assumed to be independent of stream flow. This simplification is based on the observation that most of the modeled constituents do not exhibit a strong correlation between observed concentrations and flow at higher flows, which is consistent with the way surface water quality was modeled for the DEIS. At low flow, some constituents do exhibit higher concentrations, likely due to groundwater concentrations that are higher than surface runoff concentrations. Trends in concentration due to the varying proportion of groundwater to total stream flow are implicitly accounted for in the probabilistic model due to the separate accounting of these inputs. Trends in concentration observed at higher flows are not accounted for in the probabilistic model.

This assumption was assessed by comparing scatter plots of flow versus concentration for observed data to a subset of model output. These plots are included as Figure 1 through Figure 26 of Attachment F (vanadium is omitted due to the lack of observed data). Overall, the Continuation of Existing Conditions Scenario Model calibration shows similar correlation (or lack thereof) between flow and concentration. It is our conclusion that these results do not warrant changing the modeling assumption that runoff concentrations and flow are independent. It should be noted that the 240 model points shown in Figure 1 through Figure 26 of Attachment F represent a small sample of potential Continuation of Existing Conditions Scenario Model output.

6.0 Modeling Results

This section discusses results from the probabilistic Mine Site GoldSim water quality model described in this document. Section 6.1 discusses water balances in the temporary mine features (temporary stockpiles, haul roads and RTH) and the permanent mine features (Category 1 Waste Rock Stockpile, mine pits and WWTF). Section 6.2 discusses the water quality in the mine features and the culpable sources of constituent load to the mine pits and the WWTF (complete results figures are included in Attachment G and Attachment H). Section 6.3 discusses the water quality in the groundwater flow paths leaving the Mine Site (complete results figures are included in Attachment I). Section 6.4 discusses the changes in surface water quantity (flows) in the Partridge River based on the results of the XP-SWMM model (detailed results tables and figures are included in Attachment J). Section 6.5 discusses surface water quality results in the Partridge River and in Colby Lake (complete results figures are included in Attachment K, Attachment L, and Attachment M). Finally, Section 6.6 discusses the assessment of mercury at the Mine Site which required an approach separate from the probabilistic water quality model. A previously-included qualitative discussion of the modeled effects of climate change on water quality and quantity in the long-term stockpile drainage and the flooded mine pits (moved to Reference (48)) showed a low sensitivity of the model predictions to changes in climatic inputs and has not been updated using the models presented in this report.

Also included as Attachment N to this document is the Mine Site Water Quality Model Quality Assurance Project Plan (QAPP), which contains documentation of internal (by PolyMet) and external (by the Co-Lead Agencies) review of the model inputs, model construct, and model outputs.

6.1 Mine Site Water Balances

Water balances were performed on each of the Mine Site features to account for all flow entering or leaving each feature and to quantify flow volumes. The inflows to and outflows from each of these features were determined based on each feature's respective control volume. A control volume is a defined closed region in modeling space through which water and mass flow, and within which water and mass are stored.

This section describes the modeled flows at the specified location and shows the statistics of this behavior both in tables and graphically. Each table and graph is presented in the same fashion and the following bulleted steps were taken to create the data for these graphs.

- The probabilistic GoldSim model was run at monthly time steps for 200 years (2401 time steps including the initial time zero). At each time step, the flow for each portion of the water balance at each location was individually recorded.

- After one realization (one model run through 200 years) was completed, the process was repeated until 500 model realizations were completed. The result is 500 flow values at each location at every time step.

- At every time step the flows were sorted smallest-to-largest and 3 values were chosen to represent the statistics at that particular time step.

- From the 500 estimated flows, sorted smallest-to-largest, the 50th value was chosen to represent the 10th percentile (P10), the arithmetic mean (average) was calculated from the 500 values, and the 450th value was chosen to represent the 90th percentile (P90). This indicates that at any time, 10% of the model results are less than or equal to the P10 value, the most-likely value is the mean, and 90% are less than or equal to the P90 value.

- This process was repeated for all time steps, resulting in 3 time series lines representing the 10th, mean, and 90th percentiles of flows at each location at every time step (monthly results).

- For plotting the monthly results over long time periods, the data must be summarized by year to avoid illegible plots. The monthly model outputs for the 10th, mean, and 90th percentiles is plotted on an annual basis by taking the *average* value for each statistic for a given year (i.e., the average of the twelve 90th percentile values for Mine Year 11).

One of the primary uses of the water balance results for the Mine Site is in the design of the WWTF. The WWTF design basis (Reference (4)) uses multiple types of flow estimates, including storm-event-based modeling that is not derived from the probabilistic water quality model. For the monthly flows simulated in the probabilistic model discussed here, the WWTF design basis uses the annual average of the 90th percentile flows from each mine feature. This information is presented in the sections below for each mine feature throughout operations, reclamation, and long-term closure, although the WWTF design uses only values for the selected design year.

6.1.1 Temporary Mine Features

6.1.1.1 Category 2/3 Waste Rock Stockpile

The water balance for the Category 2/3 Waste Rock Stockpile is typical of the balances for all of the temporary waste rock stockpiles. The only input of water to the stockpile is precipitation (Section 5.2.1.1); the only loss from the surface of the stockpile is evapotranspiration from the bare rock of approximately 50% of the monthly precipitation on average (Section 5.2.2.1.2). Surface runoff from the stockpile is assumed to be zero (Section 5.2.2.1.4). The remaining water infiltrates through the stockpiled waste rock and reaches the geomembrane liner and its drainage layer.

For the purposes of the probabilistic model, the change in storage within the waste rock (through wetting or drying of the rock) is assumed to be zero (Section 5.2.2.1.1). A small volume of water, defined as 0.1 inch of depth across the entire stockpile footprint, is used to perform water

chemistry calculations. This volume of stored water varies as the stockpile footprint changes but is otherwise unrelated to the stockpile's water balance or the quantity of material stored in the stockpile.

The footprint area of the Category 2/3 Waste Rock Stockpile increases in a stepwise fashion as the stockpile is developed. The stockpile's geomembrane liner reaches its maximum area by the end of Mine Year 6 and is held constant through the end of Mine Year 14, three years after material begins to be removed from the stockpile for backfilling the East Pit. All stockpiled material is removed by the end of Mine Year 19; the geomembrane is assumed to be completely removed or reclaimed one year after all waste rock is removed.

The vast majority of the water reaching the geomembrane liner is collected and conveyed to the WWTF for treatment by chemical precipitation. A very small fraction of the infiltrating water, less than 0.1% on average (Section 5.2.2.3.5), leaks through the liner and contributes flow to the surficial aquifer (the East Pit/Category 2/3 flow path) moving downgradient towards the Partridge River. The annual flow statistics for the Category 2/3 Waste Rock Stockpile water sent to the West Equalization (EQ) Basin of the WWTF and the liner leakage are shown in Figure 6-1.

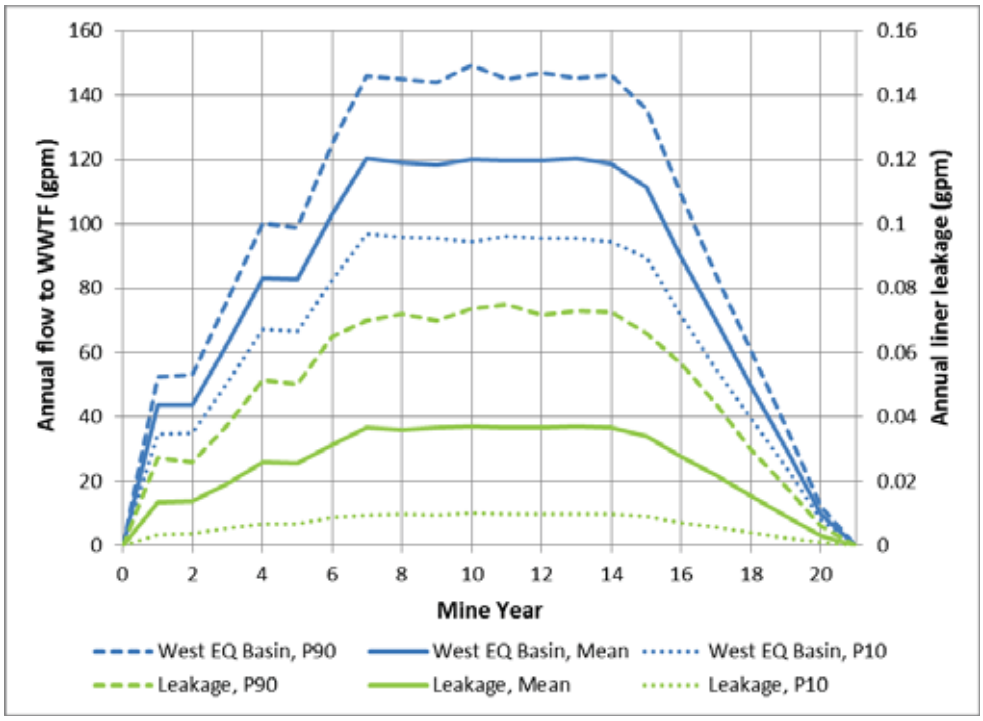


Figure 6-1 Annual Average Outflows from the Category 2/3 Waste Rock Stockpile

6.1.1.2 Category 4 Waste Rock Stockpile

The Category 4 Waste Rock Stockpile reaches its maximum footprint area by the end of Mine Year 3 and is removed in the second half of Mine Year 11. Development of the Central Pit, which occupies the same footprint as the stockpile, begins while the stockpile is being removed near the end of Mine Year 11. The fraction of the water reaching the base of the Category 4 stockpile that becomes liner leakage is lower than that for the Category 2/3 Waste Rock Stockpile due to differences in the liner design, less than 0.01% on average (Section 5.2.2.3.5). Otherwise, the water balance for the Category 4 Waste Rock Stockpile is modeled identically to the Category 2/3 Waste Rock Stockpile.

The annual flow statistics for the water sent to the West EQ Basin of the WWTF and the liner leakage are shown in Figure 6-2.

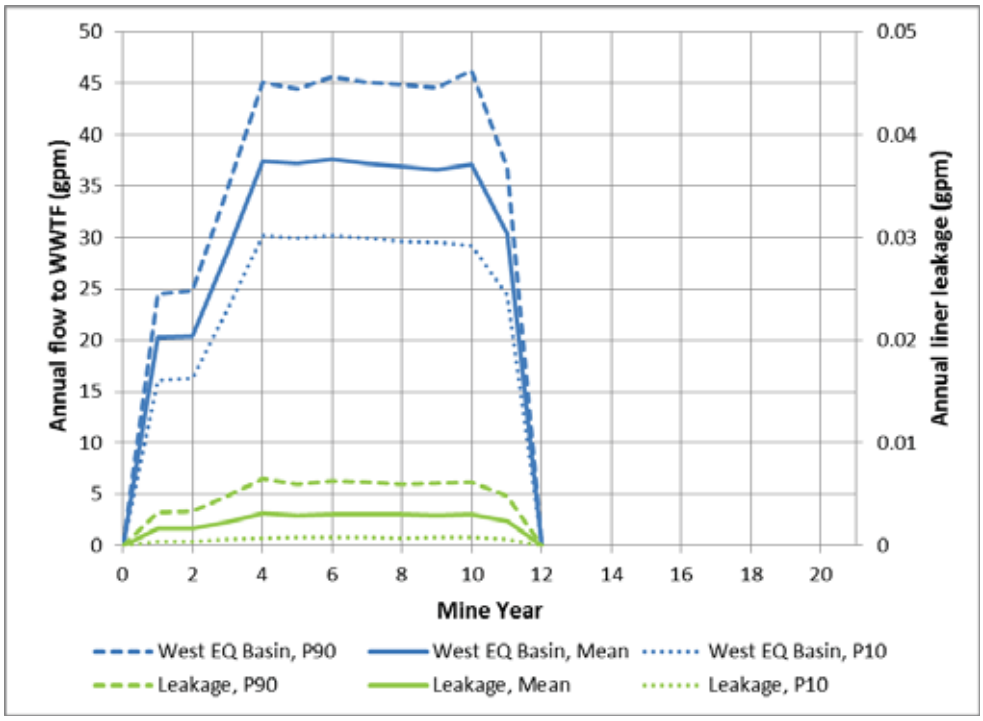


Figure 6-2 Annual Average Outflows from the Category 4 Waste Rock Stockpile

Because the Category 4 Waste Rock Stockpile is surrounded by mine pits and its footprint later becomes the Central Pit, any liner leakage from the stockpile does not enter a groundwater flow path for transport off-site. Instead, the leakage from the Category 4 Waste Rock Stockpile is assumed to enter the nearby East Pit and contribute to the flow that must be dewatered from the pit during operations.

6.1.1.3 Ore Surge Pile (OSP)

The OSP has a constant footprint throughout operations. The water balance for the OSP, therefore, does not change with time until the stockpile is removed after Mine Year 20. The liner leakage fraction for the OSP is the same as that for the Category 4 Waste Rock Stockpile (Section 5.2.2.3.5). Otherwise, the water balance for the OSP is modeled identically to the Category 2/3 Waste Rock Stockpile. The liner leakage from the OSP will contribute flow to the surficial aquifer (the OSP flow path) and move downgradient towards the Partridge River.

The annual flow statistics for the water sent to the West EQ Basin of the WWTF and the liner leakage are shown in Table 6-1 and do not vary from year to year during operations.

Table 6-1 Annual Average Outflows from the OSP

Outflows	P10 (gpm)	Average (gpm)	P90 (gpm)
Flow to WWTF West EQ Basin	16	20	24
Total Liner Leakage	0.0004	0.002	0.003

6.1.1.4 Overburden Storage and Laydown Area (OSLA)

Unlike the waste rock stockpiles, the OSLA has a base constructed of unsaturated mineral soil and stores unsaturated soil and peat. The OSLA therefore has surface hydraulic properties that are distinct from the stockpiles constructed of coarse blasted rock. The only input of water to the OSLA is precipitation (Section 5.2.1.1), but the surface of the stockpile loses water both to evapotranspiration (Section 5.2.2.1.2) and surface runoff (Section 5.2.2.5). Due to the greater water-holding capacity of the soil material, evapotranspiration is greater than for the bare rock, approximately 70% of precipitation on average, and runoff is approximately 8% of precipitation on average. The remaining water percolates through the constructed base.

The OSLA has a constant footprint area throughout operations. The water balance for the OSLA, therefore, does not change with time until any stored overburden and the constructed base are removed after Mine Year 20. Runoff from the OSLA is collected and routed to the CPS Pond, where it is combined with the WWTF effluent for pumping to the FTB Pond. Because the OSLA is unlined, all of the percolation through the OSLA surface contributes flow to the surficial aquifer (the OSLA flow path) and moves downgradient towards the Partridge River.

The annual flow statistics for the water sent to the CPS Pond and the percolation through the OSLA are shown in Table 6-2 and do not vary from year to year during operations.

Table 6-2 Annual Average Outflows from the OSLA

Outflows	P10 (gpm)	Average (gpm)	P90 (gpm)
Runoff to CPS Pond	4.3	5.4	6.6
Total Percolation	11	14	18

6.1.1.5 Rail Transfer Hopper (RTH)

The tributary area to the RTH Pond has a constant area throughout operations. The water balance for the RTH, therefore, does not change with time until the end of operations. The only input of water to the RTH is precipitation (Section 5.2.1.1), the runoff to the RTH Pond is approximately 50% of the monthly precipitation on average (Section 5.2.2.7). The remainder of the precipitation is assumed to be lost to evapotranspiration; the infiltration through the largely concrete RTH areas is assumed to be zero. Runoff from the RTH is conveyed to the East EQ Basin of the WWTF for treatment by filtration.

The annual flow statistics for the water sent to the East EQ Basin of the WWTF are shown in Table 6-3 and do not vary from year to year during operations.

Table 6-3 Annual Average Outflows from the RTH

Outflows	P10 (gpm)	Average (gpm)	P90 (gpm)
Flow to WWTF East EQ Basin	0.9	1.2	1.5

6.1.1.6 Haul Roads

The tributary area to the Haul Road Ponds is assumed for the purposes of the probabilistic model to be constant throughout operations at the maximum haul road extents. The water balance for the haul roads, therefore, does not change with time until the end of operations. The only input of water to the haul roads is precipitation (Section 5.2.1.1), the runoff to the Haul Road Ponds is approximately 50% of the monthly precipitation on average (Section 5.2.2.7). The remainder of the precipitation is assumed to be lost to evapotranspiration; the infiltration through the highly compacted haul roads is assumed to be zero. Runoff from the haul roads is conveyed to the East EQ Basin of the WWTF for treatment by filtration.

The annual flow statistics for the water sent to the East EQ Basin of the WWTF are shown in Table 6-4 and do not vary from year to year during operations.

Table 6-4 Annual Average Outflows from the Haul Roads

Outflows	P10 (gpm)	Average (gpm)	P90 (gpm)
Flow to WWTF East EQ Basin	41	53	67

6.1.2 Permanent Mine Features

6.1.2.1 Category 1 Waste Rock Stockpile

The water balance for the Category 1 Waste Rock Stockpile is similar to the balances for the temporary waste rock stockpiles with respect to the stockpile surface conditions while it is being constructed. The only water input is precipitation (Section 5.2.1.1), and the only loss from the surface of the stockpile is evapotranspiration from the bare rock of approximately 50% of the monthly precipitation on average (Section 5.2.2.1.2). Surface runoff from the stockpile is assumed to be zero (Section 5.2.2.1.4). The remaining water infiltrates through the stockpiled waste rock and reaches the base of the stockpile. Figure 6-3 illustrates water flows up until incremental reclamation begins in Mine Year 14 at the Category Waste Rock Stockpile.

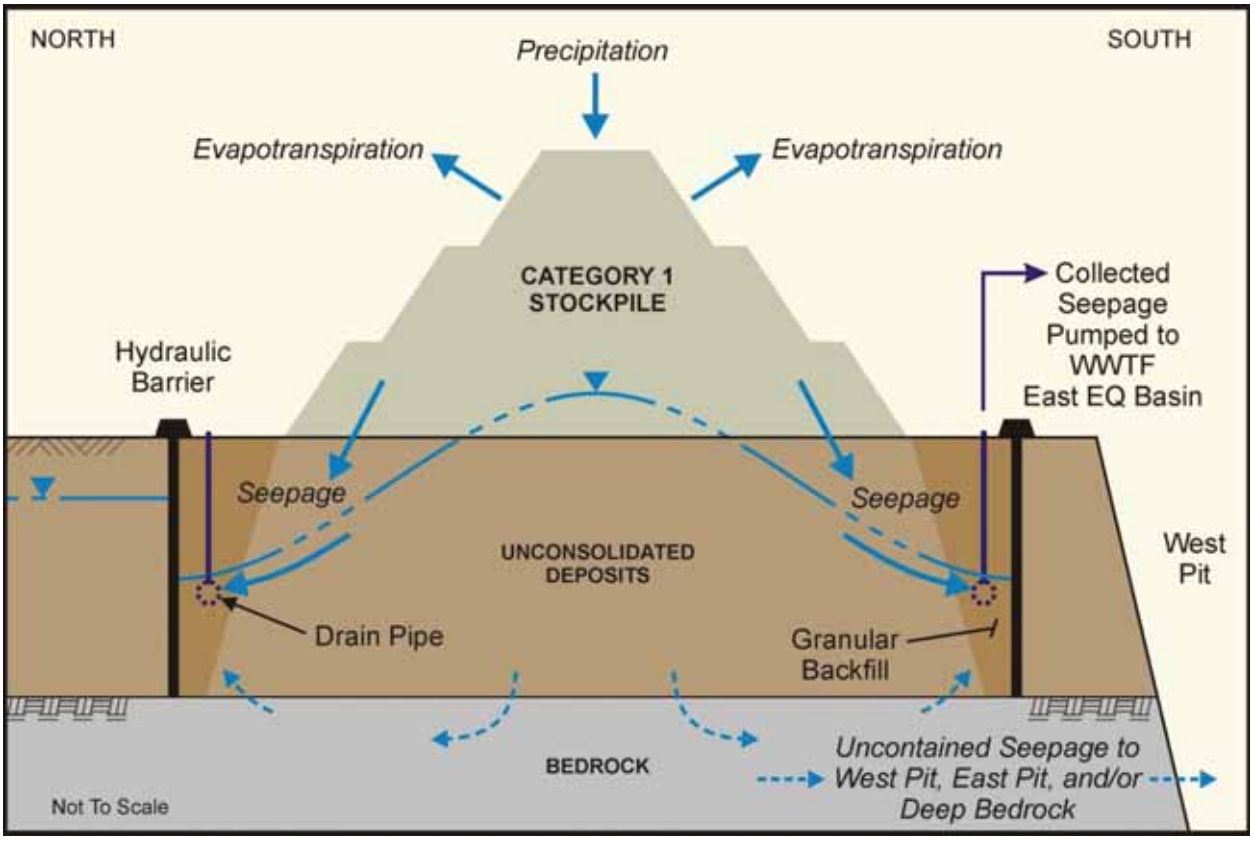


Figure 6-3 Inflows and Outflows to the Bare Category 1 Waste Rock Stockpile

The surface water balance for the Category 1 Waste Rock Stockpile changes when the stockpile is reclaimed with a geomembrane cover system beginning in Mine Year 14 (Figure 6-4). Percolation through the geomembrane cover is approximately 0.5% of the monthly precipitation on average (Section 5.2.2.1.3); evapotranspiration is greater than for the bare rock, approximately 70% of precipitation on average (Section 5.2.2.1.2); the remaining water becomes surface runoff. A portion of the surface runoff from the reclaimed stockpile is used to help flood the West Pit during the reclamation period, the rest of the runoff is routed to the Partridge River as stormwater and is not directly represented in the probabilistic model.

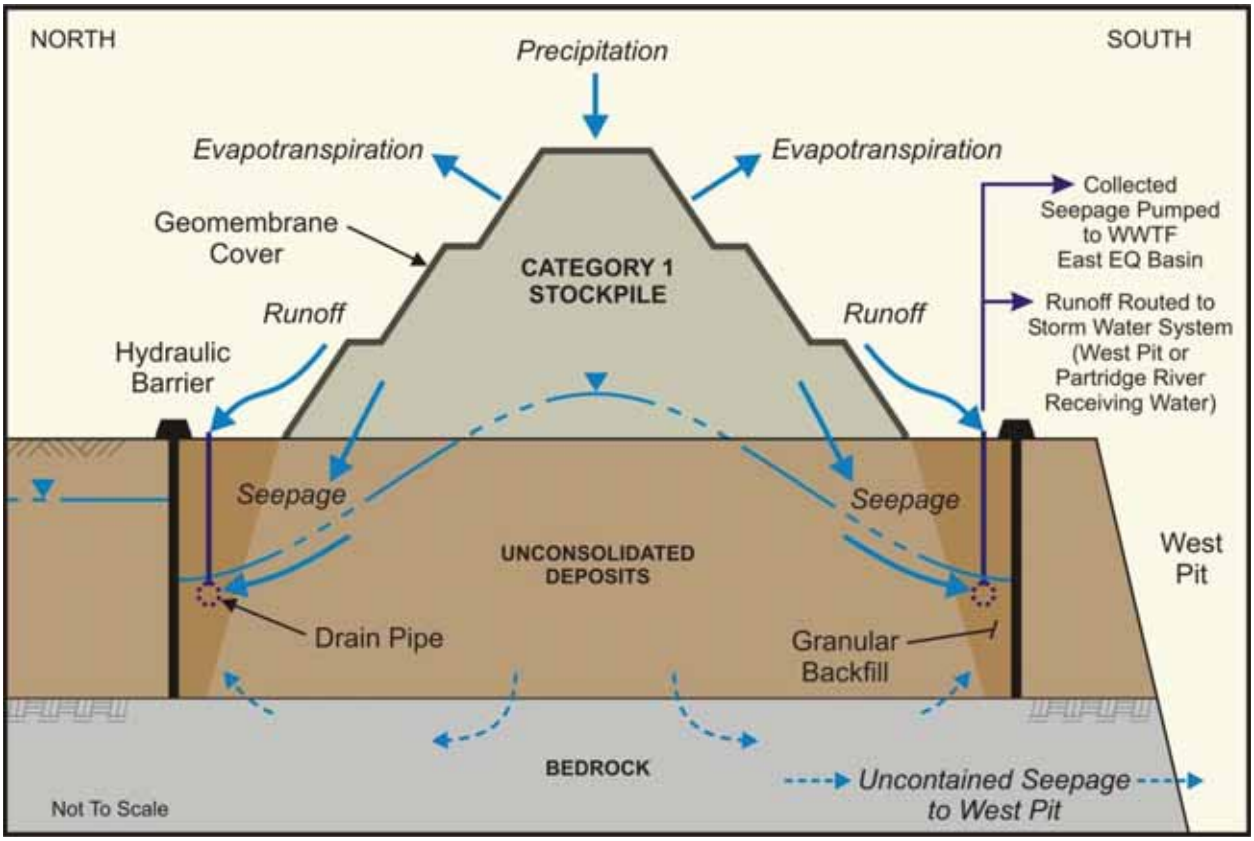


Figure 6-4 Inflows and Outflows to the Reclaimed Category 1 Waste Rock Stockpile

The footprint area of the Category 1 Waste Rock Stockpile increases in a stepwise fashion as the stockpile is developed. The stockpile reaches its maximum area by the end of Mine Year 6 and is held constant through the end of Mine Year 13. Stockpile reclamation begins at the beginning of Mine Year 14 and is complete at the end of Mine Year 21; the total area of the stockpile increases slightly during reclamation.

Because the Category 1 Waste Rock Stockpile is surrounded on all sides by a groundwater containment system, most of the water infiltrating through the waste rock is collected and conveyed to the WWTF for treatment. A portion of the infiltrating water, estimated as less than 10% (Section 5.2.2.2), bypasses the containment system and flows through groundwater into the West Pit, the East Pit, or into deep bedrock. The quantity of water bypassing the containment system will be the largest when the stockpile is bare and the mine pits are completely dewatered: the fraction of the infiltrating water that bypasses the containment system and flows to the East Pit or into deep bedrock peaks at 4% total (2% into the East Pit and 2% into deep bedrock, each representing a peak annual average value of 6.9 gpm) in Mine Year 10 and is negligible (modeled as zero) by Mine Year 20. The fraction of the infiltrating water that bypasses the containment system and flows to the West Pit is conservatively assumed to be constant through time at the maximum fraction (6%, representing a peak annual average value of 22 gpm). The

collected water from the stockpile is sent to the WWTF during operations (to the East EQ Basin), reclamation (combined with water from the East Pit porewater), and long-term closure (combined with water from the West Pit). In realizations in which the reclamation treatment of the East Pit is complete prior to the West Pit being fully flooded (and the WWTF is therefore not operational for a period of time) the collected water from the Category 1 Waste Rock Stockpile is temporarily directed the West Pit until long-term WWTF treatment commences.

The annual flow statistics for the water sent to the WWTF and the uncaptured flow to the pits and deep bedrock are shown in Figure 6-5 and Table 6-5.

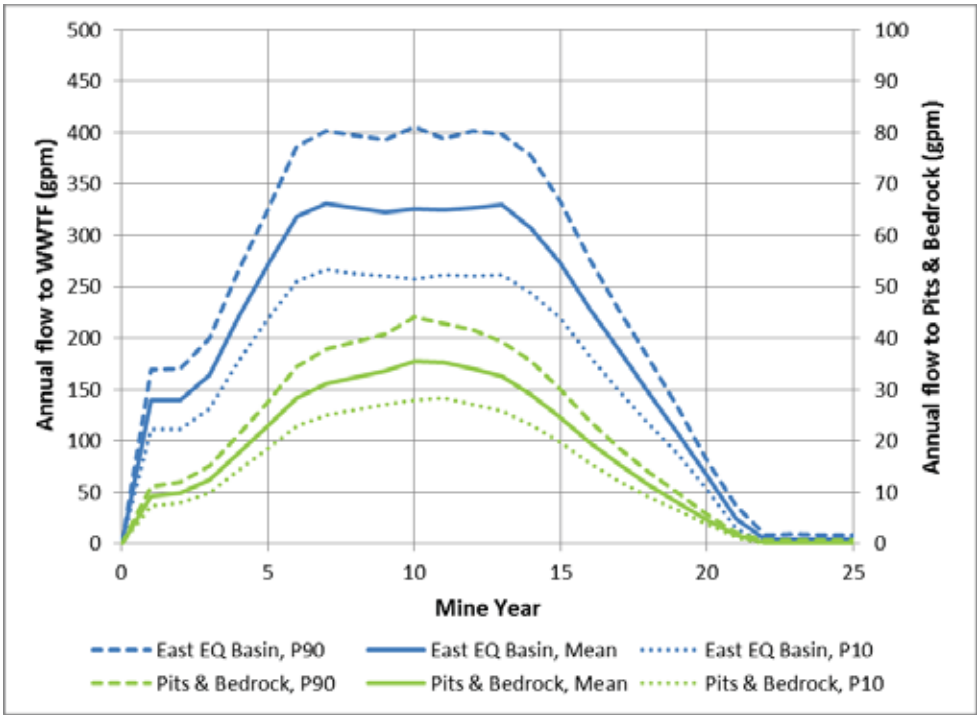


Figure 6-5 **Annual Average Outflows from the Category 1 Waste Rock Stockpile during Operations and Reclamation**

Table 6-5 **Annual Average Outflows from the Category 1 Waste Rock Stockpile in Reclamation and Long-Term Closure**

Outflows	P10 (gpm)	Average (gpm)	P90 (gpm)
Flow to WWTF	0.70	3.8	8.3
Uncaptured Flow to West Pit	0.05	0.24	0.53

6.1.2.2 East Pit

6.1.2.2.1 Operations

The water balance of the combined East and Central Pits, referred to collectively as the East Pit, is the most complex at the Mine Site. During active mining the water volume in the pit is managed through dewatering so that the only standing water is the relatively small volume in the mine pit sump. For the purposes of the probabilistic water quality model the dewatering rate is assumed to be continuously variable in order to respond to the estimated inflows without a fixed upper limit on the dewatering rate.

Inflows to the pit sump during mining include direct precipitation on the sump water surface (Section 5.2.2.6.2), runoff from the exposed pit walls, and inflowing groundwater from both the surficial deposits and bedrock (Section 5.2.2.6.3). A pit rim dike is assumed to prevent all runoff from non-pit areas from entering the pit footprint. Surface water inflows (including precipitation and pit wall runoff) during the winter months are assumed to accumulate in a snowpack that melts into the pit sump during the month of April. Outflows from the pit sump include the relatively small amount of open water evaporation from the small surface area and the dewatering pumping to maintain a constant sump volume.

Mining is complete in the East Pit during Mine Year 11 and shifts to the Central Pit until Mine Year 16. Waste rock from the temporary Category 2/3 and 4 Waste Rock Stockpiles and freshly-mined material from the West Pit is backfilled in the East Pit during this time. The backfill is flooded with excess water from the CPS in order to submerge the waste rock as quickly as possible, maintaining only 5 feet of exposed backfill above the water elevation. The remainder of the water balance inputs and outputs for the combined East and Central Pits remain the same, with changes to reflect the changing water surface elevation in the East Pit and the footprint area added when the Central Pit is developed. A schematic of the inflows and outflows during Central Pit mining (Mine Year 14) is shown in Figure 6-6.

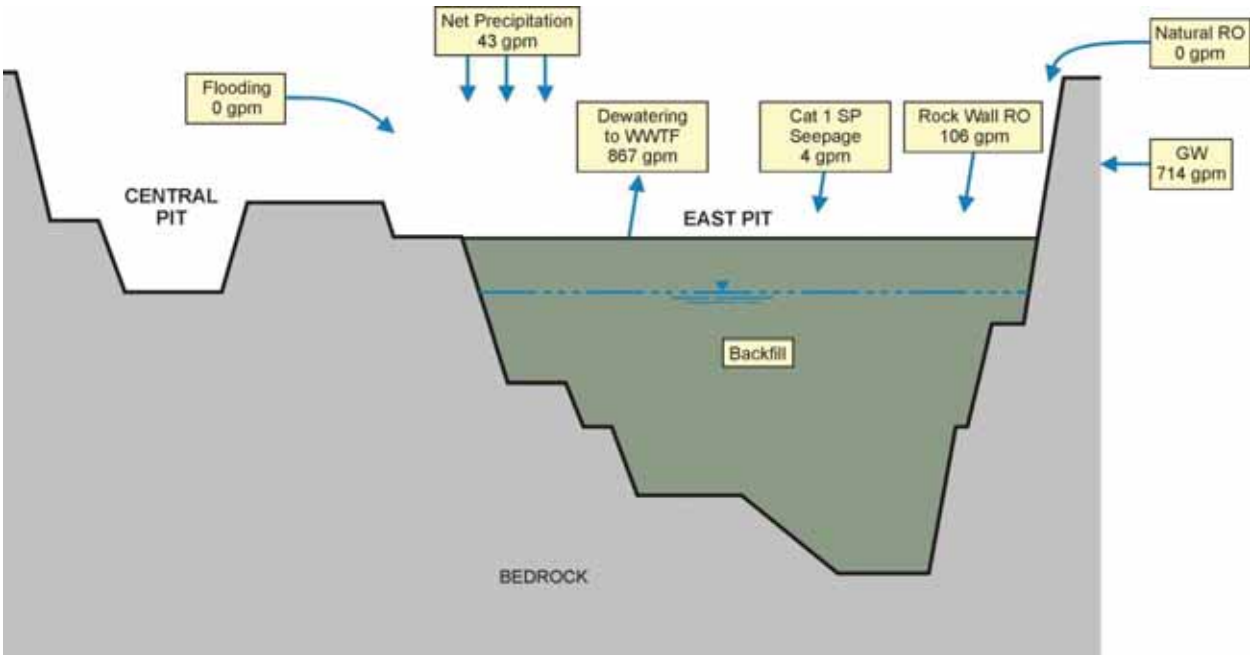


Figure 6-6 Average Inflows and Outflows to the East Pit during Mine Year 14

The annual average natural inflows to the East Pit during operations are shown in Figure 6-7. Note that the control volume for this water balance is the water in the East and Central Pit sumps and backfill, not the entire pit area. "Net precipitation", therefore represents the direct precipitation less evaporation from the water (or backfill) surface and does not include precipitation or evaporation from the exposed wall rock areas.

The annual flow statistics for the water sent to the WWTF East EQ Basin and the flooding water from the CPS are shown in Figure 6-8.

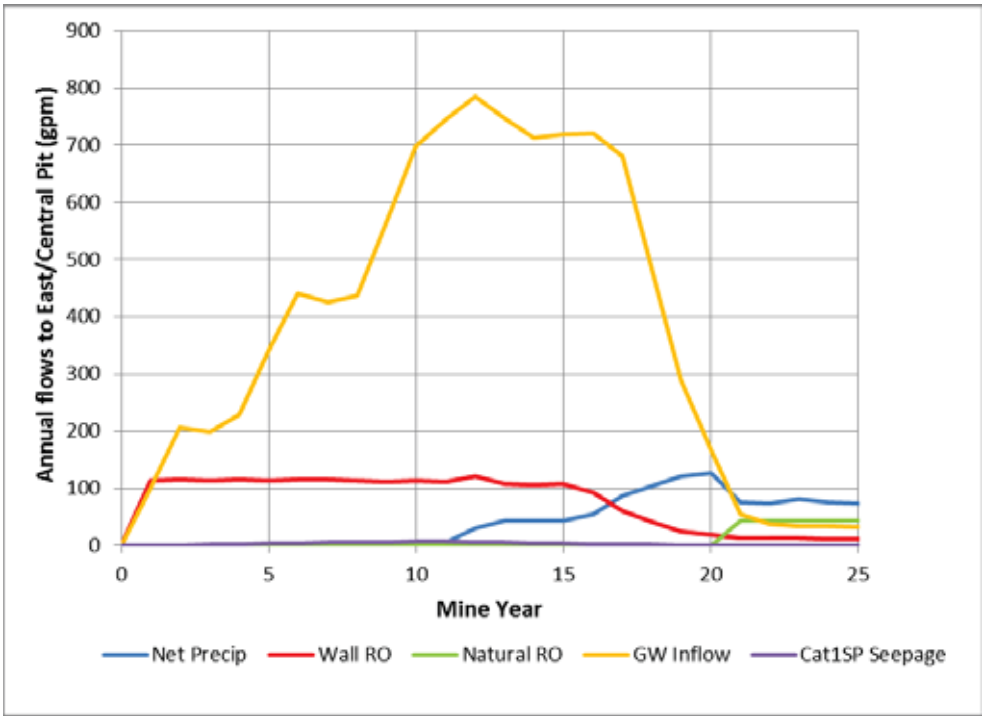


Figure 6-7 Annual Average Natural Inflows to the East Pit during Operations

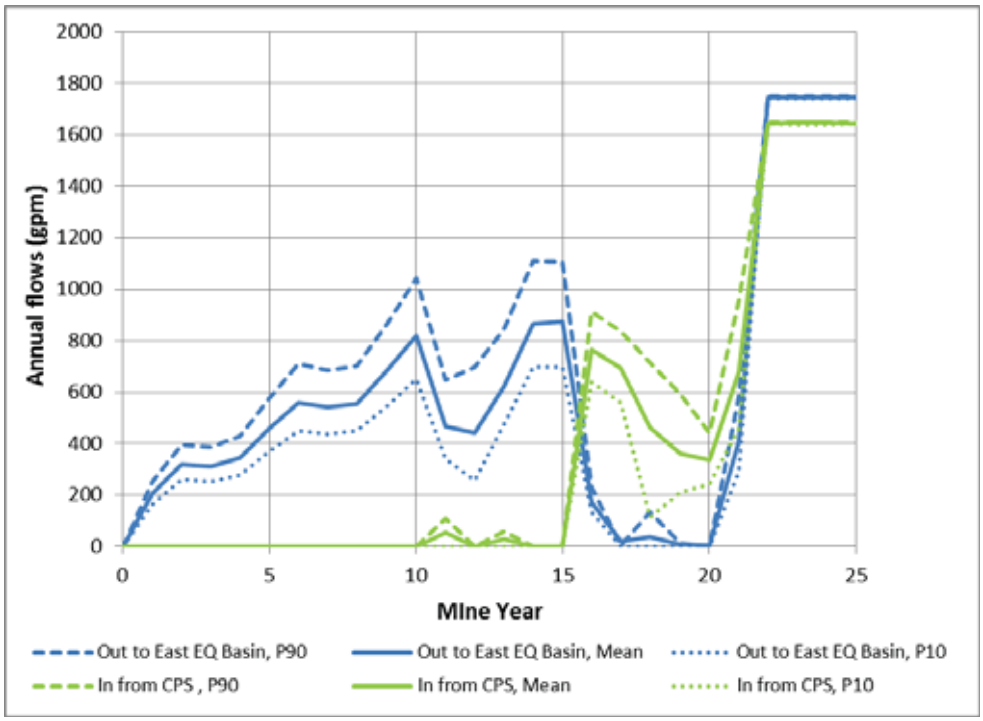


Figure 6-8 Annual Average Pumped Flows to and from the East Pit during Operations

During the initial two years of backfill placement in the East Pit (until midway through Mine Year 13), the elevation of the backfill is below the elevation of the Central Pit and flooding generally proceeds as quickly as possible. During Mine Years 14 and 15, however, the water level in the East Pit is managed to maintain safe working conditions in the Central Pit and does not increase (although the backfill elevation continues to increase). Once mining is complete in the Central Pit in Mine Year 16, the backfill in the combined pits is flooded as quickly as possible. This typically requires all of the available water from the CPS except during the last few years of mining; the entire volume of backfilled waste rock is completely submerged early in Mine Year 21. At the end of flooding a shallow wetland (approximately 3 feet deep) is created above the backfilled surface which includes a compacted till layer on top of the waste rock. Figure 6-9 shows the progression of the backfill elevation in the East and Central Pits as well as the average water level in the pits.

Note in Figure 6-8 that there is a wide range of possible flows pumped from the CPS to the East Pit during Mine Year 20 through Mine Year 22. The East Pit wetland becomes completely flooded during this time (typically midway through Mine Year 21) and the WWTF switches from "Operations" to "Reclamation" mode (Sections 6.1.2.4.1 and 6.1.2.4.2). Before this switch occurs, there is little water available at the CPS pond (Operations mode); after the switch there is a greater flow of treated porewater available to return to the pit (Reclamation mode). The spread from Mine Year 20 through Mine Year 22 occurs because different realizations have different ratios of Operations to Reclamation flows during these years depending on when the switch occurs.

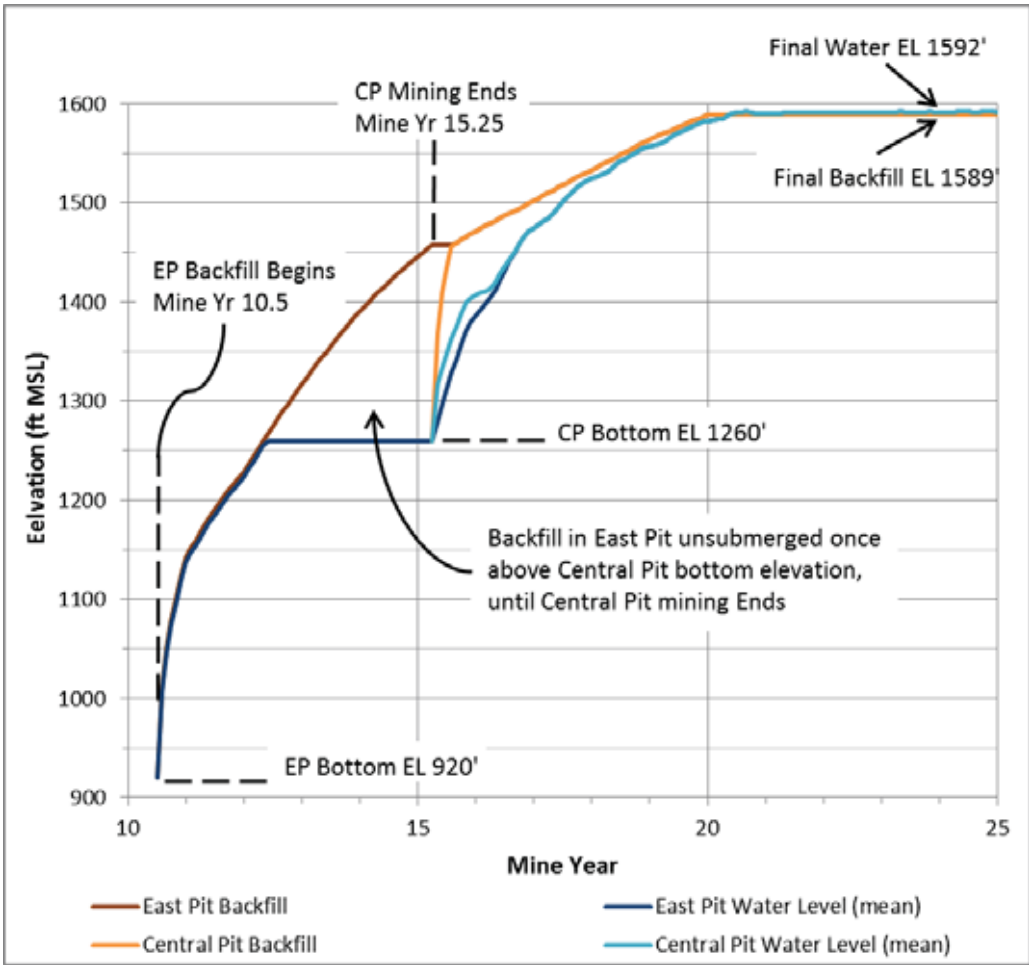


Figure 6-9 Backfill and Water Surface Elevations in the East and Central Pits

Once the water in the flooded backfill reaches the top of the bedrock along the pit rim (1577 feet MSL), outflow from the porewater to groundwater begins. Groundwater outflow contributes flow to the surficial aquifer (the East Pit/Category 2/3 flow path) and to the bedrock (East Pit flow path) and moves downgradient towards the Partridge River. The magnitude of the groundwater outflow is determined by the characteristics of the surficial and bedrock flow paths and is constant for the remainder of each realization once flow begins. An additional small flow moves from the backfill in the Central Pit through the bedrock towards the West Pit while the West Pit is empty. The range of flows is shown in Table 6-6. Note that the outflows from the East Pit via bedrock (to the bedrock flow path or to the West Pit) only begin once the pumping associated with treatment during reclamation is complete; the pumping is assumed to maintain an inward gradient in the lower porewater.

Table 6-6 Outflows to Groundwater from the East Pit

Outflows	P10 (gpm)	Average (gpm)	P90 (gpm)
Flow to East Pit / Category 2/3 surficial flow path(1)	2.1	3.9	6.2
Flow to East Pit bedrock flow path(2)	0.09	0.19	0.30
Flow to West Pit (temporary)(3)	0.08	0.10	0.13

(1) Uncertain flow once East Pit is flooded, non-time-varying
(2) Uncertain flow once East Pit pumping is complete, non-time-varying
(3) Uncertain flow only if East Pit pumping ends before West Pit is fully flooded

6.1.2.2.2 Reclamation

During the reclamation period water is pumped from the East Pit backfill for treatment in the WWTF. The primary objective of treatment during this period is to improve the water quality in the backfill porewater, and pumping continues until the sulfate concentration in the East Pit porewater is less than or equal to the groundwater quality standard of 250 mg/L. The flow rate removed from the East Pit is adjusted monthly to maintain a constant total inflow rate to the WWTF during reclamation, but is typically 1,750 gpm during Mine Year 22 through Mine Year 31. After Mine Year 31 the WWTF can accept more water from the East Pit due to decreasing flows from other sources, and the quantity extracted from the East Pit is allowed in the model to increase.

As long as East Pit treatment is ongoing, treated water from the CPS is returned to the East Pit, with the goal of replacing all of the extracted water less 100 gpm. This deficit in the East Pit water balance is estimated to be sufficient to maintain an inward and downward gradient in the East Pit backfill until treatment is complete while still maintaining saturated conditions in the East Pit backfill.

The natural inflow to the East Pit during reclamation is constant on average once the pit water reaches its final elevation. The magnitude of each flow source shown in Figure 6-7 for Mine Year 22 through Mine Year 25 continues during reclamation and long-term closure. Note that runoff from natural areas into the pit is allowed after Mine Year 20 because it is assumed that pit-rim dikes are removed to establish the long-term pit watersheds. For the flooded pit, with all backfilled waste rock submerged, the primary input of water is net precipitation (direct precipitation minus evaporation from the open water surface). During reclamation the majority of this water flows downward into the waste rock to as a result of the 100 gpm deficit. Any additional water flows over a constructed outlet structure and into the West Pit.

The annual flow statistics for the water sent to the WWTF from the East Pit during reclamation and the overflow to the West Pit are shown in Figure 6-10.

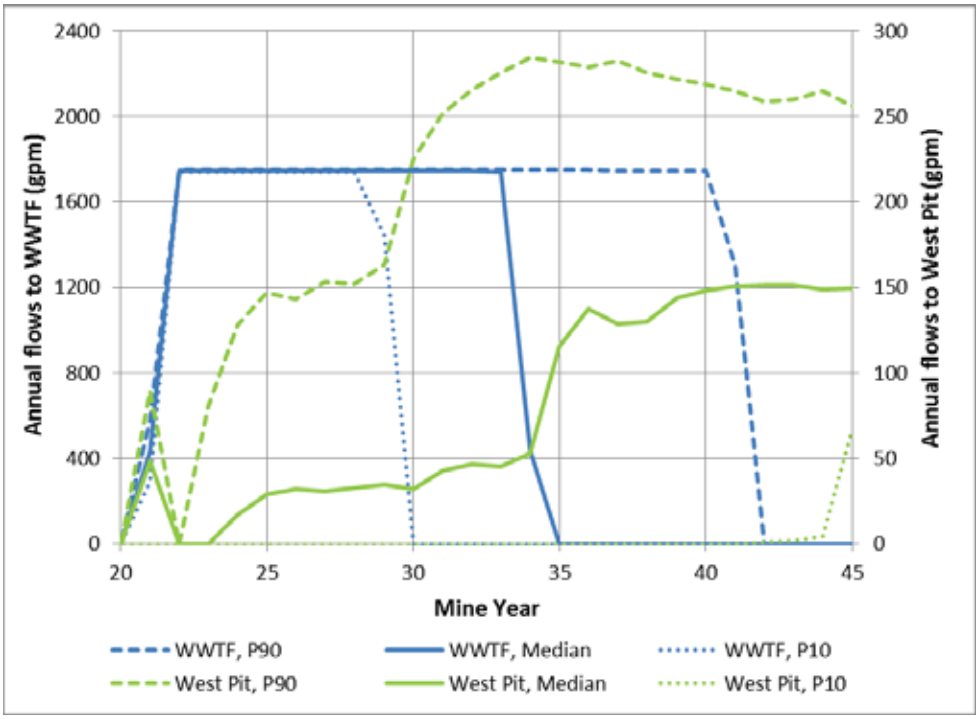


Figure 6-10 Annual Average Outflows from the East Pit during Reclamation

The reclamation period is considered to be complete when the sulfate concentration in the East Pit porewater is less than or equal to the groundwater quality standard of 250 mg/L. As shown above in Figure 6-10, the time required for pumping to the WWTF to be complete is uncertain and depends on the results of the water quality modeling for the loading to the East Pit. Figure 6-11 shows a histogram for the time to completion of East Pit treatment, ranging from Mine Year 25 to Mine Year 60 with an average time of Mine Year 34. There is a 90% probability that treatment of the East Pit porewater will be complete by the end of Mine Year 41.

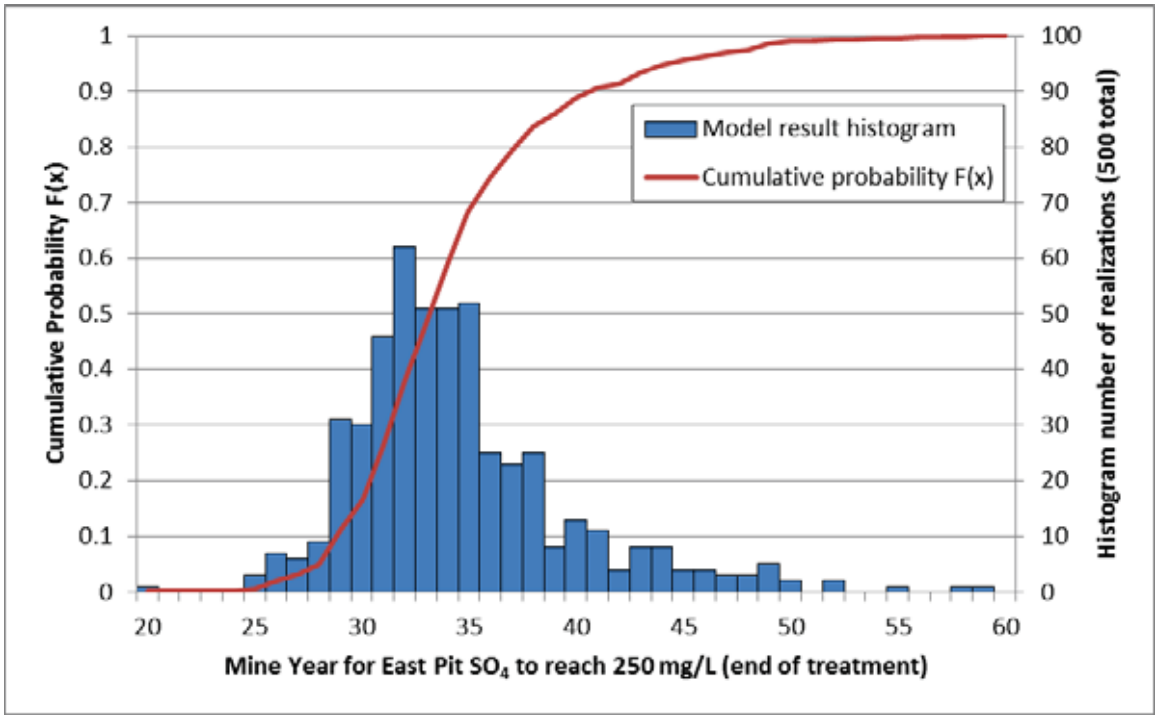


Figure 6-11 Mine Year for Complete Reclamation Treatment of the East Pit Porewater

6.1.2.2.3 Long-term

When treatment of the East Pit porewater is complete, any overflow water from the flooded pit continues to go to the West Pit. The quantity of overflow increases once treatment ceases due to the reduction in downward flow that results from the 100 gpm deficit during reclamation. The range of annual average flows from the East Pit to the West Pit is shown in Table 6-7.

Table 6-7 Annual Average Outflows from the East Pit to the West Pit in Long-Term Closure

Outflows	P10 (gpm)	Average (gpm)	P90 (gpm)
Overflow to West Pit	70	159	254

6.1.2.3 West Pit

6.1.2.3.1 Operations

The water balance of the West Pit is similar to, but simpler than, the water balance for the East Pit described above. The natural inflows to the West Pit are the same as for the East Pit and are

modeled in a similar manner: direct precipitation on the sump water surface (Section 5.2.2.6.2), runoff from the exposed pit walls, inflowing groundwater from both the surficial aquifer and bedrock (Section 5.2.2.6.3), and the uncaptured water from the Category 1 Waste Rock Stockpile that seeps to the pit via groundwater. Outflows from the pit sump include the relatively small amount of open water evaporation from the small surface area and the dewatering pumping to maintain a constant sump volume.

A schematic of the inflows and outflows from the West Pit during Mine Year 14 is shown in Figure 6-12.

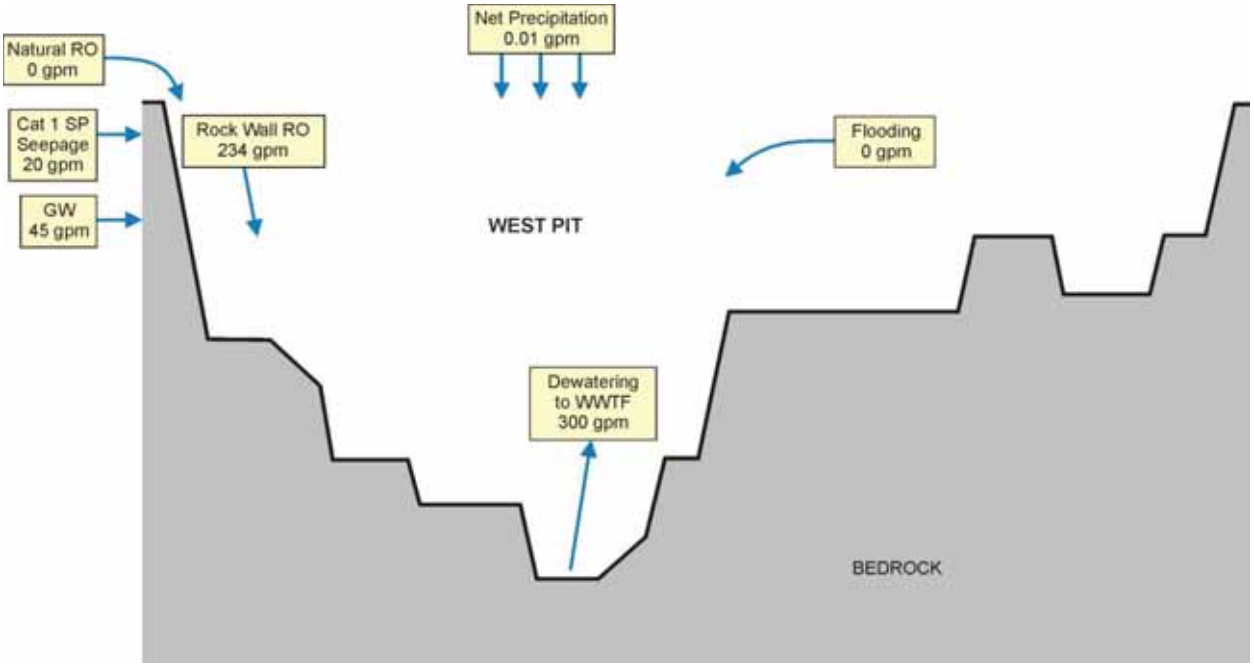


Figure 6-12 Average Inflows and Outflows to the West Pit During Mine Year 14

The annual average natural inflows to the West Pit during operations are shown in Figure 6-13. Note that the control volume for this water balance is the water in the West Pit sump, not the entire pit area. “Net precipitation”, therefore represents the direct precipitation less evaporation from the water surface and does not include precipitation or evaporation from the exposed wall rock areas.

The annual flow statistics for the water sent to the WWTF East EQ Basin during operations are shown in Figure 6-14. The increase in the dewatering rate in Mine Year 21 is due to the demand for water to complete flooding of the East Pit wetland as quickly as possible. Much of this additional water originates from the Plant Site as discussed in Section 6.1.2.3.2.

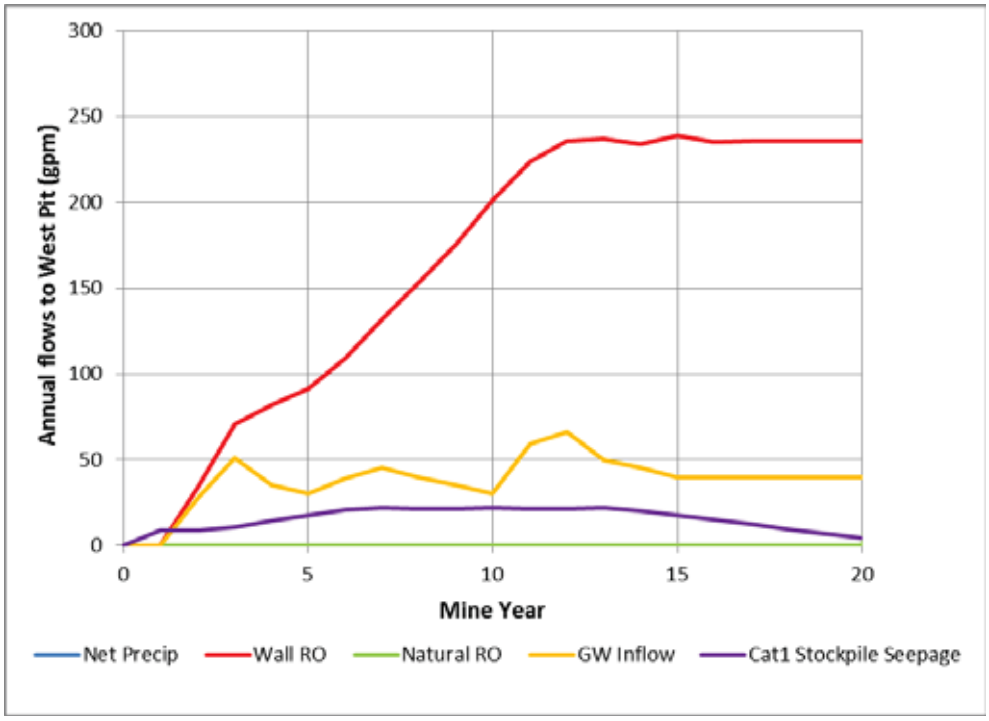


Figure 6-13 Annual Average Natural Inflows to the West Pit during Operations

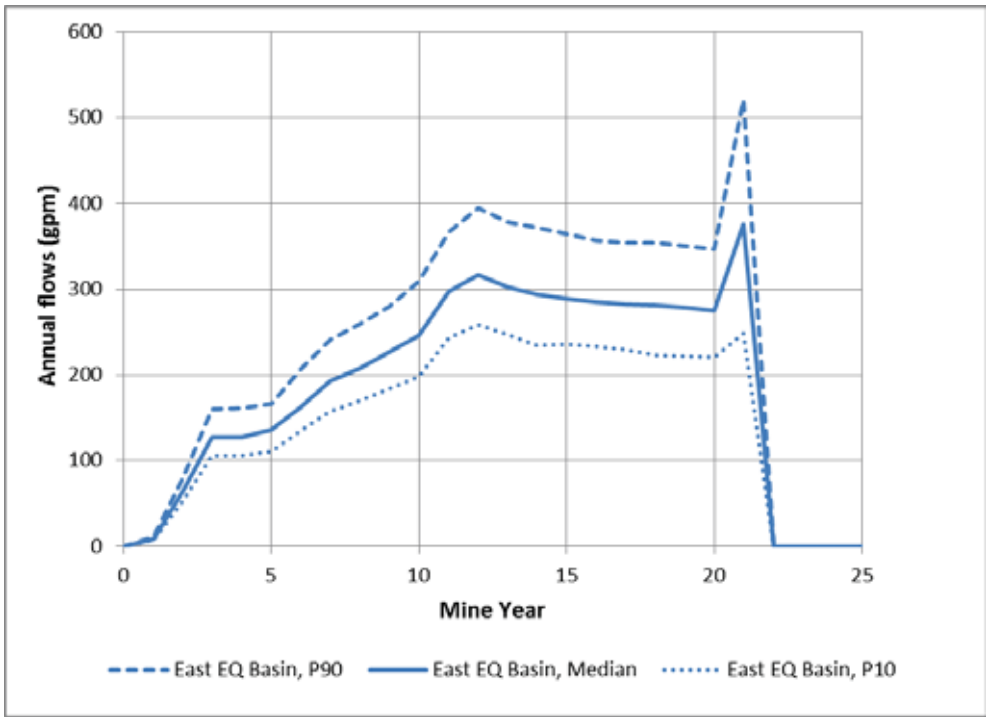


Figure 6-14 Annual Average Pumped Flows from the West Pit during Operations

6.1.2.3.2 Flooding

Once mining is complete at the end of Mine Year 20, the West Pit begins to flood during the reclamation period. The natural inflows to the pit continue to contribute flow as the pit water level rises, and additional surface runoff from non-pit areas (both natural areas and the reclaimed Category 1 stockpile) is routed into the pit. The net precipitation to the pit increases over time as the water surface area increases, with corresponding decreases in the runoff from the pit walls (especially in Mine Year 25 when a major bench is flooded). The West Pit also receives overflow water from the East Pit once East Pit flooding is complete, and the overflow from the East Pit increases when the pumping from the East Pit porewater in the Reclamation period ends by Mine Year 41. The water collected in the Category 1 Waste Rock Stockpile Containment System is also directed into the West Pit in realizations in which the East Pit reclamation treatment ends prior to complete West Pit flooding. The annual average natural inflows to the West Pit during flooding are shown in Figure 6-15.

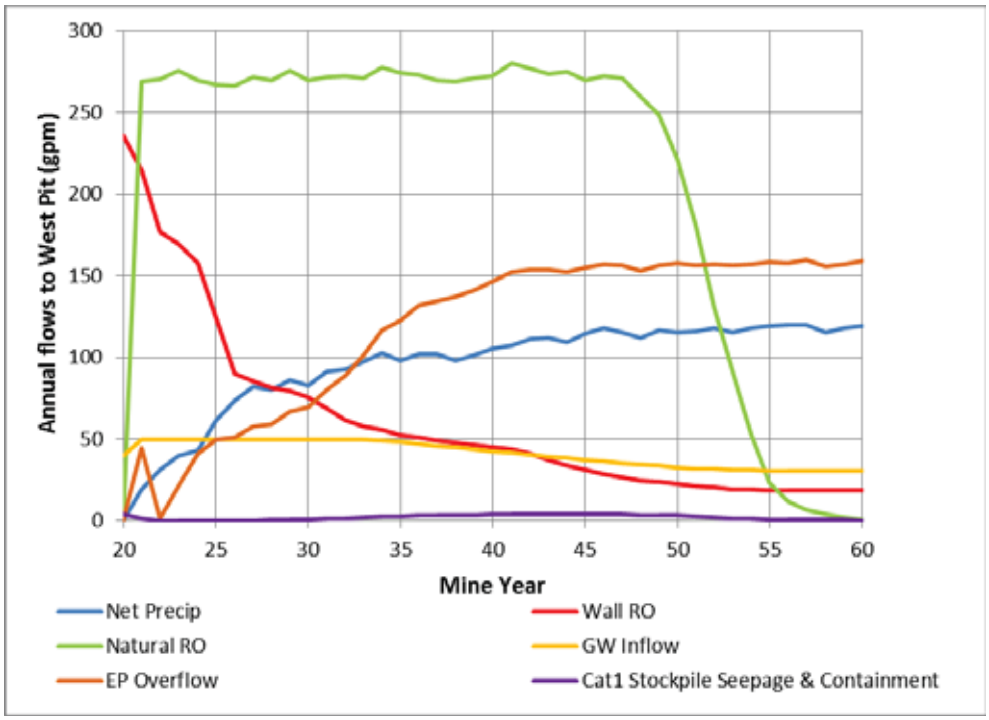


Figure 6-15 Annual Average Natural Inflows to the West Pit during Flooding

Flooding the West Pit is also accelerated by water pumped directly from the Plant Site and from excess water from the WWTF. The annual flow statistics for these two inflows are shown in Figure 6-16.

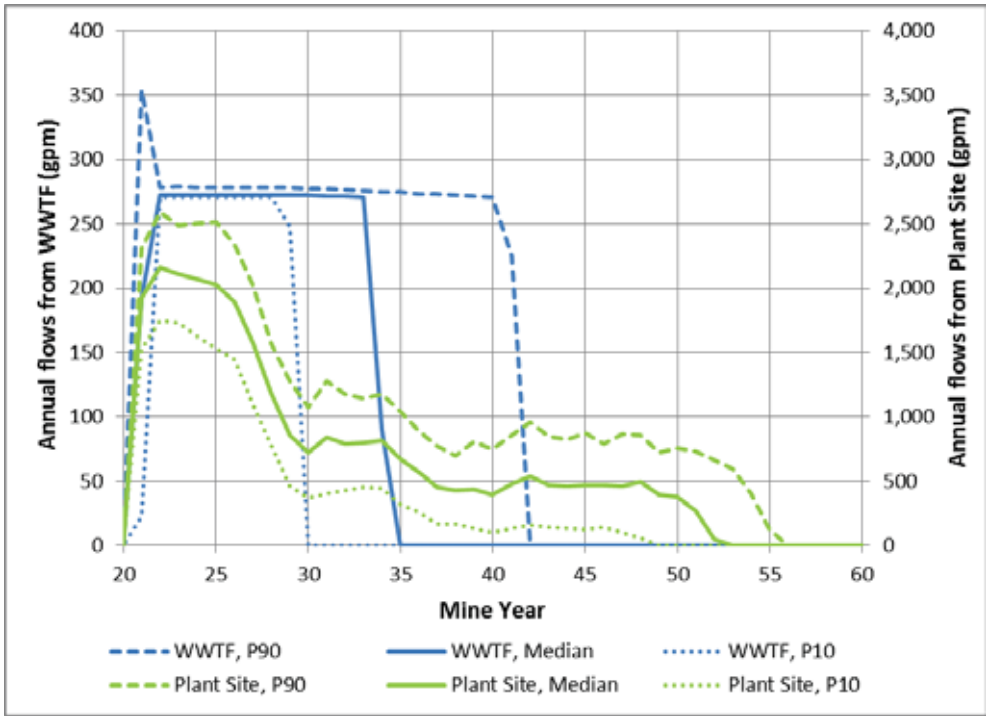


Figure 6-16 Annual Average Pumped Flows to the West Pit During Reclamation

Once the water in the flooded pit reaches the top of the bedrock along the pit rim (1550 feet MSL), outflow from the West Pit to groundwater begins. The pit water typically reaches this elevation less than five years before the pit is completely flooded. Groundwater outflow contributes flow to the surficial aquifer (the West Pit flow path) and to the bedrock (West Pit flow paths to SW004 and SW004a) and moves downgradient towards the Partridge River. The magnitude of the groundwater outflow is determined by the characteristics of the surficial and bedrock flow paths and is constant for the remainder of each realization once flow begins. The range of flows is shown in Table 6-8.

Table 6-8 Outflows to Groundwater from the West Pit

Outflows	P10 (gpm)	Average (gpm)	P90 (gpm)
Flow to West Pit surficial flow path	3.1	6.5	10.7
Flow to West Pit bedrock flow path to SW004	0.03	0.06	0.10
Flow to West Pit bedrock flow path to SW004a	0.05	0.10	0.16

6.1.2.3.3 Long-term

Once the West Pit is completely flooded the pit water begins to be treated in the long-term closure WWTF and discharged to the Partridge River (actual discharge will be to a small watercourse that flows into the Partridge River, but in the GoldSim model, the discharge is directly to the Partridge River). The time required to flood the West Pit is uncertain and is dependent on the water balance inputs to the pit. Figure 6-17 shows a histogram for the time to complete flooding of the West Pit, ranging from Mine Year 46 to Mine Year 61 with an average time of Mine Year 52. There is a 90% probability that West Pit flooding will be complete by the end of Mine Year 55.

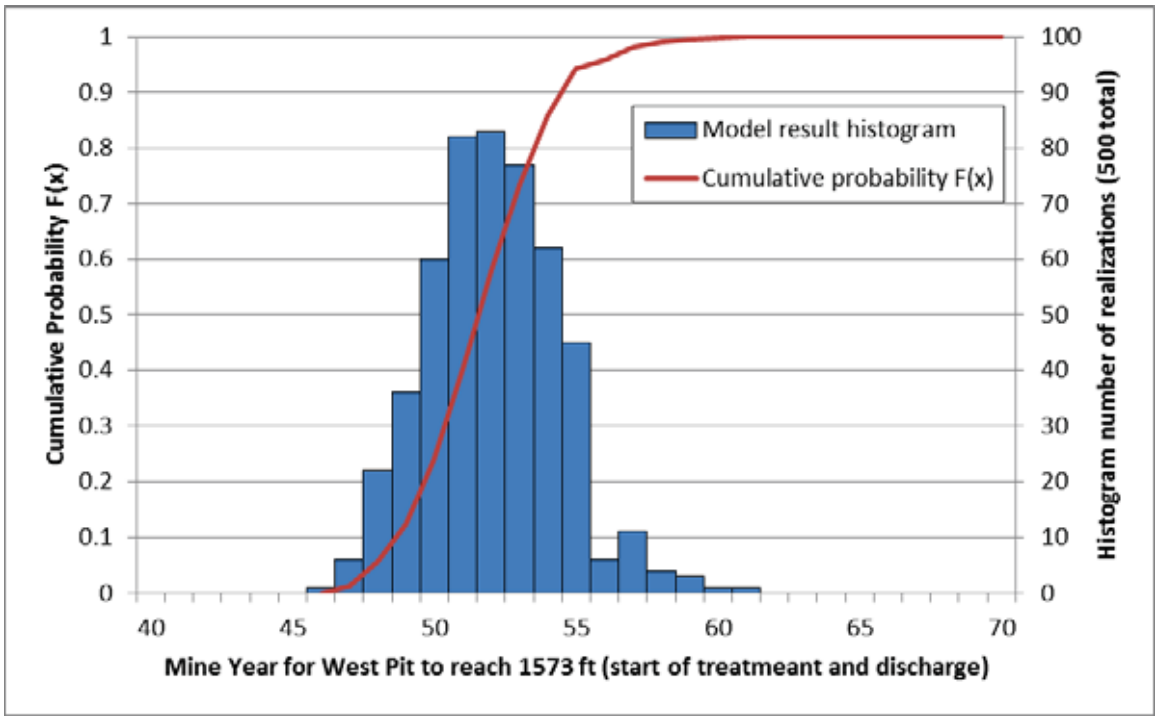


Figure 6-17 Mine Year for Complete Flooding of the West Pit

The flow of water sent from the flooded West Pit to the long-term closure WWTF in any month depends on the water level in the pit; the flow rate is varied in order to prevent overtopping of the pit. See the discussion of the long-term WWTF operating strategy as modeled in Section 6.1.2.4.3 below. The remaining natural inflows and outflows from the West Pit continue as shown in Figure 6-15 for Mine Year 55 through Mine Year 60. Note that runoff from natural and reclaimed stockpile areas is routed away from the pit after it is completely flooded.

6.1.2.4 Wastewater Treatment Facility (WWTF)

6.1.2.4.1 Operations

The WWTF in operations receives inflows of water from the various mine features discussed above. The water balance for the facility is simplified for the probabilistic model and inflows are grouped as follows: the West EQ Basin receives flow from the Category 2/3 and Category 4 Waste Rock Stockpiles and the OSP; the East EQ Basin receives flow from the Category 1 Waste Rock Stockpile, the East and West Pits, the RTH and haul roads; reject concentrate from the Plant Site WWTP is sent directly to the WWTF downstream of both basins (Figure 6-18). The annual flow statistics for the water sent to the WWTF during operations are summarized according to the equalization basins (West EQ Basin, East EQ Basin, and Plant Site WWTP reject concentrate) and are shown in Figure 6-19.

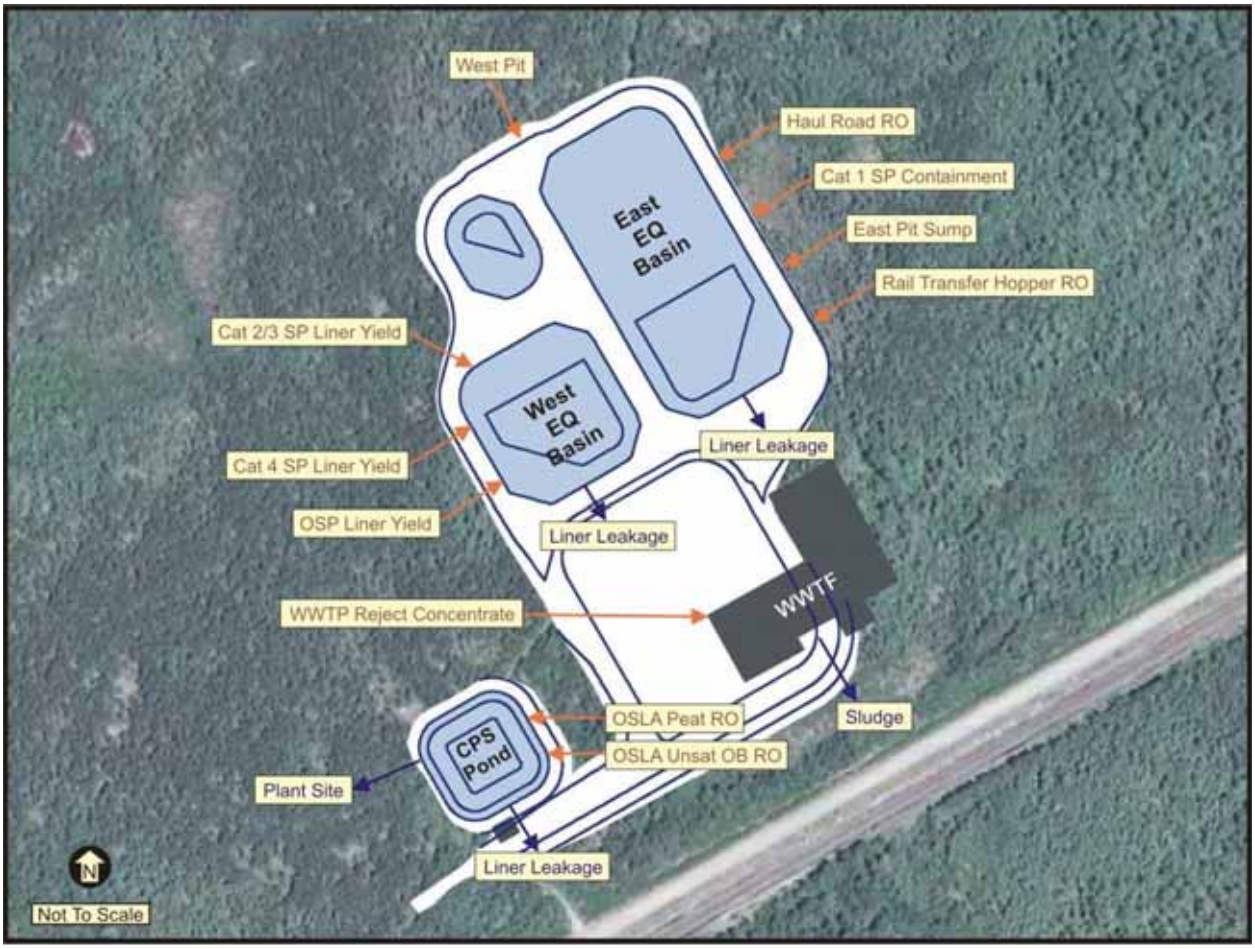


Figure 6-18 Flow Routing at the WWTF during Operations

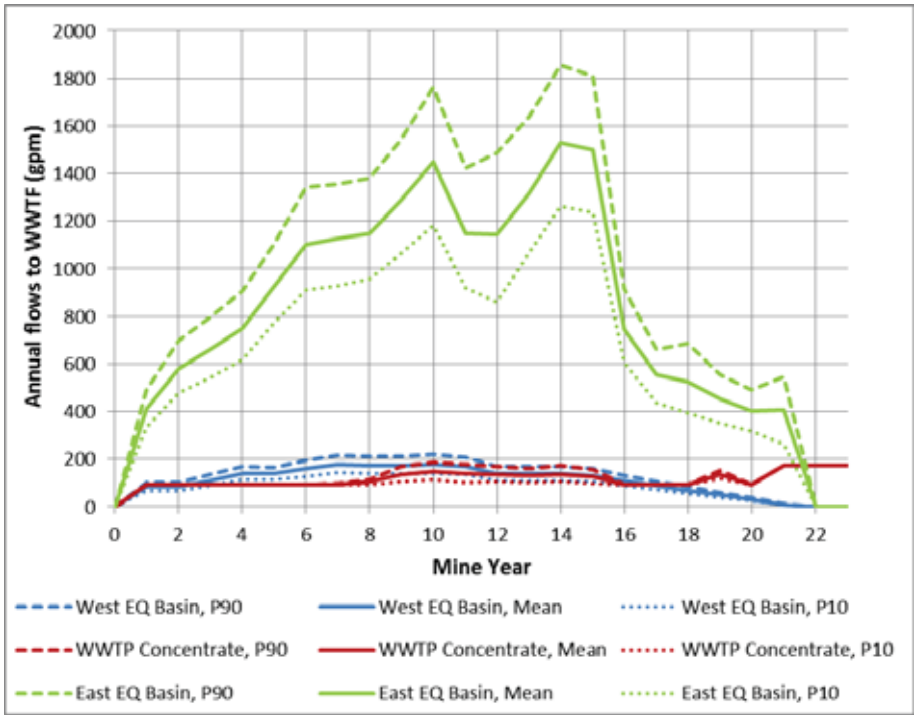


Figure 6-19 Annual Average Inflows to the WWTF during Operations

The design capacity of the WWTF has been based on the results presented in Figure 6-19 and additional storm event flow estimates provided for the WWTF preliminary design basis (Reference (4), Section 2.2.2.1). The total capacity of the WWTF will vary during operations, beginning with 1,000 gpm of capacity in the membrane treatment train (East EQ Basin flows) and 500 gpm of capacity in the chemical precipitation train (West EQ Basin and WWTP reject concentrate flows) in Mine Year 1. Capacity of both treatment trains will be increased throughout the operation, as necessary, to achieve the design operating rates.

Water is lost from the WWTF system as leakage from the equalization basins and in the water content of the filtered sludge removed from the plant itself. Leakage from the double-lined ponds is estimated at 5 gallons per acre per day during the open-water months (Section 5.2.2.9), which equates to 0.008 gpm for the West EQ Basin and 0.017 gpm for the East EQ Basin. The leakage contributes flow to the surficial aquifer (the WWTF flow path) and moves downgradient towards the Partridge River. The water loss in the filtered sludge is estimated at 5 gpm and is constant throughout operations (Section 5.2.2.8).

The WWTF effluent passes through the CPS Pond, where it is combined with the runoff collected from the OSLA for pumping to the FTB Pond or to flood the East Pit. Leakage from the double-lined CPS Pond is also estimated at 5 gallons per acre per day, equal to 0.005 gpm throughout operations. Like the equalization basins, leakage from the CPS Pond contributes flow to the surficial aquifer (the WWTF flow path).

The flow from the CPS is pumped to the FTB Pond unless it is needed for flooding the waste rock backfilled in the East and Central Pits. Through the end of Mine Year 10 the flow is pumped exclusively to the FTB Pond. During Mine Year 11 through Mine Year 13, some of the available water is used to flood the East Pit. During Mine Years 14 and 15, however, the water level in the East Pit is managed to maintain safe working conditions in the Central Pit and no water is added to the pits from the CPS. Once mining is complete in the Central Pit in Mine Year 16, most or all of the flow from the CPS is used to flood the backfill in the combined East and Central Pits until the last few years of mining. There is typically some amount of excess treated water in Mine Year 18 through Mine Year 20 that is pumped to the FTB Pond. If more water is needed to the flood the backfill than is available during operations, pumping of water originating from the West Pit may continue until flooding of the combined East and Central Pits is complete in the early years of reclamation. The annual flow statistics for the water pumped from the CPS Pond to the FTB Pond and the combined East and Central Pits are shown in Figure 6-20.

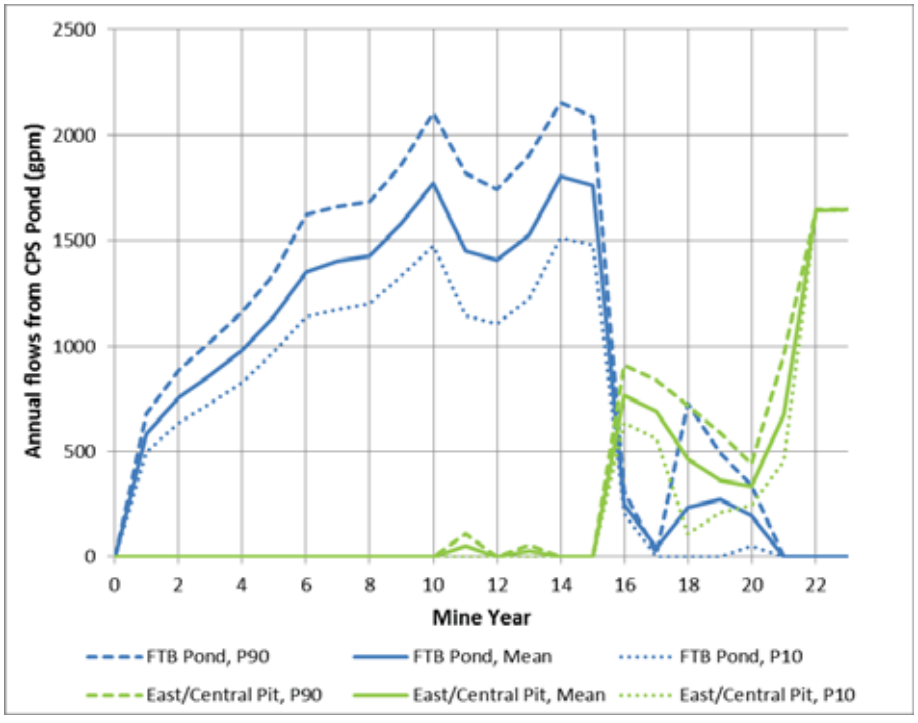


Figure 6-20 Annual Average Outflows from the CPS during Operations

6.1.2.4.2 Reclamation

The WWTF during the reclamation period receives inflows of water from a limited number of sources (Figure 6-21). The primary objective of treatment during this period is to improve the water quality in the backfilled East and Central Pits, referred to collectively as the East Pit. The WWTF also treats the collected water from the Category 1 Waste Rock Stockpile, as well as the reject concentrate from the Plant Site WWTP. The total capacity of the WWTF during this period is assumed to be 2,400 gpm, including the 20% of inflow that becomes retentate from the

initial filtration step and is treated by secondary chemical precipitation. The total allowable new inflow to the WWTF is 1,925 gpm. This value accounts for the loss of 5 gpm in the filtered sludge as described above.

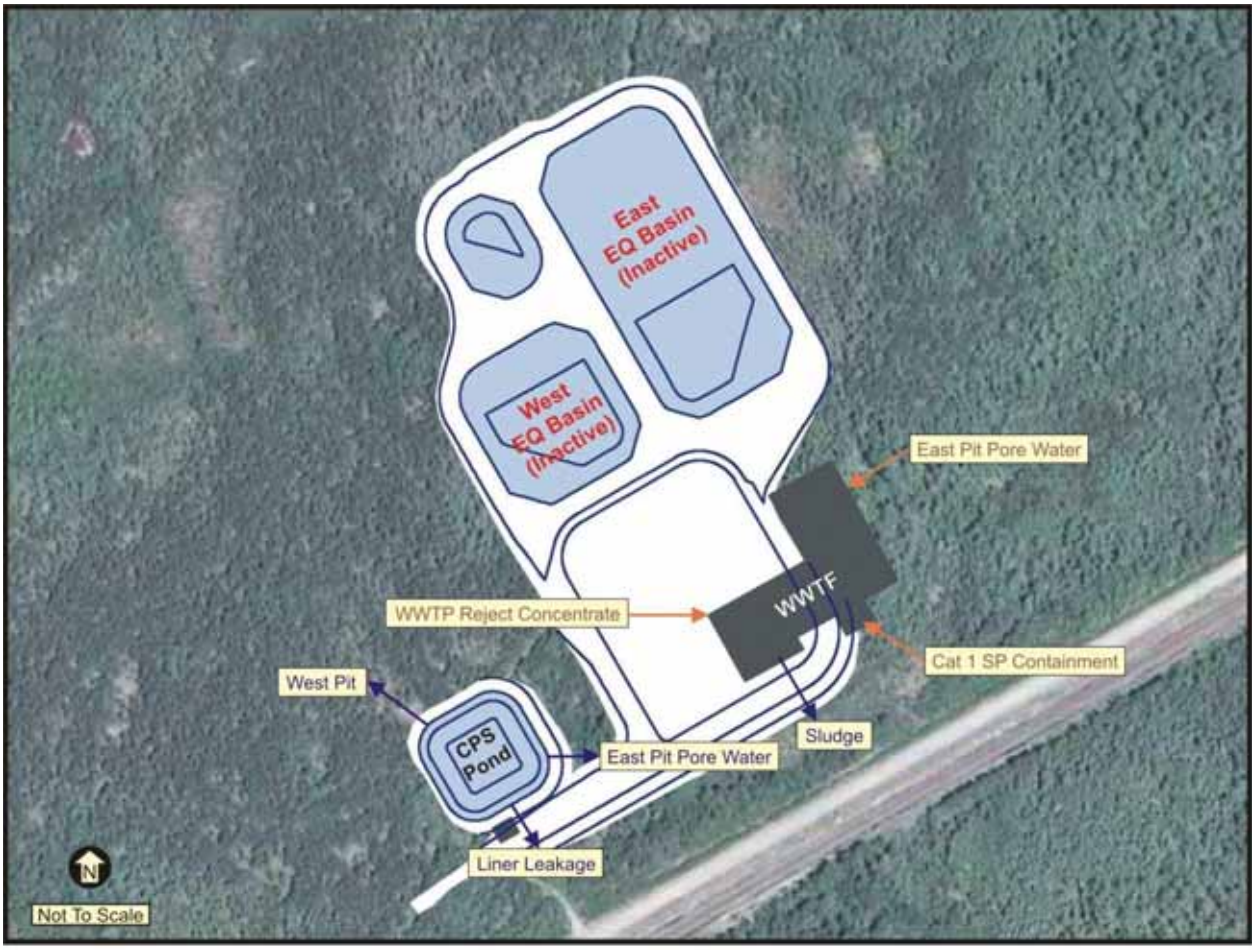


Figure 6-21 Flow Routing at the WWTF during Reclamation

Because the inflows from the Category 1 Waste Rock Stockpile and the Plant Site WWTP may vary somewhat, the flow extracted from the East Pit porewater is adjusted to maintain a constant total inflow. There is assumed to be no equalization basin at the WWTF during reclamation, and therefore no leakage from a pond liner. The annual flow statistics for the water sent to the WWTF during reclamation from the East Pit and the Plant Site WWTP reject concentrate are shown in Figure 6-22. The flows from the stockpile to the WWTF during this period are presented in Table 6-5.

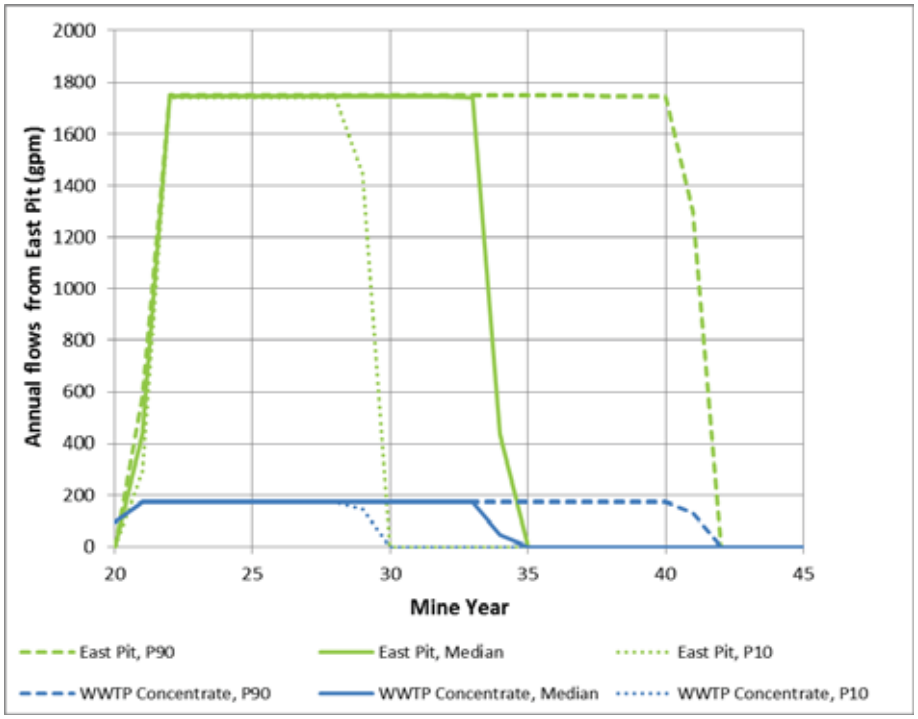


Figure 6-22 Annual Average Inflows to the WWTF during Reclamation

The WWTF effluent passes through the CPS Pond during reclamation, with leakage from the pond identical to that during operations (0.005 gpm). The flow from the CPS is primarily sent to the backfilled East Pit, with the goal of replacing all of the extracted water less 100 gpm. This deficit in the East Pit water balance is estimated to be sufficient to maintain an inward and downward gradient while still maintaining saturated conditions in the East Pit backfill until treatment is complete. The remaining water is used to flood the West Pit. The annual flow statistics for the water sent from the CPS Pond to the East/Central Pit and the West Pit are shown in Figure 6-23.

As discussed in Section 6.1.2.2.2, the reclamation period is complete when East Pit treatment finishes between Mine Year 25 and Mine Year 60 with an average time of Mine Year 34.

When East Pit treatment is complete, the WWTF no longer accepts flows from the Plant Site WWTP reject concentrate (which may cease earlier, depending on the West Pit water level) and flows from the Category 1 Waste Rock Stockpile are treated in the long-term closure WWTF described below. If East Pit treatment is complete prior to the initiation of the long-term closure WWTF (i.e., before the West Pit is entirely flooded), the small flow of collected water from the Category 1 Waste Rock Stockpile is assumed to be sent to the West Pit until the long-term closure WWTF is operational.

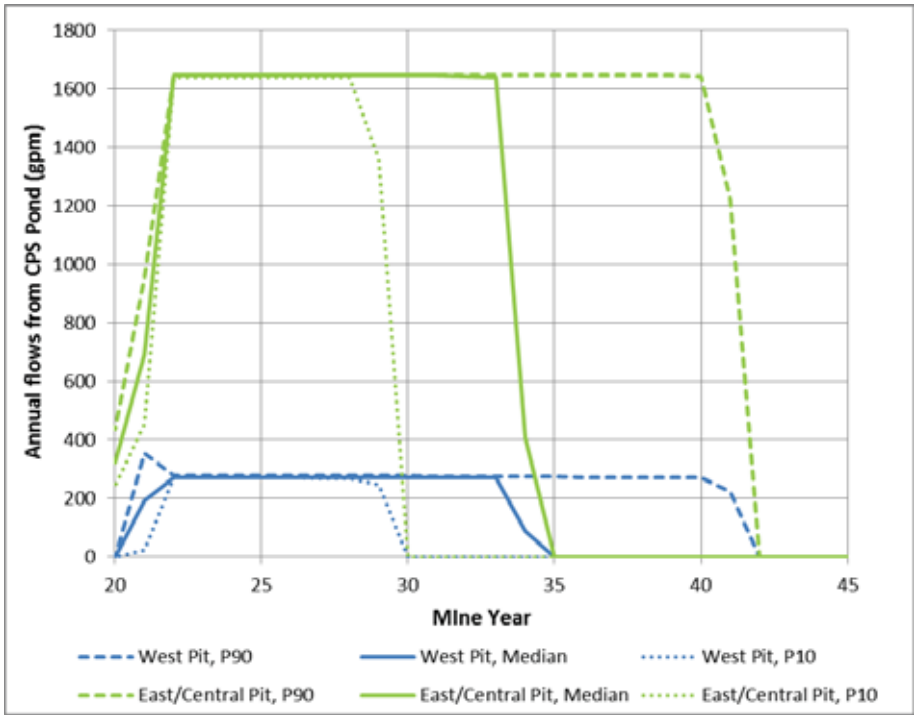


Figure 6-23 Annual Average Outflows from the CPS during Reclamation

6.1.2.4.3 Long-term closure

The WWTF in long-term closure receives inflows of water from only the Category 1 Waste Rock Stockpile and the West Pit (Figure 6-24). This phase of the WWTF is initiated when the water level in the West Pit nears its overflow elevation (Section 5.2.2.8), regardless of whether treatment of the East Pit porewater is ongoing. When East Pit porewater treatment ceases (if ongoing when the long-term closure WWTF begins treatment), flows from the Category 1 Waste Rock Stockpile are sent to the long-term closure WWTF.

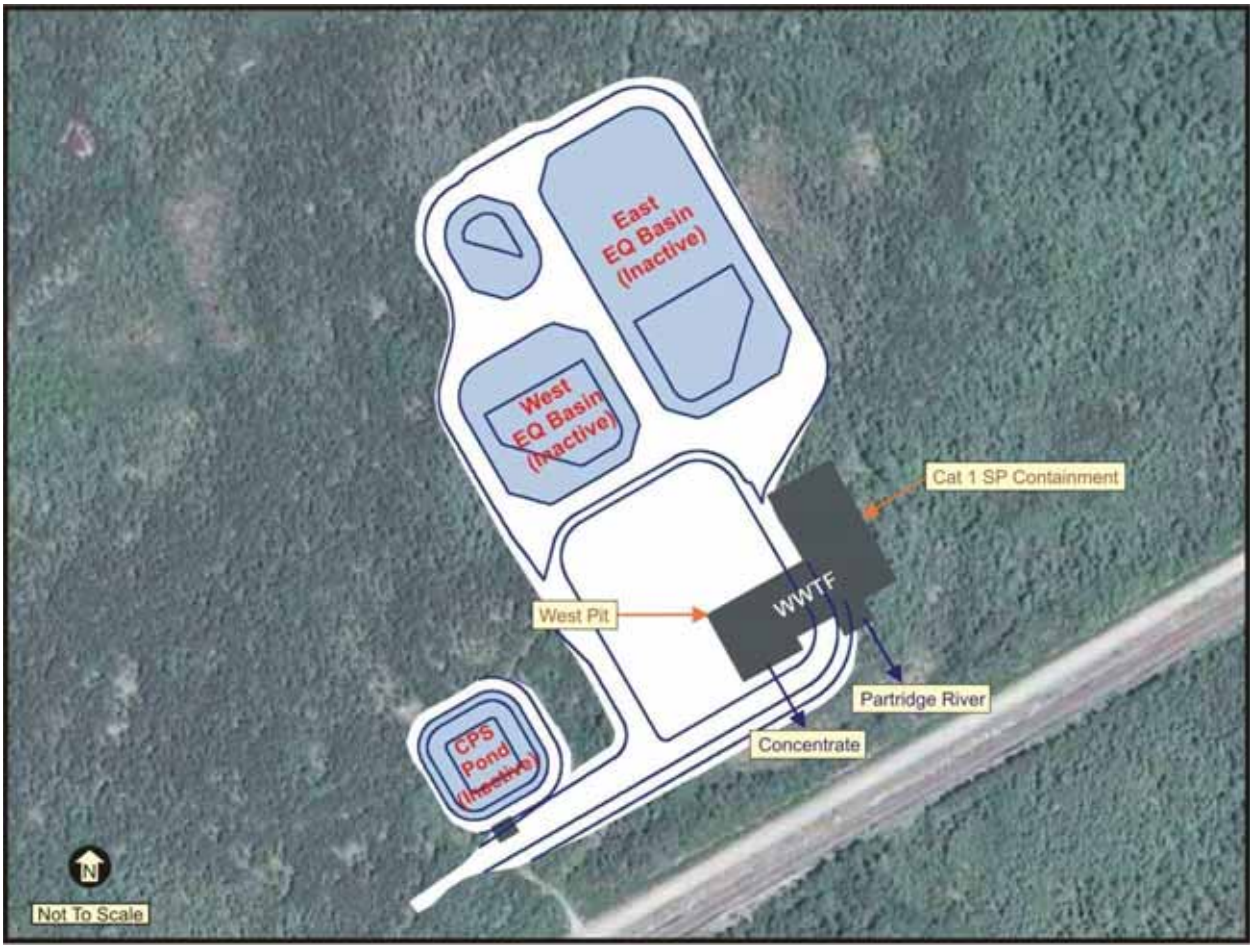


Figure 6-24 Flow Routing at the WWTF during Long-Term Closure

The total capacity required for the long-term closure WWTF is estimated to be 600 gpm based on the water balance of the long-term project features. The actual design capacity of the long-term closure WWTF, which will not be active until approximately Mine Year 53, will be refined in permitting.

The actual flow sent to the WWTF is typically half of the capacity or 300 gpm. If the water level in the West Pit is higher than 2 feet below the overflow elevation (1579 feet MSL), treatment switches to full capacity until the water level returns below 1577 feet MSL. Once the pit is completely flooded, the need for full treatment capacity typically occurs only during snowmelt or summer high-flow events. If the water level drops below a target elevation (1573 feet MSL), treatment switches to one-quarter of the capacity or 150 gpm. Regardless of the treatment flow selected, the flow removed from the West Pit plus the flow from the Category 1 Waste Rock Stockpile account for the total inflow to the WWTF. The annual flow statistics for the water sent to the WWTF during long-term closure are shown in Table 6-9.

The only loss of water from the long-term closure WWTF is 5% of the total inflow that is lost as solid residue and removed from the site. The remaining treated effluent is pumped to an unnamed creek that flows to the Partridge River near evaluation location SW004a. There are no equalization basins during long-term closure.

Table 6-9 Annual Average Flows for the WWTF in Long-Term Closure

Outflows	P10 (gpm)	Average (gpm)	P90 (gpm)
Flow from West Pit	291	321	416
Flow from Category 1 Waste Rock Stockpile	0.7	3.8	8.3
Flow to Partridge River	285	308	397

6.2 Mine Site Water Quality

For each of the Mine Site features discussed in Section 6.1, the probabilistic model estimates the water quality of the flows leaving the feature. This section describes the behavior of each constituent at each specified location and shows the statistics of this behavior both in tables and graphically. Each table and graph is presented in the same fashion and the following steps were taken to create the data for these graphs.

6.2.1 Explanation of Plots

Two types of plots are used in this section:

- plots showing concentration statistics
- plots showing loading culpability

All of the plots of concentration statistics in the Mine Site features are included in Attachment G. All of the plots of loading culpability to the mine pits are included in Attachment H. Each of these plots is described below.

6.2.1.1 Concentration Statistics Plots

Estimated mine feature water quality is shown using a series of concentration statistic plots. The following bulleted steps were taken to create the data for these plots.

- The probabilistic GoldSim model was run at monthly time steps for 200 years (2401 time steps including the initial time zero). At each time step, the concentration in each Mine Site feature for each constituent was individually recorded.

- After one realization (i.e., one model run) was completed, the process was repeated until 500 model realizations were completed. The result is 500 concentrations in each Mine Site feature of each constituent at every time step.

- At every time step, and for every constituent, the concentrations were sorted smallest-to-greatest and 3 single values were chosen to represent the statistics at that particular time step.

- Because 500 realizations were run and the results were sorted smallest-to-greatest, the 50th value was chosen to represent the 10th percentile (P10), the 250th value was chosen to represent the median (P50), and the 450th value was chosen to represent the 90th percentile (P90). This indicates that at any time, 10% of the model results are less than or equal to the P10 value, 50% are less than or equal to the P50 value, and 90% are less than or equal to the P90 value.

- This process was repeated for all time steps, resulting in 3 time series lines representing the 10th, 50th, and 90th percentiles of concentrations in each Mine Site feature at every time step (monthly results).

- For plotting the results over the entire 200 years of the simulation, the data is summarized by year to avoid illegible plots. The monthly model outputs for the 10th, 50th, and 90th percentiles are plotted on an annual basis by either

    - Taking the maximum value of each percentile for a given year (i.e., the highest 90th percentile value), or

    - Taking the average value of each percentile for a given year (i.e., the average of the twelve 90th percentile values).

The water quality results for the Mine Site features are used in the design of the WWTF and in modeling the constituent loading that leaves the site for the evaluation of impacts to groundwater and surface water quality. The WWTF design basis (Reference (4)) uses the annual average of the 90th percentile concentrations from each mine feature. This information is presented in the sections below for each mine feature throughout operations, although the WWTF design uses only values for the selected design year.

6.2.1.2 Culpability Plots

A culpability analysis was performed using the loading rates from all sources to the East and West Pits. The loading rates are compared to highlight some of the major sources of load for each constituent to the mine pits. The tables and plots in this section were created by taking the following steps:

- At any given time step, the mass loading rate (tonnes/yr) from every source contributing mass load to the East or West Pit is calculated and stored. These sources are itemized in the legend of the figures in Attachment H.

- Once the 500 realizations are complete, at every monthly time step the loading rates of a particular constituent from a particular source are sorted minimum to maximum and the median value (250th) is chosen. This step is performed for all sources and all constituents.

- The monthly median loading rates of each constituent from each source are then annualized by taking the average of the twelve monthly median loading rates each year. This results in one representative average annual median loading rate of each constituent from each source.

- A stacked bar graph is used to directly compare the average annual median loading rates from each source for any constituent to the East or West Pit. The source (uniquely colored in the figures in Attachment H) which covers the most area of the graph at any given time is therefore the most culpable source. Showing a time series graph of loading rates also helps show how the culpable source may change through time.

6.2.2 Temporary Mine Features

6.2.2.1 Category 2/3 Waste Rock Stockpile

Large Table 12 presents the annual average of the 10th, 50th, and 90th percentile concentrations for all modeled constituents in the drainage from the Category 2/3 Waste Rock Stockpile. These concentrations apply to the collected water sent to the WWTF as well as leakage through the geomembrane liner to groundwater. All waste rock is removed from the stockpile by the end of Mine Year 19, although drainage concentrations do not return to zero until the geomembrane liner is fully removed at the end of Mine Year 20 due to constituent mass retained on the liner system.

Constituent concentrations generally increase throughout operations as additional material is added to the stockpile, releasing more constituent mass. In addition, the waste rock is estimated to begin transitioning to acidic conditions once it has been exposed to oxidation for between 5 and 8 years. Figure 6-25 shows the progression of acidic conditions in the stockpile under average conditions. The estimated acidic conditions have the effect of increasing constituent release rates as well as the limiting concentrations (concentration caps) for most constituents. As a result, even though the stockpiled material begins to be removed and placed in the East Pit beginning in Mine Year 12, concentrations continue to increase until the stockpile is nearly completely removed because the proportion of acidic waste rock steadily increases.

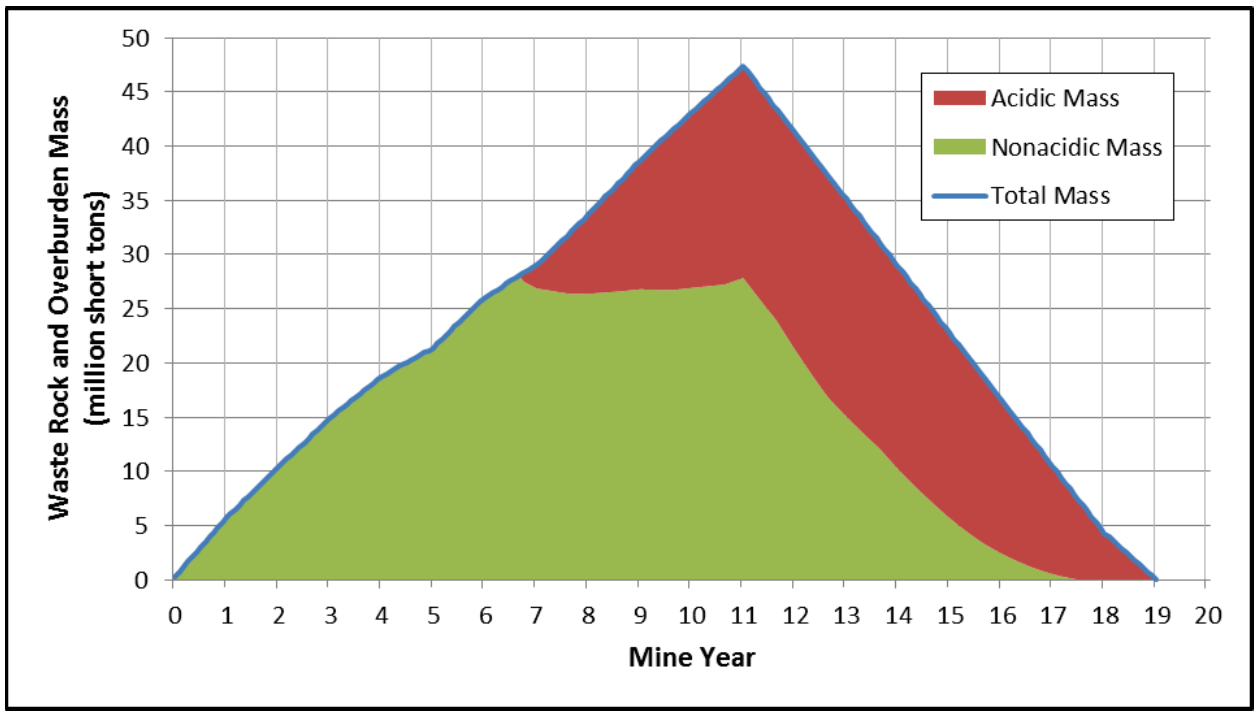


Figure 6-25 Acidic and Nonacidic Waste Rock in the Category 2/3 Stockpile

Figure 6-26 shows the range of estimated concentrations for sulfate in the Category 2/3 Waste Rock Stockpile drainage. The sulfate concentrations clearly demonstrate the effect of increasingly acidic stockpile conditions on the concentrations of the drainage water. The sulfate concentration peaks between Mine Year 12 (at the 10th percentile) and Mine Year 18 (at the 90th percentile) depending on the magnitude of the increase in the sulfate release rate for acidic conditions. Sulfate, like most other constituents, does not reach the concentration cap under acidic conditions.

Figure 6-27 shows the range of estimated concentrations for copper. Like several other constituents, the copper concentration is stable at the range defined by the nonacidic concentration cap during the early mine years, then increases along with the concentration cap as acidic conditions become more prevalent in the stockpile. The copper concentration in the Category 2/3 Waste Rock Stockpile drainage is consistently limited by either the nonacidic or the acidic concentration cap.

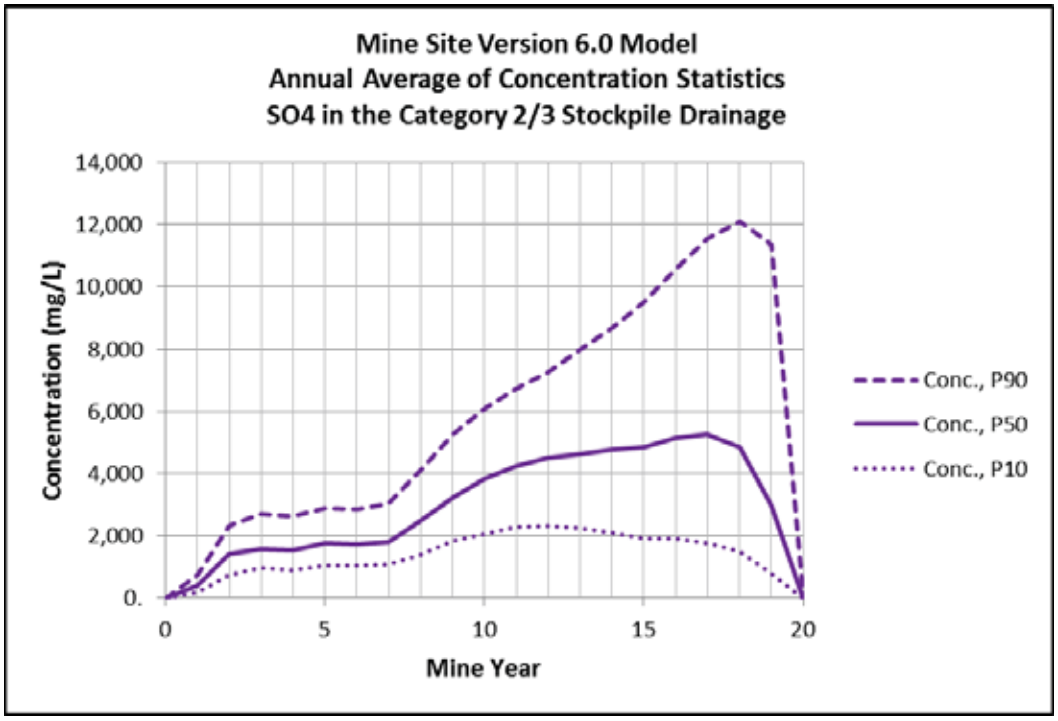


Figure 6-26 Estimated Sulfate Concentrations in the Category 2/3 Stockpile Drainage

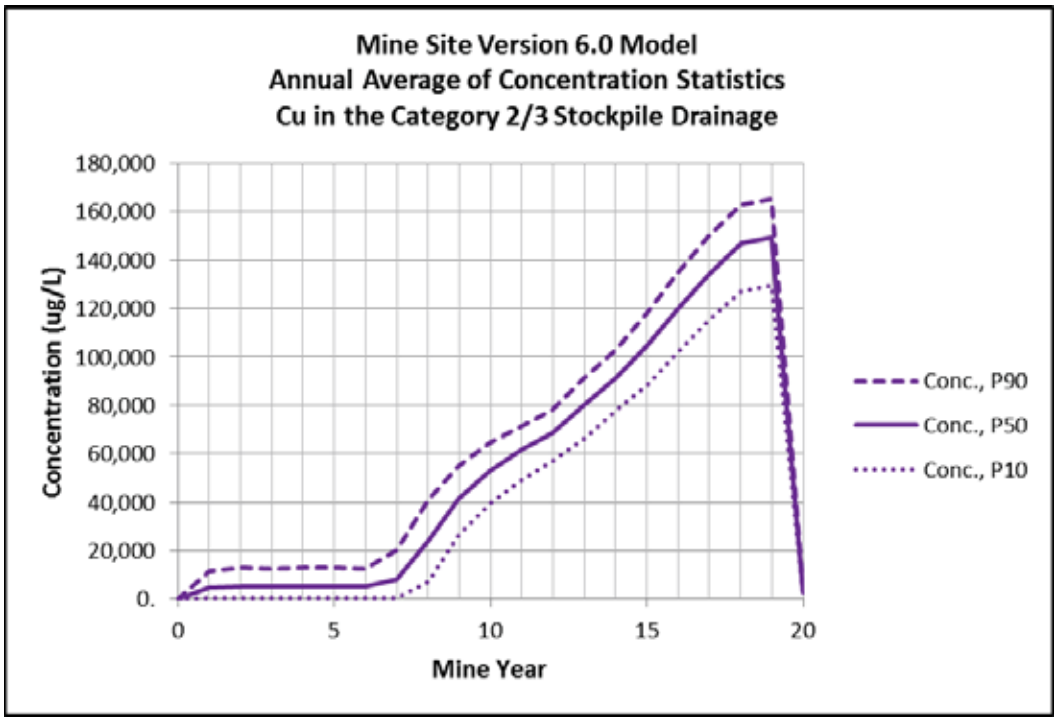


Figure 6-27 Estimated Copper Concentrations in the Category 2/3 Stockpile Drainage

6.2.2.2 Category 4 Waste Rock Stockpile

Large Table 13 presents the annual average of the 10th, 50th, and 90th percentile concentrations for all modeled constituents in the drainage from the Category 4 Waste Rock Stockpile. These concentrations apply to the collected water sent to the WWTF as well as leakage through the geomembrane liner to groundwater. All waste rock and the entire liner system is removed by the end of Mine Year 11 to allow for development of the Central Pit.

Constituent concentrations generally increase throughout operations as additional material is added to the stockpile, releasing more constituent mass. Unlike the Category 2/3 Waste Rock Stockpile, the material in the Category 4 Waste Rock Stockpile is assumed to be fully acidic immediately upon addition to the stockpile.

Figure 6-28 and Figure 6-29 show the range of estimated concentrations for sulfate and copper, respectively in the Category 4 Waste Rock Stockpile drainage. Neither of these constituents consistently reach their acidic concentration caps in this stockpile.

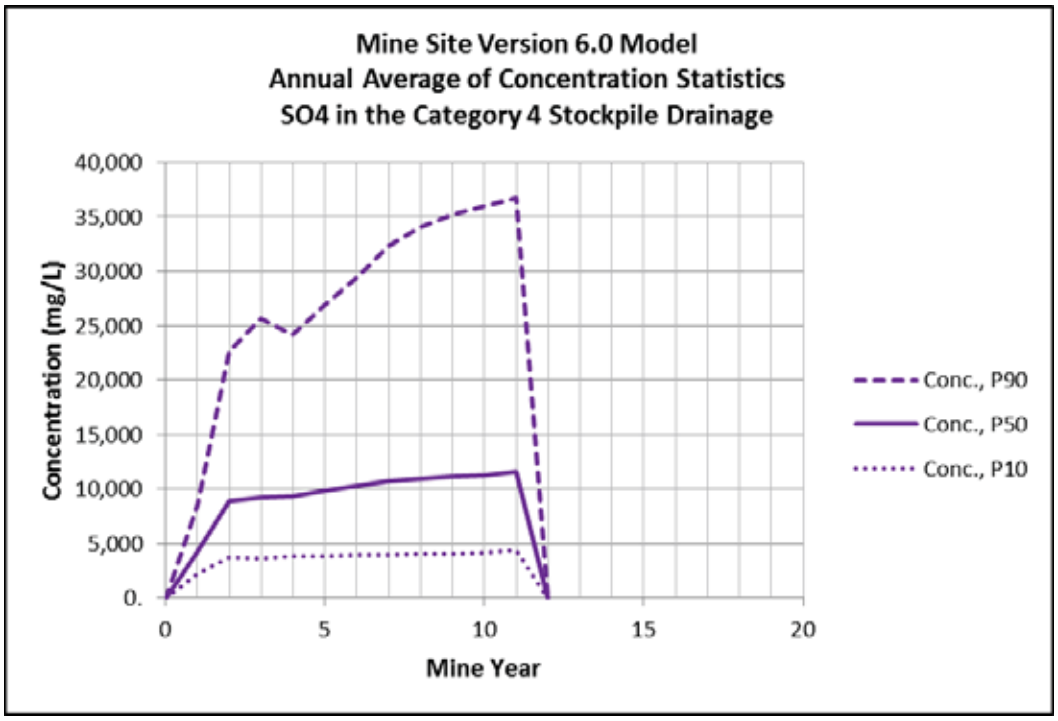


Figure 6-28 Estimated Sulfate Concentrations in the Category 4 Stockpile Drainage

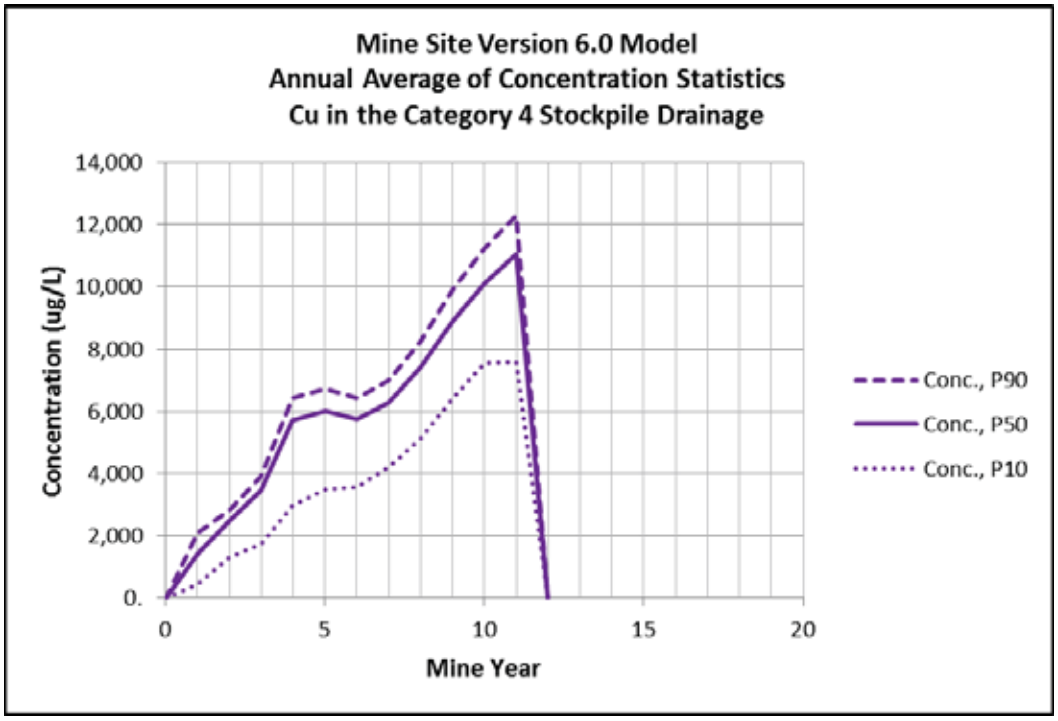


Figure 6-29 Estimated Copper Concentrations in the Category 4 Stockpile Drainage

6.2.2.3 Ore Surge Pile (OSP)

Large Table 14 presents the annual average of the 10th, 50th, and 90th percentile concentrations for all modeled constituents in the drainage from the OSP. These concentrations apply to the collected water sent to the WWTF as well as leakage through the geomembrane liner to groundwater. All stockpiled ore is removed from the stockpile by the end of Mine Year 20, although drainage concentrations do not return to zero until the geomembrane liner is fully removed at the end of Mine Year 21 due to constituent mass retained on the liner system.

Like the Category 2/3 Waste Rock Stockpile, the material in the OSP transitions to acidic conditions during operations. The stockpiled ore is conservatively assumed to remain in the OSP until the pile is completely removed, meaning that once the OSP reaches its maximum mass (end of Mine Year 5) the stockpile gradually becomes completely acidic. See Figure 6-30 for the progression of acidic conditions in the stockpile under average conditions. As a result of the increasing acidity, constituent concentrations generally increase until the end of Mine Year 11, after which they are relatively constant until the stockpile is removed.

Figure 6-31 shows the range of estimated concentrations for sulfate in the OSP drainage. The sulfate concentrations clearly demonstrate the effect of increasingly acidic stockpile conditions on the concentrations of the drainage water, and the plateau and decrease in concentrations as the stockpile is removed. Sulfate, like most other constituents, does not reach the concentration cap under acidic conditions.

Figure 6-32 shows the range of estimated concentrations for copper. Like several other constituents, the copper concentration is stable at the range defined by the nonacidic concentration cap during the early years of mining, then increases along with the concentration cap as acidic conditions become more prevalent in the stockpile. The copper concentration in the OSP drainage is consistently limited by either the nonacidic or the acidic concentration cap.

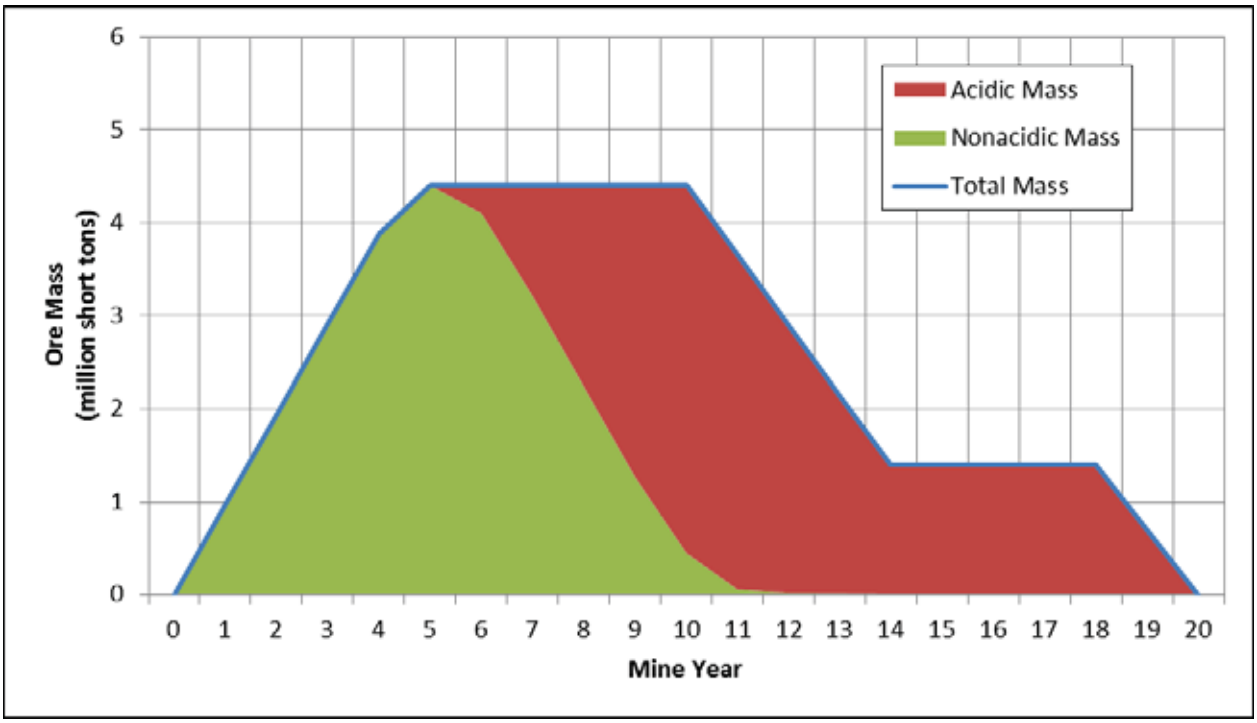


Figure 6-30 Acidic and Nonacidic Ore in the Ore Surge Pile

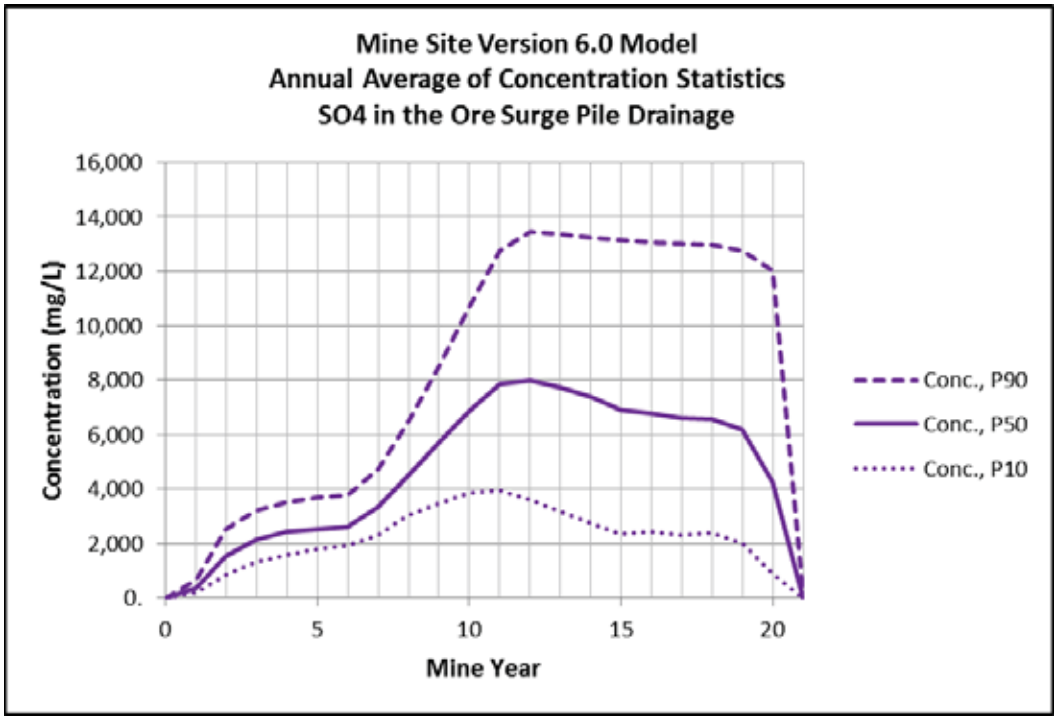


Figure 6-31 Estimated Sulfate Concentrations in the Ore Surge Pile Drainage

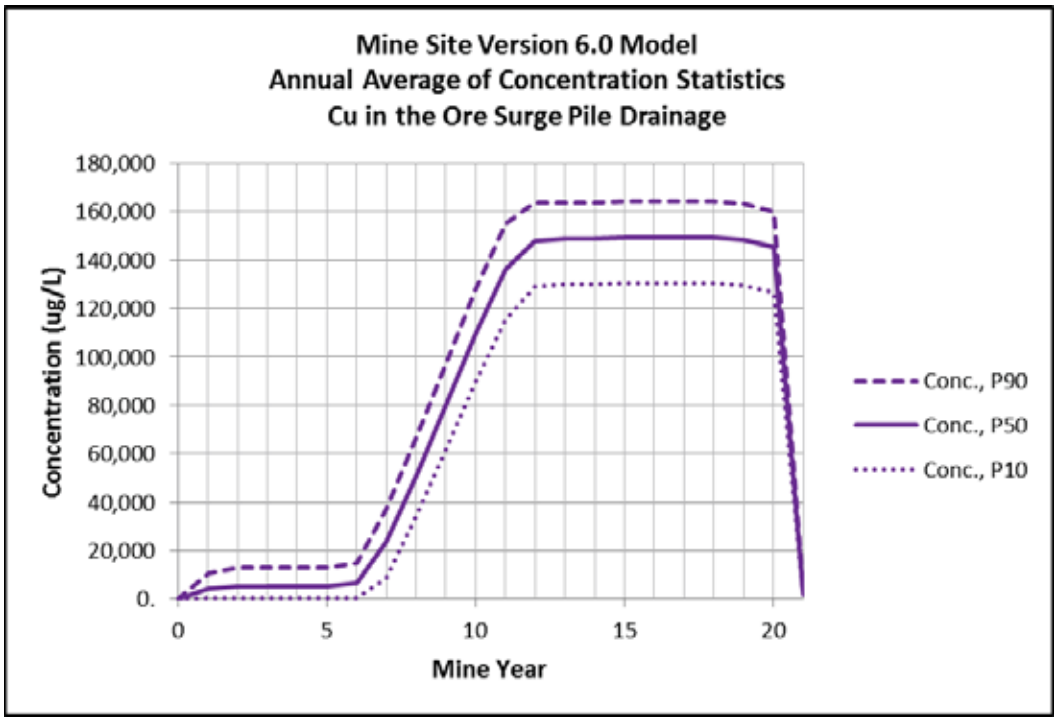


Figure 6-32 Estimated Copper Concentrations in the Ore Surge Pile Drainage

6.2.2.4 Ancillary Mine Features

For several of the mine features, the estimated water quality reporting to the WWTF does not change during operations. These features include the OSLA, RTH and haul roads. All of these features are assumed to be at their maximum extents and contain the maximum amount of load-generating material throughout operations. Large Table 15 presents the annual average of the 10th, 50th, and 90th percentile concentrations for all modeled constituents in the water collected from these features. These concentrations apply to the collected water sent to the WWTF (RTH and haul road runoff), CPS Pond (OSLA runoff), and percolation through the OSLA base to groundwater. All of these features are removed following the end of operations at the end of Mine Year 20.

6.2.3 Permanent Mine Features

6.2.3.1 Category 1 Waste Rock Stockpile

Large Table 16 presents the annual average of the 10th, 50th, and 90th percentile concentrations for all modeled constituents in the drainage from the Category 1 Waste Rock Stockpile. These concentrations apply to the collected water sent to the WWTF during operations, reclamation and long-term closure; as well as uncollected water that moves via groundwater. The stockpile is progressively reclaimed with a geomembrane cover between the start of Mine Year 14 and the end of Mine Year 21, although drainage concentrations do not reach their long-term stable values until approximately Mine Year 30 for some constituents.

Virtually all constituents are at their concentration caps for the majority of the modeled period; therefore the concentrations reported in Large Table 16 do not vary significantly through time. Many constituents reach their concentration cap (which may have a range due to uncertainty in the model inputs) within the first year of mining. An example of this behavior is shown in Figure 6-33 for copper, which is modeled as having a constant concentration for the entire 200-year simulation.

Some constituents only reach their concentration cap after the stockpile is fully reclaimed with the geomembrane cover. Constituents showing this behavior include barium, cadmium, lead, selenium, sodium, sulfate, and zinc. An example is shown in Figure 6-34 for sulfate. The sulfate concentration does not reach its long-term stable value until approximately Mine Year 30 (even though the stockpile is fully reclaimed by the end of Mine Year 21) because the model's mixing cells require several years to fully equilibrate at the very low flow rates moving through the stockpile in long-term closure.

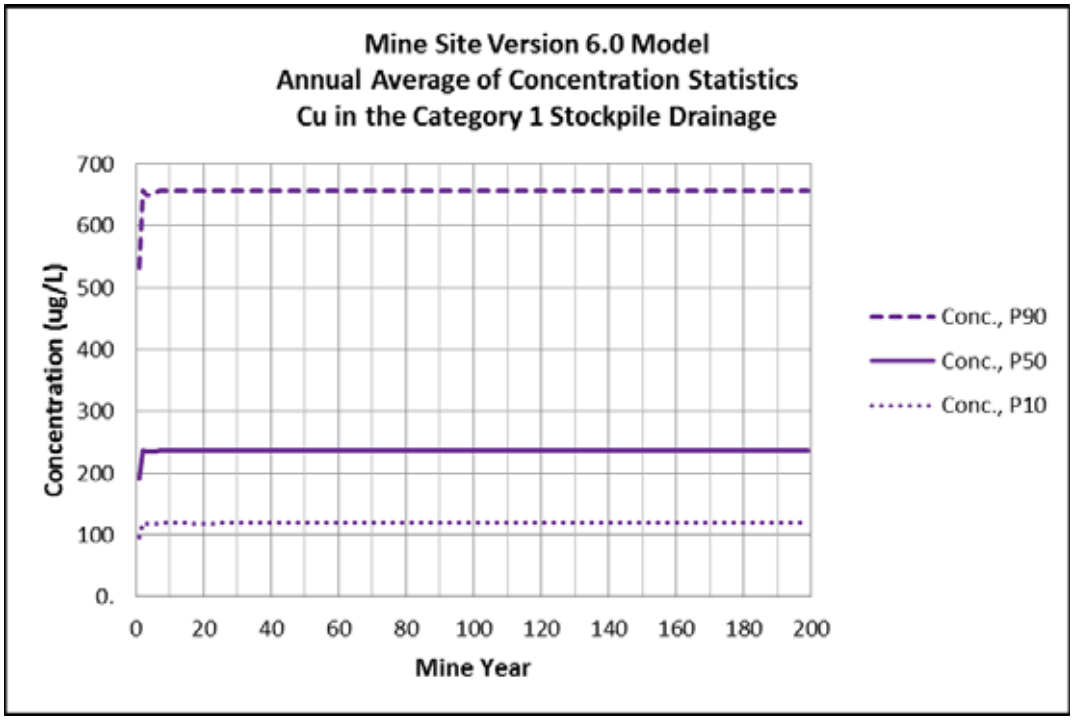


Figure 6-33 Estimated Copper Concentrations in the Category 1 Stockpile Drainage

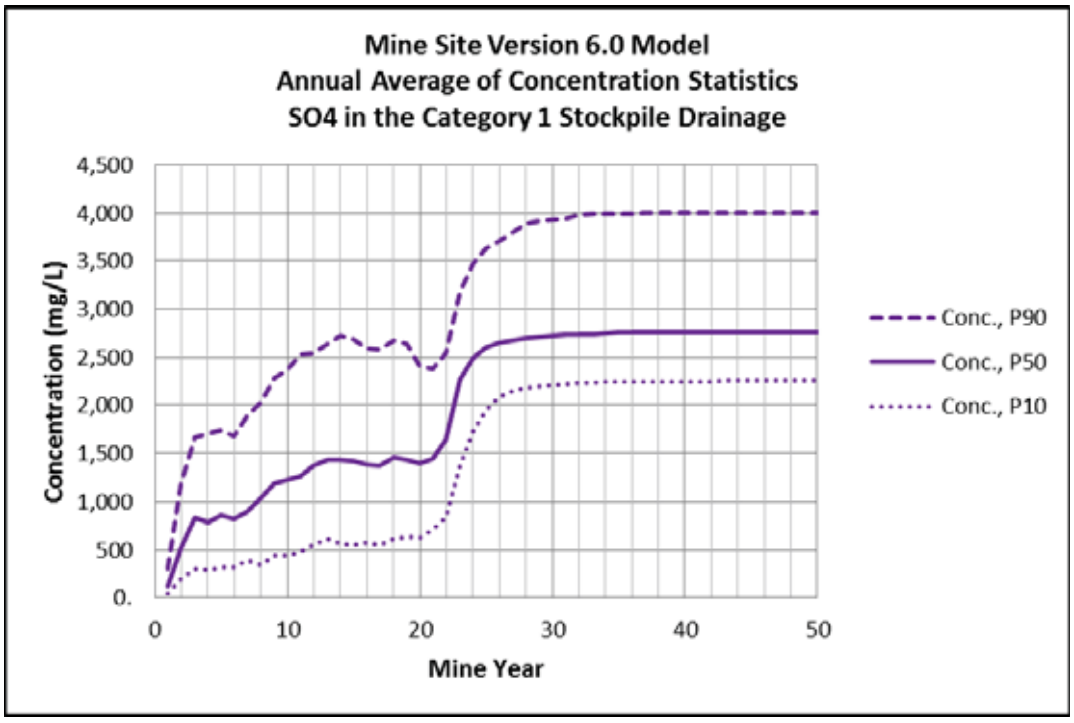


Figure 6-34 Estimated Sulfate Concentrations in the Category 1 Stockpile Drainage

6.2.3.2 East Pit

For the purposes of the water quality model the East Pit is represented by three mixing cells: the operational sump, the lower porewater, and the upper/wetland porewater. The operational sump is located within the East Pit from the beginning of operations until backfilling begins (Mine Year 10.5) and within the Central Pit during its brief mining period (Mine Year 10.75 through Mine Year 15.25). The porewater mixing cells begin to be active when backfilling begins in the East Pit, with the divide between lower and upper/wetland corresponding to the top of the bedrock pit rim of the pit (1577 feet MSL). The water quality results presented below are identified by the corresponding mixing cell.

6.2.3.2.1 Operations

Large Table 17 and Large Table 18 present the annual average of the 10th, 50th, and 90th percentile concentrations for all modeled constituents in the East Pit Sump and lower porewater, respectively. The upper/wetland porewater mixing cell is not utilized during operations. These concentrations apply to the collected water sent to the WWTF from the operational sump and from the backfill porewater.

During active mining the constituent load to the East and Central Pits is primarily from runoff from the pit walls (specifically the Category 4 Virginia Formation and ore wall rock) and from water that contacts the in-pit inventory of blasted ore. Although the pit is progressively developed throughout operations, the wall rock modeling is simplified by assuming that the entire mass of wall rock is exposed to oxidation at the beginning of mining (Section 5.2.2.6.5). The load to the operational sump from the wall rock is therefore essentially constant. Figure 6-35 shows the median annual loading for sulfate, which originates primarily from the Category 4 Virginia Formation wall rock (orange bars) and the in-pit blasted ore (light grey bars). Figure 6-36 shows the median annual loading for copper, which originates primarily from the ore wall rock (blue bars).

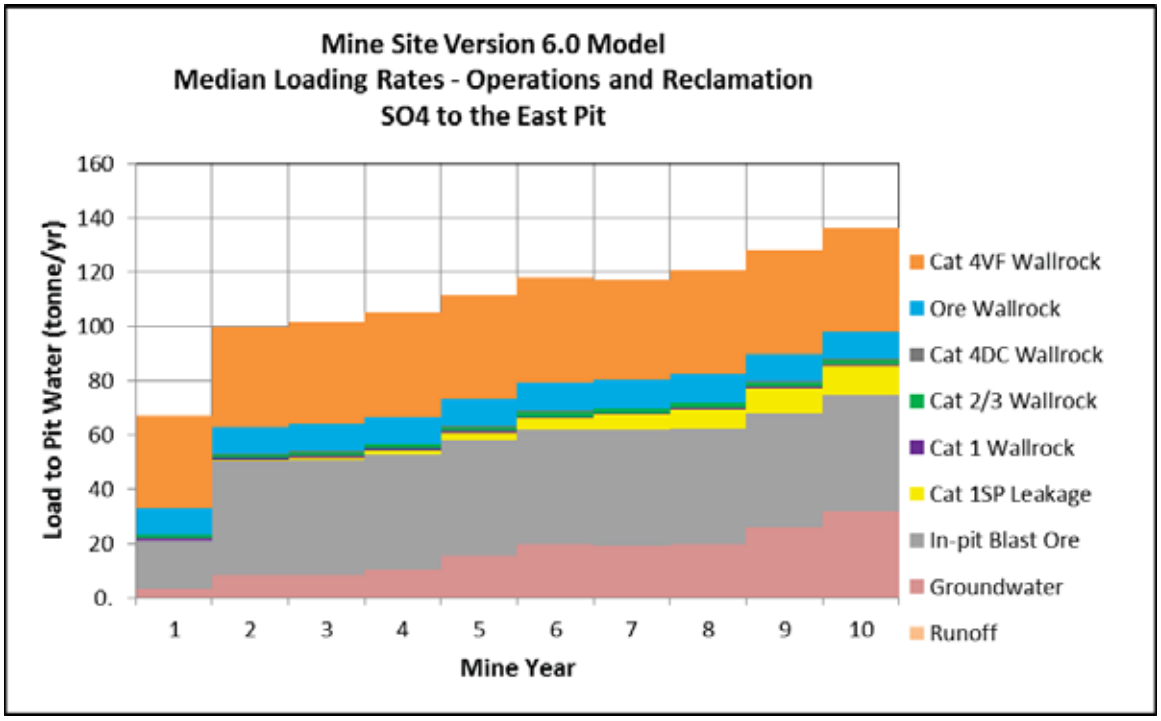


Figure 6-35 Estimated Sulfate Loading to the East Pit in Mine Year 1 through Mine Year 10

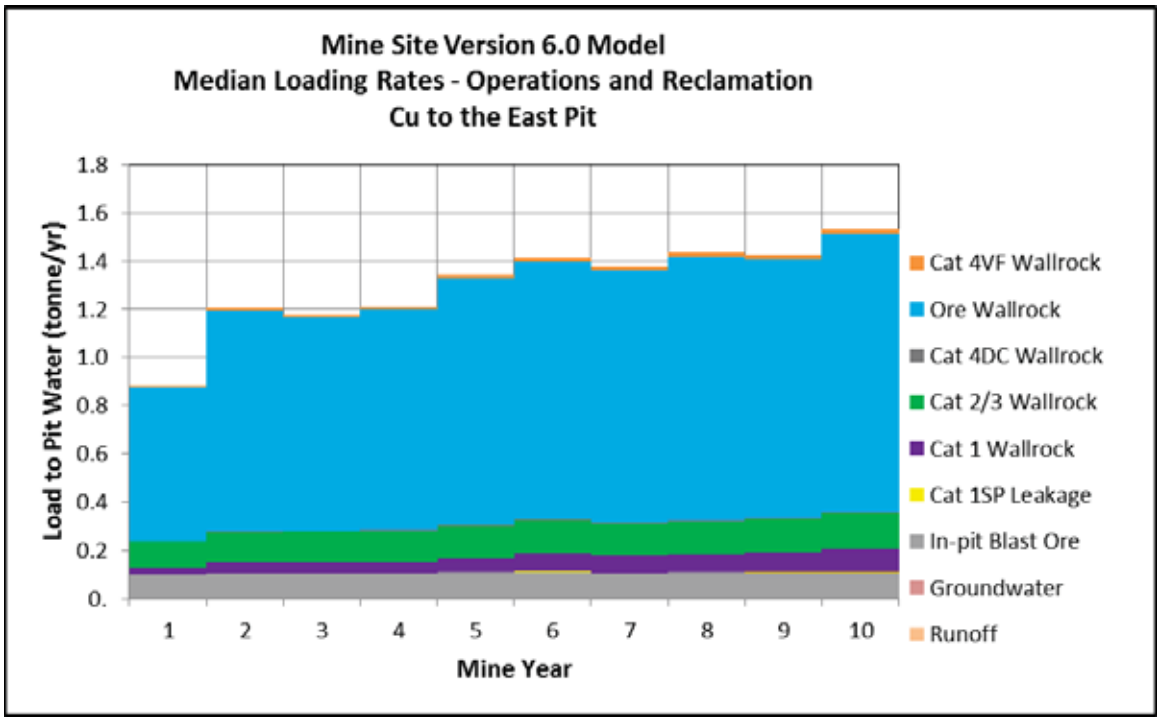


Figure 6-36 Estimated Copper Loading to the East Pit in Mine Year 1 through Mine Year 10

Concentrations in the sump generally decrease from Mine Year 1 through Mine Year 10 because the flows from groundwater, which generally has lower concentrations than the other sources of water, increase as the pit is developed. Concentrations increase temporarily during Mine Years 11 through Mine Year 16 as the Central Pit is mined, then decrease when active mining ceases during Mine Year 16. This pattern is shown in Figure 6-37 for sulfate and in Figure 6-38 for copper.

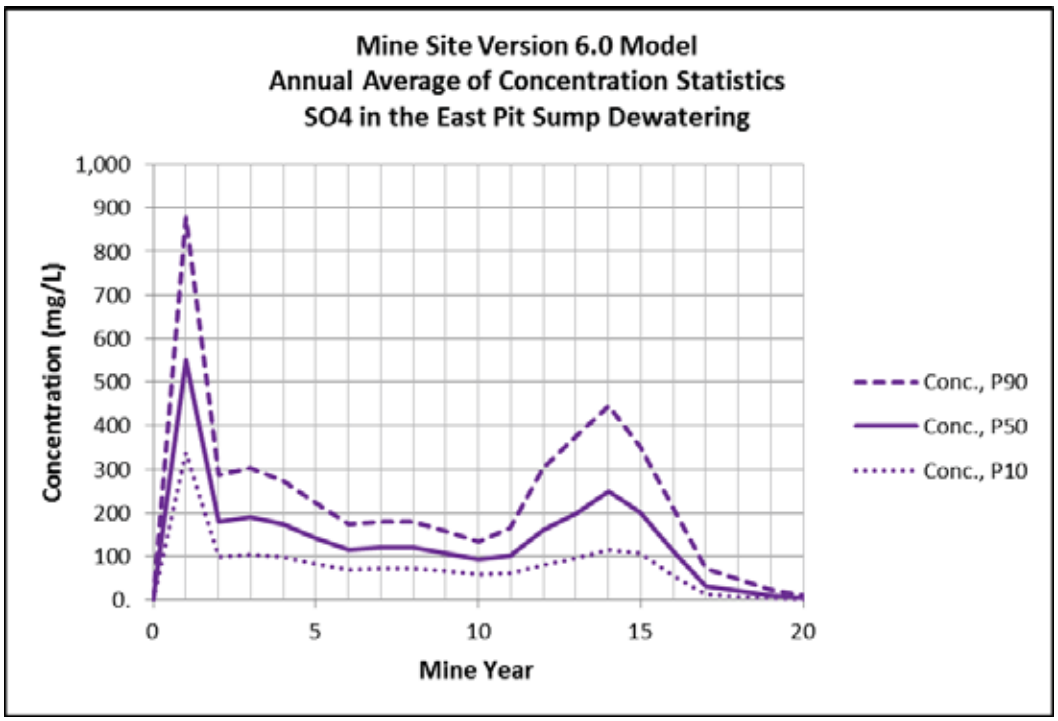


Figure 6-37 Estimated Sulfate Concentrations in the East Pit Sump Dewatering

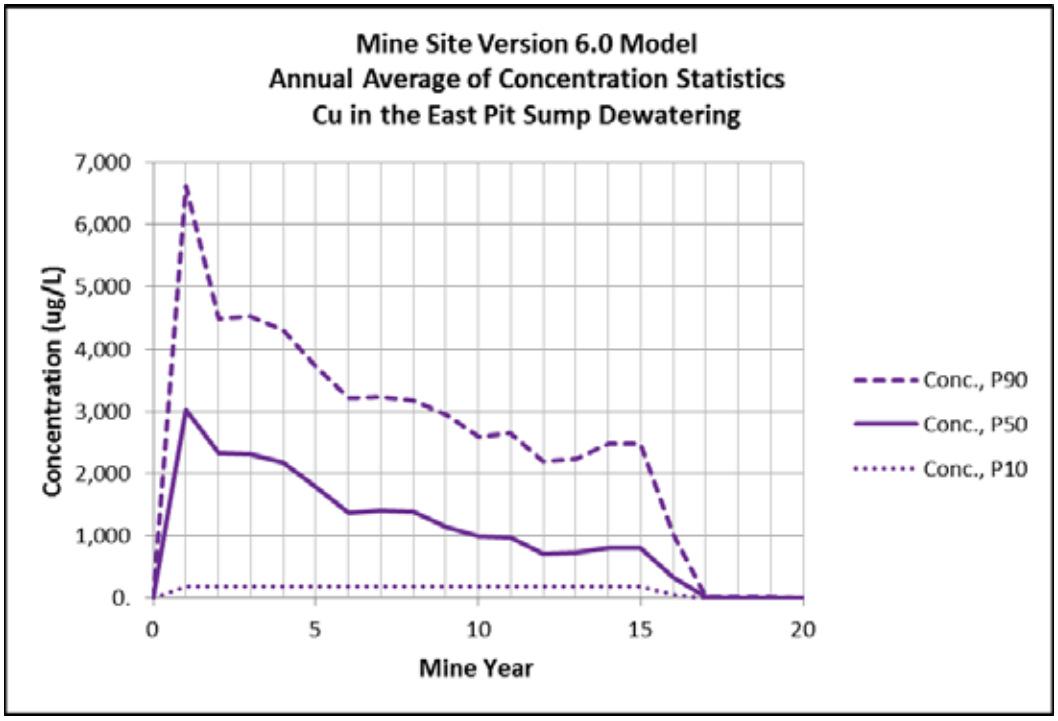


Figure 6-38 Estimated Copper Concentrations in the East Pit Sump Dewatering

When the East Pit begins to be backfilled in the second half of Mine Year 11, the first material placed in the pit is from the temporary Category 4 Waste Rock Stockpile. The Virginia Formation rock in the stockpile contributes a significant soluble constituent load to the porewater during this time, much greater than the loading during active mining or from other backfill waste rock categories for some constituents.

The loading for sulfate during Mine Year 11 through Mine Year 20 is shown in Figure 6-39; sulfate loading during the first few years of backfilling is tens of thousands of metric tons per year, compared to about 100 tons per year during Mine Year 1 through Mine Year 10 (Figure 6-35). Loading from the backfill slows while the East Pit porewater level is held constant during Mine Years 14 and 15 because no additional backfill material is submerged, then increases during the final years of pit flooding. After the initial Category 4 waste rock is submerged (red bars), the bulk of the constituent load to the porewater comes from material from the temporary Category 2/3 Waste Rock Stockpile (light purple bars).

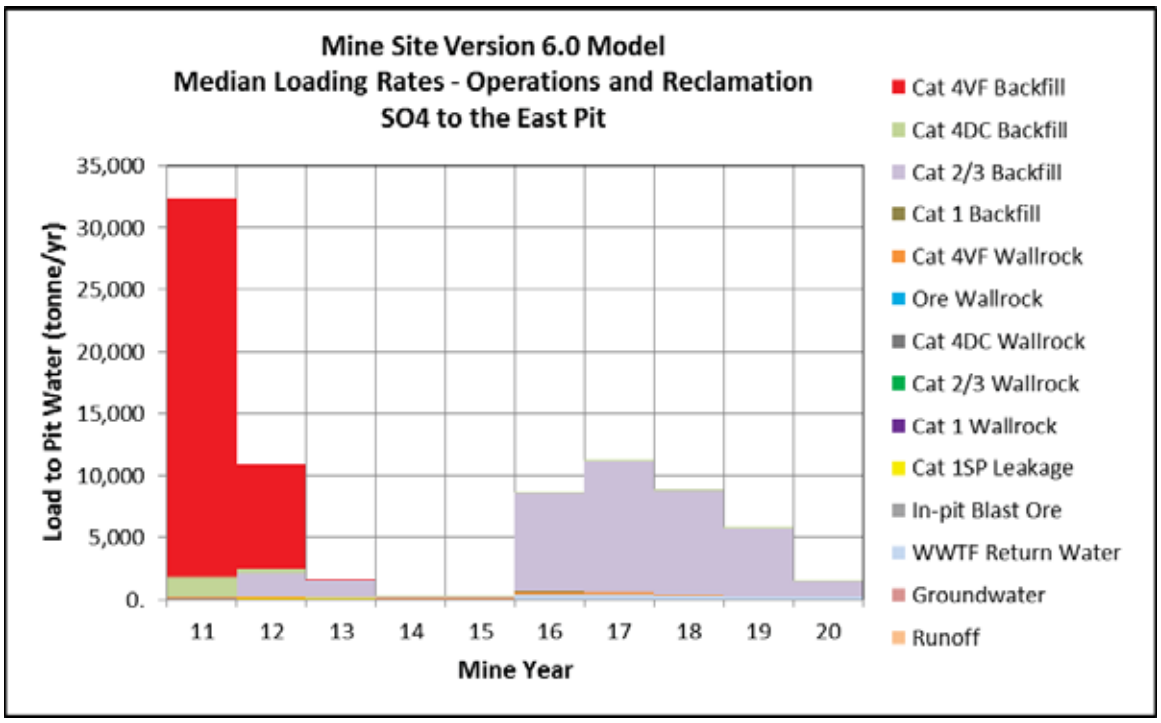


Figure 6-39 Estimated Sulfate Loading to the East Pit in Mine Year 11 through Mine Year 20

Similar to the sources of loading during operations, loading of many constituents other than sulfate originates more from the Duluth Complex backfill waste rock rather than the Virginia Formation backfill. As shown in Figure 6-40, most of the copper loading to the pit during backfilling is from the Category 2/3 waste rock and occurs in the last few years of backfilling. Like sulfate, the annual loading during backfilling for copper (up to 2,000 metric tons per year) is much greater than the loading during operations (less than 2 metric tons per year).

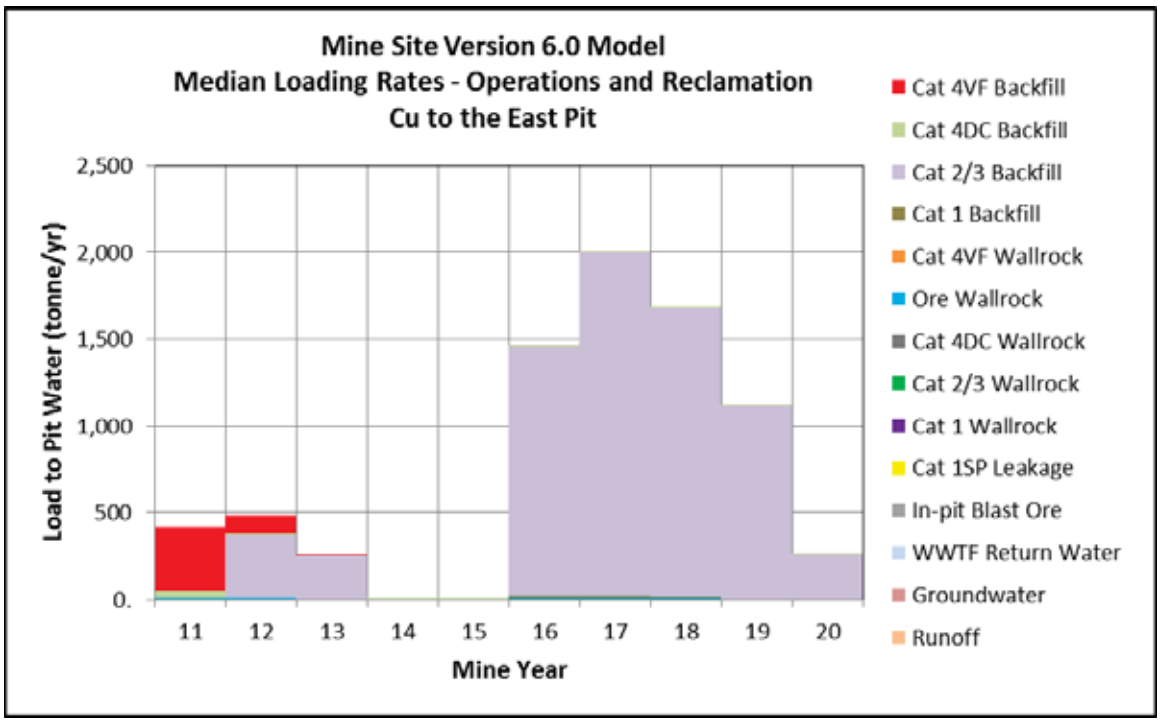


Figure 6-40 Estimated Copper Loading to the East Pit in Mine Year 11 through Mine Year 20

Concentrations in the lower porewater increase rapidly when backfilling of the East Pit begins. Many constituents reach their concentration caps within the first several years; the concentration caps applied in the backfill are based on the assumption that a pH between 6.0 and 7.5 will be maintained in the backfill through adjusting the pH of the WWTF effluent, lime/limestone addition or other adaptive water quality management strategies. The sulfate concentration in the porewater briefly reaches the concentration cap and then begins to decrease as the backfill volume increases (Figure 6-41). The copper concentration, in contrast, stays at the concentration cap throughout backfilling and into the reclamation period (Figure 6-42).

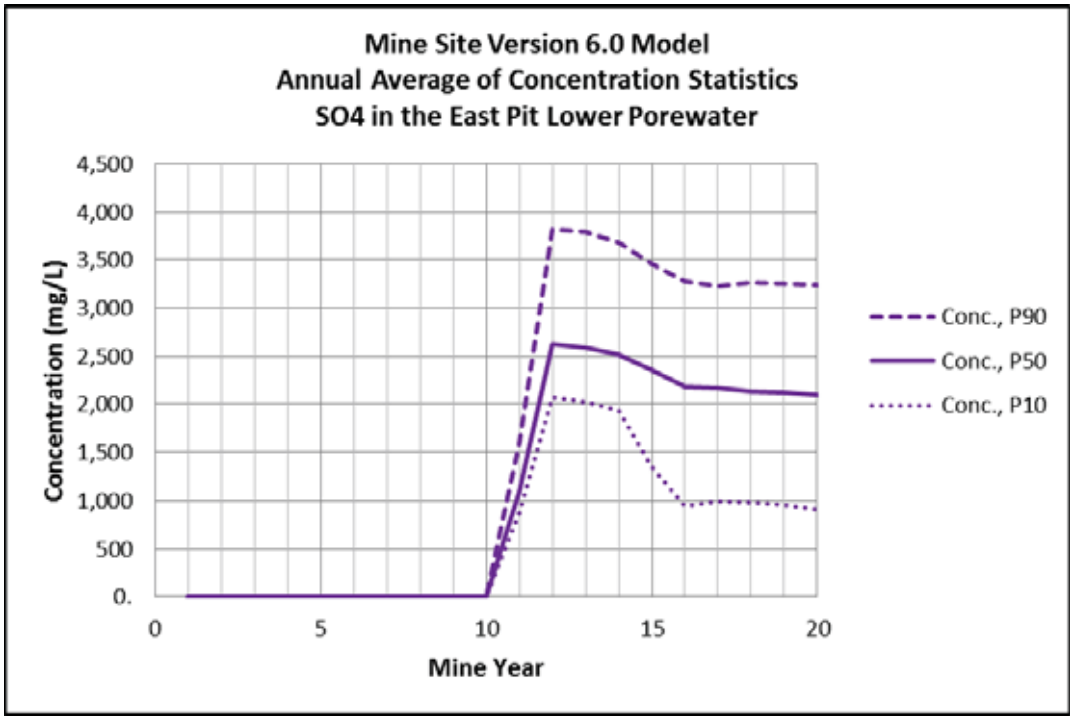


Figure 6-41 Estimated Sulfate Concentrations in the East Pit Lower Porewater

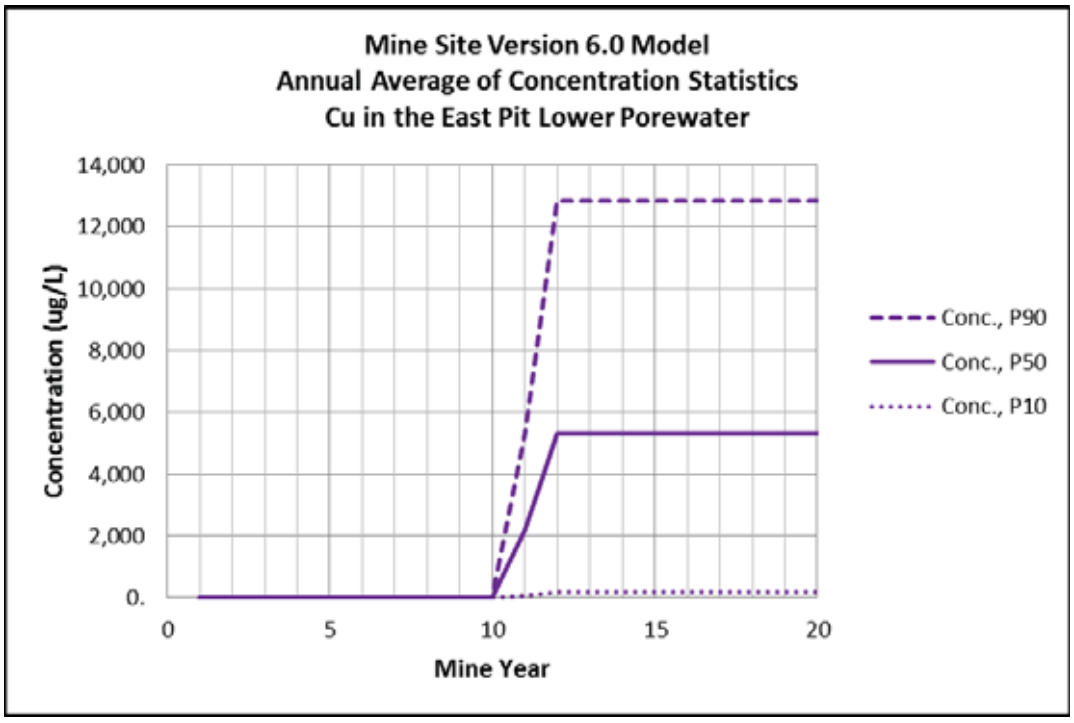


Figure 6-42 Estimated Copper Concentrations in the East Pit Lower Porewater

6.2.3.2.2 Reclamation

During the reclamation period, concentrations in the East Pit porewater change significantly for many constituents due to the extraction and treatment of the porewater in the WWTF. As discussed in Section 6.1.2.2.2, the reclamation period begins when the East Pit wetland is completely flooded and ends when the sulfate concentration in the backfill porewater is brought to 250 mg/L. Treatment is estimated to end between Mine Year 25 and Mine Year 60, with an average time of Mine Year 34 (Figure 6-11).

Large Table 18 and Large Table 19 present the annual average of the 10th, 50th, and 90th percentile concentrations for all modeled constituents in the East Pit lower porewater and upper/wetland porewater, respectively. These concentrations apply to the collected water sent to the WWTF from the backfill porewater and to the water that flows out of the East Pit to groundwater or to the West Pit.

Once the backfill and wetland are completely flooded, typically by the end of Mine Year 21 (Figure 6-9), constituent loading to the East Pit water is primarily from the remaining exposed wall rock and background groundwater. The submerged waste rock backfill contributes no additional load to the porewater during this time because it is completely subaqueous, and load is removed via pumping for treatment in the WWTF. Figure 6-43 shows the typical sources of sulfate load during the early years of reclamation, Figure 6-44 shows the sources of copper load. Constituent loading from wall rock declines over time due to the modeled depletion in sulfate release rates for Duluth Complex rock (Section 9.4 of Reference (6)) and the time required to completely flush accumulated soluble mass from the rock walls.

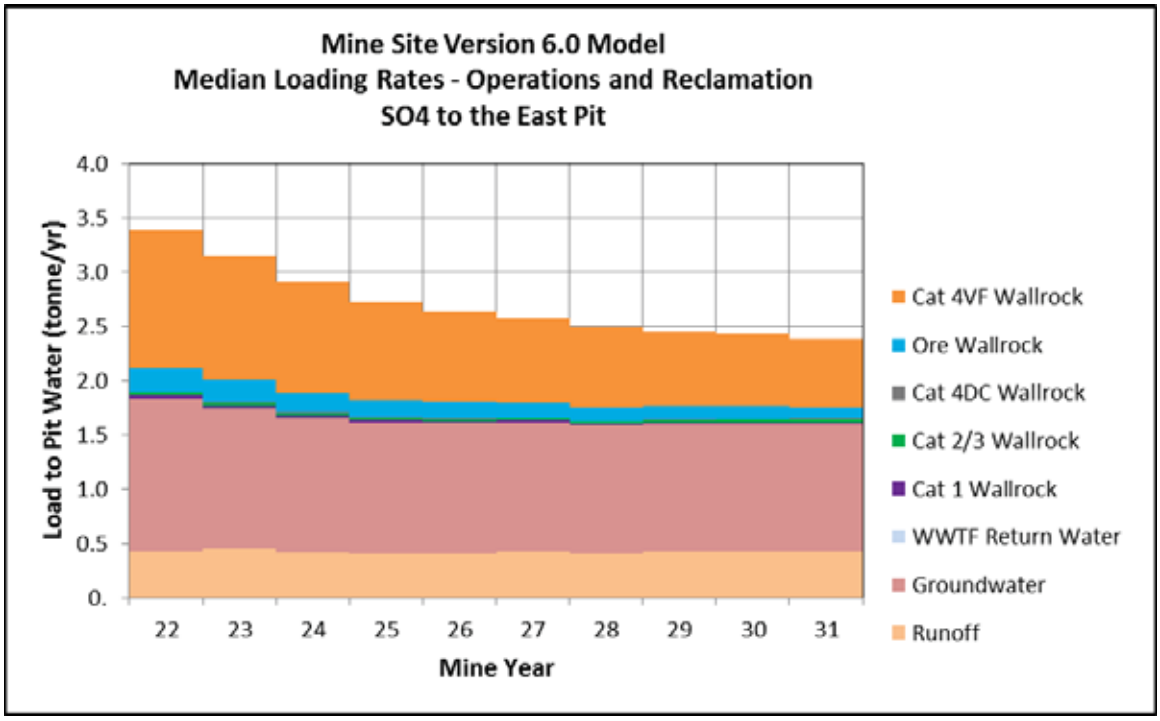


Figure 6-43 Estimated Sulfate Loading to the East Pit in Mine Year 22 through Mine Year 31

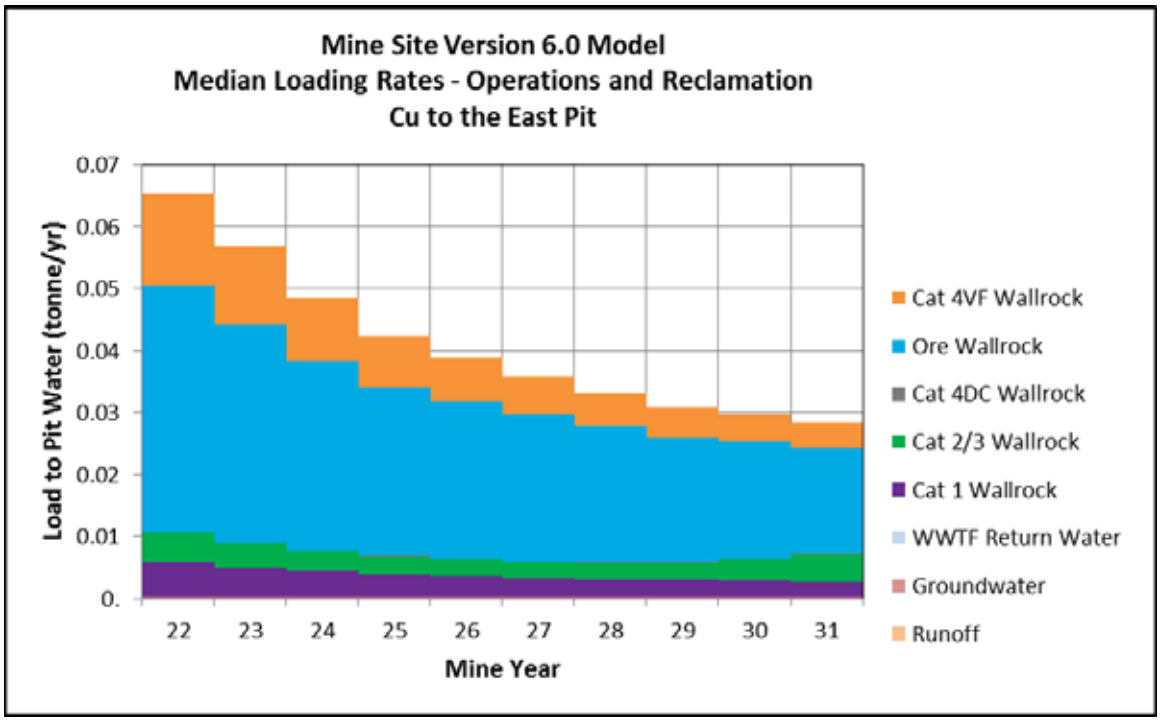


Figure 6-44 Estimated Copper Loading to the East Pit in Mine Year 22 through Mine Year 31

Constituent concentrations in the lower porewater and the upper/wetland porewater are similar at the beginning of reclamation, but concentrations decrease more rapidly in the upper/wetland porewater due to the smaller volume of water to be treated. The sulfate concentration in the upper/wetland porewater reliably reaches 250 mg/L by the end of Mine Year 24 (as shown in Figure 6-45), while the concentration in the lower porewater reaches the same concentration as much as 15 years later (Figure 6-46).

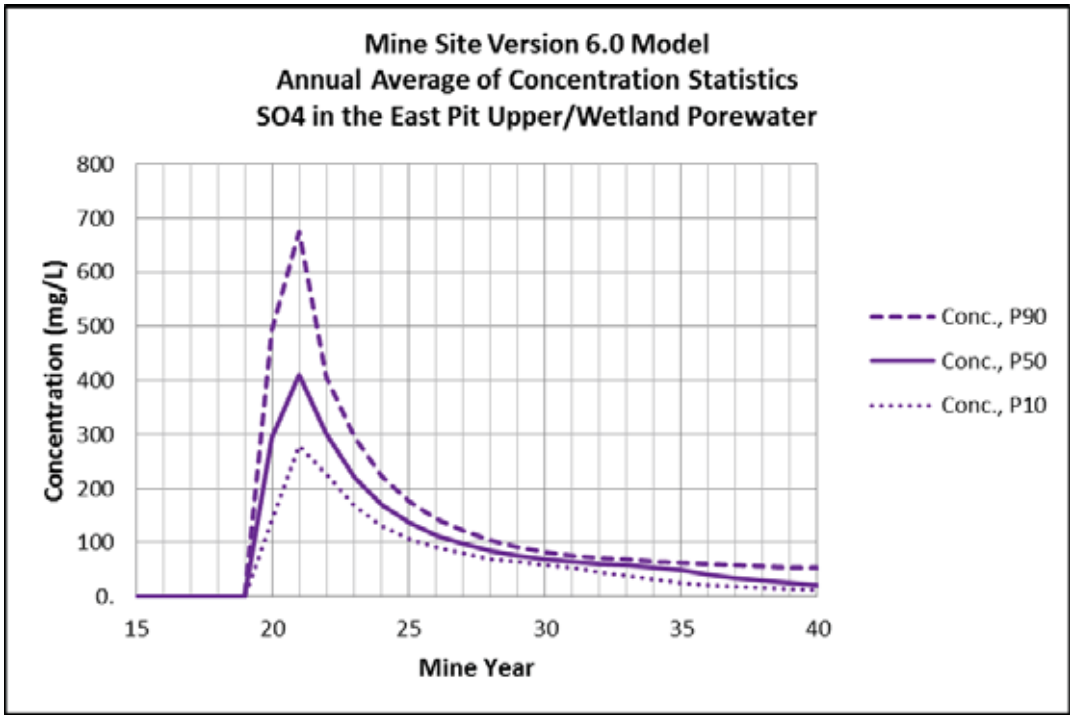


Figure 6-45 Estimated Sulfate Concentrations in the East Pit Upper/Wetland Porewater

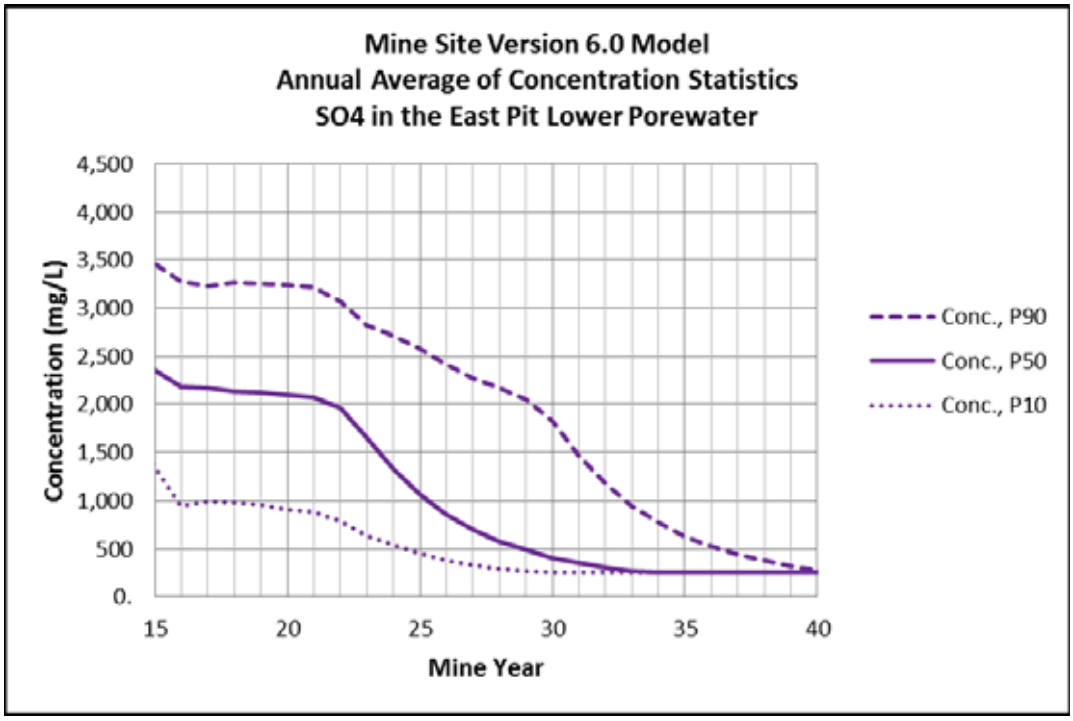


Figure 6-46 Estimated Sulfate Concentrations in the East Pit Lower Porewater

The copper concentration in both the lower and upper/wetland porewater remains constant throughout reclamation at the range defined by the copper concentration cap. Other constituents, however, show a pattern similar to that for sulfate with concentrations that decline in both mixing cells (albeit more rapidly in the upper/wetland porewater). The trend is demonstrated for cobalt in Figure 6-47 for the upper/wetland porewater and Figure 6-48 for the lower porewater.

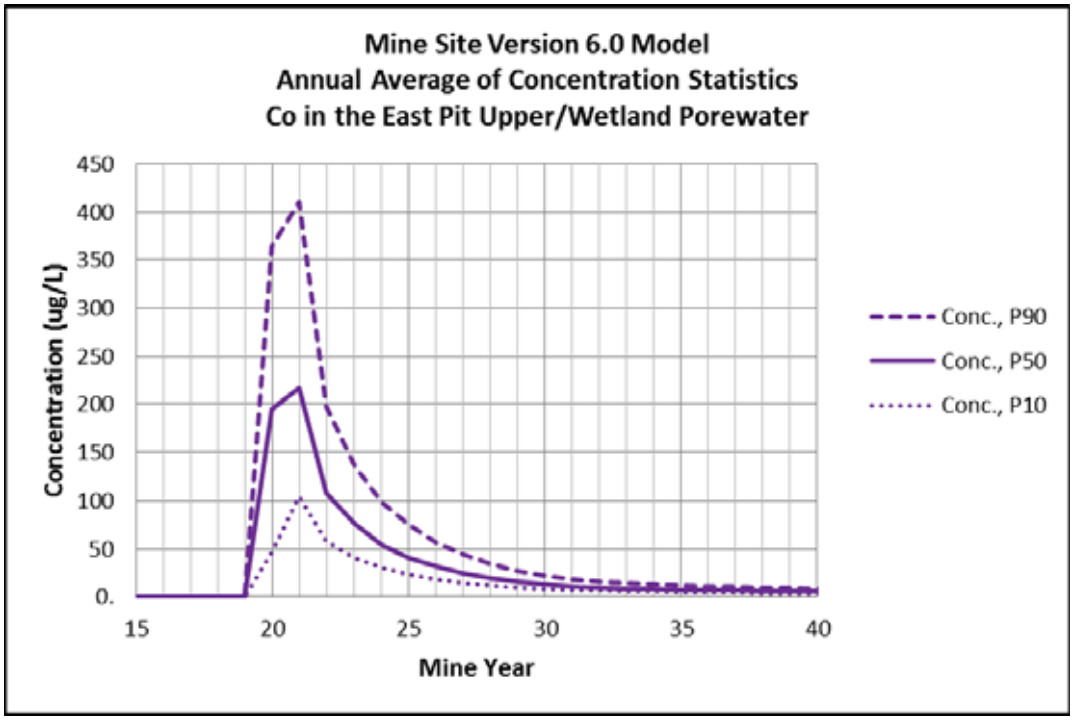


Figure 6-47 Estimated Cobalt Concentrations in the East Pit Upper/Wetland Porewater

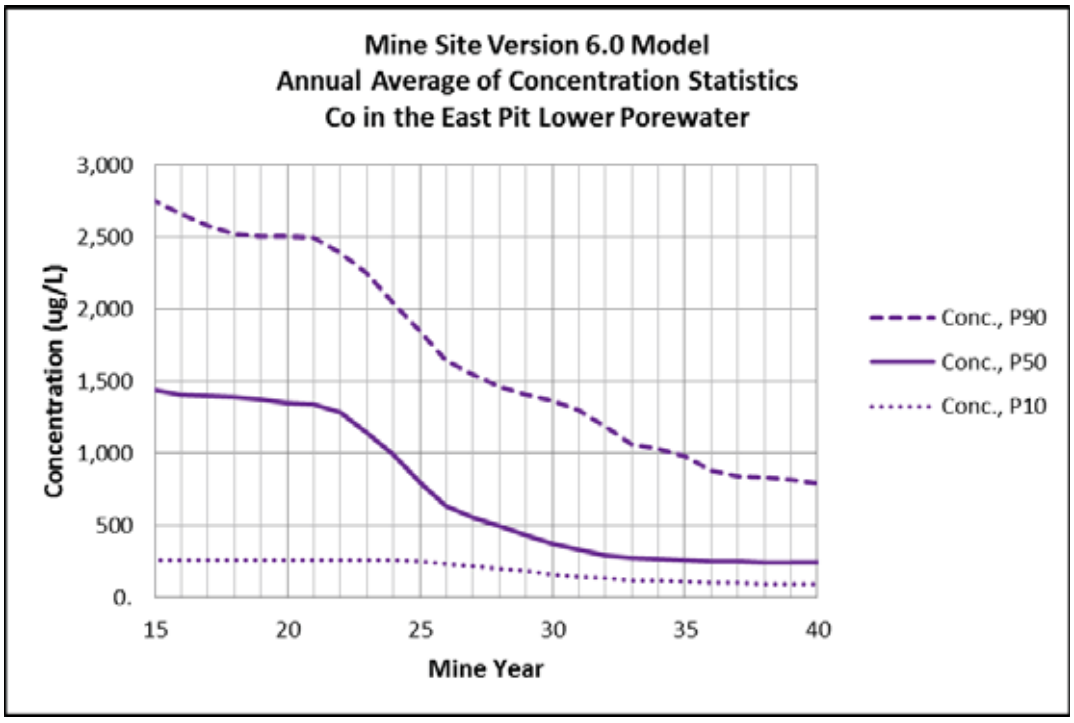


Figure 6-48 Estimated Cobalt Concentrations in the East Pit Lower Porewater

6.2.3.2.3 Long-term Closure

Following the active pumping and treatment in the reclamation period, concentrations in the East Pit porewater remain largely constant throughout long-term closure. The water flow in and out of the lower porewater is extremely low and does not add or remove significant mass from the system. Concentrations in the upper/wetland porewater are generally stable or trending downward over the long term.

Large Table 18 and Large Table 19 present the annual average of the 10th, 50th, and 90th percentile concentrations for all modeled constituents in the East Pit lower porewater and upper/wetland porewater, respectively. These concentrations apply to the water that flows out of the East Pit to groundwater or to the West Pit. As shown in Figure 6-49 for sulfate, concentrations stabilize or begin long-term decreasing trends by approximately Mine Year 60. The trend is similar for other constituents, as shown for cobalt in Figure 6-50.

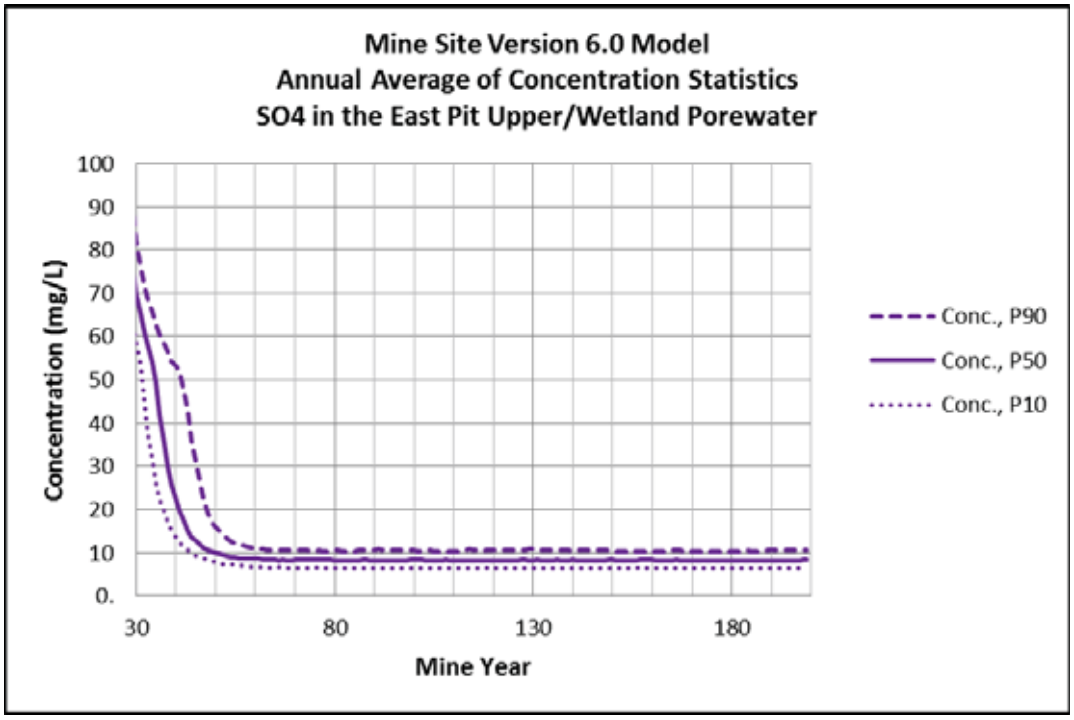


Figure 6-49 Estimated Long-Term Sulfate Concentrations in the East Pit Upper/Wetland Porewater

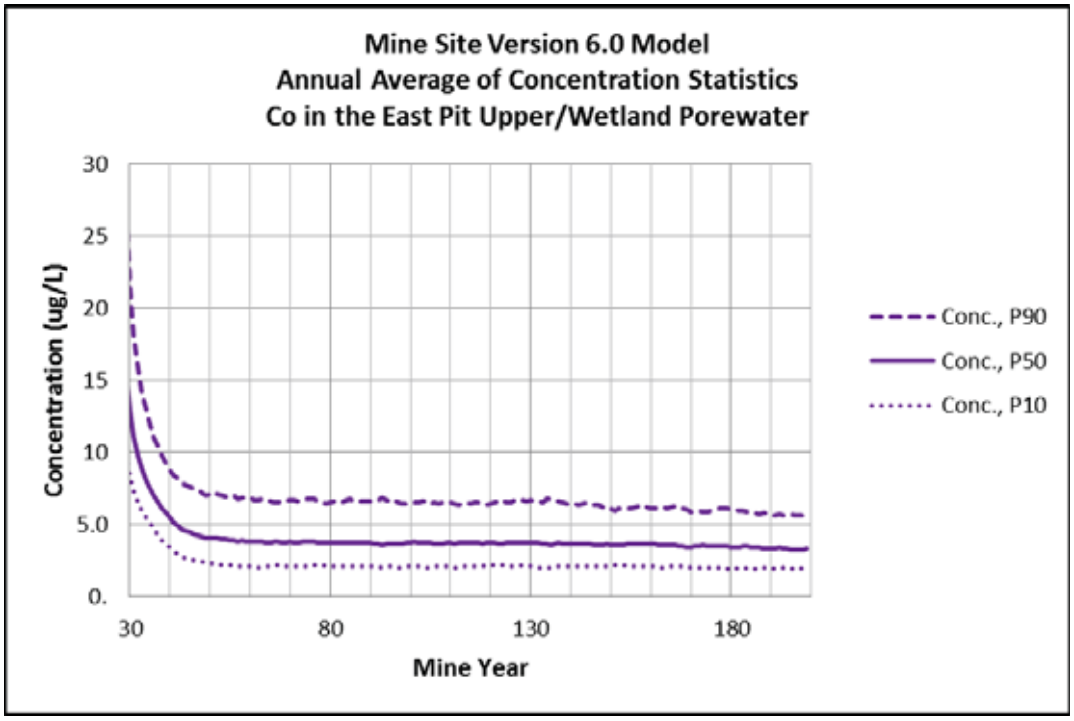


Figure 6-50 Estimated Long-Term Cobalt Concentrations in the East Pit Upper/Wetland Porewater

6.2.3.3 West Pit

For the purposes of the water quality model the West Pit is represented by a single mixing cell during operations (the operational sump), flooding and long-term closure. The results for the West Pit, therefore, are much simpler than those for the East Pit system. The West Pit is assumed to be well-mixed throughout the modeled period.

6.2.3.3.1 Operations

Large Table 20 presents the annual average of the 10th, 50th, and 90th percentile concentrations for all modeled constituents in the West Pit. These concentrations apply to the collected water sent to the WWTF from the operational sump and the well-mixed water in the flooded mine pit.

During active mining the constituent load to the West Pit is primarily from runoff from the pit walls (specifically the ore wall rock), from water that contacts the in-pit inventory of blasted ore, and from uncaptured drainage (i.e., leakage) from the Category 1 Waste Rock Stockpile. Loading from the Category 1 Waste Rock Stockpile leakage increases during operations as the stockpile footprint grows and its rock mass increases; loading then decreases as the stockpile leakage decreases following reclamation. Figure 6-51 shows the median annual loading for sulfate, which originates primarily from the Category 1 Waste Rock Stockpile (yellow bars) and

the in-pit blasted ore (grey bars). Figure 6-52 shows the median annual loading for copper, which originates primarily from the ore wall rock (blue bars).

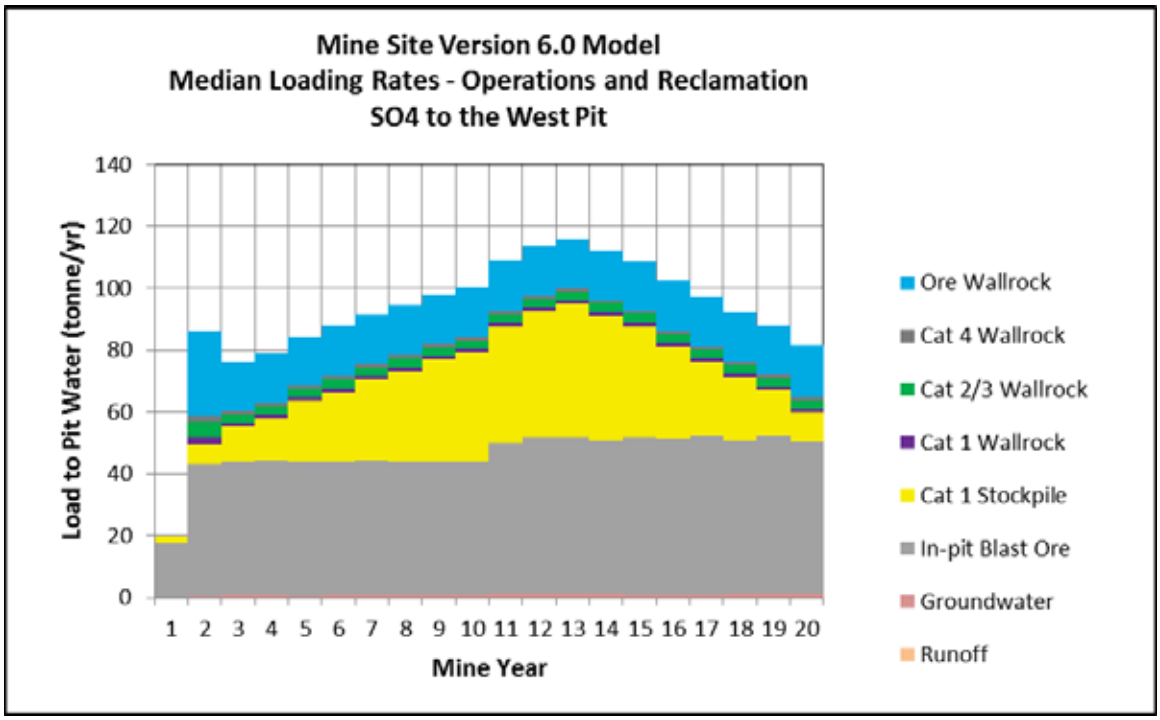


Figure 6-51 Estimated Sulfate Loading to the West Pit in Mine Year 1 through Mine Year 20

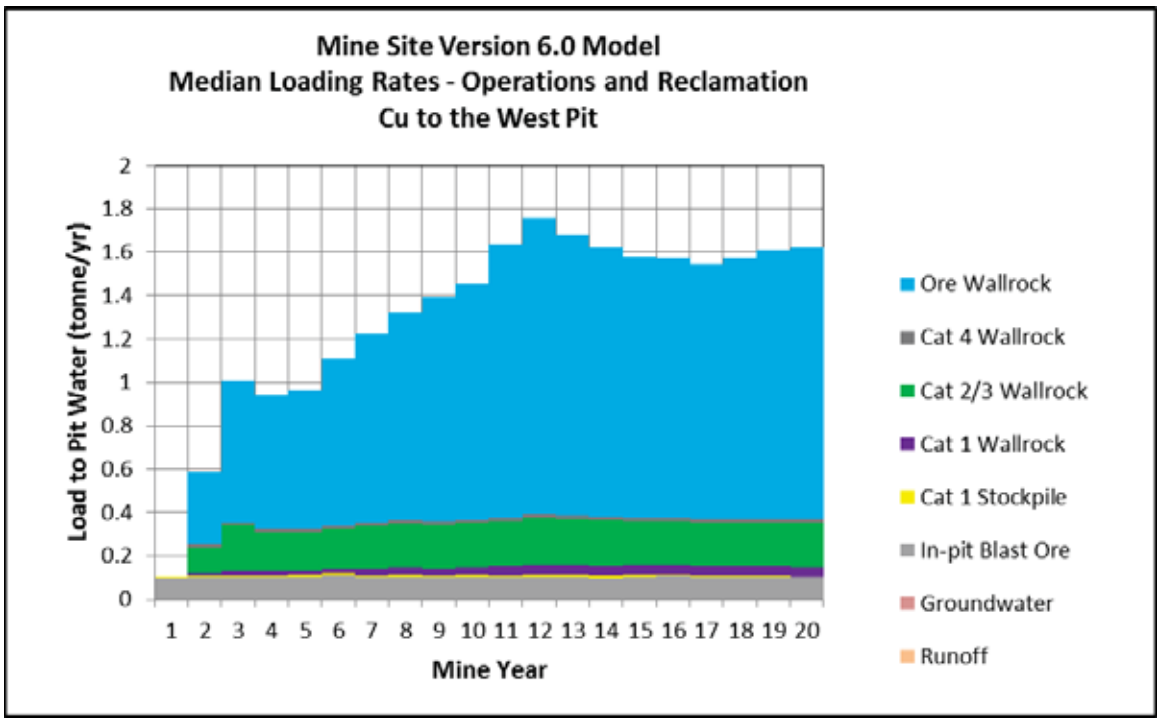


Figure 6-52 Estimated Copper Loading to the West Pit in Mine Year 1 through Mine Year 20

Concentrations in the West Pit during operations are relatively constant for most constituents. Although the pit is progressively developed throughout operations, the wall rock modeling is simplified by assuming that the entire mass of wall rock is exposed to oxidation at the beginning of mining (Section 5.2.2.6.5). The load to the operational sump from the wall rock is therefore essentially constant, with any changes over time resulting from the application of concentration caps in the wall rock runoff during mining. Increases in loading from the Category 1 Waste Rock Stockpile are generally offset by increases in the groundwater flow which typically has lower concentrations. The trend of near-constant concentration is shown in Figure 6-53 for sulfate and in Figure 6-54 for copper, which is limited by the concentration cap in the operational sump.

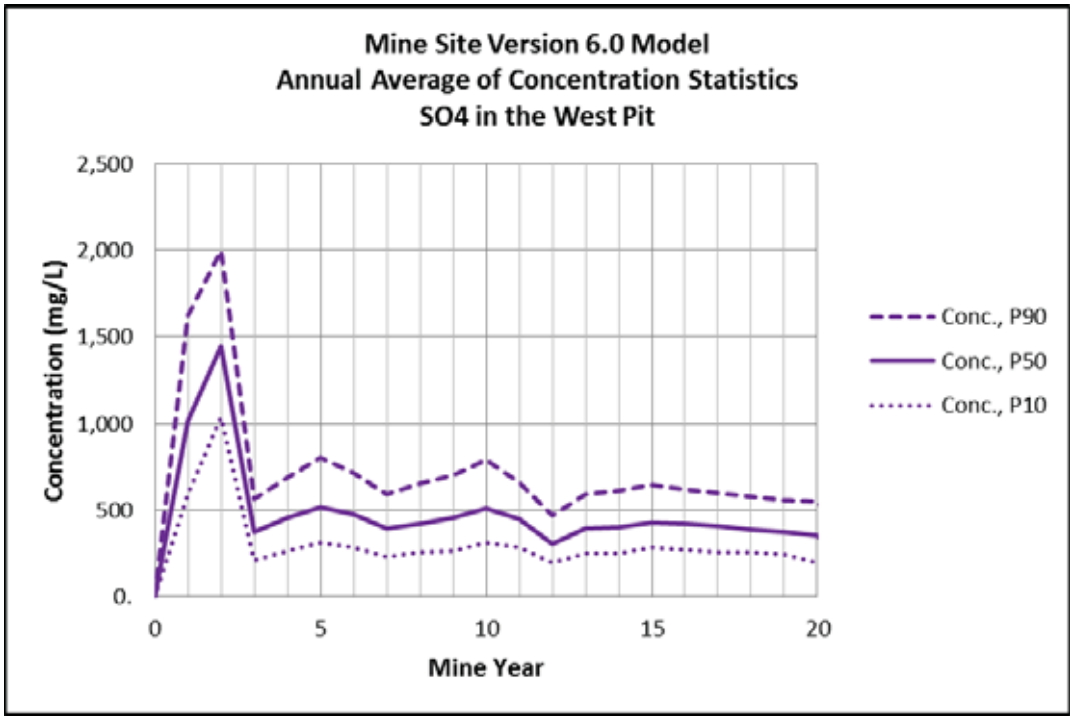


Figure 6-53 Estimated Sulfate Concentrations in the West Pit Dewatering

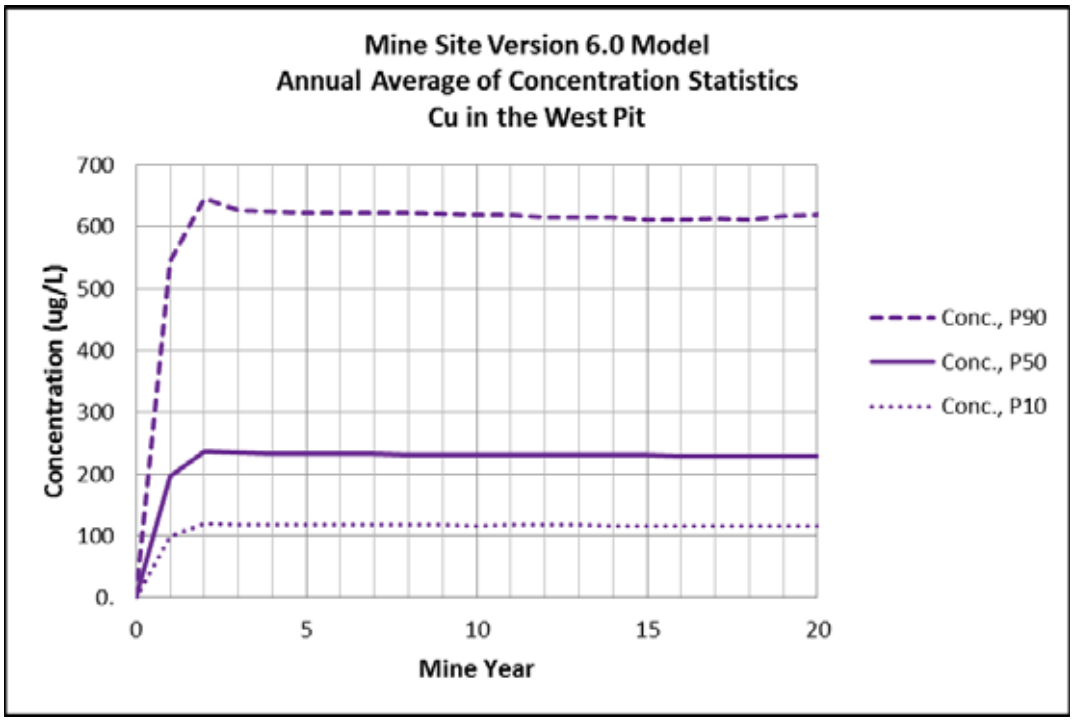


Figure 6-54 Estimated Copper Concentrations in the West Pit Dewatering

6.2.3.3.2 Reclamation

During the reclamation period the West Pit is flooded with natural inflows, excess water from the WWTF and East Pit, and a mixture of treated and untreated Tailings Basin seepage water from the Plant Site. The water in the West Pit is not treated directly during this period.

Large Table 20 presents the annual average of the 10th, 50th, and 90th percentile concentrations for all modeled constituents in the West Pit. These concentrations apply to the well-mixed water in the flooding mine pit.

During the first few years of West Pit flooding, the vast majority of the water in the pit originates from the Plant Site as a mixture of treated and untreated Tailings Basin seepage water. Beyond Mine Year 28, virtually all the water sent from the Plant Site is treated water from the WWTP. For some constituents such as sulfate, the Plant Site water represents the majority of the load to the West Pit during this period (Figure 6-55). For other constituents such as copper, the majority of the load to the West Pit comes from the wall rock (specifically the ore wall rock) and is a function of the pit flooding rate as the rising water flushes constituent mass from the walls (Figure 6-56).

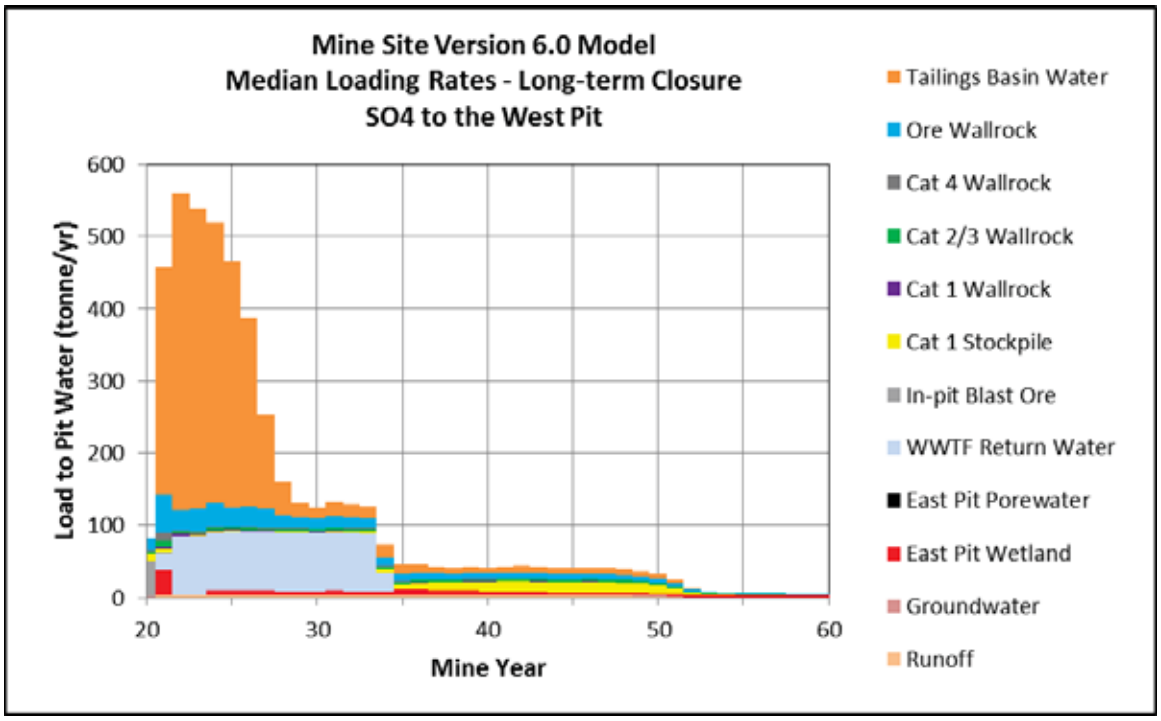


Figure 6-55 Estimated Sulfate Loading to the West Pit in Mine Year 21 through Mine Year 60

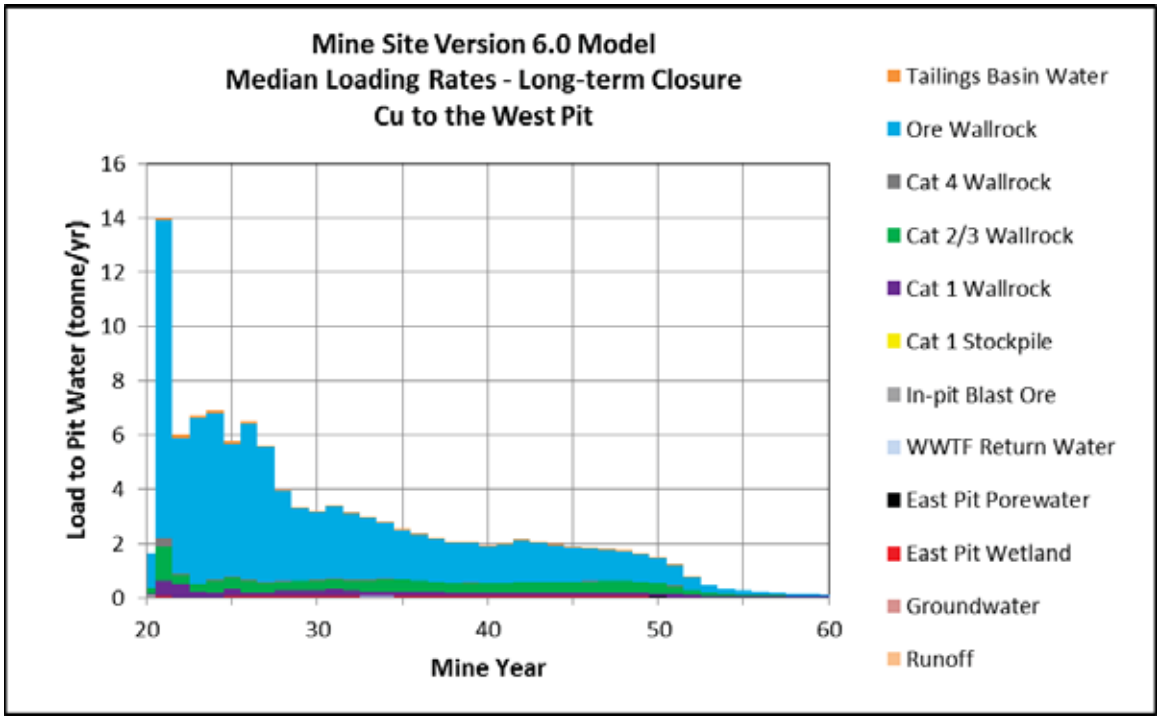


Figure 6-56 Estimated Copper Loading to the West Pit in Mine Year 21 through Mine Year 60

Constituent concentrations in the West Pit water typically decrease rapidly during the first few years of pit flooding, then continue steady or downward-trending concentrations when the pit nears overflow (approximately Mine Year 53, see Figure 6-17). Figure 6-57 shows the sulfate concentration in the pit during flooding; the copper concentration is consistent at the range defined by the uncertain concentration cap. The cobalt concentration, which has similar loading sources as copper but is not affected by a concentration cap, is shown in Figure 6-58.

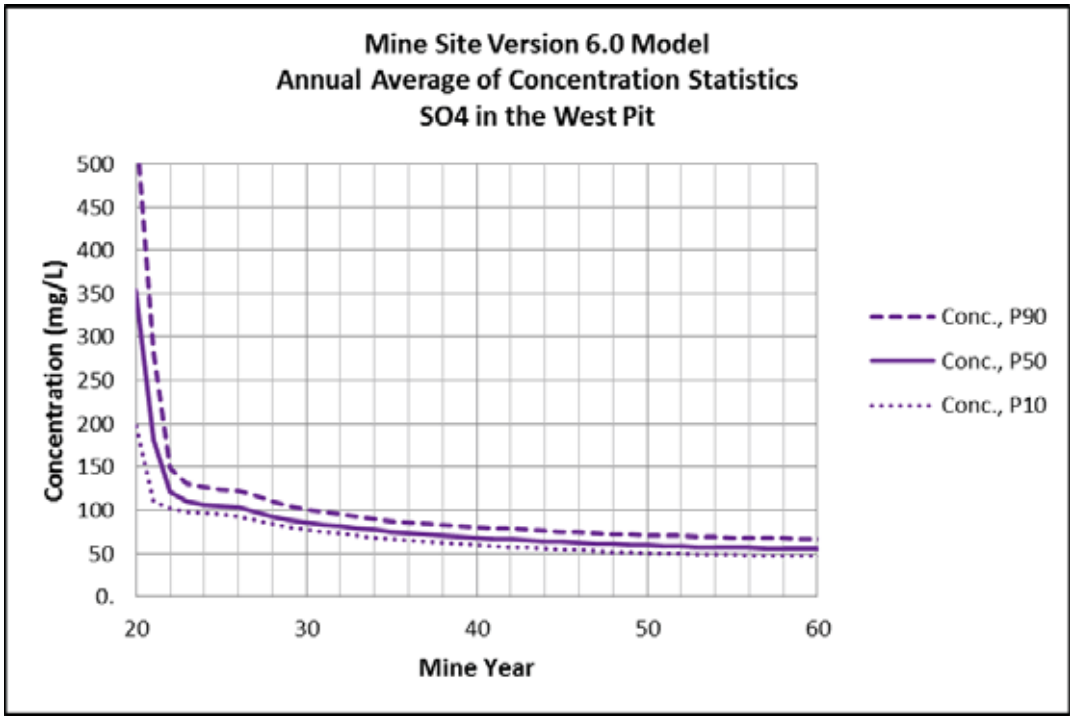


Figure 6-57 Estimated Sulfate Concentrations in the West Pit During Flooding

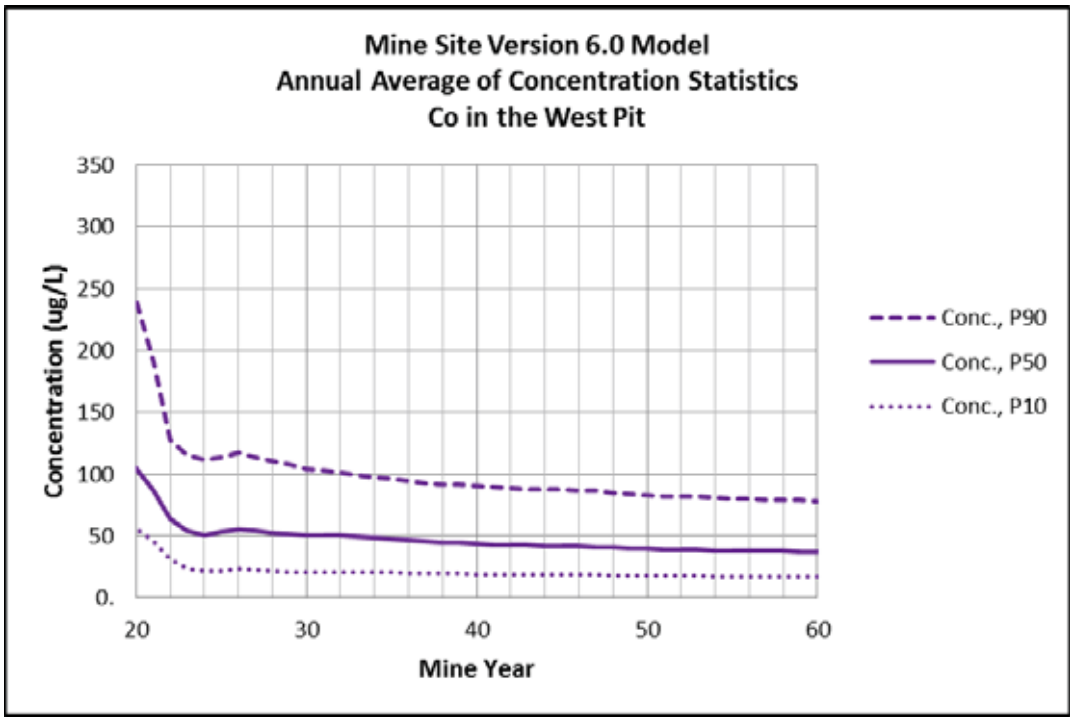


Figure 6-58 Estimated Cobalt Concentrations in the West Pit During Flooding

6.2.3.3.3 Long-term Closure

Once West Pit flooding is complete by Mine Year 55, the majority of the load to the pit water originates from the remaining exposed pit wall rock and the overflow from the East Pit wetland. Figure 6-59 shows the long-term loading to the West Pit for sulfate, which is largely derived from the East Pit upper porewater/wetland (Category 4 Virginia Formation highwalls) and the uncollected drainage from the Category 1 Waste Rock Stockpile. Figure 6-60 shows the long-term loading to the West Pit of copper, which is dominated by wall rock loading from both the East and West Pit highwalls. Constituent loading from wall rock declines over time due to the modeled depletion in sulfate release rates for Duluth Complex rock (Section 9.4 of Reference (6)) and the time required to completely flush accumulated soluble mass from the rock walls.

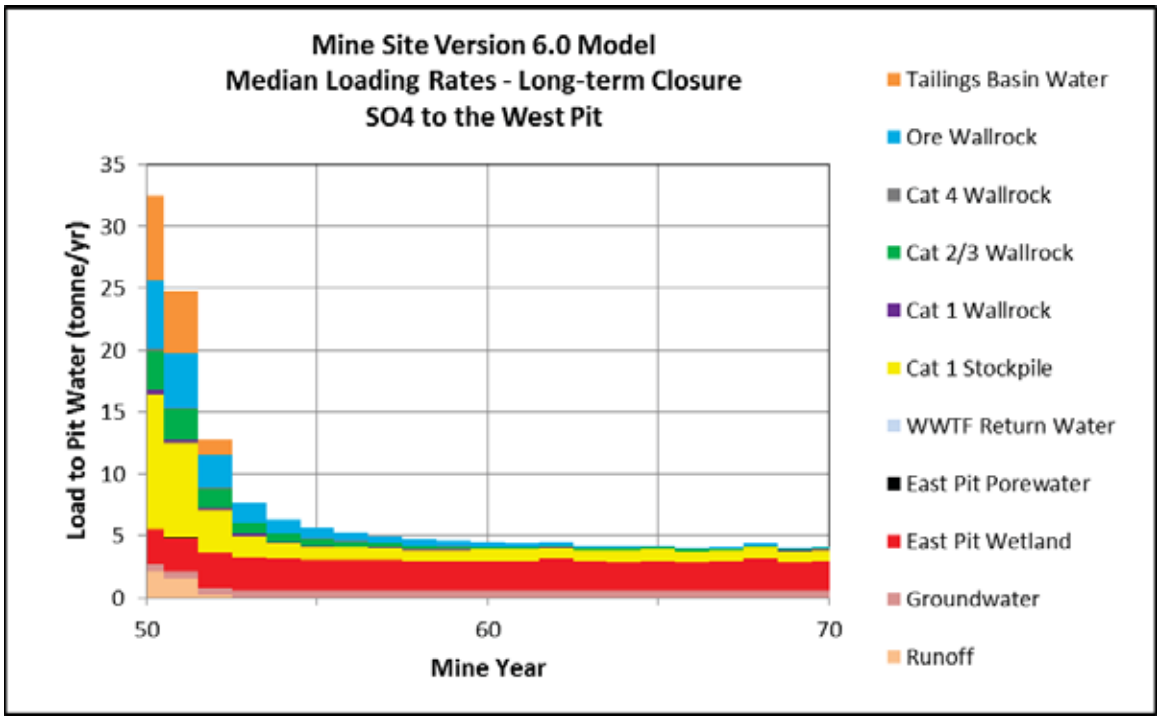


Figure 6-59 Estimated Sulfate Loading to the West Pit in Mine Year 50 through Mine Year 70

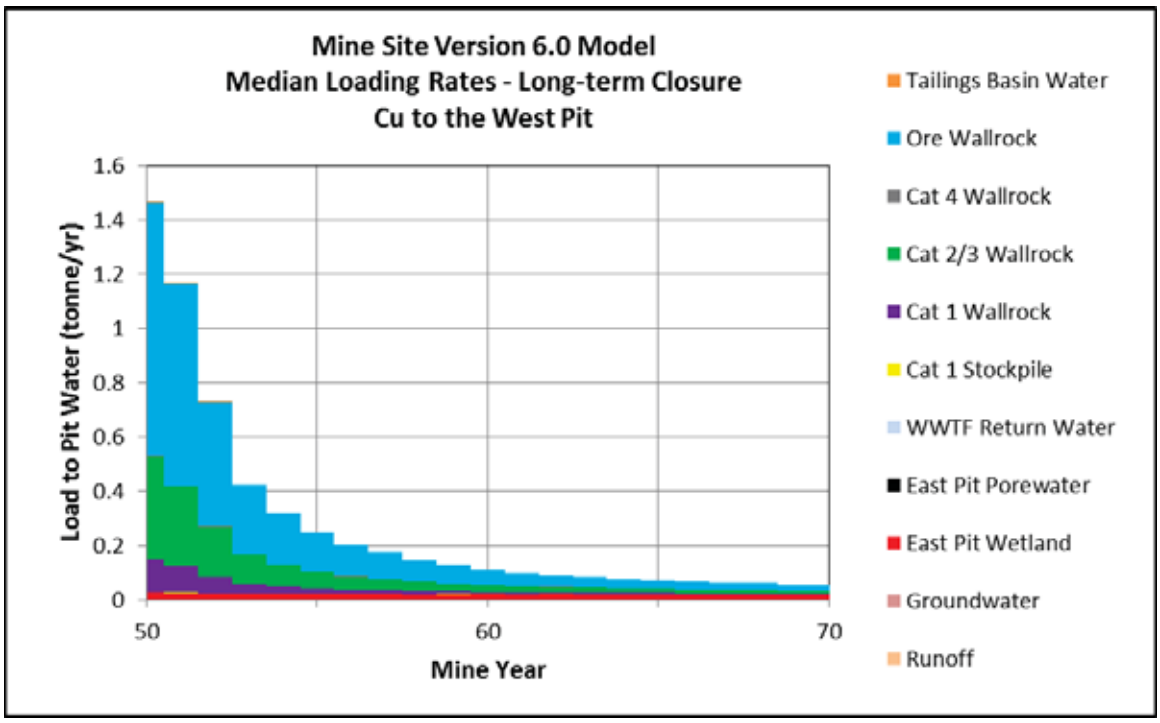


Figure 6-60 Estimated Copper Loading to the West Pit in Mine Year 50 through Mine Year 70

Concentrations are stable or downward trending for the majority of constituents, including sulfate (Figure 6-61), copper (Figure 6-62), cobalt (Figure 6-63) and nickel (Figure 6-64). Copper concentrations are typically limited by concentration caps, the remaining constituents are not limited.

The only constituent with long-term concentrations that are trending upward is barium (Figure 6-65), which originates primarily from background groundwater loading to the East Pit upper porewater/wetland. The modeled average background concentration of barium in groundwater at the Mine Site is 31 µg/L (Table 5-10), with high-end modeled values of approximately 45 µg/L (Attachment D). The barium concentration in the West Pit peaks at levels slightly above this background concentration, as evidenced by the 50th percentile line at approximately 38 µg/L at Mine Year 105 in Figure 6-65 (the 90th percentile line has not stabilized in 200 years but likely will stabilize at or slightly above 50 µg/L).

Concentrations in the West Pit generally trend downward in long-term closure because the concentration of inflowing water is less than the concentration of the well-mixed pit water at the time of complete flooding. The assumption that the pit is well mixed, therefore, is shown to be conservative: if any stratification occurs, the upper portion of the pit water (which could interact with surficial groundwater and surface water) will have concentrations more similar to the long-term inflows and lower than those estimated assuming the pit water is well mixed.

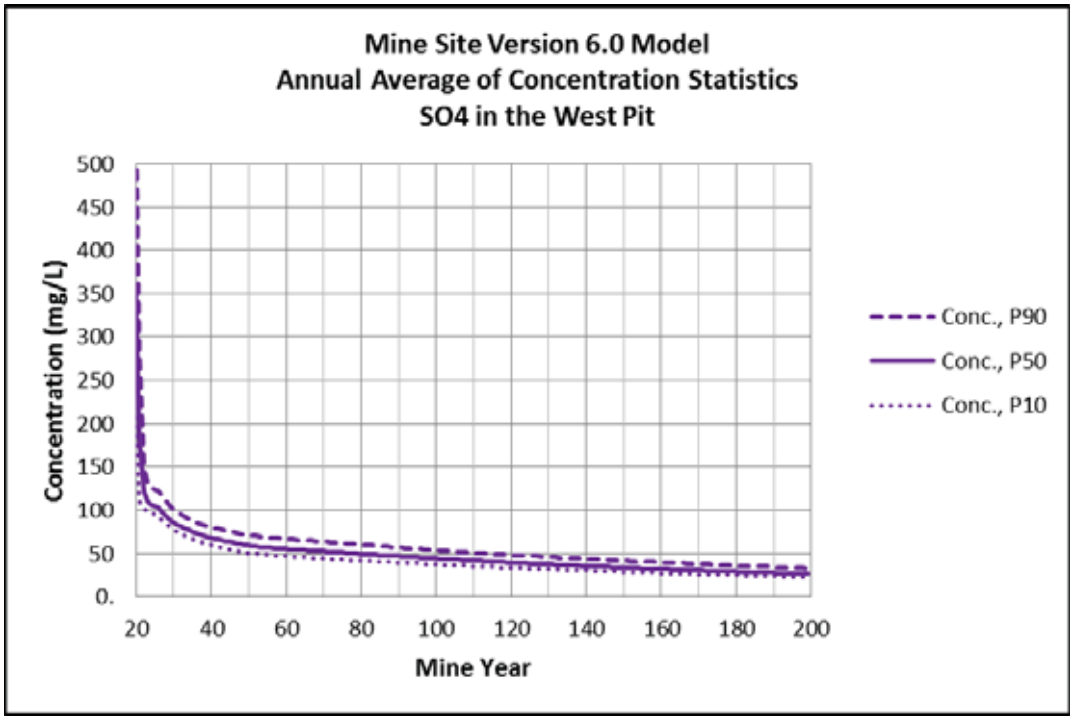


Figure 6-61 Estimated Long-term Sulfate Concentrations in the West Pit

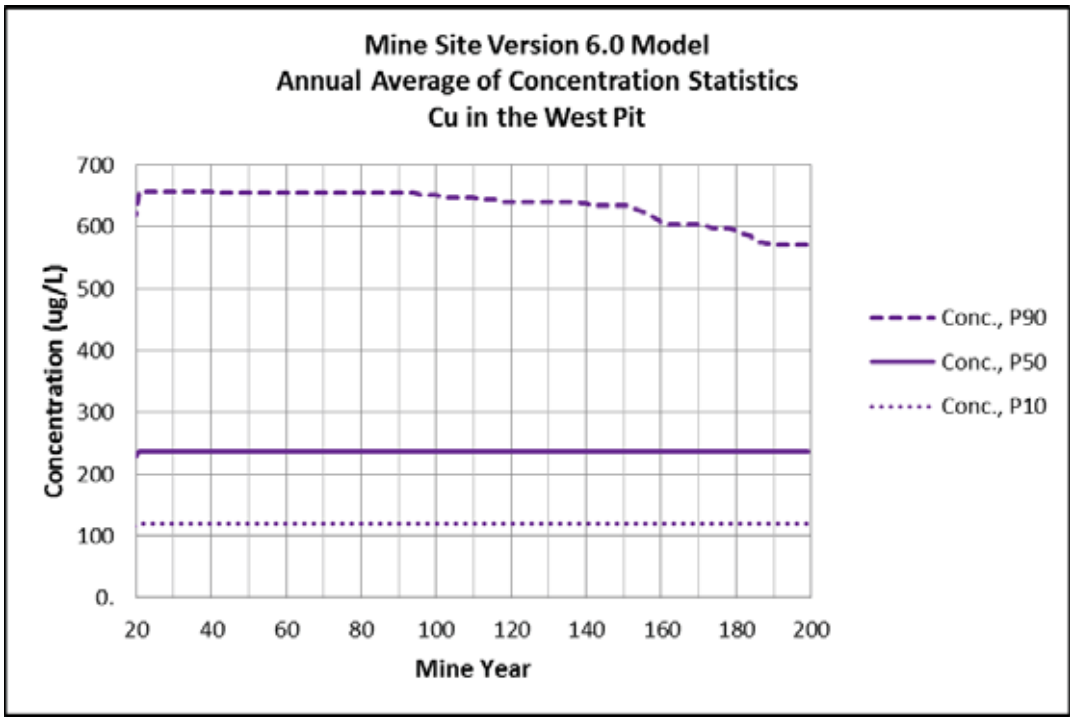


Figure 6-62 Estimated Long-term Copper Concentrations in the West Pit

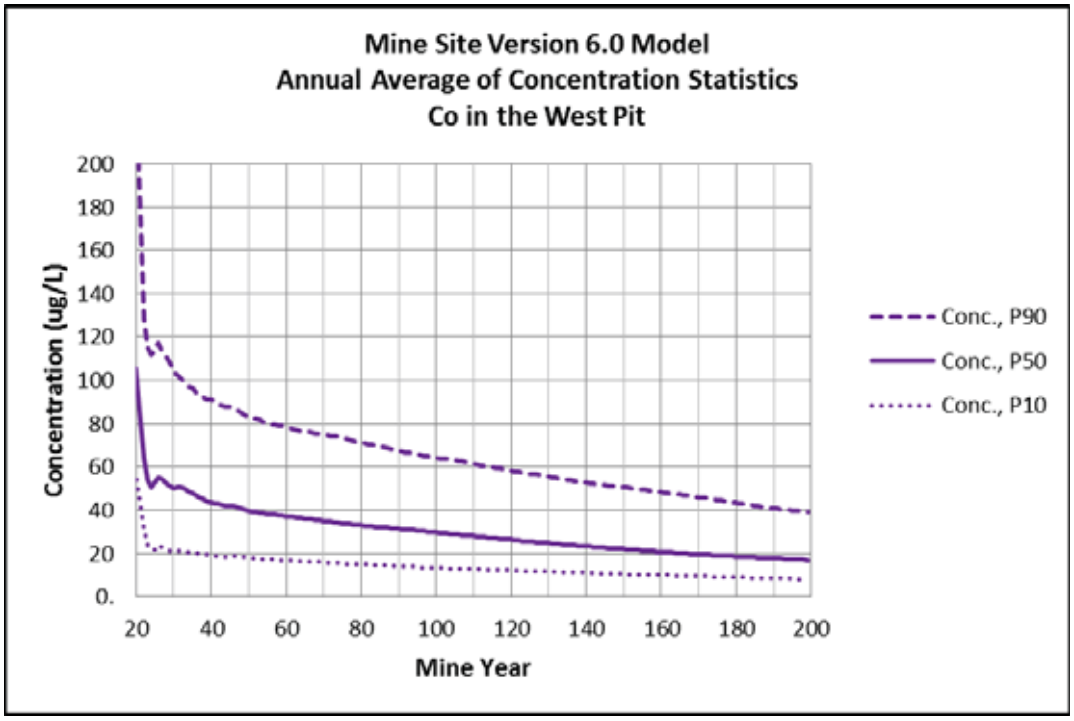


Figure 6-63 Estimated Long-term Cobalt Concentrations in the West Pit

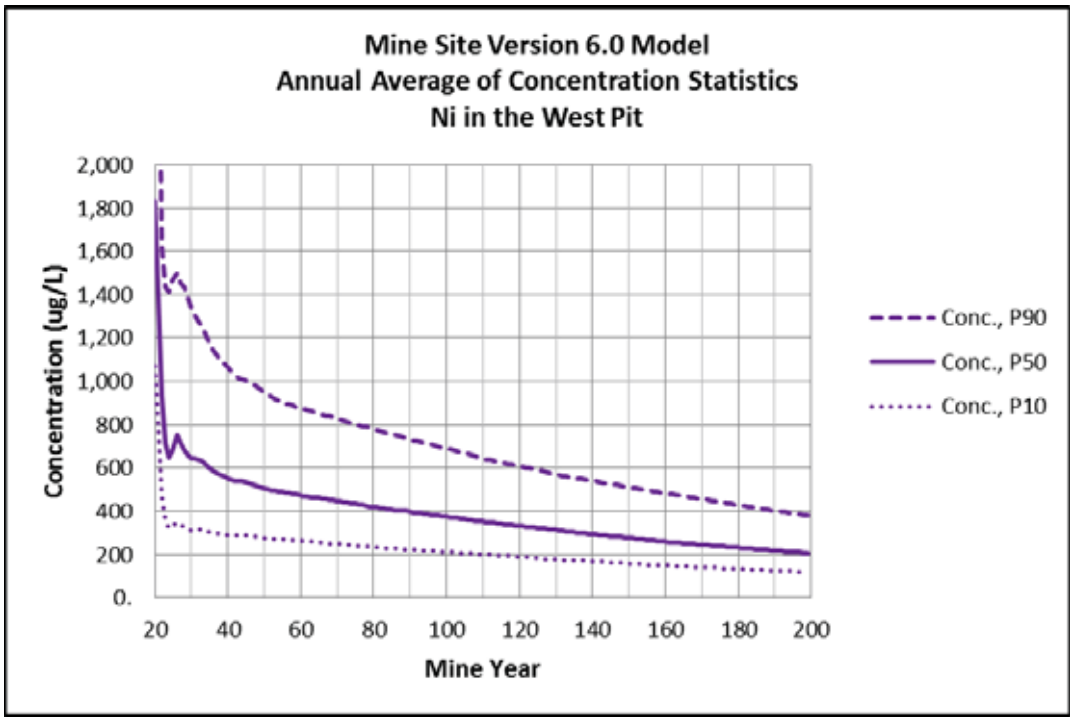


Figure 6-64 Estimated Long-term Nickel Concentrations in the West Pit

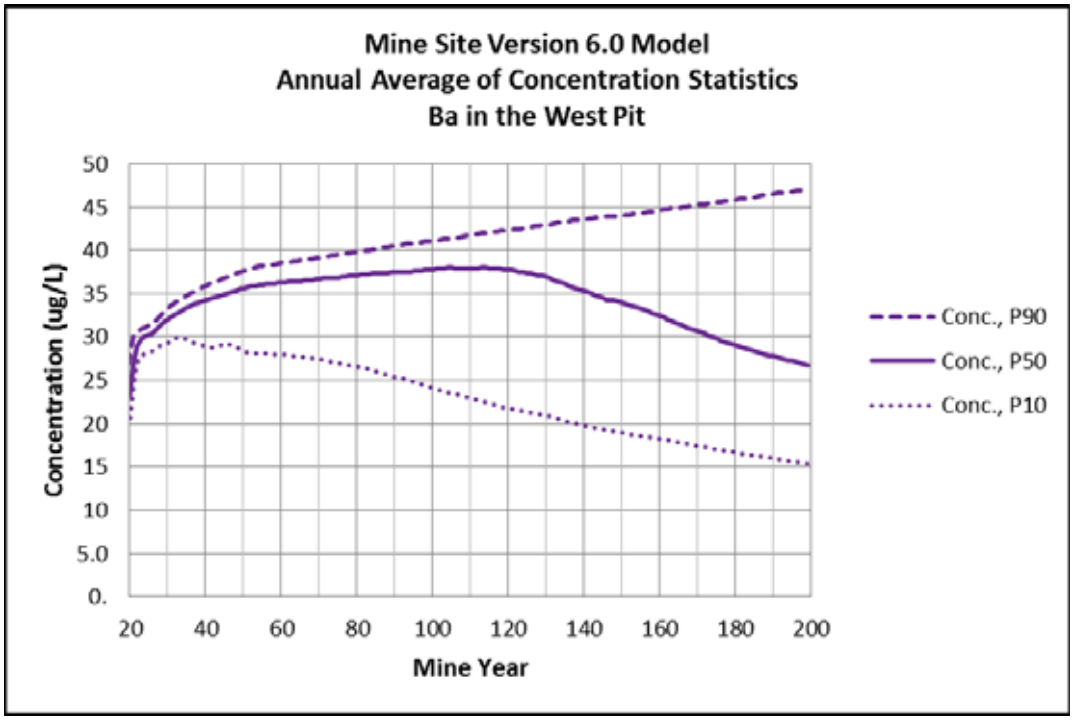


Figure 6-65 Estimated Long-term Barium Concentrations in the West Pit

6.2.3.4 Wastewater Treatment Facility (WWTF)

The WWTF receives inflows of water and dissolved constituents from the various mine features discussed in above. This section presents the results of the probabilistic model for the mixed water quality entering the WWTF.

6.2.3.4.1 Operations

As discussed in Section 6.1.2.4.1, the model of the WWTF in operations groups inflows into two equalization basins prior to treatment: the West EQ Basin receives flow from the Category 2/3 and Category 4 Waste Rock Stockpiles and the OSP; the East EQ Basin receives flow from the Category 1 Waste Rock Stockpile, the mine pits, the RTH and haul roads; reject concentrate from the Plant Site WWTP is sent directly to the WWTF downstream of both basins (Figure 6-18).

Large Table 21 through Large Table 23 present the annual average of the 10th, 50th, and 90th percentile concentrations for all modeled constituents in the West EQ Basin and East EQ Basin, and the Plant Site WWTP reject concentrate. The modeled concentrations in the equalization basins are simply the sum of the total mass loading from all of the contributing sources discussed above divided by the sum of the total flow. These concentrations apply to the collected water that is treated in the WWTF and the liner leakage from the equalization basins to groundwater. For

reference, the changing sulfate concentrations through time in each of the grouped inflows to the WWTF are shown in Figure 6-66 through Figure 6-68.

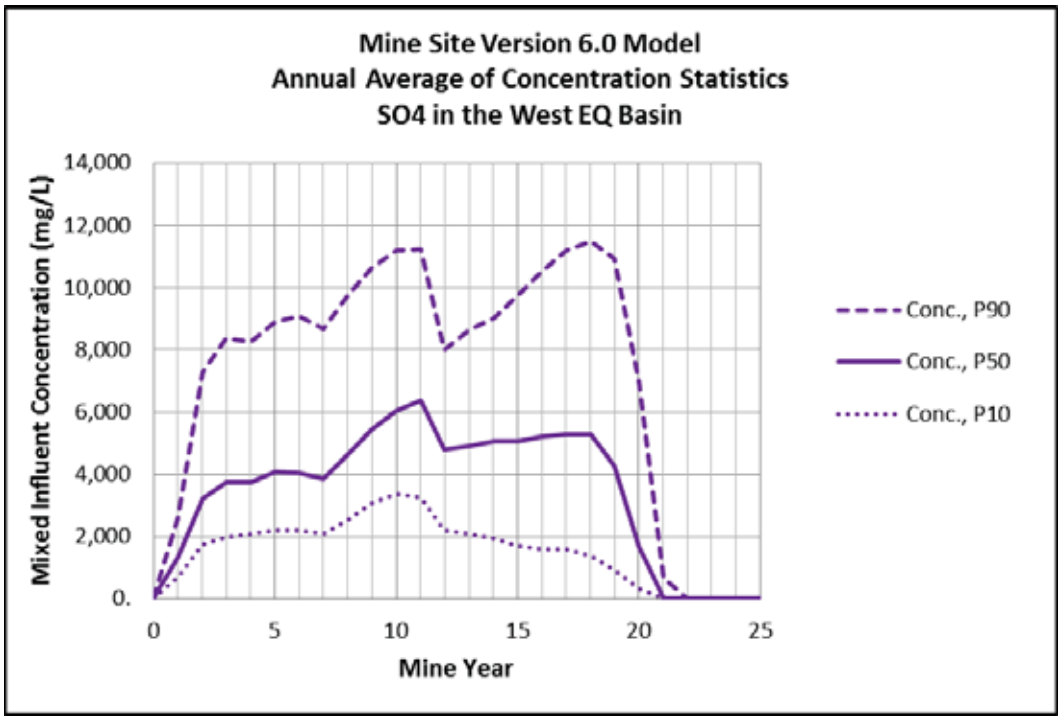


Figure 6-66 Estimated Sulfate Concentrations in the West EQ Basin

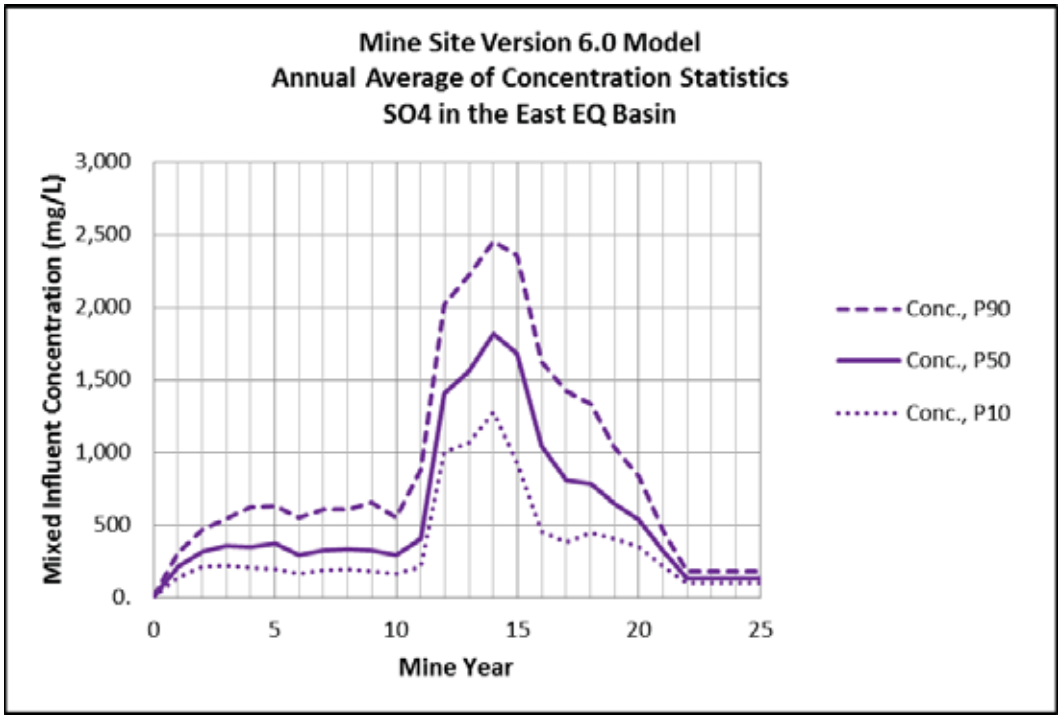


Figure 6-67 Estimated Sulfate Concentrations in the East EQ Basin

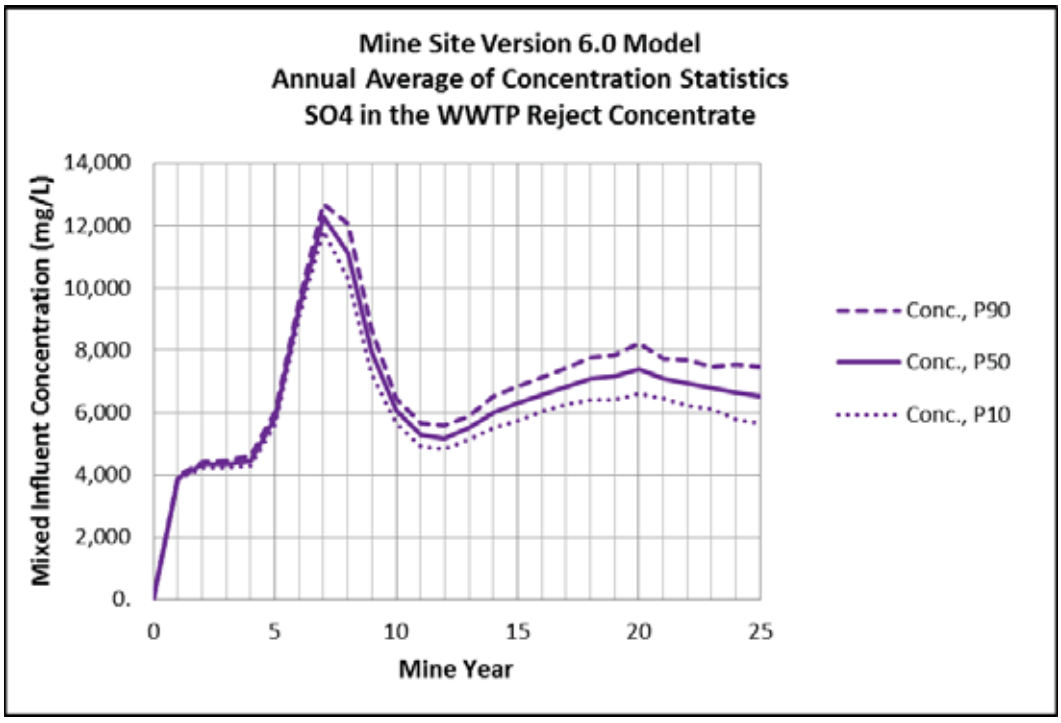


Figure 6-68 Estimated Sulfate Concentrations in the Plant Site WWTP Reject Concentrate

The water quality of the effluent from the WWTF combined with the collected runoff from the OSLA during operations (the mixed water in the CPS Pond) is assumed to be fixed at the deterministic operations effluent targets (Table 1-34 of Attachment C) throughout operations, unless the total inflowing concentration to the CPS Pond is less than the applicable target. The resulting concentrations that are used as inputs to the Plant Site model are shown in Table 1-9 and Table 1-10 of Attachment B of Reference (5).

6.2.3.4.2 Reclamation

As discussed in Section 6.1.2.4.2, the WWTF during reclamation receives water from the East Pit backfill, the Category 1 Waste Rock Stockpile, and reject concentrate from the Plant Site WWTP. The water quality of each of these sources during reclamation is discussed in the applicable sections and large tables: Section 6.2.3.2.2 and Large Table 18 (East Pit), Section 6.2.3.1 and Large Table 16 (Category 1 Waste Rock Stockpile), and Section 6.2.3.4.1 and Large Table 23 (Plant Site Reject Concentrate). The mixed water quality of the influent to the WWTF during reclamation is shown in Large Table 24 for comparison to the modeled WWTF effluent concentrations. The water quality of the effluent from the WWTF is fixed at the deterministic reclamation effluent targets (Table 1-34 of Attachment C) for most constituents and is routed to the East and West Pits as described in Section 6.1.2.4.2.

6.2.3.4.3 Long-term closure

As discussed in Section 6.1.2.4.3, the WWTF in long-term closure receives inflows of water from only the reclaimed Category 1 Waste Rock Stockpile and the West Pit. The water quality of each of these sources during reclamation is discussed in the applicable sections and large tables: Section 6.2.3.1 and Large Table 16 (Category 1 Waste Rock Stockpile), and Section 6.2.3.3.3 and Large Table 20 (West Pit).

The mixed water quality of the influent to the WWTF in long-term closure is shown in Large Table 25 for comparison to the modeled WWTF effluent concentrations. The water quality of the effluent from the WWTF is fixed at the deterministic long-term closure effluent targets (Table 1-34 of Attachment C) unless the total inflowing concentration to the WWTF is less than the applicable target. Constituents that are treated in the long-term WWTF (because influent concentrations are above the modeled effluent targets) include arsenic, cadmium, cobalt, copper, potassium, manganese, nickel, lead, sulfate, and zinc. Calcium and magnesium are also treated to achieve the effluent target for hardness.

The WWTF effluent in long-term closure is discharged to an intermittent stream that flows to the Partridge River near SW004a.

6.3 Groundwater Quality

The GoldSim model is used to evaluate estimated groundwater quality relative to the groundwater standards at the Property Boundary. Quantitative evaluations are made by comparing the 90th percentile concentration to the applicable groundwater standard consistent

with direction provided by the Co-lead Agencies as part of the IAP process (Reference (81)). For the NorthMet EIS, the Project will be assumed to estimate a significant effect on water quality if the 90th percentile model concentrations exceed an applicable standard. The State has retained the flexibility to modify this impact criteria based on site-specific factors and model results. Model estimates are also provided where the flow paths cross Dunka Road, upgradient of the future compliance points.

6.3.1 Explanation of Plots

Two types of plots are used in this section:

- plots showing concentration statistics
- plots showing an overview of groundwater concentrations for each location

Each of these plots is described below.

6.3.1.1 Concentration Statistics Plots

Plots of concentration statistics for a given constituent at a given evaluation location are generated using the same method what was used to develop the concentration statistic plots for the Mine Site features (Section 6.2.1.1). All concentration statistics plots for the groundwater flow paths are shown in Attachment I. Concentrations are summarized in tabular form for each flow path in Large Table 26 through Large Table 38, including results for both the Dunka Road and Property Boundary evaluation locations.

6.3.1.2 Overview of Groundwater Concentration Plots

At each groundwater evaluation location located at the Property Boundary, a single overview plot is created. Given the time series of summary statistics (10th percentile, median, 90th percentile) briefly described in Section 6.2.1.1, the range of concentrations shown in these figures is defined by the maximum of the 90th percentile over the modeled 200 year period, to the minimum of the 10th percentile over the modeled 200 year period. These overview figures are included as Large Figure 47 through Large Figure 54.

6.3.2 Estimated Groundwater Concentrations

For all constituents the maximum 90th percentile concentration is below the applicable groundwater quality standard or site-specific evaluation criteria at the Property Boundary (Large Figure 47 through Large Figure 54). The general response in groundwater to the Project is that concentrations at the property boundary show a temporary increase due to the loading from temporary Mine Site features and then decrease toward long-term steady state concentrations.

All surficial flow paths experience “breakthrough” of loading from the Mine Site features within the modeled 200-year period at both Dunka Road and the Property Boundary. For the surficial

flow paths that originate at the mine pits, the long-term steady state water quality reflects ongoing loading from the pits and is a function of the long-term pit water quality. For the surficial flow paths that originate at temporary mine features rather than the mine pits, groundwater concentrations return toward the natural background concentrations in the long-term.

For the bedrock flow paths that originate at the mine pits, the travel time for water to reach the Property Boundary is much longer than the modeled 200-year period. Groundwater concentrations in these flow paths are therefore unchanged from the natural background water quality.

The time required for peak groundwater concentrations to reach the Dunka Road and the Property Boundary (the "breakthrough" time) is different for each surficial flow path primarily due to the varying distances from the Mine Site features to Dunka Road and the Property Boundary (or the Partridge River, if shorter). Figure 6-69 shows the estimated sulfate concentrations in the East Pit – Category 2/3 surficial flow path, which receives loading from both temporary (Category 2/3 Waste Rock Stockpile) and permanent (East Pit) mine features. A first pulse of loading from the temporary stockpile reaches the Property Boundary at approximately Mine Year 30, and a second pulse from the flooded East Pit upper porewater/wetland reaches the Property Boundary between Mine Year 90 and Mine Year 150. This pattern is typical for all constituents along this flow path, although for some constituents the first pulse is higher than the second.

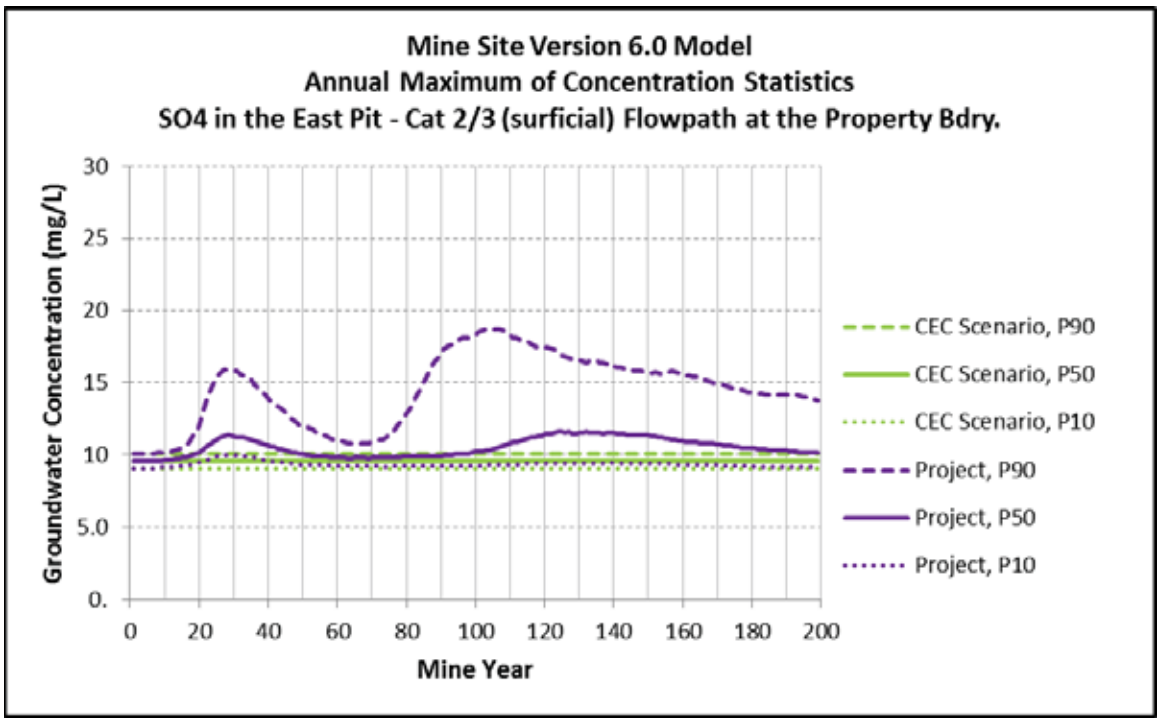


Figure 6-69 Sulfate Concentration in the East Pit – Category 2/3 Surficial Flow Path at the Property Boundary

Breakthrough of the peak groundwater concentrations is longer for the OSP surficial flow path and the WWTF surficial flow path. The modeled peak cobalt concentration occurs at the same time as the peak sulfate concentration, but is more easily distinguished from the natural background water quality in the result plots. Figure 6-70 shows the range of estimated cobalt concentrations in the OSP surficial flow path, and Figure 6-71 shows the range in the WWTF surficial flow path. Both flow paths reach their peak concentrations at approximately Mine Year 175.

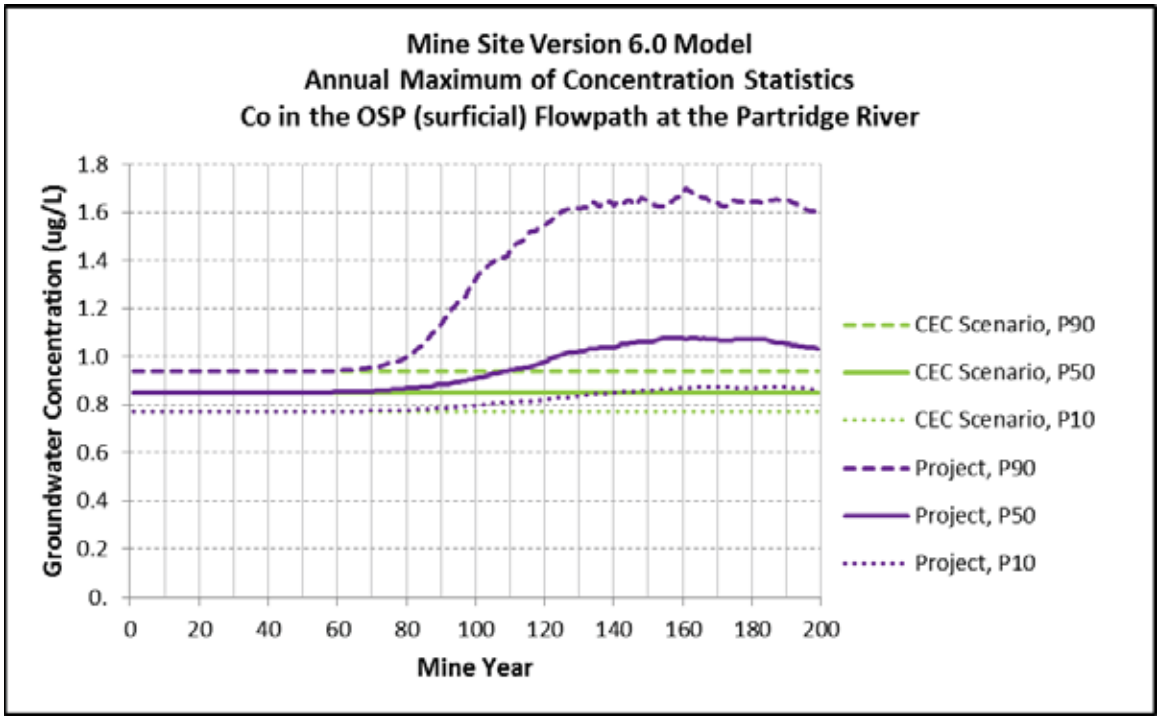


Figure 6-70 Cobalt Concentration in the OSP Surficial Flow Path at the Partridge River

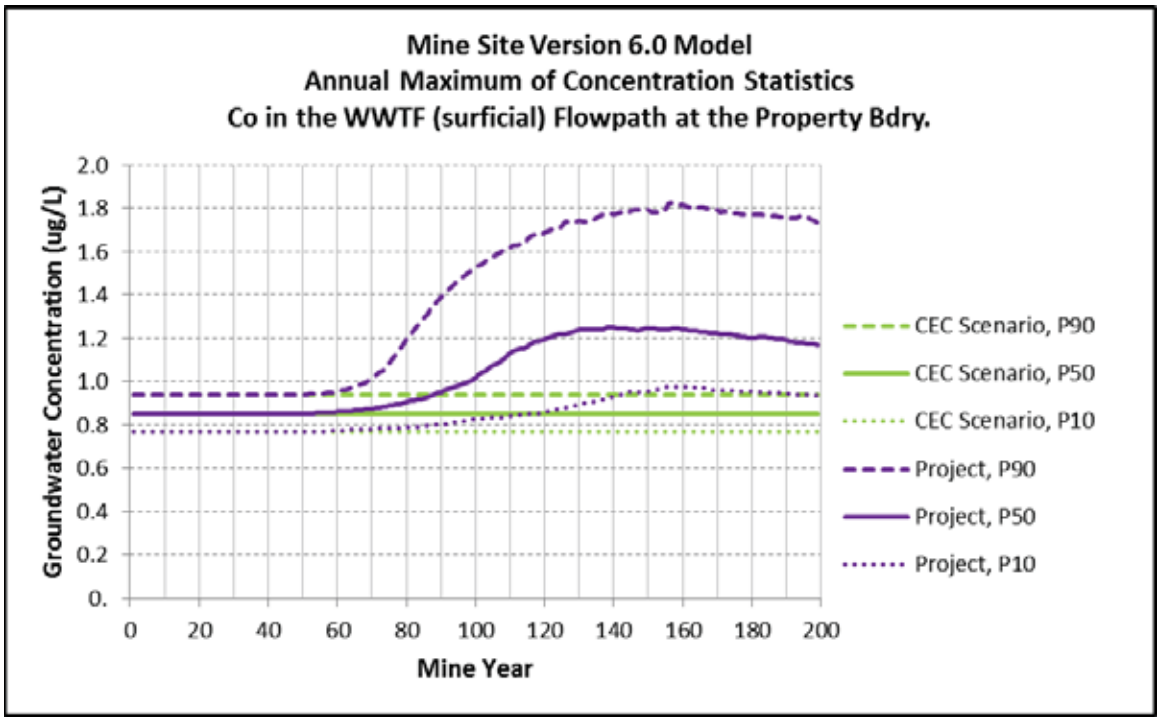


Figure 6-71 Cobalt Concentration in the WWTF Surficial Flow Path at the Property Boundary

Breakthrough of the peak groundwater concentration in the OSLA surficial flow path occurs more quickly than for the other temporary Mine Site features due to a shorter flow path length and larger flows from the unlined OSLA. Figure 6-72 shows that the sulfate concentration peaks by approximately Mine Year 20, then gradually returns to concentrations more typical of natural background groundwater. This pattern is typical for all constituents along this flow path, although for some constituents the concentration of water infiltrating through the OSLA is estimated to be lower than in the natural background groundwater, and the peak is inverted to represent the dilution effect of the infiltrating water (see Figure 6-73 for cobalt).

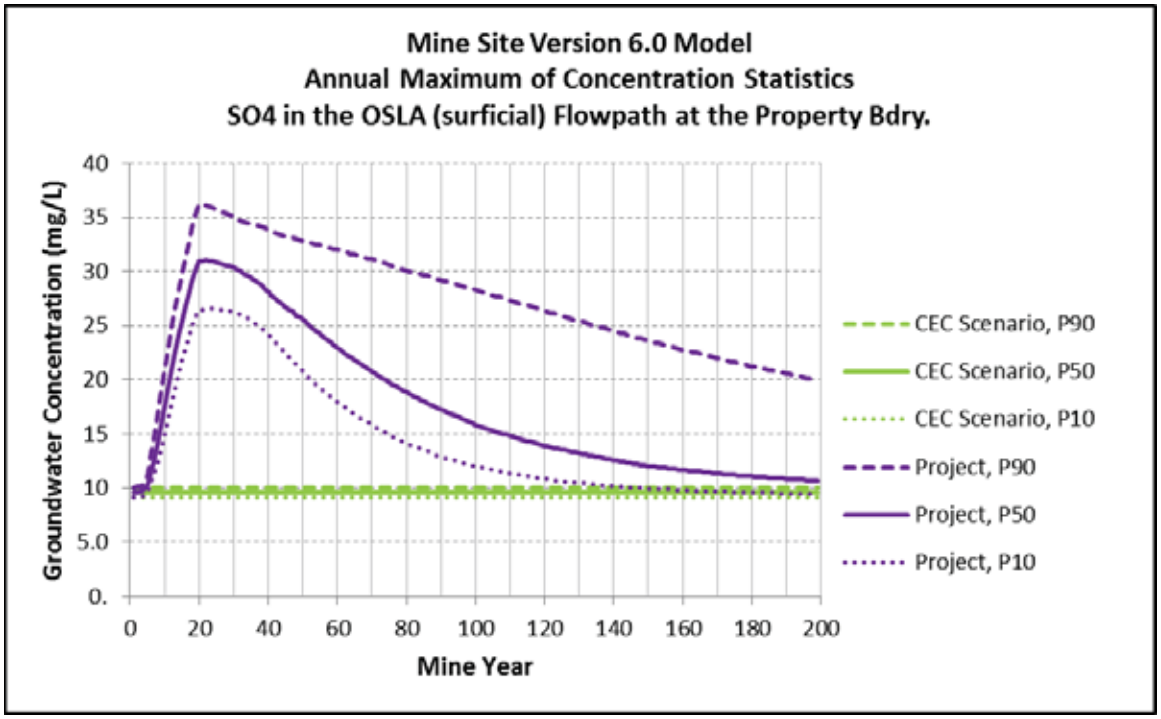


Figure 6-72 Sulfate Concentration in the OSLA Surficial Flow Path at the Property Boundary

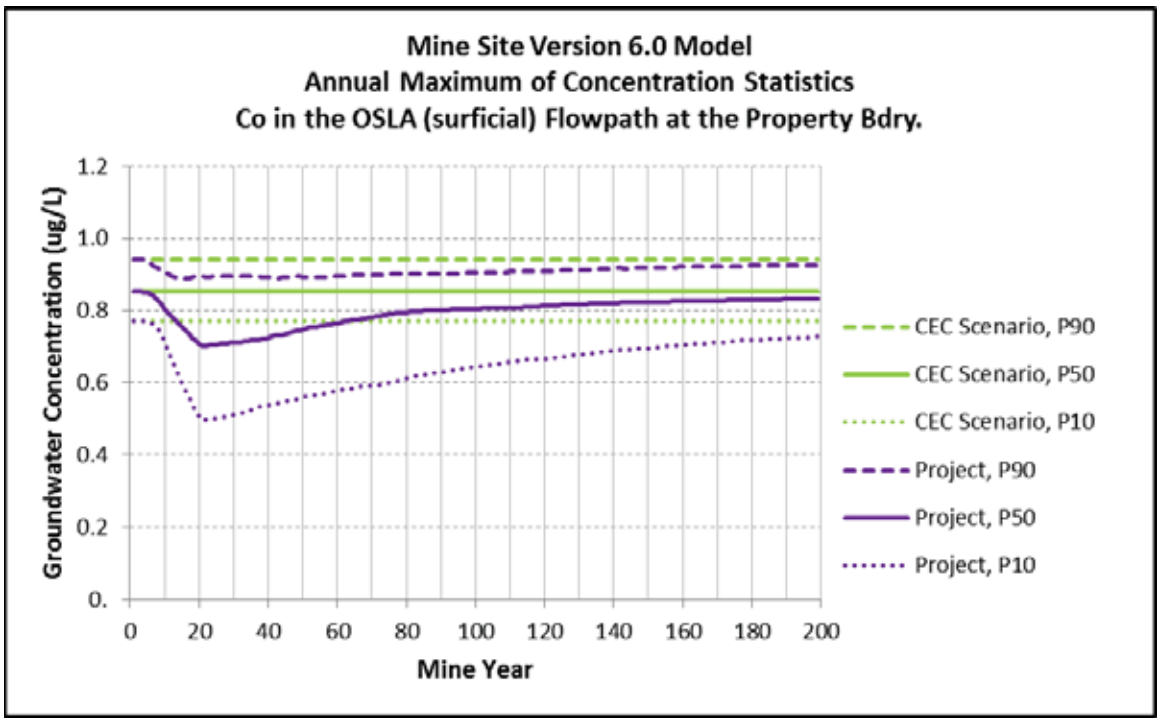


Figure 6-73 Cobalt Concentration in the OSLA Surficial Flow Path at the Property Boundary

Although the outflow from the West Pit to the surficial aquifer is the largest flux of groundwater leaving the Mine Site (see Table 6-8 for the West Pit, see also Table 6-12 for the relative flows from groundwater to the Partridge River), outflow does not begin until the pit water elevation reaches the top of the bedrock along the pit rim between Mine Year 45 and Mine Year 50. The edge of the West Pit is close to Dunka Road resulting in a breakthrough of peak concentrations in approximately 20 years (as early as Mine Year 65), as shown for sulfate in Figure 6-74. Breakthrough of the peak concentrations at the Property Boundary occurs at least 25 years later (Mine Year 90), as shown for sulfate in Figure 6-75. As discussed in Section 6.2.3.3.3, the concentration of virtually all constituents in the West Pit continues to decrease throughout the modeled 200-year period. Likewise, concentrations in the West Pit surficial flow path continue to decrease over the long term and have not reached steady-state conditions by the end of the modeled 200-year period.

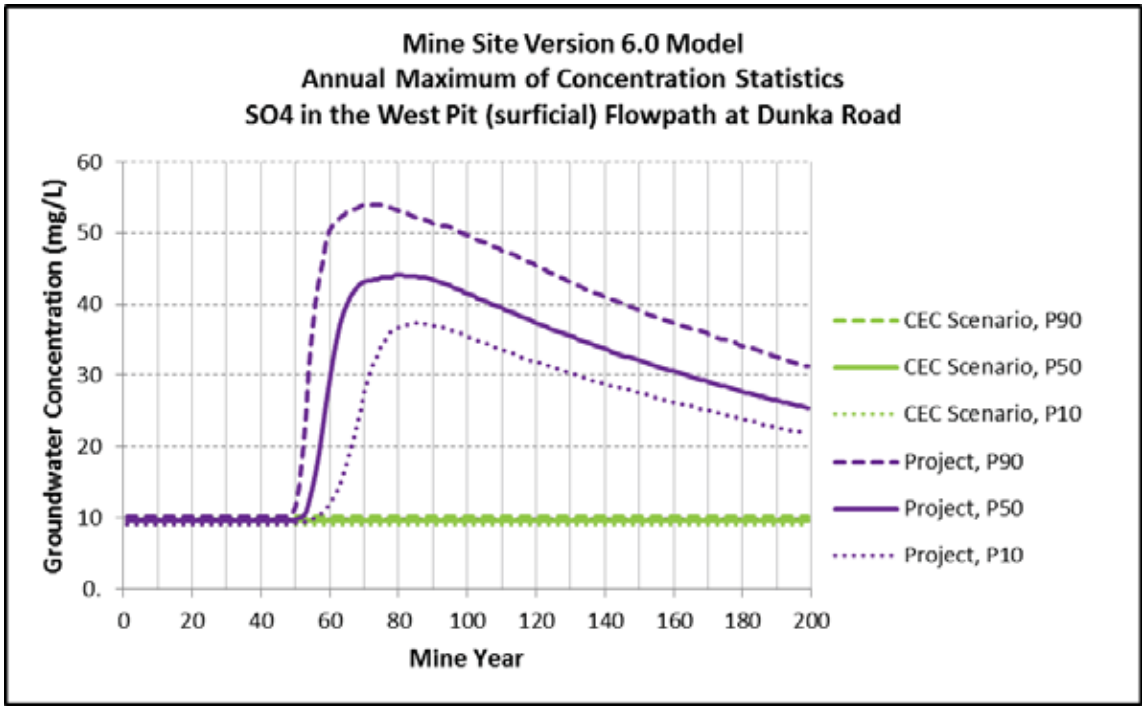


Figure 6-74 Sulfate Concentration in the West Pit Surficial Flow Path at Dunka Road

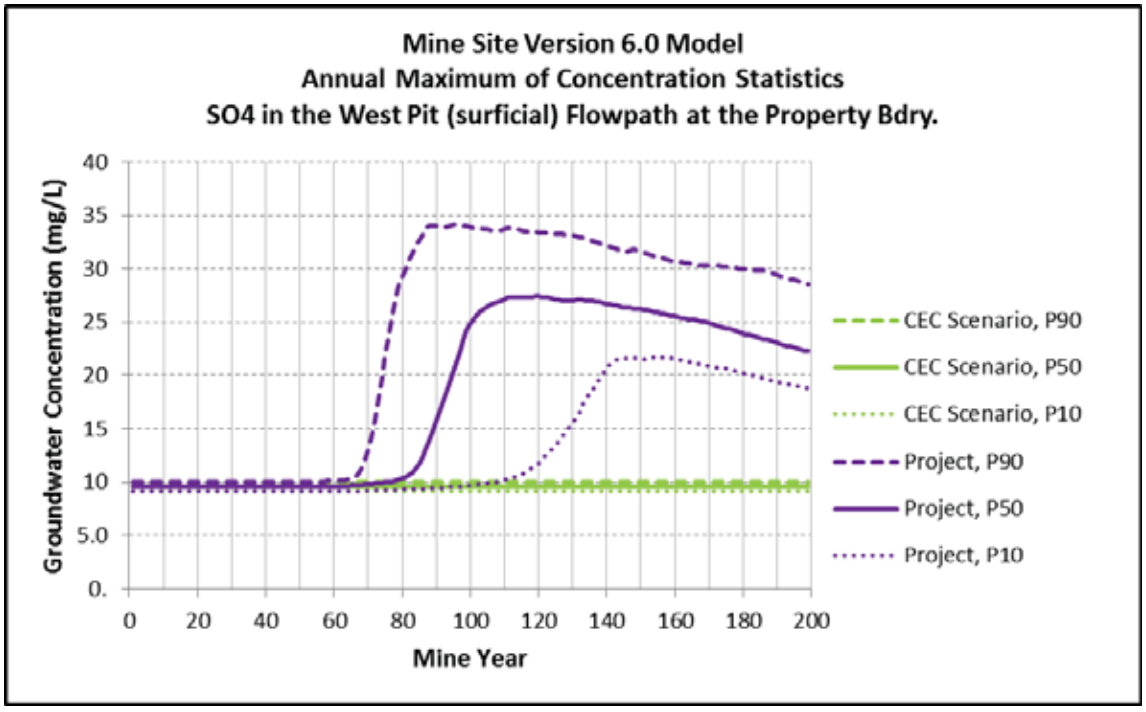


Figure 6-75 Sulfate Concentration in the West Pit Surficial Flow Path at the Property Boundary

6.3.3 Discussion of Specific Constituents

Some constituents warrant further discussion. Antimony is discussed because the model results presented for the West Pit surficial flow path at Dunka Road in Attachment I show concentrations near the groundwater standard. Total dissolved solids (TDS) is discussed because it was not identified as a constituent for inclusion in the GoldSim model, but there is a surface water standard for TDS that will need to be met by the Project.

6.3.3.1 Antimony

Model results for the Mine Site indicate that the 90th percentile concentration of antimony for the West Pit surficial flow path at Dunka Road appears to be peaking at the end of the current model simulation period (200-years) (Figure 6-76), and the "pulse" of antimony has not yet reached the Property Boundary (Figure 6-77). Antimony concentrations have peaked at Dunka Road well below the water quality standard for the other surficial flow paths. The NorthMet Mine Site Water Modeling Work Plan states that "Steady state long-term closure conditions are defined as… the groundwater concentrations at the furthest evaluation locations (i.e., Partridge River) have peaked and are declining towards an approximate steady state". Antimony appears to be meeting these criteria at Dunka Road, but not at the Property Boundary within the model simulation period.

The West Pit surficial flow path and its evaluation locations (Dunka Road and the Property Boundary) are shown on Large Figure 28. As shown in the previously agreed model results in Figure 6-76 and Figure 6-77, the 90th percentile concentration of antimony appears to be peaking at Dunka Road at the end of the model simulation period, and the "pulse" of antimony has not yet reached the Property Boundary. The transport of antimony through the surficial aquifer is delayed compared to the majority of the constituents in the model because antimony is modeled with a sorption factor as discussed in Section 5.2.3.5.

As shown in Figure 6-76, the 90th percentile concentration of antimony is below the standard (6 µg/L) when it reaches Dunka Road. The concentration of antimony will be further reduced when the peak arrives at the Property Boundary due to the continued effects of sorption and dilution with natural groundwater (mean concentration approximately 0.25 µg/L in Table 5-10).

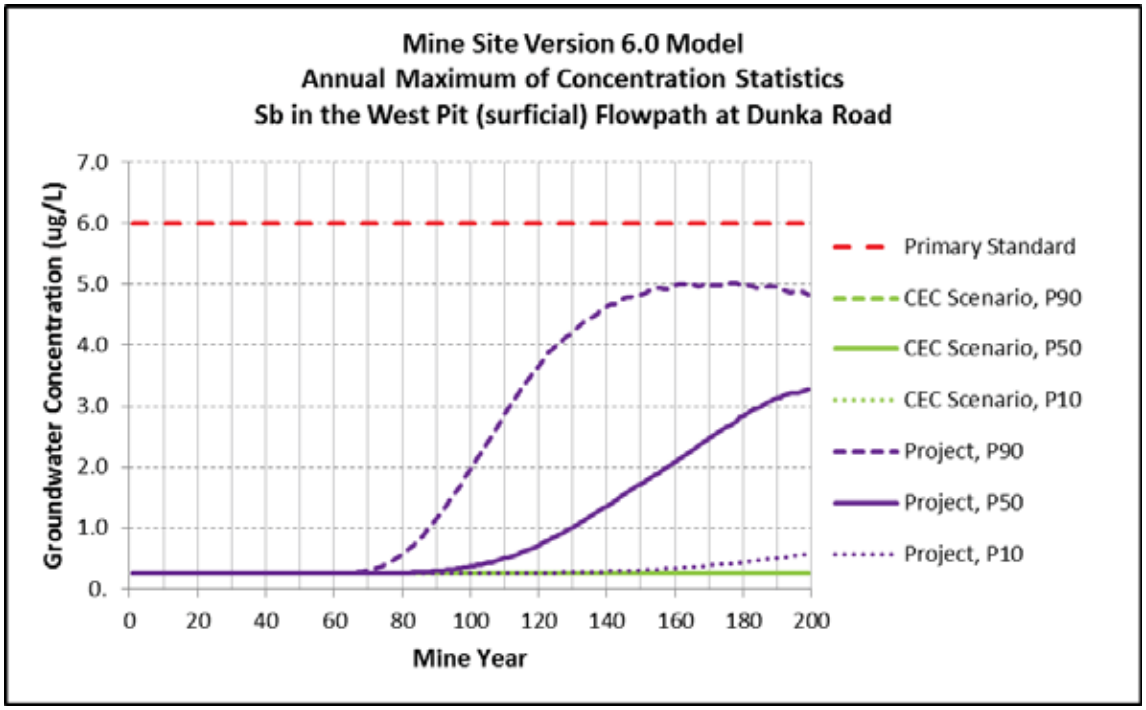


Figure 6-76 Antimony Concentration in the West Pit Surficial Flow Path at Dunka Road

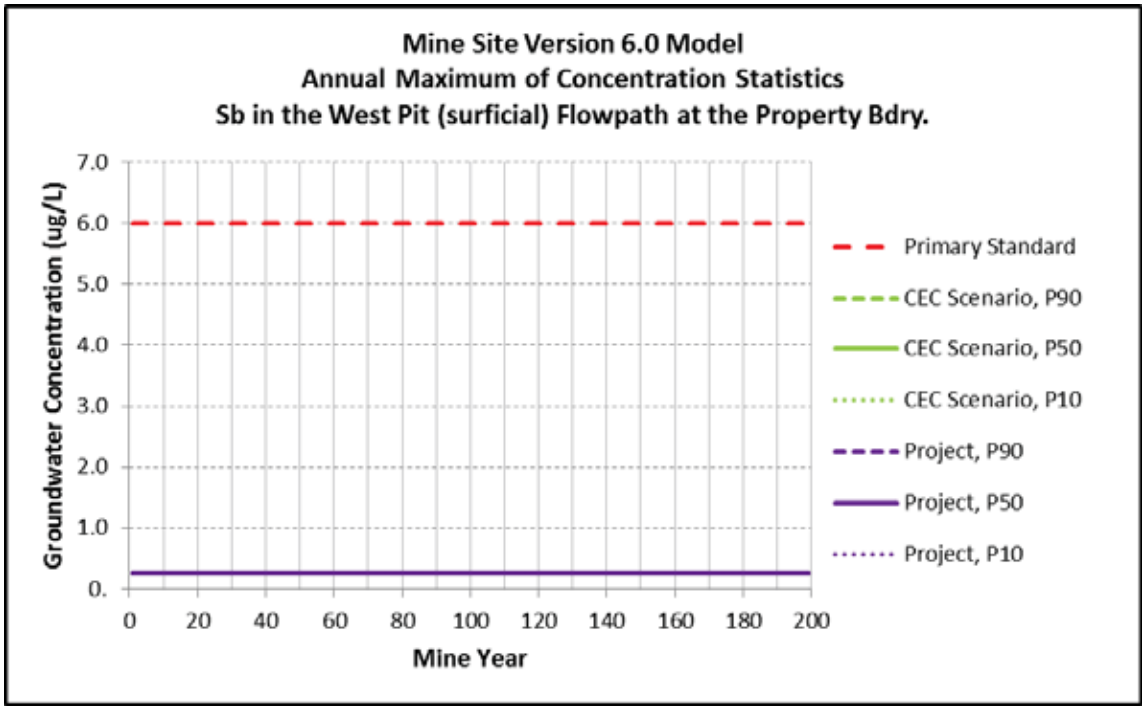


Figure 6-77 Antimony Concentration in the West Pit Surficial Flow Path at the Property Boundary

6.3.3.2 Total Dissolved Solids

Total dissolved solids (TDS) was not identified as a constituent for inclusion in the GoldSim model. However, there is a groundwater standard that will need to be met by the Project.

The Mine Site Water Quality Model is intended to independently model a suite of 28 constituents, as described in Table 2-1 of Attachment C. This suite of constituents does not include total dissolved solids (TDS). However, there are applicable surface water and groundwater standards for TDS, and the MPCA has requested that model results be compared to the TDS standards for surface water (700 mg/L) and groundwater (500 mg/L).

As described below, TDS has been estimated directly in the model at each time step using instantaneous concentrations of other constituents. Estimated TDS concentrations in groundwater are presented here while estimated TDS concentrations in surface water are presented in Section 6.5.6.4. TDS is not directly modeled by the probabilistic water quality model. However, TDS can be estimated using Equation 6-1 (Reference (82)) where all constituent concentrations are in units of mg/L.

$$TDS = 0.6 \times Alkalinity + Ca + Mg + Na + K + Cl + SO_4 + F \qquad \textbf{Equation 6-1}$$

TDS has been estimated at each time step using the instantaneous concentrations of each of the eight constituents in Equation 6-1. Sample data from groundwater wells is included in Large Table 3 and Large Table 4, and summarized in Table 6-10 below. Observed surficial groundwater TDS only exceeds 350 mg/L in one observation and averages 144 mg/L in all of the Mine Site wells combined. Observed bedrock groundwater TDS does not exceed 220 mg/L and averages 107 mg/L in all of the Mine Site wells combined.

Table 6-10 Estimated and Observed TDS in Groundwater

Data Set	P10 (mg/L)	P50 (mg/L)	P90 (mg/L)
Estimated CEC Average (surficial)	77	79	81
Estimated CEC Average (bedrock)	93	100	109
Observed Range (surficial)	72	117	189
Observed Range (bedrock)	59	101	176

Estimated TDS concentrations in the five surficial flow paths are shown in Figure 6-78 through Figure 6-82, and mirror the trends shown for other constituents in Section 6.3.2. TDS in the bedrock groundwater flow paths, like the concentrations of other constituents, is unchanged from the natural background condition at the Property Boundary.

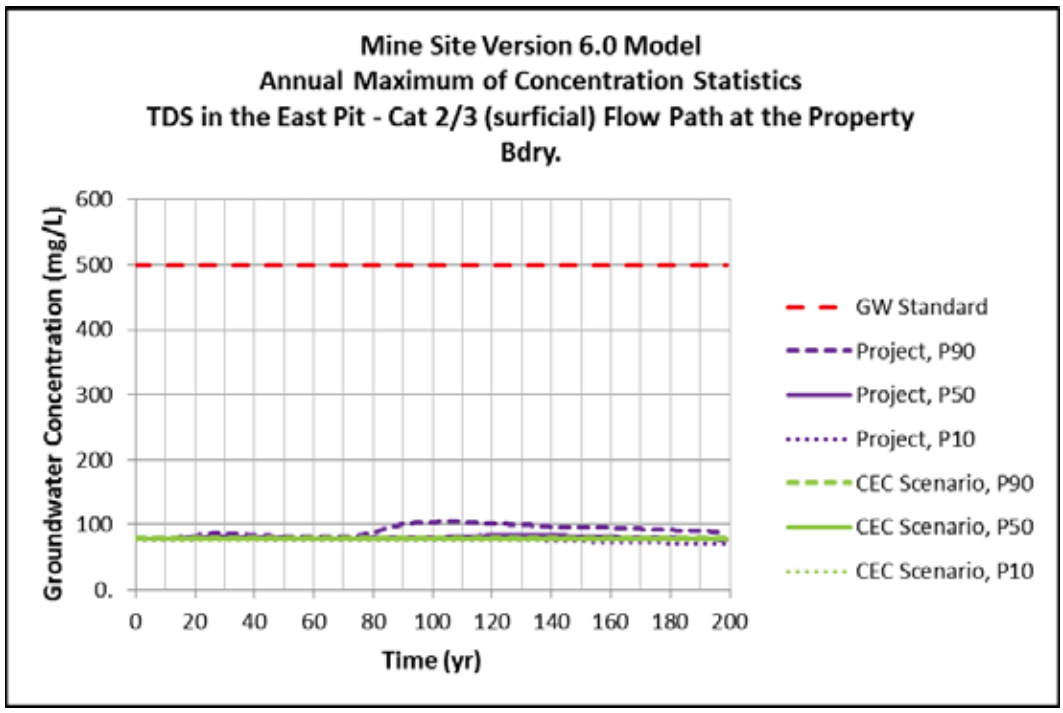


Figure 6-78 TDS Concentration in the East Pit – Category 2/3 Surficial Flow Path at the Property Boundary

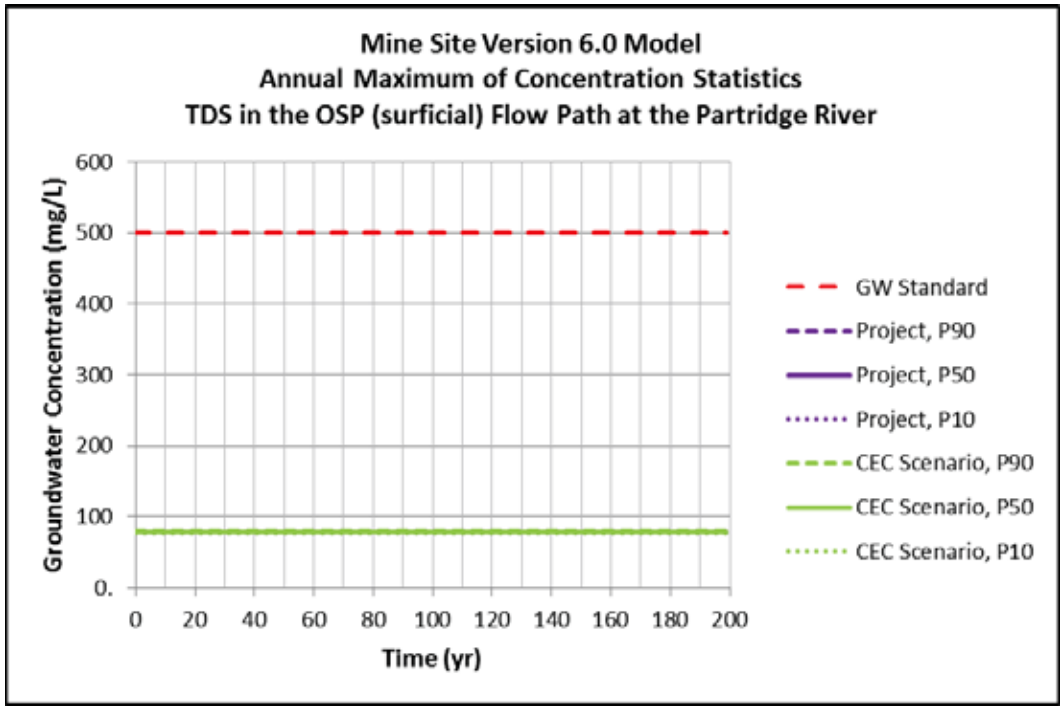


Figure 6-79 TDS Concentration in the OSP Surficial Flow Path at the Partridge River

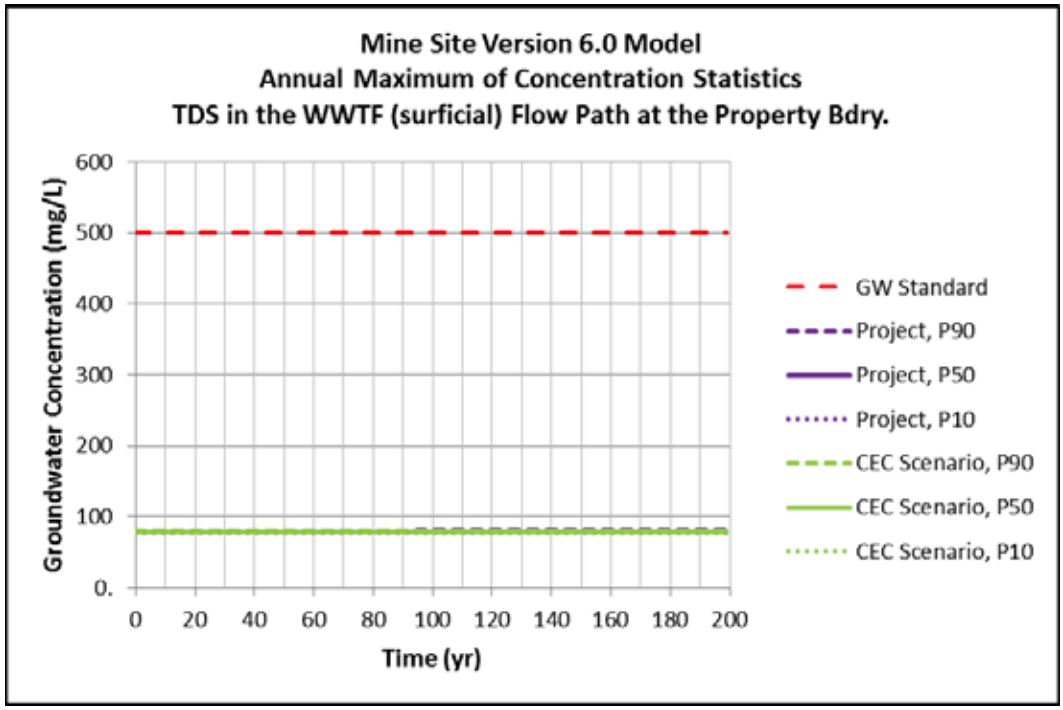


Figure 6-80 TDS Concentration in the WWTF Surficial Flow Path at the Property Boundary

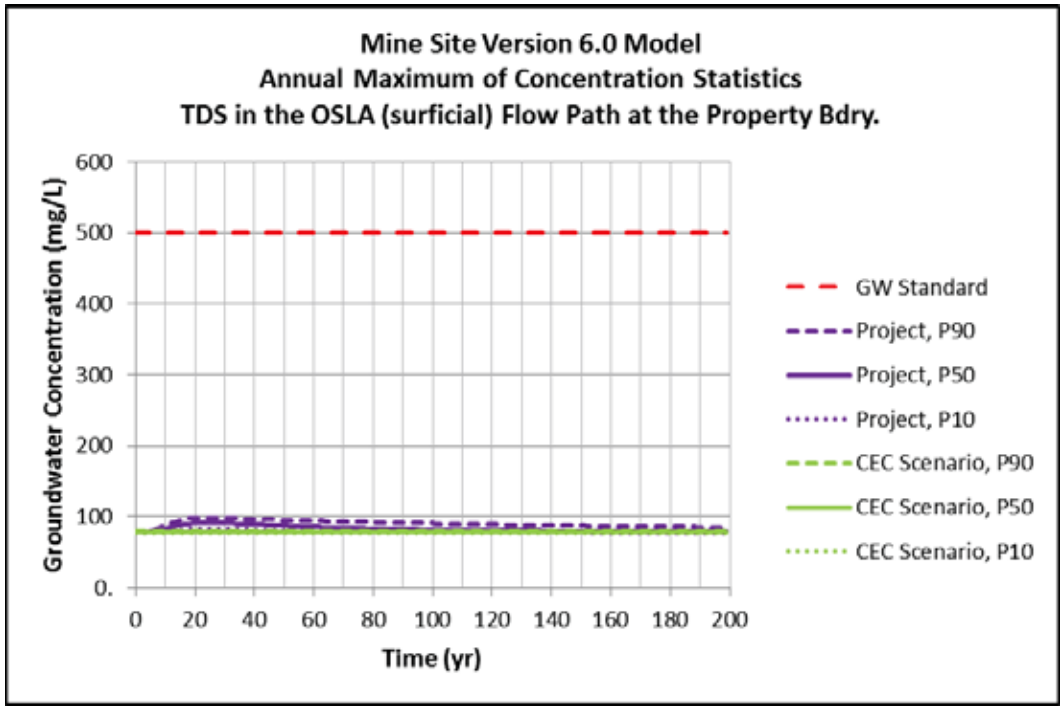


Figure 6-81 TDS Concentration in the OSLA Surficial Flow Path at the Property Boundary

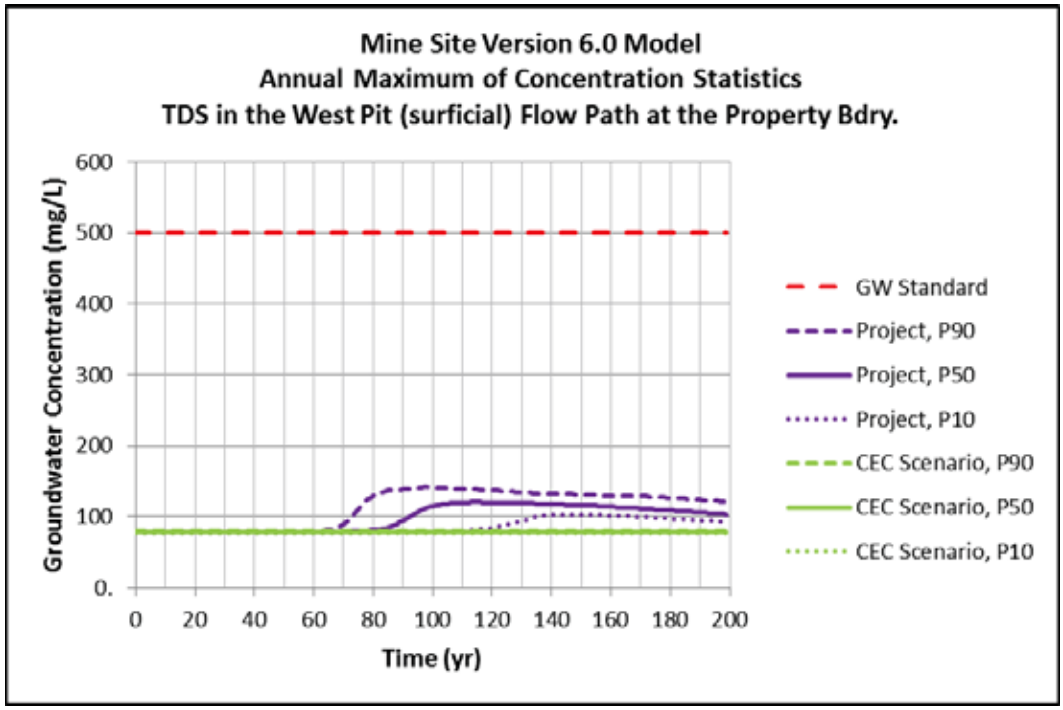


Figure 6-82 TDS Concentration in the West Pit Surficial Flow Path at the Property Boundary

As shown, the estimated TDS concentrations do not approach the groundwater standard for any flow path. For further information, the distribution of the maximum modeled TDS concentration is shown for each groundwater flow path at the property boundary or Partridge River (Figure 6-83). The maximum modeled TDS concentration—one value for each 200-year realization—almost never exceeds 200 mg/L in the groundwater, which is less than half of the applicable water quality standard (one realization out of 500 had a maximum TDS concentration above 500 mg/L in the West Pit surficial flow path).

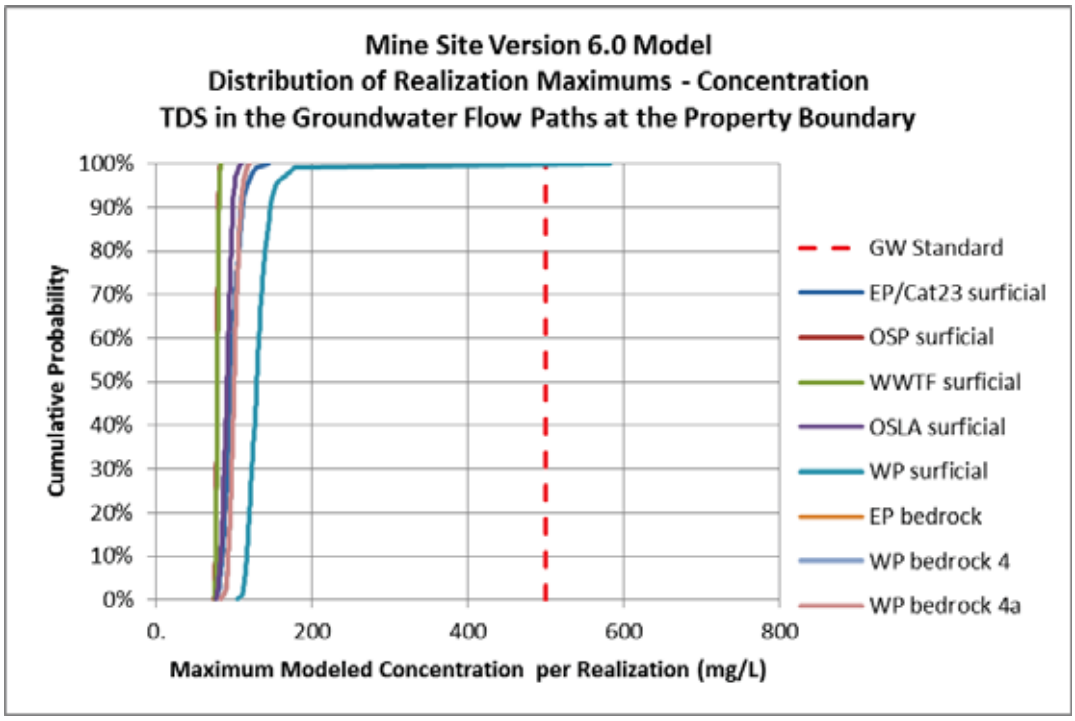


Figure 6-83 Maximum TDS Concentration in each Groundwater Flow Path per Realization

6.4 Surface Water Quantity

6.4.1 XP-SWMM Results and Streamflow Impacts

The XP-SWMM model described in Section 5.2.4.3 was used to evaluate estimated hydrologic impacts to the Partridge River resulting from the Project. XP-SWMM models were developed and run for the different scenarios described in Section 5.2.4.3.4, representing different time periods throughout the Project life. Flow data from each model was output for the locations specified in Section 5.2.4.3.3. As noted in Section 5.2.4.3.1 contributions from the Peter Mitchell Pit are not included in the existing conditions or future conditions XP-SWMM models. Thus, the relative impacts of the Project on modeled streamflow prior to the estimated closure of the Peter Mitchell Pit in 2070 (Mine Year 55) may be overestimated, as the discharge from the Peter Mitchell Pit would increase the baseline flows above what is estimated in the existing conditions XP-SWMM model. In terms of hydrologic impacts, this is a conservative approach (note that

contributions from the Peter Mitchell Pit are included in the probabilistic model, see Section 5.2.4.6.1).

6.4.1.1 Evaluation Metrics (Richter Statistics)

Summary statistics were calculated from the XP-SWMM flow output for each of the eight evaluation locations listed in Section 5.2.4.3.3 and for each of the six model scenarios listed in Section 5.2.4.3.4, as well as the existing condition; this results in a total of 56 datasets. It should be noted that results from location SW001 are not presented here, as this location is upstream of all project impacts (i.e., the project impact is estimated to be zero).

The remaining 49 output datasets were processed using a script developed in MS Visual Basic for Applications. This script allows computation of statistics for each year of the XP-SWMM model simulation period (10 years). The summary statistics presented in this report correspond to the parameters recommended in the "Range of Variability Approach" described in Reference (69) and include:

- mean flow for each calendar month
- annual maximum 1-day, 3-day, 7-day, 30-day and 90-day mean flows
- annual minimum 1-day, 3-day, 7-day, 30-day and 90-day mean flows
- number of zero-flow days
- 7-day minimum flow divided by mean flow for year
- Julian date of each annual 1-day maximum flow
- Julian date of each annual 1-day minimum flow
- number of high pulses each year; that is, the number of times per year the mean daily flow increases above the 75th-percentile of all recorded/simulated mean daily flows
- number of low pulses each year; that is, the number of times per year the mean daily flow falls below the 25th-percentile of all recorded/simulated mean daily flows
- mean duration of high pulses; that is, the number of days per year with mean flows above the 75th-percentile of all recorded/simulated mean daily flows
- mean duration of low pulses; that is, the number of days per year with mean flows below the 25th-percentile of all recorded/simulated mean daily flows
- means of all positive differences between consecutive daily values

- means of all negative differences between consecutive daily values
- number of flow reversals

Reference (69) indicates that these statistics are the key parameters used to define the degree of hydrologic alteration due to changes in the watershed. These authors also recommend using these statistics to evaluate flow and stream morphology impacts. The discussion of the XP-SWMM results focuses on average annual flows, average annual maximum flows and average annual minimum flows. The complete set of tabulated results is presented in Attachment J.

6.4.1.2 Estimated Impacts Presented as "Time-series"

The results for average annual flow, annual 1-day maximum flow, and annual 30-day minimum flow are presented in Figure 6-84 through Figure 6-90 for evaluation locations SW002 through SW006, respectively. The X-axis of each plot represents "time" in a non-linear fashion, beginning with the existing conditions and continuing through the six future periods evaluated. Results are presented as a percent change from the existing condition. Additional figures presenting results for a time period and plotting location along the X-axis are included in Attachment J.

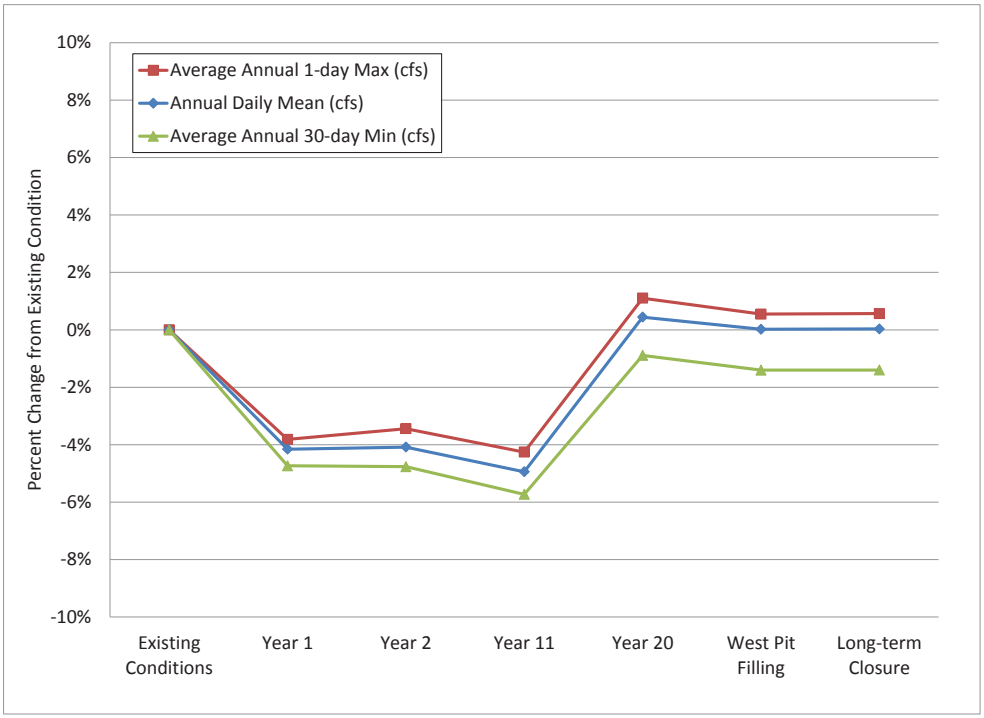


Figure 6-84 Hydrologic Impacts to Average, High and Low Flows Estimated at SW002

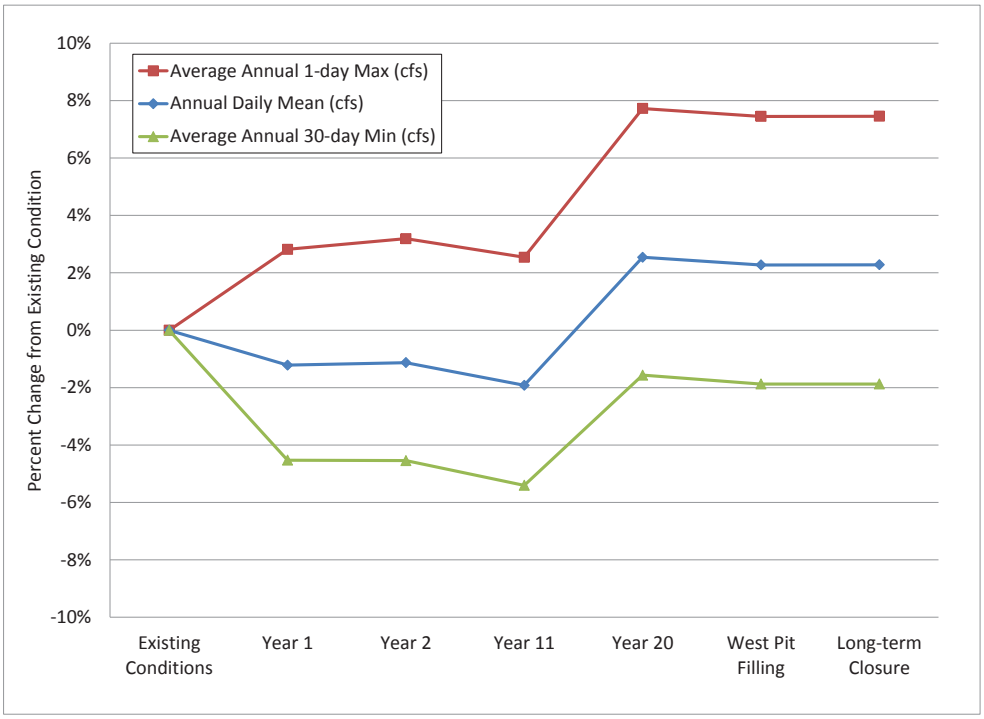


Figure 6-85 Hydrologic Impacts to Average, High and Low Flows Estimated at SW003

Figure 6-86 Hydrologic Impacts to Average, High and Low Flows Estimated at SW004

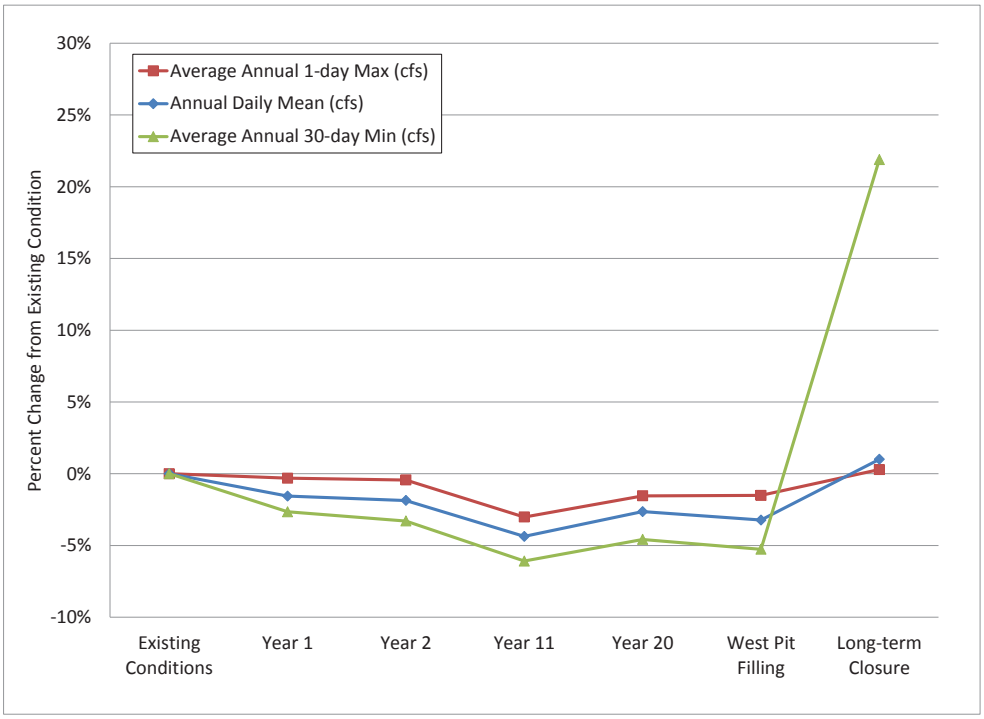


Figure 6-87 Hydrologic Impacts to Average, High and Low Flows Estimated at SW004a

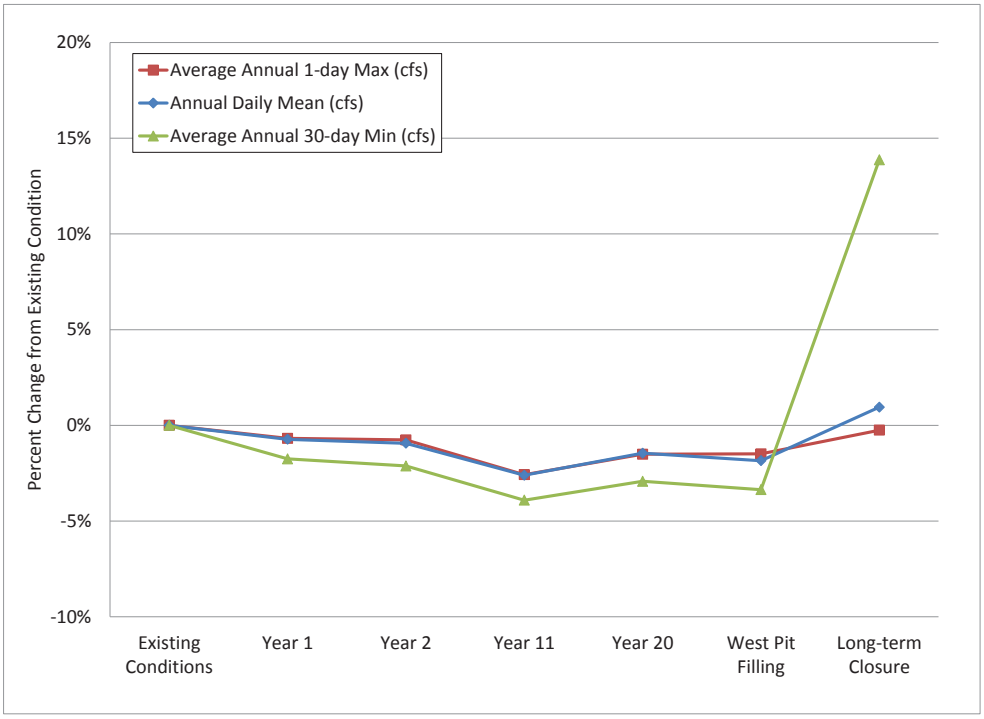


Figure 6-88 Hydrologic Impacts to Average, High and Low Flows Estimated at SW004b

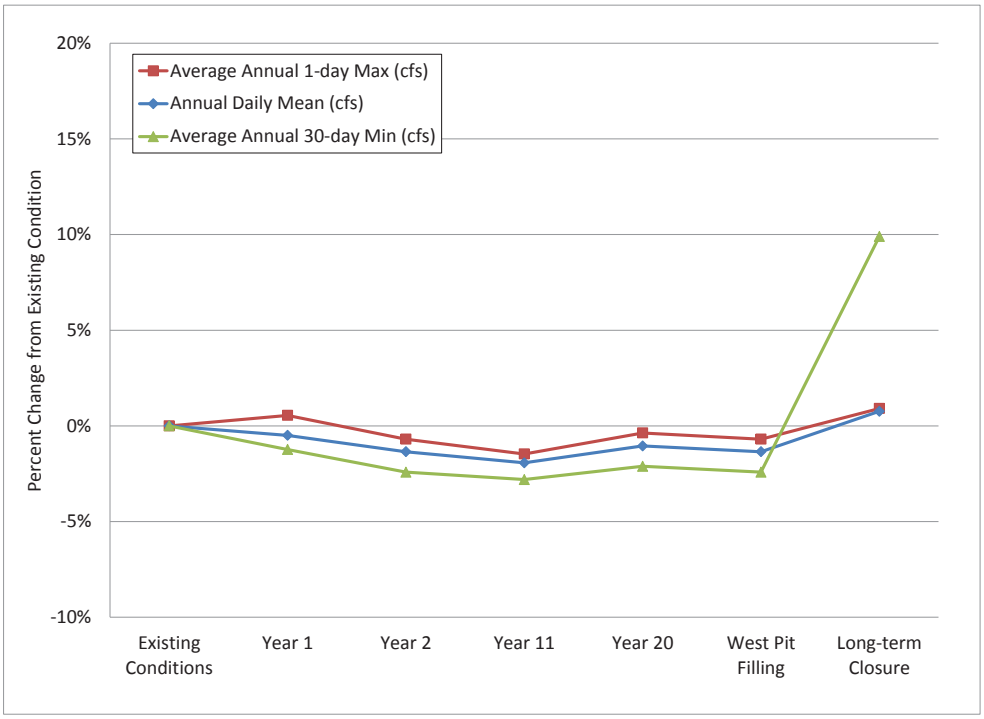


Figure 6-89 Hydrologic Impacts to Average, High and Low Flows Estimated at SW005

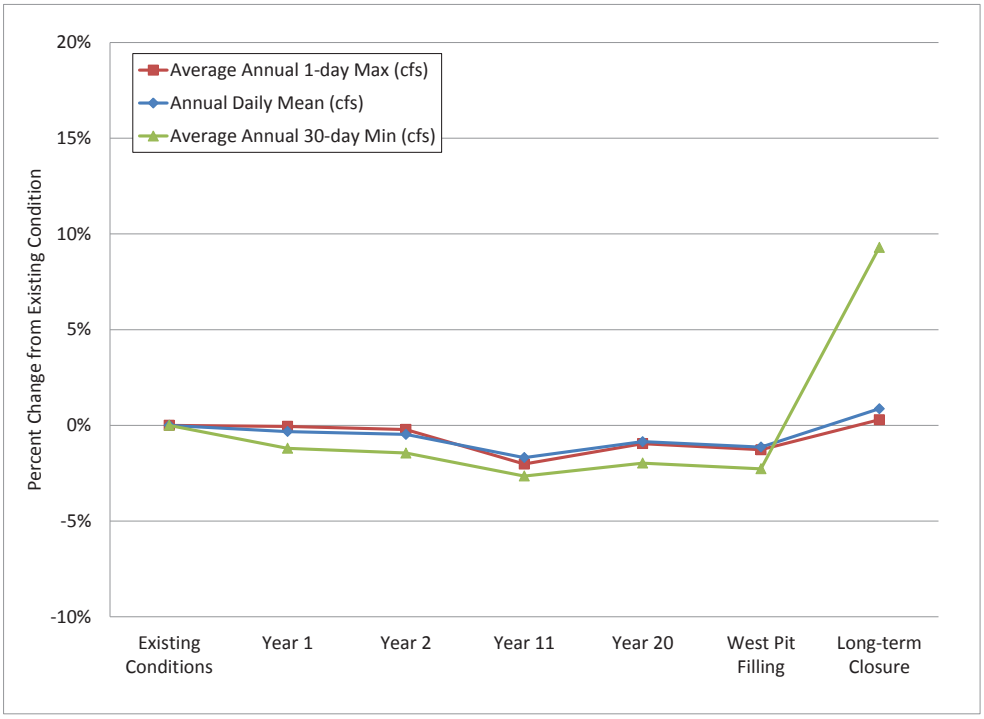


Figure 6-90 Hydrologic Impacts to Average, High and Low Flows Estimated at SW006

At each of the evaluation locations presented above, the estimated reductions in average annual and annual maximum 1-day flows are less than 5%. Conversely, increases in average annual and annual maximum 1-day flows are less than 10%. The largest reductions in average and 1-day maximum flow, measured relative to the existing condition, occur in Mine Year 11, when the largest area of the Mine Site is disturbed (in Mine Year 20, some of this disturbed area is returned to the watershed by reclaiming the Category 1 Waste Rock Stockpile). The largest single reduction is observed at SW004a, immediately downstream of most of the Mine Site. Impacts are further diminished in the downstream direction, as the Partridge River receives runoff from additional watersheds that are not impacted by the project.

Increases in average annual and annual 1-day maximum flow occur at SW002 and SW003 in Mine Year 20 and later. The increase is due to an increase in tributary watershed area resulting from the development and reclamation of the Category 1 Waste Rock Stockpile (Large Figure 26). Downstream of SW003, the increase is offset by reductions in tributary area elsewhere within the Mine Site.

The annual 30-day minimum flow is reduced as development of the Mine Site reduces tributary area, with the greatest reductions occurring in Mine Year 11. The single greatest reduction (-7%) occurs at SW004. Increases in the annual 30-day minimum flow occur at SW004a and downstream in long-term closure due to the continuous discharge from the Mine Site Waste Water Treatment Facility. The maximum increase of 22% occurs at SW004a. The increase is reduced in the downstream direction, with increases of 14%, 10% and 9% occurring at SW004b, SW005, and SW006, respectively. An increase of 22 % is well within the range of natural variability observed in the USGS historical record (located at SW006). During the four years of the USGS record with above average 30-day low flow values, the average percent increase above average was approximately 100% (i.e., approximately double the average annual 30-day minimum flow from the entire period of record).

6.4.1.3 Impacts to Partridge River Morphology

Average annual and annual 1-day maximum flows in the Partridge River are expected to remain within 10% of the existing conditions at all modeled locations throughout the life of the Project and closure (Section 6.4.1.2).

The Partridge River watershed is a mix of upland and marshland, with very little development in its watershed. The Partridge River varies from sluggish, marshy reaches to large open ponds to steep boulder rapids (Reference (78)). Most of the natural sediment delivery from the watershed to the main stem of the Partridge River is likely relatively fine sediment (clays, silts and very fine sands) that are conveyed as wash load, which corresponds to the fraction of fluvially-transported sediment that does not affect the channel morphology. A reduction in mean annual and average daily maximum flows by less than 10% should not affect the transport capacity of the wash load.

The reaches in which the bed is covered with boulders should remain morphodynamically stable unless flows are significantly increased in magnitude and the occurrence of floods becomes more

frequent. Reference (78) lists one potentially sensitive reach located north of the Mine Site along the railroad tracks where the reach was channelized. The anticipated impact of the Mine Site includes increases of less than 8% to the maximum 1-day flow throughout the Partridge River, and increases of less than 2% north of the Mine Site (SW002, Figure 6-84). This change is within the range of annual variability of 1-day maximum flows observed in the existing flow record. No impacts are expected on the stream morphology of the Partridge River.

6.4.1.4 Summary of Partridge River Hydrologic Impacts

A hydrologic/hydraulic calibrated model was used to assess the impacts of the Project on the Partridge River flows. Basic statistics characterizing flow patterns at different locations along the Partridge River indicate that average and high flows will change by less than 10% throughout the stages of Mine Site development. The changes in average and high flows are greatest in the vicinity of the Mine Site but decrease to less than 5% below the confluence with the South Branch of the Partridge River (SW004a) and less than 3% immediately upstream of Colby Lake (SW006). Low flows are decreased by less than 10% with the exception of closure, in which low flows at SW004a and downstream are increased by as much as 22% due to the constant discharge from the WWTF. This increase diminishes to 9% immediately upstream of Colby Lake.

6.4.2 Impacts to Colby Lake and Whitewater Reservoir Water Levels

Changes in Partridge River flow (Section 6.4.1) and pumping from Colby Lake to the Plant Reservoir (Reference (5)) may impact water levels within Colby Lake and Whitewater Reservoir, located downstream of the Partridge River (Large Figure 1). The average annual make-up water drawn from Colby Lake to the Plant Site varies throughout operations and reclamation between 350 and 2030 gpm, with an average annual demand of 1170 gpm. This is the total potential raw water demand from the Beneficiation Plant, the Hydrometallurgical Plant and stream augmentation (Section 4.3.9.5 of Reference (5)). The demand of the two plants varies throughout operations between 120 and 860 gpm, with an average annual demand of 320 gpm. During reclamation the plants do not operate, but a steady demand of 1600 gpm is necessary to augment flow in the tributaries and wetlands around the Tailings Basin. Once Plant Site water is no longer needed for flooding the West Pit (Section 6.1.2.3.2), the demand for water from Colby Lake decreases to zero.

Analysis of potential water level impacts to Colby Lake and Whitewater Reservoir were previously performed and are summarized in Reference (13). That analysis considered three possible levels of project demand ranging from a constant demand of 3,500 gpm to a seasonal demand of up to 8,800 gpm for three months and 4,400 gpm for the remainder of the year. Impacts were assessed based on average and dry conditions.

Per consultation with the Co-Lead Agencies, the analysis of impacts to Colby Lake and Whitewater Reservoir water levels has not been updated, as the previous modeling provides a reasonable range of estimated impacts Reference (13). Current estimates of Project-related

pumping from Colby Lake (including water for use at the Plant Site as well as tributary augmentation) are described Reference (5) and are estimated to be less than 3,500 gpm throughout the modeled period. Anticipated impacts to Partridge River flows (i.e., inflows to Colby Lake) are similar to that considered in the previous analysis performed in Reference (13). Thus, impacts to Colby Lake and Whitewater Reservoir lake levels are estimated to be less than the minimums evaluated in Reference (13).

Estimated impacts to water levels resulting from the 3,500 gpm constant demand under average conditions are summarized in Table 6-11. Impacts are assessed against the Continuation of Existing Conditions Scenario in which there is no project-related pumping from Colby Lake or project-related impacts to Partridge River flows.

Table 6-11 Previously Estimated Impacts to Water Levels in Colby Lake and Whitewater Reservoir – Average Conditions

	Colby Lake		Whitewater Reservoir	
	CEC Scenario	With Project	CEC Scenario	With Project
Withdrawal Rate (gpm)	0	3,500	0	3,500
Average Elevation (ft)	1439.45	1439.44	1439.33	1438.94
Maximum Elevation (ft)	1442.75	1442.51	1440.26	1440.25
Minimum Elevation (ft)	1438.85	1438.88	1437.41	1435.98
Maximum Fluctuation (ft)	3.90	3.63	2.85	4.22

Notes:
Values presented for Colby Lake evaluated based on four-year modeled period.
Values for Whitewater Reservoir based on April – October of four-year modeled period.
Values from Table 8 in Reference (13)

6.5 Surface Water Quality

Surface water quality is estimated by combining flows and loads from the Mine Site with flows and loads from other sources such as watershed runoff, unimpacted groundwater, and upstream point sources (Section 5.2.3.8.3). The probabilistic water quality model is used to evaluate estimated mixed water quality relative to the surface water standards at select evaluation locations. Quantitative evaluations are made by comparing the 90th percentile concentration to the applicable surface water standard consistent with direction provided by the Co-lead Agencies as part of the IAP process (Reference (81)). For the NorthMet EIS, the project will be assumed to estimate a significant effect on water quality if the 90th percentile model concentrations exceed an applicable standard. The State has retained the flexibility to modify this impact criteria based on site-specific factors and model results. For most constituents, where the surface water standard is a single value, the comparison of modeled concentrations to the standard is quite simple. However, some constituents have a hardness-based standard (cadmium, copper, nickel,

lead, and zinc) making the comparison more difficult (see Section 2.2.1 for additional discussion of these standards).

As described in Section 5.2.4.1, there are seven model evaluation locations along the Partridge River and one location in Colby Lake. Although locations SW002 and SW003 are upstream of Project constituent loading to the Partridge River, they are affected by changes in watershed area due to the Project. Location SW004a is downstream of all Project impacts, as are downstream locations SW004b, SW005, SW006 and Colby Lake. The evaluation of surface water quality in this section is organized by location.

6.5.1 Explanation of Plots

Four types of plots are used in this section:

- plots showing an overview of surface water quality estimated for each location
- plots showing concentration statistics
- plots showing probability of an exceedance statistics
- plots showing the culpability of loading to evaluation locations

The plots showing an overview of the surface water quality estimates are constructed in the same manner as the plots showing an overview of groundwater quality estimates discussed in Section 6.3.1.2 and are included as Large Figure 55 through Large Figure 62. Plots showing monthly concentration statistics, probability of exceedance statistics, and loading culpability are discussed further below.

6.5.1.1 Concentration Statistics Plots

The concentration statistics plots are generated by first, calculating representative statistical concentrations at every time step, and second, reducing the data to annual values by selecting either the highest annual concentration of each statistic or the average annual concentration of each statistic. For example, Figure 6-91 shows monthly statistics of the sulfate concentration at SW002 for 10 years. However, 200 years of highly oscillating results will render these figures illegible. Therefore, the plots are summarized further by using either the annual maximum or the annual average value for each year. Figure 6-92 shows the same sulfate concentrations at the same location, but reduced to single concentration values for each year, and for each statistic. In Figure 6-91, the monthly median concentration oscillates from about 11 mg/L to about 27 mg/L. Figure 6-92, showing the annual maximum, shows the median concentration hovering around 27 mg/L during Mine Year 0 through Mine Year 55, which is the highest value of the median each year.

Note that at SW002 (as shown in Figure 6-92), as well as at the downstream locations in the Partridge River, some constituents show significant changes in modeled concentrations for the

Continuation of Existing Conditions Scenario at Mine Year 55. These changes are entirely due to the assumed discontinuation of dewatering from the Peter Mitchell Pit at that time. Because these changes are part of the Continuation of Existing Conditions Scenario, they also occur in Mine Year 55 for the Project Model. These results should be considered for interpreting concentrations further downstream in the Partridge River, which are also affected by the discharge from the WWTF beginning at approximately the same time.

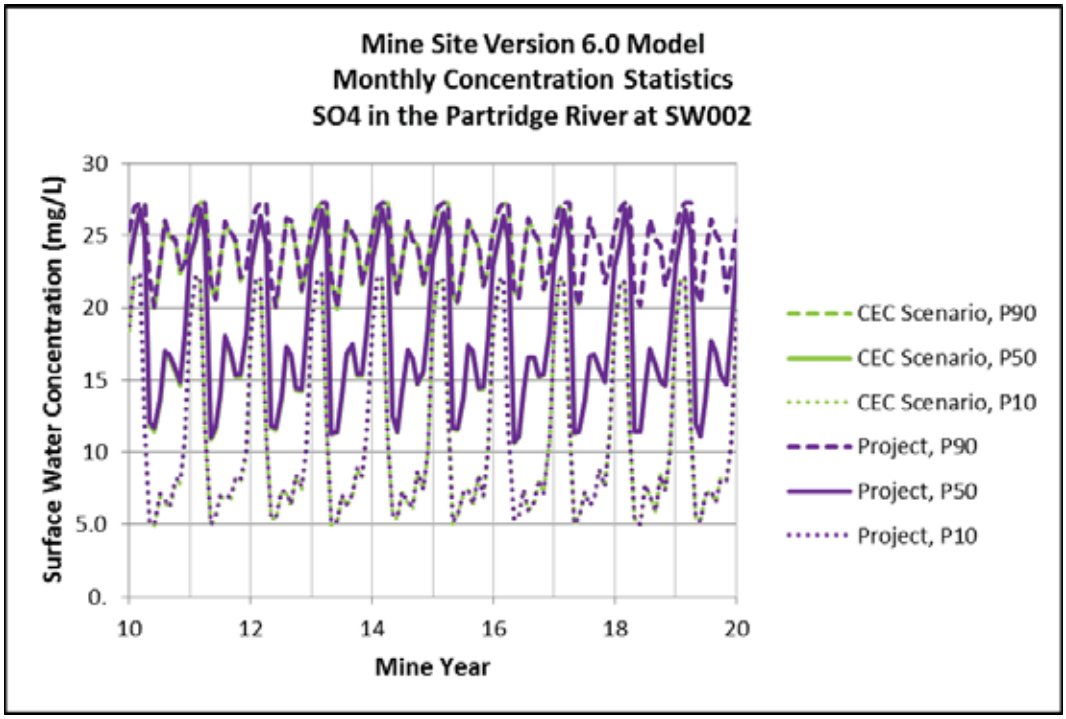


Figure 6-91 Monthly Sulfate Concentration in the Partridge River at SW002

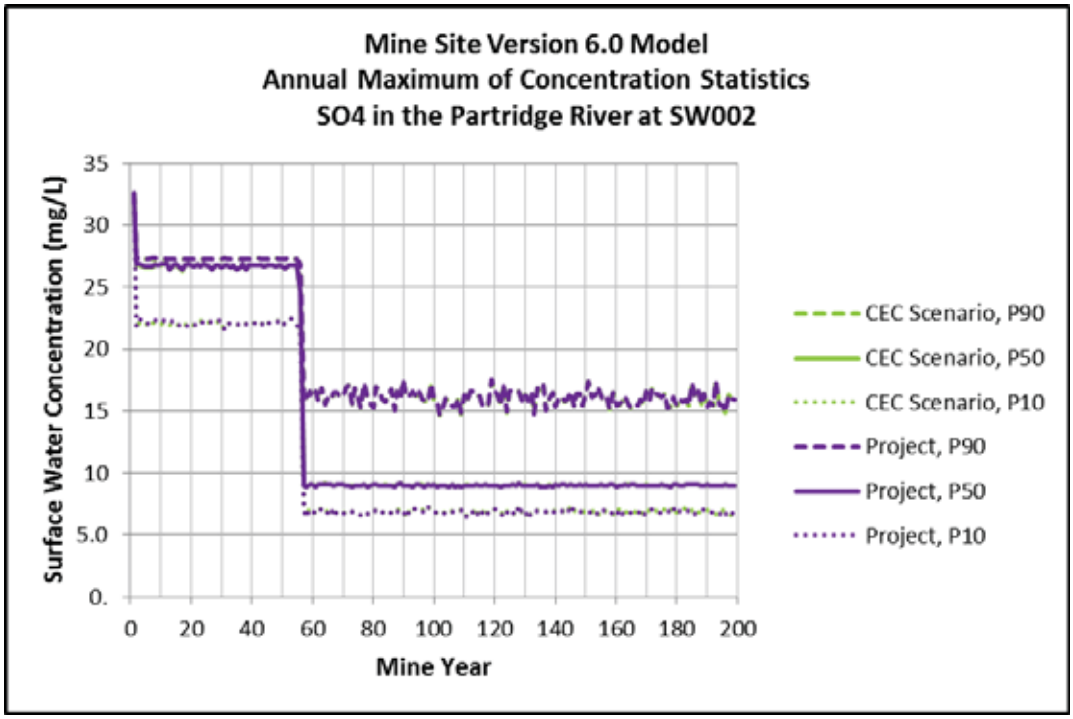


Figure 6-92 Annual Summary of Sulfate Concentration in the Partridge River at SW002

For the most part, annual maximum plots are shown in this section; however plots of both annual maximum and annual average concentration at all surface water evaluation locations are provided in Attachment K. The data is summarized in tabular form in Large Table 39 through Large Table 46.

6.5.1.2 Probability of Exceedance at any Time

The likelihood of exceedance through time is an additional method to assess the impact of the Project on surface water quality, particularly for the metals that have a hardness-based standard. The tables and plots in this section were created by taking the following steps:

- At any given time step, all constituents were individually evaluated (true/false) against the applicable surface water standard at all surface water evaluation locations. If the estimated concentration was greater than the standard, the result for that constituent, at that time, and at that location, is true; if it is not over the standard, the result is false.

- The evaluation was performed at every time step during a realization, resulting in a 200-year time series (2401 time steps/results) of true or false values.

- The process was repeated during each of the additional realizations until all 500 realizations were run. The result is a set of 500 true or false results at every time step for each constituent at each location.

- At any time step (24.33 years for example), the number of realizations showing a result of true was divided by 500, resulting in the probability of estimating an exceedance. Zero exceedances results in 0%, 50 exceedances results in 10%, etc.

- The probability of exceedance was determined for all time steps, resulting in a time series of the probability of exceeding the applicable surface water standard.

- Just as for the concentration statistics plots, the probability of exceedance plots are summarized annually by selecting either the maximum annual probability of exceedance for each year, or by the annual average probability of exceedance for each year.

The red line in the example figure, Figure 6-93, shows the probability of exceedance through time. It is possible, however, that an exceedance in the Project Model is not attributed to the Project itself and will occur with or without the Project. The above process of tracking exceedances was repeated, tracking only time steps with an exceedance in the Project Model and no exceedances in the Continuation of Existing Conditions Scenario Model. The blue-dashed line shows the probability of the Project Model simulating an exceedance when the Continuation of Existing Conditions Scenario Model will not show an exceedance. This represents the increase in the probability of an exceedance at each time step due to the Project. The red line shows the overall annual maximum probability if the Project were to occur; the blue-dashed line shows the annual maximum impact of the Project on actually causing additional exceedances.

In Figure 6-93, the vertical black-dashed lines separate the time period operations (OPS) from reclamation (REC), and the time period reclamation from long-term closure (LONG-TERM). Figure 6-93 shows that in any given year, the aluminum standard in the Partridge River at SW003 has up to an approximately 18% probability of being exceeded and is quite stable throughout the modeled 200-year period. Figure 6-93 also shows that the Project itself has a nearly zero likelihood of causing an exceedance that does not correspond to an exceedance in the Continuation of Existing Conditions Scenario Model.

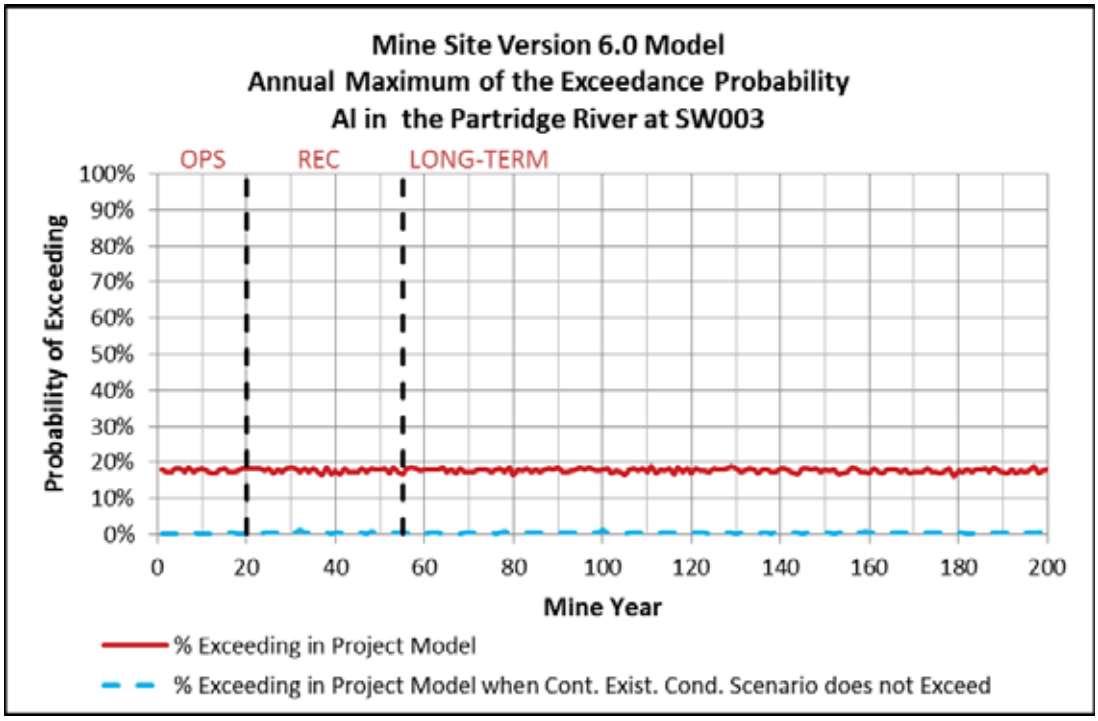


Figure 6-93 Probability of an Aluminum Exceedance in the Partridge River at SW003

All probability of exceedance plots at select surface water evaluation locations are shown in Attachment L.

6.5.1.3 Culpability Plots

The culpability plots for the eight surface water evaluation locations were created in the same manner as described in Section 6.2.1.2. All surface water culpability plots at all surface water evaluation locations are shown in Attachment M.

6.5.2 Partridge River Upstream of Mine Site Loading

Two evaluation locations in the Partridge River, SW002 and SW003, are upstream of all Project-related constituent loading to the river. These locations receive flow from natural background groundwater and surface runoff, as well as the discharge from the Peter Mitchell Pits (Section 5.2.4.6.1). The only Project-related impact to this portion of the Partridge River is a reduction in the watershed area due to development of the Mine Site. Most of the removed watershed area is restored in long-term closure, with runoff from a portion of the reclaimed Category 1 Waste Rock Stockpile being routed to the Partridge River upstream of SW002 (Section 5.2.4.3.4). Runoff from reclaimed areas is assumed to have the same water quality as runoff from natural areas.

There is very little discernible change in the modeled water quality at SW002 and SW003 between the Continuation of Existing Conditions Scenario Model and Project Model. At these locations most constituents meet the applicable surface water standard at the 90th percentile concentration; aluminum is the only exception (Large Figure 55 and Large Figure 56). Aluminum is discussed in more detail in Section 6.5.6.1.

Following MPCA guidance (Section 2.2.1), constituents with hardness-based standards are evaluated at SW002 and SW003 based on the modeled hardness at each model time step. This means that the applicable standard continuously changes as the modeled hardness changes. For the constituents with hardness-based standards, plots of the probability of an exceedance need to be assessed in order to determine whether concentrations are estimated to be above the standard at the modeled hardness. At SW002 and SW003, all of the metals with a hardness-based standard are estimated to have less than a 2% probability of an exceedance, with cadmium, nickel, and lead having no modeled exceedances (Attachment L). Copper and zinc both have a less than 2% probability of an exceedance at any time (Figure 6-94 and Figure 6-95). Note that the blue dashed lines in these figures shows that the probability of a Project-caused exceedance is essentially constant at zero (the maximum value of the blue dashed lines in Figure 6-94 and Figure 6-95 at any time is 0.4%, or 2 realizations out of 500).

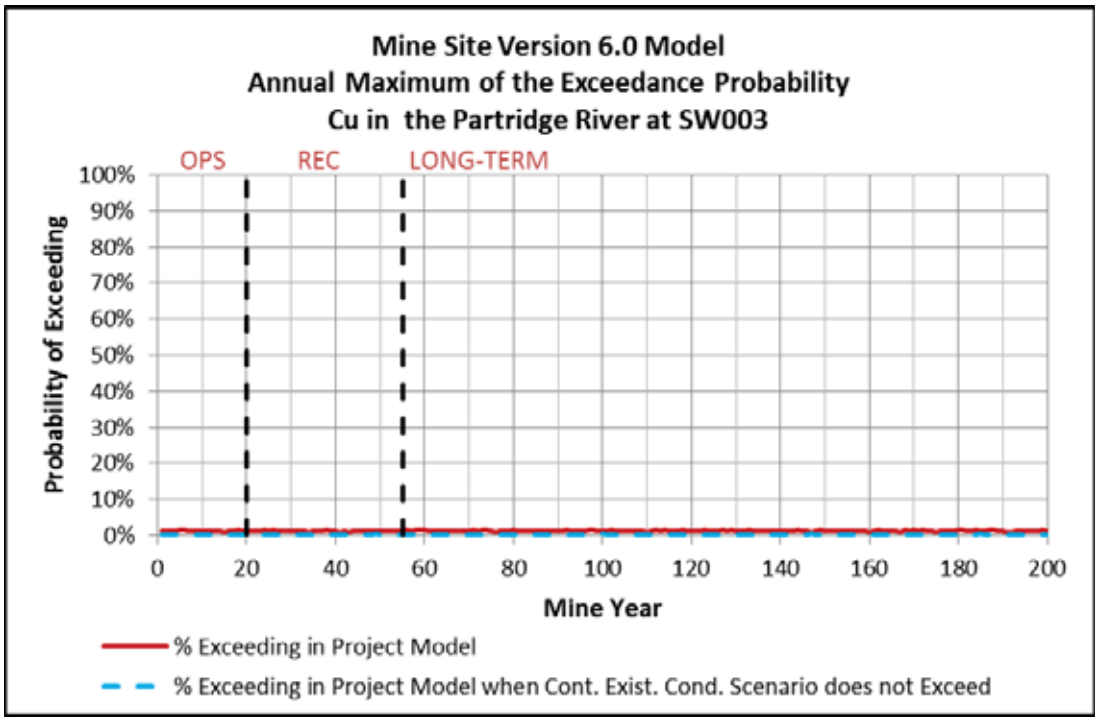


Figure 6-94 Annual Summary of the Probability of a Copper Exceedance at SW003

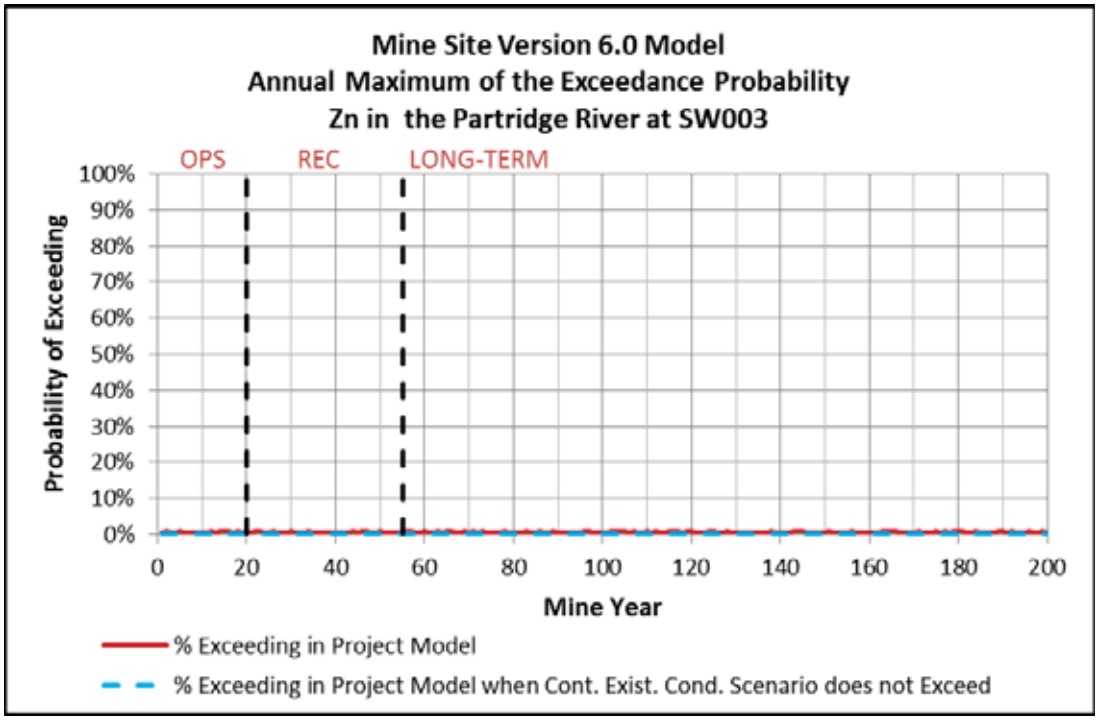


Figure 6-95 Annual Summary of the Probability of a Zinc Exceedance at SW003

6.5.3 Partridge River at SW004 and SW004a

Water that is impacted by Project-related constituent loading contributes to the Partridge River upstream of evaluation locations SW004 and SW004a. Evaluation location SW004 is downstream of most of the groundwater flow paths from the Mine Site features but upstream of loading from the West Pit surficial flow path and the long-term WWTF discharge location. Evaluation location SW004a is downstream of all Project-related constituent loading to the Partridge River. Both of these locations also experience a reduction in watershed area due to development of the Mine Site. Most of the removed watershed area becomes tributary to the West Pit in long-term closure.

Table 6-12 summarizes the contributions of water from the Mine Site flow paths to the Partridge River at SW004 and SW004a. The majority of the water from these flow paths that reaches the Partridge River originates as recharge from the unimpacted areas downgradient of the Mine Site features. The only other discharge of Project water to the Partridge River is the effluent from the WWTF in long-term closure, with an average flow of 308 gpm (Section 6.1.2.4.3). The modeled average flow under the Continuation of Existing Conditions Scenario Model is 7,630 gpm (17.0 cfs) at SW004 and 20,810 gpm (46.4 cfs) at SW004a. This does not include the discharge from the Peter Mitchell Pit which is estimated to average 1,170 gpm (2.6 cfs), and assumed to stop in Mine Year 55.

Table 6-12 Flow Summary from Mine Site to SW004 and SW004a

	From Mine Feature (Peak)			Total to Partridge River (Peak)(1)		
Source	**P10 (gpm)**	**Average (gpm)**	**P90 (gpm)**	**P10 (gpm)**	**Average (gpm)**	**P90 (gpm)**
Groundwater Flow Paths						
East Pit – Category 2/3 (surficial to SW004)	2.1(2) 0.010(3)	3.9(2) 0.037(3)	6.2(2) 0.075(3)	23	41	63
East Pit (bedrock to SW004)	0.09	0.18	0.30	0.10	0.19	0.30
OSP (surficial to SW004)	0.0004	0.002	0.003	4.5	7.6	11
WWTF (surficial to SW004)	0.03			2.5	4.3	6.3
OSLA (surficial to SW004)	11	14	18	16	24	31
West Pit (surficial)	3.1	6.5	11	8.4	18	29
West Pit (bedrock to SW004)	0.03	0.06	0.10	0.03	0.06	0.10
West Pit (bedrock to SW004a)	0.05	0.10	0.16	0.05	0.10	0.16
Surface Water Discharge						
Long-term WWTF	285	308	397	285	308	397
Continuation of Existing Conditions Scenario Model Partridge River Flow(4)						
Peter Mitchell Pit (5)	–			1,170	1,170	1,170
SW004 (5)	--			1,020	7,630	18,720
SW004a (5)	--			2,790	20,810	50,870

(1) For the groundwater flow paths, the difference between the flow from the Mine Site features and the total flow to the Partridge River is the natural recharge downgradient of the Mine Site features. There is no recharge to the bedrock flow paths; the flows leaving the East and West Pits are identical to those entering the Partridge River (Section 5.2.3.4).
(2) Flow from the flooded East Pit upper/wetland porewater.
(3) Flow from Category 2/3 Waste Rock Stockpile liner leakage.
(4) Flows shown are the annual average of the monthly flow statistics for the Continuation of Existing Conditions Scenario model, calculated as described in Section 6.5.1.1.
(5) Flow from the Peter Mitchell Pit dewatering is additive to the flows shown at SW004 and SW004a for Mine Year 0 through Mine Year 55 and ceases after Mine Year 55 in the Continuation of Existing Conditions Scenario Model.

At SW004 and SW004a most constituents meet the applicable surface water standard; aluminum is the only exception (Large Figure 57 and Large Figure 58). Aluminum is discussed in more detail in Section 6.5.6.1. Despite the flow reaching the Partridge River from the Mine Site surficial flow paths, for many constituents there is little discernible change in the modeled water quality at SW004 between the Continuation of Existing Conditions Scenario Model and Project Model.

Long-term changes in the modeled concentration at SW004 that are noticeable are often due primarily to the change in watershed area rather than loading from Project sources. An example of this behavior is shown in Figure 6-96 for fluoride. While there is little difference between the Continuation of Existing Conditions Scenario Model and Project Model for the 10th percentile and 90th percentile concentrations, there is a slight increase in the 50th percentile concentration (relative to the Continuation of Existing Conditions Scenario results) that is noticeable beyond Mine Year 55. Note that the significant decrease in the 50th percentile concentration for both models in Mine Year 55 is due to the discontinuation of Peter Mitchell Pit dewatering discharge to the Partridge River.

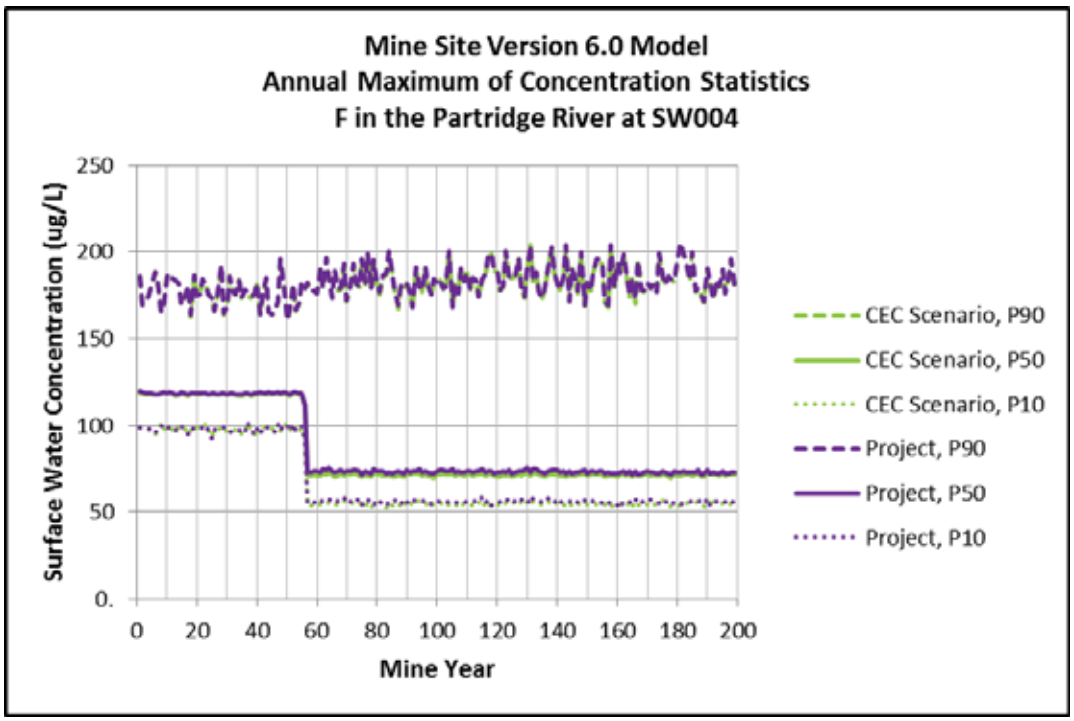


Figure 6-96 Annual Summary of Fluoride Concentration in the Partridge River at SW004

The only constituents with modeled changes in concentration at SW004 that are clearly attributable to Project loading are cobalt and sulfate. Figure 6-97 shows the estimated cobalt concentration, which increases from the Continuation of Existing Conditions Scenario especially at the 90th percentile level. The 50th percentile concentration peaks at Mine Year 50 and again at Mine Year 120, suggesting that the cobalt load originates in the East Pit – Category 2/3 surficial

flow path, which has a similar concentration shape and timing (see the estimated sulfate concentrations in groundwater at the Property Boundary in Figure 6-69). This interpretation is confirmed by the loading rates shown in Figure 6-98; note that the light blue bars representing the load from the East Pit – Category 2/3 surficial flow path are largest at Mine Year 50 and again at Mine Year 120 through Mine Year 200. Also note that the shift in concentrations at Mine Year 55 is due to the discontinuation of Peter Mitchell Pit dewatering discharge to the Partridge River, which is lower in cobalt than the background groundwater and surface runoff and therefore provides a diluting flow until Mine Year 55.

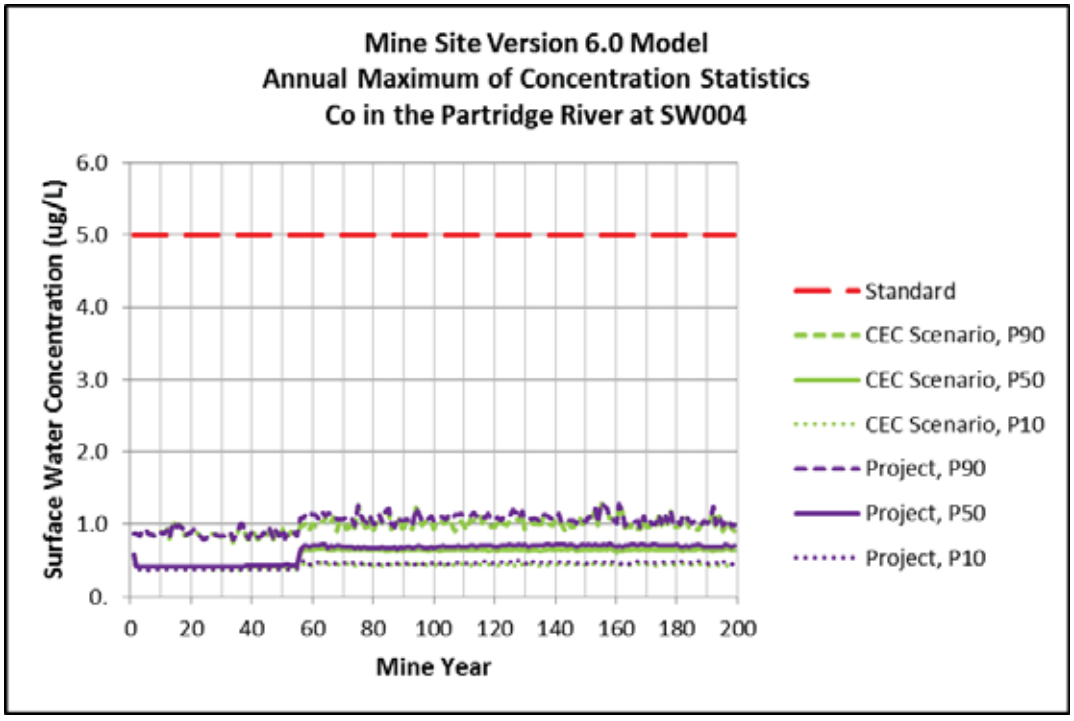


Figure 6-97 Annual Summary of Cobalt Concentration in the Partridge River at SW004

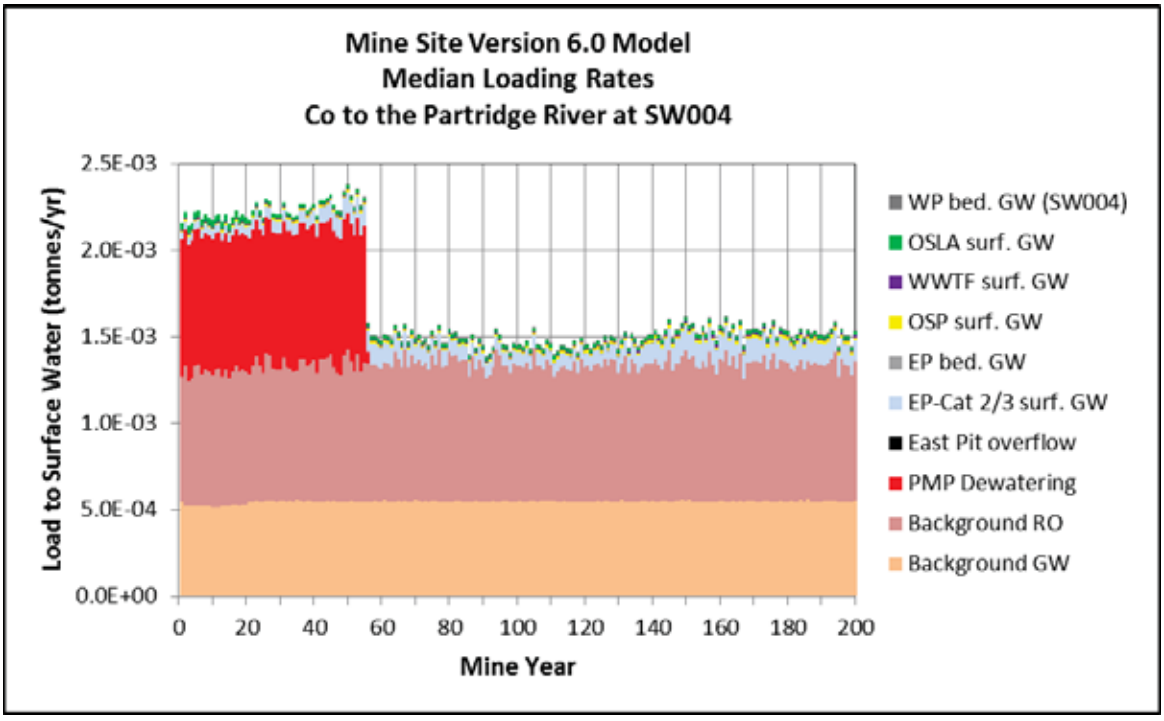


Figure 6-98 Median Cobalt Loading to the Partridge River at SW004

Figure 6-99 shows the estimated sulfate concentration at SW004, which increases slightly from the Continuation of Existing Conditions Scenario at the 50th percentile. Most of the increase occurs after Mine Year 55 and is constant thereafter; the increase is therefore due primarily to Project-related changes in the watershed area that are masked by the loading from the Peter Mitchell Pit discharge before Mine Year 55. The relative sulfate loading to SW004 is shown in Figure 6-100. The overall change in sulfate concentration in the Partridge River is discussed in more detail in Section 6.5.6.2.

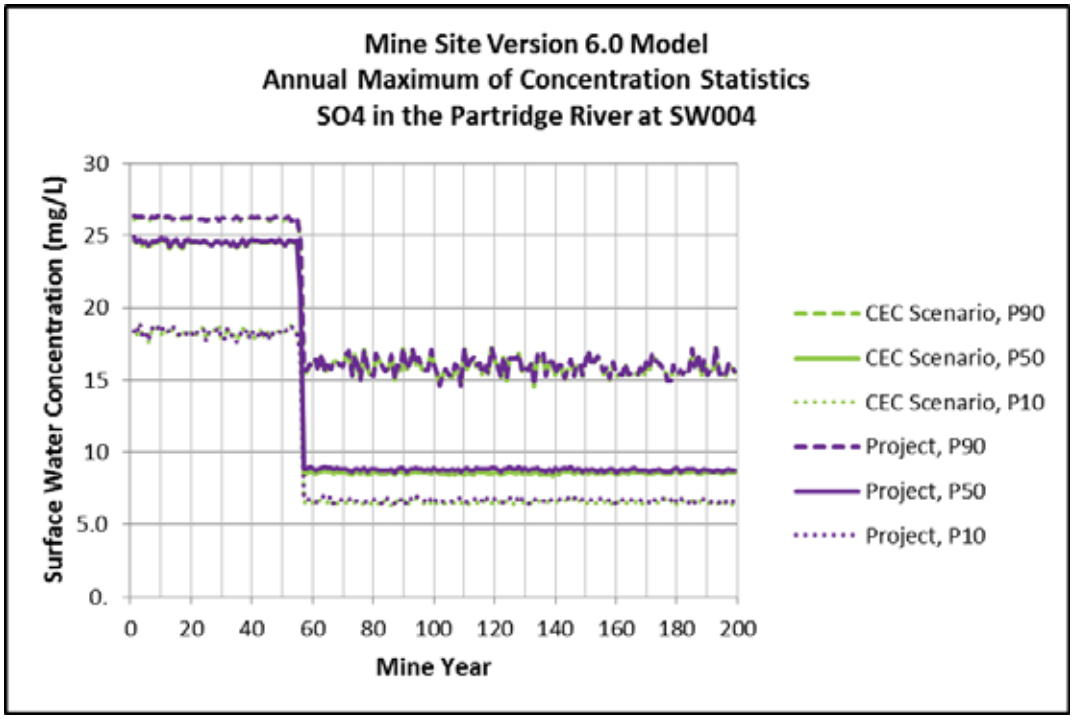


Figure 6-99 Annual Summary of Sulfate Concentration in the Partridge River at SW004

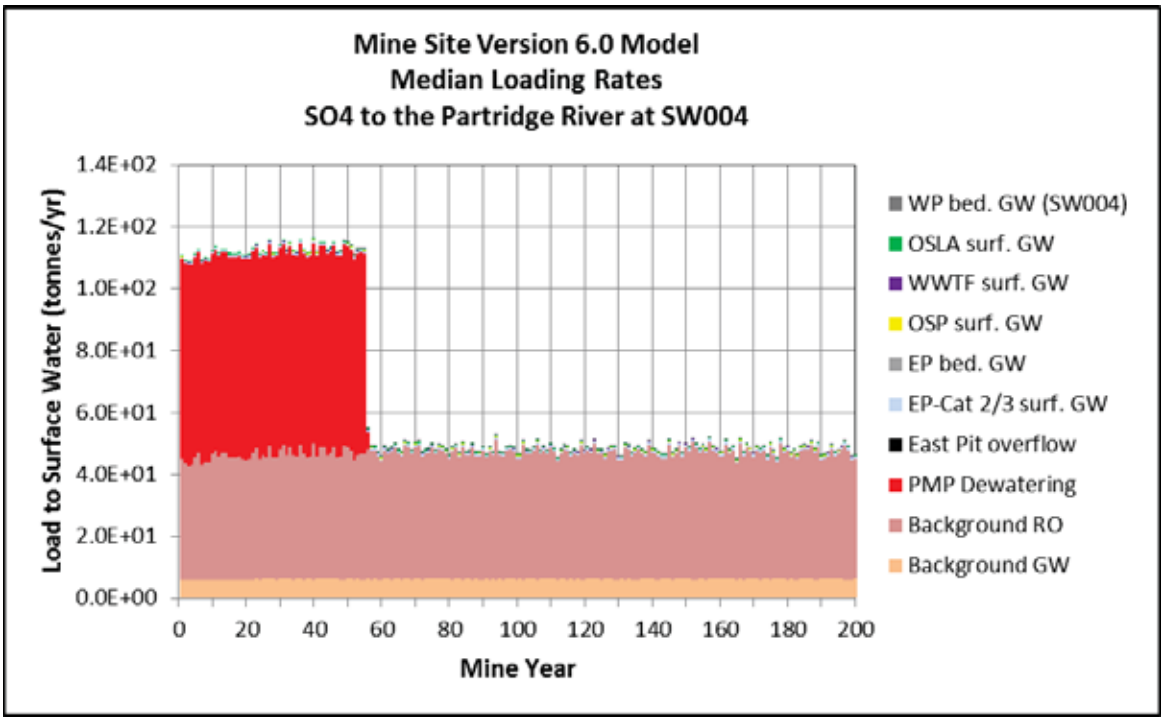


Figure 6-100 Median Sulfate Loading to the Partridge River at SW004

At evaluation location SW004a, the estimated concentration for many constituents shows a distinct discontinuity at approximately Mine Year 55, often increasing sharply. This increase is most often due to the commencement of discharge of treated effluent from the long-term WWTF, with the effluent at or near the water quality standard for many constituents. As previously discussed, the discontinuation of Peter Mitchell Pit dewatering discharge at the same time causes changes in concentrations that may increase or decrease the Partridge River concentrations for both the Continuation of Existing Conditions Scenario and Project Models. An example of this behavior is shown in Figure 6-101 for cobalt. A portion of the increasing concentration at Mine Year 55 is due to the discontinuation of the low-cobalt Peter Mitchell Pit dewatering (visible in the increase in the 50th percentile concentration for the Continuation of Existing Conditions Scenario) and the remainder is due to the Project WWTF discharge and flow path contributions. The median annual load to the Partridge River for cobalt is shown in Figure 6-102, again showing a clear increase with the WWTF discharge in approximately Mine Year 55.

The estimated concentrations of the metals with hardness-based standards are shown in Figure 6-103 through Figure 6-107 for cadmium, copper, nickel, lead, and zinc. Although these metals have hardness-based standards, following MPCA guidance (Section 2.2.1) they are evaluated based on the median hardness measured (not modeled) in the receiving stream; the standard is therefore constant as shown in the results figures. All constituents with hardness-based standards have a less than a 3.5% probability of an exceedance at SW004 and SW004a, and in all cases the likelihood of Project-caused exceedances that are not present in the Continuation of Existing Conditions Scenario Model is 0.20% (one realization out of 500) or zero (Attachment L).

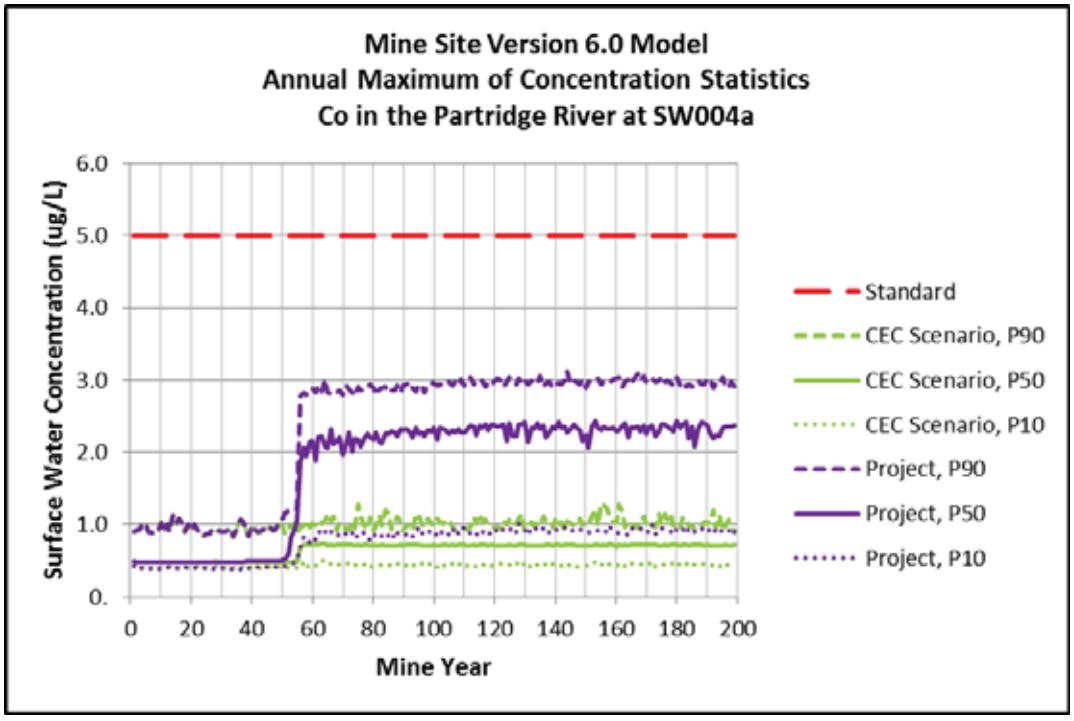


Figure 6-101 Annual Summary of Cobalt Concentration in the Partridge River at SW004a

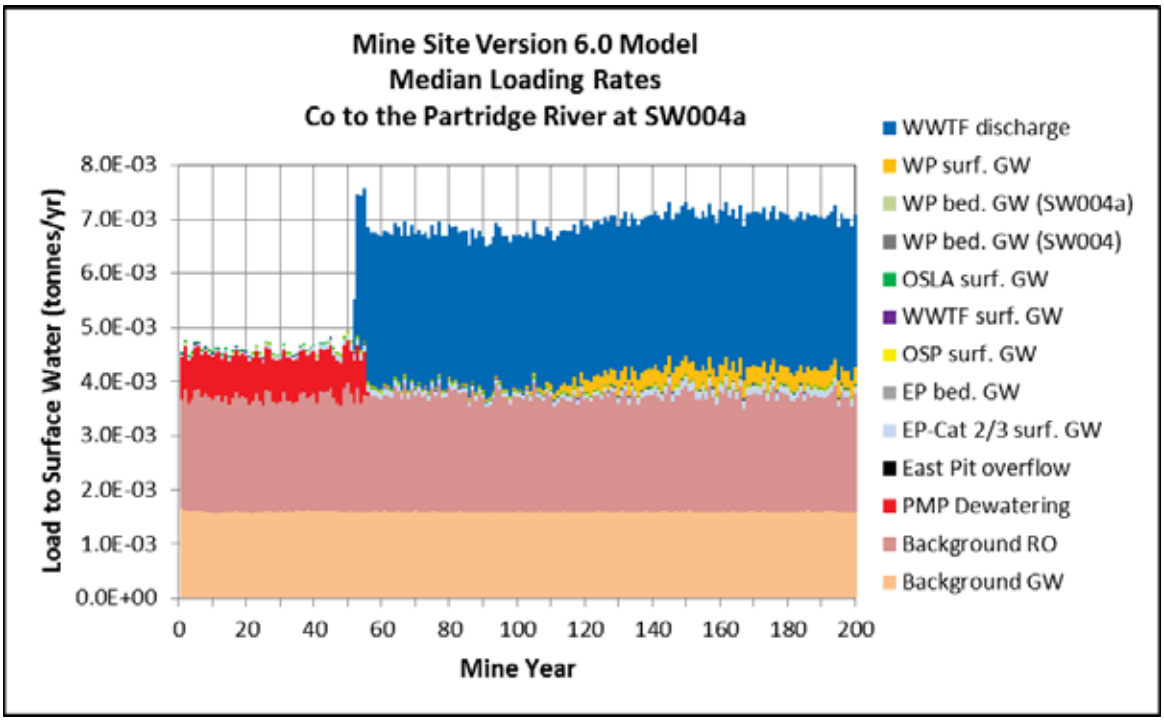


Figure 6-102 Median Cobalt Loading to the Partridge River at SW004a

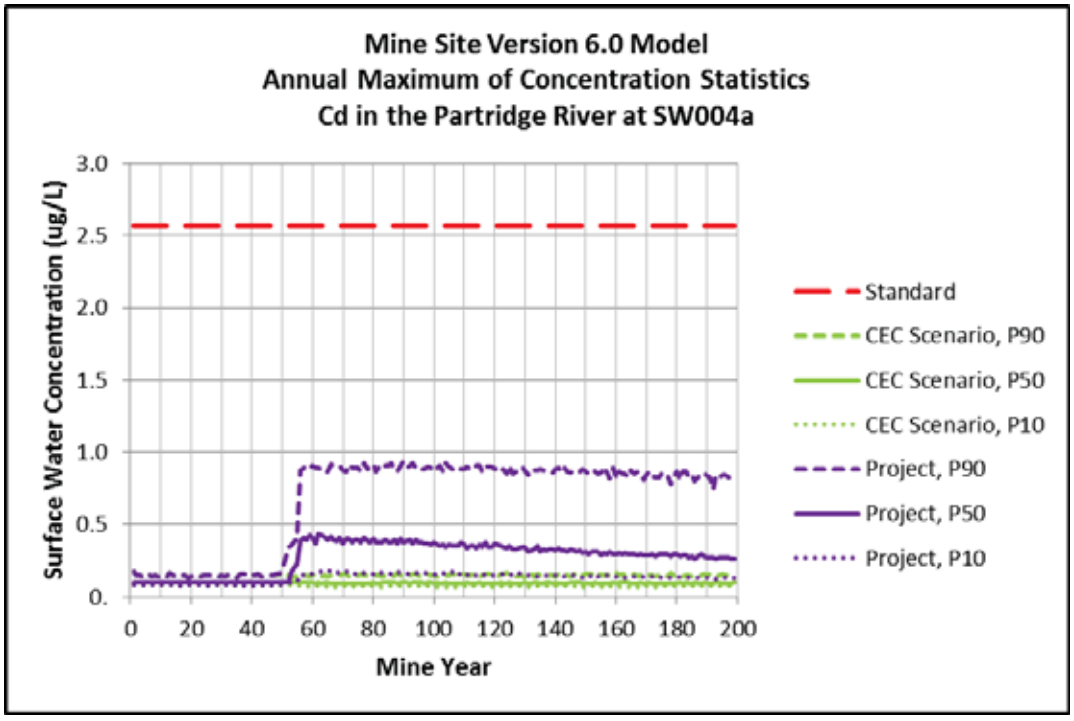


Figure 6-103 Annual Summary of Cadmium Concentration in the Partridge River at SW004a

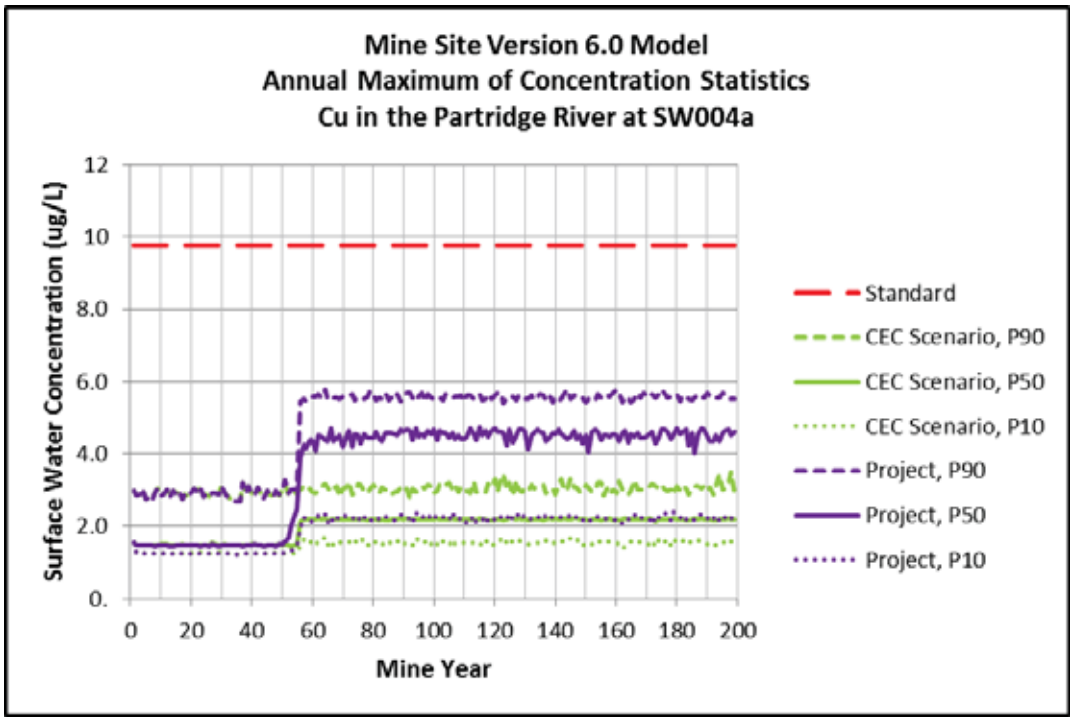


Figure 6-104 Annual Summary of Copper Concentration in the Partridge River at SW004a

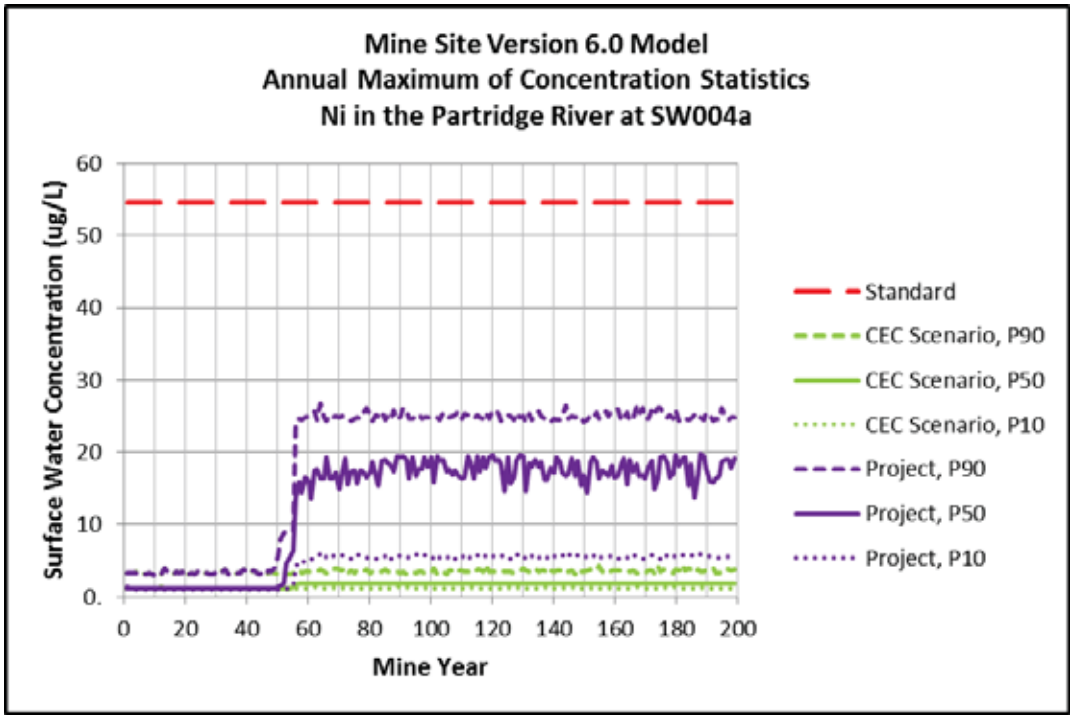


Figure 6-105 Annual Summary of Nickel Concentration in the Partridge River at SW004a

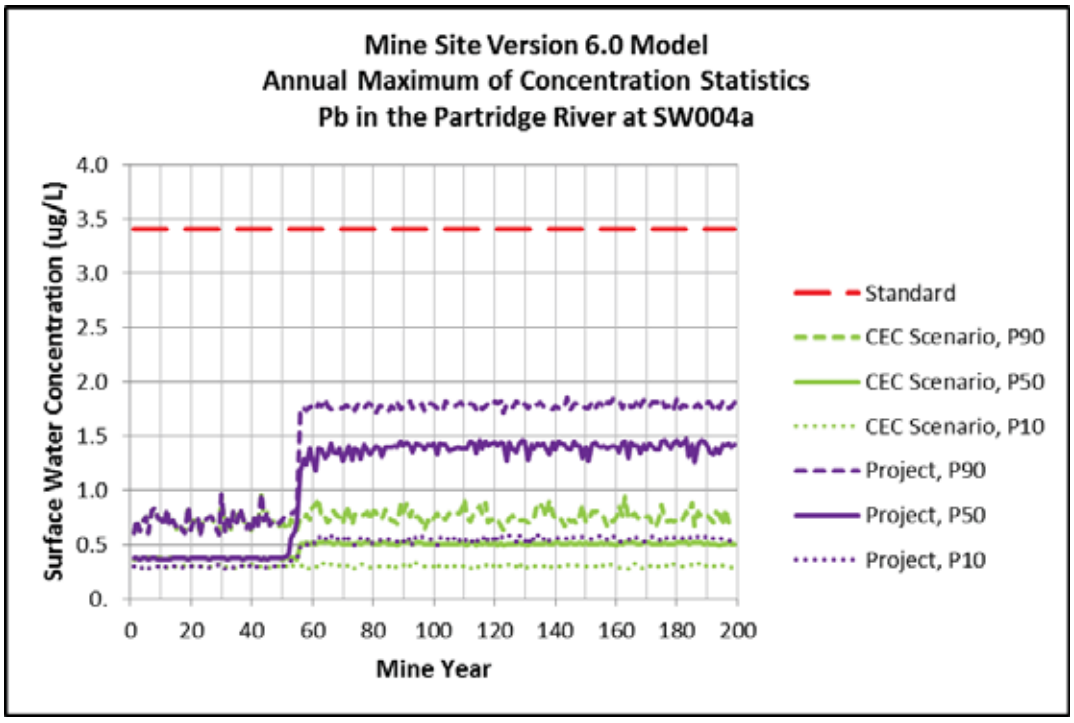


Figure 6-106 Annual Summary of Lead Concentration in the Partridge River at SW004a

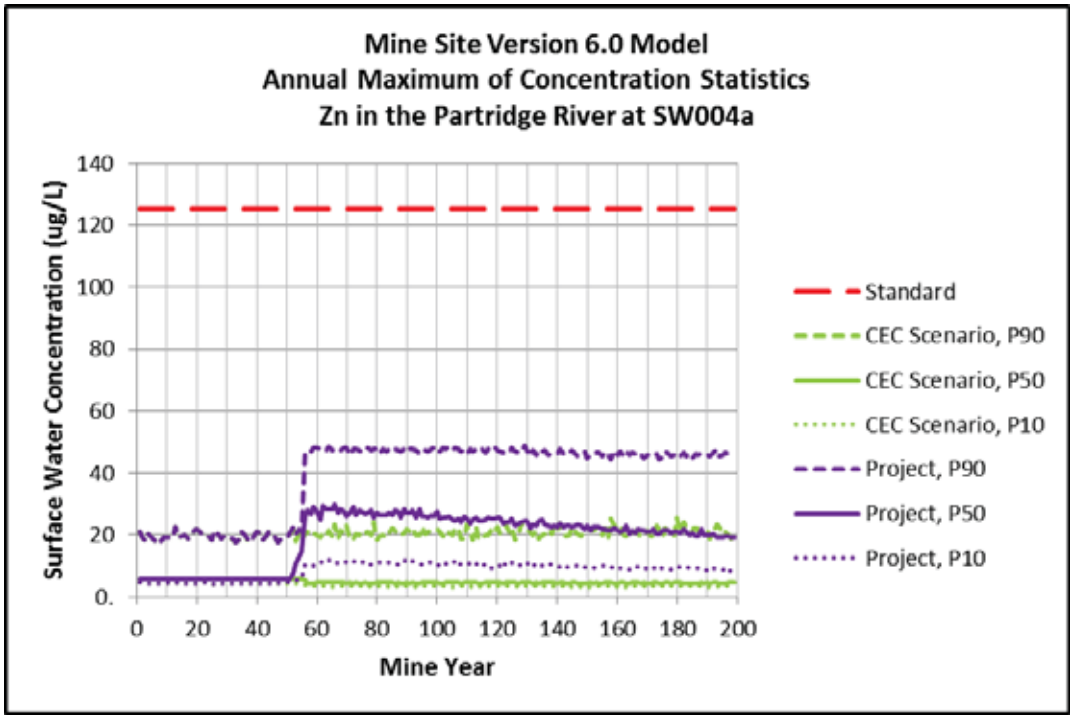


Figure 6-107 Annual Summary of Zinc Concentration in the Partridge River at SW004a

In contrast to the metals discussed above, the estimated median sulfate concentration at SW004a shows a distinct decrease when the Peter Mitchell Pit discharge is discontinued and the long-term WWTF discharge begins in approximately Mine Year 55 (Figure 6-108). The modeled effluent limit for the WWTF is 9 mg/L for sulfate, which is near the typical background concentration in the Partridge River at this location following the discontinuation of the Peter Mitchell Pit discharge. The median sulfate concentration at SW004a increases slightly in the long term (at approximately Mine Year 125) as compared to the median Continuation of Existing Conditions Scenario concentration due to loading from various surficial flow paths (Figure 6-69 and Figure 6-75). The overall change in sulfate concentration in the Partridge River is discussed in more detail in Section 6.5.6.2.

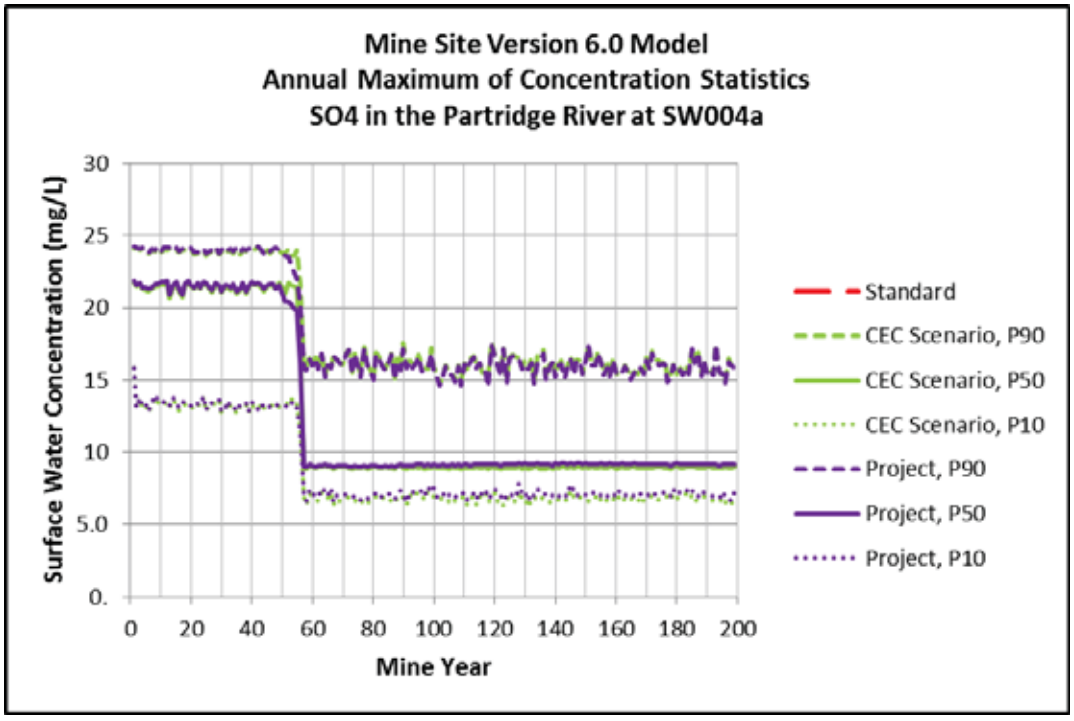


Figure 6-108 Annual Summary of Sulfate Concentration in the Partridge River at SW004a

6.5.4 Partridge River Downstream of Mine Site Loading

There is no additional constituent loading from the Mine Site to the Partridge River downstream of SW004a, and concentrations generally decrease from SW004b to SW006. At these locations most constituents meet the applicable surface water standard; aluminum and sulfate are the only exceptions (Large Figure 59 through Large Figure 61). Aluminum is discussed in more detail in Section 6.5.6.1; sulfate is discussed in more detail in Section 6.5.6.2.

Following MPCA guidance (Section 2.2.1), constituents with hardness-based standards are evaluated at SW004b, SW005 and SW006 based on the modeled hardness at each model time step. This means that the applicable standard continuously changes as the modeled hardness changes. For the constituents with hardness-based standards, plots of the probability of an exceedance need to be assessed in order to determine whether concentrations are estimated to be above the standard at the modeled hardness. This more-detailed evaluation was performed only at SW005, and all of the metals with a hardness-based standard are estimated to have less than a 7% probability of an exceedance (Attachment L). Copper (maximum probability of 3.8%) and lead (maximum probability of 7%) show the largest probability of an exceedance at any time (Figure 6-109 and Figure 6-110). Note that the blue dashed lines in these figures shows that the probability of a Project-caused exceedance that are not present in the Continuation of Existing Conditions Scenario Model is essentially constant at zero (the maximum value of the blue dashed lines in Figure 6-109 and Figure 6-110 at any time is 0.4%, or 2 realizations out of 500).

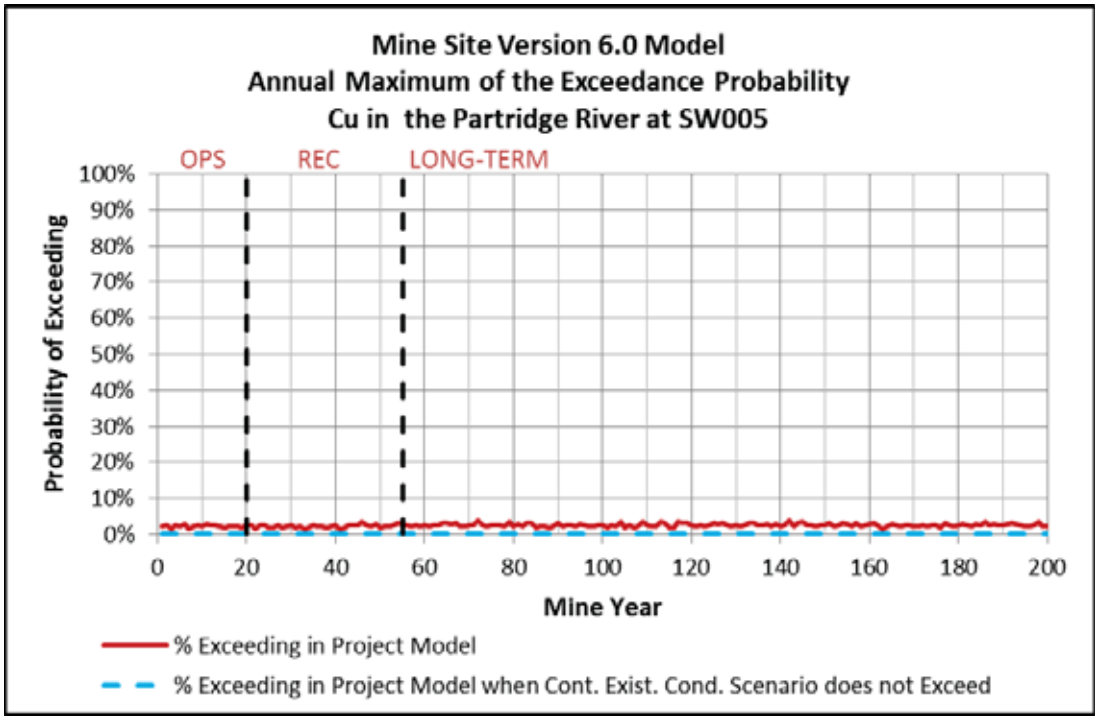


Figure 6-109 Annual Summary of the Probability of a Copper Exceedance at SW005

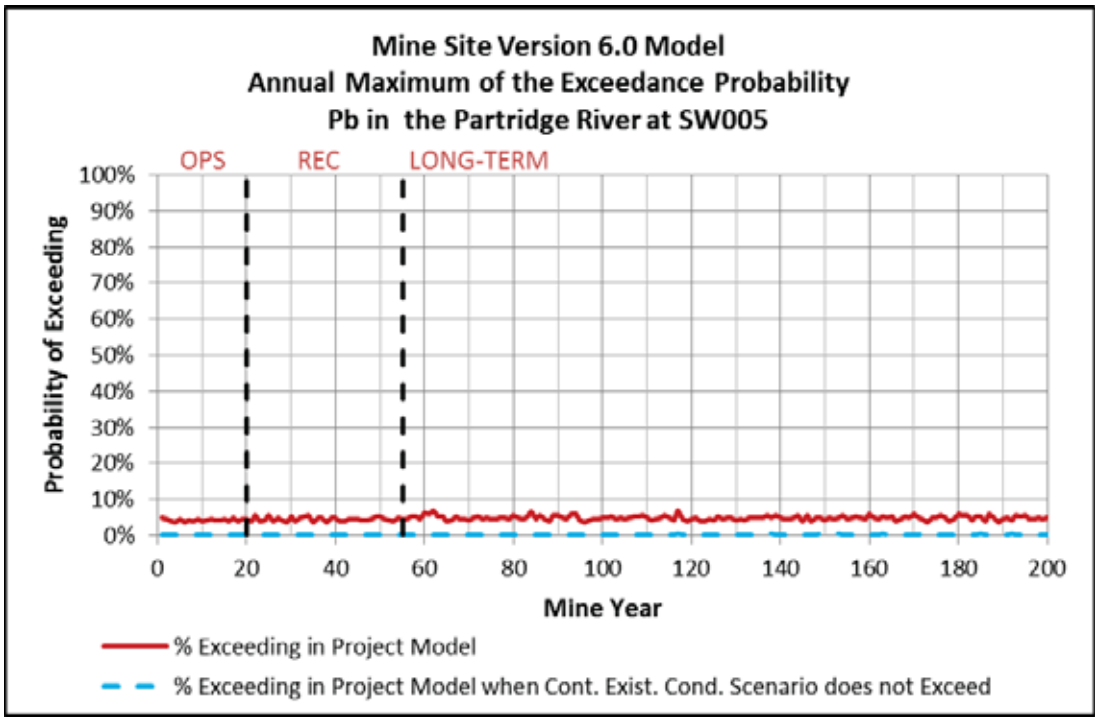


Figure 6-110 Annual Summary of the Probability of a Lead Exceedance at SW005

6.5.5 Colby Lake

The modeled concentrations in Colby Lake tend to be lower than those in the Partridge River at SW006, reflecting increased dilution of upstream loading by natural background runoff and groundwater. For some constituents, as discussed in Section 5.2.4.8, a constant loading term has been added to the model of Colby Lake (both the Continuation of Existing Conditions Scenario and Project Models) to better match observed concentrations within the lake. Therefore Colby Lake concentrations may be either higher or lower than the remainder of the Partridge River.

Because Colby Lake is designated as Class 1B (treated with simple chlorination for domestic consumption) and 2Bd (cool or warm water sportfish and drinking water), the applicable surface water quality standards are different for some constituents than for the remainder of the Partridge River (Section 2.2).

In Colby Lake most constituents meet the applicable surface water standard for both the Continuation of Existing Conditions Scenario and Project Models; exceptions include aluminum, arsenic, copper, iron, and manganese (Large Figure 62). Aluminum is discussed in more detail in Section 6.5.6.1; iron and manganese are discussed in more detail in Section 6.5.6.3; arsenic and copper are discussed in more detail in Section 6.5.6.4. Apart from arsenic, iron, and manganese, constituents with changed water quality standards in Colby Lake (relative to the rest of the Partridge River evaluation locations) include barium, beryllium, cadmium, cobalt, fluoride, antimony, sulfate, and thallium. Examples of the estimated concentration in Colby Lake are shown in Figure 6-111 for cobalt and Figure 6-112 for antimony.

For all of the constituents with hardness-based standards, except copper, the estimated concentrations in Colby Lake are less than those at SW005, and the probability of an exceedance is similar to that discussed in Section 6.5.4 above for SW005. All of the metals with a hardness-based standard (except copper) are estimated to have less than a 6% probability of an exceedance, with cadmium having no modeled exceedances (Attachment L).Copper is discussed further in Section 6.5.6.4.

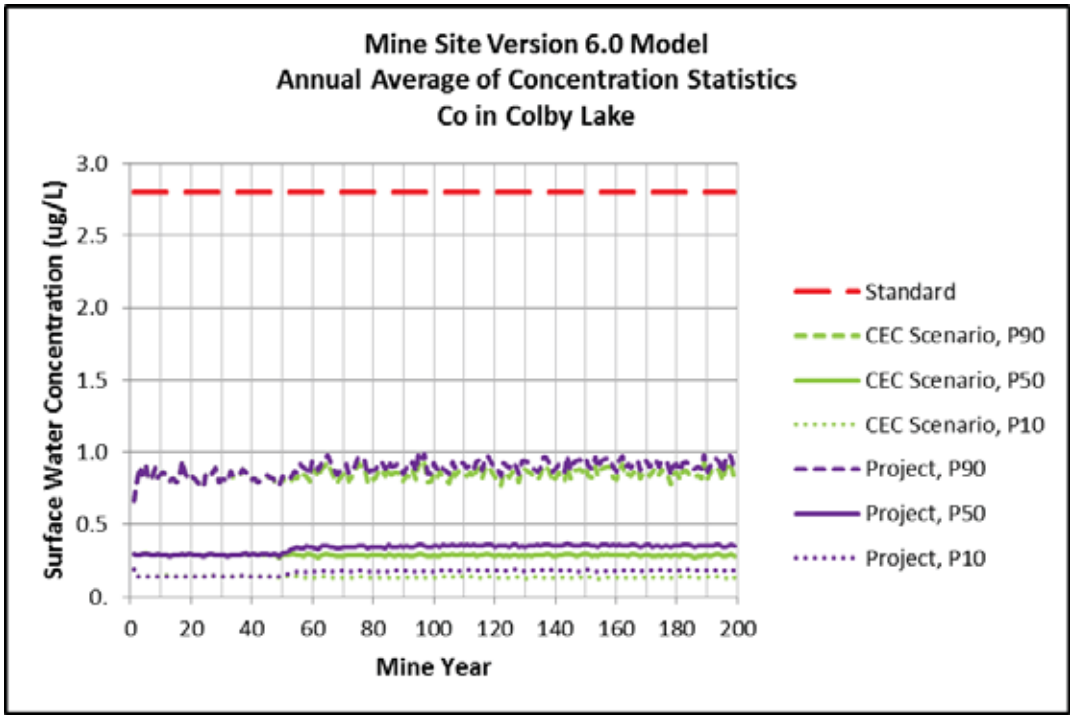


Figure 6-111 Annual Summary of Cobalt Concentration in Colby Lake

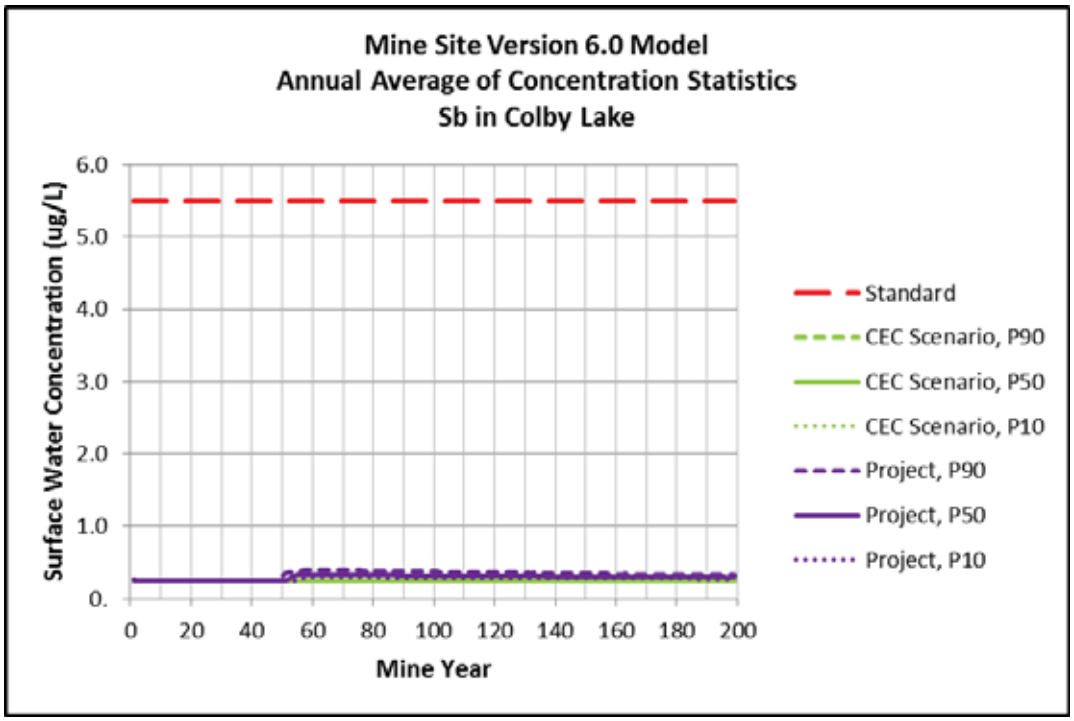


Figure 6-112 Annual Summary of Antimony Concentration in Colby Lake

6.5.6 Discussion of Specific Constituents

Some constituents warrant further discussion. Aluminum is discussed in detail because it is estimated to exceed the standard at all evaluation locations. Sulfate is discussed in detail because it is estimated to exceed the water quality standard for the protection of wild rice production areas. Arsenic, copper, iron, and manganese are discussed because they are estimated to potentially exceed the standards applicable to Colby Lake. Finally TDS is discussed because it was not identified as a constituent for inclusion in the GoldSim model, but there is a surface water standard for TDS that will need to be met by the Project.

6.5.6.1 Aluminum

6.5.6.1.1 Evaluation

Model results for the Mine Site indicate that the 90th percentile concentration of aluminum exceeds the surface water standard (125 µg/L) at all evaluation locations in the Partridge River and Colby Lake. Aluminum concentrations after Mine Year 55 increase slightly with distance downstream on the Partridge River. The exceedances and increase in concentrations downstream occur for both the Continuation of Existing Conditions Scenario Model and Project Model.

Modeled aluminum exceedances in the Partridge River occur between April and November, i.e., during the period when surface runoff contributes proportionately more to river flow than baseflow from groundwater compared to the winter months. Because surface runoff is more likely to exceed the water quality standard for aluminum than baseflow from groundwater, the Partridge River is in turn more likely to exceed the water quality standard for aluminum at times when runoff is contributing proportionately more than baseflow to river flow. The concentration of aluminum increases slightly from evaluation location SW002 to Colby Lake because runoff contributes proportionately more flow to each downstream river reach than to the previous reach. Also, the diluting effects of the Peter Mitchell Pit discharge in Mine Year 0 through Mine Year 55 diminish going downstream. There is no additional loading term added to the model for aluminum in Colby Lake.

Exceedances of the aluminum standard occur at all evaluation locations on the Partridge River: SW002, SW003, SW004, SW004a, SW004b, SW005, and SW006; similar exceedances occur at Colby Lake. Figure 6-113 through Figure 6-120 illustrate the highest annual concentration of aluminum at a 10%, 50% and 90% probability at each respective Partridge River evaluation location for the Continuation of Existing Conditions Scenario and the Project model.

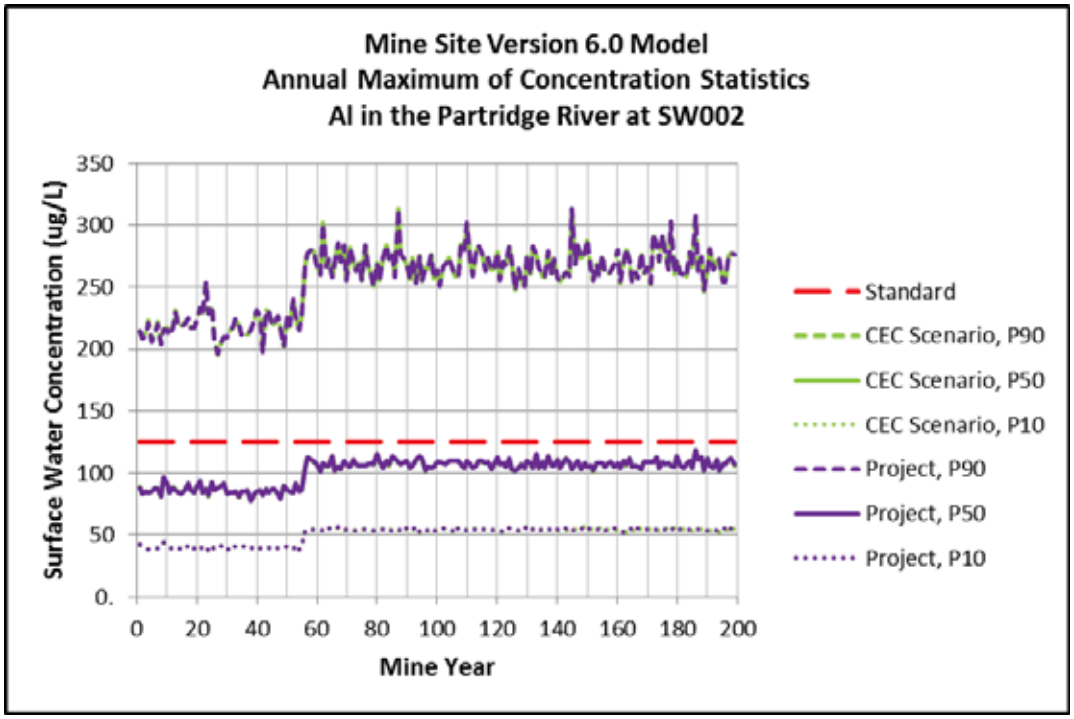


Figure 6-113 Annual Summary of Aluminum Concentration in the Partridge River at SW002

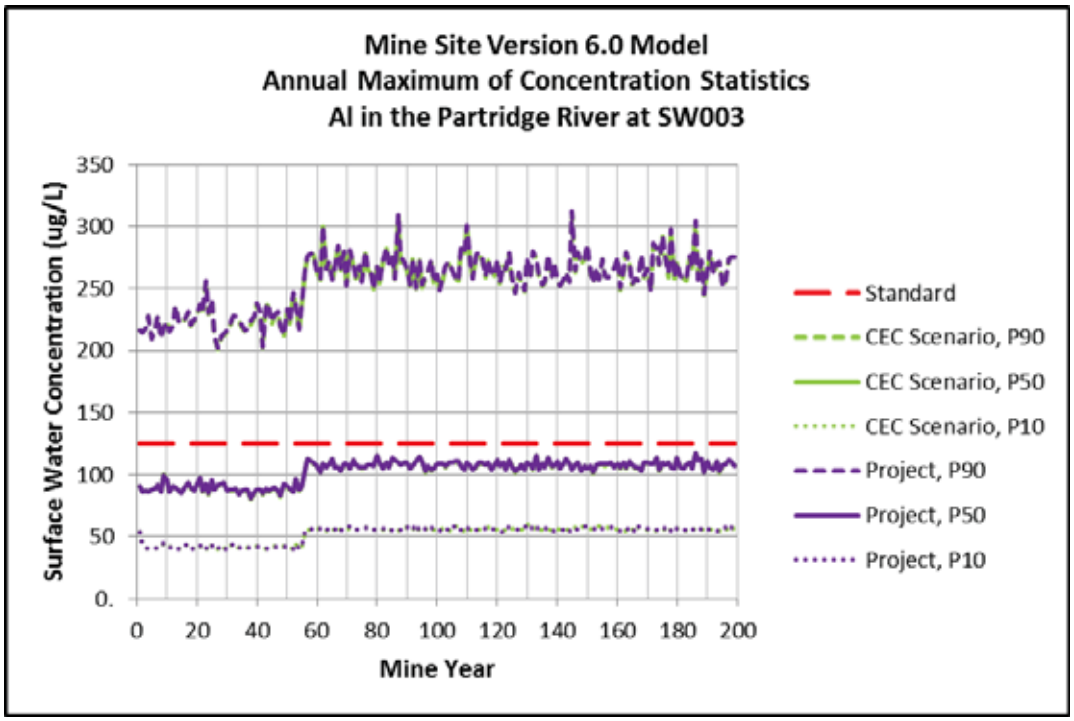


Figure 6-114 Annual Summary of Aluminum Concentration in the Partridge River at SW003

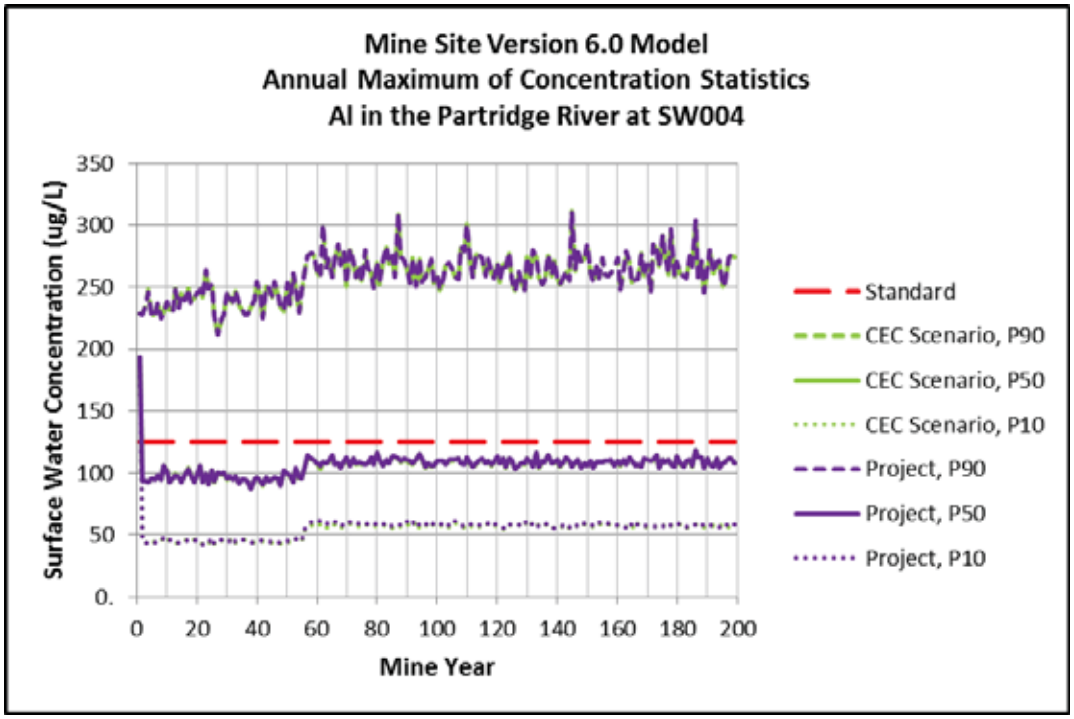


Figure 6-115 Annual Summary of Aluminum Concentration in the Partridge River at SW004

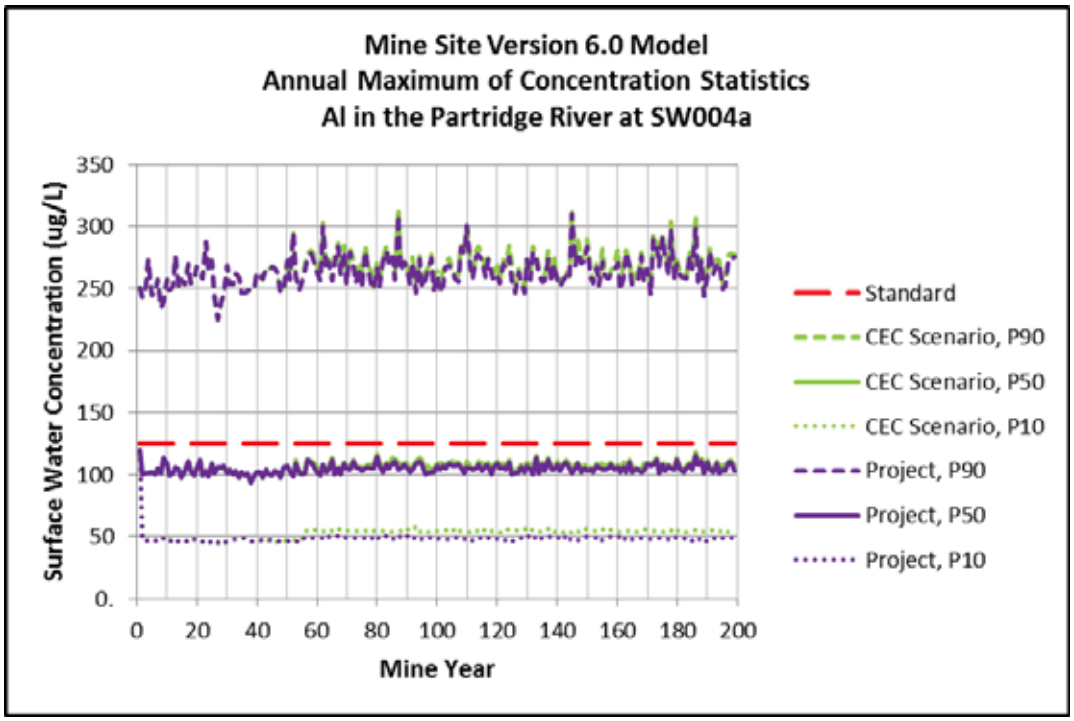


Figure 6-116 Annual Summary of Aluminum Concentration in the Partridge River at SW004a

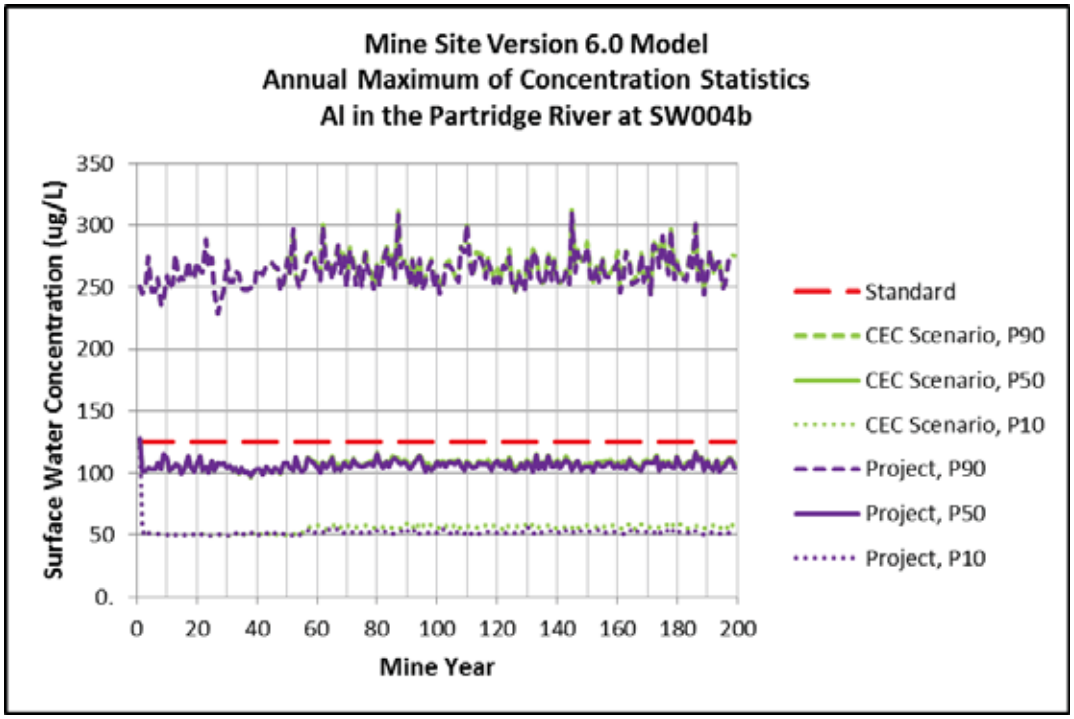


Figure 6-117 Annual Summary of Aluminum Concentration in the Partridge River at SW004b

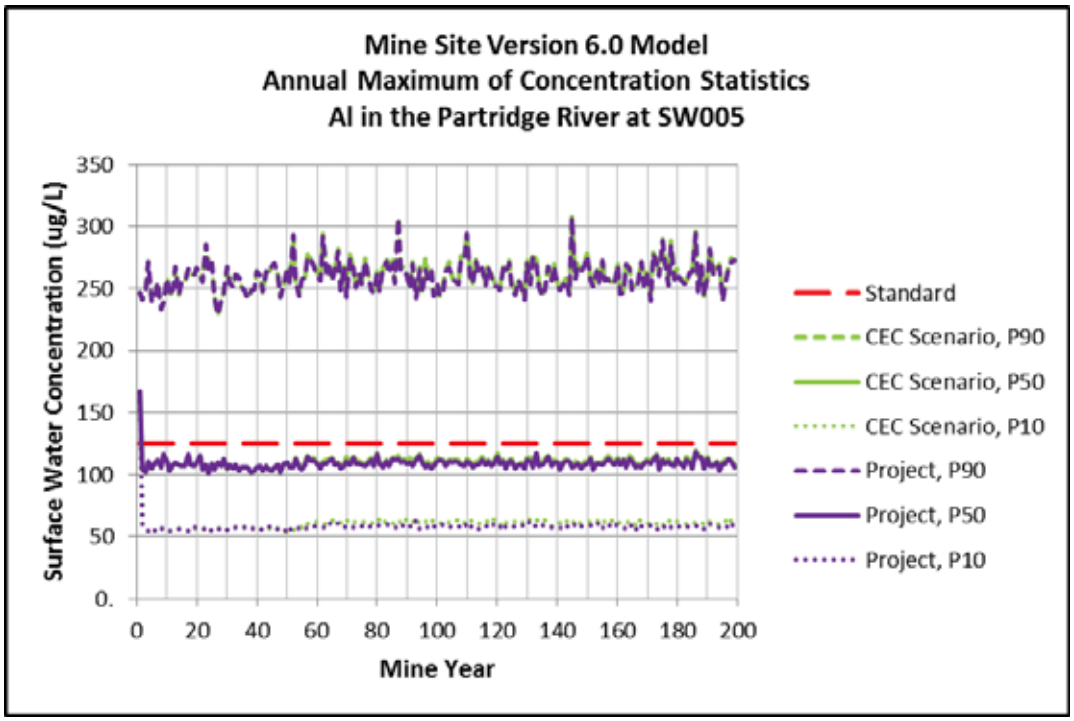


Figure 6-118 Annual Summary of Aluminum Concentration in the Partridge River at SW005

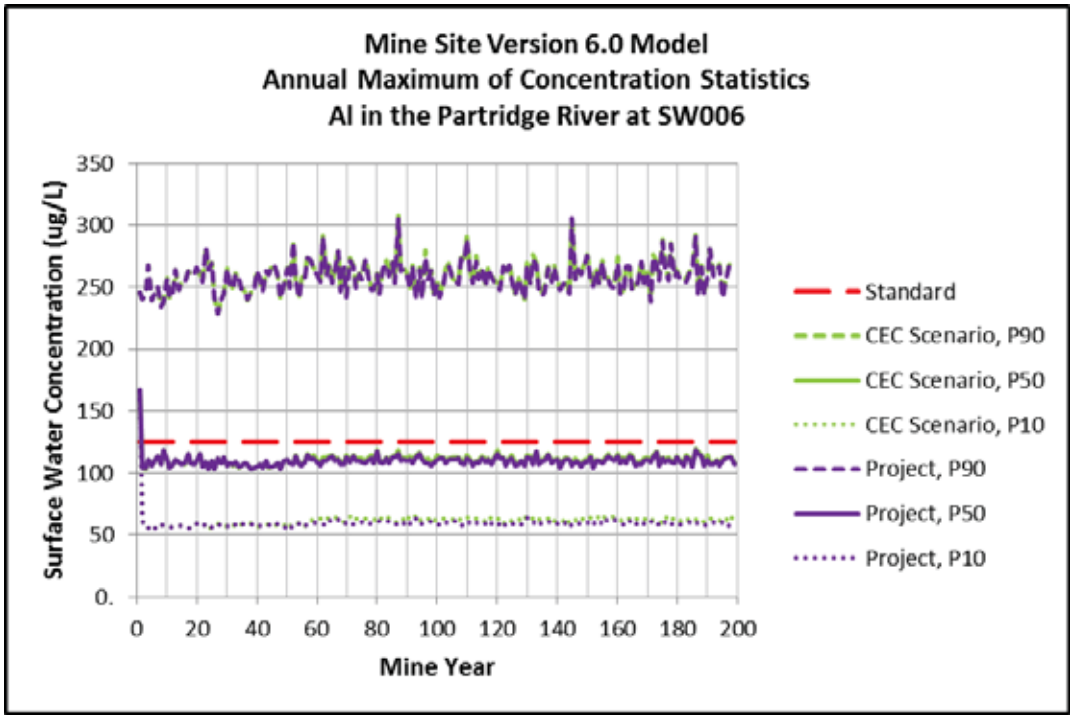


Figure 6-119 Annual Summary of Aluminum Concentration in the Partridge River at SW006

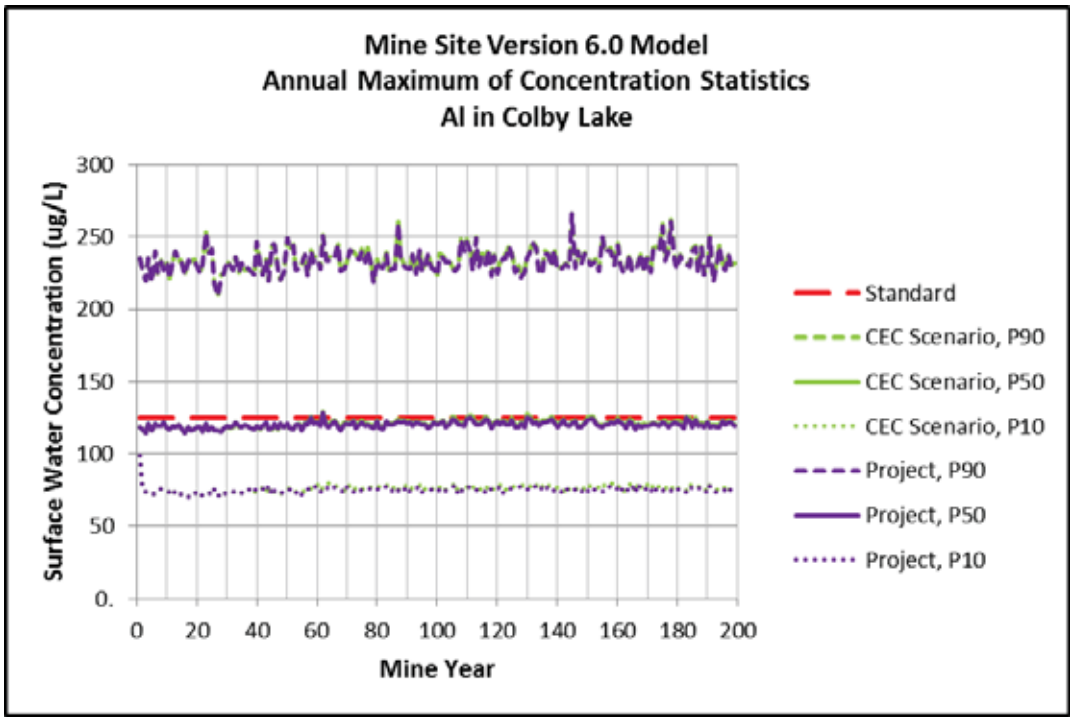


Figure 6-120 Annual Summary of Aluminum Concentration in Colby Lake

Modeled concentrations of aluminum in background surface runoff regularly exceed the water quality standard; aluminum in the calibrated runoff distribution exceeds the water quality standard approximately 40% of the time, as shown on Figure 6-121. However, modeled aluminum in groundwater almost never exceeds the water quality standard, as shown on Figure 6-122. In the Partridge River, surface runoff and baseflow from groundwater contribute to overall river flow in proportions such that, under background conditions, the water quality standard is exceeded approximately 23% of the time in the calibrated river model, as shown by the calibration distribution in Figure 6-123 (excerpted from Attachment E). This is slightly less than what has been observed, where approximately 27% of the surface water monitoring data used for calibration exceeded the standard. Note that relative to the modeling performed for the SDEIS, the calibration distribution in Figure 6-123 represents an approximately 60 µg/L increase in the 90th percentile river concentration driven by higher concentrations in the calibration data set used for the FEIS.

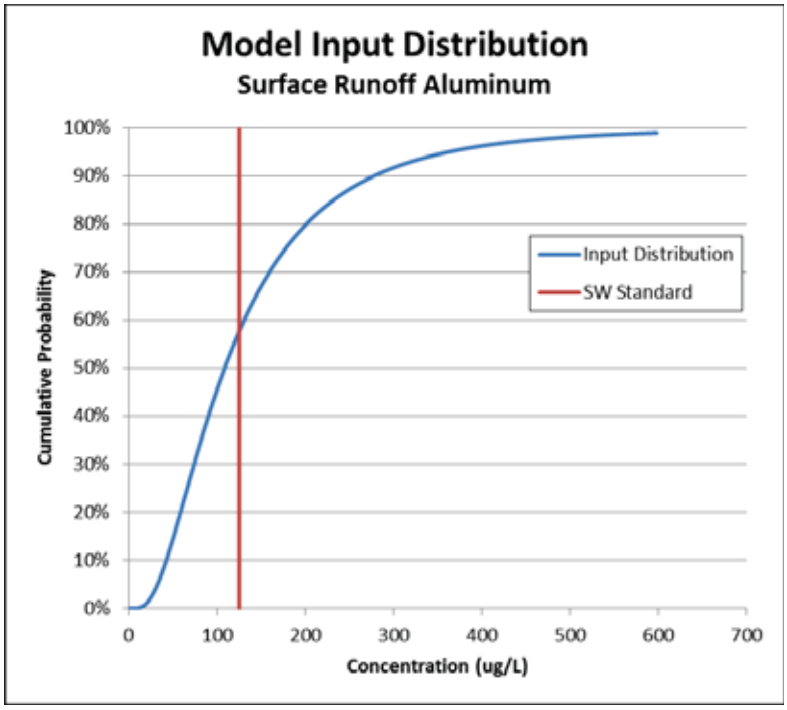


Figure 6-121 Simulated Distribution of Aluminum Concentration in Surface Runoff

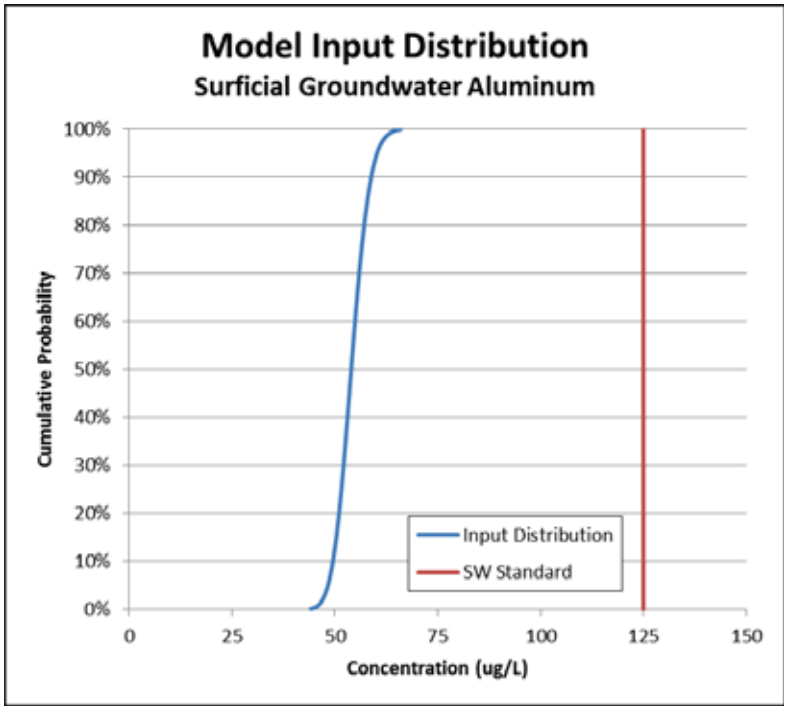


Figure 6-122 Simulated Distribution of Aluminum Concentration in Surficial Groundwater

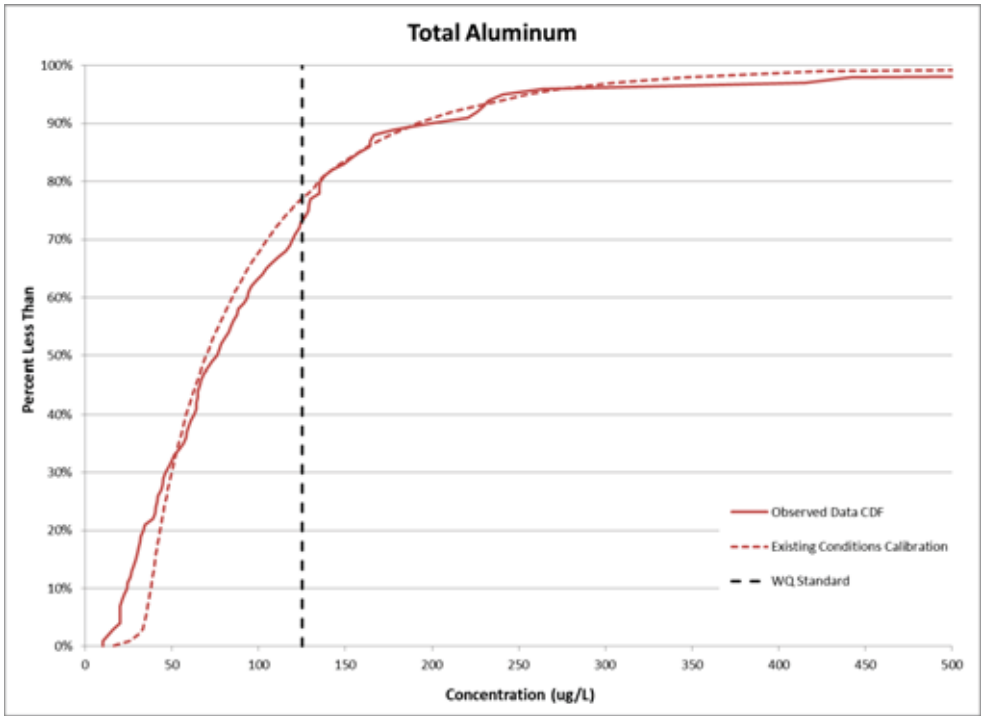


Figure 6-123 Calibration Fit to Aluminum Concentrations in the Partridge River (from Attachment E)

Potential sources of aluminum from the Project include the West Pit and the East Pit – Category 2/3 Waste Rock Stockpile. Aluminum concentrations in groundwater flow paths from each of these sources are described below:

- Aluminum concentrations in groundwater from the West Pit are consistently below 125 µg/L and actually decrease below Continuation of Existing Conditions Scenario levels in the long term, as shown on Figure 6-124.

- Groundwater from the East Pit – Category 2/3 surficial flow path does show a "pulse" of aluminum concentration that peaks at about 170 µg/L in groundwater just before the Partridge River between Mine Year 30 and Mine Year 130, however simulated aluminum concentrations are otherwise consistently below 125 µg/L, as shown on Figure 6-125. Because groundwater from the East Pit – Category 2/3 surficial flow path is diluted upon reaching the river (Table 6-12), the "pulse" is not discernable at the downstream evaluation locations during periods of higher flow (and therefore higher aluminum concentrations), as shown on Figure 6-126 (SW004 is the first surface water evaluation location downstream of the contribution of the East Pit – Category 2/3 surficial flow path).

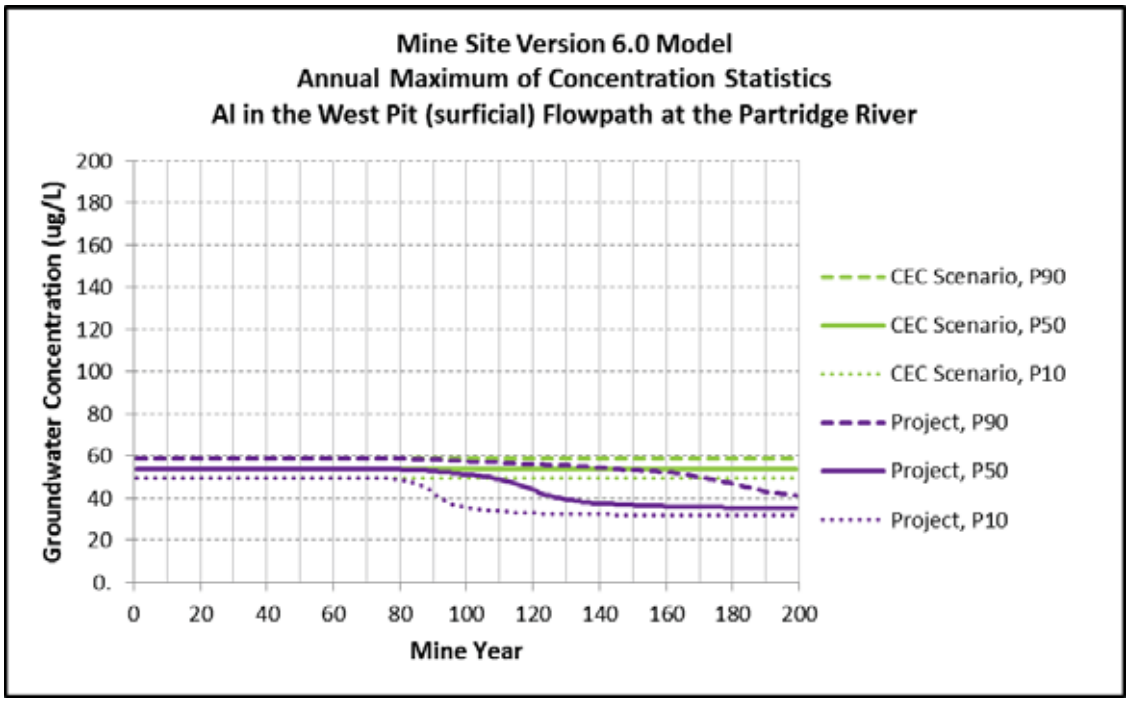


Figure 6-124 Aluminum Concentration in the West Pit Surficial Flow Path at the Partridge River

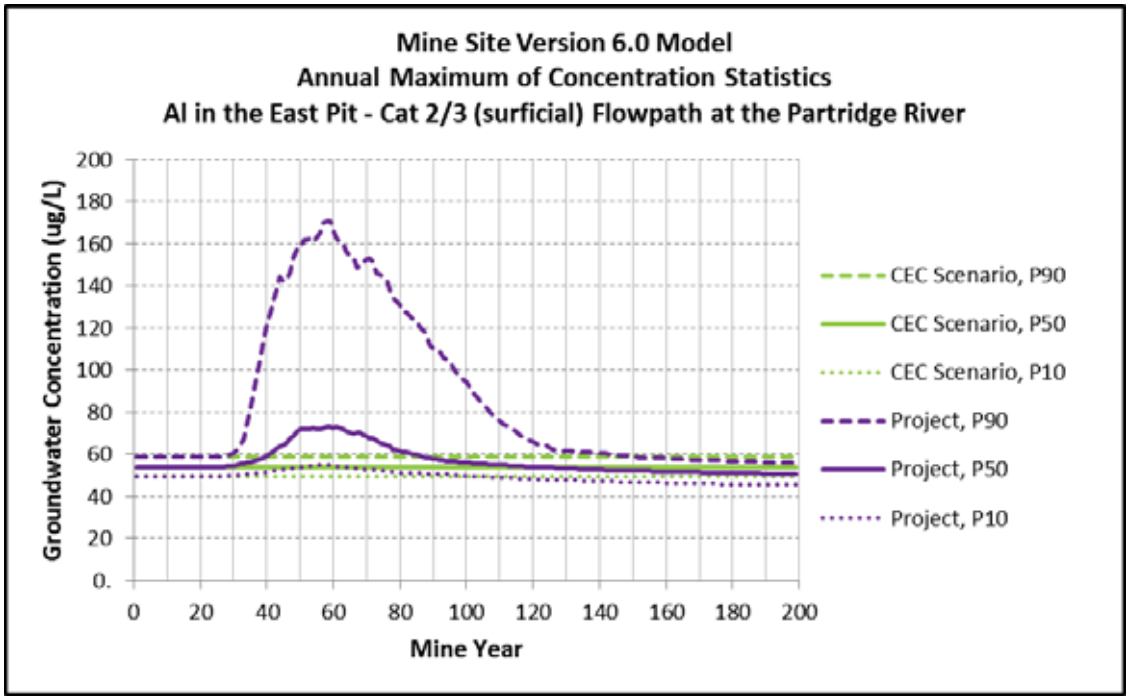


Figure 6-125 Aluminum Concentration in the East Pit – Category 2/3 Surficial Flow Path at the Partridge River

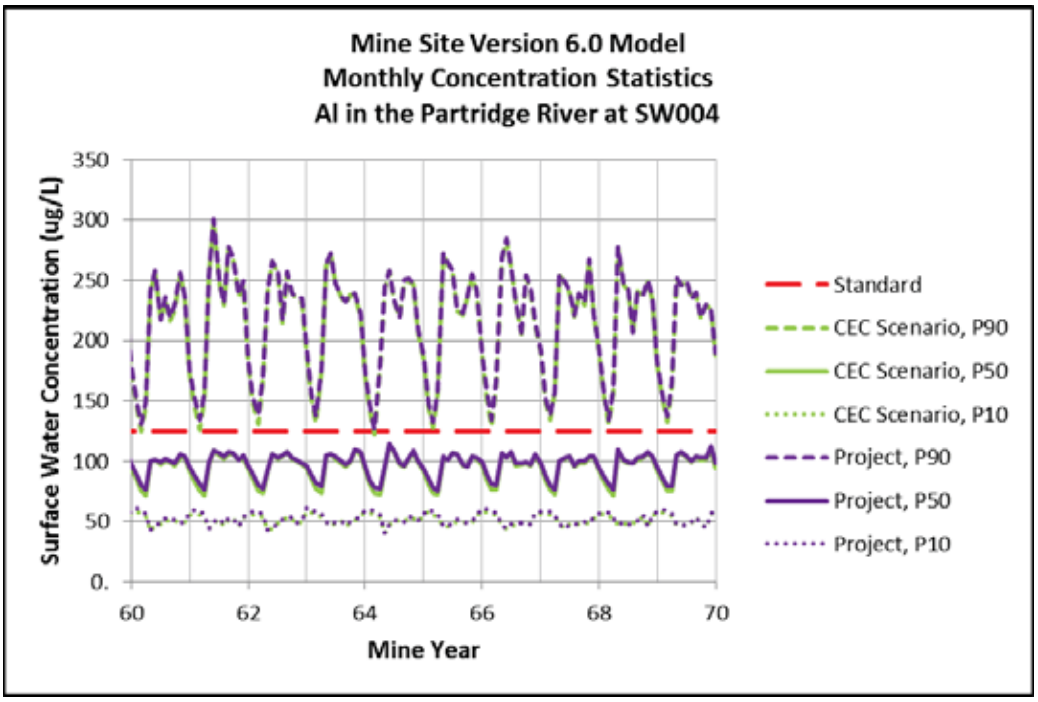


Figure 6-126 Monthly Aluminum Concentration in the Partridge River at SW004

Although the Project does have potential sources of aluminum, model results indicate that the Project does not cause concentrations of aluminum to significantly increase at SW003 and SW004. A slight increase (peak 90th percentile concentration changes of less than 5 µg/L) at these locations throughout the modeled period is not due to loading from the Project, but rather to changes in watershed area and baseflow that change the proportions of groundwater and surface water in the river. Although a slight increase in aluminum concentration is at times modeled at SW003 and SW004, the Project will primarily cause peak aluminum concentrations at SW004a and downstream evaluation locations to decrease slightly due to changes in the watershed configuration and the discharge of cleaner-than-background WWTF effluent.

The likelihood of aluminum concentrations being above 125 µg/L in any given month is nearly identical in the Continuation of Existing Conditions Scenario Model and Project Model. Figure 6-127 shows the percent of model runs that are estimated to have at least one month with aluminum concentrations exceeding 125 µg/L at SW004 for each year of the simulation. The red line shows the total percent of Project Model runs estimated to have an exceedance; the blue line shows the percent of model runs where there was an exceedance in the Project Model and no exceedance in the Continuation of Existing Conditions Scenario Model. Virtually all of the model runs that are estimated to have an exceedance will have had an exceedance even without the Project. For months where natural conditions will not cause an exceedance, there is less than a 10% probability that aluminum loading from the Project will result in concentrations rising over 125 µg/L (the maximum value for the blue line in Figure 6-127 is 3.4%). That is, there is a greater than 90% probability in any month that the Project does not cause additional exceedances. Based on PolyMet's interpretation of the definition of significant impacts, we do not believe this increase represents a significant impact for the purpose of the FEIS.

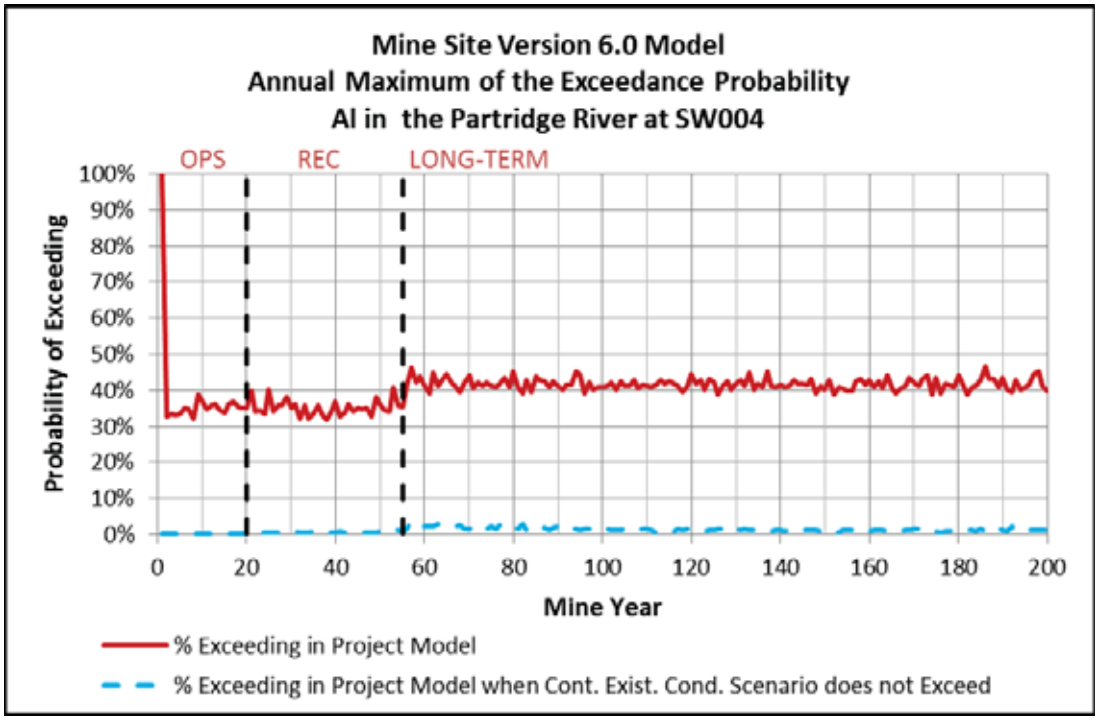


Figure 6-127 Probability of an Aluminum Exceedance in the Partridge River at SW004

6.5.6.1.2 Conclusion

Although the surface water quality standard for aluminum is exceeded, the exceedances are not due to the Project. Rather, they are due to background surface runoff which is naturally high in aluminum. Background surface runoff to the Partridge River is estimated to exceed the water quality standard approximately 40% of the time, whereas the groundwater contribution to the river is very unlikely to exceed the standard.

Although the Project does have potential sources of aluminum, modeling indicates that the Project will not significantly increase aluminum concentrations in the Partridge River, and will cause a slight decrease in the peak aluminum concentrations downstream of SW004a.

6.5.6.2 Sulfate in the Partridge River at SW005

6.5.6.2.1 Evaluation

The MPCA has indicated that the lower portion of the Upper Partridge River, from river mile approximately 22 to Colby Lake, is a water used for production of wild rice and determined that the 10 mg/L sulfate standard will apply to this reach. Evaluation location SW005 is located at the upstream edge of this reach of the Partridge River (Large Figure 20). It is the only evaluation location for the Mine Site where the wild rice standard is an impact criterion.

Currently the average sulfate concentration measured at SW005 is 10.0 mg/L (equal to the standard) and 25 of 51 samples (50%) exceeded 10 mg/L; the maximum observed concentration is 20 mg/L. Model results are consistent with these observations, estimating that under the first 55 years of the Continuation of Existing Conditions Scenario and Project Models, the annual average 50th percentile concentration is just below 10 mg/L (Figure 6-128), and the annual maximum 90th percentile concentration is approximately 18 mg/L (Figure 6-129). Both models estimate that sulfate concentrations in the river will decline by 2 to 3 mg/L on average after the discontinuation of the Peter Mitchell Pit dewatering in Mine Year 55.

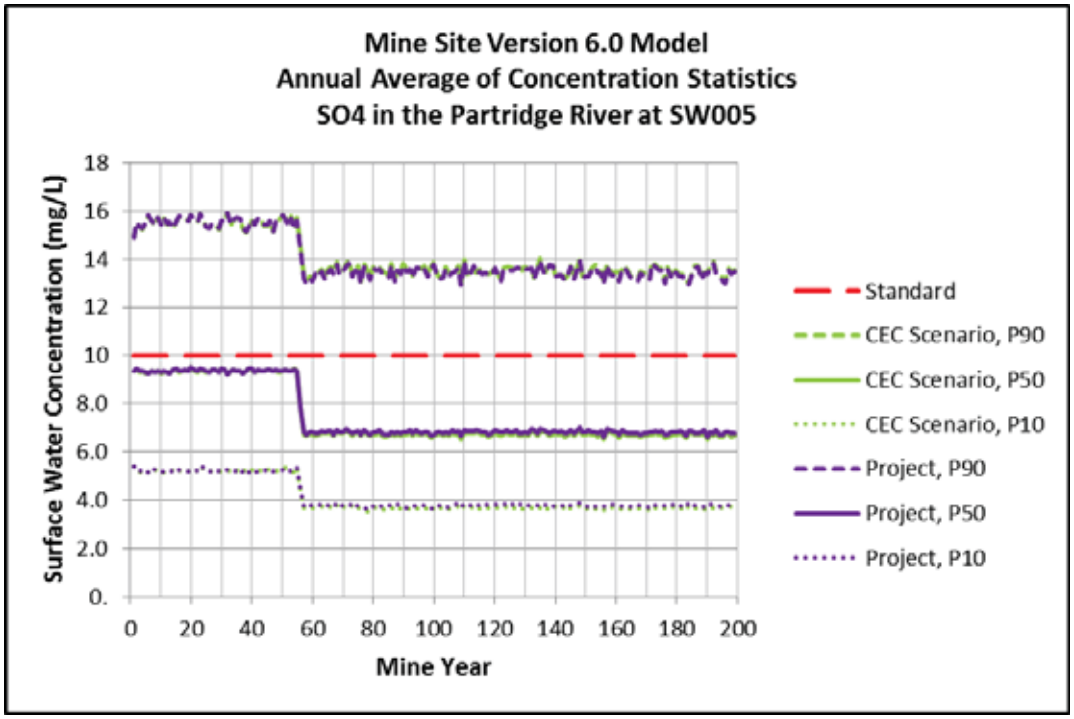


Figure 6-128 Annual Average Summary of Sulfate Concentration in the Partridge River at SW005

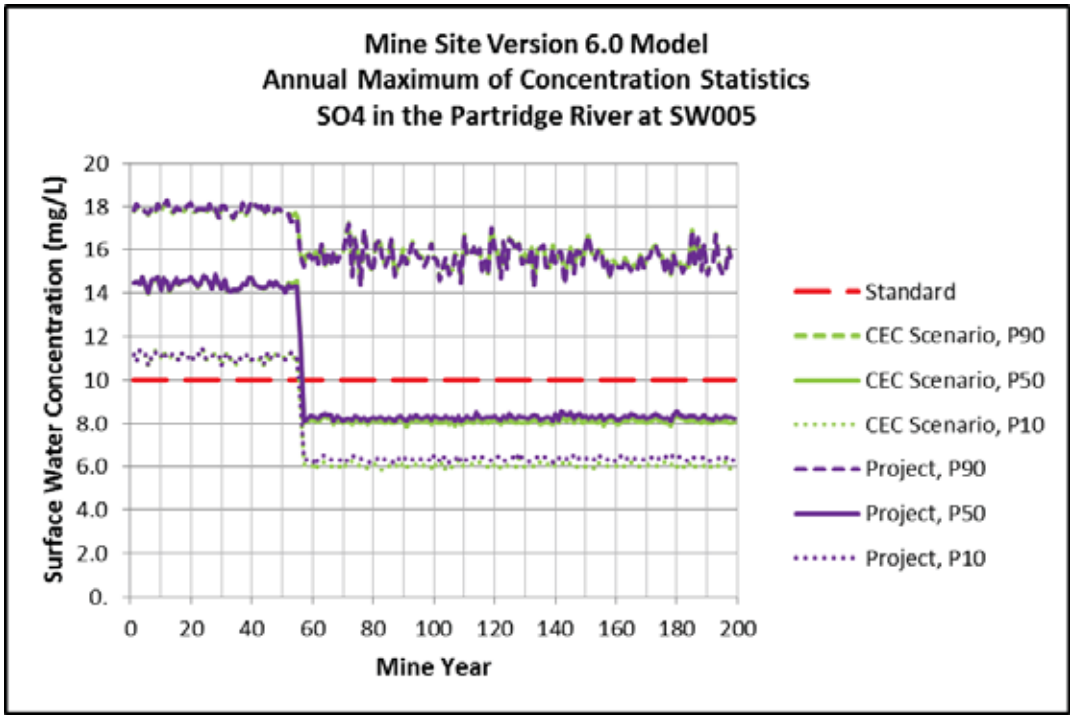


Figure 6-129 Annual Maximum Summary of Sulfate Concentration in the Partridge River at SW005

Understanding the potential impacts of the Project requires understanding the relative influence of surface runoff and unimpacted groundwater on water quality in the Partridge River. Figure 6-130 and Figure 6-131 illustrate the simulated distribution of sulfate concentrations in surface runoff (distribution developed by calibrating to measured surface water concentrations) and unimpacted groundwater baseflow under existing conditions (distribution developed using site monitoring data). Surface water is expected to have a lower average concentration, but a higher variability, while unimpacted groundwater has a higher average concentration and a lower variability. Surface runoff from unimpacted areas is expected to have a median sulfate concentration of 5.2 mg/L with a 23% probability the concentration will exceed 10 mg/L and a 10% probability the concentration will exceed 16 mg/L. Unimpacted groundwater is expected to have a median sulfate concentration of 9.6 mg/L, but the concentration is not expected to exceed 11 mg/L. In addition, the Peter Mitchell Pit discharge prior to Mine Year 55 is modeled as having a constant sulfate concentration of 28.0 mg/L.

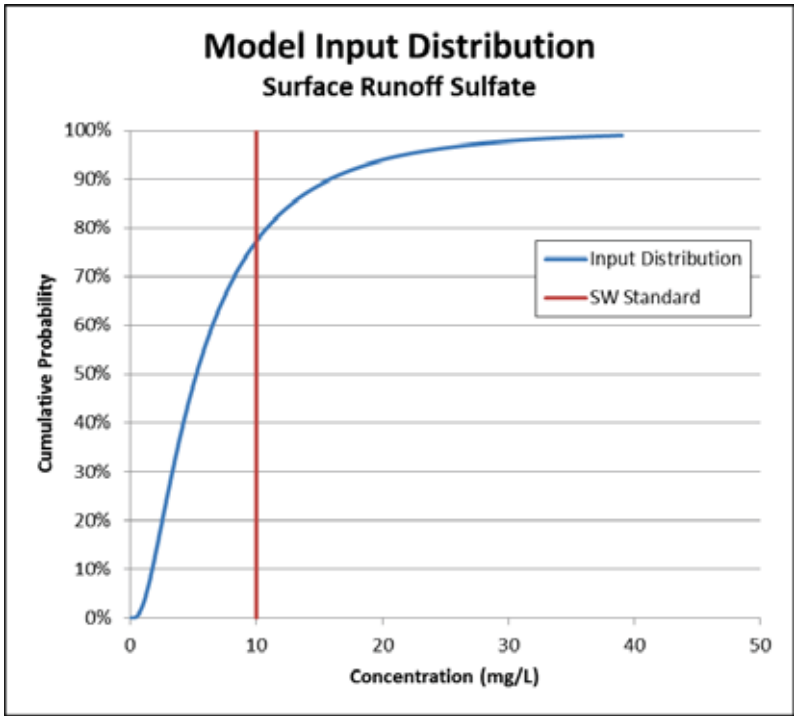


Figure 6-130 Simulated Distribution of Sulfate Concentration in Surface Runoff

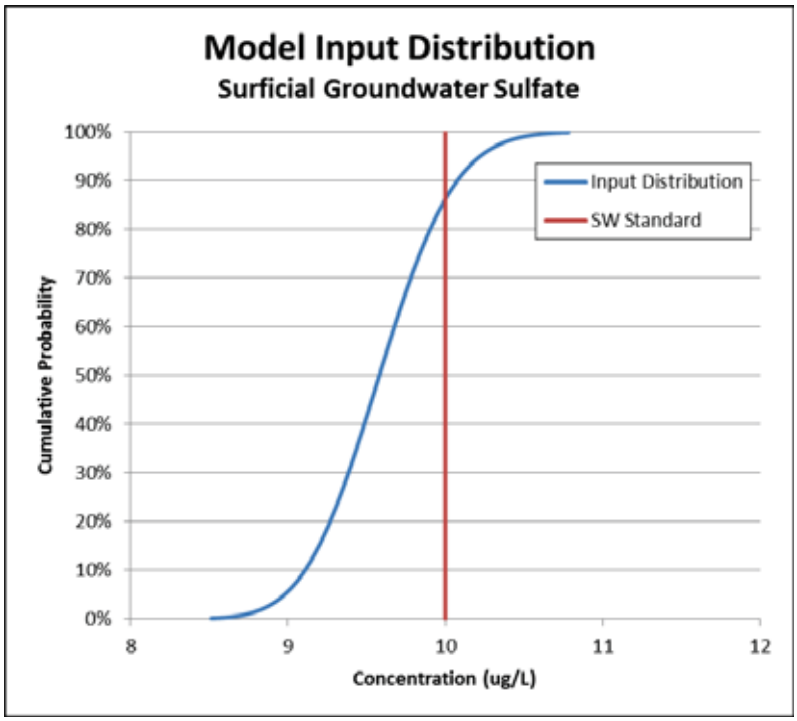


Figure 6-131 Simulated Distribution of Sulfate Concentration in Groundwater

Looking at estimated surface water quality at a monthly rather than annual scale reveals variations due to the relative influence of surface runoff, unimpacted groundwater inflow, and loading from the Peter Mitchell Pit. Figure 6-132 shows monthly water quality estimates during the first 10 years of Project operations and estimates for the Continuation of Existing Conditions Scenario (note that during this period, there is little difference between the two models). The 10th, 50th and 90th percentile concentrations all show seasonal fluctuations. Surface runoff has a greater influence during high-flow conditions, and unimpacted groundwater and Peter Mitchell Pit discharge have a greater influence during low-flow conditions. For the 10th and 50th percentile outputs, concentrations are estimated to be significantly higher during the times of year when flow is lower in the river. The 90th percentile concentrations are also high during the times of year when flow is lower in the river because unimpacted groundwater baseflow is dominant however, the 90th percentile concentrations show less seasonal variation in part because the constant concentration in the Peter Mitchell Pit discharge (modeled at 28.0 mg/L) reduces the variability of concentrations on the high end of the model results.

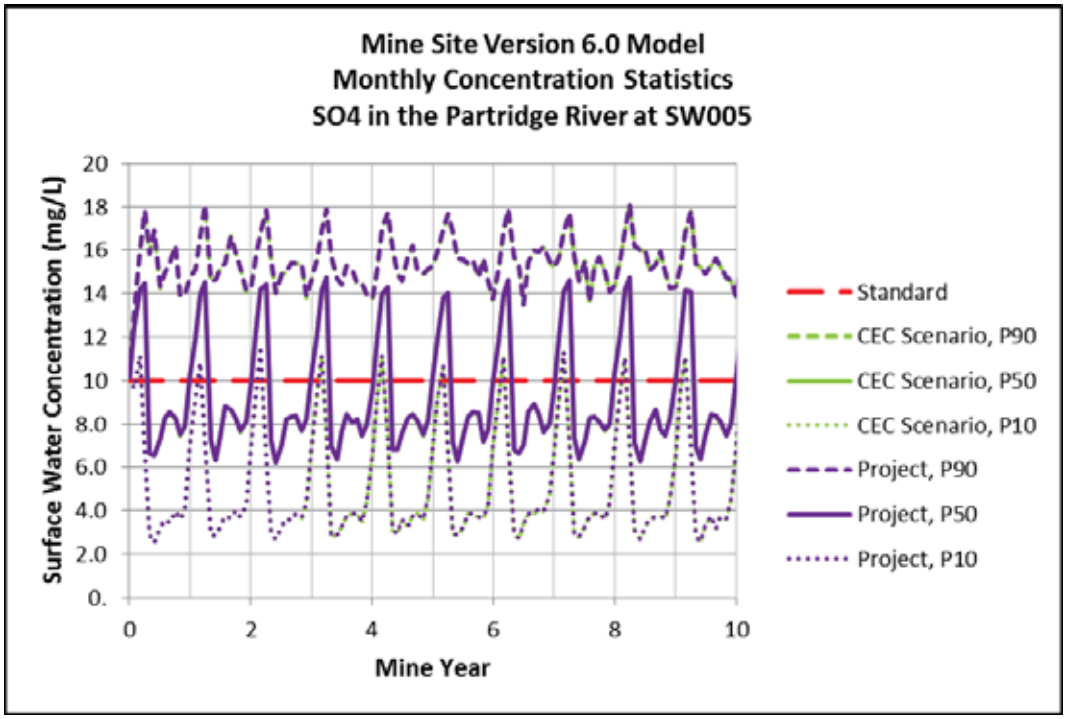


Figure 6-132 Monthly Sulfate Concentration in the Partridge River at SW005

As sulfate concentrations vary in the Partridge River due to the relative influence of surface runoff, unimpacted groundwater, and Peter Mitchell Pit dewatering, so too does the likelihood that sulfate concentrations will exceed 10 mg/L. Water quality at SW005 is more likely to exceed 10 mg/L during low-flow periods than during high-flow periods. The percent of model runs that are estimated to have an exceedance for each month during Mine Year 1 through Mine Year 10 are shown on Figure 6-133. The percent of model runs with concentrations estimated to exceed 10 mg/L increases from 25-40% during high-flow periods to approximately 95% during the low-

flow periods. This seasonal pattern in the probability of an exceedance occurs with or without the Project (note that the blue line in Figure 6-133 is essentially zero during Mine Year 1 through Mine Year 10).

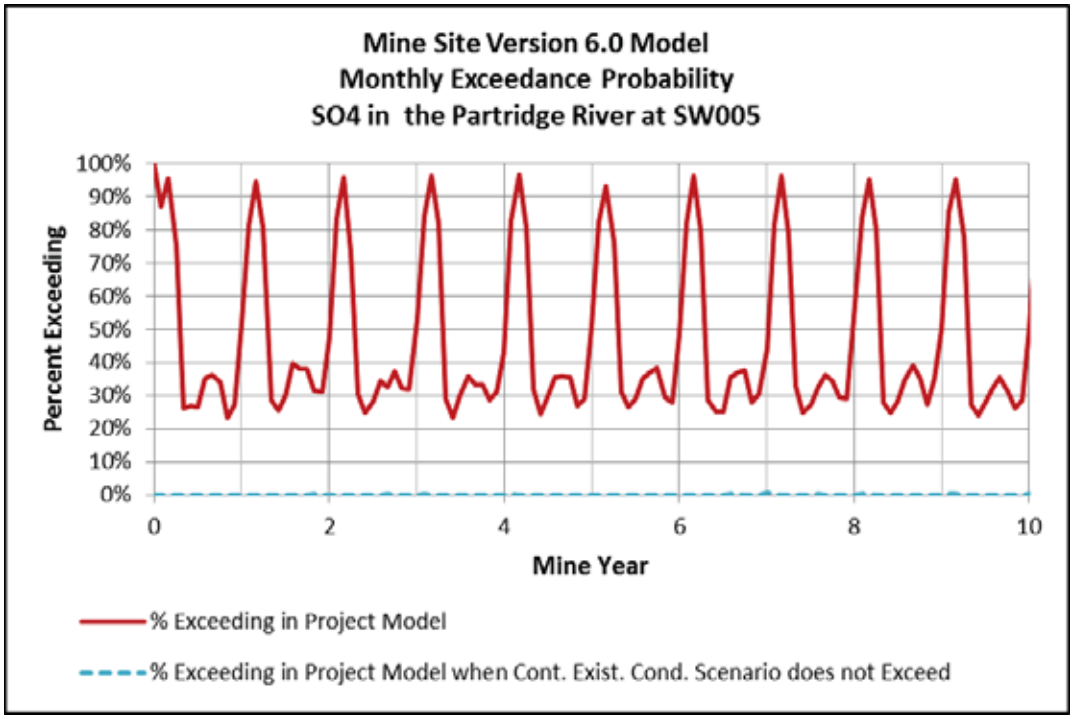


Figure 6-133 Monthly Probability of a Sulfate Exceedance in the Partridge River at SW005, Mine Year 0 through Mine Year 10

The Project could affect surface water quality in the Partridge River through several different processes:

- Changes in watershed area. The Project will reduce the watershed area directly tributary to SW005 by up to 2.6% during operations and reclamation and by 1.1% in long-term closure. As noted above, background surface runoff dilutes the sulfate contributions to the river from groundwater under some conditions.

- Discharge from the WWTF. Discharge will begin when the West Pit is flooded in approximately Mine Year 55.

- Potential changes in Mine Site groundwater due to loading from temporary sources during operations.

The primary impact that the Project will have on the Partridge River water quality during the operations (Mine Year 0 through Mine Year 20) and reclamation (Mine Year 20 through Mine Year 55) phases of the Project is the slight reduction in watershed area at SW005. There will be

no discharge of treated water to the river during this time and contributions from groundwater flow paths will generally not have reached the Partridge River.

As discussed above, the likelihood under Continuation of Existing Conditions Scenario that the sulfate concentration at SW005 is above 10 mg/L ranges from 25% during annual high-flow periods to as much as 95% during annual low-flow periods. This pattern is shown by the red line in Figure 6-133. The blue line in Figure 6-133 shows the likelihood that the Project causes the sulfate concentration to exceed 10 mg/L during time periods that will not exceed under Continuation of Existing Conditions Scenario. For this initial period of the water quality model—when the only Project impact to the river is watershed reduction—the likelihood of a new exceedance is less than 1% in any month.

During months when the modeled sulfate concentration at SW005 exceeds 10 mg/L, the contribution of the Project to the exceedance can be assessed by comparing the concentrations in the Project Model and Continuation of Existing Conditions Scenario Model. The models are synchronized so that both experience the same randomly-selected background water quality and flow conditions for each month of the simulation; the only difference is in the Project-related contributions. The difference in sulfate concentrations is shown in terms of the percent change from the Continuation of Existing Conditions Scenario Model in Figure 6-134 (note that this comparison is only performed for months when the sulfate concentration in the Project Model is above 10 mg/L). The sulfate concentration in this early period is likely to increase slightly from the Continuation of Existing Conditions Scenario Model, with a 90% probability (upper dashed line) that the increase is less than 0.5% and a 50% probability (solid line) that the increase is less than 0.3%. The increase is largest during the winter low-flow period and is lower for the remainder of the year; the magnitude of the concentration increase grows during this period as the Mine Site expands and has a greater effect on the watershed areas tributary to the Partridge River. The modeled increase in sulfate concentration is negligible and does not constitute a significant contribution to the existing concentrations in excess of 10 mg/L.

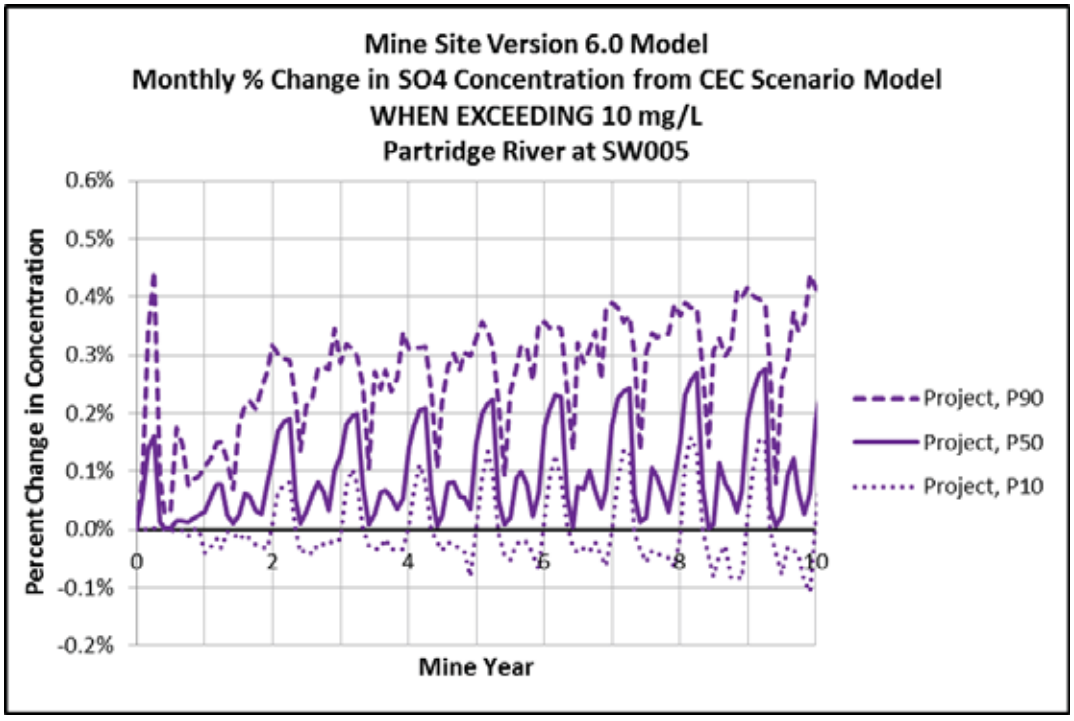


Figure 6-134 Percent Change in Sulfate Concentration at SW005 when Exceeding 10 mg/L, Mine Year 0 through Mine Year 10

In the long-term closure phase of the Project (Mine Year 55 and beyond) the Project will cause a change in both the flow of water and the load of sulfate reaching the Partridge River. The change in flow, beyond the watershed area changes discussed above, is due to the long-term WWTF that will discharge treated water from the West Pit and the Category 1 Waste Rock Stockpile to the Partridge River. The WWTF will begin to discharge when the West Pit is flooded, at approximately Mine Year 55 (Section 6.1.2.3.2). The sulfate concentration of the treated water is modeled as being fixed at 9 mg/L; the modeled average annual discharge is approximately 310 gpm. The surface water discharge from the WWTF will not exceed the sulfate standard of 10 mg/L; the constant discharge will act as additional dilution water during low-flow periods that tend to be dominated by high groundwater concentrations.

The change in sulfate load to the Partridge River from the Project will be primarily due to leakage from the temporary Category 2/3 Waste Rock Stockpile liner system, percolation through the temporary Overburden Storage and Laydown Area, and from groundwater seepage from the flooded Mine Pits, which have varying travel times to the river.

The Project's estimated effects on groundwater at the Mine Site are as follows:

- The concentration of sulfate in the East Pit – Category 2/3 surficial flow path at the Partridge River ranges from 10 mg/L to 15 mg/L and peaks at approximately Mine

Year 125, as shown in Figure 6-135. The average flow discharging from this flow path to the Partridge River is 41 gpm (Table 6-12).

- The concentration of sulfate in the surficial aquifer flow path from the OSLA at the Partridge River has a sulfate concentration between approximately 10 mg/L and 20 mg/L, though the peak concentration occurs between approximately Mine Year 50 and Mine Year 100, as shown in Figure 6-136. The average flow discharging from this flow path to the Partridge River is 24 gpm (Table 6-12).

- The concentration of sulfate in the surficial aquifer flow path from the West Pit reaches its peak sulfate concentration at the Partridge River at approximately Mine Year 110 where it has a concentration between 10 mg/L and 27 mg/L, as shown in Figure 6-137. The average flow discharging from this flow path to the Partridge River is 18 gpm (Table 6-12).

Note that these flow path discharge flows (18 gpm to 41 gpm on average) are very low relative to the natural flows in the Partridge River at SW005, even under low flow conditions. The estimated groundwater baseflow at SW005 in long-term closure is 4.84 cfs (2,170 gpm) as shown in Table 5-16, and natural flows in the river are not anticipated to drop below 4 cfs (1,800 gpm) as shown in Attachment J.

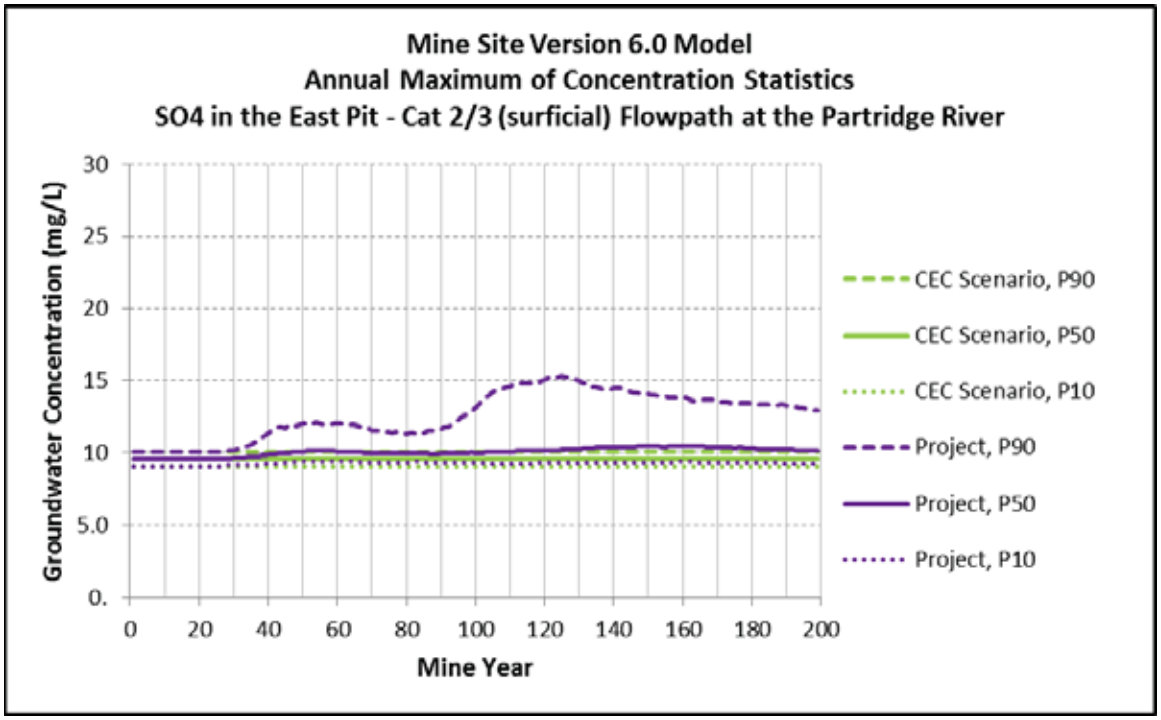


Figure 6-135 Sulfate Concentration in the East Pit – Category 2/3 Surficial Flow Path at the Partridge River

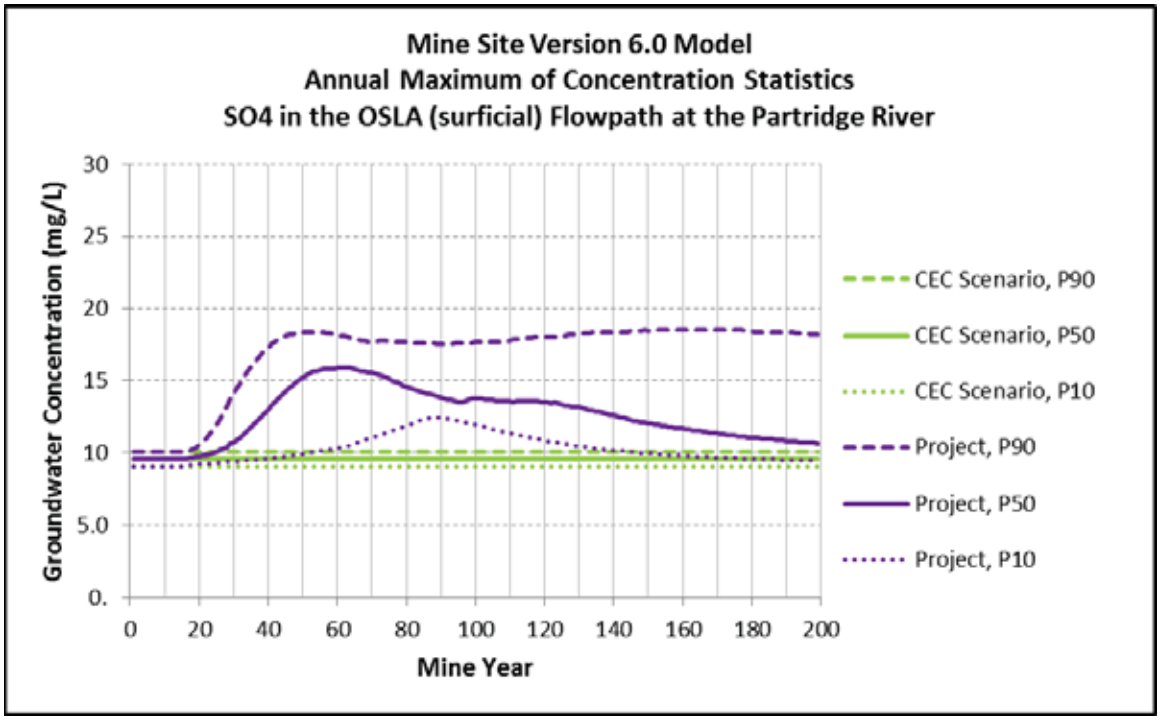


Figure 6-136 Sulfate Concentration in the OSLA Surficial Flow Path at the Partridge River

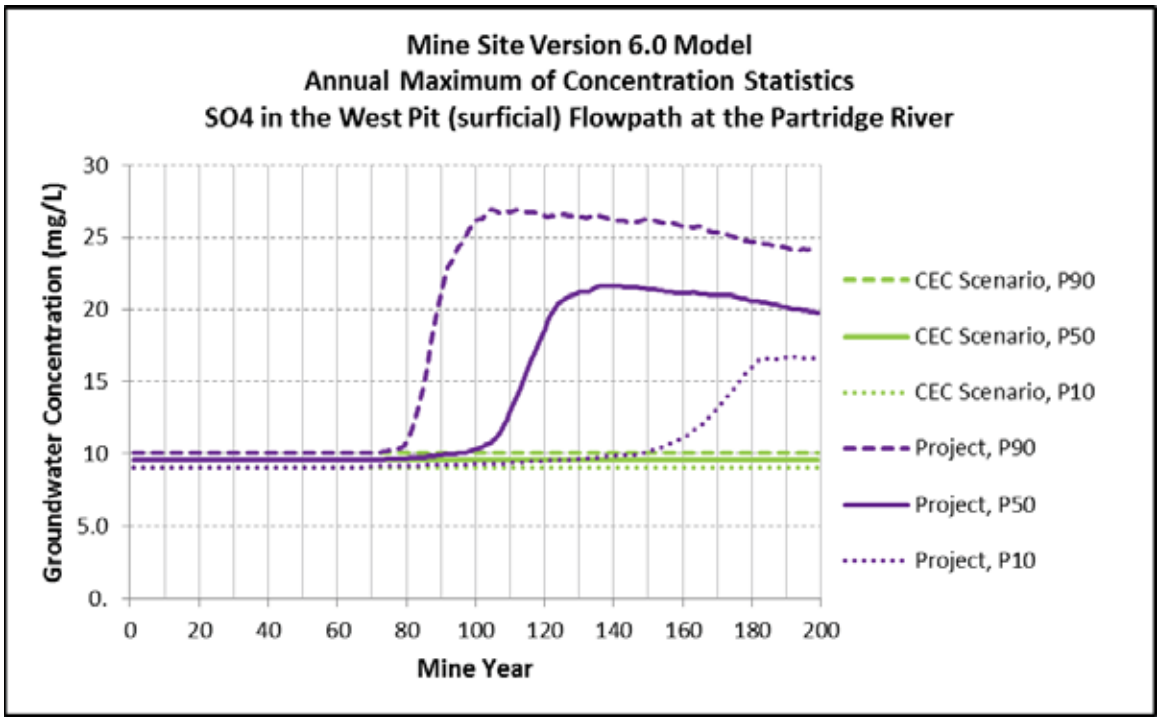


Figure 6-137 Sulfate Concentration in the West Pit Surficial Flow Path at the Partridge River

The Project is expected to have the greatest effect on sulfate concentrations at SW005 from approximately Mine Year 120 through Mine Year 130. Figure 6-138 shows the percent of model runs that are estimated to have sulfate concentrations exceeding 10 mg/L for each year of the simulation. The red line, showing the likelihood of exceeding 10 mg/L in the Project Model for at least one month per year, decreases from approximately 95% initially to 20%-30% following the discontinuation of Peter Mitchell Pit discharge in Mine Year 55, which coincides with the approximate beginning of long-term closure when the WWTF begins discharging to the Partridge River. The blue line in Figure 6-138 shows the likelihood that the Project causes the sulfate concentration to exceed 10 mg/L during time periods that will not exceed under Continuation of Existing Conditions Scenario. The blue line peaks at 1.0% at approximately Mine Year 130, indicating the greatest likelihood that the Project will cause an exceedance of 10 mg/L sulfate. This period will be discussed in more detail below.

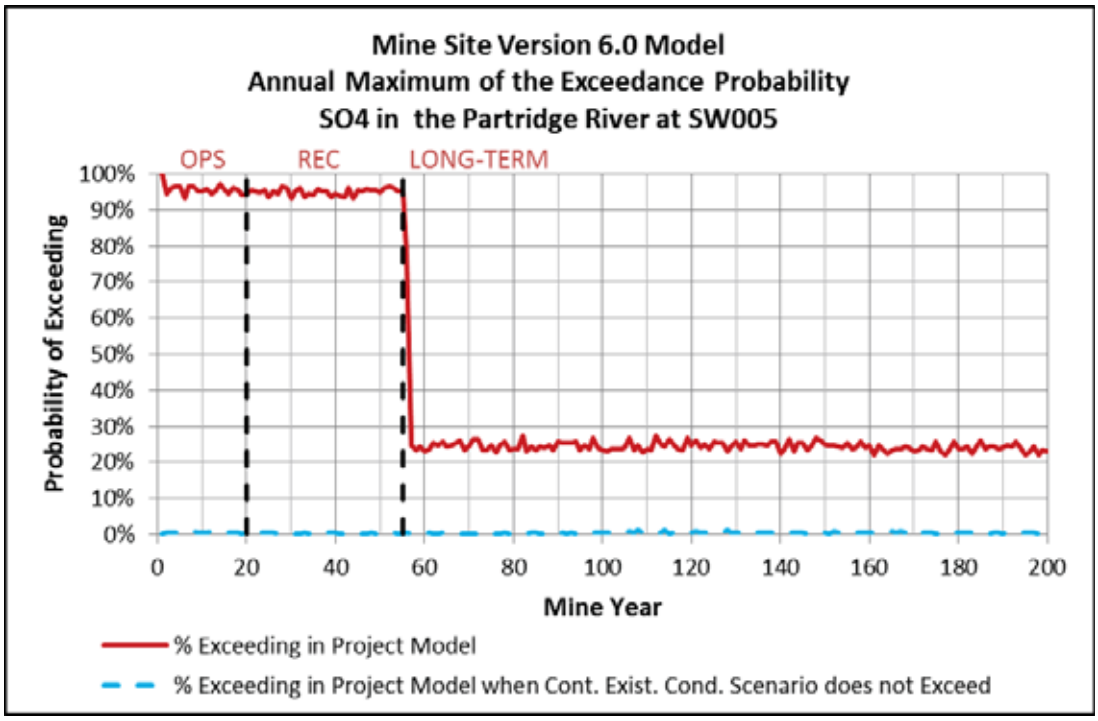


Figure 6-138 Probability of a Sulfate Exceedance in the Partridge River at SW005

Figure 6-139 shows the percent of model runs that are estimated to have the sulfate concentration exceeding 10 mg/L at SW005 for each month during Mine Year 120 through Mine Year 130. The red line shows the total percent of Project Model runs estimated to have an exceedance in any given month; the blue line shows the percent of model runs where there was an exceedance in the Project Model and no exceedance in the Continuation of Existing Conditions Scenario Model. Most of the model runs that are estimated to have an exceedance will have had an exceedance even without the Project. Under Continuation of Existing Conditions Scenario, there is between a 14% and 26% likelihood that the sulfate concentration at SW005 will exceed 10 mg/L in any given month. For months where natural conditions will not cause an exceedance,

there is less than a 10% probability that sulfate loading from the Project will cause the sulfate concentration to rise over 10 mg/L (the maximum value for the blue line in Figure 6-139 is 1.0%). The potential for the Project to cause an additional monthly exceedance of 10 mg/L is almost exclusively limited to the low-flow winter months, and there is almost no likelihood of additional exceedances caused by the Project during the high-flow summer months.

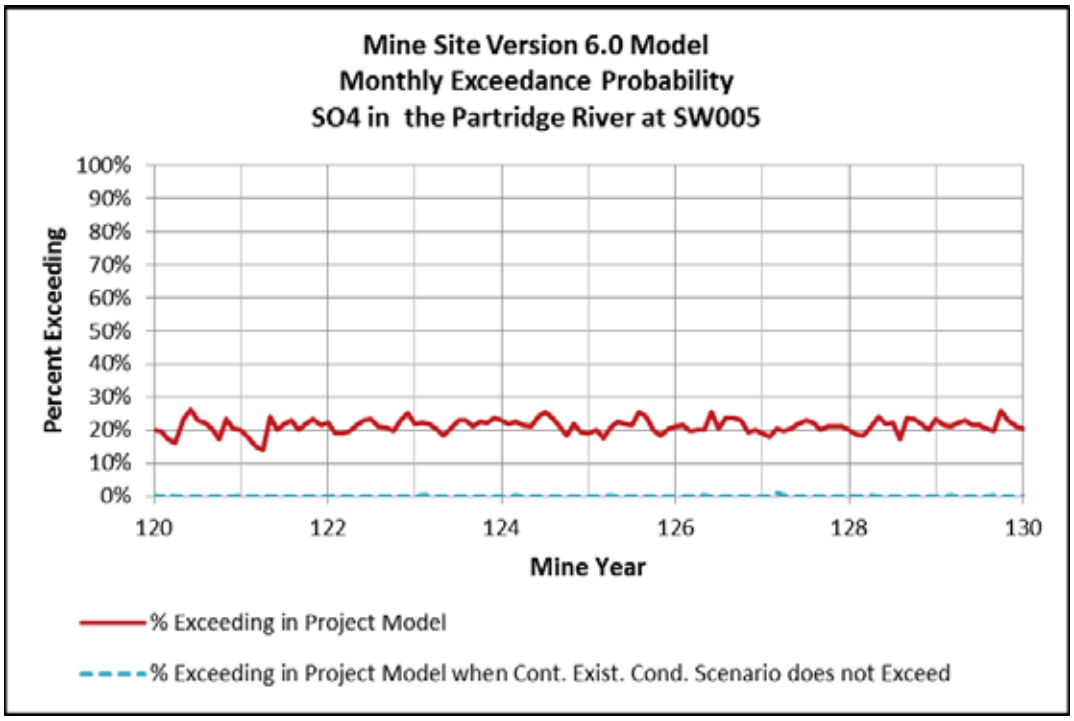


Figure 6-139 Monthly Probability of a Sulfate Exceedance in the Partridge River at SW005, Mine Year 120 through Mine Year 130

During months when the modeled sulfate concentration at SW005 exceeds 10 mg/L, the contribution of the Project to the exceedance can be assessed by comparing the concentrations in the Project Model and Continuation of Existing Conditions Scenario Model. The difference in the sulfate concentrations is shown in terms of the percent change from the Continuation of Existing Conditions Scenario Model in Figure 6-140 (note that this comparison is only performed for months when the sulfate concentration in the Project Model is above 10 mg/L). The sulfate concentration in long-term closure may increase or decrease compared to the Continuation of Existing Conditions Scenario Model. On average, the Project is more likely to decrease concentrations than increase concentrations (shown by the P50 line being almost exclusively below zero). During winter low-flow periods the sulfate concentration is most likely to increase due to the Project, with a 90% probability (upper dashed line) that the increase is less than 1%. During the remainder of the year, however, the Project has a low probability of contributing to an increase in concentration; in many months there is a 90% probability that concentrations will decrease or remain unchanged rather than increase. The modeled increase in

sulfate concentration is small, is limited to only the winter low-flow periods, and does not constitute a significant contribution to the existing concentrations in excess of 10 mg/L.

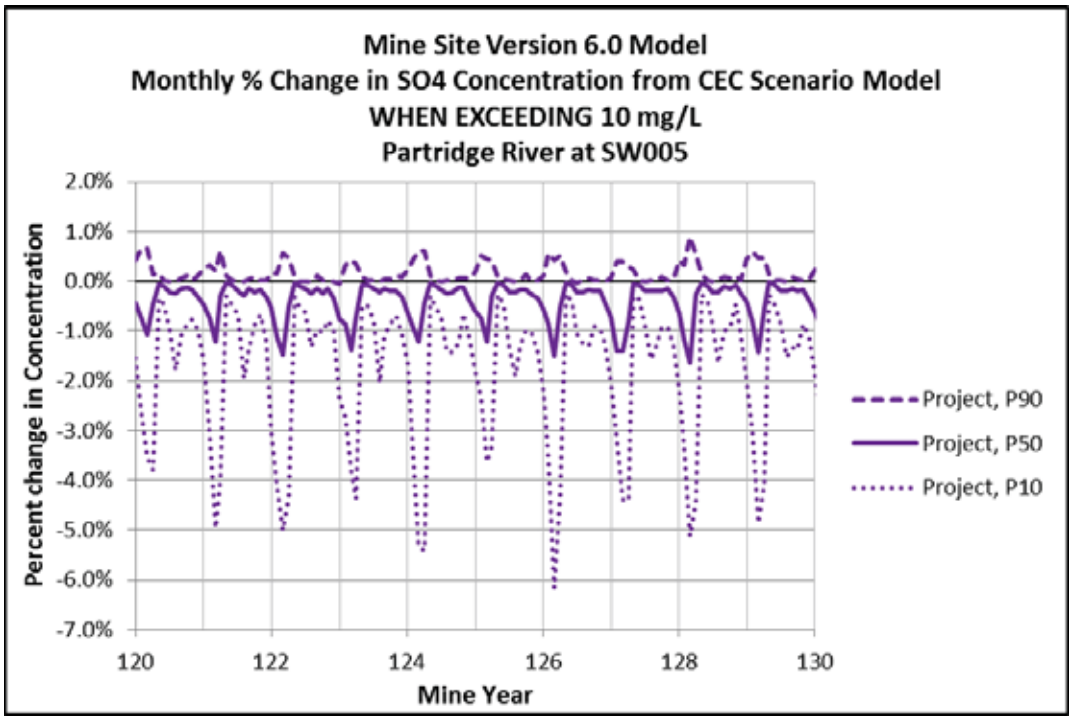


Figure 6-140 Percent Change in Sulfate Concentration at SW005 when Exceeding 10 mg/L, Mine Year 120 through Mine Year 130

6.5.6.2.2 Conclusion

Because there is a less than 10% probability that the Project will cause an additional exceedance beyond that caused by natural conditions, the Project does not significantly impact water quality as it relates to the sulfate standard at SW005. Because the modeled concentrations at SW005 will most likely decrease for much of the year and may increase by less than 1% for only a few months each year, the Project does not significantly change water quality during periods when the existing conditions exceed the sulfate standard at SW005.

The following conclusions can be drawn from the modeling results presented above:

- Measured sulfate concentrations at SW005 are currently over 10 mg/L regularly during low-flow conditions. The Continuation of Existing Conditions Scenario Model estimates that without the Project, there is a 95% probability of the sulfate concentration exceeding 10 mg/L for at least one month in a given year.

- The Project is estimated to cause a slight increase in sulfate loading to SW005 due to groundwater seepage from the mine features. The estimated potential increase in

concentration and loading is not estimated to begin until approximately 20 years after mining ceases.

- The likelihood of the Project causing an exceedance that will not occur without the Project (defined using the Continuation of Existing Conditions Scenario Model) is less than 10%. Based on PolyMet's interpretation of the definition of significant impacts, we do not believe this increase represents a significant impact for the purpose of the FEIS.

- The effect of the Project on the sulfate concentration at SW005 during months exceeding 10 mg/L ranges from a potential increase in concentration of less than 1% during winter low-flow months to a likely slight decrease in concentration during high-flow months.

During operations there will be ongoing monitoring of surface water and groundwater quality downgradient of mine features. If future modeling, informed by the results of the groundwater monitoring, shows exceedances of the applicable water quality standard for sulfate then contingency mitigation could be implemented and adapted as necessary to decrease the effects of groundwater on the Partridge River prior to an actual impact occuring. Contingency mitigation options are discussed in Reference (1).

6.5.6.3 Iron and Manganese in Colby Lake

6.5.6.3.1 Evaluation

Model results for the Mine Site indicate that manganese concentrations at Colby Lake exceed the primary and secondary drinking water standard, also known as the maximum contaminant level (MCL) and secondary maximum contaminant level (sMCL), for both the Continuation of Existing Conditions Scenario Model and Project Model. Similarly, iron concentrations at Colby Lake exceed the sMCL for both the Continuation of Existing Conditions Scenario Model and Project Model. Concentrations will decrease as a result of the Project but will remain above the standards.

Colby Lake receives water from the Partridge River downstream of the Mine Site, as shown on Large Figure 20. Figure 6-141 and Figure 6-142 illustrate the continuous exceedances of the manganese and iron standards under both Continuation of Existing Conditions Scenario and Project conditions.

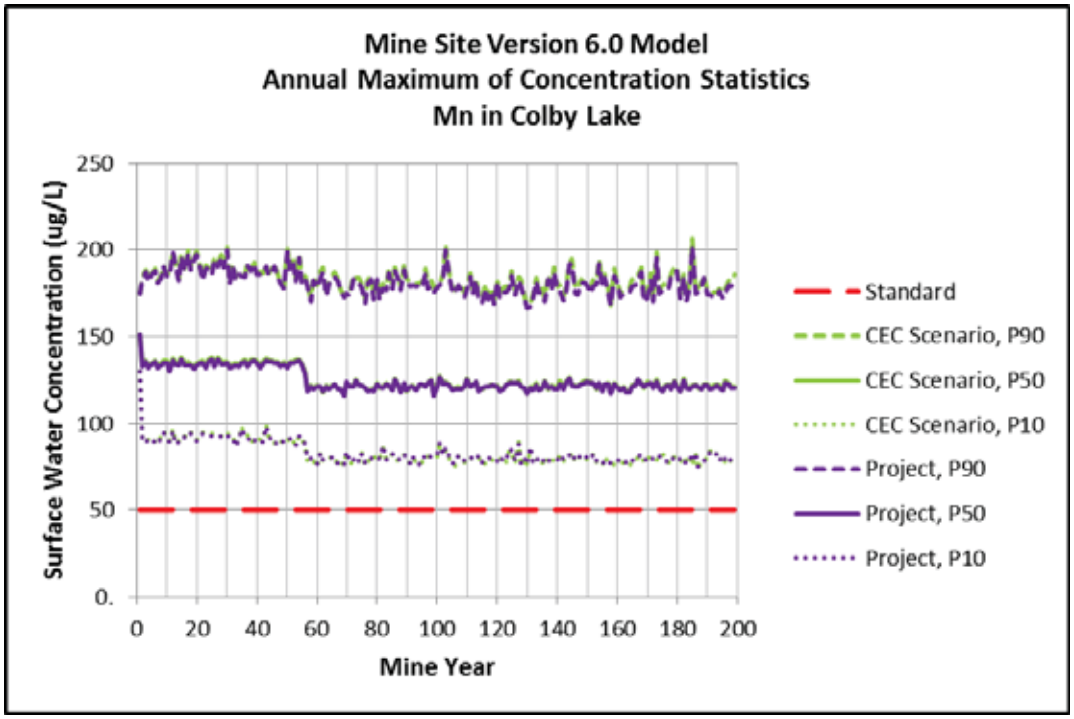


Figure 6-141 Annual Summary of Manganese Concentration in Colby Lake

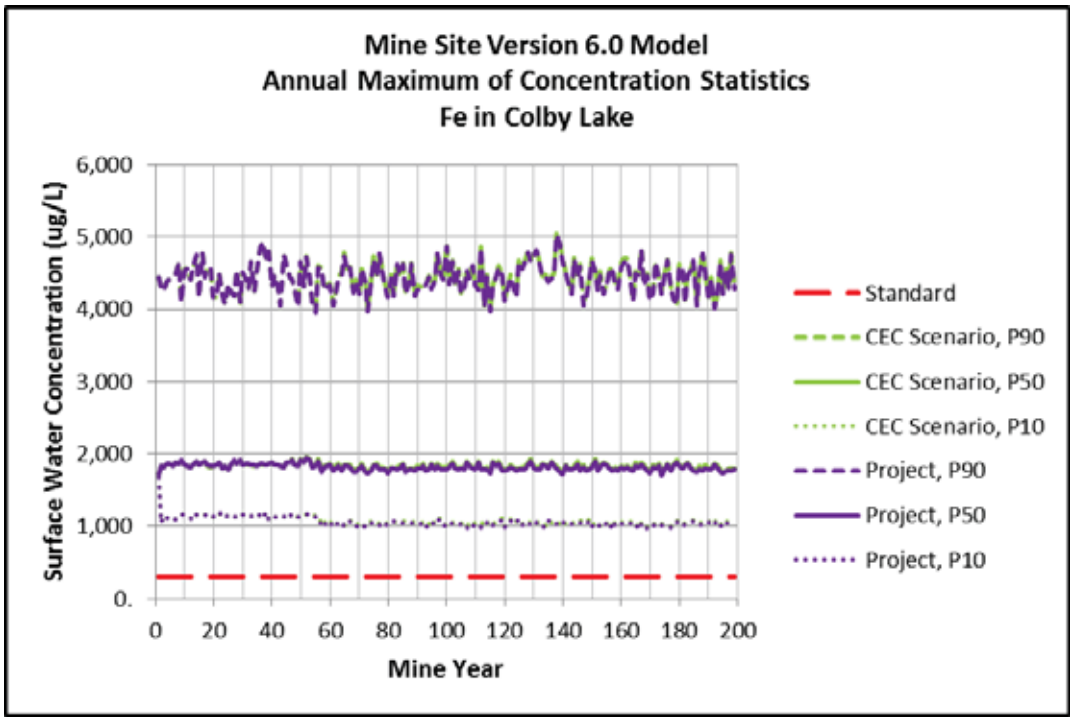


Figure 6-142 Annual Summary of Iron Concentration in Colby Lake

Under existing conditions, both iron and manganese are present well above standards in the Partridge River. Figure 6-143 illustrates the model calibration fit to the observed range of manganese concentrations, and Figure 6-144 illustrates the model calibration fit to the observed range of iron concentrations (figures excerpted from Attachment E). It is readily apparent that the manganese sMCL (50 µg/L) is exceeded by approximately 90% of background samples; the 50th percentile is approximately 110 µg/L. Similarly, the iron sMCL (300 µg/L) is exceeded by over 90% of background samples; the 50th percentile is approximately 1,600 µg/L. Elevated levels of iron and manganese occur naturally in this geologic setting.

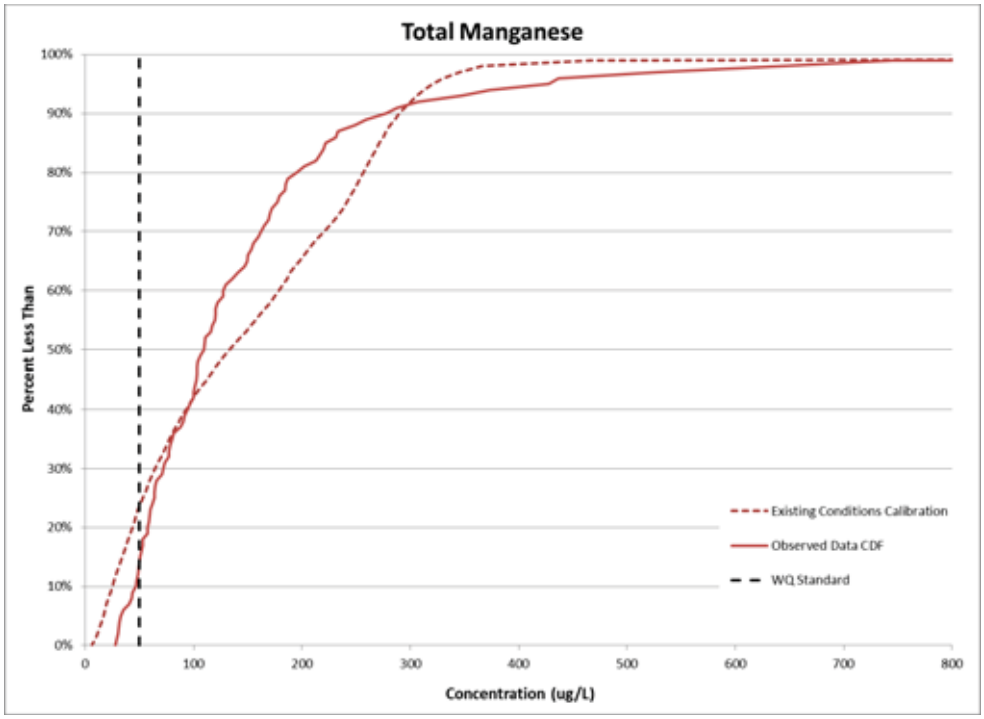


Figure 6-143 Calibration Fit to Manganese Concentrations in the Partridge River (from Attachment E)

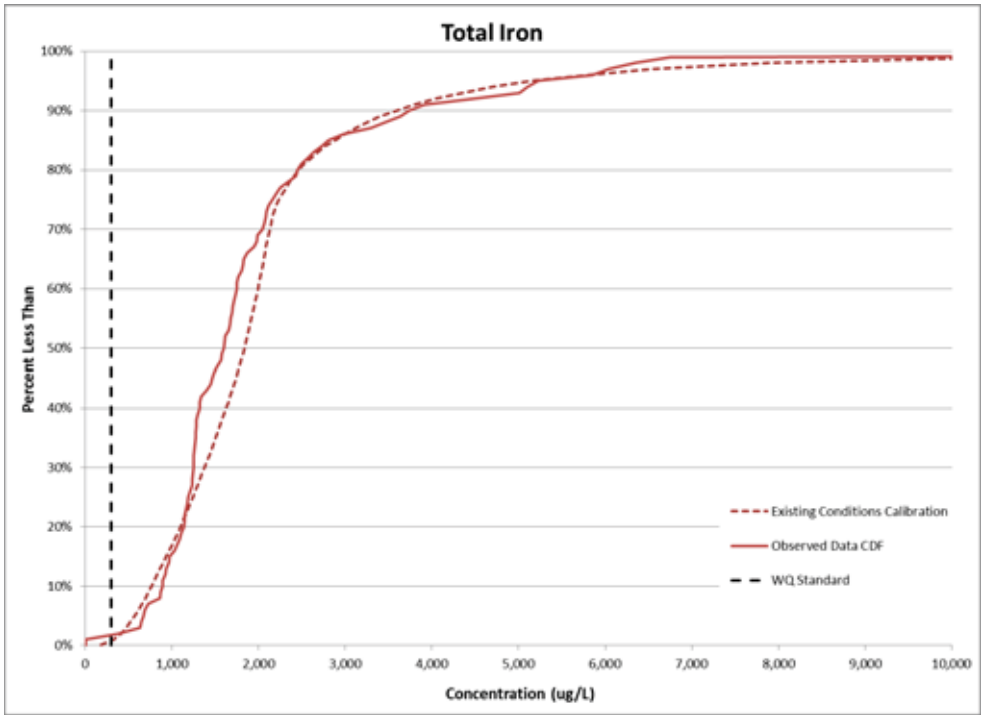


Figure 6-144 Calibration Fit to Iron Concentrations in the Partridge River (from Attachment E)

It should be noted that the Mine Site model has been calibrated to conditions in the Partridge River and to the average water quality in Colby Lake. For manganese, an additional constant loading term is added to Colby Lake to match the observed concentrations; no additional load is included for iron.

Because of the simplified modeling of Colby Lake water quality, modeled water quality in Colby Lake under Continuation of Existing Conditions Scenario is not as well-matched to measured values as modeled water quality in the Partridge River (Table 6-13 and Attachment E). For both manganese and iron the measured concentrations are somewhat higher than modeled values. For both constituents, the measured average concentration in Colby Lake exceeds the applicable sMCL. The following discussion compares the *modeled* Continuation of Existing Conditions Scenario concentrations in Colby Lake with the *modeled* Project concentrations in order to assess the relative contributions from the Project; existing concentrations in the lake are noted here only for reference. Also for reference, modeled concentrations in the Partridge River at SW005 (farthest downstream location included in Attachment E) are included as Figure 6-145 and Figure 6-146.

Table 6-13 Comparison of measured and modeled Colby Lake water quality

Constituent	sMCL (µg/L)	Measured water quality [1] (µg/L)			Modeled water quality (µg/L)		
		Min.	Avg.	Max.	P10	P50	P90
Mn	50	25	115	390	23	73	156
Fe	300	450	1,665	4,900	670	1,660	3,970

(1) Measured data from Large Table 10

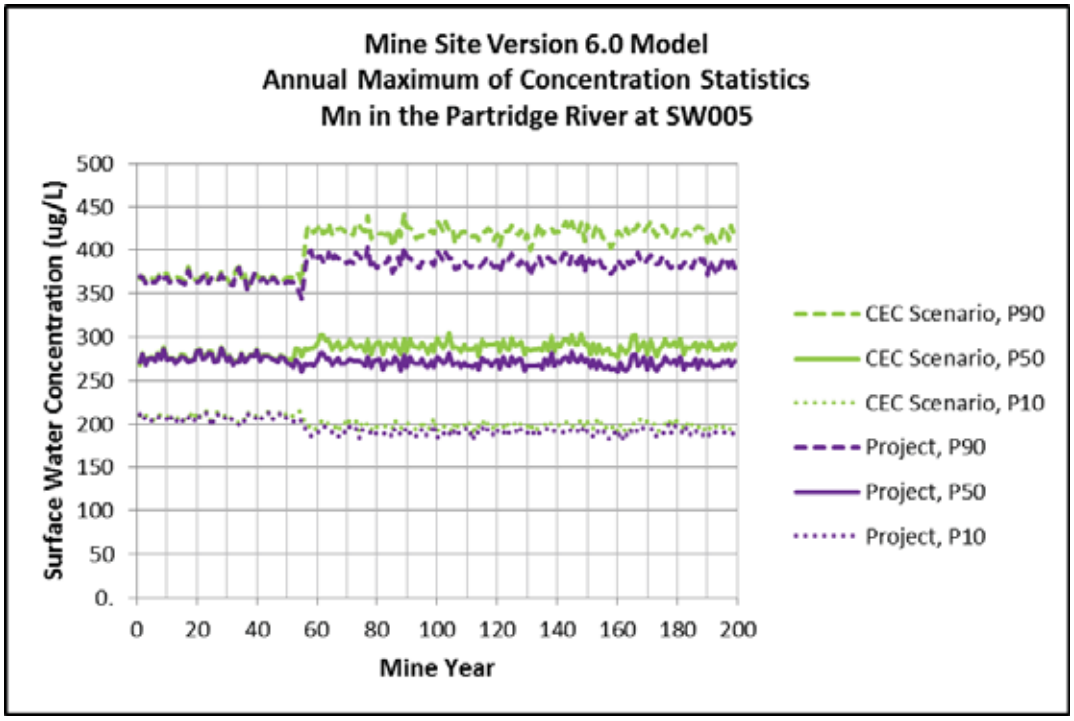


Figure 6-145 Annual Summary of Manganese Concentration in the Partridge River at SW005

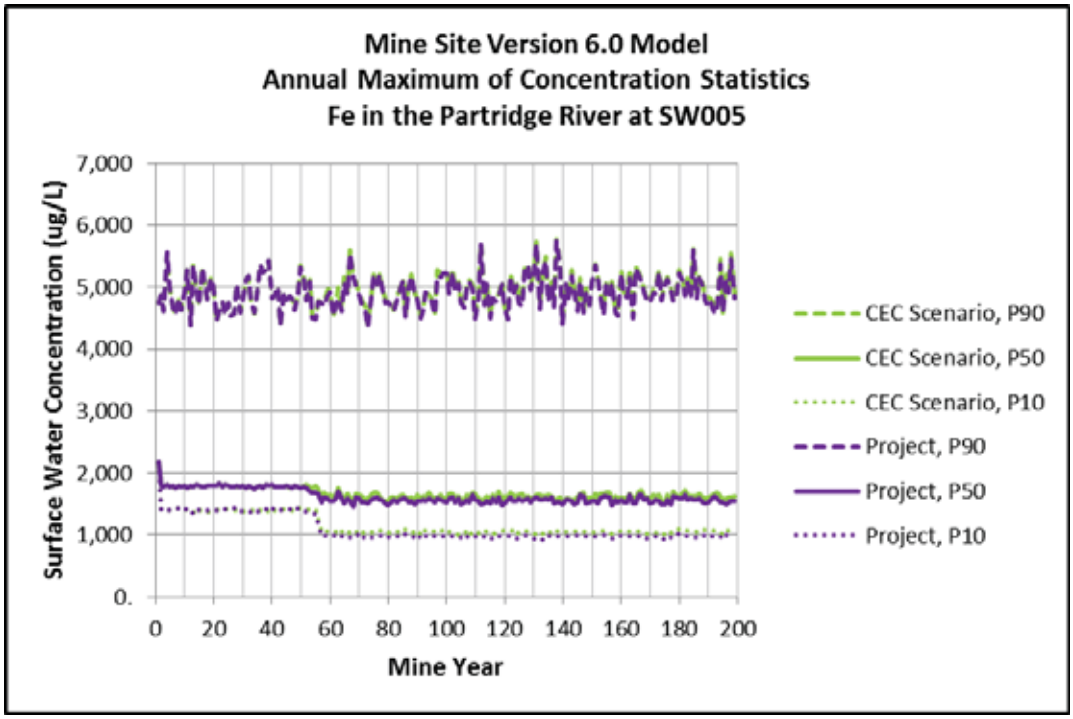


Figure 6-146 Annual Summary of Iron Concentration in the Partridge River at SW005

Potential Project sources of iron and manganese include the WWTF discharge, the East Pit – Category 2/3 surficial flow path, and the West Pit surficial flow path. The other surficial aquifer flow paths at the Mine Site have very low flows (Table 6-12) and do not represent significant potential sources of iron and manganese. The characteristics of these Project waters at the Partridge River are described below:

- Figure 6-147 and Figure 6-148 illustrate the concentrations of manganese and iron in effluent from the WWTF. The concentration of manganese is 50 µg/L, i.e., equal to the sMCL and less than the 50th percentile concentration in the Partridge River. The concentration of iron is never more than 200 µg/L, which is less than the sMCL for iron and much less than the estimated 50th percentile concentration for iron in the Partridge River.

- Figure 6-149 and Figure 6-150 illustrate the concentrations of manganese and iron in the East Pit – Category 2/3 Waste Rock Stockpile surficial aquifer flow path at the Partridge River. As shown, the Project concentrations for both manganese and iron generally mimic the concentrations under the Continuation of Existing Conditions Scenario, though they increase very slightly above existing concentrations at approximately Mine Year 40 due to loading from the stockpile reaching the river, then steadily decrease below the Continuation of Existing Conditions Scenario concentrations after approximately Mine Year 125 due to removal of the stockpile and the long-term seepage from the flooded East Pit.

- Figure 6-151 and Figure 6-152 illustrate the concentrations of manganese and iron in the West Pit surficial flow path at the Partridge River. Both the manganese and the iron standard are exceeded for the Continuation of Existing Conditions Scenario and Project conditions, however after approximately Mine Year 80, the Project causes a marked decrease in concentrations compared to the Continuation of Existing Conditions Scenario Model due to the long-term seepage from the flooded West Pit (i.e., the West Pit lake has modeled manganese and iron concentrations that are below the background concentrations, so the seepage is a source of 'clean' water).

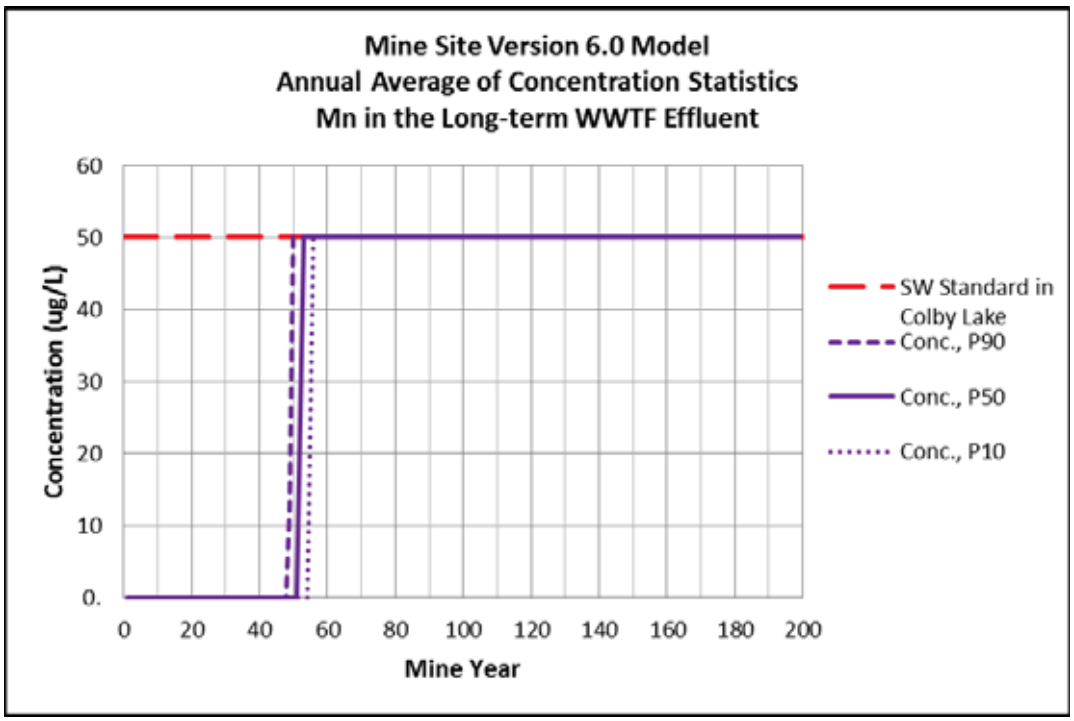


Figure 6-147 Manganese Concentration in the Long-term WWTF Effluent to the Partridge River

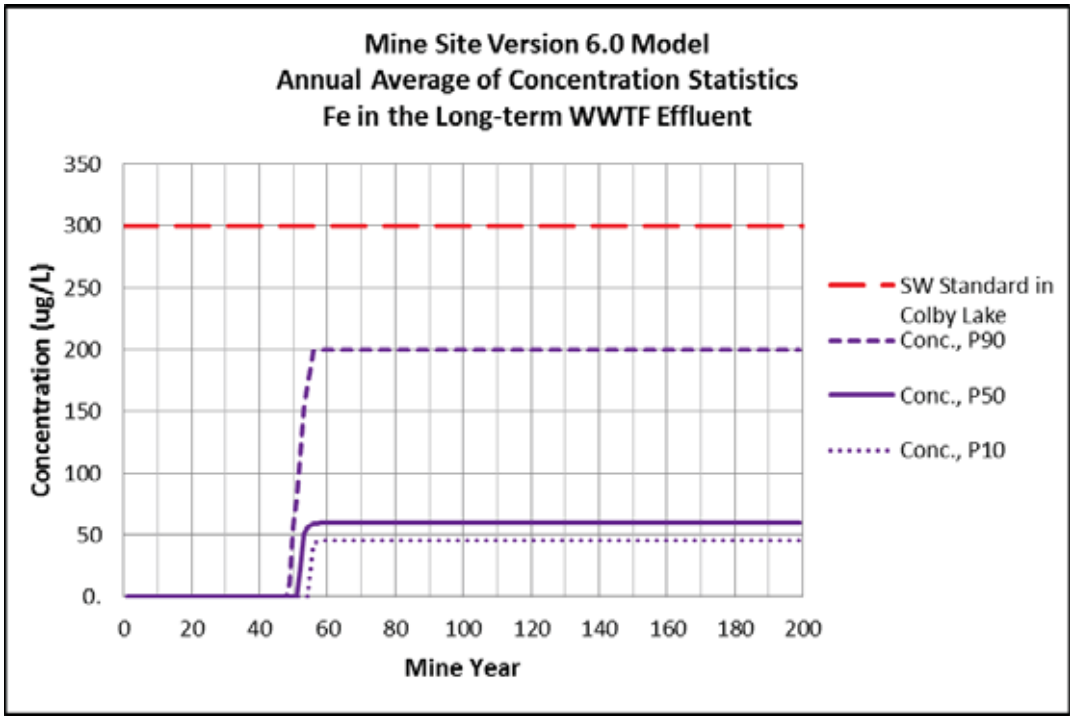


Figure 6-148 Iron Concentration in the Long-term WWTF Effluent to the Partridge River

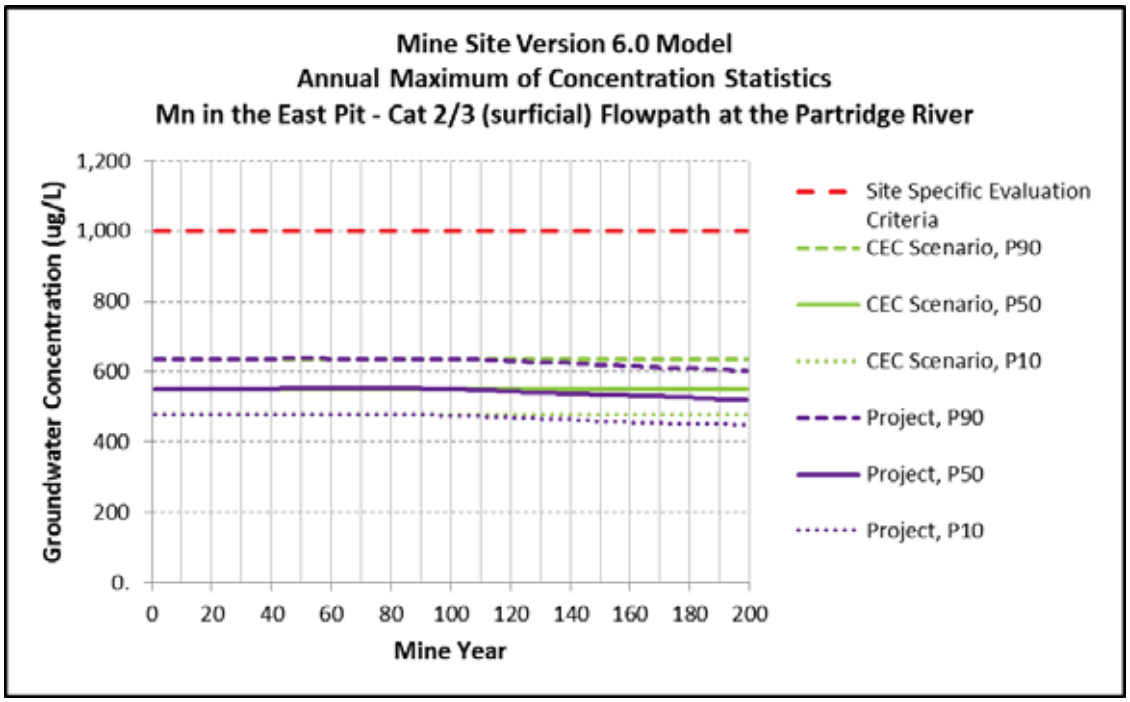


Figure 6-149 Manganese Concentration in the East Pit – Category 2/3 Surficial Flow Path at the Partridge River

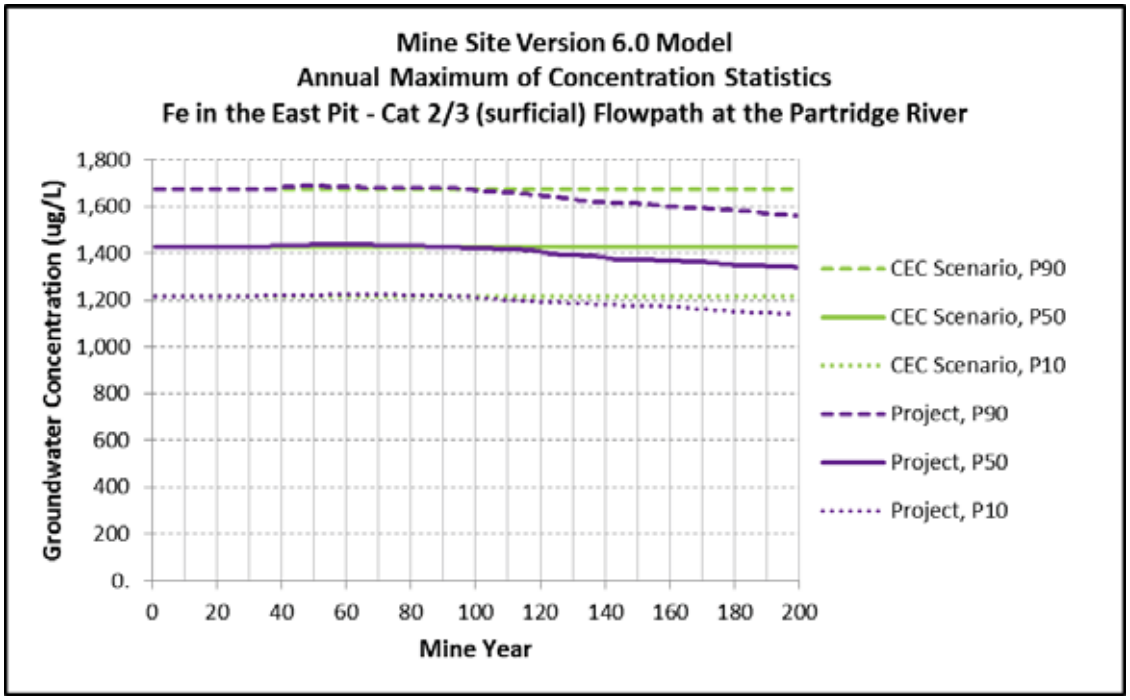


Figure 6-150 Iron Concentration in the East Pit – Category 2/3 Surficial Flow Path at the Partridge River

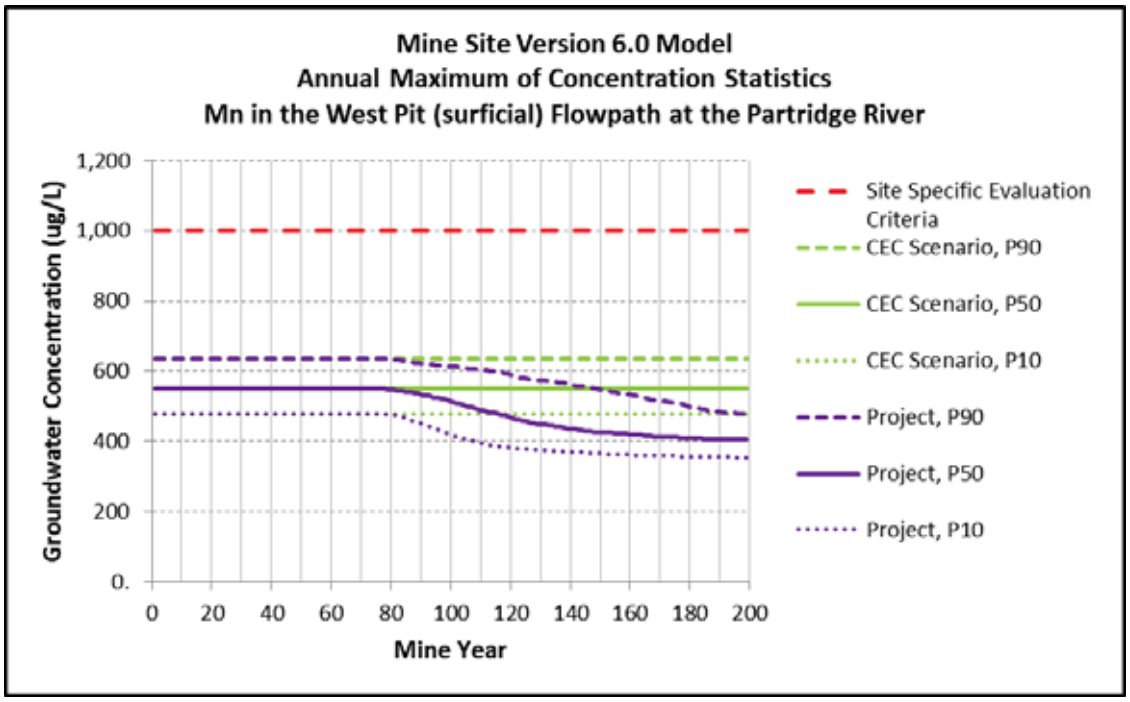


Figure 6-151 Manganese Concentration in the West Pit Surficial Flow Path at the Partridge River

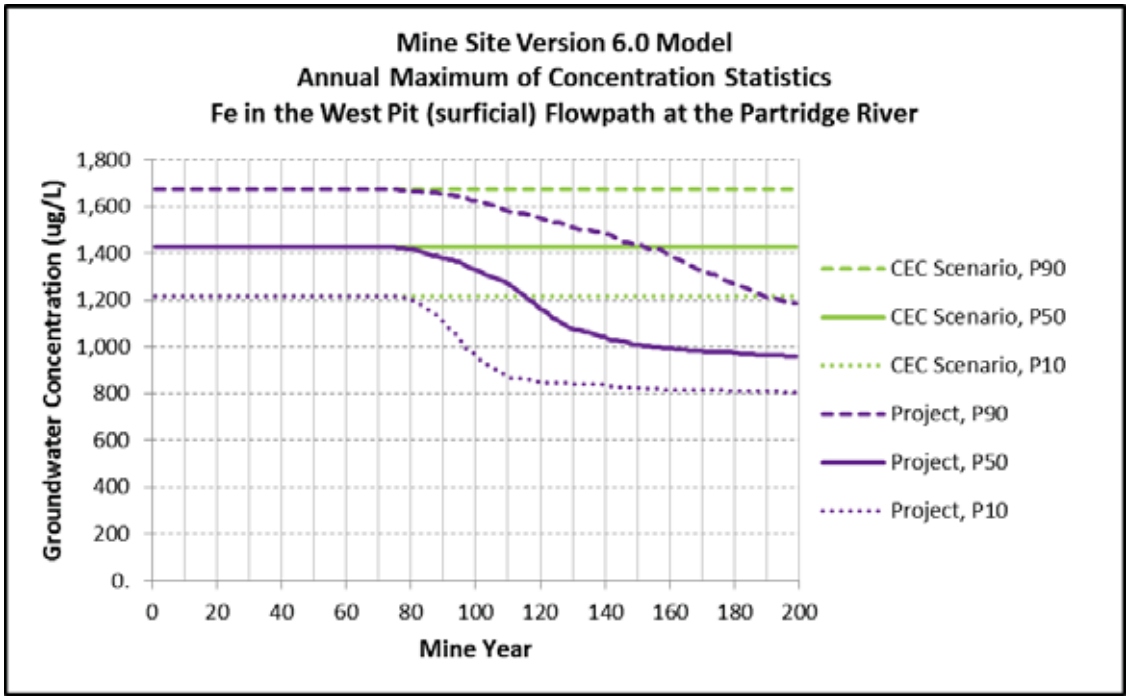


Figure 6-152 Iron Concentration in the West Pit Surficial Flow Path at the Partridge River

Although Project waters at the Partridge River do exceed the manganese and iron drinking water standards, they do not exceed the concentrations of manganese and iron that will occur under the Continuation of Existing Conditions Scenario (with the exception of the very slight increase due to the East Pit – Category 2/3 surficial flow path at Mine Year 40). Because the Partridge River is not a source of drinking water, the drinking water standards are not applicable. Downstream at Colby Lake, where the drinking water standards do apply, the Project actually causes a slight decrease in the long-term 90th percentile concentrations of manganese and iron due to changes in the watershed area and the lower-concentration long-term seepage from the flooded pits (shown on Figure 6-141 and Figure 6-142).

6.5.6.3.2 Conclusion

Background concentrations of manganese and iron are naturally high in the area of the Mine Site, which is expected and normal in an iron-mining region. Although the Project Model estimates that the manganese and iron sMCLs will be exceeded in every year at Colby Lake, all of these exceedances also occur for the Continuation of Existing Conditions Scenario Model. In fact, in the long term the Project causes a slight decrease in the 90th percentile concentrations for both manganese and iron. The discharge from the long-term WWTF to the Partridge River would meet the sMCLs for both manganese and iron, were they to apply.

6.5.6.4 Arsenic and Copper in Colby Lake

6.5.6.4.1 Evaluation

Model results for the Mine Site indicate that arsenic and copper concentrations at Colby Lake exceed the Class 2Bd surface water standard for both the Continuation of Existing Conditions Scenario Model and Project Model. The applicable standard for arsenic in Colby Lake is 2 µg/L (compared to 53 µg/L for the Partridge River); the applicable standard for copper in Colby Lake is based on the instantaneous modeled hardness (and is calculated with the same equation as for the Partridge River), and it ranges from approximately 6 µg/L to 11 µg/L (using the range of hardness values estimated in Colby Lake for the Continuation of Existing Conditions Scenario Model of 60 mg/L to 120 mg/L).

Colby Lake receives water from the Partridge River downstream of the Mine Site, as shown on Large Figure 20. Figure 6-153 and Figure 6-154 illustrate the continuous potential for exceedances of the arsenic and copper standards for both the Continuation of Existing Conditions Scenario and Project Models.

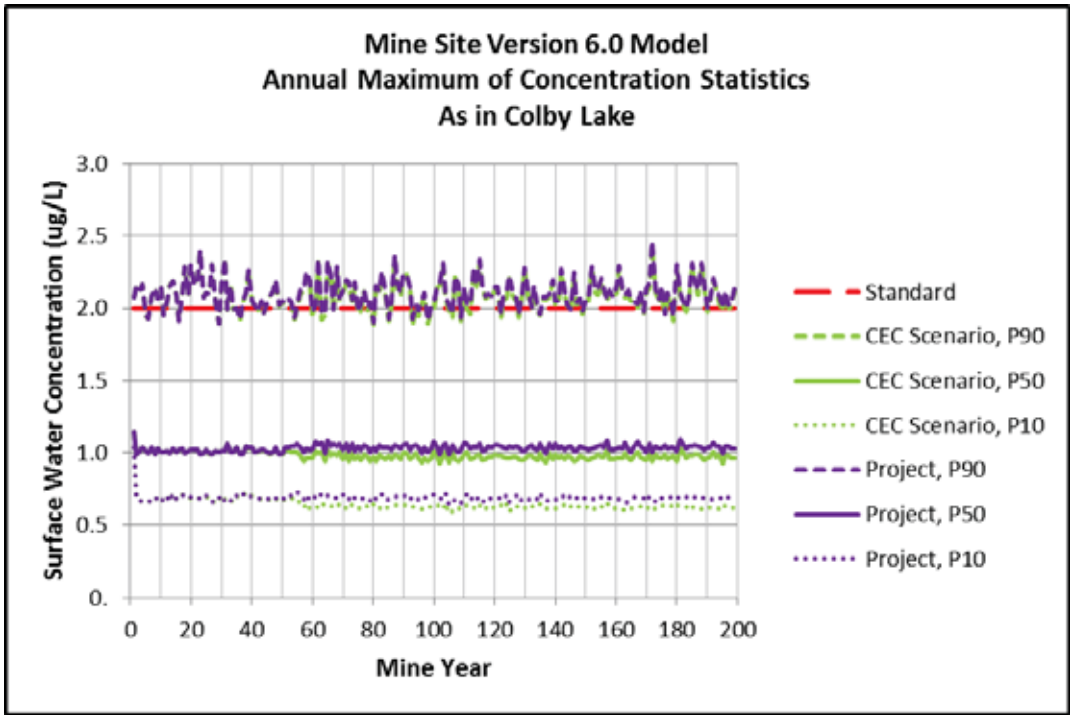


Figure 6-153 Annual Summary of Arsenic Concentration in Colby Lake

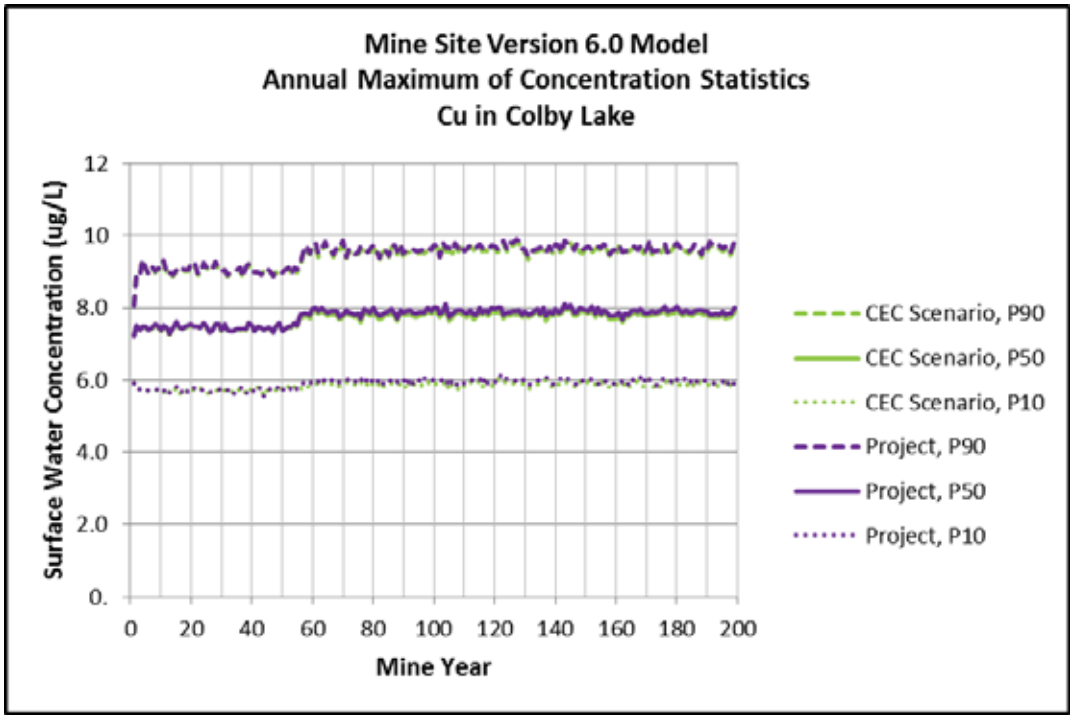


Figure 6-154 Annual Summary of Copper Concentration in Colby Lake

Under existing conditions, the 90th percentile concentration for both arsenic and copper is at or just above the surface water quality standard in Colby Lake. For arsenic this is a constant condition throughout the modeled time period; Figure 6-155 shows a constant probability of exceedance ranging from 9-14%. For copper the estimated concentrations in Colby Lake increase for the Continuation of Existing Conditions Scenario Model in Mine Year 55 with the discontinuation of discharge from the Peter Mitchell Pit. Figure 6-156 shows the probability of an exceedance for copper increasing from 1-3% before Mine Year 55 to 9-15% after Mine Year 55.

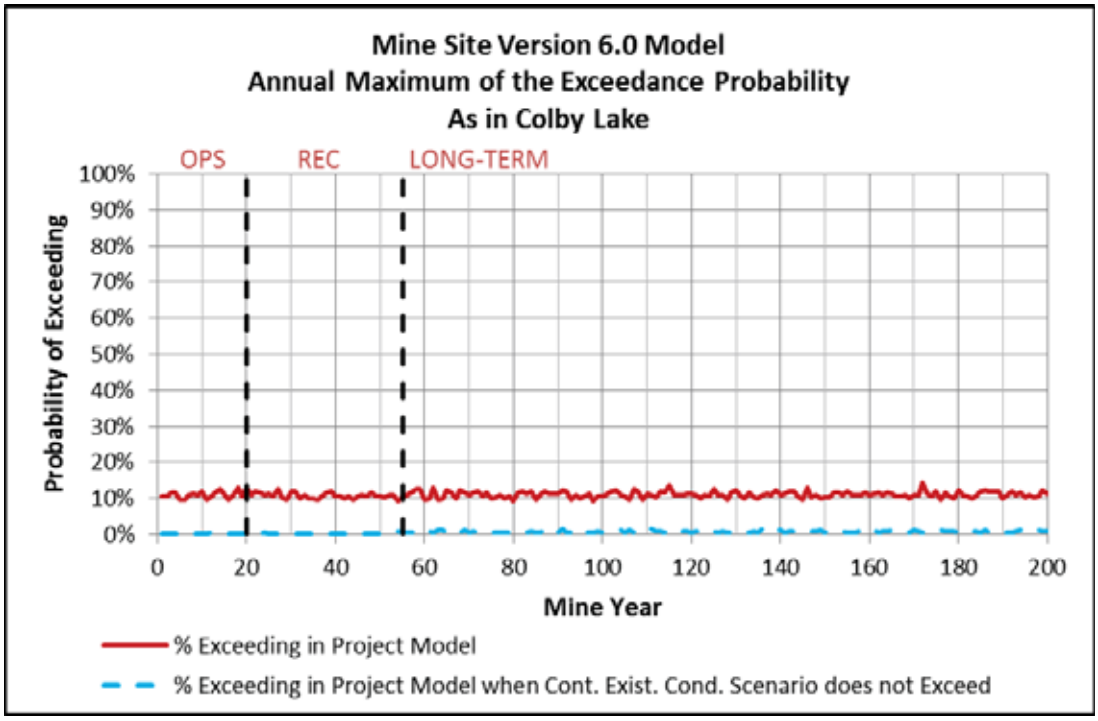


Figure 6-155 Probability of an Arsenic Exceedance in Colby Lake

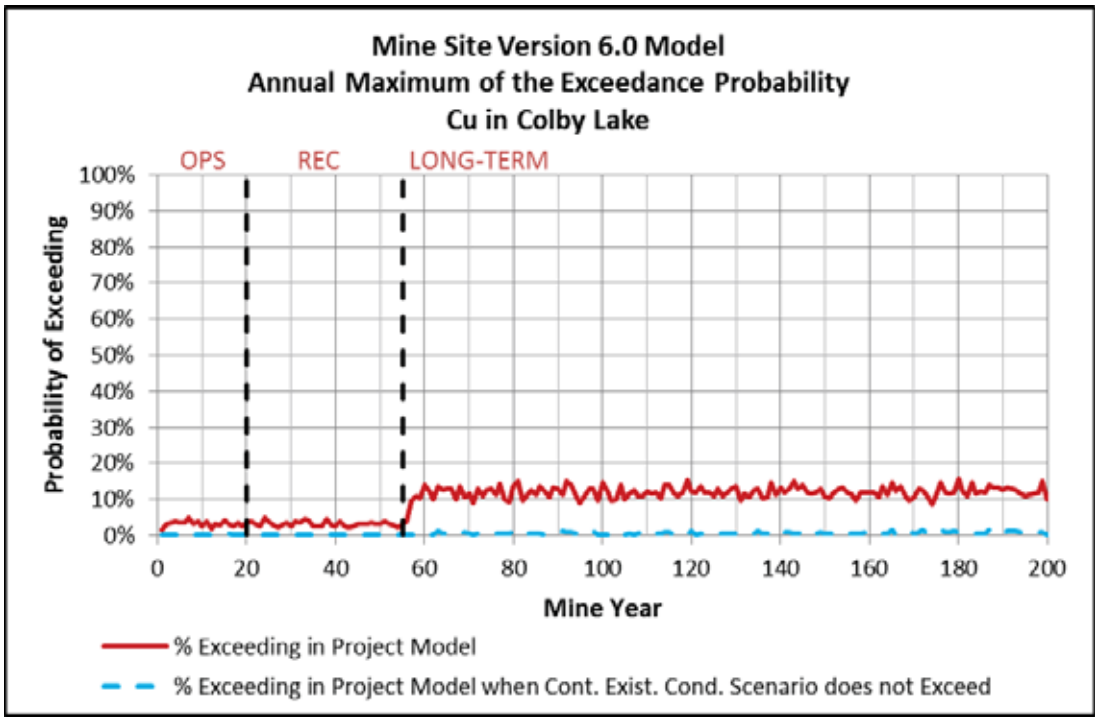


Figure 6-156 Probability of a Copper Exceedance in Colby Lake

For both of these constituents the modeled concentration in Colby Lake is higher than that in the Partridge River due to the additional loading included to calibrate to existing Colby Lake concentrations. Also, for both of these constituents the modeled discharge from the Peter Mitchell Pit serves as a diluting flow relative to the water quality standard. However, arsenic and copper differ in the relative importance of these two existing sources of load to Colby Lake.

For arsenic, the highest concentrations in Colby Lake are caused by high surface runoff concentrations combined with the additional constant loading factor assigned to Colby Lake. The simulated distribution of arsenic concentrations in surface runoff (distribution developed by calibrating to measured surface water concentrations) has a median concentration of 0.4 µg/L and an 11% probability of exceeding 2 µg/L (Figure 6-157). The probability of surface runoff exceeding the 2 µg/L arsenic standard that applies to Colby Lake mirrors the probability of Colby Lake exceeding the standard seen in Figure 6-155 and does not vary through time or seasonally. During periods with high runoff concentrations, the diluting effect from groundwater (modeled range 0.6-0.8 µg/L) and the Peter Mitchell Pit discharge (modeled at 1.3 µg/L) is minimal and the runoff component controls the peak concentration in Colby Lake.

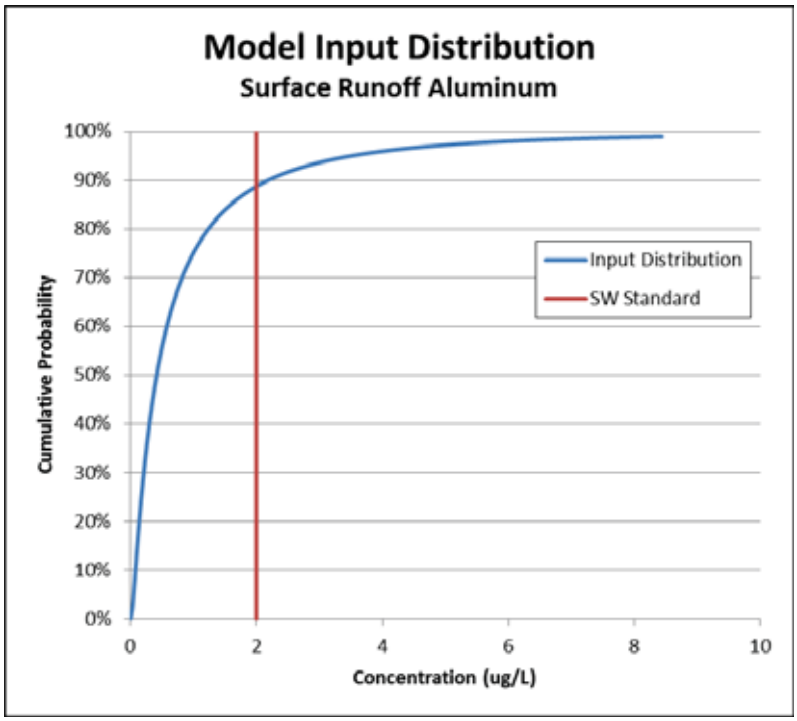


Figure 6-157 Simulated Distribution of Arsenic Concentration in Surface Runoff

For copper, the highest concentrations in Colby Lake are almost exclusively caused by the additional calibrated loading to the lake, which is by far the largest source of load under typical conditions (Figure 6-158). Both surface runoff and surficial groundwater from

unimpacted areas are modeled as having a very low likelihood of exceeding the surface water standard. As shown in Figure 6-159, there is only a 2% probability of surface runoff exceeding 6 µg/L, on the lower end of the hardness-based standard range; modeled surficial groundwater concentrations do not exceed 3 µg/L. Also, the modeled concentration of the Peter Mitchell Pit discharge is less than 1 µg/L.

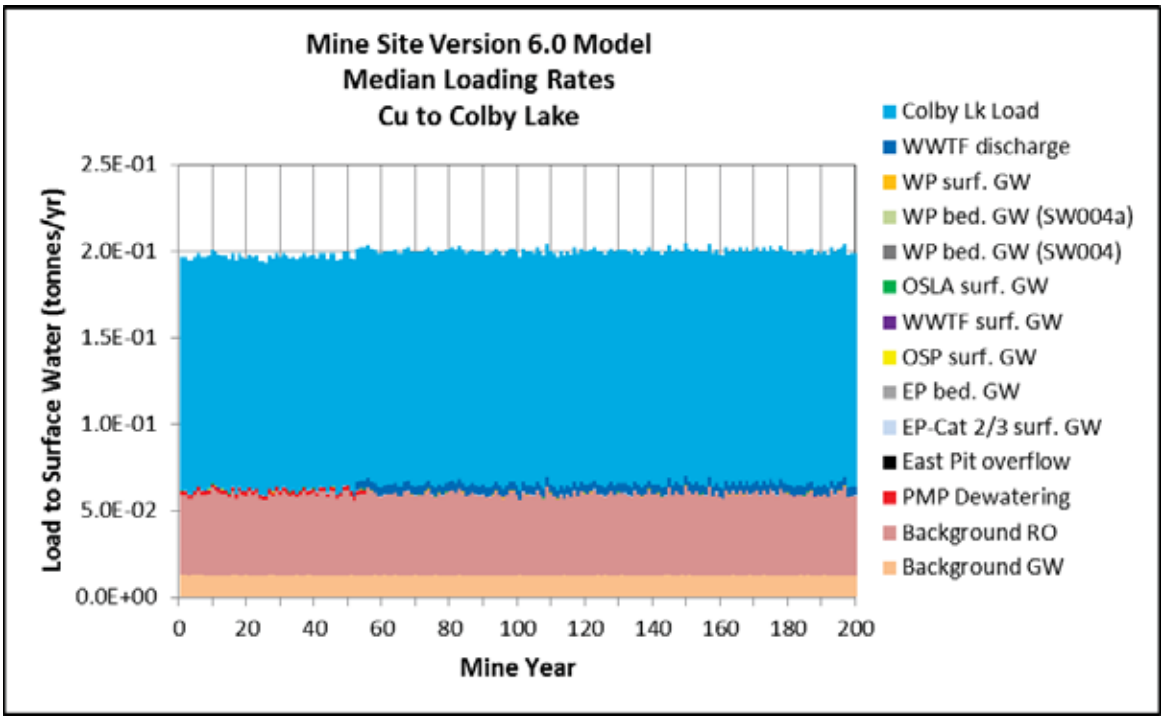


Figure 6-158 Median Copper Loading to Colby Lake

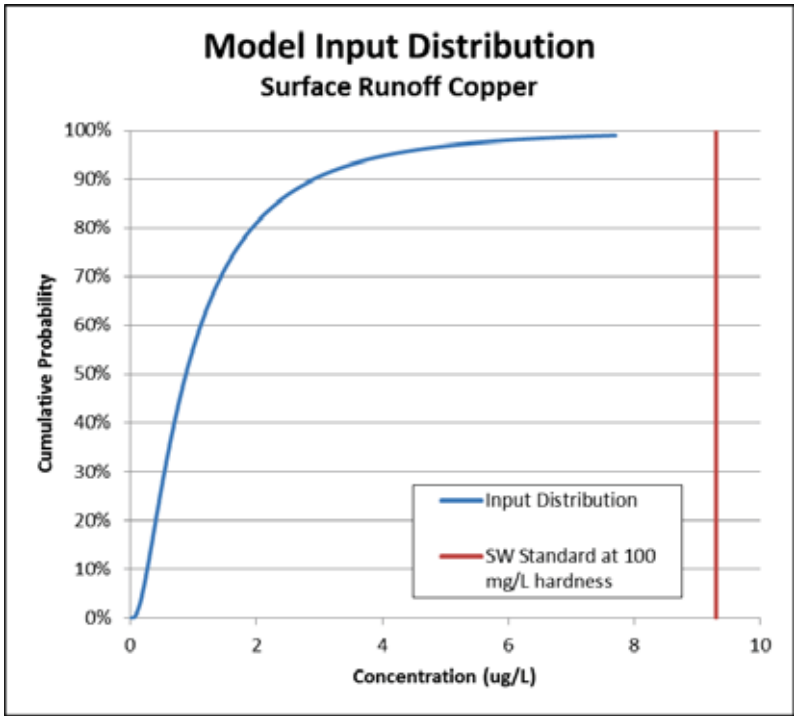


Figure 6-159 Simulated Distribution of Copper Concentration in Surface Runoff

Copper concentrations in Colby Lake peak during annual low-flow periods in the Continuation of Existing Conditions Scenario and Project Models, as shown in Figure 6-160. During these periods the constant loading term that is applied to Colby Lake causes the lake concentrations to increase significantly because the flows leaving the lake are too low to adequately flush the lake volume. Copper concentrations (Figure 6-154) and the probability of exceeding the surface water standard (Figure 6-156) increase after Mine Year 55 due to the discontinuation of the diluting flow from the Peter Mitchell Pit.

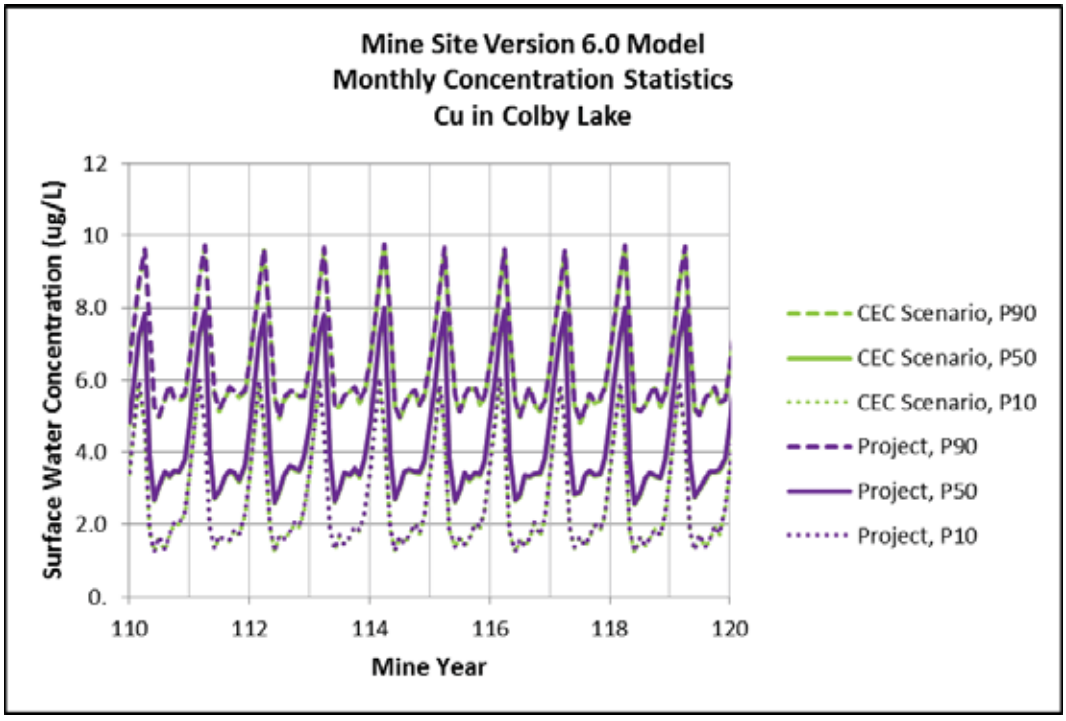


Figure 6-160 Monthly Copper Concentration in Colby Lake

Potential Project sources of arsenic and copper are limited to the WWTF discharge in long-term closure. There is minimal Project loading from the groundwater flow paths for these constituents within the 200-year simulation period because of the effects of sorption within the surficial aquifer. Figure 6-161 and Figure 6-162 show the concentrations of arsenic and copper in effluent from the WWTF; both constituents are consistently at the WWTF treatment target (4 µg/L for arsenic and 9 µg/L for copper). Note that for arsenic, the modeled WWTF treatment target of 4 µg/L is well above the expected effluent concentration for the WWTF at the point in time when it is discharging to the Partridge River based on pilot-testing performed for the Plant Site WWTP (Reference (83)). If necessary, as determined by project monitoring, the target effluent concentrations for the WWTF can be lowered as an adaptive management measure.

Although Project waters at the Partridge River upstream of Colby Lake do exceed the arsenic and (during period of low hardness) copper standards that are applicable in Colby Lake, they do not cause a significant change in the likelihood of exceedances of the standards in the lake, which are exceeded under modeled background conditions. For months where natural conditions will not cause an exceedance, there is less than a 10% probability that arsenic loading from the Project will cause the arsenic concentration in Colby Lake to exceed 2 µg/L (the maximum value for the blue line in Figure 6-155 is 1.4%). For months where natural conditions will not cause an exceedance, there is less than a 10% probability that copper loading from the Project will cause the copper concentration in Colby Lake to rise over the hardness-based standard (the maximum value for the blue line in Figure 6-156 is 1.6%).

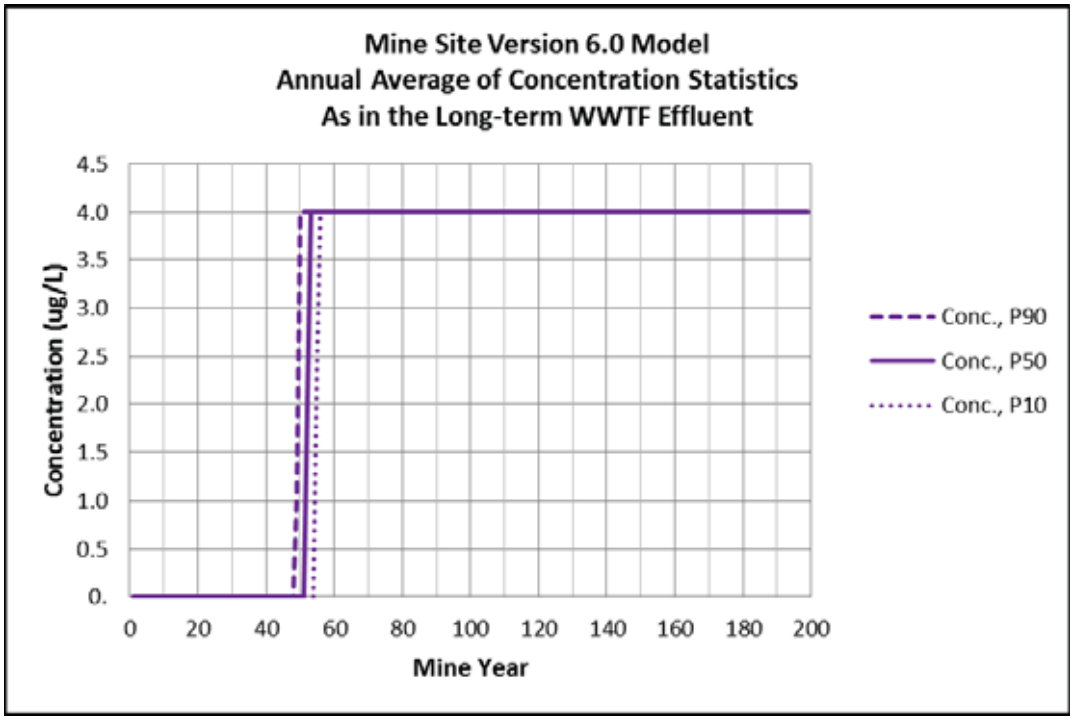


Figure 6-161 Arsenic Concentration in the Long-term WWTF Effluent to the Partridge River

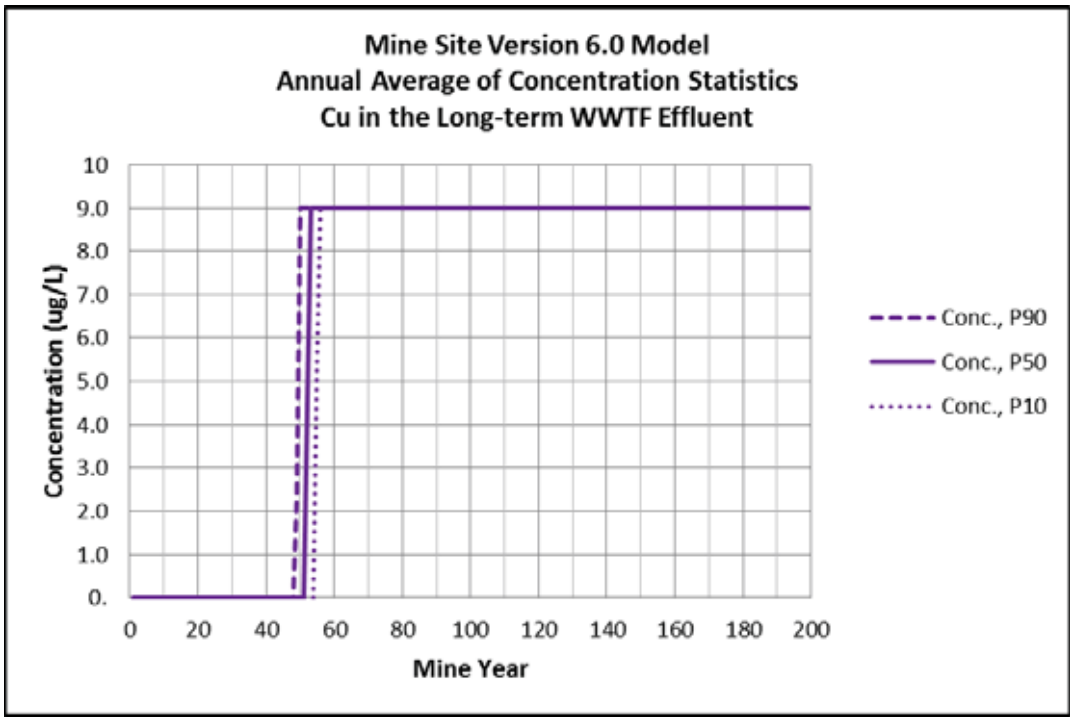


Figure 6-162 Copper Concentration in the Long-term WWTF Effluent to the Partridge River

6.5.6.4.2 Conclusion

Background loading of arsenic and copper to Colby Lake is naturally high enough to cause an appreciable probability of exceeding the water quality standards in the lake during every year of the simulation period. The likelihood of the Project causing an exceedance that will not occur without the Project (defined using the Continuation of Existing Conditions Scenario Model) is less than 10%. Based on PolyMet's interpretation of the definition of significant impacts, we do not believe this increase represents a significant impact for the purpose of the FEIS.

6.5.6.5 Total Dissolved Solids (TDS)

6.5.6.5.1 Evaluation

Total dissolved solids (TDS) was not identified as a constituent for inclusion in the GoldSim model. However, there is a surface water standard that will need to be met by the Project.

The Mine Site Water Quality Model is intended to independently model a suite of 28 constituents, as described in Table 2-1 of Attachment C. This suite of constituents does not include total dissolved solids (TDS). However, there are applicable surface water and groundwater standards for TDS, and the MPCA has requested that model results be compared to the TDS standards for surface water (700 mg/L) and groundwater (500 mg/L).

As described below, TDS has been estimated directly in the model at each time step using instantaneous concentrations of other constituents. Estimated TDS concentrations in surface water are presented here while estimated TDS concentrations in groundwater are presented in Section 6.3.3. TDS is not directly modeled by the probabilistic water quality model. However, TDS can be estimated using Equation 6-1 (Reference (82)) where all constituent concentrations are in units of mg/L.

$$TDS = 0.6 \times Alkalinity + Ca + Mg + Na + K + Cl + SO_4 + F \qquad \textbf{Equation 6-2}$$

TDS has been estimated at each time step using the instantaneous concentrations of each of the eight constituents in Equation 6-1. The range of TDS estimated using the model results underpredicts the actual range of TDS observed in surface water. TDS has been measured at evaluation locations PM-16/SW004, PM-2/SW002, and PM-3/SW003, and the measured and modeled ranges of TDS at those locations are shown in Figure 6-163.

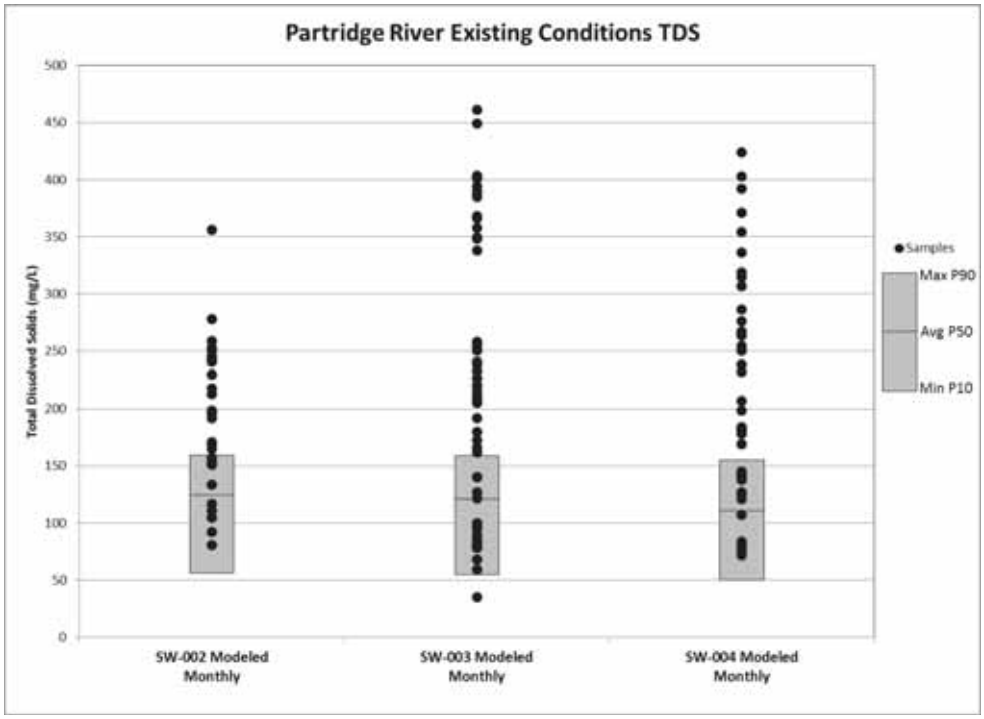


Figure 6-163 Measured Versus Modeled Existing Conditions TDS in the Partridge River

Estimated TDS concentrations at the eight surface water evaluation locations are shown in Figure 6-164 through Figure 6-171.

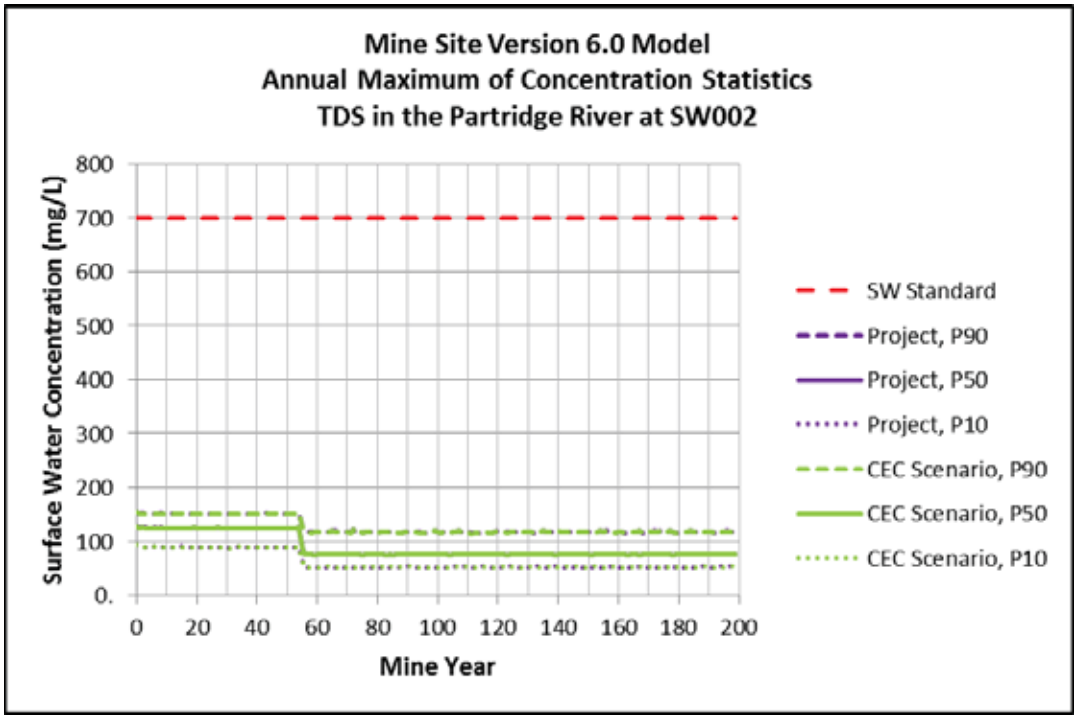


Figure 6-164 Annual Summary of TDS Concentration in the Partridge River at SW002

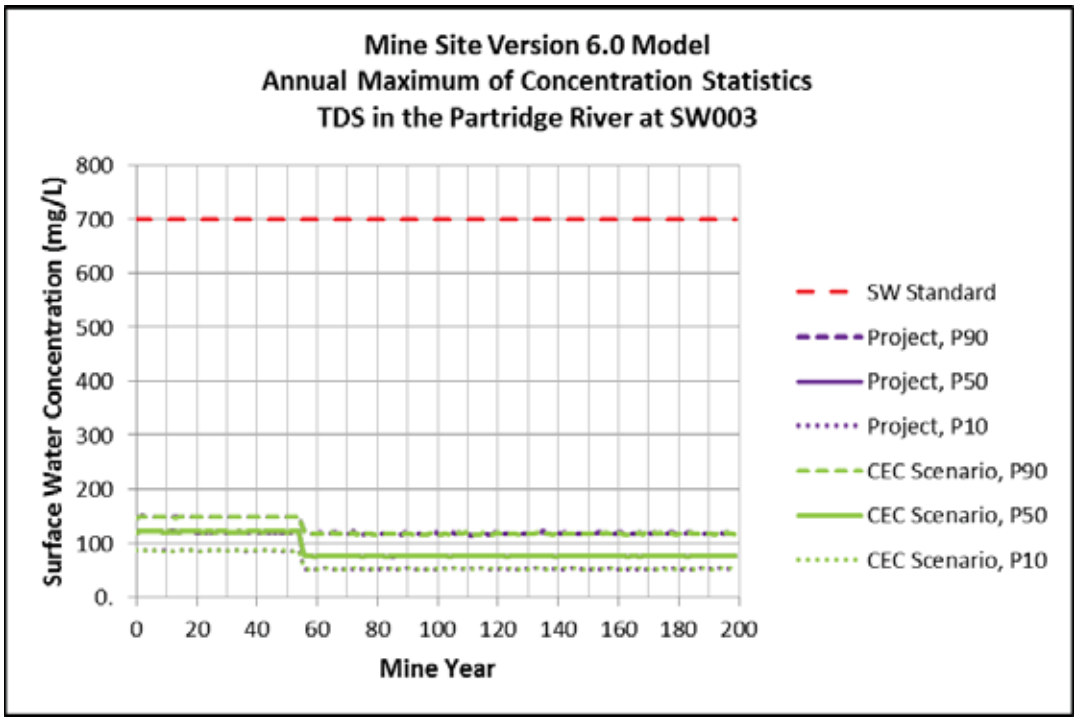


Figure 6-165 Annual Summary of TDS Concentration in the Partridge River at SW003

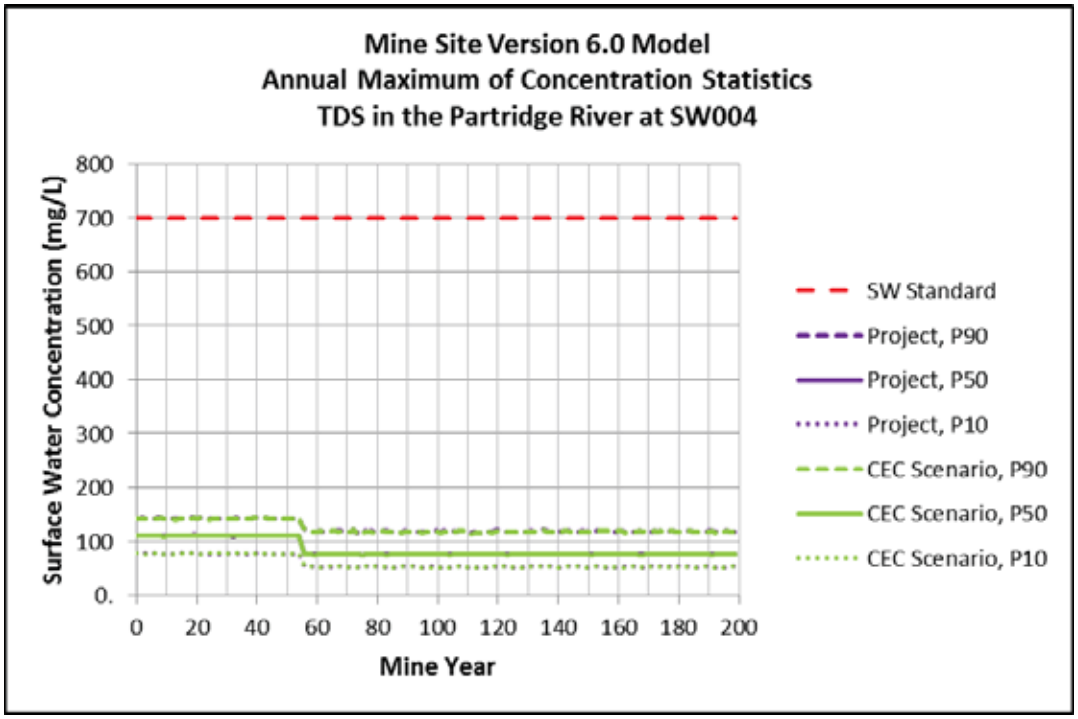


Figure 6-166 Annual Summary of TDS Concentration in the Partridge River at SW004

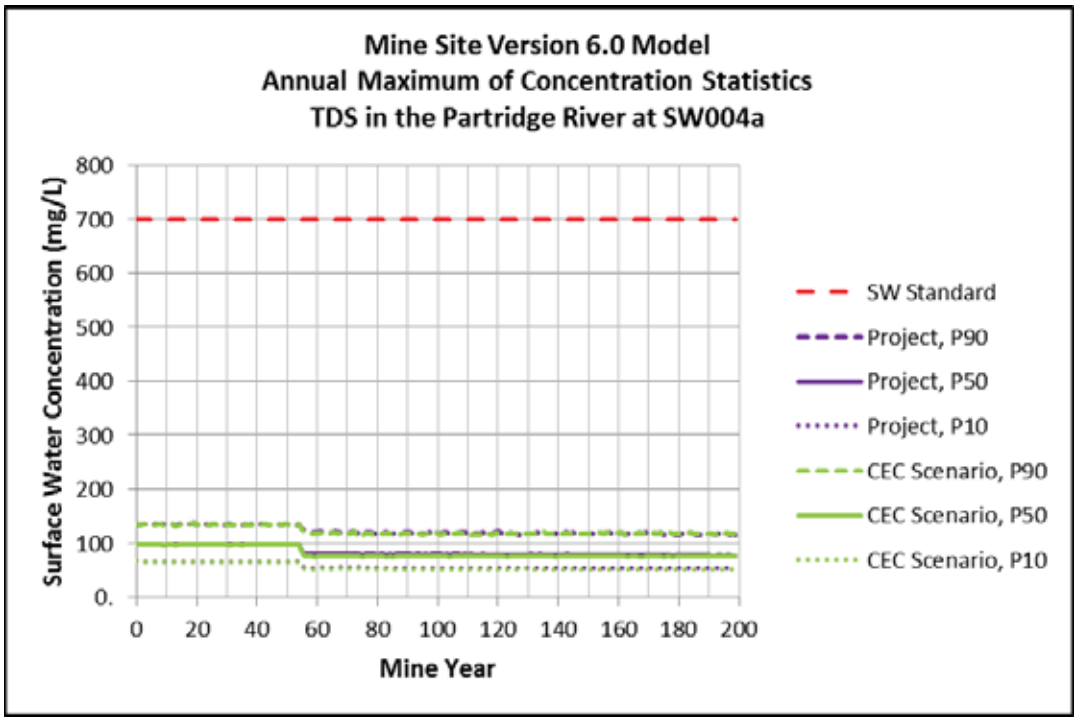


Figure 6-167 Annual Summary of TDS Concentration in the Partridge River at SW004a

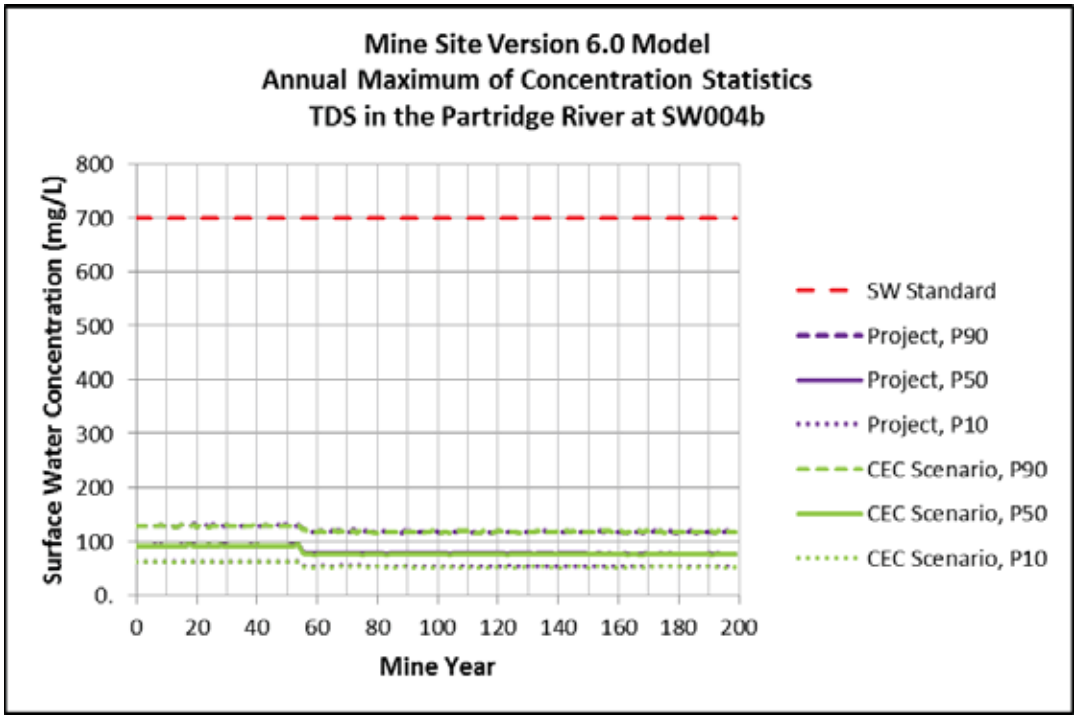


Figure 6-168 Annual Summary of TDS Concentration in the Partridge River at SW004b

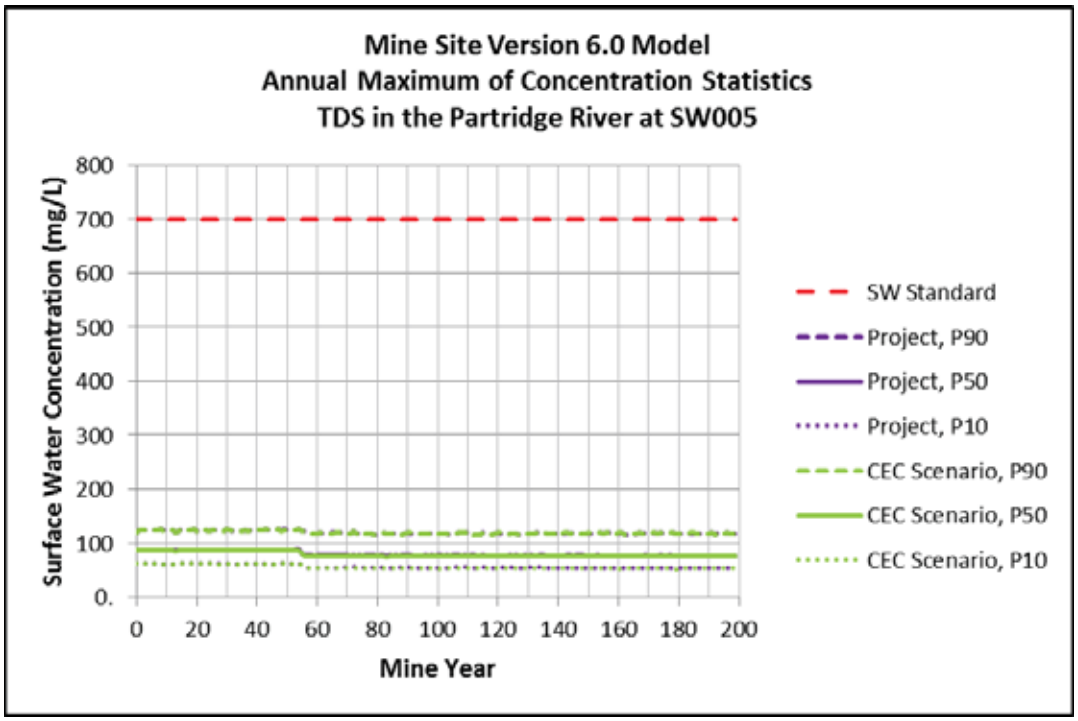


Figure 6-169 Annual Summary of TDS Concentration in the Partridge River at SW005

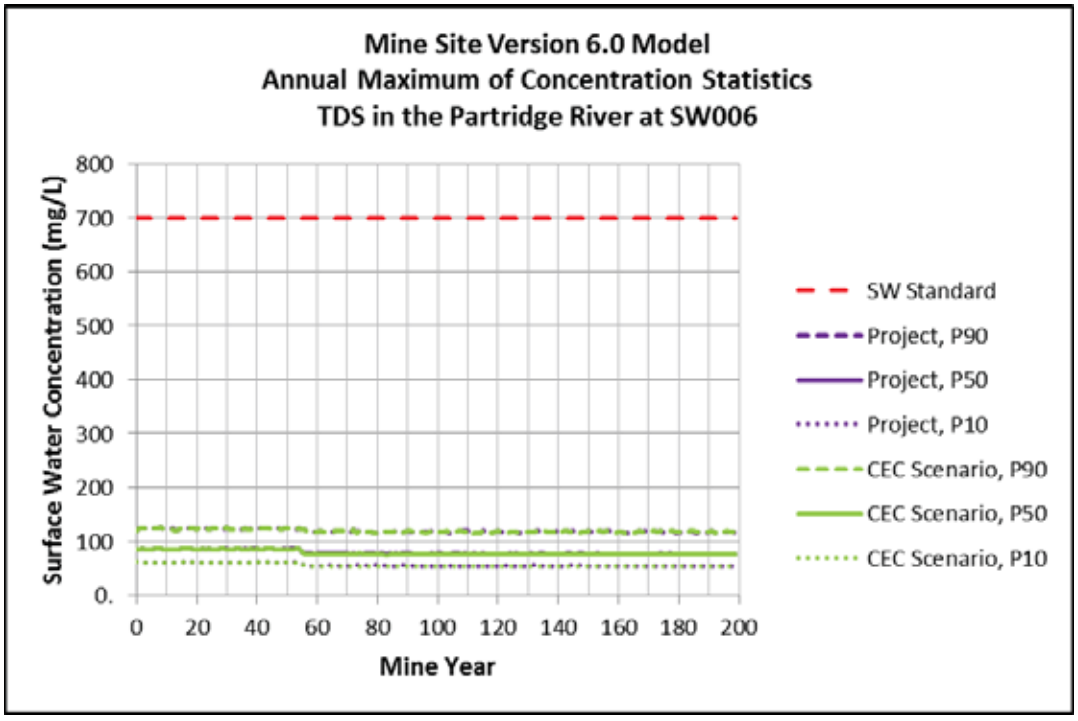


Figure 6-170 Annual Summary of TDS Concentration in the Partridge River at SW006

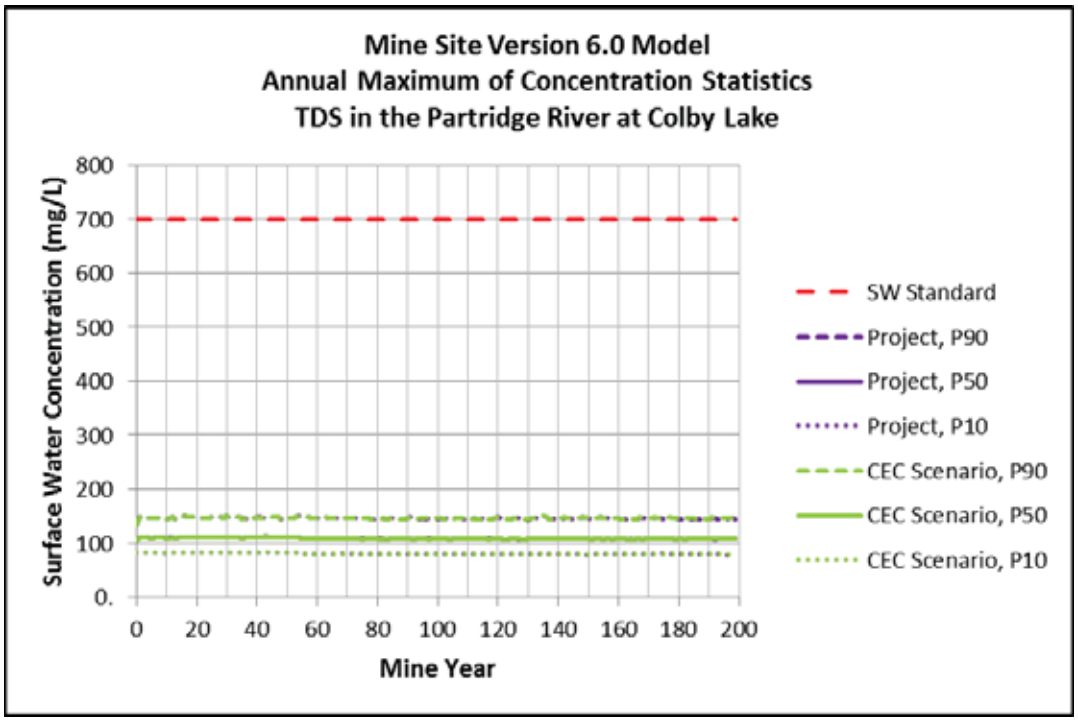


Figure 6-171 Annual Summary of TDS Concentration in Colby Lake

As shown in the previous figures, the estimated 90th percentile TDS concentrations do not approach the surface water standard in any situation. More significantly, the estimated TDS concentrations for the Continuation of Existing Conditions Scenario and Project Models are nearly identical.

6.5.6.5.2 Conclusion

Estimates of TDS from the Mine Site Water Quality Model results indicate that all surface water evaluation locations are below the TDS standard at least 90% of the time. Although the estimated TDS in the Mine Site Water Quality Model is an underestimate of the observed TDS concentrations, the model shows nearly identical results for the Continuation of Existing Conditions Scenario and Project Models. The Project, therefore, is not likely to significantly increase TDS concentrations relative to the existing concentrations, which are below the surface water quality standard of 700 mg/L.

6.6 Mercury Evaluation

6.6.1 Introduction

As presented in Large Table 2, surface waters near the Mine Site have a water quality standard for total mercury of 1.3 nanograms per liter (ng/L) (Large Table 2). Total mercury includes all species of mercury. For this evaluation, unless otherwise specified, ‘mercury’ refers to total mercury, based on unfiltered samples. While mercury is not explicitly modeled, it does need to be demonstrated that the total mercury concentration in anticipated permitted discharges (i.e., the West Pit lake overflow) will meet the anticipated discharge limit which, for the demonstration, is assumed to be the mercury standard.

This section presents background information on mercury removal processes from water bodies and analog data for existing pit lakes and natural lakes, and then outlines a mass balance approach that was used to assess future mercury concentrations in the West Pit lake and in the overflow water.

6.6.2 West Pit Lake Mercury Demonstration

6.6.2.1 Background Information

6.6.2.1.1 Mercury Removal Process from Water Bodies

Seepage lakes and headwater lakes (lakes with no significant inflowing streams, creeks or rivers) receive the majority of their water from precipitation and runoff from the direct drainage watershed (Reference (84) and Reference (85)). Water balance modeling indicates that approximately 70% of the water inflow to the West Pit after reclamation will be from precipitation on one of the two mine pits (Section 6.1.2.3). Because the West Pit is estimated to receive most of its water from precipitation and runoff from its watershed and has no inflowing streams, creeks or rivers it will be similar to a seepage lake or headwater lake.

Mercury inputs and losses from seepage and drainage lakes have been studied by several researchers (Reference (86), Reference (87), and Reference (88)). Data from these studies indicates that more than 90% of the deposited mercury is removed from the system through sedimentation (i.e., burial) or volatilized back to the atmosphere (i.e., evasion) (Reference (86); Reference (88)).

Sedimentation and evasion are two important parameters to include in the mass balance approach presented below.

6.6.2.1.2 Analog Data

Natural lakes and existing mine pit lakes in the vicinity of the Mine Site provide an analog for what can be expected for the West Pit lake at the time of overflow. Data from several natural lakes in Voyageurs National Park and existing mine pit lakes in the Aurora – Hoyt Lakes area indicate that annual average total mercury concentrations are less than 1.3 ng/L. For example, data from Reference (89) and Reference (90) indicate that several headwater lakes with minimal watershed influence (e.g., Cruiser, Fishmouth, Mukooda) have average total mercury concentrations ranging from 0.4 to 1.3 ng/L, with concentrations in individual samples ranging from 0.34 to 1.73 ng/L (Table 6-14).

Data for total mercury concentrations are available for 16 mine pit lakes in the Aurora – Hoyt Lakes area (Table 6-14). This data indicates that only 2 of the 16 mine pit lakes had average total mercury concentrations greater than 1.3 ng/L; concentrations in these 2 pit lakes were 1.6 ng/L and 1.9 ng/L. For the remainder of the pit lakes evaluated (14), average total mercury concentrations ranged from about 0.6 to 1.3 ng/L.

Table 6-14 Total Mercury Concentration Data (Unfiltered Samples) for Selected Natural Lakes and Mine Pit Lakes in Northeastern Minnesota

Pit Lake or Natural Lake	Sample Number	Average (ng/L)	Range(ng/L)
Cruiser Lake (1)	3	0.43	0.39 – 0.46
Fishmouth Lake (1)	5	1.25	0.97 – 1.73
Little Trout Lake (1)	5	0.52	0.38 – 0.86
Mukooda Lake (1)	5	0.44	0.34 – 0.55
O'Leary Lake (1)	5	0.64	0.47 – 0.78
Pit 1 (3)	6	0.95	0.5 – 2.3
Pit 1 (2)	NA	1.13	N/A
Pit 2/2E (3)	1	0.87	N/A
Pit 2W (3)	3	1.61	0.99 – 2.55
Pit 2WX (3)	2	1.19	1.18 - 1.19

Pit Lake or Natural Lake	Sample Number	Average (ng/L)	Range(ng/L)
Pit 2WX (2)	NA	0.97	N/A
Pit 3 (3)	2	1.16	0.65 – 1.66
Pit 5N (3)	1	0.74	N/A
Pit 5N (East) (3)	1	1.08	N/A
Pit 5S (3)	2	0.55	0.52 – 0.58
Pit 6 (3)	9	1.0	0.5 – 2.11
Pit 6 (2)	NA	0.9	N/A
Pit 9 (3)	2	1.02	0.86 – 1.18
Pit 9 (2)	NA	0.7	N/A
Pit 9S (3)	2	1.87	1.49 – 2.24
Pit 9S (2)	NA	0.9	N/A
Knox Pit (2)	NA	1.2	N/A
Stephens Pit (2)	NA	0.4	N/A
Dunka South (4)	2	0.75	0.7 – 0.8
Dunka Middle (4)	2	0.80	0.6 – 1.0
Dunka North (4)	NA	0.65	0.6 – 0.7

NA = Not available; the number of samples for a water body was not available in the data set used for this analysis.

(1) Data from Goldstein et al., 2003, for lakes in Voyageurs National Park. Selected precipitation-dominated lakes with minimal wetlands in the watershed; surface water samples collected in 2001 and 2002.
(2) Baseline monitoring data for mine pits in the Aurora and Hoyt Lakes area of northeast Minnesota submitted to MDNR and MPCA.
(3) Data from Cliffs Erie records.
(4) Data reflects intersection of portions of the Dunka Pit with the Duluth Complex in northeast Minnesota.

6.6.2.2 West Pit Lake Mercury Mass Balance Overview

A simple mass balance model using annual inputs and outputs was used to estimate the total mercury concentration in the West Pit lake. This simpler estimation method is preferred over a detailed mechanistic model because it incorporates the important input and removal processes for mercury, it is very transparent with regard to data inputs and it allows for easy assessment of the effect of changing parameter values on mercury concentrations.

The West Pit lake mass balance assumes that for each year, mixing of water only occurs in the upper 30 feet of the water column (i.e., only a small portion of the entire pit lake water depth is used to estimate a potential mercury concentration). Thermal stratification in a deep pit lake, a small surface area compared to total pit lake depth, and other factors (Reference (91)) are expected to limit the mixing of the pit lake water column. An assessment of stratification

conducted in 2008 for the proposed West Pit lake concluded that, based on the available data, it is likely that the West Pit lake will remain stratified (Reference (92)). Data from the MDNR (Reference (93)) and a study of northern mine pit lakes (Reference (94)) indicates that deep mine pit lakes rarely turn over due to temperature and density gradients. Therefore, an estimate that only the upper 30 feet of the water column mixes is considered conservatively reasonable, although a mixing depth of 60 feet will also be considered reasonable. The relatively shallow depth of the water column mixing assumed for the mass balance will limit the dilution effect from the water added in any one year and adds conservatism to the estimated water column mercury concentration. In other words, the mass balance for the West Pit lake will tend to concentrate the mercury in a smaller volume of water than what might actually occur.

6.6.2.3 West Pit Lake Mercury Mass Balance

Annual input and loss parameters to the West Pit lake mass balance are identified in Table 6-15, as well as estimated mean flow rates from the Goldsim modeling in Mine Year 60, when the West Pit flooding is complete and flows are considered to be stabilized. As shown in Table 6-15, potential inputs of total mercury to the West Pit lake are from precipitation, atmospheric dry deposition, groundwater inflow, Category 1 Waste Rock Stockpile drainage, other stormwater runoff within the Mine Site, supplemental water from the Plant Site WWTP and collected seepage from the FTB and inflows from the East Pit.

Table 6-15 Initial and Final Parameter Values for the Mercury Mass Balance

Parameter	Flow in Mine Year 60	Total Mercury Concentration or Flux	Identifier
Wet and Dry Deposition			
Precipitation (based on monitoring data) (1)	697 ac-ft/yr (1)	13 ng/L; 9,407 ng/m^2/yr (1)	1
Atmospheric dry deposition	N/A	3,093 ng/m^2/yr (1)	
Total wet and dry deposition	N/A	12,500 ng/ m^2/yr (1)	
Contained/Uncontained Category 1 Waste Rock Stockpile drainage	0.3 ac-ft/yr (2)	13 ng/L	2
Watershed runoff (stormwater runoff from undisturbed or reclaimed/revegetated areas; includes the runoff from the Category 1 stockpile)	30 ac-ft/yr (2)	4 ng/L(3)	3
Groundwater Inflow (shallow aquifer)	45 ac-ft/yr (2)	3 ng/L(3)	4
East Pit flow (from wetland)	248 ac-ft/yr (2)	4 ng/L	5

Parameter	Flow in Mine Year 60	Total Mercury Concentration or Flux	Identifier
Backfilled East Pit flow (groundwater) ("lower pore water seepage")	0 (2) (intermittent contribution; 0.02 to 0.15 ac-ft/yr during pit flooding)	4 ng/L	6
Treated Water: Mine Site Wastewater Treatment Facility	0 (2) (Up to 588 ac-ft/yr during pit flooding)	8 ng/L	7
Plant Site Water: Treated water from the WWTP and collected seepage water (untreated) from the FTB seepage capture systems (supplemental water for pit flooding)	0 (2) (Up to 3,500 ac-ft/yr during pit flooding)	1.3 ng/L	8
West Pit Mercury Losses			
Burial	N/A	92% of total load; 12,700 ng/m^2/yr (4)	9
Evasion/Volatilization (~ 5% of atmospheric inputs)	N/A	5% of atmospheric inputs (5)	10
Outflows	490 ac-ft/yr (2)	Varies with concentration of West Pit water column	11

ac-ft/yr = acre feet per year N/A = not applicable

(1) Precipitation volume from monitoring stations within 30 miles of the Project based on mean annual precipitation (1981-2010 climate normal); annual average Hg concentration from the National Atmospheric Deposition Program for the Fernberg Road Site (MN18) (2010-2011). Total atmospheric deposition is assumed to equal 12,500 ng/m^2/yr (Reference (95)). Dry deposition is set equal to the difference between total and wet deposition and represents about 25% of total deposition.
(2) Flow estimate from Goldsim Modeling results.
(3) Estimate of Hg concentration based on Project data.
(4) Burial rate for mercury is lower (more conservative) than initial estimate according to the burial regression equation discussed in Section 6.6.2.3.7.
(5) Volatilization rate is estimated based on the low end of the range of values discussed in Section 6.6.2.3.7.

Mercury concentrations for each potential water inflow and outflow from the West Pit lake were taken directly from a variety of information sources, including peer-reviewed literature, Project studies, other sources of monitoring data (e.g., National Atmospheric Deposition Program) or calculated based on values from one of these sources. Atmospheric deposition, mercury evasion and mercury burial parameters were developed by combining literature values with site-specific surface area information. The sources of data for each parameter are discussed below.

6.6.2.3.1 Wet and Dry Deposition

Due to the large volume of total inputs accounted for by precipitation to seepage and headwater lakes, the mercury concentration associated with precipitation has a significant impact on mercury concentrations in these water bodies. Data available for the Fernberg Road Monitoring Site near Ely (National Atmospheric Deposition Program, NADP; Site MN18) indicates an average total mercury concentration in precipitation of 13.2 ng/L over the period 1996-2009, or an average of 12.68 ng/L for the 2007 – 2008 time period (the two most recent complete years of data when the initial mass balance evaluation was conducted in first quarter 2010) (Reference (96)). In addition, Reference (97) provided a range of precipitation values for north temperate areas ranging from 5-20 ng/L with a mean of 16 ng/L. For the purpose of this mass balance analysis, the average total mercury concentration of 12.8 ng/L in precipitation at the NADP Fernberg Road Monitoring Site for the 2010-2011 time period will be used, which is consistent with the average mercury concentration of 12.7 ng/L for the 2007 – 2008 time period originally proposed to be used in this analysis.

The average total mercury concentration of 12.8 ng/L is rounded up to 13 ng/L (Identifier 1 in Table 6-15) for precipitation, which is considered representative of existing conditions as well as reasonably foreseeable potential future conditions. Based on the average precipitation mercury concentration for 2010-2011 and the long-term mean annual precipitation rate of 0.7417 meters/year, the wet deposition rate is estimated at 9,407 ng/m^2/yr.

Total deposition is assumed to equal 12,500 ng/m^2/yr (Reference (95)), which is consistent with estimated background mercury deposition rates (Reference (93)). This is considered to be a conservative estimate of future deposition rates considering the reduction in regional and global future emissions that will result from binding commitments like Minnesota's mercury total maximum daily load (TMDL) and the recently completed Minamata Convention on Mercury (January 19, 2013), an international treaty reducing the use and emissions of mercury. For this analysis, dry deposition is set equal to the difference between total deposition and wet deposition, which results in dry deposition rate of 3,093 ng/m^2/yr and is about 25% of total deposition (Identifier 1).

6.6.2.3.2 Contained/Uncontained Category 1 Waste Rock Stockpile Drainage

Most of the drainage from the Category 1 Waste Rock Stockpile is captured by a containment system and pumped to the WWTF (i.e., contained drainage). During West Pit flooding, some of the drainage flows below the containment system to the West Pit. This is referred to as uncontained Category 1 Waste Rock Stockpile drainage (i.e., leakage) and is a relatively small component of the water balance for the West Pit lake (Table 6-15). Therefore the mercury input associated with this flow is small compared to precipitation and runoff. Potential future stockpile drainage total mercury concentrations will be based on the initial mercury concentration in precipitation (12.8 ng/L) that infiltrates the stockpile and then percolates through the stockpile and forms the uncontained drainage. It will be assumed that the precipitation that infiltrates into a stockpile will not be altered by the waste rock (no adsorption of mercury to the waste rock; no contribution of mercury from the waste rock to the water moving through the stockpile) even

though there is evidence that waste rock likely adsorbs mercury from precipitation (Reference (98)). Therefore, in the initial mass balance calculations the stockpile leakage will have a total mercury concentration of 12.8 ng/L, which is rounded up to 13 ng/L (Identifier 2).

6.6.2.3.3 Watershed Runoff

There is expected to be some loss of mercury from the watershed, as well as retention of mercury in the watershed as identified by Reference (97). For the areas that contribute runoff to the pits, the total mercury concentrations observed in the Partridge River (the recipient of watershed runoff under current conditions) is a good proxy for the expected concentration of mercury in the runoff going to the West Pit lake and the East Pit wetland. Baseline data collected for the Project indicates that the average for total mercury concentration observed in the Partridge River near the Mine Site is approximately 3.5 to 3.6 ng/L; rounded to 4 ng/L. Average for total mercury concentration in Second Creek, a stream whose watershed contains a number of mining features including areas of waste rock stockpiles, is also approximately 4 ng/L. Therefore, for the initial mass balance calculations a value of 4 ng/L for total mercury concentration in runoff water (Identifier 3) and the inflow from the East Pit wetland (Identifier 5) is assumed and is considered to be a reasonably conservative estimate.

6.6.2.3.4 Groundwater Inflow

During the early phase of West Pit flooding, groundwater inflow to the West Pit will be from both the shallow and deeper bedrock. During the later stages of flooding for the West Pit lake, groundwater inflow will be primarily from the shallow aquifer. Based on monitoring data from the proposed Mine Site area, total mercury concentrations in the shallow aquifer are approximately 3 ng/L. This data is consistent with total mercury concentrations in the shallow groundwater aquifer in northern Wisconsin that ranged from about 1 ng/L to 3 ng/L (Reference (99)). In comparison, the average total mercury concentration measured in the Mine Site bedrock wells (Large Table 6) was 0.8 ng/L. For this evaluation, the average total mercury concentration for the shallow groundwater aquifer will be 3 ng/L (Identifier 4).

6.6.2.3.5 East Pit

The East Pit, after mining is completed, will be backfilled primarily with waste rock, with water in the pore spaces. A layer of compacted overburden material will be placed over the waste rock. A relatively shallow constructed wetland will then be allowed to form over the top of the compacted overburden material. The wetland will be separated from the waste rock backfill by the layer of compacted overburden material that will serve as a hydraulic barrier between the backfilled waste rock and wetland zones. The quantity of water flowing through this barrier layer will be minimal because the hydraulic head is expected to be approximately equal on both sides of the barrier. Because of the compacted overburden material, the shallow East Pit wetland will have water quality that will be largely independent of the quality of the water in the pore spaces of the backfilled waste rock.

The initial work plan for the West Pit lake mercury demonstration indicated that a mass balance would be developed for the East Pit lake as it will be similar to the mass balance for the West Pit lake (i.e., similar inputs, loss mechanisms, etc.). Even though Project plans identified that the East Pit will be filled to a specific level with waste rock and then a wetland allowed to become established on top of the compacted overburden overlaying the backfill, the concept of a mass balance for the East Pit was considered to be a challenge, but still feasible. However, from a practical standpoint, it seems that analog data can be used to estimate potential mercury concentrations for the two sources of water from the East Pit to the West Pit lake.

The flow of water from the East Pit to the West Pit is expected to occur from two zones: 1) overflow from the East Pit wetland to the West Pit lake as a channeled surface flow, and 2) subsurface or groundwater flow from the backfilled East Pit to the West Pit lake. The overflow water from the East Pit wetland to the West Pit Lake is expected to reflect background total mercury concentration in runoff water (about 4 ng/L (Identifier 5); Section 6.6.2.3.3). For the groundwater in the backfilled East Pit that has the potential to move to the West Pit lake, an average total mercury concentration of 3 ng/L (Identifier 6) was assumed based on the average background groundwater concentrations in the shallow aquifer at the proposed Mine Site.

6.6.2.3.6 Pit Flooding and Contributions from the Waste Water Treatment Facility (WWTF) and/or the Plant Site

Potential total mercury concentrations in the water pumped from the WWTF to the West Pit during flooding is estimated to range from about 3.1 ng/L to about 7.9 ng/L; mean concentration from all treatment technologies investigated is about 5 ng/L (Reference (98)). A lower concentration of 3.4 ng/L in WWTF discharge water was associated with high-density sludge (HDS) removal. As a measure of conservatism for the mass balance evaluation, a total mercury concentration of 8.0 ng/L (7.9 ng/L rounded up) (Identifier 7) is assumed to represent a potential mercury concentration in WWTF discharge water to the West Pit lake even though the WWTF will include HDS treatment of some of the water.

Potential total mercury concentration in the water pumped from the Plant Site (a blend of WWTP effluent at 1.3 ng/L and untreated FTB seepage capture system water at less than 1.3 ng/L) to the West Pit lake is assumed to have a maximum concentration of 1.3 ng/L (Identifier 8). Goldsim modeling results indicate that within about the last year or two of the West Pit flooding, just prior to overflow, the FTB seepage water is the major source of water to the West Pit. The mass balance calculations account for treated water from the WWTP and untreated FTB seepage capture system water at the Plant Site to be routed to the West Pit lake.

6.6.2.3.7 Loss of Mercury from the Pit Lake: Burial, Evasion/Volatilization, Outflow

Loss of mercury from the West Pit lake includes sedimentation, evasion and outflow via the overflow channel and through shallow groundwater. Groundwater outflow from the West Pit is estimated to be minimal over the period of pit flooding and during long-term closure. Each of the other loss mechanisms is discussed below.

Burial

Burial loss rates reported in the literature have been reviewed. A study of 55 lakes in Minnesota, including 20 lakes in northeast Minnesota indicates a median burial rate of 36 µg/m^2/yr for the northeast lakes (Reference (100)), and another study of Minnesota and Wisconsin lakes indicates a range of burial rates of 17 to 33 µg/m^2/yr (Reference (101)). Burial rate has been shown by Reference (95) to be directly proportional to the lake's catchment area, according to the regression equation (Equation 6-3):

$$Burial\ rate\ (\mu g/m^2 yr) = 12.5 + 3.27 \cdot A_d/A_o \qquad \textbf{Equation 6-3}$$

where A_d is the lake's catchment area exclusive of the lake's surface area and A_o is the lake's surface area. In long-term closure, the West Pit lake's catchment area (A_d) will be approximately 314 acres and surface area (A_o) will be approximately 296 acres. Based on these values, the regression equation indicates a burial rate of 16.0 µg/m^2/yr. However, even with the conservative assumptions used for mercury inputs to the West Pit lake discussed previously, the total mercury input in long-term closure is only expected to be 13.8 µg/m^2/yr. Because the burial rate cannot exceed the input rate, the burial rate in long-term closure was adjusted downward to 12.7 µg/m^2/yr, or 92% of total inputs (Identifier 9), which is the point at which total inputs and outputs reached a reasonable equilibrium. Because this burial rate (12.7 µg/m^2/yr) is lower than that indicated by the regression equation as well as the range of burial rates observed in studies, this represents a conservative assumption and suggests that the burial mechanism will be capable of removing more mercury from the water column if future mercury inputs were to increase. While the numerical burial rate is at the low end of the potential range of rates, a burial rate of 92% of total mercury inputs is similar to the 80 to 90% burial rate estimated for Little Rock Lake in northern Wisconsin, a small seepage lake receiving predominantly atmospheric mercury inputs (Reference (87)). Therefore, a burial rate that is 92% of total mercury inputs is considered a reasonable value for use in this analysis.

Evasion/Volatilization

Literature reviewed indicates that evasion rates are highly variable from one water body to another, from one season to another and even over the course of a single day. Mercury evasion rate studies in the Upper St. Lawrence River and Lake Ontario were estimated to range between 0 and 9.28 ng/m^2/hr (0 and 81 µg/m^2/yr) with a median value of 2.88 ng/m^2/hr (25 µg/m^2/yr) (Reference (102)). Studies conducted to assess post depositional mercury dynamics in Lake 239 (L239) in the Experimental Lakes Area in Ontario, Canada, as part of the METALLICUS project, indicate highly variable evasion rates over the course of a single day, with average daily evasion rates of 3.2 ±0.78 ng/m^2/hr (21.2-34.9 µg/m^2/yr) over a 10 day period immediately following the addition of $^{200}HgCl_2$ to the lake (Reference (103)). Reference (103) compared their measured values to the fluxes reported in literature reviewed as a part of their study which varied between 0.8 and 8.5 ng/m^2/hr (between 7 and 74 µg/m^2/yr) for freshwater lakes.

A literature review conducted as part of a study completed in October 1999 (Reference (104)) highlights mercury evasion values from the literature ranging from 3-10 ng/m^2/hr (26-88 µg/m^2/yr) with daytime evasion rates observed to be 2.5 times higher than nighttime rates (Reference (105)). In Reference (104), a two-film, gas transfer model was used to estimate mercury fluxes from a tailings basin pond, resulting in an estimated evasion rate of 2.5 ng/m^2/hr or 21.9 µg/m^2/yr, during maximum concentrate production, and the study notes that this evasion rate falls into the low end of the range for evasion rates measured for natural lakes in Sweden where mercury evasional flux ranged from 0.2 to 20.0 ng/m2/hr (2 to 175 µg/m^2/yr) and were typically observed in the range of 2 to 6 ng/m^2/hr (18-53 µg/m^2/yr).

A review of background information evaluated in the setup of the 2006 EPRI Enhancement of Watershed Analysis Risk Management Framework (WARMF) model for mercury watershed management and total maximum daily loads indicates a lower potential evasion rate than many of the other studies reviewed at 0.7 µg/m^2/yr (Reference (106)).

For the purpose of the mass balance for the West Pit, an initial evasion rate equivalent to 5% (Identifier 10) of atmospheric inputs is assumed, which results in an average flux of 0.6 µg/m^2/yr during Mine Year 21 through Mine Year 55. This value is much lower than estimated evasion rates from natural lakes (typical range from 18 to 53 µg/m^2/yr) but is based on a review of several studies that indicated evasion can range from about ~5% to about 50% of atmospheric inputs (Reference (101), Reference (86), and Reference (107)). The assumed evasion rate of 5% of atmospheric inputs is at the low end of the potential range of values. This assumption is particularly conservative considering mine pit lakes are clear water lakes, where light penetration is high, which provides more opportunity for the light-based evasion (i.e., photolysis) mechanism to operate (Reference (108) and Reference (109)). As with the burial rate, this suggests that the evasion mechanism will be capable of removing more mercury from the water column if mercury inputs were to increase.

Outflow: Pumping of Water from the West Pit Lake at Overflow

Beginning in approximately Mine Year 21, following the completion of mining operations, pit flooding will be allowed to commence. By the end of Mine Year 55 the West Pit lake will have reached a stage where it will be within about 6 feet of the overflow and that is when pumping of the lake water to the WWTF will be initiated at an anticipated long-term sustained rate of about 310 gpm (Table 6-9). The treated water from the WWTF will then be routed to an unnamed creek that flows to the Partridge River near evaluation location SW004a.

For the purpose of the West Pit lake in long-term closure, each year's loss of mercury from pumping is calculated based on the estimated volume of water to be sent to the WWTF and an initial estimate of the West Pit lake's water column mercury concentration in that year. For example, to estimate the loss of mercury from the overflow in Mine Year 55, the estimated volume of water to flow out of the West Pit lake (i.e., to be pumped to the WWTF; liters) is multiplied by the initial estimate of the water column mercury concentration in Mine Year 55 (ng/L).

$$\text{Outflow Mass}_{MY55} = \text{Outflow Volume}_{MY55} \times \text{Estimated Water Column Hg}_{MY55} \quad \textbf{Equation 6-4}$$

In this concept, all of the mercury input to the West Pit Lake is held static and is subject to loss from burial (total inputs) and volatilization (only atmospheric inputs). After the losses occur and the new water and mercury mix with the previous year's water and mercury in the top 30 feet of the water column, the water column concentration is calculated. This water column concentration is then assigned to the overflow water volume and the loss of mercury via the outflow is allowed to occur and the pit lake water column concentration is then adjusted for outflow loss in a second calculation. This concept treats the outflow as a separate loss from the West Pit lake as opposed to an alternative concept that would treat the outflow water in parallel to the inputs and losses occurring within the pit lake.

6.6.2.4 Results for the West Pit Lake Mercury Balance

Based on the initial input values from Table 6-15, the potential average total mercury concentration of the West Pit lake during flooding (Mine Year 20 through about Mine Year 55) is approximately 0.3 ng/L and the estimated concentration in Mine Year 55 (about 35 years after Mine closure) and at about the time at which discharge begins, is approximately 0.5 ng/L. Both estimated values are below the water quality standard of 1.3 ng/L for a new permitted discharge in the Lake Superior Basin. It is noted that the West Pit water will be discharged via a reverse-osmosis (RO) WWTF once the pit is completely flooded. The RO process is known to remove mercury, but this screening evaluation does not account for the likely additional loss (removal) of mercury by the RO process and thereby adds some additional conservatism to the analysis (i.e., mercury concentration in the discharge water is overestimated).

Table 6-16 provides a summary of the initial mass balance results. The largest input of mercury to the West Pit lake is atmospheric deposition (wet + dry); ~ 66% of total estimated inputs (Table 6-16). Runoff from the watershed is estimated to account for 14% of the mercury inputs (this includes the East Pit wetland overflow to the West Pit lake). Water pumped from the Plant Site is estimated to contribute about 11% of the mercury loading to the West Pit lake, while the WWTF is estimated to contribute about 8% of the mercury load to the West Pit lake. Contained/Uncontained Category 1 Waste Rock Stockpile drainage and the East Pit groundwater flow to the West Pit are estimated to contribute about 1% of the mercury load. The largest loss mechanism is burial (loss) to the bottom of the West Pit (92% of mercury inputs), with evasion/volatilization accounting for losses that are about 3% of mercury inputs (Table 6-16). Note that during this period of pit flooding, the net retention of mercury consists of both increased total water volume in West Pit lake and increasing concentration of mercury.

Table 6-16 Summary of Estimated Mercury Loading (Inputs)(1) and Losses (Outputs) for the West Pit Lake (Mine Year 20 through about Mine Year 55)

Parameters	Annual Average Load of Mercury (nanograms)	Percent of Summed Inputs	Comments
Inputs			
Atmospheric (wet + dry)	1.26E+10	66%	Dry deposition ~30% wet deposition
East Pit wetland overflow	9.03E+08	5%	Includes runoff from the East Pit watershed to the East Pit.
Stormwater Runoff (other than from the East Pit)	1.65E+09	9%	Includes runoff from the Category 1 Waste Rock Stockpile.
Groundwater	2.74E+08	1%	Includes groundwater flow from undisturbed portions of the Mine Site + groundwater inflow from the East Pit + contained/uncontained Category 1 Stockpile drainage
Wastewater Treatment Facility	1.61E+09	8%	
Pumping from the Plant Site: WTTP and collected seepage from the FTB	2.12E+09	11%	
SUM	1.91E+10		
Outputs (Losses)			
Evasion/Volatilization	6.30E+08	3%	Loss from the water column.
Burial	1.76E+10	92%	
Groundwater	NE		
Overflow (discharge)	2.58E+07	0.1%	
Removal by RO WWTF	NE		
SUM	1.82E+10		
NET (retention)			
Inputs – Outputs	8.73E+08		Net retention of Hg

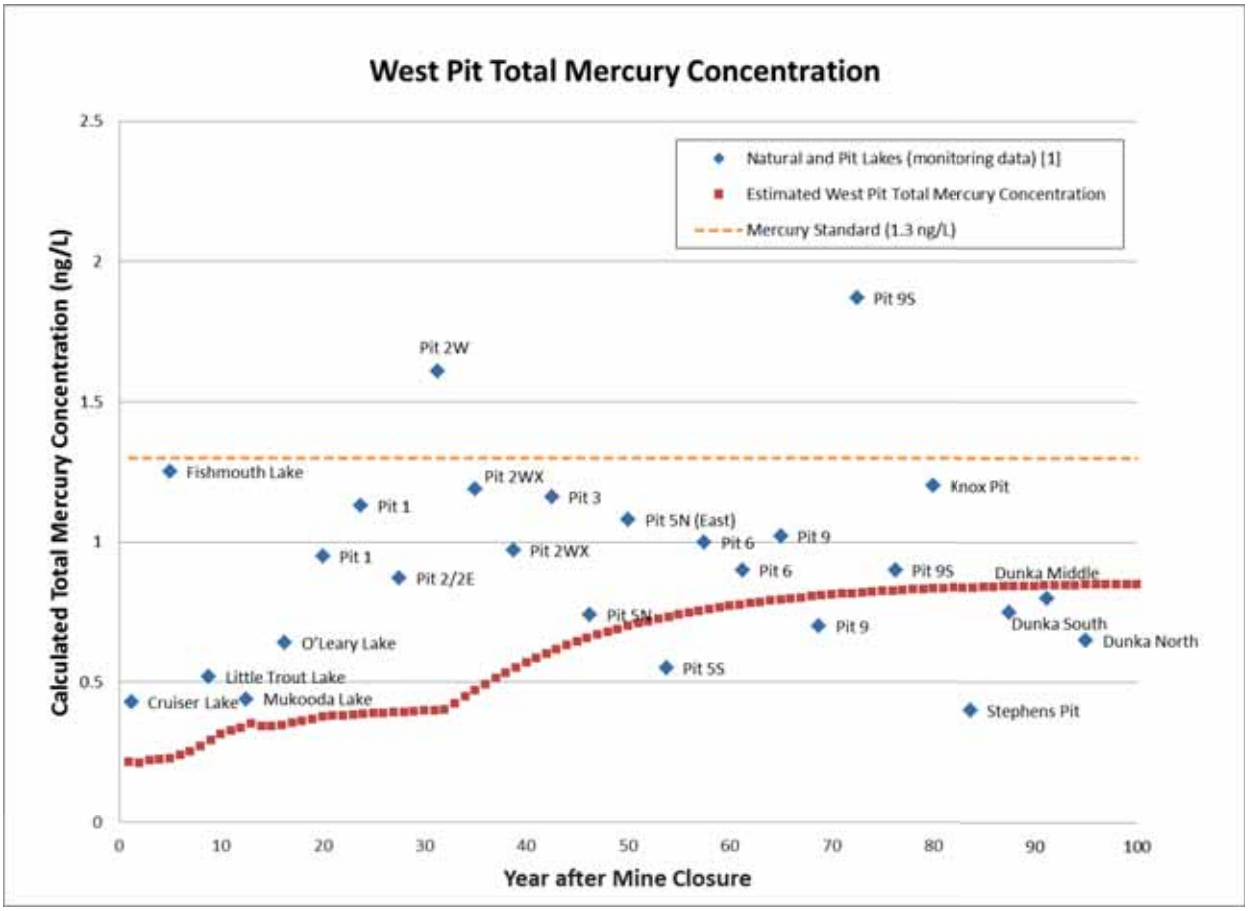
NE = not estimated for this analysis.

(1) Reasonably conservative estimates of mercury concentrations and average annual flow estimates from GoldSim modeling were used to estimate mercury loading.

Water balance modeling for the West Pit was conducted out to Mine Year 120 (about 100 years after Mine closure) with the GoldSim model. Water column mercury concentrations were

estimated for each year of water modeling (Large Table 47 and Figure 6-172) based on the estimated water volumes from the GoldSim model results and initial parameter values from Table 6-15. The mass balance calculations indicate an initial increase in the West Pit mercury concentration, approaching an equilibrium or "steady-state" condition by approximately Mine Year 90 (about 70 years after mine closure), meaning that the inputs and outputs are well "balanced" and that mercury will stop accumulating within the water column (Figure 6-172).

This equilibration in total mercury concentration occurs relatively quickly in precipitation-dominated water bodies because "… loss processes, such as evasion and sedimentation, remove total mercury much faster than it is resupplied from the atmosphere during the summer." (Reference (88)). Studies on new reservoirs in northwest Ontario indicate that export of total mercury from the water body decreased every year after the initial year of flooding, suggesting that water column total mercury concentrations will become stable relatively soon after flooding (i.e., within about 5 to 10 years) (Reference (110)). For reservoirs in northern Quebec, water quality modifications were generally no longer detectable 8 to 14 years after flooding (Reference (110)). Based on the reservoir-effects data, the West Pit lake should reach an approximate balance between inputs and outputs within about 35 years after flooding is initiated. In other words, it is expected that the mercury inputs and outputs will reach an approximate steady-state relatively quickly after the flooding process was initiated. Therefore, the water balance modeling's estimate of equilibration is consistent with these studies, although the studies indicate that the process may occur more quickly than estimated by the mass balance calculations in this analysis.



[1] Analog data values are assumed to reflect steady state conditions and are plotted on the vertical axis only and spaced horizontally for readability only.

Figure 6-172 Estimated Water Column Total Mercury Concentration in the West Pit Lake

Overall, the mass balance is considered to represent reasonably conservative assumptions of potential mercury inputs to the West Pit lake and these inputs are offset by conservative estimates of losses of mercury using literature-based values. In fact, the literature indicates that both burial and volatilization may be capable of removing more mercury, but will be limited by the amount of inputs that the West Pit lake is expected to receive. The average mercury concentration of the West Pit during flooding (Mine Year 20 through about Mine Year 55) is estimated to be about 0.3 ng/L and at the time of overflow is estimated to be about 0.5 ng/L, and then reaches an equilibrium value near 0.9 ng/L.

Based on this screening analysis, the WWTF discharge will comply with a discharge limit derived from the standard of 1.3 ng/L even if the RO treatment does not remove any mercury.

Revision History

Date	Version	Description
12/17/2010	1	Initial release
01/28/2011	2	Addition of liner leakage distribution methods (Section 5.1.2.1) Addition of pit inflow distribution methods (Section 5.1.2.3) and associated Figure Revision to Table 3.4.1.1.2-3 Addition of baseline groundwater data (Section 3.5.1.2) and associated Tables and Figures Addition of groundwater chemistry inputs to probabilistic model (Section 4.1.1) and associated Tables and Figures Addition of sorption distribution parameters (Section 4.1.3) and associated Table
02/10/2011	3	Addition of baseflow estimate for the Partridge River (Section 4.4.1.3) Addition of stockpile hydrology discussion (Section Section 6.1.1) Addition of discussion modeling low flow conditions in the Partridge River (Section 5.5.1) Revised Table, Figure, and Equation numbering
02/21/2011	4	Addition of Groundwater flow path Modeling (Section 4.2.2) and associated figures
3/25/2011	5	Additional discussion of West Pit discharge rates (Section 4.1.6) Description of modeling approach for Plant Site receiving waters (Section 4.2.4) Description and figure of Plant Site surface water model evaluation points (Section 4.2.4.1) Revision to methodology to determine baseline groundwater concentrations (Sections 4.1.1.1)
7/25/2011	6	Submittal to accompany Work Plan Major updates to majority of document. New or significantly revised sections have section titles highlighted in gray. Sections describing the Plant Site have been moved to Volume II – Plant Site. Sections without significant revisions have un-highlighted titles (Note: section titles and heading numbers may have changed from version 5)
9/26/2011	7	Updated based on agency comments on Version 6. New or significantly revised sections or paragraphs are highlighted in gray. Minor changes have only the affected sentence highlighted in gray.

Date	Version	Description
11/11/2011	8	Updated based on agency comments on Version 7. New or significantly revised sections (2.1, 4.4.4.1, 4.4.4.2, 4.5.2.1, 5.3.1.1.1, 5.4.1, 5.9 and 6.1.3.4.2) or paragraphs are highlighted in gray. Minor changes have only the affected sentence highlighted in gray.
12/02/2011	9	Updated based on agency comments on Version 8. All highlights removed.
07/02/2012	10	Updated based on approved Change Definition forms. Revised sections or paragraphs are highlighted in gray (4.4.1.2.7, 5.4.1.2, 5.4.4.2, 5.4.5, 5.6.4, 5.6.5, 5.6.5.1, 5.6.5.2, 6.1.3.3.2, 6.1.3.3.4, 6.1.3.4.5). Updated Large Table 5, Baseline groundwater monitoring data from Mine Site surficial wells
02/25/2013	11	General edits to Sections 1-4 to improve readability and constancy within the document and with other documents Edits to Section 2.3 to incorporate 2012 MPCA guidance Edits to Section 2.1 to include the site-specific groundwater evaluation criteria for Be, Tl and Mn Edits to Section 3.4 to make consistent with current modeling framework Edits to Section 4.3 to incorporate additional detail on geology and groundwater quality Edits to Section 4.3.4.2 added to provide information of the development of the site-specific groundwater evaluation criteria for Be, Tl and Mn Previous Sections 5 and 6 were combined into the new Section 5; Work Plan text and figures were also incorporated into this Section
03/08/2013	12	Added results presentation in Section 6, including previously-published Mercury Evaluation (moved to Section 6.7) Added Large Tables 11 through 39 with water quality results Added Large Figures 47 through 62 with water quality results Added Attachments G through M with hydrologic and water quality results

Date	Version	Description
12/29/2014	13	Edits to Section 4.3 and 4.4 to include data collected through 2013 and Co-Lead Agency guidance Edits to Section 5 to respond to comments and reflect updates to groundwater and surface water data and calibration Edits to Section 6 to update all results for v6.0 GoldSim modeling and updated mercury evaluation Corrected numbering of groundwater results section as 6.3 Added Section 6.5.6.4, discussion of model results for arsenic and copper in Colby Lake Removed Climate Change Sensitivity Analysis (previous Section 6.5) for submittal with compiled sensitivity analysis document (pending) Updated all Large Tables to reflect data collected through 2013 and v6.0 GoldSim modeling Updated select Large Figures to reflect data collected through 2013, revised MODFLOW modeling, and v6.0 GoldSim modeling Updated all attachments for revised MODFLOW modeling, GoldSim modeling, calibration, model results, and quality assurance review. Attachment order revised to match text.
02/27/2015	14	Minor edits throughout in response to Co-Lead Agency comments.

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Large Tables

Large Table 1
Groundwater Quality Standards
Applicable to the NorthMet Project Modeling

Constituent	Units	EPA MCL	MDH HRL	EPA sMCL	Evaluation Criteria used for Project
Ag	mg/L		0.03	0.1	0.03
Al	mg/L			0.05 - 0.2	--(1)
Alkalinity	mg/L				--
As	mg/L	0.01			0.01
B	mg/L		1		1
Ba	mg/L	2	2		2
Be	mg/L	0.004	0.00008		0.00039/0.0002(2)
Ca	mg/L				--
Cd	mg/L	0.005	0.004		0.004
Cl	mg/L			250	250
Co	mg/L				--
Cr^6	mg/L	0.1	0.1		0.1
Cu	mg/L	N/A		1	1
F	mg/L	4		2	2
Fe	mg/L			0.3	--(1)
Hardness	mg/L				--
Hg	mg/L	0.002			0.002
K	mg/L				--
Mg	mg/L				--
Mn	mg/L		0.1	0.05	1.002/0.307(2)
Na	mg/L				--
Ni	mg/L		0.1		0.1
Pb	mg/L				--
Sb	mg/L	0.006	0.006		0.006
Se	mg/L	0.05	0.03		0.03
SO_4	mg/L			250	250
Tl	mg/L	0.002	0.0006		0.0006/0.002(2)
V	mg/L		0.05		0.05
Zn	mg/L		2	5	2

(1) Secondary MCLs not considered due to high natural background conditions

(2) Site specific evaluation criteria developed for Be, Mn and Tl. First value shown represents the criteria for the surficial aquifer and the second value shown represents the criteria for bedrock.

Large Table 2
Surface Water Quality Standards
Applicable to the NorthMet Project Modeling

		Standards Applicable to Partridge and Embarrass Rivers and Tributaries				Standards Applicable to Colby Lake and Wyman Creek				
		2B	2B	3C	4A	1B	2Bd	2Bd	3C	4A
Constituent	Units	Statewide Waters	Lake Superior Basin	Statewide Waters	Statewide Waters	Statewide Waters	Statewide Waters	Lake Superior Basin	Statewide Waters	Statewide Waters
Ag	mg/L	**0.001**				(0.1)	**0.001**			
Al	mg/L	**0.125**				(0.2)	**0.125**			
Alkalinity	mg/L									
As	mg/L	0.053	**0.053**			0.01	0.002	**0.002**		
B	mg/L				**0.5**					**0.5**
Ba	mg/L					**2**				
Be	mg/L					**0.004**				
Ca	mg/L									
Cd	mg/L	0.0011 + [0.7852, -3.490]	**0.0025 +** [0.7852, -2.715]			0.005	0.0011 + [0.7852, -3.490]	**0.0025 +** [0.7852, -2.715]		
Cl	mg/L	**230**		250		(250)	**230**		250	
Co	mg/L	**0.005**					**0.0028**			
Cr^{6}	mg/L	0.011	**0.011**			0.1	0.011	**0.011**		
Cu	mg/L	0.0098 + [0.62, -0.57]	**0.0093 +** [0.8545, -1.702]			1.3 (1.0)	0.0098 + [0.62, -0.57]	**0.0093 +** [0.8545, -1.702]		
F	mg/L					**4 (2.0)**				
Fe	mg/L					**(0.3)**				
Hardness	mg/L			**500**					**500**	
Hg	ng/L	6.9	**1.3**			2000	6.9	**1.3**		
K	mg/L									
Mg	mg/L									
Mn	mg/L					(0.05)				
Na	mg/L									
Ni	mg/L	0.158 + [0.846, 1.1645]	**0.052 +** [0.846, 0.0584]				0.158 + [0.846, 1.1645]	**0.052 +** [0.846, 0.0584]		
Pb	mg/L	**0.0032 +** [1.273, -4.705]				0.015	**0.0032 +** [1.273, -4.705]			
Sb	mg/L	**0.031**				0.006	**0.0055**			
Se	mg/L	0.005	**0.005**			0.05	0.005	**0.005**		
SO_4	mg/L				**10 (at wild rice)**	**(250)**				**10 (at wild rice)**
Tl	mg/L	**0.00056**				0.002	**0.00028**			
V	mg/L									
Zn	mg/L	0.106 + [0.8473, 0.7615]	**0.12 +** [0.8473, 0.884]			(5)	0.106 + [0.8473, 0.7615]	**0.12 +** [0.8473, 0.884]		

· Standards in bold are used to evaluate the water quality modeling results of the NorthMet Project. Where standards are defined for both "Statewide Waters" (part 7050) and "Lake Superior Basin Waters" (part 7052), the "Lake Superior Basin Waters" standards govern, even if less stringent.

· Minnesota Class 4B, 5 and 6 Surface Water Quality are applicable for the waterbodies near the NorthMet Project and do not have standards related to the parameters listed above.

· Standards highlighted green were developed to protect against aquatic toxicity. Those highlighted orange were developed to protect human health. Those highlighted blue were developed to protect other uses (irrigation, industrial, aesthetic)

· Numbers in parentheses indicate a Secondary Maximum Contaminant Level.

· Standards marked + assume a total hardness of 100 mg/L for Class 2B and 2Bd. Actual equations take the following form, where the coefficients A and B are shown in brackets:

Large Table 3
Groundwater Data Summary
Mine Site Surficial Aquifer

		Location	MW-05-02	MW-05-02	MW-05-02	MW-05-02	MW-05-02	MW-05-02	MW-05-02		MW-05-02	MW-05-02		MW-05-02	MW-05-02	MW-05-02	MW-05-02		MW-05-02	
		Date	3/23/2005	11/20/2006	3/17/2009	5/3/2010	7/27/2010	10/5/2010	4/26/2011		7/20/2011	5/8/2012		6/21/2012	7/5/2012	8/23/2012	10/22/2012		5/2/2013	
		Sample Type	N	N	N	N	N	N	N	FD	N	N	FD	N	N	N	N	FD	N	FD
	Fraction	Analysis Location																		
General Parameters																				
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	--	--	**75 mg/l**	**42.6 mg/l**	**51.6 mg/l**	**36.9 mg/l**	**36 mg/l**	**36.8 mg/l**	--	--	--	--	--	--	--	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	--	--	--	--	--	--	--	--	--
Alkalinity, total	NA	Lab	**88.3 mg/l**	**68.3 mg/l**	**76.4 mg/l**	**75 mg/l**	**42.6 mg/l**	**51.6 mg/l**	**36.9 mg/l**	**36 mg/l**	**36.8 mg/l**	**37.6 mg/l**	**37.6 mg/l**	**28.8 mg/l**	**28.8 mg/l**	**28.8 mg/l**	**27.9 mg/l**	--	**35.0 mg/l**	--
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	< 2.4 mg/l	< 2.4 mg/l	< 2.4 mg/l	< 2.4 mg/l	< 2.4 mg/l	< 3 mg/l	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	--	--	--	**2.7 mg/l**	**1.8 mg/l**	**2.2 mg/l**	**2.0 h mg/l**	**2.2 h mg/l**	**2.9 mg/l**	**2.5 mg/l**	**2.5 mg/l**	**2.0 mg/l**	**2.1 mg/l**	**2.2 mg/l**	**1.7 mg/l**	--	**5.4 mg/l**	--
Carbon, total organic	NA	Lab	**8 mg/l**	**2.6 mg/l**	**1.9 mg/l**	**3.1 mg/l**	**1.9 mg/l**	**1.7 mg/l**	**1.8 h mg/l**	**1.8 h mg/l**	**2.8 mg/l**	**2.4 mg/l**	**2.2 mg/l**	**1.6 mg/l**	**1.7 mg/l**	**1.9 h mg/l**	**1.4 mg/l**	--	**4.6 mg/l**	--
Chemical Oxygen Demand	NA	Lab	**12.4 mg/l**	< 10 mg/l	< 10 mg/l	**20.1 mg/l**	< 10 mg/l	< 10 mg/l	**12.5 h mg/l**	< 10 h mg/l	**43.2 mg/l**	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	--	**20.2 mg/l**	--
Chloride	NA	Lab	**1.3 mg/l**	**1.11 mg/l**	< 0.5 mg/l	**0.55 mg/l**	< 0.5 mg/l	< 0.5 mg/l	< 0.5 h mg/l	< 0.5 h mg/l	**0.75 mg/l**	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	--	< 0.50 mg/l	--
Cyanide	NA	Lab	< 0.02 mg/l	< 0.02 mg/l	< 0.02 mg/l	< 0.0100 mg/l	< 0.02 mg/l	< 0.02 mg/l	< 0.0100 mg/l	< 0.0100 mg/l	< 0.0100 mg/l	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	--	**4.95 mg/l**	**8.21 mg/l**	**2.91 mg/l**	**10.54 mg/l**	**6.2 mg/l**	**10.88 mg/l**	--	**11.0 mg/l**	**11.45 mg/l**	--	**12.11 mg/l**	**12 mg/l**	**7.37 mg/l**	**6.25 mg/l**	--	**10.36 mg/l**	--
Fluoride	NA	Lab	**0.21 mg/l**	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 h mg/l	< 0.1 h mg/l	< 0.1 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	--	< 0.10 mg/l	--
Hardness, total, as CaCO3	NA	Lab	**84.8 mg/l**	**69.7 mg/l**	**82.8 mg/l**	**88.8 mg/l**	**45.8 mg/l**	**61.5 mg/l**	**42.4 mg/l**	**43.4 mg/l**	**89.6 mg/l**	**45.4 mg/l**	**44.0 mg/l**	**33.7 mg/l**	**33.0 mg/l**	**31.4 mg/l**	**31.1 mg/l**	--	**41.2 mg/l**	--
Nitrate + Nitrite, as N	NA	Lab	**0.33 mg/l**	**1.42 mg/l**	**0.26 mg/l**	**0.16 mg/l**	**0.29 mg/l**	**0.48 mg/l**	**0.29 h mg/l**	**0.29 h mg/l**	**0.27 mg/l**	**0.35 mg/l**	**0.37 mg/l**	**0.42 mg/l**	**0.37 mg/l**	**0.44 mg/l**	**0.56 mg/l**	--	**0.49 mg/l**	--
Nitrogen, ammonia (NH3), as N	NA	Lab	**0.24 mg/l**	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.05 mg/l	< 0.05 mg/l	< 0.1 h mg/l	< 0.1 h mg/l	< 0.1 mg/l	< 0.050 mg/l	< 0.050 mg/l	< 0.10 mg/l	< 0.10 mg/l	**0.25 b mg/l**	< 0.10 mg/l	--	**0.14 mg/l**	--
pH	NA	Lab	**10 pH units**	**6.5 pH units**	**7.0 pH units**	**7.6 pH units**	**7.1 pH units**	**7.3 pH units**	--	--	**7.0 pH units**	--	--	--	--	--	--	--	--	--
pH	NA	Field	**10.14 pH units**	**6.50 pH units**	**6.79 pH units**	**7.87 pH units**	**6.77 pH units**	**8.2 pH units**	**6.63 pH units**	--	**6.3 pH units**	**6.71 pH units**	--	**6.36 pH units**	**6.24 pH units**	**6.28 pH units**	**6.28 pH units**	--	**7.71 pH units**	--
Phosphorus, total	NA	Lab	**0.14 mg/l**	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg P/L	< 0.1 mg P/L	< 0.1 mg P/L	< 0.1 h mg P/L	< 0.1 h mg P/L	**0.84 mg P/L**	--	--	--	--	--	--	--	--	--
Redox (oxidation potential)	NA	Field	**11.9 mV**	**148 mV**	**433 mV**	**469 mV**	**453 mV**	**437 mV**	**421 mV**	--	**556 mV**	**338 mV**	--	**663 mV**	**379 mV**	**260 mV**	**140 mV**	--	**415 mV**	--
Solids, total dissolved	NA	Lab	--	--	--	**134 mg/l**	**72 mg/l**	**115 mg/l**	**81 mg/l**	**87 mg/l**	**57 mg/l**	**78.0 mg/l**	**83.0 mg/l**	**117 mg/l**	**80.0 mg/l**	**6080 mg/l**	**52.0 mg/l**	--	**108 mg/l**	--
Specific Conductance @ 25oC	NA	Field	**201 umhos/cm**	**165 umhos/cm**	**197 umhos/cm**	**512 umhos/cm**	**76.9 umhos/cm**	**199 umhos/cm**	**72.2 umhos/cm**		**54 umhos/cm**	**51.7 umhos/cm**	--	**69.7 umhos/cm**	**69.1 umhos/cm**	**67.8 umhos/cm**	**73.7 umhos/cm**	--	**75.7 umhos/cm**	--
Sulfate	NA	Lab	**10.8 mg/l**	**16.4 mg/l**	**23 mg/l**	**20.5 mg/l**	**7.1 mg/l**	**10.7 mg/l**	**6.6 h mg/l**	**6.7 h mg/l**	**6.73 mg/l**	**7.4 mg/l**	**7.4 mg/l**	**6.6 mg/l**	**7.2 mg/l**	**6.7 mg/l**	**7.2 mg/l**	--	**8.0 mg/l**	--
Temperature, degrees C	NA	Field	**2.98 deg C**	**5.8 deg C**	**3.0 deg C**	**4.3 deg C**	**11.92 deg C**	**13.8 deg C**	**4.49 deg C**	--	**10.5 deg C**	**10.6 deg C**	--	**11.42 deg C**	**10.29 deg C**	**14.64 deg C**	**10.14 deg C**	--	**3.9 deg C**	--
Turbidity	NA	Field	--	--	**0.5 NTU**	**1 NTU**	**1.1 NTU**	**0 NTU**	**0 NTU**	--	**570.0 NTU**	**6.4 NTU**	--	**0 NTU**	**1.1 NTU**	**0 NTU**	**0.7 NTU**	--	**5 NTU**	--
Metals																				
Aluminum	Dissolved	Lab	**44.6 * ug/l**	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 20.0 ug/l	< 100 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	--	**20.1 ug/l**	--
Aluminum	Total	Lab	**322 ug/l**	**31.6 ug/l**	**140 ug/l**	**428 ug/l**	**707 * ug/l**	**144 ug/l**	**91.5 ug/l**	**91.3 ug/l**	**22400 ug/l**	--	--	--	--	--	--	--	--	--
Antimony	Dissolved	Lab	--	--	--	--	--	--	--	--	--	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	--
Antimony	Total	Lab	< 3 ug/l	< 3 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	--	--	--	--	--	--	--	--	--
Arsenic	Dissolved	Lab	--	--	--	--	--	< 1 ug/l	< 1 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	**0.92 ug/l**	**1.1 ug/l**	--	< 0.50 ug/l	--
Arsenic	Total	Lab	**3.2 ug/l**	< 2 ug/l	< 2 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 0.5 ug/l	< 0.5 ug/l	**4.41 ug/l**	--	--	--	--	--	--	--	--	--
Barium	Dissolved	Lab	--	--	--	--	--	--	--	--	**2.82 ug/l**	--	--	--	--	--	--	--	--	--
Barium	Total	Lab	< 10 ug/l	< 10 ug/l	**7.3 ug/l**	**11.2 ug/l**	**7.24 ug/l**	**6.83 ug/l**	**3.23 ug/l**	**3.19 ug/l**	**102 ug/l**	**8.9 ug/l**	**9.2 ug/l**	**2.4 ug/l**	**2.4 ug/l**	**3.5 ug/l**	**4.1 ug/l**	--	**8.4 ug/l**	--
Beryllium	Total	Lab	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	**0.48 ug/l**	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	--
Boron	Dissolved	Lab	--	--	--	--	--	--	--	--	< 50 ug/l	--	--	--	--	--	--	--	--	--
Boron	Total	Lab	< 35 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	--	< 50.0 ug/l	--
Cadmium	Dissolved	Lab	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	**0.2 ug/l**	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	--
Cadmium	Total	Lab	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	**0.56 ug/l**	--	--	--	--	--	--	--	--	--
Calcium	Total	Lab	**30100 ug/l**	**18600 ug/l**	**19800 ug/l**	**24400 ug/l**	**12600 ug/l**	**16700 ug/l**	**9710 ug/l**	**9940 ug/l**	**17100 ug/l**	**10600 ug/l**	**10200 ug/l**	**7400 ug/l**	**7300 ug/l**	**7000 ug/l**	**7000 ug/l**	--	**10100 ug/l**	--
Chromium	Dissolved	Lab	< 1 ug/l	**1.1 ug/l**	**7.0 ug/l**	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	**1.2 b ug/l**	**1.5 b ug/l**	**1.0 ug/l**	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	--
Chromium	Total	Lab	**1.2 ug/l**	< 1 ug/l	**2 ug/l**	**2.17 ug/l**	**1.23 ug/l**	< 1 ug/l	< 1 ug/l	< 1 ug/l	**29.2 ug/l**	--	--	--	--	--	--	--	--	--
Cobalt	Dissolved	Lab	--	--	--	--	--	--	--	--	**0.89 ug/l**	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	**1.7 ug/l**	**1.4 ug/l**	--	< 0.20 ug/l	--
Cobalt	Total	Lab	< 1 ug/l	< 1 ug/l	**0.25 ug/l**	**0.71 ug/l**	**0.72 ug/l**	**0.2 ug/l**	< 0.2 ug/l	< 0.2 ug/l	**13.7 ug/l**	--	--	--	--	--	--	--	--	--
Copper	Dissolved	Lab	**8 ug/l**	< 2 ug/l	**1.6 ug/l**	**3.3 b ug/l**	**2.88 ug/l**	**1.93 ug/l**	**1.87 ug/l**	**1.79 ug/l**	**4.18 ug/l**	**1.8 ug/l**	**1.4 ug/l**	**1.6 ug/l**	**1.6 ug/l**	**1.5 ug/l**	**0.56 ug/l**	--	**8.2 ug/l**	--
Copper	Total	Lab	**11.2 ug/l**	**2.4 ug/l**	**2.2 b ug/l**	**8.95 ug/l**	**5.36 ug/l**	**2.32 ug/l**	**2.87 ug/l**	**2.62 ug/l**	**95.1 ug/l**	--	--	--	--	--	--	--	--	--
Iron	Dissolved	Lab	--	--	--	--	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50.0 ug/l	< 250 ug/l	**97.3 ug/l**	< 50.0 ug/l	**108 ug/l**	< 50.0 ug/l	--	< 50.0 ug/l	--
Iron	Total	Lab	**350 ug/l**	**54.3 ug/l**	**167 b ug/l**	**568 ug/l**	**696 * ug/l**	**146 ug/l**	**93.3 ug/l**	**100 ug/l**	**27400 ug/l**	--	--	--	--	--	--	--	--	--
Lead	Dissolved	Lab	--	--	--	--	--	--	--	--	< 0.5 ug/l	--	--	--	--	--	--	--	--	--
Lead	Total	Lab	< 1 ug/l	< 1 ug/l	< 0.52 ug/l	< 0.5 ug/l	**0.72 b ug/l**	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	**7.24 ug/l**	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	--
Magnesium	Total	Lab	**2300 ug/l**	**5650 ug/l**	**8090 ug/l**	**6760 ug/l**	**3490 ug/l**	**4800 ug/l**	**4400 ug/l**	**4500 ug/l**	**11400 ug/l**	**4600 ug/l**	**4500 ug/l**	**3700 ug/l**	**3600 ug/l**	**3400 ug/l**	**3300 ug/l**	--	**3900 ug/l**	--
Manganese	Dissolved	Lab	--	--	--	**0.81 b ug/l**	**24.1 ug/l**	**17.9 ug/l**	< 0.5 ug/l	< 0.5 ug/l	**91.2 ug/l**	**1.1 ug/l**	**1.1 ug/l**	**0.94 ug/l**	< 0.50 ug/l	**257 ug/l**	**398 ug/l**	--	**2.7 ug/l**	--
Manganese	Total	Lab	< 30 ug/l	**61.9 ug/l**	**5.8 b ug/l**	**34.5 ug/l**	**65.4 ug/l**	**21.9 ug/l**	**4.9 ug/l**	**3.95 ug/l**	**698 ug/l**	--	--	--	--	--	--	--	--	--
Mercury	Total	Lab	< 0.002 ug/l	**0.0005 b ug/l**	**0.00056 ug/l**	**0.001 ug/l**	**0.0006 ug/l**	**0.0007 ug/l**	**0.0010 ug/l**	**0.0010 ug/l**	**0.0070 ug/l**	**0.00063 ug/l**	**0.00054 ug/l**	< 0.00050 ug/l	< 0.00050 ug/l	**0.00062 ug/l**	< 0.00050 ug/l	< 0.00050 ug/l	**0.0022 ug/l**	**0.0022 ug/l**
Mercury methyl	Total	Lab	< 0.000025 ug/l	< 0.000146 ug/l	< 0.0001 ug/l	< 0.0001 ug/l	< 0.0001 ug/l	< 0.0001 ug/l	< 0.0001 ug/l	**0.00011 ug/l**	< 0.0001 ug/l	--	--	--	--	--	--	--	--	--
Molybdenum	Dissolved	Lab	**13.1 ug/l**	< 5 ug/l	**1.2 ug/l**	**0.5 ug/l**	**0.24 ug/l**	**0.24 ug/l**	**0.22 ug/l**	< 0.2 ug/l	**0.28 ug/l**	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	**0.26 ug/l**	**0.34 ug/l**	--	**0.35 ug/l**	--
Molybdenum	Total	Lab	**16.1 * ug/l**	< 5 ug/l	**0.34 ug/l**	**0.74 ug/l**	**0.41 ug/l**	**0.26 ug/l**	< 0.2 ug/l	< 0.2 ug/l	**0.56 ug/l**	--	--	--	--	--	--	--	--	--
Nickel	Dissolved	Lab	< 2 ug/l	< 2 ug/l	**1.8 ug/l**	**1.51 ug/l**	**1.87 ug/l**	**3.41 ug/l**	**1.49 ug/l**	**1.51 ug/l**	**4.73 ug/l**	**1.2 ug/l**	**1.2 ug/l**	**1.4 ug/l**	**1.2 ug/l**	**4.8 ug/l**	**2.4 ug/l**	--	**3.7 ug/l**	--
Nickel	Total	Lab	< 2 ug/l	< 2 ug/l	**2.5 b ug/l**	**3.73 ug/l**	**4.1 ug/l**	**3.44 ug/l**	**1.68 ug/l**	**1.73 ug/l**	**47 ug/l**	--	--	--	--	--	--	--	--	--
Palladium	Total	Lab	< 25 ug/l	< 0.1 ug/l	< 0.30 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	< 25 ug/l	< 0.01 ug/l	< 0.30 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	**1600 * ug/l**	**1930 ug/l**	**1450 ug/l**	**1790 ug/l**	**1460 ug/l**	**1670 ug/l**	**850 ug/l**	**860 ug/l**	**4700 ug/l**	**1100 ug/l**	**1100 ug/l**	**860 ug/l**	**850 ug/l**	**1000 ug/l**	**1000 ug/l**	--	**1700 ug/l**	--
Selenium	Dissolved	Lab	< 2 ug/l	< 2 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 0.2 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	--
Selenium	Total	Lab	< 2 ug/l	< 2 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	**0.33 j ug/l**	--	--	--	--	--	--	--	--	--
Silver	Dissolved	Lab	< 1 ug/l	< 1 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	--
Silver	Total	Lab	< 1 ug/l	< 2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	--	--	--	--	--	--	--	--	--
Sodium	Total	Lab	**11900 ug/l**	**5380 ug/l**	**6960 ug/l**	**5830 ug/l**	**3750 ug/l**	**4480 ug/l**	**2400 ug/l**	**2430 ug/l**	**5470 ug/l**	**2700 ug/l**	**2600 ug/l**	**2100 ug/l**	**2200 ug/l**	**2100 ug/l**	**2400 ug/l**	--	**2200 ug/l**	--
Strontium	Total	Lab	**191 ug/l**	**88.6 ug/l**	**64.2 ug/l**	**73.8 ug/l**	**44.6 ug/l**	**57.4 ug/l**	**27.3 ug/l**	**27.6 ug/l**	**98.4 ug/l**	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab	< 2 ug/l	< 2 ug/l	< 0.4 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	--
Titanium	Total	Lab	**30.7 * ug/l**	< 20 ug/l	< 10 ug/l	**25 ug/l**	**24 ug/l**	< 10 ug/l	< 10 ug/l	< 10 ug/l	**930 ug/l**	--	--	--	--	--	--	--	--	--
Vanadium	Dissolved	Lab	--	--	--	--	--	--	--	--	--	< 5.0 ug/l	< 25.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	--	< 5.0 ug/l	--
Zinc	Dissolved	Lab	< 10 ug/l	< 25 ug/l	**6.2 b ug/l**	< 6 ug/l	**6.92 ug/l**	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	--	< 6.0 ug/l	--
Zinc	Total	Lab	< 10 ug/l	< 25 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	**60.6 ug/l**	--	--	--	--	--	--	--	--	--

Large Table 3
Groundwater Data Summary
Mine Site Surficial Aquifer

		Location	MW-05-02	MW-05-02	MW-05-08		MW-05-08	MW-05-08		MW-05-08	MW-05-08	MW-05-08	MW-05-08	MW-05-08		MW-05-08		MW-05-08		MW-05-08
		Date	7/23/2013	10/1/2013	3/23/2005		11/28/2006	5/7/2009		5/5/2010	7/29/2010	10/7/2010	4/26/2011	7/21/2011		10/5/2011		11/2/2011		12/8/2011
		Sample Type	N	N	N	FD	N	N	FD	N	N	N	N	N	FD	N	FD	N	FD	N
	Fraction	Analysis Location																		
General Parameters																				
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	**51.7 mg/l**	**54.1 mg/l**	**55 mg/l**	**54.1 mg/l**	**52.7 mg/l**	**55.2 mg/l**	**54.0 mg/l**	**53.2 mg/l**	--	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	--	--	--
Alkalinity, total	NA	Lab	**62.9 mg/l**	**82.5 mg/l**	**72.8 mg/l**	**65.2 mg/l**	**67.7 mg/l**	**51.8 mg/l**	**51.6 mg/l**	**51.7 mg/l**	**54.1 mg/l**	**55 mg/l**	**54.1 mg/l**	**52.7 mg/l**	**55.2 mg/l**	**54.0 mg/l**	**53.2 mg/l**	**54.9 mg/l**	**55 mg/l**	**55.7 mg/l**
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	< 2.4 mg/l	< 2.4 mg/l	< 2.4 mg/l	< 2.4 mg/l	< 2.4 mg/l	< 2.4 mg/l	< 3 mg/l	< 2.4 mg/l	--	--	--
Carbon, dissolved organic	NA	Lab	**2.8 mg/l**	**3.3 mg/l**	--	--	--	--	--	**1.1 mg/l**	**1.3 mg/l**	**1.5 mg/l**	**1.8 h mg/l**	**1.9 mg/l**	**1.8 mg/l**	**3.4 mg/l**	**2.7 mg/l**	**2.5 mg/l**	**2.4 mg/l**	**1.8 mg/l**
Carbon, total organic	NA	Lab	**2.1 mg/l**	**2.8 mg/l**	**3.8 mg/l**	**3.3 mg/l**	**1.6 mg/l**	**1.2 mg/l**	**1.2 mg/l**	< 1 mg/l	**1.4 mg/l**	**1.1 mg/l**	**1.1 h mg/l**	**1.5 mg/l**	**1.6 mg/l**	**2.3 mg/l**	**1.8 mg/l**	**1.6 mg/l**	**1.4 mg/l**	**1.5 mg/l**
Chemical Oxygen Demand	NA	Lab	**16.2 mg/l**	**28.4 b mg/l**	**12.4 mg/l**	**8.8 mg/l**	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	**10.3 mg/l**	< 10 h mg/l	**16.3 mg/l**	**12.2 mg/l**	**18 mg/l**	**17.8 mg/l**	< 10 mg/l	**10.6 mg/l**	< 10 mg/l
Chloride	NA	Lab	< 0.50 mg/l	**1.1 mg/l**	**1.1 mg/l**	**1.3 mg/l**	**1.17 mg/l**	**0.52 mg/l**	**0.55 mg/l**	**0.58 b mg/l**	**0.52 mg/l**	< 0.5 mg/l	**0.54 h mg/l**	**0.54 mg/l**	**0.73 mg/l**	**0.86 mg/l**	**0.67 mg/l**	**0.51 mg/l**	< 0.5 mg/l	**0.63 mg/l**
Cyanide	NA	Lab	--	--	< 0.02 mg/l	< 0.02 mg/l	< 0.02 mg/l	< 0.02 mg/l	< 0.02 mg/l	< 0.0100 mg/l	< 0.02 mg/l	< 0.02 mg/l	**0.0371 mg/l**	< 0.0100 mg/l	< 0.0100 mg/l	< 0.0100 mg/l	< 0.0100 mg/l	--	--	--
Dissolved oxygen	NA	Field	**11.09 mg/l**	**4.49 mg/l**	--	--	**0.70 mg/l**	**0.92 mg/l**	--	**0.7 mg/l**	**1.02 mg/l**	**1.9 mg/l**	**1.6 mg/l**	< 0.1 mg/l	--	**5.9 mg/l**	--	**4.93 mg/l**	--	**6.65 mg/l**
Fluoride	NA	Lab	< 0.10 mg/l	< 0.10 mg/l	**0.19 mg/l**	**0.19 mg/l**	**0.11 mg/l**	**0.12 mg/l**	**0.12 mg/l**	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 h mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l
Hardness, total, as CaCO3	NA	Lab	**34.4 mg/l**	**83.4 mg/l**	**64.3 mg/l**	**66.1 mg/l**	**56.8 mg/l**	**58.9 mg/l**	**59 mg/l**	**58.9 mg/l**	**58.5 mg/l**	**58 mg/l**	**61.3 mg/l**	**68.8 mg/l**	**67.8 mg/l**	**56.6 mg/l**	**59.4 mg/l**	**55.3 mg/l**	**54.6 mg/l**	**54.5 mg/l**
Nitrate + Nitrite, as N	NA	Lab	**0.33 mg/l**	**0.12 mg/l**	**0.31 mg/l**	**0.9 mg/l**	**0.15 mg/l**	**0.22 mg/l**	**0.21 mg/l**	**0.14 mg/l**	**0.19 mg/l**	**0.17 mg/l**	**0.2 h mg/l**	**0.19 mg/l**	**0.2 mg/l**	**0.23 mg/l**	**0.22 mg/l**	**0.26 mg/l**	**0.26 mg/l**	**0.29 mg/l**
Nitrogen, ammonia (NH3), as N	NA	Lab	< 0.10 mg/l	< 0.10 mg/l	< 0.1 mg/l	< 0.1 mg/l	**0.42 mg/l**	< 0.1 mg/l	< 0.1 mg/l	< 0.05 mg/l	< 0.05 mg/l	< 0.05 mg/l	< 0.1 h mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l
pH	NA	Lab	--	--	**7.4 pH units**	**7.7 pH units**	**6.9 pH units**	**7.5 pH units**	**7.6 pH units**	**7.5 pH units**	**8.2 pH units**	**7.5 pH units**	--	**7.4 pH units**	**7.4 pH units**	**7.4 pH units**	**7.3 pH units**	--	--	--
pH	NA	Field	**7.47 pH units**	**7.51 pH units**	**7.20 pH units**	--	**7.27 pH units**	**7.87 pH units**	--	**8.24 pH units**	**8.18 pH units**	**7.0 pH units**	**7.21 pH units**	**6.6 pH units**	--	**6.8 pH units**	--	**7.03 pH units**	--	**8.54 pH units**
Phosphorus, total	NA	Lab	--	--	**0.17 mg/l**	**0.16 mg/l**	**0.14 mg/l**	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg P/L	< 0.1 mg P/L	< 0.1 mg P/L	< 0.1 h mg P/L	**0.15 mg P/L**	**0.12 mg P/L**	< 0.1 mg P/L	< 0.1 mg P/L	--	--	--
Redox (oxidation potential)	NA	Field	**437 mV**	**524 mV**	**-196.5 mV**	--	**47 mV**	**390 mV**	--	**436 mV**	**397 mV**	**326 mV**	**395 mV**	**406 mV**	--	**419 mV**	--	**330 mV**	--	**368 mV**
Solids, total dissolved	NA	Lab	**89.0 mg/l**	**136 mg/l**	--	--	--	--	--	**95 mg/l**	**94 mg/l**	**87 mg/l**	**91 mg/l**	**104 mg/l**	**95 mg/l**	**128 mg/l**	**90 mg/l**	**127 mg/l**	**106 mg/l**	**112 mg/l**
Specific Conductance @ 25oC	NA	Field	**72.8 umhos/cm**	**160.2 umhos/cm**	**183 umhos/cm**	--	**115 umhos/cm**	**119 umhos/cm**	--	**212 umhos/cm**	**116 umhos/cm**	**120 umhos/cm**	**04.6 umhos/cm**	**88 umhos/cm**	--	**130 umhos/cm**	--	**125 umhos/cm**	--	**129.6 umhos/cm**
Sulfate	NA	Lab	**6.4 mg/l**	**6.8 mg/l**	**21.2 mg/l**	**20.3 mg/l**	**11.2 mg/l**	**9.72 mg/l**	**9.73 mg/l**	**10.4 mg/l**	**9.52 mg/l**	**9.46 mg/l**	**8.93 h mg/l**	**9.1 mg/l**	**9.43 mg/l**	**9.23 mg/l**	**9.04 mg/l**	**8.92 mg/l**	**8.85 mg/l**	**9.5 mg/l**
Temperature, degrees C	NA	Field	**13.84 deg C**	**12.84 deg C**	**4.37 deg C**	--	**6.8 deg C**	**10.8 deg C**	--	**4.6 deg C**	**8.21 deg C**	**11.7 deg C**	**4.46 deg C**	**8.5 deg C**	--	**13.2 deg C**	--	**10.81 deg C**	--	**11.46 deg C**
Turbidity	NA	Field	**2.5 NTU**	**23.7 NTU**	--	--	--	**47 NTU**	--	**487 NTU**	**9.7 NTU**	**2.3 NTU**	**2.3 NTU**	**81.0 NTU**	--	**32.0 NTU**	--	**2.40 NTU**	--	**0 NTU**
Metals																				
Aluminum	Dissolved	Lab	< 20.0 ug/l	< 20.0 ug/l	**214 * ug/l**	**132 * ug/l**	**199 ug/l**	< 25 ug/l	< 25 ug/l	< 25 ug/l	**58.4 ug/l**	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l
Aluminum	Total	Lab	--	--	**1040 ug/l**	**1300 ug/l**	**2620 ug/l**	**364 ug/l**	**427 ug/l**	**661 ug/l**	**627 ug/l**	**136 ug/l**	**465 ug/l**	**5020 ug/l**	**5140 ug/l**	**1920 ug/l**	**2560 ug/l**	--	--	--
Antimony	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l
Antimony	Total	Lab	--	--	< 3 ug/l	< 3 ug/l	< 3 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	--	--	--
Arsenic	Dissolved	Lab	< 0.50 ug/l	**2.1 ug/l**	--	--	--	--	--	--	< 1 ug/l	< 1 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l
Arsenic	Total	Lab	--	--	**4.4 ug/l**	**3.1 ug/l**	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 0.5 ug/l	**0.77 ug/l**	**0.95 ug/l**	**0.56 ug/l**	**0.62 ug/l**	--	--	--
Barium	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Total	Lab	**7.5 ug/l**	**11.5 ug/l**	**32.5 ug/l**	**32 ug/l**	**28.1 ug/l**	**19.7 ug/l**	**20 ug/l**	**18.5 ug/l**	**17.9 ug/l**	**15.9 ug/l**	**15.1 ug/l**	**39.9 ug/l**	**44.1 ug/l**	**24.8 ug/l**	**27 ug/l**	**14.5 ug/l**	**13.5 ug/l**	**13.5 ug/l**
Beryllium	Total	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l
Boron	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	--	--	--
Boron	Total	Lab	< 50.0 ug/l	< 50.0 ug/l	< 35 ug/l	**38 ug/l**	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l
Cadmium	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.03 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l
Cadmium	Total	Lab	--	--	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	**0.08 j ug/l**	**0.28 ug/l**	< 0.2 ug/l	--	--	--
Calcium	Total	Lab	**7600 ug/l**	**18500 ug/l**	**14500 ug/l**	**14900 ug/l**	**12100 ug/l**	**12300 ug/l**	**12300 ug/l**	**12500 ug/l**	**12400 ug/l**	**12400 ug/l**	**13100 ug/l**	**14000 ug/l**	**13900 ug/l**	**11900 ug/l**	**12500 ug/l**	**11400 ug/l**	**11400 ug/l**	**11400 ug/l**
Chromium	Dissolved	Lab	**1.2 ug/l**	< 1.0 ug/l	< 1 ug/l	< 1 ug/l	**1.2 ug/l**	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	**1.08 ug/l**	< 1.5 ug/l	< 1.5 ug/l	< 1 ug/l
Chromium	Total	Lab	--	--	**6.1 ug/l**	**4.8 ug/l**	**3.2 ug/l**	< 1 ug/l	**1 ug/l**	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	**6.3 ug/l**	**6.72 ug/l**	**3.17 ug/l**	**4.13 ug/l**	--	--	--
Cobalt	Dissolved	Lab	< 0.20 ug/l	**4.9 ug/l**	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l
Cobalt	Total	Lab	--	--	**1.8 ug/l**	**1.6 ug/l**	< 1 ug/l	**0.32 ug/l**	**0.32 ug/l**	**0.37 ug/l**	**0.34 ug/l**	< 0.2 ug/l	**0.23 ug/l**	**2.98 ug/l**	**3.17 ug/l**	**1.16 ug/l**	**1.4 ug/l**	--	--	--
Copper	Dissolved	Lab	**1.6 ug/l**	**3.3 ug/l**	**6.4 ug/l**	**2.3 ug/l**	< 2 ug/l	**0.94 b ug/l**	< 0.7 ug/l	**0.76 ug/l**	**1.59 ug/l**	< 0.7 ug/l	**0.84 ug/l**	< 0.7 ug/l	**0.49 j ug/l**	**1.7 ug/l**	**0.95 ug/l**	< 0.7 ug/l	**0.9 ug/l**	< 0.7 ug/l
Copper	Total	Lab	--	--	**10 ug/l**	**7.8 ug/l**	**5.7 ug/l**	**1.2 ug/l**	**1.4 ug/l**	**2.06 ug/l**	**1.37 ug/l**	**0.8 ug/l**	**1.12 ug/l**	**7.82 ug/l**	**8.71 ug/l**	**6 ug/l**	**5.2 ug/l**	--	--	--
Iron	Dissolved	Lab	< 50.0 ug/l	**638 ug/l**	--	--	--	--	--	--	**78.3 ug/l**	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	**84.6 b ug/l**	**99.5 b ug/l**	< 50 ug/l
Iron	Total	Lab	--	--	**1740 ug/l**	**1940 ug/l**	**1860 ug/l**	**398 ug/l**	**442 ug/l**	**619 ug/l**	**500 ug/l**	**113 ug/l**	**336 ug/l**	**4200 ug/l**	**4450 ug/l**	**1600 ug/l**	**2000 ug/l**	--	--	--
Lead	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Total	Lab	**0.81 ug/l**	**0.69 ug/l**	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	**1.82 ug/l**	**1.97 ug/l**	**1.78 ug/l**	**1.5 ug/l**	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l
Magnesium	Total	Lab	**3800 ug/l**	**9000 ug/l**	**6800 ug/l**	**7000 ug/l**	**6470 ug/l**	**6850 ug/l**	**6860 ug/l**	**6730 ug/l**	**6680 ug/l**	**6580 ug/l**	**6950 ug/l**	**8230 ug/l**	**8040 ug/l**	**6520 ug/l**	**6850 ug/l**	**6520 ug/l**	**6350 ug/l**	**6330 ug/l**
Manganese	Dissolved	Lab	**1.1 ug/l**	**869 ug/l**	--	--	--	--	--	**62.7 ug/l**	**66.1 ug/l**	**56.5 ug/l**	**51.1 ug/l**	**71 ug/l**	**73.4 ug/l**	**68.1 ug/l**	**67.1 ug/l**	**58.4 ug/l**	**58 ug/l**	**48.5 ug/l**
Manganese	Total	Lab	--	--	**220 ug/l**	**220 ug/l**	**152 ug/l**	**101 ug/l**	**100 ug/l**	**93.1 ug/l**	**75.5 ug/l**	**61.2 ug/l**	**71.2 ug/l**	**227 ug/l**	**220 ug/l**	**116 ug/l**	**122 ug/l**	--	--	--
Mercury	Total	Lab	**0.00078 ug/l**	**0.0018 ug/l**	**0.0053 ug/l**	**0.0036 ug/l**	**0.0016 b ug/l**	**0.0014 ug/l**	**0.0009 ug/l**	**0.0009 ug/l**	**0.0011 ug/l**	< 0.0005 ug/l	< 0.0005 ug/l	**0.0025 ug/l**	**0.0014 ug/l**	**0.0013 ug/l**	**0.0014 ug/l**	< 0.0005 ug/l	< 0.0005 ug/l	< 0.0005 ug/l
Mercury methyl	Total	Lab	--	--	< 0.000025 ug/l	< 0.000025 ug/l	< 0.000056 ug/l	**0.00044 b ug/l**	**0.00024 b ug/l**	< 0.0001 ug/l	< 0.0001 ug/l	< 0.0001 ug/l	< 0.0001 ug/l	< 0.0001 ug/l	< 0.0001 ug/l	< 0.0001 ug/l	< 0.0001 ug/l	--	--	--
Molybdenum	Dissolved	Lab	< 0.30 ug/l	**0.65 ug/l**	**34.4 ug/l**	**32.9 ug/l**	< 5 ug/l	**1.2 ug/l**	**1.2 ug/l**	**1.3 ug/l**	**1.08 ug/l**	**1.09 b ug/l**	**0.92 ug/l**	**0.92 ug/l**	**0.95 ug/l**	**1.1 ug/l**	**1.02 ug/l**	**0.99 ug/l**	**0.83 ug/l**	**0.73 ug/l**
Molybdenum	Total	Lab	--	--	**35.6 * ug/l**	**33.1 * ug/l**	< 5 ug/l	**1.4 ug/l**	**1.3 ug/l**	**1.09 ug/l**	**1.02 ug/l**	**1.22 ug/l**	**0.87 ug/l**	**0.94 ug/l**	**1.06 ug/l**	**1.11 ug/l**	**1.06 ug/l**	--	--	--
Nickel	Dissolved	Lab	**1.1 ug/l**	**10.3 ug/l**	< 2 ug/l	< 2 ug/l	< 2 ug/l	**0.61 ug/l**	< 0.6 ug/l	< 0.6 ug/l	**0.89 ug/l**	**0.9 ug/l**	< 0.6 ug/l	< 0.6 ug/l	< 0.6 ug/l	< 0.6 ug/l	< 0.6 ug/l	< 0.6 ug/l	< 0.6 ug/l	< 0.6 ug/l
Nickel	Total	Lab	--	--	**7.9 ug/l**	**6.2 ug/l**	**3 ug/l**	**1.4 ug/l**	**1.4 ug/l**	**1.7 ug/l**	**1.73 ug/l**	**0.82 ug/l**	**1.05 ug/l**	**10.9 ug/l**	**11.8 ug/l**	**4.54 ug/l**	**5.06 ug/l**	--	--	--
Palladium	Total	Lab	--	--	< 25 ug/l	< 25 ug/l	< 0.1 ug/l	< 0.30 ug/l	< 0.30 ug/l	< 0.50 * ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	--	--	--
Platinum	Total	Lab	--	--	< 25 ug/l	< 25 ug/l	< 0.02 ug/l	< 0.30 ug/l	< 0.30 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	--	--	--
Potassium	Total	Lab	**1000 ug/l**	**1900 ug/l**	**1600 * ug/l**	**1600 * ug/l**	**1510 ug/l**	**1220 ug/l**	**1230 ug/l**	**1390 ug/l**	**1430 ug/l**	**1500 ug/l**	**1190 ug/l**	**1820 ug/l**	**1810 ug/l**	**1620 ug/l**	**1670 ug/l**	**1260 ug/l**	**1280 ug/l**	**1160 ug/l**
Selenium	Dissolved	Lab	< 1.0 ug/l	< 1.0 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	**0.4 j ug/l**	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l
Selenium	Total	Lab	--	--	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	**0.57 j ug/l**	< 1 ug/l	< 1 ug/l	--	--	--
Silver	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l
Silver	Total	Lab	--	--	< 1 ug/l	< 1 ug/l	< 2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	--	--	--
Sodium	Total	Lab	**2400 ug/l**	**3400 ug/l**	**15700 ug/l**	**13500 ug/l**	**7300 ug/l**	**4460 ug/l**	**4780 ug/l**	**4490 ug/l**	**4970 ug/l**	**4600 ug/l**	**4330 ug/l**	**5410 ug/l**	**5340 ug/l**	**4750 ug/l**	**4980 ug/l**	**4160 ug/l**	**4210 ug/l**	**3860 ug/l**
Strontium	Total	Lab	--	--	**35.9 ug/l**	**37.1 ug/l**	**32.6 ug/l**	**35.2 ug/l**	**36.4 ug/l**	**33.5 ug/l**	**34.7 ug/l**	**32.9 ug/l**	**33.1 ug/l**	**47.3 ug/l**	**47.5 ug/l**	**37.2 ug/l**	**40 ug/l**	--	--	--
Thallium	Total	Lab	< 0.017 ug/l	< 0.20 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 0.4 ug/l	< 0.4 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l
Titanium	Total	Lab	--	--	**113 * ug/l**	**82.6 * ug/l**	**57 ug/l**	**11 ug/l**	**14 ug/l**	**23 ug/l**	**21 ug/l**	< 10 ug/l	**11 ug/l**	**120 ug/l**	**130 ug/l**	**52 ug/l**	**66 ug/l**	--	--	--
Vanadium	Dissolved	Lab	< 5.0 ug/l	< 5.0 ug/l	--	--	--	--	--	--	--	--	--	--	--	--	--	< 10 ug/l	< 10 ug/l	< 10 ug/l
Zinc	Dissolved	Lab	**8.3 ug/l**	**7.8 ug/l**	< 10 ug/l	< 10 ug/l	< 25 ug/l	**8.4 ug/l**	< 6 ug/l	**6.92 ug/l**	**7.66 ug/l**	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 8 ug/l	**10.2 ug/l**	**7.7 ug/l**	< 6 ug/l	< 6 ug/l	< 6 ug/l
Zinc	Total	Lab	--	--	< 10 ug/l	< 10 ug/l	< 25 ug/l	< 6 ug/l	**6.4 ug/l**	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	**13.4 ug/l**	**12.3 ug/l**	**10.5 ug/l**	**8.26 ug/l**	--	--	--

Large Table 3
Groundwater Data Summary
Mine Site Surficial Aquifer

Location			MW-05-08		MW-05-08		MW-05-08	MW-05-08		MW-05-08		MW-05-08		MW-05-08	MW-05-08		MW-05-08		MW-05-08	
Date			3/26/2012		4/24/2012		5/4/2012	6/21/2012		7/26/2012		8/23/2012		10/22/2012	5/13/2013		7/23/2013		10/17/2013	
Sample Type			N	FD	N	FD	N	N	FD	N	FD	N	FD	N	N	FD	N	FD	N	FD
	Fraction	Analysis Location																		
General Parameters																				
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total	NA	Lab	**55.4 mg/l**	**54.3 mg/l**	**55.5 mg/l**	**56.6 mg/l**	**54.9 mg/l**	**51.8 mg/l**	**52.8 mg/l**	**90.5 mg/l**	**107 mg/l**	**52.8 mg/l**	**52.4 mg/l**	**53.5 mg/l**	**55.8 mg/l**	--	**68.7 mg/l**	--	**53.9 mg/l**	**53.9 mg/l**
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	**1.9 mg/l**	**1.7 mg/l**	**1.5 mg/l**	**1.8 mg/l**	**1.4 mg/l**	**1.7 mg/l**	**1.7 mg/l**	< 1.0 mg/l	< 1.0 mg/l	**1.4 mg/l**	**1.3 mg/l**	**1.4 mg/l**	**1.5 mg/l**	--	**1.4 mg/l**	--	**1.3 mg/l**	**1.4 mg/l**
Carbon, total organic	NA	Lab	**1.4 mg/l**	**1.8 mg/l**	**1.4 mg/l**	**1.5 mg/l**	**1.1 mg/l**	**1.1 mg/l**	**1.1 mg/l**	< 1.0 mg/l	< 1.0 mg/l	**1.7 b mg/l**	**2.1 b mg/l**	< 1.0 mg/l	**1.6 mg/l**	--	**1.2 mg/l**	--	**1.1 mg/l**	**1.2 mg/l**
Chemical Oxygen Demand	NA	Lab	< 10 mg/l	< 10 mg/l	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	--	< 10.0 mg/l	--	< 10.0 mg/l	**10.3 b mg/l**
Chloride	NA	Lab	< 0.5 mg/l	< 0.5 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	**0.56 mg/l**	**0.73 mg/l**	**0.67 mg/l**	**0.64 mg/l**	**0.53 mg/l**	**0.64 mg/l**	--	**0.58 mg/l**	--	< 1.0 mg/l	< 1.0 mg/l
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	**3.01 mg/l**	--	**2.34 mg/l**	--	**2.67 mg/l**	**2.44 mg/l**	--	**2.36 mg/l**	--	**2.17 mg/l**	--	**2.36 mg/l**	**0.35 mg/l**	--	**0.36 mg/l**	--	**0.71 mg/l**	--
Fluoride	NA	Lab	< 0.1 mg/l	< 0.1 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	**0.10 mg/l**	< 0.10 mg/l	**0.11 mg/l**	< 0.10 mg/l	--	< 0.10 mg/l	--	< 0.10 mg/l	< 0.10 mg/l
Hardness, total, as CaCO3	NA	Lab	**59.3 mg/l**	**55.8 mg/l**	**55.6 mg/l**	**56.5 mg/l**	**57.0 mg/l**	**54.6 mg/l**	**54.7 mg/l**	**56.6 mg/l**	**55.8 mg/l**	**56.0 mg/l**	**54.7 mg/l**	**59.2 mg/l**	**55.1 mg/l**	--	**58.5 mg/l**	--	**56.5 mg/l**	**57.5 mg/l**
Nitrate + Nitrite, as N	NA	Lab	**0.34 mg/l**	**0.29 mg/l**	**0.30 mg/l**	**0.30 mg/l**	**0.29 mg/l**	**0.32 mg/l**	**0.32 mg/l**	**0.37 mg/l**	**0.38 mg/l**	**0.37 mg/l**	**0.37 mg/l**	**0.26 mg/l**	**0.28 mg/l**	--	**0.31 mg/l**	--	**0.36 mg/l**	**0.40 mg/l**
Nitrogen, ammonia (NH3), as N	NA	Lab	< 0.1 mg/l	< 0.1 mg/l	**0.090 b mg/l**	< 0.050 mg/l	< 0.050 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	**0.14 b mg/l**	**0.33 b mg/l**	< 0.10 mg/l	< 0.10 mg/l	--	< 0.10 mg/l	--	< 0.10 mg/l	< 0.10 mg/l
pH	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	**7.25 pH units**	--	**7.68 pH units**	--	**7.18 pH units**	**6.82 pH units**	--	**6.95 pH units**	--	**6.97 pH units**	--	**7.1 pH units**	**7.21 pH units**	--	**6.94 pH units**	--	**7.18 pH units**	--
Phosphorus, total	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Redox (oxidation potential)	NA	Field	**418 mV**	--	**521 mV**	--	**301 mV**	**350 mV**	--	**259 mV**	--	**209 mV**	--	**179 mV**	**447 mV**	--	**329 mV**	--	**401 mV**	--
Solids, total dissolved	NA	Lab	**113 mg/l**	**102 mg/l**	**98.0 mg/l**	**92.0 mg/l**	**113 mg/l**	**122 mg/l**	**119 mg/l**	**104 mg/l**	**100 mg/l**	**89.0 mg/l**	**94.0 mg/l**	**86.0 mg/l**	**85.0 mg/l**	--	**102 mg/l**	--	**90.0 mg/l**	**107 mg/l**
Specific Conductance @ 25oC	NA	Field	**125.3 umhos/cm**	--	**122.9 umhos/cm**	--	**81.8 umhos/cm**	**116.5 umhos/cm**	--	**118.7 umhos/cm**	--	**119.3 umhos/cm**	--	**125.1 umhos/cm**	**113 umhos/cm**	--	**126.3 umhos/cm**	--	**126.6 umhos/cm**	--
Sulfate	NA	Lab	**8.86 mg/l**	**8.85 mg/l**	**8.8 mg/l**	**8.8 mg/l**	**8.9 mg/l**	**9.2 mg/l**	**9.2 mg/l**	**9.5 mg/l**	**9.5 mg/l**	**9.3 mg/l**	**9.3 mg/l**	**10.2 mg/l**	**9.7 mg/l**	--	**9.2 mg/l**	--	**9.3 mg/l**	**9.2 mg/l**
Temperature, degrees C	NA	Field	**4.29 deg C**	--	**6.31 deg C**	--	**6.23 deg C**	**8.3 deg C**	--	**10.08 deg C**	--	**12.42 deg C**	--	**9.07 deg C**	**4.83 deg C**	--	**7.27 deg C**	--	**8.81 deg C**	--
Turbidity	NA	Field	**0 NTU**	--	**0 NTU**	--	**0 NTU**	**0 NTU**	--	**0 NTU**	--	**0 NTU**	--	**1.5 NTU**	**0 NTU**	--	**0 NTU**	--	**0 NTU**	--
Metals																				
Aluminum	Dissolved	Lab	< 20 ug/l	< 20 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	--	< 20.0 ug/l	--	< 20.0 ug/l	**21.1 ug/l**
Aluminum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	Dissolved	Lab	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l
Antimony	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	Dissolved	Lab	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	--	**0.56 ug/l**	< 0.50 ug/l
Arsenic	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Total	Lab	**13.3 ug/l**	**12.8 ug/l**	**12.5 ug/l**	**12.8 ug/l**	**12.8 ug/l**	**12.2 ug/l**	**12.2 ug/l**	**13.2 ug/l**	**12.7 ug/l**	**12.3 ug/l**	**12.2 ug/l**	**13.9 ug/l**	**12.3 ug/l**	--	**11.4 ug/l**	--	**13.5 ug/l**	**13.6 ug/l**
Beryllium	Total	Lab	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l
Boron	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	Total	Lab	< 50 ug/l	< 50 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	--	< 50.0 ug/l	--	< 50.0 ug/l	< 50.0 ug/l
Cadmium	Dissolved	Lab	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l
Cadmium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Calcium	Total	Lab	**12400 ug/l**	**11400 ug/l**	**11400 ug/l**	**11600 ug/l**	**11700 ug/l**	**11400 ug/l**	**11200 ug/l**	**11700 ug/l**	**11600 ug/l**	**11600 ug/l**	**11300 ug/l**	**12200 ug/l**	**11300 ug/l**	--	**12100 ug/l**	--	**11600 ug/l**	**11700 ug/l**
Chromium	Dissolved	Lab	**1.29 b ug/l**	**1.71 b ug/l**	< 1.0 ug/l	**1.0 ug/l**	**2.2 b ug/l**	**1.2 ug/l**	**1.1 ug/l**	**2.5 ug/l**	**1.8 ug/l**	< 1.0 ug/l	**1.1 ug/l**	< 1.0 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	--	< 1.0 ug/l	< 1.0 ug/l
Chromium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	Dissolved	Lab	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l
Cobalt	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	Dissolved	Lab	< 0.7 ug/l	< 0.7 ug/l	< 0.50 ug/l	**0.73 ug/l**	**0.67 ug/l**	**0.54 ug/l**	< 0.50 ug/l	**0.62 ug/l**	**0.62 ug/l**	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l
Copper	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Iron	Dissolved	Lab	< 50 ug/l	< 50 ug/l	< 50.0 ug/l	< 50.0 ug/l	**61.4 b ug/l**	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	--	< 50.0 ug/l	--	< 50.0 ug/l	< 50.0 ug/l
Iron	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Total	Lab	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l
Magnesium	Total	Lab	**6880 ug/l**	**6640 ug/l**	**6600 ug/l**	**6600 ug/l**	**6700 ug/l**	**6400 ug/l**	**6500 ug/l**	**6600 ug/l**	**6500 ug/l**	**6600 ug/l**	**6400 ug/l**	**7000 ug/l**	**6500 ug/l**	--	**6900 ug/l**	--	**6700 ug/l**	**6900 ug/l**
Manganese	Dissolved	Lab	**41.5 ug/l**	**41.4 ug/l**	**39.4 ug/l**	**41.3 ug/l**	**41.0 ug/l**	**42.6 ug/l**	**41.1 ug/l**	**41.5 ug/l**	**41.0 ug/l**	**33.3 ug/l**	**32.6 ug/l**	**34.7 ug/l**	**35.0 ug/l**	--	**37.7 ug/l**	--	**38.6 ug/l**	**39.4 ug/l**
Manganese	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	Total	Lab	< 0.0005 ug/l	< 0.0005 ug/l	< 0.00050 ug/l	**0.00058 ug/l**	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	**0.00053 ug/l**	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	**0.00089 ug/l**	< 0.00050 ug/l
Mercury methyl	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Dissolved	Lab	**0.65 ug/l**	**0.66 ug/l**	**0.60 ug/l**	**0.64 ug/l**	**0.67 ug/l**	**0.69 ug/l**	**0.67 ug/l**	**1.2 b ug/l**	**0.78 b ug/l**	**0.69 ug/l**	**0.68 ug/l**	**0.80 ug/l**	**0.65 ug/l**	--	**0.58 ug/l**	--	**0.69 ug/l**	**0.67 ug/l**
Molybdenum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	Dissolved	Lab	< 0.6 ug/l	< 0.6 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	**1.1 ug/l**	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l
Nickel	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	**1170 ug/l**	**1140 ug/l**	**1100 ug/l**	**1200 ug/l**	**1200 ug/l**	**1300 ug/l**	**1300 ug/l**	**1300 ug/l**	**1300 ug/l**	**1400 ug/l**	**1400 ug/l**	**1400 ug/l**	**1100 ug/l**	--	**1300 ug/l**	--	**1300 ug/l**	**1300 ug/l**
Selenium	Dissolved	Lab	< 1 ug/l	< 1 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	--	< 1.0 ug/l	< 1.0 ug/l
Selenium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	Dissolved	Lab	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l
Silver	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sodium	Total	Lab	**4070 ug/l**	**3890 ug/l**	**3800 ug/l**	**3900 ug/l**	**4000 ug/l**	**3900 ug/l**	**3900 ug/l**	**4300 ug/l**	**4300 ug/l**	**3800 ug/l**	**3700 ug/l**	**4500 ug/l**	**3600 ug/l**	--	**4100 ug/l**	--	**4000 ug/l**	**4000 ug/l**
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	**0.50 b ug/l**	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.017 ug/l	--	< 0.20 ug/l	< 0.20 ug/l
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Dissolved	Lab	< 5 ug/l	< 5 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	--	< 5.0 ug/l	--	< 5.0 ug/l	< 5.0 ug/l
Zinc	Dissolved	Lab	< 6 ug/l	< 6 ug/l	< 6.0 ug/l	< 6.0 ug/l	**7.0 ug/l**	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	--	< 6.0 ug/l	--	< 6.0 ug/l	< 6.0 ug/l
Zinc	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Large Table 3
Groundwater Data Summary
Mine Site Surficial Aquifer

		Location	MW-05-09	MW-05-09	MW-05-09	MW-05-09	MW-05-09	MW-05-09	MW-05-09		MW-05-09	MW-05-09	MW-05-09	MW-05-09	MW-05-09	MW-05-09	MW-05-09	MW-05-09		
		Date	3/23/2005	10/5/2006	3/17/2009	5/5/2010	7/29/2010	10/7/2010	3/24/2011		4/26/2011	7/21/2011	10/5/2011	11/2/2011	12/6/2011	1/11/2012	2/13/2012	3/1/2012	4/9/2012	
		Sample Type	N	N	N	N	N	N	N	FD	N	N	N	N	N	N	N	N	N	FD
	Fraction	Analysis Location																		
General Parameters																				
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	--	--	**20.4 mg/l**	**18.6 mg/l**	**17.1 mg/l**	**20.3 mg/l**	**20.7 mg/l**	**16.4 mg/l**	**18.5 mg/l**	**15.8 mg/l**	--	--	--	--	--	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	--	--	--	--	--	--	--
Alkalinity, total	NA	Lab	**47 mg/l**	**26.4 mg/l**	**23.7 mg/l**	**20.4 mg/l**	**18.6 mg/l**	**17.1 mg/l**	**20.3 mg/l**	**20.7 mg/l**	**16.4 mg/l**	**18.5 mg/l**	**15.8 mg/l**	**16.7 mg/l**	**16 mg/l**	**15.2 mg/l**	**13.9 mg/l**	**14.6 mg/l**	**16.1 mg/l**	**16.0 mg/l**
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	< 2.4 mg/l	< 3 mg/l	< 2.4 mg/l	< 2.4 mg/l	< 2.4 mg/l	< 4 mg/l	< 4 mg/l	< 2.4 mg/l	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	--	--	--	**4.1 mg/l**	**4.7 mg/l**	**4.0 mg/l**	**3.9 mg/l**	**3.8 mg/l**	**4.7 h mg/l**	**5.3 mg/l**	**4.6 mg/l**	**4.1 mg/l**	**3.9 mg/l**	**3.4 mg/l**	**3.1 b mg/l**	**2.86 b mg/l**	**3.0 mg/l**	**3.1 mg/l**
Carbon, total organic	NA	Lab	**4.6 mg/l**	**5.2 mg/l**	**4.4 mg/l**	**5.0 mg/l**	**3.9 mg/l**	**3.6 mg/l**	**4.2 mg/l**	**4.0 mg/l**	**3.7 h mg/l**	**6.3 mg/l**	**4.0 mg/l**	**4.5 mg/l**	**4.1 mg/l**	**3.0 mg/l**	**2.78 b mg/l**	**2.47 mg/l**	**2.6 mg/l**	**2.7 mg/l**
Chemical Oxygen Demand	NA	Lab	**6.9 mg/l**	< 10 mg/l	**23.9 mg/l**	**21.9 mg/l**	**12 mg/l**	**22.5 mg/l**	**32.2 mg/l**	**28.4 mg/l**	**19.2 h mg/l**	**24 mg/l**	**35.2 mg/l**	**25 mg/l**	**26.4 mg/l**	< 10 mg/l	**16.5 mg/l**	**16.5 mg/l**	**20.6 mg/l**	**11.7 mg/l**
Chloride	NA	Lab	**5.5 mg/l**	**0.69 mg/l**	< 0.5 mg/l	< 0.5 mg/l	< 0.5 mg/l	< 0.5 mg/l	< 0.5 mg/l	< 0.5 mg/l	< 0.5 h mg/l	< 0.5 mg/l	**0.53 mg/l**	< 0.5 mg/l	< 0.5 mg/l	< 0.5 mg/l	**0.93 mg/l**	< 0.5 mg/l	< 0.50 mg/l	< 0.50 mg/l
Cyanide	NA	Lab	< 0.02 mg/l	< 0.02 mg/l	< 0.02 mg/l	< 0.0100 mg/l	< 0.02 mg/l	< 0.02 mg/l	--	--	< 0.0100 mg/l	< 0.0100 mg/l	< 0.0100 mg/l	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	--	**1.80 mg/l**	**3.71 mg/l**	**12.1 mg/l**	**11.8 mg/l**	**7.6 mg/l**	**2.84 mg/l**	--	**10.3 mg/l**	**9.9 mg/l**	**10.6 mg/l**	**8.50 mg/l**	**10.74 mg/l**	**11.22 mg/l**	**11.09 mg/l**	**11.9 mg/l**	**11.45 mg/l**	--
Fluoride	NA	Lab	**0.1 mg/l**	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 h mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.10 mg/l	< 0.10 mg/l
Hardness, total, as CaCO3	NA	Lab	**53.4 mg/l**	**45.8 mg/l**	**23.0 mg/l**	**23 mg/l**	**24.2 mg/l**	**25.8 mg/l**	**28.8 mg/l**	**29 mg/l**	**26.4 mg/l**	**75.1 mg/l**	**40.4 mg/l**	**33.2 mg/l**	**36.2 mg/l**	**27.5 mg/l**	**21.2 mg/l**	**19.6 mg/l**	**27.2 mg/l**	**28.1 mg/l**
Nitrate + Nitrite, as N	NA	Lab	< 0.1 mg/l	< 0.1 mg/l	**0.11 mg/l**	**0.18 mg/l**	**0.18 mg/l**	**0.35 mg/l**	**0.22 mg/l**	**0.23 mg/l**	**0.21 h mg/l**	**0.13 mg/l**	**0.21 mg/l**	**0.2 mg/l**	**0.27 mg/l**	**0.25 mg/l**	**0.24 mg/l**	**0.25 mg/l**	**0.39 mg/l**	**0.33 mg/l**
Nitrogen, ammonia (NH3), as N	NA	Lab	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.05 mg/l	**0.15 b mg/l**	< 0.05 mg/l	< 0.05 mg/l	< 0.05 mg/l	< 0.1 h mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	**0.099 mg/l**	< 0.050 mg/l
pH	NA	Lab	**7.5 pH units**	**7.5 pH units**	**6.8 pH units**	**6.9 pH units**	**7.1 pH units**	**6.9 pH units**	**6.9 pH units**	**6.5 pH units**	--	**6.9 pH units**	**7.1 pH units**	--	--	--	--	--	--	--
pH	NA	Field	**6.82 pH units**	**6.78 pH units**	**8.01 pH units**	**8.37 pH units**	**9.20 pH units**	**7.3 pH units**	**6.82 pH units**	--	**6.39 pH units**	**6.2 pH units**	**7.4 pH units**	**6.32 pH units**	**7.77 pH units**	**7.81 pH units**	**6.55 pH units**	**8.06 pH units**	**7.1 pH units**	--
Phosphorus, total	NA	Lab	**0.47 mg/l**	**0.25 mg/l**	**0.12 mg/l**	< 0.1 mg P/L	**0.13 mg P/L**	**0.12 mg P/L**	**0.22 mg P/L**	**0.18 mg P/L**	**0.12 h mg P/L**	**1.75 mg P/L**	**0.52 mg P/L**	--	--	--	--	--	--	--
Redox (oxidation potential)	NA	Field	**187.8 mV**	**89 mV**	**203 mV**	**493 mV**	**365 mV**	**257 mV**	**248 mV**	--	**431 mV**	**505 mV**	**399 mV**	**369 mV**	**459 mV**	**480 mV**	**399 mV**	**436 mV**	**367 mV**	--
Solids, total dissolved	NA	Lab	--	--	--	**102 mg/l**	**52 mg/l**	**95 mg/l**	**81.9 mg/l**	**71.9 mg/l**	**98 mg/l**	**114 mg/l**	**94 mg/l**	**202 mg/l**	**125 mg/l**	**76 mg/l**	**78 mg/l**	**88 h mg/l**	**85.0 mg/l**	**77.0 mg/l**
Specific Conductance @ 25oC	NA	Field	**139 umhos/cm**	**73 umhos/cm**	**80 umhos/cm**	**70 umhos/cm**	**63.2 umhos/cm**	**76.4 umhos/cm**	**66 umhos/cm**	--	**49.7 umhos/cm**	**24 umhos/cm**	**50 umhos/cm**	**53 umhos/cm**	**56.4 umhos/cm**	**52 umhos/cm**	**52 umhos/cm**	**46.1 umhos/cm**	**77.1 umhos/cm**	--
Sulfate	NA	Lab	**13.8 mg/l**	**10.4 mg/l**	**7.38 mg/l**	**12.6 mg/l**	**8.99 mg/l**	**16.9 mg/l**	**11.6 mg/l**	**11 mg/l**	**11.8 h mg/l**	**8.74 mg/l**	**7.17 mg/l**	**9.54 mg/l**	**11 mg/l**	**9.81 mg/l**	**8.83 mg/l**	**7.82 mg/l**	**19.7 mg/l**	**19.6 mg/l**
Temperature, degrees C	NA	Field	**4.20 deg C**	**9.6 deg C**	**4.7 deg C**	**5.9 deg C**	**10.03 deg C**	**14.1 deg C**	**5.3 deg C**	--	**5.51 deg C**	**17.3 deg C**	**13.4 deg C**	**11.35 deg C**	**11.78 deg C**	**9.29 deg C**	**11.36 deg C**	**8.92 deg C**	**10.03 deg C**	--
Turbidity	NA	Field	--	--	**133 NTU**	**1 NTU**	**470 NTU**	**54.7 NTU**	**18 NTU**	--	**148.9 NTU**	**860.0 NTU**	**339.4 NTU**	**140.40 NTU**	**311.8 NTU**	**105.6 NTU**	**85.6 NTU**	**41.4 NTU**	**24.5 NTU**	--
Metals																				
Aluminum	Dissolved	Lab	**910 * ug/l**	**430 ug/l**	**373 ug/l**	**154 ug/l**	**296 ug/l**	**511 ug/l**	**466 ug/l**	**411 ug/l**	**311 ug/l**	**214 ug/l**	**102 ug/l**	**139 ug/l**	**135 ug/l**	**205 ug/l**	**225 ug/l**	**258 ug/l**	**383 ug/l**	**301 ug/l**
Aluminum	Total	Lab	**4640 ug/l**	**27100 ug/l**	**4200 ug/l**	**5360 ug/l**	**6550 ug/l**	**5620 ug/l**	**9940 ug/l**	**9950 ug/l**	**5940 ug/l**	**32300 ug/l**	**16500 ug/l**	--	--	--	--	--	--	--
Antimony	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l
Antimony	Total	Lab	< 3 ug/l	< 3 ug/l	< 0.5 ug/l	**0.52 ug/l**	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	--	--	--	--	--	--	--
Arsenic	Dissolved	Lab	--	--	--	--	< 1 ug/l	< 1 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l
Arsenic	Total	Lab	**3.4 ug/l**	**4.8 ug/l**	< 2 ug/l	**1.84 ug/l**	**1.88 ug/l**	**1.82 ug/l**	**3.25 ug/l**	**3.34 ug/l**	**2.18 ug/l**	**2.38 ug/l**	**5.84 ug/l**	--	--	--	--	--	--	--
Barium	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Total	Lab	**90.7 ug/l**	**214 ug/l**	**59.2 ug/l**	**65.6 ug/l**	**71.2 ug/l**	**66.2 ug/l**	**98.4 ug/l**	**99.2 ug/l**	**71.3 ug/l**	**301 ug/l**	**159 ug/l**	**133 ug/l**	**121 ug/l**	**79.4 ug/l**	**46.8 ug/l**	**44.8 ug/l**	**43.2 ug/l**	**45.6 ug/l**
Beryllium	Total	Lab	**0.3 ug/l**	**0.7 ug/l**	< 0.2 ug/l	< 0.2 ug/l	**0.22 ug/l**	**0.2 ug/l**	**0.31 ug/l**	**0.31 ug/l**	< 0.2 ug/l	**0.84 ug/l**	**0.53 ug/l**	**0.43 ug/l**	**0.32 ug/l**	**0.23 ug/l**	< 0.20 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l
Boron	Dissolved	Lab	--	--	--	--	--	--	--	--	--	< 50 ug/l	< 50 ug/l	--	--	--	--	--	--	--
Boron	Total	Lab	**40.2 ug/l**	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50.0 ug/l	< 50 ug/l	< 50.0 ug/l	< 50.0 ug/l
Cadmium	Dissolved	Lab	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	**0.21 ug/l**	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.03 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l
Cadmium	Total	Lab	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	**0.28 ug/l**	< 0.2 ug/l	**0.22 ug/l**	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	**0.37 ug/l**	**0.29 ug/l**	--	--	--	--	--	--	--
Calcium	Total	Lab	**12100 ug/l**	**7080 ug/l**	**5190 ug/l**	**5090 ug/l**	**4820 ug/l**	**5960 ug/l**	**5610 ug/l**	**5640 ug/l**	**5490 ug/l**	**12600 ug/l**	**7010 ug/l**	**6240 ug/l**	**7370 ug/l**	**5800 ug/l**	**4800 ug/l**	**4320 ug/l**	**6500 ug/l**	**6800 ug/l**
Chromium	Dissolved	Lab	**2.5 ug/l**	**1.2 ug/l**	**1.7 b ug/l**	< 1 ug/l	**2.2 ug/l**	**2.86 ug/l**	**1.31 ug/l**	**1.29 ug/l**	**1.66 ug/l**	< 1 ug/l	< 1 ug/l	< 1.5 ug/l	< 1 ug/l	**1.99 ug/l**	< 1.0 ug/l	< 1 ug/l	**1.8 ug/l**	**1.6 ug/l**
Chromium	Total	Lab	**28.6 ug/l**	**55 ug/l**	**8.5 ug/l**	**12.4 ug/l**	**16.6 ug/l**	**12.9 ug/l**	**20.6 ug/l**	**21.5 ug/l**	**13.4 ug/l**	**50.6 ug/l**	**39.7 ug/l**	--	--	--	--	--	--	--
Cobalt	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	**0.29 ug/l**	< 0.2 ug/l	< 0.2 ug/l	< 0.50 ug/l	< 0.2 ug/l	**0.22 ug/l**	< 0.20 ug/l
Cobalt	Total	Lab	**5.4 ug/l**	**8.8 ug/l**	**2.9 ug/l**	**3.1 ug/l**	**4.88 ug/l**	**2.83 ug/l**	**4.76 ug/l**	**4.93 ug/l**	**3.49 ug/l**	**23 ug/l**	**10.6 ug/l**	--	--	--	--	--	--	--
Copper	Dissolved	Lab	**18.2 ug/l**	**7.9 ug/l**	**3.2 ug/l**	**5.6 ug/l**	**12.9 ug/l**	**8.1 ug/l**	**6.14 * ug/l**	**9.78 * ug/l**	**3.26 ug/l**	**4.56 ug/l**	**4.26 ug/l**	**3.7 ug/l**	**4.34 ug/l**	**2.88 ug/l**	**2.8 ug/l**	**2.13 ug/l**	**2.5 ug/l**	**2.6 ug/l**
Copper	Total	Lab	**72.2 ug/l**	**99.6 ug/l**	**13.9 ug/l**	**21 ug/l**	**16.8 ug/l**	**17.9 ug/l**	**36 ug/l**	**37.7 ug/l**	**17.4 ug/l**	**81.9 ug/l**	**43.8 ug/l**	--	--	--	--	--	--	--
Iron	Dissolved	Lab	--	--	--	--	**394 ug/l**	**685 ug/l**	**540 ug/l**	**455 ug/l**	**342 ug/l**	**254 ug/l**	**126 ug/l**	**265 b ug/l**	**160 ug/l**	**262 ug/l**	**269 ug/l**	**304 ug/l**	**424 ug/l**	**380 ug/l**
Iron	Total	Lab	**6400 ug/l**	**29800 ug/l**	**5210 ug/l**	**6320 ug/l**	**8600 ug/l**	**5470 ug/l**	**12400 ug/l**	**12500 ug/l**	**7530 ug/l**	**44400 ug/l**	**21500 ug/l**	--	--	--	--	--	--	--
Lead	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Total	Lab	**5.6 ug/l**	**6.1 ug/l**	**1.7 ug/l**	**2.09 ug/l**	**2.15 ug/l**	**1.76 ug/l**	**7.62 ug/l**	**7.68 ug/l**	**2.75 ug/l**	**11.5 ug/l**	**6.38 ug/l**	**5.31 ug/l**	**4.06 ug/l**	**2.43 ug/l**	**1.3 ug/l**	**1.21 ug/l**	**1.7 ug/l**	**1.4 ug/l**
Magnesium	Total	Lab	**5700 ug/l**	**6830 ug/l**	**2430 ug/l**	**2500 ug/l**	**2960 ug/l**	**2640 ug/l**	**3600 ug/l**	**3620 ug/l**	**3080 ug/l**	**10600 ug/l**	**5550 ug/l**	**4290 ug/l**	**4310 ug/l**	**3160 ug/l**	**2300 ug/l**	**2130 ug/l**	**2600 ug/l**	**2700 ug/l**
Manganese	Dissolved	Lab	--	--	--	**16.5 ug/l**	**30.2 ug/l**	**36.7 ug/l**	**23.7 ug/l**	**23.4 ug/l**	**12.7 ug/l**	**11.1 ug/l**	< 10 ug/l	**10.2 ug/l**	**7.67 ug/l**	**8.05 ug/l**	**13.2 ug/l**	**8.7 ug/l**	**12.8 ug/l**	**12.4 ug/l**
Manganese	Total	Lab	**330 ug/l**	**584 ug/l**	**497 ug/l**	**257 ug/l**	**377 ug/l**	**194 ug/l**	**266 ug/l**	**266 ug/l**	**225 ug/l**	**1770 ug/l**	**672 ug/l**	--	--	--	--	--	--	--
Mercury	Total	Lab	**0.0181 ug/l**	**0.0288 ug/l**	**0.0126 ug/l**	**0.0197 ug/l**	**0.0192 ug/l**	**0.0185 ug/l**	**0.0181 ug/l**	**0.0202 ug/l**	**0.0150 ug/l**	**0.0876 ug/l**	**0.0286 ug/l**	**0.0263 ug/l**	**0.0218 ug/l**	**0.0103 ug/l**	**0.0072 ug/l**	**0.0063 ug/l**	**0.0058 ug/l**	**0.0052 ug/l**
Mercury methyl	Total	Lab	**0.000043 ug/l**	**0.000130 ug/l**	**0.00019 ug/l**	< 0.0001 ug/l	**0.00052 ug/l**	**0.00012 ug/l**	--	--	< 0.0001 ug/l	< 0.0001 ug/l	< 0.0001 ug/l	--	--	--	--	--	--	--
Molybdenum	Dissolved	Lab	< 5 ug/l	**8.8 ug/l**	**2.0 ug/l**	**1.99 ug/l**	**2.26 ug/l**	**1.89 ug/l**	**4.76 ug/l**	**3.93 ug/l**	**2.81 ug/l**	**2.78 ug/l**	**2.46 ug/l**	**2.58 ug/l**	**1.56 ug/l**	**1.59 ug/l**	**1.8 ug/l**	**1.83 ug/l**	**1.4 ug/l**	**1.3 ug/l**
Molybdenum	Total	Lab	**12.4 * ug/l**	**12.1 ug/l**	**4.6 ug/l**	**3.96 ug/l**	**4.02 ug/l**	**3.12 ug/l**	**5.65 ug/l**	**5.46 ug/l**	**4.81 ug/l**	**1 ug/l**	**6.46 ug/l**	--	--	--	--	--	--	--
Nickel	Dissolved	Lab	< 2 ug/l	**3 ug/l**	**1.7 ug/l**	**1.93 ug/l**	**2.56 ug/l**	**3.14 ug/l**	**2.77 ug/l**	**1.93 ug/l**	**1.36 ug/l**	**1.32 ug/l**	**1.06 ug/l**	**1.21 ug/l**	**0.97 ug/l**	**1.54 ug/l**	**1.3 ug/l**	**0.96 ug/l**	**1.4 ug/l**	**1.3 ug/l**
Nickel	Total	Lab	**9.6 ug/l**	**40.2 ug/l**	**8.2 ug/l**	**10.1 ug/l**	**11.2 ug/l**	**8.53 ug/l**	**16 ug/l**	**16.7 ug/l**	**10.8 ug/l**	**45.2 ug/l**	**30.2 ug/l**	--	--	--	--	--	--	--
Palladium	Total	Lab	< 25 ug/l	< 0.1 ug/l	< 0.30 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	--	--	--	--	--	--	--
Platinum	Total	Lab	< 25 ug/l	< 0.02 ug/l	< 0.30 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	--	--	--	--	--	--	--
Potassium	Total	Lab	**2100 * ug/l**	**6870 ug/l**	**1720 ug/l**	**1890 ug/l**	**1830 ug/l**	**2010 ug/l**	**2670 ug/l**	**2620 ug/l**	**1830 ug/l**	**5010 ug/l**	**3240 ug/l**	**2810 ug/l**	**2530 ug/l**	**1900 ug/l**	**1500 ug/l**	**1470 ug/l**	**1600 ug/l**	**1700 ug/l**
Selenium	Dissolved	Lab	< 2 ug/l	< 2 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 0.2 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1.0 ug/l	< 1 ug/l	< 1.0 ug/l	< 1.0 ug/l
Selenium	Total	Lab	< 2 ug/l	< 2 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	**0.59 j ug/l**	< 1 ug/l	--	--	--	--	--	--	--
Silver	Dissolved	Lab	< 1 ug/l	< 1 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.50 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l
Silver	Total	Lab	< 1 ug/l	< 1 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	--	--	--	--	--	--	--
Sodium	Total	Lab	**9500 ug/l**	**12000 ug/l**	**6210 ug/l**	**9480 ug/l**	**7420 ug/l**	**7250 ug/l**	**10200 ug/l**	**10300 ug/l**	**8170 ug/l**	**19200 ug/l**	**6270 ug/l**	**6870 ug/l**	**5190 ug/l**	**4870 ug/l**	**4000 ug/l**	**3890 ug/l**	**5500 ug/l**	**5700 ug/l**
Strontium	Total	Lab	**37.7 ug/l**	**65.1 ug/l**	**31.1 ug/l**	**33 ug/l**	**32.2 ug/l**	**38.1 ug/l**	**41 ug/l**	**41 ug/l**	**35 ug/l**	**98.1 ug/l**	**59.4 ug/l**	--	--	--	--	--	--	--
Thallium	Total	Lab	< 2 ug/l	< 2 ug/l	< 0.4 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l
Titanium	Total	Lab	**620 * ug/l**	**1040 ug/l**	**175 ug/l**	**220 ug/l**	**340 ug/l**	**190 ug/l**	**390 ug/l**	**390 ug/l**	**270 ug/l**	**1300 ug/l**	**850 ug/l**	--	--	--	--	--	--	--
Vanadium	Dissolved	Lab												< 10 ug/l	< 10 ug/l	< 10 ug/l	< 5.0 ug/l	< 5 ug/l	< 5.0 ug/l	< 5.0 ug/l
Zinc	Dissolved	Lab	< 10 ug/l	< 25 ug/l	**21.2 b ug/l**	< 6 ug/l	**18 ug/l**	**11.8 ug/l**	**17.6 ug/l**	**18.1 ug/l**	**7.14 ug/l**	**6.08 ug/l**	**7.94 ug/l**	**11 ug/l**	**6.12 ug/l**	< 6 ug/l	**7.0 b ug/l**	< 6 ug/l	< 6.0 ug/l	**6.7 ug/l**
Zinc	Total	Lab	**11.8 ug/l**	**46.3 ug/l**	**17 ug/l**	**15.4 ug/l**	**18.9 ug/l**	**13.4 ug/l**	**20.5 ug/l**	**20.5 ug/l**	**16.6 ug/l**	**64.5 ug/l**	**44.1 ug/l**	--	--	--	--	--	--	--

Large Table 3
Groundwater Data Summary
Mine Site Surficial Aquifer

		Location	MW-05-09	MW-05-09	MW-05-09	MW-05-09	MW-05-09	MW-05-09	MW-05-09		MW-05-09		MW-1	MW-1		MW-1		MW-1	MW-1
		Date	5/8/2012	6/1/2012	7/13/2012	8/21/2012	10/29/2012	4/22/2013	7/30/2013		10/2/2013		11/7/2011	12/8/2011		1/9/2012		2/13/2012	3/19/2012
		Sample Type	N	N	N	N	N	N	N	FD	N	FD	N	N	FD	N	FD	N	N
	Fraction	Analysis Location																	
General Parameters																			
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total	NA	Lab	**16.3 mg/l**	**17.1 mg/l**	**21.0 mg/l**	**19.6 mg/l**	**13.7 mg/l**	**13.6 mg/l**	**21.9 mg/l**	--	**18.8 mg/l**	**16.6 mg/l**	**94.2 mg/l**	**86.5 mg/l**	**86.8 mg/l**	**86.3 mg/l**	**85.9 mg/l**	**87.9 mg/l**	**118 mg/l**
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	**3.9 mg/l**	**5.0 mg/l**	**3.7 mg/l**	**18.6 mg/l**	**3.1 mg/l**	**2.8 mg/l**	**4.7 mg/l**	--	**4.4 mg/l**	**4.2 mg/l**	**3.3 mg/l**	**2.9 mg/l**	**3.2 mg/l**	**3.6 mg/l**	**3.0 mg/l**	**4.01 b mg/l**	**4.15 mg/l**
Carbon, total organic	NA	Lab	**3.5 mg/l**	**4.3 mg/l**	**3.2 mg/l**	**17.3 mg/l**	**2.8 mg/l**	**2.5 mg/l**	**3.5 mg/l**	--	**4.0 mg/l**	**3.2 mg/l**	**2.8 mg/l**	**3.0 mg/l**	**3.2 mg/l**	**2.6 mg/l**	**2.6 mg/l**	**2.61 b mg/l**	**3.52 mg/l**
Chemical Oxygen Demand	NA	Lab	< 10.0 mg/l	**18.9 mg/l**	**42.6 mg/l**	**11.4 mg/l**	**25.4 mg/l**	**23.9 mg/l**	**22.0 mg/l**	--	**41.5 b mg/l**	**39.3 b mg/l**	**10.3 mg/l**	**13.6 mg/l**	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l
Chloride	NA	Lab	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	--	**1.4 mg/l**	**1.5 mg/l**	**2.26 mg/l**	**1.41 mg/l**	**2.41 mg/l**	**2.28 mg/l**	**2.28 mg/l**	**1.94 mg/l**	**1.8 mg/l**
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	**11.72 mg/l**	**10.95 mg/l**	**8.45 mg/l**	**7.59 mg/l**	**9.98 mg/l**	**12.31 mg/l**	**8.57 mg/l**	--	**9.66 mg/l**	--	**1.75 mg/l**	**8.45 mg/l**	--	**2.68 mg/l**	--	**2.37 mg/l**	**1.86 mg/l**
Fluoride	NA	Lab	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	--	< 0.10 mg/l	< 0.10 mg/l	**0.22 mg/l**	**0.25 mg/l**	**0.24 mg/l**	**0.22 mg/l**	**0.22 mg/l**	**0.2 mg/l**	**0.14 mg/l**
Hardness, total, as CaCO3	NA	Lab	**11.0 mg/l**	**10.3 mg/l**	**53.0 mg/l**	**13.8 mg/l**	**16.3 mg/l**	**15.8 mg/l**	**10.9 mg/l**	--	**18.5 mg/l**	**15.5 mg/l**	**93.1 mg/l**	**88.6 mg/l**	**85.1 mg/l**	**82.4 mg/l**	**82.3 mg/l**	**89.8 mg/l**	**107 mg/l**
Nitrate + Nitrite, as N	NA	Lab	**0.19 mg/l**	**0.18 mg/l**	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	**0.16 mg/l**	< 0.10 mg/l	--	< 0.10 mg/l	< 0.10 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l
Nitrogen, ammonia (NH3), as N	NA	Lab	< 0.050 mg/l	< 0.10 mg/l	< 0.10 mg/l	**0.15 b mg/l**	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	--	< 0.10 mg/l	< 0.10 mg/l	< 0.1 mg/l	**0.12 mg/l**	**0.11 mg/l**	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	**0.18 mg/l**
pH	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	**6.62 pH units**	**6.71 pH units**	**6.19 pH units**	**6.11 pH units**	**6.26 pH units**	**6.58 pH units**	**7.58 pH units**	--	**6.39 pH units**	--	**9.20 pH units**	**9.11 pH units**	--	**9.34 pH units**	--	**9.41 pH units**	**10.02 pH units**
Phosphorus, total	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Redox (oxidation potential)	NA	Field	**318 mV**	**327 mV**	**163 mV**	**206 mV**	**206 mV**	**499 mV**	**462 mV**	--	**505 mV**	--	**507 mV**	**348 mV**	--	**361 mV**	--	**409 mV**	**114 mV**
Solids, total dissolved	NA	Lab	**75.0 mg/l**	**77.0 mg/l**	**56.0 mg/l**	**82.0 mg/l**	**53.0 mg/l**	**78.0 mg/l**	**55.0 mg/l**	--	**87.0 * mg/l**	**52.0 * mg/l**	**163 mg/l**	**175 mg/l**	**151 mg/l**	**116 mg/l**	**102 mg/l**	**138 mg/l**	**151 mg/l**
Specific Conductance @ 25oC	NA	Field	**5.7 umhos/cm**	**24.8 umhos/cm**	**44.8 umhos/cm**	**40.9 umhos/cm**	**36 umhos/cm**	**33.9 umhos/cm**	**0 umhos/cm**	--	**42.5 umhos/cm**	--	**190 umhos/cm**	**186.7 umhos/cm**	--	**33.8 umhos/cm**	--	**84 umhos/cm**	**227.6 umhos/cm**
Sulfate	NA	Lab	**8.6 mg/l**	**9.7 mg/l**	**2.9 mg/l**	**5.2 mg/l**	**5.2 mg/l**	**8.0 mg/l**	**4.5 mg/l**	--	**3.9 mg/l**	**3.7 mg/l**	**6.65 mg/l**	**6.81 mg/l**	**6.81 mg/l**	**6.22 mg/l**	**6.2 mg/l**	**6.35 mg/l**	**6.4 mg/l**
Temperature, degrees C	NA	Field	**10.13 deg C**	**16.4 deg C**	**25.09 deg C**	**15.69 deg C**	**11.04 deg C**	**4.21 deg C**	**18.23 deg C**	--	**16.97 deg C**	--	**7.62 deg C**	**10.33 deg C**	--	**4.7 deg C**	--	**1.25 deg C**	**10.45 deg C**
Turbidity	NA	Field	**13 NTU**	**28.7 NTU**	**15.8 NTU**	**17.6 NTU**	**0 NTU**	**29.1 NTU**	**0 NTU**	--	**82.5 NTU**	--	**3.3 NTU**	**0 NTU**	--	**0.2 NTU**	--	**0 NTU**	**0 NTU**
Metals																			
Aluminum	Dissolved	Lab	**306 ug/l**	**240 ug/l**	**36.2 ug/l**	**313 ug/l**	**135 ug/l**	**201 ug/l**	**319 ug/l**	--	**363 ug/l**	**381 ug/l**	**47.3 ug/l**	**26.4 ug/l**	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25.0 ug/l	< 20 ug/l
Aluminum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.5 ug/l
Antimony	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	**1.25 ug/l**	**0.97 ug/l**	**0.98 ug/l**	**1.02 ug/l**	**1.01 ug/l**	**0.86 ug/l**	**0.92 ug/l**
Arsenic	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Total	Lab	**19.6 ug/l**	**22.9 ug/l**	**138 ug/l**	**23.7 ug/l**	**28.4 ug/l**	**30.3 ug/l**	**17.0 ug/l**	--	**49.9 * ug/l**	**30.9 * ug/l**	**15.9 ug/l**	**14.1 ug/l**	**13.9 ug/l**	**11.2 ug/l**	**11.2 ug/l**	**11.6 ug/l**	**25.3 ug/l**
Beryllium	Total	Lab	< 0.20 ug/l	< 0.20 ug/l	**0.36 ug/l**	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.2 ug/l
Boron	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	Total	Lab	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	--	< 50.0 ug/l	< 50.0 ug/l	**70.6 ug/l**	**69.9 ug/l**	**66.4 ug/l**	**77 ug/l**	**72 ug/l**	**65.6 ug/l**	**61.7 ug/l**
Cadmium	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	**0.25 ug/l**	**0.22 ug/l**	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.2 ug/l
Cadmium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Calcium	Total	Lab	**2700 ug/l**	**2400 ug/l**	**11600 ug/l**	**3300 ug/l**	**4100 ug/l**	**3800 ug/l**	**2700 ug/l**	--	**4100 ug/l**	**3800 ug/l**	**26600 ug/l**	**25000 ug/l**	**24000 ug/l**	**22000 ug/l**	**22000 ug/l**	**24300 ug/l**	**32900 ug/l**
Chromium	Dissolved	Lab	**1.8 b ug/l**	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	**1.0 ug/l**	--	**1.1 ug/l**	**1.1 ug/l**	< 1.5 ug/l	**1.36 ug/l**	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1.0 ug/l	< 1 ug/l
Chromium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	Dissolved	Lab	**0.21 ug/l**	**0.23 ug/l**	< 0.20 ug/l	**0.23 ug/l**	< 0.20 ug/l	< 0.20 ug/l	**0.28 ug/l**	--	**0.28 ug/l**	**0.27 ug/l**	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.50 ug/l	< 0.2 ug/l
Cobalt	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	Dissolved	Lab	**3.3 ug/l**	**3.5 ug/l**	**1.3 ug/l**	**2.9 ug/l**	**1.7 ug/l**	**1.8 ug/l**	**3.3 ug/l**	--	**5.6 * ug/l**	**3.6 * ug/l**	**1.39 ug/l**	**0.94 b ug/l**	**0.89 b ug/l**	**0.84 ug/l**	**1.99 ug/l**	< 0.70 ug/l	**3.85 ug/l**
Copper	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Iron	Dissolved	Lab	**328 ug/l**	**271 ug/l**	< 50.0 ug/l	**354 ug/l**	**170 ug/l**	**214 ug/l**	**356 ug/l**	--	**421 ug/l**	**455 ug/l**	**66 ug/l**	< 50 ug/l	< 50 ug/l	**59 ug/l**	< 50 ug/l	< 50.0 ug/l	< 50 ug/l
Iron	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Total	Lab	**0.54 ug/l**	**0.67 ug/l**	**5.1 ug/l**	**0.61 ug/l**	**0.67 ug/l**	**0.69 ug/l**	< 0.50 ug/l	--	**1.9 ug/l**	**1.1 ug/l**	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.5 ug/l
Magnesium	Total	Lab	**1000 ug/l**	**1000 ug/l**	**5800 ug/l**	**1300 ug/l**	**1500 ug/l**	**1500 ug/l**	**1000 ug/l**	--	**2000 ug/l**	**1500 ug/l**	**6480 ug/l**	**6360 ug/l**	**6110 ug/l**	**6680 ug/l**	**6650 ug/l**	**7100 ug/l**	**6140 ug/l**
Manganese	Dissolved	Lab	**10.5 ug/l**	**11.1 ug/l**	**25.3 ug/l**	**14.0 ug/l**	**9.7 ug/l**	**6.6 ug/l**	**16.1 ug/l**	--	**14.8 ug/l**	**16.6 ug/l**	**60.3 ug/l**	**65.4 ug/l**	**66.4 ug/l**	**71.6 ug/l**	**72.6 ug/l**	**79.4 ug/l**	**28.1 ug/l**
Manganese	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	Total	Lab	**0.0052 ug/l**	**0.0059 ug/l**	**0.0052 ug/l**	**0.0052 ug/l**	**0.0057 ug/l**	**0.0069 ug/l**	**0.0064 ug/l**	**0.0065 ug/l**	**0.0108 * ug/l**	**0.0076 * ug/l**	< 0.0005 ug/l	< 0.0005 ug/l	< 0.0005 ug/l	< 0.0005 ug/l	< 0.0005 ug/l	< 0.0005 ug/l	< 0.0005 ug/l
Mercury methyl	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Dissolved	Lab	**2.0 ug/l**	**3.4 ug/l**	**0.22 ug/l**	**1.5 ug/l**	**1.1 ug/l**	**1.3 ug/l**	**1.9 ug/l**	--	**1.7 ug/l**	**1.3 ug/l**	**4.57 ug/l**	**2.26 ug/l**	**2.29 ug/l**	**2 ug/l**	**1.97 ug/l**	**1.3 ug/l**	**1.78 ug/l**
Molybdenum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	Dissolved	Lab	**1.4 ug/l**	**1.3 ug/l**	**0.80 ug/l**	**1.3 ug/l**	**1.1 ug/l**	**1.1 ug/l**	**1.3 ug/l**	--	**1.5 ug/l**	**1.4 ug/l**	**2.53 ug/l**	**1.33 ug/l**	**0.66 ug/l**	< 0.6 ug/l	< 0.6 ug/l	**0.72 ug/l**	**2.13 ug/l**
Nickel	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	**870 ug/l**	**910 ug/l**	**3400 ug/l**	**1200 ug/l**	**1000 ug/l**	**1000 ug/l**	**980 ug/l**	--	**2100 ug/l**	**1300 ug/l**	**3020 ug/l**	**2290 ug/l**	**2180 ug/l**	**1810 ug/l**	**1820 ug/l**	**1700 ug/l**	**3610 ug/l**
Selenium	Dissolved	Lab	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	< 1.0 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1.0 ug/l	< 1 ug/l
Selenium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.50 ug/l	< 0.2 ug/l
Silver	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sodium	Total	Lab	**6700 ug/l**	**8600 ug/l**	**4900 ug/l**	**6500 ug/l**	**2600 ug/l**	**4200 ug/l**	**7800 ug/l**	--	**7300 * ug/l**	**5100 * ug/l**	**5900 ug/l**	**6500 ug/l**	**6230 ug/l**	**6350 ug/l**	**6370 ug/l**	**6600 ug/l**	**10700 ug/l**
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab	< 0.20 ug/l	< 0.20 ug/l	**0.21 ug/l**	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.017 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.2 ug/l
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Dissolved	Lab	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	--	< 5.0 ug/l	< 5.0 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 5.0 ug/l	< 5 ug/l
Zinc	Dissolved	Lab	< 6.0 ug/l	**6.4 ug/l**	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	--	**9.2 ug/l**	**8.1 ug/l**	**7.2 ug/l**	< 6 ug/l	< 6 ug/l	**6.48 ug/l**	< 6 ug/l	< 6.0 ug/l	< 6 ug/l
Zinc	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Large Table 3
Groundwater Data Summary
Mine Site Surficial Aquifer

Location			MW-1		MW-1		MW-1	MW-1	MW-1	MW-1		MW-1		MW-1	MW-1	MW-2	MW-2		MW-2	
Date			4/18/2012		5/4/2012		6/13/2012	7/26/2012	8/27/2012	10/19/2012		5/8/2013		7/23/2013	10/17/2013	11/9/2011	12/6/2011		1/4/2012	
Sample Type			N	FD	N	FD	N	N	N	N	FD	N	FD	N	N	N	N	FD	N	FD
	Fraction	Analysis Location																		
General Parameters																				
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total	NA	Lab	**96.8 mg/l**	**97.2 mg/l**	**88.0 mg/l**	**87.9 mg/l**	**86.2 mg/l**	**83.1 mg/l**	**80.5 mg/l**	**91.2 mg/l**	**88.4 mg/l**	**94.8 mg/l**	--	**88.3 mg/l**	**85.7 mg/l**	**111 BQS mg/l**	**138 mg/l**	**138 mg/l**	**141 mg/l**	**140 mg/l**
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	**3.1 mg/l**	**2.8 mg/l**	**2.8 mg/l**	**2.7 mg/l**	**2.8 mg/l**	**1.9 mg/l**	**2.3 mg/l**	**2.2 mg/l**	**2.3 mg/l**	**3.5 mg/l**	--	**2.8 mg/l**	**2.2 mg/l**	**5.2 BQS mg/l**	**6.6 mg/l**	**7.4 mg/l**	**6.1 mg/l**	**5.7 mg/l**
Carbon, total organic	NA	Lab	**2.6 mg/l**	**2.7 mg/l**	**2.4 mg/l**	**2.3 mg/l**	**2.3 mg/l**	**2.7 mg/l**	**2.4 mg/l**	**2.0 mg/l**	**2.1 mg/l**	**2.2 mg/l**	--	**2.3 mg/l**	**2.2 mg/l**	**5.2 BQS mg/l**	**5.9 mg/l**	**6.7 mg/l**	**5.6 mg/l**	**5.4 mg/l**
Chemical Oxygen Demand	NA	Lab	**22.8 mg/l**	**24.6 mg/l**	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	**10.3 mg/l**	< 10.0 mg/l	**10.1 mg/l**	**10.1 mg/l**	--	**15.4 mg/l**	**12.1 b mg/l**	**27.4 BQS mg/l**	**25.3 mg/l**	**22.5 mg/l**	**20.4 mg/l**	**20.9 mg/l**
Chloride	NA	Lab	**1.7 mg/l**	**1.7 mg/l**	**1.8 mg/l**	**1.8 mg/l**	**1.8 mg/l**	**2.1 mg/l**	**2.4 mg/l**	**2.5 mg/l**	**2.5 mg/l**	**1.9 mg/l**	--	**2.0 mg/l**	**2.6 mg/l**	**1.26 BQS mg/l**	**1.29 mg/l**	**1.27 mg/l**	**1.2 mg/l**	**1.13 mg/l**
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	**1.73 mg/l**	--	**2.1 mg/l**	--	**1.86 mg/l**	**2.1 mg/l**	**2.23 mg/l**	**1.88 mg/l**	--	**0.02 mg/l**	--	< 0.1 mg/l	**0.11 mg/l**	**7.12 BQS mg/l**	**8.02 mg/l**	--	**8 mg/l**	--
Fluoride	NA	Lab	**0.18 mg/l**	**0.17 mg/l**	**0.20 mg/l**	**0.21 mg/l**	**0.19 mg/l**	**0.18 mg/l**	**0.22 mg/l**	**0.24 mg/l**	**0.24 mg/l**	**0.20 mg/l**	--	**0.18 mg/l**	**0.19 mg/l**	< 0.1 BQS mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l
Hardness, total, as CaCO3	NA	Lab	**92.2 mg/l**	**94.2 mg/l**	**83.8 mg/l**	**86.0 mg/l**	**81.3 mg/l**	**80.2 mg/l**	**78.3 mg/l**	**80.7 mg/l**	**80.4 mg/l**	**86.4 mg/l**	--	**85.1 mg/l**	**76.9 mg/l**	**148 BQS mg/l**	**143 mg/l**	**144 mg/l**	**145 mg/l**	**148 mg/l**
Nitrate + Nitrite, as N	NA	Lab	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	--	< 0.10 mg/l	< 0.10 mg/l	< 0.1 BQS mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l
Nitrogen, ammonia (NH3), as N	NA	Lab	**0.13 b mg/l**	**0.19 b mg/l**	**0.10 mg/l**	**0.10 mg/l**	**0.10 mg/l**	< 0.10 mg/l	**0.15 mg/l**	**0.14 mg/l**	**0.13 mg/l**	**0.15 mg/l**	--	**0.19 mg/l**	**0.16 mg/l**	< 0.1 BQS mg/l	**0.11 mg/l**	**0.13 mg/l**	< 0.1 mg/l	< 0.1 mg/l
pH	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	**9.46 pH units**	--	**9.32 pH units**	--	**8.79 pH units**	**8.63 pH units**	**8.25 pH units**	**8.85 pH units**	--	**9.35 pH units**	--	**9.08 pH units**	**9.06 pH units**	**76 BQS pH unit**	**7.34 pH units**	--	**7.1 pH units**	--
Phosphorus, total	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Redox (oxidation potential)	NA	Field	**311 mV**	--	--	--	**165 mV**	**163 mV**	**242 mV**	**216 mV**	--	**415 mV**	--	**273 mV**	**98 mV**	**387 BQS mV**	**476 mV**	--	**448 mV**	--
Solids, total dissolved	NA	Lab	**157 mg/l**	**152 mg/l**	**148 mg/l**	**152 mg/l**	**152 mg/l**	**142 mg/l**	**139 mg/l**	**147 mg/l**	**164 mg/l**	**131 mg/l**	--	**162 mg/l**	**147 mg/l**	**183 BQS mg/l**	**209 mg/l**	**201 mg/l**	**188 mg/l**	**202 mg/l**
Specific Conductance @ 25oC	NA	Field	**190.3 umhos/cm**	--	**43.8 umhos/cm**	--	**140 umhos/cm**	**173.9 umhos/cm**	**177.3 umhos/cm**	**77.7 umhos/cm**	--	**172.2 umhos/cm**	--	**185.7 umhos/cm**	**178 umhos/cm**	**5.1 BQS umhos/c**	**306.9 umhos/cm**	--	**284.2 umhos/cm**	--
Sulfate	NA	Lab	**5.7 mg/l**	**5.8 mg/l**	**6.3 mg/l**	**6.3 mg/l**	**6.4 mg/l**	**6.7 mg/l**	**6.6 mg/l**	**6.4 mg/l**	**6.4 mg/l**	**6.1 mg/l**	--	**6.1 mg/l**	**6.4 mg/l**	**9.24 BQS mg/l**	**8.34 mg/l**	**8.34 mg/l**	**6.09 mg/l**	**6.06 mg/l**
Temperature, degrees C	NA	Field	**4.11 deg C**	--	**5.17 deg C**	--	**11.73 deg C**	**12.63 deg C**	**12.31 deg C**	**8.93 deg C**	--	**5.15 deg C**	--	**10.21 deg C**	**9.33 deg C**	**8.71 BQS deg C**	**13.86 deg C**	--	**11.09 deg C**	--
Turbidity	NA	Field	**0 NTU**	--	**0 NTU**	--	**0 NTU**	**0 NTU**	**0 NTU**	**1.4 NTU**	--	**0 NTU**	--	**0 NTU**	**0 NTU**	**214.2 BQS NTU**	**75.5 NTU**	--	**59.3 NTU**	--
Metals																				
Aluminum	Dissolved	Lab	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	**22.6 ug/l**	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	--	**21.6 ug/l**	< 20.0 ug/l	**6510 BQS ug/l**	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l
Aluminum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	< 0.5 BQS ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l
Antimony	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	Dissolved	Lab	**0.85 ug/l**	**0.74 ug/l**	**0.92 ug/l**	**0.94 ug/l**	**1.1 ug/l**	**1.1 ug/l**	**0.90 ug/l**	**1.0 ug/l**	**1.1 ug/l**	**0.58 ug/l**	--	< 0.50 ug/l	**1.0 ug/l**	**3.17 BQS ug/l**	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l
Arsenic	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Total	Lab	**15.9 ug/l**	**16.1 ug/l**	**10.8 ug/l**	**10.9 ug/l**	**10.0 ug/l**	**9.8 ug/l**	**7.7 ug/l**	**9.1 ug/l**	**9.0 ug/l**	**8.4 ug/l**	--	**8.2 ug/l**	**8.3 ug/l**	**154 BQS ug/l**	**83.4 ug/l**	**83.6 ug/l**	**80.2 ug/l**	**81.1 ug/l**
Beryllium	Total	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	**0.35 BQS ug/l**	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l
Boron	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	Total	Lab	**61.7 ug/l**	**61.9 ug/l**	**63.4 ug/l**	**60.1 ug/l**	**67.2 ug/l**	**67.7 ug/l**	**83.0 ug/l**	**80.0 ug/l**	**77.2 ug/l**	**58.7 ug/l**	--	**78.5 ug/l**	**99.4 ug/l**	< 50 BQS ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l
Cadmium	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	< 0.2 BQS ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l
Cadmium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Calcium	Total	Lab	**26600 ug/l**	**27200 ug/l**	**22800 ug/l**	**23700 ug/l**	**21900 ug/l**	**22200 ug/l**	**21000 ug/l**	**22500 ug/l**	**22400 ug/l**	**25100 ug/l**	--	**24100 ug/l**	**21600 ug/l**	**34800 BQS ug/l**	**35100 ug/l**	**35500 ug/l**	**34900 ug/l**	**35600 ug/l**
Chromium	Dissolved	Lab	< 1.0 ug/l	< 1.0 ug/l	**2.0 ug/l**	**1.9 b ug/l**	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	< 1.0 ug/l	**19.3 BQS ug/l**	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l
Chromium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	**5.95 BQS ug/l**	**1.77 ug/l**	**1.71 ug/l**	**1.75 ug/l**	**1.77 ug/l**
Cobalt	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	Dissolved	Lab	**0.64 ug/l**	**1.5 ug/l**	**1.1 ug/l**	**0.81 ug/l**	**0.56 ug/l**	**1.0 ug/l**	< 0.50 ug/l	**0.76 ug/l**	**0.79 ug/l**	**0.58 ug/l**	--	**0.56 ug/l**	**0.66 ug/l**	**21 BQS ug/l**	**7 * ug/l**	**3.48 * ug/l**	**3.17 ug/l**	**2.93 ug/l**
Copper	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Iron	Dissolved	Lab	< 50.0 ug/l	< 50.0 ug/l	**90.3 b ug/l**	**76.0 b ug/l**	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	--	< 50.0 ug/l	< 50.0 ug/l	**11600 BQS ug/l**	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l
Iron	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Total	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	**4.75 BQS ug/l**	**1.26 ug/l**	**1.03 ug/l**	**0.86 ug/l**	**0.88 ug/l**
Magnesium	Total	Lab	**6300 ug/l**	**6400 ug/l**	**6500 ug/l**	**6500 ug/l**	**6500 ug/l**	**6000 ug/l**	**6300 ug/l**	**6000 ug/l**	**6000 ug/l**	**5800 ug/l**	--	**6100 ug/l**	**5600 ug/l**	**14800 BQS ug/l**	**13500 ug/l**	**13500 ug/l**	**14100 ug/l**	**14400 ug/l**
Manganese	Dissolved	Lab	**42.1 ug/l**	**41.1 ug/l**	**45.6 ug/l**	**44.5 ug/l**	**50.4 ug/l**	**52.7 ug/l**	**56.1 ug/l**	**57.4 ug/l**	**57.9 ug/l**	**25.6 ug/l**	--	**43.9 ug/l**	**52.4 ug/l**	**1450 BQS ug/l**	**1770 ug/l**	**1770 ug/l**	**1900 ug/l**	**1920 ug/l**
Manganese	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	Total	Lab	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	**0.00070 ug/l**	**0.00095 ug/l**	< 0.00050 ug/l	< 0.00050 ug/l	**0.0113 BQS ug/l**	**0.0029 ug/l**	**0.0029 ug/l**	**0.0018 ug/l**	**0.0020 ug/l**
Mercury methyl	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Dissolved	Lab	**1.5 ug/l**	**1.4 ug/l**	**1.2 ug/l**	**1.2 ug/l**	**0.86 ug/l**	**1.0 b ug/l**	**0.87 ug/l**	**1.1 ug/l**	**1.1 ug/l**	**1.0 ug/l**	--	**1.0 ug/l**	**1.0 ug/l**	**2.45 BQS ug/l**	**1.8 ug/l**	**1.74 ug/l**	**1.63 ug/l**	**1.54 ug/l**
Molybdenum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	Dissolved	Lab	**0.58 ug/l**	**0.64 ug/l**	**0.56 ug/l**	**0.53 ug/l**	< 0.50 ug/l	**0.76 ug/l**	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	**18.5 BQS ug/l**	**3.82 ug/l**	**3.64 ug/l**	**3.54 ug/l**	**3.61 ug/l**
Nickel	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	**2500 ug/l**	**2600 ug/l**	**1800 ug/l**	**1800 ug/l**	**1700 ug/l**	**1700 ug/l**	**1500 ug/l**	**1700 ug/l**	**1700 ug/l**	**1900 ug/l**	--	**1800 ug/l**	**1800 ug/l**	**3890 BQS ug/l**	**2730 ug/l**	**2750 ug/l**	**2390 ug/l**	**2430 ug/l**
Selenium	Dissolved	Lab	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	< 1.0 ug/l	< 1 BQS ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l
Selenium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	< 0.2 BQS ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l
Silver	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sodium	Total	Lab	**7600 ug/l**	**7900 ug/l**	**6900 ug/l**	**6800 ug/l**	**6600 ug/l**	**7200 ug/l**	**6600 ug/l**	**7600 ug/l**	**7500 ug/l**	**8200 ug/l**	--	**7600 ug/l**	**7500 ug/l**	**6460 BQS ug/l**	**5200 ug/l**	**5190 ug/l**	**5080 ug/l**	**5160 ug/l**
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.017 ug/l	< 0.20 ug/l	< 0.2 BQS ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Dissolved	Lab	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	--	< 5.0 ug/l	< 5.0 ug/l	**17.3 BQS ug/l**	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l
Zinc	Dissolved	Lab	< 6.0 ug/l	< 6.0 ug/l	**7.2 ug/l**	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	--	< 6.0 ug/l	< 6.0 ug/l	**24.4 BQS ug/l**	**6.61 ug/l**	**9.15 ug/l**	< 6 ug/l	< 6 ug/l
Zinc	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Large Table 3
Groundwater Data Summary
Mine Site Surficial Aquifer

Location			MW-2	MW-2	MW-2	MW-2		MW-2		MW-2	MW-2	MW-2	MW-2	MW-2		MW-3	MW-3	
Date			3/27/2012	4/9/2012	5/8/2012	6/11/2012		7/13/2012		8/14/2012	10/26/2012	4/25/2013	7/25/2013	10/1/2013		11/8/2011	12/12/2011	
Sample Type			N	N	N	N	FD	N	FD	N	N	N	N	N	FD	N	N	FD
	Fraction	Analysis Location																
General Parameters																		
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total	NA	Lab	**126 mg/l**	**114 mg/l**	**70.6 mg/l**	**77.6 mg/l**	**78.0 mg/l**	**109 mg/l**	**108 mg/l**	**148 mg/l**	**146 mg/l**	**115 mg/l**	**86.8 mg/l**	**106 mg/l**	**114 mg/l**	**37 mg/l**	**37.0 mg/l**	**36.9 mg/l**
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	**6.5 mg/l**	**5.8 mg/l**	**53.9 mg/l**	**39.7 mg/l**	**38.5 mg/l**	**5.3 mg/l**	**5.5 mg/l**	**6.4 mg/l**	**5.9 mg/l**	**3.8 mg/l**	**4.4 mg/l**	**19.1 * mg/l**	**4.1 * mg/l**	**1.9 mg/l**	**2.3 mg/l**	**2.1 mg/l**
Carbon, total organic	NA	Lab	**5.4 mg/l**	**5.3 mg/l**	**57.6 mg/l**	**38.6 mg/l**	**38.8 mg/l**	**4.5 mg/l**	**4.4 mg/l**	**5.9 mg/l**	**5.6 mg/l**	**3.3 mg/l**	**3.4 mg/l**	**3.7 mg/l**	**3.7 mg/l**	**1.6 mg/l**	**2.3 mg/l**	**1.8 mg/l**
Chemical Oxygen Demand	NA	Lab	**26 mg/l**	**22.6 mg/l**	**242 mg/l**	**173 mg/l**	**178 mg/l**	**39.2 mg/l**	**28.3 mg/l**	**29.6 mg/l**	**46.7 mg/l**	**30.8 mg/l**	**28.0 mg/l**	**54.4 b mg/l**	**50.0 b mg/l**	< 10 mg/l	**11.8 mg/l**	< 10 mg/l
Chloride	NA	Lab	**0.77 mg/l**	**0.68 mg/l**	< 0.50 mg/l	**0.67 mg/l**	**0.67 mg/l**	**0.51 mg/l**	**0.51 mg/l**	**0.66 mg/l**	**0.60 mg/l**	< 0.50 mg/l	< 0.50 mg/l	< 1.0 mg/l	< 1.0 mg/l	< 0.5 mg/l	< 0.5 mg/l	< 0.5 mg/l
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	**10.46 mg/l**	**9.57 mg/l**	**8.18 mg/l**	**6.73 mg/l**	--	**7.42 mg/l**	--	**6.3 mg/l**	**6.47 mg/l**	**7.47 mg/l**	**8.05 mg/l**	**5.56 mg/l**	--	**5.01 mg/l**	**6.46 mg/l**	--
Fluoride	NA	Lab	< 0.1 mg/l	< 0.10 mg/l	**0.18 mg/l**	**0.13 mg/l**	**0.12 mg/l**	**0.10 mg/l**	**0.10 mg/l**	**0.10 mg/l**	**0.15 mg/l**	< 0.10 mg/l	**0.14 mg/l**	**0.13 mg/l**	**0.12 mg/l**	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l
Hardness, total, as CaCO3	NA	Lab	**140 mg/l**	**117 mg/l**	**34.6 mg/l**	**51.3 mg/l**	**51.7 mg/l**	**80.2 mg/l**	**79.0 mg/l**	**126 mg/l**	**154 mg/l**	**120 mg/l**	**68.8 mg/l**	**92.9 mg/l**	**100 mg/l**	**45.5 mg/l**	**43.9 mg/l**	**44.8 mg/l**
Nitrate + Nitrite, as N	NA	Lab	**0.1 b mg/l**	**0.12 mg/l**	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	**0.12 mg/l**	< 0.10 mg/l	**0.14 mg/l**	< 0.10 mg/l	**0.11 mg/l**	**0.4 mg/l**	**0.34 mg/l**	**0.34 mg/l**
Nitrogen, ammonia (NH3), as N	NA	Lab	< 0.1 mg/l	**0.15 mg/l**	< 0.050 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	**0.18 mg/l**	< 0.10 mg/l	< 0.10 mg/l	**0.59 mg/l**	< 0.10 mg/l	< 0.10 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l
pH	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	**6.52 pH units**	**6.74 pH units**	**7.69 pH units**	**7.22 pH units**	--	**6.95 pH units**	--	**6.54 pH units**	**6.51 pH units**	**6.75 pH units**	**6.89 pH units**	**8.1 pH units**	--	**6.27 pH units**	**6.58 pH units**	--
Phosphorus, total	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Redox (oxidation potential)	NA	Field	**523 mV**	**373 mV**	**299 mV**	**313 mV**	--	**157 mV**	--	**320 mV**	**171 mV**	**567 mV**	**370 mV**	**447 mV**	--	**308 mV**	**400 mV**	--
Solids, total dissolved	NA	Lab	**179 mg/l**	**173 mg/l**	**159 mg/l**	**142 mg/l**	**129 mg/l**	**136 mg/l**	**149 mg/l**	**200 mg/l**	**189 mg/l**	**150 mg/l**	**135 mg/l**	**143 mg/l**	**169 mg/l**	**107 mg/l**	**86 mg/l**	**97 mg/l**
Specific Conductance @ 25oC	NA	Field	**257.2 umhos/cm**	**256.4 umhos/cm**	**#1.5 umhos/cr**	**136.4 umhos/cm**	--	**42.1 umhos/cr**	--	**263.1 umhos/cm**	**286.4 umhos/cm**	**223.5 umhos/cm**	**189.4 umhos/cm**	**188.7 umhos/cm**	--	**113.3 umhos/cm**	**101.7 umhos/cm**	--
Sulfate	NA	Lab	**5.89 mg/l**	**12.9 mg/l**	**17.5 mg/l**	**7.9 mg/l**	**7.8 mg/l**	**6.7 mg/l**	**6.7 mg/l**	**2.3 mg/l**	**2.1 mg/l**	**6.8 mg/l**	**7.3 mg/l**	**2.9 mg/l**	**2.4 mg/l**	**11.8 mg/l**	**11.2 mg/l**	**11.1 mg/l**
Temperature, degrees C	NA	Field	**8.17 deg C**	**10.77 deg C**	**10.67 deg C**	**16.47 deg C**	--	**23.45 deg C**	--	**15.14 deg C**	**5.16 deg C**	**4.67 deg C**	**16.72 deg C**	**12.25 deg C**	--	**8.78 deg C**	**4.82 deg C**	--
Turbidity	NA	Field	**134 NTU**	**88.8 NTU**	**88.4 NTU**	**25.8 NTU**	--	**67.5 NTU**	--	**287.5 NTU**	**84.4 NTU**	**185.9 NTU**	**81.8 NTU**	**323 NTU**	--	**19.6 NTU**	**0 NTU**	--
Metals																		
Aluminum	Dissolved	Lab	< 20 ug/l	< 20.0 ug/l	**51.1 ug/l**	**27.6 ug/l**	**20.9 ug/l**	< 20.0 ug/l	< 20.0 ug/l	**77.9 ug/l**	**26.6 ug/l**	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l
Aluminum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	Dissolved	Lab	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l
Antimony	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	Dissolved	Lab	< 0.5 ug/l	< 0.50 ug/l	**1.7 ug/l**	**1.2 ug/l**	**1.1 ug/l**	**1.3 ug/l**	**1.3 ug/l**	< 0.50 ug/l	**0.64 ug/l**	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l
Arsenic	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Total	Lab	**99.8 ug/l**	**72.7 ug/l**	**43.0 ug/l**	**27.3 ug/l**	**28.7 ug/l**	**57.0 ug/l**	**55.6 ug/l**	**85.6 ug/l**	**119 ug/l**	**94.2 ug/l**	**47.0 ug/l**	**85.0 ug/l**	**96.3 ug/l**	**28.3 ug/l**	**18.6 ug/l**	**19.7 ug/l**
Beryllium	Total	Lab	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	**0.28 ug/l**	< 0.20 ug/l	< 0.20 ug/l	**0.23 ug/l**	**0.26 ug/l**	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l
Boron	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	Total	Lab	< 50 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l
Cadmium	Dissolved	Lab	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l
Cadmium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Calcium	Total	Lab	**33100 ug/l**	**27800 ug/l**	**8600 ug/l**	**14500 ug/l**	**14400 ug/l**	**21300 ug/l**	**21000 ug/l**	**31700 ug/l**	**37400 ug/l**	**28900 ug/l**	**19300 ug/l**	**23200 ug/l**	**25200 ug/l**	**10800 ug/l**	**10500 ug/l**	**10700 ug/l**
Chromium	Dissolved	Lab	< 1 ug/l	**3.0 ug/l**	**2.1 b ug/l**	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.5 ug/l	< 1 ug/l	< 1 ug/l
Chromium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	Dissolved	Lab	**1.09 ug/l**	**0.95 ug/l**	**0.31 ug/l**	**0.41 ug/l**	**0.42 ug/l**	**1.1 ug/l**	**1.2 ug/l**	< 0.20 ug/l	**1.9 ug/l**	**0.83 ug/l**	< 0.20 ug/l	**0.50 ug/l**	**0.59 ug/l**	**0.54 ug/l**	**0.36 ug/l**	**0.35 ug/l**
Cobalt	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	Dissolved	Lab	**3.51 ug/l**	**4.6 ug/l**	**4.8 ug/l**	**1.8 ug/l**	**1.4 ug/l**	**0.72 ug/l**	**0.92 ug/l**	**1.6 ug/l**	**1.0 ug/l**	**2.3 ug/l**	**1.9 ug/l**	**2.9 ug/l**	**2.5 ug/l**	**3.86 ug/l**	**1.54 ug/l**	**1.06 ug/l**
Copper	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Iron	Dissolved	Lab	**60.9 ug/l**	**57.0 ug/l**	**109 ug/l**	< 50.0 ug/l	< 50.0 ug/l	**293 ug/l**	**319 ug/l**	**89.0 ug/l**	**530 ug/l**	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	**63 ug/l**	< 50 ug/l	< 50 ug/l
Iron	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Total	Lab	**1.95 ug/l**	**1.6 ug/l**	**1.8 ug/l**	**0.57 ug/l**	**0.64 ug/l**	**1.1 ug/l**	**1.1 ug/l**	**1.4 ug/l**	**3.0 ug/l**	**2.2 ug/l**	**1.1 ug/l**	**2.4 ug/l**	**2.8 ug/l**	**0.54 ug/l**	< 0.5 ug/l	< 0.5 ug/l
Magnesium	Total	Lab	**14000 ug/l**	**11500 ug/l**	**3200 ug/l**	**3700 ug/l**	**3800 ug/l**	**6600 ug/l**	**6400 ug/l**	**11500 ug/l**	**14700 ug/l**	**11700 ug/l**	**5000 ug/l**	**8500 ug/l**	**9000 ug/l**	**4510 ug/l**	**4300 ug/l**	**4400 ug/l**
Manganese	Dissolved	Lab	**1630 ug/l**	**1070 ug/l**	**141 ug/l**	**304 ug/l**	**298 ug/l**	**1110 ug/l**	**1040 ug/l**	**9.3 ug/l**	**3280 ug/l**	**1450 ug/l**	**188 ug/l**	**682 ug/l**	**857 ug/l**	**77.3 ug/l**	**114 ug/l**	**113 ug/l**
Manganese	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	Total	Lab	**0.0028 ug/l**	**0.0048 ug/l**	**0.0054 ug/l**	**0.0023 ug/l**	**0.0022 ug/l**	**0.0034 ug/l**	**0.0033 ug/l**	**0.0059 ug/l**	**0.0081 ug/l**	**0.0066 ug/l**	**0.0034 ug/l**	**0.0098 ug/l**	**0.0130 ug/l**	**0.0023 ug/l**	< 0.0005 ug/l	< 0.0005 ug/l
Mercury methyl	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Dissolved	Lab	**1.1 ug/l**	**2.3 ug/l**	**2.5 ug/l**	**2.1 ug/l**	**2.0 ug/l**	**2.6 ug/l**	**2.6 ug/l**	**0.27 ug/l**	**2.2 ug/l**	**1.1 ug/l**	**1.7 ug/l**	**1.5 ug/l**	**1.6 ug/l**	**0.82 ug/l**	**0.7 ug/l**	**0.6 ug/l**
Molybdenum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	Dissolved	Lab	**2.91 ug/l**	**3.1 ug/l**	**1.5 ug/l**	**1.3 ug/l**	**1.2 ug/l**	**1.5 ug/l**	**1.5 ug/l**	**0.86 b ug/l**	**2.2 ug/l**	**1.3 ug/l**	< 0.50 ug/l	**1.0 ug/l**	**1.0 ug/l**	**4.48 ug/l**	**3.59 ug/l**	**3.57 ug/l**
Nickel	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	**2850 ug/l**	**2800 ug/l**	**3500 ug/l**	**2900 ug/l**	**3000 ug/l**	**3500 ug/l**	**3500 ug/l**	**3300 ug/l**	**3800 ug/l**	**2900 ug/l**	**4300 ug/l**	**4500 ug/l**	**4700 ug/l**	**1430 ug/l**	**1260 ug/l**	**1290 ug/l**
Selenium	Dissolved	Lab	< 1 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l
Selenium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	Dissolved	Lab	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l
Silver	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sodium	Total	Lab	**5860 ug/l**	**9500 ug/l**	**29800 ug/l**	**18800 ug/l**	**18500 ug/l**	**19100 ug/l**	**18900 ug/l**	**19000 ug/l**	**16400 ug/l**	**10800 ug/l**	**16000 ug/l**	**16500 ug/l**	**16500 ug/l**	**3000 ug/l**	**2940 ug/l**	**2810 ug/l**
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.017 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Dissolved	Lab	< 5 ug/l	< 5.0 ug/l	**7.8 ug/l**	**5.4 ug/l**	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l
Zinc	Dissolved	Lab	< 6 ug/l	< 6.0 ug/l	**6.4 ug/l**	**6.9 ug/l**	**6.6 ug/l**	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l
Zinc	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Large Table 3
Groundwater Data Summary
Mine Site Surficial Aquifer

Location			MW-3		MW-3	MW-3		MW-3		MW-3		MW-3		MW-3		MW-3		MW-3	MW-3	MW-3	
Date			1/17/2012		2/14/2012	3/5/2012		4/19/2012		5/7/2012		6/8/2012		7/9/2012		8/6/2012		10/9/2012	4/23/2013	7/19/2013	
Sample Type			N	FD	N	N	FD	N	FD	N	FD	N	FD	N	FD	N	FD	N	N	N	FD
	Fraction	Analysis Location																			
General Parameters																					
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total	NA	Lab	**35.5 mg/l**	**36 mg/l**	**37 mg/l**	**35.9 mg/l**	**35.8 mg/l**	**36.0 mg/l**	**34.4 mg/l**	**31.8 mg/l**	**37.4 mg/l**	**33.6 mg/l**	**31.7 mg/l**	**33.5 mg/l**	**34.2 mg/l**	**37.3 mg/l**	**48.1 mg/l**	**34.5 mg/l**	**28.6 mg/l**	**27.8 mg/l**	--
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	**2.1 mg/l**	**1.7 mg/l**	**2.45 b mg/l**	**2.0 mg/l**	**2.4 mg/l**	**2.1 mg/l**	**1.9 mg/l**	**1.5 mg/l**	**1.5 mg/l**	**1.6 mg/l**	**1.6 mg/l**	**1.8 mg/l**	**1.8 mg/l**	**1.2 mg/l**	**1.7 mg/l**	**1.7 mg/l**	**1.5 mg/l**	**1.6 mg/l**	--
Carbon, total organic	NA	Lab	**1.7 mg/l**	**1.9 mg/l**	**1.92 b mg/l**	< 1 mg/l	**1.8 mg/l**	**1.7 mg/l**	**1.8 mg/l**	**1.3 mg/l**	**1.3 mg/l**	**1.3 mg/l**	**1.3 mg/l**	**1.3 mg/l**	**1.4 mg/l**	< 1.0 mg/l	**1.2 mg/l**	**1.3 mg/l**	< 1.0 mg/l	**1.7 mg/l**	--
Chemical Oxygen Demand	NA	Lab	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	**18.8 mg/l**	**22.0 mg/l**	**10.1 mg/l**	< 10.0 mg/l	**10.1 mg/l**	**12.0 mg/l**	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	--
Chloride	NA	Lab	< 0.5 mg/l	< 0.5 mg/l	< 0.5 mg/l	< 0.5 mg/l	< 0.5 mg/l	< 0.50 h mg/l	< 0.50 h mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	--
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	**5.5 mg/l**	--	**7.16 mg/l**	**4.64 mg/l**	--	**5.94 mg/l**	--	**6.35 mg/l**	--	**5.45 mg/l**	--	**5.98 mg/l**	--	**6.16 mg/l**	--	**5.8 mg/l**	**5.72 mg/l**	**6.01 mg/l**	--
Fluoride	NA	Lab	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.10 mg/l	< 0.10 h mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	--
Hardness, total, as CaCO3	NA	Lab	**39.6 mg/l**	**39.5 mg/l**	**44.9 mg/l**	**38.7 mg/l**	**39.9 mg/l**	**39.4 mg/l**	**39.6 mg/l**	**38.5 mg/l**	**38.5 mg/l**	**39.8 mg/l**	**38.3 mg/l**	**40.9 mg/l**	**39.3 mg/l**	**38.0 mg/l**	**39.4 mg/l**	**39.7 mg/l**	**34.0 mg/l**	**35.7 mg/l**	--
Nitrate + Nitrite, as N	NA	Lab	**0.42 mg/l**	**0.43 mg/l**	**0.29 mg/l**	**0.34 mg/l**	**0.34 mg/l**	**0.40 mg/l**	**0.41 mg/l**	**0.43 mg/l**	**0.41 mg/l**	**0.49 mg/l**	**0.49 mg/l**	**0.48 mg/l**	**0.48 mg/l**	**0.50 mg/l**	**0.53 mg/l**	**0.45 mg/l**	**0.57 mg/l**	**0.63 mg/l**	--
Nitrogen, ammonia (NH3), as N	NA	Lab	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	**0.10 b mg/l**	**0.10 b mg/l**	< 0.050 mg/l	< 0.050 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	--
pH	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	**6.19 pH units**	--	**6.68 pH units**	**6.25 pH units**	--	**6.42 pH units**	--	**6.48 pH units**	--	**6.05 pH units**	--	**5.96 pH units**	--	**6.05 pH units**	--	**6.18 pH units**	**6.24 pH units**	**6.13 pH units**	--
Phosphorus, total	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Redox (oxidation potential)	NA	Field	**409 mV**	--	**407 mV**	**377 mV**	--	**525 mV**	--	**367 mV**	--	**575 mV**	--	**398 mV**	--	**285 mV**	--	**325 mV**	**520 mV**	**591 mV**	--
Solids, total dissolved	NA	Lab	**89 mg/l**	**82 mg/l**	**95 mg/l**	**106 mg/l**	**100 mg/l**	**68.0 mg/l**	**88.0 mg/l**	**68.0 mg/l**	**73.0 mg/l**	**119 mg/l**	**108 mg/l**	**117 mg/l**	**129 mg/l**	**100 mg/l**	**94.0 mg/l**	**112 mg/l**	**91.0 mg/l**	**96.0 mg/l**	--
Specific Conductance @ 25oC	NA	Field	**92.4 umhos/cm**	--	**100.1 umhos/cm**	**93.8 umhos/cm**	--	**87.8 umhos/cm**	--	**49.7 umhos/cm**	--	**55.8 umhos/cm**	--	**91 umhos/cm**	--	**91.5 umhos/cm**	--	**99.5 umhos/cm**	**89.2 umhos/cm**	**70.8 umhos/cm**	--
Sulfate	NA	Lab	**9.8 mg/l**	**9.77 mg/l**	**11.2 mg/l**	**9.16 mg/l**	**9.44 mg/l**	**11.1 h mg/l**	**11.1 h mg/l**	**10.7 mg/l**	**10.8 mg/l**	**12.9 mg/l**	**12.8 mg/l**	**12.7 mg/l**	**12.7 mg/l**	**12.8 mg/l**	**12.8 mg/l**	**11.1 mg/l**	**10.5 mg/l**	**10.2 mg/l**	--
Temperature, degrees C	NA	Field	**7.61 deg C**	--	**9.05 deg C**	**8.92 deg C**	--	**5.79 deg C**	--	**11.03 deg C**	--	**18.16 deg C**	--	**13.51 deg C**	--	**16.84 deg C**	--	**9.48 deg C**	**6.25 deg C**	**16.65 deg C**	--
Turbidity	NA	Field	**0 NTU**	--	**3.3 NTU**	**0 NTU**	--	**0 NTU**	--	**0.9 NTU**	--	**1.3 NTU**	--	**1.3 NTU**	--	**1.6 NTU**	--	**0.2 NTU**	**3 NTU**	**0.1 NTU**	--
Metals																					
Aluminum	Dissolved	Lab	< 25 ug/l	< 25 ug/l	< 25.0 ug/l	< 25 ug/l	< 25 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 200 ug/l	**22.2 ug/l**	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	--
Aluminum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	Dissolved	Lab	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 5.0 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--
Antimony	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	Dissolved	Lab	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 5.0 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--
Arsenic	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Total	Lab	**14.7 ug/l**	**14.7 ug/l**	**20.6 ug/l**	**17.4 ug/l**	**17.8 ug/l**	**15.2 ug/l**	**15.3 ug/l**	**16.2 ug/l**	**15.6 ug/l**	**18.3 ug/l**	**17.7 ug/l**	**16.1 ug/l**	**15.9 ug/l**	**17.5 ug/l**	**18.6 ug/l**	**18.2 ug/l**	**15.5 ug/l**	**15.9 ug/l**	--
Beryllium	Total	Lab	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--
Boron	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	Total	Lab	< 50 ug/l	< 50 ug/l	< 50.0 ug/l	< 50 ug/l	< 50 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	--
Cadmium	Dissolved	Lab	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 2.0 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--
Cadmium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Calcium	Total	Lab	**9300 ug/l**	**9320 ug/l**	**10800 ug/l**	**9130 ug/l**	**9480 ug/l**	**9300 ug/l**	**9300 ug/l**	**9100 ug/l**	**9100 ug/l**	**9300 ug/l**	**9000 ug/l**	**9700 ug/l**	**9200 ug/l**	**8800 ug/l**	**9200 ug/l**	**9300 ug/l**	**7700 ug/l**	**8100 ug/l**	--
Chromium	Dissolved	Lab	< 1 ug/l	< 1 ug/l	< 1.0 ug/l	< 1 ug/l	< 1 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	**1.3 ug/l**	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 10.0 ug/l	**6.3 ug/l**	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--
Chromium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	Dissolved	Lab	**0.44 ug/l**	**0.47 ug/l**	**0.48 j ug/l**	**0.39 ug/l**	**0.37 ug/l**	**0.47 ug/l**	**0.41 ug/l**	**0.43 ug/l**	**0.41 ug/l**	**0.24 ug/l**	**0.24 ug/l**	**0.29 ug/l**	**0.29 ug/l**	< 2.0 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--
Cobalt	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	Dissolved	Lab	**1.16 ug/l**	**1.02 ug/l**	**1.1 ug/l**	**0.97 ug/l**	**1.48 ug/l**	**0.97 ug/l**	**0.93 ug/l**	**1.2 ug/l**	**1.3 ug/l**	**0.96 ug/l**	**1.1 ug/l**	**1.0 ug/l**	**1.0 ug/l**	< 5.0 ug/l	**2.0 ug/l**	**1.4 ug/l**	**1.2 ug/l**	**0.91 ug/l**	--
Copper	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Iron	Dissolved	Lab	< 50 ug/l	< 50 ug/l	< 50.0 ug/l	< 50 ug/l	< 50 ug/l	< 50.0 ug/l	< 50.0 ug/l	**78.4 b ug/l**	**96.4 b ug/l**	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 500 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	--
Iron	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Total	Lab	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 h ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--
Magnesium	Total	Lab	**3980 ug/l**	**3950 ug/l**	**4400 ug/l**	**3860 ug/l**	**3940 ug/l**	**3900 ug/l**	**4000 ug/l**	**3800 ug/l**	**3800 ug/l**	**4000 ug/l**	**3900 ug/l**	**4100 ug/l**	**4000 ug/l**	**3900 ug/l**	**4000 ug/l**	**4000 ug/l**	**3600 ug/l**	**3800 ug/l**	--
Manganese	Dissolved	Lab	**104 ug/l**	**107 ug/l**	**166 ug/l**	**126 ug/l**	**122 ug/l**	**102 ug/l**	**106 ug/l**	**96.2 ug/l**	**97.2 ug/l**	**69.2 ug/l**	**68.4 ug/l**	**51.3 ug/l**	**53.0 ug/l**	**23.9 ug/l**	**21.3 ug/l**	**31.3 ug/l**	**30.3 ug/l**	**15.1 ug/l**	--
Manganese	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	Total	Lab	< 0.0005 ug/l	< 0.0005 ug/l	**0.0008 ug/l**	< 0.0005 ug/l	< 0.0005 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	**0.0053 * ug/l**	< 0.00050 * ug/l
Mercury methyl	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Dissolved	Lab	**0.35 ug/l**	**0.37 ug/l**	**0.99 ug/l**	**0.5 ug/l**	**0.46 ug/l**	**0.37 ug/l**	**0.38 ug/l**	**0.52 ug/l**	**0.49 ug/l**	**0.54 ug/l**	**0.50 ug/l**	**0.52 ug/l**	**0.51 ug/l**	< 2.0 ug/l	**0.62 ug/l**	**0.56 ug/l**	**0.58 ug/l**	**0.67 ug/l**	--
Molybdenum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	Dissolved	Lab	**3.88 ug/l**	**4 ug/l**	**3.8 ug/l**	**3.52 ug/l**	**3.45 ug/l**	**4 ug/l**	**4.3 ug/l**	**5.4 ug/l**	**5.6 ug/l**	**4.8 ug/l**	**4.8 ug/l**	**6.1 ug/l**	**6.4 ug/l**	**5.4 ug/l**	**6.8 ug/l**	**4.6 ug/l**	**4.3 ug/l**	**3.4 b ug/l**	--
Nickel	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	**980 ug/l**	**960 ug/l**	**1300 ug/l**	**1030 ug/l**	**1130 ug/l**	**1100 ug/l**	**1200 ug/l**	**1200 ug/l**	**1200 ug/l**	**1500 ug/l**	**1400 ug/l**	**1600 ug/l**	**1500 ug/l**	**1700 ug/l**	**1700 ug/l**	**1800 ug/l**	**1300 ug/l**	**1600 ug/l**	--
Selenium	Dissolved	Lab	< 1 ug/l	< 1 ug/l	< 1.0 ug/l	< 1 ug/l	< 1 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 10.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--
Selenium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	Dissolved	Lab	< 0.2 ug/l	< 0.2 ug/l	< 0.50 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 2.0 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--
Silver	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sodium	Total	Lab	**2520 ug/l**	**2500 ug/l**	**2600 ug/l**	**2380 ug/l**	**2470 ug/l**	**2400 ug/l**	**2400 ug/l**	**2400 ug/l**	**2400 ug/l**	**2900 ug/l**	**2800 ug/l**	**3200 ug/l**	**3100 ug/l**	**3200 ug/l**	**3400 ug/l**	**2900 ug/l**	**2500 ug/l**	**3100 ug/l**	--
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	**0.21 ug/l**	--
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Dissolved	Lab	< 10 ug/l	< 10 ug/l	< 5.0 ug/l	< 5 ug/l	< 5 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 50.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	--
Zinc	Dissolved	Lab	< 6 ug/l	< 6 ug/l	**7.0 ug/l**	< 6 ug/l	< 6 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	**6.1 ug/l**	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 60.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	--
Zinc	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Large Table 3
Groundwater Data Summary
Mine Site Surficial Aquifer

Location			MW-3		MW-4	MW-4		MW-4	MW-4		MW-4	MW-4	MW-4	MW-4	MW-4	MW-4	MW-4	MW-4	
Date			10/18/2013		11/8/2011	12/7/2011		1/17/2012	2/14/2012		3/5/2012	4/19/2012	5/7/2012	6/8/2012	7/9/2012	8/6/2012	10/9/2012	5/7/2013	
Sample Type			N	FD	N	N	FD	N	N	FD	N	N	N	N	N	N	N	N	FD
	Fraction	Analysis Location																	
General Parameters																			
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total	NA	Lab	**28.9 mg/l**	--	**64.5 mg/l**	**68.3 mg/l**	**68.9 mg/l**	**65.6 mg/l**	**57.8 mg/l**	**57.5 mg/l**	**56.4 mg/l**	**69.8 mg/l**	**66.4 mg/l**	**66.8 mg/l**	**68.8 mg/l**	**74.8 mg/l**	**66.4 mg/l**	**64.8 mg/l**	--
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	**1.4 mg/l**	--	**3.1 mg/l**	**5.5 mg/l**	**5.2 mg/l**	**3.6 mg/l**	**3.25 b mg/l**	**3.73 b mg/l**	**2.9 mg/l**	**6.3 mg/l**	**5.7 mg/l**	**6.4 mg/l**	**6.3 mg/l**	**5.9 mg/l**	**2.9 mg/l**	**4.3 mg/l**	--
Carbon, total organic	NA	Lab	**1.2 mg/l**	--	**3.0 mg/l**	**4.6 mg/l**	**4.4 mg/l**	**3.2 mg/l**	**2.35 b mg/l**	**2.64 b mg/l**	**1.8 mg/l**	**6.0 mg/l**	**5.4 mg/l**	**6.0 mg/l**	**5.6 mg/l**	**5.0 mg/l**	**2.6 mg/l**	**4.0 mg/l**	--
Chemical Oxygen Demand	NA	Lab	**13.2 mg/l**	--	**12.2 mg/l**	**13.4 mg/l**	**15.2 mg/l**	< 10 mg/l	**14.2 mg/l**	**13.6 mg/l**	< 10 mg/l	**30.2 mg/l**	< 10.0 mg/l	**28.3 mg/l**	**15.2 mg/l**	< 10.0 mg/l	< 10.0 mg/l	**12.9 mg/l**	--
Chloride	NA	Lab	< 1.0 mg/l	--	**0.71 mg/l**	**0.72 mg/l**	< 0.5 mg/l	**0.63 mg/l**	< 0.5 mg/l	< 0.5 mg/l	< 0.5 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	**0.59 mg/l**	**0.60 mg/l**	**0.77 mg/l**	--
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	**6.09 mg/l**	--	**3.63 mg/l**	**7.81 mg/l**	--	**2.3 mg/l**	**7.05 mg/l**	--	**3.63 mg/l**	**2.14 mg/l**	**2.48 mg/l**	**1.47 mg/l**	**1.47 mg/l**	**1.91 mg/l**	**2.15 mg/l**	**0.28 mg/l**	--
Fluoride	NA	Lab	< 0.10 mg/l	--	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	--
Hardness, total, as CaCO3	NA	Lab	**34.4 mg/l**	--	**70.5 mg/l**	**73.7 mg/l**	**73.4 mg/l**	**68.1 mg/l**	**65.9 mg/l**	**63.7 mg/l**	**59 mg/l**	**64.7 mg/l**	**62.3 mg/l**	**61.7 mg/l**	**62.8 mg/l**	**67.0 mg/l**	**63.4 mg/l**	**61.9 mg/l**	--
Nitrate + Nitrite, as N	NA	Lab	**0.75 mg/l**	--	**0.44 mg/l**	**0.22 mg/l**	**0.22 mg/l**	**0.29 mg/l**	**0.35 mg/l**	**0.32 mg/l**	**0.82 mg/l**	**0.40 mg/l**	**0.39 mg/l**	**0.32 mg/l**	**0.31 mg/l**	**0.27 mg/l**	**0.27 mg/l**	**0.24 mg/l**	--
Nitrogen, ammonia (NH3), as N	NA	Lab	< 0.10 mg/l	--	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	**0.12 b mg/l**	**0.060 mg/l**	< 0.10 mg/l	**0.13 mg/l**	**0.15 mg/l**	< 0.10 mg/l	**0.10 mg/l**	--
pH	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	**6.1 pH units**	--	**6.84 pH units**	**6.73 pH units**	--	**6.52 pH units**	**6.75 pH units**	--	**6.58 pH units**	**6.69 pH units**	**6.66 pH units**	**6.29 pH units**	**6.11 pH units**	**6.1 pH units**	**6.43 pH units**	**6.34 pH units**	--
Phosphorus, total	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Redox (oxidation potential)	NA	Field	**497 mV**	--	**108 mV**	**365 mV**	--	**377 mV**	**409 mV**	--	**354 mV**	**419 mV**	**337 mV**	**517 mV**	**320 mV**	**202 mV**	**340 mV**	**302 mV**	--
Solids, total dissolved	NA	Lab	**100 mg/l**	--	**121 mg/l**	**165 mg/l**	**96 mg/l**	**113 mg/l**	**113 mg/l**	**112 mg/l**	**122 mg/l**	**139 mg/l**	**103 mg/l**	**174 mg/l**	**156 mg/l**	**133 mg/l**	**137 mg/l**	**126 mg/l**	--
Specific Conductance @ 25oC	NA	Field	**81.7 umhos/cm**	--	**157.8 umhos/cm**	**163.5 umhos/cm**	--	**148.2 umhos/cm**	**130 umhos/cm**	--	**129.1 umhos/cm**	**149.8 umhos/cm**	**106.9 umhos/cm**	**115.2 umhos/cm**	**158.5 umhos/cm**	**159.3 umhos/cm**	**137.6 umhos/cm**	**128.1 umhos/cm**	--
Sulfate	NA	Lab	**9.6 mg/l**	--	**11.3 mg/l**	**10.4 mg/l**	**10.4 mg/l**	**7.41 mg/l**	**7.56 mg/l**	**7.56 mg/l**	**7.01 mg/l**	**8.7 mg/l**	**8.2 mg/l**	**8.8 mg/l**	**8.1 mg/l**	**7.7 mg/l**	**7.2 mg/l**	**7.3 mg/l**	--
Temperature, degrees C	NA	Field	**10.06 deg C**	--	**8.44 deg C**	**7.46 deg C**	--	**8.56 deg C**	**8.87 deg C**	--	**5.52 deg C**	**5.02 deg C**	**8.49 deg C**	**14.68 deg C**	**16.2 deg C**	**19.11 deg C**	**8.57 deg C**	**9.35 deg C**	--
Turbidity	NA	Field	**0 NTU**	--	**15.7 NTU**	**0 NTU**	--	**0 NTU**	**9.2 NTU**	--	**4 NTU**	**9.5 NTU**	**5.2 NTU**	**6.1 NTU**	**3.4 NTU**	**2.5 NTU**	**1 NTU**	**4.2 NTU**	--
Metals																			
Aluminum	Dissolved	Lab	< 20.0 ug/l	--	**27.5 ug/l**	**28.4 ug/l**	**29.4 ug/l**	< 25 ug/l	< 25.0 ug/l	< 25.0 ug/l	< 25 ug/l	**260 ug/l**	**286 ug/l**	**213 ug/l**	**141 ug/l**	**102 ug/l**	**37.7 ug/l**	**107 ug/l**	--
Aluminum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	Dissolved	Lab	< 0.50 ug/l	--	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--
Antimony	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	Dissolved	Lab	< 0.50 ug/l	--	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.5 ug/l	**0.53 ug/l**	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--
Arsenic	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Total	Lab	**16.1 ug/l**	--	**32.6 ug/l**	**34 ug/l**	**34.2 ug/l**	**29.8 ug/l**	**29.9 ug/l**	**28.9 ug/l**	**25.6 ug/l**	**28.4 ug/l**	**27.0 ug/l**	**26.9 ug/l**	**26.8 ug/l**	**29.8 ug/l**	**25.6 ug/l**	**18.2 ug/l**	--
Beryllium	Total	Lab	< 0.20 ug/l	--	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--
Boron	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	Total	Lab	< 50.0 ug/l	--	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	--
Cadmium	Dissolved	Lab	< 0.20 ug/l	--	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--
Cadmium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Calcium	Total	Lab	**8000 ug/l**	--	**14900 ug/l**	**15100 ug/l**	**15000 ug/l**	**13900 ug/l**	**13900 ug/l**	**13400 ug/l**	**12000 ug/l**	**11700 ug/l**	**11400 ug/l**	**11300 ug/l**	**11700 ug/l**	**12600 ug/l**	**12200 ug/l**	**10900 ug/l**	--
Chromium	Dissolved	Lab	< 1.0 ug/l	--	< 4.5 c ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	**1.4 b ug/l**	< 1.0 ug/l	< 1.0 ug/l	--
Chromium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	Dissolved	Lab	< 0.20 ug/l	--	**0.55 ug/l**	**1.07 ug/l**	**1.04 ug/l**	**0.68 ug/l**	**0.53 ug/l**	**0.58 ug/l**	**0.36 ug/l**	**1.8 ug/l**	**0.72 ug/l**	**1.4 ug/l**	**1.5 ug/l**	**1.6 ug/l**	**0.26 ug/l**	**3.2 ug/l**	--
Cobalt	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	Dissolved	Lab	**1.5 ug/l**	--	**3.38 ug/l**	**4.16 ug/l**	**3.29 ug/l**	**2.62 ug/l**	**2.9 ug/l**	**2.7 ug/l**	**1.95 ug/l**	**12.3 ug/l**	**13.9 ug/l**	**15.2 ug/l**	**12.3 ug/l**	**9.8 ug/l**	**4.4 ug/l**	**7.9 ug/l**	--
Copper	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Iron	Dissolved	Lab	< 50.0 ug/l	--	**316 ug/l**	**89.9 ug/l**	**116 ug/l**	**74.4 ug/l**	**55.1 ug/l**	**68.5 ug/l**	**77.4 ug/l**	**629 ug/l**	**745 ug/l**	**556 ug/l**	**642 ug/l**	**658 ug/l**	**105 ug/l**	**850 ug/l**	--
Iron	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Total	Lab	< 0.50 ug/l	--	< 0.5 ug/l	< 0.5 ug/l	**0.53 ug/l**	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--
Magnesium	Total	Lab	**3500 ug/l**	--	**8080 ug/l**	**8750 ug/l**	**8720 ug/l**	**8100 ug/l**	**7600 ug/l**	**7400 ug/l**	**7040 ug/l**	**8600 ug/l**	**8200 ug/l**	**8100 ug/l**	**8200 ug/l**	**8600 ug/l**	**8000 ug/l**	**8500 ug/l**	--
Manganese	Dissolved	Lab	**16.8 ug/l**	--	**107 ug/l**	**444 ug/l**	**446 ug/l**	**336 ug/l**	**312 ug/l**	**325 ug/l**	**199 ug/l**	**357 ug/l**	**121 ug/l**	**254 ug/l**	**315 ug/l**	**350 ug/l**	**80.2 ug/l**	**581 ug/l**	--
Manganese	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	Total	Lab	< 0.00050 ug/l	**0.00060 ug/l**	**0.0021 ug/l**	**0.0011 ug/l**	**0.0009 ug/l**	**0.0006 ug/l**	**0.0009 ug/l**	**0.0015 ug/l**	< 0.0005 ug/l	**0.0034 ug/l**	**0.0032 ug/l**	**0.0037 ug/l**	**0.0020 ug/l**	**0.0018 ug/l**	**0.00083 ug/l**	**0.0019 ug/l**	**0.0019 ug/l**
Mercury methyl	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Dissolved	Lab	**0.73 ug/l**	--	**2.55 ug/l**	**1.53 ug/l**	**1.47 ug/l**	**1.52 ug/l**	**1.6 ug/l**	**1.8 ug/l**	**1.94 ug/l**	**2.0 ug/l**	**1.8 ug/l**	**1.9 ug/l**	**1.7 ug/l**	**1.8 ug/l**	**1.5 ug/l**	**0.86 ug/l**	--
Molybdenum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	Dissolved	Lab	**4.3 ug/l**	--	**2.96 ug/l**	**3.15 ug/l**	**3.01 ug/l**	**2.29 ug/l**	**1.8 ug/l**	**1.9 ug/l**	**1.74 ug/l**	**7.6 ug/l**	**7.3 ug/l**	**7.1 ug/l**	**6.5 ug/l**	**5.6 ug/l**	**2.6 ug/l**	**6.6 ug/l**	--
Nickel	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	**1600 ug/l**	--	**2070 ug/l**	**1280 ug/l**	**1280 ug/l**	**1200 ug/l**	**1400 ug/l**	**1400 ug/l**	**1430 ug/l**	**1400 ug/l**	**1400 ug/l**	**1700 ug/l**	**2400 ug/l**	**2800 ug/l**	**2200 ug/l**	**1600 ug/l**	--
Selenium	Dissolved	Lab	< 1.0 ug/l	--	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--
Selenium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	Dissolved	Lab	< 0.20 ug/l	--	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--
Silver	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sodium	Total	Lab	**3000 ug/l**	--	**4130 ug/l**	**3710 ug/l**	**3710 ug/l**	**3210 ug/l**	**3200 ug/l**	**3100 ug/l**	**3180 ug/l**	**7900 ug/l**	**6400 ug/l**	**8500 ug/l**	**8700 ug/l**	**7900 ug/l**	**4000 ug/l**	**6300 ug/l**	--
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab	< 0.20 ug/l	--	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Dissolved	Lab	< 5.0 ug/l	--	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	--
Zinc	Dissolved	Lab	< 6.0 ug/l	--	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	**18.6 ug/l**	--
Zinc	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Large Table 3
Groundwater Data Summary
Mine Site Surficial Aquifer

Location			MW-4	MW-4	MW-5	MW-5	MW-5	MW-5	MW-5		MW-5	MW-5	MW-5	MW-5	MW-5	MW-5		MW-5	MW-5	MW-5
Date			7/19/2013	10/18/2013	11/9/2011	12/6/2011	1/4/2012	2/13/2012	3/1/2012		4/9/2012	5/8/2012	6/11/2012	7/13/2012	8/14/2012	10/26/2012		4/22/2013	7/31/2013	10/2/2013
Sample Type			N	N	N	N	N	N	N	FD	N	N	N	N	N	N	FD	N	N	N
	Fraction	Analysis Location																		
General Parameters																				
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total	NA	Lab	**70.3 mg/l**	**71.0 mg/l**	**38.3 mg/l**	**38.2 mg/l**	**37.2 mg/l**	**28.8 mg/l**	**29.3 mg/l**	**28.3 mg/l**	**29.8 mg/l**	**35.6 mg/l**	**17.5 mg/l**	**17.6 mg/l**	**28.3 mg/l**	**28.6 mg/l**	--	**21.7 mg/l**	**20.8 mg/l**	**23.2 mg/l**
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	**9.3 mg/l**	**6.9 mg/l**	**3.9 mg/l**	**3.9 mg/l**	**2.6 mg/l**	**2.46 b mg/l**	**2.33 b mg/l**	**2.10 b mg/l**	**2.2 mg/l**	**3.1 mg/l**	**3.4 b mg/l**	**2.7 mg/l**	**2.0 mg/l**	**1.8 mg/l**	--	**1.5 mg/l**	**1.9 mg/l**	**2.4 mg/l**
Carbon, total organic	NA	Lab	**9.5 mg/l**	**6.3 mg/l**	**3.9 mg/l**	**2.9 mg/l**	**2.2 mg/l**	**1.87 b mg/l**	**2.37 mg/l**	**1.75 mg/l**	**1.9 mg/l**	**5.1 mg/l**	**2.8 mg/l**	**2.4 mg/l**	**3.6 mg/l**	**1.7 mg/l**	--	**1.2 mg/l**	**1.7 mg/l**	**1.9 mg/l**
Chemical Oxygen Demand	NA	Lab	**32.3 mg/l**	**26.2 mg/l**	**32.8 mg/l**	**22.8 mg/l**	**18.4 mg/l**	**14.1 mg/l**	**19.1 mg/l**	**18.9 mg/l**	**10.0 mg/l**	**104 mg/l**	**28.3 mg/l**	< 10.0 mg/l	**22.4 mg/l**	**17.2 mg/l**	--	**14.8 mg/l**	**25.3 mg/l**	**33.7 b mg/l**
Chloride	NA	Lab	< 0.50 mg/l	< 1.0 * mg/l	**1.1 mg/l**	**0.76 mg/l**	**0.63 mg/l**	< 0.5 mg/l	< 0.5 mg/l	< 0.5 mg/l	< 0.50 mg/l	**0.51 mg/l**	< 0.50 mg/l	< 0.50 mg/l	**0.55 mg/l**	< 0.50 mg/l	--	< 0.50 mg/l	< 0.50 mg/l	< 1.0 mg/l
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	**0.38 mg/l**	**0.18 mg/l**	**9.27 mg/l**	**9.04 mg/l**	**9.52 mg/l**	**10.97 mg/l**	**10.52 mg/l**	--	**10.43 mg/l**	**10.97 mg/l**	**10.05 mg/l**	**8.13 mg/l**	**7.56 mg/l**	**8.66 mg/l**	--	**10.47 mg/l**	**8.8 mg/l**	**8.78 mg/l**
Fluoride	NA	Lab	**0.13 mg/l**	**0.11 mg/l**	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	--	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l
Hardness, total, as CaCO3	NA	Lab	**56.9 mg/l**	**59.1 mg/l**	**106 mg/l**	**71.2 mg/l**	**59.2 mg/l**	**45.0 mg/l**	**39.8 mg/l**	**41.1 mg/l**	**49.3 mg/l**	**164 mg/l**	**71.2 mg/l**	**10.9 mg/l**	**74.5 mg/l**	**39.5 mg/l**	--	**28.3 mg/l**	**59.1 mg/l**	**33.4 mg/l**
Nitrate + Nitrite, as N	NA	Lab	**0.26 mg/l**	**0.17 mg/l**	< 0.1 mg/l	**0.1 mg/l**	**0.12 mg/l**	**0.12 mg/l**	**0.15 mg/l**	**0.15 mg/l**	**0.16 mg/l**	**0.11 mg/l**	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	**0.14 mg/l**	--	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l
Nitrogen, ammonia (NH3), as N	NA	Lab	**0.26 mg/l**	**0.23 mg/l**	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	**0.097 mg/l**	< 0.050 mg/l	< 0.10 mg/l	< 0.10 mg/l	**0.17 mg/l**	< 0.10 mg/l	--	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l
pH	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	**6.4 pH units**	**6.37 pH units**	**7.11 pH units**	**7.56 pH units**	**7.89 pH units**	**6.92 pH units**	**7.55 pH units**	--	**7.16 pH units**	**6.95 pH units**	**6.31 pH units**	**5.93 pH units**	**6.6 pH units**	**6.21 pH units**	--	**6.72 pH units**	**6.29 pH units**	**6.14 pH units**
Phosphorus, total	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Redox (oxidation potential)	NA	Field	**431 mV**	**345 mV**	**218 mV**	**463 mV**	**420 mV**	**404 mV**	**453 mV**	--	**384 mV**	**320 mV**	**302 mV**	**184 mV**	**325 mV**	**193 mV**	--	**389 mV**	**431 mV**	**515 mV**
Solids, total dissolved	NA	Lab	**142 mg/l**	**141 mg/l**	**136 mg/l**	**104 mg/l**	**101 mg/l**	**81 mg/l**	**89 h mg/l**	**98 h mg/l**	**83.0 mg/l**	**112 mg/l**	**58.0 mg/l**	**41.0 mg/l**	**72.0 mg/l**	**111 mg/l**	--	**77.0 mg/l**	**67.0 mg/l**	**78.0 mg/l**
Specific Conductance @ 25oC	NA	Field	**131.1 umhos/cm**	**82.3 umhos/c**	**122.6 umhos/cm**	**100 umhos/cm**	**86 umhos/cm**	**74.4 umhos/cm**	**71.6 umhos/cm**	--	**74.8 umhos/cm**	**46.5 umhos/cm**	**4.8 umhos/cm**	**41.9 umhos/cm**	**0 umhos/cm**	**70.3 umhos/cm**	--	**45.9 umhos/cm**	**36.7 umhos/cm**	**86.5 umhos/cm**
Sulfate	NA	Lab	**6.5 mg/l**	**7.6 mg/l**	**17.4 mg/l**	**9.73 mg/l**	**6.07 mg/l**	**5.6 mg/l**	**5.3 mg/l**	**5.58 mg/l**	**6.4 mg/l**	**9.7 mg/l**	**3.8 mg/l**	**6.0 mg/l**	**4.4 mg/l**	**5.0 mg/l**	--	**5.8 mg/l**	**2.0 mg/l**	**4.6 mg/l**
Temperature, degrees C	NA	Field	**16.25 deg C**	**10.63 deg C**	**6.92 deg C**	**12.3 deg C**	**10.3 deg C**	**11.49 deg C**	**10.56 deg C**	--	**9.73 deg C**	**10 deg C**	**14.97 deg C**	**23.64 deg C**	**15.8 deg C**	**6.84 deg C**	--	**4.26 deg C**	**19.18 deg C**	**14.28 deg C**
Turbidity	NA	Field	**8.9 NTU**	**5.2 NTU**	**295.5 NTU**	**344.5 NTU**	**227.5 NTU**	**118 NTU**	**61.3 NTU**	--	**209.1 NTU**	**2530 NTU**	**624 NTU**	**270.6 NTU**	**428 NTU**	**47.7 NTU**	--	**88.1 NTU**	**224.1 NTU**	**291.9 NTU**
Metals																				
Aluminum	Dissolved	Lab	**316 ug/l**	**96.1 ug/l**	< 25 ug/l	**28.7 ug/l**	**30.5 ug/l**	< 25.0 ug/l	**33.5 ug/l**	< 25 ug/l	< 20.0 ug/l	**46.5 ug/l**	**21.0 ug/l**	**293 ug/l**	**24.0 ug/l**	**55.3 ug/l**	--	**29.3 ug/l**	**33.7 ug/l**	**52.3 ug/l**
Aluminum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Antimony	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	**1.5 ug/l**	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Arsenic	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Total	Lab	**21.0 ug/l**	**22.7 ug/l**	**197 ug/l**	**109 ug/l**	**89.4 ug/l**	**54.5 ug/l**	**43.5 ug/l**	**46.2 ug/l**	**7.5 ug/l**	**615 ug/l**	**223 ug/l**	**20.3 ug/l**	**294 ug/l**	**57.3 ug/l**	--	**41.4 ug/l**	**142 ug/l**	**57.8 ug/l**
Beryllium	Total	Lab	< 0.20 ug/l	< 0.20 ug/l	**0.7 ug/l**	**0.33 ug/l**	**0.25 ug/l**	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	**1.6 ug/l**	**0.86 ug/l**	< 0.20 ug/l	**0.54 ug/l**	< 0.20 ug/l	--	< 0.20 ug/l	**0.41 ug/l**	< 0.20 ug/l
Boron	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	Total	Lab	< 50.0 ug/l	< 50.0 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50.0 ug/l	< 50 ug/l	< 50 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	--	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l
Cadmium	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Cadmium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Calcium	Total	Lab	**11200 ug/l**	**12500 ug/l**	**23800 ug/l**	**16200 ug/l**	**13600 ug/l**	**10800 ug/l**	**9650 ug/l**	**10200 ug/l**	**11100 ug/l**	**35800 ug/l**	**14300 ug/l**	**2700 ug/l**	**22400 ug/l**	**9600 ug/l**	--	**6900 ug/l**	**13200 ug/l**	**8700 ug/l**
Chromium	Dissolved	Lab	< 1.0 ug/l	< 1.0 ug/l	< 1.5 ug/l	< 1 ug/l	< 1 ug/l	< 1.0 ug/l	< 1 ug/l	< 1 ug/l	**1.6 ug/l**	**1.4 b ug/l**	< 1.0 ug/l	**1.6 ug/l**	< 1.0 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l
Chromium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	Dissolved	Lab	**2.1 ug/l**	**2.4 ug/l**	**0.54 ug/l**	< 0.2 ug/l	< 0.2 ug/l	< 0.50 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	**0.26 ug/l**	**1.9 ug/l**	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	**0.43 ug/l**
Cobalt	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	Dissolved	Lab	**17.9 ug/l**	**8.9 ug/l**	**2.63 ug/l**	**2.38 ug/l**	**1.76 ug/l**	**1.4 ug/l**	**1.96 ug/l**	**1.56 ug/l**	**1.4 ug/l**	**2.8 ug/l**	**1.4 ug/l**	**2.6 ug/l**	**0.60 ug/l**	**1.5 ug/l**	--	**1.3 ug/l**	**1.1 ug/l**	**1.3 ug/l**
Copper	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Iron	Dissolved	Lab	**1150 ug/l**	**1110 ug/l**	**81 ug/l**	< 50 ug/l	< 50 ug/l	< 50.0 ug/l	< 50 ug/l	**57.2 ug/l**	**53.7 ug/l**	**91.3 ug/l**	< 50.0 ug/l	**313 ug/l**	**775 ug/l**	**65.0 ug/l**	--	< 50.0 ug/l	< 50.0 ug/l	**75.9 ug/l**
Iron	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Total	Lab	< 0.50 ug/l	< 0.50 ug/l	**8.03 ug/l**	**4.9 ug/l**	**3.32 ug/l**	**1.7 ug/l**	**1.35 ug/l**	**1.4 ug/l**	< 0.50 ug/l	**16.7 ug/l**	**7.4 ug/l**	< 0.50 ug/l	**2.7 ug/l**	**1.6 ug/l**	--	**1.0 ug/l**	**4.6 ug/l**	**1.5 ug/l**
Magnesium	Total	Lab	**7000 ug/l**	**6800 ug/l**	**11200 ug/l**	**7460 ug/l**	**6120 ug/l**	**4400 ug/l**	**3810 ug/l**	**3800 ug/l**	**5300 ug/l**	**18100 ug/l**	**8600 ug/l**	**1000 ug/l**	**4500 ug/l**	**3700 ug/l**	--	**2700 ug/l**	**6300 ug/l**	**2800 ug/l**
Manganese	Dissolved	Lab	**360 ug/l**	**542 ug/l**	**137 ug/l**	**88.2 ug/l**	**78.4 ug/l**	**54.7 ug/l**	**54 ug/l**	**53.2 ug/l**	**35.1 ug/l**	**24.9 ug/l**	**36.9 ug/l**	**14.6 ug/l**	**2400 ug/l**	**8.1 ug/l**	--	**6.7 ug/l**	**16.7 ug/l**	**51.1 ug/l**
Manganese	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	Total	Lab	< 0.00050 ug/l	**0.0024 ug/l**	**0.0120 ug/l**	**0.0068 ug/l**	**0.0048 ug/l**	**0.0034 ug/l**	**0.0017 ug/l**	**0.0015 ug/l**	**0.0058 ug/l**	**0.0545 ug/l**	**0.0135 ug/l**	**0.0075 ug/l**	**0.0157 ug/l**	**0.0031 ug/l**	**0.0036 ug/l**	**0.0038 ug/l**	**0.0074 ug/l**	**0.0082 ug/l**
Mercury methyl	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Dissolved	Lab	**2.8 ug/l**	**2.0 ug/l**	**3.41 ug/l**	**1.86 ug/l**	**1.2 ug/l**	**0.82 ug/l**	**0.86 ug/l**	**0.76 ug/l**	**0.78 ug/l**	**0.82 ug/l**	**0.30 ug/l**	**1.8 ug/l**	**2.6 ug/l**	**0.33 ug/l**	--	**0.33 ug/l**	**0.43 ug/l**	**0.30 ug/l**
Molybdenum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	Dissolved	Lab	**7.4 ug/l**	**6.1 ug/l**	**1.47 ug/l**	**1.49 ug/l**	**0.94 ug/l**	**0.79 ug/l**	**0.67 ug/l**	**0.69 ug/l**	**0.74 ug/l**	**0.92 ug/l**	**0.56 ug/l**	**1.2 ug/l**	**2.3 b ug/l**	**0.77 ug/l**	--	**0.68 ug/l**	< 0.50 ug/l	**0.77 ug/l**
Nickel	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	**3600 ug/l**	**4300 ug/l**	**5520 ug/l**	**3590 ug/l**	**2820 ug/l**	**2000 ug/l**	**1990 ug/l**	**2060 ug/l**	**2500 ug/l**	**8600 ug/l**	**4200 ug/l**	**1000 ug/l**	**2400 ug/l**	**2000 ug/l**	--	**1300 ug/l**	**3300 ug/l**	**1600 ug/l**
Selenium	Dissolved	Lab	< 1.0 ug/l	< 1.0 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1.0 ug/l	< 1 ug/l	< 1 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l
Selenium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.50 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Silver	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sodium	Total	Lab	**10300 ug/l**	**9000 ug/l**	**7100 ug/l**	**4500 ug/l**	**4160 ug/l**	**3100 ug/l**	**3140 ug/l**	**3240 ug/l**	**3700 ug/l**	**8600 ug/l**	**5500 ug/l**	**6400 ug/l**	**3900 ug/l**	**4200 ug/l**	--	**3000 ug/l**	**4500 ug/l**	**2800 ug/l**
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab	< 0.017 ug/l	< 0.20 ug/l	**0.26 ug/l**	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	**0.49 ug/l**	**0.22 ug/l**	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	**0.26 ug/l**	**0.31 ug/l**
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Dissolved	Lab	< 5.0 ug/l	< 5.0 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 5.0 ug/l	< 5 ug/l	< 5 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	--	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l
Zinc	Dissolved	Lab	< 6.0 ug/l	< 6.0 ug/l	< 6 ug/l	**8.39 ug/l**	< 6 ug/l	**44.4 b* ug/l**	< 6 ug/l	< 6 ug/l	< 6.0 ug/l	**6.5 ug/l**	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	--	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l
Zinc	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Large Table 3
Groundwater Data Summary
Mine Site Surficial Aquifer

			Location	MW-6D		MW-6D		MW-6D		MW-6D		MW-6D		MW-6D		MW-6D	MW-6D		MW-6D	
			Date	11/8/2011		12/9/2011		1/10/2012		2/15/2012		3/6/2012		4/6/2012		5/2/2012	6/7/2012		7/10/2012	
			Sample Type	N	FD	N	FD	N	FD	N	FD	N	FD	N	FD	N	N	FD	N	FD
	Fraction	Analysis Location																		
General Parameters																				
Alkalinity, bicarbonate, as CaCO3	NA	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total	NA	Lab		**86.1 mg/l**	**85.7 mg/l**	**88.6 mg/l**	**88.1 mg/l**	**88.6 mg/l**	**87.3 mg/l**	**87.4 mg/l**	**87.5 mg/l**	**87 mg/l**	**88.1 mg/l**	**87.8 mg/l**	**87.7 mg/l**	**86.5 mg/l**	**88.7 mg/l**	**88.2 mg/l**	**87.6 mg/l**	**87.0 mg/l**
Biochemical Oxygen Demand (5-day)	NA	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab		**2.7 mg/l**	**2.7 mg/l**	**3.0 mg/l**	**3.2 mg/l**	**3.0 mg/l**	**2.6 mg/l**	**2.39 mg/l**	**3.01 mg/l**	**3.1 b mg/l**	**3.2 b mg/l**	**2.4 mg/l**	**2.5 mg/l**	**2.3 mg/l**	**2.2 mg/l**	**2.2 mg/l**	**2.1 mg/l**	**2.1 mg/l**
Carbon, total organic	NA	Lab		**2.3 mg/l**	**2.6 mg/l**	**2.9 mg/l**	**3.2 mg/l**	**2.3 mg/l**	**2.3 mg/l**	**2.68 mg/l**	**2.25 mg/l**	**2.1 mg/l**	**2.4 mg/l**	**2.4 mg/l**	**2.2 mg/l**	**1.9 mg/l**	**1.8 mg/l**	**1.8 mg/l**	**1.9 mg/l**	**1.9 mg/l**
Chemical Oxygen Demand	NA	Lab		< 10 mg/l	**13.9 mg/l**	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10.0 mg/l	< 10.0 mg/l	**12.6 mg/l**	**11.6 mg/l**	**11.4 mg/l**	< 10.0 mg/l	**10.2 mg/l**
Chloride	NA	Lab		**0.72 mg/l**	**0.72 mg/l**	**0.6 mg/l**	**0.62 mg/l**	**0.69 mg/l**	**0.9 mg/l**	< 0.5 mg/l	< 0.5 mg/l	< 0.5 mg/l	< 0.5 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l
Cyanide	NA	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field		**6.65 mg/l**	--	**10.54 mg/l**	--	**2.42 mg/l**	--	**1.34 mg/l**	--	**1.3 mg/l**	--	--	--	**1.95 mg/l**	**1.58 mg/l**	--	**1.65 mg/l**	--
Fluoride	NA	Lab		**0.11 mg/l**	**0.11 mg/l**	**0.13 mg/l**	**0.12 mg/l**	**0.11 mg/l**	**0.13 mg/l**	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	**0.11 mg/l**	< 0.10 mg/l	**0.11 mg/l**	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l
Hardness, total, as CaCO3	NA	Lab		**95.7 mg/l**	**91.1 mg/l**	**97.7 mg/l**	**97.7 mg/l**	**92.7 mg/l**	**96.6 mg/l**	**90.5 mg/l**	**97.5 mg/l**	**91.5 mg/l**	**93.2 mg/l**	**92.2 mg/l**	**90.1 mg/l**	**94.8 mg/l**	**94.3 mg/l**	**92.5 mg/l**	**92.4 mg/l**	**91.9 mg/l**
Nitrate + Nitrite, as N	NA	Lab		< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.10 mg/l	**0.29 mg/l**	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l
Nitrogen, ammonia (NH3), as N	NA	Lab		< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	**0.084 mg/l**	**0.10 mg/l**	< 0.050 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l
pH	NA	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field		**7.84 pH units**	--	**7.5 pH units**	--	**7.62 pH units**	--	**7.76 pH units**	--	**7.56 pH units**	--	--	--	**7.25 pH units**	**7.62 pH units**	--	**7.37 pH units**	--
Phosphorus, total	NA	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Redox (oxidation potential)	NA	Field		**152 mV**	--	**308 mV**	--	**454 mV**	--	**390 mV**	--	**435 mV**	--	--	--	**330 mV**	**517 mV**	--	**265 mV**	--
Solids, total dissolved	NA	Lab		**162 mg/l**	**150 mg/l**	**143 mg/l**	**151 mg/l**	**138 mg/l**	**136 mg/l**	**136 mg/l**	**140 mg/l**	**159 mg/l**	**150 mg/l**	**134 h mg/l**	**137 h mg/l**	**141 mg/l**	**191 mg/l**	**212 mg/l**	**151 mg/l**	**142 mg/l**
Specific Conductance @ 25oC	NA	Field		**193.2 umhos/cm**	--	**93.1 umhos/cm**	--	**195.2 umhos/cm**	--	**186.6 umhos/cm**	--	**192.8 umhos/cm**	--	--	--	**150.6 umhos/cm**	**151.3 umhos/cm**	--	**184.3 umhos/cm**	--
Sulfate	NA	Lab		**11.3 mg/l**	**11.4 mg/l**	**10.6 mg/l**	**10.6 mg/l**	**9.98 mg/l**	**10.4 mg/l**	**9.96 mg/l**	**9.96 mg/l**	**9.79 mg/l**	**9.72 mg/l**	**10.1 mg/l**	**10.1 mg/l**	**9.7 mg/l**	**10.2 mg/l**	**10.2 mg/l**	**10.6 mg/l**	**10.6 mg/l**
Temperature, degrees C	NA	Field		**5.23 deg C**	--	**10.01 deg C**	--	**6.65 deg C**	--	**6.23 deg C**	--	**8.6 deg C**	--	--	--	**9.31 deg C**	**9.7 deg C**	--	**9.18 deg C**	--
Turbidity	NA	Field		**13.4 NTU**	--	**0 NTU**	--	**0 NTU**	--	**0 NTU**	--	**0.7 NTU**	--	--	--	**0.4 NTU**	**0 NTU**	--	**0 NTU**	--
Metals																				
Aluminum	Dissolved	Lab		< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25.0 ug/l	< 25.0 ug/l	< 25 ug/l	< 25 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l
Aluminum	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	Dissolved	Lab		< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Antimony	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	Dissolved	Lab		**0.94 ug/l**	**0.72 ug/l**	**0.62 ug/l**	**0.69 ug/l**	**0.95 ug/l**	**0.92 ug/l**	**0.88 ug/l**	**0.78 ug/l**	**0.84 ug/l**	**0.72 ug/l**	**0.66 ug/l**	**0.55 ug/l**	**0.76 ug/l**	**0.59 ug/l**	**0.58 ug/l**	**0.84 ug/l**	**0.74 ug/l**
Arsenic	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Dissolved	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Total	Lab		**36.7 ug/l**	**34.3 ug/l**	**30.2 ug/l**	**31.1 ug/l**	**27.2 ug/l**	**27.4 ug/l**	**22.2 ug/l**	**24.1 ug/l**	**24.5 ug/l**	**24.8 ug/l**	**22.1 ug/l**	**21.6 ug/l**	**21.5 ug/l**	**22.1 ug/l**	**22.2 ug/l**	**20.4 ug/l**	**20.9 ug/l**
Beryllium	Total	Lab		< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Boron	Dissolved	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	Total	Lab		< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50 ug/l	< 50 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l
Cadmium	Dissolved	Lab		< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Cadmium	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Calcium	Total	Lab		**22100 ug/l**	**21200 ug/l**	**22300 ug/l**	**22300 ug/l**	**20300 ug/l**	**21200 ug/l**	**20200 ug/l**	**21900 ug/l**	**20000 ug/l**	**20500 ug/l**	**19900 ug/l**	**19400 ug/l**	**20300 ug/l**	**20100 ug/l**	**19800 ug/l**	**19800 ug/l**	**19700 ug/l**
Chromium	Dissolved	Lab		< 4.5 ug/l	< 1.5 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1 ug/l	**1.85 b ug/l**	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l
Chromium	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	Dissolved	Lab		**0.32 ug/l**	**0.23 ug/l**	**0.26 ug/l**	**0.26 ug/l**	**0.23 ug/l**	**0.23 ug/l**	< 0.50 ug/l	< 0.50 ug/l	< 0.2 ug/l	**0.21 ug/l**	**0.22 ug/l**	**0.22 ug/l**	**0.20 ug/l**	**0.20 ug/l**	**0.21 ug/l**	< 0.20 ug/l	< 0.20 ug/l
Cobalt	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	Dissolved	Lab		**5.03 ug/l**	**0.94 ug/l**	< 0.7 ug/l	**0.76 ug/l**	< 0.7 ug/l	< 0.7 ug/l	< 0.70 ug/l	< 0.70 ug/l	< 0.7 ug/l	< 0.7 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Copper	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Iron	Dissolved	Lab		**127 ug/l**	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50 ug/l	< 50 ug/l	< 50.0 ug/l	< 50.0 ug/l	**50.6 ug/l**	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l
Iron	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Dissolved	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Total	Lab		**1.43 ug/l**	**1.1 ug/l**	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Magnesium	Total	Lab		**9840 ug/l**	**9260 ug/l**	**10200 ug/l**	**10200 ug/l**	**10200 ug/l**	**10600 ug/l**	**9700 ug/l**	**10400 ug/l**	**10100 ug/l**	**10200 ug/l**	**10300 ug/l**	**10100 ug/l**	**10700 ug/l**	**10700 ug/l**	**10500 ug/l**	**10500 ug/l**	**10400 ug/l**
Manganese	Dissolved	Lab		**99.7 ug/l**	**95.6 ug/l**	**180 ug/l**	**173 ug/l**	**170 ug/l**	**171 ug/l**	**162 ug/l**	**154 ug/l**	**147 ug/l**	**150 ug/l**	**168 ug/l**	**169 ug/l**	**167 ug/l**	**172 ug/l**	**173 ug/l**	**161 ug/l**	**162 ug/l**
Manganese	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	Total	Lab		**0.0009 ug/l**	**0.0011 ug/l**	< 0.0005 ug/l	< 0.0005 ug/l	< 0.0005 ug/l	< 0.0005 ug/l	< 0.0005 ug/l	< 0.0005 ug/l	< 0.0005 ug/l	< 0.0005 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l
Mercury methyl	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Dissolved	Lab		**2.31 ug/l**	**2.52 ug/l**	**3.66 ug/l**	**3.64 ug/l**	**2.5 ug/l**	**2.54 ug/l**	**1.5 ug/l**	**1.4 ug/l**	**1.39 ug/l**	**1.45 ug/l**	**1.4 ug/l**	**1.4 ug/l**	**1.5 ug/l**	**2.2 ug/l**	**2.2 ug/l**	**1.7 ug/l**	**1.6 ug/l**
Molybdenum	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	Dissolved	Lab		< 0.6 ug/l	**1.48 ug/l**	< 0.6 ug/l	< 0.6 ug/l	< 0.6 ug/l	< 0.6 ug/l	< 0.60 ug/l	< 0.60 ug/l	< 0.6 ug/l	**0.76 ug/l**	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Nickel	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Palladium	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab		**2330 ug/l**	**2140 ug/l**	**2130 ug/l**	**2080 ug/l**	**1890 ug/l**	**1980 ug/l**	**1800 ug/l**	**1900 ug/l**	**1830 ug/l**	**1830 ug/l**	**1900 ug/l**	**1900 ug/l**	**1900 ug/l**	**1900 ug/l**	**1900 ug/l**	**1900 ug/l**	**1900 ug/l**
Selenium	Dissolved	Lab		< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1 ug/l	< 1 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l
Selenium	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	Dissolved	Lab		< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Silver	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sodium	Total	Lab		**4560 ug/l**	**4470 ug/l**	**3610 ug/l**	**3730 ug/l**	**3740 ug/l**	**3860 ug/l**	**3500 ug/l**	**3800 ug/l**	**3780 ug/l**	**3820 ug/l**	**3800 ug/l**	**3700 ug/l**	**3800 ug/l**	**3900 ug/l**	**3800 ug/l**	**3900 ug/l**	**3900 ug/l**
Strontium	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab		< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Titanium	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Dissolved	Lab		< 10 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5 ug/l	< 5 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l
Zinc	Dissolved	Lab		< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6 ug/l	< 6 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	**6.3 b ug/l**	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l
Zinc	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Large Table 3
Groundwater Data Summary
Mine Site Surficial Aquifer

Location			MW-6D		MW-6D	MW-6D	MW-6D		MW-6S	MW-6S	MW-6S	MW-6S	MW-6S	MW-6S	MW-6S		MW-6S	MW-6S	MW-6S	MW-6S
Date			8/7/2012		10/11/2012	7/17/2013	10/25/2013		11/8/2011	12/9/2011	1/10/2012	2/15/2012	3/6/2012	4/6/2012	5/2/2012		6/7/2012	7/10/2012	8/7/2012	10/11/2012
Sample Type			N	FD	N	N	N	FD	N	N	N	N	N	N	N	FD	N	N	N	N
	Fraction	Analysis Location																		
General Parameters																				
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total	NA	Lab	**82.3 mg/l**	**87.3 mg/l**	**89.3 mg/l**	**91.0 mg/l**	**121 mg/l**	--	**79.6 mg/l**	**85.6 mg/l**	**85.2 mg/l**	**86.9 mg/l**	**87.0 mg/l**	**80.7 mg/l**	**76.8 mg/l**	**76.6 mg/l**	**67.9 mg/l**	**64.0 mg/l**	**64.9 mg/l**	**87.3 mg/l**
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	**1.7 mg/l**	**1.7 mg/l**	**1.9 mg/l**	**1.7 mg/l**	**1.9 mg/l**	--	**2.5 mg/l**	**3.1 mg/l**	**3.4 mg/l**	**2.97 mg/l**	**3.0 b mg/l**	**2.4 mg/l**	**2.0 mg/l**	**2.0 mg/l**	**2.0 mg/l**	**1.9 mg/l**	**1.8 mg/l**	**1.8 mg/l**
Carbon, total organic	NA	Lab	**1.6 mg/l**	**1.8 mg/l**	**1.7 mg/l**	**1.9 mg/l**	**1.8 mg/l**	--	**2.0 mg/l**	**2.5 mg/l**	**2.5 mg/l**	**2.17 mg/l**	**2.3 mg/l**	**2.0 mg/l**	**1.7 mg/l**	**1.6 mg/l**	**1.5 mg/l**	**1.7 mg/l**	**1.3 mg/l**	**1.6 mg/l**
Chemical Oxygen Demand	NA	Lab	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	**46.8 mg/l**	--	**17.6 mg/l**	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	**13.8 mg/l**	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l
Chloride	NA	Lab	**0.58 mg/l**	**0.58 mg/l**	**0.55 mg/l**	< 0.50 mg/l	< 1.0 mg/l	--	**0.63 mg/l**	**0.63 mg/l**	**0.69 mg/l**	< 0.5 mg/l	< 0.5 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	**0.55 mg/l**	**0.61 mg/l**	**0.61 mg/l**
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	**1.76 mg/l**	--	**1.73 mg/l**	**0.01 mg/l**	**0.01 mg/l**	--	**0.96 mg/l**	**5.41 mg/l**	**1.83 mg/l**	**1.93 mg/l**	**1.76 mg/l**	--	**2.83 mg/l**	--	**4.53 mg/l**	**5.09 mg/l**	**2.16 mg/l**	**1.78 mg/l**
Fluoride	NA	Lab	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	**0.10 mg/l**	--	< 0.1 mg/l	**0.12 mg/l**	**0.11 mg/l**	< 0.1 mg/l	< 0.1 mg/l	< 0.10 mg/l	**0.10 mg/l**	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l
Hardness, total, as CaCO3	NA	Lab	**96.8 mg/l**	**93.6 mg/l**	**95.5 mg/l**	**93.9 mg/l**	**95.5 mg/l**	--	**85.8 mg/l**	**94.2 mg/l**	**90.8 mg/l**	**98.5 mg/l**	**91.4 mg/l**	**88.2 mg/l**	**84.2 mg/l**	**83.1 mg/l**	**71.2 mg/l**	**68.3 mg/l**	**84.9 mg/l**	**91.4 mg/l**
Nitrate + Nitrite, as N	NA	Lab	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	--	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l
Nitrogen, ammonia (NH3), as N	NA	Lab	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	--	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.050 mg/l	< 0.050 mg/l	< 0.050 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l
pH	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	**7.51 pH units**	--	**7.58 pH units**	**7.67 pH units**	**7.88 pH units**	--	**7.45 pH units**	**7.52 pH units**	**7.49 pH units**	**7.62 pH units**	**7.54 pH units**	--	**7.2 pH units**	--	**7.05 pH units**	**6.81 pH units**	**7.25 pH units**	**7.31 pH units**
Phosphorus, total	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Redox (oxidation potential)	NA	Field	**208 mV**	--	**279 mV**	**405 mV**	**160 mV**	--	**176 mV**	**300 mV**	**428 mV**	**330 mV**	**428 mV**	--	**335 mV**	--	**523 mV**	**303 mV**	**142 mV**	**286 mV**
Solids, total dissolved	NA	Lab	**129 mg/l**	**134 mg/l**	**143 mg/l**	**133 mg/l**	**139 mg/l**	--	**137 mg/l**	**138 mg/l**	**123 mg/l**	**140 mg/l**	**144 mg/l**	**134 h mg/l**	**134 mg/l**	**132 mg/l**	**179 mg/l**	**120 mg/l**	**99.0 mg/l**	**131 mg/l**
Specific Conductance @ 25oC	NA	Field	**186.9 umhos/cm**	--	**93.5 umhos/cm**	**180.6 umhos/cm**	**170.9 umhos/cm**	--	**182.8 umhos/cm**	**186.6 umhos/cm**	**89.7 umhos/cm**	**83.7 umhos/cm**	**192.7 umhos/cm**	--	**132.8 umhos/cm**	--	**111 umhos/cm**	**81.8 umhos/cm**	**173.7 umhos/cm**	**90.7 umhos/cm**
Sulfate	NA	Lab	**10.5 mg/l**	**10.5 mg/l**	**9.6 mg/l**	**9.8 mg/l**	**10.2 mg/l**	--	**11.5 mg/l**	**11 mg/l**	**10.5 mg/l**	**10.4 mg/l**	**9.92 mg/l**	**10.8 mg/l**	**10.9 mg/l**	**10.8 mg/l**	**10.2 mg/l**	**10.8 mg/l**	**11.1 mg/l**	**9.9 mg/l**
Temperature, degrees C	NA	Field	**10.38 deg C**	--	**8.74 deg C**	**8.4 deg C**	**6.41 deg C**	--	**8.09 deg C**	**8.88 deg C**	**6.11 deg C**	**4.73 deg C**	**8.44 deg C**	--	**9.68 deg C**	--	**9.5 deg C**	**10.1 deg C**	**11.17 deg C**	**10.79 deg C**
Turbidity	NA	Field	**0 NTU**	--	**0.8 NTU**	**3.6 NTU**	**0 NTU**	--	**1.1 NTU**	**0.4 NTU**	**0.1 NTU**	**0.1 NTU**	**0.8 NTU**	--	**0 NTU**	--	**0 NTU**	**0 NTU**	**0 NTU**	**1.3 NTU**
Metals																				
Aluminum	Dissolved	Lab	**91.7 b ug/l**	**36.3 b ug/l**	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	--	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25.0 ug/l	< 25 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	**21.9 ug/l**	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l
Aluminum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Antimony	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	Dissolved	Lab	**0.50 ug/l**	**0.64 ug/l**	**1.0 ug/l**	< 0.50 ug/l	**0.87 ug/l**	--	**0.78 ug/l**	**0.72 ug/l**	**0.84 ug/l**	**0.88 ug/l**	**0.92 ug/l**	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	**0.53 ug/l**	**0.86 ug/l**
Arsenic	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Total	Lab	**21.5 ug/l**	**21.1 ug/l**	**20.3 ug/l**	**16.4 ug/l**	**17.2 ug/l**	--	**20.4 ug/l**	**21.4 ug/l**	**20.6 ug/l**	**18.8 ug/l**	**18 ug/l**	**18.8 ug/l**	**18.8 ug/l**	**18.9 ug/l**	**18.0 ug/l**	**17.3 ug/l**	**18.7 ug/l**	**17.1 ug/l**
Beryllium	Total	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Boron	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	Total	Lab	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	--	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50.0 ug/l	< 50 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l
Cadmium	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Cadmium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Calcium	Total	Lab	**20700 ug/l**	**20100 ug/l**	**20100 ug/l**	**19100 ug/l**	**19600 ug/l**	--	**18500 ug/l**	**19600 ug/l**	**18700 ug/l**	**20900 ug/l**	**18800 ug/l**	**18400 ug/l**	**17700 ug/l**	**17500 ug/l**	**15200 ug/l**	**14600 ug/l**	**17800 ug/l**	**18900 ug/l**
Chromium	Dissolved	Lab	**1.1 b ug/l**	**1.2 b ug/l**	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	< 1.5 ug/l	< 1 ug/l	< 1 ug/l	**1.2 ug/l**	< 1 ug/l	**1.0 ug/l**	**1.1 ug/l**	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	**1.7 b ug/l**	< 1.0 ug/l
Chromium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	**0.36 ug/l**	**0.5 ug/l**	**0.48 ug/l**	**0.40 j ug/l**	**0.36 ug/l**	**0.33 ug/l**	**0.20 ug/l**	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Cobalt	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	**0.60 ug/l**	< 0.50 ug/l	< 0.50 ug/l	--	**3 ug/l**	**1.52 ug/l**	**0.75 ug/l**	**0.77 ug/l**	**1.12 ug/l**	**1.2 ug/l**	**0.94 ug/l**	**1.1 ug/l**	**0.82 ug/l**	**0.74 ug/l**	**0.80 ug/l**	**1.2 ug/l**
Copper	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Iron	Dissolved	Lab	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	--	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50.0 ug/l	**77.1 ug/l**	< 50.0 ug/l	**58.1 ug/l**	**79.4 ug/l**	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l
Iron	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Total	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	**0.65 ug/l**	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Magnesium	Total	Lab	**11000 ug/l**	**10600 ug/l**	**11000 ug/l**	**11200 ug/l**	**11300 ug/l**	--	**9620 ug/l**	**11000 ug/l**	**10700 ug/l**	**11300 ug/l**	**10800 ug/l**	**10300 ug/l**	**9700 ug/l**	**9500 ug/l**	**8100 ug/l**	**7700 ug/l**	**9800 ug/l**	**10700 ug/l**
Manganese	Dissolved	Lab	**158 ug/l**	**156 ug/l**	**143 ug/l**	**113 ug/l**	**116 ug/l**	--	**108 ug/l**	**238 ug/l**	**224 ug/l**	**217 ug/l**	**186 ug/l**	**137 ug/l**	**91.2 ug/l**	**86.4 ug/l**	**44.0 ug/l**	**26.7 ug/l**	**67.4 ug/l**	**99.7 ug/l**
Manganese	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	Total	Lab	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	**0.0009 ug/l**	< 0.0005 ug/l	< 0.0005 ug/l	< 0.0005 ug/l	< 0.0005 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	**0.00056 ug/l**	< 0.00050 ug/l
Mercury methyl	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Dissolved	Lab	**0.96 ug/l**	**0.94 ug/l**	**0.90 ug/l**	**0.96 ug/l**	**0.78 ug/l**	--	**3.59 ug/l**	**3.75 ug/l**	**3.67 ug/l**	**3.3 ug/l**	**3.54 ug/l**	**2.2 ug/l**	**2.3 ug/l**	**2.2 ug/l**	**2.5 ug/l**	**3.1 ug/l**	**4.1 ug/l**	**2.5 ug/l**
Molybdenum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	**1.92 ug/l**	**1.27 ug/l**	**0.95 ug/l**	**1.3 ug/l**	**0.76 ug/l**	**1.0 ug/l**	**0.70 ug/l**	**0.59 ug/l**	**0.63 ug/l**	< 0.50 ug/l	**0.88 ug/l**	< 0.50 ug/l
Nickel	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	**2100 ug/l**	**1900 ug/l**	**2100 ug/l**	**2000 ug/l**	**2000 ug/l**	--	**1960 ug/l**	**2150 ug/l**	**1930 ug/l**	**2000 ug/l**	**1820 ug/l**	**1900 ug/l**	**1800 ug/l**	**1800 ug/l**	**1700 ug/l**	**1700 ug/l**	**2000 ug/l**	**2200 ug/l**
Selenium	Dissolved	Lab	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1.0 ug/l	< 1 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l
Selenium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.50 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Silver	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sodium	Total	Lab	**3900 ug/l**	**3700 ug/l**	**4000 ug/l**	**3900 ug/l**	**3900 ug/l**	--	**4120 ug/l**	**3870 ug/l**	**3860 ug/l**	**4100 ug/l**	**4060 ug/l**	**3900 ug/l**	**3900 ug/l**	**3900 ug/l**	**3800 ug/l**	**4100 ug/l**	**4300 ug/l**	**4400 ug/l**
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Dissolved	Lab	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	--	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 5.0 ug/l	< 5 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l
Zinc	Dissolved	Lab	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	--	< 6 ug/l	**6.19 ug/l**	< 6 ug/l	< 6.0 ug/l	< 6 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	**7.2 ug/l**	< 6.0 ug/l	< 6.0 ug/l
Zinc	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Large Table 3
Groundwater Data Summary
Mine Site Surficial Aquifer

		Location	MW-6S	MW-6S		MW-6S	MW-7		MW-7	MW-7	MW-7	MW-7	MW-7		MW-7		MW-7		MW-7	
		Date	4/24/2013	7/17/2013		10/25/2013	11/9/2011		12/12/2011	1/24/2012	2/15/2012	3/7/2012	4/23/2012		5/30/2012		6/26/2012		7/30/2012	
		Sample Type	N	N	FD	N	N	FD	N	N	N	N	N	FD	N	FD	N	FD	N	FD
	Fraction	Analysis Location																		
General Parameters																				
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total	NA	Lab	**82.2 mg/l**	**64.8 mg/l**	--	**86.9 mg/l**	**36.5 mg/l**	**36.5 mg/l**	**39.2 mg/l**	**35.7 mg/l**	**35.2 mg/l**	**35.6 mg/l**	**39.0 mg/l**	**39.1 mg/l**	**35.7 mg/l**	**35.3 mg/l**	**31.6 mg/l**	**31.8 mg/l**	**33.7 mg/l**	**31.7 mg/l**
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	**1.6 mg/l**	**1.5 mg/l**	--	**2.0 mg/l**	**2.6 mg/l**	**2.6 mg/l**	**3.4 mg/l**	**2.5 mg/l**	**2.54 mg/l**	**2.7 b mg/l**	**2.1 mg/l**	**2.6 mg/l**	**2.1 mg/l**	**2.0 mg/l**	**2.2 mg/l**	**2.4 mg/l**	**1.5 mg/l**	**1.3 mg/l**
Carbon, total organic	NA	Lab	**1.2 mg/l**	**1.6 mg/l**	--	**1.6 mg/l**	**2.2 mg/l**	**2.3 mg/l**	**2.4 mg/l**	**2.1 mg/l**	**1.79 mg/l**	**1.8 mg/l**	**2.6 mg/l**	**2.2 mg/l**	**1.6 mg/l**	**1.7 mg/l**	**2.1 mg/l**	**1.9 mg/l**	**1.6 mg/l**	**1.0 mg/l**
Chemical Oxygen Demand	NA	Lab	< 10.0 mg/l	< 10.0 mg/l	--	**13.6 mg/l**	**11.4 mg/l**	**10.4 mg/l**	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	**13.0 mg/l**	< 10.0 h mg/l	**10.0 mg/l**	**10.5 mg/l**	**10.6 mg/l**	**11.6 mg/l**	< 10.0 mg/l	< 10.0 mg/l
Chloride	NA	Lab	< 0.50 mg/l	**0.62 mg/l**	--	< 1.0 mg/l	**0.63 mg/l**	**0.63 mg/l**	**0.67 mg/l**	**0.79 mg/l**	**0.61 mg/l**	**0.58 mg/l**	< 0.50 mg/l	< 0.50 mg/l	**0.70 mg/l**	**0.70 mg/l**	**0.85 mg/l**	**0.84 mg/l**	**0.95 mg/l**	**0.95 mg/l**
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	**0.23 mg/l**	**3.96 mg/l**	--	**0.01 mg/l**	**5.86 mg/l**	--	**4 mg/l**	**2.02 mg/l**	**9.64 mg/l**	**2.23 mg/l**	**2.1 mg/l**	--	**1.6 mg/l**	--	**1.62 mg/l**	--	**1.83 mg/l**	--
Fluoride	NA	Lab	< 0.10 mg/l	< 0.10 mg/l	--	**0.11 mg/l**	< 0.1 mg/l	< 0.1 mg/l	**0.1 mg/l**	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	**0.10 mg/l**	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l
Hardness, total, as CaCO3	NA	Lab	**81.8 mg/l**	**69.7 mg/l**	--	**94.1 mg/l**	**44 mg/l**	**43.2 mg/l**	**47.4 mg/l**	**39.6 mg/l**	**47.8 mg/l**	**40.5 mg/l**	**43.3 mg/l**	**43.5 mg/l**	**39.3 mg/l**	**39.9 mg/l**	**39.3 mg/l**	**38.9 mg/l**	**40.8 mg/l**	**40.8 mg/l**
Nitrate + Nitrite, as N	NA	Lab	< 0.10 mg/l	< 0.10 mg/l	--	< 0.10 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l
Nitrogen, ammonia (NH3), as N	NA	Lab	< 0.10 mg/l	< 0.10 mg/l	--	< 0.10 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	**0.13 b mg/l**	**0.080 b mg/l**	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l
pH	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	**7.36 pH units**	**6.94 pH units**	--	**7.5 pH units**	**7.08 pH units**	--	**7.01 pH units**	**7.08 pH units**	**7.26 pH units**	**7.49 pH units**	**6.99 pH units**	--	**7.28 pH units**	--	**7.37 pH units**	--	**7.33 pH units**	--
Phosphorus, total	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Redox (oxidation potential)	NA	Field	**288 mV**	**465 mV**	--	**348 mV**	**155 mV**	--	**296 mV**	**292 mV**	**352 mV**	**419 mV**	**624 mV**	--	**274 mV**	--	**192 mV**	--	**204 mV**	--
Solids, total dissolved	NA	Lab	**127 mg/l**	**123 mg/l**	--	**134 mg/l**	**110 mg/l**	**107 mg/l**	**72 mg/l**	< 10 mg/l	**72 mg/l**	**97 mg/l**	**89.0 mg/l**	**91.0 mg/l**	**75.0 mg/l**	**63.0 mg/l**	**65.0 mg/l**	**81.0 mg/l**	**50.0 h mg/l**	**62.0 h mg/l**
Specific Conductance @ 25oC	NA	Field	**168.7 umhos/cm**	**41.1 umhos/cm**	--	**67.4 umhos/cm**	**96.9 umhos/cm**	--	**102.2 umhos/cm**	**89.8 umhos/cm**	**90.5 umhos/cm**	**90.3 umhos/cm**	**97.4 umhos/cm**	--	**48.1 umhos/cm**	--	**80.4 umhos/cm**	--	**80.6 umhos/cm**	--
Sulfate	NA	Lab	**10.3 mg/l**	**9.9 mg/l**	--	**10.3 mg/l**	**9.89 mg/l**	**9.88 mg/l**	**9.54 mg/l**	**10.4 mg/l**	**9.98 mg/l**	**9.3 mg/l**	**7.8 mg/l**	**7.7 mg/l**	**9.7 mg/l**	**9.7 mg/l**	**10 mg/l**	**9.9 mg/l**	**10 mg/l**	**10.1 mg/l**
Temperature, degrees C	NA	Field	**4.06 deg C**	**8.6 deg C**	--	**7.38 deg C**	**7.42 deg C**	--	**7.85 deg C**	**9.14 deg C**	**11.34 deg C**	**7.87 deg C**	**6.6 deg C**	--	**5.59 deg C**	--	**11.36 deg C**	--	**12.01 deg C**	--
Turbidity	NA	Field	**0.3 NTU**	**3.4 NTU**	--	**0.1 NTU**	**5.1 NTU**	--	**7.7 NTU**	**2.7 NTU**	**16.5 NTU**	**0 NTU**	**0 NTU**	--	**0.2 NTU**	--	**0 NTU**	--	**0.4 NTU**	--
Metals																				
Aluminum	Dissolved	Lab	< 20.0 ug/l	< 20.0 ug/l	--	< 20.0 ug/l	**63.5 ug/l**	**68.1 ug/l**	< 25 ug/l	< 25 ug/l	< 25.0 ug/l	< 25 ug/l	**24.1 ug/l**	**25.9 ug/l**	< 20.0 ug/l	< 20.0 ug/l	**42.9 ug/l**	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l
Aluminum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Antimony	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	--	**0.86 ug/l**	**1.2 ug/l**	**1.23 ug/l**	**0.54 ug/l**	**0.58 ug/l**	**0.67 ug/l**	**0.63 ug/l**	< 0.50 ug/l	**0.51 ug/l**	**0.84 ug/l**	**0.98 ug/l**	**0.52 ug/l**	**1.2 ug/l**	< 0.50 ug/l	**0.62 ug/l**
Arsenic	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Total	Lab	**17.6 ug/l**	**15.4 ug/l**	--	**15.9 ug/l**	**16 ug/l**	**15.8 ug/l**	**15.7 ug/l**	**11.4 ug/l**	**24.8 ug/l**	**9.6 ug/l**	**10.7 ug/l**	**10.9 ug/l**	**8.5 ug/l**	**8.7 ug/l**	**7.8 ug/l**	**7.7 ug/l**	**7.5 ug/l**	**7.4 ug/l**
Beryllium	Total	Lab	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Boron	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	Total	Lab	< 50.0 ug/l	< 50.0 ug/l	--	< 50.0 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50.0 ug/l	< 50 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l
Cadmium	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Cadmium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Calcium	Total	Lab	**16700 ug/l**	**14700 ug/l**	--	**19400 ug/l**	**9760 ug/l**	**9480 ug/l**	**10200 ug/l**	**8080 ug/l**	**9800 ug/l**	**8010 ug/l**	**8800 ug/l**	**8900 ug/l**	**7700 ug/l**	**7900 ug/l**	**7800 ug/l**	**7700 ug/l**	**8100 ug/l**	**8000 ug/l**
Chromium	Dissolved	Lab	< 1.0 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	< 1.5 ug/l	< 1.5 ug/l	**1.55 ug/l**	< 1 ug/l	< 1.0 ug/l	**1.83 b ug/l**	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	**1.5 ug/l**	< 1.0 ug/l
Chromium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	**0.96 ug/l**	**1.02 ug/l**	**0.72 ug/l**	**0.32 ug/l**	**0.20 j ug/l**	< 0.2 ug/l	**0.43 ug/l**	**0.42 ug/l**	**0.26 ug/l**	**0.26 ug/l**	**0.24 ug/l**	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Cobalt	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	Dissolved	Lab	**0.69 ug/l**	**0.79 ug/l**	--	**0.76 ug/l**	**28 ug/l**	**29.8 ug/l**	**7.32 ug/l**	**2.67 ug/l**	**2.0 ug/l**	**1.61 ug/l**	**3.8 ug/l**	**3.5 b ug/l**	**1.2 ug/l**	**1.1 ug/l**	**1.7 ug/l**	**0.94 ug/l**	**1.3 ug/l**	**1.4 ug/l**
Copper	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Iron	Dissolved	Lab	< 50.0 ug/l	< 50.0 ug/l	--	< 50.0 ug/l	**610 ug/l**	**662 ug/l**	**216 ug/l**	**73.8 b ug/l**	**50.4 ug/l**	**71.5 ug/l**	**112 ug/l**	**125 ug/l**	**65.4 ug/l**	< 50.0 ug/l	**69.3 ug/l**	**72.2 ug/l**	< 50.0 ug/l	**51.1 ug/l**
Iron	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Total	Lab	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	**6.17 ug/l**	**6.21 ug/l**	**0.81 ug/l**	< 0.5 ug/l	**0.72 ug/l**	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Magnesium	Total	Lab	**9700 ug/l**	**8000 ug/l**	--	**11100 ug/l**	**4760 ug/l**	**4740 ug/l**	**5340 ug/l**	**4710 ug/l**	**5600 ug/l**	**4980 ug/l**	**5200 ug/l**	**5200 ug/l**	**4900 ug/l**	**4900 ug/l**	**4800 ug/l**	**4800 ug/l**	**5000 ug/l**	**5100 ug/l**
Manganese	Dissolved	Lab	**64.5 ug/l**	**13.9 ug/l**	--	**42.3 ug/l**	**154 ug/l**	**153 ug/l**	**253 ug/l**	**168 ug/l**	**123 ug/l**	**113 ug/l**	**160 ug/l**	**153 ug/l**	**130 ug/l**	**129 ug/l**	**72.7 ug/l**	**81.5 ug/l**	**69.9 ug/l**	**72.4 ug/l**
Manganese	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	Total	Lab	**0.00057 ug/l**	**0.00072 ug/l**	**0.00056 ug/l**	**0.00069 ug/l**	**0.0074 ug/l**	**0.0071 ug/l**	**0.0017 ug/l**	**0.0008 ug/l**	**0.0020 ug/l**	**0.0007 ug/l**	**0.0011 ug/l**	**0.0011 ug/l**	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l
Mercury methyl	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Dissolved	Lab	**1.4 ug/l**	**2.3 ug/l**	--	**1.8 ug/l**	**1.37 ug/l**	**1.36 ug/l**	**1.83 ug/l**	**1.46 ug/l**	**1.2 ug/l**	**1.3 ug/l**	**1.0 ug/l**	**1.0 ug/l**	**1.2 ug/l**	**1.3 ug/l**	**0.56 ug/l**	**1.1 ug/l**	**1.1 ug/l**	**1.1 ug/l**
Molybdenum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	Dissolved	Lab	**0.51 ug/l**	< 0.50 ug/l	--	< 0.50 ug/l	**1.17 ug/l**	**1.14 ug/l**	**1.43 ug/l**	< 0.6 ug/l	< 0.50 ug/l	**0.74 ug/l**	**1.2 ug/l**	**1.2 ug/l**	< 0.50 ug/l	< 0.50 ug/l	**0.55 ug/l**	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Nickel	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	**1800 ug/l**	**1700 ug/l**	--	**2100 ug/l**	**1250 ug/l**	**1240 ug/l**	**1170 ug/l**	**1080 ug/l**	**1300 ug/l**	**1100 ug/l**	**840 ug/l**	**850 ug/l**	**1000 ug/l**	**1100 ug/l**	**1100 ug/l**	**1100 ug/l**	**1100 ug/l**	**1100 ug/l**
Selenium	Dissolved	Lab	< 1.0 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1.0 ug/l	< 1 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l
Selenium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.50 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Silver	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sodium	Total	Lab	**3800 ug/l**	**4800 ug/l**	--	**4500 ug/l**	**2830 ug/l**	**2740 ug/l**	**2740 ug/l**	**2020 ug/l**	**2200 ug/l**	**1970 ug/l**	**2900 ug/l**	**2900 ug/l**	**2000 ug/l**	**2100 ug/l**	**1800 ug/l**	**1800 ug/l**	**1900 ug/l**	**1900 ug/l**
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab	< 0.20 ug/l	**0.24 ug/l**	--	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Dissolved	Lab	< 5.0 ug/l	< 5.0 ug/l	--	< 5.0 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 5.0 ug/l	< 5 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l
Zinc	Dissolved	Lab	< 6.0 ug/l	< 6.0 ug/l	--	< 6.0 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6.0 ug/l	< 6 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l
Zinc	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Large Table 3
Groundwater Data Summary
Mine Site Surficial Aquifer

Location			MW-7	MW-7		MW-7	MW-7		MW-7		MW-8D		MW-8D	MW-8D	MW-8D		MW-8D	
Date			8/20/2012	10/12/2012		4/18/2013	7/31/2013		10/23/2013		12/21/2011		1/9/2012	2/3/2012	3/16/2012		4/27/2012	
Sample Type			N	N	FD	N	N	FD	N	FD	N	FD	N	N	N	FD	N	FD
	Fraction	Analysis Location																
General Parameters																		
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total	NA	Lab	**32.9 * mg/l**	**51.1 mg/l**	**51.4 mg/l**	**37.4 mg/l**	**32.0 mg/l**	**32.3 mg/l**	**59.6 mg/l**	--	**120 mg/l**	**120 mg/l**	**118 mg/l**	**120 mg/l**	**121 mg/l**	**123 mg/l**	**126 mg/l**	**125 mg/l**
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	**1.6 mg/l**	**1.6 mg/l**	**1.5 mg/l**	**1.4 mg/l**	**1.5 mg/l**	< 2.0 mg/l	**1.1 mg/l**	--	**5.5 mg/l**	**5.5 mg/l**	**4.6 mg/l**	**4.98 mg/l**	**4.7 mg/l**	**5.3 mg/l**	**4.4 mg/l**	**4.6 mg/l**
Carbon, total organic	NA	Lab	**1.3 mg/l**	**1.4 mg/l**	**1.3 mg/l**	**1.1 mg/l**	**1.0 mg/l**	< 1.0 mg/l	**1.0 mg/l**	--	**4.6 mg/l**	**4.5 mg/l**	**4.3 mg/l**	**4.13 mg/l**	**4.4 mg/l**	**4.5 mg/l**	**4.3 mg/l**	**4.6 mg/l**
Chemical Oxygen Demand	NA	Lab	< 10.0 mg/l	**10.2 mg/l**	< 10.0 mg/l	**14.0 mg/l**	< 10.0 mg/l	< 10.0 mg/l	**16.4 mg/l**	--	**16.6 mg/l**	**17.3 mg/l**	**11.6 mg/l**	< 10 mg/l	**17.6 mg/l**	**12 mg/l**	< 10.0 mg/l	< 10.0 mg/l
Chloride	NA	Lab	**0.94 mg/l**	**0.86 mg/l**	**0.87 mg/l**	**0.72 mg/l**	**0.86 mg/l**	**0.86 mg/l**	**1.1 mg/l**	--	**0.8 mg/l**	**0.82 mg/l**	**0.88 mg/l**	< 0.5 mg/l	< 0.5 mg/l	< 0.5 mg/l	< 0.50 mg/l	< 0.50 mg/l
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	**1.29 mg/l**	**2.25 mg/l**	--	**0.67 mg/l**	**0.55 mg/l**	--	**0.07 mg/l**	--	**1.02 mg/l**	--	**1.84 mg/l**	< 0.1 mg/l	**1.48 mg/l**	--	**1.72 mg/l**	--
Fluoride	NA	Lab	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	--	**0.17 mg/l**	**0.17 mg/l**	**0.16 mg/l**	**0.15 mg/l**	**0.16 mg/l**	**0.17 mg/l**	**0.16 mg/l**	**0.16 mg/l**
Hardness, total, as CaCO3	NA	Lab	**39.1 mg/l**	**39.9 mg/l**	**39.6 mg/l**	**46.4 mg/l**	**41.4 mg/l**	**40.5 mg/l**	**65.3 mg/l**	--	**125 mg/l**	**125 mg/l**	**129 mg/l**	**129 mg/l**	**130 mg/l**	**129 mg/l**	**134 mg/l**	**137 mg/l**
Nitrate + Nitrite, as N	NA	Lab	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	**0.17 mg/l**	--	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.10 mg/l	< 0.10 mg/l
Nitrogen, ammonia (NH3), as N	NA	Lab	**0.15 mg/l**	< 0.10 mg/l	< 0.10 mg/l	**0.20 mg/l**	**0.13 mg/l**	< 0.10 mg/l	< 0.10 mg/l	--	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.050 mg/l	**0.090 b mg/l**
pH	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	**7.36 pH units**	**7.69 pH units**	--	**7.34 pH units**	**7.57 pH units**	--	**7.48 pH units**	--	**7.32 pH units**	--	**7.41 pH units**	**7.12 pH units**	**7.1 pH units**	--	**7.74 pH units**	--
Phosphorus, total	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Redox (oxidation potential)	NA	Field	**148 mV**	**295 mV**	--	**401 mV**	**319 mV**	--	**312 mV**	--	**140 mV**	--	**123 mV**	**144 mV**	**123 mV**	--	**335 mV**	--
Solids, total dissolved	NA	Lab	**104 mg/l**	**82.0 mg/l**	**80.0 mg/l**	**74.0 mg/l**	**86.0 mg/l**	**87.0 mg/l**	**114 mg/l**	--	**173 mg/l**	**169 mg/l**	**150 mg/l**	**156 mg/l**	**190 mg/l**	**183 mg/l**	**201 mg/l**	**196 mg/l**
Specific Conductance @ 25oC	NA	Field	**79.8 umhos/cm**	**83.3 umhos/cm**	--	**81.8 umhos/cm**	**84.1 umhos/cm**	--	**84.3 umhos/cm**	--	**253.4 umhos/cm**	--	**258.4 umhos/cm**	**252.4 umhos/cm**	**247.5 umhos/cm**	--	**219 umhos/cm**	--
Sulfate	NA	Lab	**9.5 mg/l**	**8.4 mg/l**	**8.4 mg/l**	**8.3 mg/l**	**10.1 mg/l**	**10.1 mg/l**	**9.7 mg/l**	--	**7.26 mg/l**	**7.24 mg/l**	**7 mg/l**	**6.82 mg/l**	**6.2 mg/l**	**6.32 mg/l**	**6.4 mg/l**	**6.3 mg/l**
Temperature, degrees C	NA	Field	**12.11 deg C**	**9.07 deg C**	--	**5.06 deg C**	**9 deg C**	--	**7.53 deg C**	--	**6.05 deg C**	--	**6.6 deg C**	**7.56 deg C**	**9.42 deg C**	--	**7.73 deg C**	--
Turbidity	NA	Field	**0 NTU**	**2.2 NTU**	--	**1.8 NTU**	**0 NTU**	--	**0 NTU**	--	**4.5 NTU**	--	**0.6 NTU**	**0.6 NTU**	**1.4 NTU**	--	**0.7 NTU**	--
Metals																		
Aluminum	Dissolved	Lab	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	**23.4 ug/l**	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	--	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 20 ug/l	< 20 ug/l	< 20.0 ug/l	< 20.0 ug/l
Aluminum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l
Antimony	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	Dissolved	Lab	**0.98 ug/l**	**0.91 ug/l**	**0.90 ug/l**	**0.51 ug/l**	**0.98 ug/l**	**1.1 ug/l**	**0.80 ug/l**	--	**1.76 ug/l**	**1.82 ug/l**	**2.2 ug/l**	**2.12 ug/l**	**2.18 ug/l**	**2.16 ug/l**	**2.5 ug/l**	**2.4 ug/l**
Arsenic	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Total	Lab	**6.7 ug/l**	**6.9 ug/l**	**6.8 ug/l**	**7.9 ug/l**	**6.4 ug/l**	**6.4 ug/l**	**5.2 ug/l**	--	**25.4 ug/l**	**25.3 ug/l**	**23.6 ug/l**	**22.8 ug/l**	**19.6 ug/l**	**19.9 ug/l**	**17.8 ug/l**	**17.7 ug/l**
Beryllium	Total	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l
Boron	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	Total	Lab	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	--	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50.0 ug/l	< 50.0 ug/l
Cadmium	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l
Cadmium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Calcium	Total	Lab	**7600 ug/l**	**7900 ug/l**	**7800 ug/l**	**8900 ug/l**	**8100 ug/l**	**7900 ug/l**	**13500 ug/l**	--	**29800 ug/l**	**29800 ug/l**	**31000 ug/l**	**30900 ug/l**	**31600 ug/l**	**31500 ug/l**	**32200 ug/l**	**33100 ug/l**
Chromium	Dissolved	Lab	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1.0 ug/l	< 1.0 ug/l
Chromium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	**0.52 ug/l**	**0.5 ug/l**	**0.37 ug/l**	**0.36 ug/l**	**0.34 ug/l**	**0.35 ug/l**	**0.24 ug/l**	**0.24 ug/l**
Cobalt	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	Dissolved	Lab	**1.0 ug/l**	**2.1 ug/l**	**1.8 ug/l**	**1.9 ug/l**	**0.72 ug/l**	**0.68 ug/l**	< 0.50 ug/l	--	< 0.7 ug/l	< 0.7 ug/l	**0.7 ug/l**	< 0.7 ug/l	< 0.7 ug/l	< 0.7 ug/l	< 0.50 ug/l	< 0.50 ug/l
Copper	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Iron	Dissolved	Lab	< 50.0 ug/l	**54.2 ug/l**	< 50.0 ug/l	**64.9 ug/l**	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	--	**1270 ug/l**	**1260 ug/l**	**1290 ug/l**	**1050 ug/l**	**1150 ug/l**	**1160 ug/l**	**1210 ug/l**	**1190 ug/l**
Iron	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Total	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l
Magnesium	Total	Lab	**4900 ug/l**	**4900 ug/l**	**4900 ug/l**	**5900 ug/l**	**5100 ug/l**	**5000 ug/l**	**7700 ug/l**	--	**12300 ug/l**	**12400 ug/l**	**12500 ug/l**	**12600 ug/l**	**12400 ug/l**	**12200 ug/l**	**13000 ug/l**	**13100 ug/l**
Manganese	Dissolved	Lab	**61.6 ug/l**	**55.6 ug/l**	**56.6 ug/l**	**25.8 ug/l**	**45.0 ug/l**	**40.8 ug/l**	< 0.50 ug/l	--	**534 ug/l**	**529 ug/l**	**633 ug/l**	**708 ug/l**	**753 ug/l**	**767 ug/l**	**754 ug/l**	**741 ug/l**
Manganese	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	Total	Lab	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	**0.00078 ug/l**	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	**0.00080 ug/l**	< 0.0005 ug/l	< 0.0005 ug/l	< 0.0005 ug/l	< 0.0005 ug/l	< 0.0005 ug/l	< 0.0005 ug/l	< 0.00050 ug/l	< 0.00050 ug/l
Mercury methyl	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Dissolved	Lab	**0.99 ug/l**	**0.99 ug/l**	**1.0 ug/l**	**1.0 ug/l**	**1.2 ug/l**	**1.1 ug/l**	**0.73 ug/l**	--	**1.57 ug/l**	**1.6 ug/l**	**1.28 ug/l**	**1.54 ug/l**	**1.24 ug/l**	**1.22 ug/l**	**1.1 ug/l**	**1.1 ug/l**
Molybdenum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	Dissolved	Lab	**0.70 ug/l**	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	**1.04 ug/l**	**1.09 ug/l**	< 0.6 ug/l	< 0.6 ug/l	< 0.6 ug/l	< 0.6 ug/l	< 0.50 ug/l	< 0.50 ug/l
Nickel	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	**1100 ug/l**	**1100 ug/l**	**1200 ug/l**	**1100 ug/l**	**1200 ug/l**	**1200 ug/l**	**1600 ug/l**	--	**1410 ug/l**	**1390 ug/l**	**1300 ug/l**	**1210 ug/l**	**1370 ug/l**	**1330 ug/l**	**1300 ug/l**	**1300 ug/l**
Selenium	Dissolved	Lab	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1.0 ug/l	< 1.0 ug/l
Selenium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l
Silver	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sodium	Total	Lab	**1900 ug/l**	**2000 ug/l**	**2000 ug/l**	**2600 ug/l**	**1900 ug/l**	**1800 ug/l**	**3300 ug/l**	--	**4000 ug/l**	**3950 ug/l**	**4360 ug/l**	**4710 ug/l**	**4690 ug/l**	**4660 ug/l**	**4500 ug/l**	**4600 ug/l**
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.017 ug/l	< 0.017 ug/l	< 0.20 ug/l	--	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Dissolved	Lab	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	--	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 5 ug/l	< 5 ug/l	< 5.0 ug/l	< 5.0 ug/l
Zinc	Dissolved	Lab	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	--	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6.0 ug/l	< 6.0 ug/l
Zinc	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Large Table 3
Groundwater Data Summary
Mine Site Surficial Aquifer

Location			MW-8D		MW-8D		MW-8D		MW-8D		MW-8D	MW-8D		MW-8D	MW-8D	MW-8S		MW-8S	
Date			5/24/2012		6/18/2012		7/20/2012		8/16/2012		10/8/2012	4/18/2013		7/29/2013	10/24/2013	11/7/2011		12/13/2011	
Sample Type			N	FD	N	FD	N	FD	N	FD	N	N	FD	N	N	N	FD	N	FD
	Fraction	Analysis Location																	
General Parameters																			
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total	NA	Lab	**123 mg/l**	**119 mg/l**	**125 mg/l**	**124 mg/l**	**120 mg/l**	**116 mg/l**	**120 mg/l**	**123 mg/l**	**122 mg/l**	**127 mg/l**	--	**122 mg/l**	**121 mg/l**	**69.3 mg/l**	**69.1 mg/l**	**76.7 mg/l**	**76.8 mg/l**
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	**4.2 mg/l**	**4.2 mg/l**	**4.0 mg/l**	**4.0 mg/l**	**3.8 mg/l**	**4.4 mg/l**	**5.8 mg/l**	**4.7 mg/l**	**3.8 mg/l**	**3.7 mg/l**	--	**3.0 mg/l**	**3.3 mg/l**	**2.0 mg/l**	**2.5 mg/l**	**2.6 mg/l**	**2.4 mg/l**
Carbon, total organic	NA	Lab	**3.8 mg/l**	**3.9 mg/l**	**3.5 mg/l**	**3.5 mg/l**	**4.0 mg/l**	**3.6 mg/l**	**4.5 mg/l**	**3.4 mg/l**	**3.4 mg/l**	**3.3 mg/l**	--	**3.6 mg/l**	**3.2 mg/l**	**1.8 mg/l**	**2.1 mg/l**	**2.4 mg/l**	**1.9 mg/l**
Chemical Oxygen Demand	NA	Lab	**16.3 mg/l**	**14.4 mg/l**	**18.6 mg/l**	**13.2 mg/l**	< 10.0 mg/l	< 10.0 mg/l	**18.8 mg/l**	**11.9 mg/l**	< 10.0 mg/l	**17.5 mg/l**	--	**17.2 mg/l**	**24.0 mg/l**	**12.6 mg/l**	**11.6 mg/l**	**10.5 mg/l**	**12.2 mg/l**
Chloride	NA	Lab	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	**0.54 mg/l**	**0.54 mg/l**	**0.61 mg/l**	**0.61 mg/l**	**0.81 mg/l**	< 0.50 mg/l	--	**0.54 mg/l**	< 1.0 mg/l	**0.77 mg/l**	**0.77 mg/l**	**0.9 mg/l**	**0.9 mg/l**
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	**1.48 mg/l**	--	**1.2 mg/l**	--	**1.37 mg/l**	--	**1.76 mg/l**	--	**3.21 mg/l**	< 0.1 mg/l	--	< 0.1 mg/l	< 0.1 mg/l	**2.78 mg/l**	--	**6.48 mg/l**	--
Fluoride	NA	Lab	**0.10 mg/l**	**0.10 mg/l**	**0.16 mg/l**	**0.15 mg/l**	**0.13 mg/l**	**0.13 mg/l**	**0.16 mg/l**	**0.16 mg/l**	**0.15 mg/l**	**0.14 mg/l**	--	**0.14 mg/l**	**0.15 mg/l**	< 0.1 mg/l	< 0.1 mg/l	**0.14 mg/l**	**0.14 mg/l**
Hardness, total, as CaCO3	NA	Lab	**125 mg/l**	**124 mg/l**	**126 mg/l**	**127 mg/l**	**127 mg/l**	**128 mg/l**	**124 mg/l**	**125 mg/l**	**127 mg/l**	**135 mg/l**	--	**123 mg/l**	**128 mg/l**	**77.5 mg/l**	**78.7 mg/l**	**87.2 mg/l**	**87 mg/l**
Nitrate + Nitrite, as N	NA	Lab	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	**0.16 mg/l**	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	--	< 0.10 mg/l	< 0.10 mg/l	**0.23 mg/l**	**0.22 mg/l**	**0.18 mg/l**	**0.2 mg/l**
Nitrogen, ammonia (NH3), as N	NA	Lab	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	--	**0.13 mg/l**	**0.28 mg/l**	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l
pH	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	**7.57 pH units**	--	**7.38 pH units**	--	**7.26 pH units**	--	**7.21 pH units**	--	**7.17 pH units**	**7.5 pH units**	--	**7.46 pH units**	**7.54 pH units**	**6.10 pH units**	--	**6.77 pH units**	--
Phosphorus, total	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Redox (oxidation potential)	NA	Field	**136 mV**	--	**124 mV**	--	**82 mV**	--	**178 mV**	--	**-103 mV**	**137 mV**	--	**73 mV**	**-105 mV**	**712 mV**	--	**357 mV**	--
Solids, total dissolved	NA	Lab	**180 mg/l**	**183 mg/l**	**189 mg/l**	**174 mg/l**	**177 mg/l**	**178 mg/l**	**176 mg/l**	**179 mg/l**	**184 mg/l**	**183 mg/l**	--	**189 mg/l**	**186 mg/l**	**153 mg/l**	**142 mg/l**	**133 mg/l**	**145 mg/l**
Specific Conductance @ 25oC	NA	Field	**212.6 umhos/cm**	--	**214.7 umhos/cm**	--	**244.3 umhos/cm**	--	**249.3 umhos/cm**	--	**248.2 umhos/cm**	**240.6 umhos/cm**	--	**243.1 umhos/cm**	**48.9 umhos/c**	**166 umhos/cm**	--	**196.7 umhos/cm**	--
Sulfate	NA	Lab	**6.7 mg/l**	**6.6 mg/l**	**6.4 mg/l**	**6.5 mg/l**	**6.9 mg/l**	**6.9 mg/l**	**6.8 mg/l**	**6.8 mg/l**	**6.4 mg/l**	**6.6 mg/l**	--	**6.7 mg/l**	**6.9 mg/l**	**11.7 mg/l**	**11.7 mg/l**	**19.6 mg/l**	**19.6 mg/l**
Temperature, degrees C	NA	Field	**8.49 deg C**	--	**12.41 deg C**	--	**9.49 deg C**	--	**9.16 deg C**	--	**6.82 deg C**	**6.02 deg C**	--	**10.33 deg C**	**6.54 deg C**	**7.23 deg C**	--	**9.49 deg C**	--
Turbidity	NA	Field	**0 NTU**	--	**0 NTU**	--	**0 NTU**	--	**0 NTU**	--	**0 NTU**	**0.9 NTU**	--	**0 NTU**	**0 NTU**	**10.3 NTU**	--	**1.2 NTU**	--
Metals																			
Aluminum	Dissolved	Lab	< 20.0 ug/l	**30.2 ug/l**	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	**83.6 ug/l**	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	--	< 20.0 ug/l	< 20.0 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l
Aluminum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l
Antimony	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	Dissolved	Lab	**2.1 ug/l**	**1.9 ug/l**	**2.2 ug/l**	**2.3 ug/l**	**2.2 ug/l**	**2.2 ug/l**	**2.3 ug/l**	**2.1 ug/l**	**2.6 ug/l**	**2.4 ug/l**	--	**2.4 ug/l**	**2.3 ug/l**	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l
Arsenic	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Total	Lab	**16.5 ug/l**	**16.7 ug/l**	**14.2 ug/l**	**14.3 ug/l**	**13.4 ug/l**	**13.6 ug/l**	**12.6 ug/l**	**12.4 ug/l**	**11.7 ug/l**	**10.1 ug/l**	--	**10.2 ug/l**	**10.5 ug/l**	**20.3 ug/l**	**23.6 ug/l**	**21.3 ug/l**	**21.5 ug/l**
Beryllium	Total	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l
Boron	Dissolved	Lab	--	--	--	--	--	--	--	--	--	< 50.0 ug/l	--	--	--	--	--	--	--
Boron	Total	Lab	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	--	< 50.0 ug/l	< 50.0 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l
Cadmium	Dissolved	Lab	< 0.20 ug/l	**0.21 ug/l**	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l
Cadmium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Calcium	Total	Lab	**30300 ug/l**	**30200 ug/l**	**30800 ug/l**	**31100 ug/l**	**30900 ug/l**	**31200 ug/l**	**30100 ug/l**	**30300 ug/l**	**31400 ug/l**	**32600 ug/l**	--	**30000 ug/l**	**31000 ug/l**	**17500 ug/l**	**17800 ug/l**	**19800 ug/l**	**19600 ug/l**
Chromium	Dissolved	Lab	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	< 1.0 ug/l	< 1.5 ug/l	< 1.5 ug/l	< 1 ug/l	< 1 ug/l
Chromium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	Dissolved	Lab	**0.22 ug/l**	**0.21 ug/l**	< 0.20 ug/l	**0.21 ug/l**	**0.20 ug/l**	**0.21 ug/l**	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	**0.27 ug/l**	**0.28 ug/l**	**1.18 ug/l**	**1.16 ug/l**
Cobalt	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	**0.84 ug/l**	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	**0.83 ug/l**	**0.84 ug/l**	**0.92 ug/l**	< 0.7 ug/l
Copper	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Iron	Dissolved	Lab	**1260 ug/l**	**1220 ug/l**	**1300 ug/l**	**1330 ug/l**	**1350 ug/l**	**1420 ug/l**	**1120 ug/l**	**1130 ug/l**	**1620 ug/l**	**1230 ug/l**	--	**1370 ug/l**	**1630 ug/l**	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l
Iron	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Total	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	< 0.5 ug/l	**0.56 ug/l**	< 0.5 ug/l	< 0.5 ug/l
Magnesium	Total	Lab	**11900 ug/l**	**11700 ug/l**	**11800 ug/l**	**12000 ug/l**	**12000 ug/l**	**12200 ug/l**	**11900 ug/l**	**11900 ug/l**	**11900 ug/l**	**12900 ug/l**	--	**11800 ug/l**	**12400 ug/l**	**8200 ug/l**	**8310 ug/l**	**9180 ug/l**	**9230 ug/l**
Manganese	Dissolved	Lab	**752 ug/l**	**757 ug/l**	**744 ug/l**	**758 ug/l**	**748 ug/l**	**752 ug/l**	**635 ug/l**	**661 ug/l**	**699 ug/l**	**695 ug/l**	--	**656 ug/l**	**669 ug/l**	**130 ug/l**	**131 ug/l**	**1270 ug/l**	**1240 ug/l**
Manganese	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	Total	Lab	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	**0.0013 ug/l**	**0.0013 ug/l**	**0.0007 ug/l**	**0.0007 ug/l**
Mercury methyl	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Dissolved	Lab	**1.3 ug/l**	**1.2 ug/l**	**1.1 ug/l**	**1.2 ug/l**	**0.88 ug/l**	**0.84 ug/l**	**0.82 ug/l**	**0.86 ug/l**	**1.0 ug/l**	**0.87 ug/l**	--	**0.82 ug/l**	**0.80 ug/l**	**1.05 ug/l**	**1.07 ug/l**	**2.19 ug/l**	**2.16 ug/l**
Molybdenum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	**0.59 ug/l**	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	**2.3 ug/l**	**2.58 ug/l**	**2.47 ug/l**	**2.46 ug/l**
Nickel	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	**1200 ug/l**	**1200 ug/l**	**1200 ug/l**	**1200 ug/l**	**1200 ug/l**	**1300 ug/l**	**1300 ug/l**	**1200 ug/l**	**1200 ug/l**	**1300 ug/l**	--	**1200 ug/l**	**1300 ug/l**	**1050 ug/l**	**1110 ug/l**	**1040 ug/l**	**1010 ug/l**
Selenium	Dissolved	Lab	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	< 1.0 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l
Selenium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l
Silver	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sodium	Total	Lab	**4300 ug/l**	**4300 ug/l**	**4400 ug/l**	**4500 ug/l**	**4400 ug/l**	**4500 ug/l**	**4400 ug/l**	**4400 ug/l**	**4500 ug/l**	**4700 ug/l**	--	**4500 ug/l**	**4600 ug/l**	**5120 ug/l**	**5220 ug/l**	**7500 ug/l**	**7430 ug/l**
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.017 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Dissolved	Lab	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	--	< 5.0 ug/l	< 5.0 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l
Zinc	Dissolved	Lab	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	**9.5 ug/l**	< 6.0 ug/l	< 6.0 ug/l	--	< 6.0 ug/l	< 6.0 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l
Zinc	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Large Table 3
Groundwater Data Summary
Mine Site Surficial Aquifer

		Location	MW-8S	MW-8S		MW-8S	MW-8S	MW-8S	MW-8S	MW-8S	MW-8S		MW-8S	MW-8S	MW-8S		MW-8S		MW-9	MW-9
		Date	1/9/2012	2/13/2012		3/16/2012	4/27/2012	5/24/2012	6/18/2012	7/20/2012	10/8/2012		8/16/2012	4/18/2013	7/29/2013		10/24/2013		12/20/2011	1/23/2012
		Sample Type	N	N	FD	N	N	N	N	N	N	FD	N	N	N	FD	N	FD	N	N
	Fraction	Analysis Location																		
General Parameters																				
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total	NA	Lab	**86.5 mg/l**	**74.2 mg/l**	**73.2 mg/l**	**76.2 mg/l**	**120 mg/l**	**99.2 mg/l**	**116 mg/l**	**98.6 mg/l**	**77.1 mg/l**	**84.2 mg/l**	**93.5 mg/l**	**263 mg/l**	**89.6 mg/l**	--	**75.1 mg/l**	**77.4 mg/l**	**50.4 mg/l**	**55.8 mg/l**
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	**2.2 mg/l**	**2.72 b mg/l**	**2.80 b mg/l**	**2.5 mg/l**	**3.9 mg/l**	**2.9 mg/l**	**2.6 mg/l**	**2.6 mg/l**	**1.7 mg/l**	**1.6 mg/l**	**2.3 mg/l**	**1.9 mg/l**	**1.8 mg/l**	--	**2.6 mg/l**	**2.2 mg/l**	**24.3 mg/l**	**25.8 mg/l**
Carbon, total organic	NA	Lab	**1.7 mg/l**	**1.63 b mg/l**	**1.72 b mg/l**	**2.1 mg/l**	**3.0 mg/l**	**2.5 mg/l**	**2.1 mg/l**	**1.8 mg/l**	**1.4 mg/l**	**1.4 mg/l**	**1.6 mg/l**	**1.4 mg/l**	**2.2 mg/l**	--	**2.2 mg/l**	**2.3 mg/l**	**23.2 mg/l**	**25.1 mg/l**
Chemical Oxygen Demand	NA	Lab	< 10 mg/l	< 10 mg/l	**10.8 mg/l**	< 10 mg/l	< 10.0 mg/l	**12.1 mg/l**	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	**10.3 mg/l**	**12.9 mg/l**	--	**16.6 mg/l**	**18.9 mg/l**	**74.8 mg/l**	**68.2 mg/l**
Chloride	NA	Lab	**0.86 mg/l**	**0.58 mg/l**	**0.58 mg/l**	**0.61 mg/l**	< 0.50 mg/l	< 0.50 mg/l	**0.54 mg/l**	**0.64 mg/l**	**0.79 mg/l**	**0.78 mg/l**	**0.72 mg/l**	< 0.50 mg/l	**0.61 mg/l**	--	< 1.0 mg/l	< 1.0 mg/l	**0.9 mg/l**	**0.72 mg/l**
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	**3.55 mg/l**	**3.78 mg/l**	--	**2.97 mg/l**	**1.87 mg/l**	**1.61 mg/l**	**1.81 mg/l**	**2.51 mg/l**	**3.5 mg/l**	--	**2.67 mg/l**	**0.58 mg/l**	**1.11 mg/l**	--	**0.65 mg/l**	--	**1.51 mg/l**	**2.58 mg/l**
Fluoride	NA	Lab	**0.11 mg/l**	< 0.1 mg/l	< 0.1 mg/l	**0.11 mg/l**	**0.25 mg/l**	**0.20 mg/l**	**0.16 mg/l**	**0.11 mg/l**	**0.10 mg/l**	**0.10 mg/l**	**0.12 mg/l**	< 0.10 mg/l	< 0.10 mg/l	--	**0.15 mg/l**	**0.15 mg/l**	< 0.1 mg/l	< 0.1 mg/l
Hardness, total, as CaCO3	NA	Lab	**78.4 mg/l**	**80.2 mg/l**	**75.2 mg/l**	**79.1 mg/l**	**89.4 mg/l**	**94.8 mg/l**	**94.4 mg/l**	**88.3 mg/l**	**90.1 mg/l**	**89.0 mg/l**	**86.9 mg/l**	**56.2 mg/l**	**76.7 mg/l**	--	**41.6 mg/l**	**44.6 mg/l**	**58.1 mg/l**	**55.5 mg/l**
Nitrate + Nitrite, as N	NA	Lab	**0.22 mg/l**	**0.26 mg/l**	**0.25 mg/l**	**0.22 mg/l**	< 0.10 mg/l	**0.11 mg/l**	**0.12 mg/l**	**0.12 mg/l**	**0.33 mg/l**	**0.34 mg/l**	**0.22 mg/l**	**0.12 mg/l**	**0.17 mg/l**	--	**0.12 mg/l**	< 0.10 mg/l	< 0.1 mg/l	< 0.1 mg/l
Nitrogen, ammonia (NH3), as N	NA	Lab	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	**0.060 b mg/l**	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	**0.25 mg/l**	**0.10 mg/l**	< 0.10 mg/l	--	< 0.10 mg/l	**0.11 mg/l**	< 0.1 mg/l	**0.14 mg/l**
pH	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	**6.7 pH units**	**6.71 pH units**	--	**6.46 pH units**	**10.36 pH units**	**10.41 pH units**	**9.47 pH units**	**8.33 pH units**	**7.13 pH units**	--	**7.43 pH units**	**10.33 pH units**	**7.8 pH units**	--	**8.65 pH units**	--	**6.37 pH units**	**6.49 pH units**
Phosphorus, total	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Redox (oxidation potential)	NA	Field	**240 mV**	**336 mV**	--	**255 mV**	**308 mV**	**112 mV**	**163 mV**	**195 mV**	**82 mV**	--	**280 mV**	**234 mV**	**292 mV**	--	**292 mV**	--	**141 mV**	**201 mV**
Solids, total dissolved	NA	Lab	**99 mg/l**	**134 mg/l**	**132 mg/l**	**141 mg/l**	**179 mg/l**	**161 mg/l**	**172 mg/l**	**143 mg/l**	**152 mg/l**	**152 mg/l**	**136 mg/l**	**141 mg/l**	**148 mg/l**	--	**134 mg/l**	**132 mg/l**	**183 mg/l**	**60 mg/l**
Specific Conductance @ 25oC	NA	Field	**178.8 umhos/cm**	**161 umhos/cm**	--	**88.7 umhos/cm**	**209.3 umhos/cm**	**212.2 umhos/cm**	**193.7 umhos/cm**	**202.7 umhos/cm**	**89.1 umhos/cm**	--	**199.1 umhos/cm**	**190.8 umhos/cm**	**190.4 umhos/cm**	--	**159.5 umhos/cm**	--	**143.7 umhos/cm**	**143.2 umhos/cm**
Sulfate	NA	Lab	**9.91 mg/l**	**7.99 mg/l**	**7.99 mg/l**	**8.74 mg/l**	**9.9 mg/l**	**9.1 mg/l**	**8.0 mg/l**	**7.8 mg/l**	**7.9 mg/l**	**7.9 mg/l**	**7.9 mg/l**	**6.6 mg/l**	**7.3 mg/l**	--	**6.9 mg/l**	**6.9 mg/l**	**6.98 mg/l**	**1.28 mg/l**
Temperature, degrees C	NA	Field	**6.07 deg C**	**4.93 deg C**	--	**10.03 deg C**	**8.75 deg C**	**7.86 deg C**	**11.52 deg C**	**12.45 deg C**	**9.41 deg C**	--	**11 deg C**	**3.48 deg C**	**9.72 deg C**	--	**7.67 deg C**	--	**8.61 deg C**	**6.36 deg C**
Turbidity	NA	Field	**1.5 NTU**	**0 NTU**	--	**21.1 NTU**	**12 NTU**	**0 NTU**	**0 NTU**	**0 NTU**	**0 NTU**	--	**0 NTU**	**4.9 NTU**	**0 NTU**	--	**0 NTU**	--	**31.1 NTU**	**1.9 NTU**
Metals																				
Aluminum	Dissolved	Lab	< 25 ug/l	< 25.0 ug/l	< 25.0 ug/l	< 20 ug/l	**59.8 ug/l**	**128 ug/l**	**112 ug/l**	**53.8 ug/l**	< 20.0 ug/l	< 20.0 ug/l	**52.4 ug/l**	**121 ug/l**	**27.7 ug/l**	--	**36.7 ug/l**	**32.6 ug/l**	**617 ug/l**	**175 ug/l**
Aluminum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	Dissolved	Lab	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l
Antimony	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	Dissolved	Lab	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.5 ug/l	**4.0 ug/l**	**3.5 ug/l**	**2.2 ug/l**	**1.4 ug/l**	**1.1 ug/l**	**1.1 ug/l**	**1.3 ug/l**	**3.7 ug/l**	**1.9 ug/l**	--	**3.6 ug/l**	**3.0 ug/l**	**3.34 ug/l**	**3.94 ug/l**
Arsenic	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Total	Lab	**19.7 ug/l**	**18.3 ug/l**	**17.4 ug/l**	**21.7 ug/l**	**18.1 ug/l**	**15.9 ug/l**	**14.2 ug/l**	**11.7 ug/l**	**11.4 ug/l**	**11.0 ug/l**	**10.7 ug/l**	**11.0 ug/l**	**11.0 ug/l**	--	**7.0 ug/l**	**7.1 ug/l**	**70.3 ug/l**	**29 ug/l**
Beryllium	Total	Lab	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	**0.23 ug/l**	< 0.2 ug/l
Boron	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	< 50.0 ug/l	--	--	--	--	--	--
Boron	Total	Lab	< 50 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	--	< 50.0 ug/l	< 50.0 ug/l	< 50 ug/l	< 50 ug/l
Cadmium	Dissolved	Lab	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l
Cadmium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Calcium	Total	Lab	**17400 ug/l**	**18500 ug/l**	**17100 ug/l**	**17600 ug/l**	**33400 ug/l**	**36000 ug/l**	**31800 ug/l**	**26900 ug/l**	**25100 ug/l**	**24900 ug/l**	**25300 ug/l**	**21100 ug/l**	**22000 ug/l**	--	**12400 ug/l**	**13100 ug/l**	**13700 ug/l**	**11900 ug/l**
Chromium	Dissolved	Lab	< 1 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1 ug/l	< 1.0 ug/l	**1.5 ug/l**	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	**1.0 ug/l**	< 1.0 ug/l	--	< 1.0 ug/l	< 1.0 ug/l	< 1 ug/l	**1.16 ug/l**
Chromium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	Dissolved	Lab	**0.88 ug/l**	**0.73 ug/l**	**0.74 ug/l**	**0.69 ug/l**	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	**4.22 ug/l**	**3.71 ug/l**
Cobalt	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	Dissolved	Lab	**0.71 ug/l**	< 0.70 ug/l	< 0.70 ug/l	**0.74 ug/l**	**2.9 ug/l**	**2.9 ug/l**	**3.0 ug/l**	**1.8 ug/l**	**1.1 ug/l**	**1.2 ug/l**	**1.3 ug/l**	**2.6 ug/l**	**1.2 ug/l**	--	**3.7 ug/l**	**2.8 ug/l**	**16 ug/l**	**8.44 ug/l**
Copper	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Iron	Dissolved	Lab	**84.4 ug/l**	**97.2 ug/l**	**102 ug/l**	**137 ug/l**	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	--	< 50.0 ug/l	< 50.0 ug/l	**6520 ug/l**	**10700 ug/l**
Iron	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Total	Lab	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	**3.07 ug/l**	**0.52 ug/l**
Magnesium	Total	Lab	**8500 ug/l**	**8200 ug/l**	**7900 ug/l**	**8540 ug/l**	**1400 ug/l**	**1200 ug/l**	**3700 ug/l**	**5200 ug/l**	**6600 ug/l**	**6500 ug/l**	**5700 ug/l**	**890 ug/l**	**5300 ug/l**	--	**2600 ug/l**	**2900 ug/l**	**5800 ug/l**	**6260 ug/l**
Manganese	Dissolved	Lab	**1180 ug/l**	**1020 ug/l**	**1120 ug/l**	**895 ug/l**	**12.6 ug/l**	**3.6 ug/l**	**26.6 ug/l**	**70.6 ug/l**	**35.1 ug/l**	**35.0 ug/l**	**44.8 ug/l**	**1.2 ug/l**	**4.3 ug/l**	--	**3.2 ug/l**	**3.4 ug/l**	**928 ug/l**	**1220 ug/l**
Manganese	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	Total	Lab	**0.0006 ug/l**	< 0.0005 ug/l	< 0.0005 ug/l	**0.0018 ug/l**	**0.0045 ug/l**	**0.0029 ug/l**	**0.0026 ug/l**	**0.0019 ug/l**	**0.00053 ug/l**	**0.00056 ug/l**	**0.0011 ug/l**	**0.0041 ug/l**	**0.0016 ug/l**	**0.0016 ug/l**	**0.0035 ug/l**	**0.0034 ug/l**	**0.0137 ug/l**	**0.0030 ug/l**
Mercury methyl	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Dissolved	Lab	**1.79 ug/l**	**1.2 ug/l**	**1.2 ug/l**	**1.34 ug/l**	**11.1 ug/l**	**9.6 ug/l**	**6.1 ug/l**	**2.9 ug/l**	**1.7 ug/l**	**1.7 ug/l**	**2.2 ug/l**	**5.0 ug/l**	**1.6 ug/l**	--	**4.0 ug/l**	**3.7 ug/l**	**2.3 ug/l**	**1.99 ug/l**
Molybdenum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	Dissolved	Lab	**2.13 ug/l**	**2.2 ug/l**	**2.2 ug/l**	**1.89 ug/l**	**0.73 ug/l**	**0.85 ug/l**	**0.75 ug/l**	**0.50 ug/l**	< 0.50 ug/l	< 0.50 ug/l	**0.88 ug/l**	**0.65 ug/l**	< 0.50 ug/l	--	**1.3 ug/l**	**0.82 ug/l**	**4.6 ug/l**	**2.53 ug/l**
Nickel	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	**900 ug/l**	**930 ug/l**	**860 ug/l**	**1050 ug/l**	**3000 ug/l**	**3100 ug/l**	**2600 ug/l**	**2100 ug/l**	**1700 ug/l**	**1700 ug/l**	**2200 ug/l**	**2600 ug/l**	**1800 ug/l**	--	**1600 ug/l**	**1600 ug/l**	**1960 ug/l**	**1570 ug/l**
Selenium	Dissolved	Lab	< 1 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	< 1.0 ug/l	< 1 ug/l	< 1 ug/l
Selenium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	Dissolved	Lab	< 0.2 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l
Silver	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sodium	Total	Lab	**5170 ug/l**	**4000 ug/l**	**3700 ug/l**	**5040 ug/l**	**23100 ug/l**	**20900 ug/l**	**15500 ug/l**	**9600 ug/l**	**5900 ug/l**	**5800 ug/l**	**8900 ug/l**	**22500 ug/l**	**9400 ug/l**	--	**20000 ug/l**	**19300 ug/l**	**2600 ug/l**	< 2000 ug/l
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.017 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Dissolved	Lab	< 10 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5 ug/l	**8.9 ug/l**	**11.1 ug/l**	**10.4 ug/l**	**8.3 ug/l**	< 5.0 ug/l	< 5.0 ug/l	**5.7 ug/l**	**15.5 ug/l**	**6.8 ug/l**	--	**9.5 ug/l**	**8.8 ug/l**	< 10 ug/l	< 10 ug/l
Zinc	Dissolved	Lab	< 6 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	**19.4 ug/l**	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	--	**6.7 ug/l**	< 6.0 ug/l	**11.8 ug/l**	< 6 ug/l
Zinc	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Large Table 3
Groundwater Data Summary
Mine Site Surficial Aquifer

		Location	MW-9		MW-9		MW-9		MW-9		MW-9		MW-9		MW-9		MW-9		MW-9	MW-9
		Date	2/2/2012		3/19/2012		4/20/2012		5/16/2012		6/22/2012		7/17/2012		8/15/2012		10/30/2012	5/8/2013
		Sample Type	N	FD	N	FD	N	FD	N	FD	N	FD	N	FD	N	FD	N	N
	Fraction	Analysis Location																
General Parameters																		
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total	NA	Lab	**56.7 mg/l**	**56.5 mg/l**	**56.1 mg/l**	**54.9 mg/l**	**37.4 mg/l**	**36.9 mg/l**	**38.3 mg/l**	**37.4 mg/l**	**25.9 mg/l**	**26.6 mg/l**	**26.7 * mg/l**	**51.3 * mg/l**	**52.8 mg/l**	**55.5 mg/l**	**55.9 mg/l**	**26.1 mg/l**
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	**22.9 mg/l**	**22.8 mg/l**	**22.7 mg/l**	**22.4 mg/l**	**12.6 mg/l**	**12.6 mg/l**	**13.1 mg/l**	**13.0 mg/l**	**4.9 mg/l**	**5.0 mg/l**	**6.6 mg/l**	**6.3 mg/l**	**12.1 mg/l**	**11.0 mg/l**	**23.5 mg/l**	**4.6 mg/l**
Carbon, total organic	NA	Lab	**22.6 mg/l**	**22.7 mg/l**	**22.9 mg/l**	**22.6 mg/l**	**12.6 mg/l**	**12.6 mg/l**	**12.8 mg/l**	**12.7 mg/l**	**4.3 mg/l**	**4.4 mg/l**	**6.3 mg/l**	**6.1 mg/l**	**10.9 mg/l**	**11.1 mg/l**	**22.2 mg/l**	**3.8 mg/l**
Chemical Oxygen Demand	NA	Lab	**59.8 mg/l**	**64 mg/l**	**72 mg/l**	**67 mg/l**	**43.8 mg/l**	**43.6 mg/l**	**45.4 mg/l**	**49.5 mg/l**	< 10.0 mg/l	**13.4 mg/l**	**16.3 mg/l**	**26.6 mg/l**	**38.4 mg/l**	**41.7 mg/l**	**81.0 mg/l**	**17.6 mg/l**
Chloride	NA	Lab	< 0.5 mg/l	< 0.5 mg/l	< 0.5 mg/l	< 0.5 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	**0.52 mg/l**	**0.73 mg/l**	**0.69 mg/l**	**0.70 mg/l**	**0.54 mg/l**	**0.62 mg/l**
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	--	--	**1.99 mg/l**	--	**1.63 mg/l**	--	**1.93 mg/l**	--	**1.07 mg/l**	--	**1.33 mg/l**	--	**1.39 mg/l**	--	**1.71 mg/l**	**0.11 mg/l**
Fluoride	NA	Lab	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	**0.10 mg/l**	< 0.10 mg/l
Hardness, total, as CaCO3	NA	Lab	**58.4 mg/l**	**57.8 mg/l**	**56.8 mg/l**	**56.8 mg/l**	**41.5 mg/l**	**41.8 mg/l**	**41.1 mg/l**	**40.0 mg/l**	**25.9 mg/l**	**25.6 mg/l**	**29.1 mg/l**	**28.9 mg/l**	**40.4 mg/l**	**38.9 mg/l**	**53.7 mg/l**	**26.9 mg/l**
Nitrate + Nitrite, as N	NA	Lab	< 0.1 mg/l	< 0.1 mg/l	**0.11 mg/l**	< 0.1 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	**0.44 mg/l**
Nitrogen, ammonia (NH3), as N	NA	Lab	**0.11 mg/l**	**0.14 mg/l**	**0.19 mg/l**	**0.14 mg/l**	**0.31 mg/l**	**0.23 mg/l**	**0.17 mg/l**	**0.19 mg/l**	< 0.10 mg/l	< 0.10 mg/l	**0.12 mg/l**	**0.14 mg/l**	**0.17 mg/l**	**0.17 mg/l**	**0.26 mg/l**	< 0.10 mg/l
pH	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	--	--	**6.51 pH units**	--	**6.96 pH units**	--	**6.81 pH units**	--	**6.3 pH units**	--	**6.24 pH units**	--	**6.41 pH units**	--	**6.67 pH units**	**6.68 pH units**
Phosphorus, total	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Redox (oxidation potential)	NA	Field	--	--	**134 mV**	--	**303 mV**	--	**75 mV**	--	**198 mV**	--	**224 mV**	--	**-7 mV**	--	**3 mV**	**179 mV**
Solids, total dissolved	NA	Lab	**75 * mg/l**	**156 * mg/l**	**121 mg/l**	**108 mg/l**	**96.0 mg/l**	**103 mg/l**	**139 mg/l**	**136 mg/l**	**109 mg/l**	**107 mg/l**	**112 mg/l**	**124 mg/l**	**120 mg/l**	**126 mg/l**	**156 mg/l**	**82.0 mg/l**
Specific Conductance @ 25oC	NA	Field	--	--	**142.9 umhos/cm**	--	**118.1 umhos/cm**	--	**77.9 umhos/cm**	--	**71.1 umhos/cm**	--	**78.2 umhos/cm**	--	**100.1 umhos/cm**	--	**151.9 umhos/cm**	**67 umhos/cm**
Sulfate	NA	Lab	**1.44 mg/l**	**1.45 mg/l**	**1.97 mg/l**	**2.03 mg/l**	**6.7 mg/l**	**6.8 mg/l**	**4.9 mg/l**	**5.0 mg/l**	**4.6 mg/l**	**4.7 mg/l**	**5.1 mg/l**	**5.3 mg/l**	**4.7 mg/l**	**4.7 mg/l**	**5.7 mg/l**	**6.1 mg/l**
Temperature, degrees C	NA	Field	--	--	**7.2 deg C**	--	**4.36 deg C**	--	**5.24 deg C**	--	**9.14 deg C**	--	**11.75 deg C**	--	**10.97 deg C**	--	**6.81 deg C**	**4.07 deg C**
Turbidity	NA	Field	--	--	**0 NTU**	--	**0 NTU**	--	**0 NTU**	--	**0 NTU**	--	**0.1 NTU**	--	**1.4 NTU**	--	**0 NTU**	**0.1 NTU**
Metals																		
Aluminum	Dissolved	Lab	**145 ug/l**	**164 ug/l**	**110 ug/l**	**111 ug/l**	**65.0 ug/l**	**65.2 ug/l**	**73.1 ug/l**	**74.8 ug/l**	**61.7 ug/l**	**54.9 ug/l**	**121 * ug/l**	**70.7 * ug/l**	**167 b ug/l**	**146 b ug/l**	**115 ug/l**	**42.9 ug/l**
Aluminum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	Dissolved	Lab	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Antimony	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	Dissolved	Lab	**3.99 ug/l**	**3.96 ug/l**	**5.09 ug/l**	**5.14 ug/l**	**5.6 ug/l**	**5.7 ug/l**	**5.2 ug/l**	**5.1 ug/l**	**3.2 ug/l**	**3.4 ug/l**	**4.7 ug/l**	**4.3 ug/l**	**5.6 ug/l**	**5.9 ug/l**	**6.7 ug/l**	**2.5 ug/l**
Arsenic	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Total	Lab	**28.2 ug/l**	**28 ug/l**	**26.4 ug/l**	**26.5 ug/l**	**18.6 ug/l**	**18.6 ug/l**	**17.8 ug/l**	**18.0 ug/l**	**12.4 ug/l**	**12.2 ug/l**	**16.9 ug/l**	**16.6 ug/l**	**21.2 ug/l**	**20.6 ug/l**	**23.3 ug/l**	**10.1 ug/l**
Beryllium	Total	Lab	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Boron	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	Total	Lab	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l
Cadmium	Dissolved	Lab	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Cadmium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Calcium	Total	Lab	**12400 ug/l**	**12300 ug/l**	**12200 ug/l**	**12200 ug/l**	**8300 ug/l**	**8400 ug/l**	**8200 ug/l**	**8000 ug/l**	**5100 ug/l**	**5000 ug/l**	**5800 ug/l**	**5700 ug/l**	**8000 ug/l**	**7700 ug/l**	**11100 ug/l**	**5100 ug/l**
Chromium	Dissolved	Lab	< 1 ug/l	< 1 ug/l	**1.14 ug/l**	**1.1 ug/l**	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	**1.5 b ug/l**	**2.0 b ug/l**	**1.1 b ug/l**	< 1.0 ug/l
Chromium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	Dissolved	Lab	**3.54 ug/l**	**3.51 ug/l**	**3.52 ug/l**	**3.59 ug/l**	**1.7 ug/l**	**1.8 ug/l**	**1.7 ug/l**	**1.7 ug/l**	**1.3 ug/l**	**1.3 ug/l**	**1.5 ug/l**	**1.5 ug/l**	**1.6 ug/l**	**1.6 ug/l**	**1.9 ug/l**	**1.2 ug/l**
Cobalt	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	Dissolved	Lab	**6.41 ug/l**	**6.44 ug/l**	**2.84 ug/l**	**2.9 ug/l**	**4.7 ug/l**	**2.7 ug/l**	**3.8 ug/l**	**3.6 ug/l**	**2.0 ug/l**	**1.9 ug/l**	**3.7 * ug/l**	**2.3 * ug/l**	**4.6 ug/l**	**3.8 ug/l**	**2.4 ug/l**	**1.7 ug/l**
Copper	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Iron	Dissolved	Lab	**10600 ug/l**	**10400 ug/l**	**11900 ug/l**	**12000 ug/l**	**12100 ug/l**	**12100 ug/l**	**11800 ug/l**	**12000 ug/l**	**5910 ug/l**	**5960 ug/l**	**6530 ug/l**	**6300 ug/l**	**10100 ug/l**	**9960 ug/l**	**16500 ug/l**	**6450 ug/l**
Iron	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Total	Lab	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Magnesium	Total	Lab	**6660 ug/l**	**6580 ug/l**	**6400 ug/l**	**6400 ug/l**	**5000 ug/l**	**5100 ug/l**	**5000 ug/l**	**4900 ug/l**	**3200 ug/l**	**3200 ug/l**	**3600 ug/l**	**3600 ug/l**	**4900 ug/l**	**4800 ug/l**	**6300 ug/l**	**3400 ug/l**
Manganese	Dissolved	Lab	**1310 ug/l**	**1300 ug/l**	**1380 ug/l**	**1400 ug/l**	**1070 ug/l**	**1080 ug/l**	**959 ug/l**	**969 ug/l**	**643 ug/l**	**647 ug/l**	**723 ug/l**	**698 ug/l**	**829 ug/l**	**832 ug/l**	**1290 ug/l**	**566 ug/l**
Manganese	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	Total	Lab	**0.0033 ug/l**	**0.0033 ug/l**	**0.0016 ug/l**	**0.0015 ug/l**	**0.0016 ug/l**	**0.0016 ug/l**	**0.0021 ug/l**	**0.0032 ug/l**	**0.00096 ug/l**	**0.00097 ug/l**	**0.0014 ug/l**	**0.0014 ug/l**	**0.0018 ug/l**	**0.0018 ug/l**	**0.0015 ug/l**	**0.0012 ug/l**
Mercury methyl	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Dissolved	Lab	**2.1 ug/l**	**2.14 ug/l**	**1.55 ug/l**	**1.55 ug/l**	**1.4 ug/l**	**1.5 ug/l**	**1.5 ug/l**	**1.5 ug/l**	**0.88 ug/l**	**0.91 ug/l**	**1.8 ug/l**	**1.5 ug/l**	**1.9 ug/l**	**1.9 ug/l**	**1.8 ug/l**	**1.1 ug/l**
Molybdenum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	Dissolved	Lab	**2.16 ug/l**	**2.12 ug/l**	**1.8 ug/l**	**1.82 ug/l**	**1.1 ug/l**	**1.2 ug/l**	**1.1 ug/l**	**1.2 ug/l**	**1.1 ug/l**	**0.99 ug/l**	**1.2 ug/l**	**1.1 ug/l**	**1.6 b ug/l**	**2.0 b ug/l**	**1.3 ug/l**	**0.89 ug/l**
Nickel	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	**1560 ug/l**	**1570 ug/l**	**1510 ug/l**	**1520 ug/l**	**1300 ug/l**	**1300 ug/l**	**1300 ug/l**	**1200 ug/l**	**1200 ug/l**	**1200 ug/l**	**1300 ug/l**	**1300 ug/l**	**1700 ug/l**	**1600 ug/l**	**1800 ug/l**	**1000 ug/l**
Selenium	Dissolved	Lab	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l
Selenium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	Dissolved	Lab	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Silver	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sodium	Total	Lab	< 2000 ug/l	< 2000 ug/l	**1600 ug/l**	**1620 ug/l**	**1400 ug/l**	**1400 ug/l**	**1300 ug/l**	**1300 ug/l**	**1400 ug/l**	**1300 ug/l**	**1500 ug/l**	**1400 ug/l**	**1700 ug/l**	**1700 ug/l**	**2300 ug/l**	**1700 ug/l**
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	**0.57 ug/l**	**0.64 ug/l**	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Dissolved	Lab	< 10 ug/l	< 10 ug/l	**6.09 ug/l**	**5.83 ug/l**	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	**5.7 ug/l**	**5.7 ug/l**	**8.5 ug/l**	< 5.0 ug/l
Zinc	Dissolved	Lab	< 6 ug/l	< 6 ug/l	**6.62 ug/l**	< 6 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	**9.1 ug/l**	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l
Zinc	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Large Table 3
Groundwater Data Summary
Mine Site Surficial Aquifer

Location			MW-9		MW-9	MW-10D		MW-10D	MW-10D	MW-10D	MW-10D	MW-10D		MW-10D	MW-10D		MW-10D	
Date			7/25/2013		10/21/2013	12/19/2011		1/16/2012	2/1/2012	3/2/2012	4/17/2012	5/9/2012		6/12/2012	7/12/2012		8/8/2012	
Sample Type			N	FD	N	N	FD	N	N	N	N	N	FD	N	N	FD	N	FD
	Fraction	Analysis Location																
General Parameters																		
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total	NA	Lab	**26.3 mg/l**	--	**44.6 mg/l**	**48.6 mg/l**	**48.4 mg/l**	**47.2 mg/l**	**46.8 mg/l**	**46.6 mg/l**	**48.5 mg/l**	**49.5 mg/l**	**49.4 mg/l**	**48.4 mg/l**	**41.6 mg/l**	**42.3 mg/l**	**48.9 mg/l**	**49.3 mg/l**
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	**4.0 mg/l**	--	**26.6 mg/l**	**4.0 mg/l**	**4.1 mg/l**	**4.1 mg/l**	**2.29 mg/l**	**2.41 mg/l**	**2.4 mg/l**	**2.6 mg/l**	**2.5 mg/l**	**2.7 b mg/l**	**1.7 mg/l**	**1.8 mg/l**	**1.2 mg/l**	**1.2 mg/l**
Carbon, total organic	NA	Lab	**3.4 mg/l**	--	**23.9 mg/l**	**3.9 mg/l**	**3.5 mg/l**	**2.0 mg/l**	**1.96 mg/l**	**1.76 mg/l**	**1.9 mg/l**	**2.2 mg/l**	**1.8 mg/l**	**1.5 mg/l**	**1.4 mg/l**	**1.4 mg/l**	< 1.0 mg/l	< 1.0 mg/l
Chemical Oxygen Demand	NA	Lab	**15.3 mg/l**	--	**84.2 mg/l**	**12.3 mg/l**	**17.7 mg/l**	< 10 mg/l	< 10 mg/l	**18.4 mg/l**	**23.2 mg/l**	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l
Chloride	NA	Lab	**0.64 mg/l**	--	< 1.0 mg/l	**0.74 mg/l**	**0.73 mg/l**	**0.76 mg/l**	< 0.5 mg/l	< 0.5 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	**0.52 mg/l**	**0.52 mg/l**	**0.64 mg/l**	**0.62 mg/l**
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	< 0.1 mg/l	--	< 0.1 mg/l	**6.97 mg/l**	--	**1.52 mg/l**	**2.48 mg/l**	**1.78 mg/l**	**1.48 mg/l**	**1.74 mg/l**	--	**1.59 mg/l**	**1.5 mg/l**	--	**1.67 mg/l**	--
Fluoride	NA	Lab	< 0.10 mg/l	--	< 0.10 mg/l	**0.1 mg/l**	**0.1 mg/l**	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l
Hardness, total, as CaCO3	NA	Lab	**27.8 mg/l**	--	**52.3 mg/l**	**60.8 mg/l**	**60.6 mg/l**	**56.5 mg/l**	**55.1 mg/l**	**55.2 mg/l**	**55.0 mg/l**	**59.3 mg/l**	**58.6 mg/l**	**58.4 mg/l**	**49.9 mg/l**	**51.0 mg/l**	**49.7 mg/l**	**48.6 mg/l**
Nitrate + Nitrite, as N	NA	Lab	< 0.10 mg/l	--	< 0.10 mg/l	**1.6 mg/l**	**1.59 mg/l**	**1.32 mg/l**	**1.33 mg/l**	**1.32 mg/l**	**1.2 mg/l**	**0.91 mg/l**	**0.91 mg/l**	**1.2 mg/l**	**1.6 mg/l**	**1.6 mg/l**	**2.4 mg/l**	**2.4 mg/l**
Nitrogen, ammonia (NH3), as N	NA	Lab	**0.11 mg/l**	--	**0.27 mg/l**	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	**0.060 mg/l**	< 0.050 mg/l	< 0.050 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	**0.19 mg/l**	< 0.10 mg/l
pH	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	**6.35 pH units**	--	**6.61 pH units**	**7.22 pH units**	--	**6.87 pH units**	**6.79 pH units**	**6.72 pH units**	**6.87 pH units**	**6.77 pH units**	--	**6.87 pH units**	**6.44 pH units**	--	**6.14 pH units**	--
Phosphorus, total	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Redox (oxidation potential)	NA	Field	**185 mV**	--	**83 mV**	**202 mV**	--	**92 mV**	**170 mV**	**258 mV**	**-67 mV**	**132 mV**	--	**203 mV**	**219 mV**	--	**131 mV**	--
Solids, total dissolved	NA	Lab	**84.0 mg/l**	--	**171 mg/l**	**102 mg/l**	**114 mg/l**	**111 mg/l**	**30 mg/l**	**123 h mg/l**	**131 mg/l**	**110 mg/l**	**100 mg/l**	**124 mg/l**	**128 mg/l**	**122 mg/l**	**114 mg/l**	**106 mg/l**
Specific Conductance @ 25oC	NA	Field	**76 umhos/cm**	--	**152 umhos/cm**	**145.1 umhos/cm**	--	**135.4 umhos/cm**	**127 umhos/cm**	**134.7 umhos/cm**	**129.7 umhos/cm**	**99.1 umhos/cm**	--	**98 umhos/cm**	**123.5 umhos/cm**	--	**22.2 umhos/cm**	--
Sulfate	NA	Lab	**5.4 mg/l**	--	**6.2 mg/l**	**13 mg/l**	**13 mg/l**	**13.4 mg/l**	**12.2 mg/l**	**10.7 mg/l**	**11.2 mg/l**	**12.4 mg/l**	**12.5 mg/l**	**12.4 mg/l**	**12.1 mg/l**	**12.1 mg/l**	**11.5 mg/l**	**11.5 mg/l**
Temperature, degrees C	NA	Field	**9.4 deg C**	--	**7.85 deg C**	**11.51 deg C**	--	**8.48 deg C**	**8.33 deg C**	**8.51 deg C**	**6.85 deg C**	**10.16 deg C**	--	**12.01 deg C**	**12.89 deg C**	--	**11.35 deg C**	--
Turbidity	NA	Field	**6.7 NTU**	--	**1.7 NTU**	**2.6 NTU**	--	**0 NTU**	**7.1 NTU**	**0 NTU**	**0 NTU**	**1.7 NTU**	--	**0.4 NTU**	**0 NTU**	--	**0 NTU**	--
Metals																		
Aluminum	Dissolved	Lab	**132 ug/l**	--	**129 ug/l**	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l
Aluminum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	Dissolved	Lab	< 0.50 ug/l	--	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Antimony	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	Dissolved	Lab	**2.5 ug/l**	--	**6.4 ug/l**	< 0.5 ug/l	< 0.5 ug/l	**0.51 ug/l**	**0.6 ug/l**	**0.82 ug/l**	**0.70 ug/l**	< 0.50 ug/l	< 0.50 ug/l	**0.53 ug/l**	**0.74 ug/l**	**0.55 ug/l**	< 0.50 ug/l	< 0.50 ug/l
Arsenic	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Total	Lab	**13.4 ug/l**	--	**22.4 ug/l**	**22.7 ug/l**	**22.6 ug/l**	**22.2 ug/l**	**19.4 ug/l**	**18.9 ug/l**	**18.7 ug/l**	**19.7 ug/l**	**19.4 ug/l**	**18.7 ug/l**	**17.7 ug/l**	**18.3 ug/l**	**17.7 ug/l**	**18.2 ug/l**
Beryllium	Total	Lab	< 0.20 ug/l	--	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Boron	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	Total	Lab	< 50.0 ug/l	--	< 50.0 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 100 ug/l
Cadmium	Dissolved	Lab	< 0.20 ug/l	--	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Cadmium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Calcium	Total	Lab	**5300 ug/l**	--	**10500 ug/l**	**15500 ug/l**	**15400 ug/l**	**13800 ug/l**	**13200 ug/l**	**13500 ug/l**	**13200 ug/l**	**14000 ug/l**	**13800 ug/l**	**13800 ug/l**	**12000 ug/l**	**12300 ug/l**	**12100 ug/l**	**11900 ug/l**
Chromium	Dissolved	Lab	< 1.0 ug/l	--	< 1.0 ug/l	**1.29 ug/l**	**1.22 ug/l**	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1.0 ug/l	**1.1 ug/l**	**1.1 ug/l**	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	**1.5 b ug/l**	**1.3 b ug/l**
Chromium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	Dissolved	Lab	**1.4 ug/l**	--	**4.5 ug/l**	**1.12 ug/l**	**0.98 ug/l**	**0.97 ug/l**	**1.08 ug/l**	**0.93 ug/l**	**0.70 ug/l**	**0.76 ug/l**	**0.75 ug/l**	**0.60 ug/l**	**1.2 ug/l**	**1.2 ug/l**	**1.4 ug/l**	**1.5 ug/l**
Cobalt	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	Dissolved	Lab	**3.3 ug/l**	--	**3.0 ug/l**	**1.32 ug/l**	**0.82 ug/l**	**0.99 ug/l**	< 0.7 ug/l	< 0.7 ug/l	< 0.50 ug/l	**1.2 ug/l**	**0.57 ug/l**	**0.67 ug/l**	< 0.50 ug/l	< 0.50 ug/l	**0.50 ug/l**	**0.52 ug/l**
Copper	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Iron	Dissolved	Lab	**4870 ug/l**	--	**17900 ug/l**	**254 ug/l**	**254 ug/l**	**252 ug/l**	**398 ug/l**	**753 ug/l**	**729 ug/l**	**864 ug/l**	**873 ug/l**	**874 ug/l**	**771 ug/l**	**760 ug/l**	**667 ug/l**	**698 ug/l**
Iron	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Total	Lab	< 0.50 ug/l	--	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Magnesium	Total	Lab	**3500 ug/l**	--	**6300 ug/l**	**5370 ug/l**	**5380 ug/l**	**5360 ug/l**	**5380 ug/l**	**5220 ug/l**	**5400 ug/l**	**5900 ug/l**	**5900 ug/l**	**5800 ug/l**	**4800 ug/l**	**5000 ug/l**	**4700 ug/l**	**4600 ug/l**
Manganese	Dissolved	Lab	**498 ug/l**	--	**1130 ug/l**	**184 ug/l**	**200 ug/l**	**235 ug/l**	**282 ug/l**	**333 ug/l**	**328 ug/l**	**345 ug/l**	**362 ug/l**	**306 ug/l**	**299 ug/l**	**294 ug/l**	**281 ug/l**	**296 ug/l**
Manganese	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	Total	Lab	**0.0017 ug/l**	**0.0017 ug/l**	**0.0030 ug/l**	**0.0006 ug/l**	**0.0006 ug/l**	**0.0006 ug/l**	< 0.0005 ug/l	**0.0011 ug/l**	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	**0.00056 ug/l**	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l
Mercury methyl	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Dissolved	Lab	**1.1 ug/l**	--	**1.8 ug/l**	**4.99 ug/l**	**4.84 ug/l**	**3.68 ug/l**	**3.16 ug/l**	**3.93 ug/l**	**3.9 ug/l**	**4.2 ug/l**	**4.2 ug/l**	**3.3 ug/l**	**4.2 ug/l**	**4.2 ug/l**	**4.2 ug/l**	**4.4 ug/l**
Molybdenum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	Dissolved	Lab	**1.3 ug/l**	--	**1.6 ug/l**	**1.62 ug/l**	**1.39 ug/l**	**1.35 ug/l**	**1.35 ug/l**	**1.14 ug/l**	**0.95 ug/l**	**1.1 ug/l**	**1.2 ug/l**	**0.84 ug/l**	**1.4 ug/l**	**1.3 ug/l**	**2.3 ug/l**	**2.2 ug/l**
Nickel	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	**1400 ug/l**	--	**1600 ug/l**	**3160 ug/l**	**3170 ug/l**	**1890 ug/l**	**1670 ug/l**	**1750 ug/l**	**1800 ug/l**	**1800 ug/l**	**1800 ug/l**	**1800 ug/l**	**1600 ug/l**	**1700 ug/l**	**1500 ug/l**	**1500 ug/l**
Selenium	Dissolved	Lab	< 1.0 ug/l	--	< 1.0 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l
Selenium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	Dissolved	Lab	< 0.20 ug/l	--	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Silver	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sodium	Total	Lab	**2000 ug/l**	--	**2200 ug/l**	**4150 ug/l**	**4160 ug/l**	**4460 ug/l**	**4250 ug/l**	**4300 ug/l**	**4500 ug/l**	**4500 ug/l**	**4500 ug/l**	**4100 ug/l**	**4500 ug/l**	**4600 ug/l**	**4400 ug/l**	**4300 ug/l**
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab	< 0.017 ug/l	--	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Dissolved	Lab	< 5.0 ug/l	--	**6.3 ug/l**	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 5 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l
Zinc	Dissolved	Lab	< 6.0 ug/l	--	< 6.0 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6.0 ug/l	< 8.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l
Zinc	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Large Table 3
Groundwater Data Summary
Mine Site Surficial Aquifer

Location			MW-10D		MW-10D		MW-10D		MW-10D	MW-10S	MW-10S	MW-10S	MW-10S	MW-10S	MW-10S	MW-10S
Date			10/23/2012		4/22/2013		7/22/2013		10/28/2013	12/19/2011	1/4/2012	6/26/2012	7/12/2012	8/8/2012	10/23/2012	5/15/2013
Sample Type			N	FD	N	FD	N	FD	N	N	N	N	N	N	N	N
	Fraction	Analysis Location														
General Parameters																
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total	NA	Lab	**39.8 mg/l**	**41.4 mg/l**	**41.3 mg/l**	--	**34.4 mg/l**	--	**32.9 mg/l**	**69.5 mg/l**	**49.9 mg/l**	< 10.0 mg/l	**13.3 mg/l**	**14.6 mg/l**	**14.2 mg/l**	**15.5 mg/l**
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	**1.5 mg/l**	**1.4 mg/l**	**1.6 mg/l**	--	**1.7 mg/l**	--	**1.4 mg/l**	**44.6 mg/l**	**8.5 mg/l**	**5.3 mg/l**	**4.7 mg/l**	**3.0 mg/l**	**2.9 mg/l**	**3.9 mg/l**
Carbon, total organic	NA	Lab	**1.4 mg/l**	**1.4 mg/l**	**1.1 mg/l**	--	**1.4 mg/l**	--	**1.2 mg/l**	**40.2 mg/l**	**7.7 mg/l**	**5.1 mg/l**	**4.2 mg/l**	**2.5 mg/l**	**2.7 mg/l**	**3.7 mg/l**
Chemical Oxygen Demand	NA	Lab	< 10.0 mg/l	< 10.0 mg/l	**13.1 mg/l**	--	< 10.0 mg/l	--	**11.7 mg/l**	**133 mg/l**	**28.1 mg/l**	**29.2 mg/l**	< 10.0 mg/l	< 10.0 mg/l	**15.8 mg/l**	**16.9 mg/l**
Chloride	NA	Lab	< 0.50 mg/l	**0.50 mg/l**	< 0.50 mg/l	--	< 0.50 mg/l	--	< 1.0 mg/l	**9.33 mg/l**	**3.68 mg/l**	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	**2.09 mg/l**	--	**2.03 mg/l**	--	**0.94 mg/l**	--	**1.91 mg/l**	**11.3 mg/l**	**11.23 mg/l**	**8.44 mg/l**	**5.7 mg/l**	**8.79 mg/l**	**9.36 mg/l**	**7.95 mg/l**
Fluoride	NA	Lab	**0.11 mg/l**	**0.11 mg/l**	< 0.10 mg/l	--	< 0.10 mg/l	--	< 0.10 mg/l	**0.25 mg/l**	**0.11 mg/l**	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l
Hardness, total, as CaCO3	NA	Lab	**49.6 mg/l**	**48.9 mg/l**	**46.5 mg/l**	--	**47.3 mg/l**	--	**40.0 mg/l**	**136 mg/l**	**65.1 mg/l**	**30.8 mg/l**	**19.9 mg/l**	**16.1 mg/l**	**21.0 mg/l**	**15.2 mg/l**
Nitrate + Nitrite, as N	NA	Lab	**2.2 mg/l**	**2.1 mg/l**	**1.8 mg/l**	--	**2.2 mg/l**	--	**1.7 mg/l**	**2.66 mg/l**	**1 mg/l**	**1.0 mg/l**	**0.54 mg/l**	**1.3 mg/l**	**0.77 mg/l**	**1.3 mg/l**
Nitrogen, ammonia (NH3), as N	NA	Lab	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	--	< 0.10 mg/l	--	< 0.10 mg/l	**0.1 mg/l**	< 0.1 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l
pH	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	**6.69 pH units**	--	**6.67 pH units**	--	**6.31 pH units**	--	**6.47 pH units**	**7.23 pH units**	**7.7 pH units**	**5.3 pH units**	**5.1 pH units**	**5.66 pH units**	**5.67 pH units**	**6.89 pH units**
Phosphorus, total	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Redox (oxidation potential)	NA	Field	**159 mV**	--	**401 mV**	--	**345 mV**	--	**481 mV**	**261 mV**	**428 mV**	**320 mV**	**412 mV**	**159 mV**	**309 mV**	**481 mV**
Solids, total dissolved	NA	Lab	**110 mg/l**	**99.0 mg/l**	**116 mg/l**	--	**86.0 mg/l**	--	**93.0 mg/l**	**228 mg/l**	**131 mg/l**	**58.0 mg/l**	**73.0 mg/l**	**66.0 mg/l**	**48.0 mg/l**	**65.0 mg/l**
Specific Conductance @ 25oC	NA	Field	**123.5 umhos/cm**	--	**110.6 umhos/cm**	--	**106.9 umhos/cm**	--	**100.7 umhos/cm**	**308.1 umhos/cm**	**163.2 umhos/cm**	**46.6 umhos/cm**	**44.5 umhos/cm**	**39.7 umhos/cm**	**50.7 umhos/cm**	**52.2 umhos/cm**
Sulfate	NA	Lab	**11.2 mg/l**	**11.2 mg/l**	**10.8 mg/l**	--	**10.3 mg/l**	--	**10.3 mg/l**	**42.9 mg/l**	**17.3 mg/l**	**9.1 mg/l**	**7.4 mg/l**	**6.0 mg/l**	**9.9 mg/l**	**10 mg/l**
Temperature, degrees C	NA	Field	**7.25 deg C**	--	**8.79 deg C**	--	**8.67 deg C**	--	**6.88 deg C**	**11.4 deg C**	**11.08 deg C**	**20.19 deg C**	**16.87 deg C**	**19.36 deg C**	**8.87 deg C**	**19.51 deg C**
Turbidity	NA	Field	**0.8 NTU**	--	**0.1 NTU**	--	**0 NTU**	--	**4.4 NTU**	**52.6 NTU**	**43 NTU**	**306.3 NTU**	**80.2 NTU**	**19.7 NTU**	**68.2 NTU**	**37.5 NTU**
Metals																
Aluminum	Dissolved	Lab	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	--	< 20.0 ug/l	--	< 20.0 ug/l	**63.7 ug/l**	**35.6 ug/l**	**40.5 ug/l**	**73.2 ug/l**	**55.1 ug/l**	**36.9 ug/l**	**73.6 ug/l**
Aluminum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	--	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Antimony	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	Dissolved	Lab	**0.54 ug/l**	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	--	< 0.50 ug/l	**1.05 ug/l**	< 0.5 ug/l	**0.82 ug/l**	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Arsenic	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Total	Lab	**15.5 ug/l**	**15.2 ug/l**	**13.3 ug/l**	--	**13.9 ug/l**	--	**12.5 ug/l**	**67.3 ug/l**	**45.7 ug/l**	**85.9 ug/l**	**38.2 ug/l**	**30.1 ug/l**	**36.1 ug/l**	**30.9 ug/l**
Beryllium	Total	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	--	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	**0.25 ug/l**	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Boron	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	Total	Lab	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	--	< 50.0 ug/l	--	< 50.0 ug/l	< 50 ug/l	< 50 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l
Cadmium	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	--	< 0.20 ug/l	**0.3 ug/l**	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Cadmium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Calcium	Total	Lab	**11900 ug/l**	**11700 ug/l**	**10500 ug/l**	--	**11100 ug/l**	--	**9400 ug/l**	**38800 ug/l**	**18000 ug/l**	**6700 ug/l**	**4900 ug/l**	**4100 ug/l**	**5200 ug/l**	**3700 ug/l**
Chromium	Dissolved	Lab	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	--	< 1.0 ug/l	**3.29 ug/l**	< 1 ug/l	< 1.0 ug/l	**1.0 ug/l**	**1.4 b ug/l**	< 1.0 ug/l	< 1.0 ug/l
Chromium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	Dissolved	Lab	**0.82 ug/l**	**0.79 ug/l**	**0.71 ug/l**	--	**1.2 ug/l**	--	**0.76 ug/l**	**0.59 ug/l**	**0.23 ug/l**	**0.24 ug/l**	**0.50 ug/l**	**0.46 ug/l**	**0.30 ug/l**	< 0.20 ug/l
Cobalt	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	Dissolved	Lab	**0.74 ug/l**	**0.84 ug/l**	**1.0 ug/l**	--	**1.1 ug/l**	--	**1.5 ug/l**	**14.7 ug/l**	**7.11 ug/l**	**1.4 ug/l**	**2.4 ug/l**	**1.9 ug/l**	**2.1 ug/l**	**3.0 ug/l**
Copper	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Iron	Dissolved	Lab	**729 ug/l**	**763 ug/l**	**303 ug/l**	--	< 50.0 ug/l	--	< 50.0 ug/l	**64.9 ug/l**	**79.2 ug/l**	**54.6 ug/l**	**56.8 ug/l**	**54.4 ug/l**	< 50.0 ug/l	**51.6 ug/l**
Iron	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Total	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	--	< 0.50 ug/l	**2.26 ug/l**	**1.33 ug/l**	**2.9 ug/l**	**0.65 ug/l**	< 0.50 ug/l	**0.73 ug/l**	**0.74 ug/l**
Magnesium	Total	Lab	**4800 ug/l**	**4800 ug/l**	**4900 ug/l**	--	**4800 ug/l**	--	**4000 ug/l**	**9480 ug/l**	**4890 ug/l**	**3400 ug/l**	**1900 ug/l**	**1400 ug/l**	**1900 ug/l**	**1400 ug/l**
Manganese	Dissolved	Lab	**275 ug/l**	**268 ug/l**	**192 ug/l**	--	**172 ug/l**	--	**109 ug/l**	**87.8 ug/l**	**58.5 ug/l**	**73.3 ug/l**	**63.1 ug/l**	**67.1 ug/l**	**30.8 ug/l**	**10.9 ug/l**
Manganese	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	Total	Lab	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	**0.0050 ug/l**	**0.0034 ug/l**	**0.0141 ug/l**	**0.0023 ug/l**	**0.0018 ug/l**	**0.0023 ug/l**	**0.0025 ug/l**
Mercury methyl	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Dissolved	Lab	**3.7 ug/l**	**3.7 ug/l**	**3.2 ug/l**	--	**3.9 ug/l**	--	**2.9 ug/l**	**35.9 ug/l**	**6.13 ug/l**	**0.65 ug/l**	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.30 ug/l
Molybdenum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	Dissolved	Lab	**1.4 ug/l**	**1.8 ug/l**	**1.5 ug/l**	--	**2.9 ug/l**	--	**2.3 ug/l**	**2.76 ug/l**	**1.43 ug/l**	< 0.50 ug/l	**0.91 ug/l**	**1.2 ug/l**	**1.4 ug/l**	**1.3 ug/l**
Nickel	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	**1500 ug/l**	**1500 ug/l**	**1500 ug/l**	--	**1600 ug/l**	--	**1400 ug/l**	**3680 ug/l**	**2110 ug/l**	**1400 ug/l**	**580 ug/l**	**470 ug/l**	**780 ug/l**	**650 ug/l**
Selenium	Dissolved	Lab	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	--	< 1.0 ug/l	**4.73 ug/l**	**1.45 ug/l**	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l
Selenium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	--	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Silver	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sodium	Total	Lab	**4600 ug/l**	**4600 ug/l**	**4500 ug/l**	--	**5400 ug/l**	--	**4300 ug/l**	**9820 ug/l**	**6850 ug/l**	**4000 ug/l**	**2900 ug/l**	**2600 ug/l**	**3100 ug/l**	**6900 ug/l**
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.017 ug/l	--	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	**0.30 ug/l**
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Dissolved	Lab	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	--	< 5.0 ug/l	--	< 5.0 ug/l	< 10 ug/l	< 10 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l
Zinc	Dissolved	Lab	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	--	< 6.0 ug/l	--	< 6.0 ug/l	**19 ug/l**	**13.7 ug/l**	**6.6 ug/l**	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l
Zinc	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Large Table 3
Groundwater Data Summary
Mine Site Surficial Aquifer

Location			MW-10S	MW-10S		MW-11		MW-11		MW-11	MW-11		MW-11		MW-11
Date			7/22/2013	10/28/2013		12/20/2011		1/16/2012		2/2/2012	3/7/2012		4/17/2012		5/9/2012
Sample Type			N	N	FD	N	FD	N	FD	N	N	FD	N	FD	N
	Fraction	Analysis Location													
General Parameters															
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total	NA	Lab	**12.0 mg/l**	< 10.0 mg/l	< 10.0 mg/l	**58.8 mg/l**	**60.1 mg/l**	**58.5 mg/l**	**59.3 mg/l**	**62 mg/l**	**59.6 mg/l**	**59.9 mg/l**	**59.8 mg/l**	**60.1 mg/l**	**61.5 mg/l**
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	**4.3 mg/l**	**2.4 mg/l**	**2.1 mg/l**	**3.4 mg/l**	**2.0 mg/l**	**2.0 mg/l**	**2.2 mg/l**	**1.84 mg/l**	**2.0 b mg/l**	**2.3 b mg/l**	**1.6 mg/l**	**1.6 mg/l**	**1.8 mg/l**
Carbon, total organic	NA	Lab	**4.2 mg/l**	**2.0 mg/l**	**2.1 mg/l**	**2.0 mg/l**	**1.5 mg/l**	**1.7 mg/l**	**1.5 mg/l**	**1.43 mg/l**	**1.5 mg/l**	**1.6 mg/l**	**1.4 mg/l**	**1.4 mg/l**	**1.4 mg/l**
Chemical Oxygen Demand	NA	Lab	**14.0 mg/l**	**16.0 mg/l**	**17.2 mg/l**	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	**16.5 mg/l**	**15.0 mg/l**	< 10.0 mg/l
Chloride	NA	Lab	< 0.50 mg/l	< 1.0 mg/l	< 1.0 mg/l	**1.02 mg/l**	**1.04 mg/l**	**1.02 mg/l**	**1.02 mg/l**	**0.75 mg/l**	**0.7 mg/l**	**0.7 mg/l**	**0.69 mg/l**	**0.69 mg/l**	**0.74 mg/l**
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	**5.66 mg/l**	**10.26 mg/l**	--	**4.57 mg/l**	--	**4.5 mg/l**	--	**4.48 mg/l**	**4.84 mg/l**	--	**4.62 mg/l**	--	**4.83 mg/l**
Fluoride	NA	Lab	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l
Hardness, total, as CaCO3	NA	Lab	**17.9 mg/l**	**17.5 mg/l**	**17.1 mg/l**	**67.5 mg/l**	**66.1 mg/l**	**64.9 mg/l**	**65.3 mg/l**	**67.9 mg/l**	**68.2 mg/l**	**68.1 mg/l**	**65.1 mg/l**	**65.9 mg/l**	**67.7 mg/l**
Nitrate + Nitrite, as N	NA	Lab	**0.35 mg/l**	**2.7 mg/l**	**2.7 mg/l**	**0.17 mg/l**	**0.15 mg/l**	**0.14 mg/l**	**0.14 mg/l**	**0.12 mg/l**	**0.14 mg/l**	**0.14 mg/l**	**0.16 mg/l**	**0.16 mg/l**	**0.14 mg/l**
Nitrogen, ammonia (NH3), as N	NA	Lab	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	**0.090 mg/l**	< 0.050 mg/l	< 0.050 mg/l
pH	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	**4.95 pH units**	**5.53 pH units**	--	**8 pH units**	--	**8.11 pH units**	--	**7.79 pH units**	**8.01 pH units**	--	**8.4 pH units**	--	**8.21 pH units**
Phosphorus, total	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Redox (oxidation potential)	NA	Field	**544 mV**	**497 mV**	--	**210 mV**	--	**234 mV**	--	**273 mV**	**414 mV**	--	**214 mV**	--	**145 mV**
Solids, total dissolved	NA	Lab	**75.0 mg/l**	**64.0 mg/l**	**76.0 mg/l**	**101 mg/l**	**101 mg/l**	**110 mg/l**	**85 mg/l**	**104 mg/l**	**125 mg/l**	**119 mg/l**	**124 mg/l**	**122 mg/l**	**100 mg/l**
Specific Conductance @ 25oC	NA	Field	**45.5 umhos/cm**	**34.3 umhos/cm**	--	**142.5 umhos/cm**	--	**142.6 umhos/cm**	--	**141 umhos/cm**	**143.1 umhos/cm**	--	**138.1 umhos/cm**	--	**100.1 umhos/cm**
Sulfate	NA	Lab	**7.8 mg/l**	**5.0 mg/l**	**5.0 mg/l**	**9.22 mg/l**	**9.21 mg/l**	**9.82 mg/l**	**9.9 mg/l**	**9.69 mg/l**	**9.16 mg/l**	**9.1 mg/l**	**9.2 mg/l**	**9.2 mg/l**	**9.5 mg/l**
Temperature, degrees C	NA	Field	**16.34 deg C**	**7.56 deg C**	--	**8.79 deg C**	--	**8.43 deg C**	--	**5.65 deg C**	**5.59 deg C**	--	**4.8 deg C**	--	**6.56 deg C**
Turbidity	NA	Field	**12.1 NTU**	**22.4 NTU**	--	**0 NTU**	--	**0 NTU**	--	**0 NTU**	**0 NTU**	--	**0 NTU**	--	**0 NTU**
Metals															
Aluminum	Dissolved	Lab	**78.7 ug/l**	**44.6 ug/l**	**60.7 ug/l**	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l
Aluminum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Antimony	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	**0.66 ug/l**	**0.61 ug/l**	**0.6 ug/l**	**0.51 ug/l**	**0.76 ug/l**	**0.66 ug/l**	< 0.50 ug/l	< 0.50 ug/l
Arsenic	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Total	Lab	**16.0 ug/l**	**26.5 ug/l**	**23.7 ug/l**	**12.4 ug/l**	**12.2 ug/l**	**10.5 ug/l**	**10.8 ug/l**	**11.1 ug/l**	**9.3 ug/l**	**9.24 ug/l**	**8.5 ug/l**	**8.3 ug/l**	**7.5 ug/l**
Beryllium	Total	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Boron	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	Total	Lab	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l
Cadmium	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Cadmium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Calcium	Total	Lab	**4500 ug/l**	**4400 ug/l**	**4400 ug/l**	**14300 ug/l**	**14000 ug/l**	**13800 ug/l**	**13900 ug/l**	**14100 ug/l**	**14500 ug/l**	**14400 ug/l**	**13700 ug/l**	**13800 ug/l**	**14300 ug/l**
Chromium	Dissolved	Lab	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	**1.23 ug/l**	**1.79 b ug/l**	**3.4 ug/l**	**1.2 ug/l**	< 1.0 ug/l
Chromium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	Dissolved	Lab	< 0.20 ug/l	**0.29 ug/l**	**0.37 ug/l**	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Cobalt	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	Dissolved	Lab	**1.8 ug/l**	**2.0 ug/l**	**1.9 ug/l**	< 0.7 ug/l	< 0.7 ug/l	< 0.7 ug/l	**1.04 ug/l**	< 0.7 ug/l	**0.76 ug/l**	< 0.7 ug/l	**0.63 ug/l**	**1.6 ug/l**	**1.2 ug/l**
Copper	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Iron	Dissolved	Lab	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l
Iron	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Total	Lab	< 0.50 ug/l	**0.52 ug/l**	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Magnesium	Total	Lab	**1600 ug/l**	**1600 ug/l**	**1500 ug/l**	**7720 ug/l**	**7570 ug/l**	**7400 ug/l**	**7440 ug/l**	**7940 ug/l**	**7780 ug/l**	**7800 ug/l**	**7500 ug/l**	**7600 ug/l**	**7800 ug/l**
Manganese	Dissolved	Lab	**13.9 ug/l**	**27.4 ug/l**	**33.8 ug/l**	**22.6 ug/l**	**22.3 ug/l**	**22.3 ug/l**	**22.1 ug/l**	**23.4 ug/l**	**18.4 ug/l**	**17.8 ug/l**	**10.9 b ug/l**	**10.8 b ug/l**	**9.2 ug/l**
Manganese	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	Total	Lab	**0.0021 ug/l**	**0.0023 ug/l**	**0.0022 ug/l**	< 0.0005 ug/l	< 0.0005 ug/l	< 0.0005 ug/l	**0.0005 ug/l**	< 0.0005 ug/l	< 0.0005 ug/l	< 0.0005 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l
Mercury methyl	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Dissolved	Lab	< 0.30 ug/l	< 0.30 ug/l	< 0.30 ug/l	**4.9 ug/l**	**4.95 ug/l**	**2.92 ug/l**	**2.96 ug/l**	**1.93 ug/l**	**1.53 ug/l**	**1.59 ug/l**	**1.5 ug/l**	**1.4 ug/l**	**1.5 ug/l**
Molybdenum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	Dissolved	Lab	**0.54 ug/l**	**1.1 ug/l**	**1.1 ug/l**	**0.92 ug/l**	**0.92 ug/l**	< 0.6 ug/l	**0.61 ug/l**	< 0.6 ug/l	< 0.6 ug/l	< 0.6 ug/l	**1.4 ug/l**	< 0.50 ug/l	< 0.50 ug/l
Nickel	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	**270 ug/l**	**550 ug/l**	**460 ug/l**	**1540 ug/l**	**1530 ug/l**	**1380 ug/l**	**1340 ug/l**	**1470 ug/l**	**1670 ug/l**	**1660 ug/l**	**1500 ug/l**	**1500 ug/l**	**1500 ug/l**
Selenium	Dissolved	Lab	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l
Selenium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Silver	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Sodium	Total	Lab	**3600 ug/l**	**3100 ug/l**	**3100 ug/l**	**3040 ug/l**	**3040 ug/l**	**3240 ug/l**	**3250 ug/l**	**3460 ug/l**	**3380 ug/l**	**3360 ug/l**	**3300 ug/l**	**3400 ug/l**	**3300 ug/l**
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab	**0.20 ug/l**	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Dissolved	Lab	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 5 ug/l	< 5 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l
Zinc	Dissolved	Lab	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 8.0 ug/l	< 6.0 ug/l	< 6.0 ug/l
Zinc	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--

Large Table 3
Groundwater Data Summary
Mine Site Surficial Aquifer

Location			MW-11		MW-11	MW-11		MW-11	MW-11		MW-11	MW-11	MW-12	MW-12		MW-12
Date			6/12/2012		7/11/2012	8/20/2012		10/12/2012	4/25/2013		7/29/2013	10/23/2013	2/22/2012	3/14/2012		4/18/2012
Sample Type			N	FD	N	N	FD	N	N	FD	N	N	N	N	FD	N
	Fraction	Analysis Location														
General Parameters																
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total	NA	Lab	**58.8 mg/l**	**60.7 mg/l**	**59.7 mg/l**	**50.9 mg/l**	**56.1 mg/l**	**55.6 mg/l**	**59.6 mg/l**	--	**43.5 mg/l**	**32.7 mg/l**	**26.5 mg/l**	**26.3 mg/l**	**26.5 mg/l**	**26.1 mg/l**
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	**1.6 b mg/l**	**1.5 b mg/l**	< 1.0 mg/l	**1.2 mg/l**	**1.3 mg/l**	**1.2 mg/l**	**1.0 mg/l**	--	**2.5 mg/l**	**1.6 mg/l**	**2.93 mg/l**	**2.0 mg/l**	**2.3 mg/l**	**1.7 mg/l**
Carbon, total organic	NA	Lab	< 1.0 mg/l	**1.0 mg/l**	**1.3 mg/l**	**1.0 mg/l**	< 1.0 mg/l	< 1.0 mg/l	< 1.0 mg/l	--	**1.8 mg/l**	**1.5 mg/l**	**1.81 mg/l**	**1.8 mg/l**	**2.2 mg/l**	**1.3 mg/l**
Chemical Oxygen Demand	NA	Lab	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	--	**14.0 mg/l**	**14.5 mg/l**	< 10 mg/l	**10.7 mg/l**	< 10 mg/l	**19.9 mg/l**
Chloride	NA	Lab	**0.73 mg/l**	**0.73 mg/l**	**0.80 mg/l**	**0.87 mg/l**	**0.85 mg/l**	**0.88 mg/l**	**0.71 mg/l**	--	< 0.50 mg/l	< 1.0 mg/l	**0.6 mg/l**	**0.58 mg/l**	**0.58 mg/l**	**0.61 mg/l**
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	**4.2 mg/l**	--	**4 mg/l**	**3.14 mg/l**	--	**4.72 mg/l**	**2.68 mg/l**	--	**3.01 mg/l**	**3.47 mg/l**	**3.78 mg/l**	**3.76 mg/l**	--	**3.52 mg/l**
Fluoride	NA	Lab	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	--	< 0.10 mg/l	< 0.10 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.10 mg/l
Hardness, total, as CaCO3	NA	Lab	**65.5 mg/l**	**66.7 mg/l**	**63.8 mg/l**	**67.8 mg/l**	**68.2 mg/l**	**68.1 mg/l**	**68.9 mg/l**	--	**43.4 mg/l**	**41.1 mg/l**	**31.1 mg/l**	**29 mg/l**	**28.5 mg/l**	**27.8 mg/l**
Nitrate + Nitrite, as N	NA	Lab	**0.16 mg/l**	**0.14 mg/l**	**0.14 mg/l**	**0.14 mg/l**	**0.15 mg/l**	**0.14 mg/l**	**0.20 mg/l**	--	**0.13 mg/l**	< 0.10 mg/l	< 0.1 mg/l	**0.1 mg/l**	< 0.1 mg/l	< 0.10 mg/l
Nitrogen, ammonia (NH3), as N	NA	Lab	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	--	< 0.10 mg/l	< 0.10 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	**0.080 b mg/l**
pH	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	**8.1 pH units**	--	**7.99 pH units**	**8 pH units**	--	**8.29 pH units**	**8.13 pH units**	--	**8.13 pH units**	**8.29 pH units**	**6.69 pH units**	**6.44 pH units**	--	**6.75 pH units**
Phosphorus, total	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Redox (oxidation potential)	NA	Field	**232 mV**	--	**270 mV**	**164 mV**	--	**265 mV**	**476 mV**	--	**397 mV**	**306 mV**	**221 mV**	**194 mV**	--	**122 mV**
Solids, total dissolved	NA	Lab	**112 mg/l**	**102 mg/l**	**129 mg/l**	**105 mg/l**	**117 mg/l**	**116 mg/l**	**97.0 mg/l**	--	**76.0 mg/l**	**85.0 mg/l**	**18 mg/l**	**66 mg/l**	**73 mg/l**	**78.0 mg/l**
Specific Conductance @ 25oC	NA	Field	**99.7 umhos/cm**	--	**134.1 umhos/cm**	**137.1 umhos/cm**	--	**140.4 umhos/cm**	**127 umhos/cm**	--	**129.2 umhos/cm**	**136.1 umhos/cm**	**70.4 umhos/cm**	**68.6 umhos/cm**	--	**65.3 umhos/cm**
Sulfate	NA	Lab	**9.4 mg/l**	**9.4 mg/l**	**10.1 mg/l**	**9.9 mg/l**	**9.9 mg/l**	**9.2 mg/l**	**9.6 mg/l**	--	**7.8 mg/l**	**9.3 mg/l**	**8.79 mg/l**	**7.37 mg/l**	**7.33 mg/l**	**6.1 mg/l**
Temperature, degrees C	NA	Field	**6.75 deg C**	--	**8.92 deg C**	**9.92 deg C**	--	**7.87 deg C**	**4.18 deg C**	--	**6.24 deg C**	**6.83 deg C**	**7.24 deg C**	**5.93 deg C**	--	**3.46 deg C**
Turbidity	NA	Field	**0 NTU**	--	**0 NTU**	**0 NTU**	--	**2.2 NTU**	**4.1 NTU**	--	**1.3 NTU**	**0 NTU**	**20.1 NTU**	**4.4 NTU**	--	**0 NTU**
Metals																
Aluminum	Dissolved	Lab	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	--	< 20.0 ug/l	< 20.0 ug/l	< 25 ug/l	< 20 ug/l	< 20 ug/l	< 20.0 ug/l
Aluminum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l
Antimony	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	Dissolved	Lab	**0.62 ug/l**	**0.65 ug/l**	**0.59 ug/l**	< 0.50 ug/l	**0.52 ug/l**	< 0.50 ug/l	**0.55 ug/l**	--	< 0.50 ug/l	**1.3 ug/l**	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	**0.54 ug/l**
Arsenic	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Total	Lab	**7.0 ug/l**	**7.0 ug/l**	**5.8 ug/l**	**6.0 ug/l**	**5.9 ug/l**	**5.9 ug/l**	**5.8 ug/l**	--	**4.3 ug/l**	**7.1 ug/l**	**16.6 ug/l**	**10.3 ug/l**	**10 ug/l**	**8.7 ug/l**
Beryllium	Total	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l
Boron	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	Total	Lab	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	--	< 50.0 ug/l	< 50.0 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50.0 ug/l
Cadmium	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l
Cadmium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Calcium	Total	Lab	**13800 ug/l**	**14100 ug/l**	**13500 ug/l**	**14200 ug/l**	**14200 ug/l**	**14400 ug/l**	**14400 ug/l**	--	**8500 ug/l**	**8100 ug/l**	**7240 ug/l**	**7010 ug/l**	**6870 ug/l**	**6800 ug/l**
Chromium	Dissolved	Lab	**1.1 ug/l**	**1.1 ug/l**	**1.7 ug/l**	**1.4 ug/l**	**1.9 ug/l**	< 1.0 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	< 1.0 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1.0 ug/l
Chromium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	**0.81 ug/l**	**1.01 ug/l**	**1.02 ug/l**	**1.3 ug/l**
Cobalt	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	**0.82 ug/l**	**0.84 ug/l**	< 0.50 ug/l	--	**0.91 ug/l**	**2.1 ug/l**	**16.2 ug/l**	< 0.7 ug/l	< 0.7 ug/l	**1.2 ug/l**
Copper	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Iron	Dissolved	Lab	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	--	< 50.0 ug/l	< 50.0 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	**65.0 ug/l**
Iron	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Total	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l
Magnesium	Total	Lab	**7500 ug/l**	**7600 ug/l**	**7300 ug/l**	**7800 ug/l**	**7900 ug/l**	**7800 ug/l**	**8000 ug/l**	--	**5400 ug/l**	**5100 ug/l**	**3170 ug/l**	**2790 ug/l**	**2760 ug/l**	**2700 ug/l**
Manganese	Dissolved	Lab	**5.3 ug/l**	**5.3 ug/l**	**2.6 ug/l**	**2.2 ug/l**	**2.2 ug/l**	**1.4 ug/l**	**0.69 ug/l**	--	**0.89 ug/l**	**36.8 ug/l**	**60.8 ug/l**	**99.3 ug/l**	**101 ug/l**	**161 ug/l**
Manganese	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	Total	Lab	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	**0.00097 ug/l**	**0.0020 ug/l**	**0.0009 ug/l**	**0.0009 ug/l**	< 0.00050 ug/l
Mercury methyl	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Dissolved	Lab	**1.0 ug/l**	**1.0 ug/l**	**0.92 ug/l**	**0.81 ug/l**	**0.80 ug/l**	**0.71 ug/l**	**0.94 ug/l**	--	**0.67 ug/l**	**1.3 ug/l**	**3.35 ug/l**	**3.32 ug/l**	**3.38 ug/l**	**2.9 ug/l**
Molybdenum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	**0.66 ug/l**	**0.83 ug/l**	< 0.50 ug/l	< 0.50 ug/l	--	**1.1 ug/l**	< 0.50 ug/l	**1.04 ug/l**	**0.95 ug/l**	**0.96 ug/l**	**0.76 ug/l**
Nickel	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	**1600 ug/l**	**1600 ug/l**	**1600 ug/l**	**1600 ug/l**	**1700 ug/l**	**1700 ug/l**	**1600 ug/l**	--	**1100 ug/l**	**1100 ug/l**	**1320 ug/l**	**1210 ug/l**	**1150 ug/l**	**1100 ug/l**
Selenium	Dissolved	Lab	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	< 1.0 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1.0 ug/l
Selenium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l
Silver	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sodium	Total	Lab	**3200 ug/l**	**3200 ug/l**	**3200 ug/l**	**3400 ug/l**	**3400 ug/l**	**3500 ug/l**	**3400 ug/l**	--	**3300 ug/l**	**2000 ug/l**	**2470 ug/l**	**2250 ug/l**	**2240 ug/l**	**2200 ug/l**
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.017 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Dissolved	Lab	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	--	< 5.0 ug/l	< 5.0 ug/l	< 5 ug/l	< 5 ug/l	< 5 ug/l	< 5.0 ug/l
Zinc	Dissolved	Lab	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	--	< 8.0 ug/l	< 6.0 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 8.0 ug/l
Zinc	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Large Table 3
Groundwater Data Summary
Mine Site Surficial Aquifer

		Location	MW-12	MW-12	MW-12	MW-12		MW-12	MW-12		MW-12	MW-12		MW-13		MW-13
		Date	5/21/2012	6/25/2012	7/30/2012	8/28/2012		10/22/2012	5/22/2013		7/31/2013	10/22/2013		2/22/2012		3/14/2012
		Sample Type	N	N	N	N	FD	N	N	FD	N	N	FD	N	FD	N
	Fraction	Analysis Location														
General Parameters																
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total	NA	Lab	**26.7 mg/l**	**26.4 mg/l**	**24.8 mg/l**	**24.3 mg/l**	**24.0 mg/l**	**26.9 mg/l**	**26.0 mg/l**	--	**22.6 mg/l**	**27.3 mg/l**	**26.5 mg/l**	**39.9 mg/l**	**39.1 mg/l**	**59.6 mg/l**
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	**1.7 mg/l**	**1.4 mg/l**	< 1.0 mg/l	**1.2 mg/l**	**1.2 mg/l**	**1.3 mg/l**	**1.5 mg/l**	--	**1.0 mg/l**	**4.2 mg/l**	**1.4 mg/l**	**10.9 mg/l**	**11.1 mg/l**	**12.9 mg/l**
Carbon, total organic	NA	Lab	**1.2 mg/l**	**1.0 mg/l**	< 1.0 mg/l	**1.1 mg/l**	**2.2 mg/l**	**1.1 mg/l**	< 1.0 mg/l	--	< 1.0 mg/l	**1.0 mg/l**	**1.0 mg/l**	**10.6 mg/l**	**10.3 mg/l**	**11.8 mg/l**
Chemical Oxygen Demand	NA	Lab	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	--	< 10.0 mg/l	**15.5 mg/l**	**14.0 mg/l**	**34.2 mg/l**	**36.9 mg/l**	**38.6 mg/l**
Chloride	NA	Lab	**0.50 mg/l**	< 0.50 mg/l	**0.57 mg/l**	**0.68 mg/l**	**0.67 mg/l**	**0.67 mg/l**	**0.65 mg/l**	--	**0.58 mg/l**	< 1.0 mg/l	< 1.0 mg/l	**0.74 mg/l**	**0.71 mg/l**	**0.62 mg/l**
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	**3.92 mg/l**	**3.24 mg/l**	**3.64 mg/l**	**4.02 mg/l**	--	**3.06 mg/l**	**3.06 mg/l**	--	**4.14 mg/l**	**1.76 mg/l**	--	**2.79 mg/l**	--	**1.35 mg/l**
Fluoride	NA	Lab	**0.10 mg/l**	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	**0.10 mg/l**	< 0.10 mg/l	--	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l
Hardness, total, as CaCO3	NA	Lab	**26.7 mg/l**	**24.8 mg/l**	**25.4 mg/l**	**25.4 mg/l**	**25.5 mg/l**	**29.8 mg/l**	**24.4 mg/l**	--	**24.4 mg/l**	**27.7 mg/l**	**26.4 mg/l**	**61 mg/l**	**62.1 mg/l**	**71.8 mg/l**
Nitrate + Nitrite, as N	NA	Lab	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	**0.11 mg/l**	--	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	**0.11 mg/l**	**0.12 mg/l**	< 0.1 mg/l
Nitrogen, ammonia (NH3), as N	NA	Lab	< 0.050 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	--	**0.20 mg/l**	< 0.10 mg/l	< 0.10 mg/l	**0.41 mg/l**	**0.38 mg/l**	**0.58 mg/l**
pH	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	**6.56 pH units**	**6.27 pH units**	**6.15 pH units**	**6.26 pH units**	--	**6.51 pH units**	**6.51 pH units**	--	**6.31 pH units**	**6.53 pH units**	--	**6.27 pH units**	--	**6.07 pH units**
Phosphorus, total	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Redox (oxidation potential)	NA	Field	**342 mV**	**274 mV**	**273 mV**	**241 mV**	--	**216 mV**	**442 mV**	--	**407 mV**	**366 mV**	--	**254 mV**	--	**249 mV**
Solids, total dissolved	NA	Lab	**79.0 mg/l**	**66.0 mg/l**	**66.0 h mg/l**	**60.0 mg/l**	**62.0 mg/l**	**45.0 mg/l**	**77.0 mg/l**	--	**71.0 mg/l**	**71.0 * mg/l**	**40.0 * mg/l**	**91 mg/l**	**106 mg/l**	**161 mg/l**
Specific Conductance @ 25oC	NA	Field	**19.9 umhos/cm**	**57 umhos/cm**	**54.2 umhos/cm**	**56.1 umhos/cm**	--	**71.8 umhos/cm**	**47.5 umhos/cm**	--	**54.8 umhos/cm**	**62.5 umhos/cm**	--	**154.5 umhos/cm**	--	**178.1 umhos/cm**
Sulfate	NA	Lab	**6.1 mg/l**	**5.8 mg/l**	**6.4 mg/l**	**6.2 mg/l**	**6.3 mg/l**	**6.4 mg/l**	**5.7 mg/l**	--	**5.8 mg/l**	**5.7 mg/l**	**5.5 mg/l**	**23.3 mg/l**	**23.4 mg/l**	**13.8 mg/l**
Temperature, degrees C	NA	Field	**5.87 deg C**	**9.05 deg C**	**11.31 deg C**	**11.25 deg C**	--	**7.63 deg C**	**4.74 deg C**	--	**7.83 deg C**	**7.36 deg C**	--	**3 deg C**	--	**8.29 deg C**
Turbidity	NA	Field	**0 NTU**	**0 NTU**	**0 NTU**	**0 NTU**	--	**2.1 NTU**	**1.4 NTU**	--	**1.8 NTU**	**0 NTU**	--	**7.1 NTU**	--	**2.3 NTU**
Metals																
Aluminum	Dissolved	Lab	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	--	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	**118 ug/l**	**126 ug/l**	**108 ug/l**
Aluminum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l
Antimony	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	**0.84 ug/l**	**0.85 ug/l**	**0.85 ug/l**
Arsenic	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Total	Lab	**9.2 ug/l**	**8.6 ug/l**	**8.8 ug/l**	**8.9 ug/l**	**8.9 ug/l**	**10.1 ug/l**	**8.5 ug/l**	--	**8.3 ug/l**	**10.6 ug/l**	**10.4 ug/l**	**45.1 ug/l**	**44.4 ug/l**	**56.6 ug/l**
Beryllium	Total	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l
Boron	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	Total	Lab	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	--	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l
Cadmium	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l
Cadmium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Calcium	Total	Lab	**6500 ug/l**	**6000 ug/l**	**6200 ug/l**	**6200 ug/l**	**6200 ug/l**	**7200 ug/l**	**5800 ug/l**	--	**5900 ug/l**	**6700 ug/l**	**6400 ug/l**	**13600 ug/l**	**13900 ug/l**	**16000 ug/l**
Chromium	Dissolved	Lab	< 1.0 ug/l	< 1.0 ug/l	**1.9 ug/l**	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	**1.42 ug/l**	**1.22 ug/l**	< 1 ug/l
Chromium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	Dissolved	Lab	**1.2 ug/l**	**1.6 ug/l**	**1.5 ug/l**	**1.4 ug/l**	**1.4 ug/l**	**1.5 ug/l**	**1.7 ug/l**	--	**1.6 ug/l**	**1.7 ug/l**	**1.7 ug/l**	**3.42 ug/l**	**3.63 ug/l**	**6.21 ug/l**
Cobalt	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	Dissolved	Lab	**0.62 ug/l**	**0.75 ug/l**	< 0.50 ug/l	**0.59 ug/l**	**0.57 ug/l**	**0.99 ug/l**	< 0.50 ug/l	--	< 0.50 ug/l	**0.71 ug/l**	**0.70 ug/l**	**5.09 ug/l**	**5.29 ug/l**	**3.84 ug/l**
Copper	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Iron	Dissolved	Lab	**61.2 ug/l**	< 50.0 ug/l	**54.7 ug/l**	< 50.0 ug/l	< 50.0 ug/l	**64.7 ug/l**	**149 ug/l**	--	**108 ug/l**	**166 ug/l**	**158 ug/l**	**5470 ug/l**	**5830 ug/l**	**7040 ug/l**
Iron	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Total	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	**0.55 ug/l**	**0.51 ug/l**	< 0.5 ug/l
Magnesium	Total	Lab	**2600 ug/l**	**2400 ug/l**	**2400 ug/l**	**2400 ug/l**	**2500 ug/l**	**2900 ug/l**	**2400 ug/l**	--	**2400 ug/l**	**2700 ug/l**	**2500 ug/l**	**6560 ug/l**	**6660 ug/l**	**7740 ug/l**
Manganese	Dissolved	Lab	**163 ug/l**	**149 ug/l**	**150 ug/l**	**151 ug/l**	**148 ug/l**	**208 ug/l**	**176 ug/l**	--	**124 ug/l**	**192 ug/l**	**198 ug/l**	**502 ug/l**	**499 ug/l**	**843 ug/l**
Manganese	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	Total	Lab	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	**0.0013 ug/l**	**0.0013 ug/l**	**0.0009 ug/l**
Mercury methyl	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Dissolved	Lab	**2.3 ug/l**	**2.1 ug/l**	**1.8 ug/l**	**2.0 ug/l**	**2.0 ug/l**	**1.8 ug/l**	**1.5 ug/l**	--	**1.5 ug/l**	**2.2 ug/l**	**2.1 ug/l**	**1.08 ug/l**	**1.07 ug/l**	**0.85 ug/l**
Molybdenum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	Dissolved	Lab	**0.70 ug/l**	**1.0 ug/l**	**0.96 b ug/l**	**0.72 ug/l**	**0.75 ug/l**	**0.80 ug/l**	**0.75 ug/l**	--	**0.54 ug/l**	**0.77 ug/l**	**0.63 ug/l**	**11.2 ug/l**	**11.3 ug/l**	**15.8 ug/l**
Nickel	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	**1100 ug/l**	**1200 ug/l**	**1400 ug/l**	**1500 ug/l**	**1500 ug/l**	**1500 ug/l**	**1100 ug/l**	--	**1400 ug/l**	**1500 ug/l**	**1400 ug/l**	**1560 ug/l**	**1590 ug/l**	**1860 ug/l**
Selenium	Dissolved	Lab	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l
Selenium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l
Silver	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sodium	Total	Lab	**1900 ug/l**	**2000 ug/l**	**2100 ug/l**	**2100 ug/l**	**2100 ug/l**	**2500 ug/l**	**1900 ug/l**	--	**2000 ug/l**	**2400 ug/l**	**2400 ug/l**	**2290 ug/l**	**2310 ug/l**	**2550 ug/l**
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.017 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Dissolved	Lab	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	--	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5 ug/l	< 5 ug/l	< 5 ug/l
Zinc	Dissolved	Lab	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	--	< 8.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	**19.9 ug/l**	**21.8 ug/l**	**20.4 ug/l**
Zinc	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Large Table 3
Groundwater Data Summary
Mine Site Surficial Aquifer

			Location	MW-13	MW-13	MW-13	MW-13	MW-13	MW-13		MW-13		MW-13	MW-13		MW-14	
			Date	4/20/2012	5/16/2012	6/22/2012	7/17/2012	8/15/2012	10/30/2012		4/23/2013		7/25/2013	10/21/2013		2/23/2012	
			Sample Type	N	N	N	N	N	N	FD	N	FD	N	N	FD	N	FD
	Fraction	Analysis Location															
General Parameters																	
Alkalinity, bicarbonate, as CaCO3	NA	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total	NA	Lab		**68.1 mg/l**	**64.9 mg/l**	**47.1 mg/l**	**42.8 mg/l**	**61.9 mg/l**	**59.4 mg/l**	**63.5 mg/l**	**55.9 mg/l**	**56.0 mg/l**	**49.8 mg/l**	**60.2 mg/l**	--	**62.3 mg/l**	**59.4 mg/l**
Biochemical Oxygen Demand (5-day)	NA	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab		**23.7 mg/l**	**21.6 mg/l**	**19.4 mg/l**	**20.3 mg/l**	**24.3 mg/l**	**35.8 mg/l**	**34.4 mg/l**	**29.3 mg/l**	**27.0 mg/l**	**29.6 mg/l**	**39.9 mg/l**	--	**3.57 mg/l**	**2.66 mg/l**
Carbon, total organic	NA	Lab		**23.5 mg/l**	**21.6 mg/l**	**19.1 mg/l**	**19.4 mg/l**	**23.7 mg/l**	**33.9 mg/l**	**33.2 mg/l**	**28.3 mg/l**	**26.2 mg/l**	**26.0 mg/l**	**35.6 mg/l**	--	**1.87 mg/l**	**2.03 mg/l**
Chemical Oxygen Demand	NA	Lab		**72.7 mg/l**	**65.5 mg/l**	**57.6 mg/l**	**62.4 mg/l**	**77.2 mg/l**	**108 mg/l**	**109 mg/l**	**83.6 mg/l**	**80.9 mg/l**	**78.8 mg/l**	**116 mg/l**	--	< 10 mg/l	< 10 mg/l
Chloride	NA	Lab		**0.73 mg/l**	**0.69 mg/l**	**0.66 mg/l**	**0.74 mg/l**	**0.86 mg/l**	**0.75 mg/l**	**0.75 mg/l**	**0.63 mg/l**	**0.64 mg/l**	**0.82 mg/l**	**13.2 mg/l**	--	< 0.5 mg/l	< 0.5 mg/l
Cyanide	NA	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field		**1.75 mg/l**	**3.07 mg/l**	**1.85 mg/l**	**1.31 mg/l**	**1.82 mg/l**	**2.58 mg/l**	--	< 0.1 mg/l	--	< 0.1 mg/l	< 0.1 mg/l	--	**10.16 mg/l**	--
Fluoride	NA	Lab		< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	**0.52 mg/l**	--	< 0.1 mg/l	< 0.1 mg/l
Hardness, total, as CaCO3	NA	Lab		**72.8 mg/l**	**68.3 mg/l**	**56.0 mg/l**	**52.8 mg/l**	**58.6 mg/l**	**66.4 mg/l**	**66.5 mg/l**	**55.8 mg/l**	**56.9 mg/l**	**50.8 mg/l**	**56.7 mg/l**	--	**67 mg/l**	**64.8 mg/l**
Nitrate + Nitrite, as N	NA	Lab		< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	**0.11 mg/l**	< 0.10 mg/l	< 0.10 mg/l	--	**0.33 mg/l**	**0.33 mg/l**
Nitrogen, ammonia (NH3), as N	NA	Lab		**1.4 mg/l**	**1.4 mg/l**	**1.3 mg/l**	**1.4 mg/l**	**1.7 mg/l**	**1.8 mg/l**	**1.9 mg/l**	**1.5 mg/l**	**1.6 mg/l**	**1.5 mg/l**	**1.6 mg/l**	--	< 0.1 mg/l	< 0.1 mg/l
pH	NA	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field		**6.33 pH units**	**6.15 pH units**	**5.93 pH units**	**5.79 pH units**	**5.81 pH units**	**6.09 pH units**	--	**5.97 pH units**	--	**5.75 pH units**	**5.85 pH units**	--	**8.57 pH units**	--
Phosphorus, total	NA	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--
Redox (oxidation potential)	NA	Field		**368 mV**	**199 mV**	**237 mV**	**256 mV**	**26 mV**	**50 mV**	--	**101 mV**	--	**75 mV**	**97 mV**	--	**364 mV**	--
Solids, total dissolved	NA	Lab		**238 mg/l**	**201 mg/l**	**194 mg/l**	**176 mg/l**	**178 mg/l**	**222 mg/l**	**223 mg/l**	**196 mg/l**	**224 mg/l**	**198 mg/l**	**228 mg/l**	--	**99 * mg/l**	**58 * mg/l**
Specific Conductance @ 25oC	NA	Field		**190.8 umhos/cm**	**157 umhos/cm**	**170.7 umhos/cm**	**154.8 umhos/cm**	**168.6 umhos/cm**	**208.8 umhos/cm**	--	**188.7 umhos/cm**	--	**178.8 umhos/cm**	**210.4 umhos/cm**	--	**135.3 umhos/cm**	--
Sulfate	NA	Lab		**12.6 mg/l**	**16.8 mg/l**	**19.6 mg/l**	**19.8 mg/l**	**18.2 mg/l**	**17.6 mg/l**	**17.7 mg/l**	**15.8 mg/l**	**15.8 mg/l**	**16.8 mg/l**	**104 mg/l**	--	**7.7 mg/l**	**7.73 mg/l**
Temperature, degrees C	NA	Field		**6.23 deg C**	**16.71 deg C**	**9.5 deg C**	**9.14 deg C**	**10.33 deg C**	**4.97 deg C**	--	**4.97 deg C**	--	**8.69 deg C**	**5.68 deg C**	--	**4.25 deg C**	--
Turbidity	NA	Field		**0 NTU**	**3.8 NTU**	**0 NTU**	**0 NTU**	**0 NTU**	**0 NTU**	--	**2.5 NTU**	--	**1.4 NTU**	**0.3 NTU**	--	**0 NTU**	--
Metals																	
Aluminum	Dissolved	Lab		**161 ug/l**	**146 ug/l**	**137 ug/l**	**139 ug/l**	**230 b ug/l**	**319 ug/l**	**321 ug/l**	**211 ug/l**	**210 ug/l**	**307 ug/l**	**427 ug/l**	--	**43.2 ug/l**	**44.7 ug/l**
Aluminum	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	Dissolved	Lab		< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.5 ug/l	< 0.5 ug/l
Antimony	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	Dissolved	Lab		**0.86 ug/l**	**0.77 ug/l**	**0.78 ug/l**	**0.76 ug/l**	**0.91 ug/l**	**0.90 ug/l**	**1.0 ug/l**	**1.1 ug/l**	**1.1 ug/l**	**0.64 ug/l**	**1.5 ug/l**	--	**0.71 ug/l**	< 0.5 ug/l
Arsenic	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Dissolved	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Total	Lab		**72.8 ug/l**	**67.3 ug/l**	**54.9 ug/l**	**51.9 ug/l**	**53.6 ug/l**	**57.8 ug/l**	**56.2 ug/l**	**41.6 ug/l**	**41.9 ug/l**	**30.9 ug/l**	**39.4 ug/l**	--	**11.3 ug/l**	**10.7 ug/l**
Beryllium	Total	Lab		< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	**0.25 ug/l**	< 0.20 ug/l	< 0.20 ug/l	**0.20 ug/l**	< 0.20 ug/l	**0.27 ug/l**	--	< 0.2 ug/l	< 0.2 ug/l
Boron	Dissolved	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	Total	Lab		< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	--	< 50 ug/l	< 50 ug/l
Cadmium	Dissolved	Lab		< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.2 ug/l	< 0.2 ug/l
Cadmium	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--
Calcium	Total	Lab		**16900 ug/l**	**15300 ug/l**	**12500 ug/l**	**11700 ug/l**	**13200 ug/l**	**15300 ug/l**	**15300 ug/l**	**12300 ug/l**	**12600 ug/l**	**11500 ug/l**	**12800 ug/l**	--	**21100 ug/l**	**20200 ug/l**
Chromium	Dissolved	Lab		< 1.0 ug/l	**1.0 ug/l**	< 1.0 ug/l	**1.1 ug/l**	**1.7 b ug/l**	**1.6 b ug/l**	**1.4 b ug/l**	**2.5 ug/l**	**2.2 ug/l**	**1.7 ug/l**	**1.1 ug/l**	--	**5.66 ug/l**	**5.77 ug/l**
Chromium	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	Dissolved	Lab		**8.6 ug/l**	**8.3 ug/l**	**7.2 ug/l**	**6.0 ug/l**	**5.1 ug/l**	**5.6 ug/l**	**5.6 ug/l**	**4.9 ug/l**	**4.7 ug/l**	**3.5 ug/l**	**3.2 ug/l**	--	< 0.2 ug/l	< 0.2 ug/l
Cobalt	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	Dissolved	Lab		**2.0 ug/l**	**1.8 ug/l**	**1.5 ug/l**	**2.0 ug/l**	**1.4 ug/l**	**0.94 ug/l**	**0.91 ug/l**	**0.88 ug/l**	**0.82 ug/l**	**0.81 ug/l**	**0.88 ug/l**	--	**1.85 ug/l**	**1.92 ug/l**
Copper	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--
Iron	Dissolved	Lab		**10500 ug/l**	**11900 ug/l**	**11300 ug/l**	**10400 ug/l**	**13000 ug/l**	**21600 ug/l**	**21700 ug/l**	**21100 ug/l**	**21200 ug/l**	**19300 ug/l**	**22100 ug/l**	--	< 50 ug/l	< 50 ug/l
Iron	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Dissolved	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Total	Lab		< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.5 ug/l	< 0.5 ug/l
Magnesium	Total	Lab		**7400 ug/l**	**7300 ug/l**	**6000 ug/l**	**5700 ug/l**	**6200 ug/l**	**6800 ug/l**	**6900 ug/l**	**6100 ug/l**	**6200 ug/l**	**5400 ug/l**	**6000 ug/l**	--	**3480 ug/l**	**3480 ug/l**
Manganese	Dissolved	Lab		**1150 ug/l**	**909 ug/l**	**754 ug/l**	**597 ug/l**	**516 ug/l**	**515 ug/l**	**511 ug/l**	**470 ug/l**	**464 ug/l**	**325 ug/l**	**360 ug/l**	--	**22.2 ug/l**	**22.4 ug/l**
Manganese	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	Total	Lab		< 0.00050 ug/l	**0.00087 ug/l**	**0.00057 ug/l**	**0.00069 ug/l**	**0.00087 ug/l**	**0.0010 ug/l**	**0.0010 ug/l**	**0.00077 ug/l**	**0.00078 ug/l**	**0.00088 ug/l**	**0.0015 ug/l**	**0.0014 ug/l**	**0.0006 ug/l**	**0.0006 ug/l**
Mercury methyl	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Dissolved	Lab		**0.55 ug/l**	**0.43 ug/l**	**0.40 ug/l**	**0.42 ug/l**	**0.39 ug/l**	**0.33 ug/l**	**0.33 ug/l**	**0.36 ug/l**	**0.31 ug/l**	< 0.30 ug/l	< 0.30 ug/l	--	**2.2 ug/l**	**2.17 ug/l**
Molybdenum	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	Dissolved	Lab		**19.9 ug/l**	**20.5 ug/l**	**16.5 ug/l**	**13.5 ug/l**	**12.4 ug/l**	**12.2 ug/l**	**12.0 ug/l**	**9.1 ug/l**	**8.8 ug/l**	**5.6 ug/l**	**6.3 ug/l**	--	< 0.6 ug/l	< 0.6 ug/l
Nickel	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--
Palladium	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab		**1700 ug/l**	**1400 ug/l**	**1100 ug/l**	**1100 ug/l**	**1100 ug/l**	**1100 ug/l**	**1100 ug/l**	**1000 ug/l**	**1000 ug/l**	**1100 ug/l**	**1600 ug/l**	--	**980 ug/l**	**960 ug/l**
Selenium	Dissolved	Lab		< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	< 1 ug/l	< 1 ug/l
Selenium	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	Dissolved	Lab		< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.2 ug/l	< 0.2 ug/l
Silver	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sodium	Total	Lab		**5500 ug/l**	**5000 ug/l**	**4600 ug/l**	**4800 ug/l**	**5500 ug/l**	**8100 ug/l**	**8200 ug/l**	**6600 ug/l**	**6700 ug/l**	**7700 ug/l**	**9500 ug/l**	--	**2940 ug/l**	**2830 ug/l**
Strontium	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab		< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.017 ug/l	< 0.20 ug/l	--	< 0.2 ug/l	< 0.2 ug/l
Titanium	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Dissolved	Lab		**5.8 ug/l**	**5.9 ug/l**	**7.4 ug/l**	**7.0 ug/l**	**9.3 ug/l**	**14.9 ug/l**	**14.8 ug/l**	**12.6 ug/l**	**12.7 ug/l**	**9.1 ug/l**	**12.6 ug/l**	--	< 5 ug/l	< 5 ug/l
Zinc	Dissolved	Lab		**19.0 ug/l**	**19.5 ug/l**	**17.4 ug/l**	**15.8 ug/l**	**15.0 ug/l**	**8.8 ug/l**	**8.4 ug/l**	**6.0 ug/l**	**6.1 ug/l**	< 6.0 ug/l	< 6.0 ug/l	--	< 6 ug/l	< 6 ug/l
Zinc	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--

Large Table 3
Groundwater Data Summary
Mine Site Surficial Aquifer

Location			MW-14	MW-14		MW-14		MW-14		MW-14		MW-14		MW-14	MW-14
Date			3/26/2012	4/30/2012		5/14/2012		6/6/2012		7/27/2012		8/29/2012		10/15/2012	5/13/2013
Sample Type			N	N	FD	N	FD	N	FD	N	FD	N	FD	N	N
	Fraction	Analysis Location													
General Parameters															
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total	NA	Lab	**50 mg/l**	**49.2 mg/l**	**49.6 mg/l**	**46.7 mg/l**	**46.6 mg/l**	**39.4 mg/l**	**41.1 mg/l**	**52.8 mg/l**	**41.4 mg/l**	**39.8 mg/l**	**39.4 mg/l**	**56.2 mg/l**	**39.1 mg/l**
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	**1.8 mg/l**	**2.1 b mg/l**	**1.7 b mg/l**	**2.1 mg/l**	**1.5 mg/l**	**2.2 mg/l**	**1.8 mg/l**	**2.4 b mg/l**	**2.4 b mg/l**	**1.6 mg/l**	**2.4 mg/l**	**1.8 mg/l**	**1.6 mg/l**
Carbon, total organic	NA	Lab	**1.8 mg/l**	**1.7 mg/l**	**1.7 mg/l**	**1.8 mg/l**	**1.9 mg/l**	**1.7 mg/l**	**1.5 mg/l**	< 1.0 mg/l	**1.0 mg/l**	**1.8 mg/l**	**1.6 mg/l**	**1.5 mg/l**	**1.7 mg/l**
Chemical Oxygen Demand	NA	Lab	< 10 mg/l	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	**10.0 mg/l**	**12.2 mg/l**	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	**12.8 mg/l**	< 10.0 mg/l
Chloride	NA	Lab	< 0.5 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	**0.55 mg/l**	**0.54 mg/l**	< 0.50 mg/l	**0.54 mg/l**
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	**9.64 mg/l**	**9.85 mg/l**	--	**9.72 mg/l**	--	**8.8 mg/l**	--	**10.39 mg/l**	--	**10.39 mg/l**	--	**10.48 mg/l**	**9.39 mg/l**
Fluoride	NA	Lab	< 0.1 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l
Hardness, total, as CaCO3	NA	Lab	**54.8 mg/l**	**57.1 mg/l**	**56.0 mg/l**	**49.5 mg/l**	**49.0 mg/l**	**46.6 mg/l**	**48.2 mg/l**	**42.4 mg/l**	**41.9 mg/l**	**43.9 mg/l**	**42.6 mg/l**	**47.7 mg/l**	**39.6 mg/l**
Nitrate + Nitrite, as N	NA	Lab	**0.32 mg/l**	**0.31 mg/l**	**0.32 mg/l**	**0.35 mg/l**	**0.34 mg/l**	**0.41 mg/l**	**0.40 mg/l**	**0.45 mg/l**	**0.44 mg/l**	**0.46 mg/l**	**0.46 mg/l**	**0.45 mg/l**	**0.65 mg/l**
Nitrogen, ammonia (NH3), as N	NA	Lab	< 0.1 mg/l	**0.070 mg/l**	< 0.050 mg/l	< 0.050 mg/l	< 0.050 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	**0.15 b mg/l**	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l
pH	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	**7.17 pH units**	**7.31 pH units**	--	**6.85 pH units**	--	**6.52 pH units**	--	**6.22 pH units**	--	**6.36 pH units**	--	**6.49 pH units**	**6.52 pH units**
Phosphorus, total	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Redox (oxidation potential)	NA	Field	**464 mV**	**623 mV**	--	**363 mV**	--	**574 mV**	--	**316 mV**	--	**254 mV**	--	**307 mV**	**501 mV**
Solids, total dissolved	NA	Lab	**93 mg/l**	**108 mg/l**	**112 mg/l**	**129 mg/l**	**106 mg/l**	**97.0 mg/l**	**99.0 mg/l**	**97.0 mg/l**	**94.0 mg/l**	**79.0 mg/l**	**92.0 mg/l**	**99.0 mg/l**	**71.0 mg/l**
Specific Conductance @ 25oC	NA	Field	**121.6 umhos/cm**	**73.8 umhos/cm**	--	**65.7 umhos/cm**	--	**57.5 umhos/cm**	--	**90.2 umhos/cm**	--	**89.3 umhos/cm**	--	**96.9 umhos/cm**	**78.2 umhos/cm**
Sulfate	NA	Lab	**7.24 mg/l**	**7.0 mg/l**	**7.0 mg/l**	**6.9 mg/l**	**6.9 mg/l**	**7.1 mg/l**	**7.2 mg/l**	**7.5 mg/l**	**7.5 mg/l**	**7.3 mg/l**	**7.1 mg/l**	**6.9 mg/l**	**7.0 mg/l**
Temperature, degrees C	NA	Field	**4.37 deg C**	**5.96 deg C**	--	**6.93 deg C**	--	**6.86 deg C**	--	**8.3 deg C**	--	**9.42 deg C**	--	**7.57 deg C**	**4.44 deg C**
Turbidity	NA	Field	**0 NTU**	**0 NTU**	--	**0 NTU**	--	**0 NTU**	--	**0 NTU**	--	**0 NTU**	--	**3.3 NTU**	**2.2 NTU**
Metals															
Aluminum	Dissolved	Lab	**32.4 ug/l**	**35.1 ug/l**	**34.8 ug/l**	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l
Aluminum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	Dissolved	Lab	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Antimony	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	Dissolved	Lab	< 0.5 ug/l	**0.68 ug/l**	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Arsenic	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Total	Lab	**9.4 ug/l**	**9.9 ug/l**	**9.7 ug/l**	**8.9 ug/l**	**9.0 ug/l**	**8.5 ug/l**	**8.7 ug/l**	**7.2 ug/l**	**7.1 ug/l**	**7.1 ug/l**	**7.0 ug/l**	**7.8 ug/l**	**7.1 ug/l**
Beryllium	Total	Lab	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Boron	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	Total	Lab	< 50 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l
Cadmium	Dissolved	Lab	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Cadmium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Calcium	Total	Lab	**16400 ug/l**	**16800 ug/l**	**16400 ug/l**	**14100 ug/l**	**14000 ug/l**	**12700 ug/l**	**13100 ug/l**	**11200 ug/l**	**11100 ug/l**	**11800 ug/l**	**11400 ug/l**	**13100 ug/l**	**10100 ug/l**
Chromium	Dissolved	Lab	**5.12 ug/l**	**3.6 ug/l**	**3.4 ug/l**	**2.3 ug/l**	**2.3 ug/l**	**1.7 ug/l**	**2.1 ug/l**	**4.0 ug/l**	**2.9 ug/l**	**2.4 ug/l**	**2.2 ug/l**	**2.4 b ug/l**	**2.5 ug/l**
Chromium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	Dissolved	Lab	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Cobalt	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	Dissolved	Lab	**0.98 ug/l**	**0.82 ug/l**	**1.1 ug/l**	**2.7 ug/l**	**0.80 ug/l**	**0.78 ug/l**	**0.84 ug/l**	**1.7 ug/l**	**0.99 ug/l**	**0.74 ug/l**	**0.75 ug/l**	**0.96 ug/l**	< 0.50 ug/l
Copper	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Iron	Dissolved	Lab	< 50 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l
Iron	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Total	Lab	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Magnesium	Total	Lab	**3360 ug/l**	**3700 ug/l**	**3600 ug/l**	**3500 ug/l**	**3400 ug/l**	**3600 ug/l**	**3700 ug/l**	**3500 ug/l**	**3500 ug/l**	**3500 ug/l**	**3400 ug/l**	**3600 ug/l**	**3500 ug/l**
Manganese	Dissolved	Lab	**12.2 ug/l**	**8.3 ug/l**	**8.5 ug/l**	**6.9 ug/l**	**7.1 ug/l**	**6.7 ug/l**	**6.8 ug/l**	**4.5 ug/l**	**4.7 ug/l**	**3.3 ug/l**	**3.9 ug/l**	**2.0 ug/l**	**0.93 ug/l**
Manganese	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	Total	Lab	< 0.0005 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	**0.00077 ug/l**	**0.00070 ug/l**	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l
Mercury methyl	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Dissolved	Lab	**1.16 ug/l**	**0.75 ug/l**	**0.78 ug/l**	**0.46 ug/l**	**0.45 ug/l**	**0.37 ug/l**	**0.29 ug/l**	**0.46 ug/l**	**0.35 ug/l**	**0.34 ug/l**	**0.34 ug/l**	**0.42 ug/l**	< 0.30 ug/l
Molybdenum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	Dissolved	Lab	< 0.6 ug/l	< 0.50 ug/l	< 0.50 ug/l	**0.67 ug/l**	**0.63 ug/l**	< 0.50 ug/l	< 0.50 ug/l	**0.70 ug/l**	**0.85 ug/l**	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Nickel	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	**940 ug/l**	**930 ug/l**	**900 ug/l**	**810 ug/l**	**780 ug/l**	**830 ug/l**	**860 ug/l**	**800 ug/l**	**800 ug/l**	**910 ug/l**	**860 ug/l**	**920 ug/l**	**700 ug/l**
Selenium	Dissolved	Lab	< 1 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l
Selenium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	Dissolved	Lab	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Silver	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Sodium	Total	Lab	**2810 ug/l**	**2800 ug/l**	**2800 ug/l**	**2600 ug/l**	**2500 ug/l**	**2700 ug/l**	**2700 ug/l**	**2500 ug/l**	**2500 ug/l**	**2600 ug/l**	**2600 ug/l**	**3000 ug/l**	**2600 ug/l**
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Dissolved	Lab	< 5 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l
Zinc	Dissolved	Lab	< 6 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	**7.0 ug/l**	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l
Zinc	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--

Large Table 3
Groundwater Data Summary
Mine Site Surficial Aquifer

Location			MW-14		MW-14		MW-15	MW-15	MW-15	MW-15		MW-15	MW-15		MW-15	MW-15
Date			7/24/2013		10/29/2013		3/29/2012	4/30/2012	5/30/2012	6/27/2012		7/27/2012	8/21/2012		10/15/2012	5/23/2013
Sample Type			N	FD	N	FD	N	N	N	N	FD	N	N	FD	N	N
	Fraction	Analysis Location														
General Parameters																
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total	NA	Lab	**34.5 mg/l**	**35.0 mg/l**	**35.2 mg/l**	--	**87.9 mg/l**	**79.6 mg/l**	**78.1 mg/l**	**74.9 mg/l**	**74.9 mg/l**	**55.6 mg/l**	**81.9 mg/l**	**77.5 mg/l**	**61.6 mg/l**	**86.9 mg/l**
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	**1.5 mg/l**	**1.6 mg/l**	**1.5 mg/l**	--	**13.2 mg/l**	**15.0 mg/l**	**15.4 mg/l**	**16.1 mg/l**	**16.1 mg/l**	**17.2 mg/l**	**3.5 * mg/l**	**18.7 * mg/l**	**16.6 mg/l**	**13.5 mg/l**
Carbon, total organic	NA	Lab	**1.5 mg/l**	**1.0 mg/l**	**1.2 mg/l**	--	**13.2 mg/l**	**14.4 mg/l**	**15.4 mg/l**	**15.9 mg/l**	**15.9 mg/l**	**16.6 mg/l**	**3.8 * mg/l**	**17.7 * mg/l**	**16.1 mg/l**	**13.6 mg/l**
Chemical Oxygen Demand	NA	Lab	< 10.0 mg/l	< 10.0 mg/l	**17.3 mg/l**	--	**36.5 mg/l**	**38.9 mg/l**	**48.2 mg/l**	**42.2 mg/l**	**38.5 mg/l**	**44.3 mg/l**	**51.6 mg/l**	**50.2 mg/l**	**49.0 mg/l**	**41.6 mg/l**
Chloride	NA	Lab	< 0.50 mg/l	< 0.50 mg/l	< 1.0 mg/l	--	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	**0.75 mg/l**	**0.51 mg/l**	**0.61 mg/l**	**0.55 mg/l**
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	**10.23 mg/l**	--	**10.68 mg/l**	--	**2.38 mg/l**	**1.44 mg/l**	**1.66 mg/l**	**0.86 mg/l**	--	**0.95 mg/l**	**1.02 mg/l**	--	**1.43 mg/l**	< 0.1 mg/l
Fluoride	NA	Lab	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	--	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l
Hardness, total, as CaCO3	NA	Lab	**39.8 mg/l**	**38.9 mg/l**	**39.8 mg/l**	--	**74.8 mg/l**	**70.3 mg/l**	**66.5 mg/l**	**64.2 mg/l**	**64.1 mg/l**	**60.0 mg/l**	**59.4 mg/l**	**59.0 mg/l**	**67.8 mg/l**	**73.0 mg/l**
Nitrate + Nitrite, as N	NA	Lab	**0.65 mg/l**	**0.64 mg/l**	**0.70 mg/l**	--	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l
Nitrogen, ammonia (NH3), as N	NA	Lab	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	--	**3.3 mg/l**	**3.3 mg/l**	**3.3 mg/l**	**3.1 mg/l**	**3.1 mg/l**	**3.4 mg/l**	**3.0 mg/l**	**3.1 mg/l**	**3.5 mg/l**	**3.5 mg/l**
pH	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	**6.48 pH units**	--	**6.46 pH units**	--	**6.17 pH units**	**6.18 pH units**	**6.05 pH units**	**5.97 pH units**	--	**6.00 pH units**	**5.88 pH units**	--	**6.04 pH units**	**6.09 pH units**
Phosphorus, total	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Redox (oxidation potential)	NA	Field	**513 mV**	--	**559 mV**	--	**436 mV**	**543 mV**	**255 mV**	**136 mV**	--	**32 mV**	**183 mV**	--	**135 mV**	**245 mV**
Solids, total dissolved	NA	Lab	**93.0 mg/l**	**98.0 mg/l**	**99.0 mg/l**	--	**135 mg/l**	**133 mg/l**	**134 mg/l**	**158 mg/l**	**145 mg/l**	**147 mg/l**	**143 mg/l**	**158 mg/l**	**135 mg/l**	**145 mg/l**
Specific Conductance @ 25oC	NA	Field	**74.3 umhos/cm**	--	**84.7 umhos/cm**	--	**180 umhos/cm**	**127.3 umhos/cm**	**132 umhos/cm**	**158.3 umhos/cm**	--	**160.8 umhos/cm**	**150.9 umhos/cm**	--	**168 umhos/cm**	**177 umhos/cm**
Sulfate	NA	Lab	**6.6 mg/l**	**6.6 mg/l**	**6.5 mg/l**	--	< 1.0 mg/l	< 1.0 mg/l	< 1.0 mg/l	< 1.0 mg/l	< 1.0 mg/l	**1.0 mg/l**	**1.0 mg/l**	< 1.0 mg/l	< 1.0 mg/l	< 1.0 mg/l
Temperature, degrees C	NA	Field	**6.33 deg C**	--	**6.7 deg C**	--	**5.1 deg C**	**7.19 deg C**	**8.1 deg C**	**11.08 deg C**	--	**9.28 deg C**	**10.75 deg C**	--	**7.17 deg C**	**5.95 deg C**
Turbidity	NA	Field	**2.4 NTU**	--	**0 NTU**	--	**7.9 NTU**	**0 NTU**	**0.2 NTU**	**0 NTU**	--	**1.5 NTU**	**0 NTU**	--	**1.6 NTU**	**0 NTU**
Metals																
Aluminum	Dissolved	Lab	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	--	< 20.0 ug/l	**25.1 ug/l**	**33.1 ug/l**	**63.8 ug/l**	**66.1 ug/l**	**41.7 ug/l**	**45.2 ug/l**	**60.2 ug/l**	**39.3 ug/l**	**33.1 ug/l**
Aluminum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Antimony	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	**0.55 ug/l**	< 0.50 ug/l	< 0.50 ug/l	**0.52 ug/l**	< 0.50 ug/l	**0.86 ug/l**	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	**0.56 ug/l**
Arsenic	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Total	Lab	**5.1 ug/l**	**5.3 ug/l**	**5.7 ug/l**	--	**58.1 ug/l**	**49.7 ug/l**	**44.5 ug/l**	**42.3 ug/l**	**42.4 ug/l**	**39.6 ug/l**	**35.3 ug/l**	**35.0 ug/l**	**39.8 ug/l**	**38.2 ug/l**
Beryllium	Total	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Boron	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	Total	Lab	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	--	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l
Cadmium	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Cadmium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Calcium	Total	Lab	**10100 ug/l**	**9900 ug/l**	**10200 ug/l**	--	**17900 ug/l**	**16300 ug/l**	**15400 ug/l**	**15000 ug/l**	**15000 ug/l**	**14000 ug/l**	**13900 ug/l**	**13700 ug/l**	**15900 ug/l**	**16900 ug/l**
Chromium	Dissolved	Lab	**2.6 ug/l**	**2.2 ug/l**	**2.7 ug/l**	--	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	**1.6 ug/l**	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l
Chromium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	**3.2 ug/l**	**3.2 ug/l**	**2.6 ug/l**	**2.5 ug/l**	**2.5 ug/l**	**2.1 ug/l**	**1.5 ug/l**	**1.5 ug/l**	**1.7 ug/l**	**1.6 ug/l**
Cobalt	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	**0.58 ug/l**	--	< 0.50 ug/l	**0.63 ug/l**	**0.75 ug/l**	< 0.50 ug/l	< 0.50 ug/l	**0.87 ug/l**	< 0.50 ug/l	< 0.50 ug/l	**0.65 ug/l**	< 0.50 ug/l
Copper	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Iron	Dissolved	Lab	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	--	**3360 ug/l**	**3970 ug/l**	**4570 ug/l**	**4600 ug/l**	**4730 ug/l**	**4920 ug/l**	**5000 ug/l**	**5010 ug/l**	**5270 ug/l**	**8690 ug/l**
Iron	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Total	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Magnesium	Total	Lab	**3600 ug/l**	**3500 ug/l**	**3500 ug/l**	--	**7300 ug/l**	**7200 ug/l**	**6800 ug/l**	**6500 ug/l**	**6500 ug/l**	**6100 ug/l**	**6000 ug/l**	**6000 ug/l**	**6800 ug/l**	**7500 ug/l**
Manganese	Dissolved	Lab	**0.99 ug/l**	**0.95 ug/l**	**0.70 ug/l**	--	**656 ug/l**	**562 ug/l**	**424 ug/l**	**503 b ug/l**	**501 b ug/l**	**355 ug/l**	**284 ug/l**	**284 ug/l**	**320 ug/l**	**377 ug/l**
Manganese	Total	Lab														
Mercury	Total	Lab	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	**0.00085 ug/l**
Mercury methyl	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Dissolved	Lab	**0.33 ug/l**	< 0.30 ug/l	**0.37 ug/l**	--	**0.35 ug/l**	**0.20 ug/l**	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	**0.23 ug/l**	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.30 ug/l
Molybdenum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	**1.9 ug/l**	**1.7 ug/l**	**1.5 ug/l**	**1.5 ug/l**	**1.4 ug/l**	**1.2 ug/l**	**1.4 ug/l**	**1.2 ug/l**	**1.2 ug/l**	**0.80 ug/l**
Nickel	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	**790 ug/l**	**760 ug/l**	**860 ug/l**	--	**1100 ug/l**	**820 ug/l**	**760 ug/l**	**710 ug/l**	**700 ug/l**	**700 ug/l**	**660 ug/l**	**660 ug/l**	**740 ug/l**	**810 ug/l**
Selenium	Dissolved	Lab	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l
Selenium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Silver	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sodium	Total	Lab	**2700 ug/l**	**2600 ug/l**	**2800 ug/l**	--	**3100 ug/l**	**2800 ug/l**	**2800 ug/l**	**2700 ug/l**	**2700 ug/l**	**2900 ug/l**	**3000 ug/l**	**3000 ug/l**	**3200 ug/l**	**3400 ug/l**
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab	< 0.017 ug/l	< 0.017 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Dissolved	Lab	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	--	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l
Zinc	Dissolved	Lab	**8.4 ug/l**	< 8.0 ug/l	< 6.0 ug/l	--	**6.6 ug/l**	**6.5 ug/l**	< 8.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	**6.8 ug/l**	**6.2 ug/l**	**8.9 ug/l**	**6.1 ug/l**	< 8.0 ug/l
Zinc	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Large Table 3
Groundwater Data Summary
Mine Site Surficial Aquifer

Location			MW-15	MW-15	MW-16	MW-16		MW-16	MW-16		MW-16	MW-16		MW-16	MW-16
Date			7/30/2013	10/29/2013	2/24/2012	3/20/2012		4/24/2012	5/15/2012		6/6/2012	7/11/2012		8/28/2012	10/23/2012
Sample Type			N	N	N	N	FD	N	N	FD	N	N	FD	N	N
	Fraction	Analysis Location													
General Parameters															
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total	NA	Lab	**80.8 mg/l**	**72.0 mg/l**	**71.1 mg/l**	**73.6 mg/l**	**86.3 mg/l**	**55.3 mg/l**	**48.2 mg/l**	**48.4 mg/l**	**46.7 mg/l**	**43.8 mg/l**	**44.5 mg/l**	**46.5 mg/l**	**50.4 mg/l**
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	**16.7 mg/l**	**17.4 mg/l**	**3.49 mg/l**	**3.59 b mg/l**	**3.16 b mg/l**	**2.1 mg/l**	**2.0 mg/l**	**2.4 mg/l**	**2.3 mg/l**	**1.7 mg/l**	**1.7 mg/l**	**3.6 mg/l**	**1.6 mg/l**
Carbon, total organic	NA	Lab	**15.6 mg/l**	**20.0 mg/l**	**2.73 mg/l**	**2.24 mg/l**	**2.64 mg/l**	**1.8 mg/l**	**2.1 mg/l**	**2.0 mg/l**	**1.7 mg/l**	**1.4 mg/l**	**1.4 mg/l**	**3.2 mg/l**	**1.4 mg/l**
Chemical Oxygen Demand	NA	Lab	**54.4 mg/l**	**70.8 mg/l**	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	**15.5 mg/l**	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l
Chloride	NA	Lab	< 0.50 mg/l	< 1.0 mg/l	**1.01 mg/l**	**1.13 mg/l**	**1.14 mg/l**	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	< 0.50 mg/l	**0.60 mg/l**	< 0.50 mg/l
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	**0.01 mg/l**	< 0.1 mg/l	**2.82 mg/l**	**1.61 mg/l**	--	**3.82 mg/l**	**3.8 mg/l**	--	**4.1 mg/l**	**3.41 mg/l**	--	**3.53 mg/l**	**4.31 mg/l**
Fluoride	NA	Lab	< 0.10 mg/l	< 0.10 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l
Hardness, total, as CaCO3	NA	Lab	**67.7 mg/l**	**62.0 mg/l**	**61.2 mg/l**	**67.6 mg/l**	**68.4 mg/l**	**51.6 mg/l**	**52.2 mg/l**	**52.1 mg/l**	**49.9 mg/l**	**47.4 mg/l**	**46.8 mg/l**	**49.0 mg/l**	**48.8 mg/l**
Nitrate + Nitrite, as N	NA	Lab	< 0.10 mg/l	< 0.10 mg/l	**0.12 mg/l**	< 0.1 mg/l	< 0.1 mg/l	**0.14 mg/l**	**0.16 mg/l**	**0.16 mg/l**	**0.17 mg/l**	**0.14 mg/l**	**0.15 mg/l**	**0.18 mg/l**	**0.17 mg/l**
Nitrogen, ammonia (NH3), as N	NA	Lab	**3.3 mg/l**	**2.8 mg/l**	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	**0.10 b mg/l**	< 0.050 mg/l	< 0.050 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l
pH	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	**6.12 pH units**	**6.01 pH units**	**7.01 pH units**	**6.99 pH units**	--	**7.06 pH units**	**6.89 pH units**	--	**6.62 pH units**	**6.47 pH units**	--	**6.46 pH units**	**6.66 pH units**
Phosphorus, total	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Redox (oxidation potential)	NA	Field	**331 mV**	**266 mV**	**186 mV**	**150 mV**	--	**417 mV**	**368 mV**	--	**562 mV**	**364 mV**	--	**258 mV**	**246 mV**
Solids, total dissolved	NA	Lab	**131 mg/l**	**153 mg/l**	**78 mg/l**	**74 mg/l**	**91 mg/l**	**94.0 mg/l**	**111 mg/l**	**110 mg/l**	**94.0 mg/l**	**105 * mg/l**	**204 * mg/l**	**91.0 mg/l**	**85.0 mg/l**
Specific Conductance @ 25oC	NA	Field	**173.6 umhos/cm**	**164.3 umhos/cm**	**167.3 umhos/cm**	**165.1 umhos/cm**	--	**118.2 umhos/cm**	**71 umhos/cm**	--	**67.8 umhos/cm**	**101.2 umhos/cm**	--	**105.5 umhos/cm**	**112.6 umhos/cm**
Sulfate	NA	Lab	< 1.0 mg/l	< 2.0 mg/l	**10.7 mg/l**	**10.3 mg/l**	**10.3 mg/l**	**8.1 mg/l**	**8.2 mg/l**	**8.3 mg/l**	**8.2 mg/l**	**8.8 mg/l**	**8.7 mg/l**	**8.8 mg/l**	**9.1 mg/l**
Temperature, degrees C	NA	Field	**10.12 deg C**	**7.07 deg C**	**8.3 deg C**	**7.38 deg C**	--	**7.46 deg C**	**7.7 deg C**	--	**8.1 deg C**	**10.38 deg C**	--	**10.29 deg C**	**7.74 deg C**
Turbidity	NA	Field	**0 NTU**	**1.9 NTU**	**5.5 NTU**	**7.9 NTU**	--	**2 NTU**	**0 NTU**	--	**1 NTU**	**0.5 NTU**	--	**0.3 NTU**	**5.1 NTU**
Metals															
Aluminum	Dissolved	Lab	**33.5 ug/l**	**39.3 ug/l**	**863 ug/l**	< 20 ug/l	< 20 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l
Aluminum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Antimony	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	Dissolved	Lab	**0.80 ug/l**	**0.75 ug/l**	< 0.5 ug/l	**0.59 ug/l**	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Arsenic	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Total	Lab	**34.7 ug/l**	**29.9 ug/l**	**17.8 ug/l**	**18.2 ug/l**	**18.6 ug/l**	**10.9 ug/l**	**11.2 ug/l**	**10.9 ug/l**	**8.1 ug/l**	**6.6 ug/l**	**6.7 ug/l**	**6.9 ug/l**	**6.6 ug/l**
Beryllium	Total	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Boron	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	Total	Lab	< 50.0 ug/l	< 50.0 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l
Cadmium	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Cadmium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Calcium	Total	Lab	**15800 ug/l**	**14400 ug/l**	**12700 ug/l**	**14200 ug/l**	**14300 ug/l**	**10400 ug/l**	**10300 ug/l**	**10300 ug/l**	**9900 ug/l**	**9400 ug/l**	**9300 ug/l**	**9700 ug/l**	**9700 ug/l**
Chromium	Dissolved	Lab	< 1.0 ug/l	< 1.0 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	**1.1 ug/l**	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	**1.0 ug/l**	**1.0 ug/l**	< 1.0 ug/l	< 1.0 ug/l
Chromium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	Dissolved	Lab	**1.8 ug/l**	**1.6 ug/l**	**0.82 ug/l**	**1.29 ug/l**	**1.32 ug/l**	**1.0 ug/l**	**0.63 ug/l**	**0.64 ug/l**	**0.45 ug/l**	**0.24 ug/l**	**0.23 ug/l**	< 0.20 ug/l	< 0.20 ug/l
Cobalt	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	Dissolved	Lab	< 0.50 ug/l	**0.58 ug/l**	**1.89 ug/l**	**0.94 ug/l**	**0.93 ug/l**	**1.8 ug/l**	**2.8 ug/l**	**1.8 ug/l**	**2.1 ug/l**	**1.8 ug/l**	**1.7 ug/l**	**2.0 ug/l**	**1.8 ug/l**
Copper	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Iron	Dissolved	Lab	**9540 ug/l**	**8760 ug/l**	**369 ug/l**	< 50 ug/l	< 50 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l
Iron	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Total	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Magnesium	Total	Lab	**6900 ug/l**	**6400 ug/l**	**7160 ug/l**	**7800 ug/l**	**7940 ug/l**	**6200 ug/l**	**6400 ug/l**	**6400 ug/l**	**6100 ug/l**	**5800 ug/l**	**5700 ug/l**	**6000 ug/l**	**6000 ug/l**
Manganese	Dissolved	Lab	**350 ug/l**	**320 ug/l**	**141 ug/l**	**334 ug/l**	**339 ug/l**	**93.5 ug/l**	**46.7 ug/l**	**47.6 ug/l**	**25.6 ug/l**	**9.4 ug/l**	**9.1 ug/l**	**4.8 ug/l**	**3.0 ug/l**
Manganese	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	Total	Lab	< 0.00050 ug/l	**0.00055 ug/l**	**0.0009 ug/l**	**0.0009 ug/l**	**0.0008 ug/l**	**0.00075 ug/l**	**0.0013 ug/l**	**0.00075 ug/l**	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l
Mercury methyl	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Dissolved	Lab	< 0.30 ug/l	< 0.30 ug/l	**15 ug/l**	**10.5 ug/l**	**10.6 ug/l**	**4.9 ug/l**	**3.6 ug/l**	**3.6 ug/l**	**2.1 ug/l**	**1.6 ug/l**	**1.5 ug/l**	**2.0 ug/l**	**2.1 ug/l**
Molybdenum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	Dissolved	Lab	**0.66 ug/l**	**0.96 ug/l**	**2.17 ug/l**	**2.63 b ug/l**	**2.71 b ug/l**	**4.0 ug/l**	**3.3 ug/l**	**3.2 ug/l**	**2.8 ug/l**	**2.2 ug/l**	**2.1 ug/l**	**1.8 ug/l**	**2.0 ug/l**
Nickel	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	**770 ug/l**	**650 ug/l**	**1310 ug/l**	**1450 ug/l**	**1470 ug/l**	**1200 ug/l**	**1200 ug/l**	**1200 ug/l**	**1200 ug/l**	**1200 ug/l**	**1200 ug/l**	**1300 ug/l**	**1300 ug/l**
Selenium	Dissolved	Lab	< 1.0 ug/l	< 1.0 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l
Selenium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Silver	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Sodium	Total	Lab	**3000 ug/l**	**3200 ug/l**	**11900 ug/l**	**9470 ug/l**	**9750 ug/l**	**5200 ug/l**	**4700 ug/l**	**4700 ug/l**	**4100 ug/l**	**3700 ug/l**	**3700 ug/l**	**4300 ug/l**	**4900 ug/l**
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab	< 0.017 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Dissolved	Lab	< 5.0 ug/l	< 5.0 ug/l	< 5 ug/l	< 5 ug/l	< 5 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l
Zinc	Dissolved	Lab	< 6.0 ug/l	**8.1 ug/l**	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l
Zinc	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--

Large Table 3
Groundwater Data Summary
Mine Site Surficial Aquifer

Location			MW-16		MW-16		MW-16	MW-17	MW-17	MW-17	MW-17	MW-17	MW-17	MW-17	MW-17	MW-17
Date			5/15/2013		7/29/2013		10/28/2013	2/23/2012	3/20/2012	4/23/2012	5/15/2012	6/27/2012	7/27/2012	8/29/2012	10/19/2012	5/7/2013
Sample Type			N	FD	N	FD	N	N	N	N	N	N	N	N	N	N
	Fraction	Analysis Location														
General Parameters																
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total	NA	Lab	**45.6 mg/l**	**46.3 mg/l**	**61.6 mg/l**	--	**45.5 mg/l**	**118 mg/l**	**124 mg/l**	**129 mg/l**	**124 mg/l**	**119 mg/l**	**121 mg/l**	**131 mg/l**	**152 mg/l**	**150 mg/l**
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	**1.8 mg/l**	**1.5 mg/l**	**1.1 mg/l**	--	**1.5 mg/l**	**13.8 mg/l**	**45.8 mg/l**	**29.6 mg/l**	**28.5 mg/l**	**26.4 mg/l**	**25.0 mg/l**	**31.8 mg/l**	**39.9 mg/l**	**32.4 mg/l**
Carbon, total organic	NA	Lab	**1.5 mg/l**	**1.5 mg/l**	< 1.0 mg/l	--	**1.4 mg/l**	**14.1 mg/l**	**42.7 mg/l**	**29.0 mg/l**	**28.5 mg/l**	**26.0 mg/l**	**24.5 mg/l**	**31.6 mg/l**	**40.4 mg/l**	**33.2 mg/l**
Chemical Oxygen Demand	NA	Lab	< 10.0 mg/l	< 10.0 mg/l	< 10.0 mg/l	--	**12.8 mg/l**	**62.3 mg/l**	**433 mg/l**	**96.4 mg/l**	**79.9 mg/l**	**77.5 mg/l**	**75.0 mg/l**	**104 mg/l**	**128 mg/l**	**111 mg/l**
Chloride	NA	Lab	**0.51 mg/l**	**0.51 mg/l**	**0.76 mg/l**	--	< 1.0 mg/l	**1.64 mg/l**	**1.08 mg/l**	**0.67 mg/l**	**0.63 mg/l**	**0.60 mg/l**	**0.78 mg/l**	**0.90 mg/l**	**0.87 mg/l**	**0.84 mg/l**
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	**2.8 mg/l**	--	**3.01 mg/l**	--	**3.14 mg/l**	**4.71 mg/l**	**1.52 mg/l**	**1.56 mg/l**	**1.97 mg/l**	**1.13 mg/l**	**1.12 mg/l**	**1.42 mg/l**	**2.83 mg/l**	< 0.1 mg/l
Fluoride	NA	Lab	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	--	< 0.10 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	**0.10 mg/l**	**0.10 mg/l**
Hardness, total, as CaCO3	NA	Lab	**43.5 mg/l**	**47.7 mg/l**	**64.6 mg/l**	--	**45.1 mg/l**	**112 mg/l**	**120 mg/l**	**121 mg/l**	**122 mg/l**	**111 mg/l**	**110 mg/l**	**121 mg/l**	**134 mg/l**	**138 mg/l**
Nitrate + Nitrite, as N	NA	Lab	**0.22 mg/l**	**0.15 mg/l**	**0.16 mg/l**	--	**0.11 mg/l**	< 0.1 mg/l	< 0.1 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l
Nitrogen, ammonia (NH3), as N	NA	Lab	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	--	< 0.10 mg/l	**0.56 mg/l**	**1.18 mg/l**	**1.2 mg/l**	**1.2 mg/l**	**1.0 mg/l**	**1.1 mg/l**	**1.4 mg/l**	**1.3 mg/l**	**1.2 mg/l**
pH	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	**6.58 pH units**	--	**6.51 pH units**	--	**6.5 pH units**	**6.58 pH units**	**6.51 pH units**	**6.67 pH units**	**6.54 pH units**	**6.4 pH units**	**6.33 pH units**	**6.45 pH units**	**6.5 pH units**	**6.44 pH units**
Phosphorus, total	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Redox (oxidation potential)	NA	Field	**495 mV**	--	**470 mV**	--	**513 mV**	**161 mV**	**136 mV**	**21 mV**	**77 mV**	**-56 mV**	**59 mV**	**32 mV**	**53 mV**	**87 mV**
Solids, total dissolved	NA	Lab	**87.0 mg/l**	**78.0 mg/l**	**101 mg/l**	--	**89.0 mg/l**	**195 mg/l**	**213 mg/l**	**247 mg/l**	**256 mg/l**	**236 mg/l**	**234 mg/l**	**248 mg/l**	**342 mg/l**	**297 mg/l**
Specific Conductance @ 25oC	NA	Field	**89.6 umhos/cm**	--	**90.6 umhos/cm**	--	**79.4 umhos/cm**	**264 umhos/cm**	**290 umhos/cm**	**290.1 umhos/cm**	**238.9 umhos/cm**	**272.5 umhos/cm**	**290.1 umhos/cm**	**306.2 umhos/cm**	**359.2 umhos/cm**	**329.8 umhos/cm**
Sulfate	NA	Lab	**8.0 mg/l**	**8.0 mg/l**	**9.5 mg/l**	--	**7.8 mg/l**	**2.69 mg/l**	**8.86 mg/l**	**1.8 mg/l**	**1.6 mg/l**	**1.3 mg/l**	**1.3 mg/l**	**1.9 mg/l**	**1.7 mg/l**	**1.1 mg/l**
Temperature, degrees C	NA	Field	**7.54 deg C**	--	**6.35 deg C**	--	**6.92 deg C**	**6.03 deg C**	**7.93 deg C**	**6.62 deg C**	**7.87 deg C**	**12.08 deg C**	**13.71 deg C**	**13.36 deg C**	**8.78 deg C**	**7.2 deg C**
Turbidity	NA	Field	**3.2 NTU**	--	**1.9 NTU**	--	**2.9 NTU**	**24.9 NTU**	**11.7 NTU**	**0 NTU**	**0 NTU**	**1.3 NTU**	**4.3 NTU**	**0 NTU**	**5.9 NTU**	**0.2 NTU**
Metals																
Aluminum	Dissolved	Lab	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	--	< 20.0 ug/l	**98.3 ug/l**	**117 ug/l**	**128 ug/l**	**117 ug/l**	**227 ug/l**	**89.0 ug/l**	**105 ug/l**	**135 ug/l**	**104 ug/l**
Aluminum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Antimony	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	**0.97 ug/l**	**1.09 ug/l**	**0.87 ug/l**	**1.1 ug/l**	**0.93 ug/l**	**1.0 ug/l**	**1.0 ug/l**	**1.0 ug/l**	**0.58 ug/l**
Arsenic	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Total	Lab	**5.0 ug/l**	**4.3 ug/l**	**4.8 ug/l**	--	**4.5 ug/l**	**58.4 ug/l**	**66.6 ug/l**	**60.4 ug/l**	**60.4 ug/l**	**50.3 ug/l**	**51.3 ug/l**	**55.9 ug/l**	**67.2 ug/l**	**50.5 ug/l**
Beryllium	Total	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Boron	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	Total	Lab	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	--	< 50.0 ug/l	< 50 ug/l	< 50 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	**54.3 ug/l**
Cadmium	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Cadmium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Calcium	Total	Lab	**8600 ug/l**	**9400 ug/l**	**13400 ug/l**	--	**9000 ug/l**	**21900 ug/l**	**25600 ug/l**	**25000 ug/l**	**25100 ug/l**	**21600 ug/l**	**20500 ug/l**	**23100 ug/l**	**26000 ug/l**	**24300 ug/l**
Chromium	Dissolved	Lab	< 1.0 ug/l	< 1.0 ug/l	**1.4 ug/l**	--	< 1.0 ug/l	**3.83 ug/l**	**3.77 ug/l**	**3.5 ug/l**	**2.8 ug/l**	**4.1 ug/l**	**4.4 ug/l**	**4.1 ug/l**	**4.4 ug/l**	**5.2 ug/l**
Chromium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	**3.92 ug/l**	**5.47 ug/l**	**3.6 ug/l**	**3.8 ug/l**	**3.0 ug/l**	**3.0 ug/l**	**2.6 ug/l**	**3.3 ug/l**	**2.7 ug/l**
Cobalt	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	Dissolved	Lab	**1.7 ug/l**	**1.7 ug/l**	< 0.50 ug/l	--	**1.7 ug/l**	**49 ug/l**	**12.8 ug/l**	**7.1 ug/l**	**6.0 ug/l**	**6.8 ug/l**	**6.3 ug/l**	**4.6 ug/l**	**3.7 ug/l**	**2.7 ug/l**
Copper	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Iron	Dissolved	Lab	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	--	< 50.0 ug/l	**10400 ug/l**	**11000 ug/l**	**12600 ug/l**	**11900 ug/l**	**15600 ug/l**	**15500 ug/l**	**18200 ug/l**	**23000 ug/l**	**25000 ug/l**
Iron	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Total	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	**3.43 ug/l**	**0.88 ug/l**	**0.64 ug/l**	**0.57 ug/l**	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Magnesium	Total	Lab	**5300 ug/l**	**5900 ug/l**	**7600 ug/l**	--	**5500 ug/l**	**13800 ug/l**	**13500 ug/l**	**14200 ug/l**	**14500 ug/l**	**13900 ug/l**	**14300 ug/l**	**15400 ug/l**	**16900 ug/l**	**18700 ug/l**
Manganese	Dissolved	Lab	**1.1 ug/l**	**0.96 ug/l**	**0.59 ug/l**	--	< 0.50 ug/l	**1060 ug/l**	**1260 ug/l**	**1210 ug/l**	**1110 ug/l**	**1120 b ug/l**	**1180 ug/l**	**1180 ug/l**	**1350 ug/l**	**1340 ug/l**
Manganese	Total	Lab														
Mercury	Total	Lab	**0.00068 ug/l**	**0.00051 ug/l**	< 0.00050 ug/l	**0.00057 ug/l**	< 0.00050 ug/l	**0.0023 ug/l**	**0.0023 ug/l**	**0.0012 ug/l**	**0.0020 ug/l**	**0.0010 ug/l**	**0.0015 ug/l**	**0.00092 ug/l**	**0.00097 ug/l**	**0.00091 ug/l**
Mercury methyl	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Dissolved	Lab	**0.73 ug/l**	**0.74 ug/l**	**0.58 ug/l**	--	**0.51 ug/l**	**2.38 ug/l**	**3.45 ug/l**	**2.6 ug/l**	**2.6 ug/l**	**2.2 ug/l**	**2.9 ug/l**	**2.4 ug/l**	**2.2 ug/l**	**1.4 ug/l**
Molybdenum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	Dissolved	Lab	**1.4 ug/l**	**1.4 ug/l**	< 0.50 ug/l	--	**1.9 ug/l**	**6.26 ug/l**	**14.1 ug/l**	**9.9 ug/l**	**10.4 ug/l**	**7.6 ug/l**	**6.5 ug/l**	**6.4 ug/l**	**7.3 ug/l**	**5.8 ug/l**
Nickel	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	**990 ug/l**	**1200 ug/l**	**1600 ug/l**	--	**1200 ug/l**	**1700 ug/l**	**1650 ug/l**	**1400 ug/l**	**1400 ug/l**	**1200 ug/l**	**1300 ug/l**	**1400 ug/l**	**1300 ug/l**	**1000 ug/l**
Selenium	Dissolved	Lab	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	< 1 ug/l	< 1 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l
Selenium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Silver	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sodium	Total	Lab	**3600 ug/l**	**4000 ug/l**	**3200 ug/l**	--	**3600 ug/l**	**7210 ug/l**	**9720 ug/l**	**8400 ug/l**	**8200 ug/l**	**7400 ug/l**	**9100 ug/l**	**9800 ug/l**	**15400 ug/l**	**11600 ug/l**
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab	**0.22 ug/l**	< 0.20 ug/l	< 0.017 ug/l	--	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Dissolved	Lab	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	--	< 5.0 ug/l	**8.91 ug/l**	**8.08 ug/l**	**8.3 ug/l**	**8.0 ug/l**	**11.4 ug/l**	**10.4 ug/l**	**12.3 ug/l**	**12.9 ug/l**	**13.1 ug/l**
Zinc	Dissolved	Lab	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	--	< 6.0 ug/l	**7.59 ug/l**	**8.88 ug/l**	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	**12.9 ug/l**
Zinc	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Large Table 3
Groundwater Data Summary
Mine Site Surficial Aquifer

		Location	MW-17	MW-17	MW-18	MW-18		MW-18	MW-18	MW-18	MW-18	MW-18		MW-18	MW-18		
		Date	7/24/2013	10/22/2013	2/23/2012	3/27/2012		4/9/2012	5/14/2012	6/11/2012	7/13/2012	8/14/2012		10/26/2012	5/23/2013		
		Sample Type	N	N	N	N	FD	N	N	N	N	N	FD	N	N	FD	
	Fraction	Analysis Location															
General Parameters																	
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total	NA	Lab	**147 mg/l**	**151 mg/l**	**84.5 BQS mg/l**	**126 BQS mg/l**	**122 BQS mg/l**	**119 mg/l**	**119 mg/l**	**106 mg/l**	**108 mg/l**	**124 mg/l**	**126 mg/l**	**140 mg/l**	**124 mg/l**	--	--
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	**30.8 mg/l**	**35.5 mg/l**	**14.0 BQS mg/l**	**8.6 BQS mg/l**	**9.1 BQS mg/l**	**9.2 mg/l**	**9.0 mg/l**	**7.5 mg/l**	**7.3 mg/l**	**7.5 mg/l**	**7.1 mg/l**	**8.5 mg/l**	**6.5 mg/l**	--	--
Carbon, total organic	NA	Lab	**29.0 mg/l**	**36.1 mg/l**	**13.3 BQS mg/l**	**8.0 BQS mg/l**	**7.8 BQS mg/l**	**8.7 mg/l**	**8.4 mg/l**	**6.9 mg/l**	**6.9 mg/l**	**7.4 mg/l**	**6.8 mg/l**	**8.2 mg/l**	**6.0 mg/l**	--	--
Chemical Oxygen Demand	NA	Lab	**97.8 mg/l**	**118 mg/l**	**82.1 BQS mg/l**	**22.1 BQS mg/l**	**25.4 BQS mg/l**	**28.1 mg/l**	**35.3 mg/l**	**26.9 mg/l**	**18.5 mg/l**	**24.7 mg/l**	**25.4 mg/l**	**32.1 mg/l**	**17.9 mg/l**	--	--
Chloride	NA	Lab	**0.73 mg/l**	**1.1 mg/l**	**74.9 BQS mg/l**	**27 BQS mg/l**	**27 BQS mg/l**	**8.1 mg/l**	**2.9 mg/l**	**1.5 mg/l**	**1.2 mg/l**	**1.6 mg/l**	**1.6 mg/l**	**1.4 mg/l**	**0.87 mg/l**	--	--
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	< 0.1 mg/l	< 0.1 mg/l	**10.68 BQS mg/l**	**6.85 BQS mg/l**	--	**9.78 mg/l**	**8.52 mg/l**	**8.04 mg/l**	**6.32 mg/l**	**8.42 mg/l**	--	**7.03 mg/l**	**0.75 mg/l**	--	--
Fluoride	NA	Lab	**0.10 mg/l**	**0.12 mg/l**	< 0.1 BQS mg/l	**0.12 BQS mg/l**	**0.12 BQS mg/l**	< 0.10 mg/l	**0.11 mg/l**	< 0.10 mg/l	< 0.10 mg/l	**0.12 mg/l**	**0.12 mg/l**	**0.14 mg/l**	**0.12 mg/l**	--	--
Hardness, total, as CaCO3	NA	Lab	**136 mg/l**	**130 mg/l**	**223 BQS mg/l**	**131 BQS mg/l**	**125 BQS mg/l**	**129 mg/l**	**125 mg/l**	**110 mg/l**	**116 mg/l**	**138 mg/l**	**134 mg/l**	**153 mg/l**	**137 mg/l**	--	--
Nitrate + Nitrite, as N	NA	Lab	< 0.10 mg/l	< 0.10 mg/l	**1.19 BQS mg/l**	< 0.1 BQS mg/l	< 0.1 BQS mg/l	**0.29 mg/l**	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	**0.19 mg/l**	**0.20 mg/l**	**0.15 mg/l**	< 0.10 mg/l	--	--
Nitrogen, ammonia (NH3), as N	NA	Lab	**1.1 mg/l**	**1.2 b mg/l**	**0.14 BQS mg/l**	**0.1 BQS mg/l**	< 0.1 BQS mg/l	**0.057 mg/l**	< 0.050 mg/l	< 0.10 mg/l	**0.12 mg/l**	**0.16 mg/l**	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	--	--
pH	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	**6.48 pH units**	**6.54 pH units**	**6.84 BQS pH units**	**6.84 BQS pH units**	--	**7.44 pH units**	**7 pH units**	**6.91 pH units**	**6.61 pH units**	**6.47 pH units**	--	**7.06 pH units**	**7.04 pH units**	--	--
Phosphorus, total	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Redox (oxidation potential)	NA	Field	**193 mV**	**10 mV**	**185 BQS mV**	**527 BQS mV**	--	**435 mV**	**299 mV**	**323 mV**	**177 mV**	**311 mV**	--	**216 mV**	**455 mV**	--	--
Solids, total dissolved	NA	Lab	**298 mg/l**	**296 mg/l**	**212 BQS mg/l**	**239 BQS mg/l**	**219 BQS mg/l**	**190 mg/l**	**201 mg/l**	**191 mg/l**	**156 mg/l**	**184 mg/l**	**190 mg/l**	**194 mg/l**	**162 mg/l**	--	--
Specific Conductance @ 25oC	NA	Field	**329.8 umhos/cm**	**349.9 umhos/cm**	**494.2 BQS umhos/cm**	**371 BQS umhos/cm**	--	**283.7 umhos/cm**	**231.6 umhos/cm**	**206.8 umhos/cm**	**257.4 umhos/cm**	**0 umhos/cm**	--	**270 umhos/cm**	**258.4 umhos/cm**	--	--
Sulfate	NA	Lab	< 1.0 mg/l	< 2.0 mg/l	**30.2 BQS mg/l**	**19.6 BQS mg/l**	**19.5 BQS mg/l**	**13.8 mg/l**	**11.5 mg/l**	**13.5 mg/l**	**14.8 mg/l**	**15.1 mg/l**	**15.1 mg/l**	**12.9 mg/l**	**13.6 mg/l**	--	--
Temperature, degrees C	NA	Field	**13.52 deg C**	**7.78 deg C**	**6.66 BQS deg C**	**8.96 BQS deg C**	--	**9.03 deg C**	**16.11 deg C**	**15.77 deg C**	**22.33 deg C**	**14.81 deg C**	--	**3.72 deg C**	**6.93 deg C**	--	--
Turbidity	NA	Field	**7.9 NTU**	**0 NTU**	**1111 BQS NTU**	**90.7 BQS NTU**	--	**106.9 NTU**	**25.1 NTU**	**14.2 NTU**	**17.5 NTU**	**2036 NTU**	--	**11.7 NTU**	**82.8 NTU**	--	--
Metals																	
Aluminum	Dissolved	Lab	**94.3 ug/l**	**92.1 ug/l**	**45.6 BQS ug/l**	< 20 BQS ug/l	< 20 BQS ug/l	< 20.0 ug/l	< 20.0 ug/l	**21.7 ug/l**	**20.8 ug/l**	**25.2 ug/l**	**28.8 ug/l**	**28.9 ug/l**	< 20.0 ug/l	--	--
Aluminum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	**0.54 BQS ug/l**	< 0.5 BQS ug/l	< 0.5 BQS ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	--
Antimony	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	Dissolved	Lab	**0.66 ug/l**	< 0.50 ug/l	< 0.5 BQS ug/l	< 0.5 BQS ug/l	< 0.5 BQS ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	**0.52 ug/l**	< 0.50 ug/l	< 0.50 ug/l	--	--
Arsenic	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Total	Lab	**50.4 ug/l**	**56.7 ug/l**	**247 BQS ug/l**	**77.9 BQS ug/l**	**73.6 BQS ug/l**	**72.2 ug/l**	**50.3 ug/l**	**38.4 ug/l**	**42.2 ug/l**	**46.8 ug/l**	**42.2 ug/l**	**44.8 ug/l**	**45.7 ug/l**	--	--
Beryllium	Total	Lab	< 0.20 ug/l	< 0.20 ug/l	**0.57 BQS ug/l**	< 0.2 BQS ug/l	< 0.2 BQS ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	--
Boron	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	Total	Lab	< 50.0 ug/l	**55.2 ug/l**	< 50 BQS ug/l	< 50 BQS ug/l	< 50 BQS ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	--	--
Cadmium	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.2 BQS ug/l	< 0.2 BQS ug/l	< 0.2 BQS ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	--
Cadmium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Calcium	Total	Lab	**23200 ug/l**	**22500 ug/l**	**47100 BQS ug/l**	**31000 BQS ug/l**	**29500 BQS ug/l**	**29900 ug/l**	**29500 ug/l**	**25700 ug/l**	**27000 ug/l**	**32500 ug/l**	**31600 ug/l**	**36400 ug/l**	**29800 ug/l**	--	--
Chromium	Dissolved	Lab	**4.5 ug/l**	**5.9 ug/l**	< 1 BQS ug/l	< 1 BQS ug/l	< 1 BQS ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	**1.3 ug/l**	< 1.0 ug/l	**2.5 b ug/l**	< 1.0 ug/l	< 1.0 ug/l	--	--
Chromium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	Dissolved	Lab	**2.2 ug/l**	**2.1 ug/l**	**0.79 BQS ug/l**	**0.76 BQS ug/l**	**0.78 BQS ug/l**	**0.65 ug/l**	**0.52 ug/l**	**0.26 ug/l**	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	**0.22 ug/l**	--	--
Cobalt	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	Dissolved	Lab	**3.1 ug/l**	**3.1 ug/l**	**4.8 BQS ug/l**	**3.19 BQS ug/l**	**3.19 BQS ug/l**	**5.7 ug/l**	**6.5 ug/l**	**4.0 ug/l**	**4.2 ug/l**	**5.0 ug/l**	**5.2 ug/l**	**4.2 ug/l**	**3.4 ug/l**	--	--
Copper	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Iron	Dissolved	Lab	**25600 ug/l**	**25400 ug/l**	**112 BQS ug/l**	**85.3 BQS ug/l**	**87 BQS ug/l**	< 50.0 ug/l	**53.4 ug/l**	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	< 50.0 ug/l	--	--
Iron	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Total	Lab	< 0.50 ug/l	< 0.50 ug/l	**8.09 BQS ug/l**	**1.3 BQS ug/l**	**1.11 BQS ug/l**	**1.6 ug/l**	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	**0.65 ug/l**	--	--
Magnesium	Total	Lab	**18900 ug/l**	**18000 ug/l**	**25600 BQS ug/l**	**13000 BQS ug/l**	**12400 BQS ug/l**	**13300 ug/l**	**12500 ug/l**	**11200 ug/l**	**11700 ug/l**	**13800 ug/l**	**13400 ug/l**	**15100 ug/l**	**15200 ug/l**	--	--
Manganese	Dissolved	Lab	**1240 ug/l**	**1200 ug/l**	**358 BQS ug/l**	**422 BQS ug/l**	**419 BQS ug/l**	**366 ug/l**	**371 ug/l**	**334 ug/l**	**296 ug/l**	**137 ug/l**	**140 ug/l**	**37.3 ug/l**	**164 ug/l**	--	--
Manganese	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	Total	Lab	**0.00079 ug/l**	**0.00076 b ug/l**	**0.0182 BQS ug/l**	**0.0024 BQS ug/l**	**0.0023 BQS ug/l**	**0.0029 ug/l**	**0.0015 ug/l**	**0.0018 ug/l**	**0.0012 ug/l**	**0.0016 ug/l**	**0.0013 ug/l**	**0.0011 ug/l**	**0.0017 ug/l**	**0.0015 ug/l**	
Mercury methyl	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Dissolved	Lab	**1.3 ug/l**	**1.5 ug/l**	**8.84 BQS ug/l**	**8.57 BQS ug/l**	**8.78 BQS ug/l**	**8.7 ug/l**	**9.1 ug/l**	**7.3 ug/l**	**6.8 ug/l**	**8.1 ug/l**	**8.5 ug/l**	**7.1 ug/l**	**4.7 ug/l**	--	--
Molybdenum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	Dissolved	Lab	**4.5 ug/l**	**4.3 ug/l**	**3.82 BQS ug/l**	**2.8 BQS ug/l**	**2.86 BQS ug/l**	**2.9 ug/l**	**2.9 ug/l**	**2.3 ug/l**	**2.2 ug/l**	**2.0 b ug/l**	**2.7 b ug/l**	**0.83 ug/l**	**1.2 ug/l**	--	--
Nickel	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	**1000 ug/l**	**1000 ug/l**	**6350 BQS ug/l**	**2900 BQS ug/l**	**2730 BQS ug/l**	**2700 ug/l**	**2100 ug/l**	**1800 ug/l**	**2000 ug/l**	**2400 ug/l**	**2300 ug/l**	**2500 ug/l**	**1800 ug/l**	--	--
Selenium	Dissolved	Lab	< 1.0 ug/l	< 1.0 ug/l	**2.73 BQS ug/l**	< 1 BQS ug/l	< 1 BQS ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	--
Selenium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.2 BQS ug/l	< 0.2 BQS ug/l	< 0.2 BQS ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	--
Silver	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sodium	Total	Lab	**12900 ug/l**	**15600 ug/l**	**45500 BQS ug/l**	**33000 BQS ug/l**	**31400 BQS ug/l**	**18900 ug/l**	**11200 ug/l**	**8600 ug/l**	**8100 ug/l**	**9800 ug/l**	**9500 ug/l**	**9100 ug/l**	**7500 ug/l**	--	--
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab	**0.25 ug/l**	< 0.20 ug/l	< 0.2 BQS ug/l	< 0.2 BQS ug/l	< 0.2 BQS ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	**0.23 ug/l**	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	--
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Dissolved	Lab	**10.9 ug/l**	**10.2 ug/l**	< 5 BQS ug/l	< 5 BQS ug/l	< 5 BQS ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	< 5.0 ug/l	--	--
Zinc	Dissolved	Lab	< 6.0 ug/l	< 6.0 ug/l	**8.05 BQS ug/l**	< 6 BQS ug/l	**6.65 BQS ug/l**	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	--	--
Zinc	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Large Table 3
Groundwater Data Summary
Mine Site Surficial Aquifer

			Location	MW-18	MW-18	MW-18
			Date	7/31/2013	10/1/2013	10/2/2013
			Sample Type	N	N	N
	Fraction	Analysis Location				
General Parameters						
Alkalinity, bicarbonate, as CaCO3	NA	Lab		--	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab		--	--	--
Alkalinity, total	NA	Lab		**133 mg/l**	**133 mg/l**	--
Biochemical Oxygen Demand (5-day)	NA	Lab		--	--	--
Carbon, dissolved organic	NA	Lab		**5.9 mg/l**	**5.3 mg/l**	--
Carbon, total organic	NA	Lab		**5.8 mg/l**	**5.3 mg/l**	--
Chemical Oxygen Demand	NA	Lab		**16.6 mg/l**	**33.4 b mg/l**	--
Chloride	NA	Lab		**0.78 mg/l**	**1.8 mg/l**	--
Cyanide	NA	Lab		--	--	--
Dissolved oxygen	NA	Field		**3.81 mg/l**	--	**9.95 mg/l**
Fluoride	NA	Lab		**0.11 mg/l**	**0.13 mg/l**	--
Hardness, total, as CaCO3	NA	Lab		**160 mg/l**	**138 mg/l**	--
Nitrate + Nitrite, as N	NA	Lab		< 0.10 mg/l	< 0.10 mg/l	--
Nitrogen, ammonia (NH3), as N	NA	Lab		< 0.10 mg/l	< 0.10 mg/l	--
pH	NA	Lab		--	--	--
pH	NA	Field		**6.87 pH units**	--	**7.16 pH units**
Phosphorus, total	NA	Lab		--	--	--
Redox (oxidation potential)	NA	Field		**406 mV**	--	**502 mV**
Solids, total dissolved	NA	Lab		**199 mg/l**	**184 mg/l**	--
Specific Conductance @ 25oC	NA	Field		**250.4 umhos/cm**	--	**241.2 umhos/cm**
Sulfate	NA	Lab		**14.0 mg/l**	**11.0 mg/l**	--
Temperature, degrees C	NA	Field		**24.55 deg C**	--	**15.81 deg C**
Turbidity	NA	Field		**5.1 NTU**	--	**44.7 NTU**
Metals						
Aluminum	Dissolved	Lab		< 20.0 ug/l	< 20.0 ug/l	--
Aluminum	Total	Lab		--	--	--
Antimony	Dissolved	Lab		< 0.50 ug/l	< 0.50 ug/l	--
Antimony	Total	Lab		--	--	--
Arsenic	Dissolved	Lab		< 0.50 ug/l	**0.51 ug/l**	--
Arsenic	Total	Lab		--	--	--
Barium	Dissolved	Lab		--	--	--
Barium	Total	Lab		**61.2 ug/l**	**45.1 ug/l**	--
Beryllium	Total	Lab		< 0.20 ug/l	< 0.20 ug/l	--
Boron	Dissolved	Lab		--	--	--
Boron	Total	Lab		< 50.0 ug/l	< 50.0 ug/l	--
Cadmium	Dissolved	Lab		< 0.20 ug/l	< 0.20 ug/l	--
Cadmium	Total	Lab		--	--	--
Calcium	Total	Lab		**36000 ug/l**	**31500 ug/l**	--
Chromium	Dissolved	Lab		**1.0 ug/l**	< 1.0 ug/l	--
Chromium	Total	Lab		--	--	--
Cobalt	Dissolved	Lab		< 0.20 ug/l	< 0.20 ug/l	--
Cobalt	Total	Lab		--	--	--
Copper	Dissolved	Lab		**2.0 ug/l**	**3.3 ug/l**	--
Copper	Total	Lab		--	--	--
Iron	Dissolved	Lab		< 50.0 ug/l	< 50.0 ug/l	--
Iron	Total	Lab		--	--	--
Lead	Dissolved	Lab		--	--	--
Lead	Total	Lab		**0.91 ug/l**	**0.67 ug/l**	--
Magnesium	Total	Lab		**17100 ug/l**	**14500 ug/l**	--
Manganese	Dissolved	Lab		**67.8 ug/l**	**110 ug/l**	--
Manganese	Total	Lab		--	--	--
Mercury	Total	Lab		**0.0012 ug/l**	**0.0028 ug/l**	--
Mercury methyl	Total	Lab		--	--	--
Molybdenum	Dissolved	Lab		**4.9 ug/l**	**6.1 ug/l**	--
Molybdenum	Total	Lab		--	--	--
Nickel	Dissolved	Lab		**0.91 ug/l**	**0.79 ug/l**	--
Nickel	Total	Lab		--	--	--
Palladium	Total	Lab		--	--	--
Platinum	Total	Lab		--	--	--
Potassium	Total	Lab		**2400 ug/l**	**2200 ug/l**	--
Selenium	Dissolved	Lab		< 1.0 ug/l	< 1.0 ug/l	--
Selenium	Total	Lab		--	--	--
Silver	Dissolved	Lab		< 0.20 ug/l	< 0.20 ug/l	--
Silver	Total	Lab		--	--	--
Sodium	Total	Lab		**8400 ug/l**	**8100 ug/l**	--
Strontium	Total	Lab		--	--	--
Thallium	Total	Lab		**0.44 ug/l**	< 0.20 ug/l	--
Titanium	Total	Lab		--	--	--
Vanadium	Dissolved	Lab		< 5.0 ug/l	< 5.0 ug/l	--
Zinc	Dissolved	Lab		< 6.0 ug/l	< 6.0 ug/l	--
Zinc	Total	Lab		--	--	--

Large Table 3
Groundwater Data Summary
Mine Site Surficial Aquifer

Data Qualifiers/Footnotes	
Qualifier	**Definition**
	Not used in December 2014 probabilistic modeling
--	Not analyzed/not available.
a	Estimated value, calculated using some or all values that are estimates.
b	Potential false positive value based on blank data validation procedures.
c	Coeluting compound.
e	Estimated value, exceeded the instrument calibration range.
f	Sample was collected at a flowrate exceeding the recommended rate of 200 mL/minute.
h	EPA recommended sample preservation, extraction or analysis holding time was exceeded.
i	Indeterminate value based on failure of blind duplicate data to meet quality assurance criteria.
j	Reported value is less than the stated laboratory quantitation limit and is considered an estimated value.
p	Relative percent difference is >40% (25% CLP pesticides) between primary and confirmation GC columns.
pp	Small peak in chromatogram below method detection limit.
r	The presence of the compound is suspect based on the ID criteria of the retention time and relative retention time obtained from the examination of the chromatograms.
s	Potential false positive value based on statistical analysis of blank sample data.
v	Sample was collected under a vacuum of greater than XX inches of mercury.
*	Estimated value, QA/QC criteria not met.
**	Unusable value, QA/QC criteria not met.
N	Sample Type: Normal
FD	Sample Type: Field Duplicate
AT	Sample chromatogram is noted to be atypical of a petroleum product.
DLND	Not detected, detection limit not determined.
DF	Did not flash
EMPC	Estimated maximum possible concentration.
NA – (Not applicable)	NA indicates that a fractional portion of the sample is not part of the analytical testing or field collection procedures.
ND	Not detected.
TIC	Tentatively identified compound
BQA	Barr-applied project specific qualifier: extraction and/or analyses conducted using an alternative method and/or procedure.
BQC	Barr-applied project specific qualifier: plant shut down.
BQD	Barr-applied project specific qualifier: equipment malfunction.
BQE	Barr-applied project specific qualifier: equipment adjustment.
BQM	Barr-applied project specific qualifier: manual measurement.
BQN	Barr-applied project specific qualifier: unable to be sampled or measured due to various reasons.
BQP	Barr-applied project specific qualifier: atypical chromatographic pattern.
BQQ	Barr-applied project specific qualifier: some aspect of QA/QC was not met.
BQR	Barr-applied project specific qualifier: location was re-sampled.
BQS	Barr-applied project specific qualifier: data is considered suspect.
BQT	Barr-applied project specific qualifier: summed value not displayed due to insufficient field length.
BQU	Barr-applied project specific qualifier: historical qualifier - definition unknown.
BQV	Barr-applied project specific qualifier: estimated value.
BQX	Barr-applied project specific qualifier: see notes for qualifier definition.
BQZ	Barr-applied project specific qualifier: data is considered unusable.

Large Table 4
Groundwater Data Summary
Mine Site Bedrock

		Location	OB-1	OB-1	OB-1	OB-1	OB-1	OB-1	OB-1		OB-1	OB-1		OB-2	OB-2		OB-2	OB-2		OB-2
		Date	10/5/2006	3/17/2009	5/7/2010	7/29/2010	10/7/2010	10/13/2011	9/24/2012		10/24/2012	9/25/2013		10/3/2006	3/17/2009		5/7/2010	7/29/2010		10/7/2010
		Sample Type	N	N	N	N	N	N	N	FD	N	N	FD	N	N	FD	N	N	FD	N
	Fraction	Analysis Location																		
General Parameters																				
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	--	**35.8 mg/l**	**36.0 mg/l**	**28.6 mg/l**	**35.8 mg/l**	**98.0 mg/l**	**96.3 mg/l**	--	**38.0 mg/l**	--	--	--	--	**79.5 mg/l**	**94.2 mg/l**	**90.4 mg/l**	**93.8 mg/l**
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 20.0 mg/l	< 20.0 mg/l	--	< 10.0 mg/l	--	--	--	--	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l
Alkalinity, total	NA	Lab	**47.4 mg/l**	**52.8 mg/l**	**35.8 mg/l**	**36.0 mg/l**	**28.6 mg/l**	**35.8 mg/l**	**98.0 mg/l**	**96.3 mg/l**	--	**38.0 mg/l**	--	< 10 mg/l	**92.7 mg/l**	**89.2 mg/l**	**79.5 mg/l**	**94.2 mg/l**	**90.4 mg/l**	**93.8 mg/l**
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	< 2.4 mg/l	< 3 mg/l	< 2.4 mg/l	< 4 mg/l	< 8.0 h mg/l	< 8.0 h mg/l	< 2.4 mg/l	< 4.0 * mg/l	--	--	--	--	< 2.4 mg/l	< 3 mg/l	< 3 mg/l	< 2.4 mg/l
Carbon, dissolved organic	NA	Lab	--	--	**1.5 mg/l**	**1.3 mg/l**	**1.5 mg/l**	**2.5 mg/l**	**2.3 mg/l**	**1.9 mg/l**	--	**1.5 mg/l**	--	--	--	--	**1.6 mg/l**	**2.3 mg/l**	**2.2 mg/l**	**2.1 mg/l**
Carbon, total organic	NA	Lab	**1.5 mg/l**	**1.4 mg/l**	**1.2 mg/l**	**1.3 mg/l**	**1.1 mg/l**	**1.8 mg/l**	**1.2 mg/l**	**1.0 mg/l**	--	**1.0 mg/l**	--	**1.9 mg/l**	**1.7 mg/l**	**1.7 mg/l**	**1.7 mg/l**	**1.9 mg/l**	**2 mg/l**	**1.9 mg/l**
Chemical Oxygen Demand	NA	Lab	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	**11.2 mg/l**	**54.7 mg/l**	< 10.0 mg/l	**11.2 mg/l**	--	< 10.0 mg/l	--	< 10 mg/l	< 10 mg/l	< 10 mg/l	**13.6 mg/l**	< 10 mg/l	< 10 mg/l	**14.1 mg/l**
Chloride	NA	Lab	**15.7 mg/l**	**3.46 mg/l**	**2.39 mg/l**	**2.79 mg/l**	**2.53 mg/l**	**2.47 mg/l**	**1.5 mg/l**	**1.5 mg/l**	--	**1.6 mg/l**	--	**0.55 mg/l**	< 0.5 mg/l	< 0.5 mg/l	**0.59 mg/l**	**0.6 mg/l**	**0.66 mg/l**	< 0.5 mg/l
Cyanide	NA	Lab	< 0.02 mg/l	< 0.02 mg/l	< 0.0100 mg/l	< 0.02 mg/l	< 0.02 mg/l	< 0.0100 mg/l	**0.0132 mg/l**	**0.0120 mg/l**	--	**0.0124 mg/l**	--	< 0.02 mg/l	< 0.02 mg/l	< 0.02 mg/l	< 0.0100 mg/l	< 0.02 mg/l	< 0.02 mg/l	< 0.02 mg/l
Dissolved oxygen	NA	Field	**9.59 mg/l**	**2.51 mg/l**	**0.06 mg/l**	**0.64 mg/l**	**1.9 mg/l**	**4.4 mg/l**	**3.46 mg/l**	--	--	**1.39 mg/l**	--	**2.15 mg/l**	**0.24 mg/l**	--	**0.03 mg/l**	**0.54 mg/l**	--	**2.4 mg/l**
Fluoride	NA	Lab	**0.11 mg/l**	**0.15 mg/l**	< 0.1 mg/l	**0.16 mg/l**	**0.14 mg/l**	**0.15 mg/l**	< 0.10 mg/l	< 0.10 mg/l	--	< 0.10 mg/l	--	**0.22 mg/l**	**0.11 mg/l**	**0.11 mg/l**	< 0.1 mg/l	**0.13 mg/l**	**0.14 mg/l**	**0.15 mg/l**
Hardness, total, as CaCO3	NA	Lab	**106 mg/l**	**87.4 mg/l**	**82.7 mg/l**	**77.6 mg/l**	**53.8 mg/l**	**119 mg/l**	**53.0 mg/l**	**53.2 mg/l**	--	**49.9 mg/l**	--	**76.4 mg/l**	**97.6 mg/l**	**98.9 mg/l**	**90.6 mg/l**	**92.6 mg/l**	**94.4 mg/l**	**92.9 mg/l**
Nitrate + Nitrite, as N	NA	Lab	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.10 mg/l	< 0.10 mg/l	--	< 0.10 mg/l	--	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l
Nitrogen, ammonia (NH3), as N	NA	Lab	< 0.1 mg/l	< 0.1 mg/l	**0.07 mg/l**	**0.2 b mg/l**	**0.06 mg/l**	< 0.1 mg/l	< 0.10 mg/l	< 0.10 mg/l	--	< 0.10 mg/l	--	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.05 mg/l	< 0.05 mg/l	< 0.05 mg/l	< 0.05 mg/l
pH	NA	Lab	**9.0 pH units**	**10.4 pH units**	**9.1 pH units**	**10.4 pH units**	**9.5 pH units**	**9.9 pH units**	**7.5 pH units**	**7.9 pH units**	--	**8.5 pH units**	--	**7.6 pH units**	**7.2 pH units**	**6.9 pH units**	**7.3 pH units**	**7.7 pH units**	**7.6 pH units**	**7.6 pH units**
pH	NA	Field	**9.73 pH units**	**7.67 pH units**	**6.78 pH units**	**9.62 pH units**	**10.1 pH units**	**10.3 pH units**	**8.42 pH units**	--	--	**8.78 pH units**	--	**8.09 pH units**	**7.43 pH units**	--	**6.79 pH units**	**7.48 pH units**	--	**7.8 pH units**
Phosphorus, total	NA	Lab	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg P/L	< 0.1 mg P/L	< 0.1 mg P/L	< 0.1 mg P/L	< 0.10 mg/l	< 0.10 mg/l	--	< 0.10 mg/l	--	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg P/L	< 0.1 mg P/L	< 0.1 mg P/L	< 0.1 mg P/L
Redox (oxidation potential)	NA	Field	**-47 mV**	**167 mV**	**409 mV**	**362 mV**	**162 mg/l**	**103 mV**	**143 mV**	--	--	**351 mV**	--	**-148 mV**	**36 mV**	--	**492 mV**	**428 mV**	--	**70 mV**
Solids, total dissolved	NA	Lab	--	--	**82 mg/l**	**95 mg/l**	**92 mg/l**	**76 mg/l**	**107 mg/l**	**103 mg/l**	--	**107 mg/l**	--	--	--	--	**108 mg/l**	**114 mg/l**	**112 mg/l**	**113 mg/l**
Specific Conductance @ 25oC	NA	Field	**158 umhos/cm**	**184 umhos/cm**	**261 umhos/cm**	**161.8 umhos/cm**	**138 umhos/cm**	**160 umhos/cm**	**111 umhos/cm**		--	**104.7 umhos/cm**	--	**187 umhos/cm**	**187 umhos/cm**		**301 umhos/cm**	**80 umhos/cm**	--	**186 umhos/cm**
Sulfate	NA	Lab	**37.2 mg/l**	**29.2 mg/l**	**25.1 mg/l**	**32.2 mg/l**	**29.3 mg/l**	**31.9 mg/l**	**18.2 mg/l**	**18.2 mg/l**	--	**18.7 mg/l**	--	**10.9 mg/l**	**8.88 mg/l**	**8.89 mg/l**	**4.53 mg/l**	**8.95 mg/l**	**9.05 mg/l**	**7.23 mg/l**
Temperature, degrees C	NA	Field	**6.96 deg C**	**5.7 deg C**	**4.9 deg C**	**7.03 deg C**	**9.5 deg C**	**6.9 deg C**	**9.1 deg C**	--	--	**6.93 deg C**	--	**5.6 deg C**	**5.5 deg C**	--	**5.3 deg C**	**6.09 deg C**	--	**8.5 deg C**
Turbidity	NA	Field	--	**48 NTU**	**193.4 NTU**	**19.7 NTU**	**6.9 NTU**	**41.2 NTU**	**0 NTU**	--	--	**1.8 NTU**	--	--	**46 NTU**	--	**24 NTU**	**25 NTU**	--	**7.3 NTU**
Metals																				
Aluminum	Dissolved	Lab	**55.2 ug/l**	**127 ug/l**	**79.7 ug/l**	**98.5 ug/l**	**45.1 ug/l**	**70.1 ug/l**	< 20.0 ug/l	< 20.0 ug/l	--	< 20.0 ug/l	--	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l
Aluminum	Total	Lab	**111 ug/l**	**1690 ug/l**	**1490 ug/l**	**1580 ug/l**	**443 ug/l**	**4740 ug/l**	**26.1 b ug/l**	**23.4 b ug/l**	--	**40.7 ug/l**	--	**62.4 ug/l**	**60.6 ug/l**	**60.6 ug/l**	**48.6 ug/l**	**114 ug/l**	**132 ug/l**	< 25 ug/l
Antimony	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	Total	Lab	< 3 ug/l	**0.53 ug/l**	< 0.5 ug/l	**0.53 ug/l**	< 0.5 ug/l	**0.58 ug/l**	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	--	< 3 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l
Arsenic	Dissolved	Lab	--	--	--	< 1 ug/l	**1.15 ug/l**	**0.74 ug/l**	**0.68 ug/l**	**0.70 ug/l**	--	**0.85 ug/l**	--	--	--	--	--	< 1 ug/l	< 1 ug/l	< 1 ug/l
Arsenic	Total	Lab	< 2 ug/l	< 2 ug/l	**1.52 ug/l**	**1.8 ug/l**	**1.19 ug/l**	**2.43 ug/l**	**0.91 ug/l**	**0.97 ug/l**	--	**0.99 ug/l**	--	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l
Barium	Dissolved	Lab	--	--	--	--	--	--	**0.80 ug/l**	**0.82 ug/l**	--	**0.94 ug/l**	--	--	--	--	--	--	--	--
Barium	Total	Lab	< 10 ug/l	**16.8 ug/l**	**16.6 ug/l**	**12.6 ug/l**	**4.11 ug/l**	**29.9 ug/l**	**0.77 ug/l**	**0.75 ug/l**	--	**1.2 ug/l**	--	< 10 ug/l	**1.2 ug/l**	**1.2 ug/l**	**1.57 ug/l**	**1.49 ug/l**	**1.69 ug/l**	**1.09 ug/l**
Beryllium	Total	Lab	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	**0.36 ug/l**	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	--	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l
Boron	Dissolved	Lab	--	--	--	--	--	< 50 ug/l	< 50.0 ug/l	< 50.0 ug/l	--	< 50.0 ug/l	--	--	--	--	--	--	--	--
Boron	Total	Lab	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50.0 ug/l	< 50.0 ug/l	--	< 50.0 ug/l	--	**93.1 ug/l**	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l
Cadmium	Dissolved	Lab	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	--	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l
Cadmium	Total	Lab	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	--	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l
Calcium	Total	Lab	**29700 ug/l**	**30400 ug/l**	**26000 ug/l**	**25600 ug/l**	**15700 ug/l**	**32500 ug/l**	**11600 ug/l**	**11700 ug/l**	--	**11300 ug/l**	--	**10800 ug/l**	**14500 ug/l**	**14700 ug/l**	**14200 ug/l**	**14000 ug/l**	**14400 ug/l**	**14300 ug/l**
Chromium	Dissolved	Lab	< 1 ug/l	**1.1 b ug/l**	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	--	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l
Chromium	Total	Lab	**1.7 ug/l**	**3.5 ug/l**	**3.06 ug/l**	**2.77 ug/l**	< 1 ug/l	**9.29 ug/l**	**1.3 b ug/l**	< 1.0 ug/l	--	< 1.0 ug/l	--	**5 ug/l**	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l
Cobalt	Dissolved	Lab	--	--	--	--	--	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	--	--	--	--	--	--	--	--
Cobalt	Total	Lab	< 1 ug/l	**0.97 ug/l**	**1 ug/l**	**0.91 ug/l**	**0.25 ug/l**	**3.01 ug/l**	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	--	< 1 ug/l	**0.66 ug/l**	**0.79 ug/l**	**1.16 ug/l**	**2.27 ug/l**	**2.67 ug/l**	**0.91 ug/l**
Copper	Dissolved	Lab	**2.2 ug/l**	**0.82 ug/l**	< 0.7 ug/l	**1.31 ug/l**	**0.92 ug/l**	**0.76 ug/l**	**0.81 ug/l**	**0.79 ug/l**	--	**0.64 ug/l**	--	< 2 ug/l	**1.4 ug/l**	< 0.7 ug/l	< 0.7 ug/l	**2.33 ug/l**	**3.07 ug/l**	< 0.7 ug/l
Copper	Total	Lab	< 2 ug/l	**9.4 ug/l**	**5.36 ug/l**	**8.62 ug/l**	**2.55 ug/l**	**18.8 ug/l**	**1.0 ug/l**	**0.96 ug/l**	--	**1.0 ug/l**	--	**2.8 ug/l**	**1.7 b ug/l**	**1.8 b ug/l**	**4.44 ug/l**	**4.76 ug/l**	**6.18 ug/l**	**1.35 ug/l**
Iron	Dissolved	Lab	--	--	--	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50.0 ug/l	< 50.0 ug/l	--	< 50.0 ug/l	--	--	--	--	--	**1280 ug/l**	**1290 ug/l**	**2300 ug/l**
Iron	Total	Lab	**87.9 ug/l**	**6000 ug/l**	**13700 ug/l**	**6300 ug/l**	**1590 ug/l**	**20700 ug/l**	**57.9 b ug/l**	< 50.0 ug/l	--	**554 ug/l**	--	**334 ug/l**	**5890 * ug/l**	**8280 * ug/l**	**13400 ug/l**	**5850 * ug/l**	**8760 * ug/l**	**5690 ug/l**
Lead	Dissolved	Lab	--	--	--	--	--	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	--	--	--	--	--	--	--	--
Lead	Total	Lab	< 2 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	**0.65 ug/l**	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	--	< 1 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l
Magnesium	Total	Lab	**7720 ug/l**	**2800 ug/l**	**4320 ug/l**	**3320 ug/l**	**3540 ug/l**	**9140 ug/l**	**5800 ug/l**	**5800 ug/l**	--	**5300 ug/l**	--	**12000 ug/l**	**14900 ug/l**	**15100 ug/l**	**13400 ug/l**	**14000 ug/l**	**14200 ug/l**	**13900 ug/l**
Manganese	Dissolved	Lab	--	--	**1.5 * ug/l**	**0.83 ug/l**	**2.02 ug/l**	< 10 ug/l	**9.1 ug/l**	**8.9 ug/l**	--	**8.2 ug/l**	--	--	--	--	**212 ug/l**	**175 ug/l**	**195 ug/l**	**216 ug/l**
Manganese	Total	Lab	< 10 ug/l	**65.1 ug/l**	**103 ug/l**	**74.6 ug/l**	**20 ug/l**	**247 ug/l**	**10.3 ug/l**	**10 ug/l**	--	**12.3 ug/l**	--	**41.6 ug/l**	**168 ug/l**	**177 ug/l**	**220 ug/l**	**181 ug/l**	**189 ug/l**	**233 ug/l**
Mercury	Total	Lab	< 0.0005 ug/l	< 0.0005 ug/l	< 0.0005 ug/l	< 0.0005 ug/l	< 0.0005 ug/l	**0.0007 ug/l**	< 0.00050 ug/l	< 0.00050 ug/l	--	< 0.00050 ug/l	< 0.00050 ug/l	**0.0016 b ug/l**	**0.0007 ug/l**	**0.0005 ug/l**	< 0.0005 ug/l	**0.0007 ug/l**	**0.0009 ug/l**	< 0.0005 ug/l
Mercury methyl	Total	Lab	< 0.000056 ug/l	< 0.0001 ug/l	< 0.0001 ug/l	< 0.0001 ug/l	< 0.0001 ug/l	< 0.0001 ug/l	< 0.00003 ug/l	**0.00006 jb ug/l**	--	< 0.00003 ug/l	< 0.00003 ug/l	< 0.000056 ug/l	< 0.0001 ug/l	< 0.0001 ug/l	< 0.0001 ug/l	< 0.0001 ug/l	< 0.0001 ug/l	< 0.0001 ug/l
Molybdenum	Dissolved	Lab	< 5 ug/l	**2.5 ug/l**	**1.74 ug/l**	**2.14 ug/l**	**1.86 ug/l**	**1.89 ug/l**	**0.64 ug/l**	**0.62 ug/l**	--	**0.74 ug/l**	--	< 5 ug/l	**1.7 ug/l**	**1.8 ug/l**	**1.53 ug/l**	**1.43 ug/l**	**1.51 ug/l**	**1.78 ug/l**
Molybdenum	Total	Lab	< 5 ug/l	**2.8 ug/l**	**2.13 ug/l**	**2.41 ug/l**	**1.92 ug/l**	**2.98 ug/l**	**0.71 ug/l**	**0.62 ug/l**	--	**0.66 ug/l**	--	< 5 ug/l	**1.4 ug/l**	**1.6 ug/l**	**1.25 ug/l**	**1.37 ug/l**	**1.29 ug/l**	**1.78 ug/l**
Nickel	Dissolved	Lab	< 2 ug/l	**1.1 ug/l**	**1.98 ug/l**	**0.88 ug/l**	**2.84 ug/l**	**0.86 ug/l**	**2.3 ug/l**	**2.2 ug/l**	--	**1.9 ug/l**	--	< 2 ug/l	**2.9 ug/l**	**2.8 ug/l**	**5.93 ug/l**	**4.2 ug/l**	**4.59 ug/l**	**3.08 ug/l**
Nickel	Total	Lab	< 2 ug/l	**7.7 ug/l**	**8.36 ug/l**	**6.71 ug/l**	**4.22 ug/l**	**20.5 ug/l**	**2.5 ug/l**	**2.3 ug/l**	--	**2.2 ug/l**	--	**3.6 ug/l**	**4.9 * ug/l**	**6.9 * ug/l**	**26.2 ug/l**	**5.02 ug/l**	**6.32 ug/l**	**12.2 ug/l**
Palladium	Total	Lab	< 0.1 ug/l	< 0.30 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	--	< 0.1 ug/l	< 0.30 ug/l	< 0.30 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l
Platinum	Total	Lab	< 0.02 ug/l	< 0.30 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	--	< 0.02 ug/l	< 0.30 ug/l	< 0.30 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l
Potassium	Total	Lab	**1810 ug/l**	**2380 ug/l**	**1890 ug/l**	**1900 ug/l**	**1670 ug/l**	**2160 ug/l**	**1200 ug/l**	**1200 ug/l**	--	**1200 ug/l**	--	**1480 ug/l**	**1550 ug/l**	**1570 ug/l**	**1500 ug/l**	**1450 ug/l**	**1460 ug/l**	**1530 ug/l**
Selenium	Dissolved	Lab	< 2 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	--	< 2 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l
Selenium	Total	Lab	< 2 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	--	< 10 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l
Silver	Dissolved	Lab	< 1 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	--	< 1 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l
Silver	Total	Lab	< 1 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	--	< 1 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l
Sodium	Total	Lab	**7380 ug/l**	**11600 ug/l**	**9500 ug/l**	**12300 ug/l**	**8740 ug/l**	**10200 ug/l**	**3700 ug/l**	**3700 ug/l**	--	**4500 ug/l**	--	**19700 ug/l**	**5340 ug/l**	**5400 ug/l**	**3460 ug/l**	**5200 ug/l**	**5200 ug/l**	**5390 ug/l**
Strontium	Total	Lab	**112 ug/l**	**106 ug/l**	**87.2 ug/l**	**95.9 ug/l**	**63 ug/l**	**100 ug/l**	**51.5 ug/l**	**51.7 ug/l**	--	**52.7 ug/l**	--	**58.7 ug/l**	**62.1 ug/l**	**62.9 ug/l**	**44.2 ug/l**	**58.2 ug/l**	**57.6 ug/l**	**53.7 ug/l**
Thallium	Total	Lab	< 2 ug/l	< 0.4 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	--	< 2 ug/l	< 0.4 ug/l	< 0.4 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l
Titanium	Total	Lab	< 20 ug/l	**84.7 ug/l**	**68 ug/l**	**100 ug/l**	**22 ug/l**	**340 ug/l**	< 10.0 ug/l	< 10.0 ug/l	--	< 10.0 ug/l	--	< 20 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l
Vanadium	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	Dissolved	Lab	< 25 ug/l	**8.4 b ug/l**	< 6 ug/l	< 6 ug/l	< 6 ug/l	**6.03 ug/l**	< 6.0 ug/l	< 6.0 ug/l	--	< 6.0 ug/l	--	< 25 ug/l	**11.3 b ug/l**	< 6 ug/l	< 6 ug/l	**7.59 ug/l**	**9.55 ug/l**	< 6 ug/l
Zinc	Total	Lab	< 25 ug/l	**11.5 * ug/l**	**7.6 ug/l**	**11 ug/l**	< 6 ug/l	**43.7 ug/l**	< 6.0 ug/l	< 6.0 ug/l	--	< 6.0 ug/l	--	< 25 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l

Large Table 4
Groundwater Data Summary
Mine Site Bedrock

Location			OB-2	OB-2	OB-2	OB-2		OB-3	OB-3	OB-3	OB-3		OB-3		OB-3		OB-3	OB-3	OB-3		OB-3
Date			10/12/2011	9/25/2012	10/24/2012	9/24/2013		10/16/2006	1/4/2007	3/19/2009	5/7/2010		7/27/2010		10/7/2010		10/12/2011	9/25/2012	10/24/2012		9/24/2013
Sample Type			N	N	N	N	FD	N	N	N	N	FD	N	FD	N	FD	N	N	N	FD	N
	Fraction	Analysis Location																			
General Parameters																					
Alkalinity, bicarbonate, as CaCO3	NA	Lab	**96.4 mg/l**	**96.2 mg/l**	--	**95.6 mg/l**	--	--	--	--	**106 mg/l**	**105 mg/l**	**115 mg/l**	**112 mg/l**	**104 mg/l**	**104 mg/l**	**94.2 mg/l**	**80.0 mg/l**	--	--	**88.9 mg/l**
Alkalinity, carbonate, as CaCO3	NA	Lab	< 10 mg/l	< 20.0 mg/l	--	< 10.0 mg/l	--	--	--	--	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 20.0 mg/l	--	--	< 10.0 mg/l
Alkalinity, total	NA	Lab	**96.4 mg/l**	**96.2 mg/l**	--	**95.6 mg/l**	--	**66.2 mg/l**	--	**109 mg/l**	**106 mg/l**	**105 mg/l**	**115 mg/l**	**112 mg/l**	**104 mg/l**	**104 mg/l**	**94.2 mg/l**	**80.0 mg/l**	--	--	**88.9 mg/l**
Biochemical Oxygen Demand (5-day)	NA	Lab	**4.3 mg/l**	< 3.0 mg/l	--	< 3.0 * mg/l	--	--	--	--	< 2.4 mg/l	< 2.4 mg/l	< 3 mg/l	< 3 mg/l	< 2.4 mg/l	< 2.4 mg/l	< 4 mg/l	< 3.0 mg/l	--	--	< 4.0 * mg/l
Carbon, dissolved organic	NA	Lab	**3.3 mg/l**	**2.0 mg/l**	--	**1.9 mg/l**	--	--	--	--	**2.9 mg/l**	**2.9 mg/l**	**2.9 mg/l**	**2.8 mg/l**	**2.9 mg/l**	**2.7 mg/l**	**3.9 mg/l**	**3.1 mg/l**	--	--	**2.6 mg/l**
Carbon, total organic	NA	Lab	**2.8 mg/l**	**1.8 mg/l**	--	**1.5 mg/l**	--	**3.2 mg/l**	--	**3.0 b mg/l**	**3.8 mg/l**	**3.6 mg/l**	**2.9 mg/l**	**3.0 mg/l**	**2.9 mg/l**	**2.7 mg/l**	**3.6 mg/l**	**2.5 mg/l**	--	--	**2.6 mg/l**
Chemical Oxygen Demand	NA	Lab	**22.8 mg/l**	< 10.0 mg/l	--	**13.4 mg/l**	--	< 10 mg/l	--	**11.0 b mg/l**	**18 mg/l**	**19.2 mg/l**	< 10 mg/l	< 10 mg/l	**17.3 mg/l**	**15.7 mg/l**	**26.7 mg/l**	< 10.0 mg/l	--	--	**13.5 mg/l**
Chloride	NA	Lab	**0.88 mg/l**	**0.78 mg/l**	--	**1.1 mg/l**	--	**93.1 mg/l**	--	**0.58 b mg/l**	**0.81 mg/l**	**0.76 mg/l**	**0.75 mg/l**	**0.81 mg/l**	**0.64 mg/l**	**0.57 mg/l**	**0.95 mg/l**	**0.80 mg/l**	--	--	**1.0 mg/l**
Cyanide	NA	Lab	< 0.0100 mg/l	< 0.0100 mg/l	--	< 0.0100 mg/l	--	< 0.02 mg/l	--	< 0.02 mg/l	< 0.0100 mg/l	< 0.0100 mg/l	< 0.02 mg/l	< 0.02 mg/l	< 0.02 mg/l	< 0.02 mg/l	< 0.0100 mg/l	< 0.0100 mg/l	--	--	< 0.0100 mg/l
Dissolved oxygen	NA	Field	**1.6 mg/l**	**2.08 mg/l**	--	< 0.1 mg/l	--	**0.80 mg/l**	--	**0.12 mg/l**	**0.05 mg/l**	--	**0.27 mg/l**	--	**1.9 mg/l**	--	**2.0 mg/l**	**1.54 mg/l**	--	--	< 0.1 mg/l
Fluoride	NA	Lab	**0.16 mg/l**	**0.16 mg/l**	--	**0.15 mg/l**	--	**0.97 mg/l**	--	**0.1 b mg/l**	< 0.1 mg/l	< 0.1 mg/l	**0.12 mg/l**	**0.12 mg/l**	**0.13 mg/l**	**0.13 mg/l**	**0.12 mg/l**	**0.12 mg/l**	--	--	**0.11 mg/l**
Hardness, total, as CaCO3	NA	Lab	**97.3 mg/l**	**95.9 mg/l**	--	**91.8 mg/l**	--	**140 mg/l**	--	**129 mg/l**	**140 mg/l**	**140 mg/l**	**127 mg/l**	**122 mg/l**	**131 mg/l**	**131 mg/l**	**137 mg/l**	**151 mg/l**	--	--	**145 mg/l**
Nitrate + Nitrite, as N	NA	Lab	**0.18 mg/l**	< 0.10 mg/l	--	< 0.10 mg/l	--	< 0.1 mg/l	--	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	**0.12 mg/l**	< 0.10 mg/l	--	--	< 0.10 mg/l
Nitrogen, ammonia (NH3), as N	NA	Lab	< 0.1 mg/l	< 0.10 mg/l	--	< 0.10 mg/l	--	< 0.1 mg/l	--	< 0.1 mg/l	**0.1 mg/l**	**0.09 mg/l**	**0.11 mg/l**	**0.11 mg/l**	**0.14 mg/l**	**0.09 mg/l**	**0.11 mg/l**	< 0.10 mg/l	--	--	< 0.10 mg/l
pH	NA	Lab	**7.5 pH units**	**7.8 pH units**	--	**8.0 pH units**	--	**6.6 pH units**	--	**7.2 pH units**	**7.3 pH units**	**7.6 pH units**	**7.6 pH units**	**7.7 pH units**	**7.5 pH units**	**7.5 pH units**	**7.5 pH units**	**7.4 pH units**	--	--	**8.0 pH units**
pH	NA	Field	**7.2 pH units**	**7.53 pH units**	--	**7.55 pH units**	--	**6.72 pH units**	--	**7.25 pH units**	**7.28 pH units**	**7.26 pH units**	**7.11 pH units**	--	**7.3 pH units**	--	**7.1 pH units**	**7.22 pH units**	--	--	**7.15 pH units**
Phosphorus, total	NA	Lab	< 0.1 mg P/L	< 0.10 mg/l	--	< 0.10 mg/l	--	< 0.1 mg/l	--	< 0.1 mg/l	**0.43 mg P/L**	**0.35 mg P/L**	< 0.1 mg P/L	< 0.1 mg P/L	< 0.1 mg P/L	< 0.1 mg P/L	**0.15 mg P/L**	< 0.10 mg/l	--	--	**4.4 mg/l**
Redox (oxidation potential)	NA	Field	**112 mV**	**-29 mV**	--	**40 mV**	--	**-63 mV**	--	**147 mV**	**476 mV**	--	**425 mV**	--	**126 mV**	--	**147 mV**	**-16 mV**	--	--	**86 mV**
Solids, total dissolved	NA	Lab	**130 mg/l**	**134 mg/l**	--	**143 mg/l**	--	--	--	--	**160 mg/l**	**161 mg/l**	**146 mg/l**	**156 mg/l**	**174 mg/l**	**168 mg/l**	**190 mg/l**	**200 mg/l**	--	--	**214 mg/l**
Specific Conductance @ 25oC	NA	Field	**204 umhos/cm**	**198.6 umhos/cm**	--	**180.3 umhos/cm**	--	**198 umhos/cm**	--	**257 umhos/cm**	**440 umhos/cm**	--	**215 umhos/cm**	--	**263 umhos/cm**	--	**293 umhos/cm**	**315.4 umhos/cm**	--	--	**290.1 umhos/cm**
Sulfate	NA	Lab	**7.75 mg/l**	**8.3 mg/l**	--	**8.9 mg/l**	--	**66.4 mg/l**	--	**25.8 mg/l**	**24.3 mg/l**	**24.1 mg/l**	**19.4 mg/l**	**19.6 mg/l**	**35.6 mg/l**	**35.4 mg/l**	**47.5 mg/l**	**68.9 mg/l**	--	--	**66.3 mg/l**
Temperature, degrees C	NA	Field	**8.6 deg C**	**6.1 deg C**	--	**6.72 deg C**	--	**8.3 deg C**	--	**5.9 deg C**	**5.9 deg C**	--	**7.82 deg C**	--	**10.5 deg C**	--	**8.7 deg C**	**8.69 deg C**	--	--	**8.58 deg C**
Turbidity	NA	Field	**251.5 NTU**	**0.7 NTU**	--	**5.9 NTU**	--	--	--	**8.3 NTU**	**1 NTU**	--	**7.0 NTU**	--	**7.5 NTU**	--	**75.4 NTU**	**0.7 NTU**	--	--	**7.9 NTU**
Metals																					
Aluminum	Dissolved	Lab	< 25 ug/l	< 20.0 ug/l	--	< 20.0 ug/l	--	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 20.0 ug/l	--	--	< 20.0 ug/l
Aluminum	Total	Lab	**64.8 ug/l**	< 20.0 ug/l	--	< 20.0 ug/l	--	**388 ug/l**	**332 ug/l**	**469 ug/l**	**6950 ug/l**	**8210 ug/l**	**322 ug/l**	**274 ug/l**	**26.9 ug/l**	< 25 ug/l	**613 ug/l**	**33.6 ug/l**	--	--	**20.9 ug/l**
Antimony	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	Total	Lab	< 0.5 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	--	< 3 ug/l	< 3 ug/l	< 0.5 ug/l	< 0.5 ug/l	**0.64 ug/l**	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	--	--	< 0.50 ug/l
Arsenic	Dissolved	Lab	< 0.5 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	--	--	--	--	--	--	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 0.5 ug/l	**0.86 ug/l**	--	--	**0.92 ug/l**
Arsenic	Total	Lab	< 0.5 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	--	**4.1 ug/l**	**3.6 ug/l**	**3.3 ug/l**	**24.1 ug/l**	**26.6 ug/l**	**1.58 ug/l**	**2.35 ug/l**	< 1 ug/l	< 1 ug/l	**10.4 ug/l**	**1.1 ug/l**	--	--	**1.1 ug/l**
Barium	Dissolved	Lab	--	**0.70 ug/l**	--	**0.72 ug/l**	--	--	--	--	--	--	--	--	--	--	--	**2.3 ug/l**	--	--	**2.1 ug/l**
Barium	Total	Lab	**2.08 ug/l**	**0.77 ug/l**	--	**0.78 ug/l**	--	< 10 ug/l	< 10 ug/l	**2.8 ug/l**	**9.5 * ug/l**	**15.8 * ug/l**	**2.62 ug/l**	**3.12 ug/l**	**2.48 ug/l**	**2.5 ug/l**	**6.8 ug/l**	**2.5 ug/l**	--	--	**2.2 ug/l**
Beryllium	Total	Lab	< 0.2 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	--	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	**0.21 ug/l**	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	--	--	< 0.20 ug/l
Boron	Dissolved	Lab	< 50 ug/l	**65.9 ug/l**	--	**55.7 ug/l**	--									--	< 50 ug/l	< 50.0 ug/l	--	--	< 50.0 ug/l
Boron	Total	Lab	< 50 ug/l	< 50.0 ug/l	--	**56.1 ug/l**	--	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50.0 ug/l	--	--	< 50.0 ug/l
Cadmium	Dissolved	Lab	< 0.2 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	--	< 0.2 ug/l	--	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	**0.92 ug/l**	< 0.20 ug/l	--	--	< 0.20 ug/l
Cadmium	Total	Lab	< 0.2 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	--	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	**0.5 ug/l**	**0.6 ug/l**	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	**48 ug/l**	< 0.20 ug/l	--	--	< 0.20 ug/l
Calcium	Total	Lab	**14900 ug/l**	**13900 ug/l**	--	**13200 ug/l**	--	**21000 ug/l**	**21600 ug/l**	**21600 ug/l**	**22700 ug/l**	**22500 ug/l**	**21600 ug/l**	**20600 ug/l**	**22300 ug/l**	**22200 ug/l**	**23000 ug/l**	**24900 ug/l**	--	--	**23600 ug/l**
Chromium	Dissolved	Lab	< 1 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	--	< 1 ug/l	--	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1.0 ug/l	--	--	< 1.0 ug/l
Chromium	Total	Lab	< 1 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	--	< 2.5 ug/l	**2.7 ug/l**	**1.7 ug/l**	**2.4 ug/l**	**5.53 ug/l**	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	**4.22 ug/l**	< 1.0 ug/l	--	--	< 1.0 ug/l
Cobalt	Dissolved	Lab	--	**0.28 ug/l**	--	**0.40 ug/l**	--	--	--	--	--	--	--	--	--	--	--	**5.0 ug/l**	--	--	**4.8 ug/l**
Cobalt	Total	Lab	**3.18 ug/l**	**0.35 ug/l**	--	**0.48 ug/l**	--	**4.1 ug/l**	**6.7 ug/l**	**7.9 ug/l**	**12.3 ug/l**	**15.4 ug/l**	**8.28 ug/l**	**7.69 ug/l**	**6.57 ug/l**	**6.77 ug/l**	**23.3 ug/l**	**5.9 ug/l**	--	--	**5.1 ug/l**
Copper	Dissolved	Lab	< 0.7 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	--	< 2 ug/l	< 5 ug/l	**0.89 b ug/l**	**0.92 b ug/l**	< 0.7 ug/l	**0.79 ug/l**	**0.81 ug/l**	**2.53 ug/l**	< 0.7 ug/l	**1.87 ug/l**	< 0.50 ug/l	--	--	< 0.50 ug/l
Copper	Total	Lab	**3.96 ug/l**	< 0.50 ug/l	--	< 0.50 ug/l	--	**2.1 ug/l**	< 5 ug/l	**6.1 b ug/l**	**44.6 * ug/l**	**67.1 * ug/l**	**7.06 * ug/l**	**4.46 * ug/l**	**1.57 ug/l**	**1.52 ug/l**	**39.4 ug/l**	**0.99 ug/l**	--	--	**0.70 ug/l**
Iron	Dissolved	Lab	**142 ug/l**	**561 ug/l**	--	**865 ug/l**	--	--	--	--	--	--	**1620 ug/l**	**1610 ug/l**	**2460 ug/l**	**2460 ug/l**	**204 ug/l**	**2760 ug/l**	--	--	**3240 ug/l**
Iron	Total	Lab	**25600 ug/l**	**1560 ug/l**	--	**1360 ug/l**	--	**7040 ug/l**	**6370 ug/l**	**4320 ug/l**	**36000 ug/l**	**42500 ug/l**	**4440 ug/l**	**3690 ug/l**	**3780 ug/l**	**3600 ug/l**	**44300 ug/l**	**4200 ug/l**	--	--	**4010 ug/l**
Lead	Dissolved	Lab	--	< 0.50 ug/l	--	< 0.50 ug/l	--	--	--	--	--	--	--	--	--	--	--	< 0.50 ug/l	--	--	< 0.50 ug/l
Lead	Total	Lab	< 0.5 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	--	< 1 ug/l	< 2 ug/l	< 0.5 ug/l	**2.9 ug/l**	**4.09 ug/l**	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	**1.46 ug/l**	< 0.50 ug/l	--	--	< 0.50 ug/l
Magnesium	Total	Lab	**14600 ug/l**	**14900 ug/l**	--	**14300 ug/l**	--	**21400 ug/l**	**20600 ug/l**	**18300 ug/l**	**20300 ug/l**	**20400 ug/l**	**17800 ug/l**	**17100 ug/l**	**18400 ug/l**	**18300 ug/l**	**19300 ug/l**	**21600 ug/l**	--	--	**20800 ug/l**
Manganese	Dissolved	Lab	**188 ug/l**	**108 ug/l**	--	**129 ug/l**	--	--	--	--	**208 ug/l**	**208 ug/l**	**193 ug/l**	**195 ug/l**	**217 ug/l**	**213 ug/l**	**218 ug/l**	**210 ug/l**	--	--	**218 ug/l**
Manganese	Total	Lab	**280 ug/l**	**121 ug/l**	--	**140 ug/l**	--	**383 ug/l**	**366 ug/l**	**222 ug/l**	**279 ug/l**	**287 ug/l**	**207 ug/l**	**207 ug/l**	**222 ug/l**	**222 ug/l**	**339 ug/l**	**241 ug/l**	--	--	**225 ug/l**
Mercury	Total	Lab	**0.0009 ug/l**	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	**0.0008 b ug/l**	--	< 0.0005 ug/l	**0.0011 ug/l**	**0.0007 ug/l**	< 0.0005 ug/l	**0.0005 ug/l**	< 0.0005 ug/l	< 0.0005 ug/l	**0.0017 ug/l**	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l	< 0.00050 ug/l
Mercury methyl	Total	Lab	< 0.0001 ug/l	< 0.00003 ug/l	< 0.00003 ug/l	< 0.00003 ug/l	< 0.00003 ug/l	< 0.000056 ug/l	--	< 0.0001 ug/l	< 0.0001 ug/l	< 0.0001 ug/l	< 0.0001 ug/l	< 0.0001 ug/l	< 0.0001 ug/l	< 0.0001 ug/l	< 0.0001 ug/l	< 0.00003 ug/l	**0.00009 jb ug/l**	< 0.00003 ug/l	< 0.00003 ug/l
Molybdenum	Dissolved	Lab	**2.64 ug/l**	**1.6 ug/l**	--	**1.7 ug/l**	--	< 5 ug/l	< 5 ug/l	**0.91 ug/l**	**0.79 ug/l**	**0.8 ug/l**	**0.99 ug/l**	**0.94 ug/l**	**0.87 b ug/l**	**0.87 b ug/l**	**0.96 ug/l**	**0.74 ug/l**	--	--	**0.90 ug/l**
Molybdenum	Total	Lab	**0.76 ug/l**	**1.6 ug/l**	--	**1.8 ug/l**	--	< 5 ug/l	< 5 ug/l	**0.97 ug/l**	**0.58 ug/l**	**1.04 ug/l**	**0.94 ug/l**	**0.96 ug/l**	**0.86 ug/l**	**0.86 ug/l**	**0.29 ug/l**	**0.71 ug/l**	--	--	**0.85 ug/l**
Nickel	Dissolved	Lab	**8.31 ug/l**	**0.88 ug/l**	--	**0.82 ug/l**	--	**100 ug/l**	**158 ug/l**	**141 ug/l**	**118 ug/l**	**117 ug/l**	**122 ug/l**	**124 ug/l**	**128 ug/l**	**124 ug/l**	**104 ug/l**	**103 ug/l**	--	--	**98.2 ug/l**
Nickel	Total	Lab	**48.5 ug/l**	**1.6 ug/l**	--	**1.0 ug/l**	--	**128 ug/l**	**142 ug/l**	**160 ug/l**	**380 ug/l**	**409 ug/l**	**182 ug/l**	**171 ug/l**	**151 ug/l**	**154 ug/l**	**445 ug/l**	**123 ug/l**	--	--	**103 ug/l**
Palladium	Total	Lab	< 0.5 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	--	< 0.1 ug/l	--	< 0.30 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	--	--	< 0.50 ug/l
Platinum	Total	Lab	< 0.5 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	--	< 0.02 ug/l	--	< 0.30 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	--	--	< 0.50 ug/l
Potassium	Total	Lab	**1480 ug/l**	**1400 ug/l**	--	**1400 ug/l**	--	**2330 ug/l**	**2200 ug/l**	**1950 ug/l**	**3300 ug/l**	**3470 ug/l**	**1840 ug/l**	**1930 ug/l**	**1920 ug/l**	**1890 ug/l**	**1930 ug/l**	**2000 ug/l**	--	--	**1900 ug/l**
Selenium	Dissolved	Lab	< 1 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	--	< 2 ug/l	--	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1.0 ug/l	--	--	< 1.0 ug/l
Selenium	Total	Lab	< 1 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	--	< 2 ug/l	< 2 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1.0 ug/l	--	--	< 1.0 ug/l
Silver	Dissolved	Lab	< 0.2 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	--	< 1 ug/l	--	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	--	--	< 0.20 ug/l
Silver	Total	Lab	< 0.2 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	--	< 1 ug/l	< 1 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	--	--	< 0.20 ug/l
Sodium	Total	Lab	**6360 ug/l**	**8500 ug/l**	--	**7700 ug/l**	--	**6330 ug/l**	**6640 ug/l**	**7510 ug/l**	**7770 ug/l**	**7680 ug/l**	**7740 ug/l**	**7300 ug/l**	**7360 ug/l**	**7240 ug/l**	**7590 ug/l**	**7600 ug/l**	--	--	**7700 ug/l**
Strontium	Total	Lab	**61.6 ug/l**	**66.0 ug/l**	--	**62.9 ug/l**	--	**74.8 ug/l**	**75.5 ug/l**	**85.1 ug/l**	**92.3 ug/l**	**92.5 ug/l**	**84.4 ug/l**	**85.6 ug/l**	**84.6 ug/l**	**84.8 ug/l**	**93.8 ug/l**	**93.5 ug/l**	--	--	**92.0 ug/l**
Thallium	Total	Lab	< 0.2 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	--	< 2 ug/l	< 2 ug/l	< 0.4 ug/l	< 0.2 ug/l	**0.21 ug/l**	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	--	--	< 0.20 ug/l
Titanium	Total	Lab	< 10 ug/l	< 10.0 ug/l	--	< 10.0 ug/l	--	< 20 ug/l	< 20 ug/l	< 10 ug/l	**86 ug/l**	**101 ug/l**	**15 ug/l**	**13 ug/l**	< 10 ug/l	< 10 ug/l	**14 ug/l**	< 10.0 ug/l	--	--	< 10.0 ug/l
Vanadium	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	Dissolved	Lab	< 6 ug/l	< 6.0 ug/l	--	**6.7 ug/l**	--	< 25 ug/l	< 25 ug/l	**9.7 b ug/l**	< 6 ug/l	< 6 ug/l	**9.16 ug/l**	**9.69 ug/l**	< 6 ug/l	< 6 ug/l	**7.4 ug/l**	< 6.0 ug/l	--	--	< 6.0 ug/l
Zinc	Total	Lab	< 6 ug/l	< 6.0 ug/l	--	< 6.0 ug/l	--	< 25 ug/l	< 25 ug/l	**9.0 b ug/l**	**31.6 ug/l**	**44.6 ug/l**	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	**25 ug/l**	< 6.0 ug/l	--	--	< 6.0 ug/l

Large Table 4
Groundwater Data Summary
Mine Site Bedrock

Location			OB-3	OB-4		OB-4	OB-4	OB-4	OB-4	OB-4		OB-4	OB-4	OB-4		OB-5	OB-5		OB-5
Date			9/24/2013	10/4/2006		3/19/2009	5/5/2010	7/27/2010	10/6/2010	10/12/2011		9/25/2012	10/24/2012	9/23/2013		10/4/2006	3/19/2009		5/5/2010
Sample Type			N	N	FD	N	N	N	N	N	FD	N	N	N	FD	N	N	FD	N
	Fraction	Analysis Location																	
General Parameters																			
Alkalinity, bicarbonate, as CaCO3	NA	Lab	**88.9 mg/l**	--	--	--	**19 mg/l**	**25.9 mg/l**	**18.3 mg/l**	**16.9 mg/l**	**17 mg/l**	< 20.0 mg/l	--	**15.0 mg/l**	**14.1 mg/l**	--	--	--	**18.7 mg/l**
Alkalinity, carbonate, as CaCO3	NA	Lab	< 10.0 mg/l	< 10.0 mg/l	--	--	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 20.0 mg/l	--	< 10.0 mg/l	< 10.0 mg/l	--	--	--	< 10 mg/l
Alkalinity, total	NA	Lab	**88.9 mg/l**	**17.6 mg/l**	**17.6 mg/l**	**26.7 mg/l**	**19 mg/l**	**25.9 mg/l**	**18.3 mg/l**	**16.9 mg/l**	**17 mg/l**	< 20.0 mg/l	--	**15.0 mg/l**	**14.1 mg/l**	**25.5 mg/l**	**23.1 mg/l**	**24 mg/l**	**18.7 mg/l**
Biochemical Oxygen Demand (5-day)	NA	Lab	< 4.0 * mg/l	--	--	--	< 2.4 mg/l	< 2.4 mg/l	< 2.4 mg/l	< 3 mg/l	< 2.4 mg/l	< 3.0 mg/l	--	< 3.0 * mg/l	< 3.0 * mg/l	--	--	--	< 2.4 mg/l
Carbon, dissolved organic	NA	Lab	**2.6 mg/l**	--	--	--	**1.3 mg/l**	**1.3 mg/l**	**1.6 mg/l**	**2.7 mg/l**	**2.5 mg/l**	**1.8 mg/l**	--	**1.7 mg/l**	**1.7 mg/l**	--	--	--	**1.6 mg/l**
Carbon, total organic	NA	Lab	**2.6 mg/l**	**2.2 mg/l**	**1.9 mg/l**	**1.5 b mg/l**	**1.0 mg/l**	**1.3 mg/l**	**1.0 mg/l**	**2.2 mg/l**	**1.8 mg/l**	**1.6 mg/l**	--	**1.4 mg/l**	**1.4 mg/l**	**2.0 mg/l**	**2.0 b mg/l**	**2.0 b mg/l**	**1.6 mg/l**
Chemical Oxygen Demand	NA	Lab	**13.5 mg/l**	< 10 mg/l	< 10 mg/l	< 10 mg/l	**12.0 mg/l**	< 10 mg/l	< 10 mg/l	**30.5 mg/l**	**24.9 mg/l**	< 10.0 mg/l	--	**15.2 mg/l**	< 10.0 mg/l	< 10 mg/l	< 10 mg/l	**32.9 b mg/l**	**14.9 mg/l**
Chloride	NA	Lab	**1.0 mg/l**	**0.5 mg/l**	< 0.5 mg/l	< 0.5 mg/l	**0.77 b mg/l**	**0.61 mg/l**	**0.54 mg/l**	**0.66 mg/l**	**0.73 mg/l**	**0.74 mg/l**	--	**1.1 mg/l**	< 1.0 mg/l	< 0.5 mg/l	< 0.5 mg/l	< 0.5 mg/l	< 0.5 mg/l
Cyanide	NA	Lab	< 0.0100 mg/l	< 0.02 mg/l	< 0.02 mg/l	< 0.02 mg/l	< 0.0100 mg/l	< 0.02 mg/l	< 0.02 mg/l	< 0.0100 mg/l	< 0.0100 mg/l	< 0.0100 mg/l	--	**0.0105 mg/l**	< 0.0100 mg/l	< 0.02 mg/l	< 0.02 mg/l	< 0.02 mg/l	< 0.0100 mg/l
Dissolved oxygen	NA	Field	< 0.1 mg/l	**5.47 mg/l**	--	**1.34 mg/l**	**4.95 mg/l**	**7.00 mg/l**	**5.9 mg/l**	**8.7 mg/l**	--	**8.99 mg/l**	--	**9.23 mg/l**	--	**7.04 mg/l**	**7.07 mg/l**	--	**6.82 mg/l**
Fluoride	NA	Lab	**0.11 mg/l**	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.10 mg/l	--	< 0.10 mg/l	< 0.10 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l
Hardness, total, as CaCO3	NA	Lab	**145 mg/l**	**23.7 mg/l**	**24.1 mg/l**	**38.9 mg/l**	**37.7 mg/l**	**34.5 mg/l**	**34.7 mg/l**	**34.6 mg/l**	**30.7 mg/l**	**20.6 mg/l**	--	**18.2 mg/l**	**17.8 mg/l**	**30.7 mg/l**	**39.2 mg/l**	**38.6 mg/l**	**32.9 mg/l**
Nitrate + Nitrite, as N	NA	Lab	< 0.10 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	**0.15 mg/l**	**0.14 mg/l**	< 0.10 mg/l	--	< 0.10 mg/l	< 0.10 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l
Nitrogen, ammonia (NH3), as N	NA	Lab	< 0.10 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.05 mg/l	< 0.05 mg/l	< 0.05 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.10 mg/l	--	< 0.10 mg/l	< 0.10 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.05 mg/l
pH	NA	Lab	**8.0 pH units**	**6.1 pH units**	**5.7 pH units**	**6.4 pH units**	**6.4 pH units**	**6.7 pH units**	**6.5 pH units**	**6.5 pH units**	**5.6 pH units**	**6.7 pH units**	--	**7.1 pH units**	**7.1 pH units**	**6.0 pH units**	**6.3 pH units**	**6.5 pH units**	**6.6 pH units**
pH	NA	Field	**7.15 pH units**	**5.80 pH units**	--	**6.53 pH units**	**6.46 pH units**	**6.61 pH units**	**5.9 pH units**	**5.8 pH units**	--	**5.69 pH units**	--	**5.85 pH units**	--	**6.24 pH units**	**6.33 pH units**	--	**7.1 pH units**
Phosphorus, total	NA	Lab	**4.4 mg/l**	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg P/L	< 0.1 mg P/L	< 0.1 mg P/L	**0.19 mg P/L**	**0.15 mg P/L**	< 0.10 mg/l	--	< 0.10 mg/l	< 0.10 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg P/L
Redox (oxidation potential)	NA	Field	**86 mV**	**119 mV**	--	**401 mV**	**528 mV**	**464 mV**	**454 mV**	**399 mV**	--	**354 mV**	--	**643 mV**	--	**183 mV**	**428 mV**	--	**494 mV**
Solids, total dissolved	NA	Lab	**214 mg/l**	--	--	--	**63 mg/l**	**52 mg/l**	**74 mg/l**	**62 mg/l**	**62 mg/l**	**60.0 mg/l**	--	**51.0 mg/l**	**54.0 mg/l**	--	--	--	**129 mg/l**
Specific Conductance @ 25oC	NA	Field	**290.1 umhos/cm**	**49 umhos/cm**	--	**84 umhos/cm**	**117 umhos/cm**	**66 umhos/cm**	**69 umhos/cm**	**60 umhos/cm**	--	**40 umhos/cm**	--	**39.2 umhos/cm**	--	**45 umhos/cm**	**76 umhos/cm**	--	**92 umhos/cm**
Sulfate	NA	Lab	**66.3 mg/l**	< 1 * mg/l	**8.55 * mg/l**	**13.4 mg/l**	**14.6 mg/l**	**14.5 mg/l**	**14.7 mg/l**	**8.34 mg/l**	**8.43 mg/l**	**8.5 mg/l**	--	**8.2 mg/l**	**8.0 mg/l**	**8.24 mg/l**	**15.3 mg/l**	**15.2 mg/l**	**9.08 mg/l**
Temperature, degrees C	NA	Field	**8.58 deg C**	**8.0 deg C**	--	**5.1 deg C**	**6.9 deg C**	**7.55 deg C**	**10 deg C**	**8.7 deg C**	--	**8.3 deg C**	--	**7.4 deg C**	--	**8.3 deg C**	**4.2 deg C**	--	**4.6 deg C**
Turbidity	NA	Field	**7.9 NTU**	--	--	**27 NTU**	**202 NTU**	**11.2 NTU**	**5.8 NTU**	**216.9 NTU**	--	**0 NTU**	--	**0 NTU**	--	--	**35 NTU**	--	**4 NTU**
Metals																			
Aluminum	Dissolved	Lab	< 20.0 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 20.0 ug/l	--	< 20.0 ug/l	< 20.0 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l
Aluminum	Total	Lab	**20.9 ug/l**	**55.4 ug/l**	**62.1 ug/l**	**3600 ug/l**	**4570 ug/l**	**1680 ug/l**	**134 ug/l**	**4850 ug/l**	**3500 ug/l**	**48.9 ug/l**	--	< 20.0 ug/l	< 20.0 ug/l	**181 ug/l**	**1170 ug/l**	**1210 ug/l**	**3290 ug/l**
Antimony	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	Total	Lab	< 0.50 ug/l	< 3 ug/l	< 3 ug/l	**0.72 ug/l**	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	< 3 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l
Arsenic	Dissolved	Lab	**0.92 ug/l**	--	--	--	--	**2.47 ug/l**	< 1 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	--	--	--	--
Arsenic	Total	Lab	**1.1 ug/l**	< 2 ug/l	< 2 ug/l	**11 ug/l**	**2.64 ug/l**	**5.5 ug/l**	< 1 ug/l	**2.92 ug/l**	**2.3 ug/l**	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	**2.61 ug/l**
Barium	Dissolved	Lab	**2.1 ug/l**	--	--	--	--	--	--	--	--	**0.58 ug/l**	--	**0.64 ug/l**	**0.77 ug/l**	--	--	--	--
Barium	Total	Lab	**2.2 ug/l**	< 10 ug/l	< 10 ug/l	**14.4 ug/l**	**20.5 ug/l**	**6.45 ug/l**	**2.12 ug/l**	**32.4 ug/l**	**24 ug/l**	**0.75 ug/l**	--	**0.66 ug/l**	**0.64 ug/l**	< 10 ug/l	**5.2 ug/l**	**5.3 ug/l**	**19.6 ug/l**
Beryllium	Total	Lab	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l
Boron	Dissolved	Lab	< 50.0 ug/l	--	--	--	--	--	--	< 50 ug/l	< 50 ug/l	< 50.0 ug/l	--	< 50.0 ug/l	< 50.0 ug/l	--	--	--	--
Boron	Total	Lab	< 50.0 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50.0 ug/l	--	< 50.0 ug/l	< 50.0 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l
Cadmium	Dissolved	Lab	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l
Cadmium	Total	Lab	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	**0.31 ug/l**	**0.25 ug/l**	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l
Calcium	Total	Lab	**23600 ug/l**	**5400 ug/l**	**5480 ug/l**	**8060 ug/l**	**7520 ug/l**	**7640 ug/l**	**7790 ug/l**	**6210 ug/l**	**5910 ug/l**	**4700 ug/l**	--	**4200 ug/l**	**4100 ug/l**	**7660 ug/l**	**9590 ug/l**	**9430 ug/l**	**7190 ug/l**
Chromium	Dissolved	Lab	< 1.0 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	< 1.0 ug/l	< 1 ug/l	**1.2 b ug/l**	< 1 ug/l	< 1 ug/l
Chromium	Total	Lab	< 1.0 ug/l	< 1 ug/l	< 1 ug/l	**13.8 ug/l**	**15.9 ug/l**	**5.82 ug/l**	< 1 ug/l	**36.2 ug/l**	**24 ug/l**	< 1.0 ug/l	--	< 1.0 ug/l	< 1.0 ug/l	**2.2 ug/l**	**1.1 ug/l**	**3.1 ug/l**	**7.71 ug/l**
Cobalt	Dissolved	Lab	**4.8 ug/l**	--	--	--	--	--	--	--	--	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	--	--	--	--
Cobalt	Total	Lab	**5.1 ug/l**	< 1 ug/l	< 1 ug/l	**1.9 ug/l**	**1.76 ug/l**	**1.2 ug/l**	**0.24 ug/l**	**3.96 ug/l**	**2.92 ug/l**	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	< 1 ug/l	**0.98 ug/l**	**1.0 ug/l**	**2.55 ug/l**
Copper	Dissolved	Lab	< 0.50 ug/l	< 2 ug/l	< 2 ug/l	**2.0 b ug/l**	**0.98 ug/l**	**3.33 ug/l**	**1.25 ug/l**	**1.67 ug/l**	**0.97 ug/l**	**0.57 ug/l**	--	**0.52 ug/l**	**0.51 ug/l**	**2.3 ug/l**	**3.2 b ug/l**	**3.1 b ug/l**	**2.61 ug/l**
Copper	Total	Lab	**0.70 ug/l**	< 2 ug/l	< 2 ug/l	**8.6 b ug/l**	**9.06 ug/l**	**6.35 ug/l**	**1.34 ug/l**	**33.8 ug/l**	**27 ug/l**	**0.57 ug/l**	--	**0.57 ug/l**	**0.65 ug/l**	**3.6 ug/l**	**10.2 b ug/l**	**10.2 b ug/l**	**33.2 ug/l**
Iron	Dissolved	Lab	**3240 ug/l**	--	--	--	--	**56.8 ug/l**	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50.0 ug/l	--	< 50.0 ug/l	< 50.0 ug/l	--	--	--	--
Iron	Total	Lab	**4010 ug/l**	< 50 ug/l	< 50 ug/l	**4160 ug/l**	**5160 ug/l**	**2020 ug/l**	**168 ug/l**	**14400 ug/l**	**8860 ug/l**	**73.7 ug/l**	--	< 50.0 ug/l	< 50.0 ug/l	**548 ug/l**	**17200 ug/l**	**18900 ug/l**	**21900 ug/l**
Lead	Dissolved	Lab	< 0.50 ug/l	--	--	--	--	--	--	--	--	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	--	--	--	--
Lead	Total	Lab	< 0.50 ug/l	< 1 ug/l	< 1 ug/l	**0.58 ug/l**	**0.51 ug/l**	< 0.5 ug/l	< 0.5 ug/l	**1 ug/l**	**0.74 ug/l**	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	< 1 ug/l	**0.57 ug/l**	< 0.5 ug/l	**0.85 ug/l**
Magnesium	Total	Lab	**20800 ug/l**	**2480 ug/l**	**2520 ug/l**	**4550 ug/l**	**4590 ug/l**	**3750 ug/l**	**3710 ug/l**	**4650 ug/l**	**3880 ug/l**	**2100 ug/l**	--	**1900 ug/l**	**1800 ug/l**	**2810 ug/l**	**3710 ug/l**	**3670 ug/l**	**3620 ug/l**
Manganese	Dissolved	Lab	**218 ug/l**	--	--	--	**4.11 b ug/l**	**31.1 ug/l**	**4.72 ug/l**	< 10 ug/l	< 10 ug/l	**0.62 ug/l**	--	**0.52 ug/l**	**0.59 ug/l**	--	--	--	**14.3 ug/l**
Manganese	Total	Lab	**225 ug/l**	< 10 ug/l	< 10 ug/l	**56.6 ug/l**	**41.2 ug/l**	**36.4 ug/l**	**4.95 ug/l**	**92 ug/l**	**69.6 ug/l**	**1.0 ug/l**	--	**0.72 ug/l**	**0.76 ug/l**	< 10 ug/l	**20.6 b ug/l**	**22.2 b ug/l**	**78.5 ug/l**
Mercury	Total	Lab	< 0.00050 ug/l	**0.0009 b ug/l**	**0.0010 b ug/l**	**0.0008 ug/l**	**0.0007 ug/l**	**0.0007 ug/l**	**0.0006 ug/l**	**0.0037 ug/l**	**0.0032 ug/l**	< 0.00050 ug/l	< 0.00050 ug/l	**0.00067 ug/l**	**0.00068 ug/l**	**0.0049 ug/l**	**0.0009 ug/l**	**0.0012 ug/l**	**0.0022 ug/l**
Mercury methyl	Total	Lab	< 0.00003 ug/l	< 0.000056 ug/l	< 0.000056 ug/l	< 0.0001 ug/l	< 0.0001 ug/l	< 0.0001 ug/l	< 0.0001 ug/l	< 0.0001 ug/l	< 0.0001 ug/l	< 0.00003 ug/l	**0.00011 b ug/l**	< 0.00003 ug/l	< 0.00003 ug/l	< 0.000056 ug/l	< 0.0001 ug/l	< 0.0001 ug/l	< 0.0001 ug/l
Molybdenum	Dissolved	Lab	**0.90 ug/l**	< 5 ug/l	< 5 ug/l	**2.5 ug/l**	**0.27 ug/l**	**1.64 ug/l**	**0.39 ug/l**	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	--	< 0.30 ug/l	< 0.30 ug/l	< 5 ug/l	**0.22 ug/l**	**0.22 ug/l**	< 0.2 ug/l
Molybdenum	Total	Lab	**0.85 ug/l**	< 5 ug/l	< 5 ug/l	**3.3 ug/l**	**1.1 ug/l**	**1.94 ug/l**	**0.41 ug/l**	**0.45 ug/l**	**0.39 ug/l**	< 0.20 ug/l	--	< 0.30 ug/l	< 0.30 ug/l	< 5 ug/l	**0.9 ug/l**	**0.86 ug/l**	**0.74 ug/l**
Nickel	Dissolved	Lab	**98.2 ug/l**	< 2 ug/l	< 2 ug/l	**5.1 ug/l**	**1.34 ug/l**	**4.49 ug/l**	**2.32 ug/l**	**2.41 ug/l**	**2.05 ug/l**	**0.51 ug/l**	--	< 0.50 ug/l	< 0.50 ug/l	**5.9 ug/l**	**8.6 ug/l**	**8.3 ug/l**	**5.41 ug/l**
Nickel	Total	Lab	**103 ug/l**	< 2 ug/l	< 2 ug/l	**11.1 ug/l**	**8.25 ug/l**	**8.11 ug/l**	**2.29 ug/l**	**16.8 ug/l**	**12.6 ug/l**	**0.70 ug/l**	--	< 0.50 ug/l	< 0.50 ug/l	**4.6 ug/l**	**11.6 ug/l**	**12 ug/l**	**22.8 ug/l**
Palladium	Total	Lab	< 0.50 ug/l	< 0.1 ug/l	< 0.1 ug/l	< 0.30 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	< 0.1 ug/l	< 0.30 ug/l	< 0.30 ug/l	< 0.50 ug/l
Platinum	Total	Lab	< 0.50 ug/l	< 0.1 ug/l	< 0.1 ug/l	< 0.30 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	< 0.1 ug/l	< 0.30 ug/l	< 0.30 ug/l	< 0.50 ug/l
Potassium	Total	Lab	**1900 ug/l**	**980 ug/l**	**990 ug/l**	**2100 ug/l**	**2280 ug/l**	**1500 ug/l**	**1000 ug/l**	**3440 ug/l**	**2610 ug/l**	**750 ug/l**	--	**730 ug/l**	**710 ug/l**	**1260 ug/l**	**1320 ug/l**	**1320 ug/l**	**1760 ug/l**
Selenium	Dissolved	Lab	< 1.0 ug/l	< 2 ug/l	< 2 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	< 1.0 ug/l	< 2 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l
Selenium	Total	Lab	< 1.0 ug/l	< 10 ug/l	< 10 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	< 1.0 ug/l	< 10 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l
Silver	Dissolved	Lab	< 0.20 ug/l	< 1 ug/l	< 1 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	< 1 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l
Silver	Total	Lab	< 0.20 ug/l	< 1 ug/l	< 1 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	< 1 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l
Sodium	Total	Lab	**7700 ug/l**	< 2000 ug/l	< 2000 ug/l	**3330 ug/l**	< 2000 ug/l	**2920 ug/l**	< 2000 ug/l	< 2000 ug/l	< 2000 ug/l	**1300 ug/l**	--	**1200 ug/l**	**1200 ug/l**	< 2000 ug/l	< 2000 ug/l	< 2000 ug/l	< 2000 ug/l
Strontium	Total	Lab	**92.0 ug/l**	**18.5 ug/l**	**18.8 ug/l**	**20 ug/l**	**23.1 ug/l**	**18.6 ug/l**	**21.6 ug/l**	**23.9 ug/l**	**22.8 ug/l**	**17.6 ug/l**	--	**16.2 ug/l**	**16.1 ug/l**	**19.3 ug/l**	**30 ug/l**	**29.9 ug/l**	**26.8 ug/l**
Thallium	Total	Lab	< 0.20 ug/l	< 2 ug/l	< 2 ug/l	< 0.4 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	< 2 ug/l	< 0.4 ug/l	< 0.4 ug/l	< 0.2 ug/l
Titanium	Total	Lab	< 10.0 ug/l	< 20 ug/l	< 20 ug/l	**272 ug/l**	**340 ug/l**	**110 ug/l**	< 10 ug/l	**410 ug/l**	**220 ug/l**	< 10.0 ug/l	--	< 10.0 ug/l	< 10.0 ug/l	< 20 ug/l	**33.7 ug/l**	**37.1 ug/l**	**230 ug/l**
Vanadium	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	Dissolved	Lab	< 6.0 ug/l	< 25 ug/l	< 25 ug/l	**14.8 b ug/l**	< 6 ug/l	**21.9 ug/l**	< 6 ug/l	**6.6 ug/l**	< 6 ug/l	< 6.0 ug/l	--	< 6.0 ug/l	< 6.0 ug/l	< 25 ug/l	**23.4 b ug/l**	**13.3 b ug/l**	**9.31 ug/l**
Zinc	Total	Lab	< 6.0 ug/l	< 25 ug/l	< 25 ug/l	**18.9 b ug/l**	**15.3 ug/l**	**12.4 ug/l**	< 6 ug/l	**33.6 ug/l**	**24.6 ug/l**	< 6.0 ug/l	--	< 6.0 ug/l	< 6.0 ug/l	< 25 ug/l	**11.6 b ug/l**	**11.9 b ug/l**	**19.4 ug/l**

Large Table 4
Groundwater Data Summary
Mine Site Bedrock

		Location	OB-5	OB-5		OB-5	OB-5	OB-5	OB-5	P-1	P-2	P-2	P-2	P-2	P-2	P-3
		Date	7/27/2010	10/6/2010		10/12/2011	9/24/2012	10/24/2012	9/23/2013	1/5/2006	12/22/2005	10/24/2006	10/31/2006	11/7/2006	11/14/2006	1/5/2006
		Sample Type	N	N	FD	N	N	N	N	N	N	N	N	N	N	N
	Fraction	Analysis Location														
General Parameters																
Alkalinity, bicarbonate, as CaCO3	NA	Lab	**23.4 mg/l**	**25.8 mg/l**	**25.3 mg/l**	**25.2 mg/l**	**85.1 mg/l**	--	**20.1 mg/l**	--	--	--	--	--	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 20.0 mg/l	--	< 10.0 mg/l	--	--	--	--	--	--	--
Alkalinity, total	NA	Lab	**23.4 mg/l**	**25.8 mg/l**	**25.3 mg/l**	**25.2 mg/l**	**85.1 mg/l**	--	**20.1 mg/l**	< 10 mg/l	**98.5 mg/l**	**101 mg/l**	**105 mg/l**	**74 mg/l**	**108 mg/l**	**97.2 mg/l**
Biochemical Oxygen Demand (5-day)	NA	Lab	< 3 mg/l	< 2.4 mg/l	< 2.4 mg/l	< 6 mg/l	< 8.0 h mg/l	< 2.4 mg/l	< 3.0 * mg/l	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	**1.7 mg/l**	**2.1 mg/l**	**1.5 mg/l**	**2.7 mg/l**	**2.1 mg/l**	--	**1.8 mg/l**	--	--	--	--	--	--	--
Carbon, total organic	NA	Lab	**1.8 mg/l**	**1.3 mg/l**	**1.3 mg/l**	**2.7 mg/l**	**2.1 mg/l**	--	**1.4 mg/l**	**2.3 mg/l**	**2.4 mg/l**	**3.3 mg/l**	**3.9 mg/l**	**4.5 mg/l**	**5.3 mg/l**	**7.6 mg/l**
Chemical Oxygen Demand	NA	Lab	< 10 mg/l	< 10 mg/l	**14.2 mg/l**	**25.5 mg/l**	< 10.0 mg/l	--	**10.0 mg/l**	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	< 10 mg/l	**486 mg/l**
Chloride	NA	Lab	**0.63 mg/l**	< 0.5 mg/l	< 0.5 mg/l	**1.08 mg/l**	**0.53 mg/l**	--	< 1.0 mg/l	**6.6 mg/l**	**1.8 mg/l**	**1.29 mg/l**	**1.4 mg/l**	**1.35 mg/l**	**1.3 mg/l**	**2.1 mg/l**
Cyanide	NA	Lab	< 0.02 mg/l	< 0.02 mg/l	< 0.02 mg/l	< 0.0100 mg/l	**0.0126 mg/l**	--	**0.0253 mg/l**	< 0.02 mg/l	< 0.02 mg/l	< 0.02 mg/l	< 0.02 mg/l	< 0.02 mg/l	< 0.02 mg/l	< 0.02 * mg/l
Dissolved oxygen	NA	Field	**8.10 mg/l**	**7.2 mg/l**	--	**9.6 mg/l**	**9.15 mg/l**	--	**9.36 mg/l**	--	--	--	--	--	--	--
Fluoride	NA	Lab	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.10 mg/l	--	< 0.10 mg/l	**1.1 mg/l**	**0.53 mg/l**	**0.31 mg/l**	**0.15 mg/l**	**0.13 mg/l**	**0.37 mg/l**	**0.64 mg/l**
Hardness, total, as CaCO3	NA	Lab	**31.5 mg/l**	**35.2 mg/l**	**31 mg/l**	**40.6 mg/l**	**26.5 mg/l**	--	**24.6 mg/l**	**15 mg/l**	**56.5 mg/l**	**63.5 mg/l**	**68.6 mg/l**	**77.4 mg/l**	**82.9 mg/l**	**113 mg/l**
Nitrate + Nitrite, as N	NA	Lab	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	**0.18 mg/l**	< 0.10 mg/l	--	< 0.10 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l
Nitrogen, ammonia (NH3), as N	NA	Lab	< 0.05 mg/l	< 0.05 mg/l	< 0.05 mg/l	< 0.1 mg/l	< 0.10 mg/l	--	< 0.10 mg/l	< 0.1 mg/l	**0.27 mg/l**	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l
pH	NA	Lab	**7.0 pH units**	**6.8 pH units**	**6.6 pH units**	**6.9 pH units**	**6.8 pH units**	--	**7.3 pH units**	**8.5 pH units**	**7.8 pH units**	**7.7 pH units**	**7.1 pH units**	**8.4 pH units**	**7.5 pH units**	**6.6 pH units**
pH	NA	Field	**6.73 pH units**	**5.6 pH units**	--	**6.3 pH units**	**6.25 pH units**	--	**6.14 pH units**	--	--	--	--	--	--	--
Phosphorus, total	NA	Lab	< 0.1 mg P/L	< 0.1 mg P/L	< 0.1 mg P/L	**0.15 mg P/L**	< 0.10 mg/l	--	< 0.10 mg/l	< 0.1 mg/l	**0.11 mg/l**	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l
Redox (oxidation potential)	NA	Field	**460 mV**	**454 mV**	--	**333 mV**	**310 mV**	--	**598 mV**	--	--	--	--	--	--	--
Solids, total dissolved	NA	Lab	**51 mg/l**	**75 mg/l**	**69 mg/l**	**66 mg/l**	**69.0 mg/l**	--	**70.0 mg/l**	--	--	--	--	--	--	--
Specific Conductance @ 25oC	NA	Field	**51.4 umhos/cm**	**67 umhos/cm**	--	**70 umhos/cm**	**55.1 umhos/cm**	--	**53 umhos/cm**	--	--	--	--	--	--	--
Sulfate	NA	Lab	**9.97 mg/l**	**9.81 mg/l**	**9.77 mg/l**	**8.71 mg/l**	**10.1 mg/l**	--	**9.4 mg/l**	**1200 mg/l**	**10.5 mg/l**	**9.06 mg/l**	**7.88 mg/l**	**6.53 mg/l**	**5.76 mg/l**	**32.9 mg/l**
Temperature, degrees C	NA	Field	**8.06 deg C**	**11.0 deg C**	--	**10.0 deg C**	**10.11 deg C**	--	**8.73 deg C**	--	--	--	--	--	--	--
Turbidity	NA	Field	**54.2 NTU**	**18 NTU**	--	**1106.0 NTU**	**0 NTU**	--	**0 NTU**	--	--	--	--	--	--	--
Metals																
Aluminum	Dissolved	Lab	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 20.0 ug/l	--	< 20.0 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l
Aluminum	Total	Lab	**1460 ug/l**	**281 * ug/l**	**147 * ug/l**	**2480 ug/l**	< 20.0 ug/l	--	**24.3 ug/l**	**59.1 ug/l**	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l
Antimony	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	Total	Lab	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 3 ug/l	< 3 ug/l	< 3 ug/l	< 3 ug/l	< 3 ug/l	< 3 ug/l	< 3 ug/l
Arsenic	Dissolved	Lab	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 0.5 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	--	--	--	--	--	--	--
Arsenic	Total	Lab	**2.94 ug/l**	< 1 ug/l	< 1 ug/l	< 0.5 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	**2.2 ug/l**	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l
Barium	Dissolved	Lab	--	--	--	--	**1.7 ug/l**	--	**1.7 ug/l**	--	--	--	--	--	--	--
Barium	Total	Lab	**7.32 ug/l**	**3.18 ug/l**	**3.27 ug/l**	**20.4 ug/l**	**1.7 ug/l**	--	**1.7 ug/l**	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l
Beryllium	Total	Lab	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	**0.2 ug/l**	**0.2 ug/l**	< 0.2 ug/l	< 0.2 ug/l
Boron	Dissolved	Lab	--	--	--	< 50 ug/l	< 50.0 ug/l	--	< 50.0 ug/l	--	--	--	--	--	--	--
Boron	Total	Lab	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50.0 ug/l	--	< 50.0 ug/l	**518 ug/l**	**170 ug/l**	**194 ug/l**	**168 ug/l**	**153 ug/l**	**148 ug/l**	**76.3 ug/l**
Cadmium	Dissolved	Lab	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	**0.2 ug/l**	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l
Cadmium	Total	Lab	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	**0.54 ug/l**	< 0.20 ug/l	--	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l
Calcium	Total	Lab	**7430 ug/l**	**8120 ug/l**	**7240 ug/l**	**8900 ug/l**	**6300 ug/l**	--	**5900 ug/l**	**6200 ug/l**	**11600 ug/l**	**12800 ug/l**	**13500 ug/l**	**15500 ug/l**	**16700 ug/l**	**20400 ug/l**
Chromium	Dissolved	Lab	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l
Chromium	Total	Lab	**3.8 ug/l**	< 1 ug/l	< 1 ug/l	**9.7 ug/l**	< 1.0 ug/l	--	< 1.0 ug/l	**1.9 ug/l**	< 1 ug/l	< 1 ug/l	< 1 ug/l	**1.1 ug/l**	< 1 ug/l	**1.2 ug/l**
Cobalt	Dissolved	Lab	--	--	--	--	< 0.20 ug/l	--	< 0.20 ug/l	--	--	--	--	--	--	--
Cobalt	Total	Lab	**1.19 ug/l**	**0.23 ug/l**	< 0.2 ug/l	**5.49 ug/l**	< 0.20 ug/l	--	< 0.20 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l
Copper	Dissolved	Lab	**3.48 ug/l**	**3.47 ug/l**	**3.04 ug/l**	**1.73 ug/l**	**2.9 ug/l**	--	**3.0 ug/l**	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l
Copper	Total	Lab	**18.9 ug/l**	**3.48 ug/l**	**3.73 ug/l**	**46.3 ug/l**	**3.3 ug/l**	--	**3.5 ug/l**	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l
Iron	Dissolved	Lab	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50.0 ug/l	--	< 50.0 ug/l	--	--	--	--	--	--	--
Iron	Total	Lab	**19500 ug/l**	**756 * ug/l**	**521 * ug/l**	**35500 ug/l**	**140 b ug/l**	--	**181 ug/l**	**100 ug/l**	**140 ug/l**	**253 ug/l**	**271 ug/l**	**325 ug/l**	**351 ug/l**	**4370 ug/l**
Lead	Dissolved	Lab	--	--	--	--	< 0.50 ug/l	--	< 0.50 ug/l	--	--	--	--	--	--	--
Lead	Total	Lab	**0.94 b ug/l**	< 0.5 ug/l	< 0.5 ug/l	**1.31 ug/l**	< 0.50 ug/l	--	< 0.50 ug/l	< 1 ug/l	< 1 ug/l	< 5 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l
Magnesium	Total	Lab	**3140 ug/l**	**3630 ug/l**	**3150 ug/l**	**4470 ug/l**	**2600 ug/l**	--	**2400 ug/l**	< 2000 ug/l	**6700 ug/l**	**7670 ug/l**	**8480 ug/l**	**9410 ug/l**	**10000 ug/l**	**15000 ug/l**
Manganese	Dissolved	Lab	**9.65 ug/l**	**1.39 ug/l**	**1.21 ug/l**	**47.4 ug/l**	**1.0 ug/l**	--	**0.86 ug/l**	--	--	--	--	--	--	--
Manganese	Total	Lab	**32 ug/l**	**3.81 ug/l**	**2.87 ug/l**	**356 ug/l**	**1.4 b ug/l**	--	**1.3 ug/l**	**10 ug/l**	**20 ug/l**	**21.7 ug/l**	**23.6 ug/l**	**26.2 ug/l**	**27.3 ug/l**	**140 ug/l**
Mercury	Total	Lab	**0.0036 ug/l**	**0.0009 ug/l**	**0.0012 ug/l**	**0.0039 ug/l**	**0.00069 ug/l**	--	**0.00097 ug/l**	< 0.0005 ug/l	< 0.0005 ug/l	< 0.0005 ug/l	< 0.0005 ug/l	**0.0005 b ug/l**	< 0.0005 ug/l	< 0.0005 ug/l
Mercury methyl	Total	Lab	< 0.0001 ug/l	< 0.0001 ug/l	< 0.0001 ug/l	< 0.0001 ug/l	**0.00006 jb ug/l**	--	< 0.00003 ug/l	< 0.000025 ug/l	**0.000059 b ug/l**	< 0.000056 ug/l	**0.000070 ug/l**	< 0.000056 ug/l	< 0.000056 ug/l	< 0.000025 ug/l
Molybdenum	Dissolved	Lab	< 0.2 ug/l	**0.25 ug/l**	**0.22 ug/l**	< 0.2 ug/l	**0.23 ug/l**	--	< 0.30 ug/l	< 5 ug/l	< 5 ug/l	< 5 ug/l	< 5 ug/l	< 5 ug/l	< 5 ug/l	< 5 ug/l
Molybdenum	Total	Lab	**0.84 ug/l**	**0.23 ug/l**	**0.28 ug/l**	< 0.2 ug/l	**0.22 ug/l**	--	< 0.30 ug/l	< 5 ug/l	< 5 ug/l	< 5 ug/l	< 5 ug/l	< 5 ug/l	< 5 ug/l	< 5 ug/l
Nickel	Dissolved	Lab	**5.43 ug/l**	**5.43 ug/l**	**5.4 ug/l**	**4.38 ug/l**	**4.6 ug/l**	--	**4.6 ug/l**	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l
Nickel	Total	Lab	**12.3 ug/l**	**5.7 ug/l**	**5.88 ug/l**	**38.4 ug/l**	**4.8 ug/l**	--	**4.7 ug/l**	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l
Palladium	Total	Lab	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.1 ug/l	< 0.1 ug/l	< 0.1 ug/l	< 0.1 ug/l	< 0.1 ug/l	< 0.1 ug/l	**0.3 ug/l**
Platinum	Total	Lab	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.02 ug/l	< 0.02 ug/l	< 0.02 ug/l	< 0.02 ug/l	< 0.02 ug/l	< 0.02 ug/l	< 0.02 ug/l
Potassium	Total	Lab	**1250 ug/l**	**1260 ug/l**	**1120 ug/l**	**1660 ug/l**	**1000 ug/l**	--	**980 ug/l**	**1200 ug/l**	**1100 ug/l**	**1030 ug/l**	**1040 ug/l**	**1040 ug/l**	**1100 ug/l**	**2100 ug/l**
Selenium	Dissolved	Lab	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l
Selenium	Total	Lab	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	**4 ug/l**	< 2 ug/l	< 4 ug/l	< 2 ug/l
Silver	Dissolved	Lab	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l
Silver	Total	Lab	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l
Sodium	Total	Lab	< 2000 ug/l	< 2000 ug/l	< 2000 ug/l	< 2000 ug/l	**1500 ug/l**	--	**1500 ug/l**	**43900 ug/l**	**24300 ug/l**	**24400 ug/l**	**23200 ug/l**	**23300 ug/l**	**23900 ug/l**	**7500 ug/l**
Strontium	Total	Lab	**24.7 ug/l**	**23.7 ug/l**	**24.9 ug/l**	**41.3 ug/l**	**20.4 ug/l**	--	**19.3 ug/l**	**33.4 ug/l**	**37.9 ug/l**	**56.5 ug/l**	**60.7 ug/l**	**69.7 ug/l**	**74.9 ug/l**	**75.2 ug/l**
Thallium	Total	Lab	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l
Titanium	Total	Lab	**65 ug/l**	< 10 ug/l	< 10 ug/l	**65 ug/l**	< 10.0 ug/l	--	< 10.0 ug/l	< 10 ug/l	< 10 ug/l	< 20 ug/l	< 20 ug/l	< 20 ug/l	< 20 ug/l	< 10 ug/l
Vanadium	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	Dissolved	Lab	**15.2 ug/l**	--	--	**6.67 ug/l**	< 6.0 ug/l	--	< 6.0 ug/l	< 25 ug/l	< 10 ug/l	**59.1 ug/l**	**68.2 ug/l**	**134 ug/l**	**122 ug/l**	< 25 ug/l
Zinc	Total	Lab	**9.79 ug/l**	< 6 ug/l	< 6 ug/l	**19 ug/l**	< 6.0 ug/l	--	< 6.0 ug/l	**17.9 ug/l**	< 10 ug/l	**65.4 ug/l**	**67.7 ug/l**	**125 ug/l**	**122 ug/l**	**11.3 ug/l**

Large Table 4
Groundwater Data Summary
Mine Site Bedrock

		Location	P-4
		Date	12/22/2005
		Sample Type	N
	Fraction	Analysis Location	
General Parameters			
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--
Alkalinity, total	NA	Lab	**69.2 mg/l**
Biochemical Oxygen Demand (5-day)	NA	Lab	--
Carbon, dissolved organic	NA	Lab	--
Carbon, total organic	NA	Lab	**2.2 mg/l**
Chemical Oxygen Demand	NA	Lab	**17 mg/l**
Chloride	NA	Lab	< 0.5 mg/l
Cyanide	NA	Lab	< 0.02 mg/l
Dissolved oxygen	NA	Field	--
Fluoride	NA	Lab	**0.35 mg/l**
Hardness, total, as CaCO3	NA	Lab	**76.2 mg/l**
Nitrate + Nitrite, as N	NA	Lab	< 0.1 mg/l
Nitrogen, ammonia (NH3), as N	NA	Lab	**0.11 mg/l**
pH	NA	Lab	**8.1 pH units**
pH	NA	Field	--
Phosphorus, total	NA	Lab	< 0.1 mg/l
Redox (oxidation potential)	NA	Field	--
Solids, total dissolved	NA	Lab	--
Specific Conductance @ 25oC	NA	Field	--
Sulfate	NA	Lab	**14.1 mg/l**
Temperature, degrees C	NA	Field	--
Turbidity	NA	Field	--
Metals			
Aluminum	Dissolved	Lab	< 25 ug/l
Aluminum	Total	Lab	**57.2 ug/l**
Antimony	Dissolved	Lab	--
Antimony	Total	Lab	< 3 ug/l
Arsenic	Dissolved	Lab	--
Arsenic	Total	Lab	**5.7 ug/l**
Barium	Dissolved	Lab	--
Barium	Total	Lab	< 10 ug/l
Beryllium	Total	Lab	< 0.2 ug/l
Boron	Dissolved	Lab	
Boron	Total	Lab	**55 ug/l**
Cadmium	Dissolved	Lab	< 0.2 ug/l
Cadmium	Total	Lab	< 0.2 ug/l
Calcium	Total	Lab	**17700 ug/l**
Chromium	Dissolved	Lab	< 1 ug/l
Chromium	Total	Lab	< 1 ug/l
Cobalt	Dissolved	Lab	--
Cobalt	Total	Lab	< 1 ug/l
Copper	Dissolved	Lab	< 2 ug/l
Copper	Total	Lab	< 2 ug/l
Iron	Dissolved	Lab	--
Iron	Total	Lab	**190 ug/l**
Lead	Dissolved	Lab	--
Lead	Total	Lab	< 1 ug/l
Magnesium	Total	Lab	**7800 ug/l**
Manganese	Dissolved	Lab	--
Manganese	Total	Lab	**60 ug/l**
Mercury	Total	Lab	**0.0007 ug/l**
Mercury methyl	Total	Lab	< 0.000025 ug/l
Molybdenum	Dissolved	Lab	**28.9 ug/l**
Molybdenum	Total	Lab	**34.5 ug/l**
Nickel	Dissolved	Lab	< 2 ug/l
Nickel	Total	Lab	< 2 ug/l
Palladium	Total	Lab	< 0.1 ug/l
Platinum	Total	Lab	< 0.02 ug/l
Potassium	Total	Lab	**1700 ug/l**
Selenium	Dissolved	Lab	< 2 ug/l
Selenium	Total	Lab	< 2 ug/l
Silver	Dissolved	Lab	< 1 ug/l
Silver	Total	Lab	< 1 ug/l
Sodium	Total	Lab	**4400 ug/l**
Strontium	Total	Lab	**45.5 ug/l**
Thallium	Total	Lab	< 2 ug/l
Titanium	Total	Lab	< 10 ug/l
Vanadium	Dissolved	Lab	--
Zinc	Dissolved	Lab	< 10 ug/l
Zinc	Total	Lab	< 10 ug/l

Large Table 4
Groundwater Data Summary
Mine Site Bedrock

Data Qualifiers/Footnotes	
Qualifier	**Definition**
	Not used in December 2014 probabilistic modeling
--	Not analyzed/not available.
a	Estimated value, calculated using some or all values that are estimates.
b	Potential false positive value based on blank data validation procedures.
c	Coeluting compound.
e	Estimated value, exceeded the instrument calibration range.
f	Sample was collected at a flowrate exceeding the recommended rate of 200 mL/minute.
h	EPA recommended sample preservation, extraction or analysis holding time was exceeded.
i	Indeterminate value based on failure of blind duplicate data to meet quality assurance criteria.
j	Reported value is less than the stated laboratory quantitation limit and is considered an estimated value.
p	Relative percent difference is >40% (25% CLP pesticides) between primary and confirmation GC columns.
pp	Small peak in chromatogram below method detection limit.
r	The presence of the compound is suspect based on the ID criteria of the retention time and relative retention time obtained from the examination of the chromatograms.
s	Potential false positive value based on statistical analysis of blank sample data.
v	Sample was collected under a vacuum of greater than XX inches of mercury.
*	Estimated value, QA/QC criteria not met.
**	Unusable value, QA/QC criteria not met.
N	Sample Type: Normal
FD	Sample Type: Field Duplicate
AT	Sample chromatogram is noted to be atypical of a petroleum product.
DLND	Not detected, detection limit not determined.
DF	Did not flash
EMPC	Estimated maximum possible concentration.
NA – (Not applicable)	NA indicates that a fractional portion of the sample is not part of the analytical testing or field collection procedures.
ND	Not detected.
TIC	Tentatively identified compound
BQA	Barr-applied project specific qualifier: extraction and/or analyses conducted using an alternative method and/or procedure.
BQC	Barr-applied project specific qualifier: plant shut down.
BQD	Barr-applied project specific qualifier: equipment malfunction.
BQE	Barr-applied project specific qualifier: equipment adjustment.
BQM	Barr-applied project specific qualifier: manual measurement.
BQN	Barr-applied project specific qualifier: unable to be sampled or measured due to various reasons.
BQP	Barr-applied project specific qualifier: atypical chromatographic pattern.
BQQ	Barr-applied project specific qualifier: some aspect of QA/QC was not met.
BQR	Barr-applied project specific qualifier: location was re-sampled.
BQS	Barr-applied project specific qualifier: data is considered suspect.
BQT	Barr-applied project specific qualifier: summed value not displayed due to insufficient field length.
BQU	Barr-applied project specific qualifier: historical qualifier - definition unknown.
BQV	Barr-applied project specific qualifier: estimated value.
BQX	Barr-applied project specific qualifier: see notes for qualifier definition.
BQZ	Barr-applied project specific qualifier: data is considered unusable.

Large Table 5
Groundwater Data Analysis
Mine Site - Surficial Aquifer

	Units for Concentrations	Total Number of Samples	Number of Detects	Number of Non-Detects	Percent of Non-Detects	Minimum Concentration	Maximum Concentration	Mean Concentration
Alkalinity, bicarbonate, as CaCO3	**mg/l**	18	18	0	0.0%	15.8	75	38.42
Alkalinity, carbonate, as CaCO3	**mg/l**	18	0	18	100.0%	<10	<10	0
Alkalinity, total	**mg/l**	320	318	2	0.6%	<10	263	63.14
Biochemical Oxygen Demand (5-day)	**mg/l**	18	0	18	100.0%	<2.4	<4	0
Carbon, dissolved organic	**mg/l**	310	307	3	1.0%	<1	52.9	6.13
Carbon, total organic	**mg/l**	320	305	15	4.7%	<1	57.6	5.60
Chemical Oxygen Demand	**mg/l**	320	182	138	43.1%	6.9	433	25.45
Chloride	**mg/l**	320	173	147	45.9%	<0.5	13.2	0.82
Cyanide	**mg/l**	26	1	25	96.2%	<0.01	0.0371	0.0014
Dissolved oxygen	**mg/l**	315	298	17	5.4%	0.01	12.31	4.38
Fluoride	**mg/l**	320	82	238	74.4%	<0.1	0.52	0.11
Hardness, total, as CaCO3	**mg/l**	320	320	0	0.0%	10.3	164	66.24
Nitrogen, ammonia (NH3), as N	**mg/l**	320	97	223	69.7%	<0.05	3.5	0.26
Nitrate + Nitrite, as N	**mg/l**	320	171	149	46.6%	<0.1	2.7	0.28
pH	**pH units**	342	342	0	0.0%	4.95	10.41	7.06
Phosphorus, total	**mg/l**	27	14	13	48.2%	<0.1	1.75	0.25
Redox (oxidation potential)	**mV**	317	317	0	0.0%	-196.5	712	300.5
Solids, total dissolved	**mg/l**	311	310	1	0.3%	<10	6080	143.6
Specific Conductance @ 25oC	**umhos/cm**	318	318	0	0.0%	0	512	137.7
Sulfate	**mg/l**	320	310	10	3.1%	<1	104	9.05
Temperature	**deg C**	318	318	0	0.0%	1.25	25.09	9.34
Turbidity	**NTU**	310	310	0	0.00%	0	2530	48
Aluminum, dissolved	**mg/l**	320	135	185	57.8%	<0.02	0.91	0.070
Aluminum, total	**mg/l**	27	27	0	0.0%	0.316	32.3	5.751
Antimony, dissolved	**mg/l**	293	0	293	100.0%	<0.0005	<0.005	0
Antimony, total	**mg/l**	27	1	26	96.3%	<0.0005	<0.003	1.93E-05
Arsenic, dissolved	**mg/l**	308	140	168	54.6%	<0.0005	0.0067	0.0009199
Arsenic, total	**mg/l**	27	14	13	48.2%	<0.0005	0.00584	0.00185
Barium, dissolved	**mg/l**	1	1	0	0.0%	0.00282	0.00282	-
Barium, total	**mg/l**	320	318	2	0.6%	0.0024	0.615	0.0335
Beryllium, total	**mg/l**	320	25	295	92.2%	<0.0002	0.0016	0.00022
Boron, dissolved	**mg/l**	5	0	5	100.0%	<0.05	<0.05	0
Boron, total	**mg/l**	320	17	303	94.7%	<0.035	0.0994	0.0417
Cadmium, dissolved	**mg/l**	320	4	316	98.8%	<0.00003	<0.002	3.00E-06
Cadmium, total	**mg/l**	27	6	21	77.8%	<0.0002	0.00056	0.00025
Calcium, total	**mg/l**	320	320	0	0.0%	2.4	38.8	15.27
Chromium, dissolved	**mg/l**	320	92	228	71.3%	<0.001	<0.01	0.00133
Chromium, total	**mg/l**	27	19	8	29.6%	<0.001	0.055	0.0119
Cobalt, dissolved	**mg/l**	294	166	128	43.5%	<0.0002	0.0086	0.00093
Cobalt, total	**mg/l**	27	22	5	18.5%	<0.0002	0.023	0.00348
Copper, dissolved	**mg/l**	320	255	65	20.3%	<0.005	0.049	0.00266
Copper, total	**mg/l**	27	27	0	0.0%	0.0008	0.0996	0.0217
Iron, dissolved	**mg/l**	308	158	150	48.7%	<0.05	25.6	1.916
Iron, total	**mg/l**	27	27	0	0.0%	0.0543	44.4	6.98
Lead, dissolved	**mg/l**	1	0	1	100.0%	<0.0005	<0.0005	-
Lead, total	**mg/l**	320	77	243	75.9%	<0.0005	0.0167	0.001
Magnesium, total	**mg/l**	320	320	0	0.0%	0.89	18.9	6.828
Manganese, dissolved	**mg/l**	311	306	5	1.6%	<0.0005	3.28	0.287
Manganese, total	**mg/l**	27	26	1	3.7%	0.064	1.77	0.266
Mercury, total	**mg/l**	320	181	139	43.4%	<0.0000005	0.0000876	2.84E-06
Methyl Mercury, total	**mg/l**	26	6	20	76.9%	<0.000000025	5.20E-07	8.89E-08
Molybdenum, dissolved	**mg/l**	320	296	24	7.5%	<0.0002	3.59E-02	0.00209
Molybdenum, total	**mg/l**	27	24	3	11.1%	<0.0002	0.0356	0.00457
Nickel, dissolved	**mg/l**	320	231	89	27.8%	<0.0005	0.0205	0.00213
Nickel, total	**mg/l**	27	25	2	7.4%	0.00082	0.047	0.0107
Palladium, total	**mg/l**	27	0	27	100.0%	<0.0001	<0.025	0
Platinum, total	**mg/l**	27	0	27	100.0%	<0.00001	<0.025	0
Potassium, total	**mg/l**	320	320	0	0.0%	0.27	8.6	1.7
Selenium, dissolved	**mg/l**	320	2	318	99.4%	<0.0002	<0.01	1.93E-05
Selenium, total	**mg/l**	27	2	25	92.6%	0.00033	<0.002	3.41E-05
Silver, dissolved	**mg/l**	320	0	320	100.0%	<0.0002	<0.002	0
Silver, total	**mg/l**	27	0	27	100.0%	<0.0002	<0.002	0
Sodium, total	**mg/l**	320	318	2	0.6%	1.3	29.8	5.435
Strontium, total	**mg/l**	27	27	0	0.0%	0.0273	0.191	0.0533
Thallium, total	**mg/l**	320	16	304	95.0%	<0.00002	<0.002	0.000206
Titanium, total	**mg/l**	27	22	5	18.5%	<0.01	1.3	0.254
Vanadium, dissolved	**mg/l**	293	34	259	88.4%	<0.005	<0.05	0.00588
Zinc, dissolved	**mg/l**	320	61	259	80.9%	<0.006	<0.06	0.00686
Zinc, total	**mg/l**	27	13	14	51.9%	<0.006	0.645	0.0187

NOTE: For constituents with fewer than six detected concentrations and at least two samples, mean was calculated by assuming non-detects were zero

Large Table 6
Groundwater Data Anaylsis
Mine Site - Bedrock

	Units for Concentrations	Total Number of Samples	Number of Detects	Number of Non-Detects	Percent of Non-Detects	Minimum Concentration	Maximum Concentration	Mean Concentration
Alkalinity, bicarbonate, as CaCO3	mg/l	30	29	1	3.33%	15	115	57.57
Alkalinity, carbonate, as CaCO3	mg/l	30	0	30	100.00%	<10	<20	0
Alkalinity, total	mg/l	43	41	2	4.65%	<10	115	62.76
Biochemical Oxygen Demand (5-day)	mg/l	32	1	31	96.88%	<2.4	<8	0.13
Carbon, dissolved organic	mg/l	30	30	0	0.00%	1.3	3.9	2.15
Carbon, total organic	mg/l	43	43	0	0.00%	1	7.6	2.279
Chemical Oxygen Demand	mg/l	43	19	24	55.81%	<10	485	24.8
Chloride	mg/l	43	35	8	18.60%	<0.5	6.6	1.234
Cyanide	mg/l	42	5	37	88.10%	<0.01	0.0253	0.0018
Dissolved oxygen	mg/l	40	38	2	5.00%	0.03	9.6	3.892
Fluoride	mg/l	43	24	19	44.19%	<0.10	1.1	0.178
Hardness, total, as CaCO3	mg/l	43	43	0	0.00%	15	151	73.14
Nitrogen, ammonia (NH3), as N	mg/l	43	9	34	79.07%	<0.05	0.27	0.075
Nitrate + Nitrite, as N	mg/l	43	4	39	90.70%	<0.10	0.18	0.0146
pH	pH units	88	88	0	0.00%	5.6	10.4	7.382
Phosphorus, total	mg/l	43	6	37	86.05%	<0.10	4.4	0.905
Redox (oxidation potential)	mV	40	40	0	0.00%	-148	643	265
Solids, total dissolved	mg/l	30	30	0	0.00%	51	214	106.9
Specific Conductance @ 25oC	umhos/cm	40	40	0	0.00%	39.2	440	155.2
Sulfate	mg/l	43	43	0	0.00%	4.53	1200	45.77
Temperature	deg C	40	40	0	0.00%	4.2	11	7.519
Turbidity	NTU	25	25	0	0.00%	1	1106	98
Aluminum, dissolved	mg/l	49	6	43	87.76%	<0.02	0.127	0.0493
Aluminum, total	mg/l	49	38	11	22.45%	<0.02	6.95	0.893
Antimony, total	mg/l	49	4	45	91.84%	<0.0005	<0.003	4.82E-05
Arsenic, dissolved	mg/l	25	7	18	72.00%	<0.0005	0.00247	0.0008103
Arsenic, total	mg/l	49	22	27	55.10%	<0.0005	0.0241	0.00245
Barium, dissolved	mg/l	11	11	0	0.00%	0.00058	0.0037	0.00144
Barium, total	mg/l	49	35	14	28.57%	0.00066	0.0324	0.00603
Beryllium, total	mg/l	49	3	46	93.88%	<0.0002	0.00036	1.55E-05
Boron, dissolved	mg/l	15	2	13	86.67%	<0.05	0.0659	0.0081
Boron, total	mg/l	49	10	39	79.59%	<0.05	0.518	0.0771
Cadmium, dissolved	mg/l	48	3	45	93.75%	<0.0002	0.00092	2.83E-05
Cadmium, total	mg/l	49	4	45	91.84%	<0.0002	0.048	0.00100
Calcium, total	mg/l	49	49	0	0.00%	4.2	32.5	14.73
Chromium, dissolved	mg/l	48	2	46	95.83%	<0.001	0.0012	4.79E-05
Chromium, total	mg/l	49	23	26	53.06%	<0.001	0.0362	0.00301
Cobalt, dissolved	mg/l	11	4	7	63.64%	<0.002	0.005	0.000953
Cobalt, total	mg/l	49	31	18	36.73%	<0.0002	0.0233	0.00248
Copper, dissolved	mg/l	49	29	20	40.82%	<0.0005	<0.005	0.00136
Copper, total	mg/l	49	36	13	26.53%	<0.0005	0.0463	0.00742
Iron, dissolved	mg/l	25	11	14	56.00%	<0.05	3.24	0.651
Iron, total	mg/l	49	47	2	4.08%	<0.05	44.3	7.162
Lead, dissolved	mg/l	11	0	11	100.00%	<0.0005	<0.0005	0
Lead, total	mg/l	49	10	39	79.59%	<0.0005	<0.005	0.00064
Magnesium, total	mg/l	49	48	1	2.04%	1.9	21.6	9.255
Manganese, dissolved	mg/l	30	28	2	6.67%	0.00052	0.218	0.0812
Manganese, total	mg/l	49	46	3	6.12%	0.00072	0.383	0.111
Mercury, total	mg/l	51	25	26	50.98%	<0.0000005	4.90E-06	9.52E-07
Methyl Mercury, total	mg/l	51	5	46	90.20%	<0.000000025	1.10E-07	7.63E-09
Molybdenum, dissolved	mg/l	49	29	20	40.82%	<0.0002	0.0289	0.00163
Molybdenum, total	mg/l	49	32	17	34.69%	<0.0002	0.0345	0.00181
Nickel, dissolved	mg/l	49	37	12	24.49%	<0.0005	0.158	0.0241
Nickel, total	mg/l	49	38	11	22.45%	<0.0005	0.445	0.0435
Palladium, total	mg/l	48	1	47	97.92%	<0.0001	<0.0005	6.25E-06
Platinum, total	mg/l	48	0	48	100.00%	<0.00002	<0.0005	0
Potassium, total	mg/l	49	49	0	0.00%	0.73	3.44	1.611
Selenium, dissolved	mg/l	48	0	48	100.00%	<0.001	<0.002	0
Selenium, total	mg/l	49	1	48	97.96%	<0.001	<0.01	8.33E-05
Silver, dissolved	mg/l	48	0	48	100.00%	<0.0002	<0.001	0
Silver, total	mg/l	49	0	49	100.00%	<0.0002	<0.001	0
Sodium, total	mg/l	49	39	10	20.41%	1.2	43.9	8.086
Strontium, total	mg/l	49	49	0	0.00%	0.0162	0.112	0.0557
Thallium, total	mg/l	49	0	49	100.00%	<0.0002	<0.002	0
Titanium, total	mg/l	49	16	33	67.35%	<0.001	0.41	0.0555
Zinc, dissolved	mg/l	48	19	29	60.42%	<0.006	0.134	0.0154
Zinc, total	mg/l	49	21	28	57.14%	<0.006	0.125	0.0187

NOTE: For constituents with fewer than six detected concentrations and at least two samples, mean was calculated by assuming non-detects were zero

Large Table 7
Regional Groundwater Monitoring Data
USGS Copper-Nickel Study

			Station Number	473528091385101	473823091323501	473856091340801		474111091471401		474637091423401	474713091430001		474728091421001
			Sample Date	10/19/1976	10/19/1976	11/30/1976	7/24/1977	11/30/1976	7/26/1977	7/24/1977	11/30/1976	7/23/1977	7/24/1977
Chemical Name	Total or Dissolved	Units											
General Parameters													
Alkalinity as CaCO3	--	mg/L		57	101	53	--	167	--	--	72	--	--
Chloride	Dissolved	mg/L		5.8	1	4.2	--	1.1	--	--	0.7	--	--
Fluoride	Dissolved	mg/L		0.3	0.1	0.7	--	0	--	--	0.1	--	--
Hardness (CA, MG)	--	mg/L		80	100	71	--	130	--	--	68	--	--
pH, standard units	NA	--		6.4	6.4	6.7	6.6	6.2	6.2	5.4	6.4	6.6	7.1
Specific Conductance umhos@ 25oC	NA	umho/cm		170	210	170	--	350	--	--	190	--	--
Sulfate	Dissolved	mg/L		10	7.5	9.4	--	6.7	--	--	8.6	--	--
Metals													
Aluminum	Dissolved	ug/L		30	0	10	--	70	--	--	40	--	--
Cadmium	Dissolved	ug/L		0.04	0.49	--	0.75	--	0.27	0.2	--	0.99	0.2
Calcium	Dissolved	mg/L		22	27	16	--	19	--	--	15	--	--
Chromium	Dissolved	ug/L		0.2	0.2	--	1.1	--	2.1	16	--	0.2	1.4
Cobalt	Dissolved	ug/L		0.5	0.15	--	0.15	--	4.2	6	--	0.15	1.9
Copper	Dissolved	ug/L		1.1	13	--	3.2	--	4.1	4.5	--	2.8	3.1
Iron	Dissolved	ug/L		10	10	140	--	2400	--	--	10	--	--
Lead	Dissolved	ug/L		0.3	0.5	--	0.9	--	3.6	2	--	1	0.9
Magnesium	Dissolved	mg/L		6	8.7	7.5	--	21	--	--	7.4	--	--
Manganese	Dissolved	ug/L		90	40	20	-9999	520	-9999	-9999	10	-9999	-9999
Nickel	Dissolved	ug/L		<1	2	-9999	2	-9999	12	22	-9999	3	9
Potassium	Dissolved	mg/L		0.8	0.9	1.2	--	1.1	--	--	2.2	--	--
Silver	Dissolved	ug/L		<0.05	<0.05	-9999	<0.05	-9999	<0.05	<0.05	-9999	<0.05	<0.05
Sodium	Dissolved	mg/L		3	3.8	3.2	--	5	--	--	5.6	--	--
Zinc	Dissolved	ug/L		100	620	--	5.5	--	13	14	--	6.8	3.9

Large Table 7
Regional Groundwater Monitoring Data
USGS Copper-Nickel Study

	Station Number		474843091431901		474911091375501	474957091403001		474957091403002		474957091403101		471617092123701	471619092121701
	Sample Date		11/30/1976	7/24/1977	7/22/1977	11/30/1976	7/24/1977	11/30/1976	7/24/1977	11/30/1976	7/24/1977	11/29/1976	10/26/1976
Chemical Name	Total or Dissolved	Units											
General Parameters													
Alkalinity as CaCO3	--	mg/L	--	--	--	112	--	200	--	160	--	87	85
Chloride	Dissolved	mg/L	--	--	--	5	--	4.7	--	1.5	--	2.9	3.9
Fluoride	Dissolved	mg/L	--	--	--	0	--	0.1	--	0.1	--	0.1	0.1
Hardness (CA, MG)	--	mg/L	240	--	--	450	--	640	--	170	--	91	95
pH, standard units	NA	--	--	6.1	6.8	5.6	5.6	6.9	7.4	7	7	6.5	6.3
Specific Conductance umhos@ 25oC	NA	umho/cm	--	--	--	990	--	1250	--	360	--	220	180
Sulfate	Dissolved	mg/L	--	--	--	340	--	450	--	6.1	--	6.2	8.5
Metals													
Aluminum	Dissolved	ug/L	6	--	--	30	--	20	--	20	--	20	0
Cadmium	Dissolved	ug/L	--	0.54	0.48	--	6.2	--	1.2	--	0.14	--	8.4
Calcium	Dissolved	mg/L	58	--	--	71	--	150	--	39	--	22	24
Chromium	Dissolved	ug/L	--	0.7	1.7	--	<0.1	--	0.3	--	0.4	--	0.1
Cobalt	Dissolved	ug/L	--	23	1.8	--	530	--	12	--	0.4	--	1.3
Copper	Dissolved	ug/L	--	5	15	--	2700	--	5.5	--	2.2	--	1.8
Iron	Dissolved	ug/L	120	--	--	90	--	20	--	220	--	10	10
Lead	Dissolved	ug/L	--	0.7	2.4	--	0.1	--	0.3	--	1.6	--	0.2
Magnesium	Dissolved	mg/L	23	--	--	65	--	64	--	17	--	8.8	8.5
Manganese	Dissolved	ug/L	20000	-9999	--	5600	--	7000	--	260	--	280	330
Nickel	Dissolved	ug/L	-9999	23	6	--	20	--	15	--	7	--	3
Potassium	Dissolved	mg/L	2.8	--	--	5.2	--	9	--	2.4	--	1.3	1.6
Silver	Dissolved	ug/L	-9999	<0.05	<0.05	--	<0.05	--	0.05	--	<0.05	--	<0.05
Sodium	Dissolved	mg/L	3.3	--	--	13	--	15	--	7.4	--	2.8	3.9
Zinc	Dissolved	ug/L	--	14	29	--	130	--	6.3	--	6.5	--	9.6

Large Table 7
Regional Groundwater Monitoring Data
USGS Copper-Nickel Study

			Station Number	471629091505401	471921092091801	472218092092201		472221092092401	472254091543601	472626092084501	472842092023001	472912092032201	473151091583701	
			Sample Date	10/19/1976	10/18/1976	11/29/1976	7/25/1977	10/20/1976	10/19/1976	10/18/1976	7/25/1977	10/18/1976	11/30/1976	7/25/1977
Chemical Name	Total or Dissolved	Units												
General Parameters														
Alkalinity as CaCO3	--	mg/L		80	38	105	--	107	116	77	--	112	63	--
Chloride	Dissolved	mg/L		0.6	7.5	0.9	--	1.4	0.5	0.6	--	1.2	0.8	--
Fluoride	Dissolved	mg/L		0.3	0.1	0.1	--	0.1	0.4	0.3	--	0.1	0.1	--
Hardness (CA, MG)	--	mg/L		83	55	130	--	140	110	86	--	110	110	--
pH, standard units	NA	--		6.8	6.4	7.2	7.3	6.5	7.7	7.5	6	7.9	7	6.7
Specific Conductance umhos@ 25oC	NA	umho/cm		160	125	285	--	245	220	180	--	220	285	--
Sulfate	Dissolved	mg/L		4.8	6.8	24	--	29	1.8	12	--	3.5	57	--
Metals														
Aluminum	Dissolved	ug/L		30	0	20	--	10	20	10	--	10	0	--
Cadmium	Dissolved	ug/L		0.02	0.31	--	0.31	1.7	0.04	0.03	0.18	0.02	--	0.71
Calcium	Dissolved	mg/L		22	14	39	--	43	19	19	--	17	24	--
Chromium	Dissolved	ug/L		0.2	0.1	--	1.2	1.4	0.4	0.2	0.4	0.2	--	0.4
Cobalt	Dissolved	ug/L		0.5	0.4	--	0.3	0.7	0.6	0.7	<.3	0.3	--	<.3
Copper	Dissolved	ug/L		2.7	2	--	0.8	5.2	0.6	1.4	4.1	190	--	6
Iron	Dissolved	ug/L		10	10	110	--	280	20	10	--	10	0	--
Lead	Dissolved	ug/L		0.2	0.7	--	2.8	1.4	0.2	0.3	2.3	0.2	--	4.1
Magnesium	Dissolved	mg/L		6.9	4.8	7.3	--	8.1	14	9.4	--	17	13	--
Manganese	Dissolved	ug/L		110	200	80	--	320	70	40	--	140	660	--
Nickel	Dissolved	ug/L		1	<1	--	2	2	1	<1	4	<1	--	7
Potassium	Dissolved	mg/L		0.9	1	1.2	--	1.4	1.1	1.8	--	1.3	2.4	--
Silver	Dissolved	ug/L		<0.05	<0.05	--	<0.05	<0.05	0.08	<0.05	<0.05	<0.05	--	0.21
Sodium	Dissolved	mg/L		2.7	2.6	2.1	--	2.9	7.9	4.8	--	3.5	6.4	--
Zinc	Dissolved	ug/L		53	270	--	5	15	170	8.8	4.4	57	--	13

Large Table 7
Regional Groundwater Monitoring Data
USGS Copper-Nickel Study

Station Number			473311092045901		473501091552301	473557091512901		473946091492701	474046091513201		474107091401901		474253091574101
Sample Date			11/29/1976	7/25/1977	7/25/1977	11/30/1976	7/25/1977	11/30/1976	11/30/1976	7/26/1977	11/30/1976	7/26/1977	11/30/1976
Chemical Name	Total or Dissolved	Units											
General Parameters													
Alkalinity as CaCO3	--	mg/L	98	--	--	12	--	56	21	--	148	--	70
Chloride	Dissolved	mg/L	0.6	--	--	2	--	0.9	8.6	--	1.4	--	18
Fluoride	Dissolved	mg/L	0.1	--	--	0	--	0	0.1	--	0.1	--	0
Hardness (CA, MG)	--	mg/L	100	--	--	26	--	68	61	--	150	--	110
pH, standard units	NA	--	6.2	6.3	5.9	5.8	6.5	6.5	6.4	6.7	5.9	5.9	6.1
Specific Conductance umhos@ 25oC	NA	umho/cm	260	--	--	55	--	180	130	--	281	--	275
Sulfate	Dissolved	mg/L	14	--	--	10	--	14	34	--	4.5	--	6.5
Metals													
Aluminum	Dissolved	ug/L	10	--	--	280	--	10	4	--	0	--	0
Cadmium	Dissolved	ug/L	--	0.75	0.18	--	0.57	--	--	0.24	--	0.27	--
Calcium	Dissolved	mg/L	16	--	--	6.3	--	15	13	--	15	--	24
Chromium	Dissolved	ug/L	--	0.5	0.7	--	0.9	--	--	0.4	--	1.2	--
Cobalt	Dissolved	ug/L	--	1	<.3	--	0.6	--	--	<.3	--	10	--
Copper	Dissolved	ug/L	--	1.9	5.9	--	10	--	--	12	--	25	--
Iron	Dissolved	ug/L	20	--	--	230	--	30	80	--	26000	--	0
Lead	Dissolved	ug/L	--	1.2	4.2	--	5.3	--	--	1.1	--	13	--
Magnesium	Dissolved	mg/L	15	--	--	2.6	--	7.4	6.9	--	27	--	12
Manganese	Dissolved	ug/L	120	--	--	40	--	50	210	--	930	--	30
Nickel	Dissolved	ug/L	--	15	9	--	5	--	--	7	--	40	--
Potassium	Dissolved	mg/L	2.1	--	--	0.4	--	0.9	2.3	--	0.6	--	1.2
Silver	Dissolved	ug/L	--	<0.05	<0.05	--	<0.05	--	--	<0.05	--	<0.05	--
Sodium	Dissolved	mg/L	6.9	--	--	2.9	--	2.9	3.3	--	2	--	5.8
Zinc	Dissolved	ug/L	--	11	4.1	--	13	--	--	6.8	--	17	--

Large Table 8
Regional Groundwater Monitoring Data
MPCA Dataset (Uncensored Values)

		Well ID	129005	140851	189460	194529	414160	438784	454647	459477	463460	473065	486831	509005	509475
		Sample Date	8/20/1996	8/24/1995	8/3/1995	7/12/1995	6/5/1996	9/14/1995	7/27/1995	6/5/1996	7/26/1995	8/14/1995	8/22/1995	6/14/1995	8/22/1995
Chemical Name	Total or Dissolved	Units													
General Parameters															
Alkalinity, total	NA	mg/L	**107**	**106**	154	**31**	**150**	**164**	**103**	**95**	**205**	**137**	**217**	**102**	**290**
Bromide	NA	ug/L	<0.20	<0.2000	<0.2000	<0.2000	<0.20	<0.2000	<0.2000	<0.20	<0.2000	<0.2000	<0.2000	<0.2000	<0.2000
Carbon, total organic	NA	mg/L	**1.5**	**1.5000**	**0.7000**	**1.6000**	**3.6**	**2.3000**	**6.7000**	**1.3**	**1.1000**	**1.4000**	**15.1000**	**0.6000**	**2.6000**
Chloride	NA	mg/L	**0.46**	**0.8700**	**8.4800**	**2.5300**	**2.84**	**16.3400**	**0.5000**	**6.61**	**0.3300**	**0.4900**	**0.3400**	**0.5100**	**2.0200**
Fluoride	NA	mg/L	**0.29**	**0.4200**	**0.2210**	<0.2000	**0.62**	**0.2200**	<0.2000	<0.20	**0.2500**	<0.2000	**0.3700**	**0.3300**	**0.5500**
Nitrate (as N)	NA	mg/L	<0.5	<0.5000	<0.5000	**0.6000**	<0.5	<0.5000	<0.5000	<0.5	<0.5000	<0.5000	<0.5000	<0.5000	<0.5000
Phosphorus, total	NA	mg/L	**0.0171**	**0.0358**	**0.0344**	**0.0197**	**0.0198**	**0.4405**	**0.1818**	<0.0140	**0.0384**	**0.0217**	**0.0767**	**0.0344**	**0.0720**
Phosphorus, total as P	NA	mg/L	<0.02	<0.0200	<0.0200	<0.0200	**0.02**	**1.0200**	**0.1300**	<0.02	**0.0200**	<0.0200	**0.0600**	<0.0200	**0.0400**
Solids, total dissolved	NA	mg/L	**154**	**166.0000**	**268.0000**	**68.0000**	**206**	**250.0000**	**142.0000**	**186**	**230.0000**	**168.0000**	**272.0000**	**128.0000**	**344.0000**
Solids, total suspended	NA	mg/L	**1**	**2.0000**	**2.0000**	**6.0000**	**7**	**26.0000**	**30.0000**	**2**	**4.0000**	**12.0000**	**22.0000**	**4.0000**	**2.0000**
Sulfate (as S)	NA	mg/L	**3.08**	**4.0900**	**5.7200**	**1.6500**	**5.12**	**4.8600**	<0.1000	**5.69**	**0.8000**	**2.5300**	<0.1000	**3.4800**	<0.0100
Sulfur	NA	mg/L	**3.2761**	**4.2472**	**6.7300**	**1.7545**	**5.1742**	**5.0587**	**0.1000**	**5.6978**	**1.2007**	**2.6112**	**0.1880**	**3.8452**	**0.1597**
pH, standard units	NA	--	**7.96**	**8.20**	**7.60**	**6.10**	**7.99**	**7.90**	**6.90**	**7.03**	**7.50**	**7.10**	**7.30**	**8.40**	**7.80**
Dissolved oxygen	NA	mg/L	**0.07**	**0.04**	**0.10**	**5.94**	**0.15**	**0.16**	**0.05**	**0.12**	**0.12**	**0.50**	**0.04**	**0.00**	**0.06**
Redox (oxidation potential)	NA	mV	**-207**	**-86**	**0**	**57**	**-210**	**-35**	**-71**	**-47**	**-81**	**42**	**-120**	**-251**	**40**
Specific Conductance mmhos@ 25oC	NA	mmho/cm	**0.235**	**0.238**	**0.002**	**0.089**	**0.331**	**0.405**	**0.205**	**0.260**	**0.354**	**0.282**	**0.409**	**0.211**	**0.544**
Temperature, degrees C	NA	C	**8.30**	**8.10**	**8.40**	**5.80**	**7.40**	**8.00**	**9.70**	**8.20**	**8.10**	**7.90**	**5.90**	**10.90**	**8.50**
Metals															
Aluminum	Total	ug/L	**18.15**	**1.0200**	**2.7100**	**6.4200**	**104.84**	**756.4600**	**232.8100**	**6.49**	**0.9800**	<0.0600	**2.3000**	**3.3400**	**1.5900**
Antimony	Total	ug/L	<0.008	**0.0100**	**0.0800**	**0.0200**	<0.008	**0.0300**	**0.0100**	**0.015**	<0.0080	<0.0080	**0.0200**	**0.0200**	**0.0200**
Arsenic	Total	ug/L	**0.76**	**2.4000**	<0.0600	**0.1700**	**2.41**	**6.1400**	<0.0600	**0.09**	**3.2800**	**1.8100**	**2.1900**	**2.1500**	**2.5100**
Barium	Total	mg/L	**0.0152**	**0.0228**	**0.0952**	**0.0066**	**0.0249**	**0.1447**	**0.1325**	**0.0750**	**0.0854**	**0.0281**	**0.0882**	**0.0692**	**0.0354**
Beryllium	Total	ug/L	**0.02**	**0.0100**	<0.0100	**0.1200**	**0.02**	**0.0600**	**0.0800**	<0.01	**0.0100**	**0.0100**	**0.0400**	**0.0100**	<0.0100
Bismuth	Total	ug/L	<0.01	<0.0400	--	--	**0.02**	<0.0400	--	<0.01	--	<0.0400	<0.0400	--	<0.0400
Boron	Total	mg/L	**0.0151**	**0.0378**	**0.0128**	**0.0076**	**0.0490**	**0.0276**	**0.0156**	**0.0090**	**0.0171**	**0.0178**	**0.0540**	**0.0359**	**0.0654**
Cadmium	Total	ug/L	**0.05**	<0.0200	**0.0700**	**0.0500**	**0.13**	**0.1900**	<0.0200	**0.11**	<0.0200	<0.0200	<0.0200	**0.0800**	<0.0200
Calcium	Total	mg/L	**29.2073**	**22.1894**	**47.8952**	**8.9034**	**32.3460**	**57.0155**	**21.7521**	**40.8742**	**58.4738**	**36.8787**	**51.9492**	**25.4609**	**47.1687**
Cesium	Total	ug/L	<0.01	<0.0100	--	--	<0.01	**0.0600**	--	<0.01	--	<0.0100	<0.0100	--	**0.2700**
Chromium	Total	ug/L	**0.17**	<0.0500	**0.2200**	**0.8600**	**0.35**	**5.0300**	**2.5700**	**0.08**	**0.0800**	<0.0500	**0.4400**	**0.4500**	<0.0500
Cobalt	Total	ug/L	**0.156**	**0.1200**	**0.4300**	**0.0900**	**0.339**	**1.8700**	**0.5800**	**0.779**	**0.3600**	**1.1400**	**0.3200**	**0.1000**	**0.3000**
Copper	Total	mg/L	**0.0066**	**0.0064**	<0.0054	**0.0071**	**0.0164**	**0.1400**	**0.0103**	**0.0083**	<0.0054	<0.0054	<0.0054	**0.0202**	**0.0118**
Iron	Total	mg/L	**0.2367**	**0.0413**	**0.0985**	**0.7261**	**0.7970**	**13.7736**	**8.4016**	**0.4613**	**0.6663**	**5.2609**	**7.9684**	**0.2834**	**0.8947**
Lead	Total	ug/L	**0.07**	<0.0300	**0.1100**	**0.4600**	**1.05**	**10.5700**	**8.7300**	**0.32**	<0.0300	**0.1700**	**0.0300**	**1.7700**	<0.0300
Lithium	Total	mg/L	<0.0044	**0.0057**	**0.0053**	**0.0047**	**0.0086**	<0.0044	**0.0060**	<0.0044	<0.0044	**0.0050**	**0.0052**	**0.0085**	**0.0165**
Magnesium	Total	mg/L	**9.9408**	12.0046	**15.7092**	**3.5919**	**19.5565**	**18.1176**	**6.3318**	**5.3563**	**12.4184**	**10.1471**	**17.9139**	**6.9349**	**37.6011**
Manganese	Total	mg/L	**0.0778**	**0.0630**	**0.0155**	**0.0083**	**0.0261**	**0.3008**	**0.4196**	**0.2026**	**0.1543**	**0.5467**	**0.8347**	**0.0379**	**0.2882**
Molybdenum	Total	mg/L	<0.0041	**0.0058**	<0.0041	<0.0041	<0.0041	<0.0041	<0.0041	<0.0041	<0.0041	<0.0041	<0.0041	<0.0041	**0.0100**
Nickel	Total	mg/L	<0.0060	**0.0098**	<0.0060	<0.0060	**0.0095**	**0.0085**	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	**0.0106**	**0.0128**
Potassium	Total	mg/L	**0.4032**	**0.9836**	**5.2881**	<0.1102	**0.9365**	**2.5547**	**2.0795**	**1.3360**	**2.3847**	**0.8490**	**1.4563**	**1.3010**	**2.7049**
Rubidium	Total	mg/L	<0.3377	<0.3377	<0.3377	<0.3377	**0.3665**	<0.3377	<0.3377	<0.3377	<0.3377	<0.3377	<0.3377	**0.5975**	**0.5318**
Selenium	Total	ug/L	<1	**0.8000**	**2.5000**	**0.1000**	<1	**9.0000**	**3.2000**	<1	**2.7000**	**1.9000**	**0.9000**	**5.3000**	**3.7000**
Silicate	Total	mg/L	**11.2373**	**7.7497**	**6.6111**	**9.0673**	**7.2893**	**12.2000**	**15.8471**	**7.9589**	**9.3324**	**13.2007**	**23.0118**	**6.6445**	**9.1289**
Silver	Total	ug/L	**0.024**	<0.0090	<0.0090	**0.0200**	**0.022**	**0.0300**	<0.0090	<0.009	<0.0090	<0.0090	<0.0090	**0.0400**	<0.0090
Sodium	Total	mg/L	**3.9922**	**10.3309**	**3.2320**	**2.3239**	**7.4766**	**5.1523**	**4.4024**	**2.4980**	**4.0227**	**2.5702**	**6.3046**	**4.9859**	**11.4553**
Strontium	Total	mg/L	**0.0466**	**0.0626**	**0.0391**	**0.0276**	**0.1383**	**0.1566**	**0.1102**	**0.0918**	**0.0776**	**0.0495**	**0.1099**	**0.0867**	**0.2122**
Thallium	Total	ug/L	<0.005	<0.0050	**0.0100**	**0.0100**	**0.007**	<0.0050	**0.0100**	**0.009**	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Tin	Total	ug/L	**0.06**	**0.0700**	--	--	**0.20**	**0.1100**	--	**0.31**	--	**0.1200**	<0.0400	--	<0.0400
Titanium	Total	ug/L	<0.0034	**0.0042**	<0.0034	<0.0034	**0.0096**	**0.0176**	**0.0235**	<0.0034	<0.0034	<0.0034	**0.0041**	**0.0050**	**0.0069**
Vanadium	Total	mg/L	<0.0047	**0.0065**	**0.0081**	<0.0047	**0.0091**	**0.0109**	**0.0058**	**0.0052**	<0.0047	<0.0047	**0.0074**	**0.0080**	**0.0119**
Zirconium	Total	ug/L	**0.03**	<0.0300	--	--	**0.23**	**0.2300**	--	<0.03	--	<0.0300	**0.5900**	--	**0.0900**
Zinc	Total	mg/L	**0.0038**	**0.0098**	**0.0051**	**0.0290**	**0.0102**	**0.0762**	**0.0072**	<0.0017	**0.0046**	<0.0017	**0.0237**	**0.0080**	**0.0110**

Large Table 8
Regional Groundwater Monitoring Data
MPCA Dataset (Uncensored Values)

		Well ID	517078	527824	528235	529845	532909	536608	540230	546216
		Sample Date	8/23/1995	8/1/1995	8/22/1995	7/25/1995	6/27/1995	8/1/1995	8/21/1996	9/12/1995
Chemical Name	Total or Dissolved	Units								
General Parameters										
Alkalinity, total	NA	mg/L	**184**	**263**	**99**	**193**	**128**	**119**	**59**	**102**
Bromide	NA	ug/L	<0.2000	<0.2000	<0.2000	<0.2000	<0.2000	<0.2000	<0.20	<0.2000
Carbon, total organic	NA	mg/L	**4.1000**	**3.0000**	**9.6000**	**0.7000**	**2.0000**	**6.6000**	**4.0**	**0.6000**
Chloride	NA	mg/L	**1.8000**	**1.4800**	**5.9000**	**20.0500**	**0.6500**	**1.1600**	**0.45**	**1.0400**
Fluoride	NA	mg/L	**0.4300**	**0.4100**	**0.2000**	**0.2200**	<0.2000	<0.2000	<0.20	**0.2000**
Nitrate (as N)	NA	mg/L	<0.5000	<0.5000	<0.5000	**4.1000**	<0.5000	<0.5000	<0.5	<0.5000
Phosphorus, total	NA	mg/L	**0.0548**	**0.0402**	**0.0455**	**0.0187**	**0.1268**	**0.3065**	**0.0276**	**0.2185**
Phosphorus, total as P	NA	mg/L	**0.0300**	**0.0300**	**0.0400**	<0.0200	**0.1800**	**0.2400**	<0.02	**0.1400**
Solids, total dissolved	NA	mg/L	**266.0000**	**356.0000**	**118.0000**	**288.0000**	**124.0000**	**144.0000**	**92**	**156.0000**
Solids, total suspended	NA	mg/L	**2.0000**	**10.0000**	**16.0000**	**1.0000**	**2.0000**	**4.0000**	**3**	**26.0000**
Sulfate (as S)	NA	mg/L	**0.4200**	**6.8400**	<0.1000	**5.9600**	<0.1000	**4.8400**	**4.32**	**4.5200**
Sulfur	NA	mg/L	**0.4549**	**7.4271**	**0.1420**	**6.5005**	**0.1013**	**5.3713**	**4.6297**	**4.7015**
pH, standard units	NA	--	**8.10**	**7.50**	**6.80**	**7.80**	**8.30**	**7.00**	**6.49**	**8.20**
Dissolved oxygen	NA	mg/L	**0.05**	**0.08**	**0.10**	**6.59**	**0.00**	**0.11**	**0.14**	**0.10**
Redox (oxidation potential)	NA	mV	**-40**	**77**	**47**	**-35**	**20**	**-22**	**75**	**-58**
Specific Conductance mmhos@ 25oC	NA	mmho/cm	**0.344**	**0.072**	**0.221**	**0.428**	**0.220**	**0.071**	**0.166**	**0.230**
Temperature, degrees C	NA	C	**7.20**	**8.40**	**7.70**	**8.30**	**9.20**	**7.80**	**7.40**	**8.20**
Metals										
Aluminum	Total	ug/L	**2.3900**	**25.2300**	**72.5500**	**1.8100**	**1.8600**	**8.6900**	**5.29**	**692.8300**
Antimony	Total	ug/L	<0.0080	<0.0080	**0.0200**	<0.0080	**0.0300**	<0.0080	<0.008	<0.0080
Arsenic	Total	ug/L	**2.6200**	**1.7700**	<0.0600	**0.6300**	**18.7600**	**2.1900**	**0.15**	**1.6300**
Barium	Total	mg/L	**0.0029**	**0.0728**	**0.0472**	**0.0270**	**0.0859**	**0.0216**	**0.0377**	**0.0305**
Beryllium	Total	ug/L	**0.0100**	<0.0100	**0.1100**	<0.0100	**0.0200**	**0.0200**	<0.01	**0.0700**
Bismuth	Total	ug/L	<0.0400	--	<0.0400	--	--	--	**0.01**	**0.0100**
Boron	Total	mg/L	**0.0444**	**0.0820**	**0.0116**	**0.0158**	**0.0180**	**0.0139**	**0.0137**	**0.0198**
Cadmium	Total	ug/L	<0.0200	<0.0200	<0.0200	<0.0200	**0.0900**	<0.0200	**0.06**	<0.0200
Calcium	Total	mg/L	**0.0991**	**64.8144**	**23.6244**	**65.5134**	**31.4415**	**34.5197**	**15.4594**	**31.3551**
Cesium	Total	ug/L	<0.0100	--	**0.0900**	--	--	--	<0.01	**0.0600**
Chromium	Total	ug/L	**0.0600**	**0.1900**	**1.2600**	**1.2700**	**0.2500**	**0.4200**	**0.17**	**1.9800**
Cobalt	Total	ug/L	**0.0200**	**0.4800**	**0.2400**	**0.3700**	**0.2400**	**0.2300**	**1.157**	**2.4500**
Copper	Total	mg/L	**0.0169**	<0.0054	**0.0057**	<0.0054	<0.0054	<0.0054	**0.0101**	**0.0216**
Iron	Total	mg/L	**0.0731**	**0.8558**	**8.3194**	**0.0434**	**0.0416**	**11.1857**	**0.2113**	**2.7283**
Lead	Total	ug/L	0.0700	**0.2700**	**1.8800**	**0.0300**	**0.1600**	**0.0600**	**0.89**	**1.7600**
Lithium	Total	mg/L	**0.0116**	**0.0101**	**0.0067**	<0.0044	<0.0044	<0.0044	**0.0146**	**0.0077**
Magnesium	Total	mg/L	**0.1208**	**25.0820**	**7.2146**	**14.7745**	**7.4441**	**6.0946**	**7.1753**	**11.8287**
Manganese	Total	mg/L	**0.0020**	**1.0112**	**0.3712**	<0.0005	**0.0901**	**0.6068**	**0.0288**	**0.0870**
Molybdenum	Total	mg/L	**0.0124**	<0.0041	<0.0041	<0.0041	<0.0041	<0.0041	**0.0050**	<0.0041
Nickel	Total	mg/L	**0.0181**	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	**0.0083**	**0.0118**
Potassium	Total	mg/L	**0.4364**	**3.4836**	**1.6486**	**1.1378**	**0.8706**	**0.9135**	**4.2006**	**0.9824**
Rubidium	Total	mg/L	**0.8168**	<0.3377	<0.3377	<0.3377	<0.3377	<0.3377	**0.3412**	**0.3655**
Selenium	Total	ug/L	**1.2000**	**0.7000**	**0.8000**	**0.9000**	**0.7000**	**2.3000**	**1**	**0.7000**
Silicate	Total	mg/L	**13.8108**	**10.9297**	**12.2635**	**9.4490**	**7.4247**	**9.8567**	**9.1214**	**9.8133**
Silver	Total	ug/L	<0.0090	<0.0090	<0.0090	<0.0090	**0.0200**	<0.0090	**0.021**	**0.0300**
Sodium	Total	mg/L	**83.0187**	**10.6050**	**4.2751**	**8.0870**	**3.2823**	**2.8115**	**3.7098**	**4.0065**
Strontium	Total	mg/L	**0.0013**	**0.4360**	**0.0549**	**0.0865**	**0.1289**	**0.0608**	**0.0514**	**0.0539**
Thallium	Total	ug/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	**0.010**	<0.0050
Tin	Total	ug/L	**0.0600**	--	<0.0400	--	--	--	**0.03**	<0.0400
Titanium	Total	ug/L	**0.0109**	<0.0034	**0.0063**	<0.0034	<0.0034	<0.0034	<0.0034	**0.0470**
Vanadium	Total	mg/L	**0.0122**	<0.0047	**0.0060**	<0.0047	<0.0047	<0.0047	<0.0047	**0.0107**
Zirconium	Total	ug/L	**0.0900**	--	**1.3600**	--	--	--	**0.06**	**0.2700**
Zinc	Total	mg/L	**0.0128**	**0.0134**	**0.0041**	**0.0051**	<0.0017	**0.0051**	**0.0088**	**0.0136**

Large Table 9
NPDES Data Summary
Partridge River Headwaters

		Location	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009
		Date	9/01/1999	11/01/2008	12/01/2008	1/01/2009	2/01/2009	3/01/2009	4/01/2009	5/01/2009	7/01/2009	8/01/2009	9/01/2009	10/01/2009	11/01/2009	12/01/2009	1/01/2010	3/01/2010	4/01/2010
		Sample Type	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
		Data Status	SSource	SSource	SSource	SSource	SSource	SSource	SSource	SSource	SSource	SSource	SSource	SSource	SSource	SSource	SSource	SSource	SSource
Parameter	Total or Dissolved	Analysis Location																	
General Parameters																			
Alkalinity, bicarbonate, as HCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	89.1 mg/l	98.4 mg/l	89.4 mg/l	92.2 mg/l	126 mg/l	103 mg/l	91 mg/l
Chloride	NA	Lab	--	--	--	--	--	--	--	--	--	--	6.5 mg/l	7.67 mg/l	6.61 mg/l	6.52 mg/l	7.505 mg/l	5.055 mg/l	6.34 mg/l
Flow	NA	Lab	0.504 mgd 0.72 mgd 15.12 mgd	9 mgd 206.4 MG	9 mgd 149.4 MG	8.3 mgd 109.8 MG	5 mgd 8.3 mgd 82.2 MG	8.3 mgd 115.7 MG	8.3 mgd 118.9 MG	8.3 mgd 149.9 MG	8.2 mgd 199.7 MG	8.3 mgd 189 MG	8.3 mgd 162 MG	8.3 mgd 181 MG	8 mgd 147 MG	8.3 mgd 94.2 MG	8.3 mgd 128.5 MG	8.3 mgd 305.4 MG	8.3 mgd 70.9 MG
Hardness, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	128 mg/l	127 mg/l	124 mg/l	128 mg/l	164.5 mg/l	132.5 mg/l	120 mg/l
Nitrogen, ammonia as N	NA	Lab	--	--	--	--	--	< 0.1 mg/l	< 0.1 mg/l	0.19 mg/l < 0.145 mg/l	0.28 mg/l < 0.1 mg/l	0.21 mg/l < 0.16 mg/l	< 0.1 mg/l	< 0.1 mg/l	--	--	--	< 0.05 mg/l	< 0.05 mg/l
Nitrogen, unionized ammonia, as N	NA	Lab	< 0.007 mg/l	--	--	--	--	< 0.01 mg/l	< 0.01 mg/l	0.0049 mg/l < 0.0037 mg/l	0.022 mg/l < 0.017 mg/l	0.007 mg/l	< 0.009 mg/l	< 0.004 mg/l	--	--	--	< 0.0009 mg/l	< 0.01 mg/l
Oil and Grease - Silica gel cleanup	NA	Lab	< 0.5 mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Lab	8.24 pH units 8.44 pH units	8.25 pH units 8.32 pH units	8.25 pH units	7.8 pH units	8 pH units	8 pH units 8.1 pH units	8 pH units 8.35 pH units	8.23 pH units 8.27 pH units	8.5 pH units	8.3 pH units 8.4 pH units	8.4 pH units 8.5 pH units	8.4 pH units 8.5 pH units	8.3 pH units 8.4 pH units	8.3 pH units 8.4 pH units	8.2 pH units	8.3 pH units	8.46 pH units 8.5 pH units
Solids, total dissolved	NA	Lab	--	--	--	--	--	--	--	--	--	--	201 mg/l	185 mg/l	154 mg/l	179 mg/l	202 mg/l	166 mg/l	129 mg/l
Solids, total suspended	NA	Lab	< 1 mg/l	--	1.2 mg/l	--	< 1 mg/l	--	< 1 mg/l	--	--	< 1 mg/l	--	< 1 mg/l	--	< 1 mg/l	--	--	< 1 mg/l
Specific Conductance @ 25 ºC	NA	Field	--	--	--	--	--	--	--	--	--	--	300 umhos/cm	317 umhos/cm	296 umhos/cm	308 umhos/cm	382 umhos/cm	305 umhos/cm	283 umhos/cm
Sulfate, as SO4	NA	Lab	--	--	--	--	--	--	--	--	--	--	34.8 mg/l	37.2 mg/l	28.8 mg/l	30.8 mg/l	41.35 mg/l	25.05 mg/l	23.5 mg/l
Temperature, ºC	NA	Lab	15.5 deg C 18 deg C	--	--	--	--	3 deg C	6 deg C 8.2 deg C	13 deg C 13.9 deg C	17 deg C 19 deg C	17.5 deg C 19 deg C	18 deg C 19 deg C	8 deg C 10 deg C	--	--	--	2.15 deg C 3.5 deg C	9.7 deg C 11.7 deg C
Turbidity	NA	Field	0.38 NTU 0.5 NTU	0.63 NTU 0.83 NTU	0.45 NTU	0.51 NTU	0.86 NTU	0.65 NTU 0.66 NTU	0.63 NTU 0.65 NTU	1.3 NTU 1.6 NTU	1.2 NTU	1.4 NTU 1.5 NTU	0.75 NTU 0.81 NTU	0.79 NTU 0.87 NTU	1 NTU 1.4 NTU	1.5 NTU 2.2 NTU	1 NTU 1.3 NTU	1.25 NTU 1.6 NTU	0.75 NTU 0.9 NTU
Metals																			
Iron	Dissolved	Lab	< 30 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	76 ug/l	60 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l
Mercury	Total	Lab	--	--	< 0.0005 ug/l	--	--	< 0.0005 ug/l	--	--	--	--	< 0.0008 ug/l	--	--	< 0.0006 ug/l	--	0.0007 ug/l	--
Total Petroleum Hydrocarbons																			
Diesel Range Organics	NA	Lab	--	< 100 ug/l	< 100 ug/l	< 100 ug/l	< 100 ug/l	< 100 ug/l	< 100 ug/l	< 0.1 ug/l	< 100 ug/l	< 105 ug/l	--	--	--	--	--	--	--

Large Table 9
NPDES Data Summary
Partridge River Headwaters

			Location	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009
			Date	5/01/2010	6/01/2010	7/01/2010	8/01/2010	10/01/2010	11/01/2010	12/01/2010	1/01/2011	2/01/2011	3/01/2011	4/01/2011	5/01/2011	6/01/2011	10/01/2011	11/01/2011
			Sample Type	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
			Data Status	SSource	SSource	SSource	SSource	SSource	SSource	SSource	SSource	SSource	SSource	SSource	SSource	SSource	SSource	SSource
Parameter	Total or Dissolved	Analysis Location																
General Parameters																		
Alkalinity, bicarbonate, as HCO3	NA	Lab		98.5 mg/l	97 mg/l	87.7 mg/l	83.4 mg/l	91 mg/l	91.8 mg/l	95.7 mg/l	116 mg/l	117 mg/l	117 mg/l	85.8 mg/l	86.9 mg/l	88.1 mg/l	106 mg/l	--
Chloride	NA	Lab		7.24 mg/l	15.4 mg/l	21.05 mg/l	18.35 mg/l	13.1 mg/l	11.35 mg/l	13.1 mg/l	10.35 mg/l	6.405 mg/l	6.645 mg/l	12 mg/l	5.085 mg/l	3.18 mg/l	2.91 mg/l	--
Flow	NA	Lab		5 mgd 77.49 MG	5 mgd 187 MG	5 mgd 257.7 MG	5 mgd 162.6 MG	8.3 mgd 94.2 MG	8.3 mgd 46.9 MG	8.3 mgd 202.8 MG	8.2 mgd 15.3 MG	5 mgd 43.1 MG	5 mgd 56.1 MG	8.2 mgd 107.1 MG	5.8 MG 8.2 mgd	8.2 mgd 21.1 MG	8.2 mgd 162.2 MG	8.2 mgd 103.8 MG
Hardness, as CaCO3	NA	Lab		128 mg/l	136 mg/l	145.5 mg/l	131 mg/l	133.5 mg/l	138.5 mg/l	144.5 mg/l	148.5 mg/l	146 mg/l	140.5 mg/l	106.5 mg/l	99.1 mg/l	111.5 mg/l	122.5 mg/l	--
Nitrogen, ammonia as N	NA	Lab		< 0.05 mg/l	0.06 mg/l < 0.05 mg/l	0.04 mg/l 0.07 mg/l	0.05 mg/l 0.11 mg/l	< 0.05 mg/l	--	--	--	--	0.025 mg/l 0.1 mg/l	< 0.05 mg/l	0.085 mg/l 0.09 mg/l	0.055 mg/l 0.11 mg/l	0.08 mg/l 0.17 mg/l	--
Nitrogen, unionized ammonia, as N	NA	Lab		< 0.005 mg/l	0.006 mg/l < 0.006 mg/l	0.005 mg/l 0.008 mg/l	0.002 mg/l 0.01 mg/l	< 0.002 mg/l	--	--	--	--	0.0008 mg/l 0.003 mg/l	< 0.0008 mg/l	0.006 mg/l 0.007 mg/l	0.005 mg/l 0.01 mg/l	0.004 mg/l 0.009 mg/l	--
Oil and Grease - Silica gel cleanup	NA	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Lab		8.48 pH units 8.5 pH units	8.45 pH units 8.46 pH units	8.1 pH units 8.4 pH units	8.4 pH units	8.4 pH units	8.4 pH units	8.3 pH units 8.4 pH units	8.3 pH units 8.5 pH units	8.4 pH units 8.6 pH units	8.5 pH units 8.6 pH units	7.8 pH units 8.3 pH units	8.5 pH units	8.7 pH units	8.3 pH units	8.4 pH units
Solids, total dissolved	NA	Lab		177 mg/l	183 mg/l	209 mg/l	236 mg/l	193 mg/l	153 mg/l	188 mg/l	202 mg/l	187 mg/l	209 mg/l	112 mg/l	157 mg/l	150 mg/l	153 mg/l	--
Solids, total suspended	NA	Lab		--	1.2 mg/l	--	2.8 mg/l	1.6 mg/l	--	< 1 mg/l	--	< 1 mg/l	--	2 mg/l	--	< 1 mg/l	1.2 mg/l	--
Specific Conductance @ 25 ºC	NA	Field		316 umhos/cm	348 umhos/cm	393 umhos/cm	308 umhos/cm	320 umhos/cm	303 umhos/cm	330 umhos/cm	338 umhos/cm	312 umhos/cm	309 umhos/cm	252 umhos/cm	209 umhos/cm	219 umhos/cm	272 umhos/cm	--
Sulfate, as SO4	NA	Lab		25.7 mg/l	27 mg/l	27.75 mg/l	25.4 mg/l	27.65 mg/l	26.75 mg/l	29.05 mg/l	29.95 mg/l	27.1 mg/l	24.85 mg/l	15.1 mg/l	15.55 mg/l	16.8 mg/l	21.9 mg/l	22.9 mg/l
Temperature, ºC	NA	Lab		13.4 deg C 16.1 deg C	19.8 deg C 20.1 deg C	23.05 deg C 23.9 deg C	20.4 deg C 22.1 deg C	9.2 deg C	--	--	--	--	1.9 deg C 3 deg C	5.5 deg C 8.3 deg C	11.4 deg C 14.4 deg C	15.4 deg C	9.8 deg C 14.6 deg C	--
Turbidity	NA	Field		1.3 NTU 1.8 NTU	0.75 NTU 0.8 NTU	1 NTU 1.3 NTU	2 NTU 3.1 NTU	0.96 NTU	0.5 NTU	0.7 NTU 0.8 NTU	0.5 NTU	0.3 NTU 0.4 NTU	0.6 NTU 0.7 NTU	0.5 NTU	0.9 NTU	1 NTU	1 NTU 1.3 NTU	0.7 NTU
Metals																		
Iron	Dissolved	Lab		< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l
Mercury	Total	Lab		--	0.0005 ug/l	--	--	--	--	< 0.0005 ug/l	--	--	0.0005 ug/l	--	--	0.001 ug/l	--	--
Total Petroleum Hydrocarbons																		
Diesel Range Organics	NA	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Large Table 9
NPDES Data Summary
Partridge River Headwaters

Location			HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009	HIST-SD-009
Date			1/01/2012	5/01/2012	6/01/2012	7/01/2012	8/01/2012	9/01/2012	10/01/2012	11/01/2012	12/01/2012	1/01/2013	2/01/2013	3/01/2013	4/01/2013	5/01/2013	6/01/2013	7/01/2013	8/01/2013	9/01/2013	11/01/2013
Sample Type			N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Data Status			SSource	SSource	SSource	SSource	SSource	SSource	SSource	SSource	SSource	SSource	SSource	SSource	SSource	SSource	SSource	SSource	SSource	SSource	SSource	SSource
Parameter	Total or Dissolved	Analysis Location																				
General Parameters																						
Alkalinity, bicarbonate, as HCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chloride	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Flow	NA	Lab	9.4 mgd 134 MG	9.4 mgd 24.9 MG	9.4 mgd 142.5 MG	9.8 mgd 241.2 MG	9.4 mgd 162.9 MG	9.8 mgd 276.5 MG	9.8 mgd 293.9 MG	9.4 mgd 58.6 MG	5.8 mgd 92.4 MG	5 mgd 74.8 MG	5 mgd 141 MG	5.8 mgd 150.4 MG	10.4 mgd 206 MG	9.8 mgd 148 MG	9.5 mgd 348.5 MG	9.5 mgd 95.5 MG	9.8 mgd 164.9 MG	5.8 mgd 39.1 MG	9.4 mgd 148.9 MG
Hardness, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrogen, ammonia as N	NA	Lab	--	0.08 mg/l 0.16 mg/l	< 0.05 mg/l	0.025 mg/l 0.1 mg/l	< 0.05 mg/l	< 0.05 mg/l	0.025 mg/l 0.05 mg/l	--	--	--	--	< 0.05 mg/l	0.034 mg/l 0.091 mg/l	0.06 mg/l 0.14 mg/l	0.11 mg/l 0.23 mg/l	< 0.05 mg/l	0.07 mg/l 0.12 mg/l	< 0.05 mg/l	--
Nitrogen, unionized ammonia, as N	NA	Lab	--	0.002 mg/l 0.004 mg/l	< 0.002 mg/l	0.003 mg/l 0.01 mg/l	< 0.002 mg/l	< 0.002 mg/l	0.001 mg/l 0.005 mg/l	--	--	--	--	< 0.0002 mg/l	0.0002 mg/l 0.0006 mg/l	0.002 mg/l 0.004 mg/l	0.01 mg/l 0.02 mg/l	< 0.003 mg/l	0.006 mg/l 0.01 mg/l	< 0.003 mg/l	--
Oil and Grease - Silica gel cleanup	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Lab	8 pH units	8 pH units	7.9 pH units 8.2 pH units	8 pH units 8.5 pH units	7.9 pH units 8.1 pH units	8.1 pH units 8.2 pH units	7.8 pH units 8 pH units	7.9 pH units 8.2 pH units	8 pH units 8.1 pH units	7.6 pH units 8 pH units	7.9 pH units	7.6 pH units 7.7 pH units	7.8 pH units 8 pH units	7.9 pH units 8.2 pH units	8.5 pH units	8.2 pH units	8.3 pH units 8.4 pH units	8.3 pH units	8.1 pH units 8.2 pH units
Solids, total dissolved	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Solids, total suspended	NA	Lab	--	--	2 mg/l	--	< 1 mg/l	--	< 1 mg/l	--	< 1 mg/l	--	< 1 mg/l	--	1.2 mg/l 2.4 mg/l	--	1.8 mg/l 2 mg/l	--	1.6 mg/l	--	--
Specific Conductance @ 25 ºC	NA	Field	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sulfate, as SO4	NA	Lab	26.5 mg/l	27.3 mg/l	24.35 mg/l	27.1 mg/l	25.3 mg/l	25 mg/l	26.05 mg/l	32.6 mg/l	35.2 mg/l	35.1 mg/l	31.7 mg/l	26.3 mg/l	24.95 mg/l	14 mg/l	17.1 mg/l	16 mg/l	19.4 mg/l	24.45 mg/l	26 mg/l
Temperature, ºC	NA	Lab	--	15.1 deg C	18.35 deg C 18.9 deg C	22.3 deg C 23.5 deg C	21.2 deg C 22 deg C	17.3 deg C 21.7 deg C	10.8 deg C 13 deg C	--	--	--	--	0.3 deg C	2.1 deg C 2.8 deg C	10.8 deg C 17.4 deg C	15.2 deg C	20.9 deg C 21.2 deg C	19.5 deg C 20 deg C	19.3 deg C	--
Turbidity	NA	Field	0.8 NTU	1.7 NTU	0.9 NTU 1.1 NTU	0.5 NTU 0.6 NTU	1.1 NTU 1.2 NTU	0.7 NTU	0.8 NTU 1 NTU	0.8 NTU 1.2 NTU	0.5 NTU 0.6 NTU	0.9 NTU 1 NTU	0.8 NTU	0.6 NTU	0.9 NTU 1.1 NTU	1.1 NTU 1.3 NTU	0.9 NTU 1 NTU	1.2 NTU	1.5 NTU 1.6 NTU	1.3 NTU	0.5 NTU 0.6 NTU
Metals																						
Iron	Dissolved	Lab	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l
Mercury	Total	Lab	--	--	0.00075 ug/l	--	--	0.00055 ug/l	--	--	0.00065 ug/l	--	--	< 0.0005 ug/l	--	--	0.00115 ug/l 0.0013 ug/l	--	--	0.00074 ug/l	--
Total Petroleum Hydrocarbons																						
Diesel Range Organics	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Large Table 9
NPDES Data Summary
Partridge River Headwaters

			Location	HIST-SD-009	HIST-SD-009	HIST-SD-009
			Date	12/01/2013	2/01/2014	3/01/2014
			Sample Type	N	N	N
			Data Status	SSource	SSource	SSource
Parameter	Total or Dissolved	Analysis Location				
General Parameters						
Alkalinity, bicarbonate, as HCO3	NA	Lab	--	--	--	
Chloride	NA	Lab	--	--	--	
Flow	NA	Lab	5.8 mgd 98.5 MG	8.2 mgd 33.7 MG	8.2 mgd 40.6 MG	
Hardness, as CaCO3	NA	Lab	--	--	--	
Nitrogen, ammonia as N	NA	Lab	--	--	< 0.05 mg/l	
Nitrogen, unionized ammonia, as N	NA	Lab	--	--	< 0.0004 mg/l	
Oil and Grease - Silica gel cleanup	NA	Lab	--	--	--	
pH	NA	Lab	8.2 pH units	7.9 pH units	7.9 pH units 8 pH units	
Solids, total dissolved	NA	Lab	--	--	--	
Solids, total suspended	NA	Lab	--	< 1 mg/l	--	
Specific Conductance @ 25 ºC	NA	Field	--	--	--	
Sulfate, as SO4	NA	Lab	--	30 mg/l	32.1 mg/l	
Temperature, ºC	NA	Lab	--	--	1.2 deg C 1.4 deg C	
Turbidity	NA	Field	0.4 NTU	2.6 NTU	0.5 NTU	
Metals						
Iron	Dissolved	Lab	--	< 50 ug/l	< 50 ug/l	
Mercury	Total	Lab	--	--	0.00051 ug/l	
Total Petroleum Hydrocarbons						
Diesel Range Organics	NA	Lab	--	--	--	

Large Table 9
NPDES Data Summary
Partridge River Headwaters

Data Footnotes and Qualifiers

Footnote	
	Not used in water quality modeling as of June 13, 2014
--	Not analyzed/not available.
N	Sample Type: Normal
FD	Sample Type: Field Duplicate
NA	NA (not applicable) indicates that a fractional portion of the sample is not part of the analytical testing or field collection procedures.
ND	Not detected.
TIC	Tentatively identified compound
Validated	Laboratory data has been evaluated following Barr QA/QC procedures and/or project-specific data review requirements. Field data has been verified for transcription errors, consistency and completeness. Data transferred from the previous database (9/2009) were categorized as validated, but may be comprised of any one of the following data status categories: Validated, SSource, No QC or Legacy.
No QC	Laboratory data has been excluded from Barr QA/QC procedures.
SSource	Laboratory and/or field data obtained from a secondary source external to Barr. Second source QA/QC evaluation procedures may or may not have been performed beyond the original data generator.
Legacy	Historical laboratory data (internal at Barr). QA/QC evaluation procedures may or may not have been performed beyond the original data generator

Qualifier	
a	Estimated value, calculated using some or all values that are estimates.
b	Potential false positive value based on blank data validation procedures.
c	Coeluting compound.
e	Estimated value, exceeded the instrument calibration range.
f	Sample was collected at a flowrate exceeding the recommended rate of 200 mL/minute.
h	EPA recommended sample preservation, extraction or analysis holding time was exceeded.
i	Indeterminate value based on failure of blind duplicate data to meet quality assurance criteria.
j	Reported value is less than the stated laboratory quantitation limit and is considered an estimated value.
p	Relative percent difference is >40% (25% CLP pesticides) between primary and confirmation GC columns.
pp	Small peak in chromatogram below method detection limit.
r	The presence of the compound is suspect based on the ID criteria of the retention time and relative retention time obtained from the examination of the chromatograms.
s	Potential false positive value based on statistical analysis of blank sample data.
t	Sample positive for total coliforms but negative for *E. coli.*
v	Sample was collected under a vacuum of greater than XX inches of mercury.
*	Estimated value, QA/QC criteria not met.
**	Unusable value, QA/QC criteria not met.
AT	Sample chromatogram is noted to be atypical of a petroleum product.
EMPC	Estimated maximum possible concentration.
BQA	Barr-applied project specific qualifier: extraction and/or analyses conducted using an alternative method and/or procedure.
BQC	Barr-applied project specific qualifier: plant shut down.
BQD	Barr-applied project specific qualifier: equipment malfunction.
BQE	Barr-applied project specific qualifier: equipment adjustment.
BQM	Barr-applied project specific qualifier: manual measurement.
BQN	Barr-applied project specific qualifier: unable to be sampled or measured due to various reasons.
BQP	Barr-applied project specific qualifier: atypical chromatographic pattern.
BQQ	Barr-applied project specific qualifier: some aspect of QA/QC was not met.
BQR	Barr-applied project specific qualifier: location was re-sampled.
BQS	Barr-applied project specific qualifier: data is considered suspect.
BQT	Barr-applied project specific qualifier: summed value not displayed due to insufficient field length.
BQU	Barr-applied project specific qualifier: historical qualifier - definition unknown.
BQV	Barr-applied project specific qualifier: estimated value.
BQX	Barr-applied project specific qualifier: see notes for qualifier definition.
BQZ	Barr-applied project specific qualifier: data is considered unusable.

Large Table 10
Surface Water Data Summary
Colby Lake and Whitewater Reservoir

		Location	LC-1	LC-2	LC-3	LC-4	LC-5	Lcy-1	Lcy-1	Lcy-1	Lcy-1	Lcy-1	Lcy-1	Lcy-1	Lcy-1	Lcy-1	Lcy-1
		Date	11/19/2008	11/19/2008	11/19/2008	11/19/2008	11/19/2008	4/21/2010	5/12/2010	6/16/2010	7/27/2010	8/23/2010	9/20/2010	6/18/2013	7/24/2013	8/20/2013	9/18/2013
		Sample Type	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Parameter	Total or Dissolved	Analysis Location															
General Parameters																	
Alkalinity, bicarbonate, as CaCO3	NA	Lab	**25.7 mg/l**	**25.0 mg/l**	**33.2 mg/l**	**29.4 mg/l**	**25.7 mg/l**	--	--	--	--	--	--	--	**46.4 mg/l**	--	--
Alkalinity, total, as CaCO3	NA	Lab	**33.2 mg/l**	**25.0 mg/l**	**28.9 mg/l**	**29.4 mg/l**	**25.7 mg/l**	--	--	--	--	--	--	--	**46.4 mg/l**	--	--
Carbon, total organic	NA	Lab	**29.1 mg/l**	**30.6 mg/l**	**31.1 mg/l**	**27.3 mg/l**	**29.4 mg/l**	--	--	--	--	--	--	**24.6 mg/l**	**34.0 mg/l**	**32.0 mg/l**	**24.7 mg/l**
Chemical Oxygen Demand	NA	Lab	**79.6 mg/l**	**86.6 mg/l**	**87.6 mg/l**	**80.2 mg/l**	**81.5 mg/l**	--	--	--	--	--	--	--	**111 mg/l**	--	--
Chloride	NA	Lab	**2.28 mg/l**	**1.98 mg/l**	**2.17 mg/l**	**2.25 mg/l**	**2.18 mg/l**	--	--	--	--	--	--	**3.1 mg/l**	**2.9 mg/l**	**4.4 mg/l**	**5.3 mg/l**
Dissolved oxygen	NA	Field	--	--	--	--	--	**10.0 mg/l**	**9.45 mg/l**	**8.11 mg/l**	**7.96 mg/l**	**6.65 mg/l**	**7.94 mg/l**	**7.75 mg/l**	**6.05 mg/l**	**6.72 mg/l**	**7.52 mg/l**
Fluoride	NA	Lab	**0.1 mg/l**	< 0.1 mg/l	**0.1 mg/l**	**0.14 mg/l**	< 0.1 mg/l	--	--	--	--	--	--	--	--	--	--
Hardness, as CaCO3	NA	Lab	**61.7 mg/l**	**44.4 mg/l**	**54.6 mg/l**	**68.5 mg/l**	**45 mg/l**	**109 mg/l**	**101 mg/l**	**81.6 mg/l**	**93 mg/l**	**108 mg/l**	**119 mg/l**	**46.1 mg/l**	**70.9 mg/l**	**78.3 mg/l**	**92.3 mg/l**
Nitrate + Nitrite, as N	NA	Lab	**0.17 mg/l**	**0.37 mg/l**	**0.25 mg/l**	**0.19 mg/l**	**0.48 mg/l**	--	--	--	--	--	--	--	**0.17 mg/l**	--	--
Nitrogen, ammonia as N	NA	Lab	< 0.1 mg/l	**0.33 mg/l**	< 0.1 mg/l	< 0.1 mg/l	**0.1 mg/l**	--	--	--	--	--	--	--	**0.33 mg/l**	--	--
pH	NA	Field	--	--	--	--	--	**7.68 mg/l**	**7.96 mg/l**	**7.83 mg/l**	**7.78 mg/l**	**7.81 mg/l**	**7.96 mg/l**	**6.99 mg/l**	**7.23 mg/l**	**8.13 mg/l**	**7.4 mg/l**
Phosphorus, total, as P	NA	Lab	**0.013 mg/l**	**0.012 mg/l**	**0.012 mg/l**	**0.014 mg/l**	**0.01 mg/l**	--	--	--	--	--	--	--	**0.029 mg/l**	--	--
Solids, total dissolved	NA	Lab	**119 mg/l**	**108 mg/l**	**116 mg/l**	**128 mg/l**	**104 mg/l**	--	--	--	--	--	--	**125 mg/l**	**173 mg/l**	**205 mg/l**	**178 mg/l**
Solids, total suspended	NA	Lab	**1.2 mg/l**	**1.6 mg/l**	**1.2 mg/l**	**10.4 mg/l**	< 1 mg/l	--	--	--	--	--	--	--	--	--	--
Specific Conductance @ 25 ºC	NA	Field	--	--	--	--	--	**246.9 umhos/cm**	**226.6 umhos/cm**	**189 umhos/cm**	**191 umhos/cm**	**248.5 umhos/cm**	**273.5 umhos/cm**	**95.5 umhos/cm**	**129 umhos/cm**	**168.5 umhos/cm**	**199.7 umhos/cm**
Sulfate, as SO4	NA	Lab	**18.7 mg/l**	**10.1 mg/l**	**14.4 mg/l**	**31.7 mg/l**	**10.8 mg/l**	**60.7 mg/l**	**54 mg/l**	**36 mg/l**	**37.9 mg/l**	**44.1 mg/l**	**46.4 mg/l**	**12.9 mg/l**	**9.1 mg/l**	**18.7 mg/l**	**24.7 mg/l**
Temperature, ºC	NA	Field	--	--	--	--	--	**14.02 deg C**	**12.20 deg C**	**17.38 deg C**	**25.70 deg C**	**24.10 deg C**	**15.29 deg C**	**19.68 deg C**	**22.93 deg C**	**24.55 deg C**	**18.22 deg C**
Turbidity	NA	Field	--	--	--	--	--	**0 NTU**	**0.2 NTU**	**0.1 NTU**	**0 NTU**	**0 NTU**	**0 NTU**	**8.4 NTU**	**0 NTU**	**2 NTU**	**1.5 NTU**
Metals																	
Aluminum	Dissolved	Lab	**135 ug/l**	**171 ug/l**	**160 ug/l**	**154 ug/l**	**166 ug/l**	**58.1 ug/l**	**46.2 ug/l**	**56.6 ug/l**	**58.8 ug/l**	**43.8 ug/l**	< 25 ug/l	**108 ug/l**	**178 ug/l**	**140 ug/l**	**90.1 ug/l**
Aluminum	Total	Lab	**179 ug/l**	**243 ug/l**	**203 ug/l**	**214 ug/l**	**202 ug/l**	**71.9 ug/l**	**69.3 ug/l**	**68.9 ug/l**	**87 ug/l**	**62.9 ug/l**	**46.7 ug/l**	**124 ug/l**	**192 ug/l**	**133 ug/l**	**102 ug/l**
Antimony	Total	Lab	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	--	--	--	--	--	--	--	< 0.50 ug/l	--	--
Arsenic	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	< 2.0 ug/l	**1.6 ug/l**	**1.8 ug/l**	**1.3 ug/l**
Arsenic	Total	Lab	**0.89 j ug/l**	**0.81 j ug/l**	**0.74 j ug/l**	**0.81 j ug/l**	**0.83 j ug/l**	**0.63 ug/l**	< 0.5 ug/l	**0.78 ug/l**	**1.1 ug/l**	**0.95 ug/l**	**0.88 ug/l**	< 2.0 ug/l	**2.0 ug/l**	**1.6 ug/l**	**1.4 ug/l**
Barium	Total	Lab	**7.4 ug/l**	**6.9 ug/l**	**7.0 ug/l**	**7.6 ug/l**	**5.7 ug/l**	--	--	--	--	--	--	--	**11.3 ug/l**	--	--
Beryllium	Total	Lab	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	--	--	--	--	--	--	--	< 0.20 ug/l	--	--
Boron	Total	Lab	**61.1 ug/l**	< 50 ug/l	< 50 ug/l	**72.1 ug/l**	< 50 ug/l	--	--	--	--	--	--	--	**53.9 ug/l**	--	--
Cadmium	Total	Lab	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	--	--	--	--	--	--	--	< 0.20 ug/l	--	--
Calcium	Total	Lab	**13200 ug/l**	**8950 ug/l**	**11400 ug/l**	**15400 ug/l**	**9100 ug/l**	**26700 ug/l**	**24300 ug/l**	**19700 ug/l**	**22700 ug/l**	**26600 ug/l**	**29100 ug/l**	**9700 ug/l**	**14600 ug/l**	**17200 ug/l**	**20600 ug/l**
Chromium	Total	Lab	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	--	--	--	--	--	--	--	< 1.0 ug/l	--	--
Cobalt	Dissolved	Lab	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	**0.4 ug/l**	< 0.2 ug/l	--	--	--	--	--	--	< 0.80 ug/l	**0.57 ug/l**	**0.32 ug/l**	**0.26 ug/l**
Cobalt	Total	Lab	**0.22 ug/l**	**0.27 ug/l**	**0.21 ug/l**	**0.42 ug/l**	< 0.2 ug/l	--	--	--	--	--	--	< 0.80 ug/l	**0.64 ug/l**	**0.37 ug/l**	**0.40 ug/l**
Copper	Dissolved	Lab	**2.7 b ug/l**	**1.8 b ug/l**	**2.9 b ug/l**	**4.1 b ug/l**	**2.0 b ug/l**	--	--	--	--	--	--	**4.4 ug/l**	**3.2 ug/l**	**5.6 ug/l**	**5.1 ug/l**
Copper	Total	Lab	**2.6 ug/l**	**1.8 ug/l**	**2.3 ug/l**	**3.5 ug/l**	**1.6 ug/l**	--	--	--	--	--	--	**4.4 ug/l**	**3.5 ug/l**	**5.7 ug/l**	**5.3 ug/l**
Iron	Dissolved	Lab	**858 ug/l**	**872 ug/l**	**889 ug/l**	**813 ug/l**	**852 ug/l**	--	--	--	--	--	--	**767 ug/l**	**3890 ug/l**	**3570 ug/l**	**2650 ug/l**
Iron	Total	Lab	**1140 ug/l**	**1250 ug/l**	**1160 ug/l**	**1110 ug/l**	**1050 ug/l**	**733 ug/l**	**678 ug/l**	**715 ug/l**	**1240 ug/l**	**730 ug/l**	**451 ug/l**	**875 ug/l**	**4170 ug/l**	**3290 ug/l**	**2710 ug/l**
Lead	Total	Lab	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	--	--	--	--	--	--	< 2.0 ug/l	**0.66 ug/l**	**0.83 ug/l**	**0.86 ug/l**
Magnesium	Total	Lab	**6970 ug/l**	**5360 ug/l**	**6350 ug/l**	**7290 ug/l**	**5420 ug/l**	**10200 ug/l**	**9900 ug/l**	**7870 ug/l**	**8830 ug/l**	**10100 ug/l**	**11300 ug/l**	**5300 ug/l**	**8400 ug/l**	**8600 ug/l**	**9900 ug/l**
Manganese	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	**48.9 ug/l**	**267 ug/l**	**172 ug/l**	**276 ug/l**
Manganese	Total	Lab	**45.6 ug/l**	**64.4 ug/l**	**38.9 ug/l**	**43.7 ug/l**	**28.2 ug/l**	**25.2 ug/l**	**34.5 ug/l**	**68.1 ug/l**	**76.2 ug/l**	**125 ug/l**	**125 ug/l**	**62.4 ug/l**	**269 ug/l**	**201 ug/l**	**390 ug/l**
Mercury	Total	Lab	**0.0048 ug/l**	**0.0060 ug/l**	**0.0054 ug/l**	**0.0054 ug/l**	**0.0052 ug/l**	--	--	--	--	--	--	--	**0.0085 ug/l**	--	--
Methyl Mercury	Total	Lab	**0.00049 ug/l**	**0.00047 ug/l**	**0.00046 ug/l**	< 0.00045 ug/l	**0.00042 ug/l**	--	--	--	--	--	--	--	--	--	--
Molybdenum	Total	Lab	**0.47 ug/l**	**0.3 ug/l**	**0.3 ug/l**	**0.39 ug/l**	**0.29 ug/l**	--	--	--	--	--	--	--	**0.76 ug/l**	--	--
Nickel	Dissolved	Lab	**2.1 ug/l**	**1.8 ug/l**	**1.9 ug/l**	**2.9 ug/l**	**1.7 ug/l**	--	--	--	--	--	--	< 2.0 ug/l	**2.8 ug/l**	**3.1 ug/l**	**8.8 ug/l**
Nickel	Total	Lab	**2.6 ug/l**	**2.3 ug/l**	**2.3 ug/l**	**3.1 ug/l**	**2.0 ug/l**	--	--	--	--	--	--	< 2.0 ug/l	**3.1 ug/l**	**2.9 ug/l**	**2.3 ug/l**
Potassium	Total	Lab	**1040 ug/l**	**840 ug/l**	**970 ug/l**	**1000 ug/l**	**850 ug/l**	--	--	--	--	--	--	--	**1200 ug/l**	--	--
Selenium	Total	Lab	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	--	--	--	--	--	--	< 4.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l
Silver	Total	Lab	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	--	--	--	--	--	--	--	< 0.20 ug/l	--	--
Sodium	Total	Lab	**3420 ug/l**	**2900 ug/l**	**3290 ug/l**	**3480 ug/l**	**3140 ug/l**	--	--	--	--	--	--	--	**4900 ug/l**	--	--
Strontium	Total	Lab	**90.3 ug/l**	**40 ug/l**	**65.9 ug/l**	**128 ug/l**	**40.6 ug/l**	--	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab	**0.46 ug/l**	< 0.4 ug/l	< 0.4 ug/l	< 0.4 ug/l	< 0.4 ug/l	**0.031 ug/l**	**0.045 ug/l**	**0.039 ug/l**	**0.032 ug/l**	**0.066 b ug/l**	**0.024 ug/l**	**0.009 jb ug/l**	**0.013 j ug/l**	**0.014 j ug/l**	**0.036 ug/l**
Titanium	Total	Lab	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	--	--	--	--	--	--	--	--	--	--
Vanadium	Total	Lab	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	--	--	--	--	--	--	--	< 3.0 ug/l	--	--
Zinc	Dissolved	Lab	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	--	--	--	--	--	--	< 24.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l
Zinc	Total	Lab	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	--	--	--	--	--	--	< 24.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l

Large Table 10
Surface Water Data Summary
Colby Lake and Whitewater Reservoir

		Location	Lcy-1	Lcy-1	Lcy-1	Lcy-2		LCY-2	Lcy-2	Lcy-2		Lcy-2	Lcy-2	Lcy-2	Lcy-2	
		Date	10/30/2013	11/27/2013	12/18/2013	4/21/2010		5/12/2010	6/16/2010	7/27/2010		8/23/2010	9/20/2010	6/18/2013	7/24/2013	
		Sample Type	N	N	N	N	FD	N	N	N	FD	N	N	N	N	FD
Parameter	Total or Dissolved	Analysis Location														
General Parameters																
Alkalinity, bicarbonate, as CaCO3	NA	Lab	**63.6 mg/l**	--	--	--	--	--	--	--	--	--	--	--	**51.9 mg/l**	--
Alkalinity, total, as CaCO3	NA	Lab	**63.6 mg/l**	--	--	--	--	--	--	--	--	--	--	--	**51.9 mg/l**	--
Carbon, total organic	NA	Lab	**24.5 mg/l**	**23.9 mg/l**	**22.2 mg/l**	--	--	--	--	--	--	--	--	**22.3 mg/l**	**35.9 mg/l**	--
Chemical Oxygen Demand	NA	Lab	**77.3 mg/l**	--	--	--	--	--	--	--	--	--	--	--	**121 mg/l**	--
Chloride	NA	Lab	**4.8 mg/l**	**4.5 mg/l**	**5.1 mg/l**	--	--	--	--	--	--	--	--	**3.9 mg/l**	**3.0 mg/l**	--
Dissolved oxygen	NA	Field	**10.04 mg/l**	**13.36 mg/l**	**11.25 mg/l**	**9.95 mg/l**	--	**9.63 mg/l**	**8.31 mg/l**	**6.11 mg/l**	--	**6.81 mg/l**	**6.91 mg/l**	**7.86 mg/l**	**6.13 mg/l**	--
Fluoride	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hardness, as CaCO3	NA	Lab	**92.6 mg/l**	**94.6 mg/l**	**93.7 mg/l**	**83.4 mg/l**	**84.2 mg/l**	**85.1 mg/l**	**66.4 mg/l**	**89.5 mg/l**	**90 mg/l**	**106 mg/l**	**117 mg/l**	**46.3 mg/l**	**73.0 mg/l**	--
Nitrate + Nitrite, as N	NA	Lab	**0.20 mg/l**	--	--	--	--	--	--	--	--	--	--	--	**0.20 mg/l**	--
Nitrogen, ammonia as N	NA	Lab	**0.12 mg/l**	--	--	--	--	--	--	--	--	--	--	--	**0.30 mg/l**	--
pH	NA	Field	**7.85 mg/l**	**7.75 mg/l**	**7.37 mg/l**	**7.29 mg/l**	--	**7.70 mg/l**	**7.69 mg/l**	**7.59 mg/l**	--	**7.81 mg/l**	**7.79 mg/l**	**6.96 mg/l**	**7.13 mg/l**	--
Phosphorus, total, as P	NA	Lab	**0.024 mg/l**	--	--	--	--	--	--	--	--	--	--	--	**0.041 mg/l**	--
Solids, total dissolved	NA	Lab	**195 mg/l**	**193 mg/l**	**209 mg/l**	--	--	--	--	--	--	--	--	**125 mg/l**	**191 mg/l**	--
Solids, total suspended	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Specific Conductance @ 25 ºC	NA	Field	**200.3 umhos/cm**	**205.6 umhos/cm**	**203.8 umhos/cm**	**189.6 umhos/cm**	--	**187.6 umhos/cm**	**165 umhos/cm**	**201.9 umhos/cm**	--	**246.4 umhos/cm**	**248.5 umhos/cm**	**101.1 umhos/cm**	**132.7 umhos/cm**	--
Sulfate, as SO4	NA	Lab	**29.0 mg/l**	**31.1 mg/l**	**37.1 mg/l**	**39.5 mg/l**	**39.8 mg/l**	**36.5 mg/l**	**20.2 mg/l**	**33.2 mg/l**	**33.3 mg/l**	**38.9 mg/l**	**41.7 mg/l**	**10.1 mg/l**	**6.6 mg/l**	--
Temperature, ºC	NA	Field	**11.19 deg C**	**1.52 deg C**	**5.12 deg C**	**11.95 deg C**	--	**10.67 deg C**	**16.01 deg C**	**25.08 deg C**	--	**22.85 deg C**	**14.89 deg C**	**18.77 deg C**	**22.53 deg C**	--
Turbidity	NA	Field	**1.3 NTU**	**0 NTU**	**1.2 NTU**	**0 NTU**	--	**0 NTU**	**0 NTU**	**0 NTU**	--	**0.2 NTU**	**0 NTU**	**51.1 NTU**	**6.7 NTU**	--
Metals																
Aluminum	Dissolved	Lab	**65.5 ug/l**	**89.2 ug/l**	**81.7 ug/l**	**46.4 ug/l**	**46.3 ug/l**	**42.2 ug/l**	**71.2 ug/l**	**54.1 ug/l**	**55.1 ug/l**	**38.6 ug/l**	< 25 ug/l	**100 ug/l**	**183 ug/l**	--
Aluminum	Total	Lab	**80.7 ug/l**	**86.3 ug/l**	**92.6 ug/l**	**57.4 ug/l**	**61 ug/l**	**69 ug/l**	**83.3 ug/l**	**77.8 ug/l**	**79.5 ug/l**	**58 ug/l**	**42.8 ug/l**	**118 ug/l**	**186 ug/l**	--
Antimony	Total	Lab	< 0.50 ug/l	--	--	--	--	--	--	--	--	--	--	--	< 0.50 ug/l	--
Arsenic	Dissolved	Lab	**1.3 ug/l**	**0.90 ug/l**	**0.89 ug/l**	--	--	--	--	--	--	--	--	< 2.0 ug/l	**1.9 ug/l**	--
Arsenic	Total	Lab	**1.4 ug/l**	**0.99 ug/l**	**0.64 ug/l**	**0.53 ug/l**	**0.59 ug/l**	< 0.5 ug/l	**0.94 ug/l**	**1.0 ug/l**	< 0.1 ug/l	**0.98 ug/l**	**0.90 ug/l**	< 2.0 ug/l	**2.1 ug/l**	--
Barium	Total	Lab	< 10.0 ug/l	--	--	--	--	--	--	--	--	--	--	--	**11.3 ug/l**	--
Beryllium	Total	Lab	< 0.20 ug/l	--	--	--	--	--	--	--	--	--	--	--	< 0.20 ug/l	--
Boron	Total	Lab	**96.3 ug/l**	--	--	--	--	--	--	--	--	--	--	--	**50.2 ug/l**	--
Cadmium	Total	Lab	< 0.20 ug/l	--	--	--	--	--	--	--	--	--	--	--	< 0.20 ug/l	--
Calcium	Total	Lab	**20600 ug/l**	**21400 ug/l**	**21500 ug/l**	**19600 ug/l**	**19800 ug/l**	**19600 ug/l**	**15300 ug/l**	**21400 ug/l**	**21500 ug/l**	**25500 ug/l**	**28100 ug/l**	**9400 ug/l**	**14700 ug/l**	--
Chromium	Total	Lab	< 1.0 ug/l	--	--	--	--	--	--	--	--	--	--	--	< 1.0 ug/l	--
Cobalt	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	**0.23 ug/l**	--	--	--	--	--	--	--	--	< 0.80 ug/l	**0.66 ug/l**	--
Cobalt	Total	Lab	**0.22 ug/l**	**0.23 ug/l**	**0.20 ug/l**	--	--	--	--	--	--	--	--	< 0.80 ug/l	**0.67 ug/l**	--
Copper	Dissolved	Lab	**6.9 ug/l**	**5.6 ug/l**	**5.9 ug/l**	--	--	--	--	--	--	--	--	**2.1 ug/l**	**1.9 ug/l**	--
Copper	Total	Lab	**5.7 ug/l**	**6.0 ug/l**	**5.8 ug/l**	--	--	--	--	--	--	--	--	**2.2 ug/l**	**1.8 ug/l**	--
Iron	Dissolved	Lab	**2000 ug/l**	**1660 ug/l**	**1440 ug/l**	--	--	--	--	--	--	--	--	**972 ug/l**	**4480 ug/l**	--
Iron	Total	Lab	**2130 ug/l**	**1910 ug/l**	**1580 ug/l**	**772 ug/l**	**792 ug/l**	**765 ug/l**	**970 ug/l**	**1320 ug/l**	**1350 ug/l**	**769 ug/l**	**513 ug/l**	**1130 ug/l**	**4900 ug/l**	--
Lead	Total	Lab	**0.77 ug/l**	**0.64 ug/l**	< 0.50 ug/l	--	--	--	--	--	--	--	--	< 2.0 ug/l	< 0.50 ug/l	--
Magnesium	Total	Lab	**10000 ug/l**	**10000 ug/l**	**9800 ug/l**	**8370 ug/l**	**8440 ug/l**	**8780 ug/l**	**6860 ug/l**	**8750 ug/l**	**8820 ug/l**	**10300 ug/l**	**11400 ug/l**	**5600 ug/l**	**8800 ug/l**	--
Manganese	Dissolved	Lab	**44.8 ug/l**	**49.6 ug/l**	**68.2 ug/l**	--	--	--	--	--	--	--	--	**58.4 ug/l**	**260 ug/l**	--
Manganese	Total	Lab	**102 ug/l**	**69.0 ug/l**	**75.9 ug/l**	**28.6 ug/l**	**27.5 ug/l**	**39.5 ug/l**	**82.6 ug/l**	**80.3 ug/l**	**79.5 ug/l**	**102 ug/l**	**118 ug/l**	**63.5 ug/l**	**248 ug/l**	--
Mercury	Total	Lab	**0.0046 ug/l**	--	--	--	--	--	--	--	--	--	--	--	**0.0087 ug/l**	**0.0083 ug/l**
Methyl Mercury	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Total	Lab	**1.1 ug/l**	--	--	--	--	--	--	--	--	--	--	--	**0.73 ug/l**	--
Nickel	Dissolved	Lab	**2.4 ug/l**	**2.2 ug/l**	**2.4 ug/l**	--	--	--	--	--	--	--	--	< 2.0 ug/l	**2.7 ug/l**	--
Nickel	Total	Lab	**2.1 ug/l**	**2.4 ug/l**	**2.0 ug/l**	--	--	--	--	--	--	--	--	**2.1 ug/l**	**2.6 ug/l**	--
Potassium	Total	Lab	**1500 ug/l**	--	--	--	--	--	--	--	--	--	--	--	**1300 ug/l**	--
Selenium	Total	Lab	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	--	--	--	--	--	--	--	< 4.0 ug/l	< 1.0 ug/l	--
Silver	Total	Lab	< 0.20 ug/l	--	--	--	--	--	--	--	--	--	--	--	< 0.20 ug/l	--
Sodium	Total	Lab	**6700 ug/l**	--	--	--	--	--	--	--	--	--	--	--	**5100 ug/l**	--
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab	**0.009 j ug/l**	**0.006 j ug/l**	**0.009 j ug/l**	< 0.02 ug/l	< 0.02 ug/l	< 0.02 ug/l	**0.029 ug/l**	**0.030 ug/l**	< 0.005 ug/l	**0.053 b ug/l**	**0.026 ug/l**	< 0.005 ug/l	**0.020 j ug/l**	--
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Total	Lab	< 3.0 ug/l	--	--	--	--	--	--	--	--	--	--	--	< 3.0 ug/l	--
Zinc	Dissolved	Lab	< 6.0 ug/l	**8.1 ug/l**	**6.8 ug/l**	--	--	--	--	--	--	--	--	< 24.0 ug/l	**6.6 ug/l**	--
Zinc	Total	Lab	< 6.0 ug/l	**15.8 ug/l**	< 6.0 ug/l	--	--	--	--	--	--	--	--	< 24.0 ug/l	< 6.0 ug/l	--

Large Table 10
Surface Water Data Summary
Colby Lake and Whitewater Reservoir

Location			Lcy-2	Lcy-2	Lcy-2	Lcy-2	Lcy-2	LWr-1	LWr-1		LWr-1		LWr-1	LWr-1		LWr-1	
Date			8/20/2013	9/18/2013	10/30/2013	11/27/2013	12/18/2013	4/21/2010	5/12/2010		6/16/2010		7/27/2010	8/23/2010		9/20/2010	
Sample Type			N	N	N	N	N	N	N	FD	N	FD	N	N	FD	N	FD
Parameter	Total or Dissolved	Analysis Location															
General Parameters																	
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	--	**49.2 mg/l**	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total, as CaCO3	NA	Lab	--	--	**49.2 mg/l**	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, total organic	NA	Lab	**29.6 mg/l**	**24.2 mg/l**	**21.9 mg/l**	**18.4 mg/l**	**20.5 mg/l**	--	--	--	--	--	--	--	--	--	--
Chemical Oxygen Demand	NA	Lab	--	--	**73.7 mg/l**	--	--	--	--	--	--	--	--	--	--	--	--
Chloride	NA	Lab	**4.8 mg/l**	**5.3 mg/l**	**3.1 mg/l**	**3.9 mg/l**	**4.2 mg/l**	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	**6.87 mg/l**	**7.92 mg/l**	**11.03 mg/l**	**13.94 mg/l**	**12.63 mg/l**	**11.13 mg/l**	**9.80 mg/l**	--	**8.41 mg/l**	--	**7.08 mg/l**	**7.17 mg/l**	--	**7.65 mg/l**	--
Fluoride	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hardness, as CaCO3	NA	Lab	**82.0 mg/l**	**96.4 mg/l**	**73.0 mg/l**	**74.7 mg/l**	**77.3 mg/l**	**85.7 mg/l**	**89 mg/l**	**91.6 mg/l**	**89.6 mg/l**	**90.2 mg/l**	**90.8 mg/l**	**91.7 mg/l**	**92 mg/l**	**92.3 mg/l**	**92.8 mg/l**
Nitrate + Nitrite, as N	NA	Lab	--	--	**0.17 mg/l**	--	--	--	--	--	--	--	--	--	--	--	--
Nitrogen, ammonia as N	NA	Lab	--	--	**0.12 mg/l**	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	**8.24 mg/l**	**7.49 mg/l**	**7.82 mg/l**	**7.73 mg/l**	**7.11 mg/l**	**7.40 mg/l**	**7.95 mg/l**	--	**7.80 mg/l**	--	**8.33 mg/l**	**8.02 mg/l**	--	**8.18 mg/l**	--
Phosphorus, total, as P	NA	Lab	--	--	**0.029 mg/l**	--	--	--	--	--	--	--	--	--	--	--	--
Solids, total dissolved	NA	Lab	**204 mg/l**	**165 mg/l**	**157 mg/l**	**164 mg/l**	**184 mg/l**	--	--	--	--	--	--	--	--	--	--
Solids, total suspended	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Specific Conductance @ 25 ºC	NA	Field	**169.5 umhos/cm**	**202.5 umhos/cm**	**143.2 umhos/cm**	**157.9 umhos/cm**	**159.8 umhos/cm**	**206.6 umhos/cm**	**208.7 umhos/cm**	--	**181 umhos/cm**	--	**218.7 umhos/cm**	**220.2 umhos/cm**	--	**217.7 umhos/cm**	--
Sulfate, as SO4	NA	Lab	**16.6 mg/l**	**23.5 mg/l**	**15.5 mg/l**	**18.0 mg/l**	**14.5 mg/l**	**35.1 mg/l**	**34 mg/l**	**34 mg/l**	**35.3 mg/l**	**35.2 mg/l**	**34.8 mg/l**	**33.8 mg/l**	**33.6 mg/l**	**33.7 mg/l**	**33.8 mg/l**
Temperature, ºC	NA	Field	**23.91 deg C**	**18.32 deg C**	**6.92 deg C**	**0.42 deg C**	**1.53 deg C**	**9.54 deg C**	**10.16 deg C**	--	**17.18 deg C**	--	**23.89 deg C**	**21.84 deg C**	--	**14.64 deg C**	--
Turbidity	NA	Field	**0.9 NTU**	**0.2 NTU**	**1.8 NTU**	**3.2 NTU**	**2.4 NTU**	**0 NTU**	**0.1 NTU**	--	**0 NTU**	--	**0 NTU**	**0 NTU**	--	**0 NTU**	--
Metals																	
Aluminum	Dissolved	Lab	**130 ug/l**	**82.7 ug/l**	**83.0 ug/l**	**90.7 ug/l**	**94.2 ug/l**	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l
Aluminum	Total	Lab	**147 ug/l**	**99.9 ug/l**	**108 ug/l**	**93.3 ug/l**	**108 ug/l**	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l
Antimony	Total	Lab	--	--	< 0.50 ug/l	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	Dissolved	Lab	**1.5 ug/l**	**1.2 ug/l**	**0.92 ug/l**	**0.66 ug/l**	**0.53 ug/l**	--	--	--	--	--	--	--	--	--	--
Arsenic	Total	Lab	**1.8 ug/l**	**1.3 ug/l**	**1.2 ug/l**	**0.69 ug/l**	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	**0.53 ug/l**	**0.52 ug/l**	**0.6 ug/l**	**0.59 ug/l**	**0.56 ug/l**	**0.58 ug/l**	**0.62 ug/l**
Barium	Total	Lab	--	--	< 10.0 ug/l	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	Total	Lab	--	--	< 0.20 ug/l	--	--	--	--	--	--	--	--	--	--	--	--
Boron	Total	Lab	--	--	**60.5 ug/l**	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	Total	Lab	--	--	< 0.20 ug/l	--	--	--	--	--	--	--	--	--	--	--	--
Calcium	Total	Lab	**18000 ug/l**	**21200 ug/l**	**15300 ug/l**	**15300 ug/l**	**15400 ug/l**	**20100 ug/l**	**20500 ug/l**	**21100 ug/l**	**20800 ug/l**	**20900 ug/l**	**20900 ug/l**	**20900 ug/l**	**21000 ug/l**	**21200 ug/l**	**21400 ug/l**
Chromium	Total	Lab	--	--	< 1.0 ug/l	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	Dissolved	Lab	**0.34 ug/l**	**0.27 ug/l**	< 0.20 ug/l	**0.21 ug/l**	**0.20 ug/l**	--	--	--	--	--	--	--	--	--	--
Cobalt	Total	Lab	**0.38 ug/l**	**0.34 ug/l**	**0.21 ug/l**	< 0.20 ug/l	< 0.20 ug/l	--	--	--	--	--	--	--	--	--	--
Copper	Dissolved	Lab	**4.7 ug/l**	**4.8 ug/l**	**3.5 ug/l**	**2.6 ug/l**	**2.8 ug/l**	--	--	--	--	--	--	--	--	--	--
Copper	Total	Lab	**4.8 ug/l**	**4.9 ug/l**	**3.6 ug/l**	**2.5 ug/l**	**2.8 ug/l**	--	--	--	--	--	--	--	--	--	--
Iron	Dissolved	Lab	**3490 ug/l**	**2520 ug/l**	**1580 ug/l**	**1330 ug/l**	**1480 ug/l**	--	--	--	--	--	--	--	--	--	--
Iron	Total	Lab	**3350 ug/l**	**2830 ug/l**	**1890 ug/l**	**1550 ug/l**	**1810 ug/l**	**53.3 ug/l**	**50.3 ug/l**	**52.5 ug/l**	**72.6 ug/l**	**76.5 ug/l**	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l
Lead	Total	Lab	**0.73 ug/l**	**0.78 ug/l**	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	--	--	--	--	--	--	--	--	--
Magnesium	Total	Lab	**9000 ug/l**	**10600 ug/l**	**8400 ug/l**	**8900 ug/l**	**9400 ug/l**	**8630 ug/l**	**9170 ug/l**	**9440 ug/l**	**9160 ug/l**	**9220 ug/l**	**9370 ug/l**	**9600 ug/l**	**9600 ug/l**	**9550 ug/l**	**9550 ug/l**
Manganese	Dissolved	Lab	**176 ug/l**	**194 ug/l**	**52.7 ug/l**	**54.1 ug/l**	**69.3 ug/l**	--	--	--	--	--	--	--	--	--	--
Manganese	Total	Lab	**199 ug/l**	**283 ug/l**	**75.7 ug/l**	**58.5 ug/l**	**69.4 ug/l**	**12.8 ug/l**	**12 ug/l**	**12 ug/l**	**8.3 ug/l**	**8.5 ug/l**	**7.31 ug/l**	**11.2 ug/l**	**11.6 ug/l**	**14.4 ug/l**	**13 ug/l**
Mercury	Total	Lab	--	--	**0.0051 ug/l**	--	--	--	--	--	--	--	--	--	--	--	--
Methyl Mercury	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Total	Lab	--	--	**0.62 ug/l**	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	Dissolved	Lab	**2.8 ug/l**	**2.1 ug/l**	**1.7 ug/l**	**1.4 ug/l**	**1.4 ug/l**	--	--	--	--	--	--	--	--	--	--
Nickel	Total	Lab	**2.8 ug/l**	**2.1 ug/l**	**1.7 ug/l**	**1.4 ug/l**	**1.1 ug/l**	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	--	--	**1400 ug/l**	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	Total	Lab	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	--	--	--	--	--	--	--	--	--
Silver	Total	Lab	--	--	< 0.20 ug/l	--	--	--	--	--	--	--	--	--	--	--	--
Sodium	Total	Lab	--	--	**5200 ug/l**	--	--	--	--	--	--	--	--	--	--	--	--
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab	**0.013 j ug/l**	**0.017 j ug/l**	**0.005 j ug/l**	**0.003 j ug/l**	**0.004 j ug/l**	< 0.02 ug/l	< 0.02 ug/l	< 0.02 ug/l	**0.023 ug/l**	**0.049 ug/l**	< 0.005 ug/l	**0.020 b ug/l**	**0.020 b ug/l**	< 0.002 ug/l	< 0.002 ug/l
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Total	Lab	--	--	< 3.0 ug/l	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	Dissolved	Lab	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	**8.0 ug/l**	--	--	--	--	--	--	--	--	--	--
Zinc	Total	Lab	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	**6.1 ug/l**	--	--	--	--	--	--	--	--	--	--

Large Table 10
Surface Water Data Summary
Colby Lake and Whitewater Reservoir

		Location	LWr-2	LWr-2	LWr-2	LWr-2	LWr-2	LWr-2
		Date	4/21/2010	5/12/2010	6/16/2010	7/27/2010	8/23/2010	9/20/2010
		Sample Type	N	N	N	N	N	N
Parameter	Total or Dissolved	Analysis Location						
General Parameters								
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	--	--	--	--	--
Alkalinity, total, as CaCO3	NA	Lab	--	--	--	--	--	--
Carbon, total organic	NA	Lab	--	--	--	--	--	--
Chemical Oxygen Demand	NA	Lab	--	--	--	--	--	--
Chloride	NA	Lab	--	--	--	--	--	--
Dissolved oxygen	NA	Field	**11.09 mg/l**	**10.05 mg/l**	**8.11 mg/l**	**7.48 mg/l**	**7.07 mg/l**	**7.61 mg/l**
Fluoride	NA	Lab	--	--	--	--	--	--
Hardness, as CaCO3	NA	Lab	**86.3 mg/l**	**90.3 mg/l**	**91.2 mg/l**	**89.3 mg/l**	**92.8 mg/l**	**91.2 mg/l**
Nitrate + Nitrite, as N	NA	Lab	--	--	--	--	--	--
Nitrogen, ammonia as N	NA	Lab	--	--	--	--	--	--
pH	NA	Field	**7.51 mg/l**	**8.16 mg/l**	**7.90 mg/l**	**8.21 mg/l**	**8.08 mg/l**	**8.07 mg/l**
Phosphorus, total, as P	NA	Lab	--	--	--	--	--	--
Solids, total dissolved	NA	Lab	--	--	--	--	--	--
Solids, total suspended	NA	Lab	--	--	--	--	--	--
Specific Conductance @ 25 ºC	NA	Field	**207.1 umhos/cm**	**208.4 umhos/cm**	**198 umhos/cm**	**199 umhos/cm**	**219.7 umhos/cm**	**219.1 umhos/cm**
Sulfate, as SO4	NA	Lab	**35.1 mg/l**	**34.1 mg/l**	**35.2 mg/l**	**34.5 mg/l**	**32.9 mg/l**	**33.8 mg/l**
Temperature, °C	NA	Field	**10.62 deg C**	**10.02 deg C**	**17.03 deg C**	**23.88 deg C**	**21.44 deg C**	**14.60 deg C**
Turbidity	NA	Field	**0 NTU**	**0.2 NTU**	**0 NTU**	**0 NTU**	**0 NTU**	**0 NTU**
Metals								
Aluminum	Dissolved	Lab	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l
Aluminum	Total	Lab	< 25 ug/l	**25.4 ug/l**	< 25 ug/l	< 25 ug/l	< 25 ug/l	**25.1 ug/l**
Antimony	Total	Lab	--	--	--	--	--	--
Arsenic	Dissolved	Lab	--	--	--	--	--	--
Arsenic	Total	Lab	< 0.5 ug/l	< 0.5 ug/l	**0.51 ug/l**	**0.5 j ug/l**	**0.58 ug/l**	**0.55 ug/l**
Barium	Total	Lab	--	--	--	--	--	--
Beryllium	Total	Lab	--	--	--	--	--	--
Boron	Total	Lab	--	--	--	--	--	--
Cadmium	Total	Lab	--	--	--	--	--	--
Calcium	Total	Lab	**20200 ug/l**	**20800 ug/l**	**21100 ug/l**	**20500 ug/l**	**21200 ug/l**	**21100 ug/l**
Chromium	Total	Lab	--	--	--	--	--	--
Cobalt	Dissolved	Lab	--	--	--	--	--	--
Cobalt	Total	Lab	--	--	--	--	--	--
Copper	Dissolved	Lab	--	--	--	--	--	--
Copper	Total	Lab	--	--	--	--	--	--
Iron	Dissolved	Lab	--	--	--	--	--	--
Iron	Total	Lab	**62.6 ug/l**	**57.5 ug/l**	< 50 ug/l	< 50 ug/l	< 50 ug/l	< 50 ug/l
Lead	Total	Lab	--	--	--	--	--	--
Magnesium	Total	Lab	**8720 ug/l**	**9310 ug/l**	**9350 ug/l**	**9250 ug/l**	**9690 ug/l**	**9350 ug/l**
Manganese	Dissolved	Lab	--	--	--	--	--	--
Manganese	Total	Lab	**12 ug/l**	**8.97 ug/l**	**6.87 ug/l**	**9.97 ug/l**	**14.6 ug/l**	**11.9 ug/l**
Mercury	Total	Lab	--	--	--	--	--	--
Methyl Mercury	Total	Lab	--	--	--	--	--	--
Molybdenum	Total	Lab	--	--	--	--	--	--
Nickel	Dissolved	Lab	--	--	--	--	--	--
Nickel	Total	Lab	--	--	--	--	--	--
Potassium	Total	Lab	--	--	--	--	--	--
Selenium	Total	Lab	--	--	--	--	--	--
Silver	Total	Lab	--	--	--	--	--	--
Sodium	Total	Lab	--	--	--	--	--	--
Strontium	Total	Lab	--	--	--	--	--	--
Thallium	Total	Lab	< 0.02 ug/l	**0.035 ug/l**	**0.021 ug/l**	< 0.005 ug/l	**0.021 b ug/l**	< 0.002 ug/l
Titanium	Total	Lab	--	--	--	--	--	--
Vanadium	Total	Lab	--	--	--	--	--	--
Zinc	Dissolved	Lab	--	--	--	--	--	--
Zinc	Total	Lab	--	--	--	--	--	--

Large Table 10
Surface Water Data Summary
Colby Lake and Whitewater Reservoir

Data Qualifiers/Footnotes	
Qualifier	**Definition**
	Data not used in December 2014 probabilistic modeling.
--	Not analyzed/not available.
a	Estimated value, calculated using some or all values that are estimates.
b	Potential false positive value based on blank data validation procedures.
c	Coeluting compound.
e	Estimated value, exceeded the instrument calibration range.
f	Sample was collected at a flowrate exceeding the recommended rate of 200 mL/minute.
h	EPA recommended sample preservation, extraction or analysis holding time was exceeded.
i	Indeterminate value based on failure of blind duplicate data to meet quality assurance criteria.
j	Reported value is less than the stated laboratory quantitation limit and is considered an estimated value.
p	Relative percent difference is >40% (25% CLP pesticides) between primary and confirmation GC columns.
pp	Small peak in chromatogram below method detection limit.
r	The presence of the compound is suspect based on the ID criteria of the retention time and relative retention time obtained from the examination of the chromatograms.
s	Potential false positive value based on statistical analysis of blank sample data.
t	Sample positive for total coliforms but negative for *E. coli.*
v	Sample was collected under a vacuum of greater than XX inches of mercury.
*	Estimated value, QA/QC criteria not met.
**	Unusable value, QA/QC criteria not met.
N	Sample Type: Normal
FD	Sample Type: Field Duplicate
AT	Sample chromatogram is noted to be atypical of a petroleum product.
DLND	Not detected, detection limit not determined.
DF	Did not flash
EMPC	Estimated maximum possible concentration.
NA – (Not applicable)	NA indicates that a fractional portion of the sample is not part of the analytical testing or field collection procedures.
ND	Not detected.
TIC	Tentatively identified compound
BQA	Barr-applied project specific qualifier: extraction and/or analyses conducted using an alternative method and/or procedure.
BQC	Barr-applied project specific qualifier: plant shut down.
BQD	Barr-applied project specific qualifier: equipment malfunction.
BQE	Barr-applied project specific qualifier: equipment adjustment.
BQM	Barr-applied project specific qualifier: manual measurement.
BQN	Barr-applied project specific qualifier: unable to be sampled or measured due to various reasons.
BQP	Barr-applied project specific qualifier: atypical chromatographic pattern.
BQQ	Barr-applied project specific qualifier: some aspect of QA/QC was not met.
BQR	Barr-applied project specific qualifier: location was re-sampled.
BQS	Barr-applied project specific qualifier: data is considered suspect.
BQT	Barr-applied project specific qualifier: summed value not displayed due to insufficient field length.
BQU	Barr-applied project specific qualifier: historical qualifier - definition unknown.
BQV	Barr-applied project specific qualifier: estimated value.
BQX	Barr-applied project specific qualifier: see notes for qualifier definition.
BQZ	Barr-applied project specific qualifier: data is considered unusable.
Validated	Laboratory data has been evaluated following Barr QA/QC procedures and/or project-specific data review requirements. Field data has been verified for transcription errors, consistency and completeness. Data transferred from the previous database (9/2009) were categorized as validated, but may be comprised of any one of the following data status categories: Validated, SSource, No QC or Legacy.
No QC	Laboratory data has been excluded from Barr QA/QC procedures.
SSource	Laboratory and/or field data obtained from a secondary source external to Barr. Second source QA/QC evaluation procedures may or may not have been performed beyond the original data generator.
Legacy	Historical laboratory data (internal at Barr). QA/QC evaluation procedures may or may not have been performed beyond the original data generator

Large Table 11
Surface Water Data Summary
Partridge River Watershed and Wyman Creek

Location			PM-1 [1]	PM-1 [1]	PM-1 [1]	PM-1 [1]	PM-1 [1]	PM-1 [1]	PM-1 [1]	PM-1 [1]	PM-1 [1]	PM-1 [1]	PM-2 [1]	PM-2 [1]	PM-2 [1]	PM-2 [1]	PM-2 [1]	PM-2 [1]	PM-2 [1]	PM-2 [1]
Date			4/14/2004	5/20/2004	6/23/2004	7/28/2004	8/25/2004	9/28/2004	10/25/2004	11/16/2004	7/11/2006	5/29/2008	4/14/2004	5/20/2004	6/23/2004	7/28/2004	8/25/2004	9/28/2004	10/25/2004	11/16/2004
Sample Type			N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Parameter	Total or Dissolved	Analysis Location																		
General Parameters																				
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total, as CaCO3	NA	Lab	**92 mg/l**	**96 mg/l**	**93 mg/l**	**92.3 mg/l**	**93 mg/l**	**96.8 mg/l**	**93.4 mg/l**	**106 mg/l**	**98.9 mg/l**	**84.3 mg/l**	**52 mg/l**	**46 mg/l**	**98.1 mg/l**	**111 mg/l**	**92.6 mg/l**	**66.1 mg/l**	**65 mg/l**	**35.7 mg/l**
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, total organic	NA	Lab	**1.8 mg/l**	**1.9 mg/l**	**2.3 mg/l**	**2.1 mg/l**	--	**2.4 mg/l**	--	**1.9 mg/l**	**2.4 mg/l**	**2.2 mg/l**	**9.5 mg/l**	**15.3 mg/l**	**6.4 mg/l**	**8.5 mg/l**	--	**25.9 mg/l**	--	**12.7 mg/l**
Chemical Oxygen Demand	NA	Lab	**24 mg/l**	< 1 mg/l	**14 mg/l**	**2.2 mg/l**	--	**9 mg/l**	--	**4 mg/l**	< 10 mg/l	--	**40 mg/l**	**39 mg/l**	**26 mg/l**	**14.2 mg/l**	--	**65.2 mg/l**	--	**27 mg/l**
Chloride	NA	Lab	**0.9 mg/l**	**1.2 mg/l**	**1.6 mg/l**	**1.8 mg/l**	**1.8 mg/l**	**1.9 mg/l**	**1.8 mg/l**	**1.5 mg/l**	**1.81 mg/l**	**2.09 mg/l**	**1.2 mg/l**	**1.4 mg/l**	**1.4 mg/l**	**0.7 mg/l**	**2 mg/l**	**3.4 mg/l**	**2.5 mg/l**	**2.5 mg/l**
Cyanide	NA	Lab	< 0.02 mg/l	< 0.02 mg/l	< 0.02 mg/l	< 0.02 mg/l	--	--	--	--	--	--	< 0.02 mg/l	< 0.02 mg/l	< 0.02 mg/l	< 0.02 mg/l	--	--	--	--
Dissolved oxygen	NA	Lab	**15.2 mg/l**	**9.3 mg/l**	--	--	--	--	--	--	**9.58 mg/l**	--	**12.8 mg/l**	**7.2 mg/l**	--	--	--	--	--	--
Dissolved oxygen	NA	Field	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluoride	NA	Lab	**0.12 mg/l**	**0.16 mg/l**	**0.15 mg/l**	**0.17 mg/l**	**0.14 mg/l**	**0.14 mg/l**	**0.13 mg/l**	**0.11 mg/l**	**0.15 mg/l**	--	< 0.1 mg/l	**0.14 mg/l**	**0.14 mg/l**	**0.17 mg/l**	**0.14 mg/l**	**0.12 mg/l**	**0.1 mg/l**	< 0.1 mg/l
Hardness, as CaCO3	NA	Lab	**77.5 mg/l**	**81 mg/l**	**80.5 mg/l**	**102 mg/l**	**108 mg/l**	**105 mg/l**	**101 mg/l**	**102 mg/l**	**110 mg/l**	**103 mg/l**	**44.4 mg/l**	**38.5 mg/l**	**76.2 mg/l**	**109 mg/l**	**99.8 mg/l**	**75 mg/l**	**67.7 mg/l**	**69.3 mg/l**
Nitrate + Nitrite, as N	NA	Lab	**0.14 mg/l**	**0.2 mg/l**	**0.2 mg/l**	< 0.1 mg/l	--	**0.16 mg/l**	--	< 0.1 mg/l	< 0.1 mg/l	--	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	--	< 0.1 mg/l	--	< 0.1 mg/l
Nitrogen, ammonia as N	NA	Lab	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	--	--	--	--	--	--	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	--	--	--	--
pH	NA	Lab	**8 pH units**	**8.44 pH units**	**8.73 pH units**	**8.66 pH units**	**8.23 pH units**	**8.19 pH units**	**8.04 pH units**	**8.2 pH units**	**8.5 pH units**	--	**7.8 pH units**	**7.14 pH units**	**7.55 pH units**	**7.24 pH units**	**6.97 pH units**	**7.43 pH units**	**7.74 pH units**	**7.56 pH units**
pH	NA	Field	--	--	--	--	--	--	--	--	**8.46 pH units**	--	--	--	--	--	--	--	--	--
Phosphorus, total, as P	NA	Lab	**0.11 mg/l**	< 0.1 mg/l	< 0.1 mg/l	**0.14 mg/l**	--	< 0.1 mg/l	--	< 0.1 mg/l	< 0.1 mg/l	< 0.004 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	**0.2 mg/l**	--	< 0.1 mg/l	--	< 0.1 mg/l
Redox (oxidation potential)	NA	Field	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Solids, total dissolved	NA	Lab	**107 mg/l**	**116 mg/l**	**144 mg/l**	**93 mg/l**	**116 mg/l**	**131 mg/l**	**100 mg/l**	**123 mg/l**	**130 mg/l**	**129 mg/l**	**80 mg/l**	**78 mg/l**	**137 mg/l**	**106 mg/l**	**115 mg/l**	**136 mg/l**	**100 mg/l**	**109 mg/l**
Solids, total suspended	NA	Lab	**3 mg/l**	< 1 mg/l	**2 mg/l**	**1 mg/l**	--	**1 mg/l**	--	< 1 mg/l	< 1 mg/l	**2 mg/l**	< 1 mg/l	< 1 mg/l	**1 mg/l**	**7 mg/l**	--	**15 mg/l**	--	**1 mg/l**
Specific Conductance @ 25 ºC	NA	Lab	**214 umhos/cm**	**226.6 umhos/cm**	**215.2 umhos/cm**	**221.1 umhos/cm**	**245.7 umhos/cm**	**246.9 umhos/cm**	**231.1 umhos/cm**	**233.5 umhos/cm**	**236 umhos/cm**	--	**117 umhos/cm**	**111 umhos/cm**	**196 umhos/cm**	**213.1 umhos/cm**	**218 umhos/cm**	**152.4 umhos/cm**	**150.8 umhos/cm**	**164.6 umhos/cm**
Specific Conductance @ 25 ºC	NA	Field	--	--	--	--	--	--	--	--	**244.8 umhos/cm**	--	--	--	--	--	--	--	--	--
Sulfate, as SO4	NA	Lab	**19.3 mg/l**	**20.7 mg/l**	**22.5 mg/l**	**22 mg/l**	**19.6 mg/l**	**21.4 mg/l**	**26.1 mg/l**	**24 mg/l**	**22.9 mg/l**	**19.2 mg/l**	**10.2 mg/l**	**9.9 mg/l**	**6.2 mg/l**	**0.13 mg/l**	< 1 mg/l	< 1 mg/l	**8.8 mg/l**	**8.6 mg/l**
Temperature, ºC	NA	Lab	**4.1 deg C**	**13.6 deg C**	**16.3 deg C**	**21.4 deg C**	**20.8 deg C**	**13.1 deg C**	**9.1 deg C**	**4 deg C**	**21.1 deg C**	--	**0.6 deg C**	**11.6 deg C**	**18 deg C**	**20.5 deg C**	**18.4 deg C**	**12.7 deg C**	**8.5 deg C**	**1.7 deg C**
Temperature, ºC	NA	Field	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Turbidity	NA	Lab	**1 NTU**	**1.2 NTU**	--	--	--	--	--	--	**0.47 NTU**	--	**2 NTU**	**1.2 NTU**	--	--	--	--	--	--
Turbidity	NA	Field	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Metals																				
Aluminum	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Aluminum	Total	Lab	< 10 ug/l	**10.1 ug/l**	**11.8 ug/l**	**25.8 ug/l**	**33.9 ug/l**	< 25 ug/l	< 25 ug/l	< 25 ug/l	**28.1 ug/l**	**27.4 ug/l**	**34.5 ug/l**	**70.7 ug/l**	**13 ug/l**	**25.9 ug/l**	**46.4 ug/l**	**83.8 ug/l**	**37.6 ug/l**	**49.1 ug/l**
Antimony	Total	Lab	< 3 ug/l	< 3 ug/l	< 3 ug/l	< 3 ug/l	--	--	--	--	--	--	< 3 ug/l	< 3 ug/l	< 3 ug/l	< 3 ug/l	--	--	--	--
Arsenic	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	Total	Lab	**6.8 ug/l**	< 2 ug/l	**6.6 ug/l**	**11.7 ug/l**	--	--	--	--	--	--	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	--	--	--	--
Barium	Total	Lab	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	--	--	--	--	--	--	< 10 ug/l	< 10 ug/l	**12.3 ug/l**	**16.2 ug/l**	--	--	--	--
Beryllium	Total	Lab	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	--	--	--	--	--	--	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	--	--	--	--
Boron	Total	Lab	**80.9 ug/l**	**99.6 ug/l**	**88.8 ug/l**	**95.4 ug/l**	**108 ug/l**	**116 ug/l**	**93.5 ug/l**	**93 ug/l**	**88.5 ug/l**	--	< 35 ug/l	**37.7 ug/l**	**87.1 ug/l**	**85 ug/l**	**61.9 ug/l**	**55.5 ug/l**	**50 ug/l**	**44.5 ug/l**
Cadmium	Total	Lab	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	--	--	--	--	--	< 0.20 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	--	--	--	--
Calcium	Total	Lab	**24100 ug/l**	**25300 ug/l**	**24900 ug/l**	**23100 ug/l**	**25300 ug/l**	**24500 ug/l**	**23400 ug/l**	**23700 ug/l**	**25900 ug/l**	**25300 ug/l**	**14300 ug/l**	**12800 ug/l**	**25300 ug/l**	**27800 ug/l**	**25400 ug/l**	**18800 ug/l**	**17200 ug/l**	**17500 ug/l**
Chromium	Total	Lab	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	--	--	--	--	--	< 0.50 ug/l	**1.5 ug/l**	< 1 ug/l	< 1 ug/l	< 1 ug/l	--	--	--	--
Cobalt	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	Total	Lab	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	--	< 1 ug/l	--	< 1 ug/l	< 1 ug/l	**0.10 j ug/l**	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	--	< 1 ug/l	--	< 1 ug/l
Copper	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	Total	Lab	< 5 ug/l	< 5 ug/l	< 5 ug/l	**1.9 ug/l**	**1.4 ug/l**	**0.95 ug/l**	< 0.66 ug/l	< 0.66 ug/l	**2.5 ug/l**	**0.80 ug/l**	< 5 ug/l	< 5 ug/l	< 5 ug/l	< 0.8 ug/l	< 0.66 ug/l	< 0.66 ug/l	< 0.66 ug/l	< 0.66 ug/l
Iron	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Iron	Total	Lab	< 30 ug/l	< 30 ug/l	**40 ug/l**	**30 ug/l**	--	**30 ug/l**	--	**50 ug/l**	**0.06 ug/l**	--	**540 ug/l**	**710 ug/l**	**1060 ug/l**	**1600 ug/l**	--	**2210 ug/l**	--	**1130 ug/l**
Lead	Total	Lab	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 0.3 ug/l	< 0.3 ug/l	< 0.3 ug/l	< 0.3 ug/l	< 0.6 ug/l	**0.054 jb ug/l**	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 0.3 ug/l	**0.6 ug/l**	< 0.3 ug/l	**0.3 ug/l**
Magnesium	Total	Lab	**10100 ug/l**	**10400 ug/l**	**10500 ug/l**	**10800 ug/l**	**10800 ug/l**	**10500 ug/l**	**10200 ug/l**	**10300 ug/l**	**11000 ug/l**	**9580 ug/l**	**5600 ug/l**	**4700 ug/l**	**9300 ug/l**	**9700 ug/l**	**8800 ug/l**	**6800 ug/l**	**6000 ug/l**	**6200 ug/l**
Manganese	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	Total	Lab	**10 ug/l**	< 10 ug/l	**10 ug/l**	**10 ug/l**	--	**10 ug/l**	--	**10 ug/l**	< 10 ug/l	**3.4 ug/l**	**80 ug/l**	**50 ug/l**	**80 ug/l**	**290 ug/l**	--	**170 ug/l**	--	**180 ug/l**
Mercury	Total	Lab	**0.0008 ug/l**	**0.0022 ug/l**	**0.0007 ug/l**	< 0.01 ug/l	**0.0009 ug/l**	< 0.004 ug/l	< 0.01 ug/l	< 0.01 ug/l	< 0.002 ug/l	**0.0005 ug/l**	**0.0027 ug/l**	**0.0037 ug/l**	< 0.004 ug/l	< 0.01 ug/l	**0.0025 ug/l**	< 0.004 ug/l	< 0.01 ug/l	< 0.01 ug/l
Methyl Mercury	Total	Lab	--	--	--	--	--	--	--	--	--	< 0.0001 ug/l	--	--	--	--	--	--	--	--
Molybdenum	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Total	Lab	< 5 ug/l	< 5 ug/l	< 5 ug/l	< 5 ug/l	--	--	--	--	--	**2.0 ug/l**	< 5 ug/l	< 5 ug/l	< 5 ug/l	< 5 ug/l	--	--	--	--
Nickel	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	Total	Lab	< 5 ug/l	< 5 ug/l	< 5 ug/l	< 5 ug/l	**1.2 ug/l**	< 0.6 ug/l	< 0.6 ug/l	**0.62 ug/l**	< 0.6 ug/l	**1.2 ug/l**	< 5 ug/l	< 5 ug/l	< 5 ug/l	< 5 ug/l	**0.67 ug/l**	**1.1 ug/l**	< 0.81 ug/l	**0.91 ug/l**
Palladium	Total	Lab	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 0.3 ug/l	--	--	--	--	--	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 0.3 ug/l	--	--	--
Phosphorus, total, as P	Dissolved	Lab	--	--	--	--	--	--	--	--	< 20 ug/l	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 0.25 ug/l	--	--	--	--	--	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 0.25 ug/l	--	--	--
Potassium	Total	Lab	**2500 ug/l**	**2600 ug/l**	**2700 ug/l**	**2700 ug/l**	--	**3000 ug/l**	--	**2700 ug/l**	**2380 ug/l**	--	**2000 ug/l**	**1900 ug/l**	**2100 ug/l**	**1800 ug/l**	--	**2300 ug/l**	--	**2200 ug/l**
Selenium	Total	Lab	< 2 ug/l	< 2 ug/l	< 10 ug/l	< 2 ug/l	< 3.6 ug/l	< 3.6 ug/l	< 3.6 ug/l	< 3.6 ug/l	< 1 ug/l	--	< 2 ug/l	< 2 ug/l	< 10 ug/l	< 2 ug/l	< 3.6 ug/l	< 3.6 ug/l	< 3.6 ug/l	< 3.6 ug/l
Silver	Total	Lab	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 0.24 ug/l	< 0.24 ug/l	< 0.24 ug/l	< 0.24 ug/l	< 0.2 ug/l	--	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 0.24 ug/l	< 0.24 ug/l	< 0.24 ug/l	< 0.24 ug/l
Sodium	Total	Lab	**4100 ug/l**	**4600 ug/l**	**4800 ug/l**	**4700 ug/l**	**4800 ug/l**	**4800 ug/l**	**5000 ug/l**	**5700 ug/l**	**4510 ug/l**	--	**2200 ug/l**	**2300 ug/l**	**3900 ug/l**	**3600 ug/l**	**3300 ug/l**	**2600 ug/l**	**2800 ug/l**	**3300 ug/l**
Strontium	Total	Lab	**148 ug/l**	**156 ug/l**	**161 ug/l**	**161 ug/l**	--	--	--	--	--	--	**76 ug/l**	**67.2 ug/l**	**145 ug/l**	**156 ug/l**	--	--	--	--
Thallium	Total	Lab	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	**0.63 ug/l**	< 0.4 ug/l	< 0.4 ug/l	< 0.4 ug/l	< 0.4 ug/l	--	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 0.4 ug/l	< 0.4 ug/l	< 0.4 ug/l	< 0.4 ug/l
Tin	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Titanium	Total	Lab	< 10 ug/l	--	--	--	--	--	--	--	--	--	< 10 ug/l	--	--	--	--	--	--	--
Vanadium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	Total	Lab	< 10 ug/l	< 10 ug/l	< 10 ug/l	**10.3 ug/l**	**12.6 ug/l**	< 10 ug/l	< 10 ug/l	**10.7 ug/l**	**29 ug/l**	**0.94 j ug/l**	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	**21.7 ug/l**	**12.3 ug/l**

1 - Some monitoring locations are listed by multiple names. Equivalent locations include the following: PM-1 = SW003, PM-2 = SW002, PM-3 = SW003, PM-4 = SW005, PM16 = SW004

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Large Table 11
Surface Water Data Summary
Partridge River Watershed and Wyman Creek

Location			PM-2 [1]	PM-2 [1]	PM-2 [1]	PM-2 [1]	PM-2 [1]	PM-2 [1]	PM-2 [1]		PM-2 [1]		PM-2 [1]	PM-2 [1]	PM-2 [1]	PM-2 [1]		PM-2 [1]	PM-2 [1]	PM-2 [1]	PM-2 [1]
Date			7/11/2006	6/27/2012	6/27/2012	7/26/2012	8/23/2012	9/25/2012	10/30/2012		11/26/2012		12/18/2012	1/24/2013	2/28/2013	3/22/2013		4/22/2013	5/9/2013	6/17/2013	7/22/2013
Sample Type			N	FD	N	N	N	N	N	FD	N	FD	N	N	N	N	FD	N	N	N	N
Parameter	Total or Dissolved	Analysis Location																			
General Parameters																					
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	110 mg/l	110 mg/l	--	--	171 mg/l	--	--	--	--	184 mg/l	--	--	119 mg/l	--	--	--	--	120 mg/l
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total, as CaCO3	NA	Lab	114 mg/l	110 mg/l	110 mg/l	--	--	171 mg/l	--	--	--	--	184 mg/l	--	--	119 mg/l	--	--	--	--	120 mg/l
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, total organic	NA	Lab	7 mg/l	6.5 mg/l	6.9 mg/l	8.7 mg/l	13.1 mg/l	8.7 mg/l	6.6 mg/l	6.7 mg/l	6.0 mg/l	5.8 mg/l	9.1 mg/l	11.1 mg/l	12.2 mg/l	12.4 mg/l	--	15.3 mg/l	6.4 mg/l	5.4 mg/l	6.8 mg/l
Chemical Oxygen Demand	NA	Lab	< 10 mg/l	20.0 mg/l	13.3 mg/l	--	--	26.3 mg/l	--	--	--	--	25.4 mg/l	--	--	65.5 mg/l	--	--	--	--	22.4 mg/l
Chloride	NA	Lab	1.4 mg/l	49.7 mg/l	49.6 mg/l	33.8 mg/l	34.3 mg/l	42.3 mg/l	44.2 mg/l	44.2 mg/l	55.2 mg/l	54.9 mg/l	54.5 mg/l	43.8 mg/l	27.5 mg/l	12.0 mg/l	--	18.1 mg/l	38.9 mg/l	35.6 mg/l	32.0 mg/l
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Lab	2.89 mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	--	--	5.01 mg/l	7.34 mg/l	6.57 mg/l	9.67 mg/l	10.83 mg/l	--	11.75 mg/l	--	10.65 mg/l	7.24 mg/l	4.83 mg/l	5.55 mg/l	--	--	8.36 mg/l	8.36 mg/l	6.29 mg/l
Fluoride	NA	Lab	0.12 mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hardness, as CaCO3	NA	Lab	112 mg/l	184 mg/l	183 mg/l	157 mg/l	174 mg/l	182 mg/l	174 mg/l	175 mg/l	222 mg/l	223 mg/l	228 mg/l	224 mg/l	185 mg/l	121 mg/l	--	104 mg/l	137 mg/l	138 mg/l	167 mg/l
Nitrate + Nitrite, as N	NA	Lab	< 0.1 mg/l	2.0 mg/l	2.0 mg/l	--	--	< 0.10 mg/l	--	--	--	--	< 0.10 mg/l	--	--	0.17 mg/l	--	--	--	--	0.21 mg/l
Nitrogen, ammonia as N	NA	Lab	--	< 0.10 mg/l	< 0.10 mg/l	--	--	0.19 mg/l	--	--	--	--	0.45 mg/l	--	--	2.8 mg/l	--	--	--	--	< 0.10 mg/l
pH	NA	Lab	7.3 pH units	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	7.2 pH units	--	7.44 pH units	7.24 pH units	7.58 pH units	7.75 pH units	6.12 pH units	--	7.02 pH units	--	6.71 pH units	6.86 pH units	6.54 pH units	6.39 pH units	--	--	6.71 pH units	7.12 pH units	7.36 pH units
Phosphorus, total, as P	NA	Lab	< 0.1 mg/l	0.0040 mg/l	0.0050 mg/l	--	--	< 0.0040 mg/l	--	--	--	--	0.016 mg/l	--	--	0.078 mg/l	--	--	--	--	0.012 mg/l
Redox (oxidation potential)	NA	Field	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Solids, total dissolved	NA	Lab	140 mg/l	320 mg/l	320 mg/l	260 mg/l	312 mg/l	295 mg/l	292 mg/l	295 mg/l	395 mg/l	422 mg/l	378 mg/l	340 mg/l	277 mg/l	201 mg/l	--	185 mg/l	246 mg/l	255 mg/l	266 mg/l
Solids, total suspended	NA	Lab	1 mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Specific Conductance @ 25 °C	NA	Lab	230 umhos/cm	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Specific Conductance @ 25 °C	NA	Field	240.8 umhos/cm	--	546.1 umhos/cm	345.8 umhos/cm	451.7 umhos/cm	391.6 umhos/cm	485.8 umhos/cm	--	548.2 umhos/cm	--	555.1 umhos/cm	554.5 umhos/cm	441.7 umhos/cm	342.6 umhos/cm	--	--	405.6 umhos/cm	416 umhos/cm	455.9 umhos/cm
Sulfate, as SO4	NA	Lab	11.8 mg/l	83.0 mg/l	82.9 mg/l	41.5 mg/l	22.5 mg/l	13.1 mg/l	49.0 mg/l	49.2 mg/l	83.1 mg/l	82.8 mg/l	65.0 mg/l	34.0 mg/l	17.5 mg/l	4.5 mg/l	--	9.2 mg/l	42.7 mg/l	52.9 mg/l	55.0 mg/l
Temperature, °C	NA	Lab	20.3 deg C	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Temperature, °C	NA	Field	--	--	18.5 deg C	22.67 deg C	21.31 deg C	9.52 deg C	0.81 deg C	--	1.91 deg C	--	1.25 deg C	2.07 deg C	11.8 deg C	3.71 deg C	--	--	4.89 deg C	14.1 deg C	18.76 deg C
Turbidity	NA	Lab	3.65 NTU	--	--	--	--	--	--	--	--	--	--	--	26.0 NTU	--	--	--	--	--	--
Turbidity	NA	Field	--	--	0 NTU	0.1 NTU	2 NTU	12.4 NTU	0 NTU	--	0 NTU	--	0 NTU	0 NTU	--	31.1 NTU	--	--	0.8 NTU	12.1 NTU	13.9 NTU
Metals																					
Aluminum	Dissolved	Lab	--	31.7 ug/l	21.2 ug/l	< 20.0 ug/l	21.5 ug/l	27.9 ug/l	< 40.0 ug/l	< 40.0 ug/l	< 40.0 ug/l	< 40.0 ug/l	24.5 ug/l	21.3 ug/l	31.0 ug/l	21.3 ug/l	--	31.5 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l
Aluminum	Total	Lab	52.5 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	20.8 ug/l	26.6 ug/l	< 40.0 ug/l	< 40.0 ug/l	< 40.0 ug/l	< 40.0 ug/l	24.8 ug/l	25.4 ug/l	< 40.0 ug/l	128 ug/l	--	< 40.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	21.4 ug/l
Antimony	Total	Lab	--	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l
Arsenic	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.50 ug/l	< 0.50 ug/l
Arsenic	Total	Lab	--	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	0.53 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	0.69 ug/l	0.66 ug/l	< 0.82 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Barium	Total	Lab	--	21.5 ug/l	21.7 ug/l	--	--	19.0 ug/l	--	--	--	--	25.1 ug/l	--	--	36.0 ug/l	--	--	--	--	19.1 ug/l
Beryllium	Total	Lab	--	< 0.20 ug/l	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	--	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	--	--	< 0.20 ug/l
Boron	Total	Lab	87.1 ug/l	438 ug/l	435 ug/l	--	--	286 ug/l	--	--	--	--	264 ug/l	--	--	77.2 ug/l	--	--	--	--	387 ug/l
Cadmium	Total	Lab	--	< 0.20 ug/l	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	--	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	--	--	< 0.20 ug/l
Calcium	Total	Lab	27600 ug/l	35800 ug/l	36100 ug/l	31400 ug/l	35100 ug/l	35200 ug/l	33600 ug/l	33800 ug/l	41900 ug/l	42000 ug/l	43500 ug/l	45900 ug/l	40500 ug/l	31400 ug/l	--	22000 ug/l	26100 ug/l	26600 ug/l	32300 ug/l
Chromium	Total	Lab	--	< 1.0 ug/l	< 1.0 ug/l	--	--	< 1.0 ug/l	--	--	--	--	< 1.0 ug/l	--	--	< 1.0 ug/l	--	--	--	--	< 1.0 ug/l
Cobalt	Dissolved	Lab	--	0.38 ug/l	0.37 ug/l	0.23 ug/l	0.22 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	0.22 ug/l	0.22 ug/l	0.21 ug/l	0.41 ug/l	0.44 ug/l	0.35 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Cobalt	Total	Lab	< 1 ug/l	0.39 ug/l	0.38 ug/l	0.24 ug/l	0.22 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	0.22 ug/l	0.22 ug/l	0.23 ug/l	0.41 ug/l	0.45 ug/l	0.46 ug/l	--	0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Copper	Dissolved	Lab	--	0.79 b ug/l	0.77 b ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	1.3 ug/l	1.3 ug/l	< 0.50 ug/l	0.52 ug/l	0.54 ug/l	< 0.50 ug/l	0.81 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	0.56 ug/l	0.52 ug/l
Copper	Total	Lab	1.1 ug/l	0.86 b ug/l	0.81 b ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	1.5 ug/l	1.5 ug/l	< 0.50 ug/l	0.54 ug/l	0.65 ug/l	0.55 ug/l	0.61 ug/l	1.2 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	0.60 ug/l	0.54 ug/l
Iron	Dissolved	Lab	--	240 ug/l	231 ug/l	285 ug/l	1410 ug/l	693 ug/l	186 ug/l	173 ug/l	274 ug/l	273 ug/l	2020 ug/l	8340 ug/l	12100 ug/l	26900 ug/l	--	4720 ug/l	209 ug/l	128 ug/l	260 ug/l
Iron	Total	Lab	1.27 ug/l	285 ug/l	289 ug/l	407 ug/l	1930 ug/l	948 ug/l	214 ug/l	208 ug/l	311 ug/l	312 ug/l	2380 ug/l	8810 ug/l	13800 ug/l	30700 ug/l	--	5200 ug/l	315 ug/l	210 ug/l	350 ug/l
Lead	Total	Lab	< 0.6 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Magnesium	Total	Lab	10500 ug/l	22900 ug/l	22600 ug/l	19200 ug/l	20900 ug/l	22900 ug/l	21900 ug/l	22100 ug/l	28600 ug/l	28600 ug/l	29100 ug/l	26600 ug/l	20300 ug/l	10300 ug/l	--	11800 ug/l	17400 ug/l	17400 ug/l	21000 ug/l
Manganese	Dissolved	Lab	--	27.8 ug/l	27.8 ug/l	38.4 ug/l	170 ug/l	103 ug/l	14.8 ug/l	14.8 ug/l	32.7 ug/l	32.9 ug/l	372 ug/l	1130 ug/l	1050 ug/l	935 ug/l	--	359 ug/l	102 ug/l	14.4 ug/l	22.4 ug/l
Manganese	Total	Lab	147 ug/l	29.6 ug/l	29.4 ug/l	42.4 ug/l	183 ug/l	117 ug/l	15.5 ug/l	15.3 ug/l	34.4 ug/l	34.0 ug/l	375 ug/l	1100 ug/l	1040 ug/l	1060 ug/l	--	367 ug/l	101 ug/l	15.6 ug/l	25.1 ug/l
Mercury	Total	Lab	0.003 ug/l	0.00066 ug/l	0.00061 ug/l	--	--	0.00073 ug/l	--	--	--	--	0.00088 ug/l	--	--	0.0029 * ug/l	0.0045 * ug/l	--	--	--	0.0027 ug/l
Methyl Mercury	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Total	Lab	--	4.2 ug/l	4.3 ug/l	--	--	1.5 ug/l	--	--	--	--	1.3 ug/l	--	--	< 0.30 ug/l	--	--	--	--	3.7 ug/l
Nickel	Dissolved	Lab	--	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	0.51 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	1.5 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Nickel	Total	Lab	< 0.6 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	2.0 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total, as P	Dissolved	Lab	< 20 ug/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	1720 ug/l	5200 ug/l	5200 ug/l	--	--	3800 ug/l	--	--	--	--	4700 ug/l	--	--	2500 ug/l	--	--	--	--	4100 ug/l
Selenium	Total	Lab	< 1 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l
Silver	Total	Lab	< 0.2 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	--	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	--	--	< 0.20 ug/l
Sodium	Total	Lab	4420 ug/l	40500 ug/l	40400 ug/l	--	--	34100 ug/l	--	--	--	--	39700 ug/l	--	--	6700 ug/l	--	--	--	--	34500 ug/l
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab	< 0.4 ug/l	< 0.20 j ug/l 0.008 j ug/l	< 0.20 j ug/l 0.014 j ug/l	< 0.0004 ug/l	0.022 ug/l	0.009 j ug/l	< 0.0004 ug/l	0.0016 jb ug/l	0.0012 jb ug/l	0.0017 jb ug/l	0.008 j ug/l	0.020 j ug/l	< 0.005 ug/l	0.0043 jb ug/l	--	0.009 jb ug/l	0.0021 j ug/l	0.007 jb ug/l	0.006 j ug/l
Tin	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Total	Lab	--	< 3.0 ug/l	< 3.0 ug/l	--	--	< 3.0 ug/l	--	--	--	--	< 3.0 ug/l	--	--	< 3.0 ug/l	--	--	--	--	< 3.0 ug/l
Zinc	Dissolved	Lab	--	< 6.0 ug/l	7.1 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	--	< 6.0 ug/l	6.5 ug/l	7.2 ug/l	< 6.0 ug/l
Zinc	Total	Lab	26.5 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	9.6 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	--	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l

1 - Some monitoring locations are listed by multiple names. Equivalent locations include the following: PM-1 = SW003, PM-2 = SW002, PM-3 = SW003, PM-4 = SW005, PM16 = SW004

Large Table 11
Surface Water Data Summary
Partridge River Watershed and Wyman Creek

Location			PM-2 [1]	PM-2 [1]		PM-2 [1]	PM-2 [1]	PM-2 [1]	PM-3 [1]	PM-3 [1]	PM-3 [1]	PM-3 [1]	PM-3 [1]	PM-3 [1]	PM-3 [1]	PM-3 [1]	PM-3 [1]	PM-3 [1]	PM-3 [1]	PM-3 [1]
Date			8/19/2013	9/10/2013		10/28/2013	11/21/2013	12/17/2013	4/13/2004	5/20/2004	6/23/2004	7/28/2004	8/25/2004	9/28/2004	10/25/2004	11/16/2004	7/11/2006	8/29/2006	9/20/2006	10/13/2006
Sample Type			N	N	FD	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Parameter	Total or Dissolved	Analysis Location																		
General Parameters																				
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	--	--	135 mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total, as CaCO3	NA	Lab	--	--	--	135 mg/l	--	--	42 mg/l	42 mg/l	80.1 mg/l	98.8 mg/l	151 mg/l	65.5 mg/l	58.1 mg/l	66.3 mg/l	107 mg/l	99.8 mg/l	96.8 mg/l	85 mg/l
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, total organic	NA	Lab	5.4 mg/l	11.7 mg/l	12.0 mg/l	5.3 mg/l	10.5 mg/l	11.7 mg/l	14.5 mg/l	16.9 mg/l	10.5 mg/l	12.7 mg/l	--	26.9 mg/l	--	13.2 mg/l	9.1 mg/l	6.8 mg/l	6.2 mg/l	7.7 mg/l
Chemical Oxygen Demand	NA	Lab	--	--	--	30.9 mg/l	--	--	55 mg/l	40 mg/l	16.5 mg/l	19.5 mg/l	--	62 mg/l	--	38 mg/l	35.8 mg/l	--	--	--
Chloride	NA	Lab	34.9 mg/l	33.6 mg/l	33.6 mg/l	39.4 mg/l	35.3 mg/l	36.7 mg/l	2.9 mg/l	3.1 mg/l	2.8 mg/l	3.2 mg/l	3.4 mg/l	4.4 mg/l	4.2 mg/l	6.6 mg/l	6.61 mg/l	12.4 mg/l	10.7 mg/l	15.7 mg/l
Cyanide	NA	Lab	--	--	--	--	--	--	< 0.02 mg/l	< 0.02 mg/l	< 0.02 mg/l	< 0.02 mg/l	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Lab	--	--	--	--	--	--	12.1 mg/l	11.2 mg/l	--	--	--	--	--	--	7.2 mg/l	7.55 mg/l	9.02 mg/l	11.66 mg/l
Dissolved oxygen	NA	Field	4.66 mg/l	4.06 mg/l	--	11.07 mg/l	--	6.62 mg/l	--	--	--	--	--	--	--	--	--	--	--	--
Fluoride	NA	Lab	--	--	--	--	--	--	0.1 mg/l	0.12 mg/l	0.14 mg/l	0.17 mg/l	0.14 mg/l	0.12 mg/l	< 0.1 mg/l	0.1 mg/l	0.16 mg/l	< 0.1 mg/l	< 0.1 mg/l	0.16 mg/l
Hardness, as CaCO3	NA	Lab	185 mg/l	163 mg/l	163 mg/l	166 mg/l	164 mg/l	198 mg/l	37.5 mg/l	35.7 mg/l	65.5 mg/l	100 mg/l	95 mg/l	70.1 mg/l	61.6 mg/l	62.3 mg/l	110 mg/l	110 mg/l	113 mg/l	107 mg/l
Nitrate + Nitrite, as N	NA	Lab	--	--	--	< 0.10 mg/l	--	--	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	--	< 0.1 mg/l	--	< 0.1 mg/l	< 0.1 mg/l	--	--	--
Nitrogen, ammonia as N	NA	Lab	--	--	--	< 0.10 mg/l	--	--	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	--	--	--	--	--	--	--	--
pH	NA	Lab	--	--	--	--	--	--	8 pH units	7.52 pH units	7.95 pH units	7.56 pH units	7.18 pH units	7.36 pH units	7.74 pH units	7.74 pH units	7.6 pH units	7.35 pH units	7.38 pH units	7.98 pH units
pH	NA	Field	7.26 pH units	7.11 pH units	--	7.45 pH units	6.74 pH units	6.78 pH units					--	--	--	--	7.5 pH units	--		--
Phosphorus, total, as P	NA	Lab	--	--	--	0.0040 mg/l	--	--	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	0.18 mg/l	--	< 0.1 mg/l	--	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l
Redox (oxidation potential)	NA	Field	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Solids, total dissolved	NA	Lab	327 mg/l	307 mg/l	298 mg/l	297 mg/l	279 mg/l	343 mg/l	75 mg/l	76 mg/l	139 mg/l	120 mg/l	107 mg/l	125 mg/l	88.6 mg/l	102 mg/l	149 mg/l	165 mg/l	175 mg/l	176 mg/l
Solids, total suspended	NA	Lab	--	--	--	--	--	--	< 1 mg/l	2.7 mg/l	2 mg/l	6 mg/l	--	3 mg/l	--	3 mg/l	3 mg/l	--	--	--
Specific Conductance @ 25 °C	NA	Lab	--	--	--	--	--	--	92 umhos/cm	105 umhos/cm	171 umhos/cm	196.5 umhos/cm	198.8 umhos/cm	151.8 umhos/cm	133.4 umhos/cm	156.1 umhos/cm	243 umhos/cm	278.1 umhos/cm	250.5 umhos/cm	258.7 umhos/cm
Specific Conductance @ 25 °C	NA	Field	511.9 umhos/cm	446.4 umhos/cm	--	379.6 umhos/cm	445.2 umhos/cm	513.8 umhos/cm	--	--	--	--	--	--	--	--	252.7 umhos/cm	--	--	--
Sulfate, as SO4	NA	Lab	70.5 mg/l	33.4 mg/l	33.3 mg/l	46.8 mg/l	46.0 mg/l	36.5 mg/l	< 1 mg/l	10.7 mg/l	6.1 mg/l	0.41 mg/l	1.4 mg/l	1.3 mg/l	8.7 mg/l	7.5 mg/l	10.4 mg/l	12.8 mg/l	11.8 mg/l	15.8 mg/l
Temperature, °C	NA	Lab	--	--	--	--	--	--	1.4 deg C	12.8 deg C	18 deg C	19.8 deg C	16.9 deg C	12.3 deg C	8 deg C	1.1 deg C	20.7 deg C	17.4 deg C	10.4 deg C	2.3 deg C
Temperature, °C	NA	Field	20.24 deg C	18.25 deg C	--	3.1 deg C	0.57 deg C	3.19 deg C	--	--	--	--	--	--	--	--	--	--	--	--
Turbidity	NA	Lab	--	--	--	--	--	--	2 NTU	3.4 NTU	--	--	--	--	--	--	4.9 NTU	--	--	--
Turbidity	NA	Field	0 NTU	0 NTU	--	0 NTU	0 NTU	0.9 NTU	--	--	--	--	--	--	--	--	--	--	--	--
Metals																				
Aluminum	Dissolved	Lab	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	28.9 ug/l	--	--	--	--	--	--	--	--	--	--	--	--
Aluminum	Total	Lab	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	36.2 ug/l	30.8 ug/l	64 ug/l	95.2 ug/l	49.9 ug/l	58.1 ug/l	40.4 ug/l	62.5 ug/l	64 ug/l	63.6 ug/l	45 ug/l	--	--	--
Antimony	Total	Lab	--	--	--	< 0.50 ug/l	--	--	< 3 ug/l	< 3 ug/l	< 3 ug/l	< 3 ug/l	--	--	--	--	--	--	--	--
Arsenic	Dissolved	Lab	< 0.50 ug/l	1.1 ug/l	1.1 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	Total	Lab	< 1.0 ug/l	0.89 ug/l	0.88 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	--	--	--	--	--	--	--	--
Barium	Total	Lab	--	--	--	13.5 ug/l	--	--	< 10 ug/l	< 10 ug/l	12.7 ug/l	17.2 ug/l	--	--	--	--	--	--	--	--
Beryllium	Total	Lab	--	--	--	< 0.20 ug/l	--	--	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	--	--	--	--	--	--	--	--
Boron	Total	Lab	--	--	--	274 ug/l	--	--	< 35 ug/l	48.7 ug/l	85.6 ug/l	93.2 ug/l	64.2 ug/l	58.5 ug/l	50.9 ug/l	72.3 ug/l	104 ug/l	--	--	--
Cadmium	Total	Lab	--	--	--	< 0.20 ug/l	--	--	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	--	--	--	--	--	--	--	--
Calcium	Total	Lab	36100 ug/l	32200 ug/l	32400 ug/l	28700 ug/l	30300 ug/l	37700 ug/l	11600 ug/l	11200 ug/l	21500 ug/l	24500 ug/l	23000 ug/l	17000 ug/l	14900 ug/l	14700 ug/l	26500 ug/l	25600 ug/l	25800 ug/l	24200 ug/l
Chromium	Total	Lab	--	--	--	< 1.0 ug/l	--	--	1.4 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	--	--	--	--	--	--	--	--
Cobalt	Dissolved	Lab	0.29 ug/l	0.48 ug/l	0.45 ug/l	< 0.20 ug/l	< 0.20 ug/l	0.54 ug/l	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	Total	Lab	< 0.20 ug/l	0.28 ug/l	0.30 ug/l	< 0.20 ug/l	< 0.20 ug/l	0.49 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	--	< 1 ug/l	--	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l < 1 ug/l	< 1 ug/l
Copper	Dissolved	Lab	0.88 ug/l	0.81 ug/l	0.52 ug/l	0.62 ug/l	0.95 ug/l	0.58 ug/l	--	--	--	--	--	--	--	--	--	--	--	--
Copper	Total	Lab	0.66 ug/l	< 0.50 ug/l	< 0.50 ug/l	0.67 ug/l	0.72 ug/l	0.72 ug/l	< 5 ug/l	< 5 ug/l	< 5 ug/l	< 0.8 ug/l	0.75 ug/l	0.85 ug/l	1.5 ug/l	0.75 ug/l	< 0.7 ug/l	0.94 ug/l	0.86 ug/l 0.56 ug/l	0.49 ug/l
Iron	Dissolved	Lab	200 ug/l	888 ug/l	902 ug/l	152 ug/l	465 ug/l	2080 ug/l	--	--	--	--	--	--	--	--	--	--	--	--
Iron	Total	Lab	255 ug/l	1070 ug/l	1130 ug/l	238 ug/l	1010 ug/l	2430 ug/l	890 ug/l	1270 ug/l	1770 ug/l	2490 ug/l	--	2150 ug/l	--	1210 ug/l	1.45 ug/l	--	--	--
Lead	Total	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 0.3 ug/l	< 0.3 ug/l	< 0.3 ug/l	0.33 ug/l	< 0.6 ug/l	--	--	--
Magnesium	Total	Lab	23000 ug/l	20100 ug/l	19900 ug/l	20400 ug/l	21300 ug/l	25300 ug/l	4900 ug/l	4600 ug/l	8100 ug/l	9500 ug/l	9100 ug/l	6700 ug/l	5900 ug/l	6200 ug/l	10600 ug/l	11300 ug/l	11700 ug/l	11300 ug/l
Manganese	Dissolved	Lab	19.0 ug/l	543 ug/l	526 ug/l	13.4 ug/l	147 ug/l	632 ug/l	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	Total	Lab	18.7 ug/l	313 ug/l	323 ug/l	18.9 ug/l	155 ug/l	591 ug/l	100 ug/l	120 ug/l	220 ug/l	430 ug/l	--	170 ug/l	--	120 ug/l	184 ug/l	--	--	--
Mercury	Total	Lab	--	--	--	0.0017 ug/l	--	--	0.0034 ug/l	0.0027 ug/l	< 0.004 ug/l	< 0.01 ug/l	0.0038 ug/l	< 0.004 ug/l	< 0.01 ug/l	< 0.01 ug/l	0.002 ug/l	< 0.002 ug/l	< 0.008 ug/l	< 0.002 ug/l
Methyl Mercury	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.0003 ug/l	--
Molybdenum	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Total	Lab	--	--	--	3.2 ug/l	--	--	< 5 ug/l	< 5 ug/l	< 5 ug/l	< 5 ug/l	--	--	--	--	--	--	--	--
Nickel	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	Total	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 5 ug/l	< 5 ug/l	< 5 ug/l	< 5 ug/l	2.2 ug/l	2.4 ug/l	1.6 ug/l	1.5 ug/l	0.8 ug/l	0.37 ug/l	0.44 ug/l 0.56 ug/l	0.29 ug/l
Palladium	Total	Lab	--	--	--	--	--	--	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 0.3 ug/l	--	--	--	--	--	--	--
Phosphorus, total, as P	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 20 ug/l	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 0.25 ug/l	--	--	--	--	--	--	--
Potassium	Total	Lab	--	--	--	4800 ug/l	--	--	2000 ug/l	1900 ug/l	2100 ug/l	1700 ug/l	--	1900 ug/l	--	2200 ug/l	1930 ug/l	--	--	--
Selenium	Total	Lab	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 2 ug/l	< 2 ug/l	< 10 ug/l	< 2 ug/l	< 3.6 ug/l	< 3.6 ug/l	< 3.6 ug/l	< 3.6 ug/l	< 1 ug/l	--	--	--
Silver	Total	Lab	--	--	--	< 0.20 ug/l	--	--	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 0.24 ug/l	< 0.24 ug/l	< 0.24 ug/l	< 0.24 ug/l	< 0.2 ug/l	--	--	--
Sodium	Total	Lab	--	--	--	33300 ug/l	--	--	2300 ug/l	2700 ug/l	3900 ug/l	4200 ug/l	3700 ug/l	2900 ug/l	3000 ug/l	4700 ug/l	7020 ug/l	--	--	--
Strontium	Total	Lab	--	--	--	--	--	--	59.6 ug/l	61.5 ug/l	120 ug/l	137 ug/l	--	--	--	--	--	--	--	--
Thallium	Total	Lab	0.009 j ug/l	< 0.005 ug/l	< 0.005 ug/l	< 0.002 ug/l	< 0.0020 ug/l	< 0.002 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 0.4 ug/l	< 0.4 ug/l	< 0.4 ug/l	< 0.4 ug/l	< 0.4 ug/l	--	--	--
Tin	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Titanium	Total	Lab	--	--	--	--	--	--	< 10 ug/l	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Total	Lab	--	--	--	< 3.0 ug/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	Dissolved	Lab	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	Total	Lab	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	16.4 ug/l	52.7 ug/l	< 25 ug/l	44.1 ug/l < 25 ug/l	< 25 ug/l

1 - Some monitoring locations are listed by multiple names. Equivalent locations include the following: PM-1 = SW003, PM-2 = SW002, PM-3 = SW003, PM-4 = SW005, PM16 = SW004

Large Table 11
Surface Water Data Summary
Partridge River Watershed and Wyman Creek

Location			PM-3 [1]	PM-3 [1]	PM-3 [1]	PM-3 [1]	PM-3 [1]	PM-3 [1]	PM-3 [1]	PM-3 [1]	PM-3 [1]	PM-3 [1]	PM-3 [1]	PM-3 [1]		PM-3 [1]	PM-3 [1]	PM-3 [1]	PM-3 [1]	PM-3 [1]	PM-3 [1]	
Date			11/8/2006	3/23/2007	4/24/2007	5/22/2007	6/12/2007	7/24/2007	8/23/2007	9/20/2007	10/25/2007	11/15/2007	5/21/2008	6/11/2008		7/22/2008	10/8/2008	6/27/2012	7/26/2012	7/26/2012	8/23/2012	
Sample Type			N	N	N	N	N	N	N	N	N	N	N	N	FD	N	N	N	FD	N	N	FD
Parameter	Total or Dissolved	Analysis Location																				
General Parameters																						
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**67.6 mg/l**	--	--	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total, as CaCO3	NA	Lab	**88.6 mg/l**	**130 mg/l**	**46.7 mg/l**	**57.0 mg/l**	**89.3 mg/l**	**124 mg/l**	**139 mg/l**	**53.5 mg/l**	**67.4 mg/l**	**73.0 mg/l**	**51.5 mg/l**	**49.2 mg/l**	**49.9 mg/l**	**98.2 mg/l**	--	**67.6 mg/l**	--	--	--	--
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, total organic	NA	Lab	**4.8 mg/l**	**6.7 mg/l**	**22.8 mg/l**	**19.8 mg/l**	**18.5 mg/l**	**9.8 mg/l**	**9.4 mg/l**	**29.7 mg/l**	**17.3 mg/l**	**10.4 mg/l**	**8.6 mg/l**	**15.8 mg/l**	**15.5 mg/l**	**9.2 mg/l**	--	**28.2 mg/l**	**20.9 mg/l**	**21.3 mg/l**	**14.1 mg/l**	**12.2 mg/l**
Chemical Oxygen Demand	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**74.1 mg/l**	--	--	--	--
Chloride	NA	Lab	**9.9 mg/l**	**19.3 mg/l**	**5.64 mg/l**	**8.9 mg/l**	**12.9 mg/l**	**28.3 mg/l**	**21.6 mg/l**	**7.92 mg/l**	**27.2 mg/l**	**12.7 mg/l**	**10.8 mg/l**	**7.31 mg/l**	**7.34 mg/l**	**7.19 mg/l**	--	**14.3 mg/l**	**11.4 mg/l**	**11.4 mg/l**	**7.1 mg/l**	**7.2 mg/l**
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Lab	**13.81 mg/l**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	--	**13.1 mg/l**	**13.86 mg/l**	**4.9 mg/l**	**2.7 mg/l**	**5.2 mg/l**	--	**5.29 mg/l**	**9.9 mg/l**	**8.6 mg/l**	--	--	--	--	**9.34 mg/l**	**7.15 mg/l**	--	**7.35 mg/l**	**7.72 mg/l**	--
Fluoride	NA	Lab	< 0.1 mg/l	**0.11 mg/l**	**0.12 mg/l**	< 0.1 mg/l	**0.1 mg/l**	< 0.1 mg/l	< 0.1 mg/l	--	< 0.1 mg/l	< 0.1 mg/l	--	--	--	--	--	--	--	--	--	--
Hardness, as CaCO3	NA	Lab	**104 mg/l**	**139 mg/l**	**62.6 mg/l**	**67.4 mg/l**	**75.2 mg/l**	**123 mg/l**	**134 mg/l**	**67.6 mg/l**	**81 mg/l**	**88.1 mg/l**	**68.8 mg/l**	**66.4 mg/l**	**66.4 mg/l**	**106 mg/l**	--	**95.2 mg/l**	**108 mg/l**	**109 mg/l**	**116 mg/l**	**115 mg/l**
Nitrate + Nitrite, as N	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.53 mg/l**	--	--	--	--
Nitrogen, ammonia as N	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.10 mg/l	--	--	--	--
pH	NA	Lab	**7.13 pH units**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	--	**7.67 pH units**	**7.04 pH units**	**7.7 pH units**	**7.2 pH units**	**8.1 pH units**	--	**7.61 pH units**	**7.7 pH units**	**7.2 pH units**	--	--	--	--	**7.51 pH units**	**7.48 pH units**	--	**7.08 pH units**	**7.81 pH units**	--
Phosphorus, total, as P	NA	Lab	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.004 mg/l	< 0.004 mg/l	< 0.004 mg/l	**0.009 * mg/l**	--	**0.020 mg/l**	--	--	--	--
Redox (oxidation potential)	NA	Field	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Solids, total dissolved	NA	Lab	**163 mg/l**	**199 mg/l**	**133 mg/l**	**133 mg/l**	**147 mg/l**	**201 mg/l**	**227 mg/l**	**123 mg/l**	**132 mg/l**	**153 mg/l**	**111 mg/l**	**126 mg/l**	**114 mg/l**	**150 mg/l**	--	**174 mg/l**	**182 mg/l**	**207 mg/l**	**199 mg/l**	**198 mg/l**
Solids, total suspended	NA	Lab	--	--	--	--	--	--	--	--	--	--	**2 b mg/l**	**2.0 mg/l**	**4.0 mg/l**	**2.8 mg/l**	--	--	--	--	--	--
Specific Conductance @ 25 ºC	NA	Lab	**245.7 umhos/cm**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Specific Conductance @ 25 ºC	NA	Field	--	**169.2 umhos/cm**	**80.6 umhos/cm**	**157 umhos/cm**	**192 umhos/cm**	**356 umhos/cm**	--	**152 umhos/cm**	**216 umhos/cm**	**254 umhos/cm**	--	--	--	--	**192.1 umhos/cm**	**203.6 umhos/cm**	--	**137.4 umhos/cm**	**226.3 umhos/cm**	--
Sulfate, as SO4	NA	Lab	**22.7 mg/l**	**13.2 mg/l**	**12.5 mg/l**	**14.9 mg/l**	**12.5 mg/l**	**14.5 mg/l**	**6 mg/l**	**8.6 mg/l**	**22.1 mg/l**	**25.7 mg/l**	**18.8 mg/l**	**11.9 mg/l**	**11.9 mg/l**	**12 mg/l**	--	**25.4 mg/l**	**17.1 mg/l**	**17.1 mg/l**	**15.8 mg/l**	**15.6 mg/l**
Temperature, ºC	NA	Lab	**3.8 deg C**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Temperature, ºC	NA	Field	--	**0.2 deg C**	**4.1 deg C**	**10.8 deg C**	**17.7 deg C**	**23.6 deg C**	--	**10.6 deg C**	**5 deg C**	**0.8 deg C**	--	--	--	--	**9.9 deg C**	**18.83 deg C**	--	**19.88 deg C**	**19.06 deg C**	--
Turbidity	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Turbidity	NA	Field	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**4.92 NTU**	**1.6 NTU**	--	**3.3 NTU**	**0.6 NTU**	--
Metals																						
Aluminum	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**106 ug/l**	**90.9 ug/l**	**96.9 ug/l**	**40.0 ug/l**	**40.2 ug/l**
Aluminum	Total	Lab	--	--	--	--	--	--	--	--	--	--	**49.6 ug/l**	**78.6 ug/l**	**77.4 ug/l**	**29.2 ug/l**	--	**151 ug/l**	**121 ug/l**	**122 ug/l**	**47.3 ug/l**	**42.2 ug/l**
Antimony	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Arsenic	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**1.5 ug/l**	**1.4 ug/l**	**1.2 ug/l**	**1.2 ug/l**	**1.4 ug/l**
Barium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**14.9 ug/l**	--	--	--	--
Beryllium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.20 ug/l	--	--	--	--
Boron	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**155 ug/l**	--	--	--	--
Cadmium	Total	Lab	--	--	--	--	--	--	--	--	--	--	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	**0.054 jb ug/l**	--	< 0.20 ug/l	--	--	--	--
Calcium	Total	Lab	**23700 ug/l**	**33100 ug/l**	**14500 ug/l**	**16800 ug/l**	**17400 ug/l**	**27400 ug/l**	**30300 ug/l**	**15500 ug/l**	**18300 ug/l**	**19100 ug/l**	**15700 ug/l**	**15400 ug/l**	**15400 ug/l**	**25500 ug/l**	--	**21100 ug/l**	**24700 ug/l**	**24600 ug/l**	**27200 ug/l**	**26900 ug/l**
Chromium	Total	Lab	--	--	--	--	--	--	--	--	--	--	< 1.0 ug/l	**0.24 jb ug/l**	**0.44 jb ug/l**	**1.2 ug/l**	--	< 1.0 ug/l	--	--	--	--
Cobalt	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.29 ug/l**	**0.25 ug/l**	**0.27 ug/l**	**0.22 ug/l**	**0.21 ug/l**
Cobalt	Total	Lab	< 1 ug/l < 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	**0.14 j ug/l**	**0.15 j ug/l**	**0.15 j ug/l**	**0.26 ug/l**	--	**0.35 ug/l**	**0.34 ug/l**	**0.33 ug/l**	**0.23 ug/l**	**0.22 ug/l**
Copper	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**1.4 b ug/l**	**1.3 ug/l**	**1.4 ug/l**	**0.90 ug/l**	**0.84 ug/l**
Copper	Total	Lab	**1.1 ug/l** **0.45 ug/l**	**0.71 ug/l**	**1.4 ug/l**	**1.1 ug/l**	< 0.7 ug/l	**1 ug/l**	**1.1 ug/l**	**1.6 ug/l**	**0.99 ug/l**	**0.8 ug/l**	**0.79 b ug/l**	**1.1 ug/l**	**1.2 ug/l**	**1.2 ug/l**	--	**1.4 b ug/l**	**1.6 ug/l**	**1.6 ug/l**	**0.92 ug/l**	**0.97 ug/l**
Iron	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**1410 ug/l**	**1500 ug/l**	**1570 ug/l**	**1690 ug/l**	**1660 ug/l**
Iron	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**2180 ug/l**	**2070 ug/l**	**2060 ug/l**	**2000 ug/l**	**1960 ug/l**
Lead	Total	Lab	--	--	--	--	--	--	--	--	--	--	**0.14 jb ug/l**	**0.23 jb ug/l**	**0.25 jb ug/l**	**0.23 jb ug/l**	--	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Magnesium	Total	Lab	**11000 ug/l**	**13600 ug/l**	**6380 ug/l**	**6780 ug/l**	**7700 ug/l**	**13200 ug/l**	**14100 ug/l**	**7020 ug/l**	**8480 ug/l**	**9850 ug/l**	**7200 ug/l**	**6800 ug/l**	**6800 ug/l**	**10400 ug/l**	--	**10300 ug/l**	**11400 ug/l**	**11400 ug/l**	**11800 ug/l**	**11500 ug/l**
Manganese	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**77.3 ug/l**	**69.5 ug/l**	**69.9 ug/l**	**65.2 ug/l**	**65.7 ug/l**
Manganese	Total	Lab	--	--	--	--	--	--	--	--	--	--	**33 ug/l**	**32 ug/l**	**32 ug/l**	**60 * ug/l**	--	**103 ug/l**	**104 ug/l**	**102 ug/l**	**79.8 ug/l**	**78.2 ug/l**
Mercury	Total	Lab	< 0.002 ug/l	< 0.004 ug/l	**0.0078 ug/l**	< 0.004 ug/l	**0.0034 ug/l**	< 0.002 ug/l	**0.0014 ug/l**	**0.0054 ug/l**	**0.0028 ug/l**	**0.0015 ug/l**	**0.0020 ug/l**	**0.0031 ug/l**	**0.0030 ug/l**	**0.0014 ug/l**	--	**0.0054 ug/l**	--	--	--	--
Methyl Mercury	Total	Lab	**0.000061 ug/l**	--	--	**0.000240 ug/l**	--	**0.000492 ug/l**	--	**0.000365 ug/l**	--	**0.000188 ug/l**	**0.00012 ug/l**	**0.00030 ug/l**	**0.00026 ug/l**	**0.00032 ug/l**	--	--	--	--	--	--
Molybdenum	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Total	Lab	--	--	--	--	--	--	--	--	--	--	**2.1 ug/l**	**1.4 ug/l**	**1.4 ug/l**	**1.5 ug/l**	--	**1.8 ug/l**	--	--	--	--
Nickel	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**1.9 ug/l**	**1.2 ug/l**	**1.4 ug/l**	**1.4 ug/l**	**0.74 ug/l**
Nickel	Total	Lab	**0.27 ug/l** **0.24 ug/l**	**0.79 ug/l**	**1.0 ug/l**	**1.1 ug/l**	**1.2 ug/l**	**1.1 ug/l**	**1.6 ug/l**	**1.8 ug/l**	**1.4 ug/l**	**1.4 ug/l**	**1.2 ug/l**	**1.2 ug/l**	**1.2 ug/l**	**3.9 ug/l**	--	**1.1 ug/l**	**1.4 ug/l**	**1.4 ug/l**	**0.78 ug/l**	**0.78 ug/l**
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total, as P	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**2400 ug/l**	--	--	--	--
Selenium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l
Silver	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.20 ug/l	--	--	--	--
Sodium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**12900 ug/l**	--	--	--	--
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.20 j ug/l **0.012 j ug/l**	< 0.0004 ug/l	< 0.0004 ug/l	**0.010 j ug/l**	< 0.005 ug/l
Tin	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 3.0 ug/l	--	--	--	--
Zinc	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**7.7 ug/l**	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l
Zinc	Total	Lab	< 25 ug/l < 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	**2.1 jb ug/l**	**2.3 jb ug/l**	**2.5 jb ug/l**	**15 ug/l**	--	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l

1 - Some monitoring locations are listed by multiple names. Equivalent locations include the following: PM-1 = SW003, PM-2 = SW002, PM-3 = SW003, PM-4 = SW005, PM16 = SW004

Large Table 11
Surface Water Data Summary
Partridge River Watershed and Wyman Creek

		Location	PM-3 [1]		PM-3 [1]	PM-3 [1]	PM-3 [1]		PM-3 [1]		PM-3 [1]		PM-3 [1]		PM-3 [1]		PM-3 [1]		PM-3 [1]		PM-3 [1]	
		Date	9/25/2012		10/30/2012	11/26/2012	12/18/2012		1/24/2013		2/25/2013		3/21/2013		4/23/2013		5/9/2013		6/17/2013		7/22/2013	
		Sample Type	N	FD	N	N	N	FD	N	FD	N	FD	N	FD	N	FD	N	FD	N	FD	N	FD
Parameter	Total or Dissolved	Analysis Location																				
General Parameters																						
Alkalinity, bicarbonate, as CaCO3	NA	Lab	**102 mg/l**	**101 mg/l**	--	--	**103 mg/l**	**102 mg/l**	--	--	--	--	**121 mg/l**	**120 mg/l**	--	--	--	--	--	--	**88.9 mg/l**	**88.4 mg/l**
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total, as CaCO3	NA	Lab	**102 mg/l**	**101 mg/l**	--	--	**103 mg/l**	**102 mg/l**	--	--	--	--	**121 mg/l**	**120 mg/l**	--	--	--	--	--	--	**88.9 mg/l**	**88.4 mg/l**
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, total organic	NA	Lab	**6.9 mg/l**	**6.9 mg/l**	**7.5 mg/l**	**7.4 mg/l**	**6.3 mg/l**	**6.3 mg/l**	**5.5 mg/l**	**4.7 mg/l**	**3.8 mg/l**	**3.7 mg/l**	**4.1 mg/l**	**3.4 mg/l**	**3.2 mg/l**	**3.1 mg/l**	**18.0 mg/l**	**17.8 mg/l**	**16.2 mg/l**	**15.8 mg/l**	**25.5 mg/l**	**25.7 mg/l**
Chemical Oxygen Demand	NA	Lab	**16.5 mg/l**	**27.3 mg/l**	--	--	**10.5 mg/l**	**13.2 mg/l**	--	--	--	--	**14.0 mg/l**	< 10.0 mg/l	--	--	--	--	--	--	**81.8 mg/l**	**82.4 mg/l**
Chloride	NA	Lab	**9.8 mg/l**	**9.6 mg/l**	**13.0 mg/l**	**17.3 mg/l**	**10.8 mg/l**	**10.8 mg/l**	**6.9 mg/l**	**6.7 mg/l**	**5.2 mg/l**	**4.3 mg/l**	**3.7 mg/l**	**3.7 mg/l**	**20.1 mg/l**	**20.2 mg/l**	**8.0 mg/l**	**8.0 mg/l**	**14.3 mg/l**	**13.8 mg/l**	**11.4 mg/l**	**11.4 mg/l**
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	**10.46 mg/l**	--	**12.38 mg/l**	**12.41 mg/l**	**11.34 mg/l**	--	**11.81 mg/l**	--	**13.18 mg/l**	--	**12.89 mg/l**	--	--	--	**10.68 mg/l**	--	**8.32 mg/l**	--	**7.07 mg/l**	--
Fluoride	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hardness, as CaCO3	NA	Lab	**127 mg/l**	**123 mg/l**	**115 mg/l**	**121 mg/l**	**133 mg/l**	**127 mg/l**	**140 mg/l**	**136 mg/l**	**134 mg/l**	**131 mg/l**	**136 mg/l**	**134 mg/l**	**129 mg/l**	**130 mg/l**	**55.6 mg/l**	**55.0 mg/l**	**84.5 mg/l**	**84.9 mg/l**	**121 mg/l**	**121 mg/l**
Nitrate + Nitrite, as N	NA	Lab	**0.53 mg/l**	**0.54 mg/l**	--	--	**0.88 mg/l**	**0.87 mg/l**	--	--	--	--	**0.22 mg/l**	**0.16 mg/l**	--	--	--	--	--	--	**0.12 mg/l**	**0.13 mg/l**
Nitrogen, ammonia as N	NA	Lab	< 0.10 mg/l	< 0.10 mg/l	--	--	**0.16 mg/l**	**0.16 mg/l**	--	--	--	--	**0.30 * mg/l**	**0.35 mg/l**	--	--	--	--	--	--	< 0.10 mg/l	< 0.10 mg/l
pH	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	**7.92 pH units**	--	**7.51 pH units**	**7.96 pH units**	**6.93 pH units**	--	**7.58 pH units**	--	**7.18 pH units**	--	**7.03 pH units**	--	--	--	**6.55 pH units**	--	**7.04 pH units**	--	**7.29 pH units**	--
Phosphorus, total, as P	NA	Lab	< 0.0040 mg/l	< 0.0040 mg/l	--	--	**0.0044 mg/l**	**0.0062 mg/l**	--	--	--	--	**0.0090 mg/l**	**0.013 mg/l**	--	--	--	--	--	--	**0.031 mg/l**	**0.027 mg/l**
Redox (oxidation potential)	NA	Field	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Solids, total dissolved	NA	Lab	**166 mg/l**	**159 mg/l**	**188 mg/l**	**256 mg/l**	**207 mg/l**	**203 mg/l**	**182 mg/l**	**171 mg/l**	**165 mg/l**	**166 mg/l**	**175 mg/l**	**180 mg/l**	**194 mg/l**	**188 mg/l**	**92.0 mg/l**	**97.0 mg/l**	**172 mg/l**	**175 mg/l**	**222 mg/l**	**216 mg/l**
Solids, total suspended	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Specific Conductance @ 25 °C	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Specific Conductance @ 25 °C	NA	Field	**158.6 umhos/cm**	--	**258.2 umhos/cm**	**182.4 umhos/cm**	**175.6 umhos/cm**	--	**305.2 umhos/cm**	--	**262.6 umhos/cm**	--	**264 umhos/cm**	--	--	--	**137.7 umhos/cm**	--	**219 umhos/cm**	--	**256.7 umhos/cm**	--
Sulfate, as SO4	NA	Lab	**17.6 mg/l**	**17.3 mg/l**	**25.2 mg/l**	**33.2 mg/l**	**27.2 mg/l**	**27.2 mg/l**	**19.0 mg/l**	**18.4 mg/l**	**16.5 mg/l**	**16.2 mg/l**	**15.5 mg/l**	**15.4 mg/l**	**19.0 mg/l**	**19.0 mg/l**	**10.5 mg/l**	**10.7 mg/l**	**23.2 mg/l**	**23.2 mg/l**	**20.2 mg/l**	**20.3 mg/l**
Temperature, °C	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Temperature, °C	NA	Field	**9.16 deg C**	--	**1.61 deg C**	**0.57 deg C**	**0.31 deg C**	--	**2.75 deg C**	--	**4.48 deg C**	--	**4.38 deg C**	--	--	--	**5.65 deg C**	--	**14.14 deg C**	--	**18.97 deg C**	--
Turbidity	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Turbidity	NA	Field	**0 NTU**	--	**0 NTU**	**0 NTU**	**0 NTU**	--	**1.2 NTU**	--	**0.3 NTU**	--	**11.9 NTU**	--	--	--	**3.9 NTU**	--	**1.4 NTU**	--	**7.4 NTU**	--
Metals																						
Aluminum	Dissolved	Lab	< 20.0 ug/l	< 20.0 ug/l	< 40.0 ug/l	< 40.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 40.0 ug/l	< 40.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	**82.3 ug/l**	**80.4 ug/l**	**72.6 ug/l**	**68.2 ug/l**	**98.3 ug/l**	**95.0 ug/l**
Aluminum	Total	Lab	**24.3 ug/l**	**22.9 ug/l**	< 40.0 ug/l	< 40.0 ug/l	**22.6 ug/l**	< 20.0 ug/l	**25.6 ug/l**	**22.3 ug/l**	< 40.0 ug/l	< 40.0 ug/l	**20.3 ug/l**	**23.5 ug/l**	**22.2 ug/l**	**40.7 ug/l**	**104 ug/l**	**101 ug/l**	**116 ug/l**	**124 ug/l**	**129 ug/l**	**129 ug/l**
Antimony	Total	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	--	< 0.50 ug/l	< 0.50 ug/l
Arsenic	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.79 ug/l**	**0.84 ug/l**	**2.2 ug/l**	**2.1 ug/l**
Arsenic	Total	Lab	**0.60 ug/l**	< 0.50 ug/l	**0.62 ug/l**	< 0.50 ug/l	**0.60 ug/l**	**0.58 ug/l**	**0.58 ug/l**	**0.72 ug/l**	**0.80 ug/l**	**0.66 ug/l**	< 0.82 ug/l	< 0.82 ug/l	**1.2 ug/l**	**1.2 ug/l**	**1.0 ug/l**	**1.1 ug/l**	**0.73 ug/l**	**0.88 ug/l**	**2.4 ug/l**	**2.4 ug/l**
Barium	Total	Lab	**12.1 ug/l**	**11.8 ug/l**	--	--	**11.6 ug/l**	**11.4 ug/l**	--	--	--	--	**12.5 ug/l**	**12.4 ug/l**	--	--	--	--	--	--	**16.7 ug/l**	**17.0 ug/l**
Beryllium	Total	Lab	< 0.20 ug/l	< 0.20 ug/l	--	--	< 0.20 ug/l	< 0.20 ug/l	--	--	--	--	< 0.20 ug/l	< 0.20 ug/l	--	--	--	--	--	--	< 0.20 ug/l	< 0.20 ug/l
Boron	Total	Lab	**165 ug/l**	**150 ug/l**	--	--	**146 ug/l**	**135 ug/l**	--	--	--	--	**83.3 ug/l**	**84.0 ug/l**	--	--	--	--	--	--	**178 ug/l**	**167 ug/l**
Cadmium	Total	Lab	< 0.20 ug/l	< 0.20 ug/l	--	--	< 0.20 ug/l	< 0.20 ug/l	--	--	--	--	< 0.20 ug/l	< 0.20 ug/l	--	--	--	--	--	--	< 0.20 ug/l	< 0.20 ug/l
Calcium	Total	Lab	**29100 ug/l**	**28100 ug/l**	**25200 ug/l**	**25700 ug/l**	**29900 ug/l**	**28600 ug/l**	**33000 ug/l**	**32100 ug/l**	**32200 ug/l**	**31700 ug/l**	**32900 ug/l**	**32800 ug/l**	**28600 ug/l**	**28800 ug/l**	**12100 ug/l**	**11900 ug/l**	**17800 ug/l**	**17800 ug/l**	**26400 ug/l**	**26600 ug/l**
Chromium	Total	Lab	< 1.0 ug/l	< 1.0 ug/l	--	--	< 1.0 ug/l	< 1.0 ug/l	--	--	--	--	< 1.0 ug/l	< 1.0 ug/l	--	--	--	--	--	--	< 1.0 ug/l	< 1.0 ug/l
Cobalt	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	**0.22 ug/l**	**0.22 ug/l**	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	**0.41 ug/l**	**0.38 ug/l**
Cobalt	Total	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	**0.23 ug/l**	**0.22 ug/l**	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	**0.21 ug/l**	**0.22 ug/l**	**0.22 ug/l**	**0.22 ug/l**	**0.43 ug/l**	**0.40 ug/l**
Copper	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	**0.54 ug/l**	**0.54 ug/l**	< 0.50 ug/l	< 0.50 ug/l	**0.87 ug/l**	**0.86 ug/l**	< 0.50 ug/l	< 0.50 ug/l	**0.54 ug/l**	**0.63 ug/l**	**1.3 ug/l**	**1.4 ug/l**	**1.2 ug/l**	**1.2 ug/l**	**0.81 ug/l**	**0.76 ug/l**
Copper	Total	Lab	**0.66 ug/l**	< 0.50 ug/l	**0.58 ug/l**	**0.63 ug/l**	**0.54 ug/l**	< 0.50 ug/l	**0.82 ug/l**	**0.58 ug/l**	**1.2 ug/l**	**0.72 ug/l**	**0.60 ug/l**	< 0.50 ug/l	**0.63 ug/l**	**0.66 ug/l**	**1.6 b ug/l**	**1.8 b ug/l**	**1.4 ug/l**	**1.5 ug/l**	**0.88 ug/l**	**0.86 ug/l**
Iron	Dissolved	Lab	**792 ug/l**	**799 ug/l**	**455 ug/l**	**742 ug/l**	**628 ug/l**	**711 ug/l**	**959 ug/l**	**243 ug/l**	**419 ug/l**	**266 ug/l**	**638 * ug/l**	**215 * ug/l**	**611 ug/l**	**569 ug/l**	**912 ug/l**	**893 ug/l**	**720 ug/l**	**665 ug/l**	**3080 ug/l**	**3040 ug/l**
Iron	Total	Lab	**956 ug/l**	**916 ug/l**	**618 ug/l**	**959 ug/l**	**1190 ug/l**	**1140 ug/l**	**2060 ug/l**	**2030 ug/l**	**1670 ug/l**	**1720 ug/l**	**1850 ug/l**	**1830 ug/l**	**1040 ug/l**	**1120 ug/l**	**1240 ug/l**	**1240 ug/l**	**1150 ug/l**	**1200 ug/l**	**3840 ug/l**	**3840 ug/l**
Lead	Total	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Magnesium	Total	Lab	**13300 ug/l**	**12800 ug/l**	**12600 ug/l**	**13700 ug/l**	**14200 ug/l**	**13600 ug/l**	**14000 ug/l**	**13600 ug/l**	**12900 ug/l**	**12600 ug/l**	**13000 ug/l**	**12600 ug/l**	**14100 ug/l**	**14200 ug/l**	**6200 ug/l**	**6100 ug/l**	**9700 ug/l**	**9800 ug/l**	**13300 ug/l**	**13200 ug/l**
Manganese	Dissolved	Lab	**24.8 ug/l**	**25.3 ug/l**	**30.4 ug/l**	**89.4 ug/l**	**182 ug/l**	**182 ug/l**	**334 ug/l**	**331 ug/l**	**202 ug/l**	**202 ug/l**	**211 ug/l**	**209 ug/l**	**149 ug/l**	**153 ug/l**	**87.3 ug/l**	**85.6 ug/l**	**39.0 ug/l**	**38.8 ug/l**	**168 ug/l**	**164 ug/l**
Manganese	Total	Lab	**31.3 ug/l**	**30.0 ug/l**	**32.8 ug/l**	**96.6 ug/l**	**190 ug/l**	**184 ug/l**	**351 ug/l**	**341 ug/l**	**214 ug/l**	**216 ug/l**	**235 ug/l**	**227 ug/l**	**159 ug/l**	**164 ug/l**	**92.6 ug/l**	**98.0 ug/l**	**62.3 ug/l**	**65.2 ug/l**	**185 ug/l**	**185 ug/l**
Mercury	Total	Lab	**0.00089 ug/l**	**0.00082 ug/l**	--	--	**0.00068 ug/l**	**0.00065 ug/l**	--	--	--	--	**0.00067 ug/l**	< 0.00050 ug/l	--	--	--	--	--	--	**0.0050 ug/l**	**0.0046 ug/l**
Methyl Mercury	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Total	Lab	**1.8 ug/l**	**1.7 ug/l**	--	--	**1.8 ug/l**	**1.6 ug/l**	--	--	--	--	**1.4 ug/l**	**1.3 ug/l**	--	--	--	--	--	--	**2.2 ug/l**	**2.1 ug/l**
Nickel	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	**0.75 ug/l**	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	**0.96 ug/l**	**1.0 ug/l**	**0.53 ug/l**	**0.55 ug/l**	**0.92 ug/l**	**0.85 ug/l**
Nickel	Total	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	**0.58 ug/l**	**0.63 ug/l**	< 0.50 ug/l	< 0.50 ug/l	**0.98 b ug/l**	**1.1 b ug/l**	**0.71 ug/l**	**0.78 ug/l**	**0.92 ug/l**	**0.86 ug/l**
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total, as P	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	**3700 ug/l**	**3500 ug/l**	--	--	**3100 ug/l**	**2900 ug/l**	--	--	--	--	**3300 ug/l**	**3300 ug/l**	--	--	--	--	--	--	**2700 ug/l**	**2700 ug/l**
Selenium	Total	Lab	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l
Silver	Total	Lab	< 0.20 ug/l	< 0.20 ug/l	--	--	< 0.20 ug/l	< 0.20 ug/l	--	--	--	--	< 0.20 ug/l	< 0.20 ug/l	--	--	--	--	--	--	< 0.20 ug/l	< 0.20 ug/l
Sodium	Total	Lab	**9900 ug/l**	**9300 ug/l**	--	--	**10200 ug/l**	**9800 ug/l**	--	--	--	--	**5700 ug/l**	**5500 ug/l**	--	--	--	--	--	--	**14000 ug/l**	**14200 ug/l**
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab	**0.009 j ug/l**	< 0.002 ug/l	< 0.0004 ug/l	**0.0018 jb ug/l**	**0.006 j ug/l**	< 0.005 ug/l	**0.015 j ug/l**	< 0.005 ug/l	< 0.002 ug/l	< 0.002 ug/l	**0.0014 jb ug/l**	**0.0009 jb ug/l**	**0.009 jb ug/l**	**0.015 jb ug/l**	**0.0089 j* ug/l**	**0.0018 j* ug/l**	**0.015 jb ug/l**	< 0.005 ug/l	**0.010 j ug/l**	**0.005 j ug/l**
Tin	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Total	Lab	< 3.0 ug/l	< 3.0 ug/l	--	--	< 3.0 ug/l	< 3.0 ug/l	--	--	--	--	< 3.0 ug/l	< 3.0 ug/l	--	--	--	--	--	--	< 3.0 ug/l	< 3.0 ug/l
Zinc	Dissolved	Lab	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	**7.8 ug/l**	**6.6 ug/l**	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	**6.2 ug/l**	**7.1 ug/l**	**6.0 ug/l**	**6.6 ug/l**	< 6.0 ug/l
Zinc	Total	Lab	**6.7 ug/l**	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	**7.7 ug/l**	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l

1 - Some monitoring locations are listed by multiple names. Equivalent locations include the following: PM-1 = SW003, PM-2 = SW002, PM-3 = SW003, PM-4 = SW005, PM16 = SW004

Large Table 11
Surface Water Data Summary
Partridge River Watershed and Wyman Creek

		Location	PM-3 [1]		PM-3 [1]	PM-3 [1]		PM-3 [1]		PM-3 [1]		SW003 [1]	SW003 [1]	SW003 [1]	SW003 [1]	SW003 [1]	PM-4 [1]	PM-4 [1]	PM-4 [1]	PM-4 [1]	PM-4 [1]
		Date	8/19/2013		9/10/2013	10/28/2013		11/21/2013		12/17/2013		5/27/2010	6/17/2010	7/15/2010	8/10/2010	9/22/2010	4/13/2004	5/19/2004	6/22/2004	7/28/2004	8/24/2004
		Sample Type	N	FD	N	N	FD	N	FD	N	FD	N	N	N	N	N	N	N	N	N	N
Parameter	Total or Dissolved	Analysis Location																			
General Parameters																					
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	--	--	**77.3 mg/l**	**77.2 mg/l**	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total, as CaCO3	NA	Lab	--	--	--	**77.3 mg/l**	**77.2 mg/l**	--	--	--	--	--	--	--	--	--	**13 mg/l**	**16 mg/l**	**34 mg/l**	**63.5 mg/l**	**95 mg/l**
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, total organic	NA	Lab	**5.8 mg/l**	**5.3 mg/l**	**8.1 mg/l**	**10.4 mg/l**	**10.7 mg/l**	**9.3 mg/l**	**8.1 mg/l**	**8.3 mg/l**	**8.2 mg/l**	--	--	--	--	--	**20.3 mg/l**	**20.6 mg/l**	**22.8 mg/l**	**19.4 mg/l**	--
Chemical Oxygen Demand	NA	Lab				**47.5 mg/l**	**45.2 mg/l**	--	--	--	--	--	--	--	--	--	**54 mg/l**	**33 mg/l**	**71 mg/l**	**46 mg/l**	--
Chloride	NA	Lab	**11.1 mg/l**	**11.1 mg/l**	**9.2 mg/l**	**10.9 mg/l**	**10.9 mg/l**	**5.7 mg/l**	**5.8 mg/l**	**6.4 mg/l**	**6.3 mg/l**	--	--	--	--	--	**1.1 mg/l**	**1.1 mg/l**	**1.6 mg/l**	**2 mg/l**	**2.2 mg/l**
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.02 mg/l	< 0.02 mg/l	< 0.02 mg/l	< 0.02 mg/l	--
Dissolved oxygen	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**10.9 mg/l**	**10.6 mg/l**	--	--	--
Dissolved oxygen	NA	Field	**8.36 mg/l**	--	**8.58 mg/l**	**12.66 mg/l**	--	--	--	**12.04 mg/l**	--	**8.29 mg/l**	**7.55 mg/l**	**6.65 mg/l**	**6.0 mg/l**	**7.9 mg/l**	--	--	--	--	--
Fluoride	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	**0.16 mg/l**	**0.11 mg/l**
Hardness, as CaCO3	NA	Lab	**134 mg/l**	**135 mg/l**	**128 mg/l**	**85.9 mg/l**	**88.8 mg/l**	**104 mg/l**	**106 mg/l**	**115 mg/l**	**117 mg/l**	--	--	--	--	--	**16.9 mg/l**	**20.1 mg/l**	**34.8 mg/l**	**65.9 mg/l**	**78.2 mg/l**
Nitrate + Nitrite, as N	NA	Lab	--	--	--	< 0.10 mg/l	**0.10 b mg/l**	--	--	--	--	--	--	--	--	--	**0.14 mg/l**	**0.1 mg/l**	**0.13 mg/l**	< 0.1 mg/l	--
Nitrogen, ammonia as N	NA	Lab	--	--	--	**0.15 mg/l**	**0.11 mg/l**	--	--	--	--	--	--	--	--	--	< 0.1 mg/l	< 0.1 mg/l	**0.17 mg/l**	< 0.1 mg/l	--
pH	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**7.4 pH units**	**7.92 pH units**	**7.67 pH units**	**7.58 pH units**	**7.8 pH units**
pH	NA	Field	**7.41 pH units**	--	**7.76 pH units**	**7.26 pH units**	--	**6 pH units**	--	**7.05 pH units**	--	**7.39 pH units**	**7.47 pH units**	**7.51 pH units**	**7.4 pH units**	**7.5 pH units**	--	--	--	--	--
Phosphorus, total, as P	NA	Lab				**0.010 mg/l**	**0.011 mg/l**	--	--	--	--	--	--	--	--	--	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	**0.15 mg/l**	--
Redox (oxidation potential)	NA	Field	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Solids, total dissolved	NA	Lab	**216 mg/l**	**225 mg/l**	**210 mg/l**	**174 mg/l**	**180 mg/l**	**170 mg/l**	**175 mg/l**	**217 mg/l**	**171 mg/l**	--	--	--	--	--	**56 mg/l**	**58 mg/l**	**155 mg/l**	**90 mg/l**	**93 mg/l**
Solids, total suspended	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**2 mg/l**	**10 mg/l**	**8 mg/l**	**2 mg/l**	--
Specific Conductance @ 25 °C	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**35 umhos/cm**	**59 umhos/cm**	**78.2 umhos/cm**	**126.9 umhos/cm**	**161.7 umhos/cm**
Specific Conductance @ 25 °C	NA	Field	**308.7 umhos/cm**	--	**292.4 umhos/cm**	**171.2 umhos/cm**	--	**227.8 umhos/cm**	--	**243.4 umhos/cm**	--	**180.0 umhos/cm**	**238 umhos/cm**	**349.5 umhos/cm**	**368 umhos/cm**	**348 umhos/cm**	--	--	--	--	--
Sulfate, as SO4	NA	Lab	**31.0 mg/l**	**30.9 mg/l**	**14.4 mg/l**	**14.4 mg/l**	**14.5 mg/l**	**22.2 mg/l**	**21.8 mg/l**	**14.8 mg/l**	**14.9 mg/l**	--	--	--	--	--	< 1 mg/l	**8.1 mg/l**	**8.5 mg/l**	**0.78 mg/l**	< 1 mg/l
Temperature, °C	NA	Lab		--			--		--		--						**0.9 deg C**	**12.9 deg C**	**19.5 deg C**	**21.4 deg C**	**16.2 deg C**
Temperature, °C	NA	Field	**19.7 deg C**	--	**18.84 deg C**	**2.52 deg C**	--	**0.64 deg C**	--	**2.45 deg C**	--	**18.01 deg C**	**16.50 deg C**	**22.25 deg C**	**24.2 deg C**	**12.9 deg C**	--	--	--	--	--
Turbidity	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**1 NTU**	**3 NTU**	--	--	--
Turbidity	NA	Field	**1.7 NTU**	--	**0.8 NTU**	**4.8 NTU**	--	**0.3 NTU**	--	**4.9 NTU**	--	**0.4 NTU**	**0.6 NTU**	**0 NTU**	**0.1 NTU**	**3.9 NTU**	--	--	--	--	--
Metals																					
Aluminum	Dissolved	Lab	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	**25.9 ug/l**	**26.1 ug/l**	< 20.0 ug/l	< 20.0 ug/l	**27.0 ug/l**	**26.5 ug/l**	< 25 ug/l	**35.3 ug/l**	< 25 ug/l	< 25 ug/l	< 25 ug/l	--	--	--	--	--
Aluminum	Total	Lab	**29.2 ug/l**	**53.9 ug/l**	< 20.0 ug/l	**30.2 ug/l**	**32.8 ug/l**	**21.5 ug/l**	< 20.0 ug/l	**31.4 ug/l**	**32.2 ug/l**	**40.8 ug/l**	**69.2 ug/l**	**27.6 ug/l**	**33.2 ug/l**	**25.8 ug/l**	**140 ug/l**	**232 ug/l**	**1550 ug/l**	**107 ug/l**	--
Antimony	Total	Lab				< 0.50 ug/l	< 0.50 ug/l					--	--	--	--	--	< 3 ug/l	< 3 ug/l	< 3 ug/l	< 3 ug/l	--
Arsenic	Dissolved	Lab	**0.91 ug/l**	**0.88 ug/l**	**1.2 ug/l**	**1.4 ug/l**	**1.0 ug/l**	**0.70 ug/l**	**0.80 ug/l**	**0.60 ug/l**	**0.53 ug/l**	--	--	--	--	--	--	--	--	--	--
Arsenic	Total	Lab	< 1.0 ug/l	**1.0 ug/l**	**1.1 ug/l**	**0.67 ug/l**	**0.64 ug/l**	**0.64 ug/l**	**0.78 ug/l**	**0.60 ug/l**	**0.59 ug/l**	--	--	--	--	--	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	--
Barium	Total	Lab	--	--	--	< 10.0 ug/l	< 10.0 ug/l	--	--	--	--	--	--	--	--	--	< 10 ug/l	< 10 ug/l	**20.1 ug/l**	< 10 ug/l	--
Beryllium	Total	Lab	--	--	--	< 0.20 ug/l	< 0.20 ug/l	--	--	--	--	--	--	--	--	--	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	--
Boron	Total	Lab	--	--	--	**99.4 ug/l**	**113 ug/l**	--	--	--	--	--	--	--	--	--	< 35 ug/l	< 35 ug/l	< 35 ug/l	**57.8 ug/l**	**60 ug/l**
Cadmium	Total	Lab	--	--	--	< 0.20 ug/l	< 0.20 ug/l	--	--	--	--	--	--	--	--	--	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	--
Calcium	Total	Lab	**30300 ug/l**	**30500 ug/l**	**29400 ug/l**	**18800 ug/l**	**19200 ug/l**	**22900 ug/l**	**23600 ug/l**	**26600 ug/l**	**26900 ug/l**	--	--	--	--	--	**3900 ug/l**	**4900 ug/l**	**9500 ug/l**	**14000 ug/l**	**17600 ug/l**
Chromium	Total	Lab	--	--	--	< 1.0 ug/l	< 1.0 ug/l	--	--	--	--	--	--	--	--	--	**1 ug/l**	**1.1 ug/l**	**2.6 ug/l**	< 1 ug/l	--
Cobalt	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	**0.21 ug/l**	< 0.20 ug/l	--	--	--	--	--	--	--	--	--	--
Cobalt	Total	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	--	--	--	--	< 1 ug/l	< 1 ug/l	**2.3 ug/l**	< 1 ug/l	--
Copper	Dissolved	Lab	**0.63 ug/l**	**0.98 ug/l**	**0.61 ug/l**	**0.69 ug/l**	**0.70 ug/l**	**0.70 ug/l**	**0.66 ug/l**	**0.60 ug/l**	**0.54 ug/l**	--	--	--	--	--	--	--	--	--	--
Copper	Total	Lab	**0.75 ug/l**	**0.87 ug/l**	**0.56 ug/l**	**0.97 ug/l**	**0.70 ug/l**	**0.66 ug/l**	**0.65 ug/l**	**0.83 ug/l**	**0.64 ug/l**	--	--	--	--	--	< 5 ug/l	< 5 ug/l	< 5 ug/l	**1.2 ug/l**	**1.1 ug/l**
Iron	Dissolved	Lab	**555 ug/l**	**558 ug/l**	**1220 ug/l**	**977 ug/l**	**968 ug/l**	**469 ug/l**	**459 ug/l**	**1770 ug/l**	**1750 ug/l**	--	--	--	--	--	--	--	--	--	--
Iron	Total	Lab	**839 ug/l**	**1030 ug/l**	**1440 ug/l**	**1250 ug/l**	**1310 ug/l**	**630 ug/l**	**627 ug/l**	**2600 ug/l**	**2520 ug/l**	--	--	--	--	--	**640 ug/l**	**970 ug/l**	**5270 ug/l**	**2100 ug/l**	--
Lead	Total	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	--	--	--	--	< 1 ug/l	**1.2 ug/l**	**12.3 ug/l**	< 1 ug/l	**1.6 ug/l**
Magnesium	Total	Lab	**14200 ug/l**	**14200 ug/l**	**13300 ug/l**	**9500 ug/l**	**9900 ug/l**	**11200 ug/l**	**11500 ug/l**	**11800 ug/l**	**12000 ug/l**	--	--	--	--	--	**2700 ug/l**	**3100 ug/l**	**5000 ug/l**	**7500 ug/l**	**8300 ug/l**
Manganese	Dissolved	Lab	**29.4 ug/l**	**29.5 ug/l**	**51.4 ug/l**	**49.1 ug/l**	**48.3 ug/l**	**63.0 ug/l**	**60.9 ug/l**	**301 ug/l**	**315 ug/l**	--	--	--	--	--	--	--	--	--	--
Manganese	Total	Lab	**44.0 * ug/l**	**60.5 * ug/l**	**64.3 ug/l**	**51.3 ug/l**	**54.2 ug/l**	**64.3 ug/l**	**63.5 ug/l**	**298 ug/l**	**321 ug/l**	--	--	--	--	--	**30 ug/l**	**60 ug/l**	**780 ug/l**	**200 ug/l**	--
Mercury	Total	Lab				**0.0022 ug/l**	**0.0021 ug/l**					--	--	--	--	--	**0.0066 ug/l**	**0.0029 ug/l**	< 0.004 ug/l	< 0.01 ug/l	**0.0036 ug/l**
Methyl Mercury	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Total	Lab	--	--	--	**1.1 ug/l**	**1.2 ug/l**	--	--	--	--	--	--	--	--	--	< 5 ug/l	< 5 ug/l	< 5 ug/l	< 5 ug/l	--
Nickel	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	--	--	--	--	--	--	--	--	--
Nickel	Total	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	--	--	--	--	< 5 ug/l	< 5 ug/l	< 5 ug/l	< 5 ug/l	--
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 0.3 ug/l
Phosphorus, total, as P	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 0.25 ug/l
Potassium	Total	Lab	--	--	--	**2800 ug/l**	**2900 ug/l**	--	--	--	--	--	--	--	--	--	**1000 ug/l**	**600 ug/l**	**800 ug/l**	**1000 ug/l**	--
Selenium	Total	Lab	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	--	--	--	--	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 3.6 ug/l
Silver	Total	Lab	--	--	--	< 0.20 ug/l	< 0.20 ug/l	--	--	--	--	--	--	--	--	--	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 0.24 ug/l
Sodium	Total	Lab	--	--	--	**10100 ug/l**	**10300 ug/l**	--	--	--	--	--	--	--	--	--	**1200 ug/l**	**1700 ug/l**	**2100 ug/l**	**2800 ug/l**	**3300 ug/l**
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**17.3 ug/l**	**22.4 ug/l**	**48.1 ug/l**	**67.7 ug/l**	--
Thallium	Total	Lab	**0.005 j ug/l**	< 0.005 ug/l	< 0.005 ug/l	**0.007 j ug/l**	< 0.002 ug/l	< 0.0020 ug/l	< 0.0020 ug/l	< 0.002 ug/l	< 0.002 ug/l	--	--	--	--	--	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 0.4 ug/l
Tin	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 10 ug/l	--	--	--	--
Vanadium	Total	Lab	--	--	--	< 3.0 ug/l	< 3.0 ug/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	Dissolved	Lab	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	--	--	--	--	--	--	--	--	--	--
Zinc	Total	Lab	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	--	--	--	--	--	**11.1 ug/l**	< 10 ug/l	**16.3 ug/l**	< 10 ug/l	--

1 - Some monitoring locations are listed by multiple names. Equivalent locations include the following: PM-1 = SW003, PM-2 = SW002, PM-3 = SW003, PM-4 = SW005, PM16 = SW004

Large Table 11
Surface Water Data Summary
Partridge River Watershed and Wyman Creek

Parameter	Total or Dissolved	Analysis Location	Location	PM-4 [1]	PM-4 [1]	PM-4 [1]	PM-4 [1]	PM-4 [1]	PM-4 [1]	PM-4 [1]	PM-4 [1]	PM-4 [1]	PM-4 [1]	PM-4 [1]	PM-4 [1]	PM-4 [1]	PM-4 [1]	PM-4 [1]	PM-4 [1]	PM-4 [1]	PM-4 [1]
			Date	8/25/2004	9/27/2004	10/26/2004	11/15/2004	7/10/2006	8/28/2006	9/19/2006	10/12/2006	11/7/2006	3/22/2007	4/23/2007	5/21/2007	6/11/2007	7/23/2007	8/22/2007	9/19/2007	10/24/2007	11/14/2007	5/20/2008
			Sample Type	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
General Parameters																						
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total, as CaCO3	NA	Lab	--	**41.5 mg/l**	**37.2 mg/l**	**32 mg/l**	**92 mg/l**	**88.5 mg/l**	**103 mg/l**	**88.6 mg/l**	**74.8 mg/l**	**102 mg/l**	**37.9 mg/l**	**44.0 mg/l**	**25.4 mg/l**	**81 mg/l**	**120 mg/l**	**58.0 mg/l**	< 0 mg/l	**42.2 mg/l**	**17.6 mg/l**
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, total organic	NA	Lab	--	**33 mg/l**	--	**24.2 mg/l**	**19 mg/l**	**13.5 mg/l**	**8.6 mg/l**	**6.6 mg/l**	**10 mg/l**	**9.9 mg/l**	**18.9 mg/l**	**21.7 mg/l**	**37.1 mg/l**	**24.4 mg/l**	**15.7 mg/l**	**26.8 mg/l**	**39.3 mg/l**	**24.9 mg/l**	**21.2 mg/l**
Chemical Oxygen Demand	NA	Lab	--	**88.5 mg/l**	--	**85 mg/l**	**53.5 mg/l**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chloride	NA	Lab	--	**2.5 mg/l**	**2.4 mg/l**	**2.1 mg/l**	**11.3 mg/l**	**9.71 mg/l**	**13 mg/l**	**8.73 mg/l**	**8.93 mg/l**	**7.89 mg/l**	**4.16 mg/l**	**6.68 mg/l**	**1.79 mg/l**	**13 mg/l**	**20.3 mg/l**	**6.61 mg/l**	**2.84 mg/l**	**6.5 mg/l**	**2.25 mg/l**
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Lab	--	--	--	--	--	**6.62 mg/l**	**4.25 mg/l**	**9.32 mg/l**	**13.32 mg/l**	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	--	--	--	--	--	--	--	--	--	**10.4 mg/l**	**10.5 mg/l**	**5.26 mg/l**	**3.0 mg/l**	**7.9 mg/l**	--	**5.23 mg/l**	**9.3 mg/l**	**8.8 mg/l**	--
Fluoride	NA	Lab	--	**0.12 mg/l**	**0.1 mg/l**	< 0.1 mg/l	**0.16 mg/l**	< 0.1 mg/l	**0.1 mg/l**	**0.1 mg/l**	**0.1 mg/l**	**0.1 mg/l**	< 1 mg/l	< 1 mg/l	< 1 mg/l	**0.11 mg/l**	< 5 mg/l	< 2 mg/l	< 1 mg/l	**0.17 mg/l**	--
Hardness, as CaCO3	NA	Lab	--	**40.7 mg/l**	**41.2 mg/l**	**36.3 mg/l**	**93.4 mg/l**	**103 mg/l**	**103 mg/l**	**97.9 mg/l**	**92.5 mg/l**	**112 mg/l**	**50.2 mg/l**	**55 mg/l**	**37 mg/l**	**84.6 mg/l**	**118 mg/l**	**74 mg/l**	**43 mg/l**	**55.6 mg/l**	**29.6 mg/l**
Nitrate + Nitrite, as N	NA	Lab	--	< 0.1 mg/l	--	**0.11 mg/l**	< 0.1 mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrogen, ammonia as N	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Lab	--	**7.34 pH units**	**8.19 pH units**	**7.8 pH units**	**8.1 pH units**	**7.95 pH units**	**7.94 pH units**	**8.45 pH units**	**7.84 pH units**	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	--	--	--	--	**7.59 pH units**	--	--	--	--	**7.85 pH units**	**7.6 pH units**	**7.96 pH units**	**7.1 pH units**	**7.6 pH units**	--	**8.05 pH units**	**8.1 pH units**	**7.3 pH units**	--
Phosphorus, total, as P	NA	Lab	--	< 0.1 mg/l	--	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	**0.21 mg/l**	< 0.1 mg/l	< 0.1 mg/l	< 2 mg/l	< 0.5 mg/l	< 1 mg/l	< 0 mg/l	< 1 mg/l	< 0 mg/l	< 1 mg/l	**0.15 mg/l**	< 10 mg/l	**0.009 mg/l**
Redox (oxidation potential)	NA	Field	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Solids, total dissolved	NA	Lab	--	**108 mg/l**	**93 mg/l**	**89 mg/l**	**149 mg/l**	**340 mg/l**	**151 mg/l**	**155 mg/l**	**122 mg/l**	**168 mg/l**	**122 mg/l**	**87 mg/l**	**88 mg/l**	**188 mg/l**	**177 mg/l**	**127 mg/l**	**142 mg/l**	**146 mg/l**	**75 mg/l**
Solids, total suspended	NA	Lab	--	**4 mg/l**	--	**2 mg/l**	**9 mg/l**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 1 mg/l
Specific Conductance @ 25 °C	NA	Lab	--	**85.5 umhos/cm**	**98.8 umhos/cm**	**79.8 umhos/cm**	**212 umhos/cm**	**240.7 umhos/cm**	**257 umhos/cm**	**233 umhos/cm**	**220.8 umhos/cm**	--	--	--	--	--	--	--	--	--	--	--
Specific Conductance @ 25 °C	NA	Field	--	--	--	--	**227.1 umhos/cm**	--	--	--	--	**250.2 umhos/cm**	**121.4 umhos/cm**	**140 umhos/cm**	**68 umhos/cm**	**205 umhos/cm**	--	**166 umhos/cm**	**89.3 umhos/cm**	**140 umhos/cm**	--
Sulfate, as SO4	NA	Lab	--	**1.6 mg/l**	**8.6 mg/l**	**10.2 mg/l**	**5.14 mg/l**	**6.79 mg/l**	**8.77 mg/l**	**14.7 mg/l**	**20 mg/l**	**11.8 mg/l**	**11.8 mg/l**	**18.4 mg/l**	**6.4 mg/l**	**7.93 mg/l**	**11.9 mg/l**	**16.5 mg/l**	**7.84 mg/l**	**14.2 mg/l**	**7.48 mg/l**
Temperature, °C	NA	Lab	--	**16.9 deg C**	**7.8 deg C**	**1.4 deg C**	**24.4 deg C**	**20.2 deg C**	**13.8 deg C**	**4.8 deg C**	**4.6 deg C**	--	--	--	--	--	--	--	--	--	--	--
Temperature, °C	NA	Field	--	--	--	--	--	--	--	--	--	**0.8 deg C**	**10.4 deg C**	**12.5 deg C**	**18.8 deg C**	**26.6 deg C**	--	**13.04 deg C**	**6.3 deg C**	**2.6 deg C**	--
Turbidity	NA	Lab	--	--	--	--	--	**4.86 NTU**	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Turbidity	NA	Field	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Metals																						
Aluminum	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Aluminum	Total	Lab	**48.3 ug/l**	**127 ug/l**	**84.8 ug/l**	**124 ug/l**	**66.8 ug/l**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**135 ug/l**
Antimony	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Boron	Total	Lab	--	< 35 ug/l	< 40 ug/l	< 35 ug/l	**92 ug/l**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.051 j ug/l**
Calcium	Total	Lab	--	**8200 ug/l**	**8900 ug/l**	**7100 ug/l**	**21000 ug/l**	**23800 ug/l**	**23000 ug/l**	**21900 ug/l**	**20400 ug/l**	**25500 ug/l**	**10700 ug/l**	**11600 ug/l**	**7630 ug/l**	**18100 ug/l**	**25300 ug/l**	**15500 ug/l**	**9100 ug/l**	**11000 ug/l**	**6190 ug/l**
Chromium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.37 jb ug/l**
Cobalt	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	Total	Lab	--	< 1 ug/l	--	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 2.5 ug/l < 1 ug/l	< 1 ug/l	< 1 ug/l < 1 ug/l	< 25 ug/l	< 0.24 ug/l	< 10 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 2 ug/l	< 1 ug/l	< 25 ug/l	**0.23 ug/l**
Copper	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	Total	Lab	--	**1.5 ug/l**	**1.1 ug/l**	**1.4 ug/l**	**2.6 ug/l**	**0.86 ug/l**	**0.68 ug/l** **0.83 ug/l**	**2.6 ug/l**	**0.66 ug/l** **1.3 ug/l**	**2.0 ug/l**	**1.3 ug/l**	**1.5 ug/l**	**1 ug/l**	**2 ug/l**	**1.2 ug/l**	**1.8 ug/l**	**2.3 ug/l**	**1.5 ug/l**	**1.8 ug/l**
Iron	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Iron	Total	Lab	--	**1720 ug/l**	--	**1250 ug/l**	**2.03 ug/l**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	Total	Lab	--	**0.77 ug/l**	< 0.3 ug/l	**0.35 ug/l**	< 0.6 ug/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.22 jb ug/l**
Magnesium	Total	Lab	--	**4900 ug/l**	**4600 ug/l**	**4500 ug/l**	**9970 ug/l**	**10500 ug/l**	**11000 ug/l**	**10500 ug/l**	**10100 ug/l**	**11800 ug/l**	**5680 ug/l**	**6340 ug/l**	**4340 ug/l**	**9550 ug/l**	**13400 ug/l**	**8560 ug/l**	**5000 ug/l**	**6840 ug/l**	**3440 ug/l**
Manganese	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	Total	Lab	--	**110 ug/l**	--	**50 ug/l**	**160 ug/l**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**28 ug/l**
Mercury	Total	Lab	--	< 0.008 ug/l	< 0.01 ug/l	< 0.005 ug/l	< 0.002 ug/l	**0.002 ug/l**	**0.0011 ug/l**	< 0.002 ug/l	< 0.004 ug/l	< 0.0005 ug/l	**0.0042 ug/l**	< 0.001 ug/l	**0.0063 ug/l**	< 0.004 ug/l	**0.0022 ug/l**	**0.0050 ug/l**	**0.0093 ug/l**	**0.0048 ug/l**	**0.0056 ug/l**
Methyl Mercury	Total	Lab	--	--	--	--	--	--	**0.000081 ug/l**	--	< 0.000056 ug/l	--	--	**0.000383 ug/l**	--	**0.000396 ug/l**	--	**0.000676 ug/l**	--	**0.000639 ug/l**	**0.00029 ug/l**
Molybdenum	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.44 ug/l**
Nickel	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	Total	Lab	**1.4 ug/l**	**3.6 ug/l**	**2 ug/l**	**1.9 ug/l**	**2.2 ug/l**	**0.97 ug/l**	**1.9 ug/l** **0.69 ug/l**	**0.53 ug/l**	**0.46 ug/l** **0.57 ug/l**	**1.1 ug/l**	**0.99 ug/l**	**1.4 ug/l**	**2.4 ug/l**	**1.8 ug/l**	**2.0 ug/l**	**2.2 ug/l**	**2.6 ug/l**	**1.9 ug/l**	**1.7 ug/l**
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total, as P	Dissolved	Lab	--	--	--	--	< 20 ug/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	--	**900 ug/l**	--	**700 ug/l**	**1740 ug/l**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	Total	Lab	--	< 3.6 ug/l	< 3.6 ug/l	< 3.6 ug/l	< 1 ug/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	Total	Lab	--	< 0.24 ug/l	< 0.24 ug/l	< 0.24 ug/l	< 0.2 ug/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sodium	Total	Lab	--	**1900 ug/l**	**2100 ug/l**	**2200 ug/l**	**8770 ug/l**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab	--	< 0.4 ug/l	< 0.4 ug/l	< 0.4 ug/l	< 0.4 ug/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Tin	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	Total	Lab	< 10 ug/l	**12 ug/l**	< 10 ug/l	**11 ug/l**	**82.9 ug/l**	< 25 ug/l	< 25 ug/l < 25 ug/l	< 25 ug/l	**71.3 ug/l** **< 25 ug/l**	**80.1 ug/l**	< 10 ug/l	< 10 ug/l	< 1 ug/l	< 1 ug/l	< 0 ug/l	< 1 ug/l	< 25 ug/l	< 10 ug/l	**2.5 jb ug/l**

1 - Some monitoring locations are listed by multiple names. Equivalent locations include the following: PM-1 = SW003, PM-2 = SW002, PM-3 = SW003, PM-4 = SW005, PM16 = SW004

Large Table 11
Surface Water Data Summary
Partridge River Watershed and Wyman Creek

			Location	PM-4 [1]		PM-4 [1]	PM-4 [1]	PM-4 [1]	PM-4 [1]	PM-4 [1]		PM-4 [1]		PM-4 [1]		PM-4 [1]	PM-4 [1]	PM-4 [1]		PM-4 [1]	PM-4 [1]	PM-4 [1]
			Date	6/10/2008		7/21/2008	10/8/2008	6/28/2012	7/31/2012	8/29/2012	9/26/2012		10/31/2012	11/29/2012	12/20/2012		1/30/2013	2/27/2013	3/27/2013		4/25/2013	5/10/2013	6/17/2013
			Sample Type	N	FD	N	N	N	N	N	N	FD	N	N	N	FD	N	N	N	FD	N	N	N
Parameter	Total or Dissolved	Analysis Location																					
General Parameters																							
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	--	--	--	30.0 mg/l	--	--	93.6 mg/l	--	--	--	62.2 mg/l	--	--	--	103 mg/l	--	--	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total, as CaCO3	NA	Lab	16.4 mg/l	14.6 mg/l	65.6 mg/l	--	30.0 mg/l	--	--	93.6 mg/l	--	--	--	62.2 mg/l	--	--	--	103 mg/l	--	--	--	--
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, total organic	NA	Lab	31.3 mg/l	30.8 mg/l	22.2 mg/l	--	72.7 mg/l	39.2 mg/l	20.8 mg/l	9.3 mg/l	--	12.3 mg/l	12.7 mg/l	13.8 mg/l	--	12.1 mg/l	8.0 mg/l	7.9 mg/l	--	8.2 mg/l	22.3 mg/l	--
Chemical Oxygen Demand	NA	Lab	--	--	--	--	185 mg/l	--	--	26.5 mg/l	--	--	--	39.9 mg/l	--	--	--	20.9 mg/l	--	--	--	--
Chloride	NA	Lab	0.87 mg/l	0.83 mg/l	5.1 mg/l	--	2.4 mg/l	3.8 mg/l	5.5 mg/l	6.8 mg/l	--	6.9 mg/l	7.4 mg/l	7.0 mg/l	--	5.9 mg/l	4.2 mg/l	4.2 mg/l	--	10.8 mg/l	1.4 mg/l	--
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	--	--	--	7.19 mg/l	3.33 mg/l	4.46 mg/l	5.72 mg/l	9.19 mg/l	--	11.09 mg/l	12.22 mg/l	10.05 mg/l	--	9.51 mg/l	10.22 mg/l	11 mg/l	--	10.75 mg/l	9.23 mg/l	--
Fluoride	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hardness, as CaCO3	NA	Lab	27.9 mg/l	27.5 mg/l	76.4 mg/l	--	53.8 mg/l	70.3 mg/l	94.8 mg/l	110 mg/l	--	92.4 mg/l	75.1 mg/l	87.7 mg/l	--	113 mg/l	113 mg/l	102 mg/l	--	90.7 mg/l	23.6 mg/l	--
Nitrate + Nitrite, as N	NA	Lab	--	--	--	--	< 0.10 mg/l	--	--	< 0.10 mg/l	--	--	--	0.39 mg/l	--	--	--	0.44 mg/l	--	--	--	--
Nitrogen, ammonia as N	NA	Lab	--	--	--	--	0.18 mg/l	--	--	< 0.10 mg/l	--	--	--	< 0.10 mg/l	--	--	--	0.11 mg/l	--	--	--	--
pH	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	--	--	--	7.37 pH units	6.6 pH units	6.75 pH units	7.7 pH units	7.86 pH units	--	7.81 pH units	7.84 pH units	6.51 pH units	--	7.46 pH units	7.01 pH units	7.28 pH units	--	7.46 pH units	6.14 pH units	--
Phosphorus, total, as P	NA	Lab	0.008 mg/l	0.010 mg/l	0.021 * mg/l	--	0.057 mg/l	--	--	0.0050 mg/l	--	--	--	0.015 mg/l	--	--	--	0.018 mg/l	--	--	--	--
Redox (oxidation potential)	NA	Field	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	457 mV	--
Solids, total dissolved	NA	Lab	71 * mg/l	49 * mg/l	135 mg/l	--	189 mg/l	165 mg/l	157 mg/l	156 mg/l	--	151 mg/l	163 mg/l	219 mg/l	--	150 mg/l	150 mg/l	210 mg/l	--	153 mg/l	81.0 mg/l	--
Solids, total suspended	NA	Lab	1.6 mg/l	2.0 mg/l	1.2 mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Specific Conductance @ 25 ºC	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Specific Conductance @ 25 ºC	NA	Field	--	--	--	95.2 umhos/cm	43.8 umhos/cm	85.1 umhos/cm	160.8 umhos/cm	123.7 umhos/cm	--	192.3 umhos/cm	62 umhos/cm	50.3 umhos/cm	--	176.3 umhos/cm	224.9 umhos/cm	250 umhos/cm	--	197.9 umhos/cm	37.8 umhos/cm	--
Sulfate, as SO4	NA	Lab	4.31 mg/l	3.86 mg/l	7.26 mg/l	--	4.5 mg/l	5.7 mg/l	10.2 mg/l	12.9 mg/l	--	16.6 mg/l	18.0 mg/l	19.5 mg/l	--	18.1 mg/l	13.9 mg/l	13.3 mg/l	--	12.4 mg/l	6.3 mg/l	--
Temperature, ºC	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Temperature, ºC	NA	Field	--	--	--	10.4 deg C	20.94 deg C	22.45 deg C	21.38 deg C	10.34 deg C	--	2.41 deg C	0.69 deg C	0.64 deg C	--	0.14 deg C	2.78 deg C	5.2 deg C	--	5.67 deg C	7.14 deg C	--
Turbidity	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Turbidity	NA	Field	--	--	--	6.77 NTU	4.3 NTU	58.3 NTU	13.1 NTU	3.4 NTU	--	3.2 NTU	0 NTU	0 NTU	--	3.1 NTU	9.2 NTU	18.9 NTU	--	9.5 NTU	0 NTU	--
Metals																							
Aluminum	Dissolved	Lab	--	--	--	--	355 ug/l	167 ug/l	54.9 ug/l	26.5 ug/l	--	< 40.0 ug/l	39.8 ug/l	45.6 ug/l	--	36.9 ug/l	< 40.0 ug/l	24.3 ug/l	--	24.0 ug/l	138 ug/l	--
Aluminum	Total	Lab	217 ug/l	213 ug/l	86 ug/l	--	442 ug/l	233 ug/l	99.5 ug/l	61.2 ug/l	--	70.9 ug/l	82.5 ug/l	88.3 ug/l	--	78.3 ug/l	52.4 ug/l	54.9 ug/l	--	58.3 ug/l	164 ug/l	--
Antimony	Total	Lab	--	--	--	--	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	--
Arsenic	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	Total	Lab	--	--	--	--	3.0 ug/l	2.2 ug/l	1.2 ug/l	< 0.50 ug/l	--	0.65 ug/l	0.58 ug/l	< 0.50 ug/l	--	0.74 ug/l	0.50 ug/l	< 0.82 ug/l	--	1.1 ug/l	< 0.50 ug/l	--
Barium	Total	Lab	--	--	--	--	16.3 ug/l	--	--	< 10.0 ug/l	--	--	--	< 10.0 ug/l	--	--	--	< 10.0 ug/l	--	--	--	--
Beryllium	Total	Lab	--	--	--	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	--	< 0.20 ug/l	--	--	--	< 0.20 ug/l	--	--	--	--
Boron	Total	Lab	--	--	--	--	< 50.0 ug/l	--	--	136 ug/l	--	--	--	75.4 ug/l	--	--	--	55.5 ug/l	--	--	--	--
Cadmium	Total	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.2 ug/l	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	--	< 0.20 ug/l	--	--	--	< 0.20 ug/l	--	--	--	--
Calcium	Total	Lab	5720 ug/l	5650 ug/l	16800 ug/l	--	11200 ug/l	14500 ug/l	20500 ug/l	24100 ug/l	--	20000 ug/l	15200 ug/l	17600 ug/l	--	23900 ug/l	24800 ug/l	22600 ug/l	--	18900 ug/l	4500 ug/l	--
Chromium	Total	Lab	0.82 b ug/l	0.73 b ug/l	0.37 jb ug/l	--	< 1.0 ug/l	--	--	< 1.0 ug/l	--	--	--	< 1.0 ug/l	--	--	--	< 1.0 ug/l	--	--	--	--
Cobalt	Dissolved	Lab	--	--	--	--	2.4 ug/l	0.83 ug/l	0.44 ug/l	0.22 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	0.22 ug/l	--	0.22 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	0.21 ug/l	--
Cobalt	Total	Lab	0.30 ug/l	0.30 ug/l	0.38 ug/l	--	2.6 ug/l	0.90 ug/l	0.52 ug/l	0.28 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	0.23 ug/l	--	0.24 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	--
Copper	Dissolved	Lab	--	--	--	--	2.9 ug/l	1.4 ug/l	0.89 ug/l	0.61 ug/l	--	0.78 ug/l	0.92 ug/l	0.97 ug/l	--	2.2 ug/l	0.68 ug/l	1.5 ug/l	--	1.6 ug/l	1.8 ug/l	--
Copper	Total	Lab	2.2 ug/l	2.2 ug/l	1.5 ug/l	--	3.0 ug/l	1.7 ug/l	1.0 ug/l	0.63 ug/l	--	0.82 ug/l	0.96 ug/l	1.1 ug/l	--	2.6 ug/l	0.81 ug/l	1.7 ug/l	--	1.9 ug/l	1.9 ug/l	--
Iron	Dissolved	Lab	--	--	--	--	3920 ug/l	4060 ug/l	2370 ug/l	1050 ug/l	--	1030 ug/l	975 ug/l	1120 ug/l	--	1300 ug/l	1190 ug/l	1010 ug/l	--	987 ug/l	745 ug/l	--
Iron	Total	Lab	--	--	--	--	6020 ug/l	5080 ug/l	2600 ug/l	1290 ug/l	--	1340 ug/l	1270 ug/l	1610 ug/l	--	2090 ug/l	1980 ug/l	1670 ug/l	--	1670 ug/l	890 ug/l	--
Lead	Total	Lab	0.26 jb ug/l	0.27 jb ug/l	0.26 j ug/l	--	0.57 ug/l	0.53 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	1.0 ug/l	< 0.50 ug/l	--
Magnesium	Total	Lab	3310 ug/l	3250 ug/l	8380 ug/l	--	6300 ug/l	8300 ug/l	10600 ug/l	12100 ug/l	--	10300 ug/l	9000 ug/l	10600 ug/l	--	13000 ug/l	12500 ug/l	11200 ug/l	--	10500 ug/l	3000 ug/l	--
Manganese	Dissolved	Lab	--	--	--	--	577 ug/l	193 ug/l	201 ug/l	99.9 ug/l	--	49.4 ug/l	46.6 ug/l	76.2 ug/l	--	80.5 ug/l	53.9 ug/l	42.9 ug/l	--	63.2 ug/l	24.5 ug/l	--
Manganese	Total	Lab	42 ug/l	43 ug/l	120 ug/l	--	632 ug/l	203 ug/l	213 ug/l	109 ug/l	--	51.8 ug/l	48.8 ug/l	78.2 ug/l	--	81.1 ug/l	58.4 ug/l	46.8 ug/l	--	57.5 ug/l	27.3 ug/l	--
Mercury	Total	Lab	0.0108 ug/l	0.0110 ug/l	0.0038 ug/l	--	0.0184 ug/l	--	--	0.0015 ug/l	0.0015 ug/l	--	--	0.0027 ug/l	0.0024 ug/l	--	--	0.0017 ug/l	0.0016 ug/l	--	--	--
Methyl Mercury	Total	Lab	0.00044 ug/l	0.00059 ug/l	0.00057 ug/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Total	Lab	0.17 j ug/l	0.17 j ug/l	1.0 ug/l	--	0.41 ug/l	--	--	1.3 ug/l	--	--	--	0.55 ug/l	--	--	--	0.86 ug/l	--	--	--	--
Nickel	Dissolved	Lab	--	--	--	--	4.5 ug/l	3.3 ug/l	1.0 ug/l	< 0.50 ug/l	--	0.56 ug/l	0.76 ug/l	0.59 ug/l	--	0.80 ug/l	0.56 ug/l	1.0 ug/l	--	0.74 ug/l	1.8 ug/l	--
Nickel	Total	Lab	2.3 ug/l	2.4 ug/l	1.7 ug/l	--	4.9 ug/l	3.0 ug/l	1.2 ug/l	0.80 ug/l	--	< 0.50 ug/l	0.87 ug/l	0.67 ug/l	--	1.0 ug/l	0.65 ug/l	1.1 ug/l	--	0.88 ug/l	1.4 ug/l	--
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total, as P	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	--	--	--	--	830 ug/l	--	--	3000 ug/l	--	--	--	1800 ug/l	--	--	--	2300 ug/l	--	--	--	--
Selenium	Total	Lab	--	--	--	--	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	< 1.0 ug/l	--
Silver	Total	Lab	--	--	--	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	--	< 0.20 ug/l	--	--	--	< 0.20 ug/l	--	--	--	--
Sodium	Total	Lab	--	--	--	--	3200 ug/l	--	--	7600 ug/l	--	--	--	7200 ug/l	--	--	--	5100 ug/l	--	--	--	--
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab	--	--	--	--	0.025 * ug/l	< 0.0004 ug/l	< 0.005 ug/l	0.003 j ug/l	--	0.0013 jb ug/l	0.0116 j ug/l	< 0.0004 ug/l	--	< 0.005 ug/l	< 0.002 ug/l	0.051 * ug/l	--	0.008 j ug/l	0.0087 j* ug/l	< 0.005 ug/l
Tin	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Total	Lab	--	--	--	--	< 3.0 ug/l	--	--	< 3.0 ug/l	--	--	--	< 3.0 ug/l	--	--	--	< 3.0 ug/l	--	--	--	--
Zinc	Dissolved	Lab	--	--	--	--	11.9 ug/l	< 6.0 ug/l	6.8 ug/l	< 6.0 ug/l	--	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	--	16.1 ug/l	< 6.0 ug/l	15.8 ug/l	--	7.8 ug/l	7.1 ug/l	--
Zinc	Total	Lab	4.5 j ug/l	4.4 j ug/l	5.2 jb ug/l	--	7.4 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	--	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	--	16.4 ug/l	< 6.0 ug/l	15.9 ug/l	--	8.1 ug/l	< 6.0 ug/l	--

1 - Some monitoring locations are listed by multiple names. Equivalent locations include the following: PM-1 = SW003, PM-2 = SW002, PM-3 = SW003, PM-4 = SW005, PM16 = SW004

Large Table 11
Surface Water Data Summary
Partridge River Watershed and Wyman Creek

Location			PM-4 [1]	PM-4 [1]	PM-4 [1]	PM-4 [1]	PM-4 [1]		PM-4 [1]	PM-4 [1]	SW005	SW005	SW005	SW005 [1]		SW005 [1]	SW005 [1]	PM-5	PM-5	PM-5	PM-5
Date			6/18/2013	7/24/2013	8/20/2013	9/18/2013	10/30/2013		11/27/2013	12/18/2013	5/27/2010	6/17/2010	7/15/2010	8/10/2010		9/22/2010	10/20/2011	4/13/2004	5/19/2004	6/22/2004	7/29/2004
Sample Type			N	N	N	N	N	FD	N	N	N	N	N	N	FD	N	N	N	N	N	N
Parameter	Total or Dissolved	Analysis Location																			
General Parameters																					
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	49.8 mg/l	--	--	30.4 mg/l	--	--	--	--	29 mg/l	--	78 mg/l	--	--	88 mg/l	--	--	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total, as CaCO3	NA	Lab	--	49.8 mg/l	--	--	30.4 mg/l	--	--	--	--	29 mg/l	--	78 mg/l	--	--	--	110 mg/l	92 mg/l	142 mg/l	184 mg/l
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, total organic	NA	Lab	21.0 mg/l	41.0 mg/l	20.5 mg/l	15.1 mg/l	24.0 mg/l	--	19.2 mg/l	19.6 mg/l	--	40.5 mg/l	--	21.4 mg/l	--	--	--	4 mg/l	6.1 mg/l	9.1 mg/l	11 mg/l
Chemical Oxygen Demand	NA	Lab	--	141 mg/l	--	--	78.0 mg/l	--	--	--	--	63.9 mg/l	--	59.5 mg/l	--	--	--	2.8 mg/l	16 mg/l	25 mg/l	24 mg/l
Chloride	NA	Lab	5.7 mg/l	3.8 mg/l	9.0 mg/l	5.0 mg/l	1.8 mg/l	--	3.0 mg/l	3.4 mg/l	--	1.86 mg/l	--	16.9 mg/l	--	--	5.35 mg/l	2.1 mg/l	1.9 mg/l	2.2 mg/l	1.8 mg/l
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.02 mg/l	< 0.02 mg/l	< 0.02 mg/l	< 0.02 mg/l
Dissolved oxygen	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	10.7 mg/l	12.1 mg/l	--	--
Dissolved oxygen	NA	Field	7.31 mg/l	5.04 mg/l	6.7 mg/l	7.84 mg/l	11.15 mg/l	--	12.08 mg/l	11.07 mg/l	4.96 mg/l	6.38 mg/l	6.01 mg/l	5.31 mg/l	--	0.84 mg/l	< 0.1 mg/l	--	--	--	--
Fluoride	NA	Lab	--	--	--	--	--	--	--	--	--	< 0.1 mg/l	--	0.15 mg/l	--	--	--	0.1 mg/l	0.13 mg/l	0.1 mg/l	0.17 mg/l
Hardness, as CaCO3	NA	Lab	52.6 mg/l	72.1 mg/l	90.1 mg/l	95.8 mg/l	41.5 mg/l	--	63.6 mg/l	70.7 mg/l	40.6 mg/l	45.1 mg/l	85.2 mg/l	99.8 mg/l	--	79.9 mg/l	107 mg/l	120 mg/l	121 mg/l	156 mg/l	213 mg/l
Nitrate + Nitrite, as N	NA	Lab	--	0.14 mg/l	--	--	0.14 mg/l	--	--	--	--	< 0.1 mg/l	--	< 0.1 mg/l	--	--	--	0.75 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l
Nitrogen, ammonia as N	NA	Lab	--	0.35 mg/l	--	--	0.13 mg/l	--	--	--	--	< 0.1 mg/l	--	< 0.05 mg/l	--	--	--	< 0.1 mg/l	< 0.1 mg/l	0.13 mg/l	0.11 mg/l
pH	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.7 pH units	8.25 pH units	7.76 pH units	7.3 pH units
pH	NA	Field	6.86 pH units	6.94 pH units	8.42 pH units	7.49 pH units	7.49 pH units	--	8.09 pH units	6.94 pH units	6.49 pH units	6.91 pH units	6.81 pH units	7.21 pH units	--	7.08 pH units	6.00 pH units	--	--	--	--
Phosphorus, total, as P	NA	Lab	--	0.044 mg/l	--	--	0.032 mg/l	--	--	--	--	0.025 mg P/L	--	0.019 mg P/L	--	--	--	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	0.11 mg/l
Redox (oxidation potential)	NA	Field	--	--	--	--	--	--	--	--	--	--	--	--	--	--	453 mV	--	--	--	--
Solids, total dissolved	NA	Lab	149 mg/l	218 mg/l	195 mg/l	140 mg/l	137 mg/l	--	147 mg/l	168 mg/l	--	127 mg/l	--	188 mg/l	--	--	--	204 mg/l	204 mg/l	260 mg/l	258 mg/l
Solids, total suspended	NA	Lab	--	--	--	--	--	--	--	--	--	5.6 mg/l	--	2 mg/l	--	--	--	< 1 mg/l	4 mg/l	2 mg/l	7 mg/l
Specific Conductance @ 25 °C	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	338 umhos/cm	358 umhos/cm	403.6 umhos/cm	449 umhos/cm
Specific Conductance @ 25 °C	NA	Field	114.3 umhos/cm	132.7 umhos/cm	220.3 umhos/cm	202 umhos/cm	80 umhos/cm	--	129.7 umhos/cm	141.6 umhos/cm	78.3 umhos/cm	82 umhos/cm	100 umhos/cm	258 umhos/cm	--	173 umhos/cm	208 umhos/cm	--	--	--	--
Sulfate, as SO4	NA	Lab	10.6 mg/l	7.0 mg/l	18.9 mg/l	10 mg/l	5.1 mg/l	--	11.1 mg/l	10.3 mg/l	5 mg/l	4.57 mg/l	9.91 mg/l	15.3 mg/l	--	13 mg/l	17.5 mg/l	58.9 mg/l	76.2 mg/l	85.1 mg/l	62.1 mg/l
Temperature, °C	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.3 deg C	14.5 deg C	18.1 deg C	20 deg C
Temperature, °C	NA	Field	17.44 deg C	20.08 deg C	25.17 deg C	15.91 deg C	2.73 deg C	--	0.46 deg C	1.44 deg C	20.60 deg C	16.91 deg C	23.18 deg C	24.5 deg C	--	12.77 deg C	6.70 deg C	--	--	--	--
Turbidity	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2 NTU	3 NTU	--	--
Turbidity	NA	Field	1.9 NTU	11.5 NTU	9 NTU	1.9 NTU	2.2 NTU	--	4.2 NTU	4.7 NTU	0.8 NTU	0.8 NTU	1.0 NTU	1.1 NTU	--	0.6 NTU	2.2 NTU	--	--	--	--
Metals																					
Aluminum	Dissolved	Lab	99.2 ug/l	198 ug/l	73.4 ug/l	43.1 ug/l	121 ug/l	--	99.4 ug/l	96.8 ug/l	109 ug/l	154 ug/l	68.3 ug/l	--	--	48.1 ug/l	< 25 ug/l	--	--	--	--
Aluminum	Total	Lab	129 ug/l	240 ug/l	105 ug/l	76.2 ug/l	195 ug/l	--	124 ug/l	136 ug/l	144 ug/l	230 ug/l	129 ug/l	64.7 ug/l	--	93.4 ug/l	109 ug/l	14.4 ug/l	11.9 ug/l	31.4 ug/l	90.8 ug/l
Antimony	Total	Lab		< 0.50 ug/l	--	--	< 0.50 ug/l	--			--	--	--	--	--	--	--	< 3 ug/l	< 3 ug/l	< 3 ug/l	< 3 ug/l
Arsenic	Dissolved	Lab	< 0.50 ug/l	2.2 ug/l	1.2 ug/l	0.92 ug/l	0.94 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	--	--	--	--	--	--	--	--	--	--	--
Arsenic	Total	Lab	0.64 ug/l	2.6 ug/l	1.4 ug/l	1.3 ug/l	0.96 ug/l	--	0.55 ug/l	< 0.50 ug/l	0.67 ug/l	1.09 ug/l	1.7 ug/l	1.05 ug/l	1.12 ug/l	1.02 ug/l	--	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l
Barium	Total	Lab	--	12.9 ug/l	--	--	< 10.0 ug/l	--	--	--	--	8.01 ug/l	--	11.8 ug/l	--	--	--	< 10 ug/l	< 10 ug/l	< 10 ug/l	14.6 ug/l
Beryllium	Total	Lab	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	--	--	< 0.2 ug/l	--	< 0.2 ug/l	--	--	--	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l
Boron	Total	Lab	--	57.8 ug/l	--	--	< 50.0 ug/l	--	--	--	--	< 50 ug/l	--	157 ug/l	--	--	--	55 ug/l	43.7 ug/l	59 ug/l	67.9 ug/l
Cadmium	Total	Lab	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	--	--	0.02 j ug/l	--	< 0.02 ug/l	--	--	--	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l
Calcium	Total	Lab	10700 ug/l	14700 ug/l	18800 ug/l	20500 ug/l	8100 ug/l	--	12900 ug/l	14400 ug/l	8520 ug/l	9660 ug/l	18300 ug/l	22000 ug/l	--	16800 ug/l	23600 ug/l	24300 ug/l	26500 ug/l	30800 ug/l	35400 ug/l
Chromium	Total	Lab		< 1.0 ug/l	--	--	< 1.0 ug/l	--	--	--	--	< 1 ug/l	--	< 1 ug/l	--	--	--	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l
Cobalt	Dissolved	Lab	0.26 ug/l	0.95 ug/l	0.36 ug/l	0.33 ug/l	0.23 ug/l	--	< 0.20 ug/l	0.25 ug/l	--	0.35 ug/l	--	--	--	--	--	--	--	--	--
Cobalt	Total	Lab	0.36 ug/l	1.0 ug/l	0.42 ug/l	0.35 ug/l	0.25 ug/l	--	0.21 ug/l	0.23 ug/l	--	0.44 ug/l	--	0.3 ug/l	--	--	--	7.8 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l
Copper	Dissolved	Lab	2.0 ug/l	1.3 ug/l	0.98 ug/l	0.76 ug/l	2.5 ug/l	--	1.2 ug/l	1.8 ug/l	--	1.49 ug/l	--	--	--	--	--	--	--	--	--
Copper	Total	Lab	1.7 ug/l	1.6 ug/l	1.2 ug/l	0.81 ug/l	1.9 ug/l	--	1.4 ug/l	2.2 ug/l	--	2.1 ug/l	--	1.5 ug/l	--	--	--	< 5 ug/l	< 5 ug/l	< 0.8 ug/l	< 0.8 ug/l
Iron	Dissolved	Lab	969 ug/l	5380 ug/l	2690 ug/l	2180 ug/l	1290 ug/l	--	1080 ug/l	1810 ug/l	--	--	--	--	--	--	--	--	--	--	--
Iron	Total	Lab	1230 ug/l	6200 ug/l	2870 ug/l	2730 ug/l	1740 ug/l	--	1460 ug/l	2310 ug/l	--	1880 ug/l	--	1240 ug/l	--	--	--	340 ug/l	240 ug/l	430 ug/l	1320 ug/l
Lead	Total	Lab	< 0.50 ug/l	0.57 ug/l	0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	--	0.23 j ug/l	--	0.14 b ug/l	--	--	--	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l
Magnesium	Total	Lab	6300 ug/l	8600 ug/l	10500 ug/l	10800 ug/l	5100 ug/l	--	7600 ug/l	8400 ug/l	4690 ug/l	5100 ug/l	9600 ug/l	10900 ug/l	--	9210 ug/l	11600 ug/l	20300 ug/l	19700 ug/l	26800 ug/l	30300 ug/l
Manganese	Dissolved	Lab	64.3 ug/l	248 ug/l	103 ug/l	165 ug/l	54.1 ug/l	--	49.0 ug/l	82.5 ug/l	--	--	--	--	--	--	--	--	--	--	--
Manganese	Total	Lab	77.1 ug/l	260 ug/l	120 ug/l	171 ug/l	58.8 ug/l	--	52.9 ug/l	80.6 ug/l	--	138 ug/l	--	119 ug/l	--	--	--	230 ug/l	70 ug/l	140 ug/l	840 ug/l
Mercury	Total	Lab		0.0083 ug/l	--	--	0.0064 ug/l	0.0061 ug/l			--	0.0056 ug/l	--	0.0028 ug/l	0.0032 ug/l	--	--	0.0014 ug/l	0.0026 ug/l	< 0.004 ug/l	< 0.005 ug/l
Methyl Mercury	Total	Lab	--	--	--	--	--	--	--	--	--	0.00057 ug/l	--	0.00041 ug/l	0.00044 ug/l	--	--	--	--	--	--
Molybdenum	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Total	Lab	--	0.87 ug/l	--	--	< 0.30 ug/l	--	--	--	--	0.31 ug/l	--	1.19 ug/l	--	--	--	< 5 ug/l	< 5 ug/l	< 5 ug/l	< 5 ug/l
Nickel	Dissolved	Lab	1.6 ug/l	3.0 ug/l	1.3 ug/l	0.57 ug/l	2.1 ug/l	--	1.1 ug/l	1.3 ug/l	--	2.24 ug/l	--	--	--	--	--	--	--	--	--
Nickel	Total	Lab	2.2 ug/l	3.2 ug/l	1.5 ug/l	0.71 ug/l	1.5 ug/l	--	1.2 ug/l	1.1 ug/l	--	2.6 ug/l	--	1.9 ug/l	--	--	--	< 5 ug/l	< 5 ug/l	< 5 ug/l	< 5 ug/l
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l
Phosphorus, total, as P	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 25 ug/l	< 50 ug/l	< 25 ug/l	< 25 ug/l
Potassium	Total	Lab	--	1100 ug/l	--	--	830 ug/l	--	--	--	--	690 ug/l	--	3070 ug/l	--	--	--	5700 ug/l	4700 ug/l	6400 ug/l	6300 ug/l
Selenium	Total	Lab	< 1.0 ug/l	1.6 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	< 1.0 ug/l	--	0.37 j ug/l	--	0.36 j ug/l	--	--	--	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l
Silver	Total	Lab	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	--	--	< 0.2 ug/l	--	< 0.2 ug/l	--	--	--	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l
Sodium	Total	Lab	--	5400 ug/l	--	--	2700 ug/l	--	--	--	--	2900 ug/l	--	14300 ug/l	--	--	--	13600 ug/l	10600 ug/l	17500 ug/l	17200 ug/l
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	46.2 ug/l	--	149 ug/l	--	--	--	92.3 ug/l	103 ug/l	132 ug/l	147 ug/l
Thallium	Total	Lab	< 0.005 ug/l	< 0.005 ug/l	0.004 j ug/l	0.005 jb ug/l	0.002 j ug/l	--	< 0.0020 ug/l	0.003 j ug/l	0.02 ug/l	< 0.02 ug/l	0.007 j ug/l	0.011 j ug/l	0.008 j ug/l	0.006 j ug/l	--	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l
Tin	Total	Lab	--	--	--	--	--	--	--	--	--	< 0.5 ug/l	--	< 0.5 ug/l	--	--	--	--	--	--	--
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 10 ug/l	--	--	--
Vanadium	Total	Lab	< 3.0 ug/l	--	--	--	< 3.0 ug/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	Dissolved	Lab	7.1 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	10.3 ug/l	--	< 6.0 ug/l	< 6.0 ug/l	--	< 6 ug/l	--	--	--	--	--	--	--	--	--
Zinc	Total	Lab	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	--	< 6.0 ug/l	< 6.0 ug/l	--	< 6 ug/l	--	< 6 ug/l	--	--	--	< 10 ug/l	< 10 ug/l	10.2 ug/l	< 10 ug/l

1 - Some monitoring locations are listed by multiple names. Equivalent locations include the following: PM-1 = SW003, PM-2 = SW002, PM-3 = SW003, PM-4 = SW005, PM16 = SW004

Large Table 11
Surface Water Data Summary
Partridge River Watershed and Wyman Creek

Location			PM-5	PM-5		PM-5	PM-5		PM-5		PM-5		PM-5		PM-5	PM-5		PM-5		PM-5	PM-5	PM-5
Date			5/31/2011	6/30/2011		7/25/2011	8/22/2011		9/19/2011		10/19/2011		11/21/2011		12/28/2011	1/24/2012		2/21/2012		6/27/2012	7/26/2012	8/23/2012
Sample Type			N	N	FD	N	N	FD	N	FD	N	FD	N	FD	N	N	FD	N	FD	N	N	N
Parameter	Total or Dissolved	Analysis Location																				
General Parameters																						
Alkalinity, bicarbonate, as CaCO3	NA	Lab	138 mg/l	142 mg/l	137 mg/l	194 mg/l	189 mg/l	188 mg/l	187 mg/l	184 mg/l	138 mg/l	144 mg/l	127 mg/l	126 mg/l	188 mg/l	200 mg/l	205 mg/l	192 mg/l	192 mg/l	148 mg/l	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total, as CaCO3	NA	Lab	138 mg/l	142 mg/l	137 mg/l	194 mg/l	189 mg/l	188 mg/l	187 mg/l	184 mg/l	138 mg/l	144 mg/l	127 mg/l	126 mg/l	188 mg/l	200 mg/l	205 mg/l	192 mg/l	192 mg/l	148 mg/l	--	--
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, total organic	NA	Lab	5.6 mg/l	6.0 mg/l	6.1 mg/l	8.1 mg/l	7.4 mg/l	7.5 mg/l	8.4 mg/l	8.4 mg/l	4.9 mg/l	5.0 mg/l	5.6 mg/l	5.5 mg/l	5.5 mg/l	6.2 mg/l	6.2 mg/l	5.88 mg/l	5.54 mg/l	5.3 mg/l	6.4 mg/l	7.4 mg/l
Chemical Oxygen Demand	NA	Lab	22.7 mg/l	15.5 mg/l	15.6 mg/l	< 10 mg/l	30 mg/l	26.4 mg/l	23.4 mg/l	23.2 mg/l	19 mg/l	34 mg/l	23.5 mg/l	16.6 mg/l	18.7 mg/l	20.3 mg/l	22.1 mg/l	23 mg/l	21.6 mg/l	19.1 mg/l	--	--
Chloride	NA	Lab	1.29 mg/l	0.95 mg/l	0.96 mg/l	0.91 mg/l	0.89 mg/l	0.89 mg/l	2.02 mg/l	2.01 mg/l	2.16 mg/l	2.14 mg/l	2.22 mg/l	2.21 mg/l	2.75 mg/l	2.78 mg/l	2.79 mg/l	1.63 mg/l	1.62 mg/l	0.98 mg/l	1.2 mg/l	0.97 mg/l
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	4.06 mg/l	4.40 mg/l	--	3.16 mg/l	4.40 mg/l	--	3.36 mg/l	--	8.50 mg/l	--	6.16 mg/l	--	7.93 mg/l	9.21 mg/l	--	6.57 mg/l	--	5.99 mg/l	4.27 mg/l	2.85 mg/l
Fluoride	NA	Lab	< 0.1 mg/l	--	--	< 0.1 mg/l	--	--	0.12 mg/l	0.12 mg/l	--	--	< 0.1 mg/l	< 0.1 mg/l	--	< 0.1 mg/l	< 0.1 mg/l	--	--	--	--	--
Hardness, as CaCO3	NA	Lab	191 mg/l	178 mg/l	179 mg/l	209 mg/l	213 mg/l	194 mg/l	217 mg/l	222 mg/l	174 mg/l	175 mg/l	197 mg/l	201 mg/l	239 mg/l	258 mg/l	256 mg/l	240 mg/l	242 mg/l	174 mg/l	195 mg/l	192 mg/l
Nitrate + Nitrite, as N	NA	Lab	0.13 mg/l	0.2 mg/l	0.21 mg/l	0.21 mg/l	0.2 mg/l	0.22 mg/l	< 0.1 mg/l	< 0.1 mg/l	0.19 mg/l	0.18 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	0.26 mg/l	--	--
Nitrogen, ammonia as N	NA	Lab	< 0.1 mg/l	0.11 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	0.11 mg/l	0.12 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	0.28 mg/l	0.6 mg/l	0.55 mg/l	0.7 mg/l	0.7 mg/l	< 0.10 mg/l	--	--
pH	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	7.39 pH units	7.30 pH units	--	7.28 pH units	7.20 pH units	--	6.85 pH units	--	7.43 pH units	--	6.43 pH units	--	6.98 pH units	7.07 pH units	--	6.46 pH units	--	7.74 pH units	7.49 pH units	7.4 pH units
Phosphorus, total, as P	NA	Lab	0.012 mg P/L	0.01 mg P/L	0.011 mg P/L	0.022 mg P/L	0.024 mg P/L	0.022 mg P/L	0.023 mg P/L	0.028 mg P/L	0.011 mg P/L	0.012 mg P/L	0.01 mg P/L	0.01 mg P/L	< 0.1 mg P/L	0.018 mg P/L	0.02 mg P/L	0.031 mg P/L	0.033 mg P/L	0.010 mg/l	--	--
Redox (oxidation potential)	NA	Field	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Solids, total dissolved	NA	Lab	237 mg/l	261 mg/l	269 mg/l	272 mg/l	286 mg/l	301 mg/l	301 mg/l	299 mg/l	246 mg/l	238 mg/l	269 mg/l	257 mg/l	319 mg/l	235 mg/l	250 mg/l	266 mg/l	281 mg/l	240 mg/l	279 mg/l	274 mg/l
Solids, total suspended	NA	Lab	1.5 mg/l	--	--	1.3 mg/l	--	--	8.5 mg/l	9 mg/l	--	--	3.2 mg/l	3.2 mg/l	--	11.3 mg/l	13.3 mg/l	--	--	--	--	--
Specific Conductance @ 25 °C	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Specific Conductance @ 25 °C	NA	Field	385.0 umhos/cm	394.0 umhos/cm	--	389.0 umhos/cm	443 umhos/cm	--	461.0 umhos/cm	--	401 umhos/cm	--	366.0 umhos/cm	--	392.0 umhos/cm	403 umhos/cm	--	424 umhos/cm	--	385.9 umhos/cm	339.2 umhos/cm	383.3 umhos/cm
Sulfate, as SO4	NA	Lab	58.6 mg/l	58.7 mg/l	58.6 mg/l	44 mg/l	42.2 mg/l	42.3 mg/l	55.9 mg/l	56 mg/l	56.1 mg/l	55.9 mg/l	71 mg/l	70.7 mg/l	71.1 mg/l	73.1 mg/l	73.4 mg/l	67.4 mg/l	67.8 mg/l	61.7 mg/l	51.4 mg/l	30.3 mg/l
Temperature, °C	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Temperature, °C	NA	Field	13.46 deg C	18.20 deg C	--	18.39 deg C	17.51 deg C	--	10.69 deg C	--	6.98 deg C	--	0.18 deg C	--	0.03 deg C	0.01 deg C	--	7.79 deg C	--	20.12 deg C	21.16 deg C	18.82 deg C
Turbidity	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Turbidity	NA	Field	0 NTU	0.20 NTU	--	1.70 NTU	0.9 NTU	--	6.10 NTU	--	0 NTU	--	1.60 NTU	--	0 NTU	0.3 NTU	--	8.6 NTU	--	0 NTU	3 NTU	1.8 NTU
Metals																						
Aluminum	Dissolved	Lab	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	4.3 b ug/l	4.3 b ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l
Aluminum	Total	Lab	< 25 ug/l	< 25 ug/l	26.7 ug/l	< 25 ug/l	7.1 b ug/l	5.2 b ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	27.8 ug/l	29.5 ug/l	32.3 ug/l	165 ug/l	146 ug/l	22.4 ug/l	< 20.0 ug/l	< 20.0 ug/l
Antimony	Total	Lab	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	0.073 j ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Arsenic	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	Total	Lab	0.98 ug/l	2.2 ug/l	2.16 ug/l	2.96 ug/l	3.3 ug/l	3.2 ug/l	1.69 ug/l	1.67 ug/l	2.04 ug/l	1.95 ug/l	0.79 ug/l	0.76 ug/l	0.85 ug/l	1.05 ug/l	0.92 ug/l	1.36 ug/l	1.27 ug/l	2.8 ug/l	2.8 ug/l	2.0 ug/l
Barium	Total	Lab	7.52 ug/l	--	--	16 ug/l	--	--	20.6 ug/l	21.8 ug/l	--	--	12.8 ug/l	13.7 ug/l	--	27.3 ug/l	27 ug/l	--	--	< 10.0 ug/l	--	--
Beryllium	Total	Lab	< 0.2 ug/l	--	--	< 0.2 ug/l	--	--	< 0.2 ug/l	< 0.2 ug/l	--	--	< 0.2 ug/l	< 0.2 ug/l	--	< 0.2 ug/l	< 0.2 ug/l	--	--	< 0.20 ug/l	--	--
Boron	Total	Lab	69.9 ug/l	--	--	72.8 ug/l	--	--	< 50 ug/l	< 50 ug/l	--	--	< 50 ug/l	< 50 ug/l	--	< 50 ug/l	< 50 ug/l	--	--	62.6 ug/l	--	--
Cadmium	Total	Lab	< 0.03 ug/l	--	--	< 0.03 ug/l	--	--	< 0.03 ug/l	< 0.03 ug/l	--	--	< 0.04 ug/l	< 0.04 ug/l	--	< 0.2 ug/l	< 0.2 ug/l	--	--	< 0.20 ug/l	--	--
Calcium	Total	Lab	33800 ug/l	29900 ug/l	29900 ug/l	34600 ug/l	38600 ug/l	34700 ug/l	43400 ug/l	44400 ug/l	30500 ug/l	30700 ug/l	39200 ug/l	40200 ug/l	46600 ug/l	51100 ug/l	51300 ug/l	47400 ug/l	47900 ug/l	27300 ug/l	31700 ug/l	35000 ug/l
Chromium	Total	Lab	< 1 ug/l	--	--	< 1 ug/l	--	--	< 1 ug/l	< 1 ug/l	--	--	< 1 ug/l	< 1 ug/l	--	< 1 ug/l	< 1 ug/l	--	--	< 1.0 ug/l	--	--
Cobalt	Dissolved	Lab	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	0.3 ug/l	0.31 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	0.35 ug/l	0.54 ug/l	0.52 ug/l	0.69 ug/l	0.68 ug/l	< 0.20 ug/l	< 0.20 ug/l	0.21 ug/l
Cobalt	Total	Lab	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.50 ug/l	< 0.50 ug/l	0.26 ug/l	0.26 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	0.37 ug/l	0.54 ug/l	0.54 ug/l	0.76 ug/l	0.77 ug/l	< 0.20 ug/l	< 0.20 ug/l	0.21 ug/l
Copper	Dissolved	Lab	0.32 j ug/l	< 0.15 ug/l	< 0.15 ug/l	0.30 j ug/l	0.25 j ug/l	0.23 b ug/l	0.37 j ug/l	0.39 j ug/l	0.34 jb ug/l	0.33 jb ug/l	0.5 b ug/l	0.53 b ug/l	< 0.7 ug/l	< 0.7 ug/l	< 0.7 ug/l	0.78 b ug/l	0.60 jb ug/l	0.60 b ug/l	< 0.50 ug/l	< 0.50 ug/l
Copper	Total	Lab	0.35 j ug/l	< 0.15 ug/l	< 0.15 ug/l	0.41 j ug/l	0.14 b ug/l	< 0.50 ug/l	0.92 ug/l	0.37 j ug/l	0.47 jb ug/l	0.55 jb ug/l	0.67 b ug/l	0.57 b ug/l	0.9 ug/l	< 0.7 ug/l	< 0.7 ug/l	0.98 b ug/l	0.94 b ug/l	0.51 b ug/l	< 0.50 ug/l	< 0.50 ug/l
Iron	Dissolved	Lab	282 ug/l	311 ug/l	317 ug/l	1060 ug/l	1120 ug/l	1160 ug/l	1340 ug/l	1030 ug/l	436 ug/l	430 ug/l	1010 ug/l	1020 ug/l	1760 ug/l	3580 ug/l	3570 ug/l	2600 ug/l	2590 ug/l	376 ug/l	887 ug/l	922 ug/l
Iron	Total	Lab	458 ug/l	580 ug/l	609 ug/l	1800 ug/l	1740 ug/l	1690 ug/l	3010 ug/l	3070 ug/l	856 ug/l	843 ug/l	1470 ug/l	1510 ug/l	2710 ug/l	4420 ug/l	4310 ug/l	3940 ug/l	3890 ug/l	511 ug/l	1370 ug/l	1400 ug/l
Lead	Total	Lab	0.02 j ug/l	--	--	0.02 j ug/l	--	--	< 0.02 ug/l	< 0.02 ug/l	--	--	0.02 j ug/l	0.02 j ug/l	--	< 0.5 ug/l	< 0.5 ug/l	--	--	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Magnesium	Total	Lab	25800 ug/l	25000 ug/l	25400 ug/l	29700 ug/l	28200 ug/l	26000 ug/l	26500 ug/l	27100 ug/l	23800 ug/l	23900 ug/l	24000 ug/l	24500 ug/l	29800 ug/l	31700 ug/l	31100 ug/l	29500 ug/l	29700 ug/l	25700 ug/l	28200 ug/l	25300 ug/l
Manganese	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	158 ug/l	927 ug/l	846 ug/l
Manganese	Total	Lab	143 ug/l	246 ug/l	254 ug/l	1840 ug/l	1410 ug/l	1270 ug/l	2850 ug/l	2890 ug/l	419 ug/l	418 ug/l	873 ug/l	895 ug/l	2580 ug/l	4380 ug/l	4270 ug/l	3700 ug/l	3760 ug/l	172 ug/l	968 ug/l	873 ug/l
Mercury	Total	Lab	0.0010 ug/l	0.0011 ug/l	0.0011 ug/l	0.0019 ug/l	0.0011 ug/l	0.001 ug/l	0.0009 ug/l	0.0009 ug/l	0.0006 ug/l	0.0006 ug/l	< 0.0005 ug/l	< 0.0005 ug/l	0.0011 ug/l	0.0010 b ug/l	0.0012 b ug/l	0.0020 ug/l	0.0020 ug/l	0.0013 ug/l	--	--
Methyl Mercury	Total	Lab	0.00016 ug/l	--	--	0.00028 ug/l	--	--	0.00012 ug/l	0.00011 ug/l	--	--	< 0.0001 ug/l	< 0.0001 ug/l	--	0.00012 ug/l	0.00011 ug/l	--	--	--	--	--
Molybdenum	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Total	Lab	1.33 ug/l	1.66 ug/l	1.73 ug/l	1.87 ug/l	1.7 ug/l	1.6 ug/l	0.93 ug/l	0.91 ug/l	1.2 ug/l	1.22 ug/l	0.38 ug/l	0.42 ug/l	0.36 ug/l	0.35 ug/l	0.36 ug/l	0.3 ug/l	0.3 ug/l	1.6 ug/l	--	--
Nickel	Dissolved	Lab	< 0.6 ug/l	< 0.6 ug/l	< 0.6 ug/l	< 0.6 ug/l	< 0.6 ug/l	< 0.6 ug/l	< 0.6 ug/l	< 0.6 ug/l	< 0.6 ug/l	< 0.6 ug/l	< 0.6 ug/l	< 0.6 ug/l	< 0.6 ug/l	< 0.6 ug/l	< 0.6 ug/l	0.6 ug/l	< 0.6 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Nickel	Total	Lab	< 0.6 ug/l	< 0.6 ug/l	< 0.6 ug/l	< 0.6 ug/l	0.30 j ug/l	0.59 ug/l	< 0.6 ug/l	< 0.6 ug/l	< 0.6 ug/l	< 0.6 ug/l	< 0.6 ug/l	< 0.6 ug/l	< 0.6 ug/l	< 0.6 ug/l	< 0.6 ug/l	< 0.6 ug/l	0.62 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total, as P	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	5420 ug/l	5440 ug/l	5510 ug/l	5950 ug/l	5420 ug/l	5280 ug/l	3380 ug/l	3480 ug/l	5070 ug/l	5080 ug/l	3040 ug/l	3080 ug/l	3440 ug/l	3380 ug/l	3350 ug/l	3260 ug/l	3220 ug/l	5900 ug/l	--	--
Selenium	Total	Lab	< 0.2 ug/l	--	--	< 0.2 ug/l	--	--	< 0.2 ug/l	< 0.2 ug/l	--	--	< 0.2 ug/l	< 0.2 ug/l	--	< 1 ug/l	< 1 ug/l	--	--	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l
Silver	Total	Lab	< 0.2 ug/l	--	--	< 0.2 ug/l	--	--	< 0.2 ug/l	< 0.2 ug/l	--	--	< 0.2 ug/l	< 0.2 ug/l	--	< 0.2 ug/l	< 0.2 ug/l	--	--	< 0.20 ug/l	--	--
Sodium	Total	Lab	14600 ug/l	15200 ug/l	15400 ug/l	17400 ug/l	15600 ug/l	15200 ug/l	10900 ug/l	11100 ug/l	12700 ug/l	12900 ug/l	9600 ug/l	9660 ug/l	9980 ug/l	11200 ug/l	11000 ug/l	10800 ug/l	10900 ug/l	14900 ug/l	--	--
Strontium	Total	Lab	122 ug/l	--	--	142 ug/l	--	--	167 ug/l	170 ug/l	--	--	134 ug/l	136 ug/l	--	180 ug/l	177 ug/l	--	--	--	--	--
Thallium	Total	Lab	< 0.002 ug/l	< 0.002 ug/l	< 0.002 ug/l	< 0.02 ug/l	--	--	< 0.02 ug/l	< 0.02 ug/l	< 0.02 ug/l	< 0.02 ug/l	< 0.02 ug/l	< 0.02 ug/l	--	< 0.02 ug/l	< 0.02 ug/l	0.025 b ug/l	0.018 jb ug/l	< 0.20 j ug/l 0.013 j ug/l	< 0.0004 ug/l	< 0.005 ug/l
Tin	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Titanium	Total	Lab	< 10 ug/l	--	--	< 10 ug/l	--	--	< 10 ug/l	< 10 ug/l	--	--	< 10 ug/l	< 10 ug/l	--	< 10 ug/l	< 10 ug/l	--	--	--	--	--
Vanadium	Total	Lab	< 10 ug/l	--	--	< 10 ug/l	--	--	< 10 ug/l	< 10 ug/l	--	--	< 10 ug/l	< 10 ug/l	--	< 10 ug/l	< 10 ug/l	--	--	< 3.0 ug/l	--	--
Zinc	Dissolved	Lab	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l
Zinc	Total	Lab	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	--	--	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l

1 - Some monitoring locations are listed by multiple names. Equivalent locations include the following: PM-1 = SW003, PM-2 = SW002, PM-3 = SW003, PM-4 = SW005, PM16 = SW004

Large Table 11
Surface Water Data Summary
Partridge River Watershed and Wyman Creek

		Location	PM-5	PM-5	PM-5	PM-5	PM-5	PM-5	PM-5	PM-5		PM-5	PM-5	PM-5	PM-5	PM-5	PM-5	PM-5	PM-5	PM-5
		Date	9/25/2012	10/30/2012	11/26/2012	12/18/2012	1/24/2013	2/25/2013	3/21/2013	4/23/2013		5/16/2013	6/25/2013	7/25/2013	8/22/2013	9/19/2013	9/19/2013	10/30/2013	11/25/2013	12/12/2013
		Sample Type	N	N	N	N	N	N	N	N	FD	N	N	N	N	N	N	N	N	N
Parameter	Total or Dissolved	Analysis Location																		
General Parameters																				
Alkalinity, bicarbonate, as CaCO3	NA	Lab	172 mg/l	--	--	164 mg/l	--	--	169 mg/l	163 mg/l	161 mg/l	113 mg/l	134 mg/l	159 mg/l	184 mg/l	--	168 mg/l	124 mg/l	151 mg/l	164 mg/l
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total, as CaCO3	NA	Lab	172 mg/l	--	--	164 mg/l	--	--	169 mg/l	163 mg/l	161 mg/l	113 mg/l	134 mg/l	159 mg/l	184 mg/l	--	168 mg/l	124 mg/l	151 mg/l	164 mg/l
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	< 2.4 * mg/l	< 2.4 * mg/l	< 2.4 * mg/l	< 3.0 * mg/l	< 2.4 * mg/l	< 3.0 * mg/l	--	< 3.0 * mg/l	< 3.0 * mg/l	< 2.4 * mg/l	< 2.4 * mg/l
Carbon, dissolved organic	NA	Lab	--	--	--	--	--	--	--	2.9 mg/l	2.4 mg/l	4.1 mg/l	5.9 mg/l	5.4 mg/l	5.6 mg/l	--	4.4 mg/l	5.6 mg/l	5.6 mg/l	4.0 mg/l
Carbon, total organic	NA	Lab	7.1 mg/l	5.0 mg/l	3.4 mg/l	3.4 mg/l	4.0 mg/l	3.0 mg/l	2.9 mg/l	2.3 mg/l	2.4 mg/l	3.6 mg/l	5.6 mg/l	5.4 mg/l	6.3 mg/l	--	4.1 mg/l	5.4 mg/l	3.5 mg/l	3.6 mg/l
Chemical Oxygen Demand	NA	Lab	28.7 mg/l	--	--	12.5 mg/l	--	--	< 10.0 mg/l	14.0 mg/l	15.8 mg/l	12.9 mg/l	16.3 mg/l	18.0 mg/l	25.8 mg/l	--	30.2 mg/l	25.6 mg/l	14.3 mg/l	15.2 mg/l
Chloride	NA	Lab	2.1 mg/l	2.3 mg/l	1.9 mg/l	2.0 mg/l	2.2 mg/l	2.0 mg/l	2.0 mg/l	1.6 mg/l	1.7 mg/l	1.4 mg/l	1.9 mg/l	0.78 mg/l	1.9 mg/l	--	1.5 mg/l	1.5 mg/l	1.8 mg/l	2.2 mg/l
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	4.42 mg/l	8.92 mg/l	9.19 mg/l	7.18 mg/l	9.26 mg/l	12.72 mg/l	11.82 mg/l	11.63 mg/l	--	7.09 mg/l	6.96 mg/l	7.04 mg/l	7.54 mg/l	5.77 mg/l	5.77 mg/l	10.65 mg/l	9.83 mg/l	7.66 mg/l
Fluoride	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hardness, as CaCO3	NA	Lab	226 mg/l	186 mg/l	192 mg/l	214 mg/l	234 mg/l	228 mg/l	222 mg/l	209 mg/l	213 mg/l	147 mg/l	173 mg/l	196 mg/l	242 mg/l	--	213 mg/l	168 mg/l	217 mg/l	230 mg/l
Nitrate + Nitrite, as N	NA	Lab	< 0.10 mg/l	--	--	0.18 mg/l	--	--	0.17 mg/l	0.30 mg/l	0.30 mg/l	0.19 mg/l	0.11 mg/l	0.11 mg/l	< 0.10 mg/l	--	0.10 mg/l	0.11 mg/l	0.27 mg/l	0.14 mg/l
Nitrogen, ammonia as N	NA	Lab	< 0.10 mg/l	--	--	< 0.10 mg/l	--	--	0.17 mg/l	0.10 mg/l	0.15 mg/l	< 0.10 * mg/l	< 0.10 mg/l	< 0.10 mg/l	0.11 mg/l	--	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	0.14 mg/l
pH	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	7.34 pH units	7.3 pH units	7.57 pH units	7.15 pH units	7.55 pH units	6.95 pH units	6.69 pH units	7.37 pH units	--	6.94 pH units	6.61 pH units	8.09 pH units	7.56 pH units	7.23 pH units	7.23 pH units	7.24 pH units	7.26 pH units	6.64 pH units
Phosphorus, total, as P	NA	Lab	0.025 mg/l	--	--	0.0088 mg/l	--	--	0.019 mg/l	0.015 mg/l	0.013 mg/l	0.014 mg/l	0.0056 mg/l	< 0.10 mg/l	< 0.10 mg/l	--	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l	< 0.10 mg/l
Redox (oxidation potential)	NA	Field	--	--	--	--	--	--	--	494 mV	--	494 mV	437 mV	504 mV	403 mV	396 mV	396 mV	341 mV	546 mV	504 mV
Solids, total dissolved	NA	Lab	281 mg/l	247 mg/l	316 mg/l	295 mg/l	299 mg/l	285 mg/l	272 mg/l	310 mg/l	299 mg/l	196 mg/l	241 mg/l	248 mg/l	352 mg/l	--	294 mg/l	244 mg/l	326 mg/l	301 mg/l
Solids, total suspended	NA	Lab	--	--	--	--	--	--	--	2.8 mg/l	2.8 mg/l	6.0 mg/l	< 1.0 mg/l	1.2 mg/l	7.0 mg/l	--	25.3 mg/l	< 1.2 mg/l	< 1.7 mg/l	< 2.5 mg/l
Specific Conductance @ 25 ºC	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Specific Conductance @ 25 ºC	NA	Field	329.4 umhos/cm	371.5 umhos/cm	289 umhos/cm	365.3 umhos/cm	485.3 umhos/cm	448.4 umhos/cm	445.1 umhos/cm	474.7 umhos/cm	--	347.4 umhos/cm	392.7 umhos/cm	437.9 umhos/cm	483.4 umhos/cm	449.3 umhos/cm	449.3 umhos/cm	335 umhos/cm	441.3 umhos/cm	474.3 umhos/cm
Sulfate, as SO4	NA	Lab	55.7 mg/l	55.3 mg/l	75.6 mg/l	81.1 mg/l	82.5 mg/l	75.7 mg/l	72.6 mg/l	86.7 mg/l	85.7 mg/l	67.8 mg/l	63.3 mg/l	58.8 mg/l	88.5 mg/l	--	78.0 mg/l	61.1 mg/l	90.7 mg/l	96.2 mg/l
Temperature, °C	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Temperature, °C	NA	Field	9.67 deg C	3.96 deg C	0.99 deg C	0.51 deg C	3.2 deg C	3.82 deg C	3.45 deg C	4.45 deg C	--	9.56 deg C	20.99 deg C	22.05 deg C	20.73 deg C	16.07 deg C	16.07 deg C	5.84 deg C	0.17 deg C	0.95 deg C
Turbidity	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Turbidity	NA	Field	4.5 NTU	1.4 NTU	0 NTU	0 NTU	7.9 NTU	0.3 NTU	44.9 NTU	5.7 NTU	--	2.9 NTU	--	--	0.7 NTU	--	--	0.9 NTU	--	--
Metals																				
Aluminum	Dissolved	Lab	< 20.0 ug/l	< 40.0 ug/l	< 40.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	< 40.0 ug/l	< 20.0 ug/l	--	--	--	< 20.0 ug/l	< 20.0 ug/l	< 20.0 ug/l	--	< 20.0 ug/l	< 20.0 ug/l	23.0 ug/l	36.7 ug/l
Aluminum	Total	Lab	30.4 ug/l	< 40.0 ug/l	< 40.0 ug/l	< 20.0 ug/l	439 ug/l	< 40.0 ug/l	46.8 ug/l	--	--	--	20.8 ug/l	< 20.0 ug/l	47.0 ug/l	--	390 ug/l	< 20.0 ug/l	< 20.0 ug/l	36.4 ug/l
Antimony	Total	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	--	--	< 0.50 ug/l	< 0.50 ug/l	--	--	--	< 0.50 ug/l	--	--
Arsenic	Dissolved	Lab	--	--	--	--	--	--	--	< 0.50 ug/l	< 0.50 ug/l	0.60 ug/l	0.84 ug/l	1.0 ug/l	0.67 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	0.82 ug/l	< 0.50 ug/l
Arsenic	Total	Lab	1.6 ug/l	1.4 ug/l	1.4 ug/l	1.3 ug/l	3.6 ug/l	1.6 ug/l	1.2 ug/l	1.1 ug/l	0.97 ug/l	0.62 ug/l	0.73 ug/l	1.0 ug/l	0.64 ug/l	--	1.1 ug/l	0.65 ug/l	< 0.50 ug/l	0.72 ug/l
Barium	Total	Lab	13.5 ug/l	--	--	11.0 ug/l	--	--	16.0 ug/l	--	--	--	< 10.0 ug/l	< 10.0 ug/l	--	--	--	< 10.0 ug/l	--	--
Beryllium	Total	Lab	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	--	< 0.20 ug/l	< 0.20 ug/l	--	--	--	< 0.20 ug/l	--	--
Boron	Total	Lab	< 50.0 ug/l	--	--	53.1 ug/l	--	--	59.8 ug/l	--	--	--	59.0 ug/l	63.5 ug/l	--	--	--	< 50.0 ug/l	--	--
Cadmium	Total	Lab	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	--	< 0.20 ug/l	< 0.20 ug/l	--	--	--	< 0.20 ug/l	--	--
Calcium	Total	Lab	42300 ug/l	33600 ug/l	33300 ug/l	36000 ug/l	40200 ug/l	40300 ug/l	39100 ug/l	33000 ug/l	33700 ug/l	22400 ug/l	27500 ug/l	31700 ug/l	37500 ug/l	--	33900 ug/l	26600 ug/l	35700 ug/l	38300 ug/l
Chromium	Total	Lab	< 1.0 ug/l	--	--	< 1.0 ug/l	--	--	< 1.0 ug/l	--	--	--	< 1.0 ug/l	< 1.0 ug/l	--	--	--	< 1.0 ug/l	--	--
Cobalt	Dissolved	Lab	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	0.23 ug/l	0.22 ug/l	0.24 ug/l	--	--	--	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Cobalt	Total	Lab	0.22 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	0.47 ug/l	0.24 ug/l	0.28 ug/l	--	--	--	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	0.30 ug/l	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Copper	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	0.60 ug/l	0.51 ug/l	< 0.50 ug/l	--	--	--	0.58 ug/l	< 0.50 ug/l	0.83 ug/l	--	0.57 ug/l	0.69 ug/l	0.78 ug/l	0.81 ug/l
Copper	Total	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	1.4 ug/l	0.56 ug/l	0.79 ug/l	--	--	--	0.61 ug/l	< 0.50 ug/l	0.81 ug/l	--	1.6 ug/l	< 0.50 ug/l	0.85 ug/l	0.85 ug/l
Iron	Dissolved	Lab	1310 ug/l	340 ug/l	375 ug/l	654 ug/l	1750 ug/l	954 ug/l	1370 ug/l	217 ug/l	138 ug/l	264 ug/l	128 ug/l	237 ug/l	258 ug/l	--	325 ug/l	675 ug/l	322 ug/l	188 ug/l
Iron	Total	Lab	2100 ug/l	692 ug/l	893 ug/l	1140 ug/l	4740 ug/l	2300 ug/l	2590 ug/l	940 ug/l	958 ug/l	526 ug/l	237 ug/l	405 ug/l	468 ug/l	--	1700 ug/l	555 ug/l	595 ug/l	943 ug/l
Lead	Total	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	--	--	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	0.51 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Magnesium	Total	Lab	29100 ug/l	24900 ug/l	26300 ug/l	30100 ug/l	32500 ug/l	31000 ug/l	30200 ug/l	30800 ug/l	31400 ug/l	22000 ug/l	25200 ug/l	28300 ug/l	36100 ug/l	--	31300 ug/l	22200 ug/l	31100 ug/l	32600 ug/l
Manganese	Dissolved	Lab	1120 ug/l	259 ug/l	342 ug/l	1350 ug/l	1910 ug/l	1550 ug/l	1500 ug/l	--	--	--	95.2 ug/l	168 ug/l	235 ug/l	--	173 ug/l	154 ug/l	489 ug/l	1120 ug/l
Manganese	Total	Lab	1190 ug/l	256 ug/l	404 ug/l	1380 ug/l	2060 ug/l	1580 ug/l	1520 ug/l	--	--	--	122 ug/l	182 ug/l	271 ug/l	--	435 ug/l	163 ug/l	477 ug/l	1030 ug/l
Mercury	Total	Lab	0.00057 ug/l	--	--	< 0.00050 ug/l	--	--	0.00098 ug/l	0.00099 ug/l	0.00064 ug/l	0.0013 ug/l	0.0011 ug/l	0.00087 ug/l	0.00097 ug/l	--	0.0034 ug/l	0.0007 I ug/l	< 0.00050 ug/l	0.00056 ug/l
Methyl Mercury	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Total	Lab	0.54 ug/l	--	--	0.93 ug/l	--	--	1.1 ug/l	--	--	--	1.4 ug/l	1.8 ug/l	--	--	--	0.79 ug/l	--	--
Nickel	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	0.53 ug/l	--	--	--	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	0.72 ug/l	< 0.50 ug/l	< 0.50 ug/l
Nickel	Total	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	0.66 ug/l	--	--	--	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total, as P	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	3800 ug/l	--	--	5200 ug/l	--	--	5200 ug/l	6300 ug/l	6400 ug/l	5100 ug/l	5500 ug/l	5700 ug/l	6800 ug/l	--	7000 ug/l	3900 ug/l	4900 ug/l	5100 ug/l
Selenium	Total	Lab	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	--	--	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l
Silver	Total	Lab	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	--	< 0.20 ug/l	< 0.20 ug/l	--	--	--	< 0.20 ug/l	--	--
Sodium	Total	Lab	11200 ug/l	--	--	14300 ug/l	--	--	14600 ug/l	16000 ug/l	16300 ug/l	11900 ug/l	13600 ug/l	14900 ug/l	16400 ug/l	--	15900 ug/l	9900 ug/l	12600 ug/l	13700 ug/l
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab	0.004 j ug/l	< 0.0004 ug/l	0.0023 jb ug/l	< 0.005 ug/l	< 0.005 ug/l	< 0.002 ug/l	0.0005 jb ug/l	--	--	--	0.019 jb* ug/l	< 0.005 ug/l	< 0.002 ug/l	0.003 j ug/l	--	< 0.002 ug/l	< 0.002 ug/l	< 0.002 ug/l
Tin	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Total	Lab	< 3.0 ug/l	--	--	< 3.0 ug/l	--	--	< 3.0 ug/l	--	--	--	< 3.0 ug/l	< 3.0 ug/l	--	--	--	< 3.0 ug/l	--	--
Zinc	Dissolved	Lab	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	--	--	--	6.6 ug/l	< 6.0 ug/l	< 6.0 ug/l	--	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l
Zinc	Total	Lab	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	--	--	--	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	--	8.8 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l

1 - Some monitoring locations are listed by multiple names. Equivalent locations include the following: PM-1 = SW003, PM-2 = SW002, PM-3 = SW003, PM-4 = SW005, PM16 = SW004

Large Table 11
Surface Water Data Summary
Partridge River Watershed and Wyman Creek

Parameter	Total or Dissolved	Analysis Location	Location / Date / Sample Type	PM-6 4/13/2004 N	PM-6 5/19/2004 N	PM-6 6/22/2004 N	PM-6 7/29/2004 N	PM-6 4/23/2013 N	PM-16[1] 4/14/2004 N	PM-16[1] 5/19/2004 N	PM-16[1] 6/22/2004 N	PM-16[1] 7/29/2004 N	PM-16[1] 8/26/2004 N	PM-16[1] 9/27/2004 N	PM-16[1] 10/25/2004 N	PM-16[1] 11/15/2004 N	PM-16[1] 7/10/2006 N	PM-16[1] 8/28/2006 N	PM-16[1] 9/19/2006 N	PM-16[1] 10/12/2006 N	PM-16[1] 11/7/2006 N
General Parameters																						
Alkalinity, bicarbonate, as CaCO3	NA	Lab		--	--	--	--	148 mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total, as CaCO3	NA	Lab		62 mg/l	60 mg/l	94 mg/l	138 mg/l	148 mg/l	32 mg/l	30 mg/l	74 mg/l	96.2 mg/l	91.6 mg/l	61.6 mg/l	45.8 mg/l	56.7 mg/l	104 mg/l	101 mg/l	52.4 mg/l	93.5 mg/l	853 mg/l
Biochemical Oxygen Demand (5-day)	NA	Lab		--	--	--	--	< 2.4 * mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab		--	--	--	--	4.3 mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, total organic	NA	Lab		5.6 mg/l	8.6 mg/l	14.3 mg/l	15.2 mg/l	3.7 mg/l	15.6 mg/l	19.4 mg/l	14.3 mg/l	12.3 mg/l	--	29.5 mg/l	--	16.5 mg/l	10.3 mg/l	7.3 mg/l	8.2 mg/l	7 mg/l	6.7 mg/l
Chemical Oxygen Demand	NA	Lab		28 mg/l	22 mg/l	46 mg/l	30 mg/l	18.2 mg/l	41 mg/l	46 mg/l	30 mg/l	25 mg/l	--	77 mg/l	--	48 mg/l	19 mg/l	--	--	--	--	--
Chloride	NA	Lab		1.1 mg/l	0.8 mg/l	0.8 mg/l	0.7 mg/l	1.8 mg/l	2.1 mg/l	2.4 mg/l	2.5 mg/l	2.7 mg/l	3.5 mg/l	3.9 mg/l	3.3 mg/l	5.7 mg/l	7.76 mg/l	13.2 mg/l	16 mg/l	15.7 mg/l	9.46 mg/l
Cyanide	NA	Lab		9.9 mg/l	< 0.02 mg/l	< 0.02 mg/l	< 0.02 mg/l	--	< 0.02 mg/l	< 0.02 mg/l	< 0.02 mg/l	< 0.02 mg/l	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Lab		7.9 mg/l	9.3 mg/l	--	--	--	10.2 mg/l	11.4 mg/l	--	--	--	--	--	--	--	--	7.77 mg/l	2.66 mg/l	11.7 mg/l	14.81 mg/l
Dissolved oxygen	NA	Field		--	--	--	--	10.23 mg/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluoride	NA	Lab		< 0.1 mg/l	0.19 mg/l	0.11 mg/l	0.17 mg/l	--	< 0.1 mg/l	0.1 mg/l	< 0.1 mg/l	0.16 mg/l	0.16 mg/l	0.12 mg/l	< 0.1 mg/l	0.15 mg/l	0.17 mg/l	< 0.1 mg/l	0.12 mg/l	0.1 mg/l	< 0.1 mg/l
Hardness, as CaCO3	NA	Lab		67 mg/l	63.2 mg/l	76.2 mg/l	136 mg/l	195 mg/l	30.3 mg/l	30.2 mg/l	55.7 mg/l	95.5 mg/l	92.3 mg/l	58.9 mg/l	50.3 mg/l	57.6 mg/l	109 mg/l	116 mg/l	106 mg/l	106 mg/l	105 mg/l
Nitrate + Nitrite, as N	NA	Lab		< 0.1 mg/l	< 0.1 mg/l	0.11 mg/l	< 0.1 mg/l	0.11 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	0.11 mg/l	--	< 0.1 mg/l	--	< 0.1 mg/l	< 0.1 mg/l	--	--	--	--
Nitrogen, ammonia as N	NA	Lab		< 0.1 mg/l	< 0.1 mg/l	0.14 mg/l	< 0.1 mg/l	0.17 mg/l	< 0.1 mg/l	< 0.1 mg/l	0.14 mg/l	< 0.1 mg/l	--	--	--	--	--	--	--	--	--
pH	NA	Lab		7.7 pH units	8.05 pH units	7.64 pH units	7.42 pH units	--	8.1 pH units	7.84 pH units	8.14 pH units	7.74 pH units	7.57 pH units	7.35 pH units	7.74 pH units	6.01 pH units	8.1 pH units	7.63 pH units	7.7 pH units	7.97 pH units	7.18 pH units
pH	NA	Field		--	--	--	--	7.08 pH units	--	--	--	--	--	--	--	--	7.87 pH units	--	--	--	--
Phosphorus, total, as P	NA	Lab		0.13 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	0.026 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	--	< 0.1 mg/l	--	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l
Redox (oxidation potential)	NA	Field		--	--	--	--	500 mV	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Solids, total dissolved	NA	Lab		94 mg/l	114 mg/l	350 mg/l	157 mg/l	281 mg/l	66 mg/l	69 mg/l	111 mg/l	110 mg/l	136 mg/l	119 mg/l	103 mg/l	106 mg/l	143 mg/l	314 mg/l	166 mg/l	146 mg/l	138 mg/l
Solids, total suspended	NA	Lab		1 mg/l	13 mg/l	15 mg/l	8 mg/l	2.0 mg/l	5 mg/l	11 mg/l	< 1 mg/l	2 mg/l	--	4 mg/l	--	< 1 mg/l	6 mg/l	--	--	--	--
Specific Conductance @ 25 ºC	NA	Lab		178 umhos/cm	182 umhos/cm	181.1 umhos/cm	254.4 umhos/cm	--	72 umhos/cm	81 umhos/cm	145 umhos/cm	182.7 umhos/cm	198.4 umhos/cm	126.9 umhos/cm	107 umhos/cm	--	238 umhos/cm	275.9 umhos/cm	265.5 umhos/cm	263.2 umhos/cm	232.5 umhos/cm
Specific Conductance @ 25 ºC	NA	Field		--	--	--	--	423.6 umhos/cm	--	--	--	--	--	--	--	--	250.3 umhos/cm	--	--	--	--
Sulfate, as SO4	NA	Lab		26.2 mg/l	29.2 mg/l	7.7 mg/l	3.3 mg/l	74.0 mg/l	4.7 mg/l	9.7 mg/l	8.7 mg/l	< 1 mg/l	< 1 mg/l	1.6 mg/l	9.9 mg/l	9.6 mg/l	9.36 mg/l	12.4 mg/l	9.8 mg/l	13 mg/l	22 mg/l
Temperature, ºC	NA	Lab		0.5 deg C	13.6 deg C	16.3 deg C	18.5 deg C	--	1.8 deg C	11.6 deg C	16.3 deg C	20.7 deg C	16.4 deg C	13.4 deg C	7.6 deg C	0.1 deg C	20.6 deg C	17.8 deg C	12.1 deg C	3.2 deg C	2.5 deg C
Temperature, ºC	NA	Field		--	--	--	--	4.67 deg C	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Turbidity	NA	Lab		2 NTU	6 NTU	--	--	--	2 NTU	4 NTU	--	--	--	--	--	--	3.17 NTU	--	--	--	--
Turbidity	NA	Field		--	--	--	--	6.7 NTU	--	--	--	--	--	--	--	--	--	--	--	--	--
Metals																						
Aluminum	Dissolved	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Aluminum	Total	Lab		10.3 ug/l	79.4 ug/l	267 ug/l	52.9 ug/l	--	116 ug/l	125 ug/l	60.4 ug/l	44.7 ug/l	43.5 ug/l	87.7 ug/l	87.2 ug/l	65 ug/l	< 25 ug/l	--	--	--	--	--
Antimony	Total	Lab		< 3 ug/l	< 3 ug/l	< 3 ug/l	< 3 ug/l	--	< 3 ug/l	< 3 ug/l	< 3 ug/l	< 3 ug/l	--	--	--	--	--	--	--	--	--	--
Arsenic	Dissolved	Lab		--	--	--	--	< 0.50 ug/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	Total	Lab		< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	0.72 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	--	--	--	--	--	--	--	--	--	--
Barium	Total	Lab		< 10 ug/l	< 10 ug/l	15.4 ug/l	16.9 ug/l	--	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	--	--	--	--	--	--	--	--	--	--
Beryllium	Total	Lab		< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	--	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	--	--	--	--	--	--	--	--	--	--
Boron	Total	Lab		< 35 ug/l	< 35 ug/l	40.7 ug/l	< 35 ug/l	--	< 35 ug/l	42.9 ug/l	73.8 ug/l	88.3 ug/l	71.2 ug/l	45.7 ug/l	50.2 ug/l	51.6 ug/l	109 ug/l	--	--	--	--	--
Cadmium	Total	Lab		< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	--	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	--	--	--	--	--	--	--	--	--	--
Calcium	Total	Lab		16100 ug/l	16400 ug/l	20100 ug/l	28100 ug/l	35500 ug/l	9000 ug/l	8900 ug/l	17700 ug/l	23200 ug/l	22600 ug/l	14000 ug/l	11700 ug/l	13300 ug/l	26300 ug/l	27200 ug/l	24200 ug/l	23900 ug/l	23600 ug/l
Chromium	Total	Lab		< 1 ug/l	< 1 ug/l	1.4 ug/l	1.6 ug/l	--	2.5 ug/l	1.5 ug/l	< 1 ug/l	1.5 ug/l	--	--	--	--	--	--	--	--	--	--
Cobalt	Dissolved	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	Total	Lab		< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	--	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	--	< 1 ug/l	--	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 2.5 ug/l < 1 ug/l	< 1 ug/l	< 1 ug/l < 1 ug/l
Copper	Dissolved	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	Total	Lab		< 5 ug/l	< 5 ug/l	< 5 ug/l	< 0.8 ug/l	--	< 5 ug/l	< 5 ug/l	< 5 ug/l	1.4 ug/l	1.1 ug/l	1.4 ug/l	1.5 ug/l	1.4 ug/l	< 0.7 ug/l	0.9 ug/l	0.58 ug/l 1.1 ug/l	0.85 ug/l	1.5 ug/l 0.43 ug/l
Iron	Dissolved	Lab		--	--	--	--	758 ug/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Iron	Total	Lab		450 ug/l	920 ug/l	4480 ug/l	2230 ug/l	1280 ug/l	870 ug/l	900 ug/l	1520 ug/l	1620 ug/l	--	1810 ug/l	--	1330 ug/l	1.41 ug/l	--	--	--	--
Lead	Total	Lab		< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	--	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 0.3 ug/l	< 0.3 ug/l	< 0.3 ug/l	< 0.3 ug/l	< 0.6 ug/l	--	--	--	--
Magnesium	Total	Lab		10400 ug/l	9400 ug/l	11200 ug/l	16000 ug/l	25900 ug/l	4100 ug/l	4100 ug/l	7100 ug/l	9100 ug/l	8700 ug/l	5800 ug/l	5100 ug/l	5900 ug/l	10600 ug/l	11600 ug/l	11200 ug/l	11300 ug/l	11100 ug/l
Manganese	Dissolved	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	Total	Lab		90 ug/l	150 ug/l	710 ug/l	760 ug/l	--	90 ug/l	70 ug/l	220 ug/l	180 ug/l	--	100 ug/l	--	130 ug/l	110 ug/l	--	--	--	--
Mercury	Total	Lab		< 0.0005 ug/l	0.0016 ug/l	0.0079 ug/l	0.007 ug/l	0.00068 ug/l	0.0045 ug/l	0.0025 ug/l	< 0.004 ug/l	< 0.005 ug/l	0.0028 ug/l	< 0.008 ug/l	< 0.01 ug/l	< 0.005 ug/l	< 0.002 ug/l	0.0017 ug/l	0.0011 ug/l	< 0.002 ug/l	< 0.004 ug/l
Methyl Mercury	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00026 ug/l	--	< 0.000056 ug/l
Molybdenum	Dissolved	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Total	Lab		< 5 ug/l	< 5 ug/l	< 5 ug/l	< 5 ug/l	--	< 5 ug/l	< 5 ug/l	< 5 ug/l	< 5 ug/l	--	--	--	--	--	--	--	--	--	--
Nickel	Dissolved	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	Total	Lab		< 5 ug/l	< 5 ug/l	< 5 ug/l	< 5 ug/l	--	< 5 ug/l	< 5 ug/l	< 5 ug/l	< 5 ug/l	1.4 ug/l	3.5 ug/l	1.8 ug/l	1.3 ug/l	0.8 ug/l	0.42 ug/l	0.84 ug/l 0.46 ug/l	0.44 ug/l	0.3 ug/l 1.1 ug/l
Palladium	Total	Lab		< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	--	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 0.3 ug/l	--	--	--	--	--	--	--	--
Phosphorus, total, as P	Dissolved	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	< 20 ug/l	--	--	--	--	--
Platinum	Total	Lab		< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	--	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	< 0.25 ug/l	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab		2000 ug/l	2100 ug/l	1200 ug/l	1400 ug/l	3600 ug/l	1600 ug/l	1400 ug/l	1600 ug/l	< 2500 ug/l	--	1800 ug/l	--	1900 ug/l	1940 ug/l	--	--	--	--
Selenium	Total	Lab		< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	--	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 3.6 ug/l	< 3.6 ug/l	< 3.6 ug/l	< 3.6 ug/l	< 1 ug/l	--	--	--	--	--
Silver	Total	Lab		< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	--	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 0.24 ug/l	< 0.24 ug/l	< 0.24 ug/l	< 0.24 ug/l	< 0.2 ug/l	--	--	--	--	--
Sodium	Total	Lab		4700 ug/l	5000 ug/l	4800 ug/l	5800 ug/l	10600 ug/l	1900 ug/l	2400 ug/l	3200 ug/l	4000 ug/l	3800 ug/l	2500 ug/l	2500 ug/l	3600 ug/l	7700 ug/l	--	--	--	--	--
Strontium	Total	Lab		52.3 ug/l	57.7 ug/l	73.7 ug/l	101 ug/l	--	45.2 ug/l	47.4 ug/l	96.6 ug/l	128 ug/l	--	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab		< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	--	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 2 ug/l	< 0.4 ug/l	< 0.4 ug/l	< 0.4 ug/l	< 0.4 ug/l	< 0.4 ug/l	--	--	--	--	--
Tin	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Titanium	Total	Lab		< 10 ug/l	--	--	--	--	< 10 ug/l	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	Dissolved	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	Total	Lab		< 10 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	--	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	< 10 ug/l	18.1 ug/l	< 25 ug/l	< 25 ug/l	47.9 ug/l < 25 ug/l	< 25 ug/l	< 25 ug/l < 25 ug/l

1 - Some monitoring locations are listed by multiple names. Equivalent locations include the following: PM-1 = SW003, PM-2 = SW002, PM-3 = SW003, PM-4 = SW005, PM16 = SW004

Large Table 11
Surface Water Data Summary
Partridge River Watershed and Wyman Creek

Location			PM-16 [1]	PM-16 [1]	PM-16 [1]	PM-16 [1]	PM-16 [1]	PM-16 [1]	PM-16 [1]	PM-16 [1]	PM-16 [1]	PM-16 [1]	PM-16 [1]	PM-16 [1]	PM-16 [1]	PM-16 [1]		PM-16 [1]	PM-16 [1]	PM-16 [1]	PM-16 [1]	PM-16 [1]
Date			3/22/2007	4/23/2007	5/22/2007	6/11/2007	7/23/2007	8/22/2007	9/19/2007	10/23/2007	11/14/2007	5/20/2008	6/11/2008	7/21/2008	10/8/2008	6/28/2012		7/31/2012	8/30/2012	9/26/2012	10/31/2012	11/27/2012
Sample Type			N	N	N	N	N	N	N	N	N	N	N	N	N	N	FD	N	N	N	N	N
Parameter	Total or Dissolved	Analysis Location																				
General Parameters																						
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	**61.8 mg/l**	--	--	--	**94.5 mg/l**	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total, as CaCO3	NA	Lab	**98.2 mg/l**	**43.9 mg/l**	**38.1 mg/l**	**40.3 mg/l**	**120 mg/l**	**134 mg/l**	**69.3 mg/l**	**77.6 mg/l**	**52.9 mg/l**	**39.9 mg/l**	**36.0 mg/l**	**92.4 mg/l**	--	**61.8 mg/l**	--	--	--	**94.5 mg/l**	--	--
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, total organic	NA	Lab	**11.0 mg/l**	**21.8 mg/l**	**25.7 mg/l**	**28.1 mg/l**	**10.1 mg/l**	**11.4 mg/l**	**21.9 mg/l**	**25.8 mg/l**	**17.0 mg/l**	**12.2 mg/l**	**20.8 mg/l**	**13.1 mg/l**	--	**36.2 mg/l**	--	**29.0 mg/l**	**12.8 mg/l**	**6.0 mg/l**	**9.3 mg/l**	**8.4 mg/l**
Chemical Oxygen Demand	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	**93.7 mg/l**	--	--	--	**17.3 mg/l**	--	--
Chloride	NA	Lab	**11.4 mg/l**	**4.71 mg/l**	**7.61 mg/l**	**6.66 mg/l**	**27.6 mg/l**	**23.4 mg/l**	**11.7 mg/l**	**7.91 mg/l**	**11 mg/l**	**7.82 mg/l**	**4.68 mg/l**	**7.09 mg/l**	--	**12.2 mg/l**	--	**8.6 mg/l**	**6.8 mg/l**	**8.3 mg/l**	**11.3 mg/l**	**15.2 mg/l**
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	**11.95 mg/l**	**10.54 mg/l**	**4.7 mg/l**	**2.7 mg/l**	**9.6 mg/l**	--	**4.66 mg/l**	**6.5 mg/l**	**8.1 mg/l**	--	--	--	**8.66 mg/l**	**4.32 mg/l**	--	**4.51 mg/l**	**5.44 mg/l**	**9.9 mg/l**	**11.2 mg/l**	**9.17 mg/l**
Fluoride	NA	Lab	< 0.1 mg/l	**0.1 mg/l**	< 0.1 mg/l	< 0.1 mg/l	**0.14 mg/l**	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	**0.17 mg/l**	--	--	--	--	--	--	--	--	--	--	--
Hardness, as CaCO3	NA	Lab	**109 mg/l**	**56.9 mg/l**	**52.5 mg/l**	**52.1 mg/l**	**116 mg/l**	**126 mg/l**	**77.2 mg/l**	**61 mg/l**	**75.3 mg/l**	**54.2 mg/l**	**49.2 mg/l**	**102 mg/l**	--	**90.9 mg/l**	--	**101 mg/l**	**112 mg/l**	**115 mg/l**	**107 mg/l**	**113 mg/l**
Nitrate + Nitrite, as N	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.28 mg/l**	--	--	--	**0.32 mg/l**	--	--
Nitrogen, ammonia as N	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.10 mg/l	--	--	--	< 0.10 mg/l	--	--
pH	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	**7.6 pH units**	**7.37 pH units**	**8.3 pH units**	**7.3 pH units**	**7.6 pH units**	--	**7.29 pH units**	**7.1 pH units**	**7.2 pH units**	--	--	--	**7.22 pH units**	**6.36 pH units**	--	**6.56 pH units**	**7.17 pH units**	**7.45 pH units**	**6.38 pH units**	**7.53 pH units**
Phosphorus, total, as P	NA	Lab	< 0.1 mg/l	**0.1 mg/l**	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	**0.009 mg/l**	< 0.004 mg/l	**0.016 * mg/l**	--	**0.030 mg/l**	--	--	--	< 0.0040 mg/l	--	--
Redox (oxidation potential)	NA	Field	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**316 mV**	**211 mV**	--	--
Solids, total dissolved	NA	Lab	**173 mg/l**	**120 mg/l**	**117 mg/l**	**110 mg/l**	**195 mg/l**	**189 mg/l**	**135 mg/l**	**138 mg/l**	**143 mg/l**	**102 mg/l**	**93 mg/l**	**153 mg/l**	--	**172 mg/l**	--	**166 mg/l**	**168 mg/l**	**166 mg/l**	**183 mg/l**	**236 mg/l**
Solids, total suspended	NA	Lab	--	--	--	--	--	--	--	--	--	**3.6 b mg/l**	**2.0 mg/l**	**4 mg/l**	--	--	--	--	--	--	--	--
Specific Conductance @ 25 °C	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Specific Conductance @ 25 °C	NA	Field	**286.2 umhos/cm**	**141 umhos/cm**	**126 umhos/cm**	**121 umhos/cm**	**336 umhos/cm**	--	**183 umhos/cm**	**144.8 umhos/cm**	**169 umhos/cm**	--	--	--	**142.9 umhos/cm**	**215 umhos/cm**	--	**211.5 umhos/cm**	**253.7 umhos/cm**	**251.5 umhos/cm**	**233.7 umhos/cm**	**173.4 umhos/cm**
Sulfate, as SO4	NA	Lab	**10.5 mg/l**	**11.7 mg/l**	**12.6 mg/l**	**7.83 mg/l**	**13.7 mg/l**	**9.45 mg/l**	**9.69 mg/l**	**11.6 mg/l**	**21.5 mg/l**	**14.2 mg/l**	**8.26 mg/l**	**10.9 mg/l**	--	**19.6 mg/l**	--	**12.2 mg/l**	**11.6 mg/l**	**18.7 mg/l**	**22.5 mg/l**	**29.1 mg/l**
Temperature, °C	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Temperature, °C	NA	Field	**0.3 deg C**	**5.1 deg C**	**12.4 deg C**	**17.7 deg C**	**22.3 deg C**	--	**12.35 deg C**	**8.2 deg C**	**2.1 deg C**	--	--	--	**9.9 deg C**	**22.9 deg C**	--	**20.99 deg C**	**22.08 deg C**	**9.06 deg C**	**1.03 deg C**	**0.22 deg C**
Turbidity	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Turbidity	NA	Field	--	--	--	--	--	--	--	--	--	--	--	--	**2.61 NTU**	**1.7 NTU**	--	**3.4 NTU**	**0 NTU**	**0 NTU**	**0.7 NTU**	**0.5 NTU**
Metals																						
Aluminum	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	**120 ug/l**	--	**98.2 ug/l**	**27.1 ug/l**	< 20.0 ug/l	< 40.0 ug/l	< 40.0 ug/l
Aluminum	Total	Lab	--	--	--	--	--	--	--	--	--	**83.9 ug/l**	**91.2 ug/l**	**65.7 ug/l**	--	**154 ug/l**	--	**130 ug/l**	**33.7 ug/l**	< 20.0 ug/l	**44.5 ug/l**	< 40.0 ug/l
Antimony	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Arsenic	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	**1.8 ug/l**	--	**1.5 ug/l**	**1.3 ug/l**	< 0.50 ug/l	**0.59 ug/l**	< 0.50 ug/l
Barium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	**16.3 ug/l**	--	--	--	**10.9 ug/l**	--	--
Beryllium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.20 ug/l	--	--	--	< 0.20 ug/l	--	--
Boron	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	**136 ug/l**	--	--	--	**181 ug/l**	--	--
Cadmium	Total	Lab	--	--	--	--	--	--	--	--	--	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	--	--	--	< 0.20 ug/l	--	--
Calcium	Total	Lab	**26200 ug/l**	**12800 ug/l**	**11700 ug/l**	**11700 ug/l**	**26000 ug/l**	**28200 ug/l**	**16900 ug/l**	**13700 ug/l**	**16000 ug/l**	**12100 ug/l**	**11200 ug/l**	**24100 ug/l**	--	**19900 ug/l**	--	**22400 ug/l**	**25900 ug/l**	**25800 ug/l**	**24000 ug/l**	**24200 ug/l**
Chromium	Total	Lab	--	--	--	--	--	--	--	--	--	< 1.0 ug/l	**0.61 b ug/l**	**0.19 jb ug/l**	--	< 1.0 ug/l	--	--	--	< 1.0 ug/l	--	--
Cobalt	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.79 ug/l**	--	**0.59 ug/l**	**0.23 ug/l**	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Cobalt	Total	Lab	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	< 1 ug/l	**0.16 j ug/l**	**0.13 j ug/l**	**0.31 ug/l**	--	**0.81 ug/l**	--	**0.68 ug/l**	**0.24 ug/l**	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l
Copper	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	**1.7 ug/l**	--	**1.2 ug/l**	**0.98 ug/l**	< 0.50 ug/l	**0.68 ug/l**	**0.67 ug/l**
Copper	Total	Lab	**6.3 ug/l**	**2.5 ug/l**	**2.0 ug/l**	< 0.7 ug/l	**0.87 ug/l**	**0.91 ug/l**	**1.8 ug/l**	**1.6 ug/l**	**1.7 ug/l**	**1.5 ug/l**	**1.7 ug/l**	**1.1 ug/l**	--	**1.8 ug/l**	--	**1.3 ug/l**	**0.88 ug/l**	< 0.50 ug/l	**0.82 ug/l**	**0.68 ug/l**
Iron	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	**2370 ug/l**	--	**2710 ug/l**	**1570 ug/l**	**530 ug/l**	**577 ug/l**	**730 ug/l**
Iron	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	**3010 ug/l**	--	**3460 ug/l**	**1820 ug/l**	**682 ug/l**	**686 ug/l**	**866 ug/l**
Lead	Total	Lab	--	--	--	--	--	--	--	--	--	**0.17 jb ug/l**	**0.20 jb ug/l**	**0.16 j ug/l**	--	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Magnesium	Total	Lab	**10700 ug/l**	**6050 ug/l**	**5640 ug/l**	**5530 ug/l**	**12500 ug/l**	**13600 ug/l**	**8480 ug/l**	**6490 ug/l**	**8600 ug/l**	**5840 ug/l**	**5160 ug/l**	**10100 ug/l**	--	**10000 ug/l**	--	**10900 ug/l**	**11600 ug/l**	**12200 ug/l**	**11400 ug/l**	**12700 ug/l**
Manganese	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	**306 ug/l**	--	**208 ug/l**	**128 ug/l**	**61.2 ug/l**	**33.8 ug/l**	**65.1 ug/l**
Manganese	Total	Lab	--	--	--	--	--	--	--	--	--	**43 ug/l**	**30 ug/l**	**150 ug/l**	--	**353 ug/l**	--	**231 ug/l**	**128 ug/l**	**64.0 ug/l**	**38.5 ug/l**	**65.5 ug/l**
Mercury	Total	Lab	**0.0045 ug/l**	**0.0068 ug/l**	**0.0052 ug/l**	**0.0042 ug/l**	< 0.002 ug/l	**0.0018 ug/l**	**0.0052 ug/l**	**0.0047 ug/l**	**0.0034 ug/l**	**0.0031 ug/l**	**0.0051 ug/l**	**0.0024 ug/l**	--	**0.0087 ug/l**	**0.0086 ug/l**	--	--	**0.0013 ug/l**	--	--
Methyl Mercury	Total	Lab	--	--	**0.000346 ug/l**	--	**0.000339 ug/l**	--	**0.000514 ug/l**	--	**0.000331 ug/l**	**0.00017 ug/l**	**0.00037 ug/l**	**0.00040 ug/l**	--	--	--	--	--	--	--	--
Molybdenum	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Total	Lab	--	--	--	--	--	--	--	--	--	**1.5 ug/l**	**0.85 ug/l**	**1.6 ug/l**	--	**1.6 ug/l**	--	--	--	**1.6 ug/l**	--	--
Nickel	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	**2.0 ug/l**	--	**1.7 ug/l**	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Nickel	Total	Lab	**4.7 ug/l**	**1.6 ug/l**	**1.4 ug/l**	**1.8 ug/l**	**1 ug/l**	**1.5 ug/l**	**2 ug/l**	**1.9 ug/l**	**1.8 ug/l**	**1.5 ug/l**	**1.6 ug/l**	**0.90 b ug/l**	--	**2.0 ug/l**	--	**1.8 ug/l**	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total, as P	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	**2200 ug/l**	--	--	--	**3300 ug/l**	--	--
Selenium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	< 1.0 ug/l	--	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l
Silver	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.20 ug/l	--	--	--	< 0.20 ug/l	--	--
Sodium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	**11900 ug/l**	--	--	--	**8800 ug/l**	--	--
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.004 j ug/l**	--	< 0.0004 ug/l	< 0.005 ug/l	< 0.002 ug/l	< 0.0004 ug/l	**0.0025 jb ug/l**
Tin	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	< 3.0 ug/l	--	--	--	< 3.0 ug/l	--	--
Zinc	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	**7.3 ug/l**	--	< 6.0 ug/l	**8.7 ug/l**	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l
Zinc	Total	Lab	**78.7 ug/l**	< 25 ug/l	**25.1 ug/l**	< 25 ug/l	< 25 ug/l	**46.7 ug/l**	< 25 ug/l	< 25 ug/l	< 25 ug/l	**1.9 jb ug/l**	**2.6 jb ug/l**	**3.7 jb ug/l**	--	< 6.0 ug/l	--	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l

1 - Some monitoring locations are listed by multiple names. Equivalent locations include the following: PM-1 = SW003, PM-2 = SW002, PM-3 = SW003, PM-4 = SW005, PM16 = SW004

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Large Table 11
Surface Water Data Summary
Partridge River Watershed and Wyman Creek

Location			PM-16[1]		PM-16[1]	PM-16[1]	PM-16[1]		PM-16[1]	PM-16[1]	PM-16[1]	PM-16[1]		PM-16[1]	PM-16[1]	PM-16[1]		PM-16[1]	PM-16[1]	SW004[1]	SW004[1]	
Date			12/19/2012		1/28/2013	2/26/2013	3/26/2013		4/24/2013	5/9/2013	6/17/2013	7/23/2013		8/19/2013	9/17/2013	10/29/2013		11/25/2013	12/16/2013	5/27/2010	6/17/2010	
Sample Type			N	FD	N	N	N	FD	N	N	N	N	FD	N	N	N	FD	N	N	N	N	FD
Parameter	Total or Dissolved	Analysis Location																				
General Parameters																						
Alkalinity, bicarbonate, as CaCO3	NA	Lab	**94.2 mg/l**	--	--	--	**116 mg/l**	--	--	--	--	**81.9 mg/l**	--	--	--	**60.2 mg/l**	--	--	--	--	**64.6 mg/l**	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total, as CaCO3	NA	Lab	**94.2 mg/l**	--	--	--	**116 mg/l**	--	--	--	--	**81.9 mg/l**	--	--	--	**60.2 mg/l**	--	--	--	--	**64.6 mg/l**	--
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, total organic	NA	Lab	**6.1 mg/l**	--	**13.5 mg/l**	**3.7 mg/l**	**4.1 mg/l**	--	**3.6 mg/l**	**18.4 mg/l**	**20.0 mg/l**	**26.9 mg/l**	--	**6.3 mg/l**	**9.8 mg/l**	**17.0 mg/l**	--	**10.3 mg/l**	**9.9 mg/l**	--	**27 mg/l**	--
Chemical Oxygen Demand	NA	Lab	**21.3 mg/l**	--	--	--	< 10.0 mg/l	--	--	--	--	**93.0 mg/l**	--	--	--	**61.1 mg/l**	--	--	--	--	**32.1 mg/l**	--
Chloride	NA	Lab	**9.3 mg/l**	--	**7.0 mg/l**	**4.3 mg/l**	**3.6 mg/l**	--	**19.0 mg/l**	**5.0 mg/l**	**10.4 mg/l**	**9.9 mg/l**	--	**11.0 mg/l**	**8.0 mg/l**	**7.0 mg/l**	--	**5.7 mg/l**	**6.7 mg/l**	--	**10.5 mg/l**	--
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	**8.49 mg/l**	--	**11.32 mg/l**	**0 BQS mg/l**	**11.19 mg/l**	--	--	--	**6.53 mg/l**	**8.34 mg/l**	--	**8.44 mg/l**	**8.5 mg/l**	**11.91 mg/l**	--	**12.21 mg/l**	**12.57 mg/l**	**6.30 mg/l**	**5.70 mg/l**	--
Fluoride	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.1 mg/l**	--
Hardness, as CaCO3	NA	Lab	**116 mg/l**	--	**149 mg/l**	**128 mg/l**	**124 mg/l**	--	**115 mg/l**	**40.1 mg/l**	**70.4 mg/l**	**103 mg/l**	--	**131 mg/l**	**125 mg/l**	**70.5 mg/l**	--	**105 mg/l**	**109 mg/l**	**90.8 mg/l**	**84.1 mg/l**	--
Nitrate + Nitrite, as N	NA	Lab	**0.82 mg/l**	--	--	--	**0.26 mg/l**	--	--	--	--	**0.11 mg/l**	--	--	--	**0.12 mg/l**	--	--	--	--	< 0.1 mg/l	--
Nitrogen, ammonia as N	NA	Lab	**0.12 mg/l**	--	--	--	**0.29 mg/l**	--	--	--	--	**0.13 mg/l**	--	--	--	**0.11 mg/l**	--	--	--	--	**0.07 mg/l**	--
pH	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	**7.06 pH units**	--	**7.02 pH units**	**7.65 pH units**	**7.16 pH units**	--	--	--	**7.54 pH units**	**7.28 pH units**	--	**7.64 pH units**	**8.31 pH units**	**7.28 pH units**	--	**7.47 pH units**	**7.08 pH units**	**7.30 pH units**	**7.60 pH units**	--
Phosphorus, total, as P	NA	Lab	**0.0090 mg/l**	--			**0.0097 mg/l**	--	--	--	--	**0.034 mg/l**	--	--	--	**0.017 mg/l**	--	--	--	--	**0.047 mg P/L**	--
Redox (oxidation potential)	NA	Field			--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Solids, total dissolved	NA	Lab	**189 mg/l**	--	**173 mg/l**	**154 mg/l**	**218 mg/l**	--	**191 mg/l**	**92.0 mg/l**	**158 mg/l**	**206 mg/l**	--	**184 mg/l**	**141 mg/l**	**138 mg/l**	--	**173 mg/l**	**256 mg/l**	--	**162 mg/l**	--
Solids, total suspended	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**3.6 mg/l**	--
Specific Conductance @ 25 ºC	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Specific Conductance @ 25 ºC	NA	Field	**153 umhos/cm**	--	**281.2 umhos/cm**	**158.2 umhos/cm**	**251.2 umhos/cm**	--	--	--	**175.2 umhos/cm**	**228.8 umhos/cm**	--	**297.9 umhos/cm**	**253.2 umhos/cm**	**150 umhos/cm**	--	**233 umhos/cm**	**249.9 umhos/cm**	**207.0 umhos/cm**	**184 umhos/cm**	--
Sulfate, as SO4	NA	Lab	**25.7 mg/l**	--	**18.2 mg/l**	**16.2 mg/l**	**15.1 mg/l**	--	**18.0 mg/l**	**8.6 mg/l**	**17.2 mg/l**	**16.3 mg/l**	--	**30.3 mg/l**	**11.2 mg/l**	**10.3 mg/l**	--	**20.8 mg/l**	**15.6 mg/l**	**14.1 mg/l**	**13.1 mg/l**	--
Temperature, ºC	NA	Lab																				
Temperature, ºC	NA	Field	**0.32 deg C**	--	**2.79 deg C**	**4.54 deg C**	**7.46 deg C**	--	--	--	**14.73 deg C**	**18.74 deg C**	--	**20.2 deg C**	**13.03 deg C**	**4.05 deg C**	--	**2.17 deg C**	**0.04 deg C**	**18.60 deg C**	**20.30 deg C**	--
Turbidity	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Turbidity	NA	Field	**0 NTU**	--	**48.8 NTU**	**131 NTU**	**5.7 NTU**	--	--	--	**0 NTU**	**8.1 NTU**	--	**2.6 NTU**	**0.2 NTU**	**2.6 NTU**	--	**0.2 NTU**	**12.9 NTU**	**0 NTU**	**0 NTU**	--
Metals																						
Aluminum	Dissolved	Lab	**23.7 ug/l**	--	< 20.0 ug/l	< 40.0 ug/l	< 20.0 ug/l	--	< 20.0 ug/l	**86.2 ug/l**	**69.1 ug/l**	**97.3 ug/l**	--	**25.1 ug/l**	**20.5 ug/l**	**61.8 ug/l**	--	**27.1 ug/l**	**35.4 ug/l**	**55.4 ug/l**	**53.1 ug/l**	--
Aluminum	Total	Lab	**24.4 ug/l**	--	**4600 ug/l**	< 40.0 ug/l	**22.2 ug/l**	--	**26.1 ug/l**	**115 ug/l**	**102 ug/l**	**135 ug/l**	--	**56.2 ug/l**	**27.4 ug/l**	**64.1 ug/l**	--	**149 ug/l**	**225 ug/l**	**67.8 ug/l**	**97.8 ug/l**	--
Antimony	Total	Lab	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	--	--	--	< 0.50 ug/l	--	--	--	--	--	--
Arsenic	Dissolved	Lab	--	--	--	--	--	--	--	--	**0.68 ug/l**	**1.8 ug/l**	--	**0.93 ug/l**	**0.92 ug/l**	**0.69 ug/l**	--	**0.62 ug/l**	< 0.50 ug/l	--	--	--
Arsenic	Total	Lab	< 0.50 ug/l	--	**6.4 ug/l**	**0.51 ug/l**	< 0.82 ug/l	--	**1.1 ug/l**	**0.56 ug/l**	**0.64 ug/l**	**2.4 ug/l**	--	< 1.0 ug/l	**0.94 ug/l**	**0.99 ug/l**	--	**0.52 ug/l**	**1.2 ug/l**	**1.1 ug/l**	**1.04 ug/l**	--
Barium	Total	Lab	**10.6 ug/l**	--	--	--	**11.0 ug/l**	--	--	--	--	**15.9 ug/l**	--	--	--	< 10.0 ug/l	--	--	--	--	**11.2 ug/l**	--
Beryllium	Total	Lab	< 0.20 ug/l	--	--	--	< 0.20 ug/l	--	--	--	--	< 0.20 ug/l	--	--	--	< 0.20 ug/l	--	--	--	--	< 0.2 ug/l	--
Boron	Total	Lab	**128 ug/l**	--	--	--	**76.3 ug/l**	--	--	--	--	**150 ug/l**	--	--	--	**78.9 ug/l**	--	--	--	--	**99.9 ug/l**	--
Cadmium	Total	Lab	< 0.20 ug/l	--	--	--	< 0.20 ug/l	--	--	--	--	< 0.20 ug/l	--	--	--	< 0.20 ug/l	--	--	--	--	**0.03 j ug/l**	--
Calcium	Total	Lab	**25700 ug/l**	--	**35800 ug/l**	**30500 ug/l**	**30000 ug/l**	--	**25300 ug/l**	**8400 ug/l**	**14800 ug/l**	**22700 ug/l**	--	**29500 ug/l**	**28200 ug/l**	**15100 ug/l**	--	**23000 ug/l**	**24700 ug/l**	**21000 ug/l**	**19600 ug/l**	--
Chromium	Total	Lab	**2.1 ug/l**	--	--	--	< 1.0 ug/l	--	--	--	--	< 1.0 ug/l	--	--	--	< 1.0 ug/l	--	--	--	--	< 1 ug/l	--
Cobalt	Dissolved	Lab	**0.22 ug/l**	--	**0.91 ug/l**	< 0.20 ug/l	< 0.20 ug/l	--	**0.20 ug/l**	< 0.20 ug/l	< 0.20 ug/l	**0.52 ug/l**	--	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	< 0.20 ug/l	**0.21 ug/l**	--	**0.24 ug/l**	--
Cobalt	Total	Lab	**0.23 ug/l**	--	**8.5 ug/l**	< 0.20 ug/l	< 0.20 ug/l	--	**0.22 ug/l**	**0.20 ug/l**	**0.22 ug/l**	**0.64 ug/l**	--	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	--	**0.27 ug/l**	**0.53 ug/l**	--	**0.2 ug/l**	--
Copper	Dissolved	Lab	**0.74 ug/l**	--	< 0.50 ug/l	**0.79 ug/l**	**0.68 ug/l**	--	**0.60 ug/l**	**1.7 ug/l**	**1.7 ug/l**	**1.0 ug/l**	--	**1.9 ug/l**	**0.62 ug/l**	**1.4 ug/l**	--	**1.1 ug/l**	**0.69 ug/l**	--	**1.15 ug/l**	--
Copper	Total	Lab	**0.72 ug/l**	--	**7.8 ug/l**	**0.55 ug/l**	**0.61 ug/l**	--	**0.74 ug/l**	**2.0 ug/l**	**1.8 ug/l**	**1.1 ug/l**	--	**0.84 ug/l**	**0.65 ug/l**	**1.2 ug/l**	--	**1.8 ug/l**	**1.3 ug/l**	--	**1.41 ug/l**	--
Iron	Dissolved	Lab	**750 ug/l**	--	**996 ug/l**	**521 ug/l**	**566 ug/l**	--	**707 ug/l**	**899 ug/l**	**754 ug/l**	**3310 ug/l**	--	**819 ug/l**	**1520 ug/l**	**1150 ug/l**	--	**769 ug/l**	**1740 ug/l**	--	--	--
Iron	Total	Lab	**1140 ug/l**	--	**29100 ug/l**	**1700 ug/l**	**1600 ug/l**	--	**1110 ug/l**	**1150 ug/l**	**1060 ug/l**	**4090 ug/l**	--	**1100 ug/l**	**1820 ug/l**	**1320 ug/l**	--	**1760 ug/l**	**3280 ug/l**	--	**1580 ug/l**	--
Lead	Total	Lab	< 0.50 ug/l	--	**2.4 ug/l**	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	--	**0.12 j ug/l**	--
Magnesium	Total	Lab	**12700 ug/l**	--	**14400 ug/l**	**12600 ug/l**	**11900 ug/l**	--	**12600 ug/l**	**4700 ug/l**	**8100 ug/l**	**11300 ug/l**	--	**13900 ug/l**	**13200 ug/l**	**8000 ug/l**	--	**11500 ug/l**	**11500 ug/l**	**9320 ug/l**	**8530 ug/l**	--
Manganese	Dissolved	Lab	**145 ug/l**	--	**2150 ug/l**	**179 ug/l**	**142 ug/l**	--	**157 ug/l**	**53.4 ug/l**	**47.9 ug/l**	**220 ug/l**	--	**79.0 ug/l**	**120 ug/l**	**48.6 ug/l**	--	**70.4 ug/l**	**217 ug/l**	--	--	--
Manganese	Total	Lab	**147 ug/l**	--	**6480 ug/l**	**185 ug/l**	**150 ug/l**	--	**166 ug/l**	**57.3 ug/l**	**62.6 ug/l**	**257 ug/l**	--	**91.2 ug/l**	**127 ug/l**	**50.3 ug/l**	--	**127 ug/l**	**384 ug/l**	--	**110 ug/l**	--
Mercury	Total	Lab	**0.0010 ug/l**	**0.0011 ug/l**	--	--	< 0.00050 ug/l	< 0.00050 ug/l	--	--	--	**0.0055 ug/l**	**0.0051 ug/l**	--	--	**0.0030 ug/l**	**0.0032 ug/l**	--	--	--	**0.0068 * ug/l**	**0.0037 * ug/l**
Methyl Mercury	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.00060 ug/l**	**0.00064 ug/l**
Molybdenum	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Total	Lab	**1.3 ug/l**	--	--	--	**1.1 ug/l**	--	--	--	--	**1.9 ug/l**	--	--	--	**0.75 ug/l**	--	--	--	--	**1.01 ug/l**	--
Nickel	Dissolved	Lab	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	**0.58 ug/l**	--	< 0.50 ug/l	**1.2 ug/l**	**0.94 ug/l**	**1.1 ug/l**	--	< 0.50 ug/l	< 0.50 ug/l	**1.1 ug/l**	--	< 0.50 ug/l	**0.72 ug/l**	--	**1.38 ug/l**	--
Nickel	Total	Lab	**1.4 ug/l**	--	**7.3 ug/l**	< 0.50 ug/l	**0.58 ug/l**	--	< 0.50 ug/l	**1.4 ug/l**	**1.2 ug/l**	**1.4 ug/l**	--	< 0.50 ug/l	< 0.50 ug/l	**0.67 ug/l**	--	**0.82 ug/l**	**0.91 ug/l**	--	**1.48 ug/l**	--
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total, as P	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	**2700 ug/l**	--	--	--	**3000 ug/l**	--	--	--	--	**2200 ug/l**	--	--	--	**2100 ug/l**	--	--	--	--	**2280 ug/l**	--
Selenium	Total	Lab	< 1.0 ug/l	--	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	< 1.0 ug/l	--	**0.29 j ug/l**	--
Silver	Total	Lab	< 0.20 ug/l	--	--	--	< 0.20 ug/l	--	--	--	--	< 0.20 ug/l	--	--	--	< 0.20 ug/l	--	--	--	--	< 0.2 ug/l	--
Sodium	Total	Lab	**8800 ug/l**	--	--	--	**5100 ug/l**	--	--	--	--	**11500 ug/l**	--	--	--	**6900 ug/l**	--	--	--	--	**9670 ug/l**	--
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**121 ug/l**	--
Thallium	Total	Lab	< 0.0004 ug/l	--	**0.021 j ug/l**	< 0.002 ug/l	**0.053 * ug/l**	--	**0.003 j ug/l**	**0.0014 j ug/l**	--	**0.016 j ug/l**	--	< 0.005 ug/l	**0.026 ug/l**	**0.002 j ug/l**	--	< 0.005 ug/l	**0.003 j ug/l**	< 0.02 ug/l	**0.026 ug/l**	--
Tin	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.5 ug/l	--
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Total	Lab	< 3.0 ug/l	--	--	--	< 3.0 ug/l	--	--	--	--	< 3.0 ug/l	--	--	--	< 3.0 ug/l	--	--	--	--	--	--
Zinc	Dissolved	Lab	< 6.0 ug/l	--	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	--	< 6.0 ug/l	**6.7 ug/l**	**8.2 ug/l**	< 6.0 ug/l	--	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	--	< 6.0 ug/l	< 6.0 ug/l	--	< 6 ug/l	--
Zinc	Total	Lab	< 6.0 ug/l	--	**31.2 ug/l**	< 6.0 ug/l	< 6.0 ug/l	--	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	--	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	--	< 6.0 ug/l	< 6.0 ug/l	--	< 6 ug/l	--

1 - Some monitoring locations are listed by multiple names. Equivalent locations include the following: PM-1 = SW003, PM-2 = SW002, PM-3 = SW003, PM-4 = SW005, PM16 = SW004

Large Table 11
Surface Water Data Summary
Partridge River Watershed and Wyman Creek

			Location	SW004 [1]	SW004 [1]	SW004 [1]	SW004 [1]	SW004a	SW004a	SW004a		SW004a		SW004a		SW004a	SW004a	SW004a	SW004a	SW004a	SW004a	SW004a
			Date	7/15/2010	8/10/2010	9/22/2010	10/20/2011	5/27/2010	6/17/2010	7/15/2010		8/10/2010		9/22/2010		6/28/2012	6/28/2012	7/31/2012	8/30/2012	9/26/2012	10/31/2012	11/27/2012
			Sample Type	N	N	N	N	N	N	N	FD	N	FD	N	FD	N	N	N	N	N	N	N
Parameter	Total or Dissolved	Analysis Location																				
General Parameters																						
Alkalinity, bicarbonate, as CaCO3	NA	Lab		--	**105 mg/l**	--	**77.6 mg/l**	**44.6 mg/l**	**51.3 mg/l**	**94.5 mg/l**	--	**105 mg/l**	--	**76.1 mg/l**	--	--	**49.8 mg/l**	--	--	**94.2 mg/l**	--	--
Alkalinity, carbonate, as CaCO3	NA	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total, as CaCO3	NA	Lab		--	**105 mg/l**	--	--	**44.6 mg/l**	**51.3 mg/l**	**94.5 mg/l**	--	**105 mg/l**	--	**76.1 mg/l**	--	--	**49.8 mg/l**	--	--	**94.2 mg/l**	--	--
Biochemical Oxygen Demand (5-day)	NA	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, total organic	NA	Lab		--	**15.0 mg/l**	--	--	**28.7 mg/l**	**30.8 mg/l**	**17.4 mg/l**	--	**14.0 mg/l**	--	**22.4 mg/l**	--	--	**48.3 mg/l**	**30.4 mg/l**	**12.4 mg/l**	**8.8 mg/l**	**9.8 mg/l**	**8.7 mg/l**
Chemical Oxygen Demand	NA	Lab		--	**38.8 mg/l**	--	--	**74.6 mg/l**	**47.3 mg/l**	**46.8 mg/l**	--	**40.2 mg/l**	--	**60.2 mg/l**	--	--	**131 mg/l**	--	--	**15.9 mg/l**	--	--
Chloride	NA	Lab		--	**24.8 mg/l**	--	**6.94 mg/l**	**5.75 mg/l**	**7.38 mg/l**	**19.8 mg/l**	--	**24.2 mg/l**	--	**18.1 mg/l**	--	--	**9.2 mg/l**	**8.2 mg/l**	**6.7 mg/l**	**8.3 mg/l**	**10.7 mg/l**	**14.7 mg/l**
Cyanide	NA	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field		**5.77 mg/l**	**5.4 mg/l**	**7.0 mg/l**	< 0.1 mg/l	**5.30 mg/l**	**6.40 mg/l**	**6.53 mg/l**	--	**5.8 mg/l**	--	**8.0 mg/l**	--	**4.49 mg/l**	--	**4.95 mg/l**	**6.7 mg/l**	**10.59 mg/l**	**11.29 mg/l**	**8.77 mg/l**
Fluoride	NA	Lab		--	**0.17 mg/l**	--	--	< 0.1 mg/l	< 0.1 mg/l	**0.14 mg/l**	--	**0.17 mg/l**	--	**0.12 mg/l**	--	--	--	--	--	--	--	--
Hardness, as CaCO3	NA	Lab		**119 mg/l**	**134 mg/l**	**117 mg/l**	**92 mg/l**	**63.1 mg/l**	**69.6 mg/l**	**112 mg/l**	--	**130 mg/l**	--	**102 mg/l**	--	--	**80.5 mg/l**	**100 mg/l**	**113 mg/l**	**113 mg/l**	**104 mg/l**	**110 mg/l**
Nitrate + Nitrite, as N	NA	Lab		--	**0.16 mg/l**	--	--	**0.41 mg/l**	**0.13 mg/l**	**0.12 mg/l**	--	**0.14 mg/l**	--	< 0.1 mg/l	--	--	**0.22 mg/l**	--	--	**0.32 mg/l**	--	--
Nitrogen, ammonia as N	NA	Lab		--	< 0.05 mg/l	--	--	**0.06 mg/l**	**0.19 mg/l**	**0.08 mg/l**	--	< 0.05 mg/l	--	< 0.05 mg/l	--	--	< 0.10 mg/l	--	--	< 0.10 mg/l	--	--
pH	NA	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field		**7.21 pH units**	**7.3 pH units**	**7.3 pH units**	**5.6 pH units**	**6.60 pH units**	**7.40 pH units**	**6.52 pH units**	--	**7.2 pH units**	--	**7.1 pH units**	--	**6.41 pH units**	--	**6.76 pH units**	**7.21 pH units**	**7.38 pH units**	**7.16 pH units**	**7.8 pH units**
Phosphorus, total, as P	NA	Lab		--	**0.018 mg P/L**	--	--	**0.024 mg P/L**	**0.03 mg P/L**	**0.023 mg P/L**	--	**0.018 mg P/L**	--	**0.017 mg P/L**	--	--	**0.043 mg/l**	--	--	< 0.0040 mg/l	--	--
Redox (oxidation potential)	NA	Field		--	--	--	**446 mV**	--	--	--	--	--	--	--	--	--	--	--	**300 mV**	**170 mV**	--	--
Solids, total dissolved	NA	Lab		--	**226 mg/l**	--	--	**103 mg/l**	**145 mg/l**	**173 mg/l**	--	**222 mg/l**	--	**184 mg/l**	--	--	**190 mg/l**	**187 mg/l**	**150 mg/l**	**156 mg/l**	**163 mg/l**	**195 mg/l**
Solids, total suspended	NA	Lab		--	**3.6 mg/l**	--	--	**1.6 mg/l**	**2 mg/l**	**3.2 mg/l**	--	**2.4 mg/l**	--	**2 mg/l**	--	--	--	--	--	--	--	--
Specific Conductance @ 25 °C	NA	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Specific Conductance @ 25 °C	NA	Field		**314.4 umhos/cm**	**354 umhos/cm**	**307 umhos/cm**	**169 umhos/cm**	**138.0 umhos/cm**	**143 umhos/cm**	**318.9 umhos/cm**	--	**371 umhos/cm**	--	**267 umhos/cm**	--	**176.9 umhos/cm**	--	**204.5 umhos/cm**	**251.8 umhos/cm**	**251.9 umhos/cm**	**226.7 umhos/cm**	**166.9 umhos/cm**
Sulfate, as SO4	NA	Lab		**17.9 mg/l**	**24 mg/l**	**27 mg/l**	**6.61 mg/l**	**8.48 mg/l**	**9.4 mg/l**	**15.8 mg/l**	--	**23.5 mg/l**	--	**22.2 mg/l**	--	--	**15.3 mg/l**	**11.6 mg/l**	**11.6 mg/l**	**18.7 mg/l**	**21.5 mg/l**	**28.3 mg/l**
Temperature, °C	NA	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Temperature, °C	NA	Field		**23.39 deg C**	**26.6 deg C**	**12.2 deg C**	**6 deg C**	**21.10 deg C**	**19.70 deg C**	**26.12 deg C**	--	**25.9 deg C**	--	**12.5 deg C**	--	**21.92 deg C**	--	**21.02 deg C**	**21.79 deg C**	**9.66 deg C**	**1.06 deg C**	**0.3 deg C**
Turbidity	NA	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Turbidity	NA	Field		**0.3 NTU**	**0.3 NTU**	**3.1 NTU**	**2.6 NTU**	**0 NTU**	**0 NTU**	**0.1 NTU**	--	**0 NTU**	--	**8.0 NTU**	--	**9.7 NTU**	--	**5 NTU**	**0 NTU**	**0 NTU**	**1.6 NTU**	**0 NTU**
Metals																						
Aluminum	Dissolved	Lab		< 25 ug/l	--	< 25 ug/l	< 25 ug/l	**119 ug/l**	**103 ug/l**	**29.6 ug/l**	--	--	--	**35.8 ug/l**	--	--	**203 ug/l**	**102 ug/l**	**27.3 ug/l**	< 20.0 ug/l	< 40.0 ug/l	< 40.0 ug/l
Aluminum	Total	Lab		**33.8 ug/l**	**29.4 ug/l**	**51.3 ug/l**	**29 ug/l**	**128 ug/l**	**138 ug/l**	**59.5 ug/l**	--	**30.6 ug/l**	--	**57.5 ug/l**	--	--	**406 ug/l**	**135 ug/l**	**30.8 ug/l**	< 20.0 ug/l	**43.9 ug/l**	< 40.0 ug/l
Antimony	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Arsenic	Dissolved	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	Total	Lab		**1.2 ug/l**	**1.24 ug/l**	**0.88 ug/l**	--	**1.0 ug/l**	**1.08 ug/l**	**1.2 ug/l**	--	**1.15 ug/l**	--	**0.89 ug/l**	--	--	**2.6 ug/l**	**1.9 ug/l**	**1.2 ug/l**	< 0.50 ug/l	< 0.50 ug/l	**0.53 ug/l**
Barium	Total	Lab		--	**14.6 ug/l**	--	--	**11.1 ug/l**	**10.2 ug/l**	**13 ug/l**	--	**13.4 ug/l**	--	**10.8 ug/l**	--	--	**18.7 ug/l**	--	--	**10.7 ug/l**	--	--
Beryllium	Total	Lab		--	< 0.2 ug/l	--	--	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	--	< 0.2 ug/l	--	< 0.2 ug/l	--	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--
Boron	Total	Lab		--	**211 ug/l**	--	--	**58.2 ug/l**	**74.1 ug/l**	**156 ug/l**	--	**206 ug/l**	--	**138 ug/l**	--	--	**103 ug/l**	--	--	**149 ug/l**	--	--
Cadmium	Total	Lab		--	< 0.02 ug/l	--	--	**0.03 j ug/l**	< 0.2 ug/l	< 0.2 ug/l	--	< 0.02 ug/l	--	< 0.02 ug/l	--	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--
Calcium	Total	Lab		**27200 ug/l**	**29400 ug/l**	**25300 ug/l**	**21300 ug/l**	**14200 ug/l**	**15900 ug/l**	**25400 ug/l**	--	**28500 ug/l**	--	**21900 ug/l**	--	--	**17800 ug/l**	**22300 ug/l**	**26000 ug/l**	**25300 ug/l**	**23400 ug/l**	**23500 ug/l**
Chromium	Total	Lab		--	< 1 ug/l	--	--	< 1 ug/l	< 1 ug/l	< 1 ug/l	--	< 1 ug/l	--	< 1 ug/l	--	--	< 1.0 ug/l	--	--	< 1.0 ug/l	--	--
Cobalt	Dissolved	Lab		--	--	--	--	**0.38 ug/l**	**0.26 ug/l**	**0.22 ug/l**	--	--	--	< 0.2 ug/l	--	--	**1.8 ug/l**	**0.62 ug/l**	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	**0.20 ug/l**
Cobalt	Total	Lab		--	< 0.2 ug/l	--	--	**0.46 ug/l**	**0.31 ug/l**	**0.28 ug/l**	--	< 0.2 ug/l	--	< 0.2 ug/l	--	--	**2.2 ug/l**	**0.70 ug/l**	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	**0.20 ug/l**
Copper	Dissolved	Lab		--	--	--	--	**1.81 ug/l**	**1.47 ug/l**	**0.86 ug/l**	--	--	--	**1.05 ug/l**	--	--	**1.9 ug/l**	**1.2 ug/l**	**0.91 ug/l**	< 0.50 ug/l	**0.70 ug/l**	**0.78 ug/l**
Copper	Total	Lab		--	**0.74 ug/l**	--	--	**2.03 ug/l**	**1.62 ug/l**	**0.91 ug/l**	--	**0.76 ug/l**	--	**0.9 ug/l**	--	--	**2.5 ug/l**	**1.3 ug/l**	**0.92 ug/l**	< 0.50 ug/l	**0.76 ug/l**	**1.1 ug/l**
Iron	Dissolved	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	**3420 ug/l**	**2800 ug/l**	**1500 ug/l**	**526 ug/l**	**588 ug/l**	**930 ug/l**
Iron	Total	Lab		--	**1250 ug/l**	--	--	**1680 ug/l**	**1750 ug/l**	**1750 ug/l**	--	**1190 ug/l**	--	**1300 ug/l**	--	--	**5990 ug/l**	**3730 ug/l**	**1710 ug/l**	**659 ug/l**	**712 ug/l**	**1150 ug/l**
Lead	Total	Lab		--	< 0.03 ug/l	--	--	**0.20 j ug/l**	**0.15 j ug/l**	**0.12 j ug/l**	--	< 0.03 ug/l	--	**0.11 j ug/l**	--	--	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Magnesium	Total	Lab		**12500 ug/l**	**14600 ug/l**	**13100 ug/l**	**9430 ug/l**	**6710 ug/l**	**7270 ug/l**	**11600 ug/l**	--	**14300 ug/l**	--	**11600 ug/l**	--	--	**8700 ug/l**	**10900 ug/l**	**11700 ug/l**	**12200 ug/l**	**11000 ug/l**	**12500 ug/l**
Manganese	Dissolved	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	**525 ug/l**	**213 ug/l**	**104 ug/l**	**57.8 ug/l**	**37.1 ug/l**	**117 ug/l**
Manganese	Total	Lab		--	**113 ug/l**	--	--	**219 ug/l**	**103 ug/l**	**103 ug/l**	--	**76.3 ug/l**	--	**49.3 ug/l**	--	--	**687 ug/l**	**245 ug/l**	**106 ug/l**	**57.1 ug/l**	**41.2 ug/l**	**117 ug/l**
Mercury	Total	Lab		--	**0.0028 ug/l**	--	--	**0.0054 ug/l**	**0.0047 ug/l**	**0.0027 ug/l**	**0.0029 ug/l**	**0.0030 ug/l**	**0.0026 ug/l**	**0.0027 ug/l**	**0.0026 ug/l**	--	**0.0125 ug/l**	--	--	**0.00079 ug/l**	--	--
Methyl Mercury	Total	Lab		--	**0.00089 ug/l**	--	--	**0.56 ug/l**	**0.00059 ug/l**	**0.00076 ug/l**	**0.00064 ug/l**	**0.00072 ug/l**	**0.00078 ug/l**	**0.00030 ug/l**	**0.00026 ug/l**	--	--	--	--	--	--	--
Molybdenum	Dissolved	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Total	Lab		--	**1.73 ug/l**	--	--	**0.98 ug/l**	**0.75 ug/l**	**1.32 ug/l**	--	**1.74 ug/l**	--	**0.89 ug/l**	--	--	**1.3 ug/l**	--	--	**1.6 ug/l**	--	--
Nickel	Dissolved	Lab		--	--	--	--	**2.12 ug/l**	**1.85 ug/l**	**1.53 ug/l**	--	--	--	**1.35 ug/l**	--	--	**3.4 ug/l**	**1.8 ug/l**	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Nickel	Total	Lab		--	**1.27 ug/l**	--	--	**2.34 ug/l**	**2.08 ug/l**	**1.63 ug/l**	--	**1.31 ug/l**	--	**1.32 ug/l**	--	--	**3.8 ug/l**	**1.9 ug/l**	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Palladium	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total, as P	Dissolved	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab		--	**4020 ug/l**	--	--	**1480 ug/l**	**1680 ug/l**	**3340 ug/l**	--	**3950 ug/l**	--	**2940 ug/l**	--	--	**1800 ug/l**	--	--	**3300 ug/l**	--	--
Selenium	Total	Lab		--	**0.41 j ug/l**	--	--	< 0.2 ug/l	< 0.2 ug/l	**0.2 j ug/l**	--	**0.39 j ug/l**	--	**0.34 j ug/l**	--	--	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l
Silver	Total	Lab		--	< 0.2 ug/l	--	--	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	--	< 0.2 ug/l	--	< 0.2 ug/l	--	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--
Sodium	Total	Lab		--	**20200 ug/l**	--	--	**5870 ug/l**	**7230 ug/l**	**15600 ug/l**	--	**19800 ug/l**	--	**15900 ug/l**	--	--	**9100 ug/l**	--	--	**8700 ug/l**	--	--
Strontium	Total	Lab		--	**224 ug/l**	--	--	**83.5 ug/l**	**93.4 ug/l**	**166 ug/l**	--	**218 ug/l**	--	**155 ug/l**	--	--	--	--	--	--	--	--
Thallium	Total	Lab		< 0.005 ug/l	**0.028 ug/l**	< 0.002 ug/l	--	< 0.02 ug/l	**0.021 ug/l**	< 0.005 ug/l	--	**0.019 j ug/l**	--	< 0.002 ug/l	--	--	**0.006 j ug/l**	< 0.0004 ug/l	**0.009 j ug/l**	< 0.002 ug/l	< 0.0004 ug/l	**0.0029 jb ug/l**
Tin	Total	Lab		--	< 0.5 ug/l	--	--	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	--	< 0.5 ug/l	--	< 0.5 ug/l	--	--	--	--	--	--	--	--
Titanium	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Total	Lab		--	--	--	--	--	--	--	--	--	--	--	--	--	< 3.0 ug/l	--	--	< 3.0 ug/l	--	--
Zinc	Dissolved	Lab		--	--	--	--	**7.1 ug/l**	< 6 ug/l	< 6 ug/l	--	--	--	< 6 ug/l	--	--	**8.8 ug/l**	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l
Zinc	Total	Lab		--	< 6 ug/l	--	--	< 6 ug/l	< 6 ug/l	< 6 ug/l	--	< 6 ug/l	--	< 6 ug/l	--	--	**7.5 ug/l**	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l

1 - Some monitoring locations are listed by multiple names. Equivalent locations include the following: PM-1 = SW003, PM-2 = SW002, PM-3 = SW003, PM-4 = SW005, PM16 = SW004

Large Table 11
Surface Water Data Summary
Partridge River Watershed and Wyman Creek

		Location	SW004a	SW004a	SW004a	SW004a	SW004a	SW004a	SW004a	SW004a	SW004a	SW004a	SW004a	SW004a	SW004a	SW004b		SW004b		SW004b	
		Date	12/19/2012	1/28/2013	2/26/2013	3/26/2013	4/24/2013	5/10/2013	6/17/2013	7/23/2013	8/19/2013	9/17/2013	10/29/2013	11/26/2013	12/16/2013	5/27/2010		6/17/2010		7/15/2010	
		Sample Type	N	N	N	N	N	N	N	N	N	N	N	N	N	N	FD	N	FD	N	FD
Parameter	Total or Dissolved	Analysis Location																			
General Parameters																					
Alkalinity, bicarbonate, as CaCO3	NA	Lab	**92.1 mg/l**	--	--	**114 mg/l**	--	--	--	**68.2 mg/l**	--	--	**52.3 mg/l**	--	--	**27.7 mg/l**	--	**29.9 mg/l**	--	**68.5 mg/l**	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total, as CaCO3	NA	Lab	**92.1 mg/l**	--	--	**114 mg/l**	--	--	--	**68.2 mg/l**	--	--	**52.3 mg/l**	--	--	**27.7 mg/l**	--	**29.9 mg/l**	--	**68.5 mg/l**	--
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, total organic	NA	Lab	**6.3 mg/l**	**8.4 mg/l**	**6.2 mg/l**	**4.3 mg/l**	**7.6 mg/l**	**23.0 mg/l**	**26.3 mg/l**	**36.2 mg/l**	**7.9 mg/l**	**10.5 mg/l**	**17.2 mg/l**	**11.4 mg/l**	**16.4 mg/l**	**28.7 mg/l**	--	**38.6 mg/l**	--	**31.5 mg/l**	--
Chemical Oxygen Demand	NA	Lab	**18.4 mg/l**	--	--	< 10.0 mg/l	--	--	--	**127 mg/l**	--	--	**66.7 mg/l**	--	--	**72.8 mg/l**	--	**67.1 mg/l**	--	**85.7 mg/l**	--
Chloride	NA	Lab	**9.3 mg/l**	**6.2 mg/l**	**5.3 mg/l**	**4.7 mg/l**	**15.9 mg/l**	**2.4 mg/l**	**5.3 mg/l**	**7.6 mg/l**	**10.7 mg/l**	**7.6 mg/l**	**5.9 mg/l**	**5.8 mg/l**	**4.5 mg/l**	**1.73 mg/l**	--	**2.01 mg/l**	--	**12.1 mg/l**	--
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	**8.11 mg/l**	**10.68 mg/l**	**10.94 mg/l**	**11.29 mg/l**	--	**8.7 mg/l**	**6.23 mg/l**	**8.7 mg/l**	**8.62 mg/l**	**8.76 mg/l**	**12.56 mg/l**	**12.91 mg/l**	--	**5.43 mg/l**	--	**6.75 mg/l**	--	**6.28 mg/l**	--
Fluoride	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.1 mg/l	--	< 0.1 mg/l	--	**0.12 mg/l**	--
Hardness, as CaCO3	NA	Lab	**117 mg/l**	**127 mg/l**	**122 mg/l**	**122 mg/l**	**104 mg/l**	**27.5 mg/l**	**48.2 mg/l**	**92.3 mg/l**	**126 mg/l**	**113 mg/l**	**62.8 mg/l**	**107 mg/l**	**81.2 mg/l**	**39 mg/l**	--	**46.4 mg/l**	--	**90.5 mg/l**	--
Nitrate + Nitrite, as N	NA	Lab	**0.83 mg/l**	--	--	**0.25 mg/l**	--	--	--	**0.10 mg/l**	--	--	**0.14 mg/l**	--	--	< 0.1 mg/l	--	< 0.1 mg/l	--	< 0.1 mg/l	--
Nitrogen, ammonia as N	NA	Lab	**0.12 mg/l**	--	--	**0.31 mg/l**	--	--	--	**0.17 mg/l**	--	--	**0.12 mg/l**	--	--	**0.07 mg/l**	--	< 0.1 mg/l	--	**0.09 mg/l**	--
pH	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	**7.25 pH units**	**6.57 pH units**	**7.74 pH units**	**7.26 pH units**	--	**7.05 pH units**	**7.65 pH units**	**7.12 pH units**	**7.69 pH units**	**8.18 pH units**	**7.05 pH units**	**7.3 pH units**	--	**6.59 pH units**	--	**6.87 pH units**	--	**6.70 pH units**	--
Phosphorus, total, as P	NA	Lab	**0.010 mg/l**			**0.012 mg/l**	--	--	--	**0.050 mg/l**	--	--	**0.024 mg/l**	--	--	**0.024 mg P/L**	--	**0.026 mg P/L**	--	**0.031 mg P/L**	--
Redox (oxidation potential)	NA	Field	--	--	--	--	--	**405 mV**	--	--	--	--	--	--	--	--	--	--	--	--	--
Solids, total dissolved	NA	Lab	**185 mg/l**	**166 mg/l**	**153 mg/l**	**215 mg/l**	**195 mg/l**	**75.0 mg/l**	**123 mg/l**	**211 mg/l**	**184 mg/l**	**189 mg/l**	**135 mg/l**	**192 mg/l**	**220 mg/l**	**88 mg/l**	--	**135 mg/l**	--	**147 mg/l**	--
Solids, total suspended	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	**3 mg/l**	--	**3.6 mg/l**	--	**3.2 mg/l**	--
Specific Conductance @ 25 ºC	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Specific Conductance @ 25 ºC	NA	Field	**148.4 umhos/cm**	**258.3 umhos/cm**	**149.4 umhos/cm**	**282.9 umhos/cm**	--	**46.8 umhos/cm**	**102.8 umhos/cm**	**194.2 umhos/cm**	**291.8 umhos/cm**	**245.1 umhos/cm**	**126.7 umhos/cm**	**225.3 umhos/cm**	--	**77.0 umhos/cm**	--	**84 umhos/cm**	--	**100 umhos/cm**	--
Sulfate, as SO4	NA	Lab	**25.3 mg/l**	**16.5 mg/l**	**15.1 mg/l**	**15.0 mg/l**	**15.6 mg/l**	**5.4 mg/l**	**8.9 mg/l**	**12.6 mg/l**	**29.3 mg/l**	**10.9 mg/l**	**9.0 mg/l**	**20.6 mg/l**	**10 mg/l**	**4.9 mg/l**	--	**4.66 mg/l**	--	**10.6 mg/l**	--
Temperature, ºC	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Temperature, ºC	NA	Field	**0.35 deg C**	**2.58 deg C**	**6.34 deg C**	**8.99 deg C**	--	**4.02 deg C**	**16.02 deg C**	**18.76 deg C**	**20.16 deg C**	**12.44 deg C**	**3.38 deg C**	**1.88 deg C**	--	**20.47 deg C**	--	**17.35 deg C**	--	**25.01 deg C**	--
Turbidity	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Turbidity	NA	Field	**0 NTU**	**9.5 NTU**	**131.2 NTU**	**6.1 NTU**	--	**0 NTU**	**2.2 NTU**	**12.6 NTU**	**8.1 NTU**	**3.2 NTU**	**3.4 NTU**	**2.8 NTU**	--	**2.6 NTU**	--	**1.0 NTU**	--	**1.0 NTU**	--
Metals																					
Aluminum	Dissolved	Lab	**24.5 ug/l**	**25.7 ug/l**	< 40.0 ug/l	< 20.0 ug/l	**26.6 ug/l**	**130 ug/l**	**117 ug/l**	**189 ug/l**	**28.4 ug/l**	**26.3 ug/l**	**76.7 ug/l**	**29.4 ug/l**	**97.3 ug/l**	**116 ug/l**	--	**155 ug/l**	--	**59.9 ug/l**	--
Aluminum	Total	Lab	**37.1 ug/l**	**570 ug/l**	< 40.0 ug/l	**24.5 ug/l**	**41.6 ug/l**	**155 ug/l**	**163 ug/l**	**271 ug/l**	**58.6 ug/l**	**135 ug/l**	**180 ug/l**	**40.3 ug/l**	**112 ug/l**	**165 ug/l**	--	**249 ug/l**	--	**119 ug/l**	--
Antimony	Total	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l		< 0.50 ug/l			< 0.50 ug/l			--	--	--	--	--	--
Arsenic	Dissolved	Lab	--	--	--	--	--	--	**0.82 ug/l**	**2.3 ug/l**	**0.77 ug/l**	**0.97 ug/l**	**0.78 ug/l**	**0.50 ug/l**	**0.54 ug/l**	--	--	--	--	--	--
Arsenic	Total	Lab	< 0.50 ug/l	**0.84 ug/l**	**0.52 ug/l**	< 0.82 ug/l	**1.1 ug/l**	< 0.50 ug/l	**0.80 ug/l**	**2.9 ug/l**	< 1.0 ug/l	**0.90 ug/l**	**1.1 ug/l**	< 0.50 ug/l	**0.87 ug/l**	**0.84 ug/l**	--	**1.17 ug/l**	**1.14 ug/l**	**1.6 ug/l**	**1.7 ug/l**
Barium	Total	Lab	**11.0 ug/l**	--	--	**11.5 ug/l**	--	--	--	**17.1 ug/l**	--	--	< 10.0 ug/l	--	--	**7.37 ug/l**	--	**8.48 ug/l**	--	**11.1 ug/l**	--
Beryllium	Total	Lab	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	< 0.2 ug/l	--	< 0.2 ug/l	--	< 0.2 ug/l	--
Boron	Total	Lab	**127 ug/l**	--	--	**83.8 ug/l**	--	--	--	**115 ug/l**	--	--	**68.2 ug/l**	--	--	< 50 ug/l	--	< 50 ug/l	--	**97.2 ug/l**	--
Cadmium	Total	Lab	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	**0.03 j ug/l**	--	< 0.02 ug/l	--	< 0.2 ug/l	--
Calcium	Total	Lab	**25700 ug/l**	**28800 ug/l**	**28500 ug/l**	**29200 ug/l**	**22600 ug/l**	**5400 ug/l**	**9800 ug/l**	**20300 ug/l**	**28400 ug/l**	**25200 ug/l**	**13300 ug/l**	**23300 ug/l**	**17500 ug/l**	**8160 ug/l**	--	**9960 ug/l**	--	**19600 ug/l**	--
Chromium	Total	Lab	< 1.0 ug/l	--	--	< 1.0 ug/l	--	--	--	< 1.0 ug/l	--	--	< 1.0 ug/l	--	--	< 1 ug/l	--	< 1 ug/l	--	< 1 ug/l	--
Cobalt	Dissolved	Lab	**0.21 ug/l**	**0.39 ug/l**	**0.52 ug/l**	< 0.20 ug/l	**0.26 ug/l**	< 0.20 ug/l	**0.36 ug/l**	**1.5 ug/l**	**0.21 ug/l**	**0.21 ug/l**	< 0.20 ug/l	< 0.20 ug/l	**0.49 ug/l**	**0.25 ug/l**	--	**0.34 ug/l**	--	**0.42 ug/l**	--
Cobalt	Total	Lab	**0.22 ug/l**	**0.94 ug/l**	**0.56 ug/l**	< 0.20 ug/l	**0.28 ug/l**	< 0.20 ug/l	**0.44 ug/l**	**1.7 ug/l**	**0.25 ug/l**	**0.24 ug/l**	< 0.20 ug/l	< 0.20 ug/l	**0.48 ug/l**	**0.33 ug/l**	--	**0.45 ug/l**	--	**0.55 ug/l**	--
Copper	Dissolved	Lab	**1.3 ug/l**	**0.65 ug/l**	**0.63 ug/l**	**0.98 ug/l**	**0.82 ug/l**	**1.8 ug/l**	**1.7 ug/l**	**1.1 ug/l**	**1.1 ug/l**	**0.78 ug/l**	**1.3 ug/l**	**1.1 ug/l**	**1.0 ug/l**	**1.62 ug/l**	--	**1.66 ug/l**	--	**1.16 ug/l**	--
Copper	Total	Lab	**1.1 ug/l**	**1.9 ug/l**	**0.74 ug/l**	**1.2 ug/l**	**0.89 ug/l**	**1.9 ug/l**	**1.9 ug/l**	**1.3 ug/l**	**0.83 ug/l**	**0.82 ug/l**	**1.2 ug/l**	**9.1 ug/l**	**1.1 ug/l**	**1.81 ug/l**	--	**1.99 ug/l**	--	**1.22 ug/l**	--
Iron	Dissolved	Lab	**764 ug/l**	**902 ug/l**	**851 ug/l**	**593 ug/l**	**838 ug/l**	**715 ug/l**	**848 ug/l**	**5180 ug/l**	**927 ug/l**	**1630 ug/l**	**1150 ug/l**	**894 ug/l**	**2010 ug/l**	--	--	--	--	--	--
Iron	Total	Lab	**1150 ug/l**	**3710 ug/l**	**2090 ug/l**	**1610 ug/l**	**1250 ug/l**	**862 ug/l**	**1260 ug/l**	**6820 ug/l**	**1260 ug/l**	**2240 ug/l**	**1460 ug/l**	**967 ug/l**	**2450 ug/l**	**1180 ug/l**	--	**1940 ug/l**	--	**3450 ug/l**	--
Lead	Total	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	**0.19 j ug/l**	--	**0.25 j ug/l**	--	**0.25 j ug/l**	--
Magnesium	Total	Lab	**12800 ug/l**	**13300 ug/l**	**12300 ug/l**	**11900 ug/l**	**11600 ug/l**	**3400 ug/l**	**5800 ug/l**	**10100 ug/l**	**13500 ug/l**	**12200 ug/l**	**7200 ug/l**	**11700 ug/l**	**9100 ug/l**	**4520 ug/l**	--	**5220 ug/l**	--	**10100 ug/l**	--
Manganese	Dissolved	Lab	**147 ug/l**	**274 ug/l**	**283 ug/l**	**131 ug/l**	**151 ug/l**	**26.6 ug/l**	**80.5 ug/l**	**409 ug/l**	**90.5 ug/l**	**142 ug/l**	**47.3 ug/l**	**91.0 ug/l**	**171 ug/l**	--	--	--	--	--	--
Manganese	Total	Lab	**153 ug/l**	**428 ug/l**	**293 ug/l**	**135 ug/l**	**153 ug/l**	**30.5 ug/l**	**92.3 ug/l**	**445 ug/l**	**101 ug/l**	**157 ug/l**	**48.6 ug/l**	**71.2 ug/l**	**169 ug/l**	**117 ug/l**	--	**142 ug/l**	--	**283 ug/l**	--
Mercury	Total	Lab	**0.00091 ug/l**	--	--	**0.0010 ug/l**	--	--	--	**0.0078 ug/l**	--	--	**0.0037 ug/l**	--	--	**0.0058 ug/l**	**0.0058 ug/l**	**0.0058 ug/l**	**0.0058 ug/l**	**0.0032 ug/l**	**0.0025 ug/l**
Methyl Mercury	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.00049 ug/l**	**0.00053 ug/l**	**0.00067 ug/l**	**0.00062 ug/l**	**0.00044 ug/l**	--
Molybdenum	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Total	Lab	**1.2 ug/l**	--	--	**1.1 ug/l**	--	--	--	**1.4 ug/l**	--	--	**0.59 ug/l**	--	--	**0.38 ug/l**	--	**0.34 ug/l**	--	**1.06 ug/l**	--
Nickel	Dissolved	Lab	< 0.50 ug/l	**0.58 ug/l**	< 0.50 ug/l	**0.73 ug/l**	< 0.50 ug/l	**1.3 ug/l**	**1.5 ug/l**	**2.6 ug/l**	< 0.50 ug/l	< 0.50 ug/l	**1.1 ug/l**	< 0.50 ug/l	**1.4 ug/l**	**1.88 ug/l**	--	**2.34 ug/l**	--	**2.07 ug/l**	--
Nickel	Total	Lab	**0.62 ug/l**	**1.4 ug/l**	**0.61 ug/l**	**0.78 ug/l**	**1.0 ug/l**	**1.2 ug/l**	**1.7 ug/l**	**2.8 ug/l**	< 0.50 ug/l	< 0.50 ug/l	**0.87 ug/l**	**0.76 ug/l**	**1.2 ug/l**	**2.15 ug/l**	--	**2.71 ug/l**	--	**2.41 ug/l**	--
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total, as P	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	**2700 ug/l**	--	--	**3200 ug/l**	--	--	--	**1800 ug/l**	--	--	**1800 ug/l**	--	--	**690 ug/l**	--	**730 ug/l**	--	**1860 ug/l**	--
Selenium	Total	Lab	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 0.2 ug/l	--	**0.23 j ug/l**	--	**0.27 j ug/l**	--
Silver	Total	Lab	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	< 0.2 ug/l	--	< 0.2 ug/l	--	< 0.2 ug/l	--
Sodium	Total	Lab	**8700 ug/l**	--	--	**5600 ug/l**	--	--	--	**9400 ug/l**	--	--	**5900 ug/l**	--	--	**2700 ug/l**	--	**3060 ug/l**	--	**10000 ug/l**	--
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	**40.8 ug/l**	--	**48.5 ug/l**	--	**114 ug/l**	--
Thallium	Total	Lab	< 0.0004 ug/l	< 0.005 ug/l	< 0.002 ug/l	**0.008 j ug/l**	**0.002 j ug/l**	**0.0054 j ug/l**	--	**0.005 j ug/l**	< 0.005 ug/l	**0.018 j ug/l**	**0.042 ug/l**	< 0.005 ug/l	**0.002 j ug/l**	**0.02 ug/l**	--	< 0.02 ug/l	**0.023 ug/l**	< 0.005 ug/l	< 0.005 ug/l
Tin	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.5 ug/l	--	< 0.5 ug/l	--	< 0.5 ug/l	--
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Total	Lab	< 3.0 ug/l	--	--	< 3.0 ug/l	--	--	--	< 3.0 ug/l	--	--	< 3.0 ug/l	--	--	--	--	--	--	--	--
Zinc	Dissolved	Lab	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	**16.3 ug/l**	< 6.0 ug/l	**7.1 ug/l**	**7.2 ug/l**	**6.3 ug/l**	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6 ug/l	--	< 6 ug/l	--	< 6 ug/l	--
Zinc	Total	Lab	**10.8 ug/l**	**8.3 ug/l**	< 6.0 ug/l	**19.7 ug/l**	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	**7.5 ug/l**	< 6.0 ug/l	< 6 ug/l	--	< 6 ug/l	--	< 6 ug/l	--

1 - Some monitoring locations are listed by multiple names. Equivalent locations include the following: PM-1 = SW003, PM-2 = SW002, PM-3 = SW003, PM-4 = SW005, PM16 = SW004

Large Table 11
Surface Water Data Summary
Partridge River Watershed and Wyman Creek

		Location	SW004b	SW004b		SW004b		SW004b	SW004b	SW004b	SW004b	SW004b	SW004b	SW004b	SW004b	SW004b	SW004b	SW004b	SW004b	SW004b	SW004b	
		Date	8/10/2010	9/22/2010		6/28/2012		7/31/2012	8/29/2012	9/26/2012	10/31/2012	11/29/2012	12/20/2012	1/30/2013	2/27/2013	3/27/2013	4/25/2013	5/10/2013	6/17/2013	6/18/2013	7/24/2013	
		Sample Type	N	N	FD	N	FD	N	N	N	N	N	N	N	N	N	N	N	N	N	N	FD
Parameter	Total or Dissolved	Analysis Location																				
General Parameters																						
Alkalinity, bicarbonate, as CaCO3	NA	Lab	**79.8 mg/l**	**63.3 mg/l**	--	**29.8 mg/l**	--	--	--	**91.1 mg/l**	--	--	**74.0 mg/l**	--	--	**104 mg/l**	--	--	--	--	**58.2 mg/l**	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total, as CaCO3	NA	Lab	**79.8 mg/l**	**63.3 mg/l**	--	**29.8 mg/l**	--	--	--	**91.1 mg/l**	--	--	**74.0 mg/l**	--	--	**104 mg/l**	--	--	--	--	**58.2 mg/l**	--
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, total organic	NA	Lab	**24.2 mg/l**	**27.3 mg/l**	--	**66.2 mg/l**	--	**39.1 mg/l**	**19.1 mg/l**	**7.5 mg/l**	**13.9 mg/l**	**13.1 mg/l**	**11.9 mg/l**	**12.3 mg/l**	**8.2 mg/l**	**6.4 mg/l**	**13.3 mg/l**	**23.4 mg/l**	--	**24.8 mg/l**	**36.9 mg/l**	--
Chemical Oxygen Demand	NA	Lab	**71.4 mg/l**	**72.2 mg/l**	--	**172 mg/l**	--	--	--	**20.7 mg/l**	--	--	**34.2 mg/l**	--	--	**23.3 mg/l**	--	--	--	--	**126 mg/l**	--
Chloride	NA	Lab	**17.4 mg/l**	**12.1 mg/l**	--	**2.6 mg/l**	--	**4.1 mg/l**	**5.8 mg/l**	**6.6 mg/l**	**7.3 mg/l**	**7.9 mg/l**	**5.8 mg/l**	**6.1 mg/l**	**3.7 mg/l**	**2.9 mg/l**	**2.9 mg/l**	**1.6 mg/l**	--	**4.6 mg/l**	**5.5 mg/l**	--
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	**5.60 mg/l**	**7.26 mg/l**	--	**5.04 mg/l**	--	**5.85 mg/l**	**6.75 mg/l**	**9.74 mg/l**	**11.48 mg/l**	**11.25 mg/l**	**9.57 mg/l**	**11.98 mg/l**	**13.67 mg/l**	**10.82 mg/l**	**13.26 mg/l**	**8.58 mg/l**	--	**8.25 mg/l**	--	--
Fluoride	NA	Lab	**0.15 mg/l**	**0.11 mg/l**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hardness, as CaCO3	NA	Lab	**103 mg/l**	**83.1 mg/l**	--	**51.2 mg/l**	--	**73.4 mg/l**	**98.3 mg/l**	**112 mg/l**	**88.2 mg/l**	**82.1 mg/l**	**89.6 mg/l**	**127 mg/l**	**111 mg/l**	**106 mg/l**	**43.4 mg/l**	**24.0 mg/l**	--	**49.4 mg/l**	**83.4 mg/l**	--
Nitrate + Nitrite, as N	NA	Lab	< 0.1 mg/l	< 0.1 mg/l	--	< 0.10 mg/l	--	--	--	< 0.10 mg/l	--	--	**0.48 mg/l**	--	--	**0.31 mg/l**	--	--	--	--	**0.12 mg/l**	--
Nitrogen, ammonia as N	NA	Lab	< 0.05 mg/l	**0.1 mg/l**	--	**0.13 mg/l**	--	--	--	< 0.10 mg/l	--	--	**0.10 mg/l**	--	--	**0.20 mg/l**	--	--	--	--	**0.32 mg/l**	--
pH	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	**7.37 pH units**	**7.23 pH units**	--	**6.82 pH units**	--	**6.83 pH units**	**7.83 pH units**	**7.78 pH units**	**7.29 pH units**	**7.54 pH units**	**6.67 pH units**	**7.62 pH units**	**7.22 pH units**	**7.05 pH units**	**7.69 pH units**	**6.2 pH units**	--	**6.7 pH units**	--	--
Phosphorus, total, as P	NA	Lab	**0.022 mg P/L**	**0.016 mg P/L**	--	**0.047 mg/l**	--	--	--	< 0.0040 mg/l	--	--	**0.019 mg/l**	--	--	**0.013 mg/l**	--	--	--	--	**0.040 mg/l**	--
Redox (oxidation potential)	NA	Field	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**441 mV**	--	--	--	--
Solids, total dissolved	NA	Lab	**190 mg/l**	**155 mg/l**	--	**185 mg/l**	--	**166 mg/l**	**154 mg/l**	**148 mg/l**	**155 mg/l**	**159 mg/l**	**205 mg/l**	**172 mg/l**	**136 mg/l**	**217 mg/l**	**91.0 mg/l**	**74.0 mg/l**	--	**128 mg/l**	**195 mg/l**	--
Solids, total suspended	NA	Lab	**1.2 mg/l**	**1.2 mg/l**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Specific Conductance @ 25 °C	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Specific Conductance @ 25 °C	NA	Field	**263 umhos/cm**	**204 umhos/cm**	--	**46.1 umhos/cm**	--	**93.3 umhos/cm**	**171.5 umhos/cm**	**125.5 umhos/cm**	**188.1 umhos/cm**	**82.7 umhos/cm**	**74.3 umhos/cm**	**255.3 umhos/cm**	**227.1 umhos/cm**	**326.5 umhos/cm**	**88.3 umhos/cm**	**39.9 umhos/cm**	--	**99.3 umhos/cm**	--	--
Sulfate, as SO4	NA	Lab	**14.8 mg/l**	**14.4 mg/l**	--	**5.1 mg/l**	--	**6.1 mg/l**	**10.9 mg/l**	**15.8 mg/l**	**16.5 mg/l**	**19.6 mg/l**	**18.5 mg/l**	**16.7 mg/l**	**14.2 mg/l**	**12.1 mg/l**	**5.4 mg/l**	**5.6 mg/l**	--	**9.1 mg/l**	**9.3 mg/l**	--
Temperature, °C	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Temperature, °C	NA	Field	**24.2 deg C**	**12.53 deg C**	--	**21.02 deg C**	--	**22.16 deg C**	**20.81 deg C**	**9.24 deg C**	**1.93 deg C**	**0.92 deg C**	**2.88 deg C**	**2.65 deg C**	**3.62 deg C**	**5.6 deg C**	**6.17 deg C**	**7.21 deg C**	--	**17.4 deg C**	--	--
Turbidity	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Turbidity	NA	Field	**1.0 NTU**	**0.1 NTU**	--	**4.1 NTU**	--	**45.1 NTU**	**11 NTU**	**0 NTU**	**3 NTU**	**0.1 NTU**	**0 NTU**	**5.3 NTU**	**13.5 NTU**	**18.6 NTU**	**1.3 NTU**	**0 NTU**	--	**6.3 NTU**	--	--
Metals																						
Aluminum	Dissolved	Lab	--	**51.1 ug/l**	--	**328 ug/l**	--	**161 ug/l**	**48.0 ug/l**	**24.2 ug/l**	< 40.0 ug/l	**44.6 ug/l**	**45.3 ug/l**	**39.8 ug/l**	< 40.0 ug/l	**22.0 ug/l**	**37.2 ug/l**	**139 ug/l**	--	**120 ug/l**	**183 ug/l**	--
Aluminum	Total	Lab	**64.8 ug/l**	**75.9 ug/l**	--	**442 ug/l**	--	**228 ug/l**	**95.6 ug/l**	**40.6 ug/l**	**66.3 ug/l**	**83.3 ug/l**	**75.2 ug/l**	**80.8 ug/l**	**48.3 ug/l**	**39.4 ug/l**	**78.2 ug/l**	**176 ug/l**	--	**166 ug/l**	**222 ug/l**	--
Antimony	Total	Lab	--	--	--	< 0.50 ug/l	--	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--		< 0.50 ug/l	--
Arsenic	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.77 ug/l**	**2.0 ug/l**	--
Arsenic	Total	Lab	**1.19 ug/l**	**0.95 ug/l**	**0.96 ug/l**	**2.3 ug/l**	--	**1.9 ug/l**	**1.3 ug/l**	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	**0.51 ug/l**	**0.75 ug/l**	**0.54 ug/l**	< 0.82 ug/l	< 0.50 ug/l	**0.70 ug/l**	--	**0.65 ug/l**	**3.2 ug/l**	--
Barium	Total	Lab	**12.6 ug/l**	**9.31 ug/l**	--	**14.6 ug/l**	--	--	--	< 10.0 ug/l	--	--	< 10.0 ug/l	--	--	< 10.0 ug/l	--	--	--	--	**13.9 ug/l**	--
Beryllium	Total	Lab	< 0.2 ug/l	< 0.2 ug/l	--	< 0.20 ug/l	--	--	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	--	--	< 0.20 ug/l	--
Boron	Total	Lab	**160 ug/l**	**100 ug/l**	--	< 50.0 ug/l	--	--	--	**144 ug/l**	--	--	**79.4 ug/l**	--	--	**57.2 ug/l**	--	--	--	--	**96.7 ug/l**	--
Cadmium	Total	Lab	< 0.02 ug/l	< 0.02 ug/l	--	< 0.20 ug/l	--	--	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	--	--	< 0.20 ug/l	--
Calcium	Total	Lab	**22700 ug/l**	**17500 ug/l**	--	**10600 ug/l**	--	**15300 ug/l**	**21400 ug/l**	**24800 ug/l**	**18900 ug/l**	**16500 ug/l**	**18700 ug/l**	**27300 ug/l**	**24800 ug/l**	**24000 ug/l**	**8900 ug/l**	**4600 ug/l**	--	**10100 ug/l**	**17300 ug/l**	--
Chromium	Total	Lab	< 1 ug/l	< 1 ug/l	--	< 1.0 ug/l	--	--	--	< 1.0 ug/l	--	--	< 1.0 ug/l	--	--	< 1.0 ug/l	--	--	--	--	**1.2 ug/l**	--
Cobalt	Dissolved	Lab	--	< 0.2 ug/l	--	**1.9 ug/l**	--	**0.73 ug/l**	**0.36 ug/l**	< 0.20 ug/l	< 0.20 ug/l	< 0.20 ug/l	**0.22 ug/l**	**0.28 ug/l**	**0.24 ug/l**	< 0.20 ug/l	**0.41 ug/l**	< 0.20 ug/l	--	**0.34 ug/l**	**1.0 ug/l**	--
Cobalt	Total	Lab	**0.31 ug/l**	**0.22 ug/l**	--	**2.1 ug/l**	--	**0.83 ug/l**	**0.47 ug/l**	**0.23 ug/l**	< 0.20 ug/l	**0.23 ug/l**	**0.23 ug/l**	**0.29 ug/l**	**0.25 ug/l**	**0.21 ug/l**	**0.41 ug/l**	**0.26 ug/l**	--	**0.34 ug/l**	**1.2 ug/l**	--
Copper	Dissolved	Lab	--	**1.03 ug/l**	--	**3.4 ug/l**	--	**1.4 ug/l**	**0.88 ug/l**	**0.54 ug/l**	**0.73 ug/l**	**1.6 ug/l**	**1.1 ug/l**	**1.6 ug/l**	**0.75 ug/l**	**7.0 ug/l**	**1.6 ug/l**	**1.7 ug/l**	--	**1.9 ug/l**	**1.2 ug/l**	--
Copper	Total	Lab	**1.42 ug/l**	**1.02 ug/l**	--	**2.8 ug/l**	--	**1.5 ug/l**	**0.92 ug/l**	**0.55 ug/l**	**0.82 ug/l**	**1.2 ug/l**	**0.93 ug/l**	**1.7 ug/l**	**1.0 ug/l**	**1.5 ug/l**	**1.9 ug/l**	**2.8 ug/l**	--	**1.8 ug/l**	**1.4 ug/l**	--
Iron	Dissolved	Lab	--	--	--	**3280 ug/l**	--	**3990 ug/l**	**1870 ug/l**	**849 ug/l**	**991 ug/l**	**964 ug/l**	**1110 ug/l**	**1510 ug/l**	**1250 ug/l**	**1030 ug/l**	**603 ug/l**	**700 ug/l**	--	**870 ug/l**	**4190 ug/l**	--
Iron	Total	Lab	**1490 ug/l**	**1660 ug/l**	--	**5030 ug/l**	--	**4780 ug/l**	**2210 ug/l**	**1040 ug/l**	**1280 ug/l**	**1270 ug/l**	**1570 ug/l**	**2640 ug/l**	**2390 ug/l**	**1990 ug/l**	**1230 ug/l**	**6580 ug/l**	--	**1250 ug/l**	**5190 ug/l**	--
Lead	Total	Lab	**0.13 b ug/l**	**0.20 j ug/l**	--	**0.51 ug/l**	--	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	**0.50 ug/l**	--
Magnesium	Total	Lab	**11200 ug/l**	**8560 ug/l**	--	**6000 ug/l**	--	**8600 ug/l**	**10900 ug/l**	**12200 ug/l**	**9900 ug/l**	**9900 ug/l**	**10400 ug/l**	**14300 ug/l**	**12000 ug/l**	**11200 ug/l**	**5100 ug/l**	**3000 ug/l**	--	**5900 ug/l**	**9700 ug/l**	--
Manganese	Dissolved	Lab	--	--	--	**512 ug/l**	--	**174 ug/l**	**158 ug/l**	**75.2 ug/l**	**41.4 ug/l**	**68.0 ug/l**	**122 ug/l**	**165 ug/l**	**171 ug/l**	**96.8 ug/l**	**256 ug/l**	**18.6 ug/l**	--	**67.0 ug/l**	**248 ug/l**	--
Manganese	Total	Lab	**149 ug/l**	**72.9 ug/l**		**544 ug/l**		**194 ug/l**	**177 ug/l**	**85.6 ug/l**	**46.8 ug/l**	**72.5 ug/l**	**123 ug/l**	**164 ug/l**	**177 ug/l**	**99.9 ug/l**	**233 ug/l**	**48.6 ug/l**	--	**77.3 ug/l**	**277 ug/l**	--
Mercury	Total	Lab	**0.0032 ug/l**	**0.0039 ug/l**	**0.0037 ug/l**	**0.0185 ug/l**	**0.0183 ug/l**	--	--	**0.0014 ug/l**	--	--	**0.0021 ug/l**	--	--	**0.00082 ug/l**	--	--	--	--	**0.0083 ug/l**	**0.0085 ug/l**
Methyl Mercury	Total	Lab	**0.00065 ug/l**	**0.00032 ug/l**	**0.00028 ug/l**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Total	Lab	**1.23 ug/l**	**0.63 ug/l**	--	**0.41 ug/l**	--	--	--	**1.5 ug/l**	--	--	**0.67 ug/l**	--	--	**0.67 ug/l**	--	--	--	--	**1.1 ug/l**	--
Nickel	Dissolved	Lab	--	**1.44 ug/l**	--	**4.2 ug/l**	--	**3.0 ug/l**	**0.90 ug/l**	**0.59 ug/l**	**0.54 ug/l**	**0.89 ug/l**	**0.68 ug/l**	**0.95 ug/l**	**0.55 ug/l**	**0.83 ug/l**	**1.0 ug/l**	**1.6 ug/l**	--	**1.7 ug/l**	**2.7 ug/l**	--
Nickel	Total	Lab	**1.9 ug/l**	**1.56 ug/l**	--	**4.4 ug/l**	--	**2.9 ug/l**	**1.4 ug/l**	**0.56 ug/l**	**0.57 ug/l**	**0.96 ug/l**	**0.66 ug/l**	**0.83 ug/l**	**0.91 ug/l**	**0.79 ug/l**	**1.2 ug/l**	**1.8 ug/l**	--	**1.9 ug/l**	**2.9 ug/l**	--
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total, as P	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	**3120 ug/l**	**2090 ug/l**	--	**780 ug/l**	--	--	--	**3100 ug/l**	--	--	**1900 ug/l**	--	--	**2300 ug/l**	--	--	--	--	**1400 ug/l**	--
Selenium	Total	Lab	**0.37 j ug/l**	**0.32 j ug/l**	--	< 1.0 ug/l	--	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	< 1.0 ug/l	**5.0 ug/l**	--
Silver	Total	Lab	< 0.2 ug/l	< 0.2 ug/l	--	< 0.20 ug/l	--	--	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	--	--	< 0.20 ug/l	--
Sodium	Total	Lab	**14900 ug/l**	**10800 ug/l**	--	**3400 ug/l**	--	--	--	**7700 ug/l**	--	--	**6100 ug/l**	--	--	**4600 ug/l**	--	--	--	--	**7500 ug/l**	--
Strontium	Total	Lab	**156 ug/l**	**113 ug/l**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab	**0.025 ug/l**	**0.004 j ug/l**	**0.002 j ug/l**	**0.023 ug/l**	--	**0.0022 j ug/l**	**0.017 j ug/l**	< 0.002 ug/l	**0.0020 jb ug/l**	< 0.0004 ug/l	< 0.0004 ug/l	< 0.005 ug/l	< 0.002 ug/l	**0.030 * ug/l**	**0.005 j ug/l**	**0.0031 j ug/l**	< 0.005 ug/l	< 0.005 ug/l	< 0.005 ug/l	--
Tin	Total	Lab	< 0.5 ug/l	< 0.5 ug/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Total	Lab	--	--	--	< 3.0 ug/l	--	--	--	< 3.0 ug/l	--	--	< 3.0 ug/l	--	--	< 3.0 ug/l	--	--	--	--	< 3.0 ug/l	--
Zinc	Dissolved	Lab	--	< 6 ug/l	--	**12.6 ug/l**	--	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	**6.3 ug/l**	< 6.0 ug/l	**22.3 ug/l**	< 6.0 ug/l	< 6.0 ug/l	**8.7 ug/l**	**8.9 ug/l**	--	**7.5 ug/l**	< 6.0 ug/l	--
Zinc	Total	Lab	< 6 ug/l	< 6 ug/l	--	**7.0 ug/l**	--	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	**23.6 ug/l**	< 6.0 ug/l	< 6.0 ug/l	**7.5 ug/l**	< 6.0 ug/l	--	< 6.0 ug/l	< 6.0 ug/l	--

1 - Some monitoring locations are listed by multiple names. Equivalent locations include the following: PM-1 = SW003, PM-2 = SW002, PM-3 = SW003, PM-4 = SW005, PM16 = SW004

Large Table 11
Surface Water Data Summary
Partridge River Watershed and Wyman Creek

			Location	SW004b	SW004b	SW004b	SW004b	SW004b	LN-1	LN-1		LN-1	LN-1	LN-1	LN-1	LN-1	LN-1	LN-1	LN-1	LN-1	LN-1	LN-1
			Date	8/20/2013	9/16/2013	10/29/2013	11/26/2013	12/23/2013	3/24/2011	4/25/2011		5/31/2011	6/30/2011	7/25/2011	8/22/2011	9/19/2011	10/19/2011	11/21/2011	6/27/2012	7/26/2012	8/23/2012	9/25/2012	10/30/2012
			Sample Type	N	N	N	N	N	N	N	FD	N	N	N	N	N	N	N	N	N	N	N	N
Parameter	Total or Dissolved	Analysis Location																					
General Parameters																							
Alkalinity, bicarbonate, as CaCO3	NA	Lab		--	--	31.8 mg/l	--	--	55.5 mg/l	16.2 mg/l	14.9 mg/l	22.1 mg/l	27.2 mg/l	79.6 mg/l	57.2 mg/l	46.4 mg/l	34.9 mg/l	41.2 mg/l	34.5 mg/l	--	--	56.1 mg/l	--
Alkalinity, carbonate, as CaCO3	NA	Lab		--	--	--	--	--	--	< 10 mg/l	< 10 mg/l	--	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total, as CaCO3	NA	Lab		--	--	31.8 mg/l	--	--	55.5 mg/l	--	--	22.1 mg/l	27.2 mg/l	79.6 mg/l	57.2 mg/l	46.4 mg/l	34.9 mg/l	41.2 mg/l	34.5 mg/l	--	--	56.1 mg/l	--
Biochemical Oxygen Demand (5-day)	NA	Lab		--	--	--	--	--	--	< 3 mg/l	< 3 mg/l	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab		--	--	--	--	--	--	14.0 mg/l	14.3 mg/l	--	--	--	--	--	--	--	--	--	--	--	--
Carbon, total organic	NA	Lab	11.5 mg/l	17.4 mg/l	25.4 mg/l	19.4 mg/l	16.2 mg/l	18.6 mg/l	14.7 mg/l	14.8 mg/l	19.0 mg/l	26.2 mg/l	60.1 mg/l	35.6 mg/l	26.1 mg/l	20.2 mg/l	18.9 mg/l	38.8 mg/l	35.9 mg/l	34.7 mg/l	23.6 mg/l	16.8 mg/l
Chemical Oxygen Demand	NA	Lab			87.0 mg/l			63.9 mg/l	39.6 mg/l	40.1 mg/l	60.3 mg/l	82.1 mg/l	131 mg/l	112 mg/l	71.4 mg/l	70.6 mg/l	50.5 mg/l	95.0 mg/l	--	--	64.2 mg/l	--
Chloride	NA	Lab	9.4 mg/l	4.9 mg/l	2.5 mg/l	3.1 mg/l	3.8 mg/l	2.48 mg/l	0.62 mg/l	< 0.5 mg/l	< 0.5 mg/l	< 0.5 mg/l	< 0.5 mg/l	< 0.5 mg/l	< 0.5 mg/l	0.73 mg/l	0.92 mg/l	< 0.50 mg/l	< 0.50 mg/l	0.50 mg/l	0.64 mg/l	1.0 mg/l
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Lab						--	--	--	--											
Dissolved oxygen	NA	Field	8.12 mg/l	9.27 mg/l	11.91 mg/l	12.9 mg/l	12.41 mg/l	--	7.44 mg/l	--	4.58 mg/l	2.99 mg/l	0.17 mg/l	0.41 mg/l	2.18 mg/l	9.43 mg/l	1.69 mg/l	4.41 mg/l	2.68 mg/l	4.47 mg/l	5.08 mg/l	10.64 mg/l
Fluoride	NA	Lab	--	--	--	--	--	< 0.1 mg/l	--	--	< 0.1 mg/l	--	< 0.1 mg/l	--	< 0.1 mg/l	--	< 0.1 mg/l	--	--	--	--	--
Hardness, as CaCO3	NA	Lab	111 mg/l	92.6 mg/l	43.4 mg/l	66.9 mg/l	78.6 mg/l	54 mg/l	--	--	28.8 mg/l	35.7 mg/l	84.2 mg/l	65.4 mg/l	50.9 mg/l	38.8 mg/l	41.8 mg/l	45.2 mg/l	74.6 mg/l	72.2 mg/l	62.3 mg/l	37.3 mg/l
Nitrate + Nitrite, as N	NA	Lab	--	--	0.14 mg/l	--	--	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.10 mg/l	--	--	< 0.10 mg/l	--
Nitrogen, ammonia as N	NA	Lab	--	--	--	--	--	0.94 mg/l	--	--	< 0.1 mg/l	0.21 mg/l	0.64 mg/l	0.32 mg/l	0.29 mg/l	< 0.1 mg/l	0.25 mg/l	< 0.10 mg/l	--	--	< 0.10 mg/l	--
pH	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	7.93 pH units	7.69 pH units	6.58 pH units	7.42 pH units	7.07 pH units	--	6.64 pH units	--	6.56 pH units	6.43 pH units	6.82 pH units	6.55 pH units	6.57 pH units	7.39 pH units	6.08 pH units	7.19 pH units	6.89 pH units	7.34 pH units	7.45 pH units	6.87 pH units
Phosphorus, total, as P	NA	Lab			0.024 mg/l			< 0.1 mg P/L	--	--	0.018 mg P/L	0.022 mg P/L	0.092 mg P/L	0.075 mg P/L	0.04 mg P/L	0.023 mg P/L	0.032 mg P/L	0.029 mg/l	--	--	0.023 mg/l	--
Redox (oxidation potential)	NA	Field	--	--	--	--	--	--	486 mV	--	--	--	--	--	--	--	--	--	--	--	--	--
Solids, total dissolved	NA	Lab	182 mg/l	157 mg/l	130 mg/l	157 mg/l	140 mg/l	104 mg/l	68 mg/l	68 mg/l	69.0 mg/l	109 mg/l	192 mg/l	172 mg/l	109 mg/l	113 mg/l	109 mg/l	105 mg/l	171 mg/l	177 mg/l	109 mg/l	92.0 mg/l
Solids, total suspended	NA	Lab	--	--	--	--	--	10.5 mg/l	--	--	< 1 mg/l	--	38 mg/l	--	6 mg/l	--	3.2 mg/l	--	--	--	--	--
Specific Conductance @ 25 °C	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Specific Conductance @ 25 °C	NA	Field	282.1 umhos/cm	191.1 umhos/cm	72.1 umhos/cm	146.4 umhos/cm	177.2 umhos/cm	--	21.4 umhos/cm	--	33.0 umhos/cm	45.0 umhos/cm	189.0 umhos/cm	107 umhos/cm	85.0 umhos/cm	82 umhos/cm	80.0 umhos/cm	30.5 umhos/cm	0 umhos/cm	87.6 umhos/cm	0 umhos/cm	66.1 umhos/cm
Sulfate, as SO4	NA	Lab	25.1 mg/l	8.0 mg/l	4.2 mg/l	12.0 mg/l	8.8 mg/l	1.23 mg/l	2.32 mg/l	2.09 mg/l	< 1 mg/l	< 1 mg/l	< 1 mg/l	< 1 mg/l	< 1 mg/l	< 1 mg/l	1.1 mg/l	< 1.0 mg/l	< 1.0 mg/l	< 1.0 mg/l	< 1.0 mg/l	1.5 mg/l
Temperature, °C	NA	Lab						--		--												
Temperature, °C	NA	Field	23.96 deg C	11.37 deg C	4.04 deg C	2.64 deg C	6.99 deg C	--	4.99 deg C	--	13.86 deg C	16.60 deg C	20.10 deg C	19.54 deg C	12.63 deg C	5.98 deg C	2.19 deg C	21.96 deg C	19.08 deg C	16.91 deg C	6.25 deg C	4.48 deg C
Turbidity	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Turbidity	NA	Field	3 NTU	4.2 NTU	2.4 NTU	4.1 NTU	2.4 NTU	--	0 NTU	--	0 NTU	0.90 NTU	6.00 NTU	4.8 NTU	10.30 NTU	17.1 NTU	5.50 NTU	2.9 NTU	15.7 NTU	35.7 NTU	17.3 NTU	2.5 NTU
Metals																						
Aluminum	Dissolved	Lab	47.4 ug/l	66.5 ug/l	145 ug/l	113 ug/l	82.6 ug/l	42.7 ug/l	--	--	42.8 ug/l	68.6 ug/l	43.6 ug/l	29.4 b ug/l	< 25 ug/l	< 25 ug/l	< 25 ug/l	103 ug/l	86.3 ug/l	51.1 ug/l	27.2 ug/l	< 40.0 ug/l
Aluminum	Total	Lab	71.6 ug/l	92.2 ug/l	164 ug/l	118 ug/l	93.5 ug/l	71.5 ug/l	--	--	56.5 ug/l	68.8 ug/l	87.2 ug/l	54.1 ug/l	36 ug/l	28.5 ug/l	33.8 ug/l	121 ug/l	107 ug/l	125 ug/l	72.2 ug/l	< 40.0 ug/l
Antimony	Total	Lab			< 0.50 ug/l			--	--	--	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Arsenic	Dissolved	Lab	0.92 ug/l	1.1 ug/l	0.70 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.5 ug/l	< 0.5 ug/l	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	Total	Lab	0.93 ug/l	1.1 ug/l	1.1 ug/l	< 0.50 ug/l	0.53 ug/l	0.88 ug/l	< 0.5 ug/l	< 0.5 ug/l	0.75 ug/l	1.06 ug/l	3.57 ug/l	3.7 ug/l	2.16 ug/l	0.93 ug/l	0.69 ug/l	1.5 ug/l	2.3 ug/l	1.9 ug/l	0.94 ug/l	0.56 ug/l
Barium	Total	Lab	--	--	< 10.0 ug/l	--	--	11.4 ug/l	--	--	5.18 ug/l	--	30.6 ug/l	--	10.6 ug/l	--	6.83 ug/l	< 10.0 ug/l	--	--	< 10.0 ug/l	--
Beryllium	Total	Lab	--	--	< 0.20 ug/l	--	--	< 0.2 ug/l	--	--	< 0.2 ug/l	--	< 0.2 ug/l	--	< 0.2 ug/l	--	< 0.2 ug/l	< 0.20 ug/l	--	--	< 0.20 ug/l	--
Boron	Total	Lab	--	--	< 50.0 ug/l	--	--	< 50 ug/l	--	--	< 50 ug/l	--	< 50 ug/l	--	< 50 ug/l	--	< 50 ug/l	< 50.0 ug/l	--	--	< 50.0 ug/l	--
Cadmium	Total	Lab	--	--	< 0.20 ug/l	--	--	< 0.2 ug/l	--	--	0.03 j ug/l	--	0.04 j ug/l	--	< 0.03 ug/l	--	< 0.03 ug/l	< 0.20 ug/l	--	--	< 0.20 ug/l	--
Calcium	Total	Lab	24600 ug/l	20100 ug/l	8600 ug/l	13900 ug/l	16900 ug/l	12400 ug/l	4550 ug/l	4190 ug/l	6720 ug/l	8320 ug/l	19700 ug/l	16100 ug/l	11800 ug/l	8910 ug/l	9590 ug/l	10300 ug/l	17800 ug/l	17000 ug/l	14400 ug/l	8600 ug/l
Chromium	Total	Lab	--	--	< 1.0 ug/l	--	--	< 1 ug/l	--	--	< 1 ug/l	--	< 1 ug/l	--	< 1 ug/l	--	< 1 ug/l	< 1.0 ug/l	--	--	< 1.0 ug/l	--
Cobalt	Dissolved	Lab	0.26 ug/l	0.35 ug/l	< 0.20 ug/l	0.22 ug/l	0.26 ug/l	0.55 ug/l	--	--	< 0.2 ug/l	< 0.2 ug/l	3.07 ug/l	0.95 ug/l	0.62 ug/l	< 0.2 ug/l	0.31 ug/l	0.38 ug/l	1.1 ug/l	0.84 ug/l	0.22 ug/l	< 0.20 ug/l
Cobalt	Total	Lab	0.26 ug/l	0.43 ug/l	0.22 ug/l	0.20 ug/l	0.24 ug/l	0.73 ug/l	--	--	< 0.2 ug/l	< 0.2 ug/l	3.67 ug/l	1.1 ug/l	0.59 ug/l	< 0.2 ug/l	0.32 ug/l	0.38 ug/l	1.2 ug/l	1.1 ug/l	0.30 ug/l	< 0.20 ug/l
Copper	Dissolved	Lab	1.4 ug/l	0.82 ug/l	2.0 ug/l	1.9 ug/l	1.9 ug/l	7.61 ug/l	--	--	0.41 j ug/l	0.58 j ug/l	0.34 j ug/l	0.56 b ug/l	0.26 j ug/l	0.29 jb ug/l	0.23 b ug/l	0.66 b ug/l	< 0.50 ug/l	0.68 ug/l	1.5 ug/l	< 0.50 ug/l
Copper	Total	Lab	1.2 ug/l	1.0 ug/l	1.9 ug/l	1.6 ug/l	1.0 ug/l	< 0.7 ug/l	--	--	0.9 ug/l	0.60 j ug/l	0.91 ug/l	0.38 b ug/l	0.46 j ug/l	0.45 jb ug/l	0.29 b ug/l	0.65 b ug/l	< 0.50 ug/l	0.89 ug/l	< 0.50 ug/l	< 0.50 ug/l
Iron	Dissolved	Lab	1150 ug/l	2450 ug/l	1190 ug/l	1200 ug/l	1980 ug/l	2670 ug/l	413 ug/l	416 ug/l	536 ug/l	1880 ug/l	9180 ug/l	5150 ug/l	3770 ug/l	1400 ug/l	1880 ug/l	1480 ug/l	4030 ug/l	3430 ug/l	2060 ug/l	1020 ug/l
Iron	Total	Lab	1320 ug/l	2740 ug/l	1560 ug/l	1410 ug/l	2450 ug/l	6350 ug/l	548 ug/l	531 ug/l	927 ug/l	2250 ug/l	15700 ug/l	11300 ug/l	6250 ug/l	2360 ug/l	3270 ug/l	2370 ug/l	6280 ug/l	6080 ug/l	3700 ug/l	1530 ug/l
Lead	Total	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.5 ug/l	--	--	0.12 j ug/l	--	0.33 j ug/l	--	0.19 j ug/l	--	0.09 j ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l
Magnesium	Total	Lab	12100 ug/l	10300 ug/l	5300 ug/l	7800 ug/l	8800 ug/l	5600 ug/l	2240 ug/l	2130 ug/l	2930 ug/l	3620 ug/l	8510 ug/l	6110 ug/l	3200 ug/l	4010 ug/l	4350 ug/l	4800 ug/l	7300 ug/l	7200 ug/l	6400 ug/l	3800 ug/l
Manganese	Dissolved	Lab	85.9 ug/l	158 ug/l	40.5 ug/l	66.3 ug/l	111 ug/l	683 ug/l	20.4 ug/l	20.5 ug/l	--	--	--	--	--	--	193 ug/l	1260 ug/l	1230 ug/l	174 ug/l	88.7 ug/l	
Manganese	Total	Lab	90.4 ug/l	172 ug/l	44.3 ug/l	61.2 ug/l	103 ug/l	851 ug/l	23.3 ug/l	22.6 ug/l	32.9 ug/l	68.5 ug/l	4920 ug/l	1110 ug/l	612 ug/l	57.6 ug/l	389 ug/l	199 ug/l	1320 ug/l	1550 ug/l	223 ug/l	92.0 ug/l
Mercury	Total	Lab			0.0067 ug/l			0.0032 ug/l			0.0046 ug/l	0.0051 ug/l	0.0048 ug/l	0.0027 ug/l	0.0017 ug/l	0.0022 ug/l	0.0015 ug/l	0.0062 ug/l	--	--	0.0012 ug/l	--
Methyl Mercury	Total	Lab	--	--	--	--	--	--	--	--	0.00019 ug/l	--	0.00023 ug/l	--	< 0.0001 ug/l	--	< 0.0001 ug/l	--	--	--	--	--
Molybdenum	Dissolved	Lab	--	--	--	--	--	--	< 0.2 ug/l	< 0.2 ug/l	--	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Total	Lab	--	--	0.30 ug/l	--	--	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	0.6 ug/l	0.31 j ug/l	0.21 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.20 ug/l	--	--	< 0.20 ug/l	--
Nickel	Dissolved	Lab	0.62 ug/l	0.80 ug/l	1.6 ug/l	1.2 ug/l	1.1 ug/l	0.74 ug/l	--	--	< 0.6 ug/l	0.78 ug/l	1.48 ug/l	0.91 ug/l	< 0.6 ug/l	< 0.6 ug/l	< 0.6 ug/l	0.87 ug/l	0.96 ug/l	0.82 ug/l	< 0.50 ug/l	< 0.50 ug/l
Nickel	Total	Lab	0.69 ug/l	0.99 ug/l	1.6 ug/l	1.2 ug/l	0.89 ug/l	< 0.6 ug/l	--	--	0.6 ug/l	0.78 ug/l	2.09 ug/l	1.2 ug/l	< 0.6 ug/l	< 0.6 ug/l	< 0.6 ug/l	0.96 ug/l	0.95 ug/l	1.0 ug/l	0.55 ug/l	< 0.50 ug/l
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total, as P	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	--	--	930 ug/l	--	--	1500 ug/l	800 ug/l	750 ug/l	530 ug/l	330 ug/l	870 ug/l	376 ug/l	340 ug/l	640 ug/l	540 ug/l	480 ug/l	--	--	480 ug/l	--
Selenium	Total	Lab	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1 ug/l	--	--	< 0.2 ug/l	--	0.27 j ug/l	--	< 0.2 ug/l	--	< 0.2 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l
Silver	Total	Lab	--	--	< 0.20 ug/l	--	--	< 0.2 ug/l	--	--	< 0.2 ug/l	--	< 0.2 ug/l	--	< 0.2 ug/l	--	< 0.2 ug/l	< 0.20 ug/l	--	--	< 0.20 ug/l	--
Sodium	Total	Lab	--	--	3200 ug/l	--	--	2450 ug/l	< 2000 ug/l	< 2000 ug/l	< 2000 ug/l	< 2000 ug/l	2180 ug/l	1710 ug/l	< 2000 ug/l	< 2000 ug/l	2010 ug/l	1600 ug/l	--	--	2100 ug/l	--
Strontium	Total	Lab	--	--	--	--	--	34.4 ug/l	--	--	18.6 ug/l	--	63.6 ug/l	--	35.3 ug/l	--	27 ug/l	--	--	--	--	--
Thallium	Total	Lab	< 0.002 ug/l	0.012 j ug/l	0.009 j ug/l	< 0.0020 ug/l	< 0.005 ug/l	0.003 j ug/l	--	--	< 0.002 ug/l	< 0.002 ug/l	< 0.02 ug/l	--	< 0.02 ug/l	< 0.02 ug/l	< 0.02 ug/l	< 0.20 j ug/l 0.012 j ug/l	< 0.0004 ug/l	< 0.005 ug/l	< 0.002 ug/l	< 0.0004 ug/l
Tin	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Titanium	Total	Lab	--	--	--	--	--	--	--	--	< 10 ug/l	--	< 10 ug/l	--	< 10 ug/l	--	< 10 ug/l	--	--	--	--	--
Vanadium	Total	Lab	--	--	< 3.0 ug/l	--	--	--	--	--	< 10 ug/l	--	< 10 ug/l	--	< 10 ug/l	--	< 10 ug/l	< 3.0 ug/l	--	--	< 3.0 ug/l	--
Zinc	Dissolved	Lab	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	--	--	--	< 6 ug/l	< 6 ug/l	6.26 ug/l	< 6 ug/l	< 6 ug/l	< 6 ug/l	7.4 ug/l	7.0 ug/l	6.4 ug/l	6.9 ug/l	6.9 ug/l	< 6.0 ug/l
Zinc	Total	Lab	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6 ug/l	--	--	< 6 ug/l	< 6 ug/l	< 6 ug/l	--	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l

1 - Some monitoring locations are listed by multiple names. Equivalent locations include the following: PM-1 = SW003, PM-2 = SW002, PM-3 = SW003, PM-4 = SW005, PM16 = SW004

Large Table 11
Surface Water Data Summary
Partridge River Watershed and Wyman Creek

Location			LN-1	LN-1	LN-1	LN-1	LN-1	LN-1	LN-1	LN-1	LN-1	LN-1	WL-1		WL-1	WL-1	WL-1	WL-1	WL-1	WL-1	WL-1	WL-1
Date			11/26/2012	12/18/2012	5/9/2013	6/17/2013	7/22/2013	8/19/2013	9/10/2013	10/28/2013	11/21/2013	12/17/2013	3/24/2011		4/25/2011	5/31/2011	6/30/2011	8/22/2011	9/19/2011	10/19/2011	11/21/2011	6/27/2012
Sample Type			N	N	N	N	N	N	N	N	N	N	N	FD	N	N	N	N	N	N	N	N
Parameter	Total or Dissolved	Analysis Location																				
General Parameters																						
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	**37.5 mg/l**	--	--	**61.0 mg/l**	--	--	**22.2 mg/l**	--	--	**26.3 mg/l**	**28.6 mg/l**	**16.6 mg/l**	**29.5 mg/l**	**38.5 mg/l**	**65.6 mg/l**	**50.4 mg/l**	**35.5 mg/l**	**35 mg/l**	**39.0 mg/l**
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	< 10 mg/l	--	--	--	--	--	--	--
Alkalinity, total, as CaCO3	NA	Lab	--	**37.5 mg/l**	--	--	**61.0 mg/l**	--	--	**22.2 mg/l**	--	--	**26.3 mg/l**	**28.6 mg/l**	--	**29.5 mg/l**	**38.5 mg/l**	**65.6 mg/l**	**50.4 mg/l**	**35.5 mg/l**	**35 mg/l**	**39.0 mg/l**
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	< 3 mg/l	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	**19.3 mg/l**	--	--	--	--	--	--	--
Carbon, total organic	NA	Lab	**13.4 mg/l**	**12.5 mg/l**	**15.5 mg/l**	**19.5 mg/l**	**40.8 mg/l**	**22.2 mg/l**	**25.7 mg/l**	**12.1 mg/l**	**13.1 mg/l**	**13.1 mg/l**	**21.6 mg/l**	**21.6 mg/l**	**20.2 mg/l**	**29.6 mg/l**	**39.5 mg/l**	**36.5 mg/l**	**23.0 mg/l**	**26.2 mg/l**	**26.2 mg/l**	**46.1 mg/l**
Chemical Oxygen Demand	NA	Lab	--	**39.9 mg/l**	--	--	**127 mg/l**	--	--	**49.2 mg/l**	--	--	**76.9 mg/l**	**75.1 mg/l**	**56.4 mg/l**	**84.4 mg/l**	**126 mg/l**	**110 mg/l**	**68 mg/l**	**74.3 mg/l**	**69.2 mg/l**	**124 mg/l**
Chloride	NA	Lab	**0.88 mg/l**	**1.1 mg/l**	**0.56 b mg/l**	< 0.50 mg/l	< 0.50 mg/l	< 1.0 mg/l	< 1.0 mg/l	< 1.0 mg/l	< 1.0 mg/l	**1.5 mg/l**	**9.9 mg/l**	**6.81 mg/l**	< 0.5 mg/l	< 0.5 mg/l	< 0.5 mg/l	< 0.5 mg/l	**0.66 mg/l**	**0.83 mg/l**	< 0.5 mg/l	< 0.50 mg/l
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	**6.22 mg/l**	**3.62 mg/l**	**8.8 mg/l**	**5.97 mg/l**	**2.15 mg/l**	**4.32 mg/l**	**5.46 mg/l**	**9.96 mg/l**	--	**8.95 mg/l**	--	--	**6.23 mg/l**	**1.30 mg/l**	**1.22 mg/l**	**1.77 mg/l**	**5.67 mg/l**	**11.81 mg/l**	**9.12 mg/l**	**4.59 mg/l**
Fluoride	NA	Lab	--	--	--	--	--	--	--	--	--	--	< 0.1 mg/l	< 0.1 mg/l	--	< 0.1 mg/l	--	--	< 0.1 mg/l	--	< 0.1 mg/l	--
Hardness, as CaCO3	NA	Lab	**31.4 mg/l**	**39.0 mg/l**	**18.1 mg/l**	**28.8 mg/l**	**79.4 mg/l**	**78.5 mg/l**	**62.9 mg/l**	**24.3 mg/l**	**22.7 mg/l**	**44.1 mg/l**	**45.3 mg/l**	**44.2 mg/l**	--	**42.1 mg/l**	**53.7 mg/l**	**74.1 mg/l**	**56.5 mg/l**	**43.6 mg/l**	**38.2 mg/l**	**51.0 mg/l**
Nitrate + Nitrite, as N	NA	Lab	--	**0.11 mg/l**	--	--	< 0.10 mg/l	--	--	< 0.10 mg/l	--	--	**0.18 mg/l**	**0.17 mg/l**	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	< 0.1 mg/l	**0.1 mg/l**	< 0.1 mg/l	< 0.1 mg/l	< 0.10 mg/l
Nitrogen, ammonia as N	NA	Lab	--	**0.18 mg/l**	--	--	**0.41 mg/l**	--	--	**0.15 mg/l**	--	--	**0.4 mg/l**	**0.4 mg/l**	--	< 0.1 mg/l	**0.11 mg/l**	**0.55 mg/l**	**0.64 mg/l**	**0.21 mg/l**	**0.22 mg/l**	**0.15 mg/l**
pH	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	**7.68 pH units**	**6.65 pH units**	**6.24 pH units**	**6.23 pH units**	**6.5 pH units**	**7.03 pH units**	**6.37 pH units**	**6.93 pH units**	**7.21 pH units**	**7.07 pH units**	--	--	**6.28 pH units**	**6.45 pH units**	**6.27 pH units**	**6.54 pH units**	**6.41 pH units**	**7.32 pH units**	**6.09 pH units**	**7.05 pH units**
Phosphorus, total, as P	NA	Lab	--	**0.018 mg/l**	--	--	**0.064 mg/l**	--	--	**0.015 mg/l**	--	--	< 0.1 mg P/L	< 0.1 mg P/L	--	**0.024 mg P/L**	**0.039 mg P/L**	**0.056 mg P/L**	**0.047 mg P/L**	**0.036 mg P/L**	**0.039 mg P/L**	**0.042 mg/l**
Redox (oxidation potential)	NA	Field	--	--	--	--	--	--	--	--	--	--	--	--	**469 mV**	--	--	--	--	--	--	--
Solids, total dissolved	NA	Lab	**108 mg/l**	**98.0 mg/l**	**60.0 mg/l**	**83.0 mg/l**	**189 mg/l**	**151 mg/l**	**158 mg/l**	**95.0 mg/l**	**80.0 mg/l**	**129 mg/l**	**98 mg/l**	**103 mg/l**	**83 mg/l**	**106 mg/l**	**149 mg/l**	**177 mg/l**	**120 mg/l**	**100 mg/l**	**108 mg/l**	**134 mg/l**
Solids, total suspended	NA	Lab	--	--	--	--	--	--	--	--	--	--	**7 mg/l**	**7 mg/l**	--	< 1 mg/l	--	--	**14 mg/l**	--	**4.5 mg/l**	--
Specific Conductance @ 25 °C	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Specific Conductance @ 25 °C	NA	Field	**0 umhos/cm**	**0 umhos/cm**	**38.7 umhos/cm**	**47.5 umhos/cm**	**123 umhos/cm**	**121.4 umhos/cm**	**138 umhos/cm**	**36.6 umhos/cm**	**44.5 umhos/cm**	**90.7 umhos/cm**	--	--	**35.4 umhos/cm**	**67.0 umhos/cm**	**69.8 umhos/cm**	**159 umhos/cm**	**103.0 umhos/cm**	**105 umhos/cm**	**95.0 umhos/cm**	**52.1 umhos/cm**
Sulfate, as SO4	NA	Lab	**1.6 mg/l**	**1.8 mg/l**	**2.2 mg/l**	< 1.0 mg/l	< 1.0 mg/l	< 1.0 mg/l	< 1.0 mg/l	< 2.0 mg/l	< 2.0 mg/l	< 2.0 mg/l	**4.88 mg/l**	**4.93 mg/l**	**5.36 mg/l**	**1.5 mg/l**	< 1 mg/l	**1.07 mg/l**	**3.99 mg/l**	**5.34 mg/l**	**2.54 mg/l**	**1.2 mg/l**
Temperature, °C	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Temperature, °C	NA	Field	**0.56 deg C**	**0.61 deg C**	**4.64 deg C**	**13.07 deg C**	**16.64 deg C**	**19.12 deg C**	**19.93 deg C**	**2.79 deg C**	**5.23 deg C**	**2.39 deg C**	--	--	**5.86 deg C**	**12.48 deg C**	**17.27 deg C**	**16.40 deg C**	**11.08 deg C**	**5.82 deg C**	**0.58 deg C**	**22.71 deg C**
Turbidity	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Turbidity	NA	Field	**0.3 NTU**	**0 NTU**	**0.5 NTU**	**0 NTU**	**10.3 NTU**	**11.6 NTU**	**6.5 NTU**	**8.2 NTU**	**2.8 NTU**	**15.1 NTU**	--	--	**0 NTU**	**0 NTU**	**0.50 NTU**	**9.1 NTU**	**60.20 NTU**	**12.3 NTU**	**9.90 NTU**	**1.8 NTU**
Metals																						
Aluminum	Dissolved	Lab	< 40.0 ug/l	**33.2 ug/l**	**37.1 ug/l**	**61.9 ug/l**	**136 ug/l**	**26.2 ug/l**	**44.2 ug/l**	**24.1 ug/l**	**24.0 ug/l**	**24.5 ug/l**	**84.1 ug/l**	**64.4 ug/l**	--	**104 ug/l**	**140 ug/l**	**87.3 ug/l**	**33 ug/l**	**64.8 ug/l**	**52.1 ug/l**	**193 ug/l**
Aluminum	Total	Lab	< 40.0 ug/l	**36.8 ug/l**	**42.4 ug/l**	**94.6 ug/l**	**179 ug/l**	**31.7 ug/l**	**49.0 ug/l**	**27.8 ug/l**	**27.0 ug/l**	**96.6 ug/l**	**136 ug/l**	**118 ug/l**	--	**124 ug/l**	**144 ug/l**	**90.9 ug/l**	**66.6 ug/l**	**87.2 ug/l**	**92 ug/l**	**223 ug/l**
Antimony	Total	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l		< 0.50 ug/l			< 0.50 ug/l			--	--		< 0.5 ug/l	< 0.5 ug/l	**0.081 j ug/l**	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.50 ug/l
Arsenic	Dissolved	Lab	--	--	--	**0.72 ug/l**	**2.5 ug/l**	**1.2 ug/l**	**1.1 ug/l**	< 0.50 ug/l	**0.58 ug/l**	< 0.50 ug/l	--	--	< 0.5 ug/l	--	--	--	--	--	--	--
Arsenic	Total	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	**3.0 ug/l**	**1.3 ug/l**	**1.3 ug/l**	**0.56 ug/l**	**0.54 ug/l**	**0.73 ug/l**	**0.62 ug/l**	**0.61 ug/l**	< 0.5 ug/l	**0.89 ug/l**	**1.55 ug/l**	**2.0 ug/l**	**1.35 ug/l**	**1 ug/l**	**0.83 ug/l**	**1.7 ug/l**
Barium	Total	Lab	--	< 10.0 ug/l	--	--	**19.6 ug/l**	--	--	< 10.0 ug/l	--	--	**9.72 ug/l**	**11.6 ug/l**	--	**7.49 ug/l**	--	--	**15.7 ug/l**	--	**8.45 ug/l**	**14.1 ug/l**
Beryllium	Total	Lab	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	< 0.2 ug/l	< 0.2 ug/l	--	< 0.2 ug/l	--	--	< 0.2 ug/l	--	< 0.2 ug/l	< 0.20 ug/l
Boron	Total	Lab	--	< 50.0 ug/l	--	--	< 50.0 ug/l	--	--	< 50.0 ug/l	--	--	< 50 ug/l	< 50 ug/l	--	< 50 ug/l	--	--	< 50 ug/l	--	< 50 ug/l	< 50.0 ug/l
Cadmium	Total	Lab	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	< 0.2 ug/l	< 0.2 ug/l	--	< 0.03 ug/l	--	--	< 0.03 ug/l	--	< 0.03 ug/l	< 0.20 ug/l
Calcium	Total	Lab	**7100 ug/l**	**8900 ug/l**	**4000 ug/l**	**6500 ug/l**	**18600 ug/l**	**19200 ug/l**	**14800 ug/l**	**5600 ug/l**	**5000 ug/l**	**10100 ug/l**	**9060 ug/l**	**8830 ug/l**	**5680 ug/l**	**9330 ug/l**	**12200 ug/l**	**16700 ug/l**	**11700 ug/l**	**9160 ug/l**	**7840 ug/l**	**11700 ug/l**
Chromium	Total	Lab	--	< 1.0 ug/l	--	--	**1.6 ug/l**	--	--	< 1.0 ug/l	--	--	< 1 ug/l	< 1 ug/l	--	< 1 ug/l	--	--	< 1 ug/l	--	< 1 ug/l	< 1.0 ug/l
Cobalt	Dissolved	Lab	< 0.20 ug/l	**0.40 ug/l**	< 0.20 ug/l	< 0.20 ug/l	**1.9 ug/l**	**0.30 ug/l**	**0.30 ug/l**	< 0.20 ug/l	< 0.20 ug/l	**0.64 ug/l**	**1.63 ug/l**	**1.58 ug/l**	--	**1.29 ug/l**	**3.39 ug/l**	**8.24 ug/l**	**4.84 ug/l**	**2.76 ug/l**	**2.31 ug/l**	**7.1 ug/l**
Cobalt	Total	Lab	< 0.20 ug/l	**0.44 ug/l**	< 0.20 ug/l	< 0.20 ug/l	**1.9 ug/l**	**0.29 ug/l**	**0.27 ug/l**	< 0.20 ug/l	< 0.20 ug/l	**0.77 ug/l**	**2.09 ug/l**	**2.02 ug/l**	--	**1.43 ug/l**	**3.23 ug/l**	**8.3 ug/l**	**4.93 ug/l**	**3.08 ug/l**	**2.86 ug/l**	**7.5 ug/l**
Copper	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	**0.62 ug/l**	**0.50 ug/l**	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	**0.53 ug/l**	**16.3 ug/l**	**14.7 ug/l**	--	**3.18 ug/l**	**3.45 ug/l**	**1.25 b ug/l**	**1.44 ug/l**	**2.12 b ug/l**	**1.54 b ug/l**	**6.2 ug/l**
Copper	Total	Lab	< 0.50 ug/l	< 0.50 ug/l	**0.59 b ug/l**	**0.50 ug/l**	**0.65 ug/l**	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	**0.54 ug/l**	**6.53 ug/l**	**6.29 ug/l**	--	**3.73 ug/l**	**3.91 ug/l**	**1.8 ug/l**	**2.8 ug/l**	**3.28 ug/l**	**3.01 b ug/l**	**7.3 ug/l**
Iron	Dissolved	Lab	**1010 ug/l**	**1490 ug/l**	**593 ug/l**	**516 ug/l**	**7030 ug/l**	**2550 ug/l**	**2090 ug/l**	**587 ug/l**	**643 ug/l**	**1620 ug/l**	**1720 ug/l**	**1600 ug/l**	**395 ug/l**	**1360 ug/l**	**2780 ug/l**	**14400 ug/l**	**2970 ug/l**	**2840 ug/l**	**1740 ug/l**	**4260 ug/l**
Iron	Total	Lab	**1430 ug/l**	**2390 ug/l**	**796 ug/l**	**931 ug/l**	**9540 ug/l**	**3560 ug/l**	**3250 ug/l**	**1130 ug/l**	**1000 ug/l**	**3510 ug/l**	**3150 ug/l**	**3000 ug/l**	**456 ug/l**	**2090 ug/l**	**3500 ug/l**	**16900 ug/l**	**8770 ug/l**	**4350 ug/l**	**4690 ug/l**	**5360 ug/l**
Lead	Total	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.5 ug/l	< 0.5 ug/l	--	**0.14 j ug/l**	--	--	**0.18 j ug/l**	--	**0.17 j ug/l**	< 0.50 ug/l
Magnesium	Total	Lab	**3300 ug/l**	**4100 ug/l**	**2000 ug/l**	**3000 ug/l**	**8000 ug/l**	**7400 ug/l**	**6300 ug/l**	**2800 ug/l**	**2500 ug/l**	**4600 ug/l**	**5800 ug/l**	**5380 ug/l**	**2970 ug/l**	**4570 ug/l**	**5640 ug/l**	**7860 ug/l**	**6630 ug/l**	**5040 ug/l**	**4520 ug/l**	**5300 ug/l**
Manganese	Dissolved	Lab	**134 ug/l**	**696 ug/l**	**64.3 ug/l**	**48.4 ug/l**	**2090 ug/l**	**437 ug/l**	**242 ug/l**	**57.9 ug/l**	**104 ug/l**	**1430 ug/l**	**379 ug/l**	**342 ug/l**	**13.6 ug/l**	--	--	--	--	--	--	**1330 ug/l**
Manganese	Total	Lab	**152 ug/l**	**711 ug/l**	**68.7 ug/l**	**68.7 ug/l**	**2120 ug/l**	**463 ug/l**	**230 ug/l**	**72.9 ug/l**	**117 ug/l**	**1540 ug/l**	**441 ug/l**	**425 ug/l**	**15.2 ug/l**	**204 ug/l**	**520 ug/l**	**1990 ug/l**	**1320 ug/l**	**608 ug/l**	**590 ug/l**	**1430 ug/l**
Mercury	Total	Lab	--	**0.0016 ug/l**	--	--	**0.0092 ug/l**	--	--	**0.0021 ug/l**	--	--	**0.0074 ug/l**	**0.0079 ug/l**	--	**0.0084 ug/l**	**0.0068 ug/l**	**0.0022 ug/l**	**0.0026 ug/l**	**0.0032 ug/l**	**0.0026 ug/l**	**0.0098 ug/l**
Methyl Mercury	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.00126 ug/l**	--	--	**0.00020 ug/l**	--	**0.00021 ug/l**	--
Molybdenum	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	< 0.2 ug/l	--	--	--	--	--	--	--
Molybdenum	Total	Lab	--	< 0.20 ug/l	--	--	**0.42 ug/l**	--	--	< 0.30 ug/l	--	--	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	**0.28 j ug/l**	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	**0.22 ug/l**
Nickel	Dissolved	Lab	< 0.50 ug/l	< 0.50 ug/l	**0.62 ug/l**	< 0.50 ug/l	**1.3 ug/l**	< 0.50 ug/l	**0.64 ug/l**	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	**5.18 ug/l**	**6.26 ug/l**	--	**4.57 ug/l**	**6.47 ug/l**	**7.73 ug/l**	**5.11 ug/l**	**4.17 ug/l**	**3.74 ug/l**	**8.1 ug/l**
Nickel	Total	Lab	**0.53 ug/l**	< 0.50 ug/l	**0.64 b ug/l**	< 0.50 ug/l	**1.4 ug/l**	< 0.50 ug/l	**0.53 ug/l**	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	**4.5 ug/l**	**4.44 ug/l**	--	**4.75 ug/l**	**6.25 ug/l**	**8.0 ug/l**	**5.54 ug/l**	**4.84 ug/l**	**4.62 ug/l**	**8.5 ug/l**
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total, as P	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	--	**490 ug/l**	--	--	**840 ug/l**	--	--	**570 ug/l**	--	--	**2100 ug/l**	**2000 ug/l**	**710 ug/l**	**870 ug/l**	**550 ug/l**	**488 ug/l**	**1170 ug/l**	**810 ug/l**	**560 ug/l**	**540 ug/l**
Selenium	Total	Lab	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1 ug/l	< 1 ug/l	--	< 0.2 ug/l	--	--	< 0.2 ug/l	--	< 0.2 ug/l	< 1.0 ug/l
Silver	Total	Lab	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	< 0.2 ug/l	< 0.2 ug/l	--	< 0.2 ug/l	--	--	< 0.2 ug/l	--	< 0.2 ug/l	< 0.20 ug/l
Sodium	Total	Lab	--	**2000 ug/l**	--	--	**1800 ug/l**	--	--	**1500 ug/l**	--	--	< 2000 ug/l	**1920 ug/l**	< 2000 ug/l	< 2000 ug/l	< 2000 ug/l	**1710 ug/l**	< 2000 ug/l	< 2000 ug/l	< 2000 ug/l	**1400 ug/l**
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	--	**30 ug/l**	**29.3 ug/l**	--	**29.9 ug/l**	--	--	**41.7 ug/l**	--	**26.2 ug/l**	--
Thallium	Total	Lab	**0.0019 jb ug/l**	< 0.005 ug/l	**0.0008 j ug/l**	< 0.005 ug/l	**0.009 j ug/l**	< 0.005 ug/l	< 0.005 ug/l	< 0.002 ug/l	< 0.0020 ug/l	< 0.002 ug/l	**0.006 j ug/l**	**0.005 j ug/l**	--	**0.002 jb ug/l**	**0.004 j ug/l**	--	< 0.02 ug/l	< 0.02 ug/l	< 0.02 ug/l	< 0.20 j ug/l **0.012 j ug/l**
Tin	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	< 10 ug/l	--	--	< 10 ug/l	--	< 10 ug/l	--
Vanadium	Total	Lab	--	< 3.0 ug/l	--	--	< 3.0 ug/l	--	--	< 3.0 ug/l	--	--	--	--	--	< 10 ug/l	--	--	< 10 ug/l	--	< 10 ug/l	< 3.0 ug/l
Zinc	Dissolved	Lab	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	**7.3 ug/l**	**6.4 ug/l**	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	--	--	--	< 6 ug/l	**6.37 ug/l**	**7.28 ug/l**	**6.45 ug/l**	< 6 ug/l	< 6 ug/l	**8.9 ug/l**
Zinc	Total	Lab	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	**20 ug/l**	**19.6 ug/l**	--	< 6 ug/l	< 6 ug/l	--	< 6 ug/l	< 6 ug/l	< 6 ug/l	< 6.0 ug/l

1 - Some monitoring locations are listed by multiple names. Equivalent locations include the following: PM-1 = SW003, PM-2 = SW002, PM-3 = SW003, PM-4 = SW005, PM16 = SW004

Large Table 11
Surface Water Data Summary
Partridge River Watershed and Wyman Creek

Location			WL-1	WL-1	WL-1	WL-1	WL-1	WL-1	WL-1	WL-1	WL-1	WL-1	WL-1	WL-1	WL-1	WP-1	WP-1		WP-1	WP-1
Date			7/26/2012	8/23/2012	9/25/2012	10/30/2012	11/26/2012	12/18/2012	5/9/2013	6/17/2013	7/22/2013	8/19/2013	9/10/2013	10/28/2013	11/21/2013	12/17/2013	4/25/2011	5/31/2011		6/30/2011	12/28/2011
Sample Type			N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	FD	N	N
Parameter	Total or Dissolved	Analysis Location																			
General Parameters																					
Alkalinity, bicarbonate, as CaCO3	NA	Lab	--	--	**56.3 mg/l**	--	--	**31.6 mg/l**	--	--	**50.2 mg/l**	--	--	**20.0 mg/l**	--	--	< 10 mg/l	**14.4 mg/l**	**15.9 mg/l**	< 10 mg/l	**87.5 mg/l**
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 10 mg/l	--	--	--	--
Alkalinity, total, as CaCO3	NA	Lab	--	--	**56.3 mg/l**	--	--	**31.6 mg/l**	--	--	**50.2 mg/l**	--	--	**20.0 mg/l**	--	--	--	**14.4 mg/l**	**15.9 mg/l**	< 10 mg/l	**87.5 mg/l**
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 4 mg/l	--	--	--	--
Carbon, dissolved organic	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**28.4 mg/l**	--	--	--	--
Carbon, total organic	NA	Lab	**35.2 mg/l**	**34.3 mg/l**	**27.0 mg/l**	**20.0 mg/l**	**16.5 mg/l**	**15.3 mg/l**	**17.1 mg/l**	**24.8 mg/l**	**41.3 mg/l**	**36.9 mg/l**	**25.3 mg/l**	**17.6 mg/l**	**18.3 mg/l**	**23.4 mg/l**	**29.8 mg/l**	**43.9 mg/l**	**44.0 mg/l**	**86.2 mg/l**	**55.8 mg/l**
Chemical Oxygen Demand	NA	Lab	--	--	**84.2 mg/l**	--	--	**48.8 mg/l**	--	--	**122 mg/l**	--	--	**64.5 mg/l**	--	--	**80.9 mg/l**	**139 mg/l**	**138 mg/l**	**179 mg/l**	**165 mg/l**
Chloride	NA	Lab	< 0.50 mg/l	< 0.50 mg/l	**0.64 mg/l**	**0.90 mg/l**	**1.4 mg/l**	**1.2 mg/l**	**0.57 b mg/l**	< 0.50 mg/l	< 0.50 mg/l	< 1.0 mg/l	< 1.0 mg/l	**1.2 mg/l**	< 1.0 mg/l	**1.6 mg/l**	**0.6 mg/l**	< 0.5 mg/l	< 0.5 mg/l	< 0.5 mg/l	**1.39 mg/l**
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	**6.04 mg/l**	**5.98 mg/l**	**9.79 mg/l**	**8.74 mg/l**	**7.67 mg/l**	**7.3 mg/l**	**8.58 mg/l**	**4.84 mg/l**	**5.08 mg/l**	**8.73 mg/l**	**5.92 mg/l**	**9.31 mg/l**	--	**9.46 mg/l**	**7.82 mg/l**	**3.51 mg/l**	--	**6.79 mg/l**	**6.75 mg/l**
Fluoride	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.1 mg/l	< 0.1 mg/l	--	--
Hardness, as CaCO3	NA	Lab	**64.6 mg/l**	**62.2 mg/l**	**58.4 mg/l**	**37.6 mg/l**	**41.8 mg/l**	**50.8 mg/l**	**27.1 mg/l**	**35.7 mg/l**	**73.0 mg/l**	**73.7 mg/l**	**51.9 mg/l**	**27.9 mg/l**	**28.0 mg/l**	**52.2 mg/l**	--	**27.4 mg/l**	**28.1 mg/l**	**25.8 mg/l**	**85.8 mg/l**
Nitrate + Nitrite, as N	NA	Lab	--	--	< 0.10 mg/l	--	--	**0.11 mg/l**	--	--	< 0.10 mg/l	--	--	**0.12 b mg/l**	--	--	**0.19 mg/l**	< 0.1 mg/l	**0.11 mg/l**	< 0.1 mg/l	**0.17 mg/l**
Nitrogen, ammonia as N	NA	Lab	--	--	**0.62 mg/l**	--	--	**0.15 mg/l**	--	--	**0.10 mg/l**	--	--	**0.15 mg/l**	--	--	--	**0.25 mg/l**	**0.22 mg/l**	**0.12 mg/l**	**2.11 mg/l**
pH	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	**6.82 pH units**	**6.95 pH units**	**7.23 pH units**	**6.71 pH units**	**7.76 pH units**	**6.79 pH units**	**6.11 pH units**	**6.13 pH units**	**6.69 pH units**	**6.55 pH units**	**6.37 pH units**	**6.33 pH units**	**6.52 pH units**	**6.93 pH units**	**5.52 pH units**	**5.85 pH units**	--	**5.30 pH units**	**5.58 pH units**
Phosphorus, total, as P	NA	Lab	--	--	**0.066 mg/l**	--	--	**0.025 mg/l**	--	--	**0.052 mg/l**	--	--	**0.014 mg/l**	--	--	--	**0.054 mg P/L**	**0.055 mg P/L**	**0.043 mg P/L**	< 0.1 mg P/L
Redox (oxidation potential)	NA	Field	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**472 mV**	--	--	--	--
Solids, total dissolved	NA	Lab	**156 mg/l**	**169 mg/l**	**119 mg/l**	**105 mg/l**	**142 mg/l**	**133 mg/l**	**75.0 mg/l**	**110 mg/l**	**181 mg/l**	**179 mg/l**	**151 mg/l**	**95.0 mg/l**	**93.0 mg/l**	**144 mg/l**	**102 mg/l**	**127 mg/l**	**121 mg/l**	**172 mg/l**	**235 mg/l**
Solids, total suspended	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**7 mg/l**	**5 mg/l**	--	--
Specific Conductance @ 25 °C	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Specific Conductance @ 25 °C	NA	Field	**7.4 umhos/cm**	**108.3 umhos/cm**	**1.8 umhos/cm**	**71.7 umhos/cm**	**80.2 umhos/cm**	**54.2 umhos/cm**	**61.7 umhos/cm**	**65.4 umhos/cm**	**110.9 umhos/cm**	**124.9 umhos/cm**	**106.5 umhos/cm**	**34.6 umhos/cm**	**47.9 umhos/cm**	**101.8 umhos/cm**	**12.3 umhos/cm**	**29.0 umhos/cm**	--	**21.0 umhos/cm**	**35 umhos/cm**
Sulfate, as SO4	NA	Lab	**1.2 mg/l**	**1.4 mg/l**	**2.5 mg/l**	**5.8 mg/l**	**15.6 mg/l**	**17.0 mg/l**	**6.2 mg/l**	**2.2 mg/l**	< 1.0 mg/l	< 1.0 mg/l	**1.7 mg/l**	**2.3 mg/l**	**3.3 mg/l**	**3.5 mg/l**	**2.65 mg/l**	**1.11 mg/l**	**1.21 mg/l**	< 1 mg/l	**1.39 mg/l**
Temperature, °C	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Temperature, °C	NA	Field	**20.98 deg C**	**18.74 deg C**	**9.86 deg C**	**3.47 deg C**	**0.86 deg C**	**1.24 deg C**	**6.99 deg C**	**15.82 deg C**	**18.79 deg C**	**17.81 deg C**	**18.51 deg C**	**3.02 deg C**	**1.37 deg C**	**2.69 deg C**	**7.08 deg C**	**13.23 deg C**	--	**17.80 deg C**	**0.02 deg C**
Turbidity	NA	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Turbidity	NA	Field	**13.4 NTU**	**13.1 NTU**	**104 NTU**	**7.1 NTU**	**0.6 NTU**	**0 NTU**	**0.2 NTU**	**5.9 NTU**	**6.2 NTU**	**44.7 NTU**	**15.4 NTU**	**2.7 NTU**	**1.1 NTU**	**201.3 NTU**	**0 NTU**	**0.9 NTU**	--	**0.30 NTU**	**0.2 NTU**
Metals																					
Aluminum	Dissolved	Lab	**96.8 ug/l**	**95.6 ug/l**	**87.8 ug/l**	**47.0 ug/l**	**55.5 ug/l**	**58.0 ug/l**	**84.1 ug/l**	**116 ug/l**	**169 ug/l**	**105 ug/l**	**87.1 ug/l**	**87.7 ug/l**	**66.9 ug/l**	**84.1 ug/l**	--	**316 ug/l**	**308 ug/l**	**427 ug/l**	**201 ug/l**
Aluminum	Total	Lab	**108 ug/l**	**131 ug/l**	**113 ug/l**	**72.1 ug/l**	**62.1 ug/l**	**76.7 ug/l**	**92.3 ug/l**	**135 ug/l**	**194 ug/l**	**208 ug/l**	**106 ug/l**	**99.7 ug/l**	**73.8 ug/l**	**1310 ug/l**	--	**357 ug/l**	**337 ug/l**	**469 ug/l**	**230 ug/l**
Antimony	Total	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	--	--	< 0.50 ug/l	--	--	--	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l	< 0.5 ug/l
Arsenic	Dissolved	Lab	--	--	--	--	--	--	--	**0.89 ug/l**	**1.4 ug/l**	**1.7 ug/l**	**1.4 ug/l**	**0.82 ug/l**	**0.62 ug/l**	**0.68 ug/l**	**0.53 ug/l**	--	--	--	--
Arsenic	Total	Lab	**2.0 ug/l**	**2.4 ug/l**	**1.7 ug/l**	**0.96 ug/l**	< 0.50 ug/l	**0.59 ug/l**	< 0.50 ug/l	**0.74 ug/l**	**1.6 ug/l**	**2.0 ug/l**	**1.4 ug/l**	**0.60 ug/l**	**0.64 ug/l**	**2.3 ug/l**	**0.66 ug/l**	**1.86 ug/l**	**1.53 ug/l**	**1.9 ug/l**	**3.07 ug/l**
Barium	Total	Lab	--	--	**16.4 ug/l**	--	--	< 10.0 ug/l	--	--	**12.4 ug/l**	--	--	< 10.0 ug/l	--	--	--	**10.6 ug/l**	**12.1 ug/l**	--	--
Beryllium	Total	Lab	--	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	--	< 0.2 ug/l	< 0.2 ug/l	--	--
Boron	Total	Lab	--	--	< 50.0 ug/l	--	--	< 50.0 ug/l	--	--	< 50.0 ug/l	--	--	< 50.0 ug/l	--	--	--	< 50 ug/l	< 50 ug/l	--	--
Cadmium	Total	Lab	--	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	--	**0.03 j ug/l**	**0.05 j ug/l**	--	--
Calcium	Total	Lab	**14200 ug/l**	**13300 ug/l**	**12300 ug/l**	**8000 ug/l**	**8600 ug/l**	**10300 ug/l**	**5700 ug/l**	**7900 ug/l**	**16400 ug/l**	**16300 ug/l**	**11300 ug/l**	**5900 ug/l**	**5800 ug/l**	**10800 ug/l**	**3210 ug/l**	**6000 ug/l**	**6170 ug/l**	**5730 ug/l**	**18200 ug/l**
Chromium	Total	Lab	--	--	< 1.0 ug/l	--	--	< 1.0 ug/l	--	--	< 1.0 ug/l	--	--	< 1.0 ug/l	--	--	--	< 1 ug/l	< 1 ug/l	--	--
Cobalt	Dissolved	Lab	**6.9 ug/l**	**7.1 ug/l**	**5.2 ug/l**	**1.1 ug/l**	**0.60 ug/l**	**1.8 ug/l**	< 0.20 ug/l	**1.4 ug/l**	**3.8 ug/l**	**6.7 ug/l**	**4.9 ug/l**	**0.29 ug/l**	**0.23 ug/l**	**2.7 ug/l**	--	**1.14 ug/l**	**1.12 ug/l**	**1.25 ug/l**	**6.92 ug/l**
Cobalt	Total	Lab	**7.5 ug/l**	**7.6 ug/l**	**6.0 ug/l**	**1.2 ug/l**	**0.67 ug/l**	**1.8 ug/l**	< 0.20 ug/l	**1.5 ug/l**	**3.9 ug/l**	**7.6 ug/l**	**4.3 ug/l**	**0.32 ug/l**	**0.23 ug/l**	**4.9 ug/l**	--	**1.28 ug/l**	**1.47 ug/l**	**1.31 ug/l**	**6.6 ug/l**
Copper	Dissolved	Lab	**1.5 ug/l**	**1.3 ug/l**	**1.2 ug/l**	**2.0 ug/l**	**2.3 ug/l**	**1.8 ug/l**	**3.6 ug/l**	**3.9 ug/l**	**4.0 ug/l**	**1.4 ug/l**	**1.7 ug/l**	**3.4 ug/l**	**2.4 ug/l**	**3.8 ug/l**	--	**2.77 ug/l**	**2.74 ug/l**	**3.32 ug/l**	**1.92 ug/l**
Copper	Total	Lab	**2.3 ug/l**	**2.1 ug/l**	**2.6 ug/l**	**2.2 ug/l**	**2.6 ug/l**	**2.2 ug/l**	**3.6 b ug/l**	**4.5 ug/l**	**4.7 ug/l**	**4.0 ug/l**	**1.9 ug/l**	**3.0 ug/l**	**2.4 ug/l**	**50.9 ug/l**	--	**3.88 ug/l**	**3.6 ug/l**	**3.46 ug/l**	**2.76 ug/l**
Iron	Dissolved	Lab	**8320 ug/l**	**13700 ug/l**	**6890 ug/l**	**1740 ug/l**	**1110 ug/l**	**1680 ug/l**	**448 ug/l**	**1230 ug/l**	**2550 ug/l**	**9000 ug/l**	**4310 ug/l**	**641 ug/l**	**484 ug/l**	**2400 ug/l**	**1280 ug/l**	**3470 ug/l**	**3360 ug/l**	**3140 ug/l**	**33900 ug/l**
Iron	Total	Lab	**10400 ug/l**	**16700 ug/l**	**14700 ug/l**	**2920 ug/l**	**1610 ug/l**	**2540 ug/l**	**539 ug/l**	**1700 ug/l**	**3390 ug/l**	**17800 ug/l**	**6580 ug/l**	**914 ug/l**	**588 ug/l**	**17000 ug/l**	**1470 ug/l**	**5150 ug/l**	**5160 ug/l**	**4520 ug/l**	**35000 ug/l**
Lead	Total	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.20 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	**2.7 ug/l**	--	**0.62 ug/l**	**0.65 ug/l**	--	--
Magnesium	Total	Lab	**7100 ug/l**	**7000 ug/l**	**6700 ug/l**	**4300 ug/l**	**5000 ug/l**	**6100 ug/l**	**3100 ug/l**	**3900 ug/l**	**7800 ug/l**	**8000 ug/l**	**5800 ug/l**	**3200 ug/l**	**3300 ug/l**	**6100 ug/l**	**1740 ug/l**	**3030 ug/l**	**3080 ug/l**	**2800 ug/l**	**9800 ug/l**
Manganese	Dissolved	Lab	**1330 ug/l**	**1390 ug/l**	**1110 ug/l**	**204 ug/l**	**105 ug/l**	**387 ug/l**	**18.0 ug/l**	**195 ug/l**	**609 ug/l**	**1220 ug/l**	**830 ug/l**	**30.6 ug/l**	**27.4 ug/l**	**582 ug/l**	**87.3 ug/l**	--	--	--	--
Manganese	Total	Lab	**1410 ug/l**	**1480 ug/l**	**1240 ug/l**	**203 ug/l**	**116 ug/l**	**403 ug/l**	**18.4 ug/l**	**218 ug/l**	**622 ug/l**	**1290 ug/l**	**714 ug/l**	**36.2 ug/l**	**26.1 ug/l**	**697 ug/l**	**87 ug/l**	**353 ug/l**	**495 ug/l**	**233 ug/l**	**2690 ug/l**
Mercury	Total	Lab	--	--	**0.0024 ug/l**	--	--	**0.0021 ug/l**	--	--	**0.0076 ug/l**	--	--	**0.0046 ug/l**	--	--	--	**0.0108 ug/l**	**0.0105 ug/l**	**0.0119 ug/l**	**0.0051 ug/l**
Methyl Mercury	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**0.00082 ug/l**	--	--	--
Molybdenum	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 0.2 ug/l	--	--	--	--
Molybdenum	Total	Lab	--	--	**0.23 ug/l**	--	--	< 0.20 ug/l	--	--	**0.32 ug/l**	--	--	< 0.30 ug/l	--	--	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	< 0.2 ug/l	**0.34 ug/l**
Nickel	Dissolved	Lab	**7.5 ug/l**	**6.6 ug/l**	**4.7 ug/l**	**3.0 ug/l**	**2.2 ug/l**	**2.8 ug/l**	**2.2 ug/l**	**3.9 ug/l**	**6.8 ug/l**	**6.2 ug/l**	**5.4 ug/l**	**2.3 ug/l**	**1.8 ug/l**	**4.0 ug/l**	--	**4.17 ug/l**	**4.21 ug/l**	**5.07 ug/l**	**6.97 ug/l**
Nickel	Total	Lab	**7.9 ug/l**	**7.4 ug/l**	**5.6 ug/l**	**3.0 ug/l**	**2.5 ug/l**	**2.7 ug/l**	**1.9 b ug/l**	**4.4 ug/l**	**6.7 ug/l**	**7.2 ug/l**	**4.6 ug/l**	**2.5 ug/l**	**1.6 ug/l**	**10.5 ug/l**	--	**4.7 ug/l**	**4.53 ug/l**	**5.26 ug/l**	**7.01 ug/l**
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total, as P	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	--	--	**680 ug/l**	--	--	**520 ug/l**	--	--	**590 ug/l**	--	--	**560 ug/l**	--	--	**610 ug/l**	**510 ug/l**	**640 ug/l**	< 250 ug/l	**980 ug/l**
Selenium	Total	Lab	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	--	**0.25 j ug/l**	**0.22 j ug/l**	--	--
Silver	Total	Lab	--	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--	--	--	< 0.2 ug/l	< 0.2 ug/l	--	--
Sodium	Total	Lab	--	--	**1800 ug/l**	--	--	**2000 ug/l**	--	--	**1800 ug/l**	--	--	**1500 ug/l**	--	--	< 2000 ug/l	< 2000 ug/l	< 2000 ug/l	< 2000 ug/l	**2740 ug/l**
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	**20 ug/l**	**20.5 ug/l**	--	--
Thallium	Total	Lab	< 0.0004 ug/l	< 0.005 ug/l	< 0.002 ug/l	**0.0009 jb ug/l**	**0.0028 jb ug/l**	< 0.005 ug/l	**0.0039 j ug/l**	**0.010 jb ug/l**	**0.009 j ug/l**	< 0.005 ug/l	< 0.005 ug/l	**0.002 j ug/l**	< 0.0020 ug/l	**0.027 ug/l**	--	**0.006 jb ug/l**	**0.007 jb ug/l**	**0.005 j ug/l**	--
Tin	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	< 10 ug/l	< 10 ug/l	--	--
Vanadium	Total	Lab	--	--	< 3.0 ug/l	--	--	< 3.0 ug/l	--	--	< 3.0 ug/l	--	--	< 3.0 ug/l	--	--	--	< 10 ug/l	< 10 ug/l	--	--
Zinc	Dissolved	Lab	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	**6.4 ug/l**	< 6.0 ug/l	**6.1 ug/l**	**9.4 ug/l**	**6.3 ug/l**	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	**23.4 ug/l**	--	**10.7 ug/l**	**10.8 ug/l**	**15.1 ug/l**	**11.4 ug/l**
Zinc	Total	Lab	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	**6.9 ug/l**	**6.3 ug/l**	**6.2 ug/l**	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	**134 ug/l**	--	**10.2 ug/l**	**13 ug/l**	**13.9 ug/l**	**7.86 ug/l**

1 - Some monitoring locations are listed by multiple names. Equivalent locations include the following: PM-1 = SW003, PM-2 = SW002, PM-3 = SW003, PM-4 = SW005, PM16 = SW004

Large Table 11
Surface Water Data Summary
Partridge River Watershed and Wyman Creek

Location			WP-1	WP-1	WP-1	WP-1	WP-1	WP-1	WP-1	WP-1	WP-1	WP-1	WP-1
Date			6/27/2012	7/26/2012	10/30/2012	11/26/2012	5/9/2013	6/17/2013	7/22/2013	8/19/2013	9/10/2013	10/28/2013	11/21/2013
Sample Type			N	N	N	N	N	N	N	N	N	N	N
Parameter	Total or Dissolved	Analysis Location											
General Parameters													
Alkalinity, bicarbonate, as CaCO3	NA	Lab	< 10.0 mg/l	--	--	--	--	--	10.8 mg/l	--	--	< 10.0 mg/l	--
Alkalinity, carbonate, as CaCO3	NA	Lab	--	--	--	--	--	--	--	--	--	--	--
Alkalinity, total, as CaCO3	NA	Lab	< 10.0 mg/l	--	--	--	--	--	10.8 mg/l	--	--	< 10.0 mg/l	--
Biochemical Oxygen Demand (5-day)	NA	Lab	--	--	--	--	--	--	--	--	--	--	--
Carbon, dissolved organic	NA	Lab	--	--	--	--	--	--	--	--	--	--	--
Carbon, total organic	NA	Lab	81.2 mg/l	70.4 mg/l	26.1 mg/l	26.9 mg/l	32.7 mg/l	41.3 mg/l	125 mg/l	30.7 mg/l	25.6 mg/l	30.6 mg/l	33.7 mg/l
Chemical Oxygen Demand	NA	Lab	213 mg/l	--	--	--	--	--	355 mg/l	--	--	129 mg/l	--
Chloride	NA	Lab	< 0.50 mg/l	< 0.50 mg/l	1.2 mg/l	0.91 mg/l	0.51 b mg/l	< 0.50 mg/l	0.53 mg/l	< 1.0 mg/l	< 1.0 mg/l	< 1.0 mg/l	< 1.0 mg/l
Cyanide	NA	Lab	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Lab	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	Field	1.35 mg/l	0.35 mg/l	4.06 mg/l	3.87 mg/l	6 mg/l	2.34 mg/l	0.58 mg/l	7.54 mg/l	7.24 mg/l	4.65 mg/l	--
Fluoride	NA	Lab	--	--	--	--	--	--	--	--	--	--	--
Hardness, as CaCO3	NA	Lab	23.2 mg/l	26.0 mg/l	32.7 mg/l	25.6 mg/l	11.8 mg/l	16.1 mg/l	44.3 mg/l	22.5 mg/l	23.2 mg/l	20.3 mg/l	17.8 mg/l
Nitrate + Nitrite, as N	NA	Lab	< 0.10 mg/l	--	--	--	--	--	< 0.10 mg/l	--	--	0.25 b mg/l	--
Nitrogen, ammonia as N	NA	Lab	< 0.10 mg/l	--	--	--	--	--	0.29 mg/l	--	--	0.18 mg/l	--
pH	NA	Lab	--	--	--	--	--	--	--	--	--	--	--
pH	NA	Field	5.78 pH units	5.75 pH units	5.34 pH units	7.48 pH units	4.97 pH units	4.95 pH units	5.75 pH units	6.29 pH units	6.44 pH units	5.1 pH units	5.72 pH units
Phosphorus, total, as P	NA	Lab	0.034 mg/l	--	--	--	--	--	0.090 mg/l	--	--	0.037 mg/l	--
Redox (oxidation potential)	NA	Field	--	--	--	--	--	--	--	--	--	--	--
Solids, total dissolved	NA	Lab	130 mg/l	212 mg/l	125 mg/l	170 mg/l	79.0 mg/l	114 mg/l	312 mg/l	125 mg/l	124 mg/l	132 mg/l	123 mg/l
Solids, total suspended	NA	Lab	--	--	--	--	--	--	--	--	--	--	--
Specific Conductance @ 25 ºC	NA	Lab	--	--	--	--	--	--	--	--	--	--	--
Specific Conductance @ 25 ºC	NA	Field	0 umhos/cm	0 umhos/cm	65.5 umhos/cm	60.2 umhos/cm	29.3 umhos/cm	23.6 umhos/cm	72.3 umhos/cm	20.9 umhos/cm	40.6 umhos/cm	21.3 umhos/cm	28.8 umhos/cm
Sulfate, as SO4	NA	Lab	< 1.0 mg/l	1.2 mg/l	12.6 mg/l	10.4 mg/l	< 1.0 mg/l	< 1.0 mg/l	< 1.0 mg/l	< 1.0 mg/l	< 1.0 mg/l	3.5 mg/l	2.9 mg/l
Temperature, °C	NA	Lab	--	--	--	--	--	--	--	--	--	--	--
Temperature, °C	NA	Field	16.46 deg C	18.18 deg C	3.49 deg C	3.77 deg C	4.38 deg C	13.43 deg C	18.3 deg C	19.66 deg C	19.18 deg C	2.59 deg C	1.33 deg C
Turbidity	NA	Lab	--	--	--	--	--	--	--	--	--	--	--
Turbidity	NA	Field	0 NTU	7.4 NTU	0 NTU	1.1 NTU	0.9 NTU	15.5 NTU	22.3 NTU	6.8 NTU	11.8 NTU	2.5 NTU	0 NTU
Metals													
Aluminum	Dissolved	Lab	712 ug/l	686 ug/l	220 ug/l	255 ug/l	221 ug/l	413 ug/l	1170 ug/l	175 ug/l	112 ug/l	346 ug/l	290 ug/l
Aluminum	Total	Lab	716 ug/l	656 ug/l	234 ug/l	258 ug/l	239 ug/l	434 ug/l	1200 ug/l	214 ug/l	163 ug/l	422 ug/l	301 ug/l
Antimony	Total	Lab	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	< 0.50 ug/l	--	< 0.50 ug/l	--	--	< 0.50 ug/l	--
Arsenic	Dissolved	Lab	--	--	--	--	--	1.1 ug/l	5.8 ug/l	1.8 ug/l	1.3 ug/l	1.3 ug/l	0.87 ug/l
Arsenic	Total	Lab	2.0 ug/l	3.5 ug/l	0.89 ug/l	0.56 ug/l	0.71 ug/l	0.92 ug/l	6.0 ug/l	2.1 ug/l	2.0 ug/l	1.1 ug/l	1.0 ug/l
Barium	Total	Lab	< 10.0 ug/l	--	--	--	--	--	20.4 ug/l	--	--	< 10.0 ug/l	--
Beryllium	Total	Lab	< 0.20 ug/l	--	--	--	--	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--
Boron	Total	Lab	< 50.0 ug/l	--	--	--	--	--	< 50.0 ug/l	--	--	< 50.0 ug/l	--
Cadmium	Total	Lab	< 0.20 ug/l	--	--	--	--	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--
Calcium	Total	Lab	4600 ug/l	5300 ug/l	6100 ug/l	4500 ug/l	2200 ug/l	3100 ug/l	9000 ug/l	4900 ug/l	5000 ug/l	3800 ug/l	3200 ug/l
Chromium	Total	Lab	< 1.0 ug/l	--	--	--	--	--	1.4 ug/l	--	--	< 1.0 ug/l	--
Cobalt	Dissolved	Lab	2.1 ug/l	2.3 ug/l	0.70 ug/l	0.64 ug/l	0.65 ug/l	0.76 ug/l	4.5 ug/l	0.91 ug/l	0.84 ug/l	0.64 ug/l	0.51 ug/l
Cobalt	Total	Lab	2.1 ug/l	2.3 ug/l	0.75 ug/l	0.67 ug/l	0.66 ug/l	0.84 ug/l	4.5 ug/l	0.98 ug/l	0.87 ug/l	0.71 ug/l	0.49 ug/l
Copper	Dissolved	Lab	5.4 ug/l	5.0 ug/l	3.4 ug/l	3.4 ug/l	3.5 ug/l	4.2 ug/l	3.5 ug/l	1.1 ug/l	0.90 ug/l	5.0 ug/l	3.9 ug/l
Copper	Total	Lab	5.3 ug/l	5.3 ug/l	3.6 ug/l	3.5 ug/l	3.6 b ug/l	4.4 ug/l	3.5 ug/l	0.94 ug/l	0.86 ug/l	5.5 ug/l	3.7 ug/l
Iron	Dissolved	Lab	5220 ug/l	9350 ug/l	1400 ug/l	1390 ug/l	2210 ug/l	2150 ug/l	19800 ug/l	3120 ug/l	2450 ug/l	2000 ug/l	1570 ug/l
Iron	Total	Lab	5440 ug/l	9720 ug/l	1530 ug/l	1470 ug/l	2440 ug/l	2310 ug/l	19900 ug/l	6320 ug/l	6510 ug/l	2330 ug/l	1640 ug/l
Lead	Total	Lab	1.7 ug/l	2.1 ug/l	0.54 ug/l	< 0.50 ug/l	0.67 ug/l	0.81 ug/l	3.1 ug/l	< 0.50 ug/l	< 0.50 ug/l	0.87 ug/l	0.56 ug/l
Magnesium	Total	Lab	2800 ug/l	3100 ug/l	4200 ug/l	3500 ug/l	1500 ug/l	2000 ug/l	5300 ug/l	2500 ug/l	2600 ug/l	2600 ug/l	2400 ug/l
Manganese	Dissolved	Lab	219 ug/l	290 ug/l	170 ug/l	140 ug/l	96.5 ug/l	85.9 ug/l	427 ug/l	163 ug/l	270 ug/l	108 ug/l	86.8 ug/l
Manganese	Total	Lab	219 ug/l	293 ug/l	173 ug/l	150 ug/l	95.8 ug/l	91.3 ug/l	432 ug/l	186 ug/l	275 ug/l	111 ug/l	82.0 ug/l
Mercury	Total	Lab	0.0132 ug/l	--	--	--	--	--	0.0281 ug/l	--	--	0.0143 ug/l	--
Methyl Mercury	Total	Lab	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--
Molybdenum	Total	Lab	< 0.20 ug/l	--	--	--	--	--	0.30 ug/l	--	--	< 0.30 ug/l	--
Nickel	Dissolved	Lab	12.4 ug/l	11.5 ug/l	3.6 ug/l	3.6 ug/l	4.2 ug/l	6.3 ug/l	22.1 ug/l	2.4 ug/l	2.8 ug/l	5.4 ug/l	4.4 ug/l
Nickel	Total	Lab	12.4 ug/l	11.8 ug/l	3.8 ug/l	3.7 ug/l	4.4 b ug/l	7.0 ug/l	22.4 ug/l	2.4 ug/l	2.1 ug/l	5.3 ug/l	4.3 ug/l
Palladium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--
Phosphorus, total, as P	Dissolved	Lab	--	--	--	--	--	--	--	--	--	--	--
Platinum	Total	Lab	--	--	--	--	--	--	--	--	--	--	--
Potassium	Total	Lab	< 250 ug/l	--	--	--	--	--	850 ug/l	--	--	280 ug/l	--
Selenium	Total	Lab	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l	< 1.0 ug/l
Silver	Total	Lab	< 0.20 ug/l	--	--	--	--	--	< 0.20 ug/l	--	--	< 0.20 ug/l	--
Sodium	Total	Lab	1100 ug/l	--	--	--	--	--	1400 ug/l	--	--	1000 ug/l	--
Strontium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--
Thallium	Total	Lab	0.020 j ug/l 0.010 J ug/l	0.0022 j ug/l	0.0041 jb ug/l	0.0050 jb ug/l	0.0076 j ug/l	< 0.005 ug/l	0.018 j ug/l	< 0.005 ug/l	< 0.005 ug/l	0.006 j ug/l	0.006 j ug/l
Tin	Total	Lab	--	--	--	--	--	--	--	--	--	--	--
Titanium	Total	Lab	--	--	--	--	--	--	--	--	--	--	--
Vanadium	Total	Lab	< 3.0 ug/l	--	--	--	--	--	9.3 ug/l	--	--	< 3.0 ug/l	--
Zinc	Dissolved	Lab	13.1 ug/l	9.4 ug/l	< 6.0 ug/l	9.9 ug/l	8.0 ug/l	10.5 ug/l	16.1 ug/l	7.2 ug/l	< 6.0 ug/l	< 6.0 ug/l	6.4 ug/l
Zinc	Total	Lab	11.0 ug/l	7.2 ug/l	6.3 ug/l	< 6.0 ug/l	< 6.0 ug/l	8.3 ug/l	14.3 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l	< 6.0 ug/l

1 - Some monitoring locations are listed by multiple names. Equivalent locations include the following: PM-1 = SW003, PM-2 = SW002, PM-3 = SW003, PM-4 = SW005, PM16 = SW004

Large Table 11
Surface Water Data Summary
Partridge River Watershed and Wyman Creek

Data Qualifiers/Footnotes	
Qualifier	**Definition**
	Data not used in December 2014 probabilistic modeling.
--	Not analyzed/not available.
a	Estimated value, calculated using some or all values that are estimates.
b	Potential false positive value based on blank data validation procedures.
c	Coeluting compound.
e	Estimated value, exceeded the instrument calibration range.
f	Sample was collected at a flowrate exceeding the recommended rate of 200 mL/minute.
h	EPA recommended sample preservation, extraction or analysis holding time was exceeded.
i	Indeterminate value based on failure of blind duplicate data to meet quality assurance criteria.
j	Reported value is less than the stated laboratory quantitation limit and is considered an estimated value.
p	Relative percent difference is >40% (25% CLP pesticides) between primary and confirmation GC columns.
pp	Small peak in chromatogram below method detection limit.
r	The presence of the compound is suspect based on the ID criteria of the retention time and relative retention time obtained from the examination of the chromatograms.
s	Potential false positive value based on statistical analysis of blank sample data.
t	Sample positive for total coliforms but negative for *E. coli*.
v	Sample was collected under a vacuum of greater than XX inches of mercury.
*	Estimated value, QA/QC criteria not met.
**	Unusable value, QA/QC criteria not met.
N	Sample Type: Normal
FD	Sample Type: Field Duplicate
AT	Sample chromatogram is noted to be atypical of a petroleum product.
DLND	Not detected, detection limit not determined.
DF	Did not flash
EMPC	Estimated maximum possible concentration.
NA – (Not applicable)	NA indicates that a fractional portion of the sample is not part of the analytical testing or field collection procedures.
ND	Not detected.
TIC	Tentatively identified compound.
BQA	Barr-applied project specific qualifier: extraction and/or analyses conducted using an alternative method and/or procedure.
BQC	Barr-applied project specific qualifier: plant shut down.
BQD	Barr-applied project specific qualifier: equipment malfunction.
BQE	Barr-applied project specific qualifier: equipment adjustment.
BQM	Barr-applied project specific qualifier: manual measurement.
BQN	Barr-applied project specific qualifier: unable to be sampled or measured due to various reasons.
BQP	Barr-applied project specific qualifier: atypical chromatographic pattern.
BQQ	Barr-applied project specific qualifier: some aspect of QA/QC was not met.
BQR	Barr-applied project specific qualifier: location was re-sampled.
BQS	Barr-applied project specific qualifier: data is considered suspect.
BQT	Barr-applied project specific qualifier: summed value not displayed due to insufficient field length.
BQU	Barr-applied project specific qualifier: historical qualifier - definition unknown.
BQV	Barr-applied project specific qualifier: estimated value.
BQX	Barr-applied project specific qualifier: see notes for qualifier definition.
BQZ	Barr-applied project specific qualifier: data is considered unusable.
Validated	Laboratory data has been evaluated following Barr QA/QC procedures and/or project-specific data review requirements. Field data has been verified for transcription errors, consistency and completeness. Data transferred from the previous database (9/2009) were categorized as validated, but may be comprised of any one of the following data status categories: Validated, SSource, No QC or Legacy.
No QC	Laboratory data has been excluded from Barr QA/QC procedures.
SSource	Laboratory and/or field data obtained from a secondary source external to Barr. Second source QA/QC evaluation procedures may or may not have been performed beyond the original data generator.
Legacy	Historical laboratory data (internal at Barr). QA/QC evaluation procedures may or may not have been performed beyond the original data generator

1 - Some monitoring locations are listed by multiple names. Equivalent locations include the following: PM-1 = SW003, PM-2 = SW002, PM-3 = SW003, PM-4 = SW005, PM16 = SW004

Large Table 12 Annual Summary of Concentration Statistics for the Category 2/3 Stockpile Drainage

Constituent	Mine Year	1			5			11			14			19[4]		
	Percentile	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]
	Units															
Ag (Silver)	µg/L	1.78E-01	1.79E-01	1.80E-01	2.00E-01	2.00E-01	2.00E-01	1.33E+01	1.63E+01	1.97E+01	2.09E+01	2.48E+01	2.91E+01	3.55E+01	4.19E+01	4.83E+01
Al (Aluminum)	µg/L	1.27E-01	4.44E-01	1.55E+00	1.41E-01	4.96E-01	1.74E+00	5.11E+04	1.50E+05	3.21E+05	7.86E+04	2.28E+05	4.91E+05	1.33E+05	3.78E+05	8.27E+05
Alkalinity	mg/L	8.53E+00	2.50E+01	4.05E+01	9.56E+00	2.80E+01	4.54E+01	5.79E+00	1.66E+01	2.80E+01	3.80E+00	1.09E+01	1.84E+01	8.00E-16	1.36E-07	1.09E-01
As (Arsenic)	µg/L	8.15E+01	8.94E+01	9.01E+01	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	9.97E+01	9.98E+01	9.98E+01	9.97E+01	1.00E+02	1.00E+02
B (Boron)	µg/L	8.89E+01	8.95E+01	8.99E+01	1.00E+02	1.00E+02	1.00E+02	1.03E+02	1.38E+02	1.99E+02	1.05E+02	1.59E+02	2.54E+02	1.09E+02	2.00E+02	3.60E+02
Ba (Barium)	µg/L	2.46E+01	2.82E+01	3.27E+01	1.08E+01	1.31E+01	1.59E+01	9.07E+00	1.03E+01	1.24E+01	8.45E+00	1.00E+01	1.28E+01	6.81E+00	1.13E+01	1.86E+01
Be (Beryllium)	µg/L	3.56E-01	3.58E-01	3.59E-01	4.00E-01	4.00E-01	4.00E-01	3.94E+00	6.66E+00	8.82E+00	5.87E+00	1.01E+01	1.30E+01	9.11E+00	1.66E+01	2.13E+01
Ca (Calcium)	mg/L	7.83E+01	2.15E+02	5.19E+02	4.04E+02	6.79E+02	7.36E+02	4.74E+02	5.78E+02	6.23E+02	4.06E+02	5.14E+02	5.63E+02	3.43E+02	4.06E+02	4.63E+02
Cd (Cadmium)	µg/L	6.82E-01	4.23E+00	2.10E+01	1.44E+00	8.32E+00	3.84E+01	1.45E+01	4.57E+01	1.08E+02	1.67E+01	5.83E+01	1.45E+02	6.63E+00	6.43E+01	1.90E+02
Cl (Chloride)	mg/L	1.06E+01	4.46E+01	2.66E+02	2.26E+00	9.22E+00	5.34E+01	2.50E+00	1.02E+01	5.93E+01	5.54E-22	1.83E-21	4.51E-21	2.23E-21	7.36E-21	1.80E-20
Co (Cobalt)	µg/L	9.95E+01	2.62E+02	6.68E+02	2.36E+02	8.89E+02	2.13E+03	1.66E+03	5.46E+03	1.43E+04	1.59E+03	6.13E+03	1.94E+04	5.57E+02	2.88E+03	1.43E+04
Cr (Chromium)	µg/L	3.18E+00	6.19E+00	8.87E+00	1.00E+01	1.00E+01	1.00E+01	1.19E+01	1.23E+01	1.28E+01	1.30E+01	1.35E+01	1.41E+01	1.51E+01	1.60E+01	1.68E+01
Cu (Copper)	µg/L	1.76E+02	4.75E+03	1.14E+04	1.97E+02	5.32E+03	1.28E+04	4.93E+04	6.16E+04	7.13E+04	7.75E+04	9.15E+04	1.03E+05	1.30E+05	1.49E+05	1.65E+05
F (Fluoride)	mg/L	1.16E+00	1.81E+00	2.74E+00	1.32E+00	1.38E+00	2.02E+00	1.47E+00	1.53E+00	1.73E+00	1.54E+00	1.62E+00	1.88E+00	1.67E+00	1.78E+00	1.94E+00
Fe (Iron)	µg/L	4.40E+01	8.69E+01	1.87E+02	4.92E+01	9.72E+01	2.09E+02	1.20E+04	3.28E+04	6.88E+04	1.81E+04	5.15E+04	1.04E+05	3.09E+04	8.67E+04	1.74E+05
K (Potassium)	mg/L	1.49E+01	3.19E+01	4.76E+01	4.37E+01	5.05E+01	5.80E+01	3.65E+01	4.20E+01	4.96E+01	3.00E+01	3.69E+01	4.66E+01	1.80E+01	2.80E+01	4.21E+01
Mg (Magnesium)	mg/L	1.16E+01	3.58E+01	1.25E+02	3.42E+01	1.03E+02	3.57E+02	1.51E+02	3.89E+02	7.06E+02	1.60E+02	4.71E+02	8.97E+02	5.46E+01	3.04E+02	1.16E+03
Mn (Manganese)	µg/L	1.61E+02	5.84E+02	1.95E+03	5.92E+02	1.66E+03	3.48E+03	2.48E+03	1.12E+04	2.81E+04	2.26E+03	1.35E+04	3.93E+04	7.92E+02	7.18E+03	4.17E+04
Na (Sodium)	mg/L	1.22E+01	4.06E+01	1.18E+02	6.80E+01	1.61E+02	3.40E+02	8.57E+01	1.55E+02	2.81E+02	6.46E+01	1.19E+02	2.18E+02	2.78E+01	6.29E+01	1.66E+02
Ni (Nickel)	µg/L	1.66E+03	3.67E+03	7.43E+03	2.84E+03	1.52E+04	3.33E+04	2.75E+04	8.32E+04	2.40E+05	2.54E+04	9.32E+04	3.01E+05	8.48E+03	4.27E+04	1.74E+05
Pb (Lead)	µg/L	1.78E+00	1.79E+00	1.80E+00	2.00E+00	2.00E+00	2.00E+00	6.77E+01	1.37E+02	2.20E+02	1.05E+02	2.12E+02	3.32E+02	1.73E+02	3.60E+02	5.53E+02
Sb (Antimony)	µg/L	1.53E+01	4.09E+01	7.26E+01	1.75E+01	5.42E+01	9.08E+01	3.55E+02	6.91E+02	1.09E+03	4.47E+02	9.64E+02	1.59E+03	1.89E+02	7.03E+02	2.32E+03
Se (Selenium)	µg/L	4.93E+00	1.28E+01	3.00E+01	2.39E+01	5.50E+01	1.21E+02	5.20E+01	8.11E+01	1.31E+02	5.25E+01	8.33E+01	1.14E+02	2.19E+01	9.99E+01	1.00E+02
SO4 (Sulfate)	mg/L	1.97E+02	3.94E+02	7.46E+02	1.04E+03	1.74E+03	2.87E+03	2.30E+03	4.25E+03	6.73E+03	2.09E+03	4.75E+03	8.66E+03	7.76E+02	2.98E+03	1.13E+04
Tl (Thallium)	µg/L	1.65E-02	1.04E-01	1.79E-01	8.95E-02	2.00E-01	2.00E-01	8.26E-01	1.03E+00	7.58E+00	1.20E+00	1.43E+00	9.00E+00	1.15E+00	2.07E+00	5.20E+00
V (Vanadium)	µg/L	8.89E+00	8.94E+00	8.98E+00	1.00E+01	1.00E+01	1.00E+01	2.46E+01	2.75E+01	3.00E+01	3.35E+01	3.68E+01	3.97E+01	5.09E+01	5.50E+01	5.90E+01
Zn (Zinc)	µg/L	1.02E+02	3.05E+02	1.31E+03	1.81E+02	8.11E+02	1.76E+03	1.65E+03	3.64E+03	1.05E+04	1.78E+03	4.79E+03	1.47E+04	6.82E+02	6.32E+03	1.77E+04

Notes

[1] Values shown are the average of the monthly P10 values for the referenced Mine Year.

[2] Values shown are the average of the monthly P50 values for the referenced Mine Year.

[3] Values shown are the average of the monthly P90 values for the referenced Mine Year.

[4] The waste rock is fully removed from the Category 2/3 Waste Rock Stockpile by the end of Mine Year 19.

Large Table 13 Annual Summary of Concentration Statistics for the Category 4 Stockpile Drainage

Constituent	Mine Year	1			5			11[4]		
	Percentile	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]
	Units									
Ag (Silver)	µg/L	5.88E+00	2.14E+01	6.67E+01	8.24E+00	3.04E+01	1.31E+02	9.96E+00	3.29E+01	1.47E+02
Al (Aluminum)	µg/L	1.08E+05	2.53E+05	5.79E+05	1.47E+05	3.74E+05	8.07E+05	1.69E+05	4.05E+05	8.48E+05
Alkalinity	mg/L	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
As (Arsenic)	µg/L	1.07E+01	1.23E+02	1.03E+03	1.54E+01	1.51E+02	1.26E+03	1.92E+01	1.59E+02	1.31E+03
B (Boron)	µg/L	1.29E+02	6.18E+02	1.40E+03	1.66E+02	1.14E+03	2.62E+03	1.81E+02	1.25E+03	2.79E+03
Ba (Barium)	µg/L	4.50E+00	7.32E+01	5.36E+02	5.53E+00	8.83E+01	7.64E+02	5.95E+00	9.16E+01	8.01E+02
Be (Beryllium)	µg/L	4.39E+00	1.13E+01	9.80E+01	5.69E+00	1.40E+01	1.37E+02	6.38E+00	1.49E+01	1.42E+02
Ca (Calcium)	mg/L	1.56E+02	2.95E+02	3.69E+02	3.42E+02	4.04E+02	4.73E+02	3.71E+02	4.34E+02	5.04E+02
Cd (Cadmium)	µg/L	4.67E+01	9.07E+01	2.06E+02	5.93E+01	1.18E+02	2.76E+02	6.47E+01	1.26E+02	2.91E+02
Cl (Chloride)	mg/L	5.17E+00	2.18E+01	1.30E+02	1.23E+00	5.00E+00	2.90E+01	9.85E-01	3.98E+00	2.33E+01
Co (Cobalt)	µg/L	3.58E+03	6.45E+03	1.18E+04	7.76E+03	1.30E+04	2.41E+04	9.05E+03	1.52E+04	2.74E+04
Cr (Chromium)	µg/L	5.21E+00	8.35E+00	1.70E+01	9.86E+00	1.50E+01	5.96E+01	1.07E+01	1.72E+01	8.46E+01
Cu (Copper)	µg/L	4.39E+02	1.44E+03	2.09E+03	3.50E+03	5.99E+03	6.74E+03	7.58E+03	1.10E+04	1.23E+04
F (Fluoride)	mg/L	1.35E+00	1.83E+00	2.60E+00	1.65E+00	1.79E+00	1.94E+00	1.77E+00	1.90E+00	2.06E+00
Fe (Iron)	µg/L	7.63E+03	1.95E+05	8.37E+05	1.20E+04	2.97E+05	1.86E+06	1.53E+04	3.17E+05	2.20E+06
K (Potassium)	mg/L	1.94E+00	9.41E+00	2.03E+01	3.08E+00	1.21E+01	2.52E+01	4.20E+00	1.33E+01	2.69E+01
Mg (Magnesium)	mg/L	1.48E+02	2.77E+02	5.45E+02	4.49E+02	8.53E+02	1.74E+03	5.53E+02	1.06E+03	2.43E+03
Mn (Manganese)	µg/L	4.09E+03	8.96E+03	1.74E+04	1.70E+04	3.84E+04	7.38E+04	2.88E+04	6.11E+04	1.20E+05
Na (Sodium)	mg/L	7.00E+00	1.13E+01	2.36E+01	1.01E+01	1.65E+01	3.31E+01	1.22E+01	2.02E+01	3.97E+01
Ni (Nickel)	µg/L	4.43E+03	9.18E+03	1.67E+04	9.19E+03	1.97E+04	3.85E+04	1.39E+04	3.14E+04	6.75E+04
Pb (Lead)	µg/L	1.42E+02	2.88E+02	4.42E+02	1.81E+02	3.61E+02	5.44E+02	1.98E+02	3.86E+02	5.75E+02
Sb (Antimony)	µg/L	1.68E+02	4.14E+02	8.51E+02	3.44E+02	1.34E+03	2.92E+03	4.11E+02	1.71E+03	4.04E+03
Se (Selenium)	µg/L	2.02E+01	3.91E+01	6.91E+01	5.94E+01	9.47E+01	2.37E+02	7.64E+01	1.10E+02	3.46E+02
SO4 (Sulfate)	mg/L	2.27E+03	4.23E+03	8.62E+03	3.89E+03	9.88E+03	2.69E+04	4.37E+03	1.16E+04	3.67E+04
Tl (Thallium)	µg/L	5.78E-01	1.07E+00	1.90E+00	1.64E+00	2.28E+00	6.16E+00	2.09E+00	2.75E+00	9.45E+00
V (Vanadium)	µg/L	3.07E+00	9.78E+00	1.60E+02	5.09E+00	1.32E+01	1.94E+02	7.01E+00	1.54E+01	2.03E+02
Zn (Zinc)	µg/L	5.15E+03	7.78E+03	2.55E+04	6.41E+03	9.80E+03	3.35E+04	6.87E+03	1.07E+04	3.52E+04

Notes

[1] Values shown are the average of the monthly P10 values for the referenced Mine Year.

[2] Values shown are the average of the monthly P50 values for the referenced Mine Year.

[3] Values shown are the average of the monthly P90 values for the referenced Mine Year.

[4] The waste rock is fully removed from the Category 4 Waste Rock Stockpile by the end of Mine Year 11.

Large Table 14 Annual Summary of Concentration Statistics for the Ore Surge Pile Drainage

Constituent	Mine Year	1			5			11			14			20[4]		
	Percentile	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]
	Units															
Ag (Silver)	µg/L	1.61E-01	1.62E-01	1.63E-01	2.00E-01	2.00E-01	2.00E-01	3.34E+01	3.91E+01	4.56E+01	3.51E+01	4.15E+01	4.78E+01	3.43E+01	4.05E+01	4.67E+01
Al (Aluminum)	µg/L	1.14E-01	4.02E-01	1.41E+00	1.41E-01	4.96E-01	1.74E+00	1.25E+05	3.52E+05	7.74E+05	1.32E+05	3.77E+05	8.20E+05	1.23E+05	3.45E+05	7.77E+05
Alkalinity	mg/L	7.72E+00	2.12E+01	3.43E+01	9.56E+00	2.80E+01	4.54E+01	2.67E-01	1.17E+00	3.70E+00	6.84E-03	1.48E-01	5.10E-01	6.68E-03	1.45E-01	4.98E-01
As (Arsenic)	µg/L	5.19E+01	7.95E+01	8.16E+01	1.00E+02	1.00E+02	1.00E+02	9.98E+01	9.98E+01	9.99E+01	9.94E+01	9.95E+01	9.96E+01	9.68E+01	9.73E+01	9.78E+01
B (Boron)	µg/L	8.05E+01	8.10E+01	8.15E+01	1.00E+02	1.00E+02	1.00E+02	1.09E+02	1.93E+02	3.43E+02	1.08E+02	1.99E+02	3.58E+02	1.06E+02	1.95E+02	3.48E+02
Ba (Barium)	µg/L	2.22E+01	2.55E+01	2.97E+01	9.79E+00	1.11E+01	1.26E+01	6.66E+00	7.78E+00	9.92E+00	6.50E+00	7.95E+00	1.21E+01	6.57E+00	1.17E+01	1.97E+01
Be (Beryllium)	µg/L	3.22E-01	3.24E-01	3.26E-01	4.00E-01	4.00E-01	4.00E-01	9.06E+00	1.57E+01	2.02E+01	8.77E+00	1.63E+01	2.10E+01	3.00E+00	1.38E+01	2.02E+01
Ca (Calcium)	mg/L	4.02E+01	8.02E+01	1.52E+02	4.73E+02	6.80E+02	7.38E+02	3.70E+02	4.23E+02	4.79E+02	3.50E+02	4.06E+02	4.61E+02	1.43E+02	3.88E+02	4.47E+02
Cd (Cadmium)	µg/L	9.32E-01	2.33E+00	4.82E+00	1.61E+00	9.43E+00	3.31E+01	3.76E+01	8.29E+01	2.07E+02	2.11E+01	6.65E+01	1.76E+02	5.36E+00	2.44E+01	1.08E+02
Cl (Chloride)	mg/L	3.04E+00	1.28E+01	7.62E+01	1.89E+00	7.72E+00	4.47E+01	3.08E-21	9.23E-21	2.52E-20	3.08E-21	9.23E-21	2.52E-20	3.08E-21	9.23E-21	2.52E-20
Co (Cobalt)	µg/L	2.07E+02	6.62E+02	1.31E+03	2.63E+02	1.47E+03	2.79E+03	1.15E+04	2.81E+04	3.85E+04	6.59E+03	2.28E+04	3.94E+04	1.84E+03	8.02E+03	3.59E+04
Cr (Chromium)	µg/L	2.53E+00	4.56E+00	7.31E+00	1.00E+01	1.00E+01	1.00E+01	1.48E+01	1.56E+01	1.65E+01	1.51E+01	1.59E+01	1.67E+01	4.57E+00	1.53E+01	1.62E+01
Cu (Copper)	µg/L	1.59E+02	4.30E+03	1.04E+04	1.97E+02	5.32E+03	1.28E+04	1.22E+05	1.41E+05	1.57E+05	1.30E+05	1.49E+05	1.64E+05	1.26E+05	1.45E+05	1.60E+05
F (Fluoride)	mg/L	5.71E-01	1.07E+00	1.75E+00	1.32E+00	1.38E+00	1.81E+00	1.65E+00	1.75E+00	1.88E+00	1.66E+00	1.77E+00	1.91E+00	1.54E+00	1.75E+00	1.95E+00
Fe (Iron)	µg/L	3.98E+01	7.86E+01	1.69E+02	4.92E+01	9.72E+01	2.09E+02	2.86E+04	8.08E+04	1.62E+05	3.03E+04	8.60E+04	1.71E+05	2.96E+04	8.42E+04	1.68E+05
K (Potassium)	mg/L	7.06E+00	1.38E+01	2.45E+01	4.41E+01	5.07E+01	5.82E+01	2.00E+01	2.92E+01	4.25E+01	1.82E+01	2.79E+01	4.20E+01	1.74E+01	2.70E+01	4.08E+01
Mg (Magnesium)	mg/L	1.29E+01	2.58E+01	4.73E+01	3.87E+01	1.14E+02	3.34E+02	3.51E+02	7.32E+02	1.39E+03	2.12E+02	6.27E+02	1.33E+03	5.24E+01	2.27E+02	1.01E+03
Mn (Manganese)	µg/L	6.49E+02	1.39E+03	2.44E+03	1.05E+03	2.30E+03	3.71E+03	2.08E+04	4.57E+04	8.09E+04	1.31E+04	3.97E+04	7.92E+04	3.98E+03	1.70E+04	6.59E+04
Na (Sodium)	mg/L	8.12E+00	3.41E+01	8.78E+01	1.01E+02	2.15E+02	4.01E+02	3.93E+01	7.79E+01	1.80E+02	3.00E+01	6.63E+01	1.72E+02	2.58E+01	5.93E+01	1.58E+02
Ni (Nickel)	µg/L	2.36E+03	1.22E+04	2.62E+04	2.92E+03	3.16E+04	7.24E+04	2.27E+05	5.89E+05	7.86E+05	1.25E+05	4.60E+05	8.13E+05	3.45E+04	1.46E+05	7.45E+05
Pb (Lead)	µg/L	1.61E+00	1.62E+00	1.63E+00	2.00E+00	2.00E+00	2.00E+00	1.64E+02	3.37E+02	5.16E+02	1.74E+02	3.61E+02	5.46E+02	1.63E+02	3.42E+02	5.32E+02
Sb (Antimony)	µg/L	1.19E+01	2.80E+01	5.10E+01	1.75E+01	5.42E+01	9.08E+01	6.69E+02	1.56E+03	2.50E+03	3.12E+02	1.20E+03	2.43E+03	7.24E+01	3.59E+02	1.79E+03
Se (Selenium)	µg/L	7.73E+00	1.52E+01	2.77E+01	4.02E+01	7.93E+01	1.57E+02	9.50E+01	9.93E+01	1.03E+02	9.87E+01	9.94E+01	9.98E+01	2.87E+01	9.68E+01	9.76E+01
SO4 (Sulfate)	mg/L	1.85E+02	3.70E+02	6.98E+02	1.74E+03	2.50E+03	3.66E+03	3.71E+03	7.85E+03	1.29E+04	2.37E+03	6.94E+03	1.31E+04	6.77E+02	2.73E+03	1.15E+04
Tl (Thallium)	µg/L	1.61E-01	1.62E-01	1.63E-01	2.00E-01	2.00E-01	2.00E-01	1.84E+00	2.14E+00	2.48E+01	1.88E+00	2.12E+00	8.63E+00	8.52E-01	1.95E+00	3.23E+00
V (Vanadium)	µg/L	8.04E+00	8.09E+00	8.13E+00	1.00E+01	1.00E+01	1.00E+01	4.77E+01	5.23E+01	5.67E+01	5.04E+01	5.44E+01	5.84E+01	4.93E+01	5.32E+01	5.71E+01
Zn (Zinc)	µg/L	1.32E+02	3.46E+02	7.06E+02	1.84E+02	1.12E+03	1.94E+03	5.48E+03	7.99E+03	2.55E+04	3.28E+03	7.22E+03	2.13E+04	8.76E+02	3.64E+03	1.31E+04

Notes

[1] Values shown are the average of the monthly P10 values for the referenced Mine Year.

[2] Values shown are the average of the monthly P50 values for the referenced Mine Year.

[3] Values shown are the average of the monthly P90 values for the referenced Mine Year.

[4] The waste rock is fully removed from the Ore Surge Pile by the end of Mine Year 20.

Large Table 15 Annual Summary of Concentration Statistics for the OSLA Runoff, Rail Transfer Hopper Runoff, and Haul Road Runoff

	Feature	OSLA			RTH			Haul Roads		
	Mine Year	1 to 20[4]			1 to 20[4]			1 to 20[4]		
	Percentile	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]
Constituent	Units									
Ag (Silver)	µg/L	1.01E-01	3.74E-01	6.49E-01	2.00E-01	2.00E-01	2.00E-01	2.19E-06	3.93E-04	6.93E-02
Al (Aluminum)	µg/L	9.01E+01	1.38E+02	1.93E+02	1.41E-01	4.96E-01	1.74E+00	9.30E-01	1.41E+00	2.15E+00
Alkalinity	mg/L	1.27E+01	2.72E+01	4.22E+01	9.56E+00	2.80E+01	4.54E+01	3.48E+01	3.97E+01	5.11E+01
As (Arsenic)	µg/L	2.11E+00	2.72E+00	3.35E+00	1.00E+02	1.00E+02	1.00E+02	8.69E+00	2.61E+01	6.54E+01
B (Boron)	µg/L	9.84E+01	1.10E+02	1.22E+02	1.00E+02	1.00E+02	1.00E+02	4.00E+01	1.00E+02	1.00E+02
Ba (Barium)	µg/L	1.00E+01	1.53E+01	2.08E+01	1.28E+01	1.40E+01	1.51E+01	2.61E+01	2.83E+01	3.07E+01
Be (Beryllium)	µg/L	1.22E-01	1.49E-01	1.78E-01	4.00E-01	4.00E-01	4.00E-01	1.38E-02	1.70E-01	4.00E-01
Ca (Calcium)	mg/L	1.00E+01	1.16E+01	1.32E+01	2.85E+02	3.53E+02	4.31E+02	1.36E+02	2.21E+02	3.43E+02
Cd (Cadmium)	µg/L	4.62E-02	6.75E-02	8.91E-02	1.61E+00	7.35E+00	1.44E+01	7.90E-01	1.45E+00	3.54E+00
Cl (Chloride)	mg/L	2.63E+00	4.06E+00	5.41E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co (Cobalt)	µg/L	2.82E-01	5.98E-01	9.30E-01	2.63E+02	1.43E+03	2.45E+03	6.06E+01	1.14E+02	2.57E+02
Cr (Chromium)	µg/L	3.14E-01	5.75E-01	8.25E-01	8.83E+00	9.67E+00	1.00E+01	5.41E+00	7.78E+00	1.00E+01
Cu (Copper)	µg/L	5.20E+00	6.84E+00	8.49E+00	1.97E+02	5.32E+03	1.28E+04	1.19E+02	2.37E+02	6.57E+02
F (Fluoride)	mg/L	2.09E-01	4.22E-01	6.25E-01	1.60E+00	1.90E+00	2.17E+00	1.77E+00	2.58E+00	3.29E+00
Fe (Iron)	µg/L	3.44E+01	5.47E+01	7.68E+01	4.92E+01	9.72E+01	2.09E+02	4.58E+01	5.99E+01	1.99E+02
K (Potassium)	mg/L	1.43E+00	2.28E+00	3.12E+00	3.27E+01	3.92E+01	4.72E+01	2.12E+01	3.07E+01	4.91E+01
Mg (Magnesium)	mg/L	4.68E+00	5.34E+00	6.03E+00	3.75E+01	8.38E+01	1.42E+02	2.55E+01	4.71E+01	1.27E+02
Mn (Manganese)	µg/L	5.78E+01	9.05E+01	1.23E+02	1.05E+03	2.30E+03	3.66E+03	1.35E+02	1.89E+02	3.33E+02
Na (Sodium)	mg/L	5.66E+00	1.44E+01	2.30E+01	4.49E+01	1.26E+02	2.36E+02	2.37E+01	4.61E+01	1.59E+02
Ni (Nickel)	µg/L	1.85E+00	3.06E+00	4.20E+00	2.92E+03	2.99E+04	5.70E+04	9.90E+02	1.53E+03	2.57E+03
Pb (Lead)	µg/L	4.20E-02	8.19E-02	1.23E-01	2.00E+00	2.00E+00	2.00E+00	3.14E-01	9.27E-01	2.82E+00
Sb (Antimony)	µg/L	3.76E-01	5.88E-01	7.94E-01	1.75E+01	5.37E+01	8.65E+01	1.14E+01	3.18E+01	7.33E+01
Se (Selenium)	µg/L	4.34E-01	5.49E-01	6.67E-01	3.26E+01	5.34E+01	7.90E+01	1.56E-02	2.72E-01	4.73E+00
SO4 (Sulfate)	mg/L	3.96E+01	4.50E+01	5.07E+01	1.18E+03	1.47E+03	1.93E+03	1.36E+02	1.75E+02	2.25E+02
Tl (Thallium)	µg/L	1.96E-02	4.02E-02	5.98E-02	2.00E-01	2.00E-01	2.00E-01	4.48E-04	9.48E-03	1.57E-01
V (Vanadium)	µg/L	1.60E+00	1.94E+00	2.31E+00	1.00E+01	1.00E+01	1.00E+01	5.95E+00	1.00E+01	1.00E+01
Zn (Zinc)	µg/L	2.14E+00	3.14E+00	4.10E+00	1.84E+02	9.54E+02	1.52E+03	4.47E+01	7.18E+01	1.64E+02

Notes

[1] Values shown are the average of the monthly P10 values for the referenced Mine Year.

[2] Values shown are the average of the monthly P50 values for the referenced Mine Year.

[3] Values shown are the average of the monthly P90 values for the referenced Mine Year.

[4] Annual average concentrations do not vary with time from Mine Year 1 to 20.

Large Table 16 Annual Summary of Concentration Statistics for the Category 1 Stockpile Drainage

	Mine Year	1			5			11			14[4]			20			30[5]			75[5]		
	Percentile	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]
Constituent	Units																					
Ag (Silver)	µg/L	1.25E-06	2.55E-04	4.97E-02	9.59E-06	1.89E-03	1.98E-01	1.30E-05	3.12E-03	2.00E-01	1.90E-05	3.33E-03	2.00E-01	5.59E-05	7.43E-03	2.00E-01	1.79E-03	1.88E-01	2.00E-01	1.82E-03	2.00E-01	2.00E-01
Al (Aluminum)	µg/L	7.52E-01	1.14E+00	1.74E+00	9.22E-01	1.40E+00	2.13E+00	9.30E-01	1.41E+00	2.15E+00	9.30E-01	1.41E+00	2.15E+00	9.29E-01	1.41E+00	2.15E+00	9.30E-01	1.41E+00	2.15E+00	9.30E-01	1.41E+00	2.15E+00
Alkalinity	mg/L	2.81E+01	3.21E+01	4.14E+01	3.45E+01	3.93E+01	5.07E+01	3.48E+01	3.97E+01	5.11E+01	3.48E+01	3.97E+01	5.11E+01	3.48E+01	3.97E+01	5.11E+01	3.48E+01	3.97E+01	5.11E+01	3.48E+01	3.97E+01	5.11E+01
As (Arsenic)	µg/L	3.91E+00	1.75E+01	6.22E+01	3.31E+01	9.91E+01	9.92E+01	5.72E+01	1.00E+02	1.00E+02	6.06E+01	1.00E+02	1.00E+02	6.71E+01	1.00E+02	1.00E+02	9.99E+01	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02
B (Boron)	µg/L	2.27E+01	8.08E+01	8.14E+01	9.91E+01	9.91E+01	9.92E+01	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02
Ba (Barium)	µg/L	2.60E+01	3.20E+01	4.07E+01	1.32E+01	1.71E+01	2.37E+01	1.14E+01	1.50E+01	2.07E+01	1.09E+01	1.43E+01	1.97E+01	1.15E+01	1.45E+01	2.00E+01	9.69E+00	1.08E+01	1.16E+01	9.49E+00	1.07E+01	1.14E+01
Be (Beryllium)	µg/L	7.07E-03	1.21E-01	3.25E-01	4.83E-02	3.96E-01	3.97E-01	8.49E-02	4.00E-01	4.00E-01	1.12E-01	4.00E-01	4.00E-01	1.22E-01	4.00E-01	4.00E-01	3.99E-01	4.00E-01	4.00E-01	4.00E-01	4.00E-01	4.00E-01
Ca (Calcium)	mg/L	5.21E+01	1.44E+02	3.58E+02	4.06E+02	6.67E+02	7.11E+02	6.29E+02	6.82E+02	7.22E+02	6.34E+02	6.84E+02	7.23E+02	6.35E+02	6.84E+02	7.23E+02	6.35E+02	6.84E+02	7.23E+02	6.35E+02	6.84E+02	7.23E+02
Cd (Cadmium)	µg/L	3.56E-01	1.06E+00	2.82E+00	1.54E+00	3.21E+00	6.67E+00	1.64E+00	3.48E+00	7.39E+00	1.68E+00	3.58E+00	7.67E+00	1.68E+00	3.59E+00	7.71E+00	1.70E+00	3.67E+00	7.97E+00	1.70E+00	3.67E+00	7.97E+00
Cl (Chloride)	mg/L	8.45E+00	3.75E+01	2.66E+02	3.31E+00	1.55E+01	9.72E+01	1.70E+00	9.52E+00	6.85E+01	2.23E-02	1.07E-01	7.27E-01	2.32E-11	7.54E-07	1.84E-05	3.62E-21	1.66E-08	1.73E-04	1.59E-21	1.82E-21	2.50E-09
Co (Cobalt)	µg/L	4.43E+01	8.33E+01	1.93E+02	6.11E+01	1.22E+02	3.16E+02	6.17E+01	1.23E+02	3.19E+02	6.17E+01	1.23E+02	3.19E+02	6.17E+01	1.23E+02	3.19E+02	6.17E+01	1.23E+02	3.19E+02	6.17E+01	1.23E+02	3.19E+02
Cr (Chromium)	µg/L	2.28E+00	5.92E+00	8.14E+00	9.91E+00	9.91E+00	9.92E+00	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01
Cu (Copper)	µg/L	9.65E+01	1.91E+02	5.33E+02	1.18E+02	2.35E+02	6.51E+02	1.19E+02	2.37E+02	6.57E+02	1.19E+02	2.37E+02	6.57E+02	1.19E+02	2.37E+02	6.57E+02	1.19E+02	2.37E+02	6.57E+02	1.19E+02	2.37E+02	6.57E+02
F (Fluoride)	mg/L	9.31E-01	1.84E+00	2.81E+00	1.33E+00	1.38E+00	2.01E+00	1.34E+00	1.37E+00	1.43E+00	1.34E+00	1.37E+00	1.43E+00	1.34E+00	1.37E+00	1.42E+00	1.34E+00	1.37E+00	1.43E+00	1.34E+00	1.37E+00	1.42E+00
Fe (Iron)	µg/L	3.70E+01	4.85E+01	1.61E+02	4.54E+01	5.94E+01	1.97E+02	4.58E+01	5.99E+01	1.99E+02	4.58E+01	5.99E+01	1.99E+02	4.58E+01	5.99E+01	1.99E+02	4.58E+01	5.99E+01	1.99E+02	4.58E+01	5.99E+01	1.99E+02
K (Potassium)	mg/L	8.63E+00	2.37E+01	3.95E+01	4.31E+01	4.64E+01	5.33E+01	4.35E+01	4.69E+01	5.38E+01	4.35E+01	4.69E+01	5.38E+01	4.35E+01	4.69E+01	5.38E+01	4.35E+01	4.69E+01	5.38E+01	4.35E+01	4.69E+01	5.38E+01
Mg (Magnesium)	mg/L	1.02E+01	3.30E+01	1.10E+02	6.04E+01	1.32E+02	3.48E+02	7.37E+01	1.47E+02	3.74E+02	7.58E+01	1.50E+02	3.73E+02	7.60E+01	1.51E+02	3.76E+02	7.60E+01	1.51E+02	3.76E+02	7.61E+01	1.51E+02	3.76E+02
Mn (Manganese)	µg/L	6.21E+01	1.51E+02	2.52E+02	1.90E+02	2.30E+02	4.84E+02	1.91E+02	2.32E+02	4.96E+02	1.91E+02	2.32E+02	4.97E+02	1.91E+02	2.32E+02	4.97E+02	1.91E+02	2.32E+02	4.97E+02	1.91E+02	2.32E+02	4.97E+02
Na (Sodium)	mg/L	9.93E+00	3.56E+01	1.35E+02	7.42E+01	1.86E+02	2.74E+02	1.10E+02	2.19E+02	2.93E+02	1.15E+02	2.24E+02	2.97E+02	1.37E+02	2.26E+02	2.97E+02	1.79E+02	2.35E+02	3.05E+02	1.80E+02	2.35E+02	3.05E+02
Ni (Nickel)	µg/L	4.74E+02	1.06E+03	2.23E+03	1.28E+03	2.17E+03	6.06E+03	1.29E+03	2.23E+03	6.57E+03	1.29E+03	2.23E+03	6.61E+03	1.29E+03	2.23E+03	6.60E+03	1.29E+03	2.23E+03	6.61E+03	1.29E+03	2.23E+03	6.61E+03
Pb (Lead)	µg/L	1.47E-01	6.19E-01	2.49E+00	1.09E+00	4.41E+00	1.78E+01	1.52E+00	7.35E+00	3.02E+01	1.90E+00	8.18E+00	2.88E+01	4.00E+00	1.08E+01	3.27E+01	8.81E+01	9.99E+01	1.00E+02	1.00E+02	1.00E+02	1.00E+02
Sb (Antimony)	µg/L	7.25E+00	2.27E+01	5.76E+01	1.59E+01	5.01E+01	8.86E+01	1.70E+01	5.26E+01	9.02E+01	1.72E+01	5.35E+01	9.05E+01	1.74E+01	5.33E+01	9.05E+01	1.75E+01	5.41E+01	9.08E+01	1.75E+01	5.42E+01	9.08E+01
Se (Selenium)	µg/L	8.21E-03	1.90E-01	3.65E+00	6.56E-02	1.25E+00	2.18E+01	9.34E-02	1.68E+00	3.97E+01	1.23E-01	1.86E+00	3.71E+01	9.49E-02	2.02E+00	3.65E+01	2.55E-01	4.28E+00	7.75E+01	2.55E-01	4.46E+00	7.90E+01
SO4 (Sulfate)	mg/L	4.28E+01	1.20E+02	3.01E+02	3.13E+02	8.55E+02	1.75E+03	4.80E+02	1.27E+03	2.53E+03	5.63E+02	1.43E+03	2.72E+03	6.26E+02	1.39E+03	2.41E+03	2.21E+03	2.73E+03	3.93E+03	2.26E+03	2.79E+03	4.01E+03
Tl (Thallium)	µg/L	2.78E-04	6.85E-03	1.38E-01	2.08E-03	4.61E-02	1.98E-01	2.91E-03	7.52E-02	2.00E-01	2.95E-03	9.08E-02	2.00E-01	7.29E-03	7.57E-02	2.00E-01	1.72E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01
V (Vanadium)	µg/L	2.93E+00	8.08E+00	8.14E+00	9.91E+00	9.91E+00	9.92E+00	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01
Zn (Zinc)	µg/L	1.87E+01	5.54E+01	1.33E+02	8.54E+01	1.64E+02	3.45E+02	9.10E+01	1.81E+02	3.75E+02	9.18E+01	1.88E+02	3.83E+02	9.18E+01	1.88E+02	3.81E+02	9.22E+01	1.92E+02	3.90E+02	9.22E+01	1.92E+02	3.90E+02

Notes

[1] Values shown are the average of the monthly P10 values for the referenced Mine Year.

[2] Values shown are the average of the monthly P50 values for the referenced Mine Year.

[3] Values shown are the average of the monthly P90 values for the referenced Mine Year.

[4] Reclamation of the Category 1 Waste Rock Stockpile with a geomembrane cover starts at the beginning of Mine Year 14.

[5] Concentrations in the Category 1 Waste Rock Stockpile seepage are typically stable from approximately Mine Year 30 through long-term closure.

Large Table 17 Annual Summary of Concentration Statistics for the East Pit Sump Dewatering

Constituent	Mine Year	1[4]			5[4]			10[4]			14[5]		
	Percentile	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]
	Units												
Ag (Silver)	µg/L	1.83E-01	1.83E-01	1.83E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	1.80E-01	1.93E-01	1.99E-01
Al (Aluminum)	µg/L	1.30E-01	4.55E-01	1.59E+00	1.41E-01	4.96E-01	1.74E+00	1.41E-01	4.96E-01	1.74E+00	1.41E-01	4.96E-01	1.74E+00
Alkalinity	mg/L	8.76E+00	2.49E+01	3.87E+01	9.56E+00	2.80E+01	4.40E+01	9.56E+00	2.80E+01	4.49E+01	9.33E+00	2.04E+01	3.09E+01
As (Arsenic)	µg/L	3.20E+01	4.91E+01	9.07E+01	1.11E+01	2.66E+01	7.60E+01	8.20E+00	1.77E+01	4.87E+01	1.68E+01	3.09E+01	6.40E+01
B (Boron)	µg/L	4.92E+01	6.37E+01	8.55E+01	4.71E+01	6.18E+01	8.06E+01	4.46E+01	5.39E+01	6.84E+01	3.01E+01	4.05E+01	5.68E+01
Ba (Barium)	µg/L	2.73E+01	3.02E+01	3.43E+01	2.16E+01	2.66E+01	3.08E+01	1.77E+01	2.95E+01	3.37E+01	1.41E+01	2.17E+01	2.92E+01
Be (Beryllium)	µg/L	3.67E-01	3.67E-01	3.67E-01	4.00E-01	4.00E-01	4.00E-01	4.00E-01	4.00E-01	4.00E-01	3.42E-01	3.92E-01	4.00E-01
Ca (Calcium)	mg/L	9.40E+01	1.36E+02	2.18E+02	2.78E+01	4.26E+01	6.87E+01	2.45E+01	3.26E+01	4.63E+01	8.00E+01	1.07E+02	1.37E+02
Cd (Cadmium)	µg/L	1.40E+00	5.96E+00	2.08E+01	1.29E+00	4.02E+00	1.20E+01	9.72E-01	2.48E+00	7.26E+00	1.07E+00	2.73E+00	7.29E+00
Cl (Chloride)	mg/L	2.65E+00	8.96E+00	5.04E+01	2.04E+00	4.11E+00	1.73E+01	1.83E+00	2.98E+00	9.55E+00	3.43E-01	3.95E-01	5.95E-01
Co (Cobalt)	µg/L	1.44E+02	4.94E+02	9.41E+02	7.87E+01	1.63E+02	3.08E+02	4.37E+01	8.65E+01	1.60E+02	4.34E+01	8.70E+01	1.73E+02
Cr (Chromium)	µg/L	2.02E+00	2.82E+00	3.51E+00	7.85E-01	9.61E-01	1.25E+00	6.90E-01	7.87E-01	9.43E-01	1.53E+00	1.93E+00	2.35E+00
Cu (Copper)	µg/L	1.76E+02	3.02E+03	6.62E+03	1.87E+02	1.79E+03	3.72E+03	1.79E+02	9.92E+02	2.60E+03	1.77E+02	8.10E+02	2.48E+03
F (Fluoride)	mg/L	9.99E-01	1.85E+00	3.35E+00	2.05E-01	2.66E-01	3.73E-01	1.80E-01	2.19E-01	2.70E-01	2.09E-01	2.82E-01	3.68E-01
Fe (Iron)	µg/L	4.51E+01	8.91E+01	1.92E+02	4.92E+01	9.72E+01	2.09E+02	4.92E+01	9.72E+01	2.09E+02	4.92E+01	9.72E+01	2.09E+02
K (Potassium)	mg/L	9.13E+00	1.48E+01	2.25E+01	3.39E+00	5.10E+00	9.21E+00	2.74E+00	3.66E+00	5.83E+00	6.29E+00	8.52E+00	1.15E+01
Mg (Magnesium)	mg/L	1.47E+01	3.29E+01	7.97E+01	1.15E+01	1.57E+01	2.47E+01	1.08E+01	1.37E+01	1.87E+01	1.42E+01	2.55E+01	5.50E+01
Mn (Manganese)	µg/L	4.62E+02	8.23E+02	1.33E+03	2.47E+02	3.53E+02	5.05E+02	2.04E+02	2.78E+02	3.68E+02	2.87E+02	3.60E+02	4.66E+02
Na (Sodium)	mg/L	2.21E+01	3.75E+01	7.51E+01	1.04E+01	1.44E+01	2.20E+01	9.97E+00	1.26E+01	1.72E+01	1.83E+01	3.34E+01	4.78E+01
Ni (Nickel)	µg/L	1.52E+03	7.07E+03	1.46E+04	8.08E+02	1.79E+03	3.26E+03	4.35E+02	9.85E+02	1.75E+03	4.50E+02	8.75E+02	1.66E+03
Pb (Lead)	µg/L	1.83E+00	1.83E+00	1.83E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	1.94E+00	2.00E+00	2.00E+00
Sb (Antimony)	µg/L	8.86E+00	2.12E+01	3.74E+01	4.66E+00	8.88E+00	1.56E+01	2.93E+00	5.19E+00	8.86E+00	5.31E+00	1.09E+01	1.76E+01
Se (Selenium)	µg/L	6.52E+00	1.30E+01	2.46E+01	1.83E+00	3.04E+00	5.27E+00	1.28E+00	1.94E+00	3.15E+00	5.86E-01	1.12E+00	6.27E+00
SO4 (Sulfate)	mg/L	3.39E+02	5.50E+02	8.76E+02	8.25E+01	1.43E+02	2.22E+02	5.97E+01	9.21E+01	1.35E+02	1.16E+02	2.49E+02	4.46E+02
Tl (Thallium)	µg/L	1.20E-01	1.34E-01	1.54E-01	1.92E-01	1.98E-01	2.00E-01	1.99E-01	2.00E-01	2.00E-01	7.48E-02	9.34E-02	1.12E-01
V (Vanadium)	µg/L	7.92E+00	8.86E+00	9.17E+00	8.96E+00	9.66E+00	1.00E+01	8.91E+00	9.76E+00	1.00E+01	7.34E+00	8.24E+00	9.57E+00
Zn (Zinc)	µg/L	1.65E+02	7.16E+02	1.43E+03	1.67E+02	4.68E+02	1.15E+03	1.30E+02	2.93E+02	7.42E+02	1.28E+02	2.99E+02	7.08E+02

Notes

[1] Values shown are the average of the monthly P10 values for the referenced Mine Year.

[2] Values shown are the average of the monthly P50 values for the referenced Mine Year.

[3] Values shown are the average of the monthly P90 values for the referenced Mine Year.

[4] Results shown are for the East Pit sump. The location of the sump shifts from the East Pit to the Central Pit during Mine Year 11.

[5] Results shown are for the Central Pit sump. The location of the sump shifts from the East Pit to the Central Pit during Mine Year 11. Central Pit mining is complete during Mine Year 16.

Large Table 18 Annual Summary of Concentration Statistics for the East Pit Lower Porewater

	Mine Year	11[4]			14			20			25			41[5]			75[6]		
	Percentile	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]
Constituent	Units																		
Ag (Silver)	µg/L	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01
Al (Aluminum)	µg/L	1.41E-01	4.96E-01	1.74E+00	1.41E-01	4.96E-01	1.74E+00	1.41E-01	4.96E-01	1.74E+00	1.41E-01	4.96E-01	1.74E+00	1.41E-01	4.96E-01	1.74E+00	1.41E-01	4.96E-01	1.74E+00
Alkalinity	mg/L	9.56E+00	2.80E+01	4.54E+01	9.56E+00	2.80E+01	4.54E+01	9.56E+00	2.80E+01	4.54E+01	9.56E+00	2.80E+01	4.54E+01	9.56E+00	2.80E+01	4.54E+01	9.56E+00	2.80E+01	4.54E+01
As (Arsenic)	µg/L	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02
B (Boron)	µg/L	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02
Ba (Barium)	µg/L	3.47E+01	3.57E+01	3.64E+01	9.73E+00	1.10E+01	1.19E+01	1.01E+01	1.17E+01	1.52E+01	1.09E+01	1.44E+01	1.91E+01	2.26E+01	2.28E+01	2.29E+01	2.28E+01	2.29E+01	2.29E+01
Be (Beryllium)	µg/L	4.00E-01	4.00E-01	4.00E-01	4.00E-01	4.00E-01	4.00E-01	4.00E-01	4.00E-01	4.00E-01	4.00E-01	4.00E-01	4.00E-01	4.00E-01	4.00E-01	4.00E-01	4.00E-01	4.00E-01	4.00E-01
Ca (Calcium)	mg/L	6.38E+02	6.91E+02	7.47E+02	2.74E+02	6.69E+02	7.31E+02	3.73E+02	6.80E+02	7.33E+02	1.72E+02	6.35E+02	7.25E+02	6.43E+01	1.28E+02	7.01E+02	6.43E+01	1.26E+02	6.96E+02
Cd (Cadmium)	µg/L	1.61E+00	1.00E+01	4.37E+01	1.61E+00	1.00E+01	4.37E+01	1.61E+00	1.00E+01	4.37E+01	1.61E+00	1.00E+01	4.14E+01	1.61E+00	9.72E+00	3.49E+01	1.61E+00	9.68E+00	3.49E+01
Cl (Chloride)	mg/L	2.76E+00	6.53E+00	2.60E+01	3.48E+00	8.91E+00	2.67E+01	2.53E+01	3.30E+01	6.19E+01	5.73E+01	6.43E+01	8.99E+01	8.32E+01	9.24E+01	1.10E+02	8.25E+01	9.21E+01	1.10E+02
Co (Cobalt)	µg/L	2.63E+02	1.47E+03	2.79E+03	2.63E+02	1.45E+03	2.77E+03	2.63E+02	1.35E+03	2.50E+03	2.49E+02	8.02E+02	1.85E+03	9.52E+01	2.42E+02	7.94E+02	9.03E+01	2.39E+02	7.53E+02
Cr (Chromium)	µg/L	1.00E+01	1.00E+01	1.00E+01	7.71E+00	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01
Cu (Copper)	µg/L	1.97E+02	5.32E+03	1.28E+04	1.97E+02	5.32E+03	1.28E+04	1.97E+02	5.32E+03	1.28E+04	1.97E+02	5.32E+03	1.28E+04	1.97E+02	5.32E+03	1.28E+04	1.97E+02	5.32E+03	1.28E+04
F (Fluoride)	mg/L	3.19E+00	4.51E+00	6.61E+00	1.33E+00	1.39E+00	2.09E+00	1.33E+00	1.38E+00	1.85E+00	1.33E+00	1.42E+00	2.71E+00	1.36E+00	3.09E+00	4.38E+00	1.36E+00	3.10E+00	4.38E+00
Fe (Iron)	µg/L	4.92E+01	9.72E+01	2.09E+02	4.92E+01	9.72E+01	2.09E+02	4.92E+01	9.72E+01	2.09E+02	4.92E+01	9.72E+01	2.09E+02	4.92E+01	9.72E+01	2.09E+02	4.92E+01	9.72E+01	2.09E+02
K (Potassium)	mg/L	4.43E+01	5.08E+01	5.85E+01	4.40E+01	5.07E+01	5.78E+01	4.43E+01	5.08E+01	5.85E+01	4.43E+01	5.08E+01	5.85E+01	4.43E+01	5.08E+01	5.85E+01	4.43E+01	5.08E+01	5.85E+01
Mg (Magnesium)	mg/L	3.89E+01	1.22E+02	4.22E+02	3.78E+01	1.08E+02	3.12E+02	3.82E+01	1.03E+02	3.95E+02	3.46E+01	7.76E+01	2.84E+02	3.14E+01	4.20E+01	1.17E+02	3.13E+01	4.15E+01	1.12E+02
Mn (Manganese)	µg/L	1.05E+03	2.30E+03	3.71E+03	9.99E+02	2.13E+03	3.62E+03	7.55E+02	1.82E+03	3.52E+03	4.25E+02	1.45E+03	3.33E+03	1.32E+02	4.11E+02	2.03E+03	1.29E+02	4.00E+02	2.03E+03
Na (Sodium)	mg/L	1.61E+02	2.33E+02	4.10E+02	5.34E+01	1.27E+02	2.49E+02	1.58E+02	2.23E+02	4.17E+02	1.71E+02	2.47E+02	4.39E+02	1.71E+02	2.48E+02	4.51E+02	1.71E+02	2.47E+02	4.50E+02
Ni (Nickel)	µg/L	2.92E+03	3.16E+04	7.29E+04	2.87E+03	2.02E+04	4.26E+04	2.87E+03	1.13E+04	3.03E+04	2.28E+03	5.68E+03	1.58E+04	5.61E+02	1.12E+03	4.85E+03	5.04E+02	1.10E+03	4.79E+03
Pb (Lead)	µg/L	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00
Sb (Antimony)	µg/L	1.75E+01	5.42E+01	9.08E+01	1.75E+01	5.42E+01	9.08E+01	1.75E+01	5.42E+01	9.08E+01	1.75E+01	5.41E+01	9.08E+01	1.75E+01	5.34E+01	9.00E+01	1.75E+01	5.34E+01	9.00E+01
Se (Selenium)	µg/L	4.09E+01	8.07E+01	1.58E+02	1.65E+01	3.76E+01	8.42E+01	1.78E+01	5.44E+01	1.48E+02	9.82E+00	2.70E+01	9.14E+01	5.93E+00	7.41E+00	1.15E+01	5.91E+00	7.09E+00	1.02E+01
SO4 (Sulfate)	mg/L	2.07E+03	2.63E+03	3.82E+03	1.94E+03	2.52E+03	3.68E+03	9.09E+02	2.10E+03	3.24E+03	4.47E+02	1.06E+03	2.57E+03	2.55E+02	2.57E+02	2.64E+02	2.54E+02	2.56E+02	2.59E+02
Tl (Thallium)	µg/L	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01
V (Vanadium)	µg/L	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01
Zn (Zinc)	µg/L	1.84E+02	1.13E+03	1.96E+03	1.84E+02	1.13E+03	1.96E+03	1.84E+02	1.13E+03	1.96E+03	1.84E+02	1.13E+03	1.96E+03	1.84E+02	1.13E+03	1.96E+03	1.84E+02	1.13E+03	1.96E+03

Notes

[1] Values shown are the average of the monthly P10 values for the referenced Mine Year.

[2] Values shown are the average of the monthly P50 values for the referenced Mine Year.

[3] Values shown are the average of the monthly P90 values for the referenced Mine Year.

[4] Backfilling begins in the East Pit in the middle of Mine Year 11. Results shown are average values for the second half of Mine Year 11.

[5] Treatment of the East Pit porewater has a 90% probability of being complete by the end of Mine Year 41.

[6] Concentrations in the East Pit porewater are typically stable or trending downward in long-term closure following the end of porewater pumping for treatment.

Large Table 19 Annual Summary of Concentration Statistics for the East Pit Upper/Wetland Porewater

Constituent	Mine Year	25[4]			41[5]			75[6]		
	Percentile	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]
	Units									
Ag (Silver)	µg/L	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01
Al (Aluminum)	µg/L	1.41E-01	4.96E-01	1.74E+00	1.41E-01	4.96E-01	1.74E+00	1.41E-01	4.96E-01	1.74E+00
Alkalinity	mg/L	9.56E+00	2.80E+01	4.54E+01	9.56E+00	2.80E+01	4.54E+01	9.56E+00	2.80E+01	4.54E+01
As (Arsenic)	µg/L	1.69E+01	2.71E+01	7.09E+01	2.21E+00	3.52E+00	5.67E+00	1.56E+00	2.32E+00	3.77E+00
B (Boron)	µg/L	8.46E+01	1.00E+02	1.00E+02	2.83E+01	3.66E+01	5.45E+01	2.33E+01	2.87E+01	3.50E+01
Ba (Barium)	µg/L	2.57E+01	2.79E+01	3.02E+01	3.80E+01	5.18E+01	6.00E+01	4.29E+00	7.17E+00	7.06E+01
Be (Beryllium)	µg/L	4.00E-01	4.00E-01	4.00E-01	2.02E-01	4.00E-01	4.00E-01	8.86E-02	1.48E-01	4.00E-01
Ca (Calcium)	mg/L	3.36E+01	4.72E+01	8.20E+01	8.65E+00	1.10E+01	2.17E+01	6.93E+00	8.06E+00	9.37E+00
Cd (Cadmium)	µg/L	1.30E+00	2.31E+00	6.64E+00	2.52E-01	5.43E-01	1.44E+00	1.06E-01	1.82E-01	3.60E-01
Cl (Chloride)	mg/L	3.54E+01	4.29E+01	5.34E+01	4.08E+00	8.57E+00	3.02E+01	1.56E+00	2.02E+00	2.70E+00
Co (Cobalt)	µg/L	2.29E+01	4.03E+01	7.46E+01	3.15E+00	5.17E+00	8.40E+00	2.14E+00	3.80E+00	6.76E+00
Cr (Chromium)	µg/L	2.98E+00	3.39E+00	3.87E+00	4.96E-01	8.71E-01	2.87E+00	2.71E-01	3.15E-01	3.65E-01
Cu (Copper)	µg/L	1.97E+02	1.65E+03	6.18E+03	8.18E+01	1.64E+02	5.85E+02	2.39E+01	6.83E+01	3.11E+02
F (Fluoride)	mg/L	8.40E-01	9.68E-01	1.12E+00	9.63E-02	1.81E-01	5.04E-01	4.44E-02	5.28E-02	6.33E-02
Fe (Iron)	µg/L	4.92E+01	9.72E+01	2.09E+02	4.92E+01	9.72E+01	2.09E+02	4.92E+01	9.72E+01	2.09E+02
K (Potassium)	mg/L	4.43E+01	5.08E+01	5.85E+01	4.33E+00	9.47E+00	2.38E+01	7.41E-01	8.83E-01	1.06E+00
Mg (Magnesium)	mg/L	1.41E+01	2.02E+01	3.22E+01	4.48E+00	5.66E+00	8.39E+00	3.39E+00	3.94E+00	4.64E+00
Mn (Manganese)	µg/L	1.02E+02	1.56E+02	2.73E+02	5.87E+01	7.49E+01	1.02E+02	5.63E+01	7.28E+01	1.02E+02
Na (Sodium)	mg/L	1.61E+02	1.99E+02	2.46E+02	1.15E+01	2.49E+01	8.17E+01	2.29E+00	2.84E+00	3.61E+00
Ni (Nickel)	µg/L	2.35E+02	4.07E+02	8.07E+02	2.82E+01	4.44E+01	6.56E+01	1.55E+01	2.46E+01	4.30E+01
Pb (Lead)	µg/L	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00
Sb (Antimony)	µg/L	1.04E+01	1.40E+01	2.25E+01	9.78E-01	2.21E+00	9.13E+00	2.79E-01	3.89E-01	5.81E-01
Se (Selenium)	µg/L	2.07E+00	2.77E+00	4.42E+00	4.24E-01	6.39E-01	1.71E+00	2.74E-01	3.17E-01	3.77E-01
SO4 (Sulfate)	mg/L	1.06E+02	1.36E+02	1.76E+02	1.22E+01	1.95E+01	5.17E+01	6.62E+00	8.28E+00	1.04E+01
Tl (Thallium)	µg/L	1.03E-01	1.21E-01	1.57E-01	4.94E-02	6.77E-02	9.80E-02	4.08E-02	5.46E-02	7.51E-02
V (Vanadium)	µg/L	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.31E+00	1.00E+01	1.00E+01
Zn (Zinc)	µg/L	1.27E+02	2.01E+02	4.56E+02	2.58E+01	4.79E+01	1.11E+02	1.50E+01	2.56E+01	4.58E+01

Notes

[1] Values shown are the average of the monthly P10 values for the referenced Mine Year.

[2] Values shown are the average of the monthly P50 values for the referenced Mine Year.

[3] Values shown are the average of the monthly P90 values for the referenced Mine Year.

[4] The upper/wetland porewater (above elevation 1577') is typically not flooded until Mine Year 21.

[5] Treatment of the East Pit porewater has a 90% probability of being complete by the end of Mine Year 41.

[6] Concentrations in the East Pit porewater are typically stable or trending downward in long-term closure following the end of porewater pumping for treatment.

Large Table 20 Annual Summary of Concentration Statistics for the West Pit

Constituent	Mine Year	5			11			14			20			25			55[4]			75[5]		
	Percentile	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]
	Units																					
Ag (Silver)	µg/L	1.74E-01	1.80E-01	1.91E-01	1.70E-01	1.76E-01	1.84E-01	1.66E-01	1.72E-01	1.79E-01	1.71E-01	1.75E-01	1.83E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01	2.00E-01
Al (Aluminum)	µg/L	9.30E-01	1.41E+00	2.15E+00	9.30E-01	1.41E+00	2.15E+00	9.30E-01	1.41E+00	2.15E+00	9.30E-01	1.41E+00	2.15E+00	9.30E-01	1.41E+00	2.15E+00	9.30E-01	1.41E+00	2.15E+00	9.30E-01	1.41E+00	2.15E+00
Alkalinity	mg/L	3.09E+01	3.69E+01	4.71E+01	2.72E+01	3.49E+01	4.43E+01	2.51E+01	3.32E+01	4.31E+01	2.33E+01	3.17E+01	4.26E+01	3.48E+01	3.97E+01	5.11E+01	3.48E+01	3.97E+01	5.11E+01	3.48E+01	3.97E+01	5.11E+01
As (Arsenic)	µg/L	4.05E+01	6.22E+01	8.25E+01	3.15E+01	4.87E+01	5.77E+01	2.68E+01	4.76E+01	5.72E+01	2.65E+01	4.99E+01	5.66E+01	1.09E+01	1.36E+01	1.88E+01	8.88E+00	1.08E+01	1.49E+01	7.98E+00	9.72E+00	1.33E+01
B (Boron)	µg/L	6.81E+01	9.00E+01	9.56E+01	5.47E+01	6.58E+01	9.03E+01	5.48E+01	6.33E+01	8.72E+01	5.22E+01	6.10E+01	8.55E+01	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02
Ba (Barium)	µg/L	1.71E+01	1.96E+01	2.34E+01	1.89E+01	2.18E+01	2.50E+01	1.90E+01	2.21E+01	2.53E+01	2.05E+01	2.33E+01	2.76E+01	2.81E+01	3.03E+01	3.13E+01	2.81E+01	3.60E+01	3.82E+01	2.69E+01	3.69E+01	3.95E+01
Be (Beryllium)	µg/L	3.28E-01	3.57E-01	3.82E-01	3.10E-01	3.39E-01	3.52E-01	2.65E-01	3.36E-01	3.49E-01	2.62E-01	3.34E-01	3.52E-01	4.00E-01	4.00E-01	4.00E-01	3.50E-01	4.00E-01	4.00E-01	3.21E-01	4.00E-01	4.00E-01
Ca (Calcium)	mg/L	1.54E+02	2.45E+02	3.99E+02	1.28E+02	1.88E+02	3.10E+02	1.16E+02	1.67E+02	2.76E+02	7.89E+01	1.45E+02	3.04E+02	4.93E+01	5.50E+01	7.07E+01	3.43E+01	3.87E+01	4.95E+01	3.08E+01	3.47E+01	4.48E+01
Cd (Cadmium)	µg/L	1.30E+00	2.72E+00	5.84E+00	1.07E+00	2.42E+00	5.44E+00	1.05E+00	2.40E+00	5.34E+00	9.38E-01	2.37E+00	5.53E+00	1.16E+00	1.89E+00	4.72E+00	7.66E-01	1.50E+00	3.88E+00	6.84E-01	1.41E+00	3.63E+00
Cl (Chloride)	mg/L	4.91E+00	1.77E+01	9.82E+01	4.34E+00	1.51E+01	8.63E+01	4.91E+00	1.79E+01	1.05E+02	1.67E+00	5.21E+00	2.90E+01	1.25E+01	1.34E+01	1.54E+01	8.16E+00	1.06E+01	1.50E+01	7.29E+00	9.54E+00	1.34E+01
Co (Cobalt)	µg/L	6.10E+01	1.19E+02	2.91E+02	5.73E+01	1.08E+02	2.39E+02	5.67E+01	1.07E+02	2.38E+02	5.61E+01	1.05E+02	2.42E+02	2.19E+01	5.28E+01	1.13E+02	1.72E+01	3.82E+01	8.01E+01	1.55E+01	3.40E+01	7.35E+01
Cr (Chromium)	µg/L	3.19E+00	4.33E+00	6.13E+00	2.35E+00	3.20E+00	4.68E+00	2.07E+00	2.85E+00	4.13E+00	1.67E+00	2.55E+00	4.23E+00	3.86E+00	4.00E+00	4.14E+00	2.37E+00	2.57E+00	2.91E+00	2.10E+00	2.29E+00	2.59E+00
Cu (Copper)	µg/L	1.18E+02	2.33E+02	6.22E+02	1.17E+02	2.31E+02	6.19E+02	1.17E+02	2.30E+02	6.15E+02	1.17E+02	2.30E+02	6.19E+02	1.19E+02	2.37E+02	6.57E+02	1.19E+02	2.37E+02	6.55E+02	1.19E+02	2.37E+02	6.55E+02
F (Fluoride)	mg/L	6.96E-01	9.94E-01	1.33E+00	4.94E-01	7.06E-01	9.53E-01	4.24E-01	6.90E-01	1.01E+00	4.21E-01	7.18E-01	1.06E+00	2.85E-01	3.15E-01	3.54E-01	1.99E-01	2.49E-01	3.08E-01	1.79E-01	2.22E-01	2.75E-01
Fe (Iron)	µg/L	4.58E+01	5.99E+01	1.99E+02	4.58E+01	5.99E+01	1.99E+02	4.58E+01	5.99E+01	1.99E+02	4.58E+01	5.99E+01	1.99E+02	4.58E+01	5.99E+01	1.99E+02	4.58E+01	5.99E+01	1.99E+02	4.58E+01	5.99E+01	1.99E+02
K (Potassium)	mg/L	1.74E+01	2.76E+01	4.07E+01	1.29E+01	2.06E+01	2.84E+01	1.14E+01	1.84E+01	2.79E+01	9.85E+00	1.90E+01	2.82E+01	1.28E+01	1.42E+01	1.73E+01	7.96E+00	1.00E+01	1.37E+01	7.06E+00	8.85E+00	1.20E+01
Mg (Magnesium)	mg/L	2.84E+01	5.51E+01	1.05E+02	2.30E+01	4.41E+01	8.44E+01	2.07E+01	3.99E+01	7.78E+01	1.60E+01	3.15E+01	6.51E+01	3.27E+01	3.53E+01	3.97E+01	1.44E+01	1.58E+01	1.89E+01	1.30E+01	1.43E+01	1.69E+01
Mn (Manganese)	µg/L	1.87E+02	2.29E+02	4.57E+02	1.69E+02	2.11E+02	3.80E+02	1.56E+02	2.06E+02	3.70E+02	1.46E+02	2.02E+02	3.58E+02	1.91E+02	2.32E+02	3.12E+02	1.26E+02	1.46E+02	1.98E+02	1.21E+02	1.40E+02	1.88E+02
Na (Sodium)	mg/L	3.80E+01	6.88E+01	1.16E+02	3.51E+01	5.50E+01	8.94E+01	3.20E+01	5.05E+01	7.99E+01	2.22E+01	3.96E+01	7.87E+01	4.37E+01	5.03E+01	6.37E+01	2.58E+01	3.41E+01	5.22E+01	2.31E+01	3.03E+01	4.61E+01
Ni (Nickel)	µg/L	1.24E+03	2.06E+03	5.65E+03	1.13E+03	1.88E+03	4.51E+03	1.12E+03	1.86E+03	4.46E+03	1.09E+03	1.83E+03	4.51E+03	3.31E+02	6.84E+02	1.47E+03	2.69E+02	4.89E+02	9.02E+02	2.41E+02	4.33E+02	8.02E+02
Pb (Lead)	µg/L	2.65E+00	3.37E+00	5.42E+00	3.04E+00	4.08E+00	7.34E+00	2.92E+00	3.93E+00	6.61E+00	3.11E+00	3.97E+00	5.30E+00	7.62E+00	1.15E+01	2.09E+01	5.61E+00	7.87E+00	1.19E+01	5.10E+00	7.06E+00	1.05E+01
Sb (Antimony)	µg/L	1.29E+01	2.69E+01	4.50E+01	9.77E+00	2.04E+01	3.44E+01	9.48E+00	1.86E+01	3.20E+01	8.39E+00	1.77E+01	3.32E+01	9.90E+00	1.12E+01	1.37E+01	6.37E+00	7.68E+00	9.56E+00	5.64E+00	6.83E+00	8.50E+00
Se (Selenium)	µg/L	2.55E-01	3.85E+00	1.80E+01	2.55E-01	3.23E+00	1.62E+01	2.55E-01	3.22E+00	1.40E+01	2.55E-01	3.09E+00	1.33E+01	2.55E-01	2.71E+00	3.40E+00	2.55E-01	1.78E+00	2.41E+00	2.55E-01	1.61E+00	2.17E+00
SO4 (Sulfate)	mg/L	3.09E+02	5.20E+02	8.00E+02	2.86E+02	4.47E+02	6.64E+02	2.53E+02	4.02E+02	6.12E+02	1.99E+02	3.53E+02	5.50E+02	9.51E+01	1.05E+02	1.25E+02	4.84E+01	5.68E+01	6.85E+01	4.31E+01	5.09E+01	6.19E+01
Tl (Thallium)	µg/L	8.64E-02	1.16E-01	1.58E-01	9.07E-02	1.05E-01	1.22E-01	8.30E-02	1.04E-01	1.18E-01	9.74E-02	1.03E-01	1.21E-01	1.12E-01	1.17E-01	1.27E-01	7.75E-02	8.36E-02	9.27E-02	7.27E-02	7.82E-02	8.66E-02
V (Vanadium)	µg/L	9.17E+00	9.55E+00	9.63E+00	8.63E+00	8.98E+00	9.45E+00	8.52E+00	8.82E+00	9.25E+00	8.44E+00	8.73E+00	9.26E+00	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01	1.00E+01
Zn (Zinc)	µg/L	8.81E+01	1.66E+02	3.40E+02	8.10E+01	1.47E+02	2.94E+02	8.01E+01	1.46E+02	2.90E+02	7.81E+01	1.45E+02	3.03E+02	8.60E+01	1.16E+02	2.74E+02	6.36E+01	9.86E+01	2.29E+02	5.74E+01	9.57E+01	2.22E+02

Notes

[1] Values shown are the average of the monthly P10 values for the referenced Mine Year.

[2] Values shown are the average of the monthly P50 values for the referenced Mine Year.

[3] Values shown are the average of the monthly P90 values for the referenced Mine Year.

[4] Flooding of the West Pit has a 90% probability of being complte by the end of Mine Year 55.

[5] Concentrations in the West Pit are typically stable or trending downward in long-term closure.

Large Table 21 Annual Summary of Concentration Statistics for the West EQ Basin

Constituent	Mine Year		1			5			11			14			20		
	Percentile		Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]
	Units	Modeled WWTF Target															
Ag (Silver)	µg/L	1	1.54E+00	5.15E+00	1.50E+01	2.38E+00	7.98E+00	3.39E+01	1.68E+01	2.25E+01	4.22E+01	2.33E+01	2.69E+01	3.25E+01	2.23E+01	2.64E+01	3.07E+01
Al (Aluminum)	µg/L	125	2.57E+04	6.13E+04	1.34E+05	3.91E+04	9.95E+04	2.13E+05	1.06E+05	2.39E+05	4.02E+05	8.99E+04	2.41E+05	5.26E+05	7.99E+04	2.28E+05	4.99E+05
Alkalinity	mg/L	--	**6.09E+00**	**1.80E+01**	**2.76E+01**	**7.00E+00**	**2.06E+01**	**3.16E+01**	**3.87E+00**	**1.23E+01**	**1.93E+01**	**2.95E+00**	**9.73E+00**	**1.57E+01**	**1.58E-03**	**9.86E-02**	**3.55E-01**
As (Arsenic)	µg/L	10	6.36E+01	9.13E+01	3.04E+02	7.75E+01	1.13E+02	4.09E+02	8.49E+01	1.09E+02	3.08E+02	9.97E+01	9.98E+01	9.98E+01	6.33E+01	6.39E+01	6.43E+01
B (Boron)	µg/L	500	**9.31E+01**	**2.05E+02**	**3.72E+02**	**1.19E+02**	**3.74E+02**	7.39E+02	**1.55E+02**	**3.35E+02**	6.33E+02	**1.06E+02**	**1.64E+02**	**2.64E+02**	**6.98E+01**	**1.27E+02**	**2.27E+02**
Ba (Barium)	µg/L	2000	**2.07E+01**	**3.83E+01**	**1.38E+02**	**1.07E+01**	**3.32E+01**	**2.09E+02**	**9.05E+00**	**2.41E+01**	**1.45E+02**	**8.27E+00**	**9.61E+00**	**1.33E+01**	**4.63E+00**	**8.24E+00**	**1.48E+01**
Be (Beryllium)	µg/L	4	**1.30E+00**	**2.97E+00**	2.28E+01	**1.81E+00**	4.06E+00	3.76E+01	5.59E+00	9.92E+00	3.34E+01	6.21E+00	1.08E+01	1.41E+01	**1.78E+00**	8.58E+00	1.31E+01
Ca (Calcium)	mg/L	--	1.12E+02	1.93E+02	3.80E+02	4.06E+02	6.02E+02	6.48E+02	4.53E+02	5.31E+02	5.62E+02	3.96E+02	5.01E+02	5.43E+02	7.37E+01	2.51E+02	2.88E+02
Cd (Cadmium)	µg/L	4	1.35E+01	2.44E+01	5.63E+01	2.08E+01	4.20E+01	8.76E+01	3.89E+01	6.91E+01	1.27E+02	1.70E+01	5.99E+01	1.47E+02	**2.60E+00**	1.46E+01	6.91E+01
Cl (Chloride)	mg/L	230	**7.80E+00**	**2.61E+01**	**2.08E+02**	**1.80E+00**	**6.93E+00**	**5.04E+01**	**1.77E+00**	**7.50E+00**	**5.07E+01**	**8.85E-22**	**2.85E-21**	**7.67E-21**	**8.85E-22**	**2.85E-21**	**7.65E-21**
Co (Cobalt)	µg/L	5	1.01E+03	1.93E+03	3.25E+03	2.67E+03	4.30E+03	7.34E+03	5.02E+03	1.02E+04	1.65E+04	2.35E+03	9.04E+03	2.07E+04	8.64E+02	4.24E+03	2.23E+04
Cr (Chromium)	µg/L	11	**3.44E+00**	**6.27E+00**	**9.50E+00**	**9.94E+00**	1.12E+01	2.31E+01	1.20E+01	1.35E+01	2.69E+01	1.33E+01	1.38E+01	1.45E+01	**2.82E+00**	**9.98E+00**	**1.06E+01**
Cu (Copper)	µg/L	30	3.15E+02	3.90E+03	8.58E+03	1.53E+03	5.57E+03	1.10E+04	5.13E+04	6.11E+04	6.96E+04	8.49E+04	9.94E+04	1.10E+05	8.07E+04	9.43E+04	1.05E+05
F (Fluoride)	mg/L	2	**1.13E+00**	**1.66E+00**	2.19E+00	**1.44E+00**	**1.50E+00**	2.02E+00	**1.55E+00**	**1.60E+00**	**1.75E+00**	**1.56E+00**	**1.64E+00**	**1.88E+00**	**1.04E+00**	**1.15E+00**	2.29E+00
Fe (Iron)	µg/L	300	1.67E+03	4.78E+04	1.90E+05	2.81E+03	7.88E+04	5.39E+05	2.25E+04	9.09E+04	4.69E+05	1.97E+04	5.71E+04	1.13E+05	1.95E+04	5.46E+04	1.10E+05
K (Potassium)	mg/L	--	**1.11E+01**	**2.32E+01**	**3.17E+01**	**3.51E+01**	**4.07E+01**	**4.68E+01**	**3.03E+01**	**3.61E+01**	**4.22E+01**	**2.92E+01**	**3.64E+01**	**4.58E+01**	**1.10E+01**	**1.76E+01**	**2.69E+01**
Mg (Magnesium)	mg/L	--	4.92E+01	1.02E+02	1.82E+02	1.72E+02	3.28E+02	6.28E+02	3.01E+02	5.84E+02	9.67E+02	1.50E+02	4.67E+02	9.96E+02	2.41E+01	1.47E+02	7.12E+02
Mn (Manganese)	µg/L	50	1.30E+03	3.03E+03	5.12E+03	5.53E+03	1.17E+04	2.06E+04	1.08E+04	2.62E+04	4.48E+04	4.18E+03	1.79E+04	3.95E+04	1.81E+03	1.27E+04	4.42E+04
Na (Sodium)	mg/L	--	**1.16E+01**	**3.75E+01**	**7.23E+01**	**6.50E+01**	**1.40E+02**	**2.34E+02**	**6.04E+01**	**1.26E+02**	**2.21E+02**	**5.17E+01**	**1.14E+02**	**2.18E+02**	**1.66E+01**	**3.79E+01**	**1.05E+02**
Ni (Nickel)	µg/L	100	3.50E+03	6.98E+03	1.21E+04	6.20E+03	2.06E+04	3.44E+04	4.97E+04	1.34E+05	2.79E+05	3.53E+04	1.61E+05	4.05E+05	1.56E+04	8.19E+04	4.79E+05
Pb (Lead)	µg/L	19	3.44E+01	6.92E+01	1.07E+02	5.02E+01	9.88E+01	1.46E+02	1.20E+02	2.06E+02	2.83E+02	1.11E+02	2.32E+02	3.61E+02	1.04E+02	2.24E+02	3.47E+02
Sb (Antimony)	µg/L	31	5.66E+01	1.33E+02	2.26E+02	1.27E+02	3.73E+02	7.74E+02	4.54E+02	1.00E+03	1.53E+03	4.03E+02	9.81E+02	1.72E+03	3.24E+01	1.85E+02	1.16E+03
Se (Selenium)	µg/L	5	9.53E+00	2.04E+01	3.69E+01	4.08E+01	7.57E+01	1.35E+02	6.58E+01	9.49E+01	1.49E+02	5.80E+01	8.67E+01	1.11E+02	1.30E+01	6.28E+01	6.39E+01
SO4 (Sulfate)	mg/L	250	7.07E+02	1.32E+03	2.61E+03	2.20E+03	4.07E+03	8.90E+03	3.24E+03	6.36E+03	1.12E+04	1.94E+03	5.04E+03	9.01E+03	3.12E+02	1.66E+03	6.98E+03
Tl (Thallium)	µg/L	0.56	**1.92E-01**	**3.52E-01**	**5.35E-01**	**5.54E-01**	7.37E-01	1.82E+00	1.20E+00	2.02E+00	8.70E+00	1.31E+00	1.53E+00	8.10E+00	**4.45E-01**	1.26E+00	1.96E+00
V (Vanadium)	µg/L	50	**7.14E+00**	**8.74E+00**	**4.51E+01**	**8.70E+00**	**1.09E+01**	5.98E+01	**2.54E+01**	**2.87E+01**	6.16E+01	**3.61E+01**	**3.92E+01**	**4.23E+01**	**3.25E+01**	**3.51E+01**	**3.76E+01**
Zn (Zinc)	µg/L	388	1.38E+03	2.30E+03	6.48E+03	2.06E+03	3.40E+03	9.41E+03	3.48E+03	5.97E+03	1.51E+04	1.98E+03	4.86E+03	1.63E+04	4.20E+02	2.28E+03	6.96E+03

Notes

[1] Values shown are the average of the monthly P10 values for the referenced Mine Year.

[2] Values shown are the average of the monthly P50 values for the referenced Mine Year.

[3] Values shown are the average of the monthly P90 values for the referenced Mine Year.

2.00E+02 Values below the modeled WWTF effluent target are shown in bold with light blue shading.

Large Table 22 Annual Summary of Concentration Statistics for the East EQ Basin

Constituent	Mine Year		1			5			11			14			20		
	Percentile		Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]
	Units	Modeled WWTF Target															
Ag (Silver)	µg/L	1	**7.47E-02**	**8.27E-02**	**1.17E-01**	**1.19E-01**	**1.32E-01**	**1.88E-01**	**1.14E-01**	**1.26E-01**	**1.87E-01**	**1.38E-01**	**1.50E-01**	**1.90E-01**	**9.46E-02**	**1.08E-01**	**1.62E-01**
Al (Aluminum)	µg/L	125	**5.58E-01**	**8.74E-01**	**1.43E+00**	**6.32E-01**	**9.96E-01**	**1.67E+00**	**6.77E-01**	**1.06E+00**	**1.83E+00**	**5.58E-01**	**9.01E-01**	**1.69E+00**	**9.28E-01**	**1.41E+00**	**2.14E+00**
Alkalinity	mg/L	--	**2.10E+01**	**2.87E+01**	**3.68E+01**	**2.25E+01**	**3.35E+01**	**4.36E+01**	**2.29E+01**	**3.35E+01**	**4.38E+01**	**1.89E+01**	**3.11E+01**	**4.21E+01**	**2.72E+01**	**3.41E+01**	**4.36E+01**
As (Arsenic)	µg/L	10	1.76E+01	3.12E+01	5.69E+01	2.47E+01	4.78E+01	7.79E+01	2.52E+01	4.47E+01	5.93E+01	7.46E+01	8.34E+01	8.74E+01	3.31E+01	4.89E+01	6.27E+01
B (Boron)	µg/L	500	**3.88E+01**	**6.58E+01**	**7.81E+01**	**6.47E+01**	**7.81E+01**	**8.88E+01**	**6.05E+01**	**6.96E+01**	**8.21E+01**	**8.59E+01**	**8.91E+01**	**9.43E+01**	**5.97E+01**	**7.09E+01**	**8.53E+01**
Ba (Barium)	µg/L	2000	**2.55E+01**	**2.90E+01**	**3.36E+01**	**2.05E+01**	**2.34E+01**	**2.69E+01**	**1.81E+01**	**2.45E+01**	**2.80E+01**	**1.31E+01**	**1.46E+01**	**1.71E+01**	**2.04E+01**	**2.26E+01**	**2.58E+01**
Be (Beryllium)	µg/L	4	**1.64E-01**	**2.35E-01**	**3.35E-01**	**2.68E-01**	**3.77E-01**	**3.95E-01**	**2.61E-01**	**3.66E-01**	**3.84E-01**	**3.16E-01**	**3.74E-01**	**3.87E-01**	**2.17E-01**	**3.10E-01**	**3.64E-01**
Ca (Calcium)	mg/L	--	7.62E+01	1.27E+02	2.01E+02	1.44E+02	2.55E+02	3.00E+02	2.19E+02	2.58E+02	2.99E+02	3.44E+02	5.42E+02	5.92E+02	2.19E+02	2.71E+02	3.37E+02
Cd (Cadmium)	µg/L	4	**1.18E+00**	**3.09E+00**	7.25E+00	**1.84E+00**	**3.75E+00**	7.28E+00	**1.35E+00**	**2.95E+00**	5.42E+00	**1.96E+00**	7.24E+00	2.58E+01	**1.20E+00**	**2.62E+00**	4.93E+00
Cl (Chloride)	mg/L	230	**6.68E+00**	**1.94E+01**	**1.44E+02**	**2.55E+00**	**7.77E+00**	**5.60E+01**	**1.81E+00**	**4.42E+00**	**3.22E+01**	**2.67E+00**	**6.28E+00**	**2.89E+01**	**7.17E-01**	**2.26E+00**	**1.53E+01**
Co (Cobalt)	µg/L	5	1.03E+02	2.03E+02	3.44E+02	9.66E+01	1.56E+02	2.71E+02	6.13E+01	1.15E+02	2.72E+02	1.94E+02	9.15E+02	1.66E+03	6.43E+01	1.17E+02	2.47E+02
Cr (Chromium)	µg/L	11	**2.46E+00**	**4.02E+00**	**5.42E+00**	**3.54E+00**	**4.29E+00**	**4.98E+00**	**3.61E+00**	**4.24E+00**	**4.80E+00**	**7.17E+00**	**8.25E+00**	**8.63E+00**	**3.99E+00**	**4.92E+00**	**6.00E+00**
Cu (Copper)	µg/L	30	1.62E+02	1.29E+03	2.42E+03	1.92E+02	1.22E+03	2.18E+03	1.67E+02	5.75E+02	1.55E+03	2.06E+02	3.37E+03	7.41E+03	1.32E+02	2.62E+02	6.49E+02
F (Fluoride)	mg/L	2	**9.18E-01**	**1.32E+00**	**1.77E+00**	**6.86E-01**	**8.19E-01**	**1.05E+00**	**6.39E-01**	**7.58E-01**	**8.48E-01**	**1.18E+00**	**1.26E+00**	**1.60E+00**	**8.78E-01**	**1.11E+00**	**1.32E+00**
Fe (Iron)	µg/L	300	**4.43E+01**	**7.34E+01**	**1.57E+02**	**5.28E+01**	**9.07E+01**	**1.84E+02**	**5.00E+01**	**8.28E+01**	**1.80E+02**	**5.24E+01**	**9.37E+01**	**1.88E+02**	**4.51E+01**	**5.92E+01**	**1.75E+02**
K (Potassium)	mg/L	--	**1.18E+01**	**1.70E+01**	**2.52E+01**	**1.79E+01**	**2.12E+01**	**2.50E+01**	**1.73E+01**	**2.06E+01**	**2.44E+01**	**3.75E+01**	**4.20E+01**	**4.73E+01**	**2.07E+01**	**2.62E+01**	**3.13E+01**
Mg (Magnesium)	mg/L	--	1.72E+01	3.10E+01	7.23E+01	2.92E+01	5.59E+01	1.28E+02	3.26E+01	6.03E+01	1.32E+02	5.87E+01	1.18E+02	2.27E+02	3.31E+01	6.21E+01	1.33E+02
Mn (Manganese)	µg/L	50	2.31E+02	3.47E+02	4.84E+02	2.52E+02	3.18E+02	4.30E+02	2.05E+02	2.67E+02	4.45E+02	5.94E+02	1.40E+03	2.23E+03	1.62E+02	2.16E+02	3.66E+02
Na (Sodium)	mg/L	--	**1.58E+01**	**3.11E+01**	**8.51E+01**	**3.47E+01**	**7.23E+01**	**1.06E+02**	**3.56E+01**	**8.00E+01**	**1.14E+02**	**7.33E+01**	**1.30E+02**	**1.99E+02**	**5.11E+01**	**8.22E+01**	**1.16E+02**
Ni (Nickel)	µg/L	100	1.18E+03	2.53E+03	3.76E+03	1.24E+03	2.17E+03	3.60E+03	9.72E+02	1.81E+03	4.91E+03	2.38E+03	1.37E+04	2.46E+04	1.22E+03	2.12E+03	4.32E+03
Pb (Lead)	µg/L	19	**9.18E-01**	**1.17E+00**	**2.16E+00**	**1.64E+00**	**2.70E+00**	**7.04E+00**	**1.72E+00**	**3.37E+00**	**6.90E+00**	**1.91E+00**	**2.96E+00**	**5.84E+00**	**2.73E+00**	**4.68E+00**	**1.12E+01**
Sb (Antimony)	µg/L	31	**1.13E+01**	**2.06E+01**	3.84E+01	**1.22E+01**	**2.38E+01**	3.81E+01	**1.03E+01**	**2.20E+01**	3.64E+01	**2.17E+01**	4.56E+01	6.74E+01	**1.29E+01**	**2.81E+01**	4.43E+01
Se (Selenium)	µg/L	5	**1.57E+00**	**3.09E+00**	5.94E+00	**1.46E+00**	**2.76E+00**	1.10E+01	**7.16E-01**	**2.64E+00**	1.57E+01	1.14E+01	2.60E+01	5.72E+01	**4.17E-01**	**2.56E+00**	1.71E+01
SO4 (Sulfate)	mg/L	250	**1.42E+02**	**2.16E+02**	3.10E+02	**1.98E+02**	3.74E+02	6.36E+02	**2.13E+02**	4.08E+02	8.85E+02	1.28E+03	1.81E+03	2.45E+03	3.51E+02	5.39E+02	8.32E+02
Tl (Thallium)	µg/L	0.56	**4.86E-02**	**6.48E-02**	**1.34E-01**	**1.09E-01**	**1.36E-01**	**1.88E-01**	**9.13E-02**	**1.25E-01**	**1.70E-01**	**1.22E-01**	**1.48E-01**	**1.75E-01**	**4.77E-02**	**7.69E-02**	**1.35E-01**
V (Vanadium)	µg/L	50	**5.44E+00**	**7.84E+00**	**8.43E+00**	**9.18E+00**	**9.59E+00**	**9.93E+00**	**8.93E+00**	**9.40E+00**	**9.80E+00**	**9.37E+00**	**9.60E+00**	**9.77E+00**	**8.24E+00**	**8.98E+00**	**9.34E+00**
Zn (Zinc)	µg/L	388	**1.01E+02**	**3.26E+02**	6.33E+02	**1.43E+02**	**3.51E+02**	7.13E+02	**1.21E+02**	**2.20E+02**	4.46E+02	**1.55E+02**	7.53E+02	1.22E+03	**8.54E+01**	**1.50E+02**	**2.60E+02**

Notes

[1] Values shown are the average of the monthly P10 values for the referenced Mine Year.

[2] Values shown are the average of the monthly P50 values for the referenced Mine Year.

[3] Values shown are the average of the monthly P90 values for the referenced Mine Year.

2.00E+02 Values below the modeled WWTF effluent target are shown in bold with light blue shading.

Large Table 23 Annual Summary of Concentration Statistics for the WWTP Reject Concentrate

Constituent	Mine Year		1			5			11			14			20			25		
	Percentile		Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]
	Units	Modeled WWTF Target																		
Ag (Silver)	µg/L	1	**1.10E-01**	**1.10E-01**	**1.10E-01**	**1.50E-01**	**1.50E-01**	**1.50E-01**	**1.77E-01**	**1.90E-01**	**2.03E-01**	**1.77E-01**	**1.90E-01**	**2.03E-01**	**1.80E-01**	**1.80E-01**	**1.80E-01**	**1.38E-01**	**1.50E-01**	**1.63E-01**
Al (Aluminum)	µg/L	125	**1.11E+01**	**1.17E+01**	**1.23E+01**	**1.13E+01**	**1.20E+01**	**1.27E+01**	**3.61E+00**	**5.10E+00**	**6.60E+00**	**4.74E+00**	**7.06E+00**	**9.79E+00**	**1.63E+00**	**2.35E+00**	**3.00E+00**	**5.25E+00**	**7.74E+00**	**9.99E+00**
Alkalinity	mg/L	--	**3.13E+03**	**3.18E+03**	**3.22E+03**	**2.50E+03**	**2.57E+03**	**2.63E+03**	**6.18E+01**	**7.25E+01**	**8.25E+01**	**7.42E+01**	**1.37E+02**	**1.96E+02**	**4.45E+01**	**4.92E+01**	**5.36E+01**	**8.11E+01**	**1.44E+02**	**2.12E+02**
As (Arsenic)	µg/L	10	**3.95E+00**	**4.06E+00**	**4.16E+00**	**4.60E+00**	**5.84E+00**	**7.08E+00**	1.44E+02	2.33E+02	3.31E+02	2.78E+02	4.15E+02	5.58E+02	9.73E+02	1.06E+03	1.15E+03	5.25E+02	6.15E+02	7.03E+02
B (Boron)	µg/L	500	**2.67E+02**	**2.72E+02**	**2.76E+02**	**2.74E+02**	**2.82E+02**	**2.89E+02**	**1.41E+02**	**1.59E+02**	**1.76E+02**	**1.66E+02**	**1.99E+02**	**2.31E+02**	**1.02E+02**	**1.06E+02**	**1.10E+02**	**1.43E+02**	**1.83E+02**	**2.20E+02**
Ba (Barium)	µg/L	2000	3.49E+03	3.51E+03	3.52E+03	2.82E+03	2.84E+03	2.86E+03	**3.87E+02**	**4.00E+02**	**4.14E+02**	**3.95E+02**	**4.17E+02**	**4.39E+02**	**2.83E+02**	**3.01E+02**	**3.18E+02**	**2.78E+02**	**3.01E+02**	**3.24E+02**
Be (Beryllium)	µg/L	4	**2.30E-01**	**2.30E-01**	**2.30E-01**	**2.67E-01**	**2.80E-01**	**2.92E-01**	**3.97E-01**	**4.10E-01**	**4.23E-01**	**4.11E-01**	**4.50E-01**	**4.89E-01**	**3.68E-01**	**3.80E-01**	**3.93E-01**	**3.48E-01**	**4.03E-01**	**4.53E-01**
Ca (Calcium)	mg/L	--	1.23E+02	1.46E+02	1.67E+02	2.79E+02	4.59E+02	6.49E+02	6.92E+02	9.19E+02	1.16E+03	1.15E+03	1.54E+03	1.95E+03	2.43E+03	3.74E+03	5.00E+03	2.19E+03	2.95E+03	3.77E+03
Cd (Cadmium)	µg/L	4	**1.20E-01**	**1.20E-01**	**1.20E-01**	**1.86E-01**	**2.50E-01**	**3.13E-01**	**4.48E-01**	**7.89E-01**	**1.14E+00**	**6.61E-01**	**1.02E+00**	**1.39E+00**	**9.28E-01**	**1.64E+00**	**2.42E+00**	**6.14E-01**	**1.04E+00**	**1.44E+00**
Cl (Chloride)	mg/L	230	3.68E+02	3.76E+02	3.84E+02	3.81E+02	3.88E+02	3.95E+02	3.52E+02	4.06E+02	4.59E+02	3.67E+02	4.07E+02	4.50E+02	4.38E+02	4.96E+02	5.50E+02	3.29E+02	3.73E+02	4.16E+02
Co (Cobalt)	µg/L	5	**1.58E+00**	**2.02E+00**	**2.49E+00**	2.19E+01	5.78E+01	9.80E+01	1.03E+02	2.39E+02	3.75E+02	1.36E+02	2.88E+02	4.59E+02	2.59E+02	5.36E+02	8.47E+02	1.70E+02	3.91E+02	6.02E+02
Cr (Chromium)	µg/L	11	**4.66E-01**	**4.90E-01**	**5.16E-01**	**9.41E-01**	**1.03E+00**	**1.12E+00**	**5.16E+00**	**5.78E+00**	**6.32E+00**	**5.23E+00**	**6.07E+00**	**6.99E+00**	**6.75E+00**	**7.15E+00**	**7.55E+00**	**4.56E+00**	**5.03E+00**	**5.48E+00**
Cu (Copper)	µg/L	30	**3.60E+00**	**5.25E+00**	**6.99E+00**	2.23E+02	4.15E+02	5.96E+02	3.95E+03	6.19E+03	8.28E+03	4.87E+03	7.37E+03	9.86E+03	6.01E+03	8.83E+03	1.16E+04	3.65E+03	5.67E+03	7.83E+03
F (Fluoride)	mg/L	2	7.33E+01	7.37E+01	7.42E+01	6.62E+01	6.79E+01	6.96E+01	1.98E+01	2.22E+01	2.46E+01	1.60E+01	1.95E+01	2.30E+01	2.17E+01	2.40E+01	2.64E+01	1.23E+01	1.38E+01	1.53E+01
Fe (Iron)	µg/L	300	3.39E+04	3.46E+04	3.54E+04	5.99E+04	6.16E+04	6.34E+04	1.96E+04	2.44E+04	2.94E+04	1.98E+04	3.06E+04	4.08E+04	**1.68E+02**	**2.14E+02**	**2.63E+02**	1.07E+04	2.04E+04	2.99E+04
K (Potassium)	mg/L	--	**1.64E+02**	**1.68E+02**	**1.72E+02**	**2.01E+02**	**2.11E+02**	**2.21E+02**	**3.27E+02**	**3.85E+02**	**4.39E+02**	**4.04E+02**	**4.77E+02**	**5.49E+02**	**7.02E+02**	**7.32E+02**	**7.62E+02**	**5.05E+02**	**5.42E+02**	**5.80E+02**
Mg (Magnesium)	mg/L	--	1.25E+03	1.28E+03	1.31E+03	1.45E+03	1.53E+03	1.60E+03	1.20E+03	1.37E+03	1.53E+03	1.44E+03	1.66E+03	1.89E+03	1.42E+03	1.64E+03	1.88E+03	1.56E+03	1.88E+03	2.21E+03
Mn (Manganese)	µg/L	50	3.88E+03	4.06E+03	4.25E+03	6.52E+03	7.08E+03	7.71E+03	8.90E+03	1.14E+04	1.41E+04	1.00E+04	1.33E+04	1.66E+04	7.30E+03	1.08E+04	1.42E+04	9.00E+03	1.21E+04	1.53E+04
Na (Sodium)	mg/L	--	**1.23E+03**	**1.25E+03**	**1.26E+03**	**1.25E+03**	**1.30E+03**	**1.37E+03**	**1.14E+03**	**1.24E+03**	**1.34E+03**	**1.21E+03**	**1.32E+03**	**1.42E+03**	**1.84E+03**	**2.01E+03**	**2.19E+03**	**1.26E+03**	**1.39E+03**	**1.52E+03**
Ni (Nickel)	µg/L	100	**5.12E+00**	**8.65E+00**	**1.23E+01**	2.44E+02	8.26E+02	1.48E+03	1.89E+03	4.08E+03	6.59E+03	2.43E+03	4.60E+03	6.59E+03	4.19E+03	8.79E+03	1.37E+04	3.01E+03	6.11E+03	9.05E+03
Pb (Lead)	µg/L	19	**1.17E+00**	**1.18E+00**	**1.19E+00**	**1.51E+00**	**1.64E+00**	**1.77E+00**	3.25E+02	4.96E+02	6.51E+02	5.11E+02	7.22E+02	9.44E+02	1.12E+03	1.21E+03	1.29E+03	6.40E+02	7.32E+02	8.23E+02
Sb (Antimony)	µg/L	31	**3.51E-01**	**4.69E-01**	**5.84E-01**	**1.08E+00**	**2.18E+00**	**3.21E+00**	**6.04E+00**	**7.38E+00**	**8.73E+00**	**7.37E+00**	**8.95E+00**	**1.05E+01**	**1.45E+01**	**1.75E+01**	**2.03E+01**	**8.79E+00**	**1.07E+01**	**1.26E+01**
Se (Selenium)	µg/L	5	**5.17E-01**	**5.30E-01**	**5.43E-01**	**6.64E-01**	**6.90E-01**	**7.14E-01**	**1.51E+00**	**1.80E+00**	**2.08E+00**	**1.94E+00**	**2.30E+00**	**2.65E+00**	**3.86E+00**	5.29E+00	6.60E+00	**2.70E+00**	**3.33E+00**	**3.96E+00**
SO4 (Sulfate)	mg/L	250	3.86E+03	3.91E+03	3.96E+03	5.63E+03	5.84E+03	6.05E+03	4.91E+03	5.27E+03	5.64E+03	5.50E+03	6.00E+03	6.51E+03	6.61E+03	7.39E+03	8.23E+03	5.67E+03	6.53E+03	7.47E+03
Tl (Thallium)	µg/L	0.56	**1.50E-01**	**1.50E-01**	**1.50E-01**	**1.60E-01**	**1.60E-01**	**1.60E-01**	**1.47E-01**	**1.60E-01**	**1.73E-01**	**1.44E-01**	**1.69E-01**	**1.95E-01**	**1.68E-01**	**1.80E-01**	**1.93E-01**	**1.28E-01**	**1.40E-01**	**1.53E-01**
V (Vanadium)	µg/L	50	**3.87E+00**	**3.97E+00**	**4.08E+00**	**4.18E+00**	**4.28E+00**	**4.41E+00**	**6.79E+00**	**7.54E+00**	**8.32E+00**	**7.09E+00**	**8.04E+00**	**9.11E+00**	**8.90E+00**	**9.15E+00**	**9.39E+00**	**6.11E+00**	**6.57E+00**	**7.04E+00**
Zn (Zinc)	µg/L	388	**1.04E+01**	**1.07E+01**	**1.10E+01**	**1.44E+01**	**1.77E+01**	**2.09E+01**	**4.83E+01**	**6.57E+01**	**8.24E+01**	**6.74E+01**	**8.47E+01**	**1.02E+02**	**2.49E+02**	8.73E+02	1.56E+03	**6.09E+01**	**8.56E+01**	**1.10E+02**

Notes

[1] Values shown are the average of the monthly P10 values for the referenced Mine Year.

[2] Values shown are the average of the monthly P50 values for the referenced Mine Year.

[3] Values shown are the average of the monthly P90 values for the referenced Mine Year.

2.00E+02 Values below the modeled WWTF effluent target are shown in bold with light blue shading.

Large Table 24 Annual Summary of Concentration Statistics for the Reclamation WWTF Influent

Constituent	Mine Year		25			30			35			40			41[4]		
	Percentile		Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]
	Units	Modeled WWTF Target															
Ag (Silver)	µg/L	1	**1.94E-01**	**1.95E-01**	**1.96E-01**	**1.90E-01**	**1.92E-01**	**1.93E-01**	**1.90E-01**	**1.91E-01**	**1.93E-01**	**1.89E-01**	**1.91E-01**	**1.93E-01**	**1.89E-01**	**1.91E-01**	**1.93E-01**
Al (Aluminum)	µg/L	125	**7.68E-01**	**1.19E+00**	**2.29E+00**	**9.60E-01**	**1.43E+00**	**2.55E+00**	**9.75E-01**	**1.44E+00**	**2.56E+00**	**9.65E-01**	**1.46E+00**	**2.57E+00**	**9.65E-01**	**1.46E+00**	**2.58E+00**
Alkalinity	mg/L	--	**2.05E+01**	**3.78E+01**	**5.53E+01**	**2.25E+01**	**4.00E+01**	**5.82E+01**	**1.97E+01**	**3.66E+01**	**5.37E+01**	**1.98E+01**	**3.67E+01**	**5.39E+01**	**1.98E+01**	**3.67E+01**	**5.39E+01**
As (Arsenic)	µg/L	10	1.36E+02	1.44E+02	1.52E+02	9.56E+01	9.87E+01	1.03E+02	9.26E+01	9.52E+01	1.02E+02	9.21E+01	9.49E+01	1.02E+02	9.20E+01	9.49E+01	1.02E+02
B (Boron)	µg/L	500	**1.04E+02**	**1.07E+02**	**1.11E+02**	**1.06E+02**	**1.08E+02**	**1.10E+02**	**1.05E+02**	**1.07E+02**	**1.09E+02**	**1.05E+02**	**1.07E+02**	**1.09E+02**	**1.05E+02**	**1.07E+02**	**1.09E+02**
Ba (Barium)	µg/L	2000	**3.72E+01**	**4.10E+01**	**4.55E+01**	**3.19E+01**	**3.81E+01**	**4.23E+01**	**3.31E+01**	**3.87E+01**	**4.23E+01**	**3.42E+01**	**3.87E+01**	**4.23E+01**	**3.47E+01**	**3.87E+01**	**4.23E+01**
Be (Beryllium)	µg/L	4	**3.95E-01**	**4.00E-01**	**4.05E-01**	**3.90E-01**	**3.96E-01**	**4.04E-01**	**3.88E-01**	**3.96E-01**	**4.03E-01**	**3.87E-01**	**3.95E-01**	**4.03E-01**	**3.87E-01**	**3.95E-01**	**4.03E-01**
Ca (Calcium)	mg/L	--	4.20E+02	7.90E+02	9.36E+02	1.80E+02	3.31E+02	7.27E+02	1.27E+02	2.21E+02	6.75E+02	1.25E+02	2.03E+02	6.69E+02	1.24E+02	2.02E+02	6.68E+02
Cd (Cadmium)	µg/L	4	**1.56E+00**	8.90E+00	3.62E+01	**1.52E+00**	8.79E+00	3.52E+01	**1.51E+00**	8.56E+00	3.06E+01	**1.50E+00**	8.54E+00	3.02E+01	**1.51E+00**	8.54E+00	3.02E+01
Cl (Chloride)	mg/L	230	**8.39E+01**	**9.22E+01**	**1.15E+02**	**9.24E+01**	**9.88E+01**	**1.17E+02**	**9.28E+01**	**9.90E+01**	**1.15E+02**	**9.18E+01**	**9.78E+01**	**1.13E+02**	**9.17E+01**	**9.78E+01**	**1.12E+02**
Co (Cobalt)	µg/L	5	2.49E+02	7.30E+02	1.64E+03	1.55E+02	3.42E+02	1.20E+03	1.09E+02	2.34E+02	8.56E+02	9.42E+01	2.21E+02	6.93E+02	9.29E+01	2.20E+02	6.93E+02
Cr (Chromium)	µg/L	11	**9.23E+00**	**9.28E+00**	**9.32E+00**	**9.00E+00**	**9.03E+00**	**9.06E+00**	**8.95E+00**	**8.98E+00**	**9.04E+00**	**8.94E+00**	**8.98E+00**	**9.04E+00**	**8.94E+00**	**8.98E+00**	**9.04E+00**
Cu (Copper)	µg/L	16	6.78E+02	5.28E+03	1.18E+04	4.27E+02	4.91E+03	1.14E+04	3.91E+02	4.88E+03	1.13E+04	3.67E+02	4.85E+03	1.13E+04	3.67E+02	4.85E+03	1.13E+04
F (Fluoride)	mg/L	2	2.37E+00	2.61E+00	3.62E+00	**1.78E+00**	2.62E+00	3.94E+00	**1.61E+00**	3.14E+00	4.31E+00	**1.50E+00**	3.19E+00	4.37E+00	**1.50E+00**	3.19E+00	4.37E+00
Fe (Iron)	µg/L	300	1.06E+03	1.96E+03	2.87E+03	1.72E+03	2.52E+03	3.36E+03	1.69E+03	2.40E+03	3.19E+03	1.66E+03	2.42E+03	3.25E+03	1.66E+03	2.41E+03	3.26E+03
K (Potassium)	mg/L	--	**8.87E+01**	**9.53E+01**	**1.03E+02**	**6.61E+01**	**7.24E+01**	**8.05E+01**	**6.14E+01**	**6.78E+01**	**7.75E+01**	**5.88E+01**	**6.65E+01**	**7.74E+01**	**5.86E+01**	**6.65E+01**	**7.74E+01**
Mg (Magnesium)	mg/L	--	1.92E+02	2.45E+02	4.26E+02	1.48E+02	1.81E+02	2.92E+02	1.31E+02	1.58E+02	2.31E+02	1.27E+02	1.54E+02	2.22E+02	1.27E+02	1.53E+02	2.20E+02
Mn (Manganese)	µg/L	50	1.45E+03	2.35E+03	3.93E+03	1.11E+03	1.60E+03	3.13E+03	9.83E+02	1.36E+03	2.70E+03	9.29E+02	1.32E+03	2.62E+03	9.23E+02	1.32E+03	2.62E+03
Na (Sodium)	mg/L	--	**2.81E+02**	**3.49E+02**	**5.15E+02**	**2.34E+02**	**3.01E+02**	**4.77E+02**	**2.17E+02**	**2.91E+02**	**4.60E+02**	**2.12E+02**	**2.90E+02**	**4.55E+02**	**2.12E+02**	**2.90E+02**	**4.54E+02**
Ni (Nickel)	µg/L	90	2.58E+03	5.51E+03	1.43E+04	1.27E+03	2.37E+03	5.86E+03	7.90E+02	1.31E+03	4.55E+03	6.09E+02	1.16E+03	4.32E+03	5.84E+02	1.15E+03	4.32E+03
Pb (Lead)	µg/L	7	6.05E+01	6.87E+01	7.69E+01	1.61E+01	1.84E+01	2.19E+01	1.02E+01	1.23E+01	2.10E+01	8.37E+00	1.18E+01	2.10E+01	8.30E+00	1.18E+01	2.10E+01
Sb (Antimony)	µg/L	31	**1.68E+01**	4.85E+01	8.04E+01	**1.62E+01**	4.75E+01	7.92E+01	**1.61E+01**	4.73E+01	7.91E+01	**1.61E+01**	4.73E+01	7.91E+01	**1.61E+01**	4.73E+01	7.91E+01
Se (Selenium)	µg/L	5	8.93E+00	2.39E+01	7.97E+01	5.95E+00	1.02E+01	3.83E+01	5.36E+00	6.97E+00	1.60E+01	5.28E+00	6.67E+00	1.08E+01	5.28E+00	6.63E+00	1.05E+01
SO4 (Sulfate)	mg/L	150	9.97E+02	1.52E+03	2.84E+03	5.93E+02	7.41E+02	1.95E+03	4.79E+02	5.51E+02	8.78E+02	4.47E+02	5.18E+02	6.83E+02	4.44E+02	5.15E+02	6.74E+02
Tl (Thallium)	µg/L	0.56	**1.90E-01**	**1.91E-01**	**1.93E-01**	**1.85E-01**	**1.86E-01**	**1.88E-01**	**1.84E-01**	**1.86E-01**	**1.88E-01**	**1.83E-01**	**1.85E-01**	**1.88E-01**	**1.83E-01**	**1.85E-01**	**1.88E-01**
V (Vanadium)	µg/L	50	**9.65E+00**	**9.69E+00**	**9.73E+00**	**9.44E+00**	**9.46E+00**	**9.49E+00**	**9.39E+00**	**9.41E+00**	**9.48E+00**	**9.32E+00**	**9.41E+00**	**9.48E+00**	**9.32E+00**	**9.41E+00**	**9.48E+00**
Zn (Zinc)	µg/L	200	**1.74E+02**	9.90E+02	1.72E+03	**1.72E+02**	9.86E+02	1.70E+03	**1.70E+02**	9.85E+02	1.70E+03	**1.70E+02**	9.85E+02	1.71E+03	**1.70E+02**	9.85E+02	1.71E+03

Notes

[1] Values shown are the average of the monthly P10 values for the referenced Mine Year.

[2] Values shown are the average of the monthly P50 values for the referenced Mine Year.

[3] Values shown are the average of the monthly P90 values for the referenced Mine Year.

[4] The reclamation period (defined by the time required to treat the East Pit porewater) has a 90% probability of being complete by the end of Mine Year 41.

2.00E+02 Values below the modeled WWTF effluent target are shown in bold with light blue shading as not treated.

Large Table 25 Annual Summary of Concentration Statistics for the Long-term WWTF Influent

Constituent	Mine Year		55[4]			75			100			150			200		
	Percentile		Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]	Avg P10[1]	Avg P50[2]	Avg P90[3]
	Units	Modeled WWTF Target															
Ag (Silver)	µg/L	1	**1.05E-01**	**2.00E-01**	**2.00E-01**	**1.96E-01**	**2.00E-01**	**2.00E-01**	**1.96E-01**	**2.00E-01**	**2.00E-01**	**1.96E-01**	**2.00E-01**	**2.00E-01**	**1.96E-01**	**2.00E-01**	**2.00E-01**
Al (Aluminum)	µg/L	125	**4.99E-01**	**1.31E+00**	**2.12E+00**	**9.30E-01**	**1.41E+00**	**2.15E+00**	**9.30E-01**	**1.41E+00**	**2.15E+00**	**9.30E-01**	**1.41E+00**	**2.15E+00**	**9.30E-01**	**1.41E+00**	**2.15E+00**
Alkalinity	mg/L	--	**1.81E+01**	**3.91E+01**	**5.10E+01**	**3.48E+01**	**3.97E+01**	**5.11E+01**	**3.48E+01**	**3.97E+01**	**5.11E+01**	**3.48E+01**	**3.97E+01**	**5.11E+01**	**3.48E+01**	**3.96E+01**	**4.99E+01**
As (Arsenic)	µg/L	10	**5.16E+00**	1.16E+01	1.57E+01	**8.62E+00**	1.07E+01	1.47E+01	**7.54E+00**	**9.50E+00**	1.32E+01	**5.96E+00**	**7.55E+00**	1.05E+01	**4.71E+00**	**6.10E+00**	**8.80E+00**
B (Boron)	µg/L	500	**5.83E+01**	**1.00E+02**	**1.00E+02**	**1.00E+02**	**1.00E+02**	**1.00E+02**	**1.00E+02**	**1.00E+02**	**1.00E+02**	**8.92E+01**	**9.76E+01**	**1.00E+02**	**6.88E+01**	**7.60E+01**	**8.39E+01**
Ba (Barium)	µg/L	2000	**1.15E+01**	**3.54E+01**	**3.79E+01**	**2.68E+01**	**3.66E+01**	**3.93E+01**	**2.41E+01**	**3.73E+01**	**4.10E+01**	**1.89E+01**	**3.35E+01**	**4.38E+01**	**1.53E+01**	**2.63E+01**	**4.68E+01**
Be (Beryllium)	µg/L	4	**1.82E-01**	**4.00E-01**	**4.00E-01**	**3.22E-01**	**4.00E-01**	**4.00E-01**	**2.85E-01**	**3.87E-01**	**4.00E-01**	**2.22E-01**	**3.05E-01**	**4.00E-01**	**1.79E-01**	**2.42E-01**	**4.00E-01**
Ca (Calcium)	mg/L	--	2.05E+01	4.46E+01	6.30E+01	3.36E+01	4.14E+01	5.92E+01	2.97E+01	3.69E+01	5.40E+01	2.38E+01	2.98E+01	4.54E+01	1.92E+01	2.48E+01	3.98E+01
Cd (Cadmium)	µg/L	2	**3.83E-01**	**1.41E+00**	3.67E+00	**7.19E-01**	**1.46E+00**	3.63E+00	**6.31E-01**	**1.33E+00**	3.52E+00	**4.89E-01**	**1.05E+00**	3.23E+00	**3.90E-01**	**8.18E-01**	3.07E+00
Cl (Chloride)	mg/L	230	**3.87E+00**	**1.03E+01**	**1.46E+01**	**7.17E+00**	**9.40E+00**	**1.32E+01**	**6.25E+00**	**8.15E+00**	**1.14E+01**	**4.79E+00**	**6.18E+00**	**8.53E+00**	**3.73E+00**	**4.76E+00**	**6.49E+00**
Co (Cobalt)	µg/L	5	7.90E+00	3.65E+01	7.97E+01	1.69E+01	3.54E+01	7.50E+01	1.49E+01	3.08E+01	6.61E+01	1.18E+01	2.36E+01	5.29E+01	9.30E+00	1.85E+01	4.14E+01
Cr (Chromium)	µg/L	11	**1.32E+00**	**2.64E+00**	**3.05E+00**	**2.16E+00**	**2.38E+00**	**2.73E+00**	**1.88E+00**	**2.07E+00**	**2.39E+00**	**1.44E+00**	**1.60E+00**	**1.86E+00**	**1.12E+00**	**1.26E+00**	**1.48E+00**
Cu (Copper)	µg/L	9	5.99E+01	2.19E+02	6.48E+02	1.19E+02	2.37E+02	6.55E+02	1.19E+02	2.37E+02	6.51E+02	1.19E+02	2.37E+02	6.34E+02	1.19E+02	2.37E+02	5.75E+02
F (Fluoride)	mg/L	2	**1.07E-01**	**2.59E-01**	**3.28E-01**	**1.87E-01**	**2.37E-01**	**2.97E-01**	**1.65E-01**	**2.09E-01**	**2.60E-01**	**1.33E-01**	**1.65E-01**	**2.07E-01**	**1.07E-01**	**1.32E-01**	**1.68E-01**
Fe (Iron)	µg/L	300	**2.43E+01**	**5.81E+01**	**1.86E+02**	**4.58E+01**	**5.99E+01**	**1.99E+02**	**4.58E+01**	**5.99E+01**	**1.99E+02**	**4.58E+01**	**5.99E+01**	**1.99E+02**	**4.58E+01**	**5.99E+01**	**1.99E+02**
K (Potassium)	mg/L	0.5	4.35E+00	1.02E+01	1.39E+01	7.34E+00	9.36E+00	1.25E+01	6.38E+00	8.11E+00	1.08E+01	4.88E+00	6.23E+00	8.31E+00	3.74E+00	4.81E+00	6.51E+00
Mg (Magnesium)	mg/L	--	8.48E+00	1.72E+01	2.25E+01	1.37E+01	1.57E+01	2.10E+01	1.21E+01	1.40E+01	1.90E+01	9.63E+00	1.12E+01	1.56E+01	7.79E+00	9.19E+00	1.38E+01
Mn (Manganese)	µg/L	50	7.09E+01	1.45E+02	1.96E+02	1.22E+02	1.41E+02	1.90E+02	1.16E+02	1.35E+02	1.79E+02	1.06E+02	1.22E+02	1.57E+02	9.83E+01	1.12E+02	1.44E+02
Na (Sodium)	mg/L	--	**1.38E+01**	**3.56E+01**	**5.52E+01**	**2.47E+01**	**3.28E+01**	**4.94E+01**	**2.16E+01**	**2.88E+01**	**4.26E+01**	**1.65E+01**	**2.21E+01**	**3.31E+01**	**1.28E+01**	**1.73E+01**	**2.61E+01**
Ni (Nickel)	µg/L	50	1.30E+02	4.88E+02	9.04E+02	2.66E+02	4.68E+02	8.43E+02	2.35E+02	4.07E+02	7.26E+02	1.82E+02	3.11E+02	5.57E+02	1.39E+02	2.39E+02	4.35E+02
Pb (Lead)	µg/L	3	3.26E+00	8.47E+00	1.30E+01	5.75E+00	8.07E+00	1.20E+01	5.15E+00	7.16E+00	1.07E+01	4.21E+00	5.81E+00	8.63E+00	3.41E+00	4.76E+00	7.35E+00
Sb (Antimony)	µg/L	31	**3.52E+00**	**8.06E+00**	**1.04E+01**	**6.00E+00**	**7.35E+00**	**9.48E+00**	**5.18E+00**	**6.37E+00**	**8.32E+00**	**3.89E+00**	**4.85E+00**	**6.46E+00**	**2.94E+00**	**3.72E+00**	**5.19E+00**
Se (Selenium)	µg/L	5	**2.72E-02**	**1.80E+00**	**2.91E+00**	**2.55E-01**	**1.70E+00**	**2.85E+00**	**2.55E-01**	**1.50E+00**	**2.57E+00**	**2.55E-01**	**1.19E+00**	**2.05E+00**	**2.55E-01**	**9.47E-01**	**1.85E+00**
SO4 (Sulfate)	mg/L	9	3.16E+01	7.86E+01	1.39E+02	5.22E+01	7.32E+01	1.32E+02	4.64E+01	6.74E+01	1.28E+02	3.73E+01	5.72E+01	1.12E+02	3.02E+01	4.88E+01	1.05E+02
Tl (Thallium)	µg/L	0.56	**4.32E-02**	**8.45E-02**	**9.34E-02**	**7.34E-02**	**7.96E-02**	**8.84E-02**	**6.79E-02**	**7.39E-02**	**8.24E-02**	**5.91E-02**	**6.47E-02**	**7.27E-02**	**5.21E-02**	**5.80E-02**	**6.65E-02**
V (Vanadium)	µg/L	50	**5.70E+00**	**1.00E+01**	**1.00E+01**	**1.00E+01**	**1.00E+01**	**1.00E+01**	**1.00E+01**	**1.00E+01**	**1.00E+01**	**1.00E+01**	**1.00E+01**	**1.00E+01**	**1.00E+01**	**1.00E+01**	**1.00E+01**
Zn (Zinc)	µg/L	100	**3.35E+01**	**9.42E+01**	2.23E+02	**5.92E+01**	**9.69E+01**	2.23E+02	**5.23E+01**	**9.10E+01**	2.14E+02	**4.20E+01**	**7.82E+01**	2.03E+02	**3.39E+01**	**6.32E+01**	1.87E+02

Notes

[1] Values shown are the average of the monthly P10 values for the referenced Mine Year.

[2] Values shown are the average of the monthly P50 values for the referenced Mine Year.

[3] Values shown are the average of the monthly P90 values for the referenced Mine Year.

[4] The long-term closure period (defined by the time required for the West Pit to completely flood) has a 90% probability of beginning by the end of Mine Year 55.

2.00E+02 Values below the modeled WWTF effluent target are shown in bold with light blue shading as not treated.

Large Table 26 Annual Summary of Concentration Statistics for the East Pit - Cat 2/3 (surficial) Flow Path at Dunka Road

	Mine Year		10			20			75			100			150			200		
	Percentile		Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max
Constituent	Units	WQ Standard	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]
Ag (Silver)	µg/L	30	1.09E-01	1.11E-01	1.14E-01	1.14E-01	1.21E-01	1.42E-01	1.09E-01	1.11E-01	1.14E-01	1.09E-01	1.12E-01	1.21E-01	1.11E-01	1.20E-01	1.27E-01	1.13E-01	1.22E-01	1.27E-01
Al (Aluminum)[4]	µg/L	--	5.33E+01	6.04E+01	7.67E+01	7.81E+01	1.51E+02	3.78E+02	4.97E+01	5.44E+01	6.17E+01	4.65E+01	5.26E+01	5.80E+01	4.29E+01	4.90E+01	5.53E+01	4.21E+01	4.67E+01	5.27E+01
Alkalinity	mg/L	--	6.17E+01	6.45E+01	6.75E+01	6.17E+01	6.45E+01	6.75E+01	6.14E+01	6.44E+01	6.75E+01	5.98E+01	6.37E+01	6.73E+01	5.62E+01	6.13E+01	6.54E+01	5.49E+01	5.95E+01	6.41E+01
As (Arsenic)	µg/L	10	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.17E-01	7.63E-01	6.73E-01	7.17E-01	7.63E-01	6.74E-01	7.17E-01	7.63E-01	6.74E-01	7.17E-01	7.63E-01
B (Boron)	µg/L	1000	2.66E+01	2.71E+01	2.75E+01	2.67E+01	2.71E+01	2.76E+01	2.66E+01	2.71E+01	2.81E+01	2.67E+01	2.74E+01	3.11E+01	2.70E+01	2.81E+01	3.00E+01	2.70E+01	2.77E+01	2.89E+01
Ba (Barium)	µg/L	2000	2.94E+01	3.14E+01	3.34E+01	2.94E+01	3.13E+01	3.34E+01	2.94E+01	3.14E+01	3.34E+01	2.96E+01	3.16E+01	3.37E+01	2.82E+01	3.16E+01	3.50E+01	2.61E+01	3.00E+01	3.51E+01
Be (Beryllium)[5]	µg/L	0.45	1.16E-01	1.20E-01	1.23E-01	1.19E-01	1.24E-01	1.32E-01	1.16E-01	1.20E-01	1.25E-01	1.17E-01	1.22E-01	1.50E-01	1.19E-01	1.31E-01	1.57E-01	1.16E-01	1.28E-01	1.57E-01
Ca (Calcium)	mg/L	--	1.50E+01	1.56E+01	1.63E+01	1.52E+01	1.59E+01	1.68E+01	1.49E+01	1.56E+01	1.67E+01	1.50E+01	1.59E+01	1.84E+01	1.42E+01	1.56E+01	1.74E+01	1.39E+01	1.48E+01	1.63E+01
Cd (Cadmium)	µg/L	4	1.03E-01	1.07E-01	1.19E-01	1.07E-01	1.30E-01	2.12E-01	1.02E-01	1.04E-01	1.47E-01	1.02E-01	1.17E-01	2.91E-01	1.05E-01	1.46E-01	3.00E-01	1.06E-01	1.28E-01	2.02E-01
Cl (Chloride)	mg/L	250	6.24E-01	6.60E-01	6.98E-01	6.25E-01	6.62E-01	7.02E-01	6.28E-01	6.70E-01	1.35E+00	6.39E-01	8.25E-01	3.76E+00	7.49E-01	1.43E+00	2.84E+00	8.32E-01	1.01E+00	2.18E+00
Co (Cobalt)	µg/L	--	9.17E-01	1.23E+00	2.26E+00	1.29E+00	3.29E+00	1.24E+01	8.01E-01	9.22E-01	2.46E+00	8.28E-01	1.27E+00	5.04E+00	9.89E-01	1.87E+00	3.71E+00	1.08E+00	1.54E+00	2.81E+00
Cr (Chromium)	µg/L	100	8.92E-01	9.36E-01	9.81E-01	8.98E-01	9.45E-01	9.91E-01	8.94E-01	9.40E-01	1.00E+00	9.03E-01	9.62E-01	1.09E+00	8.31E-01	9.45E-01	1.05E+00	8.04E-01	8.74E-01	9.84E-01
Cu (Copper)	µg/L	--	2.30E+00	2.49E+00	2.69E+00	2.33E+00	2.52E+00	2.72E+00	2.47E+00	2.78E+00	3.33E+00	2.51E+00	2.85E+00	3.54E+00	2.56E+00	2.95E+00	3.79E+00	2.59E+00	3.00E+00	3.92E+00
F (Fluoride)	mg/L	2	7.07E-02	7.32E-02	7.59E-02	7.14E-02	7.41E-02	7.74E-02	7.06E-02	7.36E-02	8.63E-02	7.15E-02	7.72E-02	1.34E-01	7.01E-02	8.47E-02	1.12E-01	6.79E-02	7.34E-02	9.81E-02
Fe (Iron)[4]	µg/L	--	1.22E+03	1.43E+03	1.67E+03	1.24E+03	1.45E+03	1.73E+03	1.21E+03	1.42E+03	1.67E+03	1.17E+03	1.38E+03	1.62E+03	1.09E+03	1.30E+03	1.54E+03	1.06E+03	1.25E+03	1.48E+03
K (Potassium)	mg/L	--	1.65E+00	1.70E+00	1.76E+00	1.67E+00	1.73E+00	1.80E+00	1.64E+00	1.71E+00	2.33E+00	1.66E+00	1.88E+00	4.92E+00	1.63E+00	2.37E+00	3.91E+00	1.54E+00	1.76E+00	3.11E+00
Mg (Magnesium)	mg/L	--	6.72E+00	7.01E+00	7.36E+00	6.85E+00	7.20E+00	7.85E+00	6.71E+00	7.01E+00	7.41E+00	6.76E+00	7.14E+00	7.99E+00	6.41E+00	7.00E+00	7.64E+00	6.28E+00	6.67E+00	7.25E+00
Mn (Manganese)[4,5]	µg/L	1002	4.79E+02	5.53E+02	6.36E+02	4.86E+02	5.60E+02	6.46E+02	4.76E+02	5.49E+02	6.34E+02	4.63E+02	5.39E+02	6.25E+02	4.28E+02	5.10E+02	5.94E+02	4.17E+02	4.89E+02	5.68E+02
Na (Sodium)	mg/L	--	5.17E+00	5.40E+00	5.63E+00	5.22E+00	5.47E+00	5.77E+00	5.18E+00	5.43E+00	7.61E+00	5.25E+00	6.06E+00	1.73E+01	5.13E+00	7.66E+00	1.30E+01	4.83E+00	5.59E+00	1.04E+01
Ni (Nickel)	µg/L	100	1.87E+00	2.02E+00	2.18E+00	1.91E+00	2.08E+00	2.29E+00	2.05E+00	2.37E+00	3.68E+00	2.08E+00	2.45E+00	4.09E+00	2.11E+00	2.55E+00	4.49E+00	2.13E+00	2.60E+00	4.90E+00
Pb (Lead)	µg/L	--	5.76E-01	6.15E-01	6.58E-01	6.30E-01	6.98E-01	8.93E-01	5.72E-01	6.13E-01	6.62E-01	5.80E-01	6.28E-01	7.77E-01	6.05E-01	7.52E-01	8.70E-01	6.70E-01	8.04E-01	8.83E-01
Sb (Antimony)	µg/L	6	2.52E-01	2.54E-01	2.56E-01	2.55E-01	2.62E-01	2.95E-01	2.63E-01	2.89E-01	3.90E-01	2.63E-01	2.88E-01	3.79E-01	2.60E-01	2.80E-01	3.53E-01	2.55E-01	2.72E-01	3.27E-01
Se (Selenium)	µg/L	30	5.24E-01	5.37E-01	5.72E-01	5.39E-01	5.72E-01	6.71E-01	5.17E-01	5.27E-01	5.84E-01	5.19E-01	5.39E-01	7.39E-01	4.95E-01	5.51E-01	6.74E-01	4.83E-01	5.06E-01	6.04E-01
SO4 (Sulfate)	mg/L	250	9.51E+00	1.01E+01	1.12E+01	1.02E+01	1.19E+01	1.74E+01	9.20E+00	9.83E+00	1.25E+01	9.29E+00	1.06E+01	1.98E+01	9.40E+00	1.15E+01	1.65E+01	9.14E+00	1.00E+01	1.37E+01
Tl (Thallium)	µg/L	0.6	1.18E-01	1.24E-01	1.30E-01	1.19E-01	1.25E-01	1.32E-01	1.18E-01	1.24E-01	1.30E-01	1.17E-01	1.23E-01	1.29E-01	1.10E-01	1.19E-01	1.27E-01	1.08E-01	1.15E-01	1.23E-01
V (Vanadium)	µg/L	50	3.50E+00	3.62E+00	3.75E+00	3.52E+00	3.64E+00	3.77E+00	3.51E+00	3.64E+00	3.80E+00	3.54E+00	3.72E+00	4.36E+00	3.62E+00	4.19E+00	4.72E+00	3.45E+00	4.30E+00	4.77E+00
Zn (Zinc)	µg/L	2000	4.39E+00	4.67E+00	5.66E+00	4.88E+00	6.75E+00	1.38E+01	4.23E+00	4.47E+00	8.28E+00	4.30E+00	5.49E+00	2.10E+01	4.86E+00	9.81E+00	1.89E+01	6.05E+00	8.73E+00	1.49E+01

Notes

[1] Values shown are the maximum of the monthly P10 values for the referenced Mine Year.

[2] Values shown are the maximum of the monthly P50 values for the referenced Mine Year.

[3] Values shown are the maximum of the monthly P90 values for the referenced Mine Year.

[4] Not evaluated against the secondary groundwater standard.

[5] Evaluated against the site-specific evaluation criteria shown.

2.00E+02 Values above the applicable water quality standard are shown in bold with light red shading.

Large Table 27 Annual Summary of Concentration Statistics for the East Pit - Cat 2/3 (surficial) Flow Path at the Property Boundary

	Mine Year		10			30			75			110			150			200		
	Percentile		Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max
Constituent	Units	WQ Standard	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]
Ag (Silver)	µg/L	30	1.08E-01	1.11E-01	1.13E-01	1.13E-01	1.19E-01	1.38E-01	1.09E-01	1.11E-01	1.14E-01	1.09E-01	1.12E-01	1.22E-01	1.10E-01	1.18E-01	1.26E-01	1.12E-01	1.21E-01	1.26E-01
Al (Aluminum)[4]	µg/L	--	4.96E+01	5.40E+01	5.89E+01	7.22E+01	1.35E+02	3.35E+02	4.99E+01	5.52E+01	7.10E+01	4.62E+01	5.23E+01	5.80E+01	4.38E+01	5.00E+01	5.60E+01	4.29E+01	4.75E+01	5.33E+01
Alkalinity	mg/L	--	6.17E+01	6.46E+01	6.75E+01	6.17E+01	6.45E+01	6.75E+01	6.16E+01	6.45E+01	6.75E+01	5.96E+01	6.35E+01	6.72E+01	5.70E+01	6.19E+01	6.58E+01	5.57E+01	6.02E+01	6.45E+01
As (Arsenic)	µg/L	10	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01
B (Boron)	µg/L	1000	2.66E+01	2.70E+01	2.75E+01	2.67E+01	2.71E+01	2.76E+01	2.66E+01	2.71E+01	2.77E+01	2.68E+01	2.75E+01	3.05E+01	2.69E+01	2.80E+01	2.97E+01	2.70E+01	2.77E+01	2.89E+01
Ba (Barium)	µg/L	2000	2.94E+01	3.14E+01	3.34E+01	2.94E+01	3.13E+01	3.34E+01	2.94E+01	3.14E+01	3.34E+01	2.96E+01	3.16E+01	3.38E+01	2.87E+01	3.16E+01	3.47E+01	2.66E+01	3.03E+01	3.46E+01
Be (Beryllium)[5]	µg/L	0.45	1.16E-01	1.19E-01	1.23E-01	1.19E-01	1.23E-01	1.31E-01	1.16E-01	1.20E-01	1.24E-01	1.17E-01	1.23E-01	1.50E-01	1.19E-01	1.29E-01	1.53E-01	1.17E-01	1.27E-01	1.53E-01
Ca (Calcium)	mg/L	--	1.48E+01	1.55E+01	1.61E+01	1.51E+01	1.58E+01	1.67E+01	1.49E+01	1.56E+01	1.64E+01	1.50E+01	1.59E+01	1.80E+01	1.43E+01	1.56E+01	1.72E+01	1.40E+01	1.49E+01	1.63E+01
Cd (Cadmium)	µg/L	4	1.02E-01	1.03E-01	1.05E-01	1.06E-01	1.24E-01	1.88E-01	1.02E-01	1.04E-01	1.33E-01	1.02E-01	1.23E-01	2.72E-01	1.04E-01	1.41E-01	2.77E-01	1.05E-01	1.27E-01	2.04E-01
Cl (Chloride)	mg/L	250	6.21E-01	6.53E-01	6.88E-01	6.24E-01	6.60E-01	6.98E-01	6.25E-01	6.65E-01	9.77E-01	6.42E-01	9.31E-01	3.40E+00	6.91E-01	1.34E+00	2.71E+00	8.16E-01	9.87E-01	2.13E+00
Co (Cobalt)	µg/L	--	7.89E-01	8.74E-01	9.83E-01	1.19E+00	2.76E+00	1.04E+01	8.00E-01	9.23E-01	2.20E+00	8.36E-01	1.46E+00	4.54E+00	9.39E-01	1.78E+00	3.48E+00	1.06E+00	1.52E+00	2.73E+00
Cr (Chromium)	µg/L	100	8.90E-01	9.33E-01	9.78E-01	8.97E-01	9.42E-01	9.88E-01	8.93E-01	9.38E-01	9.88E-01	9.03E-01	9.63E-01	1.08E+00	8.45E-01	9.43E-01	1.03E+00	8.14E-01	8.86E-01	9.92E-01
Cu (Copper)	µg/L	--	2.30E+00	2.49E+00	2.69E+00	2.30E+00	2.49E+00	2.69E+00	2.30E+00	2.49E+00	2.69E+00	2.30E+00	2.49E+00	2.69E+00	2.31E+00	2.49E+00	2.69E+00	2.32E+00	2.51E+00	2.70E+00
F (Fluoride)	mg/L	2	7.03E-02	7.26E-02	7.52E-02	7.12E-02	7.38E-02	7.70E-02	7.06E-02	7.33E-02	7.91E-02	7.17E-02	7.88E-02	1.26E-01	7.09E-02	8.30E-02	1.10E-01	6.83E-02	7.43E-02	9.73E-02
Fe (Iron)[4]	µg/L	--	1.22E+03	1.43E+03	1.67E+03	1.24E+03	1.45E+03	1.71E+03	1.22E+03	1.42E+03	1.67E+03	1.16E+03	1.37E+03	1.62E+03	1.11E+03	1.32E+03	1.56E+03	1.08E+03	1.27E+03	1.50E+03
K (Potassium)	mg/L	--	1.63E+00	1.69E+00	1.74E+00	1.66E+00	1.72E+00	1.78E+00	1.64E+00	1.70E+00	1.98E+00	1.66E+00	1.96E+00	4.63E+00	1.64E+00	2.33E+00	3.75E+00	1.55E+00	1.81E+00	3.03E+00
Mg (Magnesium)	mg/L	--	6.67E+00	6.96E+00	7.26E+00	6.82E+00	7.14E+00	7.70E+00	6.71E+00	7.00E+00	7.36E+00	6.75E+00	7.13E+00	7.89E+00	6.49E+00	7.01E+00	7.63E+00	6.33E+00	6.72E+00	7.27E+00
Mn (Manganese)[4,5]	µg/L	1002	4.78E+02	5.51E+02	6.35E+02	4.85E+02	5.59E+02	6.45E+02	4.78E+02	5.51E+02	6.35E+02	4.62E+02	5.38E+02	6.23E+02	4.36E+02	5.17E+02	5.99E+02	4.24E+02	4.98E+02	5.77E+02
Na (Sodium)	mg/L	--	5.12E+00	5.35E+00	5.57E+00	5.20E+00	5.44E+00	5.70E+00	5.16E+00	5.40E+00	6.42E+00	5.26E+00	6.47E+00	1.62E+01	5.19E+00	7.50E+00	1.27E+01	4.88E+00	5.71E+00	1.01E+01
Ni (Nickel)	µg/L	100	1.86E+00	2.01E+00	2.18E+00	1.86E+00	2.01E+00	2.18E+00	1.86E+00	2.02E+00	2.18E+00	1.87E+00	2.02E+00	2.19E+00	1.88E+00	2.04E+00	2.23E+00	1.91E+00	2.08E+00	2.35E+00
Pb (Lead)	µg/L	--	5.68E-01	6.07E-01	6.48E-01	6.21E-01	6.83E-01	8.52E-01	5.72E-01	6.16E-01	6.62E-01	5.82E-01	6.33E-01	7.87E-01	5.98E-01	7.24E-01	8.48E-01	6.45E-01	7.85E-01	8.58E-01
Sb (Antimony)	µg/L	6	2.51E-01	2.53E-01	2.55E-01	2.51E-01	2.53E-01	2.55E-01	2.53E-01	2.62E-01	3.17E-01	2.55E-01	2.71E-01	3.43E-01	2.58E-01	2.76E-01	3.54E-01	2.57E-01	2.73E-01	3.33E-01
Se (Selenium)	µg/L	30	5.16E-01	5.24E-01	5.34E-01	5.34E-01	5.60E-01	6.41E-01	5.17E-01	5.27E-01	5.64E-01	5.19E-01	5.43E-01	7.14E-01	5.00E-01	5.47E-01	6.55E-01	4.86E-01	5.12E-01	6.06E-01
SO4 (Sulfate)	mg/L	250	9.15E+00	9.62E+00	1.01E+01	1.00E+01	1.13E+01	1.58E+01	9.19E+00	9.83E+00	1.14E+01	9.33E+00	1.08E+01	1.83E+01	9.39E+00	1.14E+01	1.58E+01	9.17E+00	1.01E+01	1.37E+01
Tl (Thallium)	µg/L	0.6	1.18E-01	1.24E-01	1.30E-01	1.19E-01	1.25E-01	1.32E-01	1.18E-01	1.24E-01	1.30E-01	1.16E-01	1.23E-01	1.29E-01	1.11E-01	1.20E-01	1.28E-01	1.09E-01	1.16E-01	1.25E-01
V (Vanadium)	µg/L	50	3.50E+00	3.62E+00	3.75E+00	3.52E+00	3.64E+00	3.77E+00	3.50E+00	3.64E+00	3.78E+00	3.54E+00	3.74E+00	4.39E+00	3.59E+00	4.08E+00	4.61E+00	3.49E+00	4.20E+00	4.66E+00
Zn (Zinc)	µg/L	2000	4.21E+00	4.36E+00	4.54E+00	4.72E+00	6.22E+00	1.21E+01	4.24E+00	4.46E+00	6.62E+00	4.33E+00	6.03E+00	1.95E+01	4.55E+00	9.19E+00	1.82E+01	5.81E+00	8.49E+00	1.47E+01

Notes

[1] Values shown are the maximum of the monthly P10 values for the referenced Mine Year.

[2] Values shown are the maximum of the monthly P50 values for the referenced Mine Year.

[3] Values shown are the maximum of the monthly P90 values for the referenced Mine Year.

[4] Not evaluated against the secondary groundwater standard.

[5] Evaluated against the site-specific evaluation criteria shown.

2.00E+02 Values above the applicable water quality standard are shown in bold with light red shading.

Large Table 28 Annual Summary of Concentration Statistics for the East Pit (bedrock) Flow Path at the Property Boundary

	Mine Year		10			50			75			100			150			200		
	Percentile		Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max
Constituent	Units	WQ Standard	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]
Ag (Silver)	µg/L	30	1.76E-01	2.01E-01	2.30E-01	1.76E-01	2.01E-01	2.30E-01	1.76E-01	2.01E-01	2.30E-01	1.76E-01	2.01E-01	2.30E-01	1.76E-01	2.01E-01	2.30E-01	1.76E-01	2.01E-01	2.30E-01
Al (Aluminum)[4]	µg/L	--	1.61E+01	1.81E+01	2.03E+01	1.61E+01	1.81E+01	2.03E+01	1.61E+01	1.81E+01	2.03E+01	1.61E+01	1.81E+01	2.03E+01	1.61E+01	1.81E+01	2.03E+01	1.61E+01	1.81E+01	2.03E+01
Alkalinity	mg/L	--	5.48E+01	6.41E+01	7.49E+01	5.48E+01	6.41E+01	7.49E+01	5.48E+01	6.41E+01	7.49E+01	5.48E+01	6.41E+01	7.49E+01	5.48E+01	6.41E+01	7.49E+01	5.48E+01	6.41E+01	7.49E+01
As (Arsenic)	µg/L	10	1.72E+00	2.10E+00	2.56E+00	1.72E+00	2.10E+00	2.56E+00	1.72E+00	2.10E+00	2.56E+00	1.72E+00	2.10E+00	2.56E+00	1.72E+00	2.10E+00	2.56E+00	1.72E+00	2.10E+00	2.56E+00
B (Boron)	µg/L	1000	4.01E+01	4.58E+01	5.24E+01	4.01E+01	4.58E+01	5.24E+01	4.01E+01	4.58E+01	5.24E+01	4.01E+01	4.58E+01	5.24E+01	4.01E+01	4.58E+01	5.24E+01	4.01E+01	4.58E+01	5.24E+01
Ba (Barium)	µg/L	2000	5.67E+00	6.83E+00	8.23E+00	5.67E+00	6.83E+00	8.23E+00	5.67E+00	6.83E+00	8.23E+00	5.67E+00	6.83E+00	8.23E+00	5.67E+00	6.83E+00	8.23E+00	5.67E+00	6.83E+00	8.23E+00
Be (Beryllium)[5]	µg/L	0.2	1.05E-01	1.09E-01	1.14E-01	1.05E-01	1.09E-01	1.14E-01	1.05E-01	1.09E-01	1.14E-01	1.05E-01	1.09E-01	1.14E-01	1.05E-01	1.09E-01	1.14E-01	1.05E-01	1.09E-01	1.14E-01
Ca (Calcium)	mg/L	--	1.35E+01	1.49E+01	1.64E+01	1.35E+01	1.49E+01	1.64E+01	1.35E+01	1.49E+01	1.64E+01	1.35E+01	1.49E+01	1.64E+01	1.35E+01	1.49E+01	1.64E+01	1.35E+01	1.49E+01	1.64E+01
Cd (Cadmium)	µg/L	4	1.08E-01	1.15E-01	1.23E-01	1.08E-01	1.15E-01	1.23E-01	1.08E-01	1.15E-01	1.23E-01	1.08E-01	1.15E-01	1.23E-01	1.08E-01	1.15E-01	1.23E-01	1.08E-01	1.15E-01	1.23E-01
Cl (Chloride)	mg/L	250	1.45E+00	1.78E+00	2.18E+00	1.45E+00	1.78E+00	2.18E+00	1.45E+00	1.78E+00	2.18E+00	1.45E+00	1.78E+00	2.18E+00	1.45E+00	1.78E+00	2.18E+00	1.45E+00	1.78E+00	2.18E+00
Co (Cobalt)	µg/L	--	2.03E+00	2.63E+00	3.41E+00	2.03E+00	2.63E+00	3.41E+00	2.03E+00	2.63E+00	3.41E+00	2.03E+00	2.63E+00	3.41E+00	2.03E+00	2.63E+00	3.41E+00	2.03E+00	2.63E+00	3.41E+00
Cr (Chromium)	µg/L	100	5.06E-01	5.19E-01	5.32E-01	5.06E-01	5.19E-01	5.32E-01	5.06E-01	5.19E-01	5.32E-01	5.06E-01	5.19E-01	5.32E-01	5.06E-01	5.19E-01	5.32E-01	5.06E-01	5.19E-01	5.32E-01
Cu (Copper)	µg/L	--	1.19E+00	1.36E+00	1.56E+00	1.19E+00	1.36E+00	1.56E+00	1.19E+00	1.36E+00	1.56E+00	1.19E+00	1.36E+00	1.56E+00	1.19E+00	1.36E+00	1.56E+00	1.19E+00	1.36E+00	1.56E+00
F (Fluoride)	mg/L	2	1.32E-01	1.55E-01	1.81E-01	1.32E-01	1.55E-01	1.81E-01	1.32E-01	1.55E-01	1.81E-01	1.32E-01	1.55E-01	1.81E-01	1.32E-01	1.55E-01	1.81E-01	1.32E-01	1.55E-01	1.81E-01
Fe (Iron)[4]	µg/L	--	1.09E+04	1.60E+04	2.36E+04	1.09E+04	1.60E+04	2.36E+04	1.09E+04	1.60E+04	2.36E+04	1.09E+04	1.60E+04	2.36E+04	1.09E+04	1.60E+04	2.36E+04	1.09E+04	1.60E+04	2.36E+04
K (Potassium)	mg/L	--	1.51E+00	1.61E+00	1.71E+00	1.51E+00	1.61E+00	1.71E+00	1.51E+00	1.61E+00	1.71E+00	1.51E+00	1.61E+00	1.71E+00	1.51E+00	1.61E+00	1.71E+00	1.51E+00	1.61E+00	1.71E+00
Mg (Magnesium)	mg/L	--	8.26E+00	9.58E+00	1.11E+01	8.26E+00	9.58E+00	1.11E+01	8.26E+00	9.58E+00	1.11E+01	8.26E+00	9.58E+00	1.11E+01	8.26E+00	9.58E+00	1.11E+01	8.26E+00	9.58E+00	1.11E+01
Mn (Manganese)[4,5]	µg/L	306.6	1.44E+02	1.98E+02	2.73E+02	1.44E+02	1.98E+02	2.73E+02	1.44E+02	1.98E+02	2.73E+02	1.44E+02	1.98E+02	2.73E+02	1.44E+02	1.98E+02	2.73E+02	1.44E+02	1.98E+02	2.73E+02
Na (Sodium)	mg/L	--	7.04E+00	8.59E+00	1.05E+01	7.04E+00	8.59E+00	1.05E+01	7.04E+00	8.59E+00	1.05E+01	7.04E+00	8.59E+00	1.05E+01	7.04E+00	8.59E+00	1.05E+01	7.04E+00	8.59E+00	1.05E+01
Ni (Nickel)	µg/L	100	3.33E+01	4.72E+01	6.68E+01	3.33E+01	4.72E+01	6.68E+01	3.33E+01	4.72E+01	6.68E+01	3.33E+01	4.72E+01	6.68E+01	3.33E+01	4.72E+01	6.68E+01	3.33E+01	4.72E+01	6.68E+01
Pb (Lead)	µg/L	--	4.65E-01	5.25E-01	5.93E-01	4.65E-01	5.25E-01	5.93E-01	4.65E-01	5.25E-01	5.93E-01	4.65E-01	5.25E-01	5.93E-01	4.65E-01	5.25E-01	5.93E-01	4.65E-01	5.25E-01	5.93E-01
Sb (Antimony)	µg/L	6	5.39E-01	6.25E-01	7.24E-01	5.39E-01	6.25E-01	7.24E-01	5.39E-01	6.25E-01	7.24E-01	5.39E-01	6.25E-01	7.24E-01	5.39E-01	6.25E-01	7.24E-01	5.39E-01	6.25E-01	7.24E-01
Se (Selenium)	µg/L	30	5.98E-01	6.33E-01	6.71E-01	5.98E-01	6.33E-01	6.71E-01	5.98E-01	6.33E-01	6.71E-01	5.98E-01	6.33E-01	6.71E-01	5.98E-01	6.33E-01	6.71E-01	5.98E-01	6.33E-01	6.71E-01
SO4 (Sulfate)	mg/L	250	2.09E+01	2.50E+01	2.98E+01	2.09E+01	2.50E+01	2.98E+01	2.09E+01	2.50E+01	2.98E+01	2.09E+01	2.50E+01	2.98E+01	2.09E+01	2.50E+01	2.98E+01	2.09E+01	2.50E+01	2.98E+01
Tl (Thallium)[5]	µg/L	1	2.93E-01	3.52E-01	4.25E-01	2.93E-01	3.52E-01	4.25E-01	2.93E-01	3.52E-01	4.25E-01	2.93E-01	3.52E-01	4.25E-01	2.93E-01	3.52E-01	4.25E-01	2.93E-01	3.52E-01	4.25E-01
V (Vanadium)	µg/L	50	3.50E+00	3.62E+00	3.75E+00	3.50E+00	3.62E+00	3.75E+00	3.50E+00	3.62E+00	3.75E+00	3.50E+00	3.62E+00	3.75E+00	3.50E+00	3.62E+00	3.75E+00	3.50E+00	3.62E+00	3.75E+00
Zn (Zinc)	µg/L	2000	1.01E+01	1.21E+01	1.46E+01	1.01E+01	1.21E+01	1.46E+01	1.01E+01	1.21E+01	1.46E+01	1.01E+01	1.21E+01	1.46E+01	1.01E+01	1.21E+01	1.46E+01	1.01E+01	1.21E+01	1.46E+01

Notes

[1] Values shown are the maximum of the monthly P10 values for the referenced Mine Year.

[2] Values shown are the maximum of the monthly P50 values for the referenced Mine Year.

[3] Values shown are the maximum of the monthly P90 values for the referenced Mine Year.

[4] Not evaluated against the secondary groundwater standard.

[5] Evaluated against the site-specific evaluation criteria shown.

2.00E+02 Values above the applicable water quality standard are shown in bold with light red shading.

Large Table 29 Annual Summary of Concentration Statistics for the OSP (surficial) Flow Path at Dunka Road

	Mine Year		10			40			75			100			175			200		
	Percentile		Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max
Constituent	Units	WQ Standard	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]
Ag (Silver)	µg/L	30	1.08E-01	1.11E-01	1.13E-01	1.12E-01	1.16E-01	1.24E-01	1.11E-01	1.14E-01	1.21E-01	1.10E-01	1.13E-01	1.18E-01	1.09E-01	1.12E-01	1.14E-01	1.09E-01	1.11E-01	1.14E-01
Al (Aluminum)[4]	µg/L	--	4.95E+01	5.40E+01	5.89E+01	6.53E+01	9.47E+01	1.94E+02	6.15E+01	8.24E+01	1.59E+02	5.84E+01	7.36E+01	1.33E+02	5.32E+01	6.04E+01	8.12E+01	5.23E+01	5.88E+01	7.42E+01
Alkalinity	mg/L	--	6.17E+01	6.46E+01	6.75E+01	6.17E+01	6.45E+01	6.75E+01	6.17E+01	6.45E+01	6.75E+01	6.17E+01	6.45E+01	6.75E+01	6.17E+01	6.46E+01	6.75E+01	6.17E+01	6.46E+01	6.75E+01
As (Arsenic)	µg/L	10	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01
B (Boron)	µg/L	1000	2.66E+01	2.70E+01	2.75E+01	2.66E+01	2.71E+01	2.75E+01	2.66E+01	2.71E+01	2.75E+01	2.66E+01	2.70E+01	2.75E+01	2.66E+01	2.70E+01	2.75E+01	2.66E+01	2.70E+01	2.75E+01
Ba (Barium)	µg/L	2000	2.94E+01	3.14E+01	3.34E+01	2.94E+01	3.14E+01	3.34E+01	2.94E+01	3.14E+01	3.34E+01	2.94E+01	3.14E+01	3.34E+01	2.94E+01	3.14E+01	3.34E+01	2.94E+01	3.14E+01	3.34E+01
Be (Beryllium)[5]	µg/L	0.45	1.16E-01	1.19E-01	1.23E-01	1.18E-01	1.21E-01	1.26E-01	1.17E-01	1.21E-01	1.25E-01	1.17E-01	1.20E-01	1.24E-01	1.16E-01	1.20E-01	1.23E-01	1.16E-01	1.20E-01	1.23E-01
Ca (Calcium)	mg/L	--	1.48E+01	1.54E+01	1.61E+01	1.49E+01	1.56E+01	1.62E+01	1.49E+01	1.55E+01	1.62E+01	1.49E+01	1.55E+01	1.61E+01	1.49E+01	1.55E+01	1.61E+01	1.48E+01	1.55E+01	1.61E+01
Cd (Cadmium)	µg/L	4	1.01E-01	1.03E-01	1.04E-01	1.05E-01	1.11E-01	1.33E-01	1.04E-01	1.08E-01	1.24E-01	1.03E-01	1.06E-01	1.18E-01	1.02E-01	1.04E-01	1.08E-01	1.02E-01	1.04E-01	1.07E-01
Cl (Chloride)	mg/L	250	6.20E-01	6.52E-01	6.87E-01	6.21E-01	6.53E-01	6.87E-01	6.20E-01	6.53E-01	6.87E-01	6.20E-01	6.53E-01	6.87E-01	6.20E-01	6.53E-01	6.87E-01	6.20E-01	6.52E-01	6.87E-01
Co (Cobalt)	µg/L	--	7.72E-01	8.52E-01	9.41E-01	1.50E+00	3.22E+00	8.57E+00	1.28E+00	2.44E+00	6.35E+00	1.12E+00	1.91E+00	4.70E+00	9.04E-01	1.17E+00	2.37E+00	8.72E-01	1.07E+00	1.93E+00
Cr (Chromium)	µg/L	100	8.90E-01	9.33E-01	9.78E-01	8.93E-01	9.36E-01	9.80E-01	8.92E-01	9.35E-01	9.80E-01	8.91E-01	9.35E-01	9.79E-01	8.90E-01	9.33E-01	9.78E-01	8.90E-01	9.33E-01	9.78E-01
Cu (Copper)	µg/L	--	2.30E+00	2.49E+00	2.69E+00	2.30E+00	2.49E+00	2.69E+00	2.30E+00	2.49E+00	2.69E+00	2.31E+00	2.50E+00	2.70E+00	2.32E+00	2.51E+00	2.73E+00	2.33E+00	2.52E+00	2.73E+00
F (Fluoride)	mg/L	2	7.02E-02	7.26E-02	7.51E-02	7.05E-02	7.31E-02	7.55E-02	7.04E-02	7.29E-02	7.54E-02	7.03E-02	7.28E-02	7.53E-02	7.02E-02	7.26E-02	7.52E-02	7.02E-02	7.26E-02	7.51E-02
Fe (Iron)[4]	µg/L	--	1.22E+03	1.43E+03	1.67E+03	1.23E+03	1.44E+03	1.69E+03	1.22E+03	1.44E+03	1.68E+03	1.22E+03	1.44E+03	1.68E+03	1.22E+03	1.43E+03	1.68E+03	1.22E+03	1.43E+03	1.68E+03
K (Potassium)	mg/L	--	1.63E+00	1.69E+00	1.74E+00	1.64E+00	1.69E+00	1.75E+00	1.64E+00	1.69E+00	1.75E+00	1.64E+00	1.69E+00	1.74E+00	1.64E+00	1.69E+00	1.74E+00	1.63E+00	1.69E+00	1.74E+00
Mg (Magnesium)	mg/L	--	6.67E+00	6.95E+00	7.25E+00	6.75E+00	7.06E+00	7.41E+00	6.72E+00	7.03E+00	7.36E+00	6.71E+00	7.00E+00	7.32E+00	6.68E+00	6.97E+00	7.28E+00	6.68E+00	6.97E+00	7.27E+00
Mn (Manganese)[4,5]	µg/L	1002	4.78E+02	5.51E+02	6.35E+02	4.85E+02	5.57E+02	6.44E+02	4.83E+02	5.55E+02	6.41E+02	4.82E+02	5.54E+02	6.38E+02	4.79E+02	5.52E+02	6.36E+02	4.79E+02	5.51E+02	6.36E+02
Na (Sodium)	mg/L	--	5.12E+00	5.34E+00	5.57E+00	5.15E+00	5.37E+00	5.59E+00	5.14E+00	5.36E+00	5.58E+00	5.13E+00	5.35E+00	5.57E+00	5.13E+00	5.34E+00	5.57E+00	5.12E+00	5.34E+00	5.57E+00
Ni (Nickel)	µg/L	100	1.86E+00	2.01E+00	2.18E+00	1.86E+00	2.02E+00	2.18E+00	1.88E+00	2.04E+00	2.23E+00	1.90E+00	2.07E+00	2.28E+00	1.96E+00	2.17E+00	2.53E+00	1.98E+00	2.19E+00	2.65E+00
Pb (Lead)	µg/L	--	5.68E-01	6.07E-01	6.48E-01	6.02E-01	6.52E-01	7.36E-01	5.95E-01	6.38E-01	7.01E-01	5.88E-01	6.28E-01	6.81E-01	5.77E-01	6.15E-01	6.61E-01	5.74E-01	6.13E-01	6.56E-01
Sb (Antimony)	µg/L	6	2.51E-01	2.53E-01	2.55E-01	2.52E-01	2.54E-01	2.58E-01	2.53E-01	2.57E-01	2.73E-01	2.54E-01	2.58E-01	2.83E-01	2.55E-01	2.62E-01	2.94E-01	2.55E-01	2.63E-01	2.94E-01
Se (Selenium)	µg/L	30	5.14E-01	5.23E-01	5.32E-01	5.25E-01	5.42E-01	5.68E-01	5.23E-01	5.36E-01	5.56E-01	5.21E-01	5.33E-01	5.48E-01	5.17E-01	5.27E-01	5.37E-01	5.16E-01	5.26E-01	5.35E-01
SO4 (Sulfate)	mg/L	250	9.11E+00	9.58E+00	1.01E+01	9.68E+00	1.05E+01	1.23E+01	9.56E+00	1.03E+01	1.15E+01	9.43E+00	1.01E+01	1.10E+01	9.25E+00	9.77E+00	1.04E+01	9.21E+00	9.72E+00	1.03E+01
Tl (Thallium)	µg/L	0.6	1.18E-01	1.24E-01	1.30E-01	1.18E-01	1.24E-01	1.30E-01	1.18E-01	1.24E-01	1.30E-01	1.18E-01	1.24E-01	1.30E-01	1.18E-01	1.24E-01	1.30E-01	1.18E-01	1.24E-01	1.30E-01
V (Vanadium)	µg/L	50	3.50E+00	3.62E+00	3.75E+00	3.51E+00	3.63E+00	3.76E+00	3.50E+00	3.63E+00	3.76E+00	3.50E+00	3.63E+00	3.75E+00	3.50E+00	3.62E+00	3.75E+00	3.50E+00	3.62E+00	3.75E+00
Zn (Zinc)	µg/L	2000	4.18E+00	4.34E+00	4.50E+00	4.62E+00	5.33E+00	7.80E+00	4.51E+00	5.02E+00	6.67E+00	4.43E+00	4.80E+00	6.04E+00	4.27E+00	4.50E+00	5.02E+00	4.25E+00	4.46E+00	4.86E+00

Notes

[1] Values shown are the maximum of the monthly P10 values for the referenced Mine Year.

[2] Values shown are the maximum of the monthly P50 values for the referenced Mine Year.

[3] Values shown are the maximum of the monthly P90 values for the referenced Mine Year.

[4] Not evaluated against the secondary groundwater standard.

[5] Evaluated against the site-specific evaluation criteria shown.

2.00E+02 Values above the applicable water quality standard are shown in bold with light red shading.

Large Table 30 Annual Summary of Concentration Statistics for the OSP (surficial) Flow Path at the Partridge River

	Mine Year		10			50			75			100			175			200		
	Percentile		Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max
Constituent	Units	WQ Standard	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]
Ag (Silver)	µg/L	30	1.08E-01	1.11E-01	1.13E-01	1.08E-01	1.11E-01	1.13E-01	1.08E-01	1.11E-01	1.13E-01	1.09E-01	1.11E-01	1.13E-01	1.09E-01	1.11E-01	1.14E-01	1.09E-01	1.11E-01	1.14E-01
Al (Aluminum)[4]	µg/L	--	4.95E+01	5.40E+01	5.89E+01	4.95E+01	5.40E+01	5.89E+01	4.97E+01	5.42E+01	5.94E+01	5.06E+01	5.56E+01	6.37E+01	5.23E+01	5.83E+01	6.99E+01	5.20E+01	5.79E+01	6.89E+01
Alkalinity	mg/L	--	6.17E+01	6.46E+01	6.75E+01	6.17E+01	6.46E+01	6.75E+01	6.17E+01	6.46E+01	6.75E+01	6.17E+01	6.46E+01	6.75E+01	6.17E+01	6.46E+01	6.75E+01	6.17E+01	6.46E+01	6.75E+01
As (Arsenic)	µg/L	10	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01
B (Boron)	µg/L	1000	2.66E+01	2.70E+01	2.75E+01	2.66E+01	2.70E+01	2.75E+01	2.66E+01	2.70E+01	2.75E+01	2.66E+01	2.70E+01	2.75E+01	2.66E+01	2.70E+01	2.75E+01	2.66E+01	2.70E+01	2.75E+01
Ba (Barium)	µg/L	2000	2.94E+01	3.14E+01	3.34E+01	2.94E+01	3.14E+01	3.34E+01	2.94E+01	3.14E+01	3.34E+01	2.94E+01	3.14E+01	3.34E+01	2.94E+01	3.14E+01	3.34E+01	2.94E+01	3.14E+01	3.34E+01
Be (Beryllium)[5]	µg/L	0.45	1.16E-01	1.19E-01	1.23E-01	1.16E-01	1.19E-01	1.23E-01	1.16E-01	1.19E-01	1.23E-01	1.16E-01	1.19E-01	1.23E-01	1.16E-01	1.19E-01	1.23E-01	1.16E-01	1.19E-01	1.23E-01
Ca (Calcium)	mg/L	--	1.48E+01	1.54E+01	1.61E+01	1.48E+01	1.54E+01	1.61E+01	1.48E+01	1.54E+01	1.61E+01	1.48E+01	1.54E+01	1.61E+01	1.48E+01	1.54E+01	1.61E+01	1.48E+01	1.54E+01	1.61E+01
Cd (Cadmium)	µg/L	4	1.01E-01	1.03E-01	1.04E-01	1.01E-01	1.03E-01	1.04E-01	1.01E-01	1.03E-01	1.04E-01	1.01E-01	1.03E-01	1.05E-01	1.02E-01	1.03E-01	1.06E-01	1.02E-01	1.03E-01	1.06E-01
Cl (Chloride)	mg/L	250	6.20E-01	6.52E-01	6.87E-01	6.20E-01	6.52E-01	6.87E-01	6.20E-01	6.52E-01	6.87E-01	6.20E-01	6.52E-01	6.87E-01	6.20E-01	6.53E-01	6.87E-01	6.20E-01	6.52E-01	6.87E-01
Co (Cobalt)	µg/L	--	7.72E-01	8.52E-01	9.41E-01	7.72E-01	8.52E-01	9.41E-01	7.75E-01	8.63E-01	9.74E-01	7.98E-01	9.10E-01	1.32E+00	8.72E-01	1.07E+00	1.65E+00	8.62E-01	1.03E+00	1.58E+00
Cr (Chromium)	µg/L	100	8.90E-01	9.33E-01	9.78E-01	8.90E-01	9.33E-01	9.78E-01	8.90E-01	9.33E-01	9.78E-01	8.90E-01	9.33E-01	9.78E-01	8.90E-01	9.33E-01	9.78E-01	8.90E-01	9.33E-01	9.78E-01
Cu (Copper)	µg/L	--	2.30E+00	2.49E+00	2.69E+00	2.30E+00	2.49E+00	2.69E+00	2.30E+00	2.49E+00	2.69E+00	2.30E+00	2.49E+00	2.69E+00	2.30E+00	2.49E+00	2.69E+00	2.30E+00	2.49E+00	2.69E+00
F (Fluoride)	mg/L	2	7.02E-02	7.26E-02	7.51E-02	7.02E-02	7.26E-02	7.51E-02	7.02E-02	7.26E-02	7.51E-02	7.02E-02	7.26E-02	7.51E-02	7.02E-02	7.26E-02	7.51E-02	7.02E-02	7.26E-02	7.51E-02
Fe (Iron)[4]	µg/L	--	1.22E+03	1.43E+03	1.67E+03	1.22E+03	1.43E+03	1.67E+03	1.22E+03	1.43E+03	1.67E+03	1.22E+03	1.43E+03	1.67E+03	1.22E+03	1.43E+03	1.68E+03	1.22E+03	1.43E+03	1.68E+03
K (Potassium)	mg/L	--	1.63E+00	1.69E+00	1.74E+00	1.63E+00	1.69E+00	1.74E+00	1.63E+00	1.69E+00	1.74E+00	1.63E+00	1.69E+00	1.74E+00	1.63E+00	1.69E+00	1.74E+00	1.63E+00	1.69E+00	1.74E+00
Mg (Magnesium)	mg/L	--	6.67E+00	6.95E+00	7.25E+00	6.67E+00	6.95E+00	7.25E+00	6.67E+00	6.95E+00	7.26E+00	6.67E+00	6.96E+00	7.26E+00	6.68E+00	6.97E+00	7.26E+00	6.67E+00	6.96E+00	7.26E+00
Mn (Manganese)[4,5]	µg/L	1002	4.78E+02	5.51E+02	6.35E+02	4.78E+02	5.51E+02	6.35E+02	4.78E+02	5.51E+02	6.36E+02	4.78E+02	5.52E+02	6.36E+02	4.79E+02	5.52E+02	6.36E+02	4.79E+02	5.51E+02	6.36E+02
Na (Sodium)	mg/L	--	5.12E+00	5.34E+00	5.57E+00	5.12E+00	5.34E+00	5.57E+00	5.12E+00	5.34E+00	5.57E+00	5.12E+00	5.34E+00	5.57E+00	5.12E+00	5.34E+00	5.57E+00	5.12E+00	5.34E+00	5.57E+00
Ni (Nickel)	µg/L	100	1.86E+00	2.01E+00	2.18E+00	1.86E+00	2.01E+00	2.18E+00	1.86E+00	2.01E+00	2.18E+00	1.86E+00	2.01E+00	2.18E+00	1.86E+00	2.01E+00	2.18E+00	1.86E+00	2.01E+00	2.18E+00
Pb (Lead)	µg/L	--	5.68E-01	6.07E-01	6.48E-01	5.68E-01	6.07E-01	6.48E-01	5.68E-01	6.07E-01	6.48E-01	5.70E-01	6.09E-01	6.50E-01	5.73E-01	6.11E-01	6.53E-01	5.73E-01	6.11E-01	6.53E-01
Sb (Antimony)	µg/L	6	2.51E-01	2.53E-01	2.55E-01	2.51E-01	2.53E-01	2.55E-01	2.51E-01	2.53E-01	2.55E-01	2.51E-01	2.53E-01	2.55E-01	2.51E-01	2.53E-01	2.55E-01	2.51E-01	2.53E-01	2.55E-01
Se (Selenium)	µg/L	30	5.14E-01	5.23E-01	5.32E-01	5.14E-01	5.23E-01	5.32E-01	5.15E-01	5.23E-01	5.32E-01	5.15E-01	5.24E-01	5.33E-01	5.17E-01	5.25E-01	5.34E-01	5.16E-01	5.25E-01	5.34E-01
SO4 (Sulfate)	mg/L	250	9.11E+00	9.58E+00	1.01E+01	9.11E+00	9.58E+00	1.01E+01	9.11E+00	9.59E+00	1.01E+01	9.16E+00	9.65E+00	1.02E+01	9.22E+00	9.70E+00	1.02E+01	9.18E+00	9.69E+00	1.02E+01
Tl (Thallium)	µg/L	0.6	1.18E-01	1.24E-01	1.30E-01	1.18E-01	1.24E-01	1.30E-01	1.18E-01	1.24E-01	1.30E-01	1.18E-01	1.24E-01	1.30E-01	1.18E-01	1.24E-01	1.30E-01	1.18E-01	1.24E-01	1.30E-01
V (Vanadium)	µg/L	50	3.50E+00	3.62E+00	3.75E+00	3.50E+00	3.62E+00	3.75E+00	3.50E+00	3.62E+00	3.75E+00	3.50E+00	3.62E+00	3.75E+00	3.50E+00	3.62E+00	3.75E+00	3.50E+00	3.62E+00	3.75E+00
Zn (Zinc)	µg/L	2000	4.18E+00	4.34E+00	4.50E+00	4.18E+00	4.34E+00	4.50E+00	4.19E+00	4.34E+00	4.51E+00	4.21E+00	4.38E+00	4.60E+00	4.25E+00	4.45E+00	4.75E+00	4.24E+00	4.44E+00	4.72E+00

Notes

[1] Values shown are the maximum of the monthly P10 values for the referenced Mine Year.

[2] Values shown are the maximum of the monthly P50 values for the referenced Mine Year.

[3] Values shown are the maximum of the monthly P90 values for the referenced Mine Year.

[4] Not evaluated against the secondary groundwater standard.

[5] Evaluated against the site-specific evaluation criteria shown.

2.00E+02 Values above the applicable water quality standard are shown in bold with light red shading.

Large Table 31 Annual Summary of Concentration Statistics for the WWTF (surficial) Flow Path at Dunka Road

	Mine Year		10			50			75			100			175			200		
	Percentile		Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max
Constituent	Units	WQ Standard	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]
Ag (Silver)	µg/L	30	1.09E-01	1.11E-01	1.13E-01	1.13E-01	1.17E-01	1.21E-01	1.12E-01	1.16E-01	1.19E-01	1.11E-01	1.14E-01	1.18E-01	1.10E-01	1.12E-01	1.15E-01	1.09E-01	1.12E-01	1.15E-01
Al (Aluminum)[4]	µg/L	--	5.05E+01	5.50E+01	6.02E+01	8.02E+01	1.11E+02	1.52E+02	7.32E+01	1.01E+02	1.39E+02	6.75E+01	8.79E+01	1.24E+02	5.71E+01	6.78E+01	9.21E+01	5.50E+01	6.43E+01	8.49E+01
Alkalinity	mg/L	--	6.17E+01	6.45E+01	6.75E+01	6.16E+01	6.44E+01	6.74E+01	6.16E+01	6.44E+01	6.74E+01	6.16E+01	6.44E+01	6.74E+01	6.17E+01	6.45E+01	6.75E+01	6.17E+01	6.45E+01	6.75E+01
As (Arsenic)	µg/L	10	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01
B (Boron)	µg/L	1000	2.66E+01	2.70E+01	2.75E+01	2.67E+01	2.71E+01	2.76E+01	2.66E+01	2.71E+01	2.75E+01	2.66E+01	2.71E+01	2.75E+01	2.66E+01	2.70E+01	2.75E+01	2.66E+01	2.70E+01	2.75E+01
Ba (Barium)	µg/L	2000	2.94E+01	3.14E+01	3.34E+01	2.94E+01	3.13E+01	3.34E+01	2.94E+01	3.13E+01	3.34E+01	2.94E+01	3.13E+01	3.34E+01	2.94E+01	3.14E+01	3.34E+01	2.94E+01	3.14E+01	3.34E+01
Be (Beryllium)[5]	µg/L	0.45	1.16E-01	1.19E-01	1.23E-01	1.19E-01	1.23E-01	1.29E-01	1.18E-01	1.22E-01	1.28E-01	1.18E-01	1.21E-01	1.26E-01	1.17E-01	1.20E-01	1.24E-01	1.17E-01	1.20E-01	1.24E-01
Ca (Calcium)	mg/L	--	1.48E+01	1.54E+01	1.61E+01	1.51E+01	1.57E+01	1.63E+01	1.51E+01	1.57E+01	1.63E+01	1.50E+01	1.56E+01	1.62E+01	1.49E+01	1.55E+01	1.61E+01	1.49E+01	1.55E+01	1.61E+01
Cd (Cadmium)	µg/L	4	1.02E-01	1.03E-01	1.05E-01	1.13E-01	1.23E-01	1.38E-01	1.10E-01	1.19E-01	1.32E-01	1.08E-01	1.15E-01	1.26E-01	1.04E-01	1.07E-01	1.15E-01	1.03E-01	1.06E-01	1.12E-01
Cl (Chloride)	mg/L	250	6.21E-01	6.54E-01	6.87E-01	6.47E-01	6.83E-01	7.30E-01	6.42E-01	6.78E-01	7.23E-01	6.38E-01	6.72E-01	7.12E-01	6.29E-01	6.62E-01	6.97E-01	6.27E-01	6.60E-01	6.95E-01
Co (Cobalt)	µg/L	--	8.07E-01	8.93E-01	9.90E-01	1.82E+00	2.77E+00	4.84E+00	1.56E+00	2.37E+00	4.28E+00	1.37E+00	2.01E+00	3.58E+00	9.95E-01	1.36E+00	2.23E+00	9.37E-01	1.24E+00	1.97E+00
Cr (Chromium)	µg/L	100	8.90E-01	9.33E-01	9.77E-01	8.95E-01	9.38E-01	9.82E-01	8.95E-01	9.37E-01	9.82E-01	8.94E-01	9.36E-01	9.81E-01	8.92E-01	9.34E-01	9.79E-01	8.91E-01	9.34E-01	9.78E-01
Cu (Copper)	µg/L	--	2.30E+00	2.49E+00	2.69E+00	2.30E+00	2.49E+00	2.69E+00	2.30E+00	2.49E+00	2.69E+00	2.31E+00	2.49E+00	2.69E+00	2.32E+00	2.50E+00	2.71E+00	2.32E+00	2.51E+00	2.71E+00
F (Fluoride)	mg/L	2	7.02E-02	7.26E-02	7.51E-02	7.17E-02	7.41E-02	7.66E-02	7.14E-02	7.38E-02	7.63E-02	7.11E-02	7.35E-02	7.60E-02	7.06E-02	7.30E-02	7.55E-02	7.05E-02	7.29E-02	7.54E-02
Fe (Iron)[4]	µg/L	--	1.22E+03	1.43E+03	1.67E+03	1.25E+03	1.46E+03	1.71E+03	1.24E+03	1.45E+03	1.70E+03	1.24E+03	1.44E+03	1.69E+03	1.23E+03	1.44E+03	1.68E+03	1.22E+03	1.43E+03	1.68E+03
K (Potassium)	mg/L	--	1.63E+00	1.69E+00	1.74E+00	1.68E+00	1.73E+00	1.78E+00	1.67E+00	1.72E+00	1.78E+00	1.66E+00	1.71E+00	1.77E+00	1.65E+00	1.70E+00	1.75E+00	1.65E+00	1.69E+00	1.75E+00
Mg (Magnesium)	mg/L	--	6.67E+00	6.95E+00	7.25E+00	6.81E+00	7.11E+00	7.43E+00	6.79E+00	7.08E+00	7.41E+00	6.75E+00	7.05E+00	7.37E+00	6.71E+00	7.00E+00	7.31E+00	6.70E+00	6.99E+00	7.29E+00
Mn (Manganese)[4,5]	µg/L	1002	4.78E+02	5.51E+02	6.35E+02	4.81E+02	5.54E+02	6.38E+02	4.81E+02	5.53E+02	6.37E+02	4.81E+02	5.53E+02	6.36E+02	4.79E+02	5.52E+02	6.36E+02	4.79E+02	5.52E+02	6.35E+02
Na (Sodium)	mg/L	--	5.12E+00	5.34E+00	5.57E+00	5.27E+00	5.49E+00	5.72E+00	5.25E+00	5.47E+00	5.70E+00	5.22E+00	5.44E+00	5.67E+00	5.18E+00	5.38E+00	5.62E+00	5.16E+00	5.37E+00	5.61E+00
Ni (Nickel)	µg/L	100	1.86E+00	2.01E+00	2.18E+00	1.86E+00	2.02E+00	2.18E+00	1.87E+00	2.03E+00	2.18E+00	1.88E+00	2.04E+00	2.19E+00	1.92E+00	2.08E+00	2.24E+00	1.93E+00	2.10E+00	2.25E+00
Pb (Lead)	µg/L	--	5.69E-01	6.08E-01	6.49E-01	6.22E-01	6.62E-01	7.06E-01	6.12E-01	6.53E-01	6.97E-01	6.02E-01	6.42E-01	6.85E-01	5.83E-01	6.22E-01	6.64E-01	5.79E-01	6.19E-01	6.60E-01
Sb (Antimony)	µg/L	6	2.51E-01	2.53E-01	2.55E-01	2.52E-01	2.56E-01	2.63E-01	2.54E-01	2.59E-01	2.74E-01	2.55E-01	2.62E-01	2.82E-01	2.59E-01	2.69E-01	2.93E-01	2.59E-01	2.70E-01	2.94E-01
Se (Selenium)	µg/L	30	5.15E-01	5.24E-01	5.32E-01	5.35E-01	5.49E-01	5.66E-01	5.32E-01	5.44E-01	5.61E-01	5.28E-01	5.39E-01	5.55E-01	5.20E-01	5.30E-01	5.42E-01	5.19E-01	5.29E-01	5.40E-01
SO4 (Sulfate)	mg/L	250	9.15E+00	9.61E+00	1.01E+01	1.04E+01	1.12E+01	1.24E+01	1.01E+01	1.09E+01	1.21E+01	9.88E+00	1.06E+01	1.16E+01	9.45E+00	1.01E+01	1.07E+01	9.38E+00	9.95E+00	1.06E+01
Tl (Thallium)	µg/L	0.6	1.18E-01	1.24E-01	1.30E-01	1.18E-01	1.24E-01	1.30E-01	1.18E-01	1.24E-01	1.30E-01	1.18E-01	1.24E-01	1.30E-01	1.18E-01	1.24E-01	1.30E-01	1.18E-01	1.24E-01	1.30E-01
V (Vanadium)	µg/L	50	3.50E+00	3.62E+00	3.75E+00	3.50E+00	3.63E+00	3.75E+00	3.50E+00	3.63E+00	3.75E+00	3.50E+00	3.62E+00	3.75E+00	3.50E+00	3.62E+00	3.75E+00	3.50E+00	3.62E+00	3.75E+00
Zn (Zinc)	µg/L	2000	4.23E+00	4.39E+00	4.57E+00	5.40E+00	6.23E+00	7.79E+00	5.11E+00	5.86E+00	7.39E+00	4.84E+00	5.46E+00	6.74E+00	4.44E+00	4.81E+00	5.64E+00	4.37E+00	4.71E+00	5.39E+00

Notes

[1] Values shown are the maximum of the monthly P10 values for the referenced Mine Year.

[2] Values shown are the maximum of the monthly P50 values for the referenced Mine Year.

[3] Values shown are the maximum of the monthly P90 values for the referenced Mine Year.

[4] Not evaluated against the secondary groundwater standard.

[5] Evaluated against the site-specific evaluation criteria shown.

2.00E+02 Values above the applicable water quality standard are shown in bold with light red shading.

Large Table 32 Annual Summary of Concentration Statistics for the WWTF (surficial) Flow Path at the Property Boundary

	Mine Year		10			50			75			100			175			200		
	Percentile		Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max
Constituent	Units	WQ Standard	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]
Ag (Silver)	µg/L	30	1.08E-01	1.11E-01	1.13E-01	1.08E-01	1.11E-01	1.13E-01	1.09E-01	1.11E-01	1.13E-01	1.09E-01	1.11E-01	1.14E-01	1.09E-01	1.12E-01	1.14E-01	1.09E-01	1.12E-01	1.14E-01
Al (Aluminum)[4]	µg/L	--	4.95E+01	5.40E+01	5.89E+01	4.96E+01	5.40E+01	5.89E+01	5.03E+01	5.54E+01	6.23E+01	5.19E+01	5.92E+01	7.45E+01	5.59E+01	6.45E+01	7.89E+01	5.49E+01	6.35E+01	7.71E+01
Alkalinity	mg/L	--	6.17E+01	6.46E+01	6.75E+01	6.17E+01	6.46E+01	6.75E+01	6.17E+01	6.45E+01	6.75E+01	6.17E+01	6.45E+01	6.75E+01	6.17E+01	6.45E+01	6.75E+01	6.17E+01	6.45E+01	6.75E+01
As (Arsenic)	µg/L	10	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01
B (Boron)	µg/L	1000	2.66E+01	2.70E+01	2.75E+01	2.66E+01	2.70E+01	2.75E+01	2.66E+01	2.70E+01	2.75E+01	2.66E+01	2.70E+01	2.75E+01	2.66E+01	2.70E+01	2.75E+01	2.66E+01	2.70E+01	2.75E+01
Ba (Barium)	µg/L	2000	2.94E+01	3.14E+01	3.34E+01	2.94E+01	3.14E+01	3.34E+01	2.94E+01	3.14E+01	3.34E+01	2.94E+01	3.14E+01	3.34E+01	2.94E+01	3.14E+01	3.34E+01	2.94E+01	3.14E+01	3.34E+01
Be (Beryllium)[5]	µg/L	0.45	1.16E-01	1.19E-01	1.23E-01	1.16E-01	1.19E-01	1.23E-01	1.16E-01	1.19E-01	1.23E-01	1.16E-01	1.20E-01	1.23E-01	1.17E-01	1.20E-01	1.24E-01	1.17E-01	1.20E-01	1.23E-01
Ca (Calcium)	mg/L	--	1.48E+01	1.54E+01	1.61E+01	1.48E+01	1.54E+01	1.61E+01	1.48E+01	1.54E+01	1.61E+01	1.49E+01	1.55E+01	1.61E+01	1.49E+01	1.55E+01	1.61E+01	1.49E+01	1.55E+01	1.61E+01
Cd (Cadmium)	µg/L	4	1.01E-01	1.03E-01	1.04E-01	1.01E-01	1.03E-01	1.04E-01	1.01E-01	1.03E-01	1.06E-01	1.02E-01	1.04E-01	1.10E-01	1.04E-01	1.07E-01	1.11E-01	1.03E-01	1.06E-01	1.11E-01
Cl (Chloride)	mg/L	250	6.20E-01	6.52E-01	6.87E-01	6.20E-01	6.52E-01	6.87E-01	6.20E-01	6.53E-01	6.88E-01	6.23E-01	6.56E-01	6.91E-01	6.27E-01	6.60E-01	6.92E-01	6.27E-01	6.59E-01	6.92E-01
Co (Cobalt)	µg/L	--	7.72E-01	8.52E-01	9.41E-01	7.72E-01	8.54E-01	9.41E-01	7.87E-01	8.89E-01	1.08E+00	8.27E-01	1.02E+00	1.53E+00	9.58E-01	1.21E+00	1.78E+00	9.34E-01	1.17E+00	1.73E+00
Cr (Chromium)	µg/L	100	8.90E-01	9.33E-01	9.78E-01	8.90E-01	9.33E-01	9.78E-01	8.90E-01	9.33E-01	9.78E-01	8.90E-01	9.33E-01	9.78E-01	8.91E-01	9.34E-01	9.79E-01	8.91E-01	9.34E-01	9.78E-01
Cu (Copper)	µg/L	--	2.30E+00	2.49E+00	2.69E+00	2.30E+00	2.49E+00	2.69E+00	2.30E+00	2.49E+00	2.69E+00	2.30E+00	2.49E+00	2.69E+00	2.30E+00	2.49E+00	2.69E+00	2.30E+00	2.49E+00	2.69E+00
F (Fluoride)	mg/L	2	7.02E-02	7.26E-02	7.51E-02	7.02E-02	7.26E-02	7.51E-02	7.02E-02	7.26E-02	7.52E-02	7.04E-02	7.27E-02	7.53E-02	7.04E-02	7.29E-02	7.54E-02	7.04E-02	7.29E-02	7.54E-02
Fe (Iron)[4]	µg/L	--	1.22E+03	1.43E+03	1.67E+03	1.22E+03	1.43E+03	1.67E+03	1.22E+03	1.43E+03	1.68E+03	1.22E+03	1.43E+03	1.68E+03	1.23E+03	1.43E+03	1.68E+03	1.22E+03	1.43E+03	1.68E+03
K (Potassium)	mg/L	--	1.63E+00	1.69E+00	1.74E+00	1.63E+00	1.69E+00	1.74E+00	1.63E+00	1.69E+00	1.74E+00	1.64E+00	1.69E+00	1.74E+00	1.64E+00	1.69E+00	1.75E+00	1.64E+00	1.69E+00	1.75E+00
Mg (Magnesium)	mg/L	--	6.67E+00	6.95E+00	7.25E+00	6.67E+00	6.95E+00	7.25E+00	6.68E+00	6.96E+00	7.26E+00	6.69E+00	6.97E+00	7.27E+00	6.70E+00	6.98E+00	7.28E+00	6.69E+00	6.98E+00	7.29E+00
Mn (Manganese)[4,5]	µg/L	1002	4.78E+02	5.51E+02	6.35E+02	4.78E+02	5.51E+02	6.35E+02	4.78E+02	5.51E+02	6.36E+02	4.79E+02	5.51E+02	6.36E+02	4.79E+02	5.52E+02	6.35E+02	4.79E+02	5.52E+02	6.35E+02
Na (Sodium)	mg/L	--	5.12E+00	5.34E+00	5.57E+00	5.12E+00	5.34E+00	5.57E+00	5.12E+00	5.34E+00	5.57E+00	5.13E+00	5.36E+00	5.59E+00	5.16E+00	5.37E+00	5.60E+00	5.15E+00	5.37E+00	5.60E+00
Ni (Nickel)	µg/L	100	1.86E+00	2.01E+00	2.18E+00	1.86E+00	2.01E+00	2.18E+00	1.86E+00	2.01E+00	2.18E+00	1.86E+00	2.01E+00	2.18E+00	1.86E+00	2.01E+00	2.18E+00	1.86E+00	2.01E+00	2.18E+00
Pb (Lead)	µg/L	--	5.68E-01	6.07E-01	6.48E-01	5.68E-01	6.07E-01	6.48E-01	5.70E-01	6.09E-01	6.50E-01	5.72E-01	6.14E-01	6.55E-01	5.81E-01	6.19E-01	6.59E-01	5.79E-01	6.16E-01	6.57E-01
Sb (Antimony)	µg/L	6	2.51E-01	2.53E-01	2.55E-01	2.51E-01	2.53E-01	2.55E-01	2.51E-01	2.53E-01	2.55E-01	2.51E-01	2.53E-01	2.55E-01	2.51E-01	2.53E-01	2.55E-01	2.51E-01	2.53E-01	2.55E-01
Se (Selenium)	µg/L	30	5.14E-01	5.23E-01	5.32E-01	5.14E-01	5.23E-01	5.32E-01	5.15E-01	5.24E-01	5.33E-01	5.17E-01	5.26E-01	5.36E-01	5.19E-01	5.28E-01	5.39E-01	5.19E-01	5.28E-01	5.39E-01
SO4 (Sulfate)	mg/L	250	9.11E+00	9.58E+00	1.01E+01	9.11E+00	9.58E+00	1.01E+01	9.15E+00	9.64E+00	1.01E+01	9.24E+00	9.78E+00	1.04E+01	9.41E+00	9.92E+00	1.05E+01	9.36E+00	9.89E+00	1.05E+01
Tl (Thallium)	µg/L	0.6	1.18E-01	1.24E-01	1.30E-01	1.18E-01	1.24E-01	1.30E-01	1.18E-01	1.24E-01	1.30E-01	1.18E-01	1.24E-01	1.30E-01	1.18E-01	1.24E-01	1.30E-01	1.18E-01	1.24E-01	1.30E-01
V (Vanadium)	µg/L	50	3.50E+00	3.62E+00	3.75E+00	3.50E+00	3.62E+00	3.75E+00	3.50E+00	3.62E+00	3.75E+00	3.50E+00	3.62E+00	3.75E+00	3.50E+00	3.62E+00	3.75E+00	3.50E+00	3.62E+00	3.75E+00
Zn (Zinc)	µg/L	2000	4.18E+00	4.34E+00	4.50E+00	4.18E+00	4.34E+00	4.50E+00	4.21E+00	4.39E+00	4.60E+00	4.26E+00	4.52E+00	4.98E+00	4.41E+00	4.71E+00	5.18E+00	4.37E+00	4.67E+00	5.12E+00

Notes

[1] Values shown are the maximum of the monthly P10 values for the referenced Mine Year.

[2] Values shown are the maximum of the monthly P50 values for the referenced Mine Year.

[3] Values shown are the maximum of the monthly P90 values for the referenced Mine Year.

[4] Not evaluated against the secondary groundwater standard.

[5] Evaluated against the site-specific evaluation criteria shown.

2.00E+02 Values above the applicable water quality standard are shown in bold with light red shading.

Large Table 33 Annual Summary of Concentration Statistics for the OSLA (surficial) Flow Path at Dunka Road

	Mine Year		10			20			75			100			150			200		
	Percentile		Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max
Constituent	Units	WQ Standard	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]
Ag (Silver)	µg/L	30	1.05E-01	2.69E-01	4.28E-01	1.03E-01	3.29E-01	5.56E-01	1.08E-01	1.80E-01	3.54E-01	1.09E-01	1.49E-01	3.16E-01	1.10E-01	1.21E-01	2.56E-01	1.09E-01	1.15E-01	2.11E-01
Al (Aluminum)[4]	µg/L	--	7.38E+01	1.05E+02	1.35E+02	8.31E+01	1.24E+02	1.68E+02	6.19E+01	7.72E+01	1.23E+02	5.73E+01	6.85E+01	1.12E+02	5.30E+01	6.13E+01	9.62E+01	5.15E+01	5.87E+01	8.50E+01
Alkalinity	mg/L	--	3.57E+01	4.35E+01	5.25E+01	2.22E+01	3.38E+01	4.64E+01	3.86E+01	5.42E+01	6.06E+01	4.23E+01	5.79E+01	6.34E+01	4.79E+01	6.11E+01	6.57E+01	5.22E+01	6.23E+01	6.64E+01
As (Arsenic)	µg/L	10	6.92E-01	7.36E-01	7.82E-01	7.11E-01	7.56E-01	8.03E-01	7.11E-01	7.56E-01	8.02E-01	7.10E-01	7.56E-01	8.01E-01	7.10E-01	7.55E-01	8.01E-01	7.10E-01	7.55E-01	8.00E-01
B (Boron)	µg/L	1000	6.87E+01	7.58E+01	8.37E+01	8.64E+01	9.62E+01	1.05E+02	3.95E+01	5.16E+01	7.87E+01	3.28E+01	4.20E+01	7.14E+01	2.81E+01	3.26E+01	5.95E+01	2.71E+01	2.92E+01	5.10E+01
Ba (Barium)	µg/L	2000	1.93E+01	2.26E+01	2.58E+01	1.39E+01	1.83E+01	2.29E+01	2.07E+01	2.64E+01	3.00E+01	2.22E+01	2.79E+01	3.14E+01	2.47E+01	2.95E+01	3.24E+01	2.64E+01	3.02E+01	3.27E+01
Be (Beryllium)[5]	µg/L	0.45	1.20E-01	1.37E-01	1.54E-01	1.21E-01	1.44E-01	1.68E-01	1.19E-01	1.28E-01	1.44E-01	1.18E-01	1.24E-01	1.39E-01	1.18E-01	1.22E-01	1.33E-01	1.17E-01	1.21E-01	1.30E-01
Ca (Calcium)	mg/L	--	1.23E+01	1.34E+01	1.42E+01	1.10E+01	1.23E+01	1.36E+01	1.29E+01	1.43E+01	1.52E+01	1.33E+01	1.47E+01	1.55E+01	1.38E+01	1.50E+01	1.58E+01	1.42E+01	1.51E+01	1.59E+01
Cd (Cadmium)	µg/L	4	7.08E-02	8.32E-02	9.51E-02	5.60E-02	7.40E-02	9.16E-02	7.43E-02	9.38E-02	9.95E-02	7.83E-02	9.75E-02	1.01E-01	8.59E-02	1.00E-01	1.03E-01	9.03E-02	1.01E-01	1.03E-01
Cl (Chloride)	mg/L	250	1.81E+00	2.66E+00	3.53E+00	2.30E+00	3.46E+00	4.66E+00	1.07E+00	1.58E+00	3.17E+00	8.55E-01	1.24E+00	2.81E+00	6.91E-01	8.75E-01	2.22E+00	6.45E-01	7.41E-01	1.81E+00
Co (Cobalt)	µg/L	--	5.33E-01	7.18E-01	8.93E-01	3.86E-01	6.45E-01	9.09E-01	5.95E-01	7.90E-01	9.01E-01	6.40E-01	8.04E-01	9.04E-01	6.96E-01	8.23E-01	9.19E-01	7.28E-01	8.34E-01	9.26E-01
Cr (Chromium)	µg/L	100	5.87E-01	7.36E-01	8.73E-01	4.27E-01	6.43E-01	8.46E-01	6.34E-01	8.36E-01	9.18E-01	6.80E-01	8.71E-01	9.36E-01	7.50E-01	8.97E-01	9.56E-01	8.05E-01	9.09E-01	9.63E-01
Cu (Copper)	µg/L	--	2.35E+00	2.54E+00	2.74E+00	2.40E+00	2.59E+00	2.79E+00	2.39E+00	2.59E+00	2.79E+00	2.39E+00	2.59E+00	2.79E+00	2.39E+00	2.59E+00	2.79E+00	2.39E+00	2.58E+00	2.79E+00
F (Fluoride)	mg/L	2	1.52E-01	2.81E-01	4.02E-01	1.87E-01	3.65E-01	5.34E-01	1.02E-01	1.64E-01	3.50E-01	8.77E-02	1.26E-01	3.05E-01	7.57E-02	9.18E-02	2.40E-01	7.23E-02	8.08E-02	1.94E-01
Fe (Iron)[4]	µg/L	--	5.50E+02	6.63E+02	8.11E+02	2.33E+02	2.97E+02	3.90E+02	5.84E+02	1.02E+03	1.33E+03	6.99E+02	1.14E+03	1.46E+03	8.60E+02	1.26E+03	1.57E+03	9.88E+02	1.31E+03	1.60E+03
K (Potassium)	mg/L	--	1.54E+00	2.03E+00	2.53E+00	1.48E+00	2.18E+00	2.86E+00	1.61E+00	1.85E+00	2.33E+00	1.63E+00	1.78E+00	2.23E+00	1.64E+00	1.72E+00	2.08E+00	1.64E+00	1.71E+00	1.97E+00
Mg (Magnesium)	mg/L	--	5.66E+00	6.06E+00	6.47E+00	5.08E+00	5.65E+00	6.19E+00	5.79E+00	6.45E+00	6.87E+00	5.95E+00	6.59E+00	7.01E+00	6.22E+00	6.74E+00	7.13E+00	6.40E+00	6.81E+00	7.17E+00
Mn (Manganese)[4,5]	µg/L	1002	2.52E+02	2.94E+02	3.45E+02	1.41E+02	1.74E+02	2.12E+02	2.66E+02	3.98E+02	5.12E+02	3.04E+02	4.45E+02	5.58E+02	3.65E+02	4.87E+02	5.94E+02	4.07E+02	5.08E+02	6.06E+02
Na (Sodium)	mg/L	--	5.53E+00	1.06E+01	1.56E+01	5.62E+00	1.28E+01	2.00E+01	5.41E+00	7.76E+00	1.31E+01	5.38E+00	6.60E+00	1.19E+01	5.28E+00	5.76E+00	9.86E+00	5.21E+00	5.57E+00	8.54E+00
Ni (Nickel)	µg/L	100	1.88E+00	2.03E+00	2.19E+00	1.90E+00	2.04E+00	2.21E+00	1.90E+00	2.04E+00	2.21E+00	1.90E+00	2.04E+00	2.21E+00	1.90E+00	2.04E+00	2.21E+00	1.90E+00	2.04E+00	2.21E+00
Pb (Lead)	µg/L	--	2.80E-01	3.15E-01	3.55E-01	1.41E-01	1.77E-01	2.18E-01	2.85E-01	4.52E-01	5.40E-01	3.29E-01	5.08E-01	5.88E-01	3.99E-01	5.55E-01	6.21E-01	4.53E-01	5.75E-01	6.31E-01
Sb (Antimony)	µg/L	6	2.62E-01	2.78E-01	3.06E-01	2.70E-01	3.02E-01	3.53E-01	2.68E-01	2.97E-01	3.43E-01	2.68E-01	2.96E-01	3.37E-01	2.66E-01	2.92E-01	3.29E-01	2.64E-01	2.88E-01	3.23E-01
Se (Selenium)	µg/L	30	4.75E-01	5.37E-01	6.06E-01	4.52E-01	5.44E-01	6.40E-01	4.96E-01	5.29E-01	5.84E-01	5.02E-01	5.27E-01	5.72E-01	5.08E-01	5.26E-01	5.56E-01	5.11E-01	5.25E-01	5.45E-01
SO4 (Sulfate)	mg/L	250	2.68E+01	3.03E+01	3.45E+01	3.40E+01	3.87E+01	4.39E+01	1.49E+01	1.98E+01	3.20E+01	1.20E+01	1.59E+01	2.88E+01	9.97E+00	1.20E+01	2.37E+01	9.47E+00	1.07E+01	1.99E+01
Tl (Thallium)	µg/L	0.6	6.45E-02	7.76E-02	8.94E-02	3.81E-02	5.55E-02	7.19E-02	6.90E-02	9.94E-02	1.14E-01	7.72E-02	1.08E-01	1.21E-01	9.01E-02	1.16E-01	1.26E-01	9.81E-02	1.19E-01	1.27E-01
V (Vanadium)	µg/L	50	2.47E+00	2.71E+00	2.91E+00	1.94E+00	2.27E+00	2.55E+00	2.56E+00	3.14E+00	3.41E+00	2.71E+00	3.30E+00	3.55E+00	2.96E+00	3.45E+00	3.67E+00	3.13E+00	3.51E+00	3.70E+00
Zn (Zinc)	µg/L	2000	3.11E+00	3.66E+00	4.22E+00	2.56E+00	3.34E+00	4.15E+00	3.36E+00	4.02E+00	4.32E+00	3.52E+00	4.13E+00	4.36E+00	3.75E+00	4.22E+00	4.43E+00	3.91E+00	4.26E+00	4.45E+00

Notes

[1] Values shown are the maximum of the monthly P10 values for the referenced Mine Year.

[2] Values shown are the maximum of the monthly P50 values for the referenced Mine Year.

[3] Values shown are the maximum of the monthly P90 values for the referenced Mine Year.

[4] Not evaluated against the secondary groundwater standard.

[5] Evaluated against the site-specific evaluation criteria shown.

2.00E+02 Values above the applicable water quality standard are shown in bold with light red shading.

Large Table 34 Annual Summary of Concentration Statistics for the OSLA (surficial) Flow Path at the Property Boundary

	Mine Year		10			20			75			100			150			200		
	Percentile		Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max
Constituent	Units	WQ Standard	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]
Ag (Silver)	µg/L	30	1.08E-01	1.68E-01	2.39E-01	1.05E-01	2.75E-01	4.38E-01	1.08E-01	1.79E-01	3.41E-01	1.09E-01	1.49E-01	3.09E-01	1.10E-01	1.21E-01	2.56E-01	1.09E-01	1.15E-01	2.11E-01
Al (Aluminum)[4]	µg/L	--	6.09E+01	7.36E+01	8.79E+01	7.46E+01	1.08E+02	1.39E+02	6.18E+01	7.70E+01	1.19E+02	5.73E+01	6.85E+01	1.11E+02	5.30E+01	6.13E+01	9.61E+01	5.15E+01	5.87E+01	8.50E+01
Alkalinity	mg/L	--	5.37E+01	5.79E+01	6.18E+01	3.33E+01	4.27E+01	5.18E+01	4.02E+01	5.42E+01	6.06E+01	4.28E+01	5.79E+01	6.34E+01	4.80E+01	6.11E+01	6.57E+01	5.22E+01	6.23E+01	6.64E+01
As (Arsenic)	µg/L	10	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01
B (Boron)	µg/L	1000	3.98E+01	4.59E+01	5.30E+01	6.84E+01	7.77E+01	8.73E+01	3.95E+01	5.16E+01	7.56E+01	3.28E+01	4.20E+01	7.02E+01	2.81E+01	3.26E+01	5.94E+01	2.71E+01	2.92E+01	5.10E+01
Ba (Barium)	µg/L	2000	2.61E+01	2.85E+01	3.08E+01	1.87E+01	2.22E+01	2.54E+01	2.13E+01	2.65E+01	3.00E+01	2.24E+01	2.79E+01	3.14E+01	2.48E+01	2.95E+01	3.24E+01	2.64E+01	3.02E+01	3.27E+01
Be (Beryllium)[5]	µg/L	0.45	1.18E-01	1.26E-01	1.34E-01	1.20E-01	1.37E-01	1.55E-01	1.19E-01	1.28E-01	1.43E-01	1.18E-01	1.24E-01	1.39E-01	1.18E-01	1.22E-01	1.33E-01	1.17E-01	1.21E-01	1.30E-01
Ca (Calcium)	mg/L	--	1.40E+01	1.47E+01	1.53E+01	1.21E+01	1.32E+01	1.41E+01	1.30E+01	1.43E+01	1.52E+01	1.34E+01	1.47E+01	1.55E+01	1.38E+01	1.50E+01	1.58E+01	1.42E+01	1.51E+01	1.59E+01
Cd (Cadmium)	µg/L	4	9.12E-02	9.67E-02	1.00E-01	6.86E-02	8.25E-02	9.48E-02	7.65E-02	9.39E-02	9.95E-02	7.91E-02	9.75E-02	1.01E-01	8.59E-02	1.00E-01	1.03E-01	9.03E-02	1.01E-01	1.03E-01
Cl (Chloride)	mg/L	250	1.04E+00	1.40E+00	1.92E+00	1.84E+00	2.70E+00	3.67E+00	1.07E+00	1.58E+00	3.03E+00	8.55E-01	1.24E+00	2.75E+00	6.91E-01	8.75E-01	2.21E+00	6.45E-01	7.41E-01	1.81E+00
Co (Cobalt)	µg/L	--	7.16E-01	8.04E-01	9.05E-01	5.08E-01	7.09E-01	8.95E-01	6.00E-01	7.90E-01	9.01E-01	6.44E-01	8.04E-01	9.04E-01	6.96E-01	8.23E-01	9.19E-01	7.28E-01	8.34E-01	9.26E-01
Cr (Chromium)	µg/L	100	7.99E-01	8.71E-01	9.29E-01	5.66E-01	7.29E-01	8.72E-01	6.48E-01	8.37E-01	9.18E-01	6.83E-01	8.71E-01	9.36E-01	7.50E-01	8.97E-01	9.56E-01	8.05E-01	9.09E-01	9.63E-01
Cu (Copper)	µg/L	--	2.30E+00	2.49E+00	2.69E+00	2.30E+00	2.49E+00	2.69E+00	2.30E+00	2.49E+00	2.69E+00	2.30E+00	2.49E+00	2.69E+00	2.30E+00	2.49E+00	2.69E+00	2.30E+00	2.49E+00	2.69E+00
F (Fluoride)	mg/L	2	1.00E-01	1.48E-01	2.12E-01	1.54E-01	2.85E-01	4.17E-01	1.02E-01	1.62E-01	3.33E-01	8.77E-02	1.26E-01	3.00E-01	7.57E-02	9.18E-02	2.40E-01	7.23E-02	8.08E-02	1.94E-01
Fe (Iron)[4]	µg/L	--	9.82E+02	1.17E+03	1.41E+03	4.80E+02	6.15E+02	7.97E+02	6.26E+02	1.02E+03	1.33E+03	7.16E+02	1.14E+03	1.46E+03	8.60E+02	1.26E+03	1.57E+03	9.88E+02	1.31E+03	1.60E+03
K (Potassium)	mg/L	--	1.63E+00	1.81E+00	2.05E+00	1.53E+00	2.04E+00	2.57E+00	1.61E+00	1.84E+00	2.30E+00	1.63E+00	1.78E+00	2.21E+00	1.64E+00	1.72E+00	2.08E+00	1.64E+00	1.71E+00	1.97E+00
Mg (Magnesium)	mg/L	--	6.37E+00	6.67E+00	6.95E+00	5.58E+00	6.02E+00	6.44E+00	5.86E+00	6.46E+00	6.87E+00	5.98E+00	6.59E+00	7.01E+00	6.23E+00	6.74E+00	7.13E+00	6.40E+00	6.81E+00	7.17E+00
Mn (Manganese)[4,5]	µg/L	1002	4.02E+02	4.64E+02	5.44E+02	2.32E+02	2.79E+02	3.38E+02	2.82E+02	3.98E+02	5.12E+02	3.09E+02	4.45E+02	5.58E+02	3.65E+02	4.87E+02	5.94E+02	4.07E+02	5.08E+02	6.06E+02
Na (Sodium)	mg/L	--	5.41E+00	7.31E+00	9.51E+00	5.56E+00	1.10E+01	1.60E+01	5.41E+00	7.76E+00	1.27E+01	5.38E+00	6.60E+00	1.17E+01	5.28E+00	5.76E+00	9.85E+00	5.21E+00	5.57E+00	8.54E+00
Ni (Nickel)	µg/L	100	1.86E+00	2.01E+00	2.18E+00	1.86E+00	2.01E+00	2.18E+00	1.86E+00	2.01E+00	2.18E+00	1.86E+00	2.01E+00	2.18E+00	1.86E+00	2.01E+00	2.18E+00	1.86E+00	2.01E+00	2.18E+00
Pb (Lead)	µg/L	--	4.59E-01	5.13E-01	5.60E-01	2.48E-01	2.98E-01	3.52E-01	3.05E-01	4.52E-01	5.40E-01	3.37E-01	5.08E-01	5.88E-01	4.00E-01	5.55E-01	6.21E-01	4.53E-01	5.75E-01	6.31E-01
Sb (Antimony)	µg/L	6	2.51E-01	2.53E-01	2.55E-01	2.51E-01	2.53E-01	2.55E-01	2.51E-01	2.54E-01	2.62E-01	2.52E-01	2.54E-01	2.70E-01	2.52E-01	2.56E-01	2.84E-01	2.53E-01	2.59E-01	2.88E-01
Se (Selenium)	µg/L	30	5.07E-01	5.27E-01	5.58E-01	4.72E-01	5.37E-01	6.11E-01	4.97E-01	5.29E-01	5.82E-01	5.02E-01	5.27E-01	5.71E-01	5.08E-01	5.26E-01	5.56E-01	5.11E-01	5.25E-01	5.45E-01
SO4 (Sulfate)	mg/L	250	1.49E+01	1.74E+01	2.09E+01	2.64E+01	3.10E+01	3.62E+01	1.49E+01	1.98E+01	3.06E+01	1.20E+01	1.59E+01	2.83E+01	9.97E+00	1.20E+01	2.36E+01	9.47E+00	1.07E+01	1.99E+01
Tl (Thallium)	µg/L	0.6	9.94E-02	1.09E-01	1.17E-01	6.00E-02	7.53E-02	8.87E-02	7.22E-02	9.96E-02	1.14E-01	7.82E-02	1.08E-01	1.21E-01	9.02E-02	1.16E-01	1.26E-01	9.81E-02	1.19E-01	1.27E-01
V (Vanadium)	µg/L	50	3.14E+00	3.32E+00	3.49E+00	2.38E+00	2.66E+00	2.89E+00	2.62E+00	3.14E+00	3.41E+00	2.74E+00	3.30E+00	3.55E+00	2.97E+00	3.45E+00	3.67E+00	3.13E+00	3.51E+00	3.70E+00
Zn (Zinc)	µg/L	2000	3.86E+00	4.12E+00	4.33E+00	3.06E+00	3.64E+00	4.20E+00	3.41E+00	4.02E+00	4.32E+00	3.54E+00	4.13E+00	4.36E+00	3.76E+00	4.22E+00	4.43E+00	3.91E+00	4.26E+00	4.45E+00

Notes

[1] Values shown are the maximum of the monthly P10 values for the referenced Mine Year.

[2] Values shown are the maximum of the monthly P50 values for the referenced Mine Year.

[3] Values shown are the maximum of the monthly P90 values for the referenced Mine Year.

[4] Not evaluated against the secondary groundwater standard.

[5] Evaluated against the site-specific evaluation criteria shown.

2.00E+02 Values above the applicable water quality standard are shown in bold with light red shading.

Large Table 35 Annual Summary of Concentration Statistics for the West Pit (surficial) Flow Path at Dunka Road

	Mine Year		50			70			100			125			150			200		
	Percentile		Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max
Constituent	Units	WQ Standard	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]
Ag (Silver)	µg/L	30	1.09E-01	1.11E-01	1.15E-01	1.42E-01	1.81E-01	1.86E-01	1.83E-01	1.85E-01	1.86E-01	1.83E-01	1.85E-01	1.86E-01	1.83E-01	1.85E-01	1.86E-01	1.83E-01	1.85E-01	1.86E-01
Al (Aluminum)[4]	µg/L	--	4.93E+01	5.38E+01	5.87E+01	9.79E+00	1.36E+01	3.71E+01	9.13E+00	1.04E+01	1.20E+01	9.10E+00	1.03E+01	1.16E+01	9.10E+00	1.03E+01	1.16E+01	9.10E+00	1.03E+01	1.16E+01
Alkalinity	mg/L	--	6.15E+01	6.45E+01	6.74E+01	4.09E+01	4.82E+01	5.79E+01	3.99E+01	4.39E+01	5.34E+01	3.98E+01	4.38E+01	5.34E+01	3.98E+01	4.38E+01	5.34E+01	3.98E+01	4.38E+01	5.28E+01
As (Arsenic)	µg/L	10	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01	6.75E-01	7.20E-01	7.67E-01
B (Boron)	µg/L	1000	2.67E+01	2.72E+01	3.00E+01	5.23E+01	8.45E+01	8.84E+01	8.61E+01	8.76E+01	8.88E+01	8.64E+01	8.78E+01	8.89E+01	8.40E+01	8.73E+01	8.87E+01	6.58E+01	7.24E+01	8.14E+01
Ba (Barium)	µg/L	2000	2.94E+01	3.14E+01	3.35E+01	2.95E+01	3.46E+01	3.69E+01	2.66E+01	3.62E+01	3.88E+01	2.42E+01	3.68E+01	4.00E+01	2.21E+01	3.55E+01	4.13E+01	1.88E+01	2.92E+01	4.38E+01
Be (Beryllium)[5]	µg/L	0.45	1.17E-01	1.20E-01	1.30E-01	2.14E-01	3.23E-01	3.53E-01	2.73E-01	3.46E-01	3.56E-01	2.42E-01	3.30E-01	3.56E-01	2.17E-01	2.93E-01	3.56E-01	1.76E-01	2.35E-01	3.54E-01
Ca (Calcium)	mg/L	--	1.49E+01	1.56E+01	1.66E+01	2.42E+01	3.19E+01	4.02E+01	2.67E+01	2.98E+01	3.77E+01	2.38E+01	2.67E+01	3.34E+01	2.13E+01	2.40E+01	2.96E+01	1.74E+01	1.95E+01	2.36E+01
Cd (Cadmium)	µg/L	4	1.02E-01	1.04E-01	1.73E-01	4.87E-01	1.03E+00	2.82E+00	5.55E-01	1.13E+00	3.01E+00	4.88E-01	1.03E+00	2.90E+00	4.26E-01	8.94E-01	2.75E+00	3.27E-01	6.82E-01	2.58E+00
Cl (Chloride)	mg/L	250	6.27E-01	6.70E-01	1.16E+00	4.45E+00	7.57E+00	1.15E+01	5.79E+00	7.59E+00	1.06E+01	5.06E+00	6.63E+00	9.30E+00	4.47E+00	5.81E+00	8.08E+00	3.50E+00	4.49E+00	6.09E+00
Co (Cobalt)	µg/L	--	7.94E-01	9.02E-01	2.49E+00	1.02E+01	2.59E+01	5.79E+01	1.24E+01	2.65E+01	5.68E+01	1.08E+01	2.32E+01	5.06E+01	9.46E+00	2.01E+01	4.58E+01	7.35E+00	1.52E+01	3.48E+01
Cr (Chromium)	µg/L	100	8.96E-01	9.44E-01	1.02E+00	1.54E+00	2.11E+00	2.43E+00	1.79E+00	1.95E+00	2.21E+00	1.57E+00	1.72E+00	1.95E+00	1.38E+00	1.53E+00	1.72E+00	1.10E+00	1.21E+00	1.35E+00
Cu (Copper)	µg/L	--	2.30E+00	2.49E+00	2.69E+00	2.30E+00	2.49E+00	2.69E+00	2.30E+00	2.49E+00	2.69E+00	2.30E+00	2.49E+00	2.69E+00	2.31E+00	2.51E+00	2.73E+00	2.36E+00	2.58E+00	3.22E+00
F (Fluoride)	mg/L	2	7.04E-02	7.34E-02	8.11E-02	1.34E-01	1.95E-01	2.48E-01	1.52E-01	1.86E-01	2.32E-01	1.36E-01	1.65E-01	2.06E-01	1.22E-01	1.47E-01	1.82E-01	9.87E-02	1.18E-01	1.43E-01
Fe (Iron)[4]	µg/L	--	1.20E+03	1.42E+03	1.67E+03	2.75E+02	4.14E+02	1.03E+03	2.51E+02	3.06E+02	4.31E+02	2.49E+02	3.02E+02	4.20E+02	2.49E+02	3.02E+02	4.20E+02	2.49E+02	3.02E+02	4.20E+02
K (Potassium)	mg/L	--	1.64E+00	1.71E+00	2.09E+00	4.74E+00	7.39E+00	1.04E+01	5.77E+00	7.20E+00	9.63E+00	5.02E+00	6.28E+00	8.44E+00	4.39E+00	5.48E+00	7.31E+00	3.41E+00	4.21E+00	5.56E+00
Mg (Magnesium)	mg/L	--	6.69E+00	7.01E+00	7.51E+00	1.03E+01	1.34E+01	1.57E+01	1.14E+01	1.24E+01	1.47E+01	1.02E+01	1.11E+01	1.31E+01	9.11E+00	1.00E+01	1.17E+01	7.48E+00	8.15E+00	9.42E+00
Mn (Manganese)[4,5]	µg/L	1002	4.76E+02	5.50E+02	6.33E+02	2.02E+02	2.52E+02	4.24E+02	1.87E+02	2.11E+02	2.54E+02	1.81E+02	2.02E+02	2.41E+02	1.75E+02	1.97E+02	2.34E+02	1.67E+02	1.88E+02	2.23E+02
Na (Sodium)	mg/L	--	5.15E+00	5.43E+00	7.00E+00	1.52E+01	2.50E+01	3.93E+01	1.88E+01	2.47E+01	3.72E+01	1.65E+01	2.15E+01	3.21E+01	1.44E+01	1.86E+01	2.79E+01	1.11E+01	1.43E+01	2.08E+01
Ni (Nickel)	µg/L	100	1.86E+00	2.01E+00	2.18E+00	1.86E+00	2.01E+00	2.18E+00	1.87E+00	2.02E+00	2.18E+00	1.89E+00	2.05E+00	2.27E+00	1.91E+00	2.10E+00	2.86E+00	1.97E+00	2.34E+00	8.42E+00
Pb (Lead)	µg/L	--	5.78E-01	6.26E-01	9.12E-01	3.13E+00	5.59E+00	8.86E+00	4.16E+00	5.64E+00	8.47E+00	3.73E+00	5.00E+00	7.42E+00	3.30E+00	4.42E+00	6.56E+00	2.62E+00	3.47E+00	5.08E+00
Sb (Antimony)	µg/L	6	2.51E-01	2.53E-01	2.55E-01	2.52E-01	2.55E-01	3.04E-01	2.54E-01	3.67E-01	1.95E+00	2.67E-01	8.55E-01	3.97E+00	3.09E-01	1.72E+00	4.82E+00	5.79E-01	3.29E+00	4.80E+00
Se (Selenium)	µg/L	30	5.15E-01	5.26E-01	5.67E-01	3.68E-01	1.38E+00	1.95E+00	2.99E-01	1.35E+00	1.79E+00	2.98E-01	1.21E+00	1.58E+00	2.98E-01	1.08E+00	1.41E+00	2.98E-01	8.64E-01	1.14E+00
SO4 (Sulfate)	mg/L	250	9.21E+00	9.77E+00	1.16E+01	2.74E+01	4.31E+01	5.40E+01	3.55E+01	4.15E+01	4.97E+01	3.11E+01	3.64E+01	4.43E+01	2.76E+01	3.21E+01	3.92E+01	2.17E+01	2.53E+01	3.11E+01
Tl (Thallium)	µg/L	0.6	1.17E-01	1.23E-01	1.30E-01	8.62E-02	9.47E-02	1.13E-01	7.87E-02	8.43E-02	9.19E-02	7.45E-02	7.95E-02	8.63E-02	7.05E-02	7.55E-02	8.22E-02	6.44E-02	6.93E-02	7.65E-02
V (Vanadium)	µg/L	50	3.51E+00	3.65E+00	3.91E+00	5.90E+00	8.64E+00	8.98E+00	8.78E+00	8.92E+00	9.03E+00	8.80E+00	8.93E+00	9.04E+00	8.80E+00	8.92E+00	9.04E+00	8.78E+00	8.92E+00	9.03E+00
Zn (Zinc)	µg/L	2000	4.23E+00	4.46E+00	8.71E+00	3.52E+01	7.12E+01	1.70E+02	4.57E+01	7.78E+01	1.82E+02	4.08E+01	7.40E+01	1.79E+02	3.66E+01	6.93E+01	1.73E+02	2.90E+01	5.55E+01	1.60E+02

Notes

[1] Values shown are the maximum of the monthly P10 values for the referenced Mine Year.

[2] Values shown are the maximum of the monthly P50 values for the referenced Mine Year.

[3] Values shown are the maximum of the monthly P90 values for the referenced Mine Year.

[4] Not evaluated against the secondary groundwater standard.

[5] Evaluated against the site-specific evaluation criteria shown.

2.00E+02 Values above the applicable water quality standard are shown in bold with light red shading.

Large Table 36 Annual Summary of Concentration Statistics for the West Pit (surficial) Flow Path at the Property Boundary

	Mine Year		50			75			100			125			150			200		
	Percentile		Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max
Constituent	Units	WQ Standard	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]
Ag (Silver)	µg/L	30	1.08E-01	1.11E-01	1.13E-01	1.09E-01	1.12E-01	1.31E-01	1.11E-01	1.40E-01	1.57E-01	1.17E-01	1.54E-01	1.58E-01	1.41E-01	1.55E-01	1.58E-01	1.53E-01	1.56E-01	1.58E-01
Al (Aluminum)[4]	µg/L	--	4.95E+01	5.40E+01	5.89E+01	4.31E+01	5.26E+01	5.82E+01	2.61E+01	3.72E+01	5.54E+01	2.54E+01	2.91E+01	5.02E+01	2.52E+01	2.81E+01	3.61E+01	2.49E+01	2.76E+01	3.07E+01
Alkalinity	mg/L	--	6.17E+01	6.46E+01	6.75E+01	5.96E+01	6.38E+01	6.71E+01	5.04E+01	5.81E+01	6.55E+01	4.96E+01	5.47E+01	6.25E+01	4.94E+01	5.30E+01	5.91E+01	4.91E+01	5.23E+01	5.78E+01
As (Arsenic)	µg/L	10	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01	6.73E-01	7.16E-01	7.62E-01
B (Boron)	µg/L	1000	2.66E+01	2.70E+01	2.75E+01	2.67E+01	2.74E+01	4.44E+01	2.72E+01	5.17E+01	6.47E+01	3.23E+01	6.24E+01	6.55E+01	5.24E+01	6.31E+01	6.57E+01	5.54E+01	6.15E+01	6.51E+01
Ba (Barium)	µg/L	2000	2.94E+01	3.14E+01	3.34E+01	2.96E+01	3.16E+01	3.36E+01	2.97E+01	3.26E+01	3.50E+01	2.88E+01	3.33E+01	3.58E+01	2.72E+01	3.37E+01	3.66E+01	2.47E+01	3.33E+01	3.81E+01
Be (Beryllium)[5]	µg/L	0.45	1.16E-01	1.19E-01	1.23E-01	1.17E-01	1.22E-01	1.83E-01	1.20E-01	2.06E-01	2.60E-01	1.40E-01	2.34E-01	2.64E-01	1.86E-01	2.35E-01	2.65E-01	1.70E-01	2.24E-01	2.65E-01
Ca (Calcium)	mg/L	--	1.48E+01	1.54E+01	1.61E+01	1.50E+01	1.58E+01	2.13E+01	1.54E+01	2.31E+01	2.84E+01	1.73E+01	2.35E+01	2.84E+01	2.04E+01	2.26E+01	2.70E+01	1.78E+01	2.00E+01	2.41E+01
Cd (Cadmium)	µg/L	4	1.01E-01	1.03E-01	1.04E-01	1.02E-01	1.05E-01	4.69E-01	1.05E-01	4.43E-01	1.57E+00	2.36E-01	5.82E-01	1.67E+00	3.22E-01	6.41E-01	1.73E+00	2.85E-01	5.60E-01	1.73E+00
Cl (Chloride)	mg/L	250	6.20E-01	6.52E-01	6.87E-01	6.28E-01	6.85E-01	3.26E+00	6.71E-01	3.57E+00	6.38E+00	1.48E+00	4.43E+00	6.33E+00	3.08E+00	4.27E+00	5.80E+00	2.70E+00	3.55E+00	5.06E+00
Co (Cobalt)	µg/L	--	7.72E-01	8.52E-01	9.41E-01	7.99E-01	9.57E-01	1.04E+01	9.10E-01	9.55E+00	2.98E+01	4.23E+00	1.38E+01	3.18E+01	6.34E+00	1.41E+01	3.08E+01	5.80E+00	1.14E+01	2.67E+01
Cr (Chromium)	µg/L	100	8.90E-01	9.33E-01	9.78E-01	9.01E-01	9.57E-01	1.35E+00	9.33E-01	1.46E+00	1.74E+00	1.06E+00	1.51E+00	1.70E+00	1.29E+00	1.44E+00	1.60E+00	1.12E+00	1.23E+00	1.47E+00
Cu (Copper)	µg/L	--	2.30E+00	2.49E+00	2.69E+00	2.30E+00	2.49E+00	2.69E+00	2.30E+00	2.49E+00	2.69E+00	2.30E+00	2.49E+00	2.69E+00	2.30E+00	2.49E+00	2.69E+00	2.30E+00	2.49E+00	2.69E+00
F (Fluoride)	mg/L	2	7.02E-02	7.26E-02	7.51E-02	7.08E-02	7.43E-02	1.18E-01	7.33E-02	1.24E-01	1.68E-01	8.49E-02	1.36E-01	1.64E-01	1.08E-01	1.31E-01	1.56E-01	9.63E-02	1.13E-01	1.40E-01
Fe (Iron)[4]	µg/L	--	1.22E+03	1.43E+03	1.67E+03	1.09E+03	1.38E+03	1.65E+03	6.86E+02	1.01E+03	1.50E+03	6.52E+02	8.08E+02	1.31E+03	6.43E+02	7.78E+02	1.03E+03	6.35E+02	7.54E+02	9.14E+02
K (Potassium)	mg/L	--	1.63E+00	1.69E+00	1.74E+00	1.65E+00	1.73E+00	3.70E+00	1.71E+00	4.21E+00	6.37E+00	2.30E+00	4.69E+00	6.32E+00	3.62E+00	4.53E+00	5.82E+00	3.06E+00	3.82E+00	5.11E+00
Mg (Magnesium)	mg/L	--	6.67E+00	6.95E+00	7.25E+00	6.72E+00	7.11E+00	9.39E+00	6.97E+00	9.92E+00	1.16E+01	7.78E+00	1.01E+01	1.16E+01	8.77E+00	9.68E+00	1.10E+01	7.76E+00	8.52E+00	9.94E+00
Mn (Manganese)[4,5]	µg/L	1002	4.78E+02	5.51E+02	6.35E+02	4.47E+02	5.32E+02	6.21E+02	3.33E+02	4.20E+02	5.73E+02	3.17E+02	3.67E+02	5.11E+02	3.08E+02	3.50E+02	4.30E+02	2.98E+02	3.38E+02	3.88E+02
Na (Sodium)	mg/L	--	5.12E+00	5.34E+00	5.57E+00	5.18E+00	5.49E+00	1.27E+01	5.42E+00	1.37E+01	2.39E+01	7.69E+00	1.57E+01	2.34E+01	1.17E+01	1.51E+01	2.22E+01	1.00E+01	1.28E+01	1.84E+01
Ni (Nickel)	µg/L	100	1.86E+00	2.01E+00	2.18E+00	1.86E+00	2.01E+00	2.18E+00	1.86E+00	2.01E+00	2.18E+00	1.86E+00	2.01E+00	2.18E+00	1.86E+00	2.01E+00	2.18E+00	1.86E+00	2.01E+00	2.18E+00
Pb (Lead)	µg/L	--	5.68E-01	6.07E-01	6.48E-01	5.81E-01	6.46E-01	2.35E+00	6.20E-01	2.81E+00	5.15E+00	1.22E+00	3.33E+00	5.13E+00	2.34E+00	3.23E+00	4.88E+00	2.10E+00	2.76E+00	4.07E+00
Sb (Antimony)	µg/L	6	2.51E-01	2.53E-01	2.55E-01	2.51E-01	2.53E-01	2.55E-01	2.51E-01	2.53E-01	2.55E-01	2.51E-01	2.53E-01	2.55E-01	2.51E-01	2.53E-01	2.55E-01	2.51E-01	2.53E-01	2.67E-01
Se (Selenium)	µg/L	30	5.14E-01	5.23E-01	5.32E-01	5.14E-01	5.28E-01	7.73E-01	5.07E-01	7.10E-01	1.27E+00	4.43E-01	9.71E-01	1.24E+00	4.11E-01	9.43E-01	1.18E+00	3.88E-01	8.23E-01	1.07E+00
SO4 (Sulfate)	mg/L	250	9.11E+00	9.58E+00	1.01E+01	9.25E+00	1.00E+01	2.16E+01	9.75E+00	2.49E+01	3.39E+01	1.34E+01	2.71E+01	3.33E+01	2.16E+01	2.62E+01	3.17E+01	1.87E+01	2.21E+01	2.85E+01
Tl (Thallium)	µg/L	0.6	1.18E-01	1.24E-01	1.30E-01	1.14E-01	1.22E-01	1.29E-01	9.98E-02	1.12E-01	1.25E-01	9.59E-02	1.03E-01	1.20E-01	9.30E-02	9.90E-02	1.11E-01	8.83E-02	9.42E-02	1.00E-01
V (Vanadium)	µg/L	50	3.50E+00	3.62E+00	3.75E+00	3.53E+00	3.69E+00	5.17E+00	3.63E+00	5.75E+00	6.93E+00	4.08E+00	6.71E+00	6.99E+00	5.79E+00	6.77E+00	7.02E+00	6.57E+00	6.82E+00	7.03E+00
Zn (Zinc)	µg/L	2000	4.18E+00	4.34E+00	4.50E+00	4.26E+00	4.57E+00	2.91E+01	4.53E+00	3.26E+01	9.10E+01	1.33E+01	4.06E+01	1.06E+02	2.54E+01	4.50E+01	1.06E+02	2.21E+01	4.21E+01	1.06E+02

Notes

[1] Values shown are the maximum of the monthly P10 values for the referenced Mine Year.

[2] Values shown are the maximum of the monthly P50 values for the referenced Mine Year.

[3] Values shown are the maximum of the monthly P90 values for the referenced Mine Year.

[4] Not evaluated against the secondary groundwater standard.

[5] Evaluated against the site-specific evaluation criteria shown.

2.00E+02 Values above the applicable water quality standard are shown in bold with light red shading.

Large Table 37 Annual Summary of Concentration Statistics for the West Pit (bedrock to SW004) Flow Path at the Property Boundary

	Mine Year		10			50			75			100			150			200		
	Percentile		Max P10[1]	Max P50[2]	Max P90[3]	Max P10[1]	Max P50[2]	Max P90[3]	Max P10[1]	Max P50[2]	Max P90[3]	Max P10[1]	Max P50[2]	Max P90[3]	Max P10[1]	Max P50[2]	Max P90[3]	Max P10[1]	Max P50[2]	Max P90[3]
Constituent	Units	WQ Standard																		
Ag (Silver)	µg/L	30	1.76E-01	2.01E-01	2.30E-01	1.76E-01	2.01E-01	2.30E-01	1.76E-01	2.01E-01	2.30E-01	1.76E-01	2.01E-01	2.30E-01	1.76E-01	2.01E-01	2.30E-01	1.76E-01	2.01E-01	2.30E-01
Al (Aluminum)[4]	µg/L	--	1.61E+01	1.81E+01	2.03E+01	1.61E+01	1.81E+01	2.03E+01	1.61E+01	1.81E+01	2.03E+01	1.61E+01	1.81E+01	2.03E+01	1.61E+01	1.81E+01	2.03E+01	1.61E+01	1.81E+01	2.03E+01
Alkalinity	mg/L	--	5.48E+01	6.41E+01	7.49E+01	5.48E+01	6.41E+01	7.49E+01	5.48E+01	6.41E+01	7.49E+01	5.48E+01	6.41E+01	7.49E+01	5.48E+01	6.41E+01	7.49E+01	5.48E+01	6.41E+01	7.49E+01
As (Arsenic)	µg/L	10	1.72E+00	2.10E+00	2.56E+00	1.72E+00	2.10E+00	2.56E+00	1.72E+00	2.10E+00	2.56E+00	1.72E+00	2.10E+00	2.56E+00	1.72E+00	2.10E+00	2.56E+00	1.72E+00	2.10E+00	2.56E+00
B (Boron)	µg/L	1000	4.01E+01	4.58E+01	5.24E+01	4.01E+01	4.58E+01	5.24E+01	4.01E+01	4.58E+01	5.24E+01	4.01E+01	4.58E+01	5.24E+01	4.01E+01	4.58E+01	5.24E+01	4.01E+01	4.58E+01	5.24E+01
Ba (Barium)	µg/L	2000	5.67E+00	6.83E+00	8.23E+00	5.67E+00	6.83E+00	8.23E+00	5.67E+00	6.83E+00	8.23E+00	5.67E+00	6.83E+00	8.23E+00	5.67E+00	6.83E+00	8.23E+00	5.67E+00	6.83E+00	8.23E+00
Be (Beryllium)[5]	µg/L	0.2	1.05E-01	1.09E-01	1.14E-01	1.05E-01	1.09E-01	1.14E-01	1.05E-01	1.09E-01	1.14E-01	1.05E-01	1.09E-01	1.14E-01	1.05E-01	1.09E-01	1.14E-01	1.05E-01	1.09E-01	1.14E-01
Ca (Calcium)	mg/L	--	1.35E+01	1.49E+01	1.64E+01	1.35E+01	1.49E+01	1.64E+01	1.35E+01	1.49E+01	1.64E+01	1.35E+01	1.49E+01	1.64E+01	1.35E+01	1.49E+01	1.64E+01	1.35E+01	1.49E+01	1.64E+01
Cd (Cadmium)	µg/L	4	1.08E-01	1.15E-01	1.23E-01	1.08E-01	1.15E-01	1.23E-01	1.08E-01	1.15E-01	1.23E-01	1.08E-01	1.15E-01	1.23E-01	1.08E-01	1.15E-01	1.23E-01	1.08E-01	1.15E-01	1.23E-01
Cl (Chloride)	mg/L	250	1.45E+00	1.78E+00	2.18E+00	1.45E+00	1.78E+00	2.18E+00	1.45E+00	1.78E+00	2.18E+00	1.45E+00	1.78E+00	2.18E+00	1.45E+00	1.78E+00	2.18E+00	1.45E+00	1.78E+00	2.18E+00
Co (Cobalt)	µg/L	--	2.03E+00	2.63E+00	3.41E+00	2.03E+00	2.63E+00	3.41E+00	2.03E+00	2.63E+00	3.41E+00	2.03E+00	2.63E+00	3.41E+00	2.03E+00	2.63E+00	3.41E+00	2.03E+00	2.63E+00	3.41E+00
Cr (Chromium)	µg/L	100	5.06E-01	5.19E-01	5.32E-01	5.06E-01	5.19E-01	5.32E-01	5.06E-01	5.19E-01	5.32E-01	5.06E-01	5.19E-01	5.32E-01	5.06E-01	5.19E-01	5.32E-01	5.06E-01	5.19E-01	5.32E-01
Cu (Copper)	µg/L	--	1.19E+00	1.36E+00	1.56E+00	1.19E+00	1.36E+00	1.56E+00	1.19E+00	1.36E+00	1.56E+00	1.19E+00	1.36E+00	1.56E+00	1.19E+00	1.36E+00	1.56E+00	1.19E+00	1.36E+00	1.56E+00
F (Fluoride)	mg/L	2	1.32E-01	1.55E-01	1.81E-01	1.32E-01	1.55E-01	1.81E-01	1.32E-01	1.55E-01	1.81E-01	1.32E-01	1.55E-01	1.81E-01	1.32E-01	1.55E-01	1.81E-01	1.32E-01	1.55E-01	1.81E-01
Fe (Iron)[4]	µg/L	--	1.09E+04	1.60E+04	2.36E+04	1.09E+04	1.60E+04	2.36E+04	1.09E+04	1.60E+04	2.36E+04	1.09E+04	1.60E+04	2.36E+04	1.09E+04	1.60E+04	2.36E+04	1.09E+04	1.60E+04	2.36E+04
K (Potassium)	mg/L	--	1.51E+00	1.61E+00	1.71E+00	1.51E+00	1.61E+00	1.71E+00	1.51E+00	1.61E+00	1.71E+00	1.51E+00	1.61E+00	1.71E+00	1.51E+00	1.61E+00	1.71E+00	1.51E+00	1.61E+00	1.71E+00
Mg (Magnesium)	mg/L	--	8.26E+00	9.58E+00	1.11E+01	8.26E+00	9.58E+00	1.11E+01	8.26E+00	9.58E+00	1.11E+01	8.26E+00	9.58E+00	1.11E+01	8.26E+00	9.58E+00	1.11E+01	8.26E+00	9.58E+00	1.11E+01
Mn (Manganese)[4,5]	µg/L	306.6	1.44E+02	1.98E+02	2.73E+02	1.44E+02	1.98E+02	2.73E+02	1.44E+02	1.98E+02	2.73E+02	1.44E+02	1.98E+02	2.73E+02	1.44E+02	1.98E+02	2.73E+02	1.44E+02	1.98E+02	2.73E+02
Na (Sodium)	mg/L	--	7.04E+00	8.59E+00	1.05E+01	7.04E+00	8.59E+00	1.05E+01	7.04E+00	8.59E+00	1.05E+01	7.04E+00	8.59E+00	1.05E+01	7.04E+00	8.59E+00	1.05E+01	7.04E+00	8.59E+00	1.05E+01
Ni (Nickel)	µg/L	100	3.33E+01	4.72E+01	6.68E+01	3.33E+01	4.72E+01	6.68E+01	3.33E+01	4.72E+01	6.68E+01	3.33E+01	4.72E+01	6.68E+01	3.33E+01	4.72E+01	6.68E+01	3.33E+01	4.72E+01	6.68E+01
Pb (Lead)	µg/L	--	4.65E-01	5.25E-01	5.93E-01	4.65E-01	5.25E-01	5.93E-01	4.65E-01	5.25E-01	5.93E-01	4.65E-01	5.25E-01	5.93E-01	4.65E-01	5.25E-01	5.93E-01	4.65E-01	5.25E-01	5.93E-01
Sb (Antimony)	µg/L	6	5.39E-01	6.25E-01	7.24E-01	5.39E-01	6.25E-01	7.24E-01	5.39E-01	6.25E-01	7.24E-01	5.39E-01	6.25E-01	7.24E-01	5.39E-01	6.25E-01	7.24E-01	5.39E-01	6.25E-01	7.24E-01
Se (Selenium)	µg/L	30	5.98E-01	6.33E-01	6.71E-01	5.98E-01	6.33E-01	6.71E-01	5.98E-01	6.33E-01	6.71E-01	5.98E-01	6.33E-01	6.71E-01	5.98E-01	6.33E-01	6.71E-01	5.98E-01	6.33E-01	6.71E-01
SO4 (Sulfate)	mg/L	250	2.09E+01	2.50E+01	2.98E+01	2.09E+01	2.50E+01	2.98E+01	2.09E+01	2.50E+01	2.98E+01	2.09E+01	2.50E+01	2.98E+01	2.09E+01	2.50E+01	2.98E+01	2.09E+01	2.50E+01	2.98E+01
Tl (Thallium)[5]	µg/L	1	2.93E-01	3.52E-01	4.25E-01	2.93E-01	3.52E-01	4.25E-01	2.93E-01	3.52E-01	4.25E-01	2.93E-01	3.52E-01	4.25E-01	2.93E-01	3.52E-01	4.25E-01	2.93E-01	3.52E-01	4.25E-01
V (Vanadium)	µg/L	50	3.50E+00	3.62E+00	3.75E+00	3.50E+00	3.62E+00	3.75E+00	3.50E+00	3.62E+00	3.75E+00	3.50E+00	3.62E+00	3.75E+00	3.50E+00	3.62E+00	3.75E+00	3.50E+00	3.62E+00	3.75E+00
Zn (Zinc)	µg/L	2000	1.01E+01	1.21E+01	1.46E+01	1.01E+01	1.21E+01	1.46E+01	1.01E+01	1.21E+01	1.46E+01	1.01E+01	1.21E+01	1.46E+01	1.01E+01	1.21E+01	1.46E+01	1.01E+01	1.21E+01	1.46E+01

Notes

[1] Values shown are the maximum of the monthly P10 values for the referenced Mine Year.

[2] Values shown are the maximum of the monthly P50 values for the referenced Mine Year.

[3] Values shown are the maximum of the monthly P90 values for the referenced Mine Year.

[4] Not evaluated against the secondary groundwater standard.

[5] Evaluated against the site-specific evaluation criteria shown.

2.00E+02 Values above the applicable water quality standard are shown in bold with light red shading.

Large Table 38 Annual Summary of Concentration Statistics for the West Pit (bedrock to SW004a) Flow Path at the Property Boundary

	Mine Year		10			50			75			100			150			200		
	Percentile		Max P10[1]	Max P50[2]	Max P90[3]	Max P10[1]	Max P50[2]	Max P90[3]	Max P10[1]	Max P50[2]	Max P90[3]	Max P10[1]	Max P50[2]	Max P90[3]	Max P10[1]	Max P50[2]	Max P90[3]	Max P10[1]	Max P50[2]	Max P90[3]
Constituent	Units	WQ Standard																		
Ag (Silver)	µg/L	30	1.76E-01	2.01E-01	2.30E-01	1.76E-01	2.01E-01	2.30E-01	1.76E-01	2.01E-01	2.30E-01	1.76E-01	2.01E-01	2.30E-01	1.76E-01	2.01E-01	2.30E-01	1.76E-01	2.01E-01	2.30E-01
Al (Aluminum)[4]	µg/L	--	1.61E+01	1.81E+01	2.03E+01	1.61E+01	1.81E+01	2.03E+01	1.61E+01	1.81E+01	2.03E+01	1.61E+01	1.81E+01	2.03E+01	1.61E+01	1.81E+01	2.03E+01	1.61E+01	1.81E+01	2.03E+01
Alkalinity	mg/L	--	5.48E+01	6.41E+01	7.49E+01	5.48E+01	6.41E+01	7.49E+01	5.48E+01	6.41E+01	7.49E+01	5.48E+01	6.41E+01	7.49E+01	5.48E+01	6.41E+01	7.49E+01	5.48E+01	6.41E+01	7.49E+01
As (Arsenic)	µg/L	10	1.72E+00	2.10E+00	2.56E+00	1.72E+00	2.10E+00	2.56E+00	1.72E+00	2.10E+00	2.56E+00	1.72E+00	2.10E+00	2.56E+00	1.72E+00	2.10E+00	2.56E+00	1.73E+00	2.11E+00	2.57E+00
B (Boron)	µg/L	1000	4.01E+01	4.58E+01	5.24E+01	4.01E+01	4.58E+01	5.24E+01	4.01E+01	4.58E+01	5.24E+01	4.01E+01	4.58E+01	5.24E+01	4.01E+01	4.58E+01	5.24E+01	4.01E+01	4.58E+01	5.24E+01
Ba (Barium)	µg/L	2000	5.67E+00	6.83E+00	8.23E+00	5.67E+00	6.83E+00	8.23E+00	5.67E+00	6.83E+00	8.23E+00	5.67E+00	6.83E+00	8.23E+00	5.67E+00	6.83E+00	8.23E+00	5.67E+00	6.83E+00	8.23E+00
Be (Beryllium)[5]	µg/L	0.2	1.05E-01	1.09E-01	1.14E-01	1.05E-01	1.09E-01	1.14E-01	1.05E-01	1.09E-01	1.14E-01	1.05E-01	1.09E-01	1.14E-01	1.05E-01	1.09E-01	1.14E-01	1.05E-01	1.09E-01	1.14E-01
Ca (Calcium)	mg/L	--	1.35E+01	1.49E+01	1.64E+01	1.35E+01	1.49E+01	1.64E+01	1.35E+01	1.49E+01	1.64E+01	1.35E+01	1.49E+01	1.64E+01	1.35E+01	1.49E+01	1.64E+01	1.35E+01	1.49E+01	1.65E+01
Cd (Cadmium)	µg/L	4	1.08E-01	1.15E-01	1.23E-01	1.08E-01	1.15E-01	1.23E-01	1.08E-01	1.15E-01	1.23E-01	1.08E-01	1.15E-01	1.23E-01	1.08E-01	1.15E-01	1.23E-01	1.08E-01	1.15E-01	1.24E-01
Cl (Chloride)	mg/L	250	1.45E+00	1.78E+00	2.18E+00	1.45E+00	1.78E+00	2.18E+00	1.45E+00	1.78E+00	2.18E+00	1.45E+00	1.78E+00	2.18E+00	1.45E+00	1.78E+00	2.18E+00	1.45E+00	1.78E+00	2.18E+00
Co (Cobalt)	µg/L	--	2.03E+00	2.63E+00	3.41E+00	2.03E+00	2.63E+00	3.41E+00	2.03E+00	2.63E+00	3.41E+00	2.03E+00	2.63E+00	3.41E+00	2.03E+00	2.63E+00	3.41E+00	2.04E+00	2.65E+00	3.42E+00
Cr (Chromium)	µg/L	100	5.06E-01	5.19E-01	5.32E-01	5.06E-01	5.19E-01	5.32E-01	5.06E-01	5.19E-01	5.32E-01	5.06E-01	5.19E-01	5.32E-01	5.06E-01	5.19E-01	5.32E-01	5.06E-01	5.19E-01	5.33E-01
Cu (Copper)	µg/L	--	1.19E+00	1.36E+00	1.56E+00	1.19E+00	1.36E+00	1.56E+00	1.19E+00	1.36E+00	1.56E+00	1.19E+00	1.36E+00	1.56E+00	1.19E+00	1.36E+00	1.56E+00	1.20E+00	1.38E+00	1.59E+00
F (Fluoride)	mg/L	2	1.32E-01	1.55E-01	1.81E-01	1.32E-01	1.55E-01	1.81E-01	1.32E-01	1.55E-01	1.81E-01	1.32E-01	1.55E-01	1.81E-01	1.32E-01	1.55E-01	1.81E-01	1.32E-01	1.55E-01	1.81E-01
Fe (Iron)[4]	µg/L	--	1.09E+04	1.60E+04	2.36E+04	1.09E+04	1.60E+04	2.36E+04	1.09E+04	1.60E+04	2.36E+04	1.09E+04	1.60E+04	2.36E+04	1.09E+04	1.60E+04	2.36E+04	1.09E+04	1.60E+04	2.36E+04
K (Potassium)	mg/L	--	1.51E+00	1.61E+00	1.71E+00	1.51E+00	1.61E+00	1.71E+00	1.51E+00	1.61E+00	1.71E+00	1.51E+00	1.61E+00	1.71E+00	1.51E+00	1.61E+00	1.71E+00	1.52E+00	1.61E+00	1.71E+00
Mg (Magnesium)	mg/L	--	8.26E+00	9.58E+00	1.11E+01	8.26E+00	9.58E+00	1.11E+01	8.26E+00	9.58E+00	1.11E+01	8.26E+00	9.58E+00	1.11E+01	8.26E+00	9.58E+00	1.11E+01	8.26E+00	9.58E+00	1.11E+01
Mn (Manganese)[4,5]	µg/L	306.6	1.44E+02	1.98E+02	2.73E+02	1.44E+02	1.98E+02	2.73E+02	1.44E+02	1.98E+02	2.73E+02	1.44E+02	1.98E+02	2.73E+02	1.44E+02	1.98E+02	2.73E+02	1.44E+02	1.98E+02	2.73E+02
Na (Sodium)	mg/L	--	7.04E+00	8.59E+00	1.05E+01	7.04E+00	8.59E+00	1.05E+01	7.04E+00	8.59E+00	1.05E+01	7.04E+00	8.59E+00	1.05E+01	7.04E+00	8.59E+00	1.05E+01	7.04E+00	8.60E+00	1.05E+01
Ni (Nickel)	µg/L	100	3.33E+01	4.72E+01	6.68E+01	3.33E+01	4.72E+01	6.68E+01	3.33E+01	4.72E+01	6.68E+01	3.33E+01	4.72E+01	6.68E+01	3.33E+01	4.72E+01	6.68E+01	3.34E+01	4.74E+01	6.71E+01
Pb (Lead)	µg/L	--	4.65E-01	5.25E-01	5.93E-01	4.65E-01	5.25E-01	5.93E-01	4.65E-01	5.25E-01	5.93E-01	4.65E-01	5.25E-01	5.93E-01	4.65E-01	5.25E-01	5.93E-01	4.65E-01	5.25E-01	5.94E-01
Sb (Antimony)	µg/L	6	5.39E-01	6.25E-01	7.24E-01	5.39E-01	6.25E-01	7.24E-01	5.39E-01	6.25E-01	7.24E-01	5.39E-01	6.25E-01	7.24E-01	5.40E-01	6.25E-01	7.24E-01	5.41E-01	6.28E-01	7.29E-01
Se (Selenium)	µg/L	30	5.98E-01	6.33E-01	6.71E-01	5.98E-01	6.33E-01	6.71E-01	5.98E-01	6.33E-01	6.71E-01	5.98E-01	6.33E-01	6.71E-01	5.98E-01	6.33E-01	6.71E-01	5.99E-01	6.34E-01	6.74E-01
SO4 (Sulfate)	mg/L	250	2.09E+01	2.50E+01	2.98E+01	2.09E+01	2.50E+01	2.98E+01	2.09E+01	2.50E+01	2.98E+01	2.09E+01	2.50E+01	2.98E+01	2.09E+01	2.50E+01	2.98E+01	2.10E+01	2.50E+01	2.98E+01
Tl (Thallium)[5]	µg/L	1	2.93E-01	3.52E-01	4.25E-01	2.93E-01	3.52E-01	4.25E-01	2.93E-01	3.52E-01	4.25E-01	2.93E-01	3.52E-01	4.25E-01	2.93E-01	3.52E-01	4.25E-01	2.93E-01	3.52E-01	4.25E-01
V (Vanadium)	µg/L	50	3.50E+00	3.62E+00	3.75E+00	3.50E+00	3.62E+00	3.75E+00	3.50E+00	3.62E+00	3.75E+00	3.50E+00	3.62E+00	3.75E+00	3.50E+00	3.62E+00	3.75E+00	3.50E+00	3.62E+00	3.75E+00
Zn (Zinc)	µg/L	2000	1.01E+01	1.21E+01	1.46E+01	1.01E+01	1.21E+01	1.46E+01	1.01E+01	1.21E+01	1.46E+01	1.01E+01	1.21E+01	1.46E+01	1.01E+01	1.21E+01	1.46E+01	1.01E+01	1.21E+01	1.46E+01

Notes

[1] Values shown are the maximum of the monthly P10 values for the referenced Mine Year.

[2] Values shown are the maximum of the monthly P50 values for the referenced Mine Year.

[3] Values shown are the maximum of the monthly P90 values for the referenced Mine Year.

[4] Not evaluated against the secondary groundwater standard.

[5] Evaluated against the site-specific evaluation criteria shown.

2.00E+02 Values above the applicable water quality standard are shown in bold with light red shading.

Large Table 39 Annual Summary of Concentration Statistics for the Partridge River at SW002

Constituent	Mine Year / Percentile Units	WQ Standard	10 Min P10[1]	10 Avg P50[2]	10 Max P90[3]	20 Min P10[1]	20 Avg P50[2]	20 Max P90[3]	55 Min P10[1]	55 Avg P50[2]	55 Max P90[3]	75 Min P10[1]	75 Avg P50[2]	75 Max P90[3]	100 Min P10[1]	100 Avg P50[2]	100 Max P90[3]	200 Min P10[1]	200 Avg P50[2]	200 Max P90[3]
Ag (Silver)	µg/L	1	9.64E-02	1.07E-01	1.10E-01	9.72E-02	1.06E-01	1.10E-01	9.71E-02	1.07E-01	1.10E-01	9.48E-02	1.04E-01	1.11E-01	9.44E-02	1.04E-01	1.11E-01	9.50E-02	1.04E-01	1.11E-01
Al (Aluminum)	µg/L	125	2.84E+01	5.82E+01	**2.15E+02**	2.84E+01	5.84E+01	**2.23E+02**	2.85E+01	5.84E+01	**2.27E+02**	4.44E+01	8.98E+01	**2.56E+02**	4.17E+01	9.07E+01	**2.64E+02**	4.25E+01	8.88E+01	**2.69E+02**
Alkalinity	mg/L	--	2.82E+01	7.99E+01	1.21E+02	3.07E+01	8.04E+01	1.26E+02	2.98E+01	8.06E+01	1.26E+02	1.86E+01	5.47E+01	1.46E+02	1.76E+01	5.38E+01	1.46E+02	1.85E+01	5.36E+01	1.31E+02
As (Arsenic)	µg/L	53	2.66E-01	1.01E+00	2.41E+00	2.62E-01	1.01E+00	2.16E+00	2.61E-01	1.01E+00	2.07E+00	1.19E-01	5.63E-01	2.23E+00	1.25E-01	5.67E-01	2.07E+00	1.18E-01	5.66E-01	2.19E+00
B (Boron)	µg/L	500	2.47E+01	9.91E+01	1.63E+02	2.68E+01	9.75E+01	1.61E+02	2.42E+01	9.83E+01	1.91E+02	9.50E+00	3.41E+01	1.59E+02	9.57E+00	3.44E+01	1.73E+02	1.01E+01	3.42E+01	1.97E+02
Ba (Barium)	µg/L	--	3.12E+00	1.04E+01	1.66E+01	3.18E+00	1.04E+01	1.67E+01	3.15E+00	1.05E+01	1.67E+01	2.11E+00	1.05E+01	3.04E+01	2.07E+00	1.06E+01	3.08E+01	2.02E+00	1.04E+01	3.05E+01
Be (Beryllium)	µg/L	--	9.60E-02	9.96E-02	1.03E-01	9.61E-02	9.96E-02	1.03E-01	9.61E-02	9.96E-02	1.03E-01	9.54E-02	1.02E-01	1.19E-01	9.56E-02	1.02E-01	1.19E-01	9.55E-02	1.02E-01	1.19E-01
Ca (Calcium)	mg/L	--	8.02E+00	2.24E+01	3.31E+01	8.60E+00	2.24E+01	3.33E+01	8.42E+00	2.25E+01	3.29E+01	4.99E+00	1.38E+01	3.36E+01	5.15E+00	1.38E+01	3.46E+01	5.02E+00	1.37E+01	3.18E+01
Cd (Cadmium)[4]	µg/L	--	3.13E-02	8.54E-02	1.33E-01	3.34E-02	8.63E-02	1.33E-01	3.28E-02	8.61E-02	1.33E-01	2.40E-02	7.22E-02	1.48E-01	2.38E-02	7.17E-02	1.48E-01	2.19E-02	7.33E-02	1.60E-01
Cl (Chloride)	mg/L	230	2.32E+00	1.05E+01	1.57E+01	2.49E+00	1.03E+01	1.57E+01	2.49E+00	1.05E+01	1.64E+01	6.03E-01	2.17E+00	1.35E+01	5.24E-01	2.15E+00	1.38E+01	5.47E-01	2.07E+00	1.38E+01
Co (Cobalt)	µg/L	5	7.18E-02	3.14E-01	7.62E-01	8.04E-02	3.16E-01	7.91E-01	7.97E-02	3.18E-01	7.60E-01	3.91E-02	3.94E-01	1.27E+00	4.10E-02	3.85E-01	9.50E-01	4.08E-02	3.84E-01	9.60E-01
Cr (Chromium)	µg/L	11	2.53E-01	5.58E-01	1.11E+00	2.58E-01	5.57E-01	1.08E+00	2.70E-01	5.61E-01	1.14E+00	1.93E-01	6.53E-01	1.23E+00	2.00E-01	6.48E-01	1.24E+00	2.21E-01	6.56E-01	1.34E+00
Cu (Copper)[4]	µg/L	--	4.64E-01	1.08E+00	2.54E+00	4.84E-01	1.08E+00	2.44E+00	4.53E-01	1.09E+00	2.66E+00	3.96E-01	1.50E+00	3.18E+00	3.88E-01	1.50E+00	2.91E+00	3.81E-01	1.49E+00	3.21E+00
F (Fluoride)	mg/L	--	3.50E-02	1.03E-01	1.77E-01	3.53E-02	1.02E-01	1.69E-01	3.99E-02	1.02E-01	1.75E-01	2.18E-02	6.50E-02	1.98E-01	2.23E-02	6.59E-02	1.83E-01	2.09E-02	6.44E-02	1.87E-01
Fe (Iron)	µg/L	--	6.95E+02	1.98E+03	4.60E+03	6.79E+02	1.98E+03	4.35E+03	6.38E+02	1.99E+03	4.14E+03	4.19E+02	1.42E+03	5.33E+03	4.49E+02	1.41E+03	5.41E+03	4.38E+02	1.39E+03	4.76E+03
K (Potassium)	mg/L	--	7.11E-01	2.30E+00	3.64E+00	7.22E-01	2.31E+00	3.45E+00	7.41E-01	2.30E+00	3.61E+00	3.61E-01	1.34E+00	3.90E+00	3.81E-01	1.33E+00	3.98E+00	4.07E-01	1.35E+00	3.97E+00
Mg (Magnesium)	mg/L	--	4.89E+00	1.16E+01	1.50E+01	4.86E+00	1.16E+01	1.50E+01	4.78E+00	1.16E+01	1.49E+01	3.21E+00	6.63E+00	1.43E+01	3.21E+00	6.63E+00	1.36E+01	3.26E+00	6.72E+00	1.40E+01
Mn (Manganese)	µg/L	--	2.12E+01	1.41E+02	2.44E+02	2.03E+01	1.41E+02	2.44E+02	2.26E+01	1.42E+02	2.44E+02	9.12E+00	1.63E+02	5.53E+02	7.99E+00	1.65E+02	5.68E+02	8.63E+00	1.63E+02	5.62E+02
Na (Sodium)	mg/L	--	1.77E+00	8.07E+00	1.18E+01	1.82E+00	8.03E+00	1.22E+01	1.73E+00	8.13E+00	1.18E+01	5.45E-01	3.34E+00	1.06E+01	5.70E-01	3.32E+00	1.08E+01	6.05E-01	3.34E+00	1.14E+01
Ni (Nickel)[4]	µg/L	--	2.49E-01	8.91E-01	2.65E+00	2.85E-01	8.99E-01	2.35E+00	2.92E-01	9.06E-01	2.65E+00	1.83E-01	1.16E+00	3.34E+00	1.69E-01	1.16E+00	3.22E+00	2.13E-01	1.18E+00	3.33E+00
Pb (Lead)[4]	µg/L	--	4.58E-02	2.39E-01	6.24E-01	4.94E-02	2.42E-01	5.42E-01	4.74E-02	2.41E-01	5.72E-01	2.18E-02	2.53E-01	7.73E-01	1.98E-02	2.54E-01	7.39E-01	2.04E-02	2.52E-01	7.83E-01
Sb (Antimony)	µg/L	31	2.50E-01	2.50E-01	2.51E-01	2.50E-01	2.50E-01	2.51E-01	2.50E-01	2.50E-01	2.51E-01	2.50E-01	2.51E-01	2.54E-01	2.50E-01	2.51E-01	2.54E-01	2.50E-01	2.51E-01	2.54E-01
Se (Selenium)	µg/L	5	2.80E-01	7.25E-01	1.19E+00	2.63E-01	7.12E-01	1.15E+00	2.74E-01	7.16E-01	1.16E+00	1.63E-01	4.79E-01	1.44E+00	1.66E-01	4.79E-01	1.30E+00	1.75E-01	4.79E-01	1.25E+00
SO4 (Sulfate)	mg/L	--	5.10E+00	1.83E+01	2.73E+01	5.21E+00	1.83E+01	2.73E+01	5.19E+00	1.83E+01	2.73E+01	1.90E+00	7.10E+00	1.60E+01	2.01E+00	6.98E+00	1.60E+01	2.18E+00	7.04E+00	1.51E+01
Tl (Thallium)	µg/L	0.56	4.34E-03	2.64E-02	4.79E-02	4.24E-03	2.66E-02	4.92E-02	4.52E-03	2.69E-02	4.89E-02	2.20E-03	3.43E-02	1.20E-01	2.19E-03	3.49E-02	1.21E-01	2.24E-03	3.43E-02	1.21E-01
V (Vanadium)	µg/L	--	1.03E+00	1.40E+00	1.79E+00	1.03E+00	1.41E+00	1.82E+00	1.03E+00	1.41E+00	1.81E+00	9.95E-01	1.69E+00	3.51E+00	9.97E-01	1.70E+00	3.55E+00	9.98E-01	1.69E+00	3.54E+00
Zn (Zinc)[4]	µg/L	--	1.59E+00	5.43E+00	1.62E+01	1.67E+00	5.37E+00	1.71E+01	1.66E+00	5.40E+00	1.58E+01	9.79E-01	4.12E+00	2.13E+01	8.84E-01	4.20E+00	2.19E+01	9.64E-01	3.98E+00	1.91E+01
Hardness	mg/L	500	4.95E+01	1.04E+02	1.32E+02	4.97E+01	1.04E+02	1.32E+02	4.78E+01	1.05E+02	1.31E+02	3.51E+01	6.51E+01	1.23E+02	3.53E+01	6.48E+01	1.31E+02	3.60E+01	6.49E+01	1.20E+02

Notes

[1] Values shown are the minimum of the monthly P10 values for the referenced Mine Year.

[2] Values shown are the average of the monthly P50 values for the referenced Mine Year.

[3] Values shown are the maximum of the monthly P90 values for the referenced Mine Year.

[4] Standard is hardness-based and variable. See discussion in Section 6.5.2.

2.00E+02 Values above the applicable water quality standard are shown in bold with light red shading.

Large Table 40 Annual Summary of Concentration Statistics for the Partridge River at SW003

Constituent	Mine Year / Percentile Units	WQ Standard	10 Min P10[1]	10 Avg P50[2]	10 Max P90[3]	20 Min P10[1]	20 Avg P50[2]	20 Max P90[3]	55 Min P10[1]	55 Avg P50[2]	55 Max P90[3]	75 Min P10[1]	75 Avg P50[2]	75 Max P90[3]	100 Min P10[1]	100 Avg P50[2]	100 Max P90[3]	200 Min P10[1]	200 Avg P50[2]	200 Max P90[3]
Ag (Silver)	µg/L	1	9.63E-02	1.06E-01	1.10E-01	9.68E-02	1.06E-01	1.10E-01	9.69E-02	1.06E-01	1.10E-01	9.49E-02	1.04E-01	1.11E-01	9.45E-02	1.04E-01	1.11E-01	9.50E-02	1.04E-01	1.11E-01
Al (Aluminum)	µg/L	125	2.88E+01	6.13E+01	**2.23E+02**	2.87E+01	6.18E+01	**2.28E+02**	2.88E+01	6.16E+01	**2.36E+02**	4.47E+01	9.28E+01	**2.55E+02**	4.24E+01	9.38E+01	**2.61E+02**	4.32E+01	9.19E+01	**2.68E+02**
Alkalinity	mg/L	--	2.67E+01	7.78E+01	1.21E+02	2.93E+01	7.85E+01	1.27E+02	2.85E+01	7.86E+01	1.26E+02	1.89E+01	5.45E+01	1.45E+02	1.78E+01	5.36E+01	1.45E+02	1.88E+01	5.32E+01	1.31E+02
As (Arsenic)	µg/L	53	2.41E-01	9.75E-01	2.45E+00	2.45E-01	9.74E-01	2.24E+00	2.41E-01	9.78E-01	2.08E+00	1.23E-01	5.62E-01	2.19E+00	1.28E-01	5.66E-01	2.07E+00	1.23E-01	5.63E-01	2.18E+00
B (Boron)	µg/L	500	2.27E+01	9.48E+01	1.63E+02	2.45E+01	9.31E+01	1.61E+02	2.22E+01	9.39E+01	1.92E+02	9.80E+00	3.52E+01	1.59E+02	9.61E+00	3.56E+01	1.73E+02	1.04E+01	3.55E+01	1.93E+02
Ba (Barium)	µg/L	--	2.96E+00	1.01E+01	1.69E+01	3.03E+00	1.01E+01	1.70E+01	3.01E+00	1.03E+01	1.71E+01	2.11E+00	9.81E+00	2.92E+01	2.10E+00	9.95E+00	2.97E+01	2.03E+00	9.79E+00	2.94E+01
Be (Beryllium)	µg/L	--	9.59E-02	9.96E-02	1.03E-01	9.60E-02	9.97E-02	1.03E-01	9.60E-02	9.97E-02	1.03E-01	9.54E-02	1.02E-01	1.18E-01	9.56E-02	1.02E-01	1.18E-01	9.55E-02	1.02E-01	1.18E-01
Ca (Calcium)	mg/L	--	7.64E+00	2.17E+01	3.32E+01	8.05E+00	2.17E+01	3.34E+01	7.92E+00	2.18E+01	3.30E+01	5.01E+00	1.37E+01	3.33E+01	5.34E+00	1.38E+01	3.44E+01	5.14E+00	1.37E+01	3.21E+01
Cd (Cadmium)[4]	µg/L	--	3.02E-02	8.39E-02	1.34E-01	3.19E-02	8.50E-02	1.33E-01	3.19E-02	8.48E-02	1.33E-01	2.42E-02	7.07E-02	1.46E-01	2.41E-02	7.04E-02	1.46E-01	2.21E-02	7.19E-02	1.55E-01
Cl (Chloride)	mg/L	230	2.08E+00	9.98E+00	1.57E+01	2.23E+00	9.79E+00	1.56E+01	2.29E+00	9.95E+00	1.63E+01	6.28E-01	2.32E+00	1.36E+01	5.44E-01	2.31E+00	1.39E+01	5.58E-01	2.23E+00	1.36E+01
Co (Cobalt)	µg/L	5	6.69E-02	3.13E-01	7.88E-01	7.60E-02	3.16E-01	8.21E-01	7.34E-02	3.19E-01	7.75E-01	4.09E-02	3.78E-01	1.26E+00	4.14E-02	3.70E-01	9.27E-01	4.43E-02	3.70E-01	9.83E-01
Cr (Chromium)	µg/L	11	2.46E-01	5.61E-01	1.12E+00	2.49E-01	5.60E-01	1.09E+00	2.64E-01	5.63E-01	1.16E+00	1.96E-01	6.42E-01	1.25E+00	2.03E-01	6.36E-01	1.23E+00	2.25E-01	6.44E-01	1.34E+00
Cu (Copper)[4]	µg/L	--	4.52E-01	1.10E+00	2.58E+00	4.71E-01	1.10E+00	2.49E+00	4.41E-01	1.11E+00	2.69E+00	4.04E-01	1.46E+00	3.14E+00	3.93E-01	1.46E+00	2.90E+00	3.90E-01	1.45E+00	3.20E+00
F (Fluoride)	mg/L	--	3.30E-02	1.00E-01	1.79E-01	3.27E-02	9.98E-02	1.71E-01	3.83E-02	9.94E-02	1.78E-01	2.23E-02	6.50E-02	1.97E-01	2.28E-02	6.59E-02	1.82E-01	2.14E-02	6.43E-02	1.85E-01
Fe (Iron)	µg/L	--	6.65E+02	1.94E+03	4.63E+03	6.38E+02	1.95E+03	4.46E+03	6.17E+02	1.95E+03	4.17E+03	4.31E+02	1.44E+03	5.27E+03	4.68E+02	1.43E+03	5.38E+03	4.53E+02	1.41E+03	4.74E+03
K (Potassium)	mg/L	--	6.79E-01	2.22E+00	3.69E+00	6.76E-01	2.24E+00	3.50E+00	6.90E-01	2.23E+00	3.62E+00	3.67E-01	1.33E+00	3.88E+00	3.89E-01	1.32E+00	3.89E+00	4.23E-01	1.35E+00	3.97E+00
Mg (Magnesium)	mg/L	--	4.63E+00	1.12E+01	1.48E+01	4.67E+00	1.12E+01	1.49E+01	4.66E+00	1.12E+01	1.48E+01	3.22E+00	6.63E+00	1.42E+01	3.27E+00	6.63E+00	1.35E+01	3.30E+00	6.72E+00	1.38E+01
Mn (Manganese)	µg/L	--	1.93E+01	1.38E+02	2.52E+02	1.82E+01	1.38E+02	2.53E+02	2.02E+01	1.40E+02	2.52E+02	9.47E+00	1.51E+02	5.29E+02	8.24E+00	1.52E+02	5.41E+02	8.75E+00	1.52E+02	5.33E+02
Na (Sodium)	mg/L	--	1.60E+00	7.71E+00	1.17E+01	1.67E+00	7.66E+00	1.22E+01	1.61E+00	7.76E+00	1.17E+01	5.63E-01	3.27E+00	1.05E+01	5.81E-01	3.24E+00	1.07E+01	6.10E-01	3.27E+00	1.16E+01
Ni (Nickel)[4]	µg/L	--	2.34E-01	9.01E-01	2.72E+00	2.72E-01	9.08E-01	2.37E+00	2.79E-01	9.16E-01	2.76E+00	1.96E-01	1.13E+00	3.28E+00	1.74E-01	1.13E+00	3.19E+00	2.17E-01	1.15E+00	3.29E+00
Pb (Lead)[4]	µg/L	--	4.18E-02	2.36E-01	6.47E-01	4.46E-02	2.40E-01	5.49E-01	4.24E-02	2.38E-01	5.82E-01	2.24E-02	2.42E-01	7.98E-01	2.00E-02	2.41E-01	7.37E-01	2.09E-02	2.41E-01	7.78E-01
Sb (Antimony)	µg/L	31	2.50E-01	2.50E-01	2.51E-01	2.50E-01	2.50E-01	2.51E-01	2.50E-01	2.50E-01	2.51E-01	2.50E-01	2.51E-01	2.53E-01	2.50E-01	2.51E-01	2.53E-01	2.50E-01	2.51E-01	2.53E-01
Se (Selenium)	µg/L	5	2.68E-01	7.08E-01	1.20E+00	2.54E-01	6.95E-01	1.16E+00	2.59E-01	6.99E-01	1.16E+00	1.65E-01	4.79E-01	1.44E+00	1.68E-01	4.80E-01	1.28E+00	1.80E-01	4.80E-01	1.24E+00
SO4 (Sulfate)	mg/L	--	4.78E+00	1.74E+01	2.70E+01	4.88E+00	1.74E+01	2.70E+01	4.83E+00	1.74E+01	2.71E+01	1.91E+00	7.01E+00	1.59E+01	2.04E+00	6.86E+00	1.60E+01	2.21E+00	6.93E+00	1.50E+01
Tl (Thallium)	µg/L	0.56	3.94E-03	2.60E-02	4.98E-02	3.86E-03	2.61E-02	5.13E-02	4.11E-03	2.64E-02	5.09E-02	2.25E-03	3.17E-02	1.15E-01	2.24E-03	3.19E-02	1.16E-01	2.27E-03	3.14E-02	1.15E-01
V (Vanadium)	µg/L	--	1.02E+00	1.40E+00	1.84E+00	1.02E+00	1.41E+00	1.87E+00	1.02E+00	1.41E+00	1.85E+00	9.96E-01	1.63E+00	3.40E+00	9.98E-01	1.64E+00	3.46E+00	9.98E-01	1.63E+00	3.41E+00
Zn (Zinc)[4]	µg/L	--	1.48E+00	5.35E+00	1.63E+01	1.57E+00	5.29E+00	1.77E+01	1.58E+00	5.32E+00	1.62E+01	1.03E+00	4.18E+00	2.10E+01	9.18E-01	4.28E+00	2.16E+01	1.01E+00	4.07E+00	1.90E+01
Hardness	mg/L	500	4.72E+01	1.01E+02	1.31E+02	4.69E+01	1.01E+02	1.31E+02	4.54E+01	1.02E+02	1.31E+02	3.54E+01	6.51E+01	1.22E+02	3.54E+01	6.49E+01	1.30E+02	3.64E+01	6.51E+01	1.19E+02

Notes

[1] Values shown are the minimum of the monthly P10 values for the referenced Mine Year.

[2] Values shown are the average of the monthly P50 values for the referenced Mine Year.

[3] Values shown are the maximum of the monthly P90 values for the referenced Mine Year.

[4] Standard is hardness-based and variable. See discussion in Section 6.5.2.

2.00E+02 Values above the applicable water quality standard are shown in bold with light red shading.

Large Table 41 Annual Summary of Concentration Statistics for the Partridge River at SW004

Constituent	Mine Year		10			20			55			75			125			200		
	Percentile		Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max
	Units	WQ Standard	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]
Ag (Silver)	µg/L	1	9.56E-02	1.06E-01	1.10E-01	9.62E-02	1.06E-01	1.10E-01	9.63E-02	1.06E-01	1.10E-01	9.51E-02	1.04E-01	1.14E-01	9.53E-02	1.04E-01	1.13E-01	9.51E-02	1.04E-01	1.13E-01
Al (Aluminum)	µg/L	125	3.04E+01	6.97E+01	**2.39E+02**	3.01E+01	7.03E+01	**2.45E+02**	3.08E+01	7.08E+01	**2.46E+02**	4.49E+01	9.64E+01	**2.55E+02**	4.16E+01	9.59E+01	**2.57E+02**	4.35E+01	9.49E+01	**2.70E+02**
Alkalinity	mg/L	--	2.37E+01	7.23E+01	1.23E+02	2.55E+01	7.33E+01	1.30E+02	2.45E+01	7.29E+01	1.28E+02	1.91E+01	5.43E+01	1.46E+02	1.84E+01	5.31E+01	1.30E+02	1.91E+01	5.27E+01	1.30E+02
As (Arsenic)	µg/L	53	1.86E-01	8.79E-01	2.49E+00	1.99E-01	8.82E-01	2.36E+00	1.99E-01	8.84E-01	2.13E+00	1.27E-01	5.64E-01	2.17E+00	1.22E-01	5.61E-01	2.50E+00	1.23E-01	5.63E-01	2.19E+00
B (Boron)	µg/L	500	1.75E+01	8.26E+01	1.68E+02	1.89E+01	8.14E+01	1.62E+02	1.77E+01	8.14E+01	1.95E+02	9.95E+00	3.65E+01	1.59E+02	9.89E+00	3.59E+01	1.61E+02	1.07E+01	3.66E+01	1.93E+02
Ba (Barium)	µg/L	--	2.62E+00	9.52E+00	1.82E+01	2.67E+00	9.54E+00	1.81E+01	2.66E+00	9.68E+00	1.83E+01	2.09E+00	9.30E+00	2.76E+01	2.12E+00	9.39E+00	2.79E+01	2.01E+00	9.30E+00	2.79E+01
Be (Beryllium)	µg/L	--	9.58E-02	9.98E-02	1.04E-01	9.58E-02	9.98E-02	1.04E-01	9.59E-02	9.99E-02	1.05E-01	9.55E-02	1.02E-01	1.18E-01	9.56E-02	1.02E-01	1.19E-01	9.55E-02	1.02E-01	1.18E-01
Ca (Calcium)	mg/L	--	6.85E+00	1.99E+01	3.38E+01	6.99E+00	1.99E+01	3.36E+01	6.76E+00	2.00E+01	3.34E+01	5.10E+00	1.37E+01	3.34E+01	5.01E+00	1.35E+01	3.30E+01	5.18E+00	1.38E+01	3.20E+01
Cd (Cadmium)[4]	µg/L	2.5	2.67E-02	7.99E-02	1.37E-01	2.91E-02	8.14E-02	1.36E-01	2.87E-02	8.10E-02	1.37E-01	2.45E-02	6.97E-02	1.45E-01	2.37E-02	7.17E-02	1.52E-01	2.24E-02	7.19E-02	1.54E-01
Cl (Chloride)	mg/L	230	1.59E+00	8.39E+00	1.60E+01	1.69E+00	8.29E+00	1.50E+01	1.72E+00	8.33E+00	1.63E+01	6.44E-01	2.45E+00	1.37E+01	6.15E-01	2.51E+00	1.51E+01	5.86E-01	2.37E+00	1.36E+01
Co (Cobalt)	µg/L	5	5.55E-02	3.11E-01	8.88E-01	6.28E-02	3.16E-01	8.87E-01	6.33E-02	3.31E-01	8.33E-01	4.19E-02	3.80E-01	1.27E+00	4.88E-02	3.84E-01	1.09E+00	4.55E-02	3.78E-01	9.84E-01
Cr (Chromium)	µg/L	11	2.29E-01	5.69E-01	1.18E+00	2.32E-01	5.67E-01	1.15E+00	2.43E-01	5.72E-01	1.20E+00	1.97E-01	6.31E-01	1.25E+00	2.05E-01	6.33E-01	1.29E+00	2.28E-01	6.33E-01	1.34E+00
Cu (Copper)[4]	µg/L	9.5	4.24E-01	1.15E+00	2.71E+00	4.43E-01	1.15E+00	2.68E+00	4.12E-01	1.17E+00	2.79E+00	4.08E-01	1.43E+00	3.11E+00	4.27E-01	1.43E+00	3.15E+00	3.93E-01	1.42E+00	3.20E+00
F (Fluoride)	mg/L	--	2.94E-02	9.24E-02	1.86E-01	2.79E-02	9.25E-02	1.75E-01	3.39E-02	9.18E-02	1.83E-01	2.25E-02	6.56E-02	1.96E-01	2.08E-02	6.63E-02	1.86E-01	2.20E-02	6.48E-02	1.84E-01
Fe (Iron)	µg/L	--	5.82E+02	1.83E+03	4.81E+03	5.50E+02	1.84E+03	4.72E+03	5.52E+02	1.84E+03	4.41E+03	4.41E+02	1.47E+03	5.27E+03	3.96E+02	1.45E+03	4.81E+03	4.62E+02	1.43E+03	4.74E+03
K (Potassium)	mg/L	--	6.02E-01	2.02E+00	3.76E+00	5.92E-01	2.05E+00	3.59E+00	5.76E-01	2.03E+00	3.63E+00	3.69E-01	1.32E+00	3.83E+00	3.96E-01	1.38E+00	5.03E+00	4.30E-01	1.35E+00	3.96E+00
Mg (Magnesium)	mg/L	--	4.08E+00	1.03E+01	1.44E+01	4.19E+00	1.03E+01	1.46E+01	4.31E+00	1.02E+01	1.45E+01	3.23E+00	6.64E+00	1.41E+01	3.28E+00	6.72E+00	1.28E+01	3.32E+00	6.73E+00	1.38E+01
Mn (Manganese)	µg/L	--	1.43E+01	1.31E+02	2.78E+02	1.39E+01	1.32E+02	2.78E+02	1.53E+01	1.33E+02	2.82E+02	9.24E+00	1.41E+02	4.98E+02	8.45E+00	1.42E+02	5.04E+02	8.53E+00	1.42E+02	5.02E+02
Na (Sodium)	mg/L	--	1.21E+00	6.69E+00	1.14E+01	1.31E+00	6.69E+00	1.22E+01	1.24E+00	6.73E+00	1.14E+01	5.61E-01	3.23E+00	1.05E+01	6.17E-01	3.30E+00	1.31E+01	6.19E-01	3.25E+00	1.13E+01
Ni (Nickel)[4]	µg/L	53.3	2.04E-01	9.22E-01	2.89E+00	2.40E-01	9.29E-01	2.56E+00	2.52E-01	9.48E-01	2.97E+00	1.98E-01	1.12E+00	3.28E+00	1.94E-01	1.13E+00	3.37E+00	2.21E-01	1.14E+00	3.28E+00
Pb (Lead)[4]	µg/L	3.3	3.24E-02	2.26E-01	6.72E-01	3.39E-02	2.31E-01	5.76E-01	3.28E-02	2.29E-01	6.07E-01	2.20E-02	2.32E-01	7.90E-01	2.29E-02	2.34E-01	7.39E-01	2.10E-02	2.35E-01	7.71E-01
Sb (Antimony)	µg/L	31	2.49E-01	2.50E-01	2.51E-01	2.49E-01	2.50E-01	2.51E-01	2.49E-01	2.50E-01	2.52E-01	2.49E-01	2.51E-01	2.58E-01	2.49E-01	2.51E-01	2.58E-01	2.49E-01	2.51E-01	2.59E-01
Se (Selenium)	µg/L	5	2.27E-01	6.60E-01	1.23E+00	2.26E-01	6.52E-01	1.20E+00	2.27E-01	6.53E-01	1.19E+00	1.67E-01	4.80E-01	1.44E+00	1.77E-01	4.87E-01	1.30E+00	1.81E-01	4.81E-01	1.25E+00
SO4 (Sulfate)	mg/L	--	3.70E+00	1.50E+01	2.61E+01	3.86E+00	1.51E+01	2.62E+01	4.03E+00	1.50E+01	2.62E+01	1.95E+00	7.02E+00	1.59E+01	2.35E+00	6.94E+00	1.65E+01	2.21E+00	6.92E+00	1.48E+01
Tl (Thallium)	µg/L	0.56	3.10E-03	2.50E-02	5.63E-02	3.10E-03	2.51E-02	5.72E-02	3.25E-03	2.54E-02	5.76E-02	2.22E-03	2.94E-02	1.08E-01	2.27E-03	2.96E-02	1.09E-01	2.21E-03	2.93E-02	1.08E-01
V (Vanadium)	µg/L	--	1.01E+00	1.41E+00	2.00E+00	1.01E+00	1.41E+00	2.01E+00	1.01E+00	1.41E+00	2.03E+00	9.94E-01	1.59E+00	3.26E+00	9.97E-01	1.60E+00	3.32E+00	9.97E-01	1.60E+00	3.33E+00
Zn (Zinc)[4]	µg/L	122.3	1.31E+00	5.10E+00	1.77E+01	1.31E+00	5.03E+00	1.94E+01	1.37E+00	5.08E+00	1.73E+01	1.06E+00	4.30E+00	2.10E+01	9.12E-01	4.40E+00	2.19E+01	1.04E+00	4.28E+00	1.93E+01
Hardness	mg/L	500	4.25E+01	9.32E+01	1.28E+02	4.36E+01	9.34E+01	1.28E+02	4.15E+01	9.39E+01	1.28E+02	3.54E+01	6.53E+01	1.22E+02	3.46E+01	6.46E+01	1.22E+02	3.66E+01	6.52E+01	1.20E+02

Notes

[1] Values shown are the minimum of the monthly P10 values for the referenced Mine Year.

[2] Values shown are the average of the monthly P50 values for the referenced Mine Year.

[3] Values shown are the maximum of the monthly P90 values for the referenced Mine Year.

[4] Standard is hardness-based and evaluated at a hardness of 102.5 mg/L.

2.00E+02 Values above the applicable water quality standard are shown in bold with light red shading.

Large Table 42 Annual Summary of Concentration Statistics for the Partridge River at SW004a

	Mine Year		10			20			55			75			125			200		
	Percentile		Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max
Constituent	Units	WQ Standard	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]
Ag (Silver)	µg/L	1	9.48E-02	1.05E-01	1.10E-01	9.54E-02	1.05E-01	1.10E-01	9.61E-02	1.09E-01	1.25E-01	9.61E-02	1.12E-01	1.53E-01	9.61E-02	1.12E-01	1.53E-01	9.55E-02	1.12E-01	1.54E-01
Al (Aluminum)	µg/L	125	3.36E+01	7.85E+01	**2.57E+02**	3.30E+01	7.91E+01	**2.68E+02**	2.92E+01	7.59E+01	**2.55E+02**	3.30E+01	8.30E+01	**2.50E+02**	3.19E+01	8.31E+01	**2.57E+02**	3.20E+01	8.28E+01	**2.63E+02**
Alkalinity	mg/L	--	1.98E+01	6.47E+01	1.26E+02	2.13E+01	6.58E+01	1.38E+02	2.15E+01	6.40E+01	1.33E+02	1.87E+01	5.23E+01	1.45E+02	1.74E+01	5.13E+01	1.28E+02	1.85E+01	5.10E+01	1.27E+02
As (Arsenic)	µg/L	53	1.30E-01	7.50E-01	2.58E+00	1.46E-01	7.56E-01	2.61E+00	1.65E-01	8.97E-01	2.23E+00	1.59E-01	9.16E-01	2.43E+00	1.48E-01	9.26E-01	2.47E+00	1.42E-01	9.19E-01	2.45E+00
B (Boron)	µg/L	500	1.32E+01	6.44E+01	1.71E+02	1.29E+01	6.40E+01	1.69E+02	1.38E+01	6.48E+01	2.00E+02	1.02E+01	4.35E+01	1.59E+02	1.04E+01	4.32E+01	1.64E+02	1.09E+01	4.06E+01	1.95E+02
Ba (Barium)	µg/L	--	2.24E+00	9.26E+00	2.19E+01	2.27E+00	9.31E+00	2.18E+01	2.33E+00	1.04E+01	2.30E+01	2.23E+00	1.14E+01	3.25E+01	2.25E+00	1.11E+01	3.33E+01	2.10E+00	1.05E+01	3.48E+01
Be (Beryllium)	µg/L	--	9.56E-02	1.00E-01	1.09E-01	9.56E-02	1.00E-01	1.09E-01	9.65E-02	1.11E-01	1.52E-01	9.66E-02	1.22E-01	2.44E-01	9.66E-02	1.18E-01	2.43E-01	9.62E-02	1.12E-01	2.30E-01
Ca (Calcium)	mg/L	--	5.57E+00	1.75E+01	3.48E+01	5.72E+00	1.75E+01	3.40E+01	5.65E+00	1.79E+01	3.46E+01	5.09E+00	1.50E+01	3.38E+01	5.09E+00	1.48E+01	3.36E+01	5.34E+00	1.47E+01	3.18E+01
Cd (Cadmium)[4]	µg/L	2.6	2.33E-02	7.55E-02	1.39E-01	2.53E-02	7.75E-02	1.42E-01	3.10E-02	1.29E-01	3.90E-01	3.20E-02	1.67E-01	8.90E-01	2.93E-02	1.55E-01	9.08E-01	2.88E-02	1.33E-01	7.73E-01
Cl (Chloride)	mg/L	230	1.05E+00	6.11E+00	1.57E+01	1.12E+00	6.05E+00	1.36E+01	1.21E+00	6.23E+00	1.64E+01	7.51E-01	3.23E+00	1.34E+01	6.58E-01	2.95E+00	1.53E+01	6.22E-01	2.58E+00	1.36E+01
Co (Cobalt)	µg/L	5	4.44E-02	3.23E-01	1.02E+00	4.99E-02	3.28E-01	9.12E-01	7.34E-02	5.42E-01	1.22E+00	6.43E-02	7.77E-01	2.91E+00	7.08E-02	8.30E-01	3.03E+00	7.67E-02	8.07E-01	2.93E+00
Cr (Chromium)	µg/L	11	2.14E-01	5.87E-01	1.22E+00	2.13E-01	5.86E-01	1.20E+00	2.40E-01	7.04E-01	1.26E+00	2.11E-01	8.06E-01	1.63E+00	2.19E-01	7.57E-01	1.39E+00	2.35E-01	7.04E-01	1.34E+00
Cu (Copper)[4]	µg/L	9.8	3.83E-01	1.25E+00	2.84E+00	4.00E-01	1.25E+00	2.91E+00	4.29E-01	1.65E+00	3.08E+00	4.44E-01	2.15E+00	5.57E+00	4.61E-01	2.15E+00	5.57E+00	4.41E-01	2.12E+00	5.59E+00
F (Fluoride)	mg/L	--	2.50E-02	8.19E-02	1.92E-01	2.30E-02	8.22E-02	1.83E-01	2.99E-02	8.94E-02	1.95E-01	2.41E-02	8.34E-02	1.98E-01	2.26E-02	7.91E-02	1.93E-01	2.29E-02	7.22E-02	1.86E-01
Fe (Iron)	µg/L	--	4.80E+02	1.67E+03	4.94E+03	4.65E+02	1.68E+03	5.12E+03	4.77E+02	1.58E+03	4.54E+03	4.15E+02	1.26E+03	5.26E+03	3.73E+02	1.26E+03	4.52E+03	4.35E+02	1.24E+03	4.68E+03
K (Potassium)	mg/L	--	4.86E-01	1.76E+00	3.83E+00	4.63E-01	1.79E+00	3.77E+00	4.80E-01	1.68E+00	3.67E+00	3.56E-01	1.20E+00	3.80E+00	3.85E-01	1.24E+00	4.98E+00	4.03E-01	1.23E+00	3.96E+00
Mg (Magnesium)	mg/L	--	3.62E+00	8.91E+00	1.36E+01	3.71E+00	8.96E+00	1.37E+01	3.80E+00	8.82E+00	1.38E+01	3.27E+00	6.99E+00	1.43E+01	3.29E+00	7.03E+00	1.28E+01	3.29E+00	6.93E+00	1.39E+01
Mn (Manganese)	µg/L	--	1.02E+01	1.31E+02	3.61E+02	1.00E+01	1.33E+02	3.57E+02	1.14E+01	1.26E+02	3.35E+02	8.68E+00	1.26E+02	4.17E+02	8.03E+00	1.26E+02	4.24E+02	8.02E+00	1.26E+02	4.22E+02
Na (Sodium)	mg/L	--	8.47E-01	5.34E+00	1.07E+01	8.67E-01	5.34E+00	1.22E+01	9.96E-01	6.67E+00	1.61E+01	7.95E-01	5.99E+00	2.07E+01	7.53E-01	5.39E+00	1.78E+01	7.21E-01	4.57E+00	1.24E+01
Ni (Nickel)[4]	µg/L	54.6	1.66E-01	9.68E-01	2.99E+00	1.99E-01	9.82E-01	2.80E+00	3.93E-01	3.07E+00	9.03E+00	4.03E-01	5.11E+00	2.46E+01	4.58E-01	5.38E+00	2.51E+01	4.73E-01	5.11E+00	2.49E+01
Pb (Lead)[4]	µg/L	3.4	2.21E-02	2.22E-01	7.31E-01	2.32E-02	2.28E-01	6.31E-01	3.49E-02	3.48E-01	7.94E-01	3.44E-02	4.81E-01	1.79E+00	3.78E-02	4.94E-01	1.79E+00	3.37E-02	4.85E-01	1.78E+00
Sb (Antimony)	µg/L	31	2.50E-01	2.50E-01	2.52E-01	2.50E-01	2.50E-01	2.52E-01	2.50E-01	5.34E-01	1.63E+00	2.68E-01	7.62E-01	3.60E+00	2.64E-01	6.43E-01	2.87E+00	2.58E-01	4.87E-01	1.87E+00
Se (Selenium)	µg/L	5	1.99E-01	5.96E-01	1.32E+00	1.93E-01	5.84E-01	1.25E+00	2.00E-01	6.28E-01	1.25E+00	1.78E-01	5.83E-01	1.46E+00	1.82E-01	5.67E-01	1.32E+00	1.83E-01	5.29E-01	1.26E+00
SO4 (Sulfate)	mg/L	--	2.75E+00	1.18E+01	2.39E+01	2.92E+00	1.20E+01	2.42E+01	3.12E+00	1.16E+01	2.20E+01	2.00E+00	7.22E+00	1.59E+01	2.35E+00	7.22E+00	1.65E+01	2.21E+00	7.18E+00	1.45E+01
Tl (Thallium)	µg/L	0.56	2.44E-03	2.58E-02	7.53E-02	2.44E-03	2.60E-02	7.60E-02	2.75E-03	2.84E-02	7.73E-02	2.41E-03	3.32E-02	1.07E-01	2.36E-03	3.27E-02	1.06E-01	2.31E-03	3.11E-02	1.03E-01
V (Vanadium)	µg/L	--	9.98E-01	1.45E+00	2.45E+00	1.00E+00	1.46E+00	2.46E+00	1.02E+00	1.81E+00	3.31E+00	1.02E+00	2.24E+00	6.47E+00	1.02E+00	2.29E+00	6.48E+00	1.02E+00	2.21E+00	6.51E+00
Zn (Zinc)[4]	µg/L	125.4	1.04E+00	4.71E+00	1.90E+01	1.10E+00	4.64E+00	2.18E+01	1.52E+00	8.64E+00	2.08E+01	1.54E+00	1.17E+01	4.64E+01	1.48E+00	1.09E+01	4.81E+01	1.39E+00	9.49E+00	4.54E+01
Hardness	mg/L	500	3.75E+01	8.20E+01	1.27E+02	3.91E+01	8.26E+01	1.24E+02	3.79E+01	8.33E+01	1.28E+02	3.54E+01	6.96E+01	1.23E+02	3.45E+01	6.88E+01	1.22E+02	3.70E+01	6.81E+01	1.19E+02

Notes

[1] Values shown are the minimum of the monthly P10 values for the referenced Mine Year.

[2] Values shown are the average of the monthly P50 values for the referenced Mine Year.

[3] Values shown are the maximum of the monthly P90 values for the referenced Mine Year.

[4] Standard is hardness-based and evaluated at a hardness of 105.5 mg/L.

2.00E+02 Values above the applicable water quality standard are shown in bold with light red shading.

Large Table 43 Annual Summary of Concentration Statistics for the Partridge River at SW004b

Constituent	Mine Year / Percentile		10			20			55			75			125			200		
	Units	WQ Standard	Min P10[1]	Avg P50[2]	Max P90[3]	Min P10[1]	Avg P50[2]	Max P90[3]	Min P10[1]	Avg P50[2]	Max P90[3]	Min P10[1]	Avg P50[2]	Max P90[3]	Min P10[1]	Avg P50[2]	Max P90[3]	Min P10[1]	Avg P50[2]	Max P90[3]
Ag (Silver)	µg/L	1	9.48E-02	1.05E-01	1.10E-01	9.53E-02	1.05E-01	1.10E-01	9.58E-02	1.07E-01	1.22E-01	9.58E-02	1.09E-01	1.36E-01	9.59E-02	1.09E-01	1.37E-01	9.55E-02	1.09E-01	1.37E-01
Al (Aluminum)	µg/L	125	3.84E+01	8.36E+01	**2.59E+02**	3.73E+01	8.45E+01	**2.71E+02**	3.42E+01	8.13E+01	**2.55E+02**	4.22E+01	8.87E+01	**2.50E+02**	4.00E+01	8.86E+01	**2.54E+02**	4.24E+01	8.76E+01	**2.63E+02**
Alkalinity	mg/L	--	1.96E+01	6.15E+01	1.26E+02	2.10E+01	6.23E+01	1.36E+02	2.12E+01	6.15E+01	1.34E+02	1.90E+01	5.33E+01	1.44E+02	1.83E+01	5.21E+01	1.29E+02	1.90E+01	5.17E+01	1.28E+02
As (Arsenic)	µg/L	53	1.31E-01	6.98E-01	2.55E+00	1.43E-01	7.05E-01	2.62E+00	1.56E-01	8.20E-01	2.22E+00	1.50E-01	7.96E-01	2.25E+00	1.50E-01	7.98E-01	2.51E+00	1.43E-01	7.98E-01	2.19E+00
B (Boron)	µg/L	500	1.22E+01	5.73E+01	1.70E+02	1.20E+01	5.69E+01	1.67E+02	1.29E+01	5.82E+01	1.98E+02	1.03E+01	4.06E+01	1.59E+02	1.07E+01	4.03E+01	1.62E+02	1.10E+01	3.90E+01	1.92E+02
Ba (Barium)	µg/L	--	2.19E+00	9.25E+00	2.29E+01	2.22E+00	9.31E+00	2.29E+01	2.29E+00	1.01E+01	2.39E+01	2.20E+00	1.06E+01	3.02E+01	2.22E+00	1.05E+01	3.10E+01	2.07E+00	1.02E+01	3.09E+01
Be (Beryllium)	µg/L	--	9.56E-02	1.01E-01	1.10E-01	9.56E-02	1.01E-01	1.10E-01	9.63E-02	1.08E-01	1.45E-01	9.64E-02	1.15E-01	1.90E-01	9.63E-02	1.13E-01	1.85E-01	9.60E-02	1.09E-01	1.79E-01
Ca (Calcium)	mg/L	--	5.51E+00	1.65E+01	3.45E+01	5.51E+00	1.64E+01	3.38E+01	5.42E+00	1.69E+01	3.39E+01	5.21E+00	1.45E+01	3.34E+01	5.13E+00	1.43E+01	3.29E+01	5.33E+00	1.44E+01	3.21E+01
Cd (Cadmium)[4]	µg/L	--	2.28E-02	7.37E-02	1.40E-01	2.46E-02	7.58E-02	1.42E-01	2.93E-02	1.15E-01	3.27E-01	3.10E-02	1.35E-01	5.20E-01	2.85E-02	1.27E-01	5.60E-01	2.82E-02	1.14E-01	4.75E-01
Cl (Chloride)	mg/L	230	9.57E-01	5.15E+00	1.60E+01	1.04E+00	5.12E+00	1.33E+01	1.08E+00	5.28E+00	1.61E+01	7.51E-01	2.91E+00	1.34E+01	6.67E-01	2.77E+00	1.51E+01	6.25E-01	2.49E+00	1.36E+01
Co (Cobalt)	µg/L	5	4.29E-02	3.32E-01	1.07E+00	5.24E-02	3.38E-01	9.82E-01	6.52E-02	5.06E-01	1.16E+00	5.92E-02	6.39E-01	2.08E+00	6.58E-02	6.64E-01	2.17E+00	6.73E-02	6.52E-01	2.10E+00
Cr (Chromium)	µg/L	11	2.13E-01	6.00E-01	1.22E+00	2.11E-01	5.97E-01	1.22E+00	2.32E-01	6.86E-01	1.26E+00	2.07E-01	7.44E-01	1.36E+00	2.13E-01	7.13E-01	1.32E+00	2.34E-01	6.78E-01	1.34E+00
Cu (Copper)[4]	µg/L	--	3.83E-01	1.30E+00	2.86E+00	4.02E-01	1.30E+00	2.93E+00	4.16E-01	1.61E+00	3.07E+00	4.36E-01	1.90E+00	4.23E+00	4.60E-01	1.89E+00	4.40E+00	4.34E-01	1.88E+00	4.32E+00
F (Fluoride)	mg/L	--	2.42E-02	7.74E-02	1.92E-01	2.27E-02	7.74E-02	1.83E-01	2.88E-02	8.38E-02	1.92E-01	2.36E-02	7.72E-02	1.97E-01	2.25E-02	7.41E-02	1.89E-01	2.25E-02	6.94E-02	1.84E-01
Fe (Iron)	µg/L	--	4.64E+02	1.61E+03	4.94E+03	4.60E+02	1.61E+03	5.15E+03	4.69E+02	1.55E+03	4.63E+03	4.28E+02	1.35E+03	5.23E+03	3.81E+02	1.34E+03	4.75E+03	4.51E+02	1.32E+03	4.68E+03
K (Potassium)	mg/L	--	4.68E-01	1.65E+00	3.82E+00	4.40E-01	1.67E+00	3.72E+00	4.72E-01	1.60E+00	3.65E+00	3.66E-01	1.26E+00	3.73E+00	3.95E-01	1.29E+00	4.96E+00	4.19E-01	1.28E+00	3.96E+00
Mg (Magnesium)	mg/L	--	3.51E+00	8.30E+00	1.27E+01	3.59E+00	8.36E+00	1.29E+01	3.73E+00	8.31E+00	1.37E+01	3.28E+00	6.84E+00	1.42E+01	3.30E+00	6.90E+00	1.28E+01	3.32E+00	6.85E+00	1.38E+01
Mn (Manganese)	µg/L	--	9.49E+00	1.34E+02	3.83E+02	9.47E+00	1.36E+02	3.80E+02	1.08E+01	1.30E+02	3.63E+02	9.11E+00	1.33E+02	4.33E+02	8.13E+00	1.33E+02	4.40E+02	8.36E+00	1.33E+02	4.38E+02
Na (Sodium)	mg/L	--	7.90E-01	4.79E+00	1.04E+01	8.12E-01	4.76E+00	1.22E+01	9.30E-01	5.86E+00	1.43E+01	7.29E-01	5.07E+00	1.46E+01	7.47E-01	4.65E+00	1.33E+01	7.22E-01	4.15E+00	1.17E+01
Ni (Nickel)[4]	µg/L	--	1.65E-01	1.01E+00	3.00E+00	2.03E-01	1.02E+00	2.82E+00	3.67E-01	2.65E+00	7.90E+00	3.69E-01	3.74E+00	1.61E+01	3.80E-01	3.83E+00	1.65E+01	4.40E-01	3.75E+00	1.64E+01
Pb (Lead)[4]	µg/L	--	2.14E-02	2.25E-01	7.34E-01	2.25E-02	2.31E-01	6.52E-01	3.09E-02	3.20E-01	7.68E-01	3.17E-02	3.96E-01	1.30E+00	3.63E-02	4.03E-01	1.35E+00	2.90E-02	3.96E-01	1.33E+00
Sb (Antimony)	µg/L	31	2.50E-01	2.50E-01	2.52E-01	2.50E-01	2.50E-01	2.52E-01	2.50E-01	4.62E-01	1.35E+00	2.63E-01	5.78E-01	2.24E+00	2.61E-01	4.99E-01	1.83E+00	2.56E-01	4.04E-01	1.22E+00
Se (Selenium)	µg/L	5	1.94E-01	5.68E-01	1.31E+00	1.88E-01	5.56E-01	1.24E+00	1.95E-01	5.97E-01	1.24E+00	1.77E-01	5.53E-01	1.46E+00	1.85E-01	5.40E-01	1.31E+00	1.85E-01	5.13E-01	1.24E+00
SO4 (Sulfate)	mg/L	--	2.57E+00	1.05E+01	2.16E+01	2.73E+00	1.07E+01	2.19E+01	2.87E+00	1.05E+01	2.02E+01	2.00E+00	7.09E+00	1.59E+01	2.40E+00	7.05E+00	1.65E+01	2.21E+00	7.04E+00	1.47E+01
Tl (Thallium)	µg/L	0.56	2.34E-03	2.67E-02	8.09E-02	2.35E-03	2.68E-02	8.14E-02	2.61E-03	2.86E-02	8.30E-02	2.37E-03	3.17E-02	1.06E-01	2.36E-03	3.13E-02	1.04E-01	2.29E-03	3.04E-02	1.03E-01
V (Vanadium)	µg/L	--	9.97E-01	1.49E+00	2.59E+00	1.00E+00	1.49E+00	2.60E+00	1.01E+00	1.75E+00	3.31E+00	1.01E+00	2.01E+00	5.08E+00	1.02E+00	2.03E+00	5.23E+00	1.01E+00	2.01E+00	5.14E+00
Zn (Zinc)[4]	µg/L	--	1.07E+00	4.60E+00	1.90E+01	1.01E+00	4.51E+00	2.18E+01	1.41E+00	7.65E+00	1.98E+01	1.49E+00	9.31E+00	2.96E+01	1.36E+00	8.91E+00	3.08E+01	1.34E+00	7.82E+00	2.92E+01
Hardness	mg/L	500	3.72E+01	7.72E+01	1.26E+02	3.83E+01	7.78E+01	1.24E+02	3.73E+01	7.88E+01	1.27E+02	3.56E+01	6.78E+01	1.22E+02	3.52E+01	6.70E+01	1.22E+02	3.71E+01	6.69E+01	1.19E+02

Notes

[1] Values shown are the minimum of the monthly P10 values for the referenced Mine Year.

[2] Values shown are the average of the monthly P50 values for the referenced Mine Year.

[3] Values shown are the maximum of the monthly P90 values for the referenced Mine Year.

[4] Standard is hardness-based and variable. See discussion in Section 6.5.4.

2.00E+02 Values above the applicable water quality standard are shown in bold with light red shading.

Large Table 44 Annual Summary of Concentration Statistics for the Partridge River at SW005

Constituent	Mine Year		10			20			55			75			125			200		
	Percentile		Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max
	Units	WQ Standard	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]	P10[1]	P50[2]	P90[3]
Ag (Silver)	µg/L	1	9.50E-02	1.04E-01	1.10E-01	9.54E-02	1.04E-01	1.10E-01	9.57E-02	1.06E-01	1.18E-01	9.60E-02	1.06E-01	1.20E-01	9.59E-02	1.07E-01	1.22E-01	9.57E-02	1.07E-01	1.21E-01
Al (Aluminum)	µg/L	125	4.58E+01	9.22E+01	**2.59E+02**	4.52E+01	9.36E+01	**2.67E+02**	4.29E+01	9.03E+01	**2.57E+02**	4.60E+01	9.69E+01	**2.53E+02**	4.19E+01	9.75E+01	**2.52E+02**	4.50E+01	9.63E+01	**2.60E+02**
Alkalinity	mg/L	--	2.00E+01	5.88E+01	1.23E+02	2.18E+01	5.93E+01	1.31E+02	2.19E+01	5.92E+01	1.29E+02	2.00E+01	5.37E+01	1.43E+02	1.90E+01	5.23E+01	1.26E+02	1.95E+01	5.23E+01	1.24E+02
As (Arsenic)	µg/L	53	1.33E-01	6.58E-01	2.51E+00	1.56E-01	6.55E-01	2.46E+00	1.71E-01	7.50E-01	2.18E+00	1.64E-01	6.99E-01	2.03E+00	1.59E-01	7.06E-01	2.49E+00	1.53E-01	7.04E-01	2.20E+00
B (Boron)	µg/L	500	1.24E+01	5.27E+01	1.74E+02	1.19E+01	5.12E+01	1.62E+02	1.29E+01	5.29E+01	1.95E+02	1.16E+01	4.11E+01	1.57E+02	1.12E+01	4.05E+01	1.54E+02	1.18E+01	4.02E+01	1.83E+02
Ba (Barium)	µg/L	--	2.16E+00	8.63E+00	2.15E+01	2.22E+00	8.66E+00	2.15E+01	2.27E+00	9.28E+00	2.28E+01	2.18E+00	9.04E+00	2.50E+01	2.21E+00	9.06E+00	2.51E+01	2.09E+00	8.96E+00	2.51E+01
Be (Beryllium)	µg/L	--	9.56E-02	1.00E-01	1.09E-01	9.56E-02	1.00E-01	1.09E-01	9.62E-02	1.06E-01	1.35E-01	9.62E-02	1.09E-01	1.49E-01	9.61E-02	1.08E-01	1.48E-01	9.60E-02	1.05E-01	1.43E-01
Ca (Calcium)	mg/L	--	5.81E+00	1.56E+01	3.45E+01	5.47E+00	1.56E+01	3.36E+01	5.67E+00	1.60E+01	3.34E+01	5.43E+00	1.42E+01	3.31E+01	5.38E+00	1.40E+01	3.25E+01	5.53E+00	1.41E+01	3.09E+01
Cd (Cadmium)[4]	µg/L	--	2.31E-02	7.05E-02	1.39E-01	2.55E-02	7.25E-02	1.39E-01	2.91E-02	1.04E-01	2.61E-01	3.06E-02	1.11E-01	3.07E-01	2.99E-02	1.07E-01	3.22E-01	2.89E-02	9.82E-02	2.85E-01
Cl (Chloride)	mg/L	230	1.06E+00	4.50E+00	1.55E+01	1.02E+00	4.41E+00	1.26E+01	1.08E+00	4.65E+00	1.56E+01	7.95E-01	3.03E+00	1.45E+01	7.20E-01	2.96E+00	1.48E+01	6.90E-01	2.75E+00	1.39E+01
Co (Cobalt)	µg/L	5	4.44E-02	3.24E-01	1.08E+00	5.68E-02	3.28E-01	9.91E-01	6.32E-02	4.58E-01	1.06E+00	5.94E-02	5.09E-01	1.41E+00	6.40E-02	5.21E-01	1.45E+00	6.58E-02	5.16E-01	1.39E+00
Cr (Chromium)	µg/L	11	2.16E-01	5.95E-01	1.21E+00	2.12E-01	5.93E-01	1.19E+00	2.35E-01	6.57E-01	1.23E+00	2.20E-01	6.78E-01	1.31E+00	2.24E-01	6.58E-01	1.25E+00	2.44E-01	6.40E-01	1.32E+00
Cu (Copper)[4]	µg/L	--	3.91E-01	1.31E+00	2.86E+00	4.20E-01	1.30E+00	2.84E+00	4.24E-01	1.53E+00	3.00E+00	4.38E-01	1.65E+00	3.22E+00	4.78E-01	1.66E+00	3.29E+00	4.52E-01	1.64E+00	3.19E+00
F (Fluoride)	mg/L	--	2.51E-02	7.38E-02	1.89E-01	2.37E-02	7.40E-02	1.82E-01	2.85E-02	7.90E-02	1.85E-01	2.47E-02	7.22E-02	1.93E-01	2.39E-02	7.11E-02	1.85E-01	2.43E-02	6.79E-02	1.76E-01
Fe (Iron)	µg/L	--	4.76E+02	1.60E+03	4.93E+03	4.81E+02	1.59E+03	5.05E+03	4.80E+02	1.56E+03	4.48E+03	4.79E+02	1.46E+03	5.19E+03	4.10E+02	1.44E+03	4.73E+03	4.72E+02	1.42E+03	4.56E+03
K (Potassium)	mg/L	--	4.85E-01	1.55E+00	3.81E+00	4.39E-01	1.56E+00	3.63E+00	4.76E-01	1.53E+00	3.63E+00	3.90E-01	1.29E+00	3.59E+00	4.13E-01	1.33E+00	4.86E+00	4.42E-01	1.31E+00	3.85E+00
Mg (Magnesium)	mg/L	--	3.60E+00	7.75E+00	1.25E+01	3.60E+00	7.81E+00	1.25E+01	3.85E+00	7.84E+00	1.37E+01	3.39E+00	6.77E+00	1.36E+01	3.45E+00	6.85E+00	1.24E+01	3.40E+00	6.83E+00	1.37E+01
Mn (Manganese)	µg/L	--	9.63E+00	1.24E+02	3.69E+02	9.23E+00	1.27E+02	3.63E+02	1.06E+01	1.23E+02	3.45E+02	9.14E+00	1.19E+02	3.89E+02	8.93E+00	1.20E+02	3.95E+02	8.64E+00	1.20E+02	3.86E+02
Na (Sodium)	mg/L	--	8.00E-01	4.28E+00	1.03E+01	8.25E-01	4.23E+00	1.19E+01	9.58E-01	5.15E+00	1.20E+01	7.36E-01	4.32E+00	1.08E+01	7.36E-01	4.04E+00	1.29E+01	7.19E-01	3.71E+00	1.09E+01
Ni (Nickel)[4]	µg/L	--	1.77E-01	1.01E+00	2.99E+00	2.16E-01	1.02E+00	2.95E+00	3.64E-01	2.31E+00	6.27E+00	3.94E-01	2.76E+00	8.64E+00	3.49E-01	2.77E+00	8.83E+00	4.18E-01	2.77E+00	8.67E+00
Pb (Lead)[4]	µg/L	--	2.29E-02	2.13E-01	7.08E-01	2.38E-02	2.20E-01	7.22E-01	3.08E-02	2.88E-01	8.46E-01	3.09E-02	3.16E-01	8.94E-01	3.29E-02	3.20E-01	9.31E-01	2.95E-02	3.17E-01	9.40E-01
Sb (Antimony)	µg/L	31	2.50E-01	2.50E-01	2.52E-01	2.50E-01	2.50E-01	2.52E-01	2.50E-01	4.14E-01	1.04E+00	2.60E-01	4.52E-01	1.23E+00	2.59E-01	4.04E-01	9.98E-01	2.55E-01	3.49E-01	7.28E-01
Se (Selenium)	µg/L	5	1.97E-01	5.47E-01	1.26E+00	1.89E-01	5.34E-01	1.20E+00	2.01E-01	5.73E-01	1.22E+00	1.84E-01	5.32E-01	1.44E+00	1.92E-01	5.25E-01	1.29E+00	1.92E-01	5.08E-01	1.25E+00
SO4 (Sulfate)	mg/L	10	2.54E+00	9.29E+00	**1.78E+01**	2.73E+00	9.49E+00	**1.82E+01**	2.70E+00	9.35E+00	**1.75E+01**	2.10E+00	6.88E+00	**1.57E+01**	2.51E+00	6.81E+00	**1.65E+01**	2.28E+00	6.82E+00	**1.42E+01**
Tl (Thallium)	µg/L	0.56	2.27E-03	2.50E-02	7.69E-02	2.29E-03	2.52E-02	7.58E-02	2.57E-03	2.65E-02	7.80E-02	2.32E-03	2.65E-02	8.99E-02	2.33E-03	2.64E-02	8.94E-02	2.27E-03	2.61E-02	8.84E-02
V (Vanadium)	µg/L	--	9.96E-01	1.46E+00	2.51E+00	1.00E+00	1.47E+00	2.51E+00	1.01E+00	1.65E+00	3.12E+00	1.01E+00	1.75E+00	3.77E+00	1.01E+00	1.76E+00	3.84E+00	1.01E+00	1.75E+00	3.77E+00
Zn (Zinc)[4]	µg/L	--	1.09E+00	4.66E+00	1.84E+01	1.08E+00	4.55E+00	2.06E+01	1.45E+00	6.96E+00	1.86E+01	1.62E+00	7.59E+00	2.14E+01	1.34E+00	7.42E+00	2.12E+01	1.39E+00	6.79E+00	2.04E+01
Hardness	mg/L	500	3.78E+01	7.34E+01	1.24E+02	3.84E+01	7.36E+01	1.23E+02	3.73E+01	7.52E+01	1.24E+02	3.68E+01	6.67E+01	1.19E+02	3.62E+01	6.62E+01	1.20E+02	3.76E+01	6.65E+01	1.16E+02

Notes

[1] Values shown are the minimum of the monthly P10 values for the referenced Mine Year.

[2] Values shown are the average of the monthly P50 values for the referenced Mine Year.

[3] Values shown are the maximum of the monthly P90 values for the referenced Mine Year.

[4] Standard is hardness-based and variable. See discussion in Section 6.5.4.

2.00E+02 Values above the applicable water quality standard are shown in bold with light red shading.

Large Table 45 Annual Summary of Concentration Statistics for the Partridge River at SW006

Constituent	Mine Year / Percentile Units	WQ Standard	10 Min P10[1]	10 Avg P50[2]	10 Max P90[3]	20 Min P10[1]	20 Avg P50[2]	20 Max P90[3]	55 Min P10[1]	55 Avg P50[2]	55 Max P90[3]	75 Min P10[1]	75 Avg P50[2]	75 Max P90[3]	125 Min P10[1]	125 Avg P50[2]	125 Max P90[3]	200 Min P10[1]	200 Avg P50[2]	200 Max P90[3]
Ag (Silver)	µg/L	1	9.51E-02	1.04E-01	1.10E-01	9.54E-02	1.04E-01	1.09E-01	9.58E-02	1.06E-01	1.17E-01	9.60E-02	1.06E-01	1.18E-01	9.60E-02	1.06E-01	1.18E-01	9.58E-02	1.06E-01	1.18E-01
Al (Aluminum)	µg/L	125	4.60E+01	9.41E+01	**2.57E+02**	4.54E+01	9.56E+01	**2.66E+02**	4.54E+01	9.19E+01	**2.57E+02**	4.70E+01	9.84E+01	**2.57E+02**	4.23E+01	9.88E+01	**2.56E+02**	4.57E+01	9.78E+01	**2.56E+02**
Alkalinity	mg/L	--	2.02E+01	5.83E+01	1.23E+02	2.22E+01	5.87E+01	1.30E+02	2.22E+01	5.87E+01	1.29E+02	2.03E+01	5.38E+01	1.40E+02	1.94E+01	5.27E+01	1.25E+02	1.99E+01	5.27E+01	1.22E+02
As (Arsenic)	µg/L	53	1.35E-01	6.47E-01	2.50E+00	1.58E-01	6.46E-01	2.44E+00	1.75E-01	7.31E-01	2.17E+00	1.67E-01	6.83E-01	2.03E+00	1.66E-01	6.86E-01	2.48E+00	1.56E-01	6.87E-01	2.17E+00
B (Boron)	µg/L	500	1.25E+01	5.18E+01	1.71E+02	1.20E+01	5.02E+01	1.62E+02	1.30E+01	5.15E+01	1.93E+02	1.18E+01	4.14E+01	1.56E+02	1.14E+01	4.08E+01	1.55E+02	1.19E+01	4.05E+01	1.81E+02
Ba (Barium)	µg/L	--	2.17E+00	8.51E+00	2.12E+01	2.23E+00	8.54E+00	2.11E+01	2.29E+00	9.13E+00	2.25E+01	2.20E+00	8.78E+00	2.40E+01	2.24E+00	8.79E+00	2.40E+01	2.13E+00	8.74E+00	2.38E+01
Be (Beryllium)	µg/L	--	9.56E-02	1.00E-01	1.09E-01	9.57E-02	1.00E-01	1.09E-01	9.62E-02	1.06E-01	1.32E-01	9.62E-02	1.08E-01	1.41E-01	9.61E-02	1.07E-01	1.39E-01	9.60E-02	1.05E-01	1.36E-01
Ca (Calcium)	mg/L	--	5.93E+00	1.54E+01	3.45E+01	5.49E+00	1.53E+01	3.35E+01	5.74E+00	1.58E+01	3.30E+01	5.50E+00	1.42E+01	3.30E+01	5.44E+00	1.39E+01	3.23E+01	5.54E+00	1.41E+01	3.12E+01
Cd (Cadmium)[4]	µg/L	--	2.35E-02	6.99E-02	1.38E-01	2.60E-02	7.20E-02	1.40E-01	2.92E-02	1.01E-01	2.42E-01	3.08E-02	1.05E-01	2.63E-01	3.01E-02	1.03E-01	2.79E-01	2.90E-02	9.51E-02	2.52E-01
Cl (Chloride)	mg/L	230	1.07E+00	4.36E+00	1.58E+01	1.02E+00	4.26E+00	1.23E+01	1.09E+00	4.50E+00	1.53E+01	8.12E-01	3.05E+00	1.45E+01	7.29E-01	3.00E+00	1.44E+01	7.19E-01	2.78E+00	1.38E+01
Co (Cobalt)	µg/L	5	4.49E-02	3.23E-01	1.07E+00	5.76E-02	3.26E-01	9.95E-01	6.45E-02	4.43E-01	1.02E+00	6.08E-02	4.79E-01	1.30E+00	6.48E-02	4.94E-01	1.30E+00	6.62E-02	4.89E-01	1.29E+00
Cr (Chromium)	µg/L	11	2.20E-01	5.95E-01	1.20E+00	2.13E-01	5.95E-01	1.18E+00	2.38E-01	6.51E-01	1.22E+00	2.25E-01	6.66E-01	1.32E+00	2.27E-01	6.47E-01	1.25E+00	2.47E-01	6.35E-01	1.31E+00
Cu (Copper)[4]	µg/L	--	3.95E-01	1.31E+00	2.85E+00	4.19E-01	1.30E+00	2.82E+00	4.27E-01	1.51E+00	3.07E+00	4.44E-01	1.60E+00	3.13E+00	4.86E-01	1.61E+00	3.28E+00	4.58E-01	1.58E+00	3.16E+00
F (Fluoride)	mg/L	--	2.55E-02	7.33E-02	1.88E-01	2.45E-02	7.31E-02	1.79E-01	2.86E-02	7.81E-02	1.85E-01	2.50E-02	7.12E-02	1.94E-01	2.47E-02	7.05E-02	1.84E-01	2.45E-02	6.76E-02	1.74E-01
Fe (Iron)	µg/L	--	4.86E+02	1.60E+03	4.94E+03	4.90E+02	1.59E+03	5.01E+03	4.87E+02	1.56E+03	4.46E+03	4.88E+02	1.48E+03	5.18E+03	4.17E+02	1.46E+03	4.82E+03	4.78E+02	1.44E+03	4.53E+03
K (Potassium)	mg/L	--	4.93E-01	1.53E+00	3.75E+00	4.51E-01	1.55E+00	3.61E+00	4.82E-01	1.51E+00	3.65E+00	3.93E-01	1.29E+00	3.61E+00	4.18E-01	1.33E+00	4.83E+00	4.58E-01	1.31E+00	3.82E+00
Mg (Magnesium)	mg/L	--	3.63E+00	7.65E+00	1.23E+01	3.63E+00	7.69E+00	1.24E+01	3.87E+00	7.73E+00	1.37E+01	3.44E+00	6.77E+00	1.34E+01	3.50E+00	6.83E+00	1.22E+01	3.43E+00	6.81E+00	1.36E+01
Mn (Manganese)	µg/L	--	9.82E+00	1.23E+02	3.66E+02	9.50E+00	1.25E+02	3.63E+02	1.09E+01	1.23E+02	3.42E+02	9.45E+00	1.16E+02	3.78E+02	9.38E+00	1.18E+02	3.80E+02	8.86E+00	1.17E+02	3.79E+02
Na (Sodium)	mg/L	--	8.03E-01	4.14E+00	1.03E+01	8.53E-01	4.11E+00	1.18E+01	9.73E-01	4.96E+00	1.14E+01	7.41E-01	4.14E+00	1.08E+01	7.43E-01	3.90E+00	1.25E+01	7.18E-01	3.61E+00	1.08E+01
Ni (Nickel)[4]	µg/L	--	1.85E-01	1.01E+00	3.06E+00	2.23E-01	1.02E+00	2.88E+00	3.64E-01	2.21E+00	5.85E+00	4.01E-01	2.55E+00	7.36E+00	3.50E-01	2.56E+00	7.38E+00	4.16E-01	2.56E+00	7.35E+00
Pb (Lead)[4]	µg/L	--	2.35E-02	2.10E-01	7.12E-01	2.50E-02	2.17E-01	7.27E-01	3.15E-02	2.81E-01	8.57E-01	3.15E-02	2.97E-01	8.54E-01	3.27E-02	3.01E-01	8.53E-01	3.02E-02	2.99E-01	9.02E-01
Sb (Antimony)	µg/L	31	2.50E-01	2.50E-01	2.52E-01	2.50E-01	2.50E-01	2.52E-01	2.51E-01	4.02E-01	9.56E-01	2.60E-01	4.27E-01	1.05E+00	2.59E-01	3.84E-01	8.56E-01	2.55E-01	3.36E-01	6.22E-01
Se (Selenium)	µg/L	5	2.00E-01	5.43E-01	1.25E+00	1.93E-01	5.30E-01	1.19E+00	2.02E-01	5.66E-01	1.23E+00	1.86E-01	5.27E-01	1.43E+00	1.95E-01	5.23E-01	1.27E+00	1.95E-01	5.07E-01	1.24E+00
SO4 (Sulfate)	mg/L	--	2.56E+00	9.02E+00	1.69E+01	2.75E+00	9.18E+00	1.72E+01	2.71E+00	9.10E+00	1.76E+01	2.12E+00	6.85E+00	1.57E+01	2.55E+00	6.79E+00	1.63E+01	2.29E+00	6.81E+00	1.42E+01
Tl (Thallium)	µg/L	0.56	2.31E-03	2.48E-02	7.58E-02	2.32E-03	2.49E-02	7.44E-02	2.61E-03	2.61E-02	7.71E-02	2.37E-03	2.56E-02	8.56E-02	2.40E-03	2.55E-02	8.52E-02	2.32E-03	2.53E-02	8.48E-02
V (Vanadium)	µg/L	--	9.96E-01	1.46E+00	2.50E+00	1.00E+00	1.46E+00	2.49E+00	1.01E+00	1.63E+00	3.05E+00	1.01E+00	1.70E+00	3.52E+00	1.01E+00	1.71E+00	3.57E+00	1.01E+00	1.70E+00	3.55E+00
Zn (Zinc)[4]	µg/L	--	1.11E+00	4.68E+00	1.82E+01	1.15E+00	4.57E+00	2.06E+01	1.50E+00	6.74E+00	1.93E+01	1.65E+00	7.21E+00	2.15E+01	1.40E+00	7.08E+00	2.07E+01	1.43E+00	6.53E+00	2.02E+01
Hardness	mg/L	500	3.82E+01	7.26E+01	1.24E+02	3.83E+01	7.26E+01	1.23E+02	3.74E+01	7.43E+01	1.23E+02	3.69E+01	6.66E+01	1.20E+02	3.64E+01	6.61E+01	1.19E+02	3.77E+01	6.65E+01	1.16E+02

Notes

[1] Values shown are the minimum of the monthly P10 values for the referenced Mine Year.

[2] Values shown are the average of the monthly P50 values for the referenced Mine Year.

[3] Values shown are the maximum of the monthly P90 values for the referenced Mine Year.

[4] Standard is hardness-based and variable. See discussion in Section 6.5.4.

2.00E+02 Values above the applicable water quality standard are shown in bold with light red shading.

Large Table 46 Annual Summary of Concentration Statistics for Colby Lake

Constituent	Units	WQ Standard	Mine Year: 10 Min P10[1]	10 Avg P50[2]	10 Max P90[3]	20 Min P10[1]	20 Avg P50[2]	20 Max P90[3]	55 Min P10[1]	55 Avg P50[2]	55 Max P90[3]	75 Min P10[1]	75 Avg P50[2]	75 Max P90[3]	125 Min P10[1]	125 Avg P50[2]	125 Max P90[3]	200 Min P10[1]	200 Avg P50[2]	200 Max P90[3]
Ag (Silver)	µg/L	1	9.60E-02	1.02E-01	1.07E-01	9.68E-02	1.02E-01	1.07E-01	9.72E-02	1.03E-01	1.08E-01	9.71E-02	1.03E-01	1.09E-01	9.70E-02	1.03E-01	1.08E-01	9.73E-02	1.03E-01	1.08E-01
Al (Aluminum)	µg/L	125	6.15E+01	1.11E+02	**2.32E+02**	6.05E+01	1.14E+02	**2.30E+02**	6.22E+01	1.11E+02	**2.31E+02**	6.12E+01	1.16E+02	**2.40E+02**	6.00E+01	1.17E+02	**2.38E+02**	6.19E+01	1.15E+02	**2.31E+02**
Alkalinity	mg/L	--	2.86E+01	5.79E+01	1.12E+02	2.77E+01	5.87E+01	1.15E+02	2.83E+01	5.84E+01	1.24E+02	2.72E+01	5.73E+01	1.21E+02	2.71E+01	5.62E+01	1.13E+02	2.71E+01	5.45E+01	1.09E+02
As (Arsenic)	µg/L	2	2.54E-01	7.96E-01	**2.14E+00**	2.86E-01	8.05E-01	**2.30E+00**	3.01E-01	8.33E-01	**2.01E+00**	2.86E-01	8.30E-01	1.98E+00	3.22E-01	8.43E-01	**2.23E+00**	2.85E-01	8.30E-01	**2.14E+00**
B (Boron)	µg/L	500	1.85E+01	5.36E+01	1.54E+02	1.90E+01	5.29E+01	1.47E+02	1.94E+01	5.28E+01	1.52E+02	1.78E+01	4.88E+01	1.35E+02	1.82E+01	4.71E+01	1.48E+02	1.81E+01	4.88E+01	1.60E+02
Ba (Barium)	µg/L	2000	2.97E+00	8.01E+00	1.64E+01	3.05E+00	8.08E+00	1.62E+01	3.21E+00	8.43E+00	1.67E+01	3.05E+00	8.00E+00	1.62E+01	3.13E+00	8.10E+00	1.64E+01	3.03E+00	8.12E+00	1.62E+01
Be (Beryllium)	µg/L	4	9.65E-02	1.01E-01	1.09E-01	9.66E-02	1.01E-01	1.09E-01	9.71E-02	1.04E-01	1.15E-01	9.71E-02	1.04E-01	1.16E-01	9.71E-02	1.04E-01	1.16E-01	9.69E-02	1.03E-01	1.15E-01
Ca (Calcium)	mg/L	--	8.89E+00	1.89E+01	3.31E+01	8.72E+00	1.92E+01	3.22E+01	8.83E+00	1.94E+01	3.26E+01	8.90E+00	1.86E+01	3.20E+01	8.06E+00	1.84E+01	3.19E+01	8.52E+00	1.87E+01	3.24E+01
Cd (Cadmium)[4]	µg/L	--	3.64E-02	9.27E-02	1.61E-01	4.17E-02	9.35E-02	1.62E-01	4.50E-02	1.06E-01	1.90E-01	4.34E-02	1.07E-01	1.96E-01	4.47E-02	1.07E-01	1.96E-01	4.39E-02	1.06E-01	1.96E-01
Cl (Chloride)	mg/L	230	1.50E+00	4.45E+00	1.43E+01	1.48E+00	4.24E+00	1.17E+01	1.59E+00	4.52E+00	1.39E+01	1.35E+00	3.85E+00	1.22E+01	1.38E+00	3.82E+00	1.27E+01	1.27E+00	3.70E+00	1.22E+01
Co (Cobalt)	µg/L	2.8	7.53E-02	2.86E-01	1.05E+00	9.07E-02	2.95E-01	9.82E-01	1.12E-01	3.42E-01	9.84E-01	1.05E-01	3.48E-01	1.22E+00	1.07E-01	3.45E-01	9.66E-01	1.07E-01	3.49E-01	9.54E-01
Cr (Chromium)	µg/L	11	2.67E-01	5.85E-01	1.12E+00	2.87E-01	5.77E-01	1.11E+00	3.06E-01	6.12E-01	1.16E+00	2.89E-01	6.10E-01	1.10E+00	2.90E-01	6.07E-01	1.11E+00	3.09E-01	6.13E-01	1.16E+00
Cu (Copper)[4]	µg/L	--	1.22E+00	4.19E+00	9.11E+00	1.23E+00	4.22E+00	9.20E+00	1.20E+00	4.28E+00	9.03E+00	1.25E+00	4.38E+00	9.55E+00	1.31E+00	4.40E+00	9.83E+00	1.27E+00	4.42E+00	9.67E+00
F (Fluoride)	mg/L	4	3.51E-02	7.60E-02	1.60E-01	3.56E-02	7.45E-02	1.56E-01	3.82E-02	7.63E-02	1.67E-01	3.30E-02	7.26E-02	1.62E-01	3.44E-02	7.33E-02	1.61E-01	3.22E-02	7.18E-02	1.50E-01
Fe (Iron)	µg/L	300	**6.97E+02**	**1.77E+03**	**4.54E+03**	**7.31E+02**	**1.72E+03**	**4.16E+03**	**7.38E+02**	**1.73E+03**	**3.95E+03**	**7.59E+02**	**1.71E+03**	**4.69E+03**	**6.17E+02**	**1.71E+03**	**4.66E+03**	**6.78E+02**	**1.69E+03**	**4.30E+03**
K (Potassium)	mg/L	--	6.62E-01	1.50E+00	3.39E+00	6.24E-01	1.49E+00	3.41E+00	6.35E-01	1.48E+00	3.42E+00	6.24E-01	1.43E+00	3.33E+00	5.86E-01	1.44E+00	3.90E+00	5.99E-01	1.43E+00	3.52E+00
Mg (Magnesium)	mg/L	--	4.77E+00	8.84E+00	1.34E+01	4.86E+00	8.86E+00	1.32E+01	5.01E+00	8.95E+00	1.33E+01	4.67E+00	8.61E+00	1.32E+01	4.83E+00	8.55E+00	1.32E+01	4.71E+00	8.75E+00	1.30E+01
Mn (Manganese)	µg/L	50	1.56E+01	**7.60E+01**	**1.84E+02**	1.62E+01	**7.74E+01**	**1.97E+02**	1.85E+01	**7.78E+01**	**1.81E+02**	1.56E+01	**6.99E+01**	**1.78E+02**	1.62E+01	**7.13E+01**	**1.85E+02**	1.58E+01	**7.20E+01**	**1.81E+02**
Na (Sodium)	mg/L	--	1.34E+00	4.40E+00	1.01E+01	1.43E+00	4.41E+00	1.09E+01	1.56E+00	4.73E+00	1.13E+01	1.34E+00	4.34E+00	1.05E+01	1.33E+00	4.38E+00	1.20E+01	1.23E+00	4.16E+00	1.03E+01
Ni (Nickel)[4]	µg/L	--	4.79E-01	1.66E+00	3.68E+00	5.15E-01	1.70E+00	3.80E+00	6.20E-01	2.20E+00	4.79E+00	7.30E-01	2.28E+00	5.32E+00	6.74E-01	2.36E+00	5.12E+00	7.25E-01	2.36E+00	5.40E+00
Pb (Lead)[4]	µg/L	--	8.26E-02	3.75E-01	1.01E+00	9.59E-02	3.87E-01	1.12E+00	9.30E-02	4.11E-01	1.15E+00	9.67E-02	4.17E-01	1.13E+00	1.02E-01	4.22E-01	1.16E+00	8.96E-02	4.24E-01	1.20E+00
Sb (Antimony)	µg/L	5.5	2.50E-01	2.52E-01	2.56E-01	2.50E-01	2.52E-01	2.56E-01	2.53E-01	3.24E-01	4.59E-01	2.64E-01	3.25E-01	4.58E-01	2.62E-01	3.08E-01	4.14E-01	2.57E-01	2.90E-01	3.58E-01
Se (Selenium)	µg/L	5	2.65E-01	5.46E-01	1.13E+00	2.49E-01	5.46E-01	1.10E+00	2.77E-01	5.60E-01	1.09E+00	2.46E-01	5.42E-01	1.29E+00	2.65E-01	5.50E-01	1.13E+00	2.62E-01	5.41E-01	1.16E+00
SO4 (Sulfate)	mg/L	250	8.10E+00	2.94E+01	6.72E+01	8.35E+00	2.96E+01	6.65E+01	9.05E+00	2.95E+01	6.54E+01	7.25E+00	2.94E+01	6.71E+01	8.74E+00	2.97E+01	6.81E+01	8.38E+00	2.97E+01	6.77E+01
Tl (Thallium)	µg/L	0.28	5.21E-03	2.97E-02	7.34E-02	5.72E-03	3.00E-02	7.28E-02	5.92E-03	3.06E-02	7.31E-02	5.56E-03	2.94E-02	7.32E-02	5.63E-03	3.00E-02	7.40E-02	5.64E-03	3.01E-02	7.42E-02
V (Vanadium)	µg/L	--	1.02E+00	1.31E+00	1.80E+00	1.03E+00	1.31E+00	1.79E+00	1.04E+00	1.39E+00	1.98E+00	1.04E+00	1.38E+00	1.99E+00	1.05E+00	1.39E+00	2.02E+00	1.04E+00	1.40E+00	2.03E+00
Zn (Zinc)[4]	µg/L	--	1.76E+00	5.59E+00	1.90E+01	1.75E+00	5.39E+00	1.84E+01	2.27E+00	6.43E+00	1.87E+01	2.34E+00	6.61E+00	1.93E+01	2.12E+00	6.53E+00	1.86E+01	2.07E+00	6.28E+00	1.74E+01
Hardness	mg/L	500	4.77E+01	8.59E+01	1.29E+02	4.81E+01	8.60E+01	1.26E+02	4.85E+01	8.75E+01	1.28E+02	4.90E+01	8.47E+01	1.26E+02	4.64E+01	8.38E+01	1.27E+02	4.98E+01	8.49E+01	1.26E+02

Notes

[1] Values shown are the minimum of the monthly P10 values for the referenced Mine Year.

[2] Values shown are the average of the monthly P50 values for the referenced Mine Year.

[3] Values shown are the maximum of the monthly P90 values for the referenced Mine Year.

[4] Standard is hardness-based and variable. See discussion in Section 6.5.5.

2.00E+02 Values above the applicable water quality standard are shown in bold with light red shading.

Year after Mine Closure (Year 20)	Year from Start of Mine	West Pit Surface Area in Long-Term Closure (acres)	Cat. 1 Stockpile Contributing acres	Other Site Stormwater Runoff Contributing acres	Cat 1 Stockpile Runoff, other stormwater runoff, and the Category 1 portions of the pit wall within Mine Site to West Pit FLOW (acre-feet/year)	Cat 1 Stockpile Runoff and Other stormwater runoff within Mine Site to West Pit CONC (ng/l)	Cat 1 Stockpile Runoff and Other stormwater runoff within Mine Site to West Pit Loading (ng/yr)	Contained / Uncontained Cat 1 Stockpile Drainage to West Pit FLOW (acre-feet/year)	Contained / Uncontained Cat 1 Stockpile Drainage to West Pit CONC (ng/L)	Contained/ Uncontained Cat 1 Stockpile Drainage to West Pit Loading (ng/year)	Pumping from WWTF CPS Pond FLOW (acre-feet/year)	Pumping from WWTF CPS Pond CONC (ng/L)	Pumping from WWTF CPS Pond Loading (ng/year)
NA	1	296	248	288	-	4.00	0.00E+00	14.34	13.00	2.30E+08	0	8.00	0.00E+00
NA	2	296	248	288	53.77	4.0	2.66E+08	14.34	13.00	2.30E+08	0	8.00	0.00E+00
NA	3	296	248	288	113.99	4.0	5.63E+08	17.15	13.00	2.75E+08	0	8.00	0.00E+00
NA	4	296	248	288	129.81	4.0	6.41E+08	22.69	13.00	3.64E+08	0	8.00	0.00E+00
NA	5	296	248	288	145.63	4.0	7.19E+08	28.23	13.00	4.53E+08	0	8.00	0.00E+00
NA	6	296	248	288	172.44	4.0	8.52E+08	32.88	13.00	5.28E+08	0	8.00	0.00E+00
NA	7	296	248	288	209.91	4.0	1.04E+09	34.74	13.00	5.58E+08	0	8.00	0.00E+00
NA	8	296	248	288	247.39	4.0	1.22E+09	34.74	13.00	5.58E+08	0	8.00	0.00E+00
NA	9	296	248	288	284.86	4.0	1.41E+09	34.74	13.00	5.58E+08	0	8.00	0.00E+00
NA	10	296	248	288	322.34	4.0	1.59E+09	34.74	13.00	5.58E+08	0	8.00	0.00E+00
NA	11	296	248	288	359.81	4.0	1.78E+09	34.74	13.00	5.58E+08	0	8.00	0.00E+00
NA	12	296	248	288	378.27	4.0	1.87E+09	34.74	13.00	5.58E+08	0	8.00	0.00E+00
NA	13	296	248	288	378.27	4.0	1.87E+09	34.74	13.00	5.58E+08	0	8.00	0.00E+00
NA	14	296	248	288	378.27	4.0	1.87E+09	32.56	13.00	5.23E+08	0	8.00	0.00E+00
NA	15	296	248	288	378.27	4.0	1.87E+09	28.24	13.00	4.53E+08	0	8.00	0.00E+00
NA	16	296	248	288	378.27	4.0	1.87E+09	23.93	13.00	3.84E+08	0	8.00	0.00E+00
NA	17	296	248	288	378.27	4.0	1.87E+09	19.62	13.00	3.15E+08	0	8.00	0.00E+00
NA	18	296	248	288	378.27	4.0	1.87E+09	15.31	13.00	2.46E+08	0	8.00	0.00E+00
NA	19	296	248	288	378.27	4.0	1.87E+09	11.00	13.00	1.77E+08	0	8.00	0.00E+00
NA	20	296	248	288	378.27	4.0	1.87E+09	6.69	13.00	1.07E+08	0	8.00	0.00E+00
1	21	296	248	288	592.87	4.0	2.93E+09	2.37	13.00	3.81E+07	283	8.00	2.80E+09
2	22	296	248	288	530.45	4.0	2.62E+09	0.25	13.00	4.02E+06	439	8.00	4.34E+09
3	23	296	248	288	511.16	4.0	2.52E+09	0.25	13.00	4.02E+06	439	8.00	4.34E+09
4	24	296	248	288	497.06	4.0	2.46E+09	0.25	13.00	4.02E+06	439	8.00	4.34E+09
5	25	296	248	288	447.42	4.0	2.21E+09	0.25	13.00	4.02E+06	439	8.00	4.34E+09
6	26	296	248	288	390.30	4.0	1.93E+09	0.25	13.00	4.02E+06	439	8.00	4.34E+09
7	27	296	248	288	381.59	4.0	1.88E+09	0.25	13.00	4.02E+06	439	8.00	4.34E+09
8	28	296	248	288	376.27	4.0	1.86E+09	0.25	13.00	4.02E+06	439	8.00	4.34E+09
9	29	296	248	288	372.17	4.0	1.84E+09	0.25	13.00	4.02E+06	439	8.00	4.34E+09
10	30	296	248	288	368.20	4.0	1.82E+09	0.25	13.00	4.02E+06	439	8.00	4.34E+09
11	31	296	248	288	359.83	4.0	1.78E+09	0.25	13.00	4.02E+06	439	8.00	4.34E+09
12	32	296	248	288	340.34	4.0	1.68E+09	0.25	13.00	4.02E+06	439	8.00	4.34E+09
13	33	296	248	288	335.90	4.0	1.66E+09	0.96	13.00	1.54E+07	588	8.00	5.81E+09
14	34	296	248	288	331.66	4.0	1.64E+09	4.17	13.00	6.70E+07	0	8.00	0.00E+00
15	35	296	248	288	328.80	4.0	1.62E+09	4.17	13.00	6.70E+07	0	8.00	0.00E+00
16	36	296	248	288	326.06	4.0	1.61E+09	4.17	13.00	6.70E+07	0	8.00	0.00E+00
17	37	296	248	288	324.05	4.0	1.60E+09	4.17	13.00	6.70E+07	0	8.00	0.00E+00
18	38	296	248	288	321.80	4.0	1.59E+09	4.17	13.00	6.70E+07	0	8.00	0.00E+00
19	39	296	248	288	319.88	4.0	1.58E+09	4.17	13.00	6.70E+07	0	8.00	0.00E+00
20	40	296	248	288	318.07	4.0	1.57E+09	4.17	13.00	6.70E+07	0	8.00	0.00E+00
21	41	296	248	288	316.21	4.0	1.56E+09	4.17	13.00	6.70E+07	0	8.00	0.00E+00
22	42	296	248	288	314.20	4.0	1.55E+09	4.17	13.00	6.70E+07	0	8.00	0.00E+00
23	43	296	248	288	312.20	4.0	1.54E+09	4.17	13.00	6.70E+07	0	8.00	0.00E+00
24	44	296	248	288	296.66	4.0	1.47E+09	4.17	13.00	6.70E+07	0	8.00	0.00E+00
25	45	296	248	288	291.60	4.0	1.44E+09	4.17	13.00	6.70E+07	0	8.00	0.00E+00
26	46	296	248	288	289.74	4.0	1.43E+09	4.17	13.00	6.70E+07	0	8.00	0.00E+00
27	47	296	248	288	287.88	4.0	1.42E+09	4.17	13.00	6.70E+07	0	8.00	0.00E+00
28	48	296	248	288	285.96	4.0	1.41E+09	4.17	13.00	6.70E+07	0	8.00	0.00E+00
29	49	296	248	288	283.95	4.0	1.40E+09	4.17	13.00	6.70E+07	0	8.00	0.00E+00
30	50	296	248	288	281.97	4.0	1.39E+09	4.17	13.00	6.70E+07	0	8.00	0.00E+00
31	51	296	248	288	279.31	4.0	1.38E+09	4.17	13.00	6.70E+07	0	8.00	0.00E+00
32	52	296	248	288	276.49	4.0	1.37E+09	4.17	13.00	6.70E+07	0	8.00	0.00E+00
33	53	296	248	288	52.57	4.0	2.60E+08	0.45	13.00	7.30E+06	0	8.00	0.00E+00
34	54	296	248	288	29.84	4.0	1.47E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
35	55	296	248	288	29.80	4.0	1.47E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
36	56	296	248	288	29.77	4.0	1.47E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
37	57	296	248	288	29.74	4.0	1.47E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
38	58	296	248	288	29.71	4.0	1.47E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
39	59	296	248	288	29.68	4.0	1.47E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
40	60	296	248	288	29.65	4.0	1.46E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
41	61	296	248	288	29.62	4.0	1.46E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
42	62	296	248	288	29.58	4.0	1.46E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
43	63	296	248	288	29.55	4.0	1.46E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
44	64	296	248	288	29.52	4.0	1.46E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
45	65	296	248	288	29.49	4.0	1.46E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
46	66	296	248	288	29.46	4.0	1.45E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
47	67	296	248	288	29.43	4.0	1.45E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
48	68	296	248	288	29.39	4.0	1.45E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
49	69	296	248	288	29.36	4.0	1.45E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
50	70	296	248	288	29.33	4.0	1.45E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
51	71	296	248	288	29.29	4.0	1.45E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
52	72	296	248	288	29.26	4.0	1.45E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
53	73	296	248	288	29.23	4.0	1.44E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
54	74	296	248	288	29.19	4.0	1.44E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
55	75	296	248	288	29.16	4.0	1.44E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
56	76	296	248	288	29.12	4.0	1.44E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
57	77	296	248	288	29.09	4.0	1.44E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
58	78	296	248	288	29.05	4.0	1.44E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
59	79	296	248	288	29.02	4.0	1.43E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
60	80	296	248	288	28.98	4.0	1.43E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
61	81	296	248	288	28.95	4.0	1.43E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
62	82	296	248	288	28.91	4.0	1.43E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
63	83	296	248	288	28.88	4.0	1.43E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
64	84	296	248	288	28.84	4.0	1.42E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
65	85	296	248	288	28.81	4.0	1.42E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
66	86	296	248	288	28.77	4.0	1.42E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
67	87	296	248	288	28.74	4.0	1.42E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
68	88	296	248	288	28.70	4.0	1.42E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
69	89	296	248	288	28.67	4.0	1.42E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
70	90	296	248	288	28.63	4.0	1.41E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
71	91	296	248	288	28.60	4.0	1.41E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
72	92	296	248	288	28.56	4.0	1.41E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
73	93	296	248	288	28.53	4.0	1.41E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
74	94	296	248	288	28.49	4.0	1.41E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
75	95	296	248	288	28.46	4.0	1.41E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
76	96	296	248	288	28.42	4.0	1.40E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
77	97	296	248	288	28.39	4.0	1.40E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
78	98	296	248	288	28.35	4.0	1.40E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
79	99	296	248	288	28.38	4.0	1.40E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
80	100	296	248	288	28.36	4.0	1.40E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
81	101	296	248	288	28.33	4.0	1.40E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
82	102	296	248	288	28.35	4.0	1.40E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
83	103	296	248	288	28.34	4.0	1.40E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
84	104	296	248	288	28.36	4.0	1.40E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
85	105	296	248	288	28.35	4.0	1.40E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
86	106	296	248	288	28.37	4.0	1.40E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
87	107	296	248	288	28.36	4.0	1.40E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
88	108	296	248	288	28.32	4.0	1.40E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
89	109	296	248	288	28.35	4.0	1.40E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
90	110	296	248	288	28.34	4.0	1.40E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
91	111	296	248	288	28.36	4.0	1.40E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
92	112	296	248	288	28.35	4.0	1.40E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
93	113	296	248	288	28.37	4.0	1.40E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
94	114	296	248	288	28.36	4.0	1.40E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
95	115	296	248	288	28.38	4.0	1.40E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
96	116	296	248	288	28.37	4.0	1.40E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
97	117	296	248	288	28.33	4.0	1.40E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
98	118	296	248	288	28.36	4.0	1.40E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
99	119	296	248	288	28.34	4.0	1.40E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
100	120	296	248	288	28.37	4.0	1.40E+08	0.25	13.00	4.02E+06	0	8.00	0.00E+00
Average over years 21-55					325.78	4.00	1.61E+09	2.47	13.00	3.96E+07			1.61E+09
Contribution averaged over years 21-55 (%)					15%		8.4%	0.11%		0.21%			8.4%

Table Key
Inflow
Outflow
Hg Concentration
Calculated Value
Estimated Hg Conc

Unit Conversions

1 acre-foot =	43560	ft^3
1 ft^3=	28.34685	Liters
1 acre-foot =	1234788.786	Liters
1 acre =	4046.86	m^2
Mixing Vol = 296 ac x 30' depth	8893	acre-feet

Stormwater Runoff:	1.65E+09
(runoff+stockpile drainage)	8.6%
(+East Pit overflow)	2.55E+09
	13.4%

Inputs -- Sensitivity Testing

Groundwater (shallow)	3	ng/L
Wet Dep Over Pit	9407	ng/m2/yr
Cat. 1SP & stormwater runoff	4	ng/L
Uncontained Cat 1 Drainage	13	ng/L
WWTF	8	ng/L
Pumping from Plant Site	1.3	ng/L
East Pit porewater seepage	4	ng/L
Precipitation	13	ng/L
East Pit wetland overflow	4	ng/L
Dry Deposition	3093	ng/m2/yr
Volatilization	5%	of wet+dry deposition
Burial	92%	of total inputs

Year after Mine Closure (Year 20)	Year from Start of Mine	Pumping from Plant Site FLOW (acre-feet/year)	Pumping from Plant Site CONC (ng/L)	Pumping from Plant Site Loading (ng/year)	East Pit lower porewater seepage (groundwater) FLOW (acre-feet/year)	East Pit lower porewater seepage (groundwater) CONC (ng/L)	East Pit lower porewater seepage (groundwater) Loading (ng/year)	Direct total precipitation onto West Pit FLOW (acre-feet/year)	Direct total precipitation onto West Pit CONC (ng/L)	Direct total precipitation onto West Pit Loading (Wet Deposition) (ng/yr)	Evaporation from West Pit FLOW (acre-feet/year)	Groundwater (shallow aquifer) inflow to West Pit FLOW (acre-feet/year)	Groundwater inflow to West Pit CONC (ng/L)	Groundwater inflow to West Pit Loading (ng/year)
NA	1	0	1.3	0.00E+00	-	4.00	0.00E+00	-	13.00	0.00E+00	0.00	-	3.00	0.00E+00
NA	2	0	1.3	0.00E+00	-	4.00	0.00E+00	0.05	13.00	8.45E+05	0.04	40.30	3.00	1.49E+08
NA	3	0	1.3	0.00E+00	-	4.00	0.00E+00	0.05	13.00	8.70E+05	0.04	74.50	3.00	2.76E+08
NA	4	0	1.3	0.00E+00	-	4.00	0.00E+00	0.05	13.00	8.70E+05	0.04	51.91	3.00	1.92E+08
NA	5	0	1.3	0.00E+00	-	4.00	0.00E+00	0.05	13.00	8.70E+05	0.04	43.97	3.00	1.63E+08
NA	6	0	1.3	0.00E+00	-	4.00	0.00E+00	0.05	13.00	8.70E+05	0.04	57.40	3.00	2.13E+08
NA	7	0	1.3	0.00E+00	-	4.00	0.00E+00	0.05	13.00	8.70E+05	0.04	66.56	3.00	2.47E+08
NA	8	0	1.3	0.00E+00	-	4.00	0.00E+00	0.05	13.00	8.70E+05	0.04	58.62	3.00	2.17E+08
NA	9	0	1.3	0.00E+00	-	4.00	0.00E+00	0.05	13.00	8.70E+05	0.04	51.91	3.00	1.92E+08
NA	10	0	1.3	0.00E+00	-	4.00	0.00E+00	0.05	13.00	8.70E+05	0.04	43.97	3.00	1.63E+08
NA	11	0	1.3	0.00E+00	-	4.00	0.00E+00	0.05	13.00	8.70E+05	0.04	86.72	3.00	3.21E+08
NA	12	0	1.3	0.00E+00	-	4.00	0.00E+00	0.05	13.00	8.70E+05	0.04	97.10	3.00	3.60E+08
NA	13	0	1.3	0.00E+00	-	4.00	0.00E+00	0.05	13.00	8.70E+05	0.04	73.28	3.00	2.71E+08
NA	14	0	1.3	0.00E+00	-	4.00	0.00E+00	0.05	13.00	8.70E+05	0.04	66.56	3.00	2.47E+08
NA	15	0	1.3	0.00E+00	-	4.00	0.00E+00	0.05	13.00	8.70E+05	0.04	58.62	3.00	2.17E+08
NA	16	0	1.3	0.00E+00	-	4.00	0.00E+00	0.05	13.00	8.70E+05	0.04	58.62	3.00	2.17E+08
NA	17	0	1.3	0.00E+00	-	4.00	0.00E+00	0.05	13.00	8.70E+05	0.04	58.62	3.00	2.17E+08
NA	18	0	1.3	0.00E+00	-	4.00	0.00E+00	0.05	13.00	8.70E+05	0.04	58.62	3.00	2.17E+08
NA	19	0	1.3	0.00E+00	-	4.00	0.00E+00	0.05	13.00	8.70E+05	0.04	58.62	3.00	2.17E+08
NA	20	0	1.3	0.00E+00	0.02	4.00	1.21E+05	0.05	13.00	8.70E+05	0.04	58.62	3.00	2.17E+08
1	21	3,117	1.3	5.00E+09	0.11	4.00	5.43E+05	60.09	13.00	9.65E+08	31.83	73.28	3.00	2.71E+08
2	22	3,489	1.3	5.60E+09	-	4.00	0.00E+00	184.88	13.00	2.97E+09	134.95	73.28	3.00	2.71E+08
3	23	3,397	1.3	5.45E+09	-	4.00	0.00E+00	223.49	13.00	3.59E+09	164.99	73.28	3.00	2.71E+08
4	24	3,358	1.3	5.39E+09	-	4.00	0.00E+00	251.73	13.00	4.04E+09	183.03	73.28	3.00	2.71E+08
5	25	3,291	1.3	5.28E+09	-	4.00	0.00E+00	350.99	13.00	5.63E+09	240.36	73.28	3.00	2.71E+08
6	26	3,057	1.3	4.91E+09	-	4.00	0.00E+00	465.22	13.00	7.47E+09	341.07	73.28	3.00	2.71E+08
7	27	2,534	1.3	4.07E+09	-	4.00	0.00E+00	482.65	13.00	7.75E+09	353.69	73.28	3.00	2.71E+08
8	28	1,892	1.3	3.04E+09	-	4.00	0.00E+00	493.27	13.00	7.92E+09	361.37	73.28	3.00	2.71E+08
9	29	1,424	1.3	2.29E+09	-	4.00	0.00E+00	501.50	13.00	8.05E+09	367.52	73.28	3.00	2.71E+08
10	30	1,172	1.3	1.88E+09	-	4.00	0.00E+00	509.43	13.00	8.18E+09	373.35	73.28	3.00	2.71E+08
11	31	1,378	1.3	2.21E+09	-	4.00	0.00E+00	526.16	13.00	8.45E+09	380.34	73.28	3.00	2.71E+08
12	32	1,318	1.3	2.12E+09	-	4.00	0.00E+00	565.15	13.00	9.07E+09	414.20	73.28	3.00	2.71E+08
13	33	1,291	1.3	2.07E+09	0.04	4.00	1.81E+05	574.02	13.00	9.21E+09	420.34	73.28	3.00	2.71E+08
14	34	1,300	1.3	2.09E+09	0.15	4.00	7.24E+05	582.49	13.00	9.35E+09	426.94	72.90	3.00	2.70E+08
15	35	1,078	1.3	1.73E+09	0.15	4.00	7.24E+05	588.20	13.00	9.44E+09	430.94	71.11	3.00	2.63E+08
16	36	896	1.3	1.44E+09	0.15	4.00	7.24E+05	593.69	13.00	9.53E+09	435.16	69.29	3.00	2.57E+08
17	37	704	1.3	1.13E+09	0.15	4.00	7.24E+05	597.71	13.00	9.59E+09	438.12	67.67	3.00	2.51E+08
18	38	685	1.3	1.10E+09	0.15	4.00	7.24E+05	602.20	13.00	9.67E+09	441.48	66.15	3.00	2.45E+08
19	39	707	1.3	1.14E+09	0.15	4.00	7.24E+05	606.05	13.00	9.73E+09	444.23	64.65	3.00	2.40E+08
20	40	647	1.3	1.04E+09	0.15	4.00	7.24E+05	609.68	13.00	9.79E+09	446.90	63.18	3.00	2.34E+08
21	41	752	1.3	1.21E+09	0.15	4.00	7.24E+05	613.40	13.00	9.85E+09	449.62	61.70	3.00	2.29E+08
22	42	850	1.3	1.36E+09	0.15	4.00	7.24E+05	617.42	13.00	9.91E+09	452.56	60.15	3.00	2.23E+08
23	43	747	1.3	1.20E+09	0.15	4.00	7.24E+05	621.43	13.00	9.98E+09	455.51	58.60	3.00	2.17E+08
24	44	751	1.3	1.21E+09	0.15	4.00	7.24E+05	652.51	13.00	1.05E+10	480.20	57.13	3.00	2.12E+08
25	45	768	1.3	1.23E+09	0.15	4.00	7.24E+05	662.62	13.00	1.06E+10	485.71	55.72	3.00	2.06E+08
26	46	776	1.3	1.25E+09	0.15	4.00	7.24E+05	666.35	13.00	1.07E+10	488.44	54.31	3.00	2.01E+08
27	47	784	1.3	1.26E+09	0.15	4.00	7.24E+05	670.05	13.00	1.08E+10	491.16	52.91	3.00	1.96E+08
28	48	833	1.3	1.34E+09	0.15	4.00	7.24E+05	673.89	13.00	1.08E+10	493.95	51.50	3.00	1.91E+08
29	49	700	1.3	1.12E+09	0.15	4.00	7.24E+05	677.93	13.00	1.09E+10	496.93	50.12	3.00	1.86E+08
30	50	766	1.3	1.23E+09	0.15	4.00	7.24E+05	681.89	13.00	1.09E+10	499.80	48.80	3.00	1.81E+08
31	51	773	1.3	1.24E+09	0.15	4.00	7.24E+05	687.20	13.00	1.10E+10	503.70	47.45	3.00	1.76E+08
32	52	731	1.3	1.17E+09	0.15	4.00	7.24E+05	692.83	13.00	1.11E+10	507.84	46.13	3.00	1.71E+08
33	53	191	1.3	3.07E+08	0.02	4.00	1.21E+05	696.69	13.00	1.12E+10	510.84	45.20	3.00	1.67E+08
34	54	0	1.3	0.00E+00	-	4.00	0.00E+00	696.84	13.00	1.12E+10	510.89	45.13	3.00	1.67E+08
35	55	0	1.3	0.00E+00	-	4.00	0.00E+00	696.90	13.00	1.12E+10	510.94	45.12	3.00	1.67E+08
36	56	0	1.3	0.00E+00	-	4.00	0.00E+00	696.96	13.00	1.12E+10	510.99	45.11	3.00	1.67E+08
37	57	0	1.3	0.00E+00	-	4.00	0.00E+00	697.03	13.00	1.12E+10	511.03	45.09	3.00	1.67E+08
38	58	0	1.3	0.00E+00	-	4.00	0.00E+00	697.09	13.00	1.12E+10	511.08	45.08	3.00	1.67E+08
39	59	0	1.3	0.00E+00	-	4.00	0.00E+00	697.15	13.00	1.12E+10	511.13	45.06	3.00	1.67E+08
40	60	0	1.3	0.00E+00	-	4.00	0.00E+00	697.21	13.00	1.12E+10	511.17	45.05	3.00	1.67E+08
41	61	0	1.3	0.00E+00	-	4.00	0.00E+00	697.28	13.00	1.12E+10	511.22	45.03	3.00	1.67E+08
42	62	0	1.3	0.00E+00	-	4.00	0.00E+00	697.34	13.00	1.12E+10	511.27	45.02	3.00	1.67E+08
43	63	0	1.3	0.00E+00	-	4.00	0.00E+00	697.40	13.00	1.12E+10	511.31	45.01	3.00	1.67E+08
44	64	0	1.3	0.00E+00	-	4.00	0.00E+00	697.47	13.00	1.12E+10	511.36	44.99	3.00	1.67E+08
45	65	0	1.3	0.00E+00	-	4.00	0.00E+00	697.53	13.00	1.12E+10	511.40	44.98	3.00	1.67E+08
46	66	0	1.3	0.00E+00	-	4.00	0.00E+00	697.60	13.00	1.12E+10	511.45	44.96	3.00	1.67E+08
47	67	0	1.3	0.00E+00	-	4.00	0.00E+00	697.66	13.00	1.12E+10	511.50	44.95	3.00	1.67E+08
48	68	0	1.3	0.00E+00	-	4.00	0.00E+00	697.72	13.00	1.12E+10	511.55	44.93	3.00	1.66E+08
49	69	0	1.3	0.00E+00	-	4.00	0.00E+00	697.79	13.00	1.12E+10	511.59	44.92	3.00	1.66E+08
50	70	0	1.3	0.00E+00	-	4.00	0.00E+00	697.85	13.00	1.12E+10	511.64	44.91	3.00	1.66E+08
51	71	0	1.3	0.00E+00	-	4.00	0.00E+00	697.92	13.00	1.12E+10	511.69	44.89	3.00	1.66E+08
52	72	0	1.3	0.00E+00	-	4.00	0.00E+00	697.99	13.00	1.12E+10	511.74	44.88	3.00	1.66E+08
53	73	0	1.3	0.00E+00	-	4.00	0.00E+00	698.06	13.00	1.12E+10	511.79	44.86	3.00	1.66E+08
54	74	0	1.3	0.00E+00	-	4.00	0.00E+00	698.12	13.00	1.12E+10	511.84	44.85	3.00	1.66E+08
55	75	0	1.3	0.00E+00	-	4.00	0.00E+00	698.19	13.00	1.12E+10	511.89	44.84	3.00	1.66E+08
56	76	0	1.3	0.00E+00	-	4.00	0.00E+00	698.26	13.00	1.12E+10	511.95	44.82	3.00	1.66E+08
57	77	0	1.3	0.00E+00	-	4.00	0.00E+00	698.33	13.00	1.12E+10	512.00	44.81	3.00	1.66E+08
58	78	0	1.3	0.00E+00	-	4.00	0.00E+00	698.40	13.00	1.12E+10	512.05	44.79	3.00	1.66E+08
59	79	0	1.3	0.00E+00	-	4.00	0.00E+00	698.47	13.00	1.12E+10	512.10	44.78	3.00	1.66E+08
60	80	0	1.3	0.00E+00	-	4.00	0.00E+00	698.54	13.00	1.12E+10	512.15	44.77	3.00	1.66E+08
61	81	0	1.3	0.00E+00	-	4.00	0.00E+00	698.61	13.00	1.12E+10	512.20	44.75	3.00	1.66E+08
62	82	0	1.3	0.00E+00	-	4.00	0.00E+00	698.68	13.00	1.12E+10	512.25	44.74	3.00	1.66E+08
63	83	0	1.3	0.00E+00	-	4.00	0.00E+00	698.75	13.00	1.12E+10	512.31	44.73	3.00	1.66E+08
64	84	0	1.3	0.00E+00	-	4.00	0.00E+00	698.82	13.00	1.12E+10	512.36	44.71	3.00	1.66E+08
65	85	0	1.3	0.00E+00	-	4.00	0.00E+00	698.89	13.00	1.12E+10	512.41	44.70	3.00	1.66E+08
66	86	0	1.3	0.00E+00	-	4.00	0.00E+00	698.96	13.00	1.12E+10	512.46	44.68	3.00	1.66E+08
67	87	0	1.3	0.00E+00	-	4.00	0.00E+00	699.03	13.00	1.12E+10	512.51	44.67	3.00	1.65E+08
68	88	0	1.3	0.00E+00	-	4.00	0.00E+00	699.10	13.00	1.12E+10	512.56	44.66	3.00	1.65E+08
69	89	0	1.3	0.00E+00	-	4.00	0.00E+00	699.17	13.00	1.12E+10	512.61	44.64	3.00	1.65E+08
70	90	0	1.3	0.00E+00	-	4.00	0.00E+00	699.24	13.00	1.12E+10	512.67	44.63	3.00	1.65E+08
71	91	0	1.3	0.00E+00	-	4.00	0.00E+00	699.31	13.00	1.12E+10	512.72	44.62	3.00	1.65E+08
72	92	0	1.3	0.00E+00	-	4.00	0.00E+00	699.38	13.00	1.12E+10	512.77	44.60	3.00	1.65E+08
73	93	0	1.3	0.00E+00	-	4.00	0.00E+00	699.45	13.00	1.12E+10	512.82	44.59	3.00	1.65E+08
74	94	0	1.3	0.00E+00	-	4.00	0.00E+00	699.53	13.00	1.12E+10	512.87	44.58	3.00	1.65E+08
75	95	0	1.3	0.00E+00	-	4.00	0.00E+00	699.60	13.00	1.12E+10	512.93	44.56	3.00	1.65E+08
76	96	0	1.3	0.00E+00	-	4.00	0.00E+00	699.67	13.00	1.12E+10	512.98	44.55	3.00	1.65E+08
77	97	0	1.3	0.00E+00	-	4.00	0.00E+00	699.74	13.00	1.12E+10	513.03	44.54	3.00	1.65E+08
78	98	0	1.3	0.00E+00	-	4.00	0.00E+00	699.81	13.00	1.12E+10	513.08	44.52	3.00	1.65E+08
79	99	0	1.3	0.00E+00	-	4.00	0.00E+00	699.76	13.00	1.12E+10	513.04	44.53	3.00	1.65E+08
80	100	0	1.3	0.00E+00	-	4.00	0.00E+00	699.79	13.00	1.12E+10	513.06	44.53	3.00	1.65E+08
81	101	0	1.3	0.00E+00	-	4.00	0.00E+00	699.86	13.00	1.12E+10	513.12	44.51	3.00	1.65E+08
82	102	0	1.3	0.00E+00	-	4.00	0.00E+00	699.81	13.00	1.12E+10	513.08	44.52	3.00	1.65E+08
83	103	0	1.3	0.00E+00	-	4.00	0.00E+00	699.83	13.00	1.12E+10	513.10	44.52	3.00	1.65E+08
84	104	0	1.3	0.00E+00	-	4.00	0.00E+00	699.78	13.00	1.12E+10	513.06	44.52	3.00	1.65E+08
85	105	0	1.3	0.00E+00	-	4.00	0.00E+00	699.81	13.00	1.12E+10	513.08	44.52	3.00	1.65E+08
86	106	0	1.3	0.00E+00	-	4.00	0.00E+00	699.76	13.00	1.12E+10	513.04	44.53	3.00	1.65E+08
87	107	0	1.3	0.00E+00	-	4.00	0.00E+00	699.79	13.00	1.12E+10	513.07	44.52	3.00	1.65E+08
88	108	0	1.3	0.00E+00	-	4.00	0.00E+00	699.86	13.00	1.12E+10	513.12	44.51	3.00	1.65E+08
89	109	0	1.3	0.00E+00	-	4.00	0.00E+00	699.81	13.00	1.12E+10	513.08	44.52	3.00	1.65E+08
90	110	0	1.3	0.00E+00	-	4.00	0.00E+00	699.84	13.00	1.12E+10	513.10	44.52	3.00	1.65E+08
91	111	0	1.3	0.00E+00	-	4.00	0.00E+00	699.79	13.00	1.12E+10	513.06	44.52	3.00	1.65E+08
92	112	0	1.3	0.00E+00	-	4.00	0.00E+00	699.82	13.00	1.12E+10	513.09	44.52	3.00	1.65E+08
93	113	0	1.3	0.00E+00	-	4.00	0.00E+00	699.77	13.00	1.12E+10	513.05	44.52	3.00	1.65E+08
94	114	0	1.3	0.00E+00	-	4.00	0.00E+00	699.79	13.00	1.12E+10	513.07	44.52	3.00	1.65E+08
95	115	0	1.3	0.00E+00	-	4.00	0.00E+00	699.75	13.00	1.12E+10	513.03	44.53	3.00	1.65E+08
96	116	0	1.3	0.00E+00	-	4.00	0.00E+00	699.77	13.00	1.12E+10	513.06	44.53	3.00	1.65E+08
97	117	0	1.3	0.00E+00	-	4.00	0.00E+00	699.84	13.00	1.12E+10	513.11	44.51	3.00	1.65E+08
98	118	0	1.3	0.00E+00	-	4.00	0.00E+00	699.79	13.00	1.12E+10	513.07	44.52	3.00	1.65E+08
99	119	0	1.3	0.00E+00	-	4.00	0.00E+00	699.82	13.00	1.12E+10	513.09	44.52	3.00	1.65E+08
100	120	0	1.3	0.00E+00	-	4.00	0.00E+00	699.77	13.00	1.12E+10	513.05	44.52	3.00	1.65E+08
Average over years 21-55				2.12E+09	0.08	4.00	4.17E+05	553.62		8.89E+09		63.07	3.00	2.34E+08
Contribution averaged over years 21-55 (%)				11%	0.004%		0.002%	26%		47%		2.9%		1.2%

Total load from GW 2.74E+08
(uncontained Cat 1 stockpile seep + east pit porewater + GW) 1.43%

Table Key
Inflow
Outflow
Hg Concentration
Calculated Value
Estimated Hg Conc

Year after Mine Closure (Year 20)	Year from Start of Mine	Inflow from East Pit wetland overflow FLOW (acre-feet/year)	Inflow from East Pit wetland overflow CONC (ng/L)	Inflow from East Pit Wetland (CONC --) calculated annually (ng/yr)	Dry deposition directly onto West Pit (ng/yr)	Volatilization directly from West Pit (ng/yr)	Burial (ng/yr)	Outflows from the West Pit (acre-feet/year)	Estimated Outflow CONC (ng/L)	Mass Outflow (ng/yr)
NA	1	0.00	4.0	0.00E+00	3.71E+09	1.86E+08	3.62E+09			
NA	2	0.00	4.0	0.00E+00	3.71E+09	1.86E+08	4.01E+09			
NA	3	0.00	4.0	0.00E+00	3.71E+09	1.86E+08	4.44E+09			
NA	4	0.00	4.0	0.00E+00	3.71E+09	1.86E+08	4.52E+09			
NA	5	0.00	4.0	0.00E+00	3.71E+09	1.86E+08	4.64E+09			
NA	6	0.00	4.0	0.00E+00	3.71E+09	1.86E+08	4.88E+09			
NA	7	0.00	4.0	0.00E+00	3.71E+09	1.86E+08	5.11E+09			
NA	8	0.00	4.0	0.00E+00	3.71E+09	1.86E+08	5.25E+09			
NA	9	0.00	4.0	0.00E+00	3.71E+09	1.86E+08	5.40E+09			
NA	10	0.00	4.0	0.00E+00	3.71E+09	1.86E+08	5.54E+09			
NA	11	0.00	4.0	0.00E+00	3.71E+09	1.86E+08	5.86E+09			
NA	12	0.00	4.0	0.00E+00	3.71E+09	1.86E+08	5.98E+09			
NA	13	0.00	4.0	0.00E+00	3.71E+09	1.86E+08	5.90E+09			
NA	14	0.00	4.0	0.00E+00	3.71E+09	1.86E+08	5.84E+09			
NA	15	0.00	4.0	0.00E+00	3.71E+09	1.86E+08	5.75E+09			
NA	16	0.00	4.0	0.00E+00	3.71E+09	1.86E+08	5.69E+09			
NA	17	0.00	4.0	0.00E+00	3.71E+09	1.86E+08	5.62E+09			
NA	18	0.00	4.0	0.00E+00	3.71E+09	1.86E+08	5.56E+09			
NA	19	0.00	4.0	0.00E+00	3.71E+09	1.86E+08	5.50E+09			
NA	20	0.00	4.0	0.00E+00	3.71E+09	1.86E+08	5.43E+09			
1	21	84.63	4.0	4.18E+08	3.71E+09	2.34E+08	1.48E+10	620	0.10	7.37E+07
2	22	0.00	4.0	0.00E+00	3.71E+09	3.34E+08	1.80E+10	0	0.32	0.00E+00
3	23	0.00	4.0	0.00E+00	3.71E+09	3.65E+08	1.83E+10	0	0.22	0.00E+00
4	24	20.02	4.0	9.89E+07	3.71E+09	3.88E+08	1.87E+10	0	0.22	0.00E+00
5	25	86.95	4.0	4.29E+08	3.71E+09	4.67E+08	2.01E+10	0	0.23	0.00E+00
6	26	86.98	4.0	4.30E+08	3.71E+09	5.59E+08	2.12E+10	0	0.24	0.00E+00
7	27	86.98	4.0	4.30E+08	3.71E+09	5.73E+08	2.07E+10	0	0.25	0.00E+00
8	28	86.98	4.0	4.30E+08	3.71E+09	5.81E+08	1.98E+10	0	0.27	0.00E+00
9	29	86.98	4.0	4.30E+08	3.71E+09	5.88E+08	1.93E+10	0	0.29	0.00E+00
10	30	86.98	4.0	4.30E+08	3.71E+09	5.94E+08	1.90E+10	0	0.31	0.00E+00
11	31	86.98	4.0	4.30E+08	3.71E+09	6.08E+08	1.95E+10	0	0.33	0.00E+00
12	32	86.98	4.0	4.30E+08	3.71E+09	6.39E+08	1.99E+10	0	0.34	0.00E+00
13	33	152.04	4.0	7.51E+08	3.71E+09	6.46E+08	2.16E+10	0	0.35	0.00E+00
14	34	247.78	4.0	1.22E+09	3.71E+09	6.53E+08	1.69E+10	0	0.34	0.00E+00
15	35	247.45	4.0	1.22E+09	3.71E+09	6.58E+08	1.66E+10	0	0.34	0.00E+00
16	36	247.45	4.0	1.22E+09	3.71E+09	6.62E+08	1.64E+10	0	0.35	0.00E+00
17	37	247.45	4.0	1.22E+09	3.71E+09	6.65E+08	1.62E+10	0	0.35	0.00E+00
18	38	247.45	4.0	1.22E+09	3.71E+09	6.69E+08	1.62E+10	0	0.36	0.00E+00
19	39	247.45	4.0	1.22E+09	3.71E+09	6.72E+08	1.63E+10	0	0.37	0.00E+00
20	40	247.45	4.0	1.22E+09	3.71E+09	6.75E+08	1.62E+10	0	0.38	0.00E+00
21	41	247.45	4.0	1.22E+09	3.71E+09	6.78E+08	1.64E+10	0	0.38	0.00E+00
22	42	247.45	4.0	1.22E+09	3.71E+09	6.81E+08	1.66E+10	0	0.38	0.00E+00
23	43	247.45	4.0	1.22E+09	3.71E+09	6.84E+08	1.65E+10	0	0.38	0.00E+00
24	44	247.45	4.0	1.22E+09	3.71E+09	7.09E+08	1.69E+10	0	0.38	0.00E+00
25	45	247.45	4.0	1.22E+09	3.71E+09	7.17E+08	1.70E+10	0	0.39	0.00E+00
26	46	247.45	4.0	1.22E+09	3.71E+09	7.20E+08	1.71E+10	0	0.39	0.00E+00
27	47	247.45	4.0	1.22E+09	3.71E+09	7.23E+08	1.71E+10	0	0.39	0.00E+00
28	48	247.45	4.0	1.22E+09	3.71E+09	7.26E+08	1.73E+10	0	0.39	0.00E+00
29	49	247.45	4.0	1.22E+09	3.71E+09	7.30E+08	1.71E+10	7	0.40	3.28E+06
30	50	247.45	4.0	1.22E+09	3.71E+09	7.33E+08	1.72E+10	10	0.40	4.95E+06
31	51	247.45	4.0	1.22E+09	3.71E+09	7.37E+08	1.73E+10	10	0.40	4.97E+06
32	52	247.45	4.0	1.22E+09	3.71E+09	7.42E+08	1.73E+10	10	0.40	5.00E+06
33	53	247.57	4.0	1.22E+09	3.71E+09	7.45E+08	1.55E+10	410	0.44	2.24E+08
34	54	247.59	4.0	1.22E+09	3.71E+09	7.45E+08	1.51E+10	490	0.47	2.86E+08
35	55	247.59	4.0	1.22E+09	3.71E+09	7.45E+08	1.51E+10	490	0.50	3.01E+08
36	56	247.59	4.0	1.22E+09	3.71E+09	7.45E+08	1.51E+10	490	0.52	3.16E+08
37	57	247.59	4.0	1.22E+09	3.71E+09	7.45E+08	1.51E+10	490	0.54	3.29E+08
38	58	247.59	4.0	1.22E+09	3.71E+09	7.45E+08	1.51E+10	490	0.56	3.42E+08
39	59	247.59	4.0	1.22E+09	3.71E+09	7.45E+08	1.51E+10	490	0.58	3.54E+08
40	60	247.59	4.0	1.22E+09	3.71E+09	7.45E+08	1.51E+10	490	0.60	3.65E+08
41	61	247.59	4.0	1.22E+09	3.71E+09	7.45E+08	1.51E+10	490	0.62	3.75E+08
42	62	247.59	4.0	1.22E+09	3.71E+09	7.45E+08	1.51E+10	490	0.64	3.85E+08
43	63	247.59	4.0	1.22E+09	3.71E+09	7.45E+08	1.51E+10	490	0.65	3.95E+08
44	64	247.59	4.0	1.22E+09	3.71E+09	7.45E+08	1.51E+10	490	0.67	4.04E+08
45	65	247.59	4.0	1.22E+09	3.71E+09	7.45E+08	1.51E+10	490	0.68	4.12E+08
46	66	247.59	4.0	1.22E+09	3.71E+09	7.45E+08	1.51E+10	490	0.69	4.20E+08
47	67	247.59	4.0	1.22E+09	3.71E+09	7.45E+08	1.51E+10	490	0.71	4.28E+08
48	68	247.59	4.0	1.22E+09	3.71E+09	7.46E+08	1.51E+10	490	0.72	4.35E+08
49	69	247.59	4.0	1.22E+09	3.71E+09	7.46E+08	1.51E+10	490	0.73	4.41E+08
50	70	247.59	4.0	1.22E+09	3.71E+09	7.46E+08	1.51E+10	490	0.74	4.48E+08
51	71	247.59	4.0	1.22E+09	3.71E+09	7.46E+08	1.51E+10	490	0.75	4.53E+08
52	72	247.59	4.0	1.22E+09	3.71E+09	7.46E+08	1.51E+10	490	0.76	4.59E+08
53	73	247.59	4.0	1.22E+09	3.71E+09	7.46E+08	1.51E+10	490	0.77	4.64E+08
54	74	247.59	4.0	1.22E+09	3.71E+09	7.46E+08	1.51E+10	490	0.78	4.69E+08
55	75	247.59	4.0	1.22E+09	3.71E+09	7.46E+08	1.51E+10	490	0.78	4.74E+08
56	76	247.59	4.0	1.22E+09	3.71E+09	7.46E+08	1.51E+10	490	0.79	4.78E+08
57	77	247.59	4.0	1.22E+09	3.71E+09	7.46E+08	1.51E+10	490	0.80	4.82E+08
58	78	247.59	4.0	1.22E+09	3.71E+09	7.46E+08	1.51E+10	490	0.80	4.86E+08
59	79	247.59	4.0	1.22E+09	3.71E+09	7.46E+08	1.51E+10	490	0.81	4.90E+08
60	80	247.59	4.0	1.22E+09	3.71E+09	7.46E+08	1.51E+10	490	0.82	4.94E+08
61	81	247.59	4.0	1.22E+09	3.71E+09	7.46E+08	1.51E+10	490	0.82	4.97E+08
62	82	247.59	4.0	1.22E+09	3.71E+09	7.46E+08	1.51E+10	490	0.83	5.00E+08
63	83	247.59	4.0	1.22E+09	3.71E+09	7.46E+08	1.51E+10	490	0.83	5.03E+08
64	84	247.59	4.0	1.22E+09	3.71E+09	7.46E+08	1.51E+10	490	0.84	5.06E+08
65	85	247.59	4.0	1.22E+09	3.71E+09	7.46E+08	1.51E+10	490	0.84	5.08E+08
66	86	247.59	4.0	1.22E+09	3.71E+09	7.46E+08	1.51E+10	490	0.84	5.11E+08
67	87	247.59	4.0	1.22E+09	3.71E+09	7.47E+08	1.51E+10	490	0.85	5.13E+08
68	88	247.59	4.0	1.22E+09	3.71E+09	7.47E+08	1.51E+10	490	0.85	5.15E+08
69	89	247.59	4.0	1.22E+09	3.71E+09	7.47E+08	1.51E+10	490	0.86	5.17E+08
70	90	247.59	4.0	1.22E+09	3.71E+09	7.47E+08	1.52E+10	490	0.86	5.19E+08
71	91	247.59	4.0	1.22E+09	3.71E+09	7.47E+08	1.52E+10	490	0.86	5.21E+08
72	92	247.59	4.0	1.22E+09	3.71E+09	7.47E+08	1.52E+10	490	0.86	5.23E+08
73	93	247.59	4.0	1.22E+09	3.71E+09	7.47E+08	1.52E+10	490	0.87	5.25E+08
74	94	247.59	4.0	1.22E+09	3.71E+09	7.47E+08	1.52E+10	490	0.87	5.26E+08
75	95	247.59	4.0	1.22E+09	3.71E+09	7.47E+08	1.52E+10	490	0.87	5.28E+08
76	96	247.59	4.0	1.22E+09	3.71E+09	7.47E+08	1.52E+10	490	0.87	5.29E+08
77	97	247.59	4.0	1.22E+09	3.71E+09	7.47E+08	1.52E+10	490	0.88	5.30E+08
78	98	247.59	4.0	1.22E+09	3.71E+09	7.47E+08	1.52E+10	490	0.88	5.32E+08
79	99	247.59	4.0	1.22E+09	3.71E+09	7.47E+08	1.52E+10	530	0.88	5.79E+08
80	100	247.59	4.0	1.22E+09	3.71E+09	7.47E+08	1.52E+10	490	0.88	5.34E+08
81	101	247.59	4.0	1.22E+09	3.71E+09	7.47E+08	1.52E+10	490	0.88	5.35E+08
82	102	247.59	4.0	1.22E+09	3.71E+09	7.47E+08	1.52E+10	530	0.89	5.82E+08
83	103	247.59	4.0	1.22E+09	3.71E+09	7.47E+08	1.52E+10	490	0.89	5.36E+08
84	104	247.59	4.0	1.22E+09	3.71E+09	7.47E+08	1.52E+10	530	0.89	5.84E+08
85	105	247.59	4.0	1.22E+09	3.71E+09	7.47E+08	1.52E+10	490	0.89	5.38E+08
86	106	247.59	4.0	1.22E+09	3.71E+09	7.47E+08	1.52E+10	530	0.89	5.86E+08
87	107	247.59	4.0	1.22E+09	3.71E+09	7.47E+08	1.52E+10	490	0.89	5.39E+08
88	108	247.59	4.0	1.22E+09	3.71E+09	7.47E+08	1.52E+10	490	0.89	5.40E+08
89	109	247.59	4.0	1.22E+09	3.71E+09	7.47E+08	1.52E+10	530	0.90	5.88E+08
90	110	247.59	4.0	1.22E+09	3.71E+09	7.47E+08	1.52E+10	490	0.89	5.41E+08
91	111	247.59	4.0	1.22E+09	3.71E+09	7.47E+08	1.52E+10	530	0.90	5.89E+08
92	112	247.59	4.0	1.22E+09	3.71E+09	7.47E+08	1.52E+10	490	0.90	5.42E+08
93	113	247.59	4.0	1.22E+09	3.71E+09	7.47E+08	1.52E+10	530	0.90	5.90E+08
94	114	247.59	4.0	1.22E+09	3.71E+09	7.47E+08	1.52E+10	490	0.90	5.43E+08
95	115	247.59	4.0	1.22E+09	3.71E+09	7.47E+08	1.52E+10	530	0.90	5.91E+08
96	116	247.59	4.0	1.22E+09	3.71E+09	7.47E+08	1.52E+10	490	0.90	5.44E+08
97	117	247.59	4.0	1.22E+09	3.71E+09	7.47E+08	1.52E+10	490	0.90	5.44E+08
98	118	247.59	4.0	1.22E+09	3.71E+09	7.47E+08	1.52E+10	530	0.90	5.92E+08
99	119	247.59	4.0	1.22E+09	3.71E+09	7.47E+08	1.52E+10	490	0.90	5.45E+08
100	120	247.59	4.0	1.22E+09	3.71E+09	7.47E+08	1.52E+10	530	0.90	5.93E+08
Average over years 21-55		182.77	4.00	9.03E+08	3.71E+09	6.30E+08	1.76E+10			2.58E+07
Contribution averaged over years 21-55 (%)				4.7%	19%	3.3%	92%			0.14%
				Total atmospheric (wet+dry)	1.26E+10	622.88	12,635.81			
					66%					

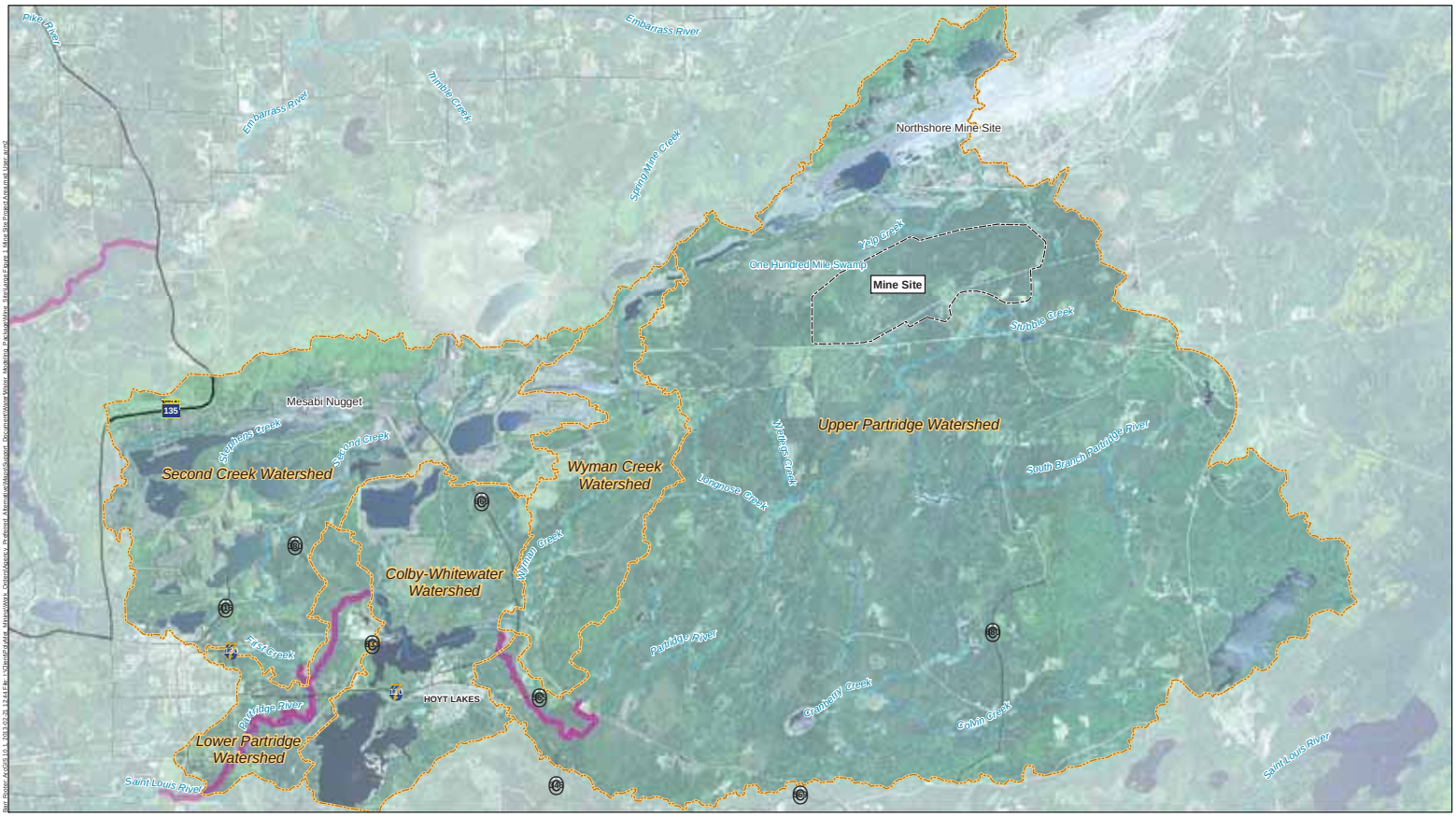
Table Key
Inflow
Outflow
Hg Concentration
Calculated Value
Estimated Hg Conc

Year after Mine Closure (Year 20)	Year from Start of Mine	West Pit Mass IN this time period (ng/yr)	West Pit Mass OUT this time period (ng/yr)	West Pit net volume added in this time period, (acre-feet/year)	Mass submerged below mixing zone this time period due to rising water levels (ng/yr)	**WEST PIT MIXING ZONE ANNUAL CONCEN-TRATION (ng/L)**	End of Year Cumulative West Pit filled volume (acre-feet/year)	End of Year Water elevation in West Pit (ft-MSL)
NA	1			14.34			0.23	940
NA	2			108.51			0.23	940
NA	3			205.74			0.23	940
NA	4			204.50			0.23	940
NA	5			217.92			0.23	940
NA	6			262.82			0.23	940
NA	7			311.31			0.23	940
NA	8			340.85			0.23	940
NA	9			371.61			0.23	940
NA	10			401.14			0.23	940
NA	11			481.37			0.23	940
NA	12			510.20			0.23	940
NA	13			486.39			0.23	940
NA	14			477.48			0.23	940
NA	15			465.23			0.23	940
NA	16			460.92			0.23	940
NA	17			456.60			0.23	940
NA	18			452.29			0.23	940
NA	19			447.98			0.23	940
NA	20			443.69			0.23	940
1	21	1.61E+10	1.51E+10	3,561.09		**0.22**	3,696	1,143
2	22	1.95E+10	1.83E+10	4,582.27		**0.21**	8,473	1,204
3	23	1.99E+10	1.87E+10	4,479.62	1.11E+09	**0.22**	13,147	1,254
4	24	2.03E+10	1.91E+10	4,457.01	1.22E+09	**0.22**	17,799	1,298
5	25	2.19E+10	2.06E+10	4,448.49	1.23E+09	**0.23**	22,435	1,331
6	26	2.31E+10	2.18E+10	4,171.03	1.18E+09	**0.24**	26,801	1,354
7	27	2.25E+10	2.12E+10	3,644.51	1.07E+09	**0.25**	30,640	1,372
8	28	2.16E+10	2.04E+10	3,000.23	9.34E+08	**0.27**	33,835	1,388
9	29	2.09E+10	1.98E+10	2,529.96	8.47E+08	**0.29**	36,559	1,401
10	30	2.06E+10	1.96E+10	2,275.98	8.24E+08	**0.31**	39,029	1,412
11	31	2.12E+10	2.01E+10	2,483.86	9.64E+08	**0.33**	41,705	1,424
12	32	2.16E+10	2.05E+10	2,409.02	9.68E+08	**0.34**	44,309	1,435
13	33	2.35E+10	2.23E+10	2,595.28	1.08E+09	**0.35**	47,098	1,446
14	34	1.83E+10	1.75E+10	2,111.87	9.15E+08	**0.34**	49,404	1,456
15	35	1.81E+10	1.73E+10	1,886.82	7.96E+08	**0.34**	51,485	1,464
16	36	1.78E+10	1.71E+10	1,701.84	7.16E+08	**0.35**	53,380	1,472
17	37	1.76E+10	1.68E+10	1,507.28	6.43E+08	**0.35**	55,081	1,478
18	38	1.76E+10	1.69E+10	1,485.67	6.50E+08	**0.36**	56,761	1,485
19	39	1.77E+10	1.69E+10	1,505.19	6.74E+08	**0.37**	58,460	1,492
20	40	1.76E+10	1.69E+10	1,442.39	6.57E+08	**0.38**	60,096	1,498
21	41	1.78E+10	1.71E+10	1,545.66	7.17E+08	**0.38**	61,835	1,505
22	42	1.80E+10	1.73E+10	1,640.74	7.67E+08	**0.38**	63,670	1,512
23	43	1.79E+10	1.72E+10	1,535.74	7.18E+08	**0.38**	65,399	1,518
24	44	1.84E+10	1.76E+10	1,529.21	7.20E+08	**0.38**	67,121	1,524
25	45	1.85E+10	1.78E+10	1,544.33	7.34E+08	**0.39**	68,859	1,531
26	46	1.86E+10	1.78E+10	1,549.66	7.42E+08	**0.39**	70,602	1,537
27	47	1.86E+10	1.79E+10	1,555.64	7.49E+08	**0.39**	72,352	1,543
28	48	1.88E+10	1.80E+10	1,602.47	7.75E+08	**0.39**	74,148	1,549
29	49	1.86E+10	1.78E+10	1,459.85	7.06E+08	**0.40**	75,801	1,555
30	50	1.87E+10	1.80E+10	1,520.27	7.43E+08	**0.40**	77,515	1,561
31	51	1.88E+10	1.81E+10	1,524.83	7.49E+08	**0.40**	79,234	1,567
32	52	1.88E+10	1.81E+10	1,480.52	7.30E+08	**0.40**	80,908	1,573
33	53	1.69E+10	1.65E+10	313.27	1.55E+08	**0.42**	81,285	1,574
34	54	1.64E+10	1.62E+10	18.71	9.76E+06	**0.45**	81,304	1,574
35	55	1.64E+10	1.62E+10	18.68	1.03E+07	**0.47**	81,323	1,574
36	56	1.64E+10	1.62E+10	18.65	1.08E+07	**0.49**	81,341	1,574
37	57	1.64E+10	1.62E+10	18.62	1.13E+07	**0.51**	81,360	1,574
38	58	1.64E+10	1.62E+10	18.59	1.18E+07	**0.53**	81,379	1,574
39	59	1.64E+10	1.62E+10	18.56	1.22E+07	**0.55**	81,397	1,574
40	60	1.64E+10	1.62E+10	18.53	1.26E+07	**0.57**	81,416	1,574
41	61	1.64E+10	1.62E+10	18.50	1.30E+07	**0.59**	81,435	1,574
42	62	1.64E+10	1.63E+10	18.47	1.34E+07	**0.60**	81,453	1,574
43	63	1.64E+10	1.63E+10	18.45	1.37E+07	**0.62**	81,472	1,574
44	64	1.64E+10	1.63E+10	18.42	1.40E+07	**0.63**	81,490	1,575
45	65	1.64E+10	1.63E+10	18.39	1.43E+07	**0.64**	81,509	1,575
46	66	1.64E+10	1.63E+10	18.36	1.46E+07	**0.66**	81,527	1,575
47	67	1.64E+10	1.63E+10	18.33	1.48E+07	**0.67**	81,545	1,575
48	68	1.64E+10	1.63E+10	18.30	1.51E+07	**0.68**	81,564	1,575
49	69	1.64E+10	1.63E+10	18.27	1.53E+07	**0.69**	81,582	1,575
50	70	1.65E+10	1.63E+10	18.24	1.55E+07	**0.70**	81,600	1,575
51	71	1.65E+10	1.63E+10	18.21	1.57E+07	**0.71**	81,619	1,575
52	72	1.65E+10	1.63E+10	18.18	1.59E+07	**0.72**	81,637	1,575
53	73	1.65E+10	1.63E+10	18.15	1.61E+07	**0.72**	81,655	1,575
54	74	1.65E+10	1.64E+10	18.12	1.62E+07	**0.73**	81,673	1,575
55	75	1.65E+10	1.64E+10	18.09	1.64E+07	**0.74**	81,691	1,575
56	76	1.65E+10	1.64E+10	18.06	1.65E+07	**0.75**	81,710	1,575
57	77	1.65E+10	1.64E+10	18.03	1.66E+07	**0.75**	81,728	1,575
58	78	1.65E+10	1.64E+10	18.00	1.67E+07	**0.76**	81,746	1,575
59	79	1.65E+10	1.64E+10	17.97	1.68E+07	**0.77**	81,764	1,575
60	80	1.65E+10	1.64E+10	17.94	1.69E+07	**0.77**	81,782	1,576
61	81	1.65E+10	1.64E+10	17.91	1.70E+07	**0.78**	81,800	1,576
62	82	1.65E+10	1.64E+10	17.88	1.71E+07	**0.78**	81,818	1,576
63	83	1.65E+10	1.64E+10	17.85	1.72E+07	**0.79**	81,836	1,576
64	84	1.65E+10	1.64E+10	17.82	1.73E+07	**0.79**	81,853	1,576
65	85	1.65E+10	1.64E+10	17.79	1.73E+07	**0.79**	81,871	1,576
66	86	1.65E+10	1.64E+10	17.75	1.74E+07	**0.80**	81,889	1,576
67	87	1.65E+10	1.64E+10	17.72	1.75E+07	**0.80**	81,907	1,576
68	88	1.65E+10	1.64E+10	17.69	1.75E+07	**0.80**	81,925	1,576
69	89	1.65E+10	1.64E+10	17.66	1.76E+07	**0.81**	81,942	1,576
70	90	1.65E+10	1.64E+10	17.63	1.76E+07	**0.81**	81,960	1,576
71	91	1.65E+10	1.64E+10	17.60	1.76E+07	**0.81**	81,978	1,576
72	92	1.65E+10	1.64E+10	17.57	1.77E+07	**0.82**	81,995	1,576
73	93	1.65E+10	1.64E+10	17.54	1.77E+07	**0.82**	82,013	1,576
74	94	1.65E+10	1.64E+10	17.51	1.77E+07	**0.82**	82,031	1,576
75	95	1.65E+10	1.64E+10	17.48	1.77E+07	**0.82**	82,048	1,576
76	96	1.65E+10	1.64E+10	17.45	1.78E+07	**0.83**	82,066	1,576
77	97	1.65E+10	1.64E+10	17.42	1.78E+07	**0.83**	82,083	1,577
78	98	1.65E+10	1.64E+10	17.39	1.78E+07	**0.83**	82,101	1,577
79	99	1.65E+10	1.65E+10	(22.91)	-2.35E+07	**0.83**	82,078	1,577
80	100	1.65E+10	1.64E+10	17.40	1.79E+07	**0.83**	82,095	1,577
81	101	1.65E+10	1.64E+10	17.37	1.79E+07	**0.84**	82,113	1,577
82	102	1.65E+10	1.65E+10	(22.93)	-2.36E+07	**0.84**	82,090	1,577
83	103	1.65E+10	1.64E+10	17.38	1.79E+07	**0.84**	82,107	1,577
84	104	1.65E+10	1.65E+10	(22.92)	-2.37E+07	**0.84**	82,084	1,577
85	105	1.65E+10	1.64E+10	17.39	1.80E+07	**0.84**	82,102	1,577
86	106	1.65E+10	1.65E+10	(22.91)	-2.38E+07	**0.84**	82,079	1,577
87	107	1.65E+10	1.64E+10	17.40	1.81E+07	**0.84**	82,096	1,577
88	108	1.65E+10	1.64E+10	17.37	1.81E+07	**0.84**	82,114	1,577
89	109	1.65E+10	1.65E+10	(22.93)	-2.39E+07	**0.84**	82,091	1,577
90	110	1.65E+10	1.64E+10	17.38	1.81E+07	**0.84**	82,108	1,577
91	111	1.65E+10	1.65E+10	(22.92)	-2.39E+07	**0.85**	82,085	1,577
92	112	1.65E+10	1.64E+10	17.39	1.82E+07	**0.85**	82,103	1,577
93	113	1.65E+10	1.65E+10	(22.92)	-2.39E+07	**0.85**	82,080	1,577
94	114	1.65E+10	1.64E+10	17.40	1.82E+07	**0.85**	82,097	1,577
95	115	1.65E+10	1.65E+10	(22.91)	-2.40E+07	**0.85**	82,075	1,576
96	116	1.65E+10	1.64E+10	17.41	1.82E+07	**0.85**	82,092	1,577
97	117	1.65E+10	1.64E+10	17.38	1.82E+07	**0.85**	82,110	1,577
98	118	1.65E+10	1.65E+10	(22.93)	-2.41E+07	**0.85**	82,087	1,577
99	119	1.65E+10	1.64E+10	17.39	1.82E+07	**0.85**	82,104	1,577
100	120	1.65E+10	1.65E+10	(22.92)	-2.41E+07	**0.85**	82,081	1,577
Average over years 21-55		1.91E+10	1.82E+10	2,146.26	7.73E+08	**0.34**	Avg. Hg Conc. for Mine Yr 21-55	
Contribution averaged over years 21-55 (%)						**0.84**	Avg. Hg Conc. for Mine Yr 101-120	

NET = IN - OUT 8.73E+08

Table Key
Inflow
Outflow
Hg Concentration
Calculated Value
Estimated Hg Conc

Large Figures



Rivers and Streams

MPCA Recommendation - Wild Rice Production

Partridge River Watershed

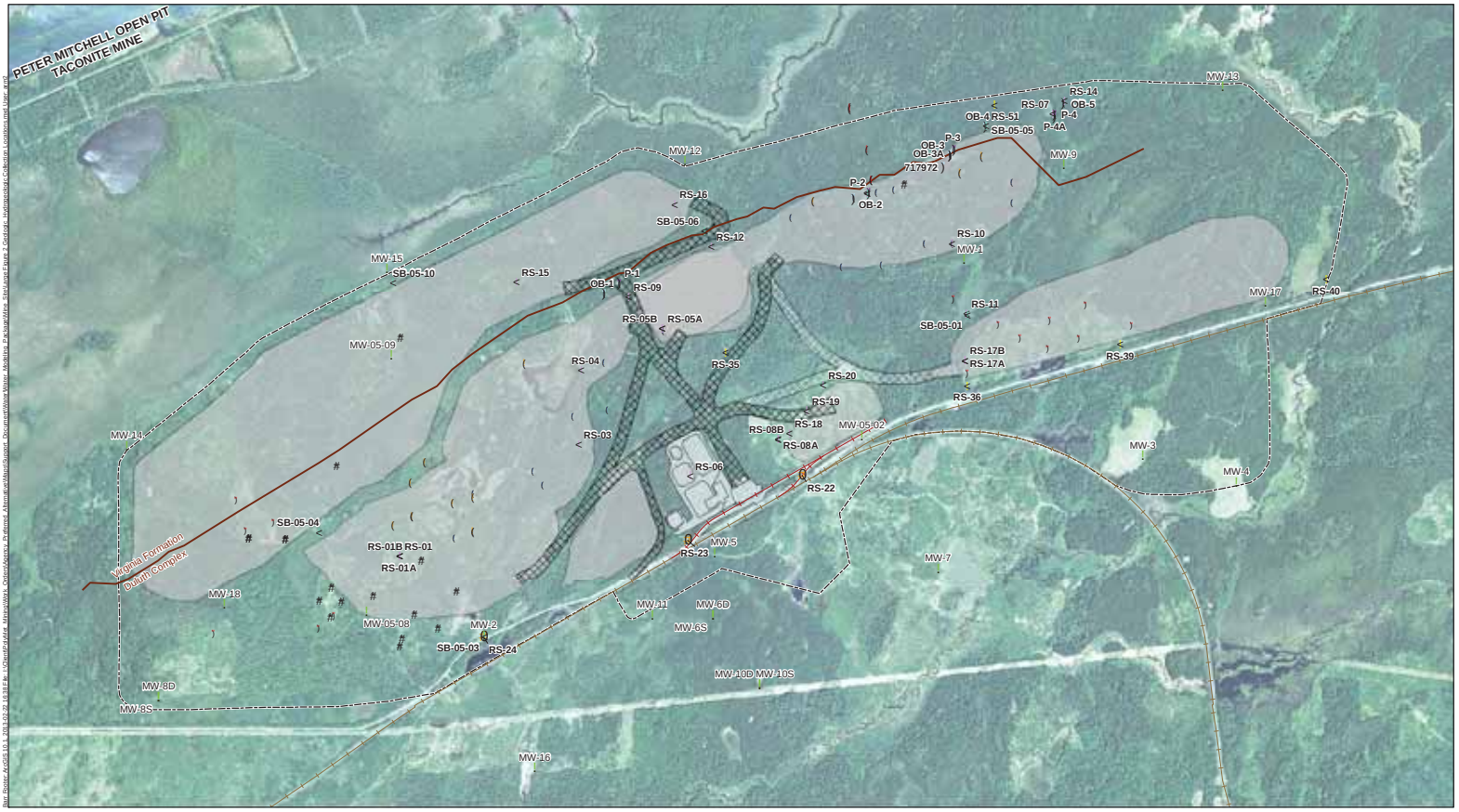
Mine Site

N

0 0.75 1.5 3

Miles

Large Figure 1
MINE SITE PROJECT AREA
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



Phase I
- (Bedrock Aquifer Testing Location - 2005
- < Soil Boring - 2005

Phase II
-) Pumping Test Wells - 2005/2006
-) Observation Wells - 2005/2006
- (Phase III - Wetland Piezometer - 2006
- < Overburden Geochem/Geotech Boring - 2008
- < Rotasonic Borings - 2011/2012
- 0 Sorption Sampling Location - 2009
- # Exploratory Borehole Sump Logging Location - 2010
- (Bedrock Groundwater Elevation Measurement - 2006
-) Golder Test Trench - 2006
- ! Monitoring Well

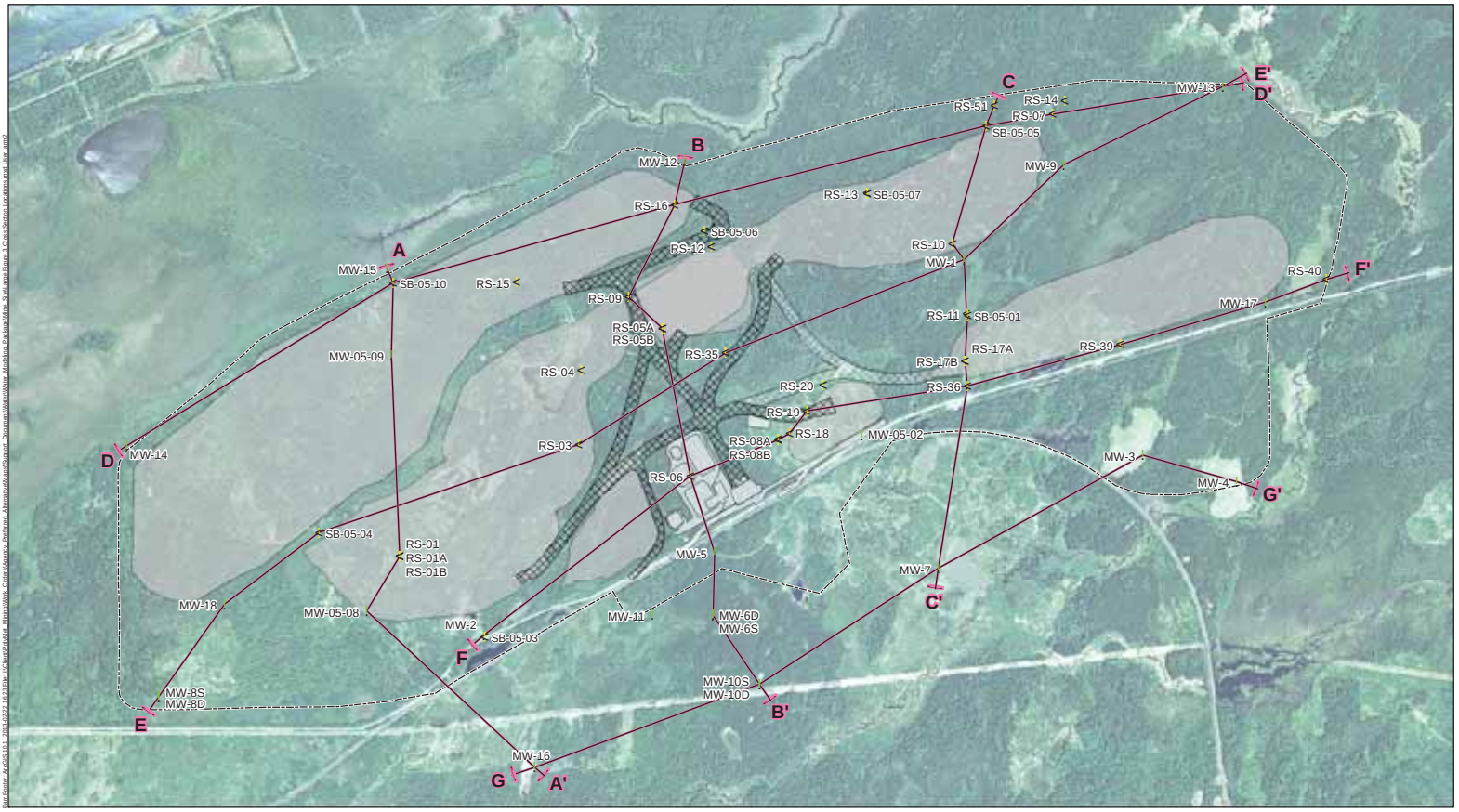
- Unit Boundaries
- Proposed Railroad Track
- Existing Private Railroad
- Mine Site

I

0 750 1,500 3,000

Feet

Large Figure 2
GEOLOGIC/HYDROGEOLOGIC
DATA COLLECTION LOCATIONS
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



! Monitoring Well

< Rotasonic Boring

Cross-Section Locations

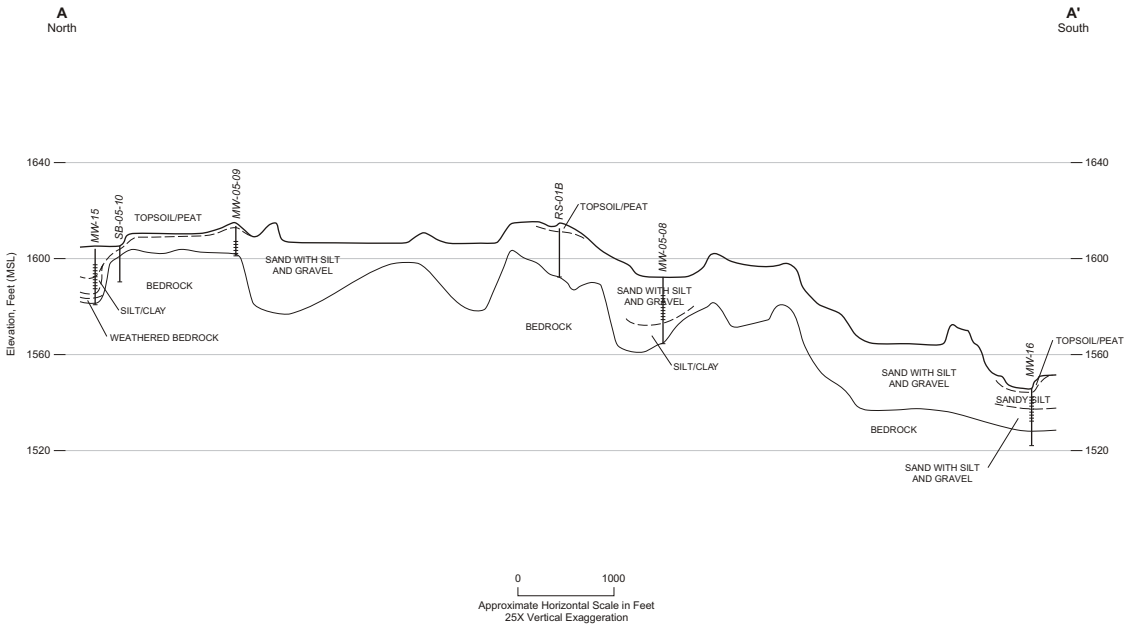
Mine Site

I

0 750 1,500 3,000

Feet

Large Figure 3
CROSS-SECTION LOCATIONS
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



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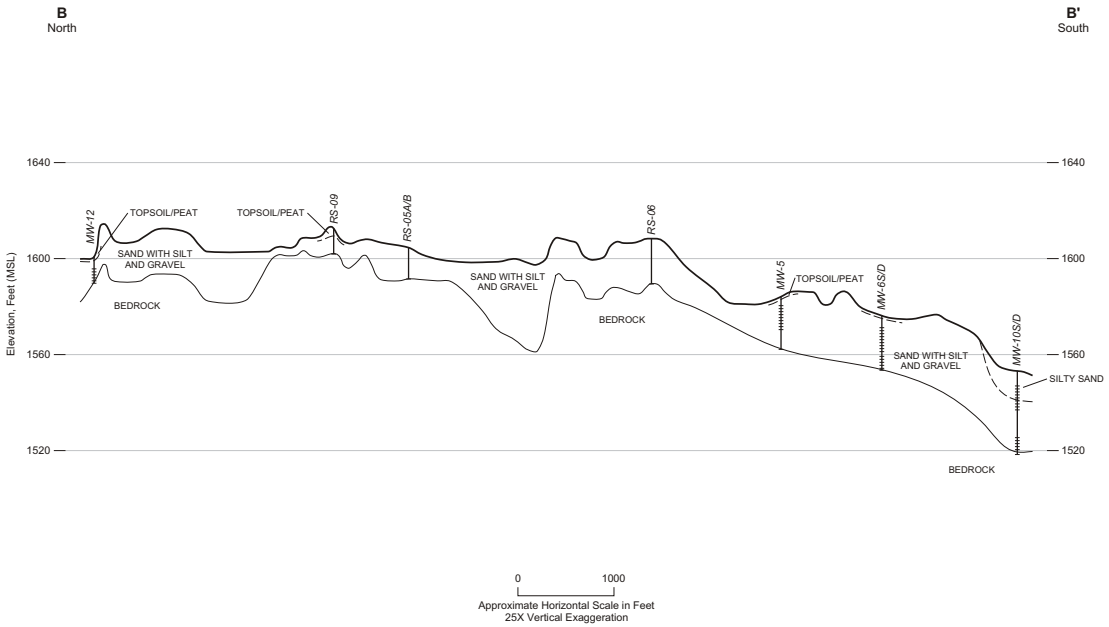
Large Figure 4

CROSS SECTION A-A'
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



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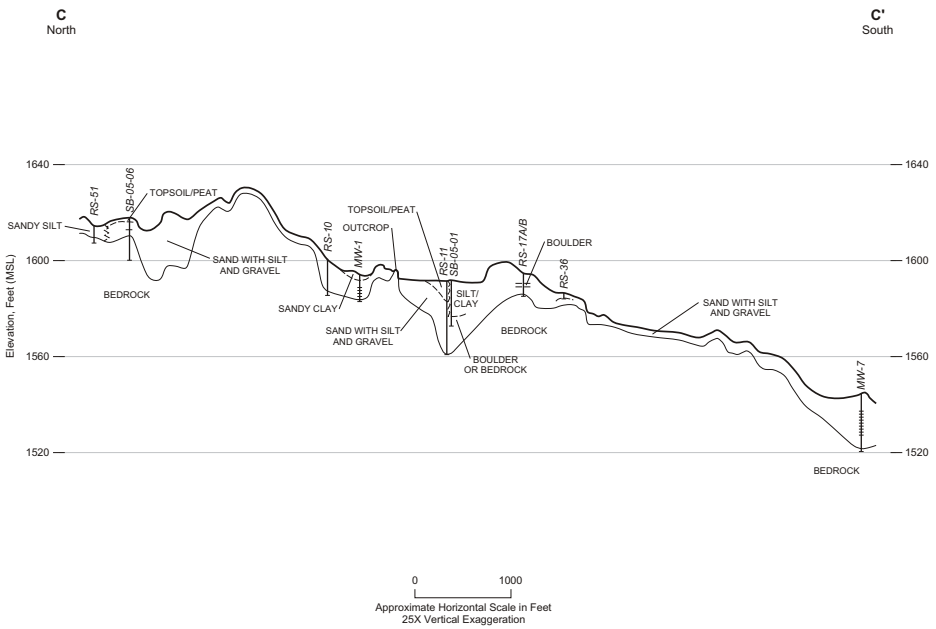
Large Figure 5

CROSS SECTION B-B'
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



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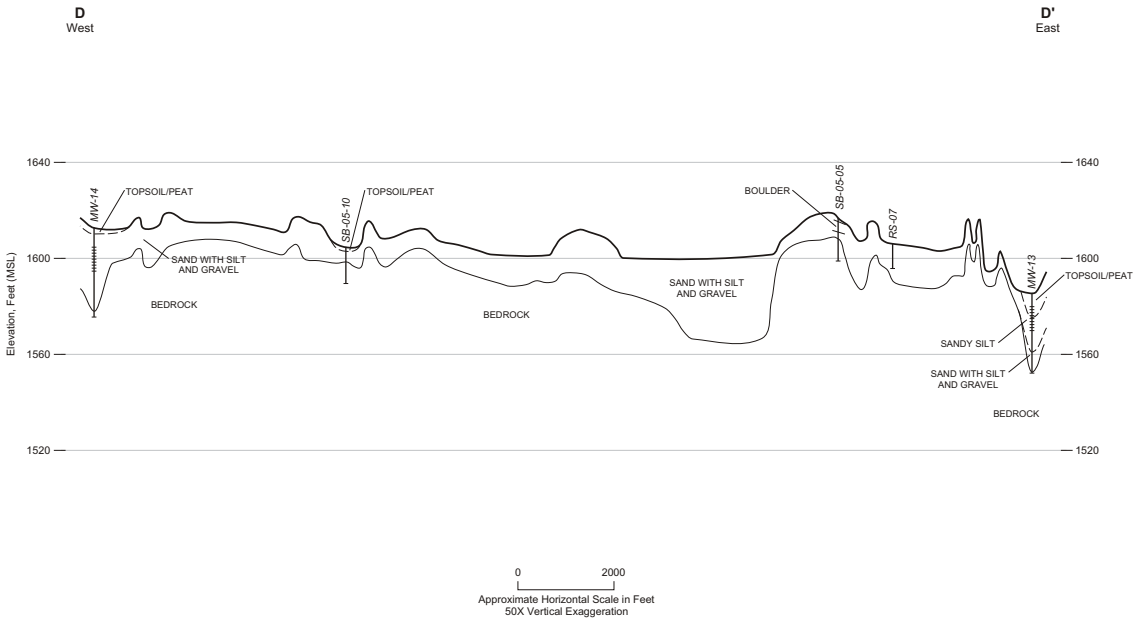
Large Figure 6

CROSS SECTION C-C'
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



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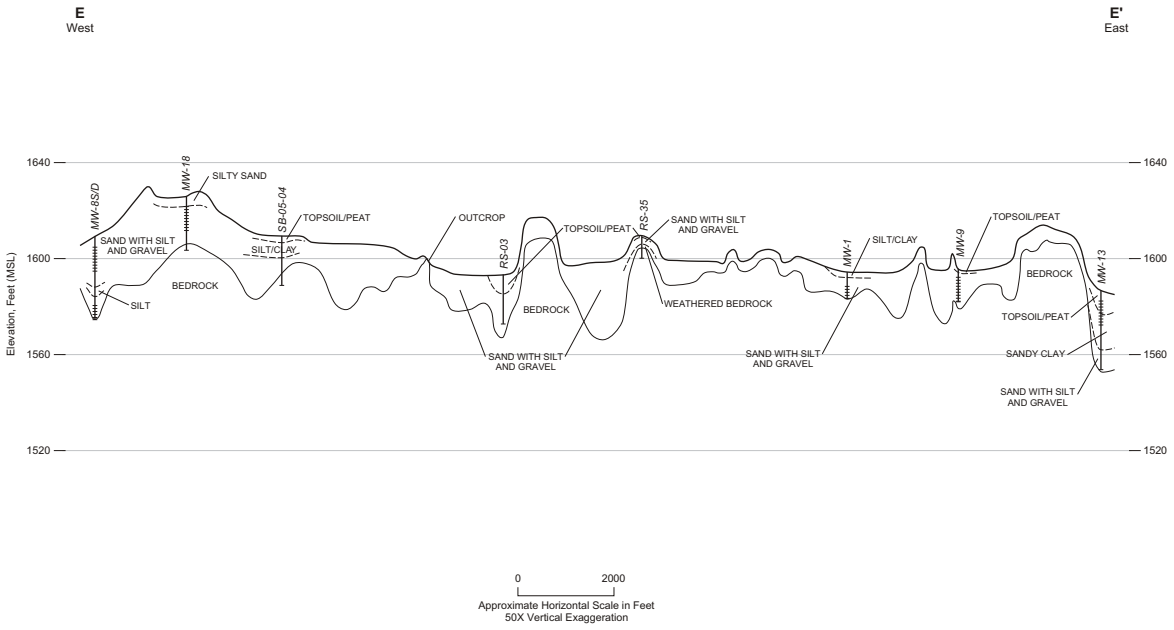
Large Figure 7

CROSS SECTION D-D'
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



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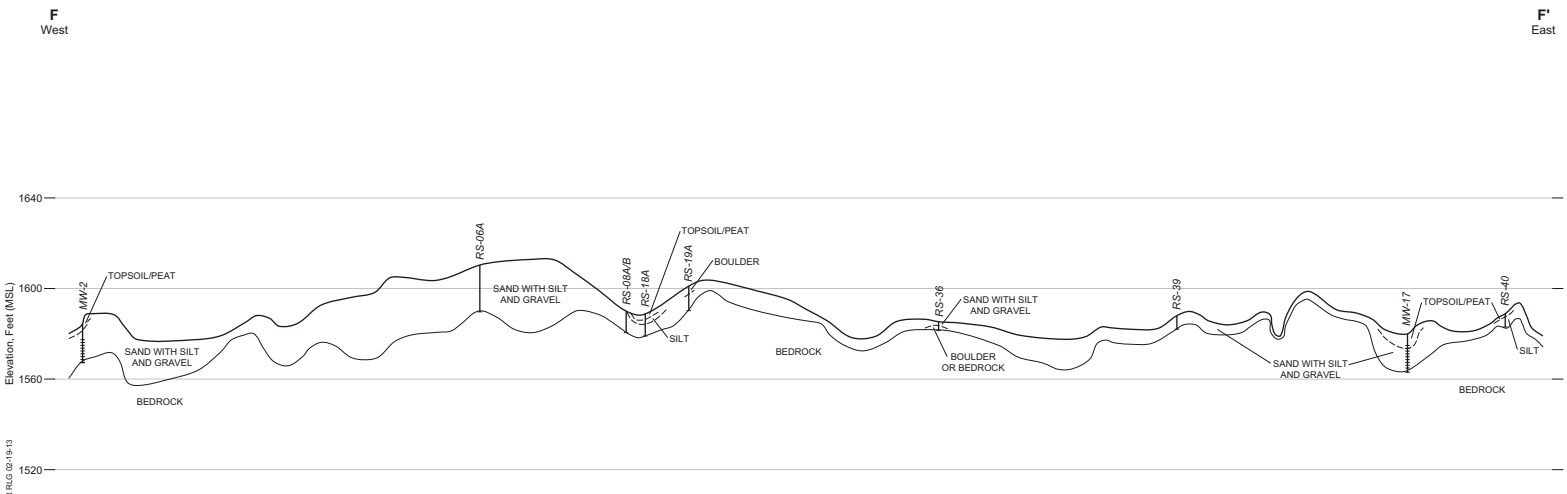
Large Figure 8

CROSS SECTION E-E'
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



0 1000

Approximate Horizontal Scale in Feet
25X Vertical Exaggeration

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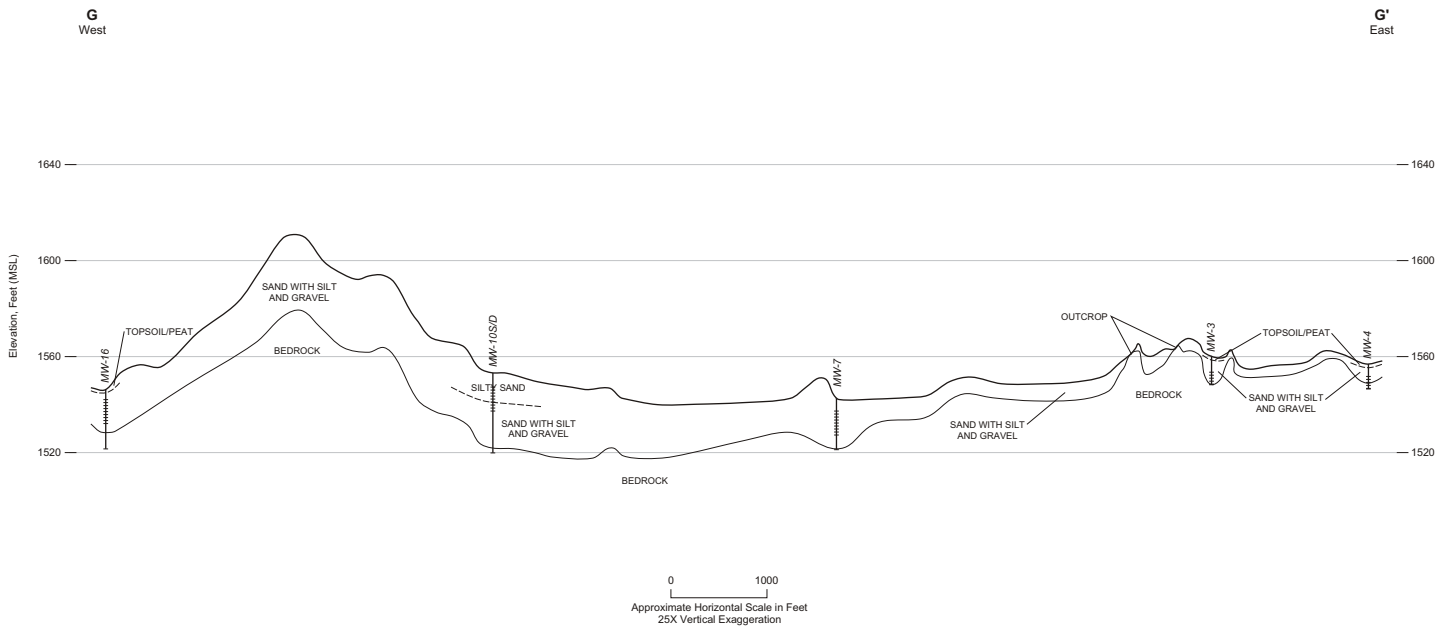
Large Figure 9

CROSS SECTION F-F'
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



Large Figure 10

CROSS SECTION G-G'
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN

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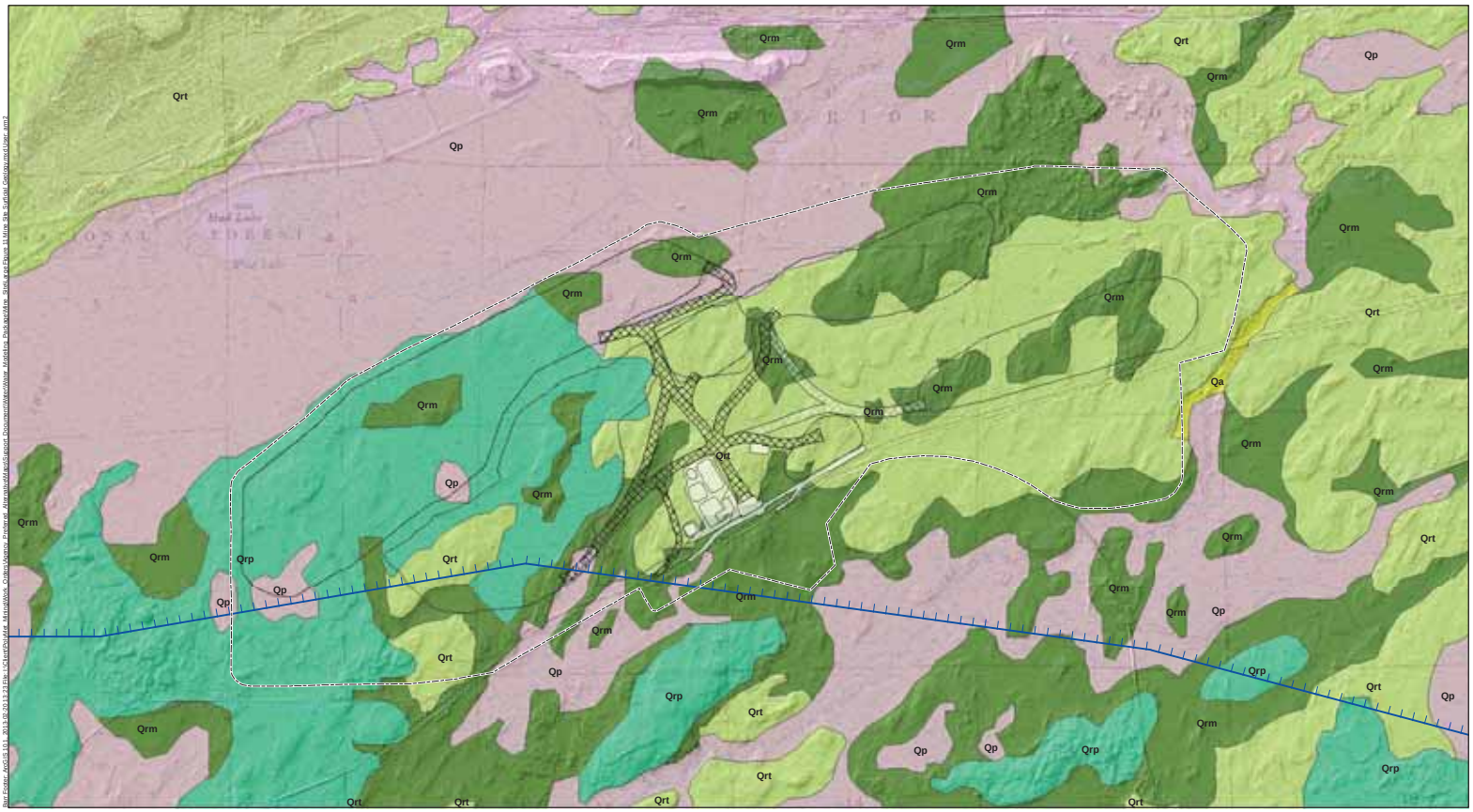


Ice Margins

Mine Site

Mine Footprint

[1] Jennings, C. and W. Reynolds. 2005. Minnesota Geological Survey Miscellaneous Map M-164, scale 1:100,000.

Quaternary Postglacial Deposits[1]

Qa — **Alluvium -** Interbedded fine-grained sand, fine-grained sandy loam, and silt loam.

Qp — **Peat -** Organic material in various stages of decomposition.

Quaternary Deposits Associated with the Rainy Lobe (Rainy Provenance)[1]

Qri — **Ice-Contact Sediment -** Sand, gravelly sand, and gravel, locally interbedded with glacial till.

Qrt — **Rainy Lobe Till -** Chiefly sandy loam matrix texture (48 to 87 percent sand, 9 to 40 perent silt, 0 to 13 percent clay); variable color; unsorted sediment with common pebbles, cobbles, and boulders.

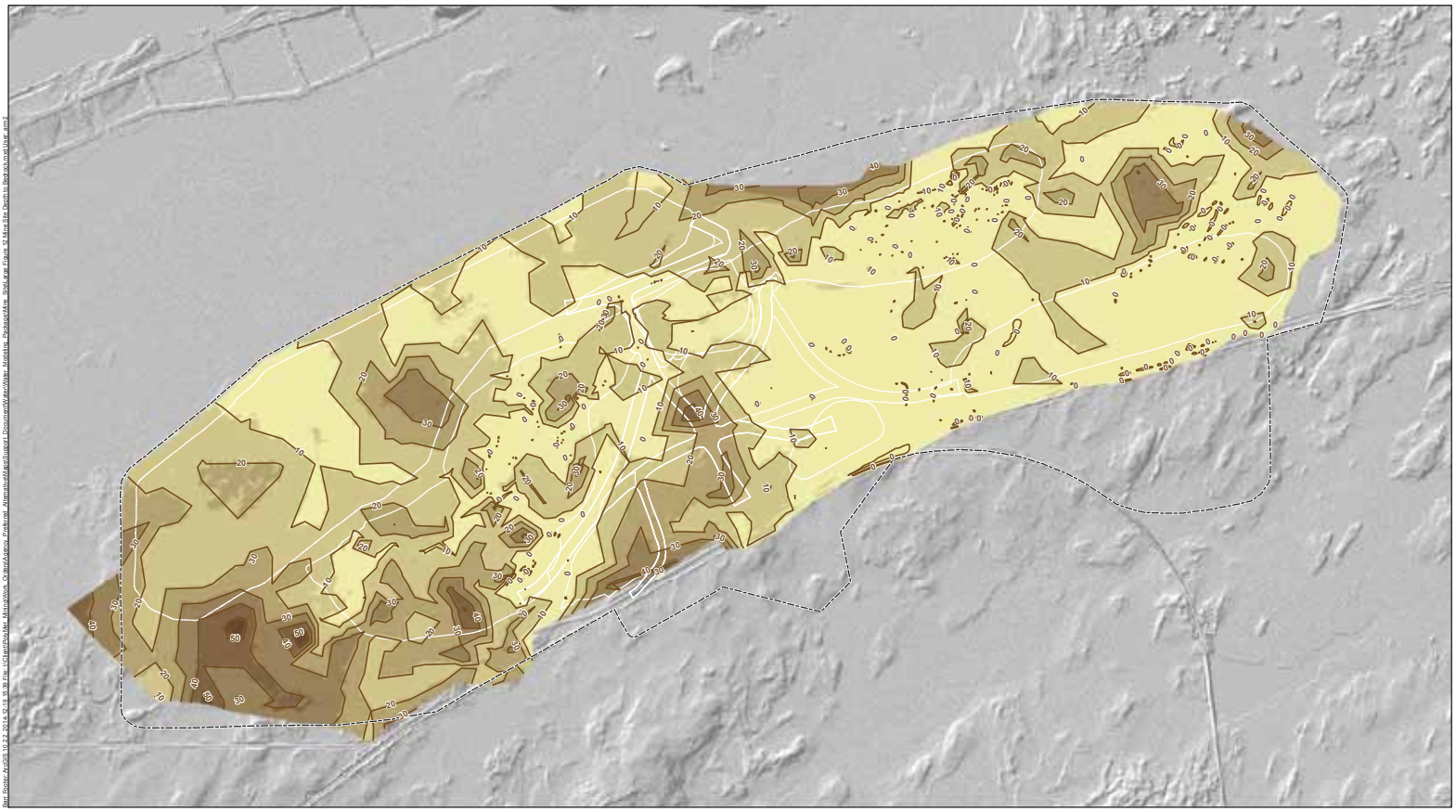
Qrm — **Till -** As above, but eroded by water, producing a less rugged surface expression and possibly concentrating coarse-grained clasts as a lag at the surface.

Qrp — **Till, Re-Sedimented Till, and Sorted Sediment -** Forms distinct but discontinuous highlands aligned with other features that mark the transition from a glacial to a proglacial setting (for example ice-contact delta fronts).

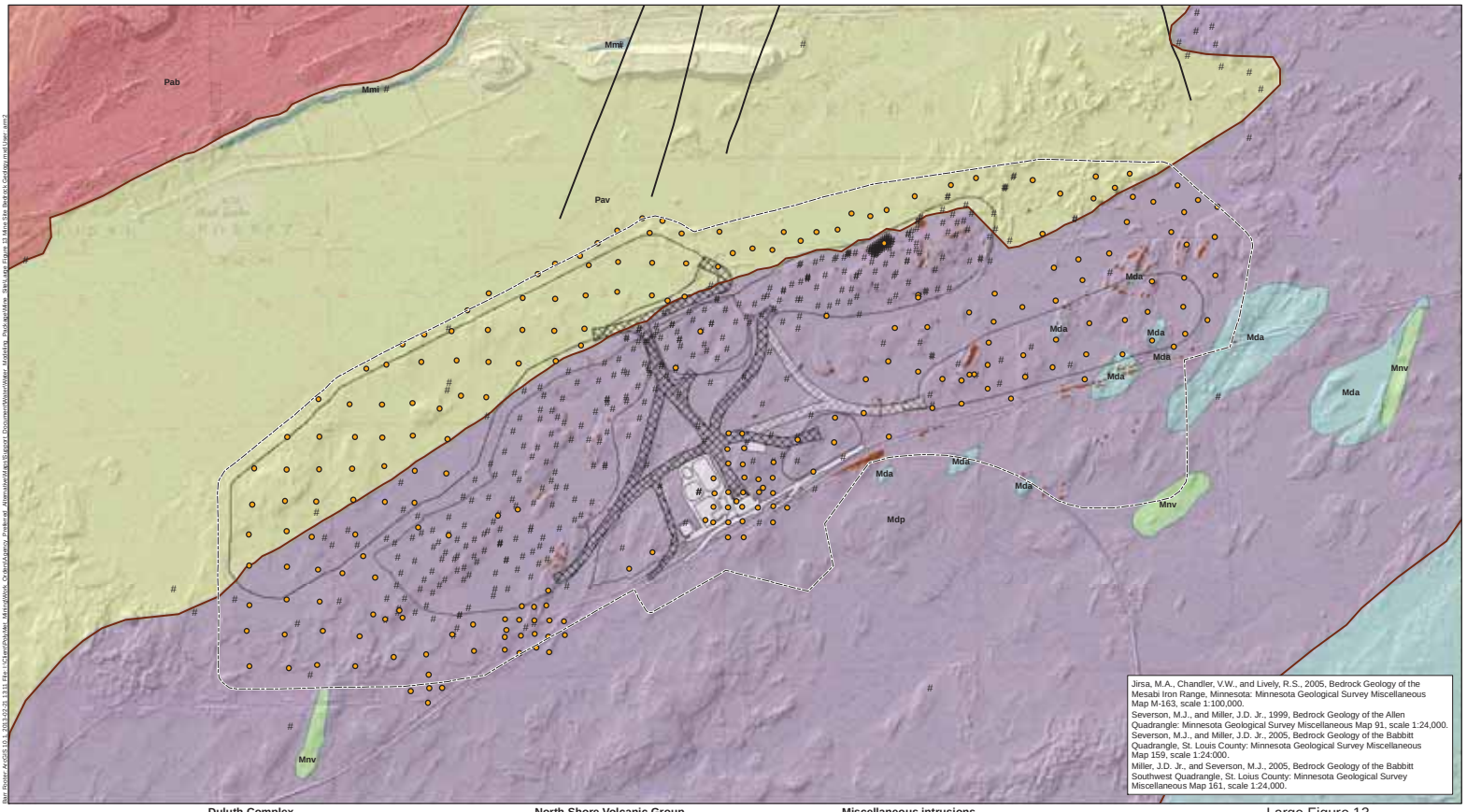
0 1,000 2,000 4,000

Feet

Large Figure 11
MINE SITE SURFICIAL GEOLOGY
JENNINGS AND REYNOLDS, 2005
NorthMet Project
Poly Met Mining, Inc.
Hoyt Lakes, MN



Large Figure 12
MINE SITE DEPTH TO BEDROCK
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



Jirsa, M.A., Chandler, V.W., and Lively, R.S., 2005, Bedrock Geology of the Mesabi Iron Range, Minnesota: Minnesota Geological Survey Miscellaneous Map M-163, scale 1:100,000.
Severson, M.J., and Miller, J.D. Jr., 1999, Bedrock Geology of the Allen Quadrangle: Minnesota Geological Survey Miscellaneous Map 91, scale 1:24,000.
Severson, M.J., and Miller, J.D. Jr., 2005, Bedrock Geology of the Babbitt Quadrangle, St. Louis County: Minnesota Geological Survey Miscellaneous Map 159, scale 1:24,000.
Miller, J.D. Jr., and Severson, M.J., 2005, Bedrock Geology of the Babbitt Southwest Quadrangle, St. Loius County: Minnesota Geological Survey Miscellaneous Map 161, scale 1:24,000.

- Mine Site
- Drill Hole
- VES point
- Geologic Contact - Approximately Located
- Fault - Approximately Located
- Bedrock Outcrop

Duluth Complex

Mdu — **Ultramafic, oxide-rich intrusions -** Coarse-grained to pegmatitic clinopyroxenite, peridotite, and dunite enriched in Fe-Ti oxide; oxide contents vary from 15 to nearly 100 percent.

Mdp — **Partridge River intrusion -** Composed predominantly of troctolite containing inclusions of volcanic honfels and anorthositic rocks; southeast-dipping; forms the base of the Duluth Complex. Typically medium- to coarse-grained, variably layered olivine-plagioclase cumulates. The basal contact zone is composed of olivine gabbro, augite troctolite, gabbronorite, and norite.

Mda — **Anorthositic series, Anorthositic series subsuite of the Duluth Complex -** Composed predominantly of medium- to coarse-grained leucocratic anorthosite, troctolite, and gabbro.

North Shore Volcanic Group

Mnv — **North Shore Volcanic Group -** A sequence of tholeiitic plateau lava flows and minor inflow sedimentary rocks, present in this area as inclusions.

Animikie Group

Pav — **Virginia Formation -** Interbedded carbonaceous shale, mudstone, siltstone, and fine-grained feldspathic graywacke.

Pab — **Biwabik Iron Formation -** Contains thick-bedded granular chert, iron silicates, magnetite, and hematite, interlayered with thin-bedded iron silicates and carbonates, magnetite, and hematite.

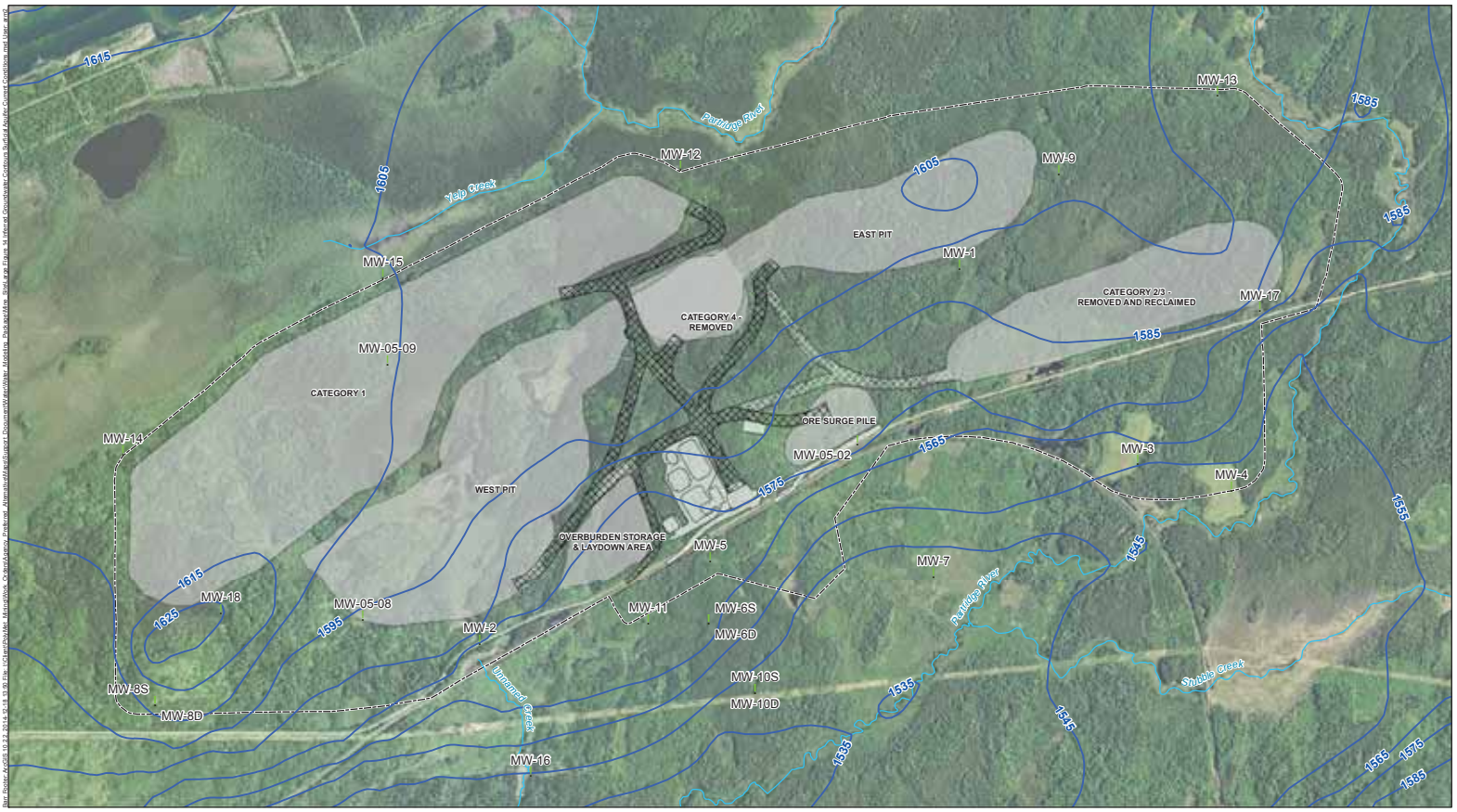
Paq — **Pokegama Quartzite -** Includes quartzite, quartz-rich siltstone, shale, and localized basal conglomerate.

Miscellaneous intrusions

Mmi — **Mafic intrusions -** Diabasic dikes and sills emplaced into Paleoproterozoic strata; typically fine- to medium-grained. Most occur at the east end of the Mesabi Range near the Duluth Complex.

0 1,000 2,000 4,000
Feet

Large Figure 13
MINE SITE BEDROCK GEOLOGY
Modified by PolyMet After Jirsa et al., 2005,
Severson and Miller, 1999 and 2005,
Miller and Severson, 2005
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



! Monitoring Well

Groundwater Elevation Contours (Ft)[1]

Streams/Rivers

Mine Site

[1]Inferred water table contours were developed using a combination of measured groundwater elevations in site monitoring wells and contours from the Mine Site MODFLOW model.

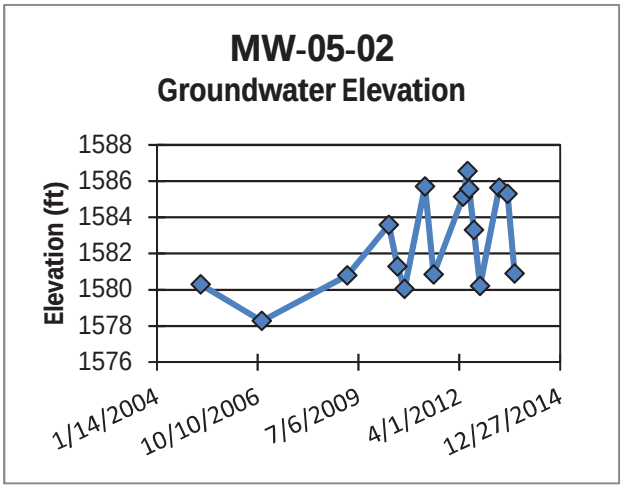
I

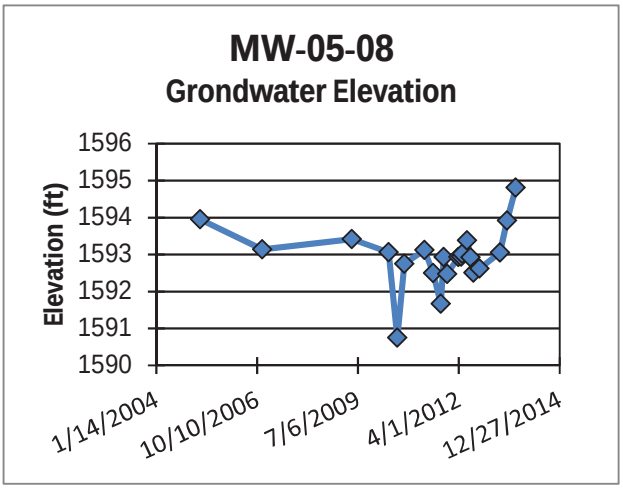
0 750 1,500 3,000

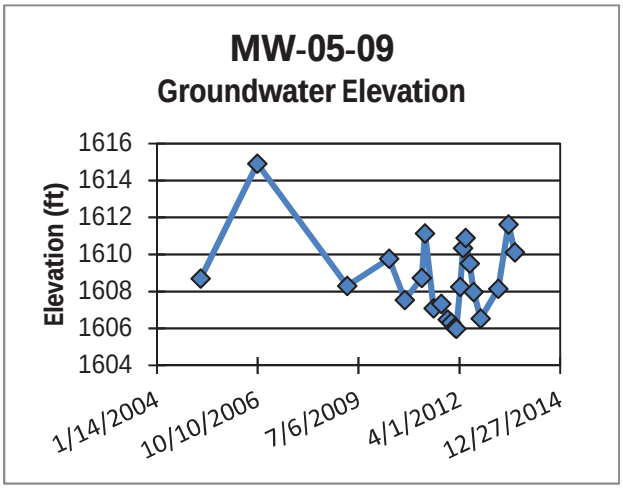
Feet

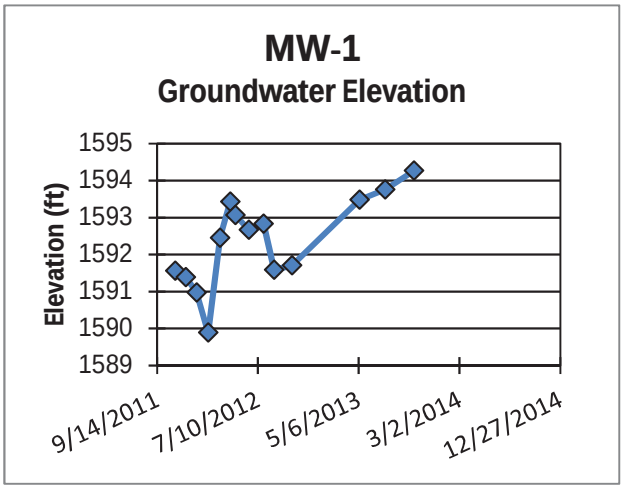
Large Figure 14
INFERRED GROUNDWATER CONTOURS
SURFICIAL AQUIFER, CURRENT CONDITIONS
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN

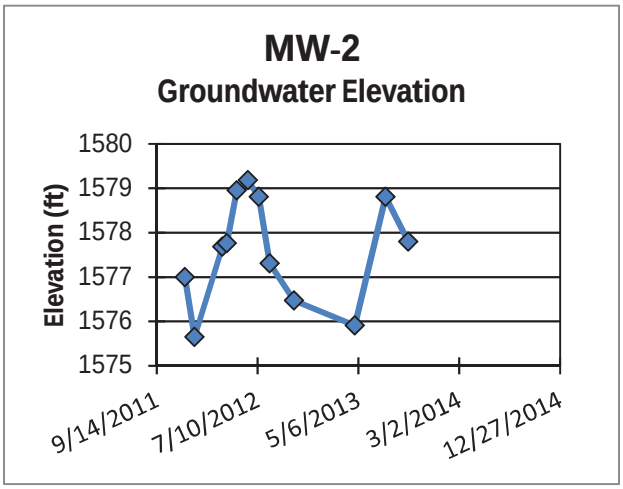
Large Figure 15
MINE SITE GROUNDWATER ELEVATION TIME SERIES
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN

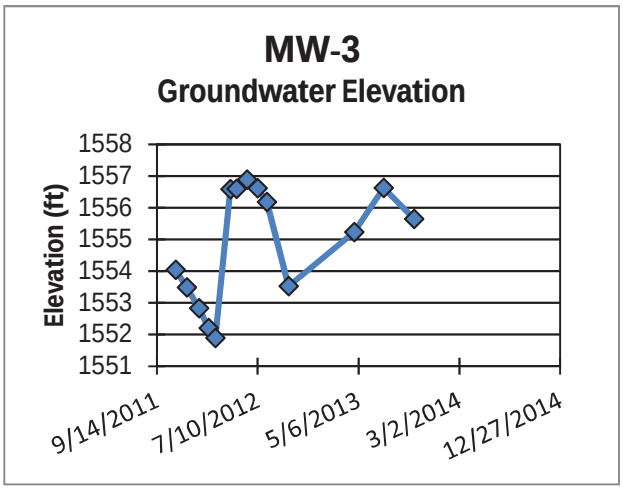




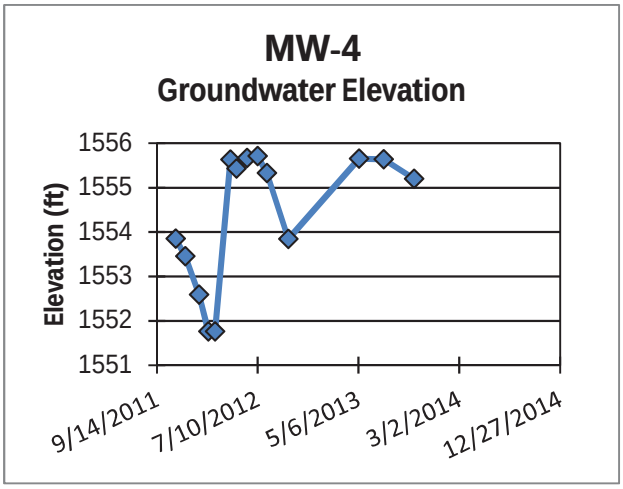


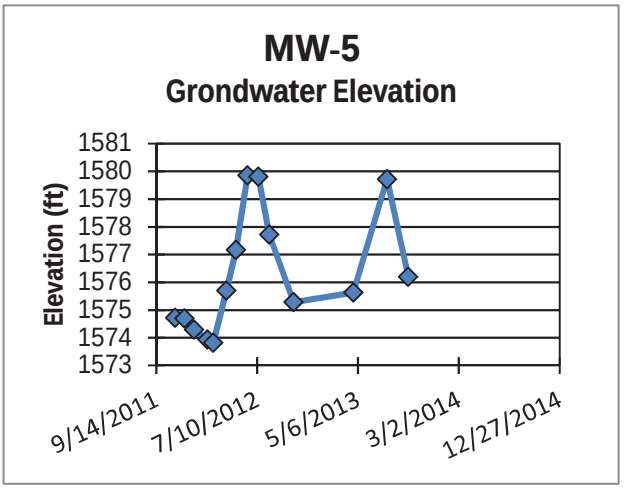


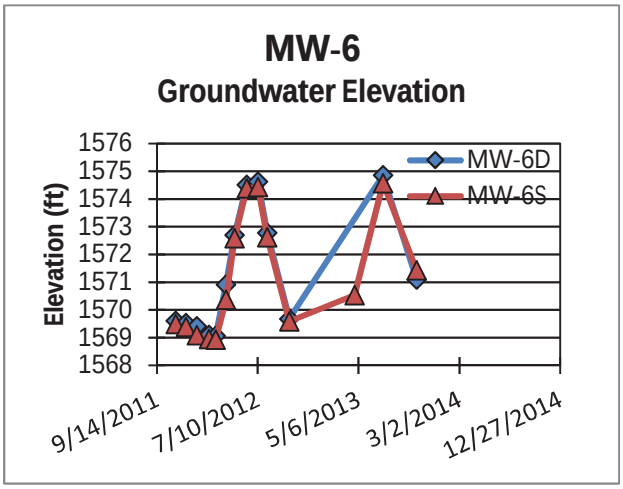


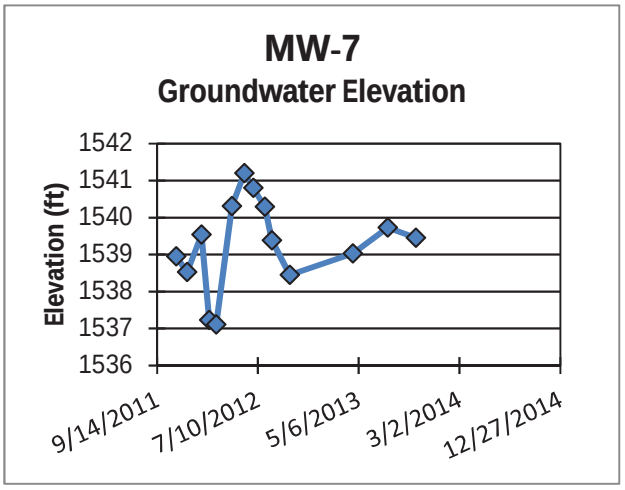


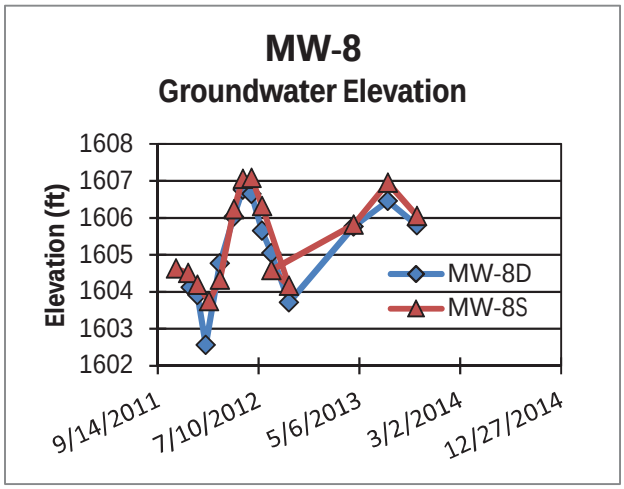
Large Figure 15
MINE SITE GROUNDWATER ELEVATION TIME SERIES
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN

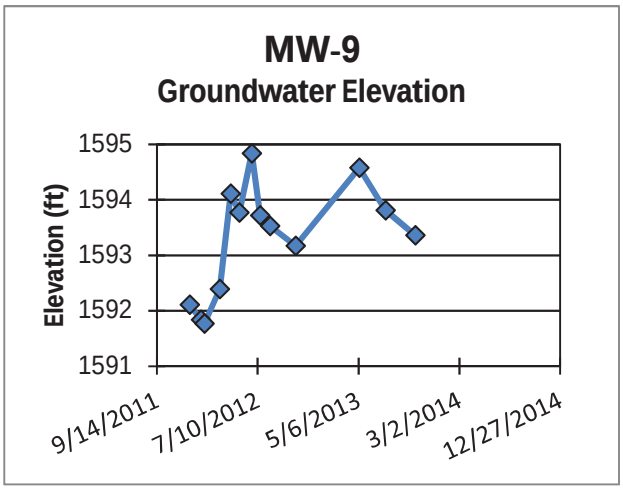




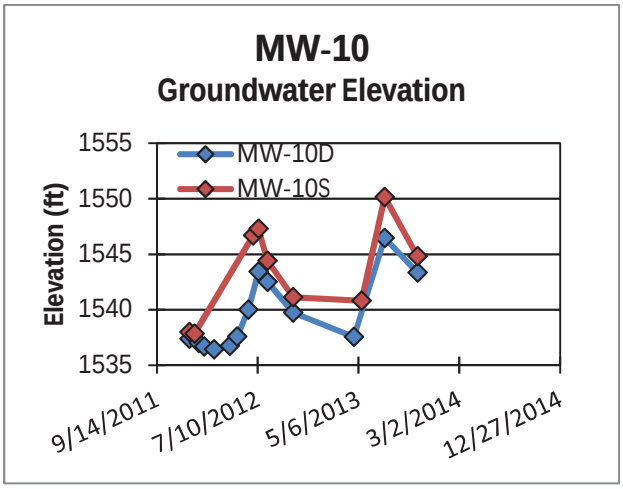


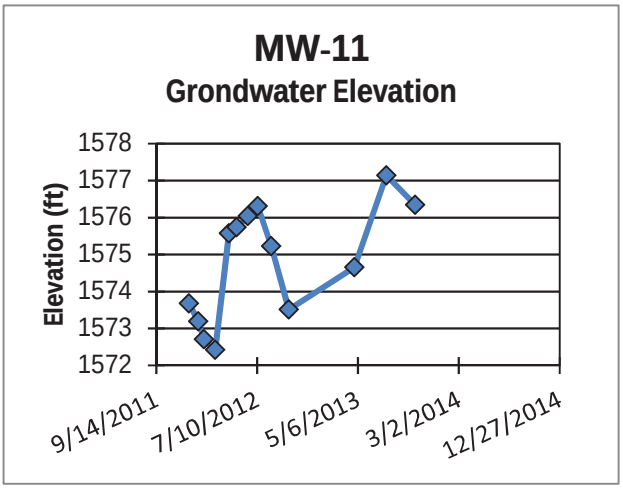


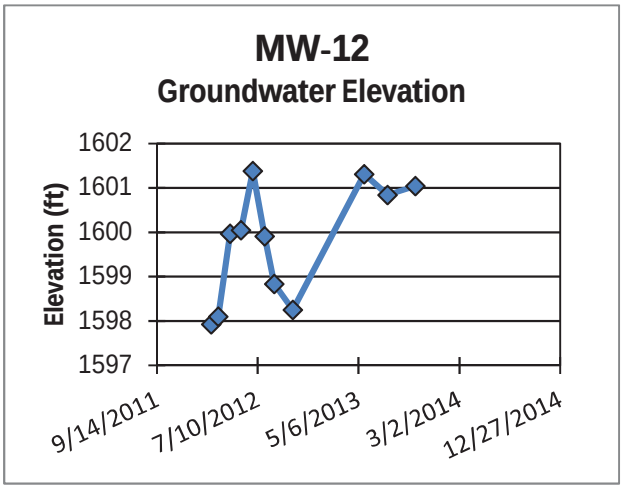


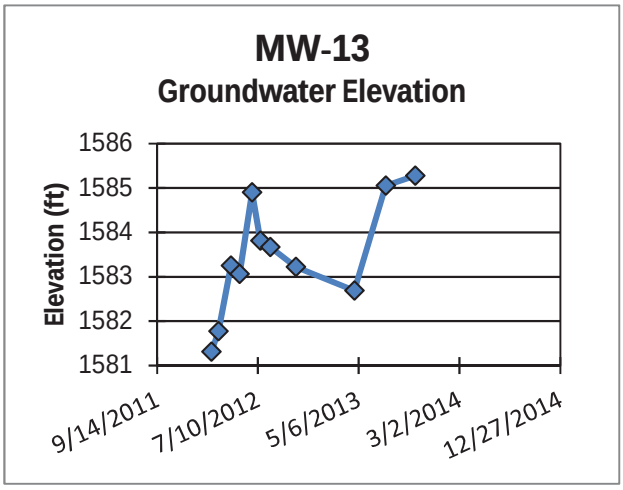


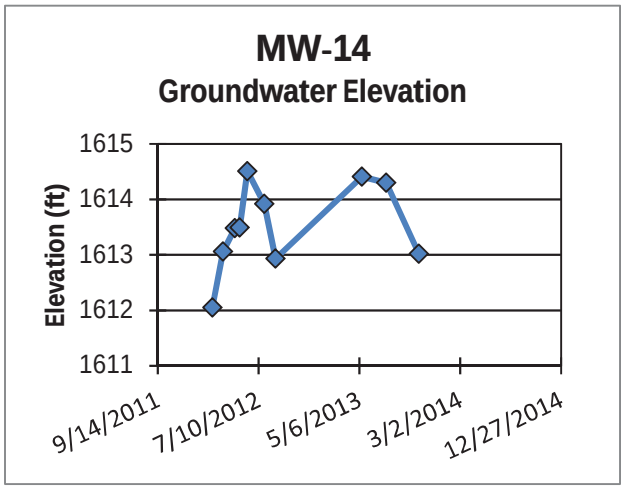
Large Figure 15
MINE SITE GROUNDWATER ELEVATION TIME SERIES
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN

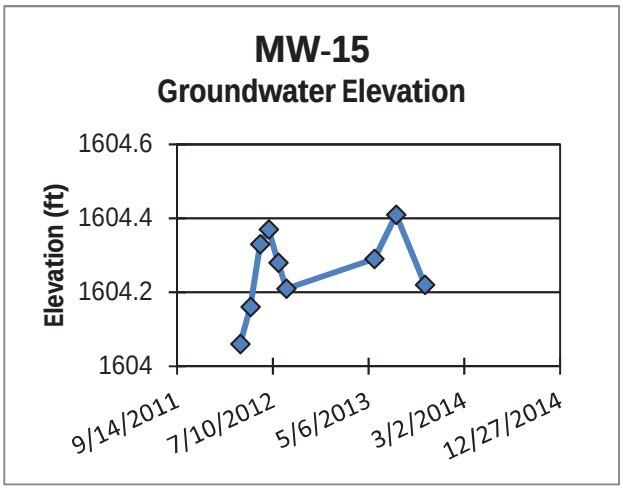




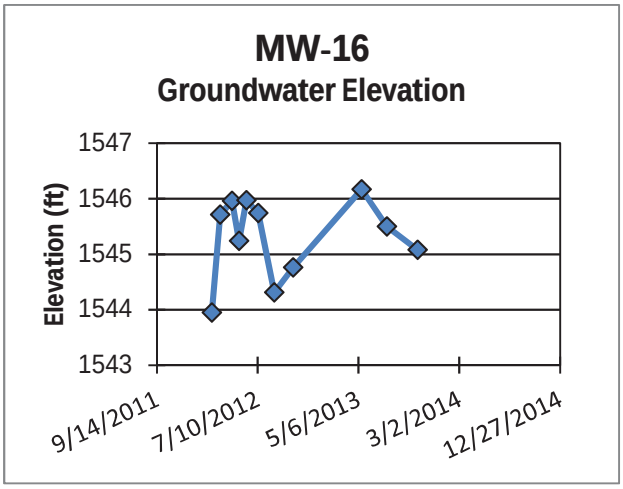


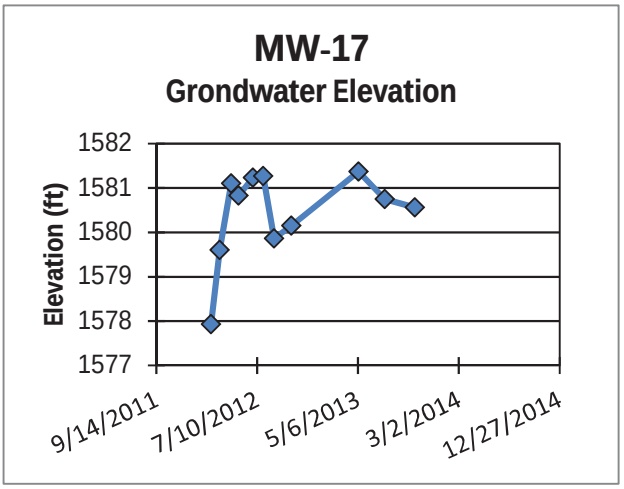


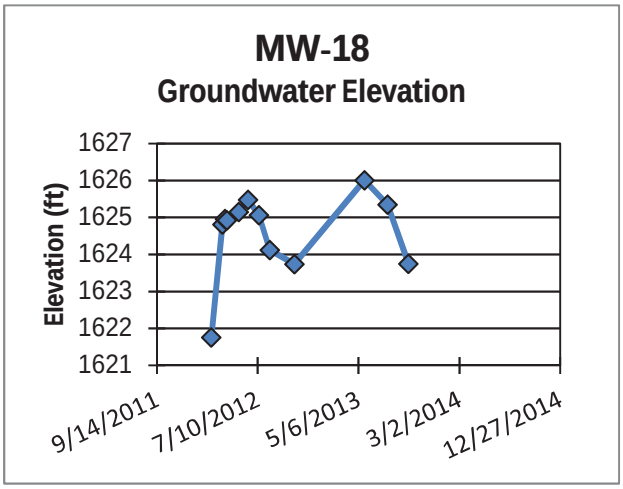




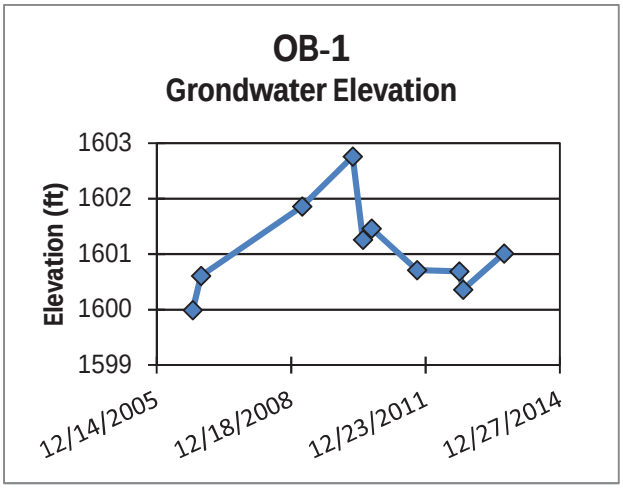
Large Figure 15
MINE SITE GROUNDWATER ELEVATION TIME SERIES
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN

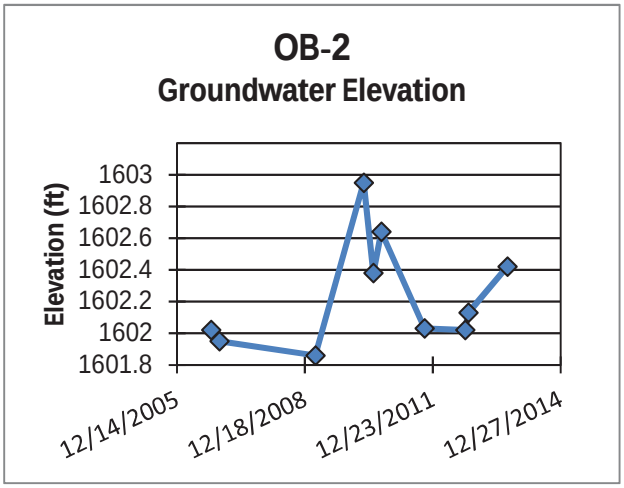


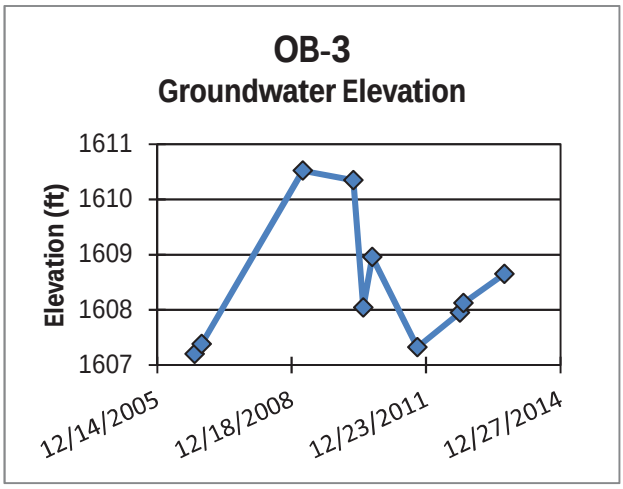


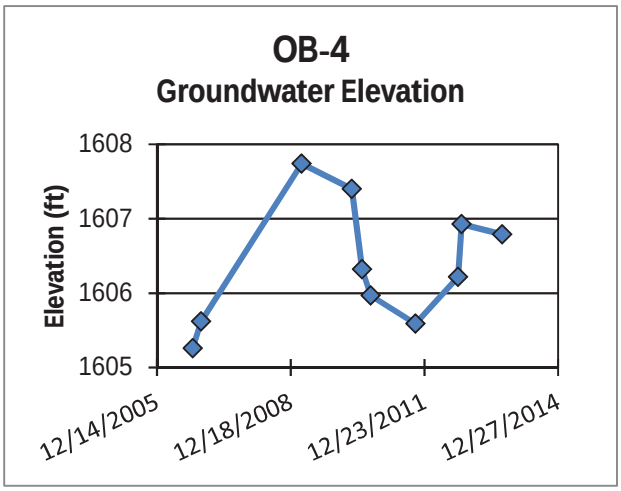


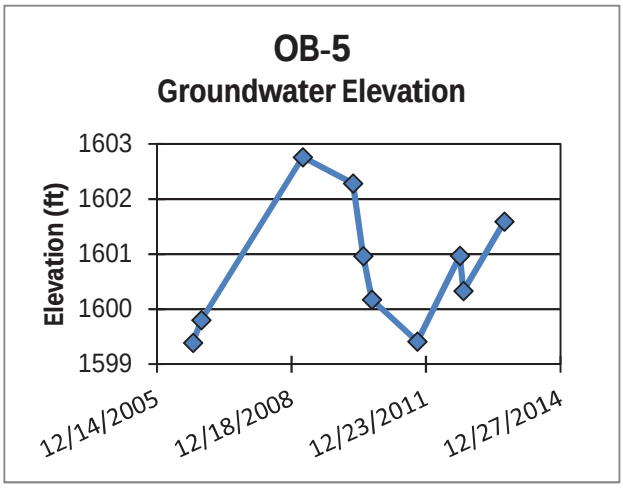
Large Figure 15
MINE SITE GROUNDWATER ELEVATION TIME SERIES
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN

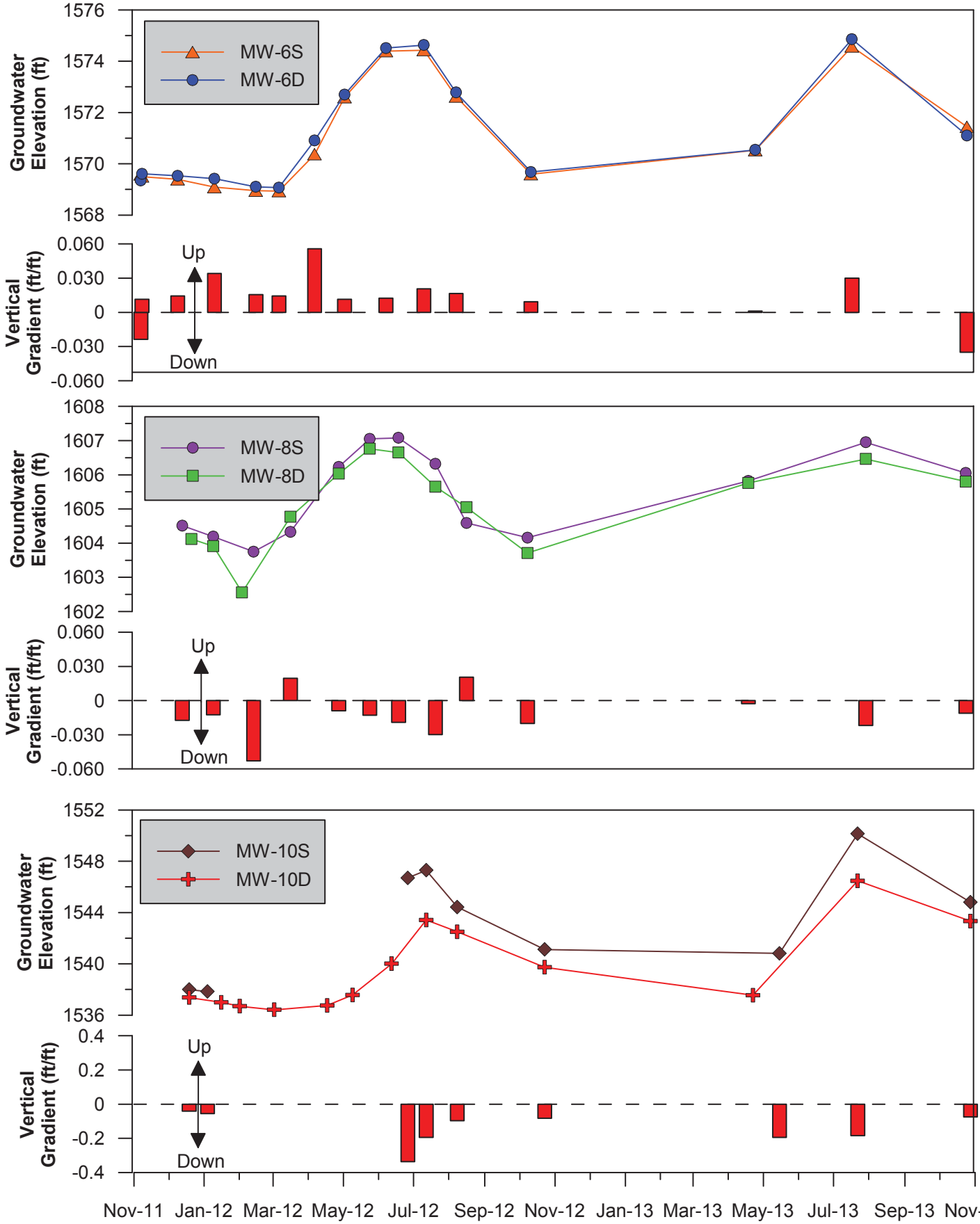












Large Figure 16
VERTICAL GROUNDWATER GRADIENTS
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN

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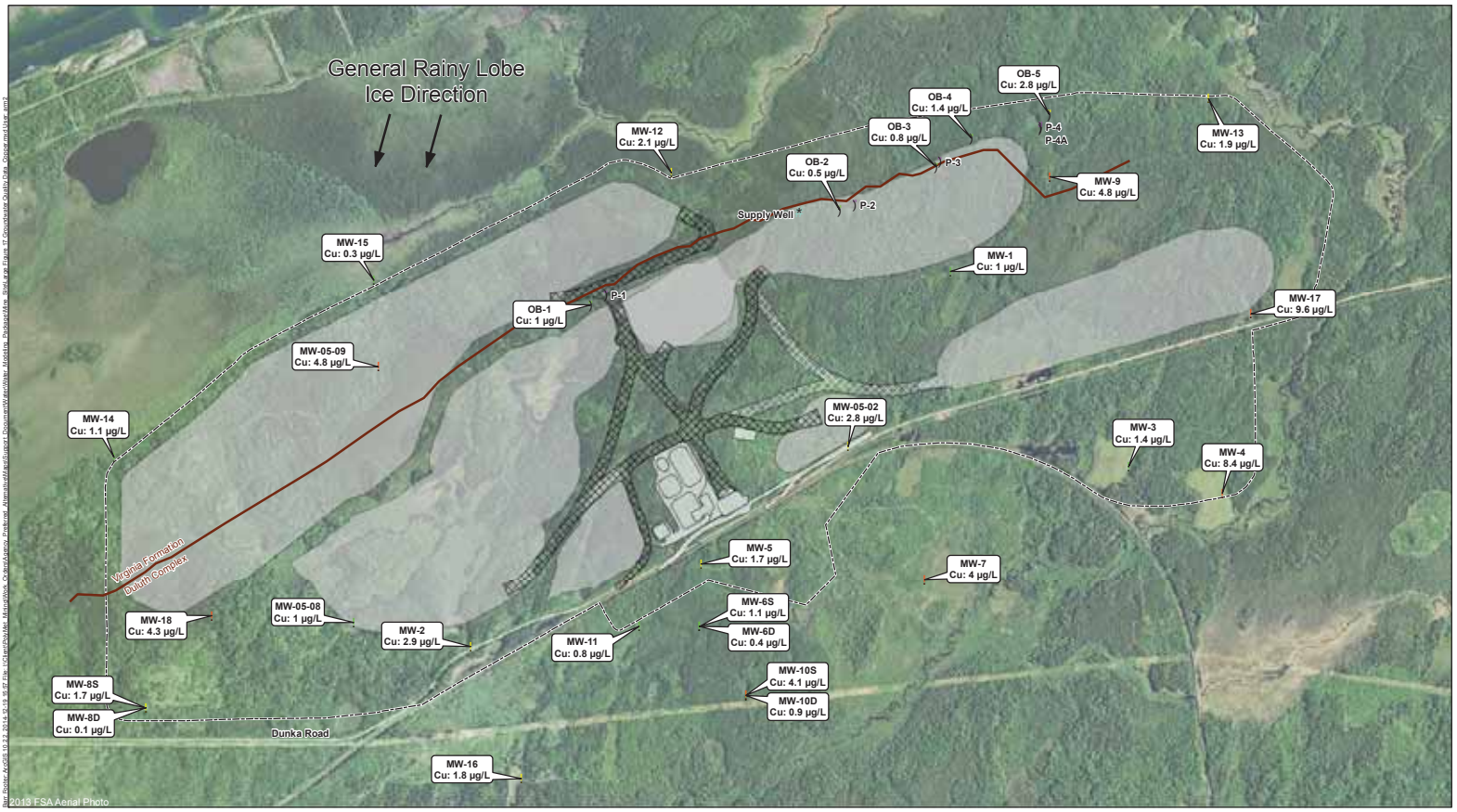


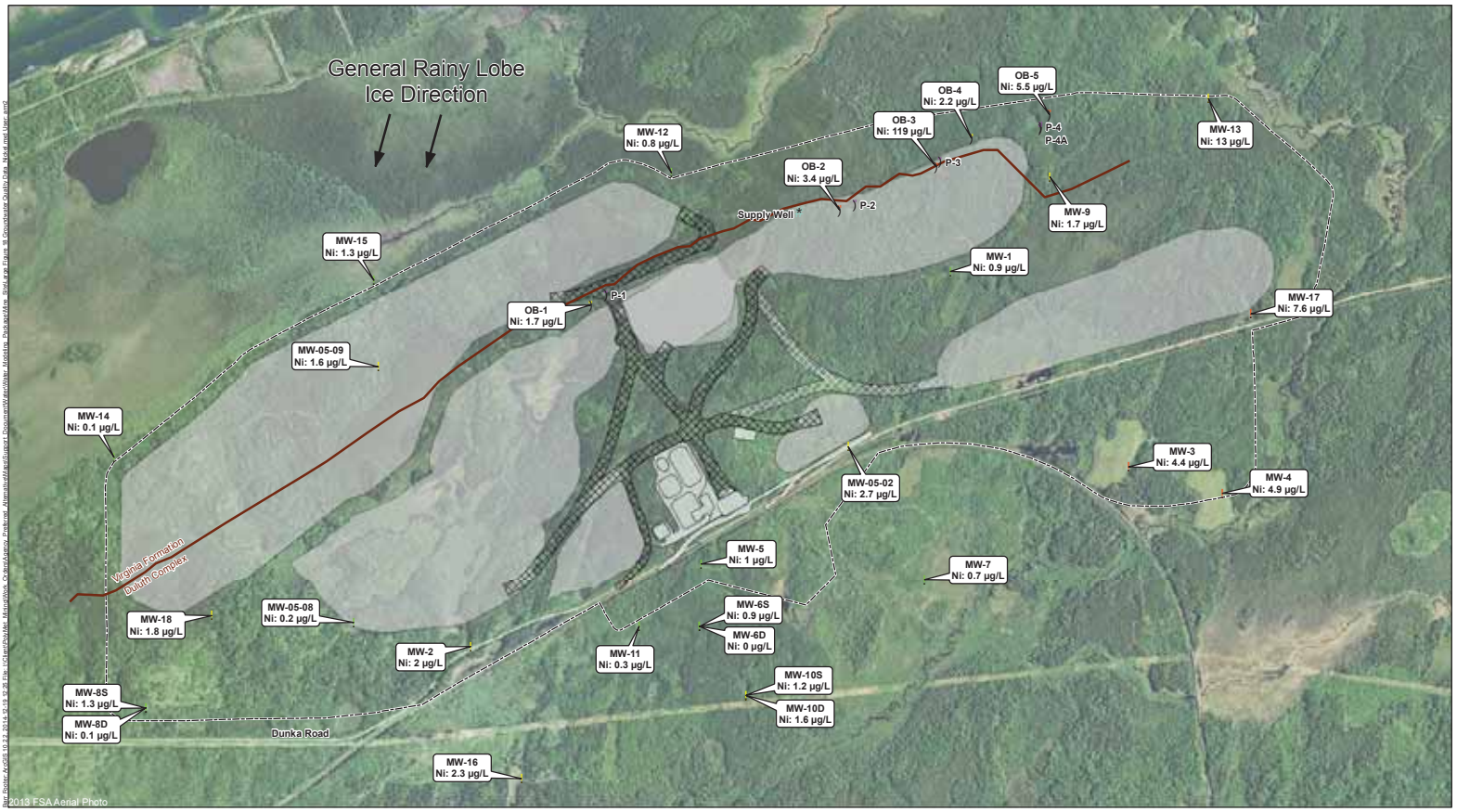
Bedrock Wells with Average Dissolved Copper in µg/L
- <1.5
- 1.5 - 3.0
- P-Series Bedrock Wells (Insufficient number of samples to determine mean concentration)

Surficial Aquifer Wells with Average Dissolved Copper in µg/L
- <1.5
- 1.5 - 3.0
- >3.0
- Unit Boundaries
- Mine Site

N

0 750 1,500 3,000
Feet

Large Figure 17
GROUNDWATER QUALITY DATA
COPPER
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



Bedrock Wells with Average Dissolved Nickel in µg/L
- 1.5 - 3.0
- >3.0
- P-Series Bedrock Wells (Insufficient number of samples to determine mean concentration)

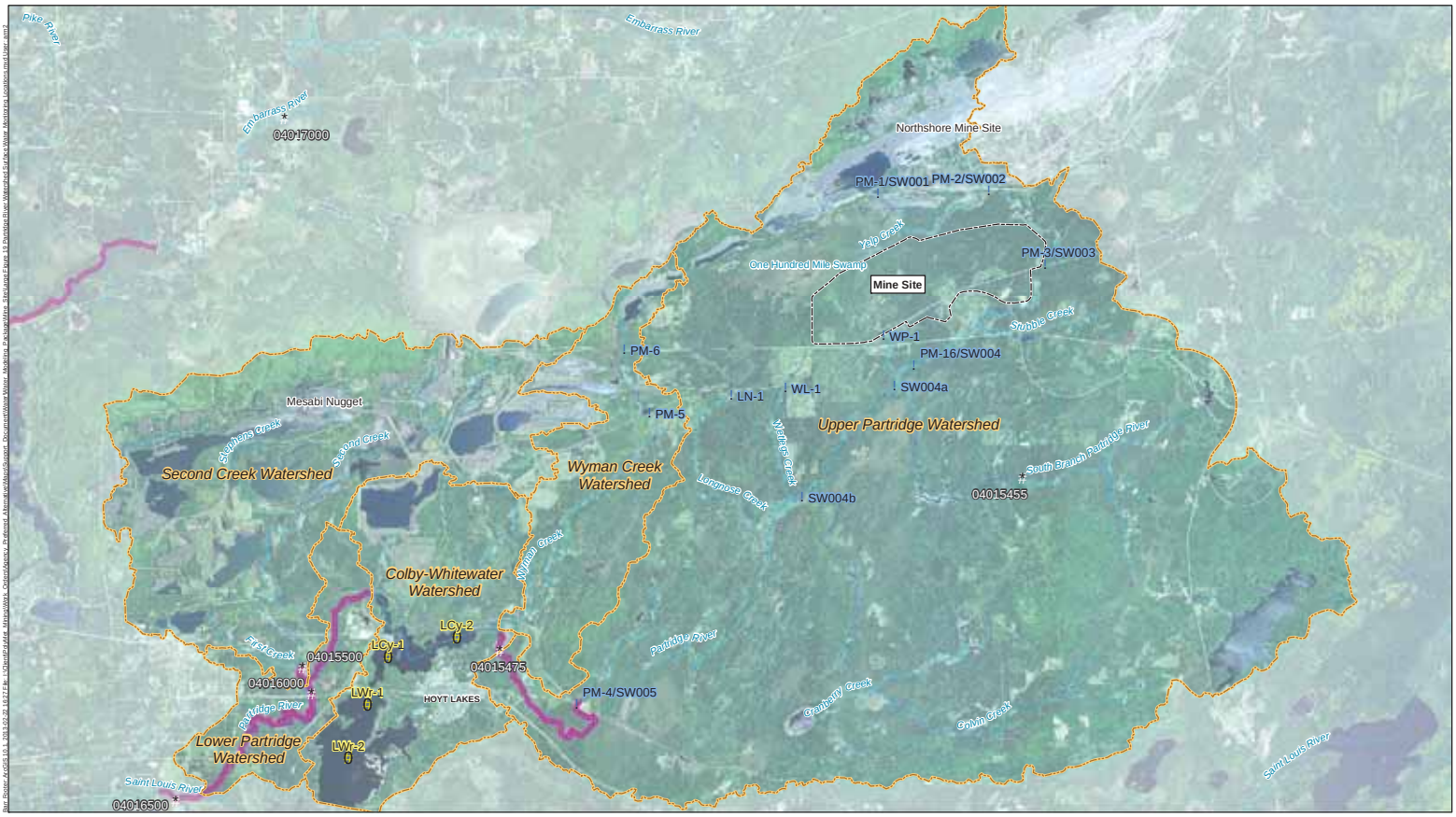
Surficial Aquifer Wells with Average Dissolved Nickel in µg/L
- <1.5
- 1.5 - 3.0
- >3.0

Unit Boundaries

Mine Site

0 750 1,500 3,000
Feet

Large Figure 18
GROUNDWATER QUALITY DATA
NICKEL
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



0 Surface Water Monitoring Locations - Colby Lake, Whitewater Reservoir

! Surface Water Monitoring Locations - Stream

* USGS Stations

Rivers and Streams

MPCA Recommendation - Wild Rice Production

Partridge River Watershed

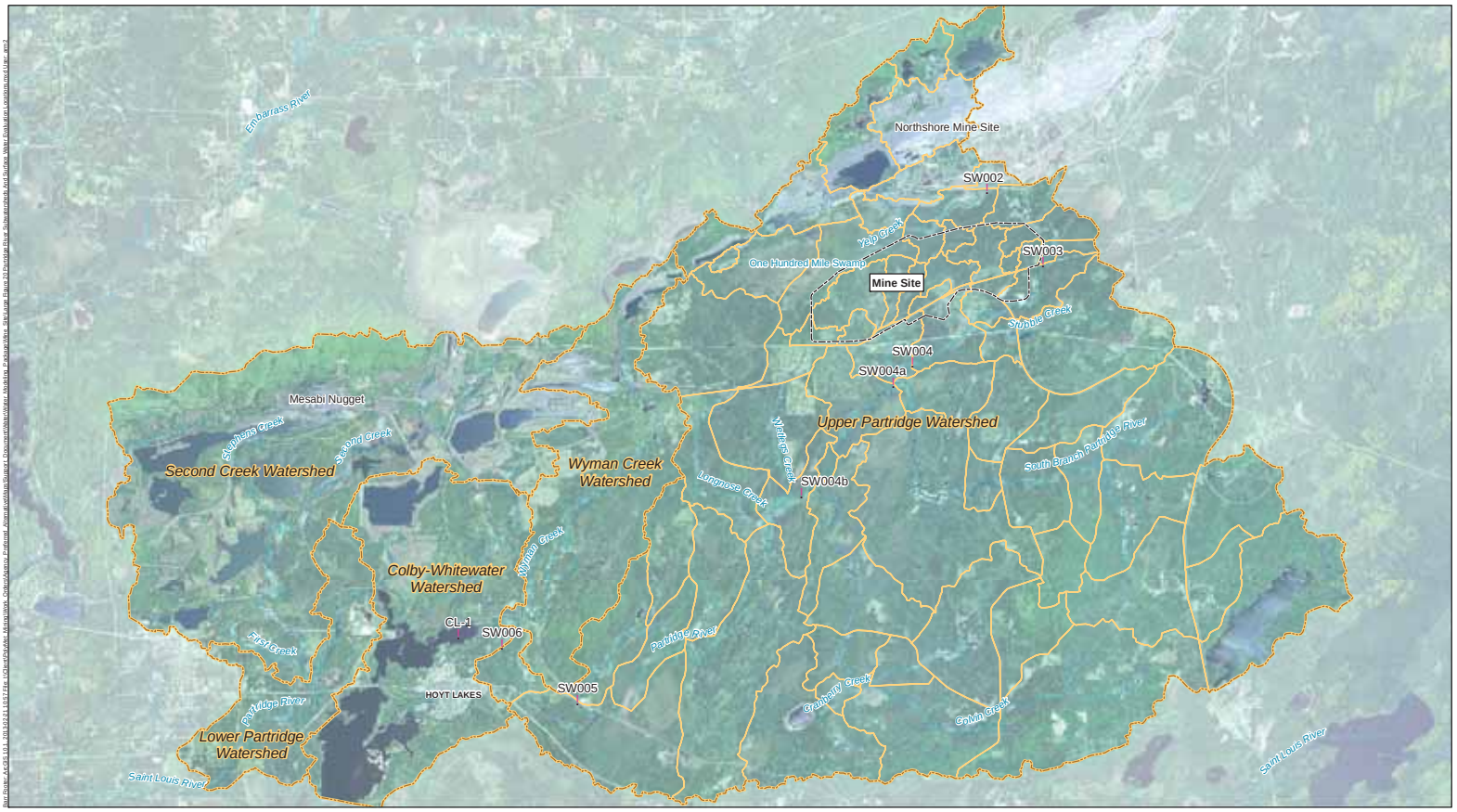
Mine Site

I

0 0.75 1.5 3

Miles

Large Figure 19
PARTRIDGE RIVER WATERSHED
SURFACE WATER MONITORING LOCATIONS
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



! Model Evaluation Locations

Partridge River Watershed

Upper Partridge River Subwatersheds

Mine Site

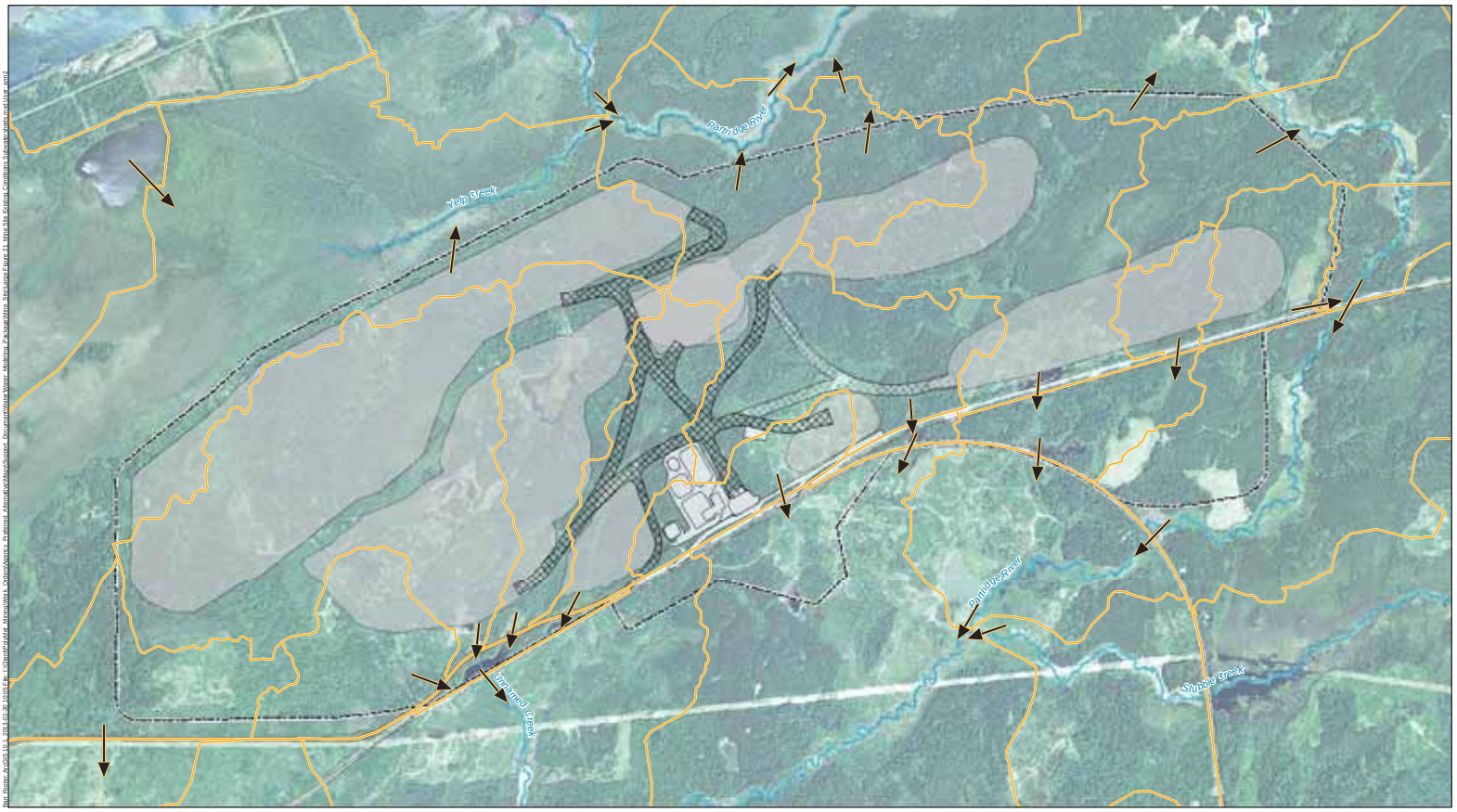
Streams/Rivers

N

0 0.75 1.5 3

Miles

Large Figure 20
PARTRIDGE RIVER SUBWATERSHEDS AND
SURFACE WATER EVALUATION LOCATIONS
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



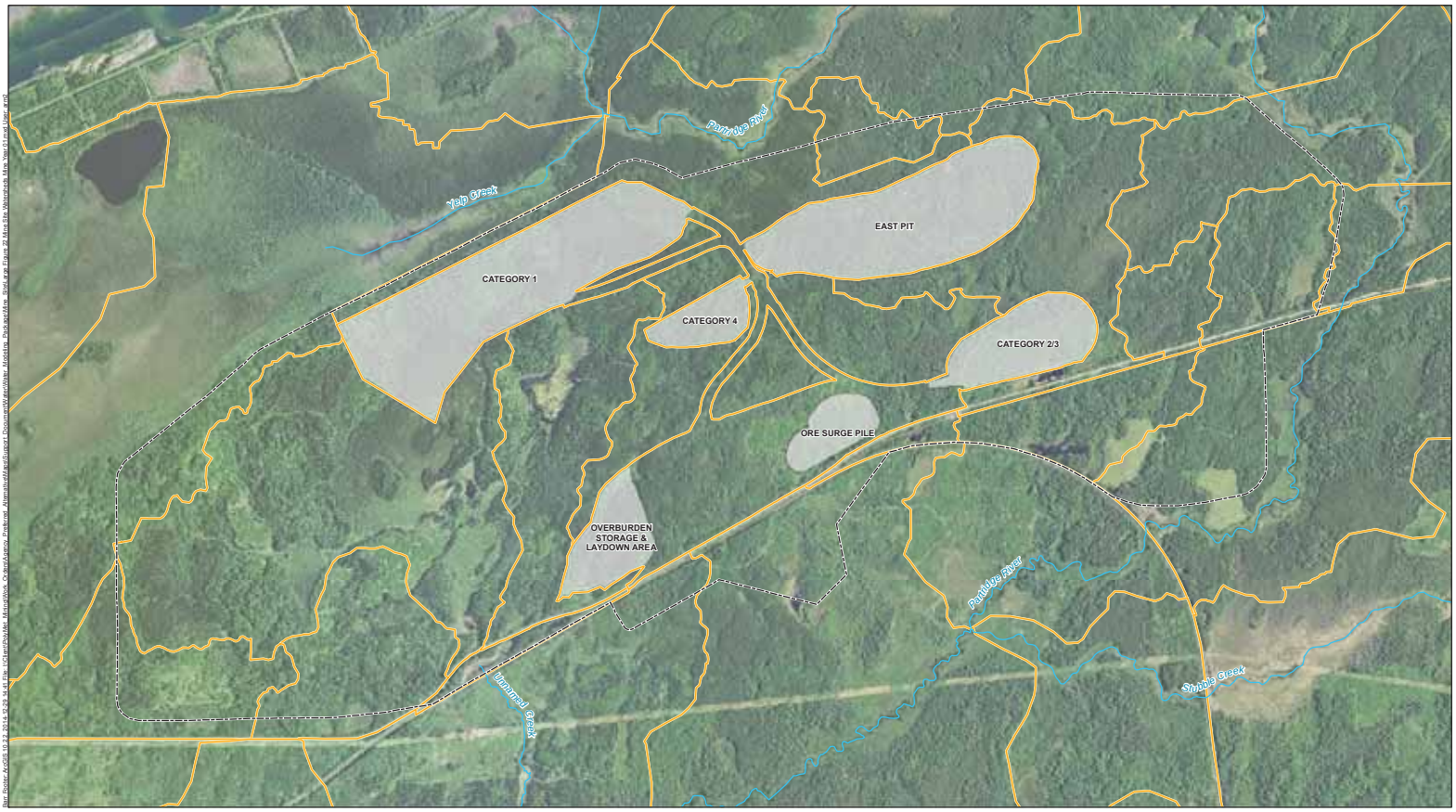
- Drainage Flow Direction
- Rivers and Streams
- Existing Subwatersheds
- Mine Site
- Mine Footprint - Maximum Extent
- Haul Roads

N

0 750 1,500 3,000

Feet

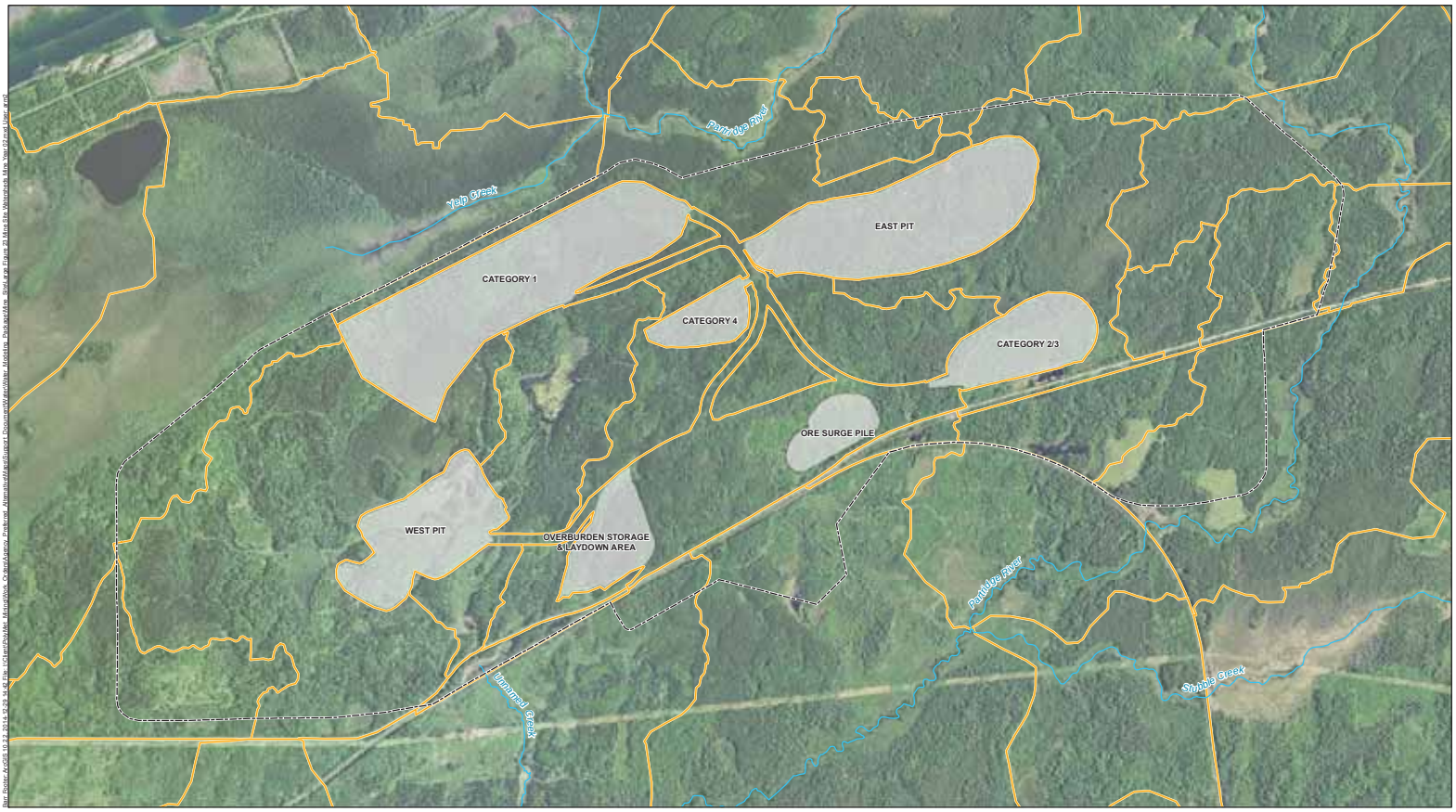
Large Figure 21
MINE SITE EXISTING CONDITIONS
SUBWATERSHEDS
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



Subwatersheds
Mine Site
Mine Pits & Stockpiles
Streams/Rivers

0 750 1,500 3,000
Feet

Large Figure 22
MINE SITE SUBWATERSHEDS -
MINE YEAR 1
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN

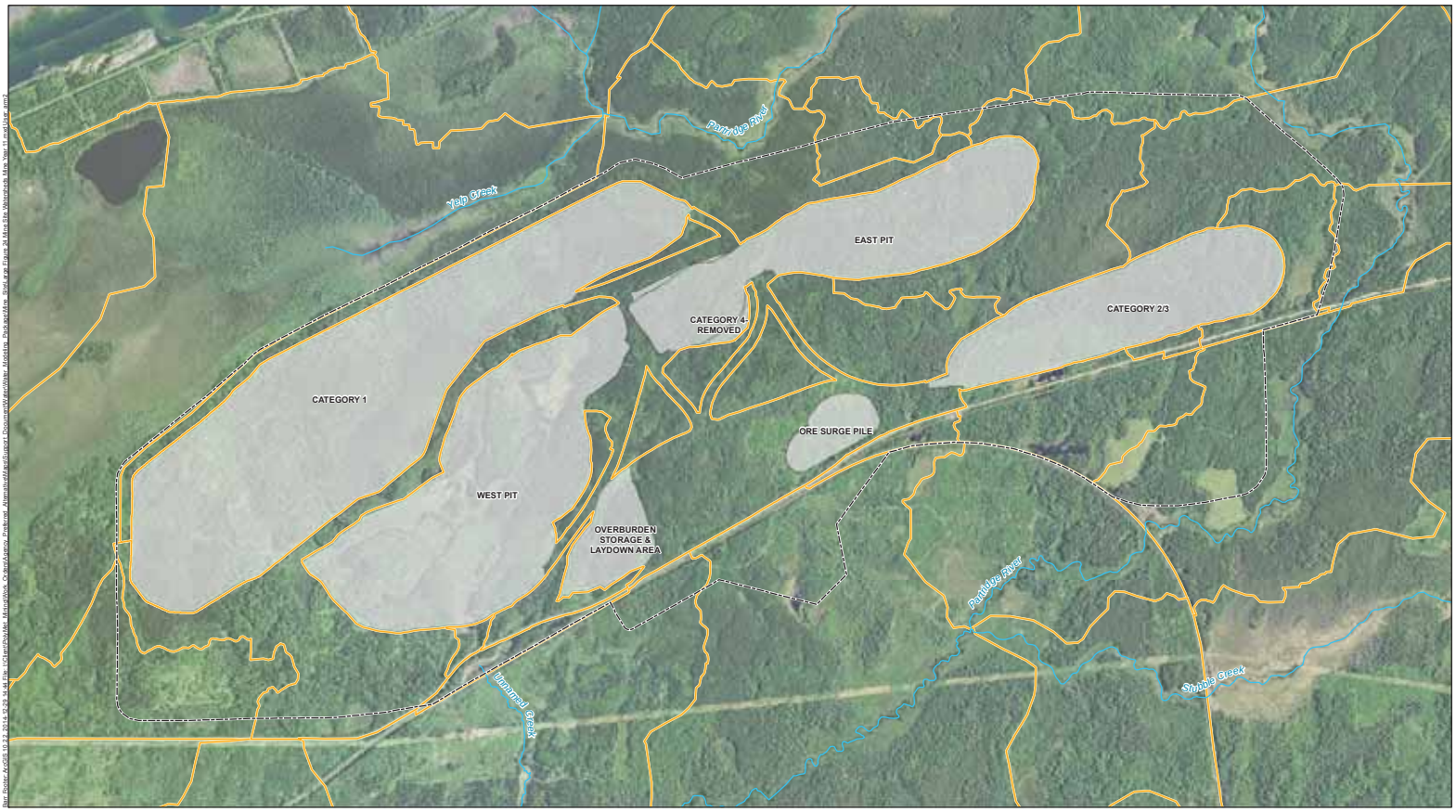


Subwatersheds
Mine Site
Mine Pits & Stockpiles
Streams/Rivers

N

0 750 1,500 3,000
Feet

Large Figure 23
MINE SITE SUBWATERSHEDS -
MINE YEAR 2
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN

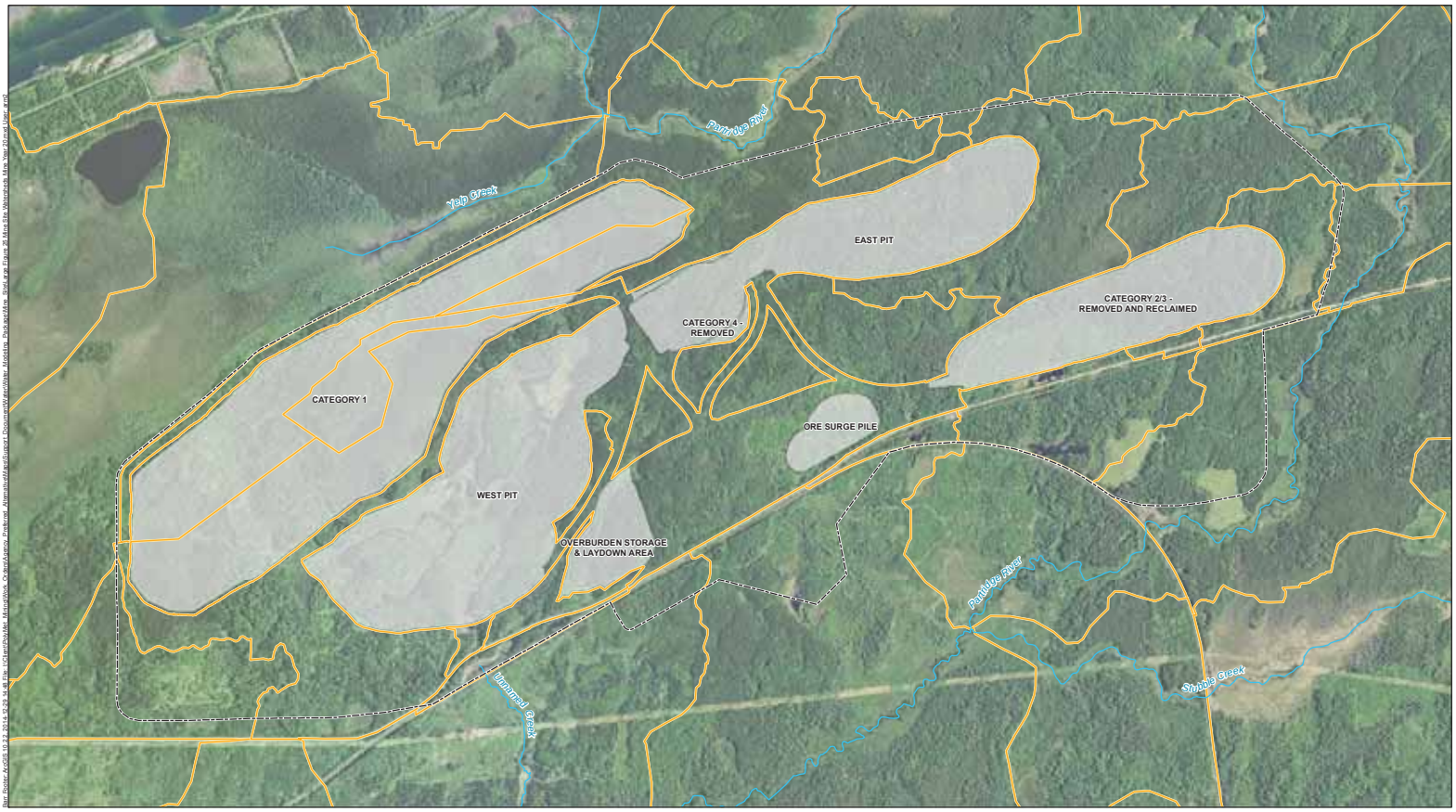


Subwatersheds
Mine Site
Mine Pits & Stockpiles
Streams/Rivers

N

0 750 1,500 3,000
Feet

Large Figure 24
MINE SITE SUBWATERSHEDS -
MINE YEAR 11
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN

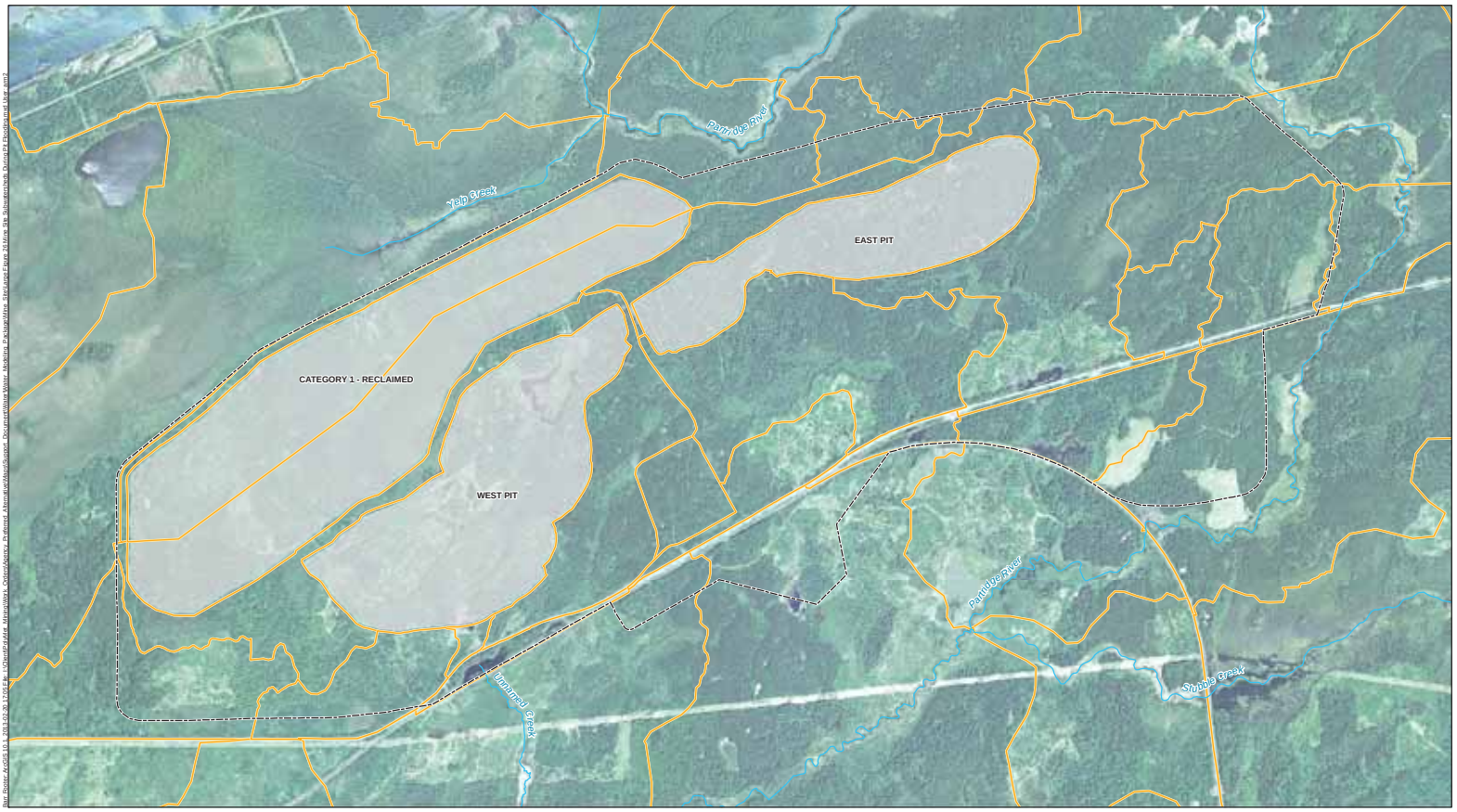


Subwatersheds
Mine Site
Mine Pits & Stockpiles
Streams/Rivers

N

0 750 1,500 3,000
Feet

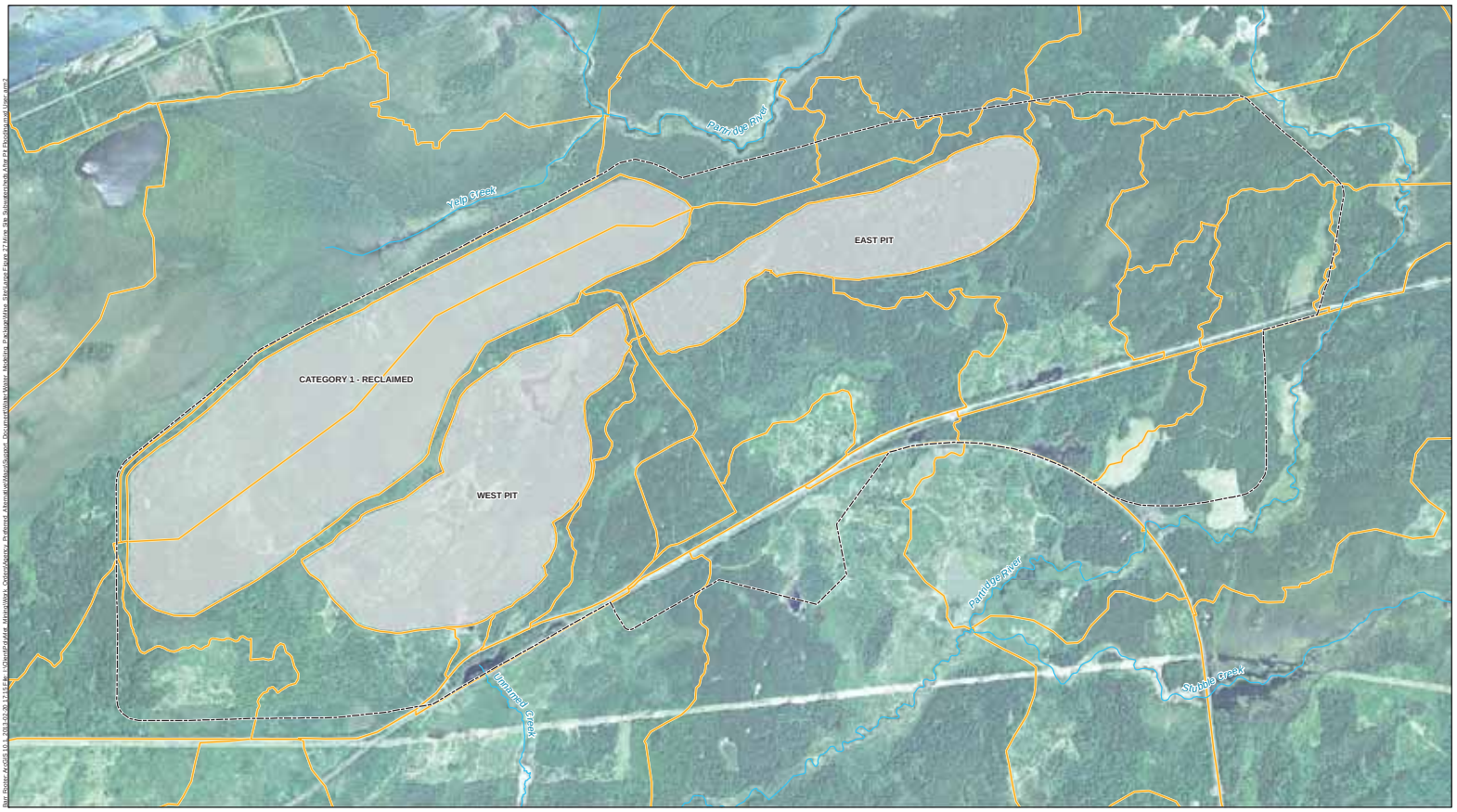
Large Figure 25
MINE SITE SUBWATERSHEDS -
MINE YEAR 20
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



Subwatersheds
Mine Site
Mine Pits & Stockpiles
Streams/Rivers

0 750 1,500 3,000
Feet

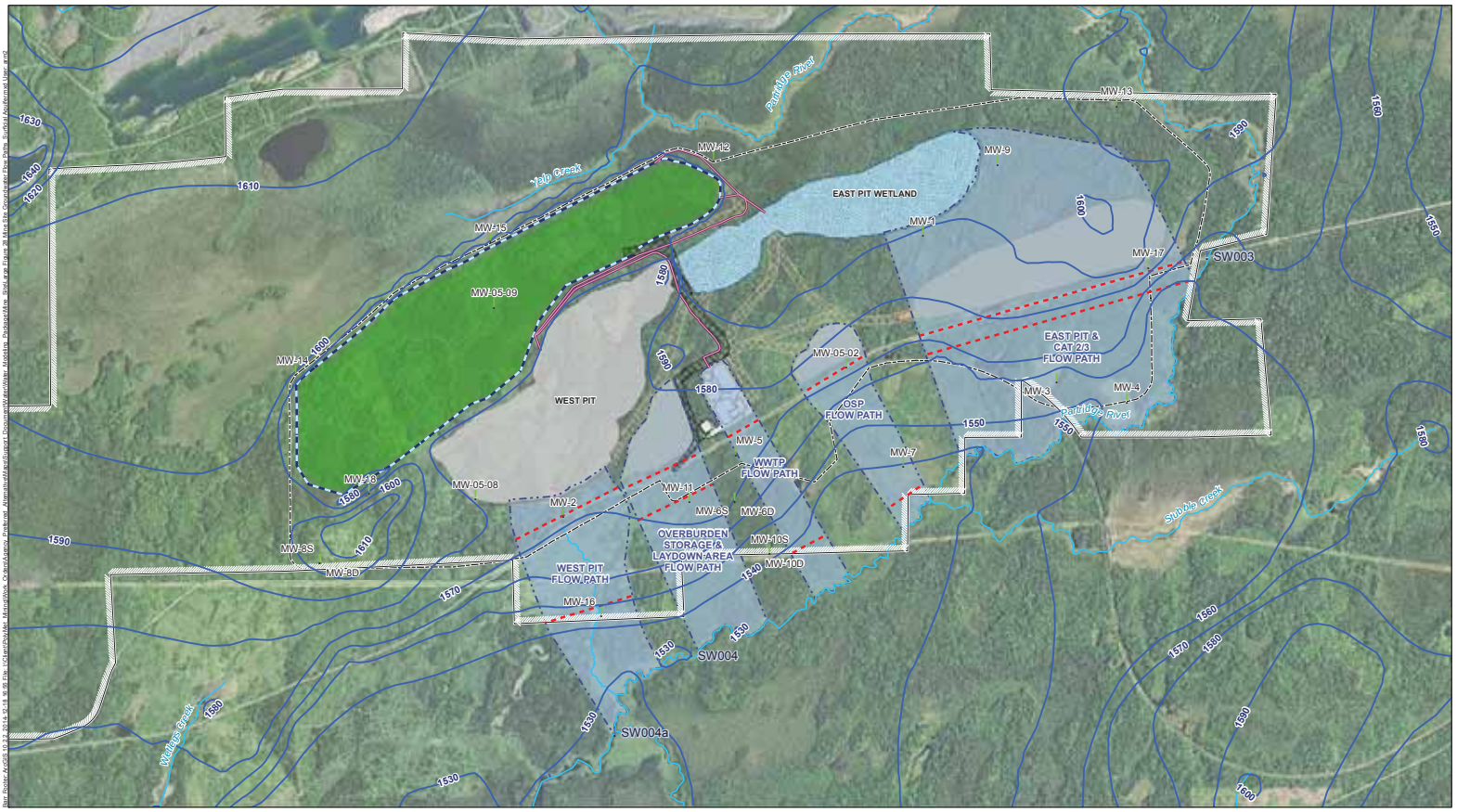
Large Figure 26
MINE SITE SUBWATERSHEDS
DURING PIT FLOODING
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



Subwatersheds
Mine Site
Mine Pits & Stockpiles
Streams/Rivers

0 750 1,500 3,000
Feet

Large Figure 27
MINE SITE SUBWATERSHEDS
AFTER PIT FLOODING
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



Mine Features
- West Pit
- East Pit Wetland
- Reclaimed Stockpile
- Removed and Reclaimed Stockpile
- Haul Roads
- Reclaimed Haul Roads

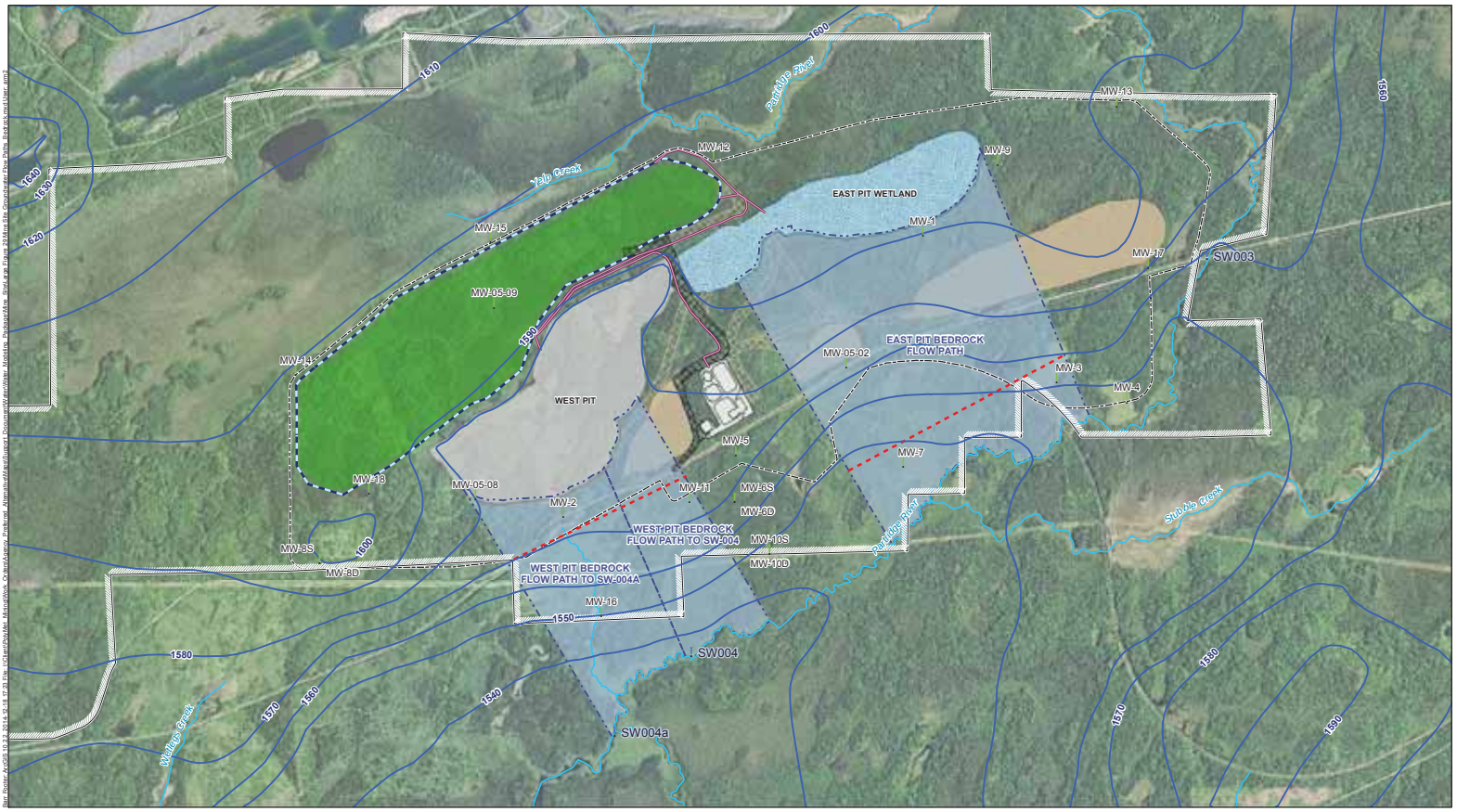
- Surface Water Monitoring Location
- Groundwater Monitoring Location
- Groundwater Containment System
- Process Water Pipe
- Groundwater Elevation Contours (Ft) at Closure[1]

[1] Inferred water table contours were developed using contours from the Mine Site MODFLOW model.

- Groundwater Evaluation Distances
- Groundwater Flow Path
- Mine Site
- Extent of Future PolyMet Lands

0 1,000 2,000 4,000
Feet

Large Figure 28
MINE SITE GROUNDWATER
FLOW PATHS - SURFICIAL AQUIFER
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



Mine Features
- West Pit
- East Pit Wetland
- Reclaimed Stockpile
- Removed and Reclaimed Stockpile
- Haul Roads
- Reclaimed Haul Roads

- Surface Water Monitoring Location
- Groundwater Monitoring Location
- Groundwater Containment System
- Process Water Pipe
- Groundwater Elevation Contours (Ft) at Closure[1]

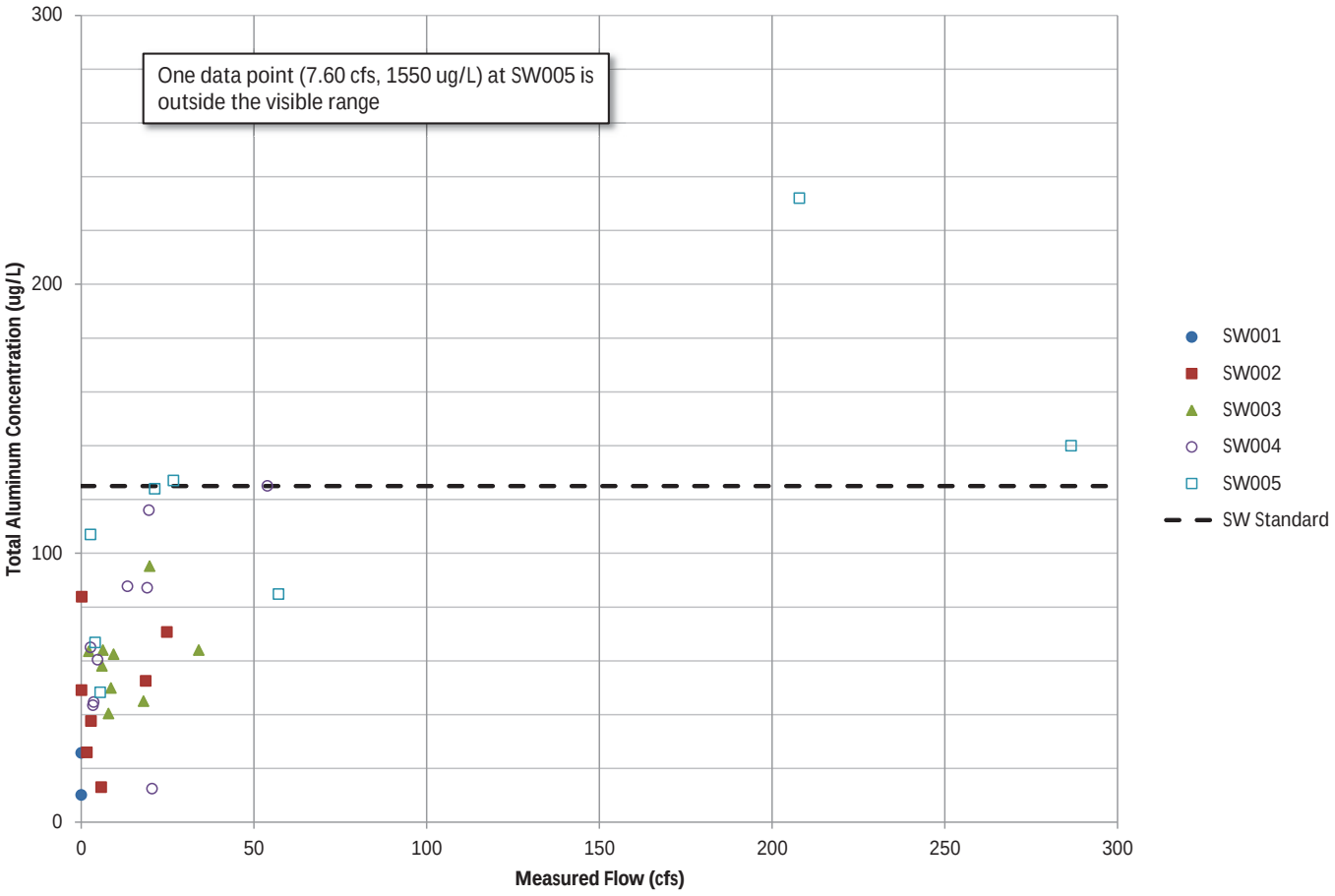
[1] Inferred water table contours were developed using contours from the Mine Site MODFLOW model.

- Groundwater Evaluation Distances
- Groundwater Flow Path
- Mine Site
- Extent of Future PolyMet Lands

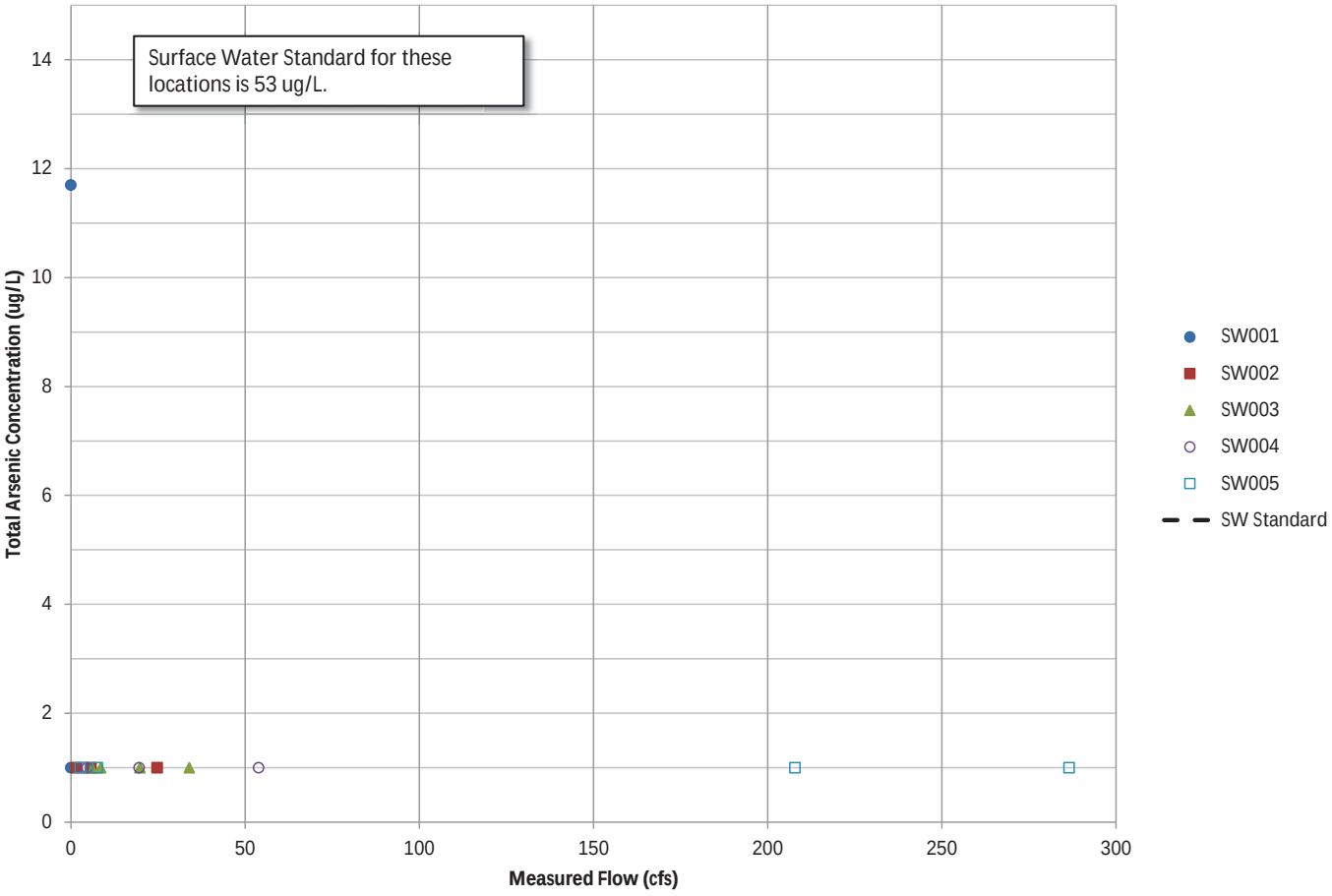
0 1,000 2,000 4,000
Feet

Large Figure 29
MINE SITE GROUNDWATER FLOW PATHS - BEDROCK
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN

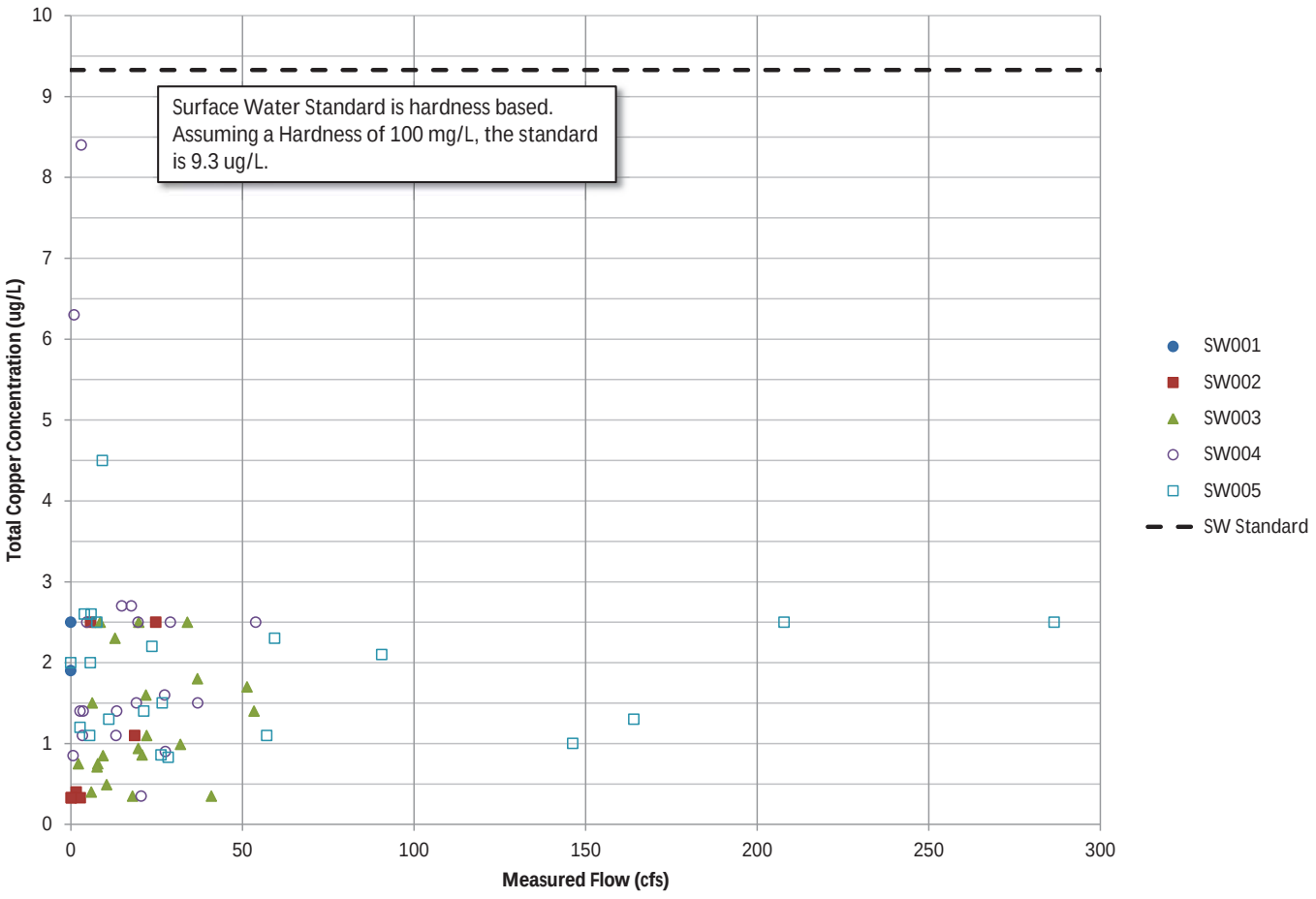
Large Figure 30 - Partridge River Water Quality - Total Aluminum Conc. vs. Flow



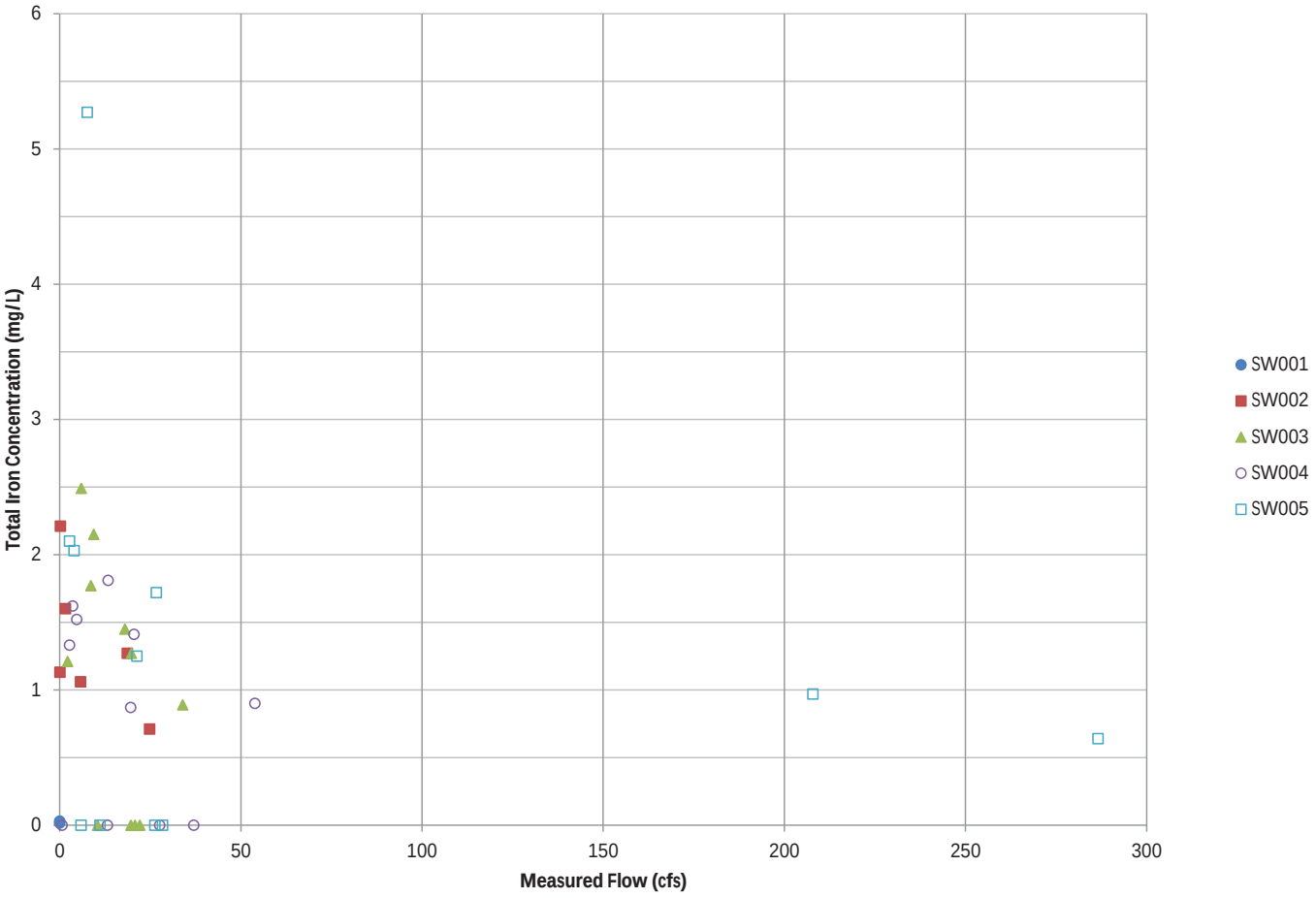
Large Figure 31 - Partridge River Water Quality - Total Arsenic Conc. vs. Flow



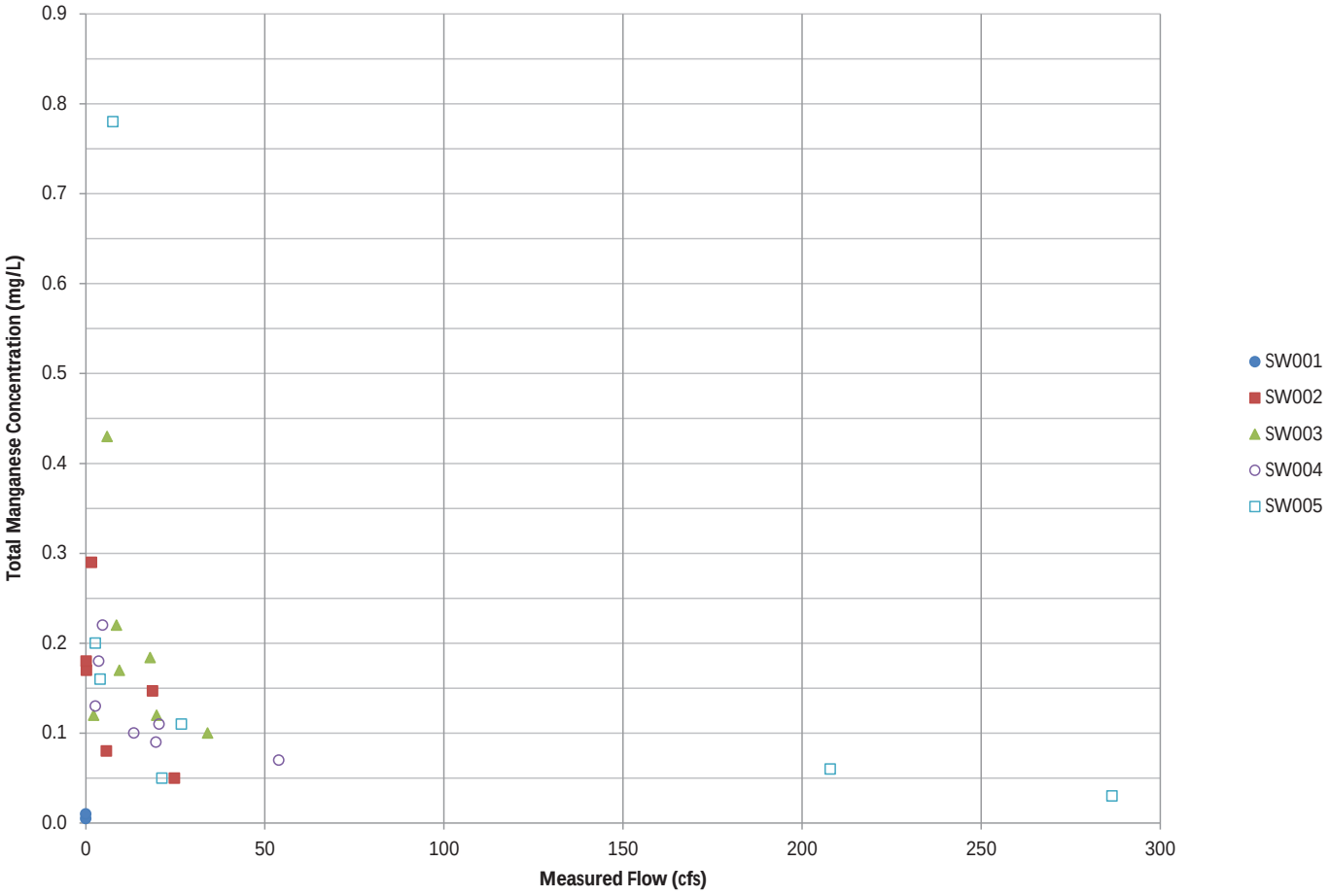
Large Figure 32 - Partridge River Water Quality - Total Copper Conc. vs. Flow



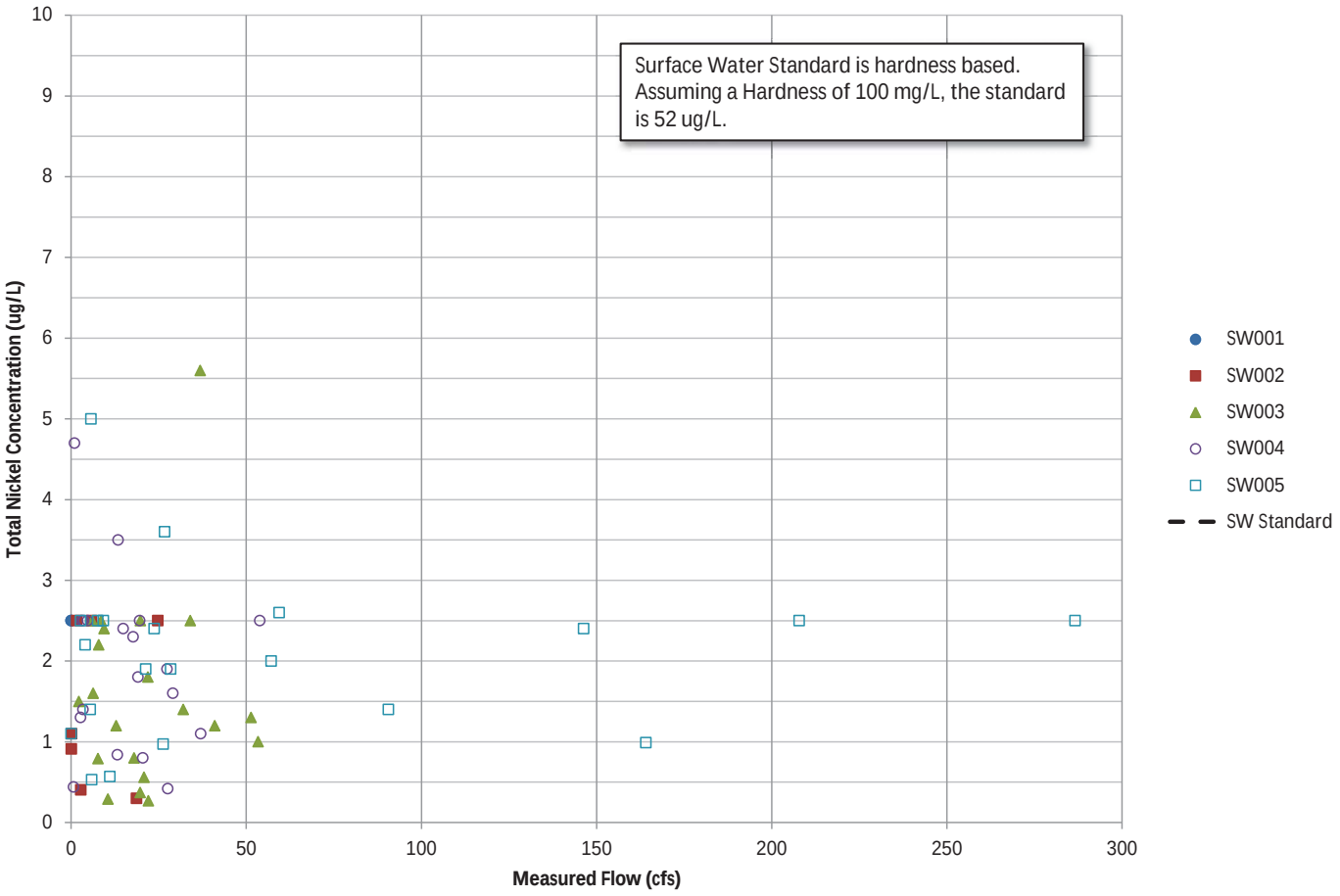
Large Figure 33 - Partridge River Water Quality - Total Iron Conc. vs. Flow



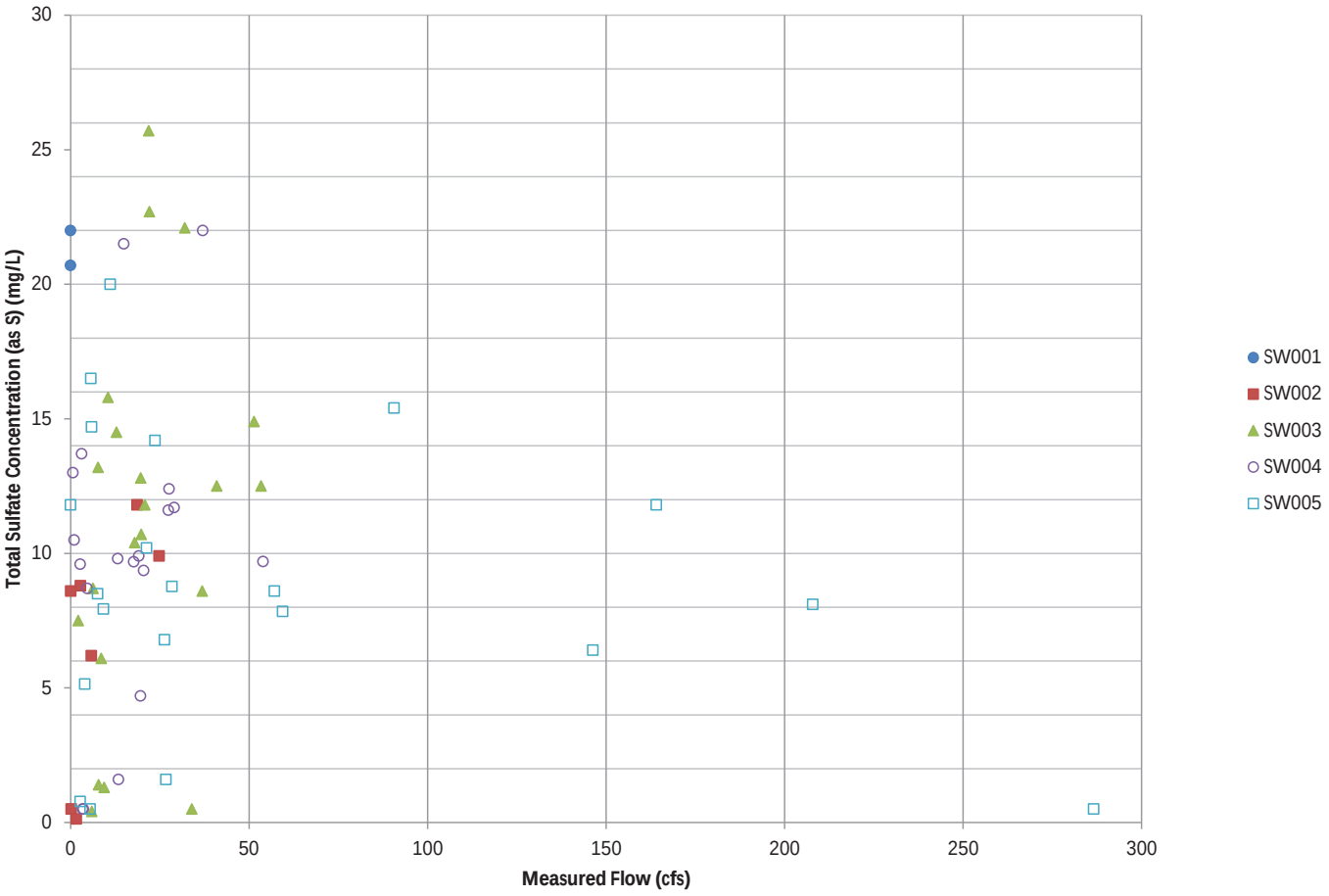
Large Figure 34 - Partridge River Water Quality - Total Manganese Conc. vs. Flow



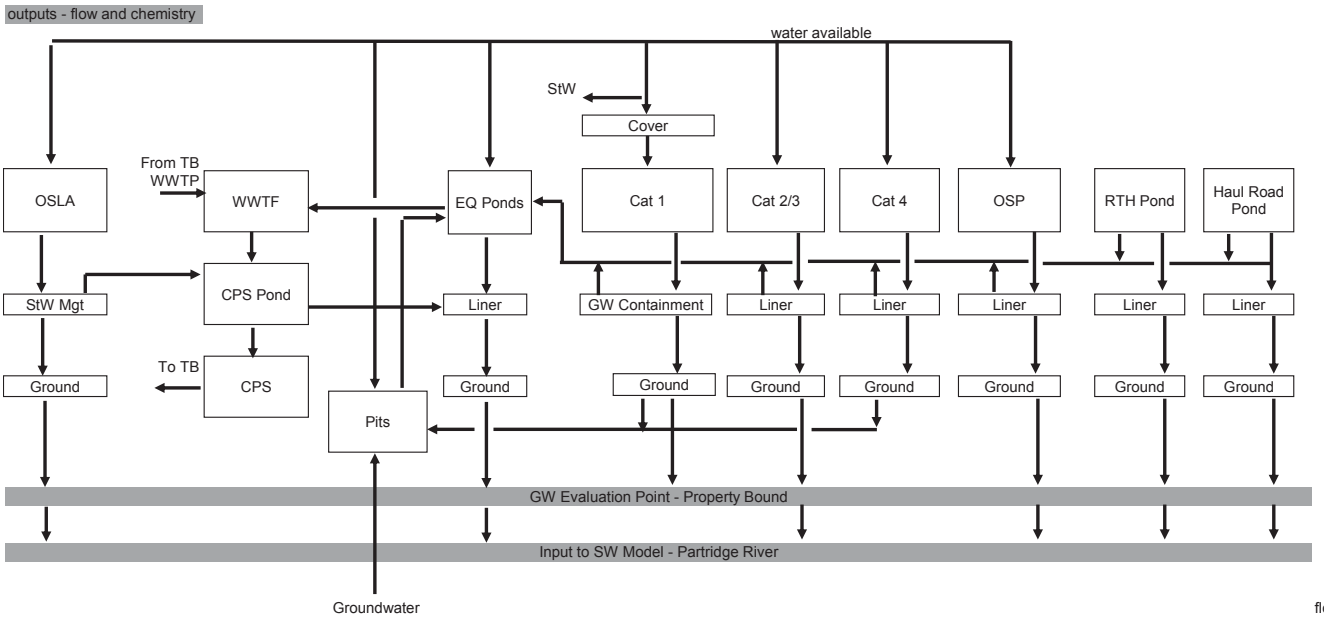
Large Figure 35 - Partridge River Water Quality - Total Nickel Conc. vs. Flow



Large Figure 36 - Partridge River Water Quality - Sulfate Conc. vs. Flow



Large Figure 37 - Mine Site Water Modeling - operations



Uncertainty Aspects

precipitation - evaporation

natural ET/Runoff conditions

generation rates, scale up for stockpile, concentration caps

liner effectiveness

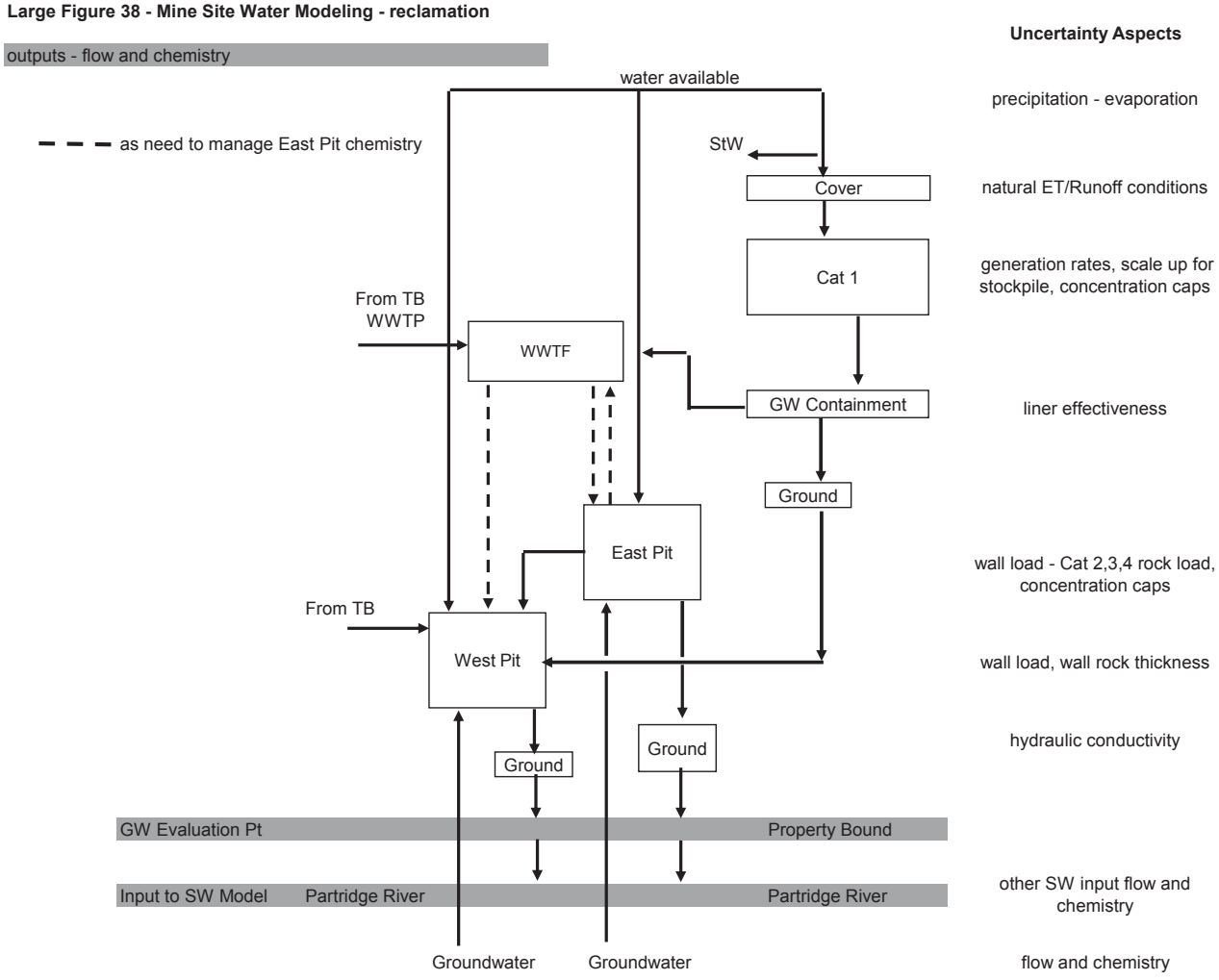
hydraulic conductivity

wall load, wall rock thickness

other SW input flow and chemistry

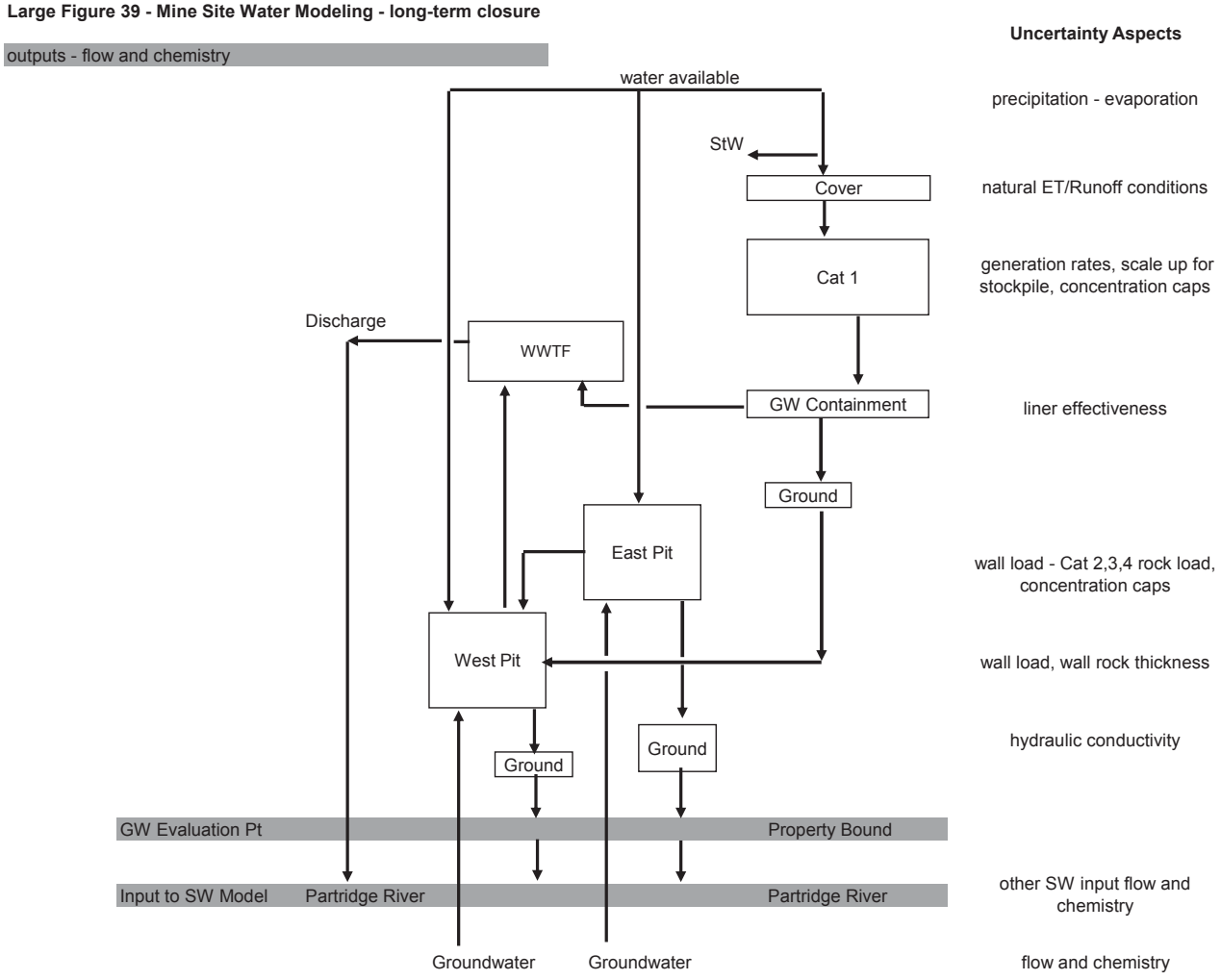
flow and chemistry

Large Figure 38 - Mine Site Water Modeling - reclamation



P:\Mpls\23 MN\69\2369862\WorkFiles\APA\Support Docs\Water Modeling Package Doc\Water Modeling Work Plan\Mine Site workplan\WMDP V13 Figs & Tables\Flowcharts.xlsx

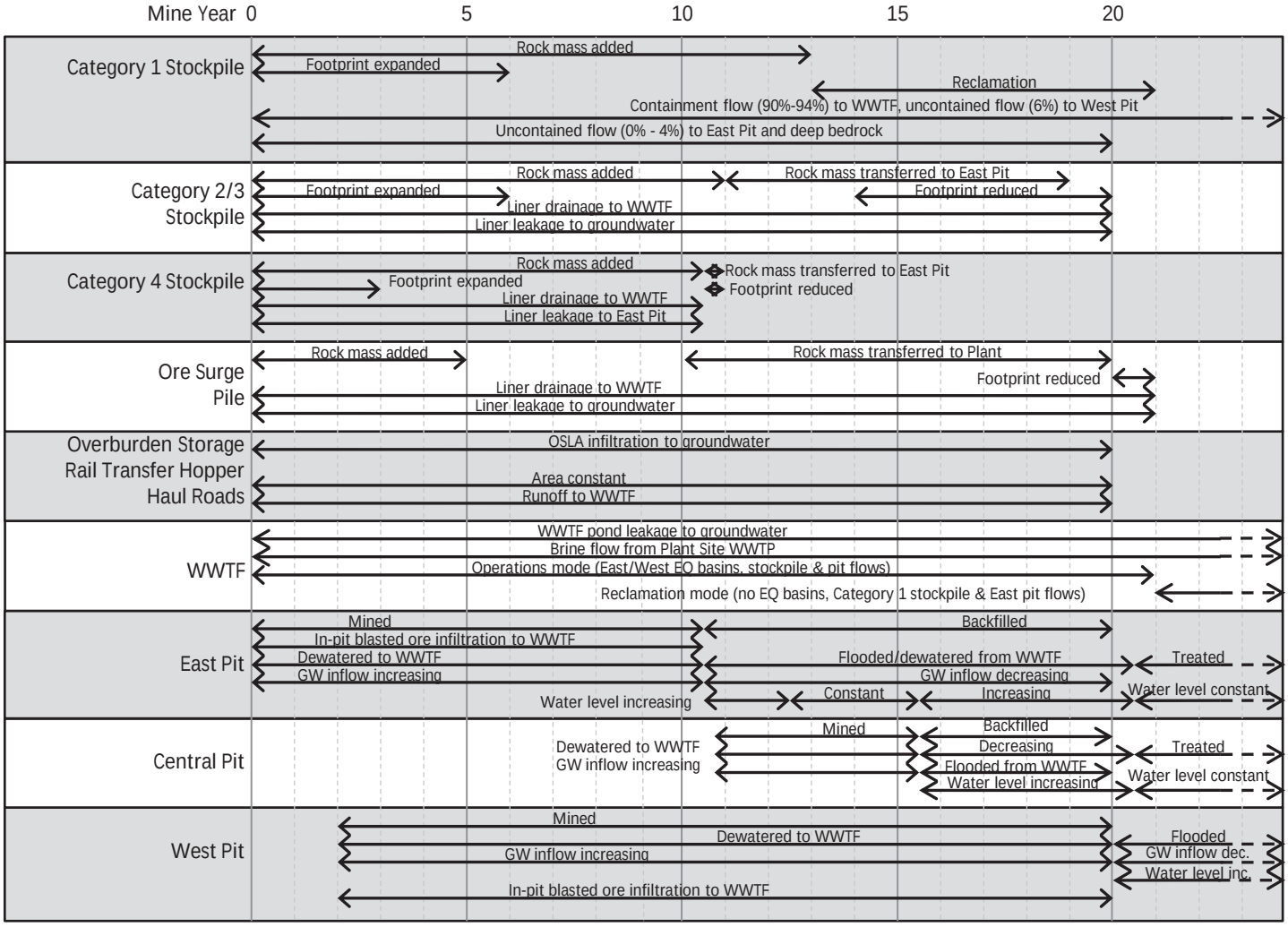
Large Figure 39 - Mine Site Water Modeling - long-term closure



P:\Mpls\23 MN\69\2369862\WorkFiles\APA\Support Docs\Water Modeling Package Doc\Water Modeling Work Plan\Mine Site workplan\WMDP V13 Figs & Tables\Flowcharts.xlsx

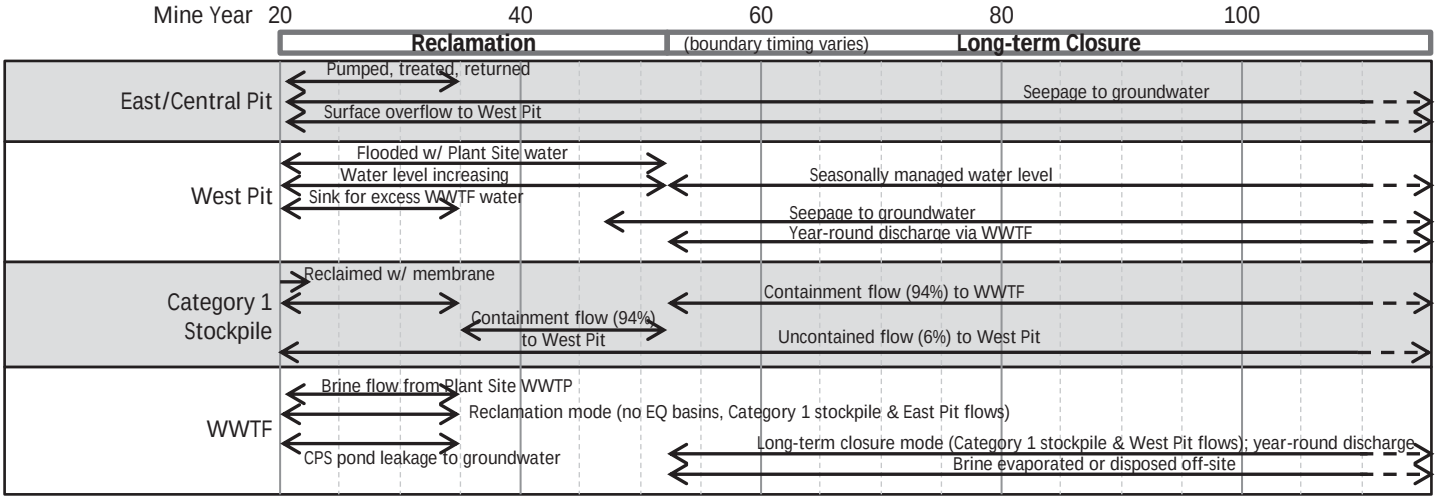
Large Figure 40

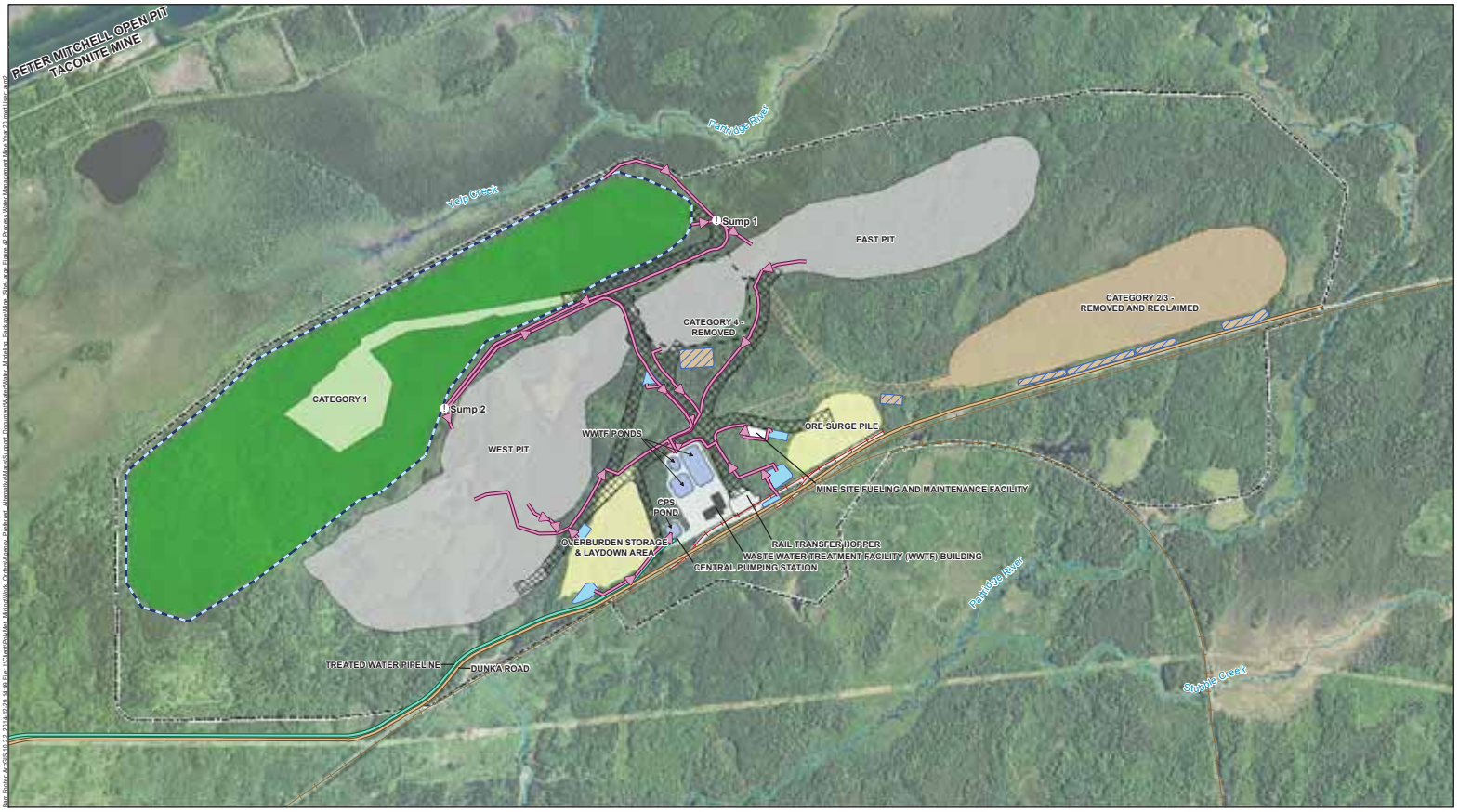
Model Feature Timeline (Operations)
NorthMet Mine Site Water Quality Model
GoldSim Model Version 6.0



Large Figure 41

Model Feature Timeline (Reclamation & Long-Term Closure)
NorthMet Mine Site Water Quality Model
GoldSim Model Version 6.0



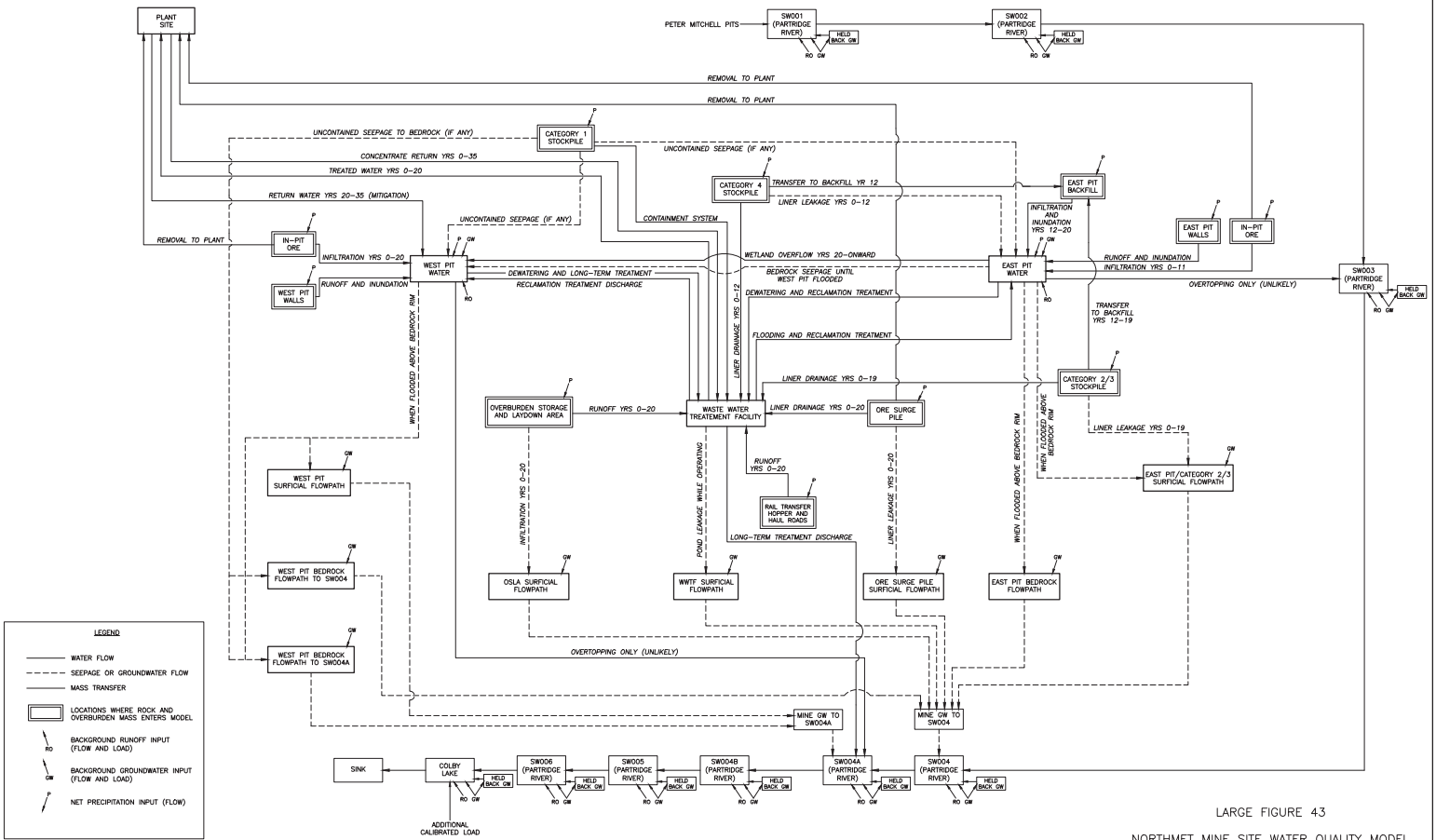


Mine Site
Active Stockpile
Removed and Reclaimed Stockpile
Removed Stockpile
Uncovered Stockpile
Covered Stockpile
Mine Pits
Reclaimed Haul Roads
Haul Roads
Proposed Railroad Track
Existing Private Railroad
Process Water Pipe
Groundwater Containment System
Reclaimed Ponds
Ponds and Sumps

N

0 750 1,500 3,000
Feet

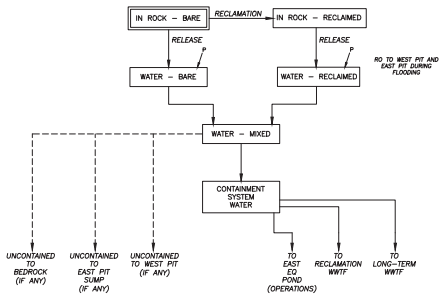
Large Figure 42
PROCESS WATER MANAGEMENT-
MINE YEAR 20
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN



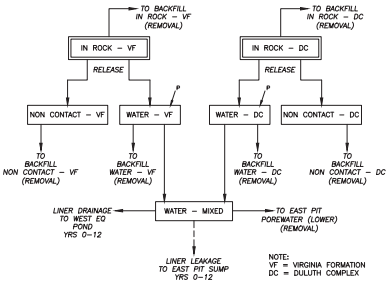
LARGE FIGURE 43

NORTHMET MINE SITE WATER QUALITY MODEL
PROJECT MODEL FLOWCHART 1
GOLDSIM MODEL VERSION 6

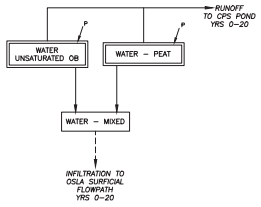
CAD USER: Rick Gartner FILE: M:\ACEPROWK\Rick\Y2009\09030_NORTHMET MINE SITE WATER QUALITY MODEL FLOWCHART 1 COLOSIM VIEWING PLOT SCALE: 1:2 PLOT DATE: 10/29/2014 9:59 AM



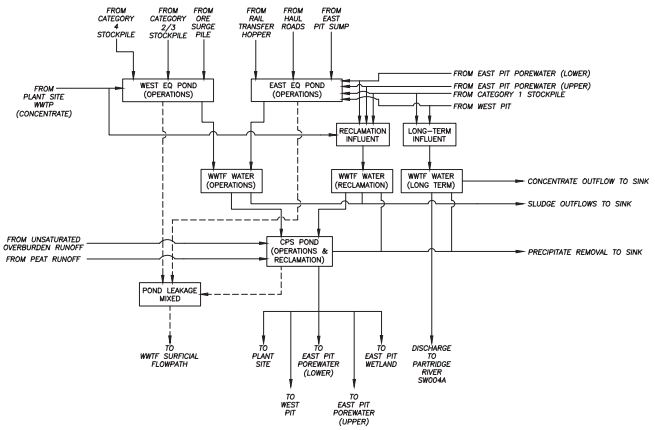
CATEGORY 1 STOCKPILE DETAILED MODEL



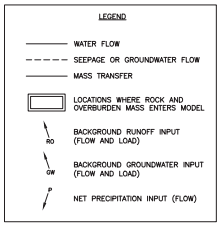
CATEGORY 4 STOCKPILE DETAILED MODEL

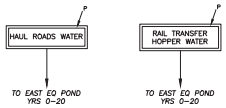


OVERBURDEN STORAGE AND LAYDOWN AREA DETAILED MODEL

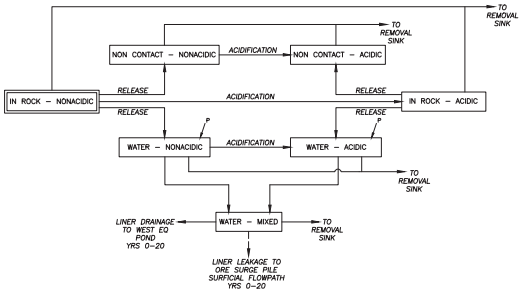


WASTE WATER TREATMENT FACILITY DETAILED MODEL

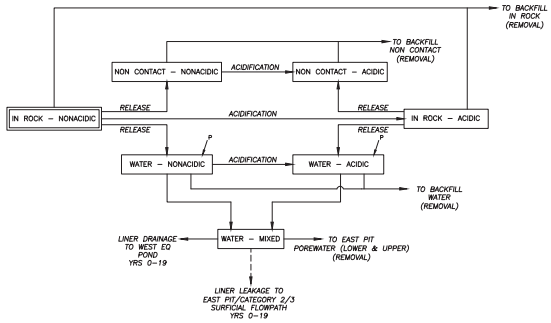




RAIL TRANSFER HOPPER AND HAUL ROAD DETAILED MODEL



ORE SURGE PILE DETAILED MODEL

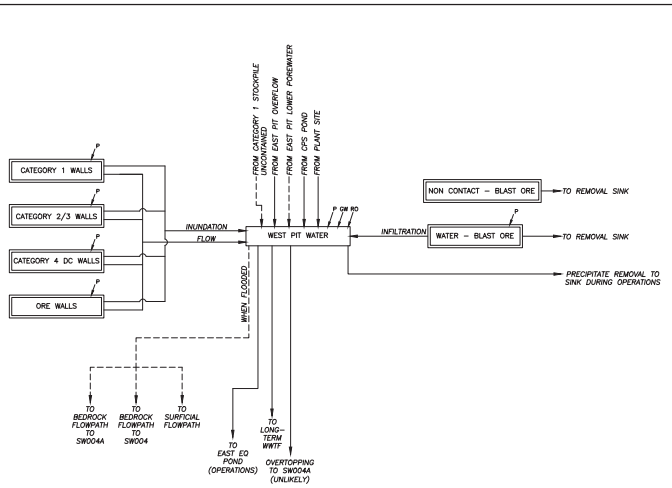


CATEGORY 2/3 STOCKPILE DETAILED MODEL

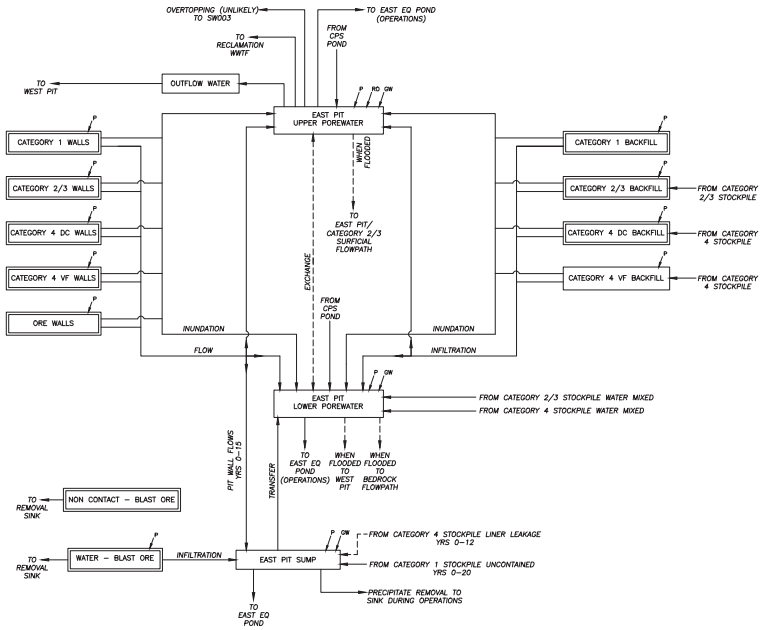
LARGE FIGURE 44

NORTHMET MINE SITE WATER QUALITY MODEL
PROJECT MODEL DETAILED FLOWCHART 2
GOLDSIM MODEL VERSION 6

CADD USER: Rick Gardner FILE: M:\ACEPROWR\GIS\Q3699\MXD\Q3_NORTHMET MINE SITE WATER QUALITY DETAILED MODEL FLOWCHART 2 GOLDSIM MILDRAY PLOT SCALE: 1:2 PLOT DATE: 12/29/2014 10:01 AM

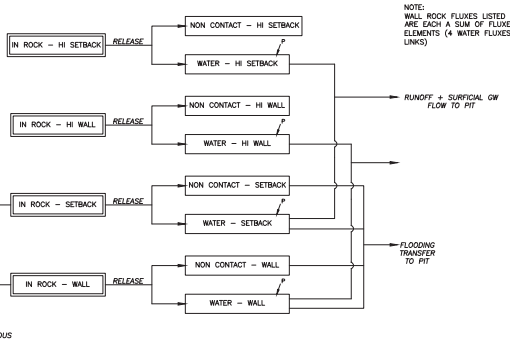


WEST PIT DETAILED MODEL



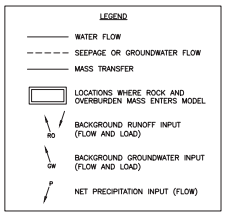
EAST PIT DETAILED MODEL

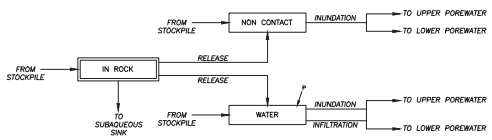
NOTE:
BACKFILL FLUXES LISTED FOR CV#4 ABOVE ARE EACH A SUM OF FLUXES FROM MULTIPLE MODEL ELEMENTS (1 WATER FLUX, 2 MASS TRANSFER LINKS)



NOTE:
WALL ROCK FLUXES LISTED FOR CV#2 AND #4 ABOVE ARE EACH A SUM OF FLUXES FROM MULTIPLE MODEL ELEMENTS (4 WATER FLUXES, 4 MASS TRANSFER LINKS)

TYPICAL WALL ROCK DETAILED MODEL
(ONE PER WALL ROCK CATEGORY)



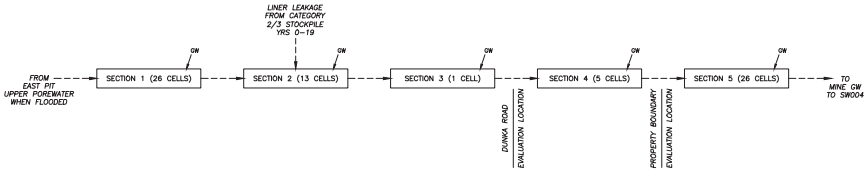


TYPICAL BACKFILL DETAILED MODEL
(ONE PER BACKFILL CATEGORY)

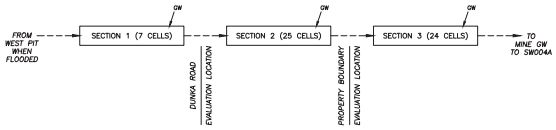
LARGE FIGURE 45

NORTHMET MINE SITE WATER QUALITY MODEL
PROJECT MODEL DETAILED FLOWCHART 3
GOLDSIM MODEL VERSION 6

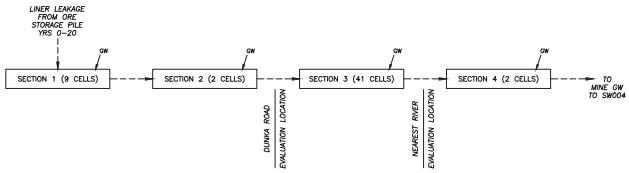
CADD USER: Rick Gardner FILE: M:\ACEPROJECTS\NORTHMET\MODEL\FLOWCHARTS\NORTHMET_MINE_SITE_WATER_QUALITY_DETAILED_MODEL_FLOWCHART_3_GOLDSIM_VALIDAT_PLOT SCALE: 1:2 PLOT DATE: 12/29/2014 10:03 AM



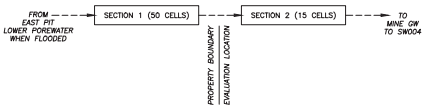
EAST PIT AND CATEGORY 2/3 STOCKPILE SURFICIAL FLOW PATH



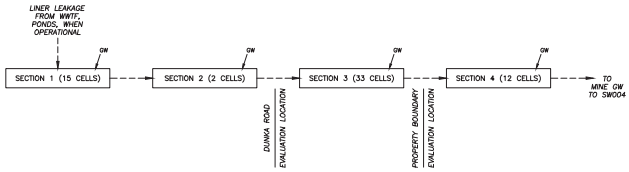
WEST PIT SURFICIAL FLOW PATH



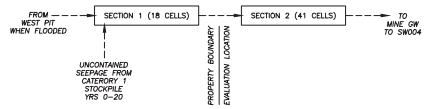
ORE SURGE PILE SURFICIAL FLOW PATH



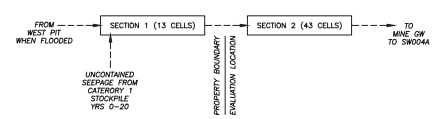
EAST PIT BEDROCK FLOW PATH



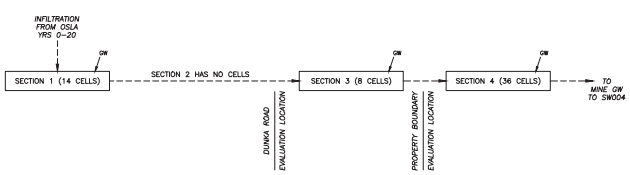
WWTF SURFICIAL FLOW PATH



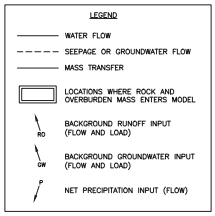
WEST PIT BEDROCK FLOW PATH TO SW004



WEST PIT BEDROCK FLOW PATH TO SW004A



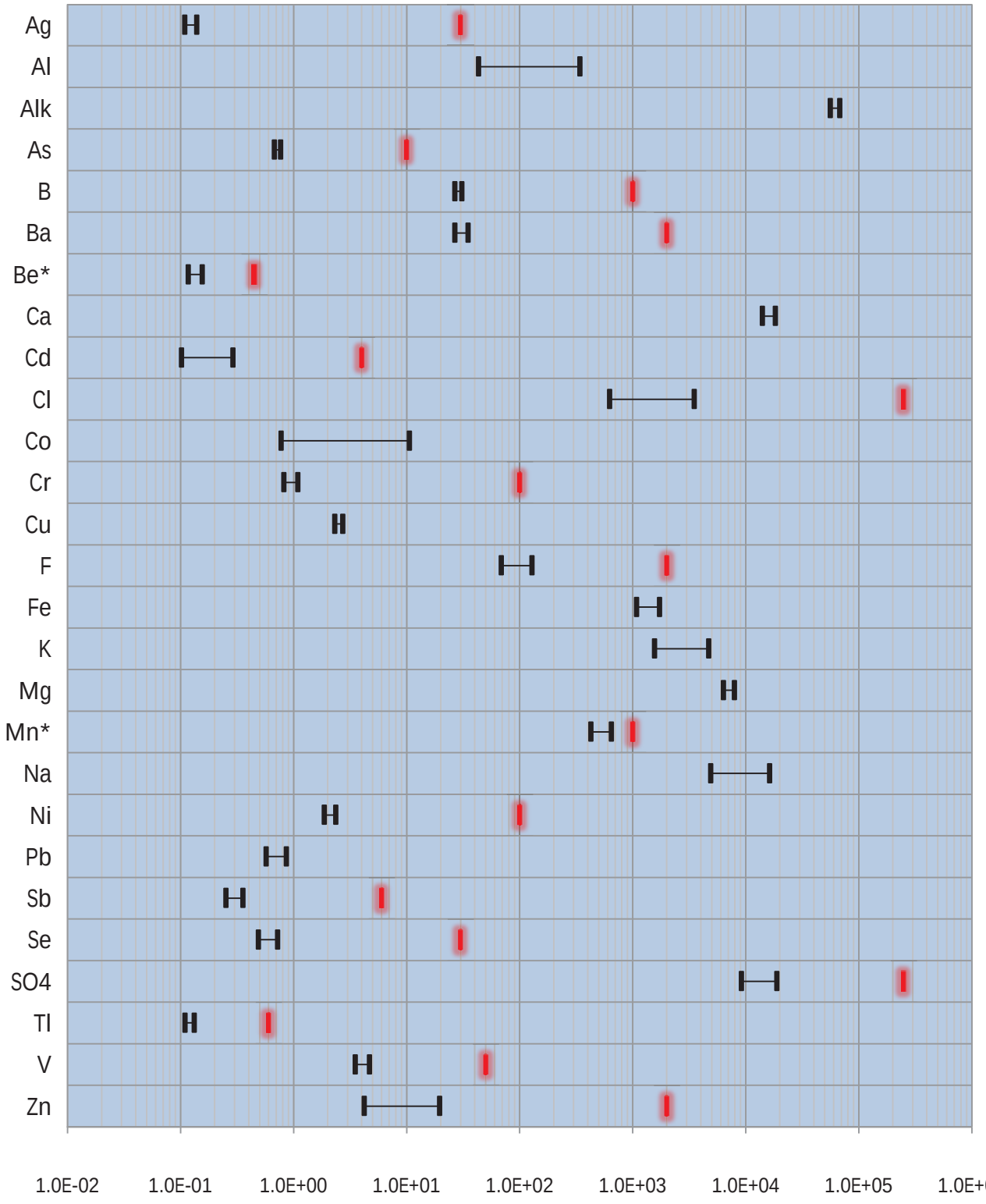
OSLA SURFICIAL FLOW PATH



LARGE FIGURE 46

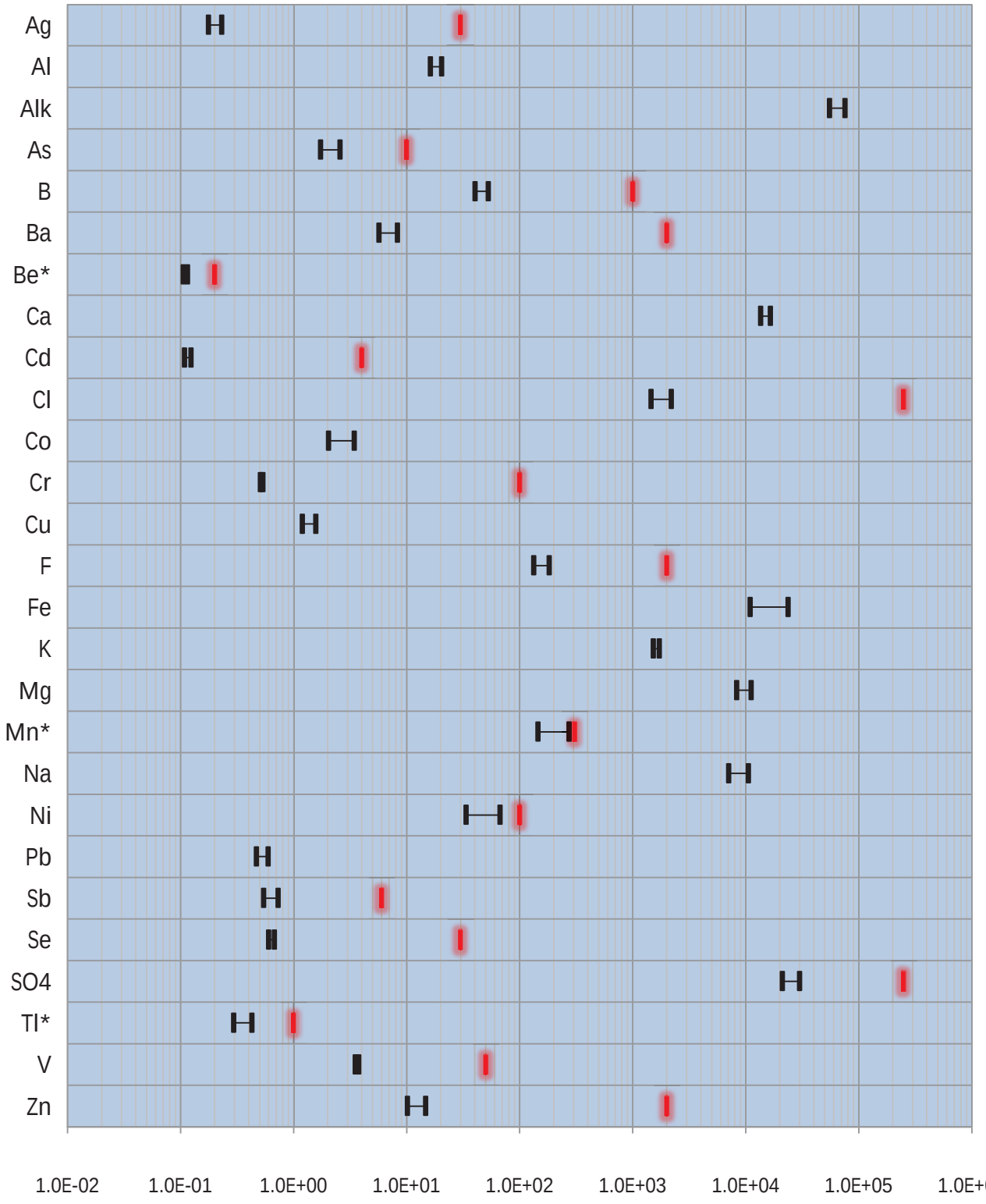
NORTHMET MINE SITE WATER QUALITY MODEL
PROJECT MODEL DETAILED FLOWCHART 4
GOLDSIM MODEL VERSION 6

CADD USER: Rick Gustner FILE: M:\ADEPTWORK\RLG\23690586200_NORTHMET MINE SITE WATER QUALITY DETAILED MODEL FLOWCHART 4 GOLDSIM VIEWING PLOT SCALE: 1:2 PLOT DATE: 12/29/2014 10:04 AM



Not all constituents have applicable standards
* Site specific evaluation criteria shown

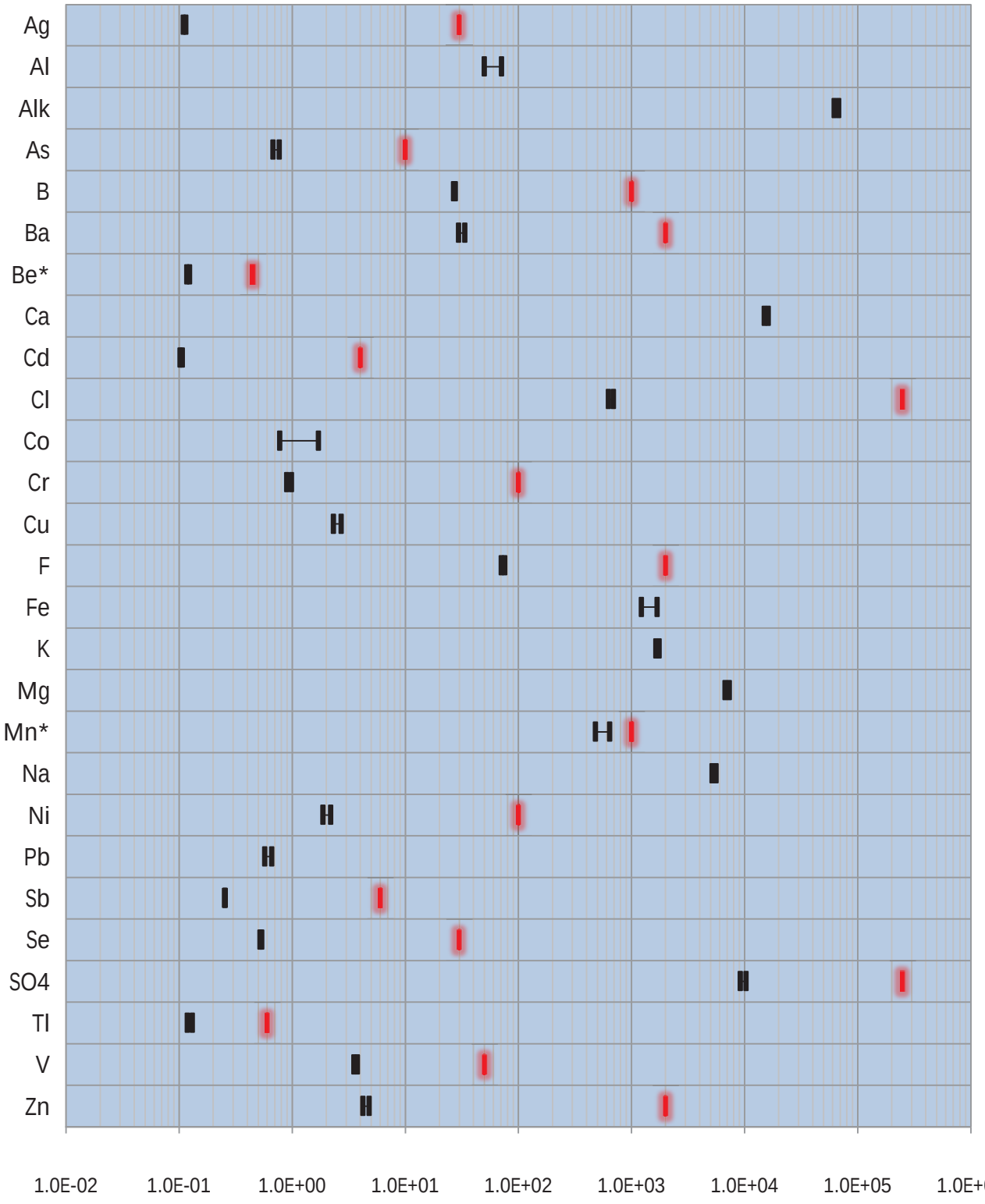
Large Figure 47 Groundwater Concentration Ranges in the East Pit/Category 2/3 (surficial) Flow Path at the Property Boundary



Not all constituents have applicable standards

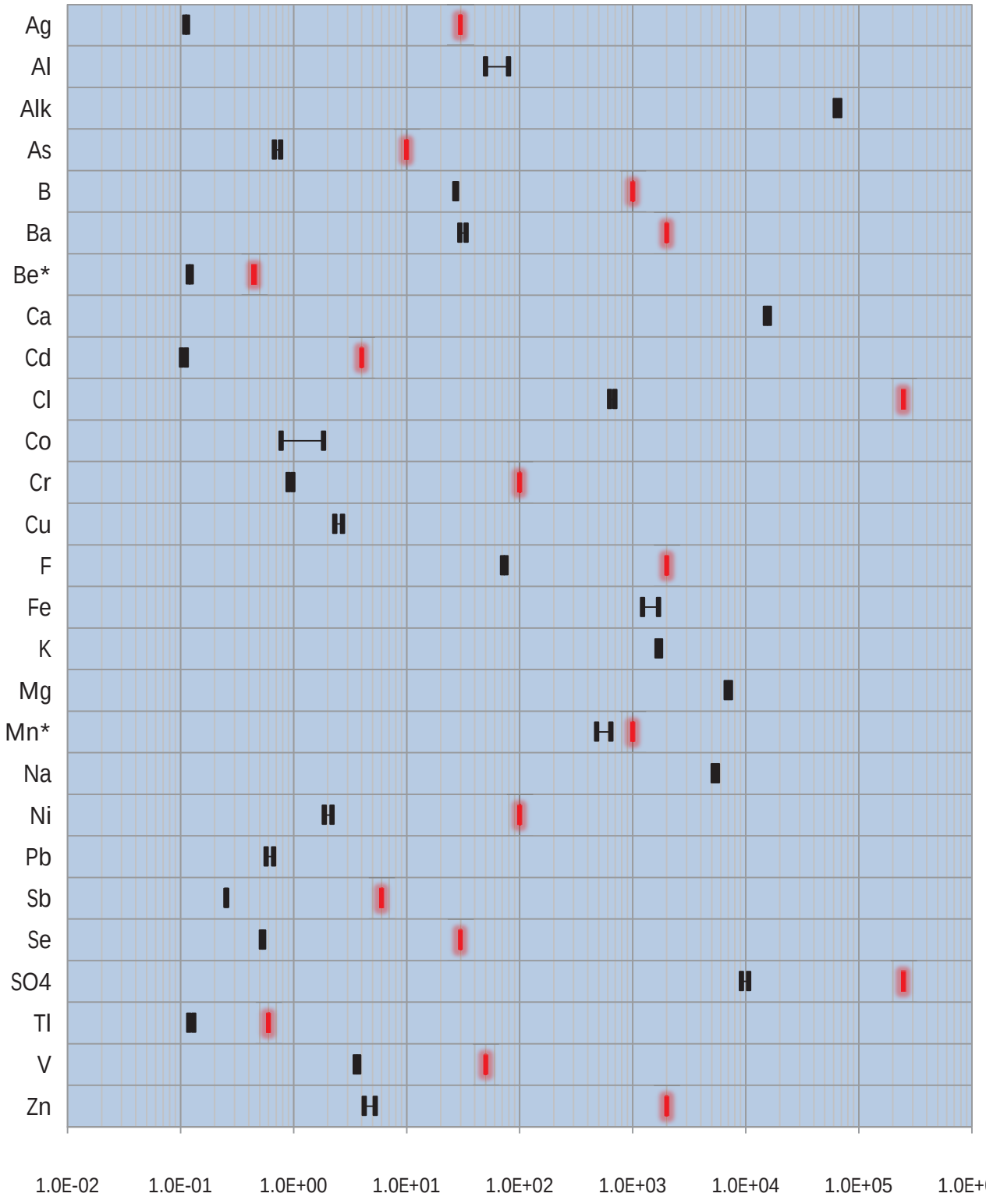
* Site specific evaluation criteria shown

Large Figure 48 Groundwater Concentration Ranges in the East Pit (bedrock) Flow Path at the Property Boundary



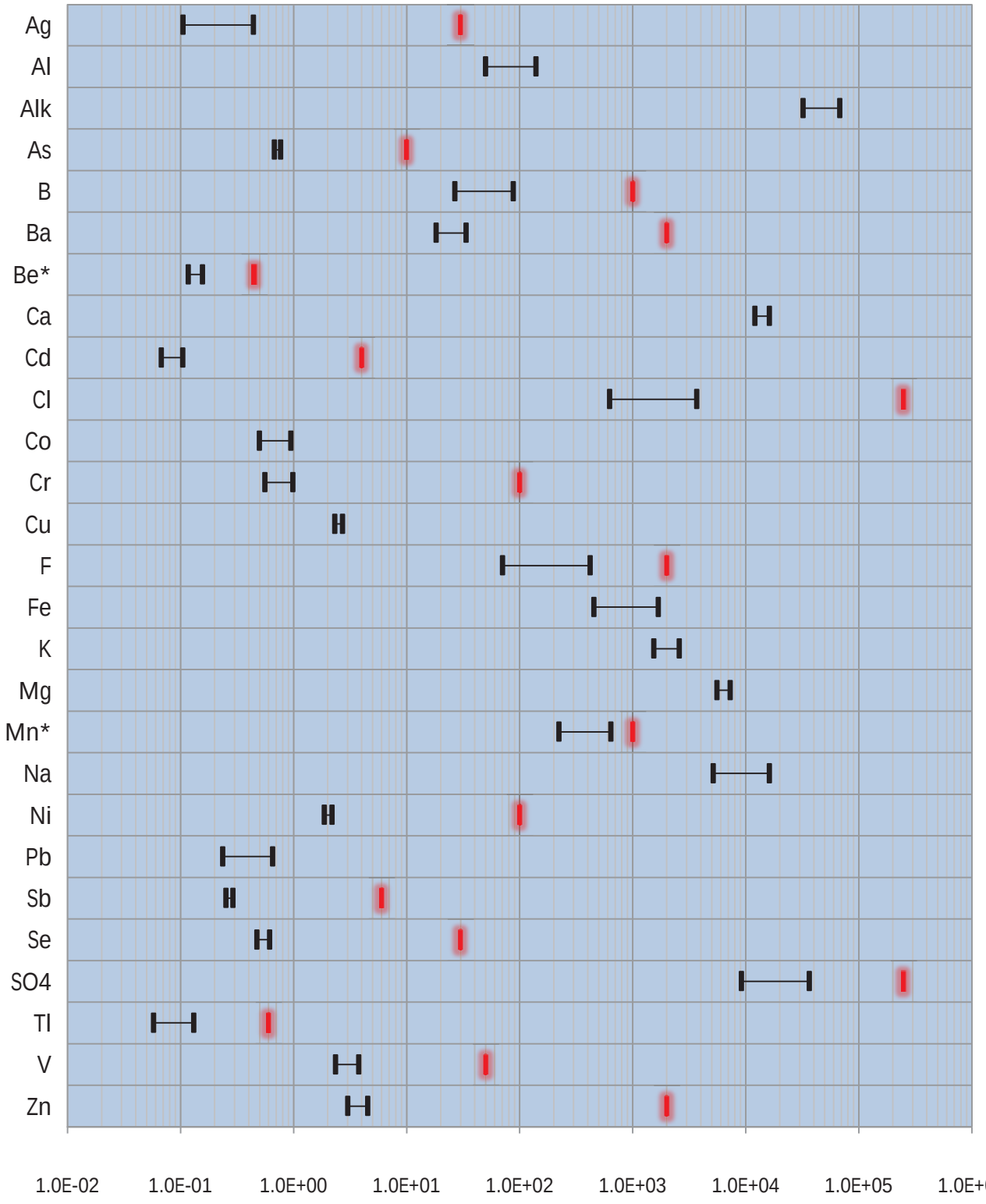
Not all constituents have applicable standards
* Site specific evaluation criteria shown

Large Figure 49 Groundwater Concentration Ranges in the OSP (surficial) Flow Path at the Partridge River



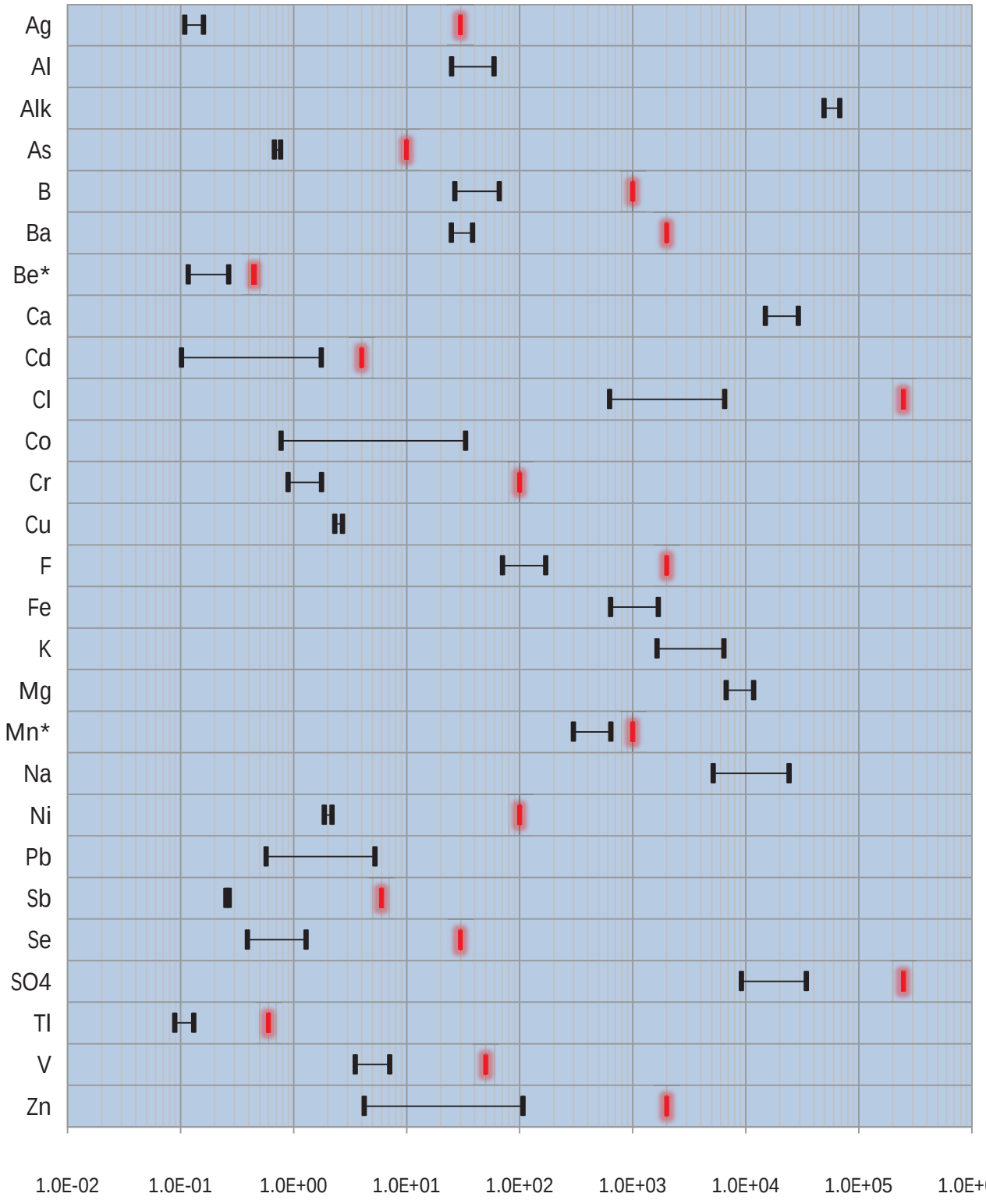
Not all constituents have applicable standards
* Site specific evaluation criteria shown

Large Figure 50 Groundwater Concentration Ranges in the WWTF (surficial) Flow Path at the Property Boundary



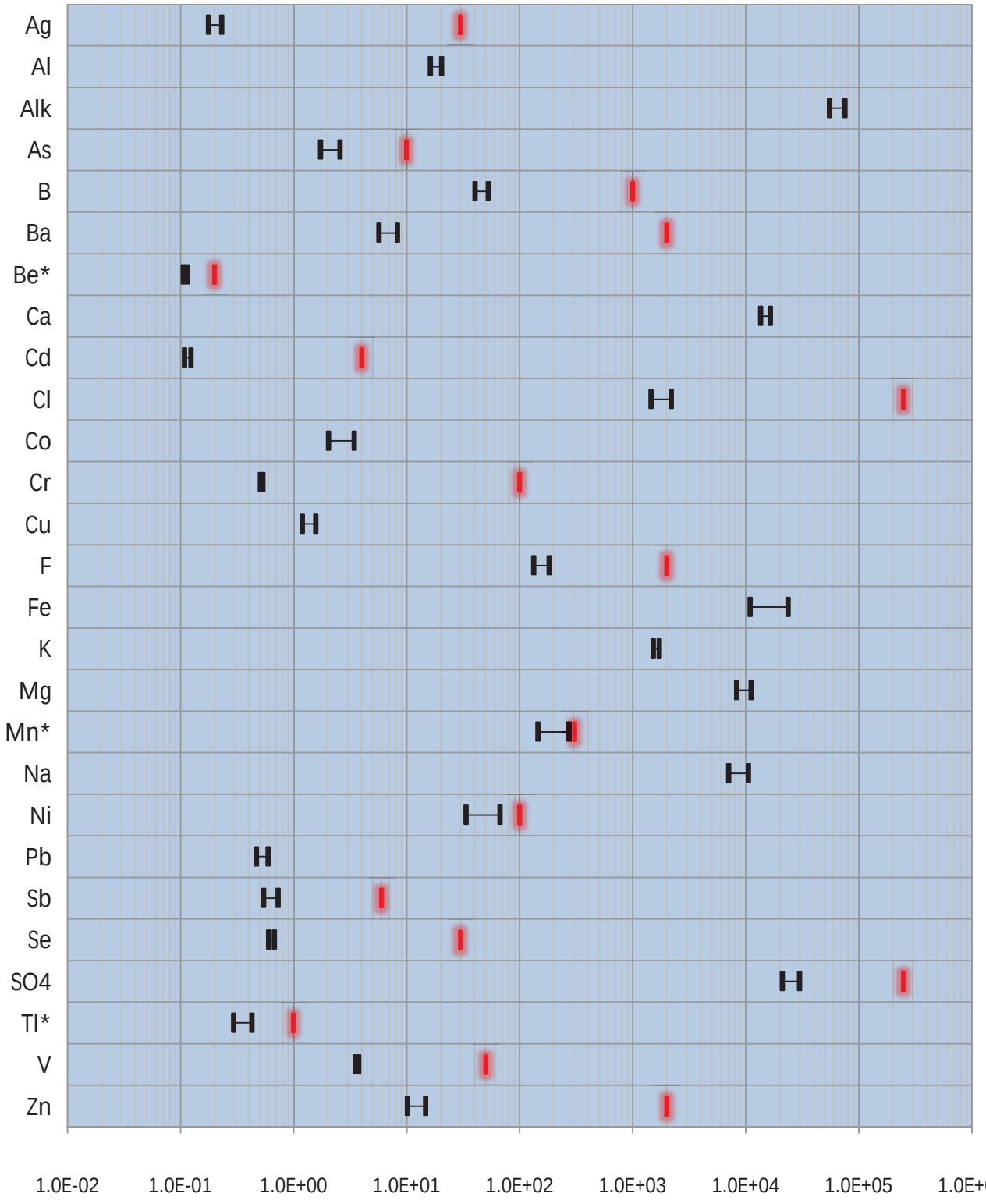
Not all constituents have applicable standards
* Site specific evaluation criteria shown

Large Figure 51 Groundwater Concentration Ranges in the OSLA (surficial) Flow Path at the Property Boundary



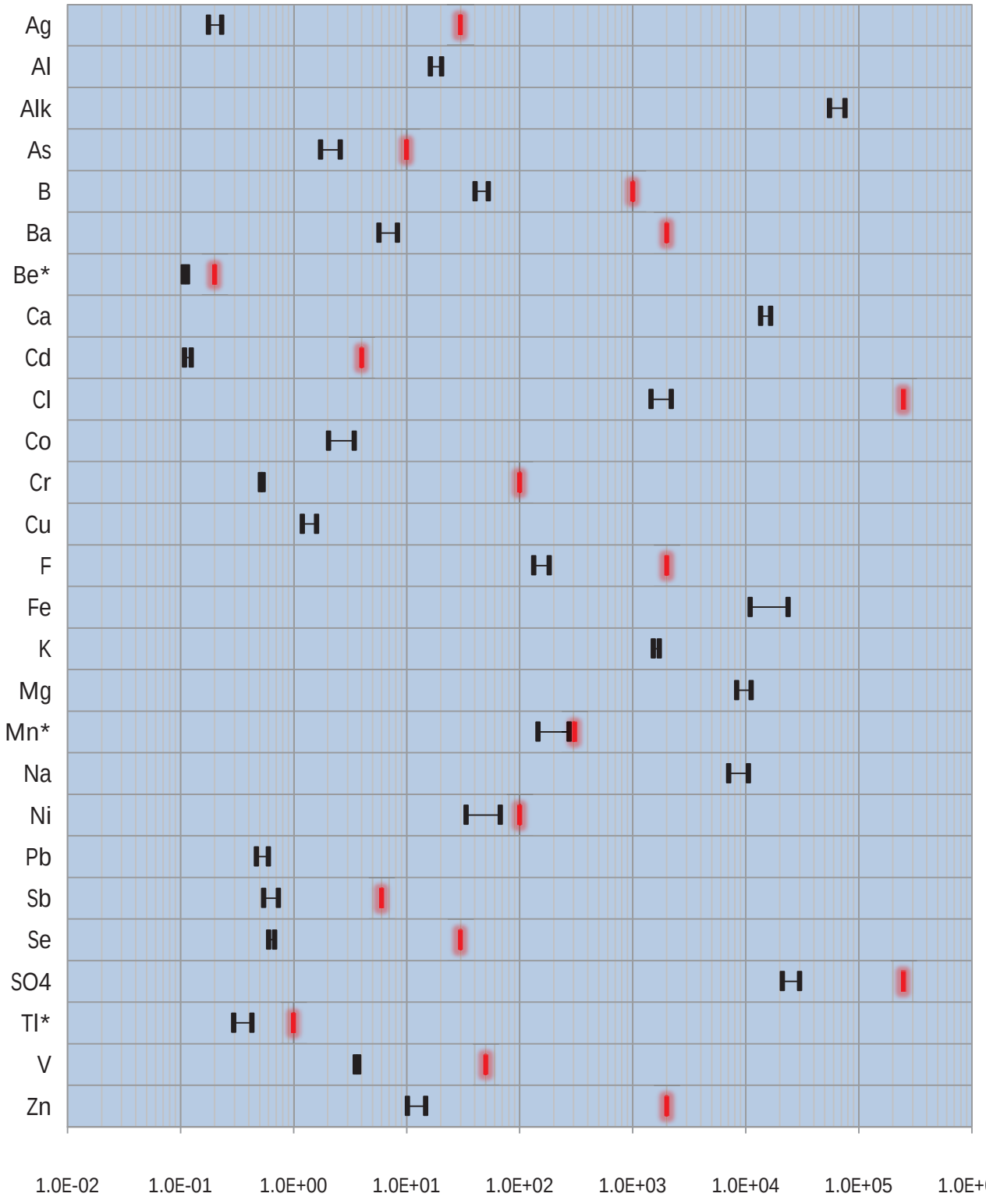
Not all constituents have applicable standards
* Site specific evaluation criteria shown

Large Figure 52 Groundwater Concentration Ranges in the West Pit (surficial) Flow Path at the Property Boundary



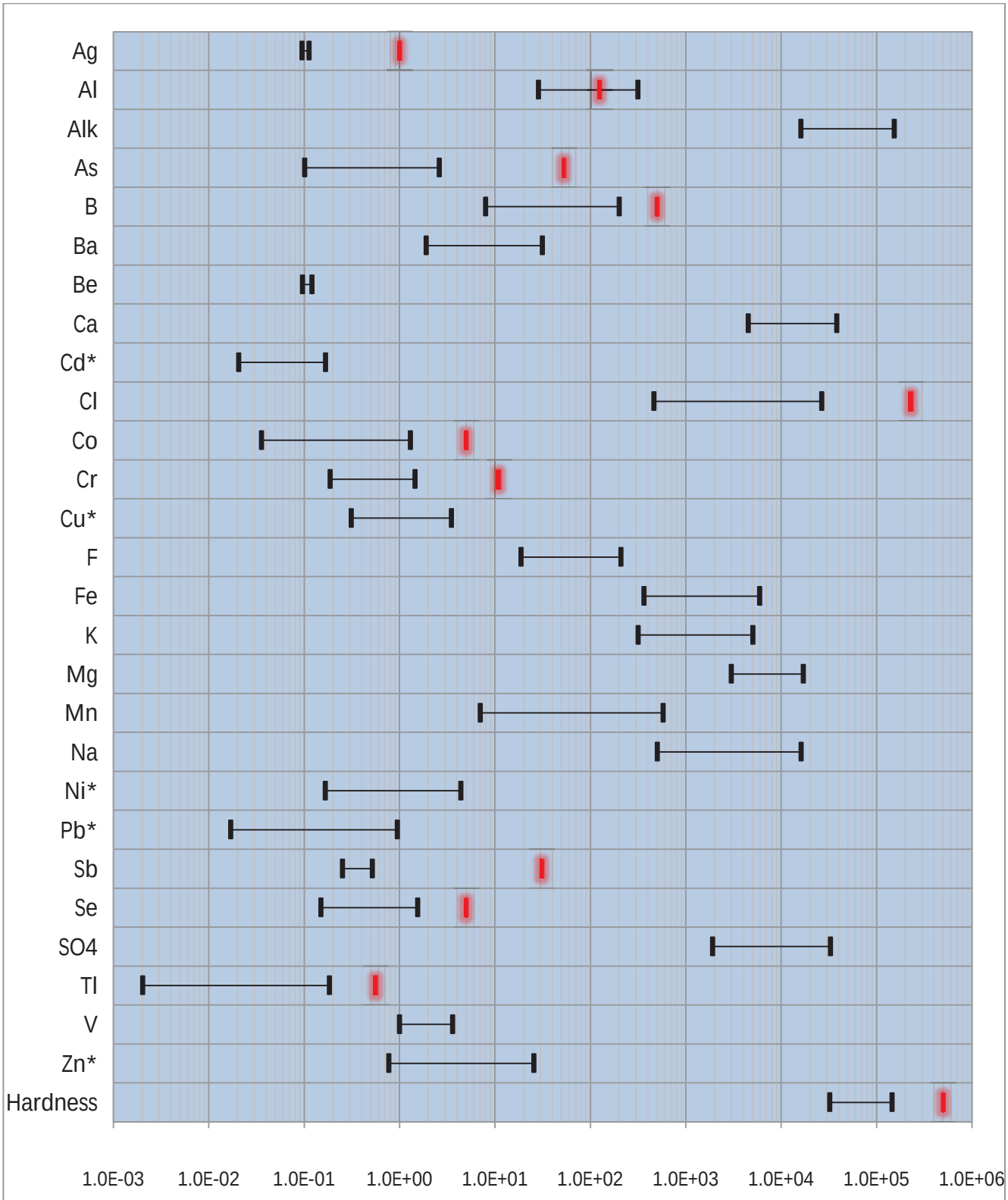
Not all constituents have applicable standards
* Site specific evaluation criteria shown

Large Figure 53 Groundwater Concentration Ranges in the West Pit (bedrock to SW004) Flow Path at the Property Boundary



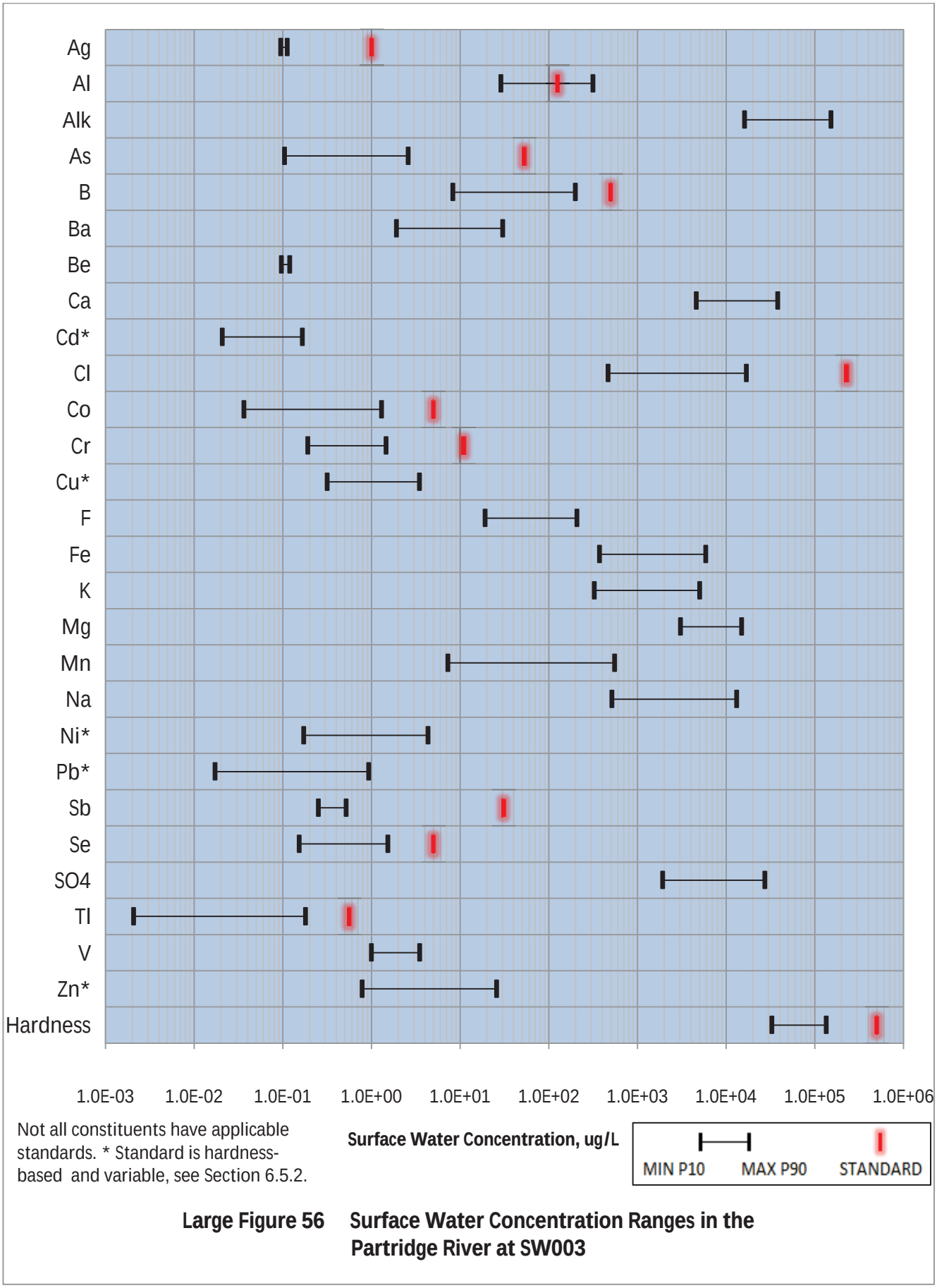
Not all constituents have applicable standards
* Site specific evaluation criteria shown

Large Figure 54 Groundwater Concentration Ranges in the West Pit (bedrock to SW004a) Flow Path at the Property Boundary



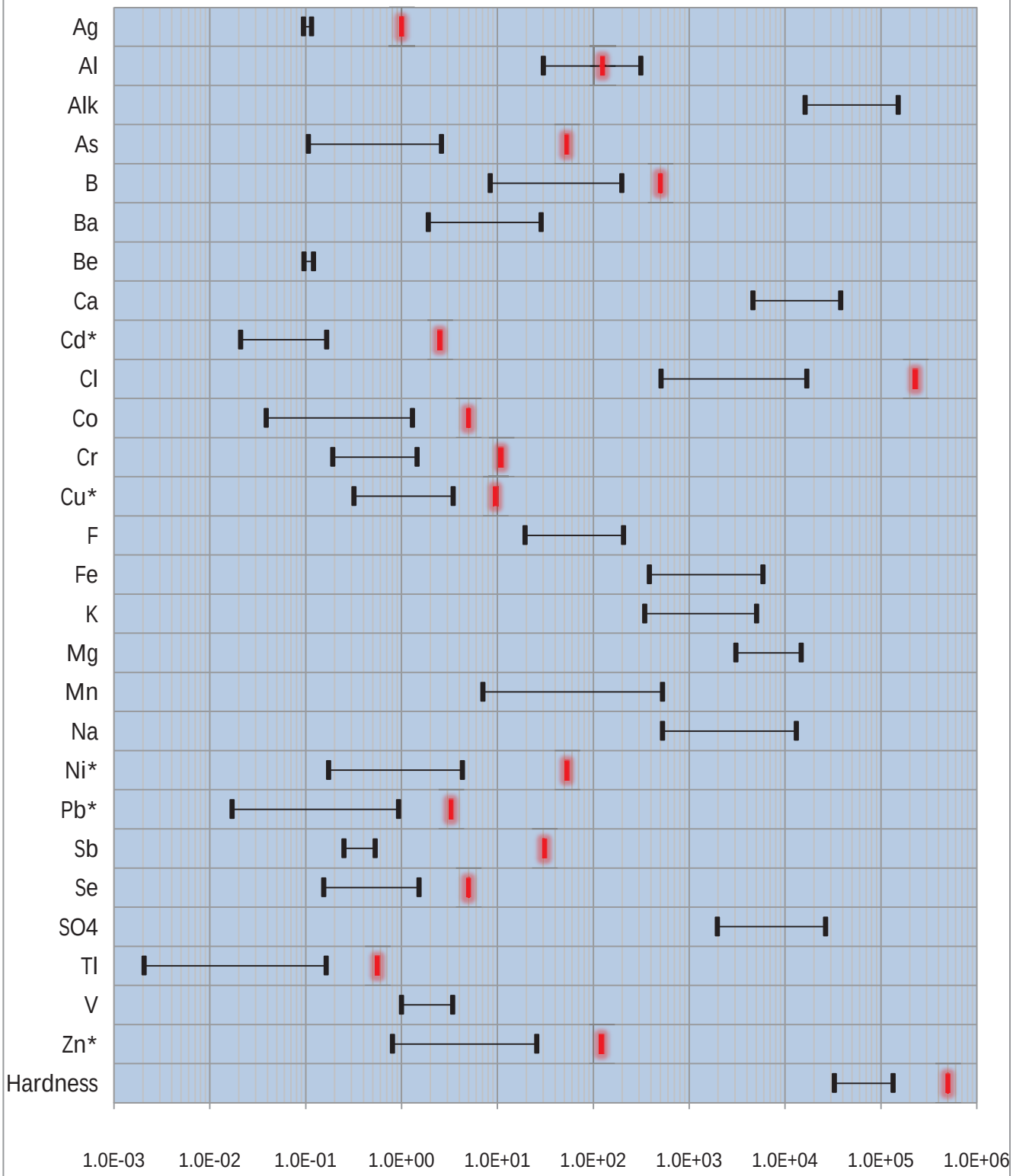
Not all constituents have applicable standards. * Standard is hardness-based and variable, see Section 6.5.2.

Large Figure 55 Surface Water Concentration Ranges in the Partridge River at SW002



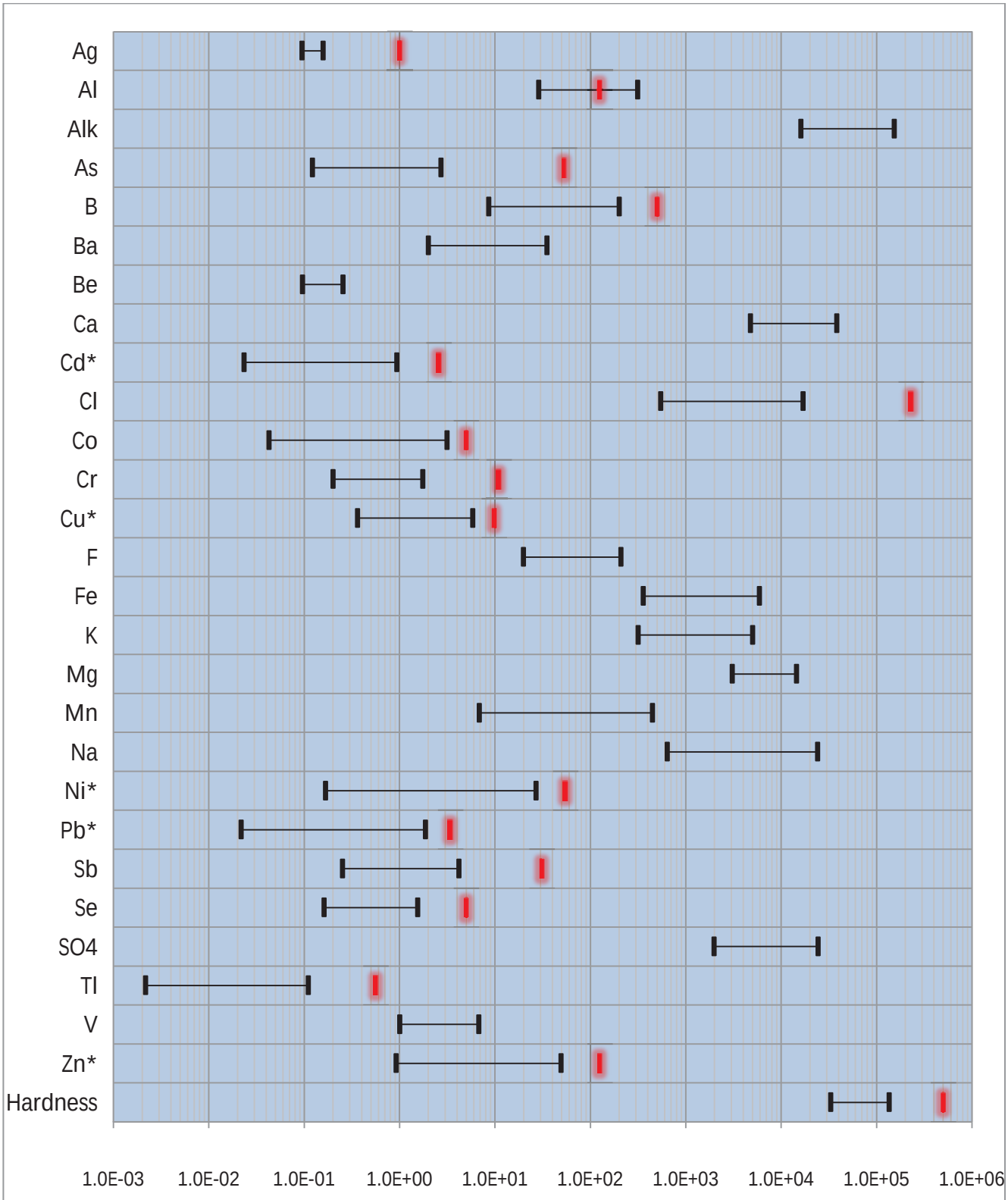
Not all constituents have applicable standards. * Standard is hardness-based and variable, see Section 6.5.2.

Large Figure 56 Surface Water Concentration Ranges in the Partridge River at SW003



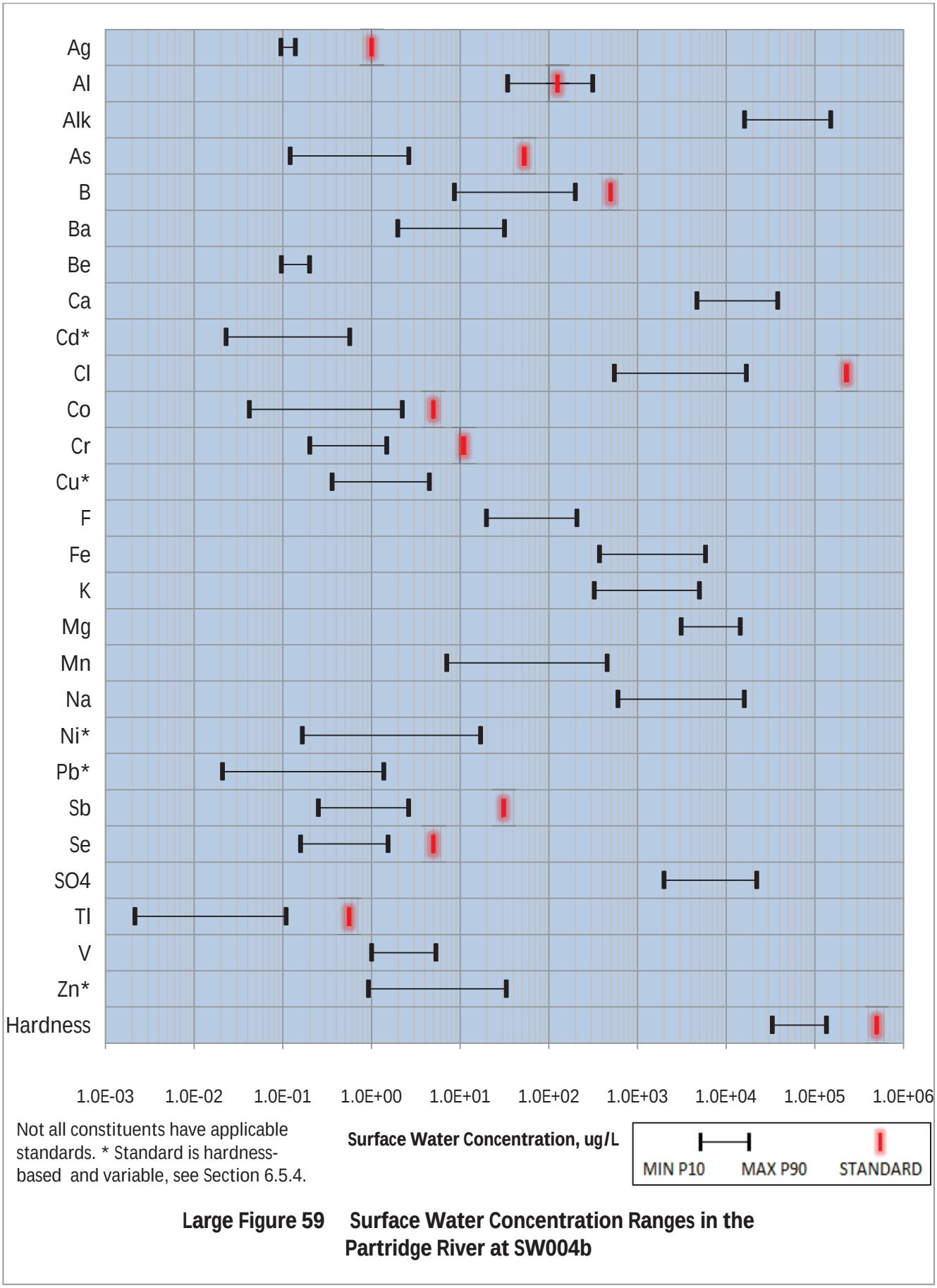
Not all constituents have applicable standards. * Standard is hardness-based and evaluated at a hardness of 90.8 mg/L

Large Figure 57 Surface Water Concentration Ranges in the Partridge River at SW004

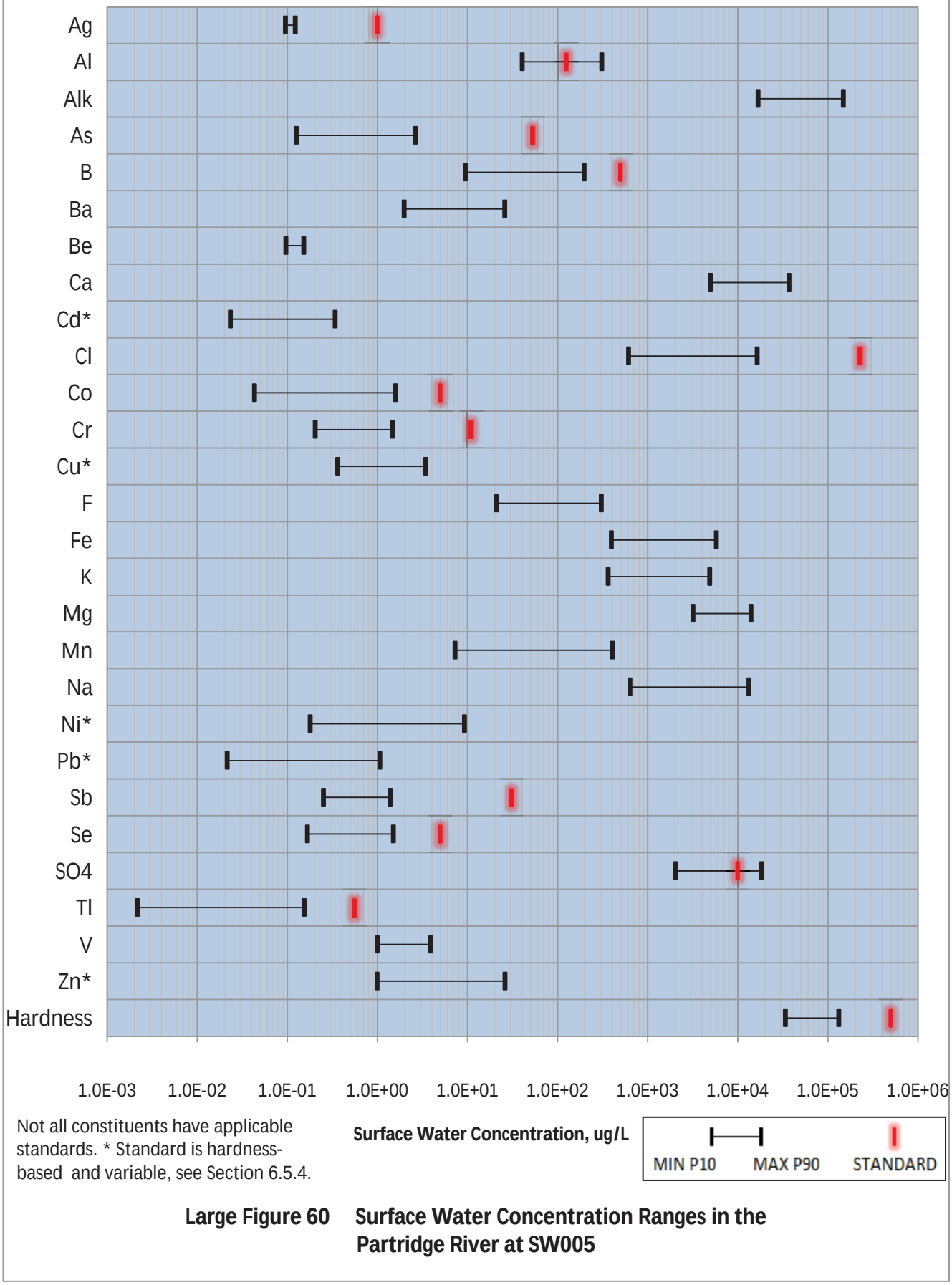


Not all constituents have applicable standards. * Standard is hardness-based and evaluated at a hardness of 102 mg/L

Large Figure 58 Surface Water Concentration Ranges in the Partridge River at SW004a

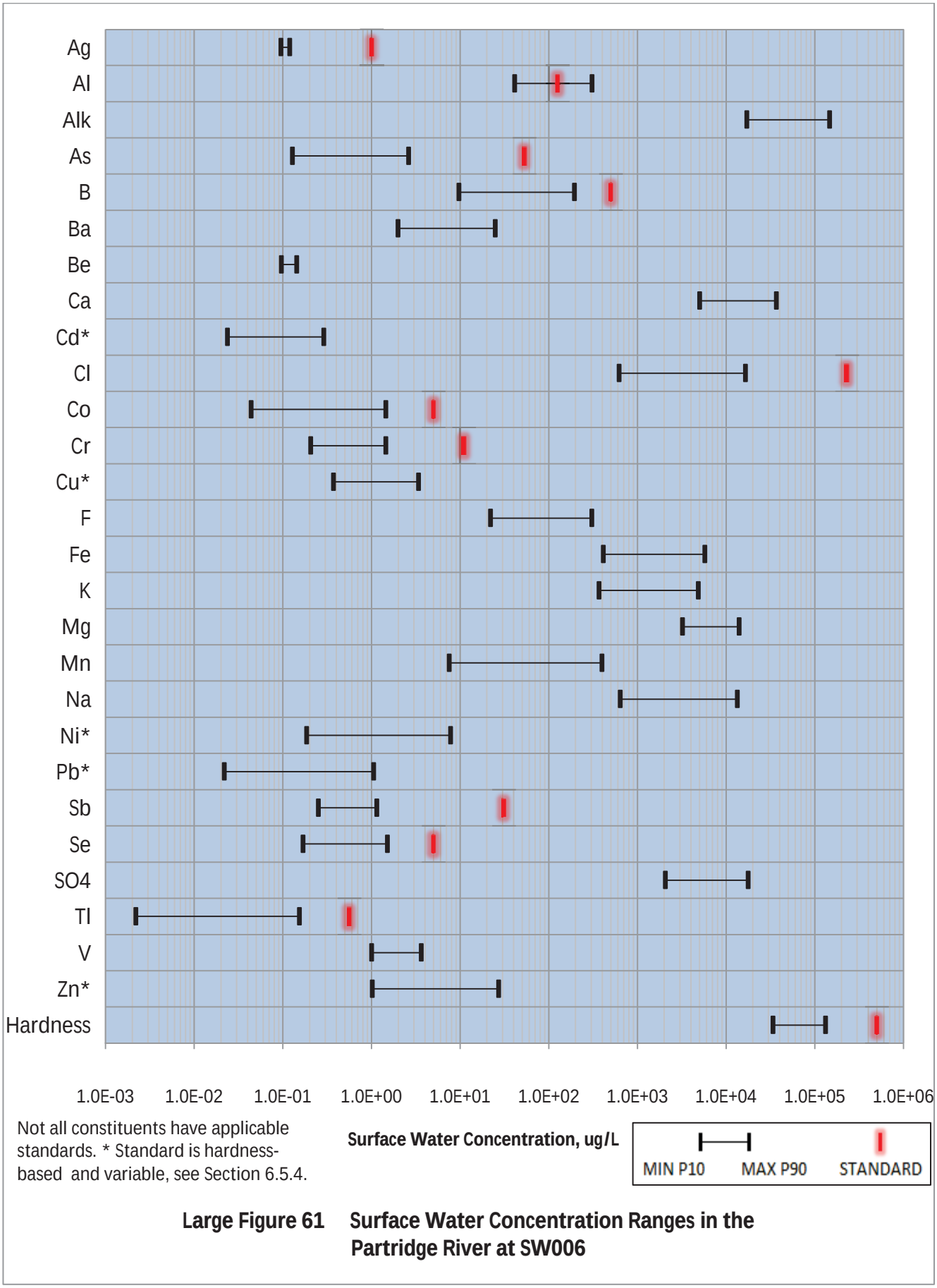


Large Figure 59 Surface Water Concentration Ranges in the Partridge River at SW004b

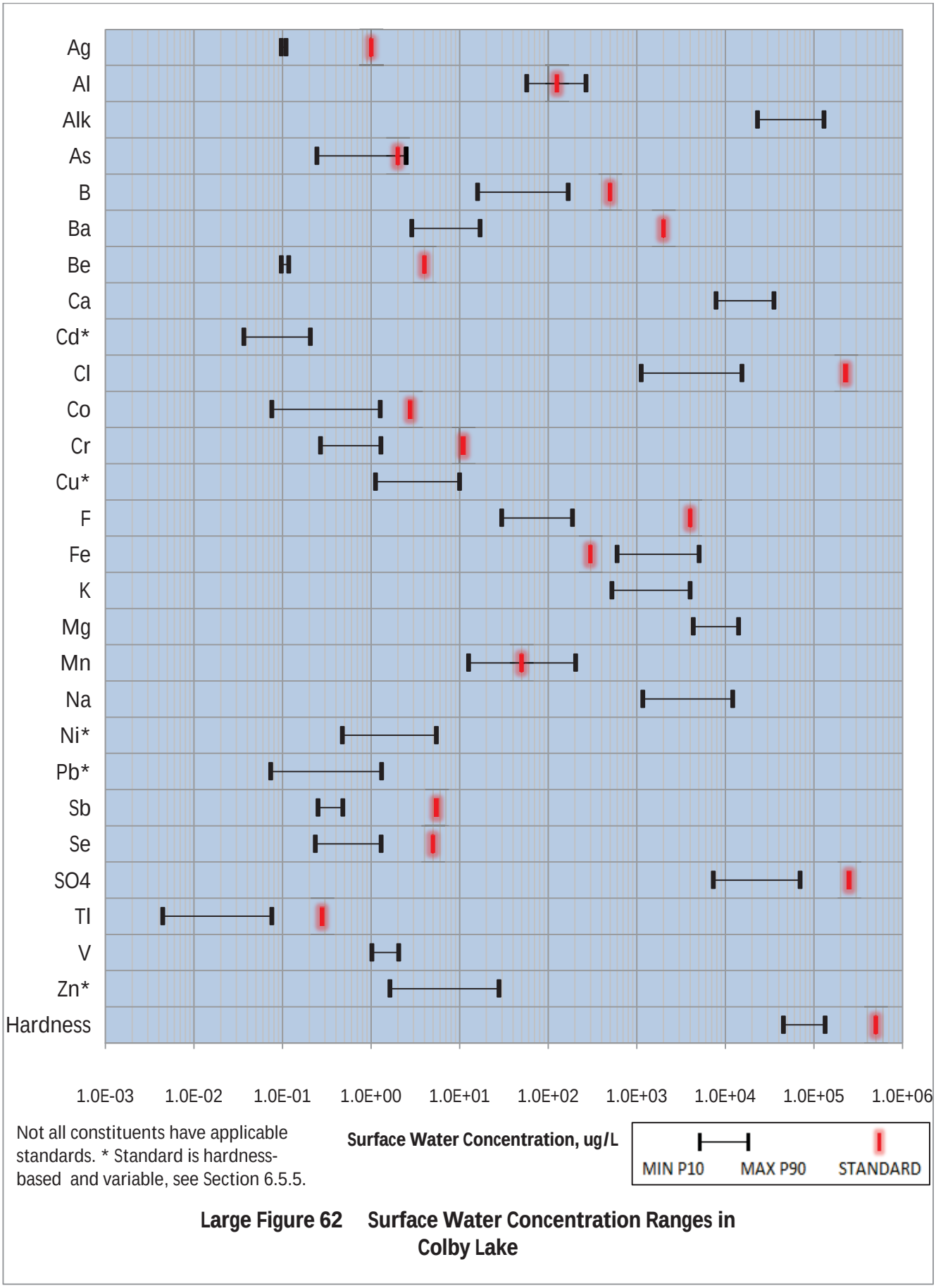


Not all constituents have applicable standards. * Standard is hardness-based and variable, see Section 6.5.4.

Large Figure 60 Surface Water Concentration Ranges in the Partridge River at SW005



Large Figure 61 Surface Water Concentration Ranges in the Partridge River at SW006



Not all constituents have applicable standards. * Standard is hardness-based and variable, see Section 6.5.5.

Large Figure 62 Surface Water Concentration Ranges in Colby Lake

Attachments

Attachment A

Boring Logs

LOG OF WELL MW-05-02

SHEET 1 OF 1

Client PolyMet Mining Corporation
Drill Contractor WDC Exploration & Wells
Project Name PolyMet Hydrogeologic Investigation
Drill Method Rotasonic
Number 23/69-862
Drilling Started 3/14/05 Ended 3/15/05
Elevation --
Location NorthMet Mine Site
Logged By Jere Mohr
Total Depth 18.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Discoloration-Odor-Sheen	Moisture	ASTM	LITHOLOGY	DESCRIPTION	WELL OR PIEZOMETER CONSTRUCTION DETAIL	DEPTH FEET
					CL		Medium brown sandy clay, upper 1' wet, then moist, very moist at 5'. Chunks of black crystalline rock at 5'.	PRO. CASING Diameter: **6 inches** Type: **Steel** Interval: **0-4 ft bgs** RISER CASING Diameter: **2 inches** Type: **PVC** Interval: **0-5 ft bgs** GROUT Type: **Cement** Interval: **0-4 ft bgs** SEAL Type: **Bentonite** Interval: **4-5 ft bgs** SANDPACK Type: **Red Flint** Interval: **5-6.5 ft bgs** SCREEN Diameter: **2 inches** Type: **PVC** Interval: **5.5-6.5 ft bgs**	
5							Duluth Complex gabbro.		5
10									10
15							End of Boring - 18 feet		15

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Telephone:
Fax:

Remarks

Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG 5 (5/27/04) 2369862.GPJ BARRLOG.GDT 1/17/06

LOG OF WELL MW-05-08

SHEET 1 OF 1

Client PolyMet Mining Corporation
Project Name PolyMet Hydrogeologic Investigation
Number 23/69-862
Location NorthMet Mine Site

Drill Contractor WDC Exploration & Wells
Drill Method Rotasonic
Drilling Started 3/16/05 Ended 3/16/05
Logged By Jere Mohr

Elevation --
Total Depth 28.5

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Discoloration-Odor-Sheen	Moisture	ASTM	LITHOLOGY	DESCRIPTION
0				Wet @ 6"	SM		Light brown medium to coarse silty sand.
5							Dark brown, well-sorted medium sand.
10				Wet	SP		
				Wet	SP		Dark brown, well-sorted fine to medium sand.
15							Grayish brown well-sorted fine to medium sand with silt.
				Wet	SP		
20				Wet	CL		Gray silty clay with granite and mafic rock fragments and pebbles. (Till)
25				Wet			
							End of Boring - 28.5 feet

WELL OR PIEZOMETER CONSTRUCTION DETAIL

PRO. CASING
Diameter: **6 inches**
Type: **Steel**
Interval: **0-5 ft bgs**

RISER CASING
Diameter: **2 inches**
Type: **PVC**
Interval: **0-7.5 ft bgs**

GROUT
Type: **Cement**
Interval: **0-5 ft bgs**

SEAL
Type: **Bentonite**
Interval: **5-7 ft bgs**

SANDPACK
Type: **Red Flint**
Interval: **7-17 ft bgs**

SCREEN
Diameter: **2 inches**
Type: **PVC**
Interval: **7.5-17.5 ft bgs**
Natural formation allowed to cave below 17.5' bgs.

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Remarks Well installed in adjacent boring (boring not logged) due to loss of casing in MW-05-08. Heaving sand - difficult drilling and well installation.

Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG 5 (5/27/04) 2369862.GPJ BARRLOG.GDT 1/17/06

LOG OF WELL MW-05-09

SHEET 1 OF 1

Client PolyMet Mining Corporation
Drill Contractor WDC Exploration & Wells
Project Name PolyMet Hydrogeologic Investigation
Drill Method Rotasonic
Number 23/69-862
Drilling Started 3/10/05 Ended 3/11/05
Elevation --
Location NorthMet Mine Site
Logged By Mark Hagley
Total Depth 13.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Discoloration-Odor-Sheen	Moisture	ASTM	LITHOLOGY	DESCRIPTION
							Topsoil.
					SP		Brown, fine-grained sand with 5-10% gravel, moist.
				Dry	SM		Gray-brown, fine-grained silty sand with up to 40% gravel, cobbles and boulders (angular), dry. Very difficult drilling (highly compacted).
5							
				Wet	SP		Brown, medium to coarse sand, uniform, wet.
							Brown silty sand with some clay and trace of gravel and cobbles, moist/wet.
10				Moist/Wet	SM		
							Gray-black, fine grained crystalline rock, magnetic (Iron formation) assumed to be a boulder.
							End of Boring - 13 feet
15							

WELL OR PIEZOMETER CONSTRUCTION DETAIL

PRO. CASING
Diameter: **6 inches**
Type: **Steel**
Interval: **0-4.5 ft bgs**

RISER CASING
Diameter: **2 inches**
Type: **PVC**
Interval: **0-7.5 ft bgs**

GROUT
Type: **Cement**
Interval: **0-4.5 ft bgs**

SEAL
Type: **Bentonite**
Interval: **4.5-6.5 ft bgs**

SANDPACK
Type: **Red Flint**
Interval: **6.5-13 ft bgs**

SCREEN
Diameter: **2 inches**
Type: **PVC**
Interval: **7.5-12.5 ft bgs**

DEPTH FEET: 5, 10, 15

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Fax:

Remarks

Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG 5 (5/27/04) 2369862.GPJ BARRLOG.GDT 1/17/06

LOG OF Boring SB-05-01

Client PolyMet Mining Corporation
Drill Contractor WDC Exploration & Wells
Project Name PolyMet Hydrogeologic Investigation
Drill Method Rotasonic
Number 23/69-862
Drilling Started 3/13/05 Ended 3/13/05
Elevation --
Location NorthMet Mine Site
Logged By Jere Mohr
Total Depth 19.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Discoloration-Odor-Sheen	Moisture	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
				Wet	CL		Light brown to gray clayey topsoil with rocks (~25%), wet at 1' bgs.	
				Wet	CL		Grayish-brown silty clay, wet.	
5					OL		Reddish-brown organic-rich silty clay.	5
							Dark brown to gray organic-rich silty clay. Rocky at ~10'. Rock is fine-grained black (Virginia Formation).	
10				Wet	OL			10
15							Black fine-grained rock (Virginia Formation).	15
				Wet				
							End of Boring - 19 feet	

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Fax:

Remarks Temp well screen (5') set from 10-15' bgs. Allowed to collapse to ~8' bgs, then bentonite chips.

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING SB-05-03

SHEET 1 OF 1

Client PolyMet Mining Corporation
Drill Contractor WDC Exploration & Wells
Project Name PolyMet Hydrogeologic Investigation
Drill Method Rotasonic
Number 23/69-862
Drilling Started 3/15/05 Ended 3/15/05
Elevation --
Location NorthMet Mine Site
Logged By Jere Mohr
Total Depth 20.5

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Discoloration-Odor-Sheen	Moisture	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
				Moist	CL		Reddish-brown sandy clay with cobbles.	
5				Wet	CL		Dark brown to gray sandy clay.	5
				Moist	CL		Reddish brown sandy clay with ~30% rocks/cobbles (Virginia Formation).	
10				Wet	SM		Gray-brown silty sand.	10
				Moist	CL		Gray sandy clay with ~20% rocks/pebbles.	
							Boulder (no recovery).	
15					CL		Very dense gray clay.	15
							Fine grained black rock (Virginia Formation).	
20							End of Boring - 20.5 feet	20

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Telephone:
Fax:

Remarks Temp well screen (5') set from 7.5' to 12.5' bgs.

Additional data may have been collected in the field which is not included on this log.

LOG OF Boring SB-05-04

SHEET 1 OF 1

Client PolyMet Mining Corporation
Drill Contractor WDC Exploration & Wells
Project Name PolyMet Hydrogeologic Investigation
Drill Method Rotasonic
Number 23/69-862
Drilling Started 3/7/05 Ended 3/8/05
Elevation --
Location NorthMet Mine Site
Logged By Mark Hagley
Total Depth 20.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Discoloration-Odor-Sheen	Moisture	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
					PT		Peat/wetland vegetation, frozen.	
					ML		Tan - brown clayey silt, uniform, moist to wet.	
5								5
					CL		Dark-gray silty clay, dense.	
					ML		Dark-gray, sandy silt with ~10% cobbles (up to 2" diameter)	
10					SM		Gray silty fine sand with 10-20% coarse gravel and cobbles (<1/2" to 3+").	10
15							Greenish-black crystalline rock - Duluth Complex gabbro.	15
							End of Boring - 20 feet	

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Fax:

Remarks Temp well screen (5') set from ~15-20' bgs, allowed to collapse from 14-20', bentonite chips from 2-14' bgs.

Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG 5 (5/27/04) 2369862.GPJ BARRLOG.GDT 1/17/06

LOG OF Boring SB-05-05

SHEET 1 OF 1

Client PolyMet Mining Corporation
Drill Contractor WDC Exploration & Wells
Project Name PolyMet Hydrogeologic Investigation
Drill Method Rotasonic
Number 23/69-862
Drilling Started 3/13/05 Ended 3/13/05
Elevation --
Location NorthMet Mine Site
Logged By Jere Mohr
Total Depth 18.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Discoloration-Odor-Sheen	Moisture	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
				Moist	CL		Dark brown to black clayey topsoil.	
							Dark black fine-grained rock (boulder).	
5								5
				Dry	SM		Medium brown silty sand.	
							Dark black fine-grained rock.	
10								10
				Dry				
15								15
							End of Boring - 18 feet	

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Telephone:
Fax:

Remarks No temp well set - dry borehole.

Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG 5 (5/27/04) 2369862.GPJ BARRLOG.GDT 1/17/06

LOG OF Boring SB-05-06

SHEET 1 OF 1

Client PolyMet Mining Corporation
Drill Contractor WDC Exploration & Wells
Project Name PolyMet Hydrogeologic Investigation
Drill Method Rotasonic
Number 23/69-862
Drilling Started 3/14/05 Ended 3/14/05
Elevation --
Location NorthMet Mine Site
Logged By Jere Mohr
Total Depth 16.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Discoloration-Odor-Sheen	Moisture	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
					OL		Organic rich dark brown clay. Frozen to 4'.	
				Wet	OL		Very loose organic rich clay.	
5							Boulder - minimal recovery. Granite recovered from ~9' bgs.	5
10				Wet	SM		Light brown silty coarse sand with pebbles.	10
				Wet	CL		Light brown silty clay with ~25% pebbles.	
15							Black fine-grained rock.	15
							End of Boring - 16 feet	

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Telephone:
Fax:

Remarks Temp well screen (5') set from 11.5 to 15.5'.

Additional data may have been collected in the field which is not included on this log.

LOG OF Boring SB-05-07

Client PolyMet Mining Corporation
Drill Contractor WDC Exploration & Wells
Project Name PolyMet Hydrogeologic Investigation
Drill Method Rotasonic
Number 23/69-862
Drilling Started 3/12/05 Ended 3/12/05
Elevation --
Location NorthMet Mine Site
Logged By Mark Hagley
Total Depth 17.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Discoloration-Odor-Sheen	Moisture	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
				Moist	SM		Brown silty sand with 10-20% cobbles and boulders (up to 4" diameter). Frost to 1.5', moist below.	
					SM		Gray/brown silty sand with trace of clay and 10-20% cobbles (<1/2" to 4").	
5								5
10					ML		Dark gray sandy silt with cobbles.	10
					SC		Very dense brown clayey sand with ~15% gravel and cobbles (to 1"). (Till)	
							Green/black coarse crystalline rock (Duluth Complex gabbro).	
15								15
							End of Boring - 17 feet	

Barr Engineering Co
Telephone:
Fax:

Remarks Temp well screen (5') set from 8-13' bgs, allowed to collapse up to 6.2', then bentonite chips above.

Additional data may have been collected in the field which is not included on this log.

LOG OF Boring SB-05-10

SHEET 1 OF 1

Client PolyMet Mining Corporation
Drill Contractor WDC Exploration & Wells
Project Name PolyMet Hydrogeologic Investigation
Drill Method Rotasonic
Number 23/69-862
Drilling Started 3/9/05 Ended 3/10/05
Elevation --
Location NorthMet Mine Site
Logged By Mark Hagley
Total Depth 14.5

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Discoloration-Odor-Sheen	Moisture	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
					PT		Peat/Organic material. Frozen.	
					SM		Fine-grained silty sand, brown, with 5-10% gravel and cobbles (up to 1/2", angular).	
5							Dark gray, fine-grained crystalline rock. Argillite (Virginia Formation).	5
10								10
15							End of Boring - 14.5 feet	15

Barr Engineering Co

Telephone:
Fax:

Remarks No temporary well set in boring; set in adjacent boring SB-05-10A

Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG 5 (5/27/04) 2369862.GPJ BARRLOG.GDT 1/17/06

LOG OF WELL SB-05-10A

Client PolyMet Mining Corporation
Drill Contractor WDC Exploration & Wells
Project Name PolyMet Hydrogeologic Investigation
Drill Method Rotasonic
Number 23/69-862
Drilling Started 3/10/05 Ended 3/10/05
Elevation --
Location NorthMet Mine Site
Logged By Mark Hagley
Total Depth 6.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Discoloration-Odor-Sheen	Moisture	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
					PT		Peat/Organic material. Frozen.	
					SM		Fine-grained silty sand, brown, with 5-10% gravel and cobbles (up to 1/2", angular).	
5					CL		Dark brown sandy clay with <5% angular gravel and cobbles (<1/2").	5
							End of Boring - 6 feet	
10								10
15								15

Barr Engineering Co

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Telephone:
Fax:

Remarks Temp well screen (4') set from 2-6' bgs, allowed to collapse to ~1.5' bgs, then bentonite chips to surface.

Additional data may have been collected in the field which is not included on this log.

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING RECORD
Minnesota Statutes, Chapter 103I

MINNESOTA UNIQUE WELL NO. 736114

WELL LOCATION

County Name: St. Louis

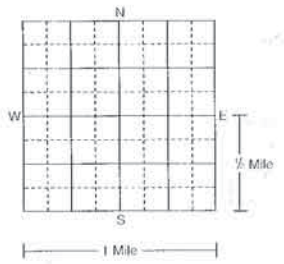
Township Name	Township No	Range No	Section No	Fraction
Babbitt	59	13	3	NW¼ SE¼ NW¼ SE¼

GPS LOCATION: Latitude ___ degrees ___ minutes ___ seconds ___ Longitude ___ degrees ___ minutes ___ seconds ___

House Number, Street Name, City, and Zip Code of Well Location: Superior National Forest

or Fire Number

Show exact location of well in section grid with "X"



Sketch map of well location. Showing property lines, roads and buildings

SEE ATTACHED

PROPERTY OWNER'S NAME/COMPANY NAME: Superior National Forest

Property owner's mailing address if different than well location address indicated above:
318 Forestry Rd.
Aurora, MN 55705

WELL OWNER'S NAME/COMPANY NAME: PolyMet Mining, Inc.

Well owner's mailing address if different than property owners address indicated above:
PO Box 475
Hoyt Lakes, MN 55705

GEOLOGICAL MATERIALS	COLOR	HARDNESS OF MATERIAL	FROM	TO
Overburden	Brown	Soft	0	7
Rocky Clay	Brown	Hard/Soft	7	11
Bedrock	Red/Gray/Bk	Hard	11	27
Bedrock	Black	Hard	27	440
Bedrock	Wht/Blk	Hard	440	610

Use a second sheet, if needed

REMARKS, ELEVATION, SOURCE OF DATA, etc: P1

IMPORTANT - FILE WITH PROPERTY PAPERS
WELL OWNER COPY 736114

WELL DEPTH (completed): 610 ft | Date Work Completed: 12/17/05

DRILLING METHOD: [ ] Cable Tool [ ] Auger [ ] Driven [x] Rotary [ ] Dug [ ] Jetted
xstratex

DRILLING FLUID: None

WELL HYDROFRACTURED? [ ] Yes [x] No FROM ___ ft TO ___ ft

USE: [ ] Domestic [ ] Noncommunity PWS [ ] Community PWS [x] Monitoring [ ] Environ. Bore Hole [ ] Irrigation [ ] Dewatering [ ] Heating/Cooling [ ] Industry/Commercial [ ] Remedial

CASING: [x] Steel [ ] Plastic; Drive Shoe? [ ] Yes [x] No; [ ] Threaded [x] Welded

HOLE DIAM

CASING DIAMETER		WEIGHT		HOLE DIAM	
6 in. to 27 ft		19	lbs./ft.	12 in. to 27 ft	
___ in. to ___ ft		___	lbs./ft.	6 in. to 610 ft	
___ in. to ___ ft		___	lbs./ft.	___ in. to ___ ft	

SCREEN: None
Make ___ Type ___ Diam ___ Slot/Gauze ___ Length ___ Set between ___ ft. and ___ ft. FITTINGS ___

OPEN HOLE: FROM 27 ft. TO 610 ft.

STATIC WATER LEVEL: 8 ft [x] below [ ] above land surface Date measured 12/17/05

PUMPING LEVEL (below land surface): 500 ft. after 36 hrs. pumping 1.2 g.p.m.

WELL HEAD COMPLETION: [ ] Pitless adapter manufacturer ___ Model ___ [ ] Casing Protection ___ [x] 12 in. above grade [ ] At-grade (Environmental Wells and Boring ONLY)

GROUTING INFORMATION: Well grouted [x] Yes [ ] No
Grout material [x] Neat cement [ ] Bentonite [ ] Concrete [ ] High Solids Bentonite

from 0 ft	to 27 ft	19	[ ] yds	[x] bags
from ___ ft	to ___ ft	___	[ ] yds	[ ] bags
from ___ ft	to ___ ft	___	[ ] yds	[ ] bags

NEAREST KNOWN SOURCE OF CONTAMINATION: None feet ___ direction ___ type ___
Well disinfected upon completion [ ] Yes [x] No

PUMP: [x] Not installed Date installed ___ Manufacturer's name ___ Model number ___ HP ___ Volts ___ Length of drop pipe ___ ft Capacity ___ g.p.m. Type: [ ] Submersible [ ] L.S. Turbine [ ] Reciprocating [ ] Jet [ ] ___

ABANDONED WELLS: Does property have any not in use and not sealed well(s) [ ] Yes [x] No

VARIANCE: Was a variance granted from the MDH for this well? [ ] Yes [x] No TN# ___

WELL CONTRACTOR CERTIFICATION
This well was drilled under my supervision and in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge.

WDC Exploration & Wells — Licensee Business Name
49653 — Lic. or Reg. No.

Mark Green — Authorized Representative Signature
1-31-06 — Date

Mark Green/Chris Fuhs — Name of Driller

HE-01205-08 (Rev. 5/02)

IC 140-0020

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING RECORD
Minnesota Statutes, Chapter 103I

MINNESOTA UNIQUE WELL NO. 736115

WELL LOCATION

County Name: St. Louis

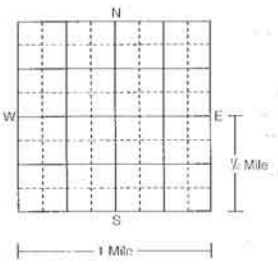
Township Name	Township No.	Range No.	Section No.	Fraction
Babbitt	59	13	2	SE SE NW

GPS LOCATION: Latitude ____ degrees ____ minutes ____ seconds ____ Longitude ____ degrees ____ minutes ____ seconds ____

House Number, Street Name, City, and Zip Code of Well Location: Hoyt Lakes, MN 55705

or Fire Number:

Show exact location of well in section grid with "X"



Sketch map of well location Showing property lines, roads and buildings

SEE ATTACHED

PROPERTY OWNER'S NAME/COMPANY NAME: Superior National Forest

Property owner's mailing address if different than well location address indicated above:
318 Forestry Rd.
Aurora, MN 55705

WELL OWNER'S NAME/COMPANY NAME: PolyMet Mining, Inc.

Well owner's mailing address if different than property owners address indicated above:
PO Box 475
Hoyt Lakes, MN 55705

GEOLOGICAL MATERIALS	COLOR	HARDNESS OF MATERIAL	FROM	TO
Clay/Rock	Blk/Brn	Sft/H	0	12
Bedrock	Red/Blk	Hard	12	27
Bedrock	Black	Hard	27	540
Bedrock	Reddish	Hard	540	610

Use a second sheet, if needed

REMARKS, ELEVATION, SOURCE OF DATA, etc: P2

IMPORTANT - FILE WITH PROPERTY PAPERS WELL OWNER COPY 736115

WELL DEPTH (completed): 610 ft. Date Work Completed: 12/13/05

DRILLING METHOD: [ ] Cable Tool [ ] Driven [ ] Dug [ ] Auger [x] Rotary [ ] Jetted [x] Stratex

DRILLING FLUID:

WELL HYDROFRACTURED? [ ] Yes [x] No FROM ____ ft. TO ____ ft.

USE: [x] Monitoring [ ] Heating/Cooling [ ] Domestic [ ] Environ. Bore Hole [ ] Industry/Commercial [ ] Noncommunity PWS [ ] Irrigation [ ] Remedial [ ] Community PWS [ ] Dewatering [ ] ____

CASING: [x] Steel [ ] Plastic; Drive Shoe? [ ] Yes [x] No; [ ] Threaded [x] Welded

CASING DIAMETER	WEIGHT	HOLE DIAM
6 in. to 27 ft.	19 lbs./ft.	12 in. to 27 ft.
____ in. to ____ ft.	____ lbs./ft.	6 in. to 610 ft.
____ in. to ____ ft.	____ lbs./ft.	____ in. to ____ ft.

SCREEN: None

Make: ____ Type: ____ Diam: ____ Slot/Gauze: ____ Length: ____ Set between ____ ft. and ____ ft. FITTINGS: ____

OPEN HOLE: FROM 27 ft. TO 610 ft.

STATIC WATER LEVEL: 11 ft. [x] below [ ] above land surface Date measured 12/13/05

PUMPING LEVEL (below land surface): 500 ft. after 36 hrs. pumping 28 g.p.m.

WELL HEAD COMPLETION: [ ] Pitless adapter manufacturer ____ Model ____ [ ] Casing Protection ____ [x] 12 in. above grade [ ] At-grade (Environmental Wells and Boring ONLY)

GROUTING INFORMATION: Well grouted [x] Yes [ ] No; Grout material [x] Neat cement [ ] Bentonite [ ] Concrete [ ] High Solids Bentonite

from 0	to 27 ft	23	[ ] yds.	[x] bags
from ____	to ____ ft	____	[ ] yds.	[ ] bags
from ____	to ____ ft	____	[ ] yds.	[ ] bags

NEAREST KNOWN SOURCE OF CONTAMINATION: None ____ feet ____ direction ____ type

Well disinfected upon completion [ ] Yes [x] No

PUMP: [x] Not installed Date installed ____

Manufacturer's name: ____ Model number: ____ HP: ____ Volts: ____ Length of drop pipe: ____ ft. Capacity: ____ g.p.m.

Type: [ ] Submersible [ ] L.S. Turbine [ ] Reciprocating [ ] Jet [ ] ____

ABANDONED WELLS: Does property have any not in use and not sealed well(s) [ ] Yes [x] No

VARIANCE: Was a variance granted from the MDH for this well? [ ] Yes [x] No TN# ____

WELL CONTRACTOR CERTIFICATION

This well was drilled under my supervision and in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge.

WDC Explortion & Wells — Licensee Business Name
49653 — Lic. or Reg. No.

Mark Green — Authorized Representative Signature
1-31-06 — Date

Mark Green/Chris Fuhs — Name of Driller

HE-01205-08 (Rev. 5/02)

IC 140-0020

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING RECORD
Minnesota Statutes, Chapter 103I

MINNESOTA UNIQUE WELL NO. 736116

WELL LOCATION

County Name: St. Louis

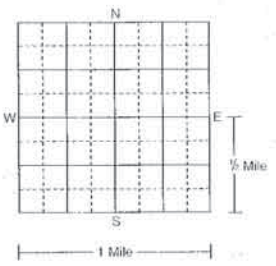
Township Name	Township No	Range No	Section No	Fraction
Babbitt	59	13	NE2SW	NE SW NE

GPS LOCATION: Latitude ___ degrees ___ minutes ___ seconds ___ Longitude ___ degrees ___ minutes ___ seconds ___

House Number, Street Name, City, and Zip Code of Well Location: Hoyt Lakes, MN 55705

or Fire Number:

Show exact location of well in section grid with "X".



Sketch map of well location Showing property lines, roads and buildings: Please see attached

PROPERTY OWNER'S NAME/COMPANY NAME: Superior National Forest

Property owner's mailing address if different than well location address indicated above:
318 Forestry Road
Aurora, MN 55705

WELL OWNER'S NAME/COMPANY NAME: PolyMet Mining, Inc.

Well owner's mailing address if different than property owners address indicated above:
PO Box 475
Hoyt Lakes, MN 55705

GEOLOGICAL MATERIALS	COLOR	HARDNESS OF MATERIAL	FROM	TO
Sand	Brown	Soft	0	3
Rock	Red	Hard	3	5
Sand/Gravel	Brown	Soft	5	10
Sand	Brown	Medium	10	17
Bedrock	Black	Hard	17	27
Bedrock	Black	Hard	27	49
Bedrock	Black	Medium	49	130
Bedrock	Black	Hard	130	610

Use a second sheet if needed

REMARKS, ELEVATION, SOURCE OF DATA, etc: P3

IMPORTANT - FILE WITH PROPERTY PAPERS WELL OWNER COPY 736116

WELL DEPTH (completed): 610 ft. Date Work Completed: 12/10/05

DRILLING METHOD: [ ] Cable Tool [ ] Driven [ ] Dug [ ] Auger [X] Rotary [ ] Jetted [X] Stratex

DRILLING FLUID:

WELL HYDROFRACTURED? [ ] Yes [X] No FROM ___ ft. TO ___ ft.

USE: [X] Monitoring [ ] Heating/Cooling [ ] Domestic [ ] Environ. Bore Hole [ ] Industry/Commercial [ ] Noncommunity PWS [ ] Irrigation [ ] Remedial [ ] Community PWS [ ] Dewatering [ ] ___

CASING: [X] Steel [ ] Plastic; Drive Shoe? [ ] Yes [X] No; [ ] Threaded [X] Welded

HOLE DIAM.

CASING DIAMETER	WEIGHT	HOLE DIAM.
6 in. to 27 ft	19 lbs./ft.	12 in. to 27 ft
___ in. to ___ ft.	___ lbs./ft.	6 in. to 610 ft
___ in. to ___ ft.	___ lbs./ft.	___ in. to ___ ft.

SCREEN None

Make ___ Type ___ Slot/Gauze ___ Set between ___ ft and ___ ft

OPEN HOLE FROM 27 ft. TO 610 ft. Diam ___ Length ___ FITTINGS ___

STATIC WATER LEVEL: 10 ft [X] below [ ] above land surface Date measured 12/10/05

PUMPING LEVEL (below land surface): 700 ft after 96 hrs. pumping 41 g.p.m.

WELL HEAD COMPLETION: [ ] Pitless adapter manufacturer ___ Model ___ [ ] Casing Protection ___ [X] 12 in. above grade [ ] At-grade (Environmental Wells and Boring ONLY)

GROUTING INFORMATION: Well grouted [X] Yes [ ] No; Grout material [X] Neat cement [ ] Bentonite [ ] Concrete [ ] High Solids Bentonite

from 0 to 27 ft	23	[ ] yds.	[X] bags
from ___ to ___ ft	___	[ ] yds.	[ ] bags
from ___ to ___ ft	___	[ ] yds.	[ ] bags

NEAREST KNOWN SOURCE OF CONTAMINATION: None ___ feet ___ direction ___ type

Well disinfected upon completion [ ] Yes [X] No

PUMP: [X] Not installed Date installed ___

Manufacturer's name ___ Model number ___ HP ___ Volts ___ Length of drop pipe ___ ft Capacity ___ g.p.m.

Type: [ ] Submersible [ ] L.S. Turbine [ ] Reciprocating [ ] Jet [ ] ___

ABANDONED WELLS: Does property have any not in use and not sealed well(s) [ ] Yes [X] No

VARIANCE: Was a variance granted from the MDH for this well? [ ] Yes [X] No TN# ___

WELL CONTRACTOR CERTIFICATION

This well was drilled under my supervision and in accordance with Minnesota Rules, Chapter 4725 The information contained in this report is true to the best of my knowledge

WDC Exploration & Wells 49653
Licensee Business Name *Lic. or Reg. No.*

Authorized Representative Signature 1-31-06 *Date*

Chris Fuhs
Name of Driller

HE-01205-08 (Rev. 5/02)

IC 140-0020

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING RECORD
Minnesota Statutes, Chapter 103I

MINNESOTA UNIQUE WELL NO. 736117

WELL LOCATION

County Name: St. Louis

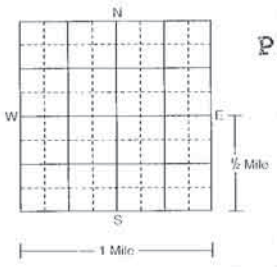
Township Name	Township No.	Range No.	Section No.	Fraction
Babbitt	59	13	2	SE NE NE

GPS LOCATION: Latitude ____ degrees ____ minutes ____ seconds ____ Longitude ____ degrees ____ minutes ____ seconds ____

House Number, Street Name, City, and Zip Code of Well Location: Hoyt Lakes, MN 55705

or Fire Number:

Show exact location of well in section grid with "X"



Sketch map of well location. Showing property lines, roads and buildings: Please see attached

PROPERTY OWNER'S NAME/COMPANY NAME: Superior National Forest

Property owner's mailing address if different than well location address indicated above:
318 Forestry Road
Aurora, MN 55705

WELL OWNER'S NAME/COMPANY NAME: PolyMet Mining, Inc.

Well owner's mailing address if different than property owners address indicated above:
PO Box 475
Hoyt Lakes, MN 55705

GEOLOGICAL MATERIALS	COLOR	HARDNESS OF MATERIAL	FROM	TO
Sand	Red/Blk	Soft	0	5
Rock Boulders	Blk/Gry	Hard	5	7
Boulder Bedrock	Gray	Hard	7	16
Boulder Bedrk	Red/Gry	Hard	16	19
Boulder Bedrk	Gray	Hard	19	25
Boulder Bedrk	Red/Gry	Med/Hard	25	26
Bedrock	Gray	Hard	26	462
Graphite	Black		462	485

Use a second sheet if needed

REMARKS, ELEVATION, SOURCE OF DATA, etc.: P4

IMPORTANT - FILE WITH PROPERTY PAPERS
WELL OWNER COPY 736117

WELL DEPTH (completed): 485 ft. Date Work Completed: 12/18/05

DRILLING METHOD: [ ] Cable Tool [ ] Driven [ ] Dug [ ] Auger [X] Rotary [ ] Jetted [X] Stratex

DRILLING FLUID: None

WELL HYDROFRACTURED? [ ] Yes [X] No FROM ____ ft. TO ____ ft.

USE: [X] Monitoring [ ] Heating/Cooling [ ] Domestic [ ] Environ. Bore Hole [ ] Industry/Commercial [ ] Noncommunity PWS [ ] Irrigation [ ] Remedial [ ] Community PWS [ ] Dewatering [ ] ____

CASING: [X] Steel [ ] Plastic; Drive Shoe? [X] Yes [ ] No; [ ] Threaded [X] Welded

CASING DIAMETER / WEIGHT

6 in. to 46 ft.	19 lbs./ft.	12 in. to 46 ft.
____ in. to ____ ft.	____ lbs./ft.	6 in. to 485 ft.
____ in. to ____ ft.	____ lbs./ft.	____ in. to ____ ft.

SCREEN: None

Make ____ Type ____ Diam. ____ Slot/Gauze ____ Length ____ Set between ____ ft. and ____ ft. FITTINGS ____

OPEN HOLE: FROM 46 ft. TO 485 ft.

STATIC WATER LEVEL: 9 ft. [X] below [ ] above land surface Date measured 12/18/05

PUMPING LEVEL (below land surface): 400 ft. after 36 hrs. pumping 40 g.p.m.

WELL HEAD COMPLETION: [ ] Pitless adapter manufacturer ____ Model ____ [ ] Casing Protection ____ [X] 12 in. above grade [ ] At-grade (Environmental Wells and Boring ONLY)

GROUTING INFORMATION: Well grouted [X] Yes [ ] No; Grout material [X] Neat cement [ ] Bentonite [ ] Concrete [ ] High Solids Bentonite

from 0	to 46 ft.	21	[ ] yds.	[X] bags
from ____	to ____ ft.	____	[ ] yds.	[ ] bags
from ____	to ____ ft.	____	[ ] yds.	[ ] bags

NEAREST KNOWN SOURCE OF CONTAMINATION: None ____ feet ____ direction ____ type

Well disinfected upon completion [ ] Yes [X] No

PUMP: [X] Not installed Date installed ____ Manufacturer's name ____ Model number ____ HP ____ Volts ____ Length of drop pipe ____ ft. Capacity ____ g.p.m. Type: [ ] Submersible [ ] L.S. Turbine [ ] Reciprocating [ ] Jet [ ] ____

ABANDONED WELLS: Does property have any not in use and not sealed well(s) [ ] Yes [X] No

VARIANCE: Was a variance granted from the MDH for this well? [ ] Yes [X] No TN# ____

WELL CONTRACTOR CERTIFICATION: This well was drilled under my supervision and in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge

WDC Exploration & Wells 49653
Licensee Business Name *Lic. or Reg. No.*

Mark Green *1-31-06*
Authorized Representative Signature *Date*

Mark Green/Chris Fuhs
Name of Driller

HE-01205-08 (Rev. 5/02)

IC 140-0020

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING RECORD
Minnesota Statutes, Chapter 103I

MINNESOTA UNIQUE WELL NO. 736121

WELL LOCATION

County Name: St. Louis

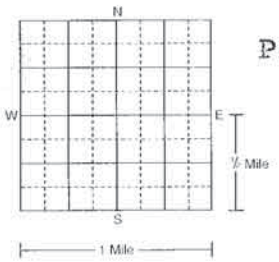
Township Name	Township No.	Range No.	Section No.	Fraction - ¼ ¼ ¼
Babbitt	59	13	3	

GPS LOCATION: Latitude N degrees 47 minutes 37 seconds 187; Longitude W degrees 91 minutes 58 seconds 567

House Number, Street Name, City, and Zip Code of Well Location: Hoyt Lakes, MN 55705

or Fire Number:

Show exact location of well in section grid with "X"



Sketch map of well location Showing property lines, roads and buildings: Please see attached

PROPERTY OWNER'S NAME/COMPANY NAME: Superior National Forest

Property owner's mailing address if different than well location address indicated above:
318 Forestry Road
Aurora, MN 55705

WELL OWNER'S NAME/COMPANY NAME: PolyMet Mining, Inc.

Well owner's mailing address if different than property owners address indicated above:
PO Box 475
Hoyt Lakes, MN 55705

GEOLOGICAL MATERIALS	COLOR	HARDNESS OF MATERIAL	FROM	TO
Rock/Sand	Brown	Hard	0	8
Rock	Gray	Hard	8	100

Use a second sheet, if needed

REMARKS, ELEVATION, SOURCE OF DATA, etc: OB1

IMPORTANT - FILE WITH PROPERTY PAPERS WELL OWNER COPY 736121

WELL DEPTH (completed): 100 ft. Date Work Completed: 12/5/05

DRILLING METHOD: [ ] Cable Tool [X] Driven [ ] Dug [ ] Auger [X] Rotary [ ] Jetted [ ]

DRILLING FLUID: None

WELL HYDROFRACTURED? [ ] Yes [X] No FROM ____ ft. TO ____ ft.

USE: [ ] Domestic [ ] Noncommunity PWS [ ] Community PWS [ ] Monitoring [ ] Environ. Bore Hole [ ] Irrigation [ ] Dewatering [ ] Heating/Cooling [ ] Industry/Commercial [X] Remedial OB [ ]

CASING: [X] Steel [ ] Plastic [ ] Drive Shoe? [ ] Yes [X] No [ ] Threaded [X] Welded [ ]

HOLE DIAM

CASING DIAMETER			WEIGHT		HOLE DIAM	
4	in. to 21	ft.	11	lbs./ft.	4	in. to 100 ft.
	in. to	ft.		lbs./ft.		in. to ft.
	in. to	ft.		lbs./ft.		in. to ft.

SCREEN None

Make ____ Type ____ Diam ____ Slot/Gauze ____ Length ____ Set between ____ ft. and ____ ft. FITTINGS ____

OPEN HOLE FROM 21 ft. TO 100 ft.

STATIC WATER LEVEL: 10 ft. [X] below [ ] above land surface Date measured 12/5/05

PUMPING LEVEL (below land surface): 100 ft. after .5 hrs. pumping 1 g.p.m.

WELL HEAD COMPLETION: [ ] Pitless adapter manufacturer ____ Model ____ [ ] Casing Protection ____ [X] 12 in. above grade [ ] At-grade (Environmental Wells and Boring ONLY)

GROUTING INFORMATION: Well grouted [X] Yes [ ] No

Grout material: [ ] Neat cement [ ] Bentonite [X] Concrete [ ] High Solids Bentonite

from 0	to 21 ft.	12	[ ] yds.	[X] bags
from ____	to ____ ft.	____	[ ] yds.	[ ] bags
from ____	to ____ ft.	____	[ ] yds.	[ ] bags

NEAREST KNOWN SOURCE OF CONTAMINATION: None ____ feet ____ direction ____ type

Well disinfected upon completion [ ] Yes [X] No

PUMP: [X] Not installed Date installed ____

Manufacturer's name ____ Model number ____ HP ____ Volts ____ Length of drop pipe ____ ft. Capacity ____ g.p.m.

Type: [ ] Submersible [ ] L.S. Turbine [ ] Reciprocating [ ] Jet [ ] ____

ABANDONED WELLS: Does property have any not in use and not sealed well(s) [ ] Yes [X] No

VARIANCE: Was a variance granted from the MDH for this well? [ ] Yes [X] No TN# ____

WELL CONTRACTOR CERTIFICATION

This well was drilled under my supervision and in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge

WDC Exploration & Wells — Licensee Business Name — 49653 Lic. or Reg. No

Mark Daniels — Authorized Representative Signature — 1-31-06 Date

Chris Fuhs — Name of Driller

HE-01205-08 (Rev. 5/02)

IC 140-0020

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING RECORD
Minnesota Statutes, Chapter 103I

MINNESOTA UNIQUE WELL NO. 736120

WELL LOCATION

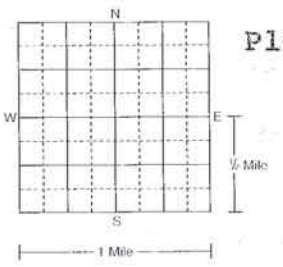
County Name: St. Louis

Township Name	Township No.	Range No.	Section No.	Fraction
Babbitt	59	13	2	¼ ¼ ¼

GPS LOCATION: Latitude N degrees 47 minutes 37 seconds 443
Longitude W degrees 91 minutes 57 seconds 538

House Number, Street Name, City, and Zip Code of Well Location: Hoyt Lakes, MN 55705
or Fire Number:

Show exact location of well in section grid with "X"



Sketch map of well location. Showing property lines, roads and buildings: Please see attached

PROPERTY OWNER'S NAME/COMPANY NAME: Superior National Forest

Property owner's mailing address if different than well location address indicated above:
318 Forestry Road
Aurora, MN 55705

WELL OWNER'S NAME/COMPANY NAME: PolyMet Mining, Inc.

Well owner's mailing address if different than property owners address indicated above:
PO Box 475
Hoyt Lakes, MN 55705

GEOLOGICAL MATERIALS	COLOR	HARDNESS OF MATERIAL	FROM	TO
Rock/Sand	Brown	Hard	0	6
Rock	Gray	Hard	6	100

Use a second sheet, if needed

REMARKS, ELEVATION, SOURCE OF DATA, etc.: OB2

IMPORTANT - FILE WITH PROPERTY PAPERS
WELL OWNER COPY 736120

WELL DEPTH (completed): 100 ft
Date Work Completed: 12/2/05

DRILLING METHOD: [ ] Cable Tool [ ] Auger [ ] _____ [X] Driven [X] Rotary [ ] Dug [ ] Jetted

DRILLING FLUID: None

WELL HYDROFRACTURED? [ ] Yes [X] No
FROM _____ ft TO _____ ft

USE: [ ] Domestic [ ] Noncommunity PWS [ ] Community PWS [ ] Monitoring [ ] Environ. Bore Hole [ ] Irrigation [ ] Dewatering [ ] Heating/Cooling [ ] Industry/Commercial [ ] Remedial [X] OB

CASING: [X] Steel [ ] Plastic [ ] _____
Drive Shoe? [ ] Yes [X] No
[ ] Threaded [X] Welded [ ] _____

CASING DIAMETER	WEIGHT	HOLE DIAM
4 in. to 18 ft.	11 lbs./ft.	4 in. to 100 ft.
_____ in. to _____ ft.	_____ lbs./ft.	_____ in. to _____ ft.
_____ in. to _____ ft.	_____ lbs./ft.	_____ in. to _____ ft.

SCREEN None
Make _____
Type _____
Slot/Gauze _____
Set between _____ ft. and _____ ft.

OPEN HOLE: FROM 18 ft. TO 100 ft.
Diam _____
Length _____
FITTINGS _____

STATIC WATER LEVEL: 11 ft [X] below [ ] above land surface Date measured 12/2/05

PUMPING LEVEL (below land surface): 100 ft after .5 hrs. pumping 1 g.p.m.

WELL HEAD COMPLETION
[ ] Pitless adapter manufacturer _____ Model _____
[ ] Casing Protection _____ [X] 12 in. above grade
[ ] At-grade (Environmental Wells and Boring ONLY)

GROUTING INFORMATION
Well grouted [ ] Yes [X] No
Grout material [ ] Neat cement [ ] Bentonite [ ] Concrete [ ] High Solids Bentonite
from _____ to _____ ft _____ [ ] yds [ ] bags
from _____ to _____ ft _____ [ ] yds [ ] bags
from _____ to _____ ft _____ [ ] yds [ ] bags

NEAREST KNOWN SOURCE OF CONTAMINATION: None feet _____ direction _____ type _____
Well disinfected upon completion [ ] Yes [X] No

PUMP
[X] Not installed Date installed _____
Manufacturer's name _____
Model number _____ HP _____ Volts _____
Length of drop pipe _____ ft. Capacity _____ g.p.m.
Type: [ ] Submersible [ ] L.S. Turbine [ ] Reciprocating [ ] Jet [ ] _____

ABANDONED WELLS
Does property have any not in use and not sealed well(s) [ ] Yes [X] No

VARIANCE
Was a variance granted from the MDH for this well? [ ] Yes [X] No TN# _____

WELL CONTRACTOR CERTIFICATION
This well was drilled under my supervision and in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge

WDC Exploration & Wells 49653
Licensee Business Name *Lic. or Reg. No.*

Authorized Representative Signature 1-31-06 *Date*

Chris Fuhs
Name of Driller

HE-01205-08 (Rev. 5/02)

IC 140-0020

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING RECORD
Minnesota Statutes, Chapter 103I

MINNESOTA UNIQUE WELL NO. 736123

WELL LOCATION

County Name: St. Louis

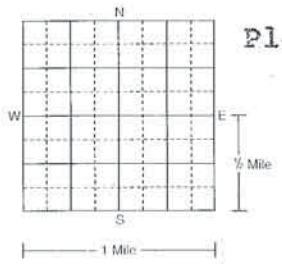
Township Name	Township No	Range No.	Section No.	Fraction
Babbitt	59	13	2	¼ ¼ ¼

GPS LOCATION 6: Latitude N degrees 47 minutes 37 seconds 557; Longitude W degrees 91 minutes 58 seconds 140

House Number, Street Name, City, and Zip Code of Well Location: Hoyt Lakes, MN 55705

or Fire Number:

Show exact location of well in section grid with "X"



Sketch map of well location Showing property lines, roads and buildings: Please see attached

PROPERTY OWNER'S NAME/COMPANY NAME: Superior National Forest

Property owner's mailing address if different than well location address indicated above:
318 Forestry Road
Aurora, MN 55705

WELL OWNER'S NAME/COMPANY NAME: PolyMet Mining, Inc.

Well owner's mailing address if different than property owners address indicated above:
PO Box 475
Hoyt Lakes, MN 55705

GEOLOGICAL MATERIALS	COLOR	HARDNESS OF MATERIAL	FROM	TO
Rock/Sand	Brown	Hard	0	7
Rock	Gray	Hard	7	100

Use a second sheet, if needed

REMARKS, ELEVATION, SOURCE OF DATA, etc: OB3

IMPORTANT - FILE WITH PROPERTY PAPERS
WELL OWNER COPY 736123

WELL DEPTH (completed): 100 ft. Date Work Completed: 12/1/05

DRILLING METHOD: [ ] Cable Tool [X] Driven [ ] Dug [ ] Auger [X] Rotary [ ] Jetted [ ]

DRILLING FLUID: None

WELL HYDROFRACTURED? [ ] Yes [X] No FROM ___ ft TO ___ ft

USE: [ ] Domestic [ ] Monitoring [ ] Heating/Cooling [ ] Noncommunity PWS [ ] Environ. Bore Hole [ ] Industry/Commercial [ ] Community PWS [ ] Irrigation [ ] Remedial [ ] Dewatering [X] OB

CASING: [X] Steel [ ] Plastic; Drive Shoe? [X] Yes [ ] No; [ ] Threaded [X] Welded

CASING DIAMETER		WEIGHT		HOLE DIAM	
4 in. to	21 ft.	11	lbs./ft.	4 in. to	100 ft.
in. to	ft.		lbs./ft.	in. to	ft.
in. to	ft.		lbs./ft.	in. to	ft.

SCREEN None
Make ___ Type ___ Slot/Gauze ___ Set between ___ ft. and ___ ft

OPEN HOLE: FROM 21 ft. TO 100 ft.
Diam ___ Length ___ FITTINGS ___

STATIC WATER LEVEL: 9 ft. [X] below [ ] above land surface Date measured 12/1/05

PUMPING LEVEL (below land surface): 100 ft. after .5 hrs. pumping 1 g.p.m.

WELL HEAD COMPLETION
[ ] Pitless adapter manufacturer ___ Model ___
[ ] Casing Protection ___ [X] 12 in. above grade
[ ] At-grade (Environmental Wells and Boring ONLY)

GROUTING INFORMATION
Well grouted [ ] Yes [X] No
Grout material [ ] Neat cement [ ] Bentonite [ ] Concrete [ ] High Solids Bentonite
from ___ to ___ ft ___ [ ] yds [ ] bags
from ___ to ___ ft ___ [ ] yds [ ] bags
from ___ to ___ ft ___ [ ] yds [ ] bags

NEAREST KNOWN SOURCE OF CONTAMINATION: None feet ___ direction ___ type ___
Well disinfected upon completion [ ] Yes [X] No

PUMP
[X] Not installed Date installed ___
Manufacturer's name ___
Model number ___ HP ___ Volts ___
Length of drop pipe ___ ft Capacity ___ g.p.m.
Type: [ ] Submersible [ ] L.S. Turbine [ ] Reciprocating [ ] Jet [ ]

ABANDONED WELLS
Does property have any not in use and not sealed well(s) [ ] Yes [X] No

VARIANCE
Was a variance granted from the MDH for this well? [ ] Yes [X] No TN# ___

WELL CONTRACTOR CERTIFICATION
This well was drilled under my supervision and in accordance with Minnesota Rules, Chapter 4725
The information contained in this report is true to the best of my knowledge.

WDC Exploration & Wells 49653
Licensee Business Name *Lic. or Reg. No.*

Mark Druce 1-31-06
Authorized Representative Signature *Date*

Chris Fuhs
Name of Driller

HE-01205-08 (Rev. 5/02)

IC 140-0020

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes, Chapter 103I

MINNESOTA UNIQUE WELL NO. 736122

WELL LOCATION

County Name: St. Louis

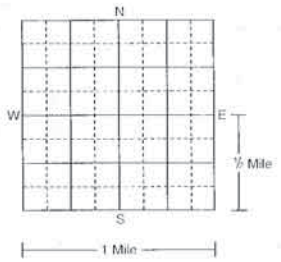
Township Name	Township No	Range No	Section No	Fraction
Babbitt	59	13	2	¼ ¼ ¼

GPS LOCATION: Latitude N degrees 47 minutes 37 seconds 559; Longitude W degrees 91 minutes 57 seconds 139

House Number, Street Name, City, and Zip Code of Well Location: Hoyt Lakes, MN 55705

or Fire Number:

Show exact location of well in section grid with "X".



Sketch map of well location Showing property lines, roads and buildings: Please see attached

PROPERTY OWNER'S NAME/COMPANY NAME: Superior National Forest

Property owner's mailing address if different than well location address indicated above:
318 Forestry Road
Aurora, MN 55705

WELL OWNER'S NAME/COMPANY NAME: PolyMet MIning, Inc.

Well owner's mailing address if different than property owners address indicated above:
PO Box 475
Hoyt Lakes, MN 55705

GEOLOGICAL MATERIALS	COLOR	HARDNESS OF MATERIAL	FROM	TO
Rock/Sand	Brown	Med/H	0	7
Rock	Gray	Hard	7	50

Use a second sheet, if needed

REMARKS, ELEVATION, SOURCE OF DATA, etc: OB3A

IMPORTANT - FILE WITH PROPERTY PAPERS WELL OWNER COPY 736122

WELL DEPTH (completed): 50 ft. Date Work Completed: 12/6/05

DRILLING METHOD: [ ] Cable Tool [ ] Auger [ ] [ ] [x] Driven [x] Rotary [ ] Dug [ ] Jetted

DRILLING FLUID: None

WELL HYDROFRACTURED? [ ] Yes [x] No FROM ft TO ft

USE: [ ] Domestic [ ] Noncommunity PWS [ ] Community PWS [ ] Monitoring [ ] Environ. Bore Hole [ ] Irrigation [ ] Dewatering [ ] Heating/Cooling [ ] Industry/Commercial [x] Remedial OB [ ]

CASING: [x] Steel [ ] Plastic; Drive Shoe? [x] Yes [ ] No; [ ] Threaded [x] Welded [ ]

CASING DIAMETER		WEIGHT		HOLE DIAM.	
4 in. to 17 ft		11	lbs./ft	4 in. to 50 ft	
in. to ft			lbs./ft	in. to ft	
in. to ft			lbs./ft.	in. to ft.	

SCREEN None

Make

Type Diam

Slot/Gauze Length

Set between ft. and ft FITTINGS

OPEN HOLE FROM 17 ft. TO 50 ft.

STATIC WATER LEVEL: 9 ft [x] below [ ] above land surface Date measured 12/6/05

PUMPING LEVEL (below land surface): 50 ft. after .5 hrs. pumping .5 g.p.m.

WELL HEAD COMPLETION: [ ] Pitless adapter manufacturer Model [ ] Casing Protection [x] 12 in. above grade [ ] At-grade (Environmental Wells and Boring ONLY)

GROUTING INFORMATION: Well grouted [ ] Yes [x] No; Grout material [ ] Neat cement [ ] Bentonite [ ] Concrete [ ] High Solids Bentonite

from to ft [ ] yds [ ] bags

from to ft [ ] yds [ ] bags

from to ft [ ] yds [ ] bags

NEAREST KNOWN SOURCE OF CONTAMINATION: None feet direction type

Well disinfected upon completion [ ] Yes [x] No

PUMP: [x] Not installed Date installed

Manufacturer's name

Model number HP Volts

Length of drop pipe ft Capacity g.p.m.

Type: [ ] Submersible [ ] L.S. Turbine [ ] Reciprocating [ ] Jet [ ]

ABANDONED WELLS: Does property have any not in use and not sealed well(s) [ ] Yes [x] No

VARIANCE: Was a variance granted from the MDH for this well? [ ] Yes [x] No TN#

WELL CONTRACTOR CERTIFICATION

This well was drilled under my supervision and in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge.

WDC Exploration & Wells — Licensee Business Name

49653 — Lic. or Reg. No.

Mark Fuhs — Authorized Representative Signature

1-31-06 — Date

Chris Fuhs — Name of Driller

HE-01205-08 (Rev. 5/02)

IC 140-0020

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING RECORD
Minnesota Statutes, Chapter 103I

MINNESOTA UNIQUE WELL NO. 736118

WELL LOCATION

County Name: St. Louis

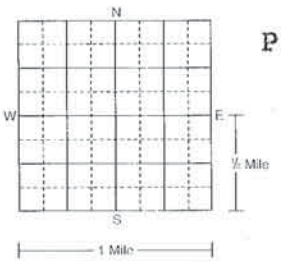
Township Name	Township No.	Range No.	Section No.	Fraction
Babbitt	59	13	2	¼ ¼ ¼

GPS LOCATION: Latitude N degrees 47 minutes 37 seconds 633
Longitude W degrees 91 minutes 56 seconds 998

House Number, Street Name, City, and Zip Code of Well Location: Hoyt Lakes, MN 55705

or Fire Number:

Show exact location of well in section grid with "X"



Sketch map of well location. Showing property lines, roads and buildings

Please see attached

PROPERTY OWNER'S NAME/COMPANY NAME: Superior National Forest

Property owner's mailing address if different than well location address indicated above:
318 Forestry Road
Aurora, MN 55705

WELL OWNER'S NAME/COMPANY NAME: PolyMet Mining, Inc.

Well owner's mailing address if different than property owners address indicated above:
PO Box 475
Hoyt Lakes, MN 55705

GEOLOGICAL MATERIALS	COLOR	HARDNESS OF MATERIAL	FROM	TO
Topsoil	Black	Soft	0	2
Clay/Sand	Brown	Medium	2	6
Rock	Gray	Hard	6	100

Use a second sheet, if needed

REMARKS, ELEVATION, SOURCE OF DATA, etc.

OB4

IMPORTANT - FILE WITH PROPERTY PAPERS
WELL OWNER COPY

736118

WELL DEPTH (completed): 100 ft
Date Work Completed: 11/19/05

DRILLING METHOD: ☐ Cable Tool ☐ Auger ☒ Driven ☒ Rotary ☐ Dug ☐ Jetted ☐ _____

DRILLING FLUID: None

WELL HYDROFRACTURED? ☐ Yes ☒ No FROM _____ ft TO _____ ft

USE: ☐ Domestic ☐ Noncommunity PWS ☐ Community PWS ☐ Monitoring ☐ Environ. Bore Hole ☐ Irrigation ☐ Dewatering ☐ Heating/Cooling ☐ Industry/Commercial ☐ Remedial ☒ OB

CASING: ☒ Steel ☐ Plastic ☐ _____ Drive Shoe? ☒ Yes ☐ No ☐ Threaded ☒ Welded

CASING DIAMETER		WEIGHT		HOLE DIAM.	
4 in. to 7 ft.		11 lbs./ft.		4 in. to 100 ft.	
_____ in. to _____ ft.		_____ lbs./ft.		_____ in. to _____ ft.	
_____ in. to _____ ft.		_____ lbs./ft.		_____ in. to _____ ft.	

SCREEN: None
Make _____ Type _____ Diam _____
Slot/Gauze _____ Length _____
Set between _____ ft. and _____ ft. FITTINGS _____

OPEN HOLE: FROM 7 ft. TO 100 ft.

STATIC WATER LEVEL: 12 ft. ☒ below ☐ above land surface Date measured 11/19/05

PUMPING LEVEL (below land surface): 100 ft. after .5 hrs. pumping 1 g.p.m.

WELL HEAD COMPLETION
☐ Pitless adapter manufacturer _____ Model _____
☐ Casing Protection _____ ☒ 12 in. above grade
☐ At-grade (Environmental Wells and Boring ONLY)

GROUTING INFORMATION
Well grouted ☐ Yes ☒ No
Grout material ☐ Neat cement ☐ Bentonite ☐ Concrete ☐ High Solids Bentonite
from _____ to _____ ft. _____ ☐ yds. ☐ bags
from _____ to _____ ft. _____ ☐ yds. ☐ bags
from _____ to _____ ft. _____ ☐ yds. ☐ bags

NEAREST KNOWN SOURCE OF CONTAMINATION: None feet _____ direction _____ type
Well disinfected upon completion ☐ Yes ☒ No

PUMP
☒ Not installed Date installed _____
Manufacturer's name _____
Model number _____ HP _____ Volts _____
Length of drop pipe _____ ft. Capacity _____ g.p.m.
Type: ☐ Submersible ☐ L.S. Turbine ☐ Reciprocating ☐ Jet ☐ _____

ABANDONED WELLS
Does property have any not in use and not sealed well(s) ☐ Yes ☒ No

VARIANCE
Was a variance granted from the MDH for this well? ☐ Yes ☒ No TN# _____

WELL CONTRACTOR CERTIFICATION
This well was drilled under my supervision and in accordance with Minnesota Rules, Chapter 4725
The information contained in this report is true to the best of my knowledge.

WDC Exploration & Wells — 49653
Licensee Business Name — *Lic. or Reg. No.*

Authorized Representative Signature — 1-31-06 *Date*

Chris Fuhs
Name of Driller

HE-01205-08 (Rev. 5/02)

IC 140-0020

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING RECORD
Minnesota Statutes, Chapter 103I

MINNESOTA UNIQUE WELL NO. 736119

WELL LOCATION

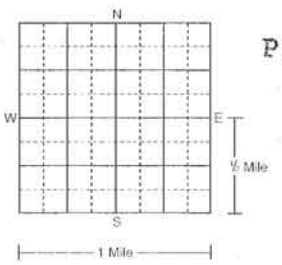
County Name: St. Louis

Township Name	Township No.	Range No.	Section No.	Fraction
Babbitt	59	13	2	¼ ¼ ¼

GPS LOCATION: Latitude N degrees 47 minutes 37 seconds 703
Longitude W degrees 91 minutes 56 seconds 677

House Number, Street Name, City, and Zip Code of Well Location: Hoyt Lakes, MN 55705
or Fire Number:

Show exact location of well in section grid with "X"



Sketch map of well location Showing property lines, roads and buildings

Please see attached

PROPERTY OWNER'S NAME/COMPANY NAME: Superior National Forest

Property owner's mailing address if different than well location address indicated above:
318 Forestry Road
Aurora, MN 55705

WELL OWNER'S NAME/COMPANY NAME: PolyMet Mining, Inc.

Well owner's mailing address if different than property owners address indicated above:
PO Box 475
Hoyt Lakes, MN 55705

GEOLOGICAL MATERIALS	COLOR	HARDNESS OF MATERIAL	FROM	TO
Topsoil	Black	Soft	0	1
Clay/Sand	Brown	Medium	1	7
Rock	Gray	Hard	7	100

Use a second sheet, if needed

REMARKS, ELEVATION, SOURCE OF DATA, etc.

ØB5

IMPORTANT - FILE WITH PROPERTY PAPERS
WELL OWNER COPY 736119

WELL DEPTH (completed): 100 ft
Date Work Completed: 11/20/05

DRILLING METHOD: ☐ Cable Tool ☒ Driven ☐ Dug ☐ Auger ☒ Rotary ☐ Jetted ☐

DRILLING FLUID: None
WELL HYDROFRACTURED? ☐ Yes ☒ No FROM ft TO ft

USE: ☐ Domestic ☐ Monitoring ☐ Heating/Cooling ☐ Noncommunity PWS ☐ Environ. Bore Hole ☐ Industry/Commercial ☐ Community PWS ☐ Irrigation ☐ Remedial ☐ Dewatering ☒ OB

CASING: ☒ Steel ☐ Plastic
Drive Shoe? ☒ Yes ☐ No ☐ Threaded ☒ Welded ☐

CASING DIAMETER	WEIGHT	HOLE DIAM.
4 in. to 18 ft	11 lbs./ft.	4 in. to 100 ft
in. to ft.	lbs./ft.	in. to ft.
in. to ft.	lbs./ft.	in. to ft.

SCREEN: None
Make
Type Diam
Slot/Gauze Length
Set between ft. and ft. FITTINGS

OPEN HOLE FROM 18 ft. TO 100 ft.

STATIC WATER LEVEL: 13 ft ☒ below ☐ above land surface Date measured 11/20/05

PUMPING LEVEL (below land surface): 100 ft. after .5 hrs. pumping 1.5 g.p.m.

WELL HEAD COMPLETION
☐ Pitless adapter manufacturer Model
☐ Casing Protection ☒ 12 in. above grade
☐ At-grade (Environmental Wells and Boring ONLY)

GROUTING INFORMATION
Well grouted ☐ Yes ☒ No
Grout material ☐ Neat cement ☐ Bentonite ☐ Concrete ☐ High Solids Bentonite
from to ft ☐ yds. ☐ bags
from to ft ☐ yds. ☐ bags
from to ft ☐ yds. ☐ bags

NEAREST KNOWN SOURCE OF CONTAMINATION: None feet direction type
Well disinfected upon completion ☐ Yes ☒ No

PUMP
☒ Not installed Date installed
Manufacturer's name
Model number HP Volts
Length of drop pipe ft. Capacity g.p.m.
Type: ☐ Submersible ☐ L.S. Turbine ☐ Reciprocating ☐ Jet ☐

ABANDONED WELLS
Does property have any not in use and not sealed well(s) ☐ Yes ☒ No

VARIANCE
Was a variance granted from the MDH for this well? ☐ Yes ☒ No TN#

WELL CONTRACTOR CERTIFICATION
This well was drilled under my supervision and in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge

WDC Exploration & Wells 49653
Licensee Business Name *Lic. or Reg. No.*

Mark Fuchs 1-31-06
Authorized Representative Signature *Date*

Chris Fuhs
Name of Driller

HE-01205-08 (Rev. 5/02)

IC 140-0020

LOG OF Boring RS-01B

Client PolyMet Mining Corporation
Drill Contractor Boart Longyear
Project Name Polymet Overburden Characterization
Drill Method Rotasonic
Number 23/69-B75 INV
Drilling Started 1/15/08 Ended 1/15/08
Elevation 1613.0
Location NorthMet Mine Site
Logged By MMB/REE
Total Depth 20.5

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH-ORP-Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
				7.05 248.1 24	Frozen	10YR 2/1 Black	OL		Organic Soil	Organic soil; 90-100% organic matter, mostly woody material. Up to 10% mineral soil.	
											1612
2										Silty sand with gravel, homogeneous, very fine- to fine-grained, angular to subrounded, fine to coarse gravel. Sand fraction is 80% quartz, 15% lithics, and 5% feldspars. Cobbles are 80% granitic rock, 15% black fine-grained metasediment (Virginia Formation?), and 5% other (foliated gneiss). **BULK SAMPLE TEST:** 1'-5' -Sieve/Hydrometer (G/S/F): 23.9/46.8/29.3 -Water Content: 8.7 -Plasticity: NP	
		1	None	5.89 256.9 10	Dry to Moist	10YR 4/4 Dark Yellowish Brown	SM				1610
4											
											1608
6									Upper Till	Sand with silt and gravel, homogeneous, medium dense, fine- to medium-grained, gravel is fine- to coarse-grained, angular to subrounded. Cobbles are 70% granitoids, 20% black fine-grained metasediment, and trace schist. Rust-colored coatings along fractures and cobble interfaces, dark red brown (7.5YR 3/4). Less than 2% dendritic or irregular mottles, fine to medium size - dark reddish brown (5YR 3/4).	
		2	None	6.55 268.1 10	Moist	10YR 3/2 Very Dark Grayish Brown	SP-SM				1606
8											
		3		5.97 258.0 17						9-10': 10% dark red (2.5YR 3/6) mottles associated with tiny fractures within matrix.	1604
										(continued)	

Barr Engineering Co.
4700 W. 77th St. Suite 200
Edina, MN 55435
Telephone: 952-832-2600
Fax: 952-832-2601

Remarks: Soil matrix and clasts were examined for visible sulfides, HCl reaction, odor, and odor after HCl. No sulfides, reaction with HCl, or unusual odors were observed, unless otherwise noted. Geochemical samples: 0-1', 1-5', 6-7', 14-15', 18-20', 20-20.5'; Geotechnical samples: 0-1', 1-5', 5-10', 10-15', 12.5-15', 15-17.5', 18-20', 20-20.5'

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-01B

Client PolyMet Mining Corporation
Project Name Polymet Overburden Characterization
Number 23/69-B75 INV
Location NorthMet Mine Site

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 1/15/08 Ended 1/15/08
Logged By MMB/REE

Elevation 1613.0
Total Depth 20.5

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH- ORP- Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
					Very Moist					Silty sand with gravel, homogeneous, medium dense, fine- to medium-grained, gravel is fine- to coarse-grained, angular to subrounded. Cobbles are 70% granitoids, 20% black fine-grained metasediment, and trace schist. Rust-colored coatings along fractures and cobble interfaces, dark red brown (7.5YR 3/4). Less than 2% dendritic or irregular mottles, fine to medium size - dark reddish brown (5YR 3/4).	1602
12			None								
		4			Wet	2.5Y 4/3 Olive Brown					1600
14				6.37 223.7 16							
							SM		Upper Till	Abundant dark red (2.5YR 3/6) staining on coarse clasts. Brownish yellow (10YR 6/6) weathering or precipitate along fractures of black, fine-grained metasediment clasts.	1598
16											
											1596
		5	None								
18				7.28 65.6 34							
											1594
										(continued)	

Barr Engineering Co.
4700 W. 77th St. Suite 200
Edina, MN 55435
Telephone: 952-832-2600
Fax: 952-832-2601

Remarks: Soil matrix and clasts were examined for visible sulfides, HCl reaction, odor, and odor after HCl. No sulfides, reaction with HCl, or unusual odors were observed, unless otherwise noted. Geochemical samples: 0-1', 1-5', 6-7', 14-15', 18-20', 20-20.5'; Geotechnical samples: 0-1', 1-5', 5-10', 10-15', 12.5-15', 15-17.5', 18-20', 20-20.5'

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-01B

Client PolyMet Mining Corporation
Drill Contractor Boart Longyear
Project Name Polymet Overburden Characterization
Drill Method Rotasonic
Number 23/69-B75 INV
Drilling Started 1/15/08 Ended 1/15/08
Elevation 1613.0
Location NorthMet Mine Site
Logged By MMB/REE
Total Depth 20.5

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH- ORP- Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
		6		8.79 -40.0 66	Moist	Gley1 3/10Y Very Dark Greenish Gray	SM		Lower Till	Silty sand, homogeneous, dense, very fine- to fine-grained sand. Gravel is fine- to coarse-grained, angular to subrounded. Cobbles are black, fine-grained metasediment and granitoid. Olive brown (2.5Y 4/3) color at bottom of borehole, irregular contact with above. Bedrock at 20.5'. End of Boring - 20.5 feet	1592
22											1590
24											1588
26											1586
28											1584

Barr Engineering Co.
4700 W. 77th St. Suite 200
Edina, MN 55435
Telephone: 952-832-2600
Fax: 952-832-2601

Remarks: Soil matrix and clasts were examined for visible sulfides, HCl reaction, odor, and odor after HCl. No sulfides, reaction with HCl, or unusual odors were observed, unless otherwise noted. Geochemical samples: 0-1', 1-5', 6-7', 14-15', 18-20', 20-20.5'; Geotechnical samples: 0-1', 1-5', 5-10', 10-15', 12.5-15', 15-17.5', 18-20', 20-20.5'

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-03

Client PolyMet Mining Corporation
Project Name Polymet Overburden Characterization
Number 23/69-B75 INV
Location NorthMet Mine Site

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 1/16/08 Ended 1/16/08
Logged By REE/JAM2

Elevation 1595.5
Total Depth 22.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH- ORP- Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
					Very Moist	2.5YR 2.5/1 Reddish Black				Fibrous peat; wood and other organic material. Note: Low recovery	
2		1									1594
4					Wet	10YR 2/1 Black	PT		Peat	Fibrous and amorphous peat, composed of primarily muddy material with trace leaf and woody organic material.	1592
6				5.17 65 116							1590
8		2									1588
											1586
										(continued)	

Barr Engineering Co.
4700 W. 77th St. Suite 200
Edina, MN 55435
Telephone: 952-832-2600
Fax: 952-832-2601

Remarks: Soil matrix and clasts were examined for visible sulfides, HCl reaction, odor, and odor after HCl. No sulfides, reaction with HCl, or unusual odors were observed, unless otherwise noted. Geochemical samples: 0-5', 5-10', 10-15', 15-20', 20-22'; Geotechnical samples: 5-10', 10-15', 15-20', 16', 19', 20-22'

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-03

Client PolyMet Mining Corporation
Project Name Polymet Overburden Characterization
Number 23/69-B75 INV
Location NorthMet Mine Site

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 1/16/08 Ended 1/16/08
Logged By REE/JAM2

Elevation 1595.5
Total Depth 22.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH- ORP- Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
					Wet					Sandy silt with a little gravel, loose, homogeneous, up to 5% organic matter from 10-12'. Sand is fine- to medium-grained, gravel is fine-grained, subangular to subrounded. Cobbles are black, fine-grained metasediment and troctolite.	1584
12		3		5.46 3 36		Gley1 5/10Y Greenish Gray	ML			12-15': No organic matter, increased gravel and sand, cobbles as above. **BULK SAMPLE TEST:** 10'-15' -Sieve/Hydrometer (G/S/F): 22.4/22.8/54.8 -Water Content: 11.3 -Plasticity: 2.6	1582
14					Wet				Upper Till		
				7.4 -208.7 50						Silty sand with gravel, homogeneous, loose, fine-grained, gravel is fine- to coarse-grained, subangular to subrounded. Cobbles are as above, also some magnetic cherty iron formation, and one pyrite-bearing rock (possibly greenstone).	1580
16											
		4			Wet		SM				1578
18				9.08 -27 37							
											1576
										(continued)	

Barr Engineering Co.
4700 W. 77th St. Suite 200
Edina, MN 55435
Telephone: 952-832-2600
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Remarks: Soil matrix and clasts were examined for visible sulfides, HCl reaction, odor, and odor after HCl. No sulfides, reaction with HCl, or unusual odors were observed, unless otherwise noted. Geochemical samples: 0-5', 5-10', 10-15', 15-20', 20-22'; Geotechnical samples: 5-10', 10-15', 15-20', 16', 19', 20-22'

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-03

Client PolyMet Mining Corporation
Project Name Polymet Overburden Characterization
Number 23/69-B75 INV
Location NorthMet Mine Site

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 1/16/08 Ended 1/16/08
Logged By REE/JAM2

Elevation 1595.5
Total Depth 22.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH- ORP- Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
		5		9.42 -200 63	Moist	Gley1 2.5/10Y Greenish Black	ML		Lower Till	Gravelly silt, homogenous, gravel is fine- to coarse-grained, subangular to subrounded. Cobbles are magnetic cherty iron formation, granitoid.	1574
22										Bedrock at 22.0', troctolite. End of Boring - 22 feet	
24											1572
26											1570
28											1568
											1566

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Remarks: Soil matrix and clasts were examined for visible sulfides, HCl reaction, odor, and odor after HCl. No sulfides, reaction with HCl, or unusual odors were observed, unless otherwise noted. Geochemical samples: 0-5', 5-10', 10-15', 15-20', 20-22'; Geotechnical samples: 5-10', 10-15', 15-20', 16', 19', 20-22'

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-04

Client PolyMet Mining Corporation
Drill Contractor Boart Longyear
Project Name Polymet Overburden Characterization
Drill Method Rotasonic
Number 23/69-B75 INV
Drilling Started 1/16/08 Ended 1/18/08
Elevation 1600.0
Location NorthMet Mine Site
Logged By REE/JAM2
Total Depth 26.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH- ORP- Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
					Wet	10YR 2/2 Very Dark Brown	OL		Organic Soil	Organic soil, composed primarily of woody material with some fine-grained organic material.	
2		1	None	5.71 124.3 22	Wet	2.5Y 3/3 Dark Olive Brown	SM		Soil	Silty sand with gravel, homogeneous, up to 10% organic material, sand is fine- to coarse-grained, gravel is subangular to subrounded. Matrix has dark reddish brown (2.5YR 3/4) mottles.	1598
4											1596
6										Silty sand with gravel, homogeneous, fine- to coarse-grained. Gravel is fine- to coarse-grained. Cobbles are fine-grained black metasediment, magnetic cherty iron formation, and granitoid.	1594
8		2	None	5.91 82 19	Wet	10YR 4/3 Brown	SM		Upper Till		1592
										(continued)	

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Remarks: Soil matrix and clasts were examined for visible sulfides, HCl reaction, odor, and odor after HCl. No sulfides, reaction with HCl, or unusual odors were observed, unless otherwise noted. Geochemical samples: 0-1', 1-5', 5-10', 10-15', 15-20', 20-25', 25-26'; Geotechnical samples: 1-5', 5-10', 10-15', 15-20', 20-25'

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-04

Client PolyMet Mining Corporation
Project Name Polymet Overburden Characterization
Number 23/69-B75 INV
Location NorthMet Mine Site

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 1/16/08 Ended 1/18/08
Logged By REE/JAM2

Elevation 1600.0
Total Depth 26.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH- ORP- Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
										Silty sand with gravel, homogeneous, same as the 5-10' interval.	
										BULK SAMPLE TEST: 10'-15' -Sieve/Hydrometer (G/S/F): 19.2/59.8/21.0 -Water Content: 10.9 -Plasticity: NP	
12		3	None	6.33 104.5 25	Wet	Transitional Mottling	SM			13-15': Gradational change in color and texture to 15-20' interval.	1588
14									Upper Till		1586
										Silty sand with gravel, homogeneous, fine- to coarse-grained. Gravel is fine- to coarse-grained, subangular to subrounded. Cobbles as above.	
16			None	6.74 -90 25						**BULK SAMPLE TEST:** 15'-20' -Sieve/Hydrometer (G/S/F): 18.0/59.3/22.7 -Water Content: 13.5 -Plasticity: NP	1584
		4			Wet	10YR 3/1 Very Dark Gray	SM				
18			None	6.85 -81.6 25					Lower Till	19-20': Matrix contains possible sulfide flakes or secondary mineralization.	1582
										20': Several troctolite cobbles with sulfide minerals.	
										(continued)	

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Remarks: Soil matrix and clasts were examined for visible sulfides, HCl reaction, odor, and odor after HCl. No sulfides, reaction with HCl, or unusual odors were observed, unless otherwise noted. Geochemical samples: 0-1', 1-5', 5-10', 10-15', 15-20', 20-25', 25-26'; Geotechnical samples: 1-5', 5-10', 10-15', 15-20', 20-25'

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-04

Client PolyMet Mining Corporation
Project Name Polymet Overburden Characterization
Number 23/69-B75 INV
Location NorthMet Mine Site

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 1/16/08 Ended 1/18/08
Logged By REE/JAM2

Elevation 1600.0
Total Depth 26.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH- ORP- Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
										Silty sand with gravel, homogeneous, fine- to coarse-grained. Gravel is fine- to coarse-grained, subangular to subrounded. Matrix has possible secondary sulfide mineralization. Cobbles are sulfide-bearing troctolite, fine-grained black metasediment, magnetic cherty iron formation, and granitoid.	
22		5	None	7.83 -87.6 17	Wet	10YR 3/1 Very Dark Gray	SM		Lower Till		1578
24			None		Dry	Gley1 2.5/N Black to Gley1 6/1 Greenish Gray	GP-GM			Gravel with silt and sand, fine- to coarse-grained. Cobbles are as above.	1576
		6		8.10 173.0 94					Bed-rock	Bedrock at 25'. Sulfide-bearing troctolite.	
26										End of Boring - 26 feet	1574
28											1572

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Remarks: Soil matrix and clasts were examined for visible sulfides, HCl reaction, odor, and odor after HCl. No sulfides, reaction with HCl, or unusual odors were observed, unless otherwise noted. Geochemical samples: 0-1', 1-5', 5-10', 10-15', 15-20', 20-25', 25-26'; Geotechnical samples: 1-5', 5-10', 10-15', 15-20', 20-25'

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-05A

Client PolyMet Mining Corporation
Project Name Polymet Overburden Characterization
Number 23/69-B75 INV
Location NorthMet Mine Site

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 1/18/08 Ended 1/18/08
Logged By REE

Elevation 1605.0
Total Depth 13.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH- ORP- Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
										Low recovery on RS-05A for 0-5'. See R5-05B log for description.	
			None	6.42 124.5 30	Moist	7.5YR 3/3 Dark Brown					1604
2		1					SM				1602
4									Upper Till		
										Silty sand with gravel, homogeneous, fine- to coarse-grained. Gravel is fine- to medium- grained, subangular to subrounded. Up to 1% organic matter. Cobbles are 60% granitoid, 30% black fine-grained metasediment, 5% cherty iron formation, and trace greenstone. Rust-colored staining on some clast surfaces.	1600
6			None	6.55 88.7 22		10YR 3/4 Dark Yellow Brown	SM				
		2			Moist						1598
8						2.5Y 4/2 Dark Gray Brown				Silty sand with gravel, transitional color change with above. Cobbles are same lithologies as above. **BULK SAMPLE TEST:** 6'-11.5' -Sieve/Hydrometer (G/S/F): 27.9/46.2/25.9 -Water Content: 12 -Plasticity: NP Note: Geotechnical laboratory homogenized 6-11.5' interval. Grain size analysis indicates 28% gravel, 46% sand, and 26% silt.	
					Moist		SM				1596
			None	6.49 166.6 19							
										(continued)	

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Remarks: Soil matrix and clasts were examined for visible sulfides, HCl reaction, odor, and odor after HCl. No sulfides, reaction with HCl, or unusual odors were observed, unless otherwise noted. Geochemical samples: 5-10', 10-13'; Geotechnical samples: 0-1', 5-6', 6-11.5', 10-11.5', 11.5-13'

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-05A

Client PolyMet Mining Corporation
Project Name Polymet Overburden Characterization
Number 23/69-B75 INV
Location NorthMet Mine Site

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 1/18/08 Ended 1/18/08
Logged By REE

Elevation 1605.0
Total Depth 13.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH- ORP- Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
						2.5Y 4/2 Dark Gray Brown	GM		Upper Till	Silty gravel with sand, fine- to coarse-grained, subangular to subrounded. Cobbles are 60% troctolite, 30% granitoid, 5% magnetic cherty iron formation with rust-colored staining, and 5% black fine-grained metasediment with rust-colored staining. **BULK SAMPLE TEST:** 10'-11.5' -Sieve/Hydrometer (G/S/F): 64.3/23.1/12.6 -Water Content: 7.2 -Plasticity: NP	1594
		3			Wet					As above, increased clay content, gray.	
12			None	8.9 -70 88		2.5Y 5/1 Gray	GM			**BULK SAMPLE TEST:** 11.5'-13' -Sieve/Hydrometer (G/S/F): 61.0/24.0/15.0 -Water Content: 6.6 -Plasticity: 1.2	1592
										Bedrock at 13.0', troctolite. End of Boring - 13 feet	
14											1590
16											1588
18											1586

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Remarks: Soil matrix and clasts were examined for visible sulfides, HCl reaction, odor, and odor after HCl. No sulfides, reaction with HCl, or unusual odors were observed, unless otherwise noted. Geochemical samples: 5-10', 10-13'; Geotechnical samples: 0-1', 5-6', 6-11.5', 10-11.5', 11.5-13'

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-05B

SHEET 1 OF 1

Client PolyMet Mining Corporation
Drill Contractor Boart Longyear
Project Name Polymet Overburden Characterization
Drill Method Rotasonic
Number 23/69-B75 INV
Drilling Started 1/18/08 Ended 1/18/08
Elevation 1605.0
Location NorthMet Mine Site
Logged By REE
Total Depth 5.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH- ORP- Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
						10YR 4/4 Dark Yellowish Brown				Silty sand with gravel, homogeneous, fine- to coarse-grained. Gravel is fine- to coarse-grained, angular to subrounded. Cobbles are 50% granitoid, 30% fine-grained, black metasediment, 20% magnetic cherty iron formation, and trace greenstone or silica rocks (possible Archean).	1604
2			None	6.13 179.0 21							
		1			Moist		SM		Upper Till		1602
			None	6.54 187.0 26		10YR 4/2 Dark Grayish Brown				3.5-4': Lens of dark grayish brown silty sand with gravel.	
4			None	6.25 193.0 25		SA 1-3.5'					
										End of Boring - 5 feet	1600
6											1598
8											1596

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Remarks: Soil matrix and clasts were examined for visible sulfides, HCl reaction, odor, and odor after HCl. No sulfides, reaction with HCl, or unusual odors were observed, unless otherwise noted. Geochemical samples: 1-5'; Geotechnical samples: 1-3.5', 3.5', 3.5-4'

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-06A

Client PolyMet Mining Corporation
Project Name Polymet Overburden Characterization
Number 23/69-B75 INV
Location NorthMet Mine Site

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 1/26/08 Ended 1/26/08
Logged By MMB/MJD/REE

Elevation 1611.0
Total Depth 21.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH- ORP- Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
			None	4.45 290.3 6		10YR 4/4 Dark Yellowish Brown	SM		Soil	Silty sand, up to 20% organic matter, homogeneous, sand is fine- to coarse-grained, gravel is fine- to coarse- grained, subrounded to subangular. Matrix is magnetic. Sand fraction is 70% quartz, 10% feldspar, and 20% white fragments. Cobbles are 75% black fine-grained metasediment, 20% magnetic iron formation, and 5% granitoid.	
			None			7.5YR 3/2 Dark Brown	SM			Silty sand, up to 30-40% organic matter, homogeneous, sand is fine- to coarse-grained. Matrix has dark-brown to black organic masses and lenses. Sand fraction is 40% quartz, 50% feldspar, and 10% lithic fragments. Cobbles are 90% granitoid, 5% fine-grained black metasediment, and 5% magnetic iron formation.	1610
2				4.84 313.0 5	Moist					Silty sand with gravel, homogeneous, sand is fine- to medium-grained, gravel is fine- to coarse grained. Matrix has less than 5% mottles, black (5YR 2.5/1) and yellowish red (5YR 4/6), and is magnetic. Sand fraction is 50% quartz, 40% feldspar, and 10% lithic fragments. Cobbles are 70% granitoid, 30% gabbroic (or possibly recrystallized metasediment) - abundant, rust staining. Large granitoid boulder from 3.5-4.5'.	
		1									1608
			None	4.99 279 11		7.5YR 3/4 Dark Brown	SM				
4					Dry						
				5.03 316 8							
										Sandy silt with gravel, firm, laminated, sand is fine- to medium-grained, gravel is fine- to medium-grained. Matrix is magnetic and has abundant mottles (30-40%), dark yellowish gray (10YR 4/6) and grayish brown (2.5YR 5/2). Sand fraction is 70% quartz, 20% feldspar, and 10% lithic fragments. Cobbles are 80% magnetic chert iron formation, 10% granitoid, and 10% fine-grained black metasediment.	1606
6			None	5.82 264 12			ML/ CL-ML		Upper Till	**BULK SAMPLE TEST:** 3.5'-7.5' -Sieve/Hydrometer (G/S/F): 16.7/25.9/57.4 -Water Content: 13.9 -Plasticity: 3.1	1604
		2				10YR 4/3 Brown				Silty sand with gravel, dense, homogeneous, sand is fine- to coarse-grained, gravel is fine- to coarse-grained. Matrix is slightly magnetic, has less than 5% disseminated mottles, very dark gray (10YR 3/1), dark brown (7.5YR 3/4), dark yellowish brown (10YR 4/6), and black mottles associated with rootlets. Increased mottles at 10-12'. Matrix has a faint rotten egg odor below 15', increasing odor with depth. Sand fraction lithology transition from 70% quartz, 10% feldspar, and 20% lithic fragments to 15% quartz, 65% feldspar, and 20% lithic fragments at 10'. Cobbles are 70% iron formation rocks (magnetic and non-magnetic), 25% granitoid, 5% other (troctolite, gabbroic).	
8										**BULK SAMPLE TEST:** 7.5'-10' -Sieve/Hydrometer (G/S/F): 23.6/48.0/28.4 -Water Content: 8.2 -Plasticity: 0.7	1602
				6.32 251 17			SM				

(continued)

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Remarks: Soil matrix and clasts were examined for visible sulfides, HCl reaction, odor, and odor after HCl. No sulfides, reaction with HCl, or unusual odors were observed, unless otherwise noted. Geochemical samples: 0.5-2', 2-4', 5-7.5', 7.5-10', 10-15', 15-19', 19-21'; Geotechnical samples: 0-1', 1-2', 2-3.5', 3.5-7.5', 7.5-10', 10-15', 15-21'; Shelby tubes: 6-7', 15-16', 16-18'

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-06A

Client PolyMet Mining Corporation
Project Name Polymet Overburden Characterization
Number 23/69-B75 INV
Location NorthMet Mine Site

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 1/26/08 Ended 1/26/08
Logged By MMB/MJD/REE

Elevation 1611.0
Total Depth 21.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH- ORP- Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
					Moist					Silty sand with gravel, dense, homogeneous, sand is fine- to coarse-grained, gravel is fine- to coarse-grained. Matrix is slightly magnetic, has less than 5% disseminated mottles, very dark gray (10YR 3/1), dark brown (7.5YR 3/4), dark yellowish brown (10YR 4/6), and black mottles associated with rootlets. Increased mottles at 10-12'. Matrix has a faint rotten egg odor below 15', increasing odor with depth. Sand fraction lithology transition from 70% quartz, 10% feldspar, and 20% lithic fragments to 15% quartz, 65% feldspar, and 20% lithic fragments at 10'. Cobbles are 70% iron formation rocks (magnetic and non-magnetic), 25% granitoid, 5% other (troctolite, gabbroic).*(continued)*	1600
12		3	None	6.81 235 17						**BULK SAMPLE TEST:** 10'-15' -Sieve/Hydrometer (G/S/F): 21.4/49.0/29.6 -Water Content: 6.8 -Plasticity: NP	1598
14					Moist to Wet	10YR 4/3 Brown	SM		Upper Till		1596
16		4		6.75 38 18							1594
18				7.86 18.0 20	Wet						1592
										(continued)	

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Remarks: Soil matrix and clasts were examined for visible sulfides, HCl reaction, odor, and odor after HCl. No sulfides, reaction with HCl, or unusual odors were observed, unless otherwise noted. Geochemical samples: 0.5-2', 2-4', 5-7.5', 7.5-10', 10-15', 15-19', 19-21'; Geotechnical samples: 0-1', 1-2', 2-3.5', 3.5-7.5', 7.5-10', 10-15', 15-21'; Shelby tubes: 6-7', 15-16', 16-18'

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-06A

Client PolyMet Mining Corporation
Project Name Polymet Overburden Characterization
Number 23/69-B75 INV
Location NorthMet Mine Site

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 1/26/08 Ended 1/26/08
Logged By MMB/MJD/REE

Elevation 1611.0
Total Depth 21.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH-ORP-Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
		5					SM		Upper Till		
										End of Boring - 21 feet	1590
22											1588
24											1586
26											1584
28											1582

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Remarks: Soil matrix and clasts were examined for visible sulfides, HCl reaction, odor, and odor after HCl. No sulfides, reaction with HCl, or unusual odors were observed, unless otherwise noted. Geochemical samples: 0.5-2', 2-4', 5-7.5', 7.5-10', 10-15', 15-19', 19-21'; Geotechnical samples: 0-1', 1-2', 2-3.5', 3.5-7.5', 7.5-10', 10-15', 15-21'; Shelby tubes: 6-7', 15-16', 16-18'

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-06R

Client PolyMet Mining Corporation
Project Name Polymet Overburden Characterization
Number 23/69-B75 INV
Location NorthMet Mine Site

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 1/29/08 Ended 1/29/08
Logged By MMB

Elevation 1611.0
Total Depth 21.5

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH-ORP-Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
							SM		Soil	See RS-06A, 0-1' for description.	
							SM			See RS-06A, 1-2' for description.	1610
2		1					SM			See RS-06A, 2-4.75' for description.	1608
4							CL			See RS-06A, 4.75-7.5' for description. **BULK SAMPLE TEST:** 3.5'-7.5' -Sieve/Hydrometer (G/S/F): 16.7/25.9/57.4 -Water Content: 13.9 -Plasticity: 3.1	1606
6									Upper Till	See RS-06A, 7.5-21.0' for description.	1604
8		2					SM			**BULK SAMPLE TEST:** 7.5'-10' -Sieve/Hydrometer (G/S/F): 23.6/48.0/28.4 -Water Content: 8.2 -Plasticity: 0.7	1602

(continued)

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Remarks: Soil matrix and clasts were examined for visible sulfides, HCl reaction, odor, and odor after HCl. No sulfides, reaction with HCl, or unusual odors were observed, unless otherwise noted. See RS-06A log for sampling intervals.

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-06R

Client PolyMet Mining Corporation
Project Name Polymet Overburden Characterization
Number 23/69-B75 INV
Location NorthMet Mine Site

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 1/29/08 Ended 1/29/08
Logged By MMB

Elevation 1611.0
Total Depth 21.5

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH-ORP-Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
										See RS-06A, 7.5-21.0' for description.*(continued)*	
										BULK SAMPLE TEST: 10'-15' -Sieve/Hydrometer (G/S/F): 21.4/49.0/29.6 -Water Content: 6.8 -Plasticity: NP	1600
12		3									1598
14							SM		Upper Till		1596
16		4									1594
18											1592
										(continued)	

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Remarks: Soil matrix and clasts were examined for visible sulfides, HCl reaction, odor, and odor after HCl. No sulfides, reaction with HCl, or unusual odors were observed, unless otherwise noted. See RS-06A log for sampling intervals.

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-06R

Client PolyMet Mining Corporation
Drill Contractor Boart Longyear
Project Name Polymet Overburden Characterization
Drill Method Rotasonic
Number 23/69-B75 INV
Drilling Started 1/29/08 Ended 1/29/08
Elevation 1611.0
Location NorthMet Mine Site
Logged By MMB
Total Depth 21.5

DEPTH FEET	SAMP. LENGTH & RECOVERY / SAMP. NUMBER	Matrix Effervescence	Soil pH-ORP-Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
						SM		Upper Till	See RS-06A, 7.5-21.0' for description.*(continued)*	
								Bed-rock	Bedrock at 21.0'. Troctolite piece, 4" thick.	1590
									End of Boring - 21.5 feet	
22										1588
24										1586
26										1584
28										1582

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Remarks: Soil matrix and clasts were examined for visible sulfides, HCl reaction, odor, and odor after HCl. No sulfides, reaction with HCl, or unusual odors were observed, unless otherwise noted. See RS-06A log for sampling intervals.

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-07

Client PolyMet Mining Corporation
Project Name Polymet Overburden Characterization
Number 23/69-B75 INV
Location NorthMet Mine Site

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 1/24/08 Ended 1/24/08
Logged By MMB/MJD/REE

Elevation 1608.0
Total Depth 11.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH- ORP- Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
					Frozen	10YR 2/2 Very Dark Brown	OL		Organic Material	Organic material; grass, roots, twigs. **BULK SAMPLE TEST:** 0'-2' -Sieve/Hydrometer (G/S/F): 25.0/42.4/32.6 -Water Content: -- -Plasticity: NP	
			None	5.61 97.8 45	Wet	10YR 2/2 Very Dark Brown	OL/OH			95% organic material (roots, grass, branches). Mineral component is silty sand with gravel. Less than 5% dark brown (10YR 3/3) mottles from 1.5-2'.	
2									Soil		1606
		1	None		Moist	2.5Y 3/3 Dark Olive Brown	SM			Gravelly silty sand, 5% organic material, sand is fine- to medium-grained. Less than 5% mottles and layers, dark brown (7.5YR 3/3). **BULK SAMPLE TEST:** 2'-3' -Sieve/Hydrometer (G/S/F): 40.1/41.5/18.4 -Water Content: 24.8 -Plasticity: NP	
				6.10 27.0 52						Gravelly silty sand, homogeneous, trace organic matter, sand is fine- to coarse-grained, gravel is fine- to coarse-grained, subrounded to subangular. Matrix is mottled: irregular, very dark brown (7.5YR 2/2) and minor strong brown (7.5YR 5/8) mottles. Sand fraction is 10% quartz, 10% feldspar, and 80% lithic fragments. Cobbles are 90% fine-grained black metasediment, 5% black cherty iron formation, and 5% granitoid.	
4						7.5YR 3/3 Dark Brown					1604
			None		Moist		SM			**BULK SAMPLE TEST:** 2'-5' -Sieve/Hydrometer (G/S/F): 37.9/44.3/17.8 -Water Content: 19.8 -Plasticity: NP	
6											1602
				6.40 60.0 17					Upper Till	Sand with silty gravel, homogeneous, sand is fine- to coarse-grained, gravel is fine- to coarse-grained, subrounded to subangular. Sandier and slightly drier toward 10'. Sand fraction and cobble lithologies are same as 3-6' interval.	
		2	None			5Y 2.5/1 Black				**BULK SAMPLE TEST:** 6'-10' -Sieve/Hydrometer (G/S/F): 47.0/39.2/13.8 -Water Content: 8.7 -Plasticity: NP	
8					Moist		GM				1600
				6.61 38.0 24							
										(continued)	

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Remarks: Soil matrix and clasts were examined for visible sulfides, HCl reaction, odor, and odor after HCl. No sulfides, reaction with HCl, or unusual odors were observed, unless otherwise noted. Geochemical samples: 1-2', 2-3', 3-5', 5-6', 6-10', 10-11'; Geotechnical samples: 0-2', 2-5', 8-10', 10-11'

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-07

Client PolyMet Mining Corporation
Drill Contractor Boart Longyear
Project Name Polymet Overburden Characterization
Drill Method Rotasonic
Number 23/69-B75 INV
Drilling Started 1/24/08 Ended 1/24/08
Elevation 1608.0
Location NorthMet Mine Site
Logged By MMB/MJD/REE
Total Depth 11.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH- ORP- Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
		3	None	7.15 -23.0 19	Wet	Gley1 2.5/10Y Greenish Black	GP-GM		Lower Till	Sandy gravel with silt, homogeneous, sand is fine-grained, gravel is fine- to coarse-grained, angular to subrounded. Matrix has a rotten egg odor after HCL, and a very dark brown (10YR 2/2) layer from 10-10.25'. Sand fraction is 50% quartz, 10% feldspar, and 40% lithic fragments. **BULK SAMPLE TEST:** 10'-11' -Sieve/Hydrometer (G/S/F): 58.8/30.3/10.9 -Water Content: 9.5 -Plasticity: NP Bedrock at 11.0'. End of Boring - 11 feet	
12											1596
14											1594
16											1592
18											1590

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Remarks: Soil matrix and clasts were examined for visible sulfides, HCl reaction, odor, and odor after HCl. No sulfides, reaction with HCl, or unusual odors were observed, unless otherwise noted. Geochemical samples: 1-2', 2-3', 3-5', 5-6', 6-10', 10-11'; Geotechnical samples: 0-2', 2-5', 8-10', 10-11'

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-07R

Client PolyMet Mining Corporation
Project Name Polymet Overburden Characterization
Number 23/69-B75 INV
Location NorthMet Mine Site

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 1/29/08 Ended 1/29/08
Logged By MMB

Elevation 1608.0
Total Depth 14.5

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH-ORP-Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
							OL		Organic Material	See RS-07 for description.	
							OL/OH				
2									Soil	**BULK SAMPLE TEST:** 2'-3' -Sieve/Hydrometer (G/S/F): 40.1/41.5/18.4 -Water Content: 24.8 -Plasticity: NP	1606
		1					SM				
4							SM				1604
6									Upper Till	**BULK SAMPLE TEST:** 6'-10' -Sieve/Hydrometer (G/S/F): 47.0/39.2/13.8 -Water Content: 8.7 -Plasticity: NP	1602
		2					GM				
8											1600
									Lower Till		

(continued)

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Remarks: Soil matrix and clasts were examined for visible sulfides, HCl reaction, odor, and odor after HCl. No sulfides, reaction with HCl, or unusual odors were observed, unless otherwise noted. Geochemical samples: 10-12', 13.5-14.5'; Geotechnical samples: 1-2', 2-3', 3-6', 6-10', 10-14.5'

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-07R

Client PolyMet Mining Corporation
Drill Contractor Boart Longyear
Project Name Polymet Overburden Characterization
Drill Method Rotasonic
Number 23/69-B75 INV
Drilling Started 1/29/08 Ended 1/29/08
Elevation 1608.0
Location NorthMet Mine Site
Logged By MMB
Total Depth 14.5

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH-ORP-Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
		3		6.63 -125 51					Lower Till	Possible fractured bedrock at 9.5' or boulders on bedrock. Soil in fractures. Sample is 0.5-4" thick core pieces of biotite argillite of Virginia formation. Rinse test at 14' has silver metallic sheen (floating graphite from graphite-bearing Virginia formation rocks?).*(continued)*	
12									Bed-rock		1596
14				7.48 -152 82						End of Boring - 14.5 feet	1594
16											1592
18											1590

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Remarks: Soil matrix and clasts were examined for visible sulfides, HCl reaction, odor, and odor after HCl. No sulfides, reaction with HCl, or unusual odors were observed, unless otherwise noted. Geochemical samples: 10-12', 13.5-14.5'; Geotechnical samples: 1-2', 2-3', 3-6', 6-10', 10-14.5'

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-08A

Client: PolyMet Mining Corporation
Project Name: Polymet Overburden Characterization
Number: 23/69-B75 INV
Location: NorthMet Mine Site

Drill Contractor: Boart Longyear
Drill Method: Rotasonic
Drilling Started: 1/26/08 Ended: 1/26/08
Logged By: MMB/MJD

Elevation: 1591.0
Total Depth: 11.0

DEPTH FEET	SAMP. LENGTH & RECOVERY / SAMP. NUMBER	Matrix Effervescence	Soil pH- ORP- Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
		None	4.35 347.5 196	Moist	7.5YR 3/4 Dark Brown	SM		Soil	Silty sand with gravel, with up to 20% organic material, homogeneous, dense, sand is fine-grained, gravel is fine-grained, subangular to subrounded. Matrix has 2-5% dark reddish brown (2.5YR 3/4) mottles associated with disseminated rootlets and pebbles. Also less than 1% gray (5YR 5/1) mottles and layer at 1'. Sand fraction is 65% quartz, 10% feldspar, and 15% lithic fragments. Cobbles are fine-grained black metasediment, black chert/iron formation, less than 5% green-black crystalline rock with quartz veins (possibly Archean).	1590
2		None	5.18 287.6 19	Wet to Moist	10YR 4/6 Dark Yellowish Brown to 2.5Y 3/3 Dark Olive Brown	SM			Silty sand with gravel, homogeneous, loose, sand is fine- to medium-grained, gravel is fine- to coarse-grained, subrounded to subangular. Occasional lenses with up to 40% clay (low plasticity). Matrix is magnetic, has mottles as above, also 30% strong brown (7.5YR 5/8) irregular to wavy mottles from 3-4'. Sand fraction is 70% quartz, 10% feldspar, and 20% lithic fragments. Cobbles are fine-grained black metasediment, fine-grained magnetic and non-magnetic cherty iron formation with rust coatings.	1588
4			5.63 262.4 16							1586
6								Upper Till	Gravelly silty sand, homogeneous, dense, sand is fine- to coarse-grained, gravel is fine- to coarse-grained, angular to subangular. Matrix has a faint rotten egg odor after HCL, 1-2% yellowish red (5YR 4/6) mottles. Sand fraction is 75% quartz, 5% feldspar, and 20% lithic fragments. Cobbles are 40% magnetic black iron formation, 30% fine-grained black metasediment, 25% non-magnetic black iron formation, and 5% granitoid. **BULK SAMPLE TEST:** 5'-11' -Sieve/Hydrometer (G/S/F): 30.5/42.5/27.0 -Water Content: 9.7 -Plasticity: NP	1584
			5.78 217.4 22			SM				
8		None		Moist	10YR 4/2 Dark Grayish Brown					1582

(continued)

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Remarks: Soil matrix and clasts were examined for visible sulfides, HCl reaction, odor, and odor after HCl. No sulfides, reaction with HCl, or unusual odors were observed, unless otherwise noted. Geochemical samples: 0.25-1', 1-5', 5-11'; Geotechnical samples: 1-5', 5-11'

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-08A

Client PolyMet Mining Corporation
Project Name Polymet Overburden Characterization
Number 23/69-B75 INV
Location NorthMet Mine Site

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 1/26/08 Ended 1/26/08
Logged By MMB/MJD

Elevation 1591.0
Total Depth 11.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH- ORP- Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
				6.77 68.3 34			SM		Upper Till		
										Bedrock at 11'. Troctolite, no visible sulfides. End of Boring - 11 feet	1580
12											1578
14											1576
16											1574
18											1572

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Remarks: Soil matrix and clasts were examined for visible sulfides, HCl reaction, odor, and odor after HCl. No sulfides, reaction with HCl, or unusual odors were observed, unless otherwise noted. Geochemical samples: 0.25-1', 1-5', 5-11'; Geotechnical samples: 1-5', 5-11'

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-09

SHEET 1 OF 1

Client PolyMet Mining Corporation
Drill Contractor Boart Longyear
Project Name Polymet Overburden Characterization
Drill Method Rotasonic
Number 23/69-B75 INV
Drilling Started 1/23/08 Ended 1/23/08
Elevation 1610.5
Location NorthMet Mine Site
Logged By REE/MJD
Total Depth 8.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH- ORP- Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
			None		Frozen	7.5YR 2.5/3 Very Dark Brown	OL/OH		Soil	Silt with sand, homogeneous, sand is fine-grained. Organic content decreases from 75% to 50%. Some grayish mottles and black (7.5YR 2.5/1) lenses, matrix is magnetic. Sand faction is 50% quartz, 30% feldspar, and 20% lithic fragments. Cobbles are 80% fine-grained black metasediment and 20% granitoid. Abundant rust-colored staining on clasts.	1610
2		1								Gravelly silty sand, homogeneous, sand is fine-grained, subangular to subrounded, gravel is fine- to coarse-grained, subangular to subrounded. Color change is gradational. Matrix is magnetic. Sand fraction is 50% quartz, 25% feldspars, and 25% lithic fragments. Cobbles are 60% fine-grained black metasediment, 20% magnetic black siltstone, 5-10% medium-grained bedded/foliated metasediment, 10% granitoid, and 5% biotite argillite. One cobble has orange precipitate or oxidation along microfractures. Increased granitoid cobbles from 5 to 7'. Occasional rust colored staining on clasts.	1608
			None	5.96 175.0 15						**BULK SAMPLE TEST:** 1'-7' -Sieve/Hydrometer (G/S/F): 31.7/50.2/18.1 -Water Content: 6.1 -Plasticity: NP	
4					Dry to Moist	10YR 4/4 Dark Yellowish Brown to 2.5Y 4/4 Olive Brown	SM		Upper Till		1606
6		2	None	6.22 116.7 13							1604
		3		5.88 182.0 2	Wet	2.5Y 3/1 Very Dark Gray	CL		Lower Till	Sandy lean clay with gravel, homogeneous, soft, sand is fine-grained, gravel is fine-grained. Matrix is magnetic, has faint rotten egg odor after HCL. Sand fraction is 70% quartz, 10% feldspars, and 20% lithic material. Cobbles are 75% granitoid, 20% fine-grained black metasediment with rust-colored staining on some surfaces, and 5% banded red and black iron formation.	
8										Bedrock at 8'. Troctolite, no visible sulfides. End of Boring - 8 feet	1602

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Remarks: Soil matrix and clasts were examined for visible sulfides, HCl reaction, odor, and odor after HCl. No sulfides, reaction with HCl, or unusual odors were observed, unless otherwise noted. Geochemical samples: 0-1', 2-5', 5-7', 7-8'; Geotechnical samples: 0-1', 1-7', 7-8'

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-10

Client PolyMet Mining Corporation
Drill Contractor Boart Longyear
Project Name Polymet Overburden Characterization
Drill Method Rotasonic
Number 23/69-B75 INV
Drilling Started 1/25/08 Ended 1/25/08
Elevation 1602.5
Location NorthMet Mine Site
Logged By MMB/MJD/REE
Total Depth 16.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH- ORP- Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
			None		Frozen	7.5YR 2.5/2 Very Dark Brown	OL/OH		Soil	Organic soil with sand. 80% organic matter (grass, roots, branches). Mineral fraction is silty sand, laminated lenses [dark yellowish brown (10YR 3/6) and black (10YR 2/1)].	1602
			None		Moist	10YR 2/2 very Dark Grayish Brown	SP-SM			Sand with silt and gravel, homogeneous, fine- to medium-grained, gravel is fine- to coarse-grained, subrounded to subangular. Sand fraction is 40% quartz, 40% feldspar, and 20% lithic fragments. Cobbles are 70% granitoid, and 30% fine-grained black metasediment with rust-colored staining.	
2			None	6.07 193.0 30	Moist	10YR 3/6 Dark Yellowish Brown	SM			Silty sand with gravel, homogeneous, fine- to medium-grained, gravel is fine- to coarse-grained, angular to subangular. Matrix has mottles associated with break-down of pebbles [bluish black (gley2 2.5/5PB)]. Sand fraction is 20% quartz, 60% feldspar, and 20% lithic fragments. Cobbles are 30% granitoid and 70% black fine-grained metasediment.	1600
4			None	5.73 241.6 12	Moist	7.5YR 3/3 Dark Brown	GM/SM		Upper Till	Sandy, silty gravel, homogeneous, fine- to coarse-grained, trace angular to subangular pebbles and cobbles. Sand fraction is 40% quartz, 30% feldspar, and 30% lithic fragments. Cobbles are 95% fine-grained metasediment with possible trace pyrite or pyrrhotite, and 5% granitoid. **BULK SAMPLE TEST:** 3.5'-5' -Sieve/Hydrometer (G/S/F): 40.5/40.2/19.3 -Water Content: 10.4 -Plasticity: 4.3	1598
6			None	7.08 60.2 20	Dry to Moist	10YR 4/3 Brown	SP			Sand with gravel, homogeneous, fine- to coarse-grained, with 20% fine- to medium-grained gravel, angular to subangular. Matrix is mottled with irregular yellowish red (5YR 4/6) and white (5YR 8/1) mottles. White mottles have no HCL reaction, but appear to be weakly cemented. Sand fraction is 85% quartz, 5% feldspar, and 10% lithic fragments. Cobbles are 95% black fine-grained metasediment and 5% magnetic cherty iron formation.	1596
8			None	6.81 152.3 30	Dry	5Y 3/1 Very Dark Gray	SM			Silty sand with gravel, homogeneous, fine- to medium-grained, gravel is fine- to coarse-grained, angular to subangular. Matrix has a faint odor after HCL. Sand fraction is 10% quartz, 20% feldspar, and 70% lithic fragments. Cobbles are 80% black fine-grained metasediment, 10% magnetic cherty iron formation, and 10% granitoid. Supernatant from 8.0' rinse test has metallic sheen/possible graphite from graphite-bearing Virginia formation rocks.	1594
										(continued)	

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Remarks: Soil matrix and clasts were examined for visible sulfides, HCl reaction, odor, and odor after HCl. No sulfides, reaction with HCl, or unusual odors were observed, unless otherwise noted. Geochemical samples: 0-1', 1-2', 2-3', 3-5.5', 5.5-7.5', 7.5-10', 10-14'; Geotechnical samples: 2-3', 3.5-5', 5.5-7.5', 7.5-10', 10-14'

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-10

Client PolyMet Mining Corporation
Project Name Polymet Overburden Characterization
Number 23/69-B75 INV
Location NorthMet Mine Site

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 1/25/08 Ended 1/25/08
Logged By MMB/MJD/REE

Elevation 1602.5
Total Depth 16.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH- ORP- Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
										Sand with gravel, homogeneous, fine- to coarse-grained, gravel is fine- to coarse-grained, angular to subangular. Matrix has a few white lenses (precipitate?), no HCL reaction, no odor. Sand fraction is 10% quartz, 10% feldspar, and 80% lithic fragments. Cobbles are 65% black fine-grained metasediment, 20% augite troctolite with weathered brown minerals, 10% magnetic, black cherty iron formation with rust-colored staining, and 5% granitoid.	1592
12			None	6.50 145.3 26	Moist	5Y 4/3 Olive	SP		Upper Till		1590
14									Bed- rock	Bedrock at 14.0'. Crushed troctolite pieces.	1588
16										End of Boring - 16 feet	1586
18											1584

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Remarks: Soil matrix and clasts were examined for visible sulfides, HCl reaction, odor, and odor after HCl. No sulfides, reaction with HCl, or unusual odors were observed, unless otherwise noted. Geochemical samples: 0-1', 1-2', 2-3', 3-5.5', 5.5-7.5', 7.5-10', 10-14'; Geotechnical samples: 2-3', 3.5-5', 5.5-7.5', 7.5-10', 10-14'

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-11

Client PolyMet Mining Corporation
Drill Contractor Boart Longyear
Project Name Polymet Overburden Characterization
Drill Method Rotasonic
Number 23/69-B75 INV
Drilling Started 1/25/08 Ended 1/25/08
Elevation 1594.0
Location NorthMet Mine Site
Logged By MMB/MJD
Total Depth 33.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH- ORP- Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
					Frozen					Fibrous peat (grass, roots, root material). Up to approximately 10% mineral soil below 5'.	
2											1592
4											1590
			None		Wet	5YR 2.5/1 Black	PT		Peat		
6				5.89 107.1 40							1588
8											1586
			None		Wet	10YR 3/2 Very Dark Grayish Brown	SM		Upper Till	Gravelly silty sand. Less than 5% organic matter, sand is fine- to coarse-grained, gravel is fine- to coarse grained. Sand fraction is 30% quartz, 10% feldspar, and 60% lithic fragments. Cobbles are 90% *(continued)*	

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Remarks: Soil matrix and clasts were examined for visible sulfides, HCl reaction, odor, and odor after HCl. No sulfides, reaction with HCl, or unusual odors were observed, unless otherwise noted. Geochemical samples: 0-9.5', 11.5-17', 17-25', 25-28', 28-31', 31-33'; Geotechnical samples: 9.5-10', 10-11.5', 17-25', 25-28', 28-31', 31-33'

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-11

Client PolyMet Mining Corporation
Drill Contractor Boart Longyear
Project Name Polymet Overburden Characterization
Drill Method Rotasonic
Number 23/69-B75 INV
Drilling Started 1/25/08 Ended 1/25/08
Elevation 1594.0
Location NorthMet Mine Site
Logged By MMB/MJD
Total Depth 33.0

DEPTH FEET	SAMP. LENGTH & RECOVERY / SAMP. NUMBER	Matrix Effervescence	Soil pH- ORP- Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
									fine-grained black metasediment, and 10% biotite argillite. **BULK SAMPLE TEST:** 9.5'-10' -Sieve/Hydrometer (G/S/F): 42.8/43.1/14.1 -Water Content: 3.7 -Plasticity: NP	
			6.31 -26.7 67		10YR 2/2 Black				Gradational change from silty sand with gravel to silty gravel with sand, sand is fine- to coarse-grained, gravel is fine- to medium-grained. Matrix has less than 5% organic material (black), and less than 5% reddish mottles (less than 1 mm in diameter) disseminated, and a faint rotten egg odor after HCL. Sand is 30% quartz, 5% feldspar, and 65% lithic fragments. Cobbles are 80-90% fine-grained black metasediment, 5-10% granitoid, and 5-10% biotite-containing anorthosite.	
12										1582
			6.47 -61.4 47	Wet	10YR 2/1 Black	SM to GM		Upper Till		
14		None								1580
			6.69 -44.1 12							
16										1578
									Gravelly sand with silt, sorted, sand is medium- to coarse-grained, gravel is fine- to coarse-grained, subrounded to subangular. Matrix has a faint rotten egg odor after HCL. Sand fraction is 60% quartz, 5% feldspar, and 35% lithic fragments. Cobbles are 80-90% fine-grained black metasediment, 5-10% granitoid, and 5-10% chert (possible Archean rocks).	
18		None	6.56 -37.5 30	Moist to Wet	Gley1 2.5/N Black	SP-SM		Out- wash	**BULK SAMPLE TEST:** 17'-25' -Sieve/Hydrometer (G/S/F): 34.8/59.0/6.2 -Water Content: 9.9 -Plasticity: NP	1576

(continued)

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Remarks: Soil matrix and clasts were examined for visible sulfides, HCl reaction, odor, and odor after HCl. No sulfides, reaction with HCl, or unusual odors were observed, unless otherwise noted. Geochemical samples: 0-9.5', 11.5-17', 17-25', 25-28', 28-31', 31-33'; Geotechnical samples: 9.5-10', 10-11.5', 17-25', 25-28', 28-31', 31-33'

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POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-11

Client PolyMet Mining Corporation
Drill Contractor Boart Longyear
Project Name Polymet Overburden Characterization
Drill Method Rotasonic
Number 23/69-B75 INV
Drilling Started 1/25/08 Ended 1/25/08
Elevation 1594.0
Location NorthMet Mine Site
Logged By MMB/MJD
Total Depth 33.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH-ORP-Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
22			None	6.51 17.0 9	Moist to Wet	Gley1 2.5/N Black	SP-SM		Out-wash	20-25': Same as 17-20' interval. Note low recovery.	1572
24											1570
26			None	6.33 31.3 25	Wet	10YR 2/1 Black	SW-SM to SP			Gradational change downward: sand with silt to sand with gravel. Sand is fine- to medium-grained, subrounded to subangular. Up to 2% organic matter in lower part of sample. Matrix has a faint rotten egg odor after HCL. Sand fraction is 50% quartz, 5% feldspar, and 45% lithic fragments. Cobbles are 85% fine-grained black metasediment, 10% magnetic cherty iron formation, and 5% granitoid. Note: Geotechnical laboratory homogenized unit. Grain size analysis indicates 23% gravel, 67% sand, 10% silt. **BULK SAMPLE TEST:** 25'-28' -Sieve/Hydrometer (G/S/F): 23.0/66.8/10.2 -Water Content: 13.7 -Plasticity: NP	1568
28			None		Wet	Gley1 3/10Y Very Dark Greenish Gray	SM		Lower Till	Gravelly silty sand, homogeneous, sand is medium-grained, gravel is fine- to medium-grained. Matrix has a faint rotten egg odor after HCL. Sand fraction is 60% quartz, 10% feldspar, and 30% lithic fragments. Cobbles are 70% fine-grained black metasediment, 20% granitoid, and 10% other.	1566

(continued)

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Remarks: Soil matrix and clasts were examined for visible sulfides, HCl reaction, odor, and odor after HCl. No sulfides, reaction with HCl, or unusual odors were observed, unless otherwise noted. Geochemical samples: 0-9.5', 11.5-17', 17-25', 25-28', 28-31', 31-33'; Geotechnical samples: 9.5-10', 10-11.5', 17-25', 25-28', 28-31', 31-33'

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-11

Client PolyMet Mining Corporation
Project Name Polymet Overburden Characterization
Number 23/69-B75 INV
Location NorthMet Mine Site

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 1/25/08 Ended 1/25/08
Logged By MMB/MJD

Elevation 1594.0
Total Depth 33.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH- ORP- Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
				6.50 -49.7 70			SM			Gravelly silty sand, homogeneous, sand is medium-grained, gravel is fine- to medium-grained. Matrix has a faint rotten egg odor after HCL. Sand fraction is 60% quartz, 10% feldspar, and 30% lithic fragments. Cobbles are 70% fine-grained black metasediment, 20% granitoid, and 10% other.*(continued)* **BULK SAMPLE TEST:** 28'-31' -Sieve/Hydrometer (G/S/F): 34.2/46.8/19.0 -Water Content: 7.1 -Plasticity: NP	
32			None		Wet	Gley1 3/10Y Very Dark Greenish Gray	SM		Lower Till	Gravelly silty sand, homogeneous, fine- to coarse-grained, gravel is fine- to medium-grained. Cobbles are 65% fine-grained black metasediment, 30% granitoid, and 5% gabbroic (no visible sulfides). **BULK SAMPLE TEST:** 31'-33' -Sieve/Hydrometer (G/S/F): 39.1/46.4/14.5 -Water Content: 15.4 -Plasticity: NP	1562
										Bedrock at 33.0'. End of Boring - 33 feet	
34											1560
36											1558
38											1556

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Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-12

Client PolyMet Mining Corporation
Project Name Polymet Overburden Characterization
Number 23/69-B75 INV
Location NorthMet Mine Site

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 1/23/08 Ended 1/23/08
Logged By MMB/MJD

Elevation 1610.0
Total Depth 22.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH-ORP-Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
			None		Frozen	7.5YR 2.5/2 Very Dark Brown to 7.5YR 2.5/3 Very Dark Brown	ML		Soil	Sandy silt, homogeneous, sand is fine-grained. Decreasing organic material from 0-2'. Approximately 2% medium-grained charcoal pieces in soil. Several clay coatings, very dark gray (7.5YR 3/1), approximately 2 mm thick at 1.2'. Sand fraction is 70% quartz, 20% feldspar, and 10% lithic fragments.	
2		1		6.77 114.8 8							1608
			Weak		Dry to Moist	10YR 5/4 Yellowish Brown	SP		Out-wash	Sand, sorted, fine-grained, angular to subround. Matrix has less than 5% carbonate-cemented nodules, weakly cemented, up to 2 cm in size. Several cobbles of black fine-grained metasediment, granitoid, and other lithologies.	
4											1606
6		2	None	7.17 111.7 33	Moist	10YR 4/4 Dark Yellowish Brown	SM		Upper Till	Silty sand with gravel, homogeneous, fine- to medium-grained, gravel is fine- to coarse-grained, subrounded to subangular. Matrix has less than 5% dark reddish brown (5YR 3/4) mottles, irregular, up to 1 cm in diameter at 7'. Sand fraction is 80% quartz, 5% feldspar, and 15% lithic fragments. Cobbles are 50% granitoid, 20% black, fine-grained metasediment, 20% magnetic cherty iron formation, 5% troctolite containing approximately 5% disseminated phyrrotite and chalcopyrite, and 5% quartzite. **BULK SAMPLE TEST:** 5.5'-10' -Sieve/Hydrometer (G/S/F): 21.7/55.3/23.0 -Water Content: 5.4 -Plasticity: NP	1604
8					Moist to Wet					8-8.5': Zone of weakly cemented carbonate layers and nodules. Occurs as masses or bridges between grains; pink (7.5YR 7/4).	1602

(continued)

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Remarks: Soil matrix and clasts were examined for visible sulfides, HCl reaction, odor, and odor after HCl. No sulfides, reaction with HCl, or unusual odors were observed, unless otherwise noted. Geochemical samples: 3-5', 7-9', 16-18', 17-20', 20-22'; Geotechnical samples: 0-2', 2-3', 3.5-5.5', 5.5-10', 10-15', 15-19.5', 19.5-20.5', 20.5-22'; Jar samples: 0-1', 4-5', 7-9', 20', 21'

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-12

Client PolyMet Mining Corporation
Drill Contractor Boart Longyear
Project Name Polymet Overburden Characterization
Drill Method Rotasonic
Number 23/69-B75 INV
Drilling Started 1/23/08 Ended 1/23/08
Elevation 1610.0
Location NorthMet Mine Site
Logged By MMB/MJD
Total Depth 22.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH- ORP- Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
12		3	Weak	7.19 116.6 15	Wet	2.5Y 4/3 Olive Brown	SM		Upper Till	Silty sand with gravel, homogeneous, fine- to medium-grained, gravel is fine- to coarse-grained, subrounded to subangular. Matrix has less than 5% dark reddish brown (5YR 3/4) mottles, irregular, up to 1 cm in diameter at 7'. Sand fraction is 80% quartz, 5% feldspar, and 15% lithic fragments. Cobbles are 50% granitoid, 20% black, fine-grained metasediment, 20% magnetic cherty iron formation, 5% troctolite containing approximately 5% disseminated phyrrotite and chalcopyrite, and 5% quartzite.*(continued)* **BULK SAMPLE TEST:** 10'-15' -Sieve/Hydrometer (G/S/F): 26.0/53.3/20.7 -Water Content: 3.7 -Plasticity: NP	1598
14											1596
16		4		7.14 44 14	Wet	2.5Y 4/3 Olive Brown	SM			Sand with silt and gravel, homogeneous, fine- to coarse-grained sand, gravel is fine- to coarse-grained, subangular to subrounded. Tiny fractures in soil matrix have approximately 2 mm thick discoloration to dark gray (2.5Y 4/1). Sand fraction is 85% quartz, 5% feldspar, and 10% lithic fragments. Cobbles are 40% fine-grained black metasediment with common red-brown staining, 40% black cherty iron formation with yellow precipitate in some fractures and rust-colored staining on surfaces, and 20% granitoid.	1594
18											1592
										19-19.5': Silt, well-sorted, abrupt contacts above and below, dark grayish brown (10YR 3/2).	
					Wet	10YR 4/3 Brown	SM		Out-wash	Sand, homogeneous, fine- to coarse-grained, subangular to subrounded. *(continued)*	

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POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-12

Client PolyMet Mining Corporation
Drill Contractor Boart Longyear
Project Name Polymet Overburden Characterization
Drill Method Rotasonic
Number 23/69-B75 INV
Drilling Started 1/23/08 Ended 1/23/08
Elevation 1610.0
Location NorthMet Mine Site
Logged By MMB/MJD
Total Depth 22.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH- ORP- Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
			Weak		Wet	10YR 4/3 Brown	SM		Out-wash	Sand, homogeneous, fine- to coarse-grained, subangular to subrounded.*(continued)*	
		5	None	7.50 68.9 26	Wet	Gley1 3/N Very Dark Gray	SM		Lower Till	Silty sand with gravel, homogeneous, dense. Sand is fine-to medium-grained, gravel is fine- to coarse-grained, subangular to subrounded. Matrix has rotten-egg odor after HCL which may be associated with yellowish brown (10YR 5/6) mottles that are 1-3 mm in diameter and disseminated throughout 1-2% the matrix. Matrix also contains 20% very dark grayish brown (2.5Y 3/2) mottles from 20.5 to 21'. Sand fraction is 50% quartz, 10% feldspar, and 40% lithic fragments. Cobbles are 40% troctolite containing trace sulfides and patches of iron staining, 30% granitoid, 15% black, fine-grained metasediment, and 5% black chert or siltstone with 2% pyrrhotite veins.	
22										Bedrock at 22'. Dark gray-black troctolite containing 2% disseminated sulfides up to 2 mm in diameter. Chalcopyrite and pyrrhotite. End of Boring - 22 feet	1588
24											1586
26											1584
28											1582

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POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-13

SHEET 1 OF 1

Client PolyMet Mining Corporation
Drill Contractor Boart Longyear
Project Name Polymet Overburden Characterization
Drill Method Rotasonic
Number 23/69-B75 INV
Drilling Started 1/24/08 Ended 1/24/08
Elevation 1606.0
Location NorthMet Mine Site
Logged By MMB/MJD
Total Depth 10.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH-ORP-Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
		1	None	6.15 62.7 42	Frozen Moist	7.5R 2.5/3 Very Dark Brown	SP-SM		Soil	Sand with silt, homogeneous, fine- to coarse-grained, subangular to subrounded. Organic matter decreases from 70% to 10% between 0-1.5'. Sand fraction is 70% quartz, 10% feldspar, and 20% lithic fragments. Several cobbles of fine-grained, black metasediment with rust-colored staining on surfaces.	
2			None		Wet	7.5R 2.5/3 Very Dark Brown and 7.5R 3/1 Very Dark Gray	SM			Silty sand, variegated, homogeneous, dense, fine- to medium-grained, subangular to subrounded, trace organic material. Several very dark gray (7.5YR 3/1) lenses. Sand fraction is same as 0-1.5' interval, cobbles are fine-grained black metasediment with rust-colored surfaces. Possible perched water at 1.5'.	1604
				6.07 106.6 27						Gravelly silty sand, homogeneous, dense, fine- to medium-grained. Gravel is fine- to coarse-grained, angular to well-rounded. Matrix has dark gray brown, dark red brown, and black mottles, and has a weak rotten egg odor after HCL. Sand fraction is 80% quartz and 20% lithic fragments. Cobbles are 65% black chert/siltstone iron formation containing some rust staining and yellow precipitate, 20% granitoid, 10% black, fine-grained metasediment, and 5% pink quartzite.	
4		2	None		Moist	Gley1 4/5GY Dark Greenish Gray	SM		Lower Till	**BULK SAMPLE TEST:** 2.5'-6' -Sieve/Hydrometer (G/S/F): 23.5/51.5/25.0 -Water Content: 11.5 -Plasticity: NP	1602
				6.47 72.3 22							
6										Interval is too destroyed by drilling to classify.	1600
8		3							Bed-rock	Bedrock at 8': Dark gray-black troctolite containing 5% visible sulfides (30% pyrrhotite, 50% chalcopyrite, 20% pyrite).	1598
										End of Boring - 10 feet	

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Remarks: Soil matrix and clasts were examined for visible sulfides, HCl reaction, odor, and odor after HCl. No sulfides, reaction with HCl, or unusual odors were observed, unless otherwise noted. Geochemical samples: 0-1.5', 1.5-2.5', 2.5-6', 8-10'; Geotechnical samples: 0-1.5', 1.5-2.5', 2.5-6'

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-14A

SHEET 1 OF 1

Client PolyMet Mining Corporation
Project Name Polymet Overburden Characterization
Number 23/69-B75 INV
Location NorthMet Mine Site

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 1/24/08 Ended 1/24/08
Logged By REE/MJD

Elevation 1609.0
Total Depth 5.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH-ORP-Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
			None		Frozen	10YR 2/1 Black to 10YR 3/6 Dark Yellowish Brown	GM		Soil	Silty gravel with sand and organic fines, decreasing organic matter from 90%-70%, sand is fine- to medium-grained. Gradational color change. **BULK SAMPLE TEST:** 0'-1.5' -Sieve/Hydrometer (G/S/F): 60.3/11.1/28.6 -Water Content: 68.8 -Plasticity: 2.2	1608
2		1	None	5.41 239.0 19		7.5YR 3/4 Dark Brown	SM			Silty sand, homogeneous, sand is fine- to medium-grained, gravel is fine- to coarse-grained, subangular to angular. Matrix has approximately 10% rootlets with associated very dark brown (7.5YR 2.5/2) mottles. Cobbles are 100% black fine-grained metasediment.	1606
					Moist				Upper Till	Silty gravel with sand, homogeneous, dense, sand is fine- to medium-grained, gravel is fine- to coarse-grained, subangular to subrounded. Cobbles are 90% fine-grained black metasediment, 5% black coarse-grained gabbro (no sulfides), 5% granitoid.	
4			None			10YR 3/4 Dark Yellowish Brown	GM			**BULK SAMPLE TEST:** 3'-5' -Sieve/Hydrometer (G/S/F): 60.2/16.1/23.7 -Water Content: 11.7 -Plasticity: NP	1604
										Bedrock at 5.0'. Black biotite argillite. End of Boring - 5 feet	
6											1602
8											1600

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Remarks: Soil matrix and clasts were examined for visible sulfides, HCl reaction, odor, and odor after HCl. No sulfides, reaction with HCl, or unusual odors were observed, unless otherwise noted. Geochemical samples: 0-1.5', 1.5-3', 3-5'; Geotechnical samples: 0-1.5', 1.5-3', 3-5'

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-14B

SHEET 1 OF 1

Client PolyMet Mining Corporation
Project Name Polymet Overburden Characterization
Number 23/69-B75 INV
Location NorthMet Mine Site

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 1/24/08 Ended 1/24/08
Logged By REE/MJD

Elevation 1609.0
Total Depth 5.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH-ORP-Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
							GM		Soil	See RS-14A, 0-1.5' interval for description.	1608
2							SM			See RS-14A, 1.5-3' interval for description.	
		1					GM		Upper Till	Similar to RS-14A, 3.0-5.0' interval. Slightly fewer fines, mottled. Mottles are yellowish red (5YR 4/6) and very dark grayish brown (10YR 3/2). Rust coloring also seen on most cobbles. Cobbles are 85% black fine-grained magnetic cherty iron formation and 5% granitoid.	1606
4											1604
										Bedrock at 5.0'. Black biotite argillite. End of Boring - 5 feet	
6											1602
8											1600

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Remarks: Soil matrix and clasts were examined for visible sulfides, HCl reaction, odor, and odor after HCl. No sulfides, reaction with HCl, or unusual odors were observed, unless otherwise noted. Geochemical samples: 0-1.5', 1.5-3', 3-5'; Geotechnical samples: 0-1.5', 1.5-3', 3-5'

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-15A-E

SHEET 1 OF 1

Client PolyMet Mining Corporation
Drill Contractor Boart Longyear
Project Name Polymet Overburden Characterization
Drill Method Rotasonic
Number 23/69-B75 INV
Drilling Started 1/27/08 Ended 1/27/08
Elevation 1615.5
Location NorthMet Mine Site
Logged By MMB/REE
Total Depth 0.5

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH- ORP- Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
				5.59 275 104	Moist	Black 7.5YR 3/3 Dark Brown	OL/OH		Organic Soil	Organic soil.	
							ML		Soil	Sandy silt with organic material, homogeneous, no odor, no mottles, no visible sulfides. **BULK SAMPLE TEST:** 0'-0.5' -Sieve/Hydrometer (G/S/F): 1.0/51.7/47.3 -Water Content: 69.7 -Plasticity: NP Hand auger refusal on rocks. End of Boring - 0.5 feet	1614
2											1612
4											1610
6											1608
8											1606

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Remarks: Soil matrix and clasts were examined for visible sulfides, HCl reaction, odor, and odor after HCl. No sulfides, reaction with HCl, or unusual odors were observed, unless otherwise noted. Geochemical samples: RS-15A-D 0-0.5'; Geotechnical samples: 0-0.5'

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-16A-C

SHEET 1 OF 1

Client PolyMet Mining Corporation
Drill Contractor Boart Longyear
Project Name Polymet Overburden Characterization
Drill Method Rotasonic
Number 23/69-B75 INV
Drilling Started 1/27/08 Ended 1/27/08
Elevation 1605.0
Location NorthMet Mine Site
Logged By MMB/REE
Total Depth 2.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH- ORP- Specific Cond.	Moisture	Matrix Color	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
				5.29 290 8	Moist	10YR 3/6 Dark Yellowish Brown	SM		Soil	Silty sand, homogeneous, no odor, no mottles, no visible sulfides. **BULK SAMPLE TEST:** 0'-2' -Sieve/Hydrometer (G/S/F): 0.4/68.4/31.2 -Water Content: 22.3 -Plasticity: NP	1604
2										Hand auger refusal on rocks. End of Boring - 2 feet	1602
4											1600
6											1598
8											1596

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Remarks: Soil matrix and clasts were examined for visible sulfides, HCl reaction, odor, and odor after HCl. No sulfides, reaction with HCl, or unusual odors were observed, unless otherwise noted. Geochemical samples: RS-16B 0-2'; Geotechnical samples: 0-2'

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-17A

SHEET 1 OF 1

Client PolyMet Mining Corporation
Project Name Polymet Overburden Characterization
Number 23/69-B75 INV
Location NorthMet Mine Site

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 1/25/08 Ended 1/25/08
Logged By MMB

Elevation 1598.0
Total Depth 8.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Color	Moisture	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
			Dark Brown	Frozen	OL/OH		Soil	Sandy organic soil. Abundant roots, grass, vegetative material.	
			Brown	Dry to Moist				Gravelly silty sand. Sand is very fine- to fine-grained. Gravel is fine- to coarse-grained. Possible low-plasticity clay from 1 to 2.5'. Gravel is subangular to subrounded with various lithologies.	
2		1			SM				1596
			Dark Brown	Moist					
4							Upper Till		1594
			Dark Brown	Moist	GM			Silty gravel with sand. Sand is very fine- to coarse-grained. Gravel is fine-to coarse-grained with various lithologies.	
6									1592
		2	Brown	Moist to Wet	SM			Silty sand with gravel, sand is very fine- to fine-grained, gravel is fine- to coarse-grained with various lithologies, subrounded to rounded.	
								Granitoid boulder.	
8								Refusal on boulder at 8.0'.	1590
								End of Boring - 8 feet	

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Remarks: Geotechnical samples collected: 1-2.5' plastic bag, 2.5-4.5' 5-gallon bucket, 4.5-6' 5-gallon bucket

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-17B

Client PolyMet Mining Corporation
Project Name Polymet Overburden Characterization
Number 23/69-B75 INV
Location NorthMet Mine Site

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 1/25/08 Ended 1/25/08
Logged By MMB

Elevation 1598.0
Total Depth 12.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Color	Moisture	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
					OL/OH		Soil	See RS-17A, 0-1' interval for description.	
2		1			SM		Upper Till	See RS-17A, 1-4.5' interval for description. **BULK SAMPLE TEST:** 2.5'-4.5' -Sieve/Hydrometer (G/S/F): 20.2/47.0/32.8 -Water Content: 13.4 -Plasticity: 0.7	1596
4									1594
					GM			See RS-17A, 4.5-6' interval for description. **BULK SAMPLE TEST:** 4.5'-6' -Sieve/Hydrometer (G/S/F): 43.8/43.0/13.2 -Water Content: 10.2 -Plasticity: NP	
6		2			SM			See RS-17A, 6-7' interval for description.	1592
								See RS-17A, 7-8' interval for description.	
8		3	Brown	Wet	SP-SM			Sand with silt and gravel. Sand is very fine- to medium-grained. Gravel is angular to rounded with various lithologies.	1590

(continued)

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Remarks: Geotechnical samples collected: 6.0-7.0' shelby tube, 8-11' 5-gallon bucket

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-17B

Client PolyMet Mining Corporation
Project Name Polymet Overburden Characterization
Number 23/69-B75 INV
Location NorthMet Mine Site

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 1/25/08 Ended 1/25/08
Logged By MMB

Elevation 1598.0
Total Depth 12.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Color	Moisture	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
		4	Brown	Wet	SP-SM		Upper Till	Sand with silt and gravel. Sand is very fine- to medium-grained. Gravel is angular to rounded with various lithologies.*(continued)*	
							Bed-rock	Troctolite bedrock, 0.8' long intact core-shaped piece.	
12								End of Boring - 12 feet	1586
14									1584
16									1582
18									1580

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Remarks: Geotechnical samples collected: 6.0-7.0' shelby tube, 8-11' 5-gallon bucket

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-18A

SHEET 1 OF 1

Client PolyMet Mining Corporation
Project Name Polymet Overburden Characterization
Number 23/69-B75 INV
Location NorthMet Mine Site

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 1/29/08 Ended 1/29/08
Logged By MMB

Elevation 1588.5
Total Depth 10.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Color	Moisture	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
			Black	Wet	SM		Soil	Silty sand with gravel, organic rich.	
									1588
		1	Yellowish Brown	Moist	ML		Upper Till	Silt with possible low plasticity clay and approximately 10% gravel, mottled. **BULK SAMPLE TEST:** 0'-5' -Sieve/Hydrometer (G/S/F): 26.1/44.1/29.8 -Water Content: 25.4 -Plasticity: 6	
2									1586
		2	Brown	Moist	SC			Clayey sand with gravel, sand is fine-grained. Note: Geotechnical laboratory homogenized 0-5' interval. Grain size analysis indicates 26% gravel, 44% sand, and 30% silt and clay.	
4									1584
		3	Dark Gray to Black	Moist	SM		Lower Till	Gravelly silty sand. **BULK SAMPLE TEST:** 5'-8' -Sieve/Hydrometer (G/S/F): 31.6/47.1/21.3 -Water Content: 21.5 -Plasticity: NP	
6									1582
8		4					Bed-rock	Bedrock at 8.0'. Troctolite core pieces.	1580
								End of Boring - 10 feet	

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Remarks: Geotechnical samples: 0-5', 5-8'

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-19A

SHEET 1 OF 1

Client PolyMet Mining Corporation
Project Name Polymet Overburden Characterization
Number 23/69-B75 INV
Location NorthMet Mine Site

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 1/31/08 Ended 1/31/08
Logged By MMB

Elevation 1600.5
Total Depth 9.5

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Color	Moisture	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
		1	Gray	Dry				Boulder	1600
2		2	10YR 4/4 Dark Yellowish Brown	Moist	SM			Silty sand with a little gravel, sand is fine- to medium-grained, with 30% irregular gray mottles in matrix. **BULK SAMPLE TEST:** 1.5'-3.5' -Sieve/Hydrometer (G/S/F): 13.0/47.0/40.0 -Water Content: 7.6 -Plasticity: 1.3	1598
4			10YR 4/2 Dark Grayish Brown	Moist	SM		Upper Till	Silty sand with gravel, sand is fine- to medium-grained. Mottled and has less than 5% reddish mottles. **BULK SAMPLE TEST:** 1'-6' -Sieve/Hydrometer (G/S/F): 22.4/45.0/32.6 -Water Content: 3.9 -Plasticity: 3.6	1596
6		3	Various	Dry	GP			Gravel with sand, driller suspects interval is cobbles broken into gravel by drilling.	1594
8									1592
							Bed-rock	Bedrock at 9.0'. Troctolite plug in core barrel.	
								End of Boring - 9.5 feet	

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Remarks: Geotechnical samples: 1-6'; Shelby tubes: 1.5-3.5'

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF Boring RS-20A

SHEET 1 OF 1

Client PolyMet Mining Corporation
Drill Contractor Boart Longyear
Project Name Polymet Overburden Characterization
Drill Method Rotasonic
Number 23/69-B75 INV
Drilling Started 1/31/08 Ended 1/31/08
Elevation 1602.5
Location NorthMet Mine Site
Logged By MMB
Total Depth 7.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Color	Moisture	ASTM	LITHOLOGY	Stratigraphic Unit	DESCRIPTION	ELEV. FEET
								Silty sand, sand is fine-grained.	
		1		Frozen					1602
			2.5Y 3/3 Dark Olive Brown	Moist					
					SM				
		2							
2								**BULK SAMPLE TEST:** 2'-3' -Sieve/Hydrometer (G/S/F): 25.4/41.5/33.1 -Water Content: 3.7 -Plasticity: NP	1600
								Silty sand with gravel, fine- to coarse-grained sand, fine- to coarse-grained gravel, boulders and cobbles. Possible low plasticity clay.	
							Upper Till	**BULK SAMPLE TEST:** 2'-4.5' -Sieve/Hydrometer (G/S/F): 28.9/41.4/29.7 -Water Content: 10.4 -Plasticity: 0.1	
		3							
4			2.5Y 4/2 Dark Grayish Brown	Moist					
					SM				1598
		4							
6									
								Bedrock at 6.5'. Troctolite pieces.	1596
		5		Dry			Bed-rock		
								End of Boring - 7 feet	
8									1594

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Remarks: Geotechnical samples: 2-4.5', 4.5-6'; Shelby tubes: 2-3'

Additional data may have been collected in the field which is not included on this log.

POLYMET_ENVIROLOG_WITHSTRATIGRAPHIC 2369B75.GPJ BARR JAN06.GDT 7/21/08

LOG OF WELL MW-1/RS-37c

Client PolyMet Mining Inc.
Drill Contractor Boart Longyear
Project Name NorthMet
Drill Method Rotosonic
Location NorthMet Mine Site
Logged By Barr/REE
Number 23/69-0862
Start: 10/25/11
End 10/25/11
Northing: 5274724.09
Easting: 578783.97
Unique Well No. 786714
Riser Elevation 1596.4
Surface Elevation 1594.3
Total Depth 10.5

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH- Specific Cond.	%GR/SA/ FINES	Moisture	ASTM	LITHOLOGY	DESCRIPTION	WELL OR PIEZOMETER CONSTRUCTION DETAIL	ELEV. FEET
0			N	7.6 0.008	5/20/75	Wet	CL		0-1.5': Sandy Clay, very fine grained sand, dark yellowish brown (10YR 4/6) with strong brown mottling.	PRO. CASING Diameter: **8 inch** Type: **Steel** Interval: **0-4 ft**	1590
			N	7.57 0.006	30/30/40		SM		1.5-6': Sandy Silt with Gravel, fine to medium grained sand, gravel content increases with depth, trace cobbles, sub-angular, dark yellowish brown (10YR 4/6).	RISER CASING Diameter: **2 inch** Type: **Sch. 40 PVC** Interval: **0-5 ft**	
5			N	8.5 0.03	50/50/0		GP		6-10.5': Sandy Gravel, coarse grained sand, bottom may be weathered bedrock, bluish gray (Gley 2 5/1).	GROUT Type: **Cement** Interval: **0-3.5 ft**	1585
10							ROCK		10-10.5': Bedrock, coarse-grained mafic rock, likely Duluth Complex. End of Boring - 10.5 feet	SEAL Type: **Hydrated bentonite chips** Interval: **3.5-4 ft**	1580
15										SANDPACK Type: **Red Flint #30** Interval: **4-10.5 ft**	
20										SCREEN Diameter: **2 inch** Type: **Sch. 40 PVC, No. 10 slot** Interval: **5.2-10.2 ft**	1575
25											1570
30											1565
35											1560

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Remarks: Three borings were advanced - MW-1 was installed in RS-37c.
Well total depth 12.00 feet from top of riser.
Ground water elevation measured on 2/12/2012.

BGS = "below ground surface"
Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG NEW (3/20/2012) 23690862_10_2011 WELL_INSTALLATION.GPJ BARR LIBR JAN06.GLB 3/23/12

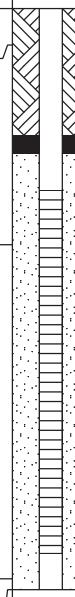
LOG OF WELL MW-2/RS-32

Client PolyMet Mining Inc.
Project Name NorthMet
Location NorthMet Mine Site
Number 23/69-0862
Start: 10/26/11
End 10/26/11

Drill Contractor Boart Longyear
Drill Method Rotosonic
Logged By Barr/REE
Northing: 5272799.38
Easting: 576322.91

Unique Well No. 786713
Riser Elevation 1585.3
Surface Elevation 1582.7
Total Depth 16.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH-Specific Cond.	%GR/SA/FINES	Moisture	ASTM	LITHOLOGY	DESCRIPTION
			N	6.60 .003	5/25/70	Moist	ML		0-1': Sandy Silt with Organics, fine grained sand, dark brown (7.5YR 3/4).
			N	7.12 .009	5/70/25				1-6.5': Silty Sand, fine to medium grained sand, gravel content increases at 4.5', coarse gravel, trace cobbles, brown (7.5YR 4/4 grading to 7.5YR 4/3 with depth).
			N	8.00 .006	30/50/20		SP		
5									
			N	8.05 .007	10/70/20	Wet			6.5-15.7': Silty Sand with Gravel, fine to medium grained sand, coarse gravel, dark greenish gray (Gley 1 4/1) with some dark yellowish brown (10YR 4/6) mottling that decreases with depth.
10							SM		
15							ROCK		15.7-16': Bedrock, coarse-grained mafic rock, likely Duluth Complex.
									End of Boring - 16 feet
20									
25									
30									
35									



WELL OR PIEZOMETER CONSTRUCTION DETAIL

PRO. CASING
Diameter: **8 inch**
Type: **Steel**
Interval: **0-4 ft**

RISER CASING
Diameter: **2 inch**
Type: **Sch. 40 PVC**
Interval: **0-5 ft**

GROUT
Type: **Cement**
Interval: **0-3.5 ft**

SEAL
Type: **Hydrated bentonite chips**
Interval: **3.5-4 ft**

SANDPACK
Type: **Red Flint #30**
Interval: **4-16 ft**

SCREEN
Diameter: **2 inch**
Type: **Sch. 40 PVC, No. 10 slot**
Interval: **5-15 ft**

ELEV. FEET: 1580, 1575, 1570, 1565, 1560, 1555, 1550

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Remarks: Soil core sample saved.
Well total depth 17.60 feet from top of riser.
Well frozen during February 2012 sampling. Ground water elevation estimated.

BGS = "below ground surface"
Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG NEW (3/20/2012) 23690862_10_2011 WELL_INSTALLATION.GPJ BARR LIBR JAN06.GLB 3/23/12

LOG OF WELL MW-3/RS-48

Client PolyMet Mining Inc.
Project Name NorthMet
Location NorthMet Mine Site
Number 23/69-0862
Start: 10/27/11
End 10/27/11
Drill Contractor Boart Longyear
Drill Method Rotosonic
Logged By Barr/REE
Northing: 5273721.07
Easting: 579699.06
Unique Well No. 786717
Riser Elevation 1561.7
Surface Elevation 1559.3
Total Depth 11.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH- Specific Cond.	%GR/SA/FINES	Moisture	ASTM	LITHOLOGY	DESCRIPTION	WELL OR PIEZOMETER CONSTRUCTION DETAIL	ELEV. FEET
0			N	8 0.004	5/35/60	Moist	ML		0-.3': Topsoil, roots, grass, organic material, black (7.5YR 2.5/1).	PRO. CASING Diameter: **8 inch** Type: **Steel** Interval: **0-4 ft**	1560
			N	7.25 0.003	10/60/35		SP		.3-1': Sandy Silt, fine grained sand, brown (7.5YR 4/3). 1-4': Silty Sand, fine to medium grained sand, trace fine gravel, brown (7.5YR 4/3).		
5			N	7.52 0.003	15/40/45		ML		4-10': Sandy Silt with Gravel, fine to medium grained sand, cohesive, coarse gravel, dark grayish brown (2.5Y 4/2) with strong brown mottling that decreases with depth.	RISER CASING Diameter: **2 inch** Type: **Sch. 40 PVC** Interval: **0-6 ft** GROUT Type: **Cement** Interval: **0-3.5 ft** SEAL Type: **Hydrated bentonite chips** Interval: **3.5-4.5 ft** SANDPACK Type: **Red Flint #30** Interval: **4.5-11 ft** SCREEN Diameter: **2 inch** Type: **Sch. 40 PVC, No. 10 slot** Interval: **6-11.0 ft**	1555
10			N	7.66 0.004	15/60/25		SP		10-10.8': Silty Sand with Gravel, fine to coarse grained sand, dark grayish brown (2.5Y 4/2) with 2 inch strong brown layer at 10 feet.		1550
			N	8.51 0.011			ROCK		10.8-11': Bedrock, coarse-grained mafic rock, likely Duluth Complex, weathered on top. End of Boring - 11 feet		1545
15											1540
20											1535
25											1530
30											1525
35											

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Remarks: Well total depth 13.18 feet from top of riser.
Ground water elevation measured on 2/12/2012.

BGS = "below ground surface"
Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG NEW (3/20/2012) 23690862_10_2011 WELL_INSTALLATION.GPJ BARR LIBR JAN06.GLB 3/23/12

LOG OF WELL MW-4/RS-49b

Client PolyMet Mining Inc.
Project Name NorthMet
Location NorthMet Mine Site
Number 23/69-0862
Start: 10/27/11
End 10/27/11
Drill Contractor Boart Longyear
Drill Method Rotosonic
Logged By Barr/REE
Northing: 5273586.12
Easting: 580179.6
Unique Well No. 786718
Riser Elevation 1558.8
Surface Elevation 1556.2
Total Depth 9.5

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH- Specific Cond.	%GR/SA/ FINES	Moisture	ASTM	LITHOLOGY	DESCRIPTION	WELL OR PIEZOMETER CONSTRUCTION DETAIL	ELEV. FEET
0			N	7.35 0.012		Moist	OL		0-.5': Organic Topsoil, black (7.5YR 2.5/1).	PRO. CASING Diameter: **8 inch** Type: **Steel** Interval: **0-3 ft**	1555
			N	6.63 0.002	20/50/30	Wet	SM		.5-2.5': Silty Sand with Gravel, medium to coarse sand, coarse gravel, brown (7.5YR 4/4) with some dark brown mottling.		
			N	6.94 0.005	10/30/60		ML		2.5-4.5': Sandy Silt with little Gravel, fine to medium grained sand, fine gravel, dark yellowish brown (10YR 4/4) with some strong brown, light yellowish brown, and dark greenish gray mottling.	RISER CASING Diameter: **2 inch** Type: **Sch. 40 PVC** Interval: **0-4.5 ft**	
5			N	8.66 0.007	15/30/55	Moist- Wet	ML			GROUT Type: **Cement** Interval: **0-2.5 ft**	1550
			N	8.17 0.008	15/60/35		SM		4.5-6.5': Sandy Silt with Gravel, fine to medium grained sand, coarse gravel, subangular, dark greenish gray (Gley 1 4/1).	SEAL Type: **Hydrated bentonite chips** Interval: **2.5-3 ft**	
			N				ROCK		6-7.5': Silty Sand with Gravel, medium to coarse grained sand, coarse gravel, olive brown (2.5Y 4/3) with some strong brown and very dark gray mottling.	SANDPACK Type: **Red Flint #30** Interval: **3-9.5 ft**	1545
10									7.5-9.5': Bedrock, coarse-grained mafic rock, likely Duluth Complex.	SCREEN Diameter: **2 inch** Type: **Sch. 40 PVC, No. 10 slot** Interval: **4.7-9.7 ft**	1540
									End of Boring - 9.5 feet		
15											1535
20											1530
25											1525
30											1520
35											

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Remarks: Three borings were advanced - MW-4 was installed in RS-49b.
Well total depth 11.9 feet from top of riser.
Ground water elevation measured on 2/12/2012.

BGS = "below ground surface"
Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG NEW (3/20/2012) 23690862_10_2011 WELL_INSTALLATION.GPJ BARR LIBR JAN06.GLB 3/23/12

LOG OF WELL MW-5/RS-33

Client PolyMet Mining Inc.
Project Name NorthMet
Location NorthMet Mine Site
Number 23/69-0862
Start: 10/28/11
End 10/28/11
Drill Contractor Boart Longyear
Drill Method Rotosonic
Logged By Barr/REE
Northing: 5273223.38
Easting: 577505.09
Unique Well No. 786708
Riser Elevation 1587.6
Surface Elevation 1584.8
Total Depth 22.0
SHEET 1 OF 1

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH- Specific Cond.	%GR/SA/ FINES	Moisture	ASTM	LITHOLOGY	DESCRIPTION	WELL OR PIEZOMETER CONSTRUCTION DETAIL	ELEV. FEET
			N	7.29		Moist	OL		0-.4': Organic Topsoil, roots, grass, organic material, black (7.5YR 2.5/1).	PRO. CASING Diameter: **8 inch** Type: **Steel** Interval: **0-3 ft**	
			N	0.010 5.93	5/75/20						
				0.001							
			N	7.85 0.009			SM		.4-4': Silty Sand, fine grained sand, fine gravel, dark brown (7.5YR 3/4) grading to brown (10YR 5/3) with depth.		
			N		10/10/80				4-18': Silty Sand with Gravel, fine to coarse grained sand, coarse gravel, grayish brown (10YR5/2).		
5			N	7.37 0.002	20/30/50	Moist-Wet				RISER CASING Diameter: **2 inch** Type: **Sch. 40 PVC** Interval: **0-4 ft** GROUT Type: **Cement** Interval: **0-2.5 ft** SEAL Type: **Hydrated bentonite chips** Interval: **2.5-3 ft** SANDPACK Type: **Red Flint #30** Interval: **3-14 ft**	1580 1575
			N	7.35 0.002							
10											
							ML				
15											1570
			N	8.41 0.008	15/15/70	Wet			18-21.7': Sandy Silt with Gravel, very fine to fine grained sand, coarse gravel, trace cobbles, sub-rounded, dark gray (2.5Y 4/1).	SCREEN Diameter: **2 inch** Type: **Sch. 40 PVC, No. 10 slot** Interval: **3.9-13.9 ft**	
20							ML				1565
							ROCK		21.7-22': Bedrock, coarse-grained mafic rock, likely Duluth Complex.		
									End of Boring - 22 feet		
25											1560
30											1555
35											1550

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Remarks: Well total depth 16.5 feet from top of riser.
Ground water elevation measured on 2/12/2012.

BGS = "below ground surface"
Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG NEW (3/20/2012) 23690862_10_2011 WELL_INSTALLATION.GPJ BARR LIBR JAN06.GLB 3/23/12

LOG OF WELL MW-6d/RS-34

Client PolyMet Mining Inc.
Project Name NorthMet
Location NorthMet Mine Site
Number 23/69-0862
Start: 10/31/11
End 10/31/11
Drill Contractor Boart Longyear
Drill Method Rotosonic
Logged By Barr/REE
Northing: 5272903.04
Easting: 577496.94
Unique Well No. 786711
Riser Elevation 1579.0
Surface Elevation 1576.6
Total Depth 22.5
SHEET 1 OF 1

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH- Specific Cond.	%GR/SA/ FINES	Moisture	ASTM	LITHOLOGY	DESCRIPTION	WELL OR PIEZOMETER CONSTRUCTION DETAIL	ELEV. FEET
0			N N	6.05 0.006	15/60/25	Moist	OL		0-.3': Organic Topsoil, roots, grass, organic material, black (7.5YR 2.5/1).	PRO. CASING Diameter: **8 inch** Type: **Steel** Interval: **0-4 ft**	1575
							SM		.3-4.5': Silty Sand with Gravel, fine grained sand, coarse gravel, sub-angular; Color: .3-.8' dark yellowish brown (10YR 4/4), .8-1.3' yellowish brown (10YR 5/4), 1.3-4.5' yellowish brown (10YR 5/4) with 10YR 5/6 mottling.		
5			N	6.75 0.014	15/30/65		ML		4.5-5': Sandy Silt with Gravel, fine grained sand, coarse gravel, sub-angular and weathered gravel, brown (10YR 4/3). 5-10': No Recovery	RISER CASING Diameter: **2 inch** Type: **Sch. 40 PVC** Interval: **0-17 ft** GROUT Type: **Cement** Interval: **0-13 ft**	1570
10			N	6.75 0.010	15/30/65	Moist- Wet	ML		10-15': Sandy Silt with Gravel, fine grained sand, coarse gravel, sub-angular, grayish brown (10YR 5/2) with dark gray (Gley 1 4/N) mottling in the bottom 1 foot.	SEAL Type: **Hydrated bentonite chips** Interval: **13-15 ft**	1565
15			N	7.34 0.030	25/60/15	Wet	SM		15-22': Silty Sand with Gravel, fine to medium grained sand, coarse gravel, trace cobbles, sub-angular, dark gray (Gley 1 4/N).	SANDPACK Type: **Red Flint #30** Interval: **15-22.5 ft** SCREEN Diameter: **2 inch** Type: **Sch. 40 PVC, No. 10 slot** Interval: **17.1-22.1 ft**	1560 1555
20							ROCK		22-22.5': Bedrock, coarse-grained mafic rock, likely Duluth Complex. End of Boring - 22.5 feet		
25											1550
30											1545
35											1540

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Remarks: Soil core sample saved.
Well total depth 24.23 feet from top of riser.
Ground water elevation measured on 2/12/2012.

BGS = "below ground surface"
Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG NEW (3/20/2012) 23690862_10_2011 WELL_INSTALLATION.GPJ BARR LIBR JAN06.GLB 3/23/12

LOG OF WELL MW-6s/RS-34

Client PolyMet Mining Inc.
Drill Contractor Boart Longyear
Project Name NorthMet
Drill Method Rotosonic
Location NorthMet Mine Site
Logged By Barr/REE
Number 23/69-0862
Start: 10/31/11
End 10/31/11
Northing: 5272901.76
Easting: 577496.82
Unique Well No. 786709
Riser Elevation 1579.3
Surface Elevation 1576.5
Total Depth 15.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH- Specific Cond.	%GR/SA/ FINES	Moisture	ASTM	LITHOLOGY	DESCRIPTION	WELL OR PIEZOMETER CONSTRUCTION DETAIL	ELEV. FEET
0			N N	6.05 0.006	15/60/25	Moist	OL		0-.3': Organic Topsoil, roots, grass, organic material, black (7.5YR 2.5/1).	PRO. CASING Diameter: **8 inch** Type: **Steel** Interval: **0-4 ft**	1575
							SM		.3-4.5': Silty Sand with Gravel, fine grained sand, fine gravel, sub-angular; Color: .3-.8' dark yellowish brown (10YR 4/4), .8-1.3' yellowish brown (10YR 5/4), 1.3-4.5' yellowish brown (10YR 5/4) with 10YR 5/6 mottling.		
5			N	6.75 0.014	15/30/65		ML		4.5-5': Sandy Silt with Gravel, fine grained sand, coarse gravel, sub-angular and weathered gravel, brown (10YR 4/3).	RISER CASING Diameter: **2 inch** Type: **Sch. 40 PVC** Interval: **0-5 ft**	1570
									5-10': No Recovery	GROUT Type: **Cement** Interval: **0-3.5 ft**	
10			N	6.75 0.010	15/30/65	Moist- Wet	ML		10-15': Sandy Silt with Gravel, fine grained sand, coarse gravel, sub-angular, grayish brown (10YR 5/2) with dark gray (Gley 1 4/N) mottling in the bottom 1 foot.	SEAL Type: **Hydrated bentonite chips** Interval: **3.5-4 ft**	1565
15			N	7.34 0.030	25/60/15	Wet	SM		15-22': Silty Sand with Gravel, fine to medium grained sand, coarse gravel, trace cobbles, sub-angular, dark gray (Gley 1 4/N).	SANDPACK Type: **Red Flint #30** Interval: **4-15 ft**	1560
20							ROCK		22-22.5': Bedrock, coarse-grained mafic rock, likely Duluth Complex.	SCREEN Diameter: **2 inch** Type: **Sch. 40 PVC, No. 10 slot** Interval: **4.9-14.9 ft**	1555
									End of Boring - 15 feet		
25											1550
30											1545
35											1540

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Remarks: Boring log lithology from MW-6d.
Well total depth 17.48 feet from top of riser.
Ground water elevation measured on 2/12/2012.

BGS = "below ground surface"
Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG NEW (3/20/2012) 23690862_10_2011 WELL_INSTALLATION.GPJ BARR LIBR JAN06.GLB 3/23/12

LOG OF WELL MW-7/RS-47

Client PolyMet Mining Inc.
Project Name NorthMet
Location NorthMet Mine Site
Number 23/69-0862
Start: 11/1/11
End 11/1/11

Drill Contractor Boart Longyear
Drill Method Rotosonic
Logged By Barr/JAM2
Northing: 5273142.6
Easting: 578651.31

Unique Well No. 786726
Riser Elevation 1544.1
Surface Elevation 1541.7
Total Depth 21.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH- Specific Cond.	%GR/SA/FINES	Moisture	ASTM	LITHOLOGY	DESCRIPTION	WELL OR PIEZOMETER CONSTRUCTION DETAIL	ELEV. FEET
0			N	9.05 0.026	<5/60/40	Moist-Wet	SM		0-5': Silty Sand, fine to medium grained sand, oxidized, dark yellowish brown (10YR 3/6).	PRO. CASING Diameter: **8 inch** Type: **Steel** Interval: **0-4 ft**	1540
5			N	7.36 0.007	25/60/15	Wet			5-15': Silty Sand with Gravel, fine to coarse grained sand that grades finer with depth, granitic sub-rounded gravel, reduced soil, bluish black (Gley 2 2.5/10B).	RISER CASING Diameter: **2 inch** Type: **Sch. 40 PVC** Interval: **0-5 ft**	1535
10			N	7.51 0.008	25/50/25		SM			GROUT Type: **Cement** Interval: **0-3 ft** SEAL Type: **Hydrated bentonite chips** Interval: **3-4 ft**	1530
15			N	8.06 0.007	20/70/10		SP-SM		15-20': Sand with Silt and Gravel, medium to coarse sand, bluish black (Gley 2 2.5/10B).	SANDPACK Type: **Red Flint #30** Interval: **4-15 ft** SCREEN Diameter: **2 inch** Type: **Sch. 40 PVC, No. 10 slot** Interval: **4.3-14.3 ft**	1525
20							ROCK		20-21': Bedrock, coarse-grained mafic rock, likely Duluth Complex. End of Boring - 21 feet		1520
25											1515
30											1510
35											1505

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Remarks: Well total depth 16.55 feet from top of riser.
Ground water elevation measured on 2/12/2012.

BGS = "below ground surface"
Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG NEW (3/20/2012) 23690862_10_2011 WELL_INSTALLATION.GPJ BARR LIBR JAN06.GLB 3/23/12

LOG OF WELL MW-8d/RS-31

Client PolyMet Mining Inc.
Drill Contractor Boart Longyear
Project Name NorthMet
Drill Method Rotosonic
Location NorthMet Mine Site
Logged By Barr/JAM2
Number 23/69-0862
Start: 12/12/11
End 12/13/11
Northing: 5272484.69
Easting: 574656.76
Unique Well No. 786728
Riser Elevation 1611.3
Surface Elevation 1609.4
Total Depth 34.5
SHEET 1 OF 1

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH- Specific Cond.	%GR/SA/FINES	Moisture	ASTM	LITHOLOGY	DESCRIPTION	ELEV. FEET
			N	8.43 0.012	25/60/15	Moist	SP		0-3': Silty Sand with Gravel, medium to coarse grained sand, oxidized, dark yellowish brown (10YR 4/4).	
			N	8.32 0.007	5/20/75					
5			N			Moist-Wet	ML		3-8': Sandy Silt, fine to medium grained sand, oxidized, dark yellowish brown (10YR 4/4).	1605
			N	7.45 0.040	30/60/10	Wet			8-21': Sand with Silt and Gravel, medium to coarse grained sand, sub-angular gravel, (10YR 2/2) from 8-10' and dark yellowish brown (10YR 4/4) from 10-21'.	
10			N	7.45 0.012	40/50/10					1600
15			N	7.96 0.013			SP			1595
20			N							1590
				7.28 0.019	<5/5/95		ML		21-25': Silt, fine grained sand, sand content increases to 15% with depth, dark yellowish brown (10YR 4/4).	
25			N	7.39 0.038	30/60/10		SP		25-28': Sand with Silt and Gravel, medium to coarse grained sand, dark yellowish brown (10YR 4/4).	1585
			N	7.67 0.007	40/50/10		SP		28-30': Sand with Silt and Gravel, medium to coarse grained sand, bluish gray (Gley 2 5/5 PB).	
30			N	8.58 0.031	50/10/40		GP		30-34': Silty Gravel with Sand, bluish gray (Gley 2 5/5 PB).	1580
							ROCK		34-34.5': Bedrock, coarse-grained mafic rock, likely Duluth Complex.	
35									End of Boring - 34.5 feet	1575

WELL OR PIEZOMETER CONSTRUCTION DETAIL

PRO. CASING
Diameter: **8 inch**
Type: **Steel**
Interval: **0-4 ft**

RISER CASING
Diameter: **2 inch**
Type: **Sch. 40 PVC**
Interval: **0-34 ft**

GROUT
Type: **Cement**
Interval: **0-24.5 ft**

SEAL
Type: **Hydrated bentonite chips**
Interval: **24.5-27 ft**

SANDPACK
Type: **Red Flint #30**
Interval: **27-34.5 ft**

SCREEN
Diameter: **2 inch**
Type: **Sch. 40 PVC, No. 10 slot**
Interval: **29.3-34.3 ft**

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Remarks: Boring log lithology from MW-8s. MW-8d bedrock at 34' BGS.
Well total depth 35.95 feet from top of riser.
Ground water elevation measured on 2/12/2012.

BGS = "below ground surface"
Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG NEW (3/20/2012) 23690862_10_2011 WELL_INSTALLATION.GPJ BARR LIBR JAN06.GLB 3/23/12

LOG OF WELL MW-8s/RS-31

Client PolyMet Mining Inc.
Drill Contractor Boart Longyear
Project Name NorthMet
Drill Method Rotosonic
Location NorthMet Mine Site
Logged By Barr/JAM2
Number 23/69-0862
Start: 11/1/11
End 11/1/11
Northing: 5272483.25
Easting: 574655.2
Unique Well No. 786712
Riser Elevation 1611.3
Surface Elevation 1609.3
Total Depth 33.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH-Specific Cond.	%GR/SA/FINES	Moisture	ASTM	LITHOLOGY	DESCRIPTION	ELEV. FEET
			N	8.43 0.012	25/60/15	Moist	SP		0-3': Silty Sand with Gravel, medium to coarse grained sand, cobbles, oxidized, dark yellowish brown (10YR 4/4).	
			N	8.32 0.007	5/20/75				3-8': Sandy Silt, fine to medium grained sand, oxidized, dark yellowish brown (10YR 4/4).	
5			N			Moist-Wet	ML			1605
			N	7.45 0.040	30/60/10	Wet			8-21': Sand with Silt and Gravel, medium to coarse grained sand, sub-angular gravel, cobbles, very dark brown (10YR 2/2) from 8-10' and dark yellowish brown (10YR 4/4) from 10-21'.	
10			N	7.45 0.012	40/50/10					1600
15			N	7.96 0.013			SP			1595
20			N	7.28 0.019	<5/5/95		ML		21-25': Silt, fine grained sand, sand content increases to 15% with depth, dark yellowish brown (10YR 4/4).	1590
25			N	7.39 0.038	30/60/10		SP		25-28': Sand with Silt and Gravel, medium to coarse grained sand, granite and mafic cobbles, dark yellowish brown (10YR 4/4).	1585
			N	7.67 0.007	40/50/10		SP		28-30': Sand with Silt and Gravel, medium to coarse grained sand, bluish gray (Gley 2 5/5 PB).	
30			N	8.58 0.031	50/10/40		GP		30-32': Silty Gravel with Sand, cobbles, bluish gray (Gley 2 5/5 PB).	1580
							ROCK		32-33': Bedrock, coarse-grained mafic rock, likely Duluth Complex, secondary pyrite mineralization in matrix.	
35									End of Boring - 33 feet	1575

WELL OR PIEZOMETER CONSTRUCTION DETAIL

- PRO. CASING
  - Diameter: **8 inch**
  - Type: **Steel**
  - Interval: **0-4 ft**
- RISER CASING
  - Diameter: **2 inch**
  - Type: **Sch. 40 PVC**
  - Interval: **0-4 ft**
- GROUT
  - Type: **Cement**
  - Interval: **0-3 ft**
- SEAL
  - Type: **Hydrated bentonite chips**
  - Interval: **3-3.5 ft**
- SANDPACK
  - Type: **Red Flint #30**
  - Interval: **3.5-15 ft**
- SCREEN
  - Diameter: **2 inch**
  - Type: **Sch. 40 PVC, No. 10 slot**
  - Interval: **4.5-14.5 ft**

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Remarks: Well total depth 16.21 feet from top of riser.
Ground water elevation measured on 2/12/2012.

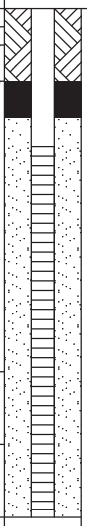
BGS = "below ground surface"
Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG NEW (3/20/2012) 23690862_10_2011 WELL_INSTALLATION.GPJ BARR LIBR JAN06.GLB 3/23/12

LOG OF WELL MW-9/RS-38

Client PolyMet Mining Inc.
Drill Contractor Boart Longyear
Project Name NorthMet
Drill Method Rotosonic
Location NorthMet Mine Site
Logged By Barr/REE
Number 23/69-0862
Start: 12/14/11
End 12/14/11
Northing: 5275210.58
Easting: 579294.32
Unique Well No. 786715
Riser Elevation 1598.6
Surface Elevation 1596.0
Total Depth 14.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH-Specific Cond.	%GR/SA/FINES	Moisture	ASTM	LITHOLOGY	DESCRIPTION
			N	5.94 0.0	5/30/65	Moist	OL		0-.5': Topsoil, silty organic rich topsoil.
			N	5.89 0.0	5/65/30		CL SM		.5-1': Sandy Clay, very fine to fine grained sand, dark yellowish brown (10YR 4/4).
			N	6.24 0.0	20/50/30				1-2': Silty Sand, fine to medium grained gravel, some secondary mineralization, dark yellowish brown (10YR 4/4)
5			N	6.10 0.0		Moist-Wet	SM		2-10': Silty Sand with Gravel, fine to medium grained sand, coarse gravel, trace cobbles, angular to subangular, dark brown (10YR 3/3).
10					70/20/10		GP		10-12': Gravel with Silt and Sand, coarse grained sand, coarse gravel, dark gray (2.5Y 4/1).
							ROCK		12-14': Bedrock, coarse-grained mafic rock, likely Duluth Complex, some sulfide mineralization.
15									End of Boring - 14 feet
20									
25									
30									
35									



WELL OR PIEZOMETER CONSTRUCTION DETAIL

PRO. CASING
Diameter: **8 inch**
Type: **Steel**
Interval: **0-4 ft**

RISER CASING
Diameter: **2 inch**
Type: **Sch. 40 PVC**
Interval: **0-4 ft**

GROUT
Type: **Cement**
Interval: **0-2 ft**

SEAL
Type: **Hydrated bentonite chips**
Interval: **2-3 ft**

SANDPACK
Type: **Red Flint #30**
Interval: **3-14 ft**

SCREEN
Diameter: **2 inch**
Type: **Sch. 40 PVC, No. 10 slot**
Interval: **3.8-13.8 ft**

ELEV. FEET: 1595, 1590, 1585, 1580, 1575, 1570, 1565, 1560

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Remarks: Well total depth 16.12 feet from top of riser.
Ground water elevation measured on 2/12/2012.

BGS = "below ground surface"
Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG NEW (3/20/2012) 23690862_10_2011 WELL_INSTALLATION.GPJ BARR LIBR JAN06.GLB 3/23/12

LOG OF WELL MW-10d/RS-50

Client PolyMet Mining Inc.
Project Name NorthMet
Location NorthMet Mine Site
Number 23/69-0862
Start: 12/15/11
End 12/15/11
Drill Contractor Boart Longyear
Drill Method Rotosonic
Logged By Barr/REE,ARP2
Northing: 5272547.19
Easting: 577735.37
Unique Well No. 786725
Riser Elevation 1554.8
Surface Elevation 1552.2
Total Depth 34.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH-Specific Cond.	%GR/SA/FINES	Moisture	ASTM	LITHOLOGY	DESCRIPTION	WELL OR PIEZOMETER CONSTRUCTION DETAIL	ELEV. FEET
0			N	6.34 0.0	5/60/35	Moist	SM		0-7': Silty Sand, very fine grained sand, dark yellowish brown (10YR 3/4) grading to yellowish brown (10YR 5/8) with depth, strong brown mottling at depth.	PRO. CASING Diameter: **8 inch** Type: **Steel** Interval: **0-4 ft** RISER CASING Diameter: **2 inch** Type: **Sch. 40 PVC** Interval: **0-27.5 ft** GROUT Type: **Cement** Interval: **0-23.5 ft** SEAL Type: **Hydrated bentonite chips** Interval: **23.5-25.5 ft** SANDPACK Type: **Red Flint #30** Interval: **25.5-34 ft** SCREEN Diameter: **2 inch** Type: **Sch. 40 PVC, No. 10 slot** Interval: **27.4-32.4 ft**	1550
5			N	7.04 0.0	5/50/45	Moist-Wet	SC		7-8': Clayey Sand with silt, very fine grained sand, more cohesive than surrounding units, dark yellowish brown (10YR 4/4).		1545
			N	6.56 0.0	5/60/35	Moist	SM		8-11': Silty Sand, very fine to fine grained sand, yellowish brown (10YR 5/4).		
10			N	7.05 0.0	30/50/20		SP		11-15': Silty Sand with Gravel, fine to coarse grained sand, trace cobbles, dark grayish brown (10YR 4/2); granite boulder from 12-15'.		1540
15			N	7.31 0.0	30/10/60		ML		15-19': Gravelly Silt with Sand, fine to coarse grained sand, trace cobbles, dark grayish brown (10YR 4/2).		1535
20			N	7.65 0.0	30/50/20		SM		19-32': Silty Sand with Gravel, medium to coarse grained sand, trace cobbles, dark yellowish brown (10YR 4/4) with strong brown and black mottling at 30'; Duluth Complex boulder at 19'.		1530
25			N	7.95 0.0							1525
30			N	8.67 0.0	30/50/20		SM		32-33': Silty Sand with Gravel, fine to medium grained sand, dark gray (10YR 4/1).		1520
							ROCK		33-34': Bedrock, coarse-grained mafic rock, likely Duluth Complex.		
35									End of Boring - 34 feet		

Barr Engineering Co.
4700 W 77th St. Suite 200
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Fax: 952-862-2601

Remarks: Well total depth 34.77 feet from top of riser.
Ground water elevation measured on 2/12/2012.

BGS = "below ground surface"
Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG NEW (3/20/2012) 23690862_10_2011 WELL_INSTALLATION.GPJ BARR LIBR JAN06.GLB 3/23/12

LOG OF WELL MW-10s/RS-50

Client PolyMet Mining Inc.
Drill Contractor Boart Longyear
Project Name NorthMet
Drill Method Rotosonic
Location NorthMet Mine Site
Logged By Barr/REE,ARP2
Number 23/69-0862
Start: 12/15/11
End 12/15/11
Northing: 5272548.82
Easting: 577735.75
Unique Well No. 786724
Riser Elevation 1554.7
Surface Elevation 1552.2
Total Depth 15.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH-Specific Cond.	%GR/SA/FINES	Moisture	ASTM	LITHOLOGY	DESCRIPTION	WELL OR PIEZOMETER CONSTRUCTION DETAIL	ELEV. FEET
			N	6.34 0.0	5/60/35	Moist			0-7': Silty Sand, very fine grained sand, dark yellowish brown (10YR 3/4) grading to yellowish brown (10YR 5/8) with depth, strong brown mottling at depth.	PRO. CASING Diameter: **8 inch** Type: **Steel** Interval: **0-4 ft**	1550
5							SM			RISER CASING Diameter: **2 inch** Type: **Sch. 40 PVC** Interval: **0-5 ft**	
			N	7.04 0.0	5/50/45	Moist-Wet	SC		7-8': Clayey Sand with silt, very fine grained sand, more cohesive than surrounding units, dark yellowish brown (10YR 4/4).		1545
			N	6.56 0.0	5/60/35	Moist	SM		8-11': Silty Sand, very fine to fine grained sand, yellowish brown (10YR 5/4).	GROUT Type: **Cement** Interval: **0-2.5 ft**	
10			N	7.05 0.0	30/50/20		SP		11-15': Silty Sand with Gravel, fine to coarse grained sand, trace cobbles, dark grayish brown (10YR 4/2); granite boulder from 12-15'.	SEAL Type: **Hydrated bentonite chips** Interval: **2.5-3.5 ft**	1540
15			N	7.31 0.0	30/10/60		ML		15-19': Gravelly Silt with Sand, fine to coarse grained sand, trace cobbles, dark grayish brown (10YR 4/2).	SANDPACK Type: **Red Flint #30** Interval: **3.5-15 ft**	1535
20							SM		19-32': Silty Sand with Gravel, medium to coarse grained sand, trace cobbles, dark yellowish brown (10YR 4/4) with strong brown and black mottling at 30'; Duluth Complex boulder at 19'.	SCREEN Diameter: **2 inch** Type: **Sch. 40 PVC, No. 10 slot** Interval: **5-15 ft**	1530
			N	7.65 0.0	30/50/20						
25			N	7.95 0.0							1525
30											
			N	8.67 0.0	30/50/20		SM		32-33': Silty Sand with Gravel, fine to medium grained sand, dark gray (10YR 4/1).		1520
							ROCK		33-34': Bedrock, coarse-grained mafic rock, likely Duluth Complex.		
35									End of Boring - 15 feet		

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Remarks: Boring log lithology from MW-10d.
Well total depth 17.55 feet from top of riser.
Ground water elevation measured on 2/12/2012.

BGS = "below ground surface"
Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG NEW (3/20/2012) 23690862_10_2011 WELL_INSTALLATION.GPJ BARR LIBR JAN06.GLB 3/23/12

LOG OF WELL MW-11/RS-46

Client PolyMet Mining Inc.
Drill Contractor Boart Longyear
Project Name NorthMet
Drill Method Rotosonic
Location NorthMet Mine Site
Logged By Barr/ARP2
Number 23/69-0862
Start: 12/16/11
End 12/16/11
Northing: 5272902.66
Easting: 577186.45
Unique Well No. 786710
Riser Elevation 1579.1
Surface Elevation 1576.9
Total Depth 21.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH-Specific Cond.	%GR/SA/FINES	Moisture	ASTM	LITHOLOGY	DESCRIPTION
0			N	5.74 0.0	10/65/25	Moist	SM		0-9': Silty Sand, clay content increases with depth, little gravel, organic material present, fine to medium grained sand, coarse gravel, angular, dark brown (10YR 3/3) grading to dark yellowish brown (10YR 4/4).
5			N	6.67 0.0					
10			N	7.45 0.0	15/70/15		SC		9-15': Clayey Sand with Gravel, medium to coarse grained sand, coarse gravel, grayish brown (10YR 5/2).
15			N	8.90 0.0	50/40/10		GP		15-18': Weathered Bedrock, composed of sand and gravel, grayish brown (10YR 5/2).
20							ROCK		18-21': Bedrock, coarse-grained mafic rock, likely Duluth Complex.
									End of Boring - 21 feet

WELL OR PIEZOMETER CONSTRUCTION DETAIL

PRO. CASING
Diameter: **8 inch**
Type: **Steel**
Interval: **0-4 ft**

RISER CASING
Diameter: **2 inch**
Type: **Sch. 40 PVC**
Interval: **0-7 ft**

GROUT
Type: **Cement**
Interval: **0-3 ft**

SEAL
Type: **Hydrated bentonite chips**
Interval: **3-5 ft**

SANDPACK
Type: **Red Flint #30**
Interval: **5-17 ft**

SCREEN
Diameter: **2 inch**
Type: **Sch. 40 PVC, No. 10 slot**
Interval: **7.1-17.1 ft**

ELEV. FEET: 1575, 1570, 1565, 1560, 1555, 1550, 1545

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Remarks: Well total depth 19.2 feet from top of riser.
Ground water elevation measured on 2/12/2012.

BGS = "below ground surface"
Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG NEW (3/20/2012) 23690862_10_2011 WELL_INSTALLATION.GPJ BARR LIBR JAN06.GLB 3/23/12

LOG OF Boring MW-12/RS-43

Client PolyMet Mining Inc.
Drill Contractor Boart Longyear
Project Name NorthMet
Drill Method Rotosonic
Location NorthMet Mine Site
Logged By Barr/ARP2
Number 23/69-0862
Start: 2/14/12
End 2/14/12
Northing: 5275230.72
Easting: 577352.77
Unique Well No. 786732
Riser Elevation 1603.4
Surface Elevation 1600.9
Total Depth 11.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH-Specific Cond.	%GR/SA/FINES	Moisture	ASTM	LITHOLOGY	DESCRIPTION	ELEV. FEET
0			N	6.80 36	10/20/70	Moist	ML		0-1.5': Organic Topsoil, wood and organic material, very dark brown (10YR 2/2).	1600
					15/30/55				1.5-9': Sandy Silt with Gravel, coarse to medium grained sand, little clay, sub-rounded coarse gravel, dark yellowish brown (10YR 4/4).	
5			N	6.30 14		Saturated	ML			1595
			N		25/30/45		ML		9-10': Sandy Silt with Gravel, medium to coarse grained sand, sub-rounded coarse gravel and cobbles, grayish brown (10YR 5/2).	
10							ROCK		10-11': Bedrock, coarse-grained mafic rock, likely Duluth Complex.	1590
									End of Boring - 11 feet	
15										1585
20										1580
25										1575
30										1570
35										1565

WELL OR PIEZOMETER CONSTRUCTION DETAIL

PRO. CASING
Diameter: **4 inch**
Type: **Steel**
Interval: **0-4 ft**

RISER CASING
Diameter: **2 inch**
Type: **Sch. 40 PVC**
Interval: **0-5.5 ft**

GROUT
Type: **Cement**
Interval: **0-2 ft**

SEAL
Type: **Hydrated bentonite chips**
Interval: **2-4 ft**

SANDPACK
Type: **Red Flint #30**
Interval: **4-11 ft**

SCREEN
Diameter: **2 inch**
Type: **Sch. 40 PVC, No. 10 slot**
Interval: **5.3-10.3 ft**

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Remarks: Well total depth 12.83 feet from top of riser.
Ground water elevation measured on 2/12/2012.

BGS = "below ground surface"
Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG NEW (3/20/2012) 23690862_10_2011 WELL_INSTALLATION.GPJ BARR LIBR JAN06.GLB 3/23/12

LOG OF Boring MW-13/RS-52

Client PolyMet Mining Inc.
Drill Contractor Boart Longyear
Project Name NorthMet
Drill Method Rotosonic
Location NorthMet Mine Site
Logged By Barr/ARP2
Number 23/69-0862
Start: 2/14/12
End 2/14/12
Northing: 5275611.7
Easting: 580109.24
Unique Well No. 786720
Riser Elevation 1588.5
Surface Elevation 1585.9
Total Depth 33.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH-Specific Cond.	%GR/SA/FINES	Moisture	ASTM	LITHOLOGY	DESCRIPTION	WELL OR PIEZOMETER CONSTRUCTION DETAIL	ELEV. FEET
0			N	6.56 52	0/0/100	Moist	PT		0-9': Peat, silty peat from 0-7' bgs, clayey peat from 7-9' bgs, wood and organic material from 2-7' bgs, very dark brown (10YR 2/2).	PRO. CASING Diameter: **4 inch** Type: **Steel** Interval: **0-4 ft**	1585
5				5.86 66						RISER CASING Diameter: **2 inch** Type: **Sch. 40 PVC** Interval: **0-5 ft**	1580
10			N	6.17 19	0/60/40	Wet	SM		9-18.5': Silty Sand, little clay, fine to coarse grained sand, coarser sand from 12-18.5' bgs, very dark gray (10YR 3/1) grading to gray (10YR 5/1) with depth.	GROUT Type: **Cement** Interval: **0-3 ft**	1575
15				5.63 22						SEAL Type: **Hydrated bentonite chips** Interval: **3-4 ft**	
										SANDPACK Type: **Red Flint #30** Interval: **4-15 ft**	1570
			N		0/30/70		ML		18.5-20': Sandy Silt, fine grained sand, brownish yellow (10YR 6/6).	SCREEN Diameter: **2 inch**	
20			N	4.28 16	0/80/20		SM		20-24': Silty Sand, fine to coarse grained sand, grayish brown (10YR 5/2).	Type: **Sch. 40 PVC, No. 10 slot** Interval: **4.8-14.8 ft**	1565
			N		30/60/10		SP-SM		24-33': Sand with Silt and Gravel, fine to coarse grained sand, coarse sub-angular gravel, dark gray (10YR 4/1).		
25				4.57 24							1560
30			N	4.85 23			ROCK		30-33': Bedrock, coarse-grained mafic rock, likely Duluth Complex.		1555
33									End of Boring - 33 feet		
35											1550

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Remarks: Well total depth 17.43 feet from top of riser.
Ground water elevation measured on 2/12/2012.

BGS = "below ground surface"
Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG NEW (3/20/2012) 23690862_10_2011 WELL_INSTALLATION.GPJ BARR LIBR JAN06.GLB 3/23/12

LOG OF Boring MW-14/RS-41

Client PolyMet Mining Inc.
Drill Contractor Boart Longyear
Project Name NorthMet
Drill Method Rotosonic
Location NorthMet Mine Site
Logged By Barr/ARP2
Number 23/69-0862
Start: 2/16/12
End 2/16/12
Northing: 5273769.82
Easting: 574492.18
Unique Well No. 786730
Riser Elevation 1615.6
Surface Elevation 1613.0
Total Depth 37.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH-Specific Cond.	%GR/SA/FINES	Moisture	ASTM	LITHOLOGY	DESCRIPTION	ELEV. FEET
0			N	5.83 48	0/0/100	Moist	OL		0-2.5': Organic Topsoil, organic material (roots), black (10YR 2/1) with strong brown mottling at 2.5'.	
			N	6.42 25	15/60/25		SM		2.5-6.5': Silty Sand with Gravel, fine to coarse grained sand, fine to coarse angular gravel, mica present, dark brown (7.5YR 3/4).	1610
5			N	5.86 18	25/45/30		SM		6.5-15': Silty Sand with Gravel, fine to coarse grained sand, coarse angular gravel, little clay, brown (10YR 4/3).	1605
10				6.18 18		Wet				1600
15			N	6.00 18	10/90/0		SP		15-21': Sand, coarse grained sand, gravel content increases with depth, brown (10YR 4/3).	1595
20			N	5.41 18	15/50/35		SM		21-35': Silty Sand with Gravel, fine to coarse grained sand, coarse angular gravel, gravel content increases with depth, brown (7.5YR 4/2).	1590
25				6.30 32						1585
30				6.26 33	30/40/30					1580
35							ROCK		35-37': Bedrock, coarse-grained mafic rock, likely Duluth Complex.	
									End of Boring - 37 feet	

WELL OR PIEZOMETER CONSTRUCTION DETAIL

- PRO. CASING
  - Diameter: **4 inch**
  - Type: **Steel**
  - Interval: **0-4 ft**
- RISER CASING
  - Diameter: **2 inch**
  - Type: **Sch. 40 PVC**
  - Interval: **0-8 ft**
- GROUT
  - Type: **Cement**
  - Interval: **0-4 ft**
- SEAL
  - Type: **Hydrated bentonite chips**
  - Interval: **4-6 ft**
- SANDPACK
  - Type: **Red Flint #30**
  - Interval: **6-18 ft**
- SCREEN
  - Diameter: **2 inch**
  - Type: **Sch. 40 PVC, No. 10 slot**
  - Interval: **7.6-17.6 ft**

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Remarks: Well total depth 20.20 feet from top of riser.
Ground water elevation measured on 2/12/2012.

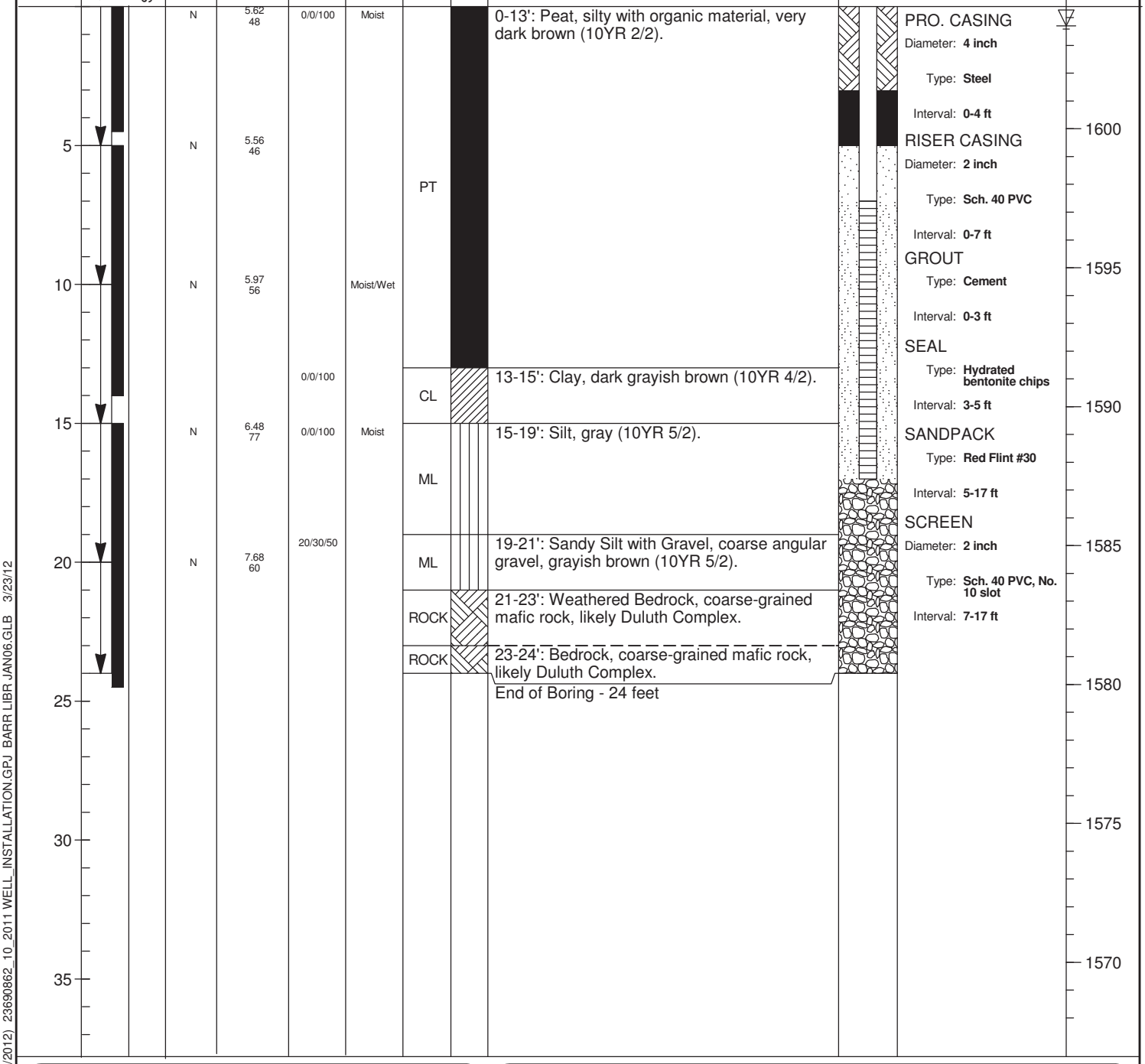
BGS = "below ground surface"
Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG NEW (3/20/2012) 23690862_10_2011 WELL_INSTALLATION.GPJ BARR LIBR JAN06.GLB 3/23/12

LOG OF Boring MW-15/RS-42

Client PolyMet Mining Inc.
Drill Contractor Boart Longyear
Project Name NorthMet
Drill Method Rotosonic
Location NorthMet Mine Site
Logged By Barr/ARP2
Number 23/69-0862
Start: 2/16/12
End 2/17/12
Northing: 5274678.08
Easting: 575826.33
Unique Well No. 786731
Riser Elevation 1606.8
Surface Elevation 1604.4
Total Depth 24.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH-Specific Cond.	%GR/SA/FINES	Moisture	ASTM	LITHOLOGY	DESCRIPTION	ELEV. FEET
0			N	5.62 48	0/0/100	Moist			0-13': Peat, silty with organic material, very dark brown (10YR 2/2).	
5			N	5.56 46			PT			1600
10			N	5.97 56		Moist/Wet				1595
					0/0/100		CL		13-15': Clay, dark grayish brown (10YR 4/2).	
15			N	6.48 77	0/0/100	Moist	ML		15-19': Silt, gray (10YR 5/2).	1590
					20/30/50		ML		19-21': Sandy Silt with Gravel, coarse angular gravel, grayish brown (10YR 5/2).	
20			N	7.68 60			ROCK		21-23': Weathered Bedrock, coarse-grained mafic rock, likely Duluth Complex.	1585
							ROCK		23-24': Bedrock, coarse-grained mafic rock, likely Duluth Complex.	
25									End of Boring - 24 feet	1580
30										1575
35										1570



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Remarks: Well frozen during February 2012 sampling. Total well depth not measured and ground water elevation estimated.

BGS = "below ground surface"
Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG NEW (3/20/2012) 23690862_10_2011 WELL_INSTALLATION.GPJ BARR LIBR JAN06.GLB 3/23/12

LOG OF Boring MW-16/RS-45

Client PolyMet Mining Inc.
Drill Contractor Boart Longyear
Project Name NorthMet
Drill Method Rotosonic
Location NorthMet Mine Site
Logged By Barr/REE
Number 23/69-0862
Start: 2/17/12
End 2/17/12
Northing: 5272121.62
Easting: 576583.73
Unique Well No. 786727
Riser Elevation 1549.2
Surface Elevation 1546.6
Total Depth 25.0
SHEET 1 OF 1

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH-Specific Cond.	%GR/SA/FINES	Moisture	ASTM	LITHOLOGY	DESCRIPTION	WELL OR PIEZOMETER CONSTRUCTION DETAIL	ELEV. FEET
						Moist	OL		0-2': Organic Topsoil, very dark grayish brown (10YR 3/2).	PRO. CASING Diameter: **4 inch** Type: **Steel** Interval: **0-4 ft**	1545
			N	5.26 6	5/60/35		SM		2-5': Silty Sand, fine grained sand, dark grayish brown (10YR 4/2) with strong brown and gray mottles.		
5			N	4.75 27	Tr/10/90	Wet	ML		5-9': Silt, little very fine grained sand towards top, dark gray (10YR 4/1).	RISER CASING Diameter: **2 inch** Type: **Sch. 40 PVC** Interval: **0-5 ft**	1540
			N		Tr/90/10		SP-SM		9-10': Sand with Silt, medium grained sand, strong brown (7.5YR 5/6).	GROUT Type: **Cement** Interval: **0-3 ft**	
10			N	3.84 16	15/75/10				10-19': Sand with Silt and Gravel, medium to coarse grained sand, coarse sub-angular gravel, brown (10YR 5/3);	SEAL Type: **Hydrated bentonite chips** Interval: **3-4 ft**	1535
			N	5.72 65			SP-SM		13.7-14': Silt layer, gray with strong brown mottling above it.		
15			N	4.10 23						SANDPACK Type: **Red Flint #30** Interval: **4-15 ft**	1530
										SCREEN Diameter: **2 inch** Type: **Sch. 40 PVC, No. 10 slot** Interval: **4.7-14.7 ft**	
20							ROCK		19-25': Bedrock, coarse-grained mafic rock, likely Duluth Complex.		1525
25									End of Boring - 25 feet		1520
30											1515
35											1510

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Remarks: Well total depth 17.28 feet from top of riser.
Ground water elevation measured on 2/12/2012.

BGS = "below ground surface"
Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG NEW (3/20/2012) 23690862_10_2011 WELL_INSTALLATION.GPJ BARR LIBR JAN06.GLB 3/23/12

LOG OF Boring MW-17/RS-53

Client PolyMet Mining Inc.
Drill Contractor Boart Longyear
Project Name NorthMet
Drill Method Rotosonic
Location NorthMet Mine Site
Logged By Barr/REE
Number 23/69-0862
Start: 2/18/12
End 2/18/12
Northing: 5274506.46
Easting: 580327.09
Unique Well No. 786719
Riser Elevation 1583.3
Surface Elevation 1580.7
Total Depth 17.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH-Specific Cond.	%GR/SA/FINES	Moisture	ASTM	LITHOLOGY	DESCRIPTION	WELL OR PIEZOMETER CONSTRUCTION DETAIL	ELEV. FEET
0			N			Frozen			0-6.5': Organic Silt, organic wetland material at top, soft, very dark brown (10YR 2/2).	PRO. CASING Diameter: **4 inch** Type: **Steel** Interval: **0-4 ft**	1580
			N	6.59 51	Tr/Tr/95	Moist	OL			RISER CASING Diameter: **2 inch** Type: **Sch. 40 PVC** Interval: **0-5 ft**	
5											1575
			N	7.23 26	15/55/30	Wet			6.5-15': Silty Sand with Gravel, very fine to fine grained sand, coarse gravel to cobbles, dark gray (10YR 4/1).	GROUT Type: **Cement** Interval: **0-3 ft**	
10			N	7.89 36			SM			SEAL Type: **Hydrated bentonite chips** Interval: **3-4 ft**	1570
15							ROCK		15-17': Bedrock, coarse-grained mafic rock, likely Duluth Complex.	SANDPACK Type: **Red Flint #30** Interval: **4-15 ft**	1565
									End of Boring - 17 feet	SCREEN Diameter: **2 inch** Type: **Sch. 40 PVC, No. 10 slot** Interval: **4.6-14.6 ft**	
20											1560
25											1555
30											1550
35											1545

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Remarks: Well total depth 17.23 feet from top of riser.
Ground water elevation measured on 2/12/2012.

BGS = "below ground surface"
Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG NEW (3/20/2012) 23690862_10_2011 WELL_INSTALLATION.GPJ BARR LIBR JAN06.GLB 3/23/12

LOG OF Boring MW-18/RS-44

Client PolyMet Mining Inc.
Drill Contractor Boart Longyear
Project Name NorthMet
Drill Method Rotosonic
Location NorthMet Mine Site
Logged By Barr/REE
Number 23/69-0862
Start: 2/19/12
End 2/19/12
Northing: 5272958.45
Easting: 574994.18
Unique Well No. 786729
Riser Elevation 1629.7
Surface Elevation 1627.0
Total Depth 23.0
SHEET 1 OF 1

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH-Specific Cond.	%GR/SA/FINES	Moisture	ASTM	LITHOLOGY	DESCRIPTION	WELL OR PIEZOMETER CONSTRUCTION DETAIL	ELEV. FEET
0			N	6.48 23	5/70/25	Frozen	SM		0-2.5': Silty Sand, fine to medium grained sand, trace coarse rounded gravel, dark yellowish brown (10YR 5/4).	PRO. CASING Diameter: **4 inch** Type: **Steel** Interval: **0-4 ft**	1625
			N	5.72 11	5/85/10	Moist	SP-SM		2.5-4': Sand with Silt, fine to medium grained sand, trace coarse subangular gravel, brown (7.5YR 4/4).		
			N	6.22 15	10/40/50		ML		4-5': Sandy Silt, very fine to fine grained sand, medium sub-angular gravel, brown (10YR 5/3) with strong brown mottling towards top.	RISER CASING Diameter: **2 inch** Type: **Sch. 40 PVC** Interval: **0-5 ft**	
5			N	6.47 22	15/55/30	Wet	SM		5-8': Silty Sand with Gravel, fine to medium grained sand, medium sub-angular gravel, brown (10YR 5/3).		1620
			N	6.49 16	15/30/55				8-21': Sandy Silt with Gravel, fine grained sand, medium to coarse angular to sub-angular gravel, dark gray (10YR 4/1).	GROUT Type: **Cement** Interval: **0-3 ft**	
10			N	7.97 36						SEAL Type: **Hydrated bentonite chips** Interval: **3-4 ft**	1615
15			N	9.57 30			ML			SANDPACK Type: **Red Flint #30** Interval: **4-15 ft**	1610
20							ROCK		21-23': Bedrock, coarse-grained mafic rock, likely Duluth Complex.	SCREEN Diameter: **2 inch** Type: **Sch. 40 PVC, No. 10 slot** Interval: **5-15.0 ft**	1605
									End of Boring - 23 feet		
25											1600
30											1595
35											

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Remarks: Well total depth 17.71 feet from top of riser.
Ground water elevation measured on 2/12/2012.

BGS = "below ground surface"
Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG NEW (3/20/2012) 23690862_10_2011 WELL_INSTALLATION.GPJ BARR LIBR JAN06.GLB 3/23/12

LOG OF Boring RS-35

Client PolyMet Mining Inc.
Drill Contractor Boart Longyear
Project Name NorthMet
Drill Method Rotosonic
Location NorthMet Mine Site
Logged By Barr/REE
Riser Elevation
Surface Elevation --
Number 23/69-0862
Start: 10/25/11
End 10/25/11
Northing:
Easting:
Total Depth 8.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH- Specific Cond.	%GR/SA/ FINES	Moisture	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
			N N	7.06 0.010	20/20/60	Moist-Wet	OL		0-.3': Topsoil, grass, roots, organic material, dark brown (7.5YR 3/4).	
							ML		.3-3': Sandy Silt with Gravel, fine grained sand, sub-angular coarse gravel, dark yellowish brown (10YR 3/6) with strong brown oxidation mottling.	
			N N	6.45 0.002	45/40/15		GP		3-4': Silty Gravel with Sand, medium grained sand, sub-angular coarse gravel, dark yellowish brown (10YR 3/3).	
							GP		4-5': Weathered Bedrock, coarse grained mafic cobbles, greenish grey (Gley 2 5/1).	
5							ROCK		5-8': Bedrock, coarse-grained mafic rock, likely Duluth Complex.	5
									End of Boring - 8 feet	
10										10
15										15
20										20
25										25
30										30
35										35

Barr Engineering Co.
4700 W 77th St. Suite 200
Edina, MN 55435
Telephone: 952-832-2600
Fax: 952-862-2601

Remarks: Three borings were advanced - the boring log is of RS-35a.

BGS = "below ground surface"
Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG NEW (3/20/2012) 23690862_10_2011 WELL_INSTALLATION.GPJ BARR LIBR JAN06.GLB 3/23/12

LOG OF Boring RS-36

Client PolyMet Mining Inc.
Drill Contractor Boart Longyear
Project Name NorthMet
Drill Method Rotosonic
Location NorthMet Mine Site
Logged By Barr/REE
Riser Elevation
Surface Elevation --
Number 23/69-0862
Start: 10/25/11
End 10/25/11
Northing:
Easting:
Total Depth 2.2
SHEET 1 OF 1

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH- Specific Cond.	%GR/SA/ FINES	Moisture	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
			N N	7.24 0.006	10/50/40	Moist Moist- Wet	OL SM		0-.2': Topsoil, grass, roots, organic material, dark brown (7.5YR 3/4). .2-1.5': Silty Sand, fine grained sand, trace sub-angular coarse gravel, dark brown (10YR 3/3).	
			N	6.80 0.002	40/50/10		SP ROCK		1.5-2': Sand with Silt and Gravel, fine grained sand, sub-angular coarse gravel, cobbles, yellowish brown (10YR 5/6). 2-2.3': Bedrock, coarse grained mafic bedrock, likely Duluth Complex. End of Boring - 2.2 feet	
5										5
10										10
15										15
20										20
25										25
30										30
35										35

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Remarks: Two borings were advanced - the boring log is of RS-36a.

BGS = "below ground surface"
Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG NEW (3/20/2012) 23690862_10_2011 WELL_INSTALLATION.GPJ BARR LIBR JAN06.GLB 3/23/12

LOG OF Boring RS-39

Client PolyMet Mining Inc.
Drill Contractor Boart Longyear
Project Name NorthMet
Drill Method Rotosonic
Location NorthMet Mine Site
Logged By Barr/REE
Riser Elevation
Surface Elevation --
Number 23/69-0862
Start: 10/24/11
End 10/24/11
Northing:
Easting:
Total Depth 5.5

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH- Specific Cond.	%GR/SA/FINES	Moisture	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
			N	6.09 0.049		Moist	OL		0-1': Organic Topsoil, dark yellow brown (10YR 3/4).	
			N	5.97 0.007	35/50/15		SP		2-3': Silty Sand with Gravel, fine grained sand, cobbles, yellowish brown (10YR 5/6).	
			N	6.03 0.004			SP		3-4.5': Silty Sand with Gravel, fine grained sand, pale brown (10YR 6/3).	
5			N	6.44 0.014			ROCK		4.5-5': Bedrock, coarse-grained mafic rock, likely Duluth Complex.	5
									End of Boring - 5.5 feet	
10										10
15										15
20										20
25										25
30										30
35										35

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Fax: 952-862-2601

Remarks: Three borings were advanced - the boring log is of RS-39b.

BGS = "below ground surface"
Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG NEW (3/20/2012) 23690862_10_2011 WELL_INSTALLATION.GPJ BARR LIBR JAN06.GLB 3/23/12

LOG OF Boring RS-40

Client PolyMet Mining Inc.
Drill Contractor Boart Longyear
Project Name NorthMet
Drill Method Rotosonic
Location NorthMet Mine Site
Logged By Barr/REE
Riser Elevation
Surface Elevation --
Number 23/69-0862
Start: 10/28/11
End 10/28/11
Northing:
Easting:
Total Depth 6.0
SHEET 1 OF 1

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH- Specific Cond.	%GR/SA/ FINES	Moisture	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
			N N N	8.22 0.010 6.92 0.002 6.75 0.004	15/15/70 5/10/85	Moist- Dry	OL ML		0-.5': Topsoil, grass, roots, organic material, brown (10YR 4/3). .5-4': Silt with Sand, very-fine to fine grained sand, fine gravel, one 4" cobble at 1.5', yellowish brown (10YR 5/8) at top grading to yellow (10YR 7/6).	
5			N	6.72 0.004	10/25/65		ML ROCK		4-5.5': Sandy Silt, fine to coarse grained sand, trace fine gravel, light brownish gray (10YR 6/2). 5.5-6': Bedrock, coarse grained mafic rock, likely Duluth Complex. End of Boring - 6 feet	5
10										10
15										15
20										20
25										25
30										30
35										35

Barr Engineering Co.
4700 W 77th St. Suite 200
Edina, MN 55435
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Fax: 952-862-2601

Remarks: Two borings were advanced - the boring log is of RS-40a.

BGS = "below ground surface"
Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG NEW (3/20/2012) 23690862_10_2011 WELL_INSTALLATION.GPJ BARR LIBR JAN06.GLB 3/23/12

LOG OF Boring RS-51

Client PolyMet Mining Inc.
Drill Contractor Boart Longyear
Project Name NorthMet
Drill Method Rotosonic
Location NorthMet Mine Site
Logged By Barr/REE
Riser Elevation
Surface Elevation --
Number 23/69-0862
Start: 12/13/11
End 12/13/11
Northing:
Easting:
Total Depth 6.5

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Matrix Effervescence	Soil pH- Specific Cond.	%GR/SA/ FINES	Moisture	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
			N N	5.65 0.0 5.1 0.0	5/15/80	Moist-Dry	ML		0-5': Silt with Sand, very fine grained sand, yellowish brown (10YR 5/6) grading to grayish brown (10YR 5/2).	
5							ROCK		5-6.5': Bedrock, coarse-grained mafic rock, likely Duluth Complex.	5
									End of Boring - 6.5 feet	
10										10
15										15
20										20
25										25
30										30
35										35

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Remarks: Three borings were advanced - the boring log is of RS-51c.

BGS = "below ground surface"
Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG NEW (3/20/2012) 23690862_10_2011 WELL_INSTALLATION.GPJ BARR LIBR JAN06.GLB 3/23/12

Attachment B

Groundwater Modeling of the NorthMet Mine Site

Groundwater Modeling of the NorthMet Mine Site

Supporting Document for Water Modeling Data Package Volume 1 – Mine Site

Prepared for
Poly Met Mining Inc.

February 2015

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Duluth, MN 55802
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Groundwater Modeling of the NorthMet Mine Site

February 2015

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Acronyms, Abbreviations, and Units

Acronym Abbreviation, or Unit	Description
BIF	Biwabik Iron Formation
cfs	cubic feet per second
DEIS	Draft Environmental Impact Statement
DEM	digital elevation model
FEIS	Final Environmental Impact Statement
MDNR	Minnesota Department of Natural Resources
meta-sedimentary	metamorphosed sedimentary
MSL	mean sea level
SDEIS	Supplemental Draft Environmental Impact Statement
TMR	Telescopic Mesh Refinement
USGS	U.S. Geological Survey
K	hydraulic conductivity term
L	length
M	thickness
W	width
WWTF	Wastewater Treatment Facility

1.0 Introduction

This report describes the technical approach, rationale, and scope for groundwater flow modeling that was conducted for the Poly Met Mining Inc. (PolyMet) NorthMet Project (Project) Mine Site. The groundwater modeling was completed to support the probabilistic modeling used to estimate Project water balances and water quality impacts presented in the NorthMet Project Water Modeling Data Package Volume 1 – Mine Site (Reference (1)). This report describes the objectives of the groundwater modeling, the site conceptual model, the modeling methodology, and the modeling results. The modeling was based on the current understanding of the Mine Site conditions and the Project Description (Reference (2)) developed for the Final Environmental Impact Statement (FEIS).

1.1 Objectives

The primary objective of this study was to estimate the amount of groundwater expected to flow into the mine pits during operations and pit flooding, and to evaluate the groundwater flow conditions following pit closure. To meet these objectives, a series of numerical groundwater flow models were developed. These models were designed to simulate current conditions, conditions during mining, conditions during reclamation, and conditions during long-term closure.

1.2 Background

The Mine Plan (Reference (3)) defines the proposed pit designs. The pits will be located primarily in the Duluth Complex, with a portion of the East Pit intersecting the Virginia Formation.

Multiple hydrogeologic investigations have been conducted at the Mine Site:

- The Phase I investigation (Reference (4)) characterized the hydrogeologic properties of the unconsolidated deposits and the Duluth Complex.
- The Phase II investigation (Reference (5)) characterized the hydrogeologic conditions of the Virginia Formation.
- The Phase III investigation (Reference (6)) further characterized the hydrogeologic properties of the Virginia Formation and the connection between the Virginia Formation and the overlaying wetlands.
- Additional monitoring wells were installed in the unconsolidated deposits between November 2011 and February 2012.

During the Draft Environmental Impact Statement (DEIS) process, results from the Phase I, II, and III hydrogeologic investigations were incorporated into a series of groundwater models developed for the Mine Site. As part of the modeling effort for the Supplemental Draft Environmental Impact Statement (SDEIS) completed in 2012, the models were updated to incorporate revised estimates of baseflow to the Partridge River and groundwater elevation data from monitoring wells installed at the Mine Site from November 2011 through February 2012. For the FEIS modeling effort, the groundwater models were

updated to incorporate groundwater elevation data collected through 2013 and minor changes as recommended by the co-lead agencies in response to comments received on the SDEIS. This report documents the current version of the models developed for the FEIS.

1.3 Report Organization

This report is organized into five sections, including this introduction. Section 2.0 presents the conceptual model of hydrogeology at the Mine Site. Section 3.0 discusses the modeling approach and calibration methods and results. Predictive simulations of mine operations and closure conditions are presented in Section 4.0. A report summary and conclusions are presented in Section 5.0. Exhibit A provides a technical memorandum discussing NorthMet bedrock groundwater elevation measurements.

2.0 Conceptual Model

A *hydrogeologic conceptual model* is a schematic description of how water enters, flows through, and leaves the groundwater system. Its purpose is to describe the major sources and sinks of water, the grouping or division or of hydrostratigraphic units into aquifers and aquitards, the direction of groundwater flow, the interflow of groundwater between aquifers, and the interflow of water between surface waters and groundwater. The hydrogeologic conceptual model is both scale-dependent (e.g., local conditions may not be identical to regional conditions) and dependent upon the questions being addressed. It is important when developing a conceptual model to strive for an effective balance: the model should be kept as simple as possible while still adequately representing the system to analyze the problem at hand.

2.1 Geologic Units

2.1.1 Unconsolidated Deposits

Geomorphically, the Mine Site is part of the Superior Upland Province and is characterized by bedrock hills and ridges which are interspersed with peat bogs and wetlands (Reference (7)). At the Mine Site, the bedrock surface appears to be hummocky. Much of the Mine Site is covered by low lying peat/wetland deposits, with the remaining area covered by rolling to undulating Wisconsin age Rainy Lobe drift. Regionally, Rainy Lobe drift is generally a bouldery till with high clay content, but variability is observed at a local scale. In the region, it appears that significant quantities of outwash (sand and gravel), with thicknesses greater than 100 feet, are present only in the Embarrass River basin north of the Plant Site (northwest of the Mine Site) and the Dunka River basin northeast of the Mine Site (Reference (7)). Elsewhere in the region, including at the Mine Site, the unconsolidated deposits form a thin cover over the bedrock.

Based on data collected during site-specific investigations, the unconsolidated deposits across the Mine Site are relatively heterogeneous, ranging from very dense clay to well-sorted sand. Although predominantly sandy deposits have been encountered in various intervals in some borings, these deposits do not appear to be laterally extensive or continuous. On a local scale, the unconsolidated deposits are typically poorly sorted and contain numerous cobbles and boulders (Reference (4)) and can generally be classified as till, consistent with previously published interpretations of the glacial stratigraphy of the area (e.g., Reference (8), Reference (9), and Reference (10)). The unconsolidated material at the Mine Site area can generally be subdivided into two units (the “lower till” and “upper till”), peat deposits in topographic lows, scattered topsoil and/or alluvium, and a clayey till unit that does not appear to be laterally continuous across the Site. The lower and upper till units are differentiated by color, stratigraphic sequence, and mineralogical differences of sand fractions. Based on drilling, geophysics, and outcrop mapping, the depth to bedrock across the property averages less than 14 feet, and ranges from 0 to 59 feet. The thickest unconsolidated deposits are generally associated with wetland areas, which tend to fill the pre-existing depressions in the bedrock.

The bouldery till of the Rainy Lobe that covers the majority of the Mine Site has an estimated hydraulic conductivity range of 0.1 to 30 feet/day (Reference (11)). Lab permeameter tests on the silty sand from

drill core and test trenches at the Mine Site found the hydraulic conductivity values to be 0.00043 to 0.0081 feet/day; note that these tests were specifically targeting low-permeability material and are not considered representative of the Mine Site deposits as a whole. Field testing of the various unconsolidated deposits found a range of hydraulic conductivity values from 0.012 to 31 feet/day (Reference (4)).

2.1.2 Bedrock

The bedrock in the vicinity of the Mine Site consists of granites and associated lithologies overlain by metamorphosed sedimentary (meta-sedimentary) rocks that host the northeast trending Biwabik Iron Formation (BIF), and the intruded igneous Duluth Complex, which is the source of the ore to be mined. The proposed mine pits will be located primarily within the Duluth Complex, with a portion of the East Pit intersecting the Virginia Formation. The site bedrock geology is shown on Large Figure 1. Cross-sections through the proposed mine pits that show the relationship between the various units are presented on Large Figure 2 and Large Figure 3. The BIF is generally considered to be the most permeable unit, locally acting as a water source for residential and community wells. The Virginia Formation and Duluth Complex are less permeable (Reference (11)). Groundwater flow within the bedrock is primarily through fractures and other secondary porosity features, as the rocks have low primary hydraulic conductivity.

This section provides an overview of the bedrock conceptual model, particularly as it pertains to the development of the groundwater flow models. A more detailed summary of the current understanding of bedrock structure and hydrogeology at the Mine Site and the Plant Site, and description of the regional and local bedrock geology and hydrogeology, including the nature of fractured bedrock, can be found in Reference (12).

2.1.2.1 Duluth Complex

Barr (Reference (4)) conducted 10 aquifer performance tests in exploratory drillholes that ranged in depth from 328 to 1,303 feet. Hydraulic conductivity values for the Duluth Complex at the Mine Site ranged from 2.6×10^{-4} to 4.1×10^{-2} feet/day, with a geometric mean of 2.3×10^{-3} feet/day. Five of the tests were conducted in boreholes within approximately 1,000 feet of the contact with the Virginia Formation, where the hydraulic conductivity is believed to be affected by the characteristics of the contact. The five remaining tests were located south of the proposed mine pits, further from the contact with the Virginia Formation, and the hydraulic conductivity estimates derived from these tests are generally about an order of magnitude lower than those derived from tests conducted closer to the Virginia Formation contact. The geometric mean hydraulic conductivity from the five aquifer tests conducted south of the contact was 4.7×10^{-4} feet/day.

2.1.2.2 Virginia Formation

At the Mine Site, five pumping tests (three 36-hour tests, one 96-hour test, and one 30-day test) were conducted in four wells completed within the Virginia Formation, near the contact with the Duluth Complex. Pumping test data suggest that the upper approximately 600 feet of the Virginia Formation has a bulk hydraulic conductivity of 2.4×10^{-3} to 6.8×10^{-1} feet/day. Specific capacity testing was conducted in two of the Virginia Formation wells to assess the relative permeability of the upper (0-300 feet) versus

lower (300-600 feet) portions of the formation. This work found the upper portion of the Virginia formation to be approximately three to five times more permeable than the lower portion (Reference (6)). The geometric mean hydraulic conductivity estimated for the upper 300 feet of the Virginia Formation was approximately 3.7×10^{-1} feet/day, and the geometric mean hydraulic conductivity estimated for the lower portions of the formation (300-600 feet) was approximately 7.6×10^{-2} feet/day.

2.1.2.3 Giants Range Granite

Siegel and Ericson (Reference (11)) measured specific capacity in one well in the upper 200 feet of the Giants Range, and found hydraulic conductivity was 2.6×10^{-2} feet/day. This well was located less than 1-mile to the east of the Plant Site. Specific capacity data from a residential well located north of the Plant Site suggests that the hydraulic conductivity of the upper 47 feet of the granite at that location is approximately 42 feet/day. The log for this well indicates that the top of bedrock is at 18 feet below grade and the well also extends to 18 feet below grade. Because the well casing apparently does not extend into bedrock, it is possible that the higher hydraulic conductivity estimate at this well may reflect some degree of hydraulic connection with the unconsolidated deposits. The hydraulic conductivity of uppermost portions of the Giants Range granite (<20 feet) was tested at five locations during a 2014 geotechnical investigation in the Plant Site area (Appendix A of Reference (12)). Hydraulic conductivity values for the upper portion of the Giant's Range granite at the Plant Site range from effectively zero (e.g., no water was produced in three of the packer test intervals) to 2 feet/day, with a geometric mean of 5.4×10^{-2} feet/day (for the purposes of calculating a geometric mean, the lowest hydraulic conductivity value measured during the investigation was used for the three intervals that did not produce water).

2.1.2.4 Biwabik Iron Formation

The Biwabik Iron Formation (BIF), which comprises the footwall at depth below the Virginia Formation at the Mine Site, represents the most hydraulically conductive of the bedrock units at NorthMet. Where the BIF is present in sub-crop, it is recognized as a regional water resource; weathered and leached BIF can supply 1,000 gal/min in wells that supply villages on the Mesabi Iron Range (Reference (13)). When it is exposed near the surface (i.e., Peter Mitchell Pit to the north of the Mine Site), fractures are widespread and include bedding-plane fractures, joints, and variably oriented large- and small-offset faults (i.e., Siphon Fault, Donora Fault). Although most groundwater discharge to local taconite mine pits comes from the interface between the surficial deposits and the bedrock (Reference (14)), groundwater discharging from joints within the BIF are common in dewatered pits (Reference (15)). Siegel and Ericson (Reference (11)) measured specific capacity in four wells screened in the BIF. These data suggest that hydraulic conductivity of the BIF ranges from 1.5×10^{-1} to 16 feet/day (with a geometric mean of 9.1×10^{-1} feet/day).

The hydraulic conductivity of the BIF at depth below the NorthMet mine pits likely will be less than where it is exposed in sub-crop, due to the decreased aperture width resulting from the confining stress exerted by the overlying Virginia Formation and Duluth Complex. Unlike the taconite mine pits described above, the Virginia Formation, not the BIF, will be exposed along portions of the NorthMet mine pits. There will be a minimum separation of 150 feet between the pit walls and the BIF (Reference (3)) and seepage from the BIF is not anticipated.

2.2 Sources and Sinks for Water

Sources of water to the groundwater flow system include:

- infiltration of precipitation
- groundwater seepage from wetlands and losing segments of streams and rivers
- seepage from nearby mine-pit lakes

Sinks that remove water from the saturated system include:

- discharge to wetlands and gaining segments of streams and rivers
- discharge to local mine pits that are currently being dewatered or are in the process of flooding

Evaporation from soil and free-water surfaces is assumed to be accounted for in the recharge component (i.e., recharge from precipitation includes losses from evaporation).

2.3 Local Flow System

Saturated conditions exist within the unconsolidated deposits at the Mine Site. Groundwater divides in this area generally coincide with surface-water divides. Regionally, groundwater within the unconsolidated deposits flows primarily to the south, from the Embarrass Mountains to the Partridge River; however, groundwater flow is interrupted by bedrock outcrops, which cause deviations in the groundwater flow field (Reference (11)). At the Mine Site, groundwater flow is generally to the southeast toward the Partridge River, which represents a discharge area for shallow groundwater. Measured groundwater elevations indicate that there is a groundwater divide in the northern portion of the Mine Site. Groundwater to the north of the divide flows toward the portion of the Partridge River that borders the northern portion of the Site. Recharge to the unconsolidated deposits is by infiltration of precipitation. Because the unconsolidated deposits are thin, flow paths are generally thought to be short, with the recharge areas being very near the discharge areas.

Groundwater flow directions in shallow bedrock are similar to groundwater flow directions in the unconsolidated deposits, indicating water in the bedrock is hydraulically connected with the overlaying unconsolidated deposits to some degree, though the connection is likely weak and spatially variable. According to Siegel and Ericson (Reference (11)), the interaction between the unconsolidated deposits and the bedrock is assumed to be insignificant due to the low permeability of the bedrock. Site-specific observations confirm this assumption of a weak hydraulic connection; groundwater elevations in the unconsolidated deposits were minimally affected by pumping in the bedrock during the Phase III Hydrogeologic Investigation (Reference (6)). Recharge to the bedrock is by infiltration of precipitation in outcrop areas and leakage from the overlying unconsolidated aquifers where there is a connection with the bedrock (Reference (11)). In general, groundwater in the bedrock flows from northwest to southeast.

2.4 Hydrologic Model Selection

Groundwater flow within fractured bedrock, such as at the Mine Site, is more challenging to simulate than flow in unconsolidated deposits. The available fracture-based modeling codes require detailed characterization of the geometry and hydraulic properties of individual fractures. However, at a large scale (such as the scale of this study), the fractures can reliably be assumed to be sufficiently interconnected that the fractured rock medium behaves similar to a porous medium. By assuming that the aquifer acts as an equivalent porous medium at the scale of the study, it is possible to use conventional porous media modeling codes such as MODFLOW to simulate the general direction and magnitude of groundwater flow in fractured bedrock (Reference (16); Reference (17)). This assumption was used to estimate groundwater inflow into the mine pits at the various stages of pit development.

MODFLOW simulates three-dimensional, steady-state, and transient groundwater flow (saturated) using finite-difference approximations of the differential equation of groundwater flow:

$$\frac{\partial}{\partial x}\left(K_{xx}\frac{\partial h}{\partial x}\right)+\frac{\partial}{\partial y}\left(K_{yy}\frac{\partial h}{\partial y}\right)+\frac{\partial}{\partial z}\left(K_{zz}\frac{\partial h}{\partial z}\right)-W=S_s\frac{\partial h}{\partial t}$$

where:

K_{xx}, K_{yy}, and K_{zz}: three principal directions of the hydraulic conductivity tensor
W: sources and sinks
S_s: specific storage
h: hydraulic head
t: time

For steady-state simulations, the partial derivative of head with respect to time is zero and the right side of Laplace's equation, above, equals zero.

MODFLOW was developed by the U.S. Geological Survey (USGS) and is in the public domain. It is widely used and accepted. The regional model (described in Section 3.1) used MODFLOW-2000, the current-conditions simulation in the local-scale model (described in Section 3.2) used MODFLOW-96, and simulations of mine operations and closure conditions in the local-scale model (described in Section 4.0) used MODFLOW-NWT (Reference (18)). MODFLOW-NWT was used to overcome potential issues with model instability caused by "dry" model cells. During mine operations, drawdown occurs in areas of the model adjacent to the pits and, in some cases, the hydraulic head may fall below the bottom elevation of some model cells. When this occurs in a model cell, the cell is considered "dry" by MODFLOW. If model cells become dry and then re-wet during a simulation, serious problems with model convergence and stability may result. MODFLOW-NWT is an alternate formulation of MODFLOW-2005 (Reference (19)) specifically intended for solving problems involving drying and rewetting nonlinearities of the unconfined groundwater-flow equation. The graphical user interface Groundwater Vistas (Versions 6) (Reference (20)) was used to support the development of the MODFLOW models, although some elements of the models were developed outside of Groundwater Vistas.

3.0 Model Construction and Calibration

An approach called Telescopic Mesh Refinement (TMR) (Reference (21)) was used for the Mine Site models. The TMR approach uses a local-scale model that is embedded in a regional model. The regional model is used to define the boundary conditions for the local-scale model. This approach is useful for sites where physical or hydraulic boundaries of the aquifer lie outside of the area of interest. At the Mine Site, it was not possible to determine *a priori* what the aquifer boundaries were for the bedrock units. The TMR approach was used to account for uncertainty in the location of boundaries.

3.1 Regional Model

A single-layer regional model of the area surrounding the Mine Site was constructed for use in the DEIS. This model provided the boundary conditions for the smaller, local-scale model (local model) that was used to estimate groundwater inflow rates into the pits. Note that the regional model was not updated for the SDEIS or FEIS groundwater modeling, as the local-scale model results were not sensitive to the lateral boundary conditions defined by the regional model (Reference (22).

3.1.1 Model Grid and Layers

A single, flat-lying model layer, covering approximately 1,000 square miles was used to simulate groundwater flow within the various bedrock units (Large Figure 4). The bottom elevation of the model was set below the maximum depth of the proposed pits at an elevation of 640 feet above mean sea level (MSL). The model grid was rotated 45 degrees to better align with the axis of the mine. The model grid was refined at the Mine Site, with the final grid coarser at the boundaries and outside the area of interest (cells of approximately 1,640 feet on a side) and more refined at the Mine Site (cells of approximately 820 feet on a side).

3.1.2 Boundary Conditions

Internal boundary conditions were used to represent surface-water features. Major rivers and lakes were simulated as either river cells or constant-head cells. River and lake stage information was obtained from 7.5-minute USGS quadrangle maps. Boundary conditions are shown on Large Figure 5.

The upper model boundary was simulated as a specified-flux boundary representing recharge to the bedrock. A single recharge zone was used. The value of recharge was allowed to vary during model calibration between expected upper and lower boundaries.

Perimeter model boundaries were set as no-flow boundaries in the regional model. The model perimeter was set sufficiently far from the Mine Site so that the no-flow boundaries do not affect groundwater flow estimates at the Mine Site.

3.1.3 Hydraulic Conductivity Distribution

Hydraulic conductivity distribution was based on the bedrock geology of the area (Reference (23)). Four zones were used, with a single zone representing each of the major bedrock units: the BIF, the Giants

Range granite, the Duluth Complex, and the Virginia Formation. Hydraulic conductivity values for the BIF and the Giants Range granite were set using literature values (Reference (11)). The hydraulic conductivity of the Duluth Complex and the Virginia Formation were set using values calculated as part of the Phase I and Phase II Hydrogeologic Investigations, respectively. Hydraulic conductivity values used in the regional model are shown in Table 3-1.

Table 3-1 Hydraulic Conductivity Values used in the Regional Model

	Hydraulic Conductivity (feet/day)
Duluth Complex	0.0014
Virginia Formation	0.33
BIF	0.72
Giants Range granite	0.029

3.1.4 Calibration

The regional model was calibrated to water levels measured through 2008 in wetland areas at the Mine Site. Approximately 25 water-level targets were used (Reference (24)). The regional model calibration has not been updated since 2008 because sensitivity analysis conducted on the DEIS version of the model (Reference (22)) indicated that the local-scale model results were not sensitive to the lateral boundary conditions defined by the regional model.

During model calibration, recharge was adjusted until there was an acceptable match between measured and simulated heads. The model was calibrated using the automated calibration capabilities of MODFLOW-2000 (Reference (25)). The results of the model calibration are shown on Large Figure 6. The optimized recharge value for the model was 0.001 inches/year. This low recharge rate is consistent with information from regional studies which indicate that there is likely little interaction between the unconsolidated deposits and the bedrock due to the low permeability of the bedrock (Reference (11)).

3.2 Local-Scale Model

3.2.1 Model Grid and Layers

A grid covering an area of approximately 100 square miles was extracted from the regional model and used for the local-scale model (Large Figure 4). The model grid was further refined at the Mine Site, with the final grid coarser at the boundaries and outside of the area of interest (cells of approximately 330-660 feet on a side) and more refined at the Mine Site (cells of approximately 50-100 feet on a side) (Large Figure 7).

The local-scale model was vertically discretized into eight layers: one layer simulating the unconsolidated deposits, and seven layers simulating bedrock. Layer elevations have remained unchanged since the DEIS version of the model. The bottom of Layer 1 was set equal to the bedrock-surface elevation as defined in Reference (26). The bottom elevations of some layers were modified slightly in some locations to prevent

portions of the layer from going dry during model simulations. Vertical discretization was needed to accurately simulate the footwall and headwall geology of the pit at various stages of pit development. Bottom elevations for Layers 2-7 were set to correspond to the elevations of major benches in the mine pits and pit bottom elevations at various stages of mine development. The bottom elevation for Layer 8 was set at -65 feet mean sea level (MSL), which corresponds roughly to the estimated bottom elevation of the BIF at the Mine Site. Model layer bottom elevations are shown in Table 3-2.

Table 3-2 Model Layer Bottom Elevations

	Bottom Elevation (feet MSL)
Layer 1	1400 – 1585
Layer 2	1350
Layer 3	1270
Layer 4	1050
Layer 5	890
Layer 6	700
Layer 7	330
Layer 8	-65

For model stability during the calibration, all model layers were represented as confined. Modeling unconfined aquifers as confined layers with appropriate layer thickness is a recommended approach for reducing model run times (Reference (27)). As long as the model layer thicknesses are consistent with the saturated thickness of the aquifer layers, the confined model is a reasonable approximation of the unconfined system. Simulation of unconfined layers introduces model non-linearity which reduces the effectiveness of the automated calibration methods that were used with this model. In addition, if model cells that contain calibration observations become dry during a simulation, the modeled value of the water level in that cell is not available, so an automated calibration that includes that observation would fail.

3.2.2 Boundary Conditions

3.2.2.1 Constant-head Cells

The perimeter model boundaries were extracted from the regional model as constant-head cells with head values corresponding to the regional model's simulated values at these locations. Internal boundary conditions from the regional model were further refined near the Mine Site due to the smaller grid cells in this area. Additional boundaries, such as constant-head cells simulating the water levels in the Peter Mitchell Pits, were added during the DEIS calibration process. Large Figure 7 shows the boundary conditions in Layer 1.

3.2.2.2 River Cells

Within the local model, the river stage was adjusted to more accurately represent the river elevation in the vicinity of the Mine Site. Stage values for the Partridge River and its tributaries were extracted from a high-resolution digital elevation model (DEM) of the Mine Site created from a combination of 2010 LiDAR data in the immediate project area (plus a 500-foot buffer), Minnesota Department of Natural Resources (MDNR) data, and USGS DEM data.

River cell conductance was treated as an adjustable parameter during model calibration. In MODFLOW, the conductance of a river cell is defined by the following equation (Reference (16)):

$$C_{RIV} = \frac{KLW}{M}$$

where:
K = Vertical hydraulic conductivity of river bottom sediment [L/T]
L = Length of river within model cell [L]
W = Width of river within model cell [L]
M = Thickness of river bottom sediment [L]

A "baseline" conductance value was calculated for each river cell using the equation above. The baseline conductance value assigned to each river cell was determined by calculating the length (L) of the river present in each river cell based on a 1:24,000-scale polyline shapefile of the Partridge River. The width (W) and thickness (M) terms of the equation were both assumed to equal 1 meter, and the hydraulic conductivity term (K) was assigned a value of 1 meter/day. Therefore, the initial value of conductance for each model cell was equal to the length of river present within the cell. During calibration, the vertical hydraulic conductivity of the river sediment (K) was varied, and the baseline conductance value was multiplied by the updated value of the hydraulic conductivity to calculate the conductance for each river cell.

The conductance term was allowed to vary spatially by dividing the Partridge River and its tributaries into eight reaches (Large Figure 8), and allowing the conductance of each reach to vary independently. The reaches generally consist of tributaries to the Partridge River (e.g., Reach 3, Reach 5) or reaches of the Partridge River between its confluence with tributary streams (e.g., Reach 2, Reach 4). The reaches were selected to separate portions of the main river channel and tributaries that may have different hydraulic characteristics so that they can be allowed to vary independently during model calibration.

3.2.3 Hydraulic Conductivity

Hydraulic conductivity was parameterized in the model using both zones and pilot points, as described below. Hydraulic conductivity zones for each model layer are shown on Large Figure 9 through Large Figure 16.

3.2.3.1 Unconsolidated Deposits

Two hydraulic conductivity zones were used to simulate the unconsolidated deposits in Layer 1: one zone representing deposits beneath wetland areas, referred to as “wetland deposits” and one zone representing deposits in upland areas, referred to as “upland deposits”. Boundaries of the wetland deposits have remained unchanged since the DEIS model, and were based on the wetland delineation presented in Reference (28). Hydraulic conductivity within each zone was simulated as heterogeneous using the “pilot points” methodology for spatial parameterization. Using this technique, pilot points were placed within the model domain, and the hydraulic conductivity at each point was adjusted during calibration. The hydraulic conductivity of each model cell was calculated from the hydraulic conductivities assigned to the pilot points using an interpolation scheme.

The unconsolidated deposits were treated as anisotropic (i.e., vertical and horizontal hydraulic conductivity values were not equal) and were assigned a fixed vertical hydraulic conductivity value of 0.003 feet/day. The value used for vertical hydraulic conductivity was set to balance two primary constraints: (1) the value should be close to estimates based on field measurements of horizontal hydraulic conductivity, and (2) the value should result in model-estimated drawdown that is reasonably consistent with observations at nearby mines. While vertical hydraulic conductivity of the unconsolidated deposits has not been measured in the field, field testing for horizontal hydraulic conductivity has been completed. Field testing of the various unconsolidated deposits found a range of hydraulic conductivity values from 0.012 to 31 feet/day (Reference (4)), and horizontal hydraulic conductivity values for materials ranging from silt to fine sand range from approximately 0.003 feet/day to 3 feet/day (Reference (30)). Because vertical hydraulic conductivity is generally lower than horizontal hydraulic conductivity in stratified deposits (Reference (31)), the hydraulic conductivity value used is within the plausible range for materials found at the site. Additionally, large areas of drawdown within the unconsolidated deposits are not observed adjacent to other dewatered mine pits in the area, and, in some cases, wetland areas are present very close to these pits (Reference (29)). Although the primary intent of the model is to predict groundwater inflow rates to the mine pits (which are not sensitive to vertical hydraulic conductivity of the unconsolidated deposits (Reference (22)), the vertical hydraulic conductivity value in the model was set so that the drawdown estimated by the model was reasonably consistent with what is expected based on the minimal drawdown observed around other dewatered mine pits in the area.

3.2.3.2 Bedrock

Bedrock units in the local model were represented by five hydraulic conductivity zones: one zone for the Duluth Complex, two zones for the Virginia Formation, one zone for the BIF and one zone for the Giants Range granite. Specific capacity tests conducted as part of the Phase III Hydrogeologic Investigation (Reference (5)) show that the upper portion of the Virginia Formation is more permeable than the lower portion. As such, one hydraulic conductivity zone was used to represent the upper portion of the formation (Layers 2 through 4) and one zone was used to represent the lower portion of the formation (Layers 5 through 8). A three-dimensional model of the geologic contacts developed by PolyMet (Reference (32)) was used in this study. For the various layers, the boundary between the zones representing the Virginia Formation and the Duluth Complex and the boundary between the zones

representing the Virginia Formation and the BIF was based on the location of these contacts at the elevation of the center of each layer.

The horizontal and vertical hydraulic conductivity values for the bedrock zones were allowed to vary during calibration; however, only one pilot point was placed in each bedrock zone in a given layer. The use of only one pilot point per layer in a given zone results in a hydraulic conductivity field that is laterally homogeneous within the zone. Because bedrock units span model layers, horizontal hydraulic conductivity of pilot points in deeper layers of the model were set equal to the horizontal hydraulic conductivity of the shallower layers, resulting in homogeneous distribution of bedrock horizontal hydraulic conductivity for a given unit both laterally and with depth. Bedrock units were treated as anisotropic by tying the vertical hydraulic conductivity values to the horizontal hydraulic conductivity values during calibration. Vertical hydraulic conductivity values were set at one-tenth of the calibration-based values of horizontal hydraulic conductivity.

3.2.3.3 Recharge

The same two zones (wetland deposits and upland deposits) that were used to represent the hydraulic conductivity of the unconsolidated deposits were also used to represent recharge in the local-scale model (Large Figure 9). Conceptually, baseflow in the Partridge River at any point is expected to be directly related to the recharge that occurs over the surface watershed tributary to that point (Reference (1)). The recharge rates assigned to the wetland deposits and upland deposits (0.36 and 1.8 inches/year, respectively) were set such that they maintained the same ratio between one another as the DEIS version of the local-scale model, and the total recharge applied to the SW004 surface watershed was consistent with the estimate of baseflow at SW004 (Section 4.4.1.3 of Reference (1)).

3.2.4 Storage Parameters

Two storage zones were used in the transient groundwater models used to simulate future conditions: one zone for the unconsolidated deposits in Layer 1 and one zone for the bedrock units in Layers 2 through 8. The storage parameters used in the transient models are shown in Table 3-3.

Table 3-3 Storage Parameters Used in the Local Model

	Specific Yield (-)	Specific Storage ($feet^{-1}$)
Unconsolidated Deposits (model Layer 1)	0.25	3×10^{-6}
Bedrock Units (model Layers 2-8)	0.05	3×10^{-6}

Specific storage values were consistent with calculated values for the Virginia Formation, as reported in Reference (5), as well as with literature values for fractured rock ($2x10^{-5}$ to $9x10^{-7}$ $feet^{-1}$) (Reference (33)). The specific yield of the unconsolidated deposits was set based on an average literature value for sand and silt (Reference (33)).

3.2.5 Model Calibration

A steady-state version of the local-scale model was calibrated to represent current conditions using the automated calibration software PEST (Reference (34), Reference (35)), providing the starting point for the predictive simulations discussed in Section 4.0. Through systematic adjustment of model parameters within a user-specified range, PEST attempts to minimize the difference between observed and modeled values.

3.2.5.1 Calibration Objective

The objective of the model calibration was to minimize the difference between observed and simulated values (i.e., residuals) for a variety of different types of calibration targets (Section 3.2.5.3). When using PEST, the difference between observed and modeled values is quantified as the sum of squared weighted residuals and is termed the objective function or "phi." Therefore, the goal of the calibration was to minimize the objective function. Calibration observations were grouped by type (e.g., unconsolidated aquifer heads, bedrock heads, and baseflow) and observations were assigned weights so that the contribution of each observation group to the initial objective function was roughly equal.

In addition to minimizing the objective function, the model calibration was considered acceptable if the following criteria were met:

- the absolute residual mean was less than 15% of the observed range in heads
- simulated flows at SW002, SW003, and SW004 were within 5% of the flow estimated by the XP-SWMM model
- widespread areas of simulated heads significantly above the ground surface did not result

3.2.5.2 Calibration Parameters

During model calibration, the following parameters were allowed to vary within user-specified ranges:

- horizontal hydraulic conductivity of pilot points located within the wetland deposits
- horizontal hydraulic conductivity of pilot points located within the upland deposits
- horizontal hydraulic conductivity of the bedrock units (as noted above, vertical hydraulic conductivity was tied to horizontal hydraulic conductivity during the calibration process)
- conductance of the river cells simulating the Partridge River and its tributaries

3.2.5.3 Calibration Data Sets

The local model was calibrated using head measurements in both the unconsolidated deposits and bedrock. Head measurements from 24 monitoring wells in the unconsolidated deposits and 29 wells and boreholes in the bedrock were used as calibration observations. The unconsolidated deposit head targets were located in Layer 1, and bedrock head targets were located in Layer 2. For wells with routine water level measurements, average groundwater elevations calculated with data through 2013 were used as the

calibration observations. Bedrock groundwater elevations measured in wells and exploratory drill holes during December 2006 (Exhibit A) were used as additional observations. Head observations used for model calibration are shown on Large Figure 17 and groundwater elevation data for the unconsolidated deposits and bedrock is included as Large Table 1 and Large Table 2, respectively.

In addition to head targets, the model was calibrated to estimates of baseflow in the Partridge River at monitoring stations SW002, SW003, and SW004 (Large Figure 8). For this purpose, baseflow is defined as the groundwater contribution to streamflow. The estimates of baseflow used as calibration targets at SW002, SW003, and SW004 are 0.41 cfs, 0.51 cfs, and 0.92 cfs, respectively (Section 4.4.1.3 of Reference (1)).

Information was also added to the calibration to minimize two undesirable outcomes: areas of simulated heads significantly above the ground surface and bias in the simulated heads. Control points were added across the model domain (Large Figure 17). At these locations, if simulated heads exceeded the ground surface elevation, a penalty was added to the objective function. Similarly, bias in model results, a predominance of positive or negative residuals, was minimized by including the calculated bias in simulated heads as a calibration observation.

3.2.5.4 Prior Information and Regularization

Due to the high degree of parameterization inherent with the pilot point approach to calibration, “prior information” was included in the calibration to help achieve numerical stability and address the potential problem of non-uniqueness associated with highly parameterized models. In PEST, prior information generally takes the form of preferred values for parameters or relationships between parameters. Prior information does not impose hard constraints on parameter values; rather PEST will attempt to match the preferred parameter values or relationships between parameters to the extent possible, and a contribution will be added to the objective function if the model values deviate from the preferred values.

At the Mine Site, hydraulic conductivity estimates were available from analysis of aquifer testing data for nine monitoring wells completed in the unconsolidated deposits (Reference (4)). Hydraulic conductivity estimates from aquifer tests ranged from 0.012 feet/day to 31 feet/day. Additionally, grain size distribution data was collected from soil samples at 19 rotasonic borings completed in 2008. Hydraulic conductivity was estimated for each soil sample with a method relating grain size distribution to permeability (Reference (36)). Hydraulic conductivity estimates were averaged for boring locations with grain size distribution data at multiple depth intervals. Two grain-size samples were excluded from the average hydraulic conductivity calculation at one location (RS-11) due to anomalously high values associated with high gravel content, which is not representative of the bulk aquifer properties. Hydraulic conductivity estimates using the Reference (36) method ranged from 2.2 feet/day to 167 feet/day. Pilot points at each of the hydraulic conductivity estimate locations were assigned prior information in the model calibration to constrain the hydraulic conductivity values of those pilot points based on the site-specific data. The locations of hydraulic conductivity estimates for the unconsolidated deposits used as prior information are shown on Large Figure 17. To minimize heterogeneity within the model, prior information was also included for several pilot points to keep their values as close as possible to surrounding pilot points.

Prior information was also used in the calibration to constrain the hydraulic conductivity of the bedrock units. For the BIF, Giants Range granite, Upper Virginia Formation, and Lower Virginia Formation, the preferred values of horizontal hydraulic conductivity were the value used for the DEIS models, which were based on a combination of site-specific aquifer testing data and published regional data. Consistent with guidance from the co-lead Agencies (Reference (37)), the preferred value of the Duluth Complex horizontal hydraulic conductivity was 4.5×10^{-4} feet/day, estimated from the five borehole tests conducted south of the proposed pits, away from the Virginia Formation contact.

3.2.5.5 Calibration Results

Optimized hydraulic conductivity values are summarized in Table 3-4. Because the horizontal hydraulic conductivity of the unconsolidated deposits varies by cell, the range of values and mean value in each zone resulting from the calibration are shown. Large Figure 18 shows the calibrated hydraulic conductivity distribution in Layer 1 for the area of interest, including the average hydraulic conductivity for each of the GoldSim groundwater flow path areas. Table 3-5 provides a comparison between the estimated and calibrated hydraulic conductivity values at locations where prior information was included in the calibration. Calibrated hydraulic conductivity values generally compare well with the estimated values.

Table 3-4 Optimized Hydraulic Conductivity Values

Model Parameter	Value (feet/day)
Horizontal hydraulic conductivity – Upland deposits	Range: 0.056 - 167 Mean: 19.2
Horizontal hydraulic conductivity – Wetland deposits	Range: 0.003 - 224 Mean: 23.7
Vertical hydraulic conductivity – Upland and wetland deposits (1)	0.0028 (1)
Hydraulic conductivity – Giants Range granite	$K_{xx} = K_{yy} = 0.029$ $K_{zz} = 0.0029$
Hydraulic conductivity – Biwabik Iron Formation	$K_{xx} = K_{yy} = 0.87$ $K_{zz} = 0.087$
Hydraulic conductivity – Virginia Formation, Upper Portion	$K_{xx} = K_{yy} = 0.31$ $K_{zz} = 0.031$
Hydraulic conductivity – Duluth Complex	$K_{xx} = K_{yy} = 4.4x10^{-4}$ $K_{zz} = 4.4x10^{-5}$
Hydraulic conductivity – Virginia Formation, Lower Portion	$K_{xx} = K_{yy} = 0.079$ $K_{zz} = 0.0079$
Vertical hydraulic conductivity term of Partridge River Reach 1	41.0
Vertical hydraulic conductivity term of Partridge River Reach 2	32.8
Vertical hydraulic conductivity term of Partridge River Reach 3	25.6
Vertical hydraulic conductivity term of Partridge River Reach 4	18.5
Vertical hydraulic conductivity term of Partridge River Reach 5	13.2
Vertical hydraulic conductivity term of Partridge River Reach 6	10.4
Vertical hydraulic conductivity term of Partridge River Reach 7	8.8
Vertical hydraulic conductivity term of Partridge River Reach 8	10.0

(1) Parameter not allowed to vary during calibration

Table 3-5 Estimated and Calibrated Hydraulic Conductivity Values

Location	Horizontal Hydraulic Conductivity	
	Estimated Value (feet/day)	Calibrated Value (feet/day)
Unconsolidated Deposits:		
MW-05-02	31	17
MW-05-08	0.062	1.7
MW-05-09	0.027	0.024
SB-05-01	26	30
SB-05-03	0.014	0.096
SB-05-04	0.033	2.3
SB-05-06	0.012	0.012
SB-05-07	3.6	2.1
SB-05-10	0.11	0.11
RS-01B	10	26
RS-03	3.6	1.7
RS-04	17	19
RS-05A	18	18
RS-06	5.9	7.0
RS-07	72	29
RS-08A	12	7.2
RS-09	21	18
RS-10	7.9	0.95
RS-11	66	67
RS-12	52	52
RS-13	27	17
RS-14	92	76
RS-15	5.6	6.2
RS-16	32	41
RS-17B	56	53
RS-18	6.9	2.9
RS-19	10	9.6
RS-20	9.2	16

	Horizontal Hydraulic Conductivity	
Location	**Estimated Value (feet/day)**	**Calibrated Value (feet/day)**
Bedrock:		
Duluth Complex	$4.5x10^{-4}$	$4.4x10^{-4}$
Biwabik Iron Formation	0.98	0.87
Upper Virginia Formation	0.33	0.31
Lower Virginia Formation	0.085	0.079
Giants Range granite	0.029	0.029

Simulated groundwater contours from the calibrated model for Layers 1 and 2 are shown on Large Figure 19 and Large Figure 20, respectively. The baseline conditions simulation generally matches the expected flow directions in both the unconsolidated deposits and the bedrock. In Layer 2, the model-simulated gradient was slightly flatter than observed in the field. As a result, the model underestimates head in high-head areas, and overestimates head in low head areas.

Head residuals for model layers 1 and 2 are also shown on Figures 3-9a and 3-9b. A scatter plot of simulated and observed head values is presented in Large Figure 21. The mean residual was 1.0 feet, and the absolute residual mean was 2.9 feet. The range of observed heads (maximum head measured minus minimum head measured) was 85 feet. The absolute residual mean was 3.4% of the observed range in heads, satisfying one of the calibration objectives indicated in Section 3.2.5.1.

As described in Section 3.2.5.1, minimizing the occurrence of simulated heads above the ground surface was one objective of the calibration. Large Figure 22 presents a comparison of modeled heads and the ground surface (based on DEM of the Mine Site created from a combination of 2010 LiDAR data in the immediate project area (plus a 500-feet buffer), MDNR data, and USGS DEM data). Within the area of interest, estimated heads were above the ground surface only in limited areas, and estimated heads did not exceed 10 feet above the ground surface.

Simulated values of baseflow to the Partridge River are summarized in Table 3-6 along with their target values. Baseflow estimates at all three locations satisfy the calibration objective indicated in Section 3.2.5.1 of having the MODFLOW-simulated flow within 5% of the XP-SWMM simulated flow.

Table 3-6 Comparison between Estimated and Modeled Baseflow

Location	XP-SWMM Estimated Baseflow (cfs)	MODFLOW Modeled Baseflow (cfs)
SW002	0.41	0.40
SW003	0.51	0.51
SW004	0.92	0.93

The overall mass balance error of the calibration simulation was 0.004%. This falls well below the guidance provided in Reference (33), who state that "Ideally the error in the water balance is less than 0.1%" and "error of around 1%, however, is usually considered acceptable."

Overall, the calibration was determined to be acceptable given the model and calibration objectives.

3.2.6 Assumptions and Limitations of the Model

The groundwater flow models that were constructed and calibrated for this evaluation are a necessary simplification of groundwater flow in the vicinity of the Mine Site. The models have limitations that are the result of assumptions and simplifications that are inherent in any groundwater modeling:

- The use of a conventional porous media modeling code can accurately simulate flow within the bedrock units at the Mine Site, which is assumed to be primarily through interconnected fractures, at the scale of this study. It is assumed that the fractures are sufficiently interconnected such that the fractured rock medium behaves similar to a porous medium.
- The bedrock units at the Mine Site are assumed to be homogeneous in terms of hydraulic conductivity. In reality, all geologic material has variations resulting in heterogeneity. The assumption of homogeneity is considered appropriate given the modeling objectives for this evaluation.
- The model will not simulate any off-site well pumping or pit dewatering. The Peter Mitchell Pits, located north of the Mine Site, have historically been dewatered periodically. However, future operation of these pits cannot be anticipated and was not simulated. Effects of dewatering at the Peter Mitchell Pits was not evaluated as part of this work.
- The validity of the modeling results is based on the assumption that the conceptual model is a reasonable representation of the groundwater flow system. The conceptual model, in turn, is based on the data that were collected at the Mine Site and the interpretation of those data. Errors in the data or data interpretation that affect the groundwater flow model's conceptualization may result in errors in the flow simulation.
- The groundwater flow model was designed with the specific goal of estimating groundwater flow rates into the mine pits during operation and closure. If the model is to be used for other purposes, the validity of the model for that purpose must be carefully evaluated.
- Model calibration was based on a single set of real data. Ideally, a model would be calibrated to more than one set of real data representing different hydrological conditions (i.e., different times of the year) to address the issue of nonuniqueness, the condition where multiple sets of input parameters can result in equally acceptable matches to observed data. However, given that hydrological conditions in this area tend to be relatively steady over time (as indicated by persistent wetland conditions), it is unlikely a different set of data could be obtained representing a significantly different hydrological condition. To address the issue of nonuniqueness, head and flow observation were used during calibration, and prior information was used to constrain

hydraulic conductivity estimates. These are two standard methods for addressing model nonuniqueness (Reference (33)). In addition, as described in the management plan (Section 6.4 of Reference (38)), the model will be updated if differences between the monitoring data the model are observed as the result of modeling assumptions that have been demonstrated to be incorrect.

4.0 Predictive Simulations and Results

The calibrated local-scale model was used to simulate groundwater flow during and after mining operations for the purpose of estimating groundwater inflow rates to the mine pits. Large Figure 23 shows the key mine features during operations. The model-estimated groundwater inflow rates are an input to the GoldSim model (Reference (1)).

A set of transient simulations was set up to represent the 20-year period of mine pit operations. The simulations included a stress period for each year of operations. Key milestones during the 20-year mining progression are summarized below for reference:

- **Mine Year 1 to 10**. The East Pit and West Pit will be mined and dewatered.
- **Mine Year 11**. The East Pit will be at its maximum extent.
- **Mine Year 12**. The East Pit will begin to be backfilled.
- **Mine Year 15**. The East Pit will be partially filled with rock.
- **Mine Year 20**. The East Pit will be filled with rock and flooded with water to its maximum extent and the West Pit will be at its maximum extent.

Following the completion of mining of the West Pit in Mine Year 20, the dewatering of the pit will cease and additional water will be pumped into the pit to accelerate the pit flooding process. A series of steady-state model simulations were run to estimate groundwater inflow rates into the West Pit at various stages of flooding.

Two model simulations were run to evaluate groundwater conditions during long-term closure (i.e., once the system has reached equilibrium). The first long-term closure simulation represented conditions with each pit at the expected outflow elevation (East and Central Pits at 1592 feet MSL and West Pit at 1579 feet MSL). The second long-term closure simulation represented a hypothetical situation where the elevations of the pits reach their maximum and exceed the outflow elevation: East and Central Pits at 1595 feet MSL, and West Pit at 1585 feet MSL. In the GoldSim model, the East and Central Pit water elevation may exceed the constructed outflow elevation (1592 feet MSL) during a small number of model time steps if outflow is limited by the constructed weir capacity and the pit flows from this simulation are used to calculate the pit inflows from groundwater in GoldSim in these situations.

4.1 Modifications to the Calibrated Model

For predictive simulations, the assumption of confined layers used for the calibration was no longer valid because the saturated thickness in some areas of the model decreases as pit dewatering proceeds. Therefore, model layers were changed to convertible layers (MODFLOW Type 3). With convertible layers, the transmissivity and storage values assigned to each cell are a function of the saturated thickness of the cell during the simulation.

4.1.1 Representation of Mine Pits

Drain cells were used to simulate the mine pits during periods when the pits will be dewatered. Drain cell elevations were based on the elevation of the pit wall or floor, depending on location. Drain cell conductance was set such that it was several orders of magnitude higher than the hydraulic conductivity of the aquifers while maintaining a stable solution with low mass-balance error. The locations of active drain cells and elevation assigned to each drain cell was based on pit geometry information for Mine Year 1, Mine Year 2, Mine Year 5, Mine Year 11, and Mine Year 20 (Reference (38)). Linear interpolation was used to calculate drain cell elevations for years with no pit geometry information available, and the drain cell elevations were updated at the beginning of each stress period (i.e., at the start of each year). For each year of mining, the estimated pit wall or floor elevation was compared to the model layer elevations of the cells within the footprint. If the pit elevation fell below the bottom of a given model cell, the drain cell elevation was set to 0.01 meter above the bottom of the cell to essentially create a “dry” cell, but without introducing the potential instability of a drain elevation set below the cell bottom. If the pit wall or bottom elevation was above the bottom of the cell, it was used as the drain control elevation. Large Figure 24 through Large Figure 26 show how the mine pits were represented at some key time periods: Mine Year 1, Mine Year 11, and Mine Year 20.

4.1.1.1 Representation of the East Pit during Backfilling and Flooding

During Mine Year 12 to Mine Year 20, the East Pit will no longer be dewatered and will be filled with waste rock and flooded. The water level in this pit will rise when pit dewatering stops. Similarly, mining will be complete in the Central Pit in Mine Year 15 and backfilling will commence. In the model simulations, the pits were represented using specified-head cells during backfilling. The elevations assigned to the specified-head cells during each stress period were based on the pit flooding schedule (Reference (38)).

4.1.1.2 Representation of the West Pit Filling and Long-Term Closure Conditions

Following the completion of mining of the West Pit in Mine Year 20, the dewatering of the pit will cease and additional water will be pumped into the pit. For each stage of flooding simulated, the elevation of the water in the pit was set using specified-head cells. For the long-term closure simulations, the elevation of the water level in each pit was set using specified-head cells.

4.1.2 Representation of Stockpile Areas

For the predictive simulations, leakage through stockpile liners and the Wastewater Treatment Facility (WWTF) equalization basins was represented as areas of specified recharge. Recharge was not applied within the footprint of the Category 1 Waste Rock Stockpile; flow within this stockpile was simulated in a separate model (Attachment E of Reference (38)), and recharge was omitted. For the remaining stockpile areas, recharge was set at the liner leakage rates determined using the GoldSim model (Table 4-1). The extents of the recharge areas were based on the current Mine Plan (Reference (3)). The Category 1 Waste Rock Stockpile footprint was expanded as the simulation proceeded but the other features were represented at their full size with specified recharge starting in Mine Year 1.

Table 4-1 Stockpile Area Recharge Rates

Stockpile	Specified Recharge Rate, feet/day	Specified Recharge Rate, inches/year
Category 1 Stockpile	0	0
Overburden Storage and Laydown Area	1.4×10^{-3}	6.1
WWTF Equalization Basins	4.1×10^{-4}	1.8
OSP	2.5×10^{-7}	1.1×10^{-3}
Category 2/3 Stockpile	9.4×10^{-7}	4.1×10^{-3}

4.1.3 Representation of the Category 1 Stockpile Containment System

More detailed MODFLOW modeling of the Category 1 Stockpile Groundwater Containment System was completed to estimate the capture efficiency of the system (Attachment E of Reference (38)). However, the groundwater containment system was represented in the local-scale model as described in this section.

The groundwater containment system will surround the perimeter of the Category 1 Waste Rock Stockpile near the stockpile toe. It will include a low permeability cutoff wall extending to the top of the bedrock surface and a high permeability drainage collection trench located on the inside of the cutoff wall. The drainage collection system will consist of a slotted or perforated horizontal drain pipe surrounded by aggregate within a trench excavated to bedrock and backfilled with granular, free-draining material. (Reference (2)).

The groundwater containment system was represented in the model by placing drain cells in Layer 1 around the perimeter of the stockpile. The control elevation of each drain cell was set equal to 0.01 meters above the bottom of Layer 1, which is an approximation of the top of bedrock surface. Setting the drain cell elevation to 0.01 meter above the bottom of Layer 1 approximates a drain pipe located at the bedrock surface, while preventing the drain from causing the model cell to go dry. The conductance of each drain cell was assumed to be proportional to the length of the drain pipe within the cell and was calculated using a formula similar to that used for river cells. The drain width and thickness (diameter) within each cell were assumed to equal 1 meter and the hydraulic conductivity of the backfill material was assumed to equal 33 feet/day to represent a permeable coarse-grained backfill material. Therefore, the conductance of each drain cell was equal to 10 times the length of the drain within the cell.

The low-permeability cutoff wall was simulated by assigning a low value of hydraulic conductivity to the model cells along the barrier alignment. The hydraulic conductivity of the cutoff wall was set equal to 0.028 feet/day.

4.2 Predictive Simulation Results

4.2.1 Pit Inflow Rates

The predictive simulations were used to estimate the amount of groundwater that can be expected to flow into the mine pits during operations. Zone-based analysis was used to calculate the net groundwater

inflow rates to the pits during operations, West Pit flooding, and long-term closure. Specific zones were defined within the model domain for the pits, surficial deposits, and bedrock units by layer. Mass balance was calculated for each zone from the MODFLOW cell-by-cell flow file and summarized for the net flow into the pits. The net flow of groundwater to the pits was calculated by taking the difference between the flow from the rest of the model to the pit zone minus the flow leaving the pit zone and entering the rest of the model. Table 4-2 shows the estimated groundwater inflow rates for operations.

Table 4-2 Estimated Pit Inflow Rates - Operations

Mine Year	East Pit Groundwater Inflow (gpm)	Central Pit Groundwater Inflow (gpm)	West Pit Groundwater Inflow (gpm)
1	220	0	0
2	190	0	60
3	210	0	40
4	250	0	30
5	450	0	30
6	430	0	50
7	420	0	40
8	460	0	40
9	690	0	30
10	710	0	30
11	760	30	80
12	760	20	50
13	700	10	50
14	710	10	40
15	710	10	40
16	570	10	40
17	380	10	40
18	270	10	40
19	170	10	40
20	40	10	40

Groundwater inflow into the East Pit increases from Mine Year 1 to Mine Year 11 as the pit expands laterally and vertically. Starting in Mine Year 12, backfill of the pit with rock and water will begin and dewatering of the East Pit will cease. The Central Pit, which will eventually become part of the East Pit, will be mined from Mine Year 12 to Mine Year 15. Starting in Mine Year 16, the pit will be filled with rock and

flooded with water, and dewatering will cease. The filling and flooding of the Central and East Pits is described in Reference (38). Note that in the GoldSim model, the pit inflows to the Central and East Pits shown in Table 4-2 for Mine Year 16 to Mine Year 20 are converted to an elevation-based lookup table to allow for uncertainty in the timing of pit flooding during the latter part of operations.

Groundwater inflow into the West Pit is predicted to increase as the pit expands laterally and vertically, and to reach a maximum in Mine Year 11. Although the West Pit continues to deepen after Mine Year 11, groundwater inflow does not continue to increase, likely due to the development of unsaturated conditions adjacent to the pit. As the drawdown caused by the pit deepening expands in the unconsolidated deposits and bedrock, the transmissivity and the rate of flow to the open face decline and overall pit inflow decreases, despite the expansion of the pit.

The maximum model mass balance error for the operations simulations was 0.03%.

Estimated groundwater elevations in Mine Year 20 for the unconsolidated aquifer and bedrock are shown on Large Figure 27 and Large Figure 28, respectively.

4.2.2 West Pit Flooding

Simulated groundwater inflow rates into the West Pit during flooding, as a function of groundwater elevation, are shown on Table 4-3. Inflow rates during West Pit flooding were insensitive to the pit stage, because the majority of the groundwater inflow to the West Pit comes from the unconsolidated deposits, and the pit stages evaluated are generally below the top of bedrock elevation. The maximum model mass balance error for the West Pit flooding simulations was 0.004%.

Table 4-3 Estimated Groundwater Inflow Rates - West Pit Flooding

West Pit Water Elevation (feet MSL)	Groundwater Inflow Rate (gpm)
940	50
1000	50
1100	50
1200	50
1320	50
1450	50

4.2.3 Long-Term Closure Conditions

Simulated groundwater flow rates for the long-term closure simulations are shown in Table 4-4. The maximum model mass balance error for the closure simulations was 0.01%.

Table 4-4 Estimated Groundwater Inflow and Outflow Rates – Long-term Closure Conditions

			East Pit		Central Pit		West Pit	
East Pit Elevation (feet MSL)	Central Pit Elevation (feet MSL)	West Pit Elevation (feet MSL)	Inflow (gpm)	Outflow (gpm)	Inflow (gpm)	Outflow (gpm)	Inflow (gpm)	Outflow (gpm)
1592	1592	1579	30	<10	<10	20	40	10
1595	1595	1585	20	10	10	40	30	20

4.3 Sensitivity Analysis

Consistent with guidance from the Co-lead Agencies, a separate sensitivity analysis was not completed for this version of the Mine Site MODFLOW model. A sensitivity analysis was completed with the MODFLOW for the DEIS and is summarized in Reference (22). In addition, the impact of uncertainty in groundwater inflow rates to the pits is evaluated within the probabilistic framework of the GoldSim model.

5.0 Summary and Conclusions

A major component of the Mine Site water balance is the groundwater flow into the mine pits. Groundwater inflows from unconsolidated deposits, the Duluth Complex, and the Virginia Formation were estimated using the industry standard finite difference groundwater modeling code MODFLOW. A regional-scale model was constructed to define the boundary conditions for a local-scale model, which simulates an approximately 100-square mile area encompassing the proposed mine pits. The model incorporated data collected as part of the Phase I, Phase II, and Phase III Hydrogeologic Investigations, which provided information on the hydraulic conductivity of the Duluth Complex, the Virginia Formation and the unconsolidated deposits (Reference (4), Reference (5) and Reference (6)). In addition, water level data from additional monitoring wells installed in 2011 and 2012 were used for model calibration. The model was calibrated to groundwater levels in both the bedrock and the unconsolidated deposits and to estimates of baseflow in the Partridge River.

Transient model realizations simulating the pits in various stages of development were constructed based on the proposed mine plan (Reference (3)). Groundwater inflow rates to the pits were estimated in each model realization. Additional model realizations were developed to estimate groundwater flow rates to the pits during pit flooding and following closure.

The four calibration objectives were met: the objective function was minimized; the absolute residual mean was less than 15% of the observed range in heads; simulated flow at three locations (SW002, SW003 and SW004) were within 5% of the XP-SWMM simulated flow; and widespread areas of simulated heads significantly above the ground surface did not result.

The following conclusions can be drawn from the modeling described in this report:

- Groundwater flow into the mine pits is estimated to increase from approximately 220 gpm to 870 gpm between Mine Year 1 and Mine Year 11 as the pits expand horizontally and vertically. Groundwater flow into the East Pit will begin to decrease starting in Mine Year 12 as the pit is backfilled with rock and flooded. Groundwater flow into the West Pit peaks at Mine Year 11 and thereafter ranges from 40 gpm to 50 gpm through long-term closure.

- During long-term closure, both the East Pit and the West Pit are estimated to have a net flow of groundwater into the pits. The East Pit is estimated to lose a small amount of water (<10 gpm) to both the unconsolidated aquifer and the bedrock; the West Pit is estimated to lose 20 gpm to the unconsolidated deposits and less than 1 gpm to the bedrock. The pits are estimated to lose slightly more water under a scenario where the pit water levels rise above their anticipated surface outflow elevations (as might occur temporarily during spring snowmelt or very wet conditions).

6.0 References

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Large Tables

Large Table 1
Groundwater Elevation Measurements, Unconsolidated Deposits
Poly Met Mining Inc.

Location	Date	Elevation, ft MSL
MW-05-02	03/23/2005	1580.30
MW-05-02	11/20/2006	1578.27
MW-05-02	03/17/2009	1580.78
MW-05-02	05/03/2010	1583.58
MW-05-02	07/27/2010	1581.29
MW-05-02	10/05/2010	1580.05
MW-05-02	04/26/2011	1585.71
MW-05-02	07/20/2011	1580.84
MW-05-02	05/08/2012	1585.13
MW-05-02	06/21/2012	1586.55
MW-05-02	07/05/2012	1585.56
MW-05-02	08/23/2012	1583.29
MW-05-02	10/22/2012	1580.20
MW-05-02	05/02/2013	1585.64
MW-05-02	07/23/2013	1585.30
MW-05-02	10/01/2013	1580.90
Average of All Data		1582.71
MW-05-08	03/23/2005	1593.95
MW-05-08	11/28/2006	1593.14
MW-05-08	05/07/2009	1593.42
MW-05-08	05/05/2010	1593.06
MW-05-08	07/29/2010	1590.75
MW-05-08	10/07/2010	1592.75
MW-05-08	04/26/2011	1593.12
MW-05-08	07/21/2011	1592.50
MW-05-08	10/05/2011	1591.67
MW-05-08	11/02/2011	1592.93
MW-05-08	12/08/2011	1592.47
MW-05-08	03/26/2012	1592.93
MW-05-08	04/24/2012	1592.94
MW-05-08	05/04/2012	1593.02
MW-05-08	06/21/2012	1593.38
MW-05-08	07/26/2012	1592.92
MW-05-08	08/23/2012	1592.51
MW-05-08	10/22/2012	1592.62
MW-05-08	05/13/2013	1593.05
MW-05-08	07/23/2013	1593.92
MW-05-08	10/17/2013	1594.81
Average of All Data		1592.95

Location	Date	Elevation, ft MSL
MW-05-09	03/23/2005	1608.70
MW-05-09	10/05/2006	1614.91
MW-05-09	03/17/2009	1608.31
MW-05-09	05/05/2010	1609.77
MW-05-09	10/07/2010	1607.54
MW-05-09	03/24/2011	1608.74
MW-05-09	04/26/2011	1611.14
MW-05-09	07/21/2011	1607.10
MW-05-09	10/05/2011	1607.34
MW-05-09	12/06/2011	1606.48
MW-05-09	01/11/2012	1606.31
MW-05-09	02/13/2012	1606.06
MW-05-09	03/01/2012	1605.98
MW-05-09	04/09/2012	1608.26
MW-05-09	05/08/2012	1610.34
MW-05-09	06/01/2012	1610.90
MW-05-09	07/13/2012	1609.51
MW-05-09	08/21/2012	1607.97
MW-05-09	10/29/2012	1606.53
MW-05-09	04/22/2013	1608.15
MW-05-09	07/30/2013	1611.63
MW-05-09	10/02/2013	1610.12
Average of All Data		1608.72
MW-1	11/07/2011	1591.56
MW-1	12/08/2011	1591.39
MW-1	01/09/2012	1590.97
MW-1	02/13/2012	1589.89
MW-1	03/19/2012	1592.45
MW-1	04/18/2012	1593.43
MW-1	05/04/2012	1593.07
MW-1	06/13/2012	1592.67
MW-1	07/26/2012	1592.83
MW-1	08/27/2012	1591.59
MW-1	10/19/2012	1591.71
MW-1	05/08/2013	1593.48
MW-1	07/23/2013	1593.76
MW-1	10/17/2013	1594.27
Average of All Data		1592.36

Large Table 1
Groundwater Elevation Measurements, Unconsolidated Deposits
Poly Met Mining Inc.

Location	Date	Elevation, ft MSL
MW-2	11/07/2011	1576.58
MW-2	11/09/2011	1576.56
MW-2	12/06/2011	1577.00
MW-2	01/04/2012	1575.65
MW-2	02/13/2012	1574.84
MW-2	03/27/2012	1577.68
MW-2	04/04/2012	1577.71
MW-2	04/09/2012	1577.76
MW-2	05/08/2012	1578.95
MW-2	06/11/2012	1579.18
MW-2	07/13/2012	1578.81
MW-2	08/14/2012	1577.31
MW-2	10/26/2012	1576.47
MW-2	04/25/213	1575.91
MW-2	07/25/2013	1578.81
MW-2	10/01/2013	1577.80
Average of All Data		1577.31
MW-3	11/08/2011	1554.04
MW-3	12/12/2011	1553.49
MW-3	01/17/2012	1552.83
MW-3	02/14/2012	1552.20
MW-3	03/05/2012	1551.89
MW-3	04/19/2012	1556.59
MW-3	05/07/2012	1556.60
MW-3	06/08/2012	1556.89
MW-3	07/09/2012	1556.62
MW-3	08/06/2012	1556.18
MW-3	10/09/2012	1553.53
MW-3	04/23/2013	1555.23
MW-3	07/19/2013	1556.63
MW-3	10/18/2013	1555.65
Average of All Data		1554.88
MW-4	11/08/2011	1553.85
MW-4	12/07/2011	1553.45
MW-4	01/17/2012	1552.59
MW-4	02/14/2012	1551.76
MW-4	03/05/2012	1551.76
MW-4	04/19/2012	1555.63
MW-4	05/07/2012	1555.43
MW-4	06/08/2012	1555.67
MW-4	07/09/2012	1555.71
MW-4	08/06/2012	1555.33
MW-4	10/09/2012	1553.84
MW-4	05/07/2013	1555.65
MW-4	07/19/2013	1555.64
MW-4	10/18/2013	1555.20
Average of All Data		1554.39

Location	Date	Elevation, ft MSL
MW-5	11/07/2011	1574.75
MW-5	11/08/2011	1574.71
MW-5	11/09/2011	1574.72
MW-5	12/06/2011	1574.70
MW-5	01/04/2012	1574.29
MW-5	02/13/2012	1573.93
MW-5	03/01/2012	1573.82
MW-5	04/04/2012	1575.54
MW-5	04/09/2012	1575.70
MW-5	05/08/2012	1577.16
MW-5	06/11/2012	1579.85
MW-5	07/13/2012	1579.81
MW-5	08/14/2012	1577.72
MW-5	10/26/2012	1575.28
MW-5	04/22/2013	1575.63
MW-5	07/31/2013	1579.71
MW-5	10/02/2013	1576.20
Average of All Data		1576.09
MW-6S	10/06/2010	1570.37
MW-6S	11/07/2011	1569.58
MW-6S	11/08/2011	1569.50
MW-6S	12/09/2011	1569.39
MW-6S	01/10/2012	1569.09
MW-6S	02/15/2012	1568.95
MW-6S	03/06/2012	1568.93
MW-6S	04/06/2012	1570.37
MW-6S	05/02/2012	1572.59
MW-6S	06/07/2012	1574.39
MW-6S	07/10/2012	1574.43
MW-6S	08/07/2012	1572.62
MW-6S	10/11/2012	1569.59
MW-6S	04/24/2013	1570.53
MW-6S	07/17/2013	1574.57
MW-6S	10/25/2013	1571.44
Average of All Data		1571.02

Large Table 1
Groundwater Elevation Measurements, Unconsolidated Deposits
Poly Met Mining Inc.

Location	Date	Elevation, ft MSL
MW-6D	11/07/2011	1569.35
MW-6D	11/08/2011	1569.61
MW-6D	12/09/2011	1569.53
MW-6D	01/10/2012	1569.42
MW-6D	02/15/2012	1569.10
MW-6D	03/06/2012	1569.07
MW-6D	04/06/2012	1570.91
MW-6D	05/02/2012	1572.70
MW-6D	06/07/2012	1574.51
MW-6D	07/10/2012	1574.63
MW-6D	08/07/2012	1572.78
MW-6D	10/11/2012	1569.68
MW-6D	04/24/2013	1570.54
MW-6D	07/17/2013	1574.86
MW-6D	10/25/2013	1571.10
Average of All Data		1571.19
MW-7	11/07/2011	1539.59
MW-7	11/09/2011	1538.95
MW-7	12/12/2011	1538.53
MW-7	01/24/2012	1539.54
MW-7	02/15/2012	1537.23
MW-7	03/07/2012	1537.11
MW-7	04/23/2012	1540.31
MW-7	05/30/2012	1541.20
MW-7	06/26/2012	1540.80
MW-7	07/30/2012	1540.29
MW-7	08/20/2012	1539.38
MW-7	10/12/2012	1538.45
MW-7	04/18/2013	1539.03
MW-7	07/31/2013	1539.73
MW-7	10/23/2013	1539.45
Average of All Data		1539.31

Location	Date	Elevation, ft MSL
MW-8S	11/07/2011	1604.63
MW-8S	12/13/2011	1604.51
MW-8S	01/09/2012	1604.19
MW-8S	02/13/2012	1603.75
MW-8S	03/16/2012	1604.33
MW-8S	04/27/2012	1606.23
MW-8S	05/24/2012	1607.05
MW-8S	06/18/2012	1607.08
MW-8S	07/20/2012	1606.32
MW-8S	08/16/2012	1604.59
MW-8S	08/16/2012	1604.59
MW-8S	10/08/2012	1604.16
MW-8S	04/18/2013	1605.82
MW-8S	07/29/2013	1606.95
MW-8S	10/24/2013	1606.05
Average of All Data		1605.35
MW-8D	12/21/2011	1604.12
MW-8D	01/09/2012	1603.91
MW-8D	02/03/2012	1602.56
MW-8D	03/16/2012	1604.77
MW-8D	04/27/2012	1606.03
MW-8D	05/24/2012	1606.76
MW-8D	06/18/2012	1606.65
MW-8D	07/20/2012	1605.65
MW-8D	08/16/2012	1605.05
MW-8D	10/08/2012	1603.71
MW-8D	04/18/2013	1605.76
MW-8D	07/29/2013	1606.46
MW-8D	10/24/2013	1605.80
Average of All Data		1605.17

Large Table 1
Groundwater Elevation Measurements, Unconsolidated Deposits
Poly Met Mining Inc.

Location	Date	Elevation, ft MSL
MW-9	12/20/2011	1592.11
MW-9	01/23/2012	1591.84
MW-9	02/02/2012	1591.77
MW-9	03/19/2012	1592.39
MW-9	04/20/2012	1594.11
MW-9	05/16/2012	1593.77
MW-9	06/22/2012	1594.84
MW-9	07/17/2012	1593.72
MW-9	08/15/2012	1593.53
MW-9	10/30/2012	1593.17
MW-9	05/08/2013	1594.58
MW-9	07/25/2013	1593.81
MW-9	10/21/2013	1593.36
Average of All Data		1593.31
MW-10S	12/19/2011	1537.99
MW-10S	01/04/2012	1537.84
MW-10S	06/26/2012	1546.70
MW-10S	07/12/2012	1547.30
MW-10S	08/08/2012	1544.42
MW-10S	10/23/2012	1541.12
MW-10S	05/15/2013	1540.81
MW-10S	07/22/2013	1550.14
MW-10S	10/28/2013	1544.81
Average of All Data		1543.46
MW-10D	12/19/2011	1537.37
MW-10D	01/16/2012	1536.99
MW-10D	02/01/2012	1536.69
MW-10D	03/02/2012	1536.41
MW-10D	04/17/2012	1536.75
MW-10D	05/09/2012	1537.57
MW-10D	06/12/2012	1540.01
MW-10D	07/12/2012	1543.42
MW-10D	08/08/2012	1542.50
MW-10D	10/23/2012	1539.73
MW-10D	04/22/2013	1537.55
MW-10D	07/22/2013	1546.47
MW-10D	10/28/2013	1543.33
Average of All Data		1539.60

Location	Date	Elevation, ft MSL
MW-11	12/20/2011	1573.68
MW-11	01/16/2012	1573.19
MW-11	02/02/2012	1572.71
MW-11	03/07/2012	1572.42
MW-11	04/17/2012	1575.57
MW-11	05/09/2012	1575.74
MW-11	06/12/2012	1576.04
MW-11	07/11/2012	1576.31
MW-11	08/20/2012	1575.23
MW-11	04/25/2013	1574.66
MW-11	07/29/2013	1577.14
MW-11	10/23/2013	1576.34
Average of All Data		1574.92
MW-12	02/22/2012	1597.93
MW-12	03/14/2012	1598.10
MW-12	04/18/2012	1599.97
MW-12	05/21/2012	1600.05
MW-12	06/25/2012	1601.38
MW-12	07/30/2012	1599.91
MW-12	08/28/2012	1598.84
MW-12	10/22/2012	1598.25
MW-12	05/22/2013	1601.31
MW-12	07/31/2013	1600.84
MW-12	10/22/2013	1601.04
Average of All Data		1599.78
MW-13	02/22/2012	1581.31
MW-13	03/14/2012	1581.77
MW-13	04/20/2012	1583.25
MW-13	05/16/2012	1583.06
MW-13	06/22/2012	1584.90
MW-13	07/17/2012	1583.81
MW-13	08/15/2012	1583.67
MW-13	10/30/2012	1583.22
MW-13	04/23/2013	1582.69
MW-13	07/25/2013	1585.05
MW-13	10/21/2013	1585.28
Average of All Data		1583.46

Large Table 1
Groundwater Elevation Measurements, Unconsolidated Deposits
Poly Met Mining Inc.

Location	Date	Elevation, ft MSL
MW-14	02/23/2012	1612.05
MW-14	03/26/2012	1613.06
MW-14	04/30/2012	1613.48
MW-14	05/14/2012	1613.49
MW-14	06/06/2012	1614.51
MW-14	07/27/2012	1613.92
MW-14	08/29/2012	1612.93
MW-14	05/13/2013	1614.41
MW-14	07/24/2013	1614.30
MW-14	10/29/2013	1613.02
Average of All Data		1613.52
MW-15	02/23/2012	1603.64
MW-15	03/29/2012	1604.06
MW-15	04/30/2012	1604.16
MW-15	05/30/2012	1604.33
MW-15	06/27/2012	1604.37
MW-15	07/27/2012	1604.28
MW-15	08/21/2012	1604.21
MW-15	05/23/2013	1604.29
MW-15	07/30/2013	1604.41
MW-15	10/29/2013	1604.22
Average of All Data		1604.20
MW-16	02/24/2012	1543.95
MW-16	03/20/2012	1545.71
MW-16	04/24/2012	1545.96
MW-16	05/15/2012	1545.24
MW-16	06/06/2012	1545.97
MW-16	07/11/2012	1545.74
MW-16	08/28/2012	1544.31
MW-16	10/23/2012	1544.76
MW-16	05/15/2013	1546.17
MW-16	07/29/2013	1545.50
MW-16	10/28/2013	1545.08
Average of All Data		1545.31
MW-17	02/23/2012	1577.93
MW-17	03/20/2012	1579.60
MW-17	04/23/2012	1581.10
MW-17	05/15/2012	1580.83
MW-17	06/27/2012	1581.23
MW-17	07/27/2012	1581.27
MW-17	08/29/2012	1579.86
MW-17	10/19/2012	1580.15
MW-17	05/07/2013	1581.37
MW-17	07/24/2013	1580.75
MW-17	10/22/2013	1580.56
Average of All Data		1580.42

Location	Date	Elevation, ft MSL
MW-18	02/23/2012	1621.76
MW-18	03/27/2012	1624.81
MW-18	04/04/2012	1624.96
MW-18	04/09/2012	1624.93
MW-18	05/14/2012	1625.15
MW-18	06/11/2012	1625.48
MW-18	07/13/2012	1625.06
MW-18	08/14/2012	1624.12
MW-18	10/26/2012	1623.74
MW-18	05/03/2013	1626.01
MW-18	07/31/2013	1625.35
MW-18	10/01/2013	1623.75
Average of All Data		1624.59

Large Table 2
Groundwater Elevation Measurements, Bedrock
Poly Met Mining Inc.

Location	Date	Elevation, ft MSL
OB-1	10/05/2006	1599.99
OB-1	12/13/2006	1600.61
OB-1	03/17/2009	1601.86
OB-1	05/07/2010	1602.76
OB-1	07/29/2010	1601.26
OB-1	10/07/2010	1601.46
OB-1	10/13/2011	1600.71
OB-1	09/24/2012	1600.69
OB-1	10/24/2012	1600.36
OB-1	09/25/2013	1601.01
Average of All Data		1601.07
OB-2	10/03/2006	1602.02
OB-2	12/13/2006	1601.95
OB-2	03/17/2009	1601.86
OB-2	05/07/2010	1602.95
OB-2	07/29/2010	1602.38
OB-2	10/07/2010	1602.64
OB-2	10/12/2011	1602.03
OB-2	09/25/2012	1602.02
OB-2	10/24/2012	1602.13
OB-2	09/24/2013	1602.42
Average of All Data		1602.24
OB-3	10/16/2006	1607.20
OB-3	12/13/2006	1607.38
OB-3	03/19/2009	1610.52
OB-3	05/07/2010	1610.35
OB-3	07/27/2010	1608.04
OB-3	10/07/2010	1608.96
OB-3	10/12/2011	1607.32
OB-3	09/25/2012	1607.95
OB-3	10/24/2012	1608.12
OB-3	09/24/2013	1608.65
Average of All Data		1608.45
OB-4	10/04/2006	1605.26
OB-4	12/13/2006	1605.62
OB-4	03/19/2009	1607.74
OB-4	05/05/2010	1607.40
OB-4	07/27/2010	1606.32
OB-4	10/06/2010	1605.97
OB-4	10/12/2011	1605.59
OB-4	09/25/2012	1606.22
OB-4	10/24/2012	1606.93
OB-4	09/23/2013	1606.79
Average of All Data		1606.38

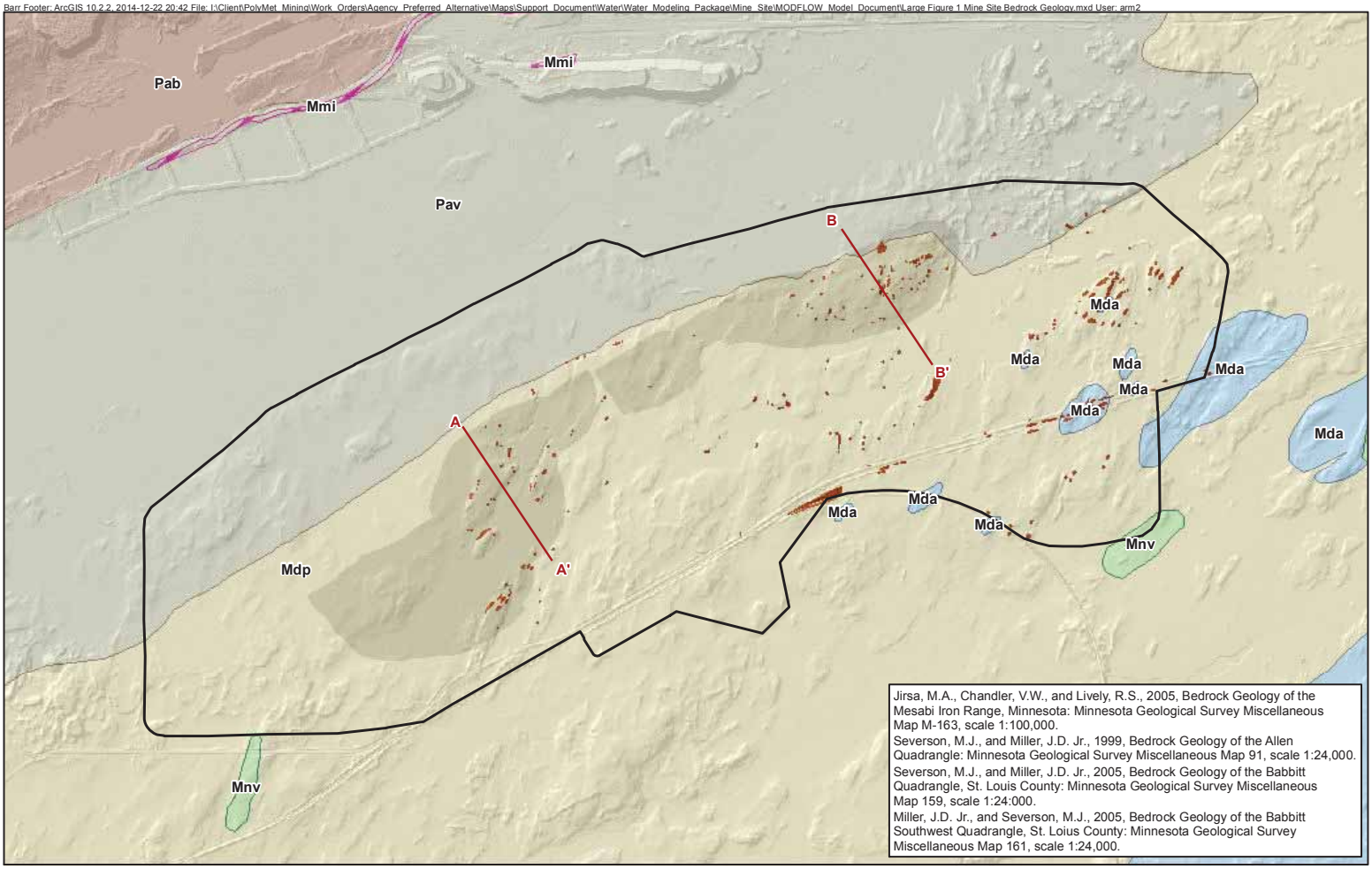
Location	Date	Elevation, ft MSL
OB-5	10/04/2006	1599.39
OB-5	12/13/2006	1599.80
OB-5	03/19/2009	1602.76
OB-5	05/05/2010	1602.28
OB-5	07/27/2010	1600.96
OB-5	10/06/2010	1600.17
OB-5	10/12/2011	1599.41
OB-5	09/24/2012	1600.97
OB-5	10/24/2012	1600.33
OB-5	09/23/2013	1601.59
Average of All Data		1600.77
OB-3A	12/13/2006	1607.64
P-1	12/13/2006	1601.26
P-2	12/13/2006	1602.15
P-3	12/13/2006	1607.71
P-4	12/13/2006	1598.85
26054	12/13/2006	1594.28
26141	12/13/2006	1592.75
05-405N	12/13/2006	1605.96
05-414N	12/13/2006	1582.72
05-424N	12/13/2006	1592.97
05-434N	12/13/2006	1591.69
05-442N	12/13/2006	1601.71
05-447N	12/13/2006	1599.54
05-449N	12/13/2006	1584.08
05-456Q	12/13/2006	1597.69
05-472N	12/13/2006	1599.08
05-473G	12/13/2006	1601.54
05-487N	12/13/2006	1598.13
05-490N	12/13/2006	1601.77
05-495N	12/13/2006	1596.25
05-498N	12/13/2006	1601.04
05-500Q	12/13/2006	1607.56
05-505H	12/13/2006	1602.21
05-506H	12/13/2006	1608.84

Large Table 3
Calibration Observations and Residuals
Poly Met Mining Inc.

Observation Name	Observation Type	Observed Value	Simulated Value	Residual
MW-1	Head Observation, Unconsolidated Deposits	1592.36	1588.53	3.82
MW-2		1577.33	1578.05	-0.72
MW-3		1554.89	1554.39	0.50
MW-4		1554.40	1553.40	0.99
MW-5		1576.08	1573.11	2.98
MW-6		1571.10	1570.33	0.77
MW-7		1539.30	1540.37	-1.06
MW-8		1605.28	1606.83	-1.55
MW-9		1593.31	1599.12	-5.81
MW-10		1541.17	1541.02	0.16
MW-11		1574.93	1572.26	2.68
MW-12		1599.77	1599.25	0.52
MW-13		1583.46	1584.94	-1.48
MW-14		1613.52	1608.44	5.08
MW-15		1604.20	1605.83	-1.63
MW-16		1545.31	1545.41	-0.11
MW-17		1580.41	1579.68	0.73
MW-18		1624.61	1625.51	-0.90
MW-05-02		1582.71	1575.35	7.36
MW-05-08		1592.95	1595.35	-2.40
MW-05-09		1608.73	1605.49	3.24
26054	Head Observation, Bedrock	1594.29	1597.49	-3.20
26141		1592.75	1595.89	-3.14
05-405N		1605.97	1600.83	5.14
05-414N		1582.71	1593.98	-11.27
05-424N		1592.98	1594.02	-1.04
05-434N		1591.70	1591.08	0.62
05-442N		1601.71	1601.41	0.29
05-447N		1599.54	1600.28	-0.74
05-449N		1584.09	1594.29	-10.20
05-456Q		1597.67	1596.88	0.79
05-472N		1599.08	1595.64	3.44
05-473G		1601.54	1598.43	3.11
05-487N		1598.13	1597.47	0.66
05-490N		1601.77	1601.23	0.55
05-495N		1596.26	1595.20	1.06
05-498N		1601.05	1600.92	0.13
05-500Q		1607.55	1598.14	9.40
05-505H		1602.20	1600.70	1.50
05-506H		1608.83	1600.78	8.05
OB-1		1601.08	1602.26	-1.17
OB-2		1602.23	1600.73	1.50
OB-3		1608.46	1600.68	7.78
OB-3a		1607.64	1600.67	6.97
OB-4		1606.40	1599.63	6.77
OB-5		1600.75	1597.63	3.13
P-1		1601.25	1602.11	-0.87
P-2		1602.17	1600.70	1.47
P-3		1607.71	1600.55	7.16
P-4		1598.85	1597.89	0.97
SW002	Baseflow Observation	0.41	0.40	0.01
SW003		0.51	0.51	0.00
SW004		0.92	0.93	-0.01
SW004a		2.44	1.57	0.87
SW004b		3.81	-0.01	3.82

Large Figures

Barr Footer: ArcGIS 10.2.2, 2014-12-22 20:42 File: I:\Client\PolyMet_Mining\Work_Orders\Agency_Preferred_Alternative\Maps\Support_Document\Water\Water_Modeling_Package\Mine_Site\MODFLOW_Model_Document\Large Figure 1 Mine Site Bedrock Geology.mxd User: arm2



Cross-Section Location

Pits - Mine Year 11

Mine Site

Bedrock outcrop in project area

Bedrock Geology[1]

Mnv - North Shore Volcanic Group

Pab - Biwabik Iron Formation

Mda - Anorthositic series subsuite of the Duluth Complex

Mdp - Partridge River intrusion

Pav - Virginia Formation

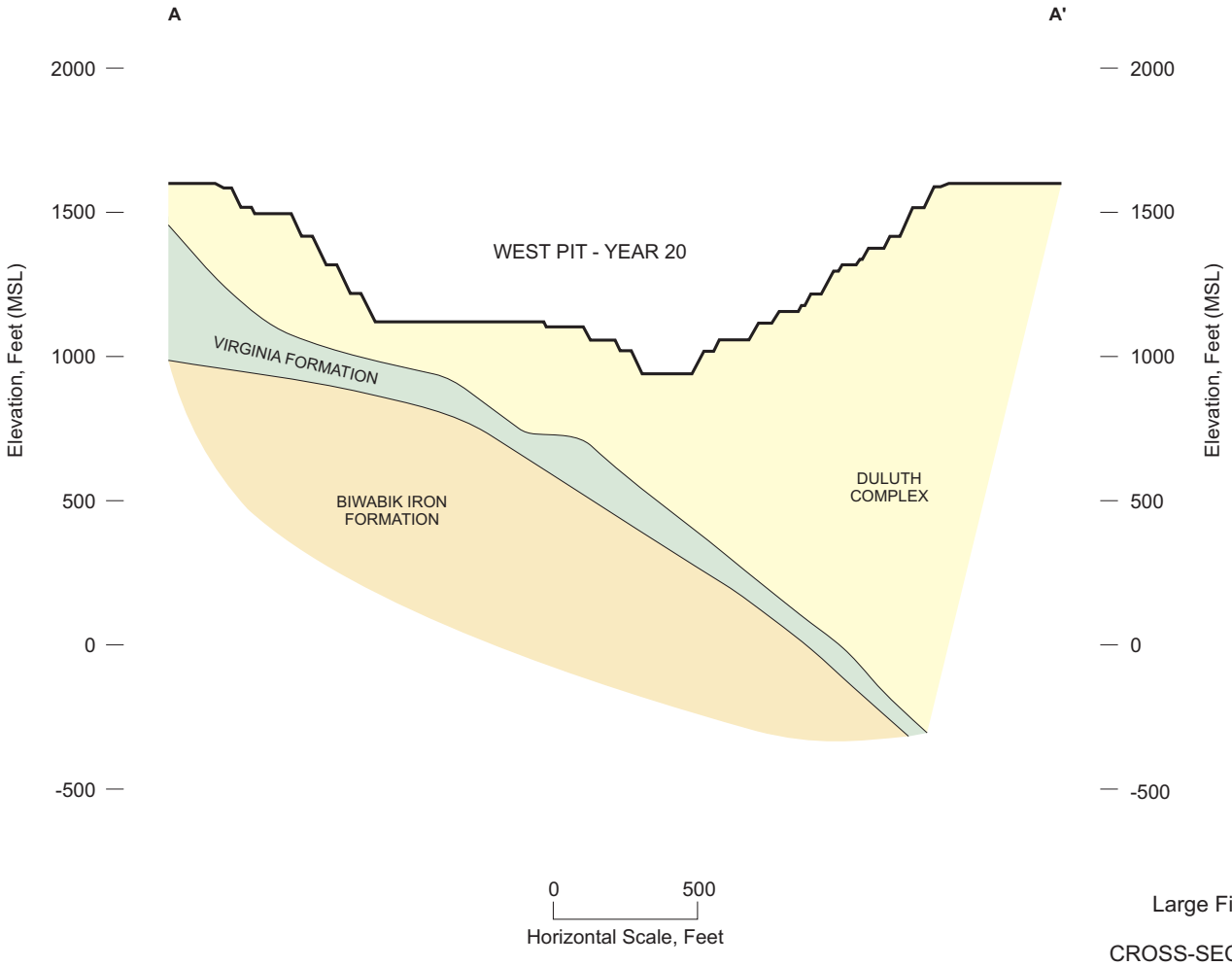
Mmi - Mafic intrusions

0 1,250 2,500 5,000

Feet

Large Figure 1
MINE SITE BEDROCK GEOLOGY
Modified by PolyMet After Jirsa et al., 2005,
Severson and Miller, 1999 and 2005,
Miller and Severson, 2005
NorthMet Project
Poly Met Mining, Inc.

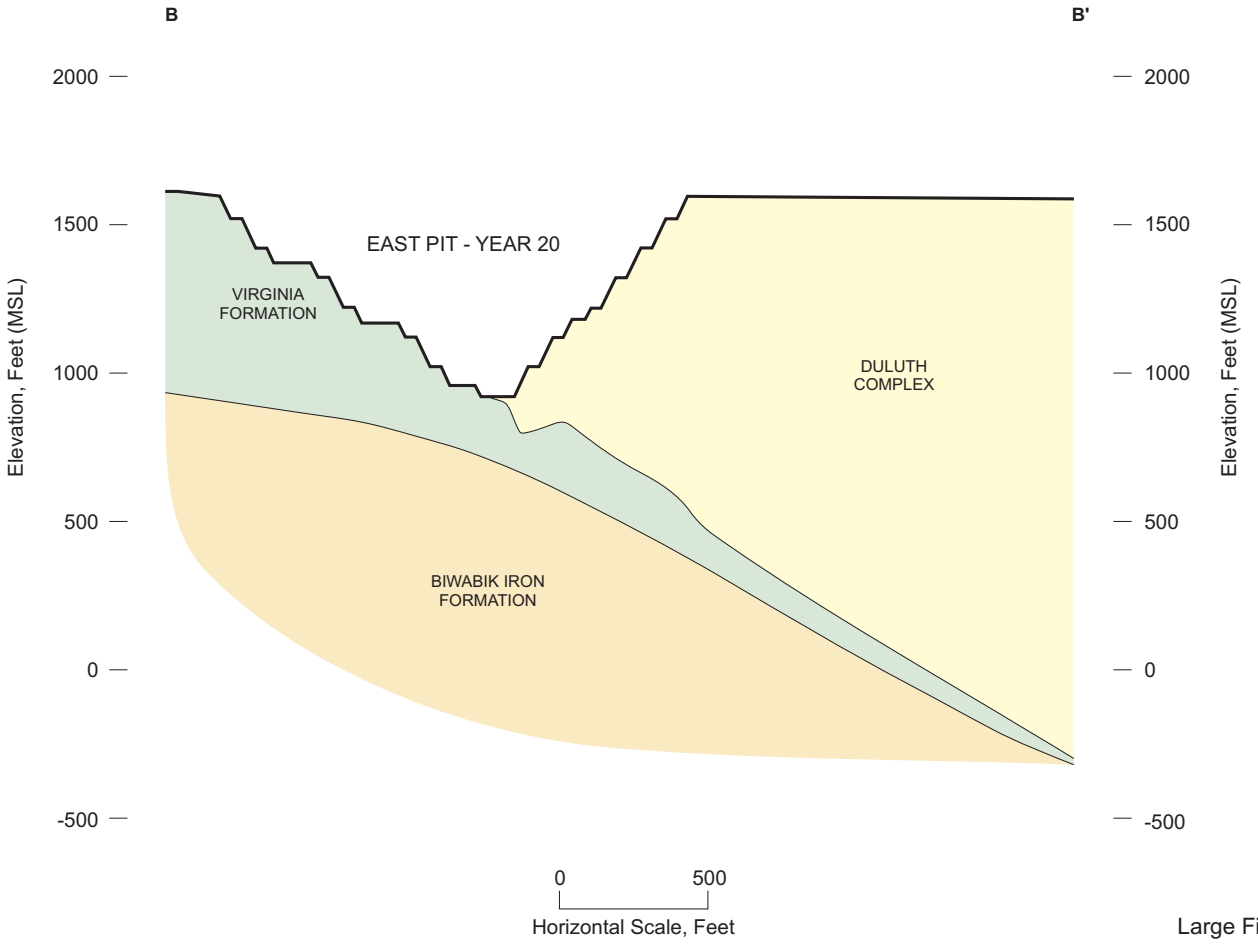
P:\Mpls\23 MN\69\2369862\WorkFiles\Figures_Graphics\2014 Cross Sections_Figures\Cross Section A-A' West Pit.CDR RLG 12-29-14



Large Figure 2

CROSS-SECTION A-A'
PolyMet Mining
Hoyt Lakes, MN

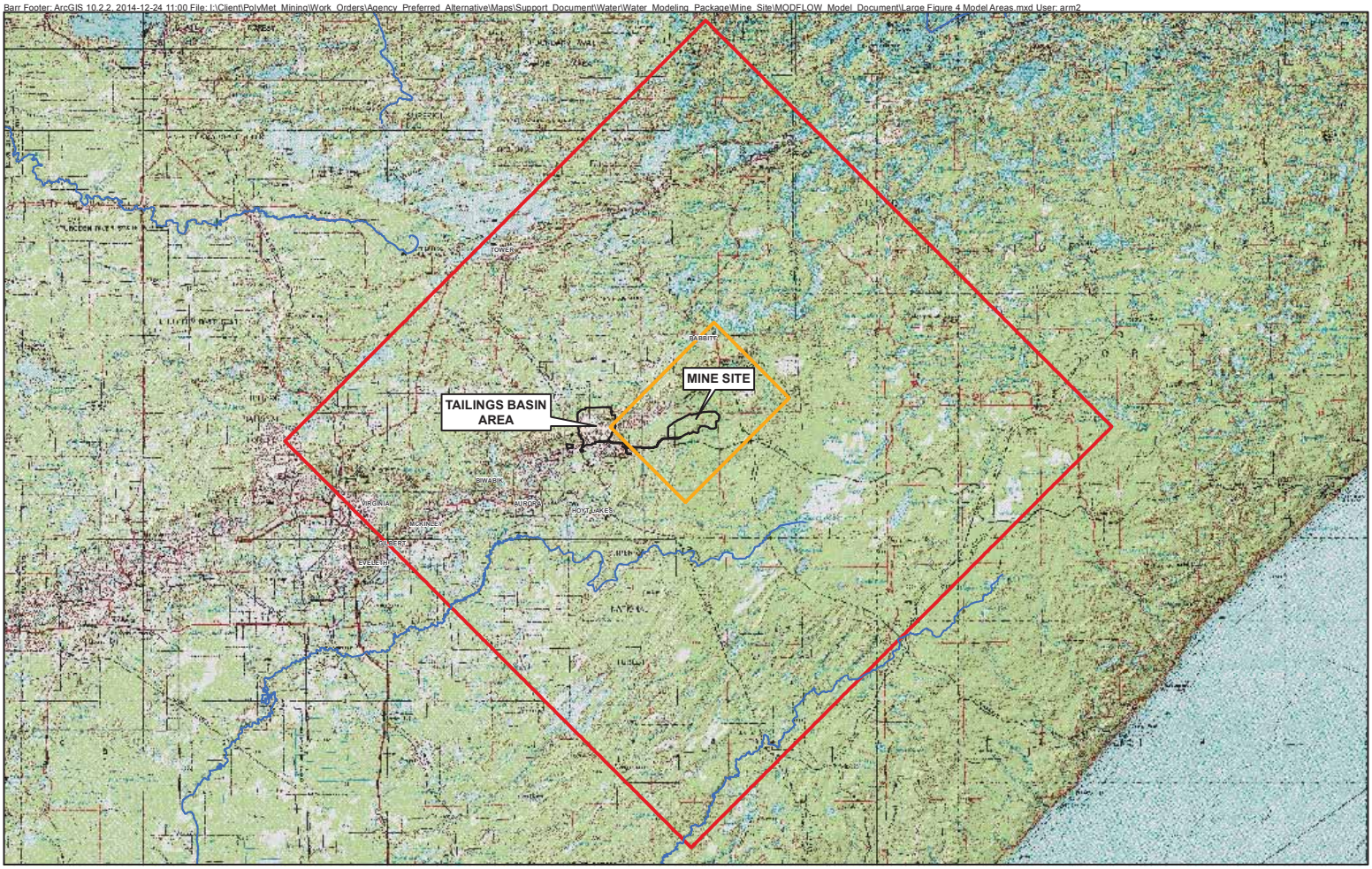
P:\Mpls\23 MN\69\2369862\WorkFiles\Figures_Graphics\2014 Cross Sections_Figures\Cross Section B-B' East Pit.CDR RLG 12-29-14



Large Figure 3

CROSS-SECTION B-B'
PolyMet Mining
Hoyt Lakes, MN

Barr Footer: ArcGIS 10.2.2, 2014-12-24 11:00 File: I:\Client\PolyMet_Mining\Work_Orders\Agency_Preferred_Alternative\Maps\Support_Document\Water\Water_Modeling_Package\Mine_Site\MODFLOW_Model_Document\Large Figure 4 Model Areas.mxd User: arm2



Regional Model Area
Local-Scale Model Area
Project Areas
Major River

0 5 10 20
Miles

LargeFigure 4
MODEL AREAS
NorthMet Project
Poly Met Mining, Inc.

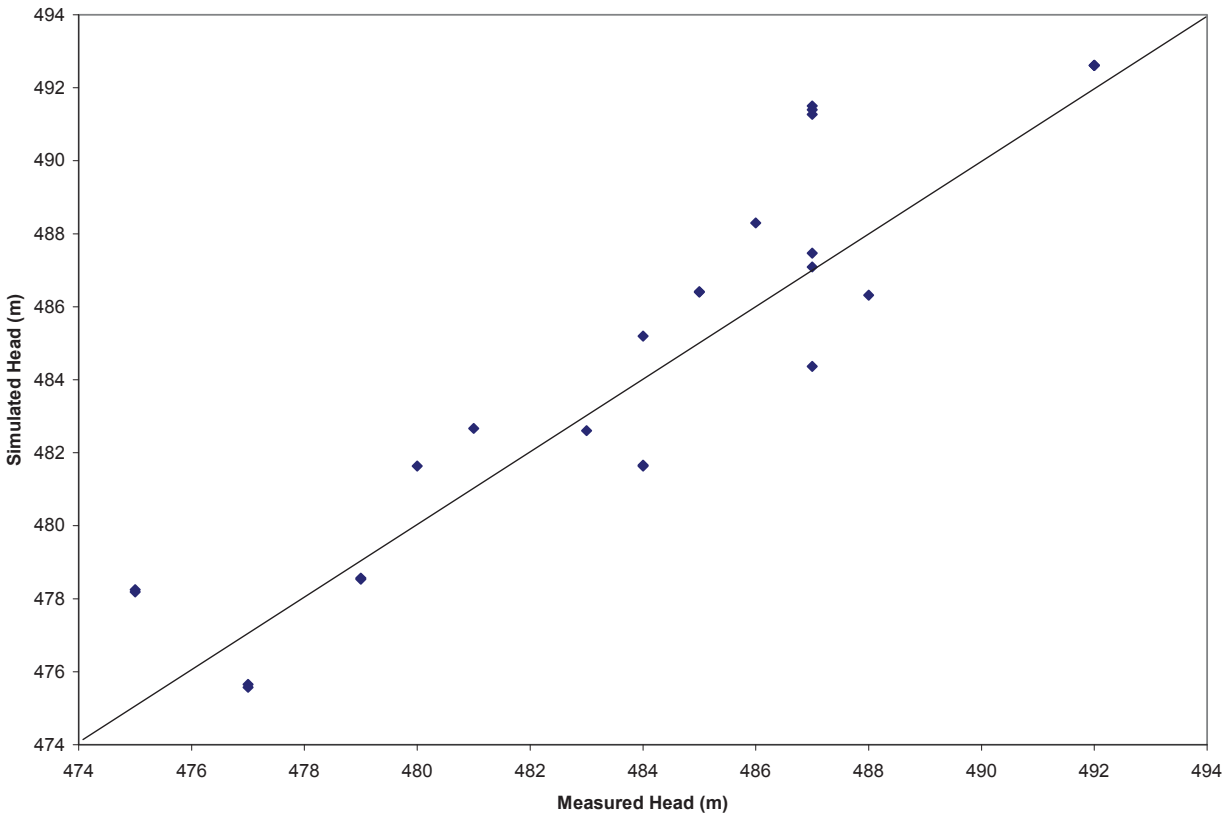
Barr Footer: ArcGIS 10.2.2, 2014-12-24 11:13 File: I:\Client\PolyMet_Mining\Work_Orders\Agency_Preferred_Alternative\Maps\Support_Document\Water\Water_Modeling_Package\Mine_Site\MODFLOW_Model_Document\Large Figure 5 Boundary Conditions in the Regional Model.mxd User: arm2

Regional Model Area
Project Areas
Constant Head Cell
River Cell

0 5 10 20
Miles

Large Figure 5
BOUNDARY CONDITIONS
IN THE REGIONAL MODEL
NorthMet Project
Poly Met Mining, Inc.

Figure 3-3 Regional Model Calibration Results



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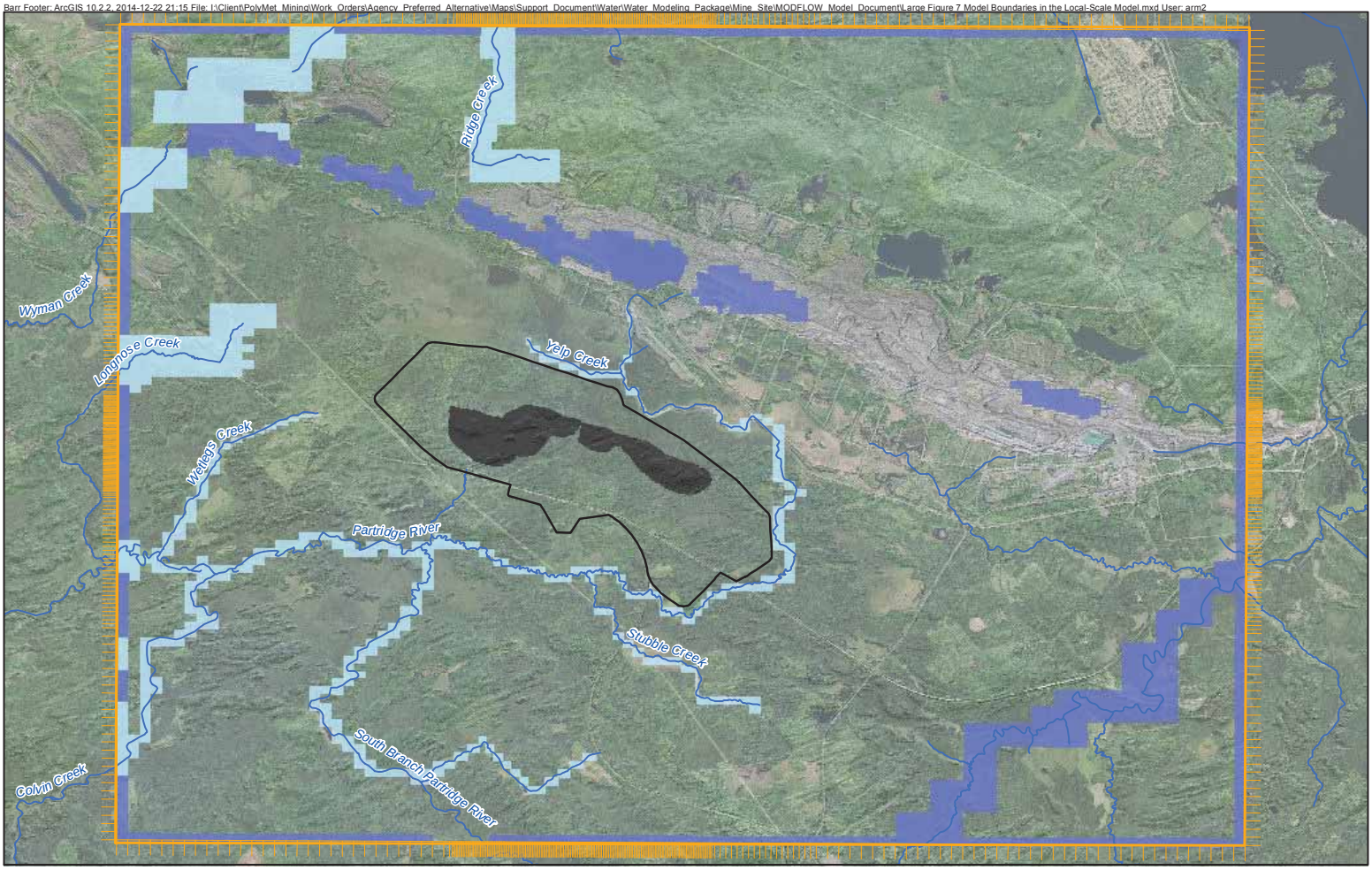
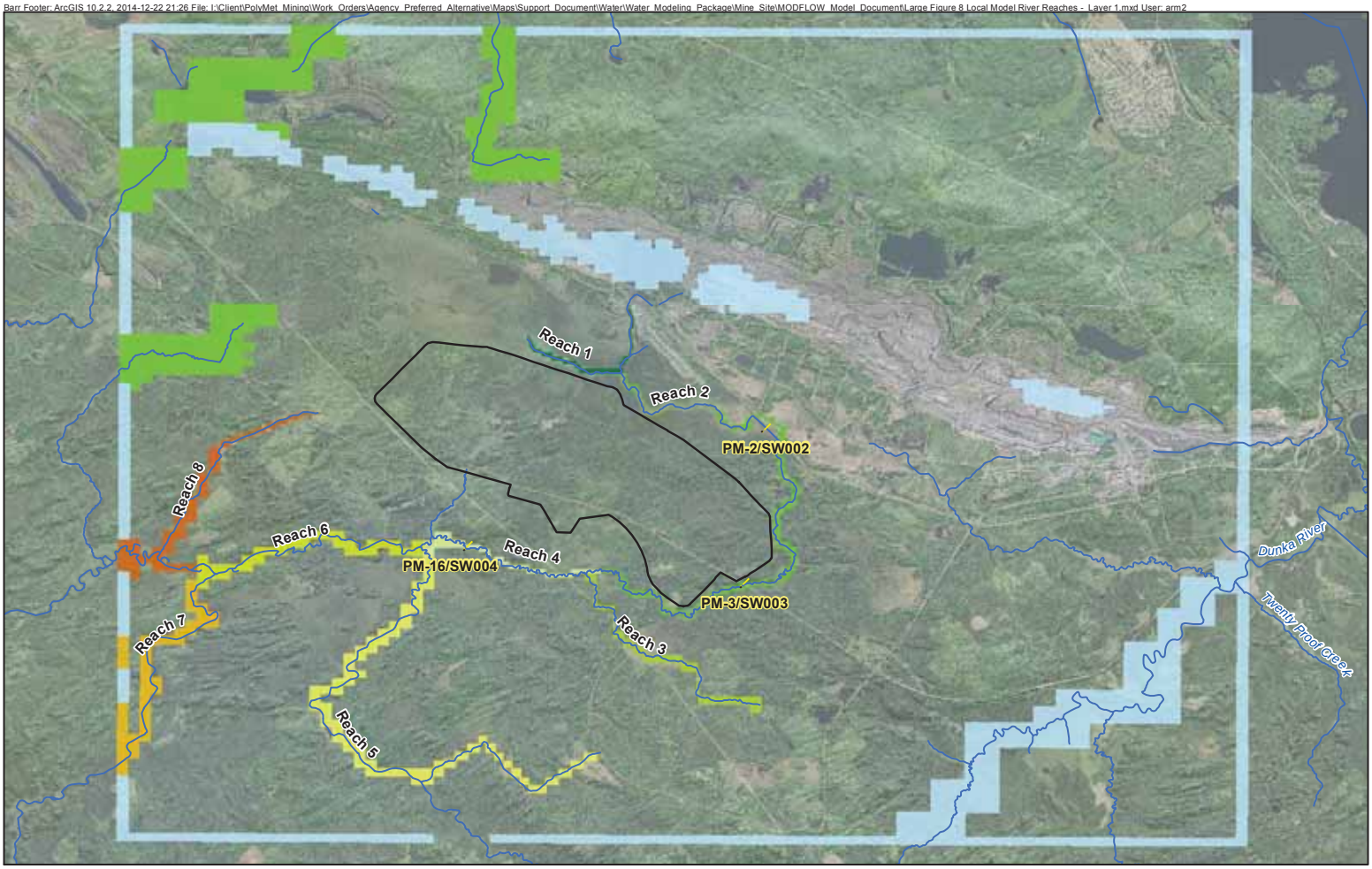


Local-Scale Model Area
Model Grid
Constant Head Cell
River Cell
Mine Site
Pits - Mine Year 11

0 0.65 1.3 2.6
Miles

Large Figure 7
MODEL BOUNDARIES IN
THE LOCAL-SCALE MODEL
NorthMet Project
Poly Met Mining, Inc.

Barr Footer: ArcGIS 10.2.2, 2014-12-22 21:26 File: I:\Client\PolyMet_Mining\Work_Orders\Agency_Preferred_Alternative\Maps\Support_Document\Water\Water_Modeling_Package\Mine_Site\MODFLOW_Model_Document\Large Figure 8 Local Model River Reaches - Layer 1.mxd User: arm2



! Surface Water Monitoring Stations

Mine Site

Specified Head Cell

River Cell Not Adjusted During Calibration

River Cells Adjusted During Calibration

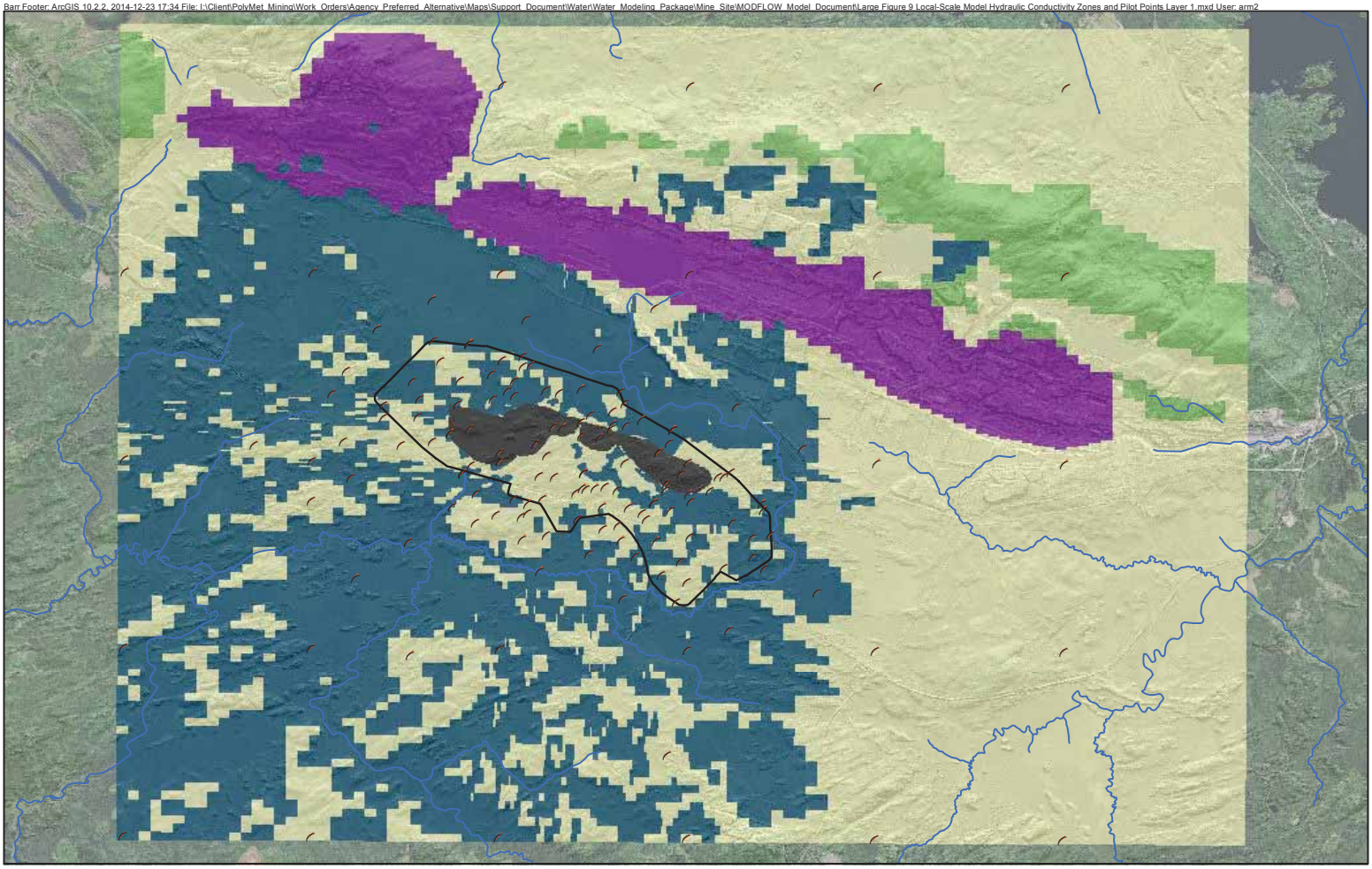
1
2
3
4
5
6
7
8

0 0.65 1.3 2.6

Miles

Large Figure 8
LOCAL MODEL RIVER REACHES - LAYER 1
NorthMet Project
Poly Met Mining, Inc.

Barr Footer: ArcGIS 10.2.2, 2014-12-23 17:34 File: I:\Client\PolyMet_Mining\Work_Orders\Agency_Preferred_Alternative\Maps\Support_Document\Water\Water_Modeling_Package\Mine_Site\MODFLOW_Model_Document\Large Figure 9 Local-Scale Model Hydraulic Conductivity Zones and Pilot Points Layer 1.mxd User: arm2



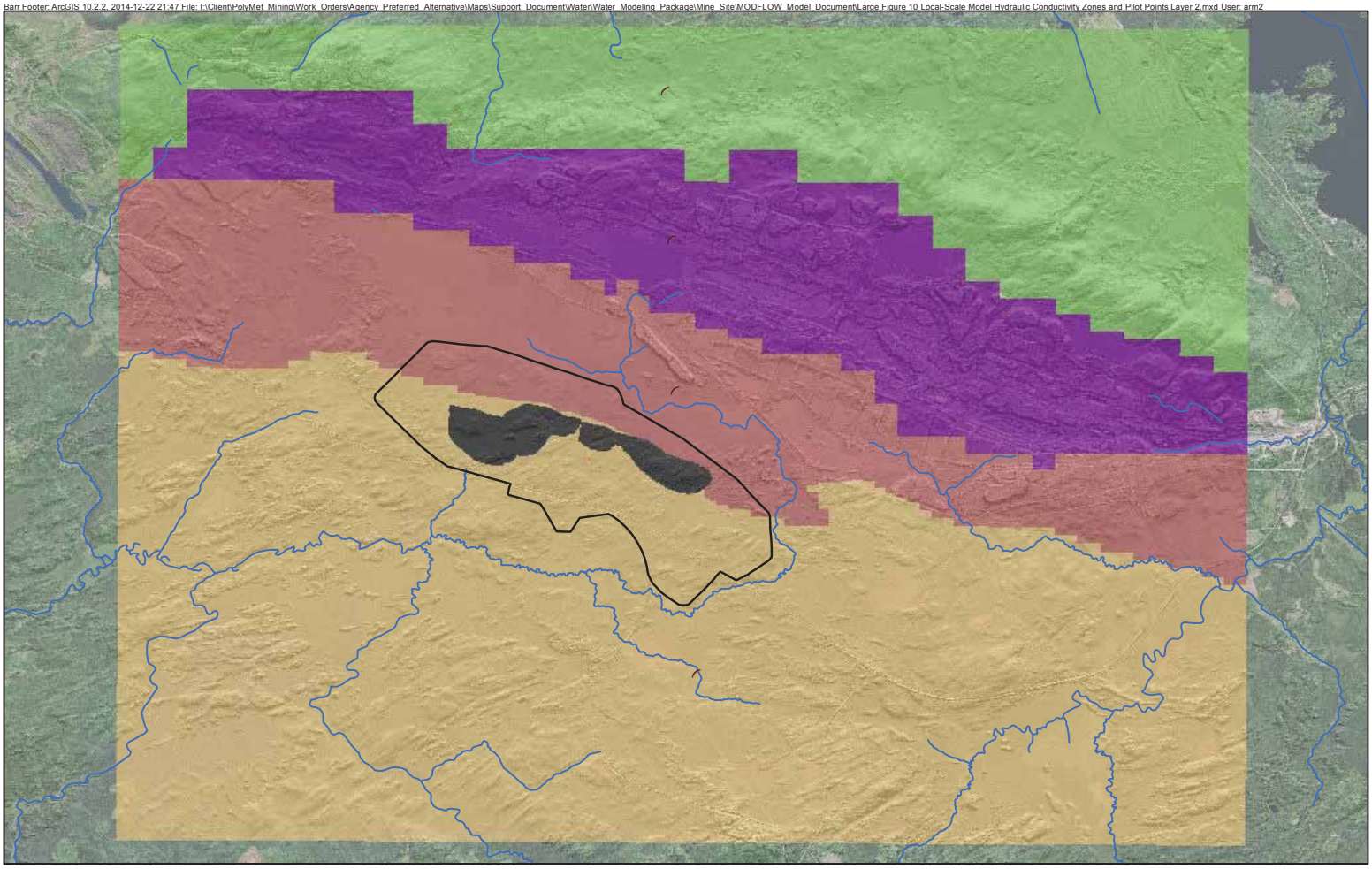
Pilot Points
River or Stream
Mine Site

Hydraulic Conductivity Zones
Giants Range Granite
Biwabik Iron Formation
Upland Deposits
Wetland Desposits

0 0.65 1.3 2.6
Miles

Large Figure 9
LOCAL-SCALE MODEL
HYDRAULIC CONDUCTIVITY ZONES
AND PILOT POINTS - LAYER 1
NorthMet Project
Poly Met Mining, Inc.

Barr Footer: ArcGIS 10.2.2, 2014-12-22 21:47 File: I:\Client\PolyMet_Mining\Work_Orders\Agency_Preferred_Alternative\Maps\Support_Document\Water\Water_Modeling_Package\Mine_Site\MODFLOW_Model_Document\Large Figure 10 Local-Scale Model Hydraulic Conductivity Zones and Pilot Points Layer 2.mxd User: arm2



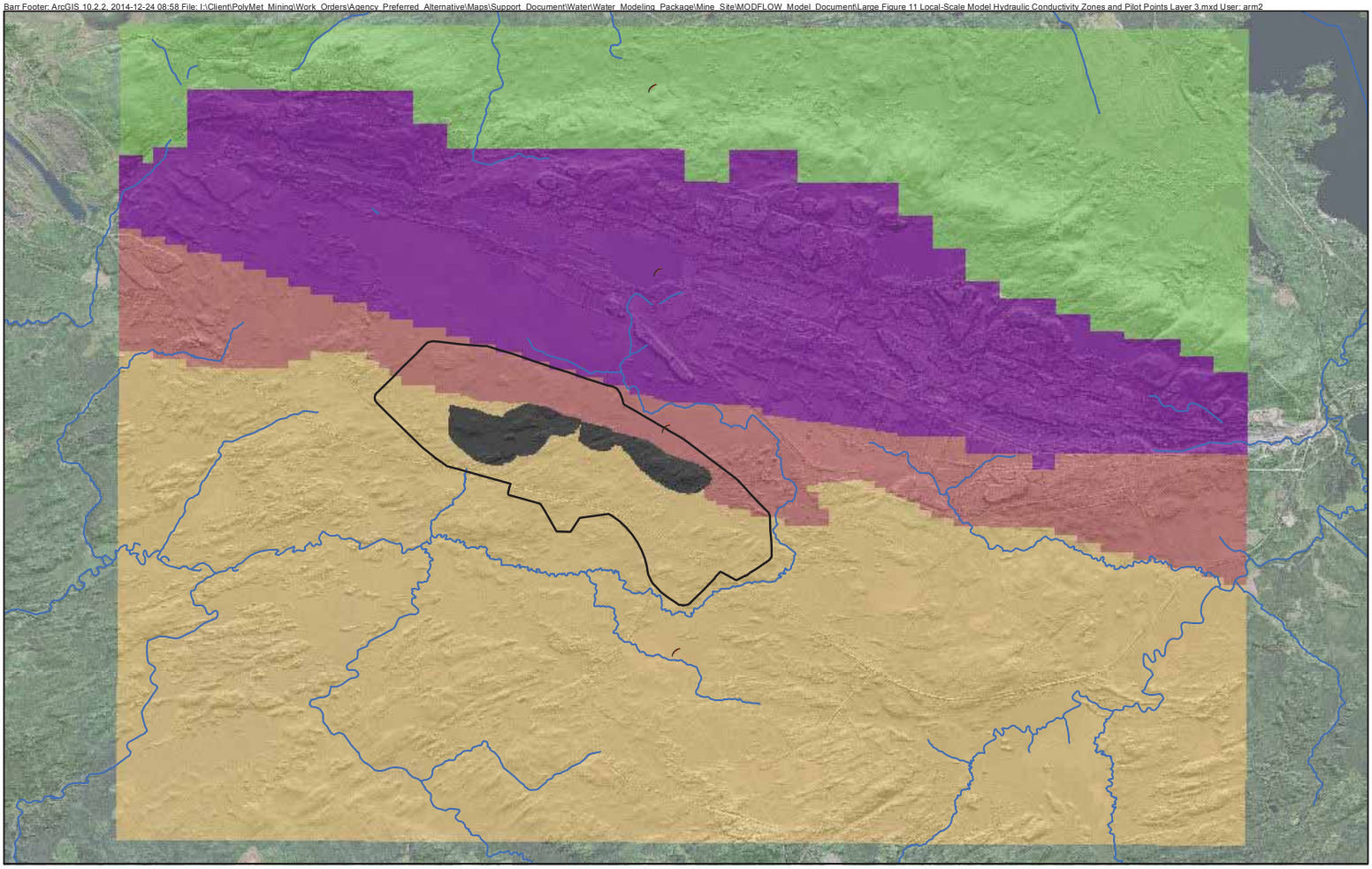
Pilot Points
Mine Site
River or Stream

Hydraulic Conductivity Zones
Duluth Complex
Giants Range Granite
Virginia Formation - Upper
Biwabik Iron Formation

0 0.65 1.3 2.6
Miles

Large Figure 10
LOCAL-SCALE MODEL
HYDRAULIC CONDUCTIVITY ZONES
AND PILOT POINTS - LAYER 2
NorthMet Project
Poly Met Mining, Inc.

Barr Footer: ArcGIS 10.2.2, 2014-12-24 08:58 File: I:\Client\PolyMet_Mining\Work_Orders\Agency_Preferred_Alternative\Maps\Support_Document\Water\Water_Modeling_Package\Mine_Site\MODFLOW_Model_Document\Large Figure 11 Local-Scale Model Hydraulic Conductivity Zones and Pilot Points Layer 3.mxd User: arm2



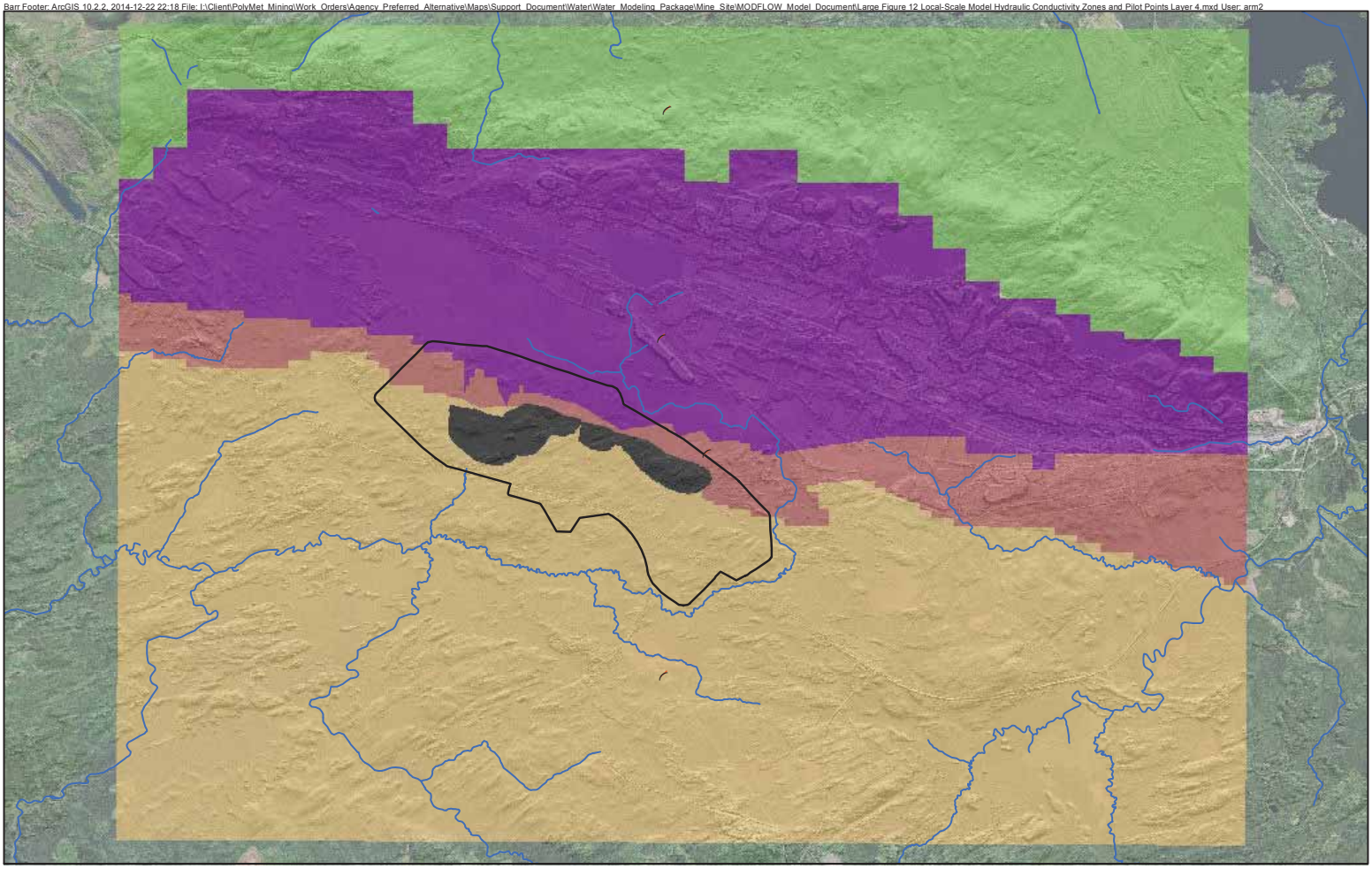
Pilot Points
Mine Site
River or Stream

Hydraulic Conductivity Zones
Duluth Complex
Giants Range Granite
Virginia Formation - Upper
Biwabik Iron Formation

0 0.65 1.3 2.6
Miles

Large Figure 11
LOCAL-SCALE MODEL
HYDRAULIC CONDUCTIVITY ZONES
AND PILOT POINTS - LAYER 3
NorthMet Project
Poly Met Mining, Inc.

Barr Footer: ArcGIS 10.2.2, 2014-12-22 22:18 File: I:\Client\PolyMet_Mining\Work_Orders\Agency_Preferred_Alternative\Maps\Support_Document\Water\Water_Modeling_Package\Mine_Site\MODFLOW_Model_Document\Large Figure 12 Local-Scale Model Hydraulic Conductivity Zones and Pilot Points Layer 4.mxd User: arm2



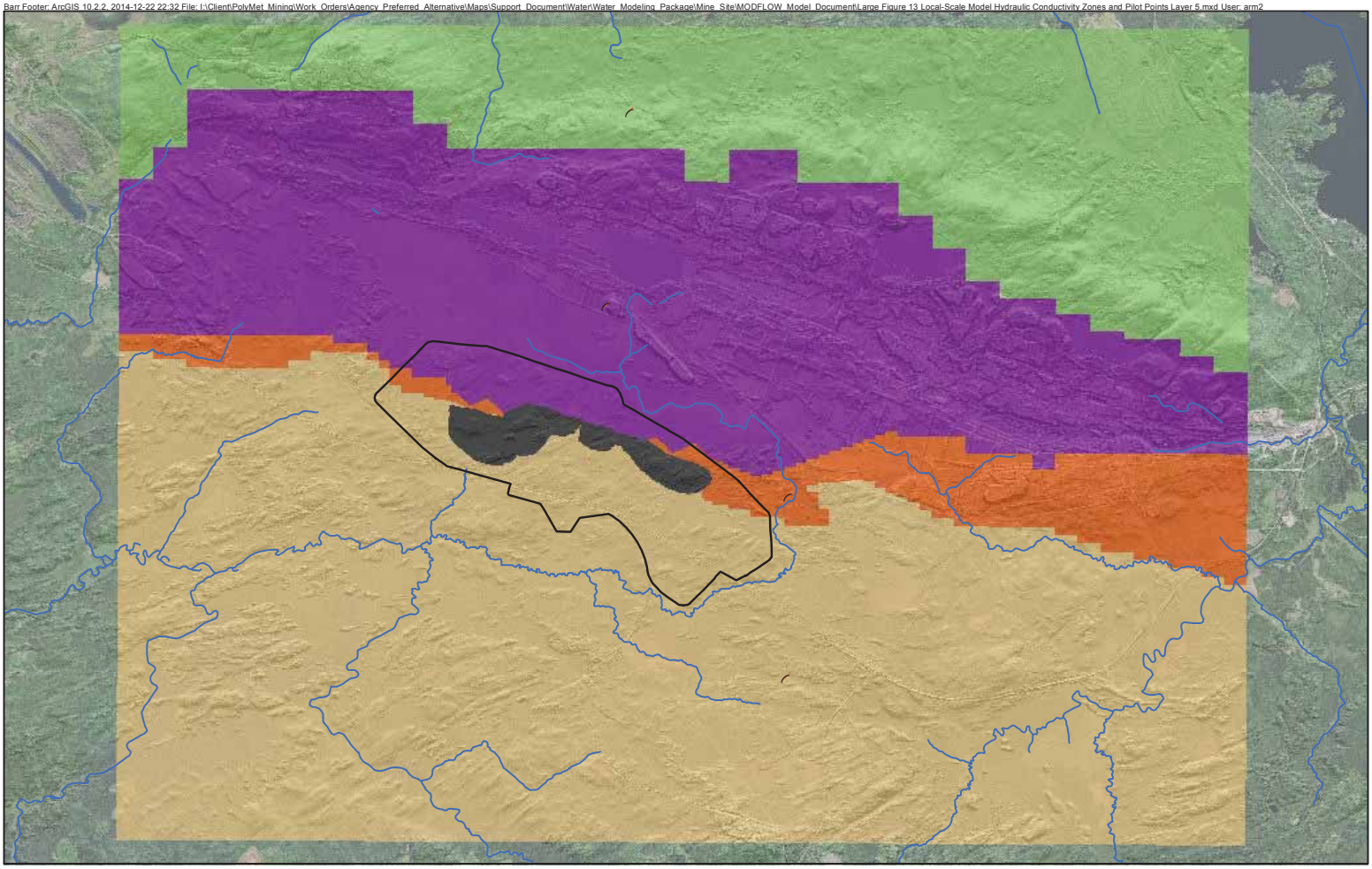
Pilot Points
Mine Site
River or Stream

Hydraulic Conductivity Zones
Duluth Complex
Giants Range Granite
Virginia Formation - Upper
Biwabik Iron Formation

0 0.65 1.3 2.6
Miles

Large Figure 12
LOCAL-SCALE MODEL
HYDRAULIC CONDUCTIVITY ZONES
AND PILOT POINTS - LAYER 4
NorthMet Project
Poly Met Mining, Inc.

Barr Footer: ArcGIS 10.2.2, 2014-12-22 22:32 File: I:\Client\PolyMet_Mining\Work_Orders\Agency_Preferred_Alternative\Maps\Support_Document\Water\Water_Modeling_Package\Mine_Site\MODFLOW_Model_Document\Large Figure 13 Local-Scale Model Hydraulic Conductivity Zones and Pilot Points Layer 5.mxd User: arm2



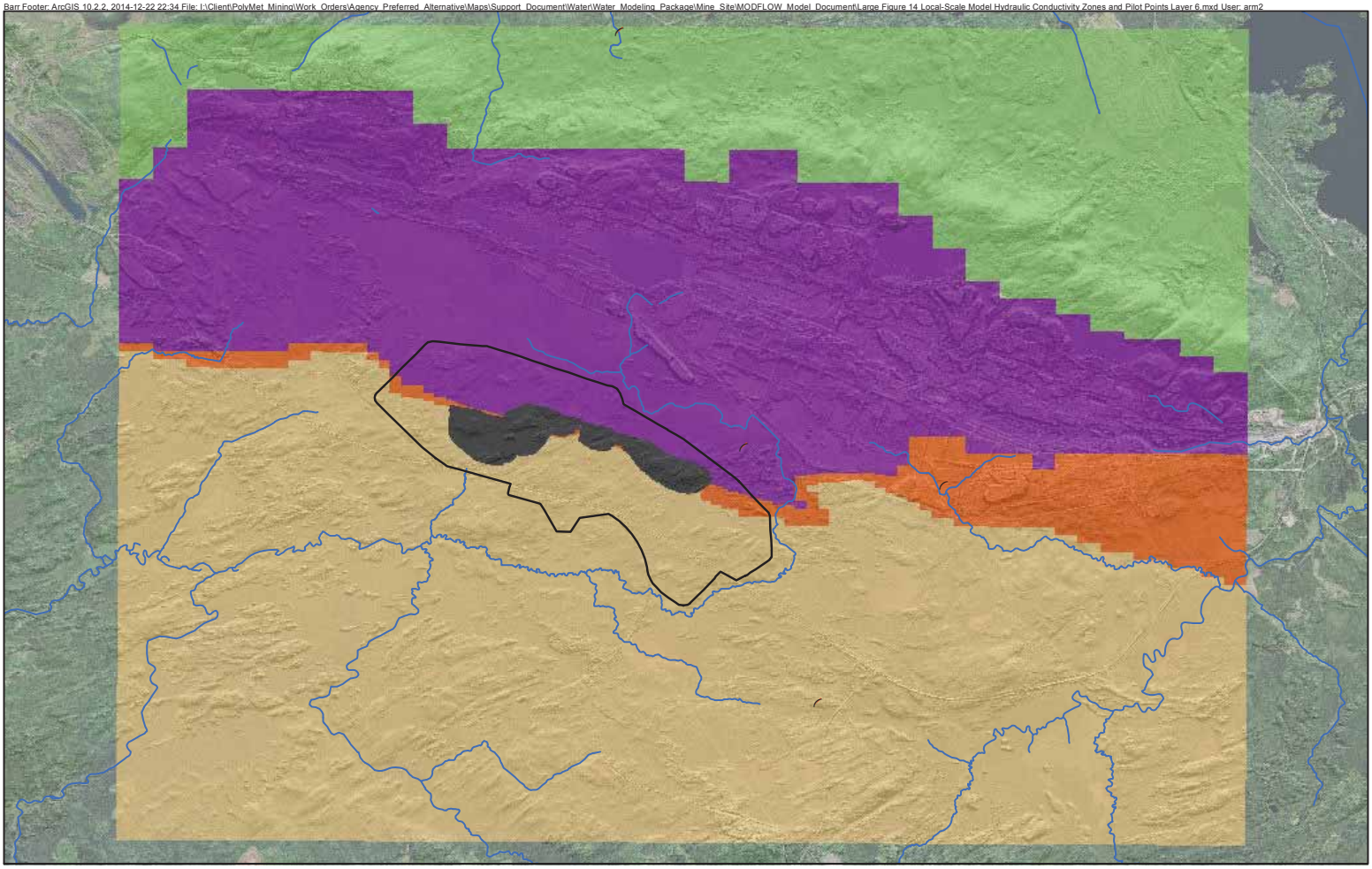
Pilot Points
Mine Site
River or Stream

Hydraulic Conductivity Zones
Duluth Complex
Giants Range Granite
Virginia Formation - Lower
Biwabik Iron Formation

0 0.65 1.3 2.6
Miles

Large Figure 13
LOCAL-SCALE MODEL
HYDRAULIC CONDUCTIVITY ZONES
AND PILOT POINTS - LAYER 5
NorthMet Project
Poly Met Mining, Inc.

Barr Footer: ArcGIS 10.2.2, 2014-12-22 22:34 File: I:\Client\PolyMet_Mining\Work_Orders\Agency_Preferred_Alternative\Maps\Support_Document\Water\Water_Modeling_Package\Mine_Site\MODFLOW_Model_Document\Large Figure 14 Local-Scale Model Hydraulic Conductivity Zones and Pilot Points Layer 6.mxd User: arm2



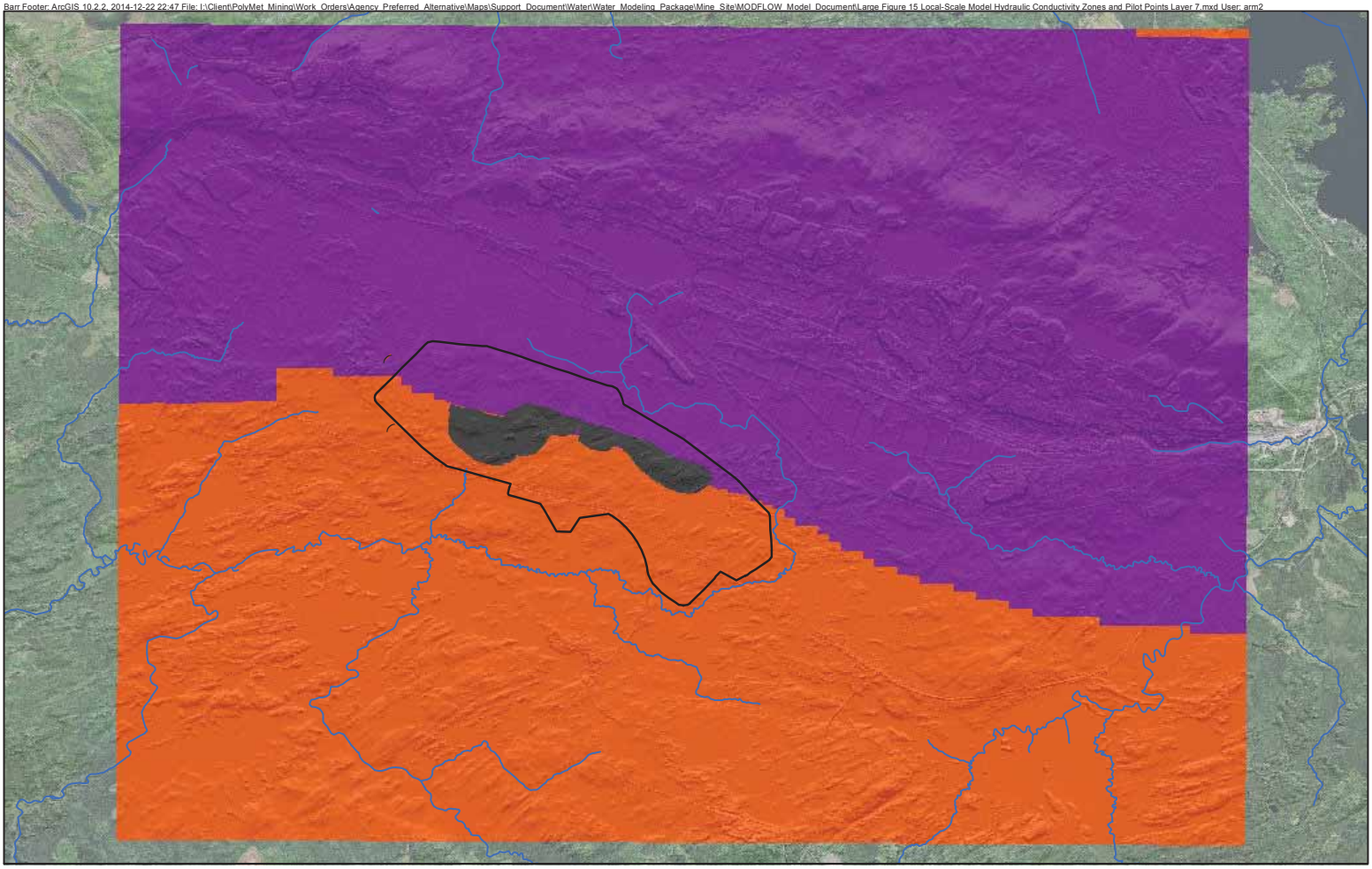
Pilot Points
Mine Site
River or Stream

Hydraulic Conductivity Zones
Duluth Complex
Giants Range Granite
Virginia Formation - Lower
Biwabik Iron Formation

0 0.65 1.3 2.6
Miles

Large Figure 14
LOCAL-SCALE MODEL
HYDRAULIC CONDUCTIVITY ZONES
AND PILOT POINTS - LAYER 6
NorthMet Project
Poly Met Mining, Inc.

Barr Footer: ArcGIS 10.2.2, 2014-12-22 22:47 File: I:\Client\PolyMet_Mining\Work_Orders\Agency_Preferred_Alternative\Maps\Support_Document\Water\Water_Modeling_Package\Mine_Site\MODFLOW_Model_Document\Large Figure 15 Local-Scale Model Hydraulic Conductivity Zones and Pilot Points Layer 7.mxd User: arm2



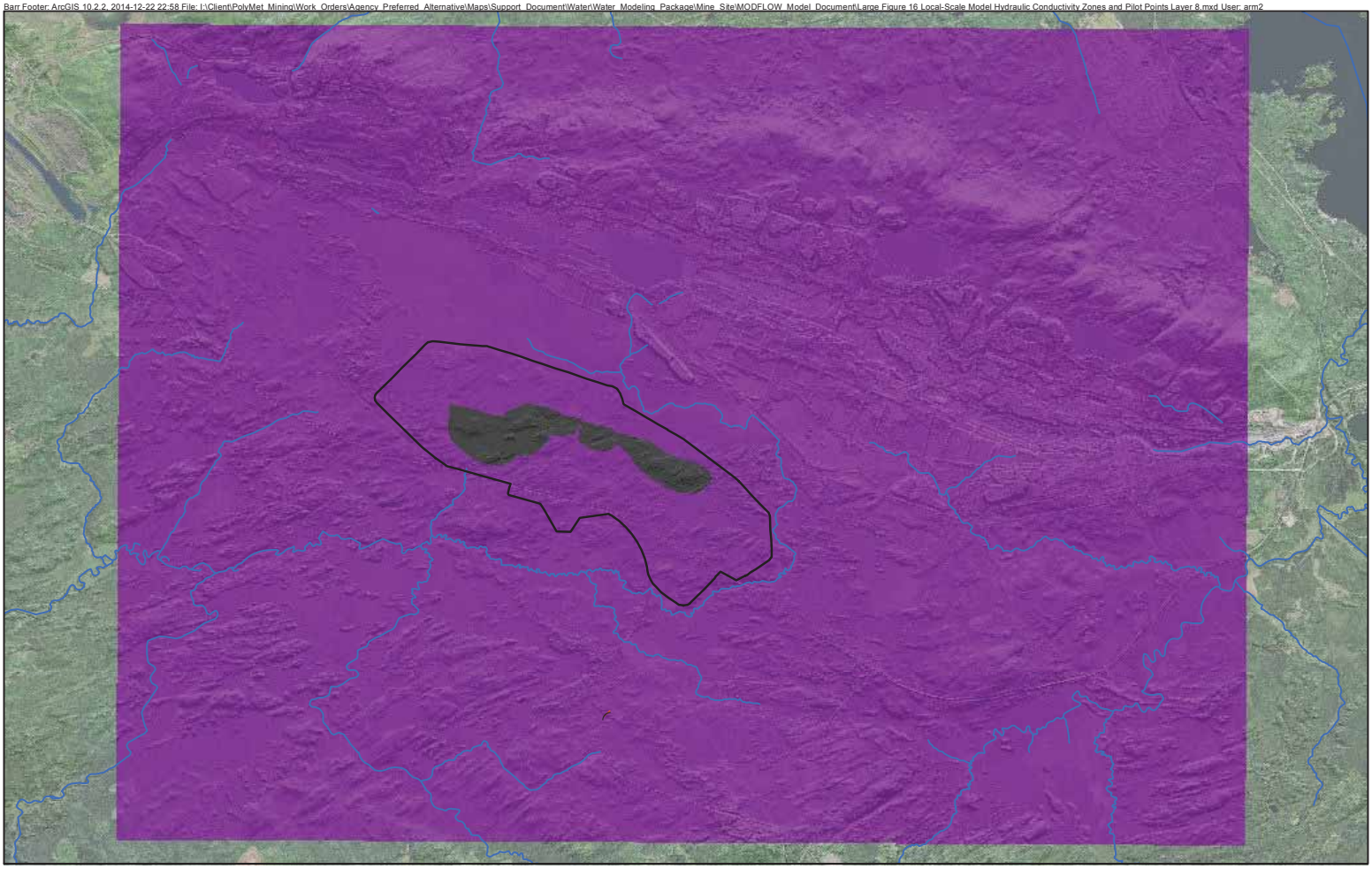
Pilot Points
Mine Site
River or Stream

Hydraulic Conductivity Zones
Duluth Complex
Giants Range Granite
Virginia Formation - Lower
Biwabik Iron Formation

0 0.65 1.3 2.6
Miles

Large Figure 15
LOCAL-SCALE MODEL
HYDRAULIC CONDUCTIVITY ZONES
AND PILOT POINTS - LAYER 7
NorthMet Project
Poly Met Mining, Inc.

Barr Footer: ArcGIS 10.2.2, 2014-12-22 22:58 File: I:\Client\PolyMet_Mining\Work_Orders\Agency_Preferred_Alternative\Maps\Support_Document\Water\Water_Modeling_Package\Mine_Site\MODFLOW_Model_Document\Large Figure 16 Local-Scale Model Hydraulic Conductivity Zones and Pilot Points Layer 8.mxd User: arm2



Pilot Points
Mine Site
River or Stream

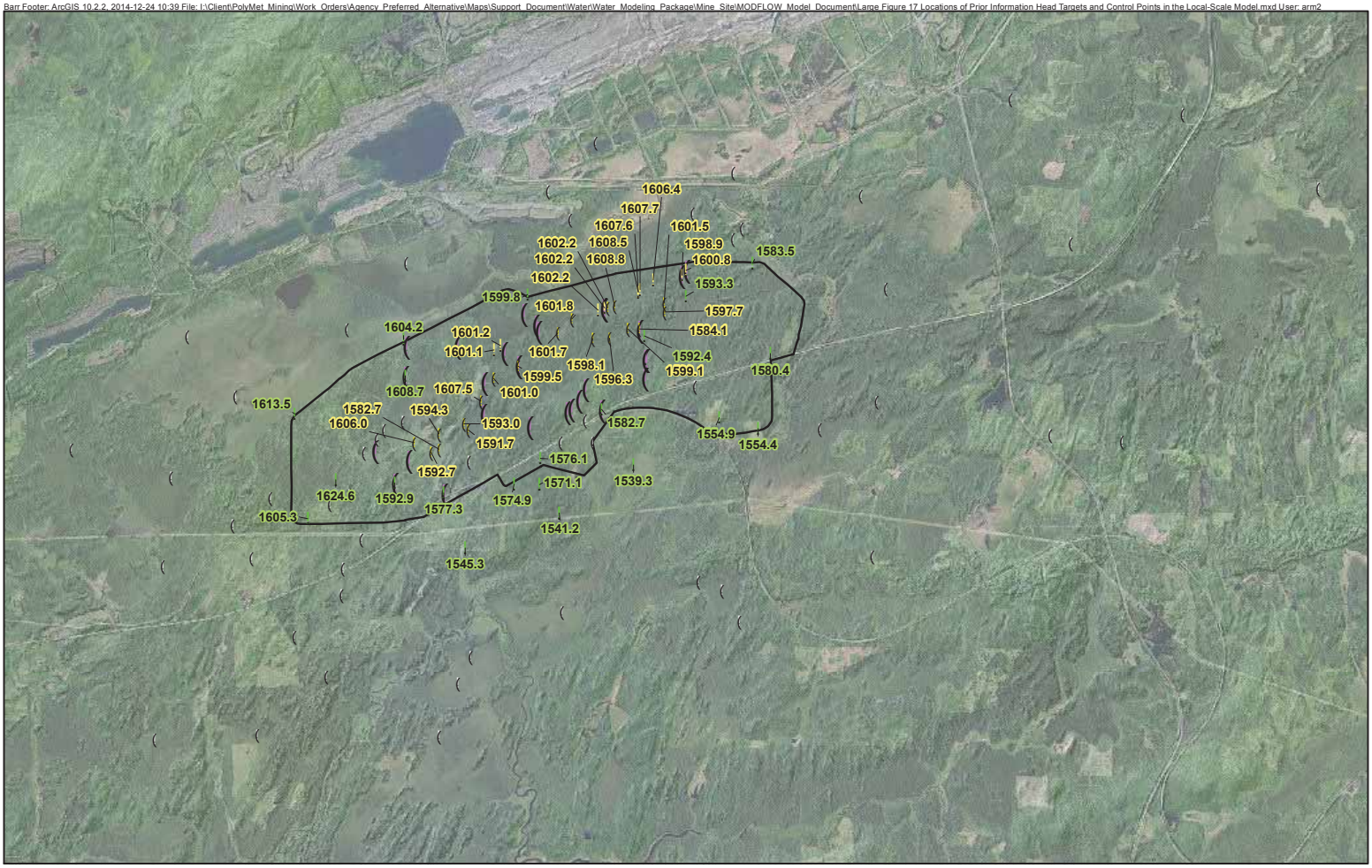
Hydraulic Conductivity Zones
Duluth Complex
Giants Range Granite
Virginia Formation - Lower
Biwabik Iron Formation

N

0 0.65 1.3 2.6
Miles

Large Figure 16
LOCAL-SCALE MODEL
HYDRAULIC CONDUCTIVITY ZONES
AND PILOT POINTS - LAYER 8
NorthMet Project
Poly Met Mining, Inc.

Barr Footer: ArcGIS 10.2.2, 2014-12-24 10:39 File: I:\Client\PolyMet_Mining\Work_Orders\Agency_Preferred_Alternative\Maps\Support_Document\Water\Water_Modeling_Package\Mine_Site\MODFLOW_Model_Document\Large Figure 17 Locations of Prior Information Head Targets and Control Points in the Local-Scale Model.mxd User: arm2



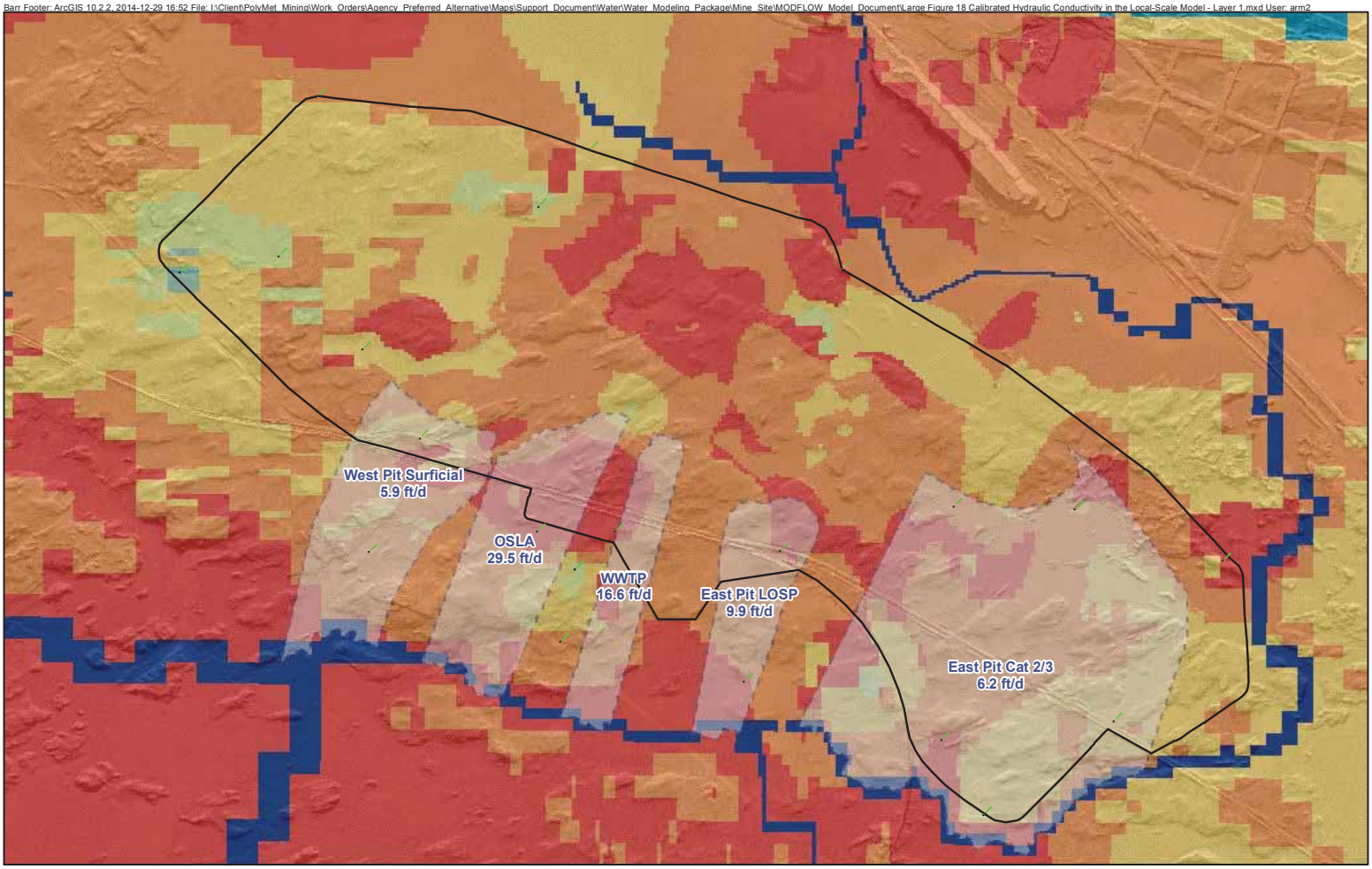
! Surficial Wells
. Bedrock Wells
(Bedrock Boreholes
(Control Point Locations
(Hydraulic Conductivity Prior Information

Mine Site

0 0.5 1 2
Miles

Large Figure 17
LOCATIONS OF PRIOR INFORMATION, HEAD TARGETS AND CONTROL POINTS IN THE LOCAL-SCALE MODEL
NorthMet Project
Poly Met Mining, Inc.

Barr Footer: ArcGIS 10.2.2, 2014-12-29 16:52 File: I:\Client\PolyMet_Mining\Work_Orders\Agency_Preferred_Alternative\Maps\Support_Document\Water\Water_Modeling_Package\Mine_Site\MODFLOW_Model_Document\Large Figure 18 Calibrated Hydraulic Conductivity in the Local-Scale Model - Layer 1.mxd User: arm2



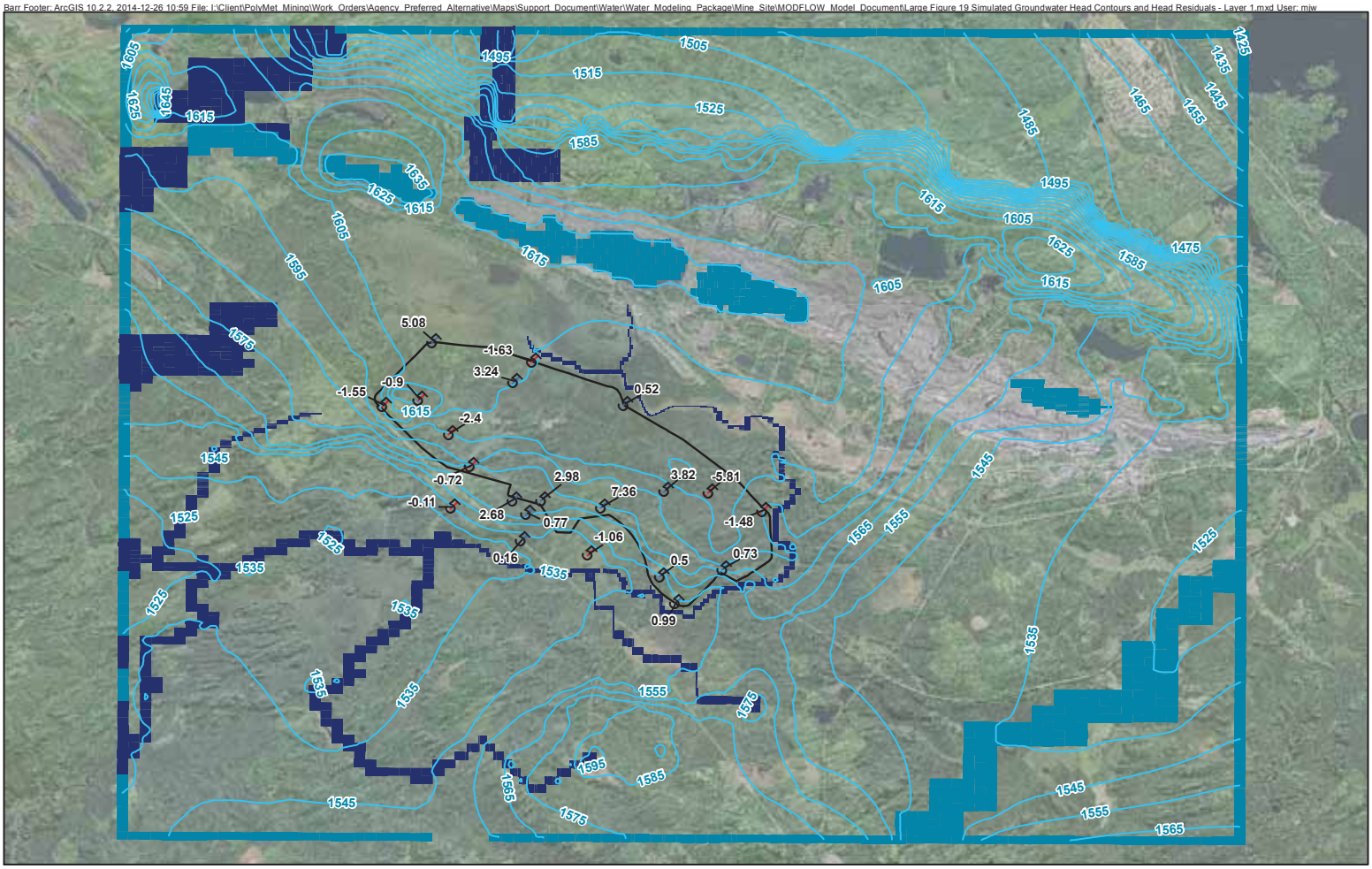
Monitoring Well
Groundwater Flow Paths
Specified Head Cell
River Cell
Mine Site

Hydraulic Conductivity (ft/d)
<0.001
0.001 - 0.01
0.01 - 0.1
0.1 - 1.0
1.0 - 10
>10

0 1,250 2,500 5,000
Feet

Large Figure 18
CALIBRATED HYDRAULIC CONDUCTIVITY
IN THE LOCAL-SCALE MODEL - LAYER 1
NorthMet Project
Poly Met Mining, Inc.

Barr Footer: ArcGIS 10.2.2, 2014-12-26 10:59 File: I:\Client\PolyMet_Mining\Work_Orders\Agency_Preferred_Alternative\Maps\Support_Document\Water\Water_Modeling_Package\Mine_Site\MODFLOW_Model_Document\Large Figure 19 Simulated Groundwater Head Contours and Head Residuals - Layer 1.mxd User: miw



5 Unconsolidated Monitoring Well with Negative Head Residuals in Feet

5 Unconsolidated Monitoring Well with Positive Head Residuals in Feet

Simulated Groundwater Head Contours (Ft)

River Cell

Specified Head Cell

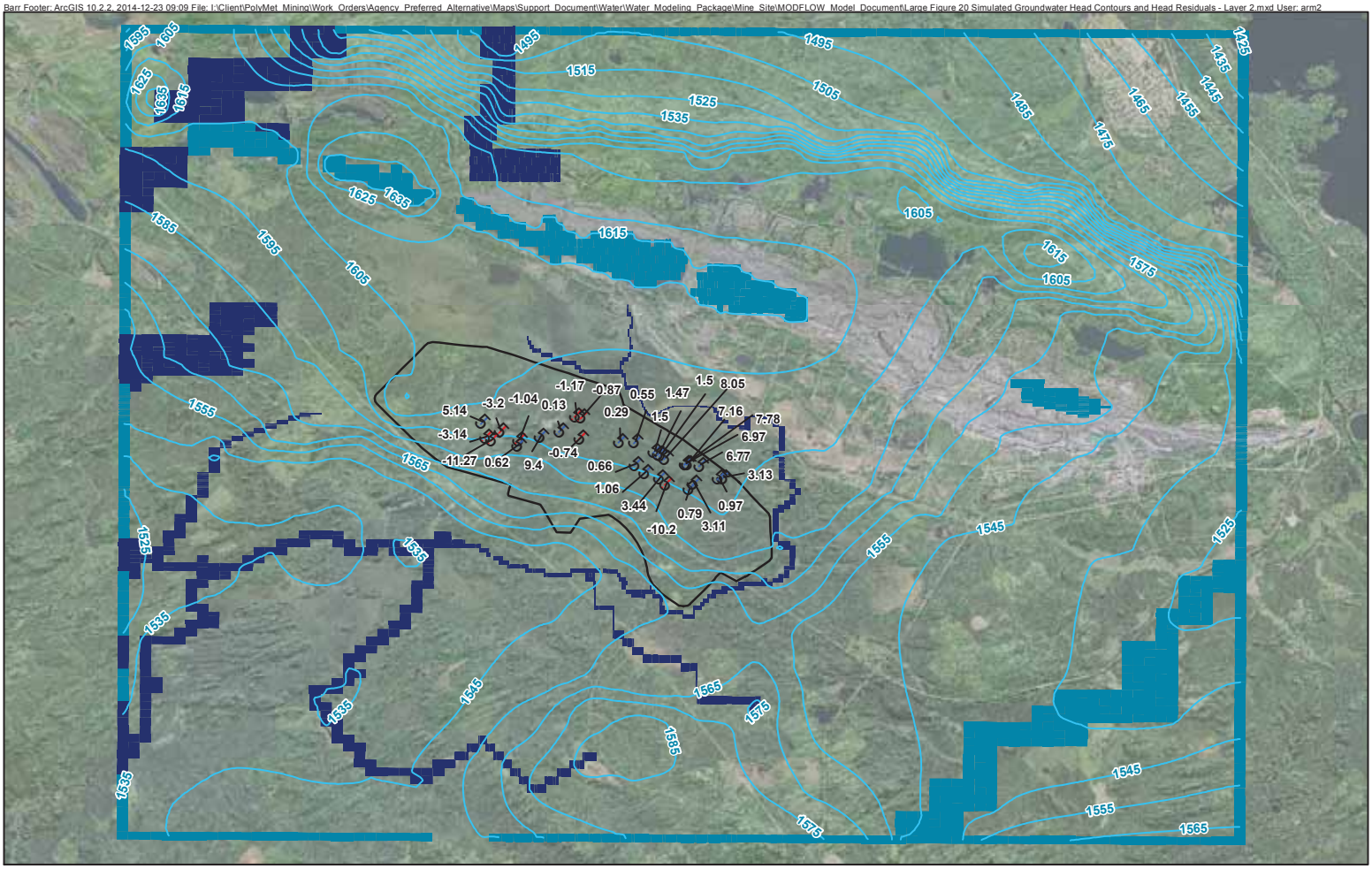
Mine Site

0 0.65 1.3 2.6

Miles

Large Figure 19
SIMULATED GROUNDWATER HEAD CONTOURS
AND HEAD RESIDUALS - LAYER 1
NorthMet Project
Poly Met Mining, Inc.

Barr Footer: ArcGIS 10.2.2, 2014-12-23 09:09 File: I:\Client\PolyMet_Mining\Work_Orders\Agency_Preferred_Alternative\Maps\Support_Document\Water\Water_Modeling_Package\Mine_Site\MODFLOW_Model_Document\Large Figure 20 Simulated Groundwater Head Contours and Head Residuals - Layer 2.mxd User: arm2



5 Unconsolidated Monitoring Well with Negative Head Residuals in Feet

5 Unconsolidated Monitoring Well with Positive Head Residuals in Feet

River Cell

Specified Head Cell

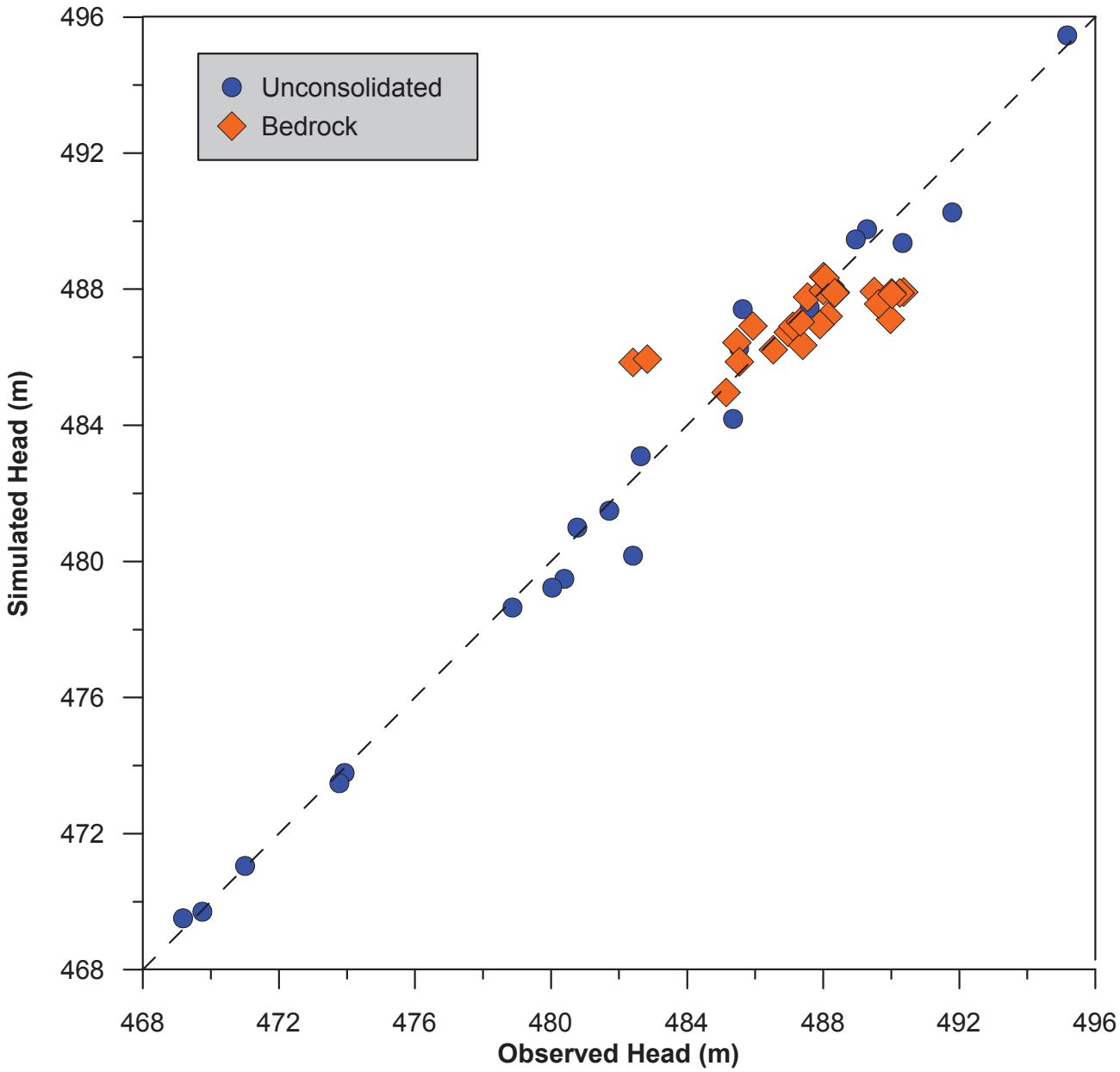
Mine Site

0 0.65 1.3 2.6

Miles

Large Figure 20
SIMULATED GROUNDWATER HEAD CONTOURS
AND HEAD RESIDUALS - LAYER 2
NorthMet Project
Poly Met Mining, Inc.

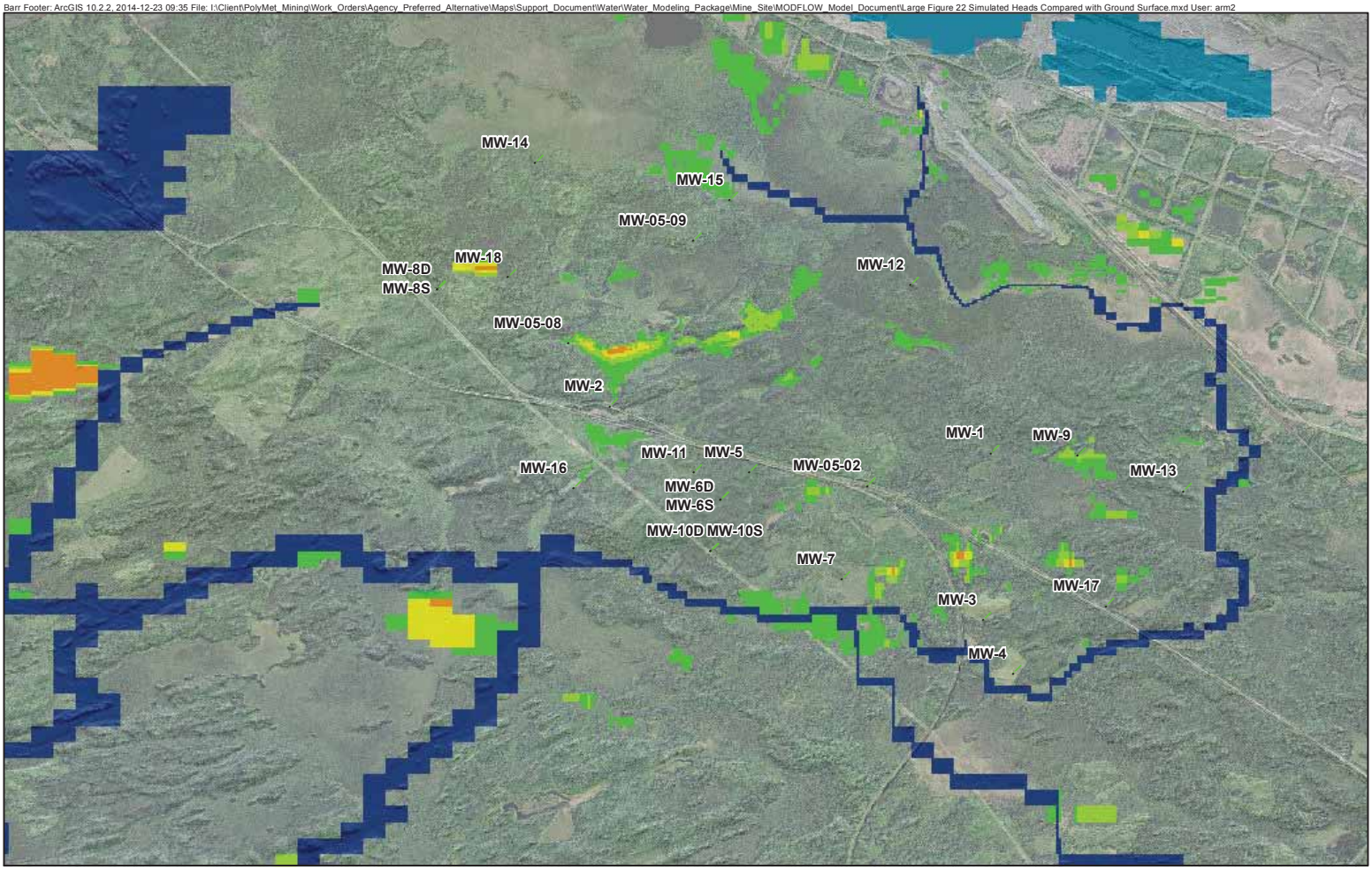
P:\Mpls\23 MN\69\2369862\WorkFiles\APA\Support Docs\Water Modeling Package Doc\Attachment\Mine Site\Attachment B - MODFLOW\Figures\UpdatedFigures-postedbyARM2\Large Figure 21 Observed vs. simulated head in the local model.grf



Large Figure 21

OBSERVED VS. SIMULATED HEAD IN THE LOCAL MODEL
NorthMet Project
Poly Met Mining Inc.
Hoyt Lakes, MN

Barr Footer: ArcGIS 10.2.2, 2014-12-23 09:35 File: I:\Client\PolyMet_Mining\Work_Orders\Agency_Preferred_Alternative\Maps\Support_Document\Water\Water_Modeling_Package\Mine_Site\MODFLOW_Model_Document\Large Figure 22 Simulated Heads Compared with Ground Surface.mxd User: arm2



! Unconsolidated Monitoring Well

River Cell

Specified Head Cell

Simulated Head - Ft Above Ground

>10

6-10

4-6

2-4

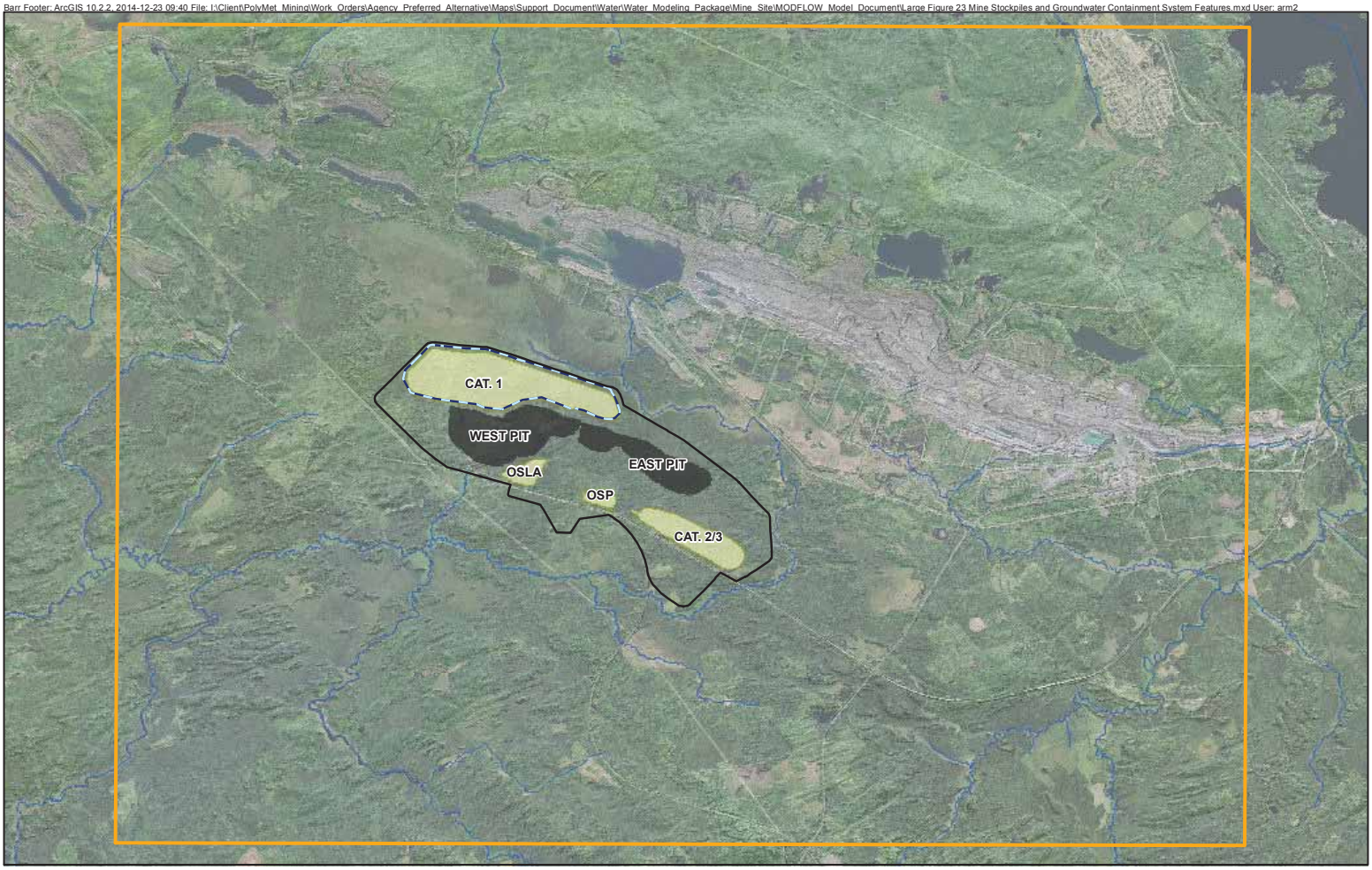
0-2

0 1,750 3,500 7,000

Feet

Large Figure 22
SIMULATED HEADS COMPARED WITH GROUND SURFACE
NorthMet Project
Poly Met Mining, Inc.

Barr Footer: ArcGIS 10.2.2, 2014-12-23 09:40 File: I:\Client\PolyMet_Mining\Work_Orders\Agency_Preferred_Alternative\Maps\Support_Document\Water\Water_Modeling_Package\Mine_Site\MODFLOW_Model_Document\Large Figure 23 Mine Stockpiles and Groundwater Containment System Features.mxd User: arm2



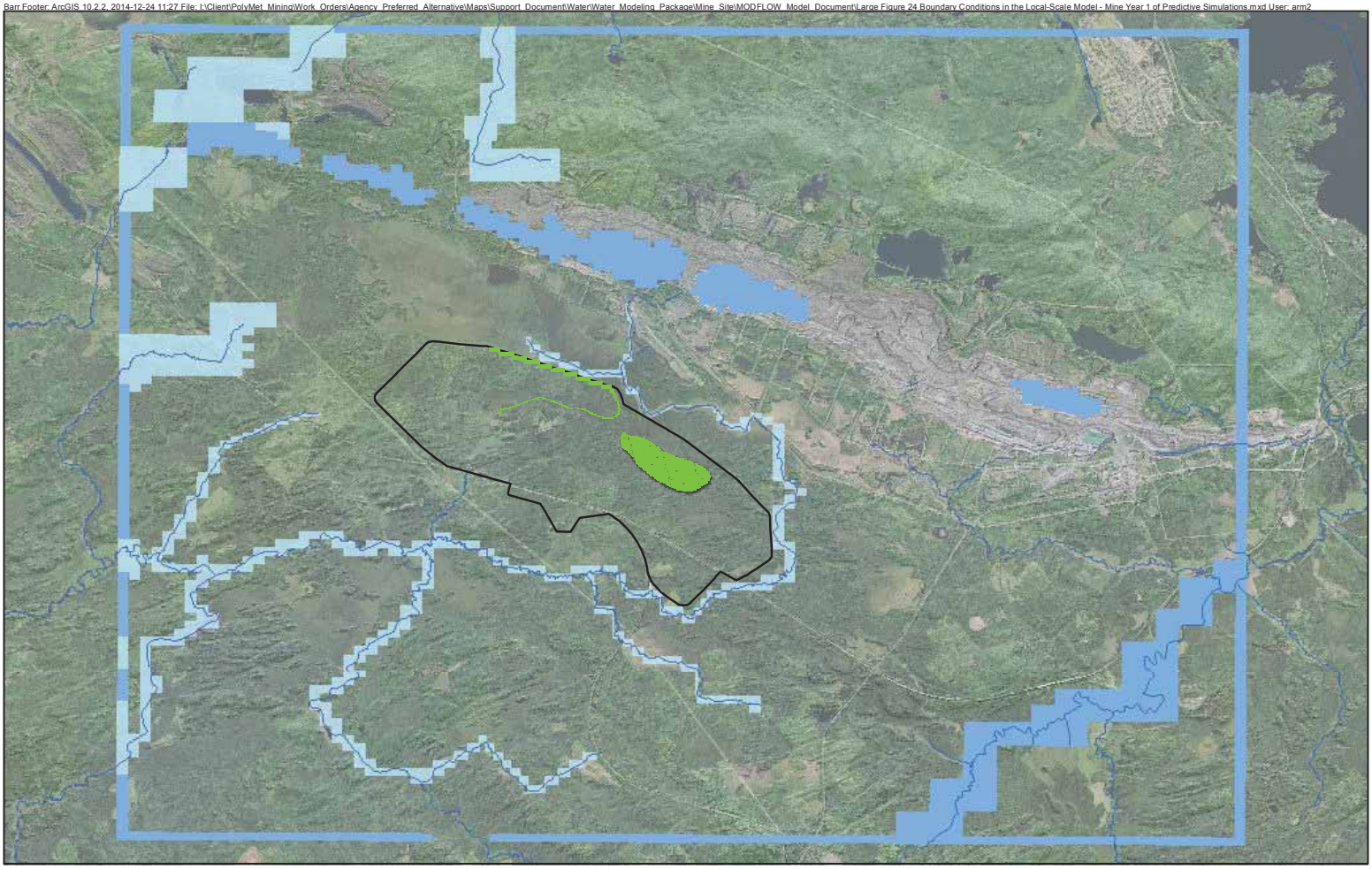
Local-Scale Model Area
Project Areas
Groundwater Containment System
Active Stockpile - Mine Year 11
Pits - Mine Year 11

N

0 0.65 1.3 2.6
Miles

Large Figure 23
MINE, STOCKPILES, AND GROUNDWATER CONTAINMENT SYSTEM FEATURES
NorthMet Project
Poly Met Mining, Inc.

Barr Footer: ArcGIS 10.2.2, 2014-12-24 11:27 File: I:\Client\PolyMet_Mining\Work_Orders\Agency_Preferred_Alternative\Maps\Support_Document\Water\Water_Modeling_Package\Mine_Site\MODFLOW_Model_Document\Large Figure 24 Boundary Conditions in the Local-Scale Model - Mine Year 1 of Predictive Simulations.mxd User: arm2

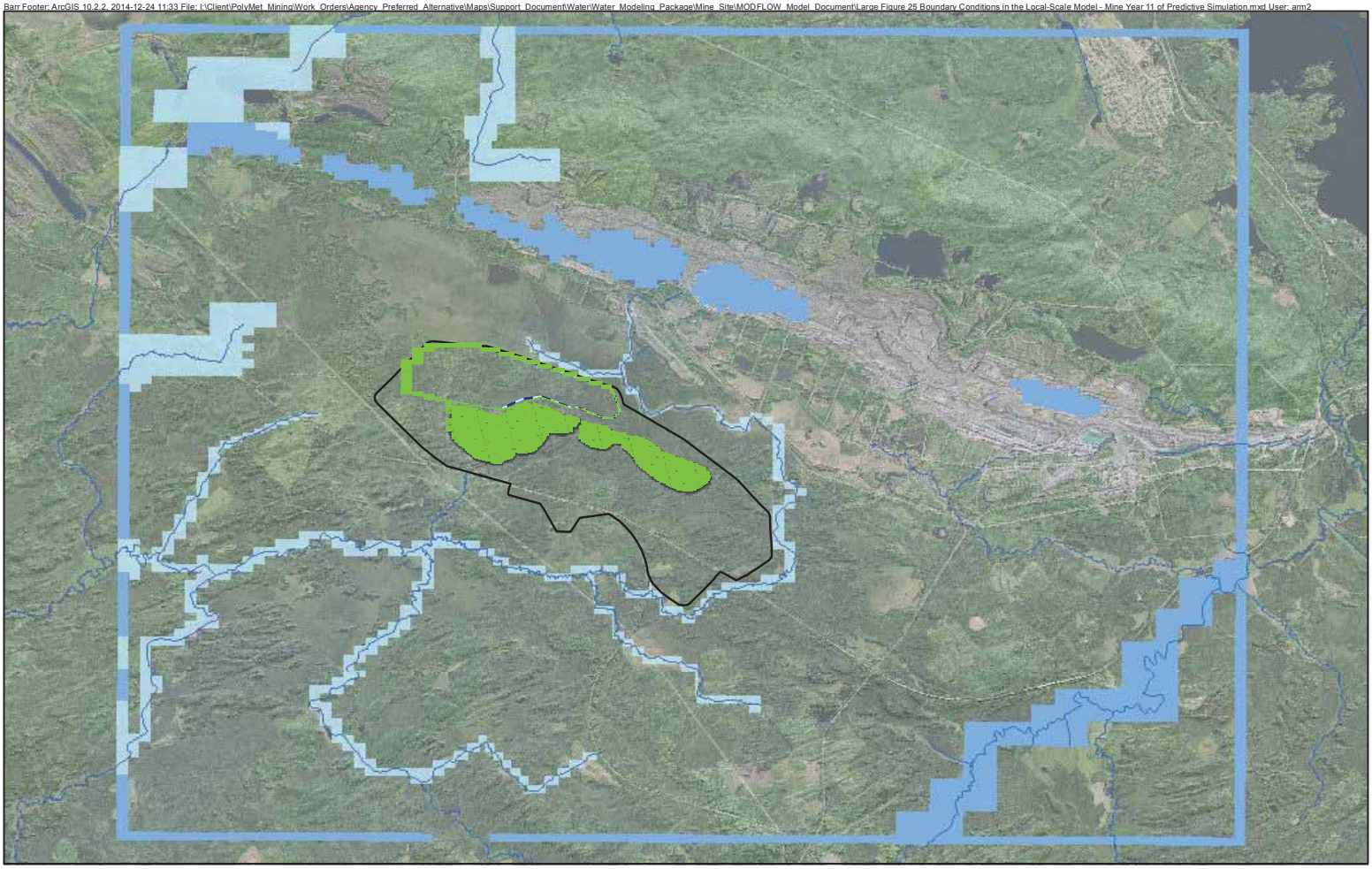


Drain Cell
Constant Head Cells
River Cell
Mine Site

0 0.65 1.3 2.6
Miles

Large Figure 24
BOUNDARY CONDITIONS IN THE LOCAL-SCALE MODEL - MINE YEAR 1 OF PREDICTIVE SIMULATIONS
NorthMet Project
Poly Met Mining, Inc.

Barr Footer: ArcGIS 10.2.2, 2014-12-24 11:33 File: I:\Client\PolyMet_Mining\Work_Orders\Agency_Preferred_Alternative\Maps\Support_Document\Water\Water_Modeling_Package\Mine_Site\MODFLOW_Model_Document\Large Figure 25 Boundary Conditions in the Local-Scale Model - Mine Year 11 of Predictive Simulation.mxd User: arm2

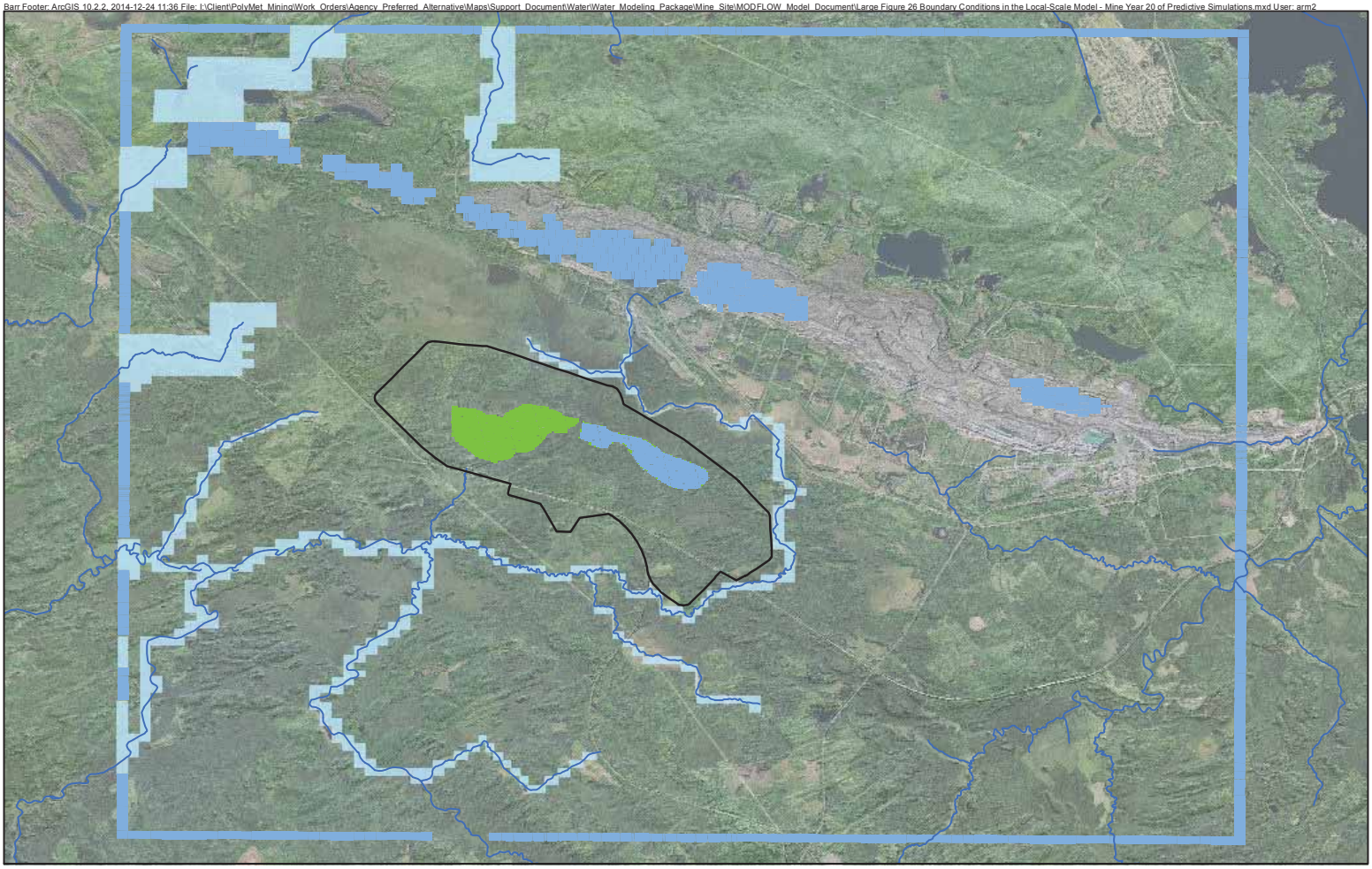


Drain Cell
Constant Head Cells
River Cell
Mine Site

0 0.65 1.3 2.6
Miles

Large Figure 25
BOUNDARY CONDITIONS IN THE LOCAL-SCALE MODEL - MINE YEAR 11 OF PREDICTIVE SIMULATIONS
NorthMet Project
Poly Met Mining, Inc.

Barr Footer: ArcGIS 10.2.2, 2014-12-24 11:36 File: I:\Client\PolyMet_Mining\Work_Orders\Agency_Preferred_Alternative\Maps\Support_Document\Water\Water_Modeling_Package\Mine_Site\MODFLOW_Model_Document\Large Figure 26 Boundary Conditions in the Local-Scale Model - Mine Year 20 of Predictive Simulations.mxd User: arm2

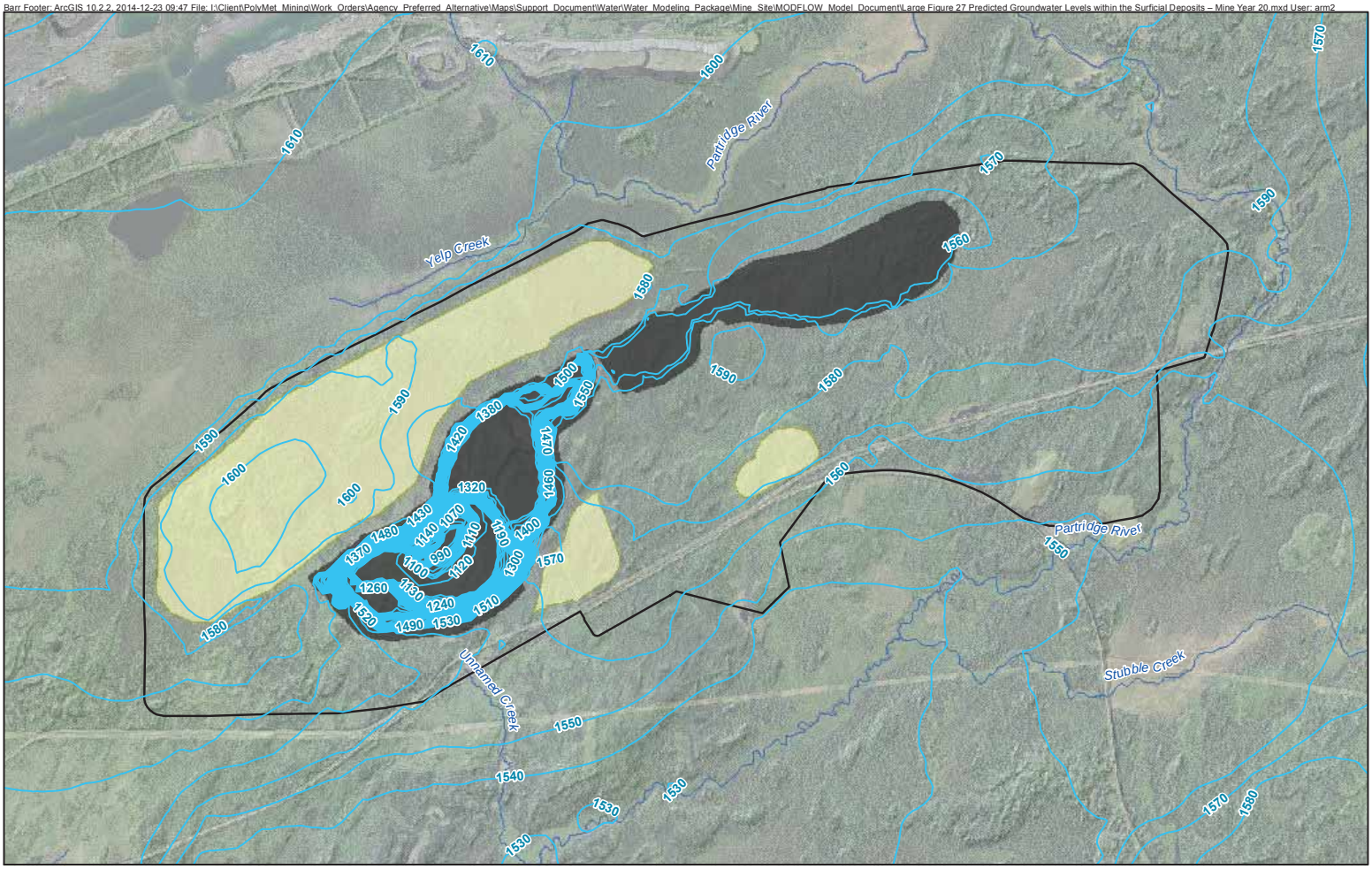


Drain Cell
Constant Head Cells
River Cell
Mine Site

0 0.65 1.3 2.6
Miles

Large Figure 26
BOUNDARY CONDITIONS IN THE LOCAL-SCALE MODEL - MINE YEAR 20 OF PREDICTIVE SIMULATIONS
NorthMet Project
Poly Met Mining, Inc.

Barr Footer: ArcGIS 10.2.2, 2014-12-23 09:47 File: I:\Client\PolyMet_Mining\Work_Orders\Agency_Preferred_Alternative\Maps\Support_Document\Water\Water_Modeling_Package\Mine_Site\MODFLOW_Model_Document\Large Figure 27 Predicted Groundwater Levels within the Surficial Deposits – Mine Year 20.mxd User: arm2

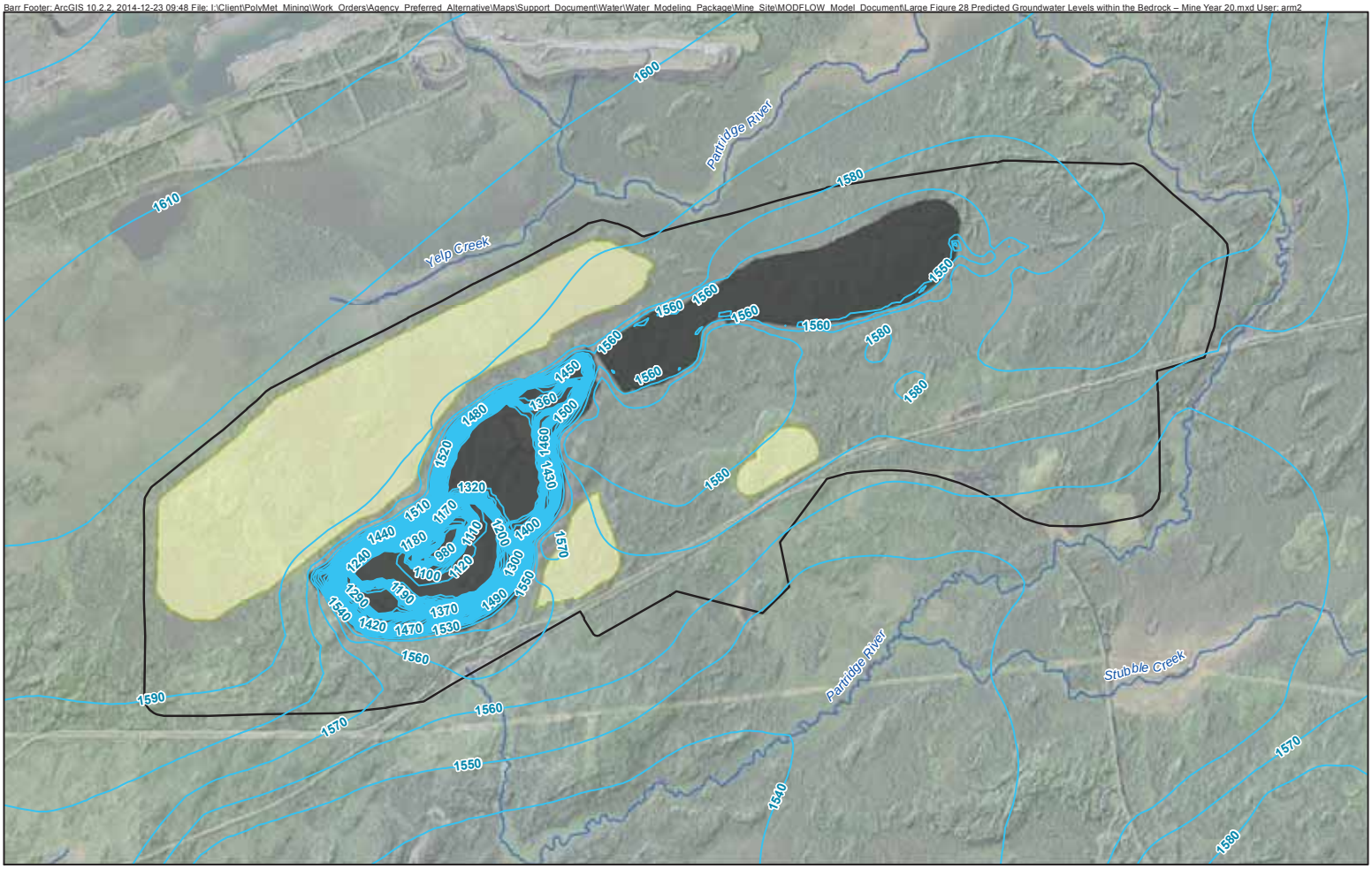


Simulated Water Table (feet)
Contour Interval = 10 feet
Project Areas
Active Stockpile - Mine Year 20
Pits - Mine Year 20

0 1,250 2,500 5,000
Feet

Large Figure 27
PREDICTED GROUNDWATER LEVELS WITHIN THE SURFICIAL DEPOSITS - MINE YEAR 20
NorthMet Project
Poly Met Mining, Inc.

Barr Footer: ArcGIS 10.2.2, 2014-12-23 09:48 File: I:\Client\PolyMet_Mining\Work_Orders\Agency_Preferred_Alternative\Maps\Support_Document\Water\Water_Modeling_Package\Mine_Site\MODFLOW_Model_Document\Large Figure 28 Predicted Groundwater Levels within the Bedrock – Mine Year 20.mxd User: arm2



Simulated Piezometric Surface (feet)
Contour Interval = 10 feet

Project Areas

Active Stockpile - Mine Year 20

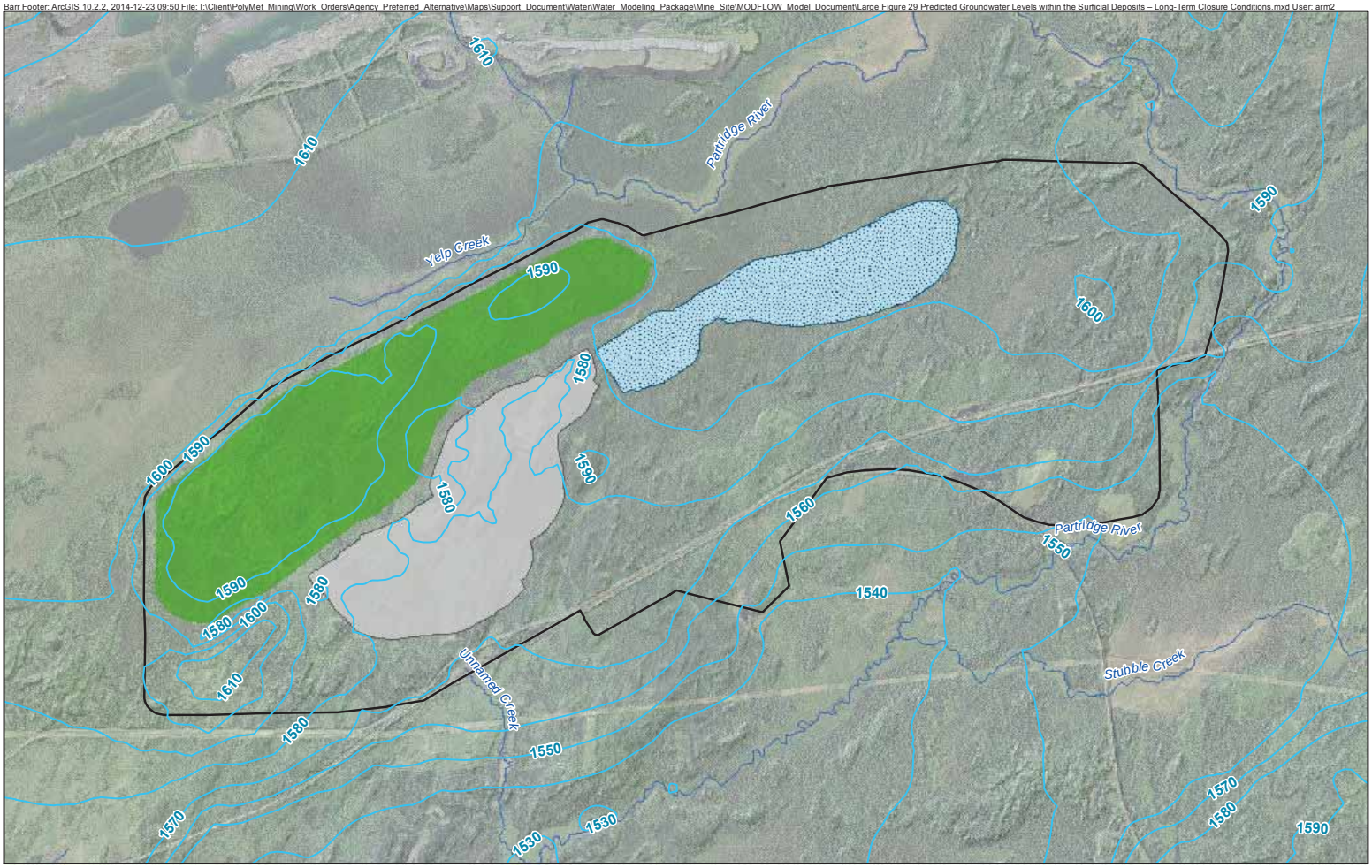
Pits - Mine Year 20

0 1,250 2,500 5,000

Feet

Large Figure 28
PREDICTED GROUNDWATER LEVELS
WITHIN THE BEDROCK – MINE YEAR 20
NorthMet Project
Poly Met Mining, Inc.

Barr Footer: ArcGIS 10.2.2, 2014-12-23 09:50 File: I:\Client\PolyMet_Mining\Work_Orders\Agency_Preferred_Alternative\Maps\Support_Document\Water\Water_Modeling_Package\Mine_Site\MODFLOW_Model_Document\Large Figure 29 Predicted Groundwater Levels within the Surficial Deposits – Long-Term Closure Conditions.mxd User: arm2

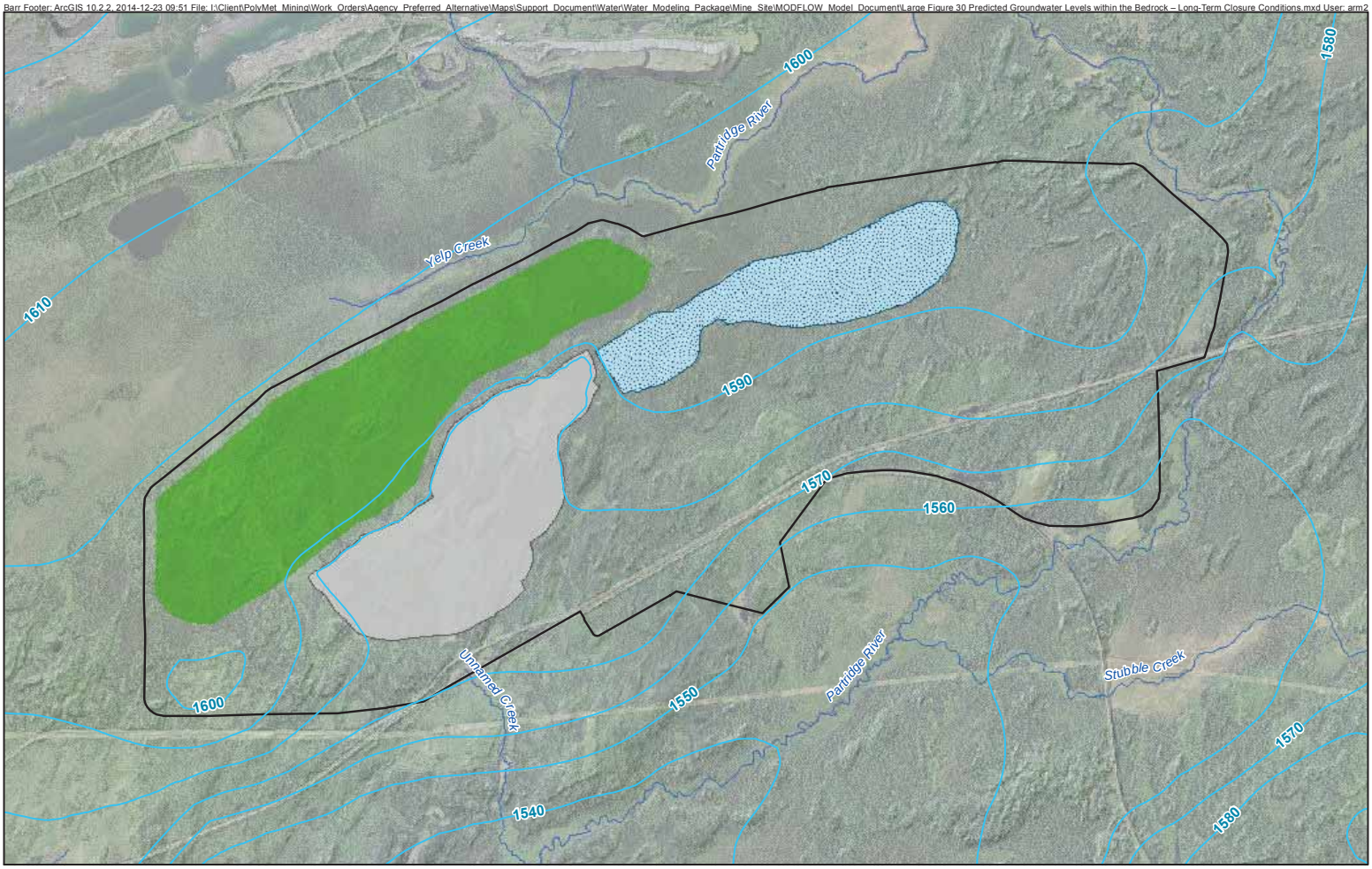


Simulated Water Table (feet)
Contour Interval = 10 feet
Project Areas
Covered Stockpile
West Pit
East Pit Wetland

0 1,250 2,500 5,000
Feet

Large Figure 29
PREDICTED GROUNDWATER LEVELS WITHIN THE SURFICIAL DEPOSITS – LONG-TERM CLOSURE CONDITIONS
NorthMet Project
Poly Met Mining, Inc.

Barr Footer: ArcGIS 10.2.2, 2014-12-23 09:51 File: I:\Client\PolyMet_Mining\Work_Orders\Agency_Preferred_Alternative\Maps\Support_Document\Water\Water_Modeling_Package\Mine_Site\MODFLOW_Model_Document\Large Figure 30 Predicted Groundwater Levels within the Bedrock – Long-Term Closure Conditions.mxd User: arm2



Simulated Piezometric Surface (feet)
Contour Interval = 10 feet
Project Areas
Covered Stockpile
West Pit
East Pit Wetland

0 1,250 2,500 5,000
Feet

Large Figure 30
PREDICTED GROUNDWATER LEVELS
WITHIN THE BEDROCK –
LONG-TERM CLOSURE CONDITIONS
NorthMet Project
Poly Met Mining, Inc.

Exhibit A

NorthMet Bedrock Groundwater Elevation Measurements Technical Memorandum

Barr Engineering Company
332 West Superior Street, Suite 600 • Duluth, MN 55802
Phone: 218-727-5218 • Fax: 218-727-6450 • www.barr.com *An EEO Employer*

Minneapolis, MN • Hibbing, MN • Duluth, MN • Ann Arbor, MI • Jefferson City, MO

Technical Memorandum

To: Project File
From: Jeré Mohr and Tina Pint
Subject: NorthMet Bedrock Groundwater Elevation Measurements
Date: January 11, 2006
Project: 23/69-862 007 02D

This memorandum summarizes field activities and data analysis conducted to evaluate groundwater elevations and flow direction at the NorthMet Mine Site (Site). These results will be used for calibration of the groundwater model for the Site.

Proposed groundwater elevation measurement locations were selected to provide relatively uniform coverage across the Site. Groundwater levels were measured on December 13-14, 2006. Due to access issues, final groundwater elevation measurement locations were selected in the field. A total of 31 water levels were measured. The majority of measurements (19) were taken from PolyMet 2005 exploratory drill hole locations, as these were the easiest locations to access and open. Two measurements were collected from 1970s US Steel drill holes. The remainder of the measurements (10) were taken from Barr wells, which were installed in 2005 as part of Phase II of the Hydrogeologic Investigation. Borehole locations and measuring point elevations were surveyed by Northern Lights Surveying and Mapping of Virginia, MN between December 18 and December 29, 2006. The survey was completed using a real-time kinematic GPS survey system. Elevation measurements were referenced to mean sea level (MSL) and x,y coordinates were provided in both UTM (Zone 15 North, NAD83) and State Plane coordinate systems. Depth to groundwater measurements taken in angled boreholes were corrected to vertical depths in order to calculate groundwater elevations at these locations. Measurement locations and groundwater elevations are summarized in Table 1.

In order to check the accuracy of the survey data, the x,y coordinates of each location were compared to x,y coordinates supplied by PolyMet. Apparently, two locations were surveyed incorrectly, as there are large discrepancies (>50 ft) between the surveyed location and the PolyMet provided location. These two locations were removed from Table 1 and are not shown on Figure 1. By comparing the surveyed

coordinates to the comprehensive list of borings provided by PolyMet, it believed that the location surveyed as 05-433M is actually 26128 and the location surveyed as 05-442N is actually 05-441. The surveyed ground surface elevations at each location were also compared to TIN elevation data provided by PolyMet. Except for the two locations mentioned previously, surveyed and estimated elevations appeared to generally coincide. As a final check, the casing stick up measured in the field at each location was compared to the stick up calculated using the survey data.

Groundwater elevation measurement locations and contoured groundwater elevations are shown in Figure 1. Groundwater elevations at 05-449N, 05-472N, 50-499N, 05-500Q, and 05-506H appeared to be anomalous and were not used for contouring. Groundwater appears to flow from northwest to southeast, which is generally consistent with the conceptual regional hydrogeologic model.

Table 1
Groundwater Elevations - December 13-14, 2006
PolyMet Mining, Inc.

Boring/Well	UTM Coordinates (m)		State Plane Coordinates (ft)		Dip (deg)	Borehole length (ft)	Vertical depth (ft)	Ground Elevation (ft)		Surveyed measuring point elevation (ft)	Measured distance to groundwater (ft)	Vertical depth to groundwater (ft)	Groundwater elevation (ft)	Comments
	x	y	x	y				Estimated from TIN	Surveyed					
26054	576265.1	5273526.7	2899614.0	735167.3	90	776	776.0	1598.2	1598.0	1600.32	6.04	6.04	1594.28	
26141	576169.1	5273296.6	2899299.7	734411.7	90	1585	1585.0	1592.4	1592.5	1595.12	2.37	2.37	1592.75	
05-405N	575952.8	5273409.7	2898589.4	734781.8	72	769	731.4	1606.8	1606.2	1607.29	1.40	1.33	1605.96	
05-414N	576265.1	5273331.4	2899614.7	734526.2	65	1438	1297.9	1592.5	1592.7	1593.64	12.10	10.92	1582.72	water level rising
05-424N	576571.1	5273641.3	2900617.4	735544.7	66	1087	992.3	1594.3	1593.6	1595.33	2.59	2.36	1592.97	
05-434N	576621.9	5273570.5	2900784.6	735312.5	65	729	662.8	1593.2	1592.6	1593.44	1.92	1.75	1591.69	
05-447G	577239.3	5274359.2	2902807.2	737903.5	46	499	359.0	1603.6	1605.3	1605.79	8.69	6.25	1599.54	water level rising
05-449N	578719.5	5274808.1	2907662.8	739383.2	64	1136	1016.2	1603.0	1601.7	1602.15	20.19	18.07	1584.08	
05-456Q	579027.4	5275016.7	2908672.1	740068.9	63	1169	1042.1	1598.9	1598.0	1599.47	2.00	1.78	1597.69	
05-472N	578578.1	5274808.2	2907198.6	739382.7	65	925	837.7	1603.9	1605.4	1606.42	8.11	7.34	1599.08	
05-473G	579026.5	5275122.8	2908668.8	740417.3	64	1059	954.2	1612.1	1609.4	1609.49	8.82	7.95	1601.54	
05-487N	578153.6	5274687.2	2905806.2	738983.7	65	906	821.3	1605.4	1604.6	1604.87	7.43	6.74	1598.13	
05-490N	577893.3	5274942.7	2904950.7	739821.4	45	218	154.1	1608.7	1609.5	1609.92	11.53	8.15	1601.77	
05-495N	578356.5	5274697.6	2906472.0	739018.9	66	1208	1100.1	1601.5	1599.8	1600.11	4.24	3.86	1596.25	
05-498N	576935.1	5274197.4	2901809.5	737371.3	66	598	544.2	1604.6	1610.7	1610.94	10.88	9.90	1601.04	
05-499N	576952.1	5273956.0	2901866.4	736579.0	65	908	821.6	1617.9	1620.7	1621.00	7.13	6.45	1614.55	
05-500Q	576775.7	5273922.2	2901287.7	736467.6	64	838	755.1	1614.7	1614.3	1614.64	7.86	7.08	1607.56	
05-505H	578331.7	5275068.9	2906388.8	740237.3	89	298	297.9	1608.4	1609.4	1609.62	7.41	7.41	1602.21	
05-506H	578420.4	5275083.1	2906680.0	740284.3	71	329	311.4	1617.5	1618.9	1619.23	10.98	10.39	1608.84	
OB-1	576938.8	5274551.3	2901820.1	738532.7	90	100	100.0	1610.2	1611.1	1613.21	12.60	12.60	1600.61	
OB-2	578216.3	5275040.0	2906010.4	740141.9	90	100	100.0	1609.0	1608.7	1610.70	8.75	8.75	1601.95	
OB-3	578710.1	5275261.2	2907629.7	740870.1	90	100	100.0	1615.9	1616.1	1617.85	10.47	10.47	1607.38	
OB-3A	578711.5	5275263.2	2907634.5	740876.5	90	50	50.0	1615.8	1615.8	1617.05	9.39	9.39	1607.66	
OB-4	578893.1	5275409.5	2908229.6	741357.3	90	100	100.0	1618.7	1619.5	1620.94	15.32	15.32	1605.62	
OB-5	579292.7	5275528.9	2909540.5	741750.9	90	100	100.0	1609.0	1609.3	1611.73	11.93	11.93	1599.80	
P-1	577016.0	5274605.2	2902073.2	738709.9	90	610	610.0	1614.1	1616.9	1617.79	16.53	16.53	1601.26	
P-2	578294.3	5275068.9	2906266.2	740237.3	90	610	610.0	1606.2	1606.3	1607.85	5.70	5.70	1602.15	
P-3	578730.5	5275289.7	2907696.7	740963.5	90	610	610.0	1615.4	1615.0	1619.57	11.86	11.86	1607.71	
P-4	579248.2	5275468.8	2909394.6	741553.5	90	485	485.0	1607.0	1608.2	1609.66	10.81	10.81	1598.85	

Ben Foster Date: 1/11/2007 8:30:49 AM File: I:\Client\PolymetMapsMxds_Site_GW_Model\Groundwater_contours.mxd User: JAM2

0 750 1,500
Feet

Groundwater elevation contour (ft MSL)
Contour interval = 2 ft

Groundwater elevation measurement used for contouring (ft MSL)

Groundwater elevation measurement not used for contouring (ft MSL)

Figure 1

GROUNDWATER ELEVATIONS
DECEMBER 13-14, 2006
PolyMet Mining Co.
Hoyt Lakes, MN

Attachment C

Input Variables for the Mine Site Model

Table 1-1 **Input Variables for the Mine Site Model**

Variable Name	*Units*	*Deterministic/ Uncertain*	*Sampling/ Calculation Frequency*	*Distribution*	*Mean or Mode*	*Standard Deviation*	*Minimum*	*Maximum*	*Description*	*Source of Input Data*	*Modeling Package Section*
Water Quality Standards											
Ground_Standards	[mg/L]	Deterministic	N/A	Constant	Vector by Constituent. Reference Table 1-2				Primary and secondary groundwater quality standards applicable to the project	MN Rules 7050 and 4717	Water Section 2.1 *MN GW Standards*
Surface_Standards	[mg/L]	Deterministic	N/A	Constant	Vector by Constituent. Reference Table 1-3				Constant surface water quality standards applicable to the project	MN Rules 7050 and 7052	Water Section 2.2 *MN SW Standards*
Hardness_Coefficients	[--]	Deterministic	N/A	Constant	Vector by Constituent. Reference Table 1-4				Hardness-dependent surface water quality standards applicable to the project	MN Rules 7050 and 7052	Water Section 2.2 *MN SW Standards*
Wild_Rice_Sulfate	[mg/L]	Deterministic	N/A	Constant	10	N/A	N/A	N/A	Seasonal sulfate standard in wild rice waters	MN Rules 7050	Water Section 2.3 *Wild Rice Standard*
Wild_Rice_Locs	[--]	Deterministic	N/A	Constant	Vector by location. Reference Table 1-17				Locations where the wild rice standard applies	MPCA staff guidance	Water Section 2.3 *Wild Rice Standard*
Hardness_forStandard	[mg/L]	Deterministic	N/A	Constant	Vector by location. Reference Table 1-17				Hardness used to evaluate hardness-dependent standards, if other than modeled	MPCA staff guidance	Water Section 2.2 *MN SW Standards*
General Engineering Variables											
Closure_Year	[yr]	Deterministic	N/A	Constant	20	N/A	N/A	N/A	Year after mining when operations cease and closure begins	Project Description	Water Section 5.1 *Conceptual Model*
Ore_Processing_Rate	[tonm/day]	Deterministic	N/A	Constant	30,860	N/A	N/A	N/A	Mine rate of ore production and transfer to Plant Site	Project Description	Water Section 5.1 *Conceptual Model*
Ore_Storage_Time	[mon]	Uncertain	Realization	Uniform	N/A	N/A	1	6	Length of time that any unit of ore is stored in in-pit stockpiles	Assumed	Waste Section 10.6.3.1 *Ore Leaching Load*
Category 1 Waste Rock Stockpile Characteristics											
Cat1SP_Mass	[ton]	Deterministic	Timestep	Time Series	Imported from worksheet. Reference Table 1-5				Mass of waste rock in stockpile from Mine Plan	Rock/OB Management Plan	Water Section 5.1 *Conceptual Model*
Cat1SP_Bare_Geomem	[acre]	Deterministic	Timestep	Time Series	Imported from worksheet. Reference Table 1-5				Bare area of stockpile if geomembrane installed	AWMP Section 2 (pending)	AWMP Section 2 (pending)
Cat1SP_Reclaim_Geomem	[acre]	Deterministic	Timestep	Time Series	Imported from worksheet. Reference Table 1-5				Reclaimed area of stockpile if geomembrane installed, begins at end of mining	AWMP Section 2 (pending)	AWMP Section 2 (pending)
Cat1SP_RO_EP	[acre]	Deterministic	N/A	Constant	0	N/A	N/A	N/A	Area with runoff directed to the East Pit during pit flooding	XPSWMM Model GIS analysis	Water Section 5.1 *Conceptual Model*
Cat1SP_RO_WP	[acre]	Deterministic	N/A	Constant	279	N/A	N/A	N/A	Area with runoff directed to the West Pit during pit flooding	XPSWMM Model GIS analysis	Water Section 5.1 *Conceptual Model*
Cat1SP_Contain_EP	[acre]	Deterministic	N/A	Time Series	Imported from worksheet. Reference Table 1-5				Area with contained seepage that is directed to the East Pit	Rock/OB Management Plan	Water Section 6.1.3.1 *Active Waste Rock and Ore Stockpiles*
Cat1SP_Contain_WP_Extend	[acre]	Deterministic	N/A	Time Series	Imported from worksheet. Reference Table 1-5b				Area with contained seepage that is directed to the West Pit, extended to include entire footprint	AWMP Section 3 (pending)	AWMP Section 3 (pending)
Cat1SP_Sulfur	[%S]	Deterministic	N/A	Constant	0.063	N/A	N/A	N/A	Mass-weighted average sulfur content of stockpile	Block Model	Waste Section 4.3.2 *Sulfur Content*
Category 2/3 Waste Rock Stockpile Characteristics											
Cat23SP_Mass	[ton]	Deterministic	Timestep	Time Series	Imported from worksheet. Reference Table 1-6				Mass of waste rock in stockpile from Mine Plan	Rock/OB Management Plan	Water Section 5.1 *Conceptual Model*
Cat23SP_SatOB	[yd^3]	Deterministic	Timestep	Time Series	Imported from worksheet. Reference Table 1-6				Volume of saturated overburden in stockpile from Mine Plan	Rock/OB Management Plan	Water Section 5.1 *Conceptual Model*
Cat23SP_Bare	[acre]	Deterministic	Timestep	Time Series	Imported from worksheet. Reference Table 1-6				Bare area of stockpile from Mine Plan	Rock/OB Management Plan	Water Section 5.1 *Conceptual Model*
Cat23SP_Sulfur	[%S]	Deterministic	N/A	Constant	0.21	N/A	N/A	N/A	Mass-weighted average sulfur content of stockpile	Block Model	Waste Section 4.3.2 *Sulfur Content*

Table 1-1 **Input Variables for the Mine Site Model**

Variable Name	*Units*	*Deterministic/ Uncertain*	*Sampling/ Calculation Frequency*	*Distribution*	*Mean or Mode*	*Standard Deviation*	*Minimum*	*Maximum*	*Description*	*Source of Input Data*	*Modeling Package Section*
Category 4 Waste Rock Stockpile Characteristics											
Cat4SP_MassDC	[ton]	Deterministic	Timestep	Time Series	Imported from worksheet. Reference Table 1-7				Mass of Duluth Complex waste rock in stockpile from Mine Plan	Rock/OB Management Plan	Water Section 5.1 *Conceptual Model*
Cat4SP_MassVF	[ton]	Deterministic	Timestep	Time Series	Imported from worksheet. Reference Table 1-7				Mass of Virginia Formation waste rock in stockpile from Mine Plan	Rock/OB Management Plan	Water Section 5.1 *Conceptual Model*
Cat4SP_SatOB	[yd^3]	Deterministic	Timestep	Time Series	Imported from worksheet. Reference Table 1-7				Volume of saturated overburden in stockpile from Mine Plan	Rock/OB Management Plan	Water Section 5.1 *Conceptual Model*
Cat4SP_Bare	[acre]	Deterministic	Timestep	Time Series	Imported from worksheet. Reference Table 1-7				Bare area of stockpile from Mine Plan	Rock/OB Management Plan	Water Section 5.1 *Conceptual Model*
Ore Surge Pile											
OSP_Mass	[ton]	Deterministic	Timestep	Time Series	Imported from worksheet. Reference Table 1-8				Mass in the OSP from Mine Plan	Rock/OB Management Plan	Water Section 5.1 *Conceptual Model*
OSP_Bare	[acre]	Deterministic	Timestep	Time Series	Imported from worksheet. Reference Table 1-8				Bare area of the OSP from Mine Plan	Rock/OB Management Plan	Water Section 5.1 *Conceptual Model*
OSP_Sulfur	[%S]	Deterministic	N/A	Constant	0.608	N/A	N/A	N/A	Mass-weighted average sulfur content of stockpile	Block Model	Waste Section 4.3.2 *Sulfur Content*
Overburden Storage and Laydown Area Characteristics											
UnsatOB_Bare	[acre]	Deterministic	Timestep	Constant	22.4	N/A	N/A	N/A	Area of unsaturated overburden in the OSLA, assumed to be half of the total area	Rock/OB Management Plan	Water Section 5.1 *Conceptual Model*
Peat_Bare	[acre]	Deterministic	Timestep	Constant	22.4	N/A	N/A	N/A	Area of peat in the OSLA, assumed to be half of the total area	Rock/OB Management Plan	Water Section 5.1 *Conceptual Model*
East Pit Characteristics											
EP_Elev_to_Volume	[ft^3]	Deterministic	N/A	Lookup	Imported from worksheet. Reference Figure 1-1				Volume of final pit shell as a function of elevation	Mine Plan	Water Section 5.1 *Conceptual Model*
EP_Volume_to_Elev	[ft]	Deterministic	N/A	Lookup	Imported from worksheet. Reference Figure 1-1				Water surface elevation as a function of volume of final pit shell (inverse of Elev_to_Volume)	Mine Plan	Water Section 5.1 *Conceptual Model*
EP_Elev_to_PlanArea	[ft^2]	Deterministic	N/A	Lookup	Imported from worksheet. Reference Figure 1-2				Plan view area of final pit shell as a function of elevation	Mine Plan	Water Section 5.1 *Conceptual Model*
EP_Footprint_Area	[acre]	Deterministic	N/A	Constant	154.7	N/A	N/A	N/A	Area contributing runoff during operations	Mine Plan	Water Section 5.1 *Conceptual Model*
EP_Min_Elev	[ft]	Deterministic	N/A	Constant	920	N/A	N/A	N/A	Minimum elevation in the East Pit	Mine Plan	Water Section 5.1 *Conceptual Model*
EP_Water_Limit_Elev	[ft]	Deterministic	N/A	Constant	1260	N/A	N/A	N/A	Limiting elevation for backfill flooding in the EP during CP mining	Mine Plan	Water Section 5.1 *Conceptual Model*
EP_BlastOre_Mass	[ton]	Deterministic	Timestep	Time Series	Imported from worksheet. Reference Table 1-9				Blasted inventory of ore in pit awaiting removal	Mine Plan	Water Section 5.1 *Conceptual Model*
Central Pit Characteristics											
CP_Elev_to_Volume	[ft^3]	Deterministic	N/A	Lookup	Imported from worksheet. Reference Figure 1-1				Volume of final pit shell as a function of elevation	Mine Plan	Water Section 5.1 *Conceptual Model*
CP_Volume_to_Elev	[ft]	Deterministic	N/A	Lookup	Imported from worksheet. Reference Figure 1-1				Water surface elevation as a function of volume of final pit shell (inverse of Elev_to_Volume)	Mine Plan	Water Section 5.1 *Conceptual Model*
CP_Elev_to_PlanArea	[ft^2]	Deterministic	N/A	Lookup	Imported from worksheet. Reference Figure 1-2				Plan view area of final pit shell as a function of elevation	Mine Plan	Water Section 5.1 *Conceptual Model*
CP_Footprint_Area	[acre]	Deterministic	N/A	Constant	51.9	N/A	N/A	N/A	Area contributing runoff during operations, only applies after CP_Mine_Start	Mine Plan	Water Section 5.1 *Conceptual Model*
CP_Min_Elev	[ft]	Deterministic	N/A	Constant	1260	N/A	N/A	N/A	Minimum elevation in the Central Pit	Mine Plan	Water Section 5.1 *Conceptual Model*
CP_Max_Elev	[ft]	Deterministic	N/A	Constant	1420	N/A	N/A	N/A	Maximum elevation of the pit, point where EP/CP combine	Mine Plan	Water Section 5.1 *Conceptual Model*
CP_Mine_Start	[yr]	Deterministic	N/A	Constant	10.75	N/A	N/A	N/A	Mine year that mining in the Central Pit begins	Mine Plan	Water Section 5.1 *Conceptual Model*
CP_Mine_End	[yr]	Deterministic	N/A	Constant	15.25	N/A	N/A	N/A	Mine year that mining in the Central Pit is complete	Mine Plan	Water Section 5.1 *Conceptual Model*

Table 1-1 **Input Variables for the Mine Site Model**

Variable Name	*Units*	*Deterministic/ Uncertain*	*Sampling/ Calculation Frequency*	*Distribution*	*Mean or Mode*	*Standard Deviation*	*Minimum*	*Maximum*	*Description*	*Source of Input Data*	*Modeling Package Section*
Combined East/Central Pit Characteristics											
EPCP_Elev_to_Volume	[ft^3]	Deterministic	N/A	Lookup	Imported from worksheet. Reference Figure 1-1				Volume of final pit shell as a function of elevation	Mine Plan	Water Section 5.1 *Conceptual Model*
EPCP_Volume_to_Elev	[ft]	Deterministic	N/A	Lookup	Imported from worksheet. Reference Figure 1-1				Water surface elevation as a function of volume of final pit shell (inverse of Elev_to_Volume)	Mine Plan	Water Section 5.1 *Conceptual Model*
EPCP_Elev_to_PlanArea	[ft^2]	Deterministic	N/A	Lookup	Imported from worksheet. Reference Figure 1-2				Plan view area of final pit shell as a function of elevation	Mine Plan	Water Section 5.1 *Conceptual Model*
EPCP_Sump_Area	[ft^2]	Deterministic	N/A	Constant	1,000	N/A	N/A	N/A	Water surface area in the sump	Assumed value	Water Section 6.1.3.3 *Water Balance, Mine Pits*
EPCP_Sump_Volume	[ft^3]	Deterministic	N/A	Constant	10,000	N/A	N/A	N/A	Volume of the sump, assumed to be always full	Assumed value	Water Section 6.1.3.3 *Water Balance, Mine Pits*
EPCP_Elev_to_WallFrac	[%]	Deterministic	N/A	Lookup	Vector by category, imported from worksheet. Reference Figure 1-3a				Fraction of each rock category in wall rock in final pit shell as a function of elevation	Mine Plan	Water Section 5.1 *Conceptual Model*, Waste Section 4.3.2 *Sulfur Content*
EPCP_Elev_to_WallArea	[ft^2]	Deterministic	N/A	Lookup	Imported from worksheet. Reference Figure 1-4				Plan view area of wall rock in final pit shell as a function of elevation	Mine Plan	Water Section 5.1 *Conceptual Model*, Waste Section 4.3.2 *Sulfur Content*
EPCP_Elev_to_SetBackArea	[ft^2]	Deterministic	N/A	Lookup	Imported from worksheet. Reference Figure 1-4				Plan view area of pit rim set back above final pit shell as a function of elevation	Mine Plan	Water Section 5.1 *Conceptual Model*, Waste Section 4.3.2 *Sulfur Content*
EPCP_SetBack_Elev	[ft]	Deterministic	N/A	Constant	1574	N/A	N/A	N/A	Lowest elevation of the pit rim set back	Mine Plan	Water Section 5.1 *Conceptual Model*, Waste Section 4.3.2 *Sulfur Content*
EPCP_Elev_to_Sulfur	[%]	Deterministic	N/A	Lookup	Vector by category, imported from worksheet. Reference Figures 1-5, 1-6 and 1-7				Area-weighted average wall rock sulfur content in final pit shell as a function of elevation	Mine Plan	Waste Section 4.3.2 *Sulfur Content*
EPCP_Direct_Mass	[ton]	Deterministic	Timestep	Time Series	Vector by category, imported from worksheet. Reference Table 1-10				Mass of waste rock direct from West Pit to East Pit in Mine Plan	Rock/OB Management Plan	Water Section 5.1 *Conceptual Model*
EPCP_Max_Mass	[ton]	Deterministic	N/A	Constant	140,191,500	N/A	N/A	N/A	Maximum tonnage of backfill rock in the East Pit	Rock/OB Management Plan	Water Section 5.1 *Conceptual Model*
EPCP_Total_Mass	[ton]	Deterministic	N/A	Time Series	Imported from worksheet. Reference Table 1-10b				Mass of total backfill to East Pit in Mine Plan (all rock types together, no overburden)	Rock/OB Management Plan	Water Section 5.1 *Conceptual Model*
EPCP_Max_OBVol	[yd^3]	Deterministic	N/A	Constant	4,498,100	N/A	N/A	N/A	Maximum volume of backfill saturated OB in the East Pit	Rock/OB Management Plan	Water Section 5.1 *Conceptual Model*
EPCP_Total_OBVol	[yd^3]	Deterministic	N/A	Time Series	Imported from worksheet. Reference Table 1-10b				Volume of total saturated OB backfill to East Pit in Mine Plan	Rock/OB Management Plan	Water Section 5.1 *Conceptual Model*
EPCP_Backfill_Margin	[ft]	Deterministic	N/A	Constant	5	N/A	N/A	N/A	Required minimum distance between the top of the waste rock and the water	Mine Plan	Waste Section 9.6.2 *Backfill Modeling Parameters*
EPCP_RO_Flooding	[acre]	Deterministic	N/A	Constant	83	N/A	N/A	N/A	Area contributing to runoff to the East Pit during West Pit flooding	XPSWMM Model GIS analysis	Water Section 6.1.3.3 *Water Balance, Mine Pits*
EPCP_RO_PostClos	[acre]	Deterministic	N/A	Constant	83	N/A	N/A	N/A	Area contributing to runoff to the East Pit in post-closure	XPSWMM Model GIS analysis	Water Section 6.1.3.3 *Water Balance, Mine Pits*
EPCP_Outlet_Elev	[ft]	Deterministic	N/A	Constant	1592	N/A	N/A	N/A	Elevation at the constructed outlet structure	Mine Plan	Water Section 5.1 *Conceptual Model*
EPCP_Outlet_Length	[ft]	Deterministic	N/A	Constant	20	N/A	N/A	N/A	Length of the constructed outlet structure weir	Mine Plan	Water Section 5.1 *Conceptual Model*
EPCP_Spill_Elev	[ft]	Deterministic	N/A	Constant	1594	N/A	N/A	N/A	Elevation at the pit rim low point	Mine Plan	Water Section 5.1 *Conceptual Model*

Table 1-1 **Input Variables for the Mine Site Model**

Variable Name	*Units*	*Deterministic/ Uncertain*	*Sampling/ Calculation Frequency*	*Distribution*	*Mean or Mode*	*Standard Deviation*	*Minimum*	*Maximum*	*Description*	*Source of Input Data*	*Modelling Package Section*
West Pit Characteristics											
WP_Elev_to_Volume	[ft^3]	Deterministic	N/A	Lookup	Imported from worksheet. Reference Figure 1-1				Volume of final pit shell as a function of elevation	Mine Plan	Water Section 5.1 *Conceptual Model*
WP_Volume_to_Elev	[ft]	Deterministic	N/A	Lookup	Imported from worksheet. Reference Figure 1-1				Water surface elevation as a function of volume of final pit shell (inverse of Elev_to_Volume)	Mine Plan	Water Section 5.1 *Conceptual Model*
WP_Elev_to_PlanArea	[ft^2]	Deterministic	N/A	Lookup	Imported from worksheet. Reference Figure 1-2				Plan view area of final pit shell as a function of elevation	Mine Plan	Water Section 5.1 *Conceptual Model*
WP_Footprint_Area	[acre]	Deterministic	N/A	Time Series	Imported from worksheet. Reference Table 1-9b				Area contributing runoff during operations	Mine Plan	Water Section 5.1 *Conceptual Model*
WP_Min_Elev	[ft]	Deterministic	N/A	Constant	940	N/A	N/A	N/A	Minimum elevation in the West Pit	Mine Plan	Water Section 5.1 *Conceptual Model*
WP_Outlet_Elev	[ft]	Deterministic	N/A	Constant	1573	N/A	N/A	N/A	Elevation at the constructed outlet structure	Design variable	Water Section 5.5.2 *West Pit Overflow*
WP_Spill_Elev	[ft]	Deterministic	N/A	Constant	1579	N/A	N/A	N/A	Elevation at the pit rim low point	Mine Plan	Water Section 5.1 *Conceptual Model*
WP_Sump_Area	[ft^2]	Deterministic	N/A	Constant	1,000	N/A	N/A	N/A	Water surface area in the sump	Assumed value	Water Section 6.1.3.3 *Water Balance, Mine Pits*
WP_Sump_Volume	[ft^3]	Deterministic	N/A	Constant	10,000	N/A	N/A	N/A	Volume of the sump, assumed to be always full	Assumed value	Water Section 6.1.3.3 *Water Balance, Mine Pits*
WP_Elev_to_WallFrac	[%]	Deterministic	N/A	Lookup	Vector by category, imported from worksheet. Reference Figure 1-3b				Fraction of each rock category in wall rock in final pit shell as a function of elevation	Mine Plan	Water Section 5.1 *Conceptual Model*, Waste Section 4.3.2 *Sulfur Content*
WP_Elev_to_WallArea	[ft^2]	Deterministic	N/A	Lookup	Imported from worksheet. Reference Figure 1-4				Plan view area of wall rock in final pit shell as a function of elevation	Mine Plan	Water Section 5.1 *Conceptual Model*, Waste Section 4.3.2 *Sulfur Content*
WP_Elev_to_SetBackArea	[ft^2]	Deterministic	N/A	Lookup	Imported from worksheet. Reference Figure 1-4				Plan view area of pit rim set back above final pit shell as a function of elevation	Mine Plan	Water Section 5.1 *Conceptual Model*, Waste Section 4.3.2 *Sulfur Content*
WP_SetBack_Elev	[ft]	Deterministic	N/A	Constant	1544	N/A	N/A	N/A	Lowest elevation of the pit rim set back	Mine Plan	Water Section 5.1 *Conceptual Model*, Waste Section 4.3.2 *Sulfur Content*
WP_Elev_to_Sulfur	[%]	Deterministic	N/A	Lookup	Vector by category, imported from worksheet. Reference Figures 1-5, 1-6 and 1-7				Area-weighted average wall rock sulfur content in final pit shell as a function of elevation	Mine Plan	Waste Section 4.3.2 *Sulfur Content*
WP_BlastOre_Mass	[ton]	Deterministic	Timestep	Time Series	Imported from worksheet. Reference Table 1-9				Blasted inventory of ore in pit awaiting removal	Mine Plan	Water Section 5.1 *Conceptual Model*
WP_RO_Flooding	[acre]	Deterministic	N/A	Constant	291	N/A	N/A	N/A	Area contributing to runoff to the West Pit during pit flooding	XPSWMM Model GIS analysis	Water Section 6.1.3.3 *Water Balance, Mine Pits*
WP_RO_PostClos	[acre]	Deterministic	N/A	Constant	0	N/A	N/A	N/A	Area contributing to runoff to the West Pit in post-closure	XPSWMM Model GIS analysis	Water Section 6.1.3.3 *Water Balance, Mine Pits*

Table 1-1 **Input Variables for the Mine Site Model**

Variable Name	*Units*	*Deterministic/ Uncertain*	*Sampling/ Calculation Frequency*	*Distribution*	*Mean or Mode*	*Standard Deviation*	*Minimum*	*Maximum*	*Description*	*Source of Input Data*	*Modeling Package Section*
Waste Water Treatment Facility Characteristics											
WestPond_Area	[acre]	Deterministic	N/A	Constant	4.9	N/A	N/A	N/A	Liner area of the equalization pond receiving water from the Cat 1 stockpile, pit dewatering, and haul roads	Water Management Plan	Water Section 6.1.3.4 *Water Balance, Other Facilities*
EastPond_Area	[acre]	Deterministic	N/A	Constant	2.4	N/A	N/A	N/A	Liner area of the equalization pond receiving water from the other process water features	Water Management Plan	Water Section 6.1.3.4 *Water Balance, Other Facilities*
CPS_Pond_Area	[acre]	Deterministic	N/A	Constant	1.3	N/A	N/A	N/A	Liner area of the CPS pond	Water Management Plan	Water Section 6.1.3.4 *Water Balance, Other Facilities*
Pond_Leakage	[gal/ac/day]	Deterministic	N/A	Constant	5	N/A	N/A	N/A	Leakage from lined WWTF and CPS ponds when full (summer months)	Water Management Plan	Water Section 6.1.3.4 *Water Balance, Other Facilities*
Pump_Limit_EP	[gpm]	Deterministic	N/A	Constant	5,000	N/A	N/A	N/A	Highest pumping rate between the WWTF and East Pit allowed	Design variable, model results will determine appropriate design value (lower than shown)	Water Section 6.1.3.3 *Water Balance, Mine Pits*
Pump_Limit_CP	[gpm]	Deterministic	N/A	Constant	5,000	N/A	N/A	N/A	Highest pumping rate between the WWTF and Central Pit allowed	Design variable, model results will determine appropriate design value (lower than shown)	Water Section 6.1.3.3 *Water Balance, Mine Pits*
Pump_Limit_WP	[gpm]	Deterministic	N/A	Constant	5,000	N/A	N/A	N/A	Highest pumping rate between the WWTF and West Pit allowed	Design variable, model results will determine appropriate design value (lower than shown)	Water Section 6.1.3.3 *Water Balance, Mine Pits*
Reclam_Pump_Total	[gpm]	Deterministic	N/A	Constant	2,400	N/A	N/A	N/A	Total rate of treatment from East Pit and other higher-strength sources in reclamation	Design variable, may change due to model results	Water Section 6.1.3.3 *Water Balance, Mine Pits*
LongTerm_Pump_WP	[gpm]	Deterministic	N/A	Constant	600	N/A	N/A	N/A	Total rate of treatment and discharge from the West Pit	Design variable, may change due to model results	Water Section 6.1.3.3 *Water Balance, Mine Pits*
WWTF_Targets	[mg/L]	Deterministic	N/A	Constant	Vector by Constituent. Reference Table 1-34				Treatment effluent target concentrations	Water Management Plan	Water Section 6.1.3.4 *Water Balance, Other Facilities*
WWTF_Targets_Reclam	[mg/L]	Deterministic	N/A	Constant	Vector by Constituent. Reference Table 1-34				Treatment effluent target concentrations during pit treatment during reclamation	Water Management Plan	Water Section 6.1.3.4 *Water Balance, Other Facilities*
WWTF_Targets_LongTerm	[mg/L]	Deterministic	N/A	Constant	Vector by Constituent. Reference Table 1-34				Treatment effluent target concentrations during long-term treatment and discharge	Water Management Plan	Water Section 6.1.3.4 *Water Balance, Other Facilities*
RTH_Trib_Area	[acre]	Deterministic	N/A	Constant	1.65	N/A	N/A	N/A	Contributing area to the RTH pond for runoff calculation	Water Management Plan	Water Section 6.1.3.4 *Water Balance, Other Facilities*
RTH_Ore_Depth	[ft]	Deterministic	N/A	Constant	1.0	N/A	N/A	N/A	Depth of spilled fine ore material on RTH	Water Management Plan	Water Section 6.1.3.4 *Water Balance, Other Facilities*
HR_Trib_Area	[acre]	Deterministic	N/A	Constant	72.4	N/A	N/A	N/A	Contributing area to the Haul Road ponds for runoff calculation	Water Management Plan	Water Section 6.1.3.4 *Water Balance, Other Facilities*
HR_Cat1_Depth	[ft]	Deterministic	N/A	Constant	1.0	N/A	N/A	N/A	Depth of crushed fine Category 1 waste rock material on haul roads	Water Management Plan	Water Section 6.1.3.4 *Water Balance, Other Facilities*
Concentrate_toWWTF_Flow	[gpm]	Uncertain	Month	Trunc. Normal	Imported from worksheet. Reference Table 1-38		0	1.00E+10	Brine returned from the Plant Site to the chemical precipitation plant	Water Management Plan	Water Section 6.1.3.4 Water Balance, Other Facilities
Concentrate_toWWTF_Conc	[mg/L]	Uncertain	Month	Trunc. Normal	Vector by Constituent. Reference Table 1-39 & 1-40		0	1.00E+10	Water quality of brine returned from the Plant Site to the chemical precipitation plant	Water Management Plan	Water Section 6.1.3.4 Water Balance, Other Facilities
Sludge_Water_Out	[gpm]	Deterministic	N/A	Constant	5	N/A	0	0	Water lost from the WWTF system in the dewatered sludge	Water Management Plan	Water Section 6.1.3.4 Water Balance, Other Facilities
EP_Return_Deficit	[gpm]	Deterministic	N/A	Constant	100	N/A	0	0	Flow not returned to East Pit in order to maintain an inward GW gradient	Water Management Plan	Water Section 6.1.3.4 Water Balance, Other Facilities
Retentate_Reclam	[%]	Deterministic	N/A	Constant	20%	N/A	0	0	Portion of inflows to the higher-concentration UF/NF line that is further treated in the chemical precipitation	Water Management Plan	Water Section 6.1.3.4 Water Balance, Other Facilities
Concentrate_LongTerm	[%]	Deterministic	N/A	Constant	5%	N/A	0	0	Portion of inflows to the RO line that is lost to evaporation or removal from site	Water Management Plan	Water Section 6.1.3.4 Water Balance, Other Facilities

Table 1-1 **Input Variables for the Mine Site Model**

Variable Name	*Units*	*Deterministic/ Uncertain*	*Sampling/ Calculation Frequency*	*Distribution*	*Mean or Mode*	*Standard Deviation*	*Minimum*	*Maximum*	*Description*	*Source of Input Data*	*Modeling Package Section*
Climatic Variables											
Annual_Precip_Cuberoot	$[in^{1/3}]$	Uncertain	Annual	Trunc. Normal	3.05	0.16	0	N/A	Cube root of the annual precipitation	HiDen Climate network for Mine Site (1980-2010 climate normal)	Water Section 5.2.1 *Climate Inputs*
Monthly_Precip_Factors	[%]	Deterministic	N/A	Constant	Vector by month. Reference Table 1-11				Factors for partitioning annual precipitation to monthly	HiDen Climate network for Mine Site (1980-2010 climate normal)	Water Section 5.2.1 *Climate Inputs*
Annual_Evap	[in/yr]	Uncertain	Annual	Normal	20.8	1.33	N/A	N/A	Annual evaporation from open water	HiDen Climate network for Mine Site (1980-2010 climate normal); Baker (1979)	Water Section 5.2.1 *Climate Inputs*
Monthly_Evap_Factors	[%]	Deterministic	N/A	Constant	Vector by month. Reference Table 1-11				Factors for partitioning annual open water evaporation to monthly	Baker (1979) for partitioning ratios	Water Section 5.2.1 *Climate Inputs*
SnowmeIt	[--]	Deterministic	N/A	Constant	4	N/A	N/A	N/A	Month when snowmeIt occurs	USGS Gage Data	Water Section 6.1.3.3 *Water Balance, Mine Pits*
Freezeup	[--]	Deterministic	N/A	Constant	11	N/A	N/A	N/A	Month when freezeup occurs, consistent with WWTF design team definition	USGS Gage Data	Water Section 6.1.3.3 *Water Balance, Mine Pits*
Background Chemistry											
GW_Conc_Surf	[mg/L]	Uncertain	Realization	Transformed Normal	Vector by Constituent. Reference Table 1-12				Surficial groundwater concentrations in the Partridge River watershed	Analysis of PolyMet background water quality data	Water Section 5.3.1 *Background Groundwater*
GW_Conc_Bed	[mg/L]	Uncertain	Realization	Transformed Normal	Vector by Constituent. Reference Table 1-12				Bedrock groundwater concentrations in the Partridge River watershed	Analysis of PolyMet background water quality data	Water Section 5.3.1 *Background Groundwater*
SW_Conc_RO	[mg/L]	Uncertain	Month	Lognormal	Vector by Constituent. Reference Table 1-13				Calibrated surface runoff concentrations in the Partridge River watershed	Calibration of model to baseline conditions	Water Section 5.3.1 *Background Surface Runoff*
SW_Conc_PMP	[mg/L]	Deterministic	N/A	Constant	Vector by Constituent. Reference Table 1-13				Concentration leaving the Peter Mitchell Pits	2004-2007 WQ modeling at SW-001	Water Section 5.5.3.1 *Other (Non-Project) Loads*
Flow_PMP	[cfs]	Deterministic	N/A	Constant	2.6	N/A	N/A	N/A	Flow from Peter Mitchell Pit dewatering to SW-001	Calibration of model to baseline conditions	Water Section 5.5.3.1 *Other (Non-Project) Loads*
Flow_PMP_end	[yr]	Deterministic	N/A	Constant	55	N/A	N/A	N/A	Mine Year when flow from Peter Mitchell Pit ends, equivalent to year 2070	Northshore Mine Plan	Water Section 5.5.3.1 *Other (Non-Project) Loads*
SW_Conc_Partridge	[mg/L]	Deterministic	N/A	Constant	Matrix by Constituent and location. Reference Table 1-14				Baseline existing chemistry in Partridge River used to evaluate model	2004-2010 Monitoring Data of Partridge River	Water Section 4.4.4.1 *Water Quality ,Partridge River*
Load_Colby	[kg/yr]	Deterministic	N/A	Constant	Vector by Constituent. Reference Table 1-13				Calibrated additional loading to Colby Lake	Calibration of model to baseline conditions	Water Section 5.5.3.1 *Other (Non-Project) Loads*
Groundwater Flowpath Characteristics											
I_ops	[--]	Uncertain	Realization	Uniform	Vector by flowpath. Reference Table 1-15				Average hydraulic gradient along aquifer	Mine Site MODFLOW model	Water Section 5.4.1 *Groundwater Flowpath Modeling*
I_close	[--]	Uncertain	Realization	Uniform	Vector by flowpath. Reference Table 1-15				Average hydraulic gradient along aquifer in closure	Mine Site MODFLOW model	Water Section 5.4.1 *Groundwater Flowpath Modeling*
Thick	[m]	Deterministic	N/A	Constant	Vector by flowpath. Reference Table 1-15				Aquifer thickness	Assumed value	Water Section 5.4.1 *Groundwater Flowpath Modeling*
EL_Pit	[ft]	Deterministic	N/A	Constant	Vector by flowpath. Reference Table 1-15				Pit surficial outflow elevation	GIS data/calculations	Water Section 5.4.1 *Groundwater Flowpath Modeling*
Width	[m]	Deterministic	N/A	Constant	Vector by flowpath. Reference Table 1-15				Flowpath width	GIS data/calculations	Water Section 5.4.1 *Groundwater Flowpath Modeling*
L_Upstream	[m]	Deterministic	N/A	Constant	Vector by flowpath. Reference Table 1-15				Length upstream of stockpile	GIS data/calculations	Water Section 5.4.1 *Groundwater Flowpath Modeling*
L_Stock	[m]	Deterministic	N/A	Constant	Vector by flowpath. Reference Table 1-15				Source (stockpile) length	GIS data/calculations	Water Section 5.4.1 *Groundwater Flowpath Modeling*
L_Eval_1	[m]	Deterministic	N/A	Constant	Vector by flowpath. Reference Table 1-15				Length to Evaluation Point #1	GIS data/calculations	Water Section 5.4.1 *Groundwater Flowpath Modeling*
L_Eval_2	[m]	Deterministic	N/A	Constant	Vector by flowpath. Reference Table 1-15				Length to Evaluation Point #2	GIS data/calculations	Water Section 5.4.1 *Groundwater Flowpath Modeling*
L_Eval_3	[m]	Deterministic	N/A	Constant	Vector by flowpath. Reference Table 1-15				Length to Evaluation Point #3	GIS data/calculations	Water Section 5.4.1 *Groundwater Flowpath Modeling*
L_Total	[m]	Deterministic	N/A	Constant	Vector by flowpath. Reference Table 1-15				Total flowpath length	GIS data/calculations	Water Section 5.4.1 *Groundwater Flowpath Modeling*

Table 1-1 **Input Variables for the Mine Site Model**

Variable Name	*Units*	*Deterministic/ Uncertain*	*Sampling/ Calculation Frequency*	*Distribution*	*Mean or Mode*	*Standard Deviation*	*Minimum*	*Maximum*	*Description*	*Source of Input Data*	*Modeling Package Section*
Groundwater Flow Variables											
Bedrock_Porosity	[--]	Deterministic	N/A	Constant	0.05	N/A	N/A	N/A	Porosity of the bedrock flowpaths	Mine Site MODFLOW model (Bedrock units)	Water Section 5.4.1 *Groundwater Flowpath Modeling*
Surficial_Porosity	[--]	Deterministic	N/A	Constant	0.3	N/A	N/A	N/A	Porosity of the surficial flowpaths	Assumed value, e.g. Fetter, 2001	Water Section 5.4.1 *Groundwater Flowpath Modeling*
K_Flowpath	[m/d]	Uncertain	Realization	Triangular	Vector by flowpath. Reference Table 1-15				Hydraulic conductivity of the surficial and bedrock material	Mine Site MODFLOW model (Duluth Complex), constraints discussed in Water Section 5.4.1	Water Section 5.4.4 *Groundwater Transport in GoldSim*
Recharge_min	[in/yr]	Deterministic	N/A	Constant	0.36	N/A	N/A	N/A	Minimum allowed recharge in surficial aquifer (for checking calculated value)	Mine Site MODFLOW model	Water Section 5.4.1 *Groundwater Flowpath Modeling*
Recharge_max	[in/yr]	Deterministic	N/A	Constant	1.8	N/A	N/A	N/A	Maximum allowed recharge in surficial aquifer (for checking calculated value)	Mine Site MODFLOW model	Water Section 5.4.1 *Groundwater Flowpath Modeling*
Surficial_Density	[kg/m3]	Deterministic	N/A	Constant	1,500	N/A	N/A	N/A	Dry (bulk) Density of the surficial deposits	USDA St. Louis County Soil Survey Database	Water Section 5.4.1 *Groundwater Flowpath Modeling*
Kd_Surficial	[L/kg]	Deterministic	N/A	Constant	Vector by Constituent. Reference Table 1-16				Sorption coefficients for the surficial aquifer (As, Sb, Cu, Ni)	EPA screening-level values	Water Section 5.4.3 *Sorption*
Stream Reach Characteristics											
Segment_Area	[m^2]	Deterministic	N/A	Constant	Vector by location. Reference Table 1-17				Cross sectional area of each segment upstream of each node	RS26 geomorphic surveys	Water Section 5.5 *Surface Water Modeling*
Segment_Length	[m]	Deterministic	N/A	Constant	Vector by location. Reference Table 1-17				Length of river upstream of each node	GIS data	Water Section 5.5 *Surface Water Modeling*
Colby_Volume	[acre-ft]	Deterministic	N/A	Constant	5,300	N/A	N/A	N/A	Colby Lake storage volume from RS73B	DNR bathymetric maps (summarized in RS73B)	Water Section 6.1.5 *Water Balance, Colby Lake*
Contributing_Area	[acre]	Deterministic	N/A	Time Series	Matrix by location and year. Reference Table 1-18				Contributing watershed area to each river node (incremental), used to calculate recharge	XPSWMM Model GIS analysis	Water Section 5.6.4 *Modeling Future Conditions*
Stream Flow Variables											
Streamflow_SW006_(Month)	[cfs]	Uncertain	Timestep	User-defined	Imported from worksheet. Reference Table 1-19				Randomly sampled daily streamflow at SW-006 for each month	USGS gage data (corrected for PMP dewatering)	Water Section 5.6.5 *Developing Probabilistic Model Inputs*
Inc_Flow_Factor_(Month)	[--]	Deterministic	N/A	Time Series	Imported from worksheet. Reference Table 1-20a through 1-20l				Factor to multiply Q at SW006 to get the incremental inflow between nodes for each month	XP-SWMM model results (relative differences)	Water Section 5.6.5 *Developing Probabilistic Model Inputs*
GW_Inc_Baseflow	[cfs]	Deterministic	N/A	Time Series	Imported from worksheet. Reference Table 1-21				Baseflow adding to evaluation points via natural groundwater	XP-SWMM model results scaled to observed baseflow at SW-006	Water Section 5.6.5 *Developing Probabilistic Model Inputs*

Table 1-1 **Input Variables for the Mine Site Model**

Variable Name	*Units*	*Deterministic/ Uncertain*	*Sampling/ Calculation Frequency*	*Distribution*	*Mean or Mode*	*Standard Deviation*	*Minimum*	*Maximum*	*Description*	*Source of Input Data*	*Modeling Package Section*
Stockpile Hydrology											
Bare_ET	[--]	Uncertain	Realization	Normal	0.524	0.020	N/A	N/A	ET from bare waste rock as a fraction of precipitation	Analysis of Amax test pile data (Eger and Lapakko, 1985)	Water Section 6.1.1 *Stockpile Hydrology Modeling*
Bare_RO	[--]	Deterministic	N/A	Constant	0	N/A	N/A	N/A	Runoff from bare portion of the stockpile as a fraction of precipitation	Assumed value	Water Section 6.1.1 *Stockpile Hydrology Modeling*
Reclaim_ET	[--]	Uncertain	Realization	Normal	0.704	0.023	N/A	N/A	ET from reclaimed waste rock as a fraction of precipitation	Analysis of Amax test pile data (Eger and Lapakko, 1985)	Water Section 6.1.1 *Stockpile Hydrology Modeling*
Reclaim_RO	[--]	Uncertain	Realization	Trunc. Normal	0.082	0.0027	0	N/A	Runoff from reclaimed waste rock as a fraction of precipitation	Analysis of Amax test pile data (Eger and Lapakko, 1985)	Water Section 6.1.1 *Stockpile Hydrology Modeling*
Cat1SP_Geomem_Perc	[--]	Uncertain	Realization	Lognormal	0.00527	0.00636	N/A	N/A	Percolation through membrane-covered stockpile as a fraction of precipitation	Range used in membrane cover modeling for DEIS	AWMP Section 2 (pending)
Cat1SP_Leak_WP	[%]	Deterministic	N/A	Constant	6%	N/A	N/A	N/A	Fraction of Cat 1 stockpile seepage water that bypasses the containment system to the West Pit	MODFLOW modeling of the stockpile	Water Section 6.1.3.1 *Active Waste Rock and Ore Stockpiles*
Cat1SP_Leak_EP	[%]	Deterministic	N/A	Time Series	Imported from worksheet. Reference Table 1-5				Fraction of Cat 1 stockpile seepage water that bypasses the containment system to the East Pit	MODFLOW modeling of the stockpile	Water Section 6.1.3.1 Active Waste Rock and Ore Stockpiles
Cat1SP_Leak_Bed	[%]	Deterministic	N/A	Time Series	Imported from worksheet. Reference Table 1-5				Fraction of Cat 1 stockpile seepage water that bypasses the containment system to bedrock	MODFLOW modeling of the stockpile	Water Section 6.1.3.1 Active Waste Rock and Ore Stockpiles
Mean_Bare_Infilt	[in/yr]	Deterministic	N/A	Constant	13.5	N/A	N/A	N/A	Infiltration for mean stockpile conditions (precip., ET, RO) for use as flowpath initial condition	Calculated from mean of other model parameters	Water Section 6.1.1 *Stockpile Hydrology Modeling*
Mean_Reclaim_Infilt	[in/yr]	Deterministic	N/A	Constant	6.1	N/A	N/A	N/A	Infiltration for mean stockpile conditions (precip., ET, RO) for use as flowpath initial condition	Calculated from mean of other model parameters	Water Section 6.1.1 *Stockpile Hydrology Modeling*
Liner_Leak_23	[--]	Uncertain	Realization	Lognormal	0.000302	0.000274	N/A	N/A	Fraction of water from the top of the liner that leaks (Cat 2/3 stockpile)	FOSM Analysis on HELP model results	Water Section 6.1.3 *Water Balance, Active Stockpiles*
Liner_Leak_4_OSP	[--]	Uncertain	Realization	Lognormal	0.000081	0.000073	N/A	N/A	Fraction of water from the top of the liner that leaks (Cat 4 and OSP)	FOSM Analysis on HELP model results	Water Section 6.1.3 *Water Balance, Active Stockpiles*
Pit Hydrology											
Wall_RO	[--]	Uncertain	Realization	Uniform	N/A	N/A	0.4	0.6	Runoff from bare pit walls as a fraction of precipitation	Best professional judgment (watershed avg ~40%)	Water Section 6.1.3.3 *Water Balance, Mine Pits*
Natural_RO_Winter	[--]	Uncertain	Annual	Trunc. Normal	0.63	0.275	0	N/A	Runoff (frozen period) from non-stockpile areas as a fraction of precipitation	Calculated from annual fraction and open-water seasonal fraction	Water Section 6.1.3.3 *Water Balance, Mine Pits*
Natural_RO_Summer	[--]	Uncertain	Annual	Trunc. Normal	0.30	0.092	0	N/A	Runoff (open water period) from non-stockpile areas as a fraction of precipitation	Average watershed yield from Partridge River (USGS gage)	Water Section 6.1.3.3 *Water Balance, Mine Pits*
Pit_GW_Uncertainty_unshift	[--]	Uncertain	Realization	Log-Normal	0.3	0.31	N/A	N/A	Uncertainty multiplier for the groundwater flow into the pits (un-shifted)	Best professional judgment	Water Section 6.1.3.3 *Water Balance, Mine Pits*
Pit_GW_Uncertainty_shift	[--]	Deterministic	N/A	Constant	0.7	N/A	N/A	N/A	Upward shift for uncertainty multiplier for the groundwater flow into the pits (shifted mean = 1.0)	Best professional judgment	Water Section 6.1.3.3 *Water Balance, Mine Pits*
WP_GW_Inflow	[gpm]	Deterministic	Timestep	Time Series/ Lookup	Imported from worksheet. Reference Table 1-22a and 1-22b				Groundwater inflow to the pit as a function of time or elevation	MODFLOW modeling	Water Section 5.4.5 *Groundwater Modeling, MODFLOW*
WP_GW_Surf	[%]	Deterministic	Timestep	Time Series/ Lookup	Imported from worksheet. Reference Table 1-22a and 1-22b				Surficial fraction of inflow to the pit as a function of elevation	MODFLOW modeling	Water Section 5.4.5 *Groundwater Modeling, MODFLOW*
EP_GW_Inflow	[gpm]	Deterministic	Timestep	Time Series/ Lookup	Imported from worksheet. Reference Table 1-22a and 1-22b				Groundwater inflow to the pit as a function of time or elevation	MODFLOW modeling	Water Section 5.4.5 *Groundwater Modeling, MODFLOW*
EP_GW_Surf	[%]	Deterministic	Timestep	Time Series/ Lookup	Imported from worksheet. Reference Table 1-22a and 1-22b				Surficial fraction of inflow to the pit as a function of elevation	MODFLOW modeling	Water Section 5.4.5 *Groundwater Modeling, MODFLOW*
CP_GW_Inflow	[gpm]	Deterministic	Timestep	Time Series/ Lookup	Imported from worksheet. Reference Table 1-22a and 1-22b				Groundwater inflow to the pit as a function of time or elevation	MODFLOW modeling	Water Section 5.4.5 *Groundwater Modeling, MODFLOW*
CP_GW_Surf	[%]	Deterministic	Timestep	Time Series/ Lookup	Imported from worksheet. Reference Table 1-22a and 1-22b				Surficial fraction of inflow to the pit as a function of elevation	MODFLOW modeling	Water Section 5.4.5 *Groundwater Modeling, MODFLOW*
CP_to_WP	[gpm]	Deterministic	N/A	Constant	0.1	N/A	N/A	N/A	Flow through bedrock from East Pit porewater to West Pit during pit filling (0 after West Pit is full)	MODFLOW modeling	Water Section 5.4.5 *Groundwater Modeling, MODFLOW*

Table 1-1 **Input Variables for the Mine Site Model**

Variable Name	*Units*	*Deterministic/ Uncertain*	*Sampling/ Calculation Frequency*	*Distribution*	*Mean or Mode*	*Standard Deviation*	*Minimum*	*Maximum*	*Description*	*Source of Input Data*	*Modeling Package Section*
Geochemical Parameters for Pollutant Release											
OB_Concs_Unsat	[mg/L]	Uncertain	Realization	Uniform	Vector by Constituent. Reference Table 1-23				Seepage concentrations from unsaturated OB storage areas	Analysis of overburden leach test data	Waste Section 7.1 *Leachate Water Quality, Unsaturated Overburden*
OB_Concs_Peat	[mg/L]	Uncertain	Realization	Uniform	Vector by Constituent. Reference Table 1-23				Seepage concentrations from peat storage areas	Analysis of overburden leach test data	Waste Section 7.1 *Leachate Water Quality, Peat*
Cat1_Release	[varies]	Uncertain	Realization	Varies	Vector by Constituent. Reference Table 1-24				Release rates and ratios for Category 1 waste rock	Analysis of HCT, Aqua Regia, and Microprobe data	Waste Section 8.1 *Laboratory Release Rates*
Cat23_Release	[varies]	Uncertain	Realization	Varies	Vector by Constituent. Reference Table 1-25				Release rates and ratios for Category 2/3 waste rock	Analysis of HCT, Aqua Regia, and Microprobe data	Waste Section 8.1 *Laboratory Release Rates*
Cat4DC_Release	[varies]	Uncertain	Realization	Varies	Vector by Constituent. Reference Table 1-26				Release rates and ratios for Duluth Complex Category 4 waste rock	Analysis of HCT, Aqua Regia, and Microprobe data	Waste Section 8.1 *Laboratory Release Rates*
Ore_Release	[varies]	Uncertain	Realization	Varies	Vector by Constituent. Reference Table 1-27				Release rates and ratios for ore in the OSP	Analysis of HCT, Aqua Regia, and Microprobe data	Waste Section 8.1 *Laboratory Release Rates*
Cat4VF_Release	[varies]	Uncertain	Realization	Varies	Vector by Constituent. Reference Table 1-28				Release rates and ratios for Virginia Formation Category 4 waste rock	Analysis of HCT, Aqua Regia, and Microprobe data	Waste Section 8.1 *Laboratory Release Rates*
Rock_Content_All	[mg/kg]	Deterministic	N/A	Constant	Matrix by Constituent and Rock Type. Reference Table 1-29				Content of constituents of concern in waste rock	Analysis of Aqua Regia data	Waste Section 8.4.1 *Depletion*
Cat1_ConcCaps	[mg/L]	Uncertain	Realization	Varies	Vector by Constituent. Reference Table 1-30				Concentration caps for Category 1 waste rock	Analysis of laboratory and analog site data	Waste Section 8.3 *Concentration caps*
Cat1_pH	[s.u.]	Uncertain	Realization	Uniform	N/A	N/A	7.0	7.5	Assumed distribution of porewater pH in the Category 1 stockpile	Geochemical modeling of Category 1 waste rock	Waste Section 8.3 *Concentration caps*
Cat234_pH	[s.u.]	Uncertain	Realization	Uniform	N/A	N/A	6.0	7.5	Assumed distribution of porewater pH in the nonacidic Category 2/3 and Category 4 rock	Assumed pH prior to onset of acidic conditions	Waste Section 8.3 *Concentration caps*
Cat234_nonacid_ConcCaps	[mg/L]	Uncertain	Realization	Varies	Vector by Constituent. Reference Table 1-31				Concentration caps for nonacidic Duluth Complex Category 2/3/4 waste rock and ore	Analysis of laboratory and analog site data	Waste Section 8.3 *Concentration caps*
Cat234_acid_ConcCaps	[mg/L]	Uncertain	Realization	Varies	Vector by Constituent. Reference Table 1-32				Concentration caps for acidic Duluth Complex Category 2/3/4 waste rock and ore	Analysis of laboratory and analog site data	Waste Section 8.3 *Concentration caps*
Cat4VF_ConcCaps	[mg/L]	Uncertain	Realization	Varies	Vector by Constituent. Reference Table 1-33				Concentration caps for acidic Virginia Formation Category 4 waste rock	Analysis of laboratory and analog site data	Waste Section 8.3 *Concentration caps*
Geochemical Parameters for Scaling											
Scale_Factor_MDNR	[--]	Uncertain	Year	Beta	0.128	0.085	0.019	0.687	Scaling factor for Category 1 stockpile	MDNR analysis of Dunka Mine data.	Waste Section 8.2.8 *Lab to Field Scale Up, Category 1 Waste Rock Stockpile*
Contact_Factor	[--]	Uncertain	Realization	Triangular	0.5	N/A	0.1	0.9	Fraction of waste rock contacted by water	Professional judgement	Waste Section 8.2 *Lab to Field Scale Up*
Size_Factor	[--]	Uncertain	Realization	Triangular	0.14	N/A	0.08	0.35	Scaling factor to adjust to field scale waste rock	Analysis of NorthMet and AMAX data	Waste Section 8.2 *Lab to Field Scale Up*
Field_Temp	[C]	Uncertain	Year	Normal	2.004	1.388	N/A	N/A	Stockpile or wall internal temperature, same as air temperature	HiDen Climate data for1981-2010	Waste Section 8.2 *Lab to Field Scale Up*
Field_Temp_Mean	[C]	Uncertain	Realization	Normal	2.004	0.2534	N/A	N/A	Average annual temperature, used for acid onset timing	HiDen Climate data for1981-2010	Waste Section 8.2 *Lab to Field Scale Up*
Lab_Temp	[C]	Deterministic	N/A	Constant	20	N/A	N/A	N/A	Laboratory temperature (known)	RS 53/42	Waste Section 8.2 *Lab to Field Scale Up*
Activation_Energy	[kJ/mol]	Uncertain	Realization	Uniform	N/A	N/A	47	63	Activation energy of pyrrhotite for the Arrhenius equation	Literature-reported range	Waste Section 8.2 *Lab to Field Scale Up*
Wall_Temp_Solar	[C]	Deterministic	N/A	Constant	1.5	N/A	N/A	N/A	Average temp. increase for portion of pit wall that has solar heating	Energy balance for pit wall face	Waste Section 9.3 *Lab to Field Scale Up*
Size_factor_walls	[--]	Uncertain	Realization	Uniform	N/A	N/A	0.05	0.15	Scaling factor to adjust to field scale wall rock	Professional judgement	Waste Section 9.3 *Lab to Field Scale Up*
Geochemical Parameters for Acidic Conditions and Decay											
Acid_Onset_Time_23	[yr]	Uncertain	Realization	Triangular	6.81	N/A	5.33	7.79	Time for Category 2/3 rock to go acidic in the laboratory	Analysis of DNR long-term reactor data	Waste Section 8.2 *Lab to Field Scale Up*
Acid_Onset_Time_4DC	[yr]	Uncertain	Realization	Triangular	5.41	N/A	4.97	6.81	Time for Duluth Complex Category 4 rock to go acidic in the laboratory	Analysis of DNR long-term reactor data	Waste Section 8.2 *Lab to Field Scale Up*
Acid_Factor_DC	[--]	Uncertain	Realization	Beta	8.20	7.48	1.01	32.36	Increase in sulfate release when Duluth Complex rock goes acidic **(correlation to a1 = -0.831)**	Analysis of DNR long-term reactor data and NorthMet humidity cells	Waste Section 8.2 *Lab to Field Scale Up*
Decay_a1	[--]	Uncertain	Realization	Uniform	N/A	N/A	-1.088	-0.087	Parameter to define shape of decay of sulfate release in wall rock **(correlated to acid factor and a0)**	Analysis of DNR long-term reactor data and NorthMet humidity cells	Waste Section 9.4 *Acidificatoin and Long-Term Decay*
Decay_a0	[--]	Uncertain	Realization	Uniform	N/A	N/A	1.60	3.48	Parameter to define shape of decay of sulfate release in wall rock **(correlation to a1 = -0.989)**	Analysis of DNR long-term reactor data and NorthMet humidity cells	Waste Section 9.4 *Acidificatoin and Long-Term Decay*

Table 1-1 **Input Variables for the Mine Site Model**

Variable Name	*Units*	*Deterministic/ Uncertain*	*Sampling/ Calculation Frequency*	*Distribution*	*Mean or Mode*	*Standard Deviation*	*Minimum*	*Maximum*	*Description*	*Source of Input Data*	*Modeling Package Section*
Geochemical Parameters for Pit Wall and Backfill											
Begin_Oxidizing_EP	[yr]	Deterministic	Realization	Constant	0	N/A	N/A	N/A	Average point in the mine life when rock walls begin oxidizing	Assumed	Waste Section 9.6.1 *Age of Pit Walls*
Begin_Oxidizing_WP	[yr]	Deterministic	Realization	Constant	0	N/A	N/A	N/A	Average point in the mine life when rock walls begin oxidizing	Assumed	Waste Section 9.6.1 *Age of Pit Walls*
SetBack_Depth_Fraction	[--]	Deterministic	N/A	Constant	0.1	N/A	N/A	N/A	Average depth of oxidizing bedrock in the upper unblasted bench, relative to the pit wall depths	Professional judgement	Waste Section 9.2 Mass of Reactive Wall Rock
Wall_Depth_DC	[m]	Uncertain	Realization	Triangular	2	N/A	1	3	Average depth of oxidizing Duluth Complex wall rock	Professional judgement	Waste Section 9.2 *Mass of Reactive Wall Rock*
Wall_Depth_VF	[m]	Uncertain	Realization	Triangular	4	N/A	2	6	Average depth of oxidizing Virginia Formation wall rock	Professional judgement	Waste Section 9.2 *Mass of Reactive Wall Rock*
South_Face_EP	[--]	Deterministic	N/A	Constant	0.5	N/A	N/A	N/A	Portion of pit wall that is south-facing and subject to solar heating	Assumed	Waste Section 9.3 *Lab to Field Scale Up*
South_Face_WP	[--]	Deterministic	N/A	Constant	0.5	N/A	N/A	N/A	Portion of pit wall that is south-facing and subject to solar heating	Assumed	Waste Section 9.3 *Lab to Field Scale Up*
WR_Swell	[--]	Deterministic	N/A	Constant	0.3	N/A	N/A	N/A	Swelling of the rock due to void spaces	Rock/OB Management Plan	Waste Section 9.6.2 *Backfill Modeling Parameters*
WR_Sp_Gravity	[--]	Deterministic	N/A	Constant	2.93	N/A	N/A	N/A	Specific gravity of the waste rock	Rock/OB Management Plan	Waste Section 9.6.2 *Backfill Modeling Parameters*
SatOB_Porosity	[--]	Deterministic	N/A	Constant	0.2	N/A	N/A	N/A	Porosity of the saturated overburden backfill	Rock/OB Management Plan	Waste Section 9.6.2 *Backfill Modeling Parameters*
SatOB_BulkDens	[ton/cy]	Deterministic	N/A	Constant	1.472	N/A	N/A	N/A	Compacted bulk density of the saturated overburden	Rock/OB Management Plan	Waste Section 9.6.2 *Backfill Modeling Parameters*
Parameters for Plant Site Water											
TB_toWP_Flow	[gpm]	Uncertain	Month	Trunc. Normal	Imported from worksheete. Reference Table 1-35		0	1.00E+10	Flow returned from the Plant Site to the West Pit in closure **(autocorrelation = 0.9)**	AWMP Section 7 (pending)	AWMP Section 7 (pending)
TB_toWP_Conc	[mg/L]	Uncertain	Month	Trunc. Normal	Vector by Constituent. Reference Table 1-36 & 1-37		0	1.00E+10	Water quality returned from the Plant Site to the West Pit in closure	AWMP Section 7 (pending)	AWMP Section 7 (pending)
TB_Stop_Elev	[ft]	Deterministic	N/A	Constant	1550	N/A	0	0	West Pit elevation that stops water transfer from the Plant Site to the West Pit	AWMP Section 7 (pending)	AWMP Section 7 (pending)
TB_Stop_Vol	[acre-ft]	Deterministic	N/A	Constant	50,000	N/A	0	0	Transferred water volume that stops water transfer from the Plant Site to the West Pit	AWMP Section 7 (pending)	AWMP Section 7 (pending)
Parameters for Model Stability											
Water_Depth	[in]	Deterministic	N/A	Constant	0.1	N/A	N/A	N/A	Average depth of water at the bottom of stockpile (for volume calculation)	Assumed, small value leads to less "memory" of previous timestep	
Tiny_Area	[acre]	Deterministic	N/A	Constant	0.001	N/A	N/A	N/A	Tiny area to prevent dividing by zero	Assumed	
Tiny_Mass	[kg]	Deterministic	N/A	Constant	0.001	N/A	N/A	N/A	Tiny mass to prevent dividing by zero	Assumed	
Tiny_Volume	[m^3]	Deterministic	N/A	Constant	0.001	N/A	N/A	N/A	Tiny volume to prevent dividing by zero	Assumed	

Table 1-2 Groundwater Quality Standards

Constituent	*[Ground_Standards.Primary] Primary Standard (mg/L)*	*[Ground_Standards.Secondary] Secondary Standard (mg/L)*
Ag*	0.03	0.1
Al†	--	0.2
Alk	--	--
As	0.01	--
B*	1	--
Ba	2	--
Be*	0.00008	--
Ca	--	--
Cd*	0.004	--
Cl	--	250
Co	--	--
Cr	0.1	--
Cu	--	--
F	4	2
Fe†	--	0.30
K	--	--
Mg	--	--
Mn*†	0.1	0.05
Na	--	--
Ni*	0.1	--
Pb	--	--
Sb	0.006	--
Se*	0.03	--
SO_4	--	250
Tl*	0.0006	--
V*	0.05	--
Zn*	2	5
Hardness	--	--

Notes

* Primary standard from MN Rules 4717 (HRLs); all other primary standards from MN Rules 7050 (EPA MCLs)

-- indicates no applicable standard

† Secondary standards presented for reference but not used for impact assessment

Table 1-3 Constant Surface Water Quality Standards

Constituent	*[Surface_Standards.Partridge] All Surface Waters except Colby Lake (mg/L)*	*[Surface_Standards.Colby] Colby Lake (mg/L)*
Ag	0.001	0.001
Al	0.125	0.125
Alk	--	--
As*	0.053	0.002
B	0.50	0.50
Ba	--	2
Be	--	0.004
Ca	--	--
Cd†	--	0.005
Cl	230	230
Co	0.005	0.0028
Cr*	0.011	0.011
Cu†	--	--
F	--	4
Fe	--	0.30
K	--	--
Mg	--	--
Mn	--	0.05
Na	--	--
Ni†	--	--
Pb†	--	--
Sb	0.031	0.0055
Se*	0.005	0.005
SO_4 (non-wild rice areas)	--	250
Tl	0.00056	0.00028
V	--	--
Zn†	--	--
Hardness	500	500

Notes

* From MN Rules 7052; all others from MN Rules 7050

† See Table 1-4 for hardness-based standards

-- indicates no applicable constant standard or hardness standard is limiting

Table 1-4 **Coefficients for Hardness-Dependent Surface Water Quality Standards**

	[Surface_Standards.Hardness_Coefficients]		
Constituent	*A*	*B*	**Value at 100 mg/L Hardness (mg/L)**
Cd*	0.7852	-2.715	0.0025
Cu*	0.8545	-1.702	0.0093
Ni*	0.846	0.0584	0.0522
Pb	1.273	-4.705	0.0032
Zn*	0.8473	0.884	0.1198

Notes

* From MN Rules 7052; all others from MN Rules 7050

$$Std\left(\frac{mg}{L}\right) = \frac{e^{A\cdot\ln\left(Hardness\left(\frac{mg}{L}\right)\right)+B}}{1000}$$

Table 1-5 Mine Plan Summary for the Category 1 Waste Rock Stockpile

Time (years)	*[Cat1SP_Mass] Stockpile Mass (short tons)*	*[Cat1SP_Bare _Geomem] Bare Area (acres)*	*[Cat1SP_Reclaim _Geomem] Reclaimed Area (acres)*	*[Cat1SP_Contain_EP] Containment Area to East Pit (acres)**	*[Cat1SP_Contain_WP_ Extend] Containment Area to West Pit (acres)**	*[Cat1SP_Leak_EP] Containment Leakage to East Pit (%)*	*[Cat1SP_Leak_Bed] Containment Leakage to Bedrock (%)*
0	0	212.7	0	132.3	80.4	0.0	0.0
1	18,707,500	212.7	0	132.3	80.4	0.2	0.2
2	33,724,200	212.7	0	132.3	80.4	0.4	0.4
3	49,863,200	294.9	0	150.7	144.2	0.6	0.6
4	62,659,900	377.1	0	155.8	221.3	0.8	0.8
5	74,401,200	459.3	0	168.9	290.4	1.0	1.0
6	91,243,400	515.4	0	185.6	329.8	1.2	1.2
7	101,648,400	515.4	0	185.6	329.8	1.4	1.4
8	118,588,200	515.4	0	185.6	329.8	1.6	1.6
9	131,144,400	515.4	0	185.6	329.8	1.8	1.8
10	144,118,600	515.4	0	185.6	329.8	2.0	2.0
11	154,299,000	515.4	0	185.6	329.8	1.8	1.8
12	165,072,100	515.4	0	0	515.4	1.6	1.6
13	167,922,100	515.4	0	0	515.4	1.4	1.4
21	167,922,100	0	525.9	0	525.9	0	0
2000	167,922,100	0	525.9	0	526	0	0

Notes

Based on PolyMet block model, GIS shapefile data, and Containment System modeling

* Area with seepage reporting toward the pits via the seepage containment system; may be pumped directly to WWTF or treated in PRB prior to entering pits

Table 1-6 Mine Plan Summary for the Category 2/3 Waste Rock Stockpile

Time (years)	*[Cat23SP_Mass] Duluth Complex Stockpile Mass (short tons)*	*[Cat23SP_SatOB] Saturated Overburden Stockpile Volume (cubic yards)*	*[Cat23SP_Bare] Bare Area (acres)*
0	0	203,000	62.1
1	5,238,800	346,300	62.1
2	9,671,600	489,600	62.1
3	13,968,700	632,900	117.8
4	17,624,300	776,200	117.8
5	20,039,300	919,500	117.8
6	24,388,300	1,151,600	171.1
7	26,954,300	1,383,700	171.1
8	31,286,500	1,615,800	171.1
9	35,946,700	1,847,900	171.1
10	40,017,200	2,080,000	171.1
11	44,021,100	2,312,100	171.1
12	38,281,600	2,023,100	171.1
13	32,542,100	1,734,100	171.1
14	26,802,500	1,445,100	171.1
15	21,063,000	1,156,000	142.6
16	15,323,500	867,000	114.1
17	9,584,000	578,000	85.6
18	3,844,400	289,000	57.1
19	0	0	28.6
20	0	0	0.0
2000	0	0	0.0

Notes

Based on PolyMet block model, overburden management, and GIS shapefile data

Overburden quantity based on 2010 LIDAR data for pit and stockpile stripping, 2009 data for other sources

Table 1-7 Mine Plan Summary for the Category 4 Waste Rock Stockpile

Time (years)	*[Cat4SP_MassDC] Duluth Complex Stockpile Mass (short tons)*	*[Cat4SP_MassVF] Virginia Formation Stockpile Mass (short tons)*	*[Cat4SP_SatOB] Saturated Overburden Stockpile Volume (cubic yards)*	*[Cat4SP_Bare] Bare Area (acres)*
0	0	0	140,500	28.9
1	34,900	1,454,300	273,100	28.9
2	38,400	2,213,300	405,700	28.9
3	152,200	3,227,200	538,300	52.9
4	218,500	3,988,400	670,900	52.9
5	218,500	4,430,300	803,500	52.9
6	268,700	5,045,700	1,033,900	52.9
7	352,900	5,510,500	1,264,300	52.9
8	451,500	5,522,500	1,494,800	52.9
9	572,800	5,534,800	1,725,200	52.9
10	631,600	5,552,800	1,955,600	52.9
10.5	649,000	5,557,800	2,186,000	52.9
11	0	0	0	0.0
12	0	0	0	0.0
2000	0	0	0	0.0

Notes

Based on PolyMet block model, overburden management, and GIS shapefile data

Overburden quantity based on 2010 LIDAR data for pit and stockpile stripping, 2009 data for other sources

Table 1-8 Mine Plan Summary for the Ore Surge Pile

Time (years)	*[OSP_Mass] Stockpile Mass (short tons)*	*[OSP_Bare] Bare Area (acres)*
0	0	28.3
1	970,000	28.3
2	1,940,000	28.3
3	2,910,000	28.3
4	3,880,000	28.3
5	4,400,000	28.3
10	4,400,000	28.3
11	3,650,000	28.3
12	2,900,000	28.3
13	2,150,000	28.3
14	1,400,000	28.3
18	1,400,000	28.3
19	700,000	28.3
20	0	28.3
21	0	0.0
2000	0	0

Notes

Based on PolyMet operational plan and GIS shapefile data

Table 1-9 Blasted Ore Inventory in the Mine Pits

Time (years)	*[EP_BlastOre_Mass] East Pit Blasted Ore Mass (short tons)*	*[WP_BlastOre_Mass] West Pit Blasted Ore Mass (short tons)*
0	0	0
1	1,455,000	1,455,000
10	1,455,000	1,455,000
10.5	0	2,910,000
19	0	2,910,000
20	0	0
2000	0	0

Notes

Based on PolyMet operational plan, equivalent to 3 months capacity

Table 1-9b Mine Pit Footprint Area

Time (years)	*[WP_Footprint_Area] West Pit Footprint Area (acres)*
0	0
1	0
2	89.8
5	130.0
11	320.5
2000	320.5

Table 1-10 Cumulative Waste Rock Moved Directly to the East Pit from the West Pit

Time (years)	*[EPCP_Direct_Mass(Cat1)] Category 1 Waste Rock Total Mass (short tons)*	*[EPCP_Direct_Mass(Cat23)] Category 2/3 Waste Rock Total Mass (short tons)*	*[EPCP_Direct_Mass(Cat4DC)] Duluth Complex Category 4 Waste Rock Total Mass (short tons)*	*[EPCP_Direct_Mass(Cat4VF)] Virginia Formation Category 4 Waste Rock Total Mass (short tons)*	*[EPCP_Direct_Mass(Ore)] Ore Total Mass (short tons)*
0	0	0	0	0	0
11	0	0	0	0	0
12	0	4,784,600	50,100	0	0
13	5,283,600	10,497,500	86,400	0	0
14	13,757,800	14,134,000	153,300	0	0
15	19,923,800	18,823,800	247,400	0	0
16	24,367,900	22,612,600	1,113,700	0	0
17	28,390,300	25,017,600	1,642,000	0	0
18	33,982,800	27,966,500	1,942,100	0	0
19	40,927,300	32,745,900	2,162,400	0	0
20	48,772,600	38,761,200	2,429,800	0	0
2000	48,772,600	38,761,200	2,429,800	0	0

Notes

Based on PolyMet block model data, does not include mass from temporary stockpiles

Table 1-10b Cumulative Total Waste Rock Moved to the East Pit

Time (years)	*[EPCP_Total_Mass _ByCat(Cat1)] Category 1 Waste Rock Total Mass (short tons)*	*[EPCP_Total_Mass _ByCat(Cat23)] Category 2/3 Waste Rock Total Mass (short tons)*	*[EPCP_Total_Mass _ByCat(Cat4DC)] Duluth Complex Category 4 Waste Rock Total Mass (short tons)*	*[EPCP_Total_Mass _ByCat(Cat4VF)] Virginia Formation Category 4 Waste Rock Total Mass (short tons)*	*[EPCP_Total_Mass _ByCat(Ore)] Ore Total Mass (short tons)*	*[EPCP_Total_Mass] Total Backfill Waste Rock Mass (short tons)*	*[EPCP_Total_OBVol] Saturated Overburden Total Volume (cubic yards)*
0	0	0	0	0	0	0	0
10.5	0	0	0	0	0	0	0
11	0	0	649,000	5,557,800	0	6,206,800	2,186,000
12	0	10,524,100	699,100	5,557,800	0	16,781,000	2,475,000
13	5,283,600	21,976,500	735,400	5,557,800	0	33,553,300	2,764,000
14	13,757,800	31,352,600	802,300	5,557,800	0	51,470,500	3,053,000
15	19,923,800	41,781,900	896,400	5,557,800	0	68,159,900	3,342,100
16	24,367,900	51,310,200	1,762,700	5,557,800	0	82,998,600	3,631,100
17	28,390,300	59,454,700	2,291,000	5,557,800	0	95,693,800	3,920,100
18	33,982,800	68,143,200	2,591,100	5,557,800	0	110,274,900	4,209,100
19	40,927,300	76,767,000	2,811,400	5,557,800	0	126,063,500	4,498,100
20	48,772,600	82,782,300	3,078,800	5,557,800	0	140,191,500	4,498,100
2000	48,772,600	82,782,300	3,078,800	5,557,800	0	140,191,500	4,498,100

Notes

Based on PolyMet block model data, **includes** mass of rock (and saturated overburden volume) from temporary stockpiles

Table 1-11 Seasonal Distribution of Annual Open Water Evaporation and Annual Precipitation

Month	*[Monthly_Evap_Factors] Open Water Evaporation*	*[Monthly_Precip_Factors] Precipitation*
January	0.0%	2.8%
February	0.0%	2.4%
March	0.0%	3.1%
April	4.7%	6.5%
May	18.5%	11.6%
June	21.0%	14.0%
July	23.6%	14.0%
August	18.8%	13.9%
September	10.9%	13.5%
October	2.4%	9.6%
November	0.0%	5.2%
December	0.0%	3.3%
Annual Total	100.0%	100.0%

Notes

Source: Open water evaporation based on Baker (1979)

Source: Precipitation from UMN Climatology Working Group - NWS data near Mine Site

Table 1-12 Average Background Groundwater Quality Distributions

Constituent	Distribution	[GW_Conc.Surf] Surficial Aquifer			[GW_Conc.Bed] Bedrock		
		Log Mean α ln(ug/L)	Log Mean α Std. Error ln(ug/L)	Log Std. Dev. Β ln(ug/L)	Log Mean α ln(ug/L)	Log Mean α Std. Error ln(ug/L)	Log Std. Dev. Β ln(ug/L)
Ag	Lognormal	-2.24E+00	1.56E-02	2.79E-01	-1.87E+00	1.04E-01	7.23E-01
Al	Lognormal	3.27E+00	6.72E-02	1.20E+00	2.70E+00	8.97E-02	6.28E-01
Alk	Lognormal	1.09E+01	3.51E-02	6.28E-01	1.07E+01	1.22E-01	8.47E-01
As	Lognormal	-6.96E-01	4.86E-02	8.51E-01	1.57E-01	1.55E-01	1.08E+00
B	Lognormal	3.27E+00	1.26E-02	2.26E-01	3.56E+00	1.05E-01	7.33E-01
Ba	Lognormal	3.05E+00	5.00E-02	8.93E-01	1.40E+00	1.45E-01	1.02E+00
Be	Lognormal	-2.20E+00	2.13E-02	3.80E-01	-2.24E+00	3.32E-02	2.33E-01
Ca	Lognormal	9.49E+00	3.14E-02	5.60E-01	9.46E+00	7.81E-02	5.47E-01
Cd	Lognormal	-2.29E+00	9.90E-03	1.77E-01	-2.22E+00	5.10E-02	3.54E-01
Cl	Lognormal	6.22E+00	4.00E-02	7.15E-01	6.86E+00	1.61E-01	1.11E+00
Co	Lognormal	-1.03E+00	7.71E-02	1.32E+00	-3.67E-02	2.02E-01	1.42E+00
Cr	Lognormal	-2.84E-01	3.66E-02	6.55E-01	-6.66E-01	1.96E-02	1.36E-01
Cu	Lognormal	3.23E-01	6.07E-02	1.08E+00	2.63E-02	1.07E-01	7.51E-01
F	Lognormal	4.17E+00	2.64E-02	4.72E-01	4.68E+00	1.23E-01	8.52E-01
Fe	Lognormal	4.90E+00	1.24E-01	2.17E+00	7.44E+00	3.03E-01	2.12E+00
K	Lognormal	7.33E+00	2.45E-02	4.37E-01	7.33E+00	4.80E-02	3.36E-01
Mg	Lognormal	8.67E+00	3.29E-02	5.88E-01	8.84E+00	1.16E-01	8.09E-01
Mn	Lognormal	4.38E+00	1.12E-01	1.96E+00	3.77E+00	2.49E-01	1.74E+00
Na	Lognormal	8.41E+00	3.28E-02	5.86E-01	8.47E+00	1.56E-01	1.09E+00
Ni	Lognormal	9.40E-02	6.16E-02	1.10E+00	2.05E+00	2.72E-01	1.90E+00
Pb	Lognormal	-9.18E-01	5.12E-02	9.14E-01	-8.65E-01	9.47E-02	6.63E-01
Sb	Lognormal	-1.38E+00	5.80E-03	9.98E-02	-7.93E-01	1.15E-01	8.04E-01
Se	Lognormal	-6.75E-01	1.30E-02	2.32E-01	-5.05E-01	4.49E-02	3.11E-01
SO_4	Lognormal	8.92E+00	3.94E-02	7.04E-01	9.67E+00	1.37E-01	9.51E-01
Tl	Lognormal	-2.33E+00	3.90E-02	6.97E-01	-1.57E+00	1.46E-01	1.02E+00
V*	Lognormal	1.18E+00	2.71E-02	4.64E-01	1.18E+00	2.71E-02	4.64E-01
Zn	Lognormal	1.34E+00	2.81E-02	5.02E-01	2.00E+00	1.44E-01	1.00E+00

Notes

Values have been updated using the methodology in "Calibration of the Existing Natural Watershed at the Mine Site", Version 4 (June 2012) for the surficial aquifer to include all PolyMet data through October 2013. The same analysis method (see Water Modeling Data Package Section 5.3.1.2) was used to develop distributions for the bedrock water quality, which are uncalibrated and reflect PolyMet monitoring data only (through October 2013).

* Vanadium concentration data are not available for the bedrock at the Mine Site. The distribution from the surficial aquifer data is assumed.

$$\mu = e^{\left(\alpha + \frac{\beta^2}{2}\right)}$$

Table 1-13 Existing Surface Water Concentrations

Constituent	*[SW_Conc.RO] RO Concentration*		*[SW_Conc.PMP] Northshore Discharge (mg/L)*	*[SW_Conc.Load_Colby] Colby Lake add'l Loading (kg/yr)*
	Mean (mg/L)	*St. Dev. (mg/L)*		
Ag	1.01E-04	5.80E-06	1.09E-04	0
Al	1.42E-01	1.20E-01	2.74E-02	0
Alk*	6.50E+01	6.80E+01	9.90E+01	0
As	9.60E-04	2.00E-03	1.33E-03	6.00E+00
B	7.30E-02	1.30E-01	1.41E-01	0
Ba	2.50E-03	1.20E-03	1.43E-02	1.10E+02
Be	9.60E-05	9.60E-07	1.00E-04	1.30E-01
Ca	1.68E+01	1.60E+01	2.86E+01	1.67E+05
Cd	7.20E-05	6.90E-05	1.00E-04	1.10E+00
Cl*	6.30E+00	1.30E+01	1.63E+01	0
Co	4.20E-04	1.60E-03	3.39E-04	0
Cr	6.30E-04	5.90E-04	5.47E-04	0
Cu	1.36E-03	1.60E-03	9.75E-04	1.35E+02
F	8.80E-02	1.00E-01	1.28E-01	0
Fe*	2.30E+00	3.30E+00	2.31E+00	0
K	1.80E+00	2.40E+00	3.00E+00	0
Mg	7.50E+00	4.80E+00	1.52E+01	7.00E+04
Mn	4.00E-02	6.50E-01	1.91E-01	5.40E+01
Na	4.70E+00	1.10E+01	1.20E+01	3.10E+04
Ni	1.48E-03	3.50E-03	8.73E-04	2.80E+01
Pb	3.80E-04	3.30E-03	2.94E-04	8.50E+00
Sb	2.50E-04	2.50E-07	2.50E-04	1.00E-01
Se	6.40E-04	6.90E-04	8.72E-04	0
SO_4*	7.60E+00	8.00E+00	2.80E+01	1.02E+06
Tl	1.00E-06	1.00E-08	3.61E-05	7.60E-01
V	9.70E-04	9.70E-06	1.50E-03	3.00E+00
Zn	9.00E-03	2.10E-02	6.21E-03	0

Notes

Values have been updated using the methodology in "Calibration of the Existing Natural Watershed at the Mine Site", Version 4 (June 2012) to reflect updated surficial groundwater distributions in Table 1-12 and PolyMet surface water quality data through December 2013. The calibration target has been changed to include only locations SW003 through SW005 (excluding SW002).

Source for NorthShore Discharge: PolyMet surface water monitoring at SW001 and SW002, combined mean values. Constituents marked with * include monitoring data from NorthShore NPDES discharge location SD009 from November 2008 through March 2014 in the calculation of average concentrations. NorthShore reported bicarbonate alkalinity as HCO_3 was assumed to be equivalent to total alkalinity and converted to units of $CaCO_3$.

Table 1-14 **Initial Concentrations in the Partridge River (mg/L)**

	[SW_Conc.Partridge] **Partridge River Evaluation Point**								
Constituent	*SW-001*	*SW-002*	*SW-003*	*SW-004*	*SW-004a*	*SW-004b*	*SW-005*	*SW-006*	*Colby Lake*
Ag	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Al	0.0180	0.0306	0.0539	0.1933	0.1195	0.1273	0.1669	0.1669	0.0991
Alk	94.6	101.8	83.2	97	76.6	59.8	56.5	56.5	47.9
As	0.0065	0.0005	0.0009	0.0011	0.0009	0.0010	0.0010	0.0010	0.0010
B	0.0960	0.1661	0.0940	0.0930	0.116	0.0759	0.0514	0.0514	0.0605
Ba	0.0050	0.0177	0.0113	0.0096	0.0120	0.0089	0.0087	0.0087	0.0079
Be	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Ca	24.6	30.0	22.9	21.1	21.8	16.9	15.3	15.3	19.5
Cd	0.0001	0.0001	0.0001	0.0001	0.0001	0.00007	0.0001	0.0001	0.0001
Cl	1.64	26.47	10.29	9.18	9.3	5.69	5.68	5.68	4.03
Co	0.0005	0.0003	0.0003	0.0006	0.0004	0.0004	0.0012	0.0012	0.0003
Cr	0.0005	0.0006	0.0006	0.0009	0.0005	0.0006	0.0007	0.0007	0.0005
Cu	0.0016	0.0008	0.0010	0.0015	0.0015	0.0015	0.0016	0.0016	0.0041
F	0.141	0.114	0.095	0.096	0.106	0.0960	0.303	0.303	0.0880
Fe	0.026	2.90	1.54	2.56	2.03	2.40	2.18	2.18	1.665
K	2.65	3.17	2.43	2.22	2.54	1.72	1.36	1.36	1.268
Mg	10.4	16.92	10.30	9.74	10.6	8.92	8.10	8.10	8.95
Mn	0.0079	0.246	0.135	0.339	0.170	0.148	0.138	0.138	0.1154
Na	4.78	16.10	6.45	6.73	10.2	6.72	4.38	4.38	5.03
Ni	0.0014	0.0007	0.0011	0.0015	0.0012	0.0016	0.0017	0.0017	0.0021
Pb	0.0003	0.0003	0.0003	0.0003	0.0002	0.0003	0.0008	0.0008	0.0006
Sb	0.0015	0.0005	0.0005	0.0005	0.0003	0.0003	0.0005	0.0005	0.0003
Se	0.0017	0.0009	0.0009	0.0007	0.0004	0.0006	0.0008	0.0008	0.0007
SO_4	21.8	32.61	15.14	13.9	15.9	11.3	10.11	10.11	28.7
Tl	0.0006	0.0002	0.0002	0.00016	0.00001	0.00001	0.0002	0.0002	0.0000
V*	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	0.0013
Zn	0.0089	0.0053	0.0085	0.0103	0.0046	0.0042	0.0105	0.0105	0.0053

Notes

Source: Surface water monitoring, mean values, updated to include all data through December 2013

Surface water data not available for V, mean groundwater value assumed

Surface water data not available for SW-006, values for SW-005 assumed

Table 1-15 **Groundwater Flowpath Characteristics**

			Groundwater Flowpath							
Variable Name	*Units*	*Description*	*East Pit (Bedrock)*	*East Pit & Cat 2/3 Stockpile (Surficial Aquifer)*	*Ore Surge Pile*	*Waste Water Treatment Facility*	*Overburden Storage Area*	*West Pit (Surficial Aquifer)*	*West Pit (Bedrock to SW-004)*	*West Pit (Bedrock to SW-004a)*
I_ops	[--]	Minimum flowpath gradient (uniform distribution)	N/A	3.87E-03	9.47E-03	8.38E-03	8.88E-03	3.99E-03	N/A	N/A
		Maximum flowpath gradient (uniform distribution)	N/A	4.34E-03	1.02E-02	8.96E-03	9.50E-03	4.65E-03	N/A	N/A
I_close	[--]	Minimum flowpath gradient (uniform distribution)	8.05E-03	5.99E-03	N/A	N/A	N/A	8.97E-03	8.70E-03	9.07E-03
		Maximum flowpath gradient (uniform distribution)	8.59E-03	6.46E-03	N/A	N/A	N/A	9.63E-03	9.37E-03	9.73E-03
Thick	[m]	Aquifer thickness	15	5	5	5	5	5	15	15
EL_Pit	[ft]	Pit surficial outflow elevation	N/A	1577	N/A	N/A	N/A	1550	N/A	N/A
Width	[m]	Flowpath width	1735	1440	430	240	550	665	535	810
L_Upstream	[m]	Length upstream of stockpile	N/A	775	N/A	N/A	N/A	N/A	N/A	N/A
L_Stock	[m]	Source (stockpile) length	N/A	395	230	420	375	N/A	N/A	N/A
L_Eval_1	[m]	Length to Evaluation Point #1 (Dunka Rd.)	N/A	30	40	60	5	175	N/A	N/A
L_Eval_2	[m]	Length to Evaluation Point #2 (Prop. or river)	1435	140	1085	910	235	680	505	340
L_Eval_3	[m]	Length to Evaluation Point #3 (Average river)	440	780	60	340	985	650	1115	1160
L_Total	[m]	Total flowpath length	1875	2120	1415	1730	1600	1505	1620	1500
K_Flowpaths	[m/d]	Minimum hydraulic conductivity	0.001	0.82	0.24	0.41	2.06	0.39	0.001	0.001
		Most likely hydraulic conductivity (mode)	0.003	1.94	0.52	0.88	3.55	1.31	0.003	0.003
		Maximum hydraulic conductivity	0.010	5.49	1.31	2.20	6.17	4.73	0.010	0.010

Table 1-16 Coefficients for Surficial Aquifer Sorption

Constituent	*Units*	*Distribution*	*Min K_d*	*Mean/Mode K_d*	*Max K_d*
As*	L/kg	Constant	N/A	25	N/A
Cu#	L/kg	Constant	N/A	22	N/A
Ni*	L/kg	Constant	N/A	16	N/A
Sb†	L/kg	Triangular	1.3	1.6	6.1

Notes

* Constant values shown are recommended screening values from EPA guidance document:

U.S. EPA, 1996. Soil Screening Guidance: User's Guide.
U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response,
Washington, D.C., EPA/540/R-96/018.

Constant value shown is lowest value used in risk assessments from EPA summary document:
U.S. EPA, 2005. Partition Coefficients for Metals in Surface Water, Soil, and Waste.
U.S. Environmental Protection Agency, Office of Solid Research and Development,
Washington, D.C., EPA/600/R-05/074.

† Minimum value shown is lowest reported value from EPA summary document:
U.S. EPA, 2005. Partition Coefficients for Metals in Surface Water, Soil, and Waste.
U.S. Environmental Protection Agency, Office of Solid Research and Development,
Washington, D.C., EPA/600/R-05/074.
Mode and maximum values shown are the lowest values from PolyMet site-specific testing (Mine and Plant sites).

Table 1-17 Partridge River Reach Characteristics

Partridge River Evaluation Point	*[Segment_Length] Upstream Reach Length (m)*	*[Segment_Area] Cross Sectional Area (m^2)*	*[Wild_Rice_Locs] Wild Rice Location?*	*[Hardness_forStandard] Hardness used for Evaluating Standards (mg/L)**
SW-001	400	0.3	No	--
SW-002	4,800	2.0	No	--
SW-003	4,200	2.5	No	--
SW-004	6,600	4.8	No	102.5
SW-004a	1,300	13.8	No	105.5
SW-004b	5,200	20.6	No	--
SW-005	15,300	26.7	Yes	--
SW-006	5,200	28.0	No	--
Colby Lake	1,200	28.0	No	--

Notes

Dimensions shown are for the reach upstream of each evaluation point, wild rice location applies to the point itself

Based on GIS public waters shapefile data and PolyMet stream surveys

Wild rice locations based on MPCA staff guidance

* For non-discharge locations, the hardness used for evaluating hardness-based standards will be the modeled instantaneous hardness at that location. For locations receiving loading from project features, the hardness used will be the existing median measured hardness (values shown).

Table 1-18 Partridge River Tributary Areas

	[Contributing_Area] Incremental Tributary Area (acres)								
Year	*SW-001*	*SW-002*	*SW-003*	*SW-004*	*SW-004a*	*SW-004b*	*SW-005*	*SW-006*	*Colby Lake*
0	670	3,838	1,042	5,016	19,991	15,108	13,400	2,991	12,580
1	670	3,637	1,042	4,669	19,834	15,108	13,400	2,991	12,580
2	670	3,636	1,042	4,669	19,736	15,108	13,400	2,991	12,580
11	670	3,594	1,037	4,606	19,134	15,108	13,400	2,991	12,580
20	670	3,814	1,037	4,605	19,378	15,108	13,400	2,991	12,580
21	670	3,792	1,042	4,893	18,936	15,108	13,400	2,991	12,580
50	670	3,792	1,042	4,893	19,506	15,108	13,400	2,991	12,580
2000	670	3,792	1,042	4,893	19,506	15,108	13,400	2,991	12,580

Notes

Based on updated GIS shapefile data

* Area tributary to the West Pit during and after filling is not included (modeled seperately)

Table 1-19 Distributions of Daily Flow at SW-006 (Existing Conditions) by Month

Percentile	*January*	*February*	*March*	*April*	*May*	*June*	*July*	*August*	*September*	*October*	*November*	*December*
Minimum	1.70	1.00	0.61	4.00	17.00	6.00	0.54	0.68	5.30	17.00	13.00	5.30
5%	1.91	1.10	0.90	18.75	25.22	8.50	1.84	2.55	6.29	17.00	14.00	6.21
10%	2.00	1.16	1.11	41.70	43.58	10.00	4.08	11.00	6.97	17.10	14.00	6.73
25%	2.38	1.50	1.90	59.60	67.72	32.59	10.21	16.25	23.27	28.00	18.19	7.83
50%	8.00	2.00	6.55	168.18	171.80	74.90	46.26	37.00	61.90	62.15	37.38	14.00
75%	11.75	8.95	27.00	340.72	317.97	128.97	101.20	168.75	108.72	117.83	62.00	21.71
90%	15.20	14.18	91.90	497.65	589.80	199.97	554.60	268.70	167.21	262.45	129.98	31.54
95%	17.55	19.79	141.90	575.97	742.05	283.92	741.55	403.55	214.00	376.45	181.16	41.63
Maximum	22.00	23.89	209.00	1940.48	874.00	566.01	866.00	480.00	366.97	760.23	459.38	86.49

Notes

Based on USGS data adjusted for Peter Mitchell Pit dewatering (see Water Modeling Data Package Vol 1 - Mine Site, Section 4.4.1.2)

Table 1-20a **Incremental Percent of Predicted Flow at SW-006 Entering Each Evaluation Point - January***

Year	*SW001*	*SW-002*	*SW-003*	*SW-004*	*SW-004a*	*SW-004b*	*SW-005*	*SW-006*	*CL*
0	1.06%	5.93%	2.04%	7.84%	31.82%	24.98%	21.66%	4.66%	20.00%
1	1.06%	5.64%	2.22%	7.40%	31.61%	25.20%	21.72%	4.81%	20.00%
2	1.06%	5.64%	2.23%	7.40%	31.46%	25.20%	21.06%	5.48%	20.00%
11	1.06%	5.58%	2.22%	7.30%	30.41%	25.19%	21.74%	4.82%	20.00%
20	1.06%	5.96%	2.24%	7.29%	30.86%	25.20%	21.73%	4.81%	20.00%
21	1.06%	5.93%	2.25%	7.77%	30.12%	25.19%	21.73%	4.82%	20.00%
50	1.06%	5.93%	2.25%	7.77%	31.12%	25.21%	21.73%	4.81%	20.00%
2000	1.06%	5.93%	2.25%	7.77%	31.12%	25.21%	21.73%	4.81%	20.00%

Table 1-20b **Incremental Percent of Predicted Flow at SW-006 Entering Each Evaluation Point - February***

Year	*SW001*	*SW-002*	*SW-003*	*SW-004*	*SW-004a*	*SW-004b*	*SW-005*	*SW-006*	*CL*
0	1.24%	6.66%	1.56%	8.46%	31.20%	24.47%	21.24%	5.17%	20.00%
1	1.24%	6.33%	1.77%	7.99%	31.03%	24.70%	21.30%	5.32%	20.00%
2	1.24%	6.33%	1.77%	7.99%	30.87%	24.70%	20.64%	5.98%	20.00%
11	1.24%	6.27%	1.77%	7.88%	29.82%	24.70%	21.32%	5.32%	20.00%
20	1.24%	6.69%	1.76%	7.87%	30.26%	24.70%	21.31%	5.32%	20.00%
21	1.24%	6.66%	1.77%	8.39%	29.48%	24.70%	21.31%	5.32%	20.00%
50	1.24%	6.66%	1.77%	8.38%	30.49%	24.70%	21.30%	5.32%	20.00%
2000	1.24%	6.66%	1.77%	8.38%	30.49%	24.70%	21.30%	5.32%	20.00%

Table 1-20c **Incremental Percent of Predicted Flow at SW-006 Entering Each Evaluation Point - March***

Year	*SW001*	*SW-002*	*SW-003*	*SW-004*	*SW-004a*	*SW-004b*	*SW-005*	*SW-006*	*CL*
0	1.52%	7.39%	1.65%	8.64%	33.54%	24.80%	16.51%	5.94%	20.00%
1	1.52%	7.02%	1.90%	8.14%	33.35%	25.06%	16.61%	6.09%	20.00%
2	1.52%	7.03%	1.90%	8.14%	33.18%	25.06%	15.97%	6.74%	20.00%
11	1.52%	6.95%	1.89%	8.02%	32.05%	25.09%	16.72%	6.08%	20.00%
20	1.52%	7.43%	1.88%	8.00%	32.52%	25.07%	16.65%	6.08%	20.00%
21	1.52%	7.39%	1.89%	8.55%	31.69%	25.07%	16.68%	6.08%	20.00%
50	1.52%	7.39%	1.89%	8.54%	32.77%	25.05%	16.60%	6.09%	20.00%
2000	1.52%	7.39%	1.89%	8.54%	32.77%	25.05%	16.60%	6.09%	20.00%

Table 1-20d **Incremental Percent of Predicted Flow at SW-006 Entering Each Evaluation Point - April***

Year	*SW001*	*SW-002*	*SW-003*	*SW-004*	*SW-004a*	*SW-004b*	*SW-005*	*SW-006*	*CL*
0	1.13%	6.31%	1.54%	8.41%	31.47%	24.34%	21.91%	4.89%	20.00%
1	1.13%	6.01%	1.74%	7.95%	31.28%	24.57%	21.97%	5.04%	20.00%
2	1.13%	6.01%	1.74%	7.95%	31.12%	24.57%	21.31%	5.70%	20.00%
11	1.13%	5.95%	1.73%	7.84%	30.08%	24.57%	21.98%	5.04%	20.00%
20	1.13%	6.35%	1.73%	7.84%	30.52%	24.57%	21.97%	5.04%	20.00%
21	1.13%	6.32%	1.74%	8.34%	29.76%	24.57%	21.97%	5.04%	20.00%
50	1.13%	6.32%	1.74%	8.33%	30.76%	24.57%	21.97%	5.04%	20.00%
2000	1.13%	6.32%	1.74%	8.33%	30.76%	24.57%	21.97%	5.04%	20.00%

Percentages are incremental flow relative to SW-006 (i.e. total flow into Colby Lake is 120% of flow into SW-006)

Table 1-20e **Incremental Percent of Predicted Flow at SW-006 Entering Each Evaluation Point - May***

Year	*SW001*	*SW-002*	*SW-003*	*SW-004*	*SW-004a*	*SW-004b*	*SW-005*	*SW-006*	*CL*
0	1.25%	5.57%	1.56%	7.84%	29.15%	24.49%	25.36%	4.78%	20.00%
1	1.25%	5.28%	1.74%	7.41%	28.98%	24.69%	25.40%	4.93%	20.00%
2	1.25%	5.29%	1.74%	7.41%	28.83%	24.68%	24.73%	5.59%	20.00%
11	1.25%	5.23%	1.73%	7.31%	27.86%	24.65%	25.35%	4.93%	20.00%
20	1.25%	5.60%	1.74%	7.32%	28.27%	24.67%	25.38%	4.93%	20.00%
21	1.25%	5.57%	1.75%	7.78%	27.56%	24.66%	25.37%	4.93%	20.00%
50	1.25%	5.57%	1.75%	7.78%	28.49%	24.69%	25.41%	4.93%	20.00%
2000	1.25%	5.57%	1.75%	7.78%	28.49%	24.69%	25.41%	4.93%	20.00%

Table 1-20f **Incremental Percent of Predicted Flow at SW-006 Entering Each Evaluation Point - June***

Year	*SW001*	*SW-002*	*SW-003*	*SW-004*	*SW-004a*	*SW-004b*	*SW-005*	*SW-006*	*CL*
0	1.51%	7.03%	1.47%	8.89%	31.21%	24.69%	19.82%	5.36%	20.00%
1	1.51%	6.68%	1.70%	8.39%	31.05%	24.92%	19.90%	5.51%	20.00%
2	1.51%	6.69%	1.71%	8.39%	30.89%	24.93%	19.25%	6.17%	20.00%
11	1.51%	6.61%	1.70%	8.28%	29.83%	24.93%	19.95%	5.51%	20.00%
20	1.51%	7.07%	1.69%	8.27%	30.26%	24.93%	19.92%	5.51%	20.00%
21	1.51%	7.04%	1.70%	8.81%	29.45%	24.93%	19.93%	5.51%	20.00%
50	1.51%	7.04%	1.70%	8.81%	30.48%	24.92%	19.90%	5.51%	20.00%
2000	1.51%	7.04%	1.70%	8.81%	30.48%	24.92%	19.90%	5.51%	20.00%

Table 1-20g **Incremental Percent of Predicted Flow at SW-006 Entering Each Evaluation Point - July***

Year	*SW001*	*SW-002*	*SW-003*	*SW-004*	*SW-004a*	*SW-004b*	*SW-005*	*SW-006*	*CL*
0	1.51%	5.91%	1.40%	8.01%	27.39%	23.62%	26.58%	5.58%	20.00%
1	1.51%	5.60%	1.60%	7.57%	27.25%	23.81%	26.61%	5.73%	20.00%
2	1.51%	5.61%	1.60%	7.57%	27.11%	23.81%	25.94%	6.38%	20.00%
11	1.51%	5.54%	1.60%	7.46%	26.17%	23.78%	26.53%	5.72%	20.00%
20	1.51%	5.94%	1.59%	7.46%	26.55%	23.80%	26.57%	5.73%	20.00%
21	1.51%	5.91%	1.60%	7.94%	25.83%	23.79%	26.56%	5.72%	20.00%
50	1.51%	5.91%	1.60%	7.94%	26.74%	23.81%	26.62%	5.73%	20.00%
2000	1.51%	5.91%	1.60%	7.94%	26.74%	23.81%	26.62%	5.73%	20.00%

Table 1-20h **Incremental Percent of Predicted Flow at SW-006 Entering Each Evaluation Point - August***

Year	*SW001*	*SW-002*	*SW-003*	*SW-004*	*SW-004a*	*SW-004b*	*SW-005*	*SW-006*	*CL*
0	1.79%	7.04%	1.67%	8.35%	30.33%	23.78%	20.89%	6.15%	20.00%
1	1.79%	6.68%	1.90%	7.86%	30.18%	24.02%	20.96%	6.30%	20.00%
2	1.79%	6.68%	1.91%	7.85%	30.02%	24.02%	20.31%	6.95%	20.00%
11	1.79%	6.61%	1.90%	7.74%	28.98%	24.03%	20.98%	6.28%	20.00%
20	1.79%	7.08%	1.89%	7.71%	29.40%	24.02%	20.97%	6.29%	20.00%
21	1.79%	7.04%	1.90%	8.25%	28.60%	24.02%	20.97%	6.29%	20.00%
50	1.79%	7.05%	1.90%	8.25%	29.61%	24.01%	20.96%	6.30%	20.00%
2000	1.79%	7.05%	1.90%	8.25%	29.61%	24.01%	20.96%	6.30%	20.00%

Percentages are incremental flow relative to SW-006 (i.e. total flow into Colby Lake is 120% of flow into SW-006)

Table 1-20i **Incremental Percent of Predicted Flow at SW-006 Entering Each Evaluation Point - September***

Year	*SW001*	*SW-002*	*SW-003*	*SW-004*	*SW-004a*	*SW-004b*	*SW-005*	*SW-006*	*CL*
0	1.52%	6.60%	1.73%	8.45%	29.81%	23.97%	22.11%	5.79%	20.00%
1	1.52%	6.26%	1.95%	7.97%	29.67%	24.19%	22.17%	5.94%	20.00%
2	1.52%	6.26%	1.95%	7.97%	29.51%	24.19%	21.51%	6.59%	20.00%
11	1.52%	6.19%	1.95%	7.86%	28.49%	24.20%	22.17%	5.93%	20.00%
20	1.52%	6.63%	1.95%	7.85%	28.90%	24.19%	22.17%	5.93%	20.00%
21	1.52%	6.60%	1.96%	8.37%	28.12%	24.19%	22.17%	5.93%	20.00%
50	1.52%	6.60%	1.96%	8.37%	29.11%	24.19%	22.17%	5.94%	20.00%
2000	1.52%	6.60%	1.96%	8.37%	29.11%	24.19%	22.17%	5.94%	20.00%

Table 1-20j **Incremental Percent of Predicted Flow at SW-006 Entering Each Evaluation Point - October***

Year	*SW001*	*SW-002*	*SW-003*	*SW-004*	*SW-004a*	*SW-004b*	*SW-005*	*SW-006*	*CL*
0	1.25%	6.49%	1.64%	8.45%	31.15%	24.51%	21.26%	5.24%	20.00%
1	1.25%	6.16%	1.85%	7.98%	30.98%	24.73%	21.33%	5.39%	20.00%
2	1.25%	6.17%	1.85%	7.98%	30.82%	24.73%	20.67%	6.05%	20.00%
11	1.25%	6.10%	1.84%	7.87%	29.78%	24.73%	21.35%	5.39%	20.00%
20	1.25%	6.52%	1.84%	7.87%	30.21%	24.73%	21.34%	5.39%	20.00%
21	1.25%	6.49%	1.85%	8.38%	29.44%	24.73%	21.34%	5.39%	20.00%
50	1.25%	6.49%	1.85%	8.37%	30.44%	24.73%	21.33%	5.39%	20.00%
2000	1.25%	6.49%	1.85%	8.37%	30.44%	24.73%	21.33%	5.39%	20.00%

Table 1-20k **Incremental Percent of Predicted Flow at SW-006 Entering Each Evaluation Point - November***

Year	*SW001*	*SW-002*	*SW-003*	*SW-004*	*SW-004a*	*SW-004b*	*SW-005*	*SW-006*	*CL*
0	0.87%	5.79%	1.76%	8.53%	28.92%	25.51%	24.50%	4.13%	20.00%
1	0.87%	5.51%	1.94%	8.08%	28.76%	25.70%	24.54%	4.28%	20.00%
2	0.87%	5.51%	1.94%	8.08%	28.61%	25.69%	23.87%	4.95%	20.00%
11	0.87%	5.46%	1.93%	7.97%	27.64%	25.65%	24.51%	4.30%	20.00%
20	0.87%	5.82%	1.95%	7.99%	28.04%	25.68%	24.53%	4.29%	20.00%
21	0.87%	5.79%	1.95%	8.47%	27.31%	25.67%	24.52%	4.29%	20.00%
50	0.87%	5.79%	1.95%	8.47%	28.25%	25.71%	24.55%	4.28%	20.00%
2000	0.87%	5.79%	1.95%	8.47%	28.25%	25.71%	24.55%	4.28%	20.00%

Table 1-20l **Incremental Percent of Predicted Flow at SW-006 Entering Each Evaluation Point - December***

Year	*SW001*	*SW-002*	*SW-003*	*SW-004*	*SW-004a*	*SW-004b*	*SW-005*	*SW-006*	*CL*
0	0.92%	5.22%	2.14%	7.71%	30.39%	24.74%	24.90%	3.98%	20.00%
1	0.92%	4.96%	2.29%	7.29%	30.19%	24.95%	24.94%	4.13%	20.00%
2	0.92%	4.97%	2.30%	7.29%	30.04%	24.94%	24.27%	4.80%	20.00%
11	0.92%	4.92%	2.28%	7.19%	29.04%	24.92%	24.90%	4.15%	20.00%
20	0.92%	5.25%	2.32%	7.19%	29.47%	24.93%	24.92%	4.14%	20.00%
21	0.92%	5.22%	2.32%	7.65%	28.77%	24.93%	24.91%	4.14%	20.00%
50	0.92%	5.22%	2.32%	7.65%	29.72%	24.95%	24.95%	4.13%	20.00%
2000	0.92%	5.22%	2.32%	7.65%	29.72%	24.95%	24.95%	4.13%	20.00%

Percentages are incremental flow relative to SW-006 (i.e. total flow into Colby Lake is 120% of flow into SW-006)

Table 1-21 Partridge River Baseflow

	[GW_Inc_Baseflow] *Incremental Flow from Groundwater into each Evaluation Point (cfs)*								
Year	*SW-001*	*SW-002*	*SW-003*	*SW-004*	*SW-004a*	*SW-004b*	*SW-005*	*SW-006*	*Colby Lake*
0	0.065	0.341	0.104	0.405	1.528	1.369	1.097	0.365	1.055
1	0.065	0.322	0.100	0.376	1.515	1.367	1.103	0.363	1.055
2	0.065	0.322	0.101	0.376	1.500	1.369	1.059	0.408	1.055
11	0.065	0.318	0.100	0.371	1.441	1.369	1.108	0.363	1.055
20	0.065	0.338	0.100	0.370	1.459	1.370	1.105	0.365	1.055
21	0.065	0.336	0.101	0.393	1.420	1.370	1.106	0.364	1.055
50	0.065	0.336	0.101	0.393	1.469	1.371	1.102	0.366	1.055
2000	0.065	0.336	0.101	0.393	1.469	1.371	1.102	0.366	1.055

Notes

Source: 2012 XP-SWMM modeling (and area relationship for Colby Lake), scaled from USGS data, see Water Modeling Data Package Vol 1 - Mine Site, Section 4.4.1.3
Incremental flows reflect updated XP-SWMM modeling.

Table 1-22a **Groundwater Inflows to the Pits During Operations**

	East Pit		Central Pit		West Pit	
Year	*[EP_GW_Inflow_Ops] Flow Rate (gpm)*	*[EP_GW_Surf_Ops] Surficial Percent*	*[CP_GW_Inflow_Ops] Flow Rate (gpm)*	*[CP_GW_Surf_Ops] Surficial Percent*	*[WP_GW_Inflow_Ops] Flow Rate (gpm)*	*[WP_GW_Surf_Ops] Surficial Percent*
0	0	100	0	100	0	100
1	220	19.0	0	100	0	100
2	190	13.5	0	100	60	98.3
3	210	8.5	0	100	40	96.3
4	250	5.5	0	100	30	93.9
5	450	2.4	0	100	30	91.4
6	430	2.2	0	100	50	95.6
7	420	2.1	0	100	40	90.9
8	460	1.9	0	100	40	85.4
9	690	1.2	0	100	30	81.3
10	710	1.2	0	100	30	74.4
10.75	760	0.8	30	99.6	80	91.0
11	760	0.8	30	99.6	80	91
12	760	0.8	20	96.5	50	86.8
13	700	0.8	10	92.6	50	83.8
14	710	0.7	10	87.1	40	81.6
15	710	0.7	10	75.8	40	77.9
16	*570*	*0.8*	*10*	*75.2*	40	75.3
17	*380*	*1.2*	*10*	*80.4*	40	72.3
18	*270*	*1.7*	*10*	*81.9*	40	70.4
19	*170*	*2.6*	*10*	*84.6*	40	67.1
20	*40*	*9.5*	*10*	*98.6*	40	63.7
2000	*90*	*4.8*	*10*	*100*	*40*	*64.4*

Note: Time series not used beyond year 15 for East/Central pit and year 20 for West Pit, values shown are necessary for input but not used in model. See Table 1-22b for inflow lookup in closure.

Table 1-22b **Groundwater Inflows to the Pits During Backfilling and Closure**

West Pit		
WS Elevation (ft)	*Flow Rate (gpm)*	*Surficial Percent*
940	50	80.1
1000	50	80.1
1100	50	80.6
1200	50	81.5
1320	50	83.7
1450	50	89.1
1579	30	98.4
1585	30	98.8

East Pit		
WS Elevation (ft)	*Flow Rate (gpm)*	*Surficial Percent*
1260	730	0.8
1360	710	0.7
1435	710	0.7
1485	570	0.8
1530	320	1.5
1565	190	2.4
1592	30	29.2
1595	20	53.2

Central Pit		
WS Elevation (ft)	*Flow Rate (gpm)*	*Surficial Percent*
1260	10	75.8
1360	10	75.3
1435	8	82.3
1485	7	85.5
1530	6	93.8
1565	6	98.6
1592	1	98.6
1595	6	100.0

Table 1-23 **Peat and Unsaturated Overburden Leachate Concentrations**

		[OB_Concs.Peat] *Peat*		*[OB_Concs.Unsat]* *Unsaturated Overburden*	
Constituent	*Distribution*	*Minimum (mg/L)*	*Maximum (mg/L)*	*Minimum (mg/L)*	*Maximum (mg/L)*
Ag	Uniform	0.000025	0.0014	0.000025	0.00005
Al	Uniform	0.042	0.13	0.068	0.32
Alk	Uniform	8.54	82.69	4.62	13.06
As	Uniform	0.0029	0.0044	0.0004	0.0032
B	Uniform	0.18	0.23	0.0005	0.03
Ba	Uniform	0.01	0.035	0.003	0.014
Be	Uniform	0.0001	0.0002	0.0001	0.0002
Ca	Uniform	15.8	22.9	1.77	5.92
Cd	Uniform	0.00002	0.00004	0.00005	0.00016
Cl	Uniform	2.73	9.16	0.74	3.62
Co	Uniform	0.00005	0.0007	0.00005	0.0016
Cr	Uniform	0.0001	0.001	0.0001	0.0011
Cu	Uniform	0.003	0.011	0.005	0.0083
F	Uniform	0.08	1.1	0.025	0.48
Fe	Uniform	0.02	0.12	0.02	0.06
K	Uniform	1.47	5.69	0.66	1.28
Mg	Uniform	7.76	10.9	0.66	2.07
Mn	Uniform	0.0592	0.192	0.0075	0.105
Na	Uniform	4.23	47.3	1.82	4.26
Ni	Uniform	0.0015	0.0066	0.0008	0.0033
Pb	Uniform	0.000025	0.00023	0.000025	0.00005
Sb	Uniform	0.0005	0.0007	0.00005	0.0011
Se	Uniform	0.0006	0.0009	0.0001	0.0006
SO_4	Uniform	68.3	93.4	1.74	16.5
Tl	Uniform	0.00001	0.00011	0.00001	0.00003
V	Uniform	0.0025	0.0043	0.0004	0.0006
Zn	Uniform	0.0005	0.004	0.002	0.006

Notes

Minimum values from MWMP tests; LOD/2 substituted for non-detects

Maximum value from MWMP tests; LOD substituted for non-detects

Table 1-24 Category 1 Release Distributions

Constituent	*Method*	*Source*	*Units*	*Distribution*	*Mean/Mode*	*St. Dev.*	*Minimum*	*Maximum*
Ag	Rate	HCT (1+2)*	mg Ag/kg/week	Lognormal	6.46E-06	2.11E-02	N/A	N/A
Al	Ca ratio	Anorthite Formula	mg Al / mg Ca	Constant	1.35E+00	N/A	N/A	N/A
Alkalinity	Rate	HCT (1+2)	mg Alk/kg/week	Beta	4.92E+00	2.21E+00	2.63E+00	1.15E+01
As	Rate	HCT (1+2)*	mg As/kg/week	Lognormal	1.85E-04	1.84E-04	N/A	N/A
B	Rate	HCT (1+2)*	mg B/kg/week	Lognormal	4.33E-03	1.27E-02	N/A	N/A
Ba	K ratio	Aqua Regia	mg Ba / mg K	Normal	2.90E-02	1.98E-04	N/A	N/A
Be	Rate	HCT (1+2)*	mg Be/kg/week	Lognormal	6.37E-06	4.61E-05	N/A	N/A
Ca	Rate	HCT (1+2)	mg Ca/kg/week	Beta	1.15E+00	3.48E-01	5.78E-01	2.34E+00
Cd	Zn rate ratio	HCT (2)	mg Cd / mg Zn	Beta	2.03E-02	5.10E-03	1.44E-02	4.44E-02
Cl	Flush	HCT (all)	mg Cl/kg	Beta	9.78E+00	1.17E+01	1.38E+00	7.30E+01
Co	Ni rate ratio	HCT (2)	mg Co / mg Ni	Beta	1.55E-01	5.11E-02	7.28E-02	3.11E-01
Cr	Rate	HCT (1+2)*	mg Cr/kg/week	Lognormal	5.90E-05	2.80E-05	N/A	N/A
Cu	S ratio	Aqua Regia	mg Cu / mg S	Normal	5.87E-01	2.51E-02	N/A	N/A
F	Rate	HCT (1+2)	mg F/kg/week	Beta	2.33E-02	1.08E-03	1.99E-02	2.52E-02
Fe	S ratio	Pyrrhotite microprobe	mg Fe / mg S	Beta	1.62E+00	8.72E-02	1.49E+00	1.92E+00
K	Rate	HCT (1+2)	mg K/kg/week	Beta	2.14E-01	9.17E-02	1.02E-01	4.98E-01
Mg	Rate	HCT (1+2)	mg Mg/kg/week	Beta	3.14E-01	2.04E-01	1.31E-01	1.10E+00
Mn	SO_4 rate ratio	HCT (2)	mg Mn / mg SO_4	Beta	1.96E-03	9.73E-04	1.15E-03	5.95E-03
Na	Rate	HCT (1+2)	mg Na/kg/week	Beta	4.13E-01	4.02E-01	1.28E-01	2.50E+00
Ni	S ratio	Cat 4 Aqua Regia	mg Ni / mg S	Normal	3.06E-02	1.86E-03	N/A	N/A
Pb	Rate	HCT (1+2)*	mg Pb/kg/week	Lognormal	6.56E-06	6.44E-06	N/A	N/A
Sb	Rate	Reactor*	mg Sb/kg/week	Lognormal	4.36E-04	4.81E-04	N/A	N/A
Se	SO_4 rate ratio	HCT (2)*	mg Se / mg SO_4	Lognormal	1.90E-05	2.32E-04	N/A	N/A
SO_4	Rate Regression	HCT (1+2)	mg SO_4/kg/week/%S	Normal	13.92	0.581	N/A	N/A
Tl	Rate	HCT (1+2)*	mg Tl/kg/week	Lognormal	9.23E-07	1.77E-05	N/A	N/A
V	Rate	HCT (1+2)*	mg V/kg/week	Lognormal	1.52E-04	1.68E-04	N/A	N/A
Zn	Mg ratio	Aqua Regia	mg Zn / mg Mg	Normal	1.81E-03	1.35E-05	N/A	N/A

Additional Distributions for Selected Constituents

Constituent	*Method*	*Source*	*Units*	*Distribution*	*Mean/Mode*	*St. Dev.*	*Minimum*	*Maximum*
Al	Na ratio	Albite Formula	mg Al / mg Na	Constant	1.17E+00	N/A	N/A	N/A
Fe	Mg ratio	Olivine microprobe	mg Fe / mg Mg	Beta	1.87E+00	6.75E-01	1.19E+00	4.51E+00
Ni	Mg ratio	Olivine microprobe	mg Ni / mg Mg	Beta	4.59E-03	1.95E-03	1.10E-04	7.43E-03

N/A = not used

Notes

- Humidity cell data used through February 2011 unless noted otherwise.
- HCT (1+2) indicates average rates from humidity cells over Condition 1 and Condition 2.
- HCT (2) indicates average rates from humidity cells over Condition 2.
- * indicates average rates from humidity cells over conditions noted with refined modeling of non-detects (see Section 8.1.2.1). Data used though December 2013.
- For Sb only the smaller MDNR-style reactors were used to estimate a release rate, including refined modeling of non-detects. Data used through February 2007.
- Except for SO_4, all distributions from humidity cell data represent the full range of the observed values, with no weighting.
- Distributions from aqua regia data represent the uncertainty in the average ratios, weighted by geologic unit.
- Distributions from microprobe data represent the full range of the observed ratios for each mineral, with no weighting.
- For nickel, S ratio from Category 4 aqua regia data represents the effect of all sulfide minerals combined.
- For chloride, release is a one-time flush from newly-exposed waste rock with a distribution determined from all humidity cells combined.

Table 1-25 Category 2/3 Release Distributions

Constituent	*Method*	*Source*	*Units*	*Distribution*	*Mean/Mode*	*St. Dev.*	*Minimum*	*Maximum*
Ag	S ratio	Aqua Regia	mg Ag / mg S	Normal	1.32E-04	4.54E-06	N/A	N/A
Al	Ca ratio	Anorthite Formula	mg Al / mg Ca	Constant	1.35E+00	N/A	N/A	N/A
Alkalinity	Nonacidic rate	HCT (1+2)	mg Alk/kg/week	Beta	4.50E+00	2.59E+00	1.45E+00	1.10E+01
As	S ratio	Aqua Regia	mg As / mg S	Normal	1.67E-03	1.28E-04	N/A	N/A
B	Nonacidic rate	HCT (1+2)*	mg B/kg/week	Lognormal	5.84E-03	1.10E-03	N/A	N/A
Ba	K ratio	Aqua Regia	mg Ba / mg K	Normal	2.93E-02	5.69E-04	N/A	N/A
Be	K ratio	Aqua Regia	mg Be / mg K	Normal	1.87E-04	3.77E-06	N/A	N/A
Ca	SO_4 rate ratio	HCT (1+2)	mg Ca / mg SO_4	Beta	6.81E-01	4.29E-01	2.61E-01	2.59E+00
Cd	Zn rate ratio	HCT (2)	mg Cd / mg Zn	Beta	1.65E-02	1.20E-02	1.01E-03	5.84E-02
Cl	Flush	HCT (all)	mg Cl/kg	Beta	9.78E+00	1.17E+01	1.38E+00	7.30E+01
Co	Ni rate ratio	HCT (2)	mg Co / mg Ni	Beta	8.29E-02	3.91E-02	2.24E-02	2.06E-01
Cr	Nonacidic rate	HCT (1+2)*	mg Cr/kg/week	Lognormal	5.49E-05	2.19E-05	N/A	N/A
Cu	S ratio	Aqua Regia	mg Cu / mg S	Normal	3.59E-01	8.84E-03	N/A	N/A
F	Nonacidic rate	HCT (1+2)	mg F/kg/week	Beta	2.36E-02	1.45E-03	2.04E-02	2.74E-02
Fe	S ratio	Pyrrhotite microprobe	mg Fe / mg S	Beta	1.62E+00	8.72E-02	1.49E+00	1.92E+00
K	SO_4 rate ratio	HCT (1+2)	mg K / mg SO_4	Beta	1.29E-01	8.54E-02	5.39E-02	4.00E-01
Mg	SO_4 rate ratio	HCT (1+2)	mg Mg / mg SO_4	Beta	1.39E-01	1.06E-01	3.37E-02	4.96E-01
Mn	SO_4 rate ratio	HCT (2)	mg Mn / mg SO_4	Beta	2.81E-03	2.56E-03	4.36E-04	1.10E-02
Na	SO_4 rate ratio	HCT (1+2)	mg Na / mg SO_4	Beta	1.33E-01	9.29E-02	3.54E-02	4.51E-01
Ni	S ratio	Cat 4 Aqua Regia	mg Ni / mg S	Normal	3.06E-02	1.86E-03	N/A	N/A
Pb	S ratio	Aqua Regia	mg Pb / mg S	Normal	1.24E-03	5.95E-05	N/A	N/A
Sb	S ratio	Aqua Regia	mg Sb / mg S	Normal	6.53E-04	2.81E-05	N/A	N/A
Se	SO_4 rate ratio	HCT (2)	mg Se / mg SO_4	Beta	3.54E-05	1.67E-05	1.30E-05	9.16E-05
SO_4	Rate Regression	HCT (1+2)	mg SO_4/kg/week/%S	Normal	13.92	0.581	N/A	N/A
Tl	Nonacidic rate	HCT (1+2)*	mg Tl/kg/week	Lognormal	2.73E-06	8.15E-06	N/A	N/A
V	K ratio	Aqua Regia	mg V / mg K	Normal	2.32E-02	7.29E-04	N/A	N/A
Zn	Ni rate ratio	HCT (2)	mg Zn / mg Ni	Beta	3.35E-01	3.71E-01	3.31E-02	1.60E+00

Additional Distributions for Selected Constituents

Constituent	*Method*	*Source*	*Units*	*Distribution*	*Mean/Mode*	*St. Dev.*	*Minimum*	*Maximum*
Al	Na ratio	Albite Formula	mg Al / mg Na	Constant	1.17E+00	N/A	N/A	N/A
Fe	Mg ratio	Olivine microprobe	mg Fe / mg Mg	Beta	1.87E+00	6.75E-01	1.19E+00	4.51E+00
Ni	Mg ratio	Olivine microprobe	mg Ni / mg Mg	Beta	4.59E-03	1.95E-03	1.10E-04	7.43E-03

Acidic-Conditions Distributions for Selected Constituents

Constituent	*Method*	*Source*	*Units*	*Distribution*	*Mean/Mode*	*St. Dev.*	*Minimum*	*Maximum*
Alkalinity	Acidic rate	No release	mg Alk/kg/week	Constant	0	N/A	N/A	N/A
B	Acidic rate	HCT (3)	mg B/kg/week	Triangular	4.58E-04	N/A	4.58E-04	1.61E-02
Cr	Acidic rate	HCT (3)	mg Cr/kg/week	Triangular	9.17E-05	N/A	9.17E-05	1.06E-04
F	Acidic rate	HCT (3)	mg F/kg/week	Triangular	2.29E-02	N/A	2.27E-03	2.29E-02
Tl	Acidic rate	HCT (3)	mg Tl/kg/week	Triangular	9.17E-06	N/A	9.17E-06	2.29E-05

N/A = not used

Notes

- Humidity cell data used through February 2011 unless noted otherwise.
- HCT (1+2) indicates average rates from humidity cells over Condition 1 and Condition 2.
- HCT (2) indicates average rates from humidity cells over Condition 2.
- HCT (3) indicates average rates from humidity cells over Condition 3.
- * indicates average rates from humidity cells over conditions noted with refined modeling of non-detects (see Section 8.1.2.1). Data used though December 2013.
- Except for SO4, all distributions from humidity cell data represent the full range of the observed values, with no weighting.
- Acidic release rate for SO_4 to be determined from nonacidic rate times an acidic increase factor, as discussed in Section 8.2.
- Distributions from aqua regia data represent the uncertainty in the average ratios, weighted by geologic unit.
- Distributions from microprobe data represent the full range of the observed ratios for each mineral, with no weighting.
- For nickel, S ratio from Category 4 aqua regia data represents the effect of all sulfide minerals combined.
- For chloride, release is a one-time flush from newly-exposed waste rock with a distribution determined from all humidity cells combined.

Table 1-26 Duluth Complex Category 4 Release Distributions

Constituent	*Method*	*Source*	*Units*	*Distribution*	*Mean/Mode*	*St. Dev.*	*Minimum*	*Maximum*
Ag	S ratio	Aqua Regia	mg Ag / mg S	Normal	3.30E-05	3.21E-06	N/A	N/A
Al	Ca ratio	Anorthite Formula	mg Al / mg Ca	Constant	1.35E+00	N/A	N/A	N/A
Alkalinity	Nonacidic rate	HCT (1+2)	mg Alk/kg/week	Beta	4.43E+00	2.60E+00	1.47E+00	1.10E+01
As	S ratio	Aqua Regia	mg As / mg S	Normal	1.40E-03	1.13E-04	N/A	N/A
B	Nonacidic rate	HCT (1+2)*	mg B/kg/week	Lognormal	9.99E-03	6.37E-03	N/A	N/A
Ba	K ratio	Aqua Regia	mg Ba / mg K	Normal	2.46E-02	1.17E-03	N/A	N/A
Be	K ratio	Aqua Regia	mg Be / mg K	Normal	3.30E-04	3.04E-05	N/A	N/A
Ca	SO_4 rate ratio	HCT (1+2)	mg Ca / mg SO_4	Beta	3.56E-01	1.26E-01	1.80E-01	7.91E-01
Cd	Zn rate ratio	HCT (2)	mg Cd / mg Zn	Beta	9.16E-03	5.39E-03	2.70E-03	3.15E-02
Cl	Flush	HCT (all)	mg Cl/kg	Beta	9.78E+00	1.17E+01	1.38E+00	7.30E+01
Co	Ni rate ratio	HCT (2)	mg Co / mg Ni	Beta	1.56E-01	7.51E-02	7.79E-02	4.64E-01
Cr	Nonacidic rate	HCT (1+2)*	mg Cr/kg/week	Lognormal	4.34E-05	7.03E-05	N/A	N/A
Cu	S ratio	Aqua Regia	mg Cu / mg S	Normal	6.81E-02	4.76E-03	N/A	N/A
F	Nonacidic rate	HCT (1+2)	mg F/kg/week	Beta	4.68E-02	4.78E-02	2.16E-02	3.37E-01
Fe	S ratio	Pyrrhotite microprobe	mg Fe / mg S	Beta	1.62E+00	8.72E-02	1.49E+00	1.92E+00
K	SO_4 rate ratio	HCT (1+2)	mg K / mg SO_4	Beta	1.00E-01	5.61E-02	2.61E-04	2.45E-01
Mg	SO_4 rate ratio	HCT (1+2)	mg Mg / mg SO_4	Beta	6.61E-02	4.17E-02	2.92E-02	2.00E-01
Mn	SO_4 rate ratio	HCT (2)	mg Mn / mg SO_4	Beta	2.94E-03	2.15E-03	5.94E-04	9.00E-03
Na	SO_4 rate ratio	HCT (1+2)	mg Na / mg SO_4	Beta	1.06E-01	1.02E-01	1.43E-02	4.51E-01
Ni	S ratio	Cat 4 Aqua Regia	mg Ni / mg S	Normal	3.06E-02	1.86E-03	N/A	N/A
Pb	S ratio	Aqua Regia	mg Pb / mg S	Normal	3.97E-04	4.33E-05	N/A	N/A
Sb	S ratio	Aqua Regia	mg Sb / mg S	Normal	1.30E-04	9.01E-06	N/A	N/A
Se	SO_4 rate ratio	HCT (2)	mg Se / mg SO_4	Beta	1.87E-05	9.12E-06	9.15E-06	4.91E-05
SO_4	Nonacidic rate	HCT (1+2)	mg SO_4/kg/week	Beta	1.27E+01	8.37E+00	3.74E+00	5.50E+01
Tl	Nonacidic rate	HCT (1+2)*	mg Tl/kg/week	Lognormal	7.36E-06	6.40E-06	N/A	N/A
V	K ratio	Aqua Regia	mg V / mg K	Normal	4.33E-02	3.24E-03	N/A	N/A
Zn	Ni rate ratio	HCT (2)	mg Zn / mg Ni	Beta	4.42E-01	6.69E-01	3.47E-02	3.50E+00

Additional Distributions for Selected Constituents

Constituent	*Method*	*Source*	*Units*	*Distribution*	*Mean/Mode*	*St. Dev.*	*Minimum*	*Maximum*
Al	Na ratio	Albite Formula	mg Al / mg Na	Constant	1.17E+00	N/A	N/A	N/A
Fe	Mg ratio	Olivine microprobe	mg Fe / mg Mg	Beta	1.87E+00	6.75E-01	1.19E+00	4.51E+00
Ni	Mg ratio	Olivine microprobe	mg Ni / mg Mg	Beta	4.59E-03	1.95E-03	1.10E-04	7.43E-03

Acidic-Conditions Distributions for Selected Constituents

Constituent	*Method*	*Source*	*Units*	*Distribution*	*Mean/Mode*	*St. Dev.*	*Minimum*	*Maximum*
Alkalinity	Acidic rate	No release	mg Alk/kg/week	Constant	0	N/A	N/A	N/A
B	Acidic rate	HCT (3)	mg B/kg/week	Beta	2.52E-03	2.33E-03	5.06E-04	1.00E-02
Cr	Acidic rate	HCT (3)	mg Cr/kg/week	Beta	1.07E-04	1.20E-05	9.34E-05	1.47E-04
F	Acidic rate	HCT (3)	mg F/kg/week	Beta	2.57E-02	4.30E-03	2.25E-02	4.19E-02
Tl	Acidic rate	HCT (3)	mg Tl/kg/week	Beta	1.54E-05	7.45E-06	9.73E-06	4.26E-05

N/A = not used

Notes

- Humidity cell data used through February 2011 unless noted otherwise.
- HCT (1+2) indicates average rates from humidity cells over Condition 1 and Condition 2.
- HCT (2) indicates average rates from humidity cells over Condition 2.
- HCT (3) indicates average rates from humidity cells over Condition 3.
- * indicates average rates from humidity cells over conditions noted with refined modeling of non-detects (see Section 8.1.2.1). Data used though December 2013.
- All distributions from humidity cell data represent the full range of the observed values, with no weighting.
- Acidic release rate for SO4 to be determined from nonacidic rate times an acidic increase factor, as discussed in Section 8.2.
- Distributions from aqua regia data represent the uncertainty in the average ratios, weighted by geologic unit.
- Distributions from microprobe data represent the full range of the observed ratios for each mineral, with no weighting.
- For nickel, S ratio from Category 4 aqua regia data represents the effect of all sulfide minerals combined.
- For chloride, release is a one-time flush from newly-exposed waste rock with a distribution determined from all humidity cells combined.

Table 1-27 Ore Release Distributions

Constituent	*Method*	*Source*	*Units*	*Distribution*	*Mean/Mode*	*St. Dev.*	*Minimum*	*Maximum*
Ag	S ratio	Aqua Regia	mg Ag / mg S	Normal	1.87E-04	2.80E-06	N/A	N/A
Al	Ca ratio	Anorthite Formula	mg Al / mg Ca	Constant	1.35E+00	N/A	N/A	N/A
Alkalinity	Nonacidic rate	HCT (1+2)	mg Alk/kg/week	Triangular	1.52E+00	N/A	1.37E+00	1.52E+00
As	S ratio	Aqua Regia	mg As / mg S	Normal	9.20E-04	3.48E-05	N/A	N/A
B	Nonacidic rate	HCT (1+2)	mg B/kg/week	Triangular	5.85E-03	N/A	5.09E-03	1.49E-02
Ba	K ratio	Aqua Regia	mg Ba / mg K	Normal	2.77E-02	1.06E-04	N/A	N/A
Be	K ratio	Aqua Regia	mg Be / mg K	Normal	1.22E-04	1.97E-06	N/A	N/A
Ca	SO_4 rate ratio	HCT (1+2)	mg Ca / mg SO_4	Triangular	2.16E-01	N/A	2.16E-01	2.18E-01
Cd	Zn rate ratio	HCT (2)	mg Cd / mg Zn	Triangular	5.76E-03	N/A	5.76E-03	6.72E-03
Cl	Flush	HCT (all)	mg Cl/kg	Beta	9.78E+00	1.17E+01	1.38E+00	7.30E+01
Co	Ni rate ratio	HCT (2)	mg Co / mg Ni	Triangular	4.86E-02	N/A	4.86E-02	6.08E-02
Cr	Nonacidic rate	HCT (1+2)	mg Cr/kg/week	Triangular	1.10E-04	N/A	1.10E-04	1.18E-04
Cu	S ratio	Aqua Regia	mg Cu / mg S	Normal	5.04E-01	5.62E-03	N/A	N/A
F	Nonacidic rate	HCT (1+2)	mg F/kg/week	Triangular	2.39E-02	N/A	2.39E-02	2.96E-02
Fe	S ratio	Pyrrhotite microprobe	mg Fe / mg S	Beta	1.62E+00	8.72E-02	1.49E+00	1.92E+00
K	SO_4 rate ratio	HCT (1+2)	mg K / mg SO_4	Triangular	3.97E-02	N/A	3.22E-02	4.16E-02
Mg	SO_4 rate ratio	HCT (1+2)	mg Mg / mg SO_4	Triangular	7.29E-02	N/A	7.29E-02	8.22E-02
Mn	SO_4 rate ratio	HCT (2)	mg Mn / mg SO_4	Triangular	5.89E-03	N/A	5.45E-03	6.27E-03
Na	SO_4 rate ratio	HCT (1+2)	mg Na / mg SO_4	Triangular	1.21E-02	N/A	1.21E-02	2.96E-01
Ni	S ratio	Ore Aqua Regia	mg Ni / mg S	Normal	1.53E-01	3.26E-03	N/A	N/A
Pb	S ratio	Aqua Regia	mg Pb / mg S	Normal	1.05E-03	4.85E-05	N/A	N/A
Sb	S ratio	Aqua Regia	mg Sb / mg S	Normal	3.38E-04	1.17E-05	N/A	N/A
Se	SO_4 rate ratio	HCT (2)	mg Se / mg SO_4	Triangular	4.01E-05	N/A	4.01E-05	4.42E-05
SO_4	Rate Regression	HCT (1+2)	mg SO_4/kg/week/%S	Normal	13.92	0.581	N/A	N/A
Tl	Nonacidic rate	HCT (1+2)	mg Tl/kg/week	Triangular	2.22E-05	N/A	1.74E-05	2.22E-05
V	K ratio	Aqua Regia	mg V / mg K	Normal	2.19E-02	3.36E-04	N/A	N/A
Zn	Ni rate ratio	HCT (2)	mg Zn / mg Ni	Triangular	2.28E-02	N/A	2.26E-02	3.00E-02

Additional Distributions for Selected Constituents

Constituent	*Method*	*Source*	*Units*	*Distribution*	*Mean/Mode*	*St. Dev.*	*Minimum*	*Maximum*
Al	Na ratio	Albite Formula	mg Al / mg Na	Constant	1.17E+00	N/A	N/A	N/A
Fe	Mg ratio	Olivine microprobe	mg Fe / mg Mg	Beta	1.87E+00	6.75E-01	1.19E+00	4.51E+00
Ni	Mg ratio	Olivine microprobe	mg Ni / mg Mg	Beta	4.59E-03	1.95E-03	1.10E-04	7.43E-03

N/A = not used

Notes

- HCT (1+2) indicates average rates from humidity cells over Condition 1 and Condition 2.
- HCT (2) indicates average rates from humidity cells over Condition 2.
- Except for SO4, all distributions from humidity cell data represent the full range of the observed values in the humidity cells, with no weighting. Distributions from humidity cells shown here are only used for the blended OSP; Category 2/3 humidity cells are used to capture the full range of variability in the ore wall rock.
- Acidic release rate for SO4 to be determined from nonacidic rate times an acidic increase factor, as discussed in Section 8.2.
- Distributions from aqua regia data represent the uncertainty in the average ratios, weighted by geologic unit.
- Distributions from microprobe data represent the full range of the observed ratios for each mineral, with no weighting.
- For nickel, S ratio from ore aqua regia data represents the effect of all sulfide minerals combined.
- For B, Cr, F, and Tl no increase in release rates due to acidic conditions is indicated by laboratory data.
- For chloride, release is a one-time flush from newly-exposed waste rock with a distribution determined from all humidity cells combined.

Table 1-28 Virginia Formation Category 4 Release Distributions

Constituent	*Method*	*Source*	*Units*	*Distribution*	*Mean/Mode*	*St. Dev.*	*Minimum*	*Maximum*
Ag	S ratio	Aqua Regia	mg Ag / mg S	Normal	3.42E-05	2.23E-06	N/A	N/A
Al	Ca ratio	Anorthite Formula	mg Al / mg Ca	Constant	1.35E+00	N/A	N/A	N/A
Alkalinity	Acidic rate	No release	mg Alk/kg/week	Constant	0	N/A	N/A	N/A
As	S ratio	Aqua Regia	mg As / mg S	Normal	2.87E-03	1.28E-04	N/A	N/A
B	Acidic rate	HCT (3)	mg B/kg/week	Triangular	6.70E-03	N/A	6.70E-03	1.70E-02
Ba	K ratio	Aqua Regia	mg Ba / mg K	Normal	1.51E-02	5.79E-04	N/A	N/A
Be	S ratio	Aqua Regia	mg Be / mg S	Normal	1.02E-04	1.02E-05	N/A	N/A
Ca	SO_4 rate ratio	HCT (3)	mg Ca / mg SO_4	Triangular	2.32E-02	N/A	2.32E-02	2.50E-01
Cd	S ratio	Aqua Regia	mg Cd / mg S	Normal	1.88E-04	5.11E-05	N/A	N/A
Cl	Flush	HCT (all)	mg Cl/kg	Beta	9.78E+00	1.17E+01	1.38E+00	7.30E+01
Co	S ratio	Aqua Regia	mg Co / mg S	Normal	4.26E-03	6.15E-04	N/A	N/A
Cr	Acidic rate	HCT (3)	mg Cr/kg/week	Triangular	1.11E-04	N/A	9.14E-05	1.28E-04
Cu	S ratio	Aqua Regia	mg Cu / mg S	Normal	2.51E-02	2.59E-03	N/A	N/A
F	Acidic rate	HCT (3)	mg F/kg/week	Triangular	2.50E-02	N/A	2.50E-02	4.98E-02
Fe	SO_4 rate ratio	HCT (3)	mg Fe / mg SO_4	Triangular	5.80E-02	N/A	3.98E-02	3.16E-01
K	SO_4 rate ratio	HCT (3)	mg K / mg SO_4	Triangular	8.03E-03	N/A	8.03E-03	1.79E-02
Mg	SO_4 rate ratio	HCT (3)	mg Mg / mg SO_4	Triangular	5.32E-02	N/A	2.93E-02	7.83E-02
Mn	Acidic rate	HCT (3)	mg Mn/kg/week	Triangular	7.11E-02	N/A	3.49E-02	1.56E-01
Na	SO_4 rate ratio	HCT (3)	mg Na / mg SO_4	Triangular	5.64E-03	N/A	5.64E-03	1.79E-02
Ni	S ratio	Aqua Regia	mg Ni / mg S	Normal	1.76E-02	1.39E-03	N/A	N/A
Pb	S ratio	Aqua Regia	mg Pb / mg S	Normal	9.23E-04	3.07E-04	N/A	N/A
Sb	S ratio	Aqua Regia	mg Sb / mg S	Normal	2.70E-04	2.28E-05	N/A	N/A
Se	SO_4 rate ratio	HCT (3)	mg Se / mg SO_4	Triangular	8.52E-06	N/A	4.86E-06	9.20E-06
SO_4	Acidic rate	HCT (3)	mg SO_4/kg/week	Triangular	5.76E+01	N/A	4.44E+01	5.76E+01
Tl	Acidic rate	HCT (3)	mg Tl/kg/week	Triangular	1.11E-05	N/A	9.92E-06	1.21E-05
V	K ratio	Aqua Regia	mg V / mg K	Normal	2.18E-02	1.07E-03	N/A	N/A
Zn	S ratio	Aqua Regia	mg Zn / mg S	Normal	3.03E-02	2.88E-03	N/A	N/A

Additional Distributions for Selected Constituents

Constituent	*Method*	*Source*	*Units*	*Distribution*	*Mean/Mode*	*St. Dev.*	*Minimum*	*Maximum*
Al	Na ratio	Albite Formula	mg Al / mg Na	Constant	1.17E+00	N/A	N/A	N/A

N/A = not used

Notes

- HCT (3) indicates average rates from humidity cells over Condition 3.
- All distributions from humidity cell data represent the full range of the observed values, with no weighting.
- Distributions from aqua regia data represent the uncertainty in the average ratios, weighted by geologic unit.
- For chloride, release is a one-time flush from newly-exposed waste rock with a distribution determined from all humidity cells combined.

Table 1-29 **Average Whole Rock Content for Depletion (ppm)**

Constituent	*Units*	*[Rock_Content.All(Cat1)] Category 1*	*[Rock_Content.All(Cat23)] Category 2/3*	*[Rock_Content.All(Cat4DC)] Category 4 Duluth Complex*	*[Rock_Content.All(Cat4VF)] Category 4 Virginia Formation*	*[Rock_Content.All(Ore)] Ore*
Ag	ppm	1.35E-01	2.80E-01	3.63E-01	3.61E-01	1.31E+00
Al	ppm	4.07E+04	3.86E+04	4.04E+04	3.23E+04	3.84E+04
Alkalinity*	ppm	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
As	ppm	2.47E+00	3.52E+00	1.99E+01	3.20E+01	6.92E+00
B	ppm	7.94E+00	7.32E+00	9.16E+00	8.82E+00	5.02E+00
Ba	ppm	4.07E+01	4.85E+01	5.57E+01	1.04E+02	4.72E+01
Be	ppm	2.43E-01	2.66E-01	6.15E-01	5.77E-01	1.81E-01
Ca	ppm	2.22E+04	2.18E+04	1.79E+04	5.93E+03	2.11E+04
Cd	ppm	4.19E-01	4.59E-01	7.34E-01	1.42E+00	9.72E-01
Cl*	ppm	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
Co	ppm	4.83E+01	4.99E+01	6.05E+01	2.56E+01	7.48E+01
Cr	ppm	1.01E+02	8.74E+01	1.23E+02	1.86E+02	8.26E+01
Cu	ppm	2.15E+02	7.47E+02	7.18E+02	2.17E+02	3.58E+03
F*	ppm	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
Fe	ppm	6.17E+04	5.97E+04	5.47E+04	5.28E+04	7.14E+04
K	ppm	1.40E+03	1.72E+03	2.66E+03	8.18E+03	1.75E+03
Mg	ppm	4.00E+04	3.30E+04	2.00E+04	1.37E+04	3.63E+04
Mn	ppm	7.01E+02	6.28E+02	3.69E+02	2.43E+02	6.65E+02
Na	ppm	5.80E+03	5.12E+03	3.40E+03	9.94E+02	4.87E+03
Ni	ppm	2.55E+02	3.29E+02	3.33E+02	1.35E+02	9.72E+02
Pb	ppm	2.45E+00	2.52E+00	5.10E+00	5.87E+00	6.22E+00
Sb	ppm	1.34E+00	1.31E+00	1.48E+00	1.74E+00	1.78E+00
Se*	ppm	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
SO_4†	ppm	1.90E+03	6.30E+03	2.85E+04	7.28E+04	2.70E+04
Tl	ppm	4.78E+00	4.74E+00	4.75E+00	4.30E+00	3.40E+00
V	ppm	3.32E+01	3.77E+01	9.11E+01	1.36E+02	3.69E+01
Zn	ppm	6.83E+01	7.18E+01	1.04E+02	2.51E+02	8.11E+01

Notes

* Whole rock content data not available. No depletion modeled.

† Sulfur data from Block Model (S converted to SO_4), all others from drill core dataset

Table 1-30 Category 1 Concentration Cap Distributions

Constituent	*Method*	*Source*	*Units*	*Distribution*	*Mean/Mode*	*St. Dev.*	*Minimum*	*Maximum*
Ag	Limit	Dunka Seep	mg/L	Constant	2.00E-04	N/A	N/A	N/A
Al	Function pH (Solubility equation)		mg/L		N/A	N/A	N/A	N/A
Alkalinity	Function pH (AMAX data)		mg/L		N/A	N/A	N/A	N/A
As	Limit	Whistle Mine	mg/L	Constant	1.00E-01	N/A	N/A	N/A
B	Limit	Whistle Mine	mg/L	Constant	1.00E-01	N/A	N/A	N/A
Ba	Solubility equation				N/A	N/A	N/A	N/A
Be	Limit	Dunka Seep	mg/L	Constant	4.00E-04	N/A	N/A	N/A
Ca	Solubility equation				N/A	N/A	N/A	N/A
Cd	Function Zn limit, Cd/Zn release ratio				N/A	N/A	N/A	N/A
Cl	No limit				N/A	N/A	N/A	N/A
Co	Function pH (AMAX data)				N/A	N/A	N/A	N/A
Cr	Limit	Whistle Mine	mg/L	Constant	1.00E-02	N/A	N/A	N/A
Cu	Function pH (AMAX data)				N/A	N/A	N/A	N/A
F	Solubility equation				N/A	N/A	N/A	N/A
Fe	Function pH (AMAX data)		mg/L		N/A	N/A	N/A	N/A
K	Function pH (AMAX data)		mg/L		N/A	N/A	N/A	N/A
Mg	Function Ca limit, Mg/Ca release ratio				N/A	N/A	N/A	N/A
Mn	Function pH (AMAX data)		mg/L		N/A	N/A	N/A	N/A
Na	Function pH (AMAX data)		mg/L		N/A	N/A	N/A	N/A
Ni	Function pH (AMAX data)		mg/L		N/A	N/A	N/A	N/A
Pb	Limit	Whistle Mine	mg/L	Constant	1.00E-01	N/A	N/A	N/A
Sb	Limit	NorthMet Lab Data	mg/L	Uniform	N/A	N/A	8.30E-03	1.00E-01
Se	Function SO4 limit, Se/SO4 release ratio				N/A	N/A	N/A	N/A
SO4	Solubility equation				N/A	N/A	N/A	N/A
Tl	Limit	Dunka Seep	mg/L	Constant	2.00E-04	N/A	N/A	N/A
V	Limit	Whistle Mine	mg/L	Constant	1.00E-02	N/A	N/A	N/A
Zn	Function pH (AMAX data)		mg/L		N/A	N/A	N/A	N/A

N/A = not used

pH-based Range from AMAX Data
(95th percentile values, all units mg/L)

pH	*Alkalinity*	*Co*	*Cu*	*Fe*	*K*	*Mn*	*Na*	*Ni*	*Zn*
8.1	6.90E+01	3.95E-02	3.95E-02	5.80E-02	4.57E+01	1.59E-01	3.13E+02	4.55E-01	2.48E-02
8.0	5.45E+01	1.00E-02	2.00E-02	2.00E-02	4.30E+01	1.40E-01	1.15E+02	2.00E-01	5.20E-02
7.9	4.00E+01	7.58E-02	5.73E-02	3.80E-02	4.80E+01	2.88E-01	3.90E+02	5.26E-01	8.88E-02
7.8	5.73E+01	6.00E-02	1.31E-01	5.50E-02	3.95E+01	2.05E-01	3.70E+02	3.75E-01	6.50E-02
7.7	5.04E+01	4.36E-02	1.23E-01	6.35E-02	4.37E+01	3.19E-01	4.68E+02	4.85E-01	1.15E-01
7.6	5.07E+01	4.00E-02	1.54E-01	7.75E-02	4.72E+01	2.10E-01	3.10E+02	4.55E-01	1.19E-01
7.5	4.82E+01	5.00E-02	1.00E-01	4.00E-02	4.60E+01	2.27E-01	2.18E+02	9.05E-01	9.64E-02
7.4	4.92E+01	7.00E-02	9.68E-02	4.20E-02	4.28E+01	1.72E-01	2.19E+02	1.28E+00	7.00E-02
7.3	3.59E+01	9.30E-02	2.00E-01	5.00E-02	5.04E+01	2.00E-01	2.31E+02	1.62E+00	1.33E-01
7.2	3.55E+01	1.36E-01	1.78E-01	1.01E-01	4.28E+01	1.75E-01	1.73E+02	2.08E+00	1.70E-01
7.1	3.45E+01	2.33E-01	2.85E-01	7.50E-02	4.61E+01	3.86E-01	1.38E+02	4.31E+00	2.93E-01
7.0	2.60E+01	2.80E-01	5.20E-01	4.00E-02	3.99E+01	3.08E-01	1.32E+02	5.91E+00	4.05E-01

pH-based Range from AMAX Data
(maximum values, all units mg/L)

pH	*Alkalinity*	*Co*	*Cu*	*Fe*	*K*	*Mn*	*Na*	*Ni*	*Zn*
8.1	7.00E+01	4.00E-02	4.00E-02	6.00E-02	4.60E+01	1.60E-01	3.17E+02	4.60E-01	2.50E-02
8.0	5.50E+01	1.00E-02	2.00E-02	2.00E-02	4.30E+01	1.40E-01	1.15E+02	2.00E-01	5.20E-02
7.9	4.00E+01	9.00E-02	6.00E-02	4.00E-02	4.90E+01	2.90E-01	3.95E+02	5.65E-01	9.00E-02
7.8	5.90E+01	7.00E-02	1.70E-01	6.00E-02	4.00E+01	2.40E-01	3.72E+02	4.20E-01	7.00E-02
7.7	5.10E+01	5.20E-02	1.31E-01	7.00E-02	5.00E+01	3.40E-01	5.55E+02	5.90E-01	1.20E-01
7.6	5.90E+01	6.00E-02	1.90E-01	2.10E-01	5.20E+01	2.30E-01	3.39E+02	1.07E+00	1.34E-01
7.5	5.27E+01	5.00E-02	1.30E-01	7.00E-02	6.00E+01	2.40E-01	3.13E+02	1.70E+00	1.00E-01
7.4	5.40E+01	8.00E-02	1.80E-01	6.00E-02	5.32E+01	1.90E-01	3.22E+02	1.35E+00	1.12E-01
7.3	3.60E+01	1.20E-01	2.60E-01	6.00E-02	5.90E+01	3.00E-01	2.60E+02	2.29E+00	2.30E-01
7.2	4.50E+01	1.50E-01	3.40E-01	7.00E-01	4.43E+01	2.40E-01	2.00E+02	3.42E+00	2.30E-01
7.1	4.10E+01	3.10E-01	7.50E-01	8.00E-02	4.80E+01	9.70E-01	5.91E+02	7.02E+00	3.70E-01
7.0	4.30E+01	6.20E-01	2.30E+00	4.00E-02	4.30E+01	3.80E-01	2.60E+02	1.30E+01	5.50E-01

Notes
- All distributions from Whistle Mine data represent the detection limit used for nonacidic conditions.

- Dunka Seep indicates the highest observed concentration or detection limit from the available Dunka Mine data (a single sampling event in May 2006 at Seep X) multiplied by a factor of 10.
- NorthMet Lab Data indicates a range between the highest observed concentration in the NorthMet tailings humidity cells and an estimated field-scale value developed by MDNR.

- All distributions from AMAX data represent a uniform distribution between the 95th percentile and maximum observed value at the referenced pH for AMAX piles with 0.64% S.
- Concentration caps for all constituents not shown are calculated from the equations shown below.

$$SO_4\left(\frac{mg}{L}\right) = 1294 \times \frac{[Mg + .5Na + .5K]\left(\frac{mmol}{kg \cdot week}\right)}{Ca\left(\frac{mmol}{kg \cdot week}\right)} + 1760$$

$$Ca\left(\frac{mmol}{L}\right) = \frac{2SO_{4,Cap}\left(\frac{mmol}{L}\right) + Alk_{Cap}\left(\frac{mmol}{L}\right) - K_{Cap}\left(\frac{mmol}{L}\right)}{2 + \frac{[2Mg + Na]\left(\frac{mmol}{kg \cdot week}\right)}{Ca\left(\frac{mmol}{kg \cdot week}\right)}}$$

$$Mg\left(\frac{mg}{L}\right) = Ca_{Cap}\left(\frac{mg}{L}\right) \cdot \left[\frac{Mg}{Ca}\right]\left(\frac{mg}{kg \cdot week}\right)$$

$$\log\left[Ba\left(\frac{mg}{L}\right)\right] = -0.32 \times \log\left[SO_4\left(\frac{mg}{L}\right)\right] - 0.87$$

$$F\left(\frac{mol}{L}\right) = \sqrt{\frac{8.91\text{x}10^{-11}\left(\frac{mol^3}{kg^3}\right)}{Ca\left(\frac{mol}{L}\right)}} \times \left[\rho_{water}\left(\frac{\text{kg}}{L}\right)\right]^{1.5}$$

$$\log\left[Al\left(\frac{mg}{L}\right)\right] = 0.909 \cdot \text{pH} - 9.44$$

Table 1-31 Duluth Complex Category 2/3, 4, and Ore Concentration Cap Distributions (Nonacidic Conditions)

Constituent	*Method*	*Source*	*Units*	*Distribution*	*Mean/Mode*	*St. Dev.*	*Minimum*	*Maximum*
Ag	Limit	Dunka Seep	mg/L	Constant	2.00E-04	N/A	N/A	N/A
Al	Function pH (Solubility equation)		mg/L		N/A	N/A	N/A	N/A
Alkalinity	Function pH (AMAX data)		mg/L		N/A	N/A	N/A	N/A
As	Limit	Whistle Mine	mg/L	Constant	1.00E-01	N/A	N/A	N/A
B	Limit	Whistle Mine	mg/L	Constant	1.00E-01	N/A	N/A	N/A
Ba	Solubility equation				N/A	N/A	N/A	N/A
Be	Limit	Dunka Seep	mg/L	Constant	4.00E-04	N/A	N/A	N/A
Ca	Solubility equation				N/A	N/A	N/A	N/A
Cd	Function Zn limit, Cd/Zn release ratio				N/A	N/A	N/A	N/A
Cl	No limit				N/A	N/A	N/A	N/A
Co	Function pH (AMAX data)				N/A	N/A	N/A	N/A
Cr	Limit	Whistle Mine	mg/L	Constant	1.00E-02	N/A	N/A	N/A
Cu	Function pH (AMAX data)				N/A	N/A	N/A	N/A
F	Solubility equation				N/A	N/A	N/A	N/A
Fe	Function pH (AMAX data)		mg/L		N/A	N/A	N/A	N/A
K	Function pH (AMAX data)		mg/L		N/A	N/A	N/A	N/A
Mg	Function Ca limit, Mg/Ca release ratio				N/A	N/A	N/A	N/A
Mn	Function pH (AMAX data)		mg/L		N/A	N/A	N/A	N/A
Na	Function pH (AMAX data)		mg/L		N/A	N/A	N/A	N/A
Ni	Function pH (AMAX data)		mg/L		N/A	N/A	N/A	N/A
Pb	Limit	Whistle Mine	mg/L	Constant	2.00E-03	N/A	N/A	N/A
Sb	Limit	NorthMet Lab Data	mg/L	Uniform	N/A	N/A	8.30E-03	1.00E-01
Se	Function SO4 limit, Se/SO4 release ratio				N/A	N/A	N/A	N/A
SO4	Solubility equation				N/A	N/A	N/A	N/A
Tl	Limit	Dunka Seep	mg/L	Constant	2.00E-04	N/A	N/A	N/A
V	Limit	Whistle Mine	mg/L	Constant	1.00E-02	N/A	N/A	N/A
Zn	Function pH (AMAX data)		mg/L		N/A	N/A	N/A	N/A

N/A = not used

pH-based Range from AMAX Data
(95th percentile values, all units mg/L)

pH	*Alkalinity*	*Co*	*Cu*	*Fe*	*K*	*Mn*	*Na*	*Ni*	*Zn*
7.5	4.79E+01	2.48E-01	1.30E-01	7.45E-02	4.60E+01	1.40E+00	4.68E+02	1.50E+00	1.00E-01
7.4	4.90E+01	2.04E-01	1.47E-01	5.90E-02	4.21E+01	1.49E+00	3.94E+02	1.58E+00	9.73E-02
7.3	3.59E+01	9.30E-02	2.00E-01	5.00E-02	5.04E+01	2.00E-01	2.31E+02	1.62E+00	1.33E-01
7.2	3.53E+01	1.89E-01	2.33E-01	1.68E-01	4.25E+01	1.72E+00	3.47E+02	3.21E+00	1.82E-01
7.1	3.45E+01	2.31E-01	2.84E-01	8.00E-02	4.60E+01	6.46E-01	1.85E+02	4.31E+00	2.91E-01
7.0	2.60E+01	5.08E-01	5.59E-01	5.00E-02	3.96E+01	2.48E+00	2.41E+02	7.40E+00	4.09E-01
6.9	2.80E+01	1.02E+00	3.70E+00	1.78E-01	4.18E+01	1.90E+00	1.82E+02	1.98E+01	7.30E-01
6.8	2.16E+01	1.45E+00	5.02E+00	7.00E-02	5.06E+01	1.13E+00	1.50E+02	2.98E+01	1.24E+00
6.7	2.18E+01	1.24E+00	4.30E+00	1.02E-01	4.80E+01	3.61E+00	1.69E+02	2.06E+01	8.78E-01
6.6	1.44E+01	1.05E+00	5.44E+00	1.26E-01	5.07E+01	2.91E+00	2.05E+02	2.46E+01	8.66E-01
6.5	1.60E+01	1.52E+00	6.50E+00	6.00E-02	4.65E+01	1.39E+00	1.42E+02	3.15E+01	1.26E+00
6.4	1.53E+01	2.10E+00	7.09E+00	1.86E-01	4.88E+01	3.45E+00	1.78E+02	5.08E+01	1.51E+00
6.3	1.17E+01	2.11E+00	8.85E+00	8.40E-02	5.04E+01	3.03E+00	2.38E+02	4.75E+01	1.29E+00
6.2	6.90E+00	2.56E+00	1.02E+01	4.00E-02	5.37E+01	4.01E+00	4.39E+02	7.00E+01	1.87E+00
6.1	9.90E+00	3.13E+00	1.49E+01	5.85E-02	6.15E+01	3.26E+00	1.27E+02	8.35E+01	2.33E+00
6.0	9.40E+00	1.42E+00	8.56E+00	3.00E-02	4.97E+01	3.40E+00	1.64E+02	3.02E+01	1.60E+00

pH-based Range from AMAX Data
(maximum values, all units mg/L)

pH	*Alkalinity*	*Co*	*Cu*	*Fe*	*K*	*Mn*	*Na*	*Ni*	*Zn*
7.5	5.27E+01	2.80E-01	1.70E-01	1.50E-01	6.00E+01	1.68E+00	7.00E+02	1.70E+00	1.74E-01
7.4	5.40E+01	2.16E+00	1.80E-01	7.00E-02	5.32E+01	2.40E+00	4.91E+02	2.15E+01	3.96E-01
7.3	3.60E+01	1.20E-01	2.60E-01	6.00E-02	5.90E+01	3.00E-01	2.60E+02	2.29E+00	2.30E-01
7.2	4.50E+01	8.10E-01	3.40E-01	7.00E-01	4.43E+01	2.14E+00	8.62E+02	6.70E+00	2.30E-01
7.1	4.10E+01	3.10E-01	7.50E-01	1.20E-01	4.80E+01	1.64E+00	1.11E+03	7.02E+00	3.70E-01
7.0	4.30E+01	1.24E+00	2.30E+00	6.00E-02	4.30E+01	3.05E+00	2.69E+02	1.30E+01	5.50E-01
6.9	5.03E+01	1.71E+00	6.24E+00	3.00E-01	5.52E+01	2.28E+00	2.13E+02	4.50E+01	1.15E+00
6.8	3.30E+01	2.41E+00	7.25E+00	1.20E-01	5.80E+01	1.74E+00	3.13E+02	4.40E+01	1.65E+00
6.7	3.30E+01	1.41E+00	5.01E+00	1.30E-01	4.84E+01	5.57E+00	3.30E+02	4.10E+01	1.17E+00
6.6	3.90E+01	3.22E+00	1.10E+01	1.02E+00	8.40E+01	3.23E+00	2.40E+02	8.00E+01	2.25E+00
6.5	2.10E+01	1.87E+00	6.95E+00	6.00E-02	5.60E+01	1.89E+00	3.04E+02	4.30E+01	1.53E+00
6.4	2.20E+01	3.24E+00	7.57E+00	3.90E-01	5.10E+01	4.07E+00	2.70E+02	7.95E+01	1.69E+00
6.3	1.36E+01	2.30E+00	1.70E+01	1.00E-01	5.20E+01	3.32E+00	2.49E+02	6.70E+01	1.56E+00
6.2	6.90E+00	3.65E+00	1.20E+01	4.00E-02	5.40E+01	4.10E+00	6.09E+02	9.10E+01	2.01E+00
6.1	9.90E+00	3.34E+00	1.70E+01	6.00E-02	6.35E+01	3.36E+00	1.30E+02	9.10E+01	2.58E+00
6.0	1.11E+01	1.60E+00	1.10E+01	3.00E-02	5.20E+01	3.40E+00	2.01E+02	3.20E+01	1.61E+00

Notes
• All distributions from Whistle Mine data represent the detection limit used for nonacidic conditions.

• Dunka Seep indicates the highest observed concentration or detection limit from the available Dunka Mine data (a single sampling event in May 2006 at Seep X) multiplied by a factor of 10.
• NorthMet Lab Data indicates a range between the highest observed concentration in the NorthMet tailings humidity cells and an estimated field-scale value developed by MDNR.

• All distributions from AMAX data represent a uniform distribution between the 95th percentile and maximum observed value at the referenced pH for all AMAX piles (0.64% S to 1.4% S).
• Concentration caps for all constituents not shown are calculated from the equations shown below.

$$SO_4\left(\frac{mg}{L}\right) = 1294 \times \frac{[Mg + .5Na + .5K]\left(\frac{mmol}{kg \cdot week}\right)}{Ca\left(\frac{mmol}{kg \cdot week}\right)} + 1760$$

$$\log\left[Al\left(\frac{mg}{L}\right)\right] = 0.909 \cdot \text{pH} - 9.44$$

$$Ca\left(\frac{mmol}{L}\right) = \frac{2SO_{4,Cap}\left(\frac{mmol}{L}\right) + Alk_{Cap}\left(\frac{mmol}{L}\right) - K_{Cap}\left(\frac{mmol}{L}\right)}{2 + \frac{[2Mg + Na]\left(\frac{mmol}{kg \cdot week}\right)}{Ca\left(\frac{mmol}{kg \cdot week}\right)}}$$

$$Mg\left(\frac{mg}{L}\right) = Ca_{Cap}\left(\frac{mg}{L}\right) \cdot \left[\frac{Mg}{Ca}\right]\left(\frac{mg}{kg \cdot week}\right)$$

$$\log\left[Ba\left(\frac{mg}{L}\right)\right] = -0.32 \times \log\left[SO_4\left(\frac{mg}{L}\right)\right] - 0.87$$

$$F\left(\frac{mol}{L}\right) = \sqrt{\frac{8.91\text{x}10^{-11}\left(\frac{mol^3}{kg^3}\right)}{Ca\left(\frac{mol}{L}\right)}} \times \left[\rho_{water}\left(\frac{kg}{L}\right)\right]^{1.5}$$

Table 1-32 Duluth Complex Category 2/3, 4, and Ore Concentration Cap Distributions (Acidic Conditions)

Distribution Fit to AMAX, Whistle, and Vangorda Mine Data

Constituent	*Method*	*Source*	*Units*	*Distribution*	*Mean/Mode*	*St. Dev.*	*Minimum*	*Maximum*
Ag	Cap	Whistle Mine	mg/L	Beta	4.20E-02	4.62E-03	3.40E-02	5.00E-02
Al	Cap	Whistle Mine	mg/L	Beta	4.33E+02	2.56E+02	1.13E+02	1.00E+03
Alkalinity	No cap				N/A	N/A	N/A	N/A
As	Cap	Whistle Mine	mg/L	Constant	1.00E-01	N/A	N/A	N/A
B	Cap	Whistle Mine	mg/L	Beta	2.19E-01	9.45E-02	9.23E-02	5.00E-01
Ba	Solubility equation				N/A	N/A	N/A	N/A
Be	Cap	Whistle Mine	mg/L	Beta	1.62E-02	4.31E-03	5.26E-03	2.21E-02
Ca	Cap	Whistle Mine	mg/L	Beta	4.09E+02	4.15E+01	2.62E+02	5.54E+02
Cd	Cap	Whistle Mine	mg/L	Beta	1.47E-01	8.84E-02	5.35E-02	4.51E-01
Cl	No cap				N/A	N/A	N/A	N/A
Co	Cap	Whistle Mine	mg/L	Beta	3.04E+01	9.27E+00	8.68E+00	4.14E+01
Cr	Cap	Whistle Mine	mg/L	Beta	1.60E-02	5.77E-04	1.50E-02	1.70E-02
Cu	Cap	AMAX pH 3-4	mg/L	Beta	1.49E+02	1.30E+01	9.79E+01	1.79E+02
F	Solubility equation				N/A	N/A	N/A	N/A
Fe	Cap	Whistle Mine	mg/L	Beta	9.57E+01	5.56E+01	1.61E+00	4.32E+02
K	Cap	Whistle Mine	mg/L	Beta	2.92E+01	9.52E+00	9.39E+00	1.53E+02
Mg	Cap	Whistle Mine	mg/L	Beta	9.92E+02	3.92E+02	4.82E+02	2.11E+03
Mn	Cap	Whistle Mine	mg/L	Beta	5.48E+01	2.32E+01	1.75E+01	1.03E+02
Na	Cap	Whistle Mine	mg/L	Beta	8.75E+01	6.32E+01	2.48E+01	7.17E+02
Ni	Cap	Whistle Mine	mg/L	Beta	6.41E+02	1.90E+02	9.97E+01	8.41E+02
Pb	Cap	Whistle Mine	mg/L	Beta	3.64E-01	1.36E-01	1.28E-01	6.00E-01
Sb	Cap	Whistle Mine	mg/L	Beta	2.00E+00	5.77E-01	1.00E+00	3.00E+00
Se	Cap	Whistle Mine	mg/L	Constant	1.00E-01	N/A	N/A	N/A
SO4	Cap	Whistle Mine	mg/L	Beta	9.52E+03	3.39E+03	3.29E+03	1.81E+04
Tl	Cap	Vangorda Mine	mg/L	Beta	4.47E-02	1.22E-01	2.00E-03	2.18E+00
V	Cap	Whistle Mine	mg/L	Beta	5.50E-02	2.89E-03	5.00E-02	6.00E-02
Zn	Cap	Whistle Mine	mg/L	Beta	1.54E+01	1.21E+01	6.34E+00	6.00E+01

N/A = not used

Notes

- All distributions from Whistle and Vangorda Mine data represent the full range of the observed values.
- All distributions from AMAX data represent the full range of the highest 5% of observed values in each 0.1 pH increment over the indicated pH range.
- Concentration caps for all constituents not shown are calculated from the equations shown below.

$$\log\left[Ba\left(\frac{mg}{L}\right)\right] = -0.32 \times \log\left[SO_4\left(\frac{mg}{L}\right)\right] - 0.87$$

$$F\left(\frac{mol}{L}\right) = \sqrt{\frac{8.91\text{x}10^{-11}\left(\frac{mol^3}{kg^3}\right)}{Ca\left(\frac{mol}{L}\right)}} \times \left[\rho_{water}\left(\frac{\text{kg}}{L}\right)\right]^{1.5}$$

Table 1-33 Virginia Formation Category 4 Concentration Cap Distributions (Acidic Conditions)

Distribution Fit to AMAX, Whistle, and Vangorda Mine Data

Constituent	*Method*	*Source*	*Units*	*Distribution*	*Mean/Mode*	*St. Dev.*	*Minimum*	*Maximum*
Ag	Cap	Vangorda Mine	mg/L	Beta	5.86E-02	7.07E-02	6.24E-03	8.65E-01
Al	Cap	Whistle Mine	mg/L	Beta	4.33E+02	2.56E+02	1.13E+02	1.00E+03
Alkalinity	No cap				N/A	N/A	N/A	N/A
As	Cap	Vangorda Mine	mg/L	Beta	4.21E-01	5.54E-01	1.13E-02	2.50E+00
B	Cap	Vangorda Mine	mg/L	Beta	1.39E+00	9.65E-01	1.30E-02	3.27E+00
Ba	Cap	Vangorda Mine	mg/L	Beta	2.61E-01	3.60E-01	4.96E-03	1.92E+00
Be	Cap	Vangorda Mine	mg/L	Beta	4.59E-02	6.33E-02	5.24E-03	3.20E-01
Ca	Cap	Vangorda Mine	mg/L	Beta	4.09E+02	4.85E+01	3.28E+02	4.98E+02
Cd	Cap	Whistle Mine	mg/L	Beta	1.47E-01	8.84E-02	5.35E-02	4.51E-01
Cl	No cap				N/A	N/A	N/A	N/A
Co	Cap	Vangorda Mine	mg/L	Beta	1.53E+01	6.81E+00	6.98E+00	3.08E+01
Cr	Cap	Vangorda Mine	mg/L	Beta	9.19E-02	1.52E-01	9.60E-03	8.70E-01
Cu	Cap	Vangorda Mine	mg/L	Beta	1.37E-01	1.03E-01	3.06E-02	6.08E-01
F	Solubility equation				N/A	N/A	N/A	N/A
Fe	Cap	Vangorda Mine	mg/L	Beta	8.60E+02	1.14E+03	6.00E+00	5.08E+03
K	Cap	Vangorda Mine	mg/L	Beta	1.26E+01	8.42E+00	6.00E-01	3.00E+01
Mg	Cap	Vangorda Mine	mg/L	Beta	2.03E+03	1.48E+03	5.75E+02	6.20E+03
Mn	Cap	Vangorda Mine	mg/L	Beta	1.55E+03	1.10E+03	3.30E+02	4.32E+03
Na	Cap	Vangorda Mine	mg/L	Beta	1.67E+01	1.01E+01	7.39E+00	1.22E+02
Ni	Cap	Vangorda Mine	mg/L	Beta	1.08E+01	5.45E+00	4.17E+00	2.33E+01
Pb	Cap	Whistle Mine	mg/L	Beta	3.64E-01	1.36E-01	1.28E-01	6.00E-01
Sb	Cap	Vangorda Mine	mg/L	Beta	3.25E+00	2.78E+00	1.00E-03	1.60E+01
Se	Cap	Vangorda Mine	mg/L	Beta	4.34E-01	5.99E-01	7.33E-02	3.20E+00
SO4	Cap	Vangorda Mine	mg/L	Beta	2.23E+04	2.21E+04	3.54E+03	1.00E+05
Tl	Cap	Vangorda Mine	mg/L	Beta	4.47E-02	1.22E-01	2.00E-03	2.18E+00
V	Cap	Vangorda Mine	mg/L	Beta	6.00E-02	9.66E-02	3.00E-03	5.15E-01
Zn	Cap	Whistle Mine	mg/L	Beta	1.54E+01	1.21E+01	6.34E+00	6.00E+01

N/A = not used

Notes

- All distributions from Whistle and Vangorda Mine data represent the full range of the observed values.
- Concentration caps for all constituents not shown are calculated from the equations shown below.

$$F\left(\frac{mol}{L}\right) = \sqrt{\frac{8.91\text{x}10^{-11}\left(\frac{mol^3}{kg^3}\right)}{Ca\left(\frac{mol}{L}\right)}} \times \left[\rho_{water}\left(\frac{kg}{L}\right)\right]^{1.5}$$

Table 1-34 **Waste Water Treatment Facility Effluent Targets**

Constituent	*[WWTF_Effluent. WWTF_Targets] Operations Target Concentration (mg/L)*	*[WWTF_Effluent. WWTF_Targets_Reclam] Reclamation Target Concentration (mg/L)*	*[WWTF_Effluent. WWTF_Targets_LongTerm] Long-Term Target Concentration (mg/L)*
Ag	0.001	0.001	0.001
Al	0.125	0.125	0.125
Alk	N/A	N/A	N/A
As	0.01	0.01	0.004
B	0.5	0.5	0.5
Ba	2	2	2
Be	0.004	0.004	0.004
Ca*	N/A	N/A	N/A
Cd	0.004	0.004	0.002
Cl	230	230	230
Co	0.005	0.005	0.005
Cr	0.011	0.011	0.011
Cu	0.03	0.016	0.009
F	2	2	2
Fe	0.3	0.3	0.3
K	N/A	N/A	0.5
Mg*	N/A	N/A	N/A
Mn	0.05	0.05	0.05
Na	N/A	N/A	N/A
Ni	0.100	0.090	0.050
Pb	0.019	0.007	0.003
Sb	0.031	0.031	0.031
Se	0.005	0.005	0.005
SO_4	250	150	9
Tl	0.00056	0.00056	0.00056
V	0.05	0.05	0.05
Zn	0.388	0.200	0.100
Hardness	250	200	100

Notes

Source: RS29T and RS29T Appendix C

* Calcium and magnesium concentrations are limited by the target hardness concentration

Constituents without defined limits are assumed to not be removed by the WWTF

Table 1-35 Flow Rates from the Plant Site

Time (yrs)	*[TB_toWP_Flow(Mean)] Mean Annual Flow (gpm)*	*[TB_toWP_Flow(StDev)] Standard Deviation of Annual Flow (gpm)*
0	0	0
20	2108	329
21	2163	322
22	2106	303
23	2082	343
24	2040	397
25	1895	351
26	1571	353
27	1173	314
28	881	334
29	725	275
30	852	338
31	816	293
32	800	276
33	805	281
34	665	282
35	550	260
36	416	269
37	418	214
38	400	310
39	365	285
40	436	308
41	498	335
42	434	304
43	440	297
44	442	322
45	472	249
46	458	313
47	504	280
48	423	236
49	460	269
50	465	269
51	427	292
52	456	280
53	459	305
54	499	233
55	0	0

Notes

Source: Plant Site probabilistic water quality model, Version 6

Table 1-36 *[TB_toWP_ConcMean]* **Mean Concentration in the Water from the Plant Site (mg/L)**

	Time (yrs)																		
Constituent	*0*	*20*	*21*	*22*	*23*	*24*	*25*	*26*	*27*	*28*	*29*	*30*	*31*	*32*	*33*	*34*	*35*	*36*	*37*
Ag	0	1.40E-04	1.50E-04	1.50E-04	1.50E-04	1.40E-04	1.40E-04	1.40E-04	1.30E-04	1.20E-04	1.10E-04	1.10E-04	1.10E-04	1.10E-04	1.10E-04	1.00E-04	1.00E-04	9.00E-05	9.00E-05
Al	0	9.68E-03	1.13E-02	1.14E-02	1.16E-02	1.09E-02	1.08E-02	1.02E-02	1.05E-02	1.06E-02	1.07E-02	1.06E-02	1.06E-02	1.05E-02	1.06E-02	1.06E-02	1.07E-02	1.13E-02	1.14E-02
Alk	0	9.85E+01	1.15E+02	1.14E+02	1.13E+02	1.09E+02	1.05E+02	1.01E+02	9.96E+01	9.95E+01	9.94E+01	9.86E+01	9.80E+01	9.80E+01	9.84E+01	9.86E+01	9.86E+01	9.89E+01	9.86E+01
As	0	8.96E-03	9.69E-03	9.61E-03	9.64E-03	9.80E-03	9.94E-03	9.91E-03	9.89E-03	9.94E-03	9.97E-03	9.89E-03	9.93E-03	9.96E-03	9.94E-03	1.00E-02	1.00E-02	1.00E-02	1.00E-02
B	0	2.09E-01	2.42E-01	2.42E-01	2.39E-01	2.33E-01	2.22E-01	2.11E-01	2.06E-01	2.03E-01	2.00E-01	1.96E-01	1.94E-01	1.95E-01	1.95E-01	1.94E-01	1.93E-01	1.91E-01	1.91E-01
Ba	0	8.93E-03	9.83E-03	9.69E-03	9.46E-03	9.16E-03	8.24E-03	6.68E-03	5.56E-03	5.15E-03	5.06E-03	5.20E-03	5.10E-03	5.05E-03	5.10E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03
Be	0	3.90E-04	4.30E-04	4.30E-04	4.30E-04	4.20E-04	4.10E-04	3.90E-04	3.80E-04	3.70E-04	3.60E-04	3.50E-04	3.50E-04	3.50E-04	3.50E-04	3.50E-04	3.40E-04	3.40E-04	3.30E-04
Ca	0	5.03E+01	5.50E+01	5.41E+01	5.29E+01	5.12E+01	4.79E+01	4.17E+01	3.72E+01	3.56E+01	3.53E+01	3.57E+01	3.54E+01	3.53E+01	3.54E+01	3.51E+01	3.51E+01	3.51E+01	3.51E+01
Cd	0	1.00E-03	9.90E-04	9.60E-04	8.90E-04	8.50E-04	8.40E-04	8.30E-04	7.70E-04	7.00E-04	6.50E-04	6.10E-04	5.80E-04	5.60E-04	5.50E-04	5.20E-04	4.70E-04	4.30E-04	4.00E-04
Cl	0	6.63E+00	7.34E+00	6.93E+00	6.57E+00	6.08E+00	5.05E+00	3.29E+00	1.99E+00	1.48E+00	1.37E+00	1.56E+00	1.43E+00	1.37E+00	1.43E+00	1.30E+00	1.30E+00	1.30E+00	1.30E+00
Co	0	4.85E-03	5.36E-03	5.32E-03	5.27E-03	5.23E-03	5.19E-03	5.06E-03	5.00E-03	5.00E-03	5.00E-03	4.99E-03	5.00E-03	4.99E-03	4.99E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03
Cr	0	4.17E-03	4.18E-03	4.21E-03	4.23E-03	4.23E-03	4.11E-03	3.85E-03	3.32E-03	2.77E-03	2.36E-03	2.12E-03	1.98E-03	1.91E-03	1.86E-03	1.81E-03	1.74E-03	1.69E-03	1.65E-03
Cu	0	2.60E-02	2.80E-02	2.62E-02	2.64E-02	2.68E-02	2.47E-02	1.74E-02	1.11E-02	9.43E-03	9.13E-03	9.57E-03	9.26E-03	9.16E-03	9.20E-03	9.00E-03	9.00E-03	9.00E-03	9.00E-03
F	0	9.37E-02	1.01E-01	9.49E-02	9.27E-02	9.36E-02	8.72E-02	6.88E-02	5.52E-02	5.11E-02	5.03E-02	5.10E-02	5.05E-02	5.03E-02	5.04E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02
Fe	0	1.29E+00	1.47E+00	1.44E+00	1.39E+00	1.26E+00	1.03E+00	6.90E-01	4.38E-01	3.42E-01	3.14E-01	3.62E-01	3.30E-01	3.19E-01	3.24E-01	3.00E-01	3.00E-01	3.00E-01	3.00E-01
K	0	4.05E+00	4.43E+00	4.15E+00	4.03E+00	3.77E+00	3.19E+00	1.98E+00	9.69E-01	6.24E-01	5.44E-01	6.52E-01	5.77E-01	5.45E-01	5.73E-01	5.00E-01	5.00E-01	5.00E-01	5.00E-01
Mg	0	3.93E+01	4.41E+01	4.19E+01	4.00E+01	3.61E+01	2.92E+01	1.70E+01	7.66E+00	4.28E+00	3.48E+00	4.71E+00	3.89E+00	3.56E+00	3.91E+00	3.00E+00	3.00E+00	3.00E+00	3.00E+00
Mn	0	3.01E-01	3.38E-01	3.24E-01	3.09E-01	2.86E-01	2.32E-01	1.47E-01	8.40E-02	5.87E-02	5.32E-02	6.37E-02	5.67E-02	5.34E-02	5.74E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02
Na	0	1.75E+01	1.95E+01	1.83E+01	1.71E+01	1.55E+01	1.27E+01	7.68E+00	3.97E+00	2.52E+00	2.20E+00	2.67E+00	2.34E+00	2.19E+00	2.35E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00
Ni	0	4.94E-02	5.38E-02	5.30E-02	5.26E-02	5.30E-02	5.35E-02	5.09E-02	5.00E-02	5.00E-02	5.00E-02	4.98E-02	4.99E-02	4.99E-02	4.98E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02
Pb	0	4.36E-03	4.70E-03	4.52E-03	4.48E-03	4.59E-03	4.53E-03	3.82E-03	3.20E-03	3.03E-03	3.01E-03	3.00E-03	3.00E-03	3.00E-03	3.00E-03	3.00E-03	3.00E-03	3.00E-03	3.00E-03
Sb	0	9.89E-03	9.92E-03	9.73E-03	9.17E-03	8.61E-03	8.41E-03	8.03E-03	7.47E-03	6.71E-03	6.14E-03	5.73E-03	5.55E-03	5.38E-03	5.24E-03	5.03E-03	4.82E-03	4.61E-03	4.48E-03
Se	0	2.84E-03	2.89E-03	2.88E-03	2.81E-03	2.75E-03	2.70E-03	2.60E-03	2.31E-03	1.93E-03	1.64E-03	1.43E-03	1.30E-03	1.21E-03	1.16E-03	1.08E-03	1.00E-03	9.30E-04	8.80E-04
SO_4	0	9.25E+01	1.04E+02	9.97E+01	9.61E+01	8.64E+01	6.99E+01	4.20E+01	2.00E+01	1.17E+01	1.00E+01	1.31E+01	1.13E+01	1.03E+01	1.07E+01	9.00E+00	9.00E+00	9.00E+00	9.00E+00
Tl	0	1.30E-04	1.30E-04	1.30E-04	1.30E-04	1.30E-04	1.20E-04	1.20E-04	1.10E-04	1.00E-04	1.00E-04	9.00E-05	9.00E-05	9.00E-05	9.00E-05	8.00E-05	8.00E-05	7.00E-05	7.00E-05
V	0	5.67E-03	5.75E-03	5.72E-03	5.63E-03	5.55E-03	5.48E-03	5.30E-03	4.89E-03	4.38E-03	4.04E-03	3.77E-03	3.64E-03	3.57E-03	3.50E-03	3.36E-03	3.07E-03	2.79E-03	2.63E-03
Zn	0	7.23E-02	7.64E-02	7.43E-02	7.13E-02	7.06E-02	7.01E-02	7.07E-02	6.53E-02	6.11E-02	5.63E-02	5.25E-02	4.96E-02	4.84E-02	4.73E-02	4.41E-02	3.90E-02	3.46E-02	3.16E-02

Notes

Source: Plant Site probabilistic water quality model, Version 6

Table 1-36 (continued) [TB_toWP_ConcMean] Mean Concentration in the Water from the Plant Site (mg/L)

	Time (yrs)																	
Constituent	*38*	*39*	*40*	*41*	*42*	*43*	*44*	*45*	*46*	*47*	*48*	*49*	*50*	*51*	*52*	*53*	*54*	*55*
Ag	9.00E-05	9.00E-05	9.00E-05	9.00E-05	8.00E-05	8.00E-05	8.00E-05	8.00E-05	8.00E-05	8.00E-05	8.00E-05	8.00E-05	8.00E-05	8.00E-05	8.00E-05	8.00E-05	8.00E-05	0
Al	1.10E-02	1.11E-02	1.13E-02	1.13E-02	1.13E-02	1.16E-02	1.13E-02	1.13E-02	1.11E-02	1.13E-02	1.12E-02	1.10E-02	1.10E-02	1.14E-02	1.13E-02	1.11E-02	1.12E-02	0
Alk	9.86E+01	9.81E+01	9.80E+01	9.79E+01	9.77E+01	9.78E+01	9.75E+01	9.77E+01	9.72E+01	9.73E+01	9.75E+01	9.74E+01	9.71E+01	9.73E+01	9.70E+01	9.75E+01	9.65E+01	0
As	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	0
B	1.91E-01	1.91E-01	1.90E-01	1.90E-01	1.90E-01	1.91E-01	1.91E-01	1.92E-01	1.90E-01	1.91E-01	1.91E-01	1.91E-01	1.92E-01	1.93E-01	1.93E-01	1.93E-01	1.92E-01	0
Ba	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	0
Be	3.30E-04	3.30E-04	3.30E-04	3.30E-04	3.20E-04	3.20E-04	3.20E-04	3.20E-04	3.10E-04	3.20E-04	3.10E-04	3.10E-04	3.10E-04	3.20E-04	3.20E-04	3.20E-04	3.10E-04	0
Ca	3.51E+01	3.51E+01	3.51E+01	3.51E+01	3.51E+01	3.51E+01	3.51E+01	3.51E+01	3.51E+01	3.51E+01	3.51E+01	3.51E+01	3.51E+01	3.51E+01	3.51E+01	3.51E+01	3.51E+01	0
Cd	3.80E-04	3.80E-04	3.80E-04	3.70E-04	3.50E-04	3.40E-04	3.40E-04	3.40E-04	3.40E-04	3.40E-04	3.30E-04	3.30E-04	3.40E-04	3.30E-04	3.40E-04	3.50E-04	3.40E-04	3.30E-04	0
Cl	1.30E+00	1.30E+00	1.30E+00	1.30E+00	1.30E+00	1.30E+00	1.30E+00	1.30E+00	1.30E+00	1.30E+00	1.30E+00	1.30E+00	1.30E+00	1.30E+00	1.30E+00	1.30E+00	1.30E+00	0
Co	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	0
Cr	1.64E-03	1.63E-03	1.61E-03	1.57E-03	1.53E-03	1.51E-03	1.50E-03	1.49E-03	1.47E-03	1.46E-03	1.46E-03	1.47E-03	1.46E-03	1.46E-03	1.47E-03	1.47E-03	1.46E-03	0
Cu	9.00E-03	9.00E-03	9.00E-03	9.00E-03	9.00E-03	9.00E-03	9.00E-03	9.00E-03	9.00E-03	9.00E-03	9.00E-03	9.00E-03	9.00E-03	9.00E-03	9.00E-03	9.00E-03	9.00E-03	0
F	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	0
Fe	3.00E-01	3.00E-01	3.00E-01	3.00E-01	3.00E-01	3.00E-01	3.00E-01	3.00E-01	3.00E-01	3.00E-01	3.00E-01	3.00E-01	3.00E-01	3.00E-01	3.00E-01	3.00E-01	3.00E-01	0
K	5.00E-01	5.00E-01	5.00E-01	5.00E-01	5.00E-01	5.00E-01	5.00E-01	5.00E-01	5.00E-01	5.00E-01	5.00E-01	5.00E-01	5.00E-01	5.00E-01	5.00E-01	5.00E-01	5.00E-01	0
Mg	3.00E+00	3.00E+00	3.00E+00	3.00E+00	3.00E+00	3.00E+00	3.00E+00	3.00E+00	3.00E+00	3.00E+00	3.00E+00	3.00E+00	3.00E+00	3.00E+00	3.00E+00	3.00E+00	3.00E+00	0
Mn	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	0
Na	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	2.00E+00	0
Ni	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	5.00E-02	0
Pb	3.00E-03	3.00E-03	3.00E-03	3.00E-03	3.00E-03	3.00E-03	3.00E-03	3.00E-03	3.00E-03	3.00E-03	3.00E-03	3.00E-03	3.00E-03	3.00E-03	3.00E-03	3.00E-03	3.00E-03	0
Sb	4.35E-03	4.33E-03	4.23E-03	4.10E-03	4.00E-03	3.95E-03	3.92E-03	3.86E-03	3.82E-03	3.84E-03	3.85E-03	3.86E-03	3.90E-03	3.82E-03	3.83E-03	3.88E-03	3.82E-03	0
Se	8.40E-04	8.20E-04	8.10E-04	8.00E-04	7.70E-04	7.60E-04	7.30E-04	7.20E-04	7.10E-04	7.00E-04	7.00E-04	7.00E-04	6.90E-04	6.90E-04	6.90E-04	6.90E-04	6.90E-04	0
SO_4	9.00E+00	9.00E+00	9.00E+00	9.00E+00	9.00E+00	9.00E+00	9.00E+00	9.00E+00	9.00E+00	9.00E+00	9.00E+00	9.00E+00	9.00E+00	9.00E+00	9.00E+00	9.00E+00	9.00E+00	0
Tl	7.00E-05	6.00E-05	6.00E-05	6.00E-05	6.00E-05	6.00E-05	6.00E-05	6.00E-05	6.00E-05	6.00E-05	6.00E-05	6.00E-05	6.00E-05	6.00E-05	6.00E-05	6.00E-05	6.00E-05	0
V	2.54E-03	2.50E-03	2.47E-03	2.41E-03	2.36E-03	2.32E-03	2.30E-03	2.29E-03	2.28E-03	2.27E-03	2.25E-03	2.27E-03	2.27E-03	2.26E-03	2.28E-03	2.29E-03	2.28E-03	0
Zn	2.96E-02	2.84E-02	2.78E-02	2.71E-02	2.57E-02	2.53E-02	2.51E-02	2.50E-02	2.47E-02	2.44E-02	2.45E-02	2.46E-02	2.43E-02	2.42E-02	2.43E-02	2.38E-02	2.35E-02	0

Notes

Source: Plant Site probabilistic water quality model, Version 6

Table 1-37 *[TB_toWP_ConcStdev]* **Standard Devation of Concentration in the Water from the Plant Site (mg/L)**

	Time (yrs)																		
Constituent	*0*	*20*	*21*	*22*	*23*	*24*	*25*	*26*	*27*	*28*	*29*	*30*	*31*	*32*	*33*	*34*	*35*	*36*	*37*
Ag	0	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05
Al	0	2.15E-03	2.40E-03	2.48E-03	2.73E-03	2.56E-03	2.60E-03	2.41E-03	2.52E-03	2.54E-03	2.50E-03	2.54E-03	2.62E-03	2.54E-03	2.70E-03	2.57E-03	2.48E-03	2.94E-03	2.89E-03
Alk	0	9.64E+00	9.93E+00	1.01E+01	9.66E+00	8.87E+00	7.78E+00	6.46E+00	4.77E+00	3.95E+00	2.52E+00	4.18E+00	4.02E+00	3.88E+00	4.02E+00	2.87E+00	2.86E+00	1.71E+00	2.22E+00
As	0	3.60E-04	3.50E-04	3.70E-04	4.00E-04	3.90E-04	2.70E-04	1.30E-04	9.00E-05	5.00E-05	2.00E-05	9.00E-05	5.00E-05	3.00E-05	5.00E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
B	0	1.94E-02	1.94E-02	1.83E-02	1.96E-02	1.75E-02	1.89E-02	2.01E-02	1.92E-02	1.68E-02	1.38E-02	1.45E-02	1.37E-02	1.42E-02	1.51E-02	1.70E-02	1.55E-02	1.64E-02	1.44E-02
Ba	0	1.46E-03	1.58E-03	1.44E-03	1.73E-03	1.80E-03	1.71E-03	1.21E-03	4.30E-04	1.20E-04	5.00E-05	1.60E-04	8.00E-05	4.00E-05	8.00E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Be	0	4.00E-05	5.00E-05	5.00E-05	6.00E-05	6.00E-05	6.00E-05	6.00E-05	6.00E-05	6.00E-05	6.00E-05	6.00E-05	6.00E-05	6.00E-05	7.00E-05	7.00E-05	7.00E-05	7.00E-05	7.00E-05
Ca	0	6.54E+00	7.05E+00	6.54E+00	7.32E+00	8.00E+00	6.79E+00	4.69E+00	1.60E+00	3.78E-01	1.28E-01	4.42E-01	2.40E-01	1.29E-01	2.18E-01	7.00E-05	7.00E-05	0.00E+00	0.00E+00
Cd	0	3.40E-04	3.20E-04	3.20E-04	2.70E-04	2.60E-04	2.60E-04	2.50E-04	2.20E-04	1.80E-04	1.60E-04	1.40E-04	1.40E-04	1.30E-04	1.30E-04	1.20E-04	1.10E-04	1.10E-04	1.00E-04
Cl	0	1.89E+00	1.94E+00	1.86E+00	2.00E+00	2.05E+00	1.99E+00	1.44E+00	5.36E-01	1.42E-01	5.56E-02	2.01E-01	1.01E-01	5.73E-02	1.00E-01	3.00E-05	3.00E-05	0.00E+00	0.00E+00
Co	0	4.10E-04	5.30E-04	5.00E-04	4.50E-04	4.20E-04	3.20E-04	1.70E-04	1.10E-04	8.00E-05	2.00E-05	1.00E-05	0.00E+00	1.00E-05	1.00E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cr	0	3.00E-04	3.00E-04	3.40E-04	3.20E-04	3.10E-04	3.30E-04	3.40E-04	2.70E-04	2.00E-04	1.50E-04	1.60E-04	1.40E-04	1.30E-04	1.20E-04	1.10E-04	1.20E-04	1.20E-04	1.20E-04
Cu	0	7.60E-03	8.96E-03	7.72E-03	8.48E-03	9.50E-03	8.79E-03	6.14E-03	1.60E-03	3.40E-04	1.00E-04	4.50E-04	2.00E-04	1.30E-04	1.50E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
F	0	1.68E-02	1.75E-02	1.46E-02	1.74E-02	2.22E-02	2.04E-02	1.34E-02	4.06E-03	8.30E-04	2.60E-04	7.50E-04	3.60E-04	2.00E-04	2.90E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fe	0	3.46E-01	4.14E-01	4.25E-01	4.53E-01	4.86E-01	3.94E-01	2.82E-01	1.08E-01	3.30E-02	1.07E-02	4.80E-02	2.35E-02	1.50E-02	1.87E-02	1.00E-05	1.00E-05	0.00E+00	0.00E+00
K	0	1.34E+00	1.34E+00	1.22E+00	1.45E+00	1.65E+00	1.42E+00	1.07E+00	3.66E-01	9.67E-02	3.42E-02	1.19E-01	5.97E-02	3.54E-02	5.73E-02	2.00E-05	2.00E-05	0.00E+00	0.00E+00
Mg	0	1.24E+01	1.24E+01	1.29E+01	1.27E+01	1.50E+01	1.42E+01	1.02E+01	3.63E+00	1.00E+00	3.75E-01	1.34E+00	6.94E-01	4.35E-01	7.13E-01	2.30E-04	2.80E-04	0.00E+00	0.00E+00
Mn	0	8.97E-02	1.00E-01	9.58E-02	9.97E-02	1.09E-01	9.71E-02	7.07E-02	2.65E-02	6.78E-03	2.52E-03	1.07E-02	5.23E-03	2.64E-03	5.73E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na	0	5.41E+00	5.98E+00	5.56E+00	6.02E+00	6.41E+00	5.73E+00	4.08E+00	1.54E+00	4.07E-01	1.59E-01	5.25E-01	2.63E-01	1.49E-01	2.72E-01	8.00E-05	1.00E-04	0.00E+00	0.00E+00
Ni	0	5.32E-03	6.16E-03	5.67E-03	5.14E-03	4.81E-03	4.29E-03	1.81E-03	7.00E-04	4.30E-04	0.00E+00	1.60E-04	1.00E-04	8.00E-05	1.40E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pb	0	6.00E-04	6.30E-04	5.10E-04	6.40E-04	8.10E-04	8.30E-04	5.90E-04	1.60E-04	2.00E-05	0.00E+00	0.00E+00	1.00E-05	1.00E-05	1.00E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sb	0	1.69E-03	1.60E-03	1.45E-03	1.48E-03	1.33E-03	1.55E-03	1.31E-03	1.20E-03	1.07E-03	8.60E-04	8.80E-04	8.60E-04	8.00E-04	7.90E-04	7.20E-04	7.80E-04	8.90E-04	9.00E-04
Se	0	4.50E-04	4.20E-04	4.30E-04	4.40E-04	4.40E-04	4.80E-04	4.30E-04	3.90E-04	3.00E-04	2.40E-04	2.00E-04	1.60E-04	1.40E-04	1.40E-04	1.10E-04	1.20E-04	1.20E-04	1.20E-04
SO_4	0	2.89E+01	3.21E+01	3.36E+01	3.59E+01	3.93E+01	3.27E+01	2.38E+01	8.59E+00	2.13E+00	7.78E-01	3.23E+00	1.78E+00	1.03E+00	1.29E+00	6.10E-04	7.60E-04	0.00E+00	0.00E+00
Tl	0	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05
V	0	3.90E-04	3.80E-04	3.90E-04	3.80E-04	3.90E-04	3.70E-04	3.80E-04	2.70E-04	2.30E-04	1.80E-04	1.90E-04	1.70E-04	1.50E-04	1.50E-04	1.30E-04	1.30E-04	1.40E-04	1.30E-04
Zn	0	7.94E-03	9.48E-03	1.18E-02	1.37E-02	1.49E-02	1.61E-02	1.70E-02	1.31E-02	1.11E-02	8.86E-03	8.09E-03	6.73E-03	6.25E-03	6.36E-03	5.83E-03	5.60E-03	5.79E-03	5.76E-03

Notes

Source: Plant Site probabilistic water quality model, Version 6

Table 1-37 (continued) [TB_toWP_ConcStdev] Standard Devation of Concentration in the Water from the Plant Site (mg/L)

	Time (yrs)																	
Constituent	*38*	*39*	*40*	*41*	*42*	*43*	*44*	*45*	*46*	*47*	*48*	*49*	*50*	*51*	*52*	*53*	*54*	*55*
Ag	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	0
Al	2.79E-03	2.69E-03	3.04E-03	3.01E-03	3.15E-03	3.09E-03	3.00E-03	3.04E-03	3.07E-03	3.16E-03	3.03E-03	2.84E-03	2.99E-03	3.25E-03	3.18E-03	3.20E-03	3.20E-03	0
Alk	2.32E+00	2.22E+00	2.37E+00	2.71E+00	2.68E+00	2.85E+00	3.02E+00	2.75E+00	2.71E+00	3.56E+00	2.67E+00	2.95E+00	3.50E+00	3.46E+00	3.09E+00	2.72E+00	3.93E+00	0
As	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0
B	1.46E-02	1.42E-02	1.43E-02	1.45E-02	1.51E-02	1.60E-02	1.68E-02	1.52E-02	1.66E-02	1.64E-02	1.66E-02	1.64E-02	1.72E-02	1.80E-02	1.86E-02	1.81E-02	1.80E-02	0
Ba	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0
Be	8.00E-05	8.00E-05	8.00E-05	8.00E-05	8.00E-05	8.00E-05	8.00E-05	8.00E-05	8.00E-05	8.00E-05	9.00E-05	9.00E-05	9.00E-05	8.00E-05	9.00E-05	9.00E-05	9.00E-05	0
Ca	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0
Cd	1.00E-04	1.00E-04	1.00E-04	1.10E-04	9.00E-05	9.00E-05	8.00E-05	9.00E-05	9.00E-05	9.00E-05	9.00E-05	9.00E-05	9.00E-05	1.00E-04	1.00E-04	9.00E-05	1.00E-04	0
Cl	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0
Co	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0
Cr	1.20E-04	1.20E-04	1.10E-04	1.10E-04	1.10E-04	1.10E-04	1.00E-04	1.00E-04	1.00E-04	1.00E-04	1.00E-04	1.00E-04	1.00E-04	1.00E-04	1.00E-04	1.00E-04	1.00E-04	0
Cu	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0
F	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E-05	1.00E-05	2.00E-05	1.00E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0
Fe	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0
K	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0
Mg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0
Mn	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0
Na	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0
Ni	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0
Pb	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0
Sb	8.50E-04	8.60E-04	8.00E-04	8.00E-04	7.90E-04	7.60E-04	7.30E-04	7.00E-04	7.10E-04	7.40E-04	7.20E-04	7.70E-04	7.90E-04	7.30E-04	7.80E-04	8.20E-04	8.10E-04	0
Se	1.20E-04	1.20E-04	1.20E-04	1.20E-04	1.20E-04	1.10E-04	1.00E-04	1.00E-04	9.00E-05	9.00E-05	9.00E-05	9.00E-05	9.00E-05	1.00E-04	1.00E-04	1.00E-04	1.00E-04	0
SO_4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0
Tl	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	0
V	1.30E-04	1.30E-04	1.20E-04	1.30E-04	1.30E-04	1.30E-04	1.10E-04	1.10E-04	1.00E-04	1.20E-04	1.30E-04	1.20E-04	1.10E-04	1.20E-04	1.10E-04	1.00E-04	1.10E-04	0
Zn	4.99E-03	4.56E-03	4.58E-03	4.82E-03	4.22E-03	3.92E-03	3.94E-03	4.16E-03	4.33E-03	4.34E-03	4.68E-03	4.95E-03	4.55E-03	4.62E-03	5.01E-03	4.69E-03	4.64E-03	0

Notes

Source: Plant Site probabilistic water quality model, Version 6

Table 1-38 Concentrate Flow Rates from the Plant Site WWTF

Time (yrs)	*[Concentrate_toWWTF_Flow(Mean)] Mean Annual Flow (gpm)*	*[Concentrate_toWWTF_Flow(StDev)] Standard Deviation of Annual Flow (gpm)*
0	94	0.0
1	94	0.0
2	94	0.0
3	94	0.0
4	94	0.0
5	94	0.0
6	95	0.5
7	105	8.0
8	137	24.8
9	150	28.4
10	139	30.2
11	137	25.4
12	131	23.5
13	137	26.6
14	128	22.2
15	94	0.0
16	94	0.0
17	94	0.0
18	135	13.4
19	95	0.1
20	175	0
25	175	0
30	175	0
35	175	0
40	175	0
45	175	0
50	175	0
56	0	0

Notes

Source: Plant Site probabilistic water quality model, Version AWMP 6

Table 1-39 *[Concentrate_toWWTF_ConcMean]* **Mean Concentration in the concentrate from the Plant Site WWTF (mg/L)**

	Time (yrs)																			
Constituent	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*
Ag	1.10E-04	1.20E-04	1.20E-04	1.20E-04	1.50E-04	2.20E-04	3.00E-04	2.90E-04	2.40E-04	2.10E-04	1.90E-04	1.90E-04	1.90E-04	1.90E-04	1.90E-04	1.90E-04	1.90E-04	1.80E-04	1.70E-04	1.80E-04
Al	1.17E-02	1.29E-02	1.28E-02	1.25E-02	1.20E-02	1.18E-02	1.05E-02	8.56E-03	7.13E-03	6.33E-03	5.11E-03	5.22E-03	5.88E-03	7.27E-03	7.18E-03	4.33E-03	2.99E-03	2.48E-03	5.92E-03	2.34E-03
Alk	3.18E+03	3.50E+03	3.49E+03	3.26E+03	2.57E+03	1.59E+03	8.21E+02	2.77E+02	1.17E+02	8.43E+01	7.22E+01	7.40E+01	8.10E+01	1.37E+02	1.58E+02	8.42E+01	5.52E+01	5.04E+01	1.59E+02	4.90E+01
As	4.06E-03	4.65E-03	4.87E-03	5.14E-03	5.85E-03	7.05E-03	3.51E-02	9.91E-02	1.37E-01	1.76E-01	2.37E-01	3.10E-01	3.77E-01	4.13E-01	5.33E-01	7.96E-01	9.51E-01	1.03E+00	8.29E-01	1.06E+00
B	2.72E-01	3.00E-01	2.99E-01	2.91E-01	2.82E-01	2.79E-01	2.64E-01	2.31E-01	1.99E-01	1.80E-01	1.58E-01	1.60E-01	1.73E-01	1.99E-01	1.94E-01	1.45E-01	1.20E-01	1.10E-01	1.63E-01	1.06E-01
Ba	3.51E+00	3.84E+00	3.83E+00	3.63E+00	2.84E+00	1.63E+00	8.52E-01	5.62E-01	4.57E-01	4.18E-01	4.00E-01	3.94E-01	4.07E-01	4.18E-01	4.08E-01	3.83E-01	3.44E-01	3.17E-01	3.15E-01	3.00E-01
Be	2.30E-04	2.60E-04	2.60E-04	2.60E-04	2.80E-04	3.50E-04	4.20E-04	4.40E-04	4.20E-04	4.20E-04	4.10E-04	4.20E-04	4.30E-04	4.50E-04	4.40E-04	4.20E-04	3.90E-04	3.80E-04	4.00E-04	3.80E-04
Ca	1.46E+02	2.00E+02	2.52E+02	2.85E+02	4.55E+02	6.00E+02	8.13E+02	8.33E+02	8.28E+02	8.86E+02	9.21E+02	1.09E+03	1.28E+03	1.52E+03	1.94E+03	2.61E+03	3.13E+03	3.40E+03	3.15E+03	3.73E+03
Cd	1.20E-04	1.40E-04	1.60E-04	1.80E-04	2.50E-04	3.80E-04	5.80E-04	6.50E-04	6.70E-04	7.20E-04	8.00E-04	9.00E-04	9.90E-04	1.01E-03	1.08E-03	1.32E-03	1.46E-03	1.55E-03	1.41E-03	1.64E-03
Cl	3.76E+02	4.14E+02	4.15E+02	4.05E+02	3.88E+02	3.98E+02	4.24E+02	4.27E+02	4.10E+02	4.04E+02	4.06E+02	4.09E+02	4.12E+02	4.07E+02	4.01E+02	4.09E+02	4.29E+02	4.52E+02	4.64E+02	4.95E+02
Co	2.03E-03	3.04E-03	5.56E-03	2.44E-02	5.48E-02	1.01E-01	1.74E-01	2.00E-01	1.97E-01	2.02E-01	2.35E-01	2.63E-01	2.80E-01	2.85E-01	3.19E-01	4.31E-01	5.01E-01	5.24E-01	4.57E-01	5.46E-01
Cr	4.90E-04	6.00E-04	7.00E-04	8.10E-04	1.03E-03	1.75E-03	3.22E-03	4.52E-03	5.03E-03	5.32E-03	5.74E-03	5.93E-03	6.21E-03	6.09E-03	6.23E-03	7.07E-03	7.24E-03	7.23E-03	6.05E-03	7.18E-03
Cu	5.31E-03	5.86E-03	1.62E-02	8.34E-02	4.08E-01	1.50E+00	3.30E+00	4.74E+00	5.23E+00	5.57E+00	6.17E+00	6.64E+00	7.25E+00	7.27E+00	7.31E+00	8.75E+00	9.12E+00	9.05E+00	7.50E+00	8.88E+00
F	7.37E+01	8.12E+01	8.13E+01	7.90E+01	6.78E+01	5.02E+01	3.84E+01	3.24E+01	2.73E+01	2.39E+01	2.23E+01	2.10E+01	2.08E+01	1.96E+01	1.95E+01	2.23E+01	2.33E+01	2.39E+01	2.02E+01	2.40E+01
Fe	3.46E+01	3.83E+01	3.80E+01	3.97E+01	6.17E+01	1.15E+02	1.54E+02	1.30E+02	7.76E+01	4.41E+01	2.45E+01	1.99E+01	2.29E+01	3.04E+01	2.85E+01	1.35E+01	4.53E+00	8.16E-01	1.60E+01	2.16E-01
K	1.68E+02	1.90E+02	1.98E+02	2.06E+02	2.11E+02	2.29E+02	2.72E+02	3.02E+02	3.19E+02	3.46E+02	3.83E+02	4.19E+02	4.63E+02	4.75E+02	5.19E+02	6.16E+02	6.69E+02	7.03E+02	6.28E+02	7.32E+02
Mg	1.28E+03	1.42E+03	1.43E+03	1.42E+03	1.52E+03	1.75E+03	1.85E+03	1.72E+03	1.56E+03	1.47E+03	1.36E+03	1.41E+03	1.51E+03	1.67E+03	1.70E+03	1.54E+03	1.52E+03	1.56E+03	1.86E+03	1.64E+03
Mn	4.07E+00	4.56E+00	4.54E+00	4.77E+00	7.10E+00	1.19E+01	1.48E+01	1.45E+01	1.31E+01	1.21E+01	1.15E+01	1.18E+01	1.22E+01	1.33E+01	1.32E+01	1.17E+01	1.10E+01	1.05E+01	1.27E+01	1.07E+01
Na	1.25E+03	1.38E+03	1.38E+03	1.36E+03	1.31E+03	1.25E+03	1.28E+03	1.25E+03	1.21E+03	1.21E+03	1.24E+03	1.28E+03	1.32E+03	1.32E+03	1.35E+03	1.45E+03	1.58E+03	1.73E+03	1.74E+03	2.01E+03
Ni	8.58E-03	2.19E-02	5.59E-02	3.34E-01	7.86E-01	1.24E+00	2.15E+00	2.72E+00	3.01E+00	3.38E+00	4.01E+00	4.37E+00	4.65E+00	4.58E+00	5.07E+00	6.97E+00	8.13E+00	8.59E+00	7.15E+00	8.91E+00
Pb	1.18E-03	1.31E-03	1.31E-03	1.31E-03	1.64E-03	1.98E-02	1.22E-01	2.34E-01	3.15E-01	3.87E-01	4.96E-01	5.81E-01	6.79E-01	7.14E-01	7.90E-01	1.02E+00	1.14E+00	1.19E+00	9.77E-01	1.21E+00
Sb	4.60E-04	7.20E-04	1.06E-03	1.45E-03	2.15E-03	2.95E-03	4.24E-03	5.09E-03	5.55E-03	6.32E-03	7.43E-03	8.19E-03	8.80E-03	8.91E-03	1.00E-02	1.32E-02	1.50E-02	1.61E-02	1.42E-02	1.74E-02
Se	5.30E-04	5.80E-04	5.80E-04	5.80E-04	6.90E-04	1.04E-03	1.49E-03	1.65E-03	1.60E-03	1.65E-03	1.81E-03	1.97E-03	2.14E-03	2.29E-03	2.68E-03	3.59E-03	4.22E-03	4.57E-03	4.00E-03	5.23E-03
SO_4	3.91E+03	4.33E+03	4.35E+03	4.45E+03	5.83E+03	9.30E+03	1.23E+04	1.11E+04	7.96E+03	6.07E+03	5.27E+03	5.20E+03	5.51E+03	5.98E+03	6.27E+03	6.57E+03	6.85E+03	7.09E+03	7.13E+03	7.42E+03
Tl	1.50E-04	1.60E-04	1.60E-04	1.60E-04	1.60E-04	1.80E-04	2.20E-04	2.10E-04	1.80E-04	1.60E-04	1.60E-04	1.60E-04	1.70E-04	1.70E-04	1.80E-04	1.80E-04	1.80E-04	1.80E-04	1.60E-04	1.80E-04
V	3.97E-03	4.43E-03	4.48E-03	4.48E-03	4.29E-03	4.44E-03	5.49E-03	6.48E-03	6.86E-03	7.08E-03	7.55E-03	7.93E-03	8.29E-03	8.09E-03	8.16E-03	9.05E-03	9.25E-03	9.22E-03	7.82E-03	9.14E-03
Zn	1.07E-02	1.22E-02	1.32E-02	1.41E-02	1.76E-02	2.51E-02	3.87E-02	4.74E-02	5.22E-02	5.83E-02	6.61E-02	7.45E-02	8.23E-02	8.49E-02	9.24E-02	3.36E-01	5.54E-01	6.92E-01	4.61E-01	8.26E-01

Notes

Source: Plant Site probabilistic water quality model, Version 6

Table 1-39 (continued) [Concentrate_toWWTF_ConcMean] Mean Concentration in the concentrate from the Plant Site WWTF (mg/L)

	Time (yrs)																			
Constituent	*20*	*21*	*22*	*23*	*24*	*25*	*26*	*27*	*28*	*29*	*30*	*31*	*32*	*33*	*34*	*35*	*36*	*37*	*38*	*39*
Ag	1.70E-04	1.70E-04	1.60E-04	1.60E-04	1.50E-04	1.50E-04	1.40E-04	1.30E-04	1.20E-04	1.10E-04	1.10E-04	1.10E-04	1.10E-04	1.10E-04	1.00E-04	1.00E-04	9.00E-05	9.00E-05	9.00E-05	9.00E-05
Al	6.97E-03	7.28E-03	7.36E-03	7.68E-03	7.74E-03	8.27E-03	9.07E-03	9.97E-03	1.03E-02	1.04E-02	1.00E-02	1.02E-02	1.03E-02	1.04E-02	1.05E-02	1.06E-02	1.11E-02	1.09E-02	1.10E-02	1.10E-02
Alk	1.32E+02	1.31E+02	1.37E+02	1.44E+02	1.43E+02	1.56E+02	1.78E+02	1.84E+02	1.74E+02	1.66E+02	1.34E+02	1.18E+02	1.14E+02	1.17E+02	1.21E+02	1.24E+02	1.25E+02	1.23E+02	1.19E+02	1.23E+02
As	7.15E-01	6.87E-01	6.86E-01	6.76E-01	6.18E-01	5.38E-01	4.17E-01	2.85E-01	1.86E-01	1.21E-01	1.00E-01	8.72E-02	8.34E-02	8.35E-02	7.95E-02	7.65E-02	7.34E-02	6.72E-02	6.79E-02	6.78E-02
B	1.72E-01	1.77E-01	1.79E-01	1.80E-01	1.82E-01	1.87E-01	1.96E-01	2.00E-01	1.99E-01	1.99E-01	1.91E-01	1.92E-01	1.93E-01	1.92E-01	1.93E-01	1.92E-01	1.92E-01	1.92E-01	1.92E-01	1.91E-01
Ba	3.12E-01	3.08E-01	3.02E-01	3.00E-01	3.01E-01	2.95E-01	2.82E-01	2.60E-01	2.35E-01	2.18E-01	2.00E-01	1.97E-01	1.95E-01	1.94E-01	1.88E-01	1.73E-01	1.64E-01	1.59E-01	1.59E-01	1.59E-01
Be	4.00E-04	4.00E-04	4.00E-04	4.00E-04	4.00E-04	3.90E-04	3.90E-04	3.80E-04	3.70E-04	3.60E-04	3.50E-04	3.50E-04	3.50E-04	3.50E-04	3.50E-04	3.40E-04	3.40E-04	3.30E-04	3.40E-04	3.40E-04
Ca	3.00E+03	2.94E+03	2.92E+03	2.94E+03	2.95E+03	2.77E+03	2.43E+03	1.91E+03	1.42E+03	1.11E+03	9.16E+02	8.18E+02	8.07E+02	7.55E+02	6.94E+02	6.45E+02	6.09E+02	6.07E+02	6.11E+02	5.95E+02
Cd	1.25E-03	1.20E-03	1.14E-03	1.08E-03	1.04E-03	9.50E-04	8.80E-04	7.80E-04	7.10E-04	6.60E-04	6.20E-04	6.00E-04	5.70E-04	5.60E-04	5.10E-04	4.70E-04	4.20E-04	4.00E-04	3.90E-04	3.90E-04
Cl	4.88E+02	4.66E+02	4.35E+02	4.01E+02	3.75E+02	3.54E+02	3.36E+02	3.10E+02	2.79E+02	2.53E+02	2.27E+02	2.16E+02	2.09E+02	2.03E+02	1.92E+02	1.73E+02	1.59E+02	1.51E+02	1.48E+02	1.47E+02
Co	4.12E-01	4.19E-01	4.05E-01	4.02E-01	3.86E-01	3.67E-01	3.15E-01	2.61E-01	2.09E-01	1.68E-01	1.40E-01	1.18E-01	1.12E-01	1.02E-01	9.04E-02	8.23E-02	7.41E-02	7.28E-02	6.79E-02	6.30E-02
Cr	5.43E-03	5.25E-03	5.24E-03	5.21E-03	5.02E-03	4.68E-03	4.06E-03	3.34E-03	2.74E-03	2.35E-03	2.14E-03	2.01E-03	1.92E-03	1.88E-03	1.81E-03	1.74E-03	1.68E-03	1.63E-03	1.62E-03	1.61E-03
Cu	6.30E+00	6.02E+00	5.96E+00	5.87E+00	5.61E+00	5.26E+00	4.58E+00	3.74E+00	3.04E+00	2.69E+00	2.47E+00	2.40E+00	2.36E+00	2.30E+00	2.10E+00	1.75E+00	1.48E+00	1.36E+00	1.33E+00	1.32E+00
F	1.81E+01	1.71E+01	1.63E+01	1.50E+01	1.38E+01	1.27E+01	1.09E+01	9.35E+00	7.74E+00	6.72E+00	5.85E+00	5.52E+00	5.06E+00	4.83E+00	4.49E+00	3.86E+00	3.37E+00	3.19E+00	3.03E+00	2.96E+00
Fe	1.69E+01	1.83E+01	1.83E+01	1.95E+01	2.02E+01	2.21E+01	2.53E+01	2.79E+01	2.77E+01	2.66E+01	2.47E+01	2.45E+01	2.49E+01	2.49E+01	2.48E+01	2.48E+01	2.51E+01	2.50E+01	2.50E+01	2.53E+01
K	6.13E+02	5.96E+02	5.86E+02	5.69E+02	5.42E+02	5.04E+02	4.51E+02	3.85E+02	3.25E+02	2.85E+02	2.57E+02	2.45E+02	2.39E+02	2.34E+02	2.22E+02	2.04E+02	1.88E+02	1.82E+02	1.77E+02	1.75E+02
Mg	1.93E+03	1.91E+03	1.91E+03	1.90E+03	1.89E+03	1.87E+03	1.83E+03	1.71E+03	1.54E+03	1.42E+03	1.29E+03	1.25E+03	1.24E+03	1.22E+03	1.20E+03	1.14E+03	1.12E+03	1.10E+03	1.10E+03	1.09E+03
Mn	1.23E+01	1.20E+01	1.23E+01	1.24E+01	1.21E+01	1.20E+01	1.19E+01	1.15E+01	1.08E+01	1.04E+01	9.85E+00	9.81E+00	9.88E+00	9.94E+00	9.88E+00	9.49E+00	9.29E+00	9.16E+00	9.12E+00	9.17E+00
Na	1.86E+03	1.79E+03	1.67E+03	1.52E+03	1.38E+03	1.28E+03	1.20E+03	1.09E+03	9.57E+02	8.55E+02	7.73E+02	7.22E+02	7.10E+02	6.85E+02	6.36E+02	5.71E+02	5.18E+02	4.99E+02	4.87E+02	4.84E+02
Ni	6.66E+00	6.68E+00	6.42E+00	6.32E+00	6.05E+00	5.84E+00	4.96E+00	4.08E+00	3.16E+00	2.40E+00	2.09E+00	1.78E+00	1.74E+00	1.60E+00	1.36E+00	1.26E+00	1.09E+00	1.03E+00	9.92E-01	9.87E-01
Pb	8.47E-01	8.11E-01	8.12E-01	7.84E-01	7.34E-01	6.50E-01	5.25E-01	3.76E-01	2.53E-01	1.77E-01	1.39E-01	1.21E-01	1.12E-01	1.09E-01	1.02E-01	8.93E-02	8.08E-02	7.50E-02	7.39E-02	7.41E-02
Sb	1.33E-02	1.29E-02	1.24E-02	1.16E-02	1.07E-02	9.88E-03	8.84E-03	7.68E-03	6.79E-03	6.18E-03	5.88E-03	5.64E-03	5.48E-03	5.35E-03	5.07E-03	4.83E-03	4.63E-03	4.46E-03	4.37E-03	4.37E-03
Se	3.88E-03	3.66E-03	3.59E-03	3.44E-03	3.34E-03	3.13E-03	2.80E-03	2.34E-03	1.93E-03	1.64E-03	1.44E-03	1.31E-03	1.22E-03	1.17E-03	1.07E-03	1.00E-03	9.30E-04	8.90E-04	8.60E-04	8.50E-04
SO_4	7.10E+03	6.96E+03	6.80E+03	6.67E+03	6.56E+03	6.30E+03	5.94E+03	5.28E+03	4.51E+03	3.98E+03	3.53E+03	3.32E+03	3.21E+03	3.14E+03	2.97E+03	2.77E+03	2.61E+03	2.56E+03	2.56E+03	2.53E+03
Tl	1.50E-04	1.50E-04	1.50E-04	1.40E-04	1.40E-04	1.30E-04	1.20E-04	1.10E-04	1.00E-04	9.00E-05	9.00E-05	9.00E-05	9.00E-05	9.00E-05	8.00E-05	8.00E-05	7.00E-05	7.00E-05	7.00E-05	7.00E-05
V	7.38E-03	7.15E-03	7.01E-03	6.83E-03	6.58E-03	6.24E-03	5.65E-03	4.96E-03	4.40E-03	4.04E-03	3.82E-03	3.68E-03	3.60E-03	3.54E-03	3.34E-03	3.02E-03	2.77E-03	2.61E-03	2.54E-03	2.50E-03
Zn	2.11E-01	1.17E-01	9.51E-02	9.06E-02	8.51E-02	8.16E-02	7.53E-02	6.70E-02	6.17E-02	5.69E-02	5.33E-02	5.09E-02	4.95E-02	4.79E-02	4.38E-02	3.87E-02	3.42E-02	3.14E-02	3.00E-02	2.91E-02

Notes

Source: Plant Site probabilistic water quality model, Version 6

Table 1-39 (continued) [Concentrate_toWWTF_ConcMean] Mean Concentration in the concentrate from the Plant Site WWTF (mg/L)

	Time (yrs)															
Constituent	*40*	*41*	*42*	*43*	*44*	*45*	*46*	*47*	*48*	*49*	*50*	*51*	*52*	*53*	*54*	*55*
Ag	9.00E-05	9.00E-05	8.00E-05	8.00E-05	8.00E-05	8.00E-05	8.00E-05	8.00E-05	8.00E-05	8.00E-05	8.00E-05	8.00E-05	8.00E-05	8.00E-05	8.00E-05	0
Al	1.09E-02	1.11E-02	1.11E-02	1.10E-02	1.11E-02	1.08E-02	1.10E-02	1.11E-02	1.10E-02	1.08E-02	1.09E-02	1.12E-02	1.11E-02	1.09E-02	1.10E-02	0
Alk	1.20E+02	1.16E+02	1.10E+02	1.08E+02	1.06E+02	1.05E+02	1.01E+02	1.04E+02	1.02E+02	1.03E+02	1.01E+02	1.05E+02	1.09E+02	1.04E+02	1.02E+02	0
As	6.68E-02	5.98E-02	5.54E-02	5.76E-02	5.42E-02	5.21E-02	5.22E-02	5.38E-02	5.23E-02	5.27E-02	5.44E-02	5.67E-02	5.79E-02	5.75E-02	5.48E-02	0
B	1.91E-01	1.91E-01	1.91E-01	1.91E-01	1.92E-01	1.92E-01	1.91E-01	1.91E-01	1.92E-01	1.92E-01	1.93E-01	1.94E-01	1.94E-01	1.93E-01	1.93E-01	0
Ba	1.58E-01	1.57E-01	1.55E-01	1.55E-01	1.55E-01	1.54E-01	1.54E-01	1.53E-01	1.54E-01	1.55E-01	1.55E-01	1.56E-01	1.58E-01	1.59E-01	1.59E-01	0
Be	3.40E-04	3.30E-04	3.30E-04	3.20E-04	3.20E-04	3.20E-04	3.20E-04	3.20E-04	3.20E-04	3.20E-04	3.20E-04	3.20E-04	3.20E-04	3.20E-04	3.10E-04	0
Ca	5.93E+02	5.54E+02	5.34E+02	5.61E+02	5.41E+02	5.39E+02	5.14E+02	5.19E+02	5.22E+02	5.24E+02	5.40E+02	5.33E+02	5.26E+02	5.18E+02	5.19E+02	0
Cd	3.80E-04	3.70E-04	3.50E-04	3.50E-04	3.40E-04	3.40E-04	3.40E-04	3.30E-04	3.30E-04	3.30E-04	3.30E-04	3.40E-04	3.40E-04	3.30E-04	3.30E-04	0
Cl	1.46E+02	1.45E+02	1.45E+02	1.44E+02	1.43E+02	1.42E+02	1.42E+02	1.42E+02	1.43E+02	1.42E+02	1.41E+02	1.41E+02	1.42E+02	1.42E+02	1.42E+02	0
Co	6.66E-02	6.37E-02	5.78E-02	5.87E-02	6.02E-02	6.48E-02	5.95E-02	5.95E-02	6.11E-02	5.59E-02	5.49E-02	5.93E-02	5.70E-02	5.73E-02	5.77E-02	0
Cr	1.59E-03	1.56E-03	1.52E-03	1.50E-03	1.49E-03	1.49E-03	1.45E-03	1.46E-03	1.45E-03	1.45E-03	1.44E-03	1.45E-03	1.44E-03	1.46E-03	1.45E-03	0
Cu	1.30E+00	1.30E+00	1.30E+00	1.30E+00	1.29E+00	1.28E+00	1.27E+00	1.30E+00	1.28E+00	1.28E+00	1.28E+00	1.30E+00	1.32E+00	1.33E+00	1.32E+00	0
F	2.80E+00	2.97E+00	2.93E+00	2.69E+00	2.80E+00	2.81E+00	2.80E+00	2.80E+00	2.67E+00	2.69E+00	2.69E+00	2.64E+00	2.66E+00	2.63E+00	2.71E+00	0
Fe	2.54E+01	2.51E+01	2.53E+01	2.54E+01	2.54E+01	2.56E+01	2.53E+01	2.53E+01	2.59E+01	2.58E+01	2.62E+01	2.64E+01	2.66E+01	2.67E+01	2.68E+01	0
K	1.73E+02	1.69E+02	1.65E+02	1.64E+02	1.64E+02	1.63E+02	1.60E+02	1.62E+02	1.60E+02	1.60E+02	1.60E+02	1.60E+02	1.61E+02	1.63E+02	1.61E+02	0
Mg	1.10E+03	1.07E+03	1.08E+03	1.07E+03	1.07E+03	1.07E+03	1.07E+03	1.06E+03	1.07E+03	1.07E+03	1.07E+03	1.07E+03	1.07E+03	1.08E+03	1.08E+03	0
Mn	9.10E+00	8.67E+00	8.45E+00	8.26E+00	8.14E+00	8.04E+00	7.97E+00	7.97E+00	7.93E+00	7.92E+00	7.88E+00	7.92E+00	7.95E+00	7.99E+00	7.97E+00	0
Na	4.81E+02	4.67E+02	4.63E+02	4.77E+02	4.68E+02	4.62E+02	4.61E+02	4.59E+02	4.61E+02	4.60E+02	4.58E+02	4.60E+02	4.59E+02	4.58E+02	4.50E+02	0
Ni	1.05E+00	9.03E-01	9.01E-01	9.99E-01	9.45E-01	8.99E-01	8.56E-01	9.05E-01	9.36E-01	9.03E-01	9.10E-01	8.81E-01	9.36E-01	8.87E-01	9.19E-01	0
Pb	7.27E-02	7.04E-02	6.85E-02	6.79E-02	6.77E-02	6.69E-02	6.73E-02	6.65E-02	6.71E-02	6.67E-02	6.72E-02	6.85E-02	7.11E-02	7.27E-02	7.11E-02	0
Sb	4.23E-03	4.11E-03	3.99E-03	3.92E-03	3.89E-03	3.88E-03	3.89E-03	3.91E-03	3.87E-03	3.80E-03	3.92E-03	3.83E-03	3.82E-03	3.86E-03	3.90E-03	0
Se	8.40E-04	8.10E-04	7.90E-04	7.70E-04	7.40E-04	7.30E-04	7.20E-04	7.10E-04	7.10E-04	7.10E-04	7.10E-04	7.10E-04	7.10E-04	7.10E-04	7.00E-04	0
SO_4	2.50E+03	2.48E+03	2.49E+03	2.47E+03	2.47E+03	2.47E+03	2.44E+03	2.47E+03	2.50E+03	2.46E+03	2.49E+03	2.46E+03	2.49E+03	2.51E+03	2.50E+03	0
Tl	7.00E-05	6.00E-05	6.00E-05	6.00E-05	6.00E-05	6.00E-05	6.00E-05	6.00E-05	6.00E-05	6.00E-05	6.00E-05	6.00E-05	6.00E-05	6.00E-05	6.00E-05	0
V	2.46E-03	2.41E-03	2.35E-03	2.32E-03	2.30E-03	2.30E-03	2.28E-03	2.27E-03	2.25E-03	2.28E-03	2.26E-03	2.27E-03	2.28E-03	2.29E-03	2.28E-03	0
Zn	2.82E-02	2.69E-02	2.64E-02	2.57E-02	2.55E-02	2.52E-02	2.47E-02	2.47E-02	2.45E-02	2.45E-02	2.44E-02	2.46E-02	2.42E-02	2.38E-02	2.37E-02	0

Notes

Source: Plant Site probabilistic water quality model, Version 6

Table 1-40 *[Concentrate_toWWTF_ConcStdev]* **Standard Devation of Concentration in the concentrate from the Plant Site WWTF (mg/L)**

	Time (yrs)																			
Constituent	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*
Ag	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	0.00E+00	0.00E+00	1.00E-05	0.00E+00
Al	4.80E-04	5.00E-04	4.70E-04	5.40E-04	5.40E-04	7.10E-04	8.00E-04	7.60E-04	1.13E-03	1.50E-03	1.19E-03	1.42E-03	1.57E-03	1.95E-03	2.03E-03	8.80E-04	5.70E-04	4.90E-04	1.65E-03	5.30E-04
Alk	3.34E+01	4.69E+01	4.33E+01	5.24E+01	5.20E+01	7.03E+01	8.70E+01	5.51E+01	2.76E+01	1.12E+01	8.02E+00	9.74E+00	9.65E+00	4.73E+01	6.58E+01	1.75E+01	3.31E+00	3.29E+00	4.39E+01	3.50E+00
As	8.00E-05	1.70E-04	2.90E-04	5.60E-04	1.00E-03	7.90E-04	1.89E-02	5.10E-02	6.71E-02	7.07E-02	7.46E-02	9.85E-02	1.04E-01	1.06E-01	1.33E-01	9.33E-02	8.51E-02	8.43E-02	1.08E-01	7.25E-02
B	3.28E-03	3.95E-03	3.50E-03	4.01E-03	5.93E-03	6.97E-03	8.86E-03	8.97E-03	1.30E-02	1.85E-02	1.44E-02	1.71E-02	1.84E-02	2.61E-02	2.60E-02	5.68E-03	3.37E-03	3.16E-03	1.64E-02	3.16E-03
Ba	1.21E-02	1.71E-02	2.00E-02	2.98E-02	1.41E-02	2.02E-02	1.84E-02	1.31E-02	1.53E-02	1.27E-02	1.10E-02	1.09E-02	1.26E-02	1.71E-02	1.77E-02	1.43E-02	1.26E-02	1.32E-02	1.30E-02	1.40E-02
Be	0.00E+00	0.00E+00	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	2.00E-05	3.00E-05	2.00E-05	2.00E-05	1.00E-05	1.00E-05	2.00E-05	1.00E-05
Ca	1.78E+01	2.81E+01	5.40E+01	7.50E+01	1.47E+02	1.00E+02	1.38E+02	1.53E+02	1.39E+02	1.76E+02	1.87E+02	2.29E+02	2.83E+02	3.07E+02	4.47E+02	6.53E+02	8.31E+02	8.24E+02	7.74E+02	9.97E+02
Cd	0.00E+00	1.00E-05	2.00E-05	3.00E-05	5.00E-05	6.00E-05	1.00E-04	1.50E-04	1.80E-04	2.20E-04	2.70E-04	2.70E-04	2.90E-04	2.90E-04	3.00E-04	4.30E-04	5.10E-04	5.50E-04	5.10E-04	5.80E-04
Cl	6.10E+00	6.58E+00	7.56E+00	8.15E+00	5.70E+00	1.06E+01	1.65E+01	2.85E+01	3.13E+01	3.05E+01	3.88E+01	4.14E+01	3.54E+01	3.22E+01	3.16E+01	3.58E+01	3.98E+01	4.20E+01	3.83E+01	4.35E+01
Co	3.50E-04	6.00E-04	2.22E-03	1.64E-02	3.21E-02	4.01E-02	6.31E-02	8.05E-02	9.20E-02	9.28E-02	1.12E-01	1.25E-01	1.28E-01	1.27E-01	1.44E-01	1.74E-01	2.10E-01	2.19E-01	2.06E-01	2.29E-01
Cr	2.00E-05	5.00E-05	4.00E-05	5.00E-05	7.00E-05	1.60E-04	2.90E-04	3.00E-04	5.00E-04	5.50E-04	4.70E-04	4.90E-04	5.10E-04	7.20E-04	7.30E-04	3.00E-04	2.50E-04	2.90E-04	5.30E-04	3.10E-04
Cu	1.33E-03	1.54E-03	9.09E-03	4.95E-02	1.40E-01	4.61E-01	9.39E-01	1.29E+00	1.36E+00	1.51E+00	1.68E+00	1.84E+00	2.03E+00	1.94E+00	1.98E+00	2.31E+00	2.27E+00	2.26E+00	1.96E+00	2.20E+00
F	3.62E-01	5.60E-01	5.66E-01	9.10E-01	1.34E+00	1.39E+00	1.54E+00	1.68E+00	2.49E+00	2.38E+00	1.87E+00	1.87E+00	1.90E+00	2.64E+00	2.52E+00	1.51E+00	1.36E+00	1.58E+00	1.92E+00	1.88E+00
Fe	5.95E-01	7.22E-01	6.44E-01	7.79E-01	1.35E+00	2.49E+00	5.19E+00	8.63E+00	4.26E+00	3.99E+00	3.69E+00	4.49E+00	5.67E+00	7.73E+00	7.64E+00	2.74E+00	1.29E+00	4.34E-01	5.02E+00	3.65E-02
K	2.93E+00	4.66E+00	4.68E+00	6.03E+00	7.55E+00	9.68E+00	1.87E+01	3.17E+01	3.38E+01	3.97E+01	4.37E+01	4.54E+01	5.85E+01	5.67E+01	6.18E+01	4.07E+01	3.19E+01	2.76E+01	4.37E+01	2.30E+01
Mg	2.30E+01	2.88E+01	3.05E+01	4.43E+01	5.92E+01	7.51E+01	9.00E+01	9.96E+01	1.12E+02	1.38E+02	1.28E+02	1.43E+02	1.45E+02	1.79E+02	1.73E+02	1.36E+02	1.39E+02	1.45E+02	1.77E+02	1.77E+02
Mn	1.43E-01	1.57E-01	1.41E-01	1.61E-01	4.62E-01	9.82E-01	1.56E+00	1.77E+00	1.92E+00	1.90E+00	2.03E+00	2.28E+00	2.29E+00	2.51E+00	2.49E+00	2.39E+00	2.49E+00	2.40E+00	2.71E+00	2.63E+00
Na	1.32E+01	2.37E+01	2.56E+01	3.69E+01	4.39E+01	3.97E+01	5.81E+01	7.52E+01	6.48E+01	7.14E+01	7.88E+01	7.73E+01	9.12E+01	8.18E+01	1.00E+02	7.39E+01	8.87E+01	1.07E+02	1.17E+02	1.37E+02
Ni	2.98E-03	8.01E-03	2.78E-02	2.38E-01	5.52E-01	5.97E-01	8.36E-01	1.12E+00	1.33E+00	1.50E+00	1.78E+00	1.82E+00	1.83E+00	1.70E+00	1.83E+00	2.61E+00	3.12E+00	3.59E+00	2.82E+00	3.72E+00
Pb	1.00E-05	2.00E-05	3.00E-05	3.00E-05	1.00E-04	8.02E-03	3.41E-02	6.38E-02	8.69E-02	8.97E-02	1.28E-01	1.34E-01	1.54E-01	1.67E-01	1.74E-01	1.10E-01	7.53E-02	6.71E-02	1.05E-01	6.96E-02
Sb	9.00E-05	1.90E-04	3.80E-04	5.80E-04	8.50E-04	8.10E-04	8.80E-04	9.30E-04	9.00E-04	9.70E-04	1.07E-03	1.19E-03	1.22E-03	1.24E-03	1.74E-03	1.73E-03	1.96E-03	2.15E-03	2.40E-03	2.27E-03
Se	1.00E-05	1.00E-05	1.00E-05	1.00E-05	2.00E-05	3.00E-05	8.00E-05	1.60E-04	2.10E-04	2.00E-04	2.20E-04	2.50E-04	2.60E-04	2.80E-04	4.50E-04	4.80E-04	5.70E-04	6.20E-04	6.30E-04	1.05E-03
SO_4	4.23E+01	6.18E+01	7.87E+01	1.17E+02	1.63E+02	1.83E+02	3.63E+02	6.79E+02	5.70E+02	3.12E+02	2.89E+02	2.94E+02	3.00E+02	3.95E+02	4.05E+02	4.38E+02	4.62E+02	5.39E+02	5.64E+02	6.17E+02
Tl	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	2.00E-05	2.00E-05	1.00E-05	0.00E+00	1.00E-05	1.00E-05	1.00E-05
V	8.00E-05	5.00E-05	4.00E-05	5.00E-05	9.00E-05	2.30E-04	3.40E-04	5.30E-04	6.40E-04	6.60E-04	6.00E-04	5.50E-04	4.90E-04	7.50E-04	8.00E-04	2.30E-04	1.40E-04	1.60E-04	5.10E-04	1.90E-04
Zn	2.30E-04	4.70E-04	8.80E-04	1.55E-03	2.55E-03	2.72E-03	5.04E-03	7.93E-03	1.03E-02	1.18E-02	1.32E-02	1.47E-02	1.43E-02	1.40E-02	1.76E-02	1.95E-01	3.60E-01	4.59E-01	2.89E-01	5.65E-01

Notes

Source: Plant Site probabilistic water quality model, Version 6

Table 1-40 (continued) [Concentrate_toWWTF_ConcStdev] Standard Devation of Concentration in the concentrate from the Plant Site WWTF (mg/L)

	Time (yrs)																			
Constituent	*20*	*21*	*22*	*23*	*24*	*25*	*26*	*27*	*28*	*29*	*30*	*31*	*32*	*33*	*34*	*35*	*36*	*37*	*38*	*39*
Ag	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05
Al	1.89E-03	1.85E-03	1.81E-03	2.03E-03	1.85E-03	2.09E-03	2.26E-03	2.34E-03	2.50E-03	2.41E-03	2.37E-03	2.40E-03	2.48E-03	2.61E-03	2.50E-03	2.58E-03	2.74E-03	2.63E-03	2.72E-03	2.76E-03
Alk	5.23E+01	5.05E+01	5.12E+01	5.86E+01	5.40E+01	6.53E+01	7.28E+01	7.58E+01	6.74E+01	6.06E+01	3.97E+01	2.56E+01	2.13E+01	2.41E+01	2.66E+01	2.90E+01	3.03E+01	2.86E+01	2.60E+01	2.81E+01
As	7.78E-02	7.13E-02	7.21E-02	6.66E-02	6.82E-02	6.39E-02	5.14E-02	4.09E-02	3.14E-02	2.51E-02	2.16E-02	2.38E-02	2.34E-02	2.06E-02	2.00E-02	1.88E-02	1.86E-02	1.60E-02	1.80E-02	2.18E-02
B	2.75E-02	2.72E-02	2.65E-02	2.94E-02	3.02E-02	2.89E-02	2.43E-02	1.71E-02	1.32E-02	1.13E-02	1.18E-02	1.21E-02	1.31E-02	1.37E-02	1.69E-02	1.60E-02	1.53E-02	1.50E-02	1.40E-02	1.29E-02
Ba	1.20E-02	1.26E-02	1.71E-02	2.01E-02	1.83E-02	1.92E-02	2.03E-02	1.76E-02	1.48E-02	1.38E-02	1.44E-02	1.34E-02	1.31E-02	1.43E-02	1.34E-02	1.41E-02	1.45E-02	1.38E-02	1.45E-02	1.27E-02
Be	3.00E-05	3.00E-05	3.00E-05	4.00E-05	4.00E-05	4.00E-05	5.00E-05	5.00E-05	6.00E-05	6.00E-05	6.00E-05	6.00E-05	6.00E-05	6.00E-05	7.00E-05	7.00E-05	7.00E-05	7.00E-05	8.00E-05	8.00E-05
Ca	7.29E+02	7.00E+02	7.05E+02	7.31E+02	6.63E+02	6.36E+02	5.59E+02	4.03E+02	2.90E+02	2.19E+02	1.88E+02	1.68E+02	1.83E+02	1.58E+02	1.35E+02	1.17E+02	1.05E+02	1.31E+02	1.35E+02	1.37E+02
Cd	4.20E-04	4.10E-04	3.80E-04	3.50E-04	3.30E-04	2.70E-04	2.60E-04	2.00E-04	1.70E-04	1.60E-04	1.40E-04	1.30E-04	1.30E-04	1.20E-04	1.10E-04	1.10E-04	1.00E-04	1.00E-04	9.00E-05	1.00E-04
Cl	3.47E+01	3.22E+01	2.97E+01	2.99E+01	3.42E+01	3.66E+01	3.36E+01	2.55E+01	2.31E+01	1.80E+01	1.96E+01	1.91E+01	1.50E+01	1.62E+01	1.37E+01	1.21E+01	1.18E+01	1.29E+01	1.19E+01	1.18E+01
Co	1.72E-01	1.77E-01	1.74E-01	1.74E-01	1.69E-01	1.60E-01	1.30E-01	1.18E-01	9.91E-02	8.34E-02	7.21E-02	6.28E-02	6.08E-02	5.70E-02	5.21E-02	4.95E-02	4.38E-02	4.38E-02	4.09E-02	4.17E-02
Cr	4.00E-04	3.60E-04	3.20E-04	3.10E-04	3.60E-04	3.10E-04	2.60E-04	2.30E-04	1.80E-04	1.40E-04	1.40E-04	1.30E-04	1.00E-04	1.10E-04	1.10E-04	1.00E-04	1.20E-04	1.00E-04	1.00E-04	1.20E-04
Cu	1.72E+00	1.61E+00	1.62E+00	1.68E+00	1.56E+00	1.46E+00	1.17E+00	9.12E-01	7.40E-01	6.29E-01	5.76E-01	5.51E-01	5.61E-01	5.82E-01	5.08E-01	4.03E-01	3.53E-01	3.12E-01	3.01E-01	3.14E-01
F	1.64E+00	1.37E+00	1.27E+00	1.24E+00	1.22E+00	1.30E+00	1.10E+00	9.95E-01	8.30E-01	7.02E-01	5.96E-01	6.32E-01	5.54E-01	5.52E-01	6.48E-01	5.43E-01	5.02E-01	5.18E-01	5.35E-01	5.31E-01
Fe	6.69E+00	6.98E+00	5.85E+00	7.83E+00	7.78E+00	8.27E+00	7.81E+00	6.31E+00	6.39E+00	6.92E+00	6.37E+00	6.85E+00	6.11E+00	5.87E+00	5.99E+00	6.44E+00	6.55E+00	6.56E+00	6.91E+00	6.59E+00
K	3.78E+01	3.22E+01	2.85E+01	2.77E+01	2.94E+01	2.40E+01	2.19E+01	2.15E+01	1.82E+01	1.76E+01	1.65E+01	1.67E+01	1.64E+01	1.51E+01	1.40E+01	1.37E+01	1.31E+01	1.39E+01	1.43E+01	1.48E+01
Mg	2.10E+02	2.14E+02	2.18E+02	2.48E+02	2.52E+02	2.31E+02	2.33E+02	2.23E+02	1.89E+02	1.74E+02	1.67E+02	1.86E+02	1.62E+02	1.46E+02	1.51E+02	1.56E+02	1.62E+02	1.57E+02	1.47E+02	1.48E+02
Mn	2.75E+00	2.27E+00	2.54E+00	2.44E+00	2.45E+00	2.45E+00	2.18E+00	1.65E+00	1.62E+00	1.38E+00	1.40E+00	1.41E+00	1.38E+00	1.52E+00	1.44E+00	1.34E+00	1.31E+00	1.36E+00	1.32E+00	1.33E+00
Na	9.58E+01	9.04E+01	8.41E+01	1.01E+02	9.99E+01	1.05E+02	9.28E+01	9.06E+01	8.65E+01	7.12E+01	7.83E+01	7.01E+01	7.39E+01	7.32E+01	6.50E+01	6.88E+01	6.38E+01	6.31E+01	5.70E+01	6.60E+01
Ni	2.75E+00	2.75E+00	2.67E+00	2.46E+00	2.39E+00	2.32E+00	2.08E+00	1.75E+00	1.27E+00	8.90E-01	8.54E-01	7.59E-01	6.66E-01	6.88E-01	5.44E-01	5.69E-01	5.54E-01	5.46E-01	5.12E-01	5.54E-01
Pb	8.05E-02	7.20E-02	7.24E-02	6.71E-02	7.22E-02	5.65E-02	4.85E-02	3.98E-02	2.35E-02	1.79E-02	1.67E-02	1.58E-02	1.38E-02	1.40E-02	1.36E-02	1.09E-02	1.16E-02	9.86E-03	9.86E-03	1.20E-02
Sb	1.77E-03	1.84E-03	1.65E-03	1.57E-03	1.50E-03	1.39E-03	1.36E-03	1.11E-03	9.00E-04	7.90E-04	7.60E-04	7.10E-04	7.60E-04	7.10E-04	6.90E-04	7.60E-04	8.30E-04	7.60E-04	7.90E-04	7.60E-04
Se	6.60E-04	5.40E-04	5.20E-04	4.70E-04	4.90E-04	4.80E-04	4.50E-04	3.70E-04	2.70E-04	2.30E-04	1.90E-04	1.50E-04	1.30E-04	1.40E-04	1.00E-04	1.20E-04	1.20E-04	1.30E-04	1.10E-04	1.20E-04
SO_4	5.12E+02	5.94E+02	5.39E+02	6.79E+02	6.64E+02	7.16E+02	7.11E+02	6.37E+02	5.31E+02	5.01E+02	4.41E+02	4.64E+02	4.36E+02	3.61E+02	3.85E+02	3.54E+02	3.90E+02	3.52E+02	3.99E+02	4.09E+02
Tl	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05
V	4.70E-04	4.10E-04	3.80E-04	3.70E-04	3.70E-04	3.10E-04	2.60E-04	2.10E-04	1.80E-04	1.50E-04	1.50E-04	1.40E-04	1.40E-04	1.30E-04	1.20E-04	1.30E-04	1.30E-04	1.20E-04	1.10E-04	1.20E-04
Zn	1.01E-01	3.29E-02	1.98E-02	2.01E-02	1.94E-02	1.87E-02	1.65E-02	1.23E-02	1.04E-02	8.56E-03	6.91E-03	6.56E-03	6.21E-03	6.05E-03	5.37E-03	5.61E-03	5.40E-03	5.43E-03	4.61E-03	4.62E-03

Notes

Source: Plant Site probabilistic water quality model, Version 6

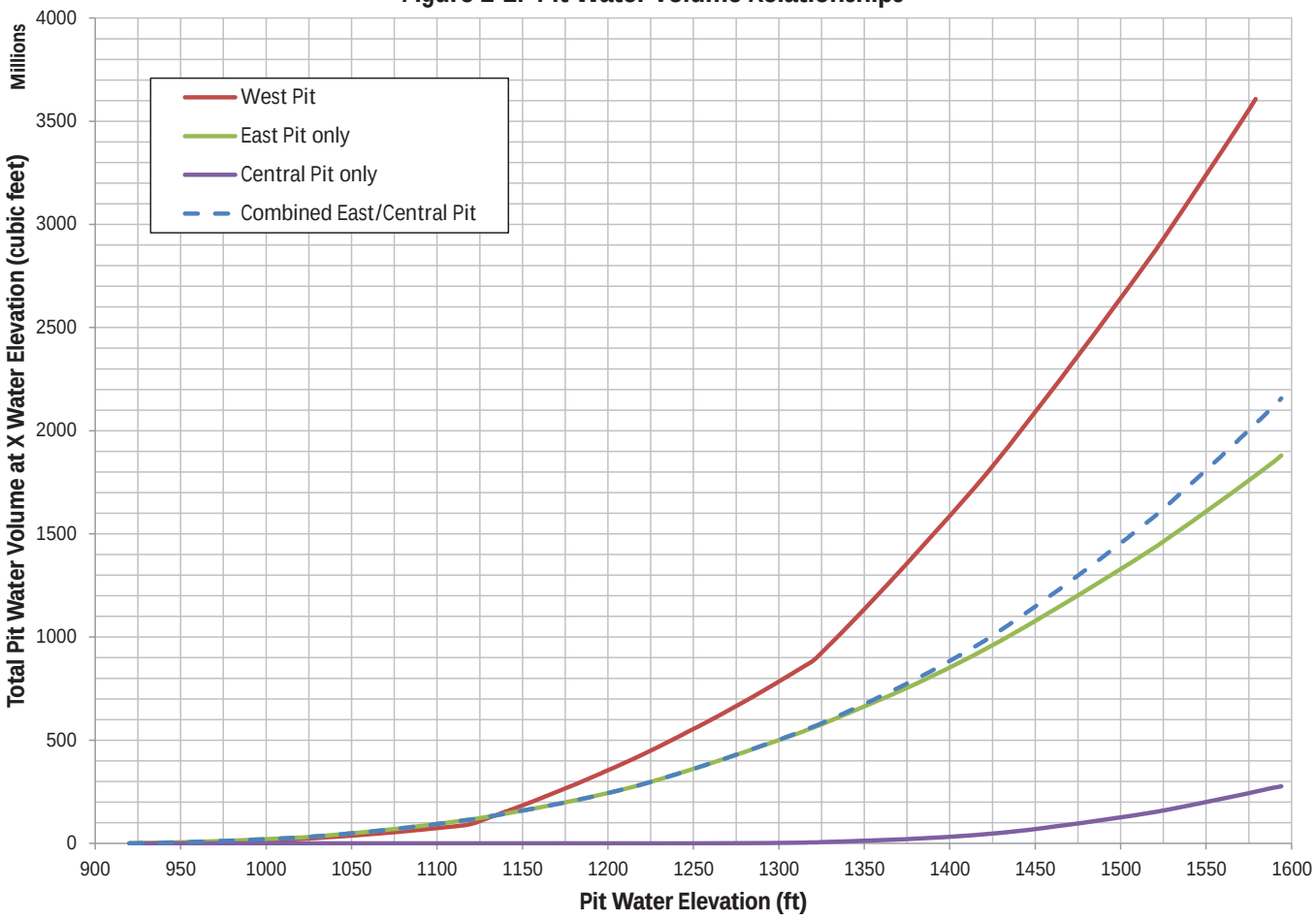
Table 1-40 (continued) [Concentrate_toWWTF_ConcStdev] Standard Devation of Concentration in the concentrate from the Plant Site WWTF (mg/L)

	Time (yrs)															
Constituent	*40*	*41*	*42*	*43*	*44*	*45*	*46*	*47*	*48*	*49*	*50*	*51*	*52*	*53*	*54*	*55*
Ag	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	0
Al	2.75E-03	2.97E-03	2.93E-03	2.86E-03	2.88E-03	2.79E-03	3.04E-03	2.98E-03	2.99E-03	2.80E-03	3.07E-03	3.12E-03	3.08E-03	2.96E-03	3.21E-03	0
Alk	2.63E+01	2.43E+01	2.03E+01	2.00E+01	1.80E+01	1.68E+01	1.50E+01	1.70E+01	1.54E+01	1.61E+01	1.38E+01	1.69E+01	1.97E+01	1.47E+01	1.41E+01	0
As	1.99E-02	1.85E-02	1.80E-02	2.03E-02	1.82E-02	1.73E-02	1.97E-02	2.00E-02	1.90E-02	1.76E-02	1.62E-02	1.77E-02	1.88E-02	2.05E-02	1.77E-02	0
B	1.35E-02	1.44E-02	1.46E-02	1.60E-02	1.48E-02	1.41E-02	1.58E-02	1.57E-02	1.60E-02	1.64E-02	1.75E-02	1.70E-02	1.77E-02	1.78E-02	1.85E-02	0
Ba	1.40E-02	1.22E-02	1.33E-02	1.31E-02	1.32E-02	1.32E-02	1.41E-02	1.23E-02	1.15E-02	1.11E-02	1.20E-02	1.21E-02	1.28E-02	1.14E-02	1.31E-02	0
Be	8.00E-05	8.00E-05	8.00E-05	8.00E-05	8.00E-05	8.00E-05	8.00E-05	8.00E-05	9.00E-05	8.00E-05	8.00E-05	8.00E-05	9.00E-05	9.00E-05	8.00E-05	0
Ca	1.36E+02	1.12E+02	1.00E+02	1.14E+02	1.23E+02	1.25E+02	1.22E+02	1.17E+02	1.20E+02	1.18E+02	1.24E+02	1.16E+02	1.21E+02	1.06E+02	1.07E+02	0
Cd	1.00E-04	1.00E-04	1.00E-04	8.00E-05	9.00E-05	8.00E-05	9.00E-05	9.00E-05	8.00E-05	9.00E-05	9.00E-05	1.00E-04	1.00E-04	9.00E-05	9.00E-05	0
Cl	1.25E+01	1.30E+01	1.13E+01	9.77E+00	1.15E+01	1.16E+01	1.17E+01	1.15E+01	1.15E+01	1.15E+01	1.14E+01	1.21E+01	1.20E+01	1.15E+01	1.11E+01	0
Co	4.37E-02	4.02E-02	3.56E-02	3.57E-02	3.84E-02	4.02E-02	3.66E-02	3.69E-02	3.97E-02	3.56E-02	3.34E-02	3.63E-02	3.41E-02	3.69E-02	3.50E-02	0
Cr	1.10E-04	1.00E-04	9.00E-05	9.00E-05	1.00E-04	9.00E-05	9.00E-05	9.00E-05	8.00E-05	8.00E-05	9.00E-05	9.00E-05	1.00E-04	9.00E-05	9.00E-05	0
Cu	3.23E-01	3.24E-01	3.37E-01	3.23E-01	3.46E-01	3.71E-01	3.25E-01	3.16E-01	3.46E-01	3.77E-01	3.67E-01	3.66E-01	3.51E-01	3.49E-01	3.51E-01	0
F	4.40E-01	5.33E-01	5.55E-01	4.37E-01	4.56E-01	4.77E-01	5.26E-01	4.63E-01	3.68E-01	5.00E-01	5.53E-01	4.69E-01	4.61E-01	4.21E-01	5.35E-01	0
Fe	6.61E+00	7.17E+00	6.82E+00	6.67E+00	7.15E+00	7.05E+00	6.85E+00	6.65E+00	7.25E+00	6.98E+00	7.19E+00	6.99E+00	7.35E+00	7.00E+00	7.01E+00	0
K	1.30E+01	1.37E+01	1.47E+01	1.55E+01	1.42E+01	1.38E+01	1.47E+01	1.33E+01	1.38E+01	1.41E+01	1.30E+01	1.42E+01	1.31E+01	1.24E+01	1.29E+01	0
Mg	1.35E+02	1.57E+02	1.37E+02	1.69E+02	1.72E+02	1.53E+02	1.73E+02	1.76E+02	1.67E+02	1.80E+02	1.62E+02	1.55E+02	1.61E+02	1.77E+02	1.57E+02	0
Mn	1.35E+00	1.27E+00	1.34E+00	1.29E+00	1.30E+00	1.25E+00	1.30E+00	1.37E+00	1.40E+00	1.43E+00	1.39E+00	1.43E+00	1.43E+00	1.35E+00	1.35E+00	0
Na	6.73E+01	6.24E+01	6.35E+01	7.19E+01	7.14E+01	6.83E+01	6.80E+01	6.64E+01	6.11E+01	6.27E+01	5.92E+01	6.13E+01	6.98E+01	6.34E+01	5.49E+01	0
Ni	5.14E-01	5.00E-01	5.36E-01	4.96E-01	5.10E-01	4.45E-01	5.10E-01	5.23E-01	4.67E-01	5.27E-01	4.97E-01	5.01E-01	4.75E-01	4.91E-01	5.35E-01	0
Pb	1.21E-02	1.22E-02	1.27E-02	1.16E-02	1.13E-02	1.04E-02	1.07E-02	1.14E-02	1.22E-02	1.03E-02	1.00E-02	9.99E-03	1.15E-02	1.02E-02	1.13E-02	0
Sb	7.30E-04	7.50E-04	6.80E-04	6.10E-04	6.50E-04	6.30E-04	7.00E-04	7.30E-04	7.10E-04	6.70E-04	7.20E-04	7.00E-04	7.00E-04	7.60E-04	8.10E-04	0
Se	1.20E-04	1.20E-04	1.20E-04	1.10E-04	9.00E-05	9.00E-05	9.00E-05	9.00E-05	9.00E-05	9.00E-05	9.00E-05	1.00E-04	1.00E-04	1.10E-04	1.00E-04	0
SO_4	4.51E+02	4.28E+02	3.89E+02	4.55E+02	3.95E+02	4.01E+02	4.33E+02	4.15E+02	3.88E+02	4.50E+02	4.09E+02	4.90E+02	4.46E+02	4.31E+02	4.51E+02	0
Tl	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	0
V	1.30E-04	1.10E-04	1.20E-04	1.20E-04	1.10E-04	1.00E-04	9.00E-05	1.10E-04	1.10E-04	1.00E-04	1.10E-04	1.10E-04	1.10E-04	1.00E-04	1.10E-04	0
Zn	4.50E-03	4.40E-03	4.43E-03	3.53E-03	4.33E-03	3.88E-03	4.11E-03	4.21E-03	4.39E-03	4.53E-03	4.04E-03	4.77E-03	4.51E-03	4.53E-03	4.35E-03	0

Notes

Source: Plant Site probabilistic water quality model, Version 6

Figure 1-1: Pit Water Volume Relationships



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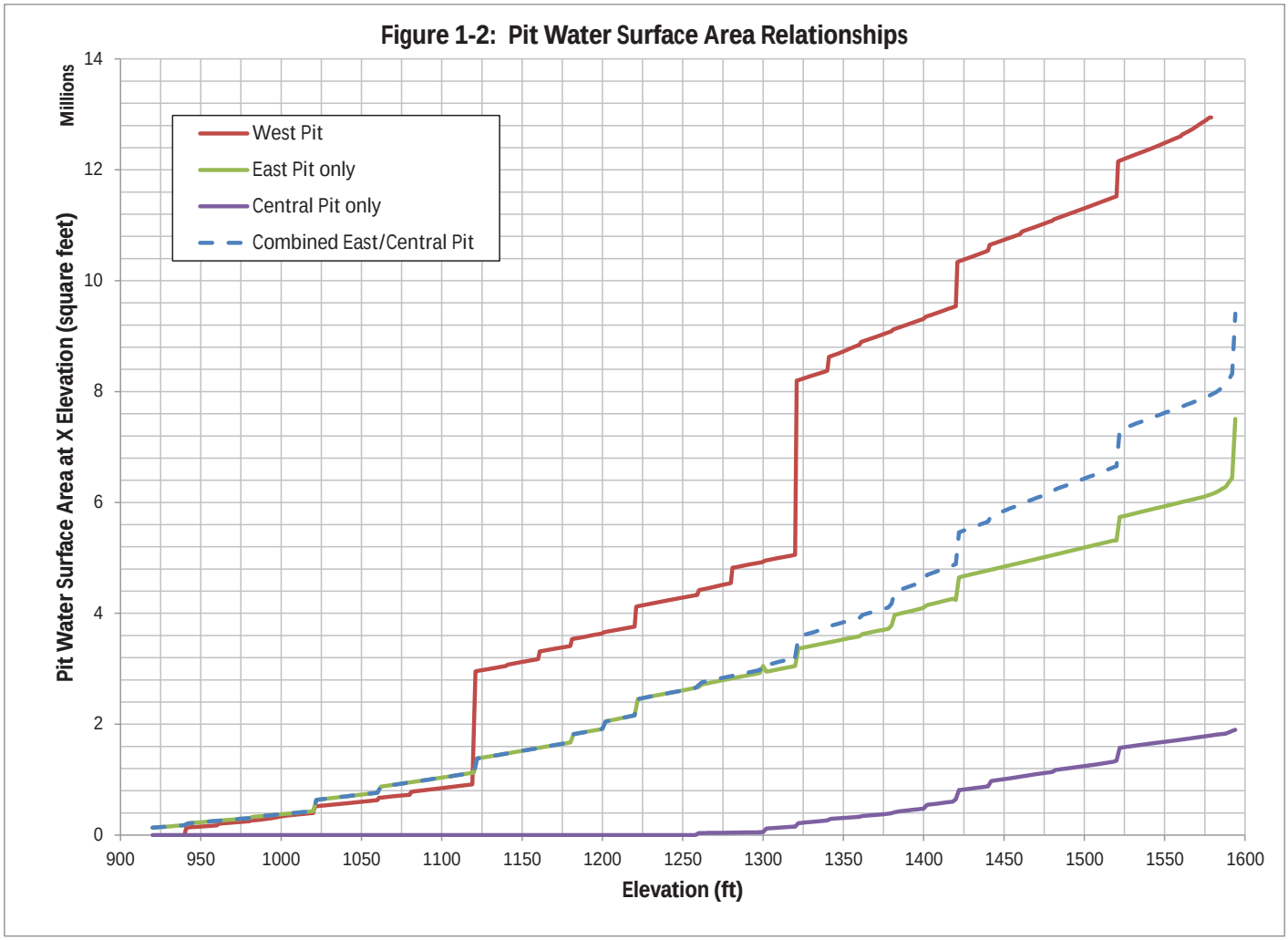

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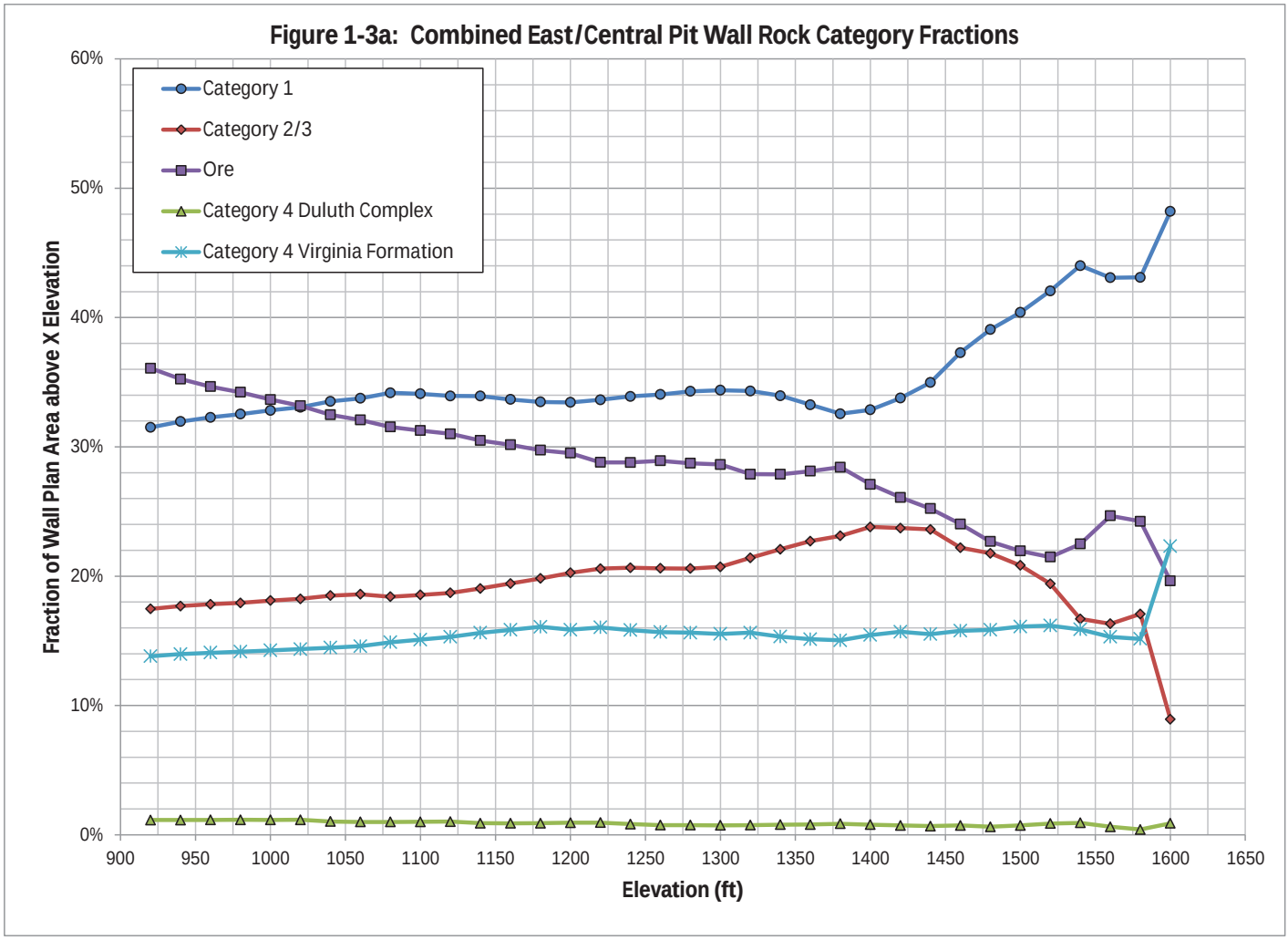

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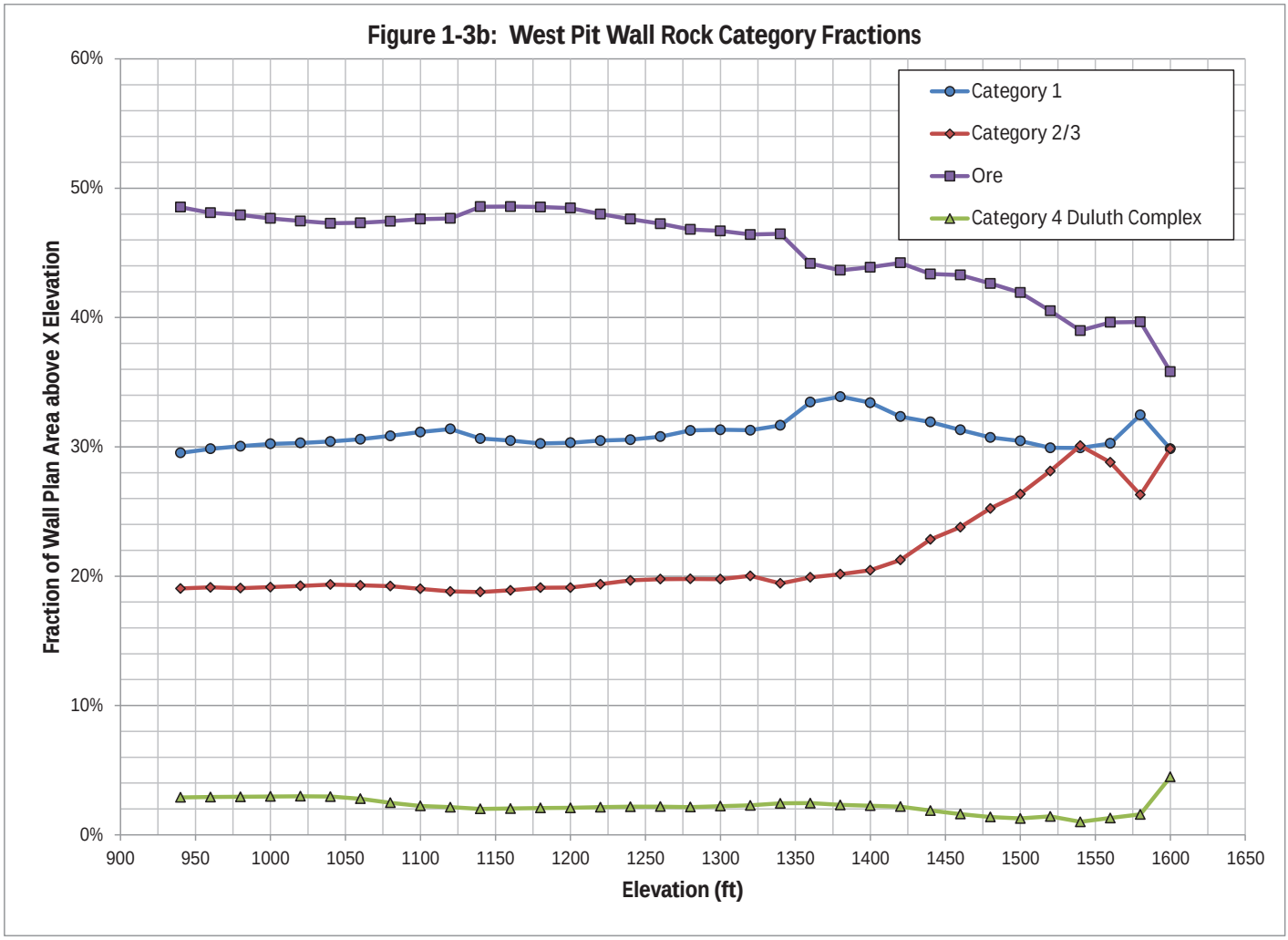

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Figure 1-4: Pit Wall Rock Areas

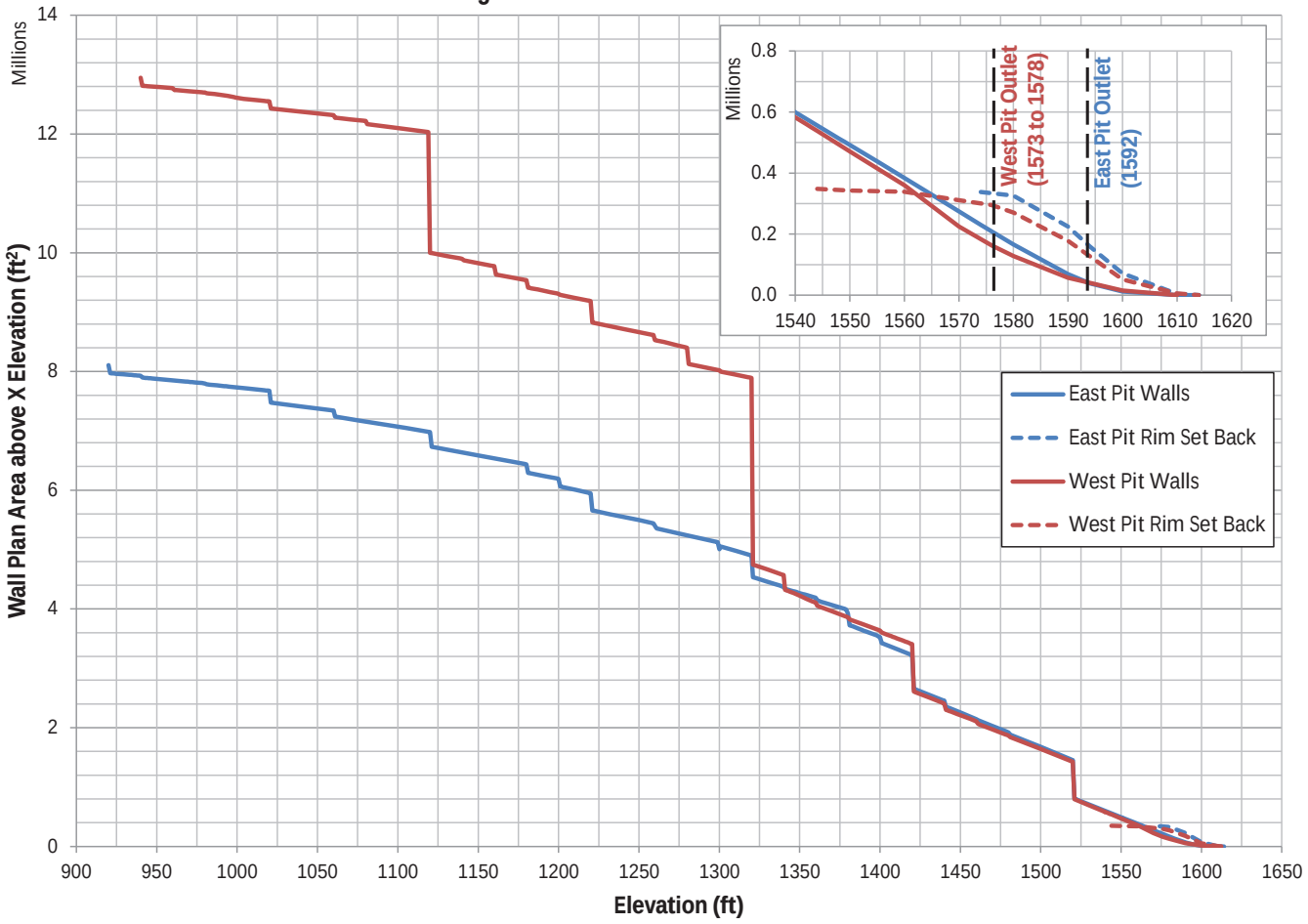

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Figure 1-5: Category 1 Wall Rock Sulfur Content

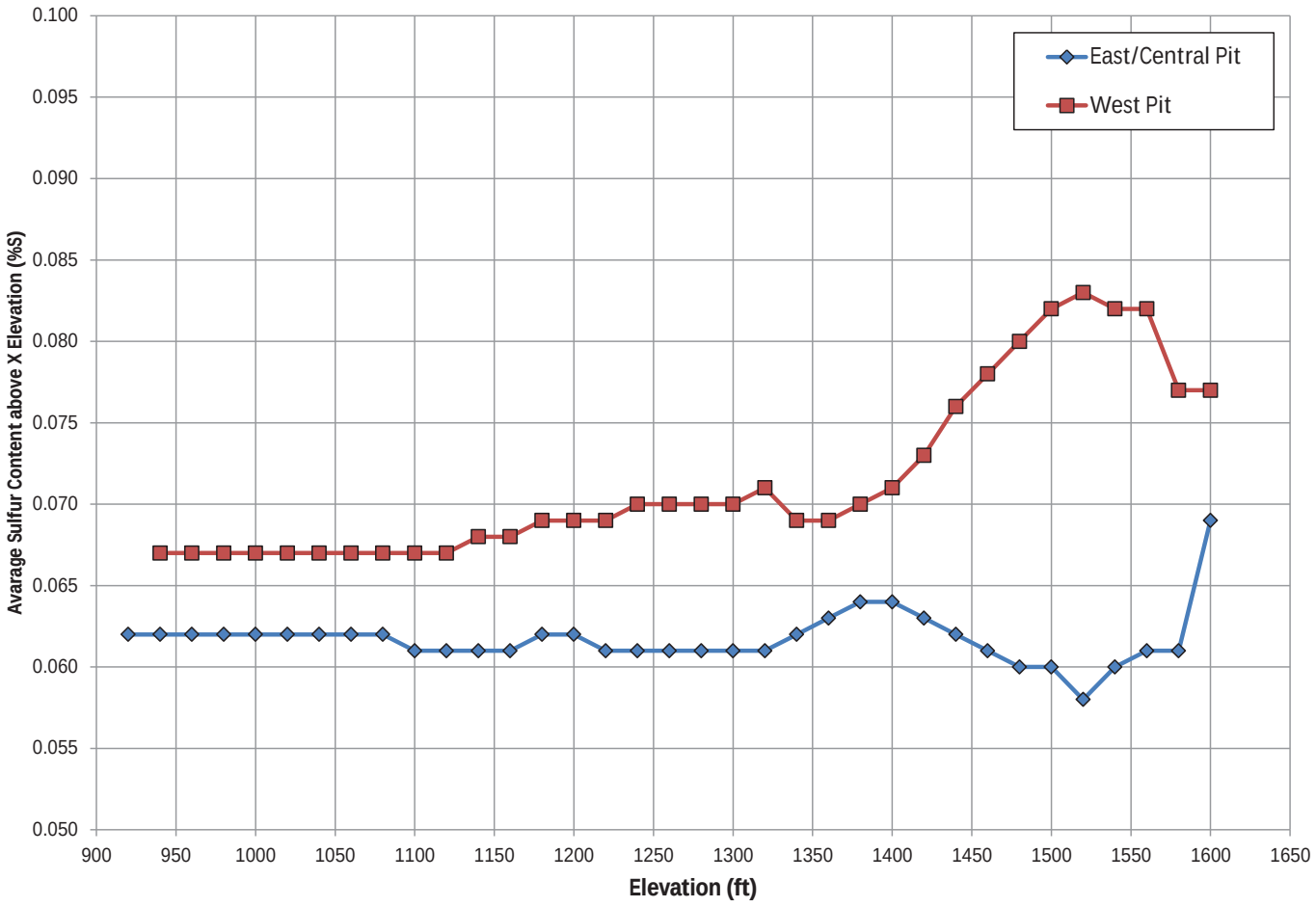

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Figure 1-6: Category 2/3 Wall Rock Sulfur Content

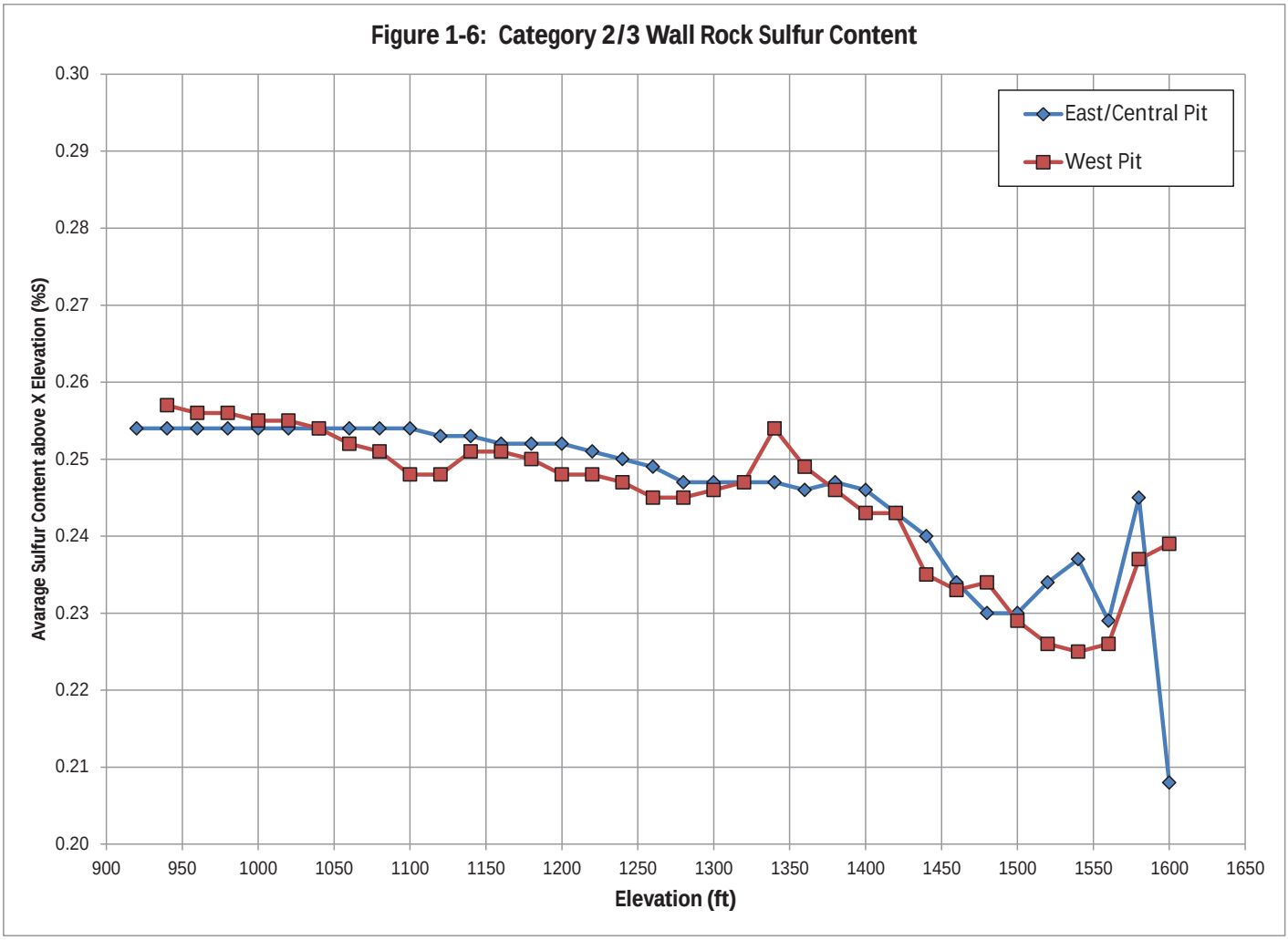

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Figure 1-7: Ore Wall Rock Sulfur Content

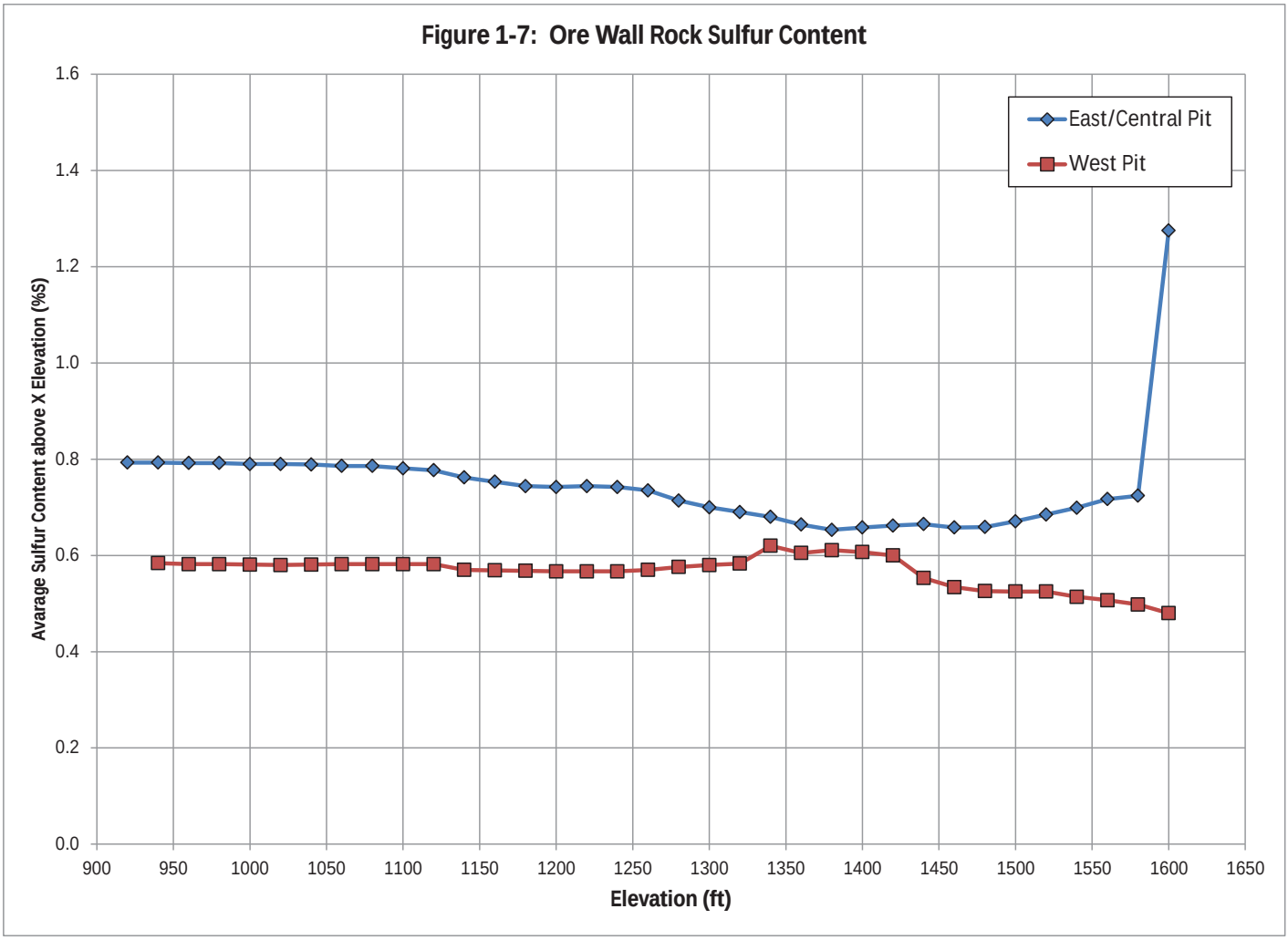

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Table 2-1 Output Constituents for the Mine Site Model

Constituent
Ag
Al
Alk
As
B
Ba
Be
Ca
Cd
Cl
Co
Cr
Cu
F
Fe
K
Mg
Mn
Na
Ni
Pb
Sb
Se
SO4
Tl
V
Zn
Hardness

Table 2-2 Output Locations for the Mine Site Model

Surface Water Evaluation Locations

Evaluation Location	*Applicable Standards*
SW-002	SW
SW-003	SW
SW-004	SW
SW-004a	SW
SW-004b	SW
SW-005	SW, WR
SW-006	SW
Colby Lake	SW
West Pit	SW

Groundwater Evaluation Locations

Flowpath	*Evaluation Locations*	*Applicable Standards*	*Receiving Partridge River Node*
East Pit & Cat 2/3 (surficial)	Dunka Rd., Prop. Bound.	GW	SW-004
East Pit (bedrock)	Prop. Bound.	GW	SW-004
OSP (surficial)	Dunka Rd., Partridge River	GW	SW-004
WWTF	Dunka Rd., Prop. Bound.	GW	SW-004
OSLA (surficial)	Dunka Rd., Prop. Bound.	GW	SW-004
West Pit (surficial)	Dunka Rd., Prop. Bound.	GW	SW-004a
West Pit (bedrock)	Prop. Bound.	GW	SW-004, SW-004a

Attachment D

Surficial Aquifer Background Groundwater Distributions

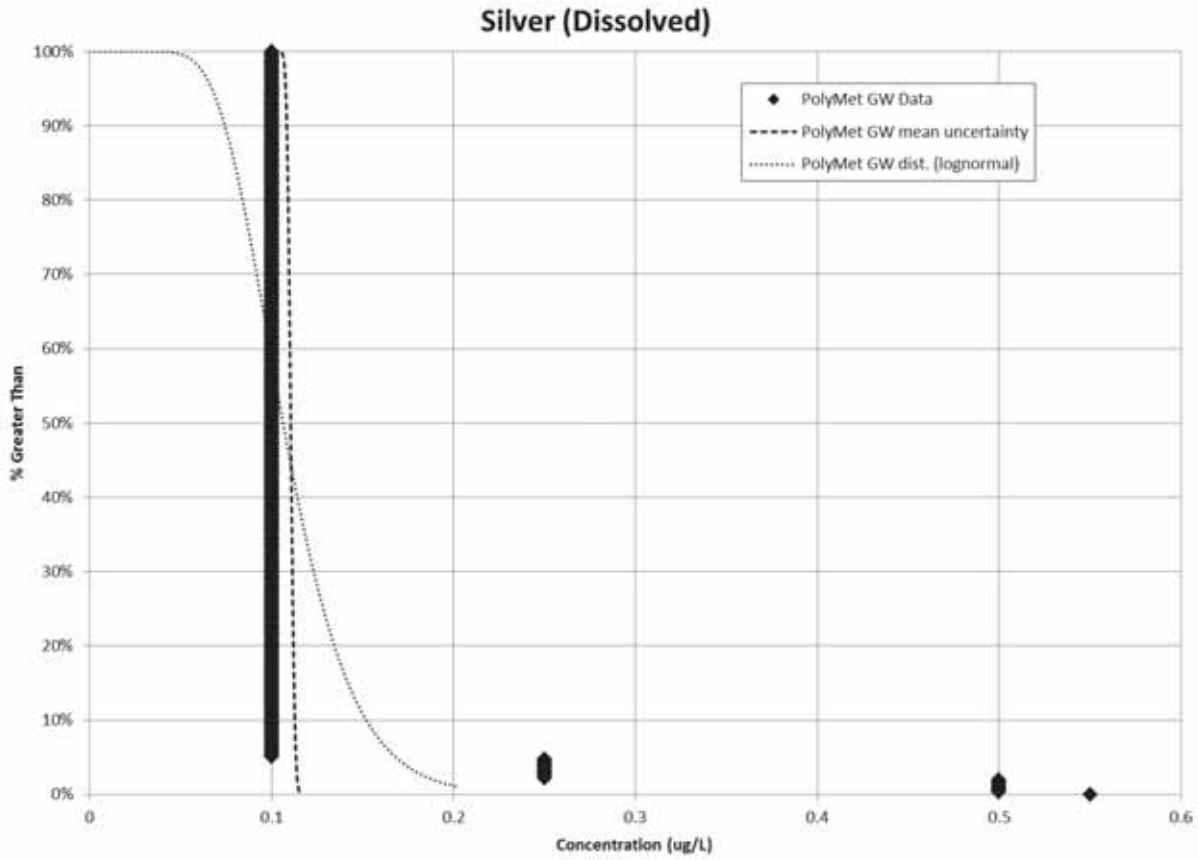


Figure 1 Background groundwater distributions – Silver (Ag)

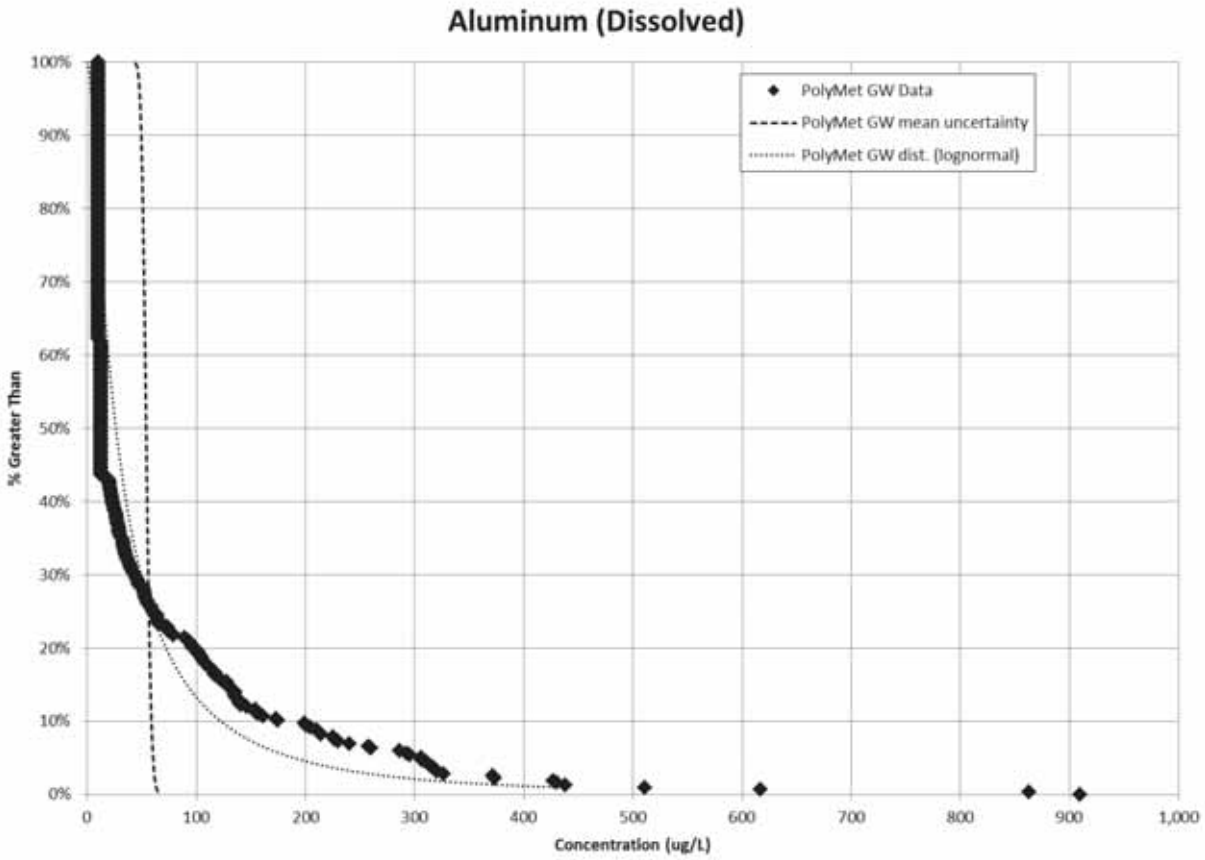


Figure 2 Background groundwater distributions – Aluminum (Al)

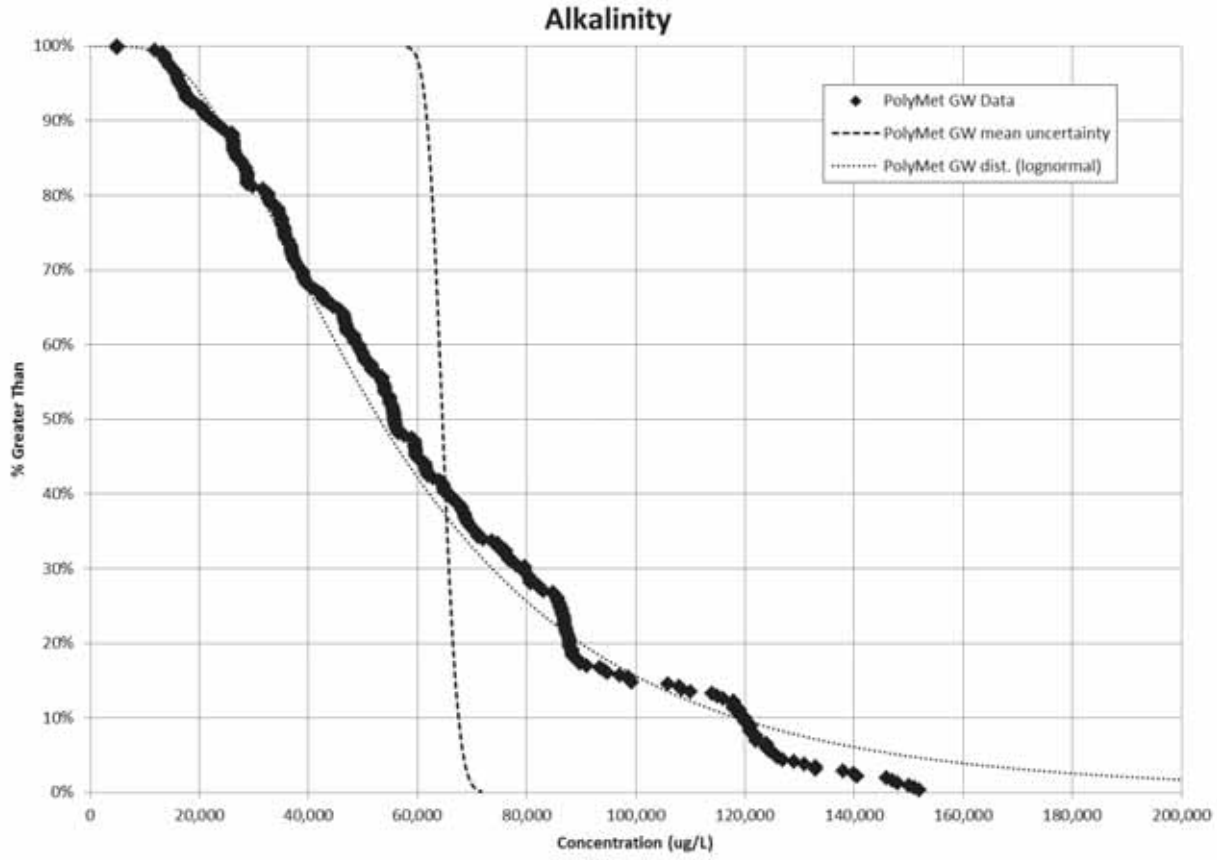


Figure 3 Background groundwater distributions – Alkalinity

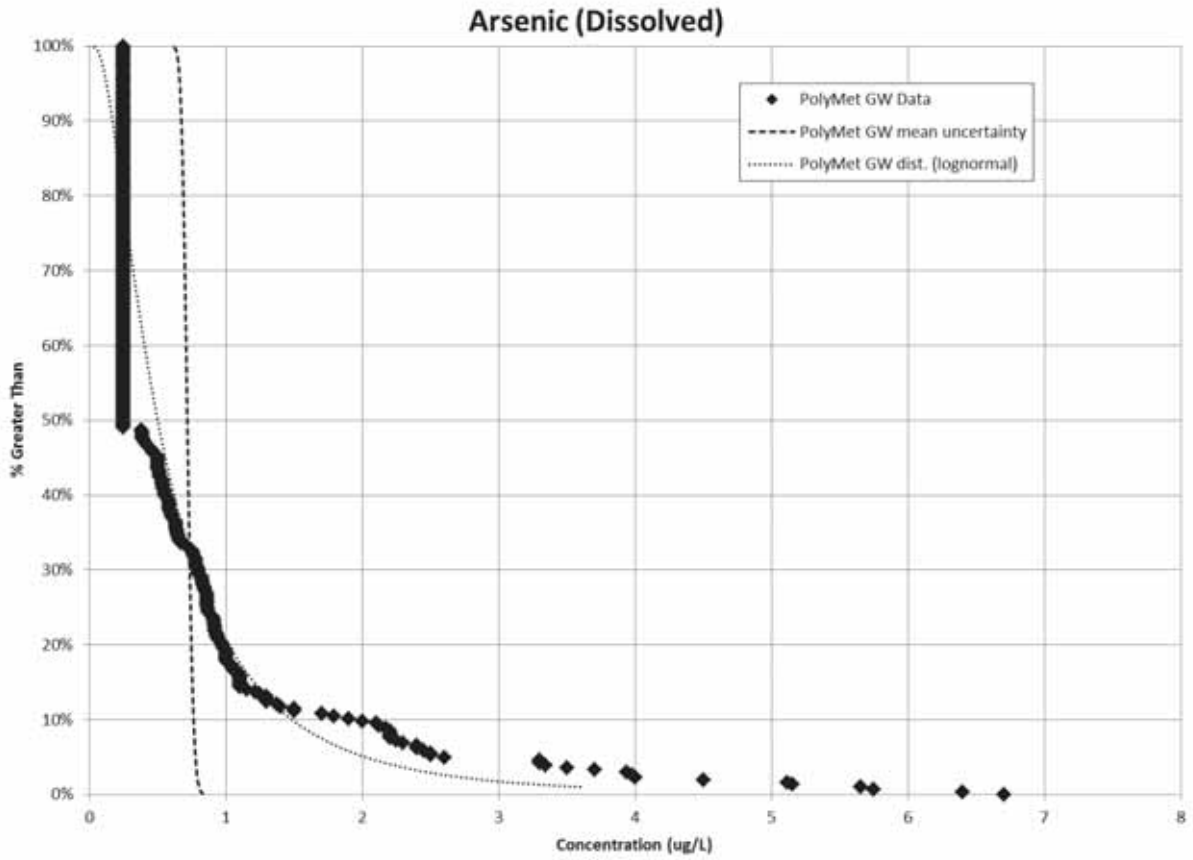


Figure 4 Background groundwater distributions – Arsenic (As)

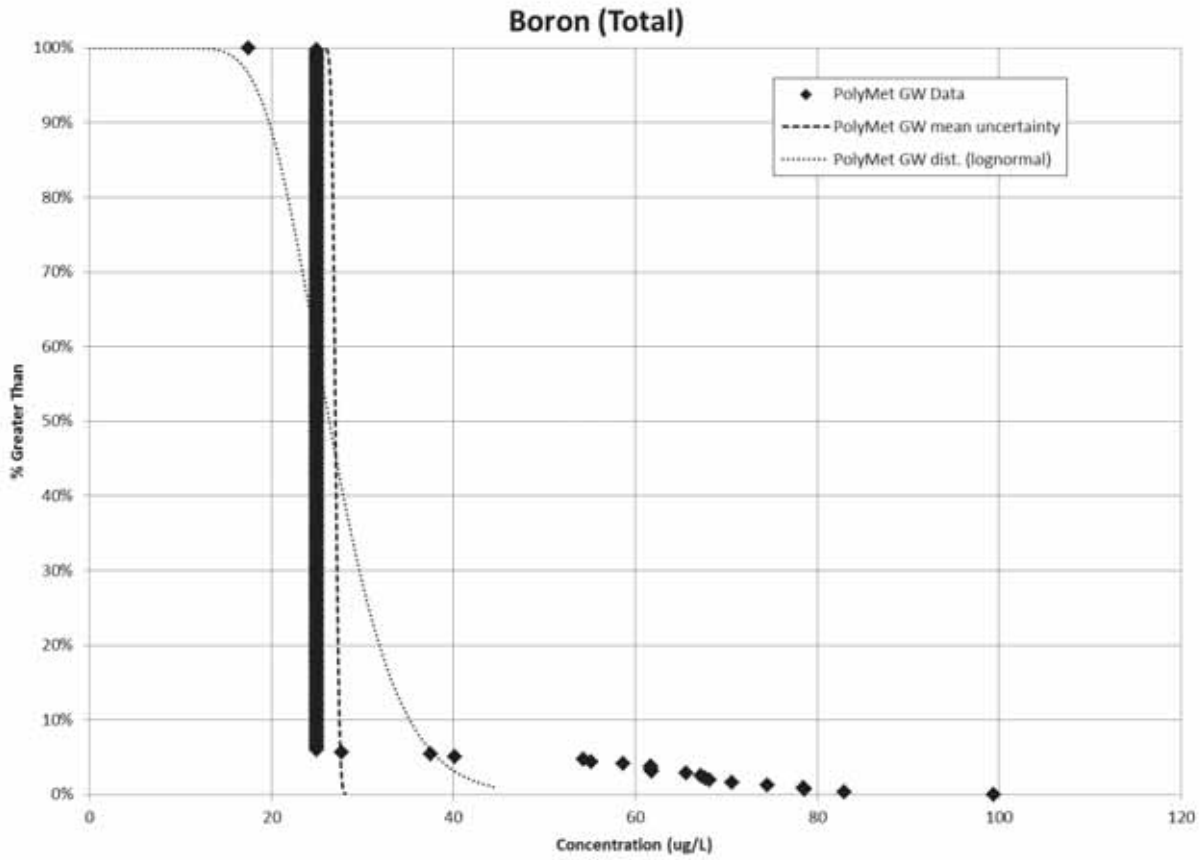


Figure 5 Background groundwater distributions – Boron (B)

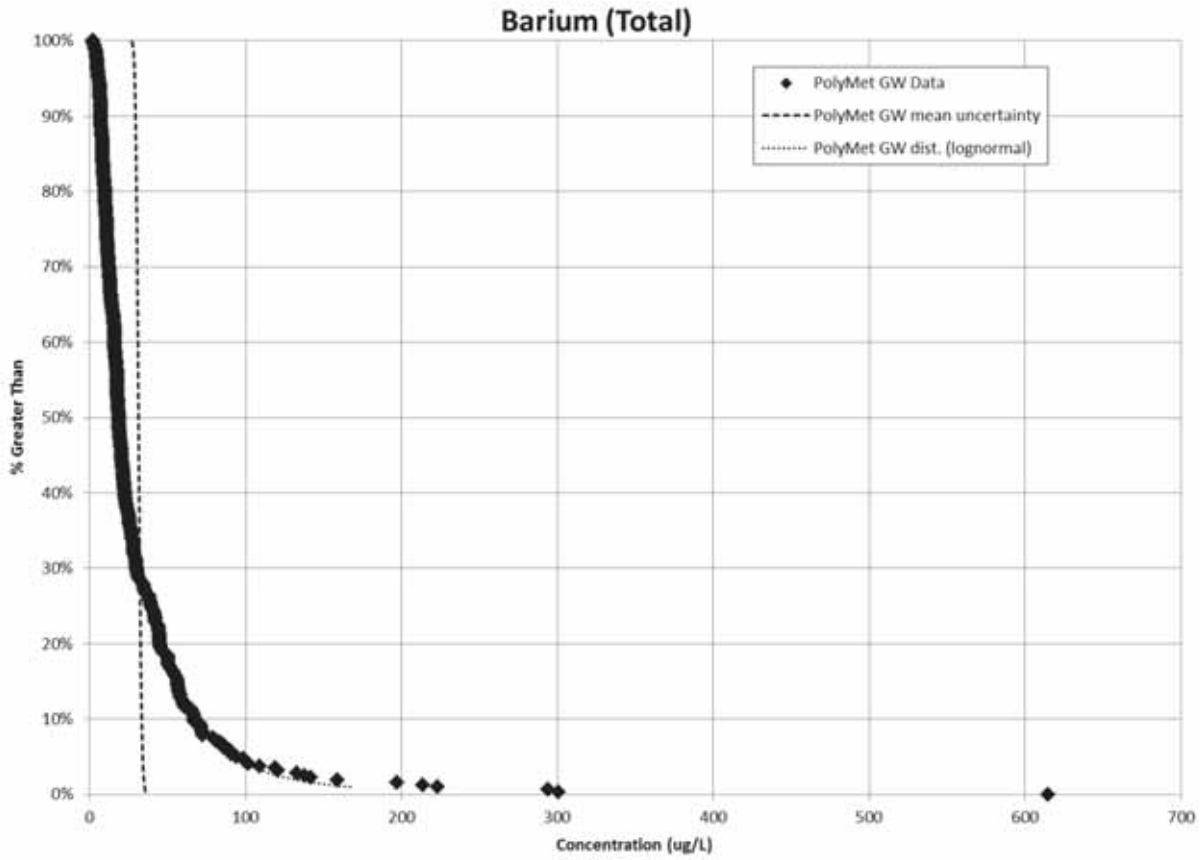


Figure 6 Background groundwater distributions – Barium (Ba)

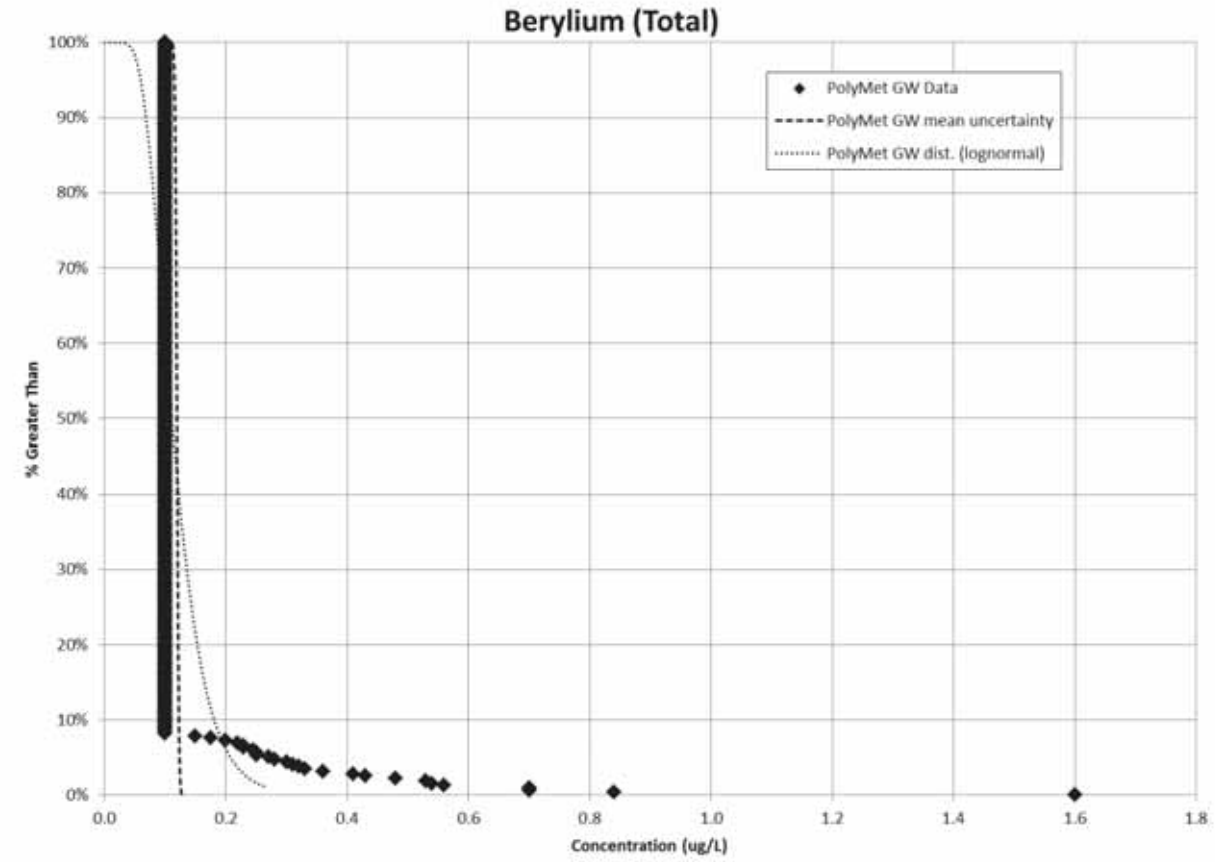


Figure 7 Background groundwater distributions – Beryllium (Be)

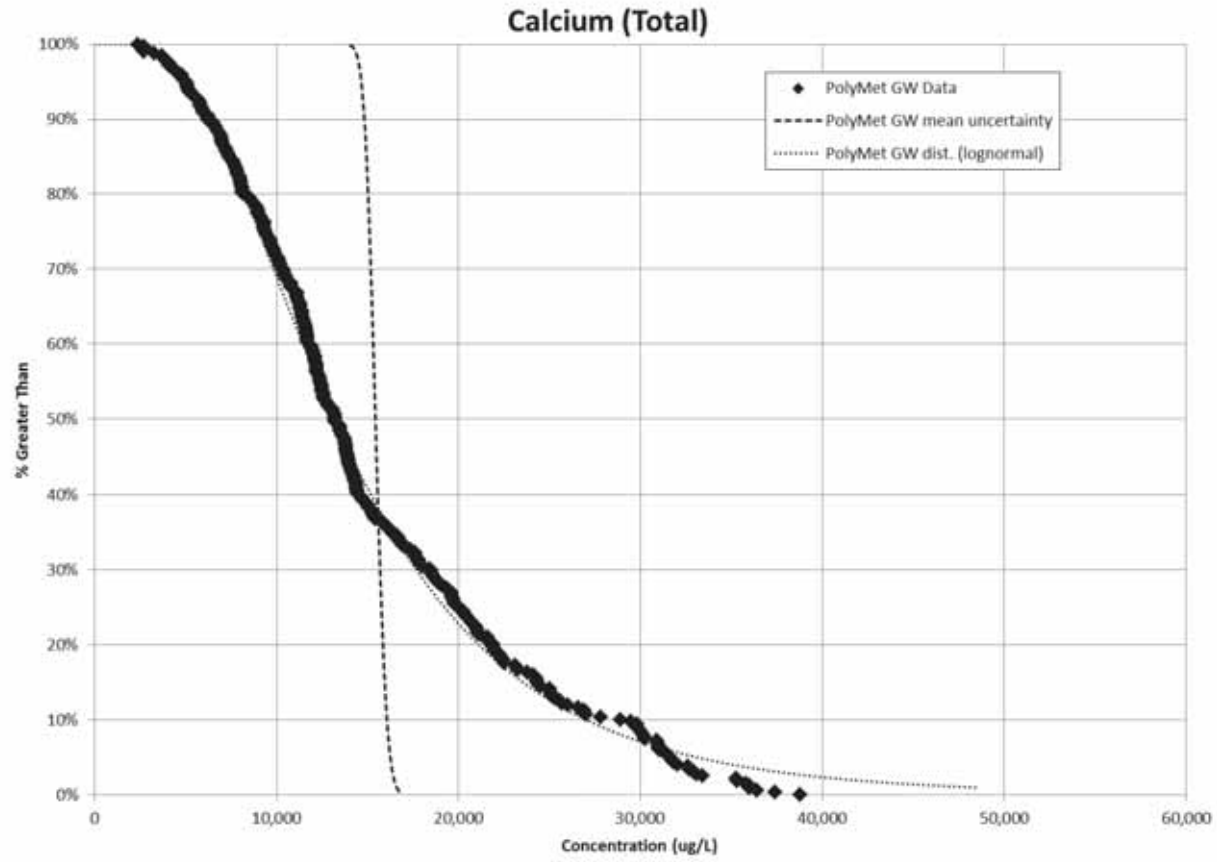


Figure 8 Background groundwater distributions – Calcium (Ca)

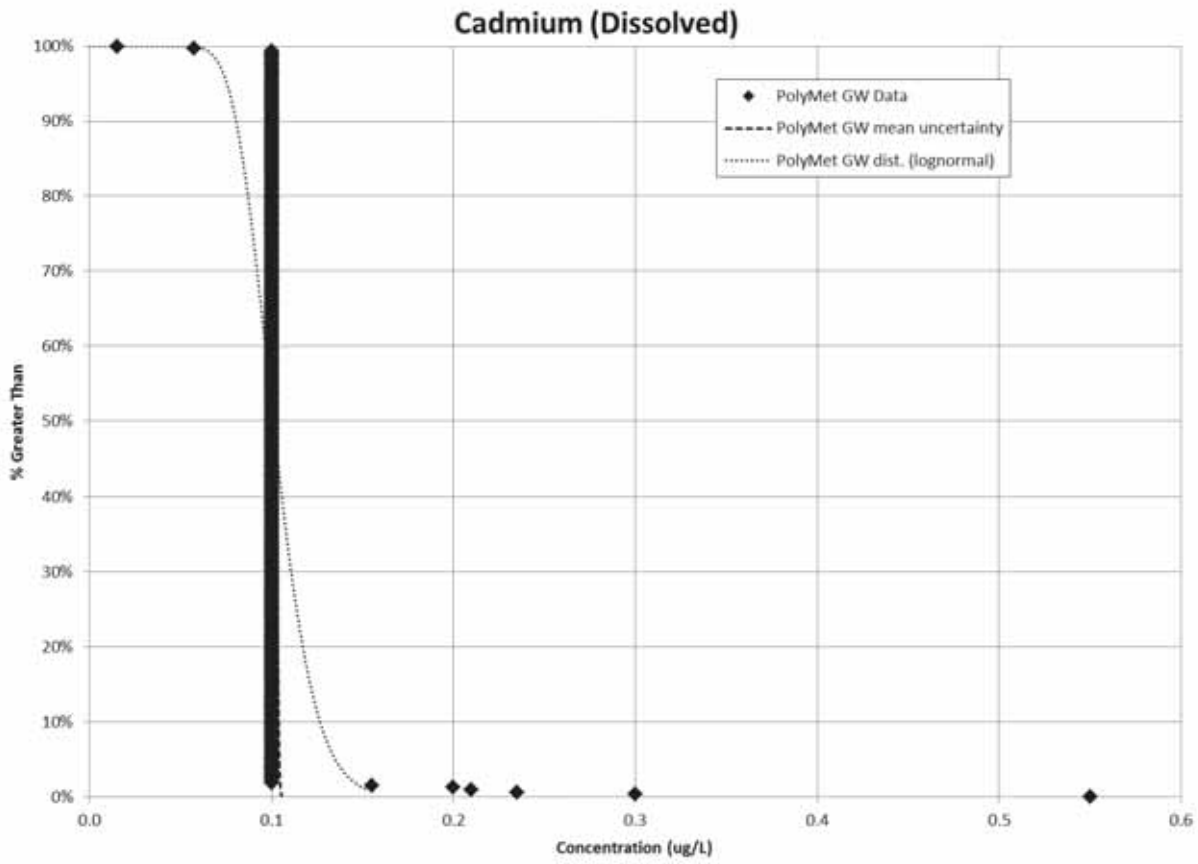


Figure 9 Background groundwater distributions – Cadmium (Cd)

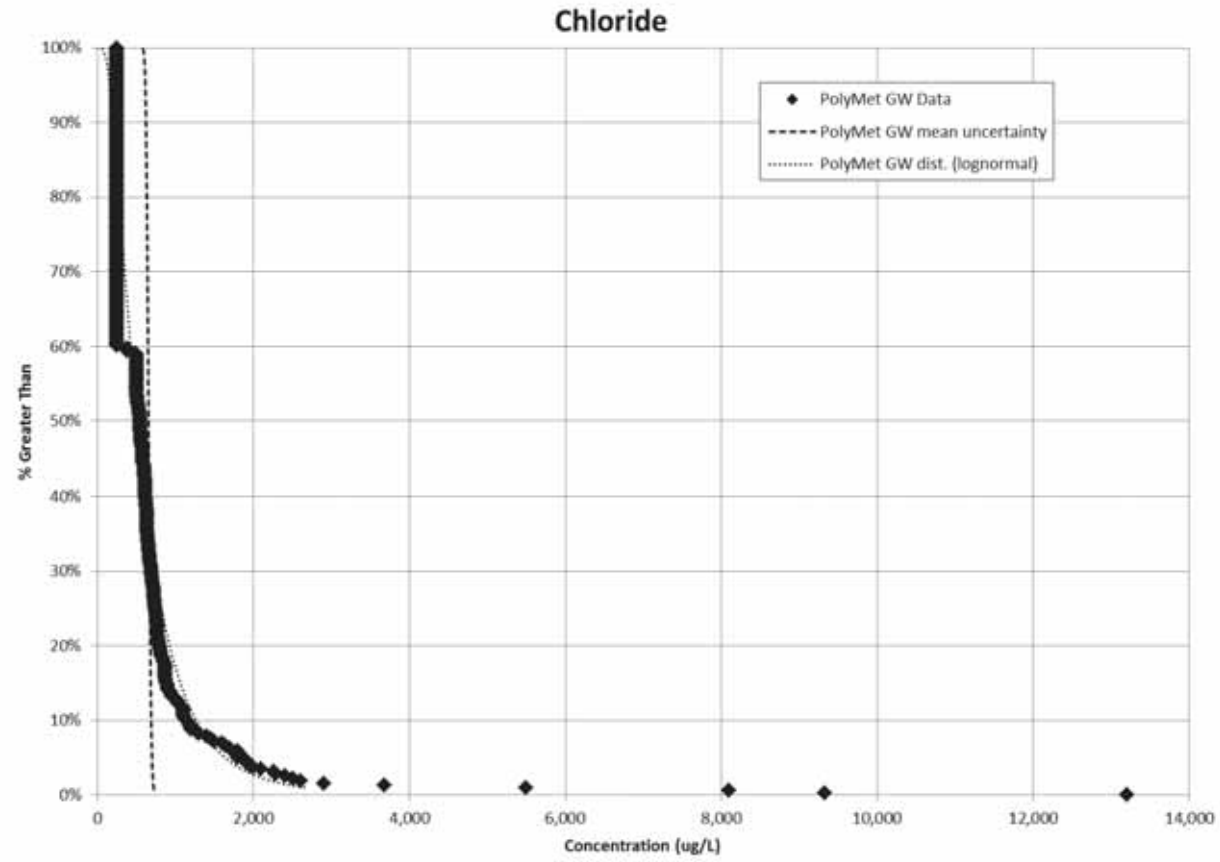


Figure 10 Background groundwater distributions – Chloride (Cl)

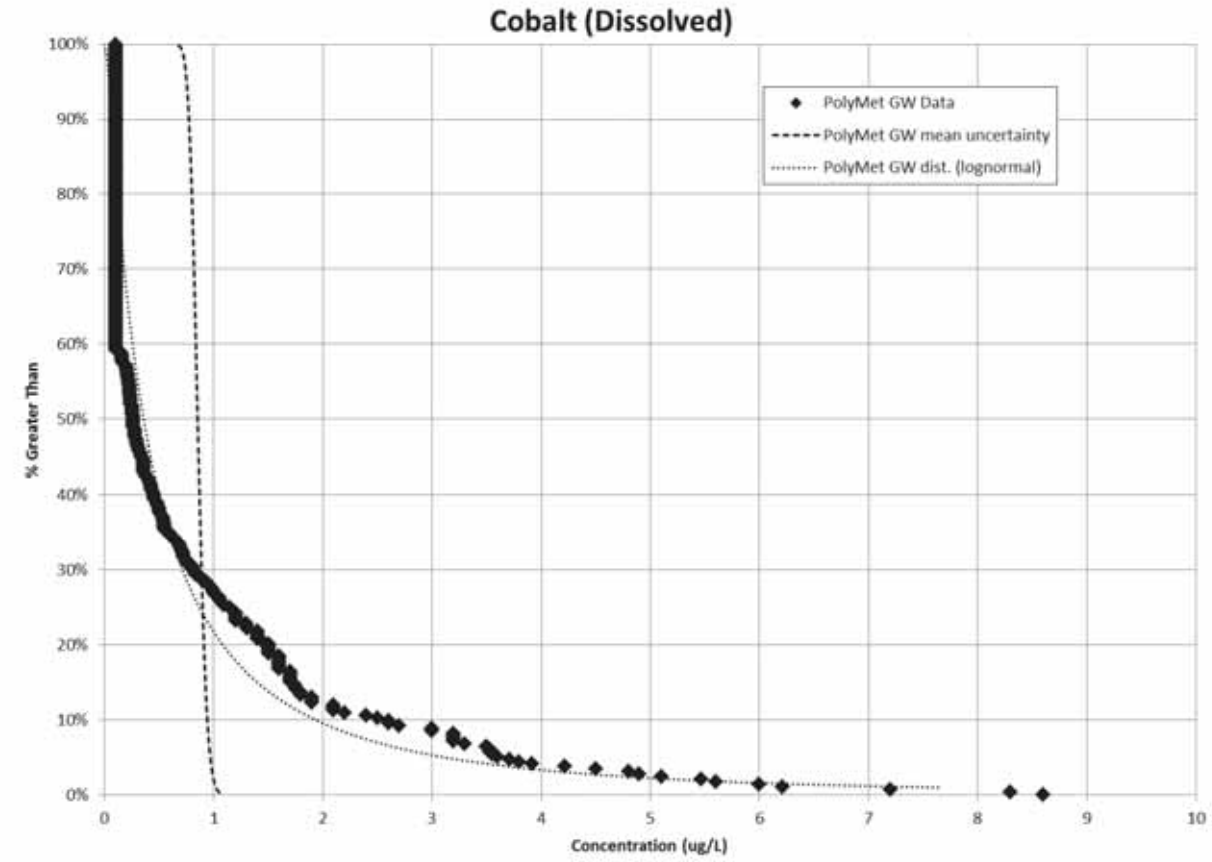


Figure 11 Background groundwater distributions – Cobalt (Co)

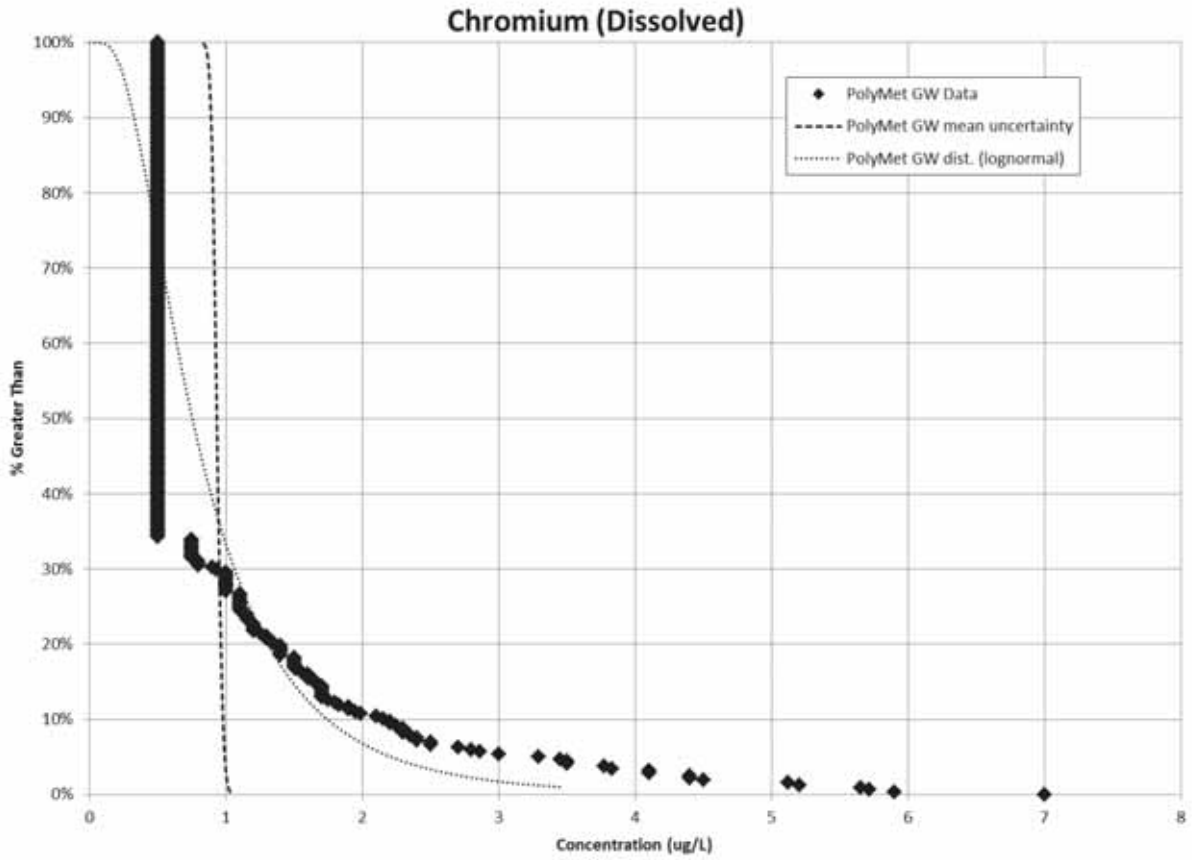


Figure 12 Background groundwater distributions – Chromium (Cr)

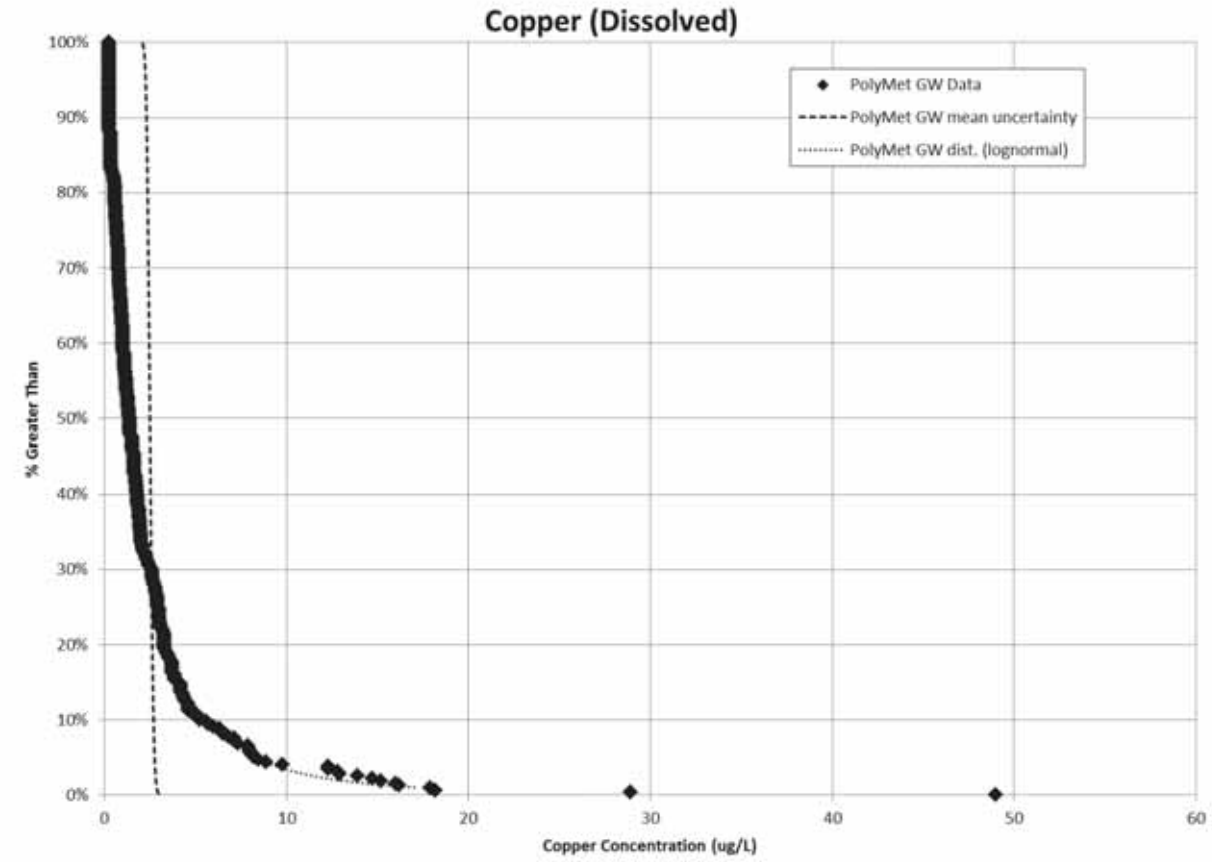


Figure 13 Background groundwater distributions – Copper (Cu)

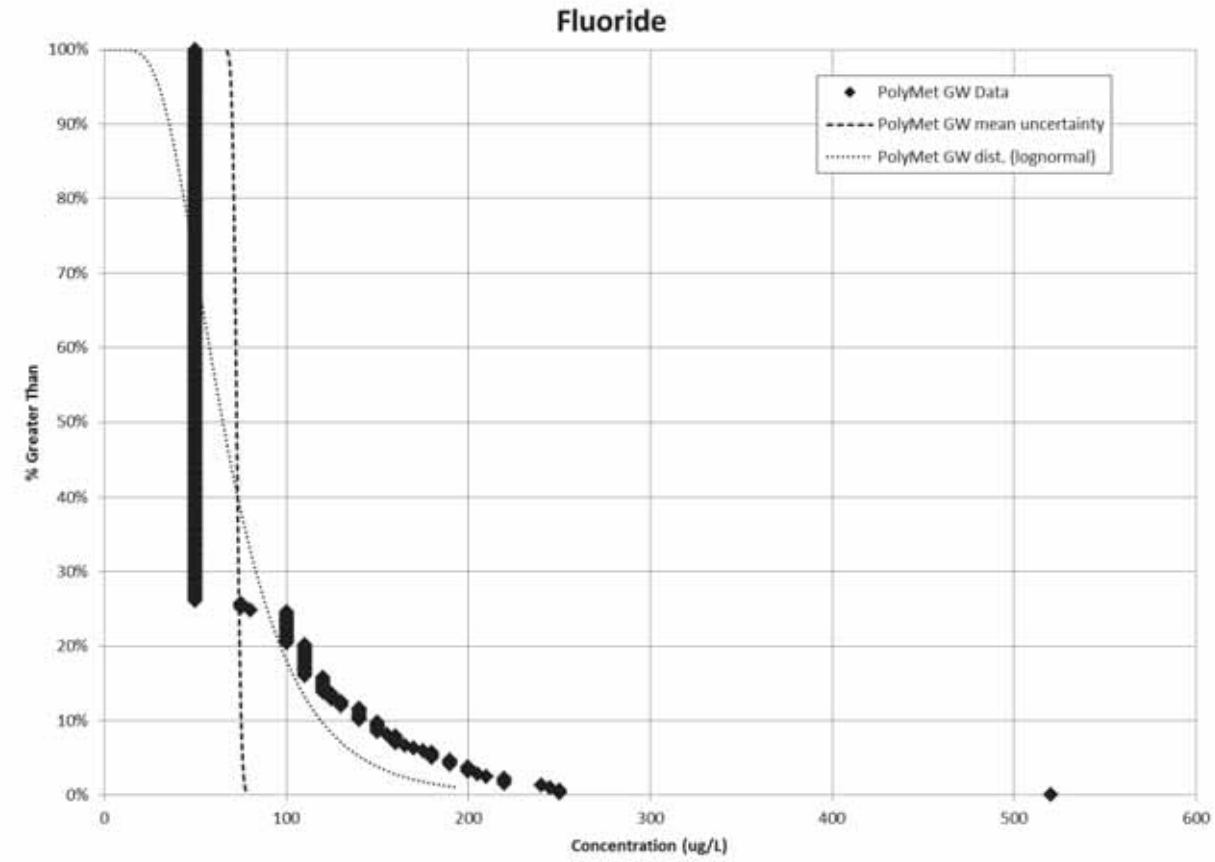


Figure 14 Background groundwater distributions – Fluoride (F)

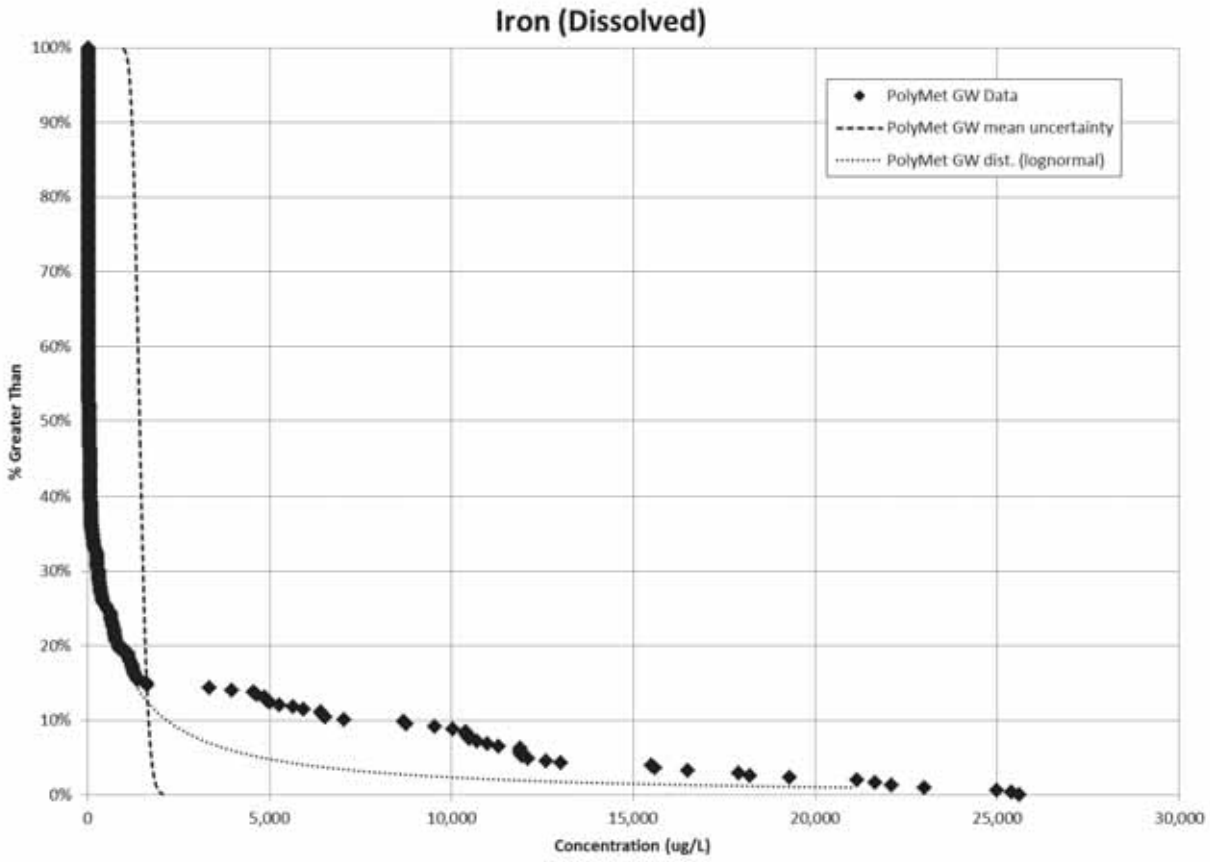


Figure 15 Background groundwater distributions – Iron (Fe)

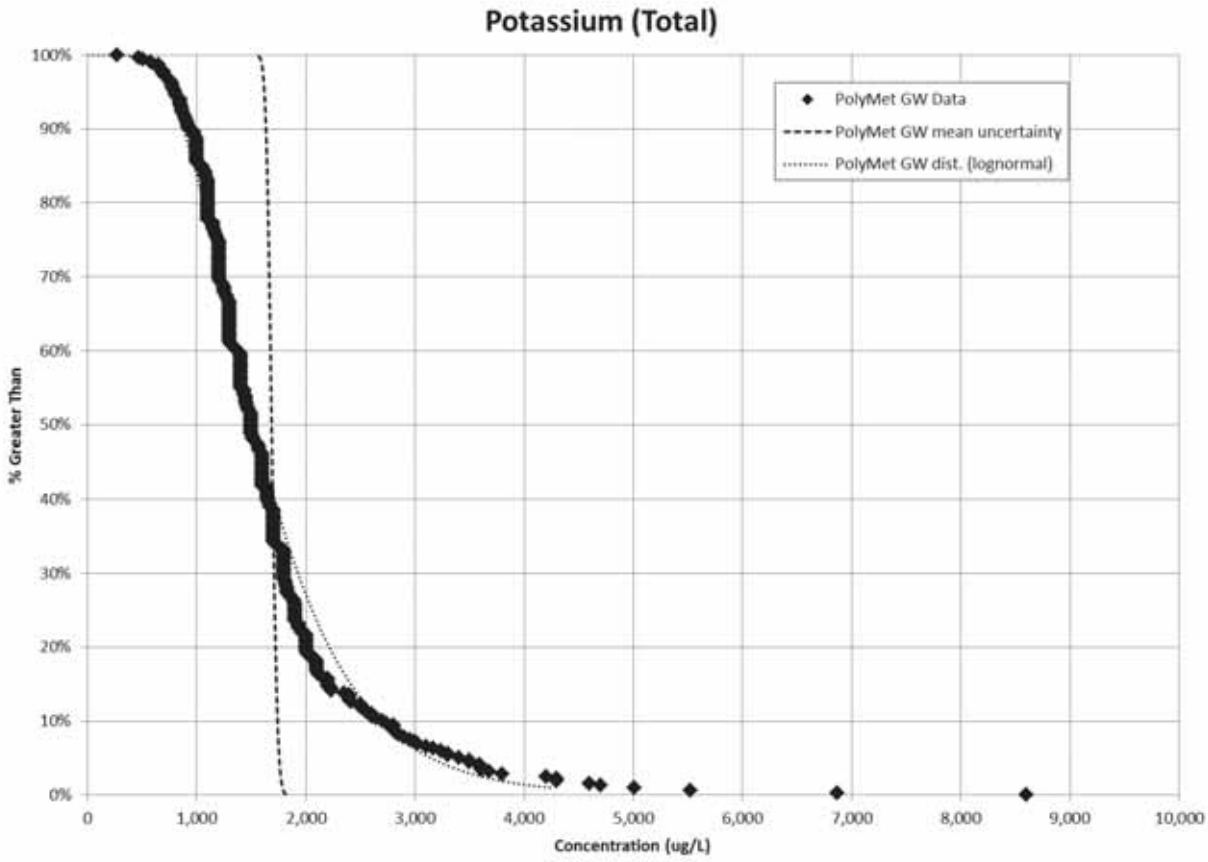


Figure 16 Background groundwater distributions – Potassium (K)

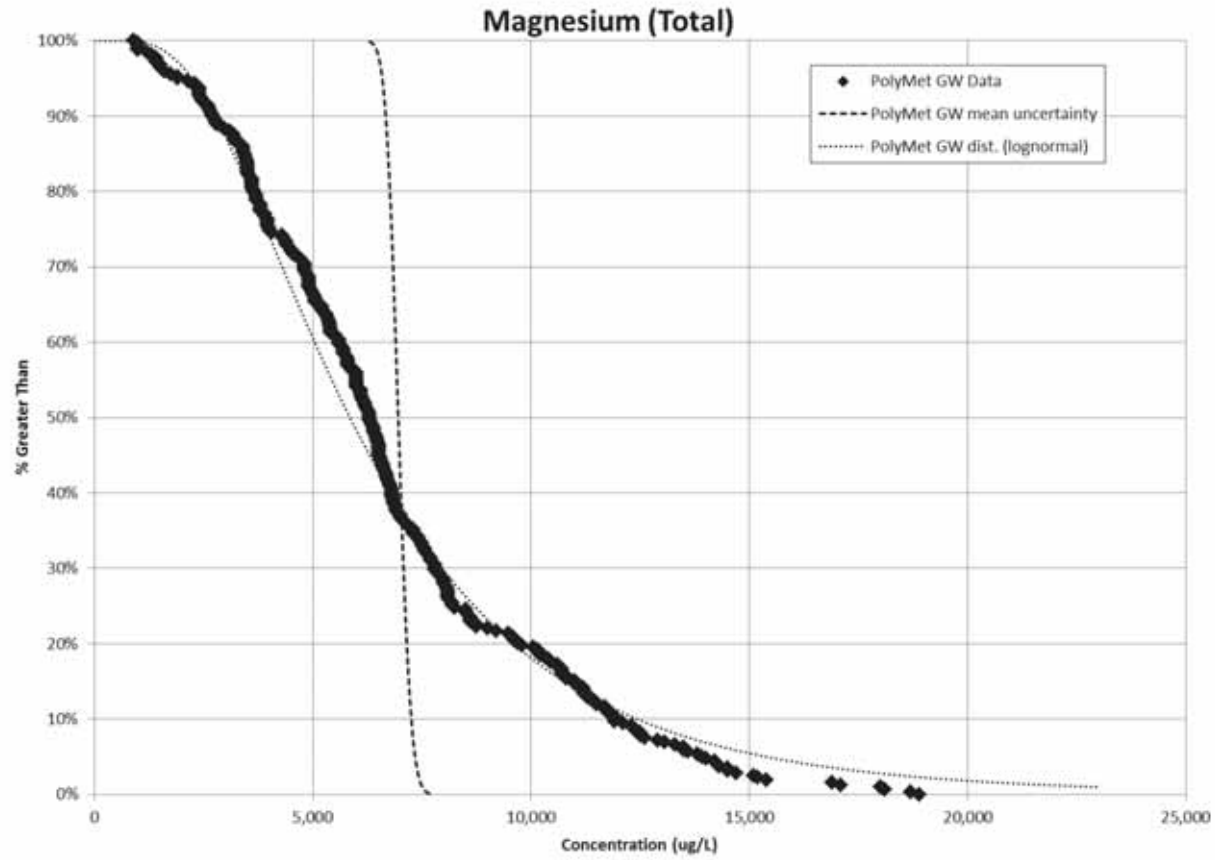


Figure 17 Background groundwater distributions – Magnesium (Mg)

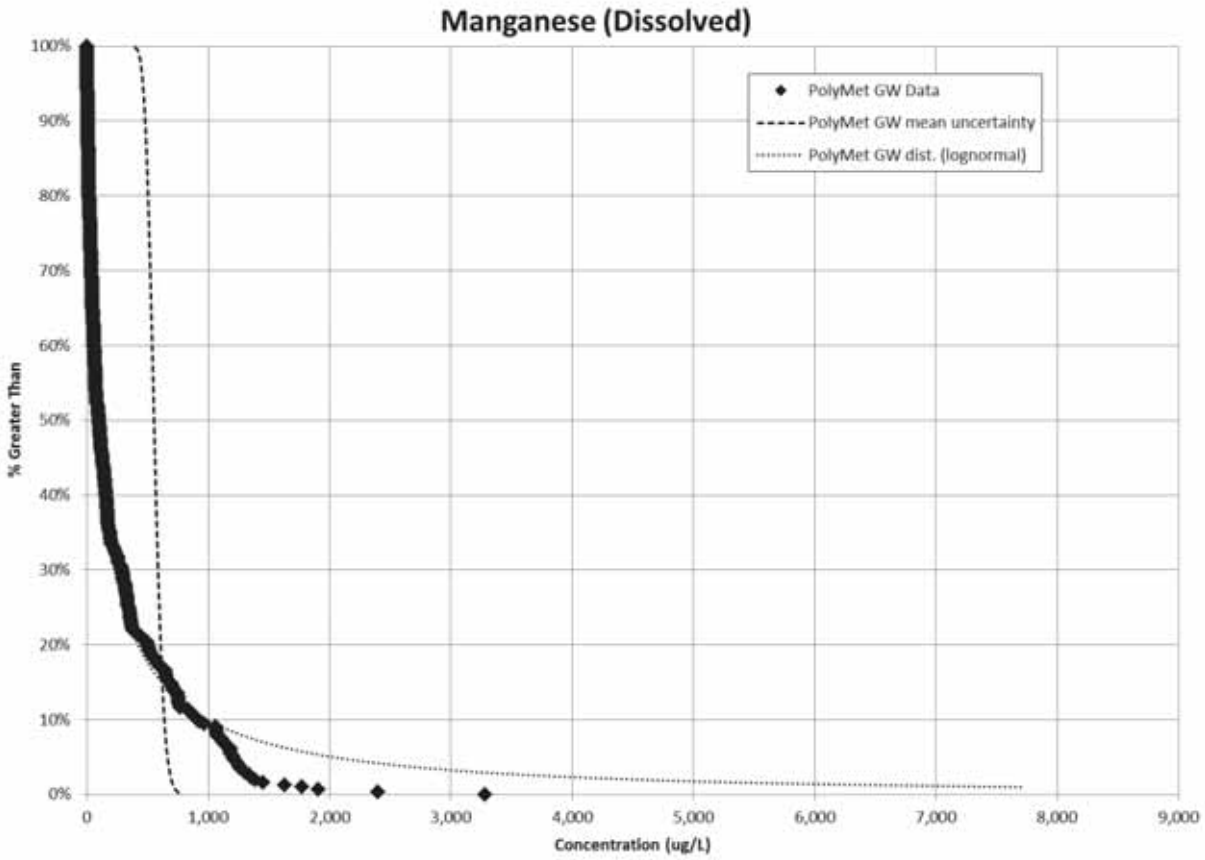


Figure 18 Background groundwater distributions – Manganese (Mn)

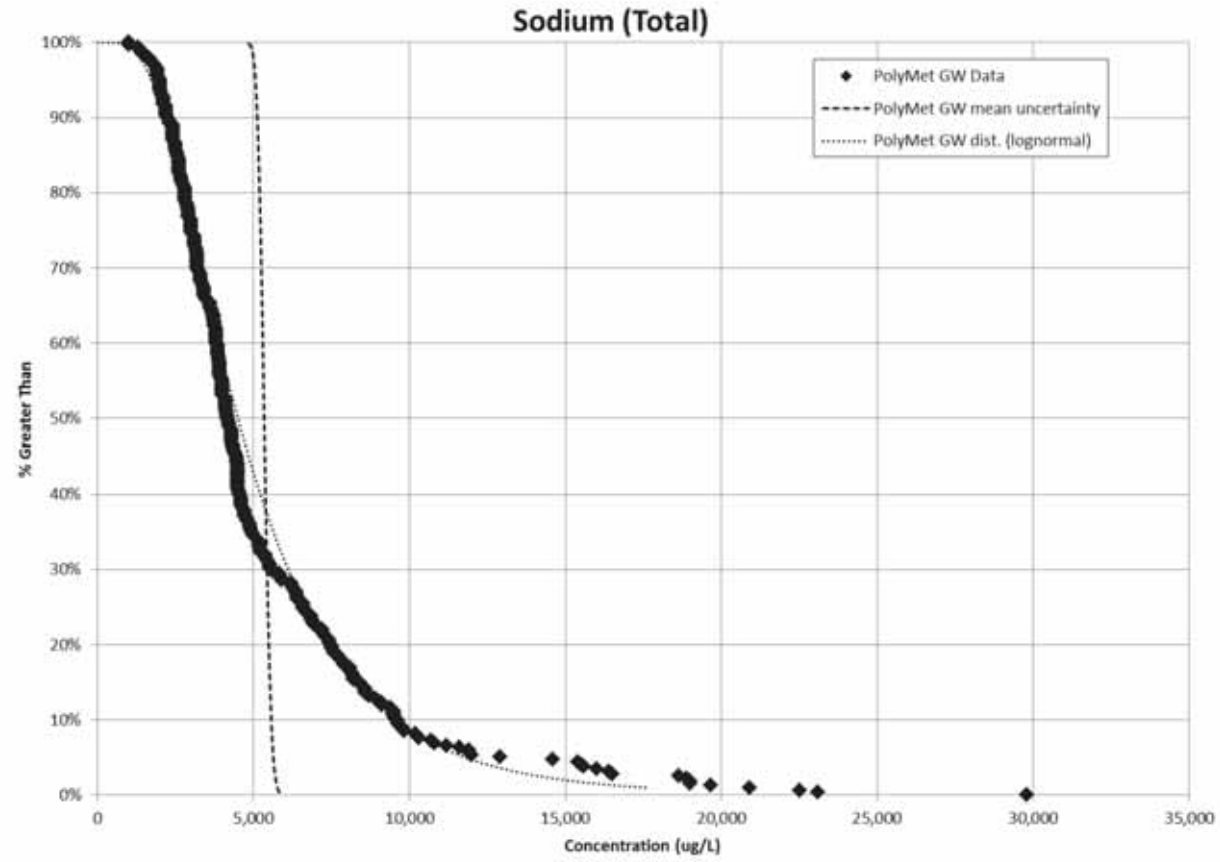


Figure 19 Background groundwater distributions – Sodium (Na)

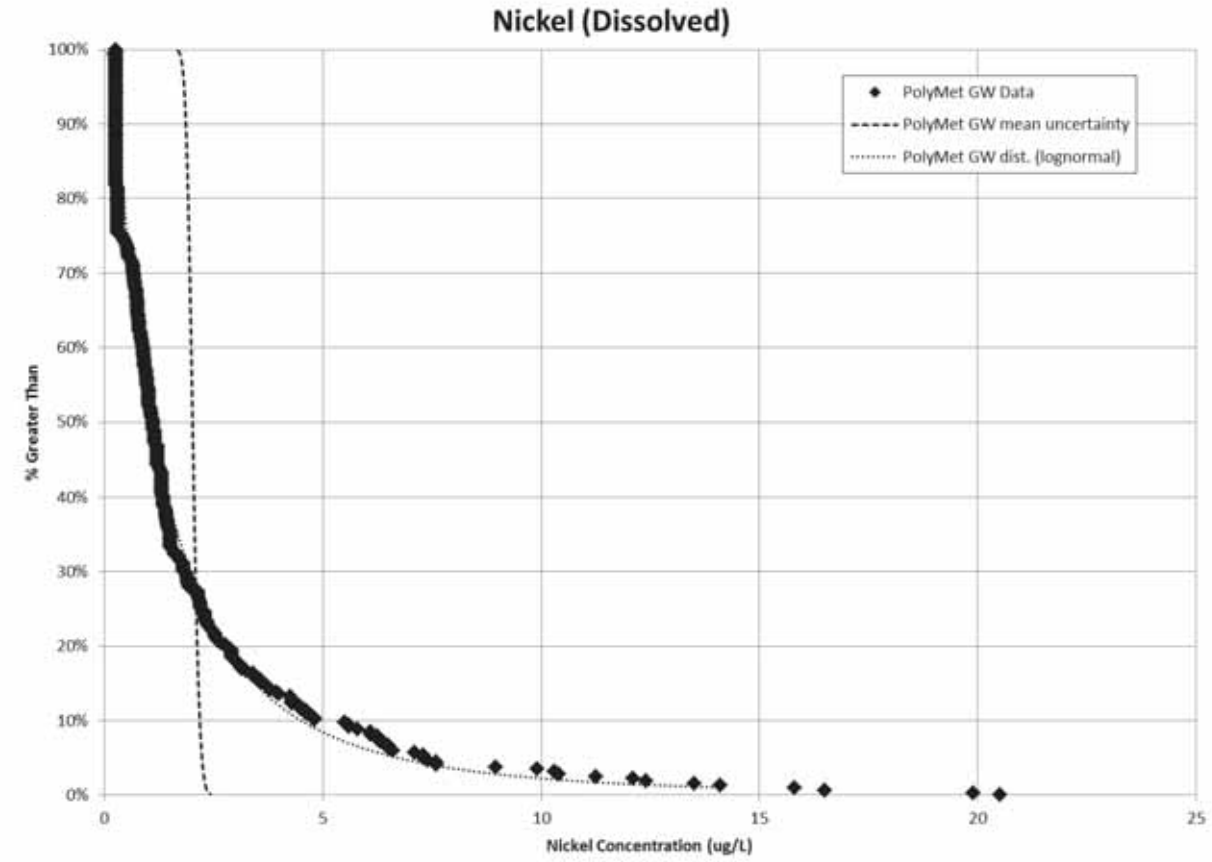


Figure 20 Background groundwater distributions – Nickel (Ni)

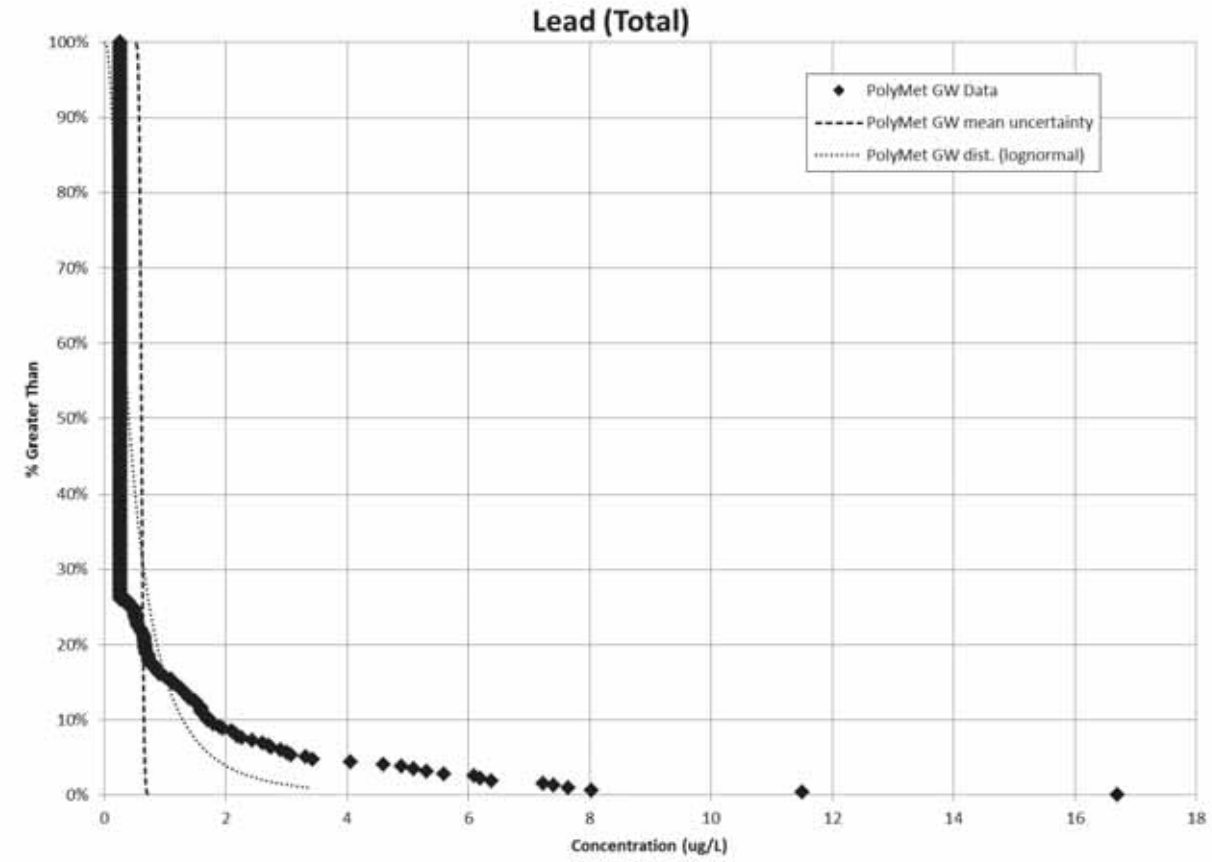


Figure 21 Background groundwater distributions – Lead (Pb)

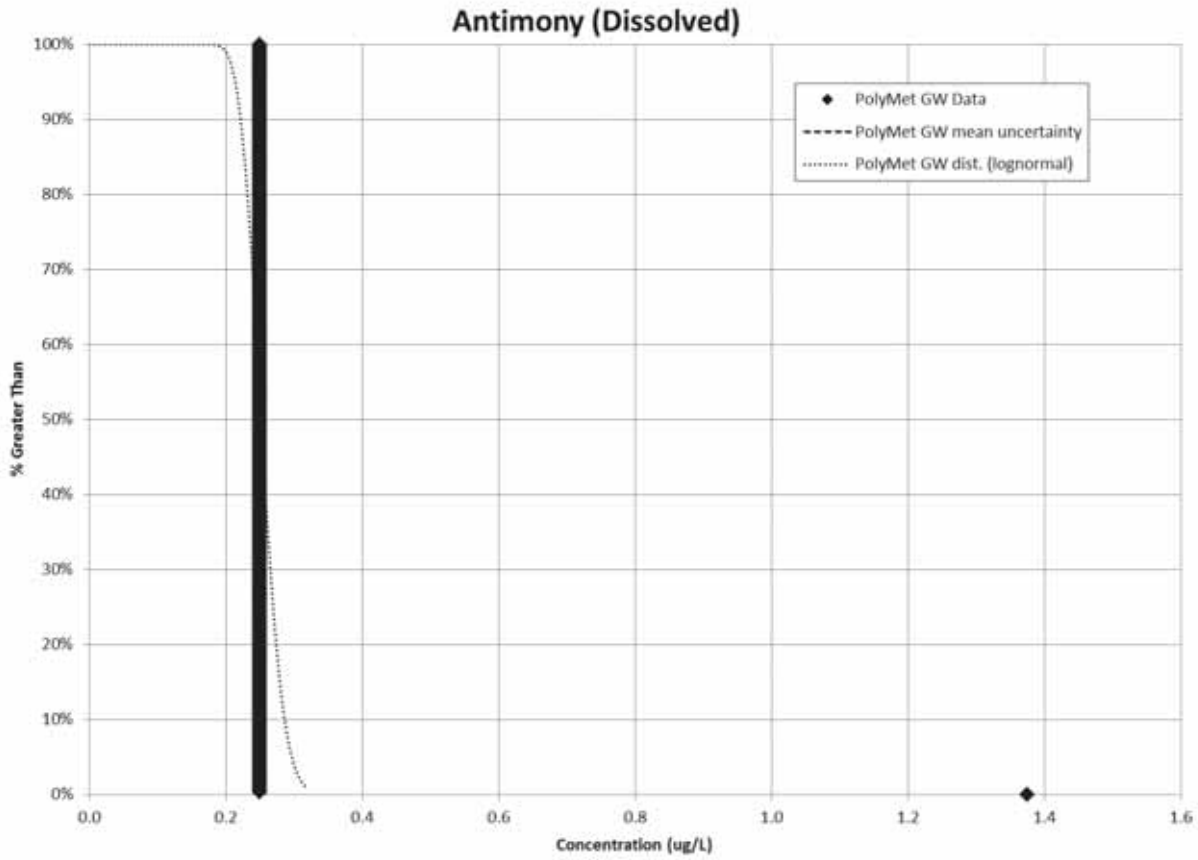


Figure 22 Background groundwater distributions – Antimony (Sb)

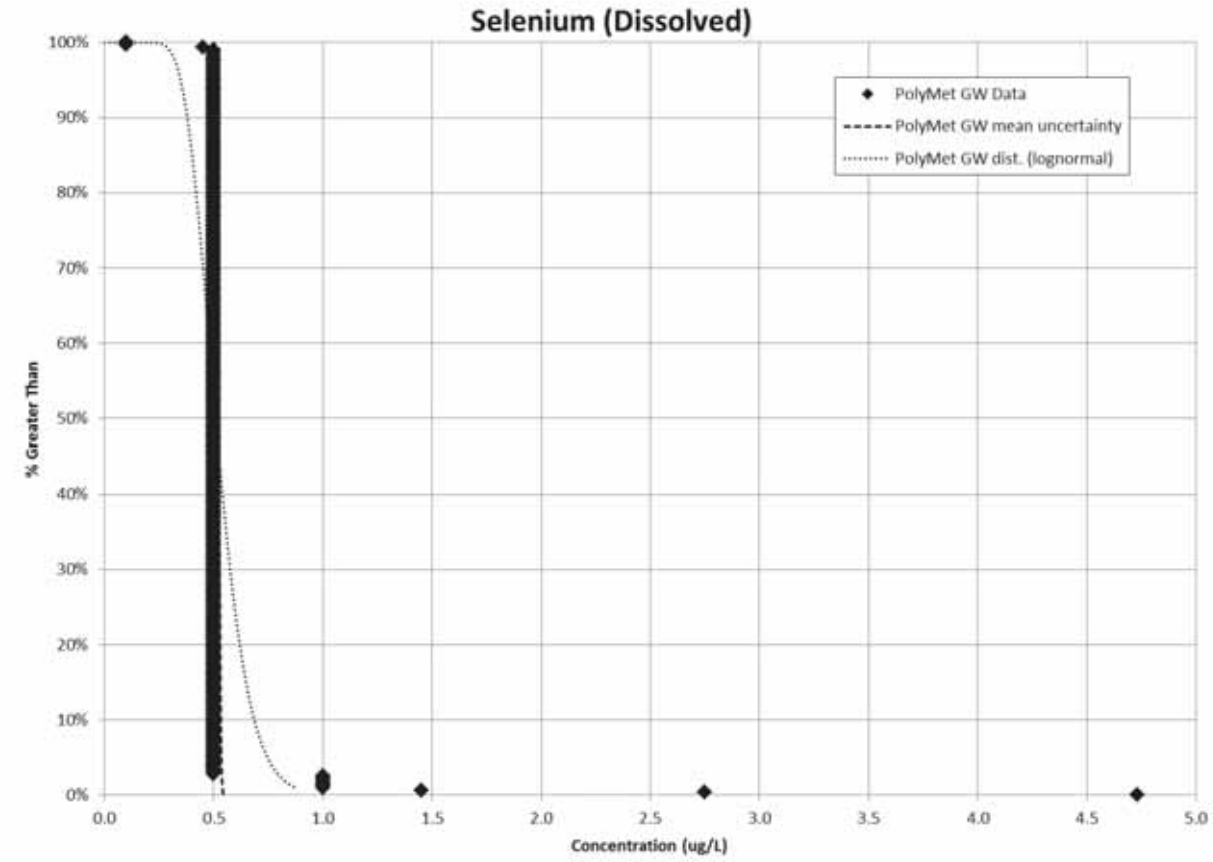


Figure 23 Background groundwater distributions – Selenium (Se)

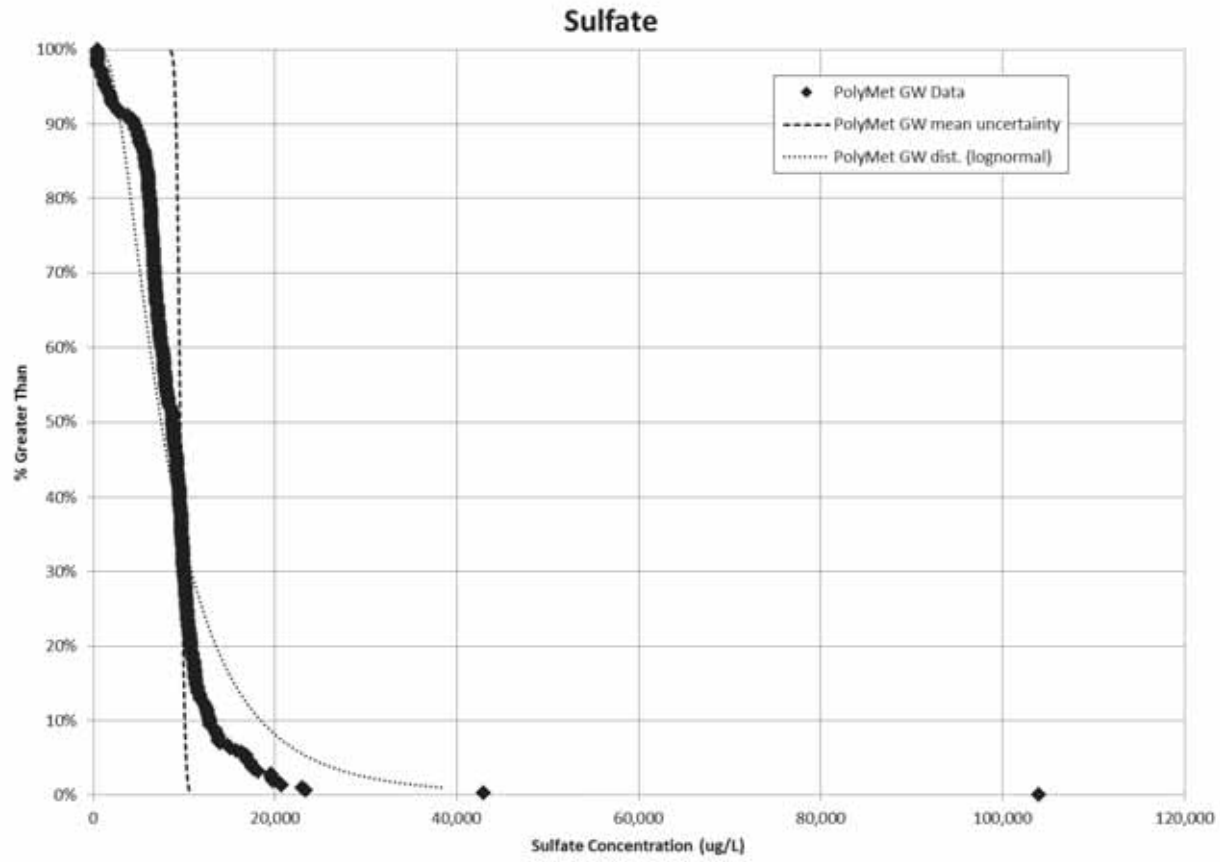


Figure 24 Background groundwater distributions – Sulfate (SO4)

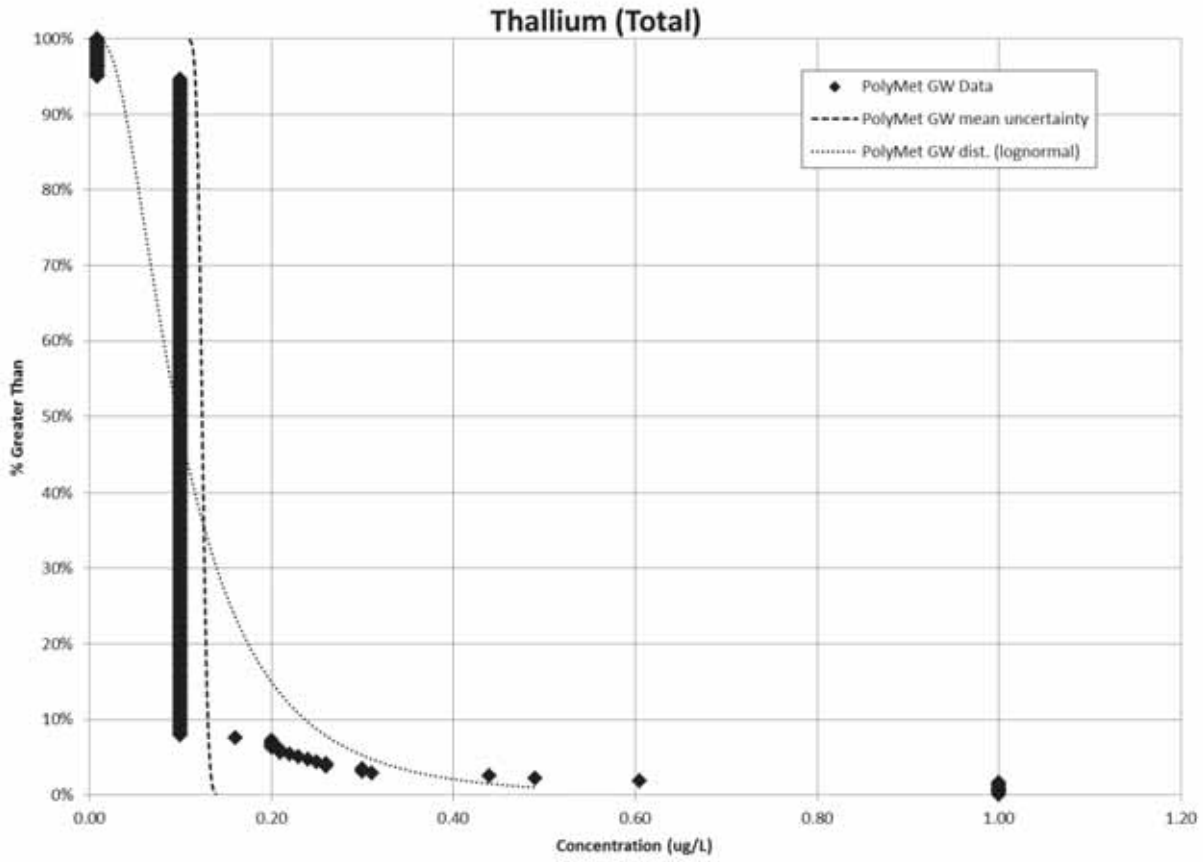


Figure 25 Background groundwater distributions – Thallium (Tl)

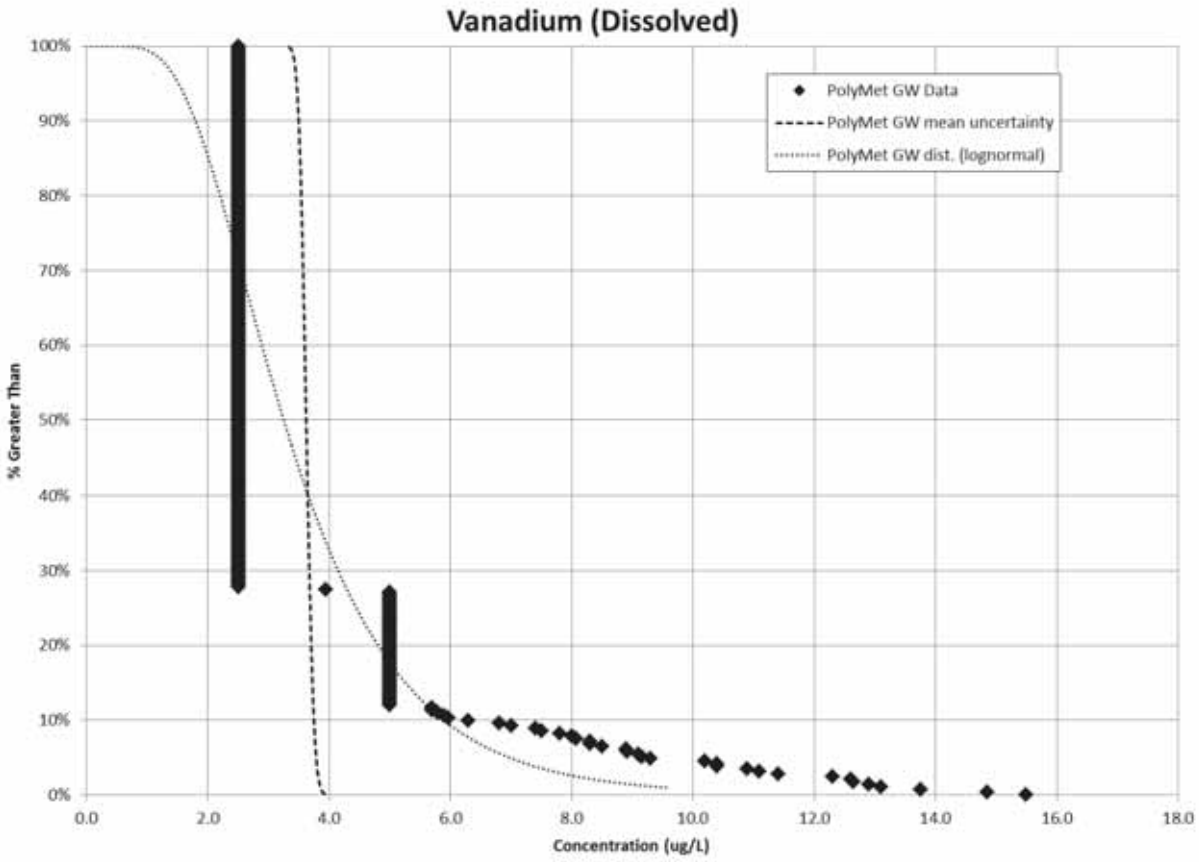


Figure 26 Background groundwater distributions – Vanadium (V)

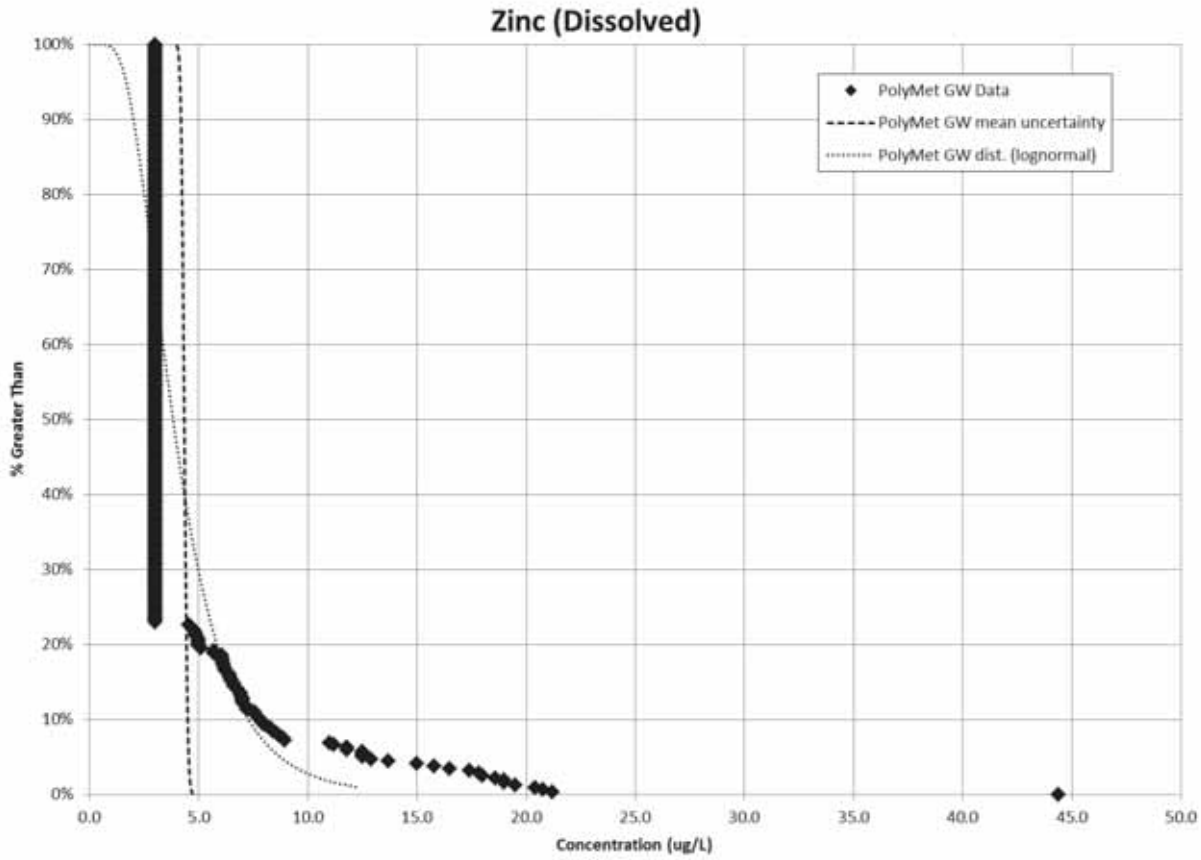


Figure 27 Background groundwater distributions – Zinc (Zn)

Attachment E

Calibration of Surface Runoff Concentrations

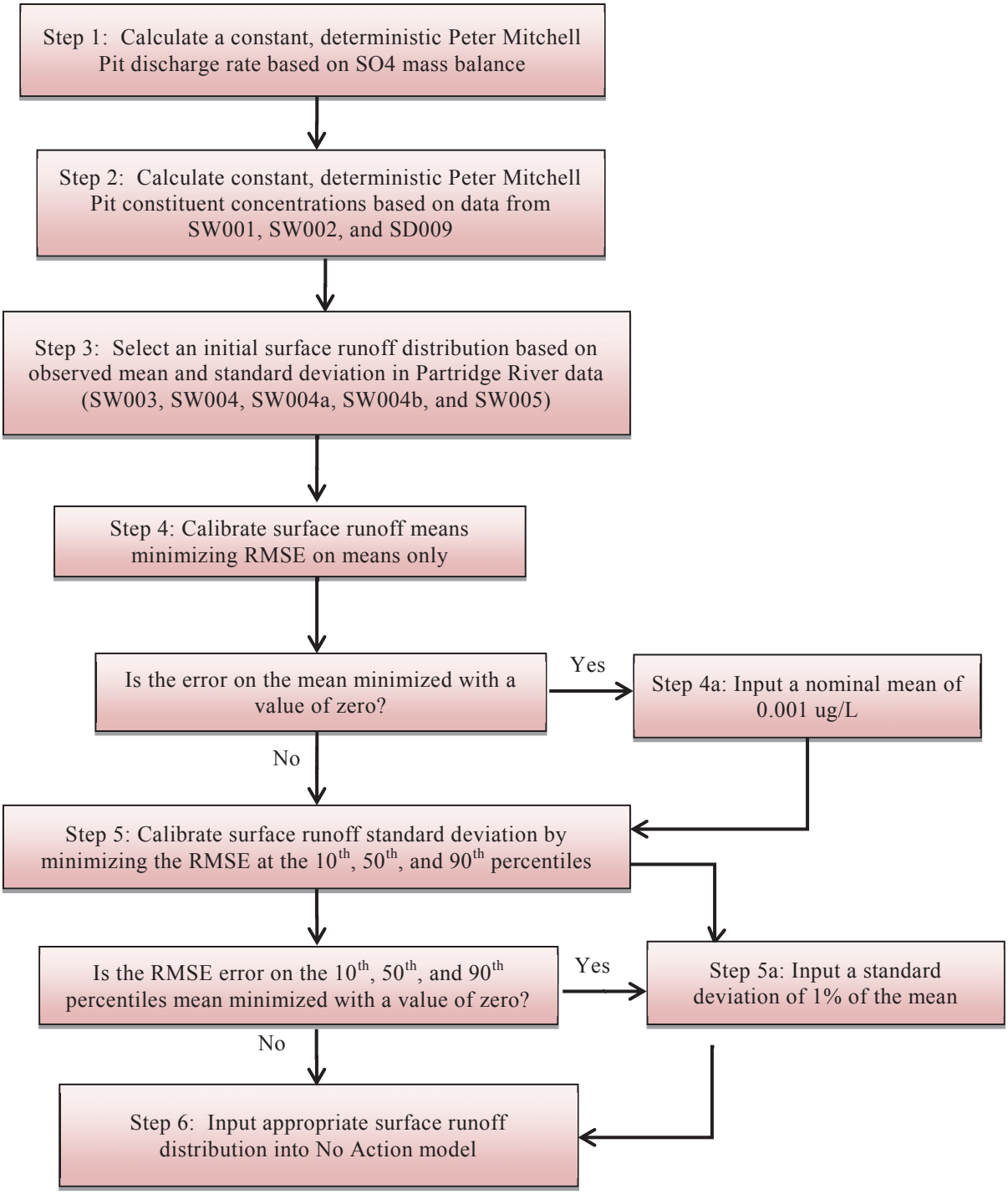


Figure 1 **Flow chart of Mine Site groundwater and surface runoff calibration**

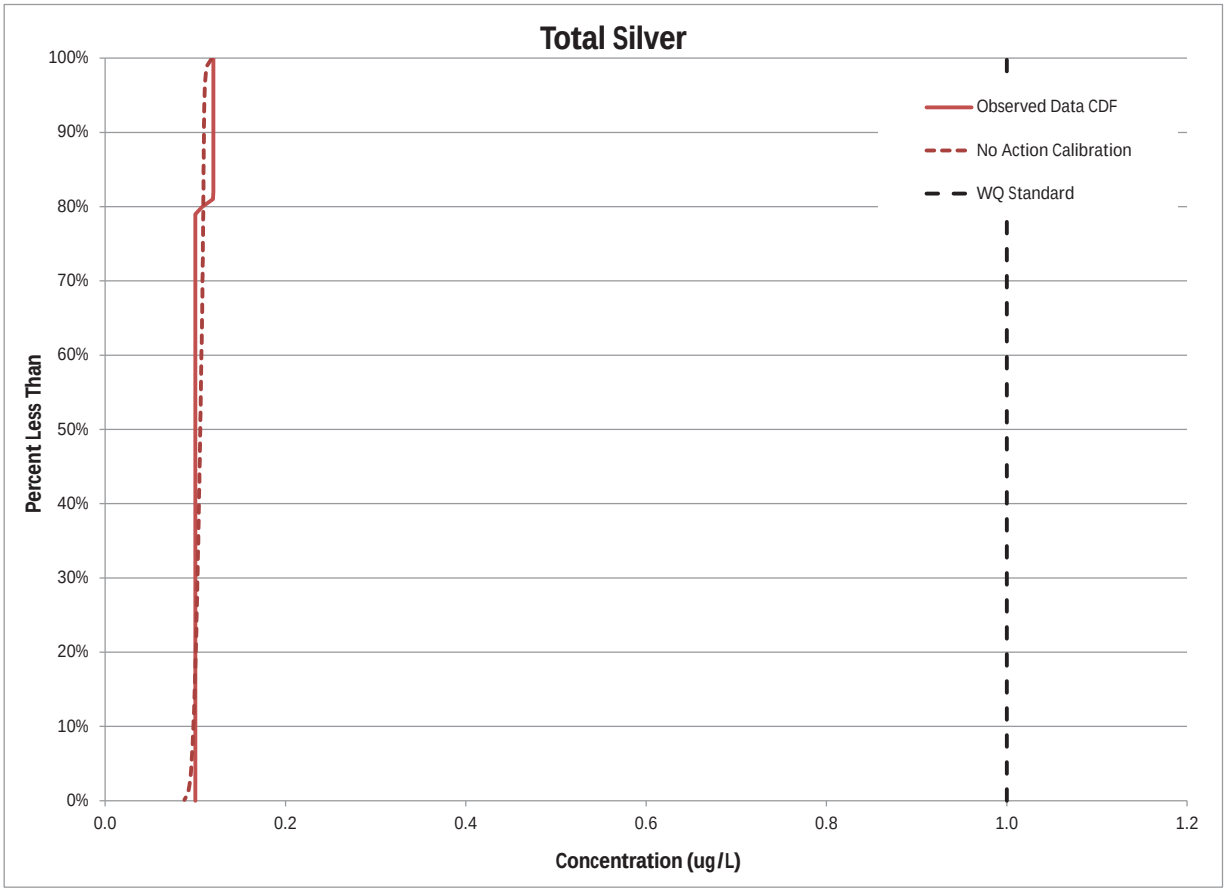


Figure 2 **Observed Partridge River concentrations (SW003 – SW005) and No Action model fit – Total Silver (Ag)**

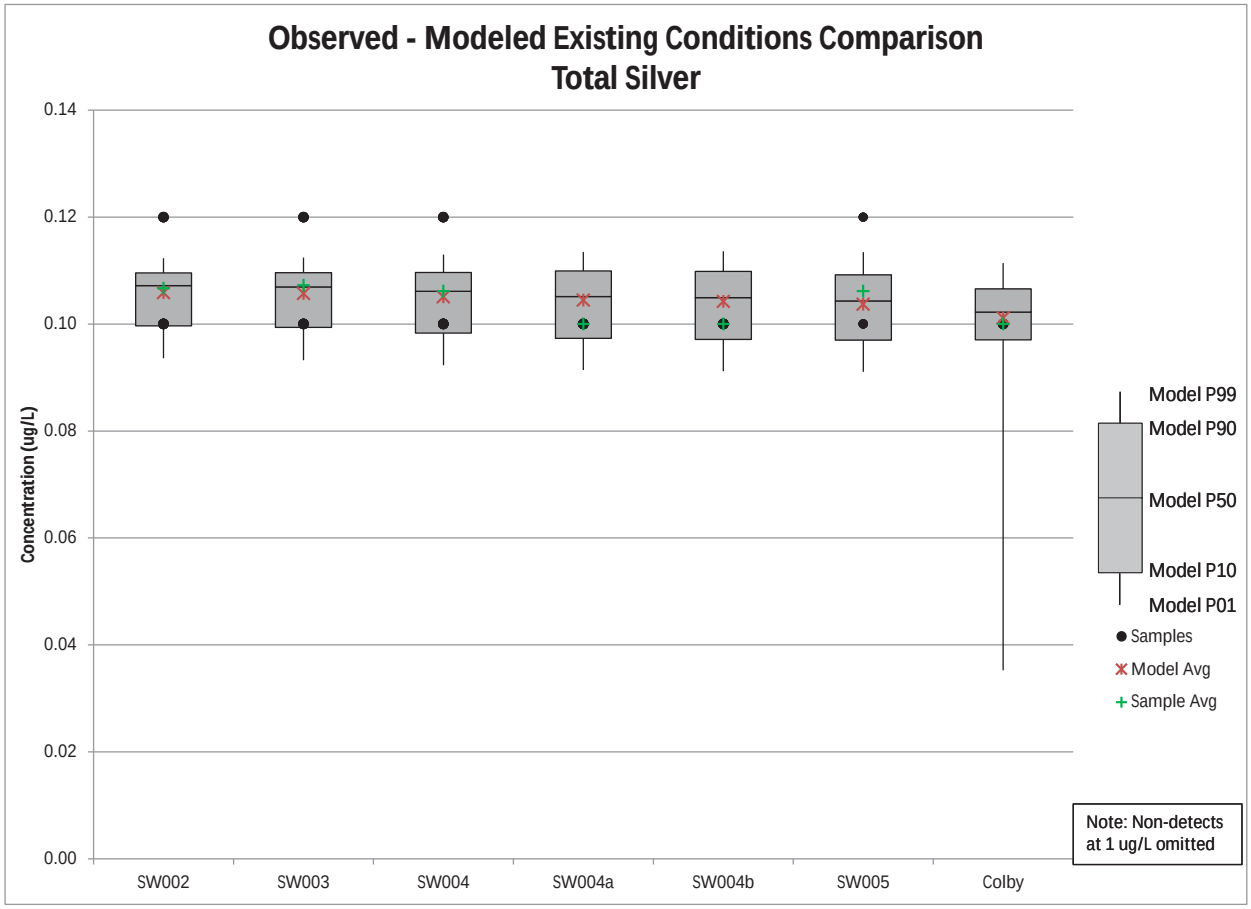


Figure 3 **Observed Partridge River concentrations (by location) and No Action model fit – Total Silver (Ag)**

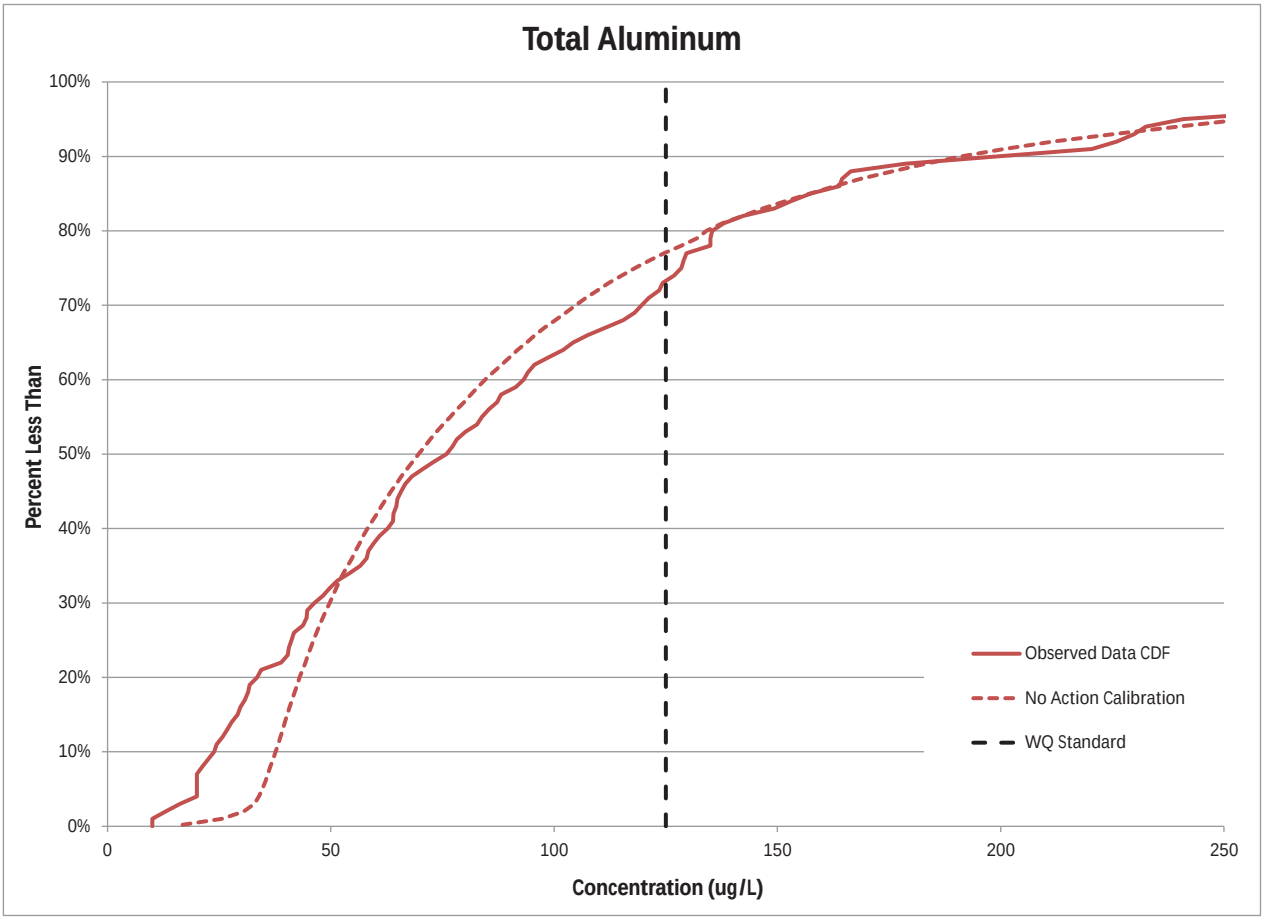


Figure 4 **Observed Partridge River concentrations (SW003 – SW005) and No Action model fit – Total Aluminum (Al)**

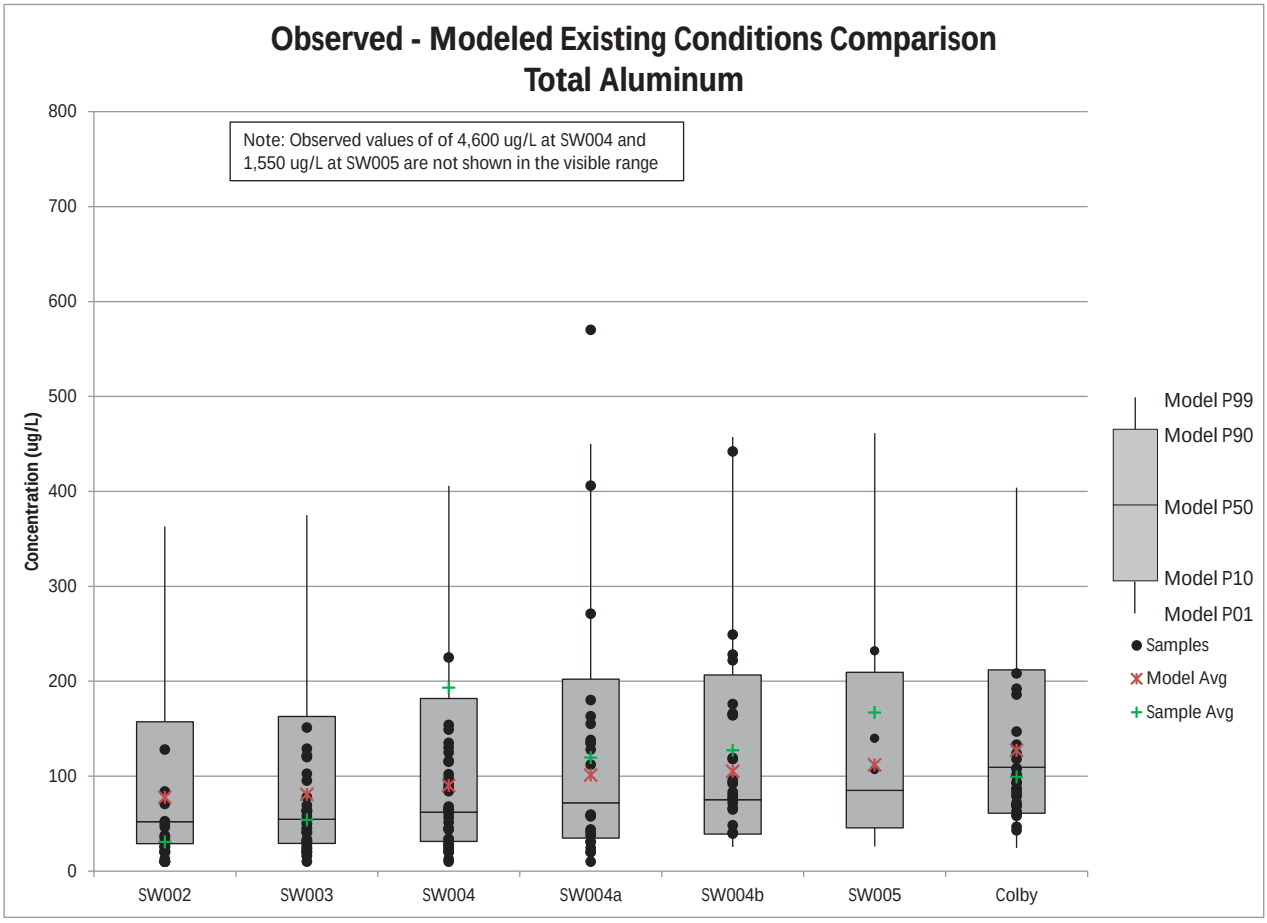


Figure 5 **Observed Partridge River concentrations (by location) and No Action model fit – Total Aluminum (Al)**

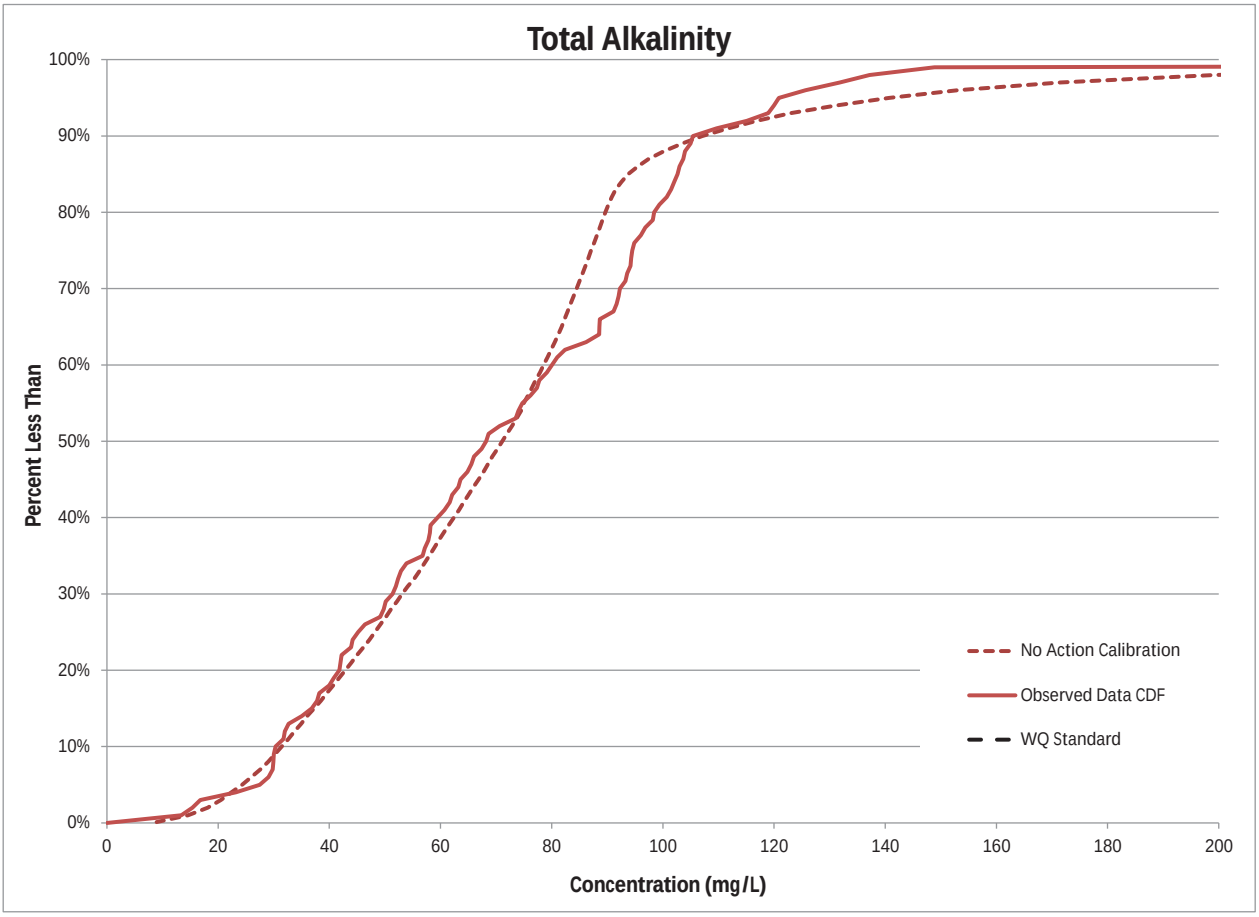


Figure 6 **Observed Partridge River concentrations (SW003 – SW005) and No Action model fit – Total Alkalinity**

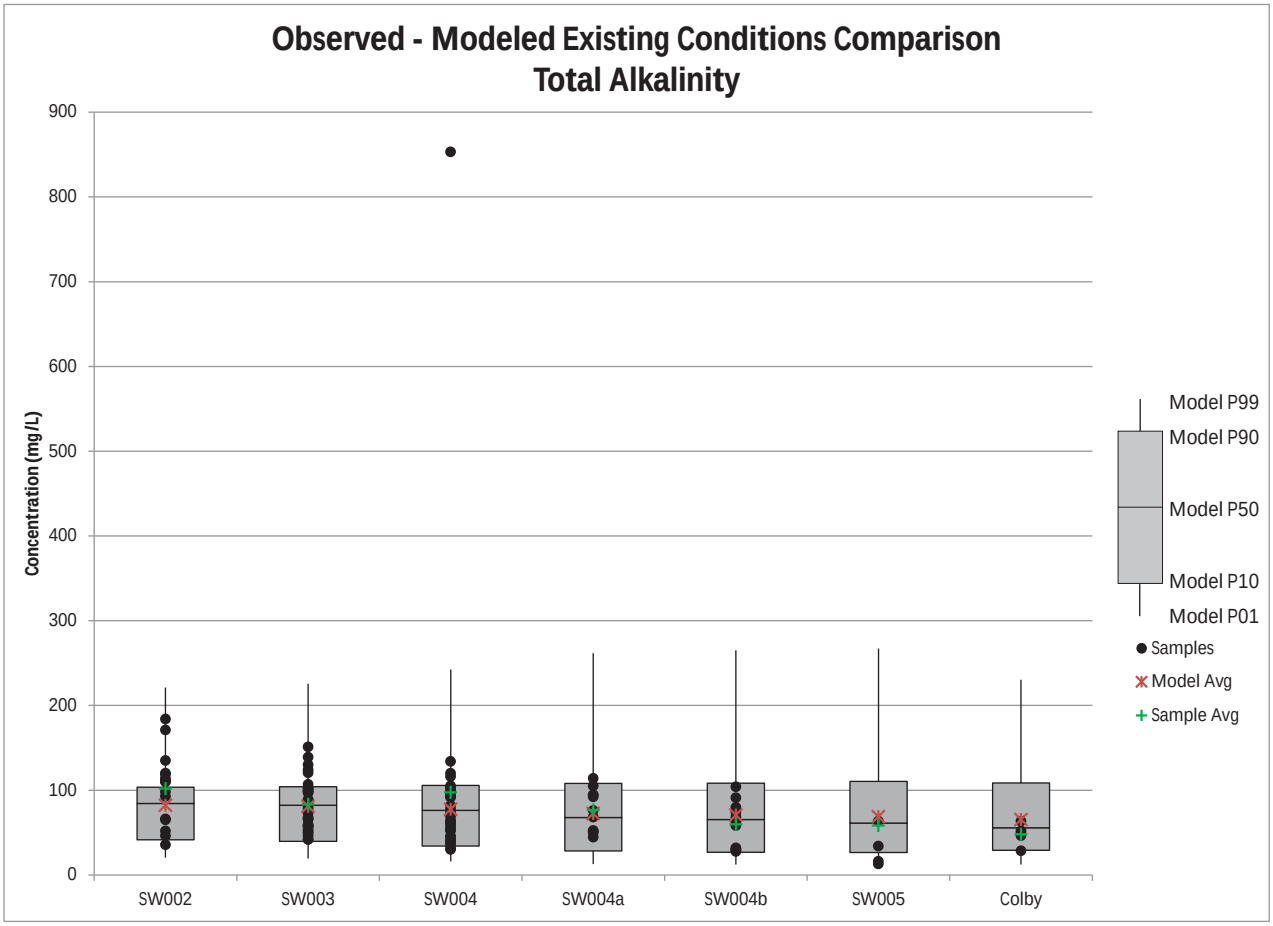


Figure 7 **Observed Partridge River concentrations (by location) and No Action model fit – Total Alkalinity**

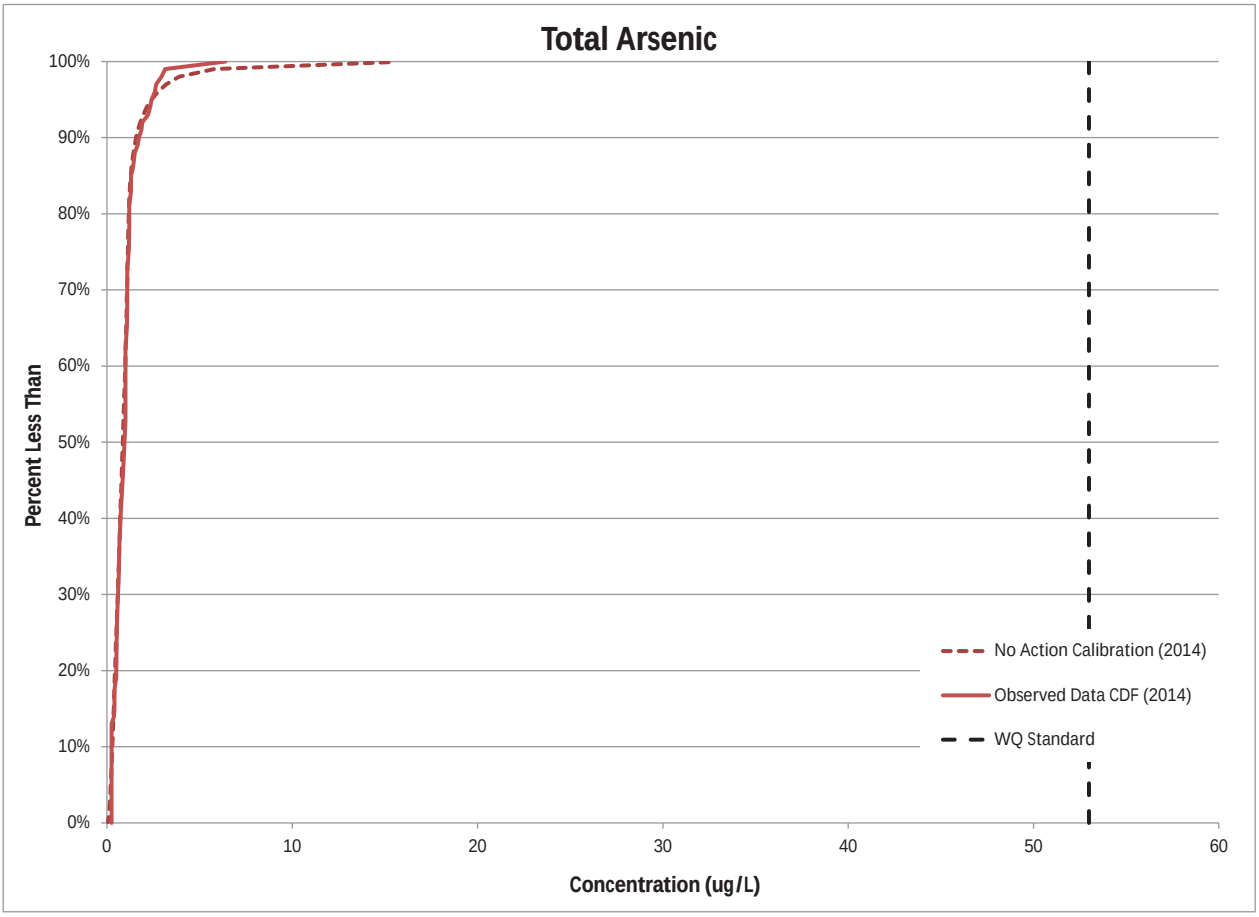


Figure 8 **Observed Partridge River concentrations (SW003 – SW005) and No Action model fit – Total Arsenic (As)**

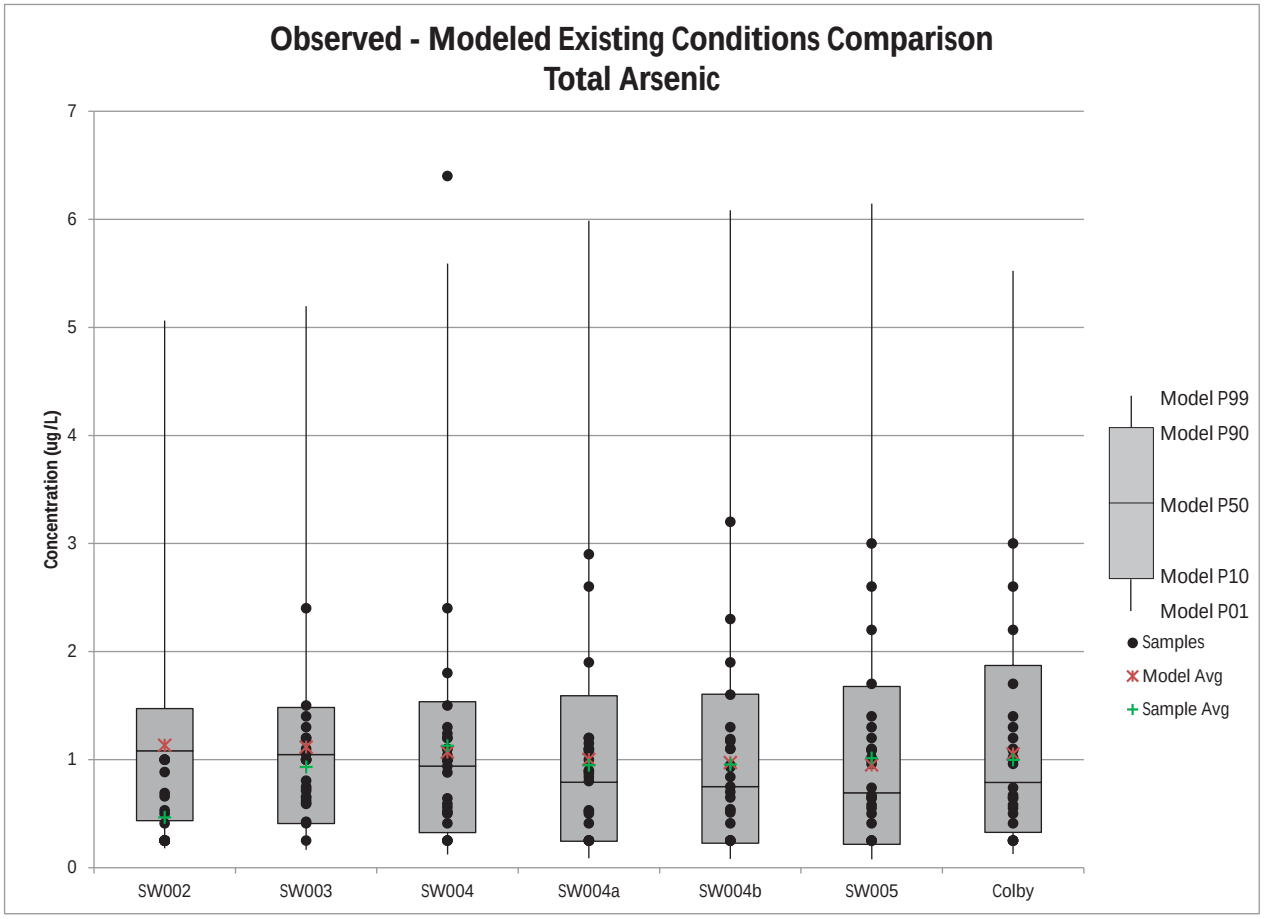


Figure 9 **Observed Partridge River concentrations (by location) and No Action model fit – Total Arsenic (As)**

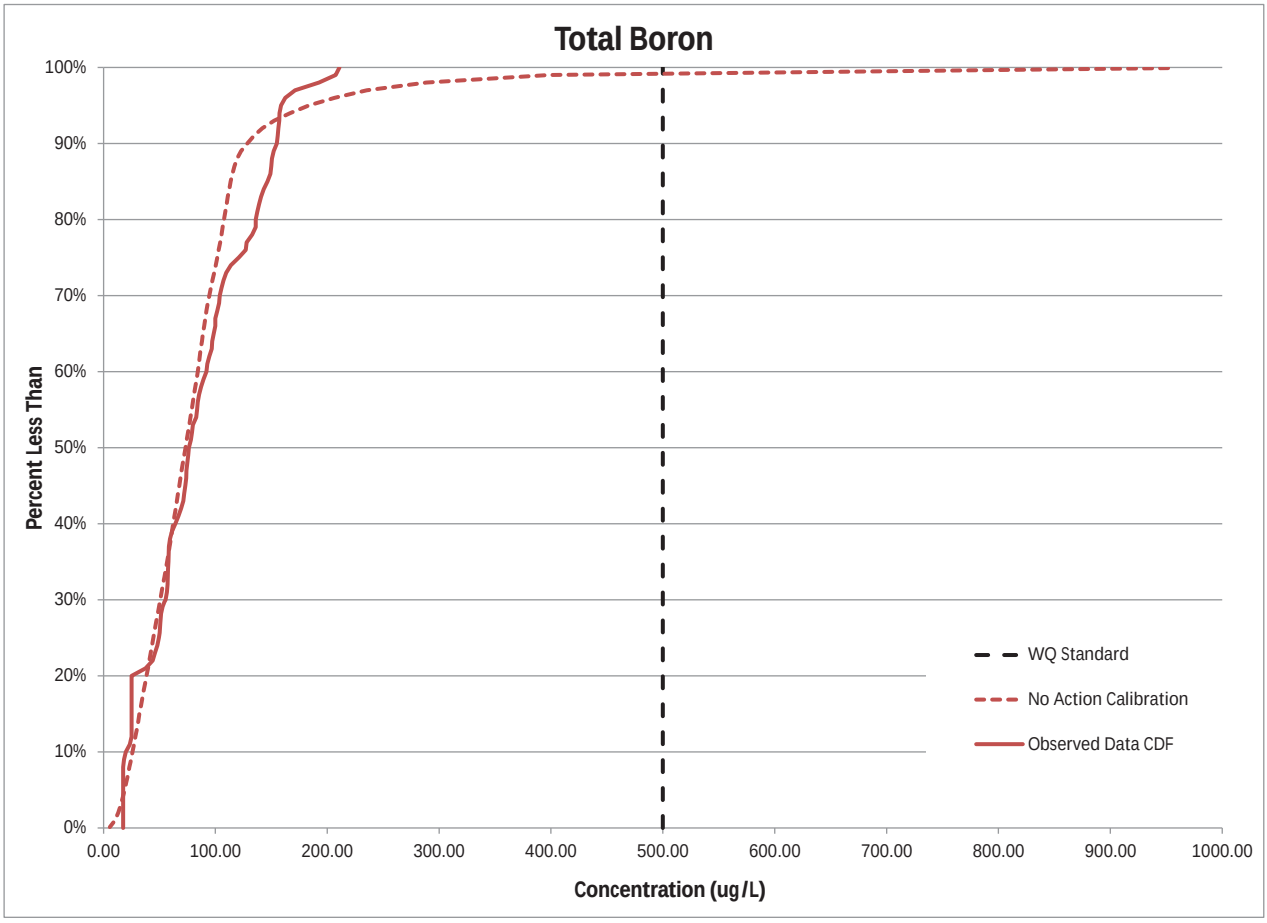


Figure 10 **Observed Partridge River concentrations (SW003 – SW005) and No Action model fit – Total Boron (B)**

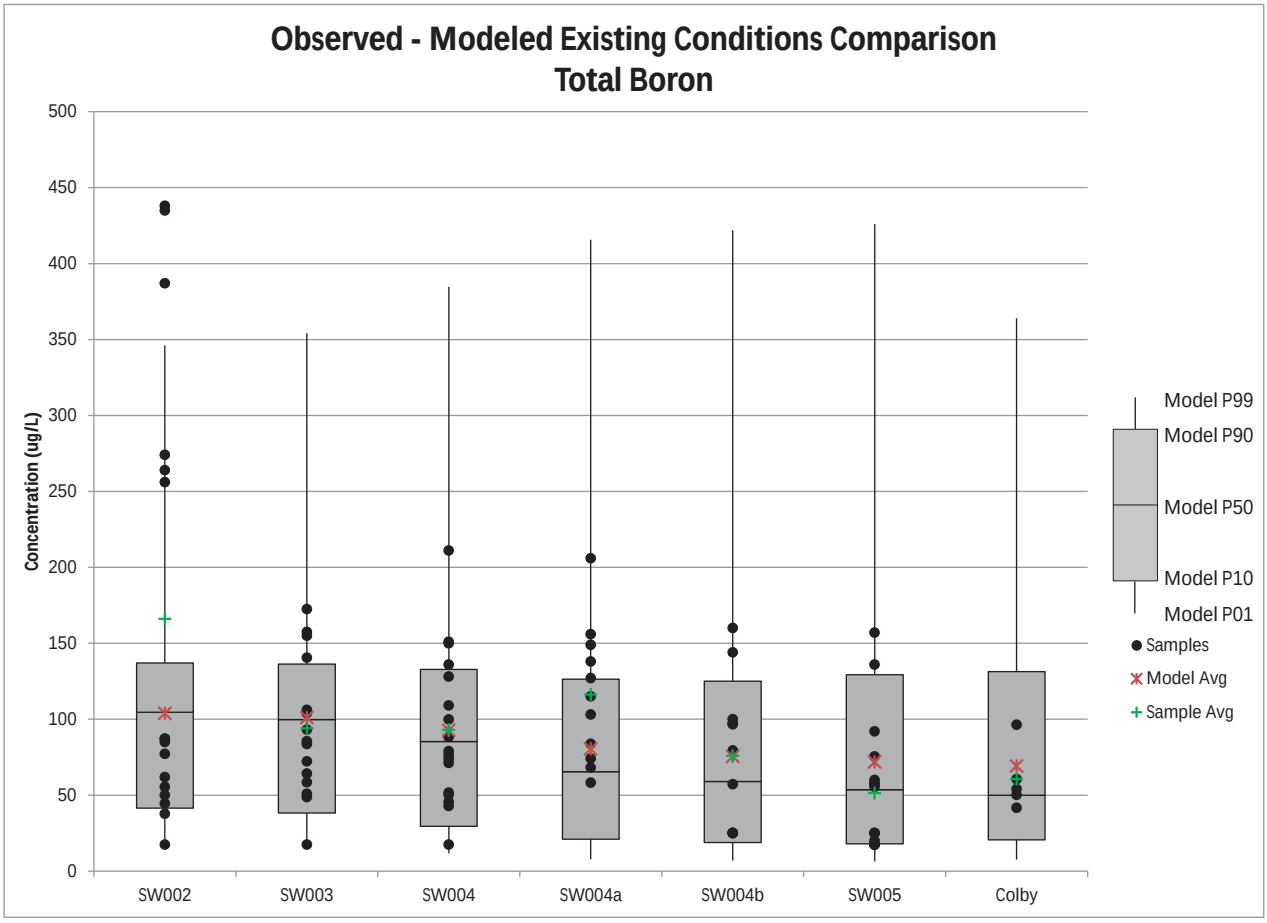


Figure 11 **Observed Partridge River concentrations (by location) and No Action model fit – Total Boron (B)**

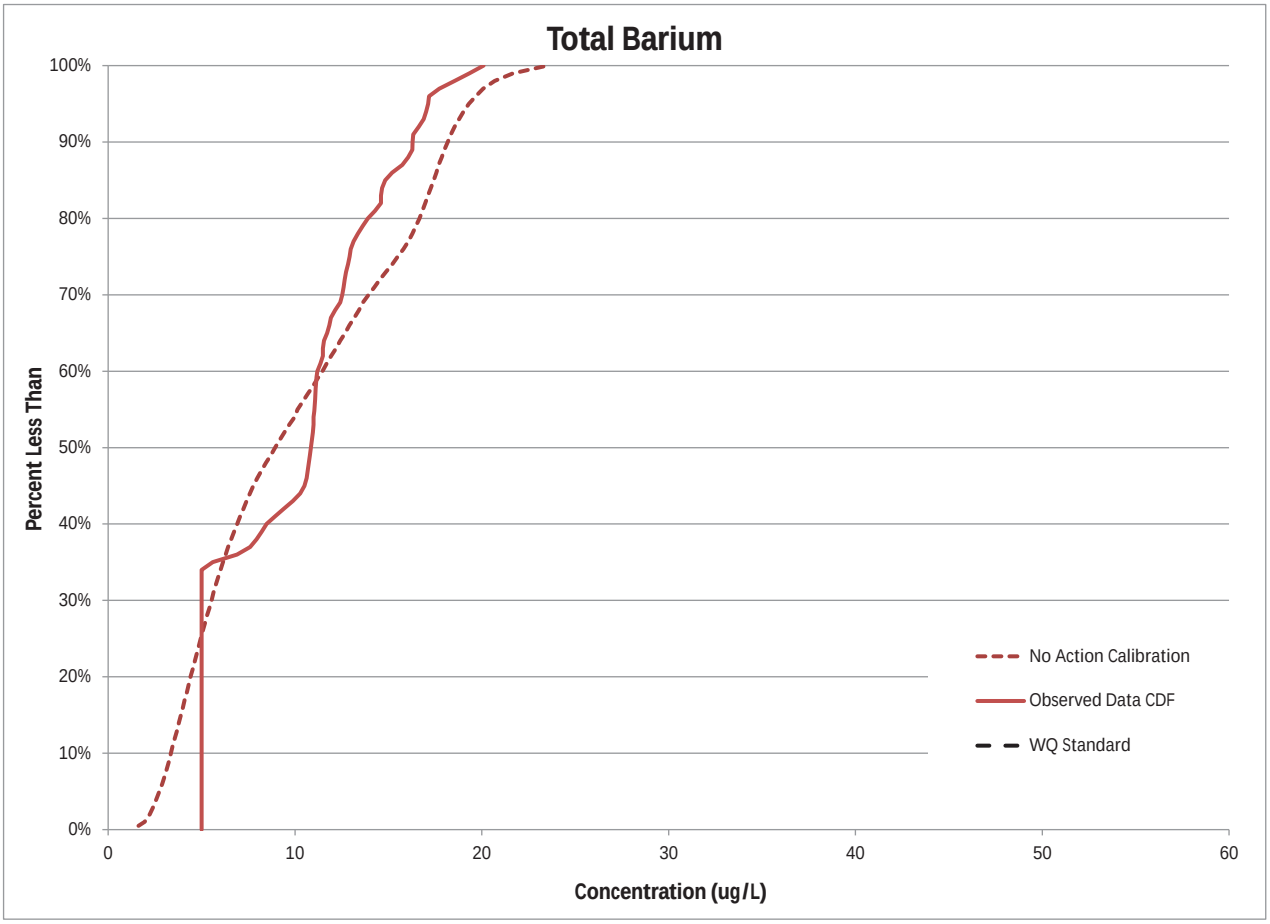


Figure 12 **Observed Partridge River concentrations (SW003 – SW005) and No Action model fit – Total Barium (Ba)**

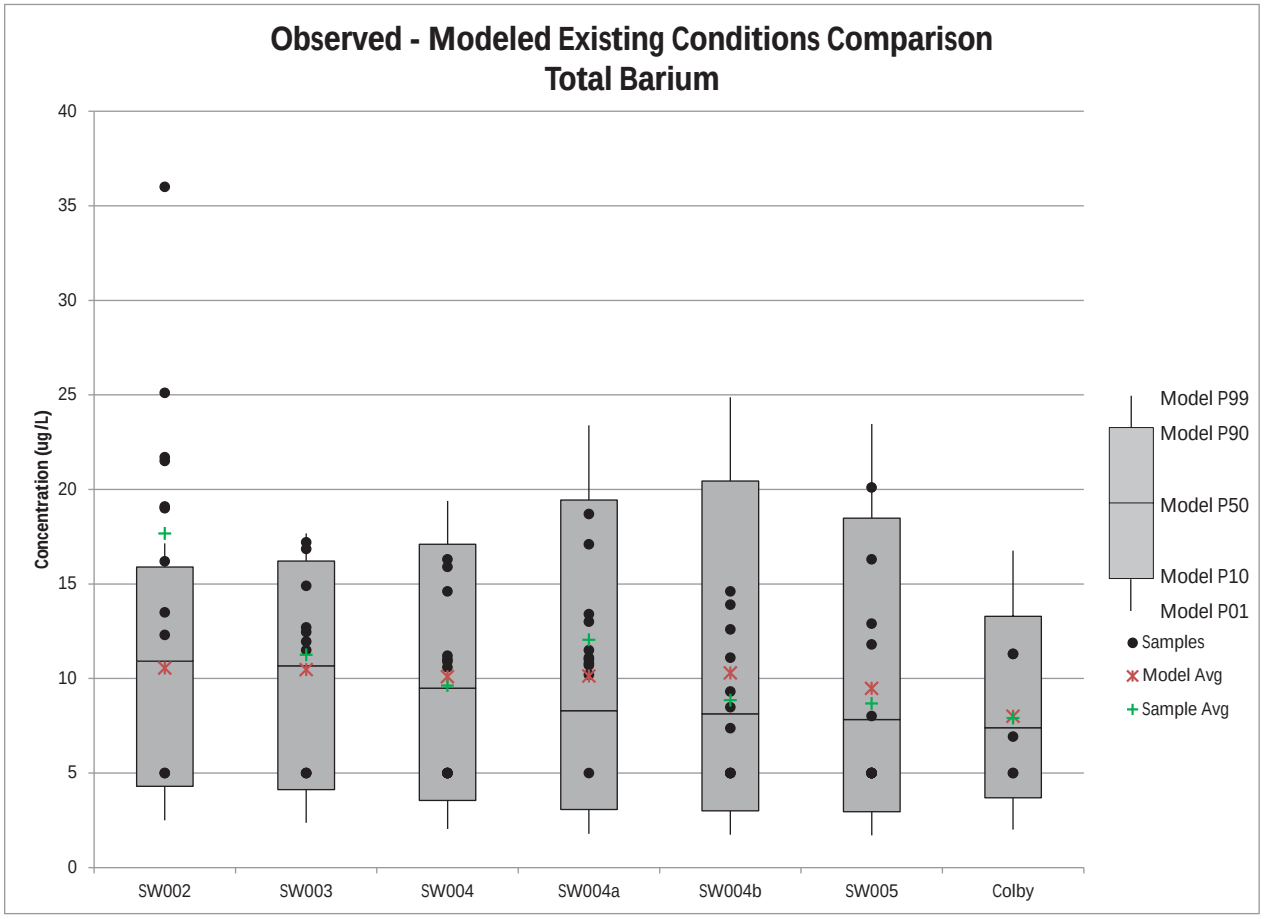


Figure 13 **Observed Partridge River concentrations (by location) and No Action model fit – Total Barium (Ba)**

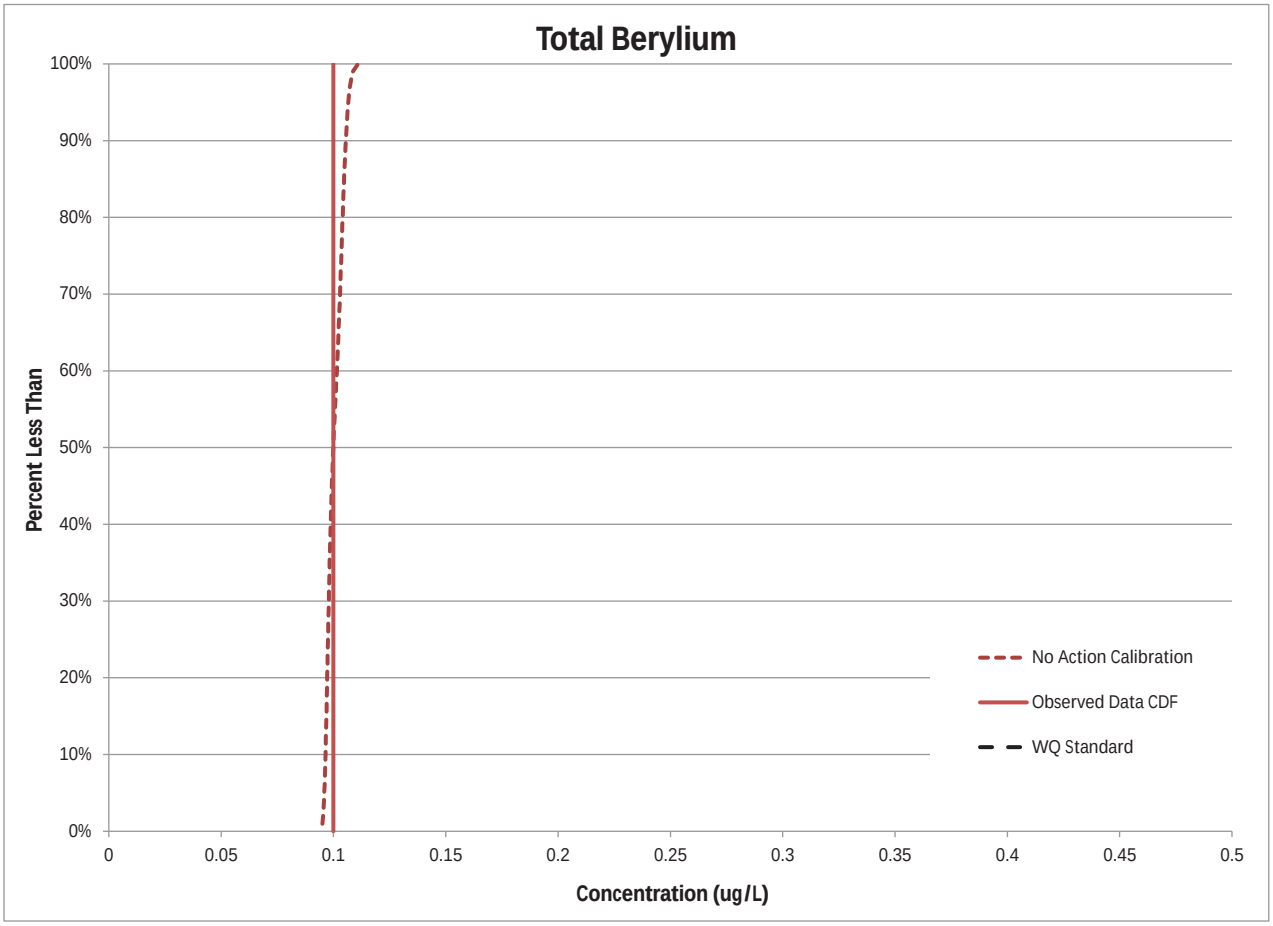


Figure 14 **Observed Partridge River concentrations (SW003 – SW005) and No Action model fit – Total Beryllium (Be)**

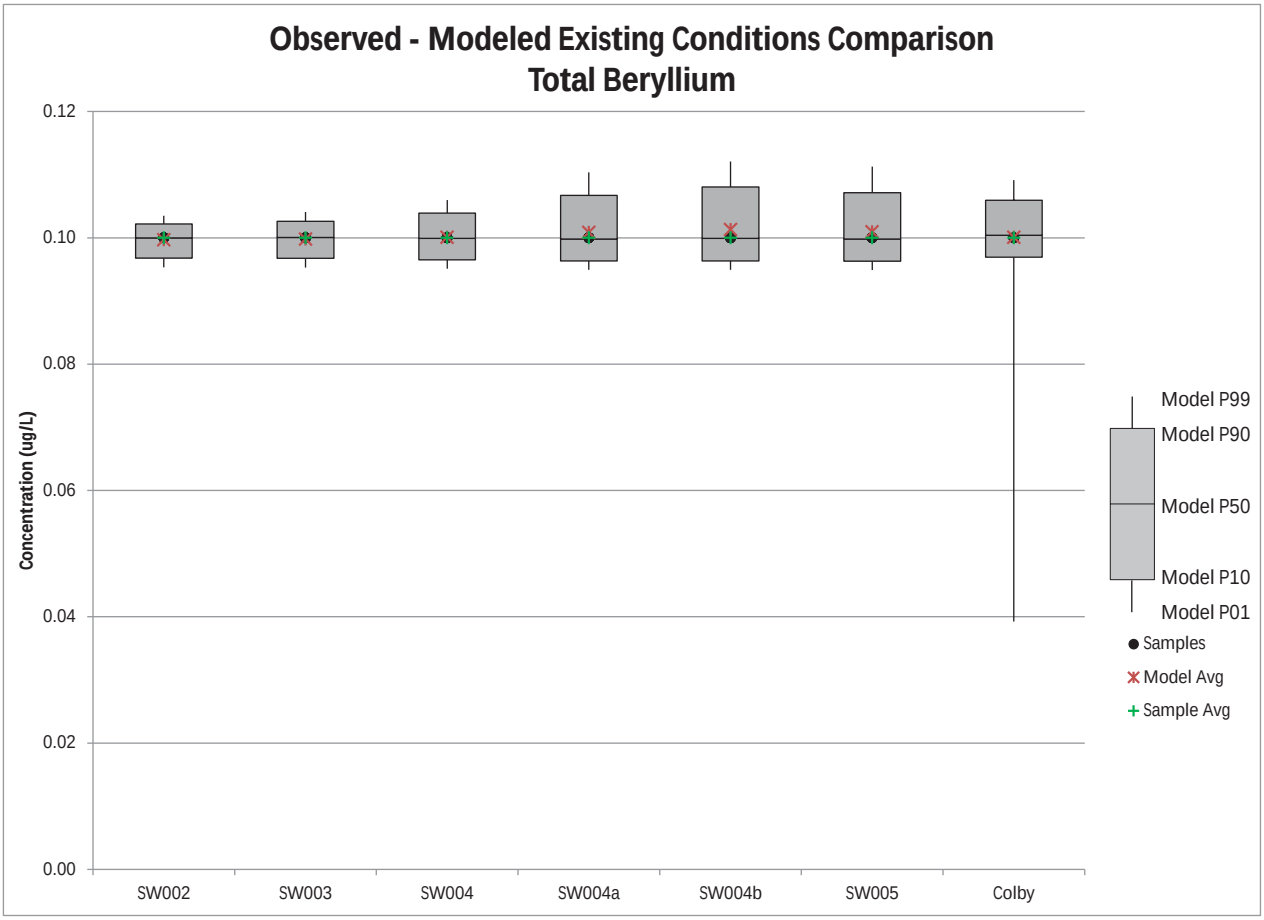


Figure 15 **Observed Partridge River concentrations (by location) and No Action model fit – Total Beryllium (Be)**

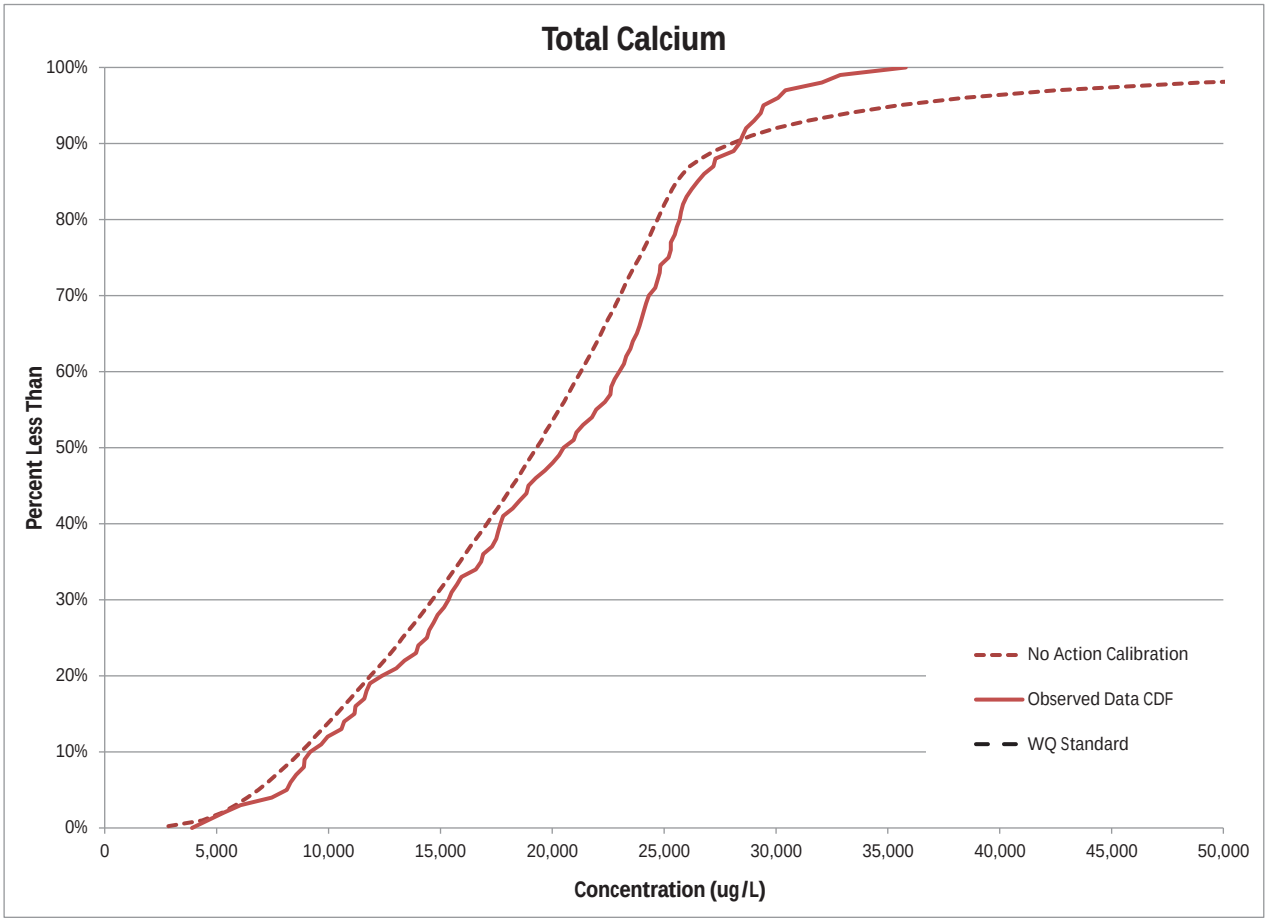


Figure 16 **Observed Partridge River concentrations (SW003 – SW005) and No Action model fit – Total Calcium (Ca)**

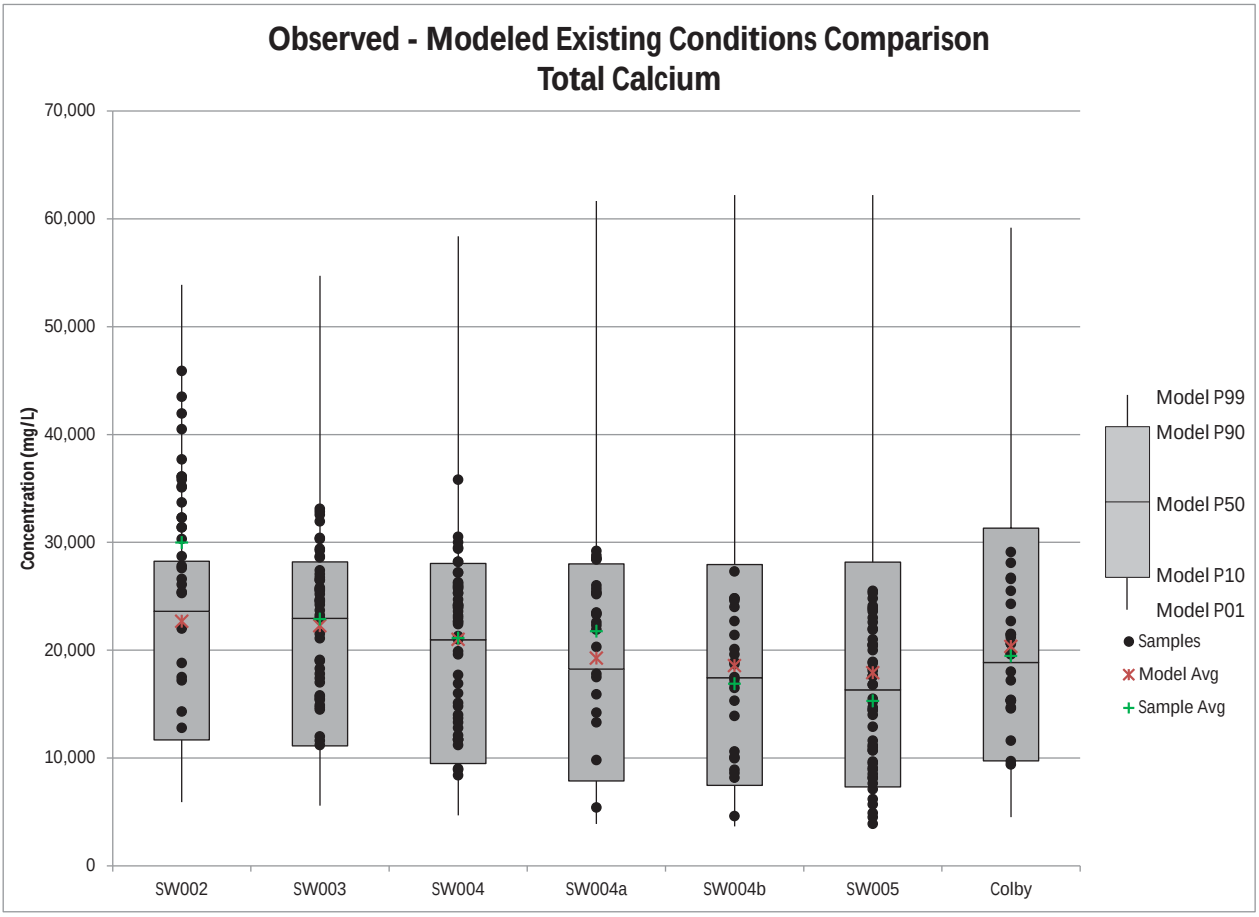


Figure 17 **Observed Partridge River concentrations (by location) and No Action model fit – Total Calcium (Ca)**

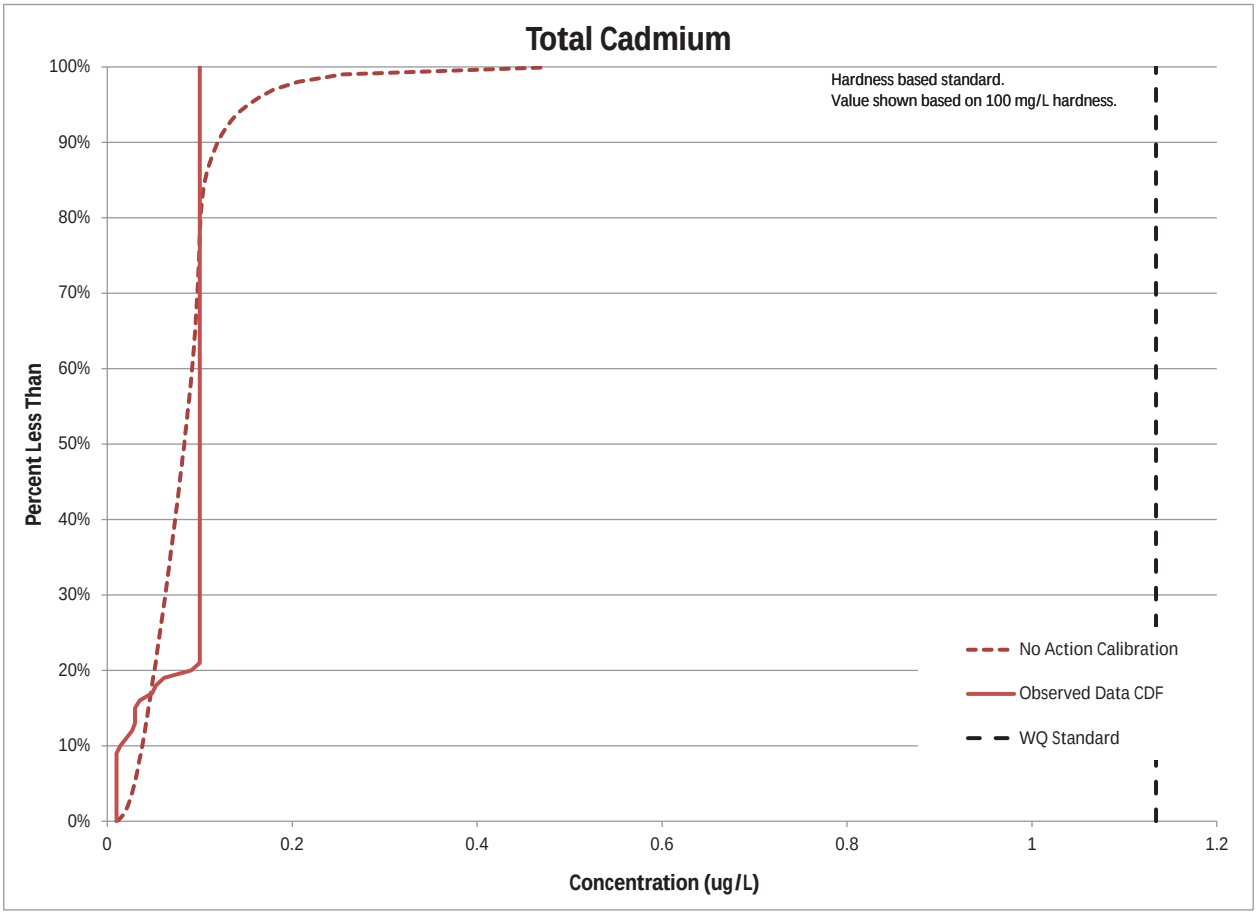


Figure 18 **Observed Partridge River concentrations (SW003 – SW005) and No Action model fit – Total Cadmium (Cd)**

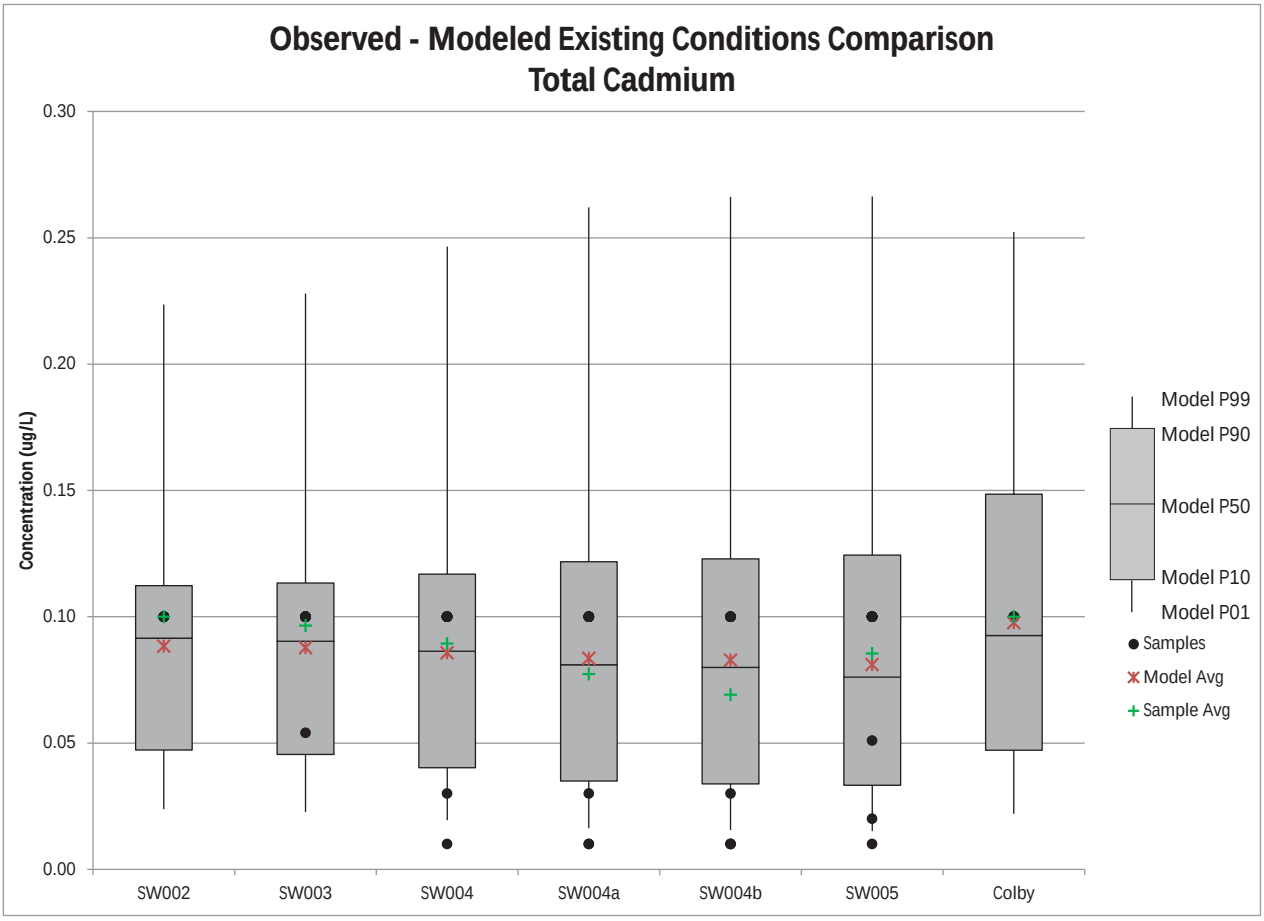


Figure 19 **Observed Partridge River concentrations (by location) and No Action model fit – Total Cadmium (Cd)**

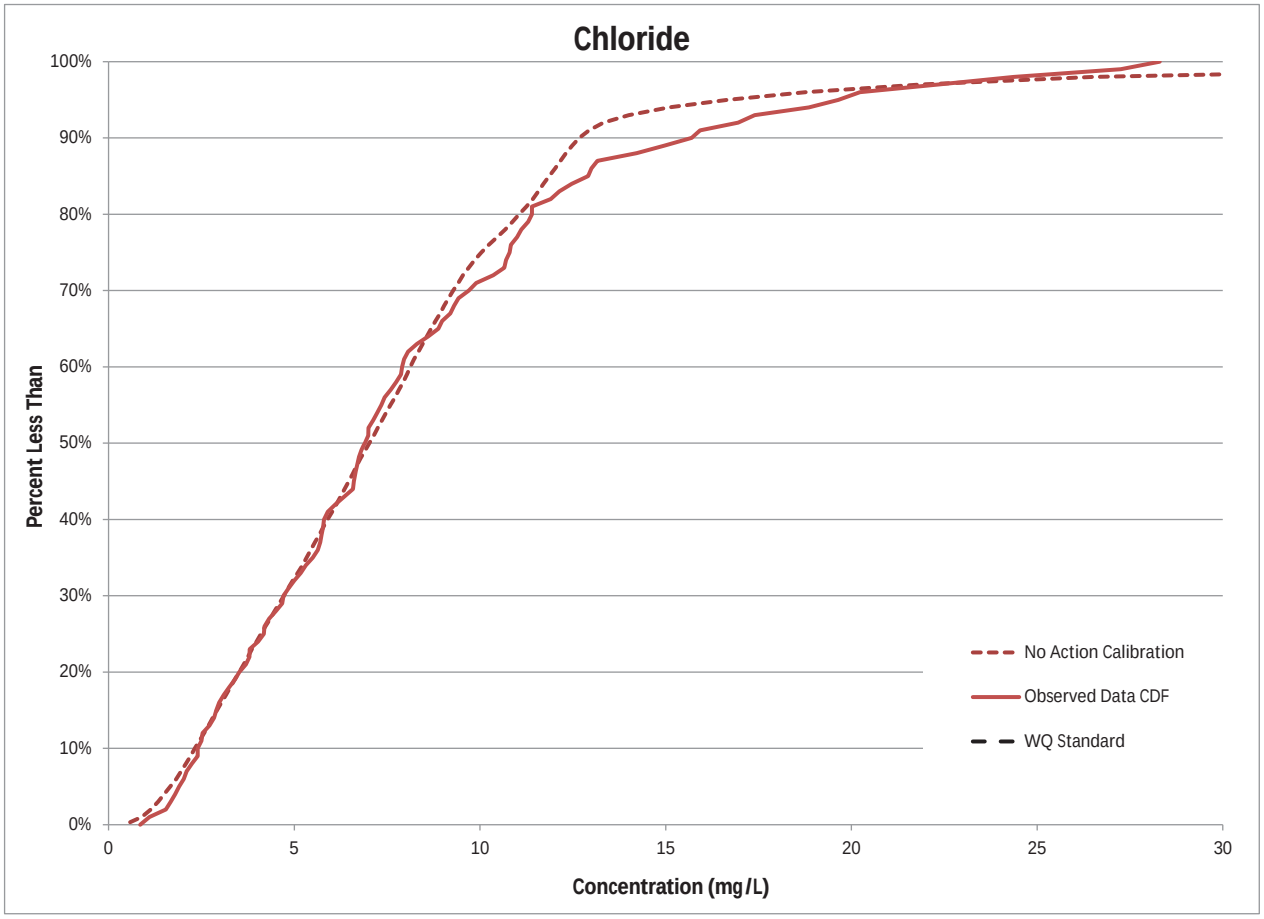


Figure 20 **Observed Partridge River concentrations (SW003 – SW005) and No Action model fit – Chloride (Cl)**

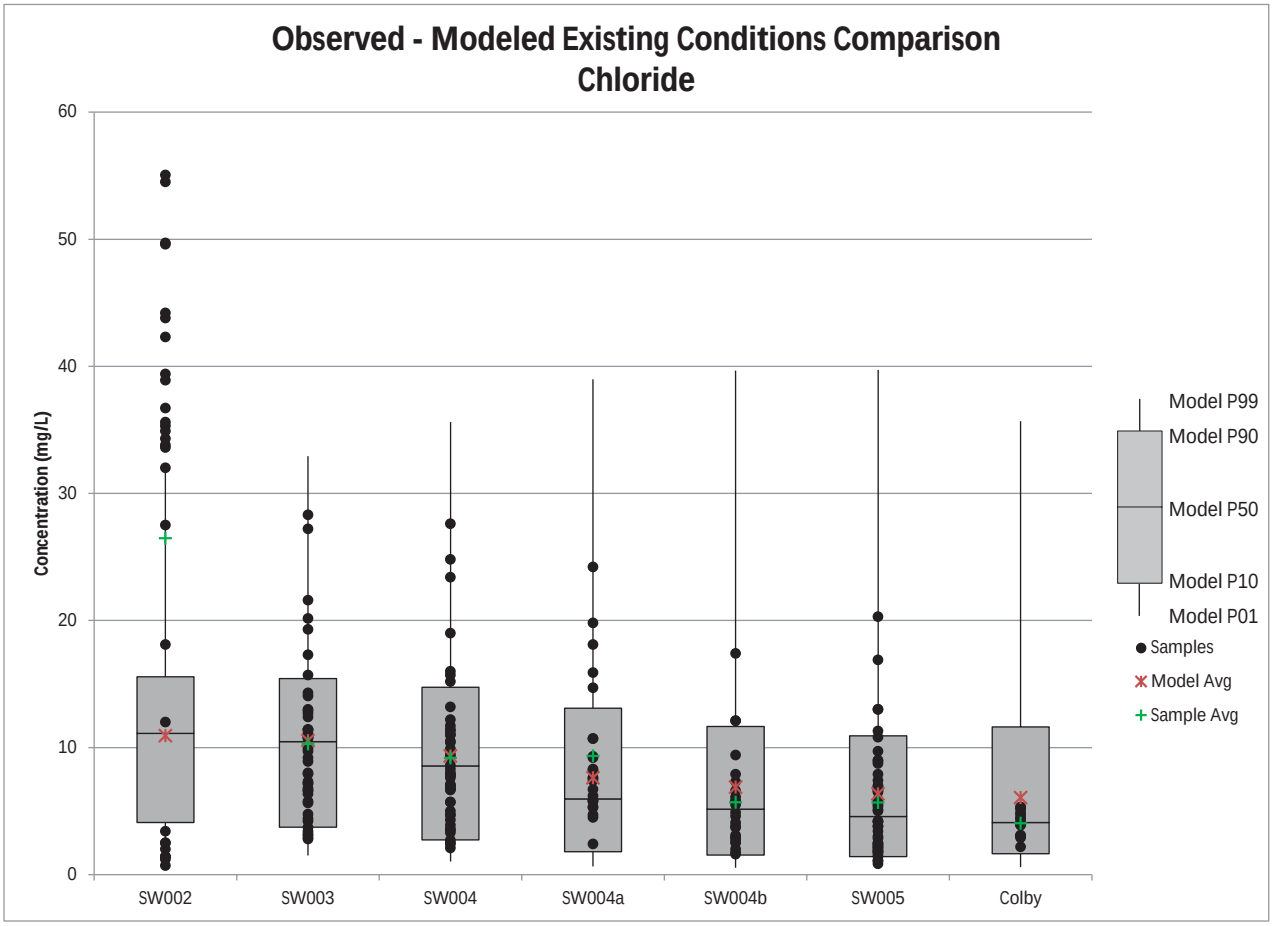


Figure 21 **Observed Partridge River concentrations (by location) and No Action model fit – Chloride (Cl)**

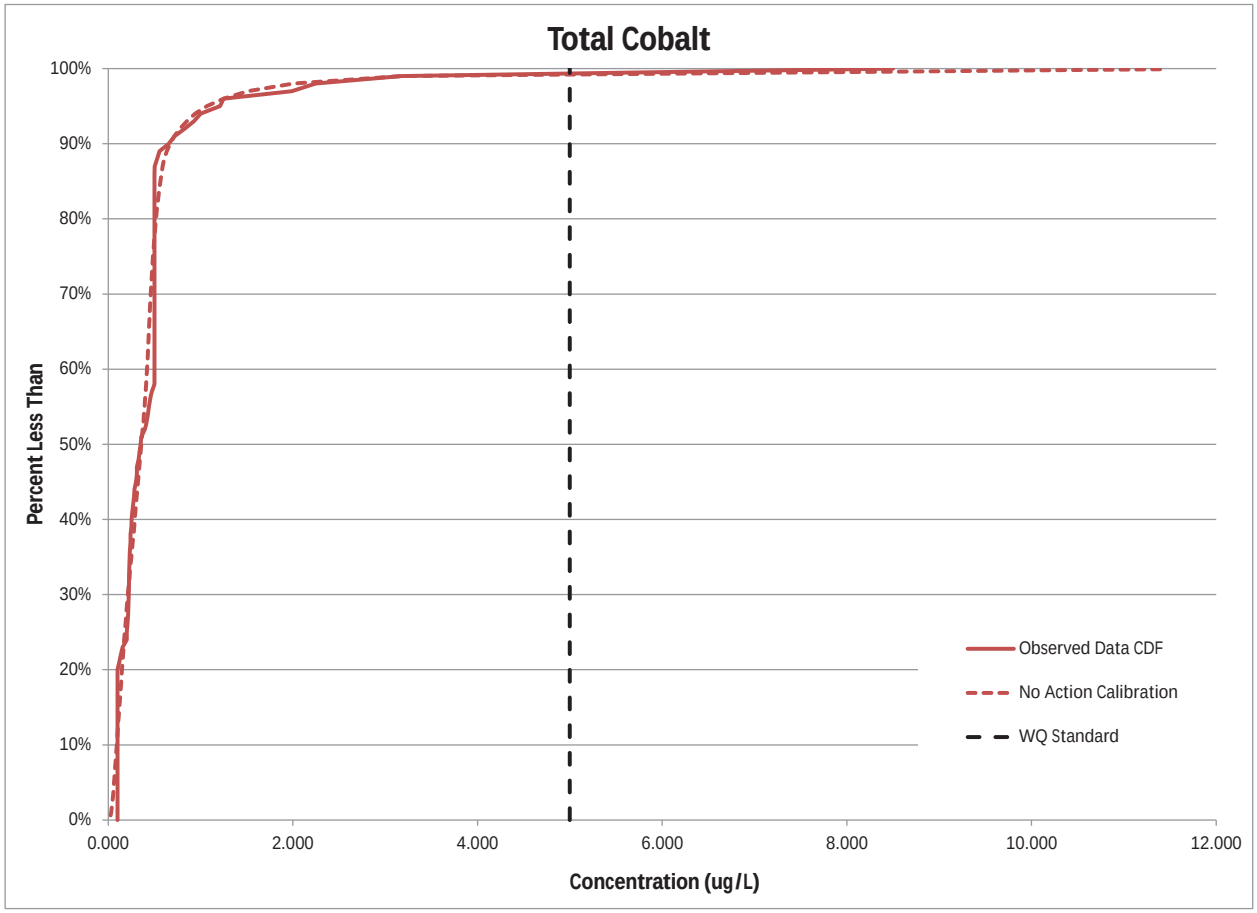


Figure 22 **Observed Partridge River concentrations (SW003 – SW005) and No Action model fit – Total Cobalt (Co)**

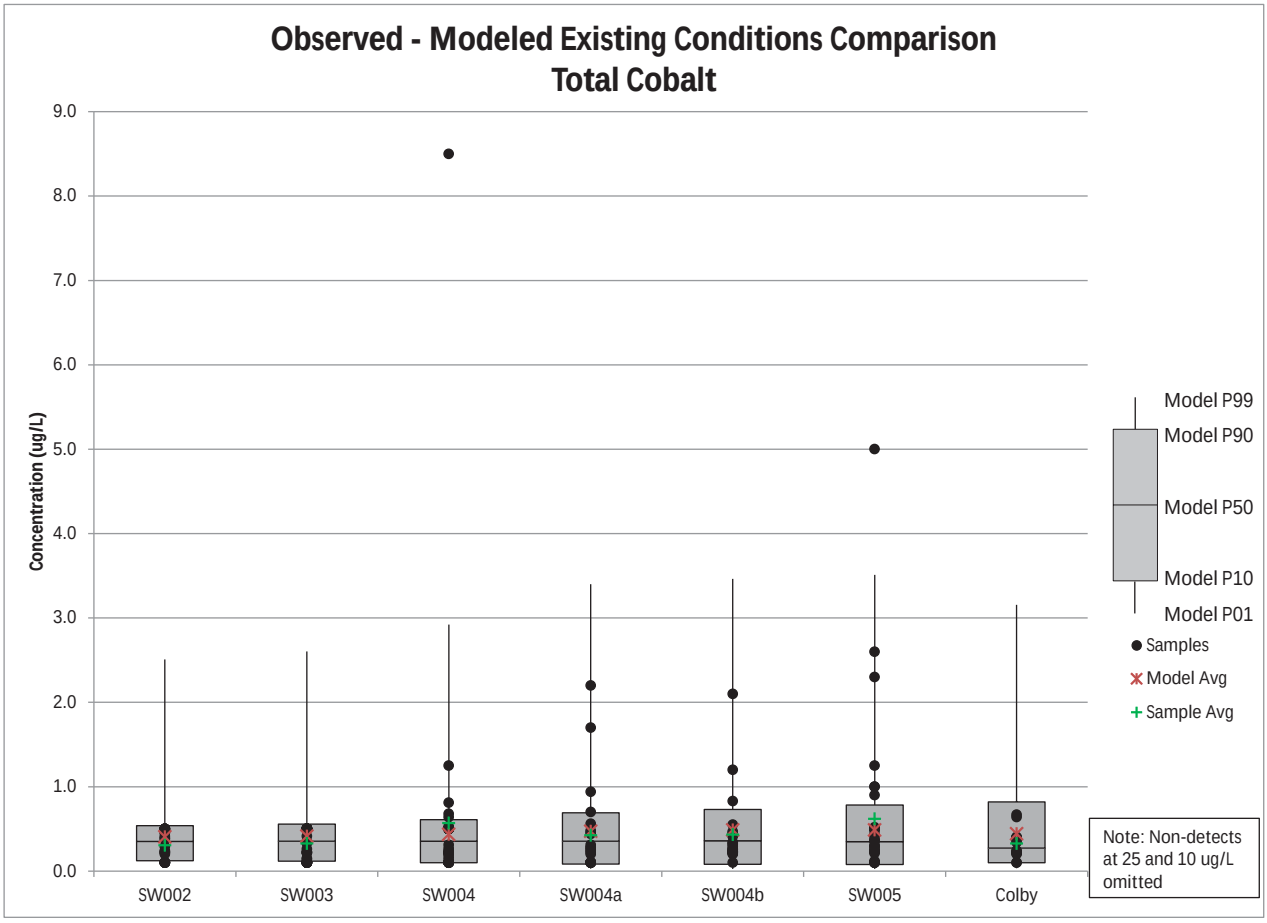


Figure 23 **Observed Partridge River concentrations (by location) and No Action model fit – Total Cobalt (Co)**

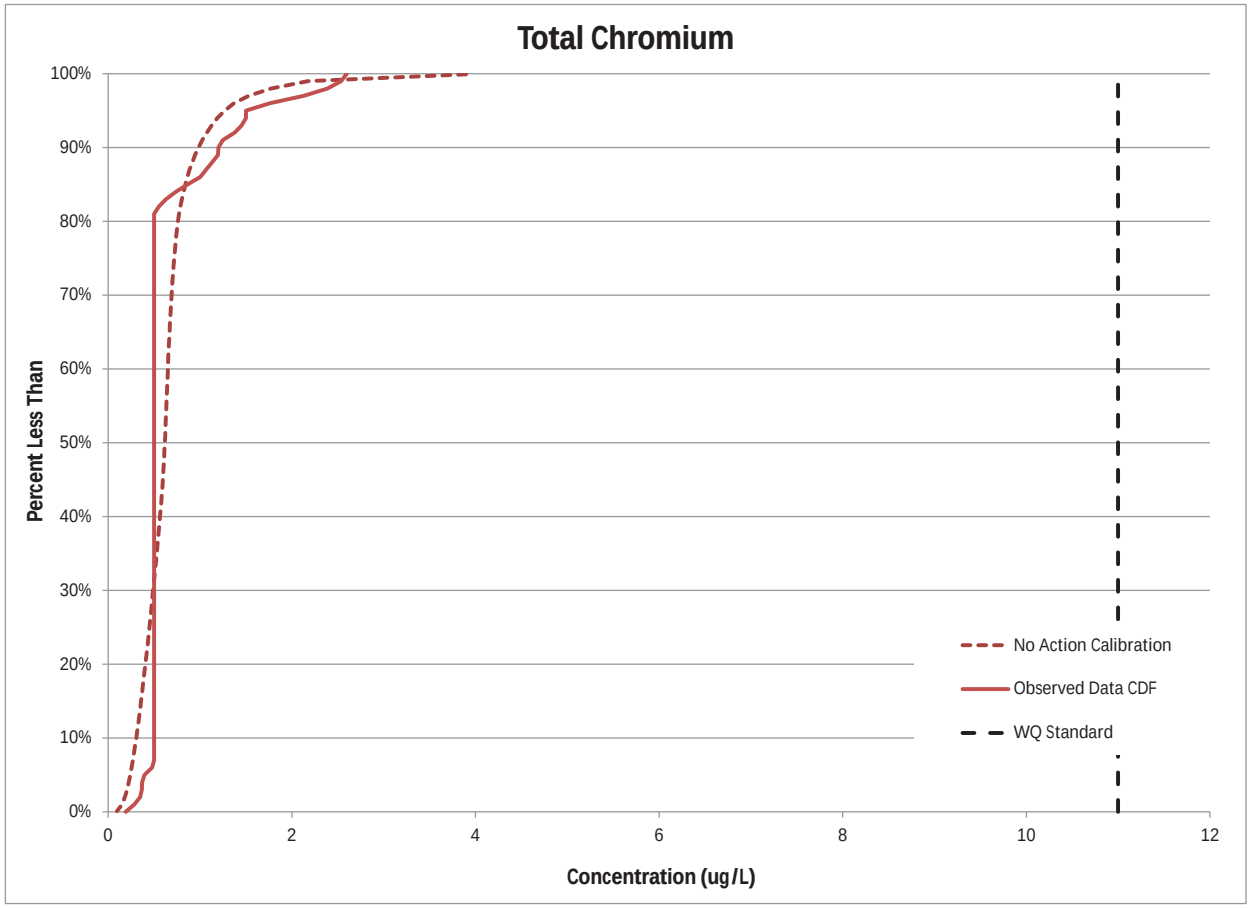


Figure 24 **Observed Partridge River concentrations (SW003 – SW005) and No Action model fit – Total Chromium (Cr)**

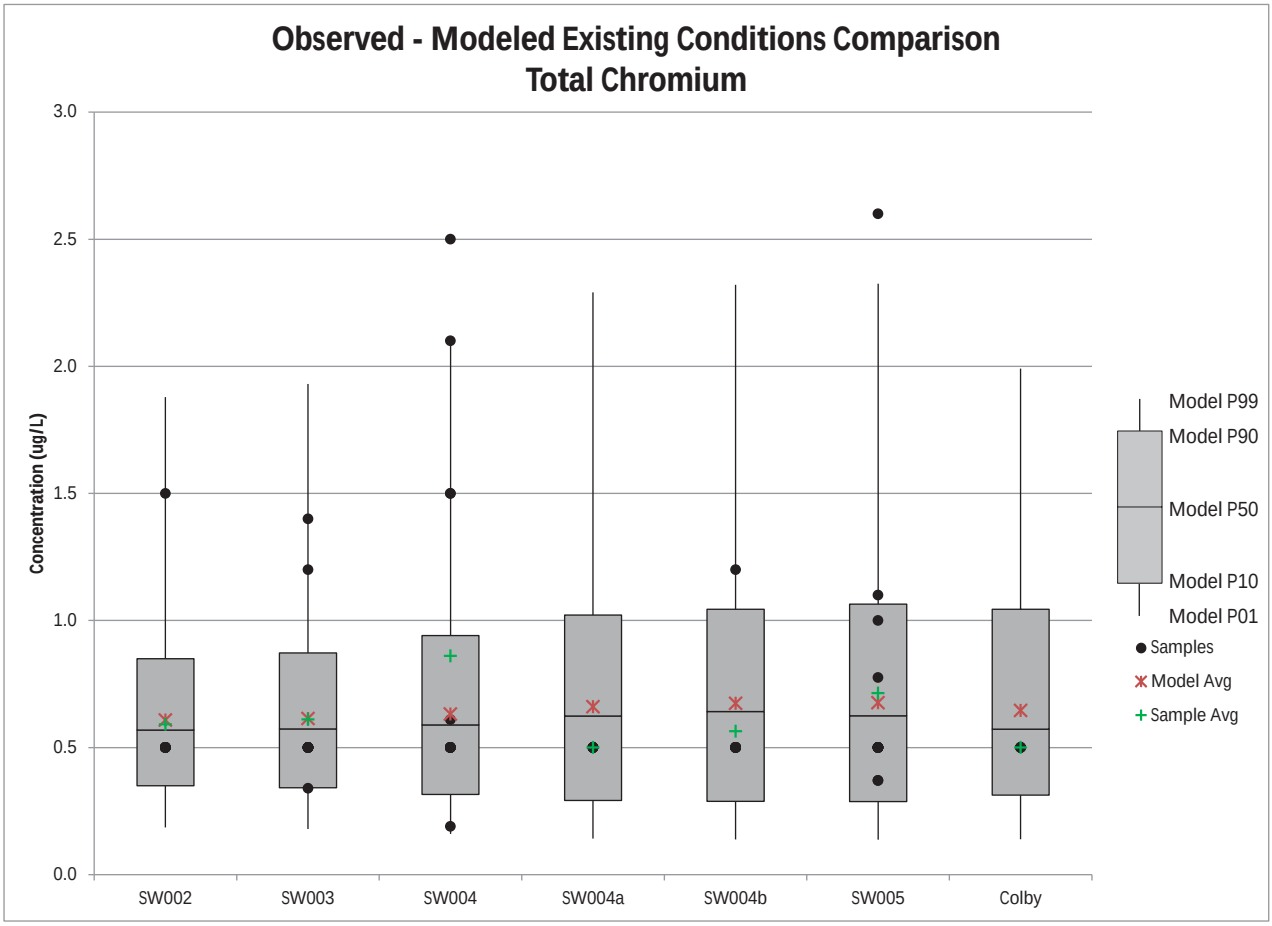


Figure 25 **Observed Partridge River concentrations (by location) and No Action model fit – Total Chromium (Cr)**

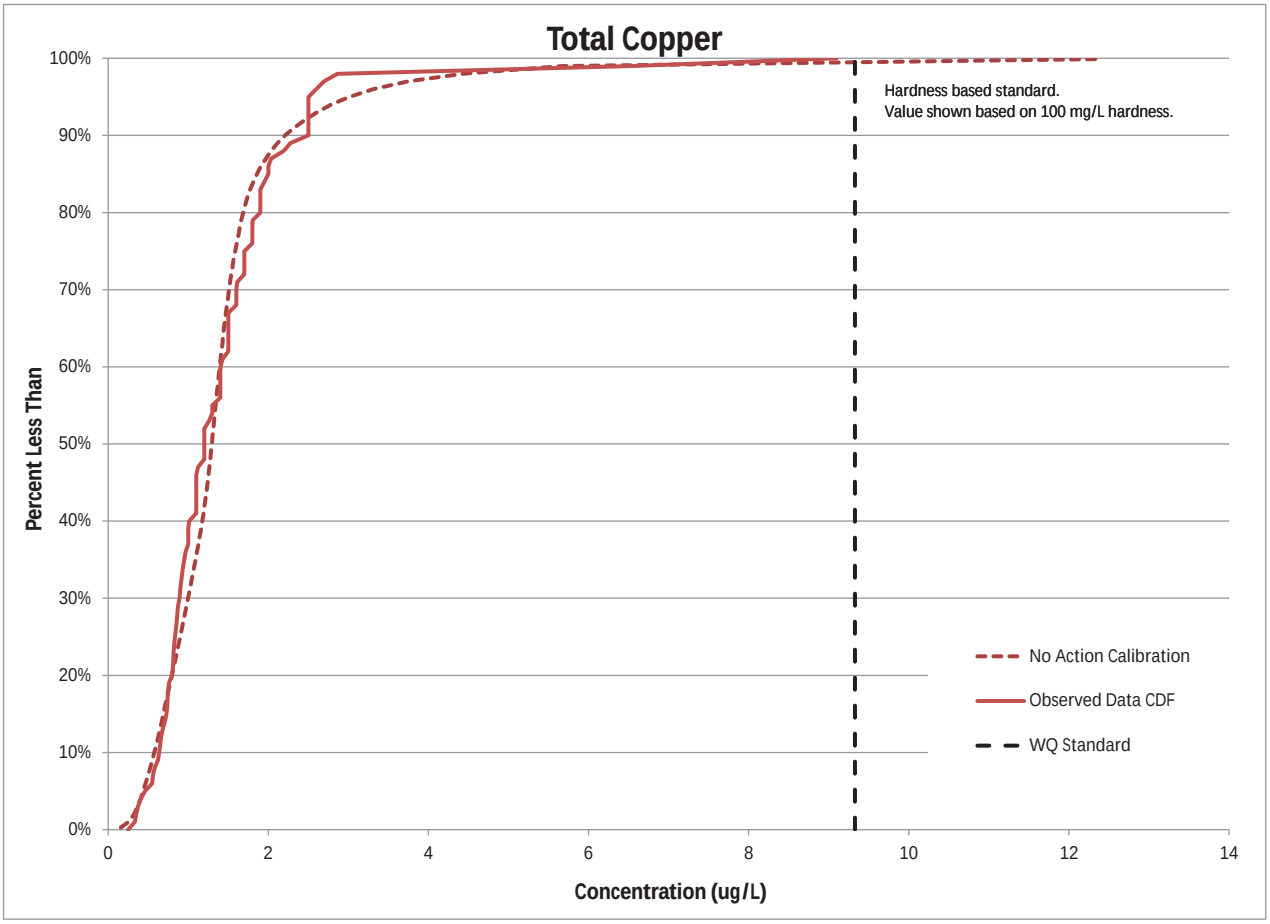


Figure 26 **Observed Partridge River concentrations (SW003 – SW005) and No Action model fit – Total Copper (Cu)**

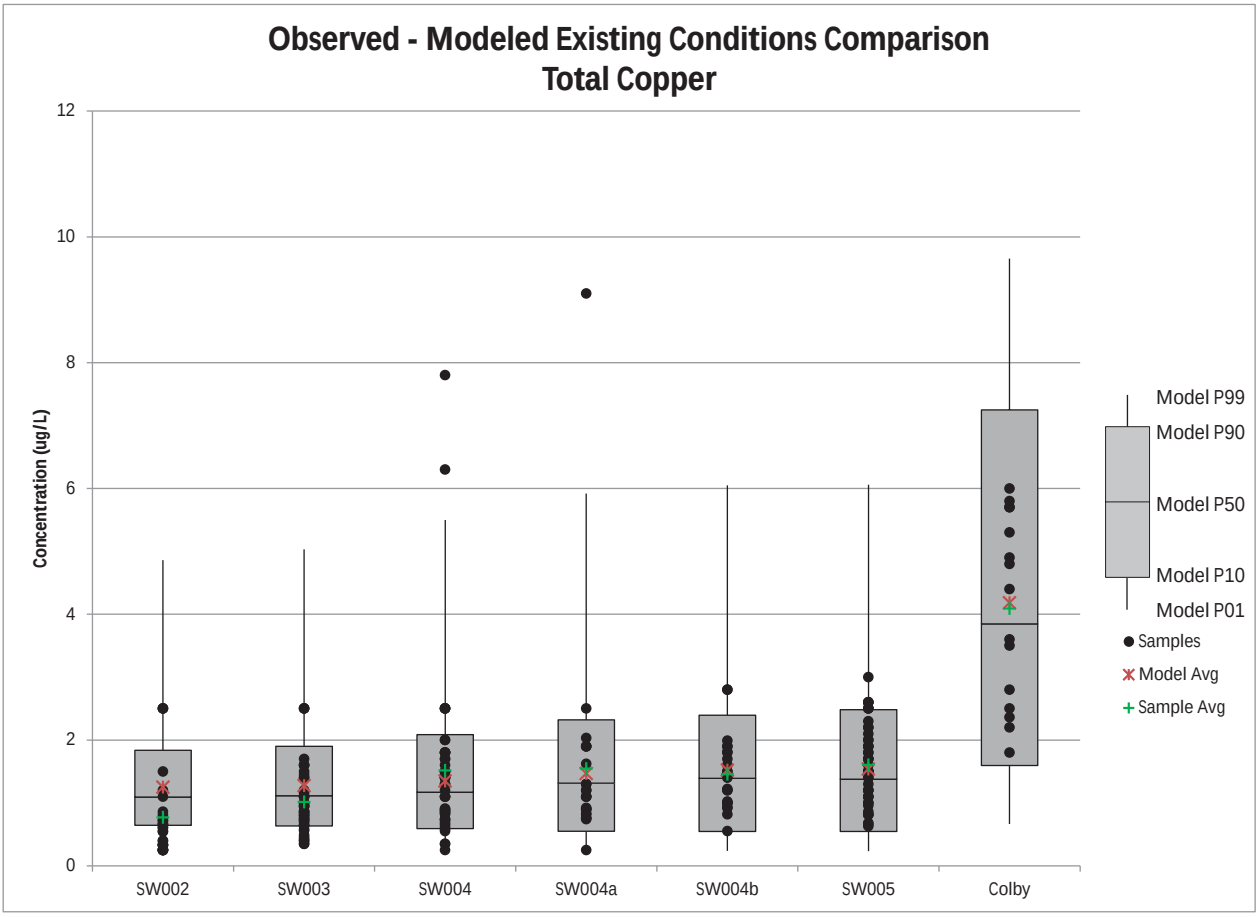


Figure 27 **Observed Partridge River concentrations (by location) and No Action model fit – Total Copper (Cu)**

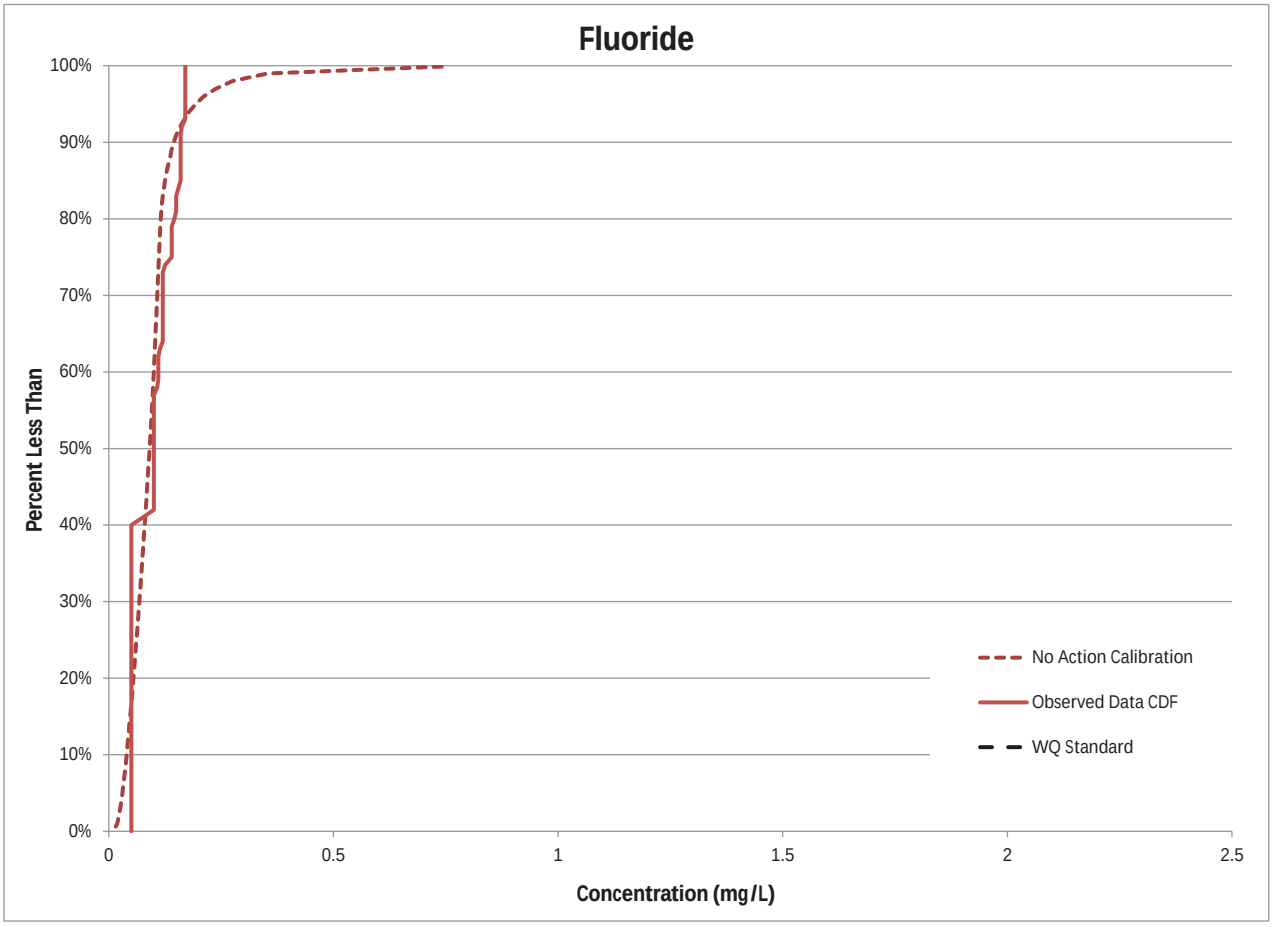


Figure 28 **Observed Partridge River concentrations (SW003 – SW005) and No Action model fit – Fluoride (F)**

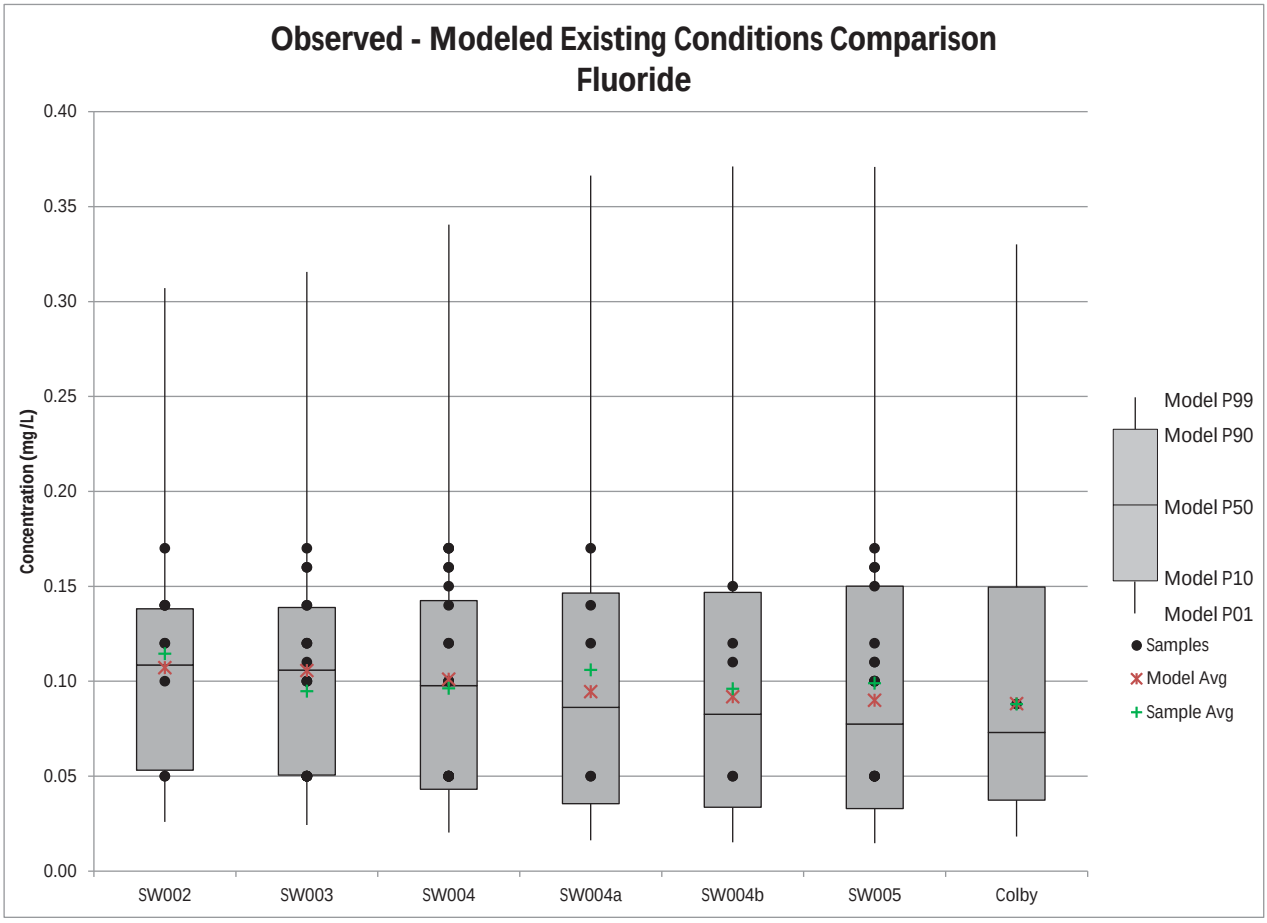


Figure 29 **Observed Partridge River concentrations (by location) and No Action model fit – Fluoride (F)**

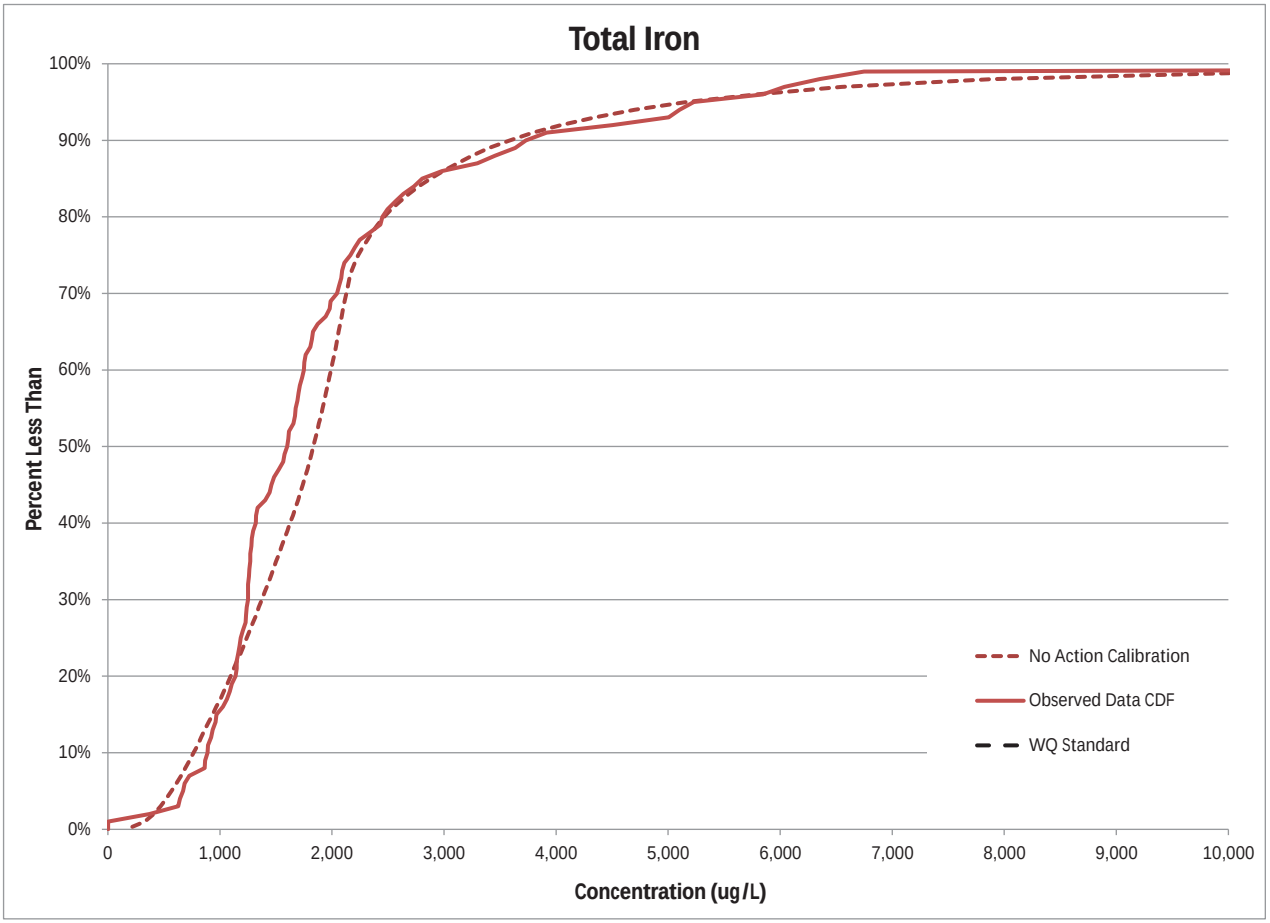


Figure 30 **Observed Partridge River concentrations (SW003 – SW005) and No Action model fit – Total Iron (Fe)**

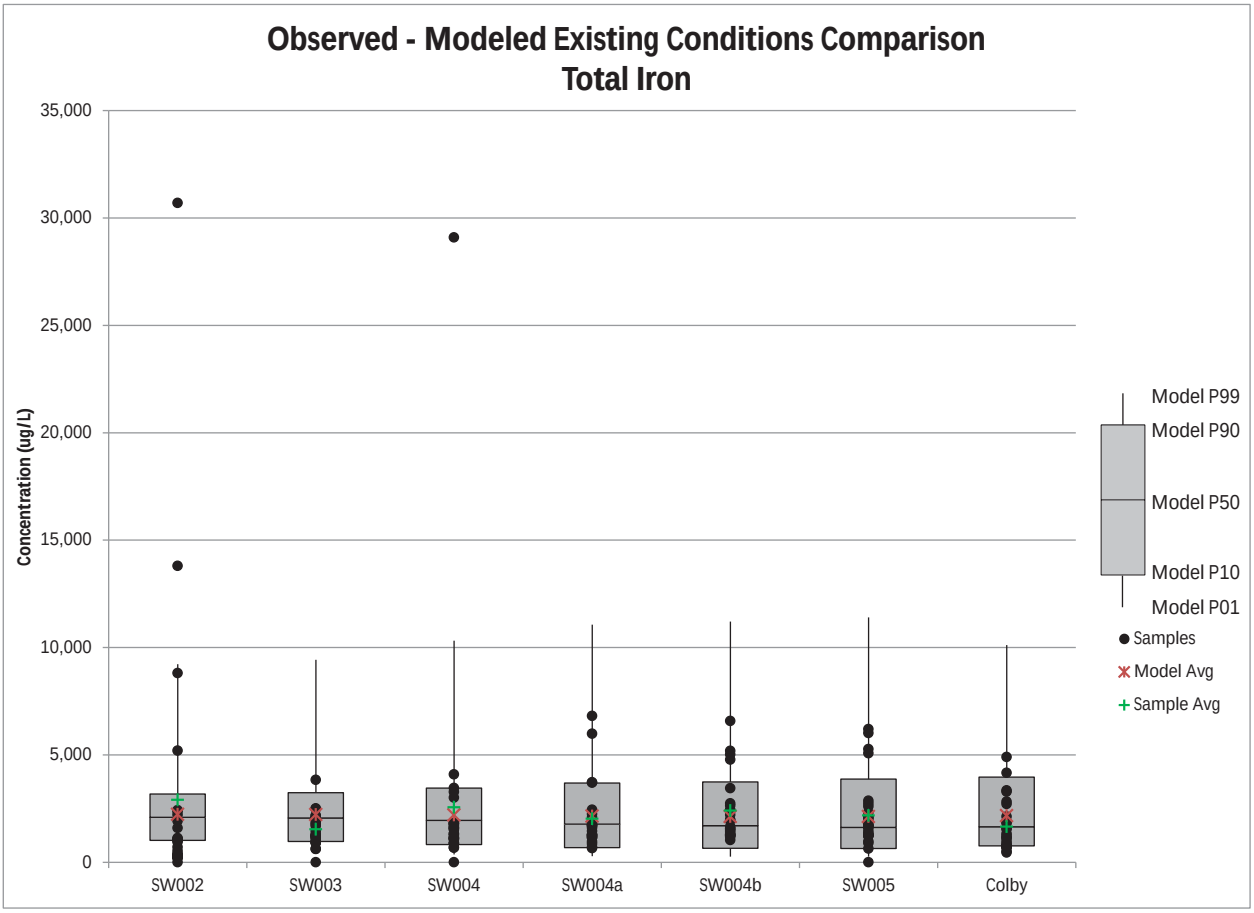


Figure 31 **Observed Partridge River concentrations (by location) and No Action model fit – Total Iron (Fe)**

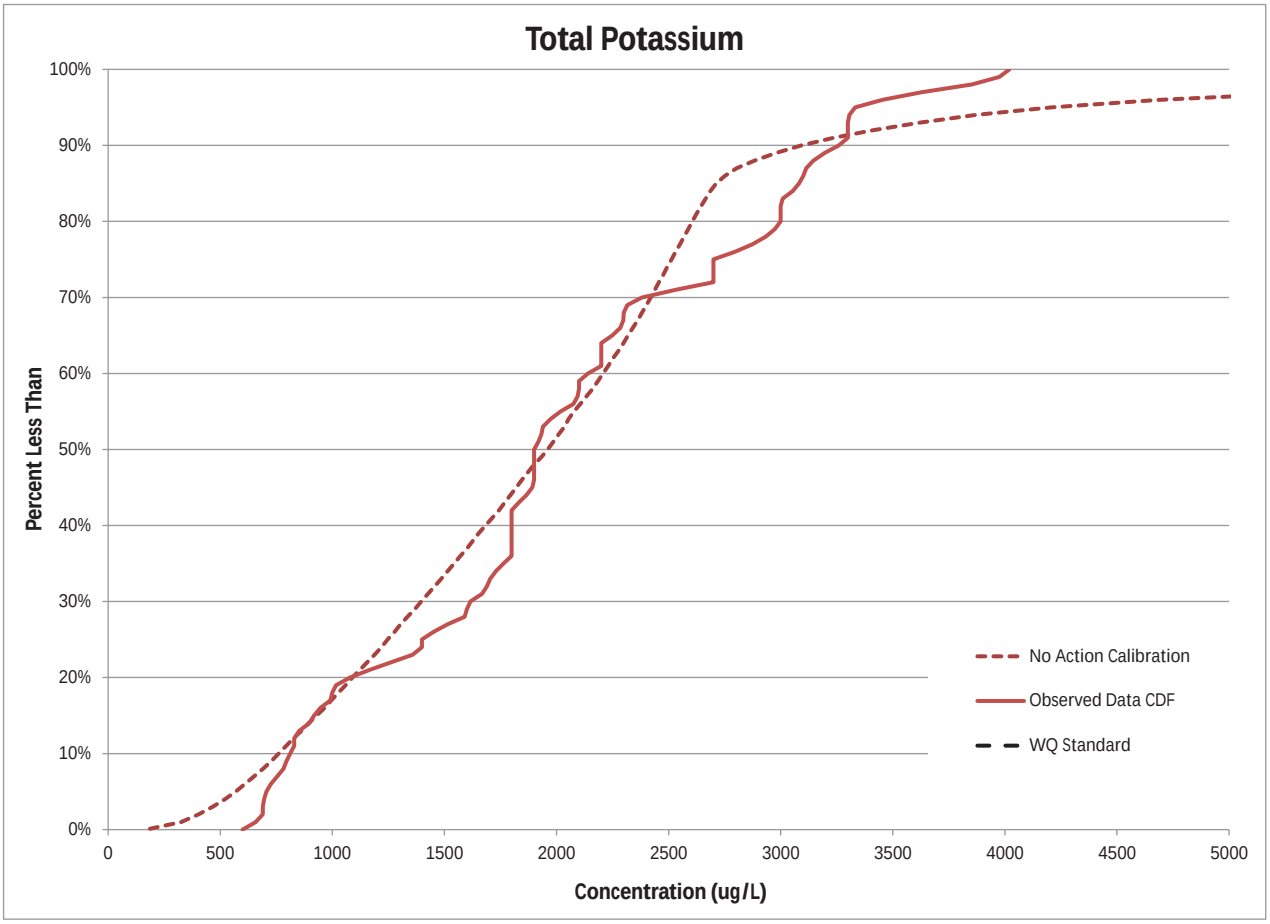


Figure 32 **Observed Partridge River concentrations (SW003 – SW005) and No Action model fit – Total Potassium (K)**

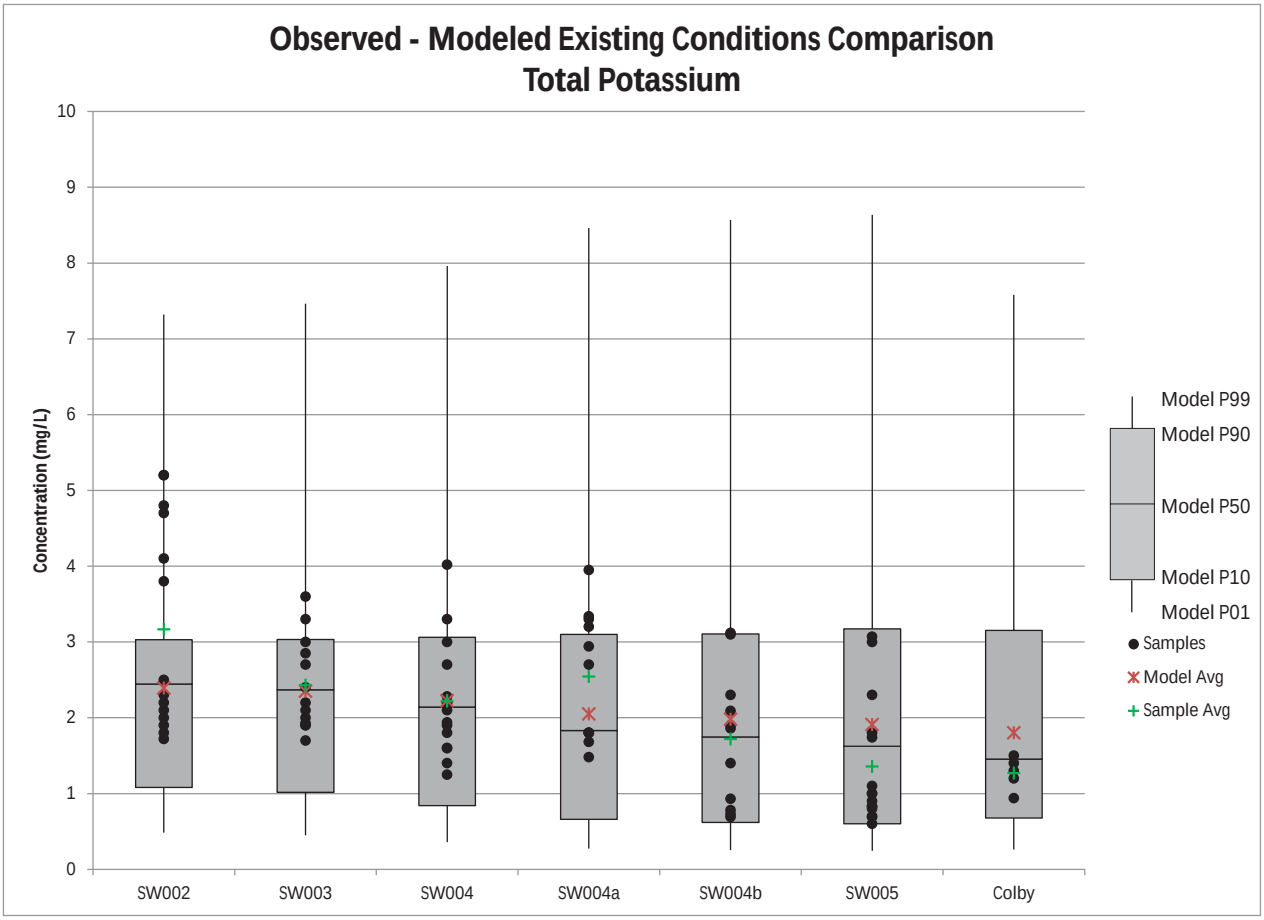


Figure 33 **Observed Partridge River concentrations (by location) and No Action model fit – Total Potassium (K)**

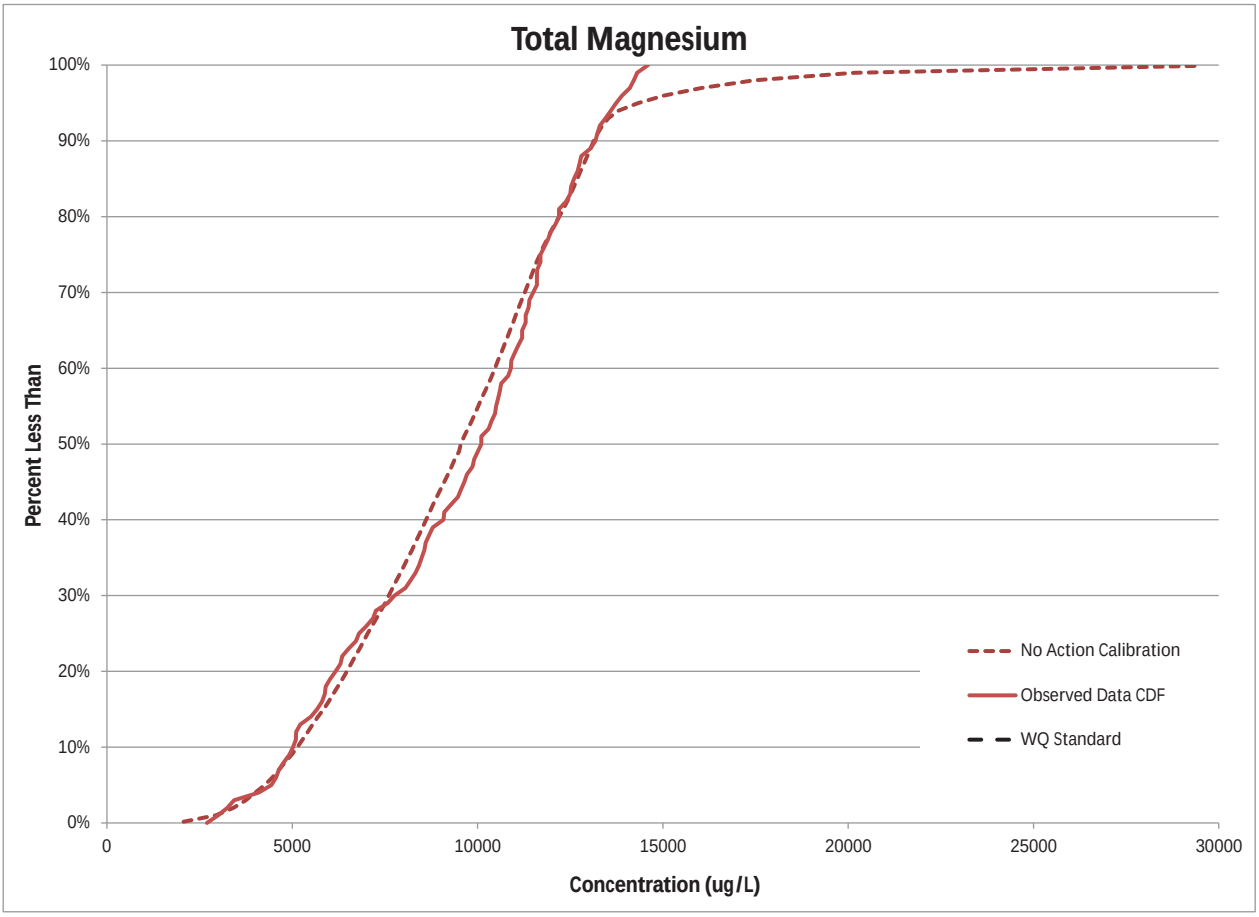


Figure 34 **Observed Partridge River concentrations (SW003 – SW005) and No Action model fit – Total Magnesium (Mg)**

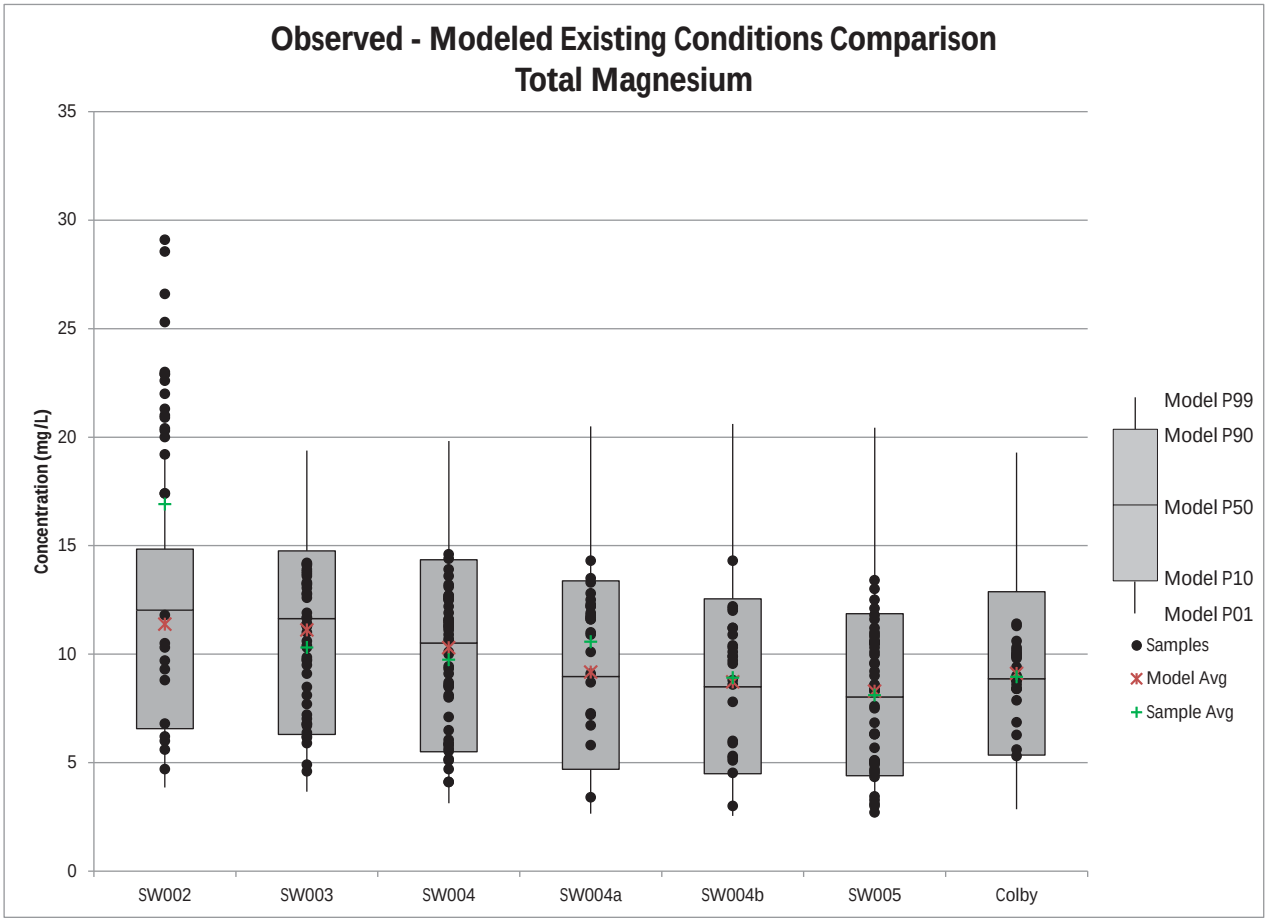


Figure 35 **Observed Partridge River concentrations (by location) and No Action model fit – Total Magnesium (Mg)**

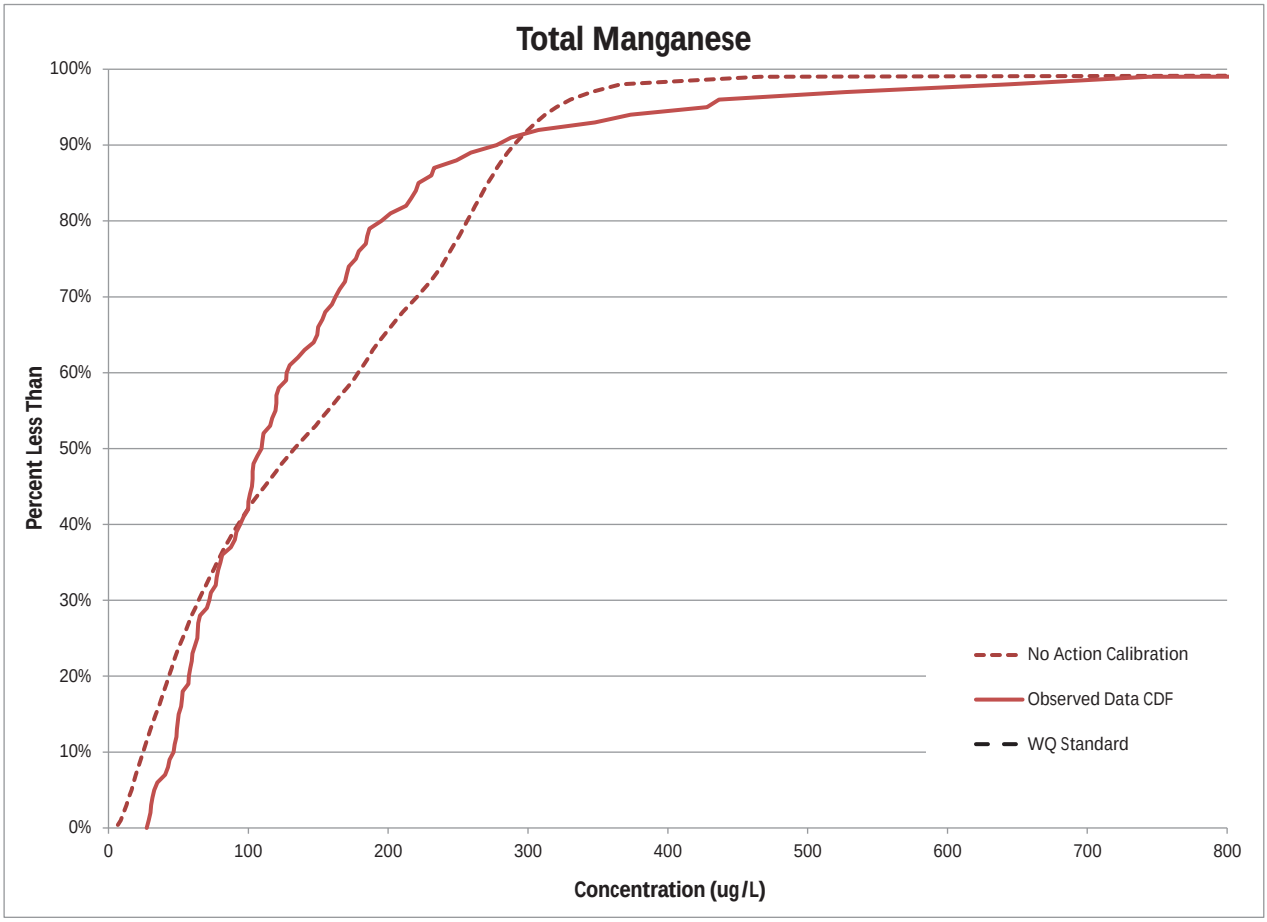


Figure 36 **Observed Partridge River concentrations (SW003 – SW005) and No Action model fit – Total Manganese (Mn)**

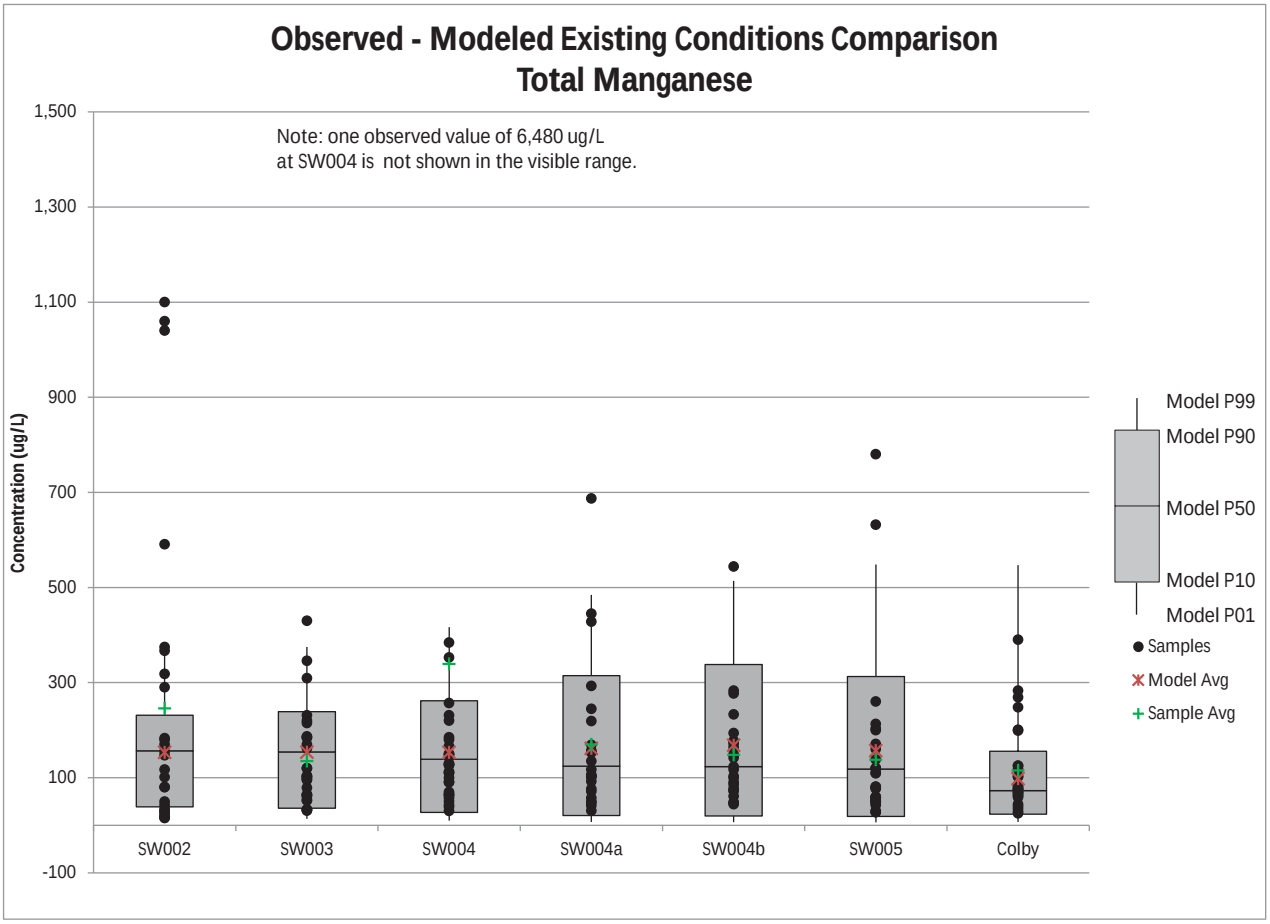


Figure 37 **Observed Partridge River concentrations (by location) and No Action model fit – Total Manganese (Mn)**

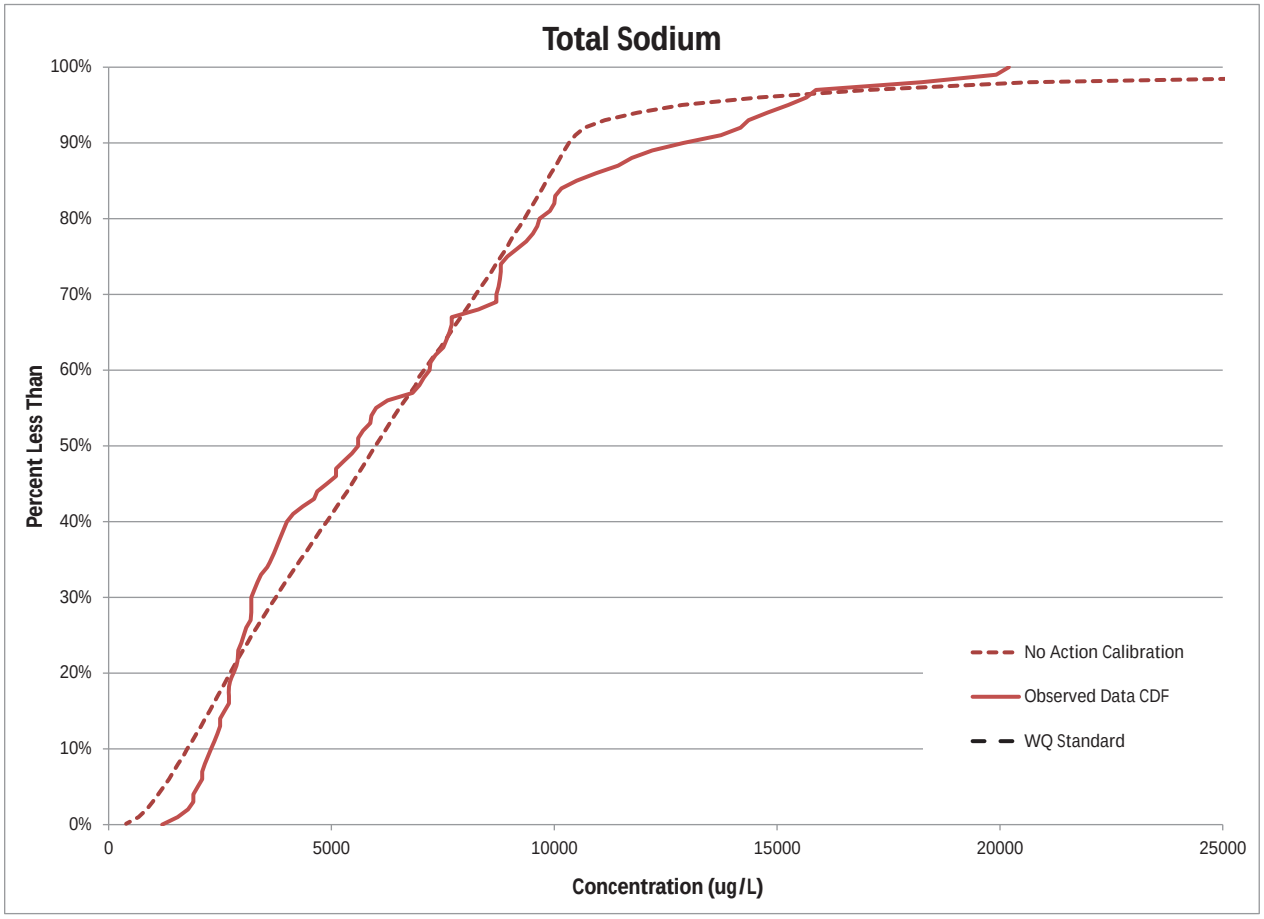


Figure 38 **Observed Partridge River concentrations (SW003 – SW005) and No Action model fit – Total Sodium (Na)**

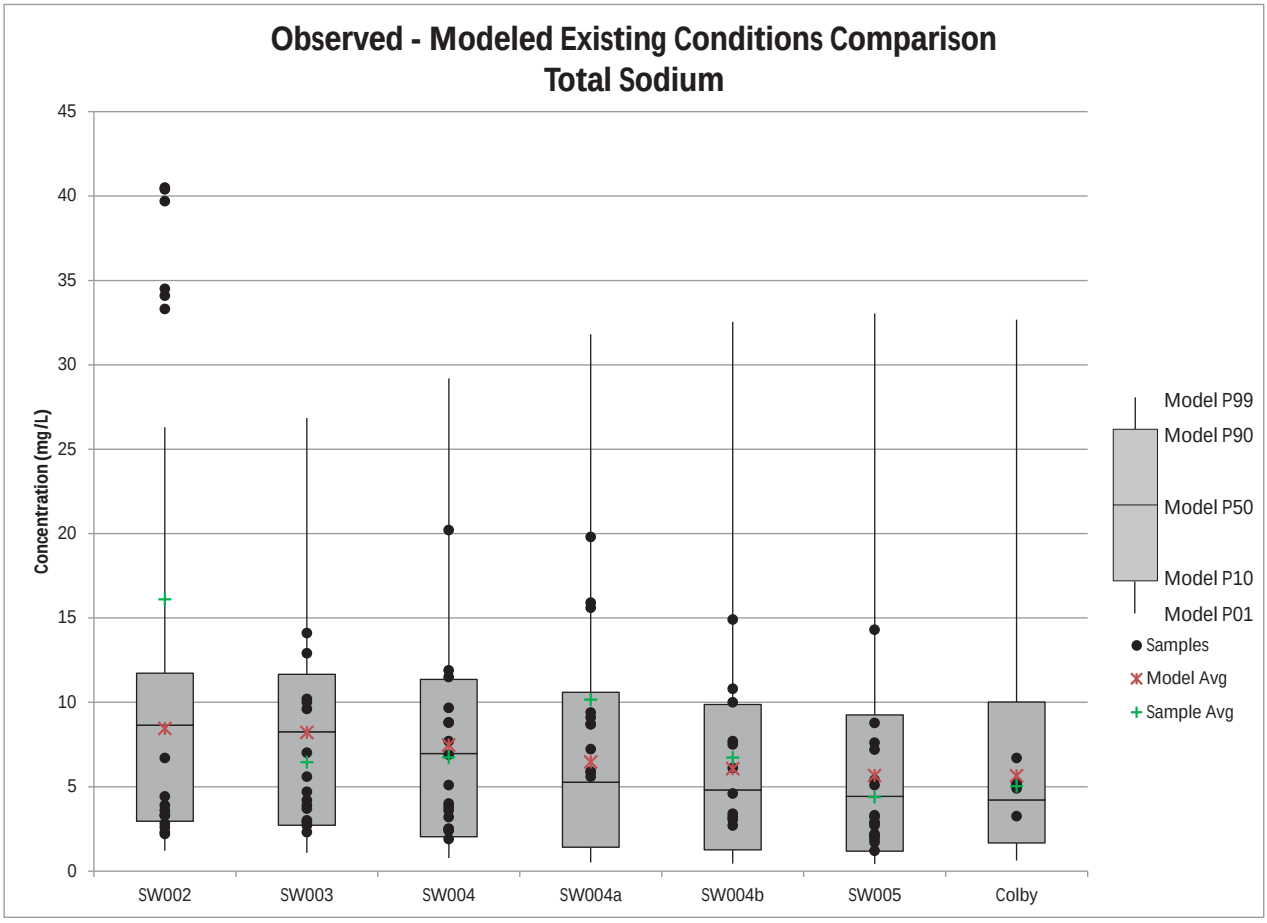


Figure 39 **Observed Partridge River concentrations (by location) and No Action model fit – Total Sodium (Na)**

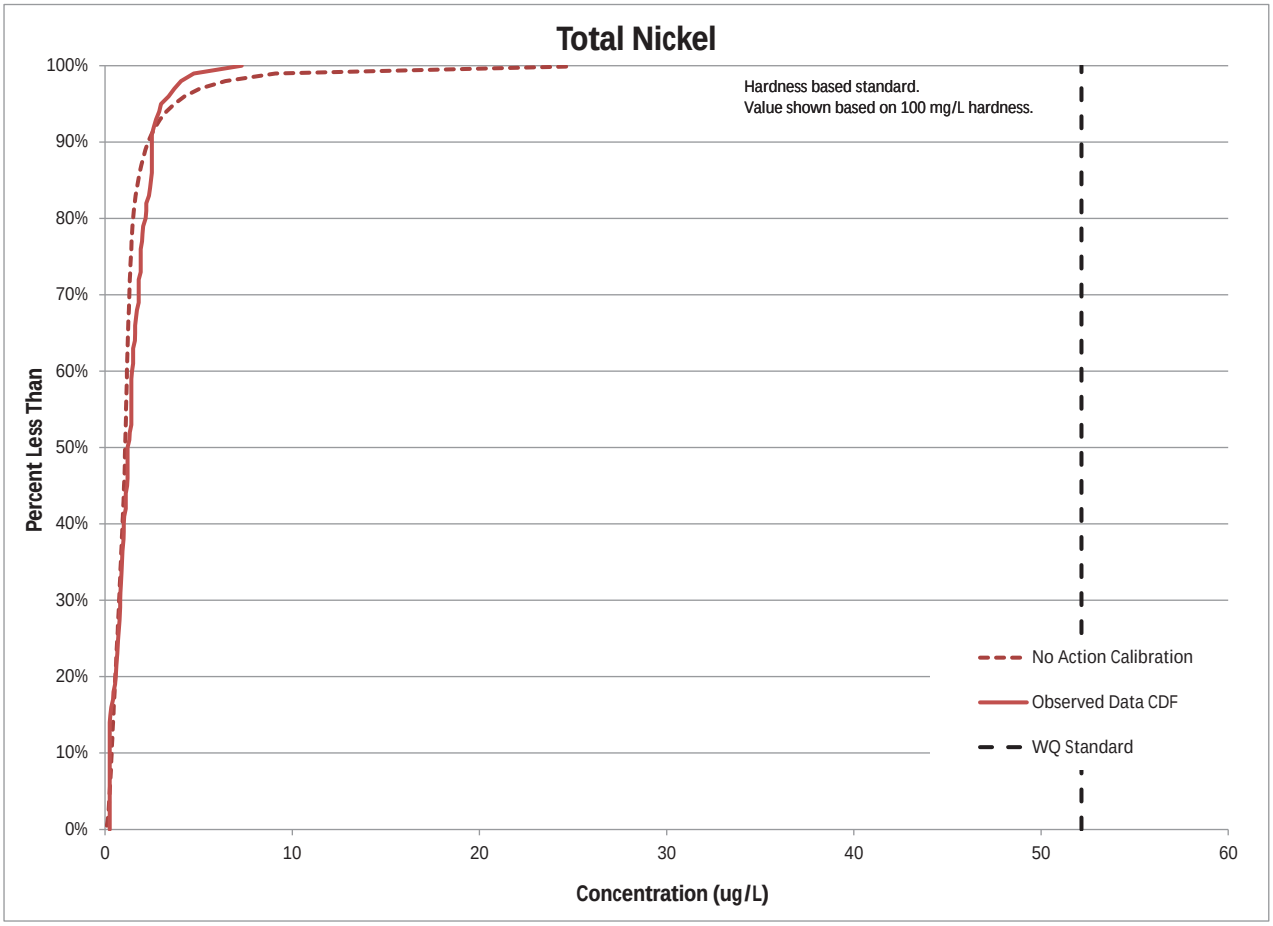


Figure 40 **Observed Partridge River concentrations (SW003 – SW005) and No Action model fit – Total Nickel (Ni)**

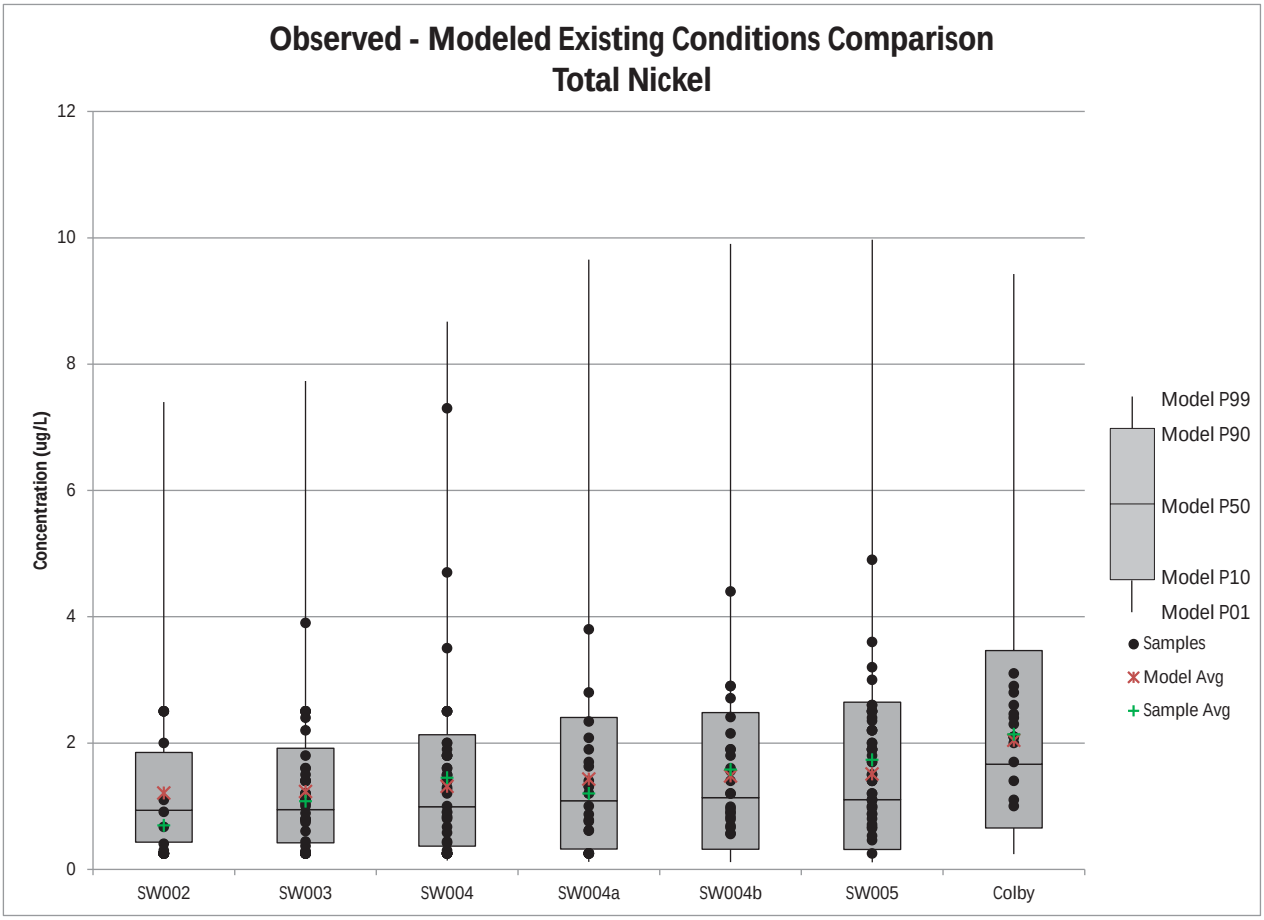


Figure 41 **Observed Partridge River concentrations (by location) and No Action model fit – Total Nickel (Ni)**

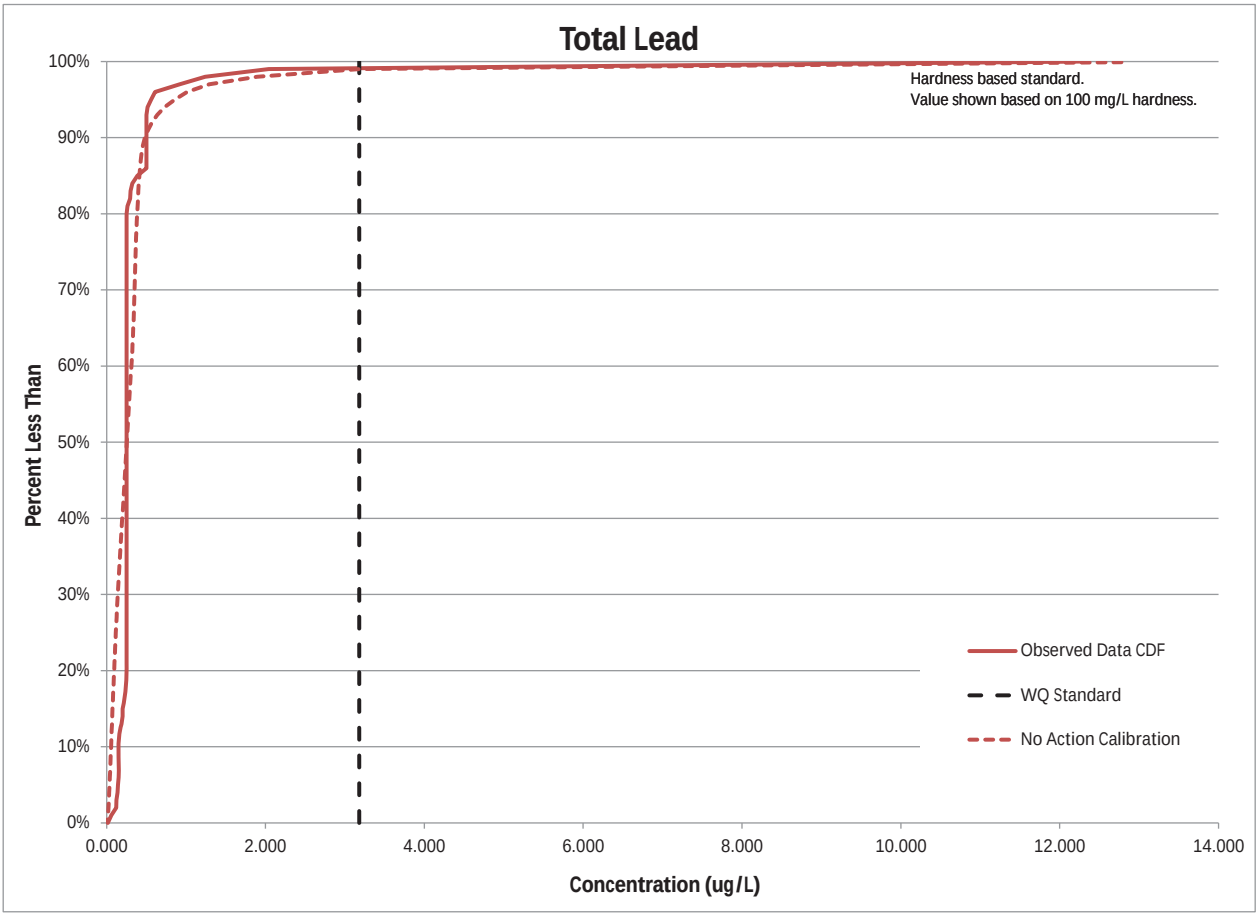


Figure 42 **Observed Partridge River concentrations (SW003 – SW005) and No Action model fit – Total Lead (Pb)**

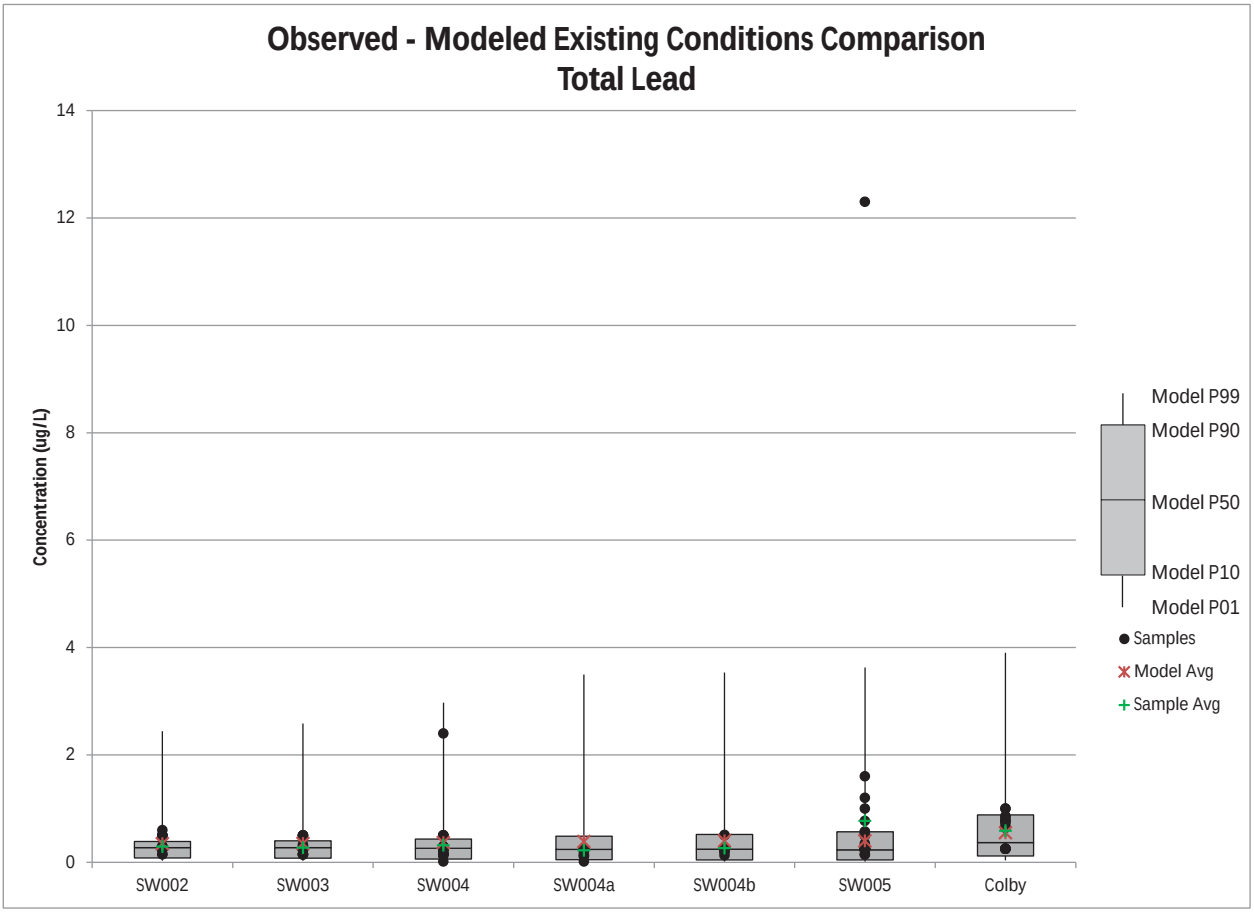


Figure 43 **Observed Partridge River concentrations (by location) and No Action model fit – Total Lead (Pb)**

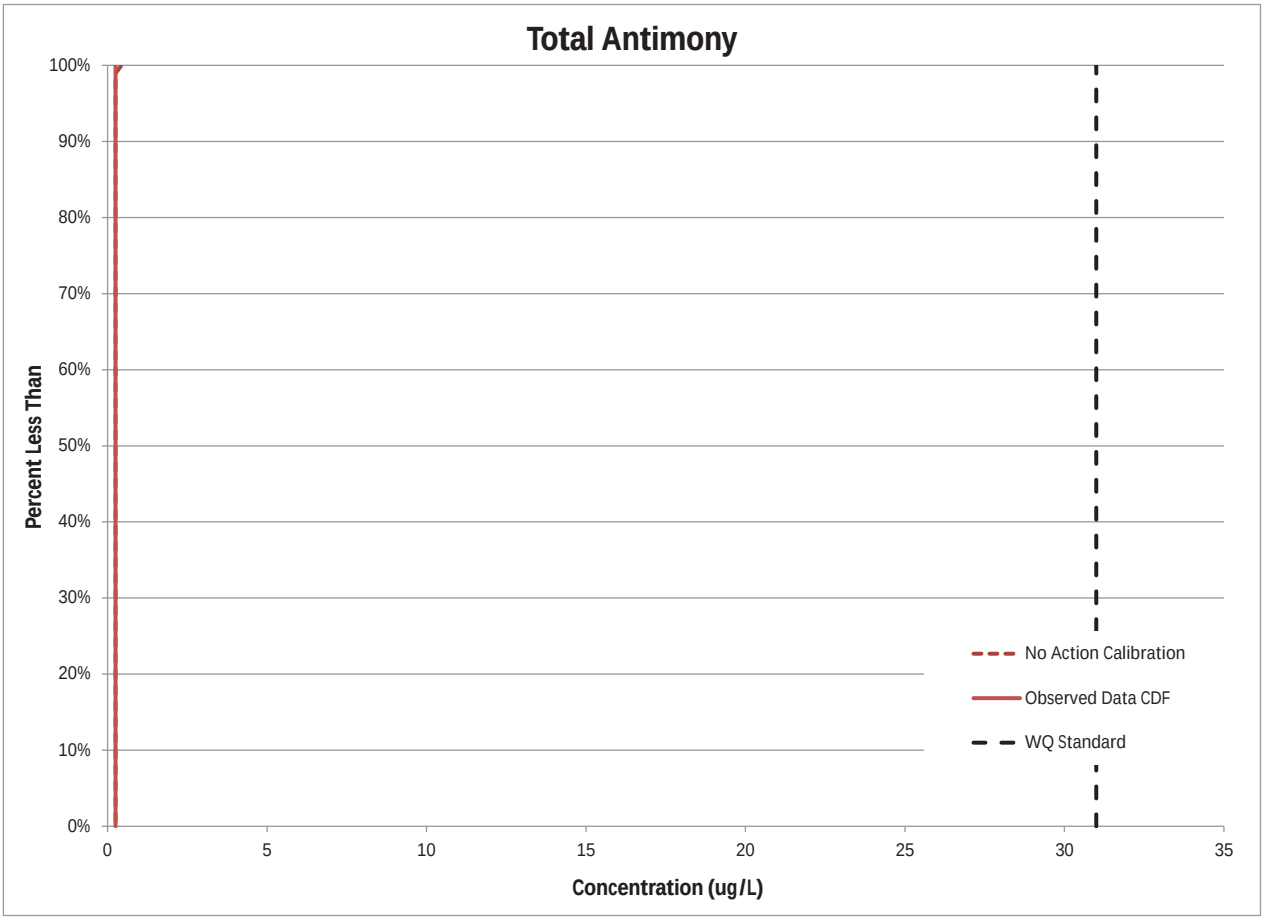


Figure 44 **Observed Partridge River concentrations (SW003 – SW005) and No Action model fit – Total Antimony (Sb)**

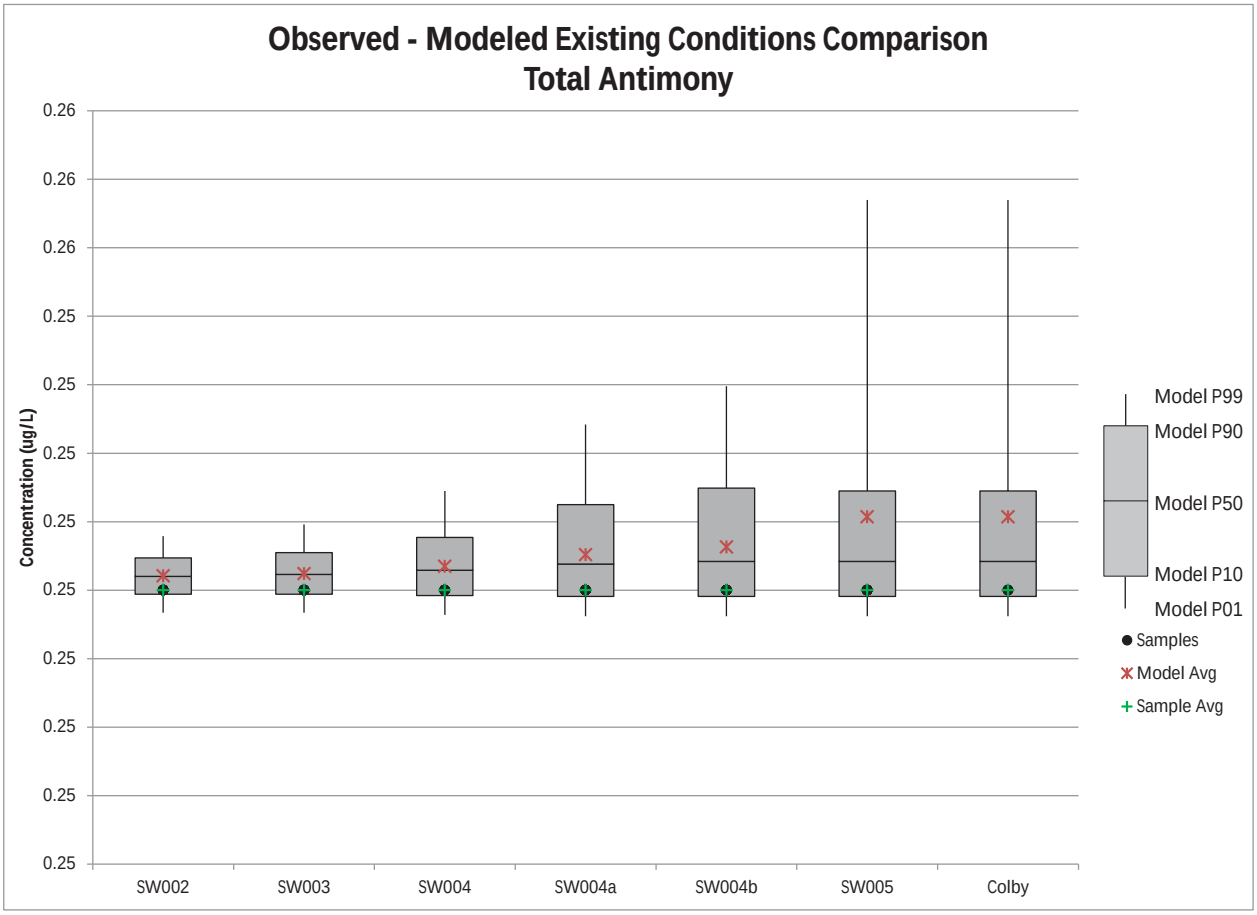


Figure 45 **Observed Partridge River concentrations (by location) and No Action model fit – Total Antimony (Sb)**

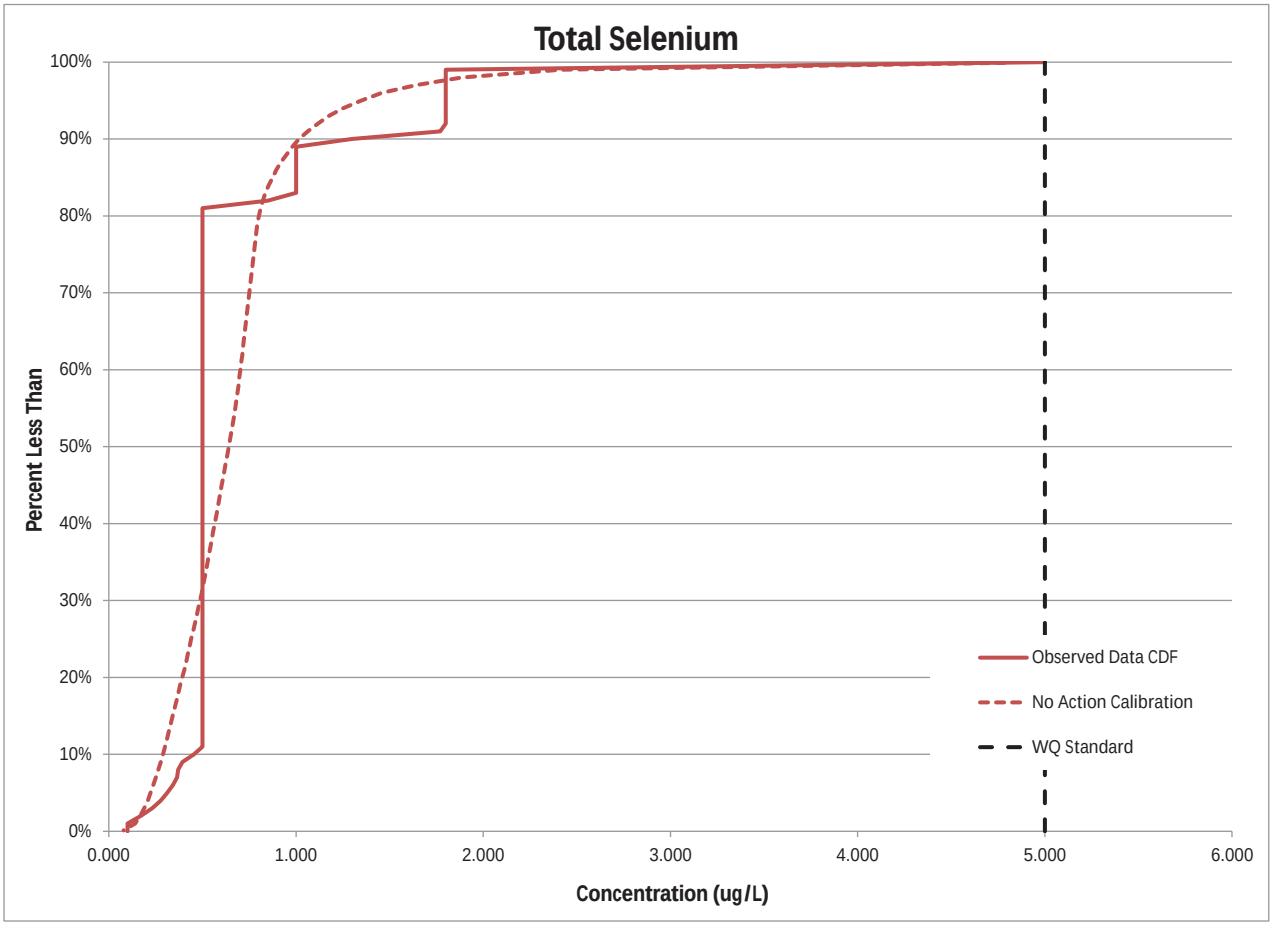


Figure 46 **Observed Partridge River concentrations (SW003 – SW005) and No Action model fit – Total Selenium (Se)**

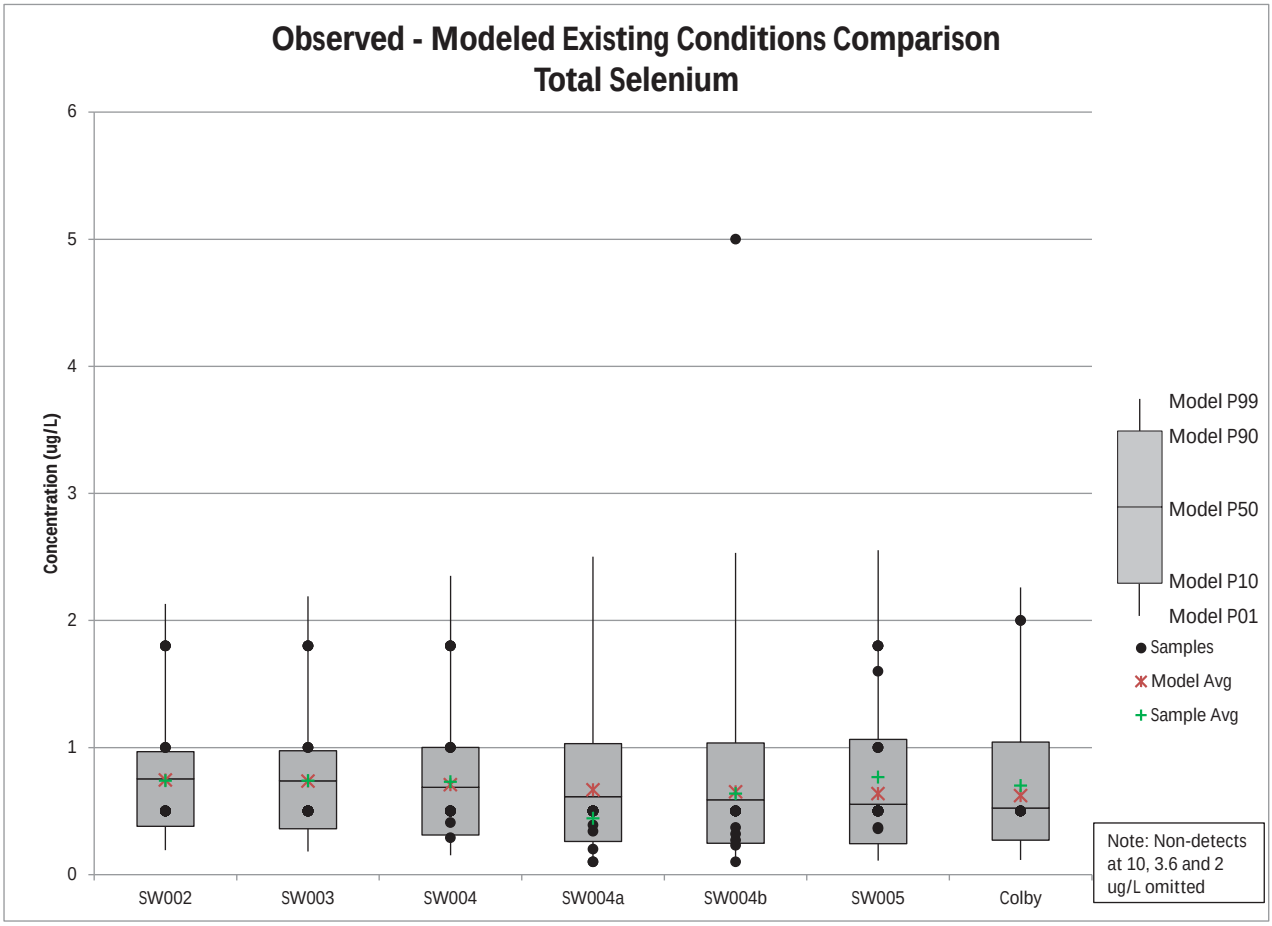


Figure 47 **Observed Partridge River concentrations (by location) and No Action model fit – Total Selenium (Se)**

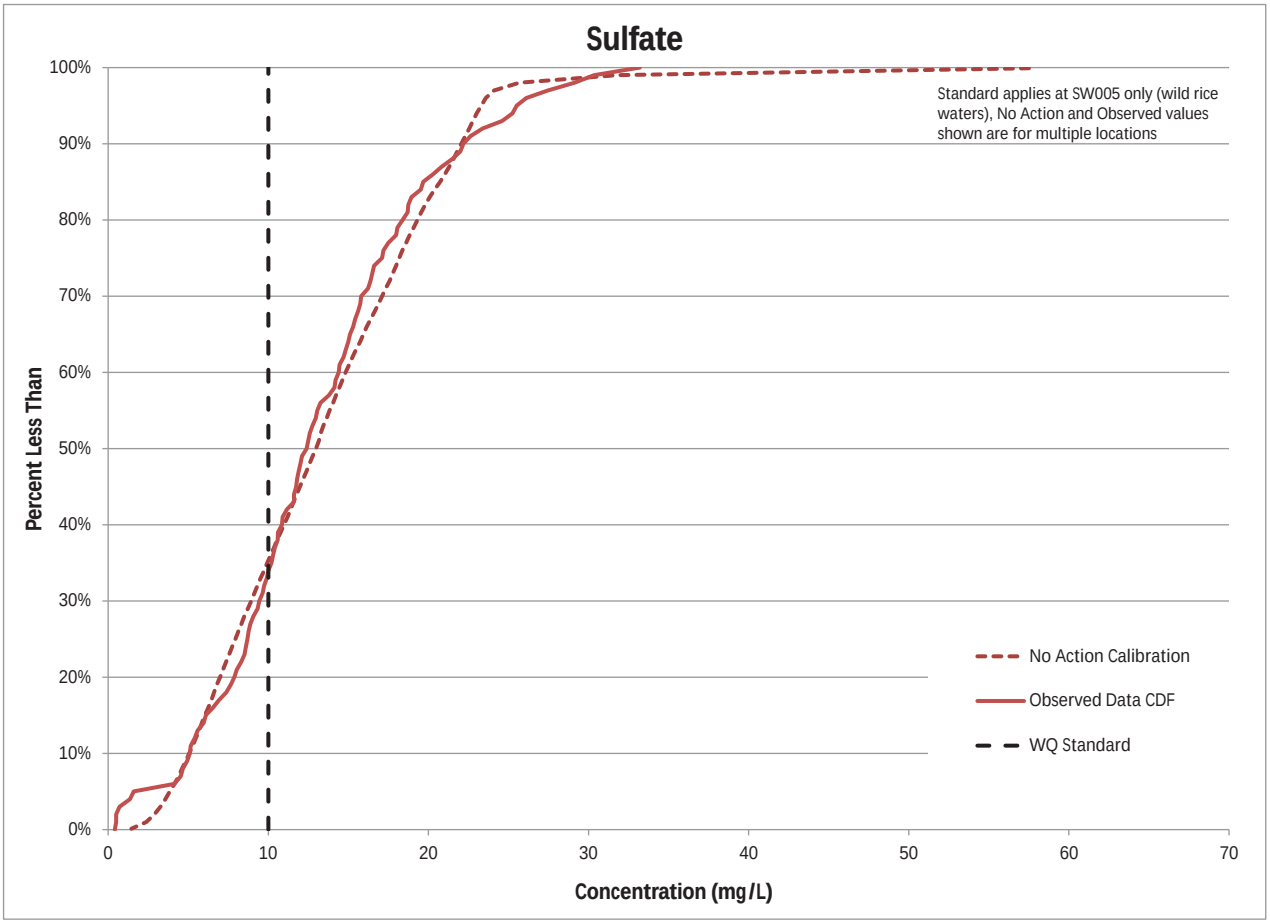


Figure 48 **Observed Partridge River concentrations (SW003 – SW005) and No Action model fit– Sulfate (SO4)**

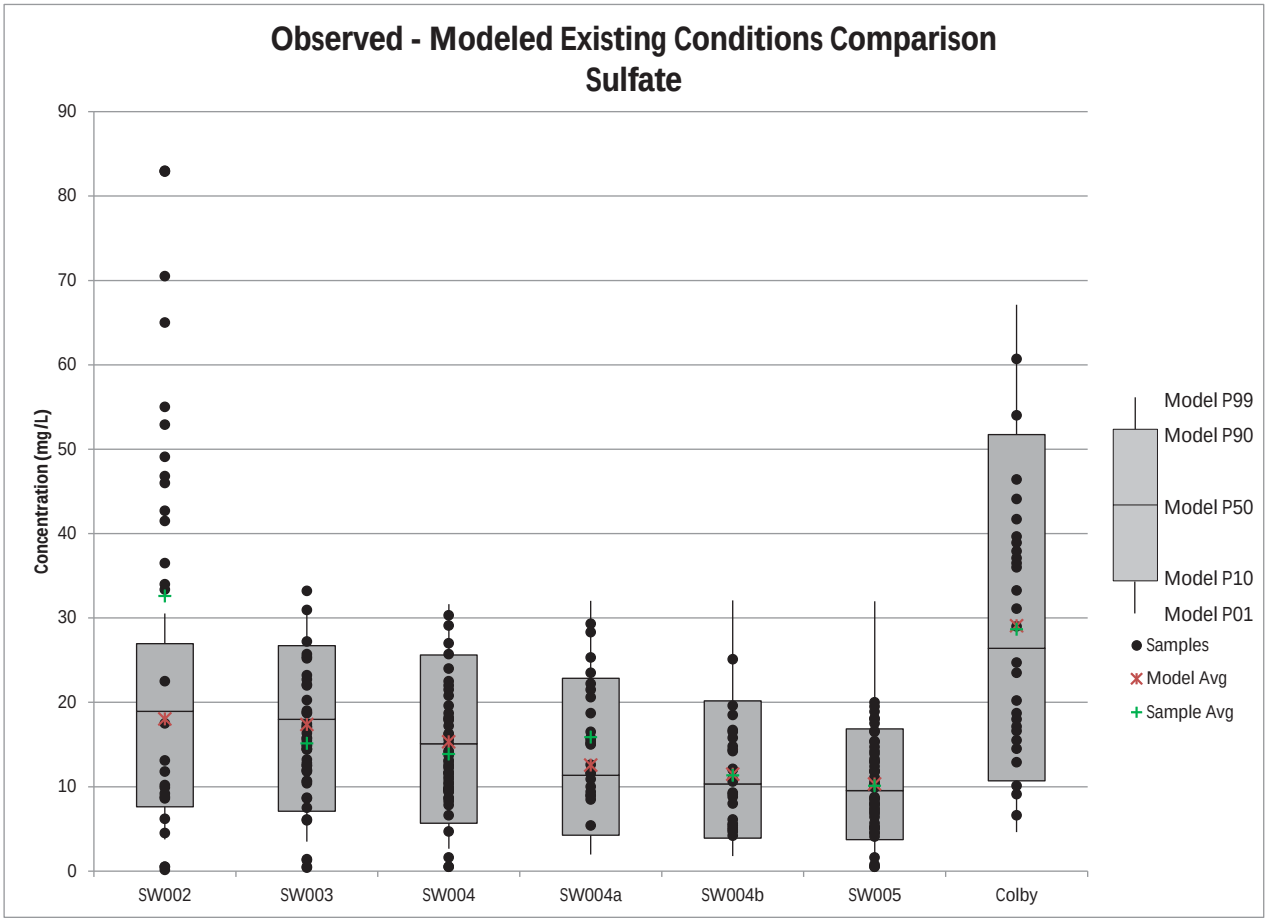


Figure 49 **Observed Partridge River concentrations (by location) and No Action model fit– Sulfate (SO4)**

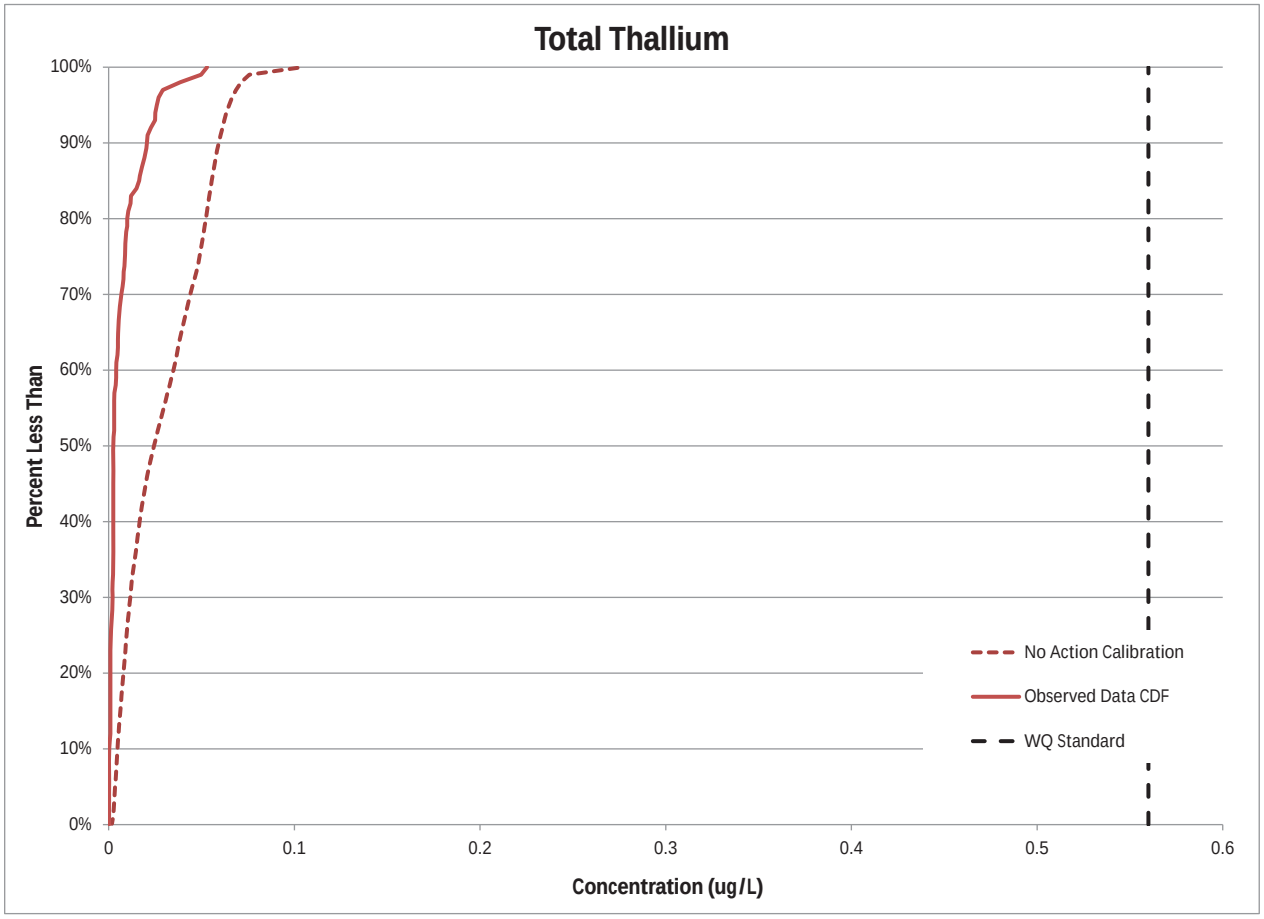


Figure 50 **Observed Partridge River concentrations (SW003 – SW005) and No Action model fit– Total Thallium (Tl)**

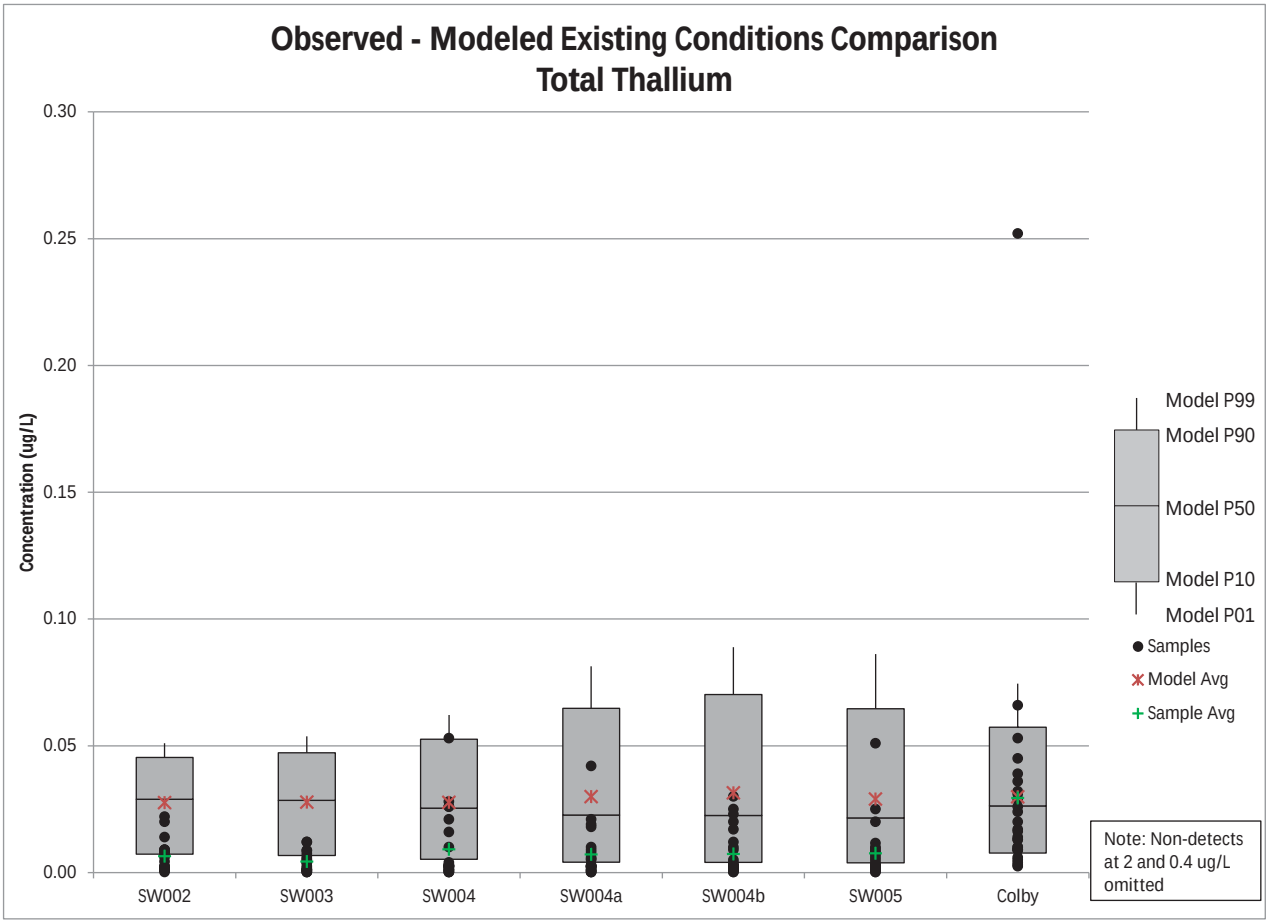


Figure 51 **Observed Partridge River concentrations (by location) and No Action model fit– Total Thallium (Tl)**

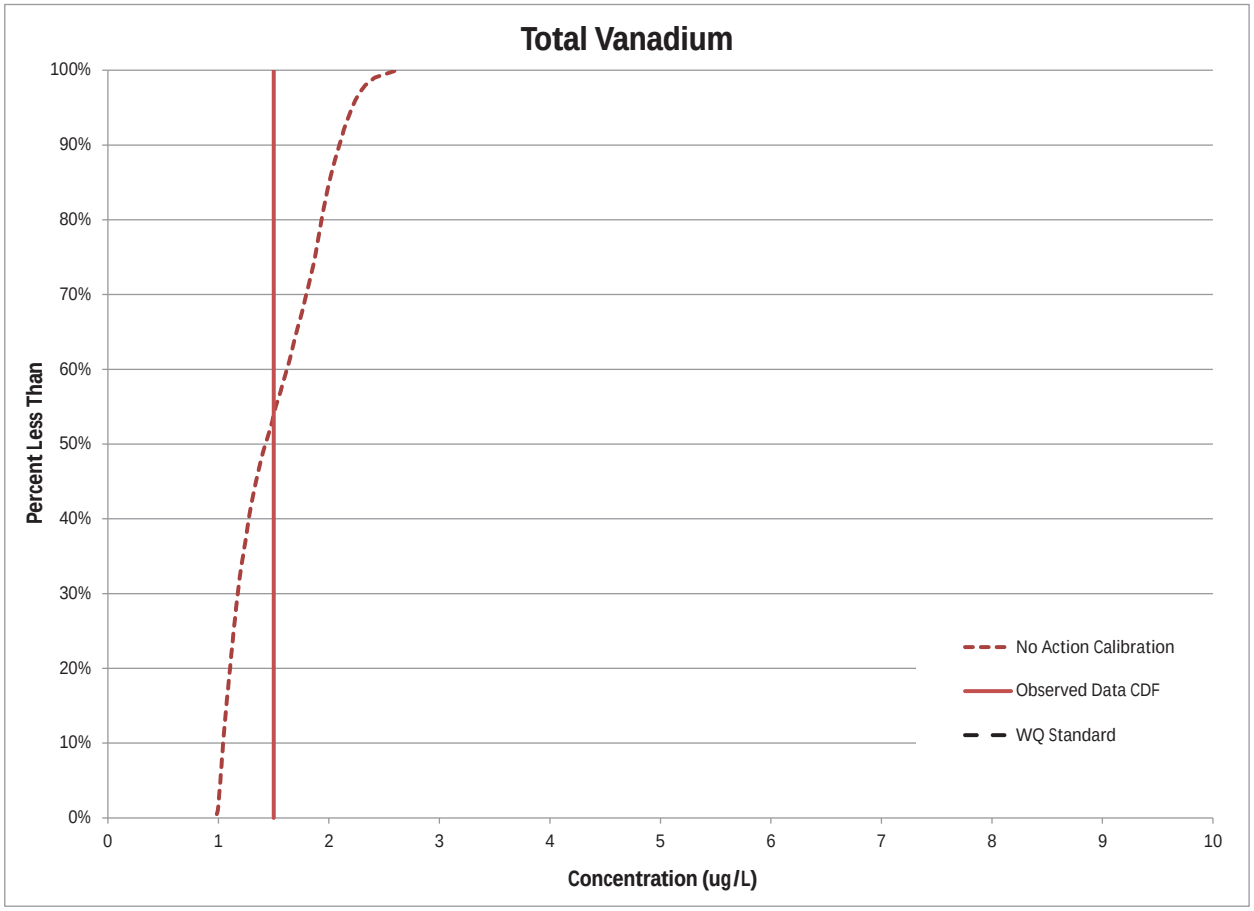


Figure 52 **Observed Partridge River concentrations (SW003 – SW005) and No Action model fit – Total Vanadium (V)**

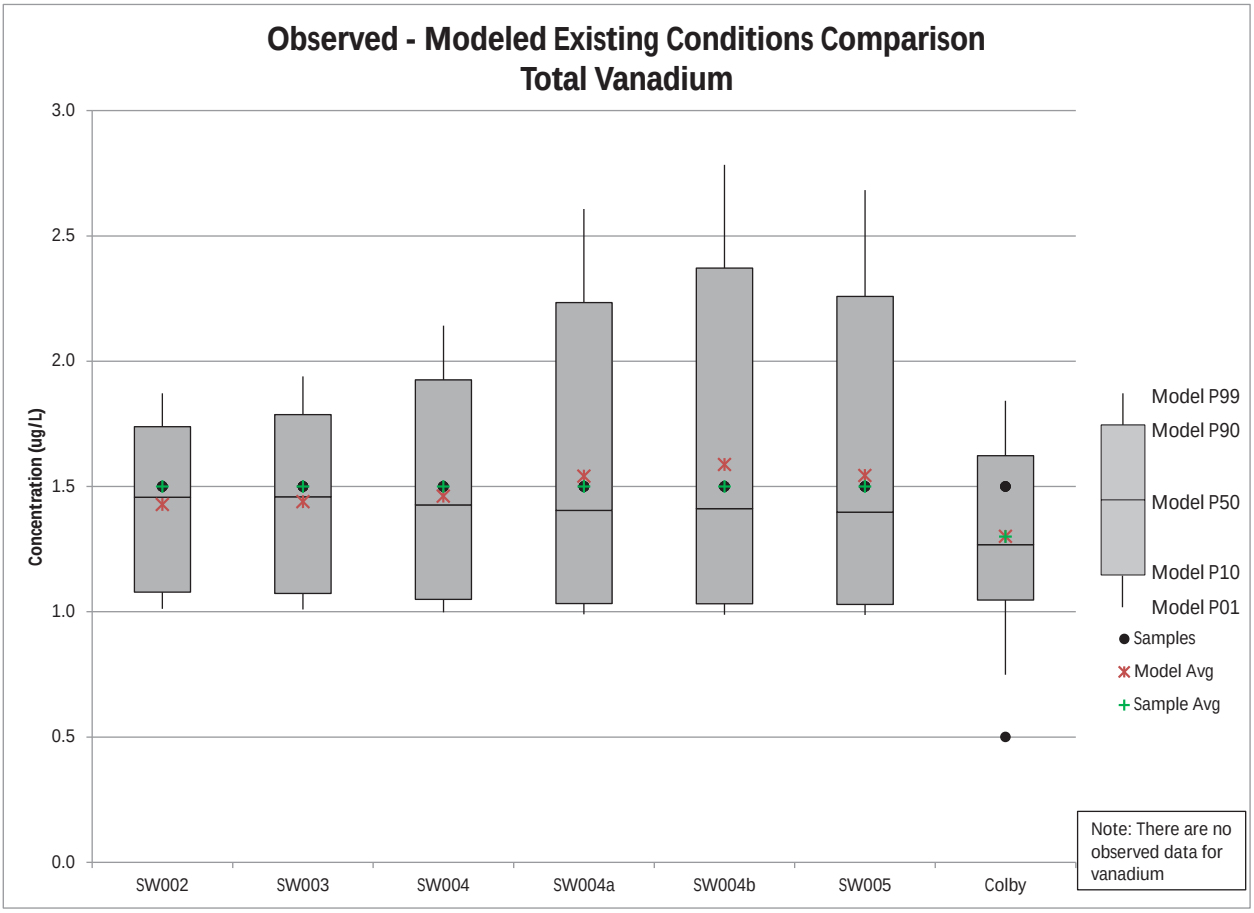


Figure 53 **Observed Partridge River concentrations (by location) and No Action model fit – Total Vanadium (V)**

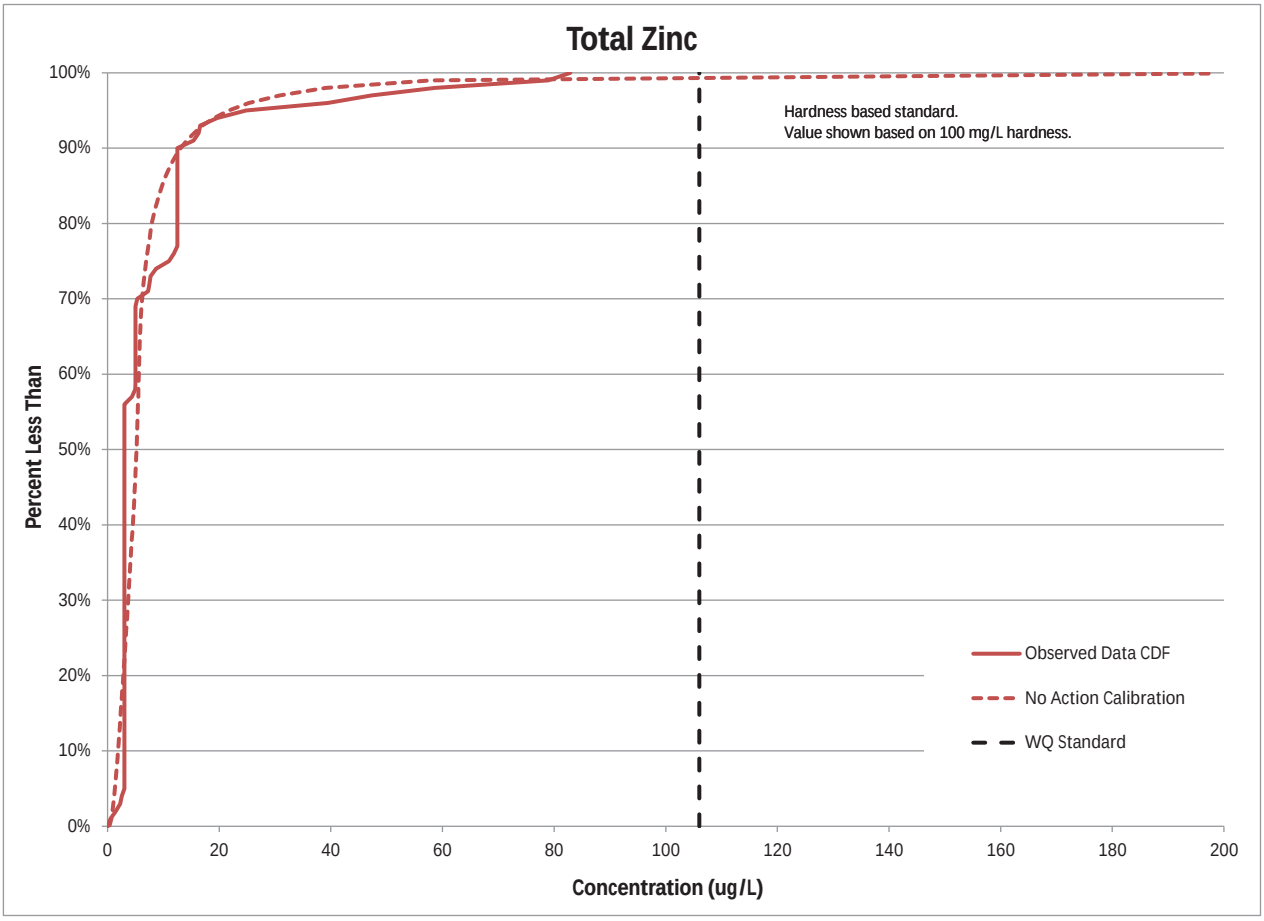


Figure 54 **Observed Partridge River concentrations (SW003 – SW005) and No Action model fit – Total Zinc (Zn)**

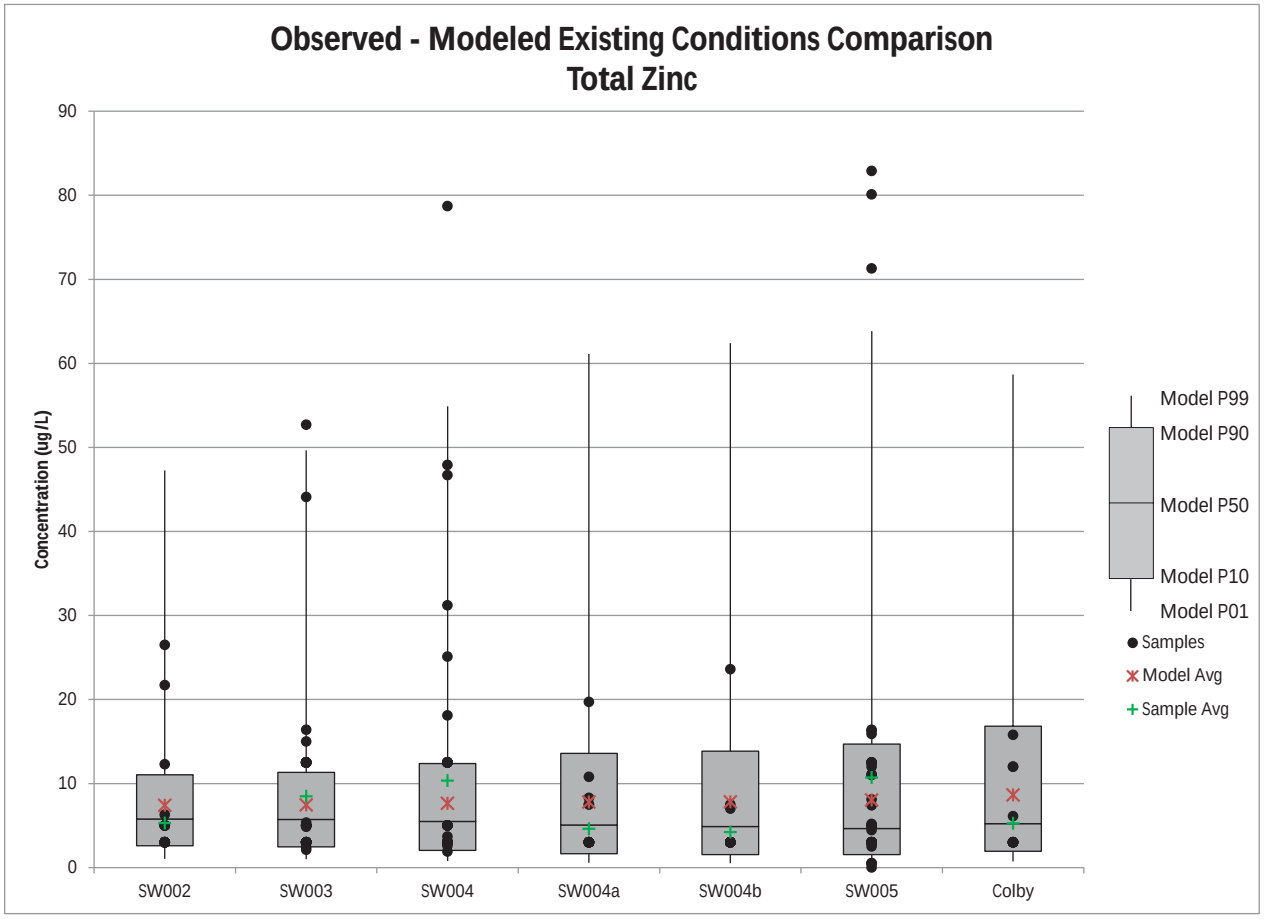


Figure 55 **Observed Partridge River concentrations (by location) and No Action model fit – Total Zinc (Zn)**

Attachment F

Partridge River Flow versus Concentration

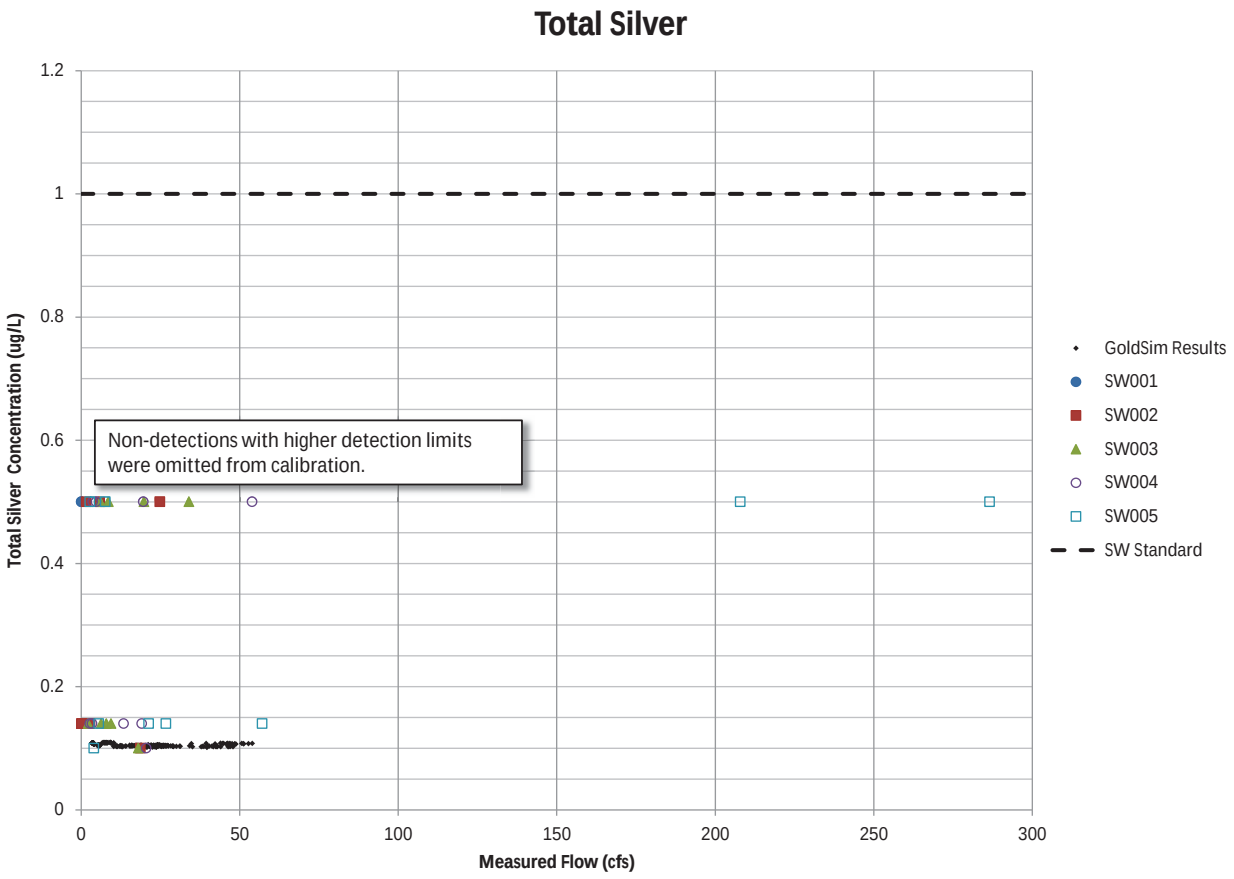


Figure 1 **Correlation of flow and concentration (modeled and observed) – Silver (Ag)**

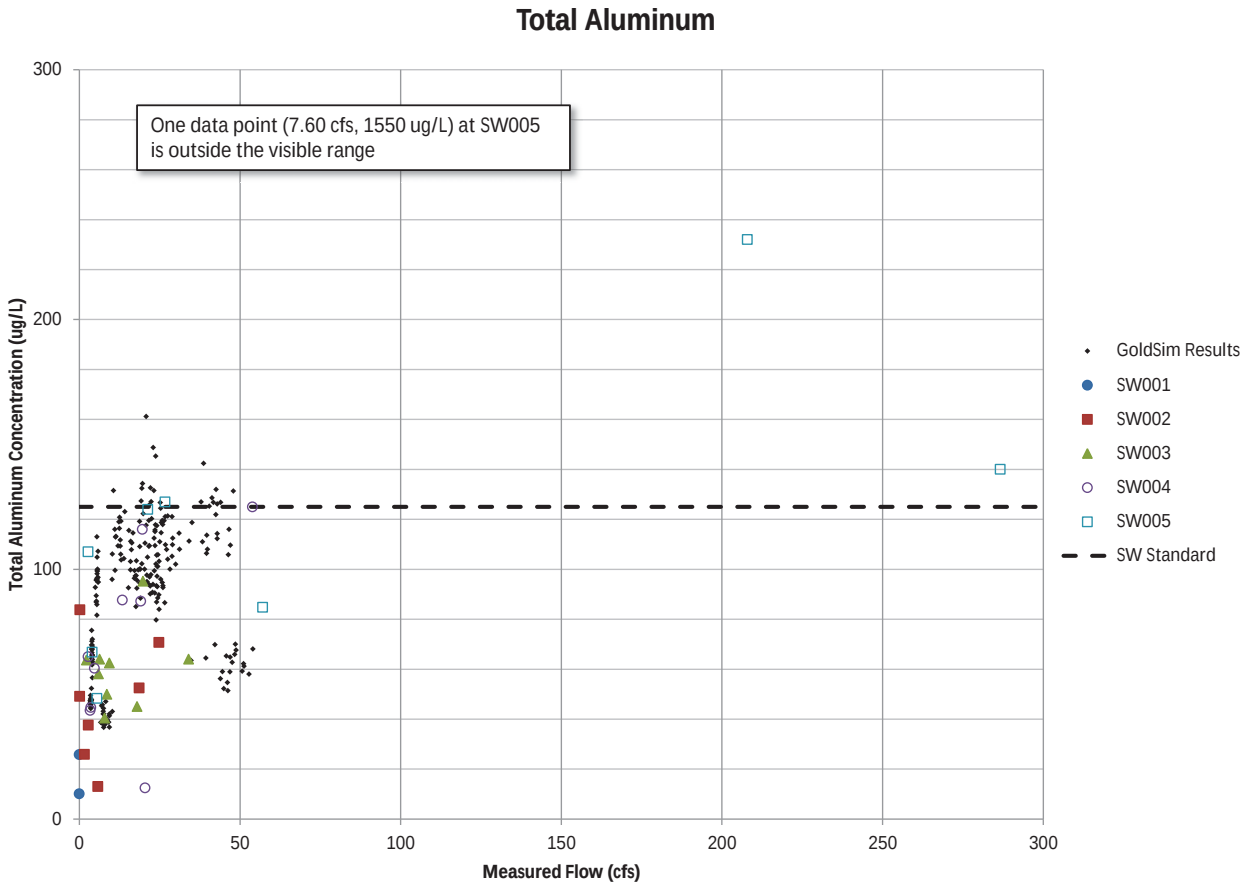


Figure 2 **Correlation of flow and concentration (modeled and observed) – Aluminum (Al)**

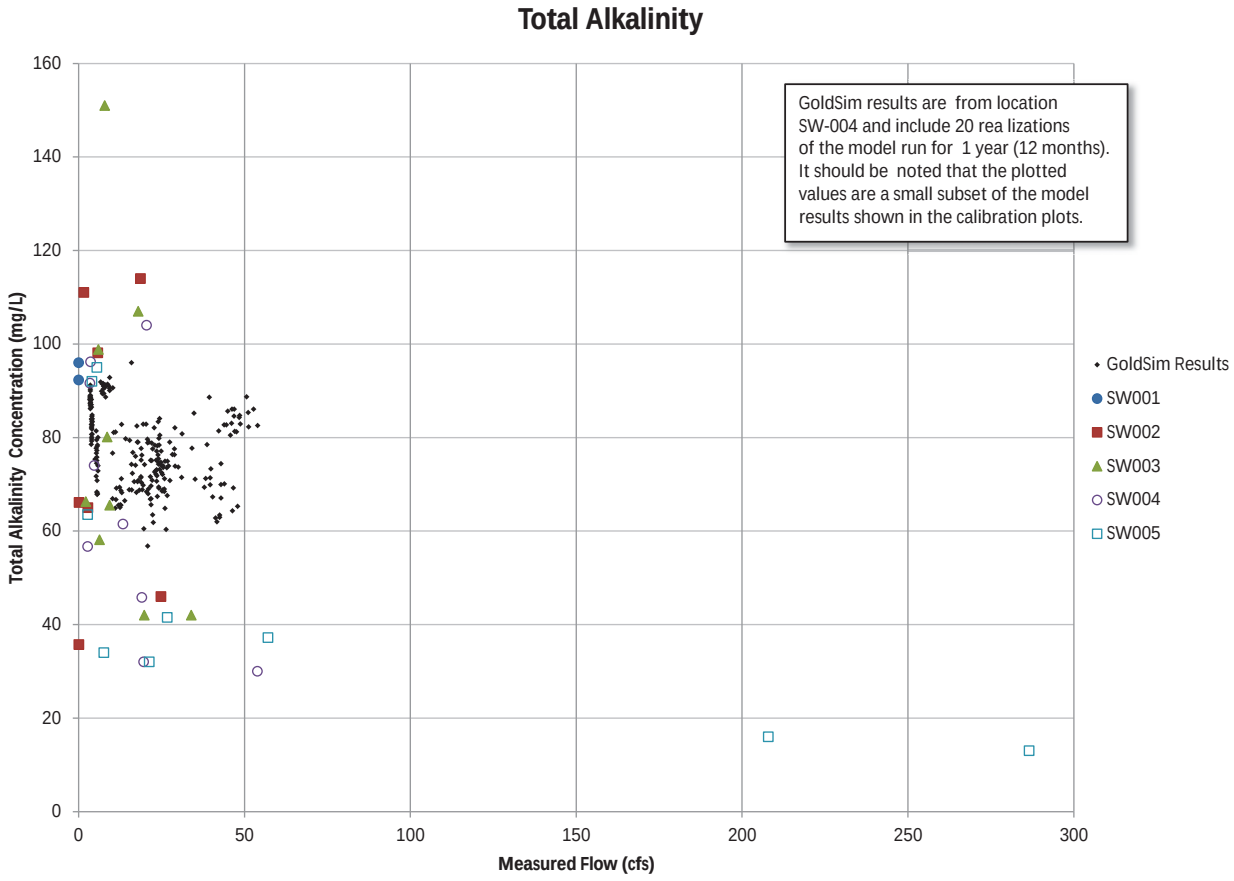


Figure 3 **Correlation of flow and concentration (modeled and observed) – Alkalinity**

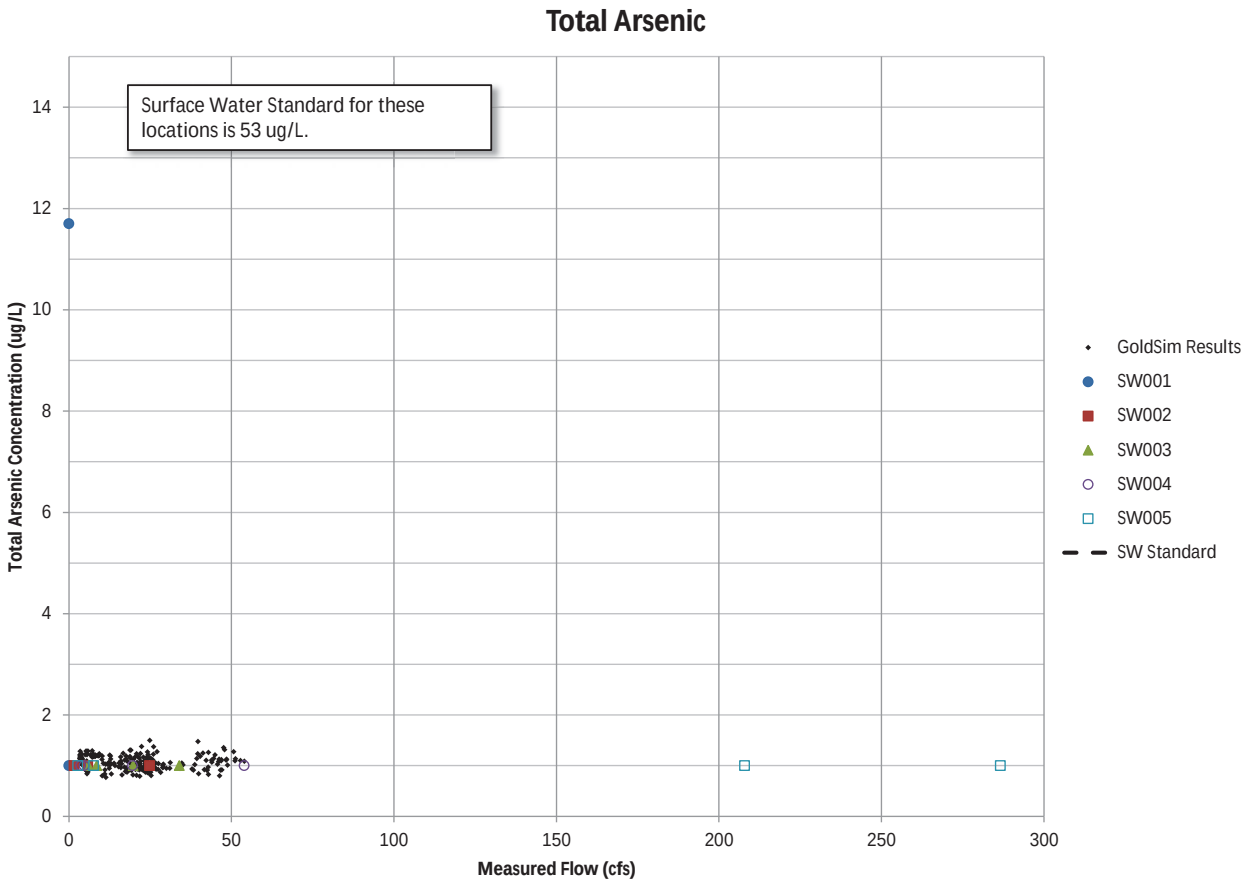


Figure 4 **Correlation of flow and concentration (modeled and observed) – Arsenic (As)**

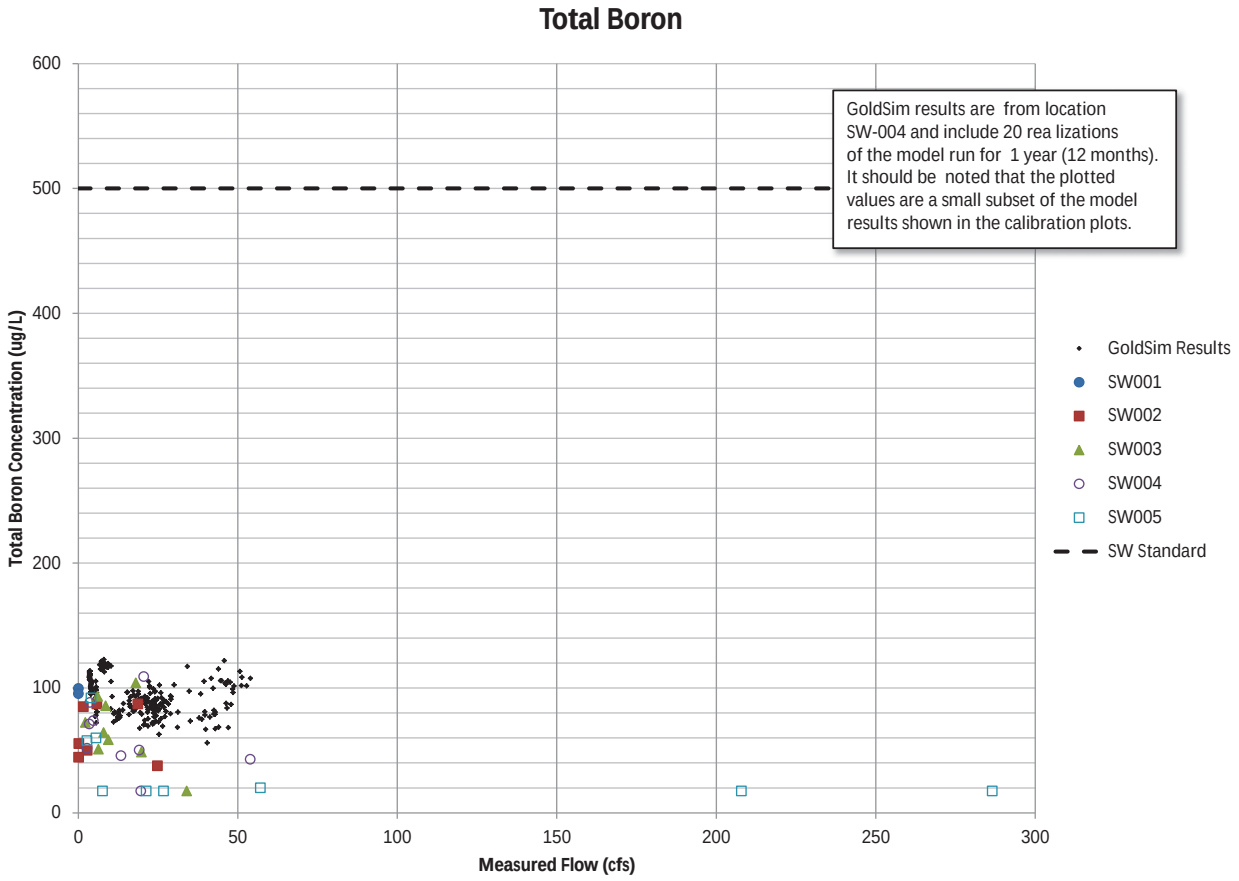


Figure 5 **Correlation of flow and concentration (modeled and observed) – Boron (B)**

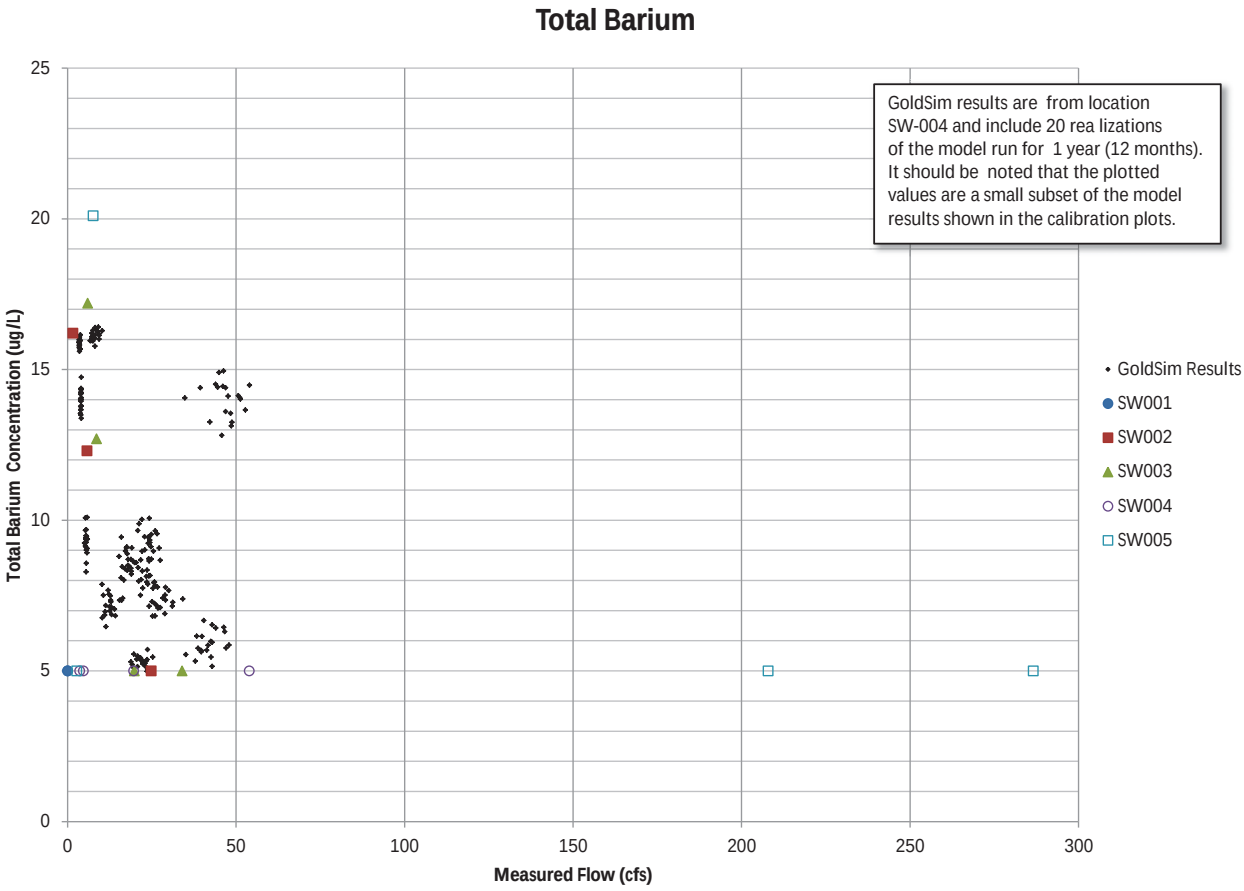


Figure 6 **Correlation of flow and concentration (modeled and observed) – Barium (Ba)**

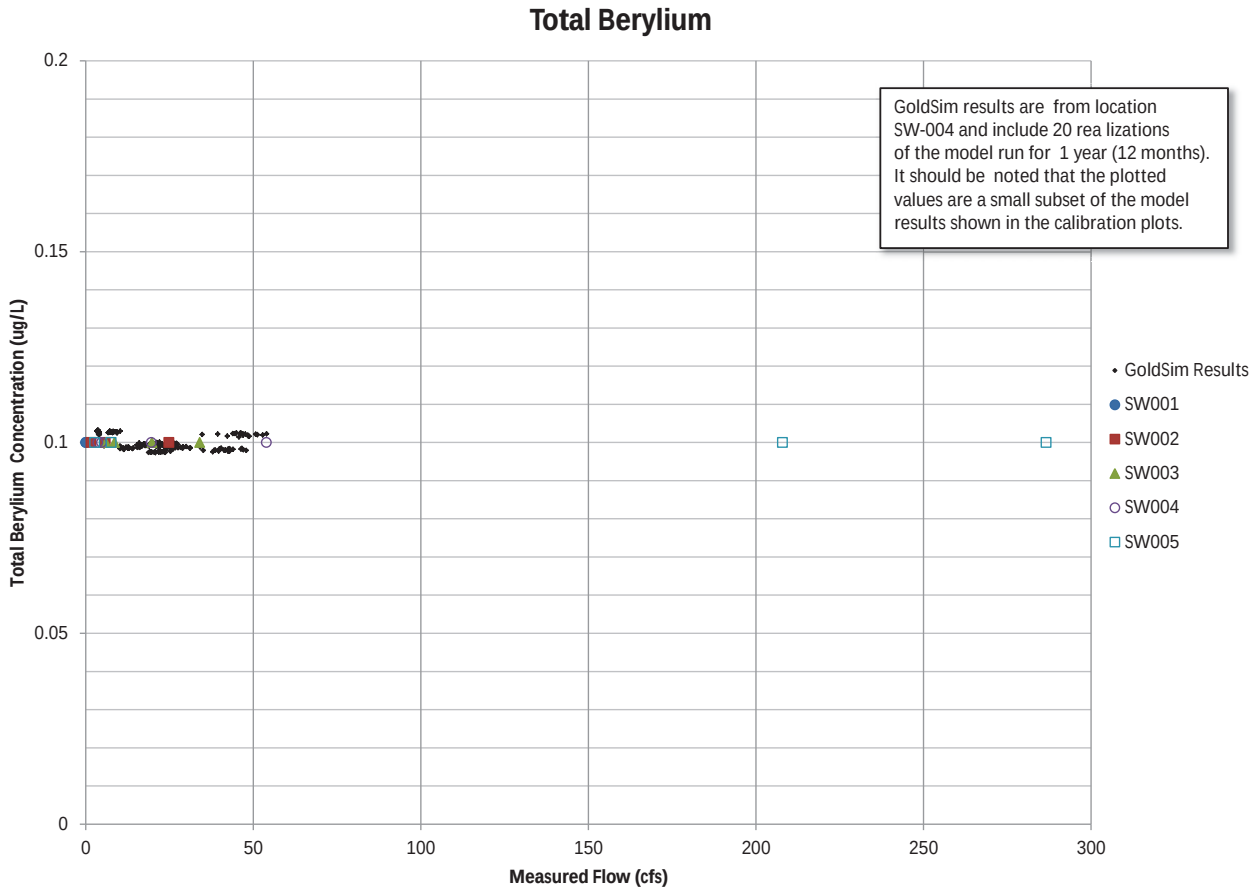


Figure 7 **Correlation of flow and concentration (modeled and observed) – Beryllium (Be)**

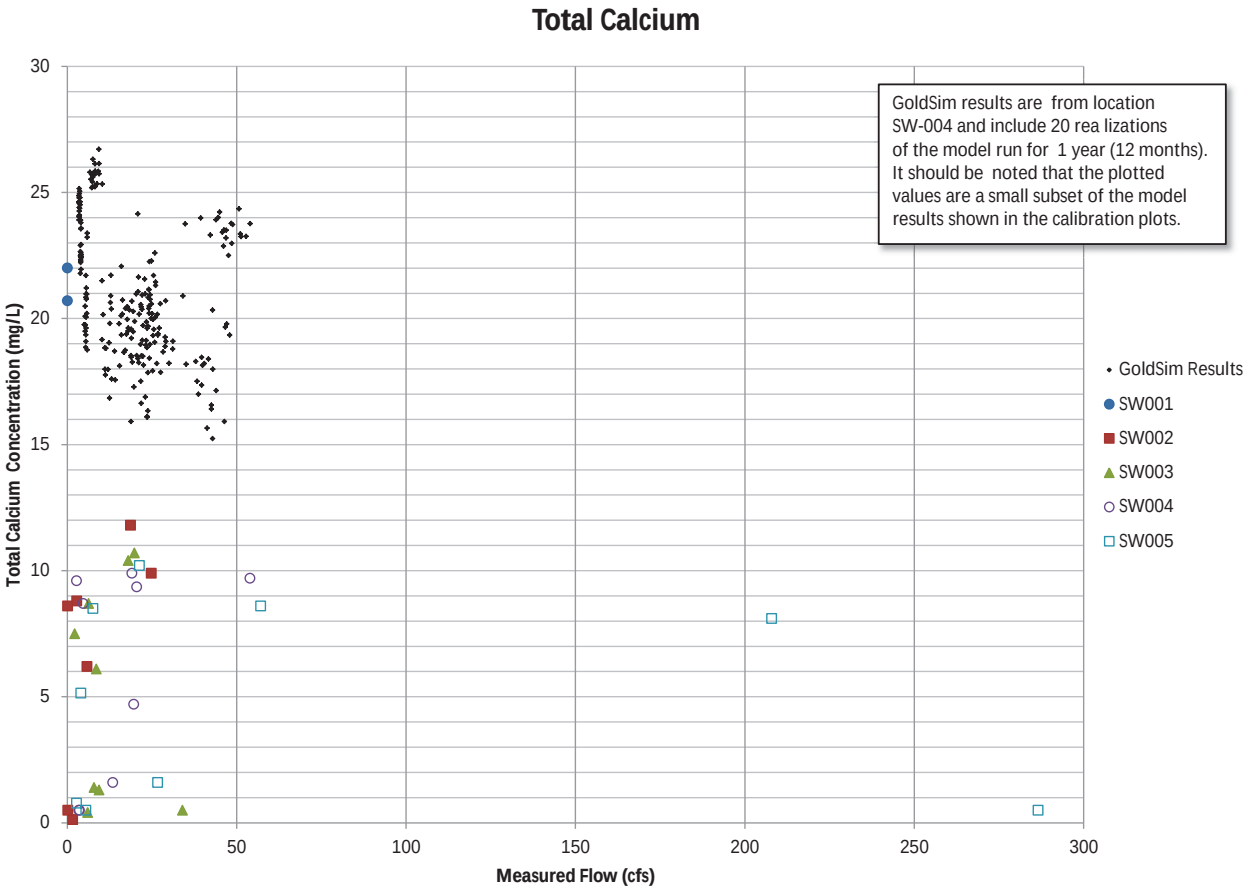


Figure 8 **Correlation of flow and concentration (modeled and observed) – Calcium (Ca)**

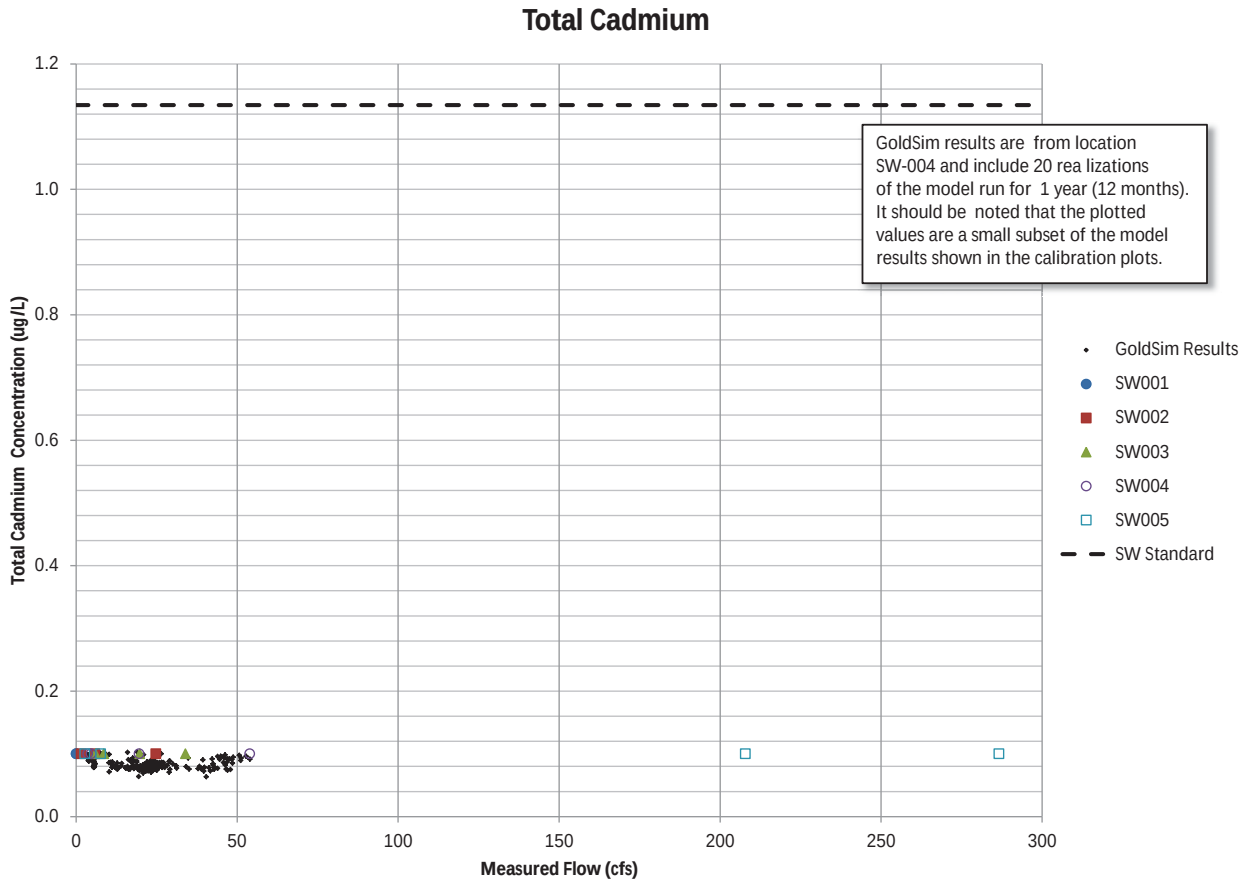


Figure 9 **Correlation of flow and concentration (modeled and observed) – Cadmium (Cd)**

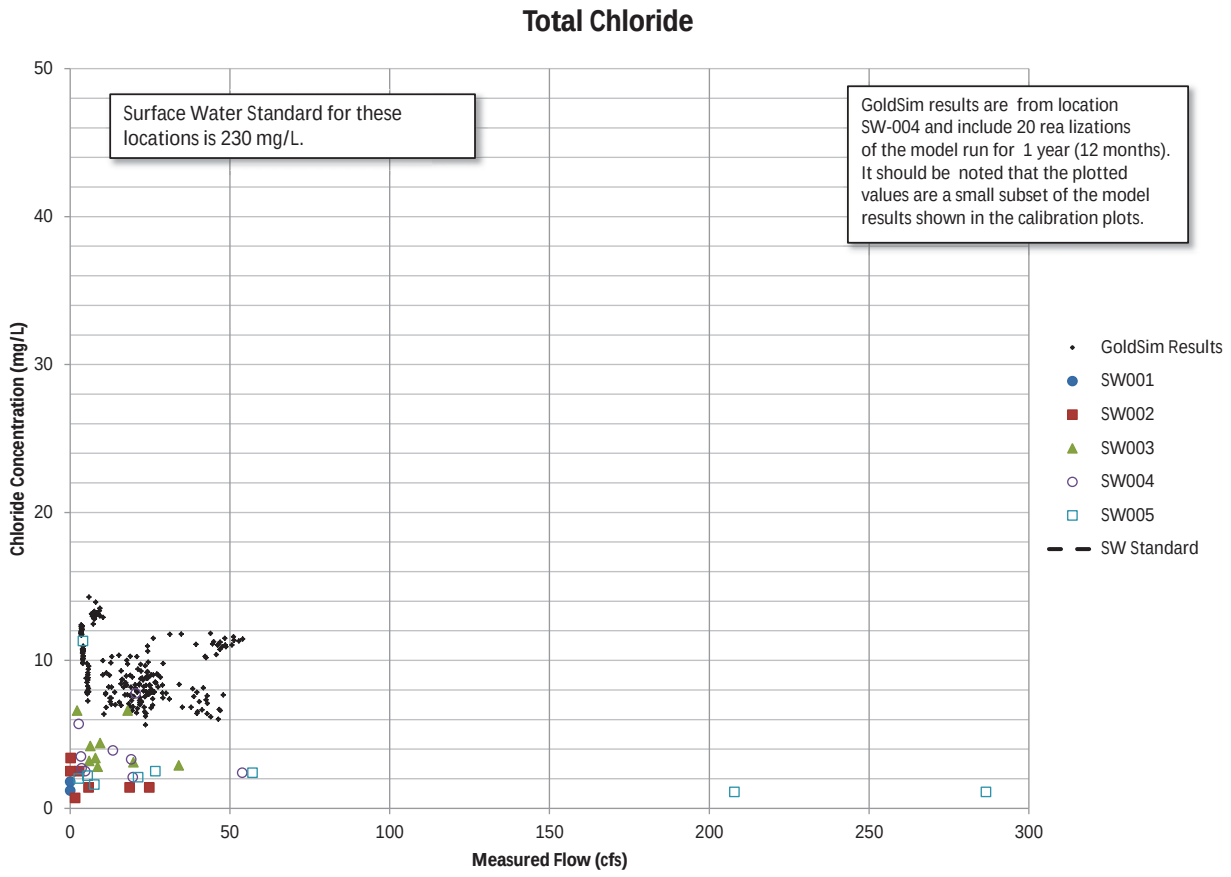


Figure 10 **Correlation of flow and concentration (modeled and observed) – Chloride (Cl)**

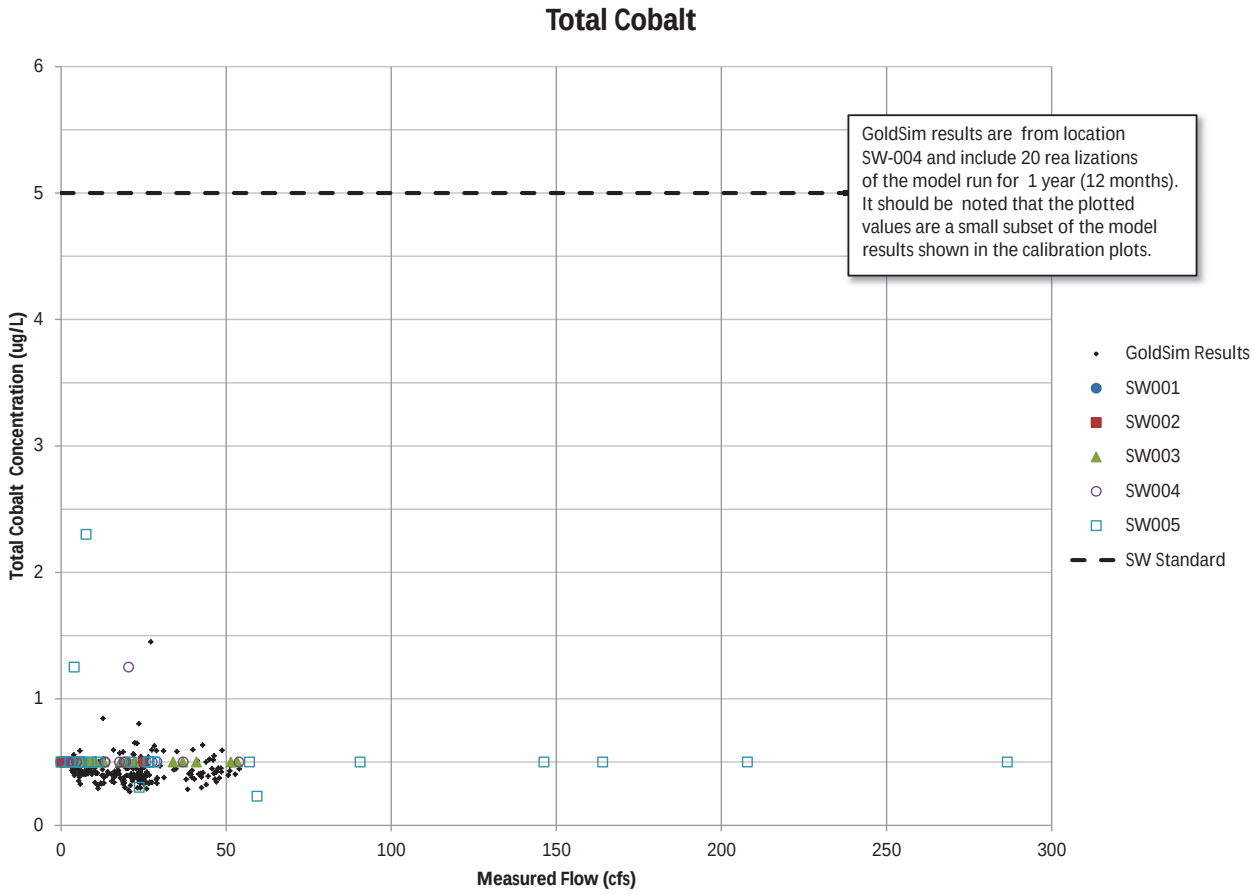


Figure 11 Correlation of flow and concentration (modeled and observed) – Cobalt (Co)

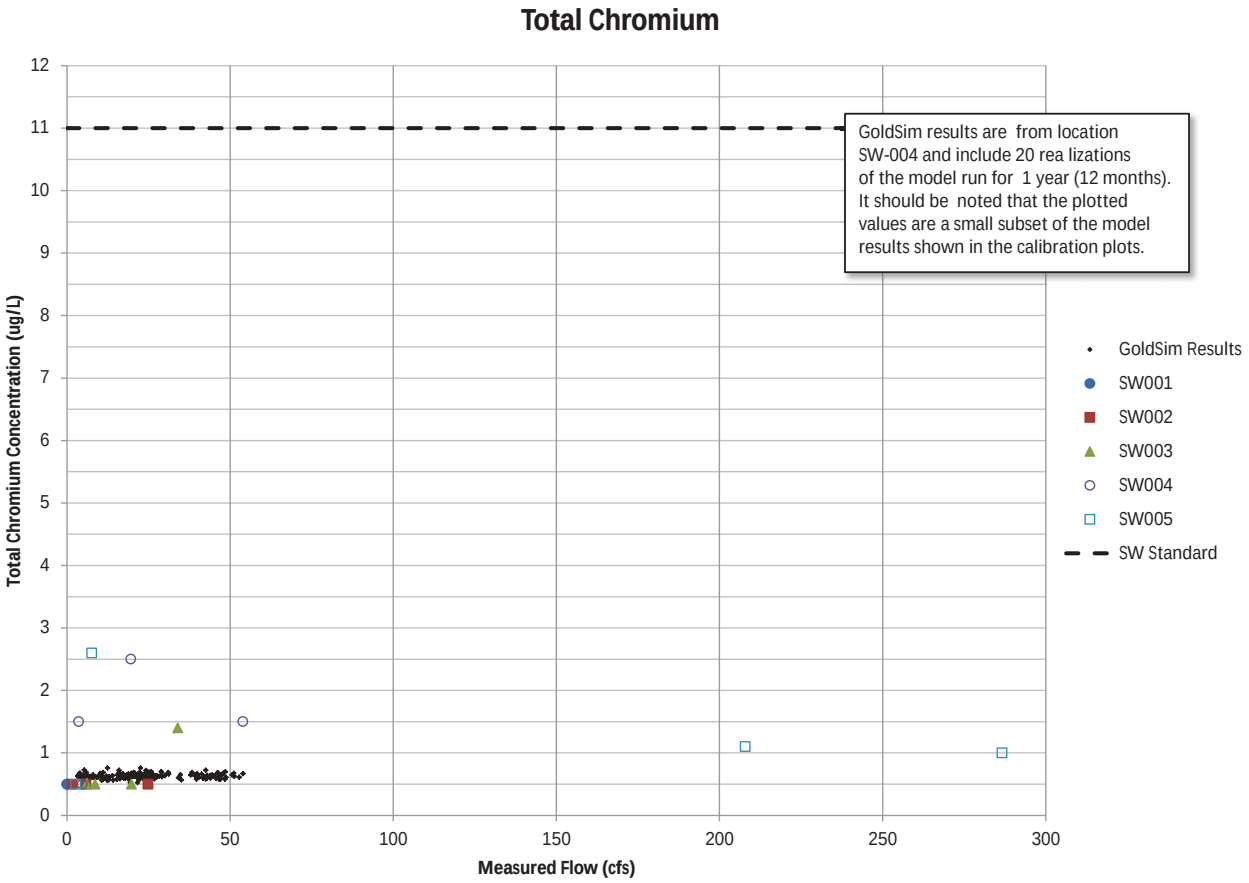


Figure 12 **Correlation of flow and concentration (modeled and observed) – Chromium (Cr)**

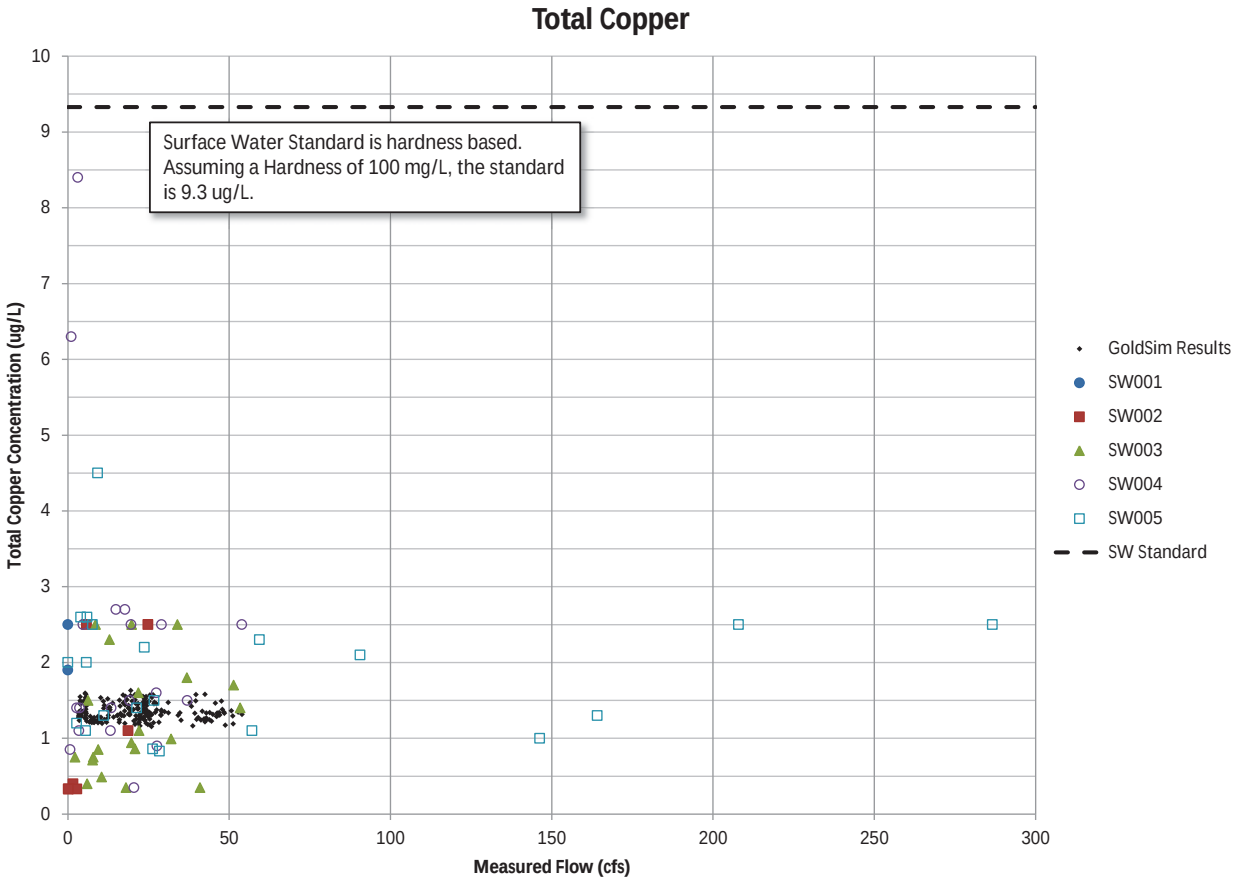


Figure 13 Correlation of flow and concentration (modeled and observed) – Copper (Cu)

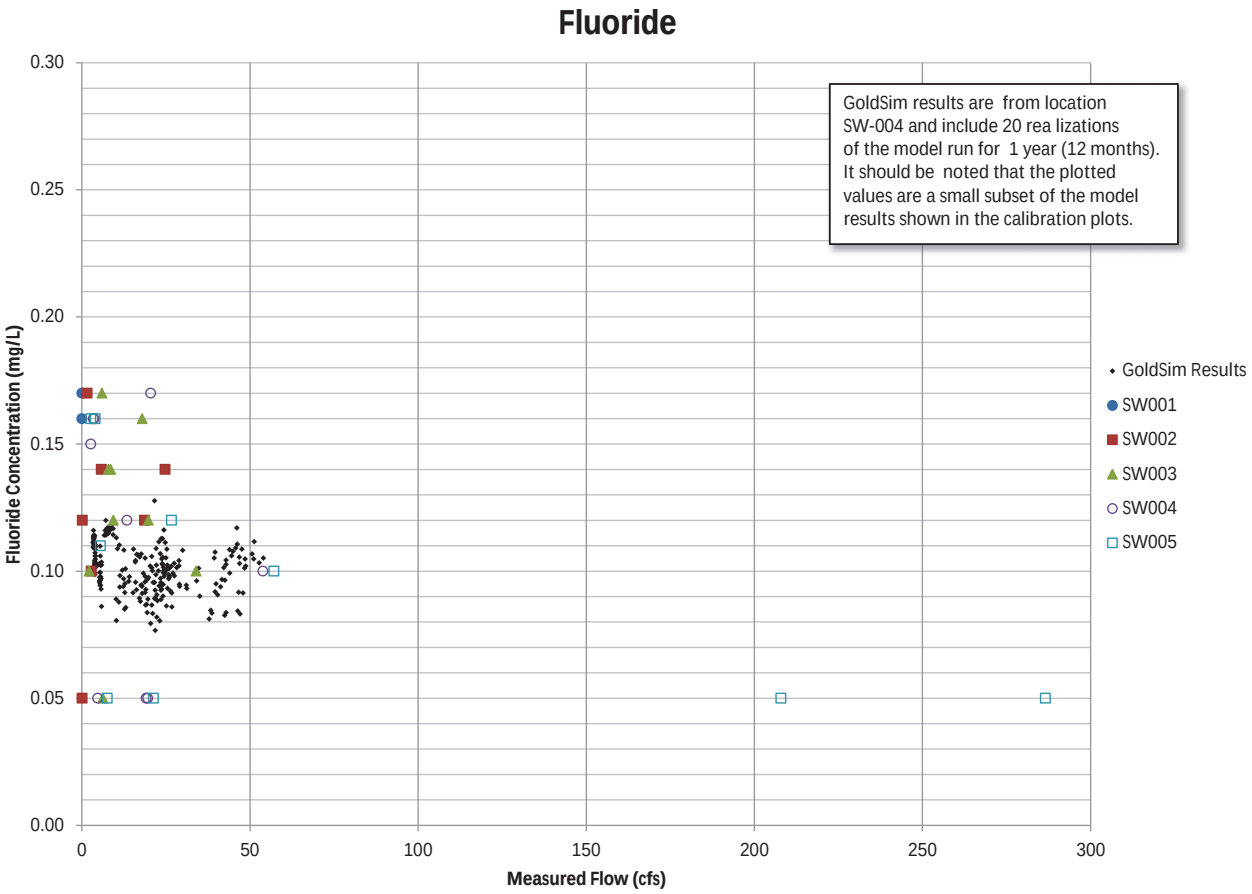


Figure 14 Correlation of flow and concentration (modeled and observed) – Fluoride (F)

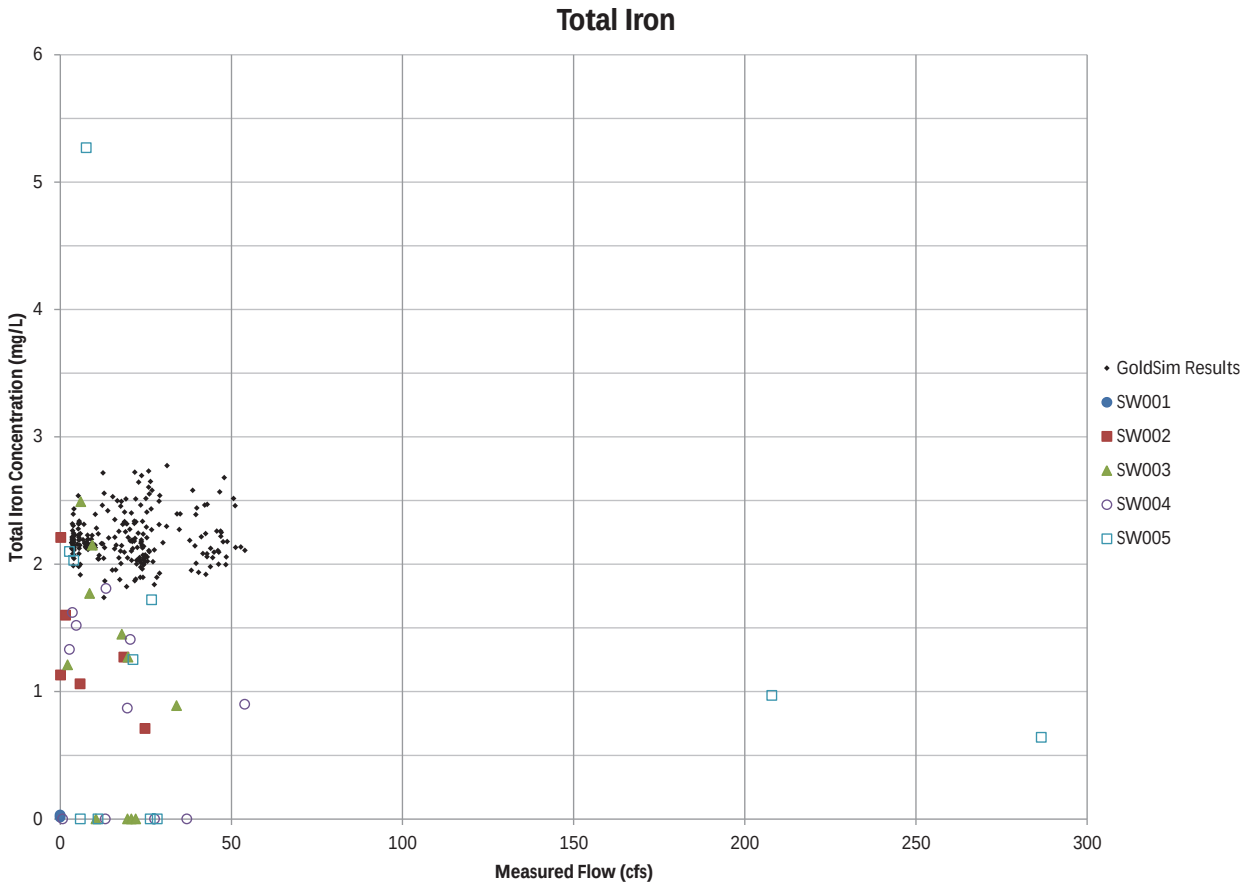


Figure 15 **Correlation of flow and concentration (modeled and observed) – Iron (Fe)**

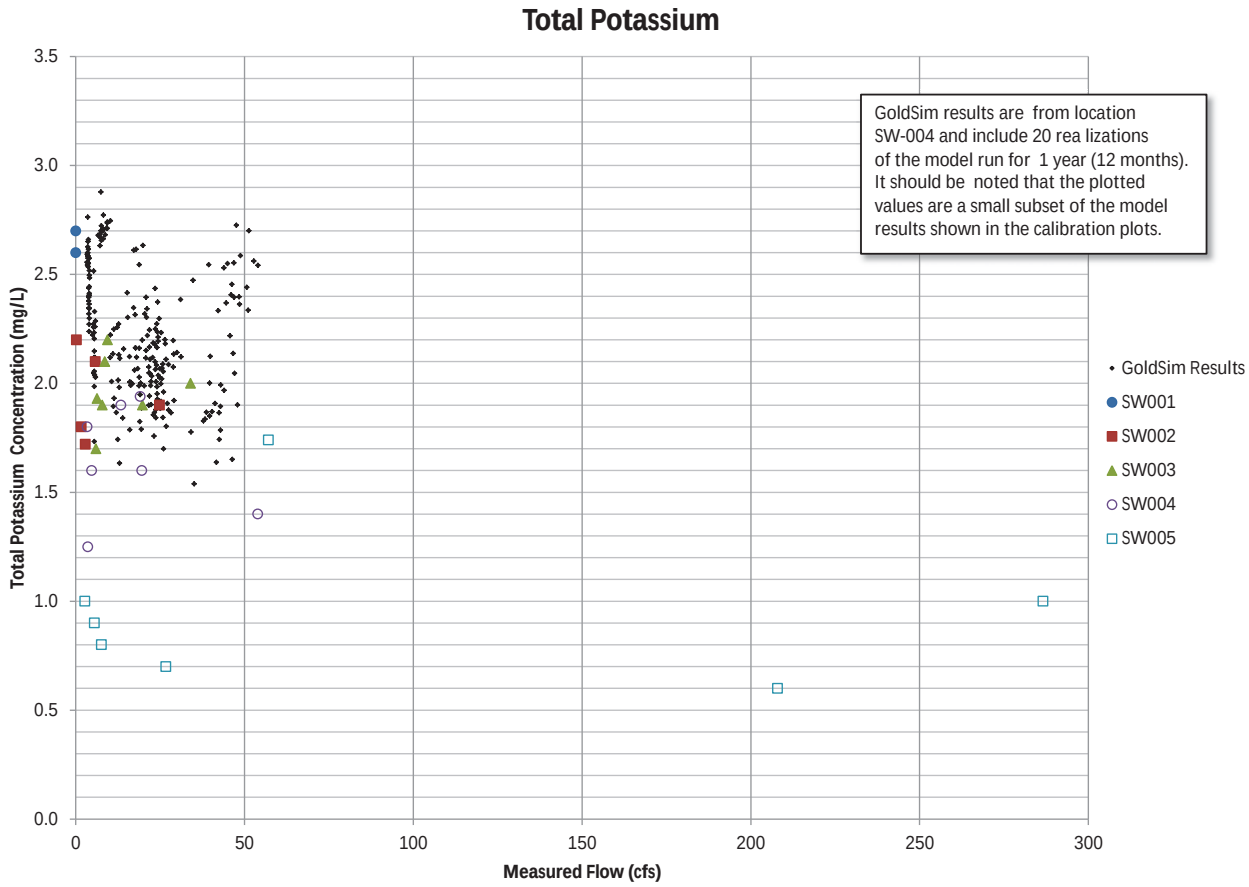


Figure 16 **Correlation of flow and concentration (modeled and observed) – Potassium (K)**

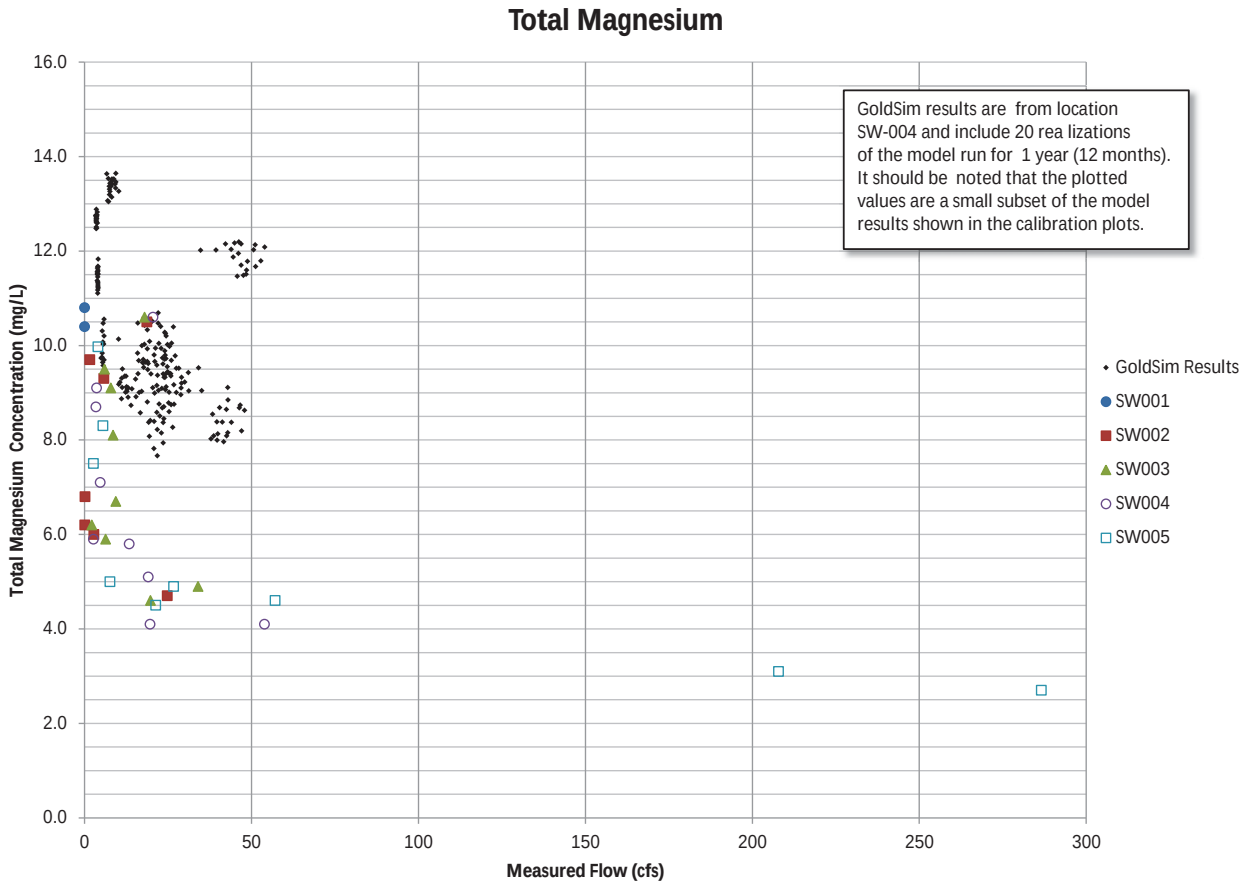


Figure 17 **Correlation of flow and concentration (modeled and observed) – Magnesium (Mg)**

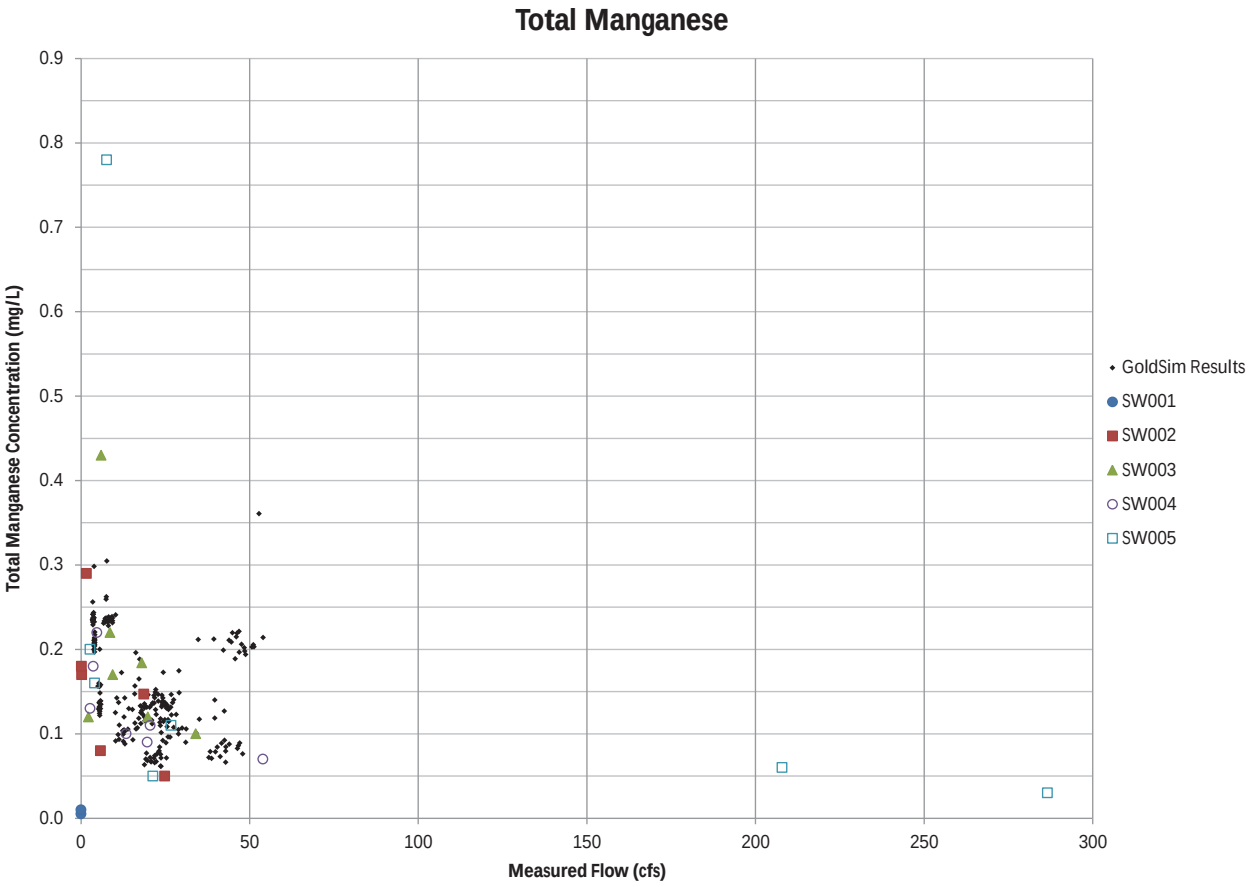


Figure 18 **Correlation of flow and concentration (modeled and observed) – Manganese (Mn)**

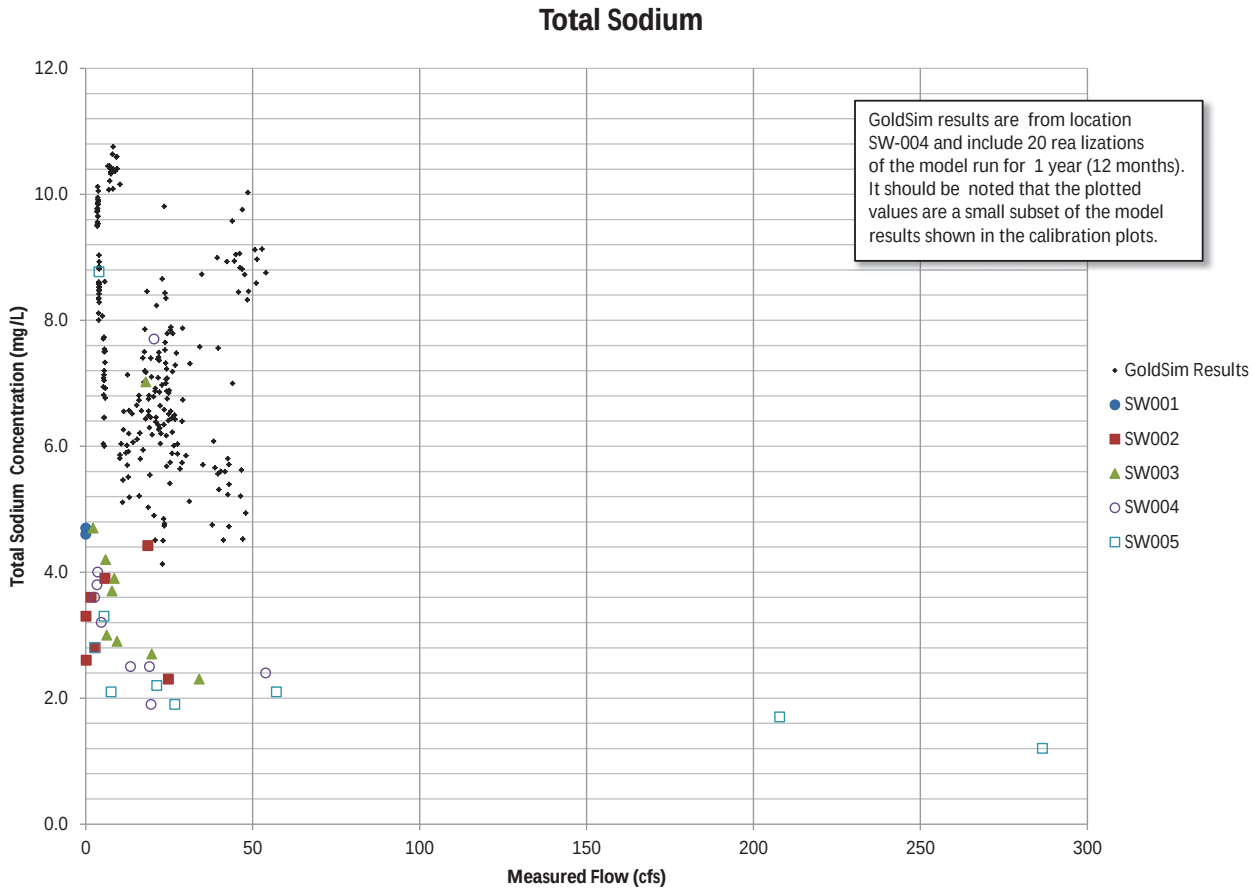


Figure 19 Correlation of flow and concentration (modeled and observed) – Sodium (Na)

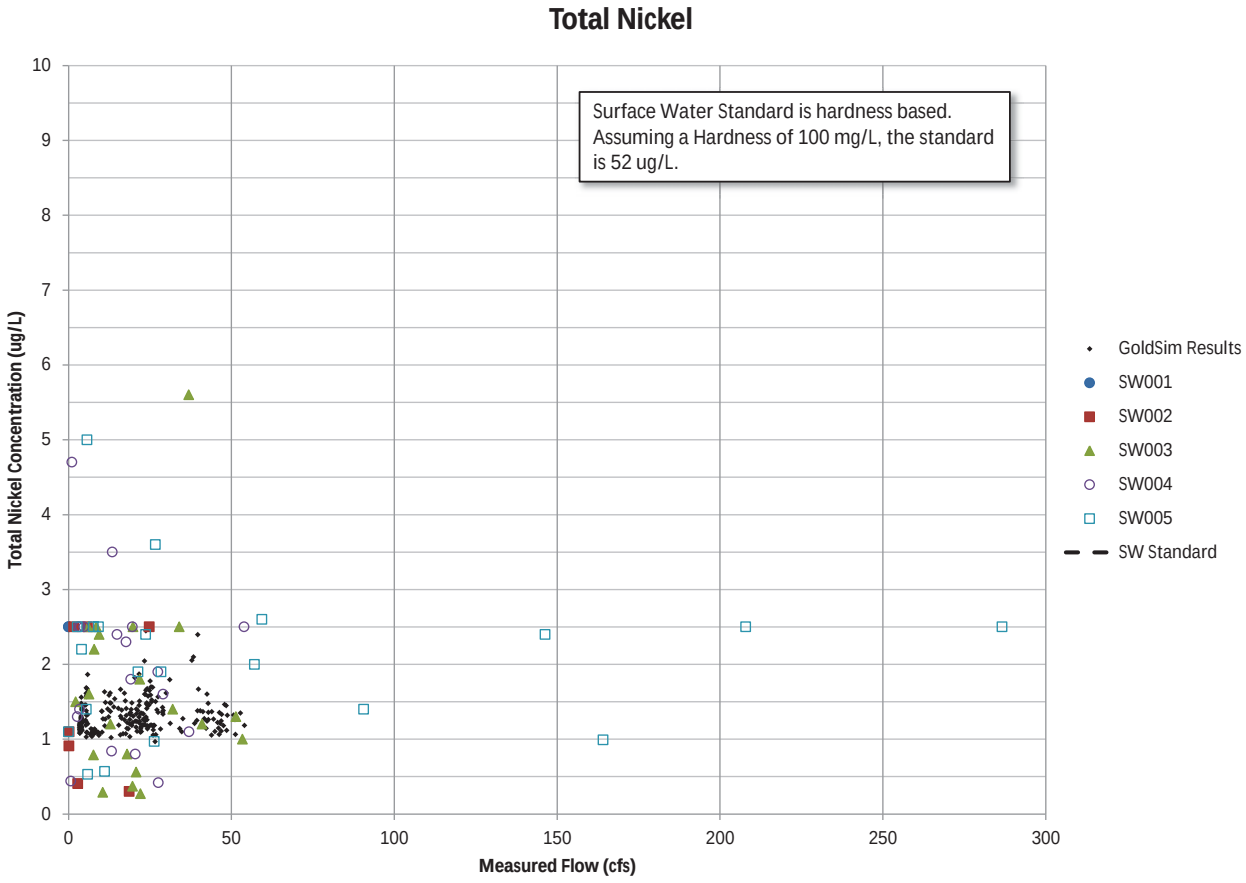


Figure 20 **Correlation of flow and concentration (modeled and observed) – Nickel (Ni)**

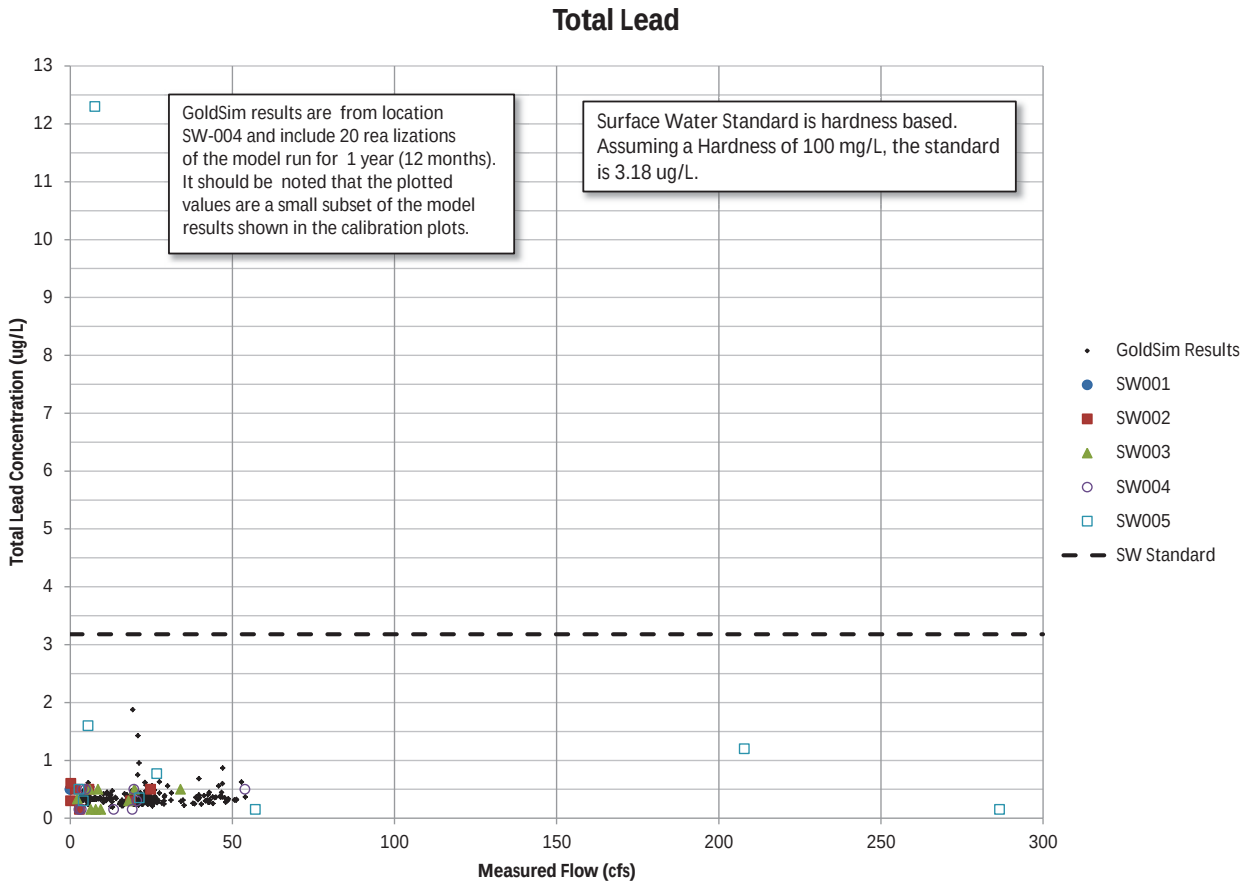


Figure 21 Correlation of flow and concentration (modeled and observed) – Lead (Pb)

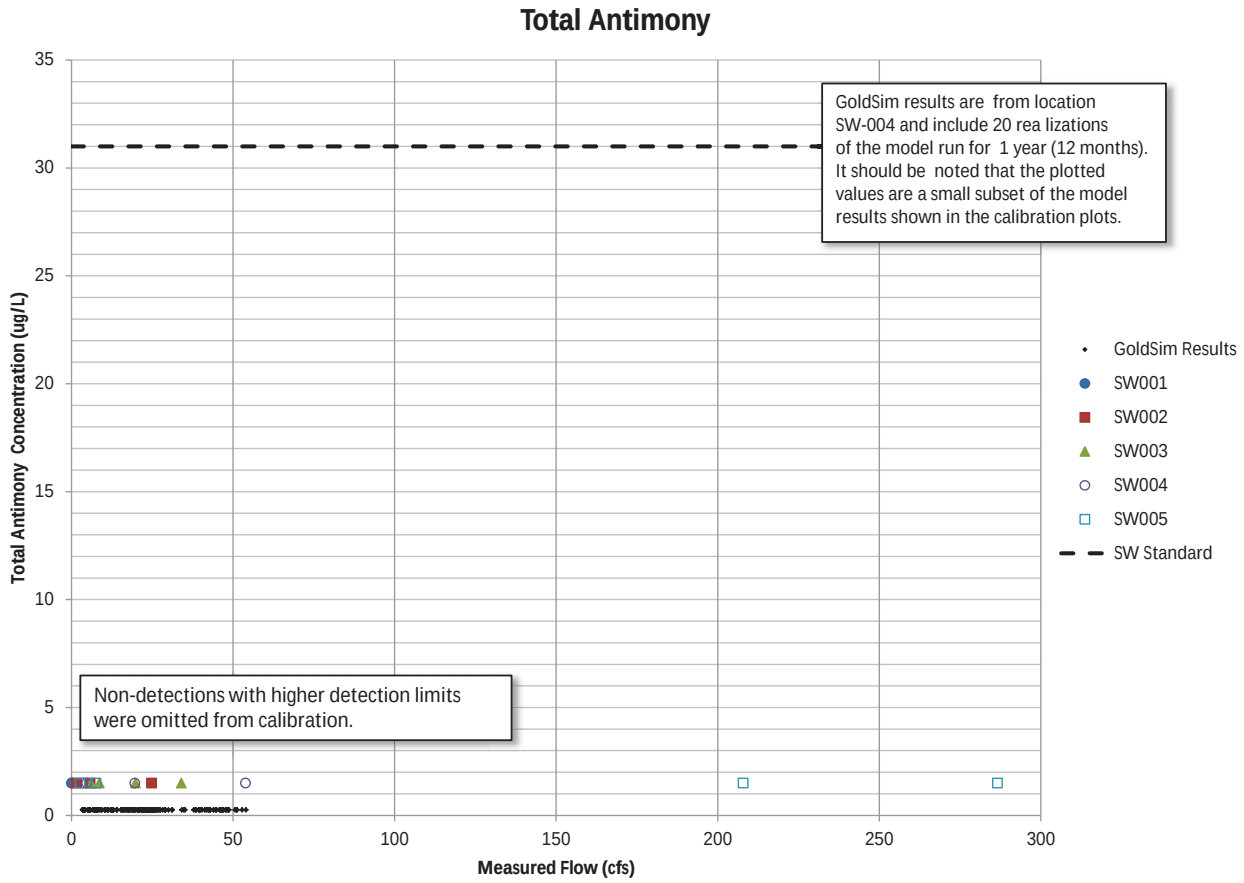


Figure 22 **Correlation of flow and concentration (modeled and observed) – Antimony (Sb)**

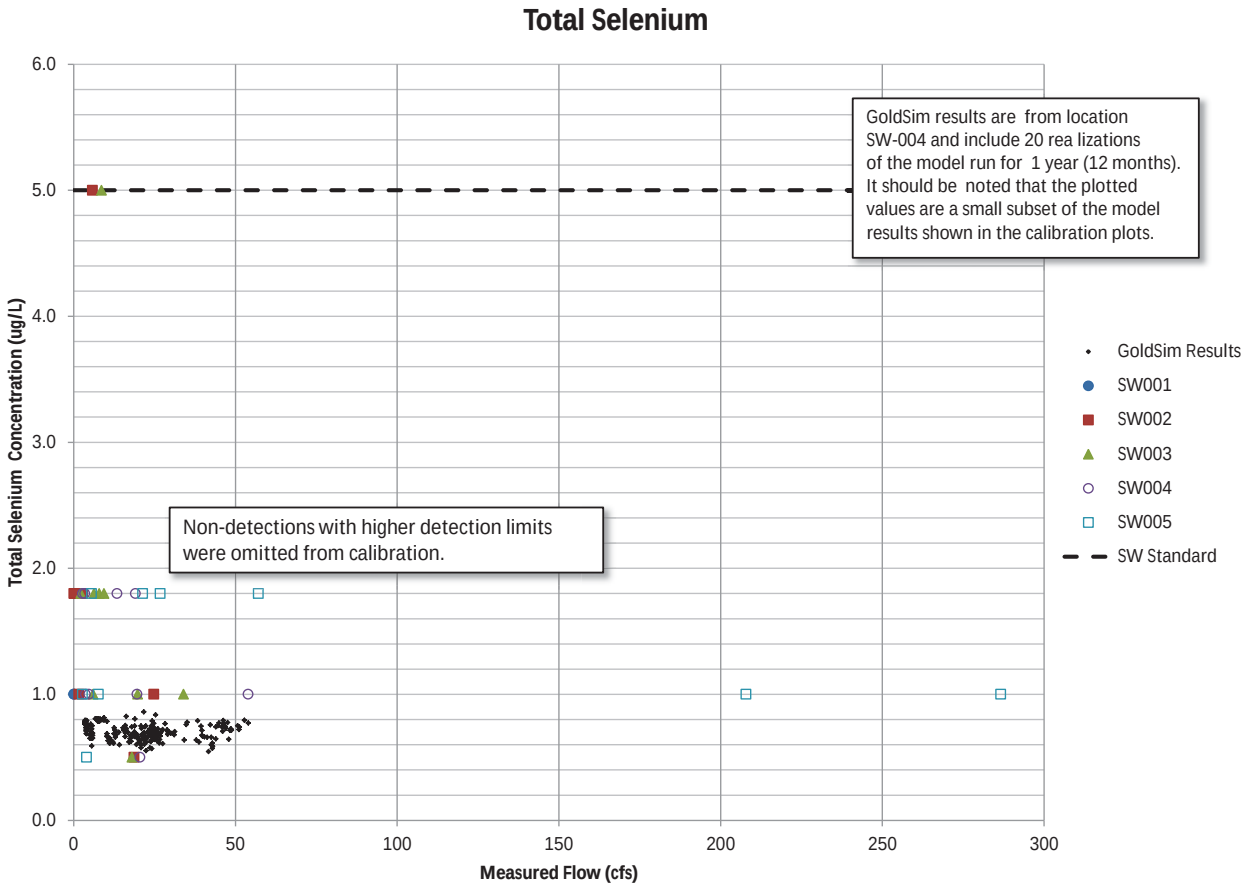


Figure 23 **Correlation of flow and concentration (modeled and observed) – Selenium (Se)**

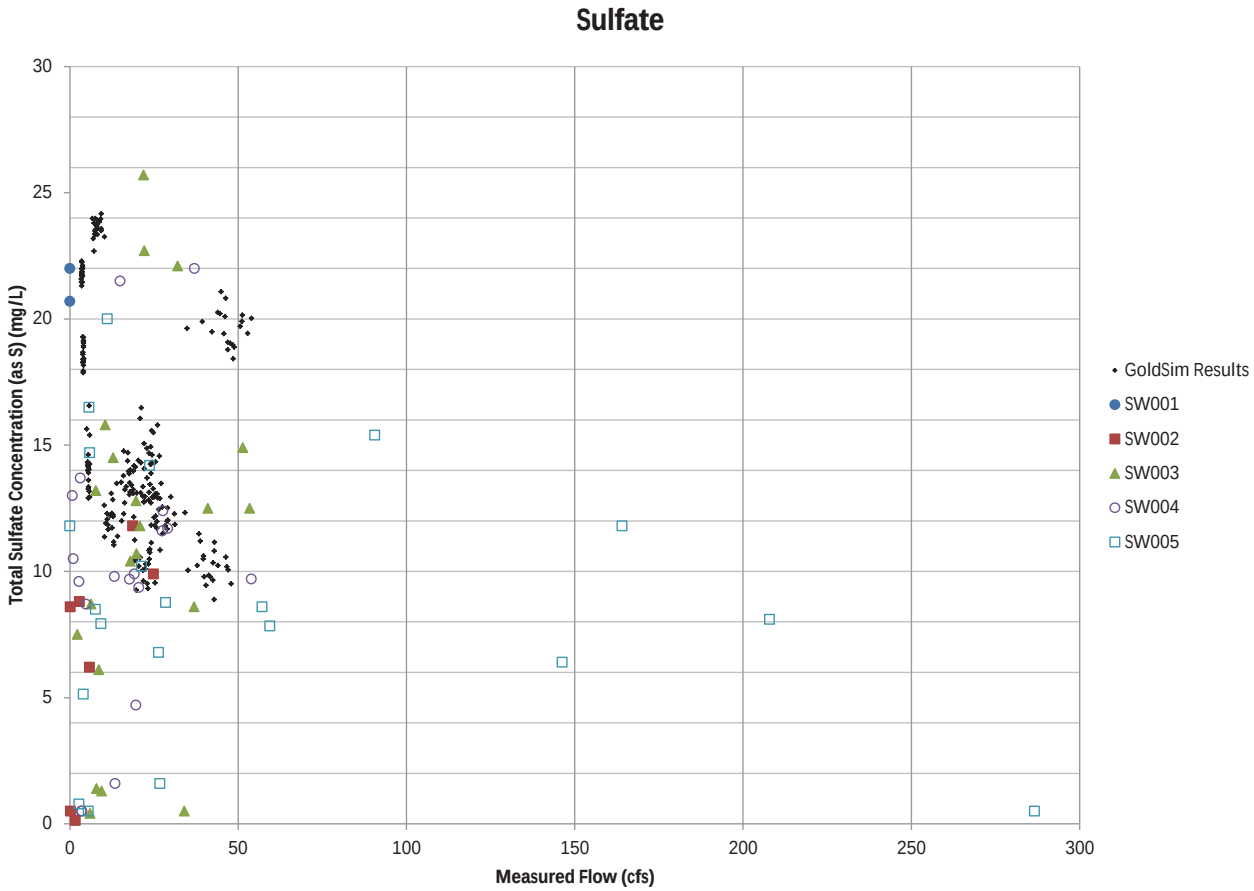


Figure 24 **Correlation of flow and concentration (modeled and observed) – Sulfate (SO4)**

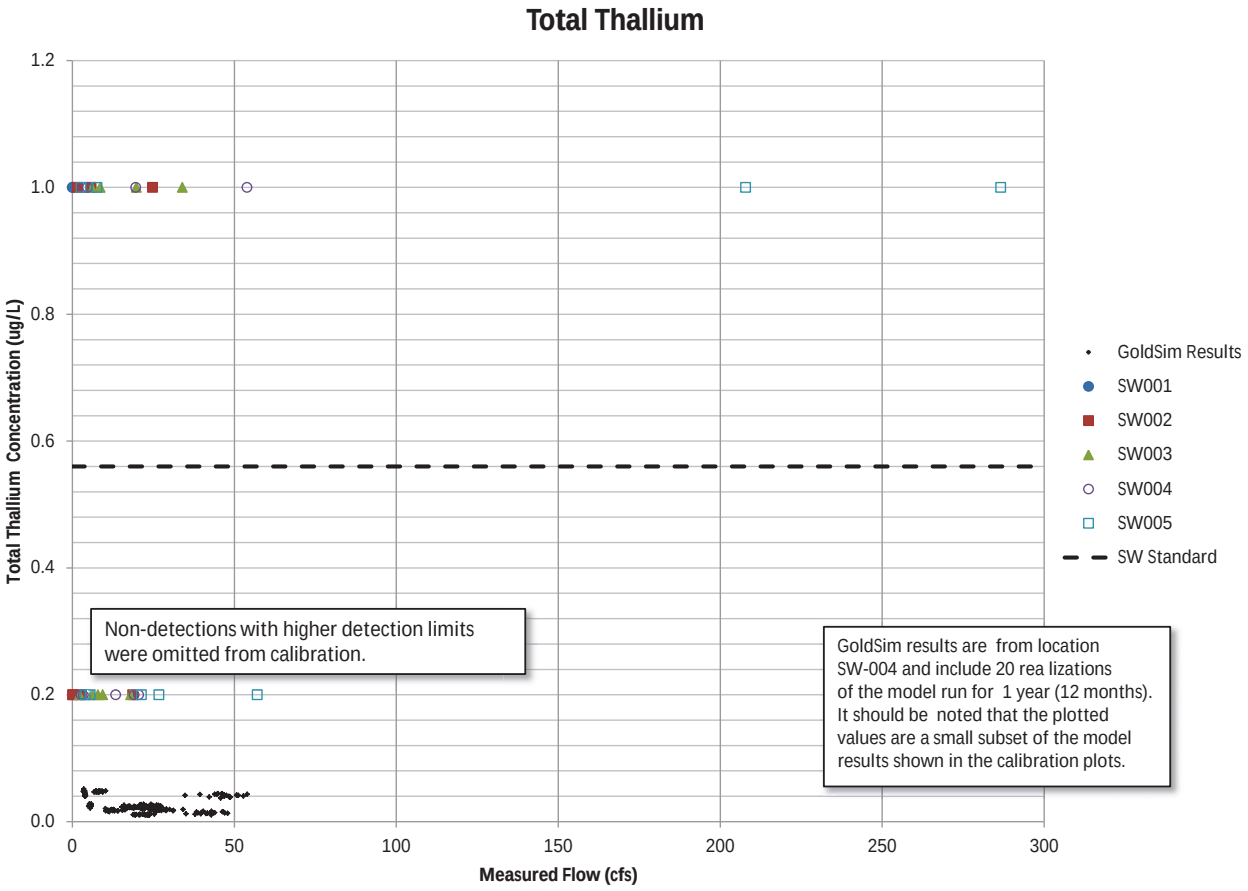


Figure 25 Correlation of flow and concentration (modeled and observed) – Thallium (Tl)

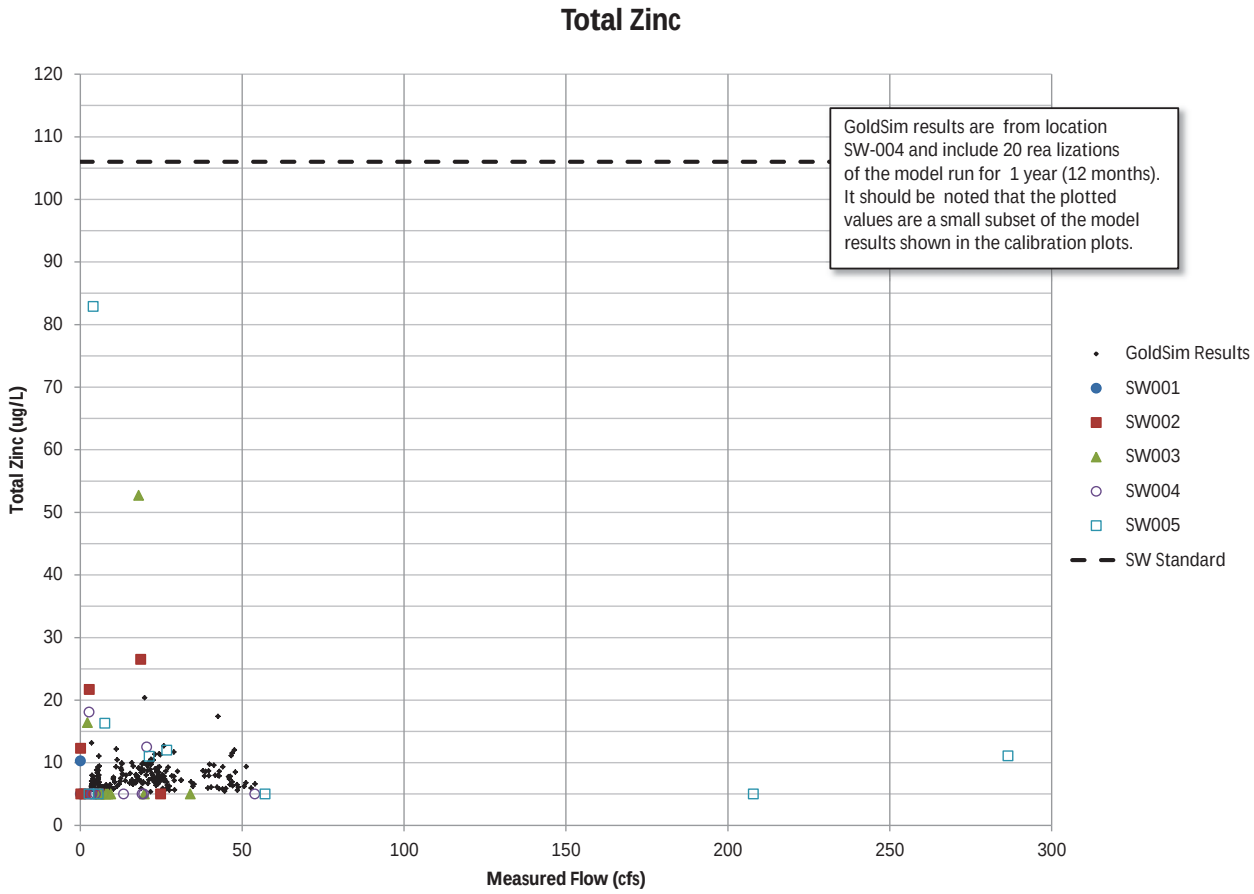


Figure 26 **Correlation of flow and concentration (modeled and observed) – Zinc Znl)**

Attachment G

Concentration Statistics for the Mine Site Features

Attachment G Concentration Statistics for the Mine Site Features

Estimated Mine Site feature water quality is shown in this attachment using a series of concentration statistic plots. Data for these plots were created as follows:

- The probabilistic GoldSim model was run at monthly time steps for 200 years (2401 time steps including the initial time zero). At each time step, the concentration for each Mine Site feature for each constituent was individually recorded.

- After one realization (i.e., one model run) was completed, the process was repeated until 500 model realizations were completed. The result is 500 estimated concentrations for each Mine Site feature of each constituent at every time step.

- At every time step, and for every constituent, the 500 estimated concentrations were sorted smallest-to-largest and 3 single values were chosen to represent the statistics at that particular time step.

- From the 500 estimate concentrations, sorted smallest-to-largest, the 50th value was chosen to represent the 10th percentile (P10), the 250th value was chosen to represent the median (P50), and the 450th value was chosen to represent the 90th percentile (P90). This indicates that at any time, 10% of the model results are less than or equal to the P10 value, 50% are less than or equal to the P50 value, and 90% are less than or equal to the P90 value.

- This process was repeated for all time steps, resulting in 3 time series lines representing the 10th, 50th, and 90th percentiles of concentrations for each Mine Site feature at every time step (monthly results).

- For plotting the results over the entire 200 years of the simulation, the data was summarized by year to make the plots legible. The monthly model outputs for the 10th, 50th, and 90th percentiles are plotted on an annual basis by taking the maximum value of each percentile for a given year (i.e., the highest 90th percentile value).

The figure numbering convention is "**Figure W-XX-YY.Z**" where:

- **W** indicates the Attachment.
- **XX** is a counter indicating the location, numbered according to the table below.
- **YY** is a counter indicating the constituent; in this attachment it will count from "01" to "27" to show the 27 independently modeled constituents.
- **Z** is a numerical value, 1 or 2. A value of 1 indicates that the annual maximum has been plotted and a value of 2 indicates that the annual average has been plotted. In this attachment, only the annual average (2) has been plotted.

Location	Number
Category 2/3 Waste Rock Stockpile Drainage	01
Category 4 Waste Rock Stockpile Drainage	02
Ore Surge Pile Drainage	03
Overburden Storage and Laydown Area Runoff	04
Rail Transfer Hopper Runoff	05
Haul Road Runoff	06
Category 1 Waste Rock Stockpile Drainage	07
East Pit Sump Dewatering	08
East Pit Lower Porewater	09
East Pit Upper/Wetland Porewater	10
West Pit	11
West Equalization Basin	12
East Equalization Basin	13
WWTP Reject Concentrate	14
Reclamation WWTF Influent	15
Long-term WWTF Influent	16

For several constituents at three Mine Site features (East Pit Upper/Wetland Porewater, West Pit and the East EQ Basin), a temporary decrease in the feature's water volume causes sharp increases in the model-reported concentration. This is a result of the available constituent mass being divided by a water volume of nearly zero, leading to high concentrations for constituents without defined concentration caps. These conditions only persist for brief periods (3-4 time steps) and during these periods untreated flow does not leave these features. The y-axes of the applicable plots have been adjusted to not show the extremely high concentrations and are so noted.

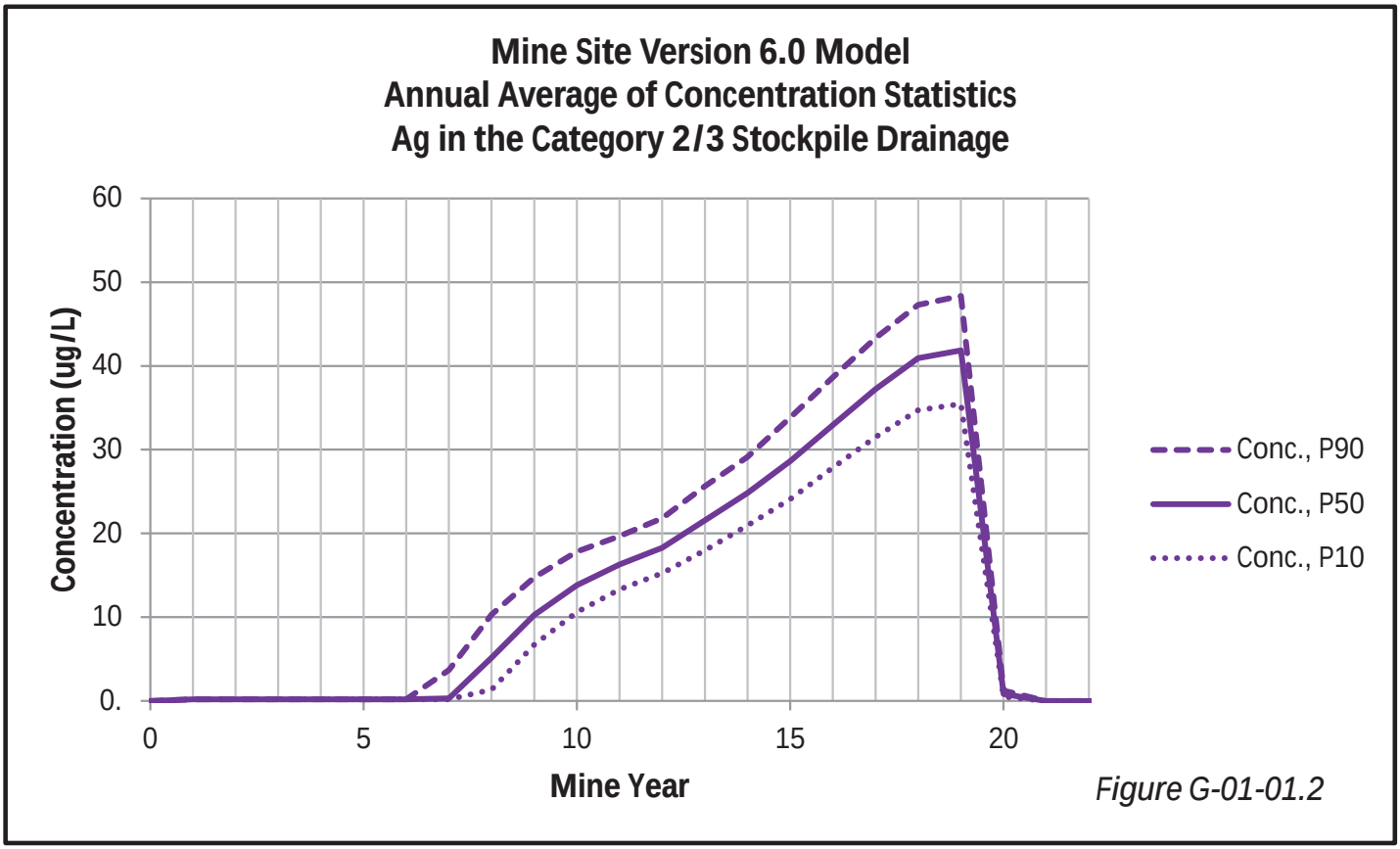


Figure G-01-01.2

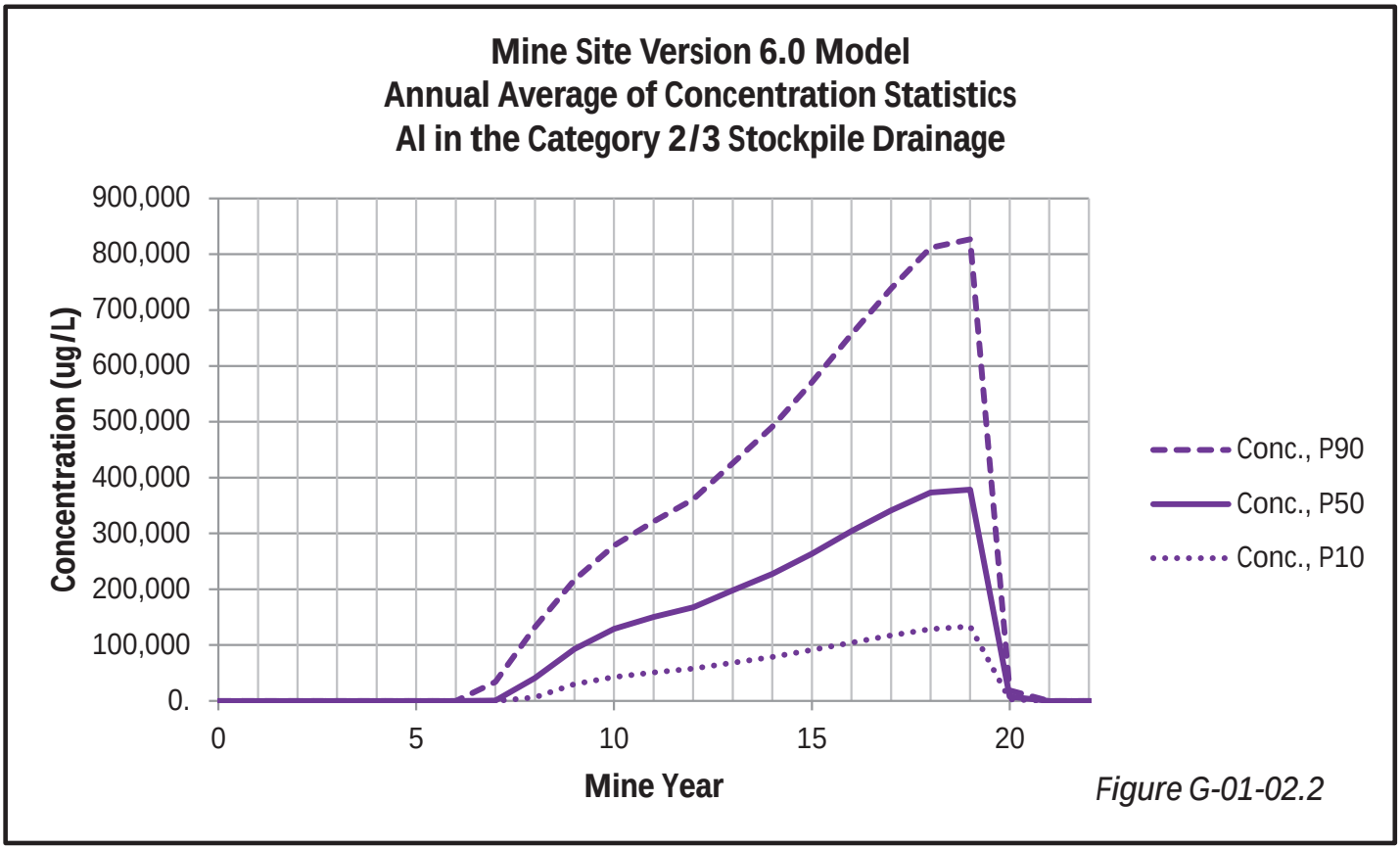


Figure G-01-02.2

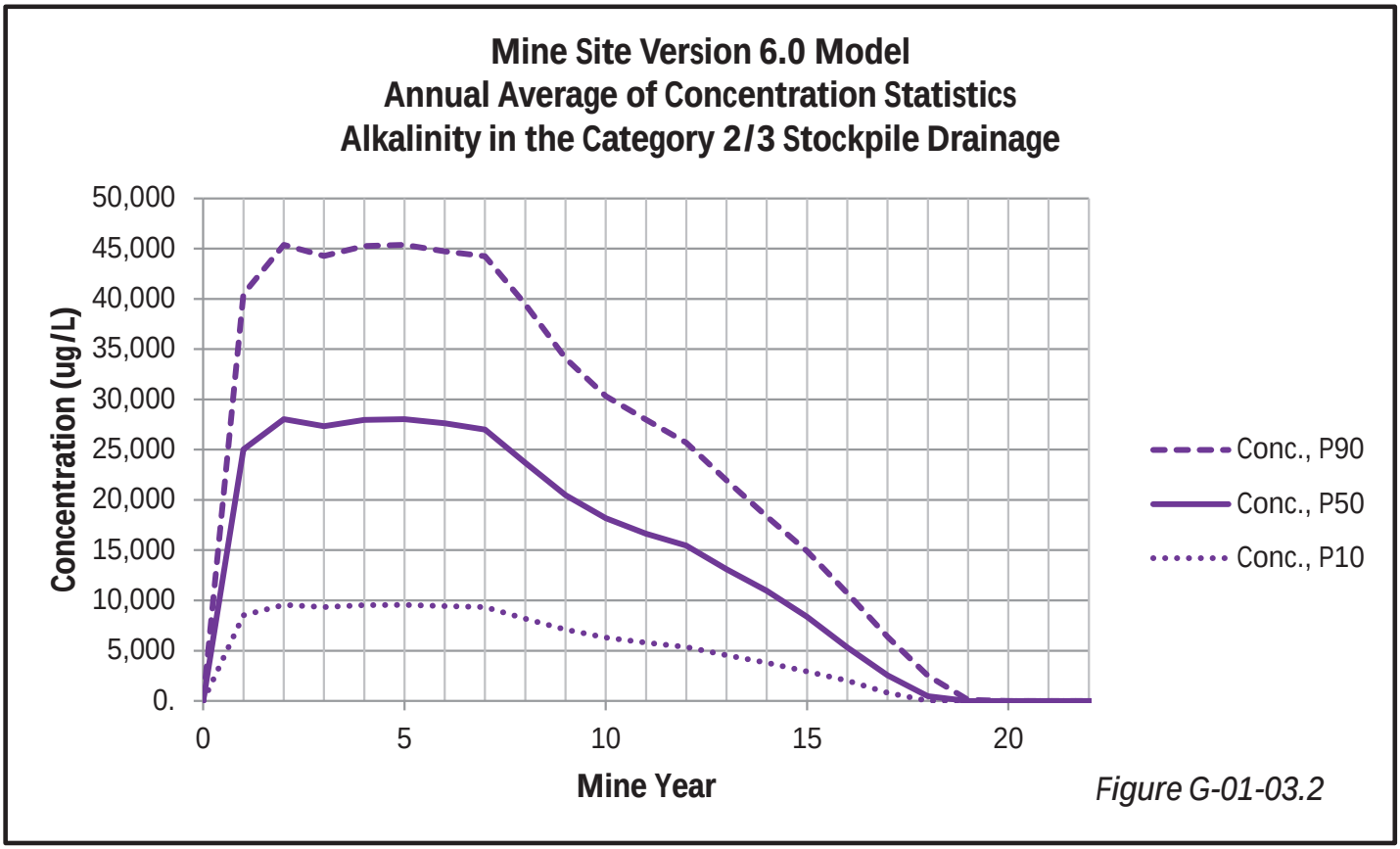


Figure G-01-03.2

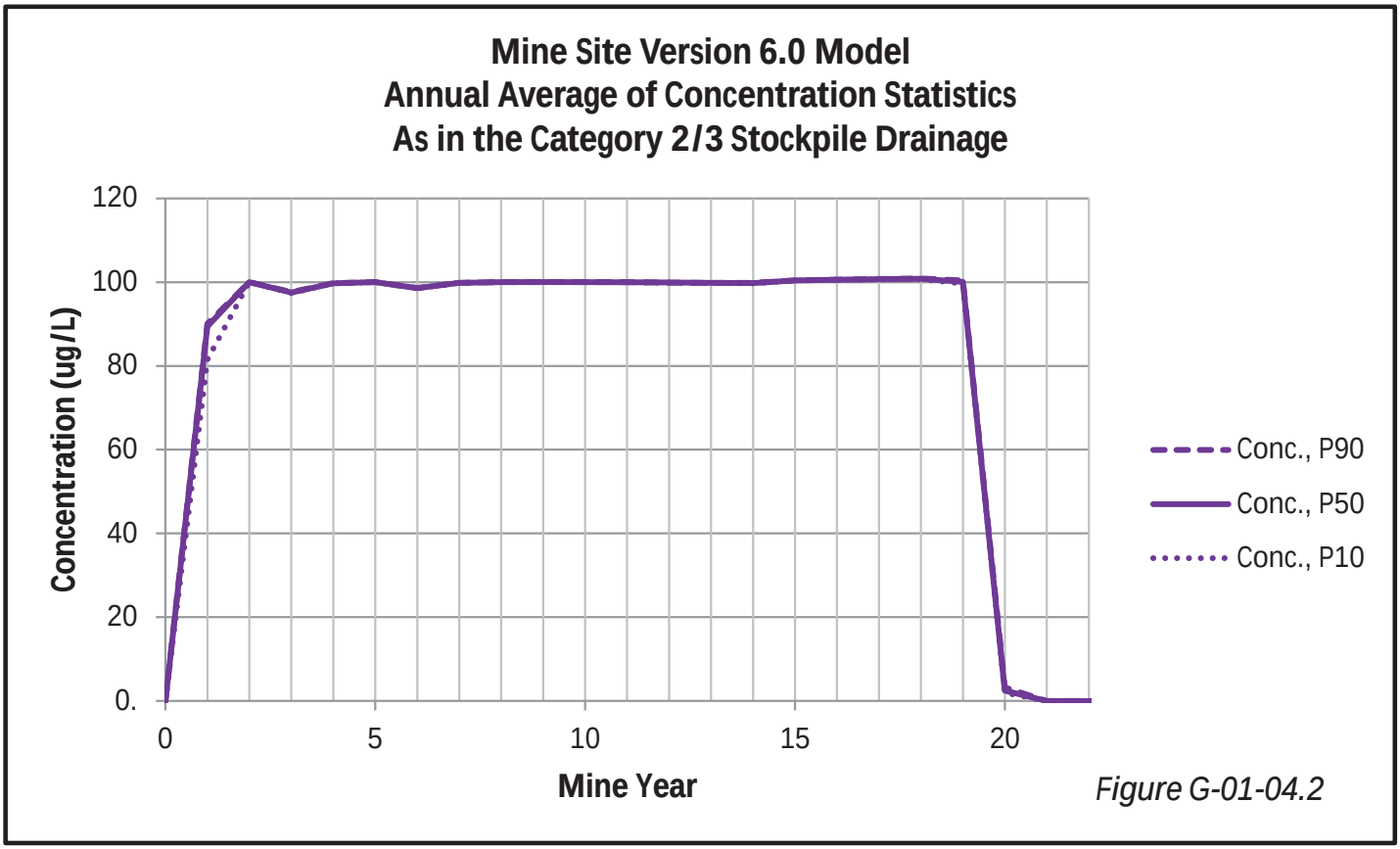
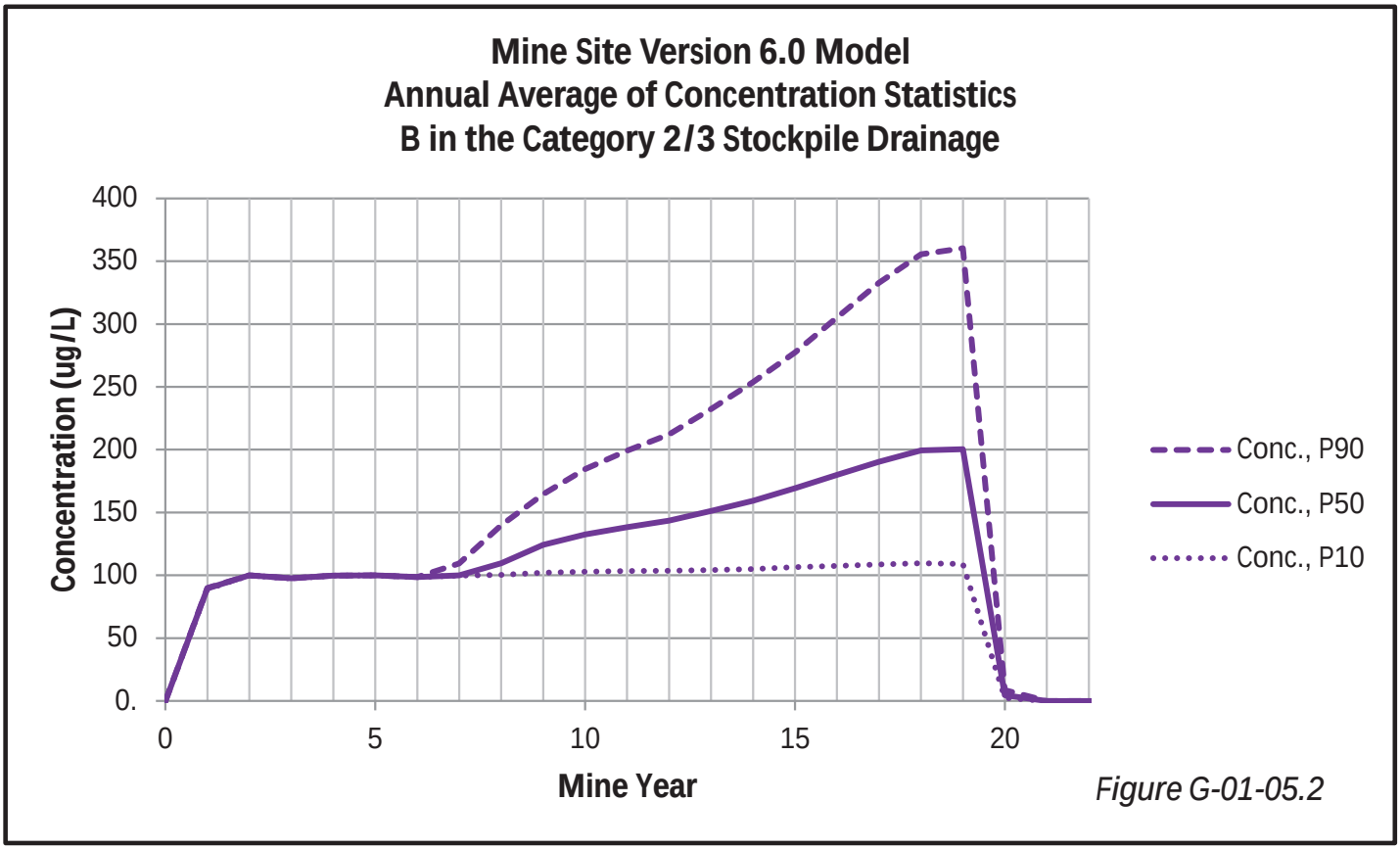


Figure G-01-04.2



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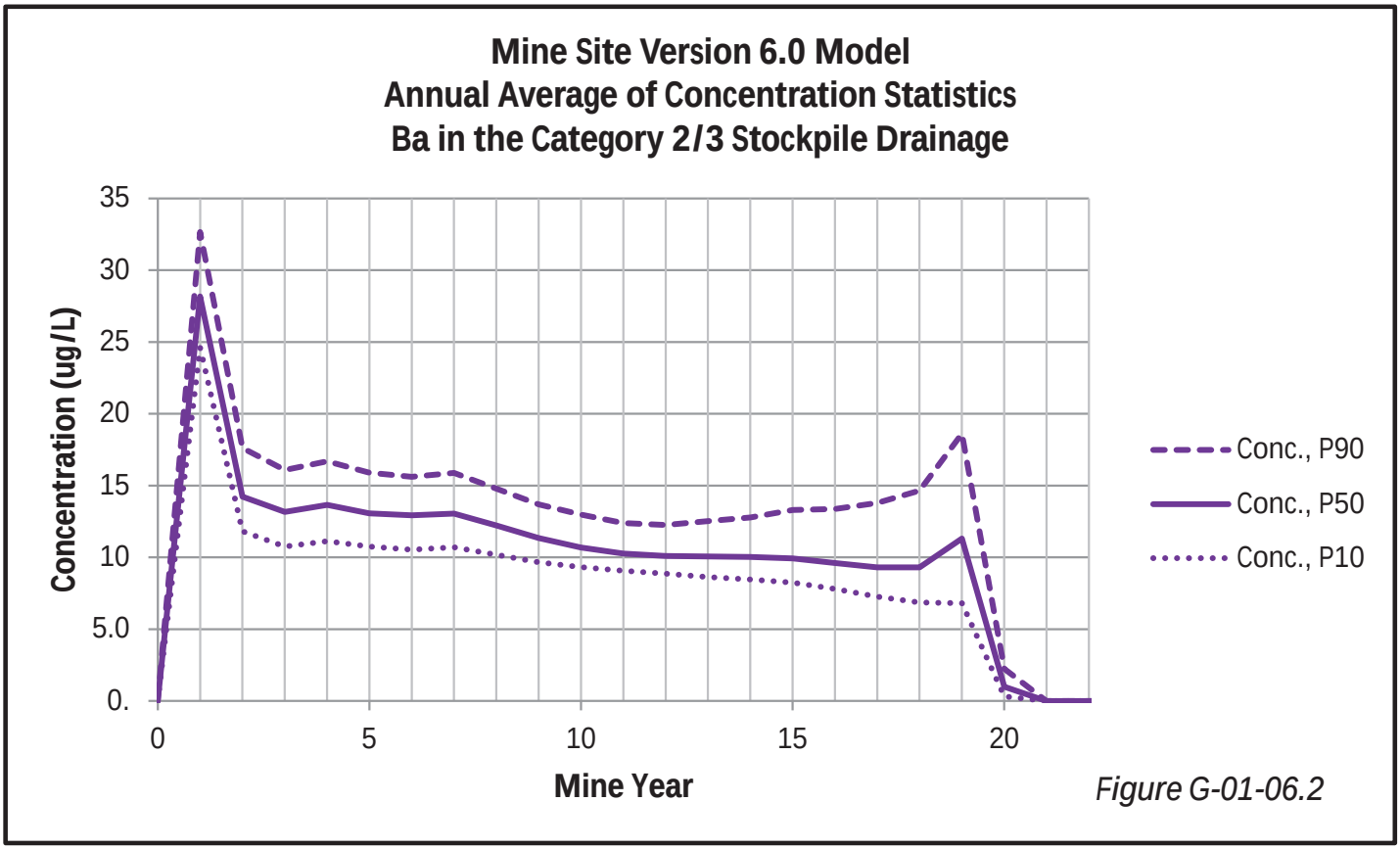

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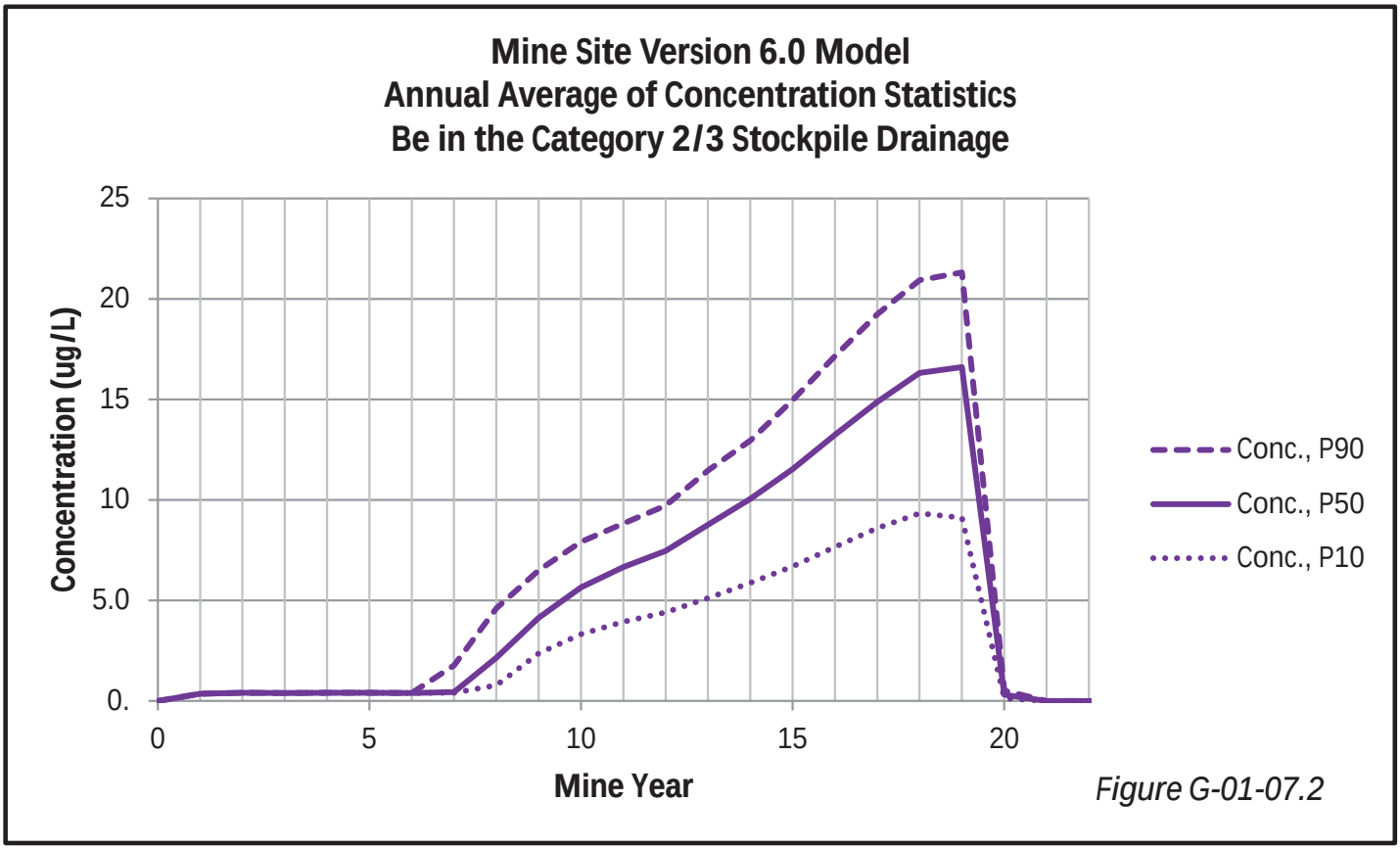

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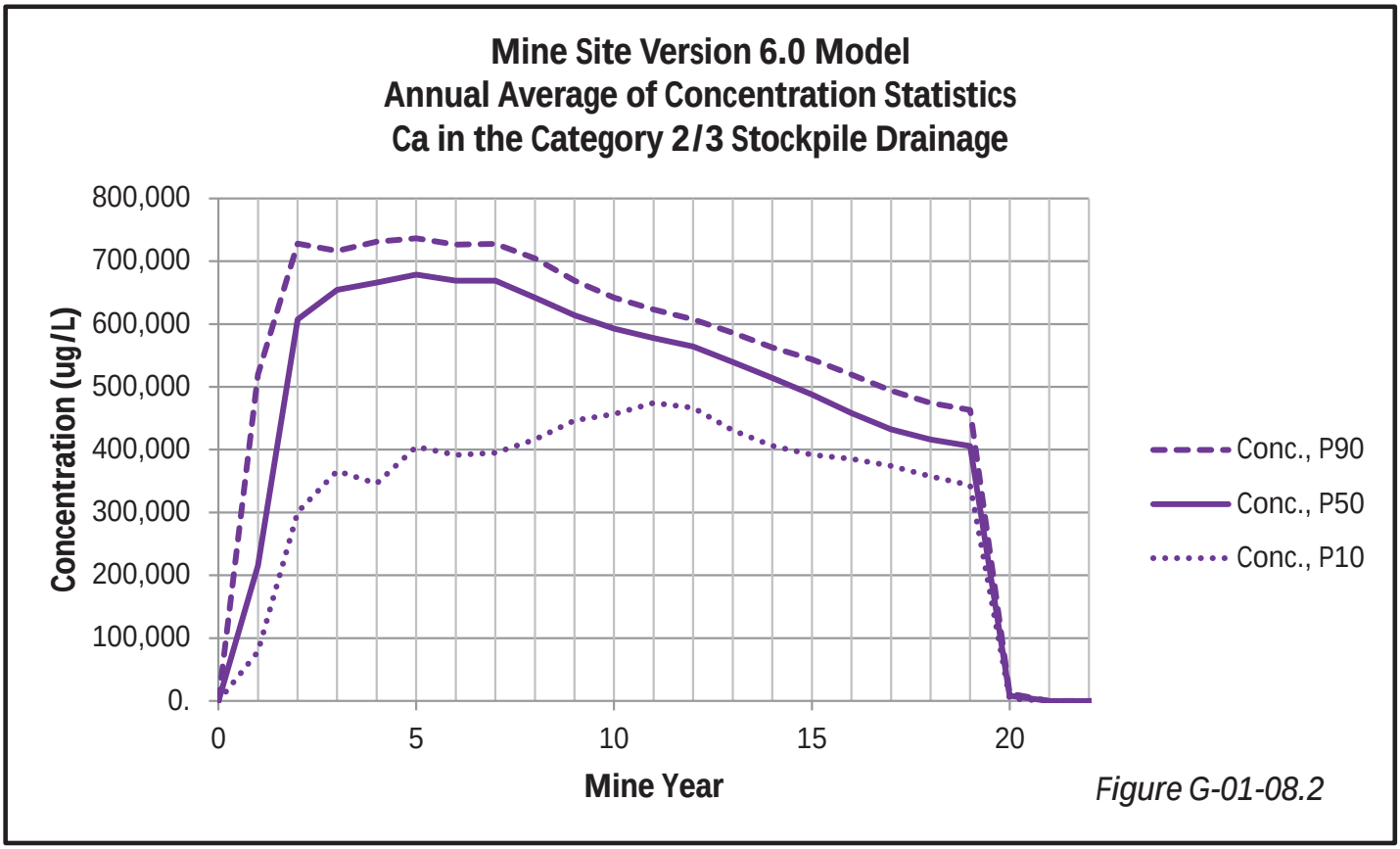

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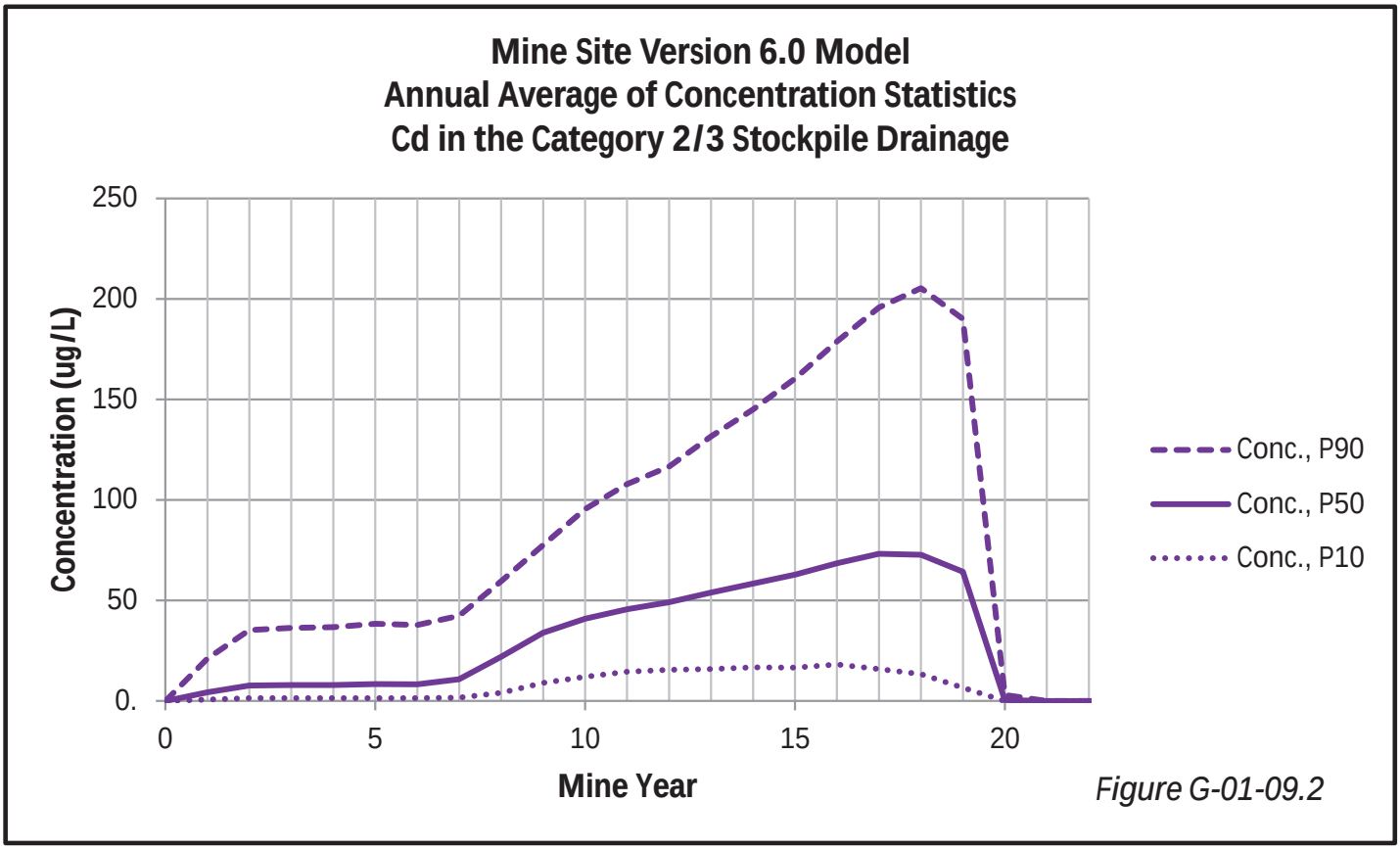

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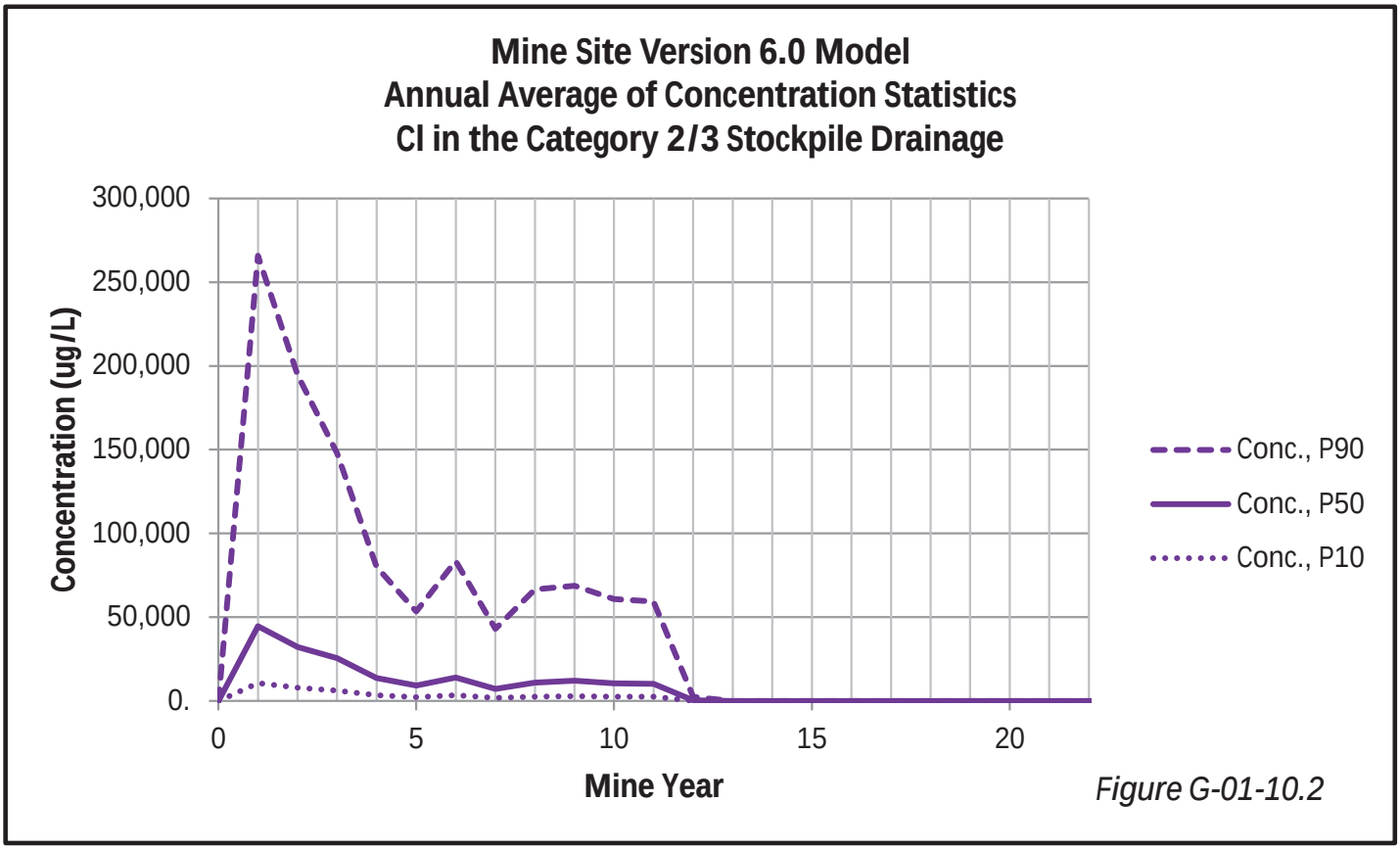

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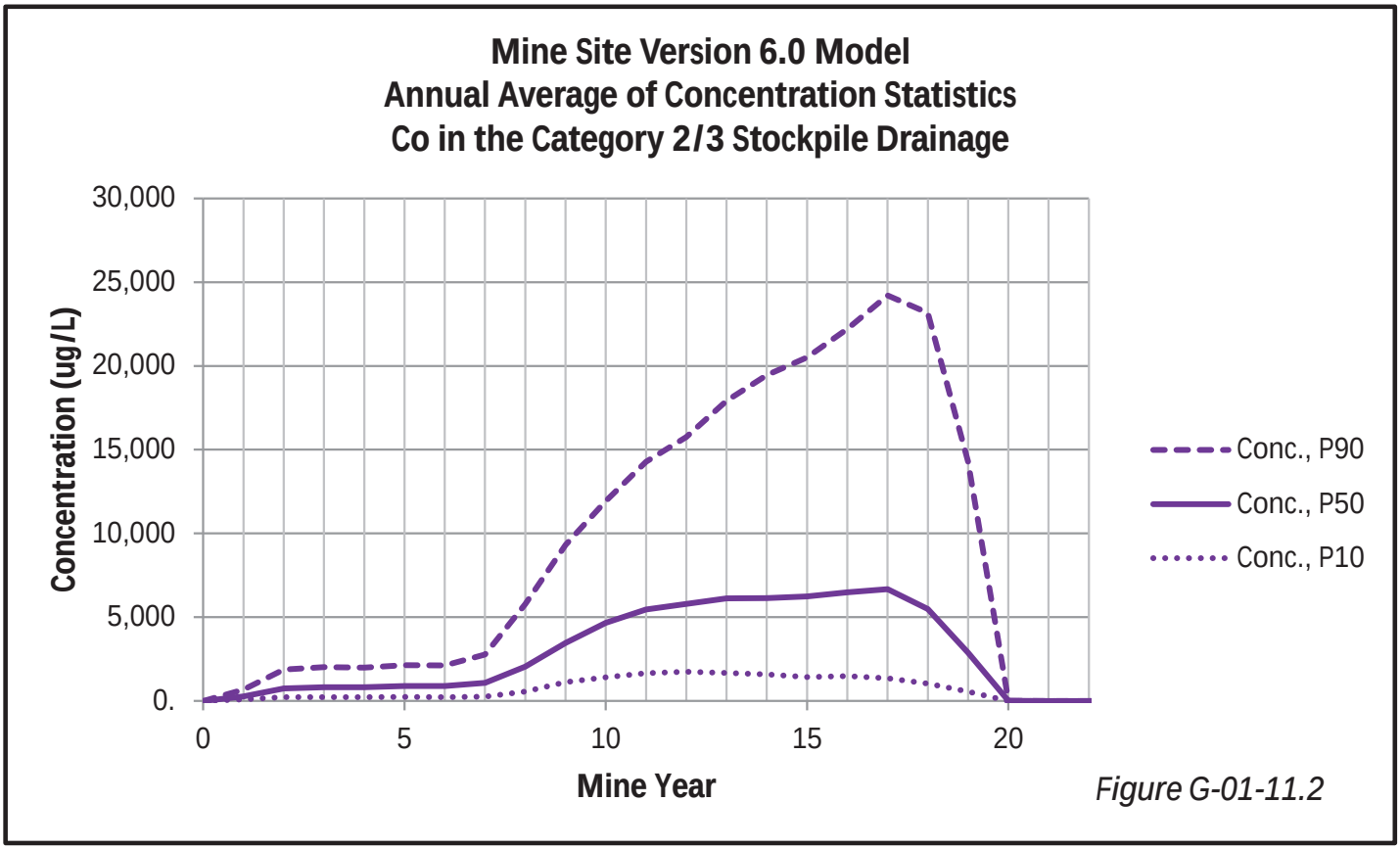

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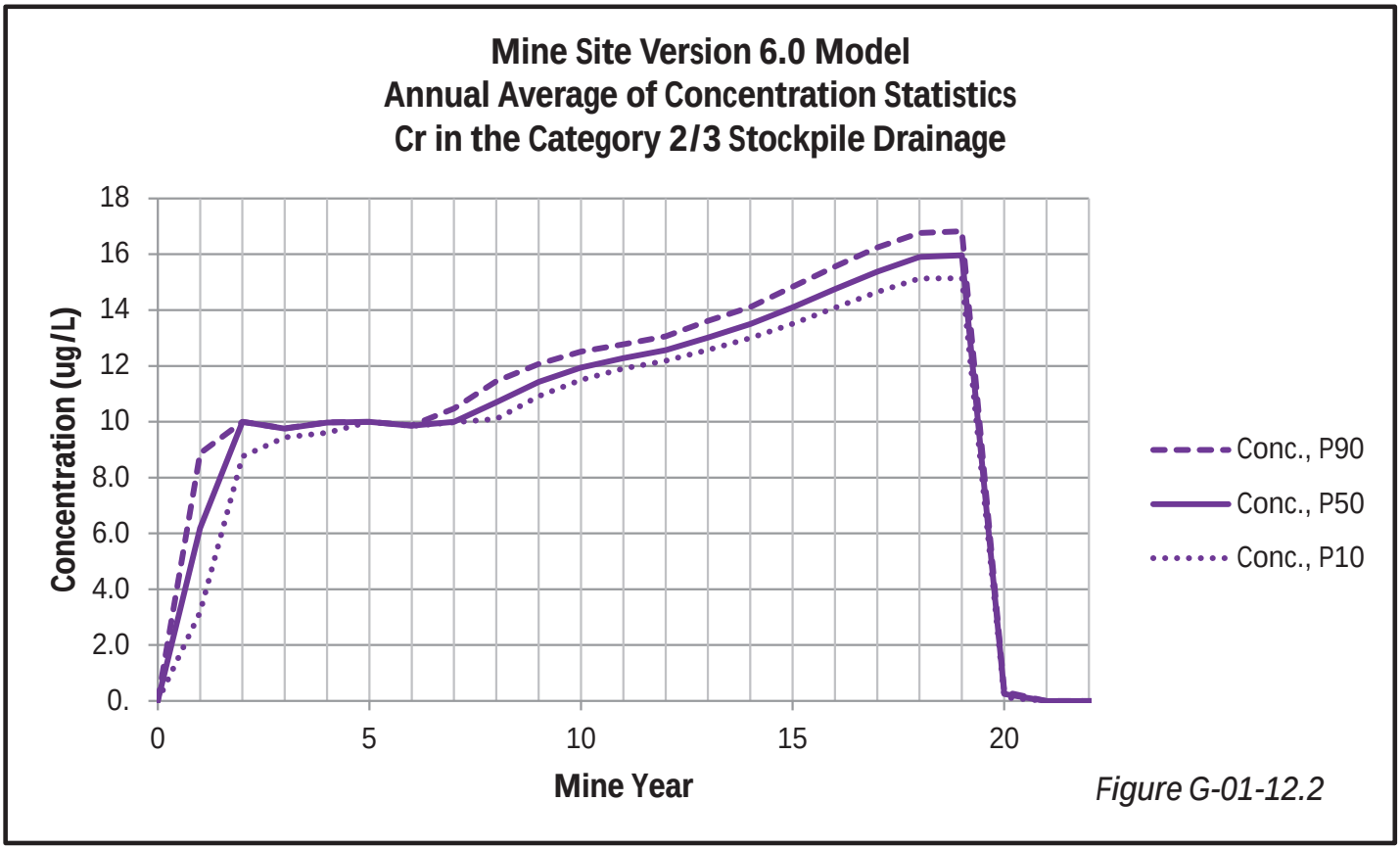

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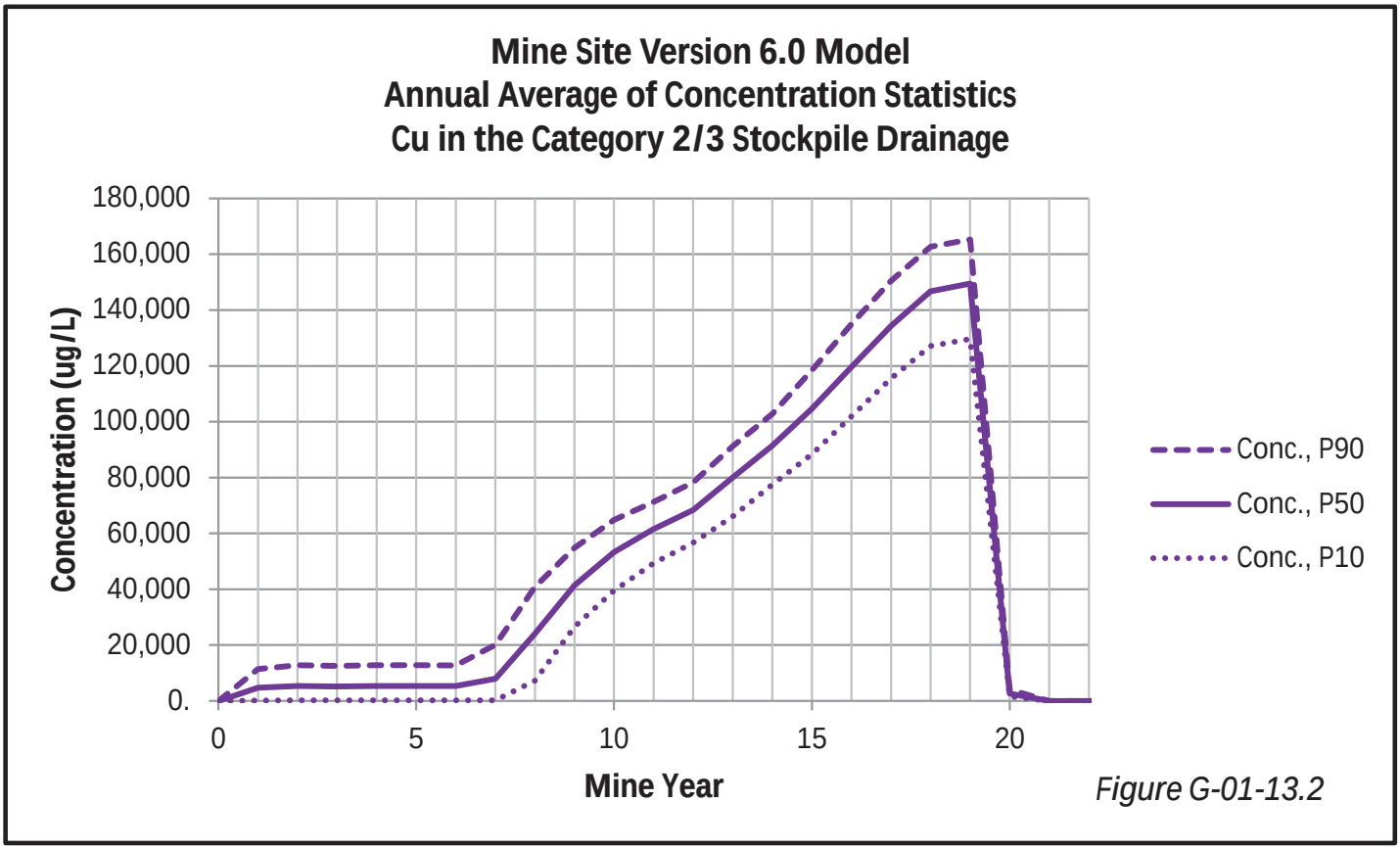

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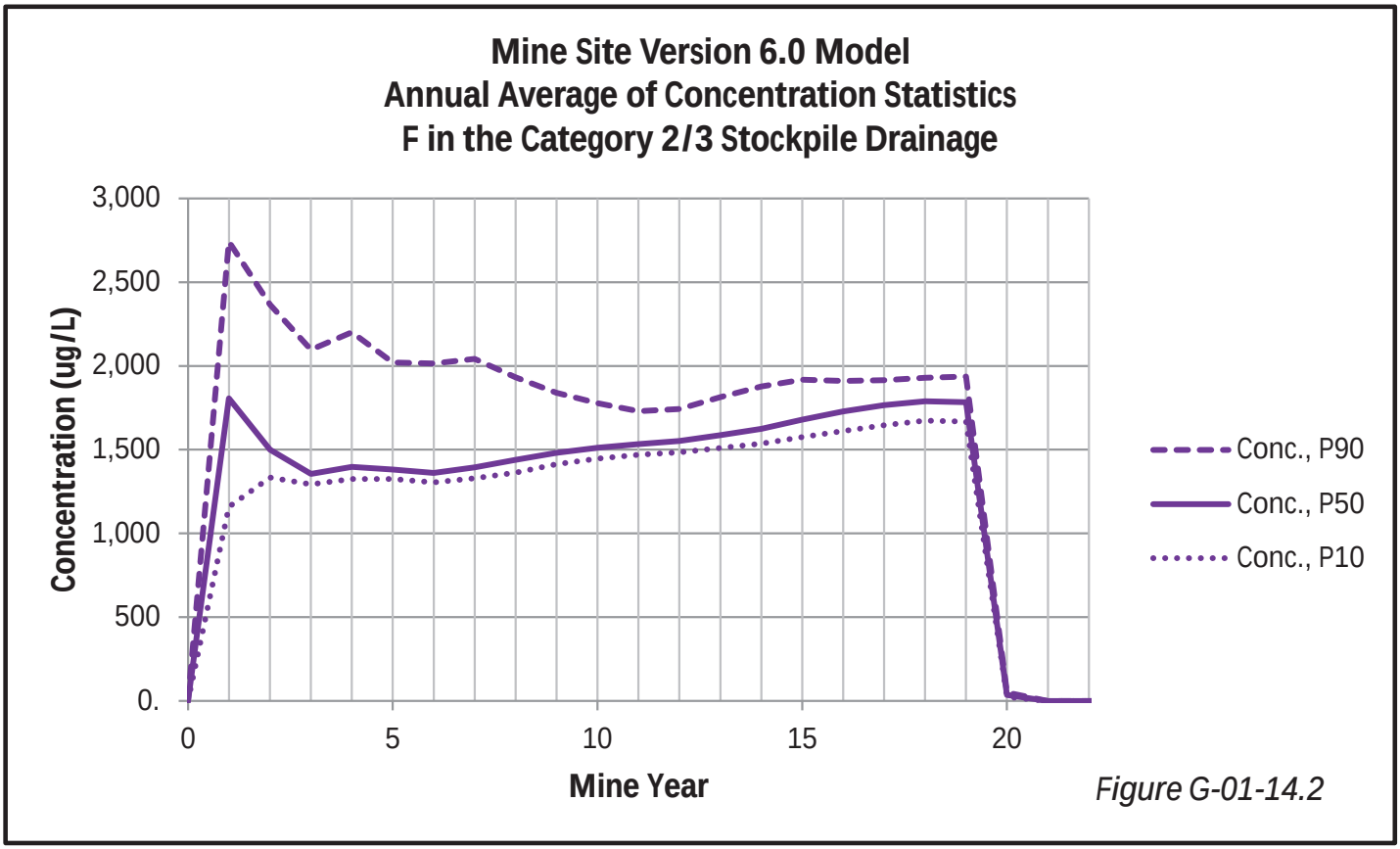

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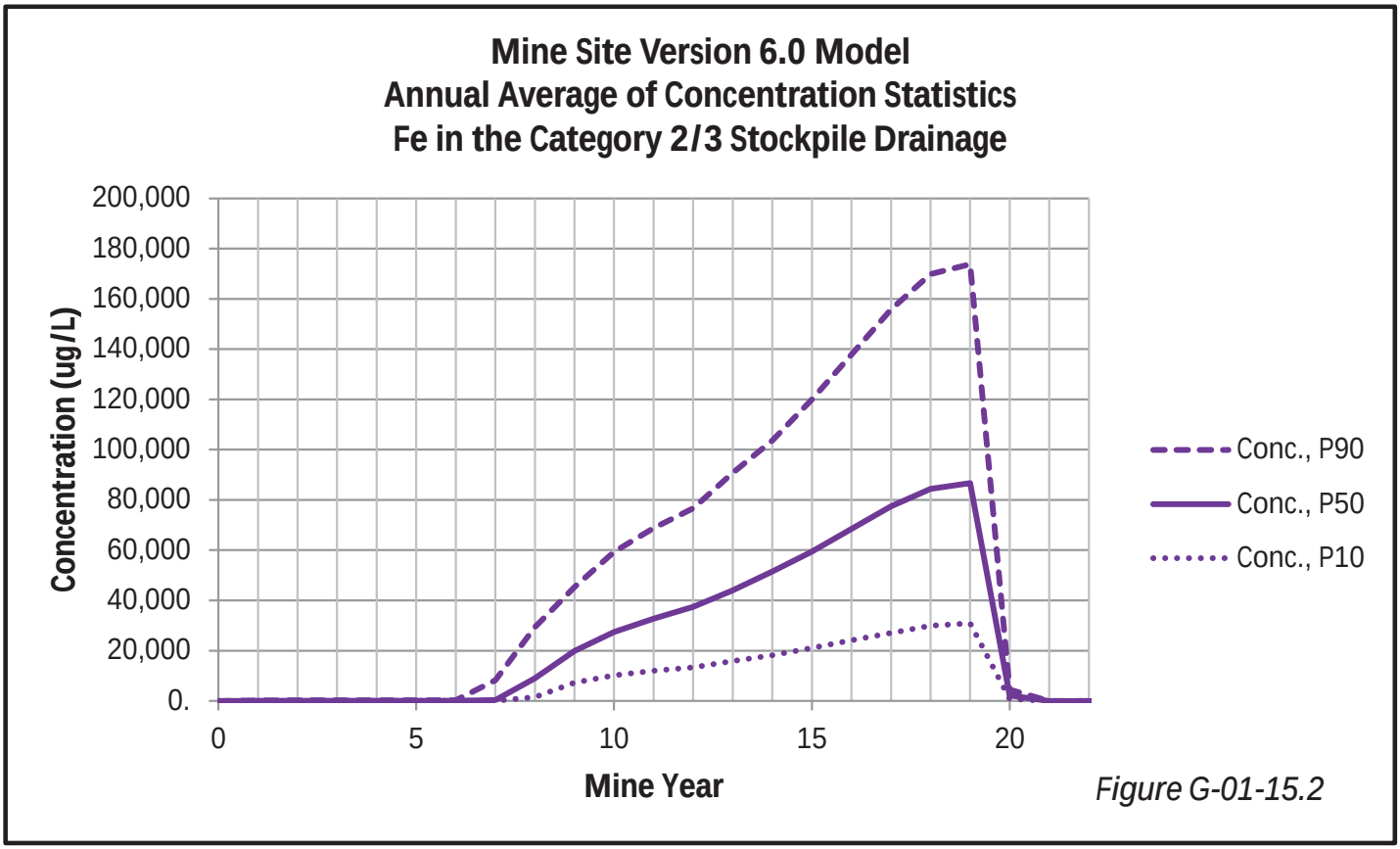

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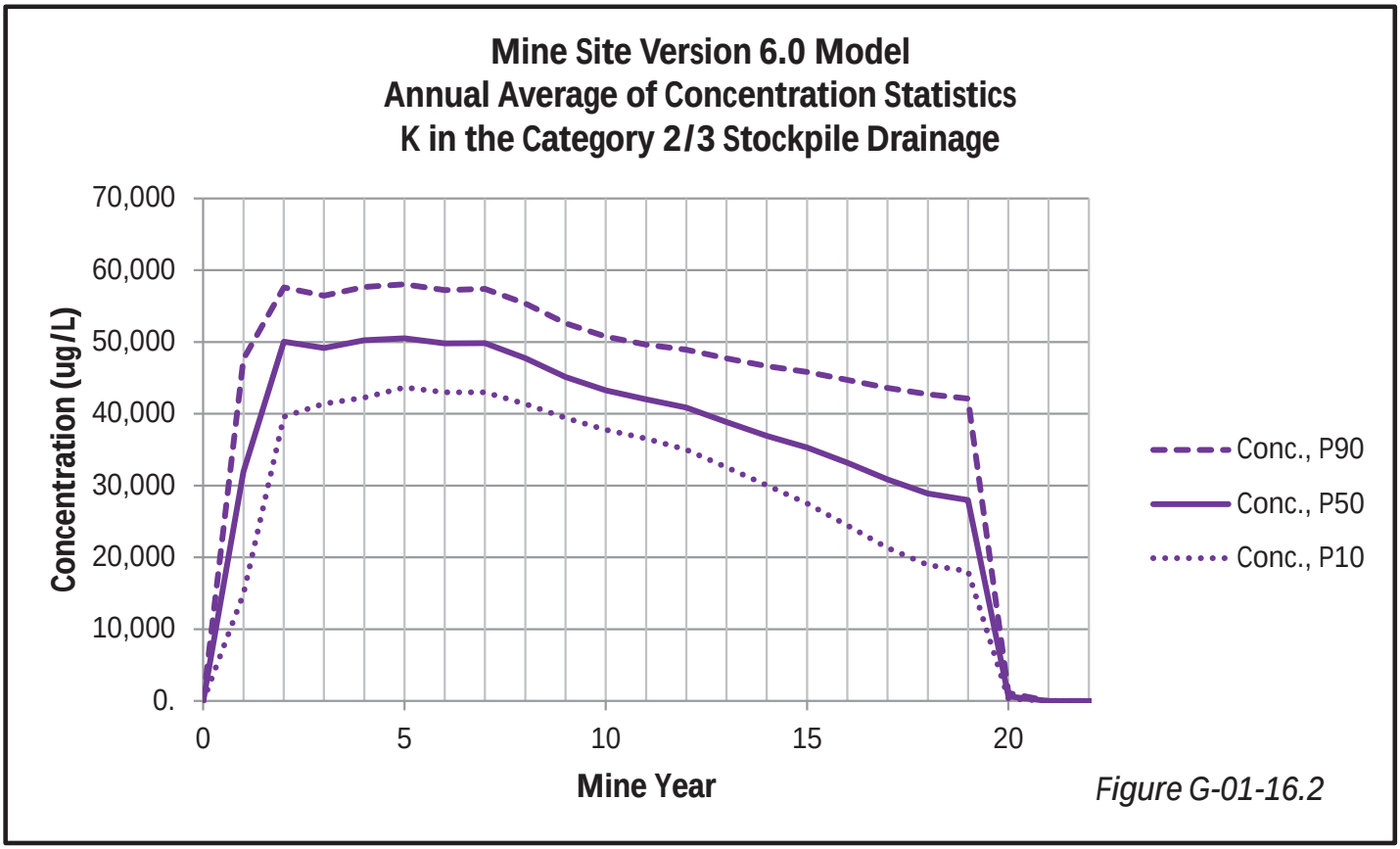

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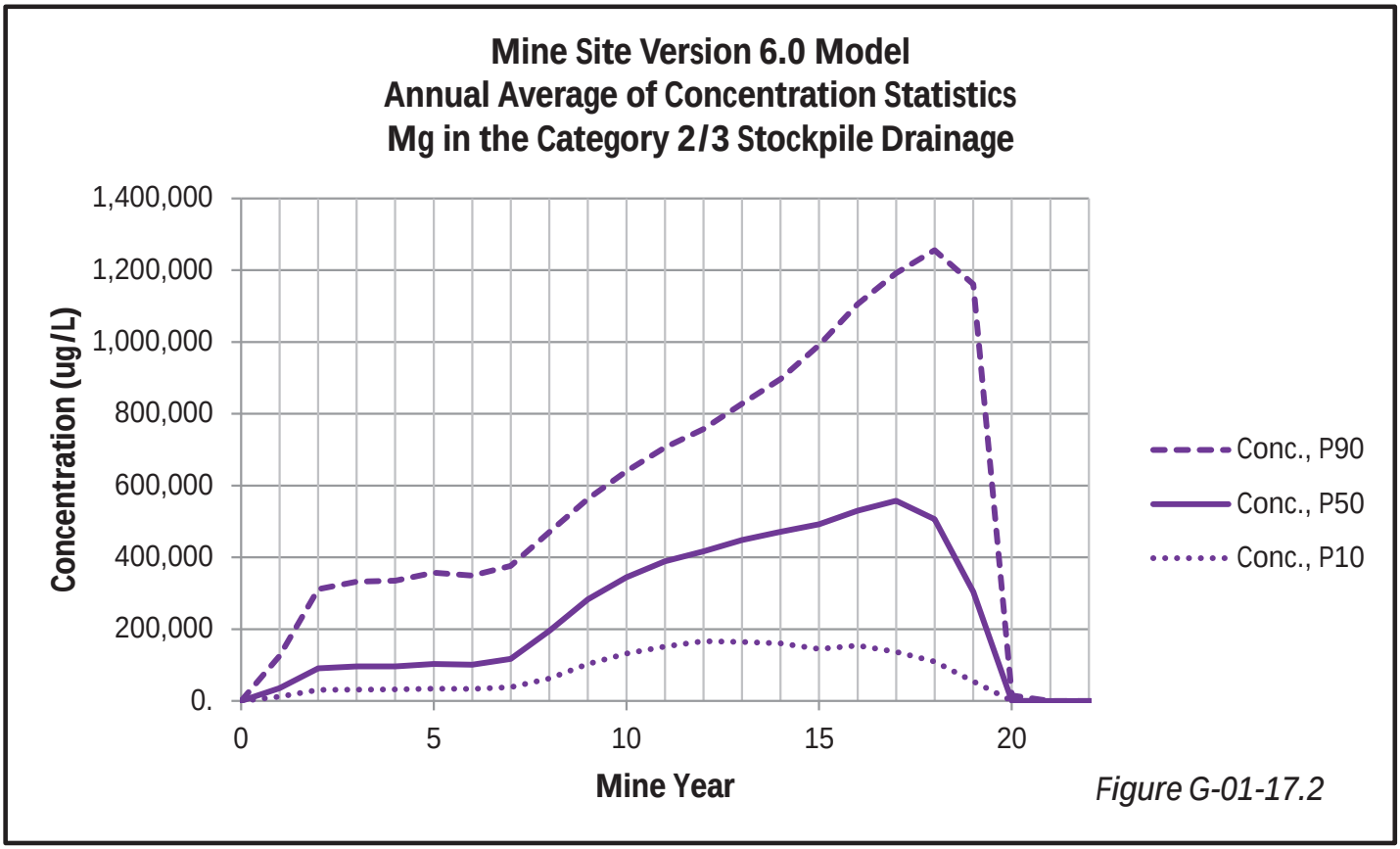

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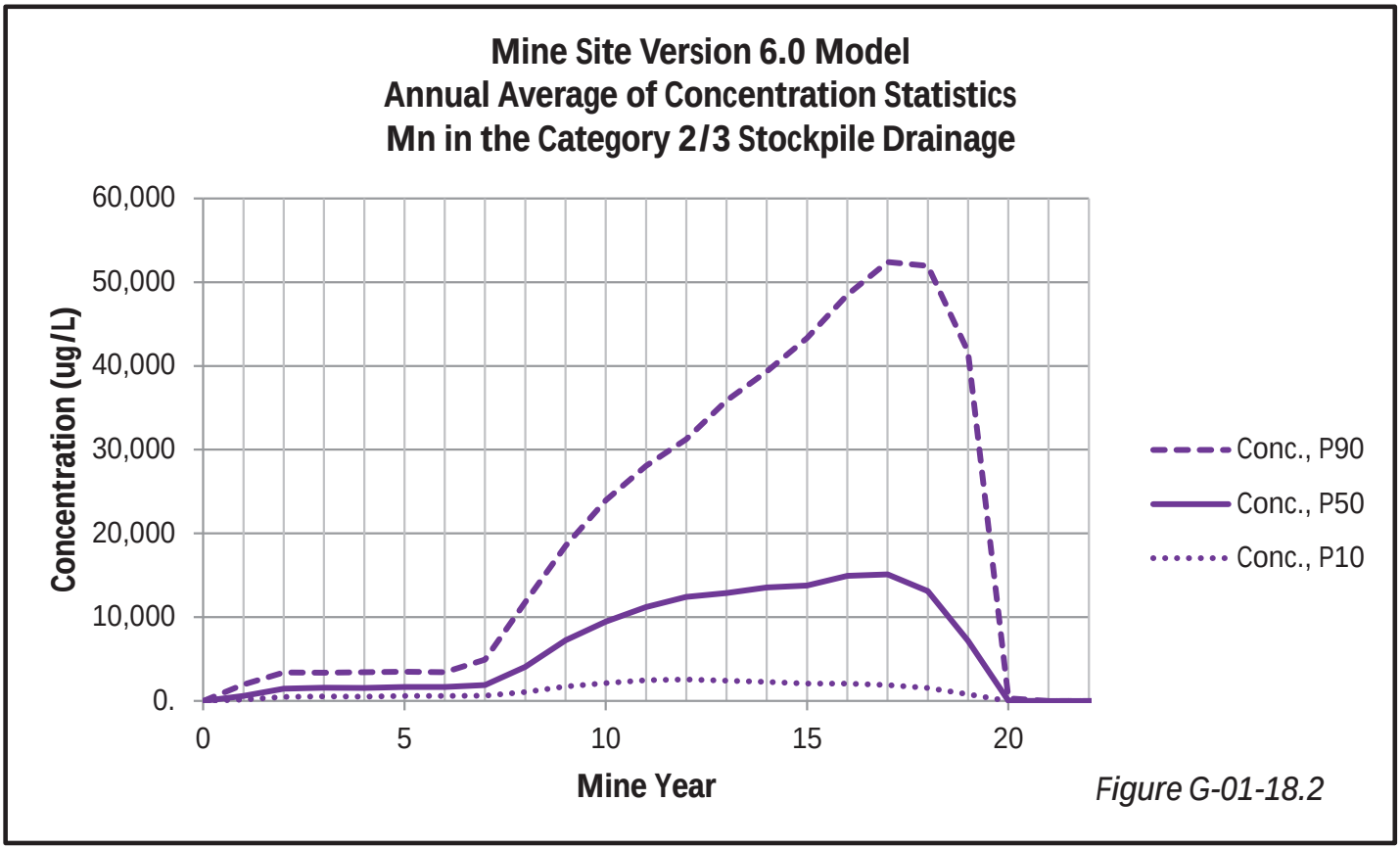

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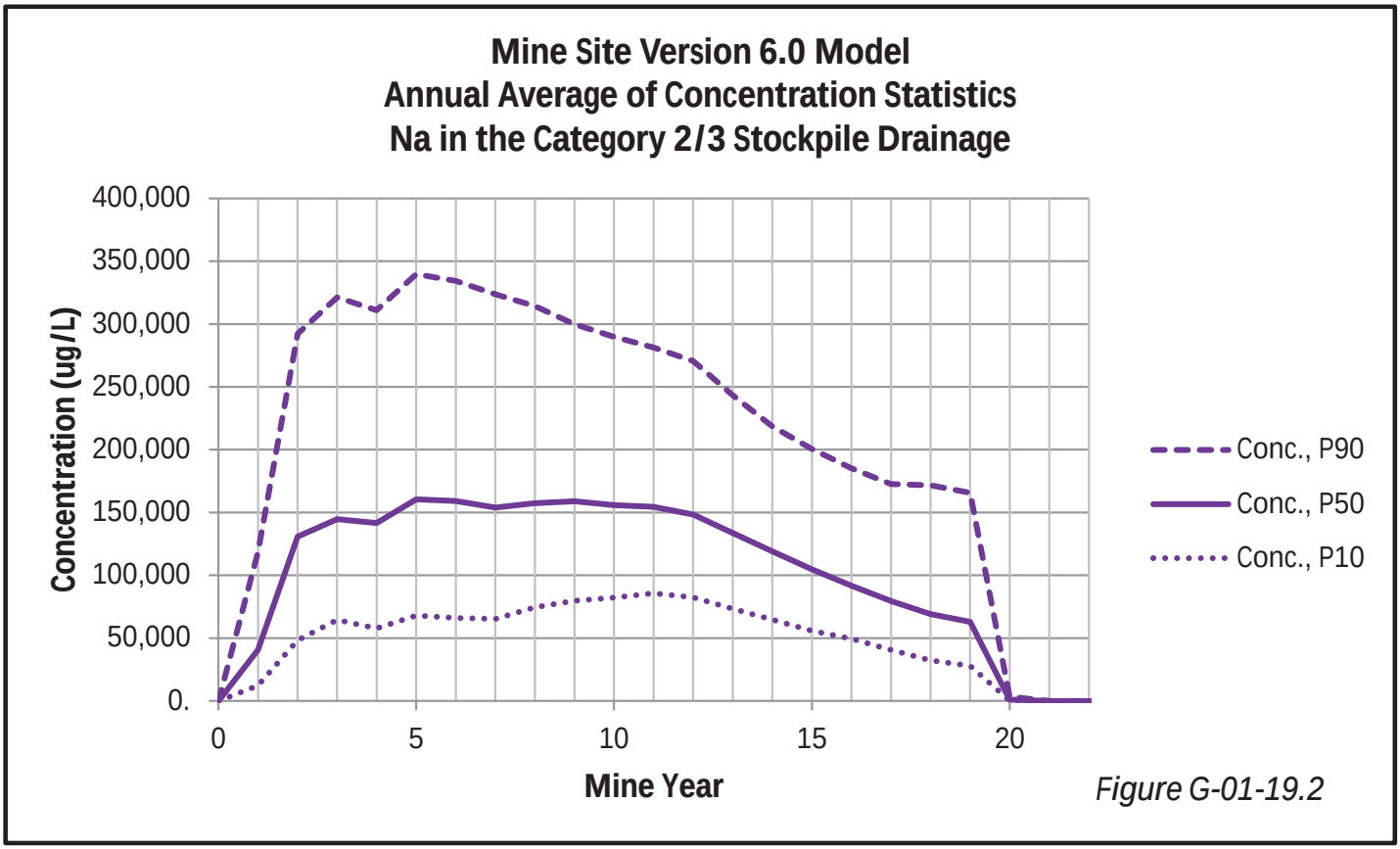

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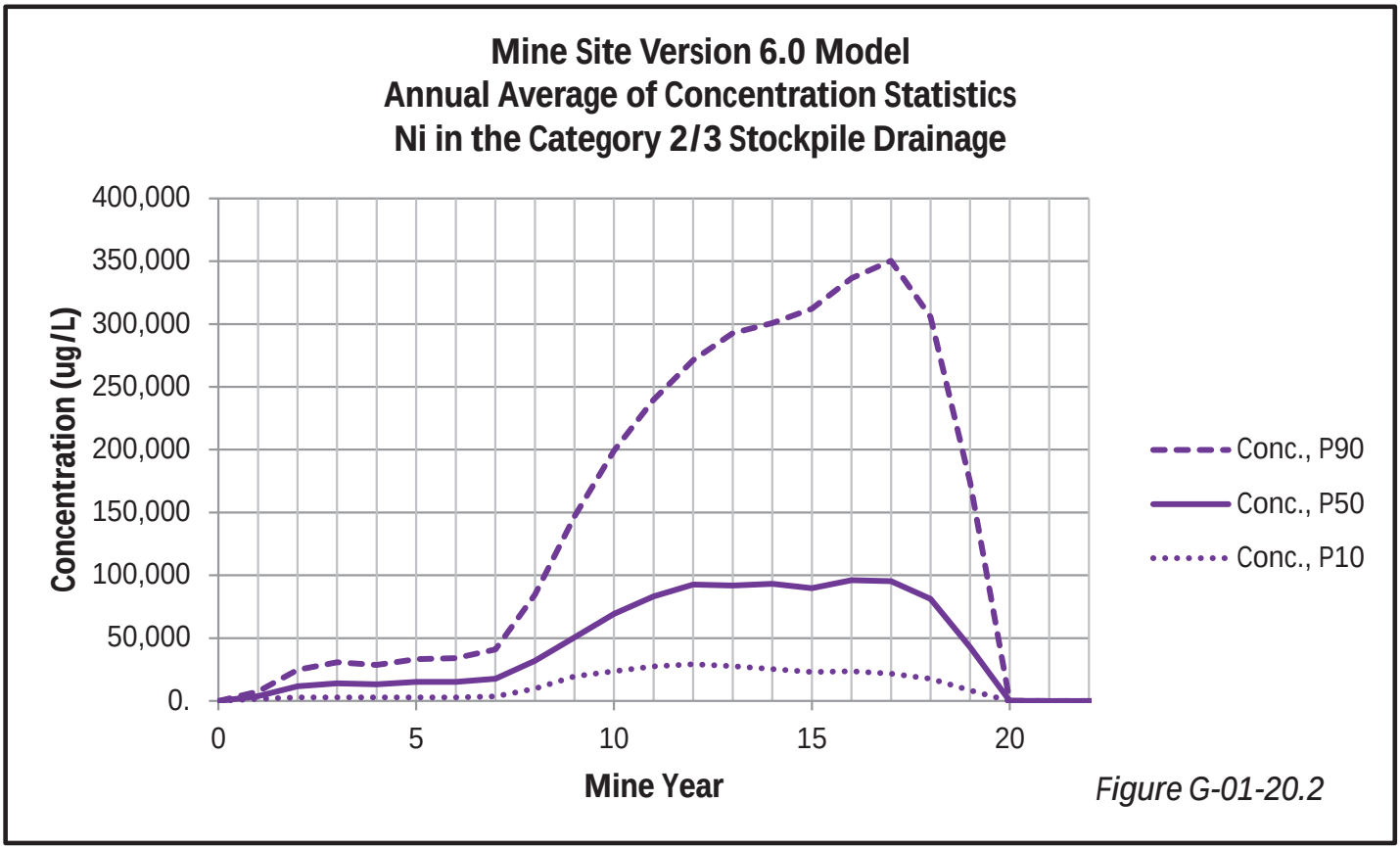

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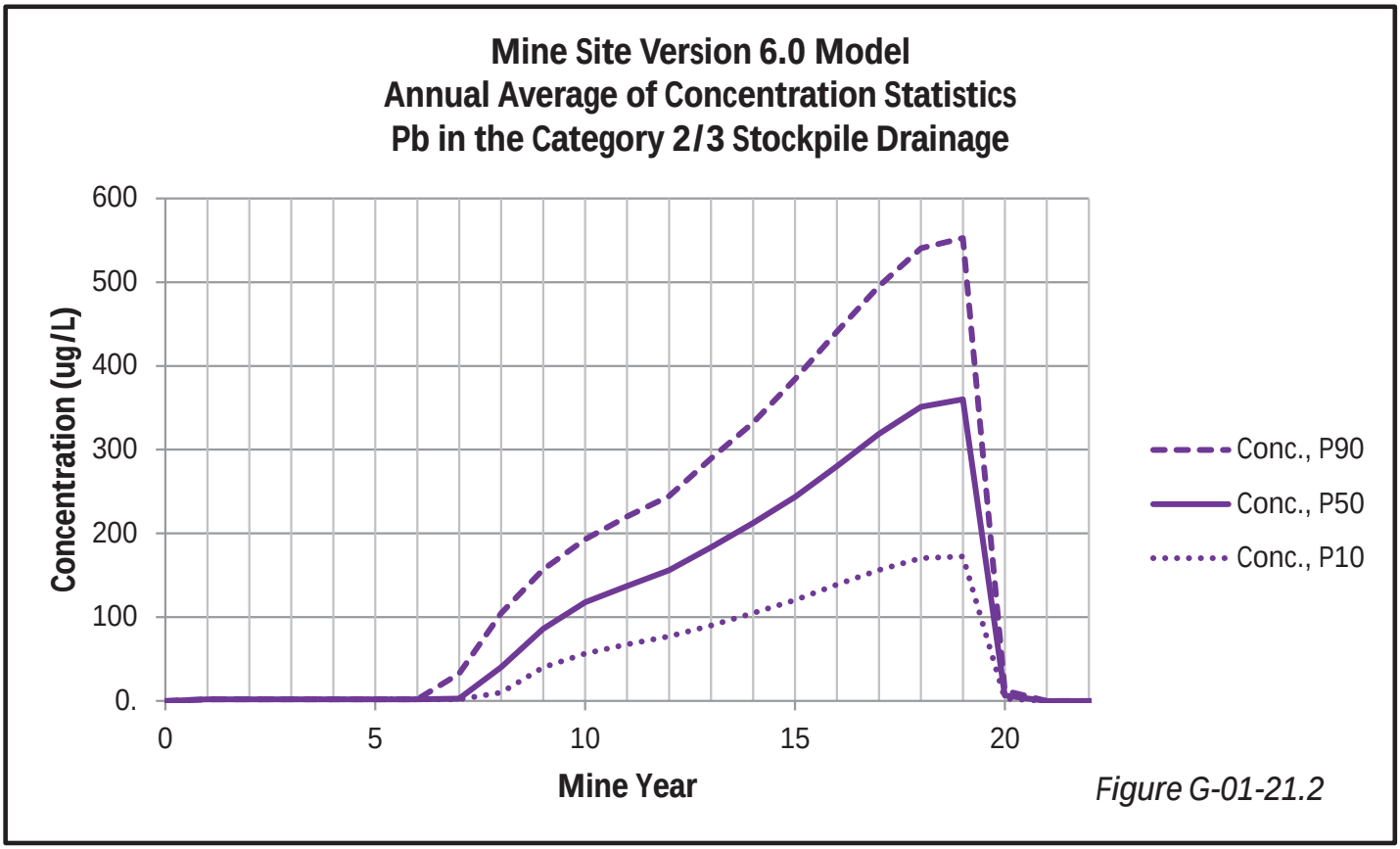

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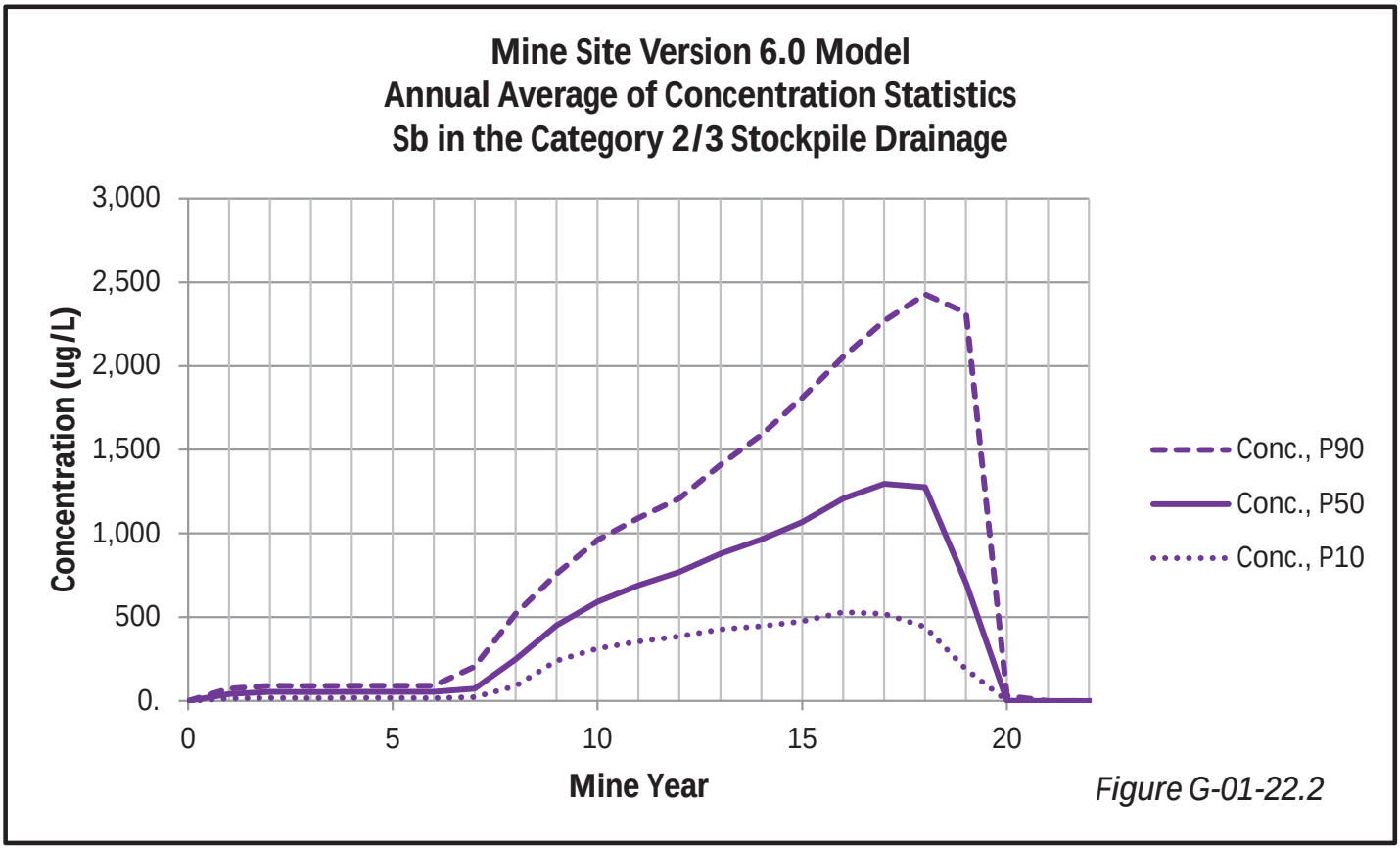

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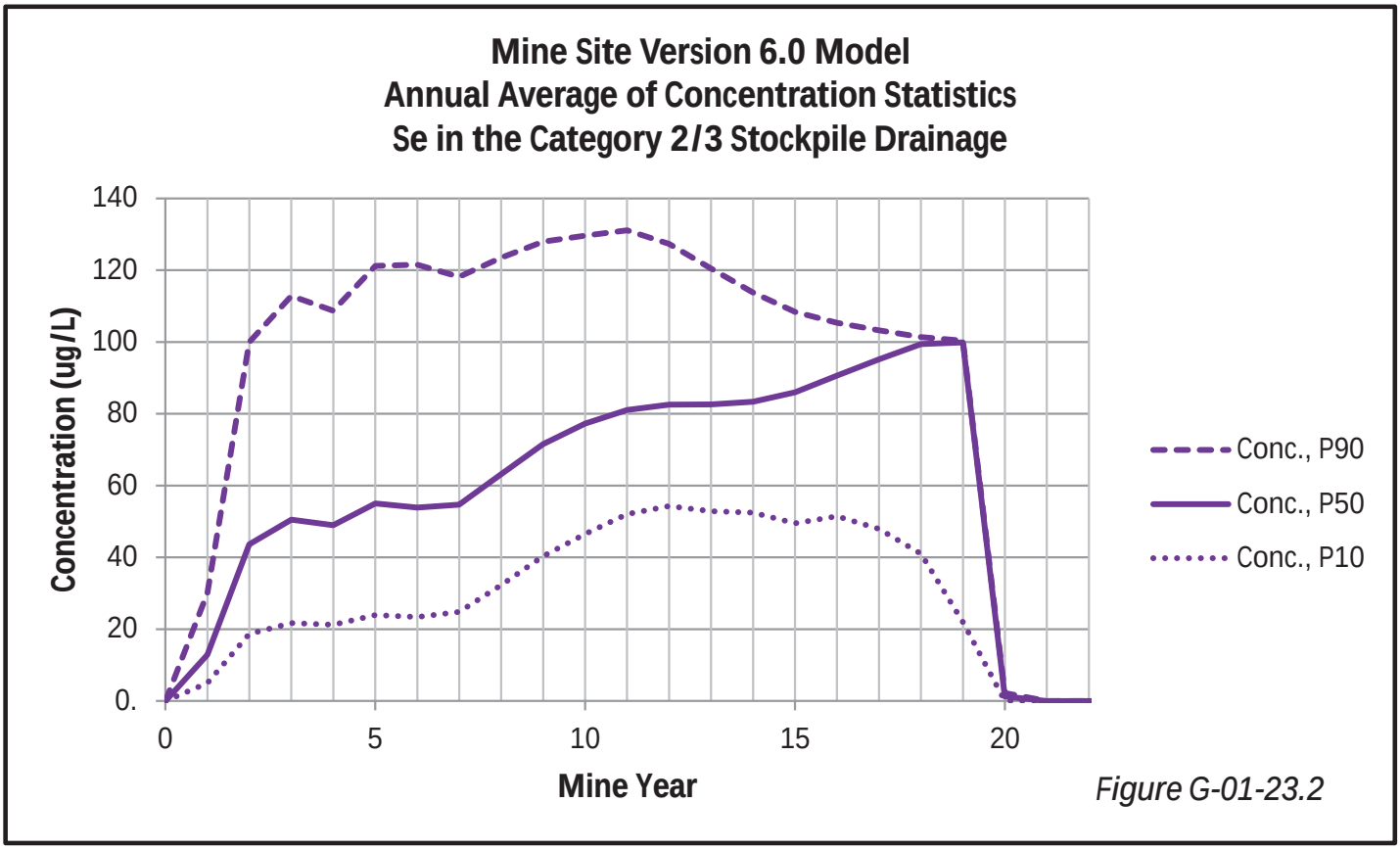

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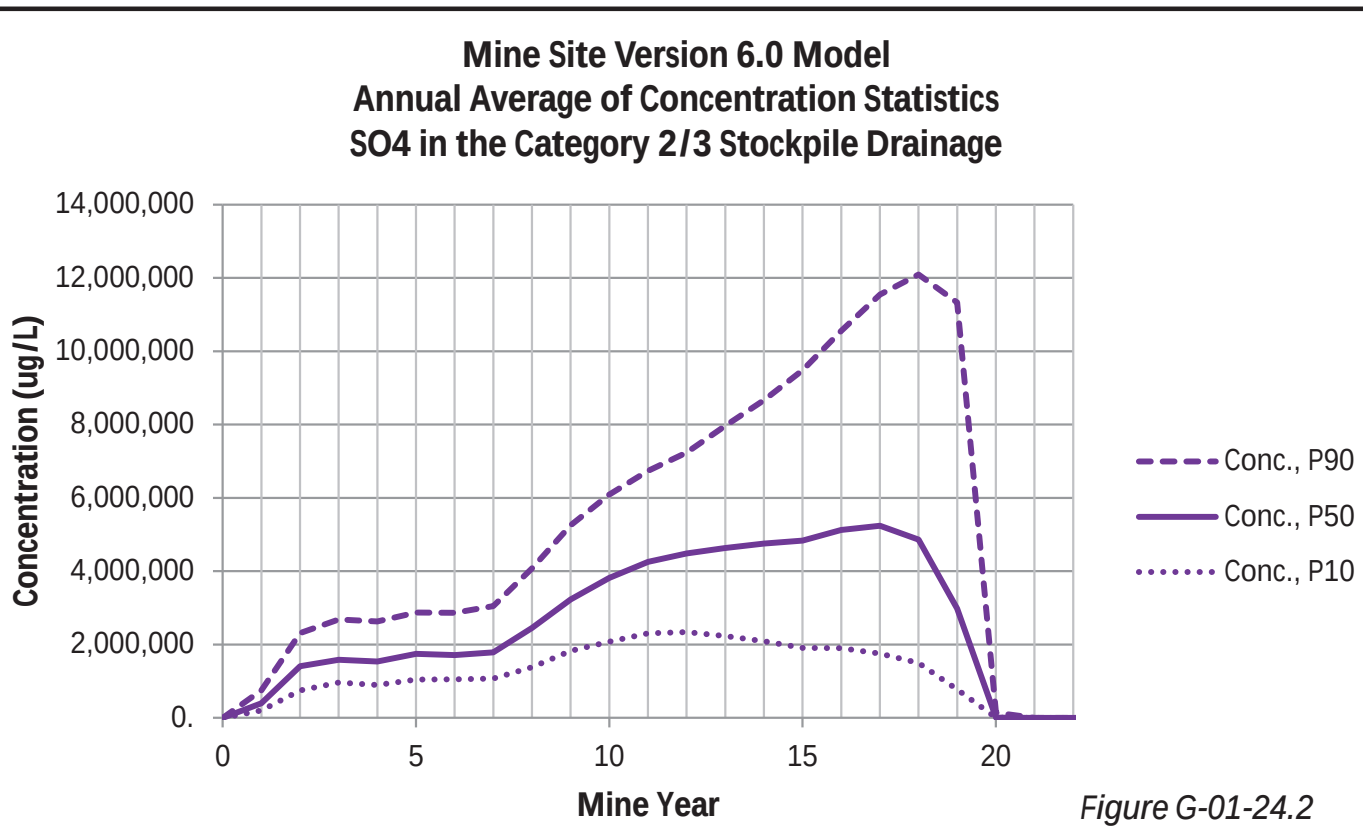

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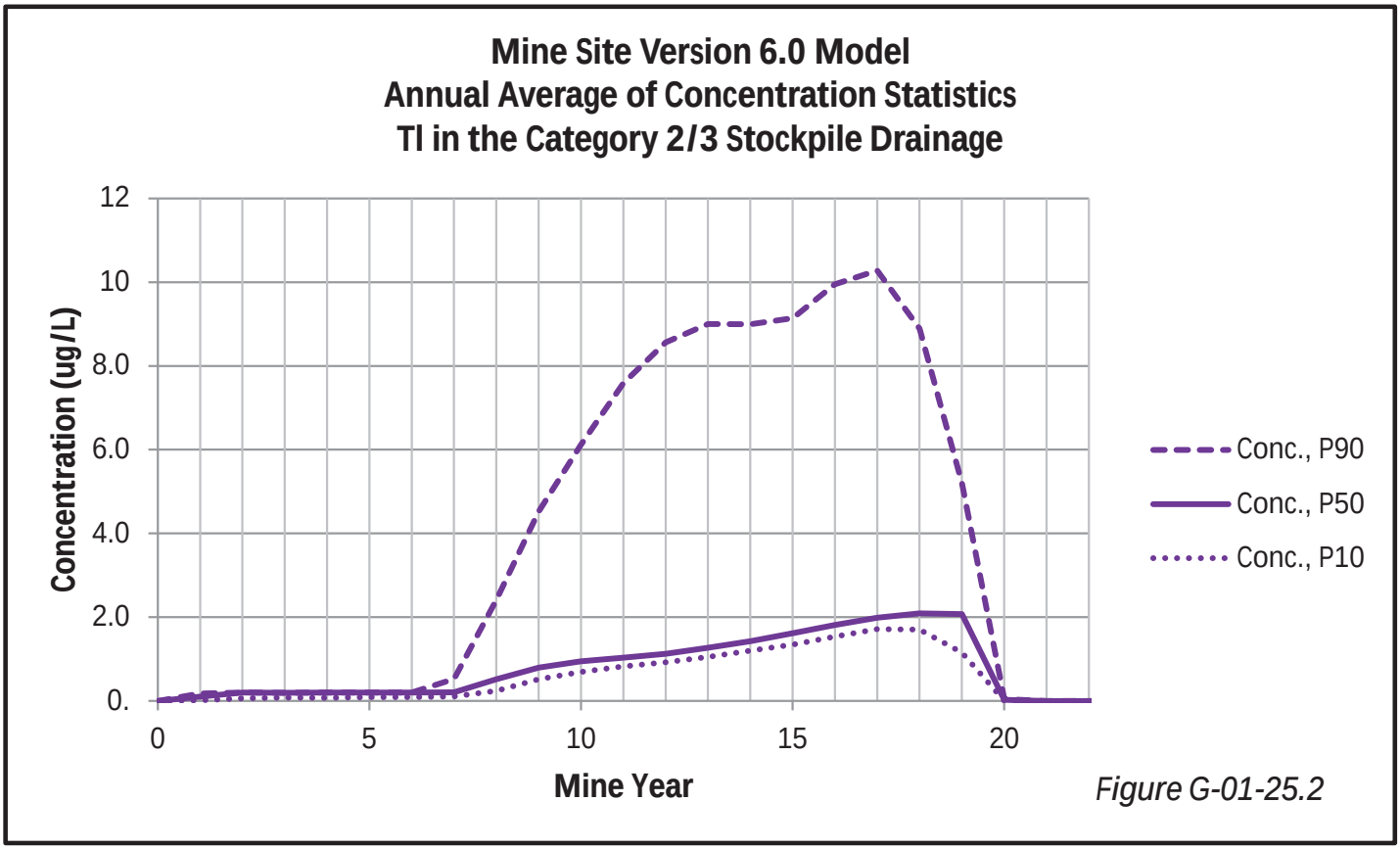

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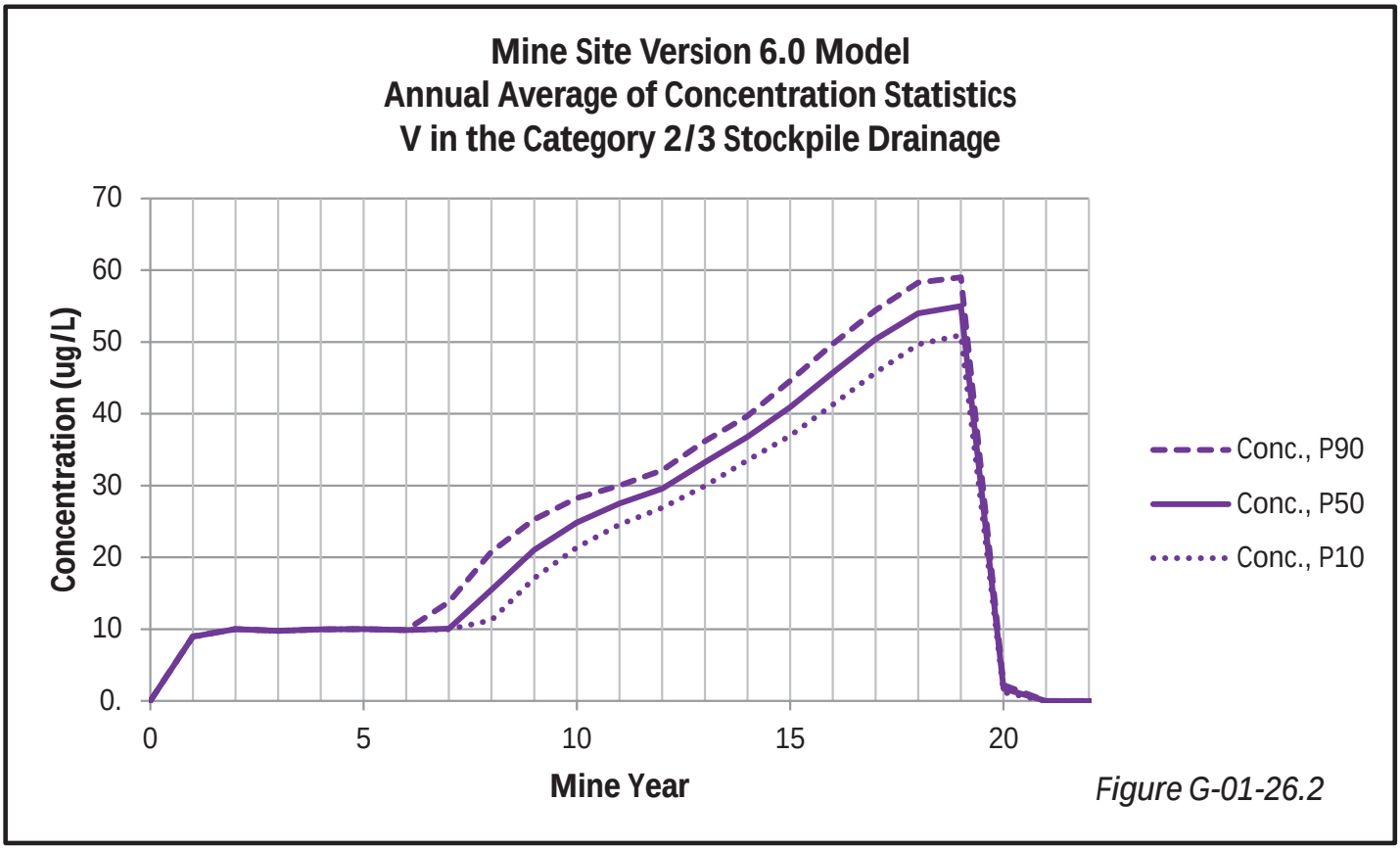

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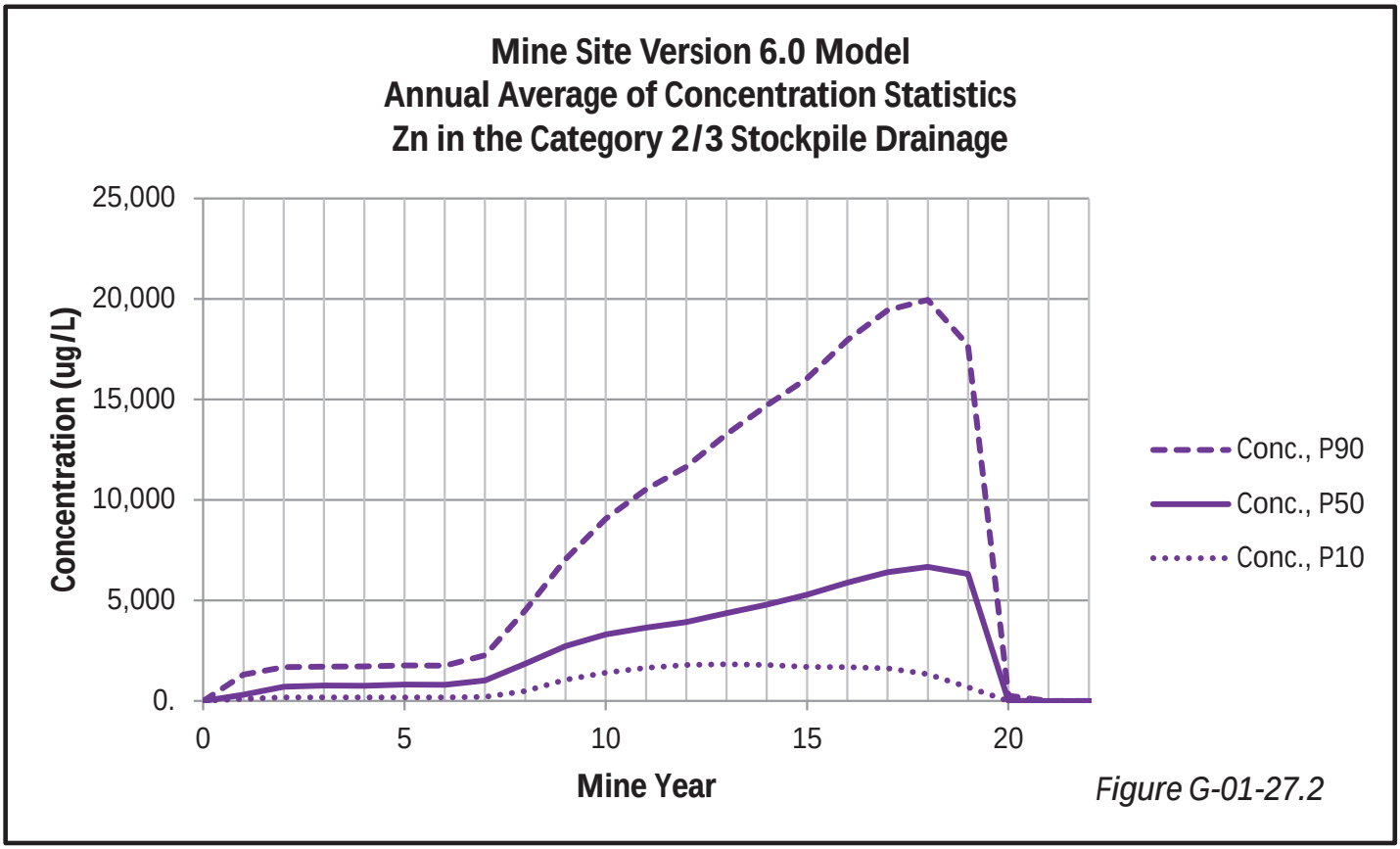

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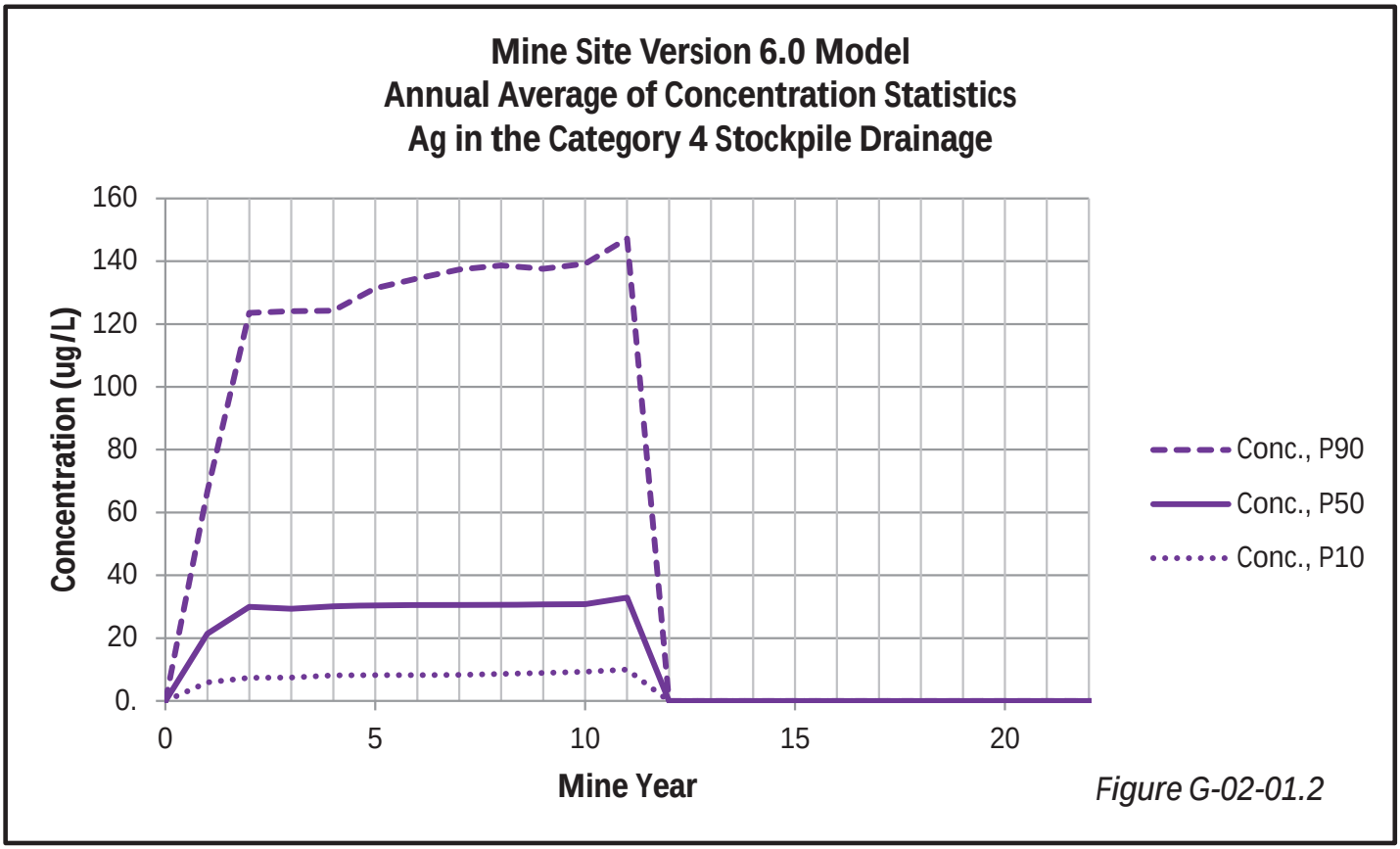

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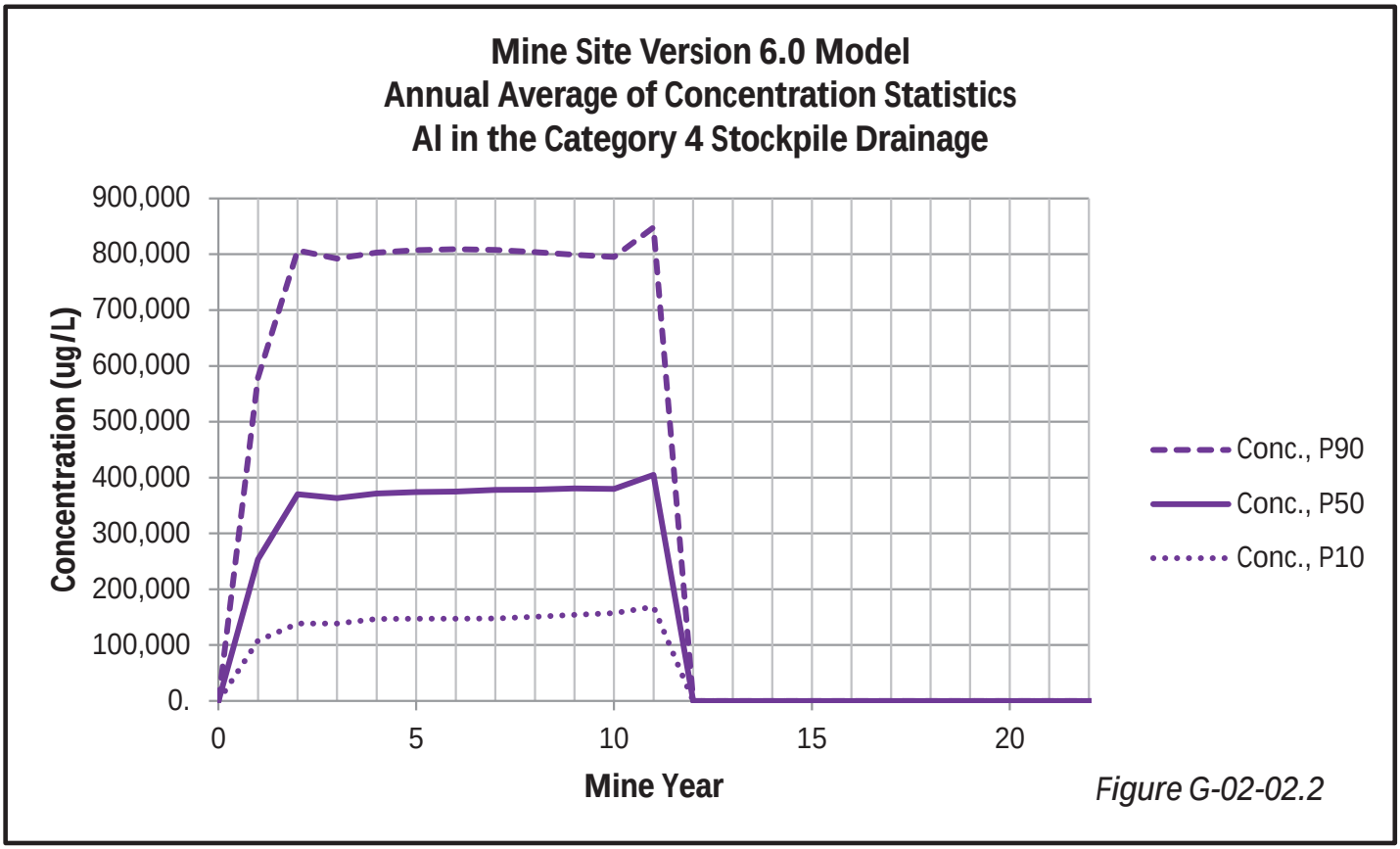

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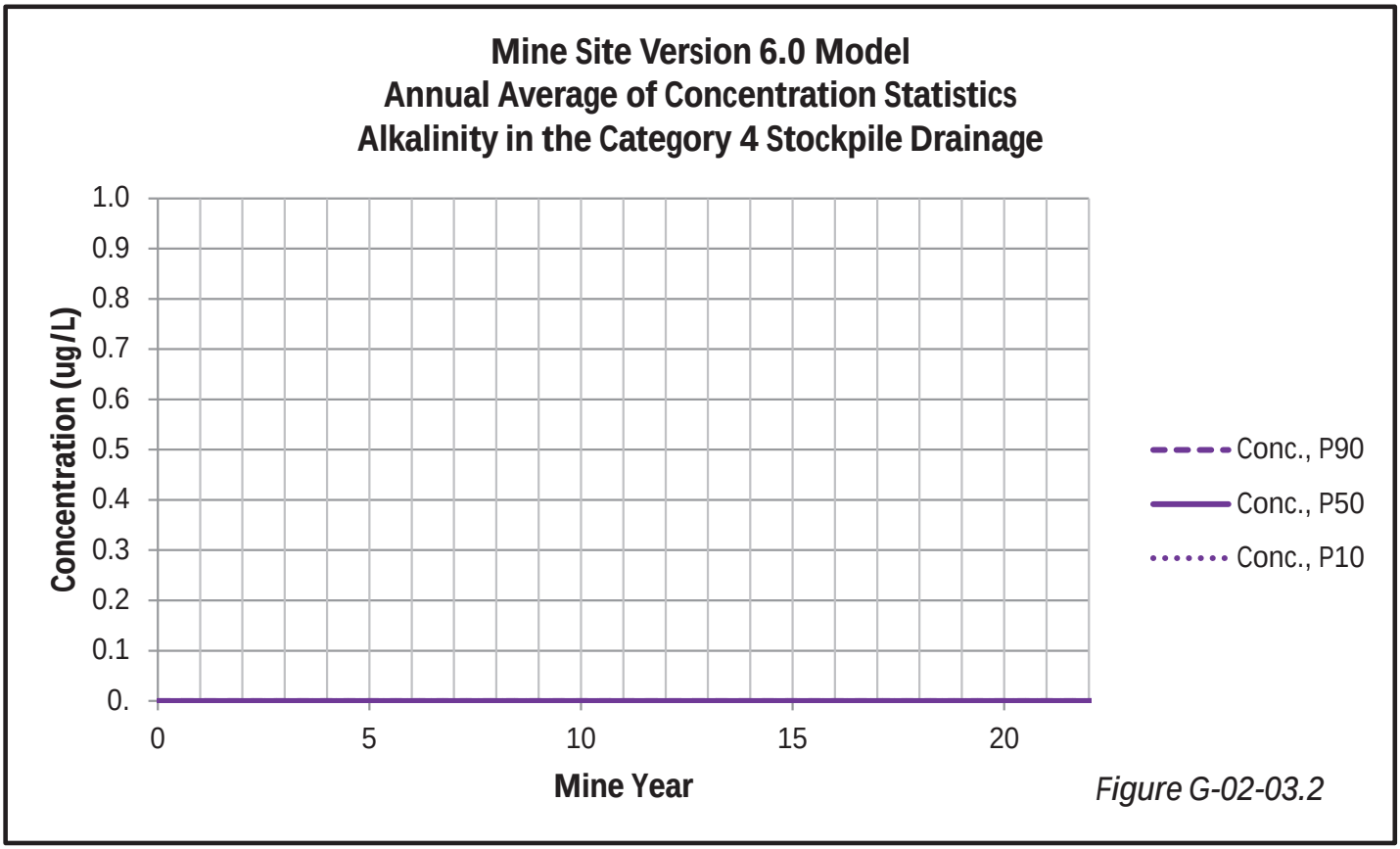

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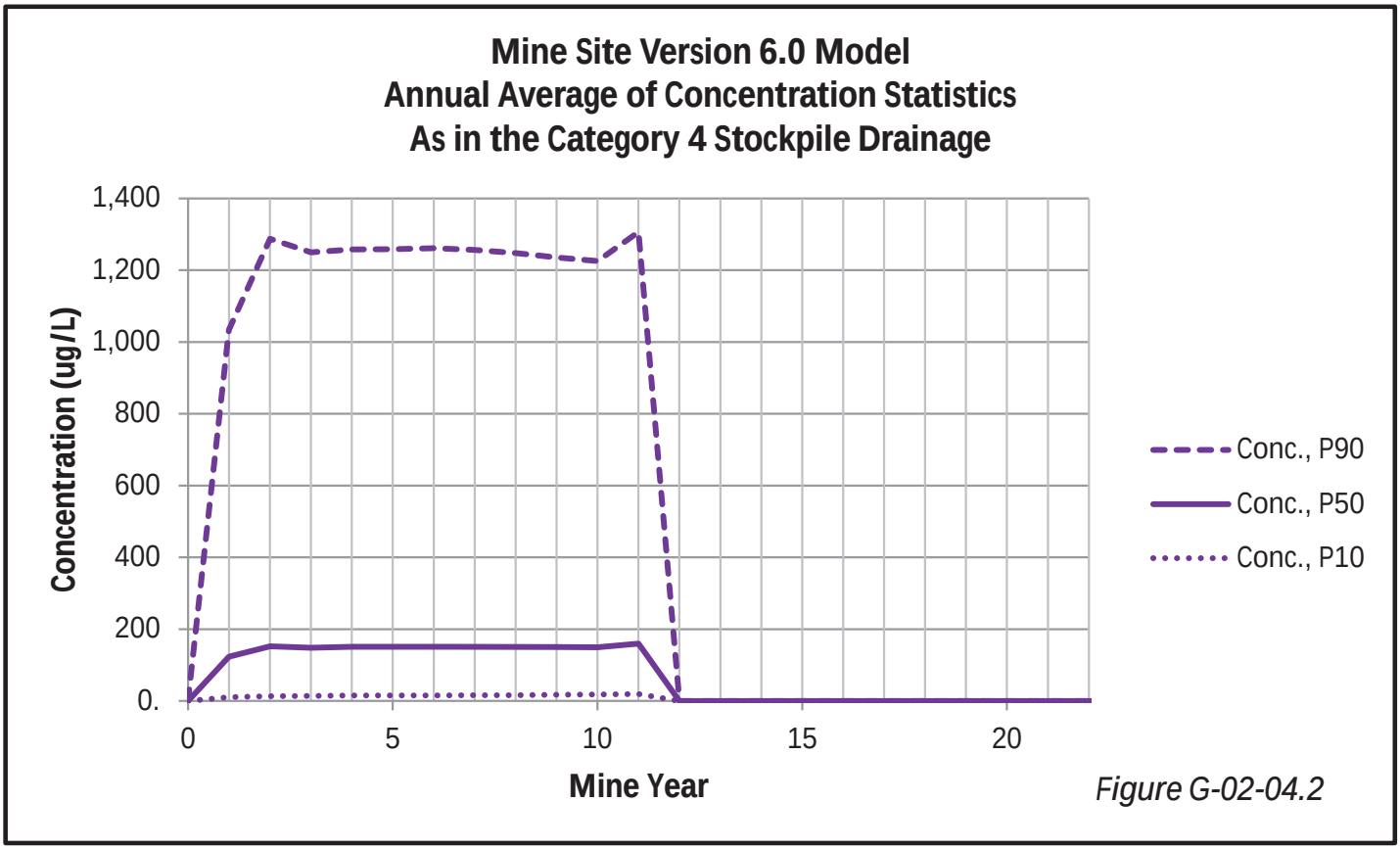

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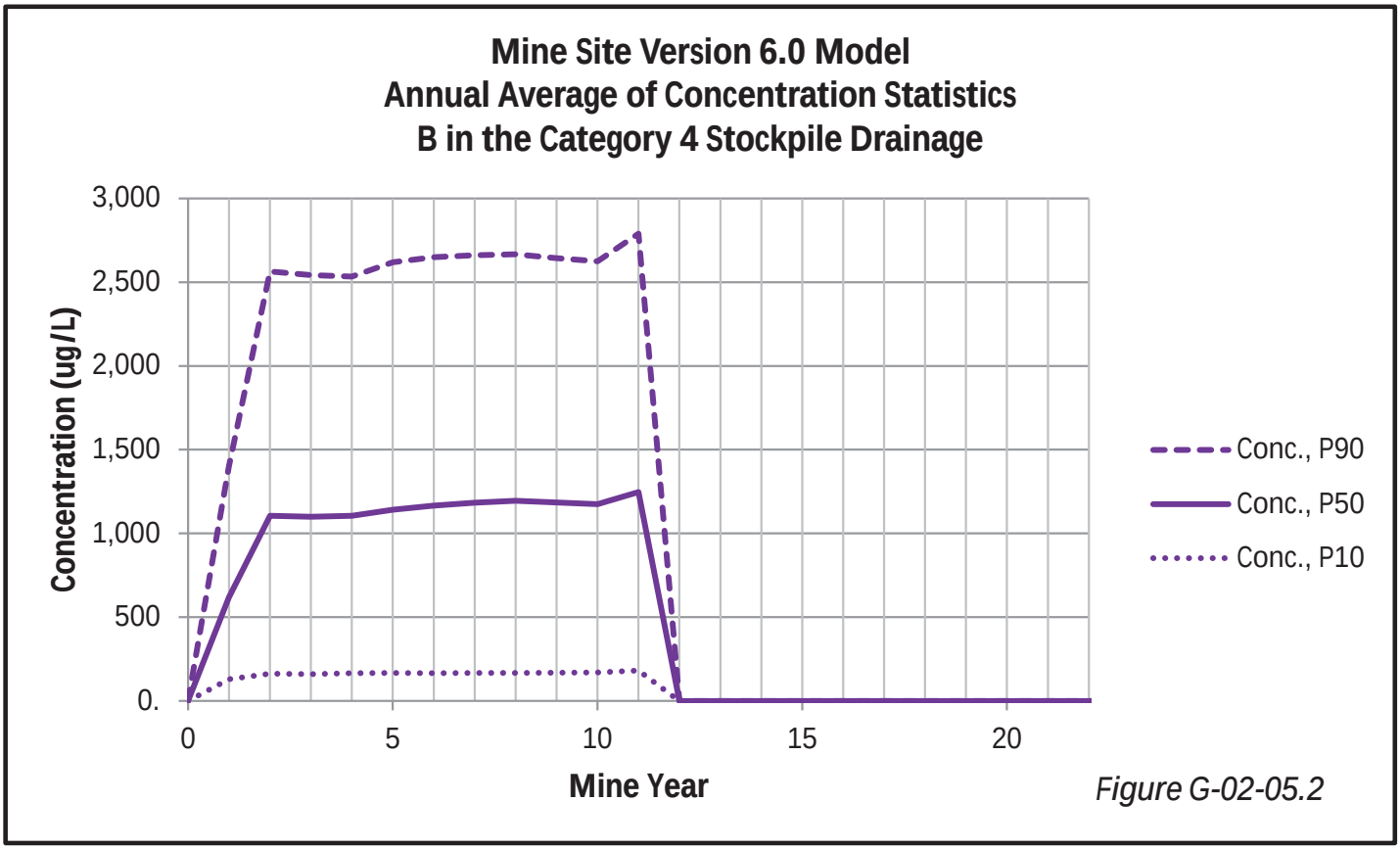

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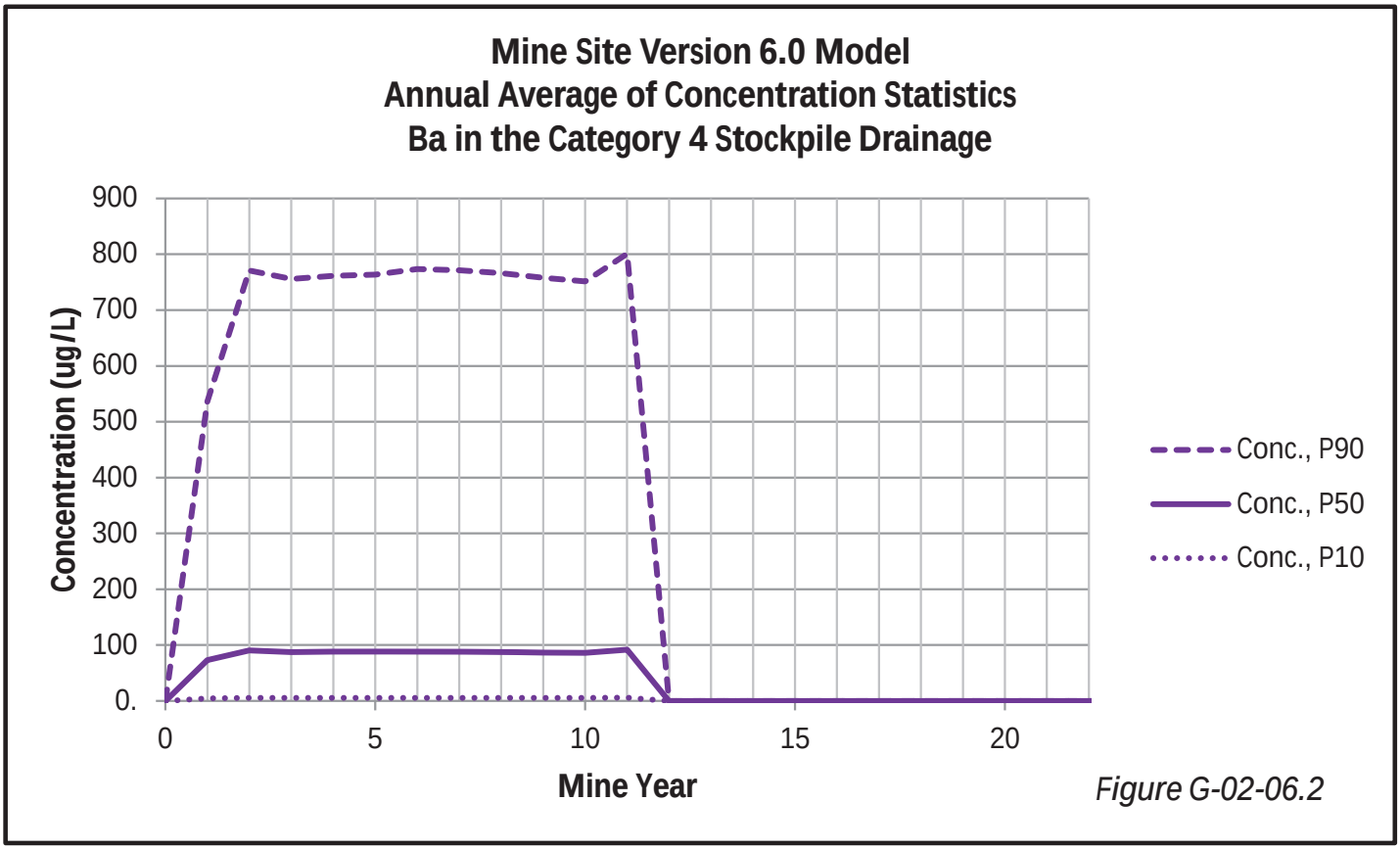

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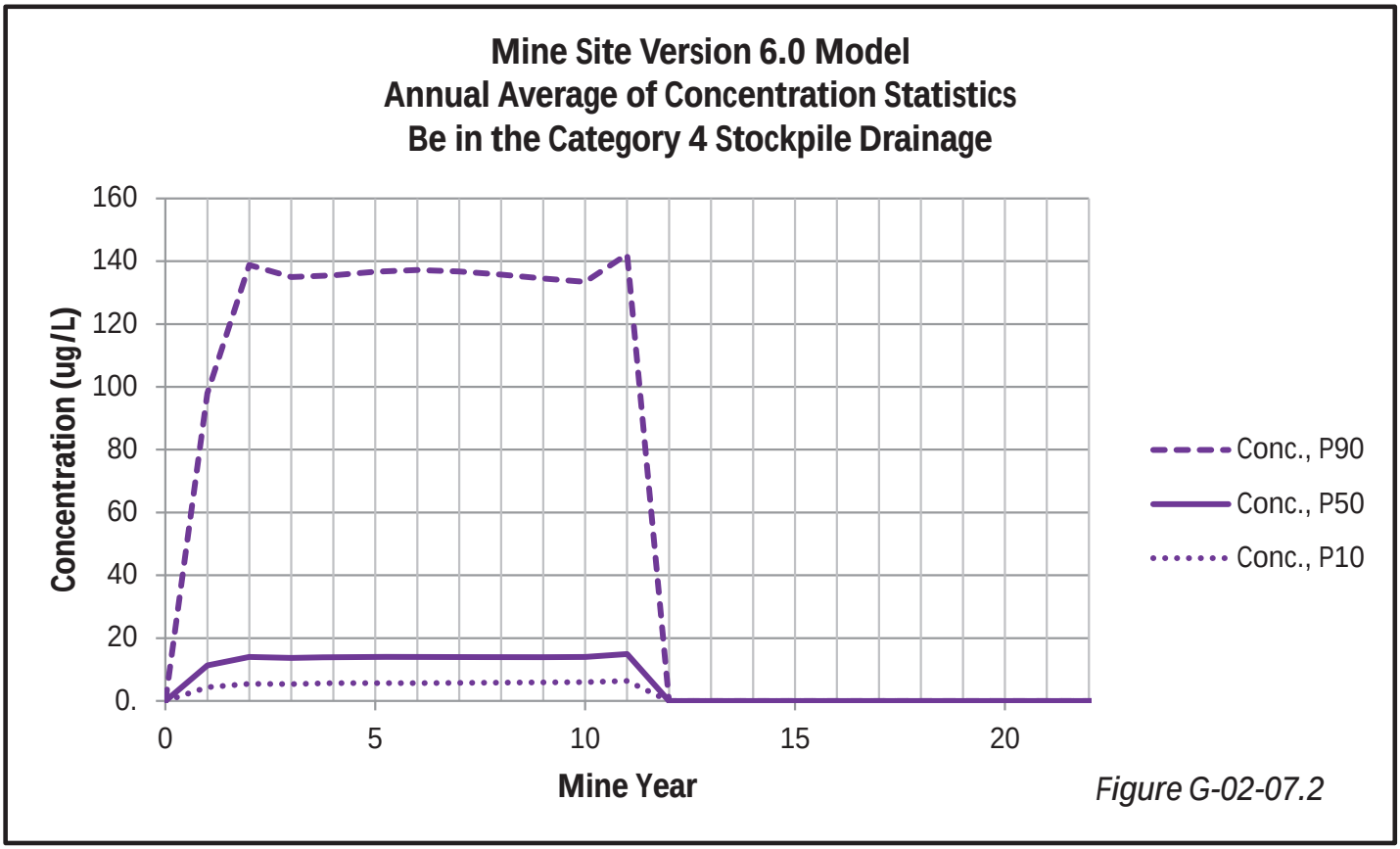

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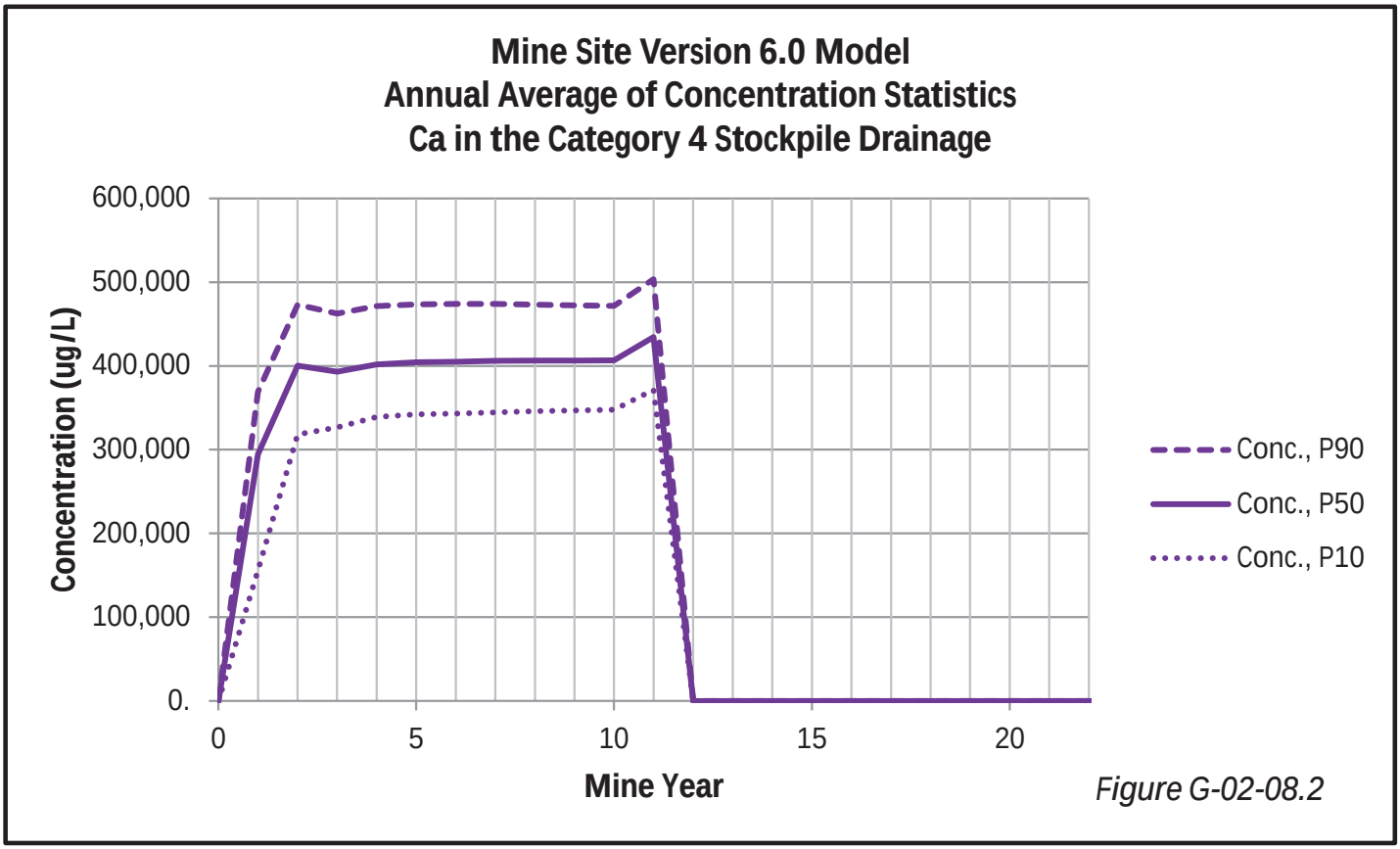

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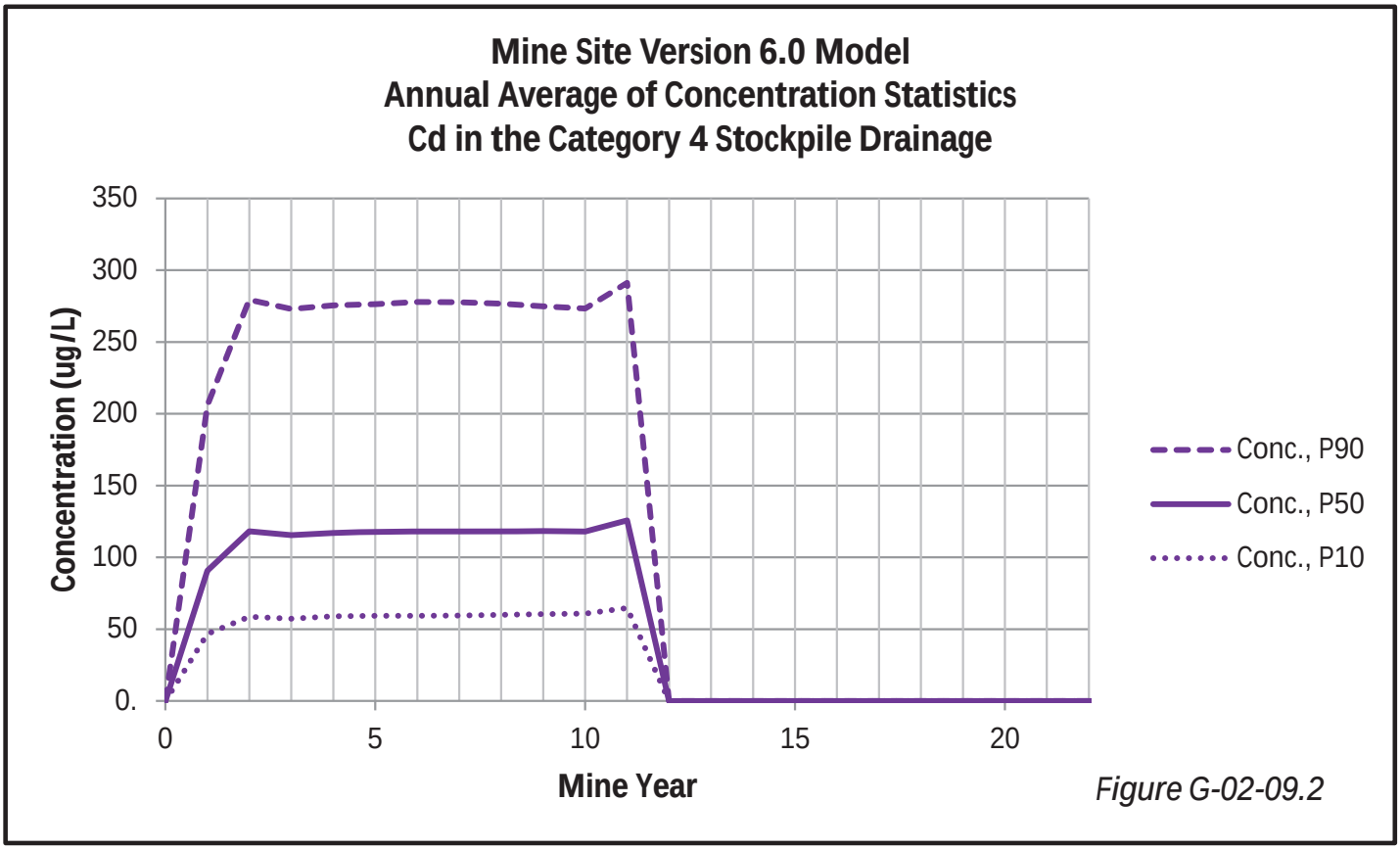

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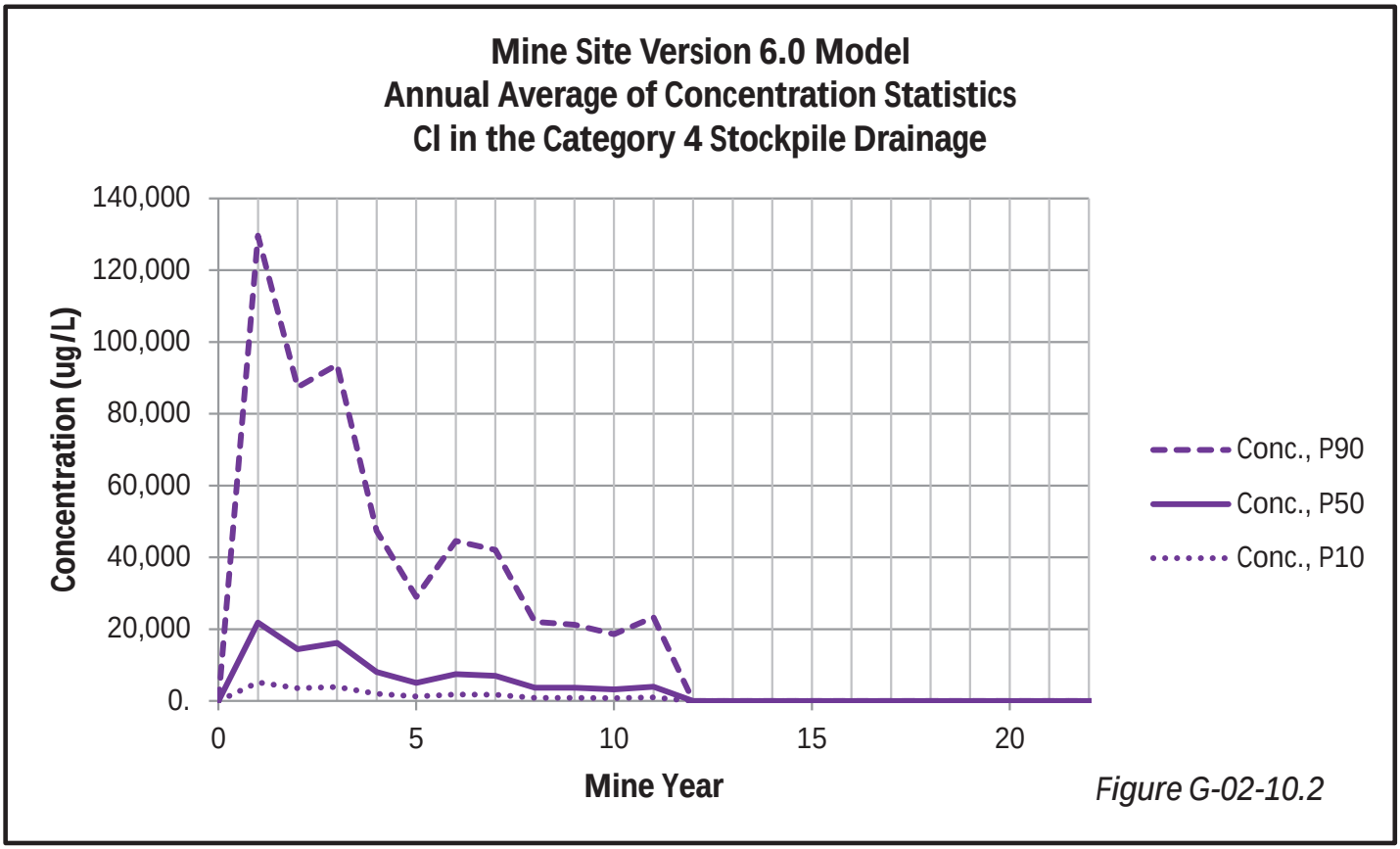

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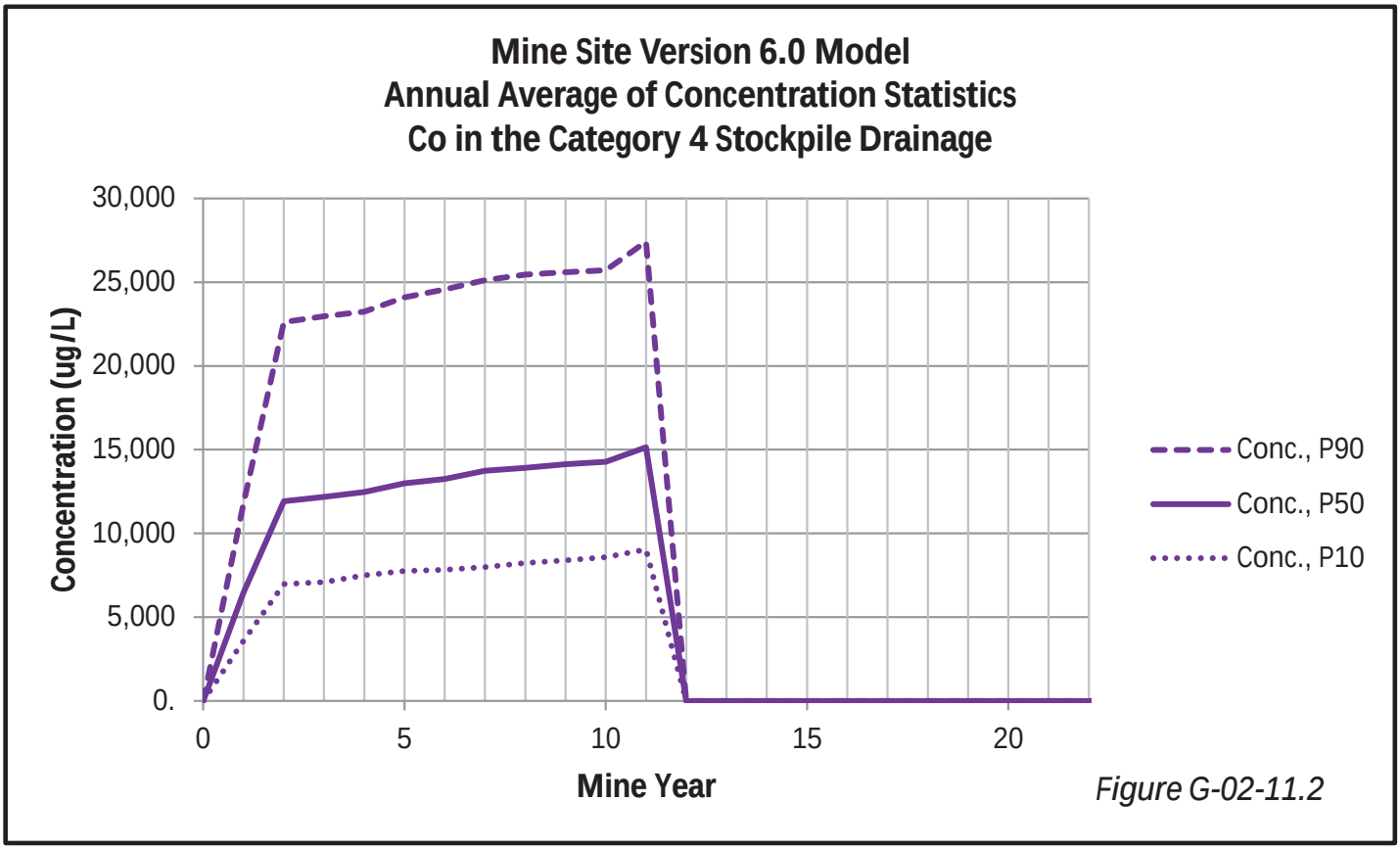

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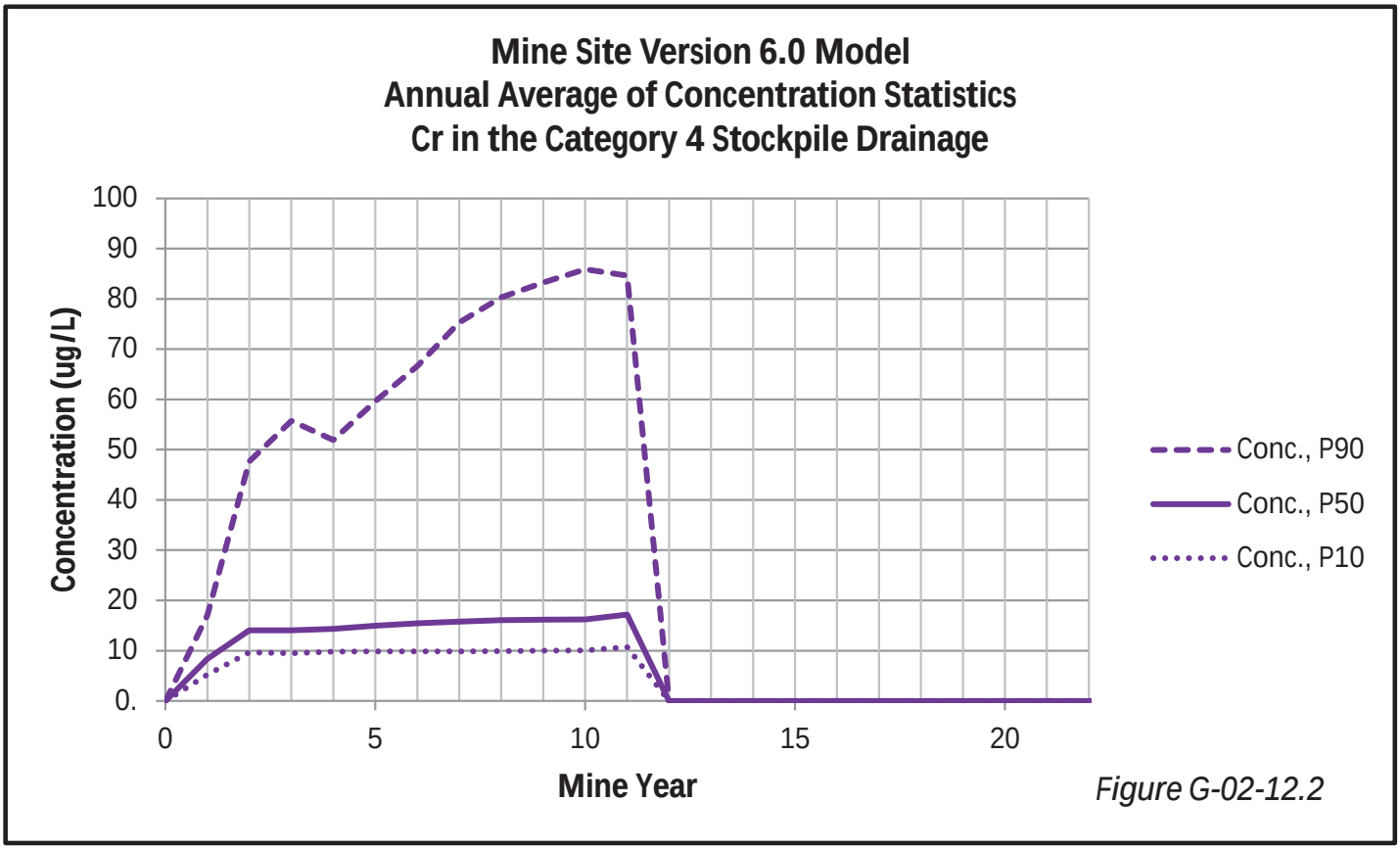

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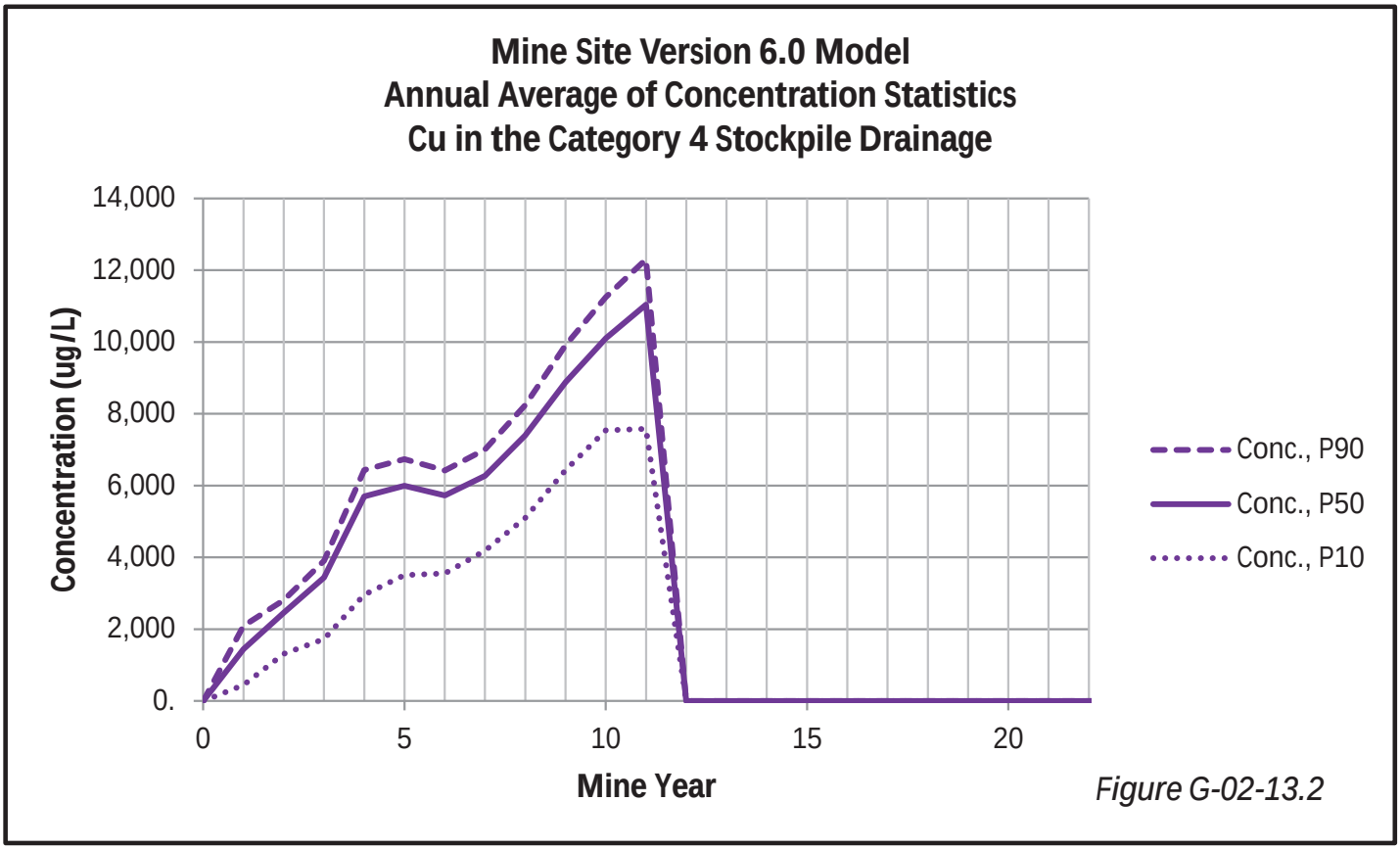

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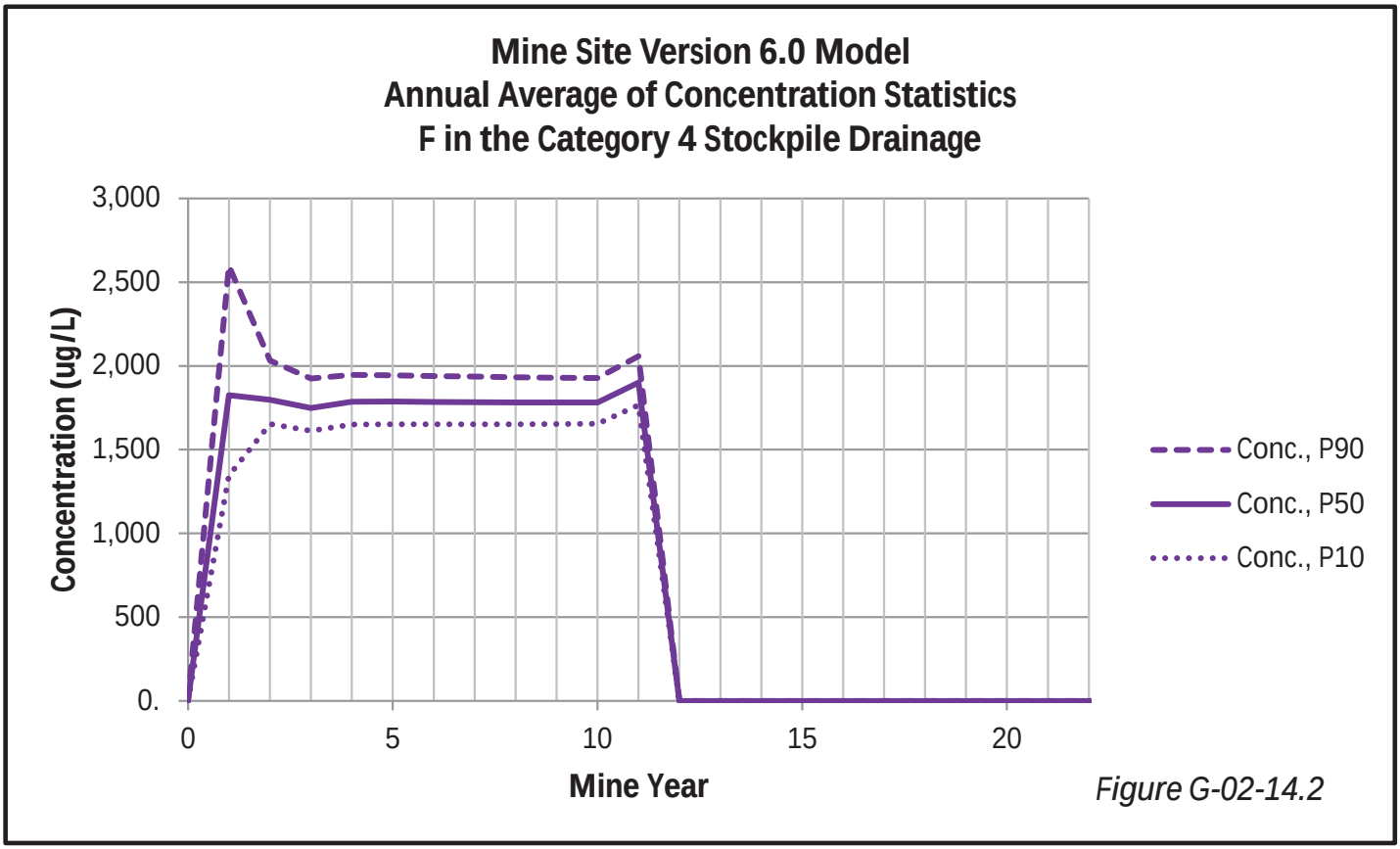

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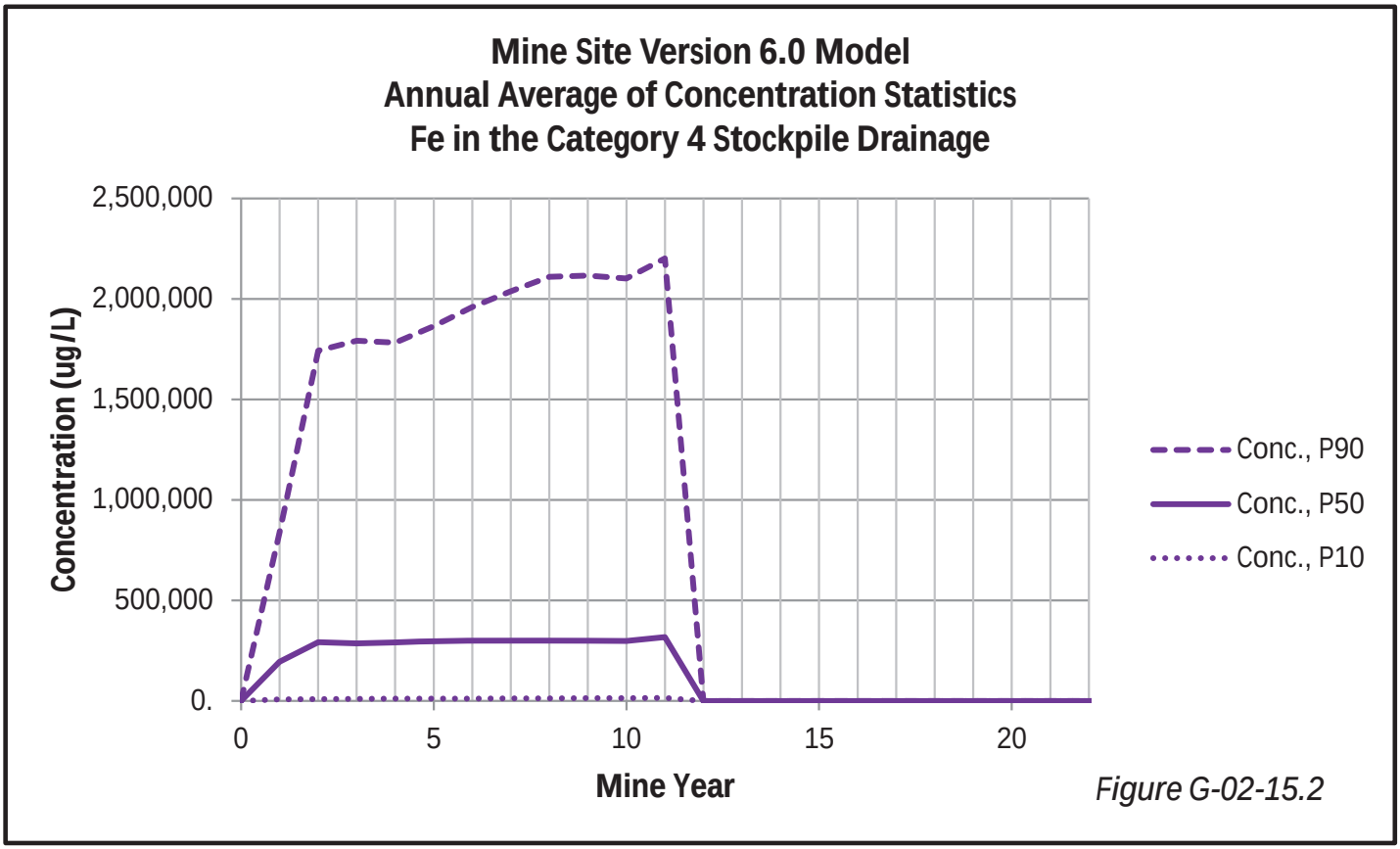

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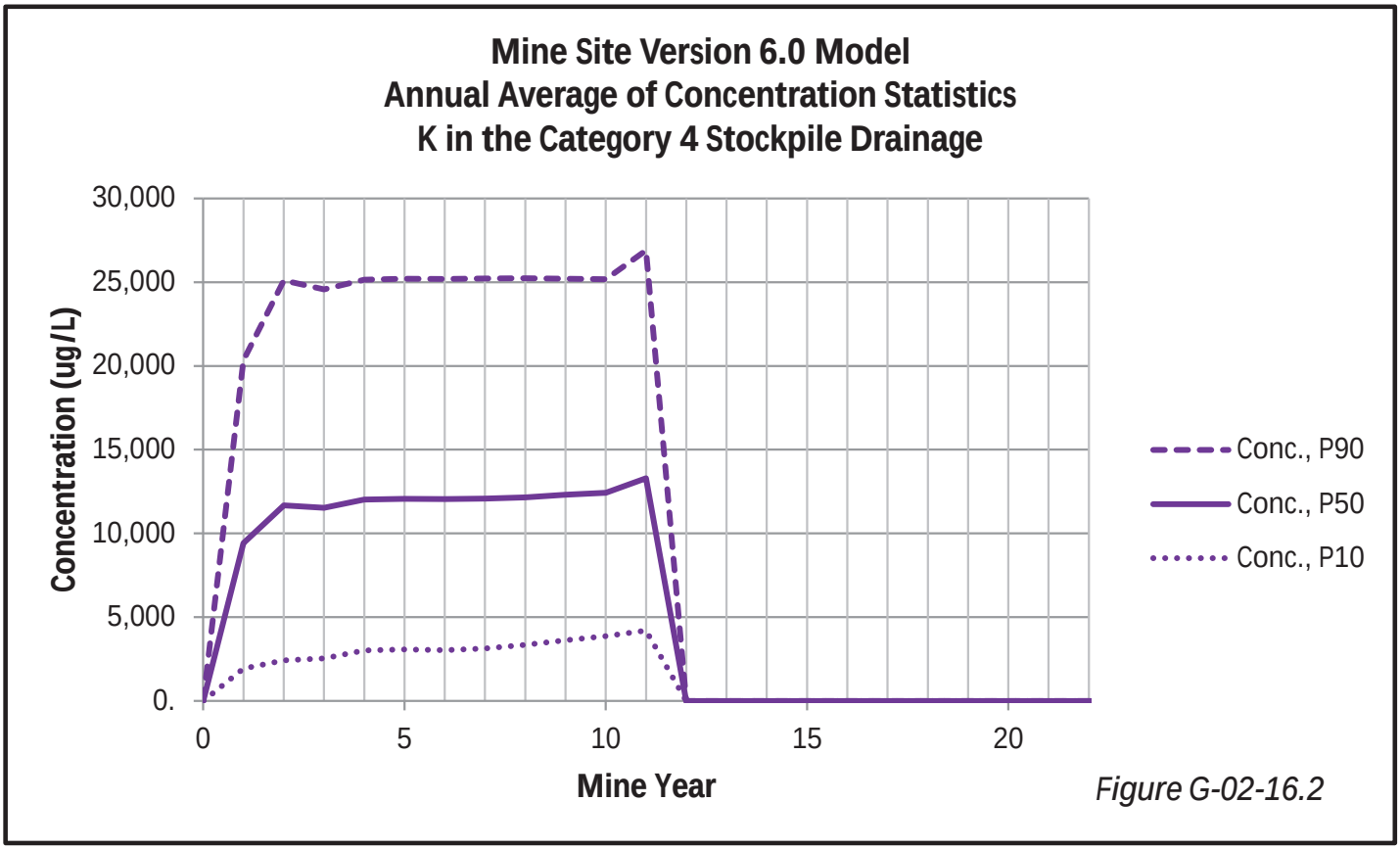

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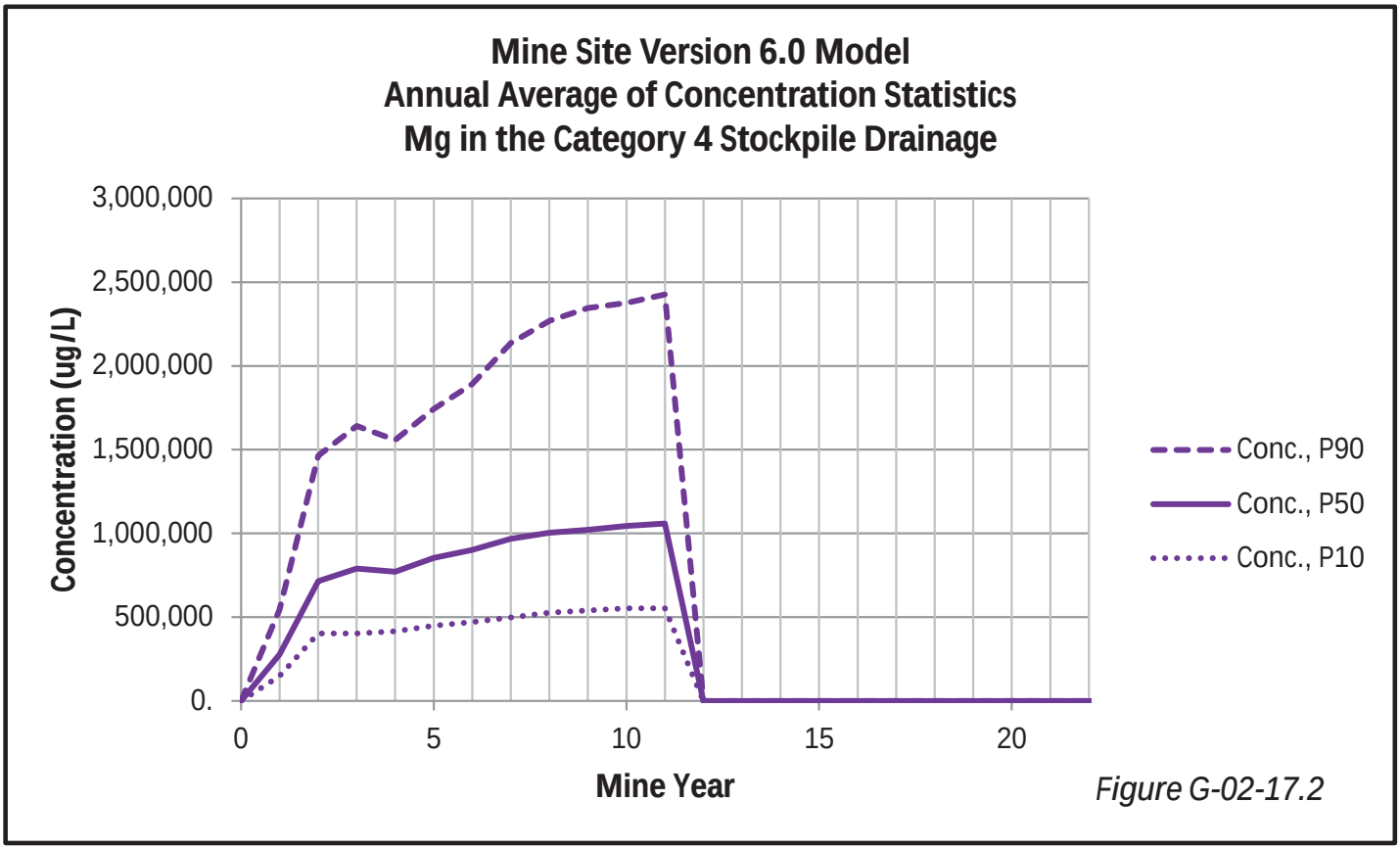

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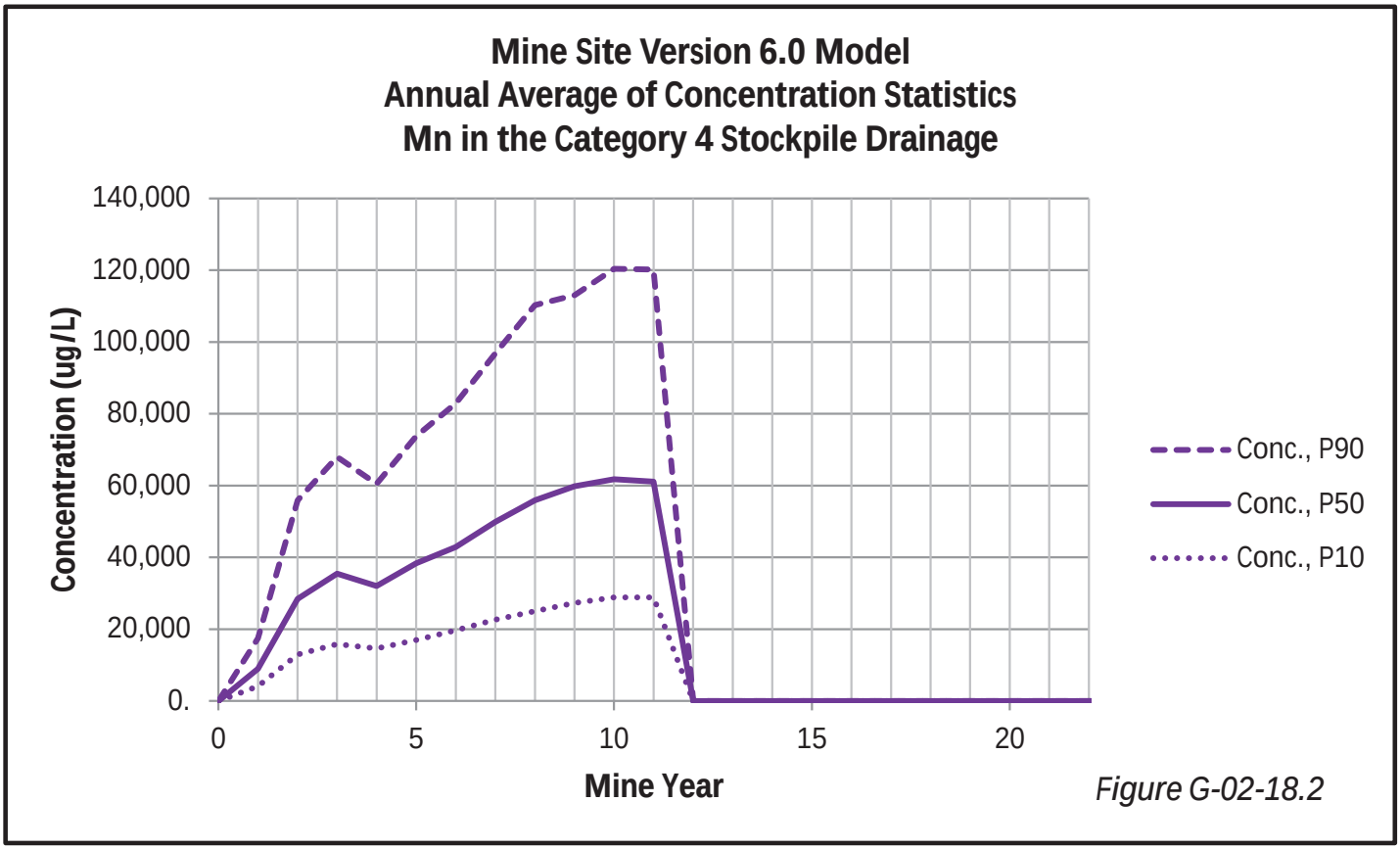

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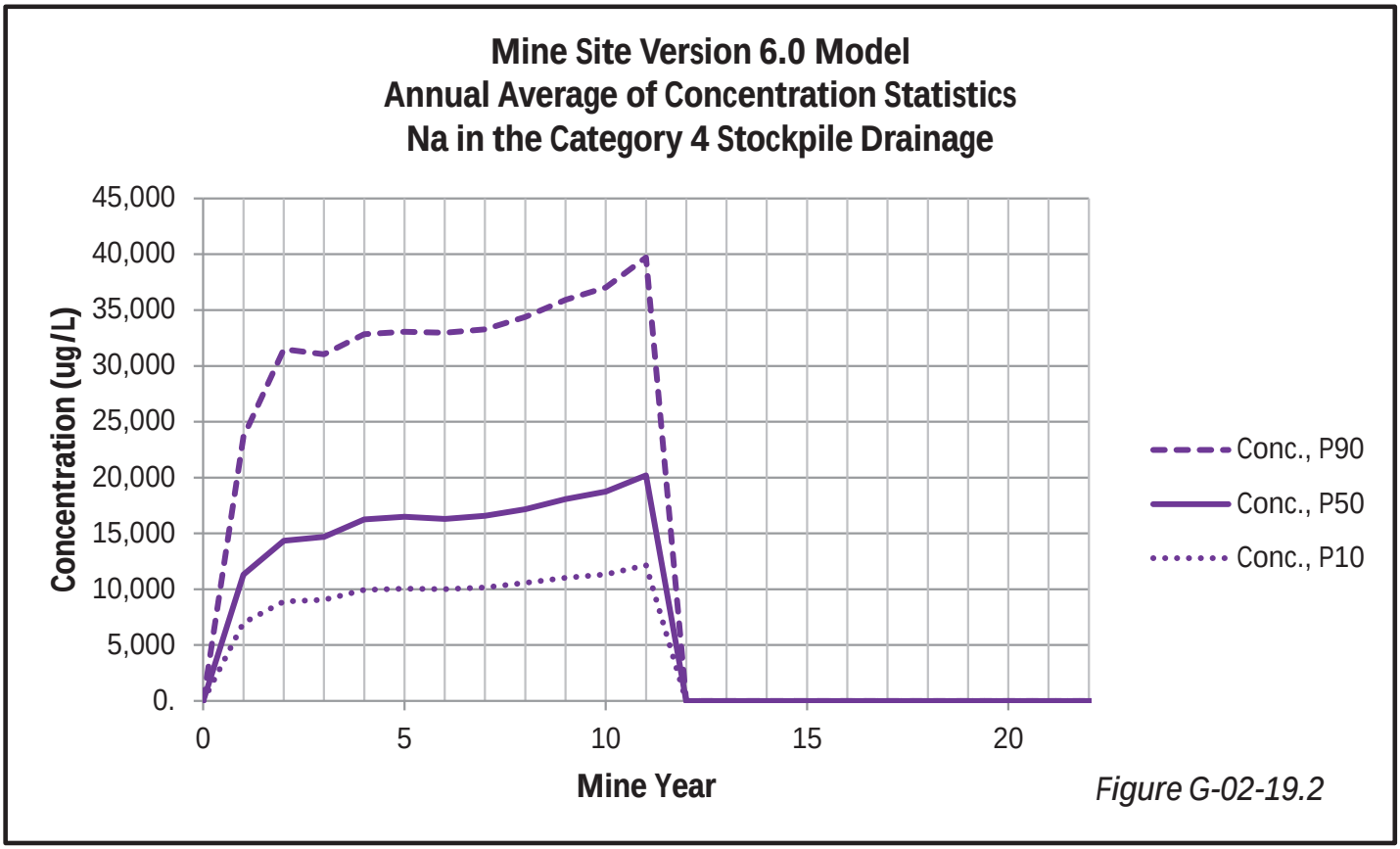

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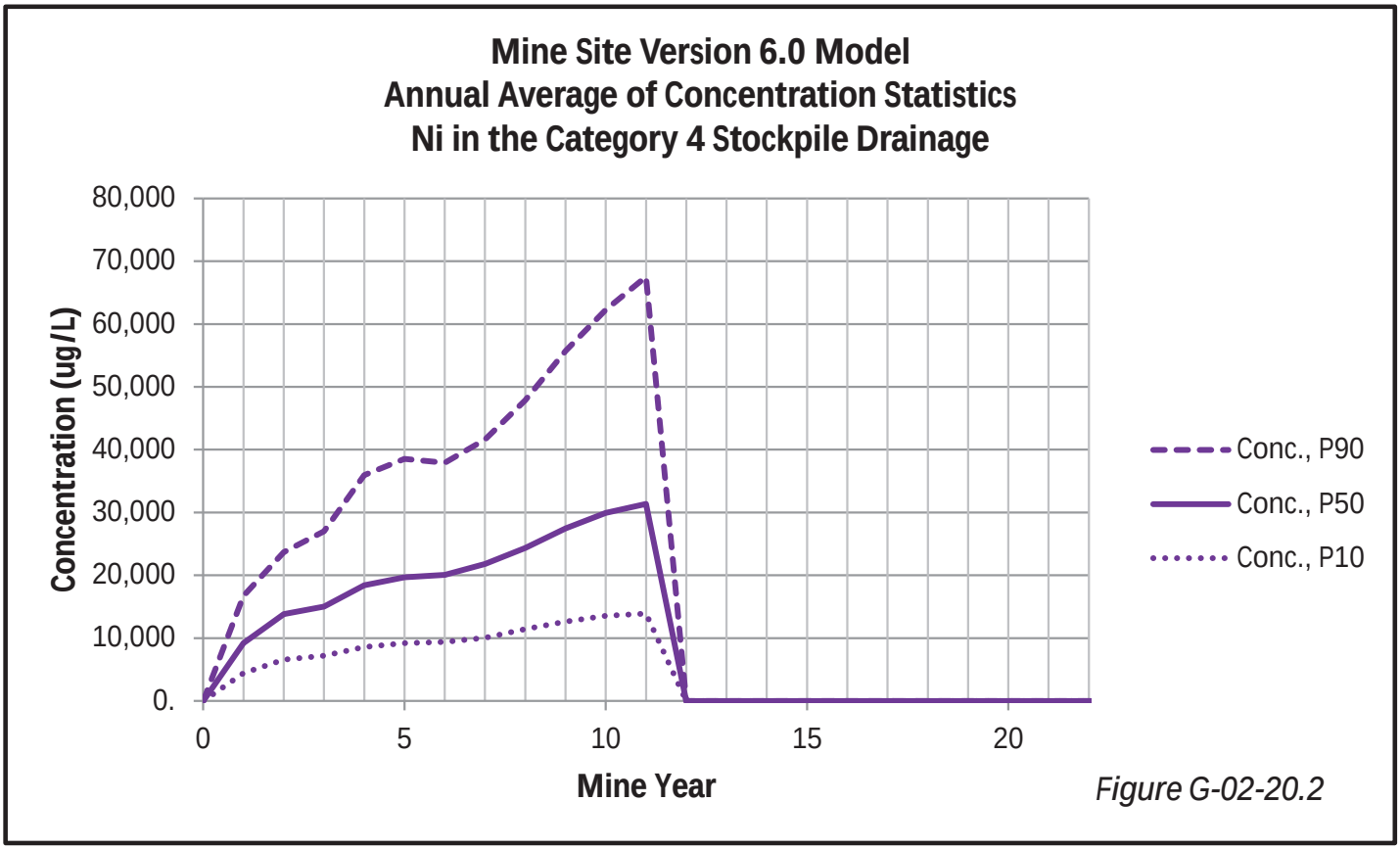

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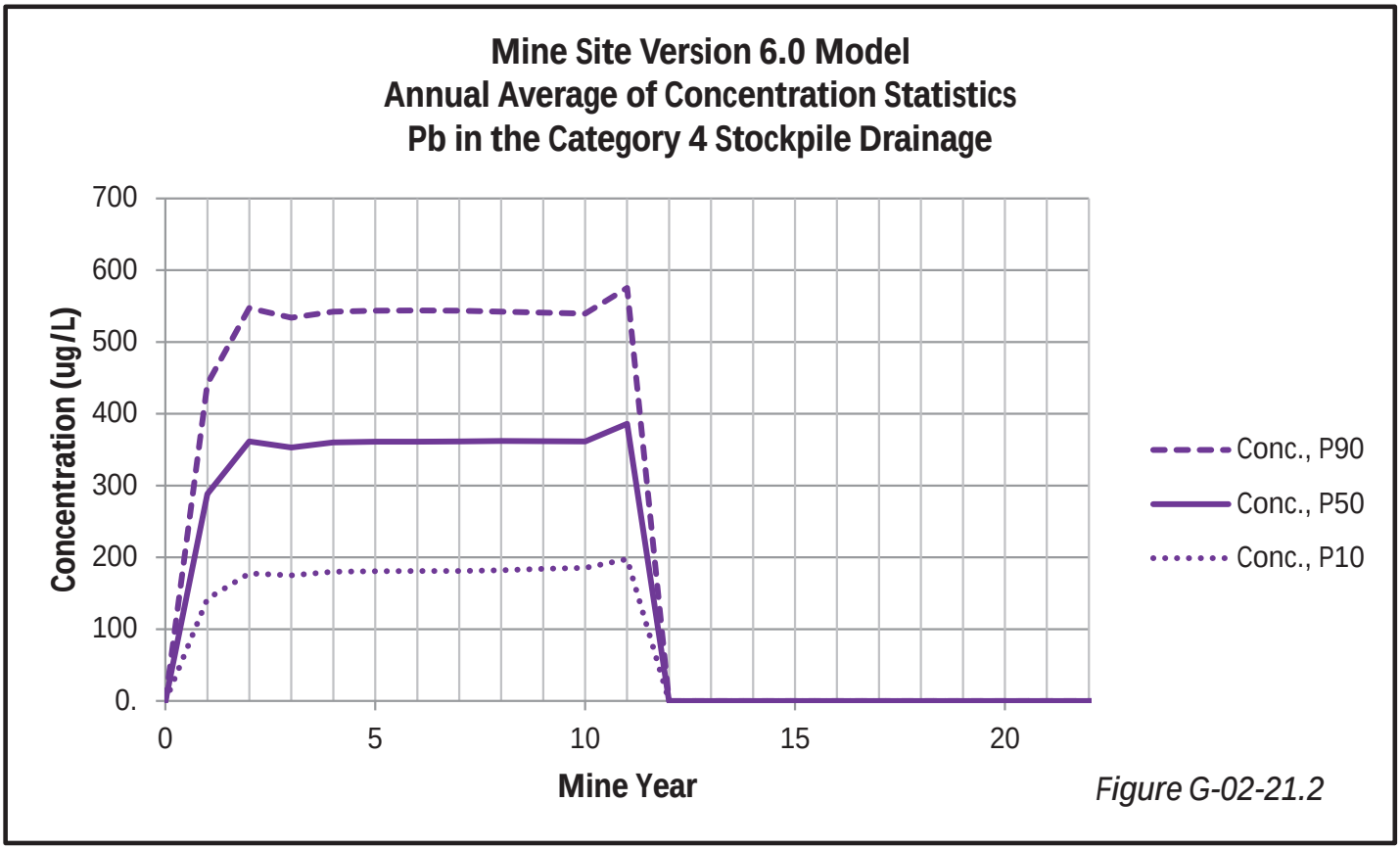

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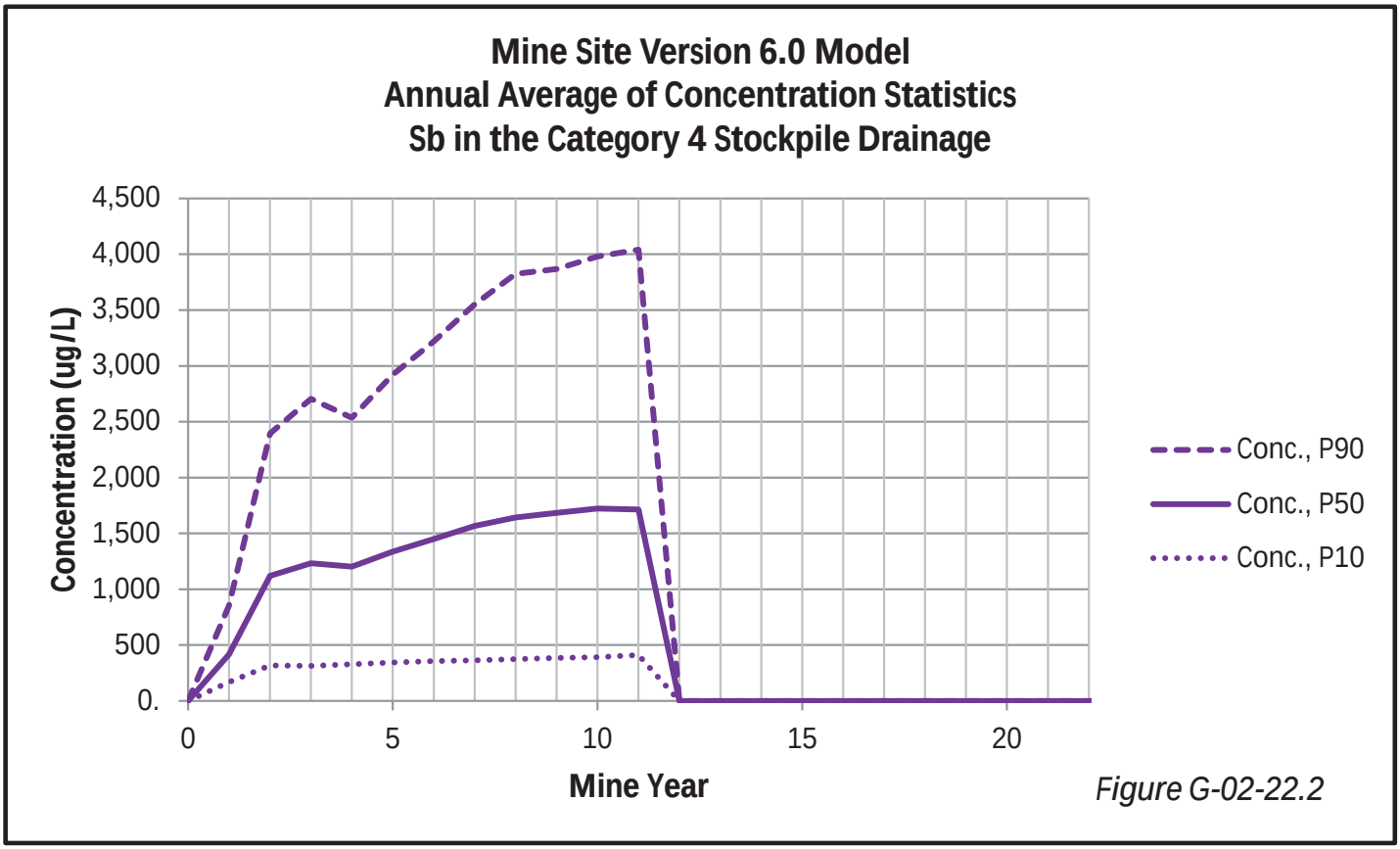

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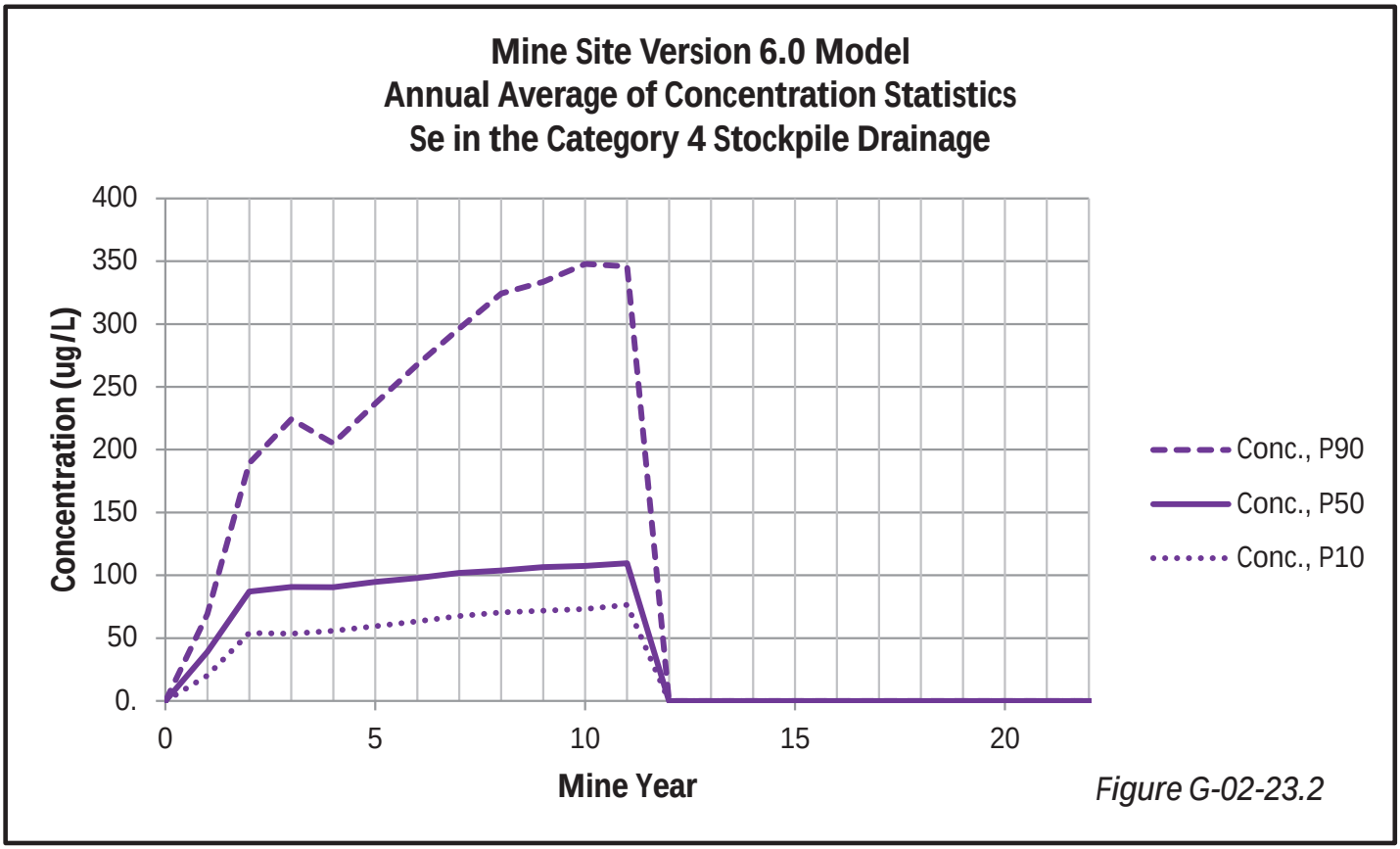

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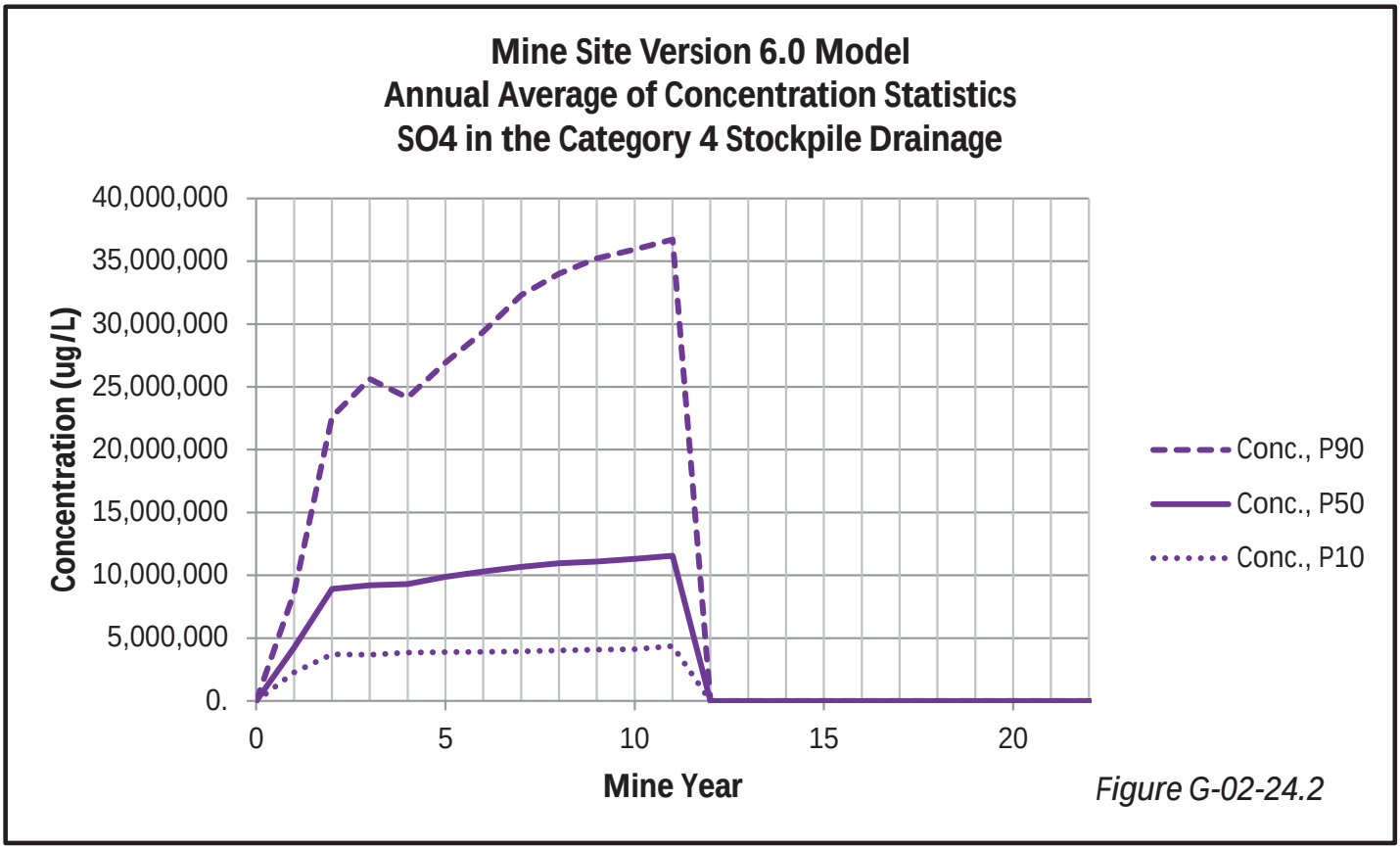

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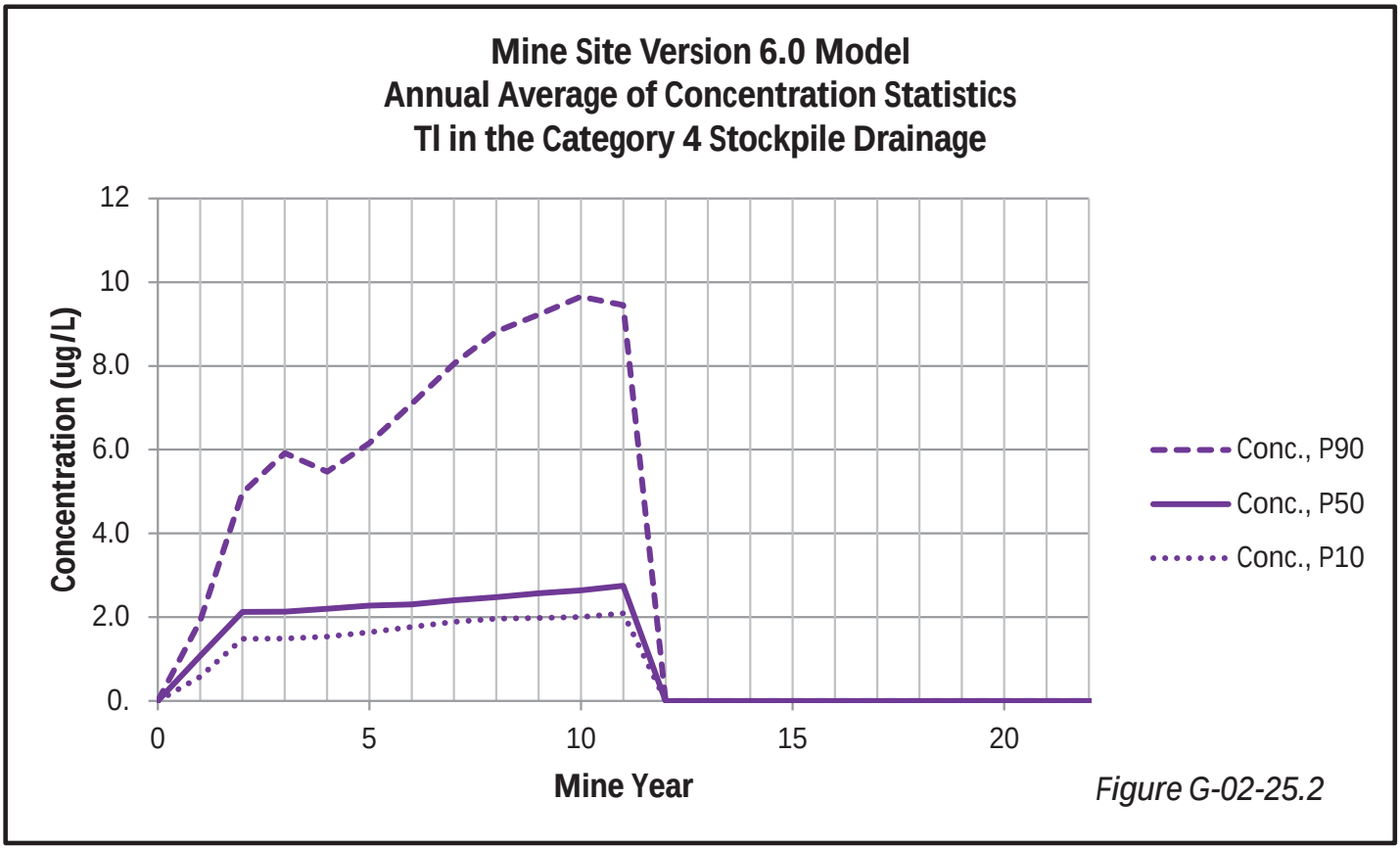

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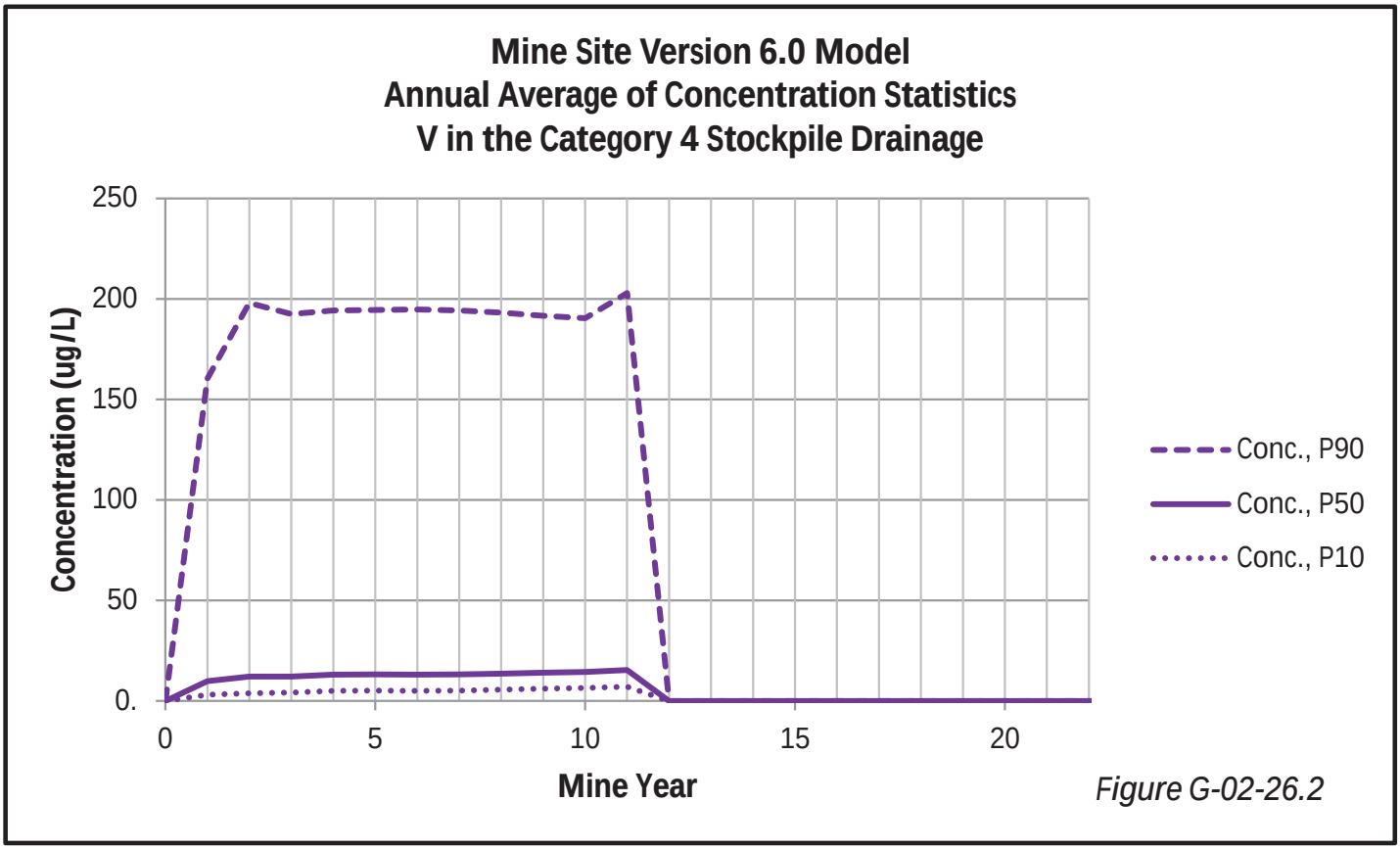

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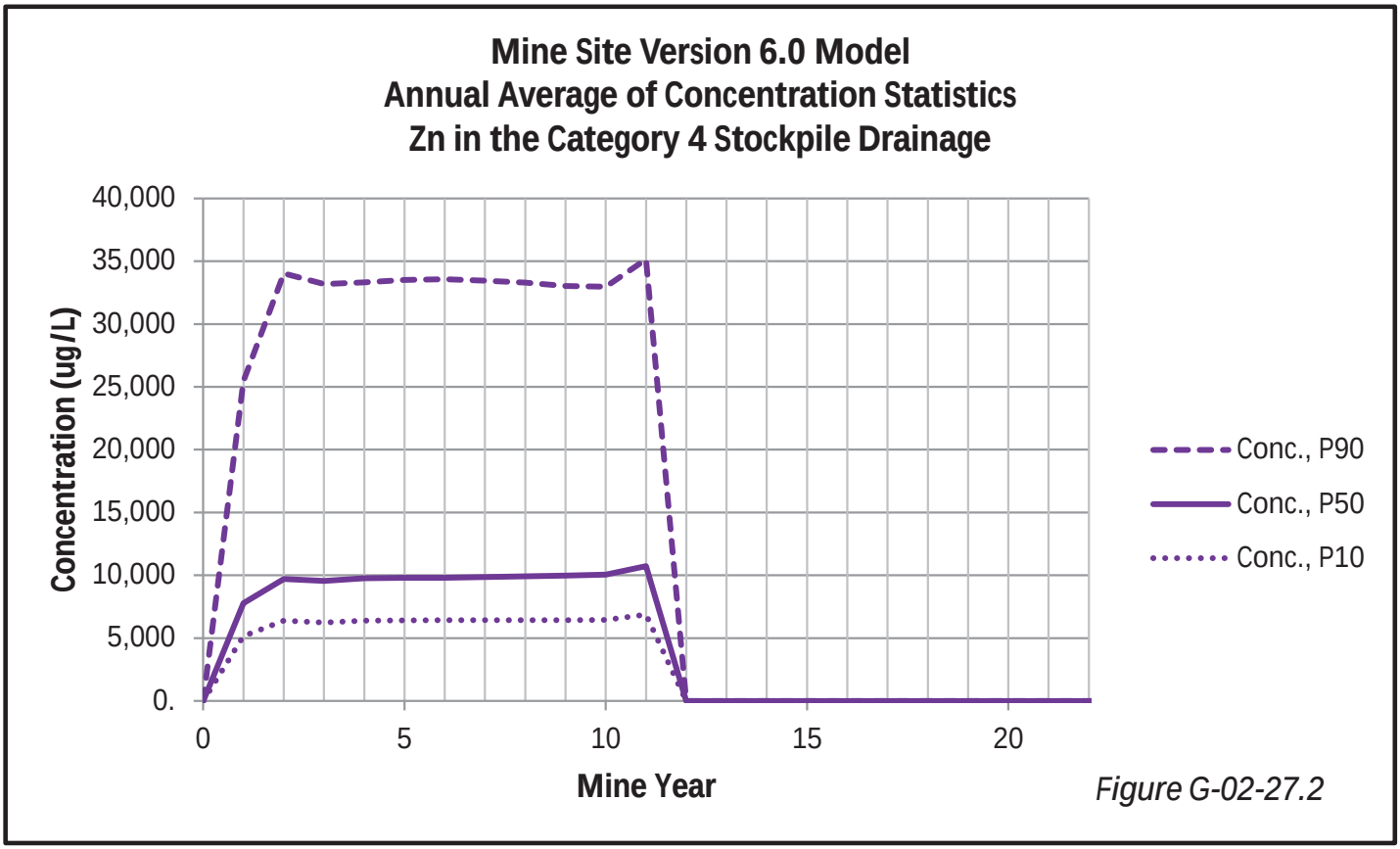

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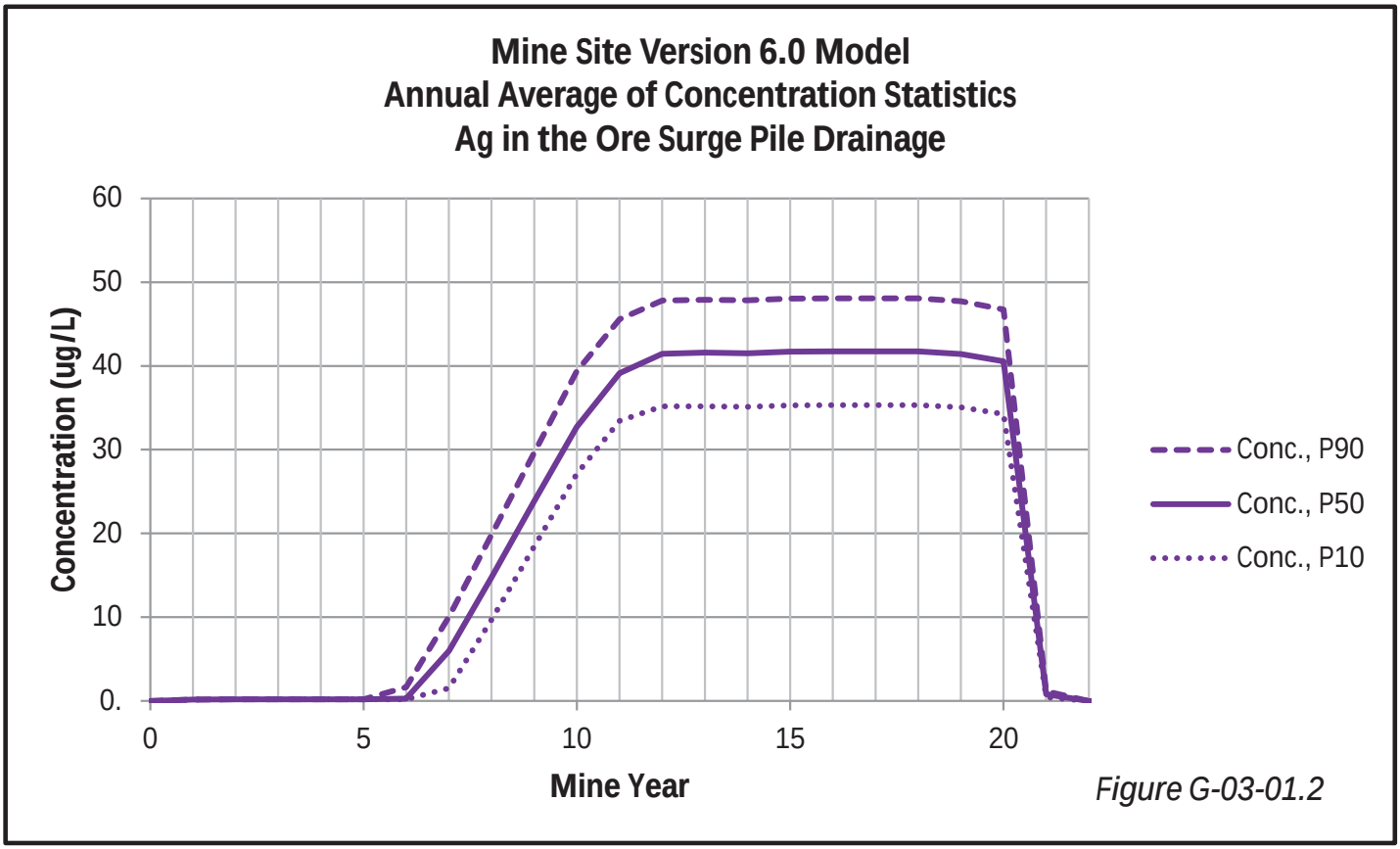

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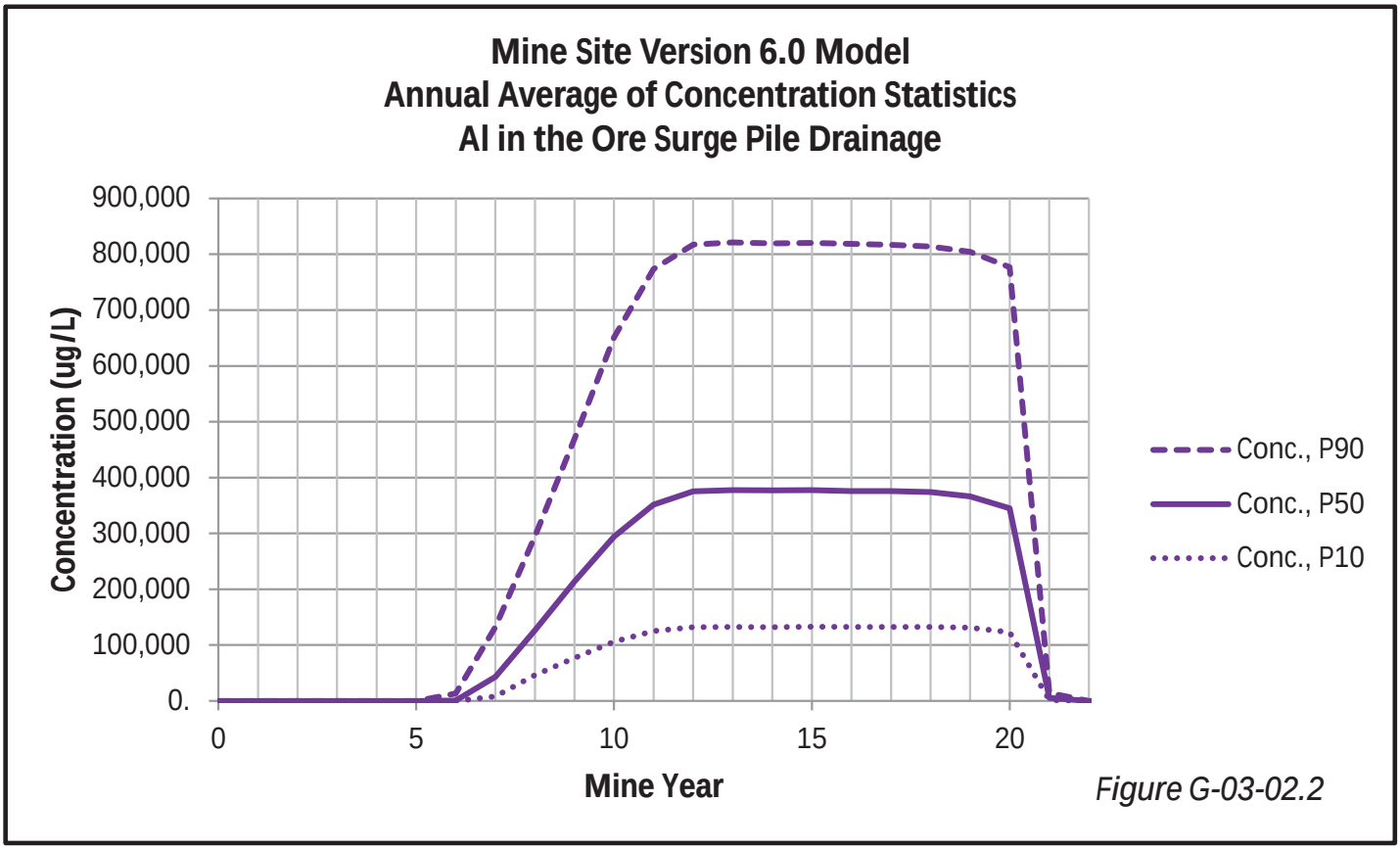

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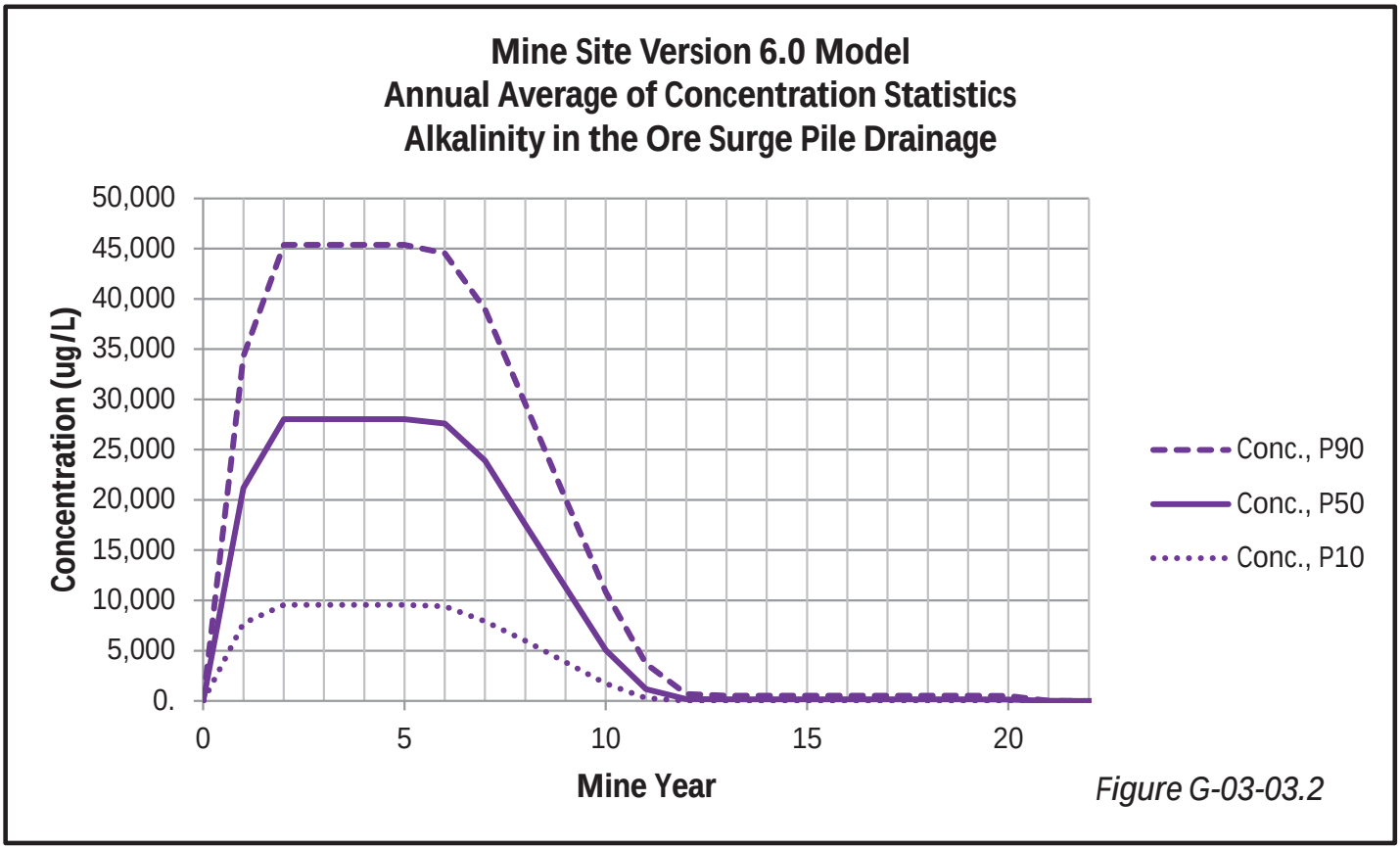

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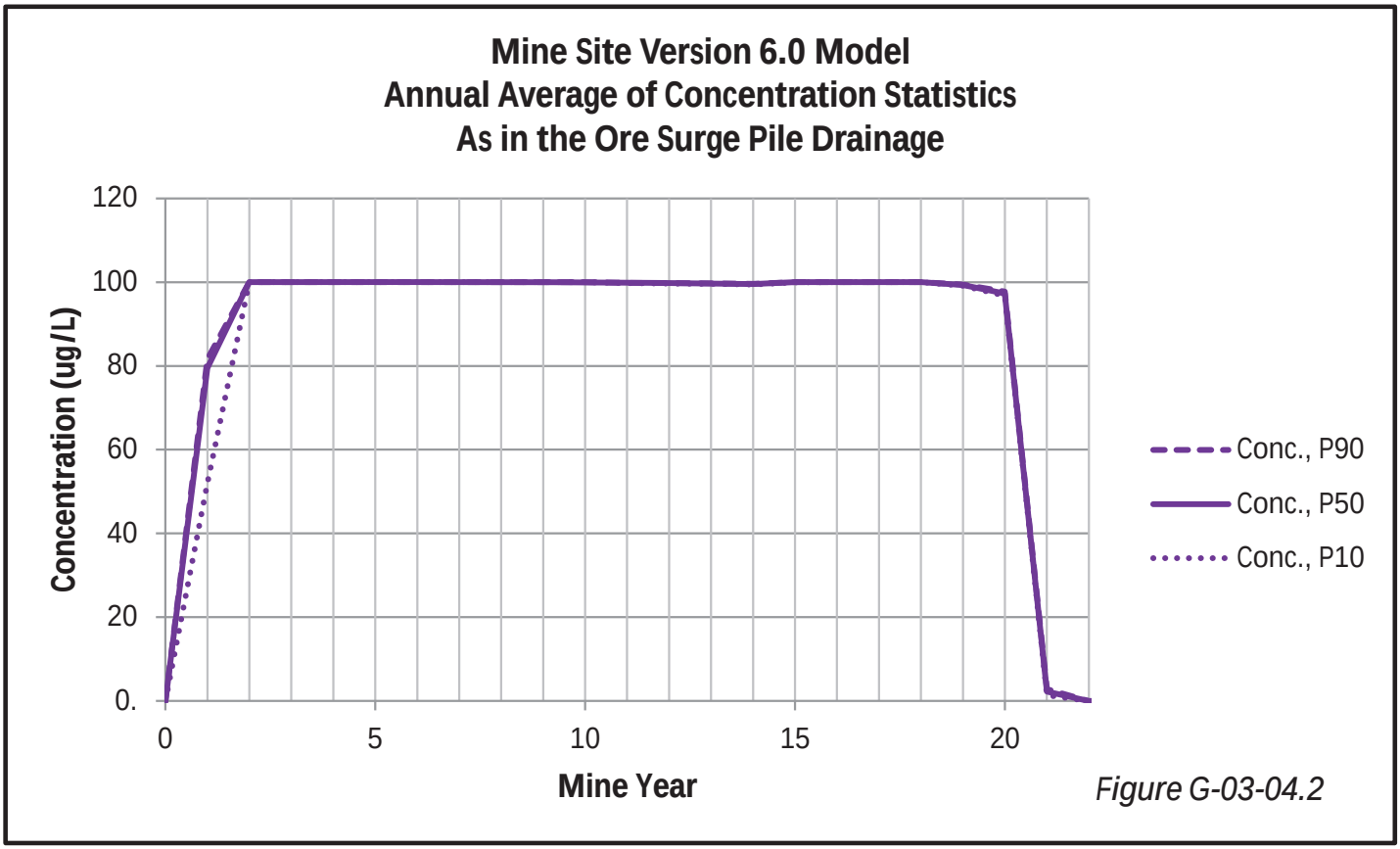

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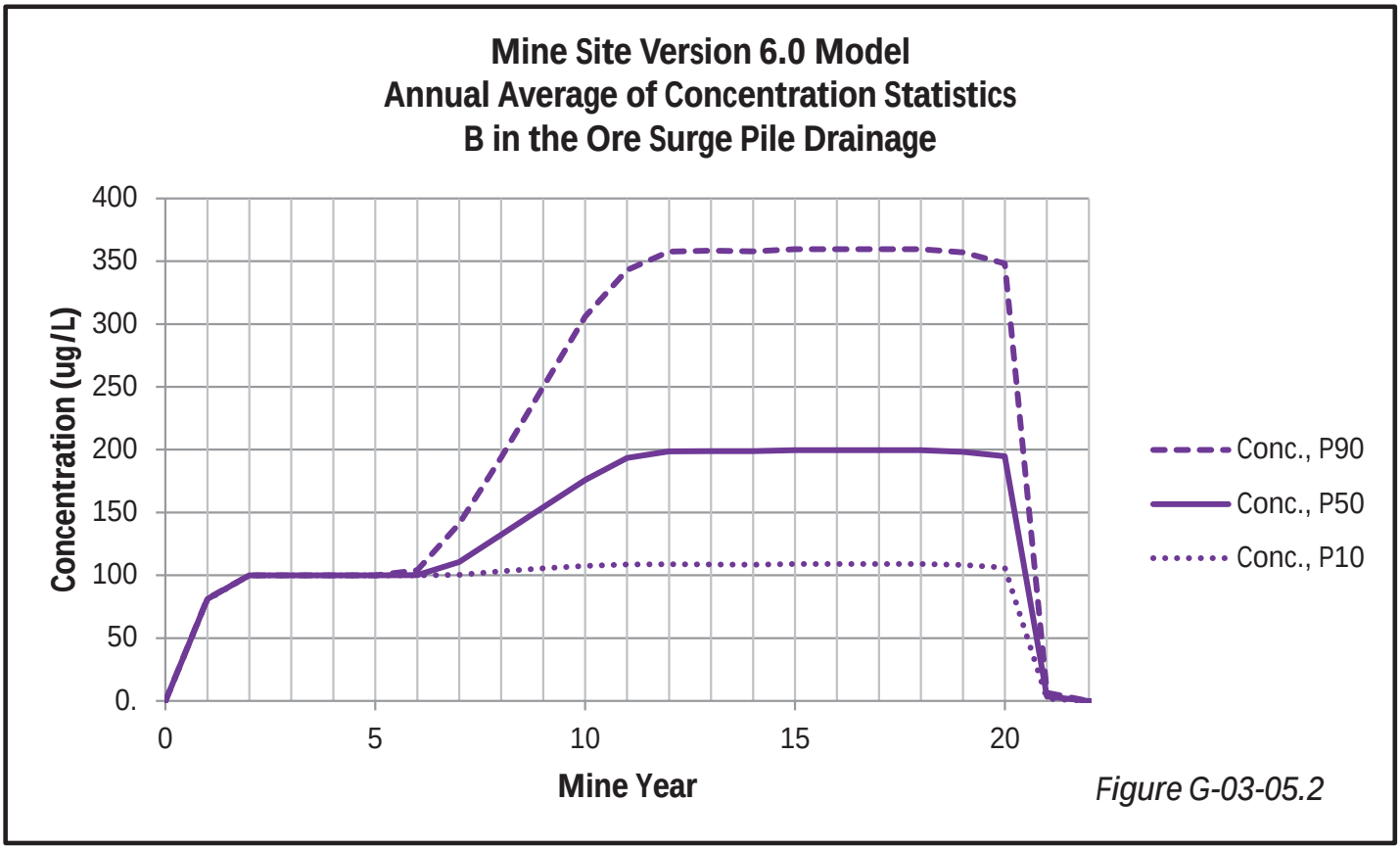

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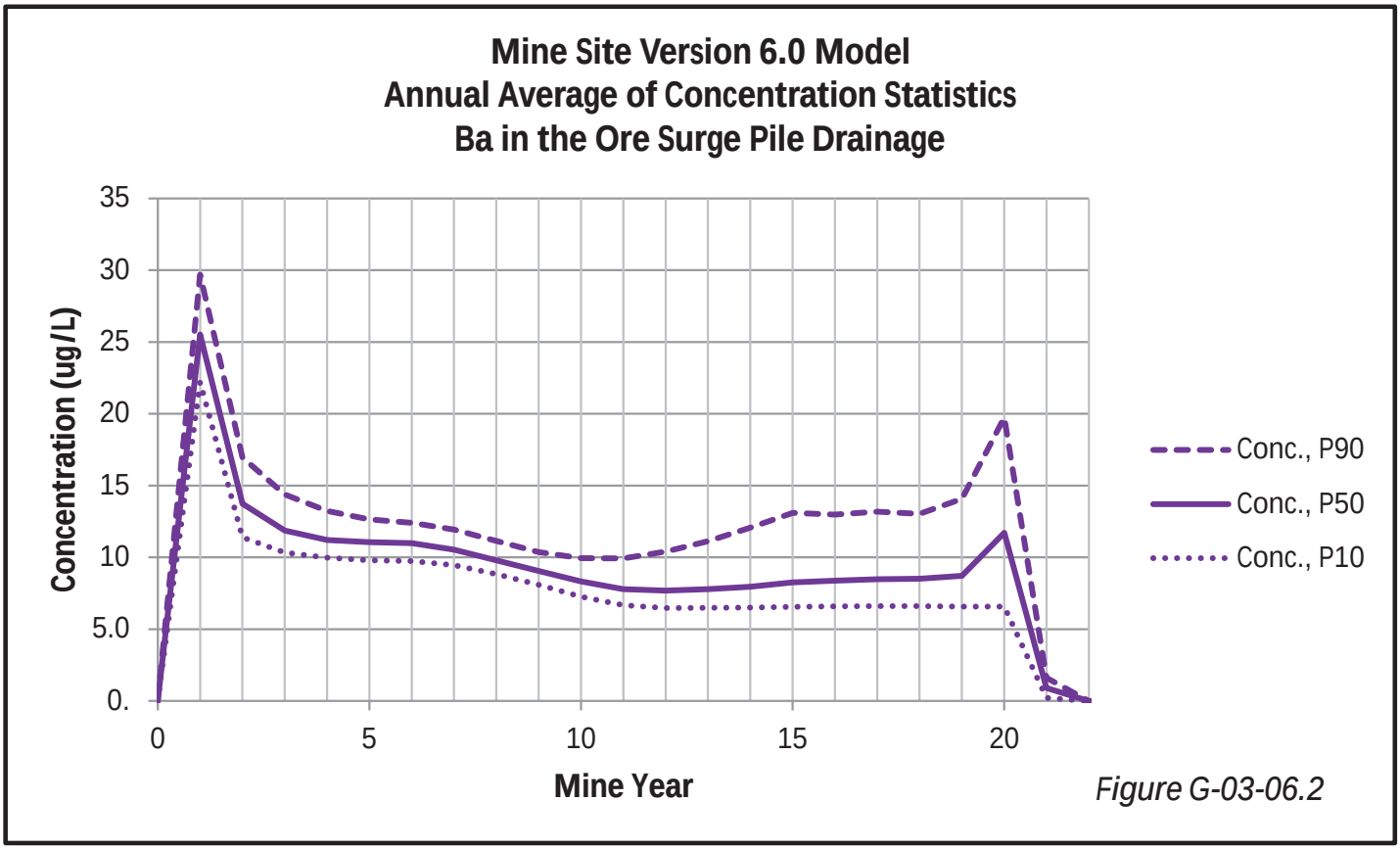

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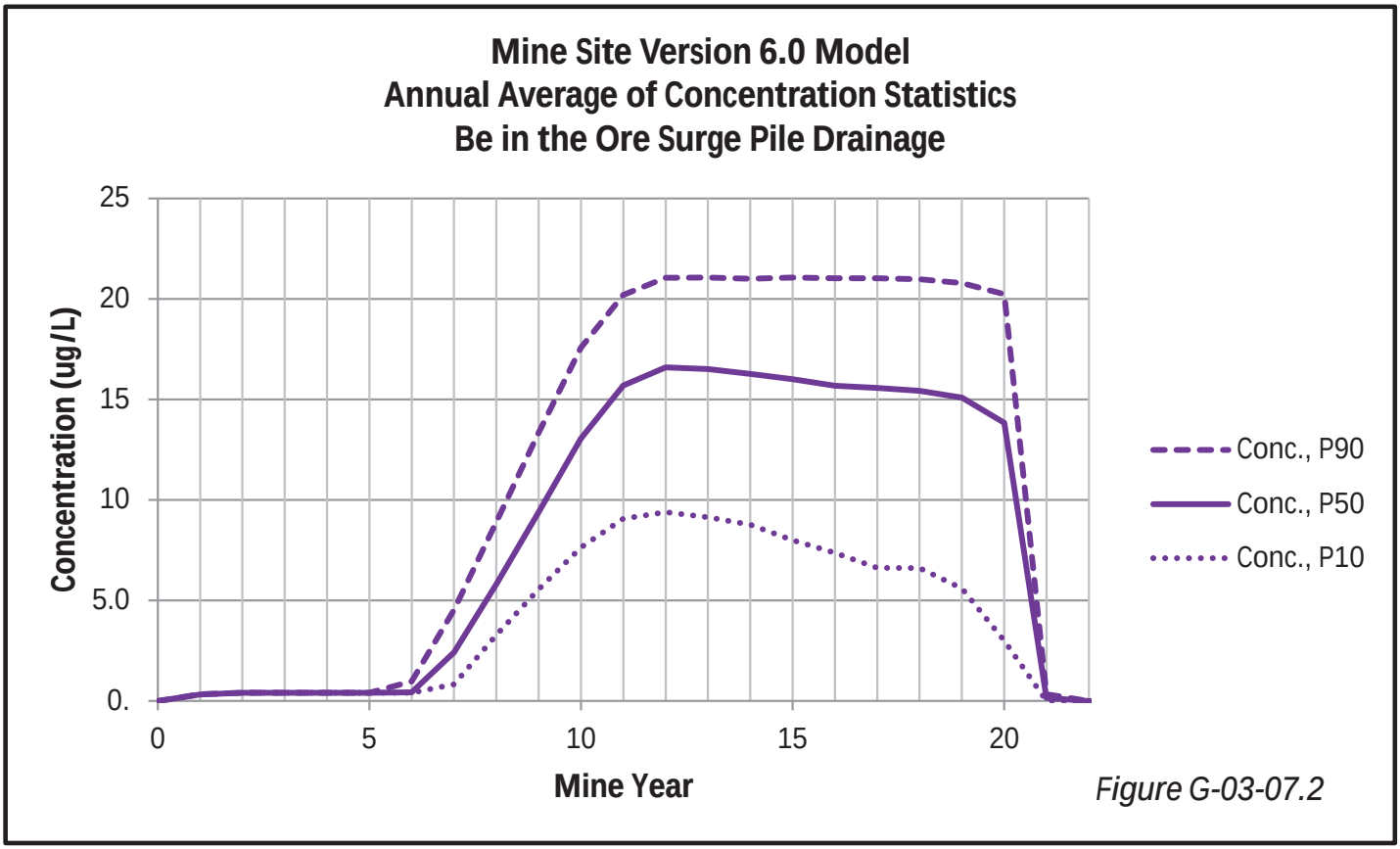

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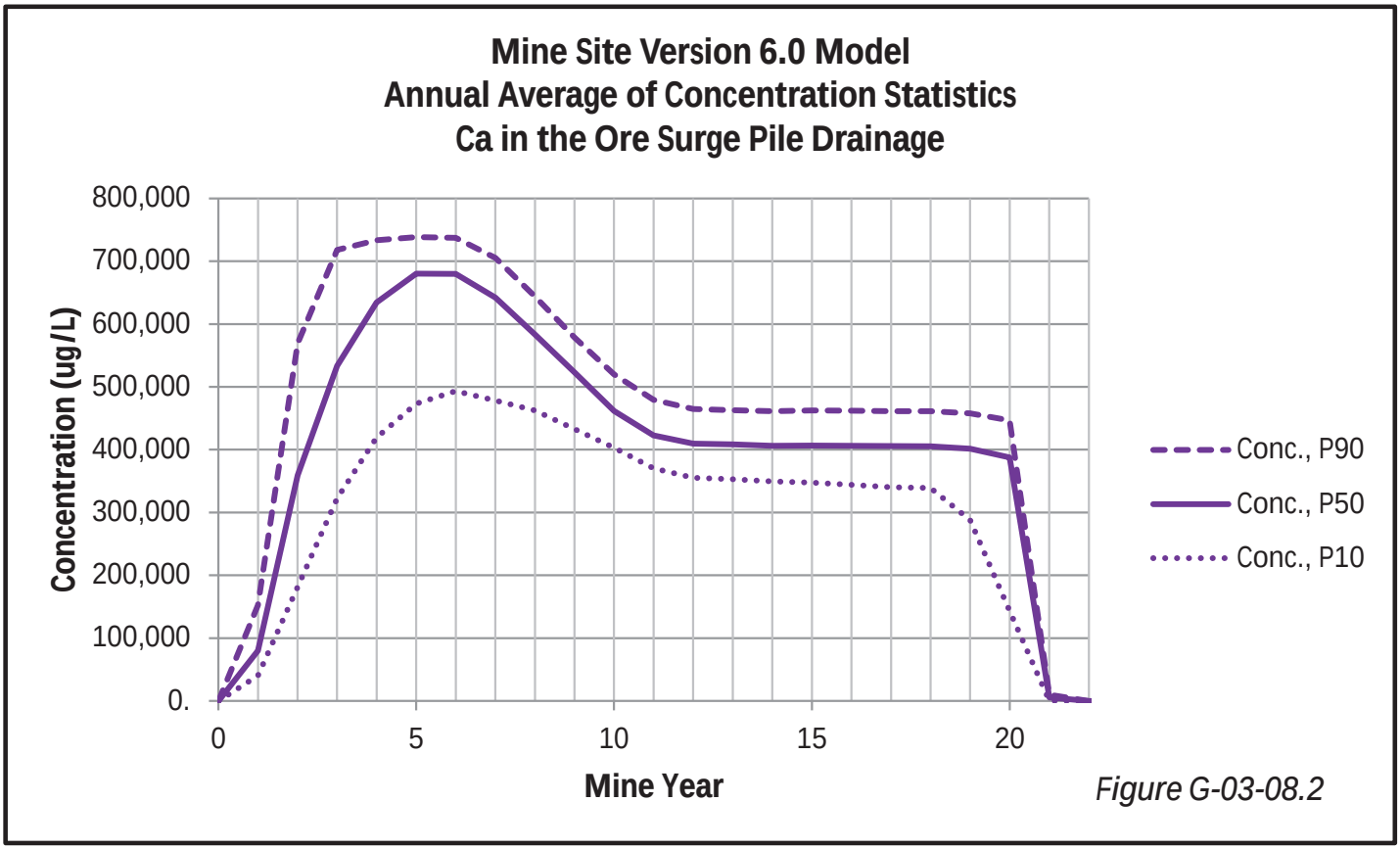

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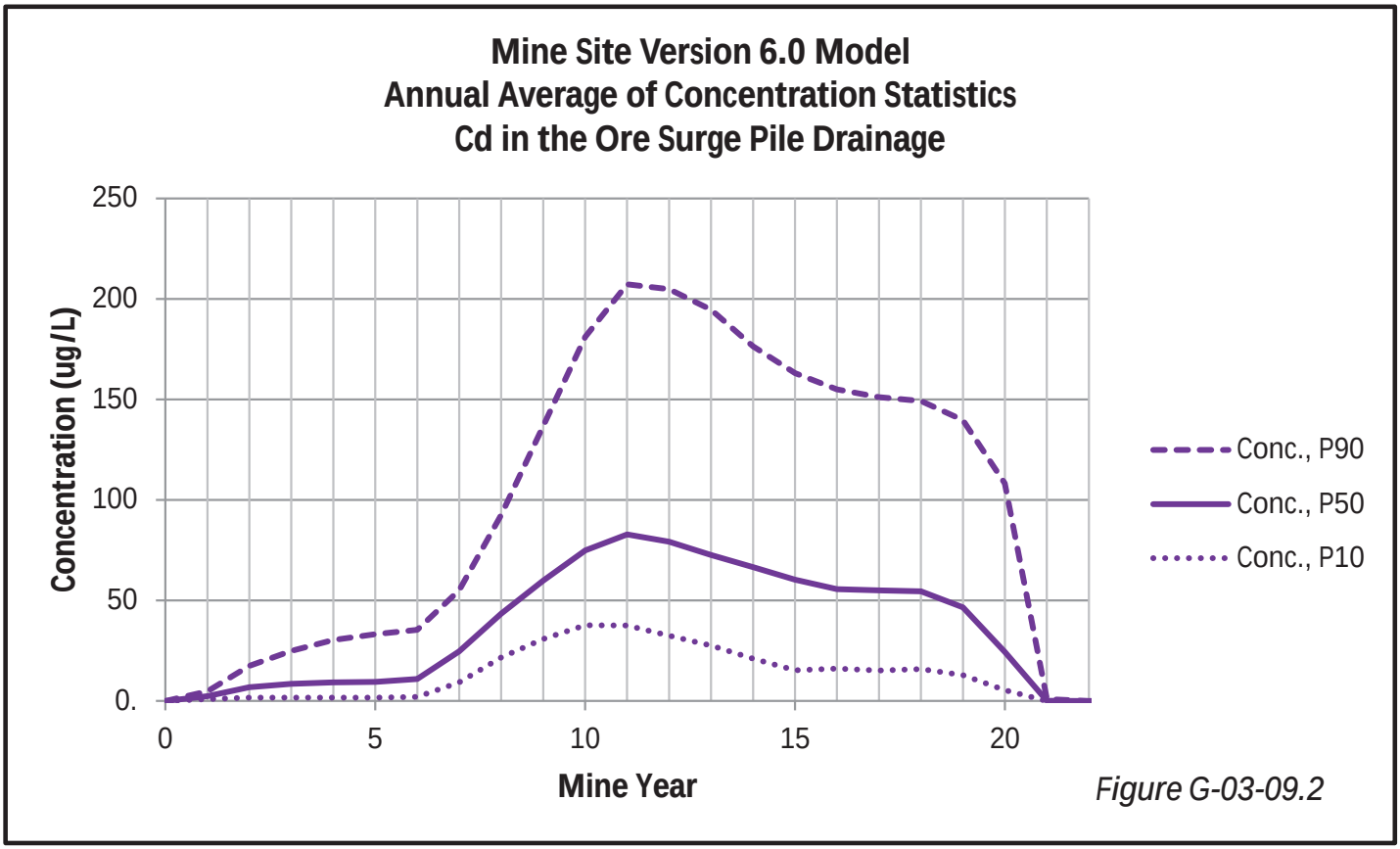

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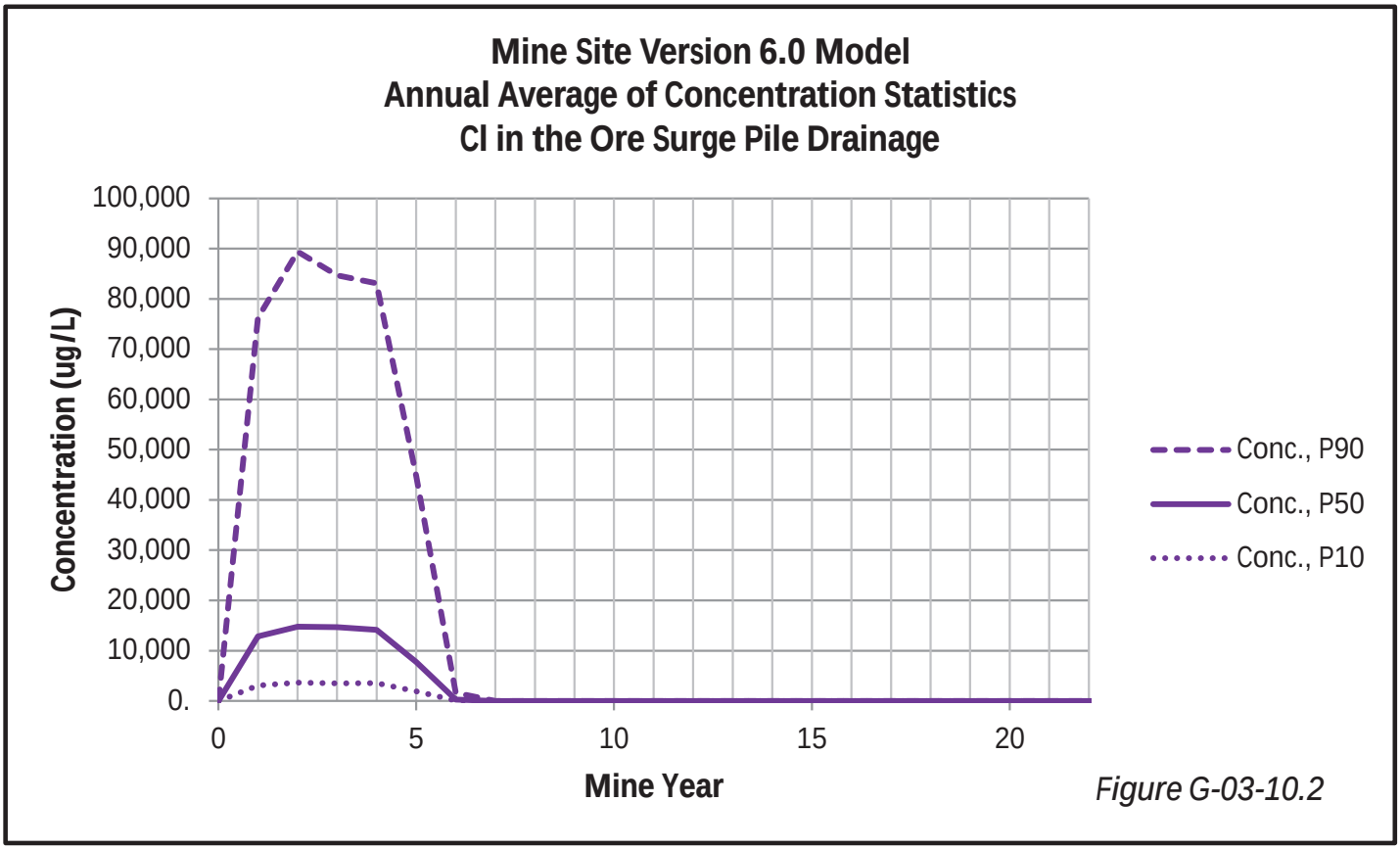

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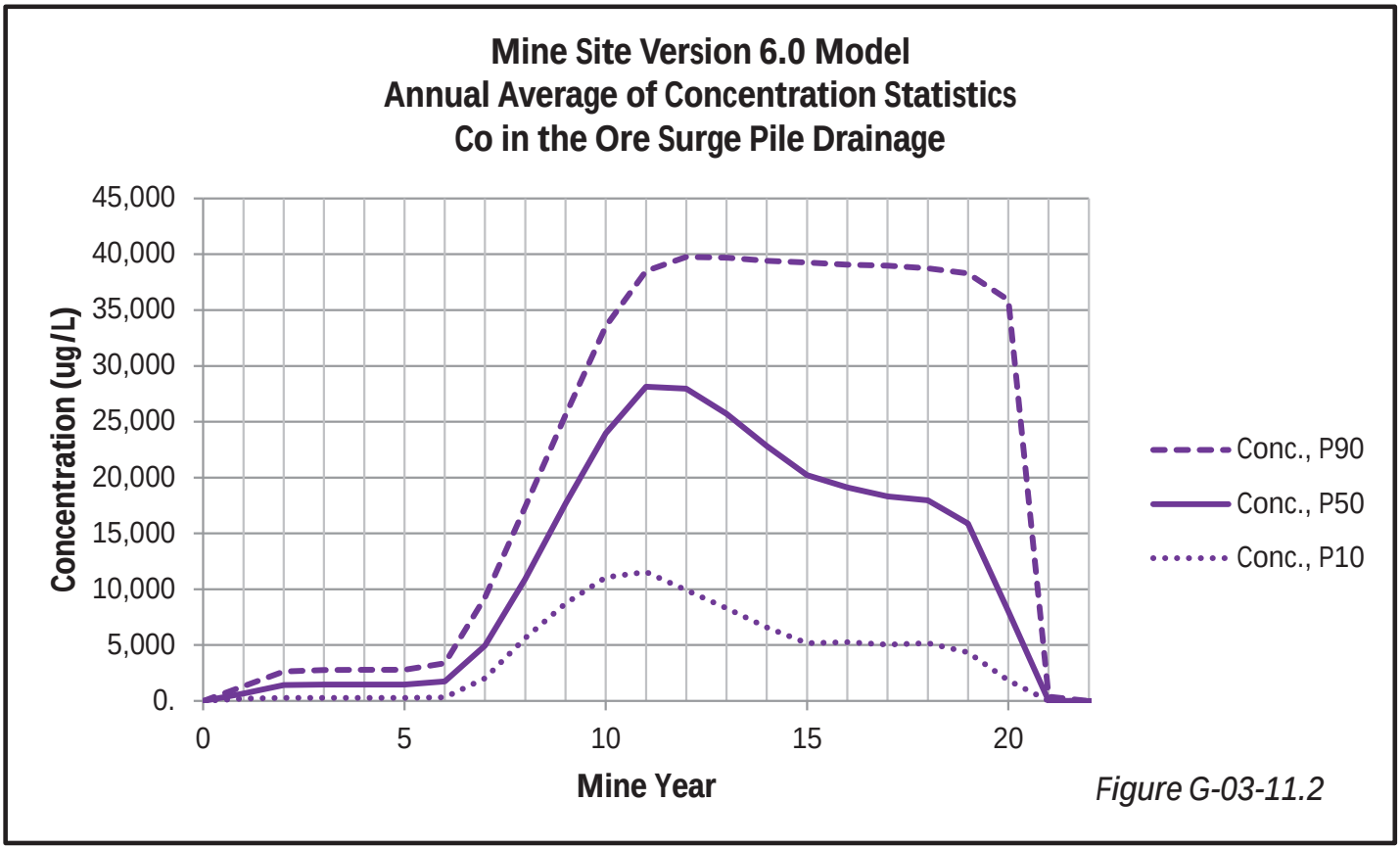

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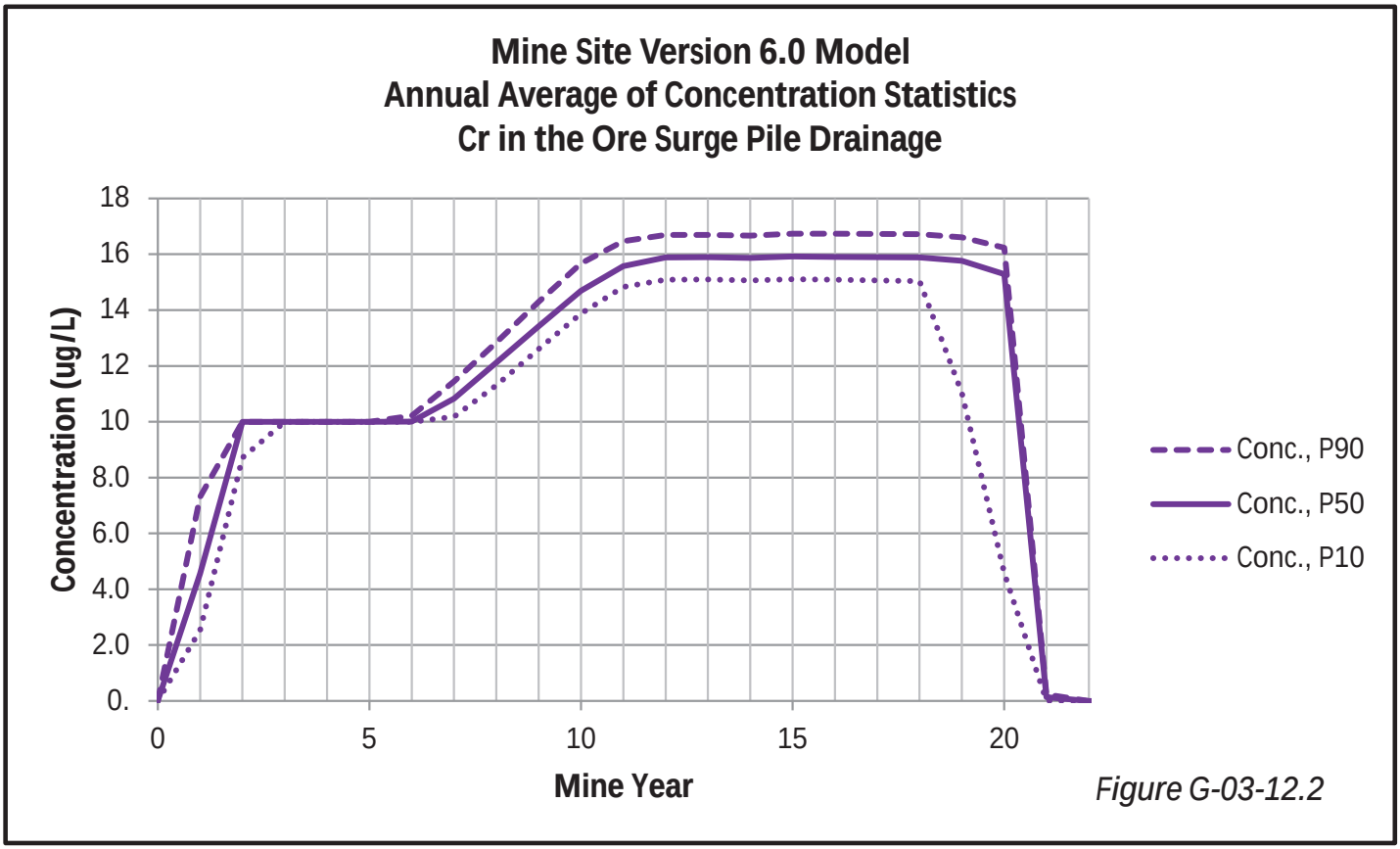

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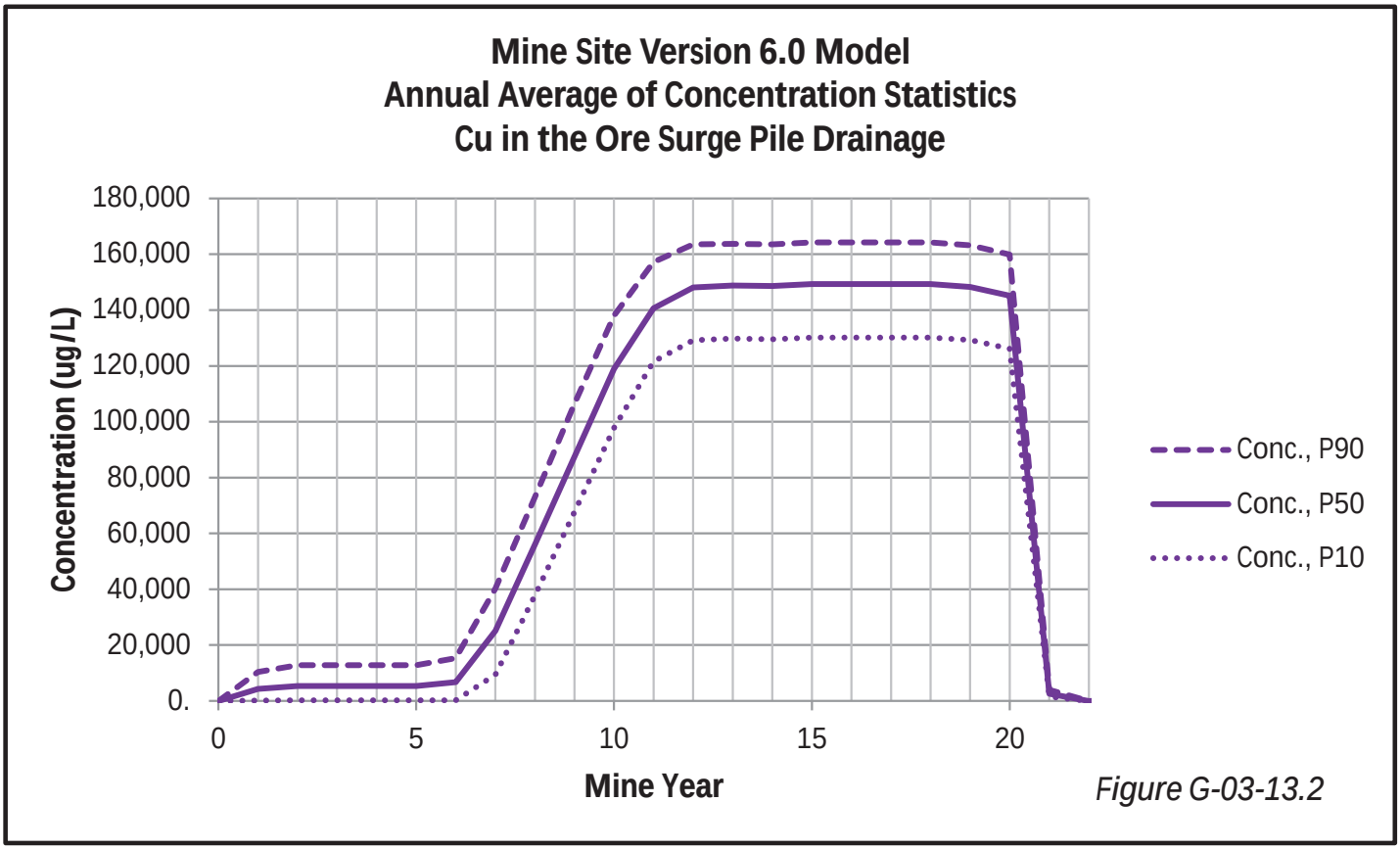

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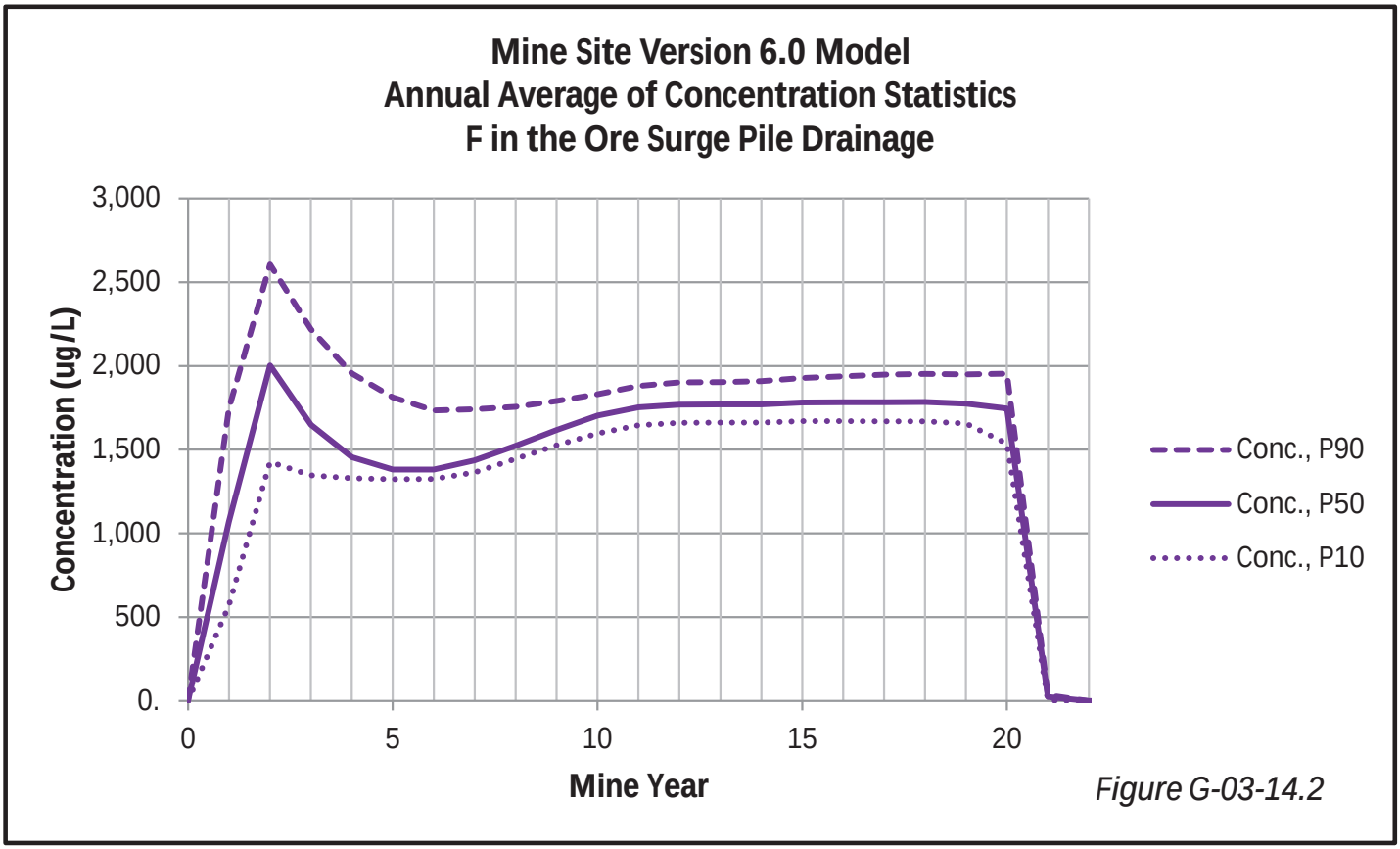

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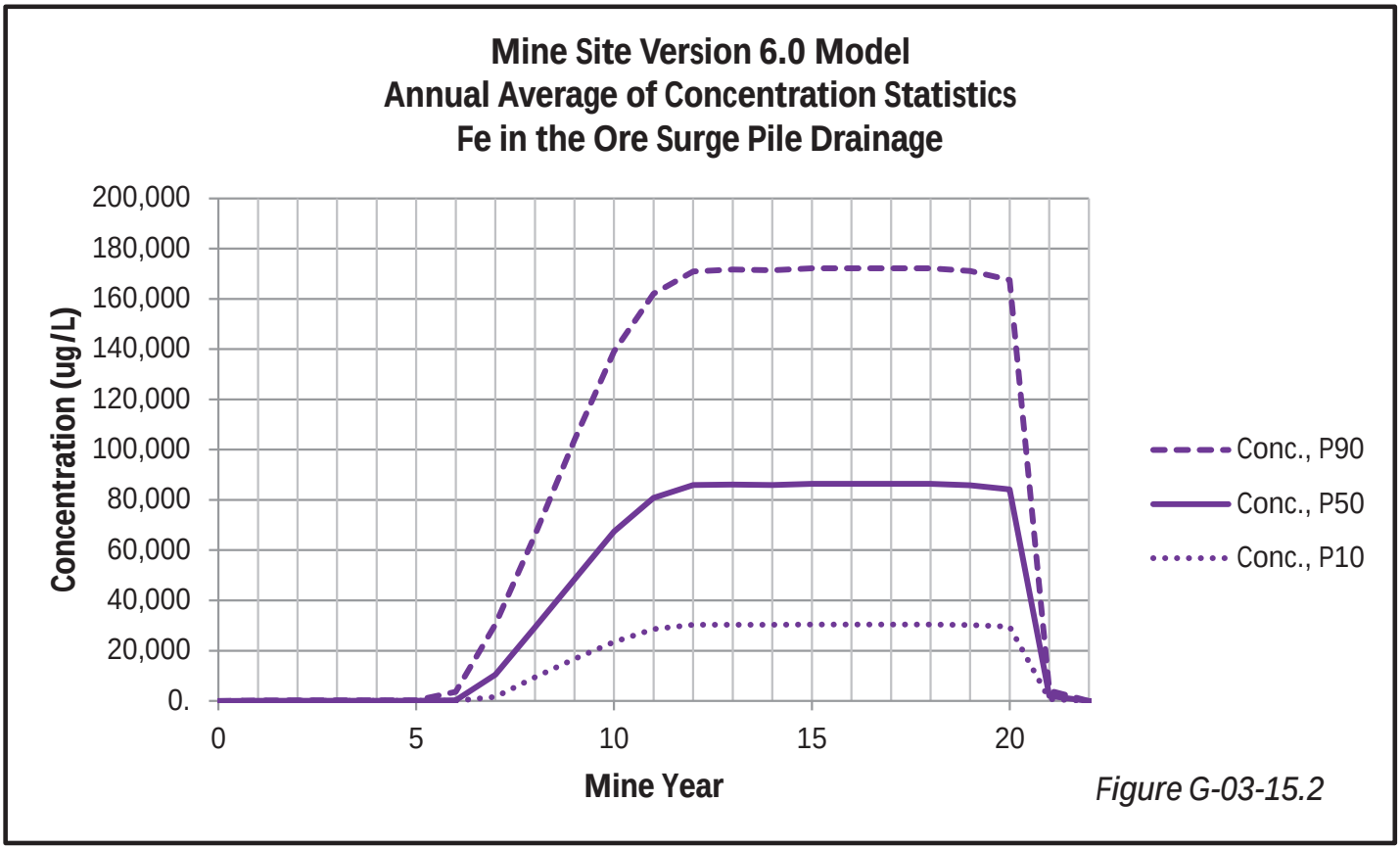

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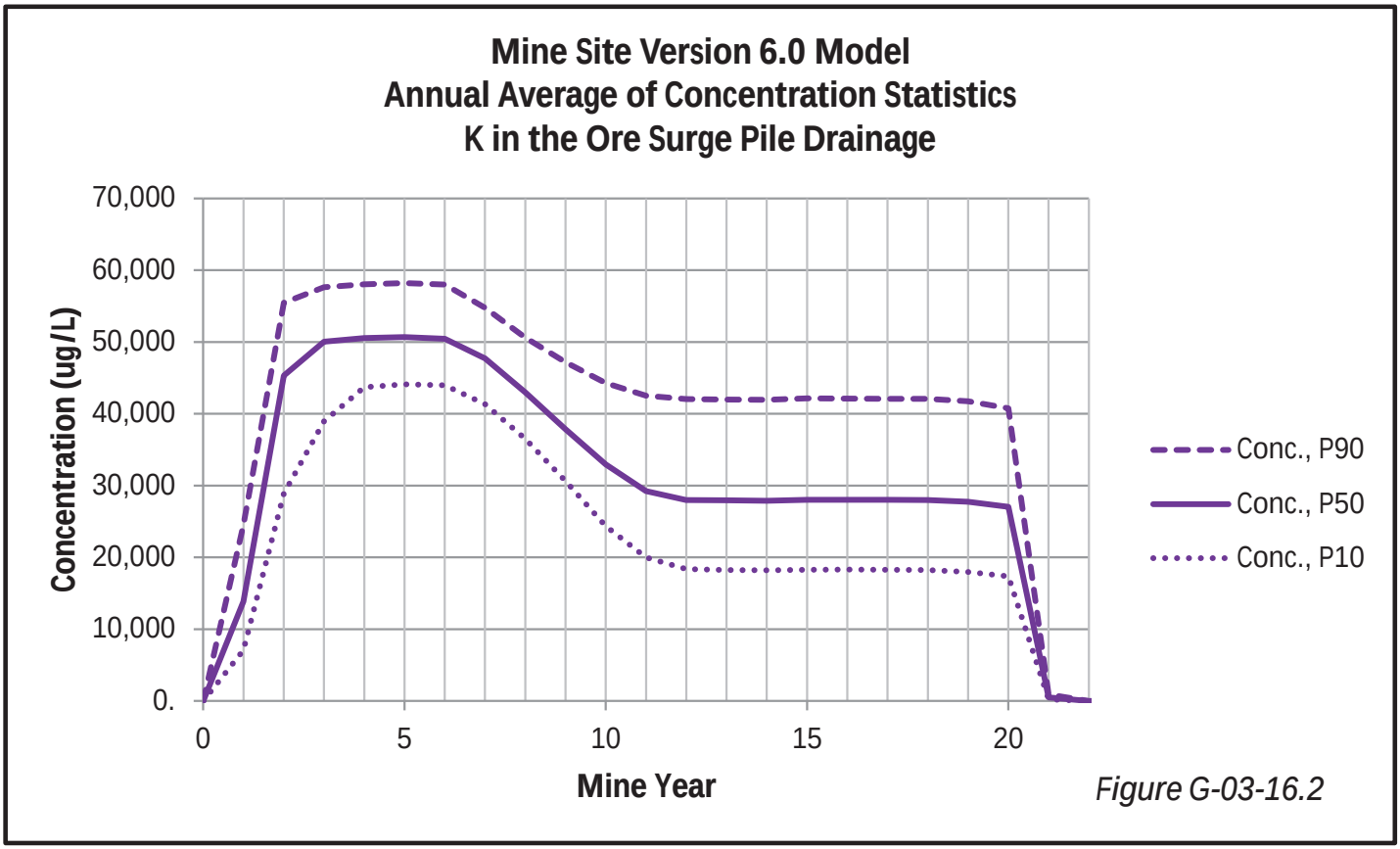

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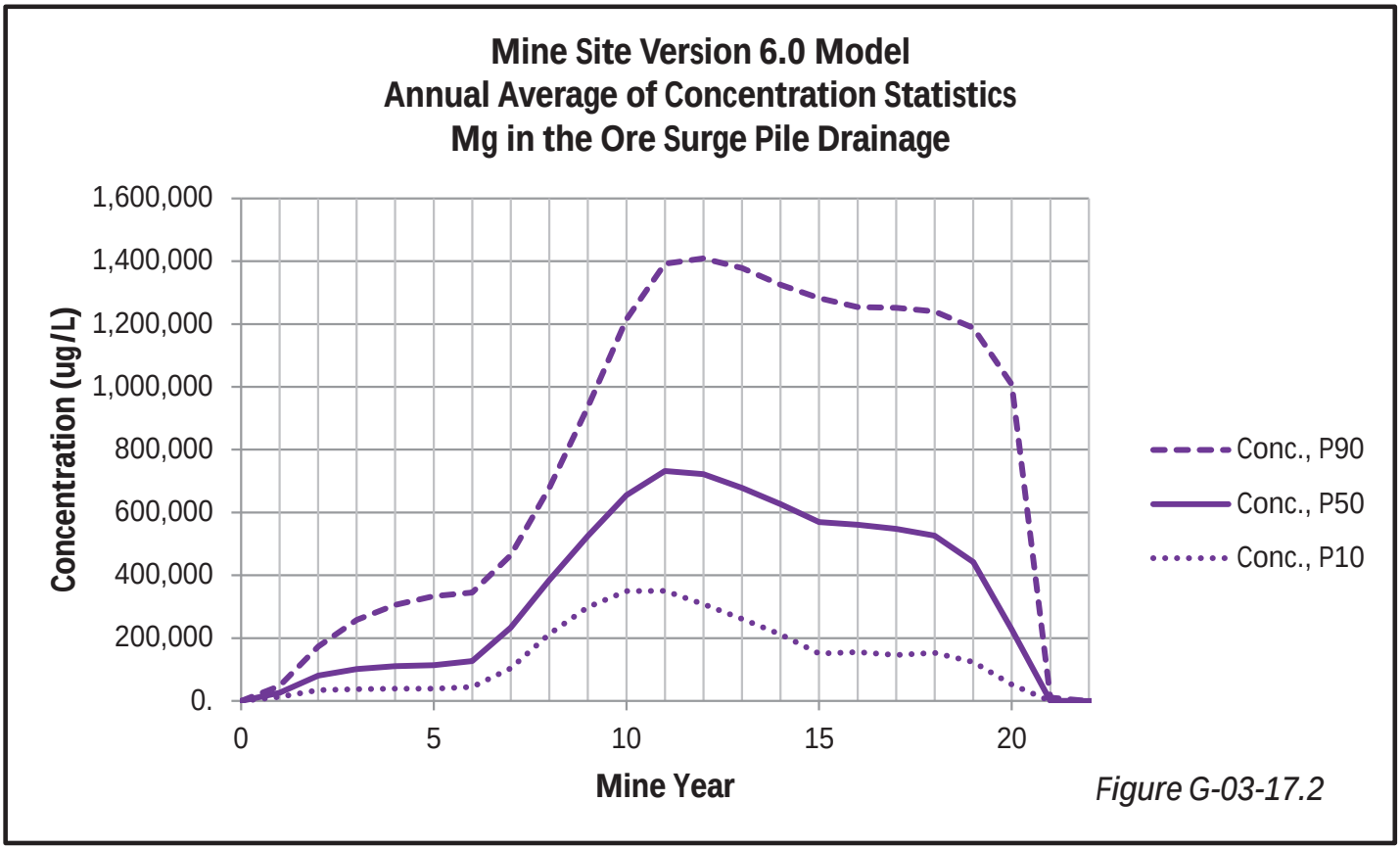

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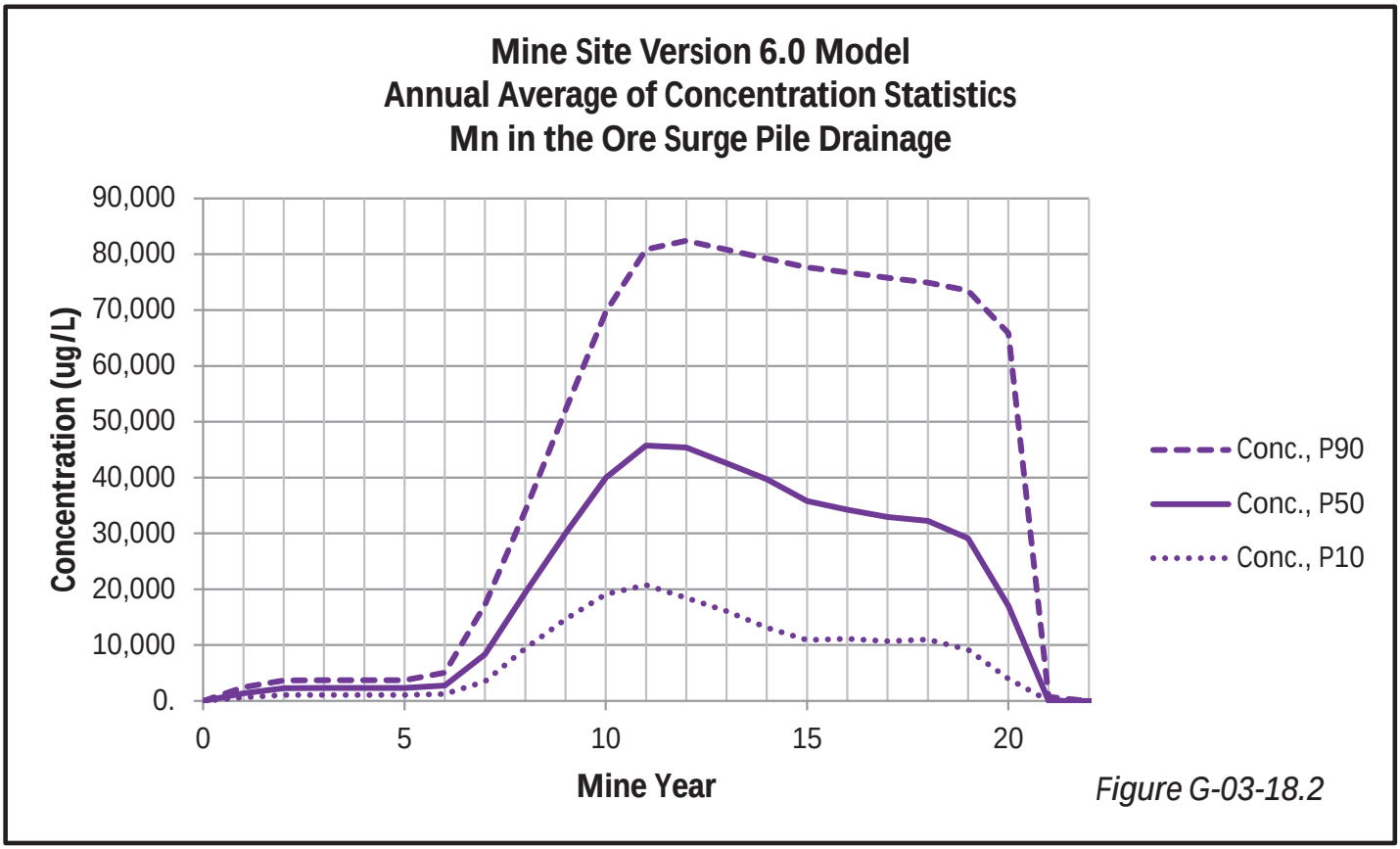

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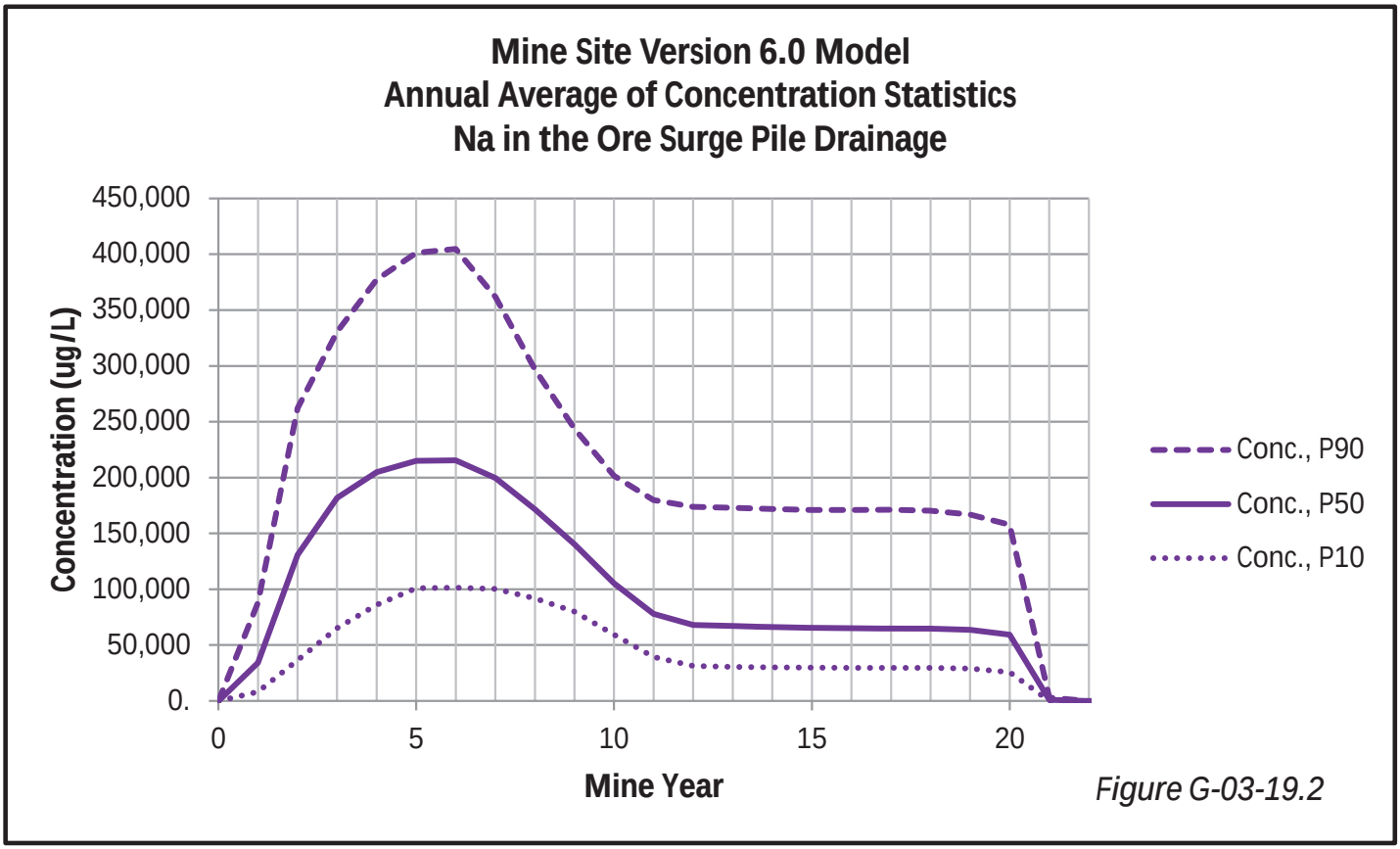

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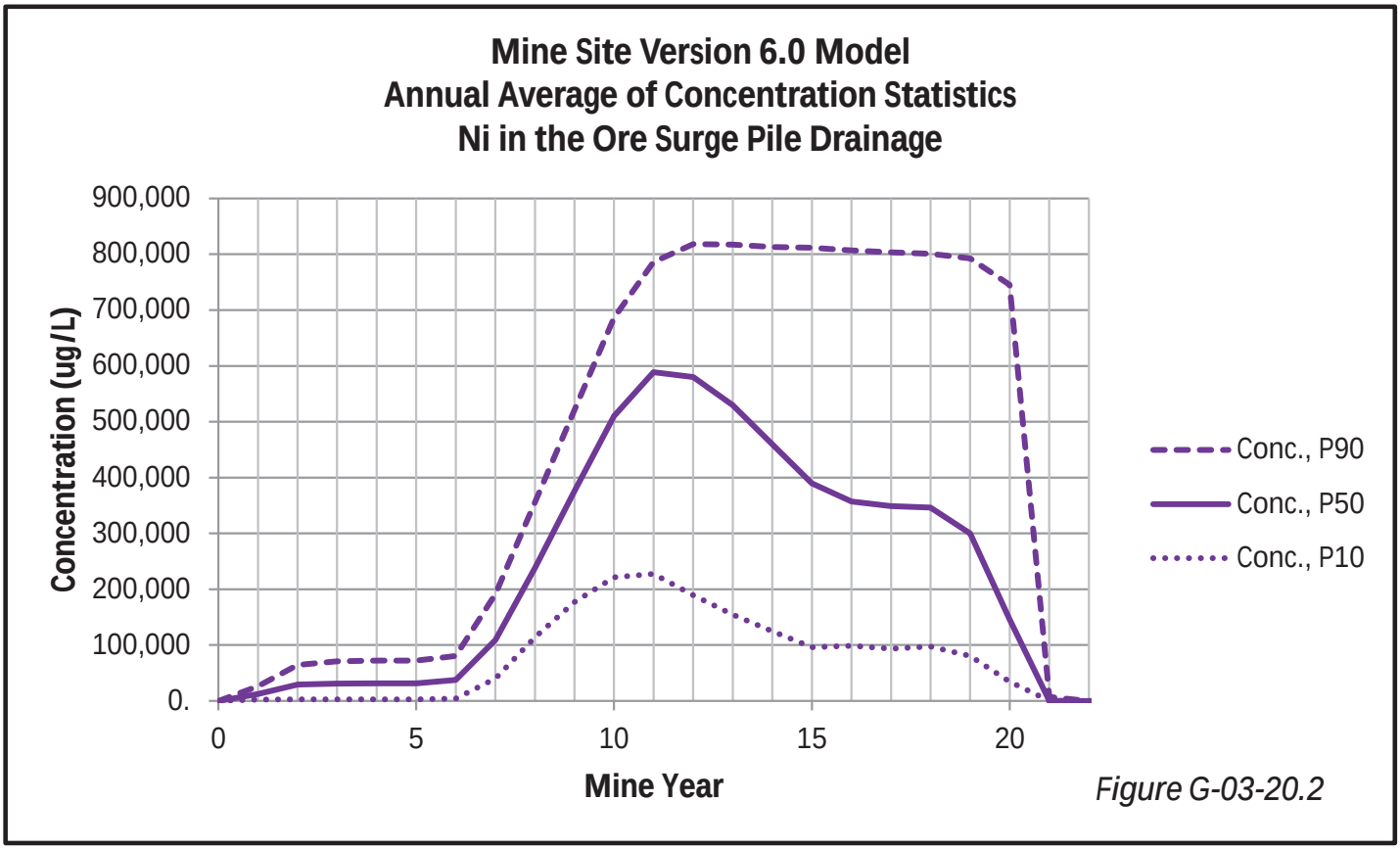

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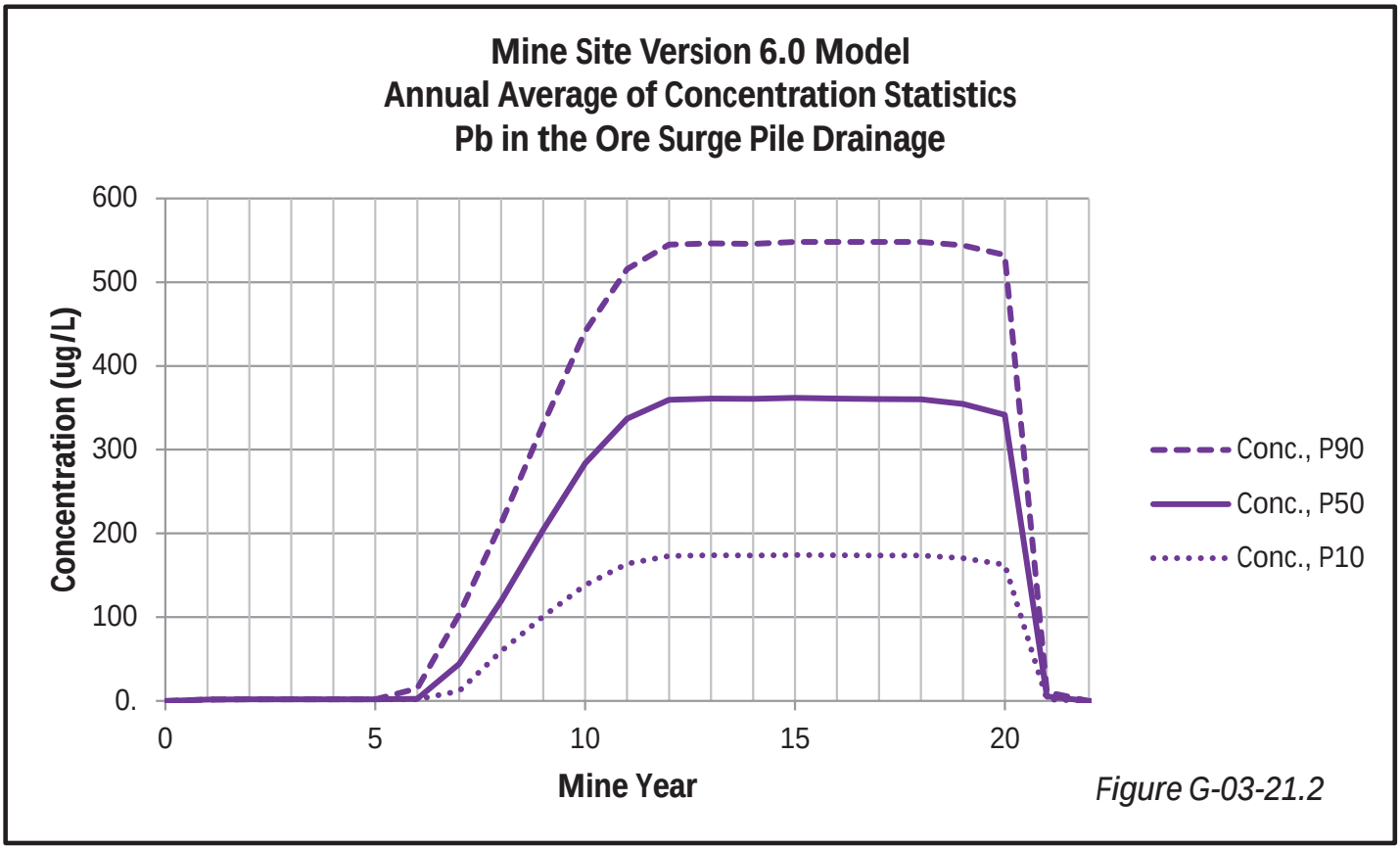

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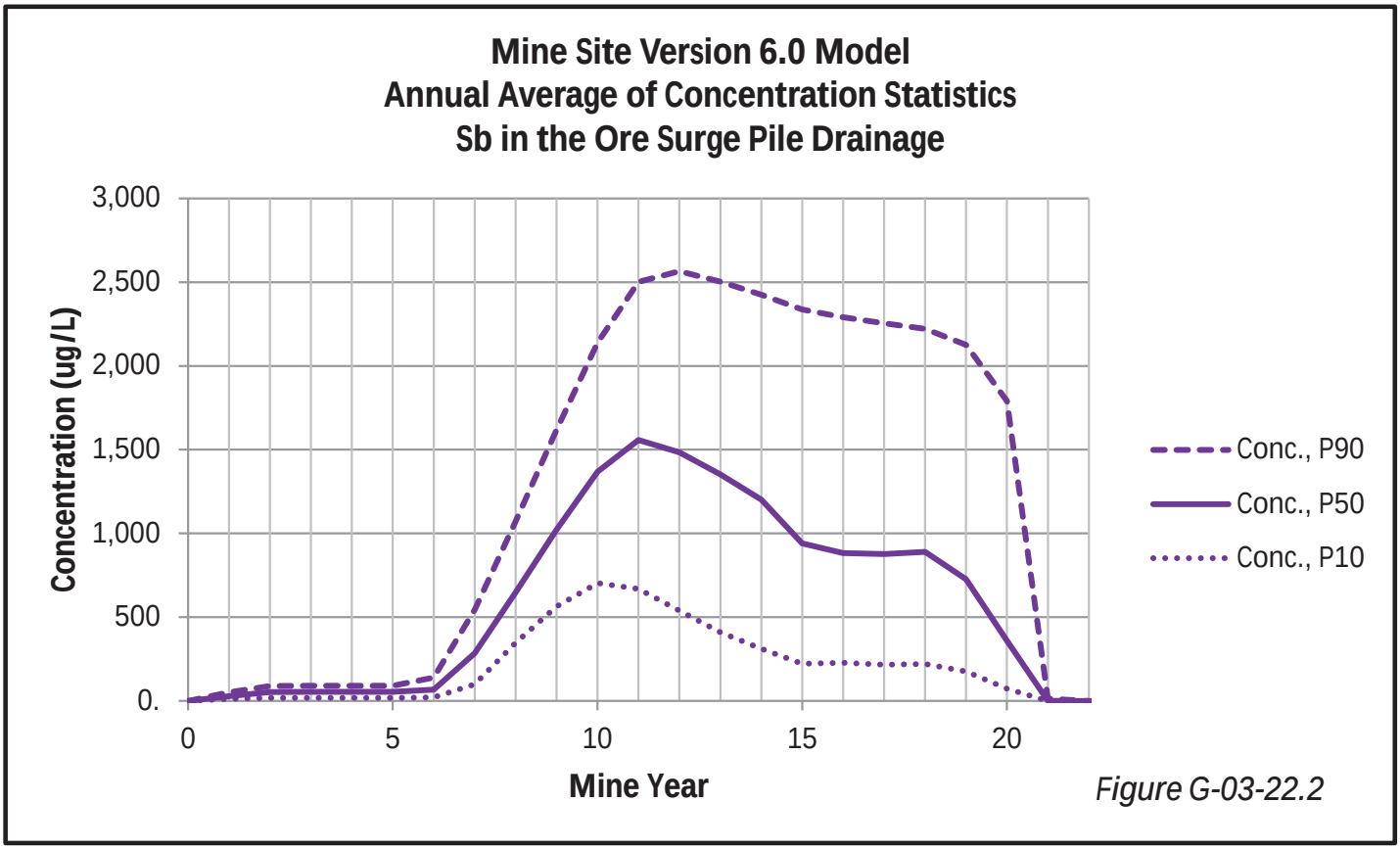

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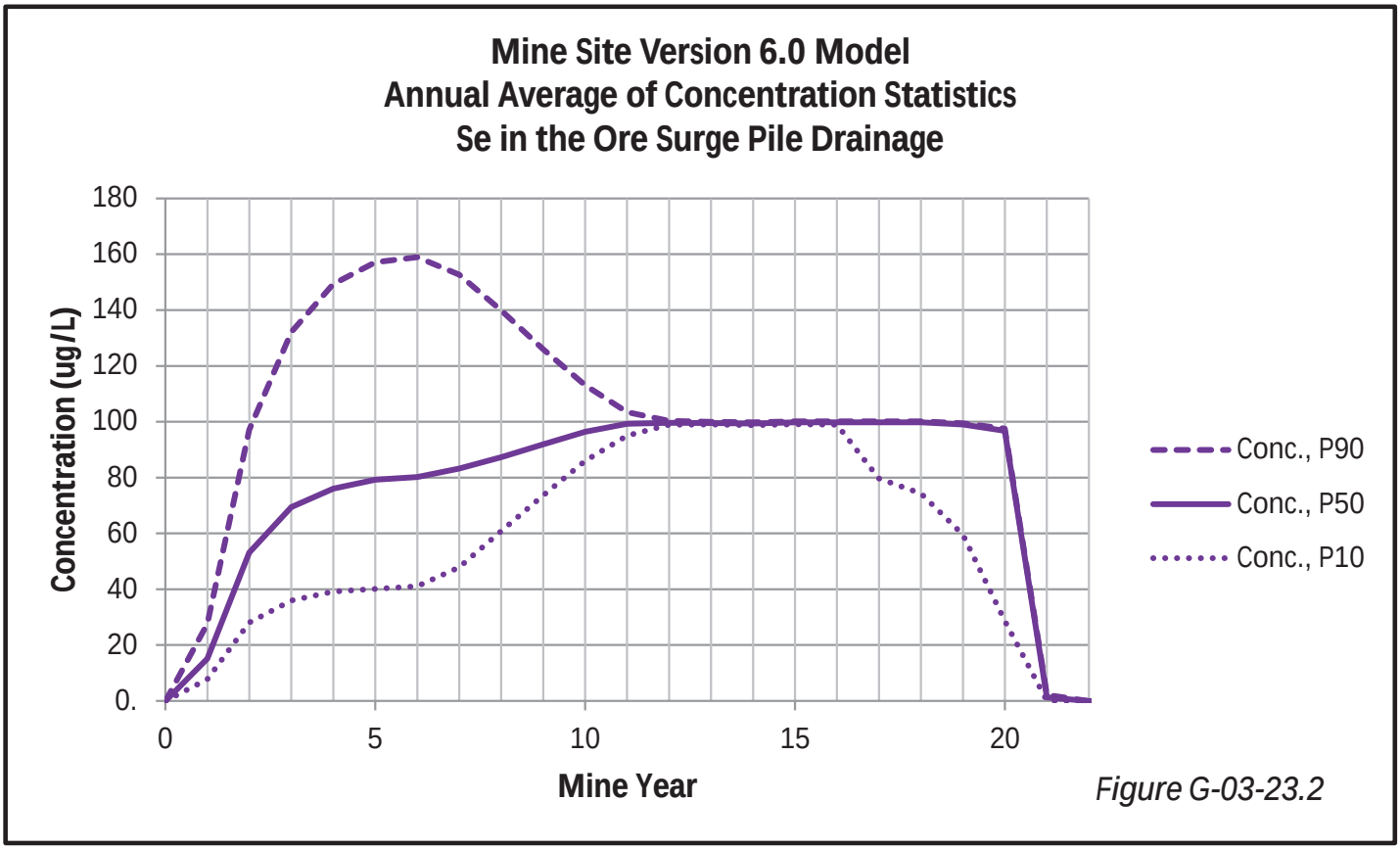

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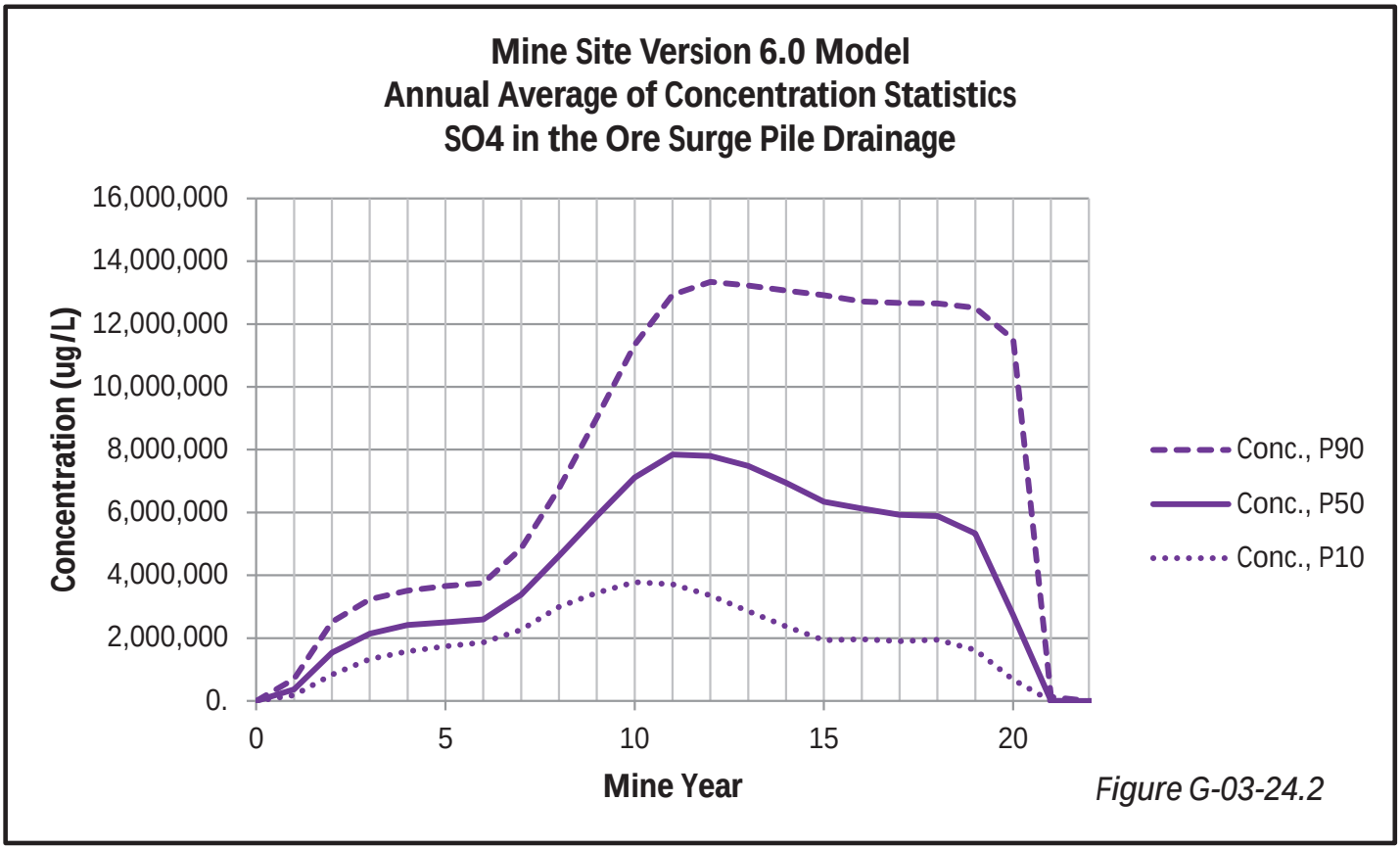

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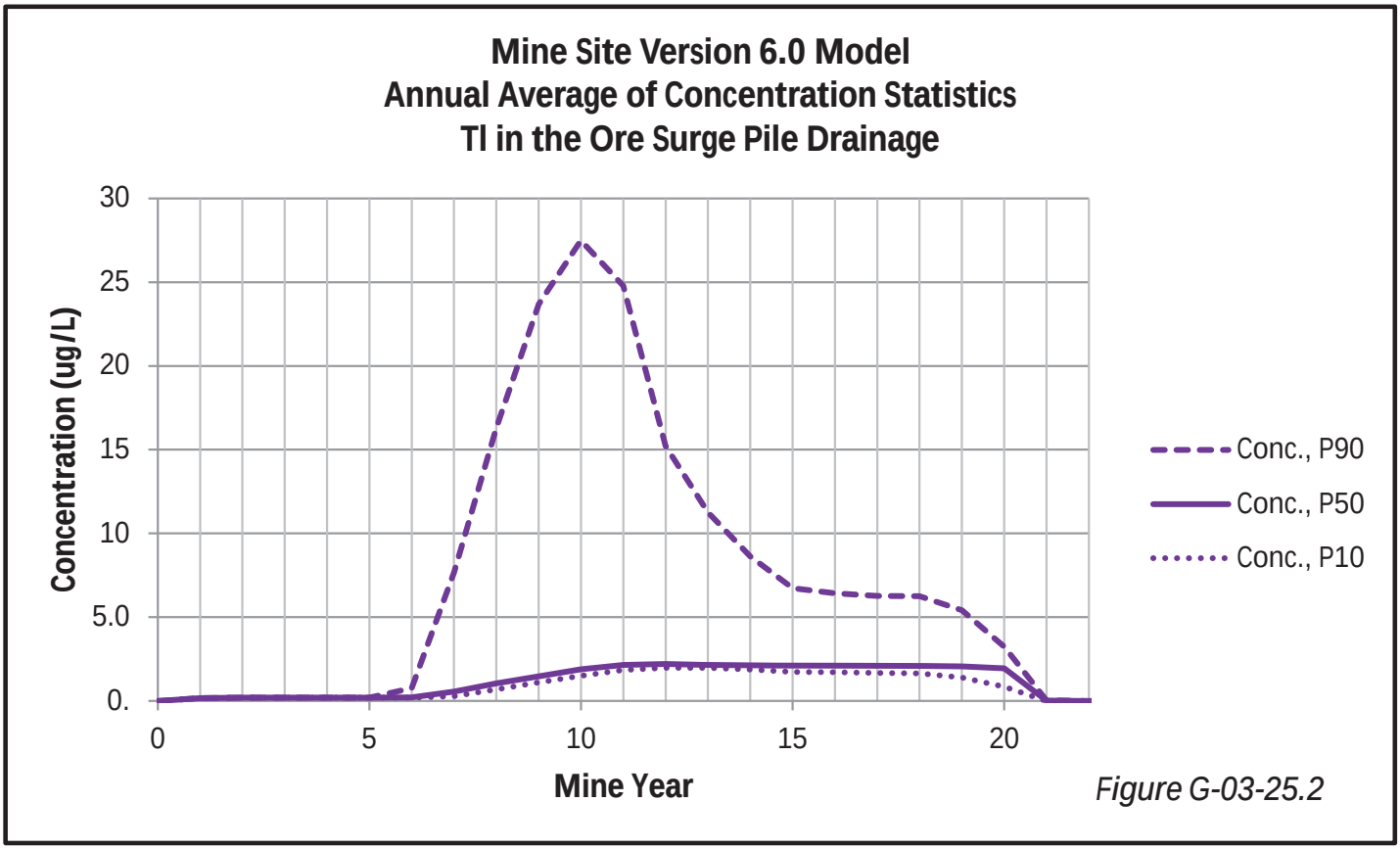

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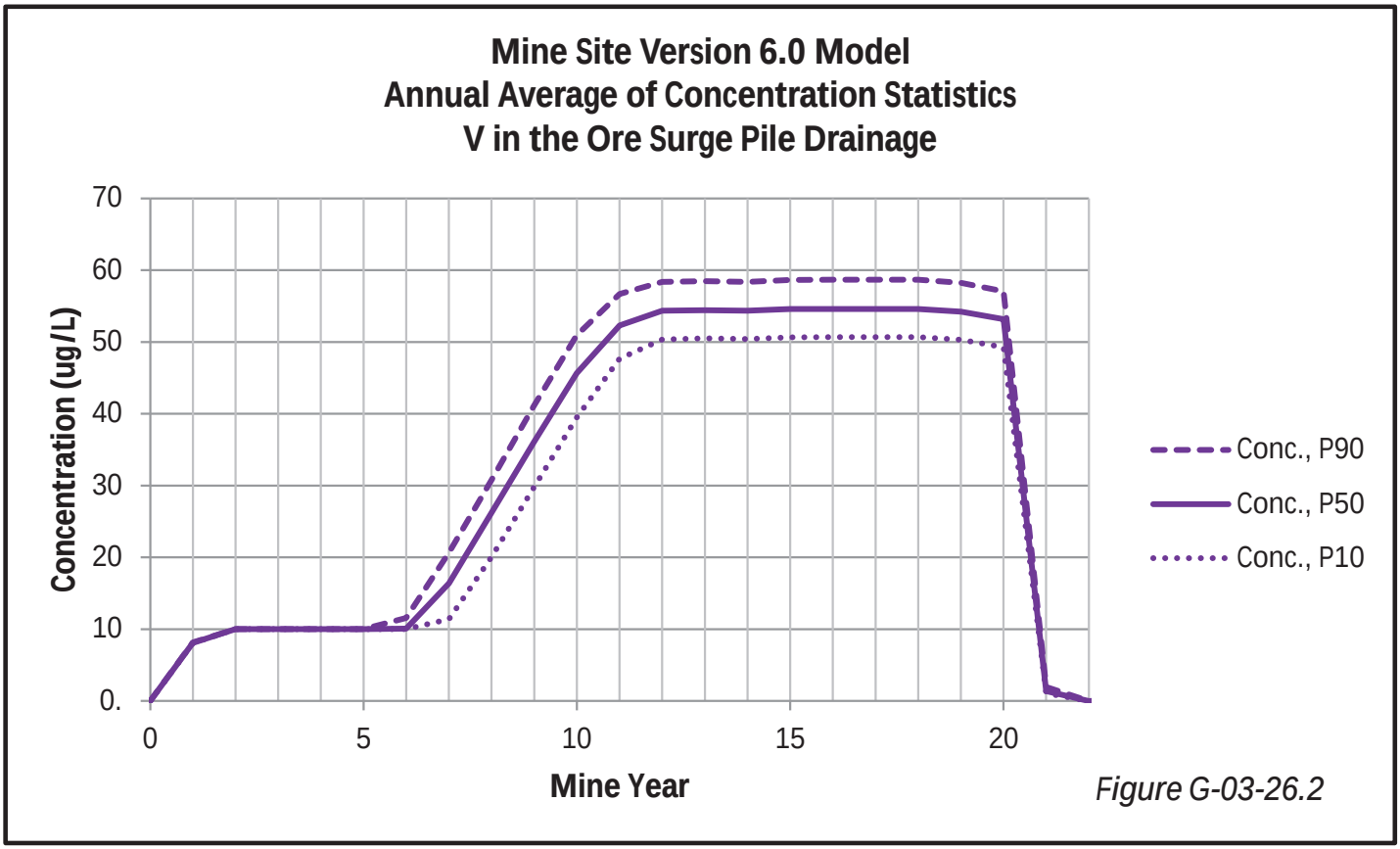

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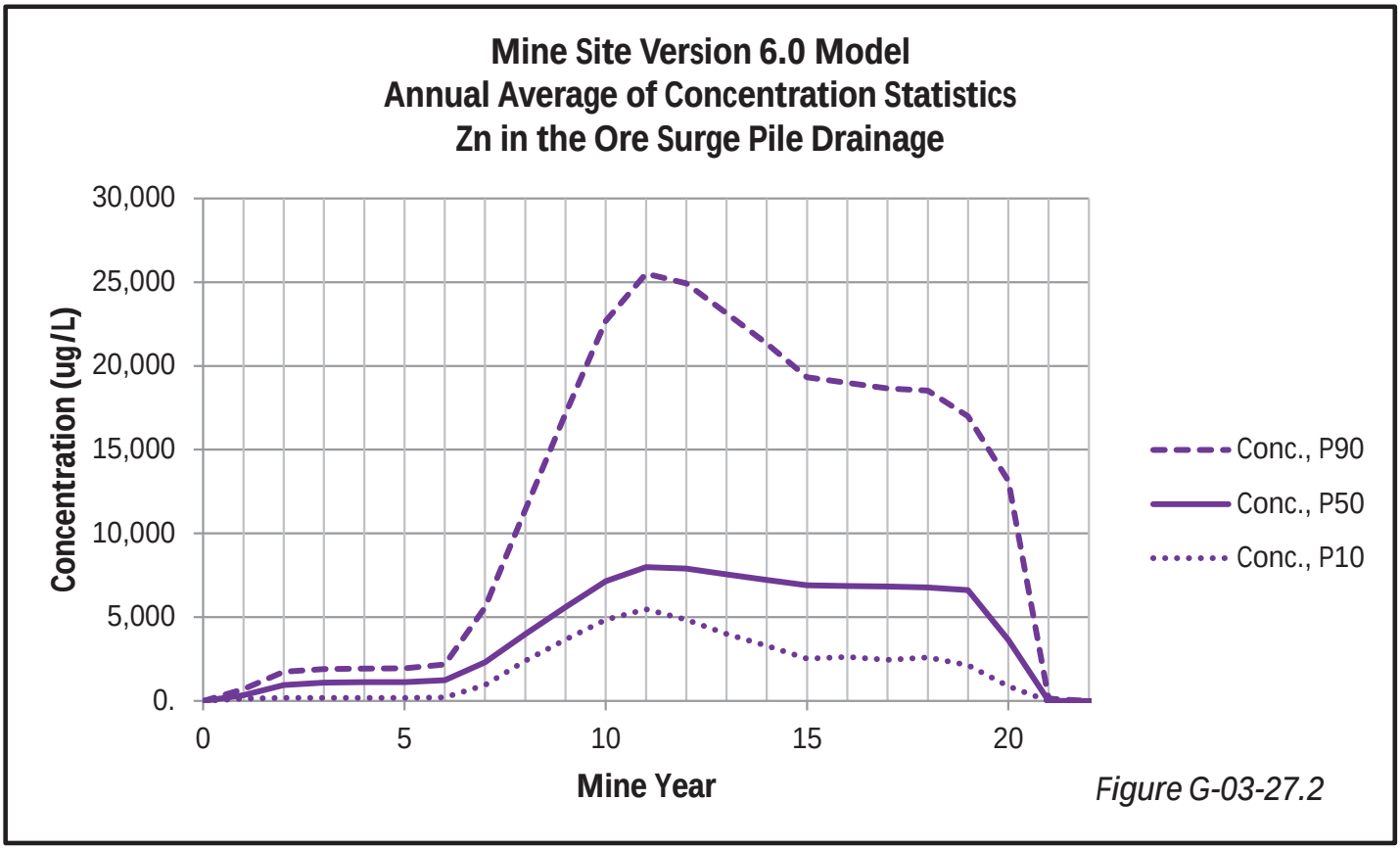

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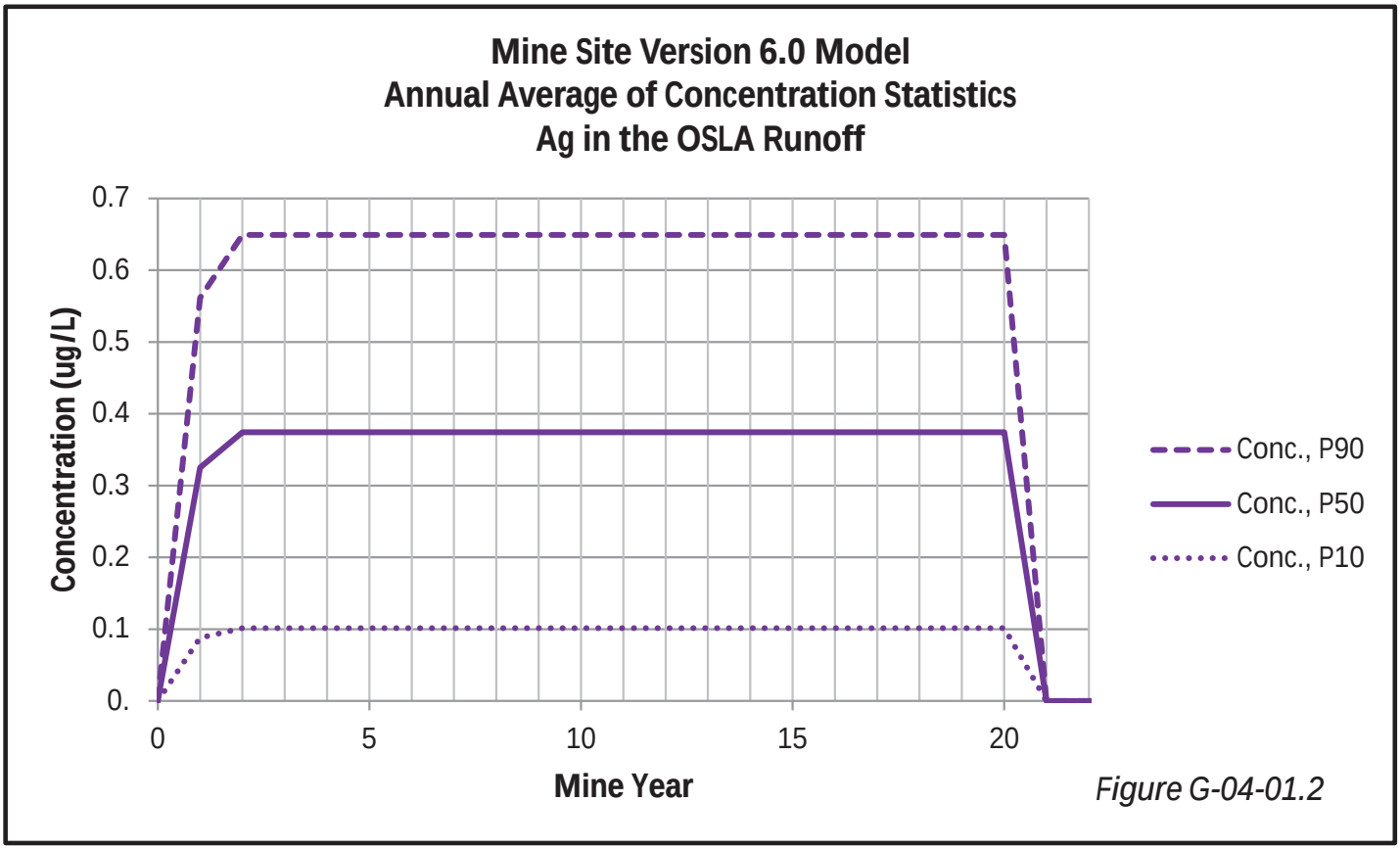

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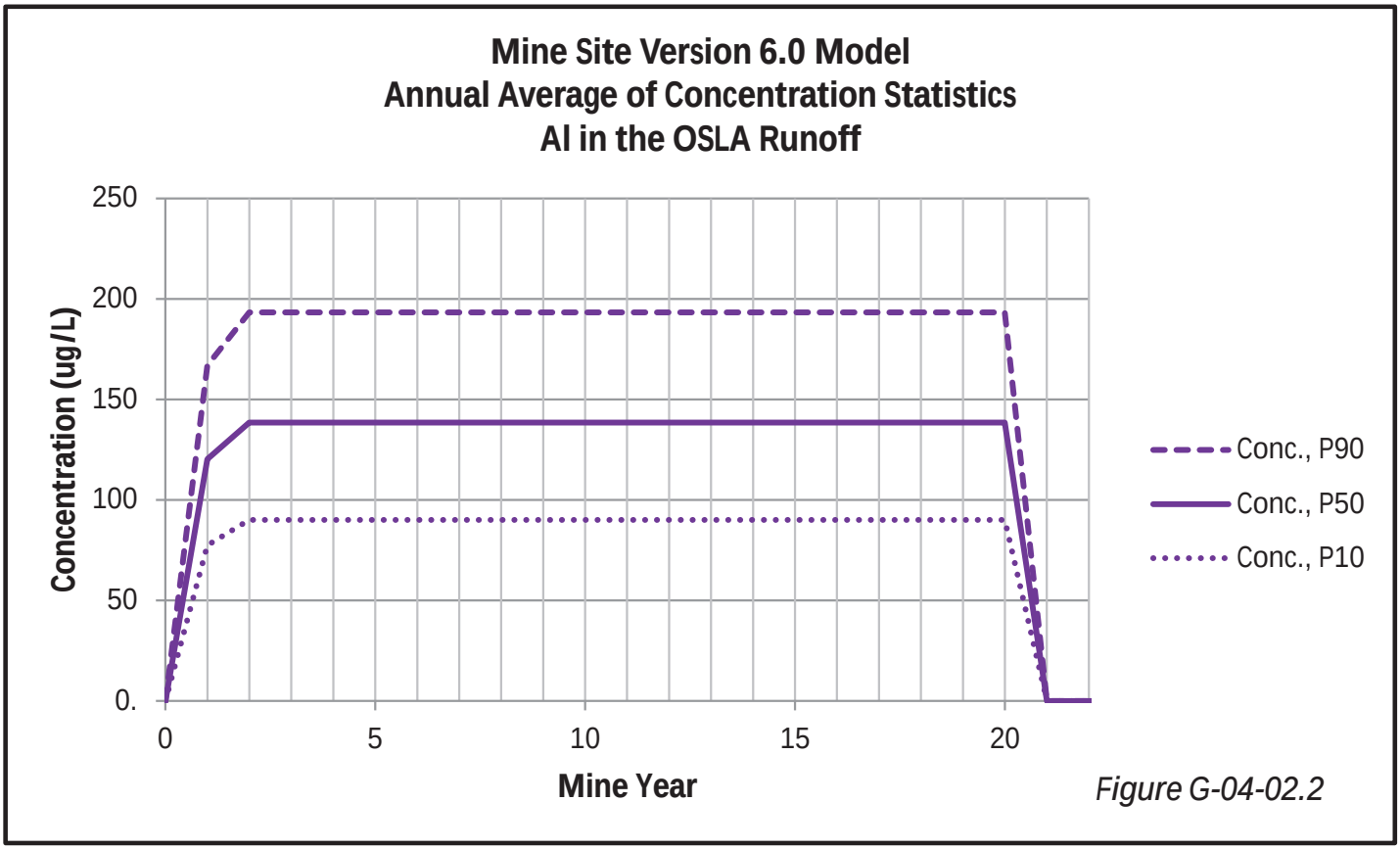

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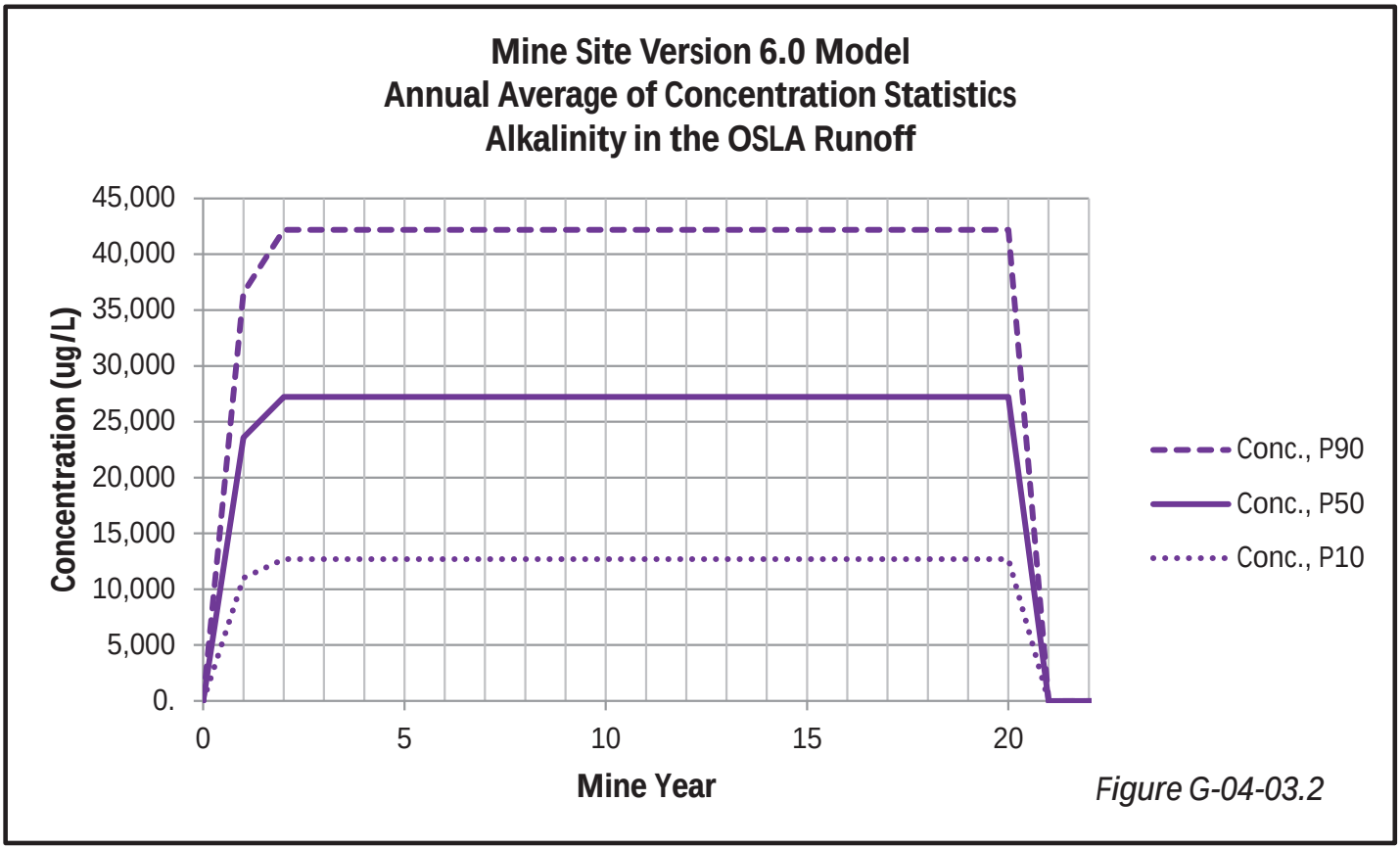

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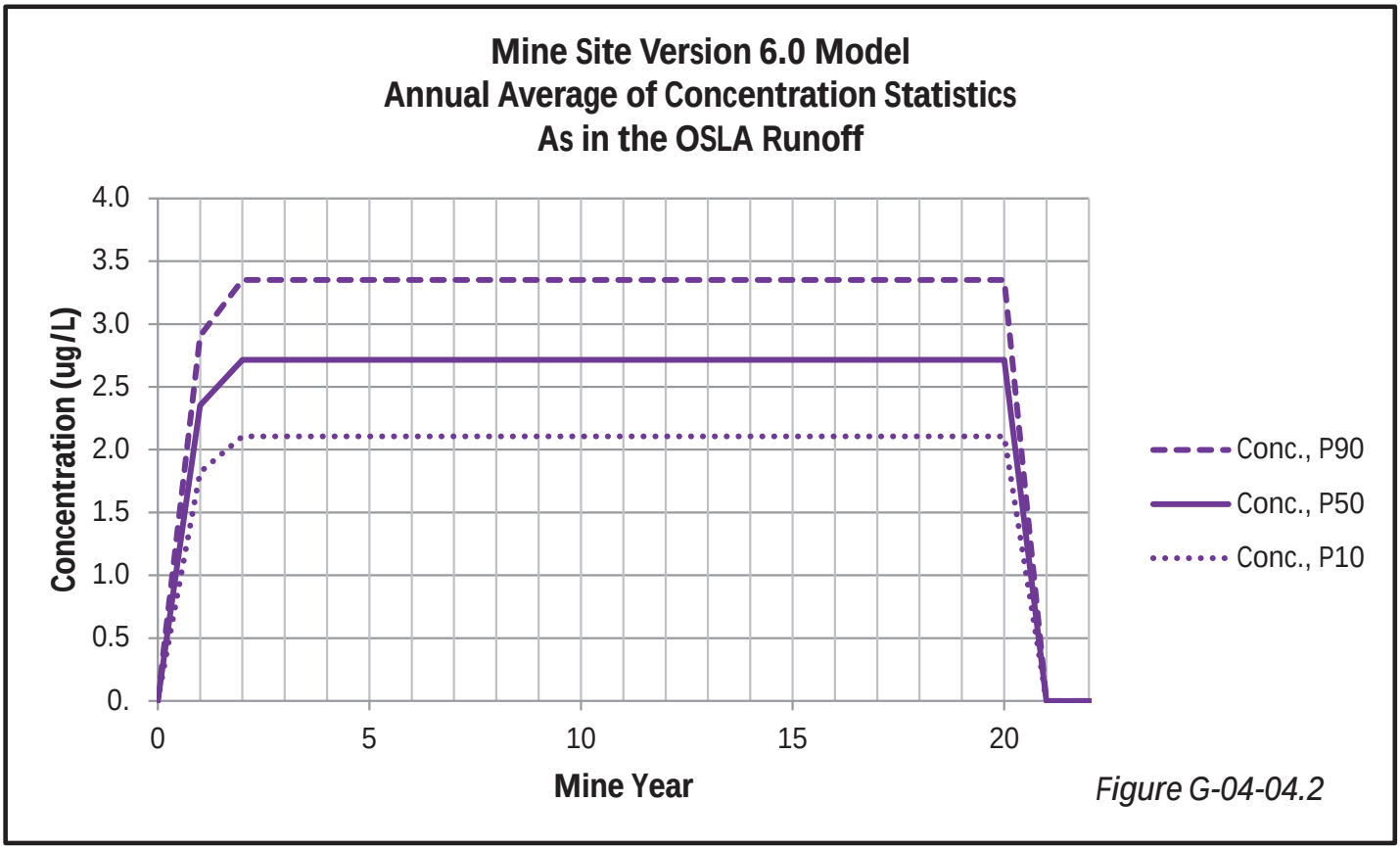

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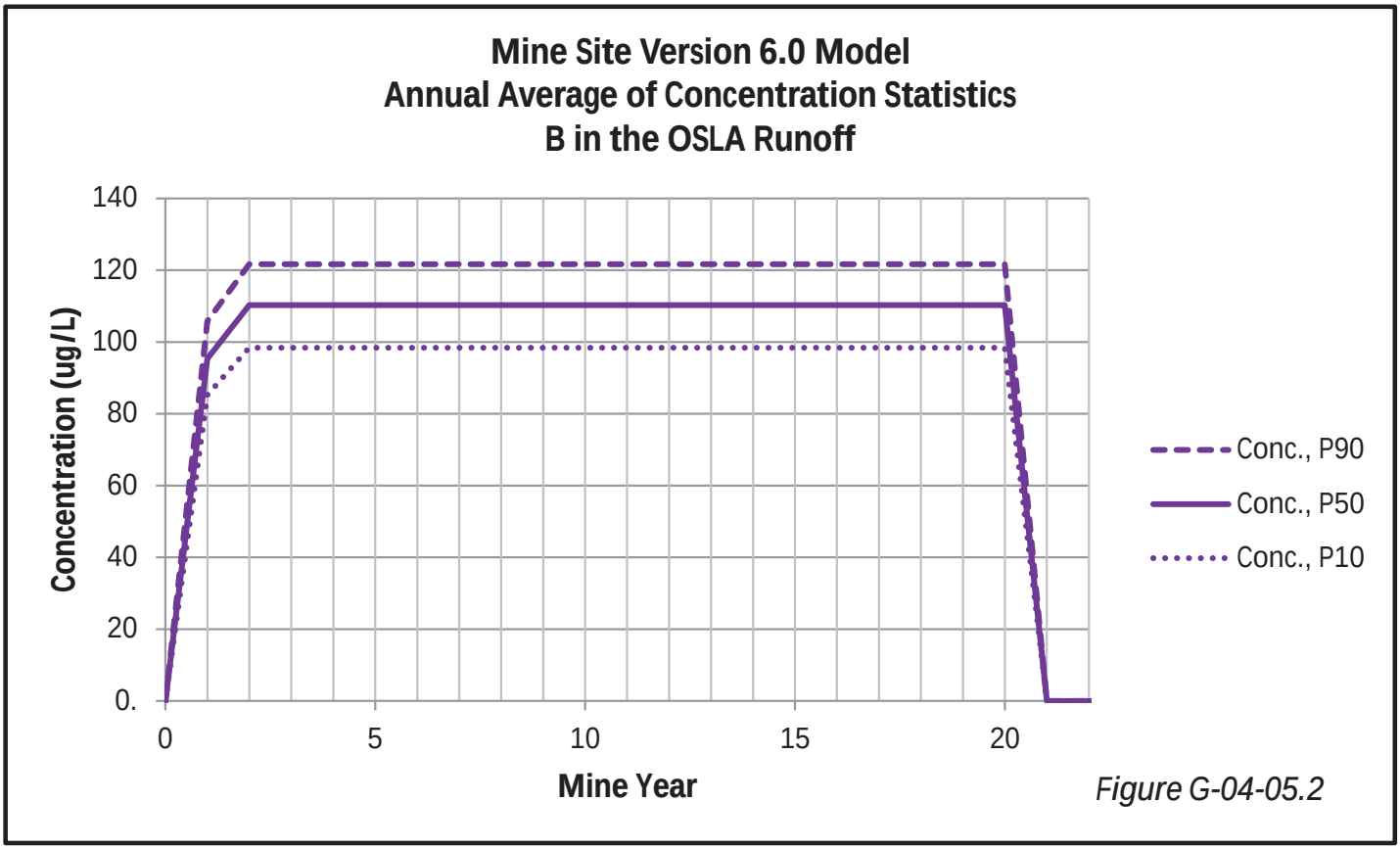

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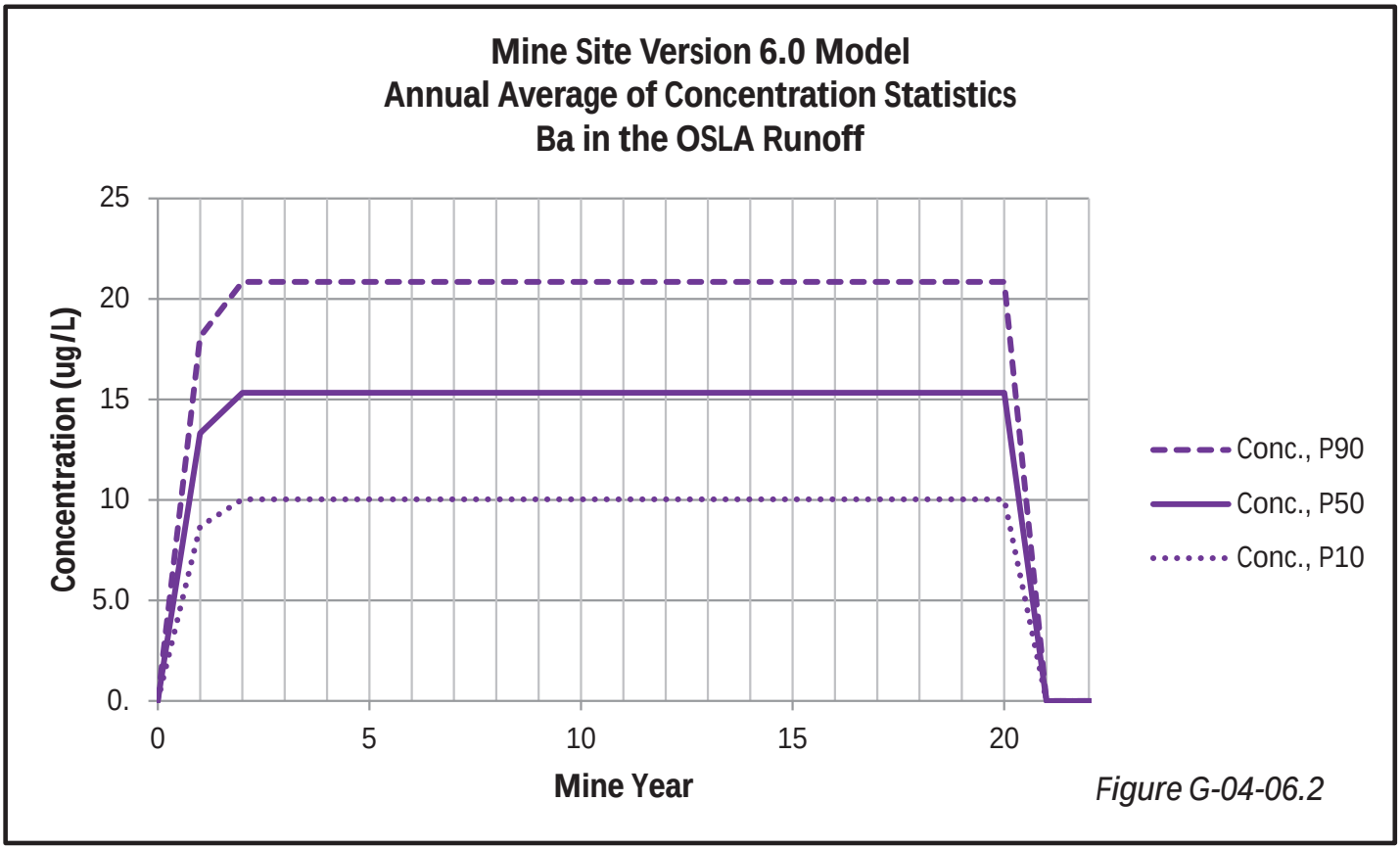

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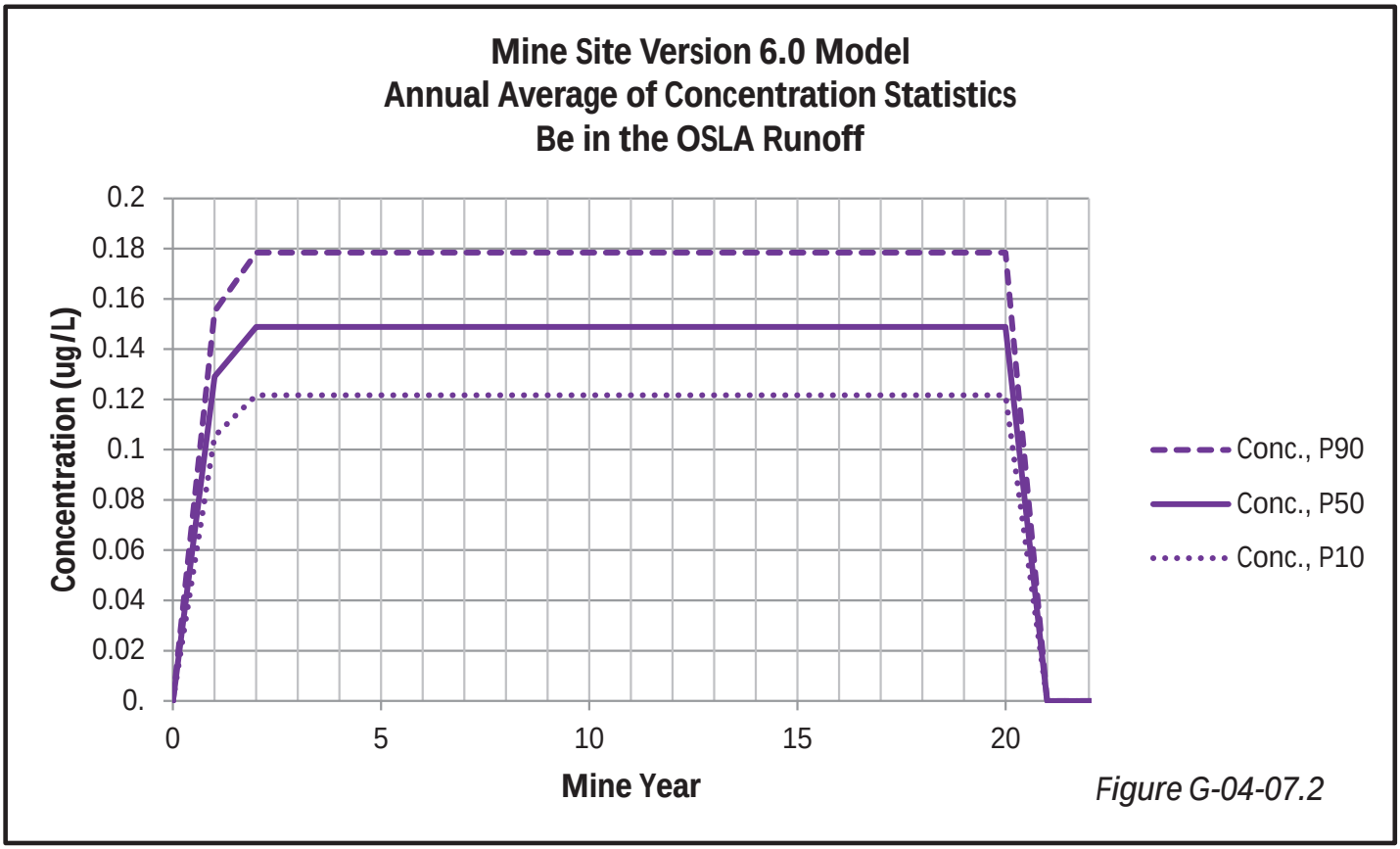

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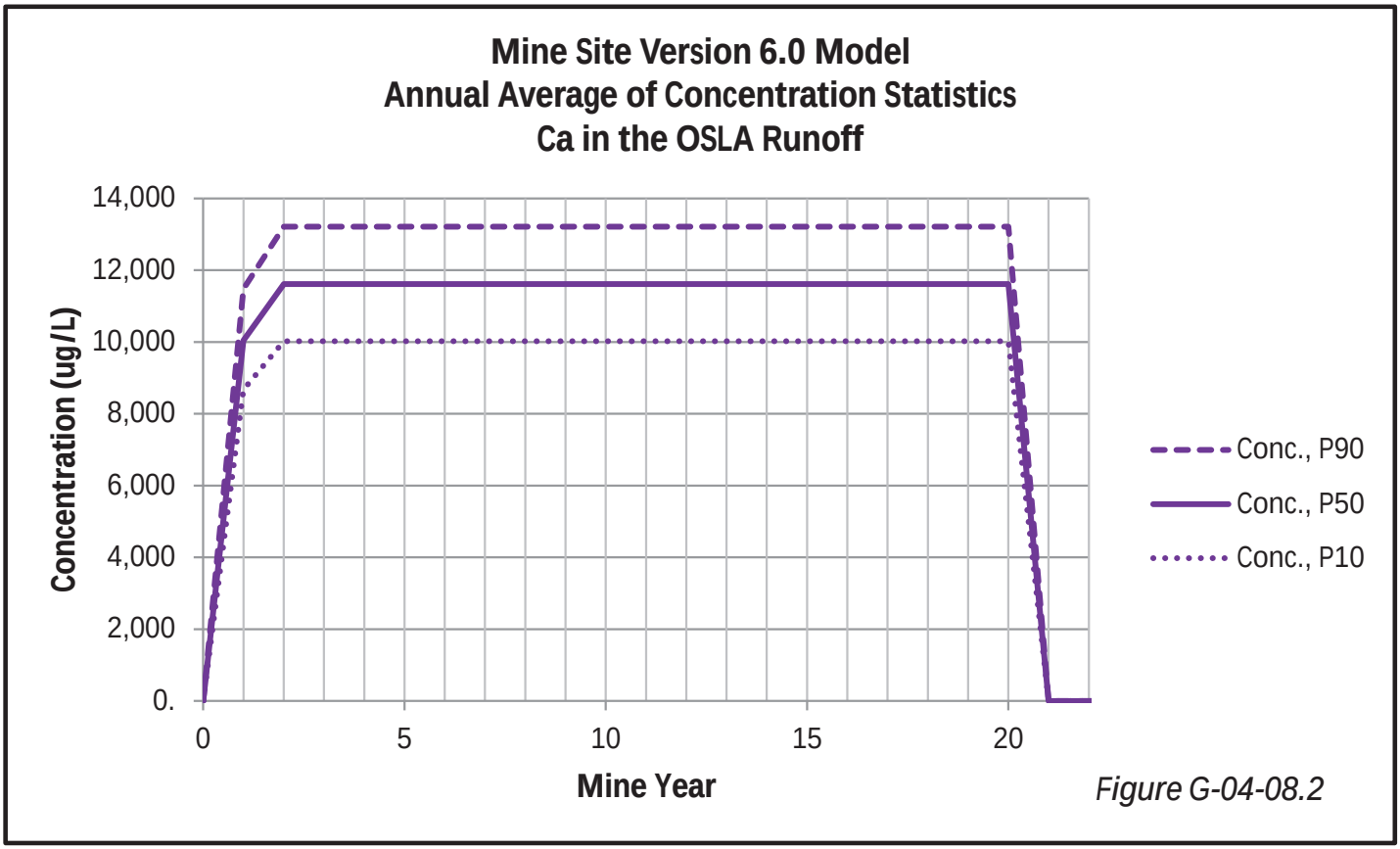

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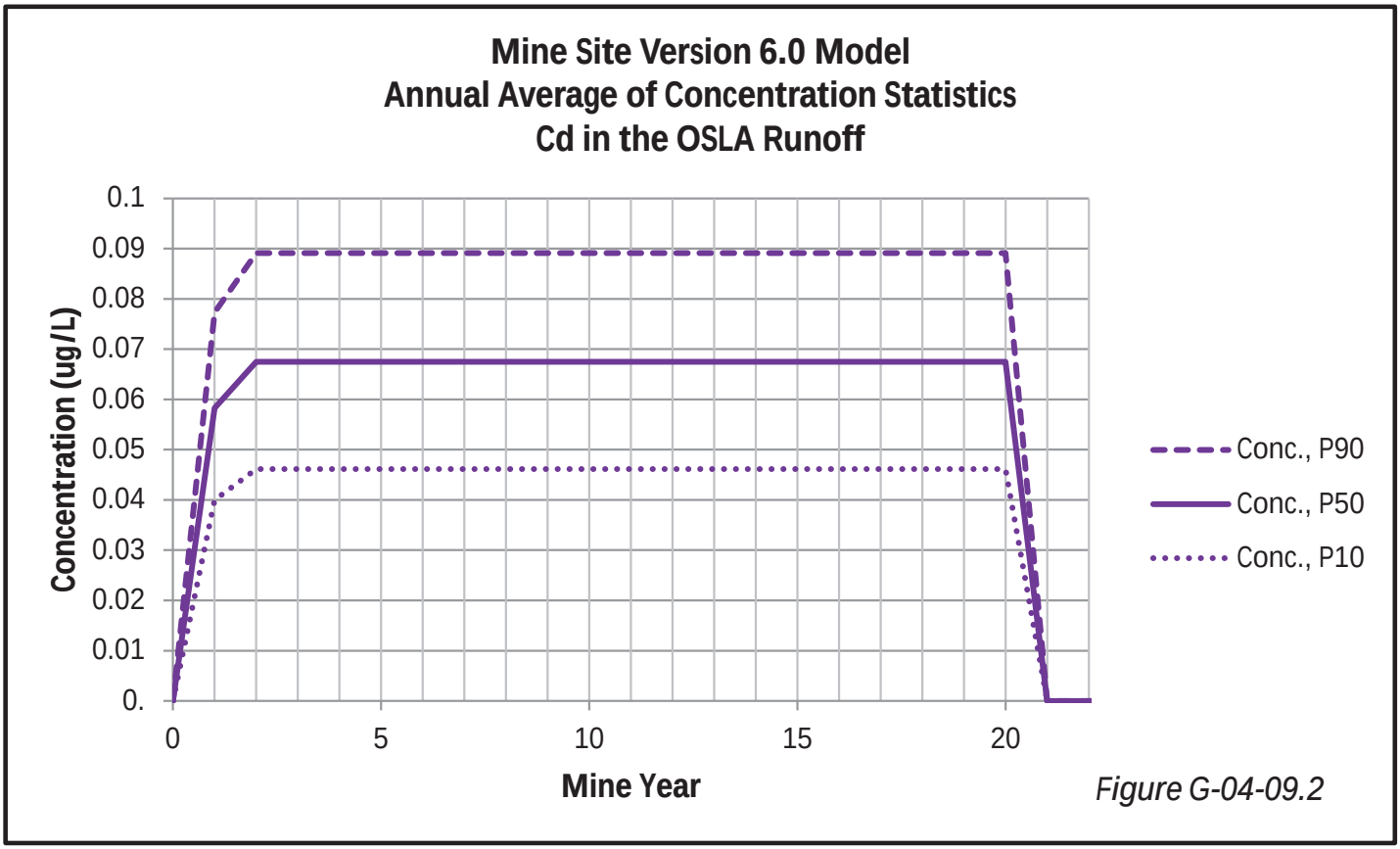

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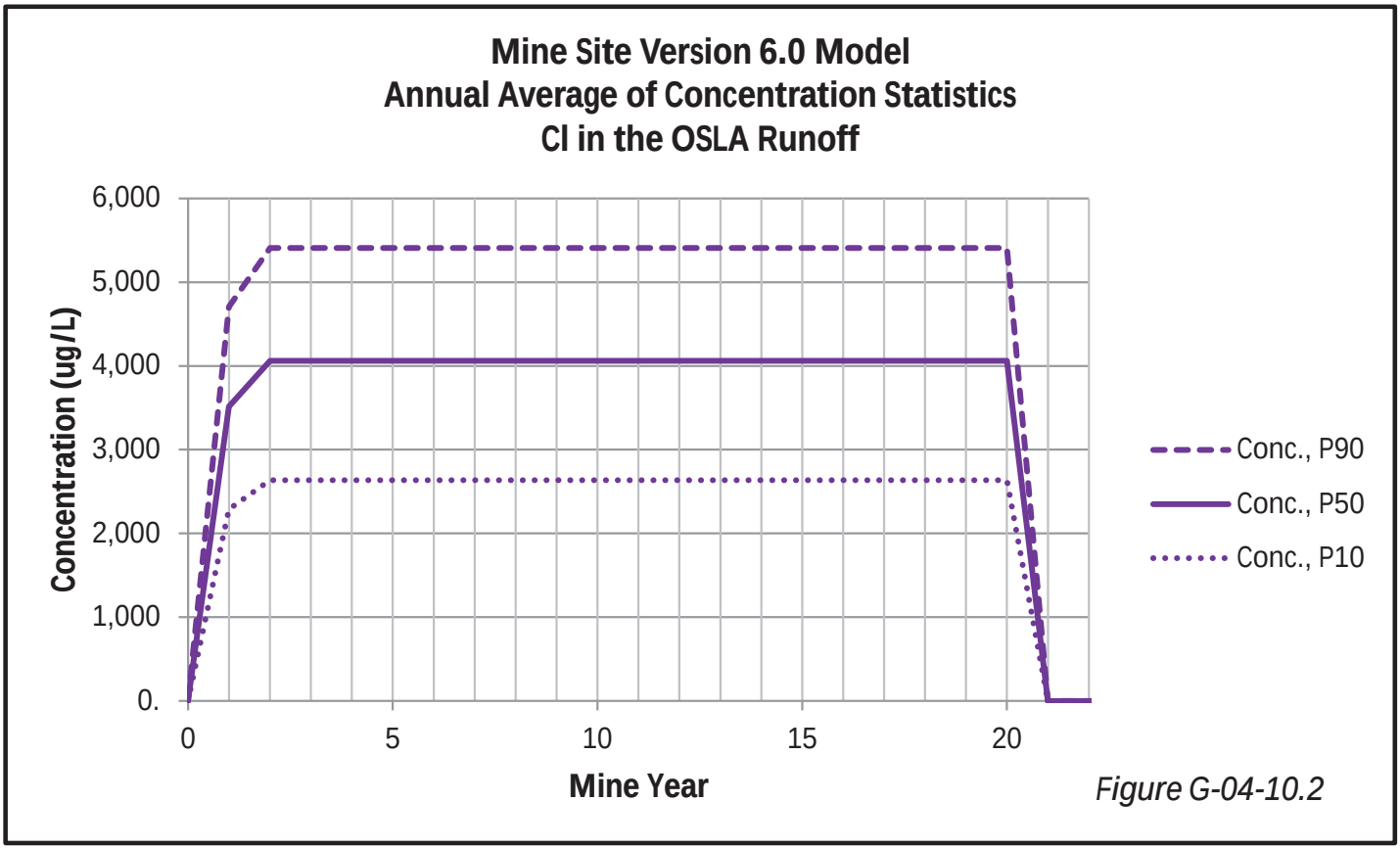

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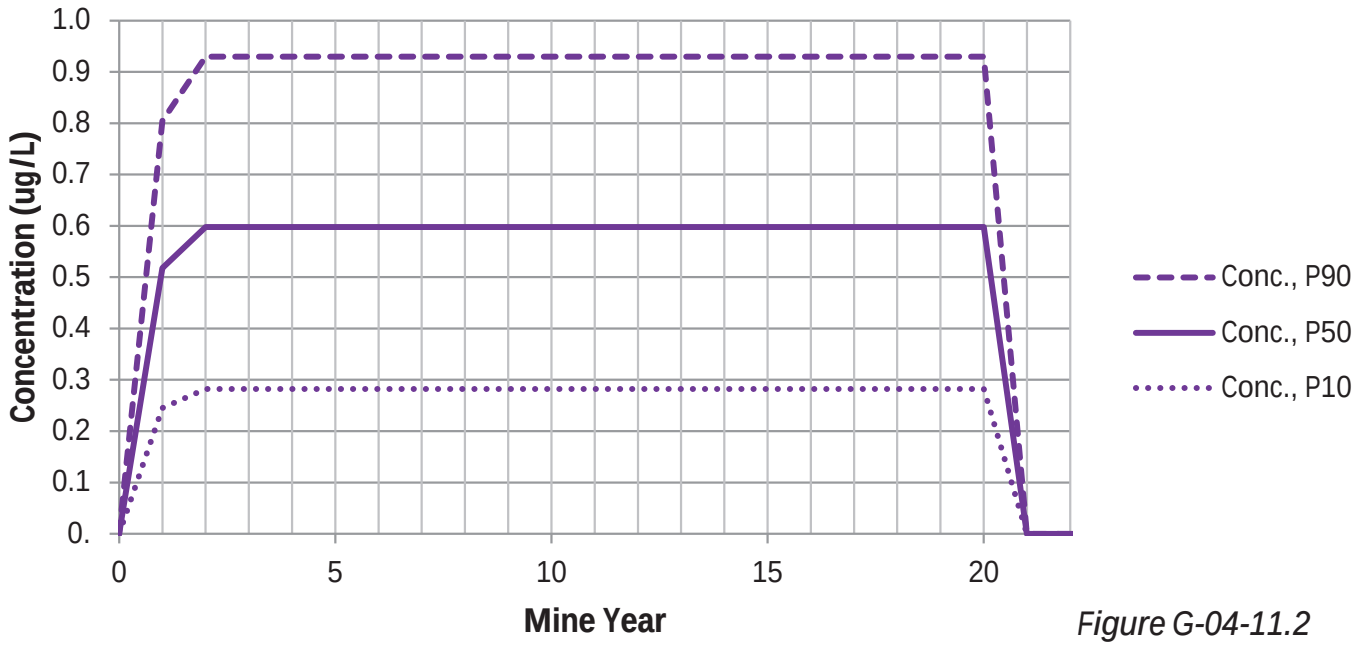

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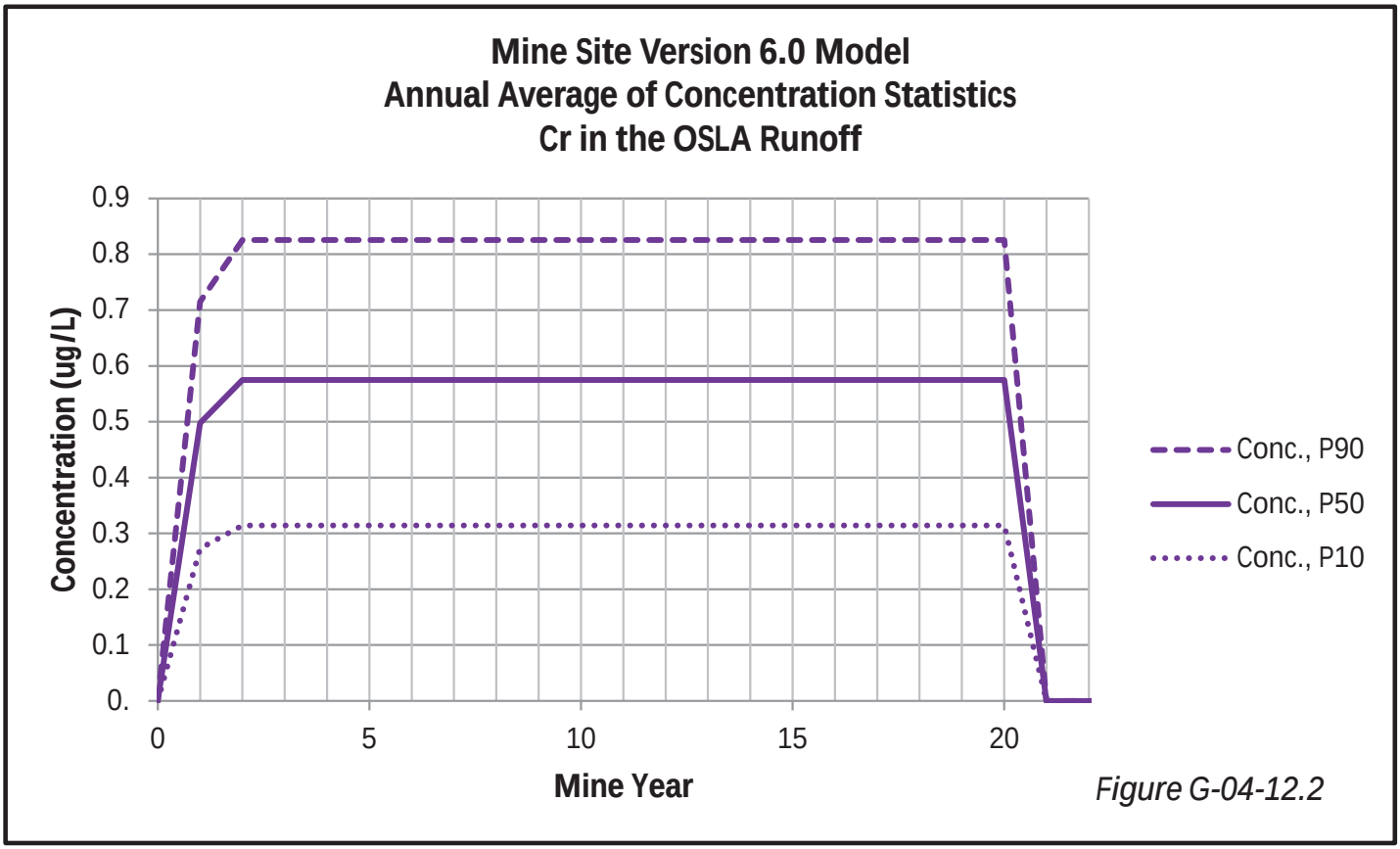

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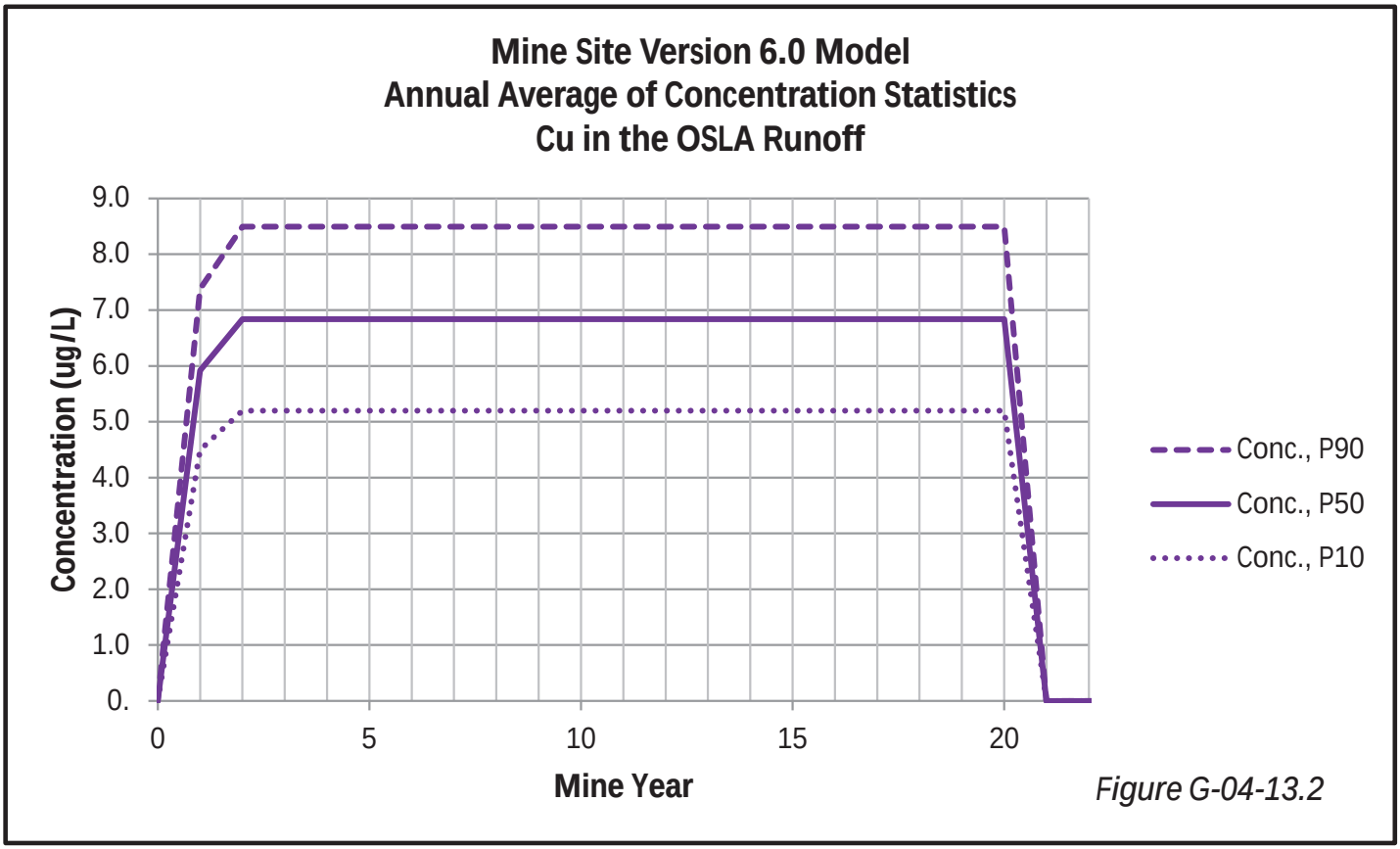

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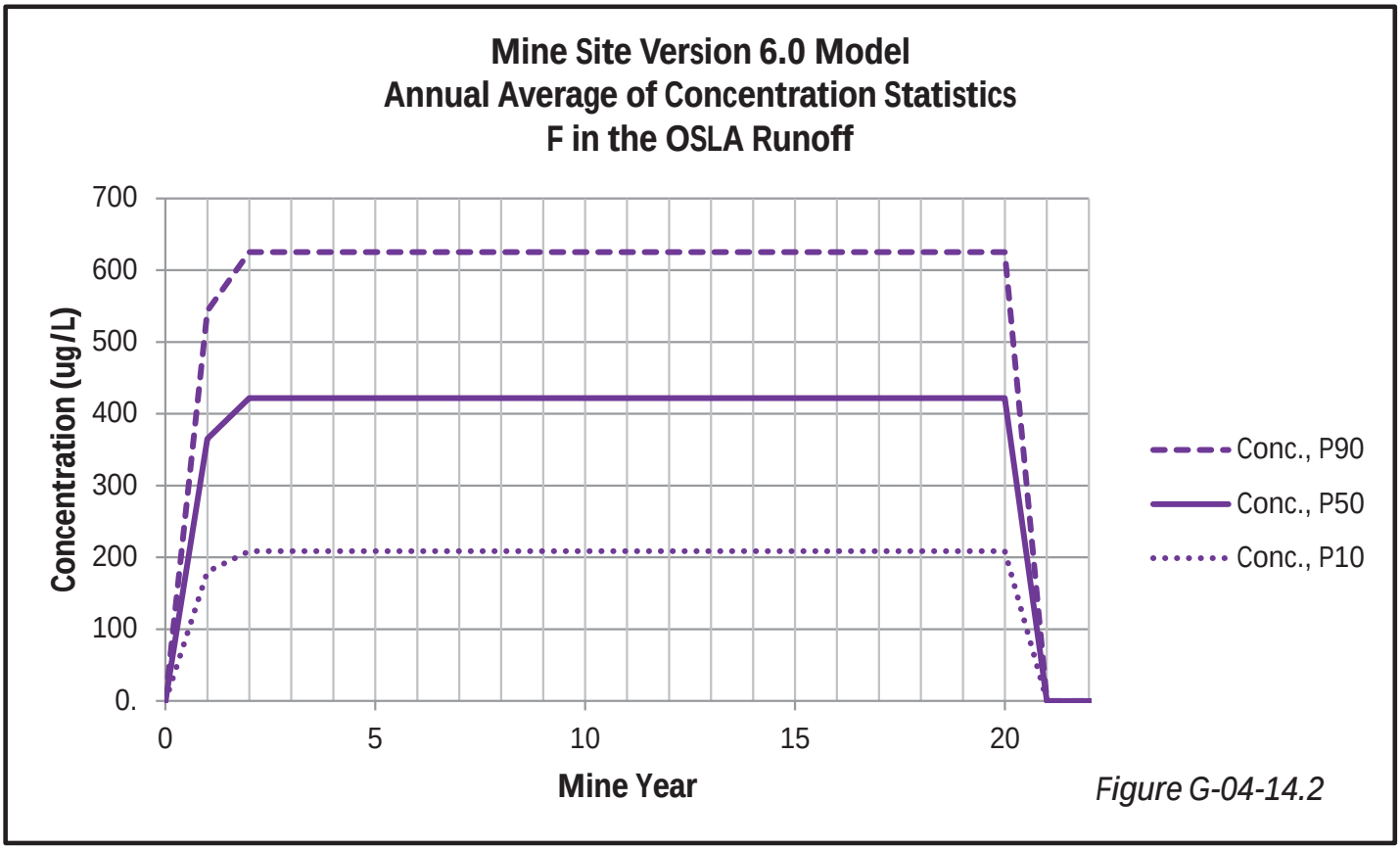

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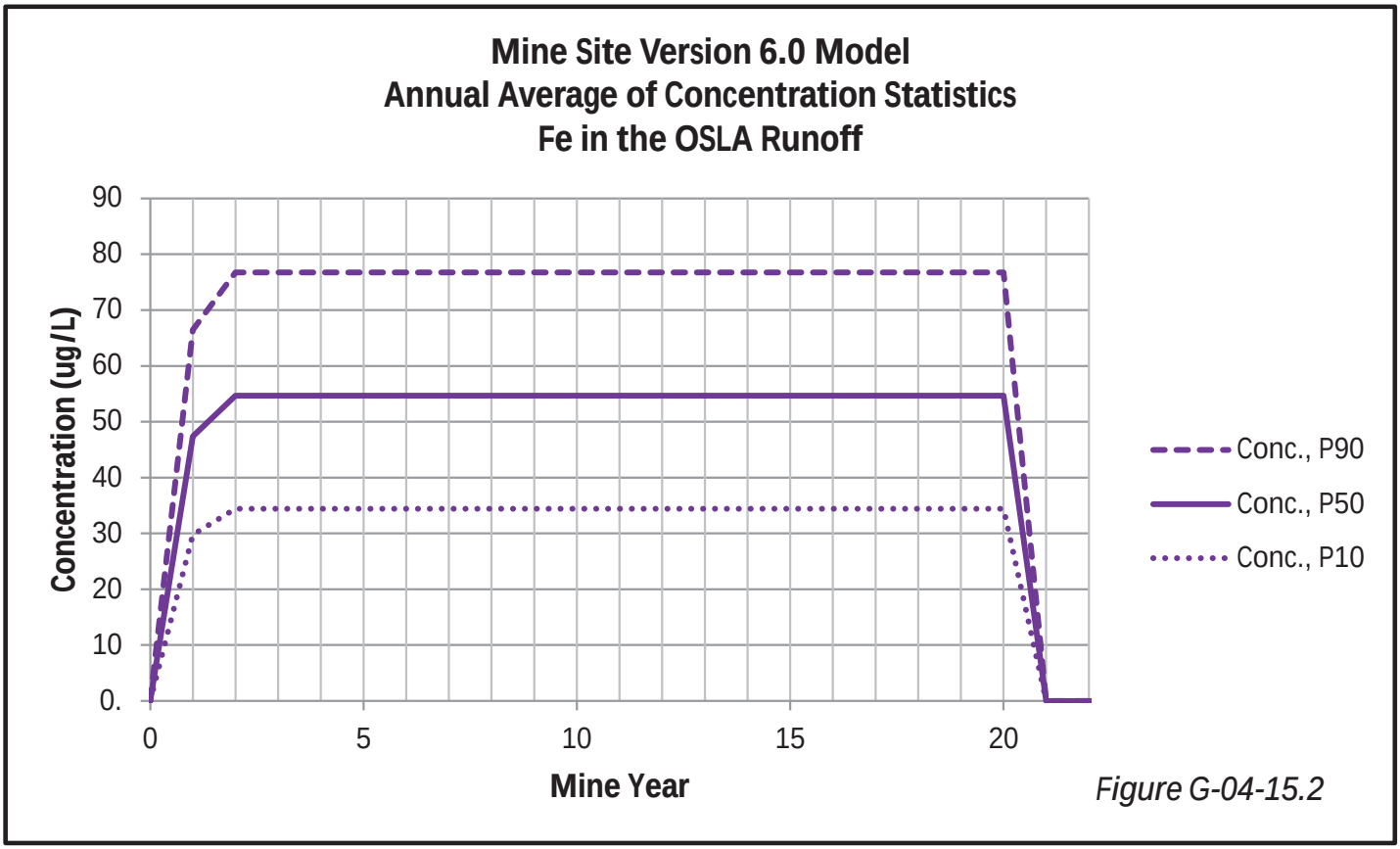

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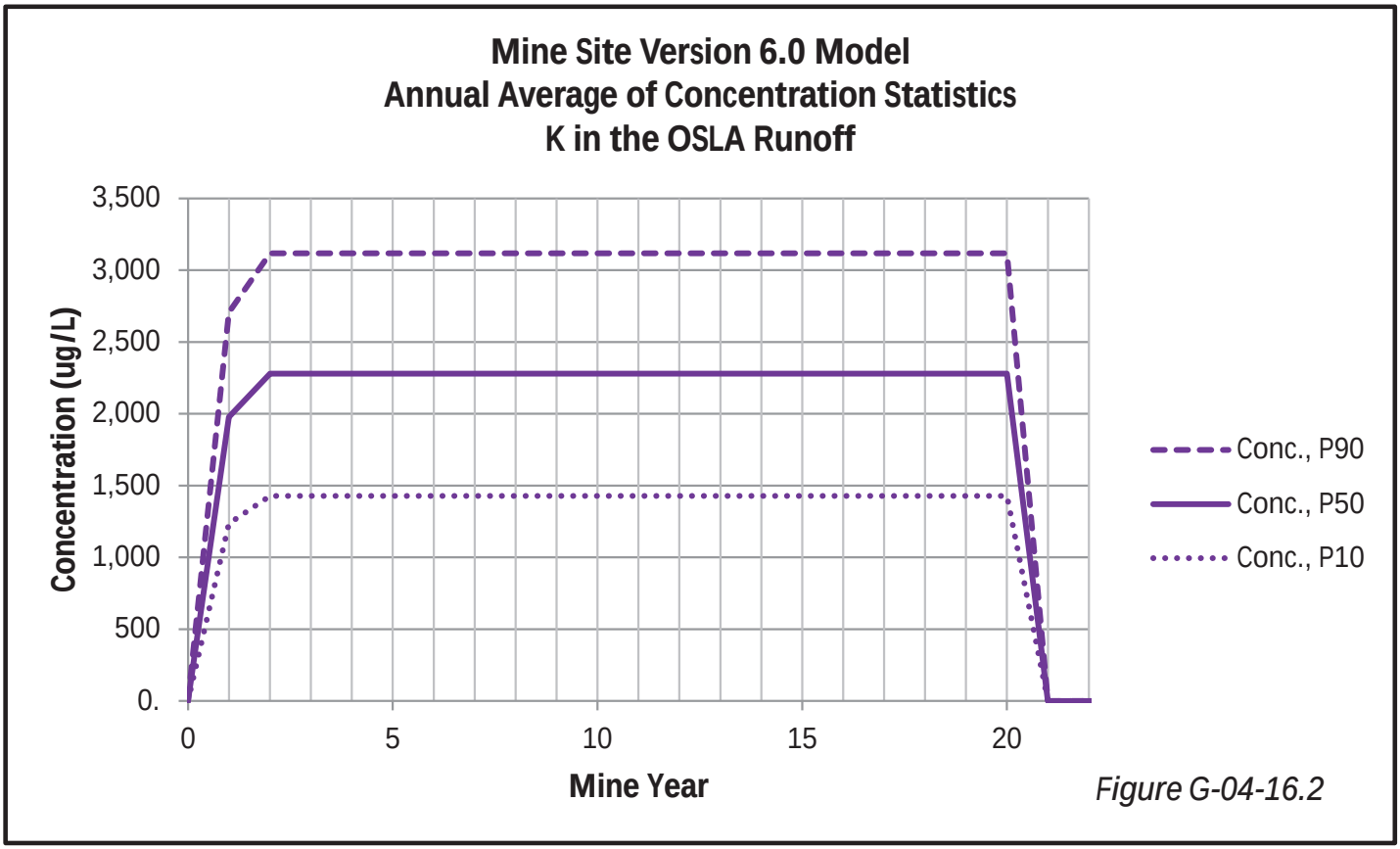

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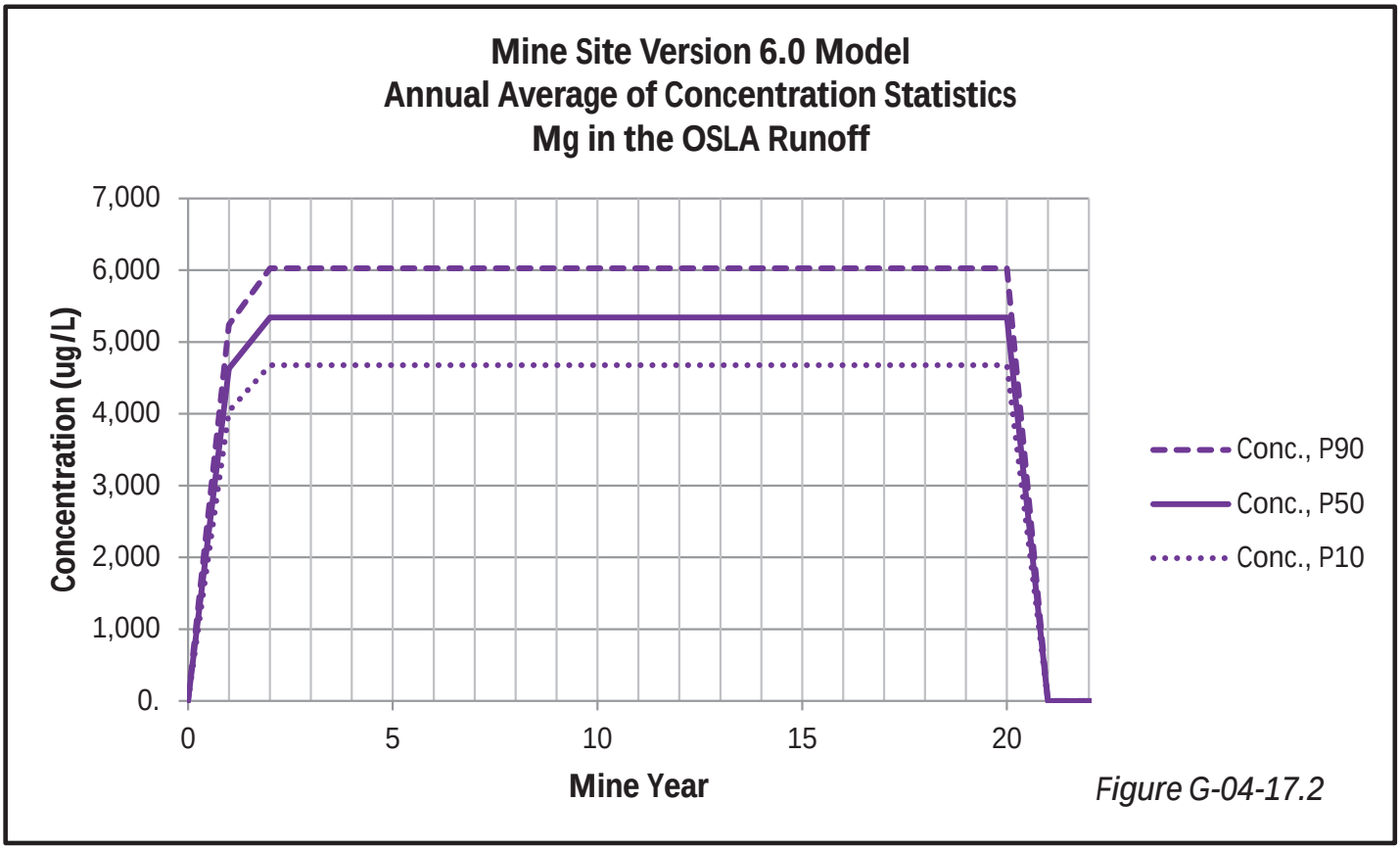

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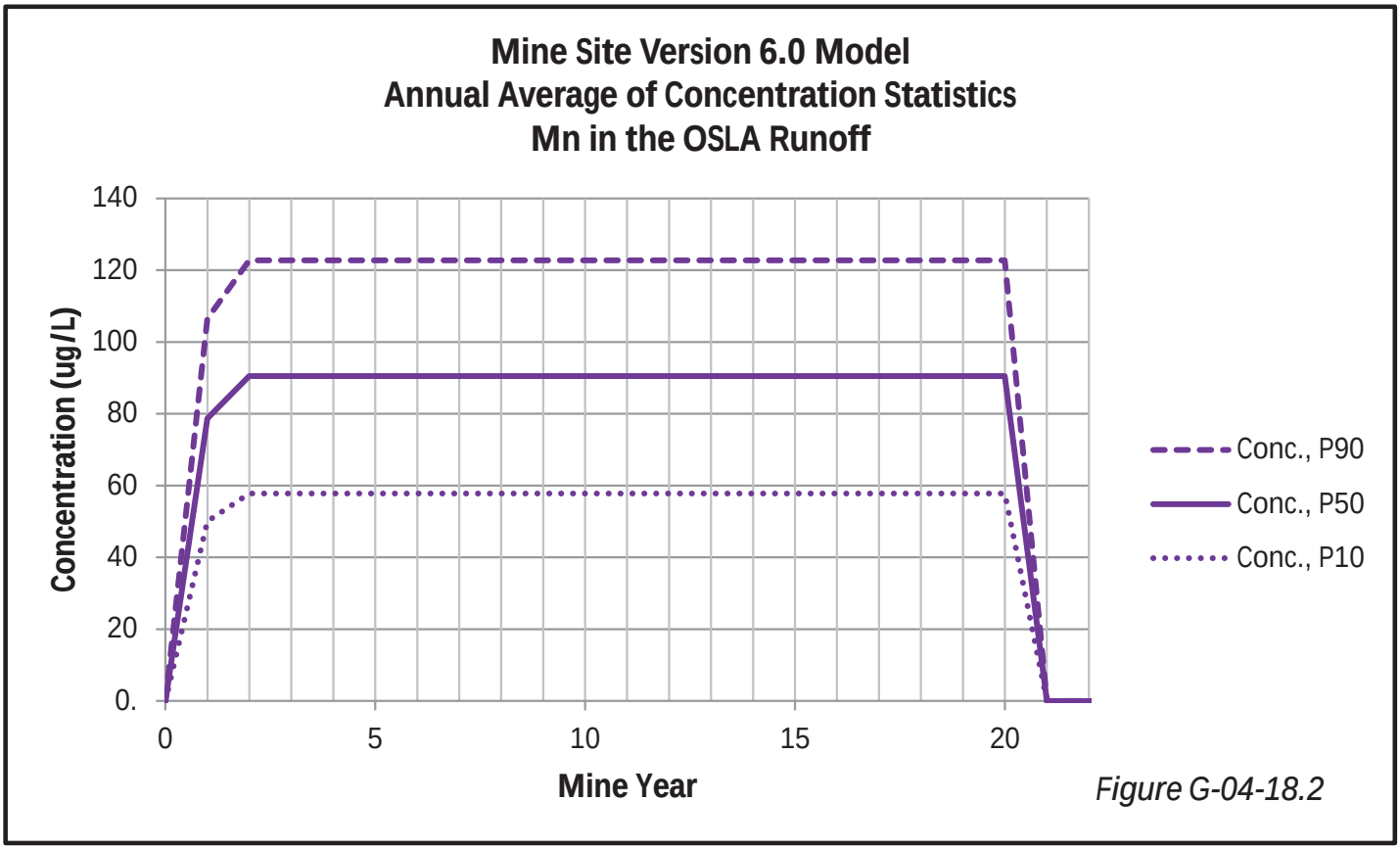

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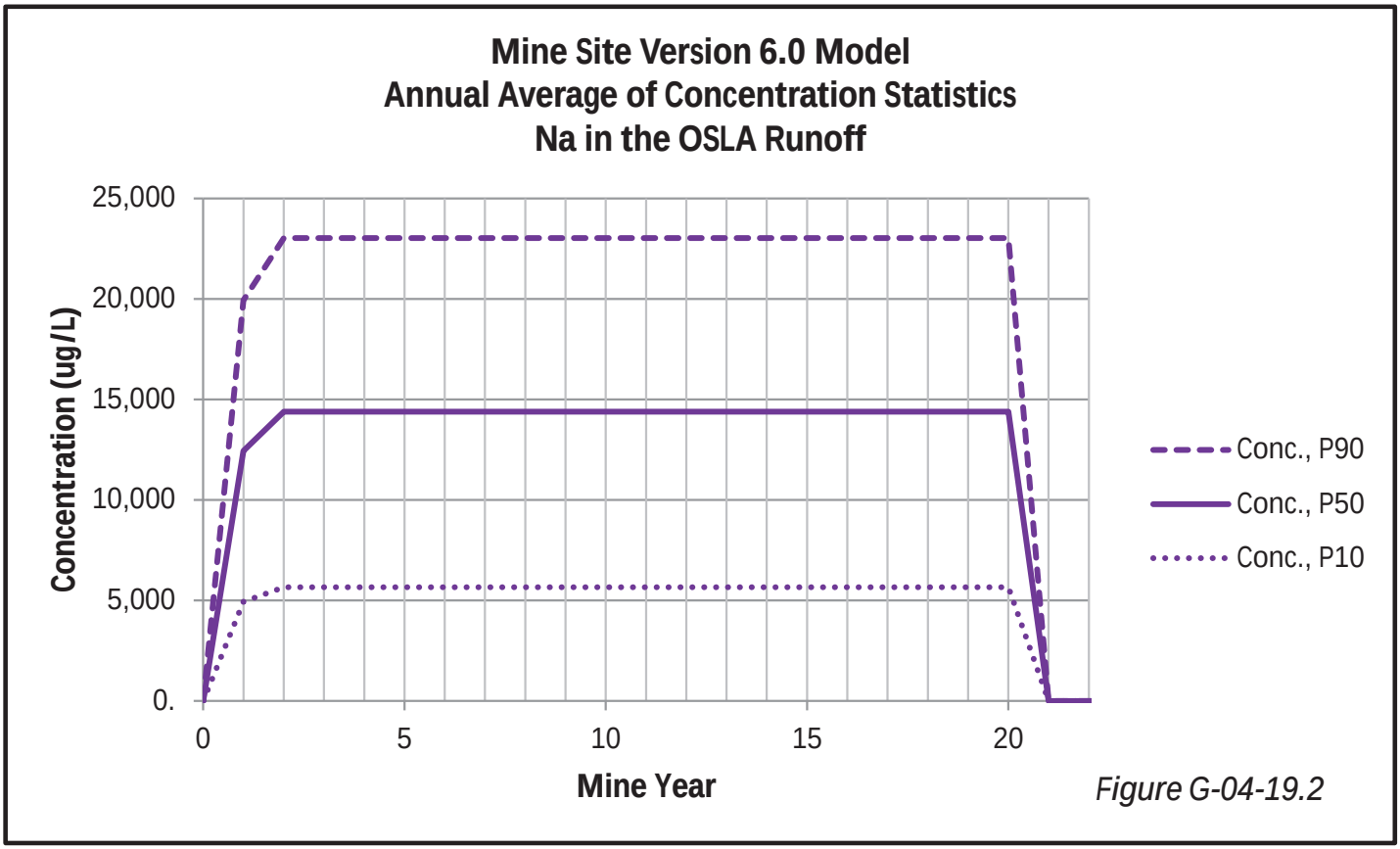

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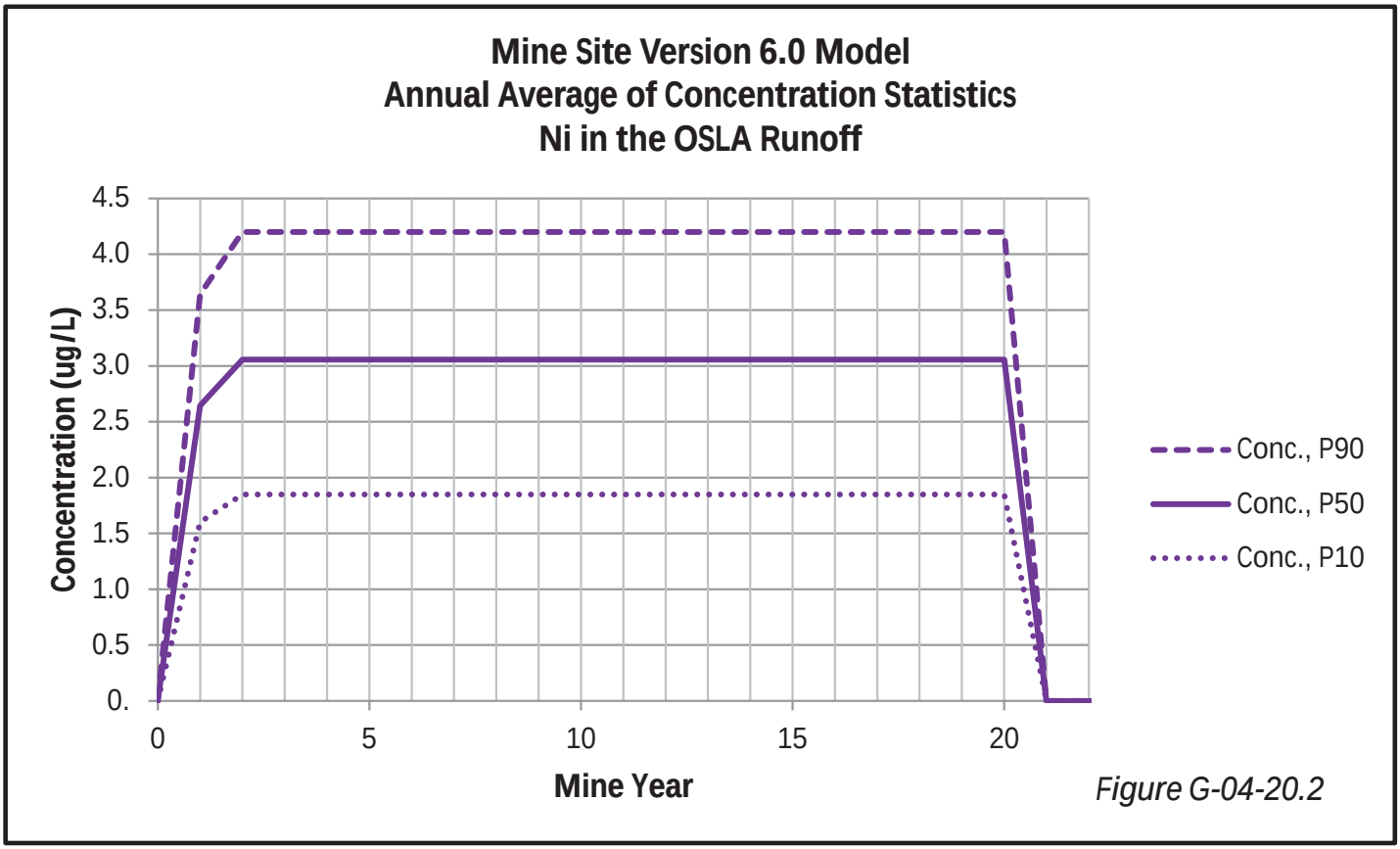

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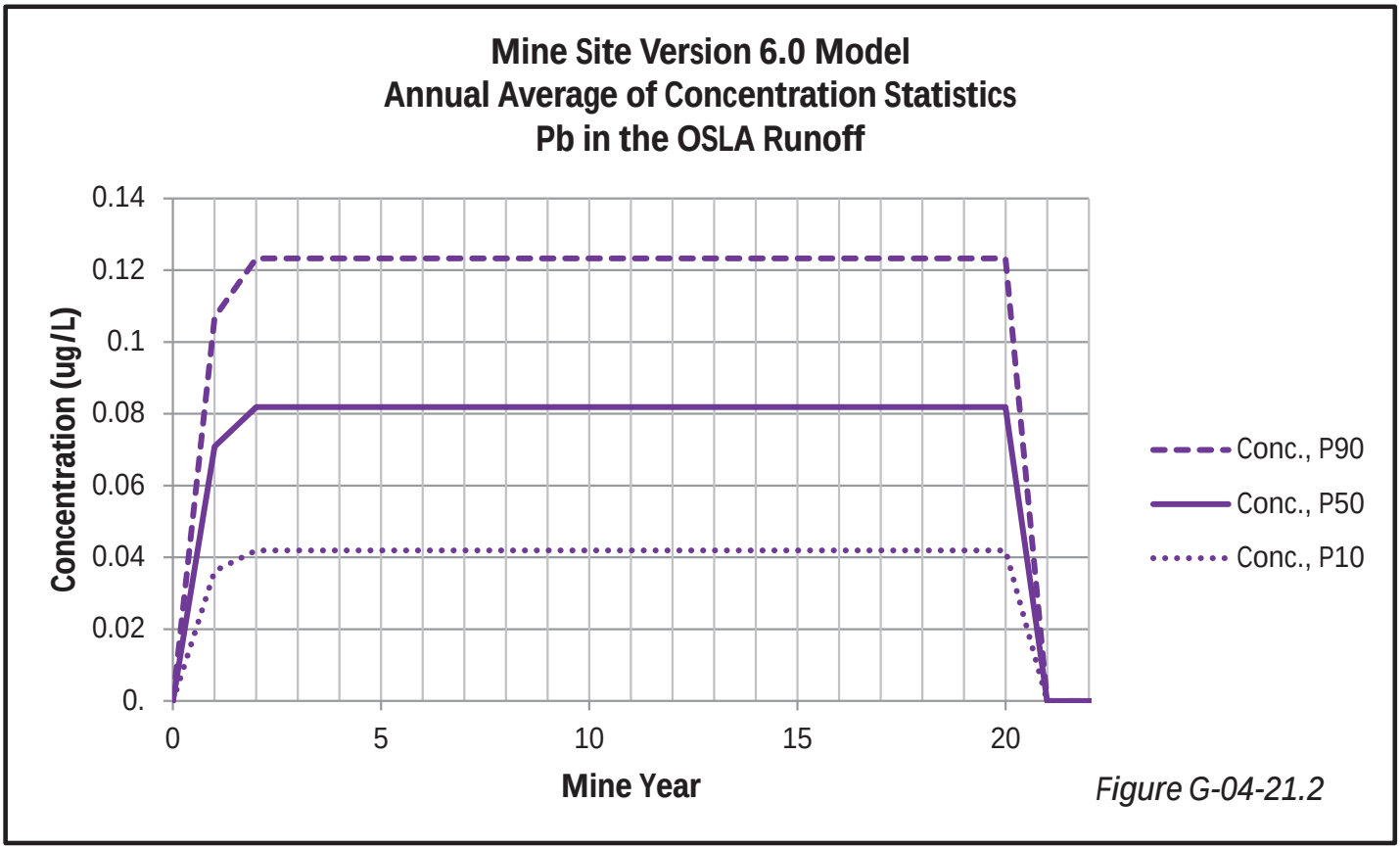

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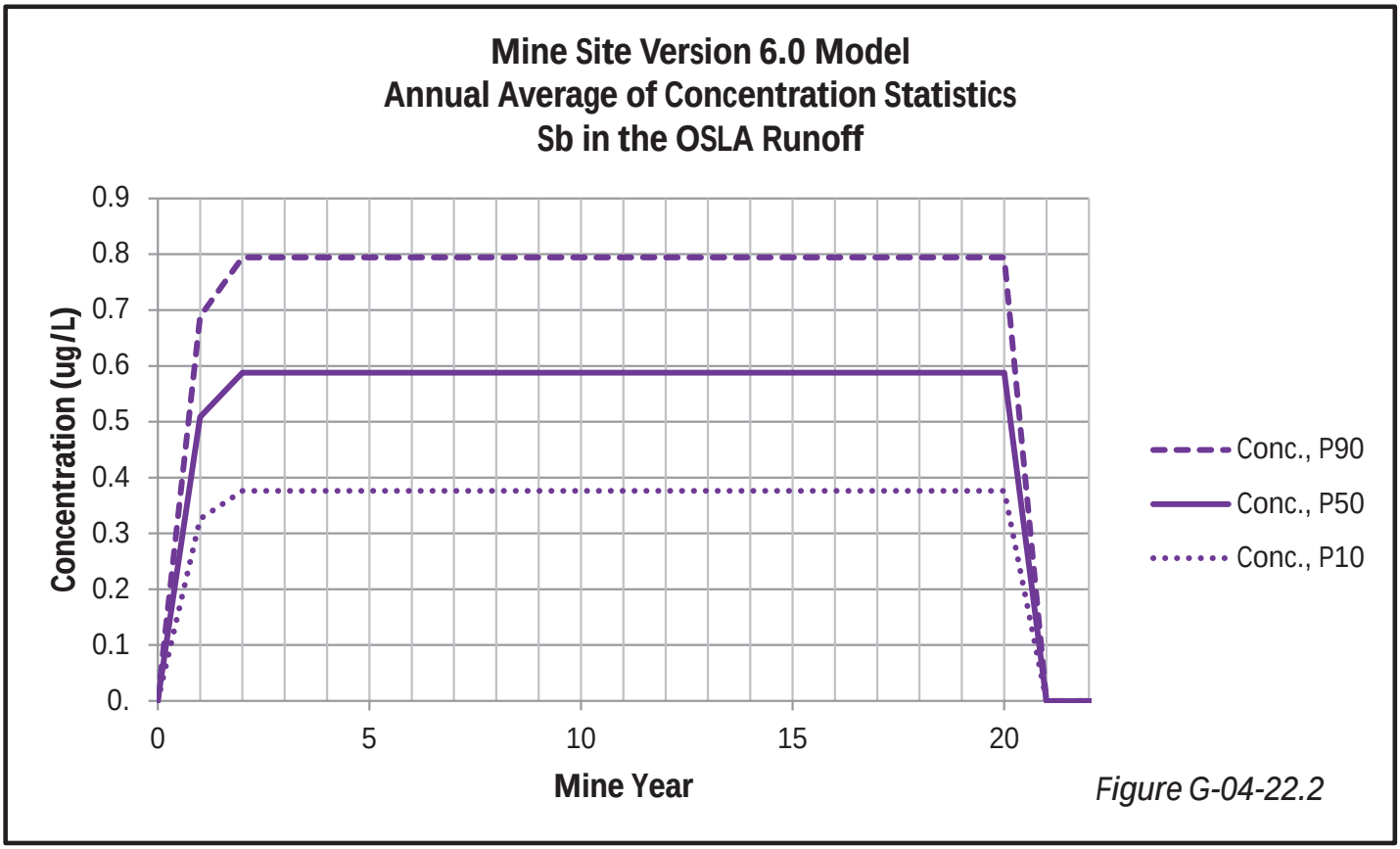

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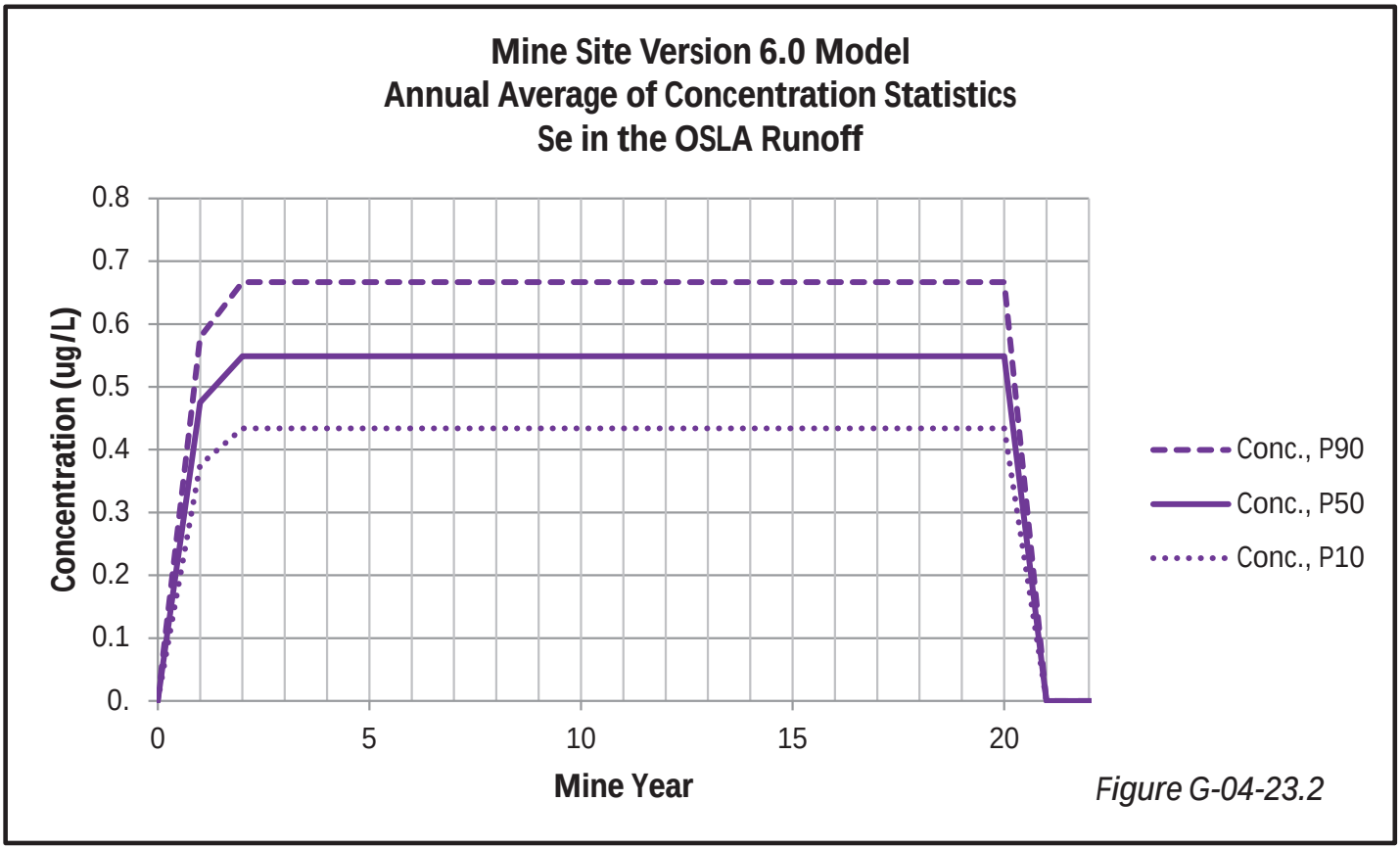

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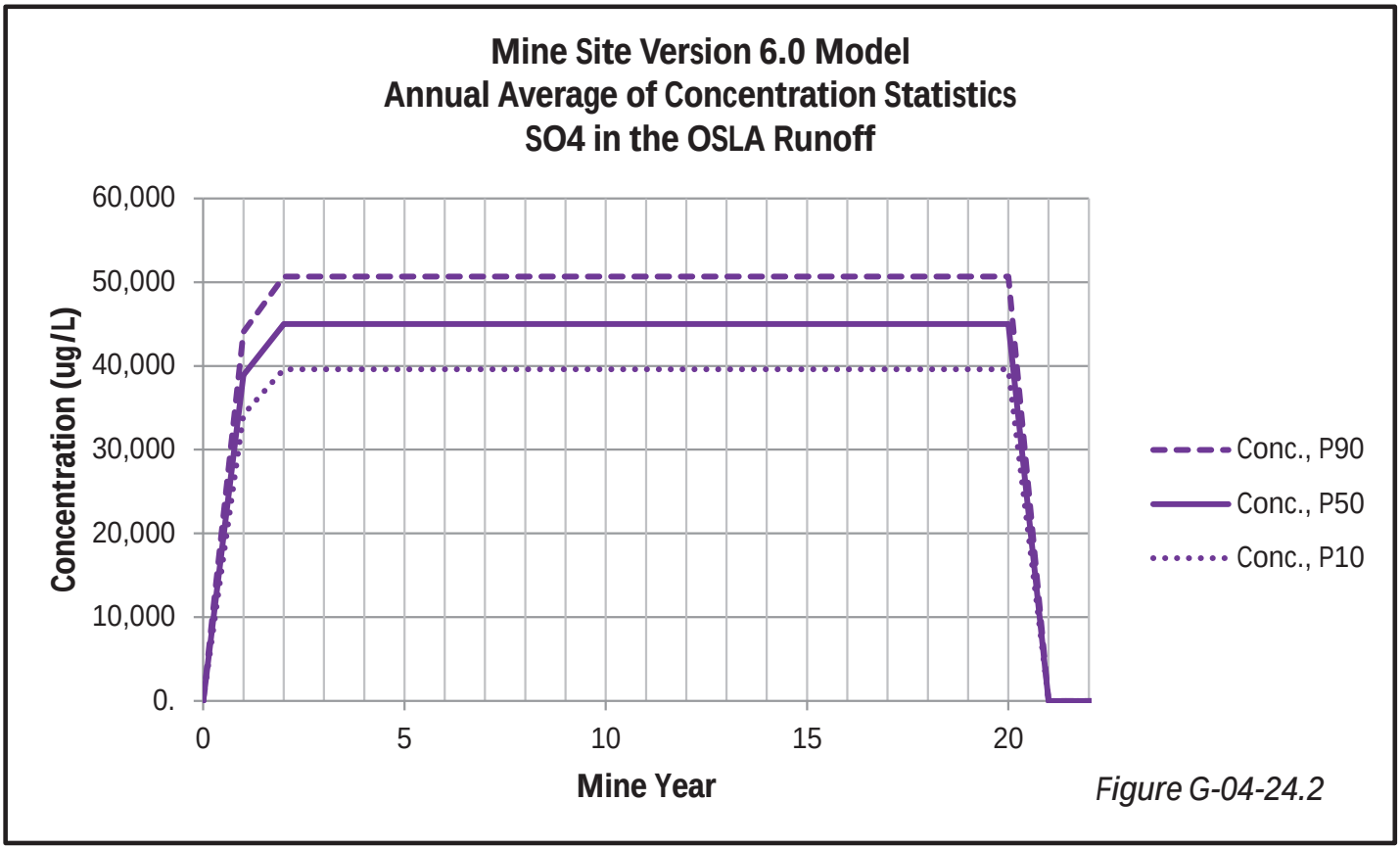

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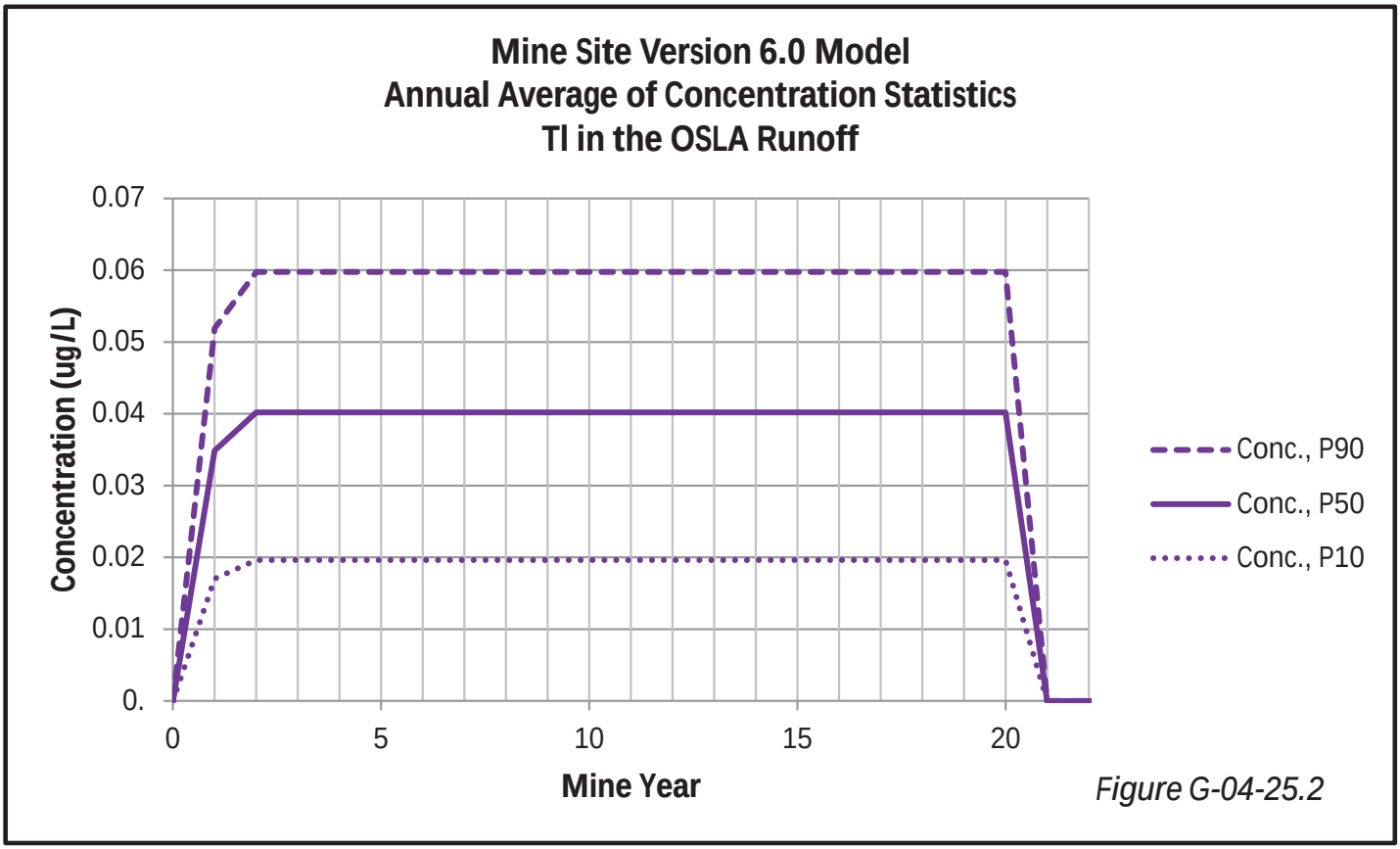

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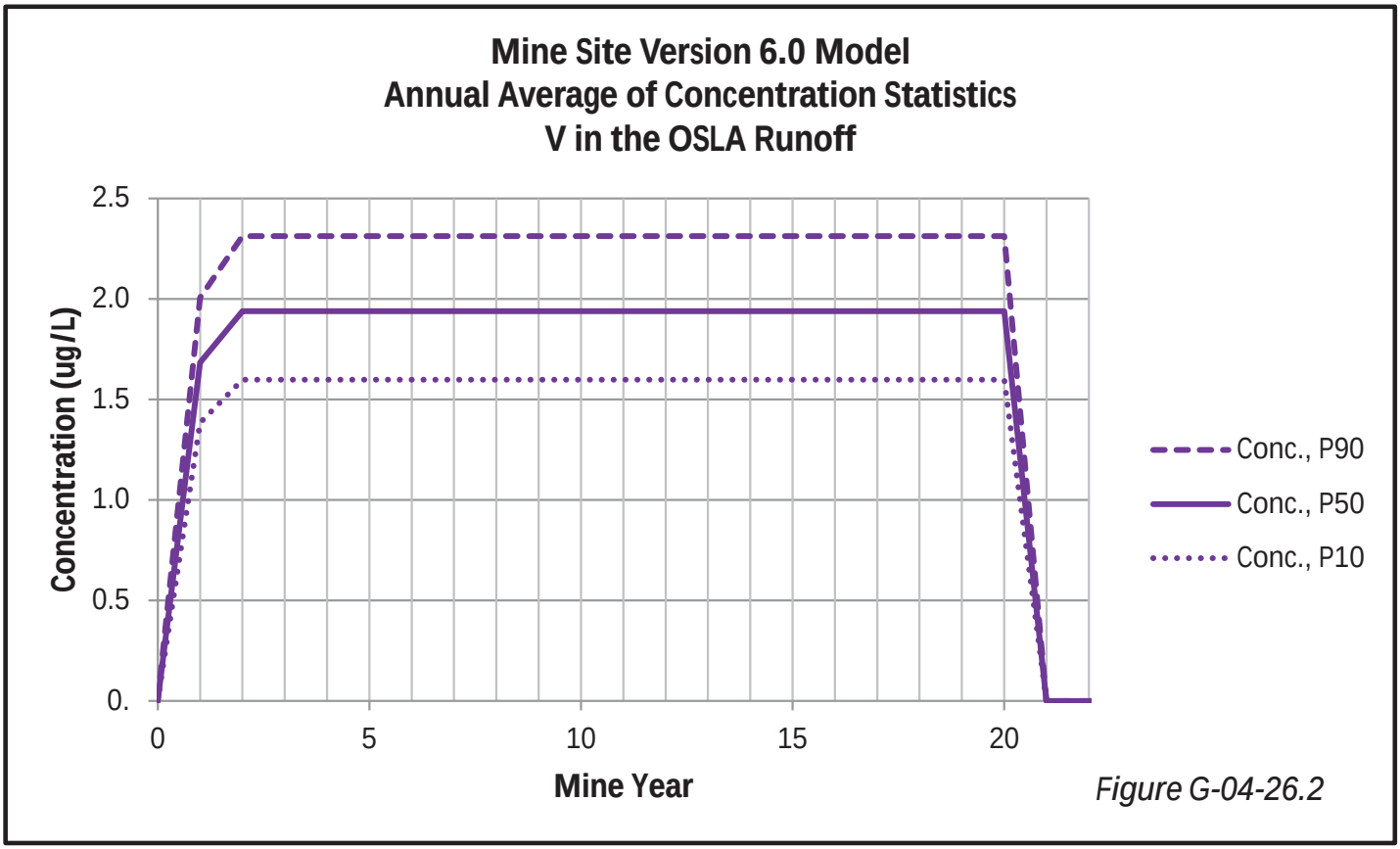

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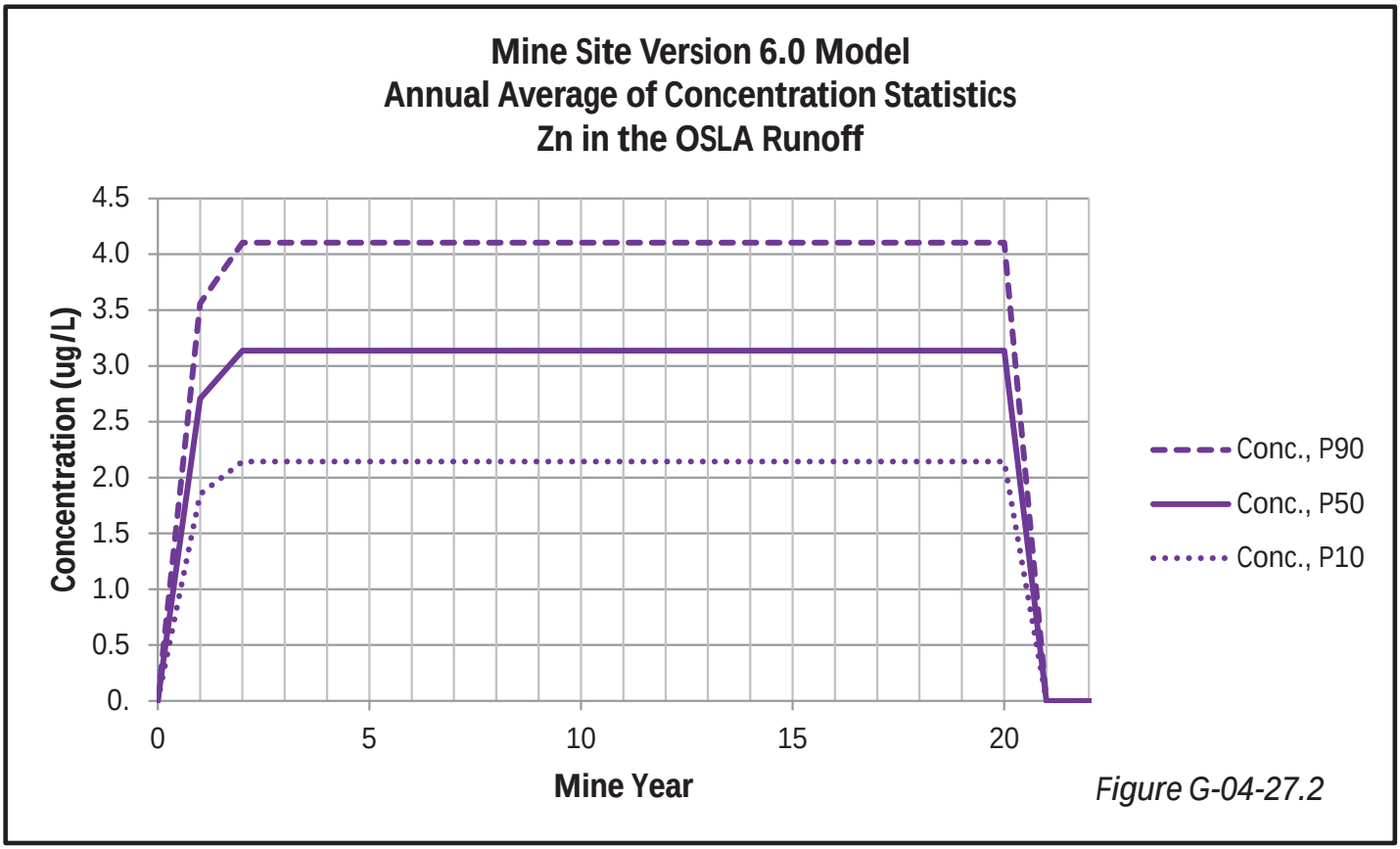

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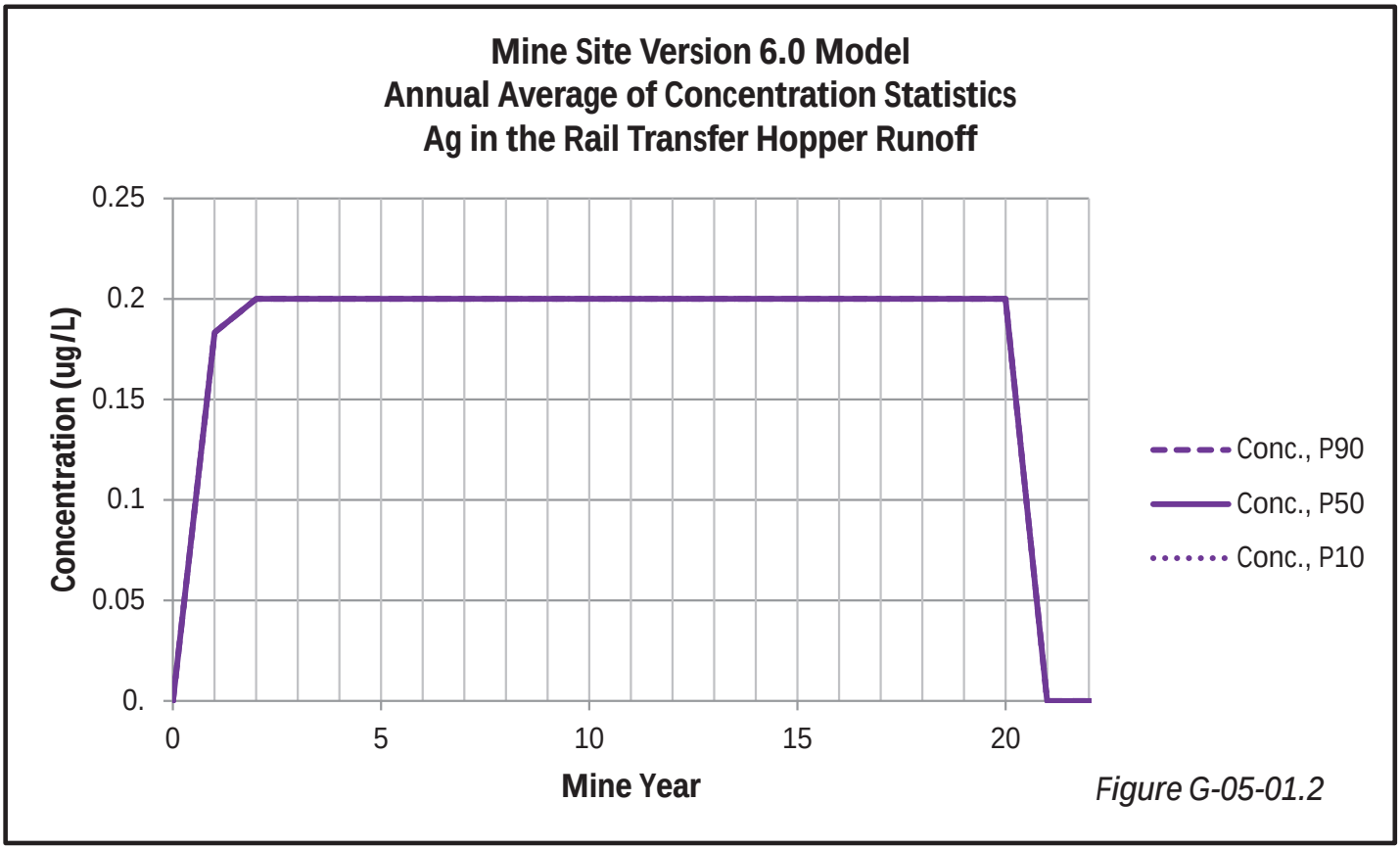

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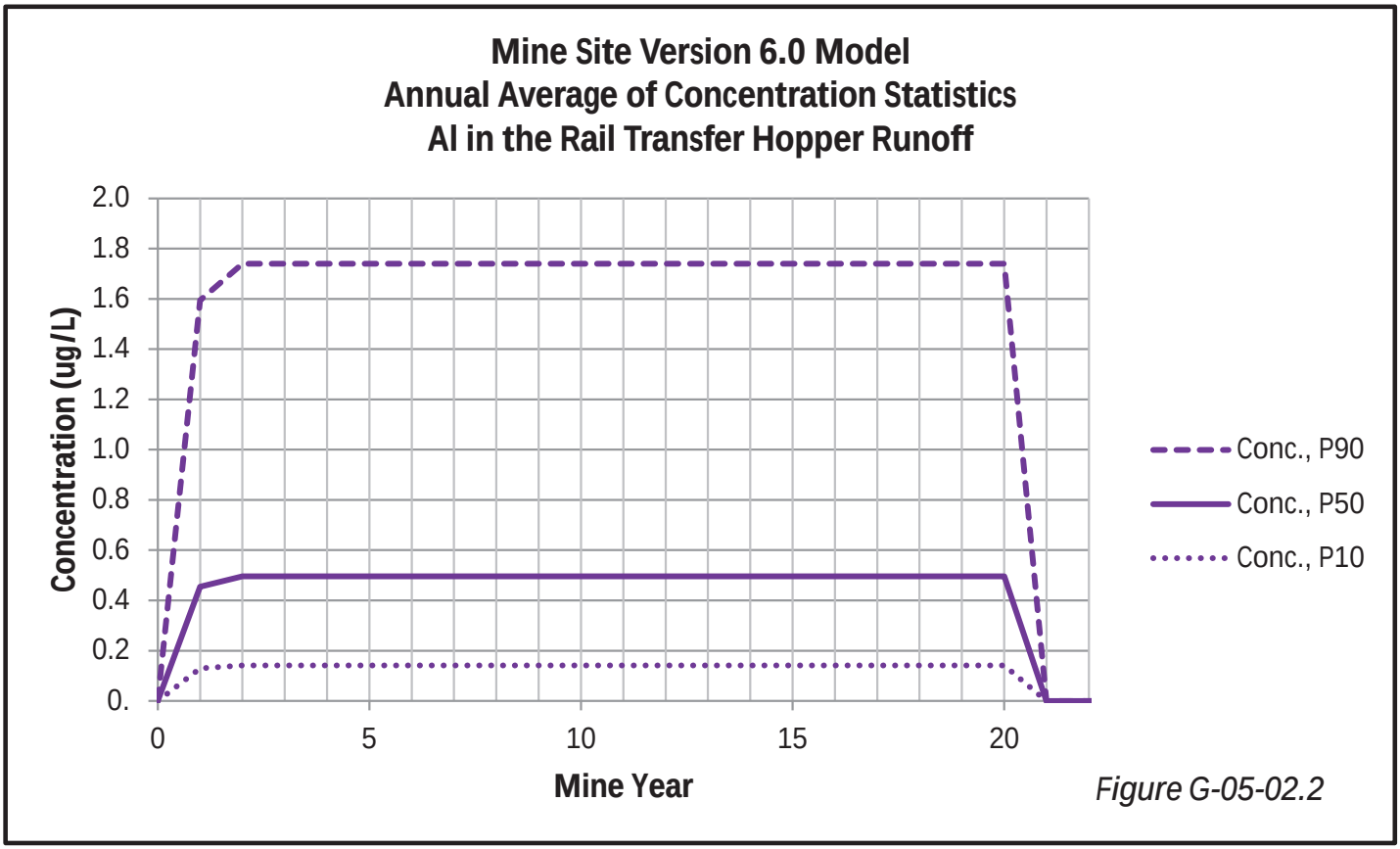

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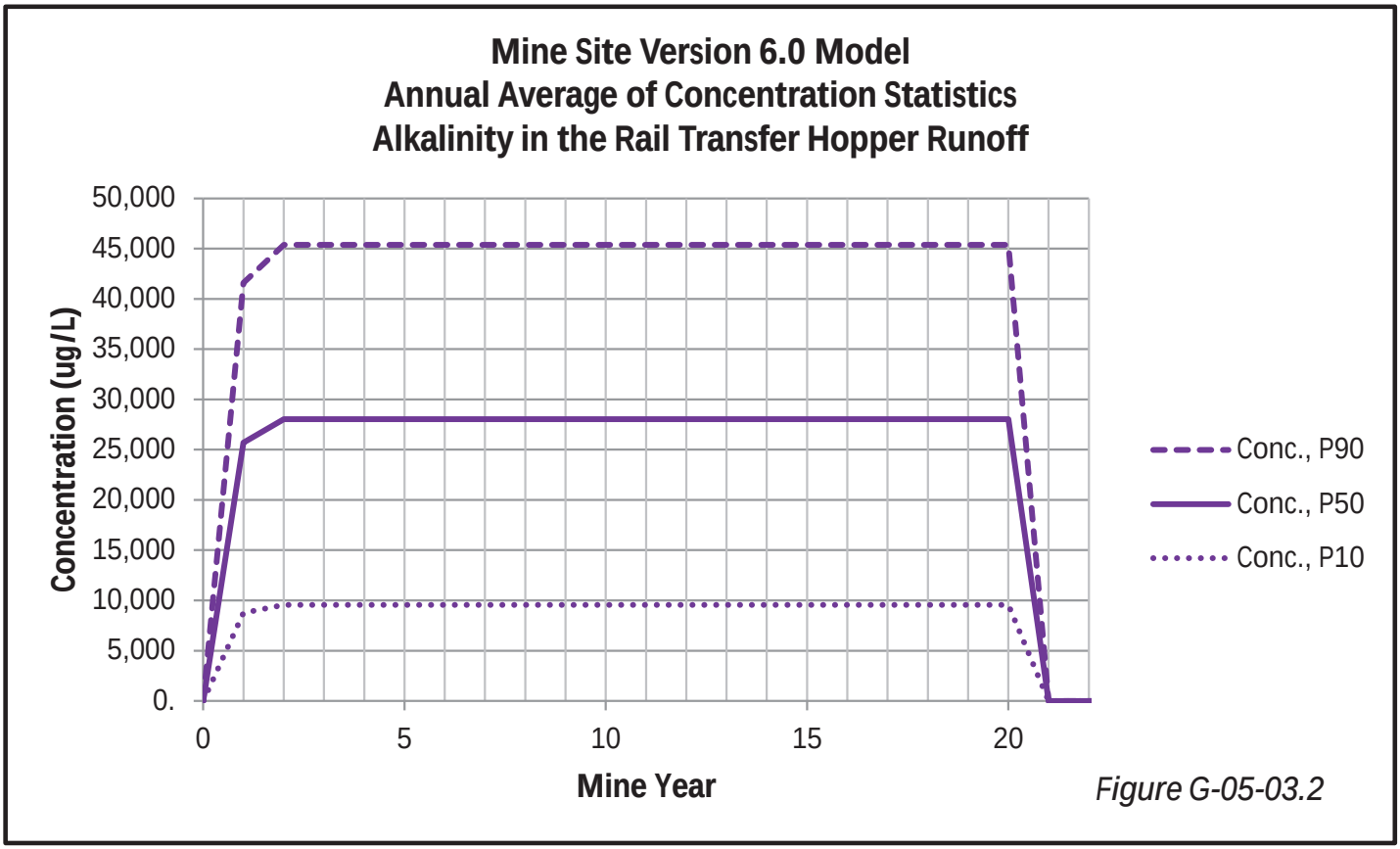

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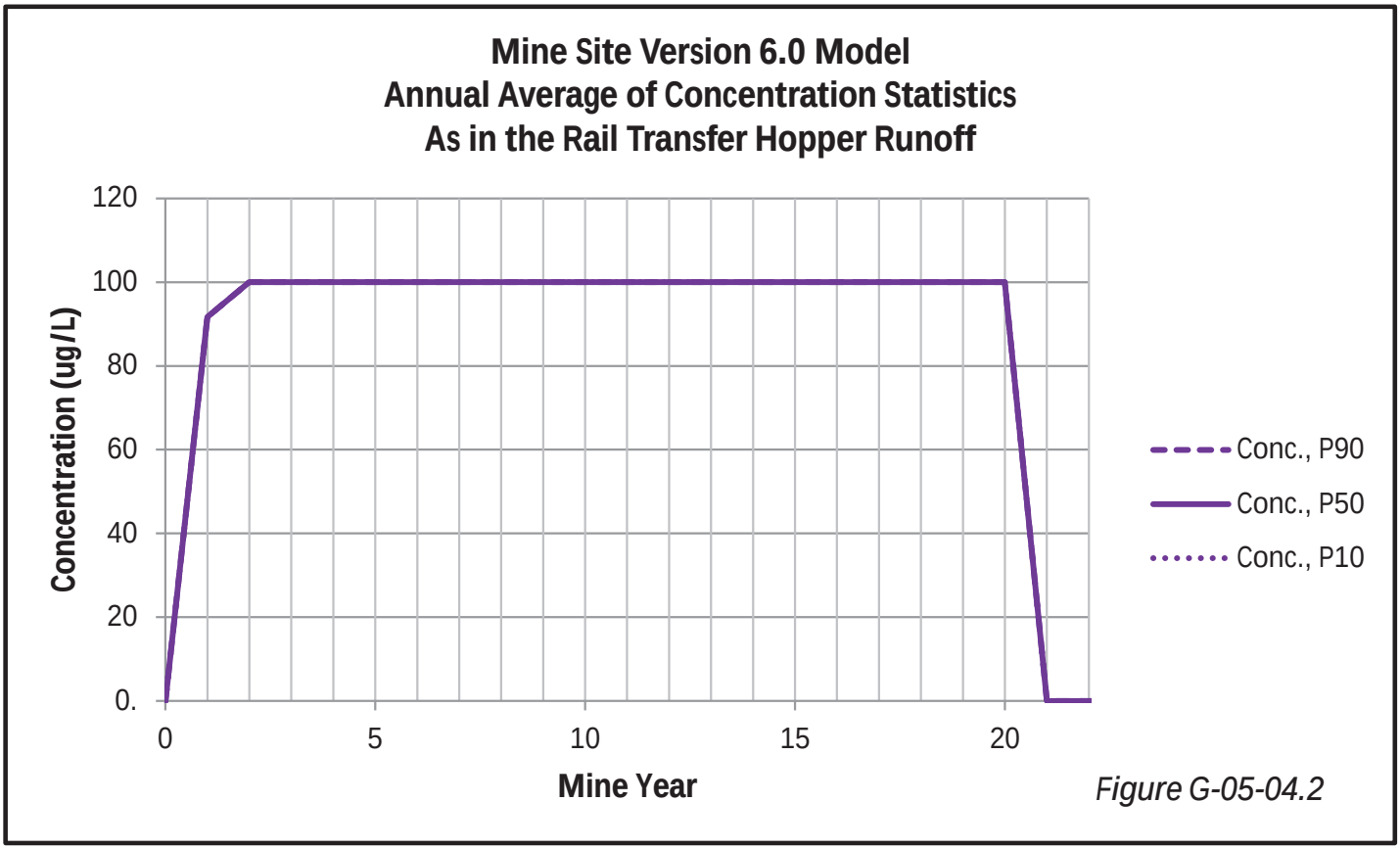

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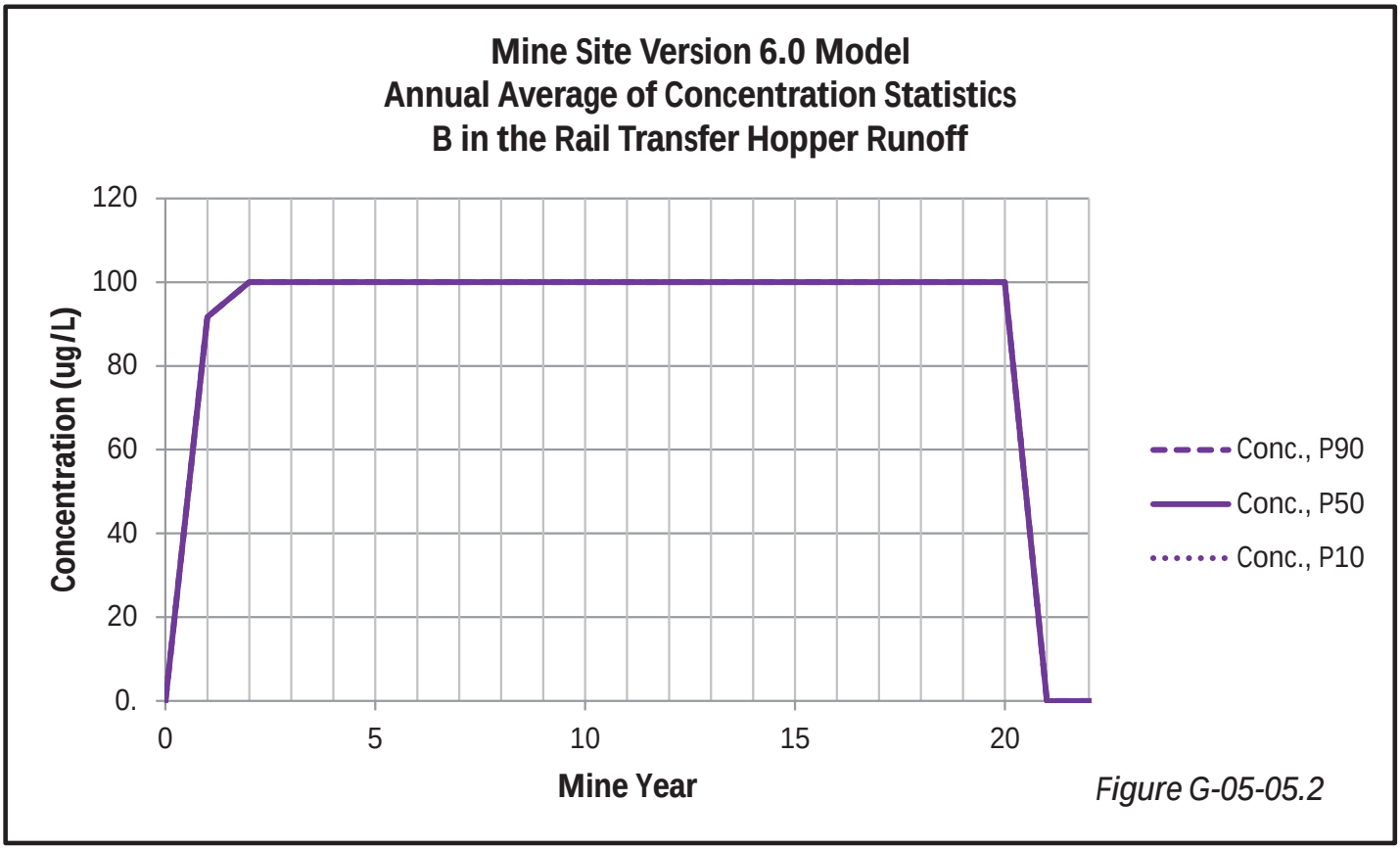

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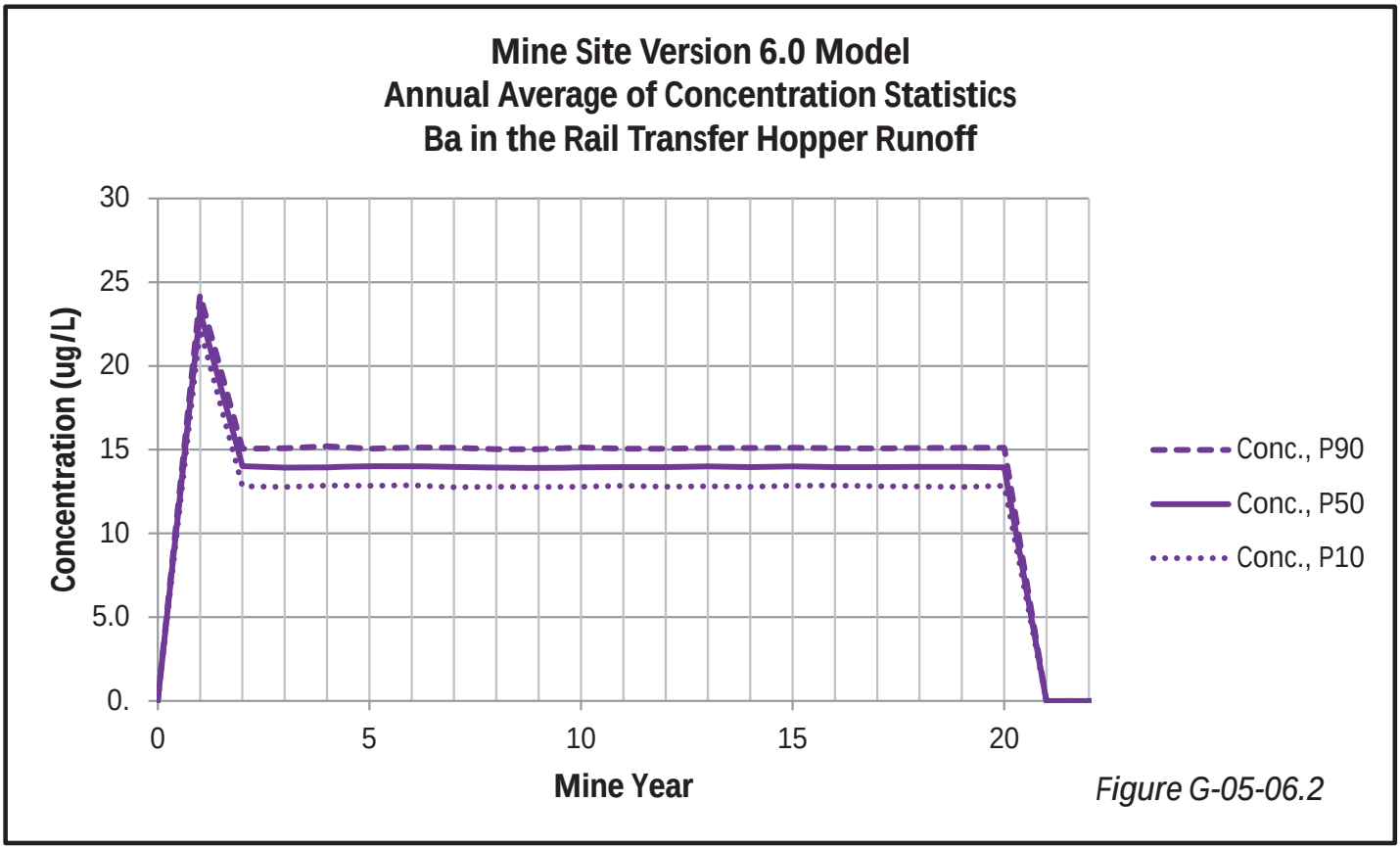

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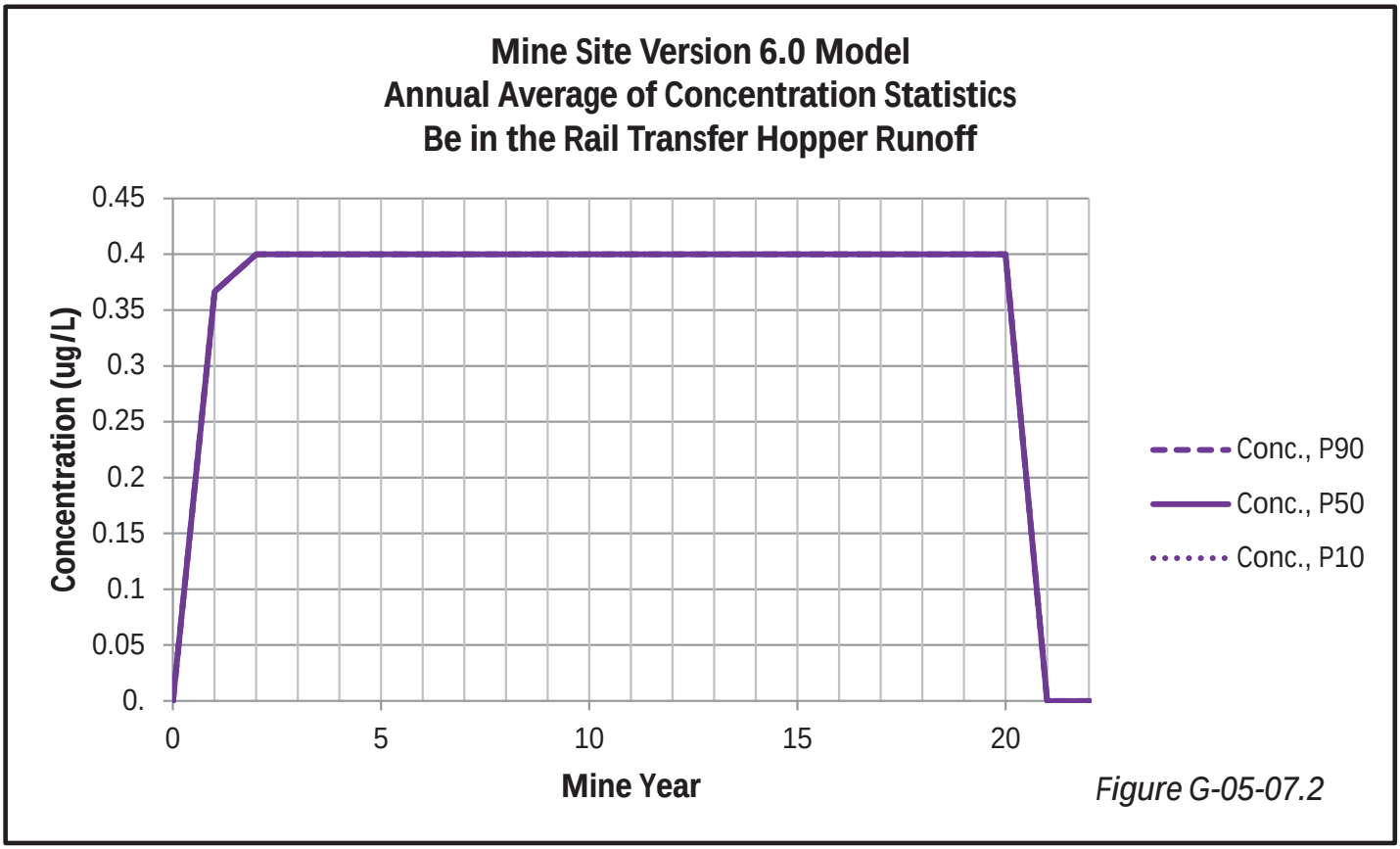

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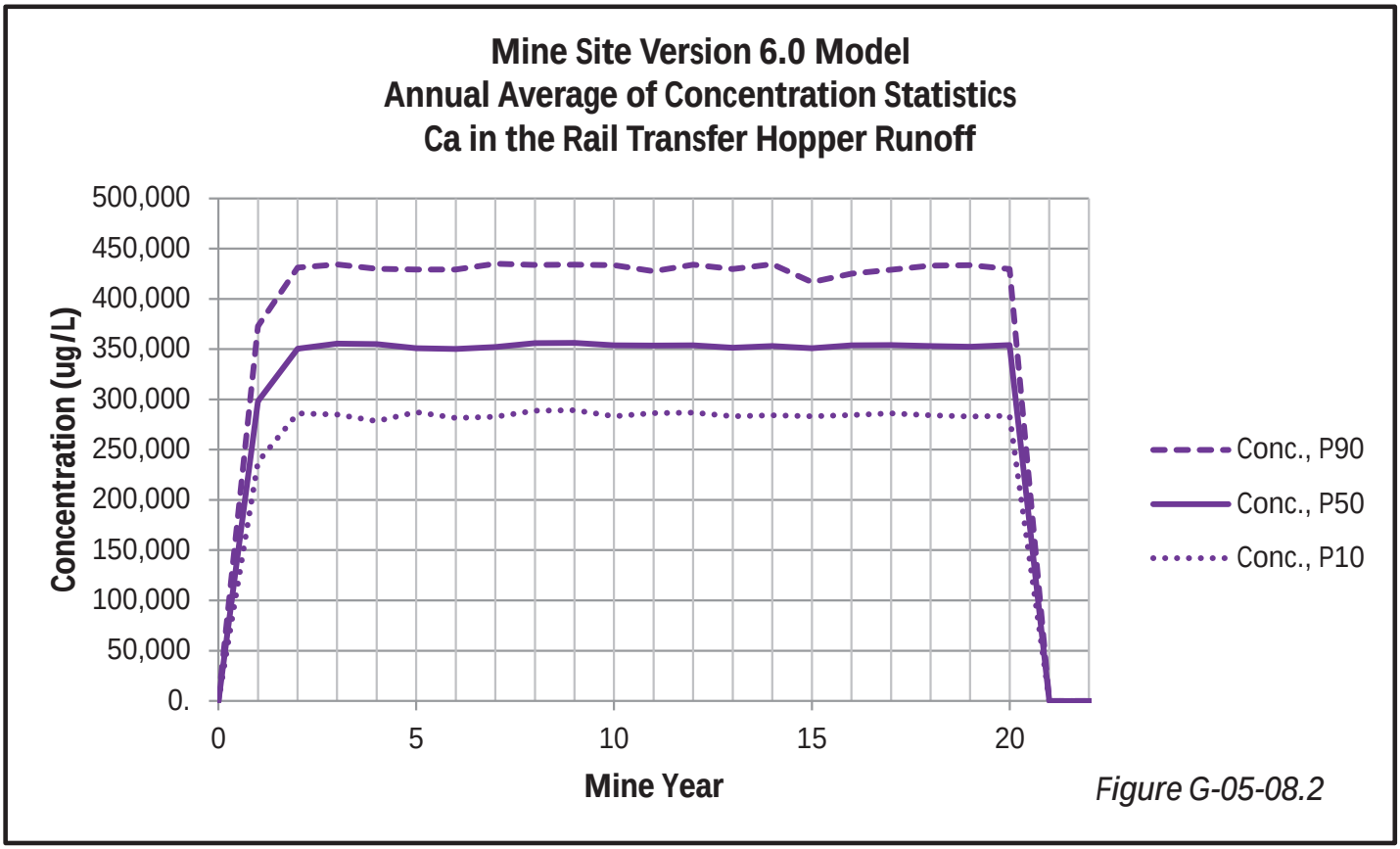

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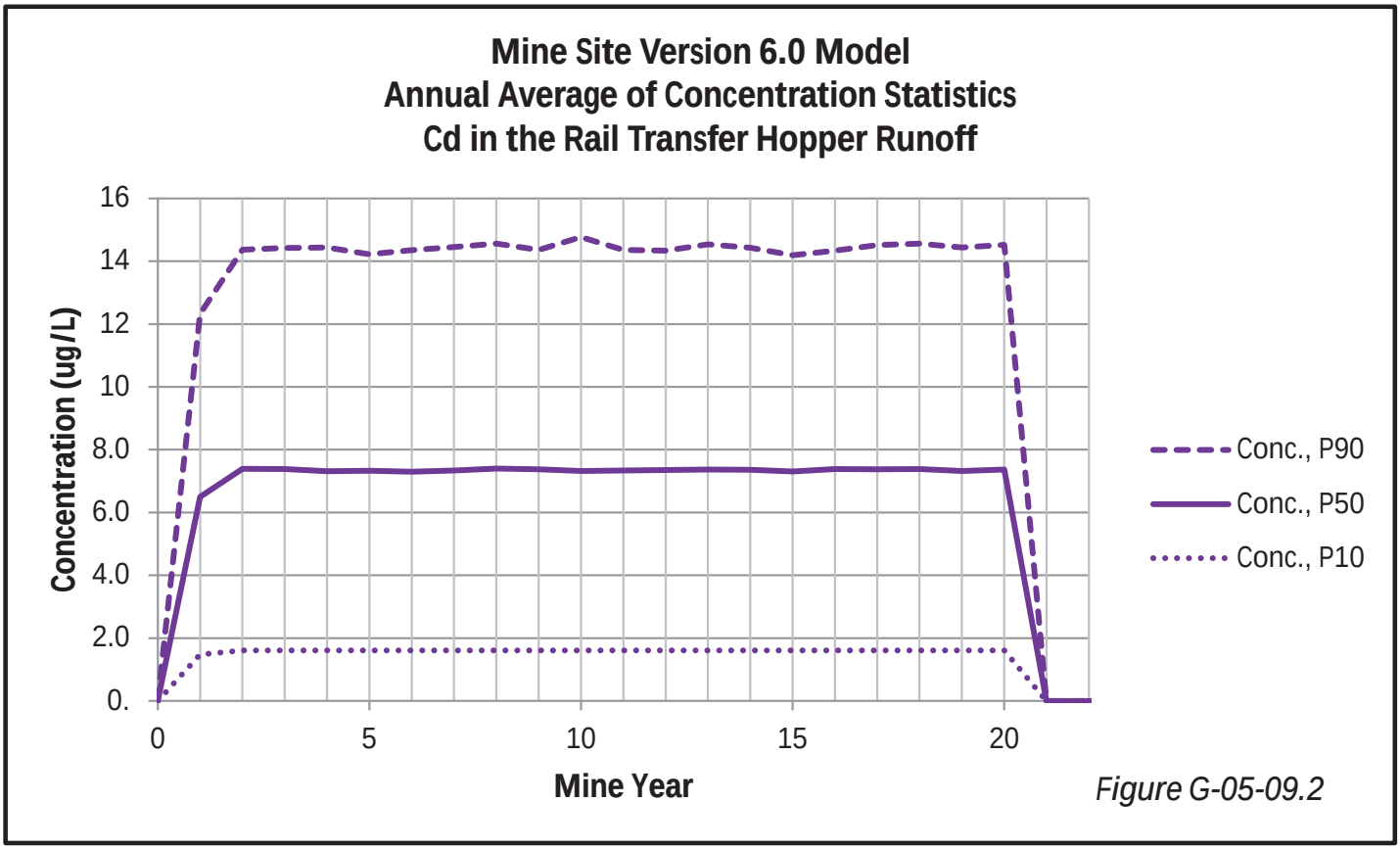

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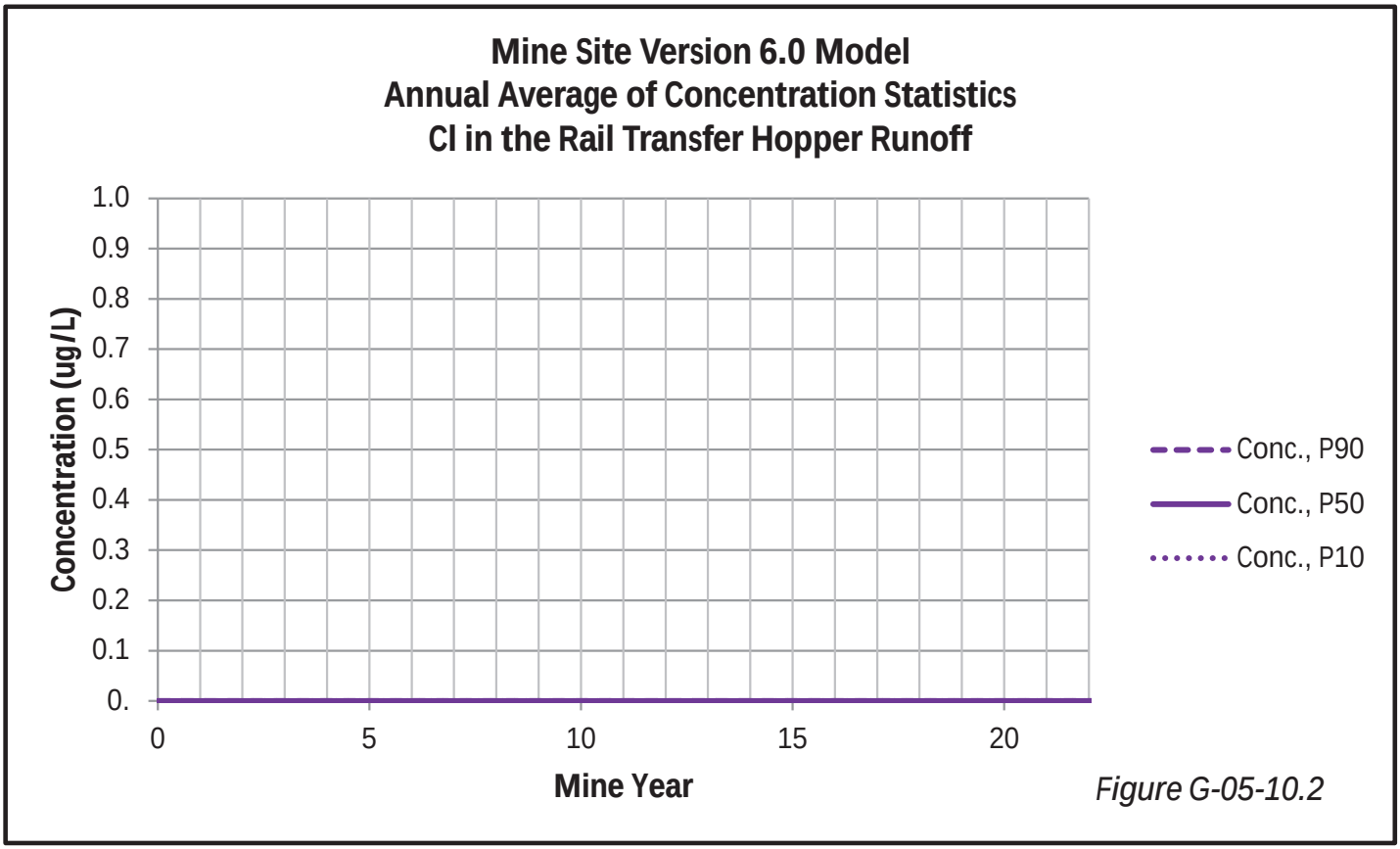

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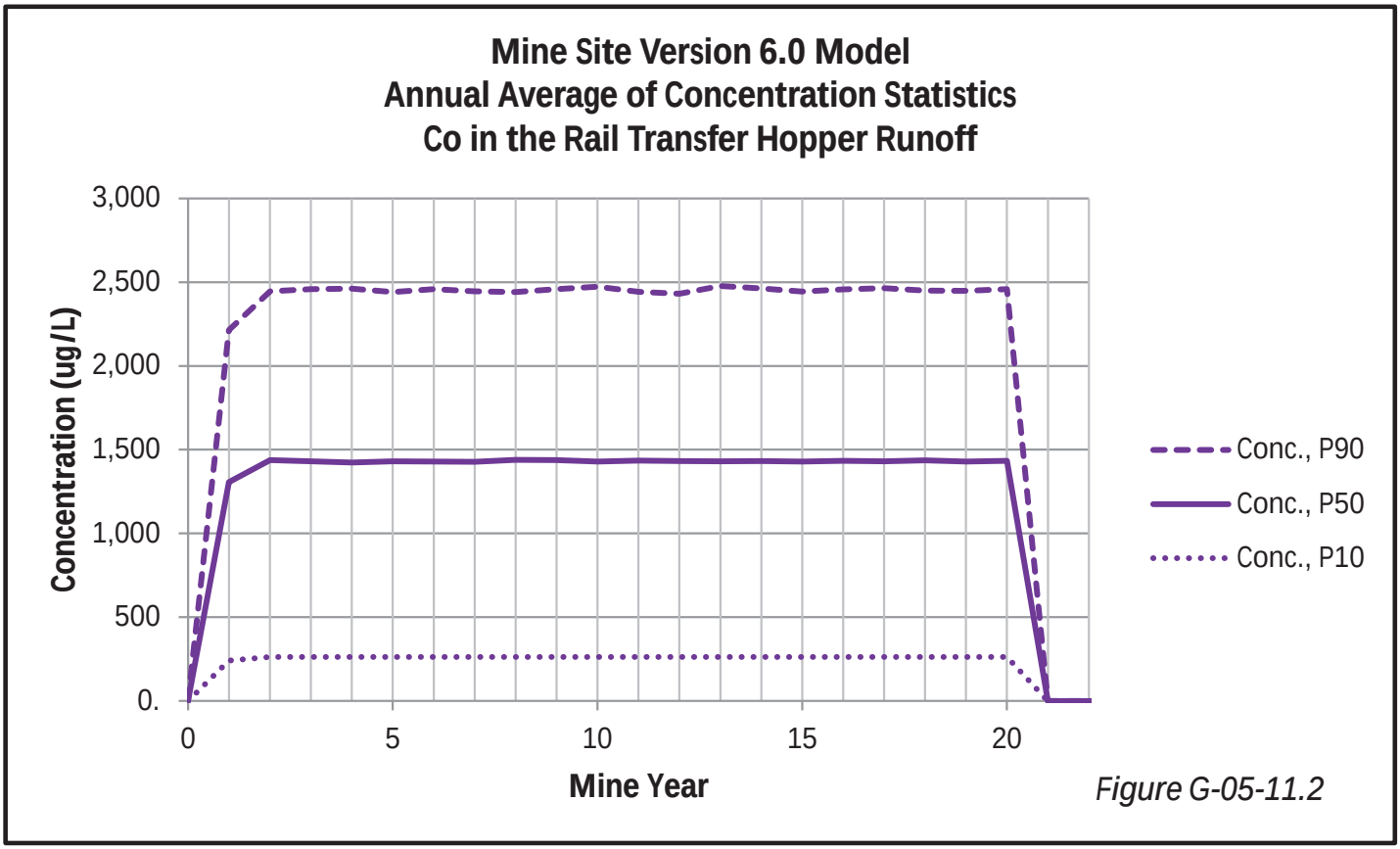

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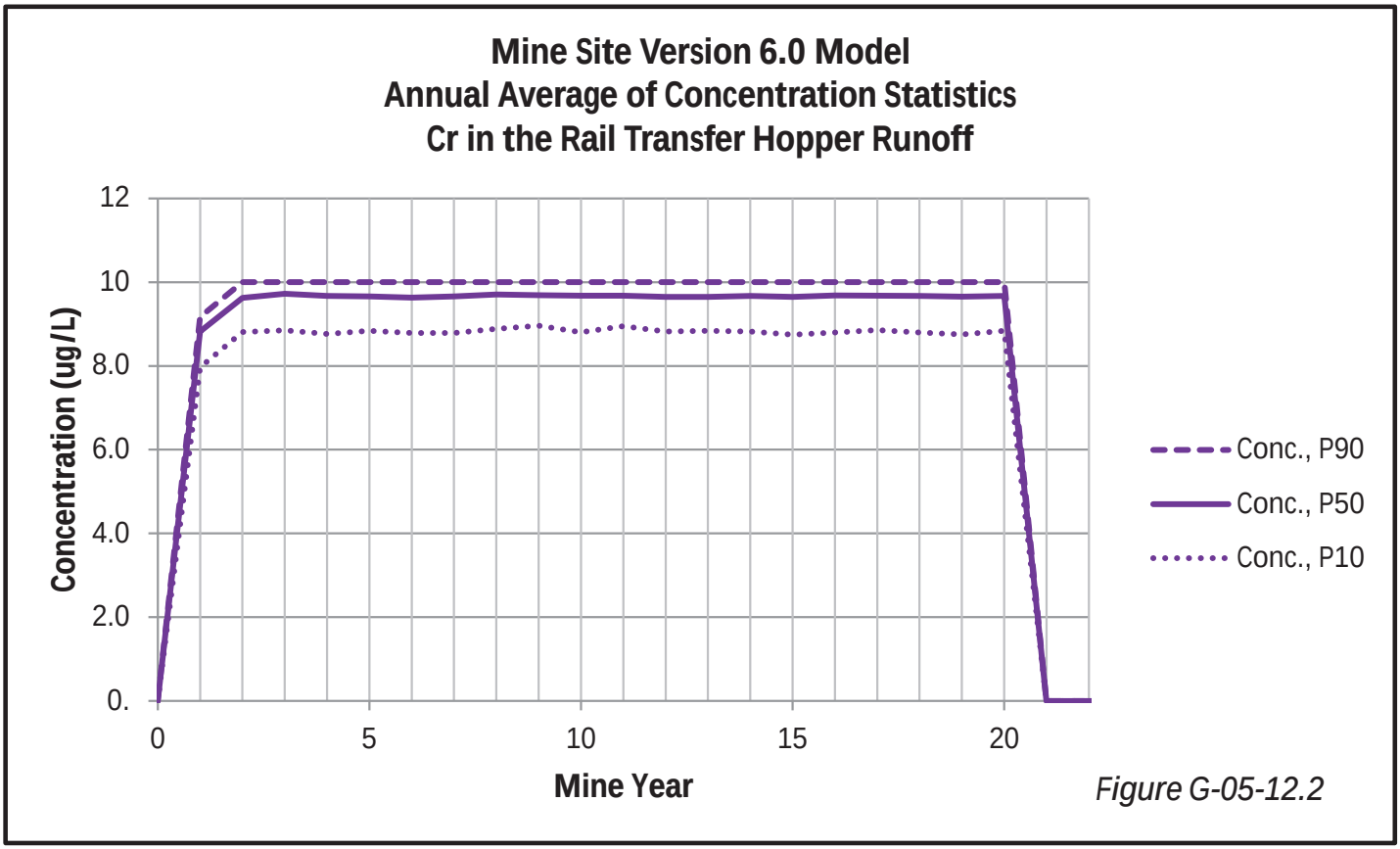

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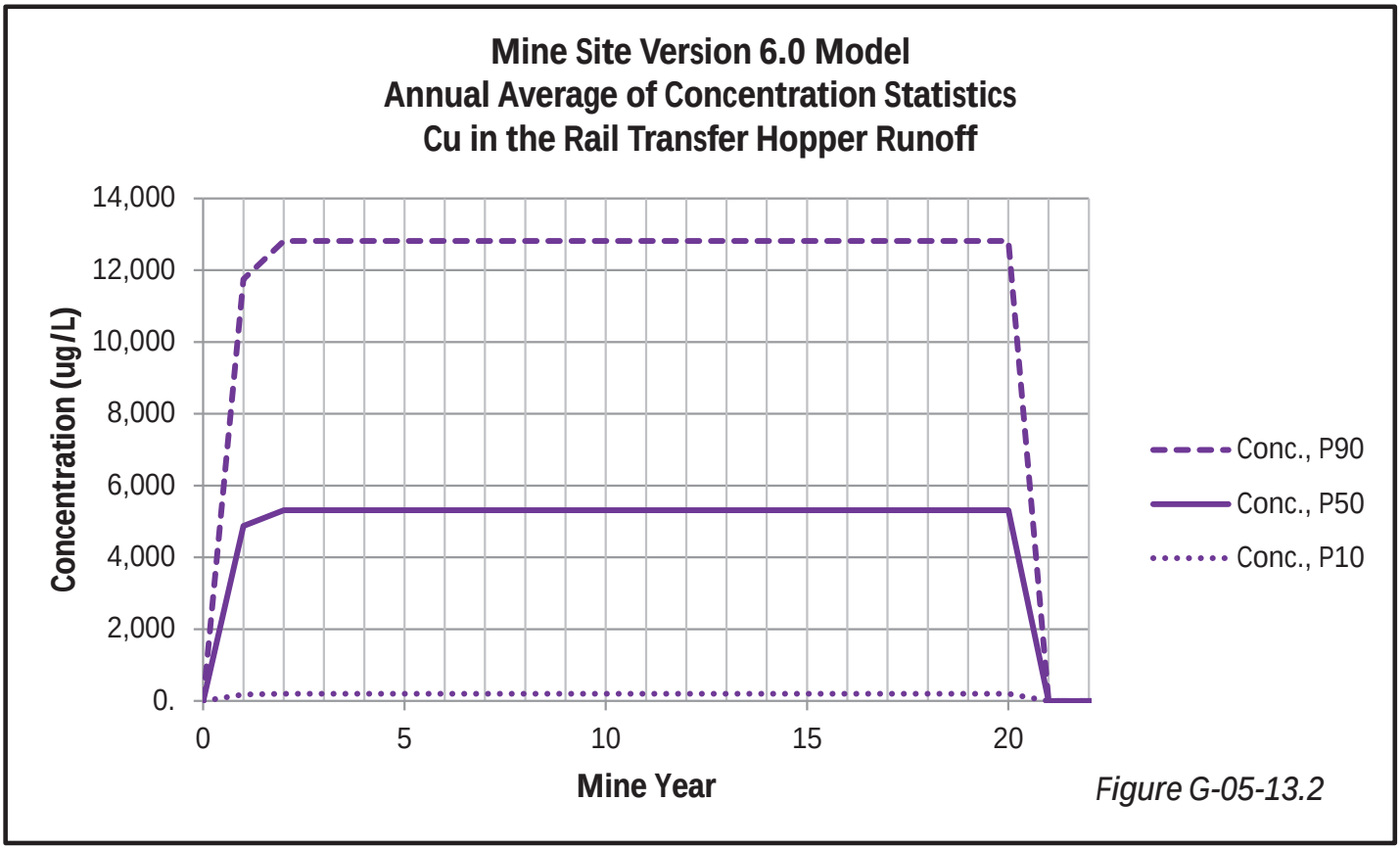

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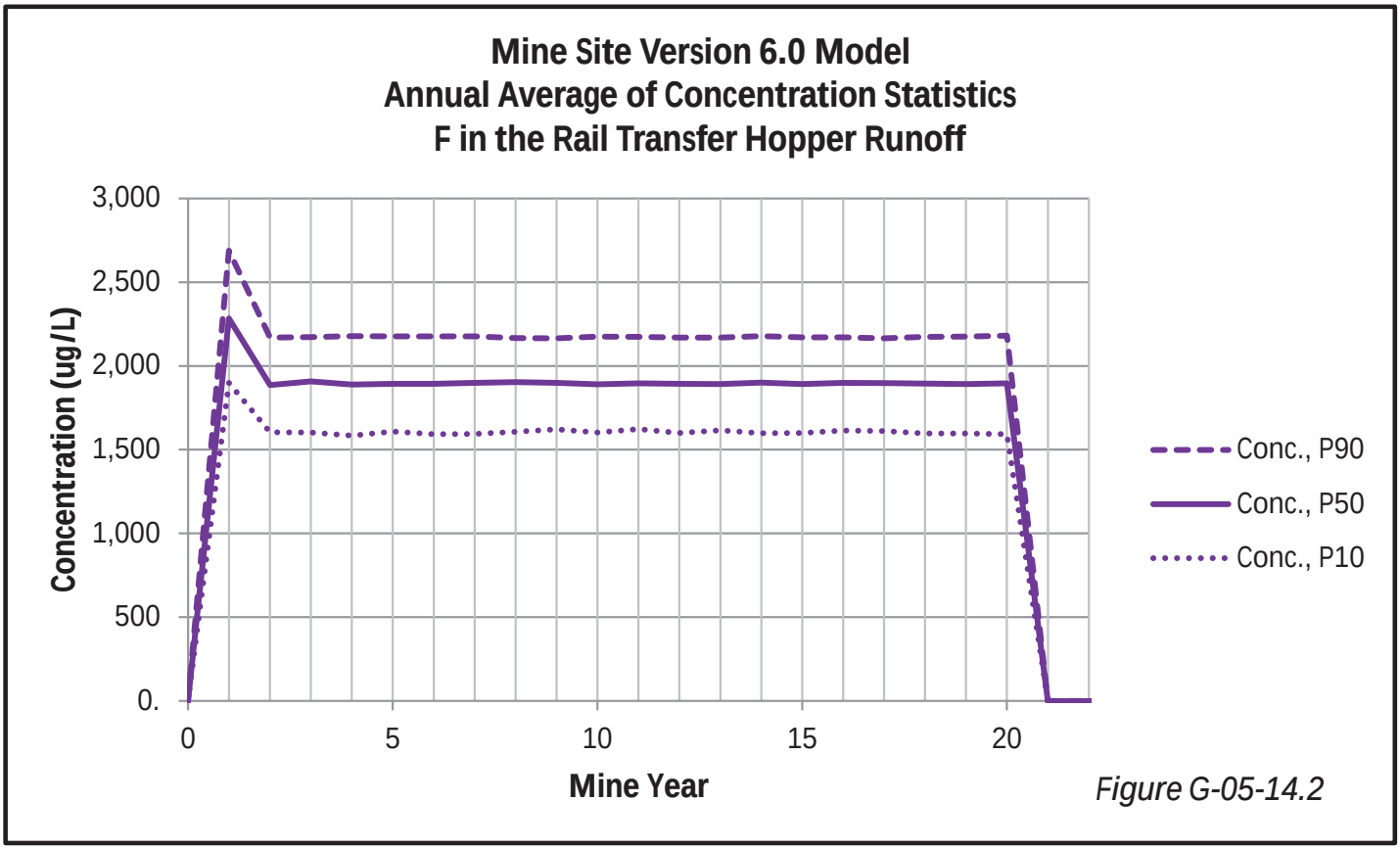

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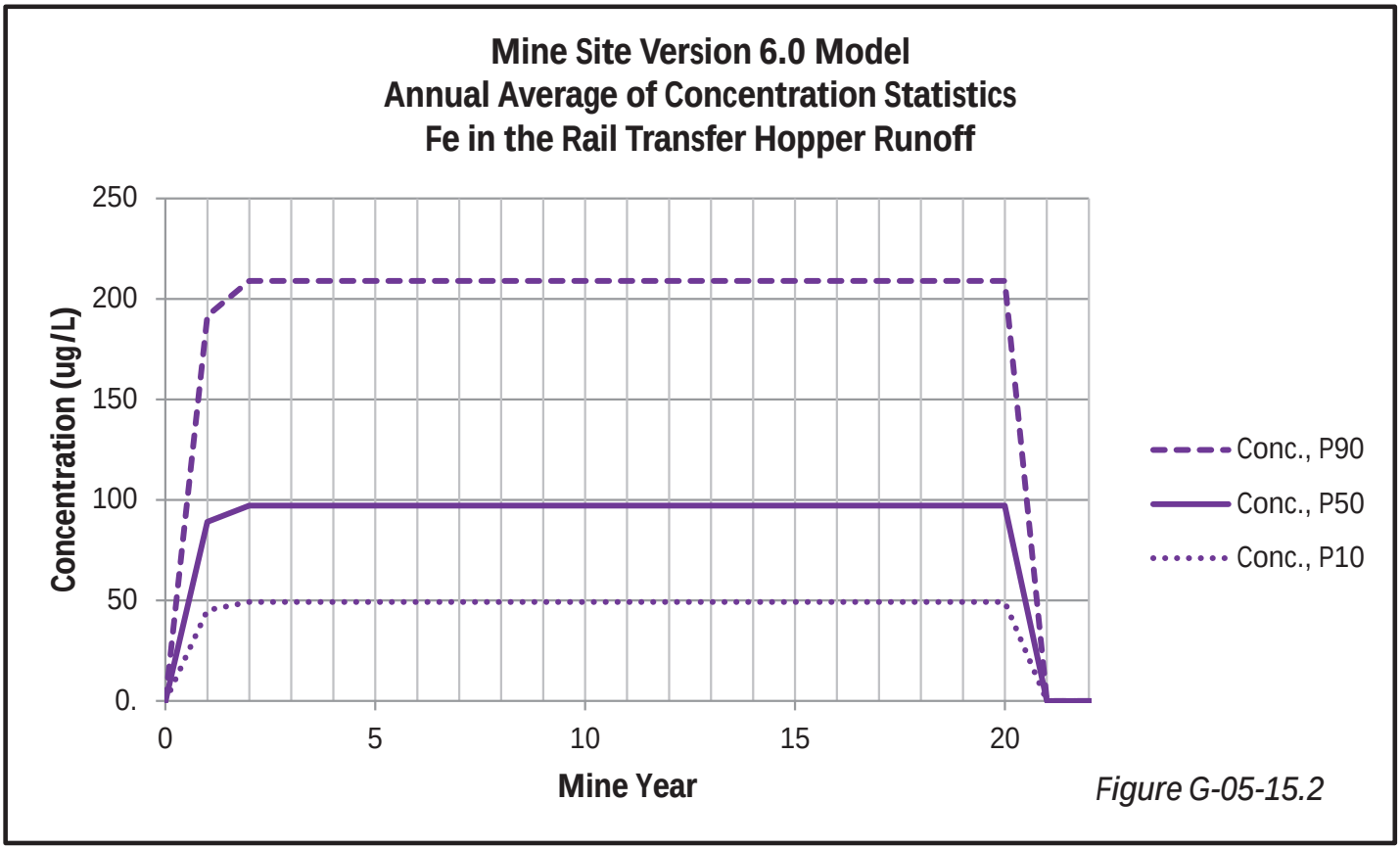

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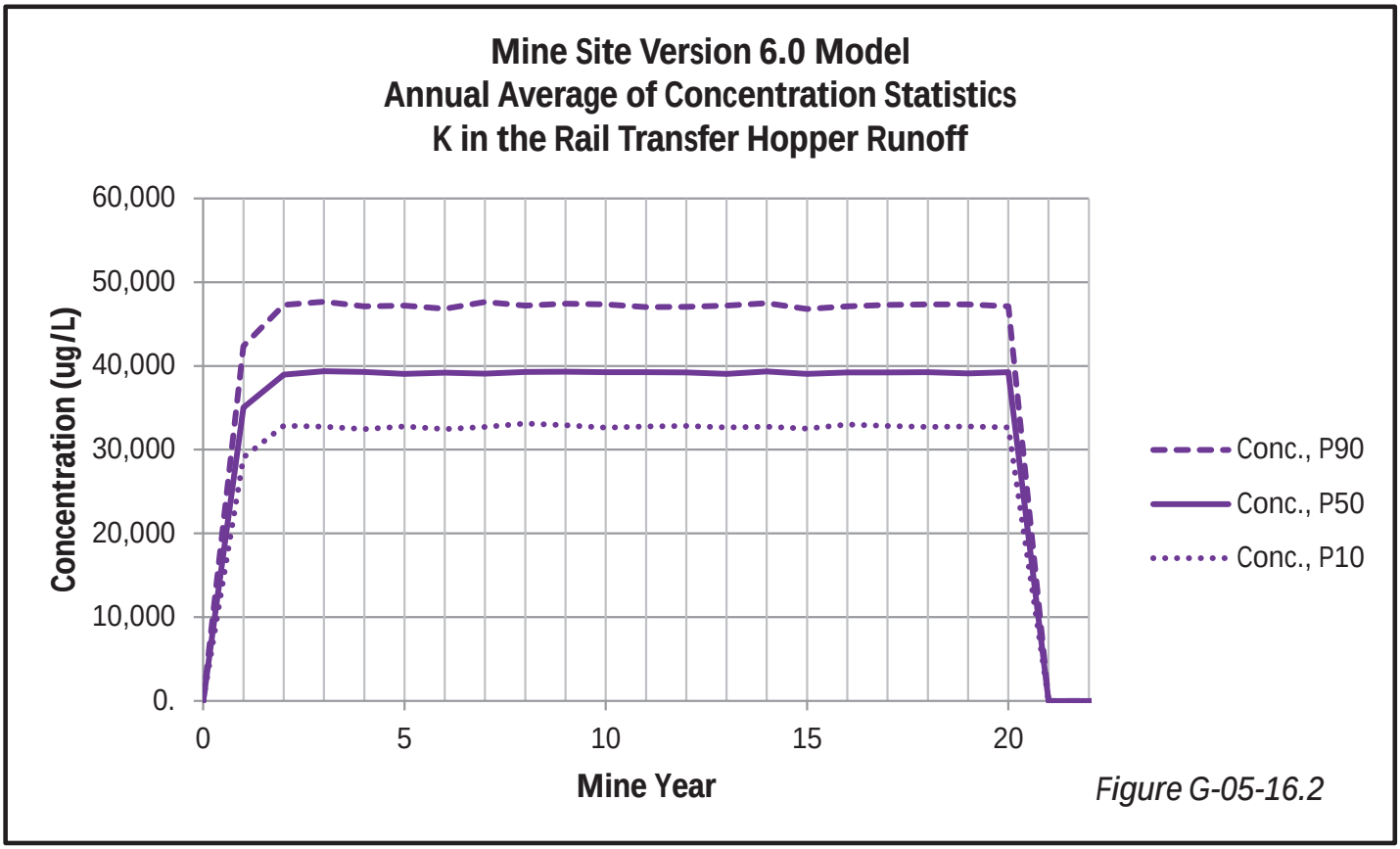

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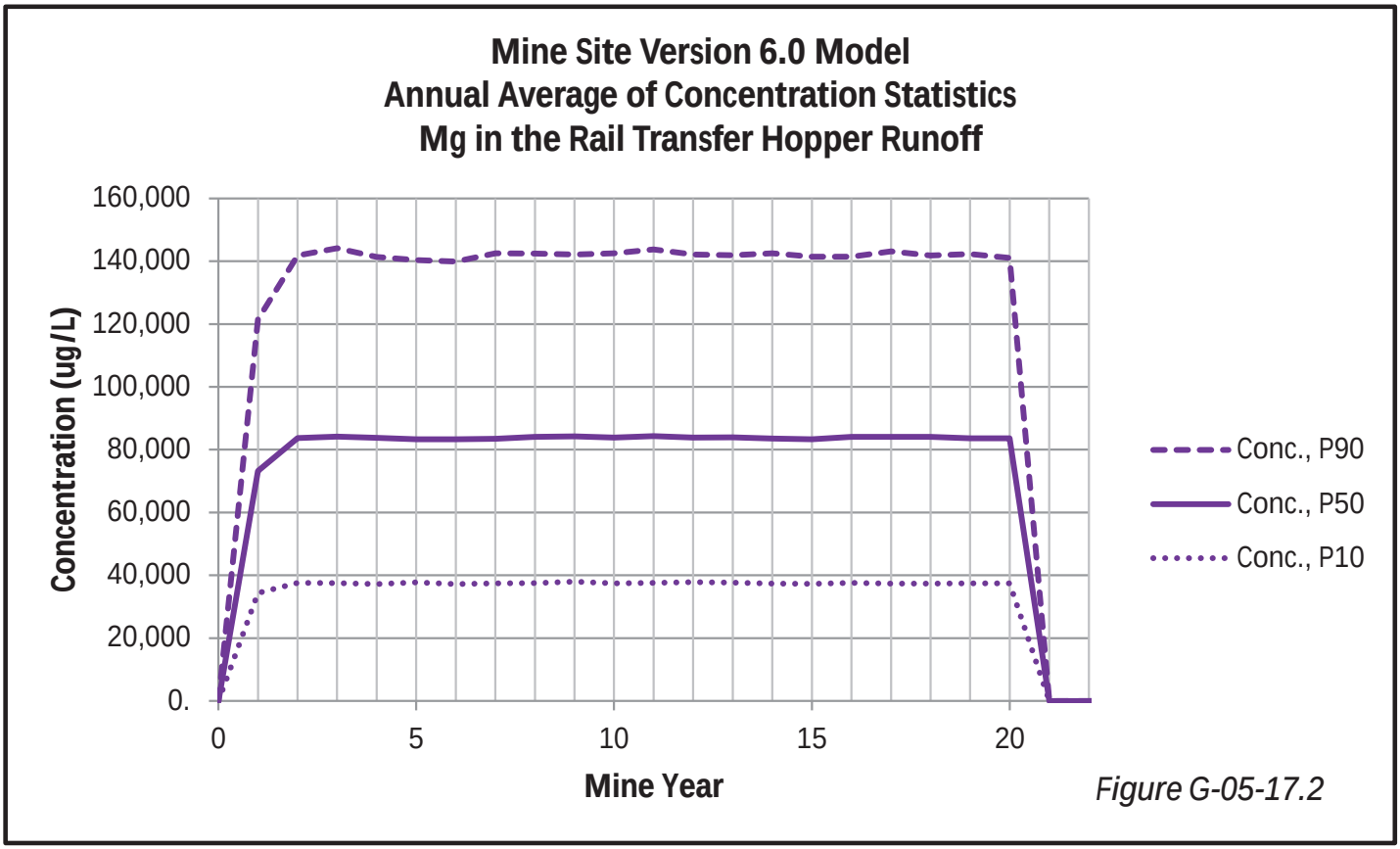

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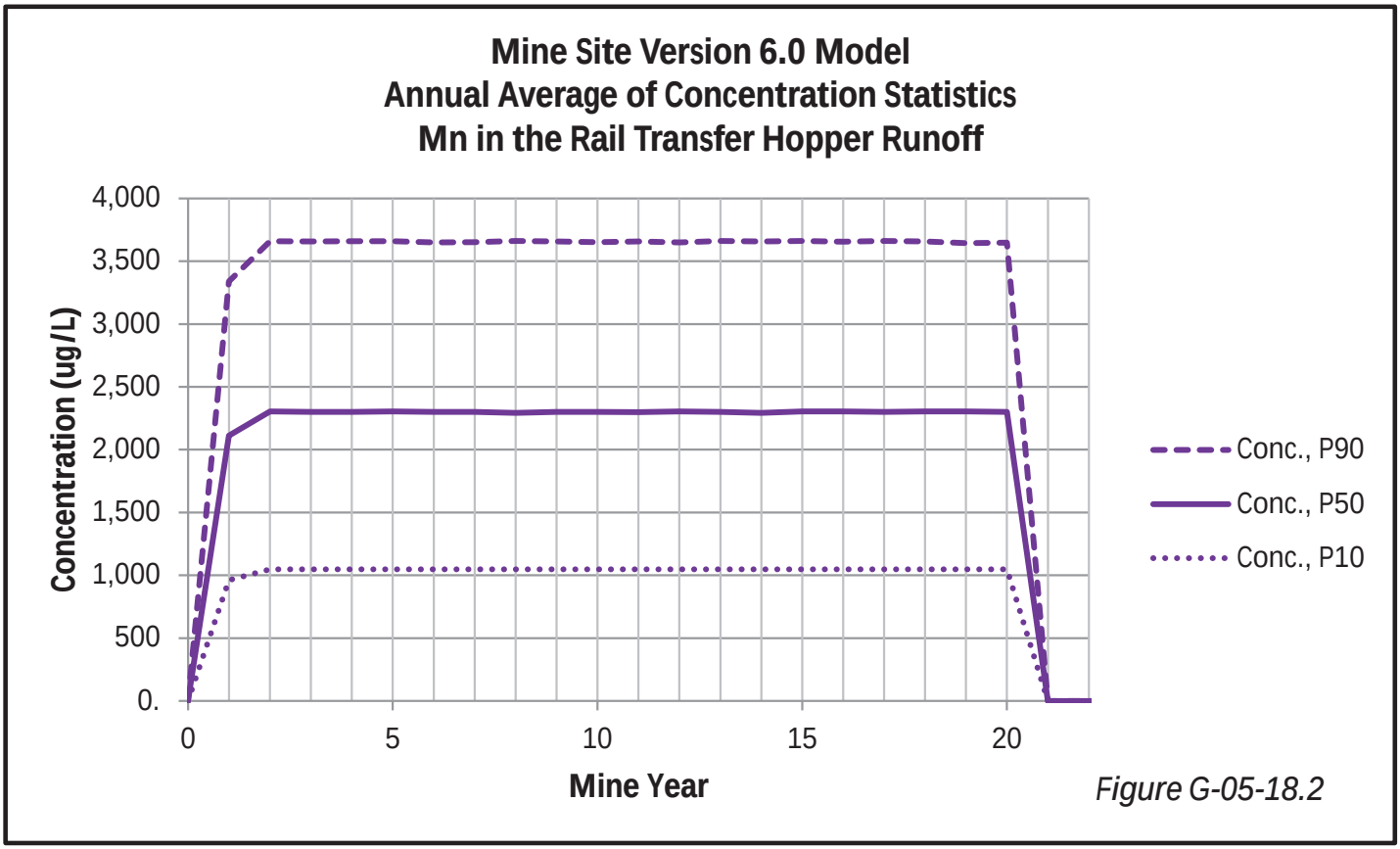

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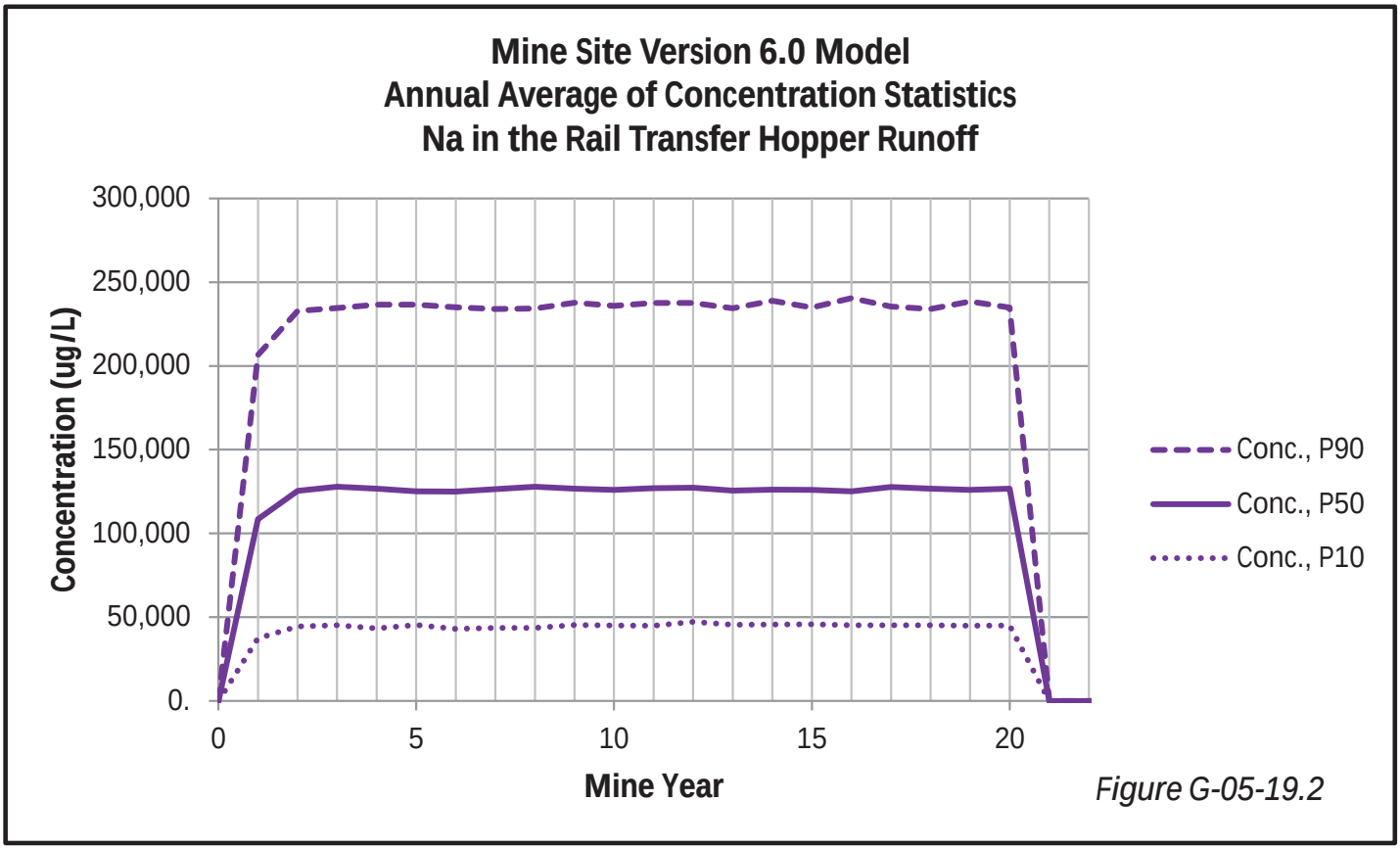

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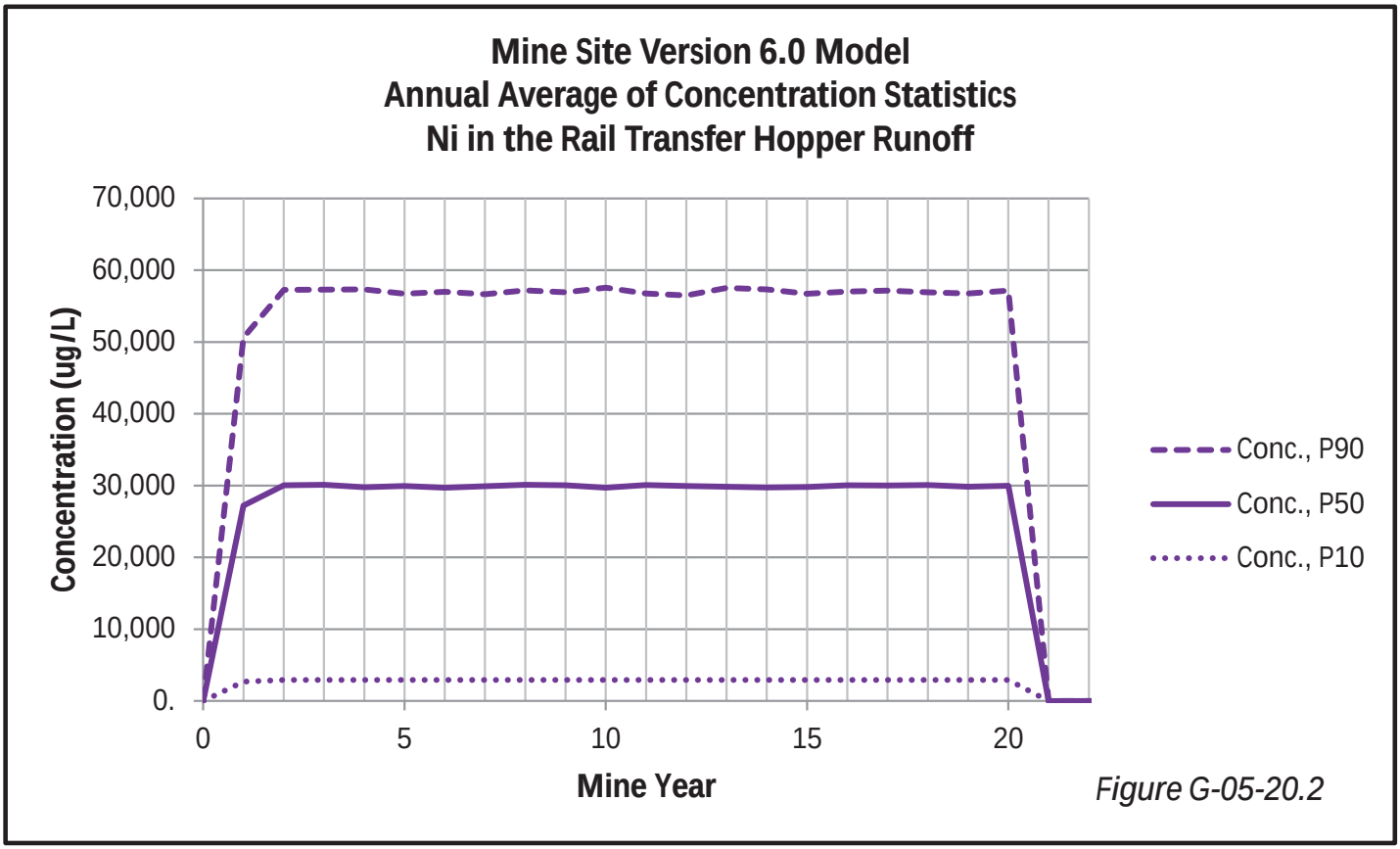

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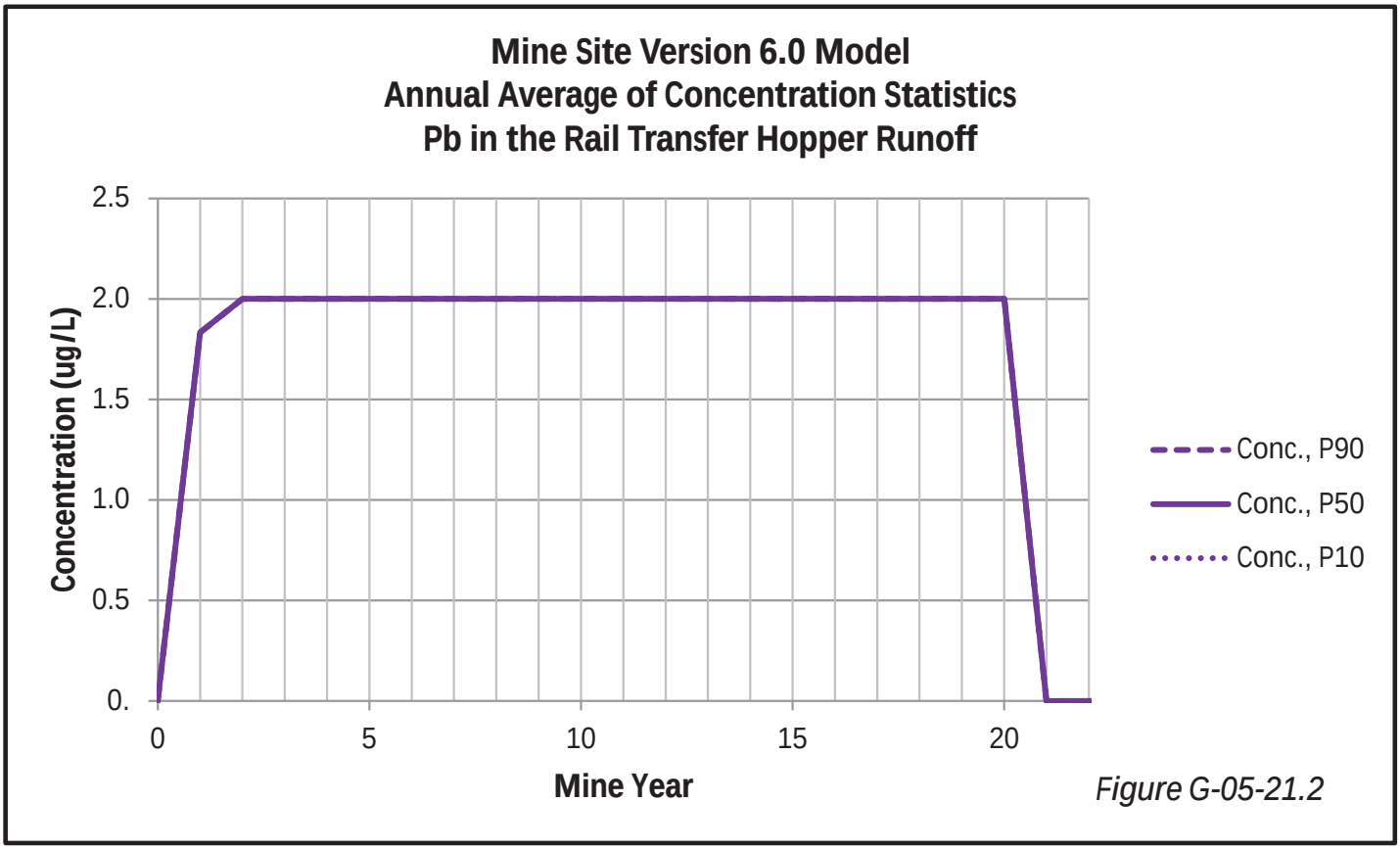

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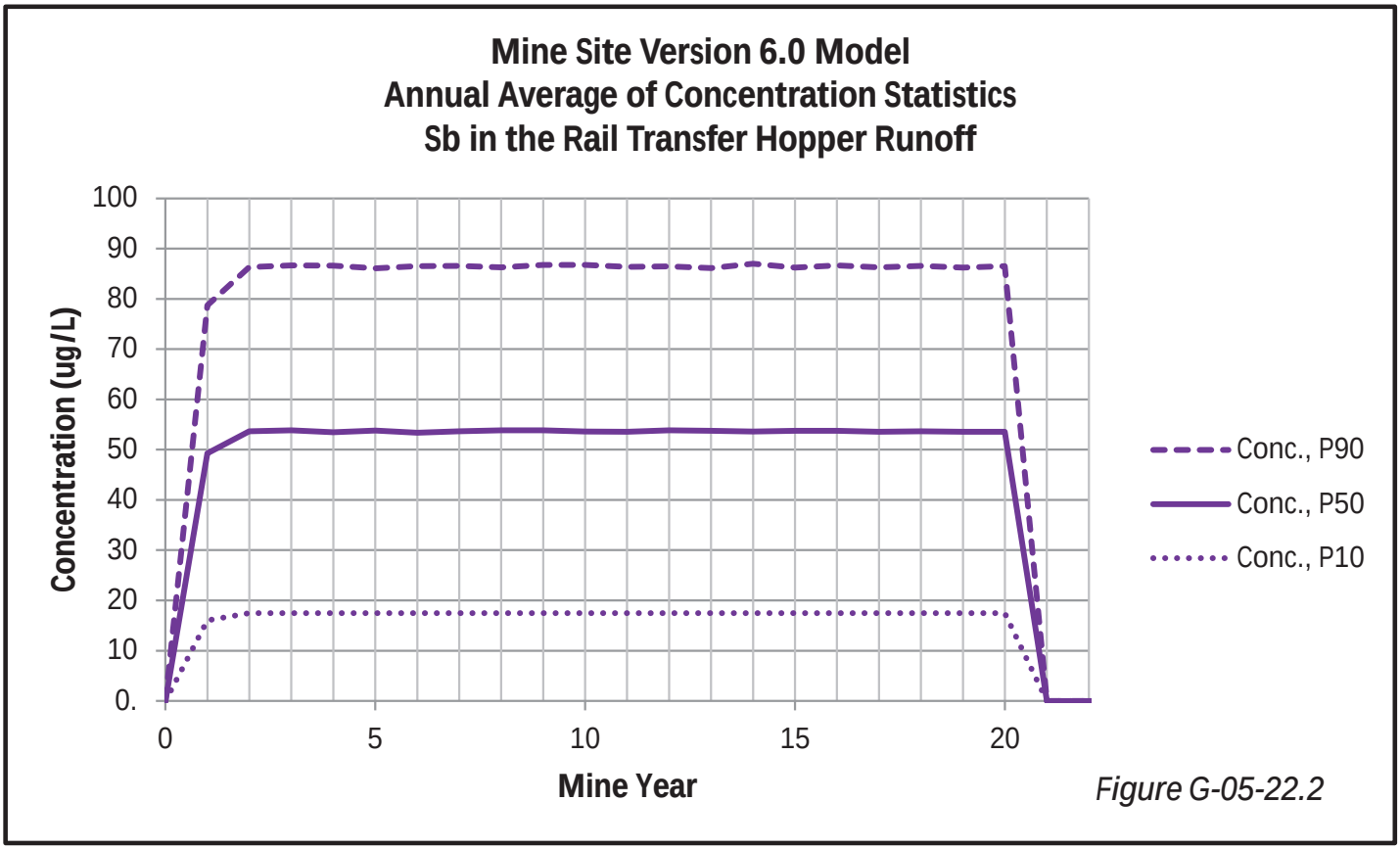

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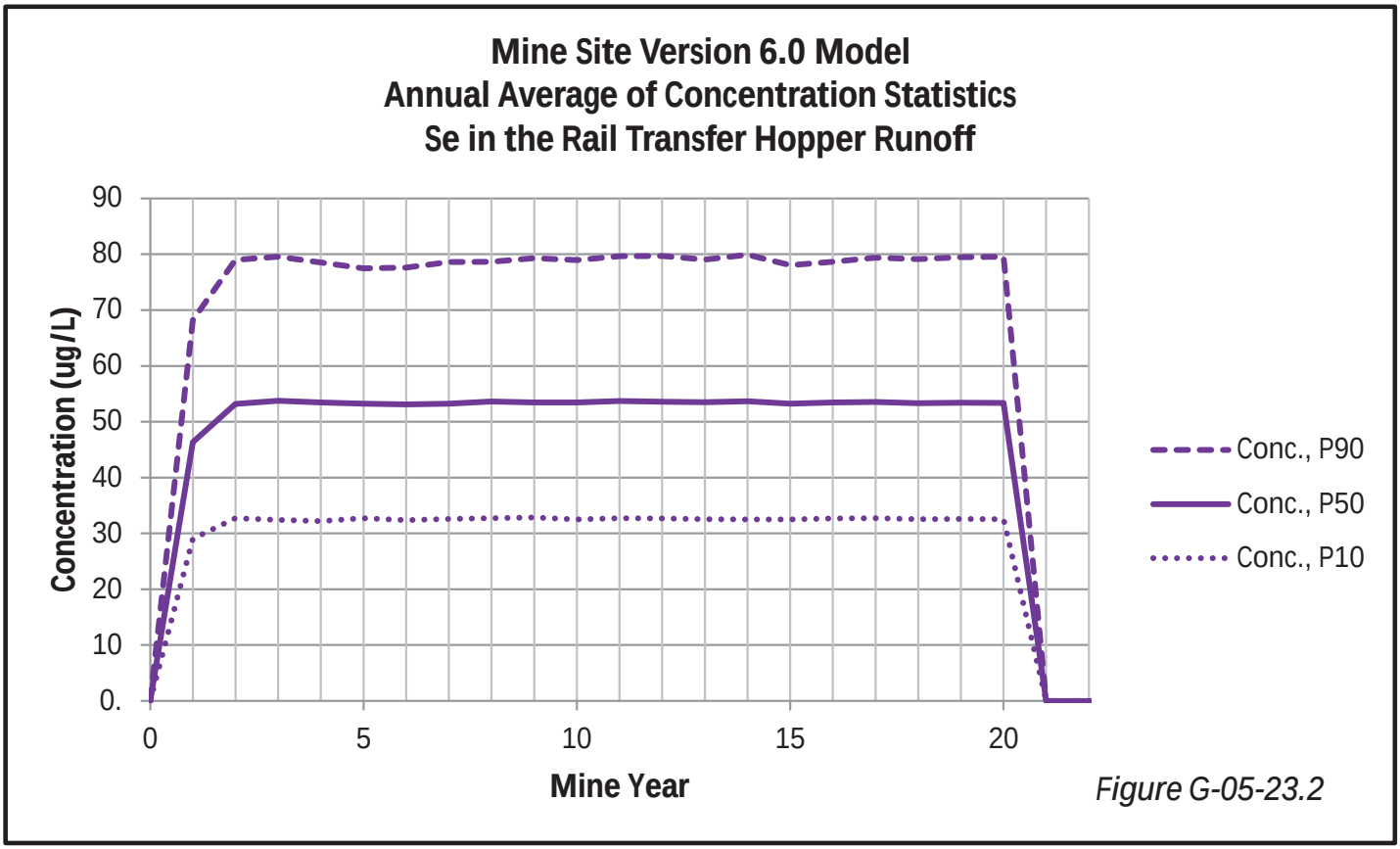

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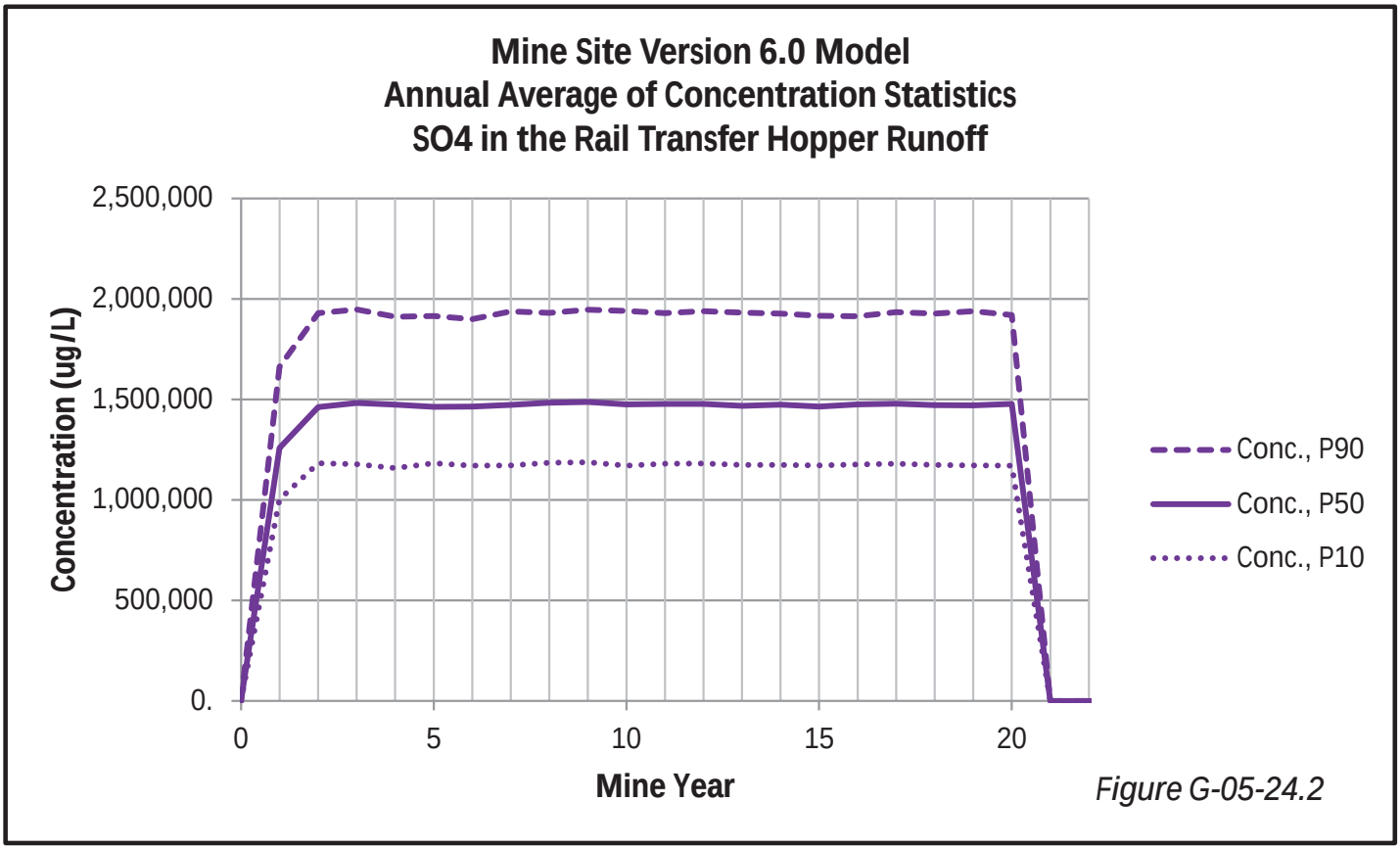

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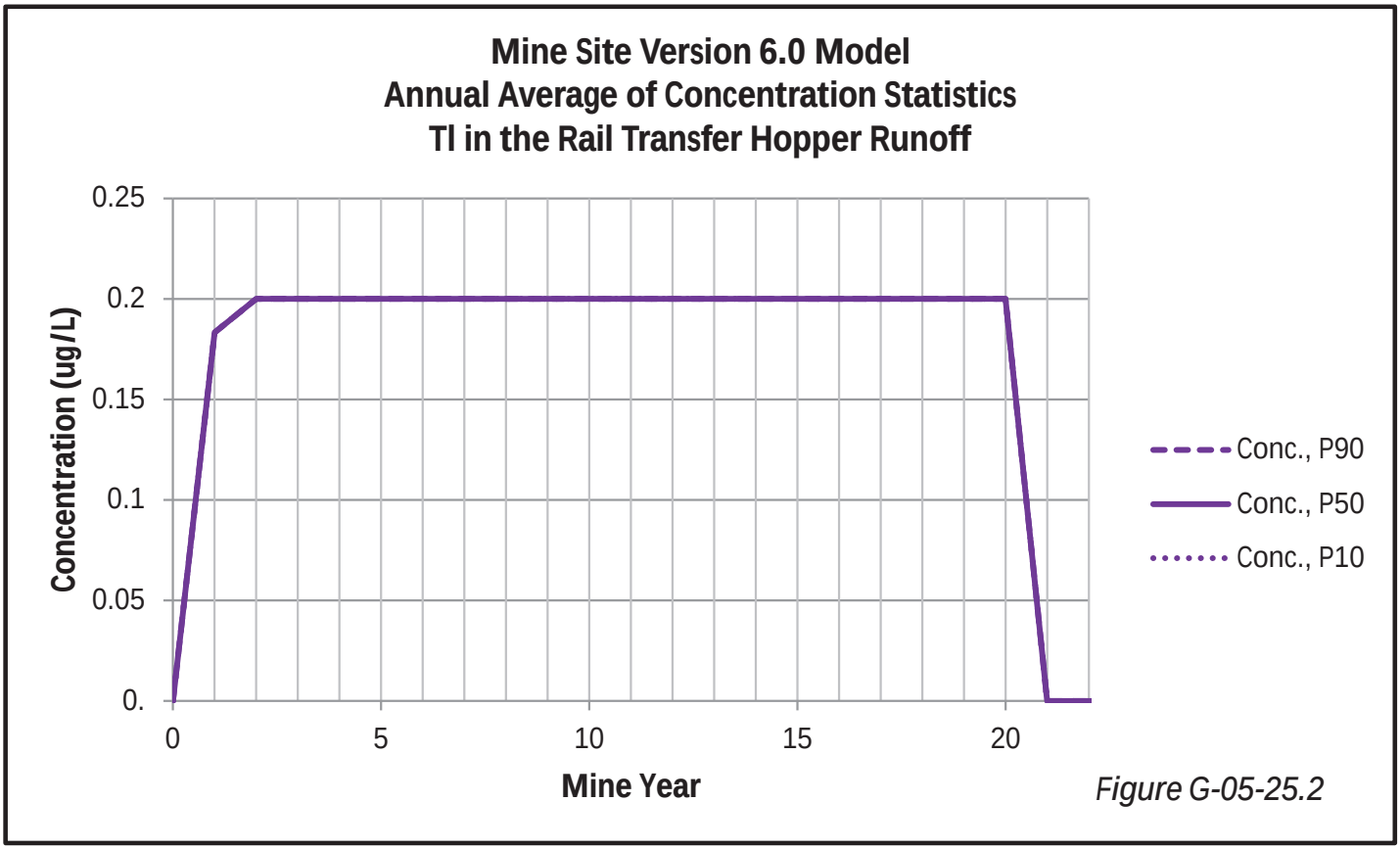

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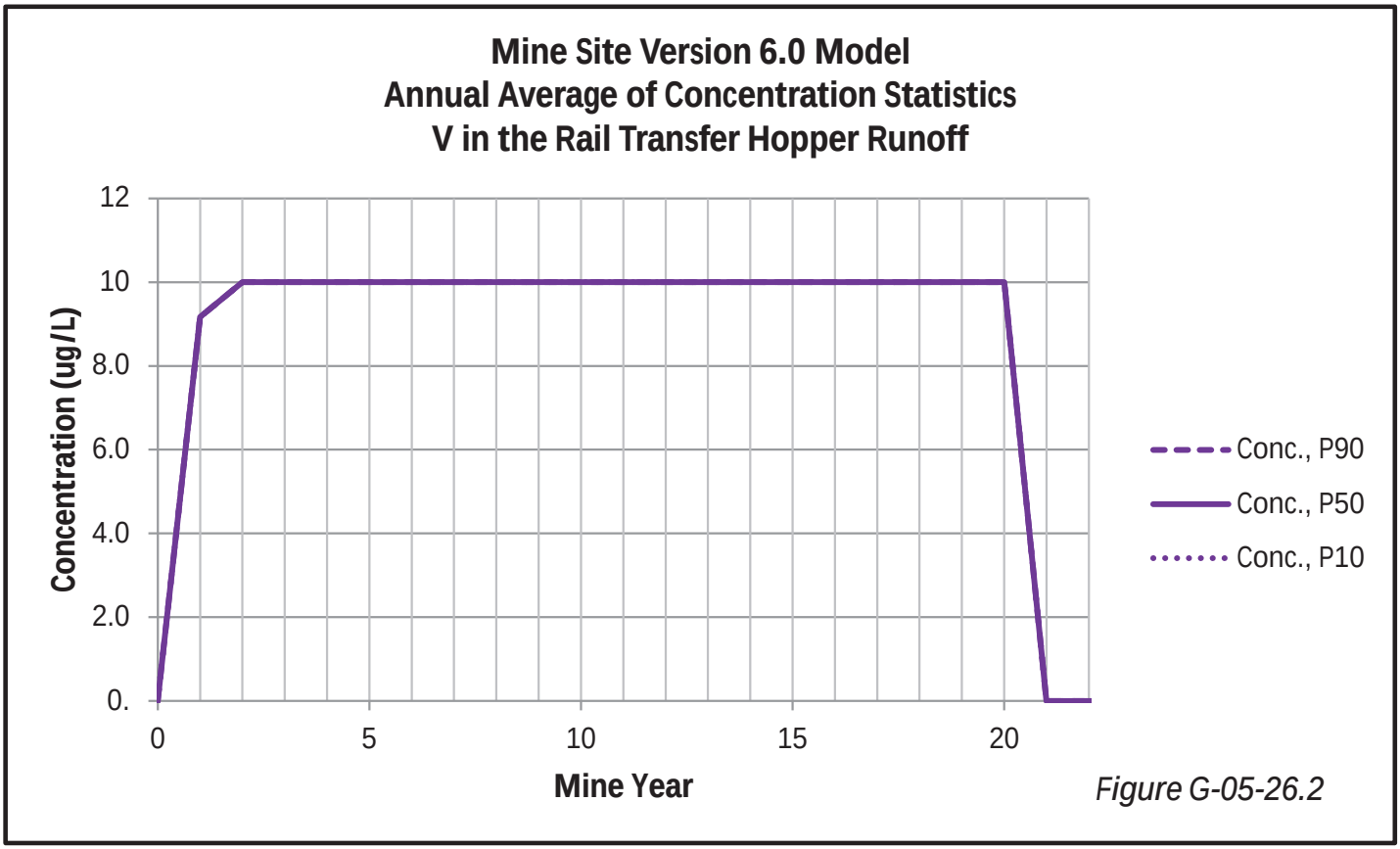

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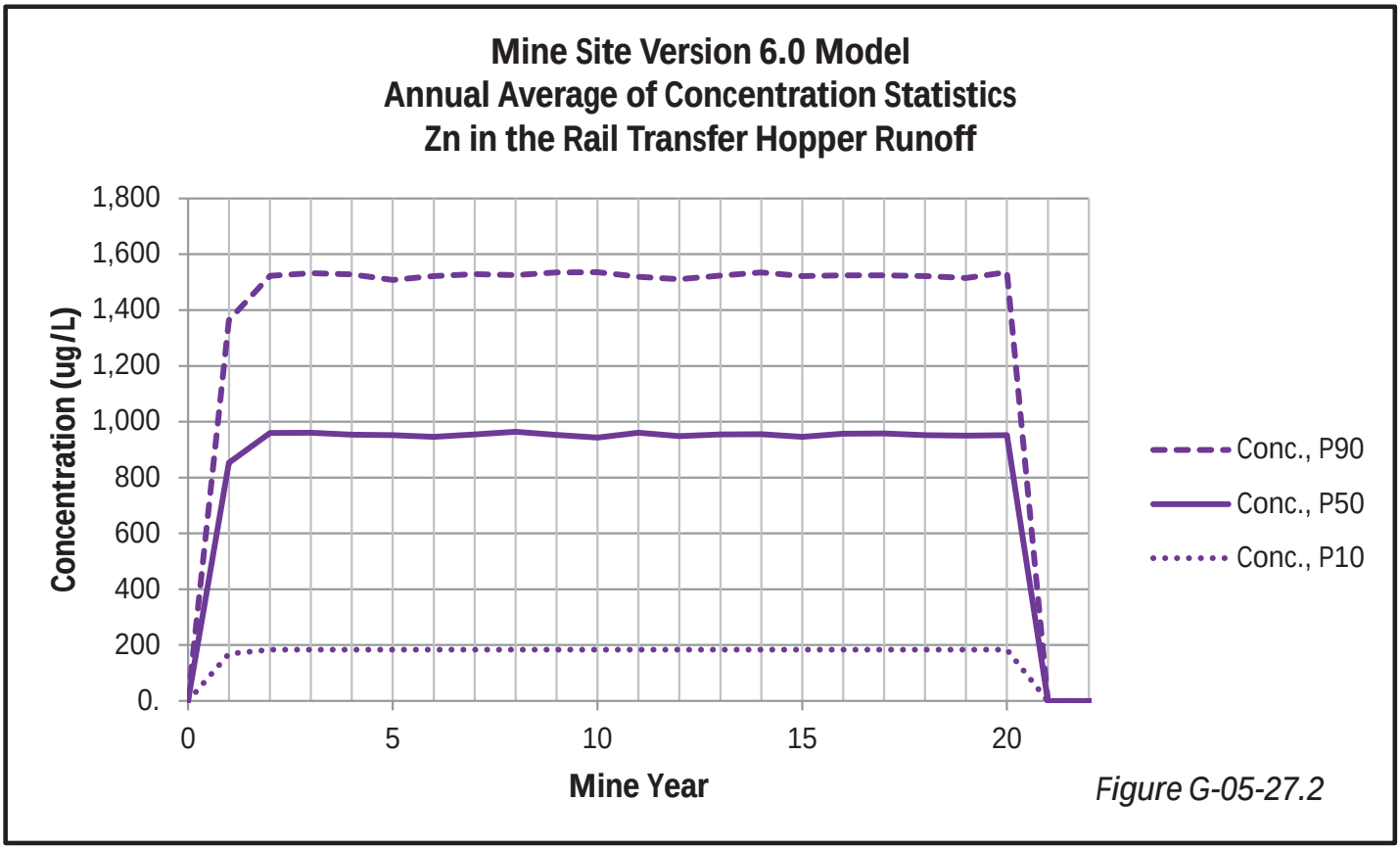

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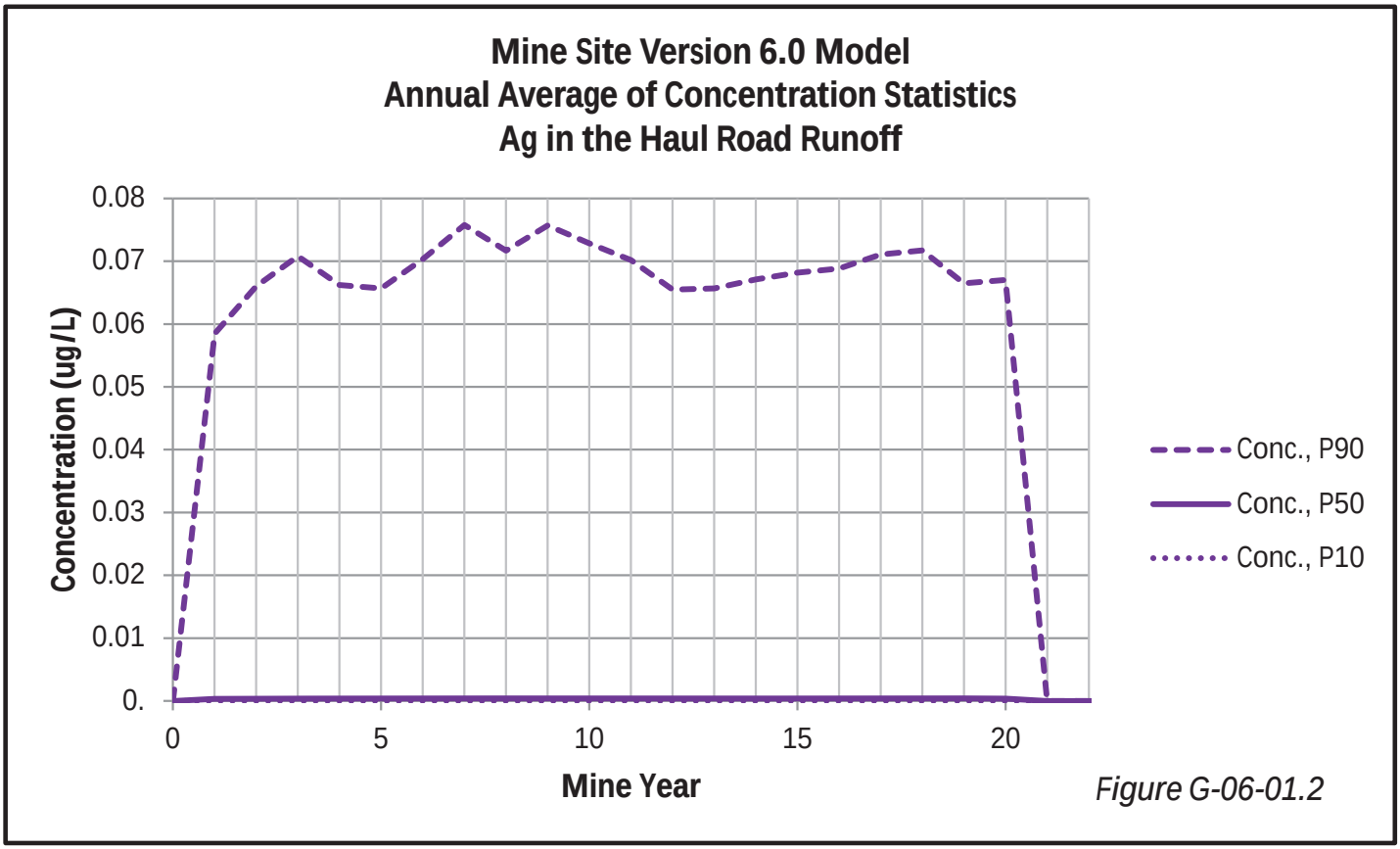

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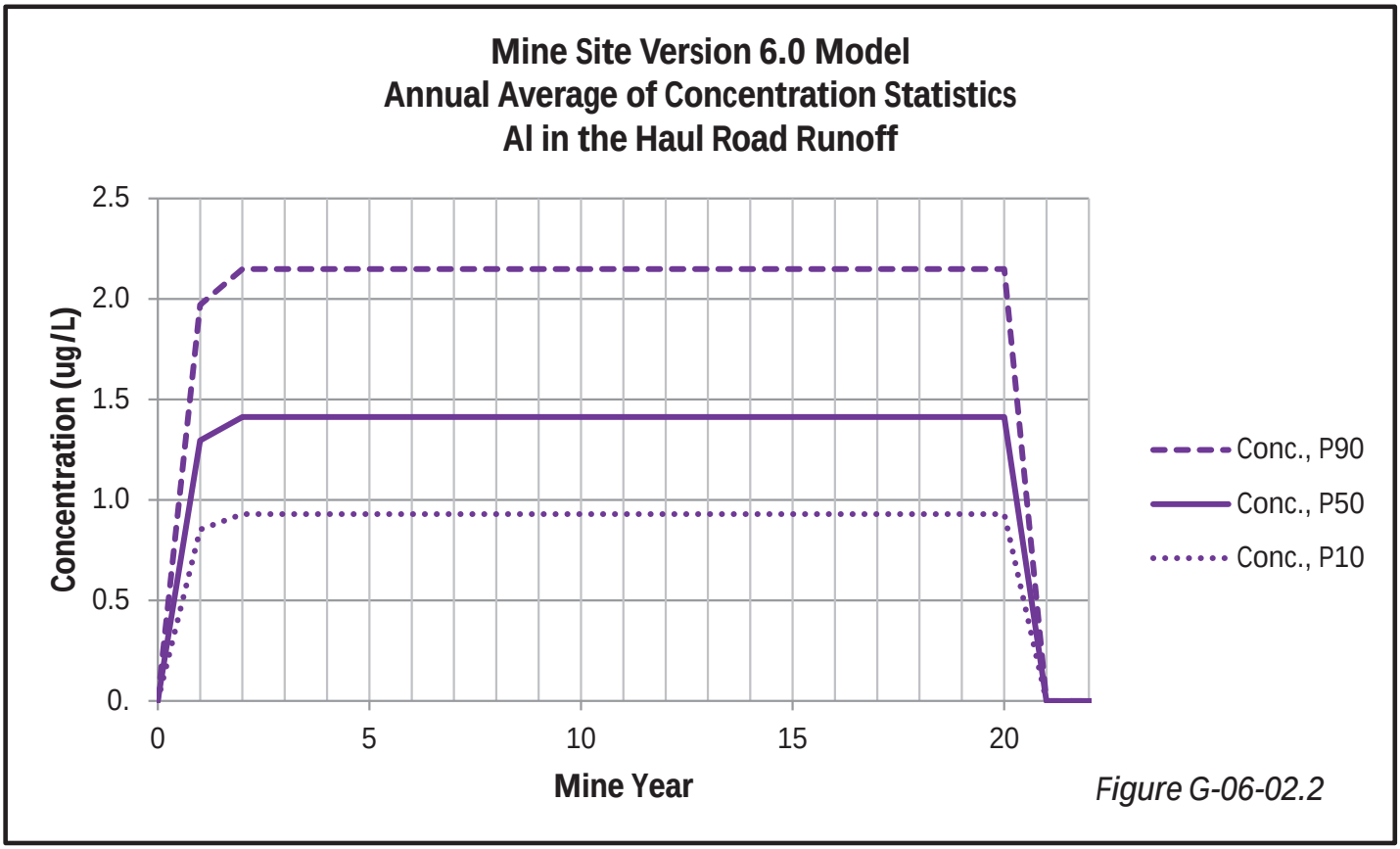

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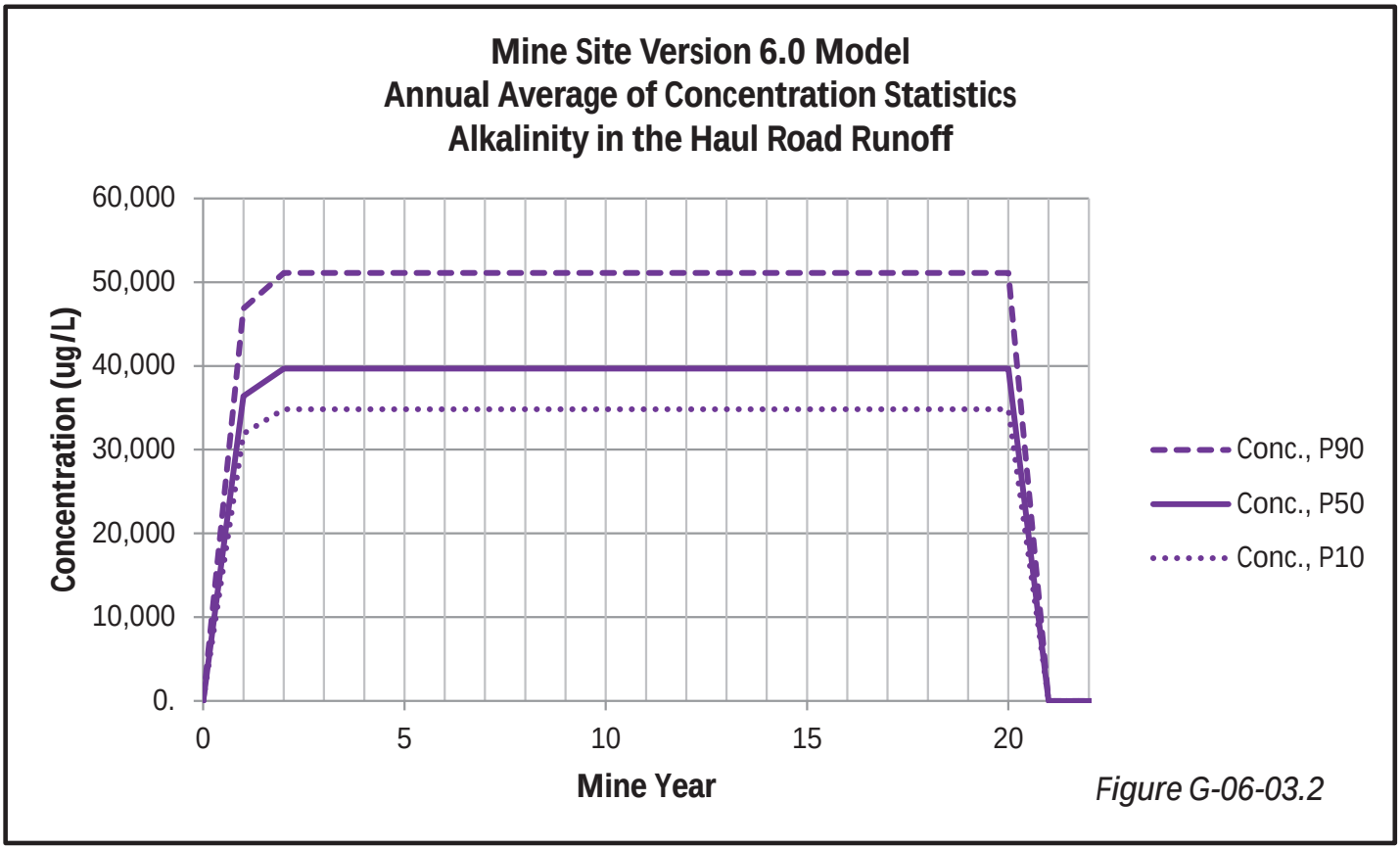

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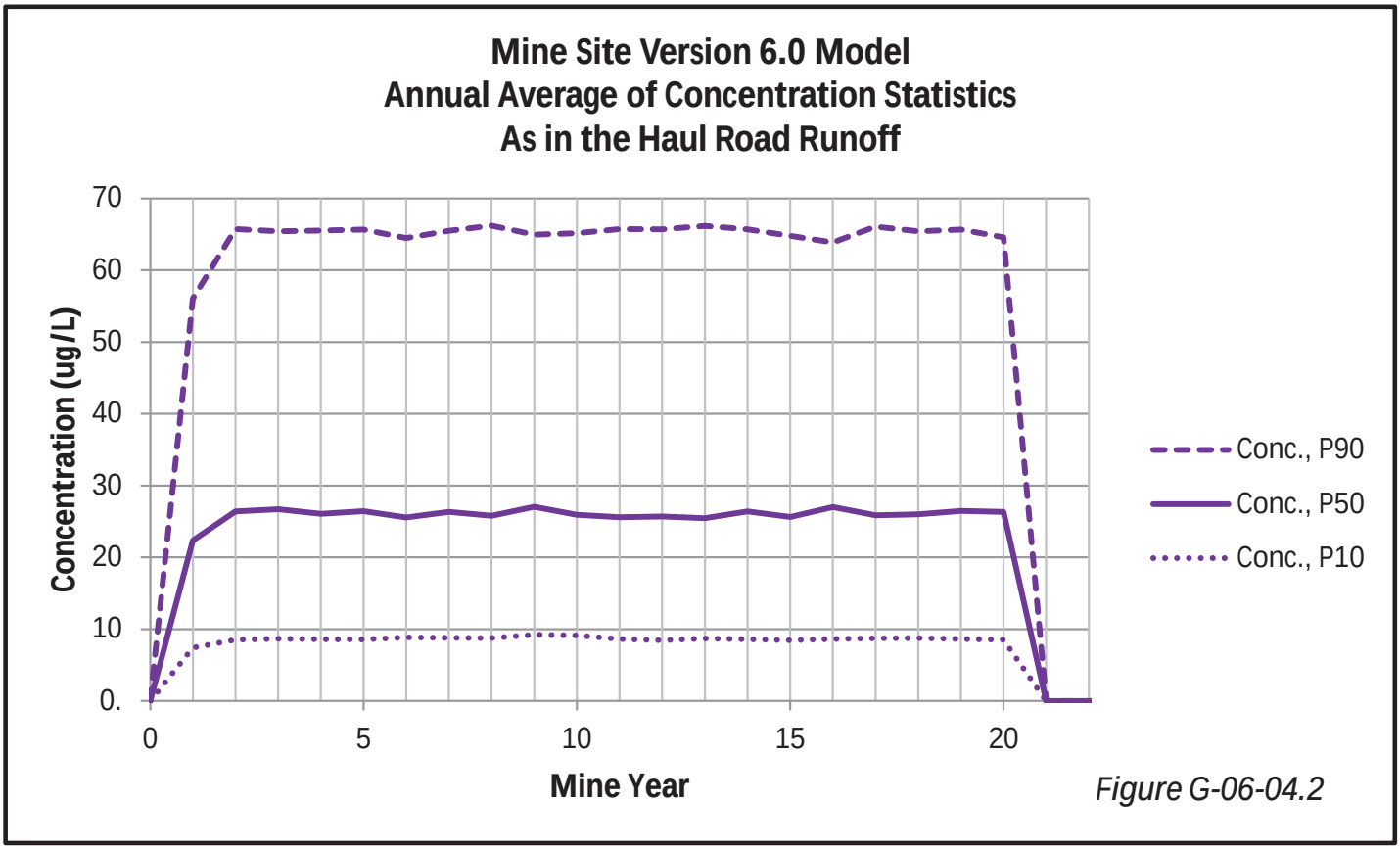

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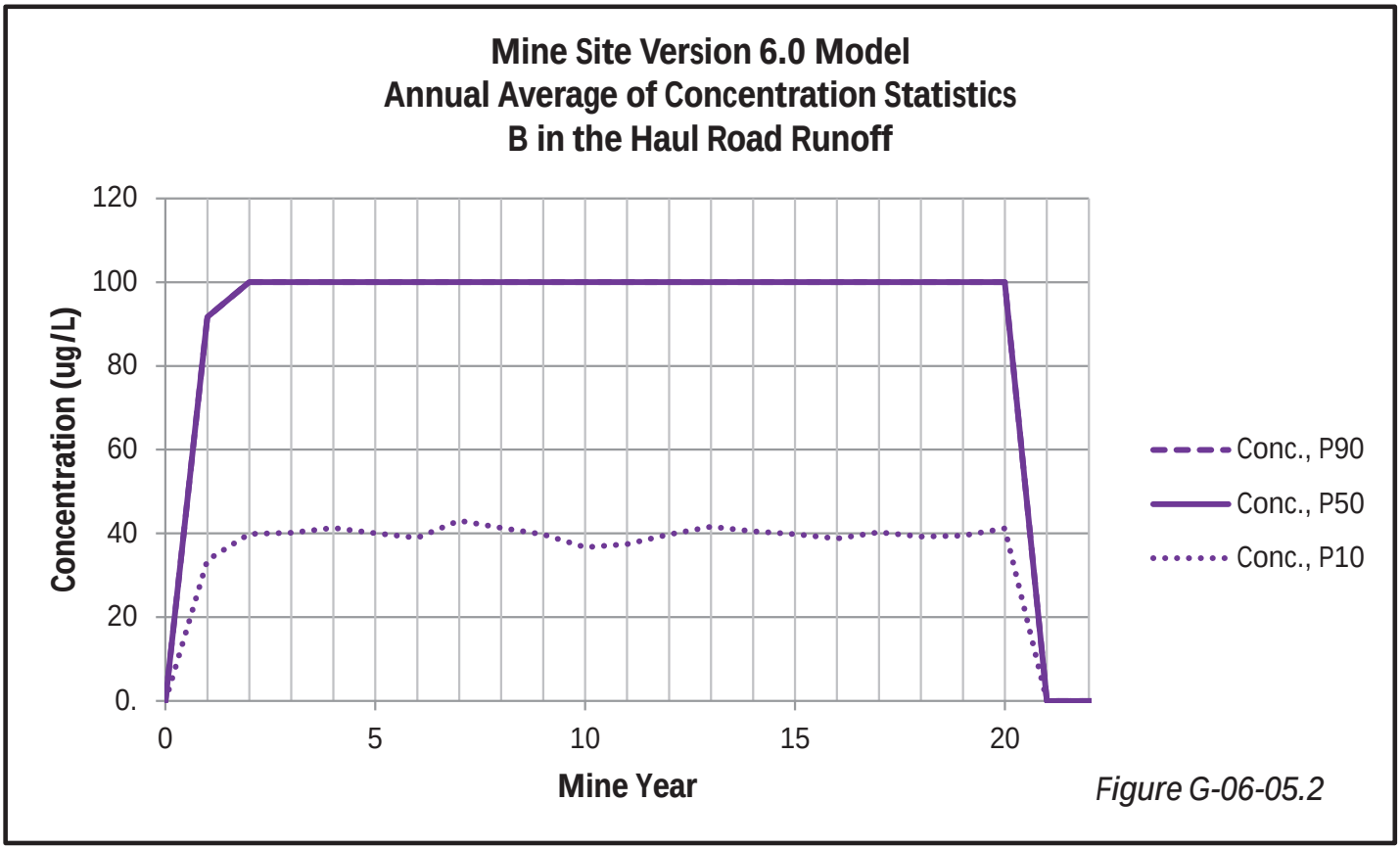

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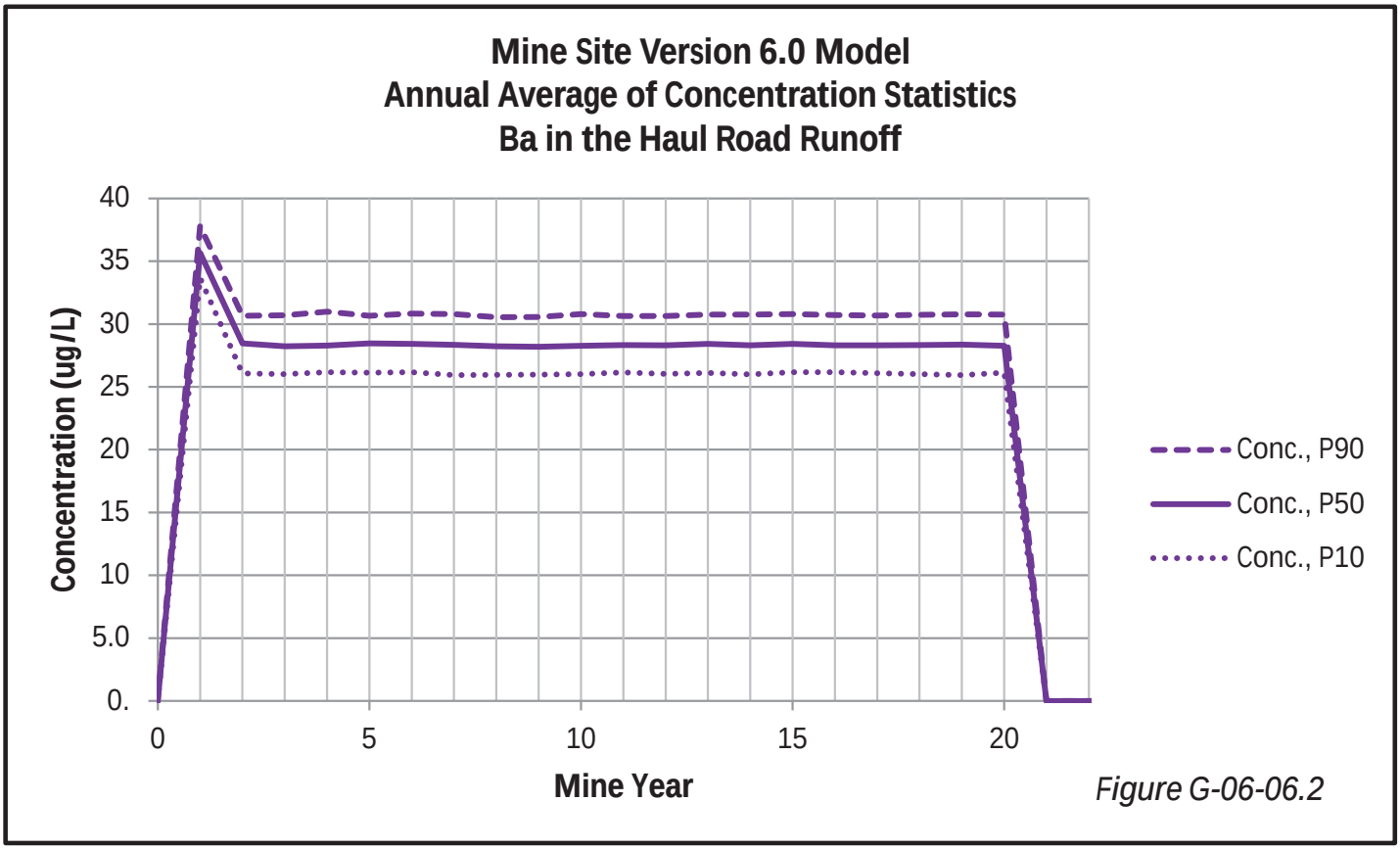

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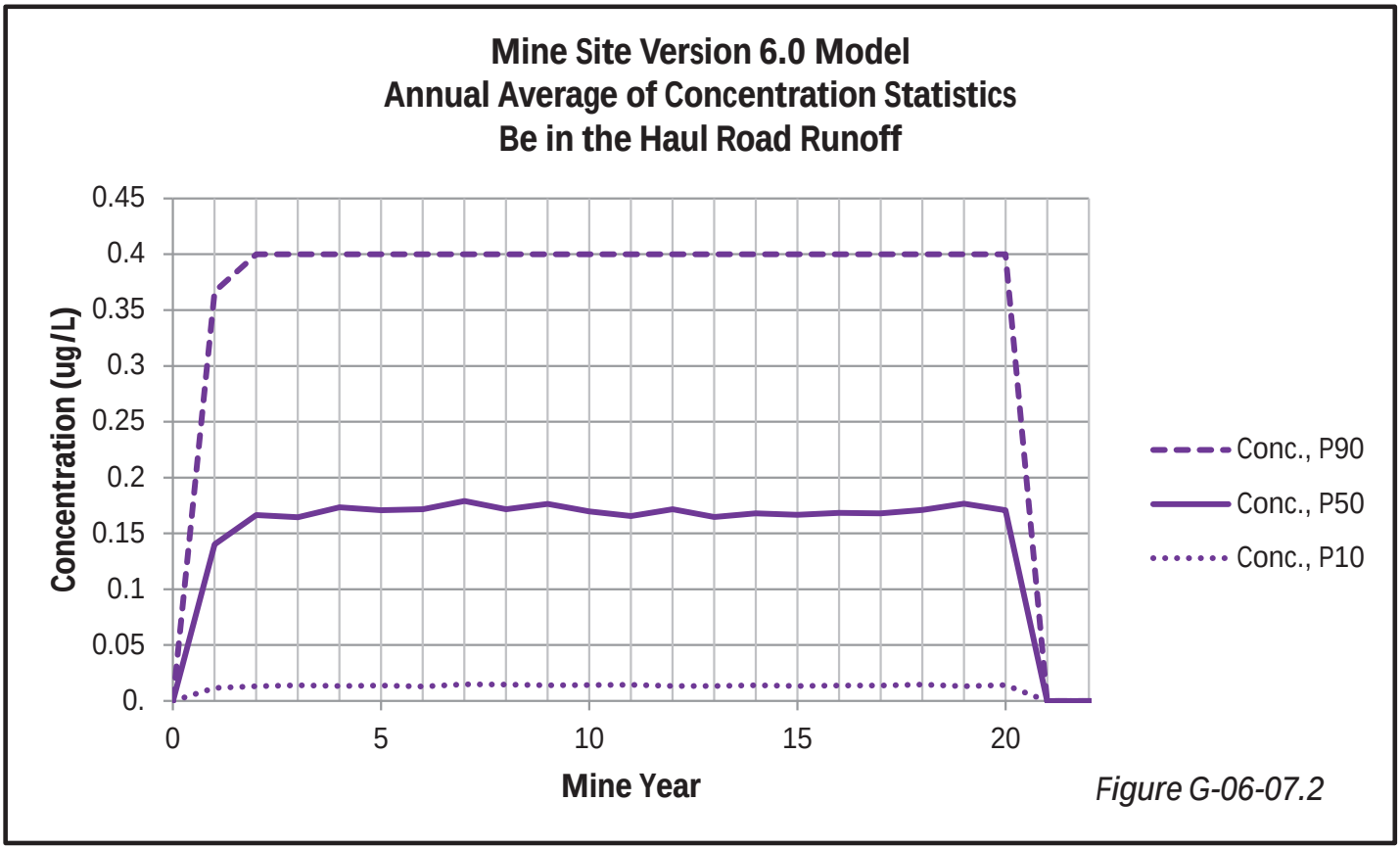

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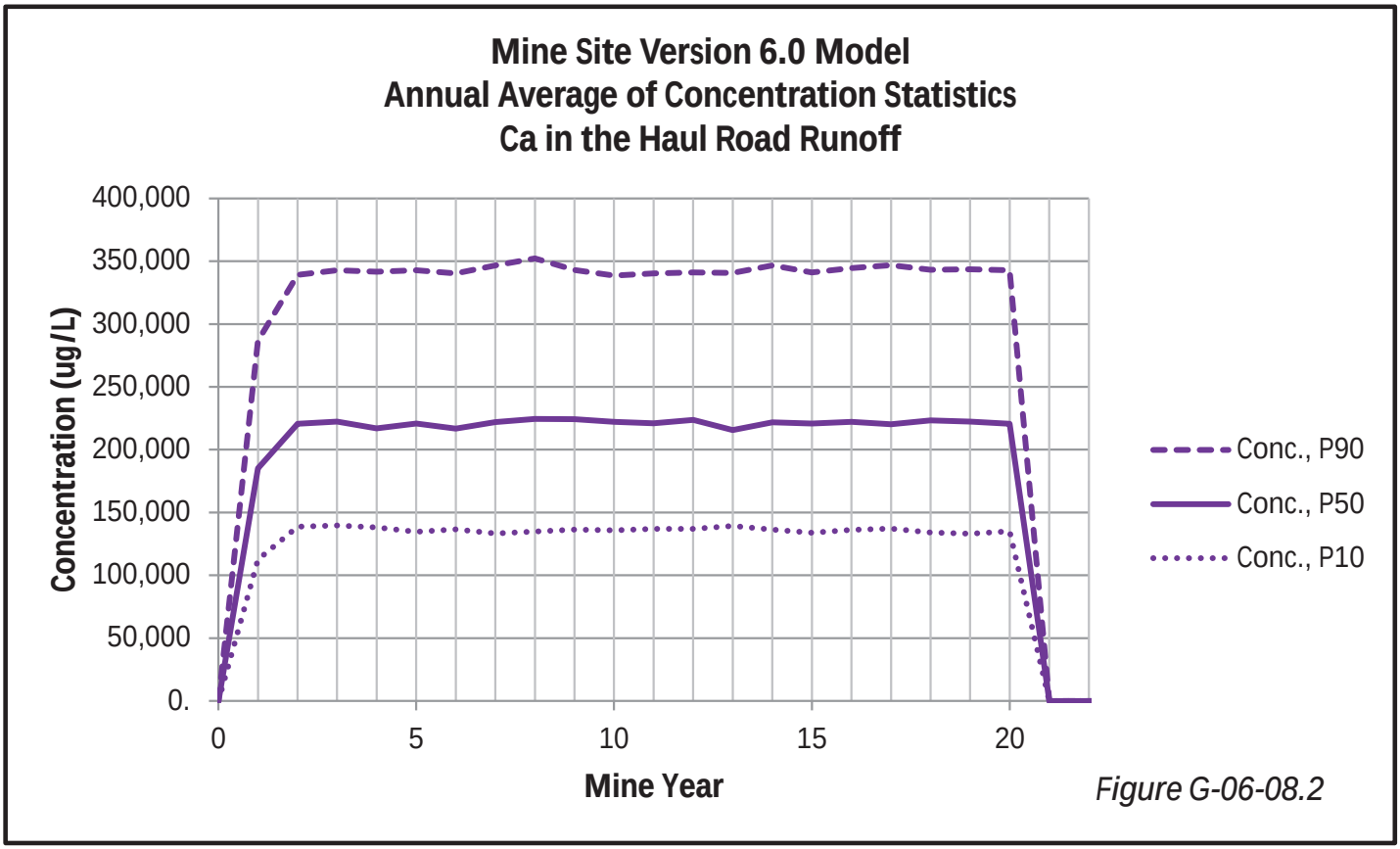

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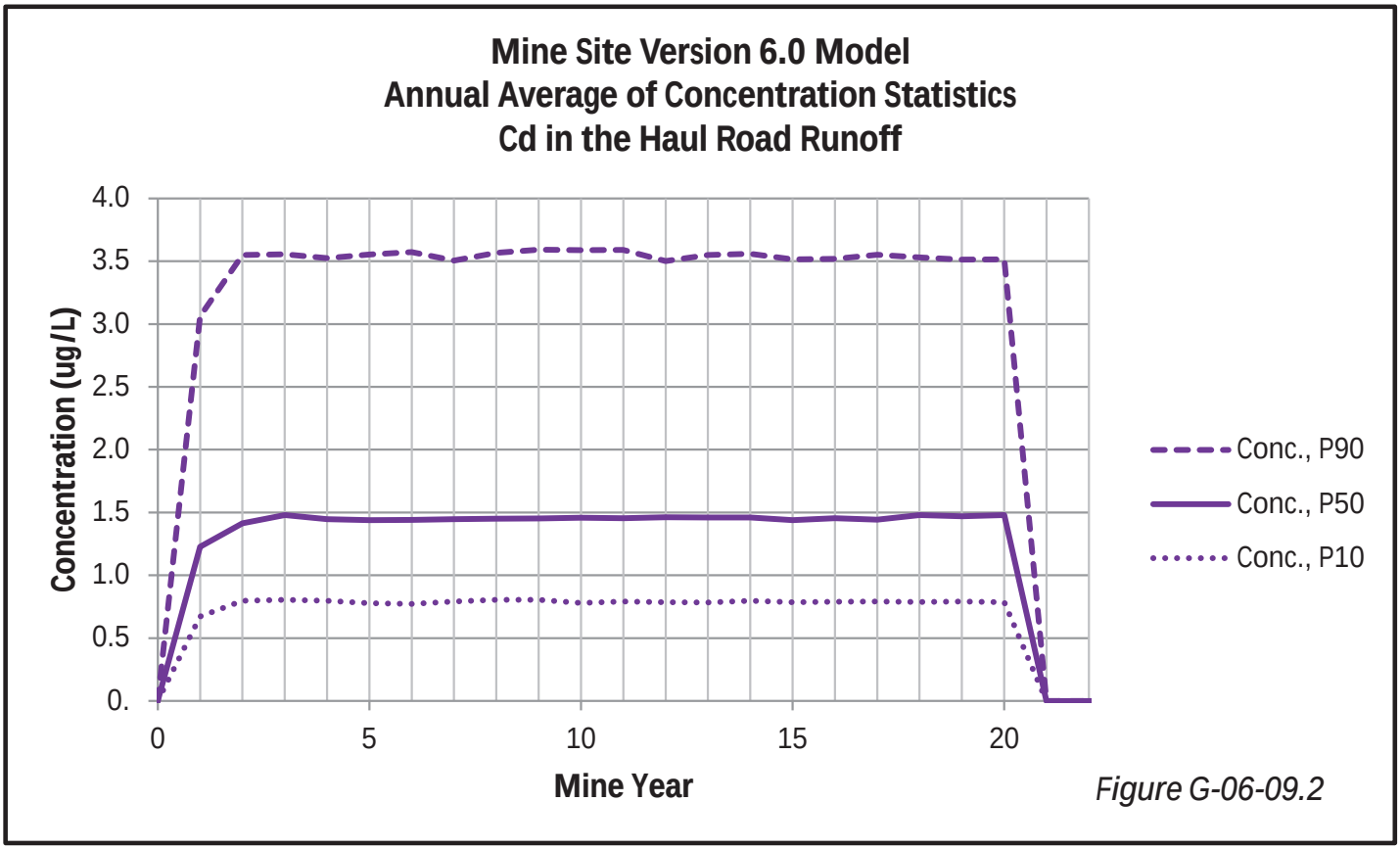

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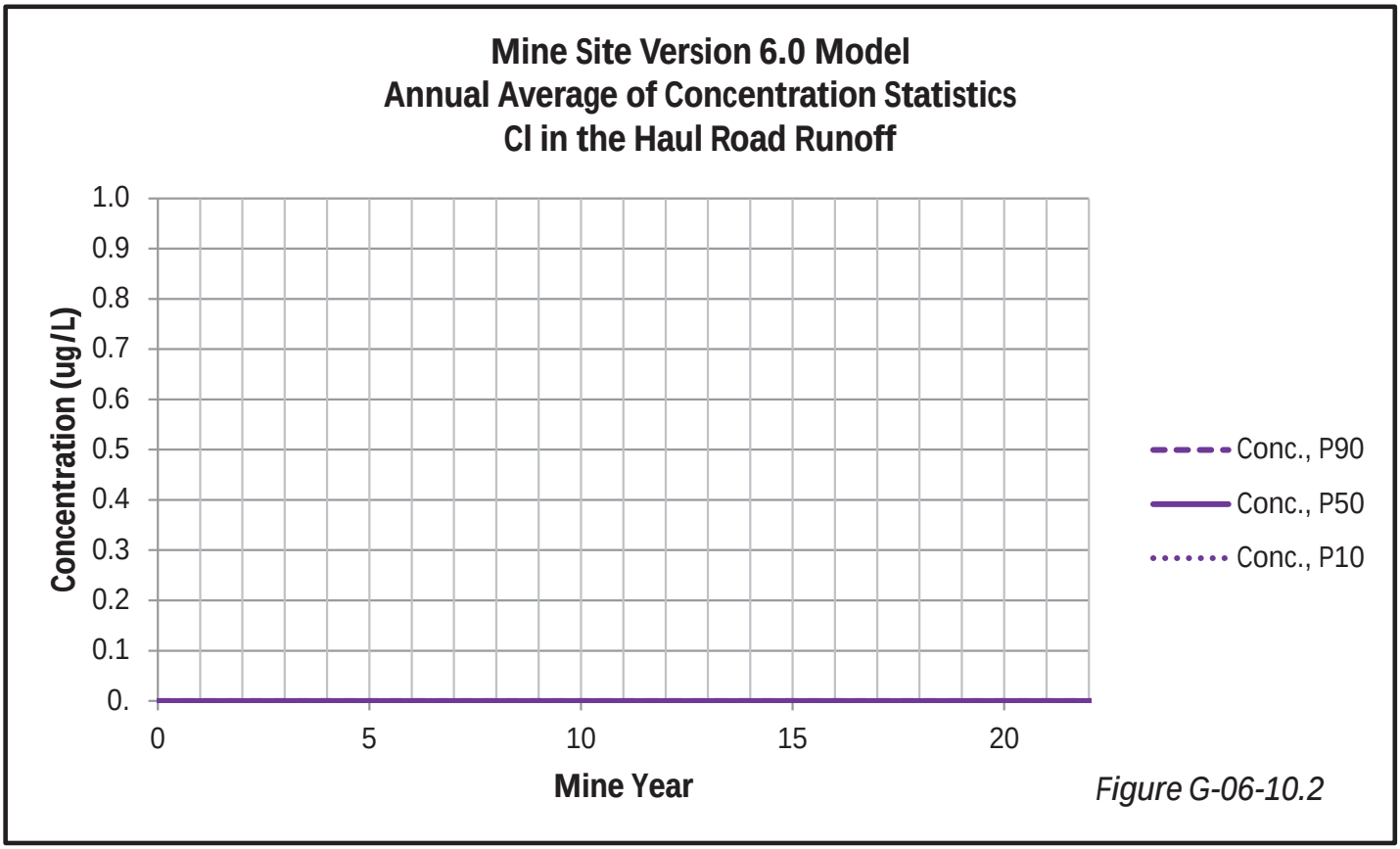

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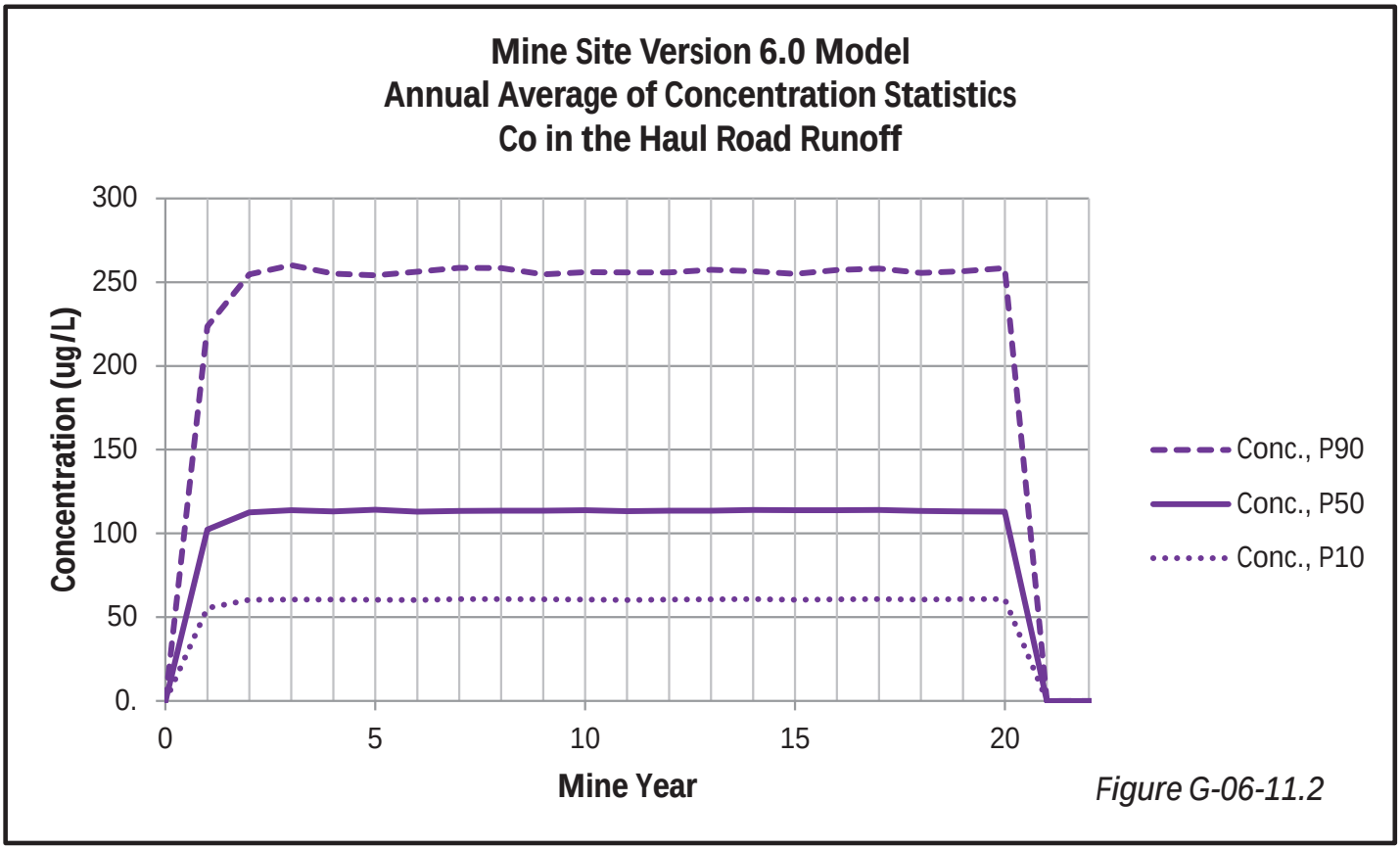

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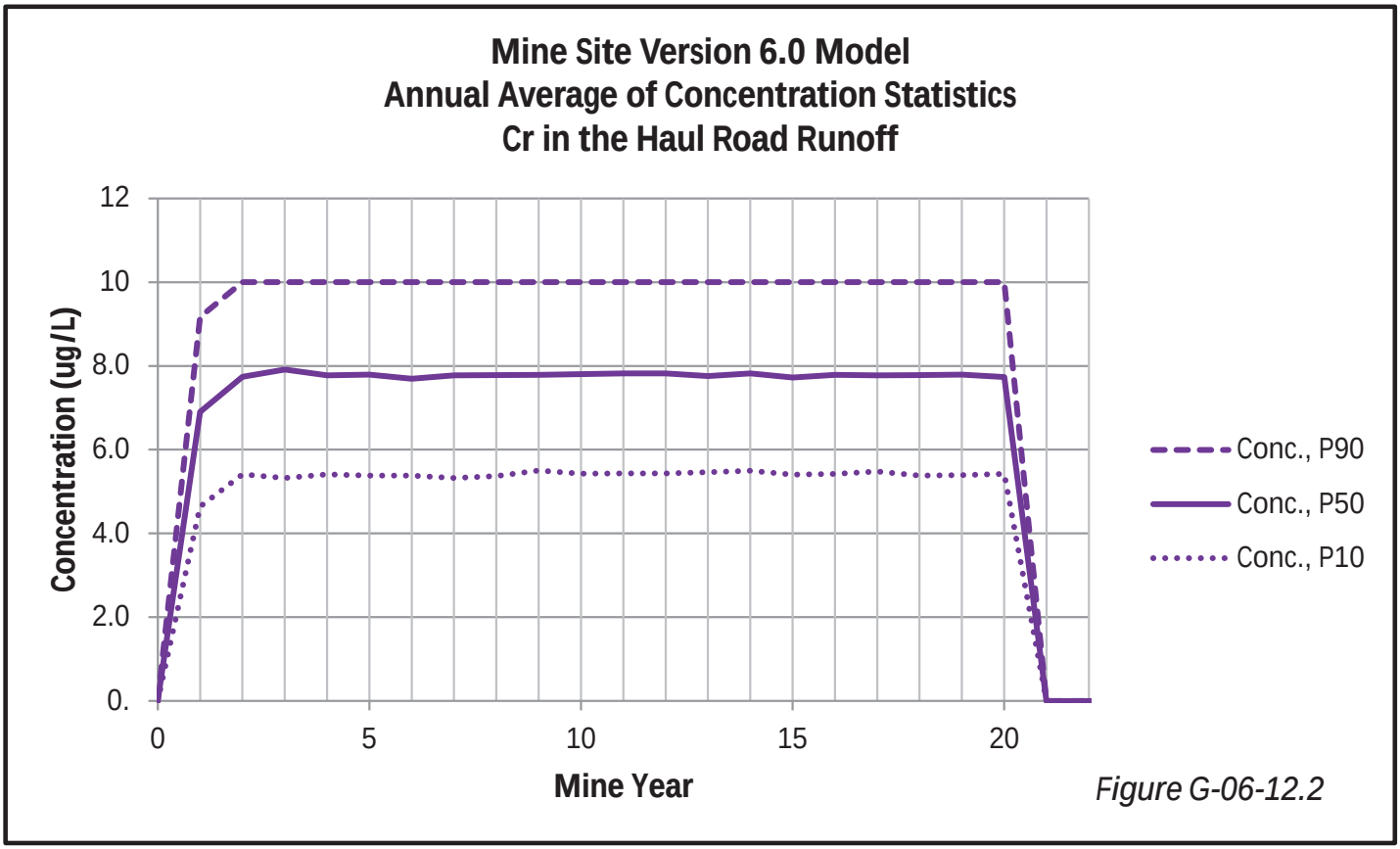

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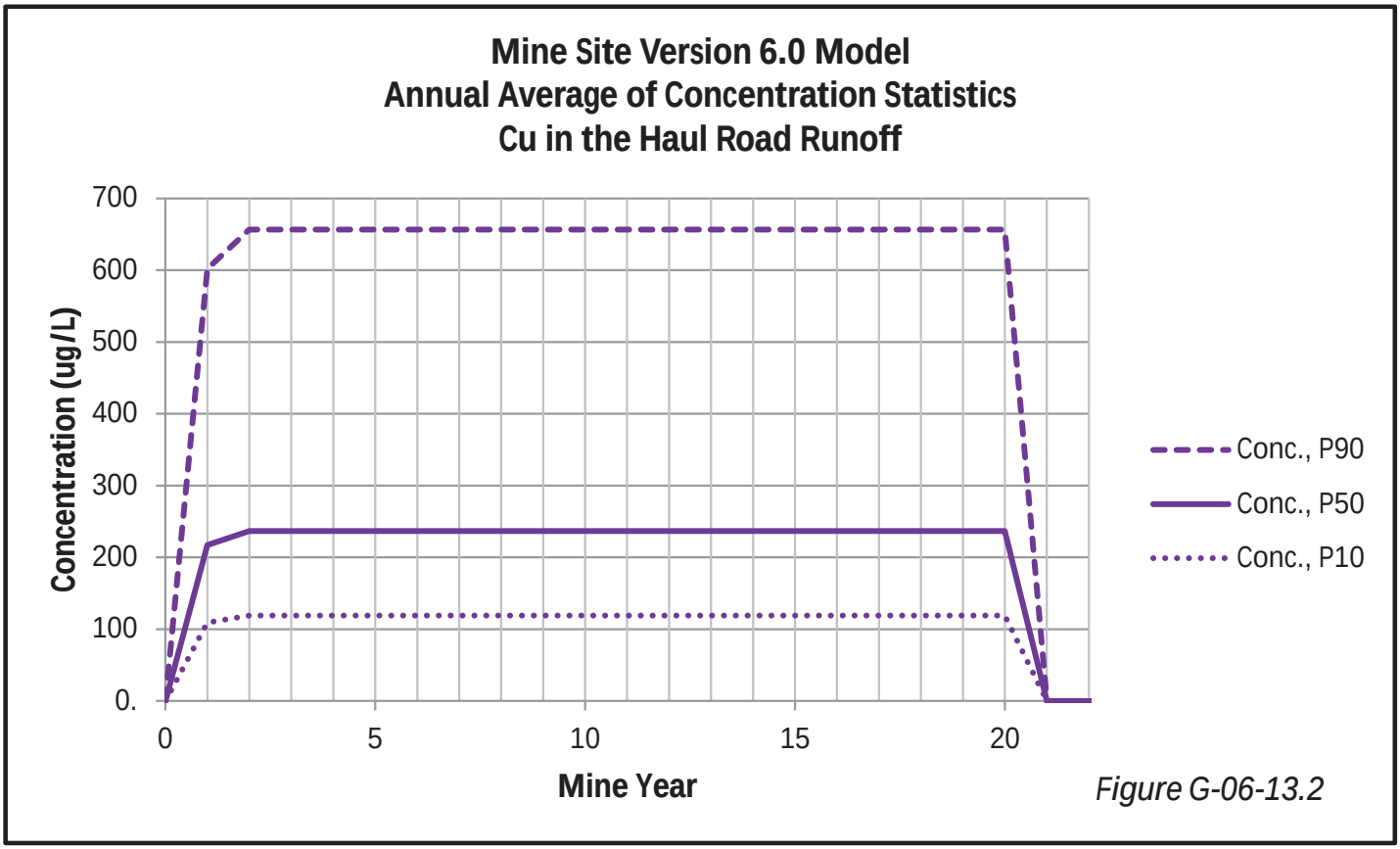

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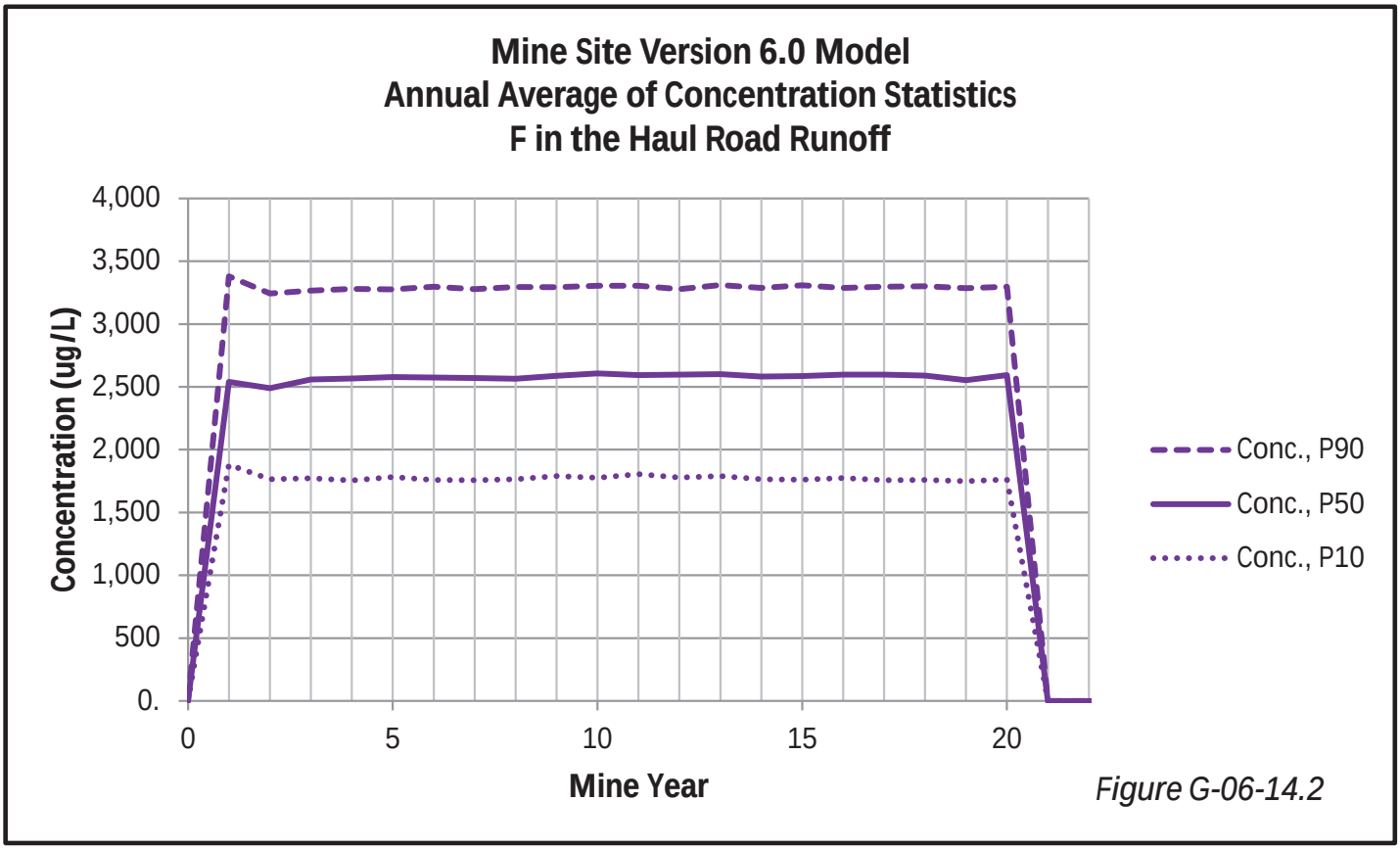

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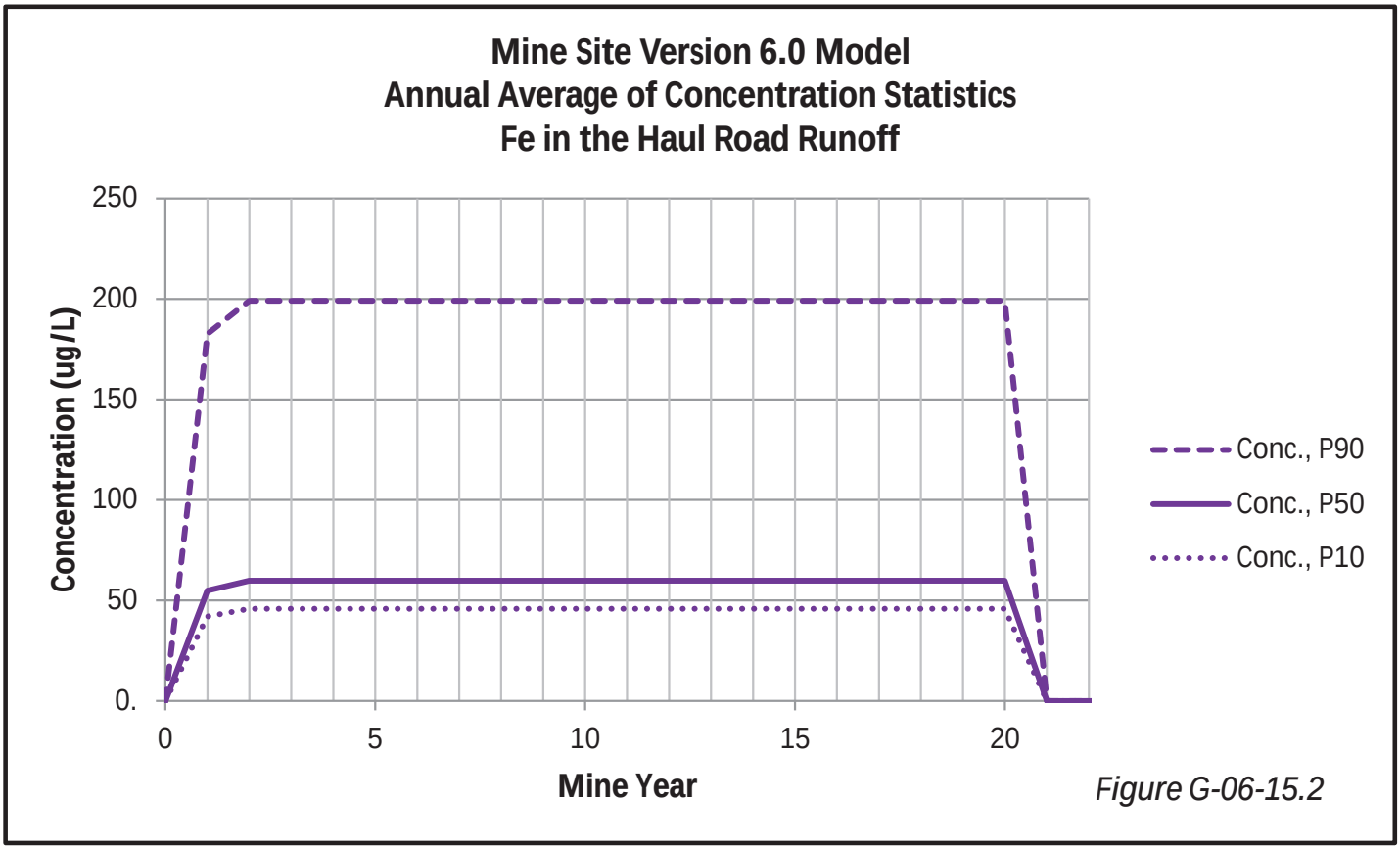

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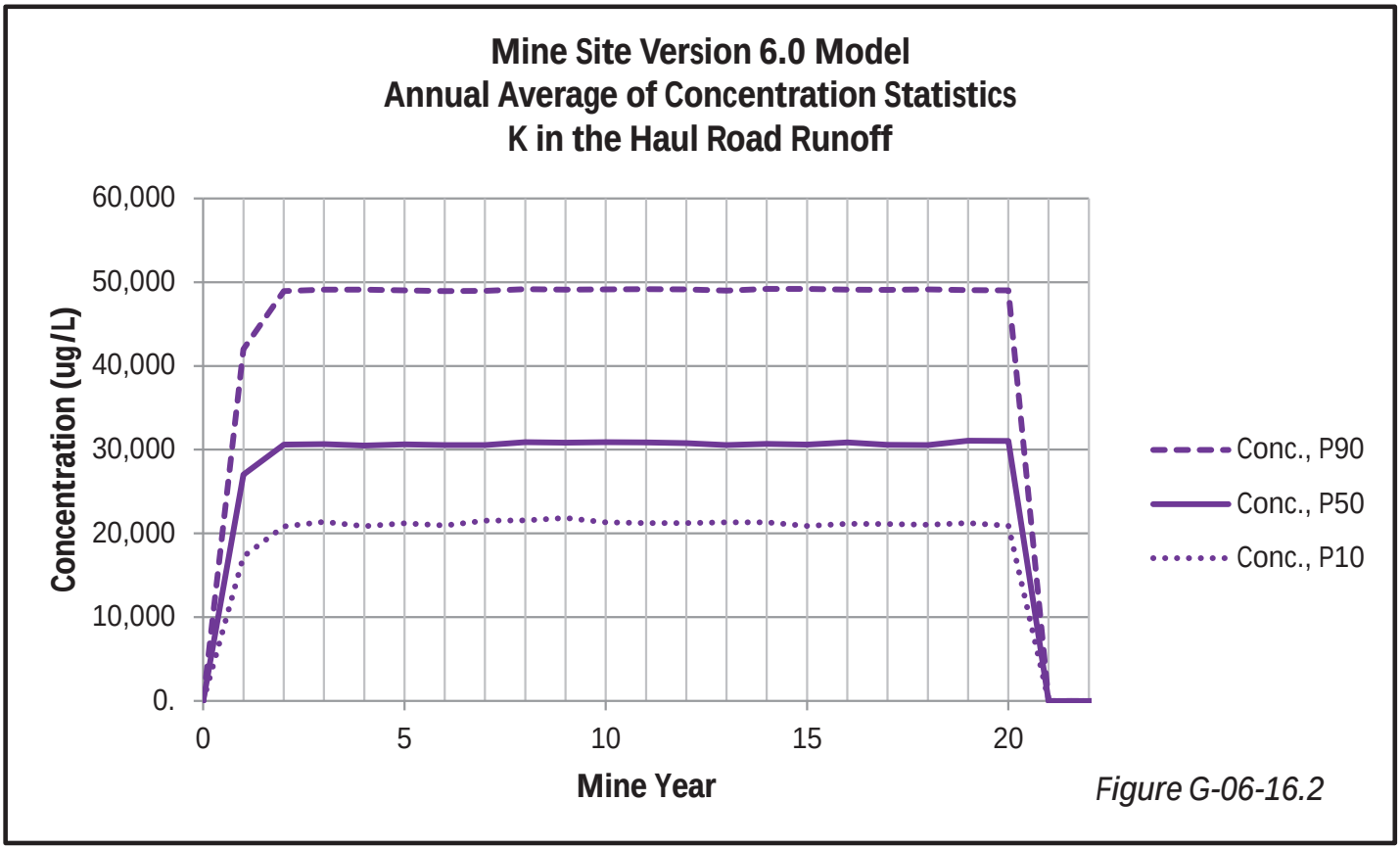

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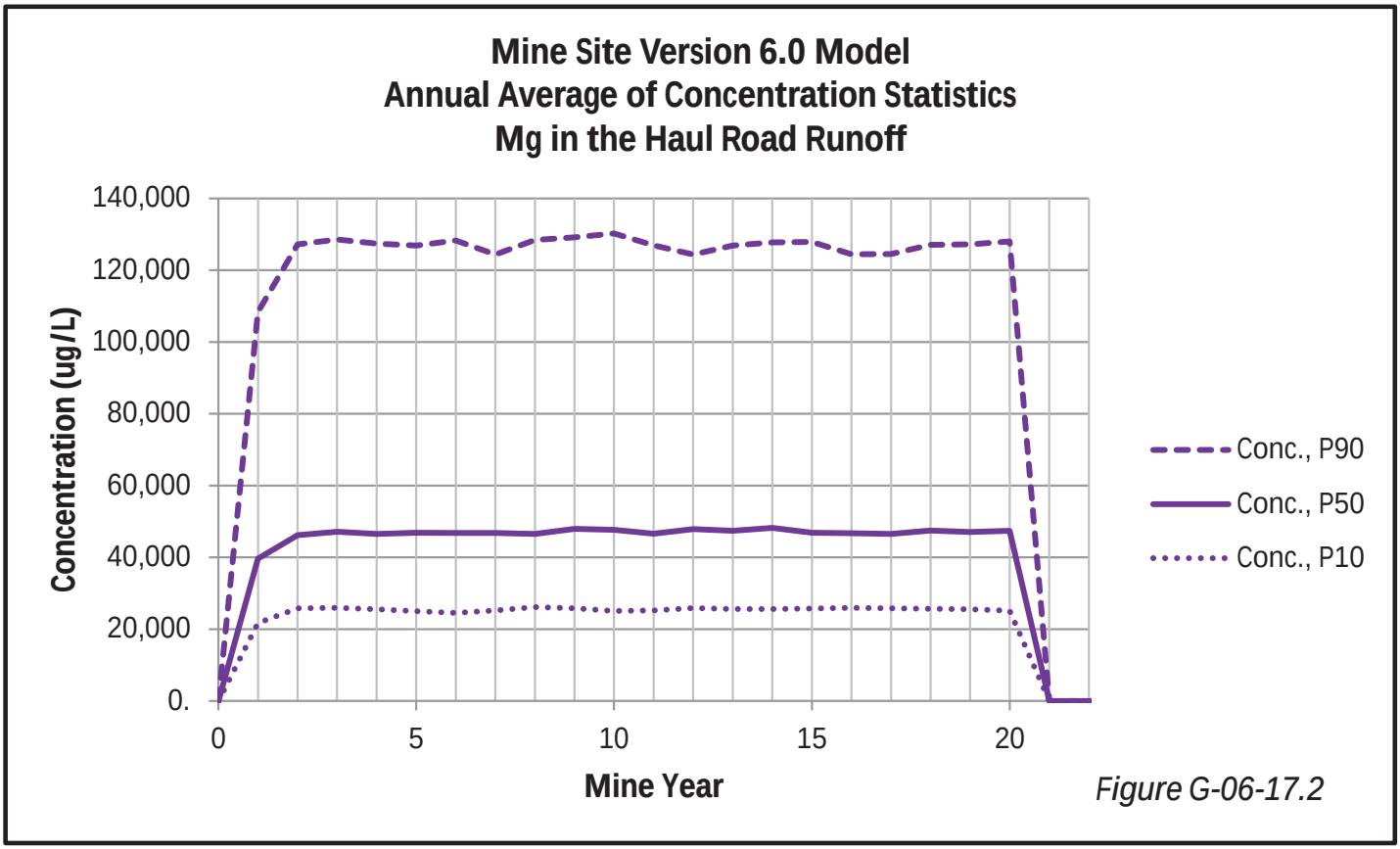

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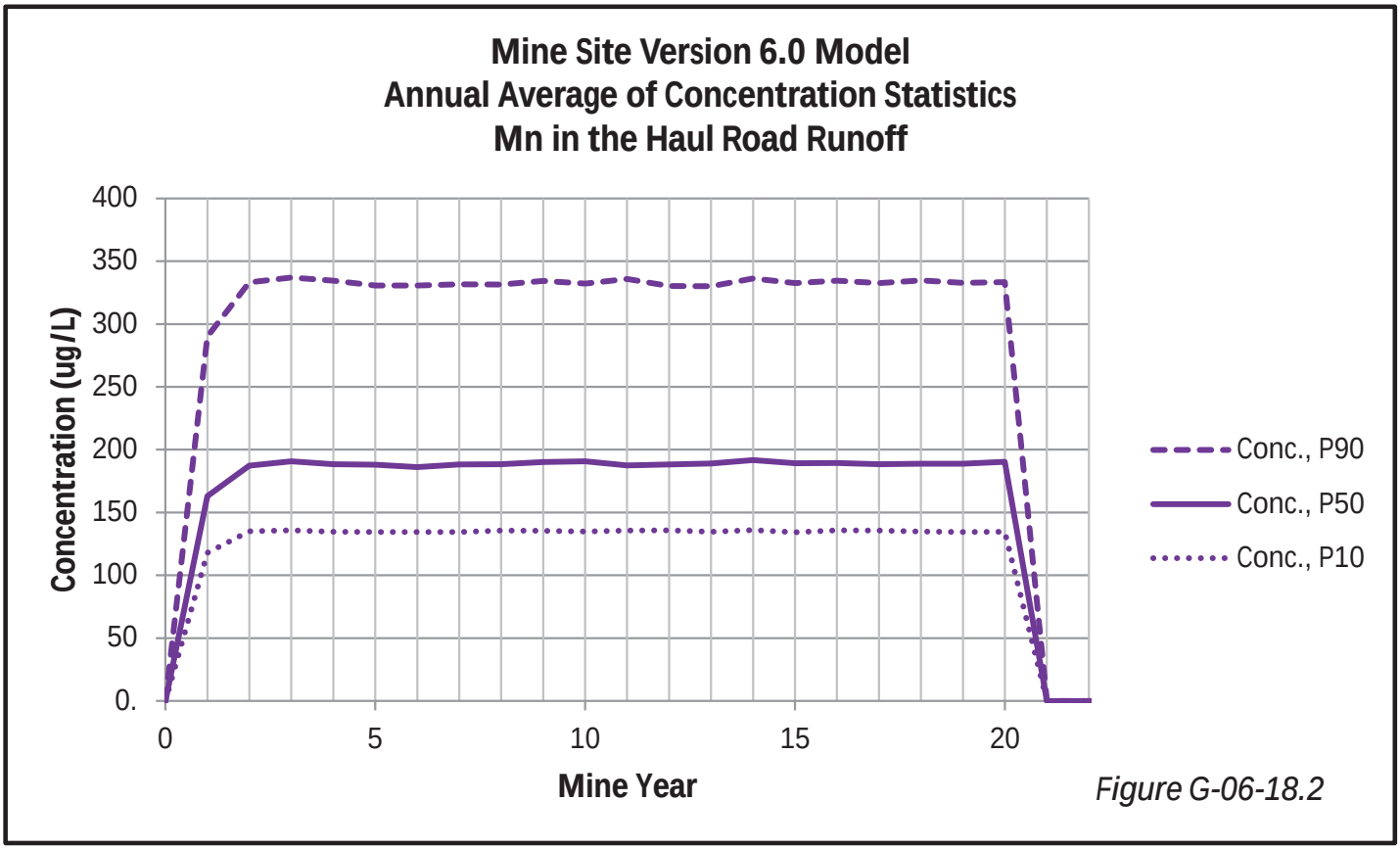

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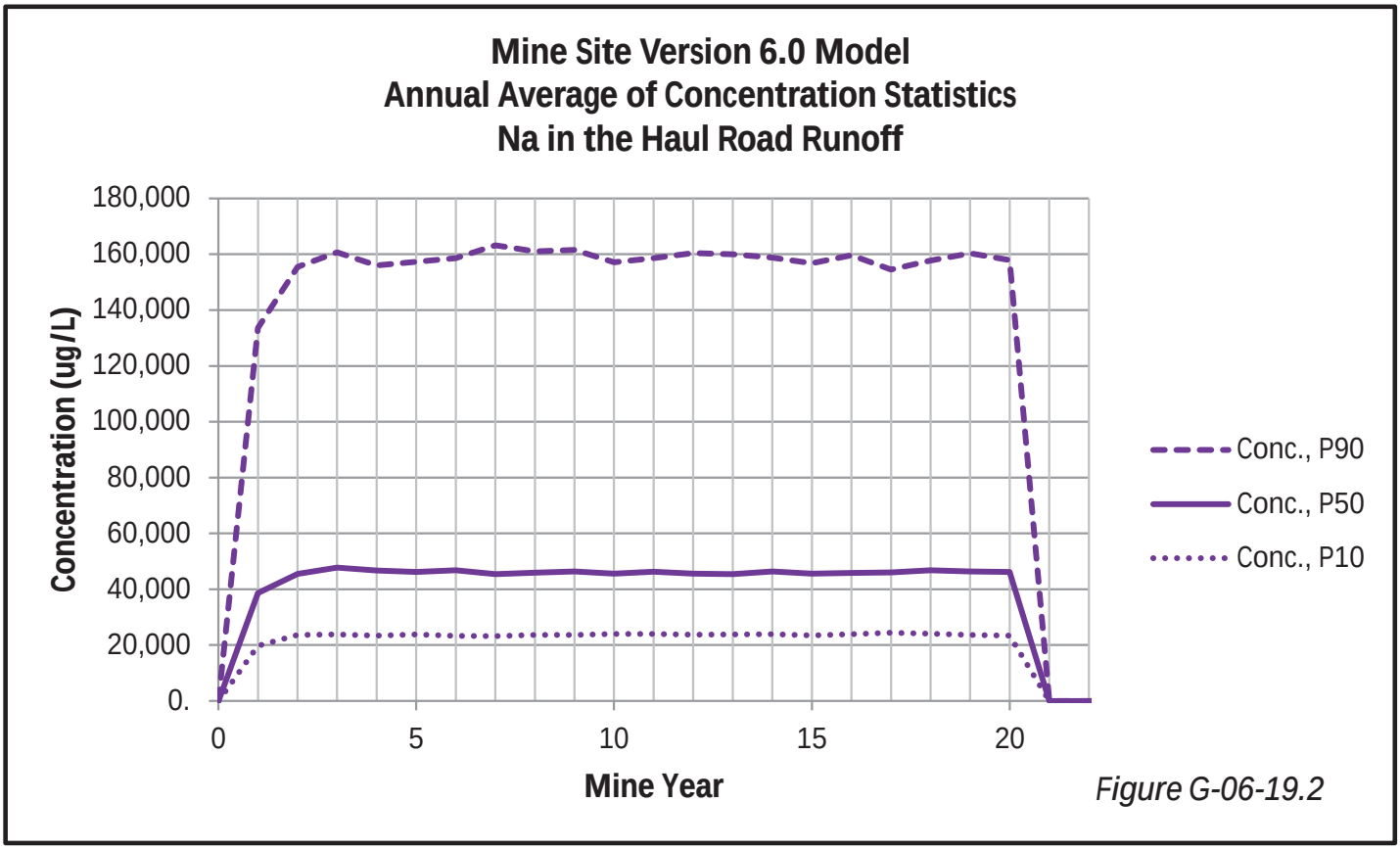

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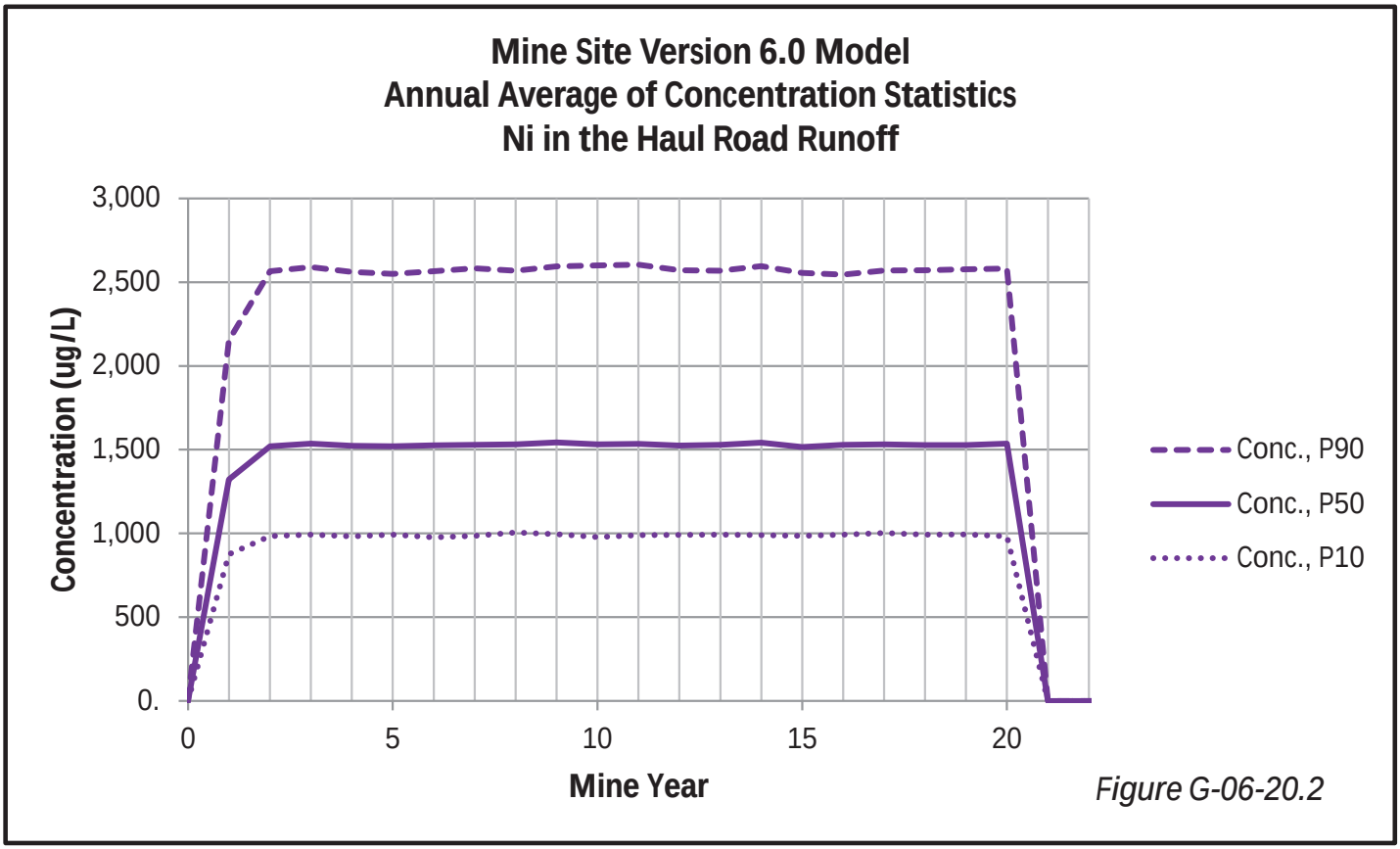

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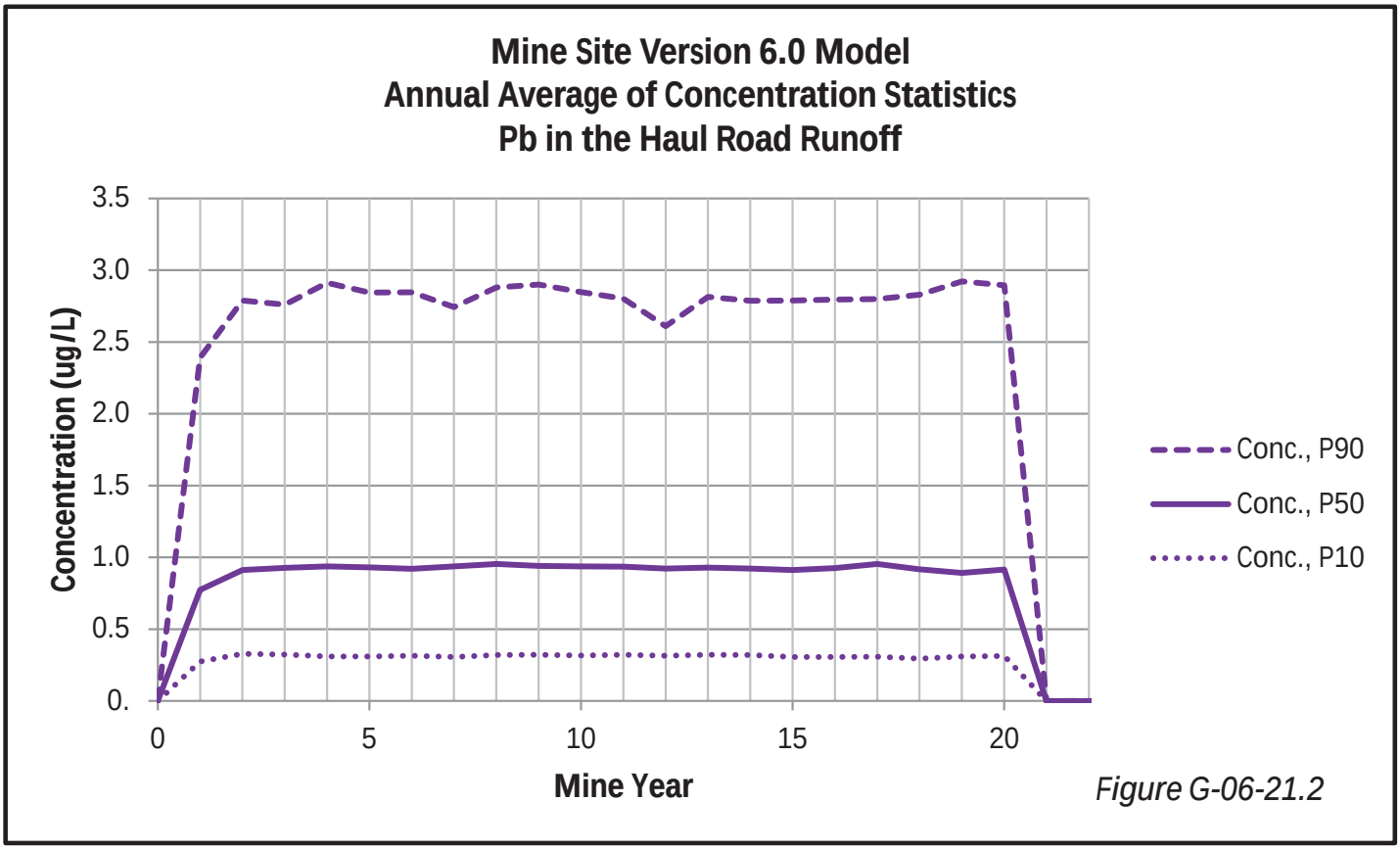

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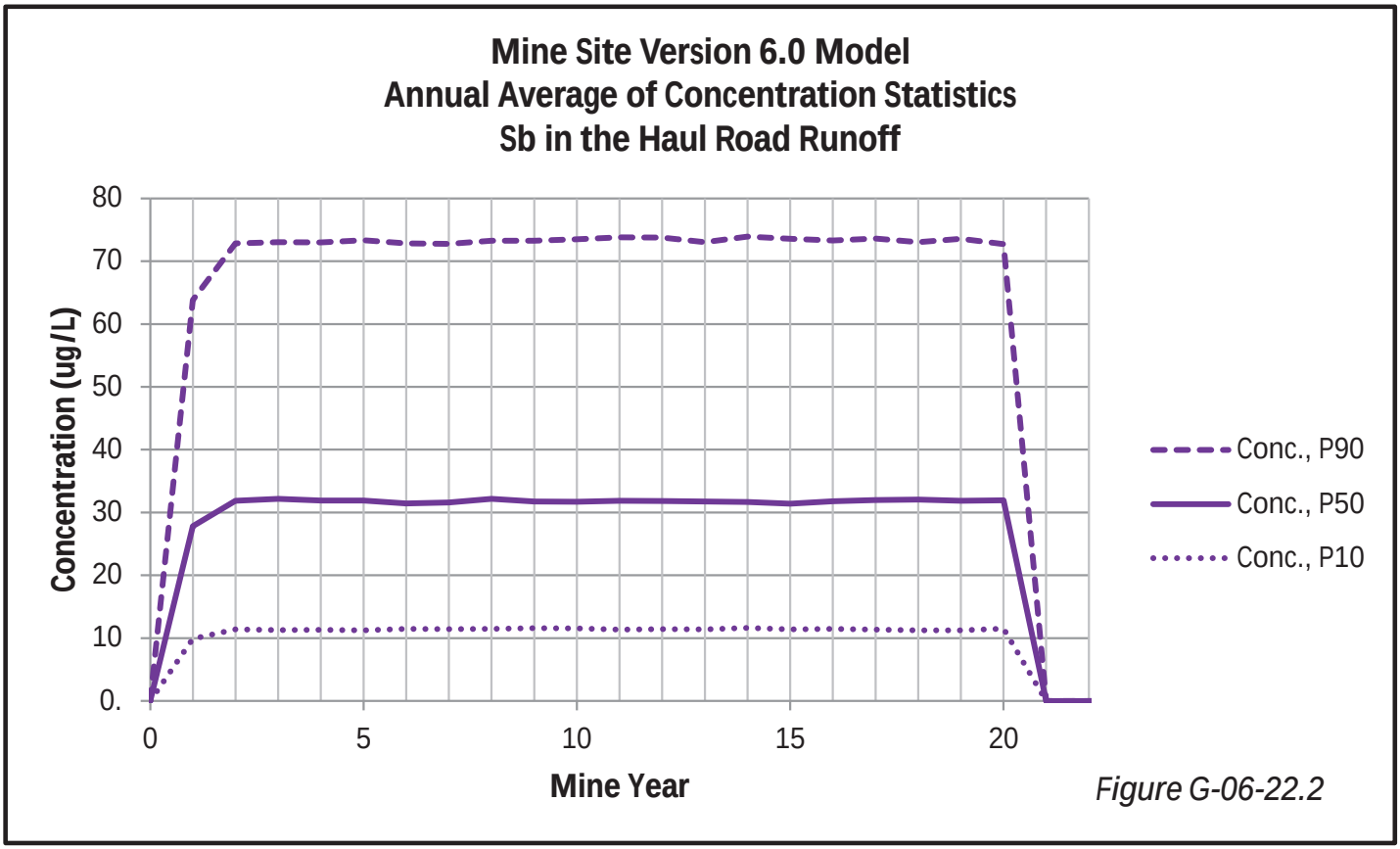

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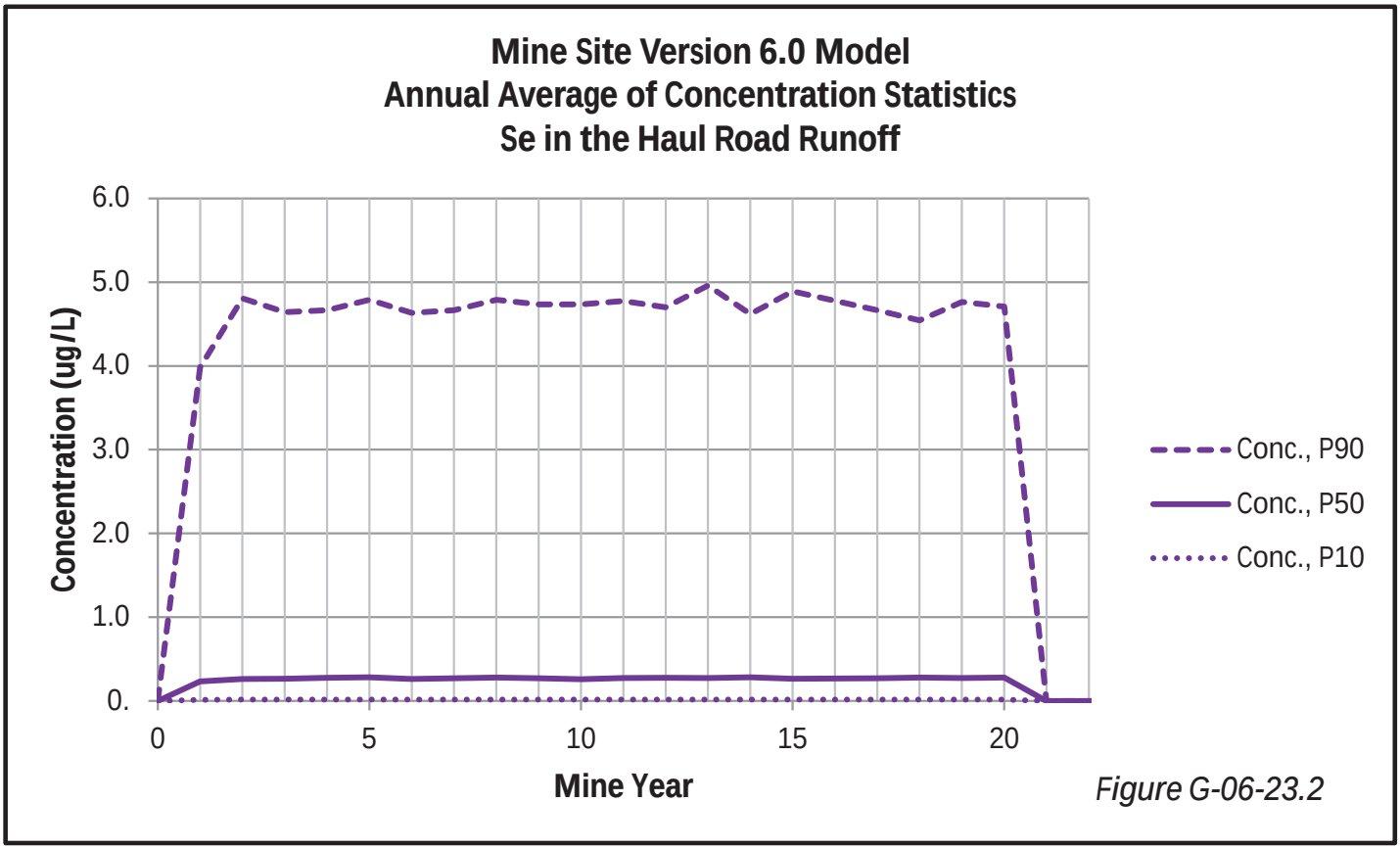

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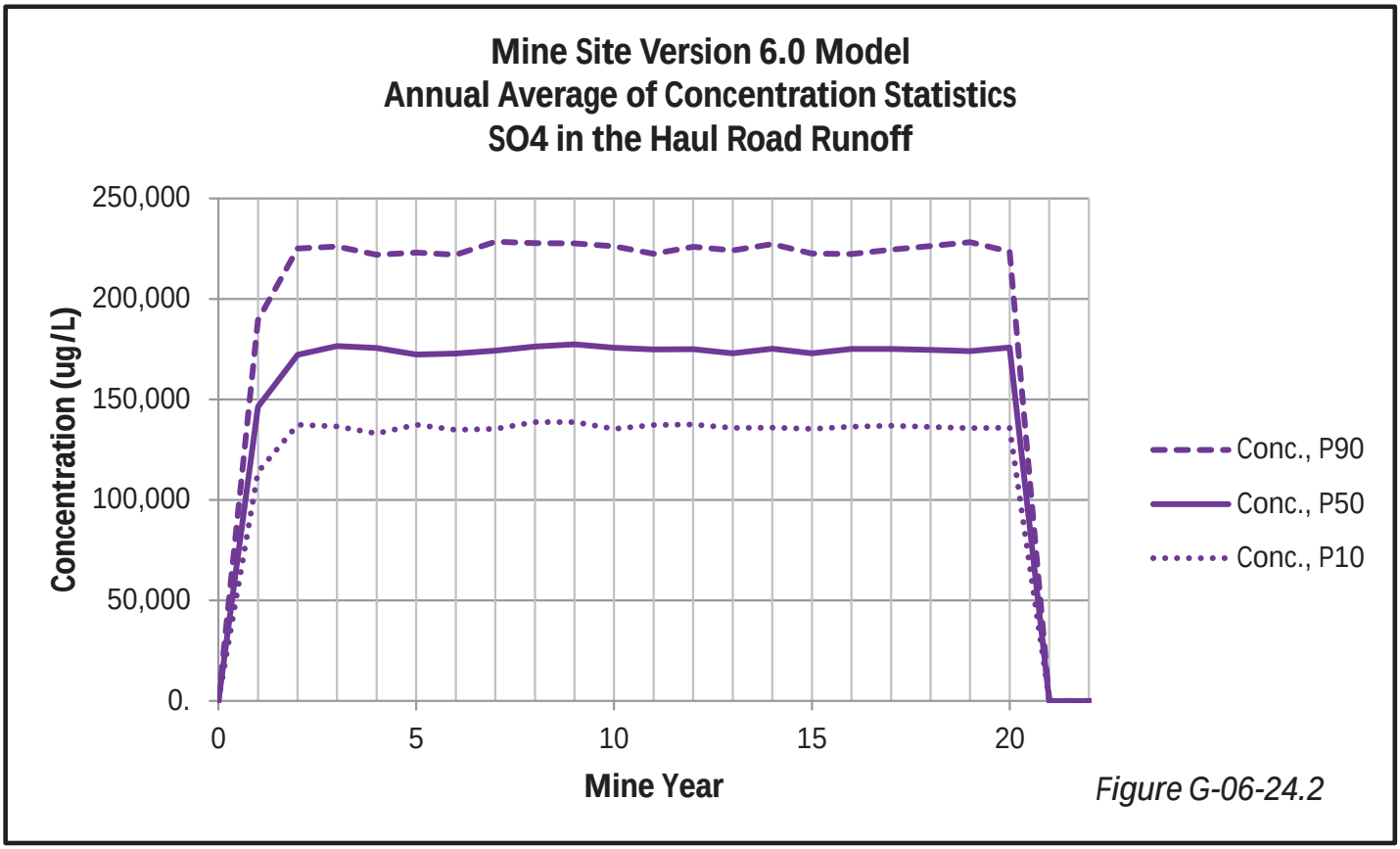

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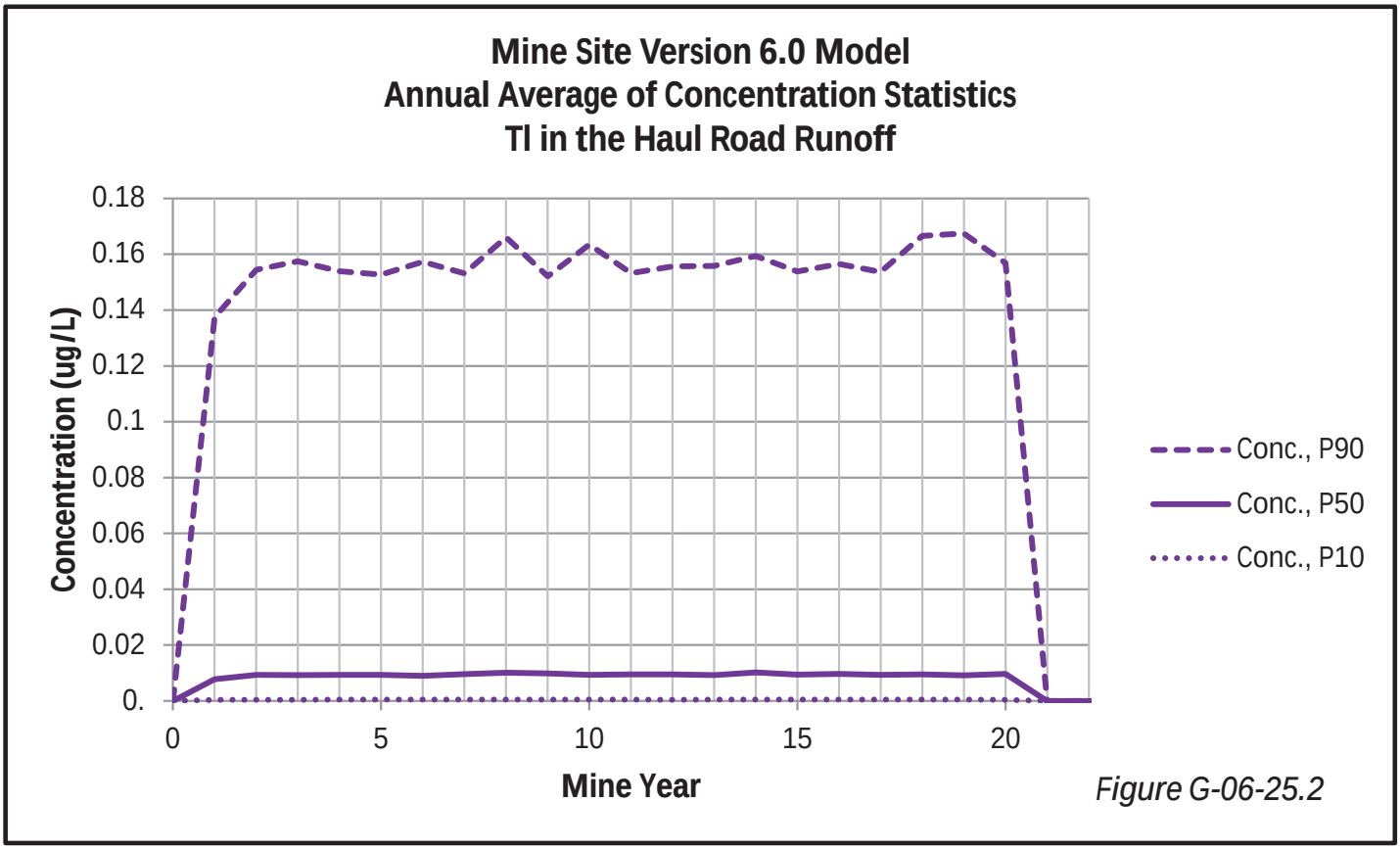

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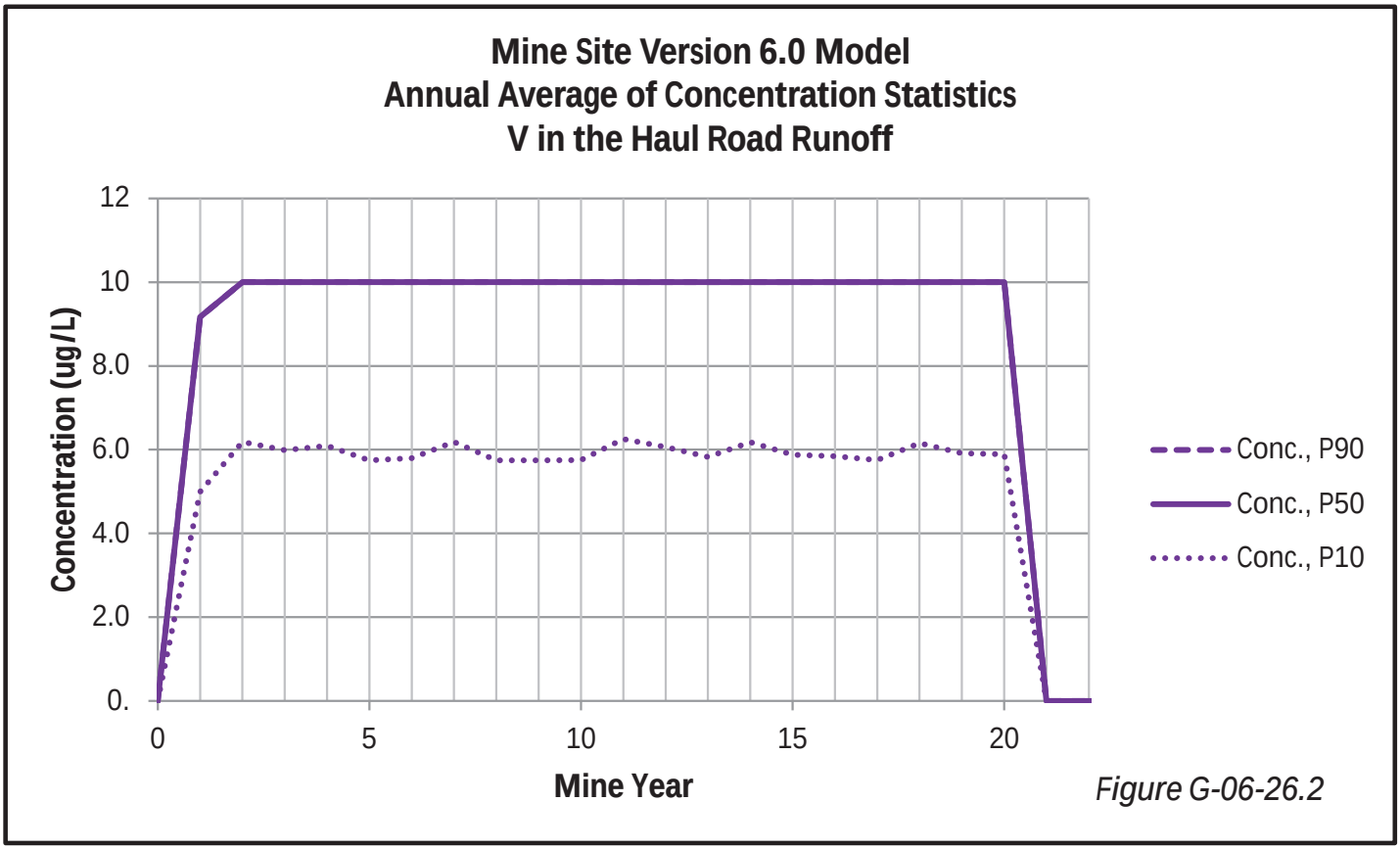

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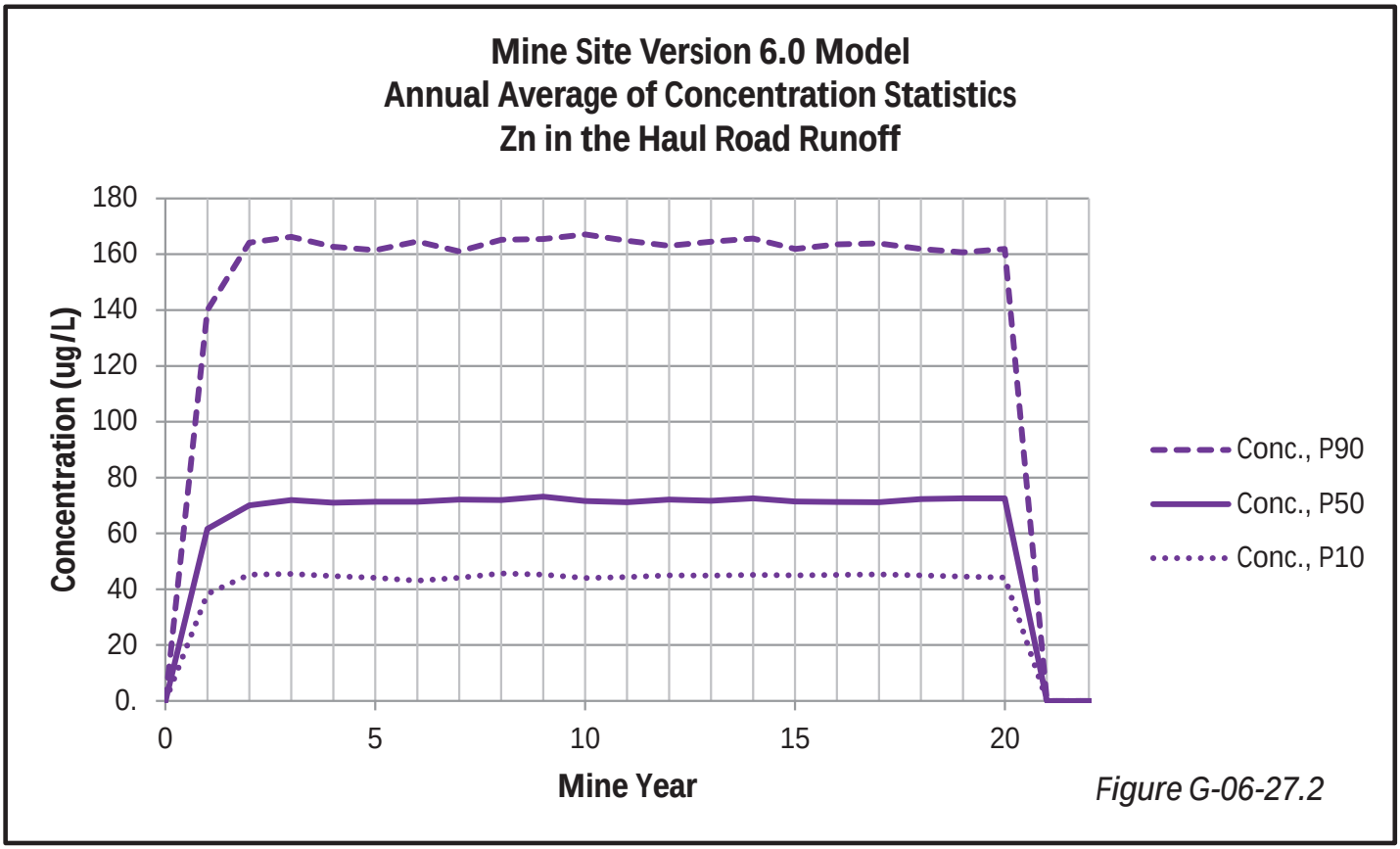

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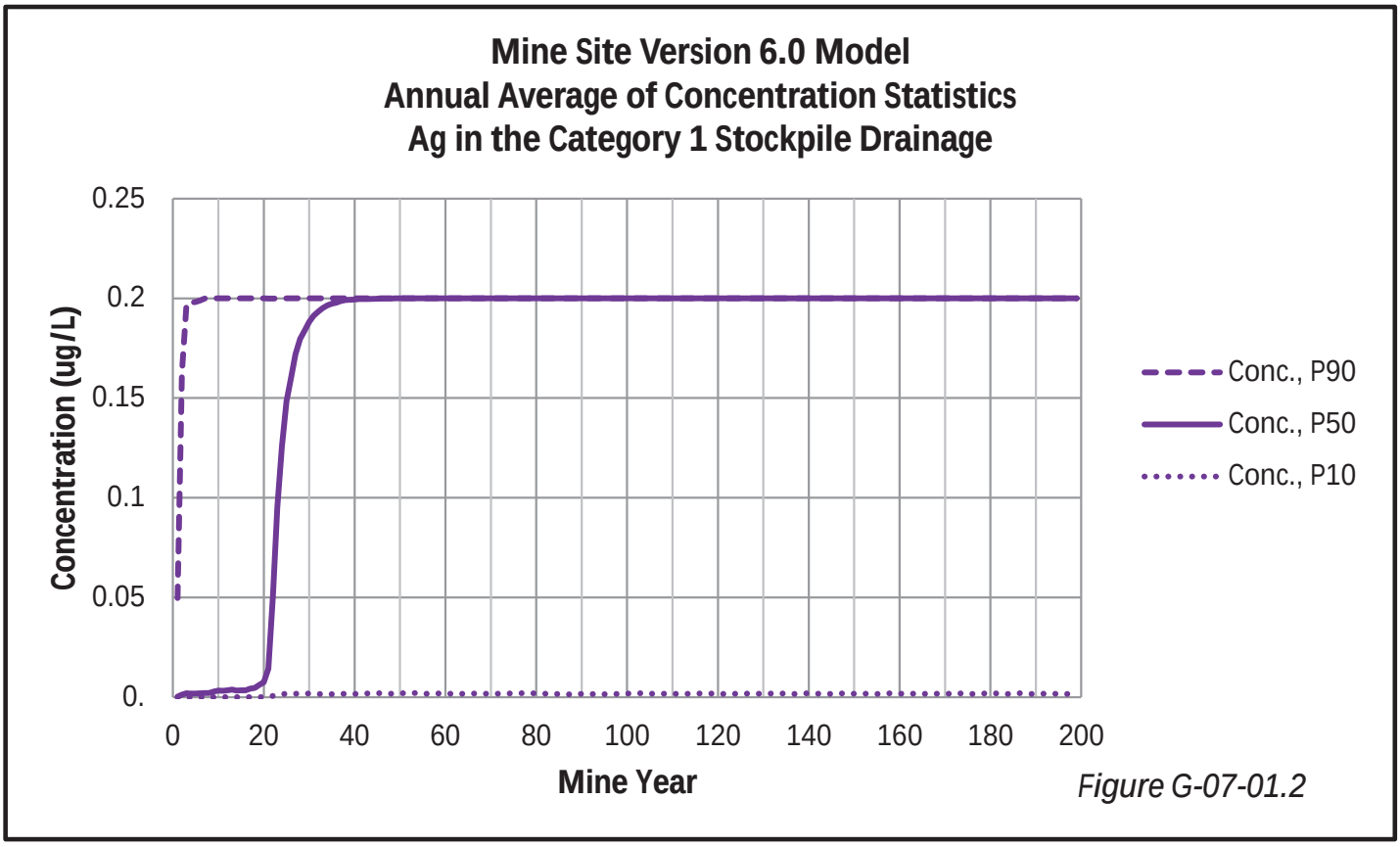

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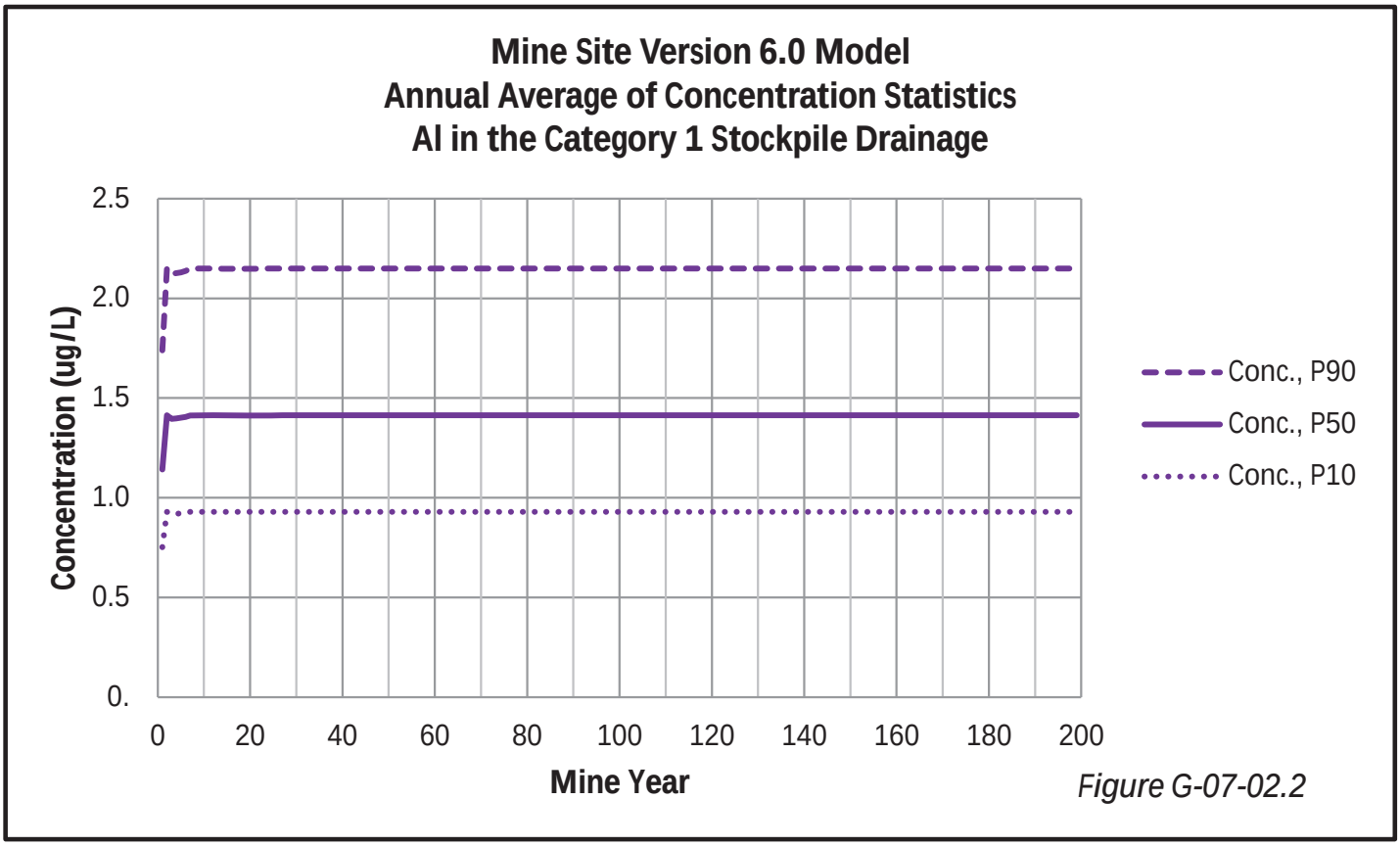

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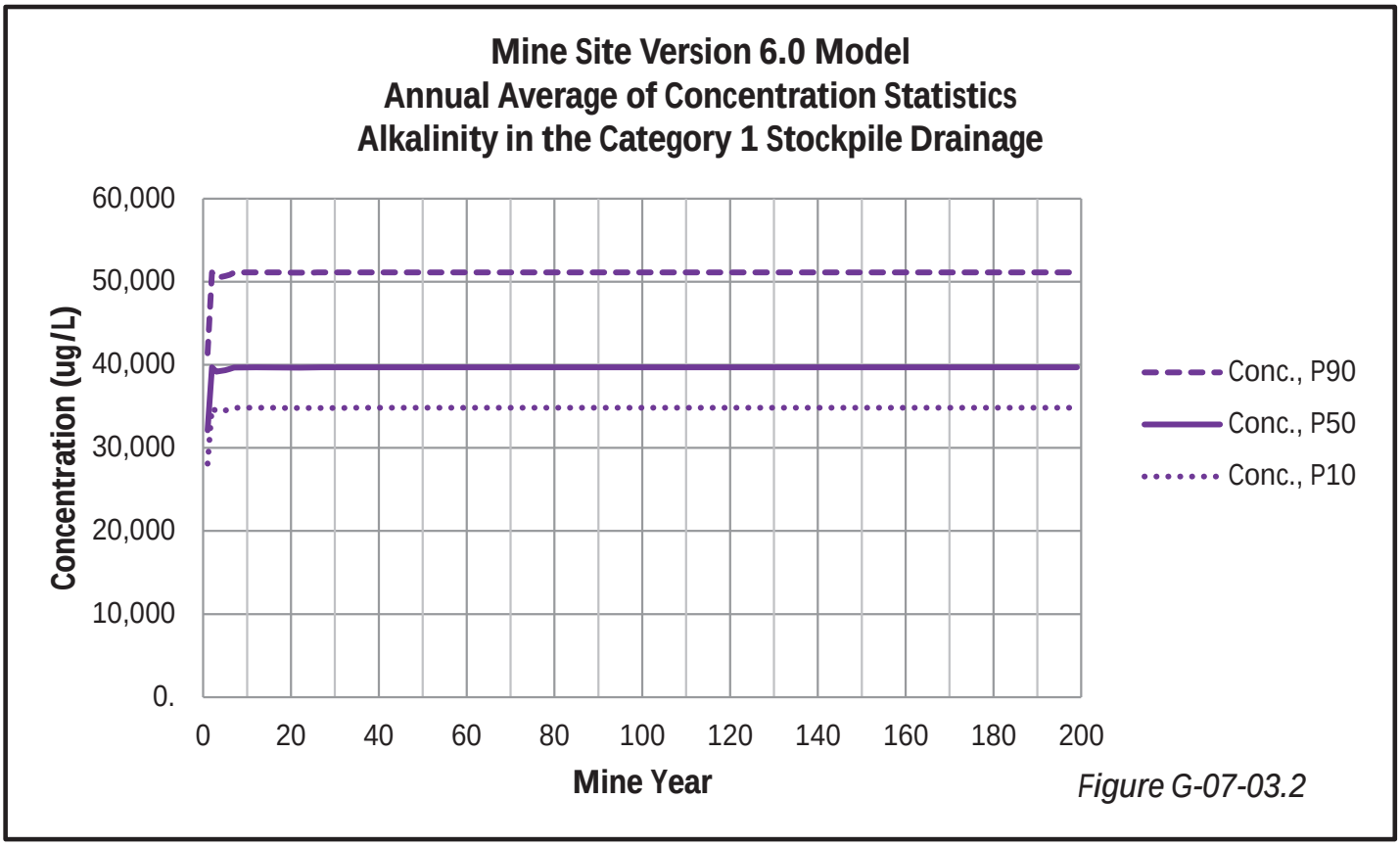

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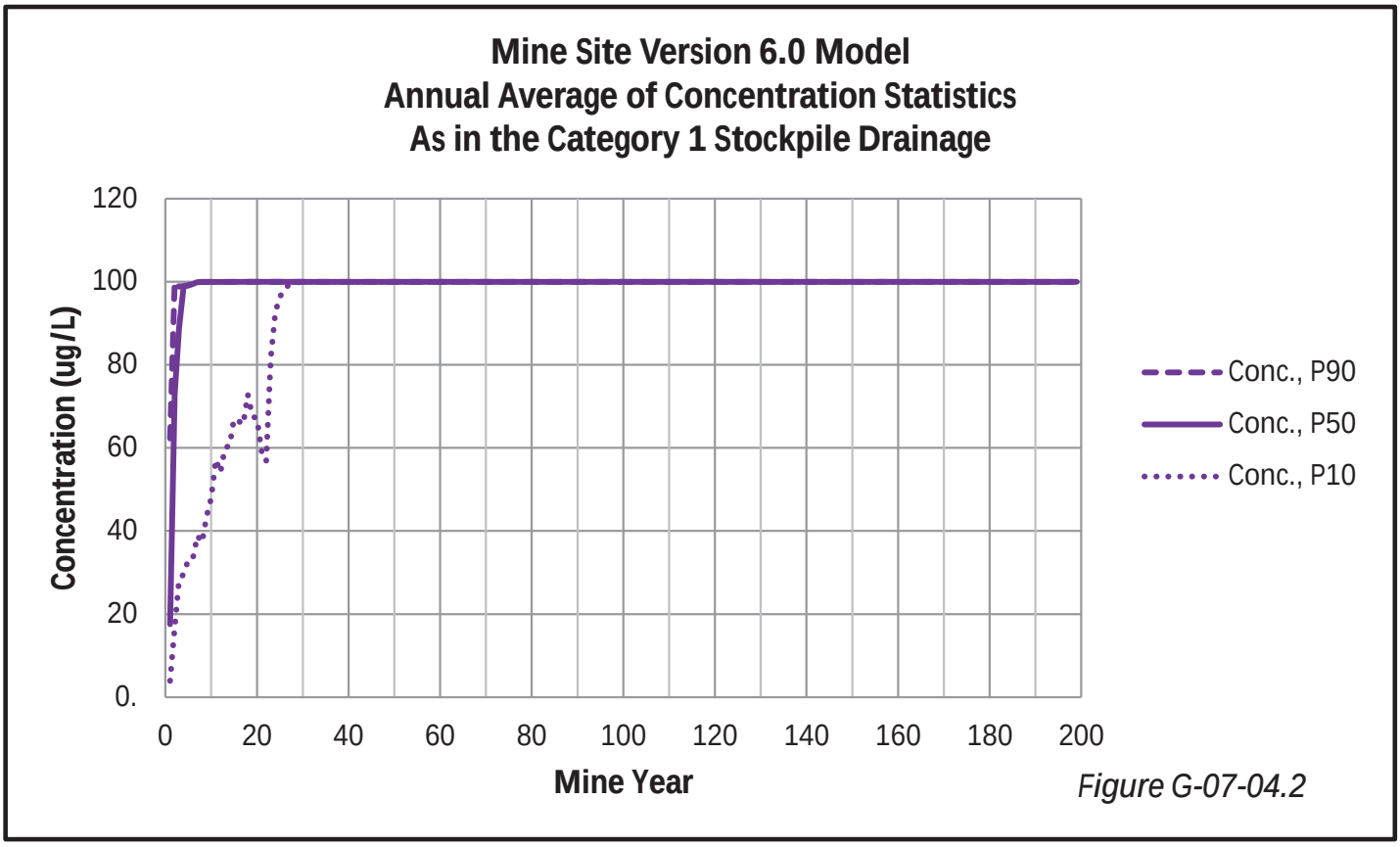

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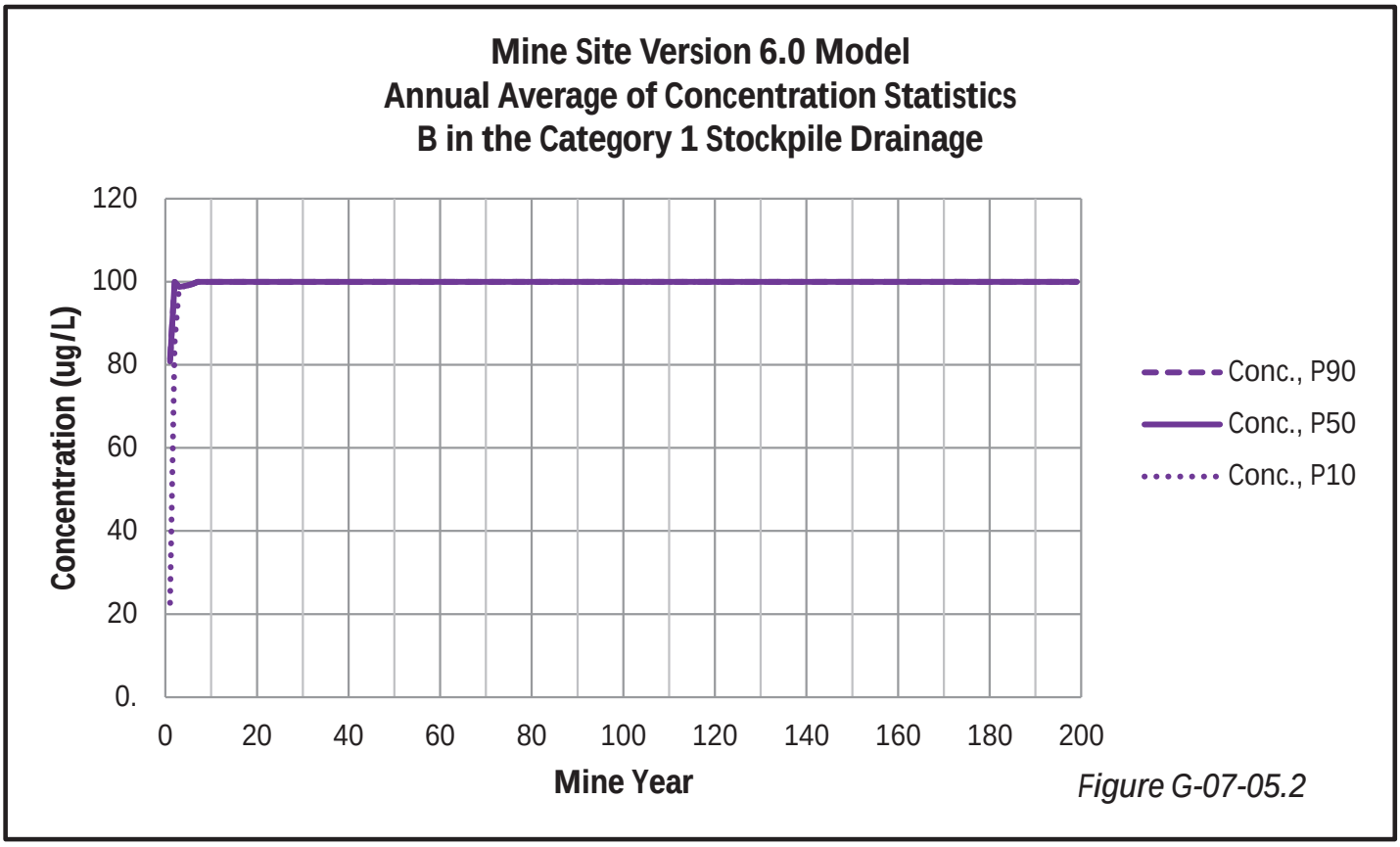

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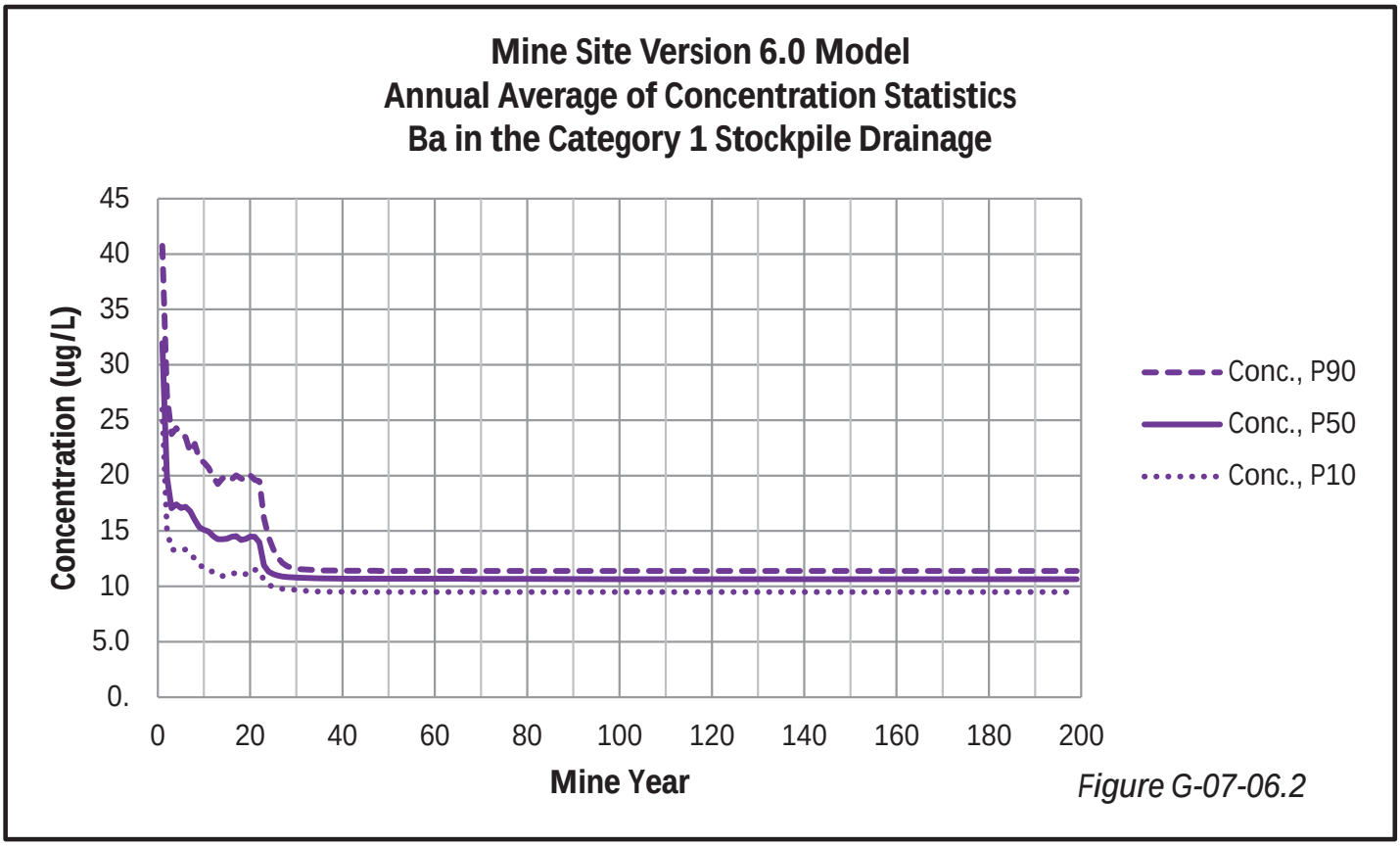

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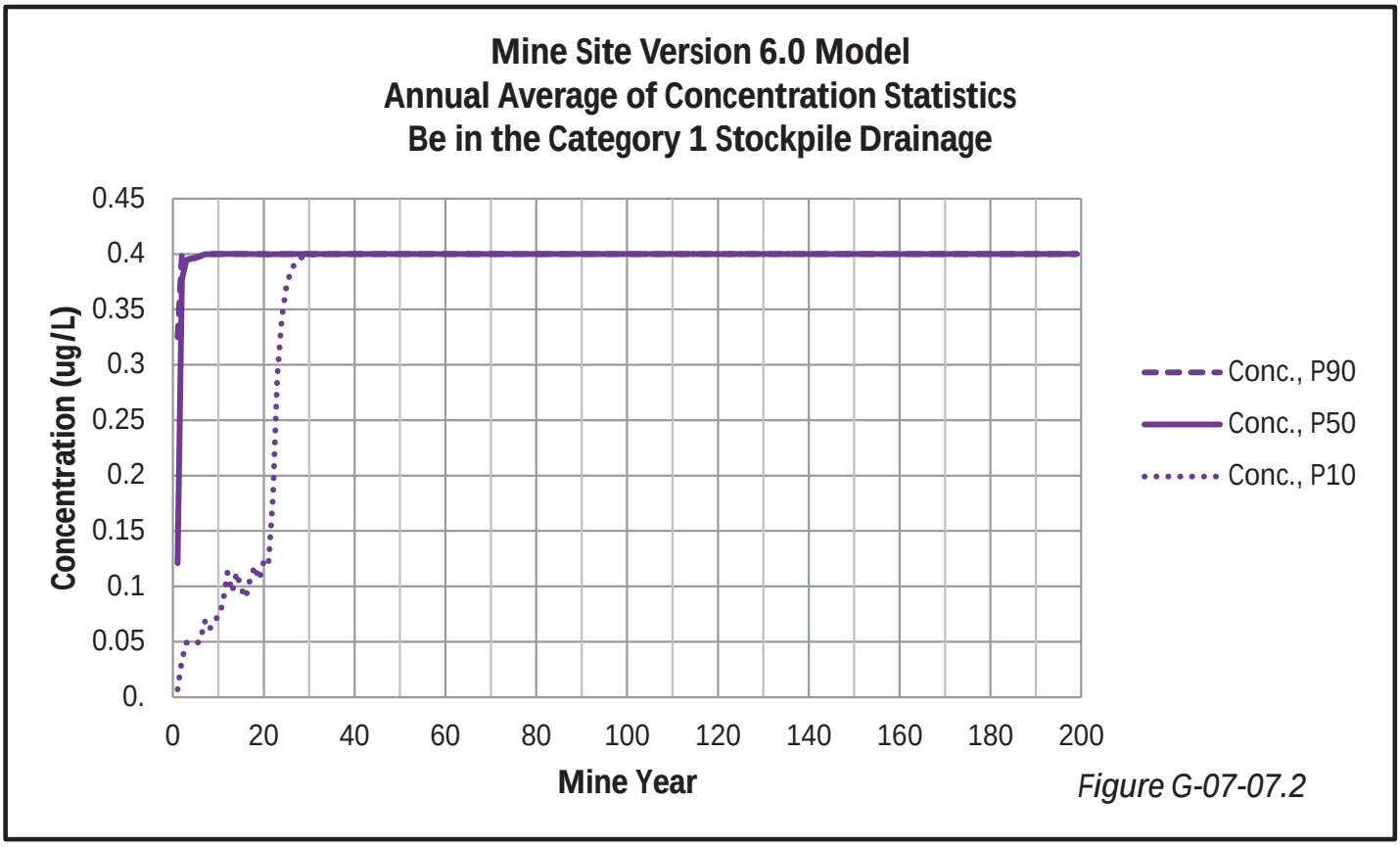

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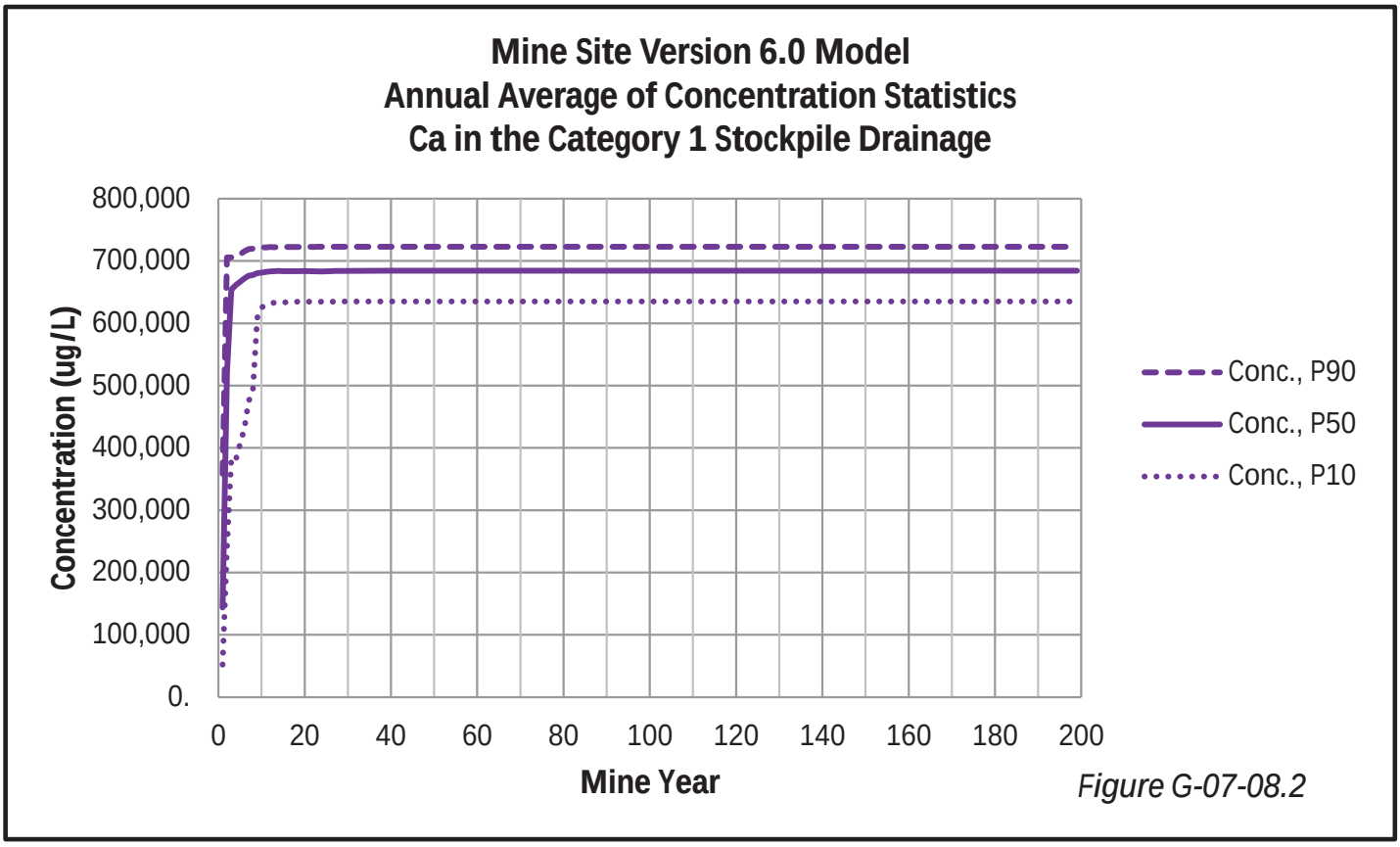

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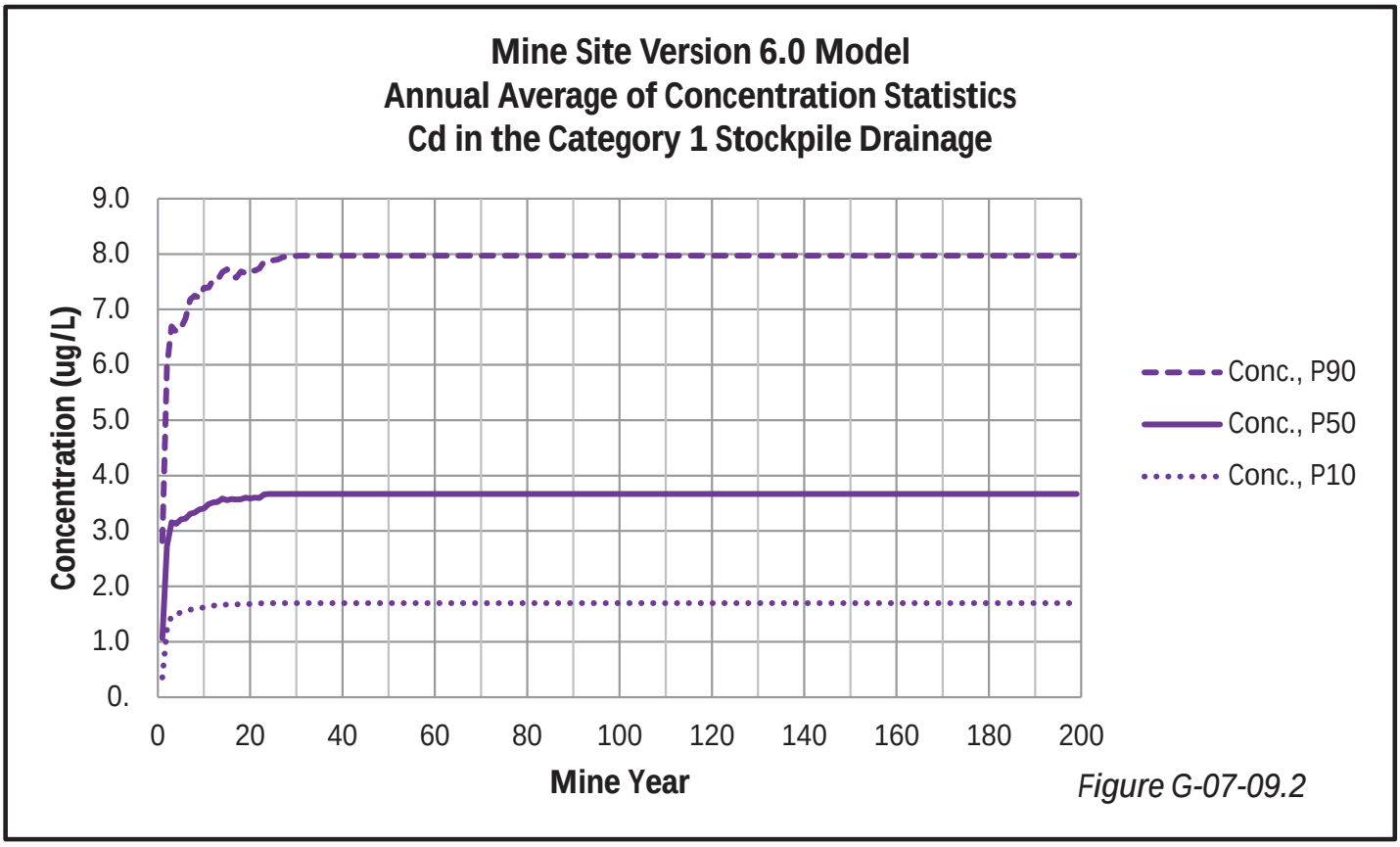

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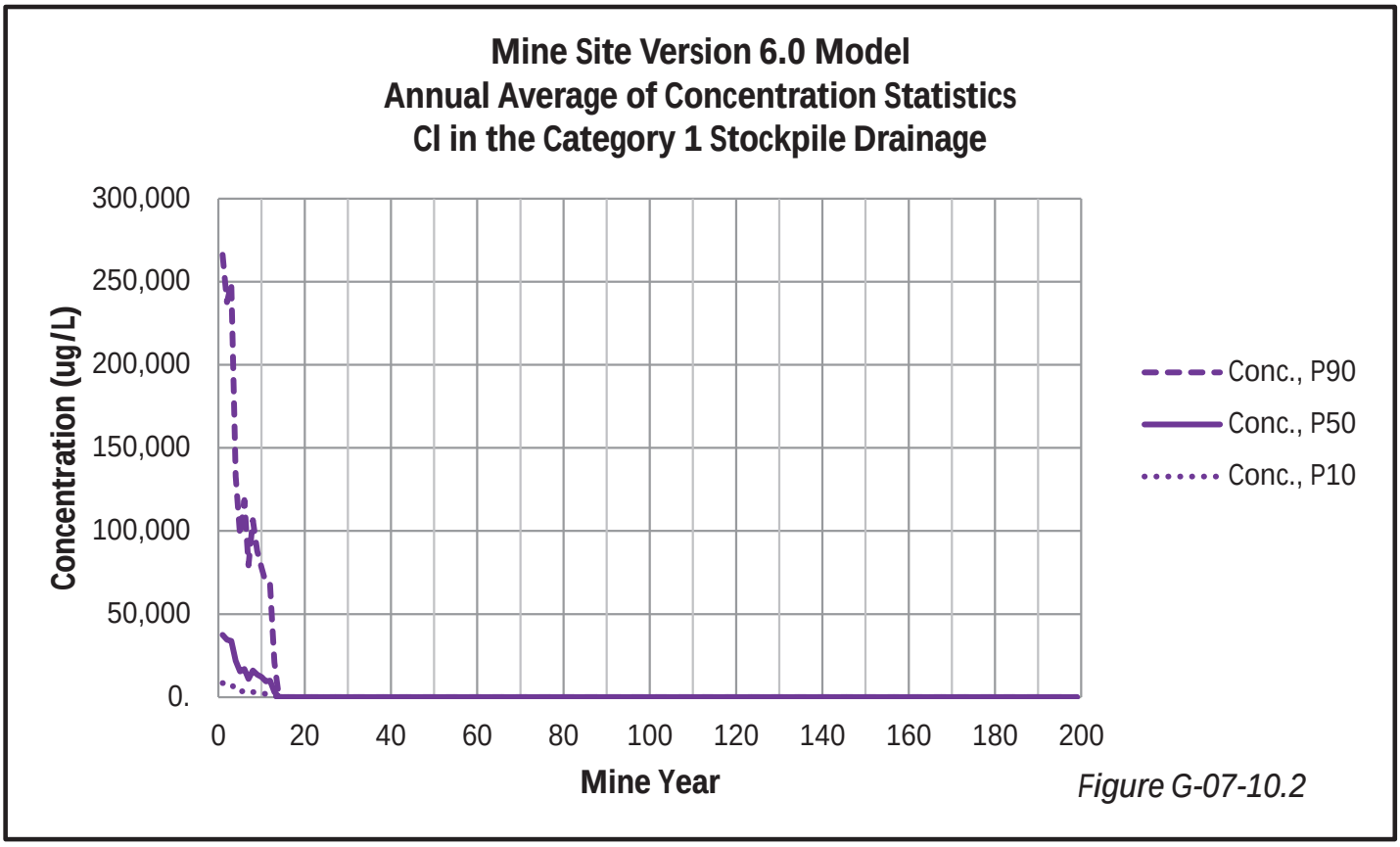

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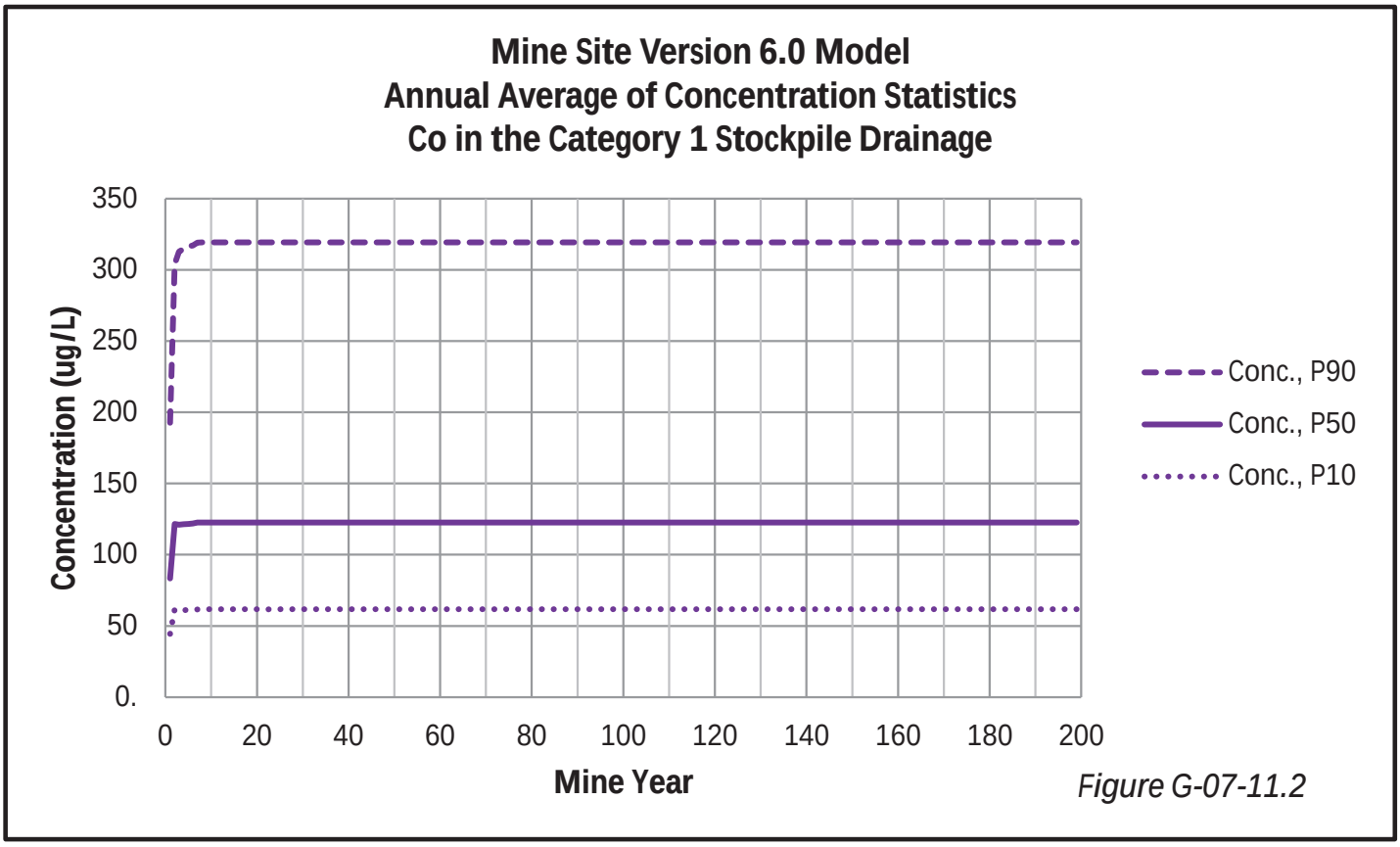

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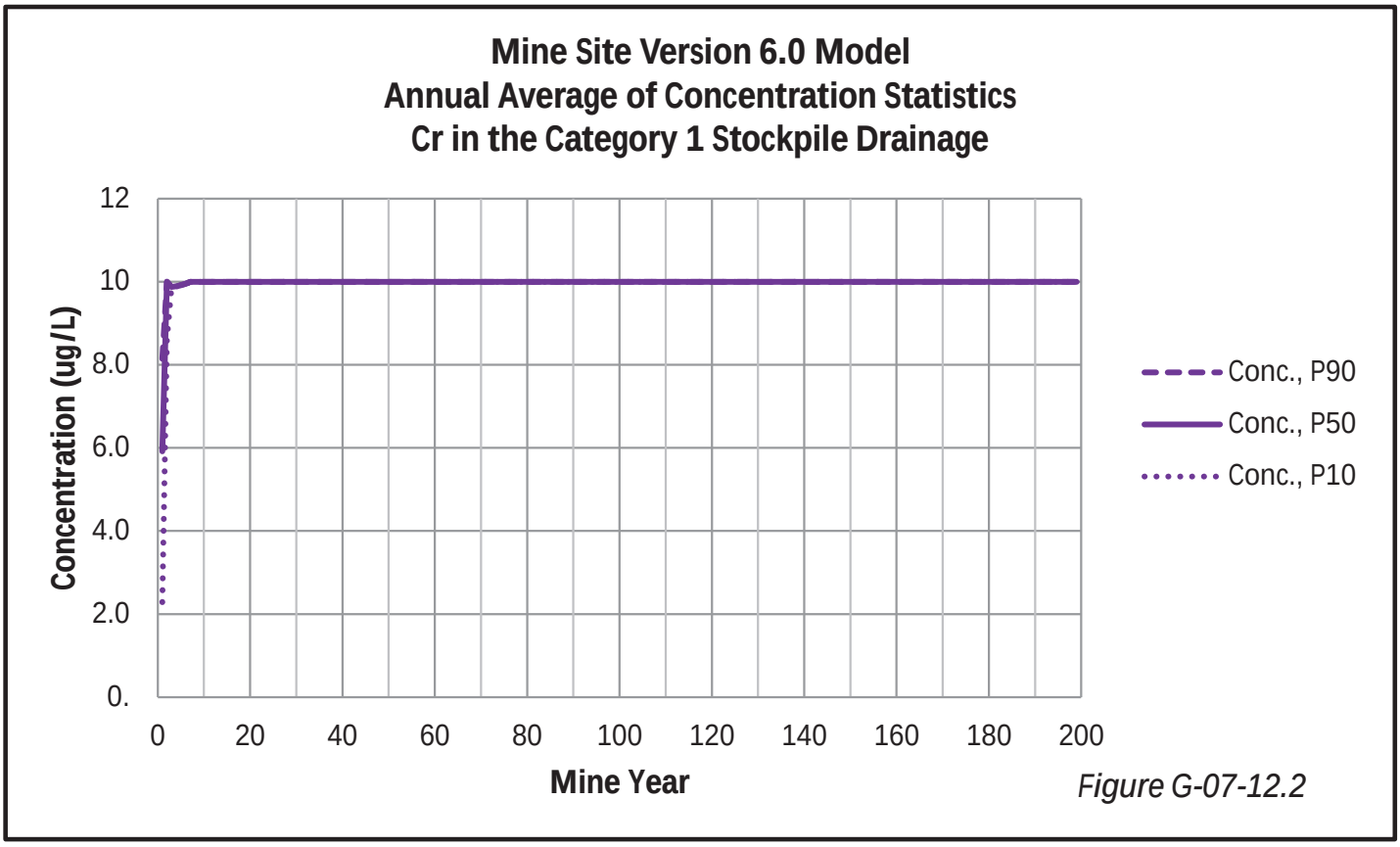

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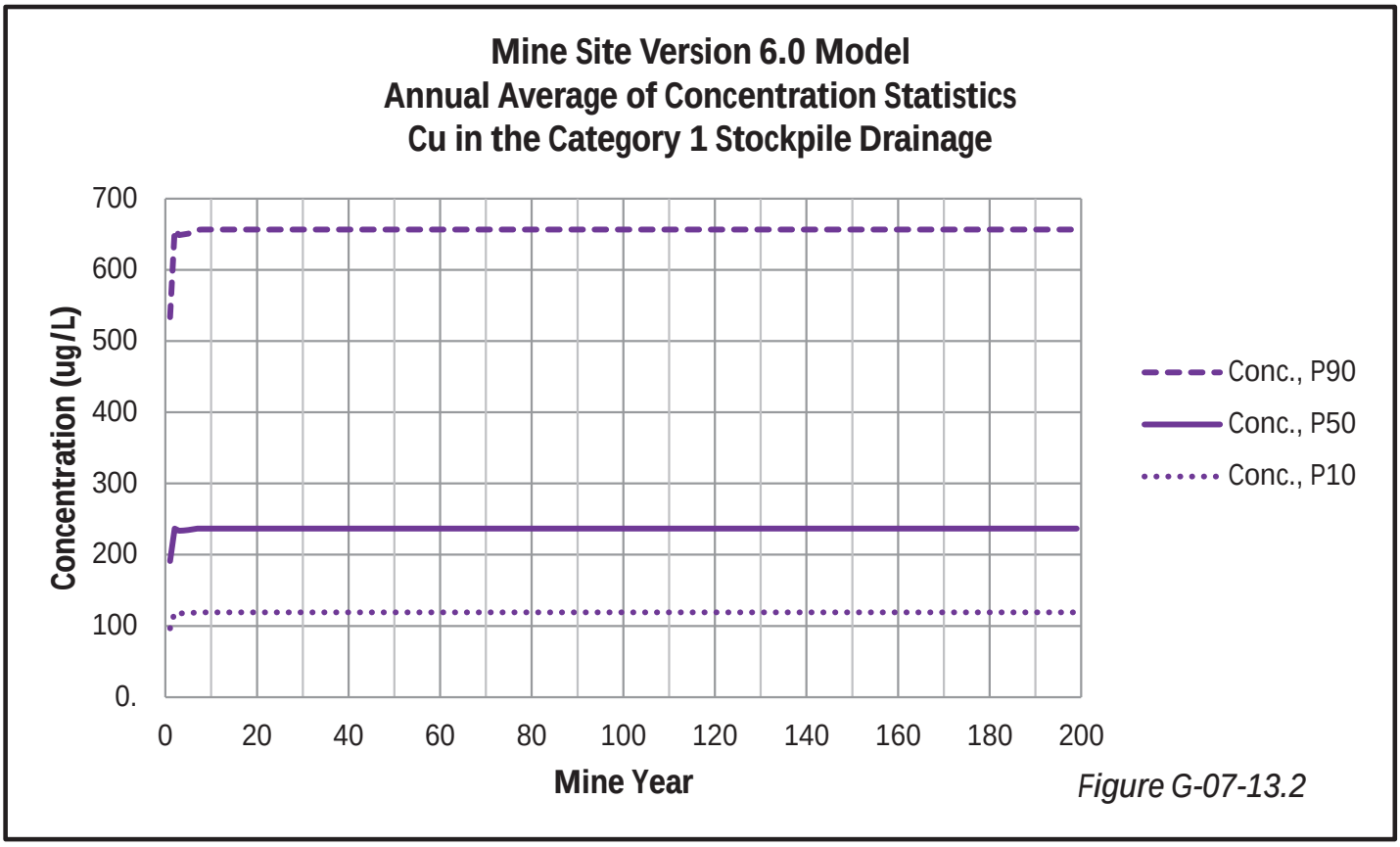

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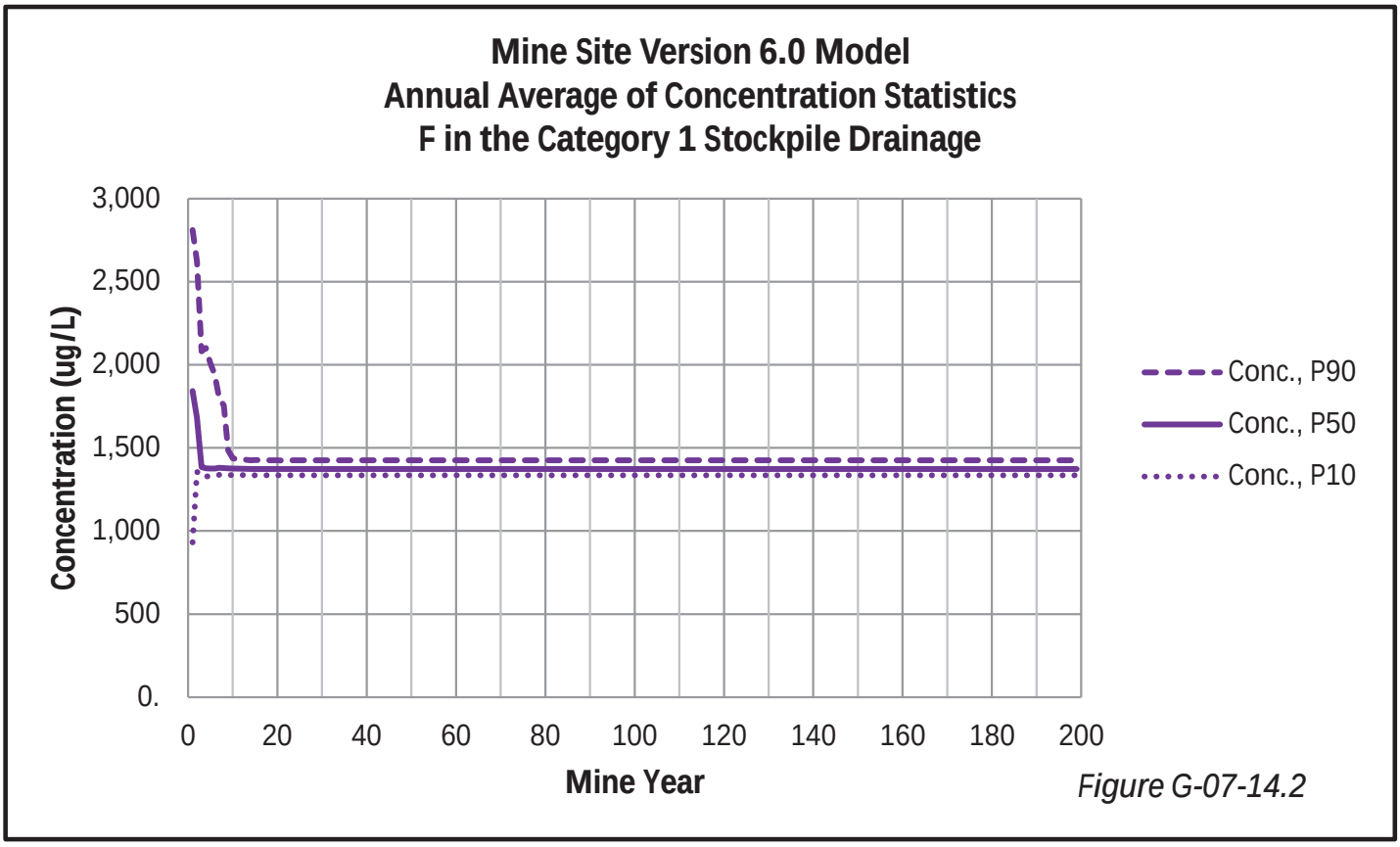

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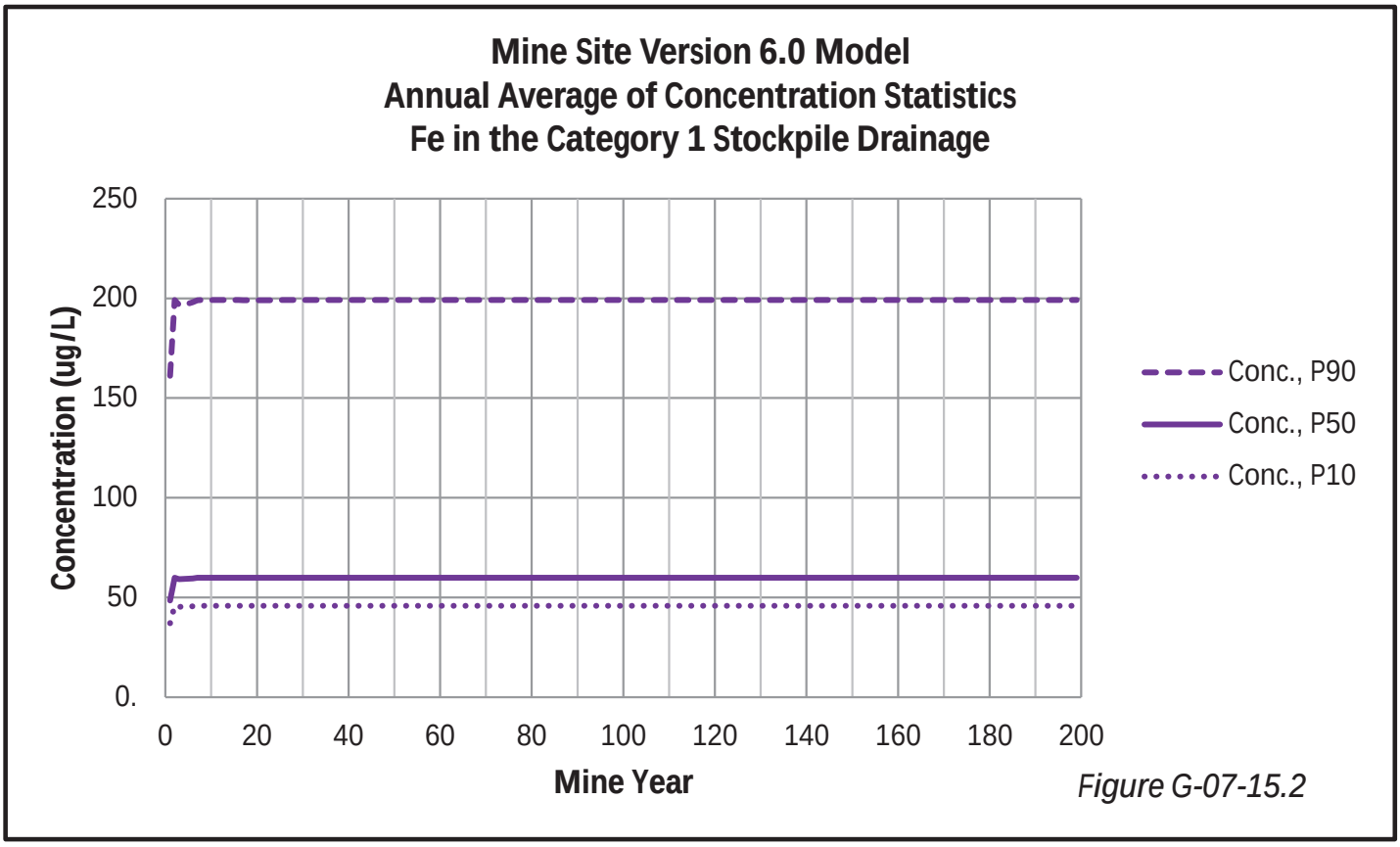

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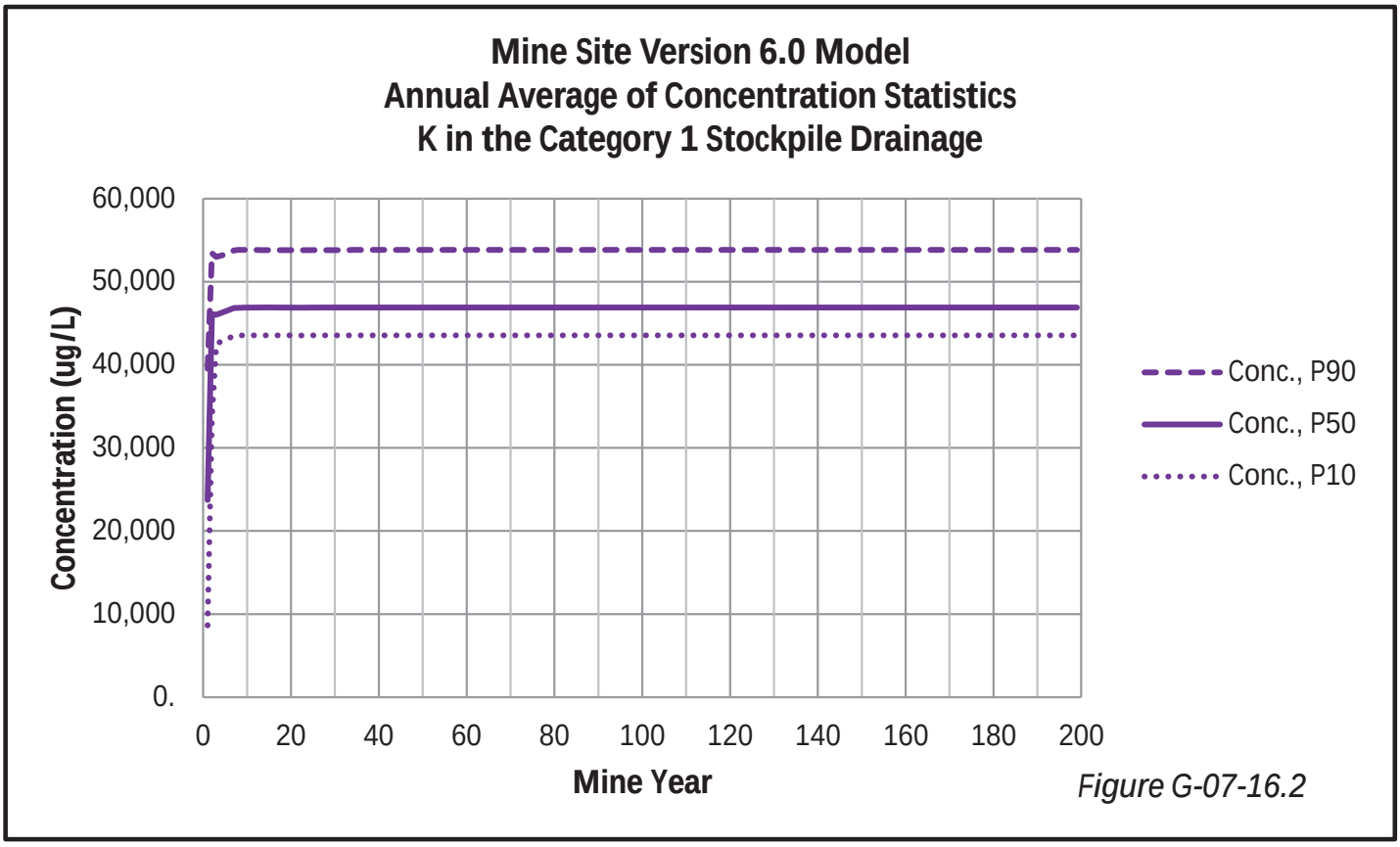

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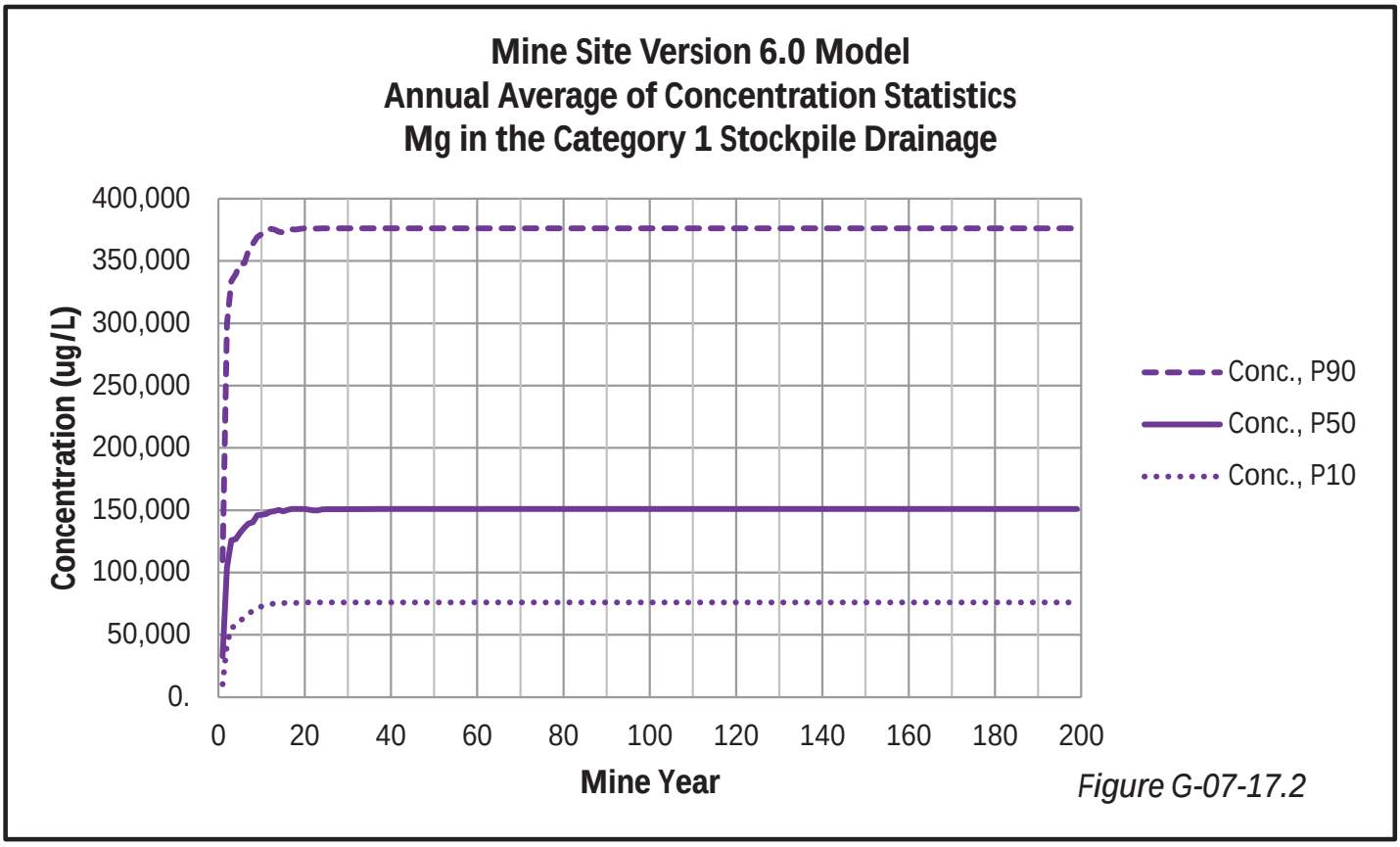

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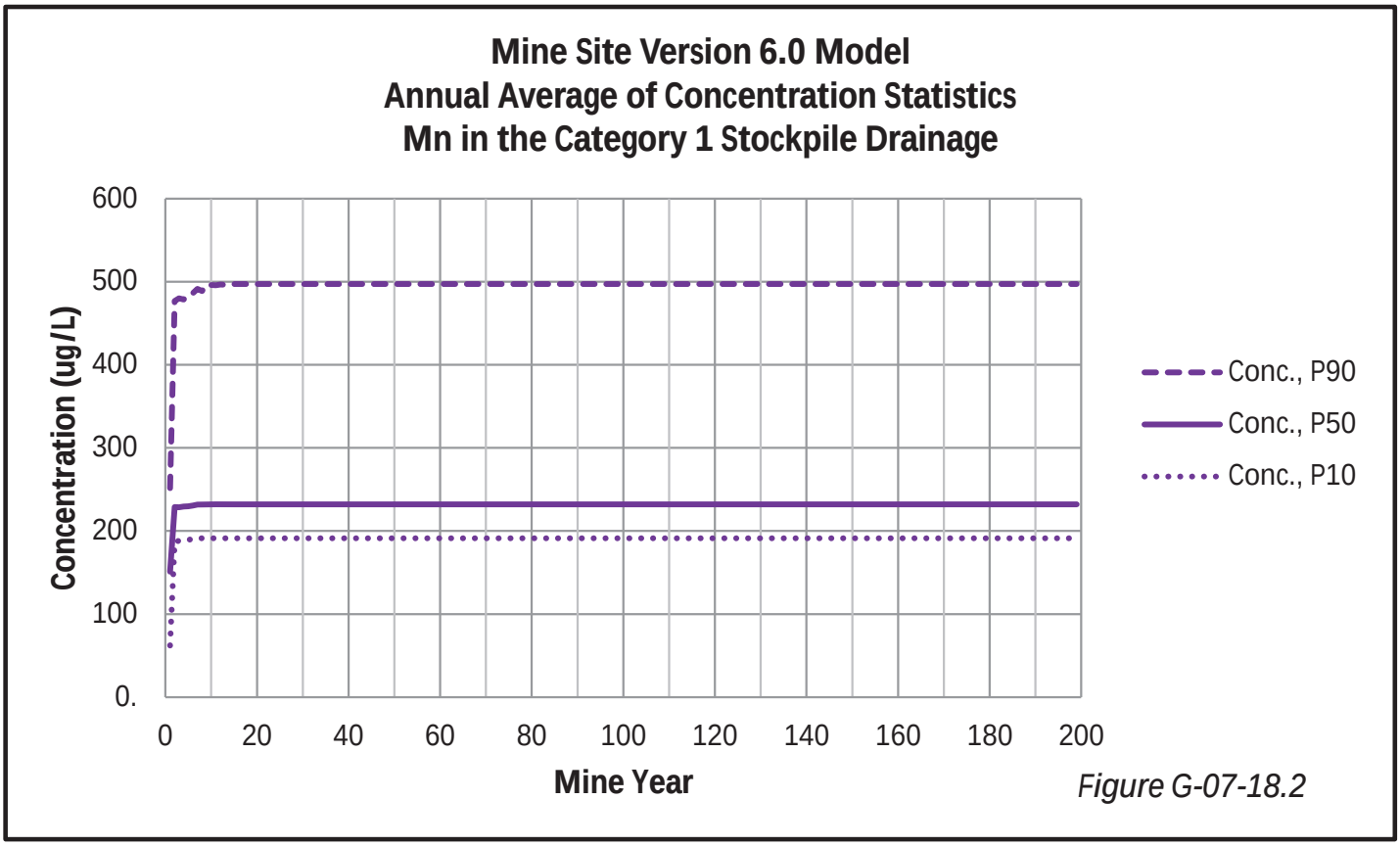

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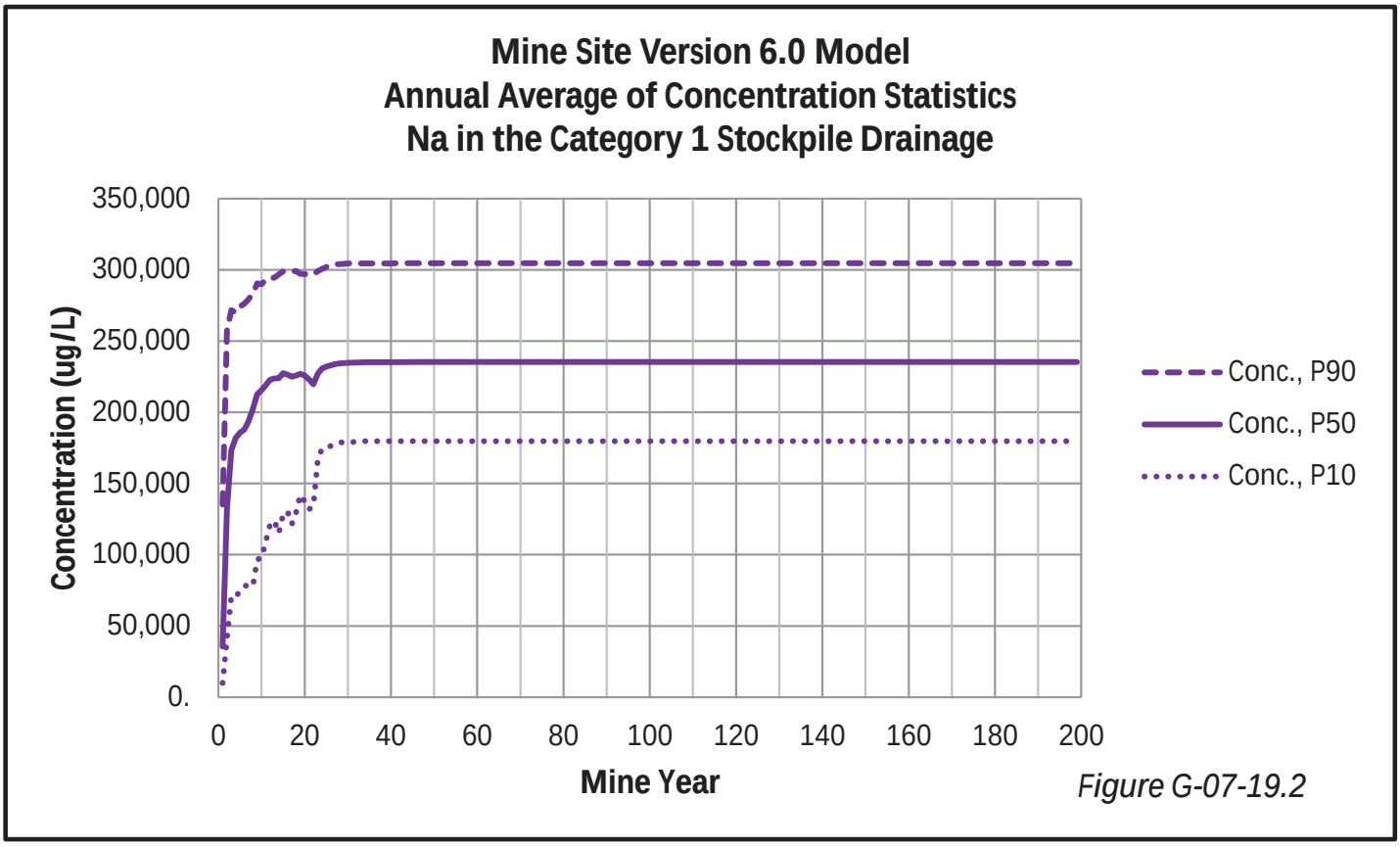

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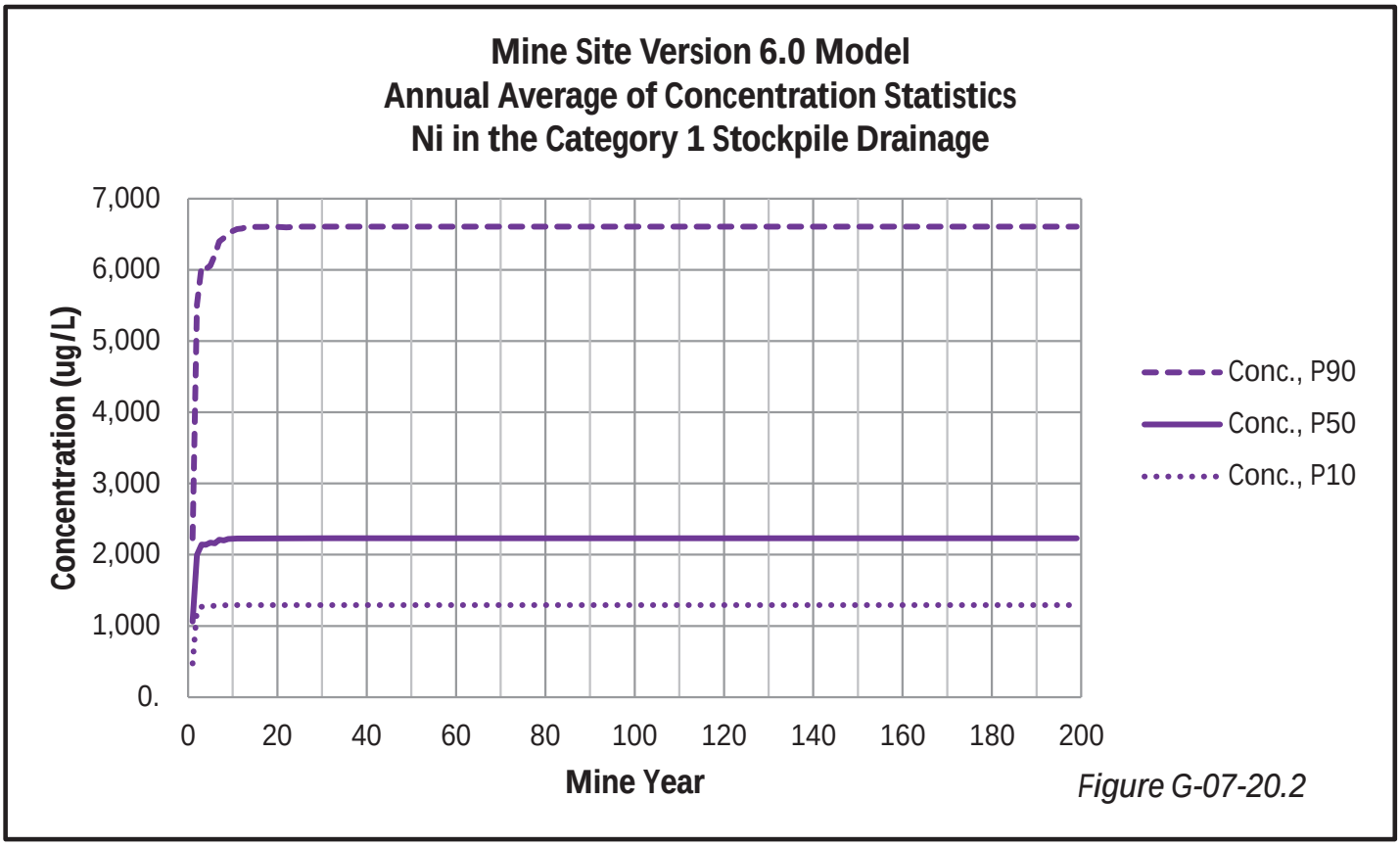

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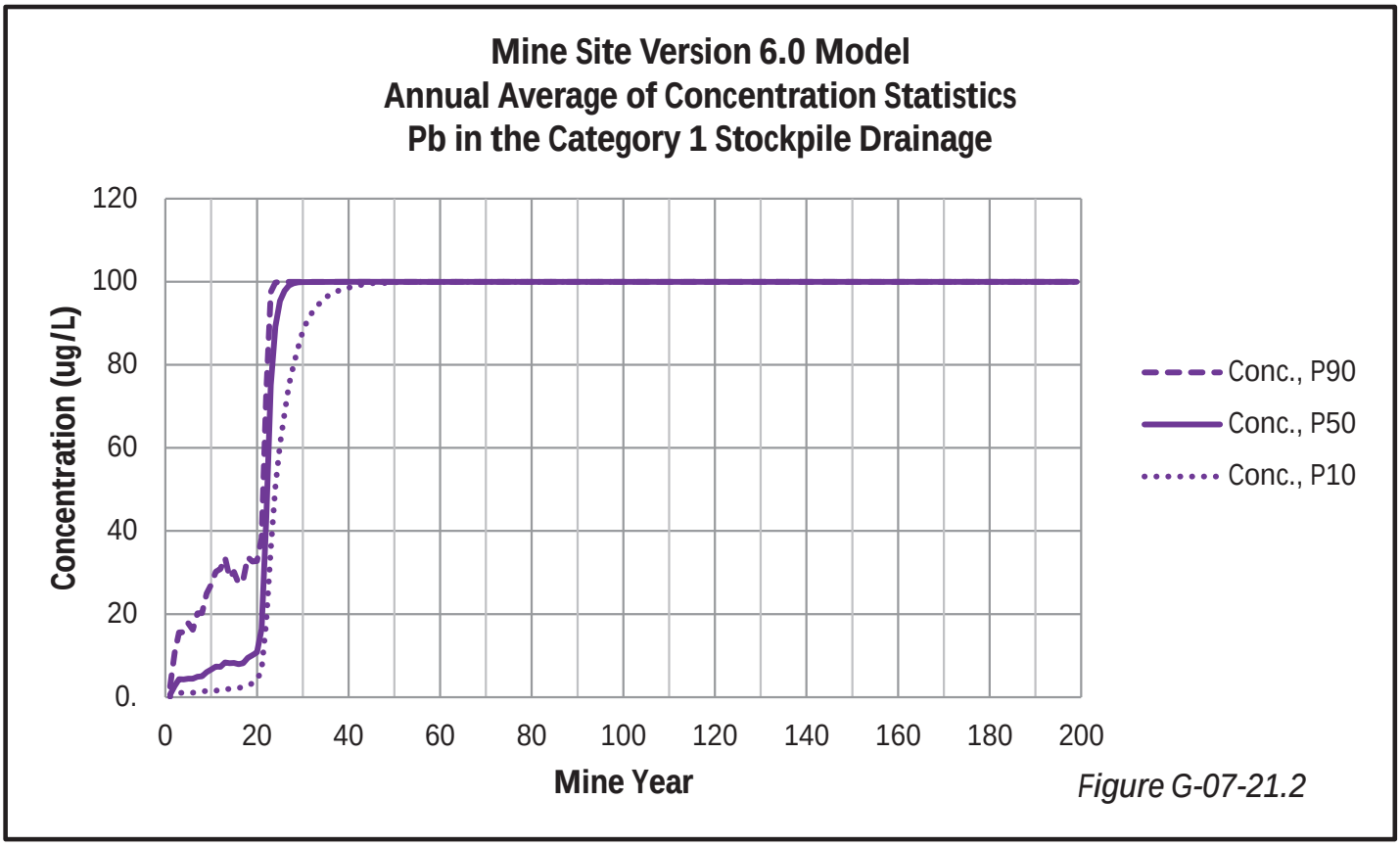

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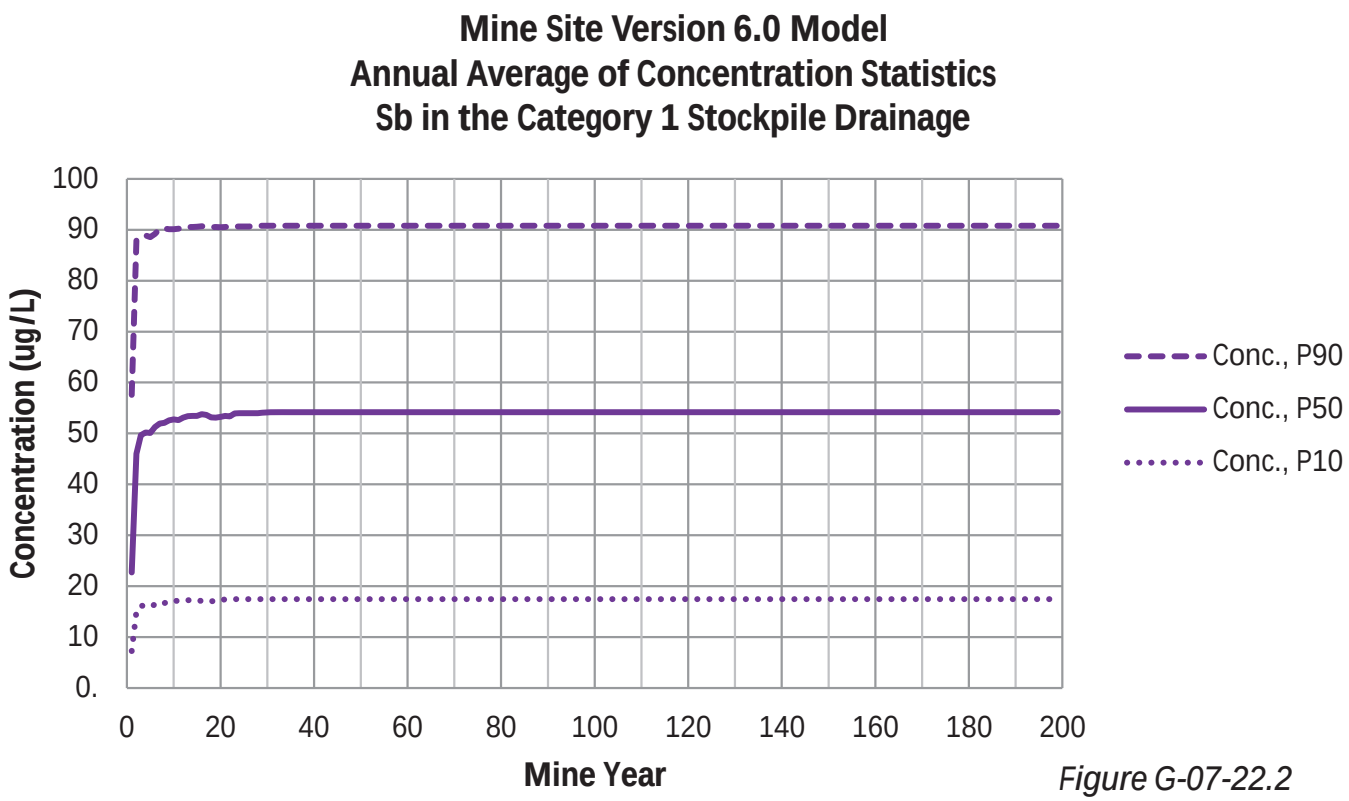

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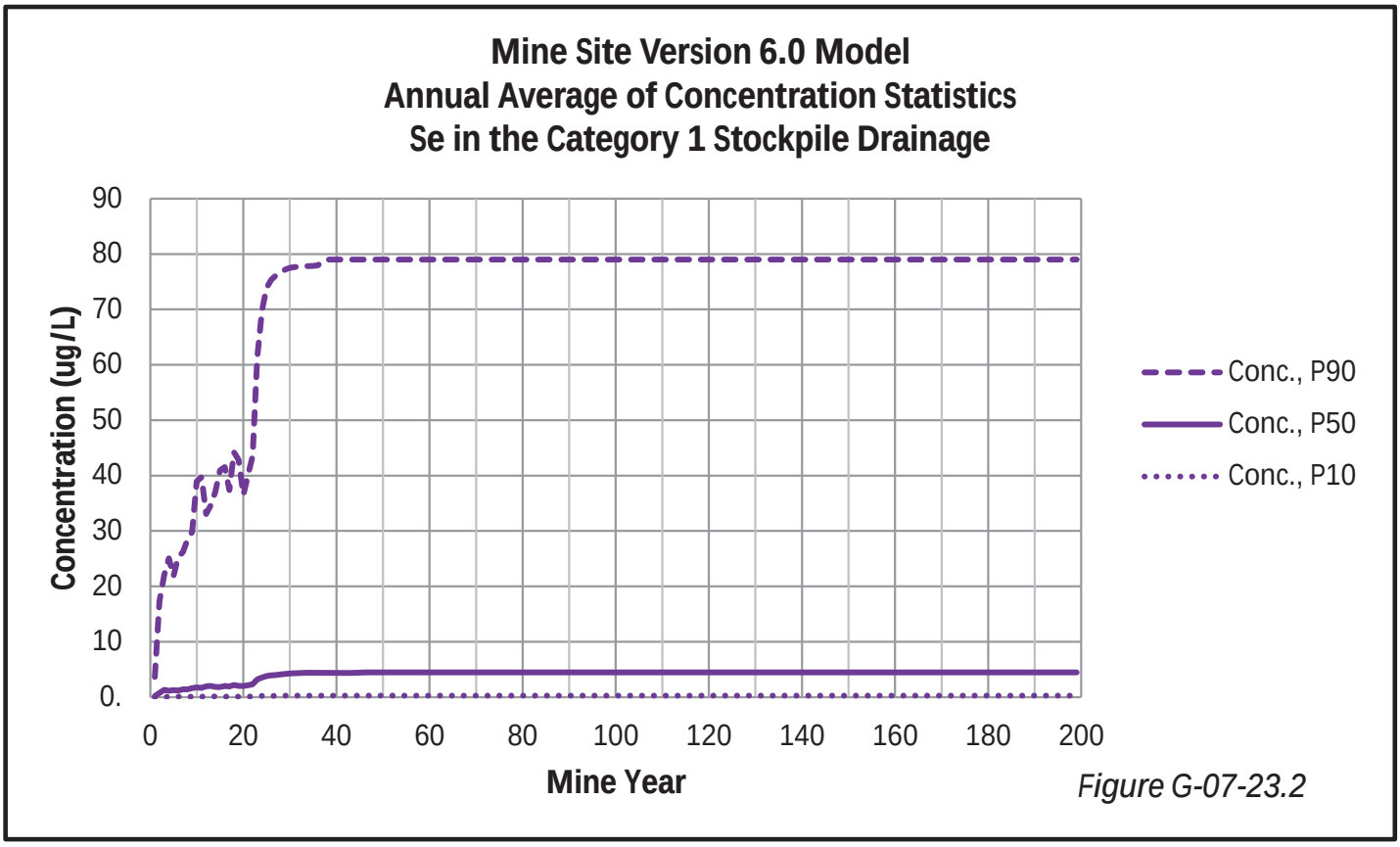

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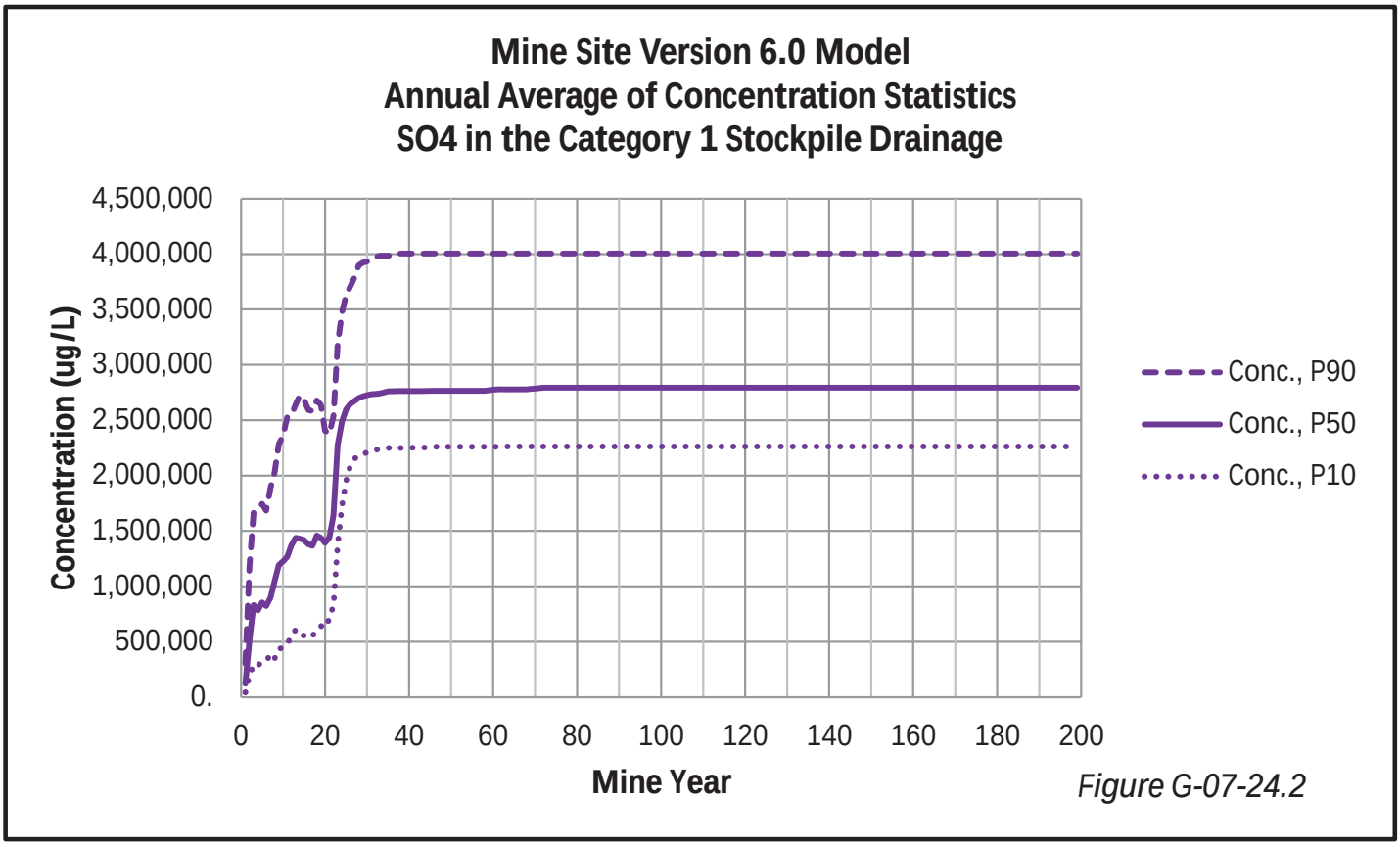

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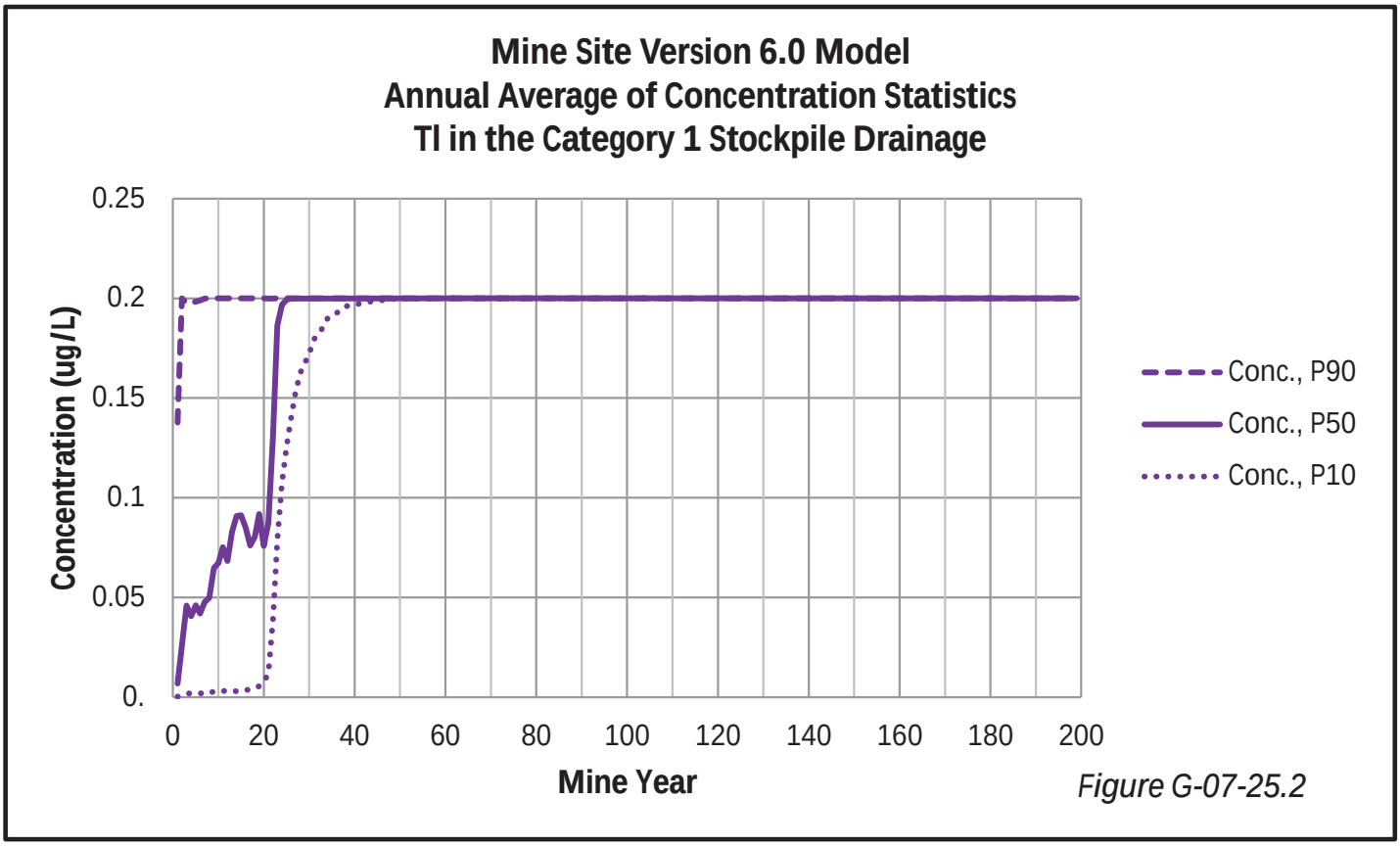

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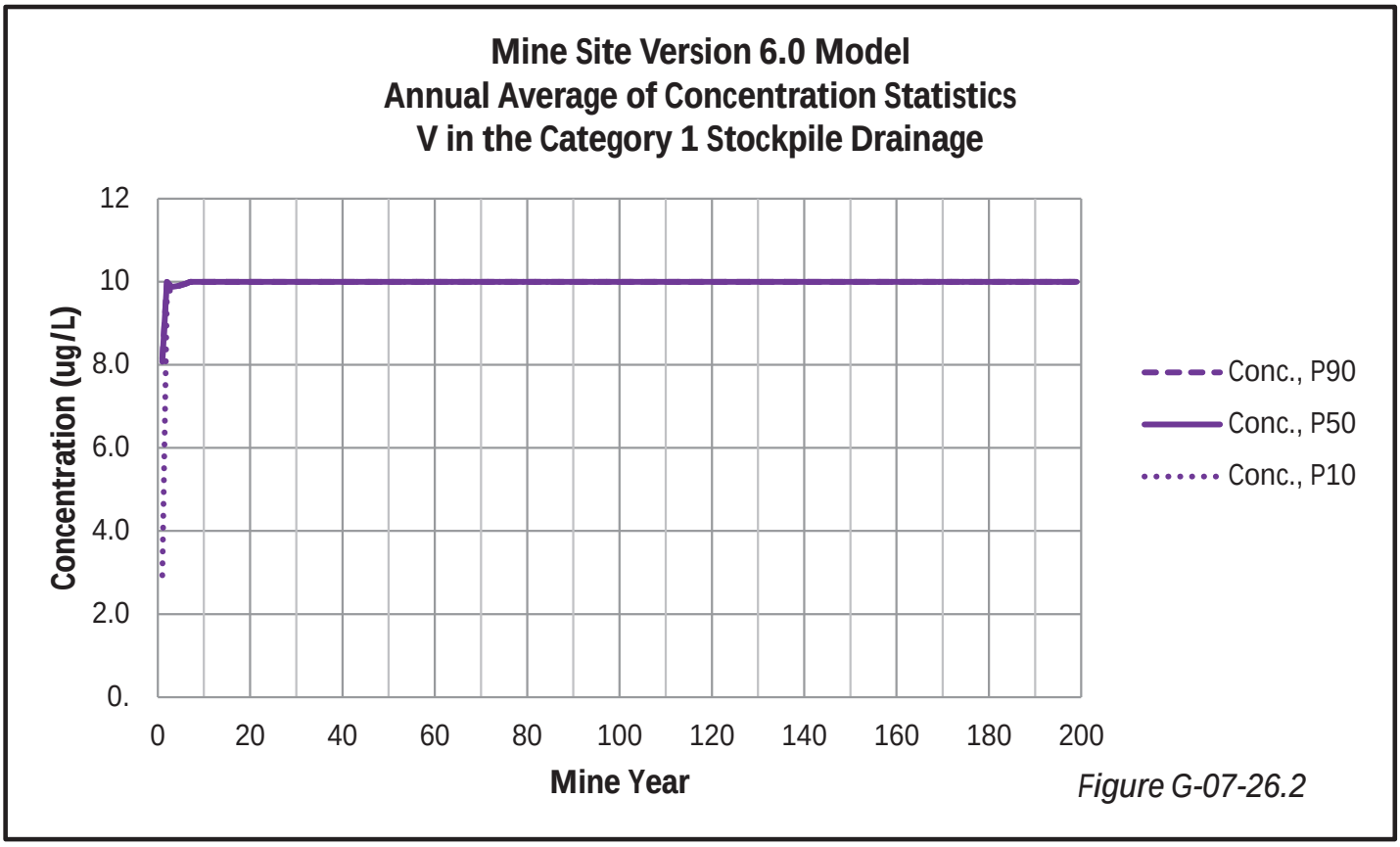

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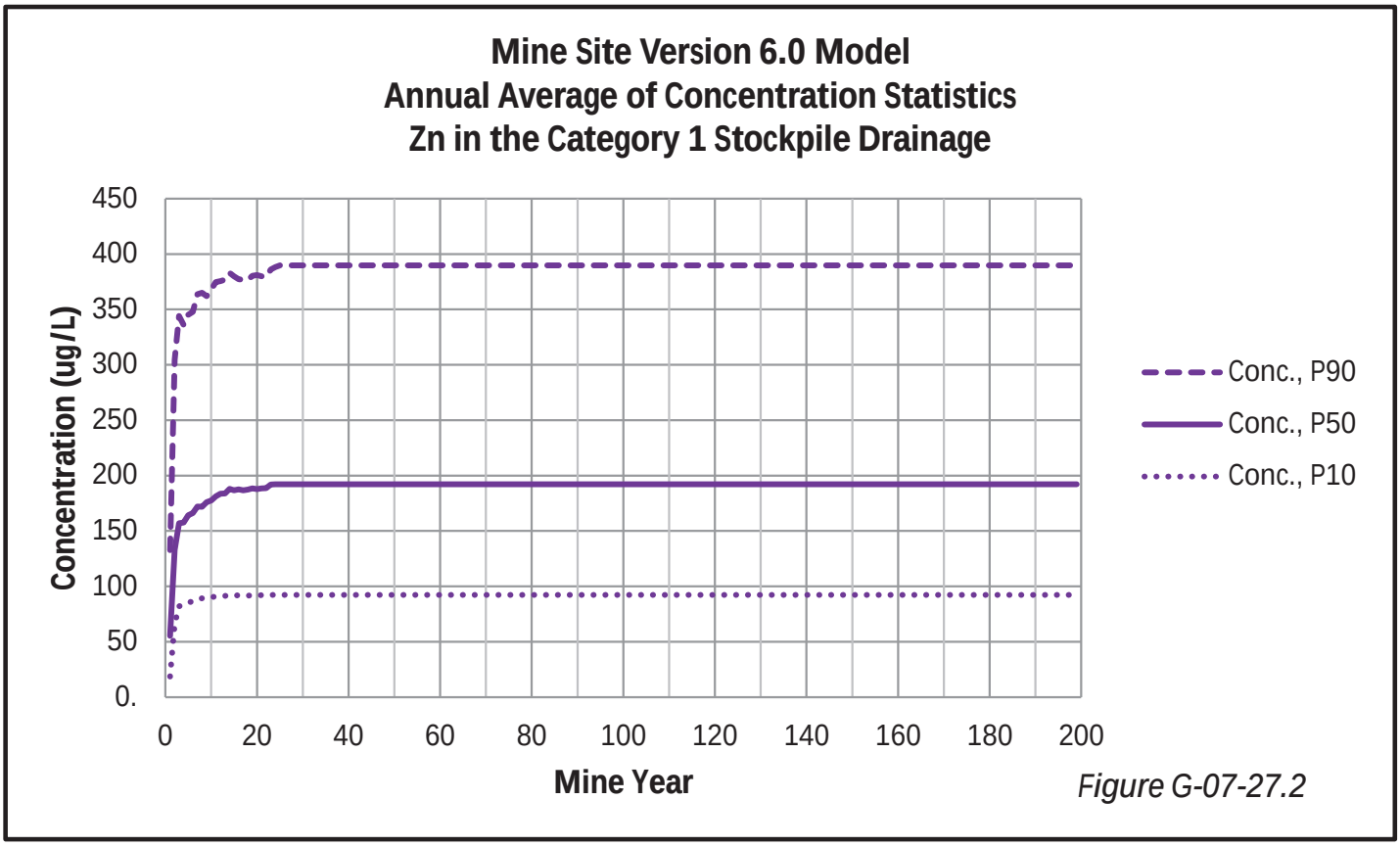

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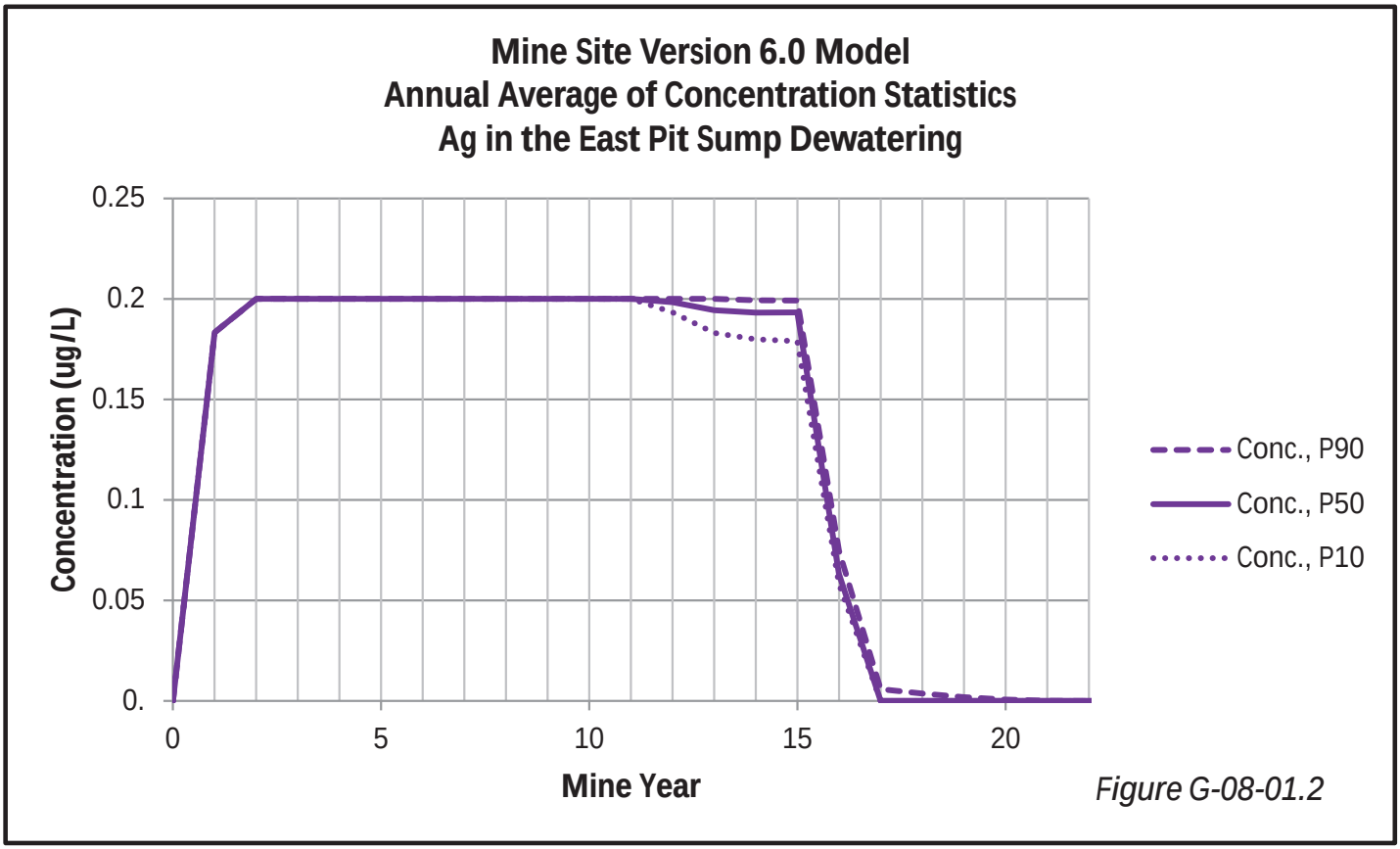

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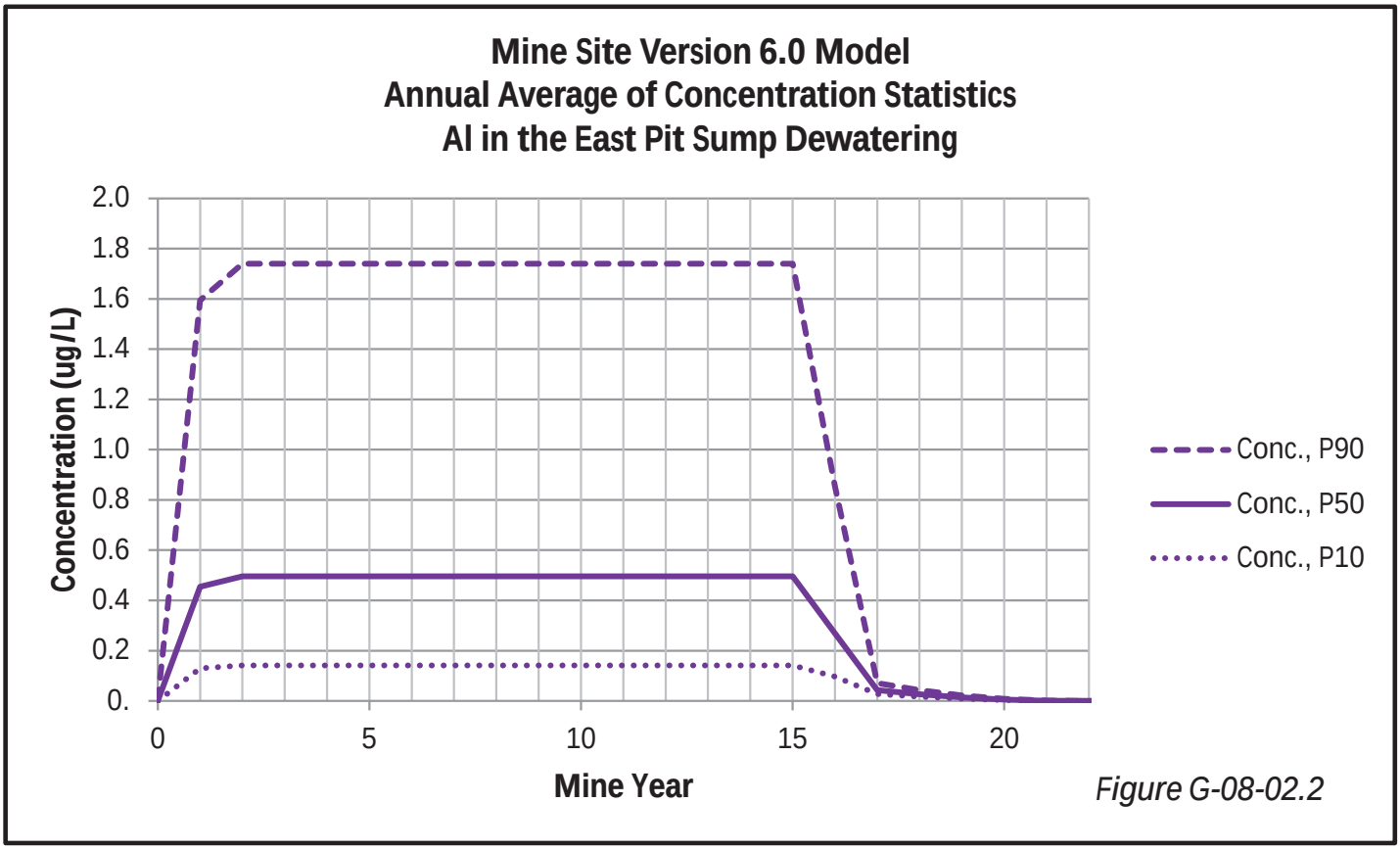

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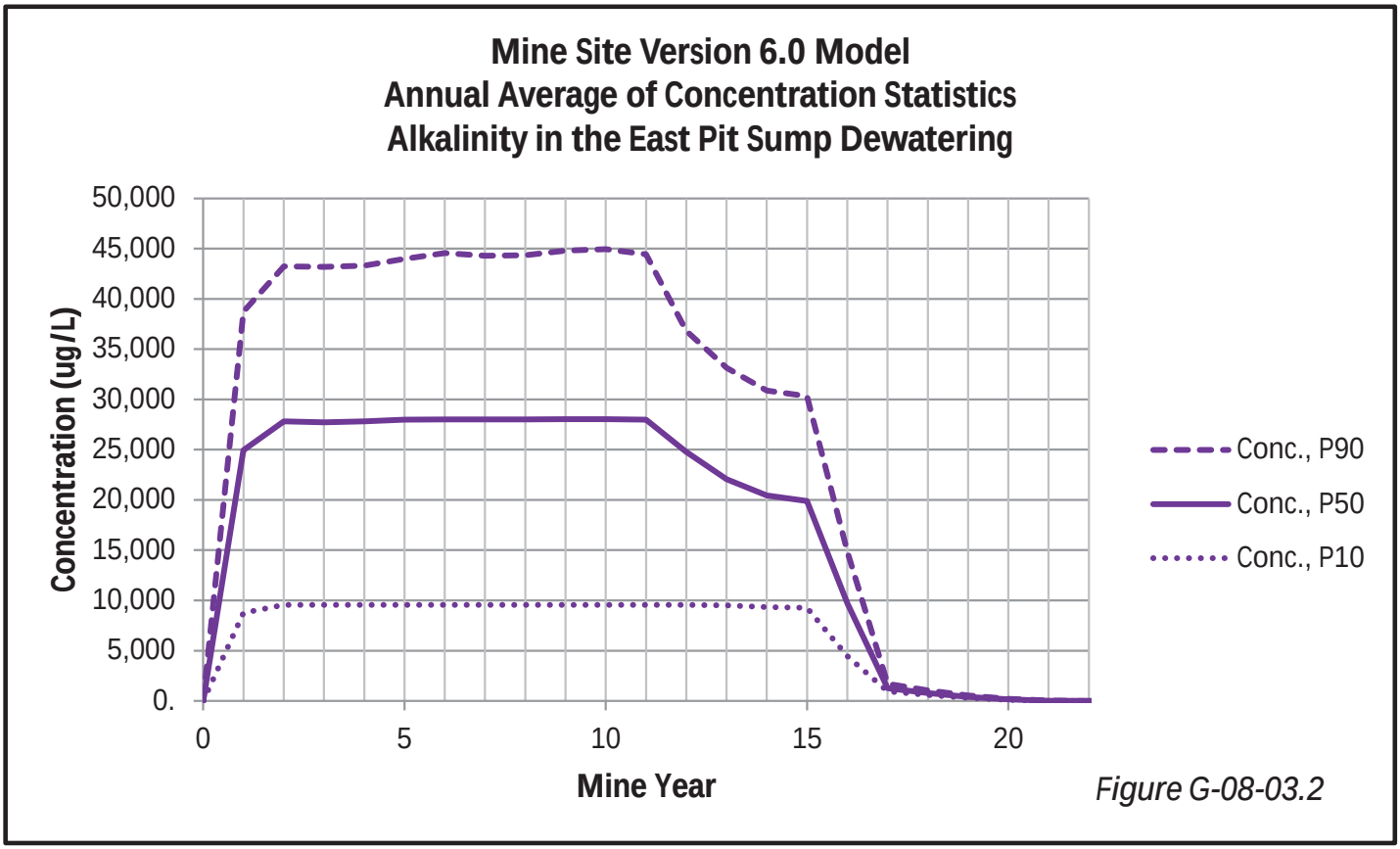

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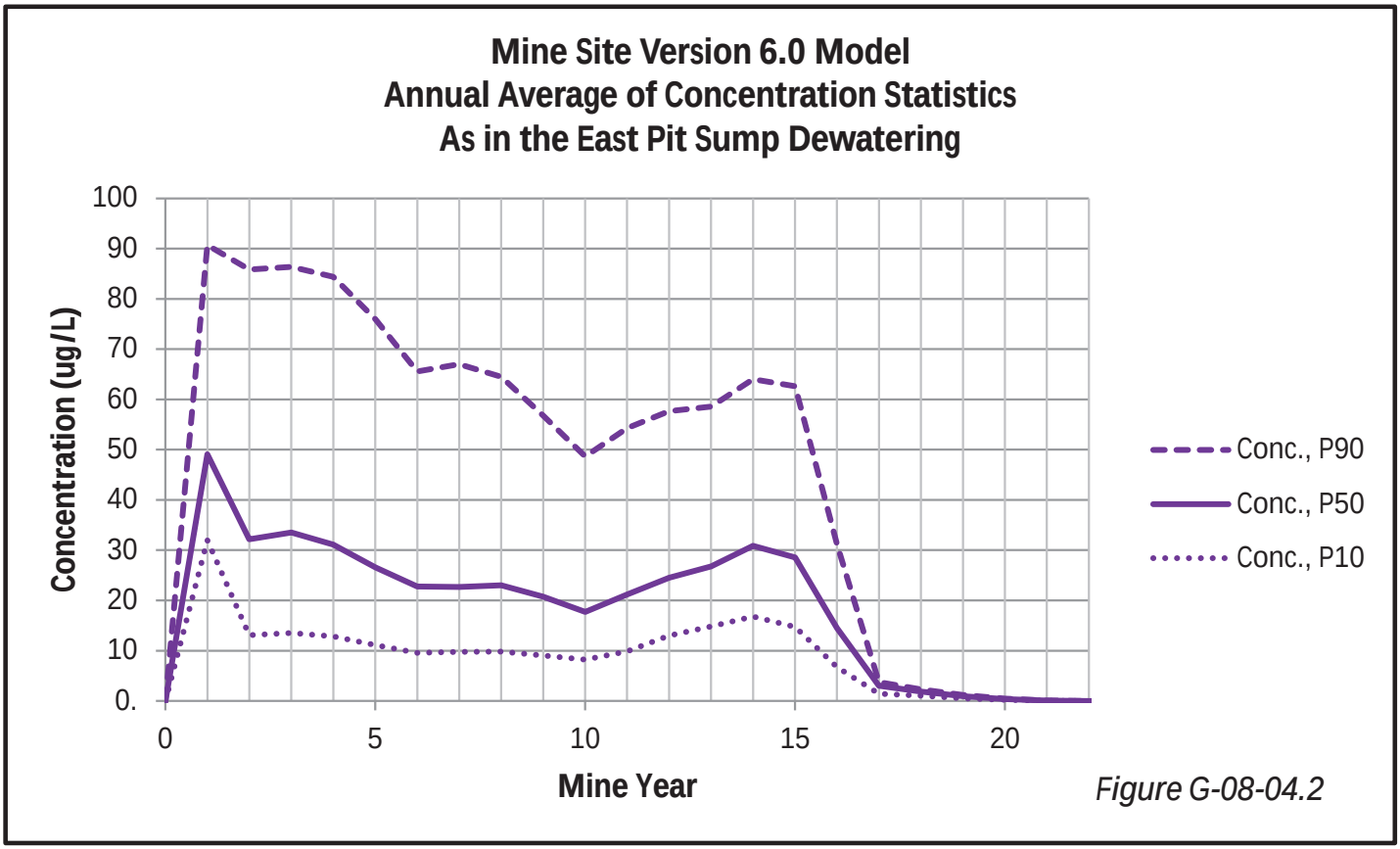

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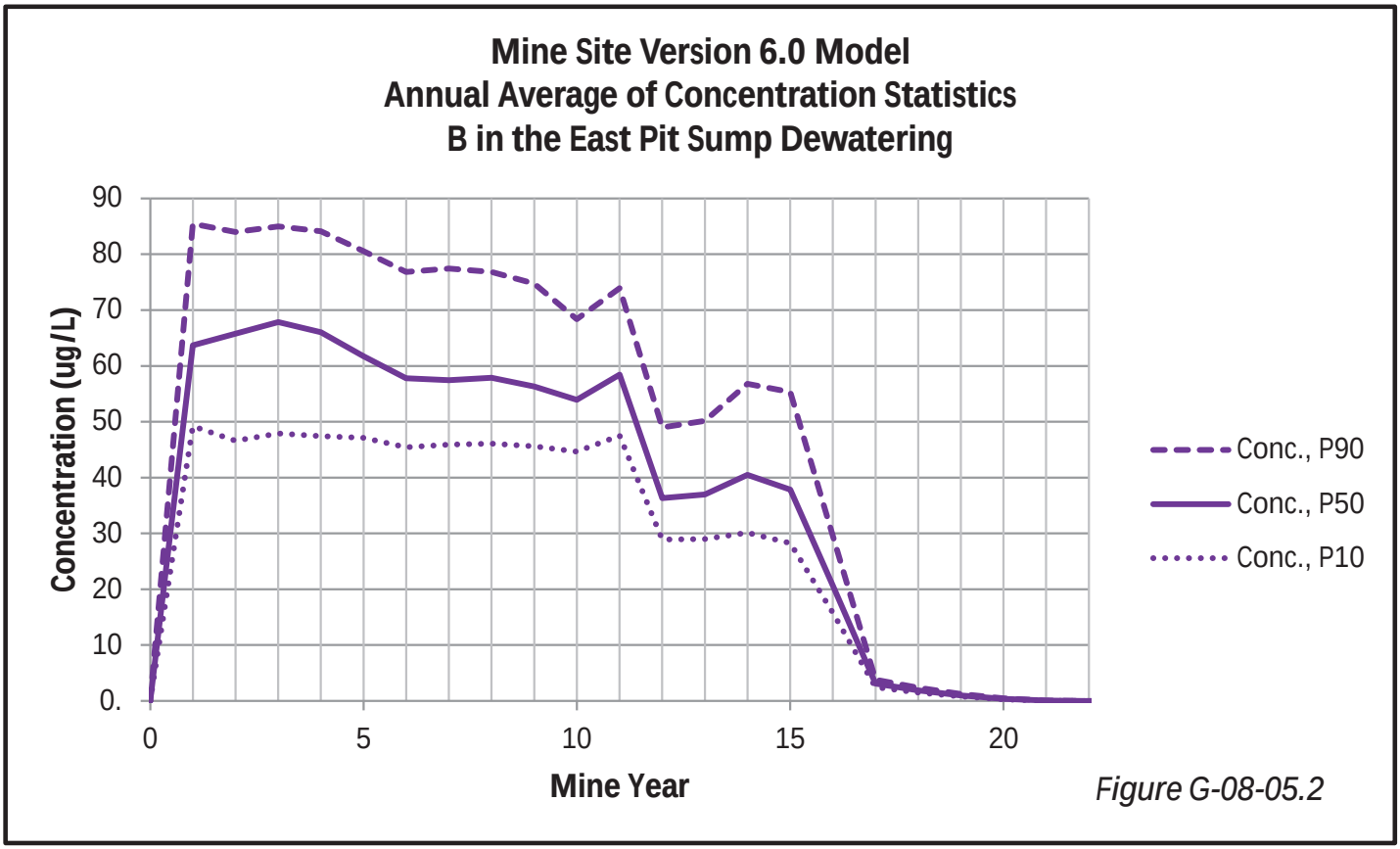

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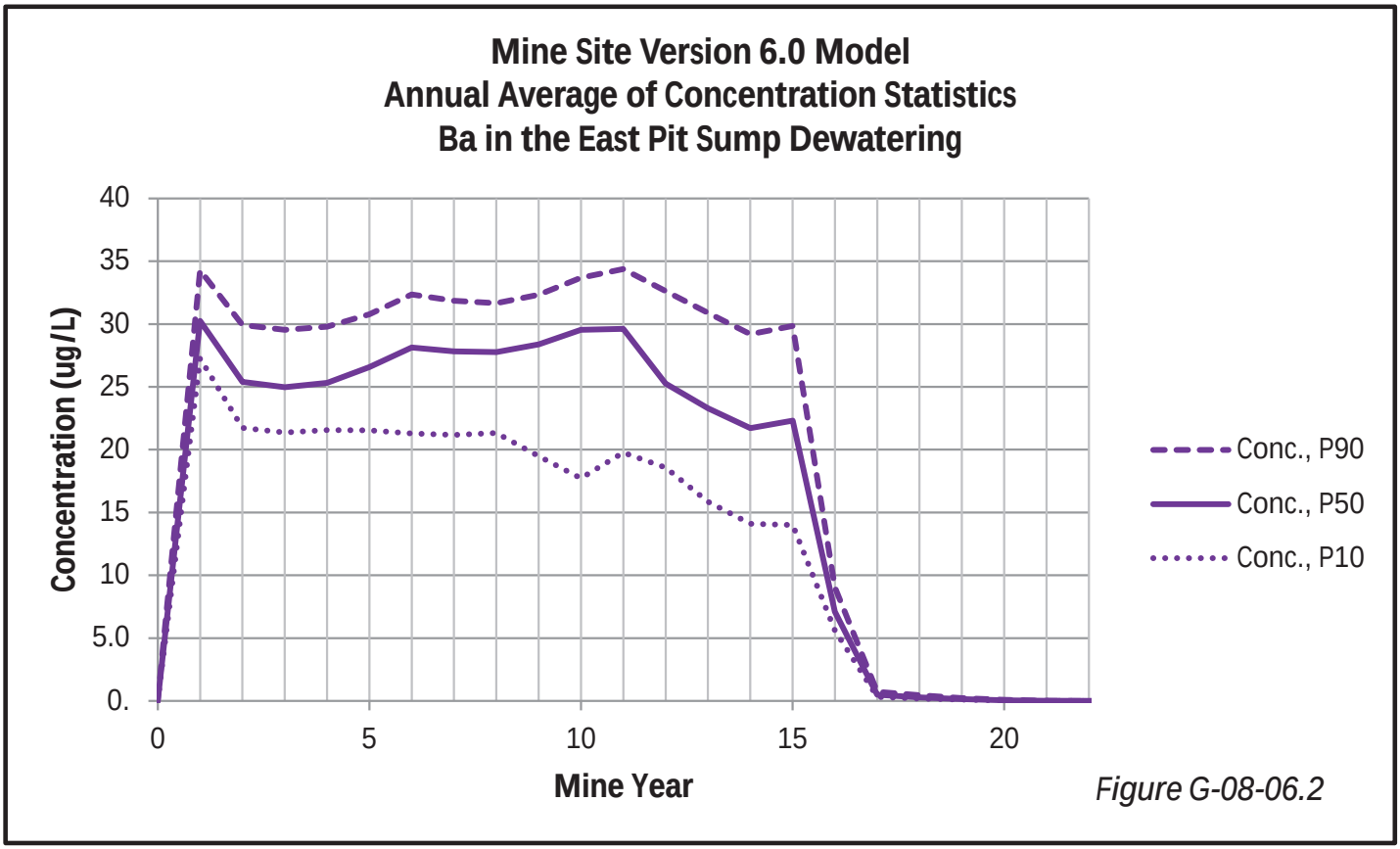

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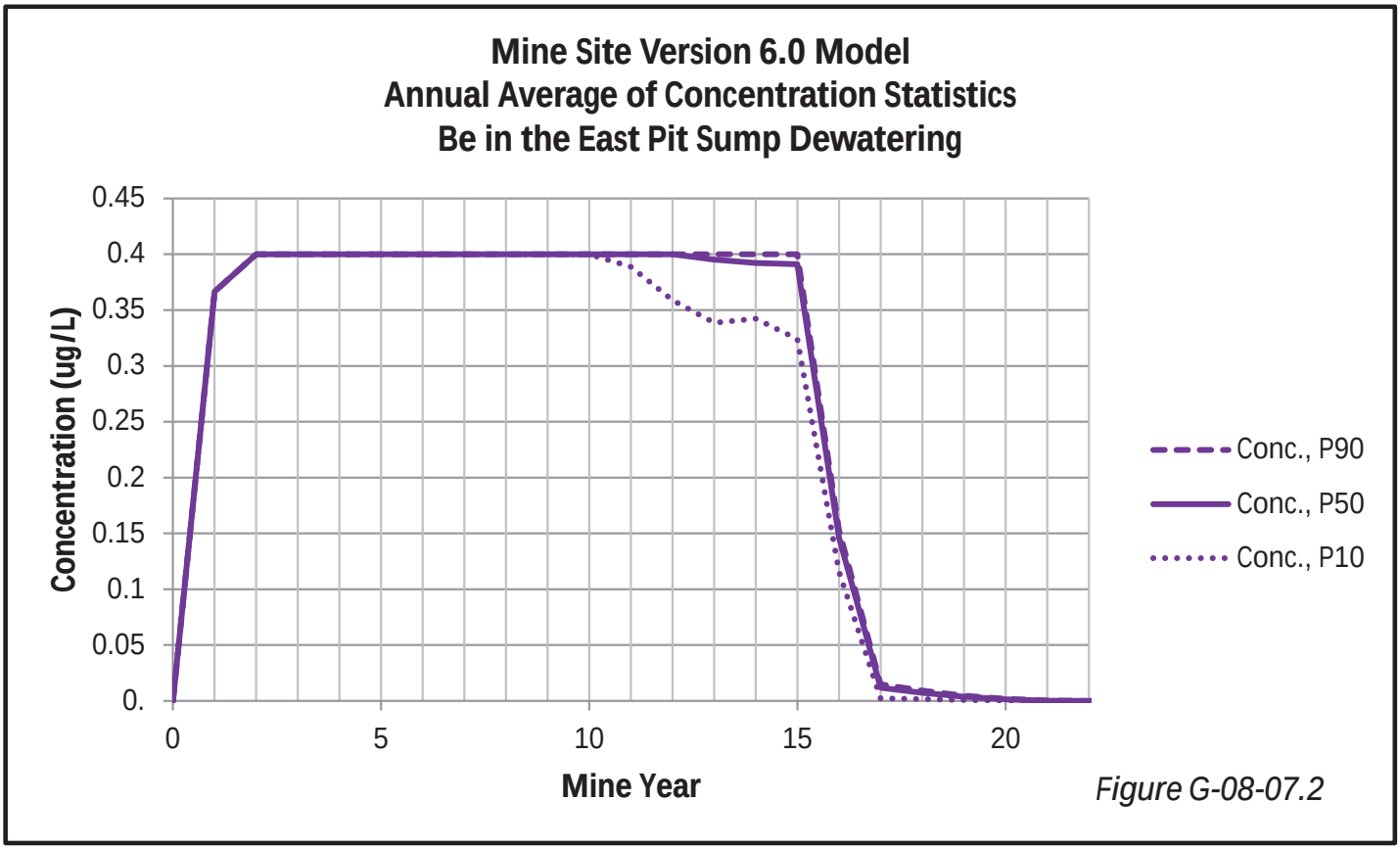

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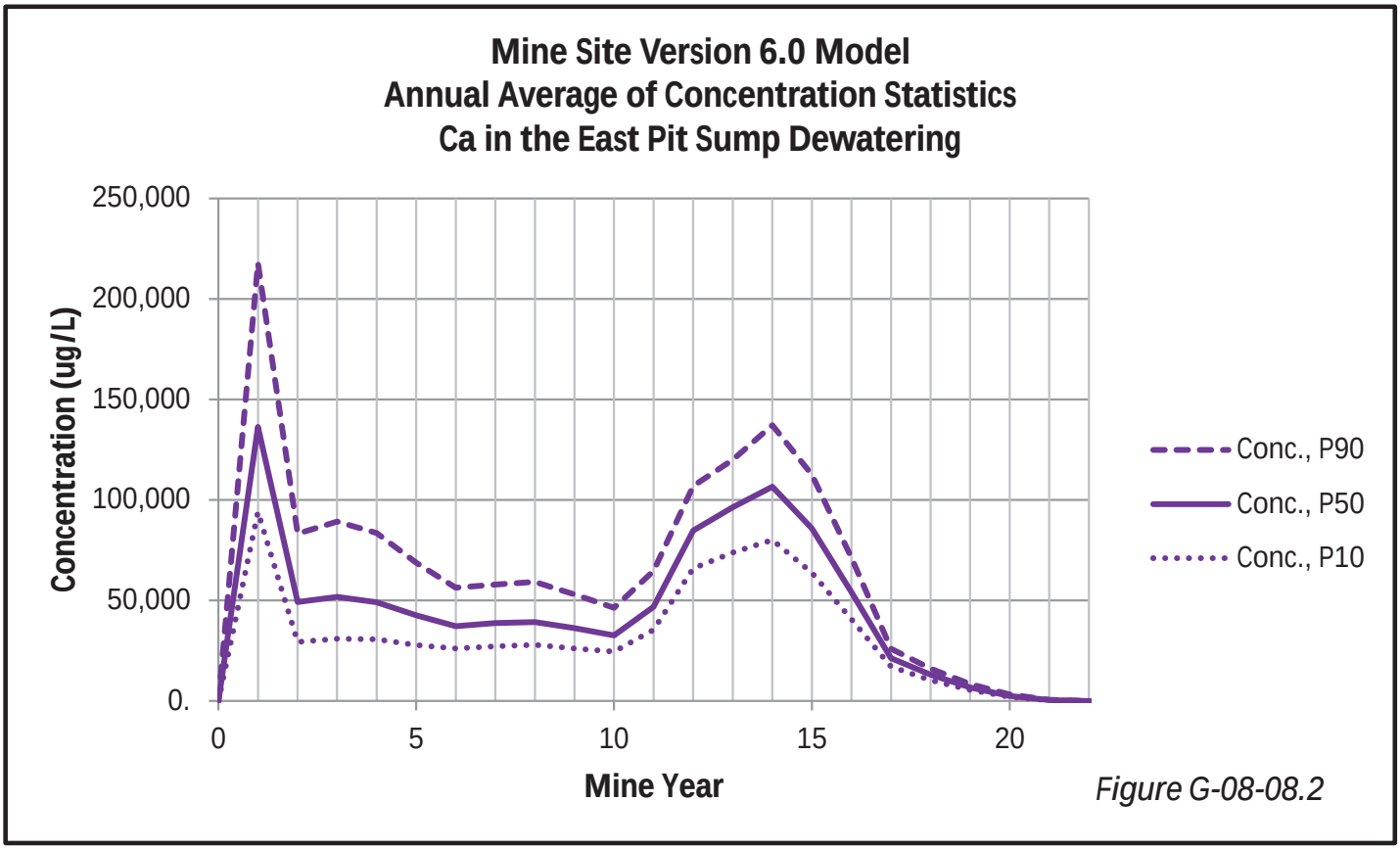

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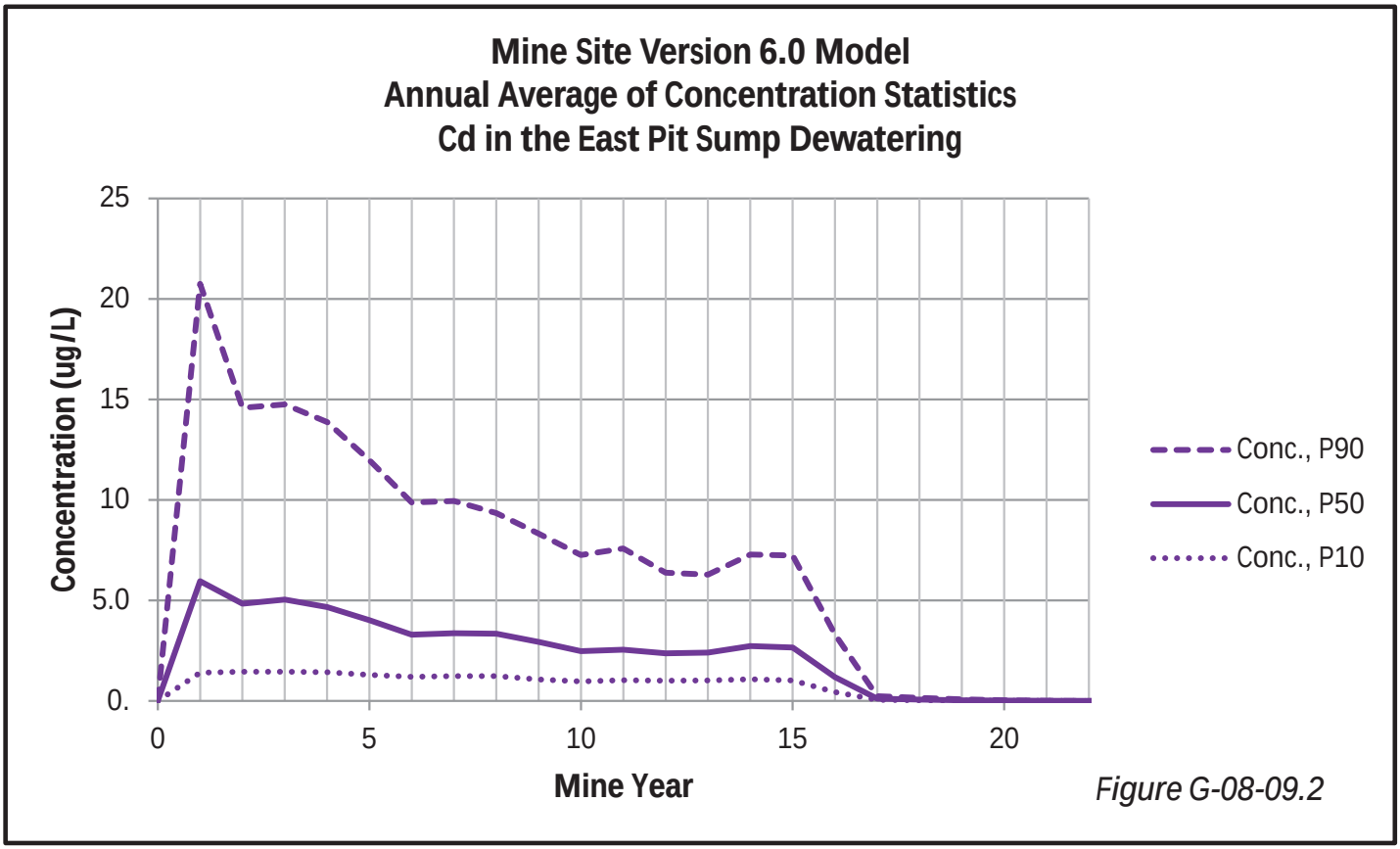

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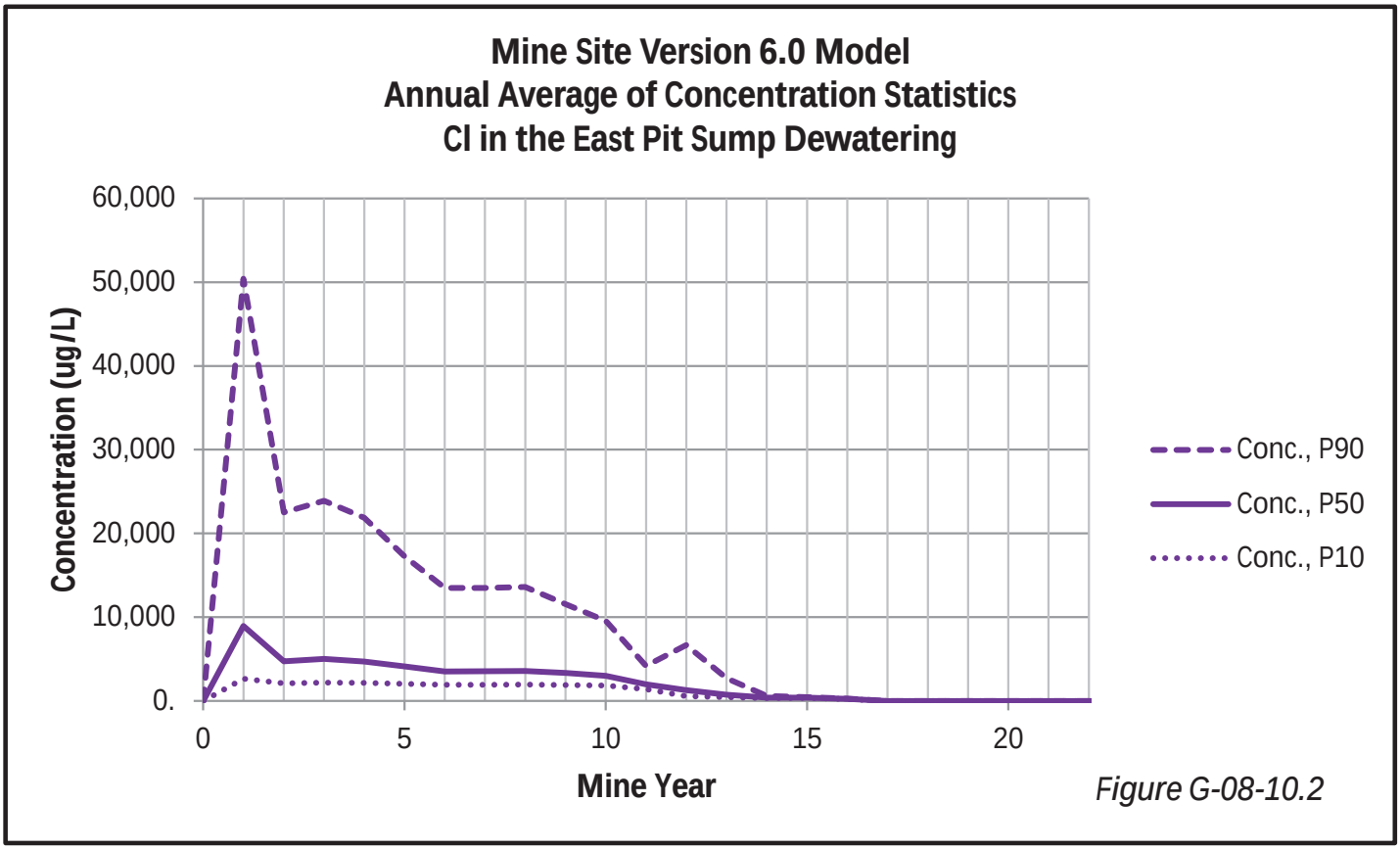

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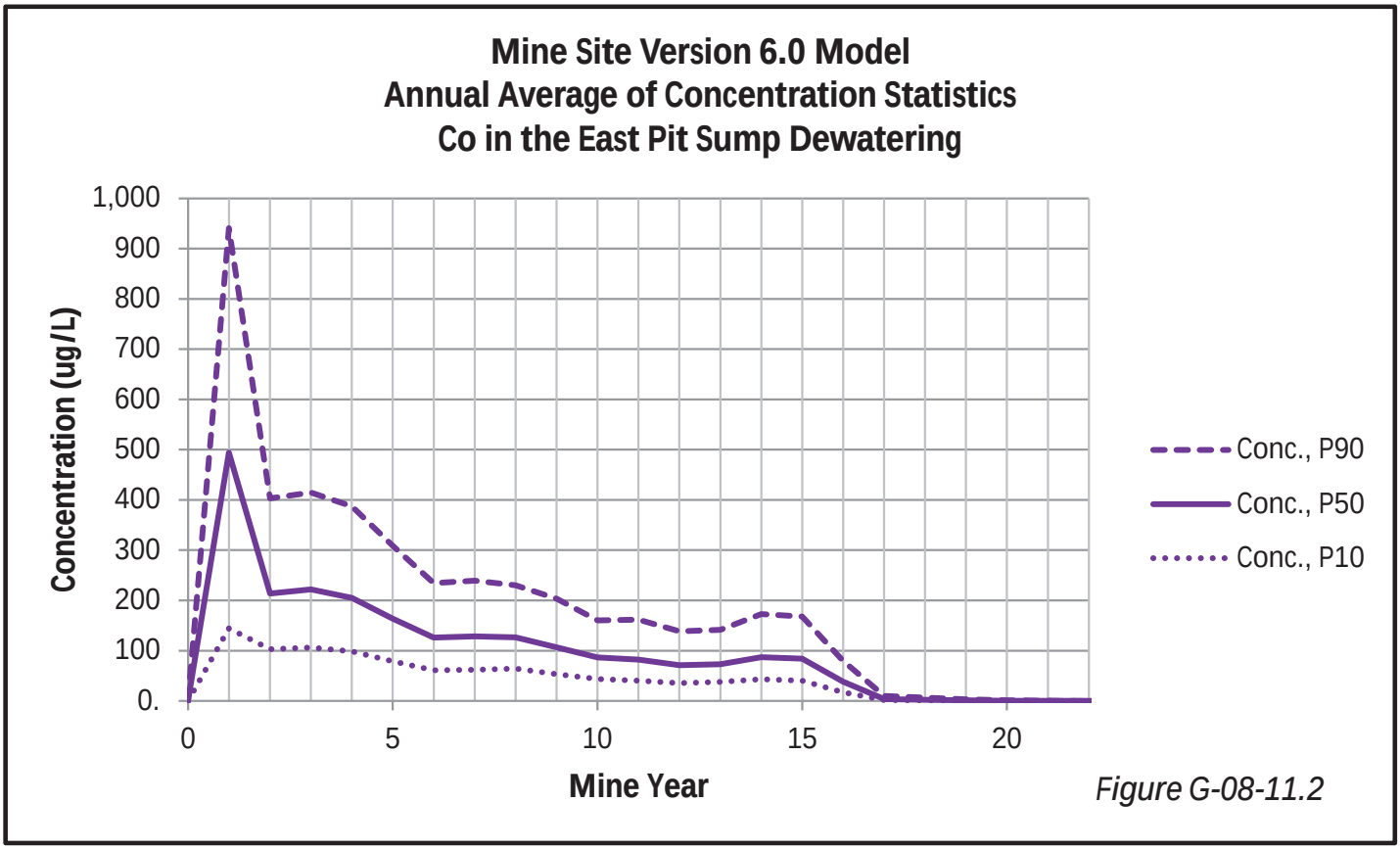

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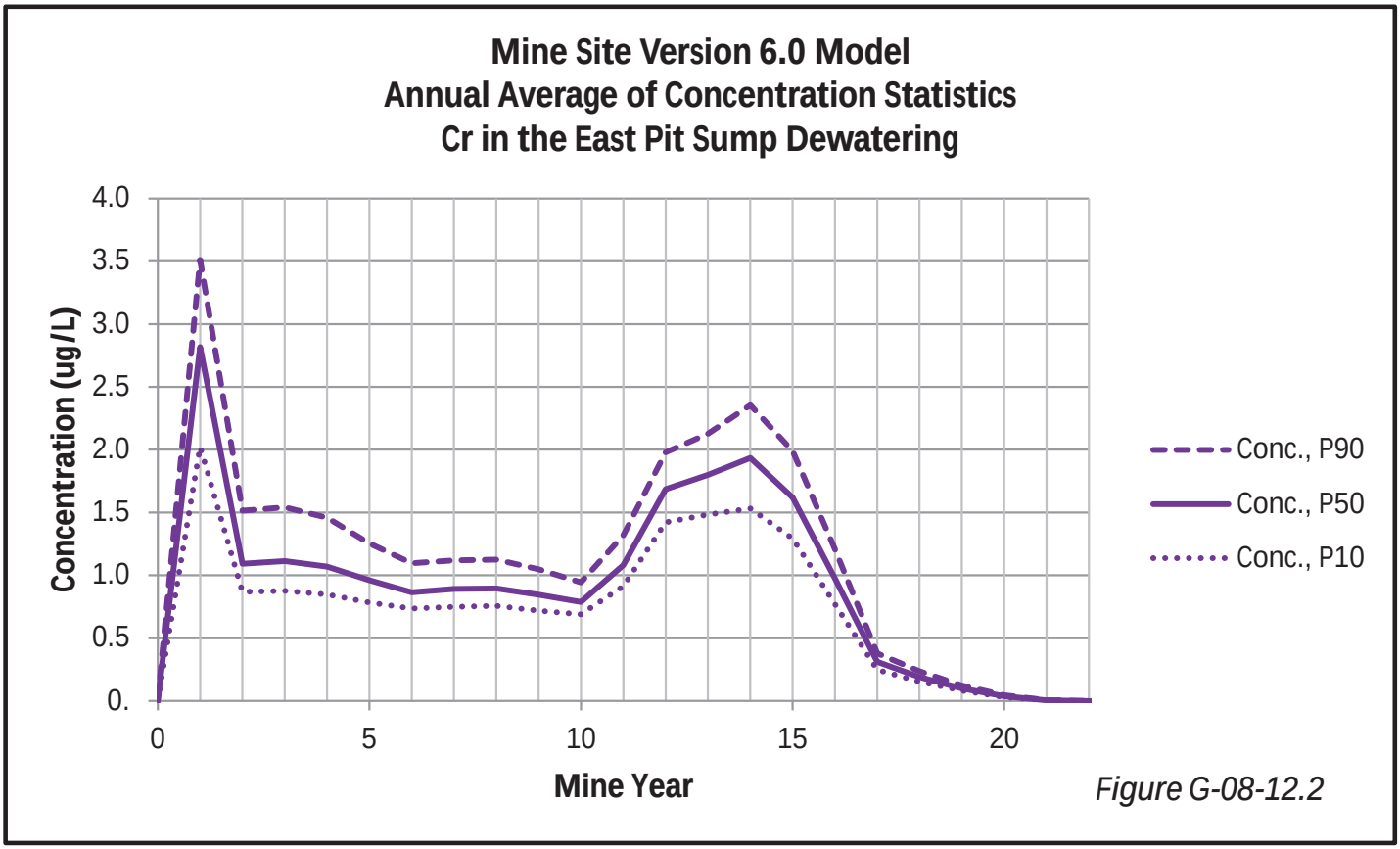

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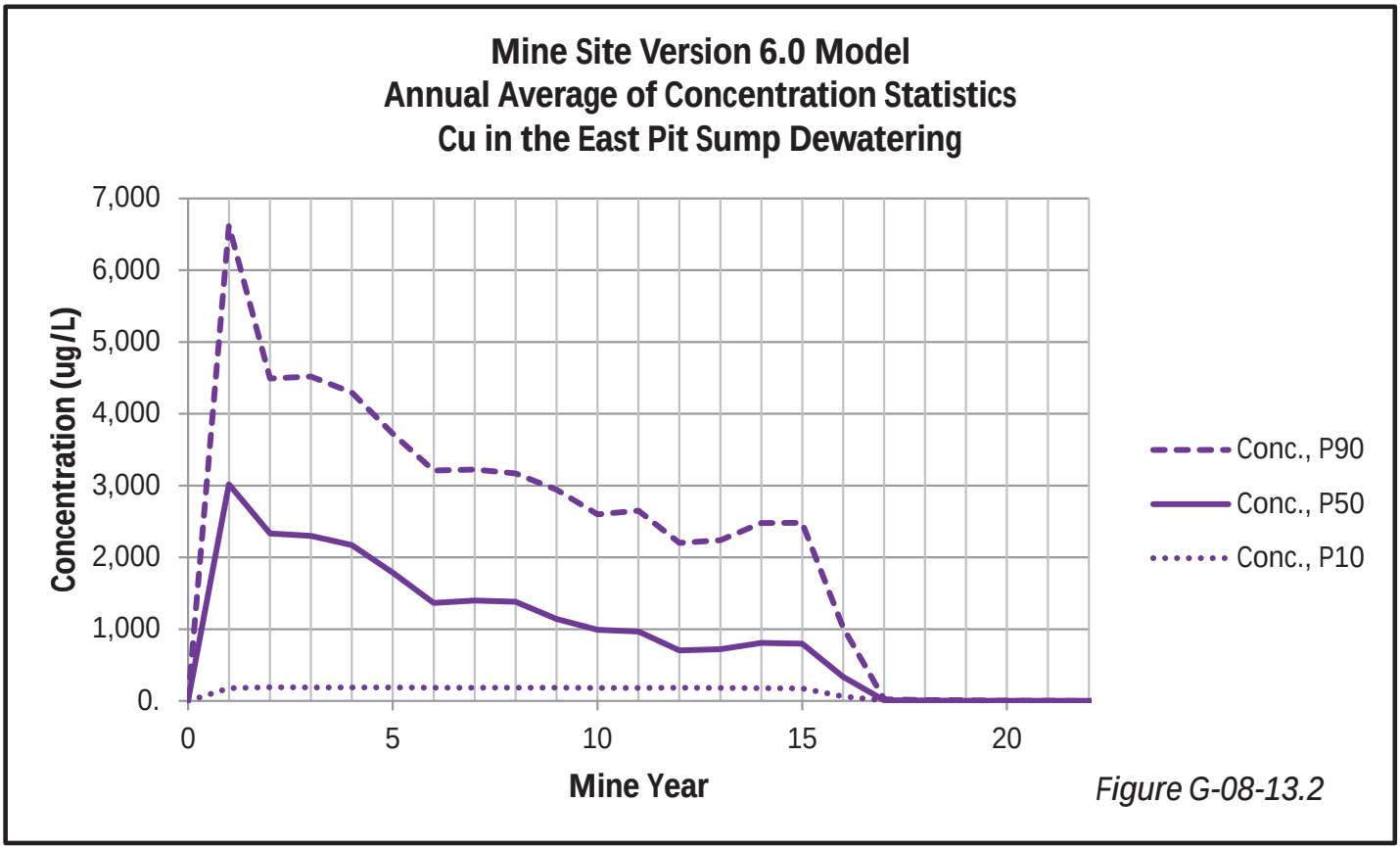

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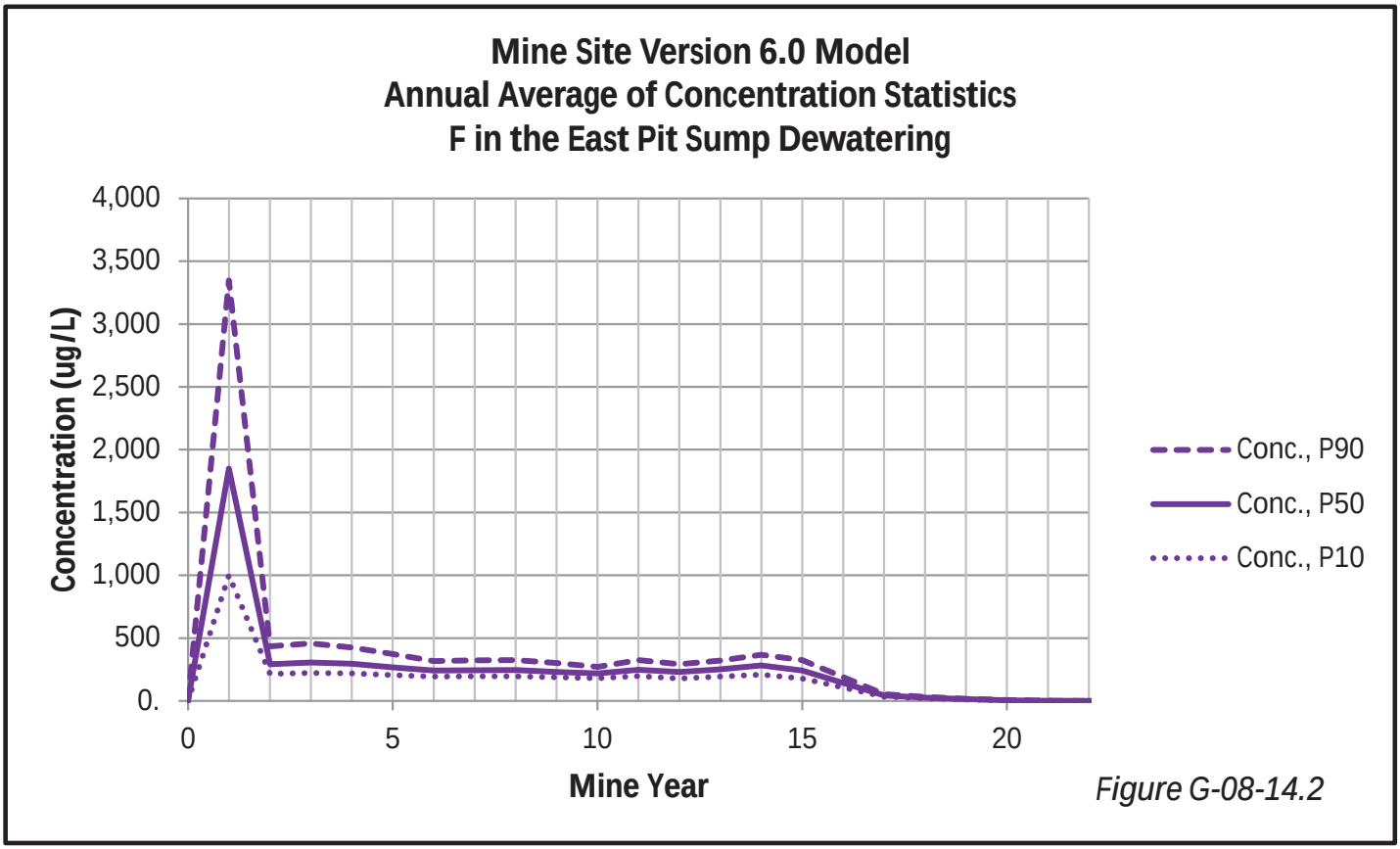

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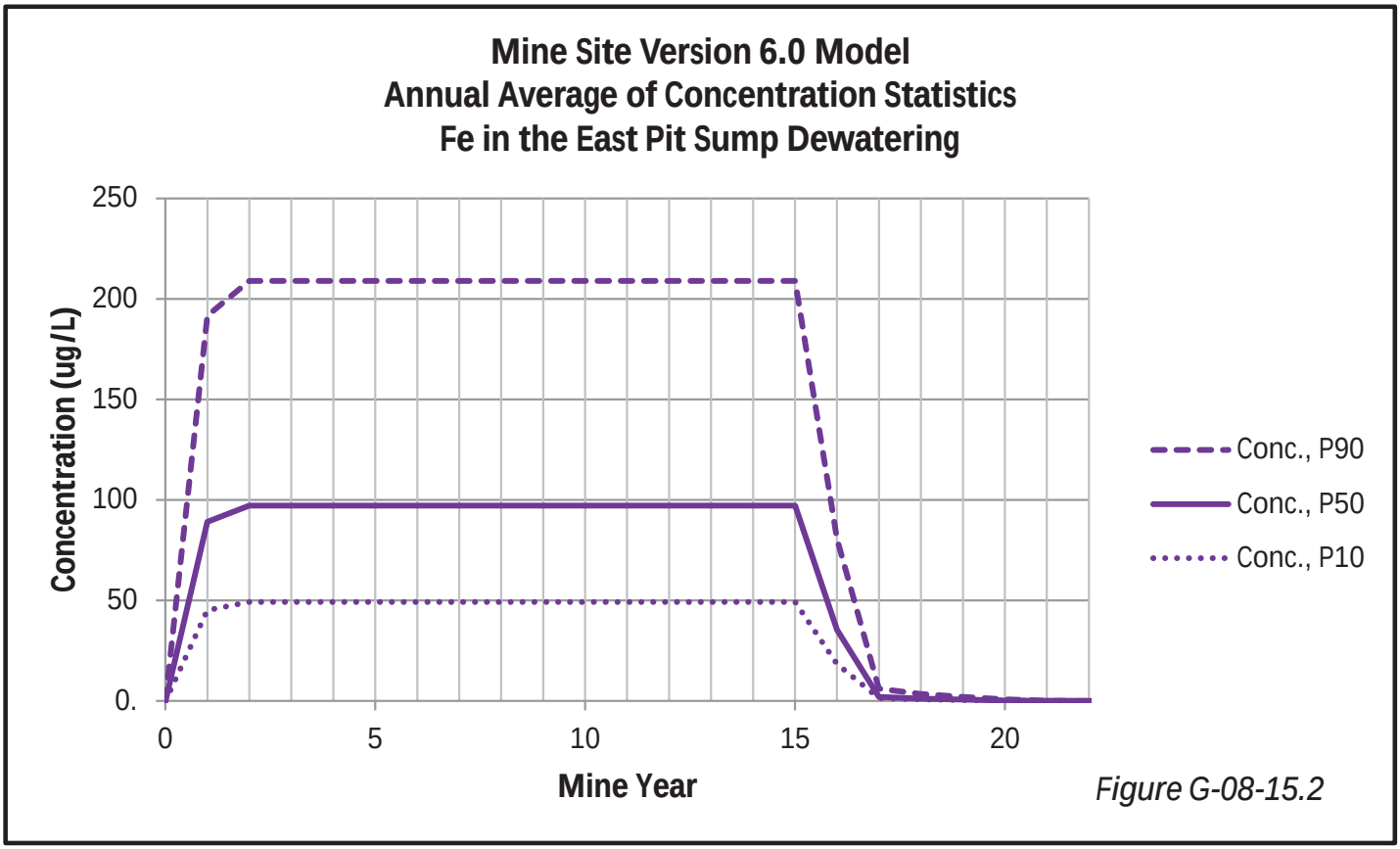

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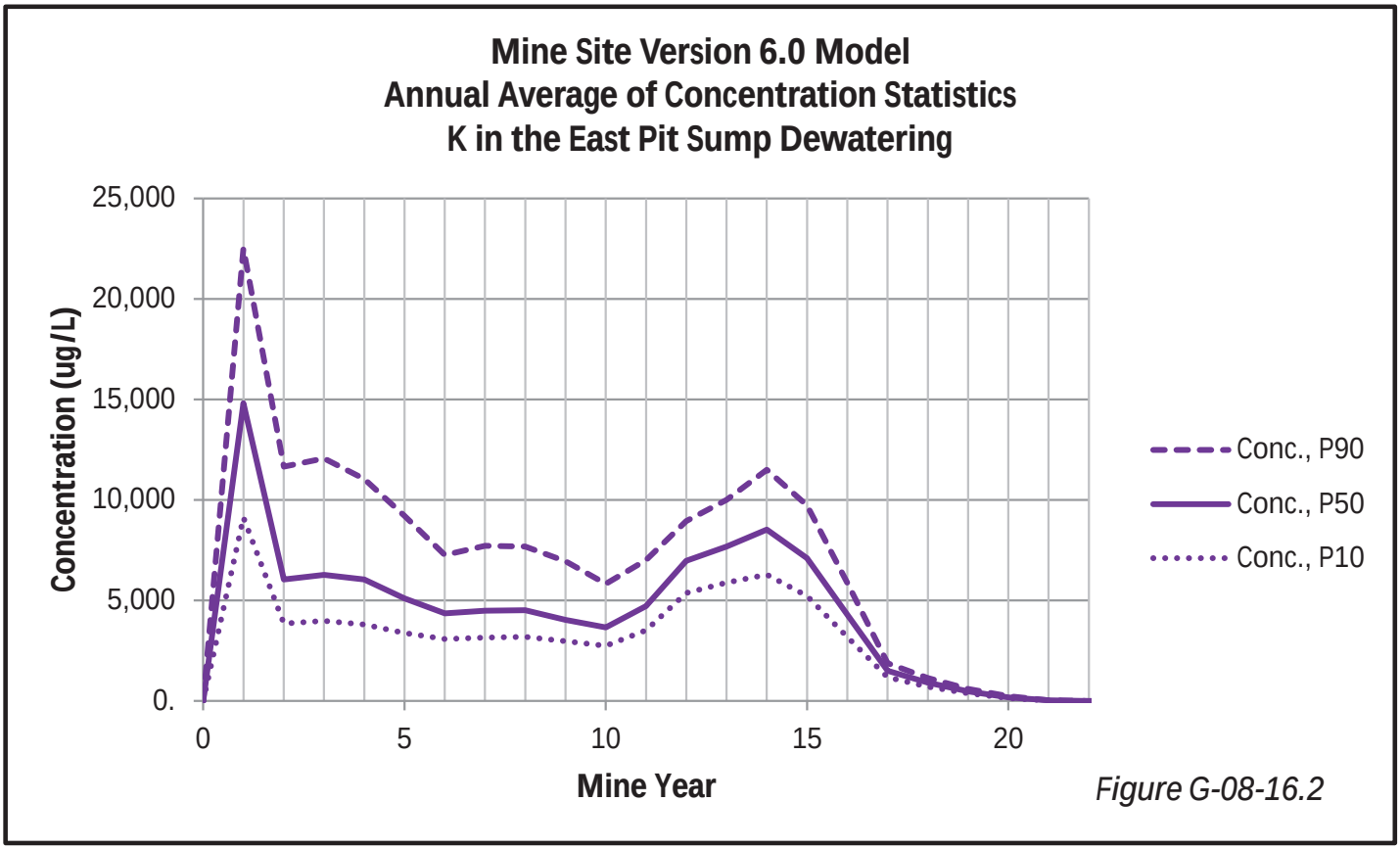

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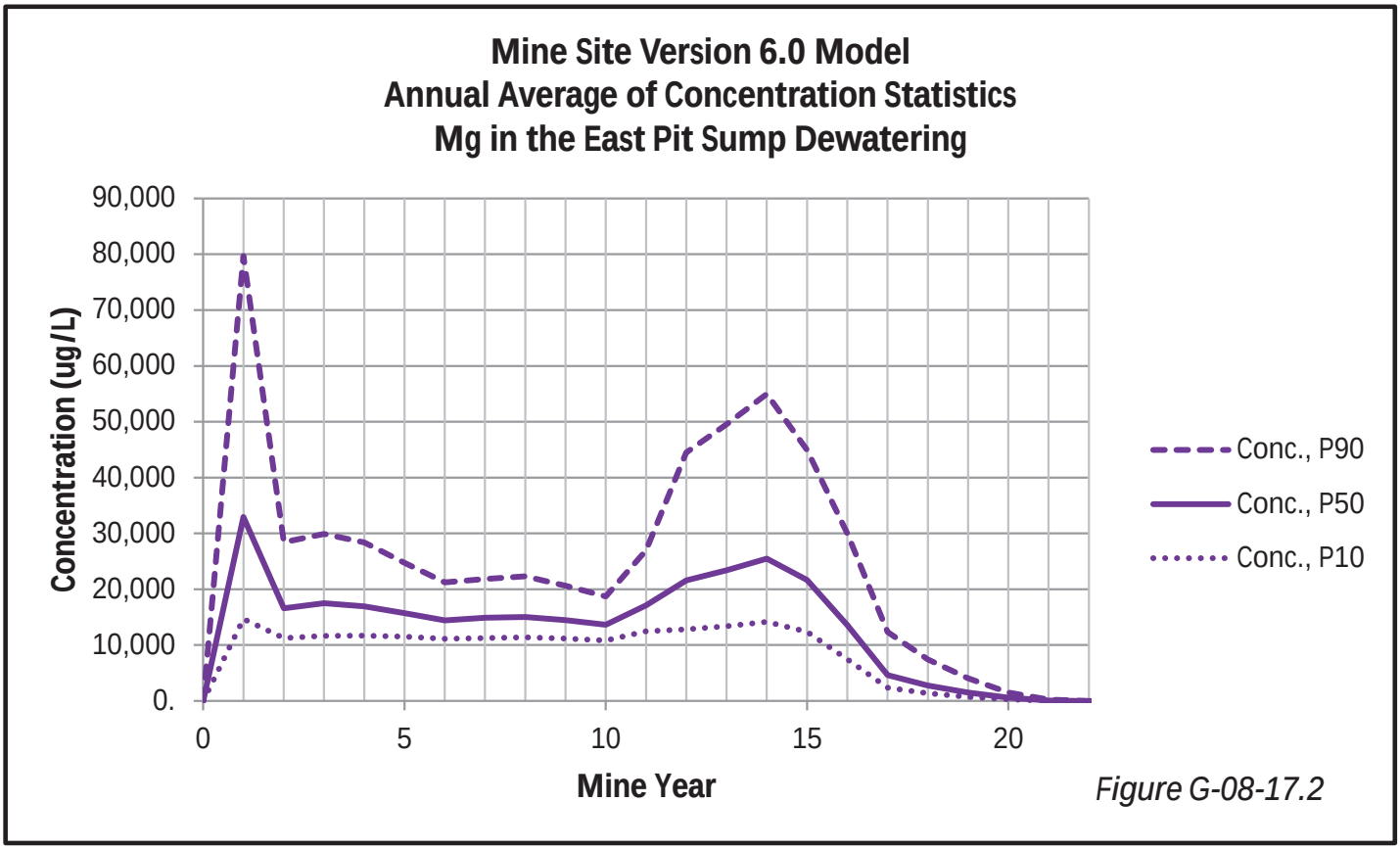

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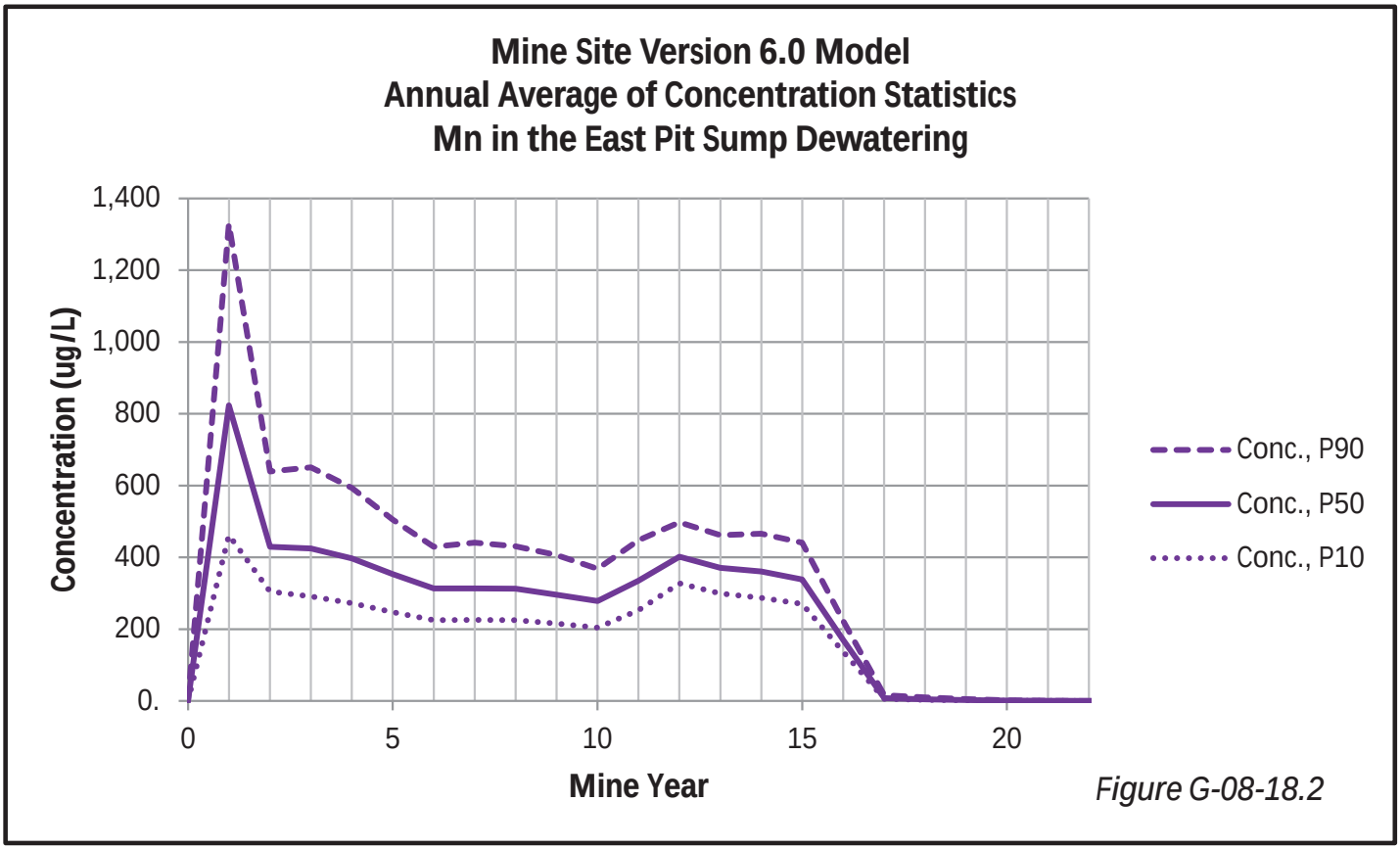

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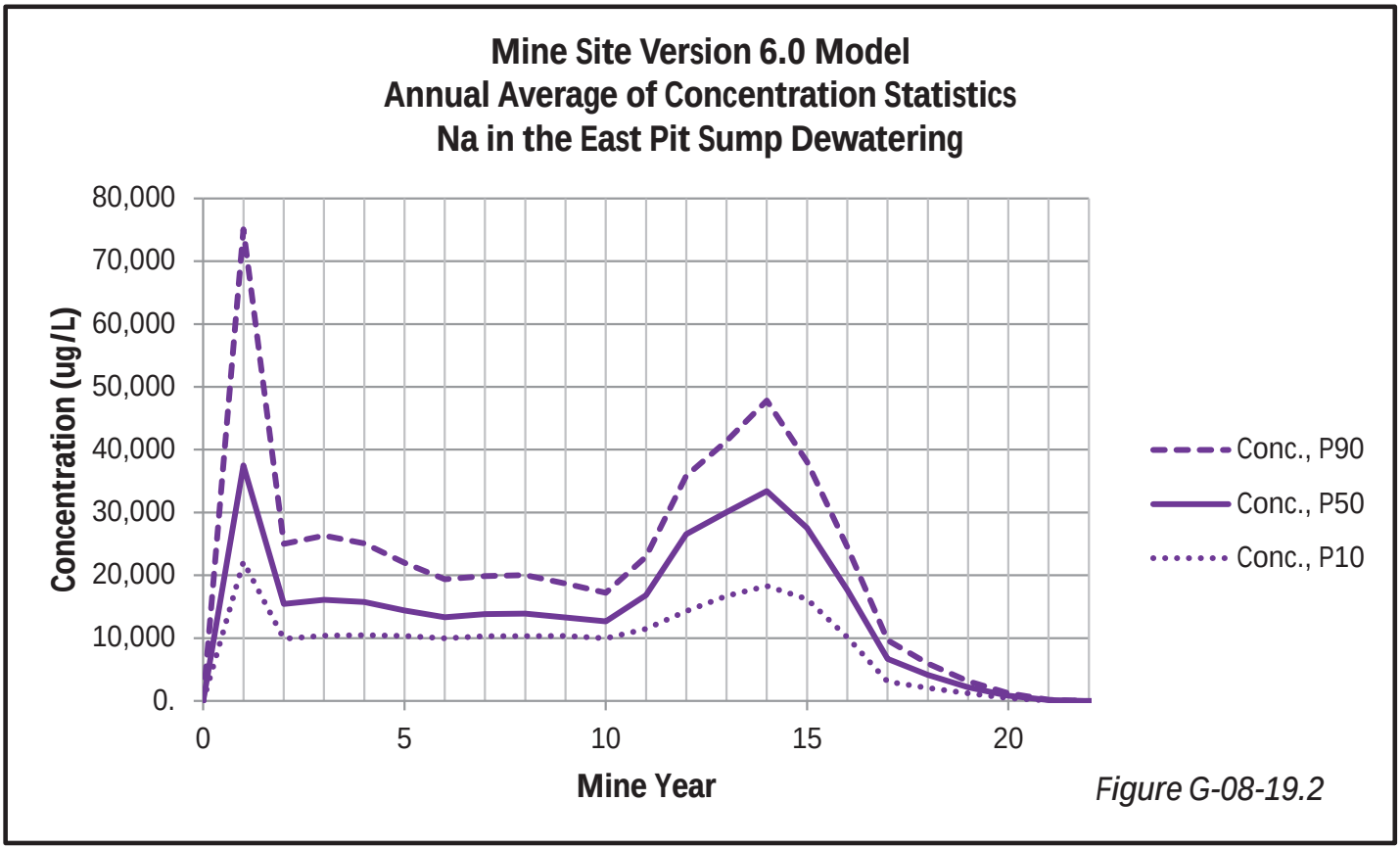

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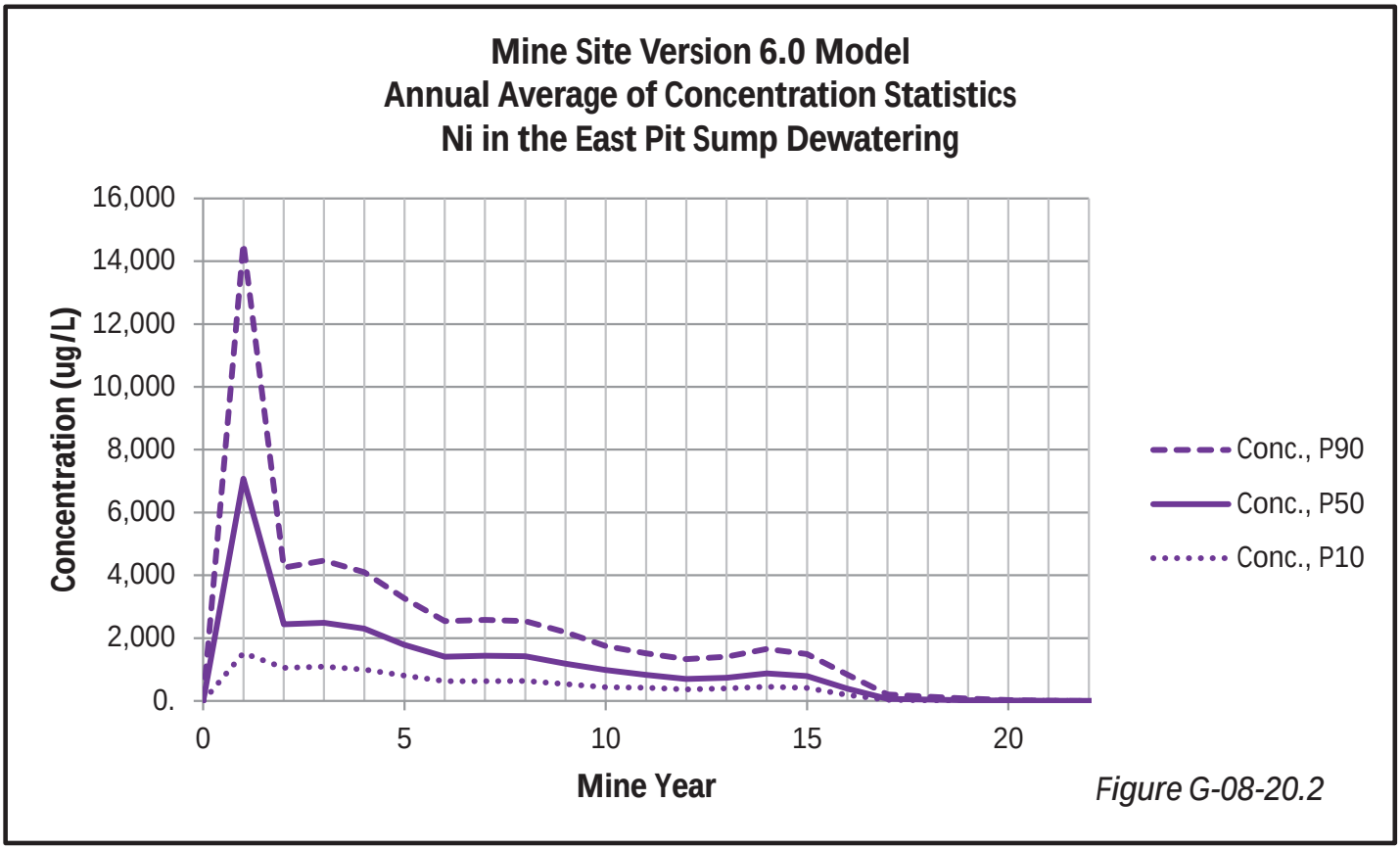

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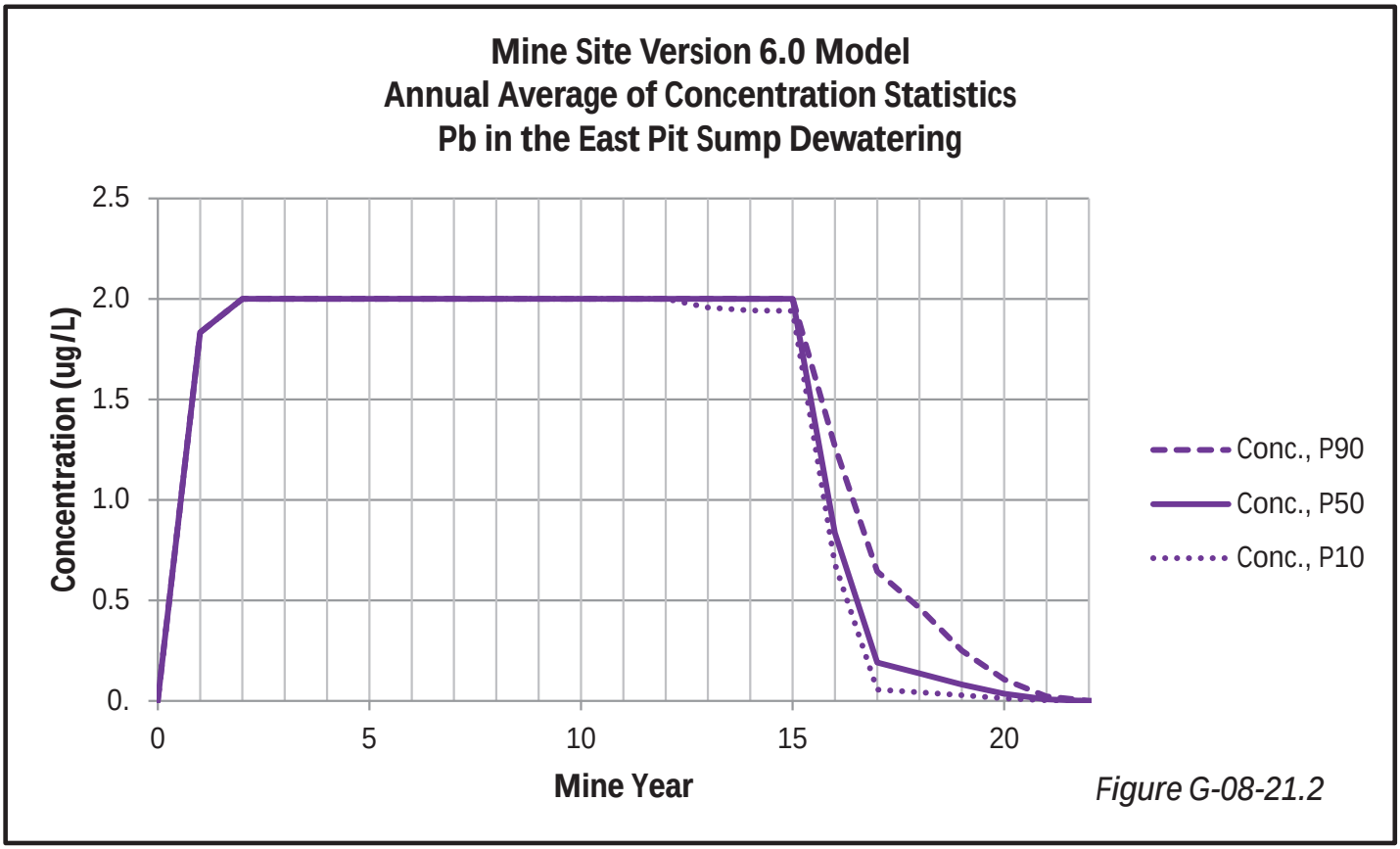

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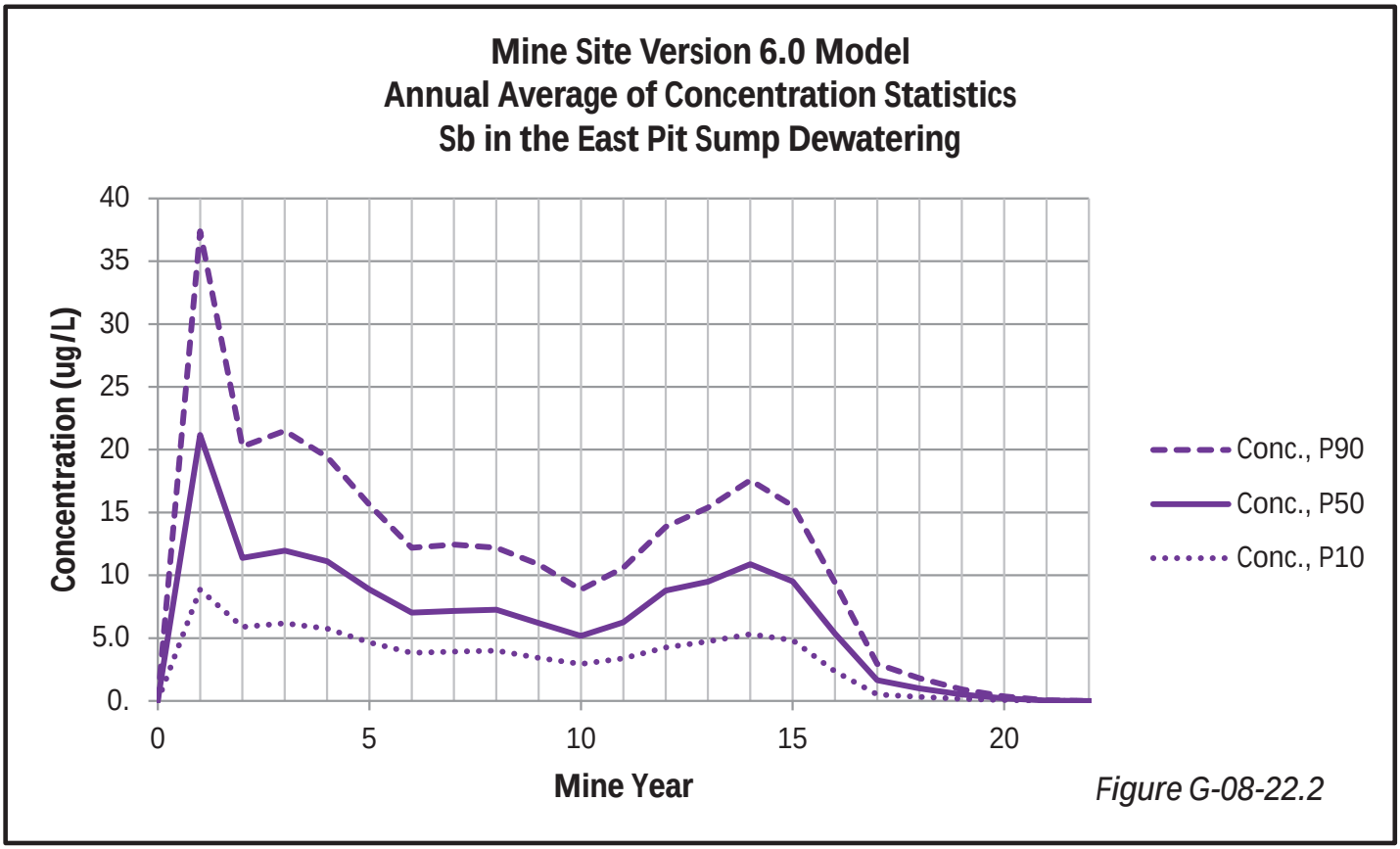

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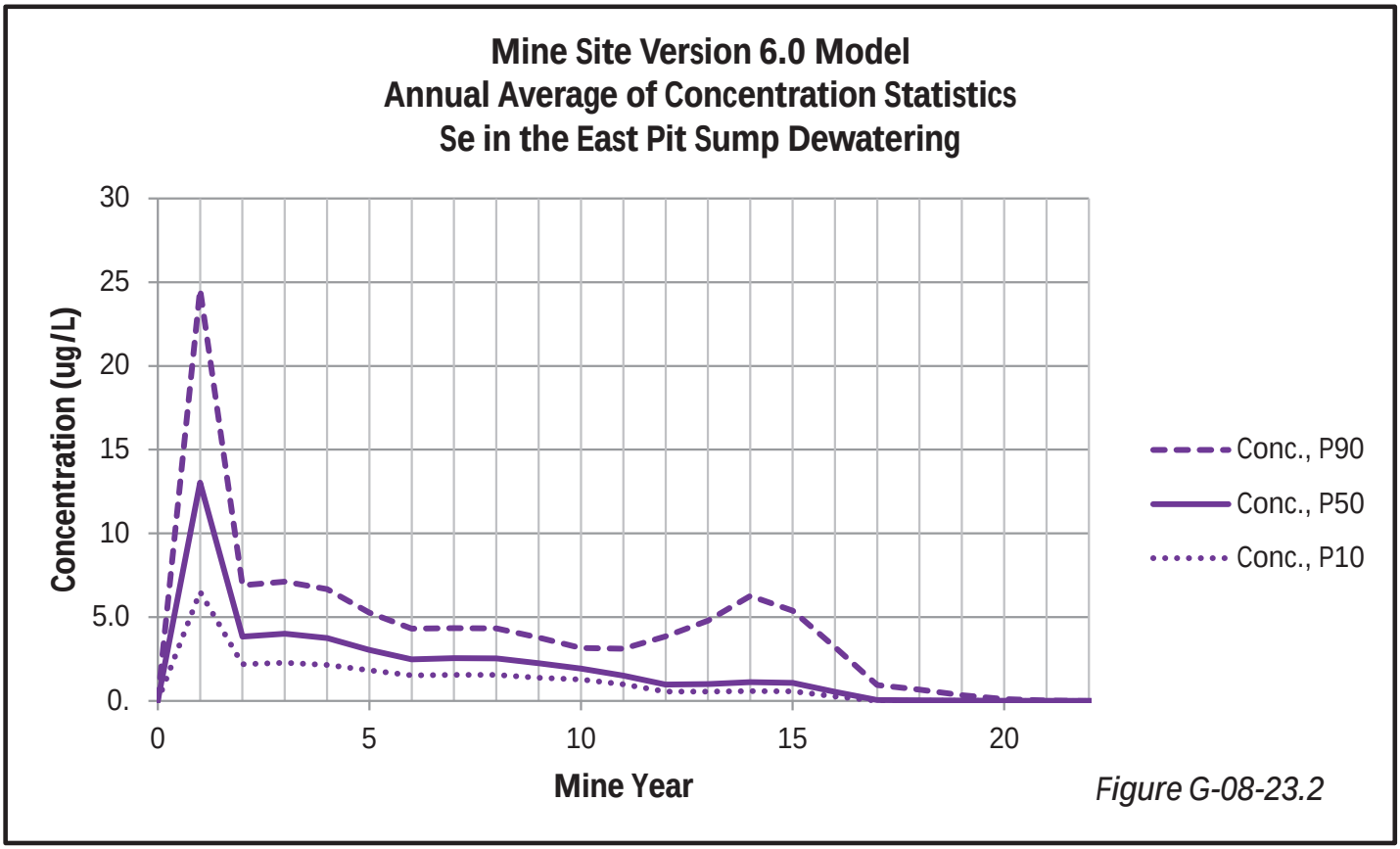

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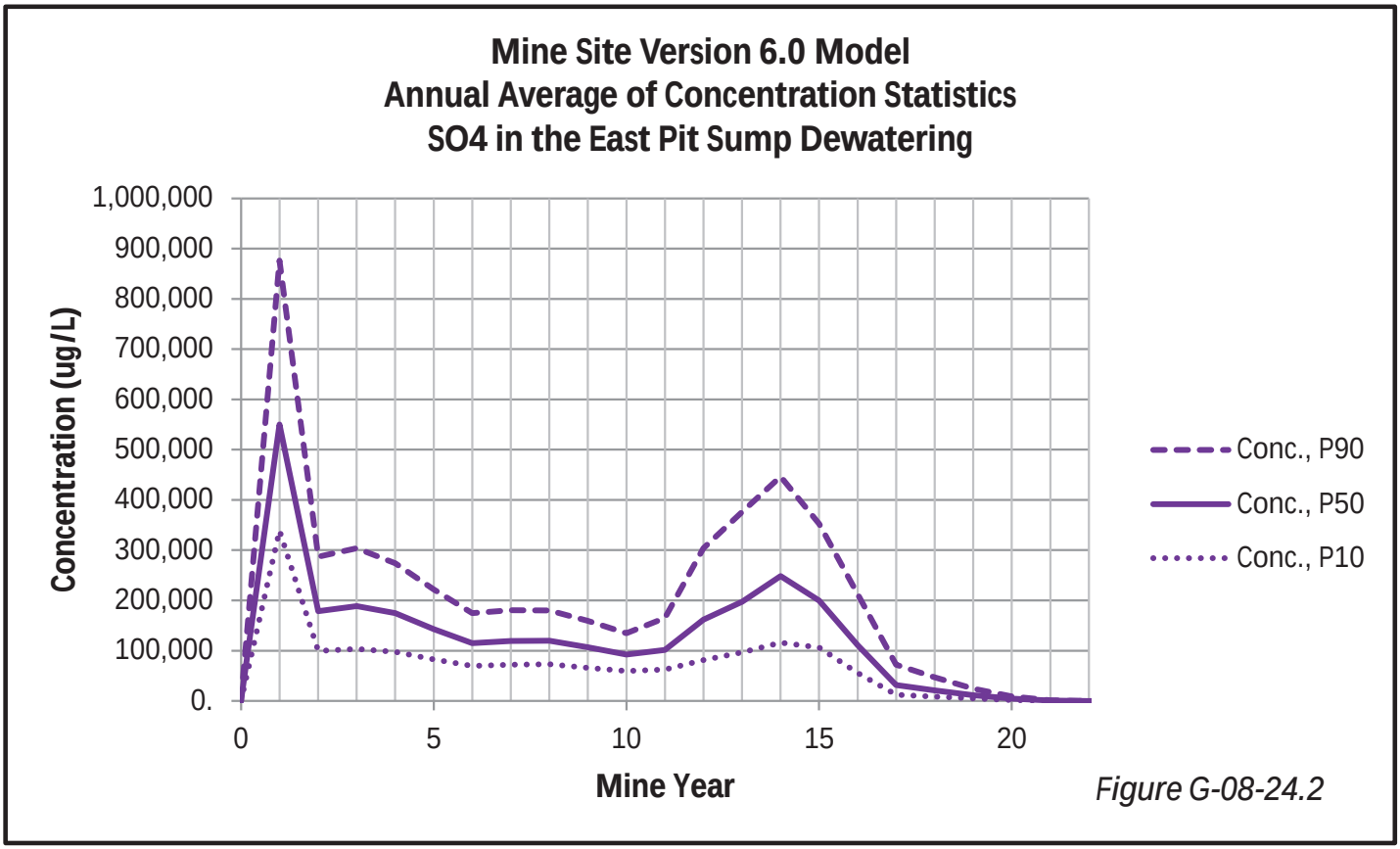

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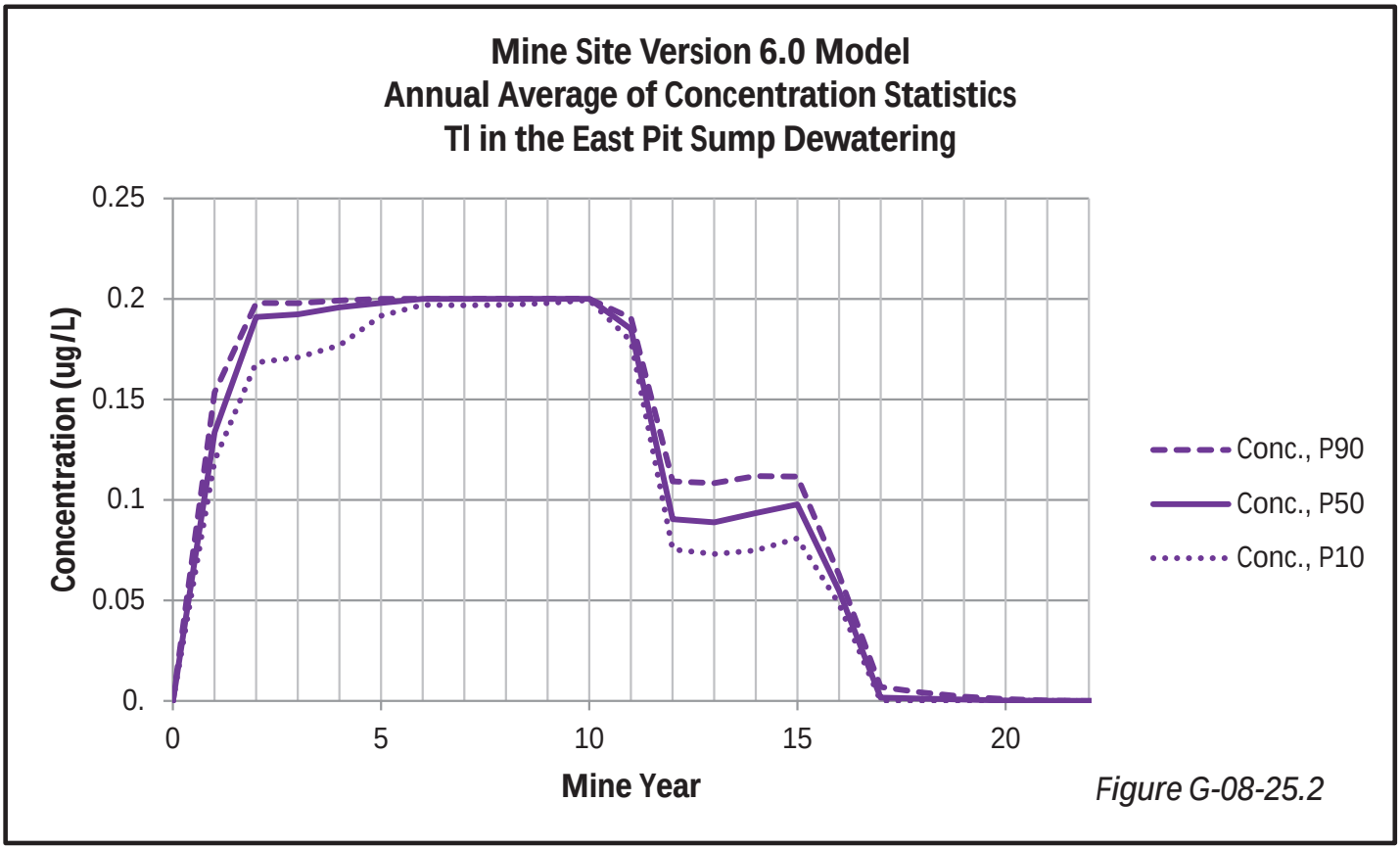

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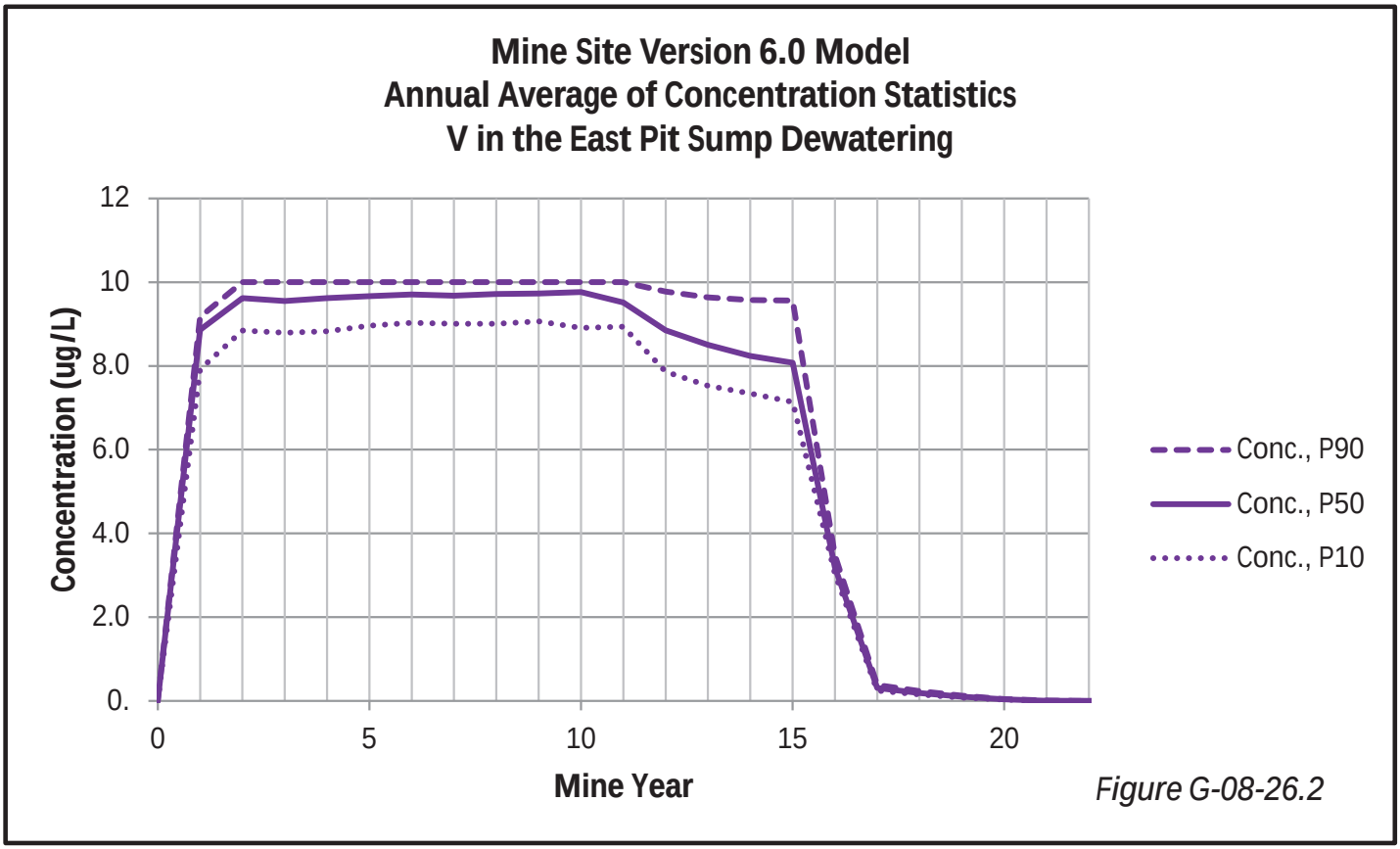

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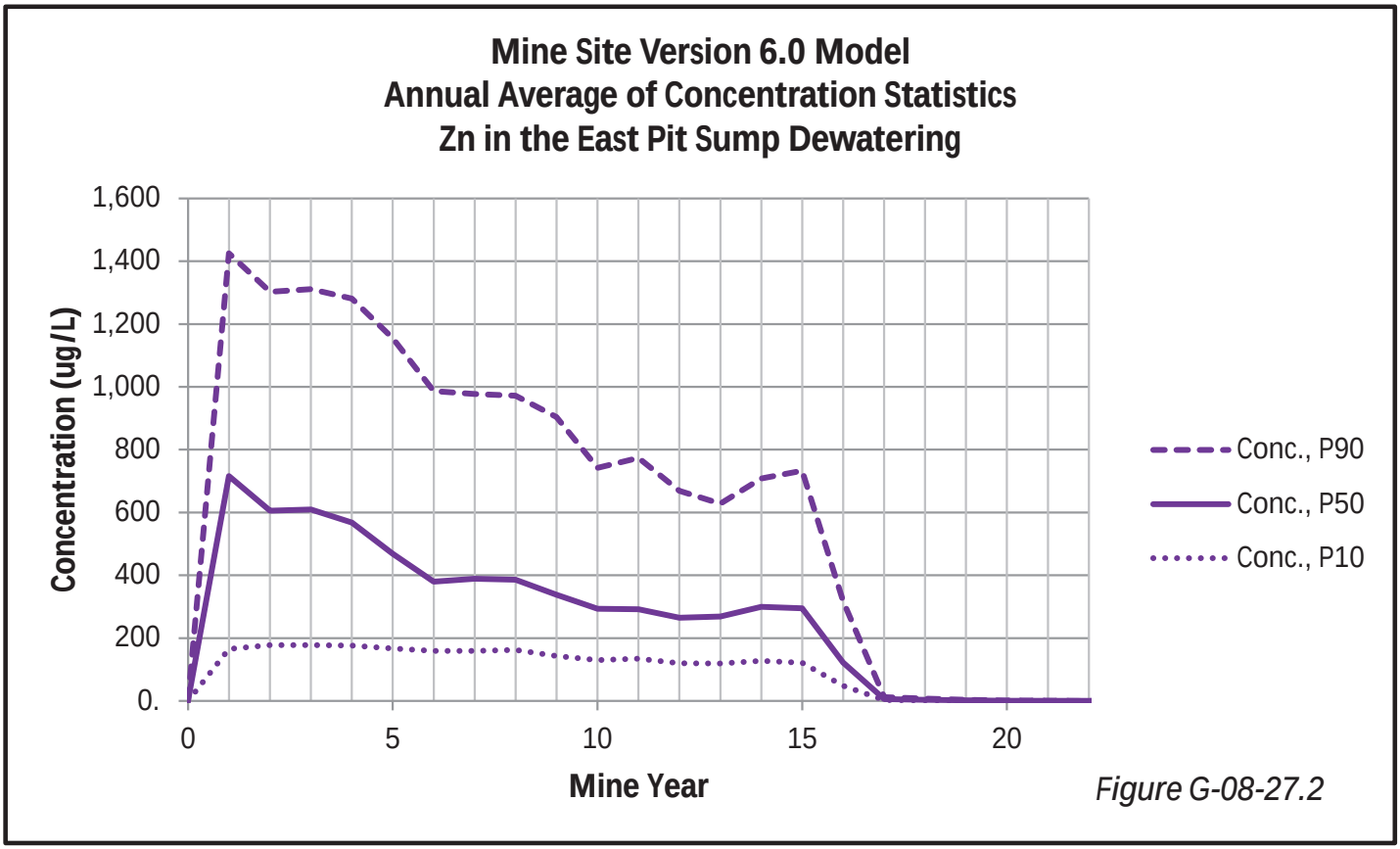

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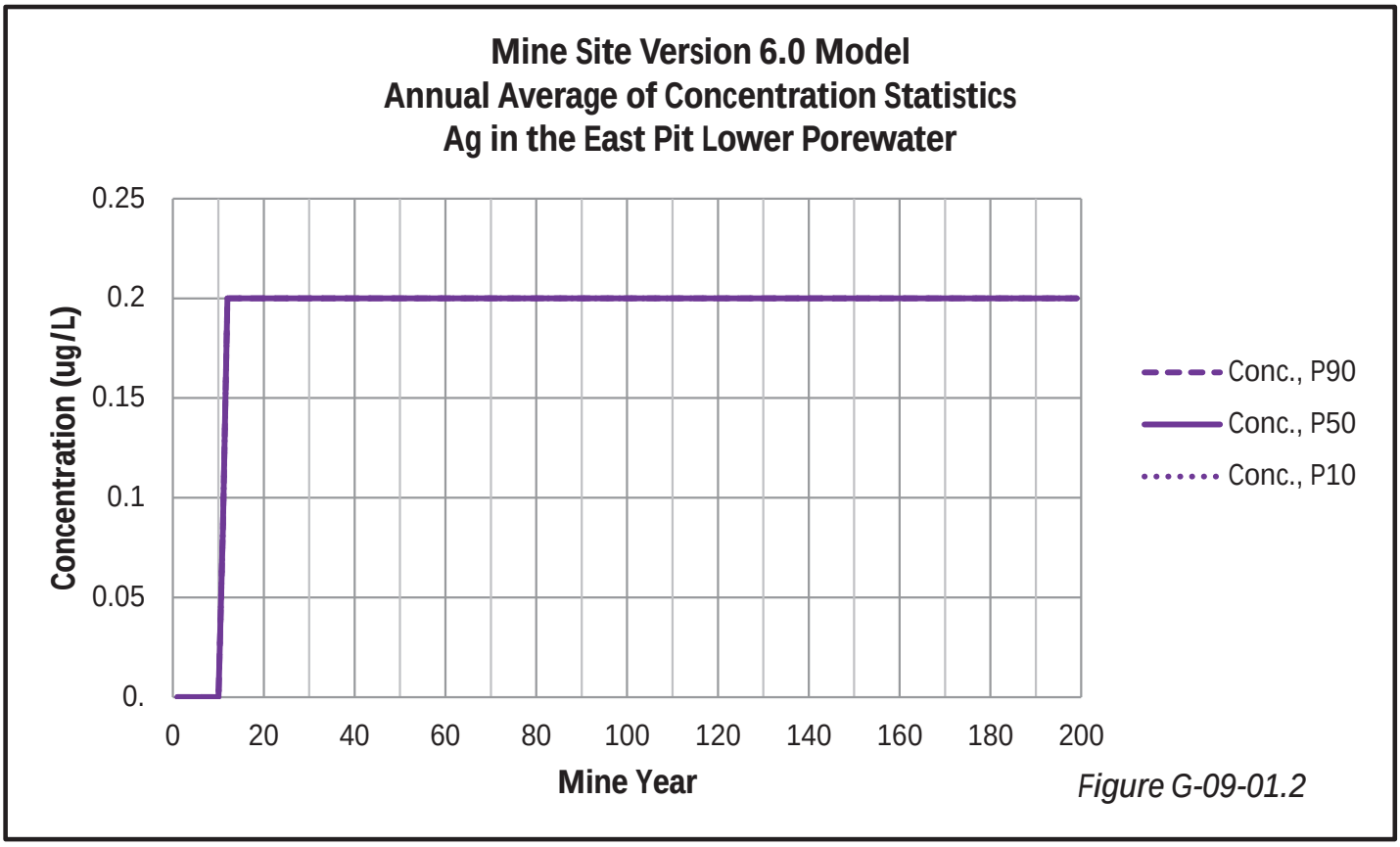

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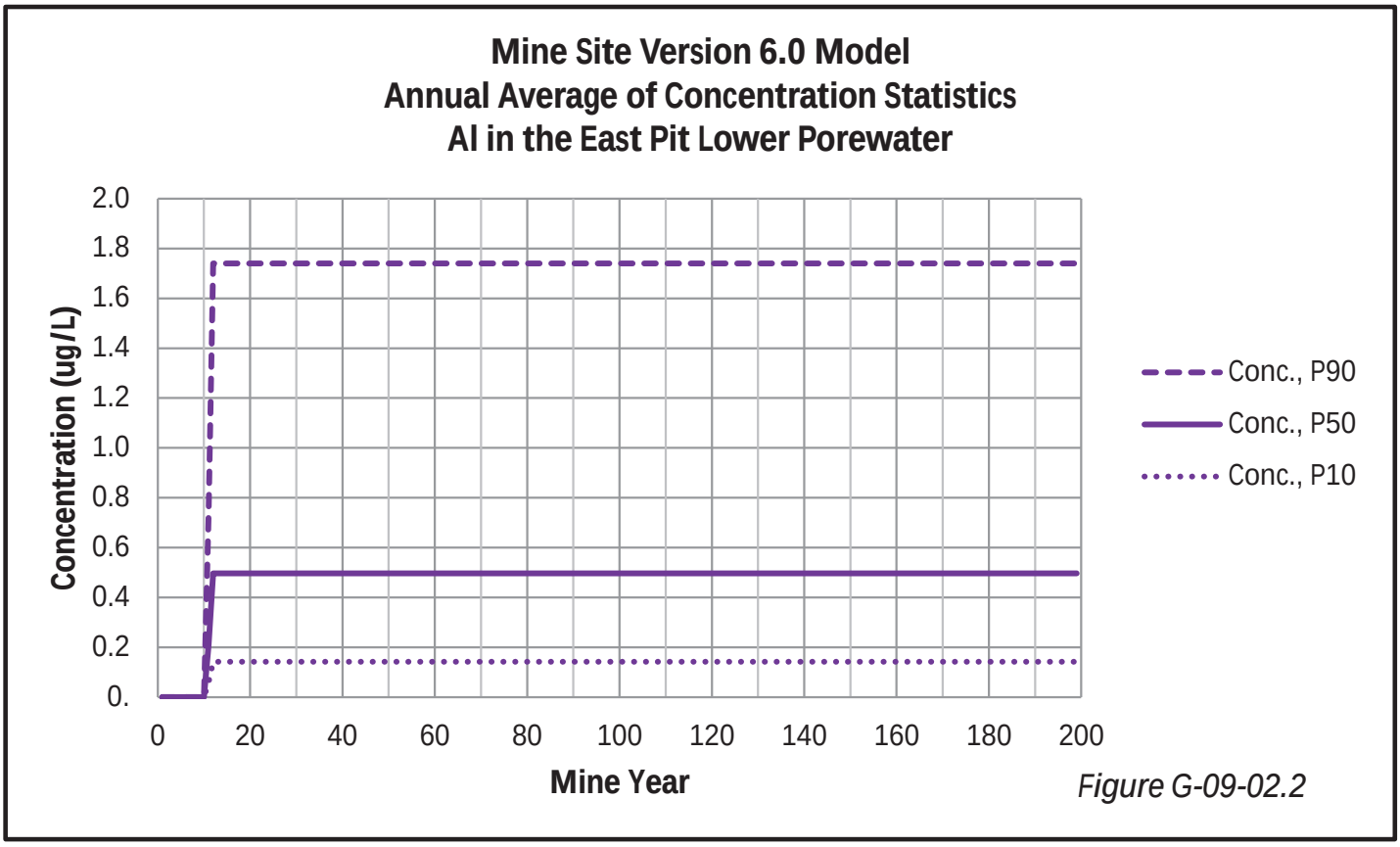

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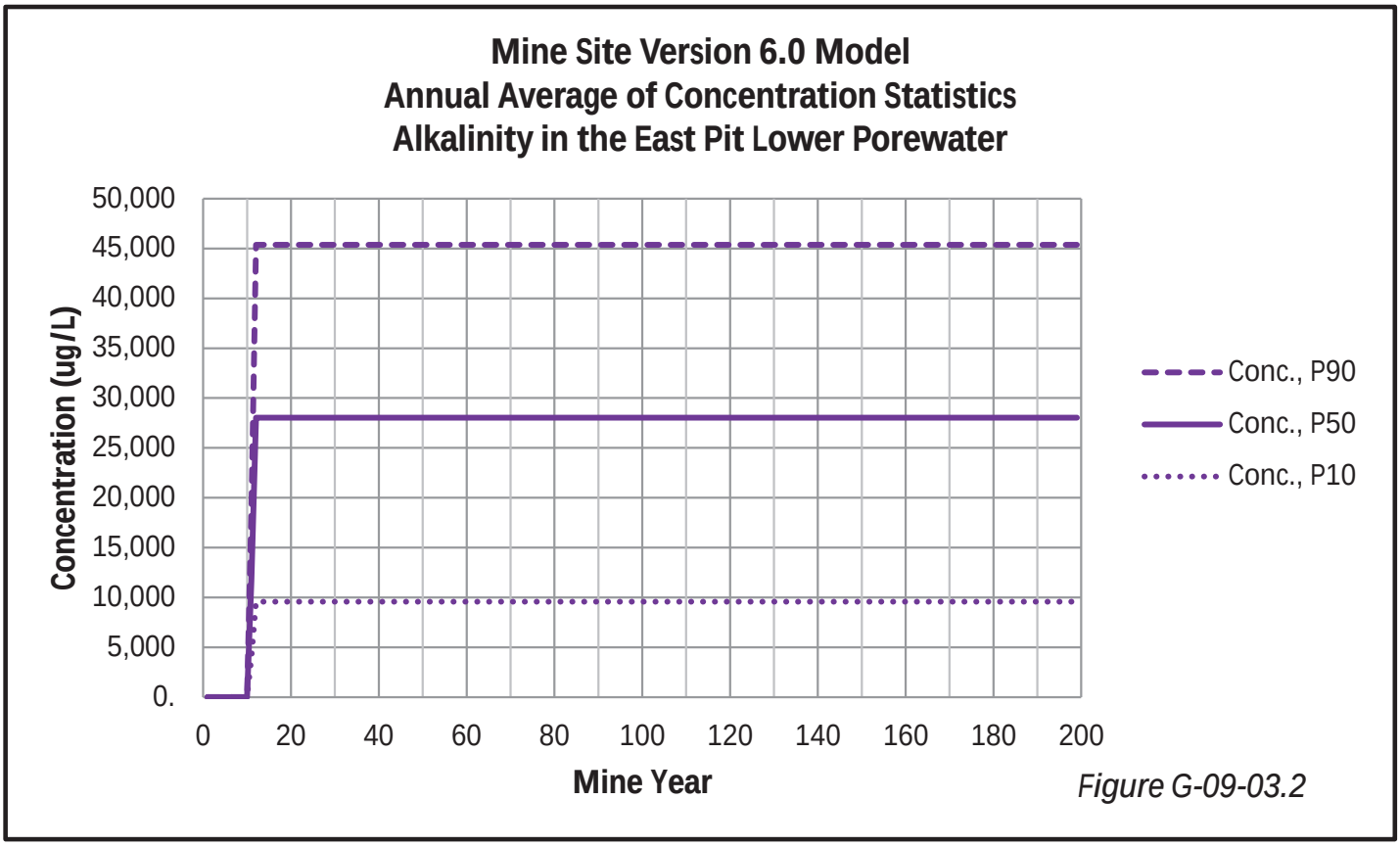

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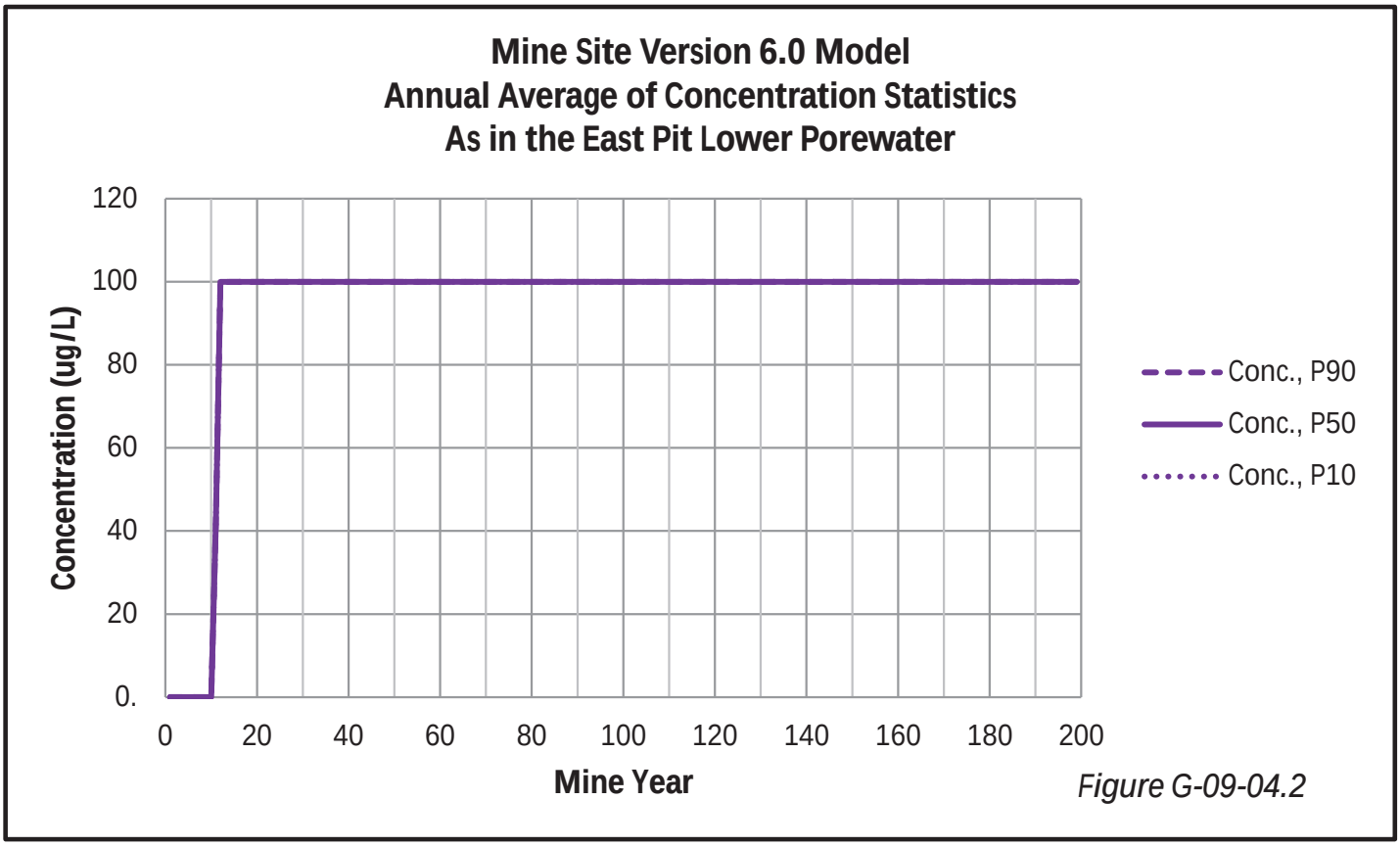

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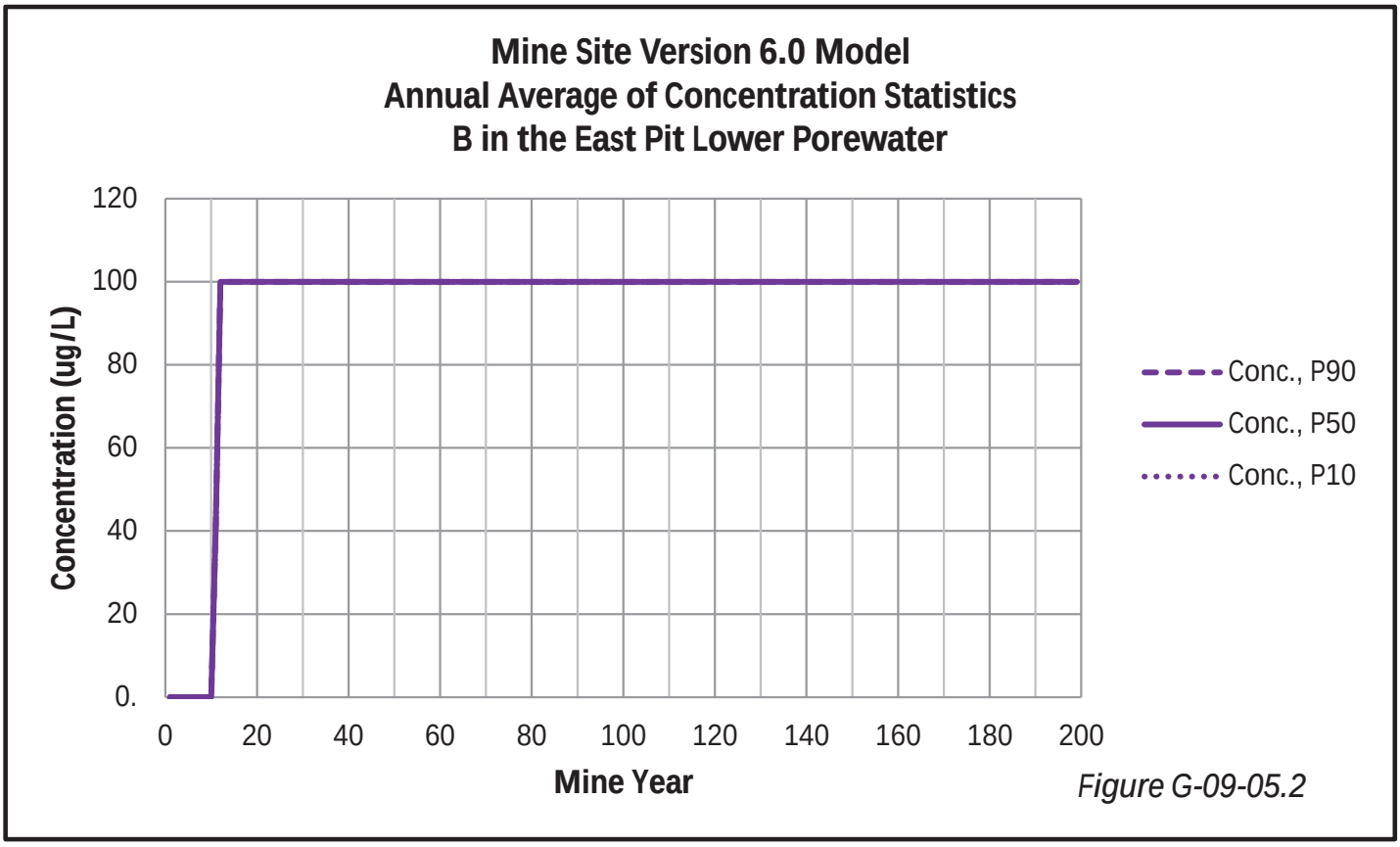

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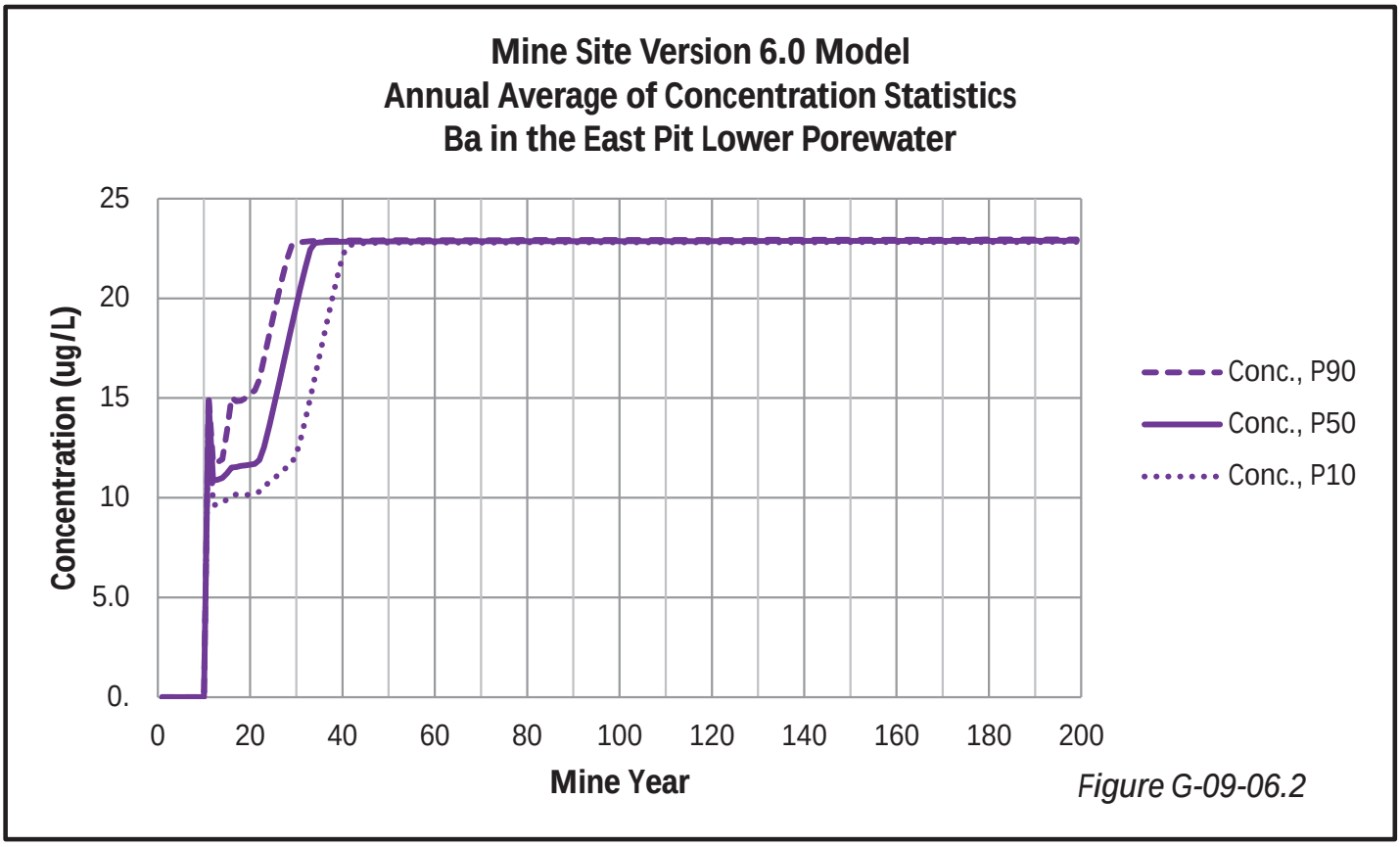

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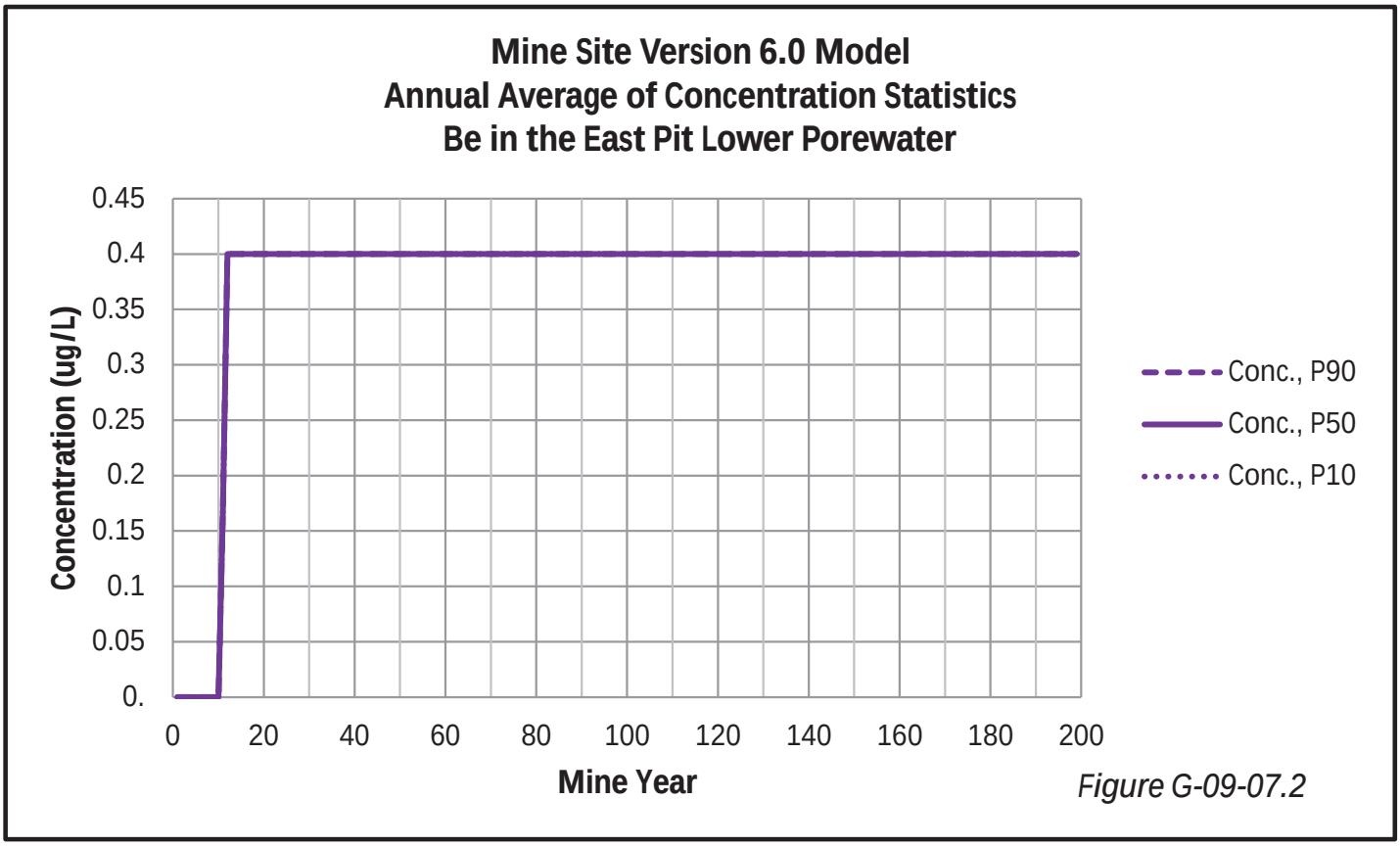

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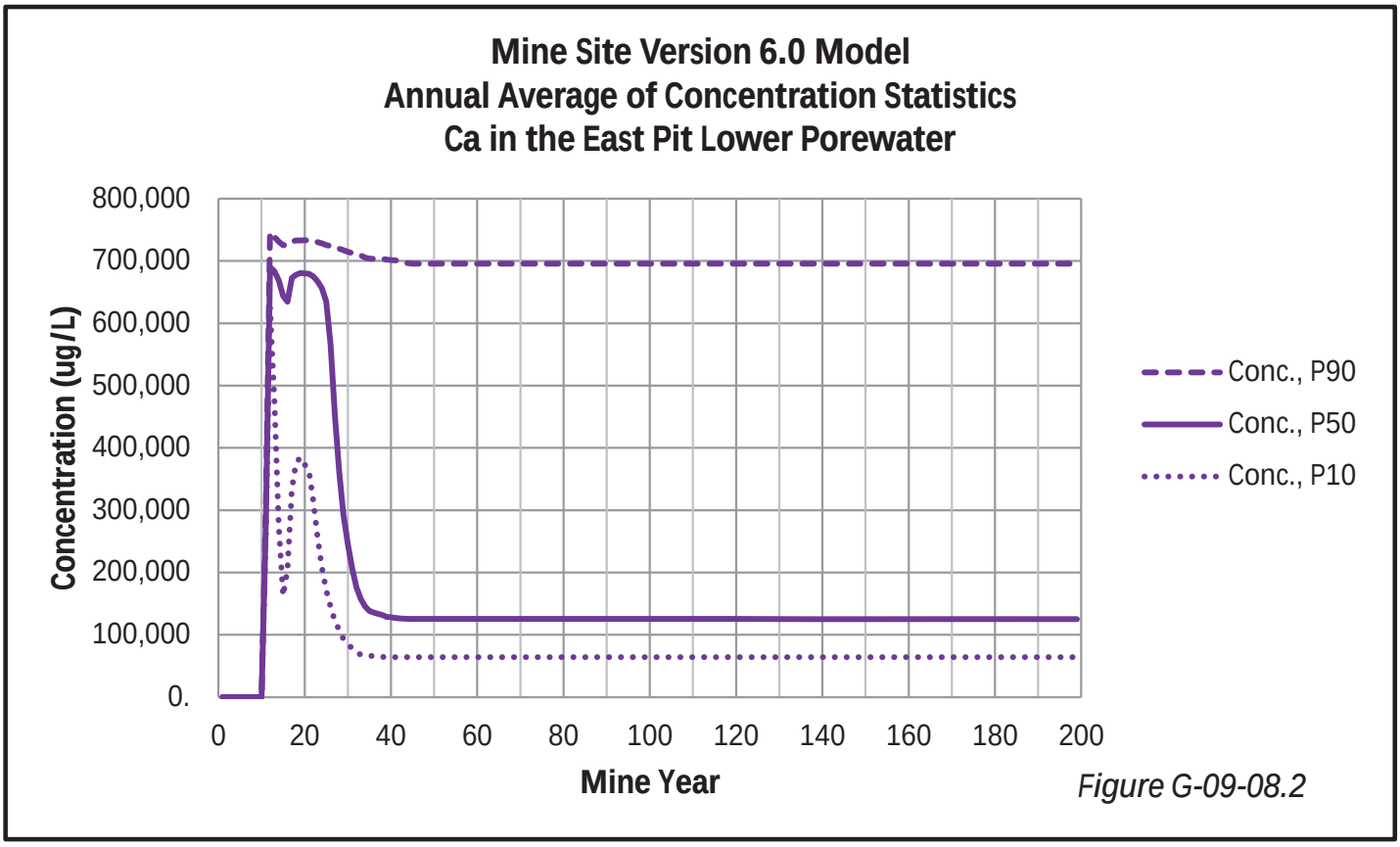

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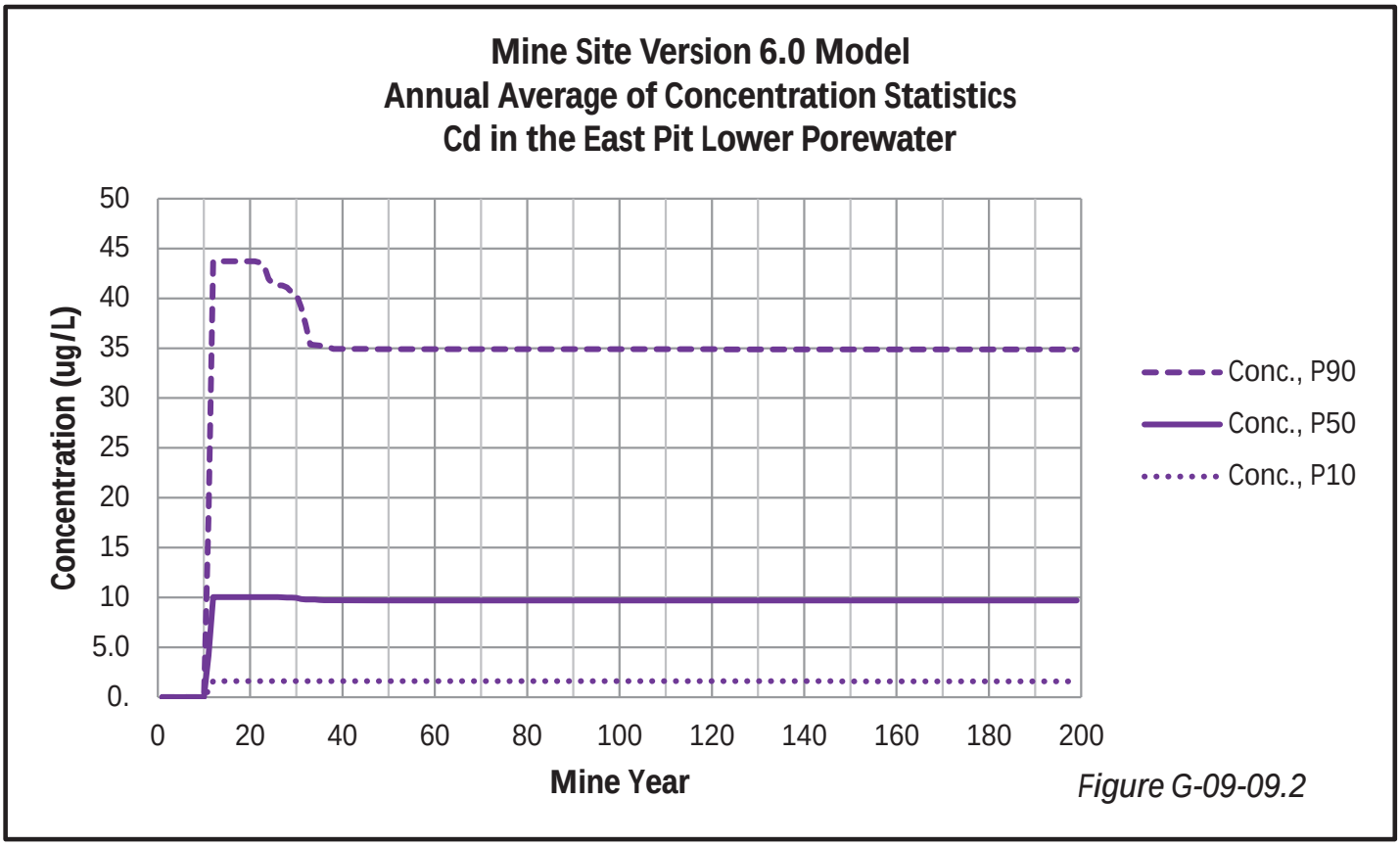

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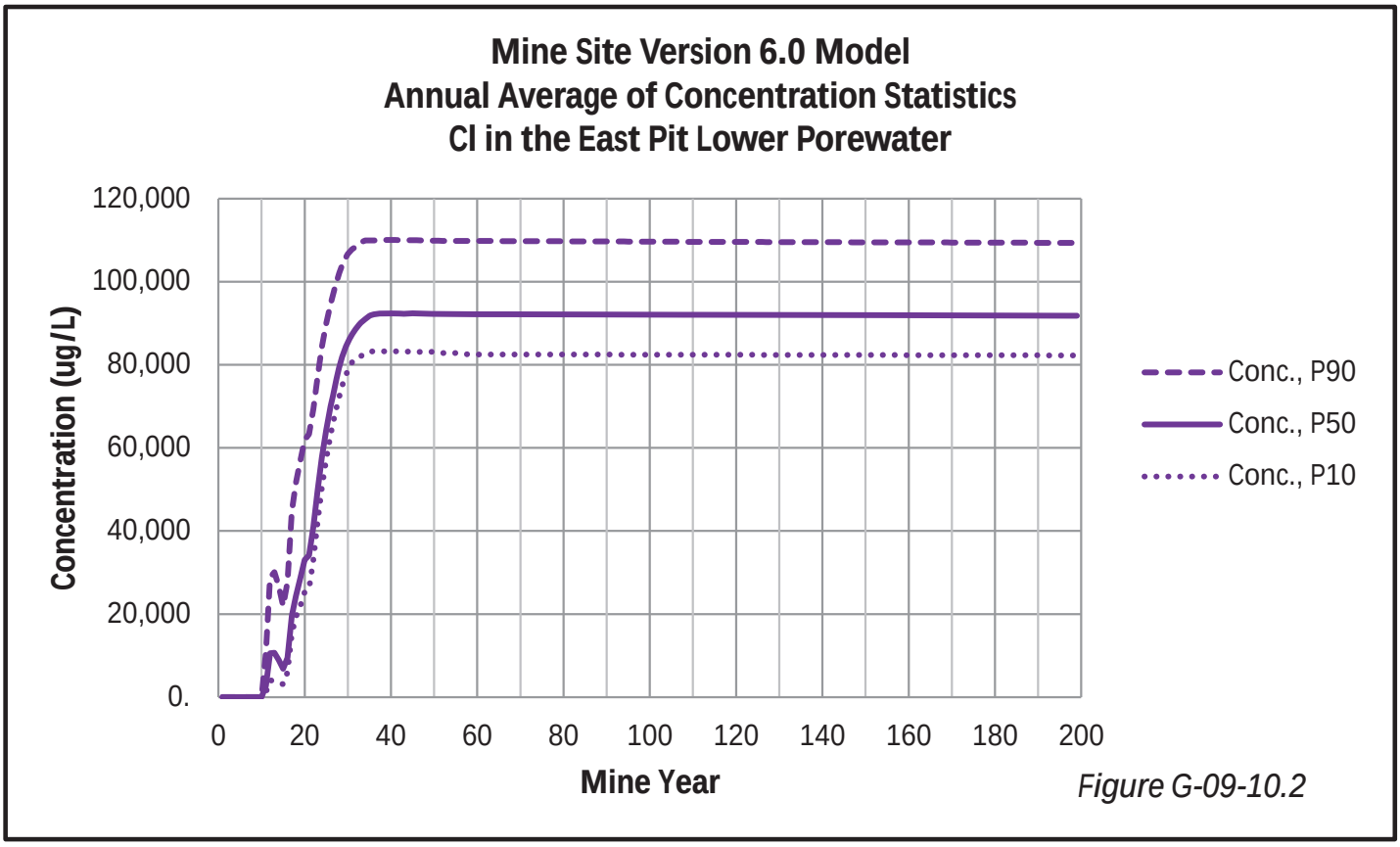

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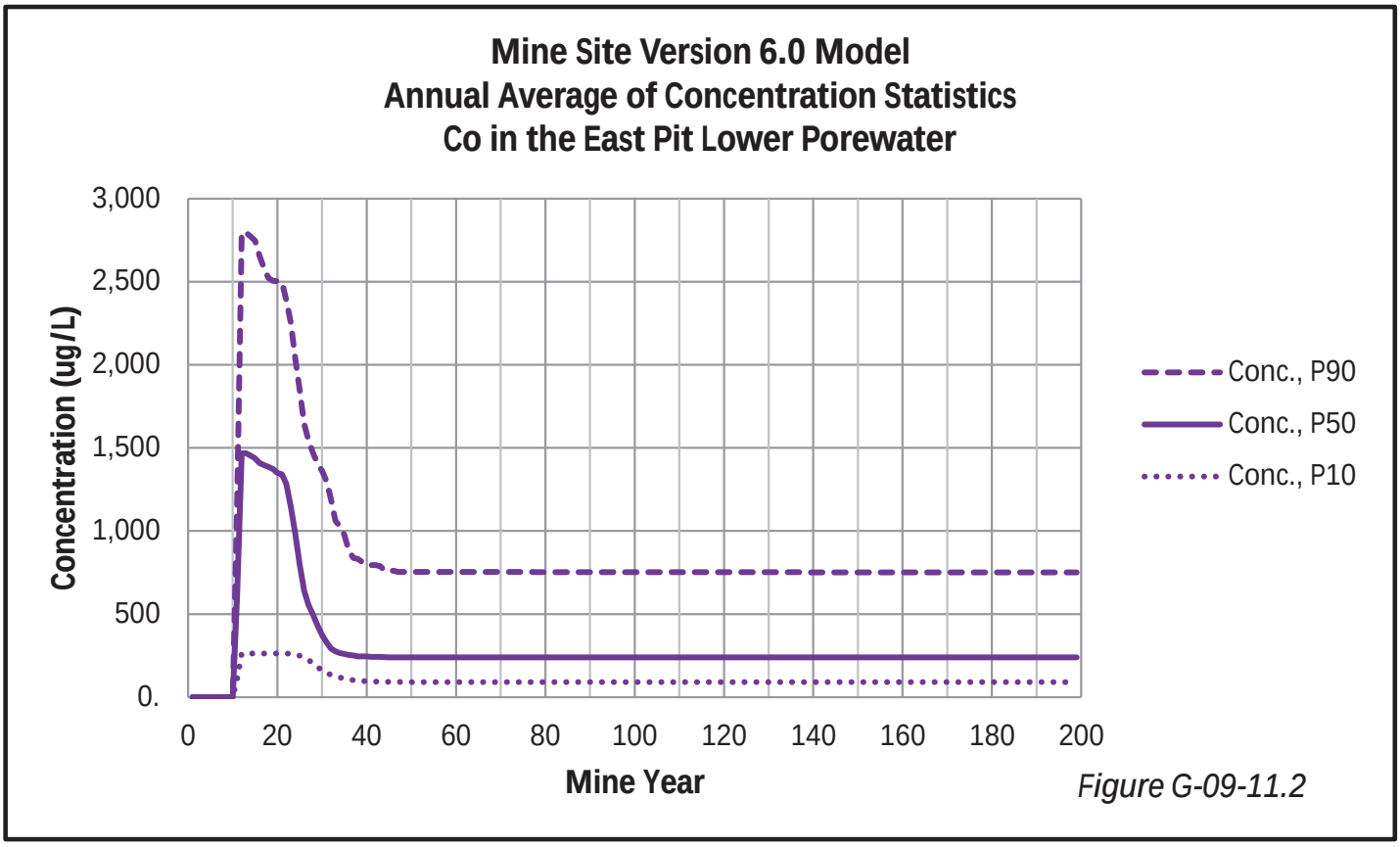

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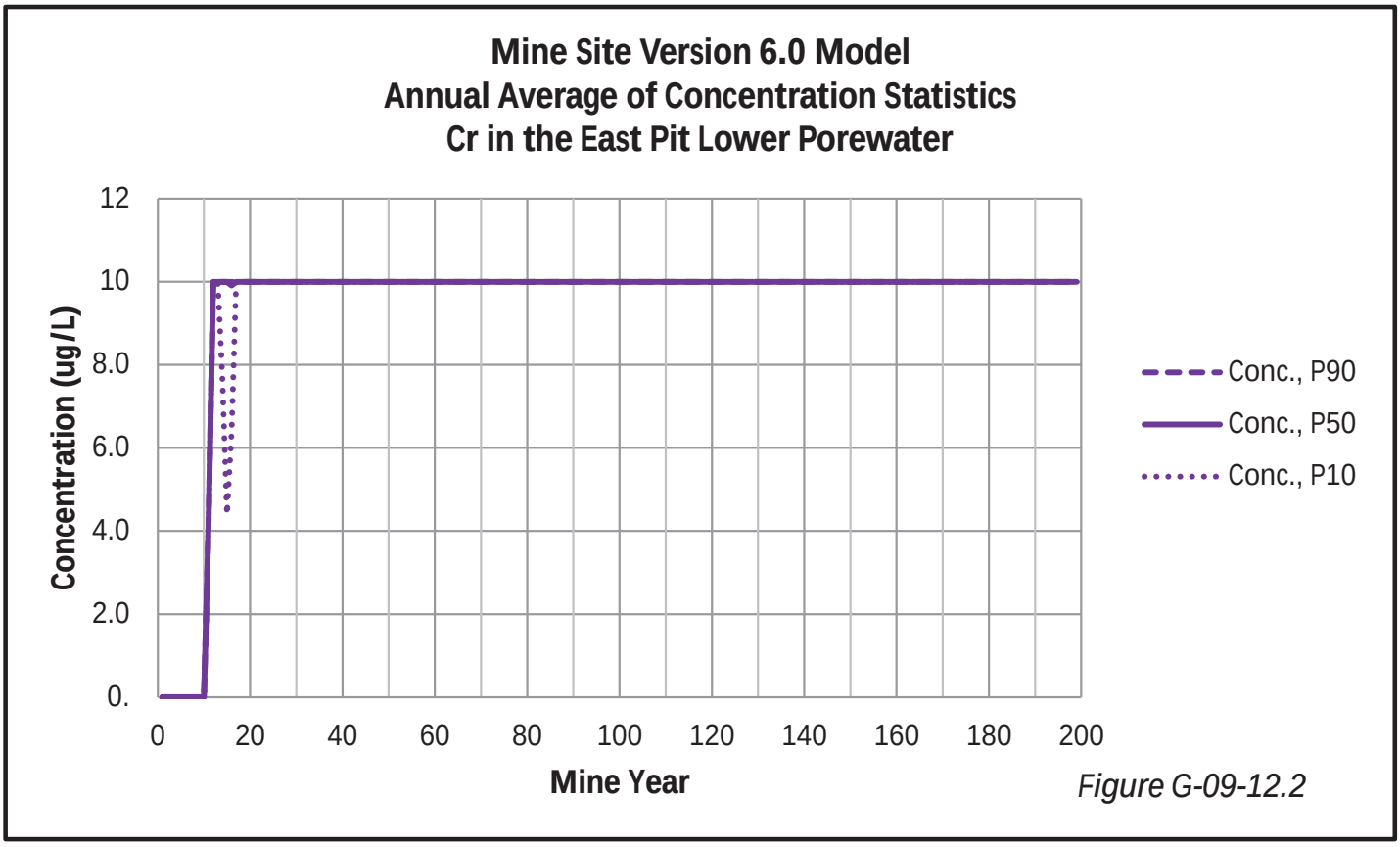

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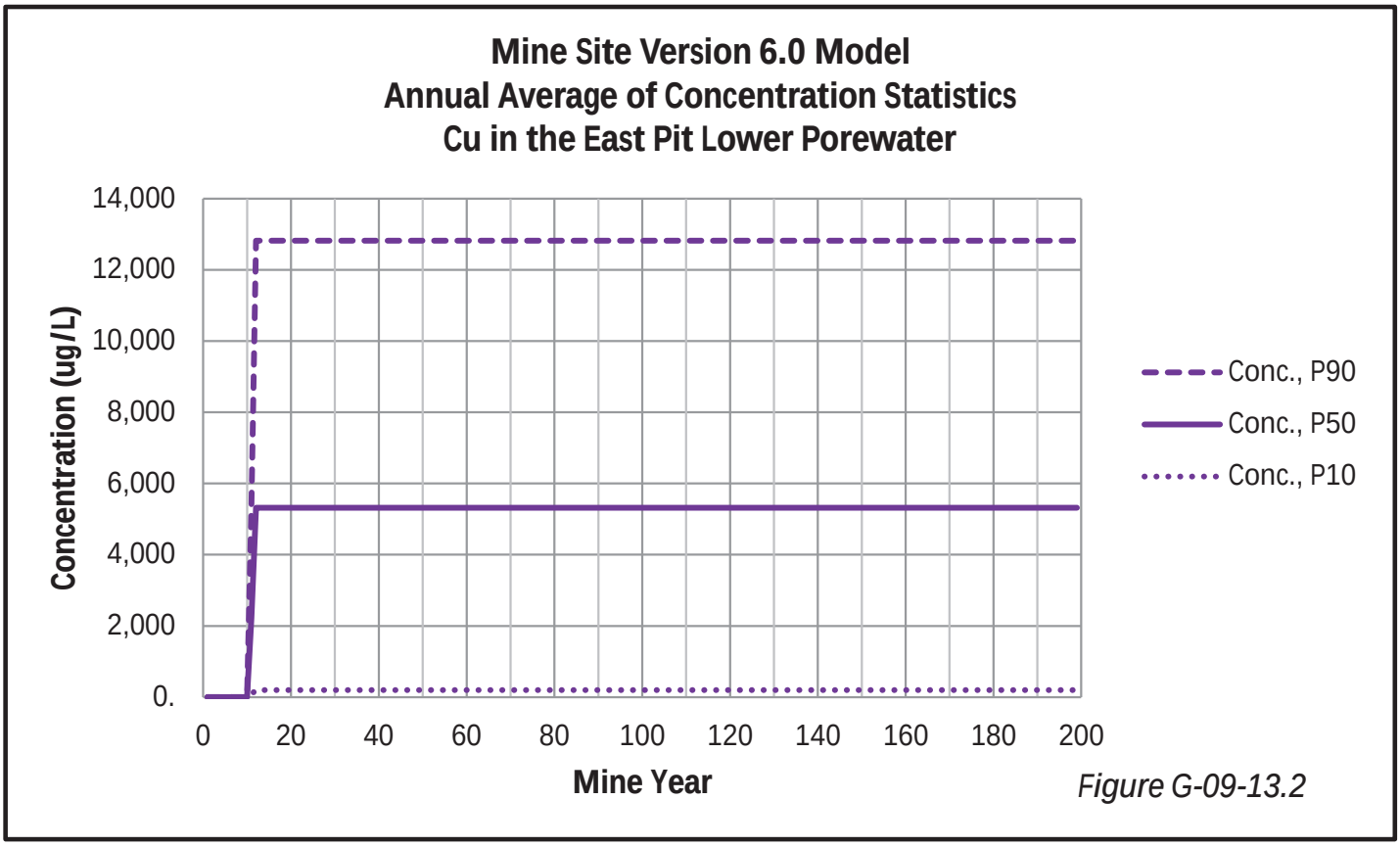

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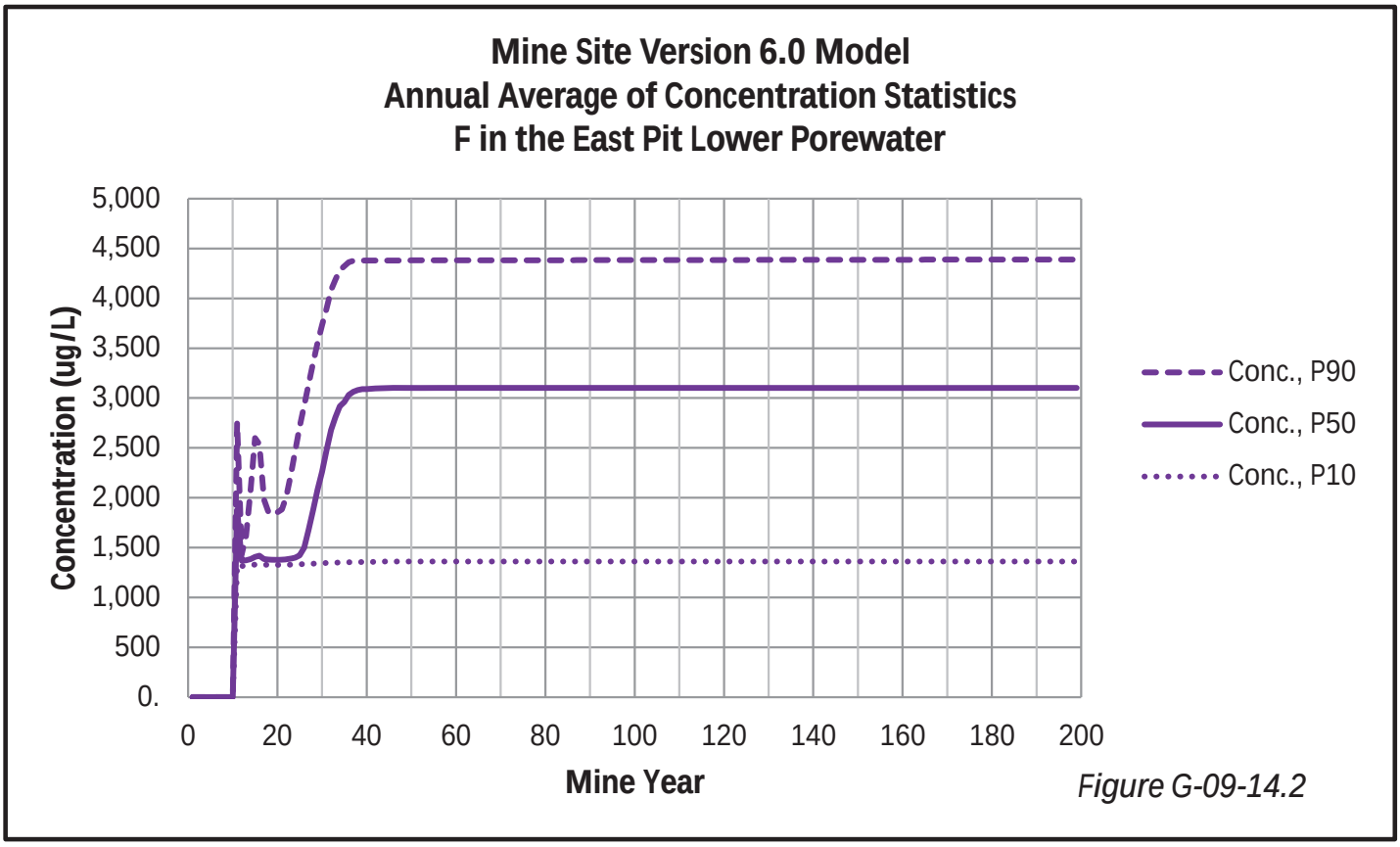

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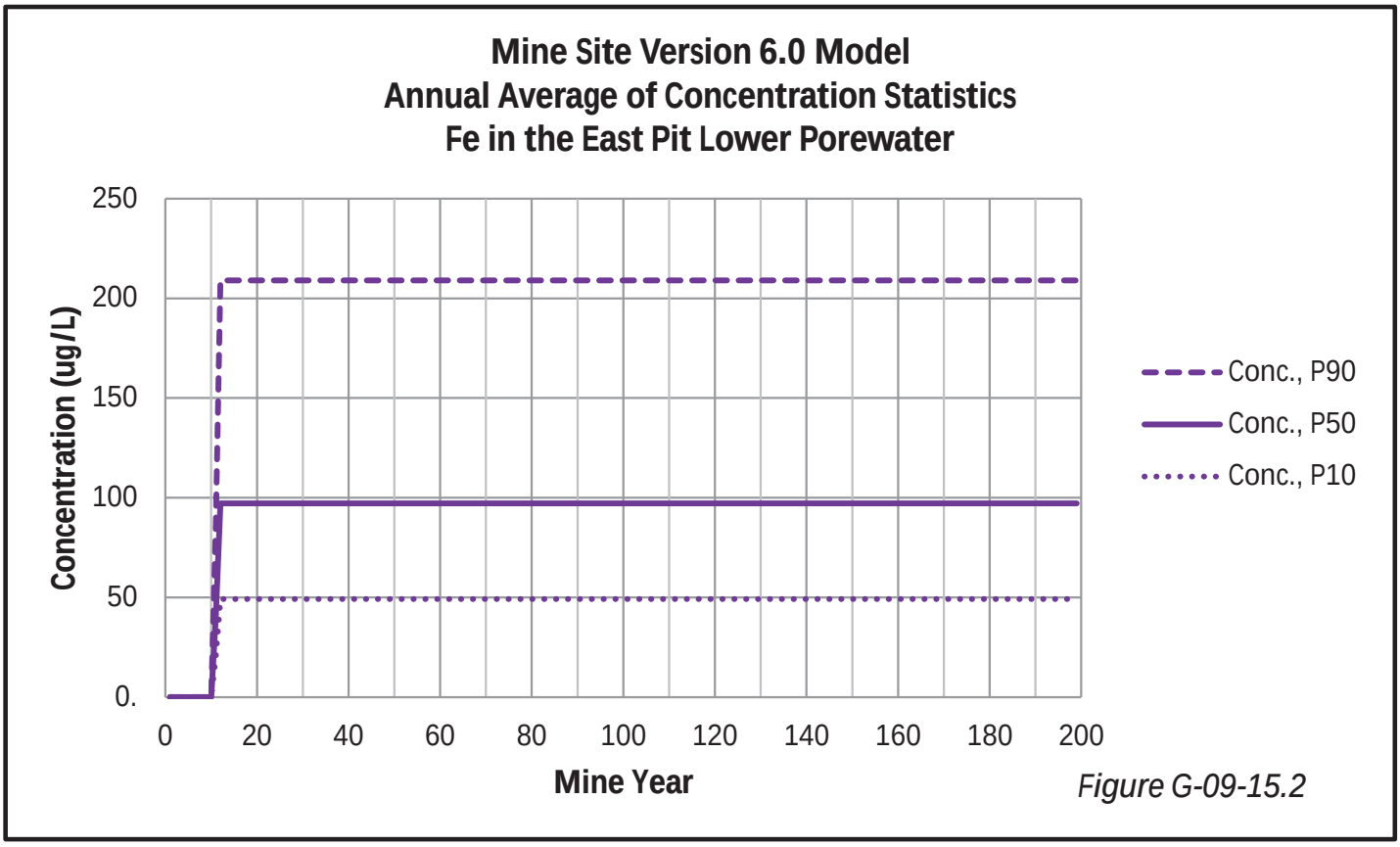

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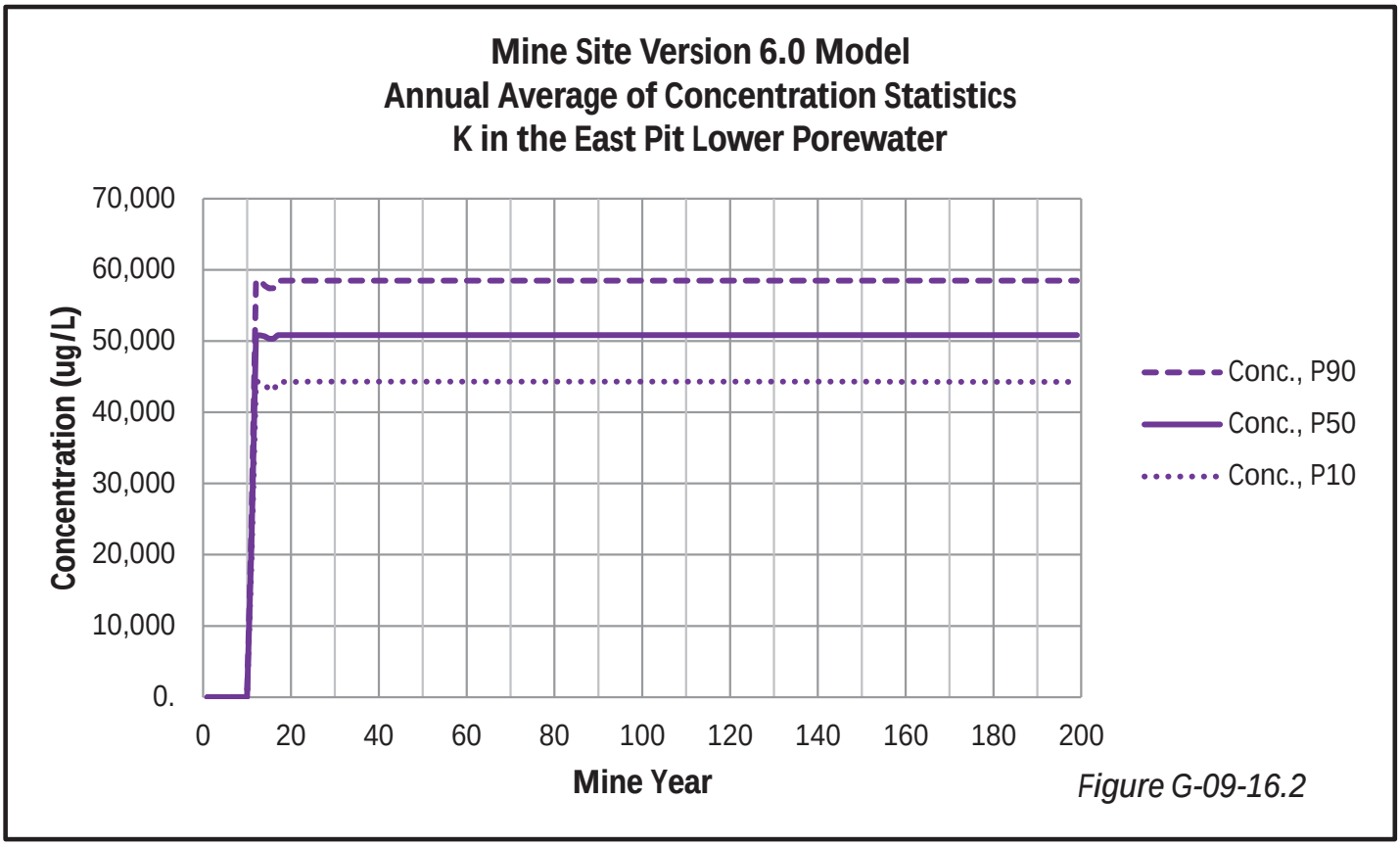

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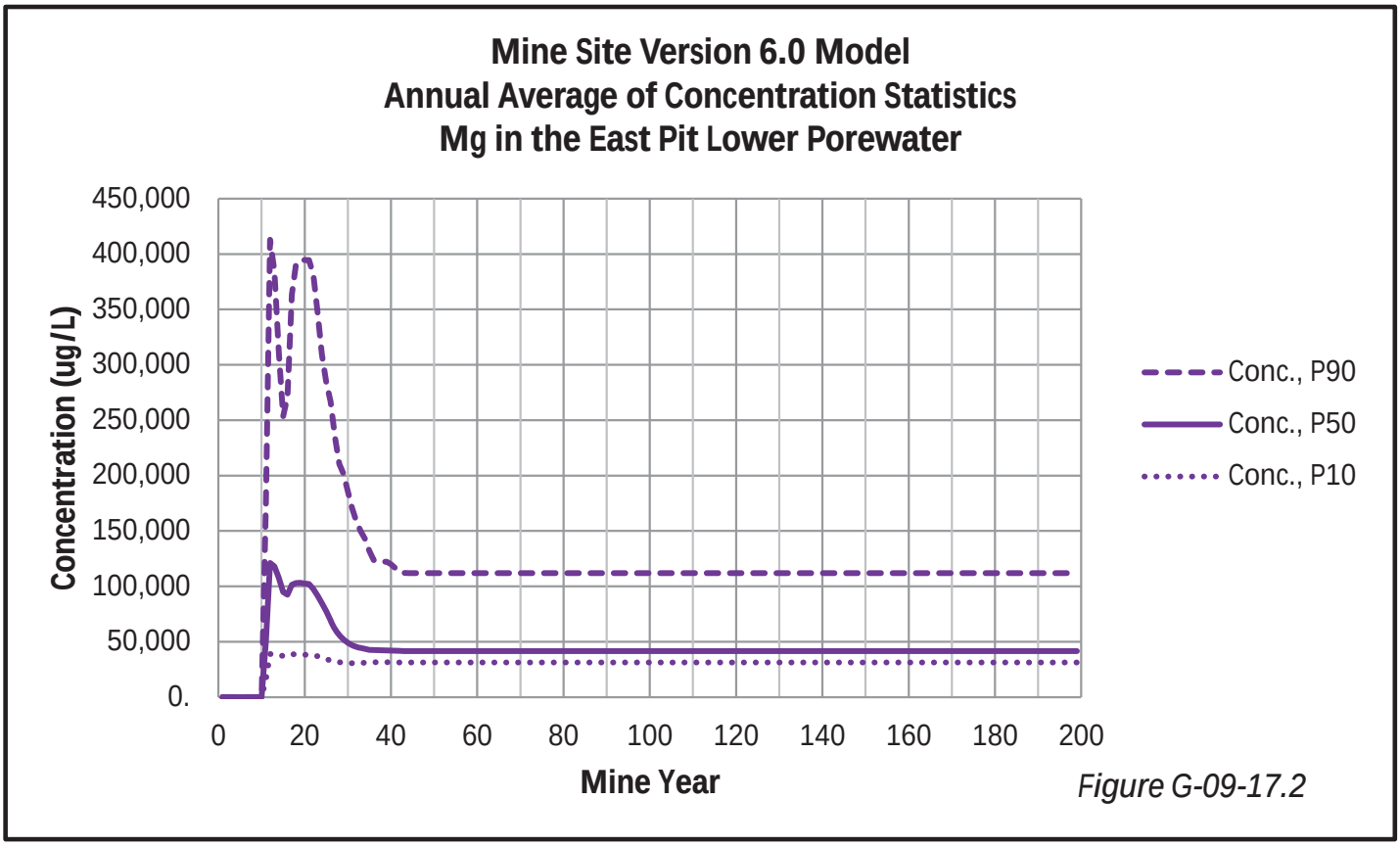

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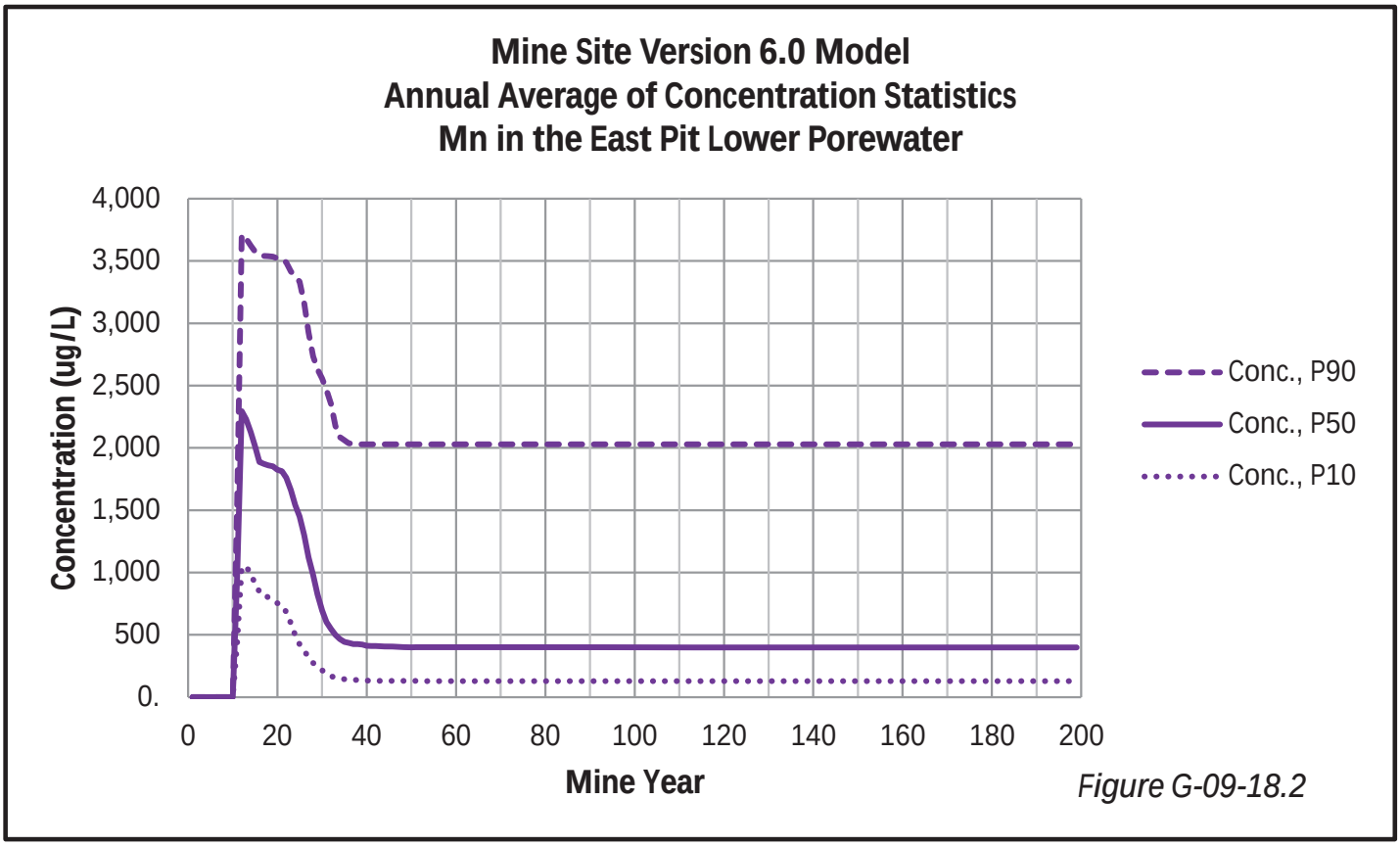

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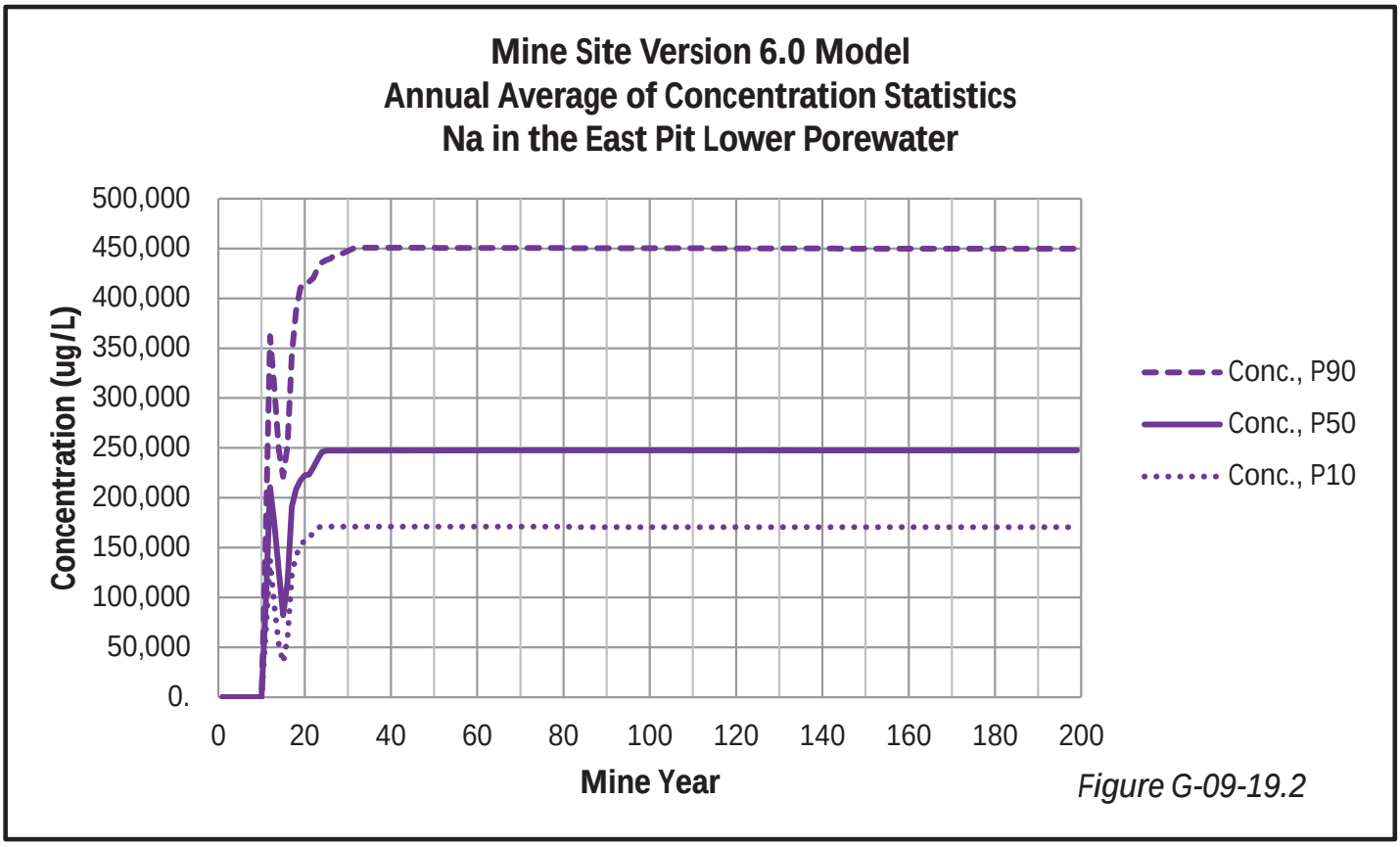

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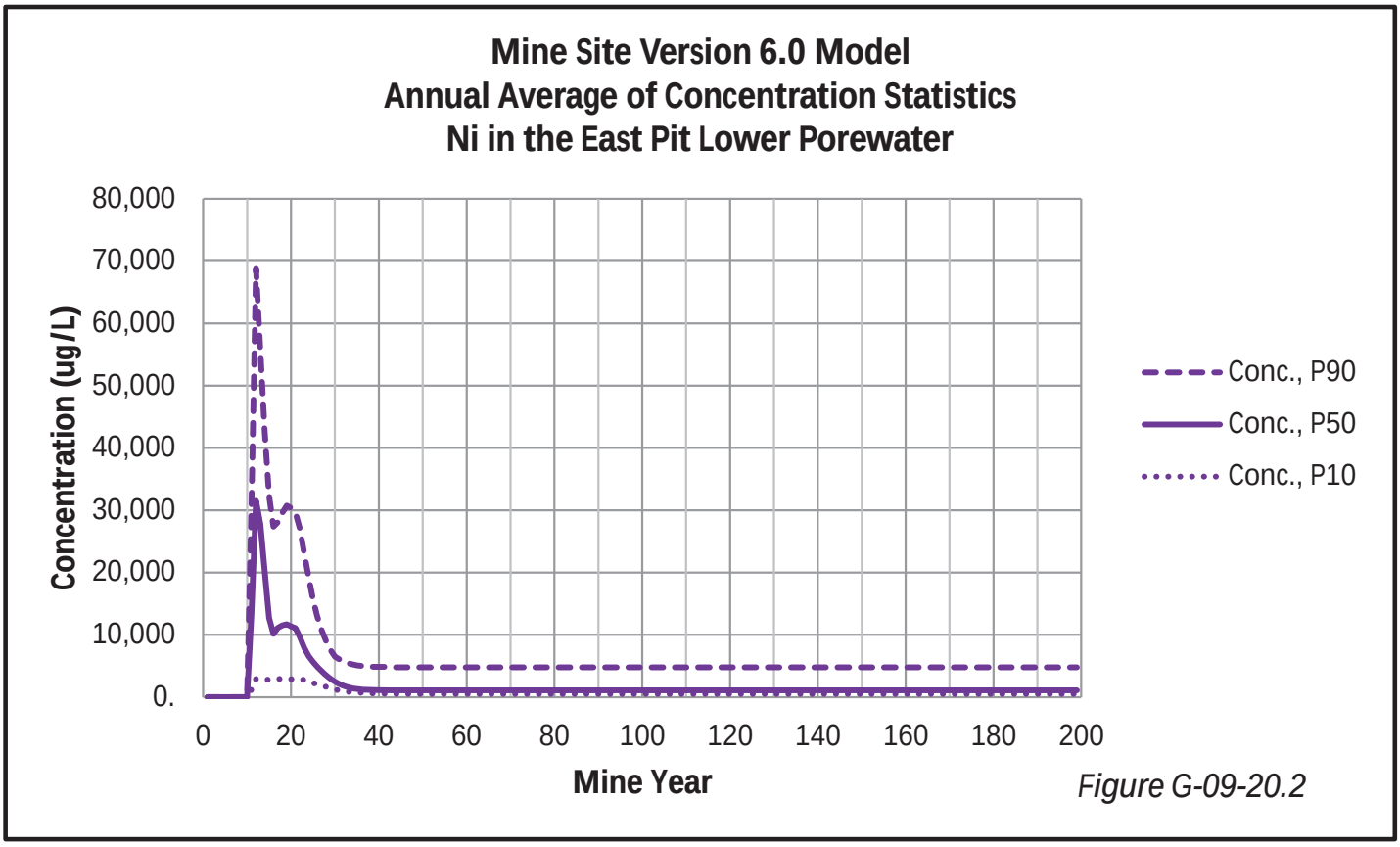

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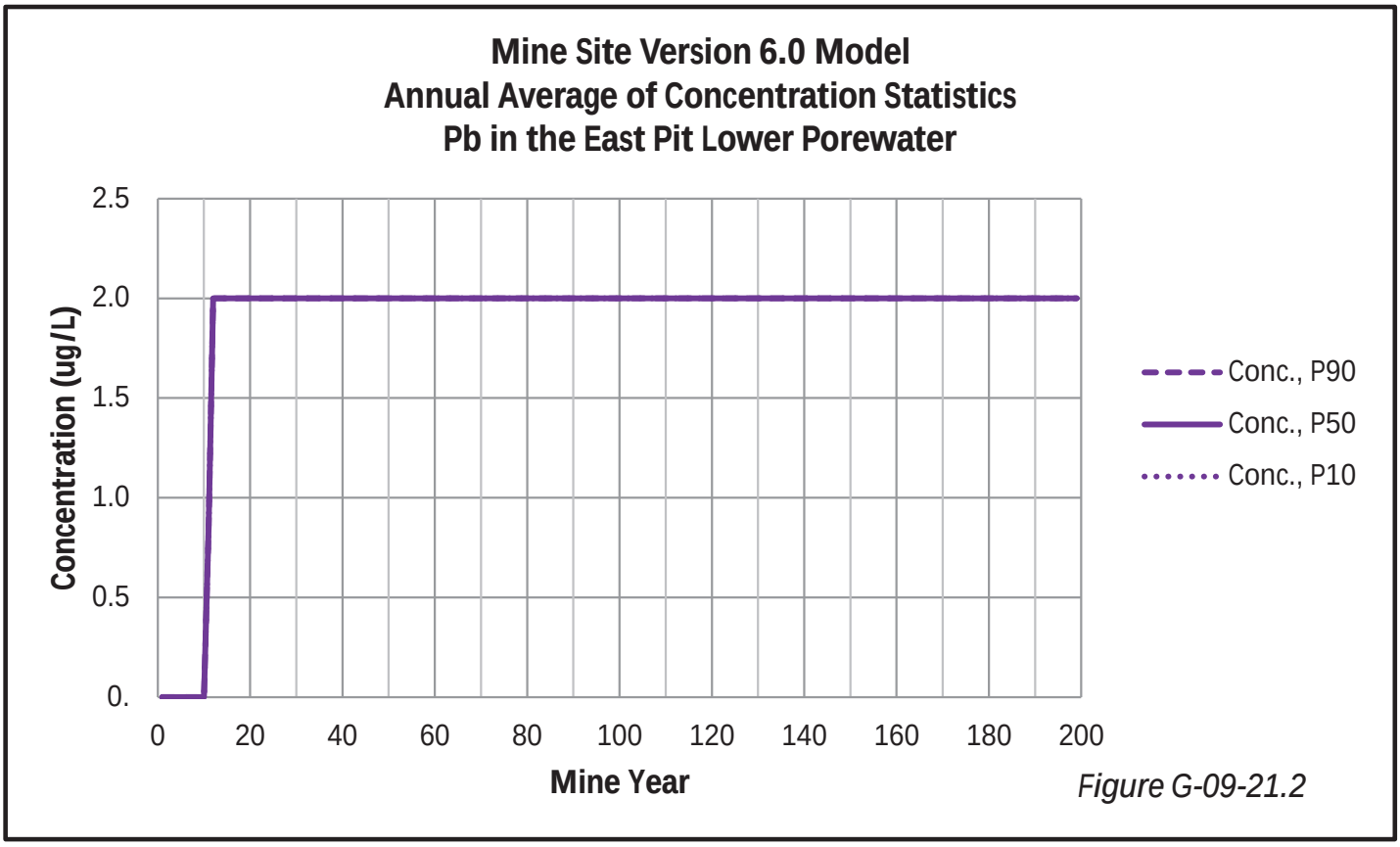

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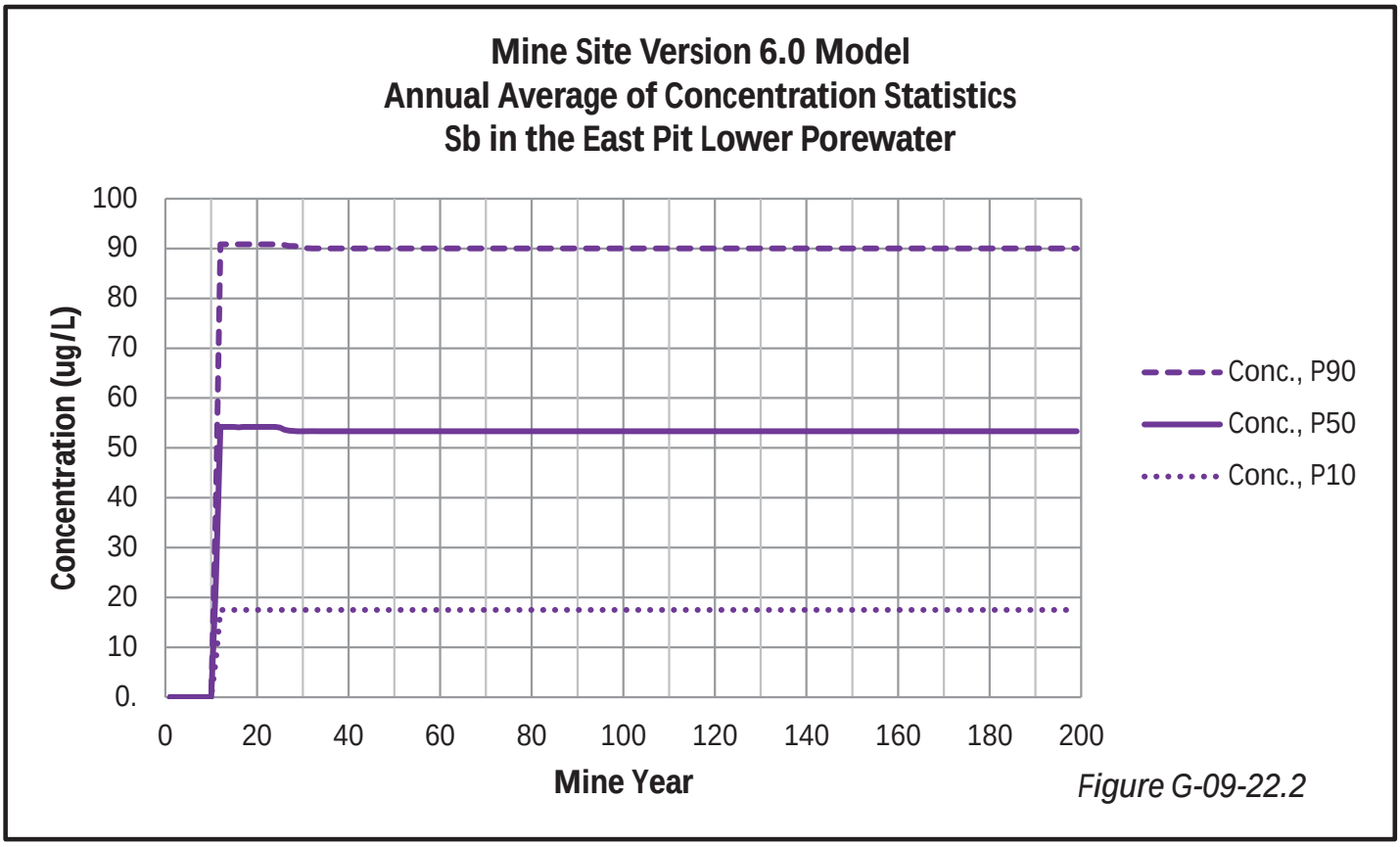

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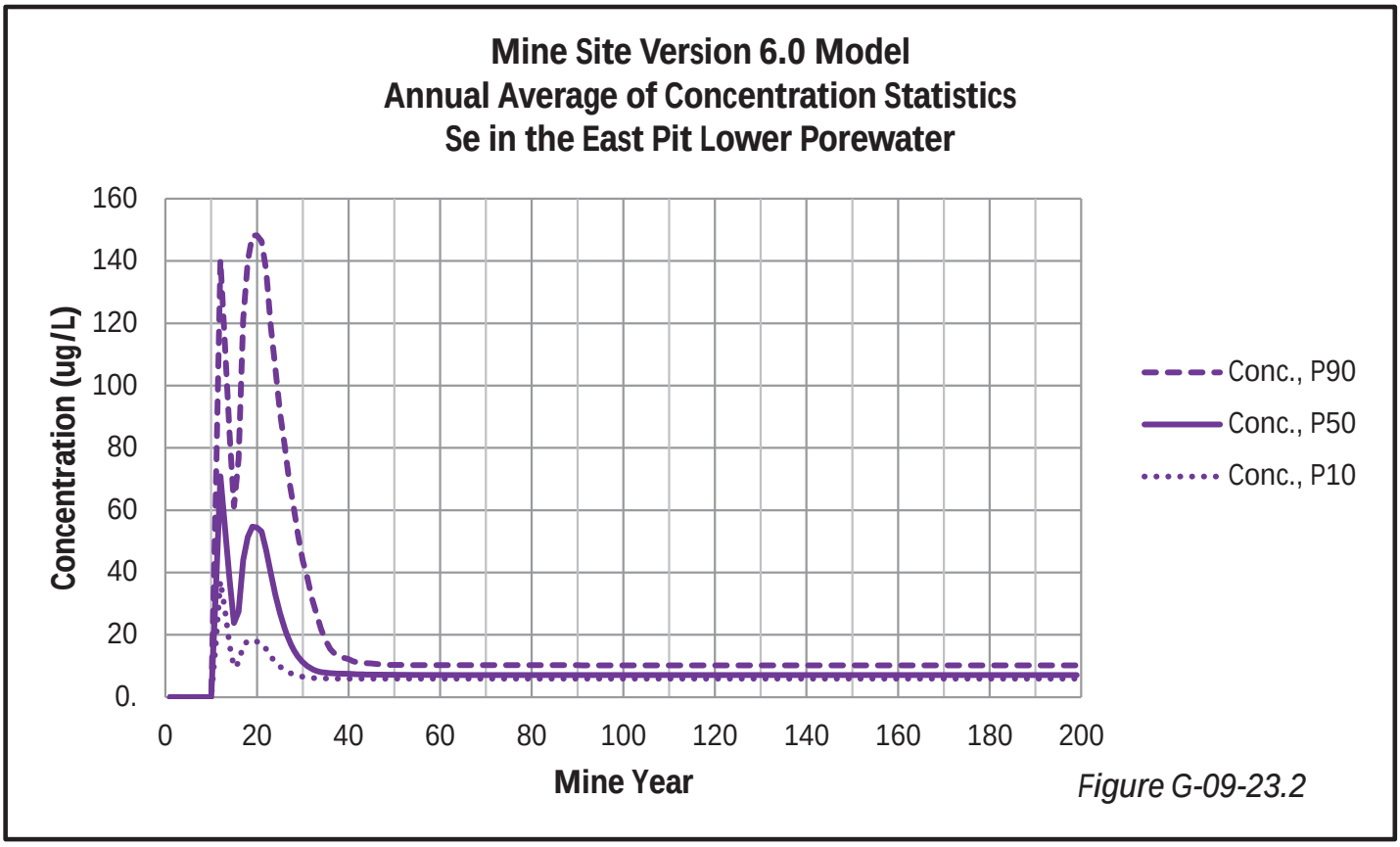

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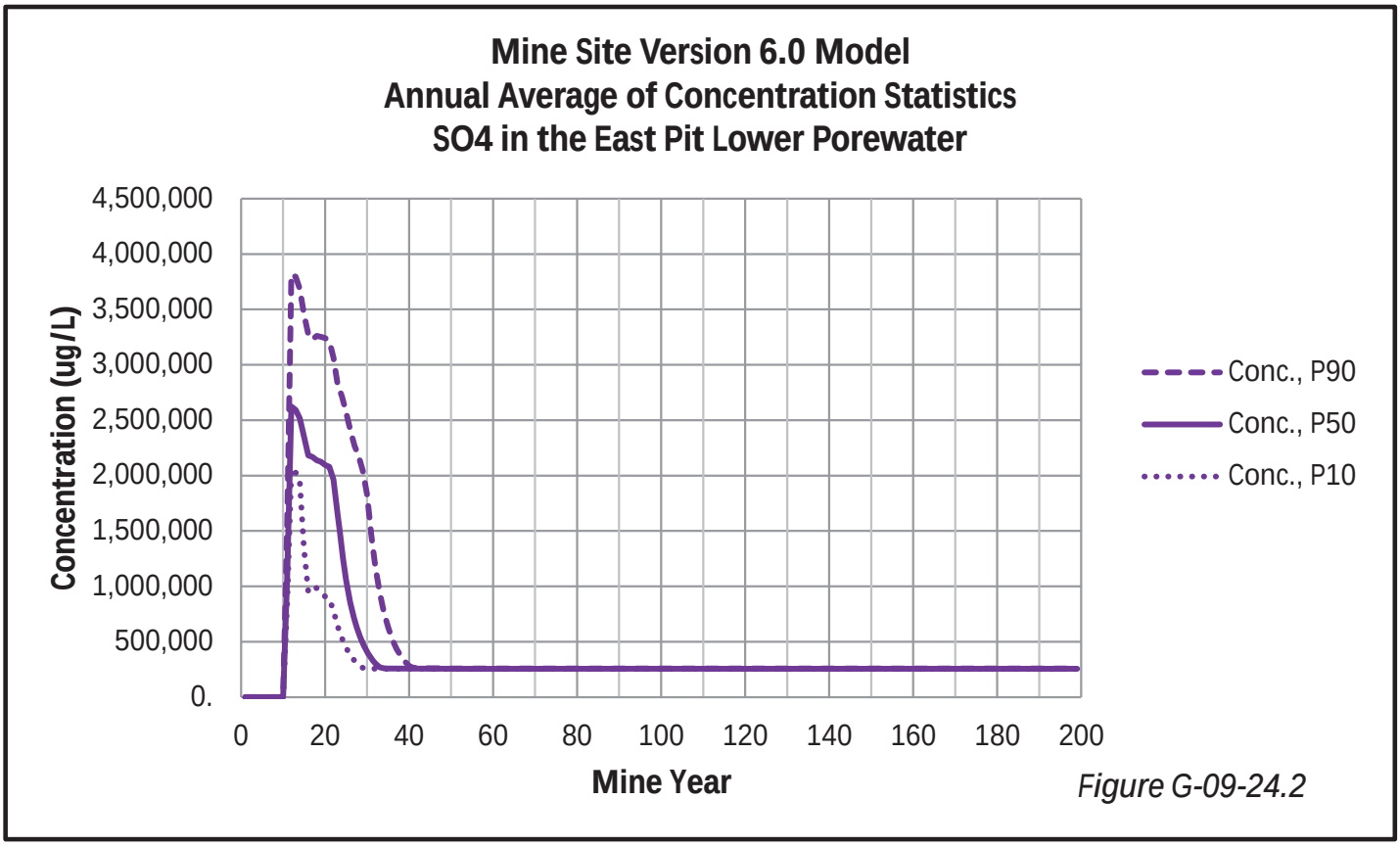

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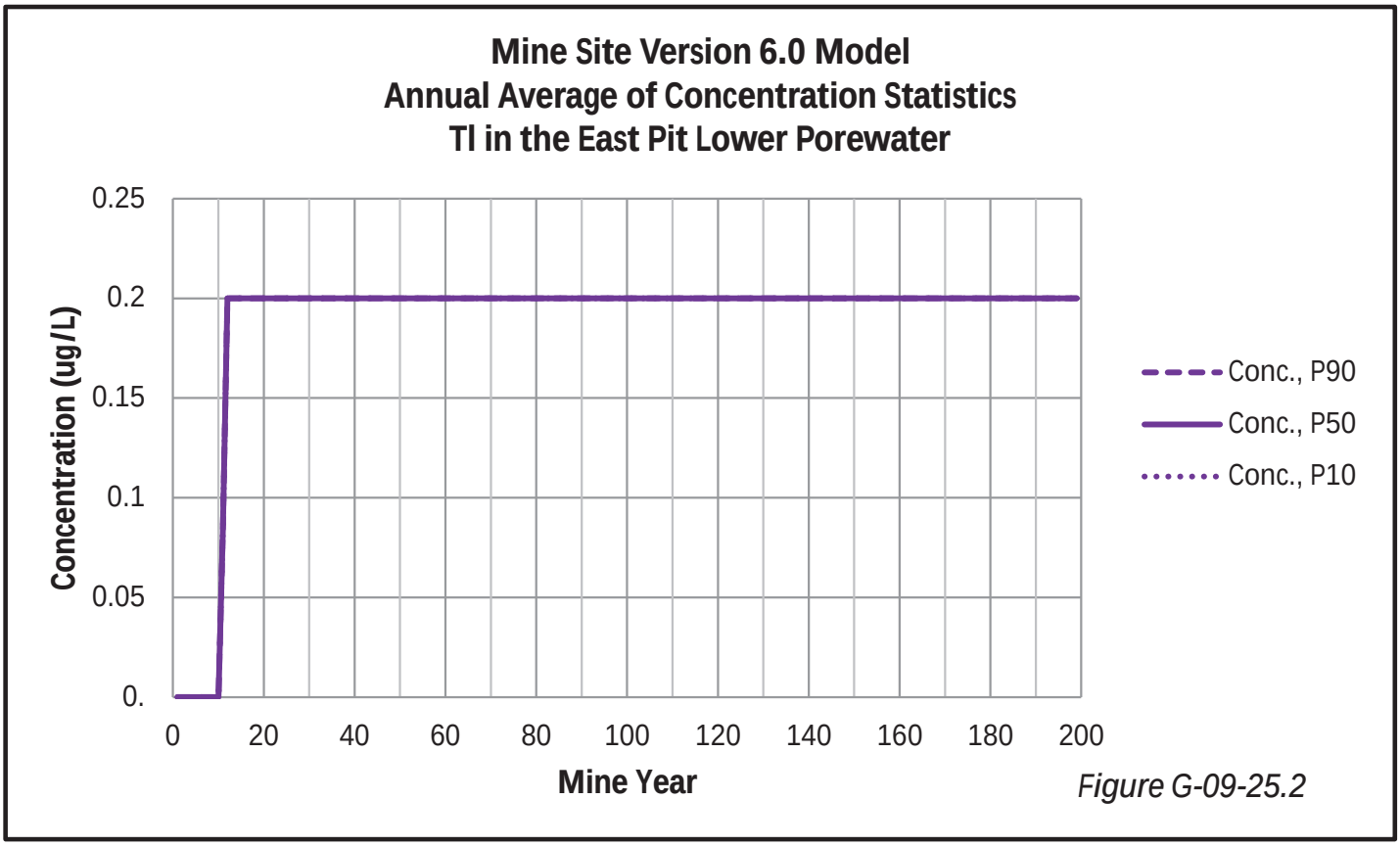

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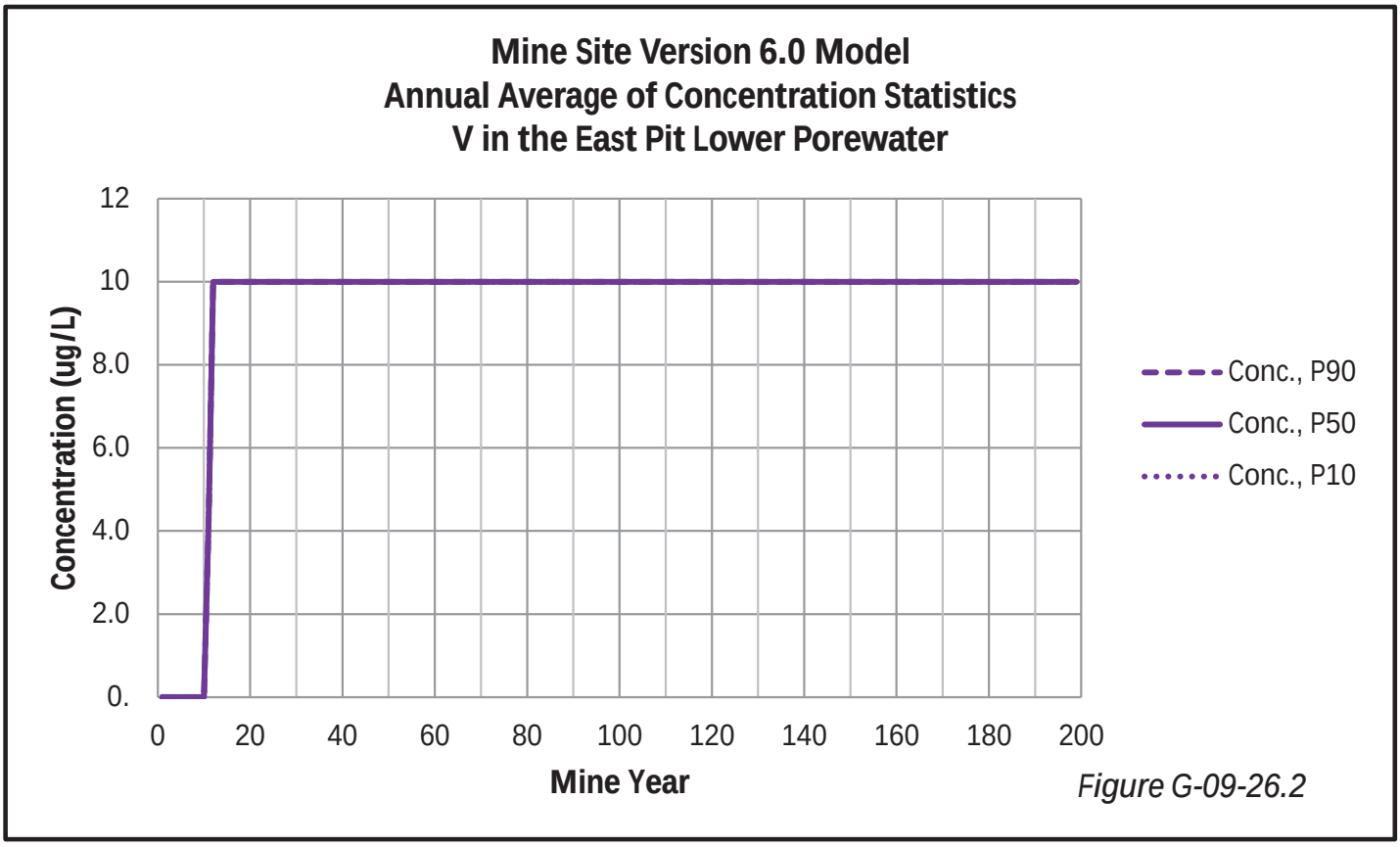

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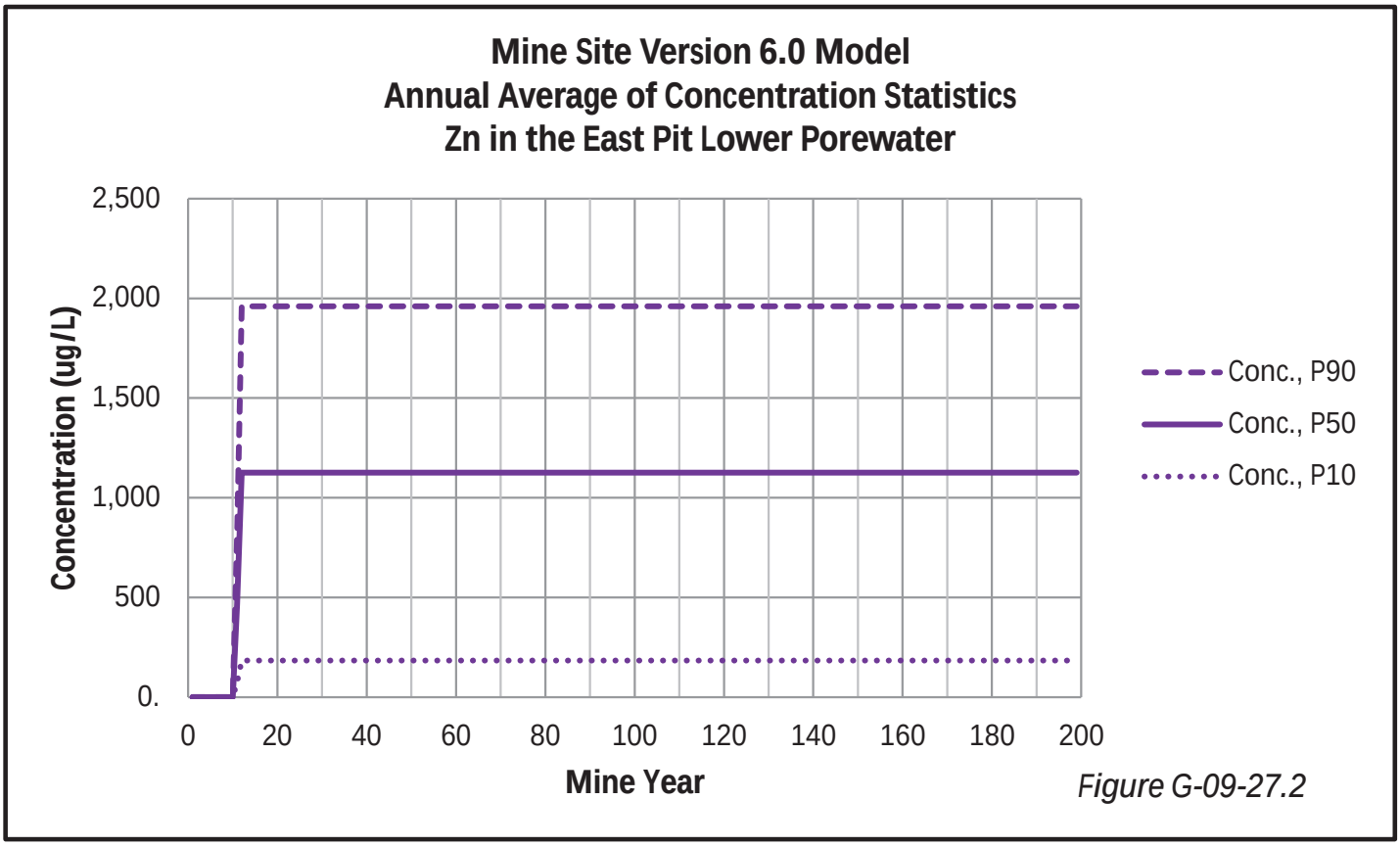

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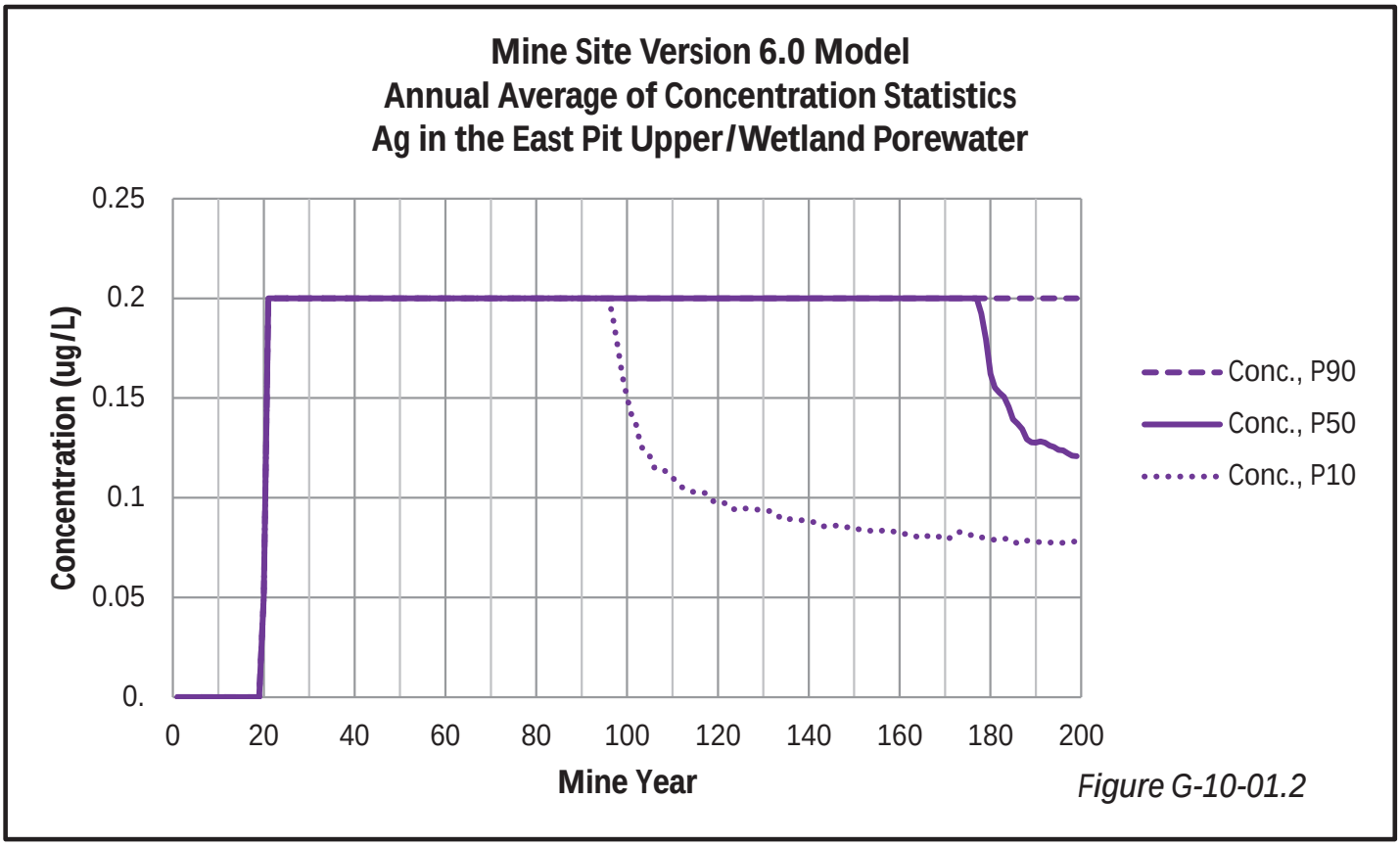

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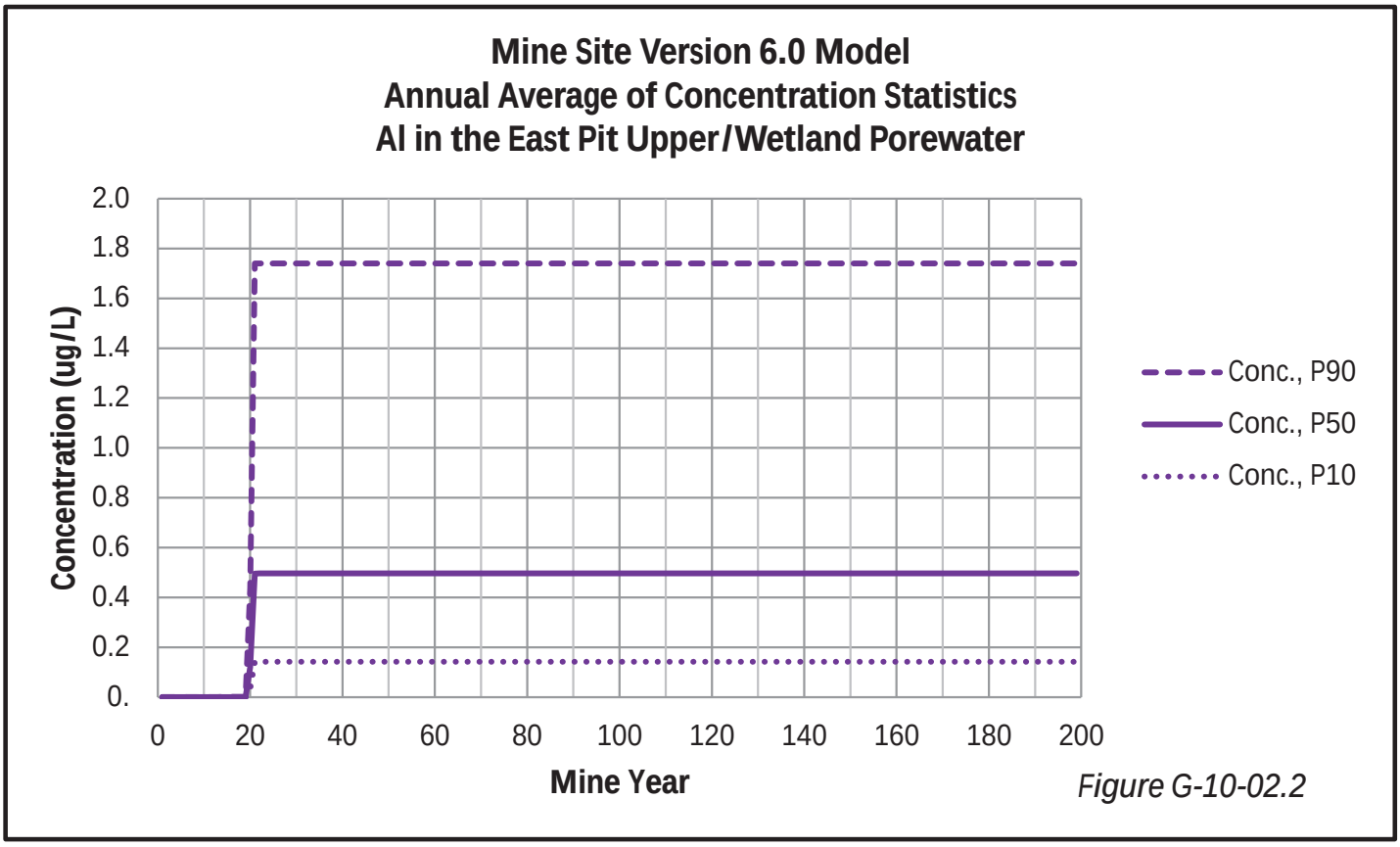

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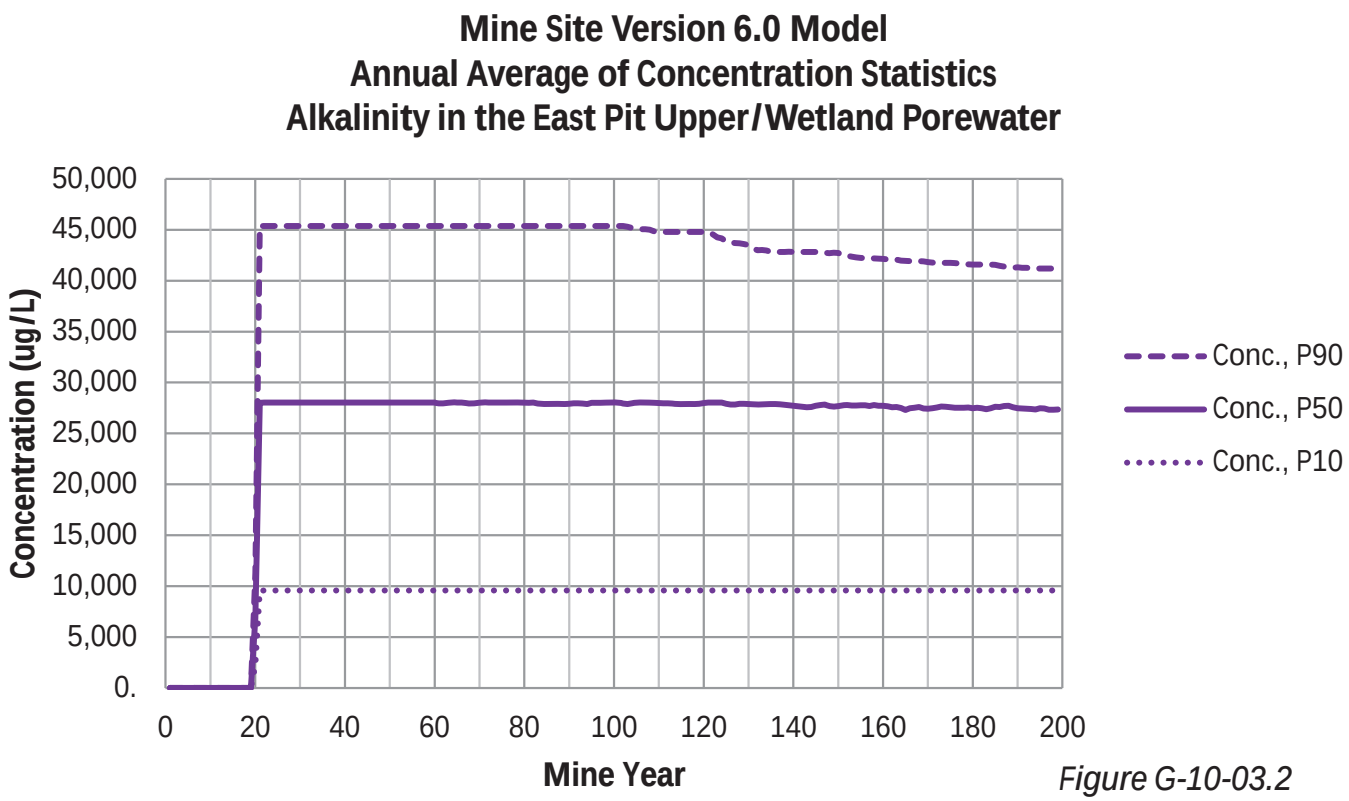

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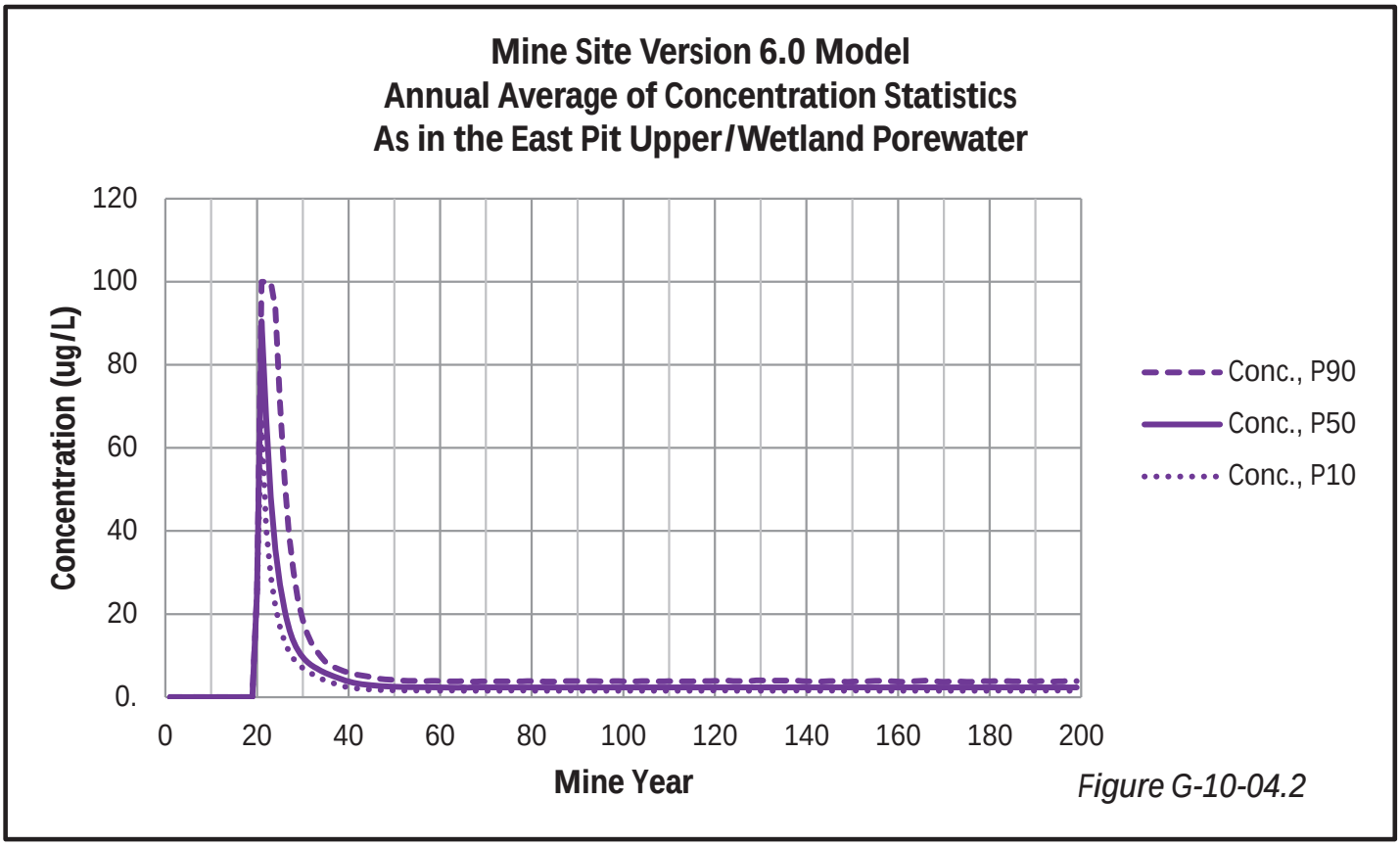

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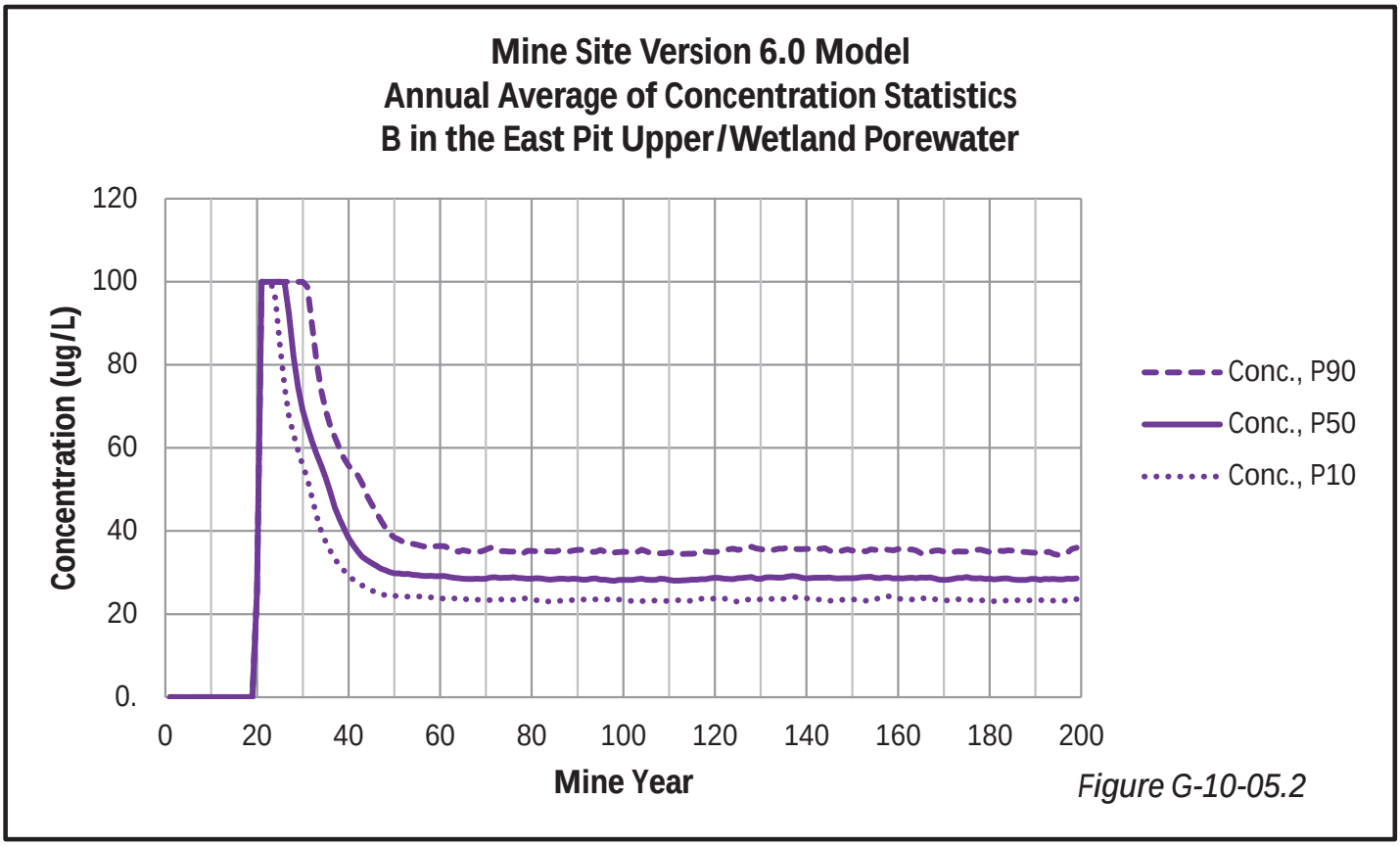

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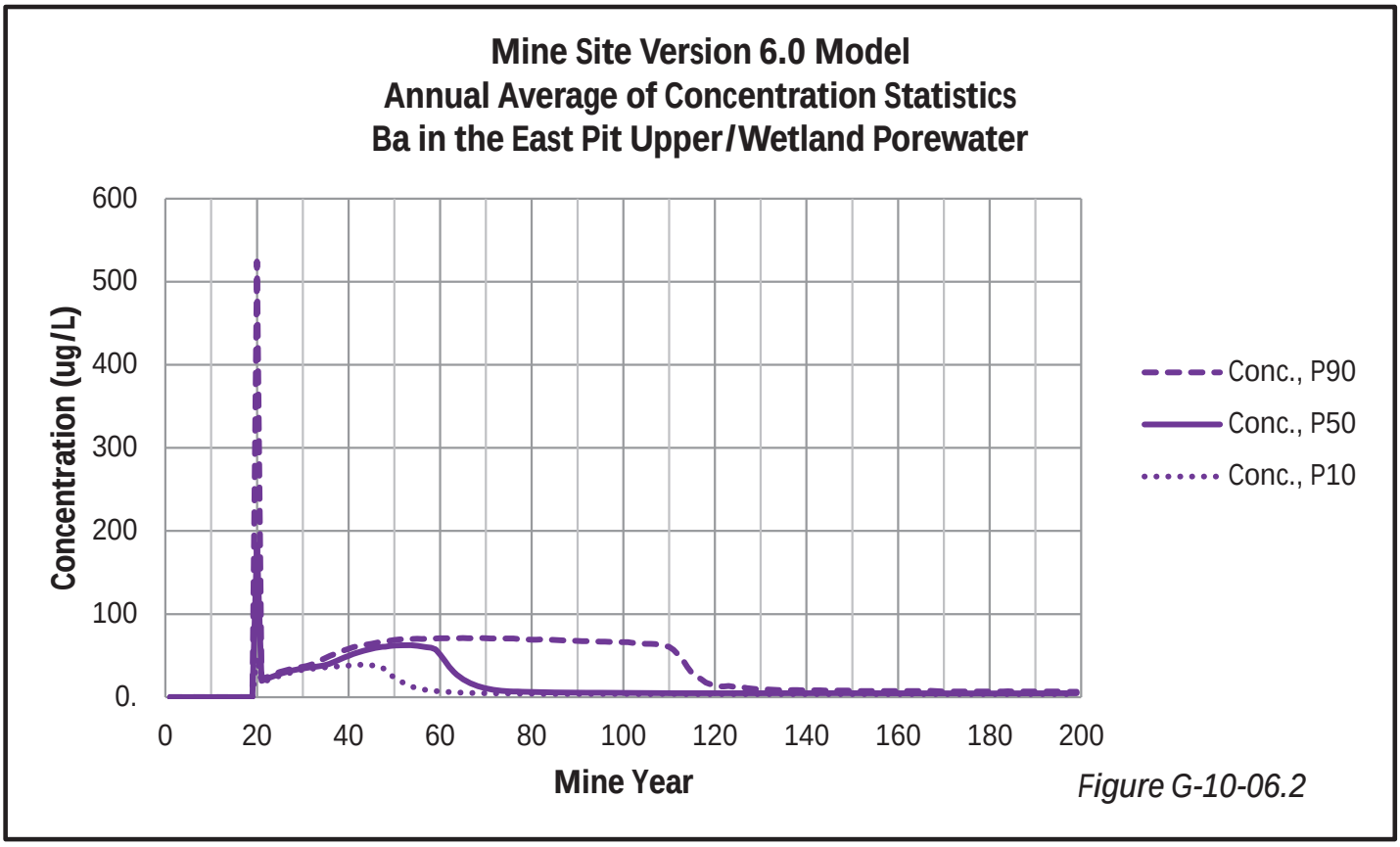

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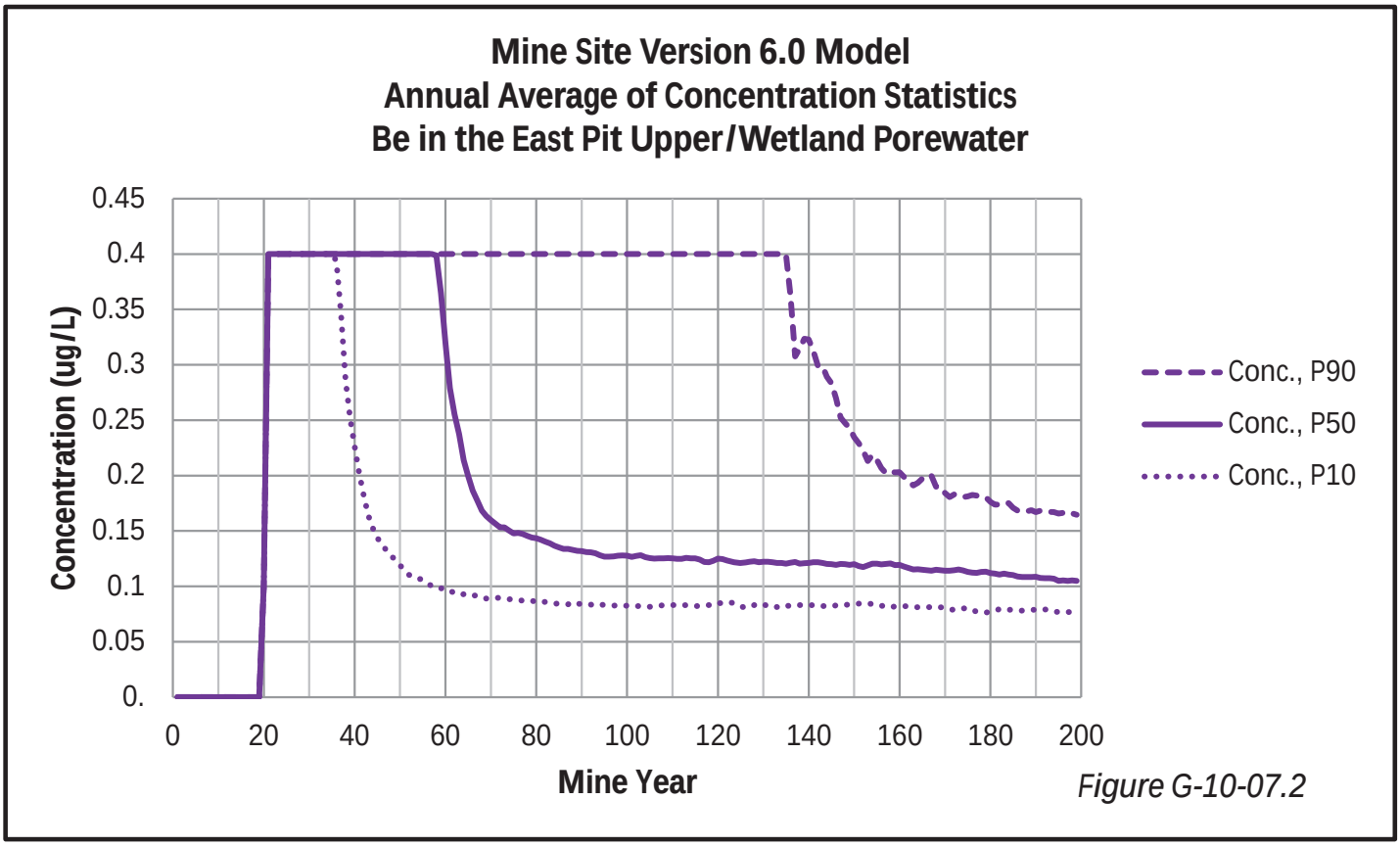

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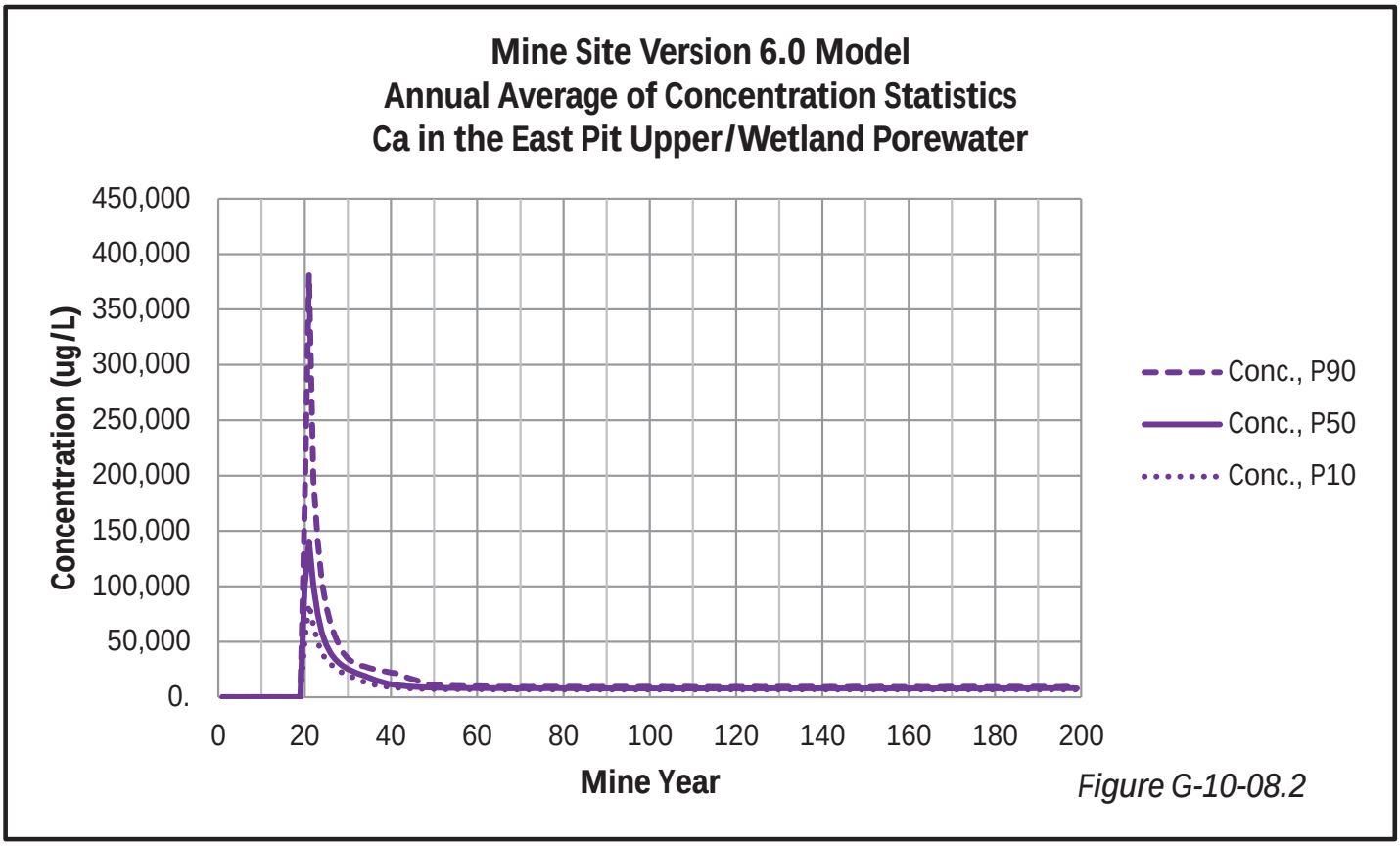

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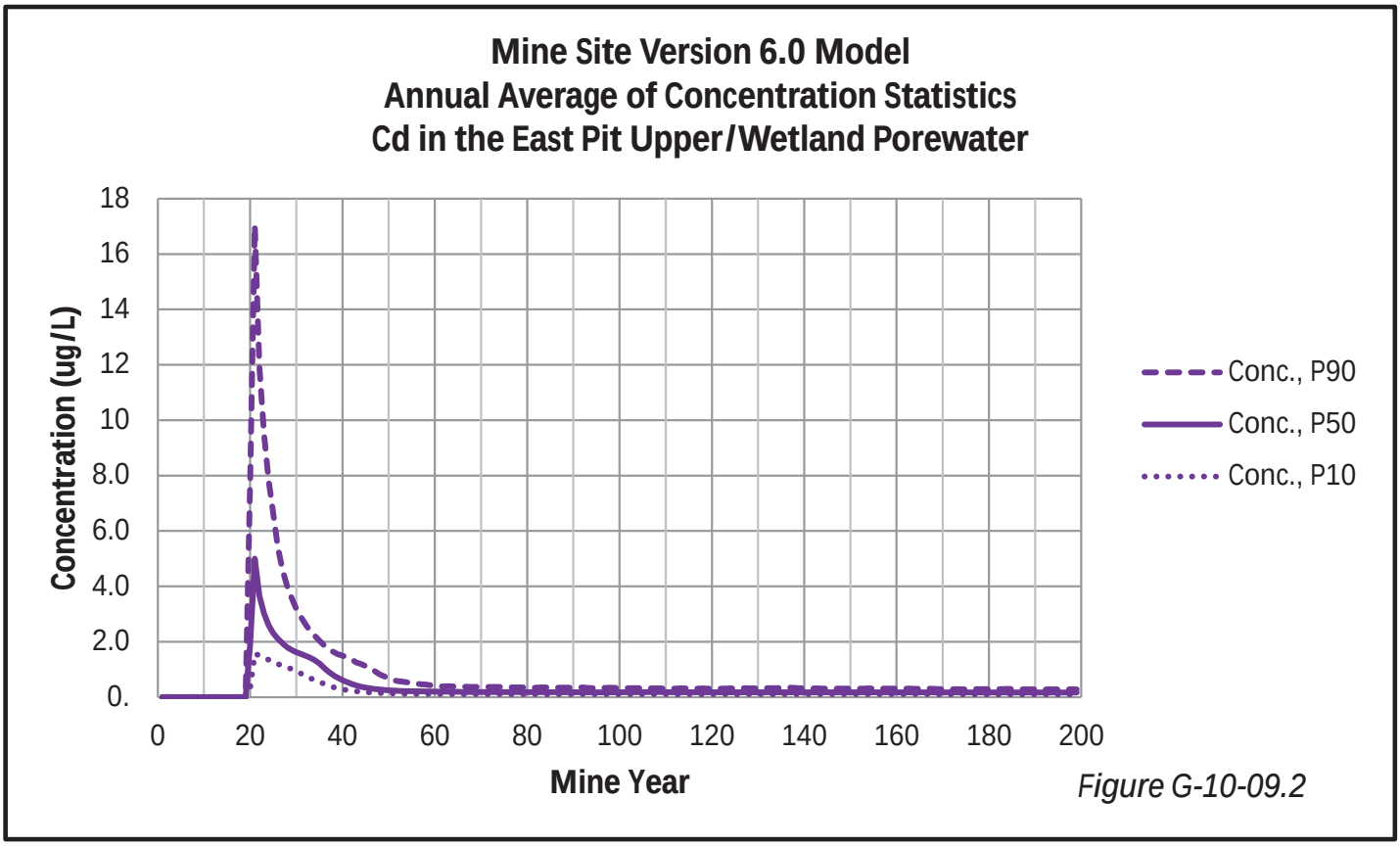

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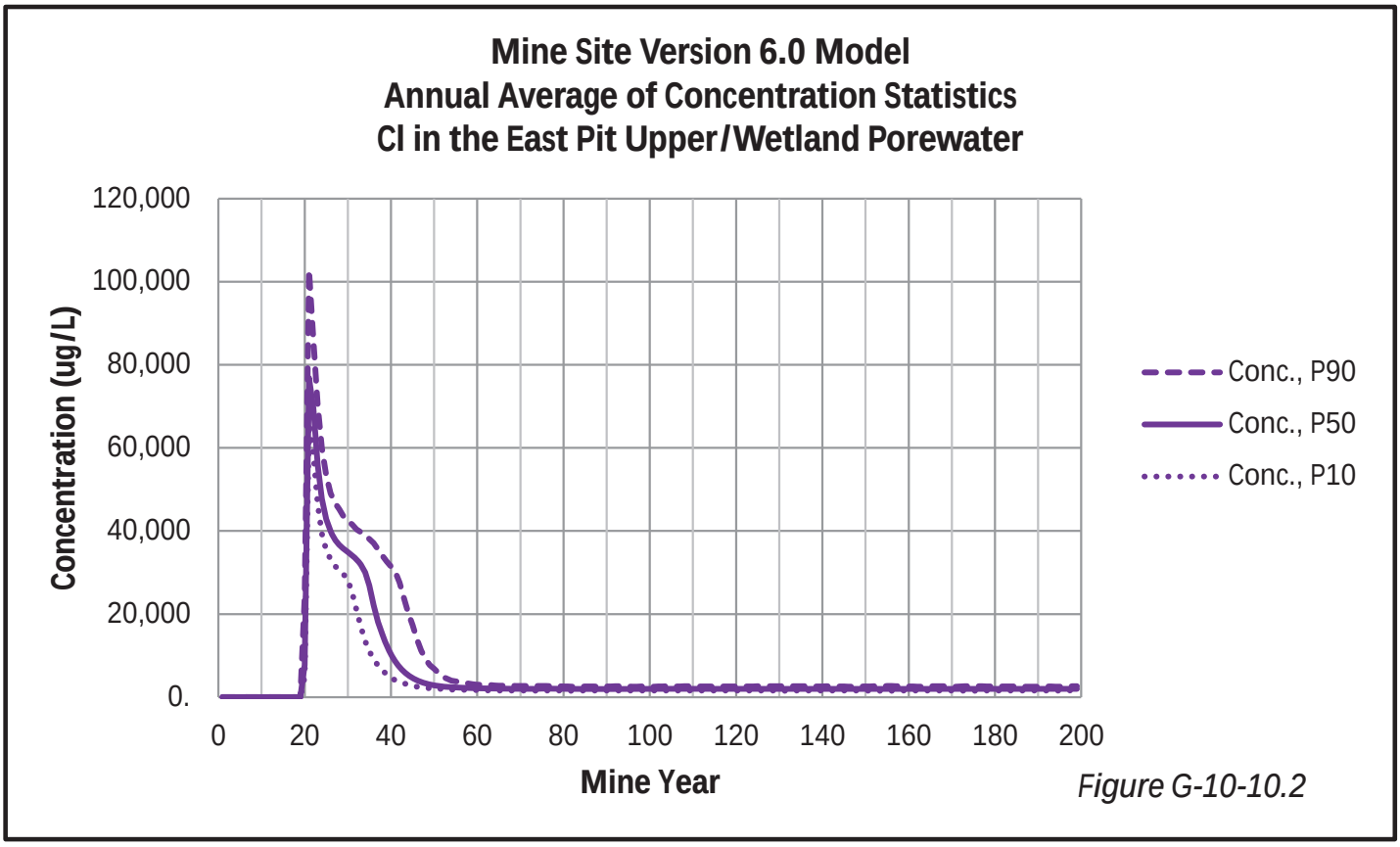

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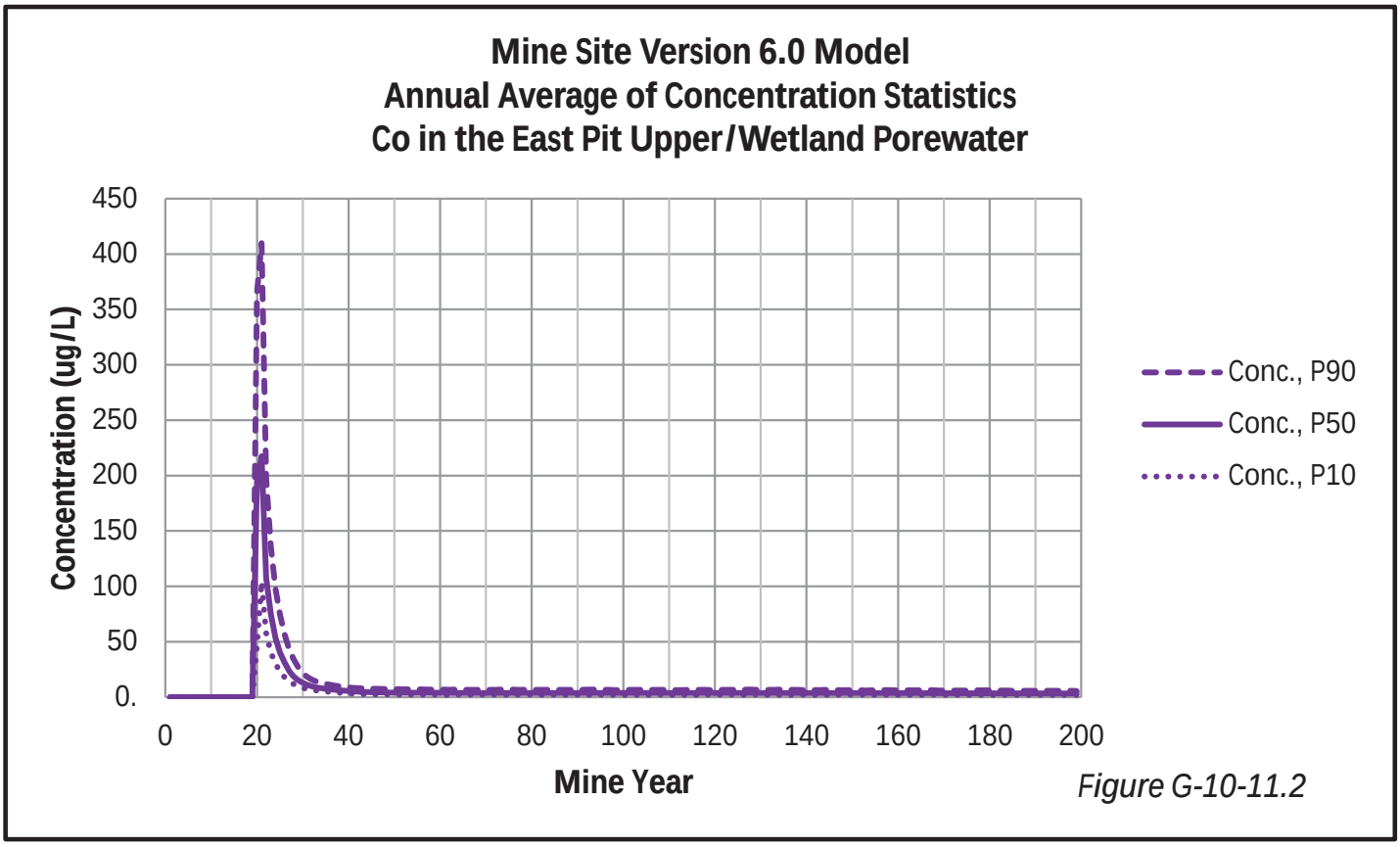

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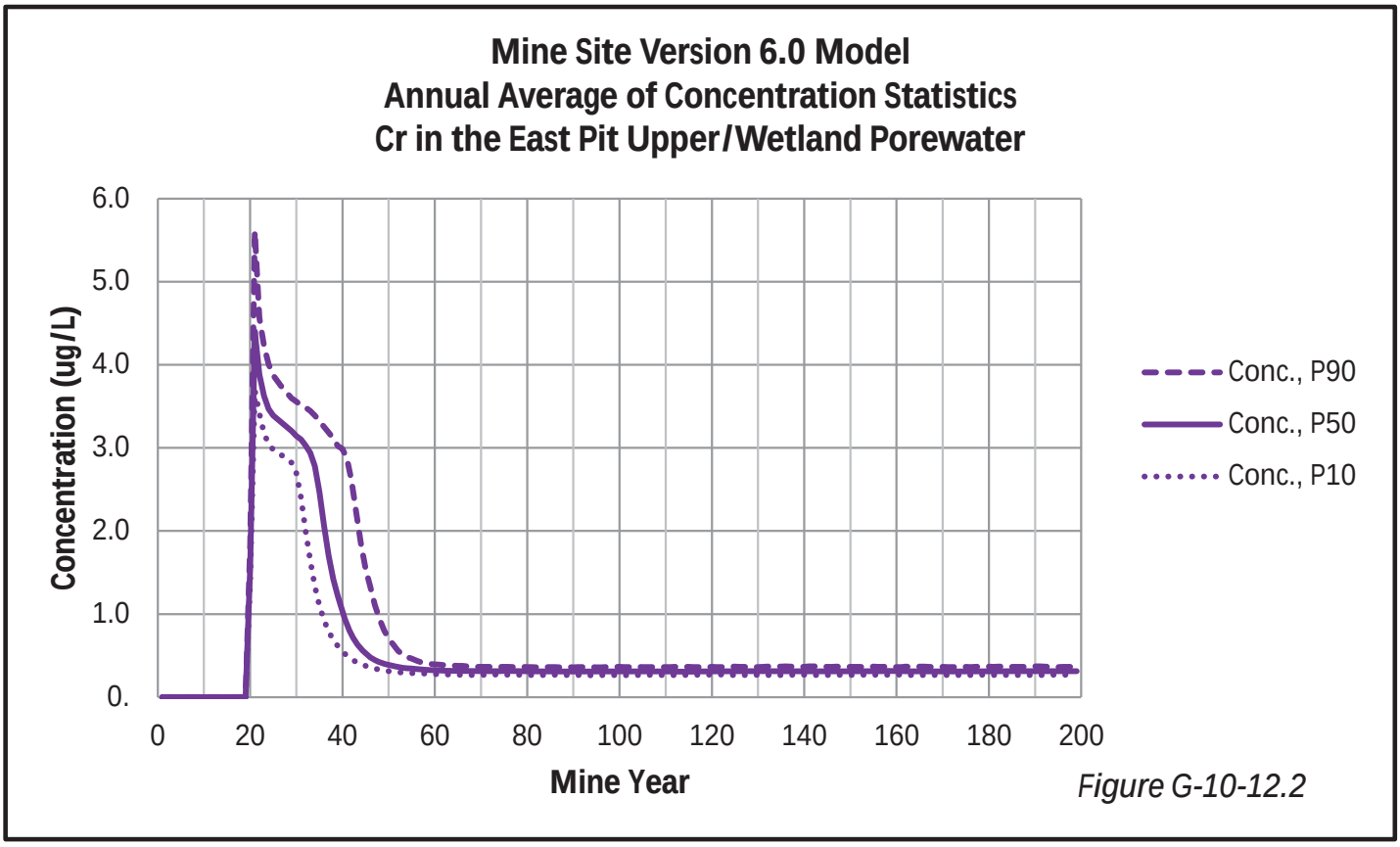

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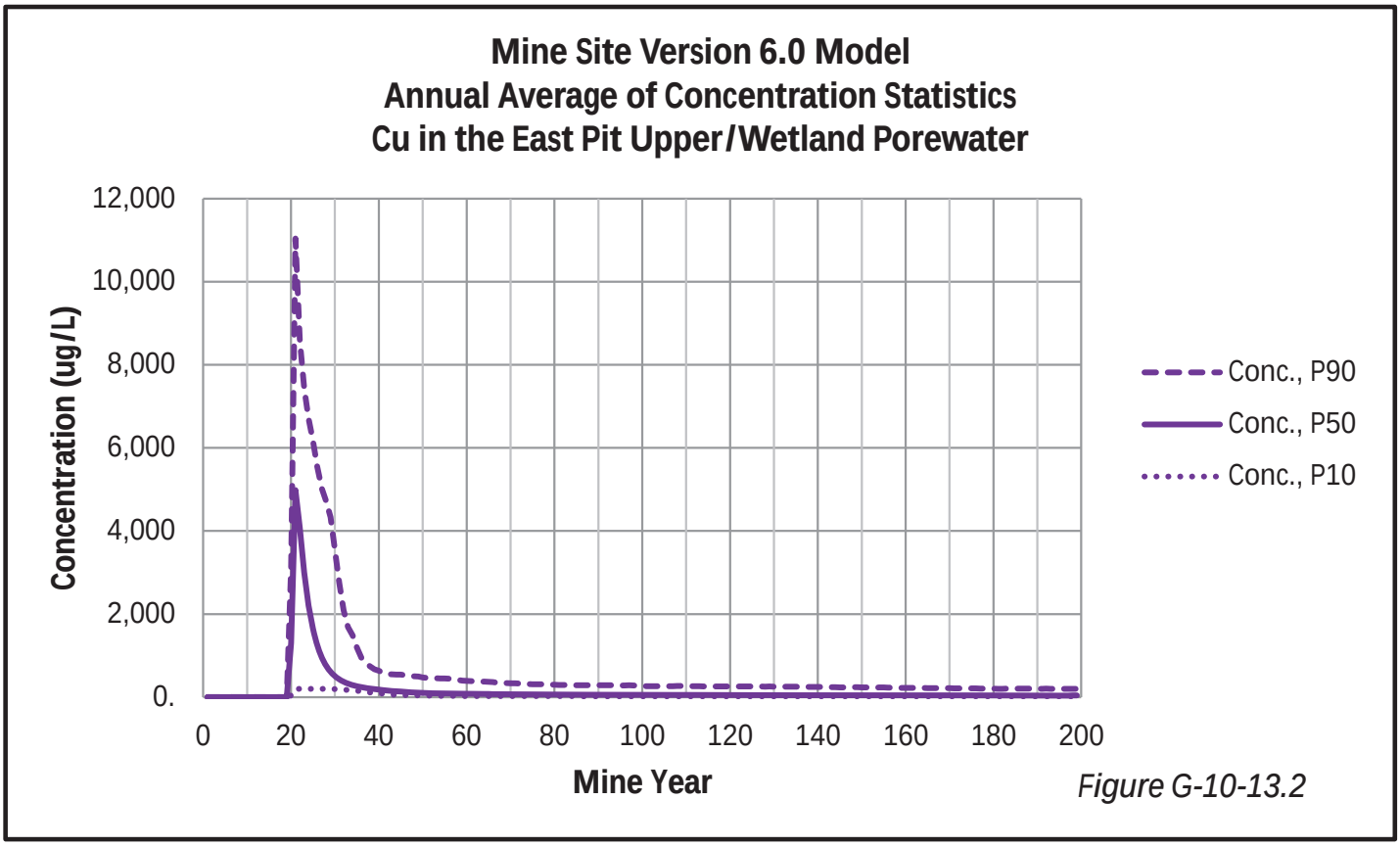

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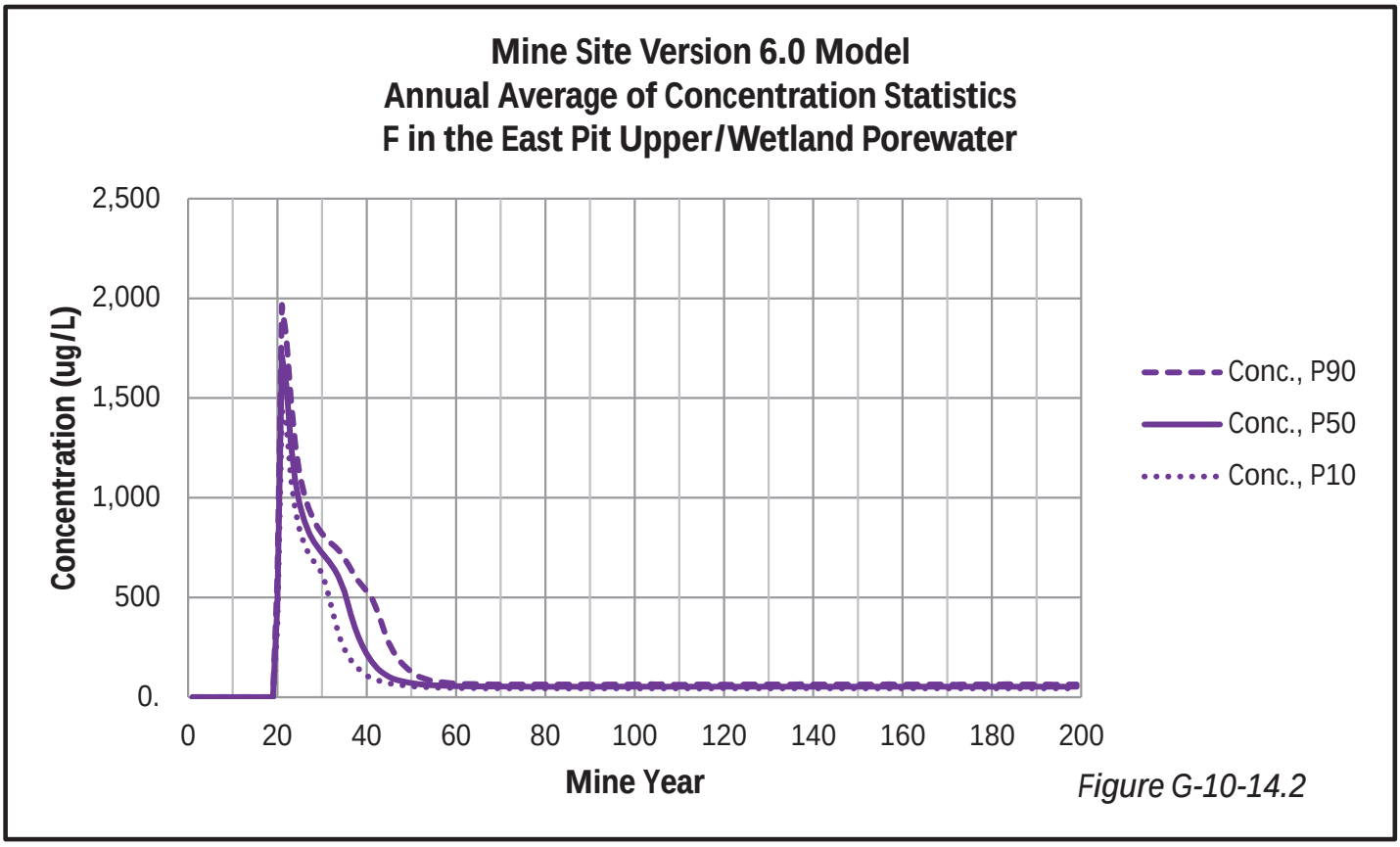

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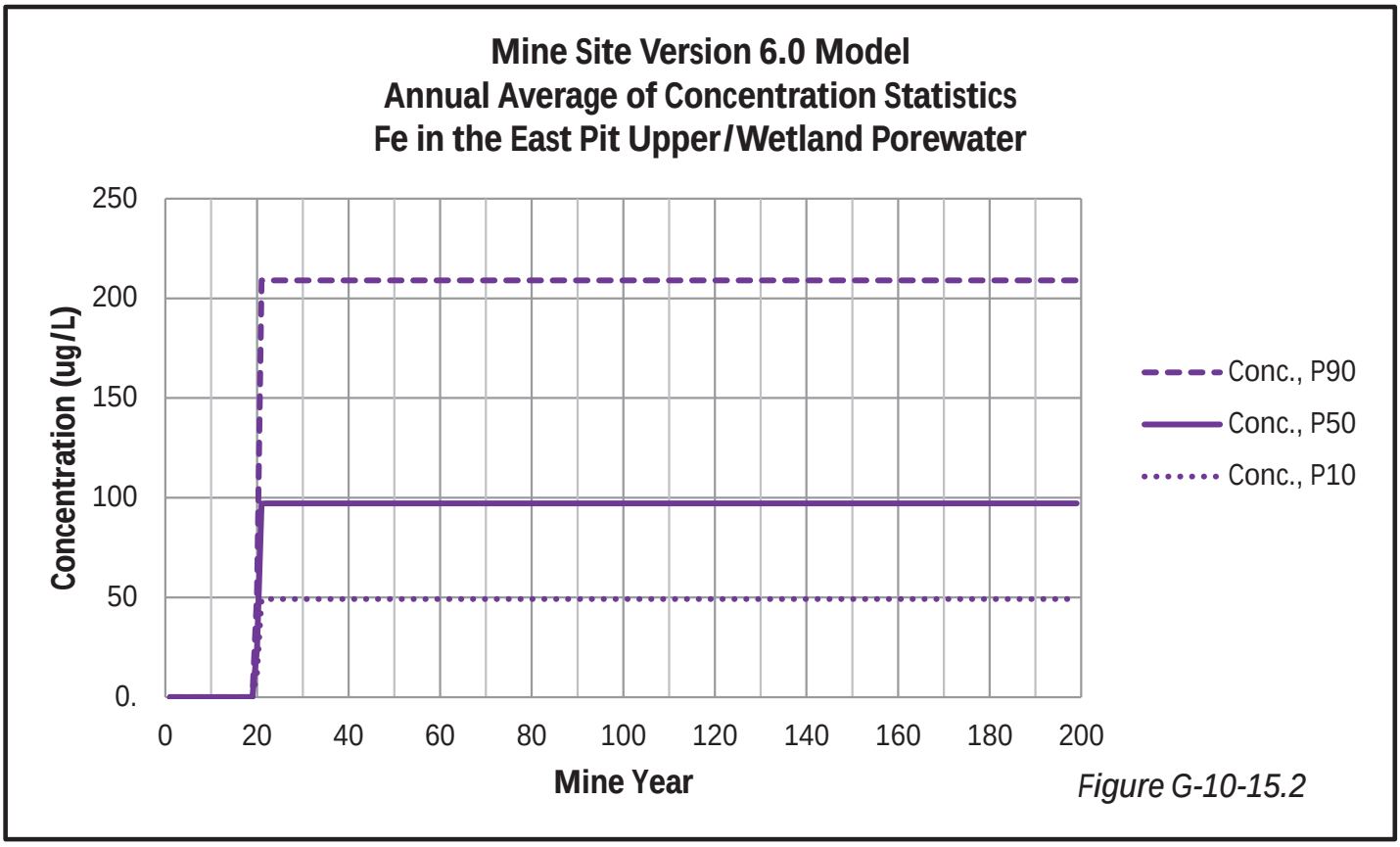

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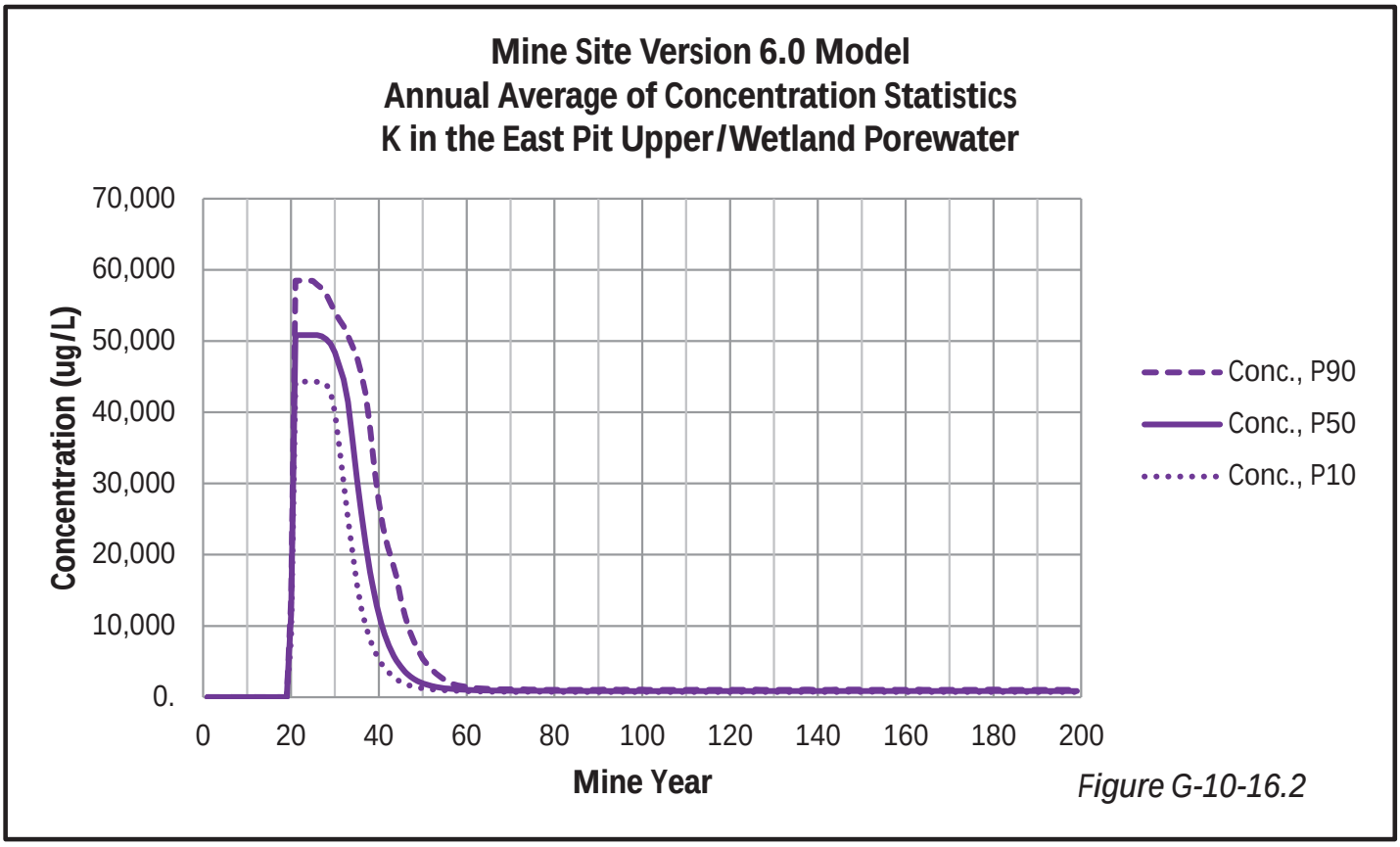

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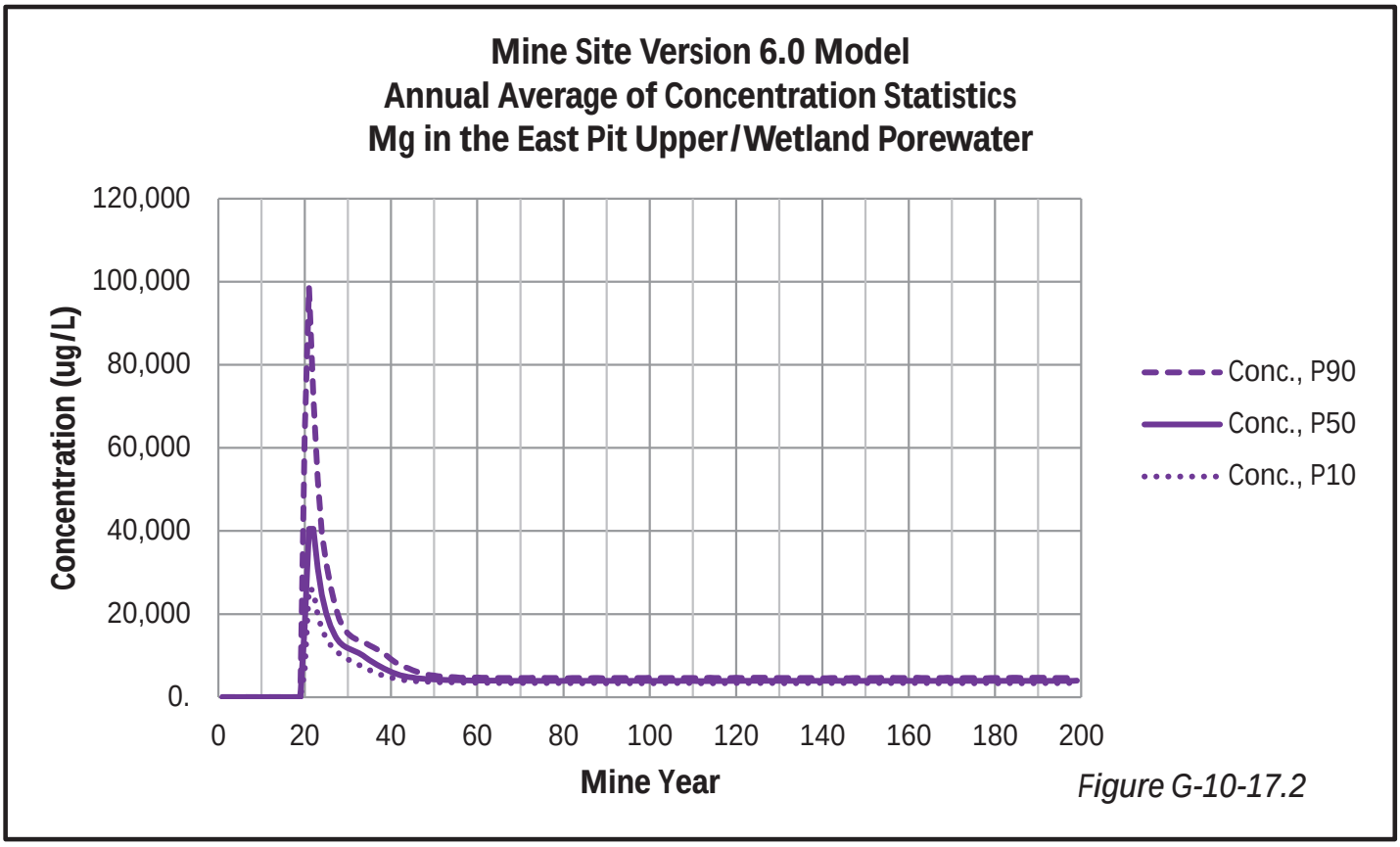

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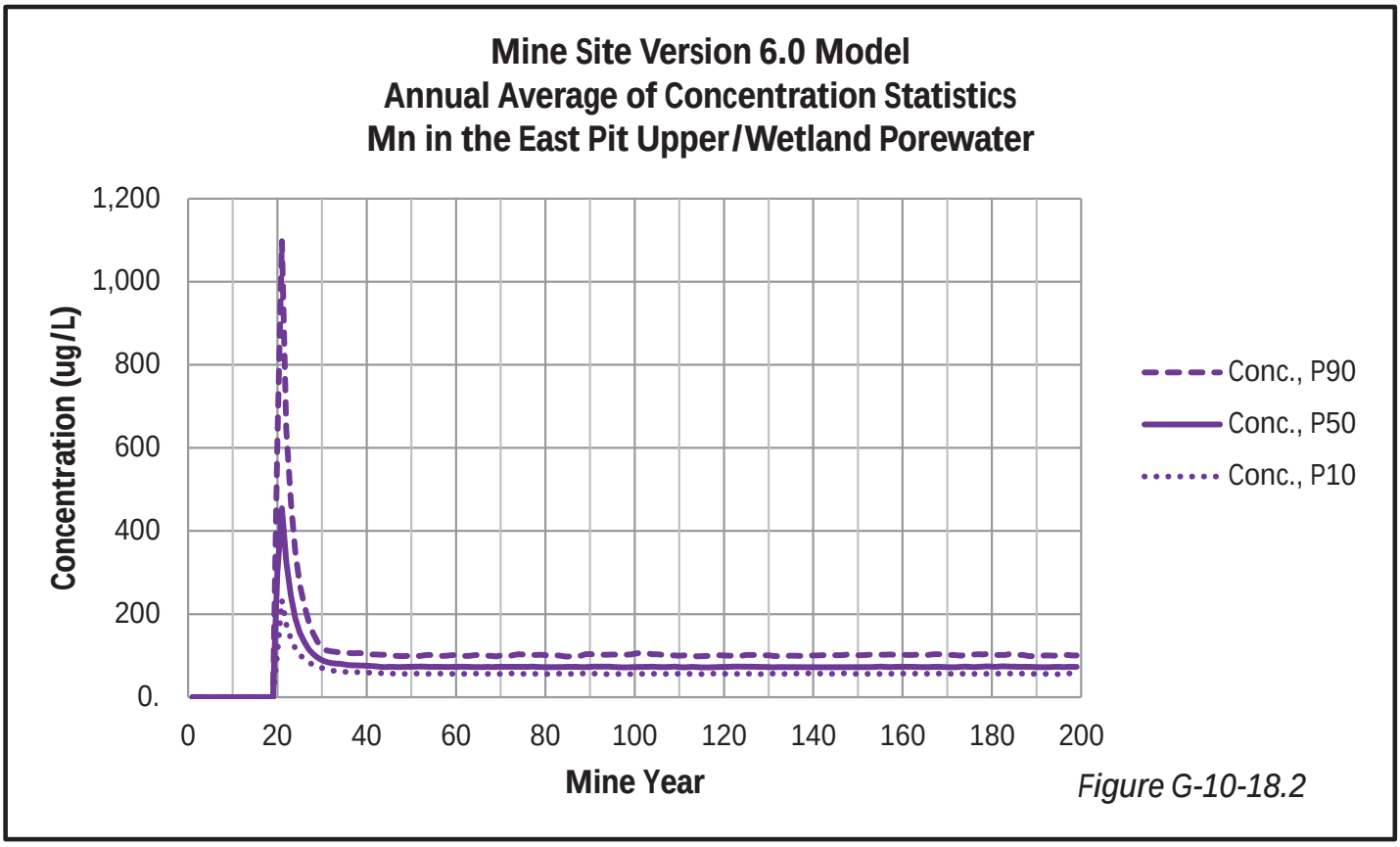

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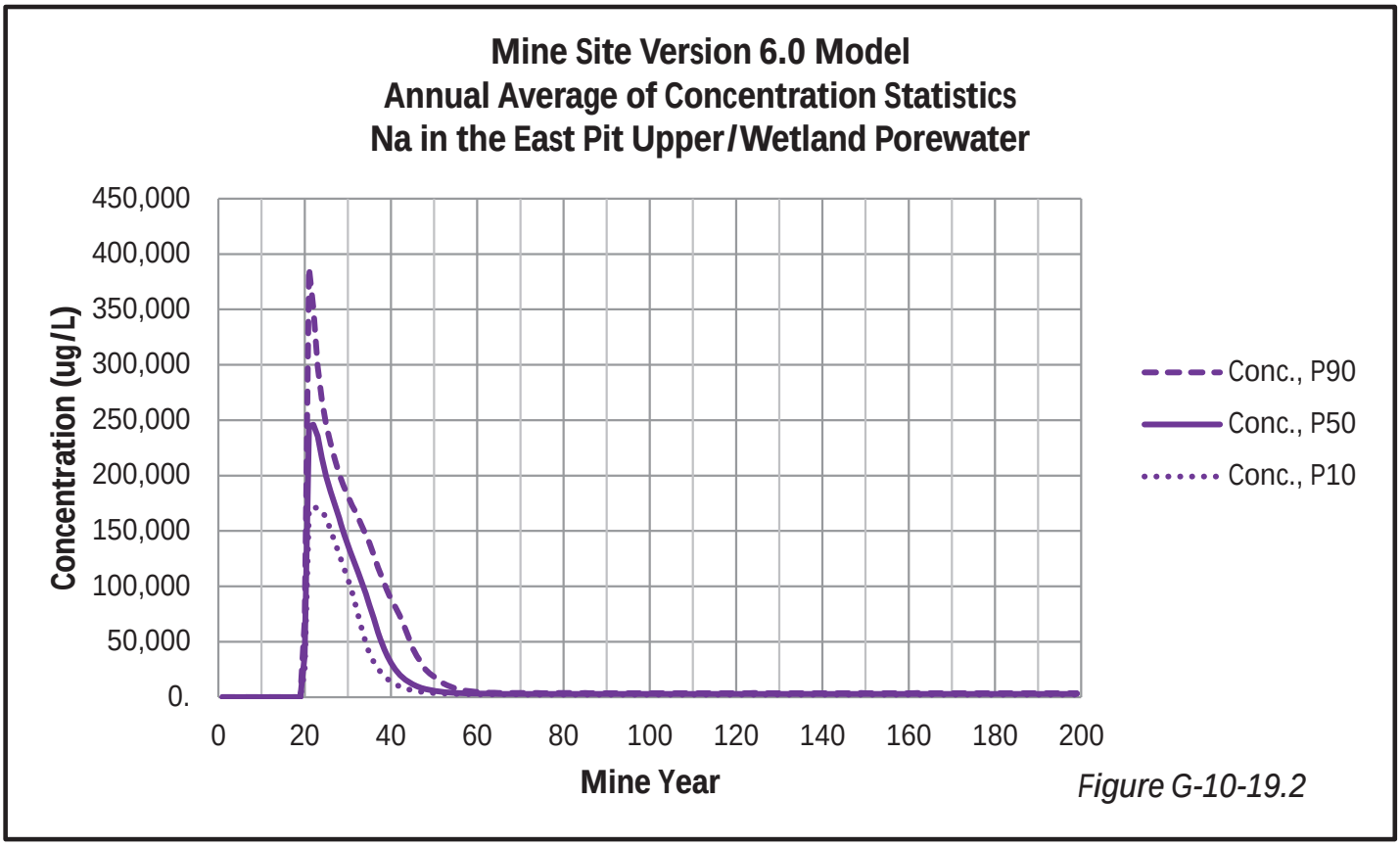

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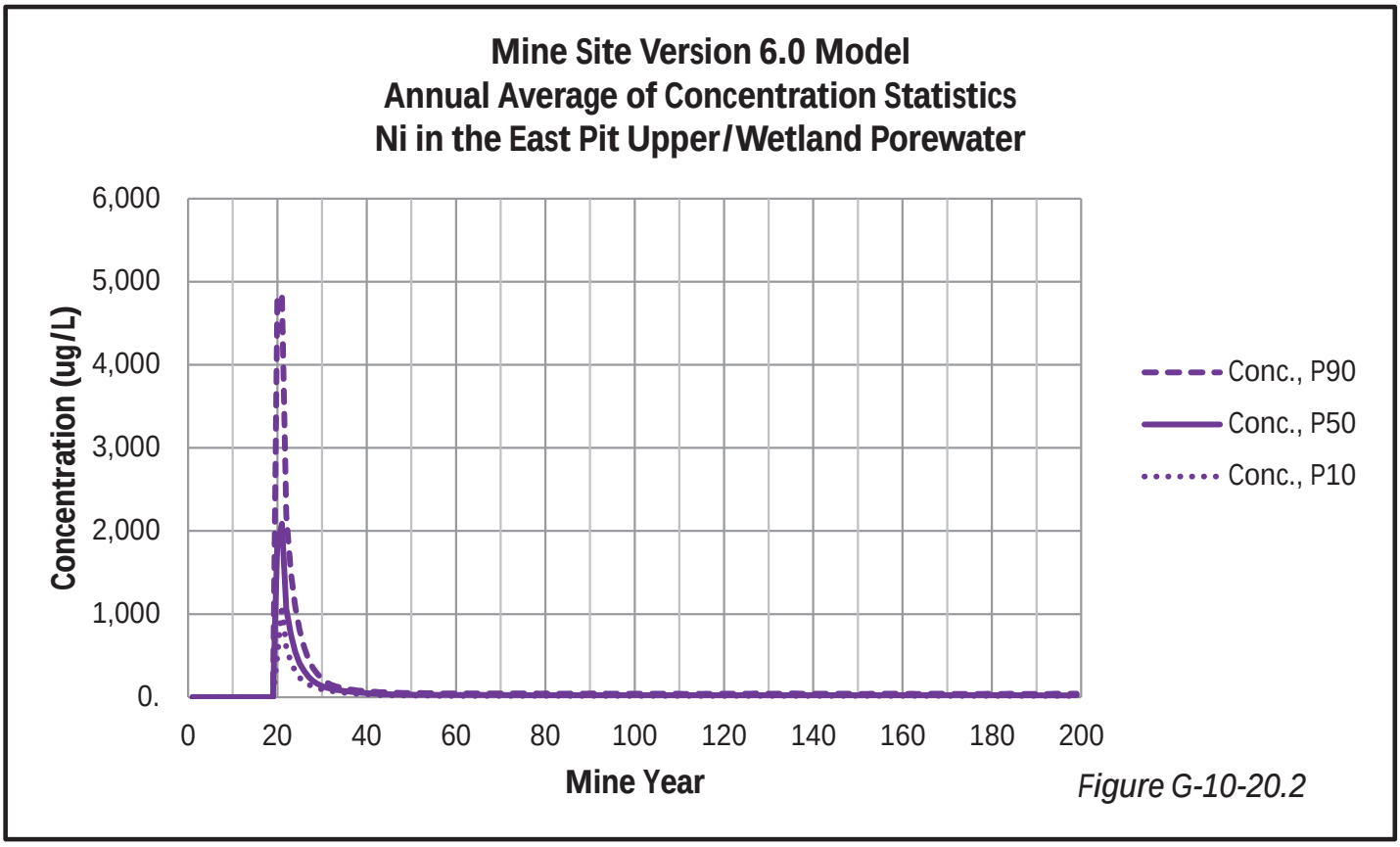

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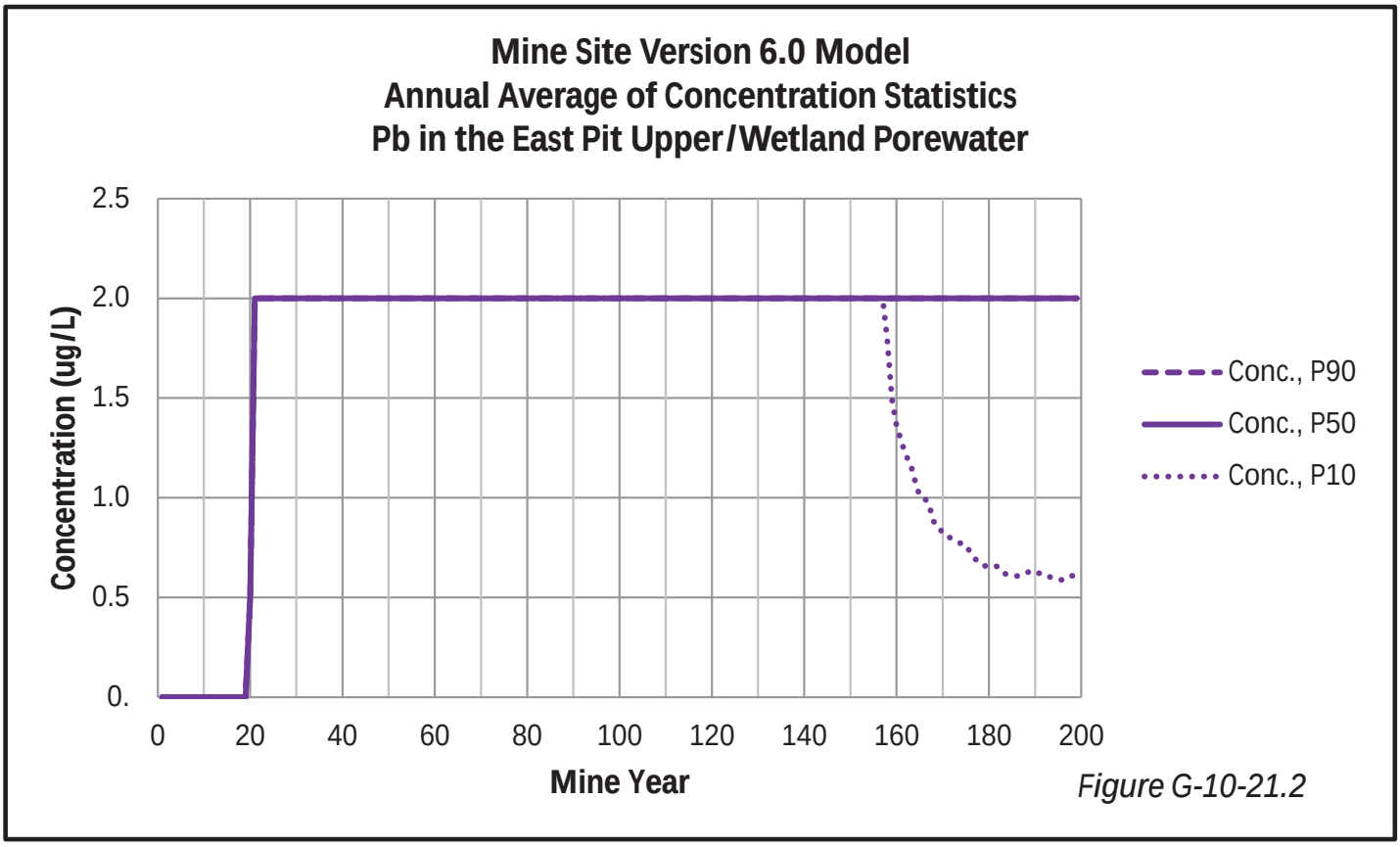

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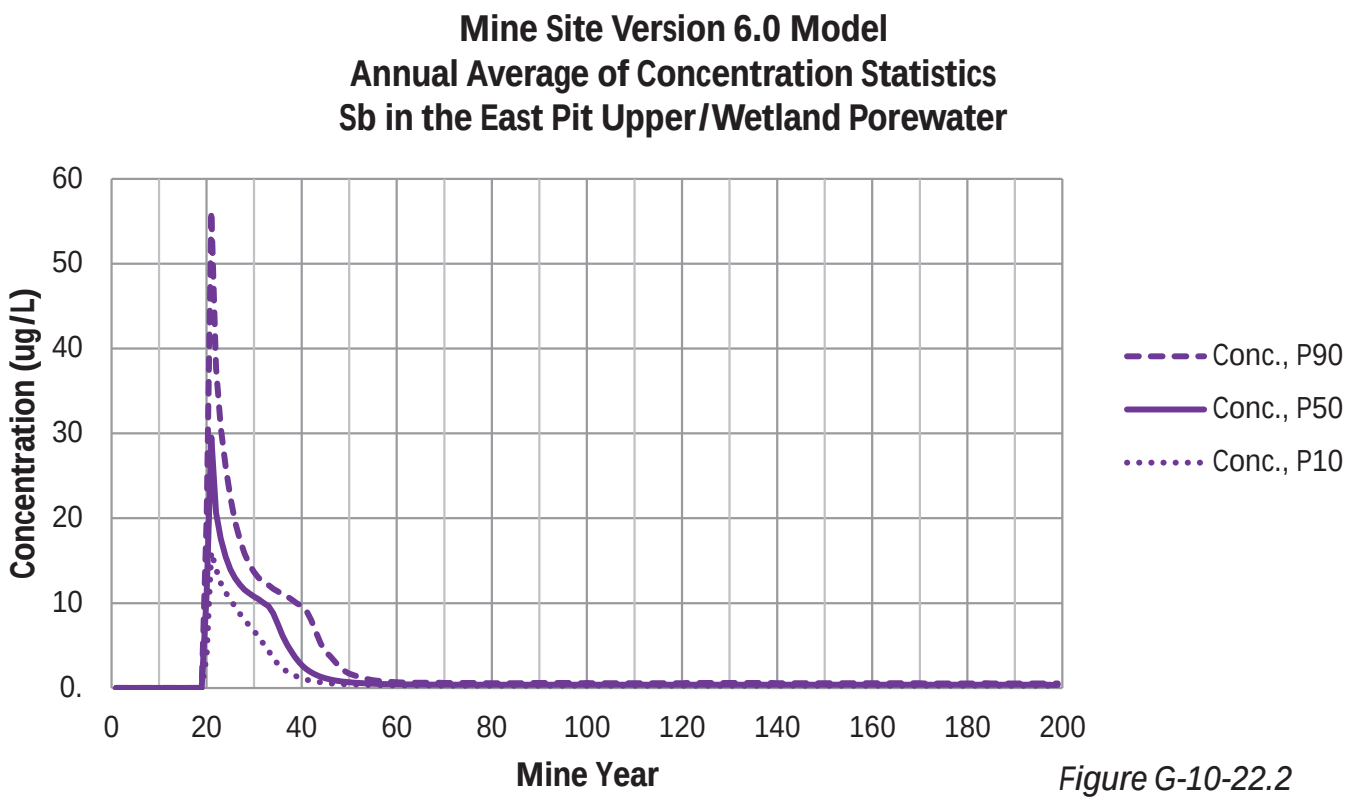

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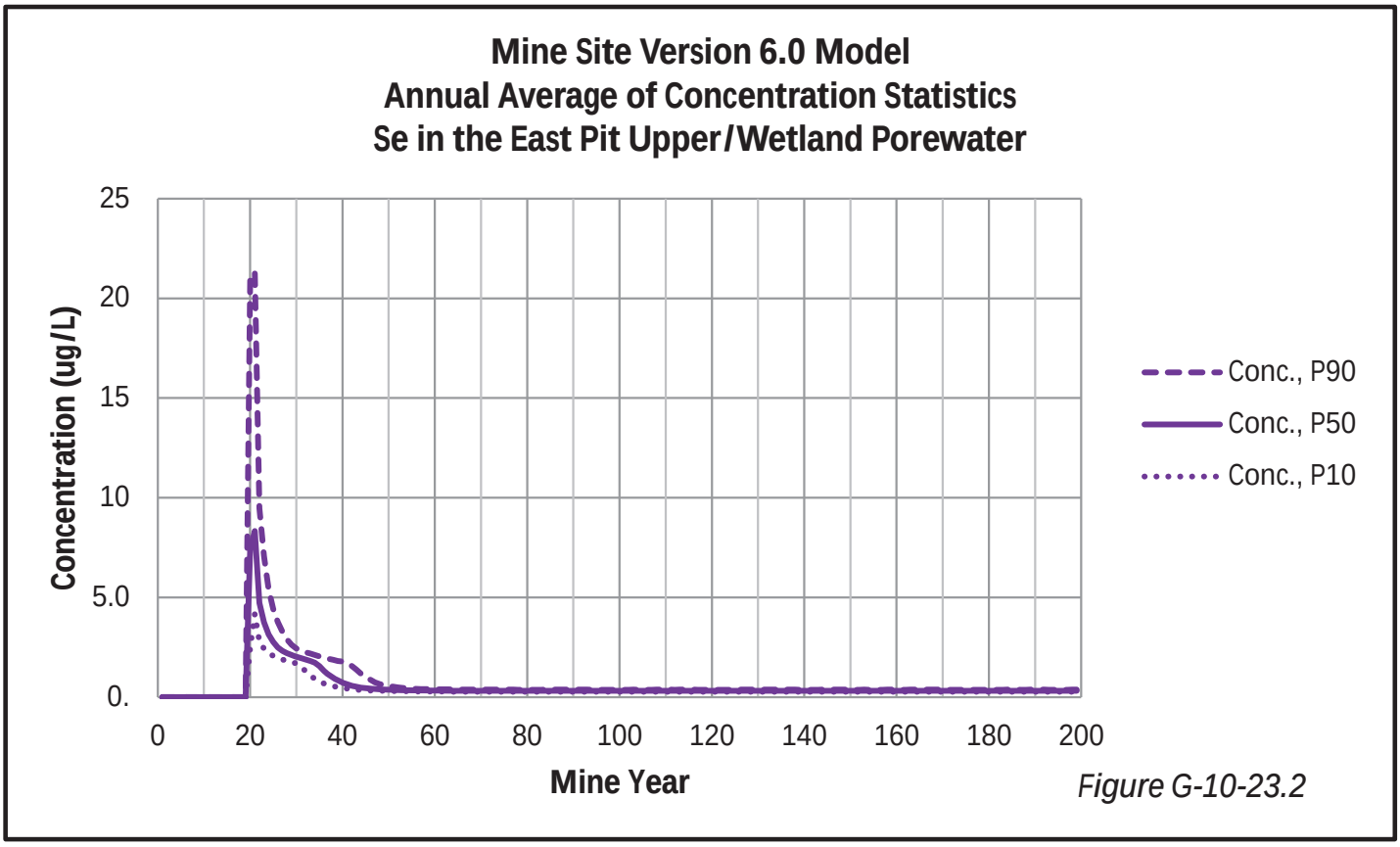

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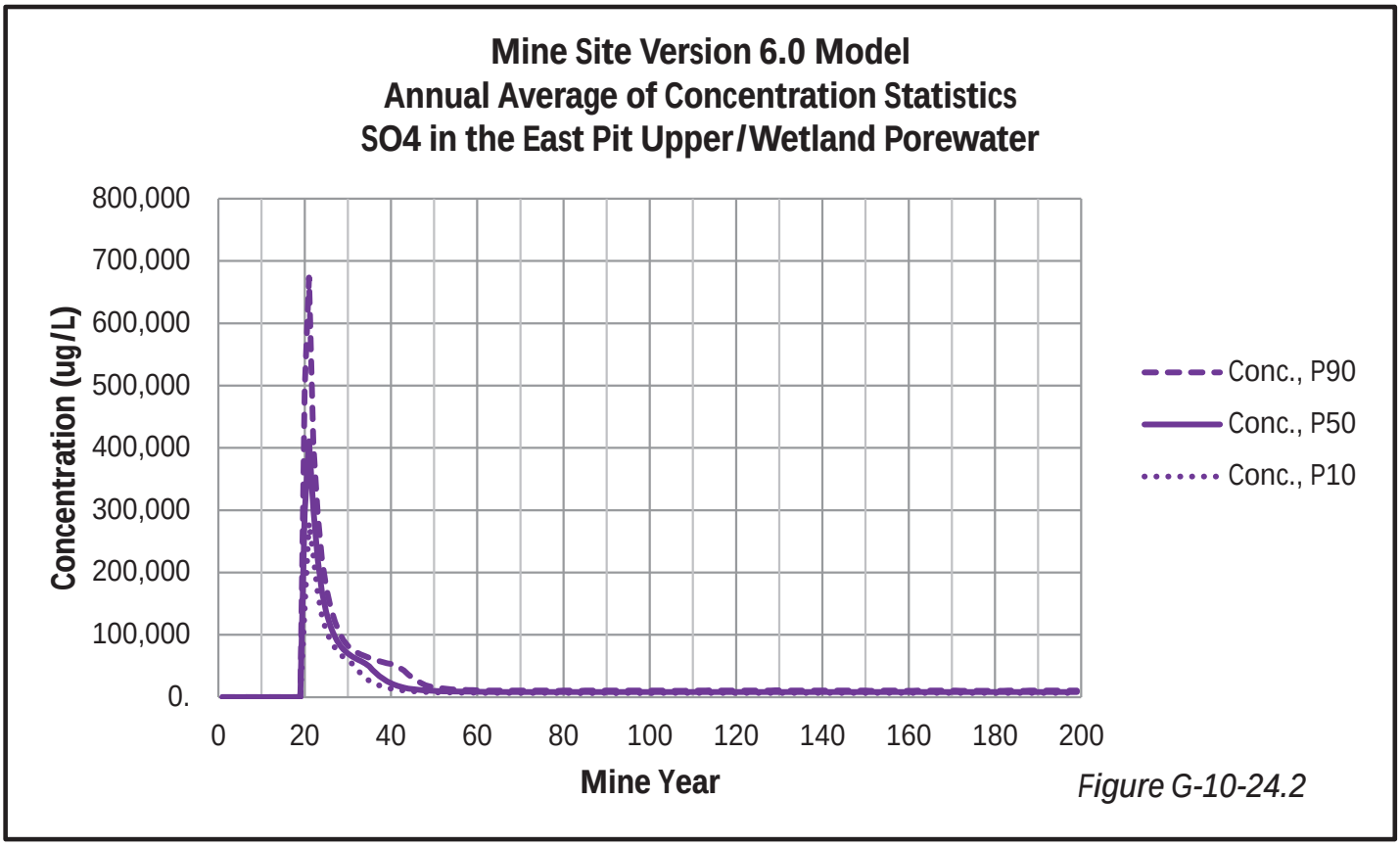

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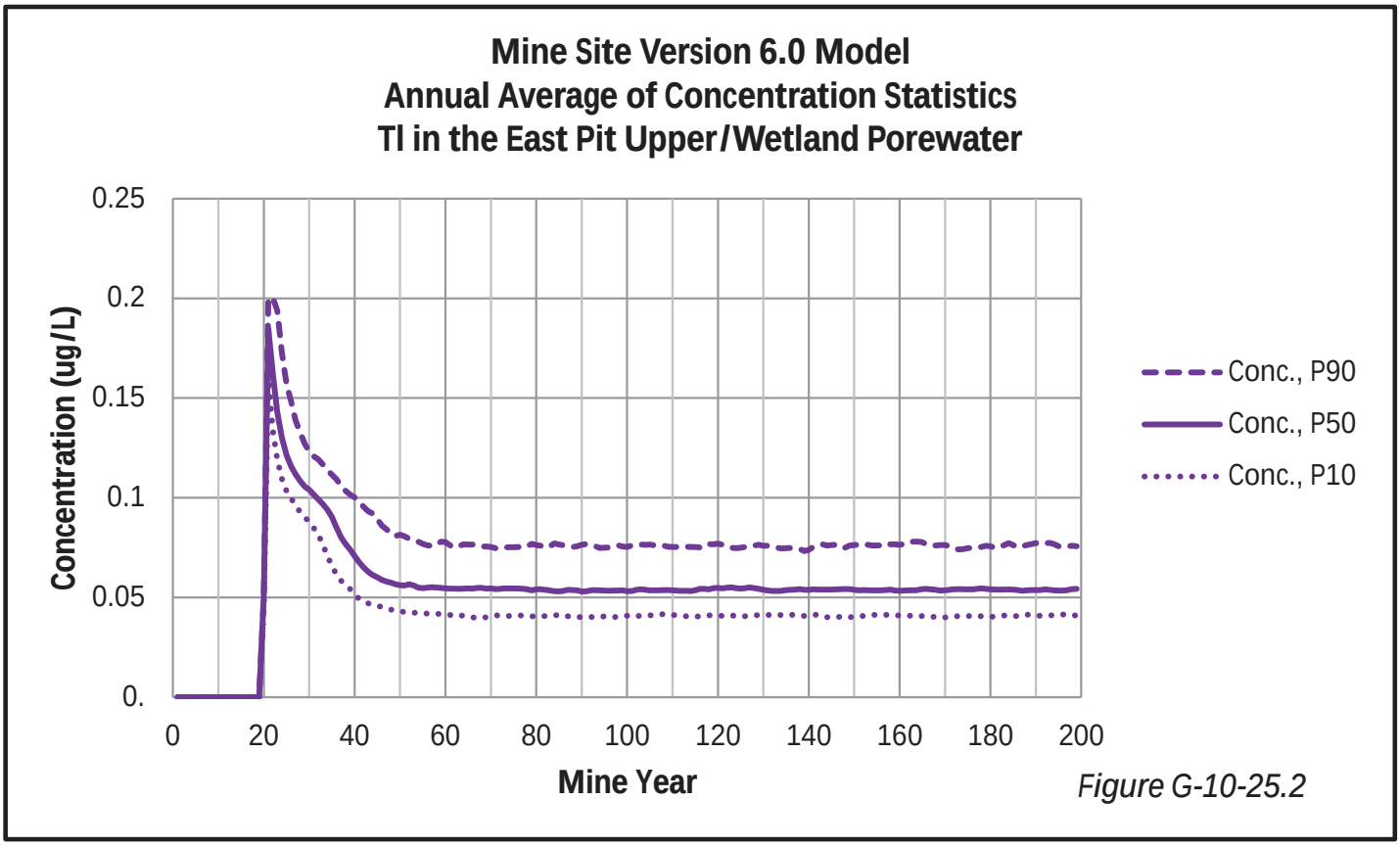

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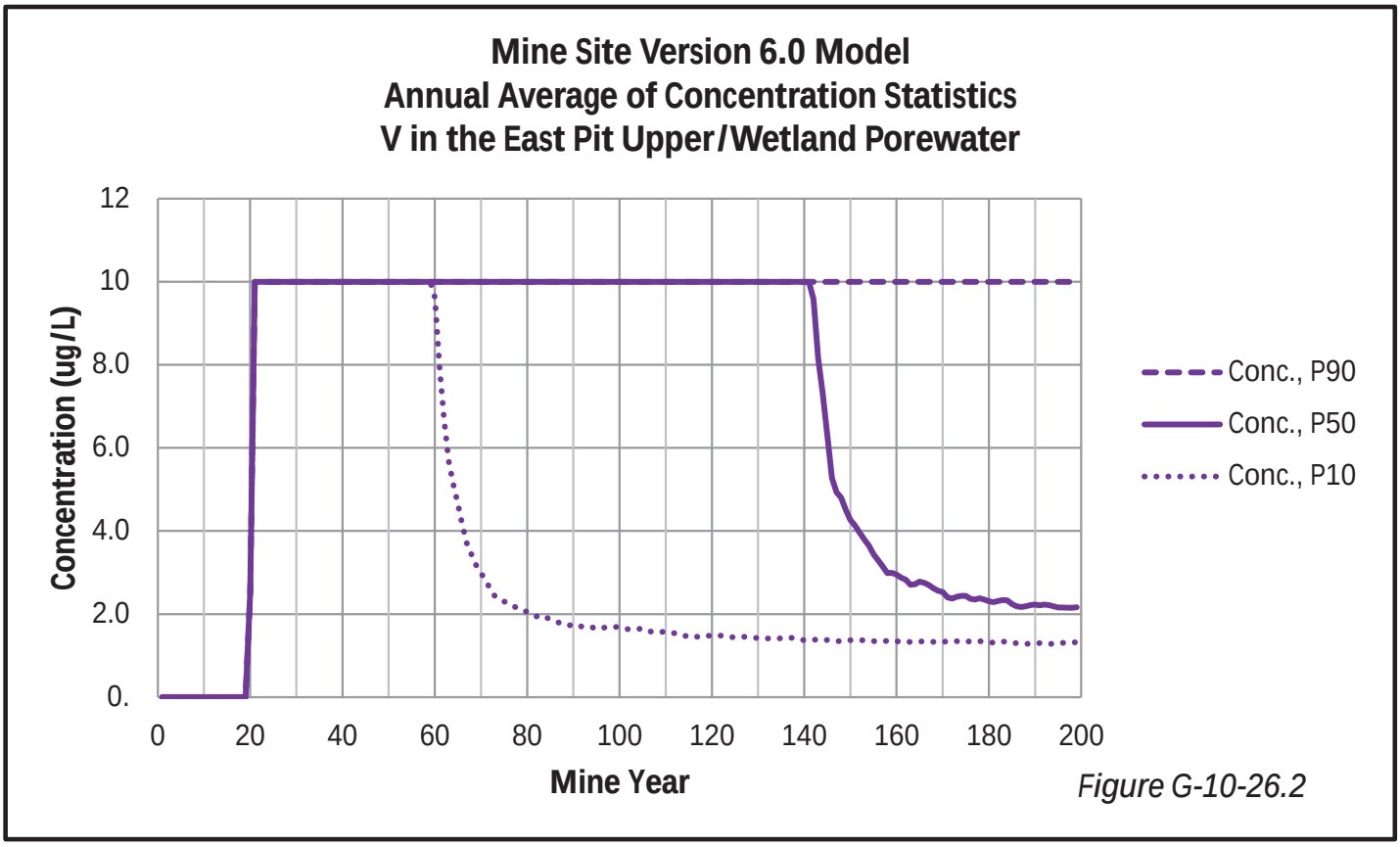

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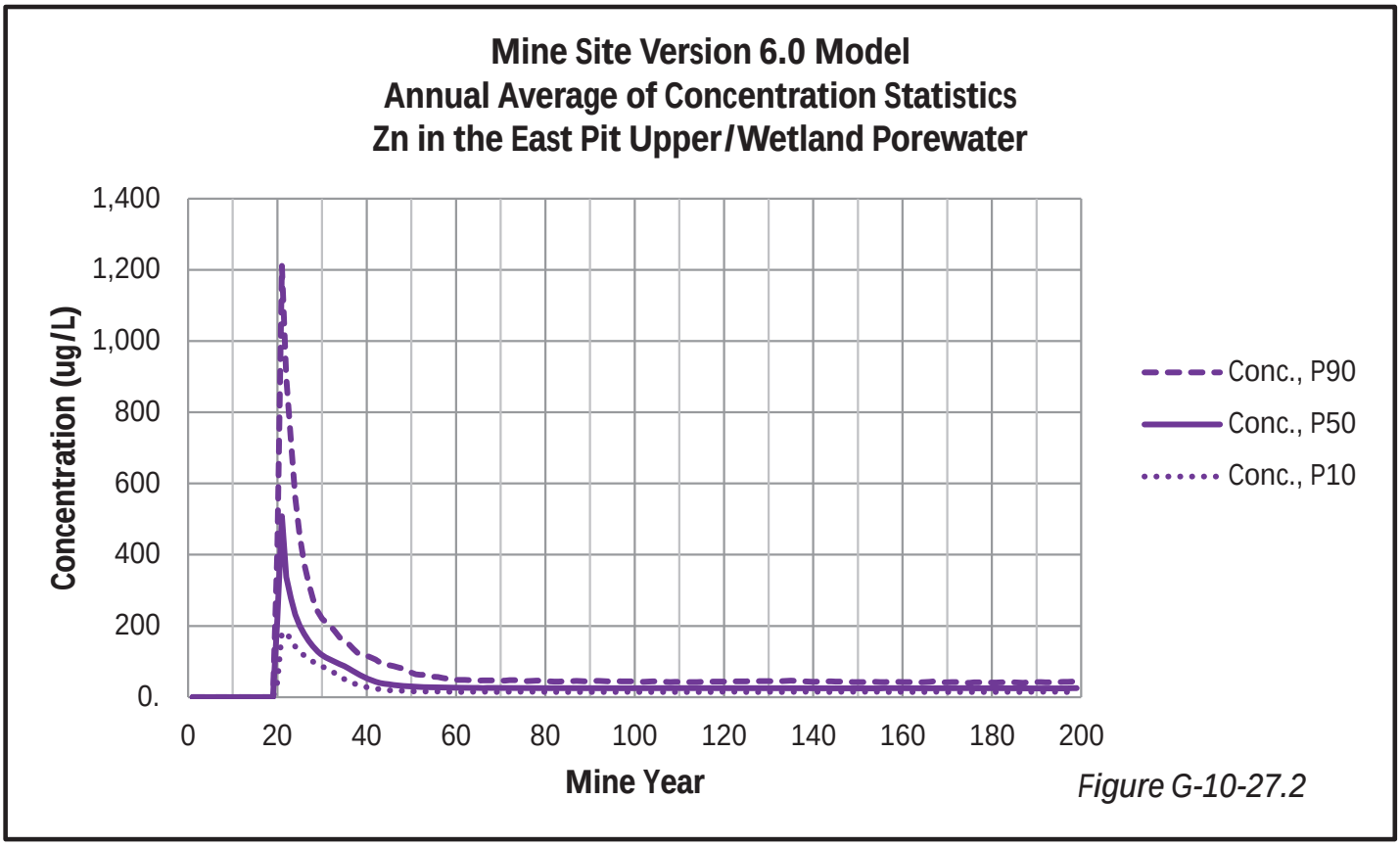

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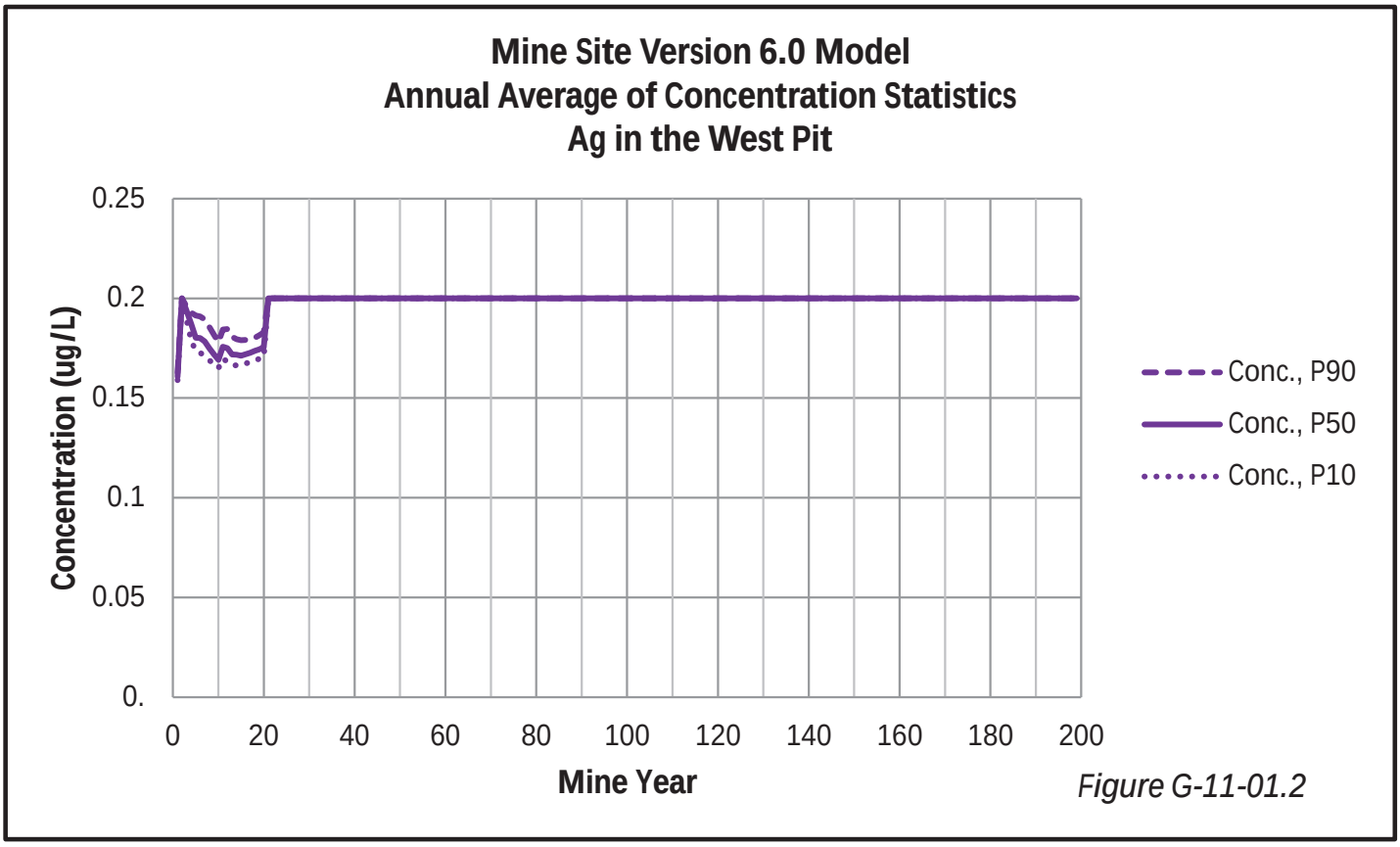

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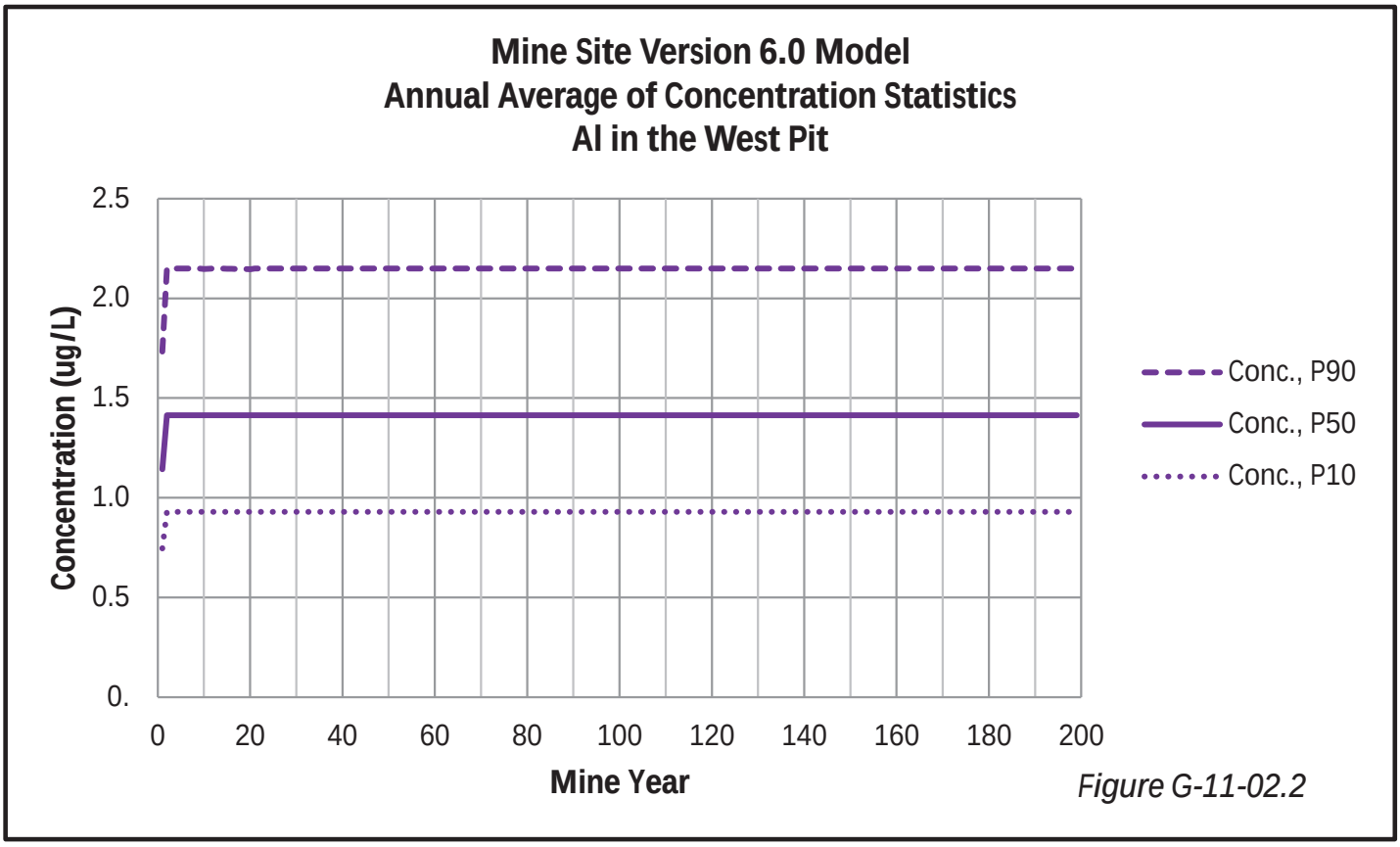

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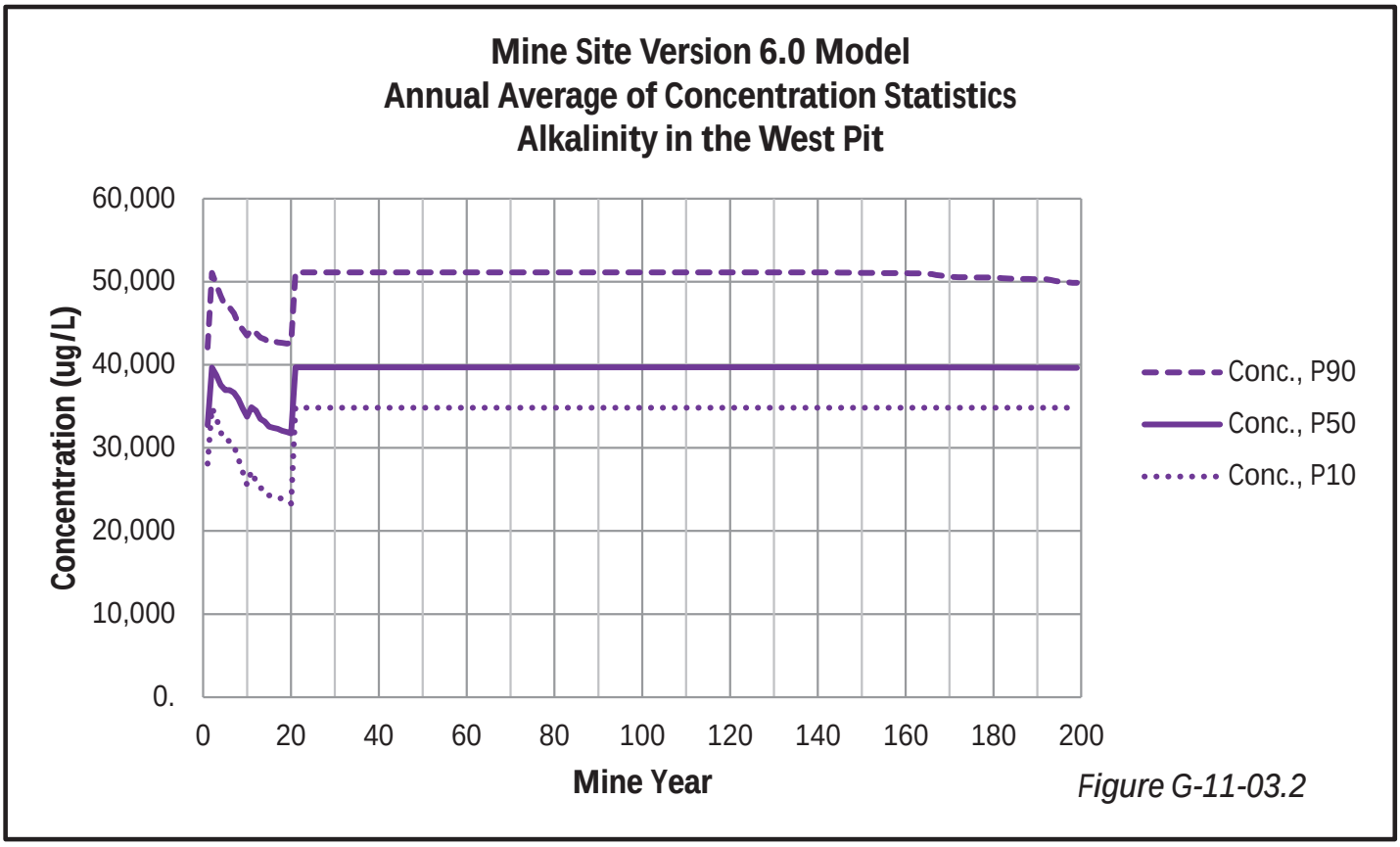

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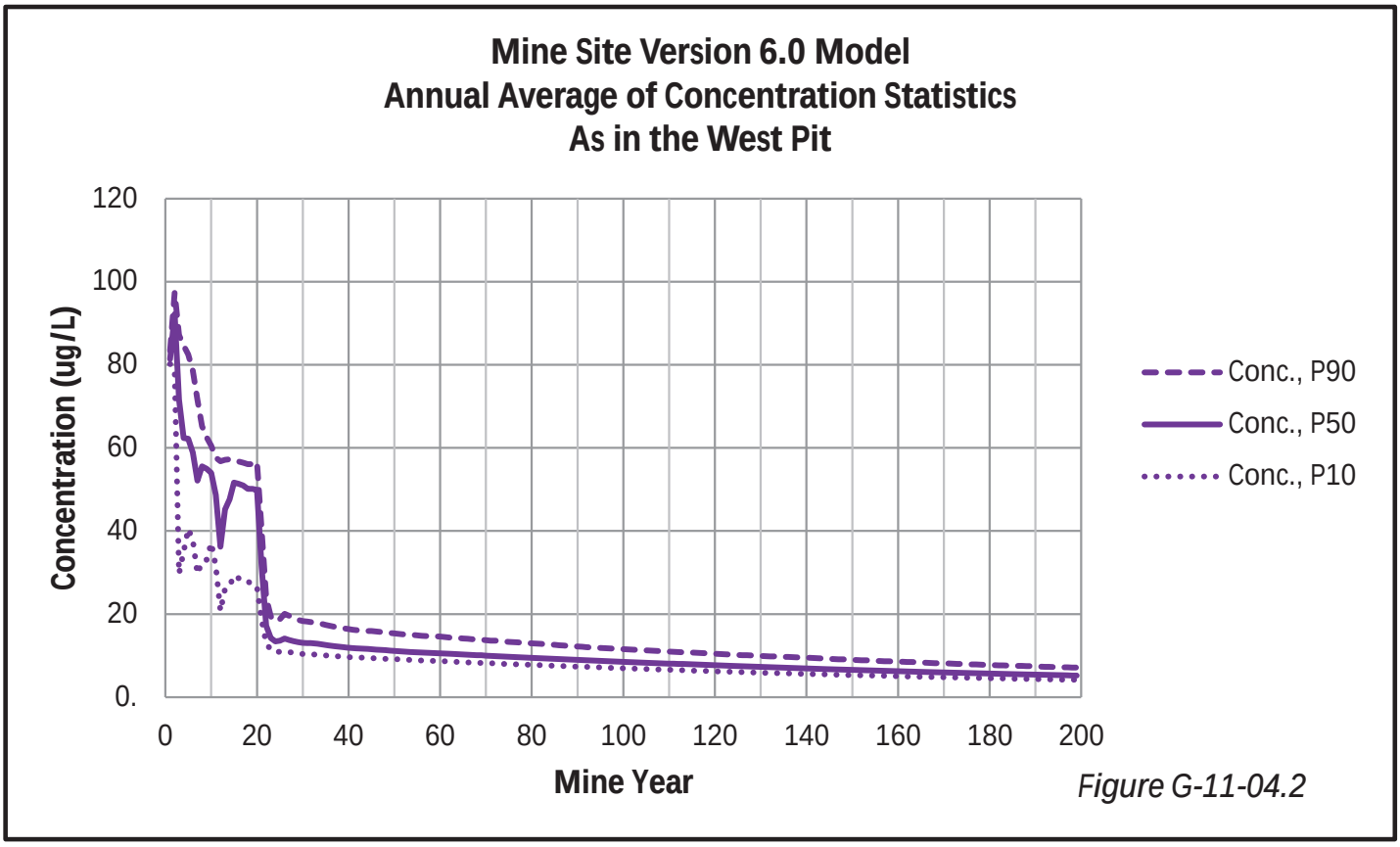

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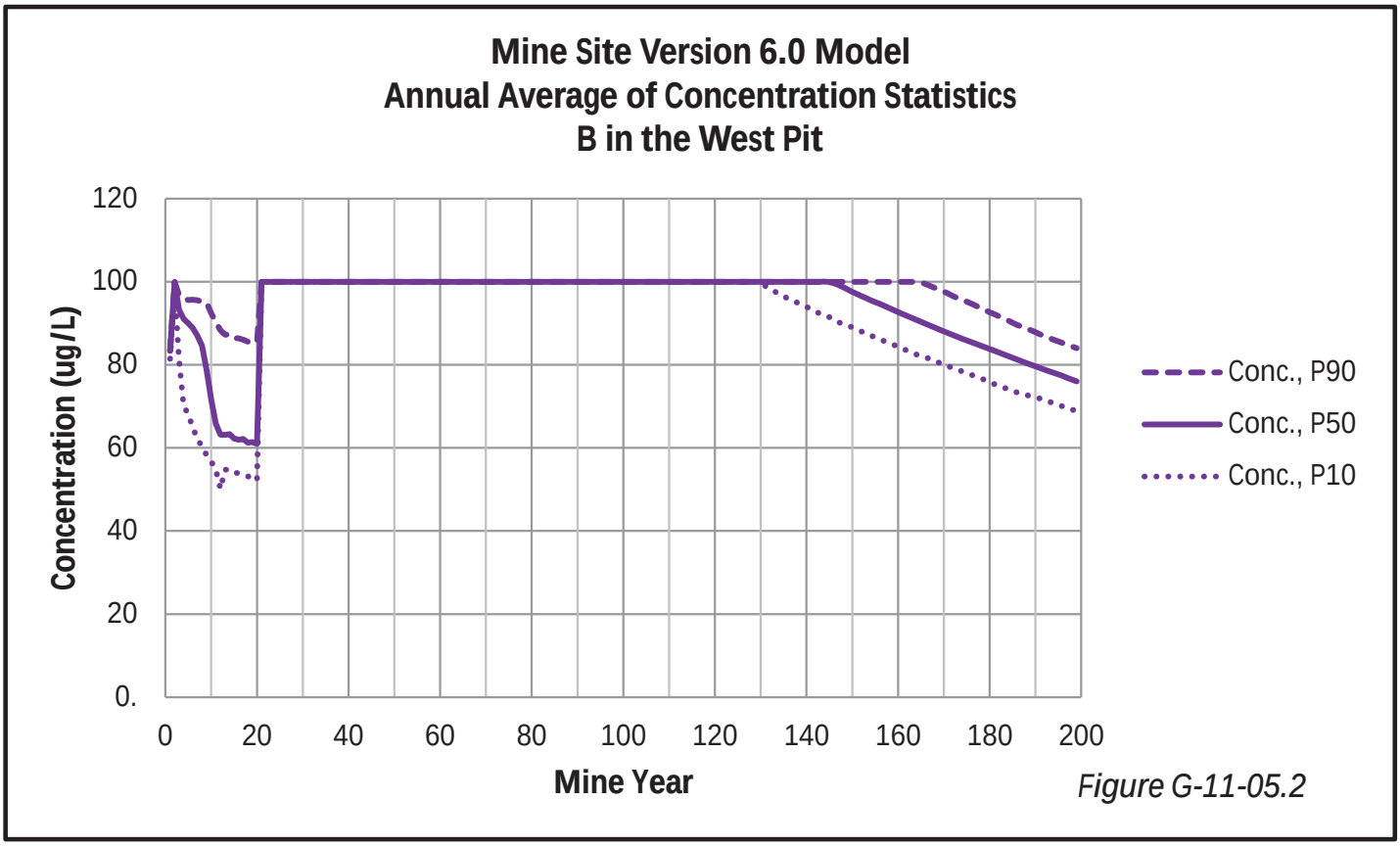

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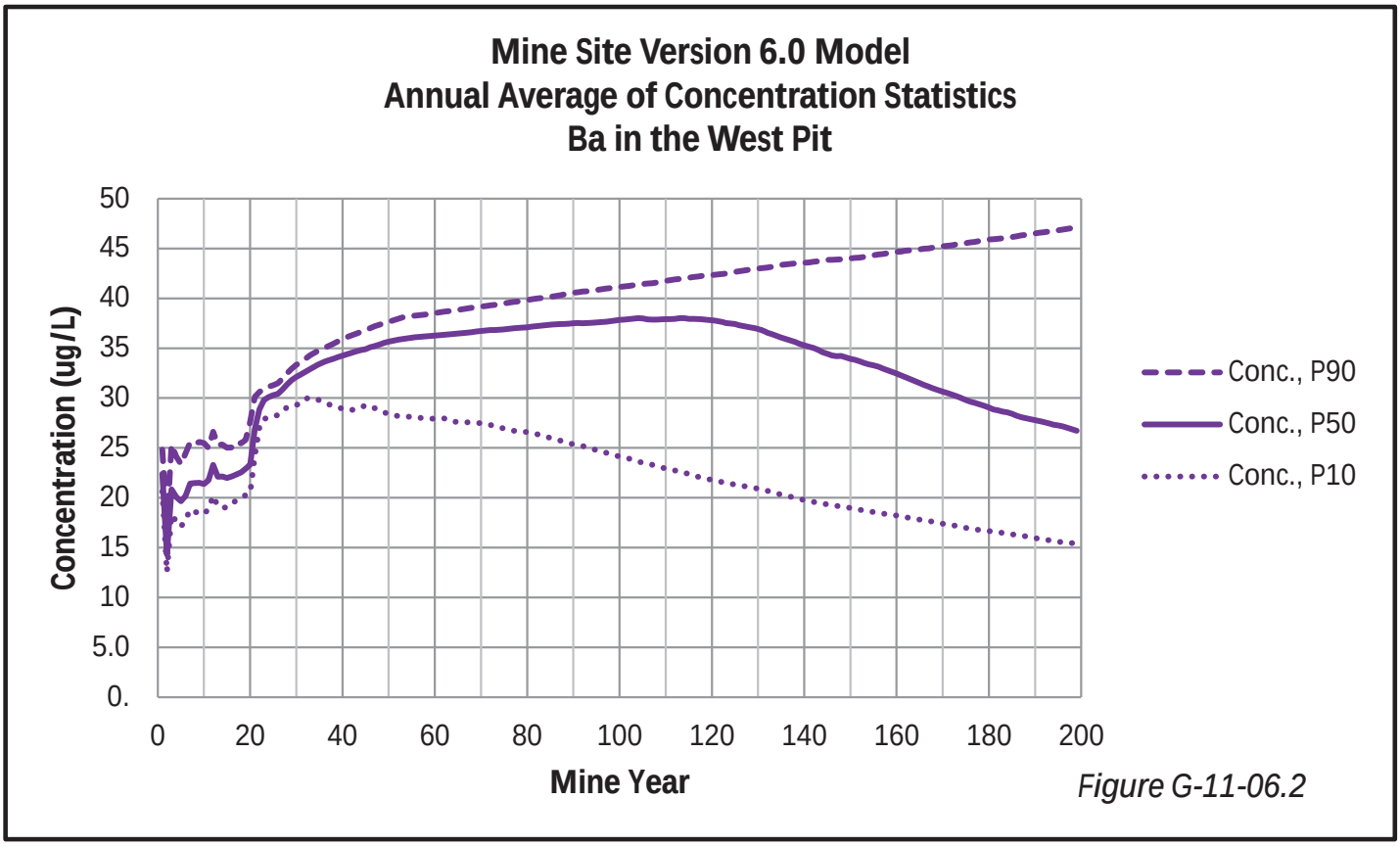

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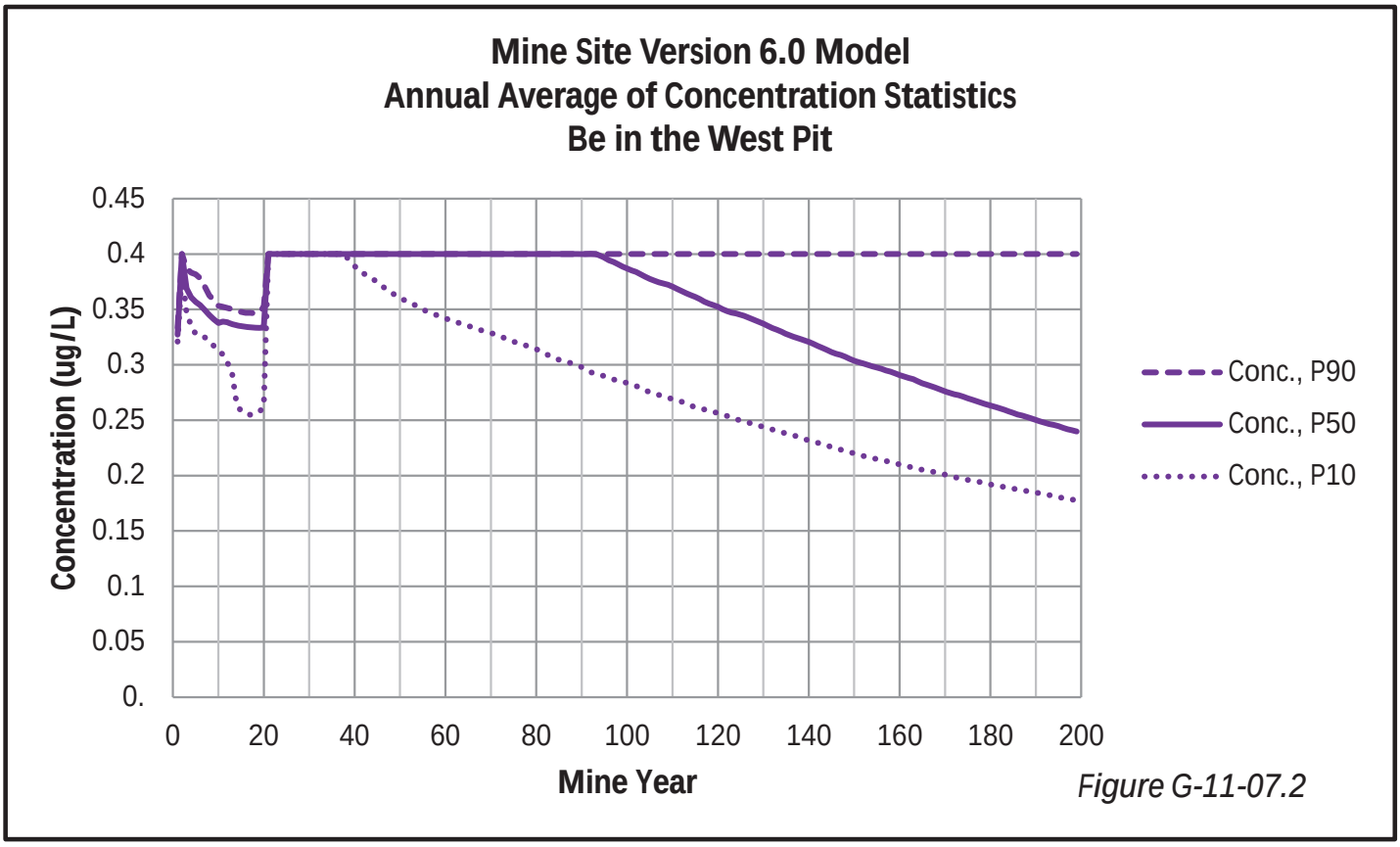

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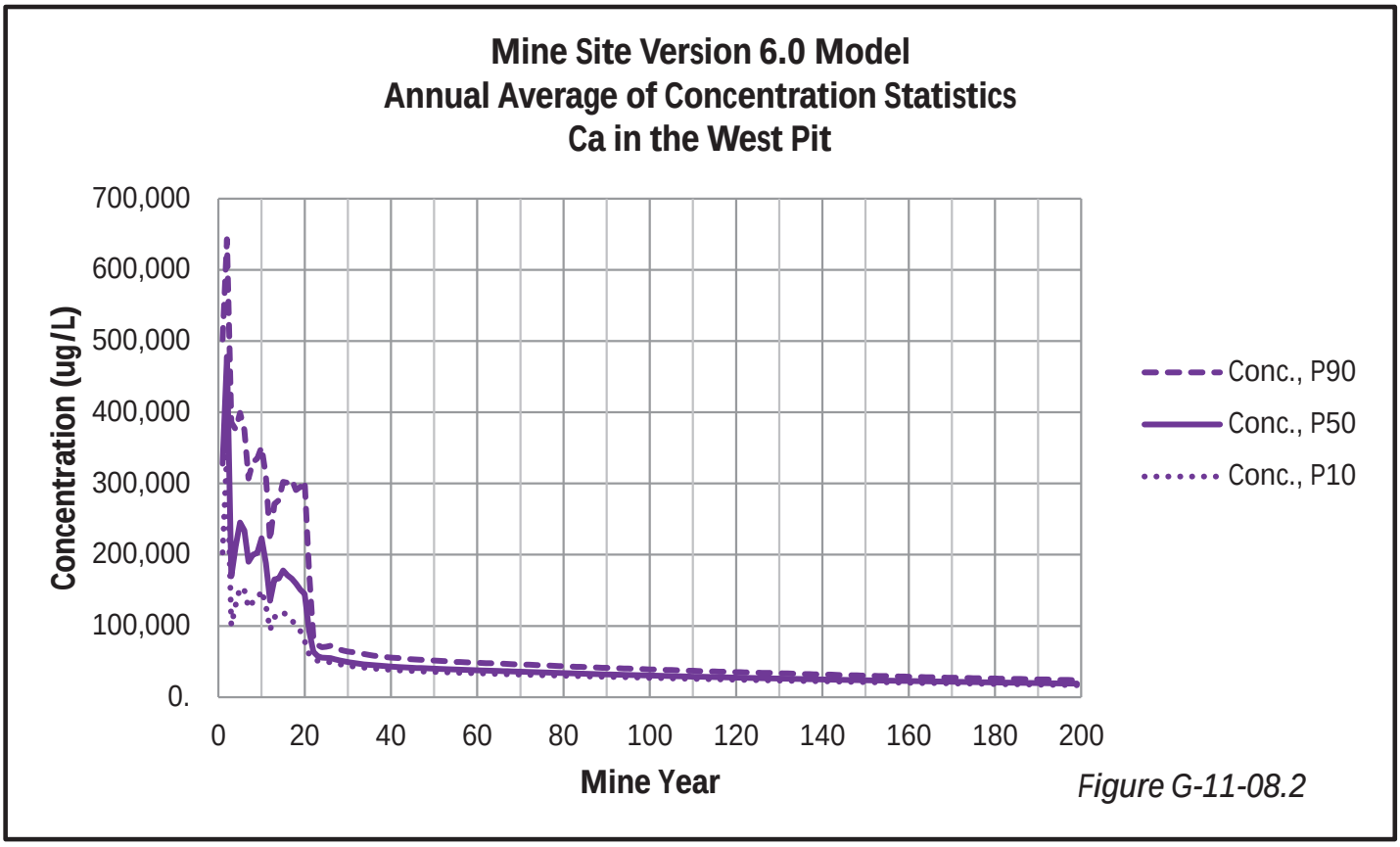

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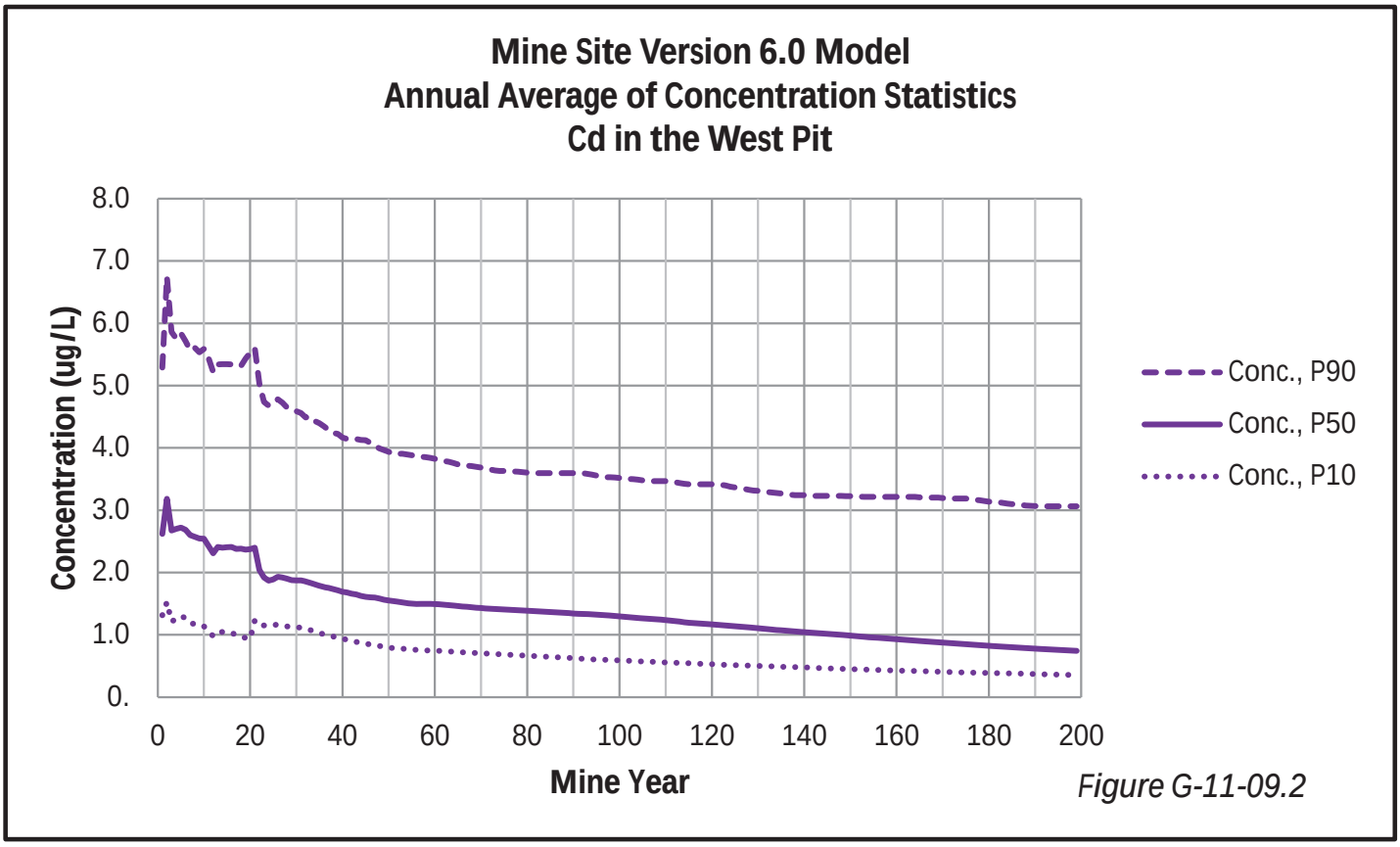

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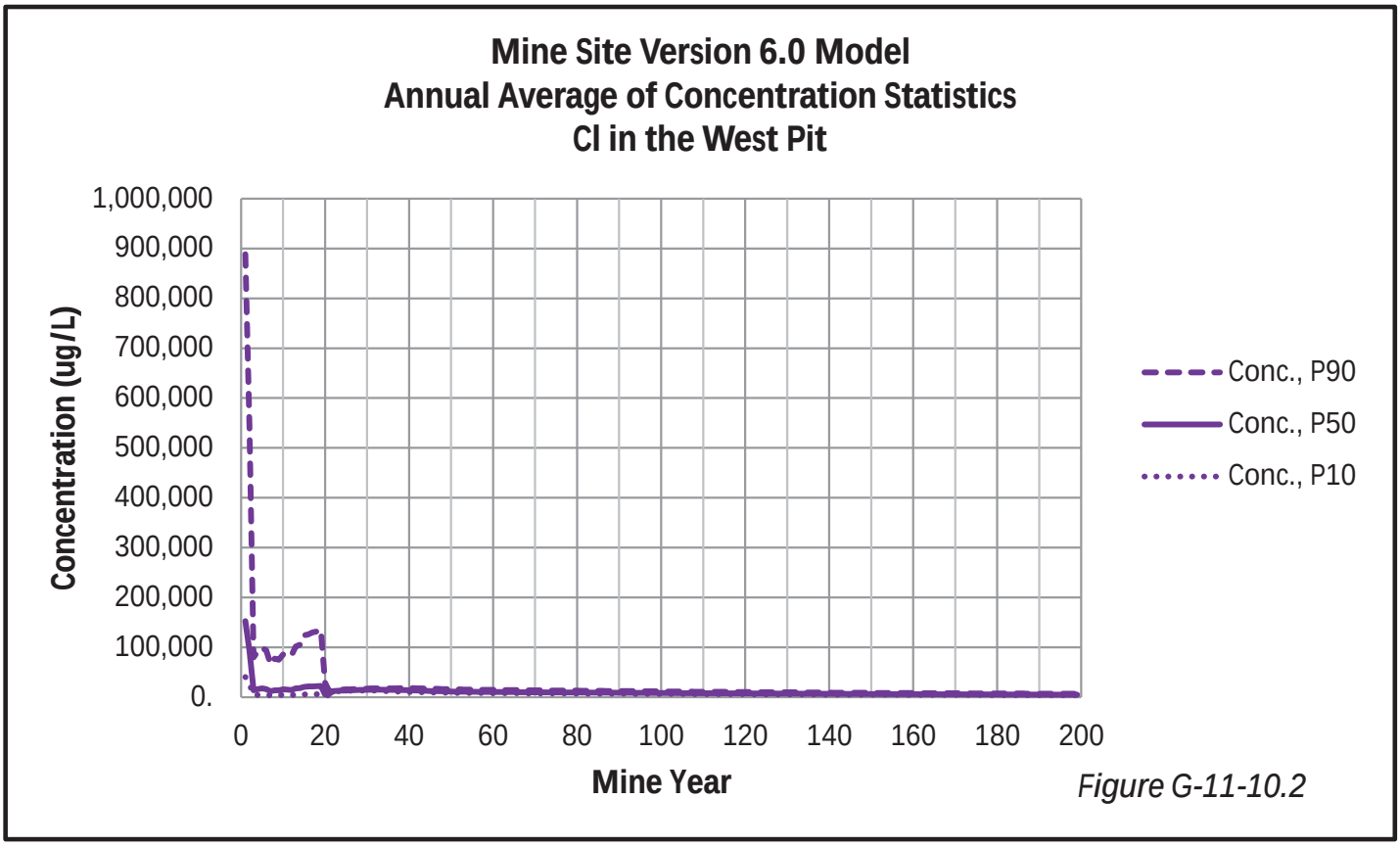

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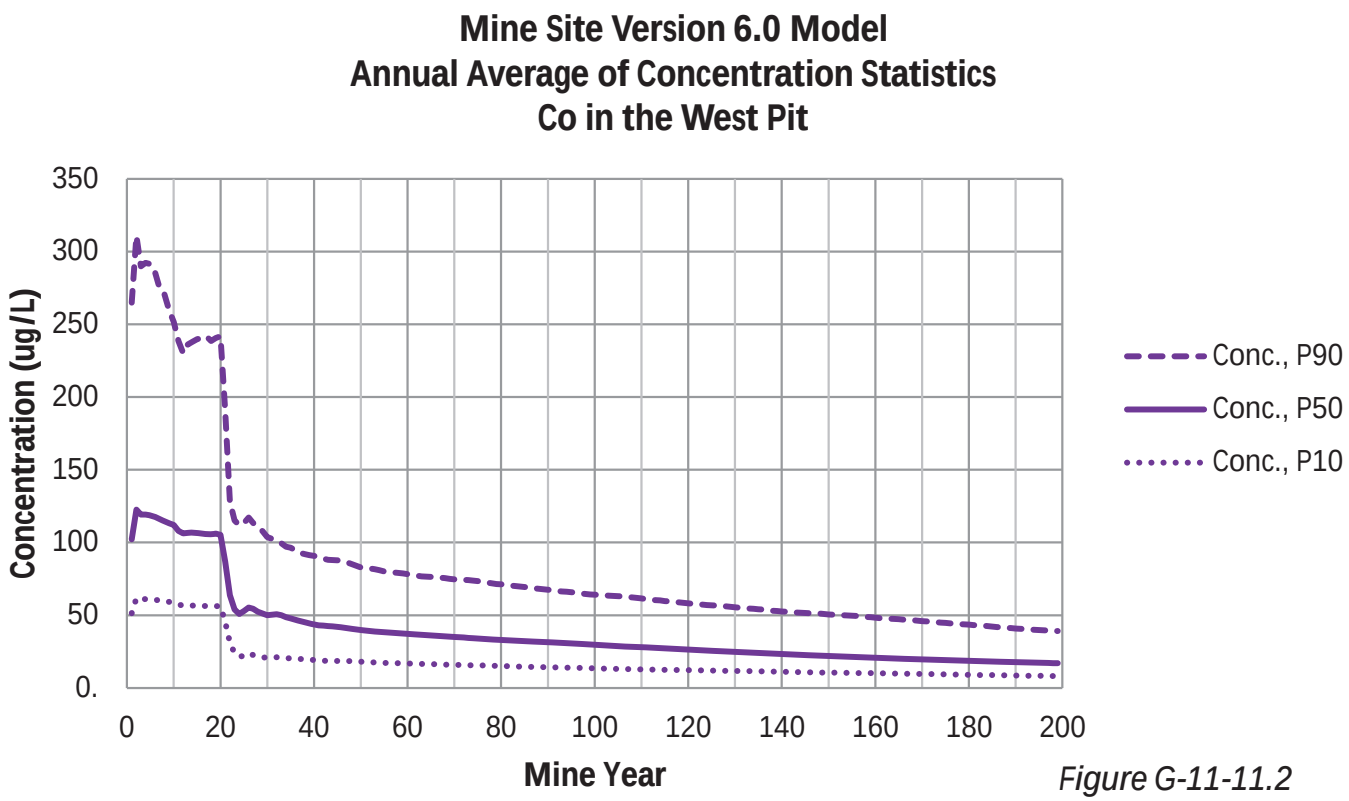

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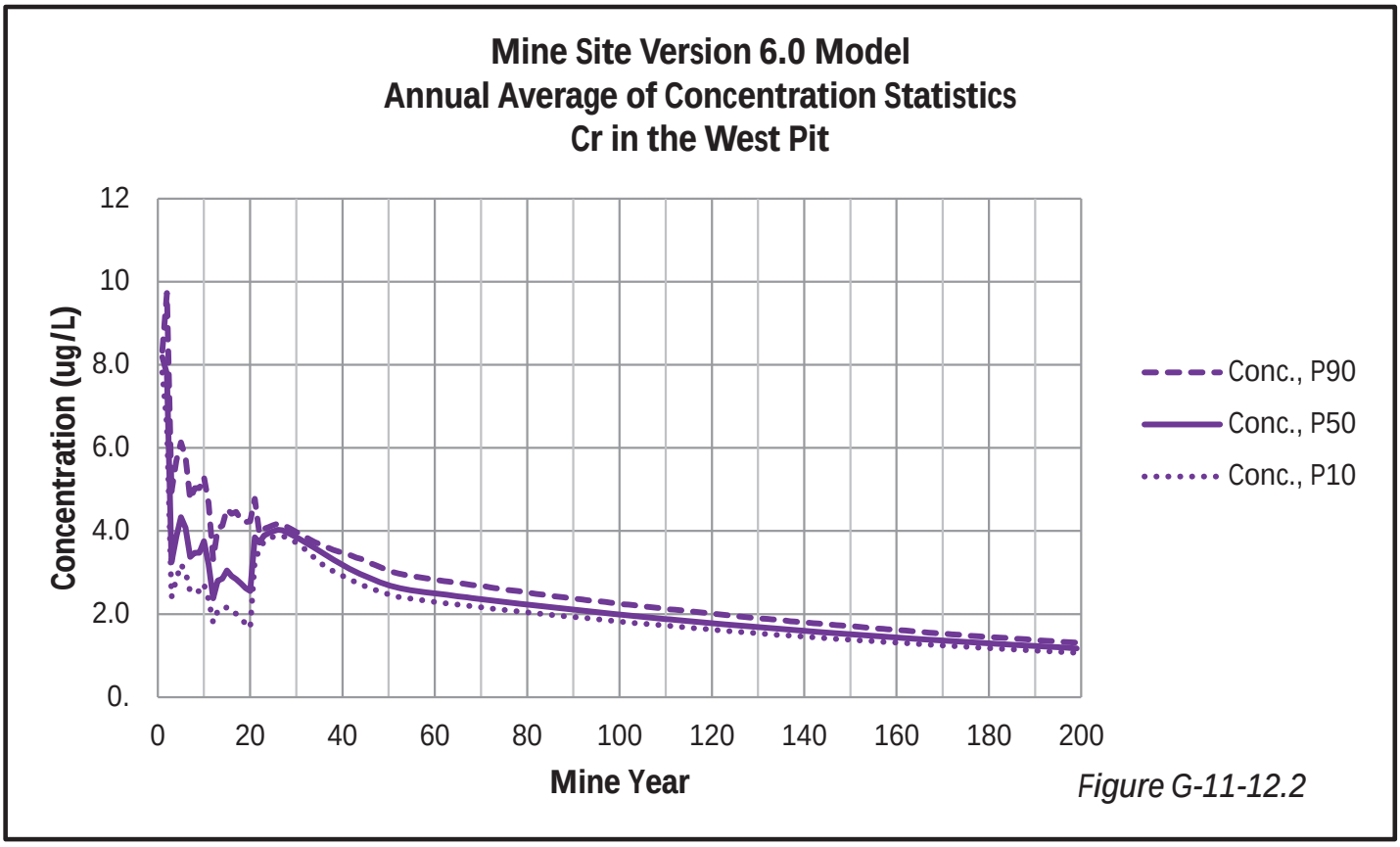

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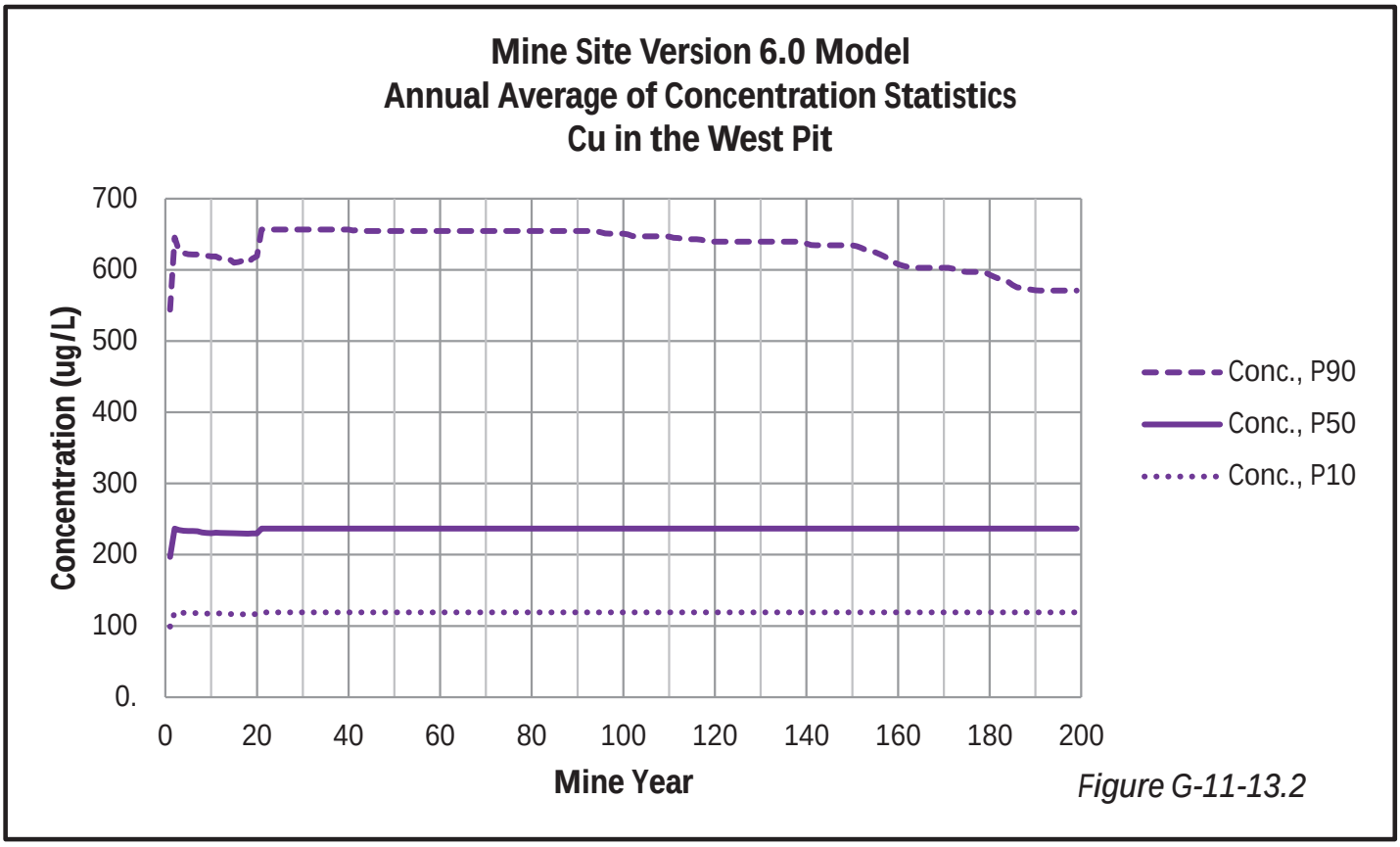

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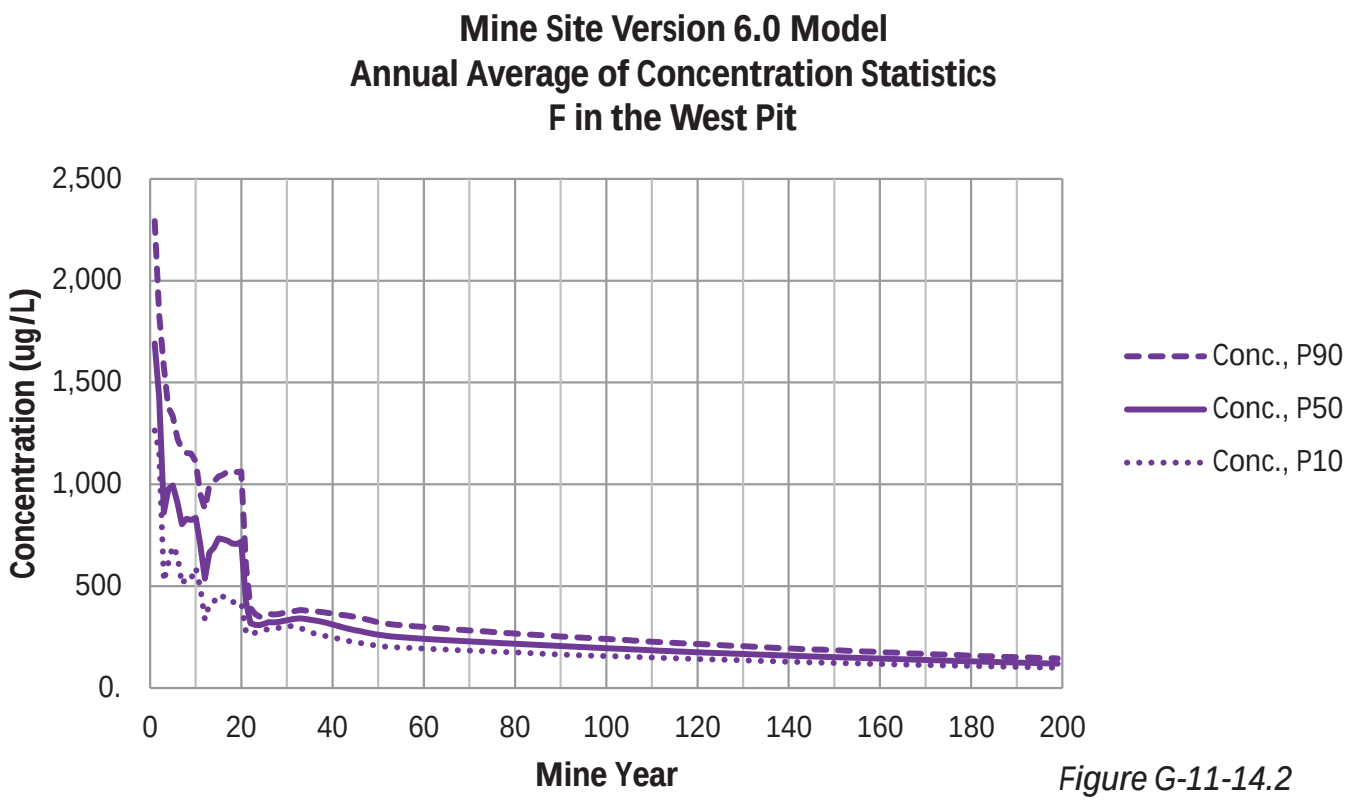

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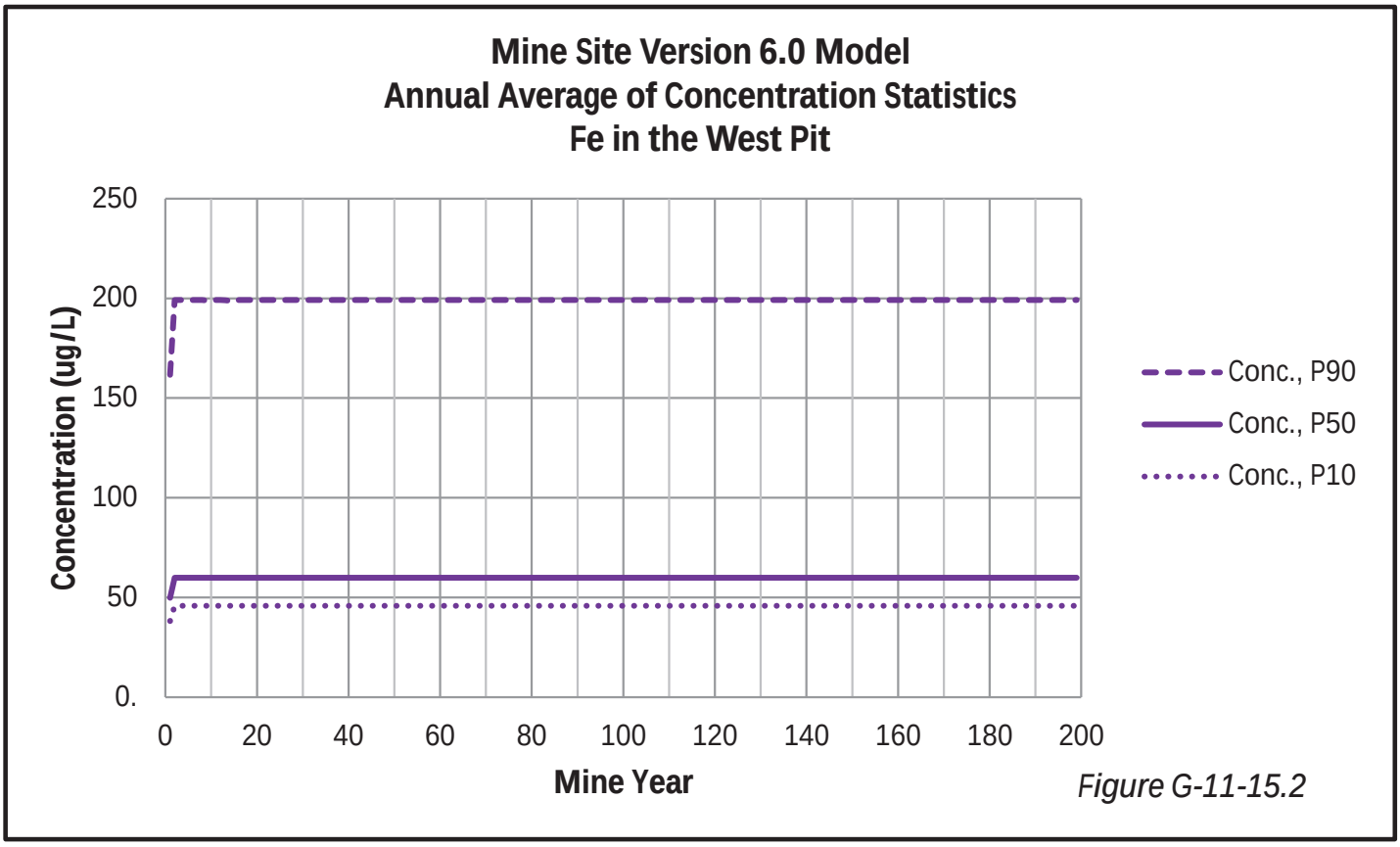

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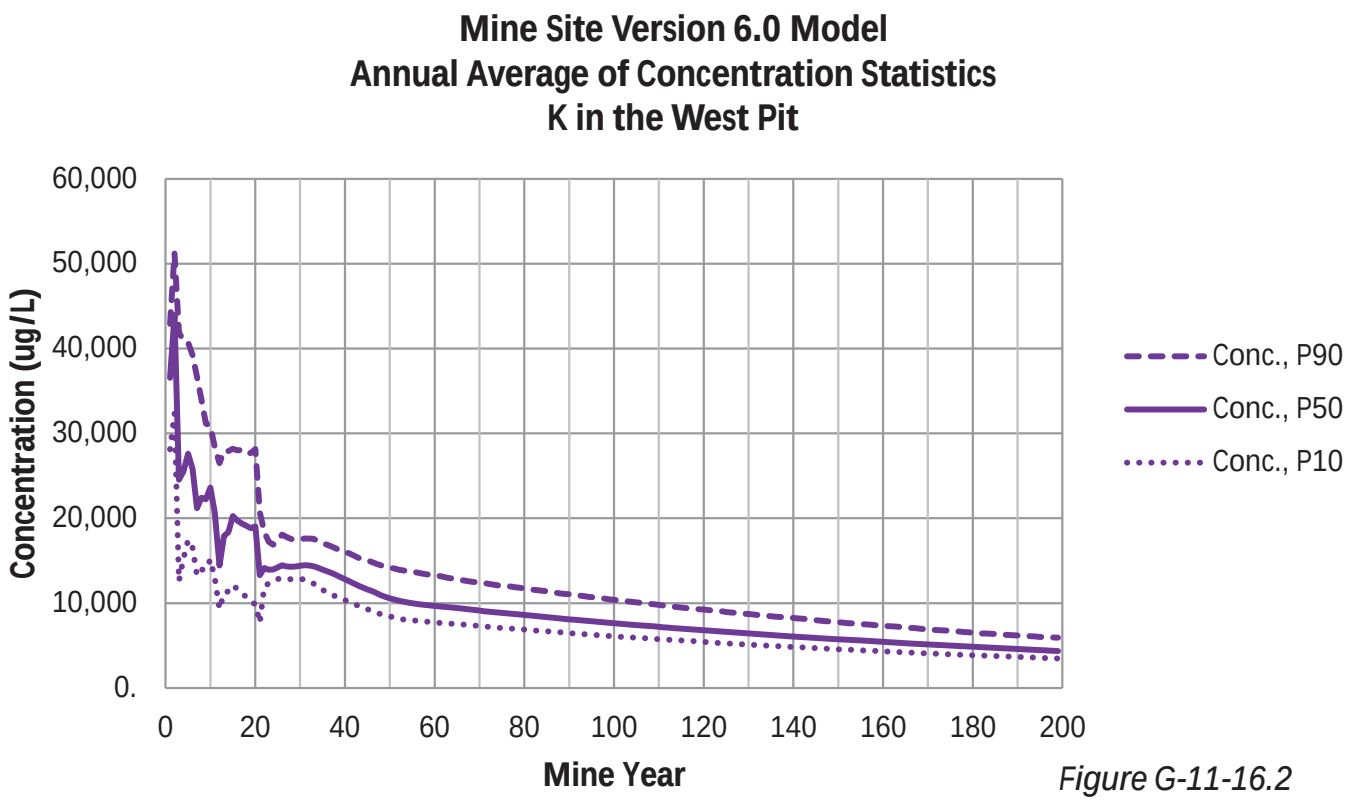

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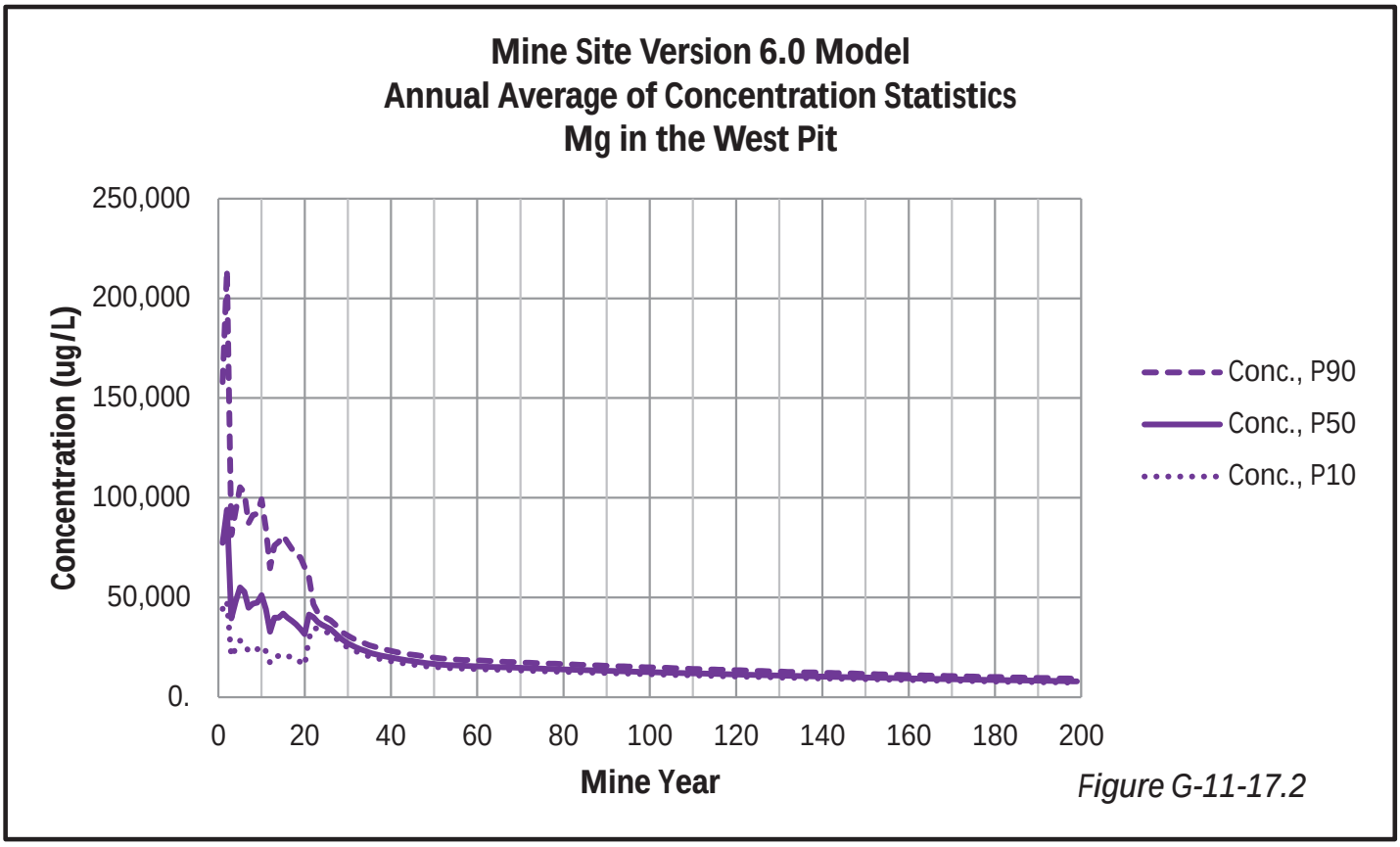

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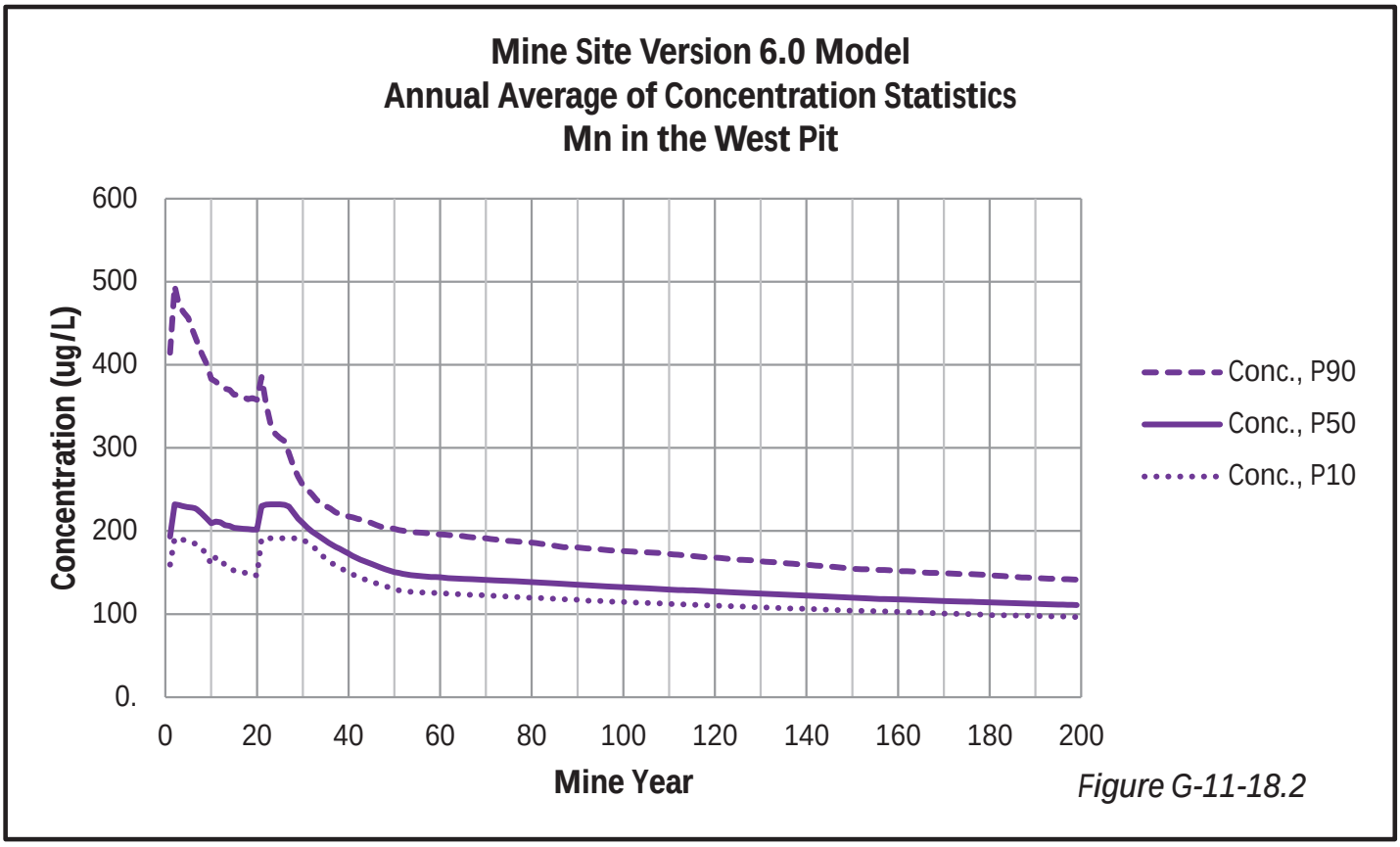

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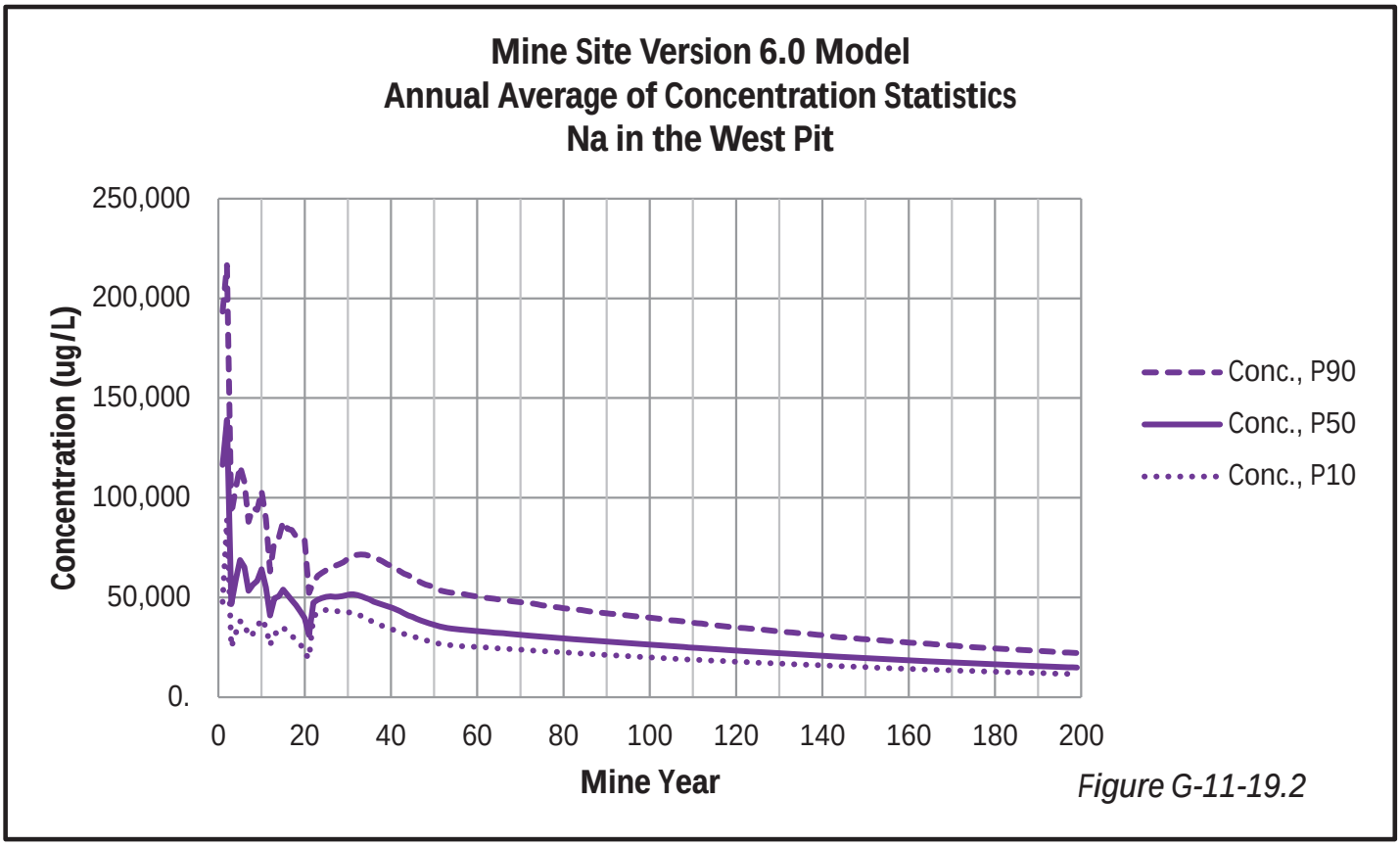

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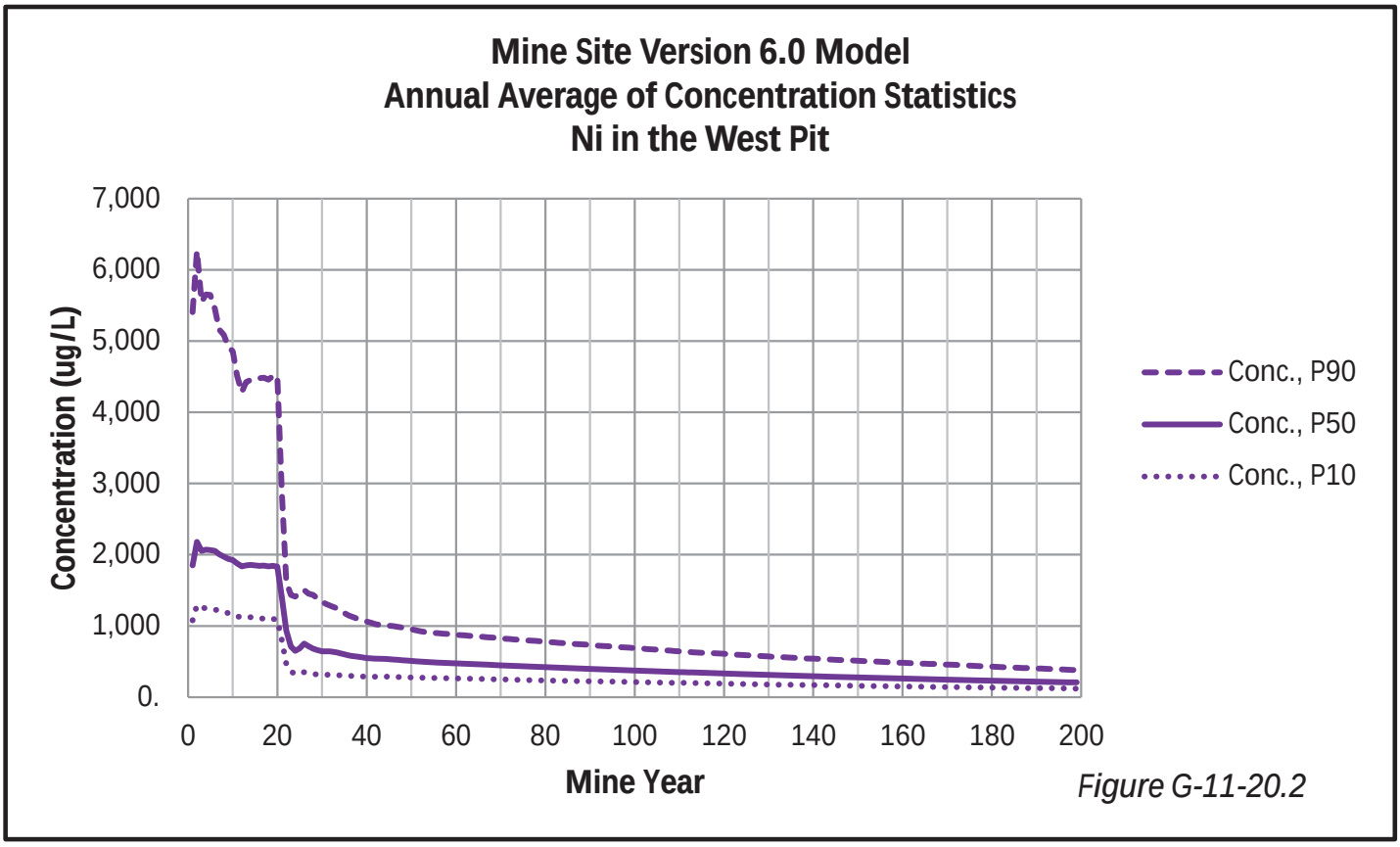

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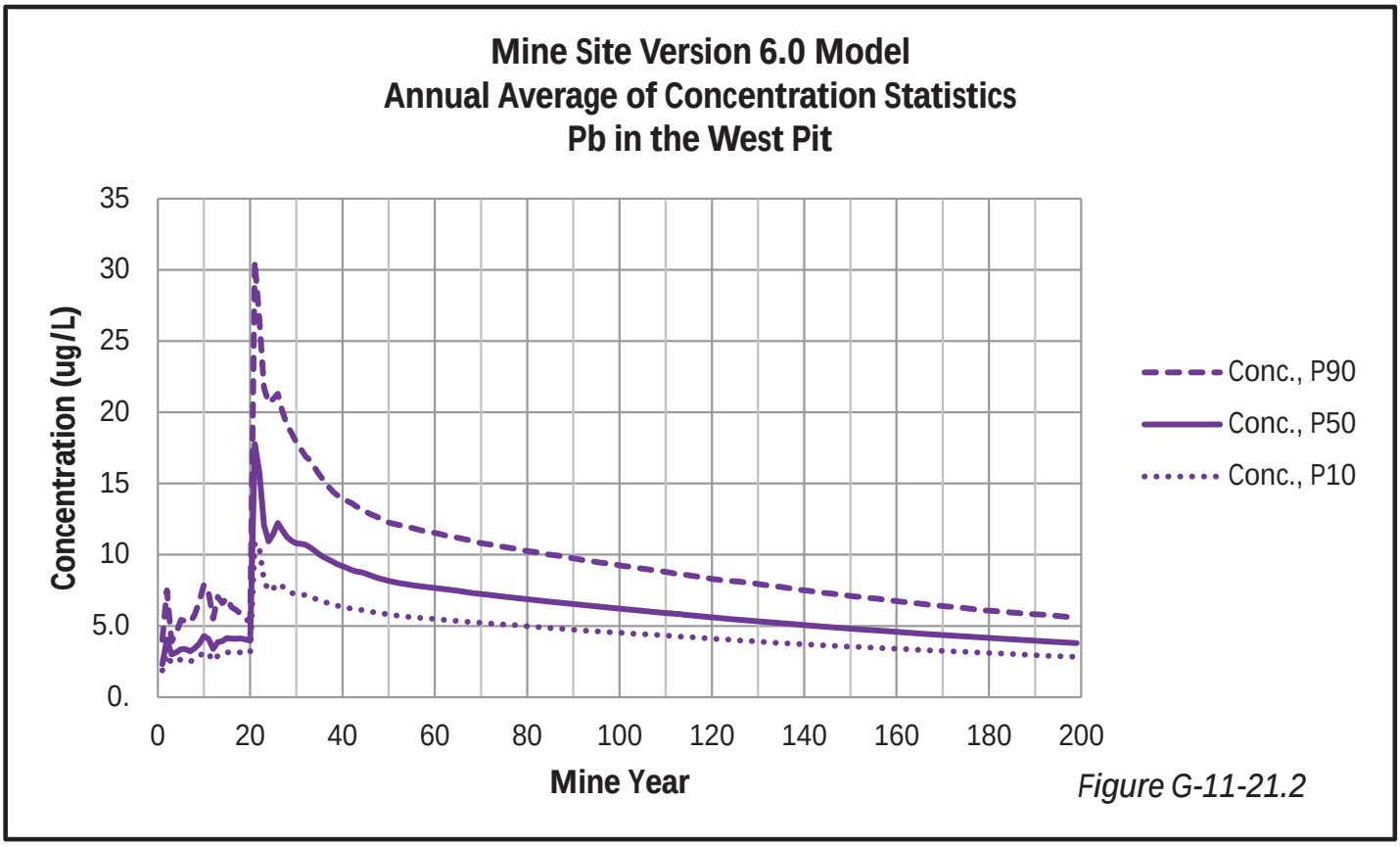

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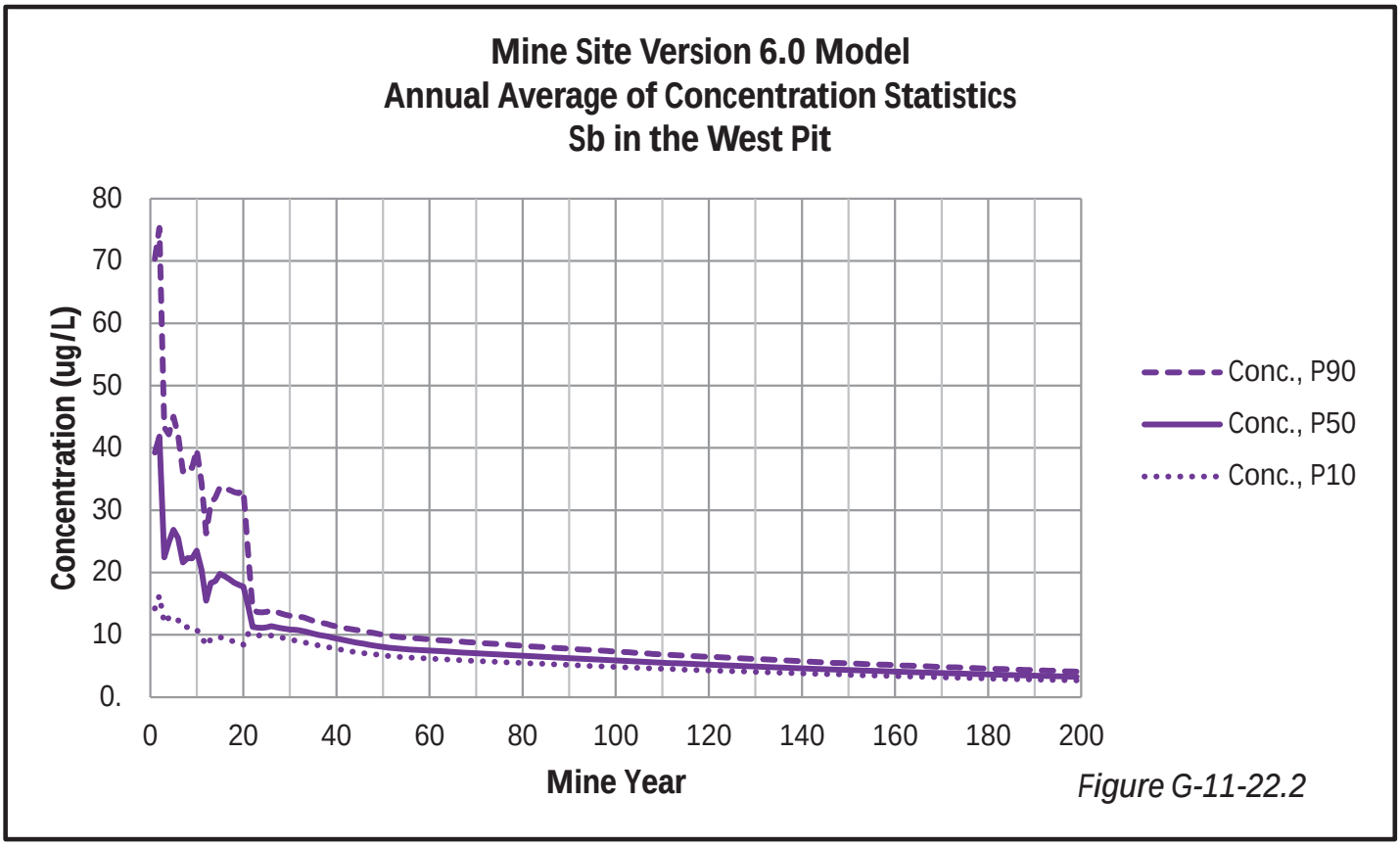

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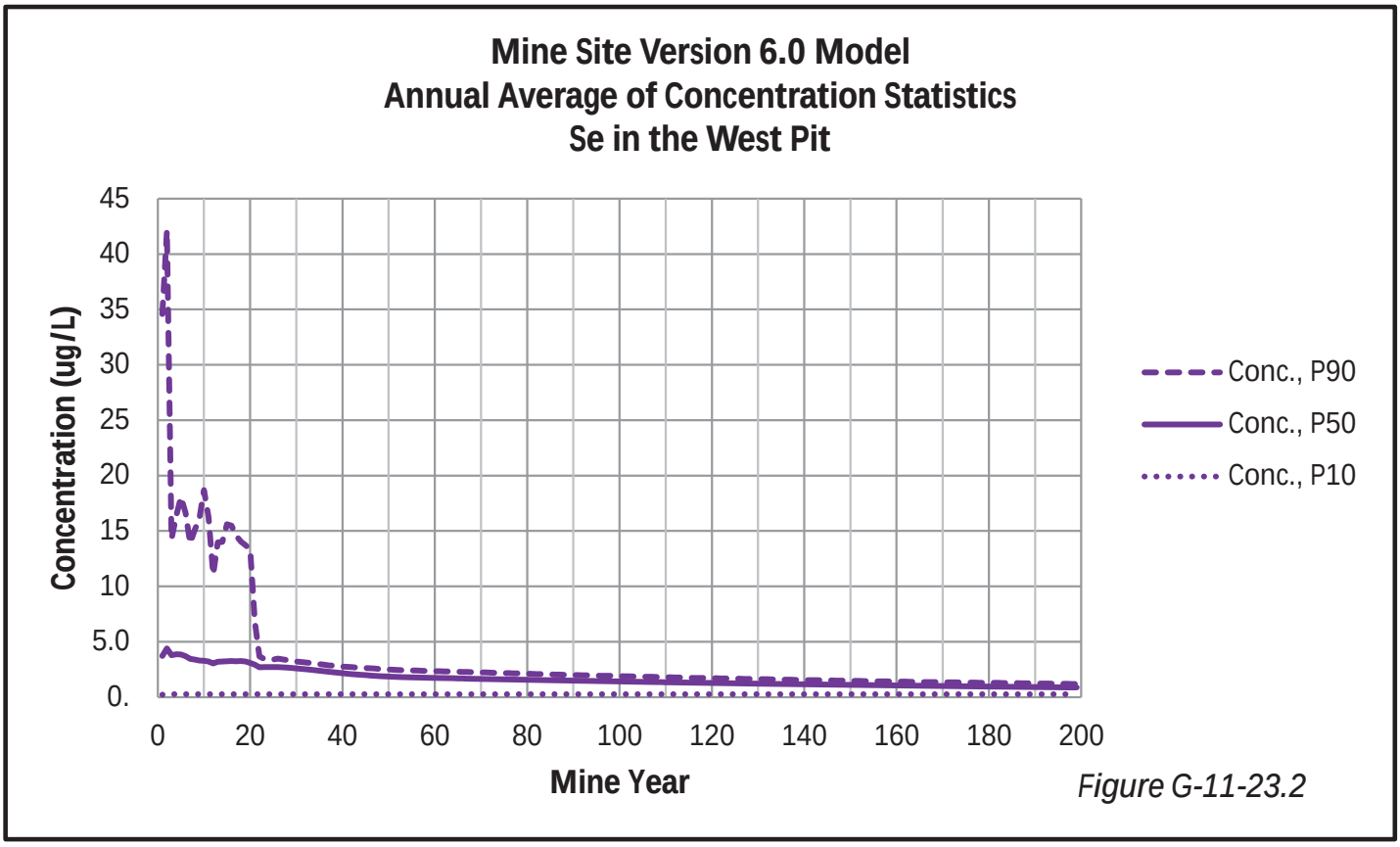
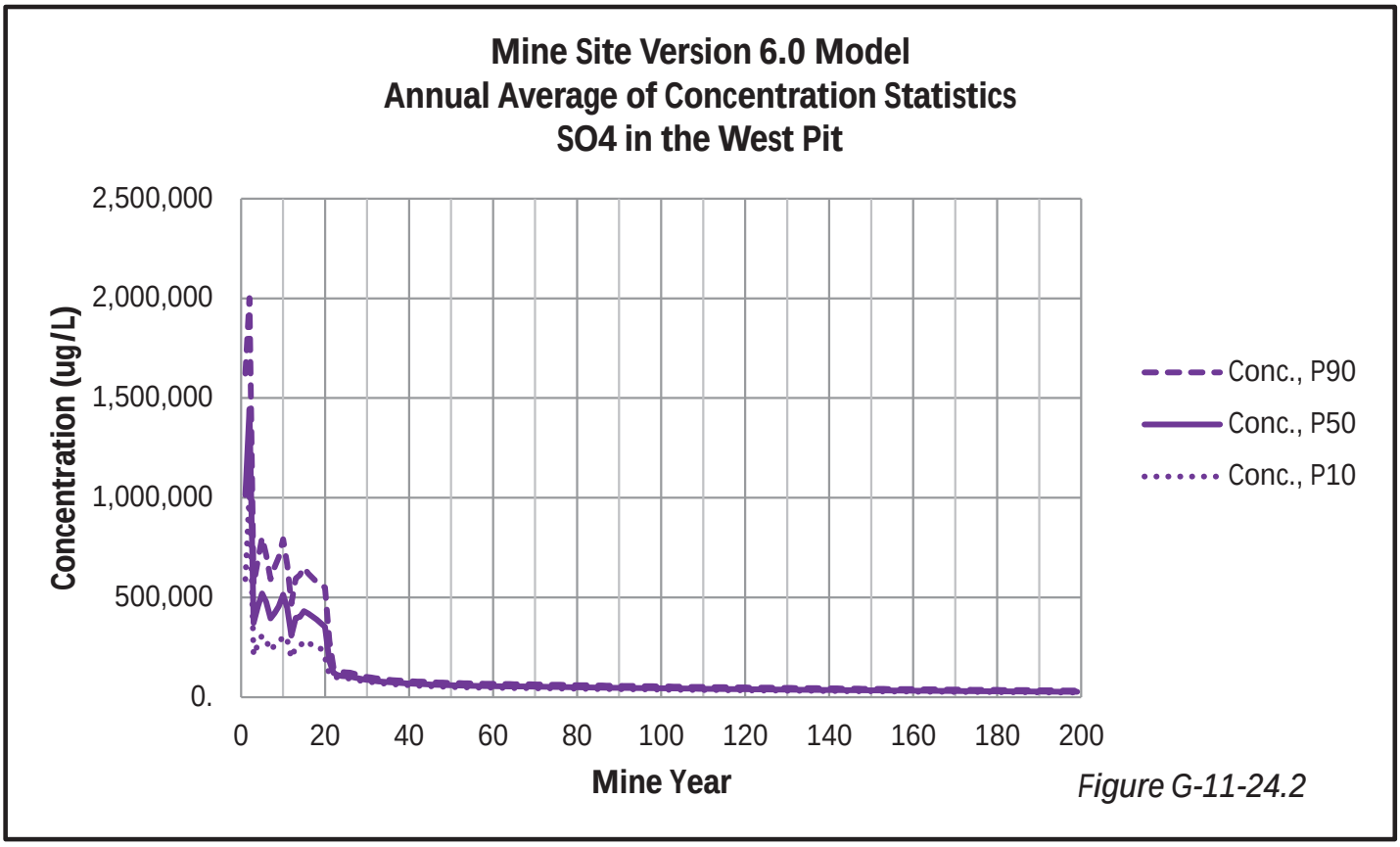


Figure G-11-23.2



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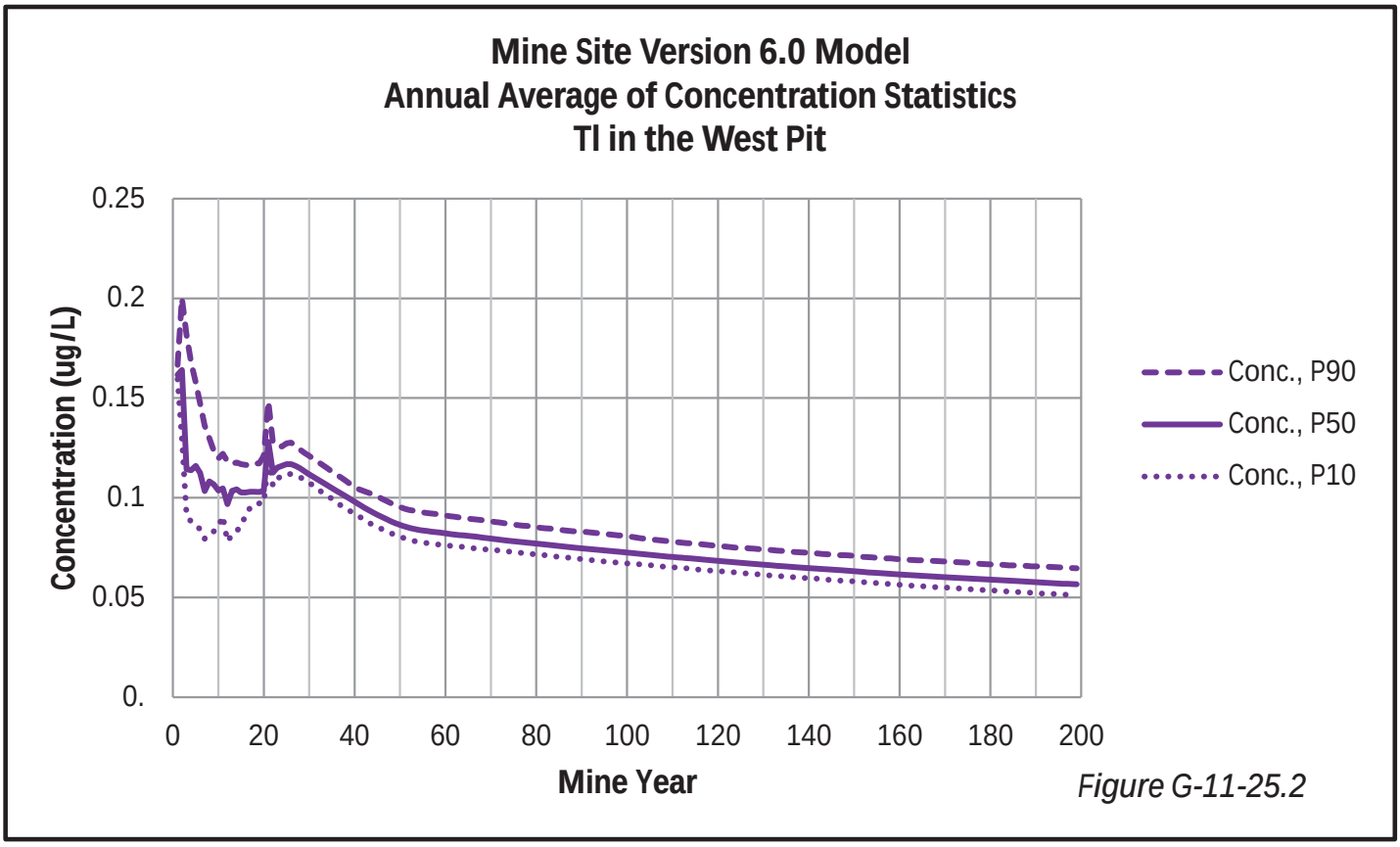

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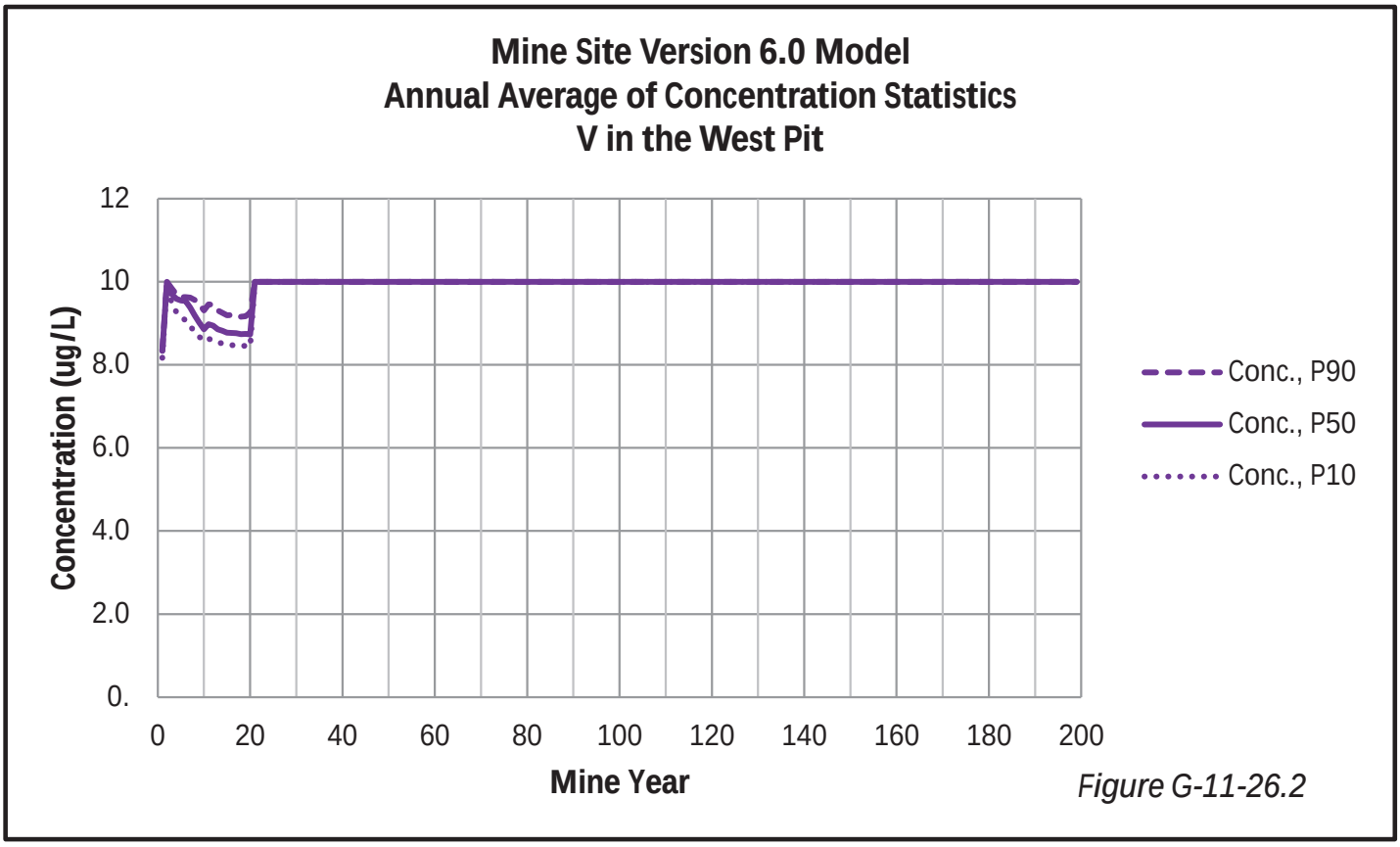

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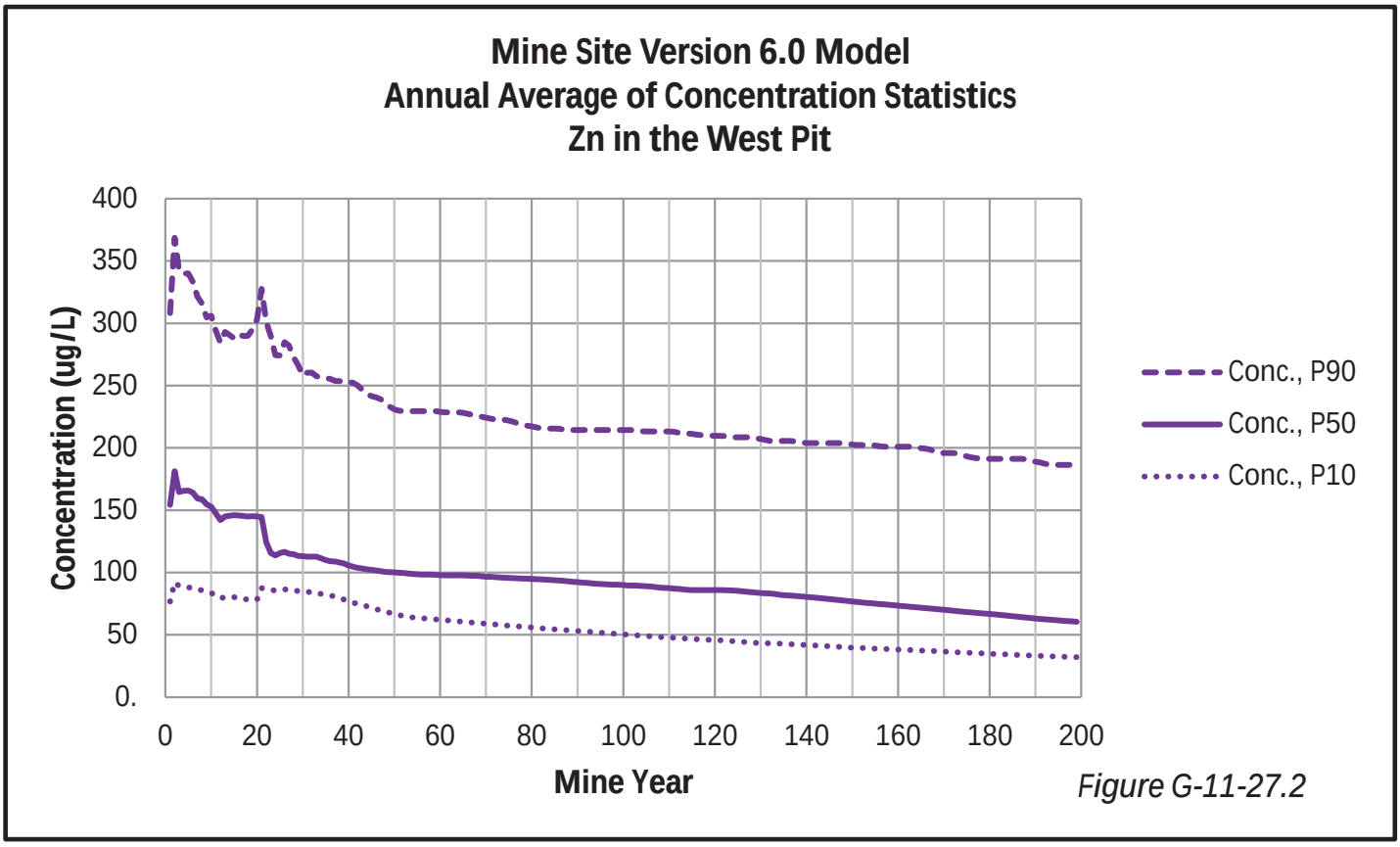

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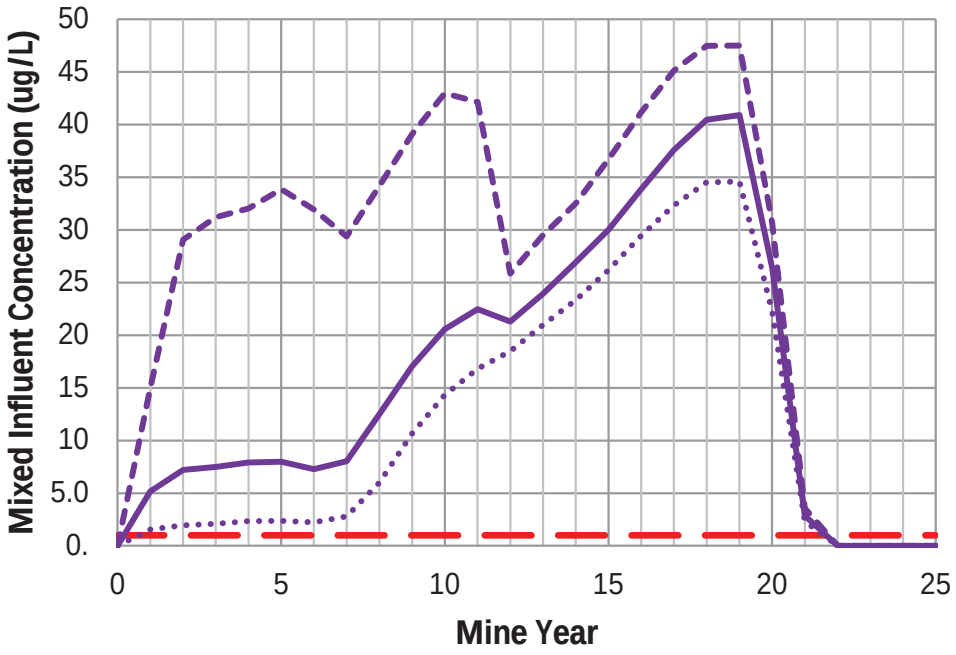


Modeled WWTF Target

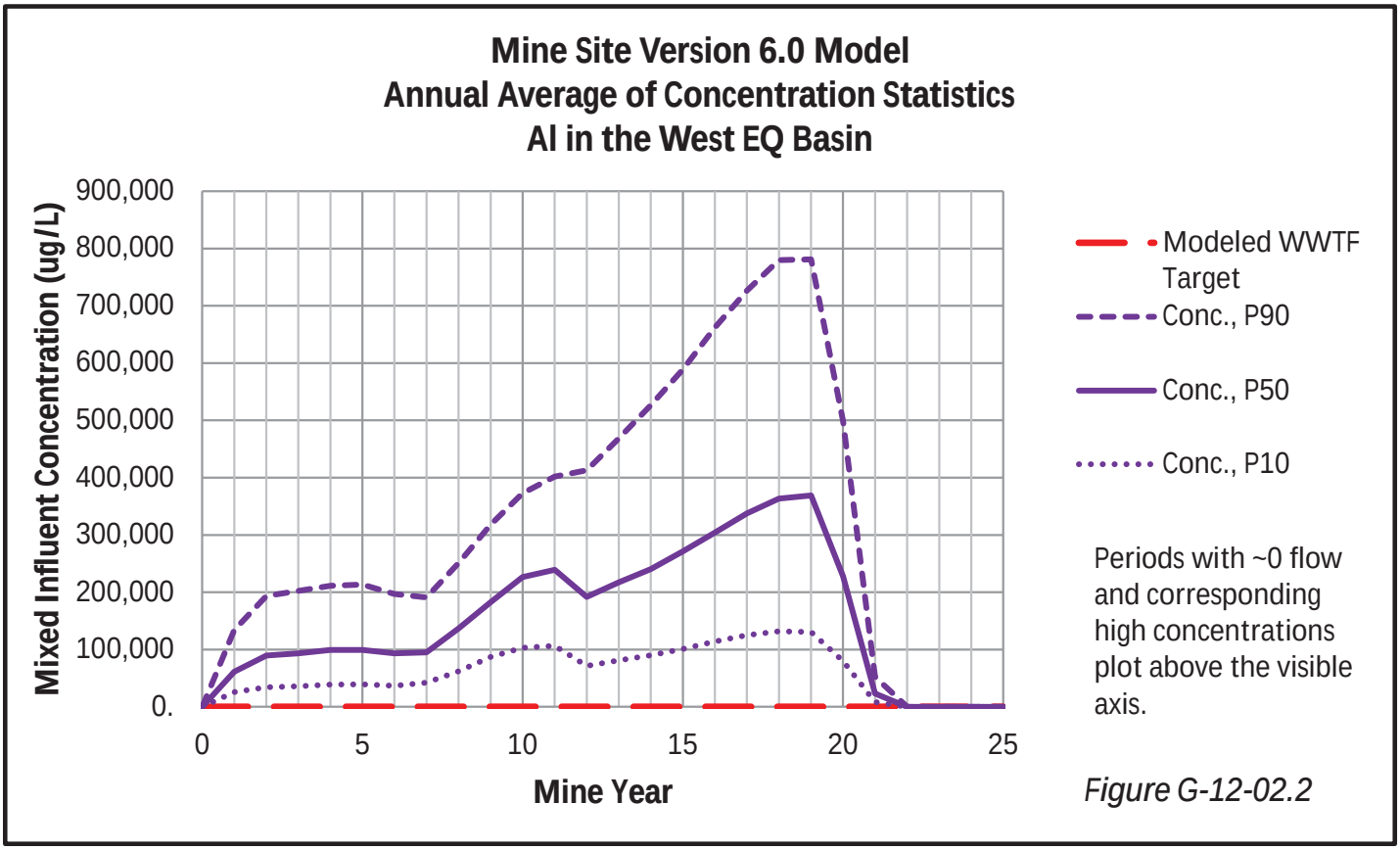
Conc., P90

Conc., P50

Conc., P10

Periods with ~0 flow and corresponding high concentrations plot above the visible axis.

Figure G-12-01.2



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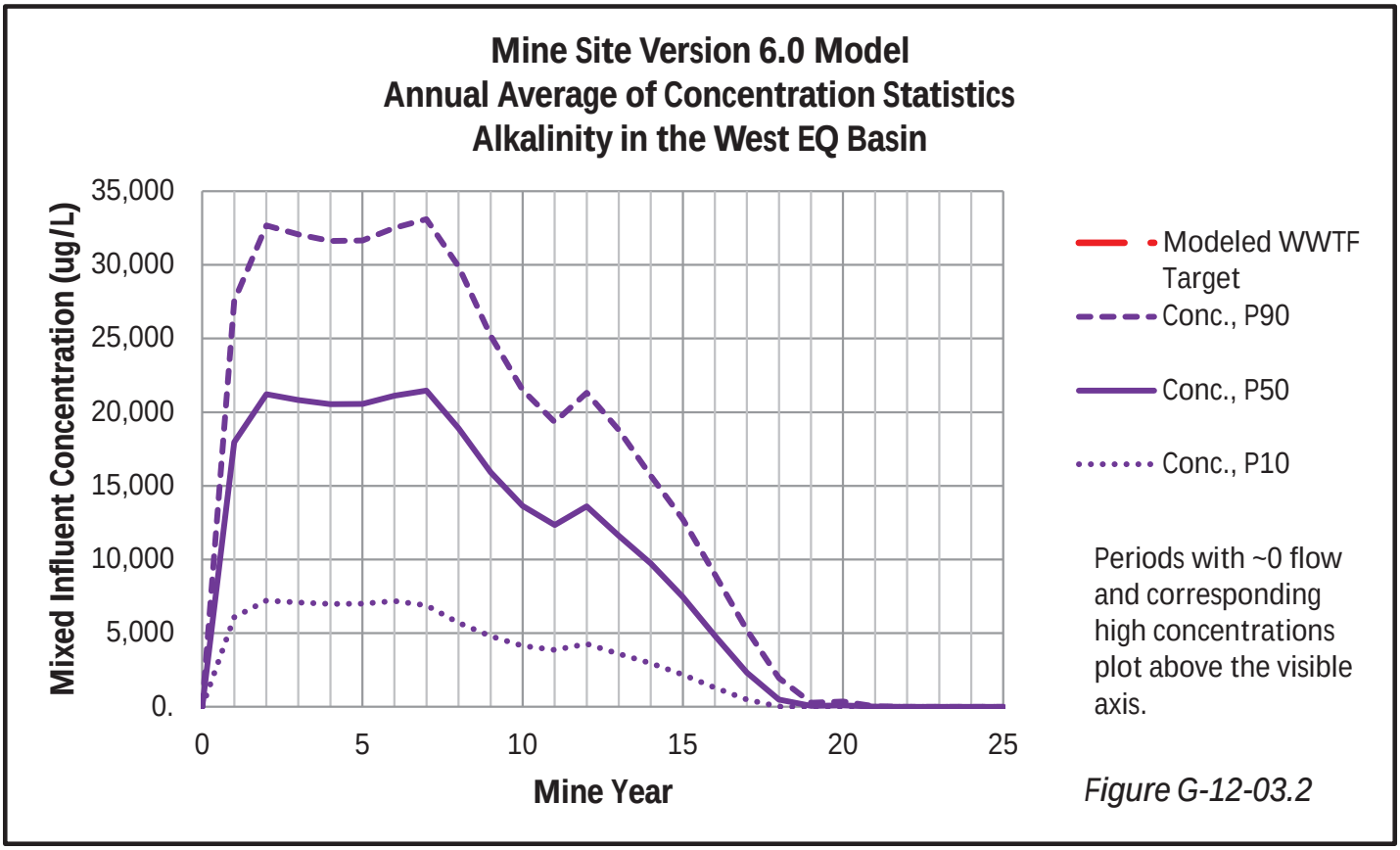

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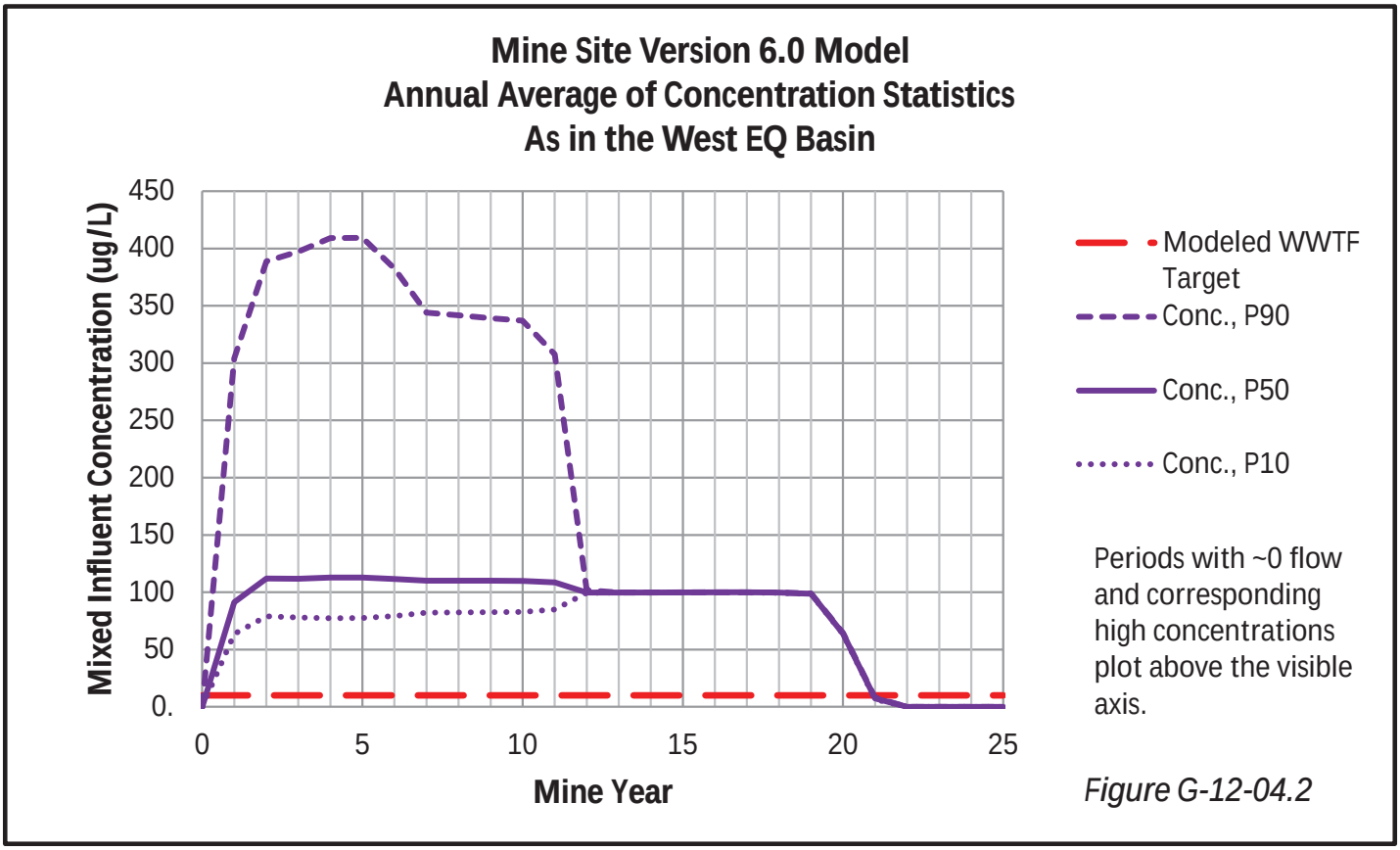

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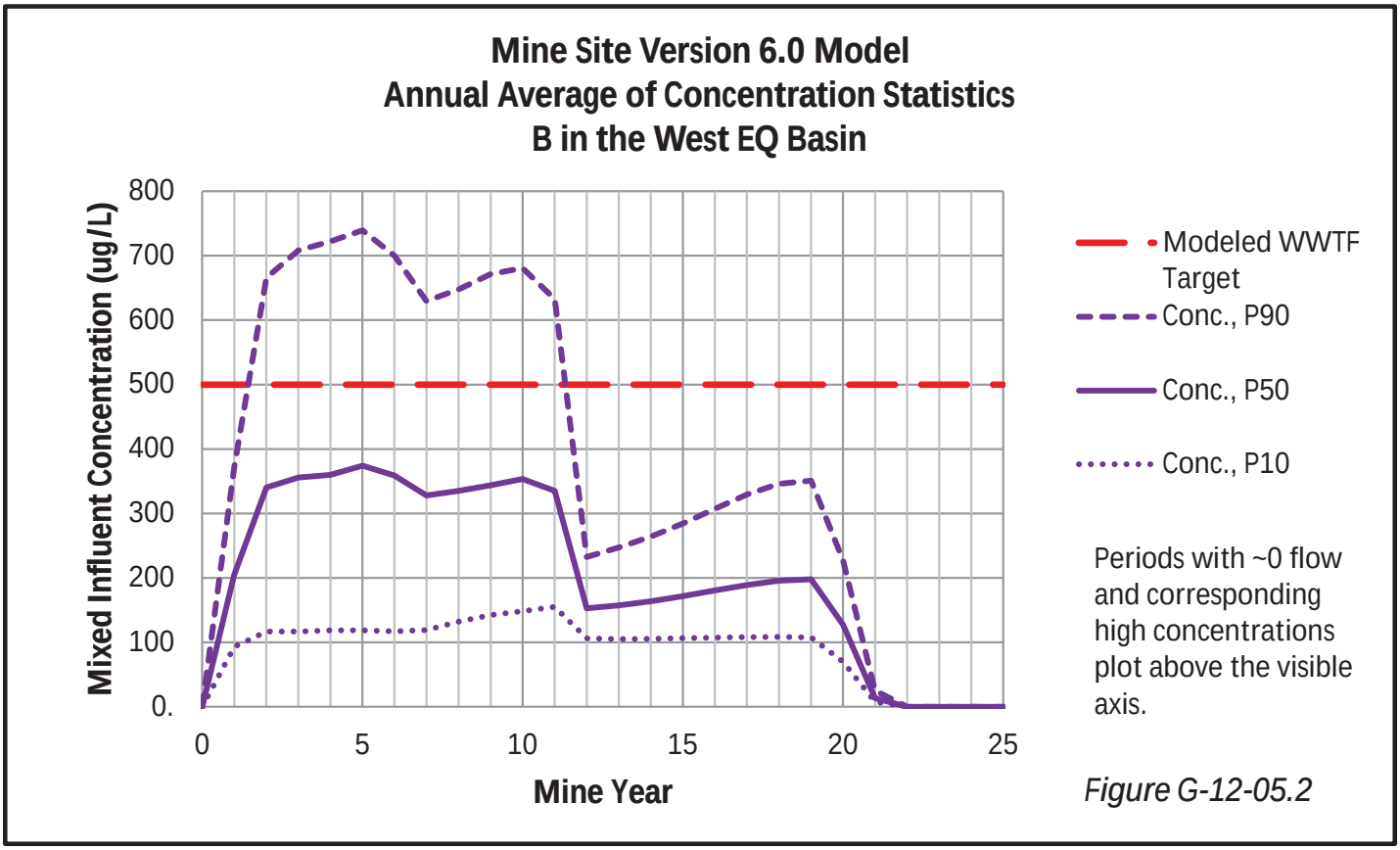

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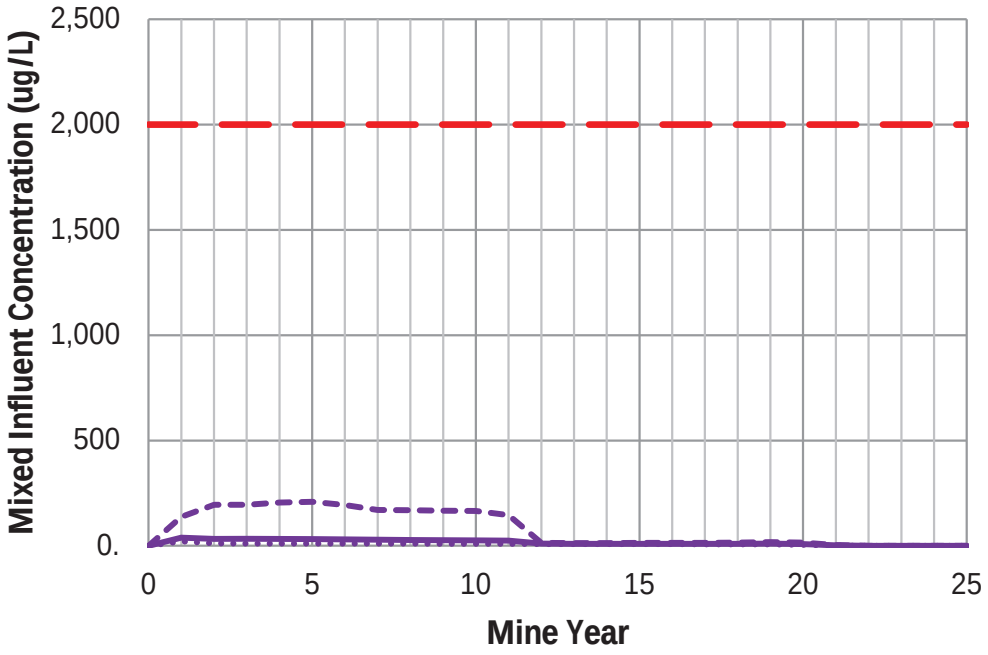


Modeled WWTF Target

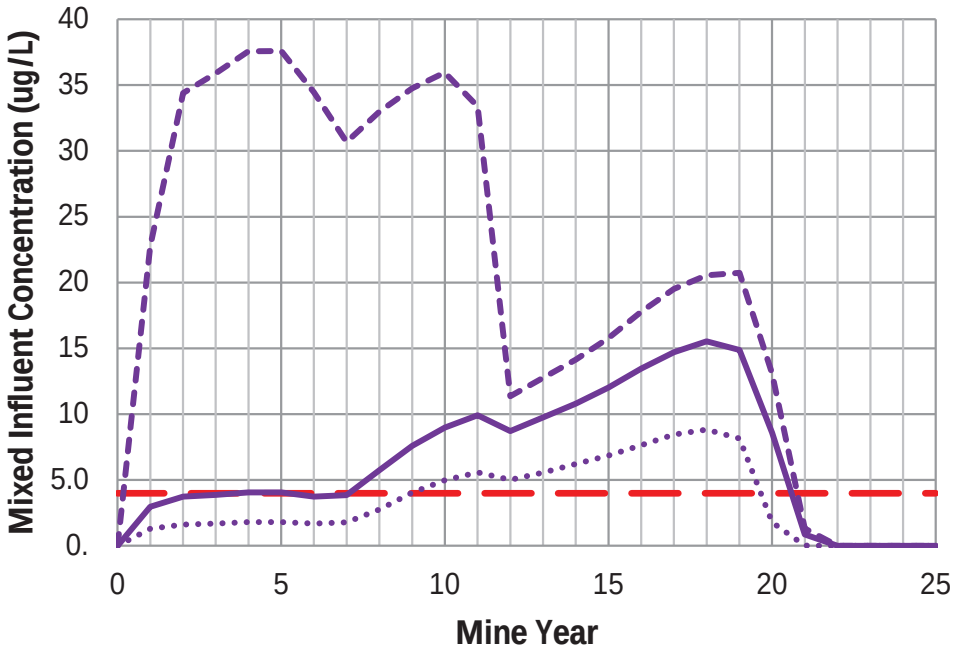
Conc., P90

Conc., P50

Conc., P10

Periods with ~0 flow and corresponding high concentrations plot above the visible axis.

Figure G-12-06.2



Modeled WWTF Target

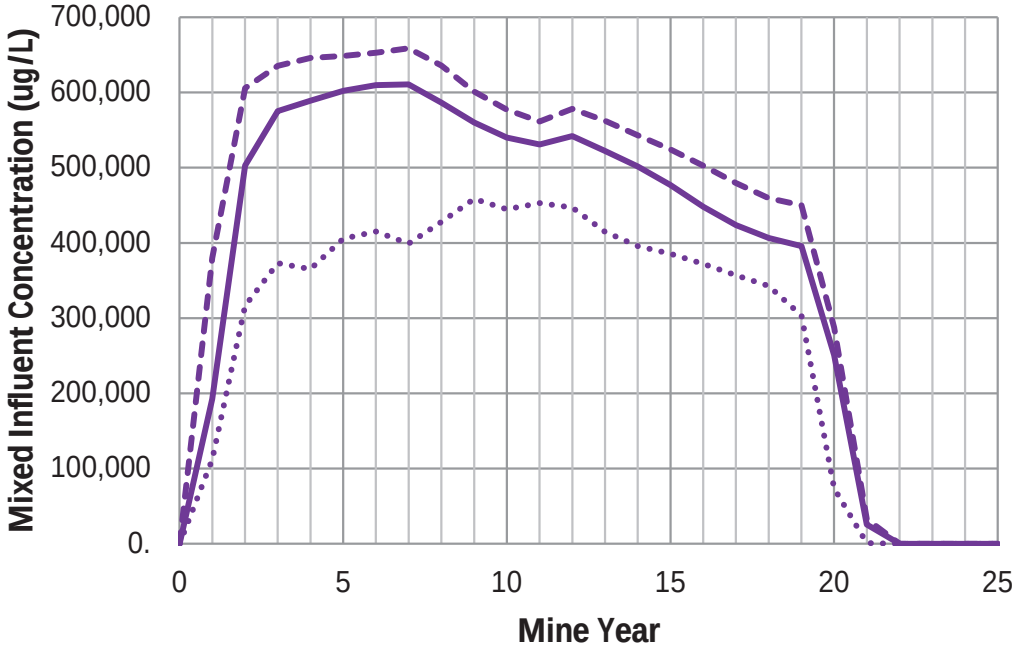
Conc., P90

Conc., P50

Conc., P10

Periods with ~0 flow and corresponding high concentrations plot above the visible axis.

Figure G-12-07.2



Modeled WWTF Target

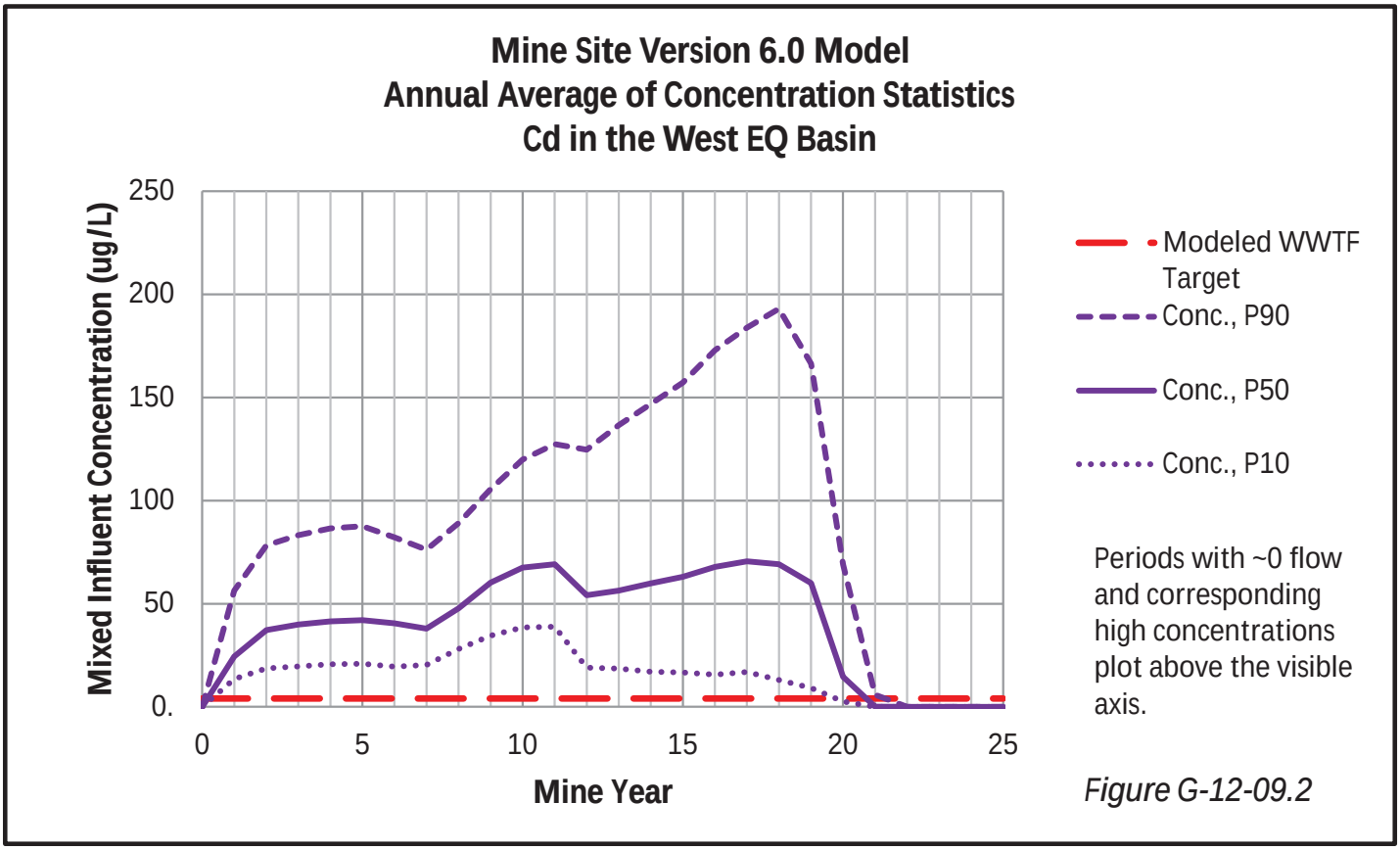
Conc., P90

Conc., P50

Conc., P10

Periods with ~0 flow and corresponding high concentrations plot above the visible axis.

Figure G-12-08.2



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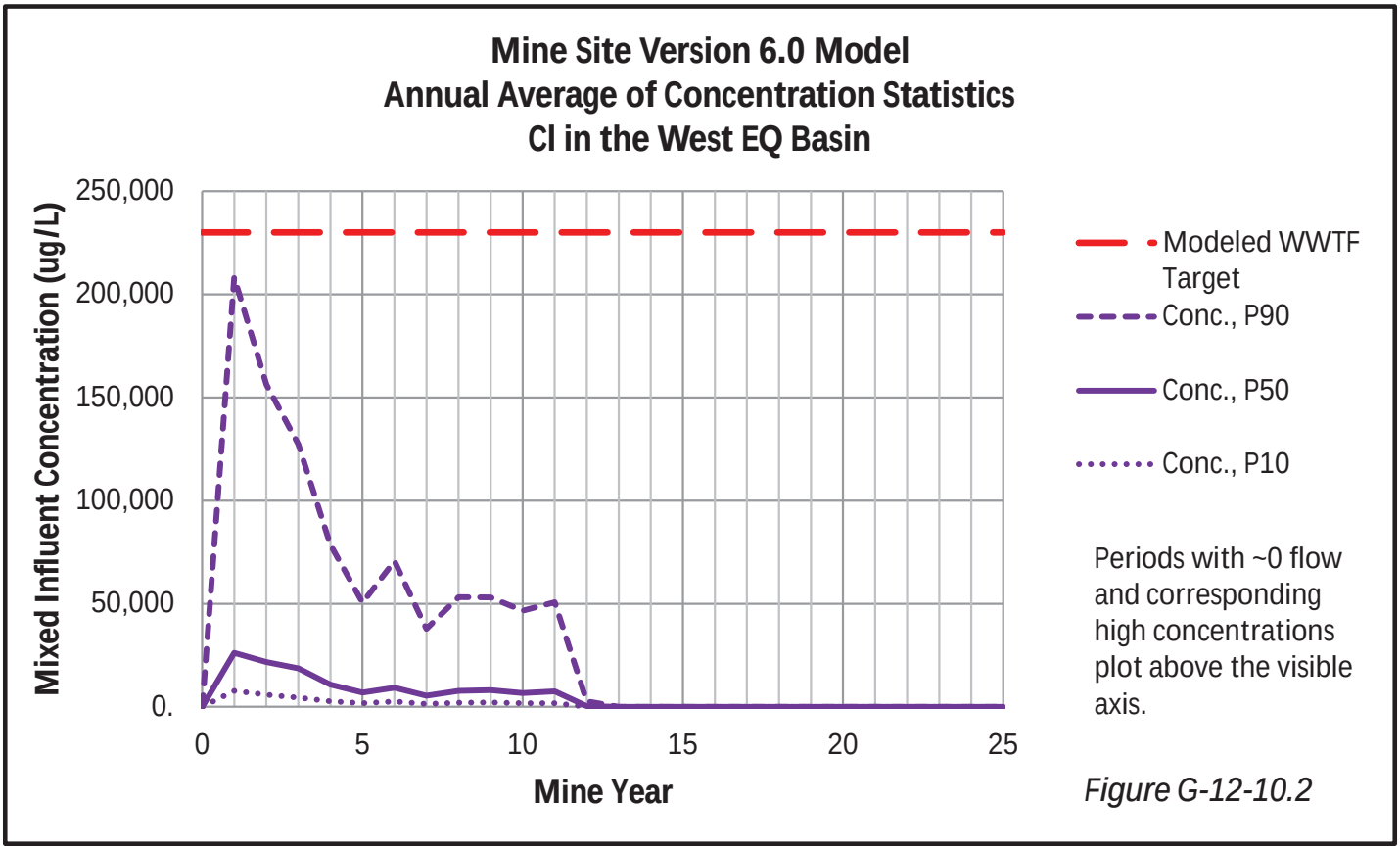

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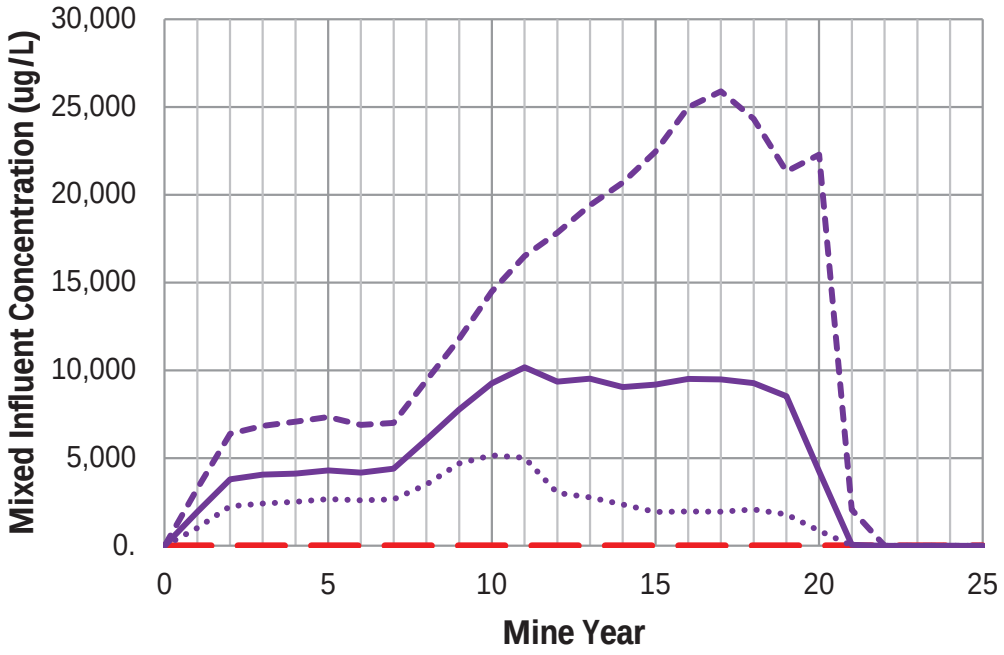


Modeled WWTF Target

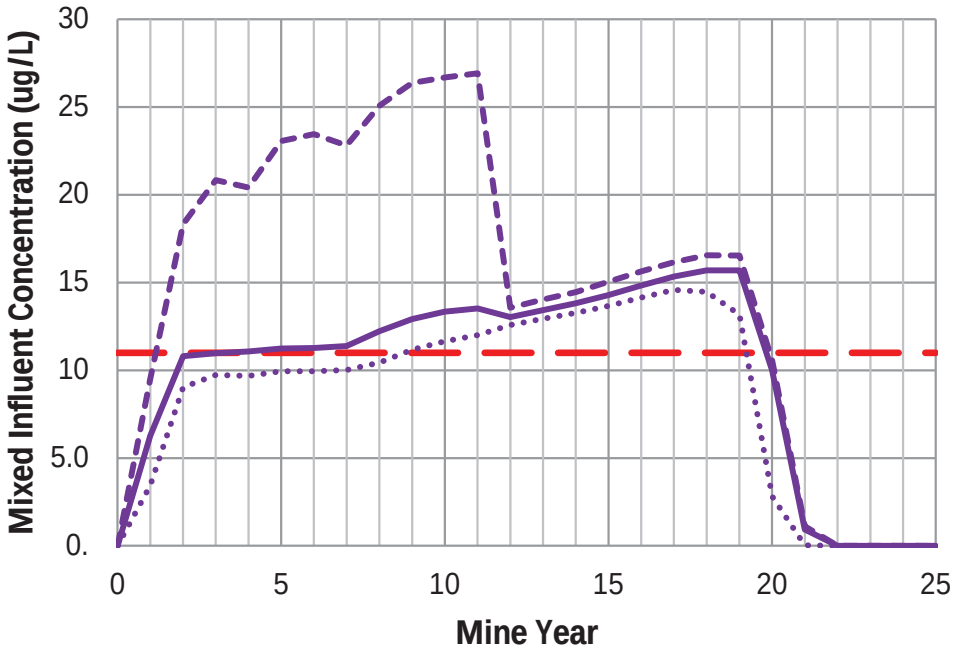
Conc., P90

Conc., P50

Conc., P10

Periods with ~0 flow and corresponding high concentrations plot above the visible axis.

Figure G-12-11.2



Modeled WWTF Target

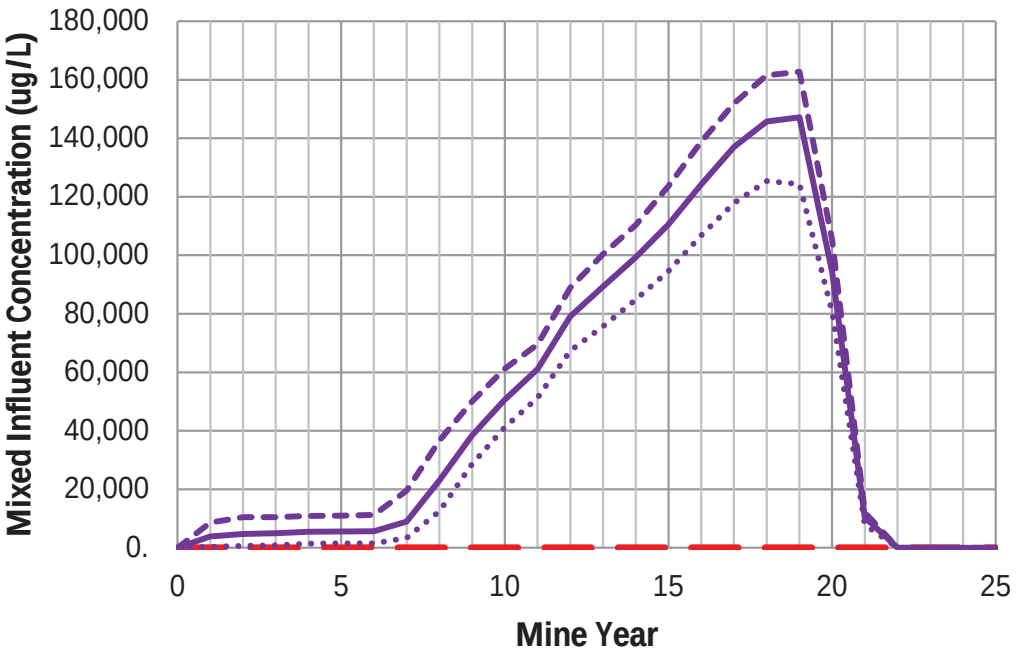
Conc., P90

Conc., P50

Conc., P10

Periods with ~0 flow and corresponding high concentrations plot above the visible axis.

Figure G-12-12.2



Modeled WWTF Target

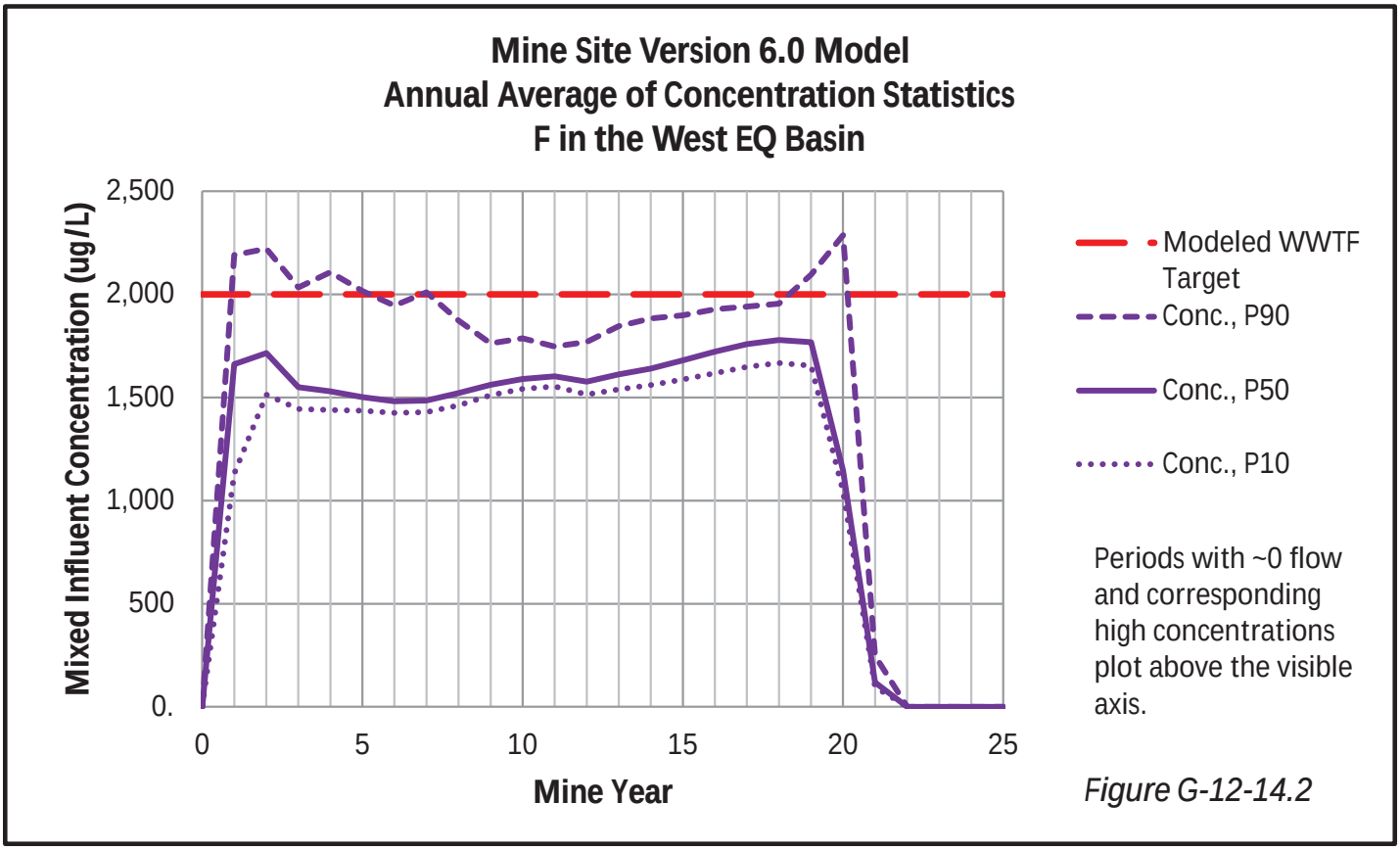
Conc., P90

Conc., P50

Conc., P10

Periods with ~0 flow and corresponding high concentrations plot above the visible axis.

Figure G-12-13.2



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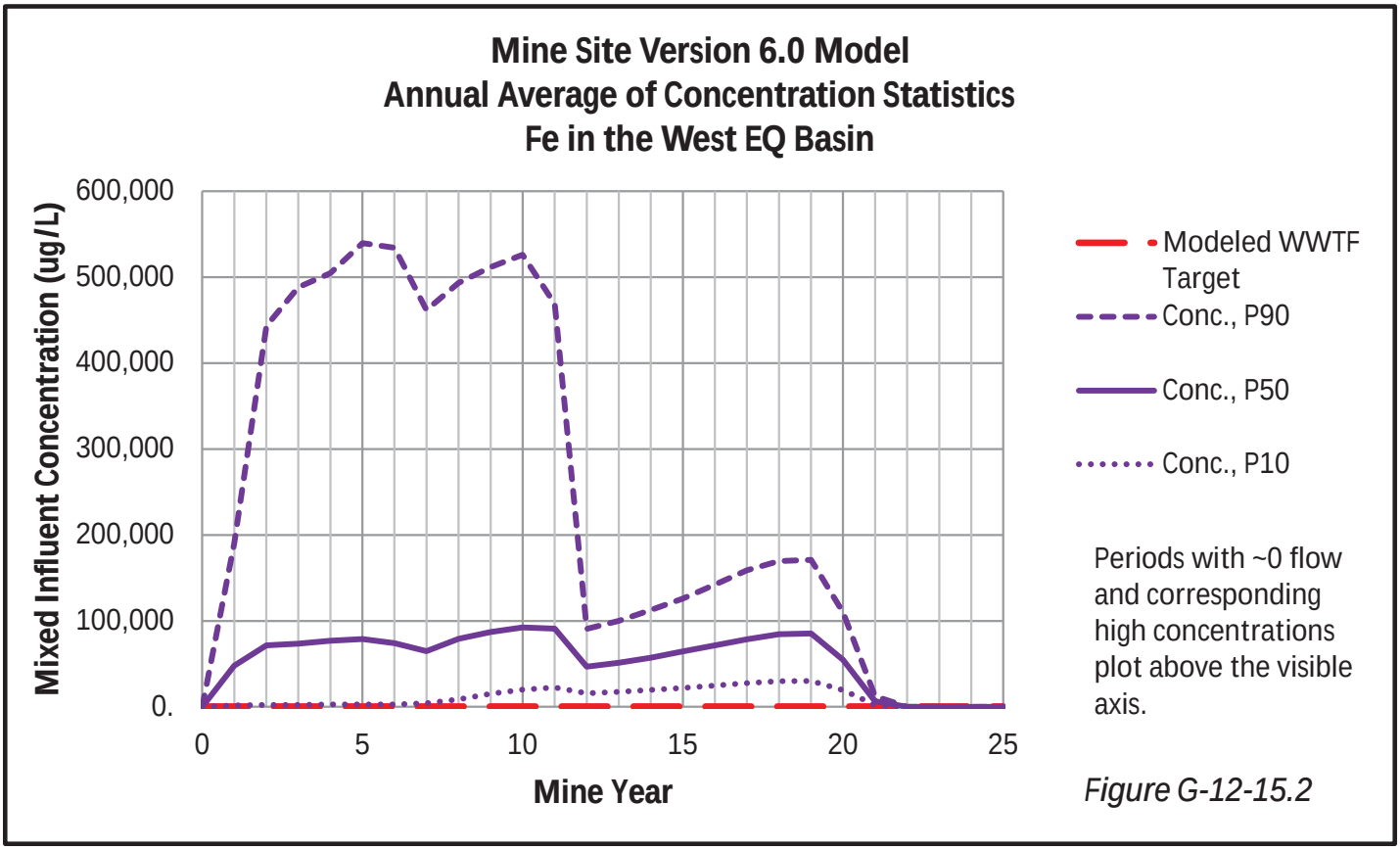

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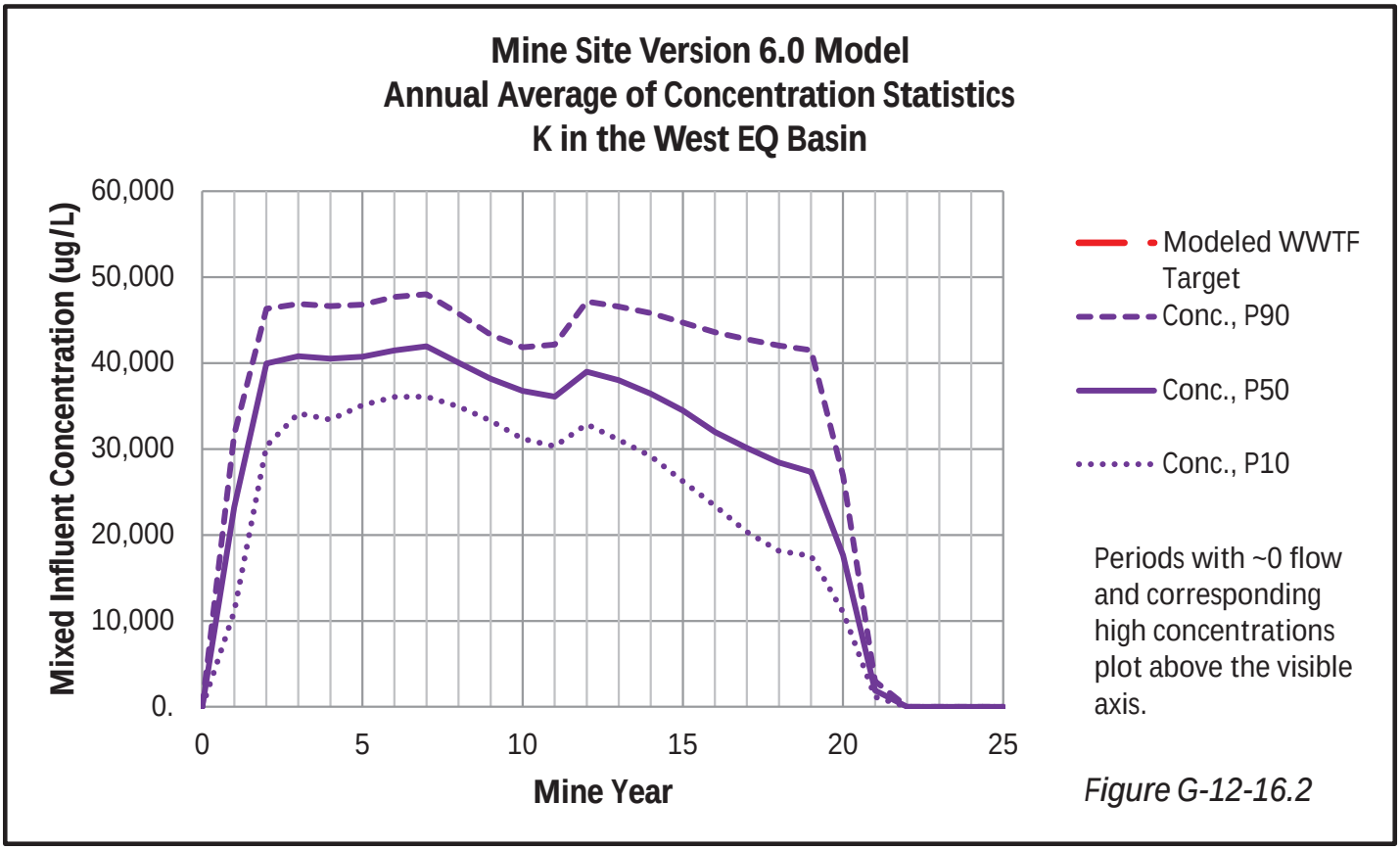

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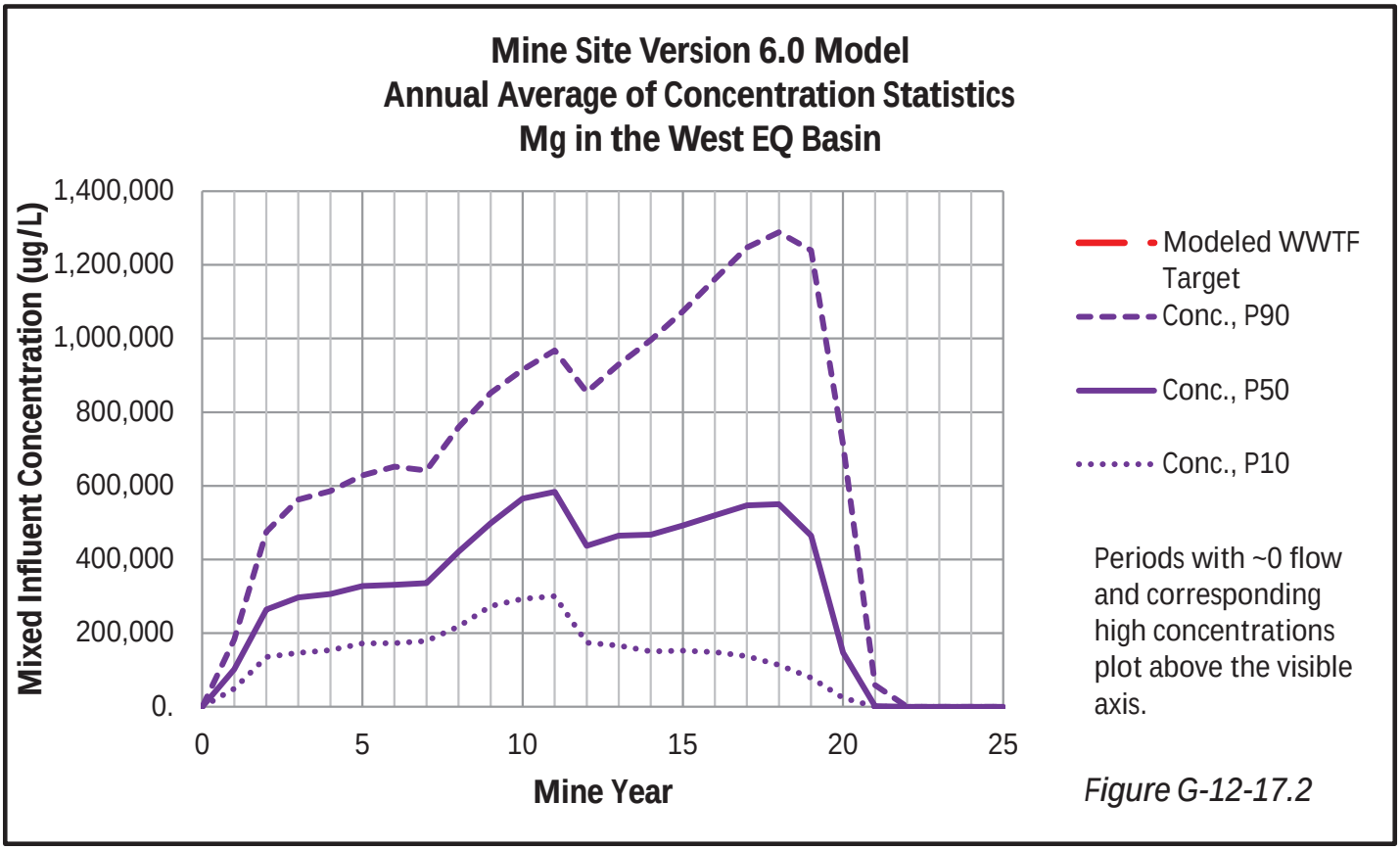
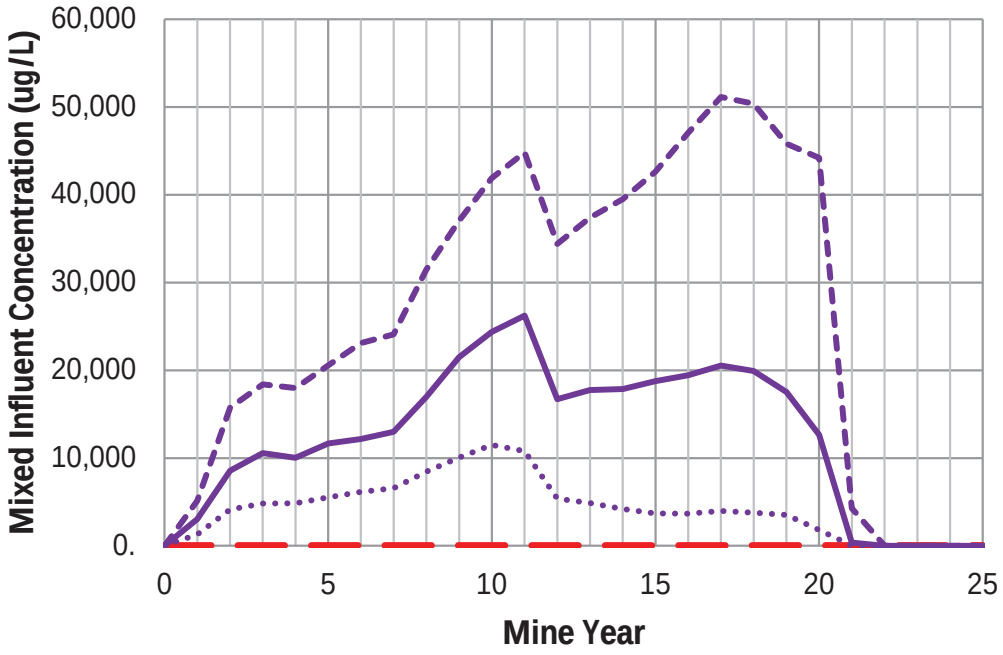


Figure G-12-17.2



Modeled WWTF Target

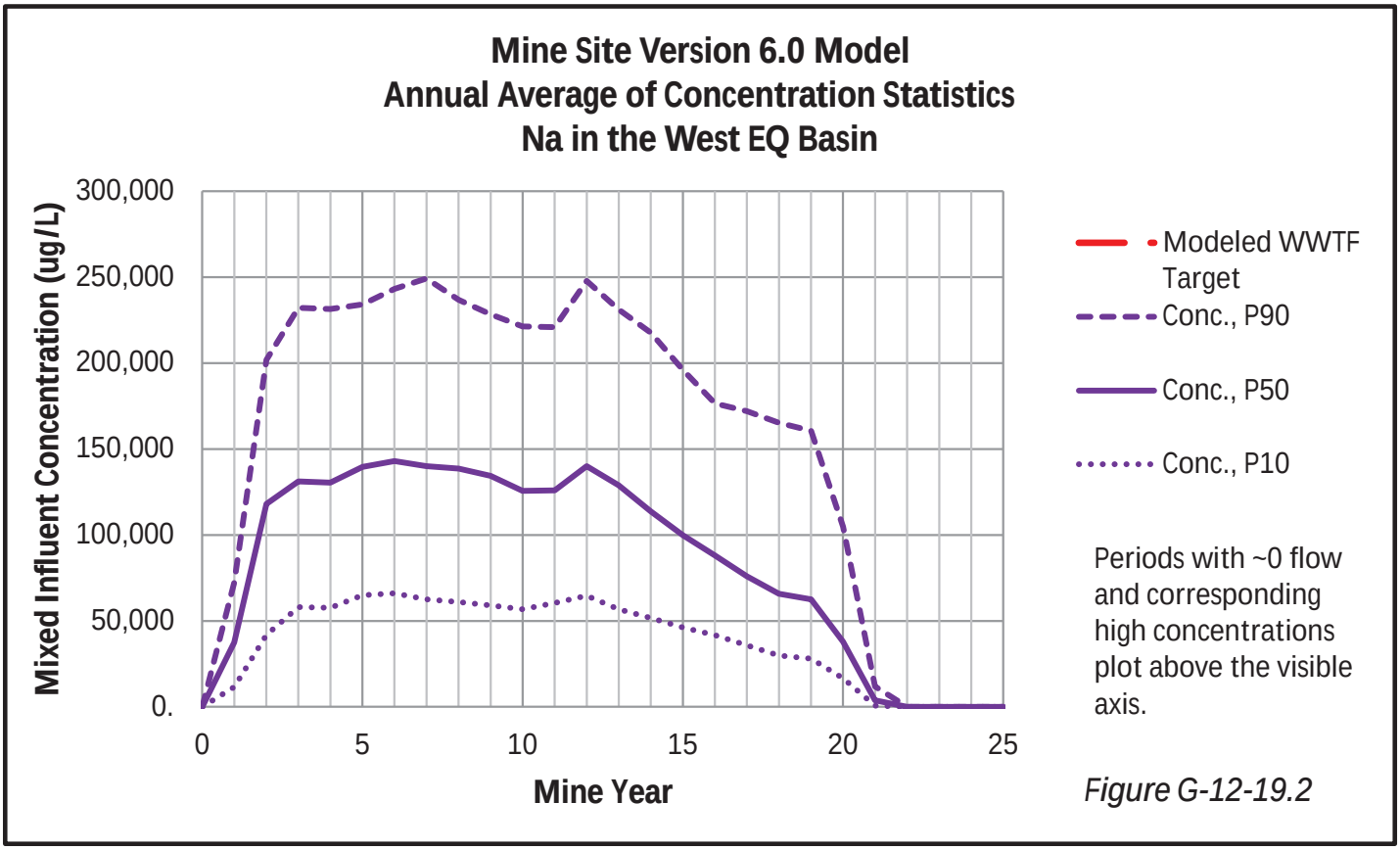
Conc., P90

Conc., P50

Conc., P10

Periods with ~0 flow and corresponding high concentrations plot above the visible axis.

Figure G-12-18.2



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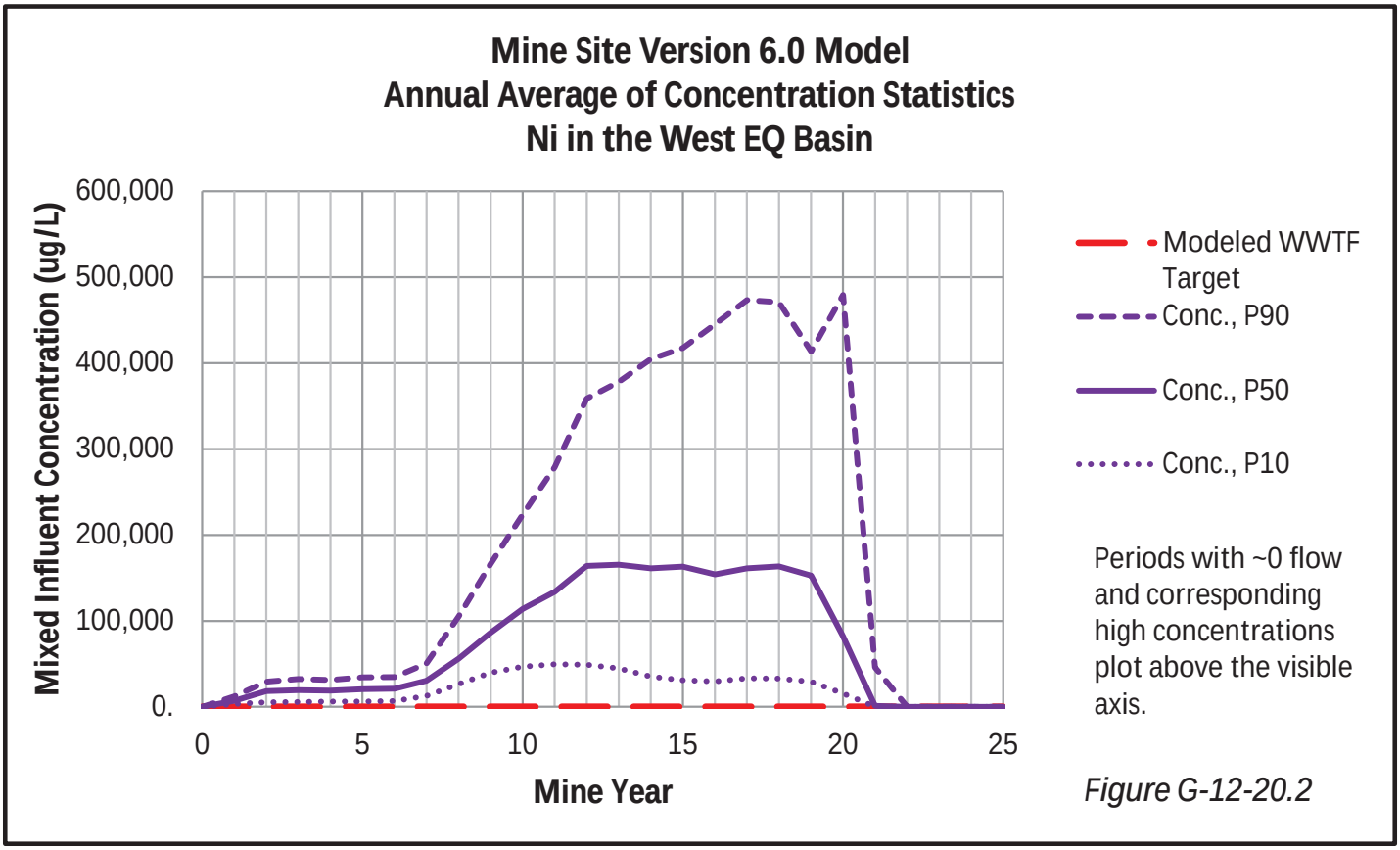

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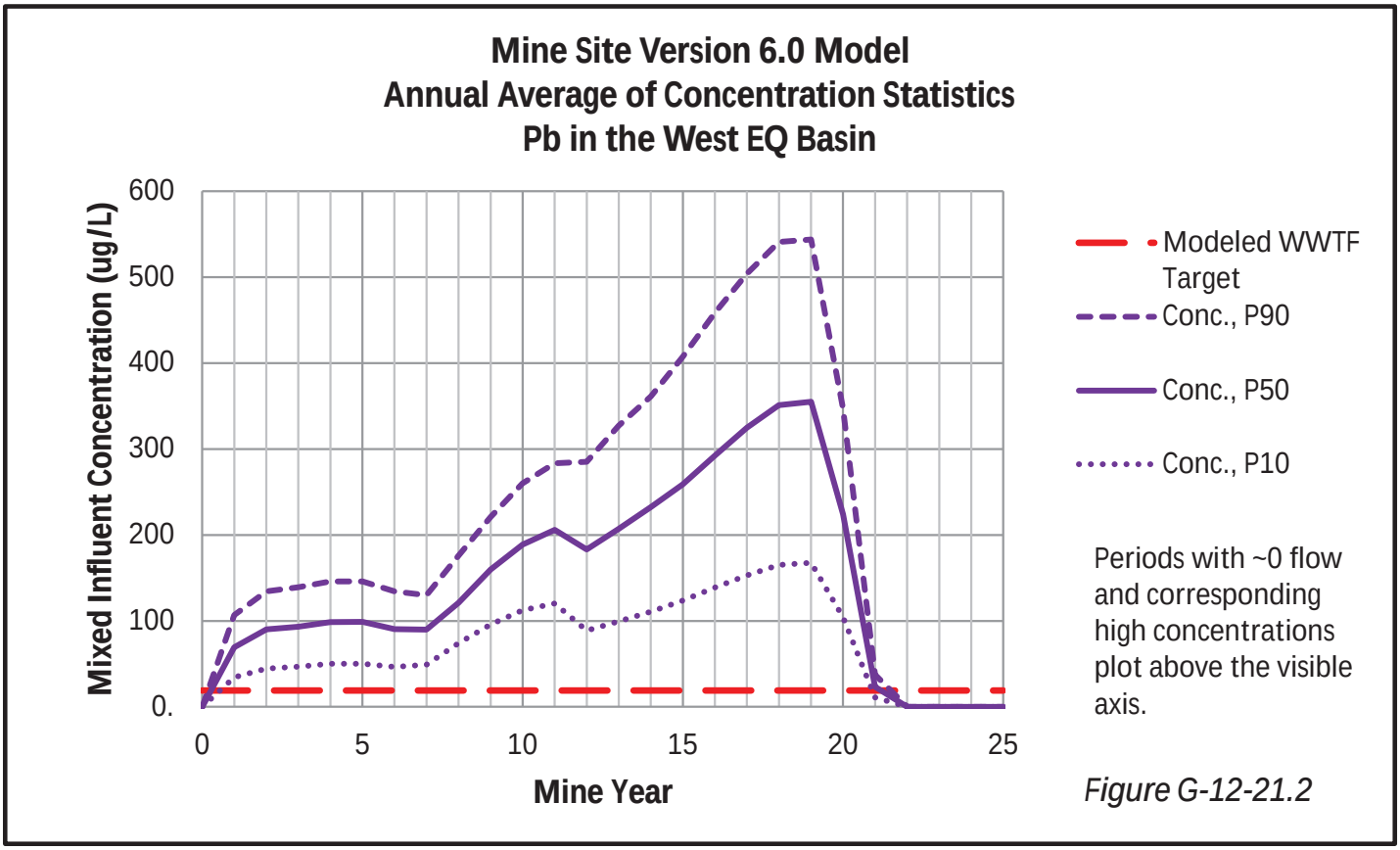

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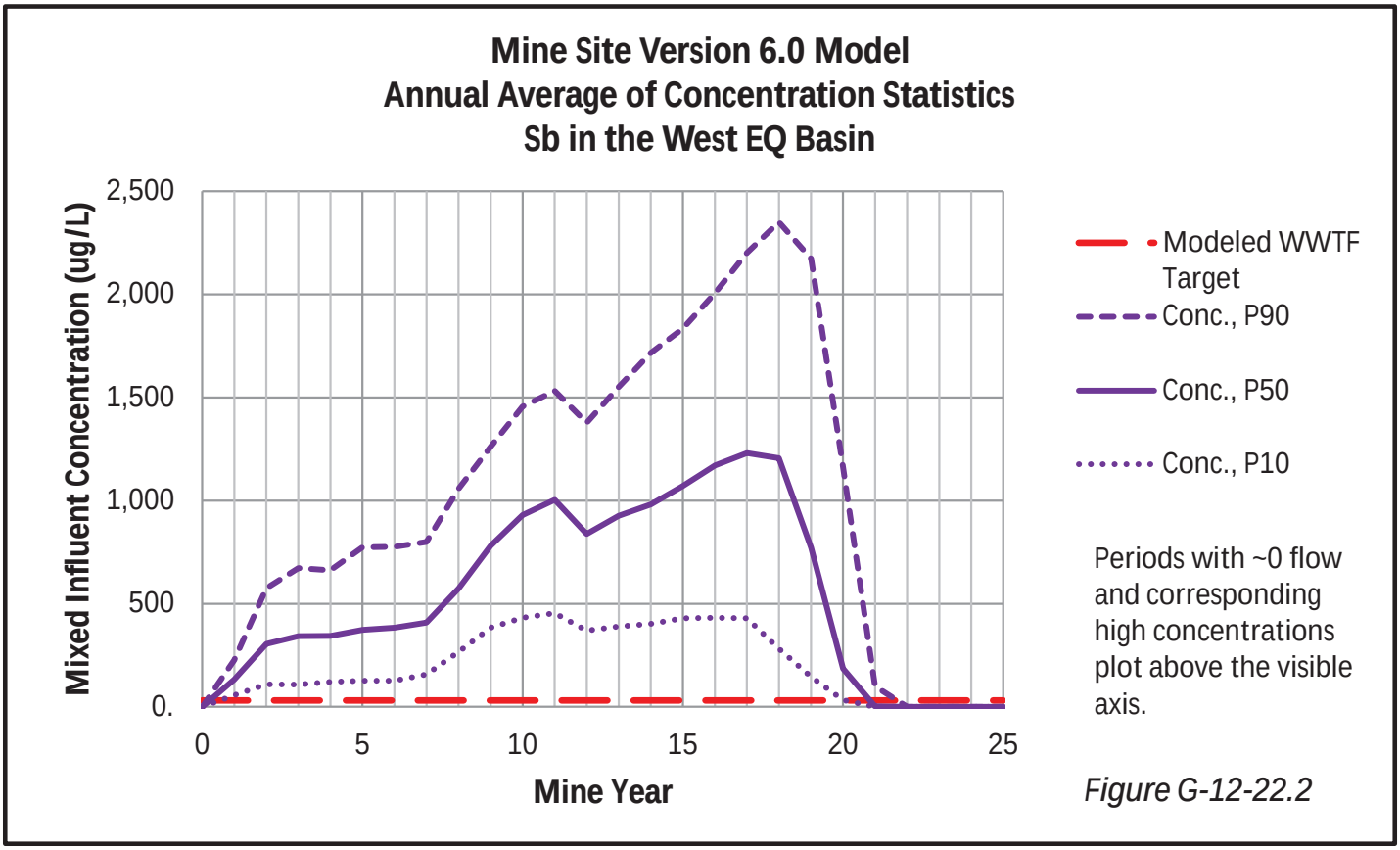

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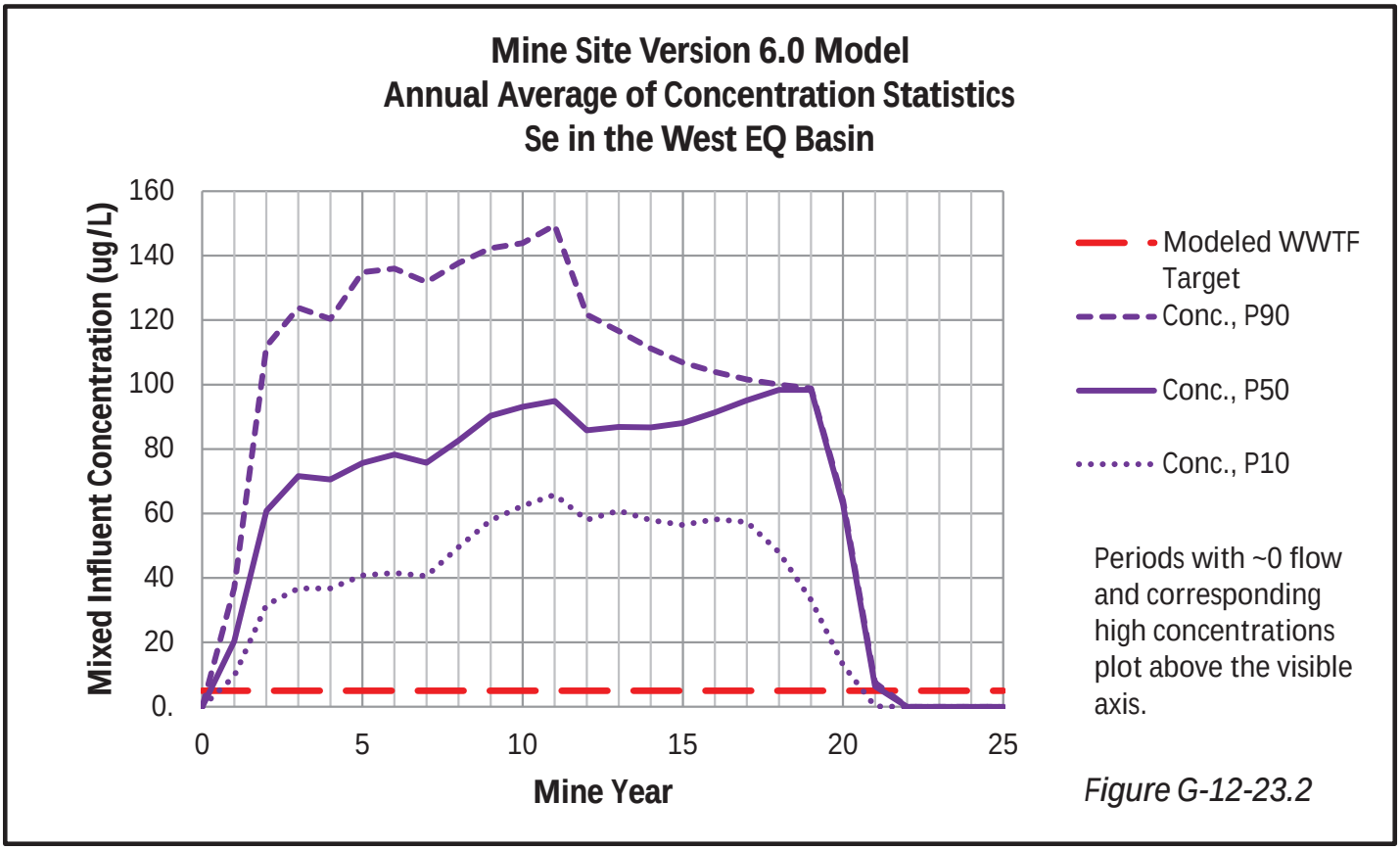

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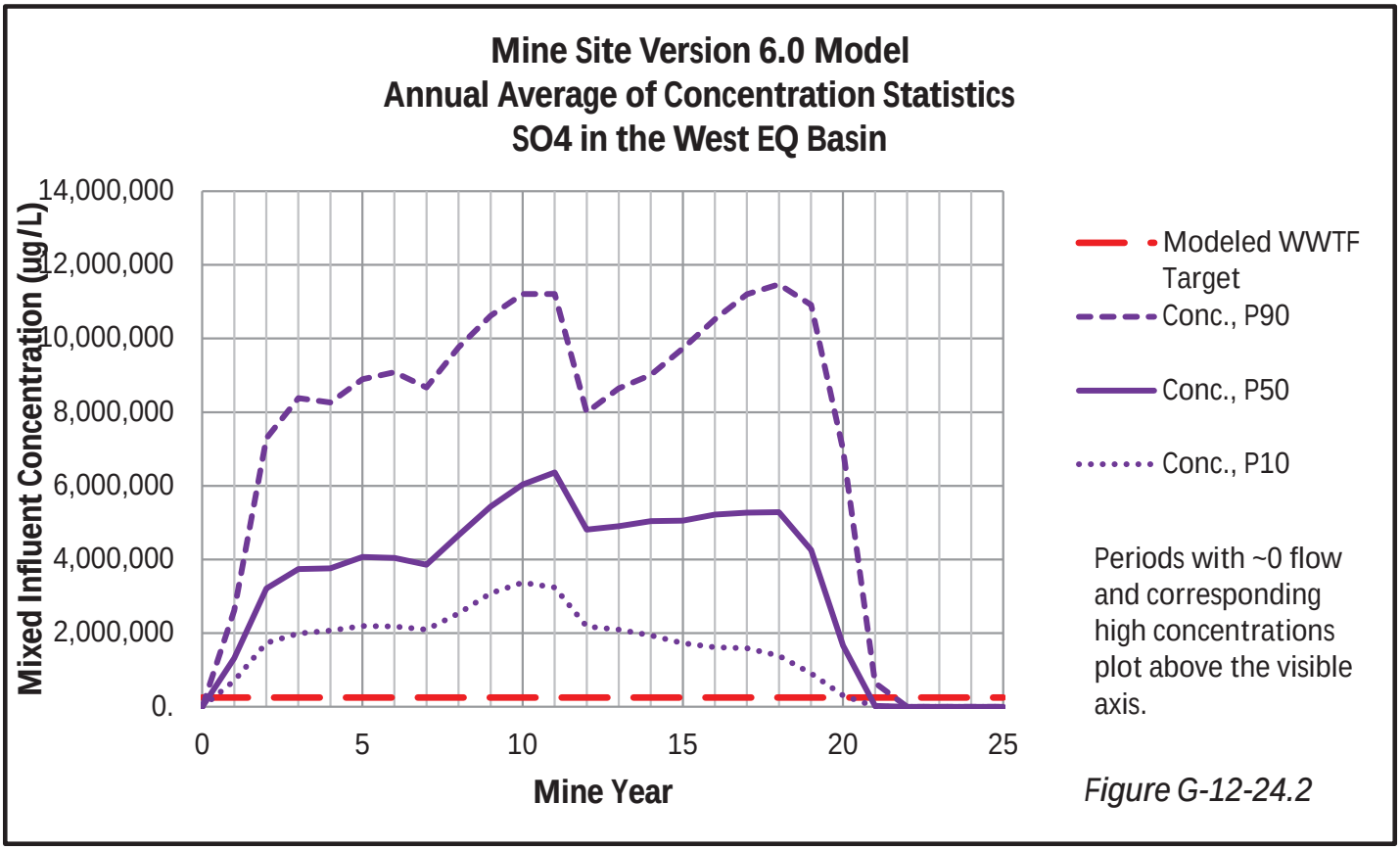

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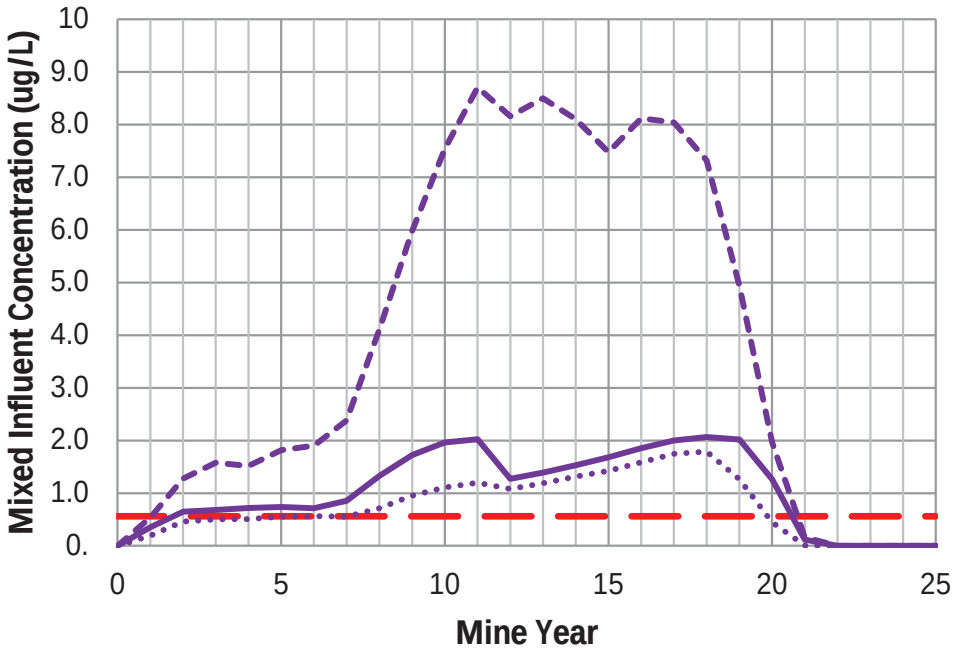


Modeled WWTF Target

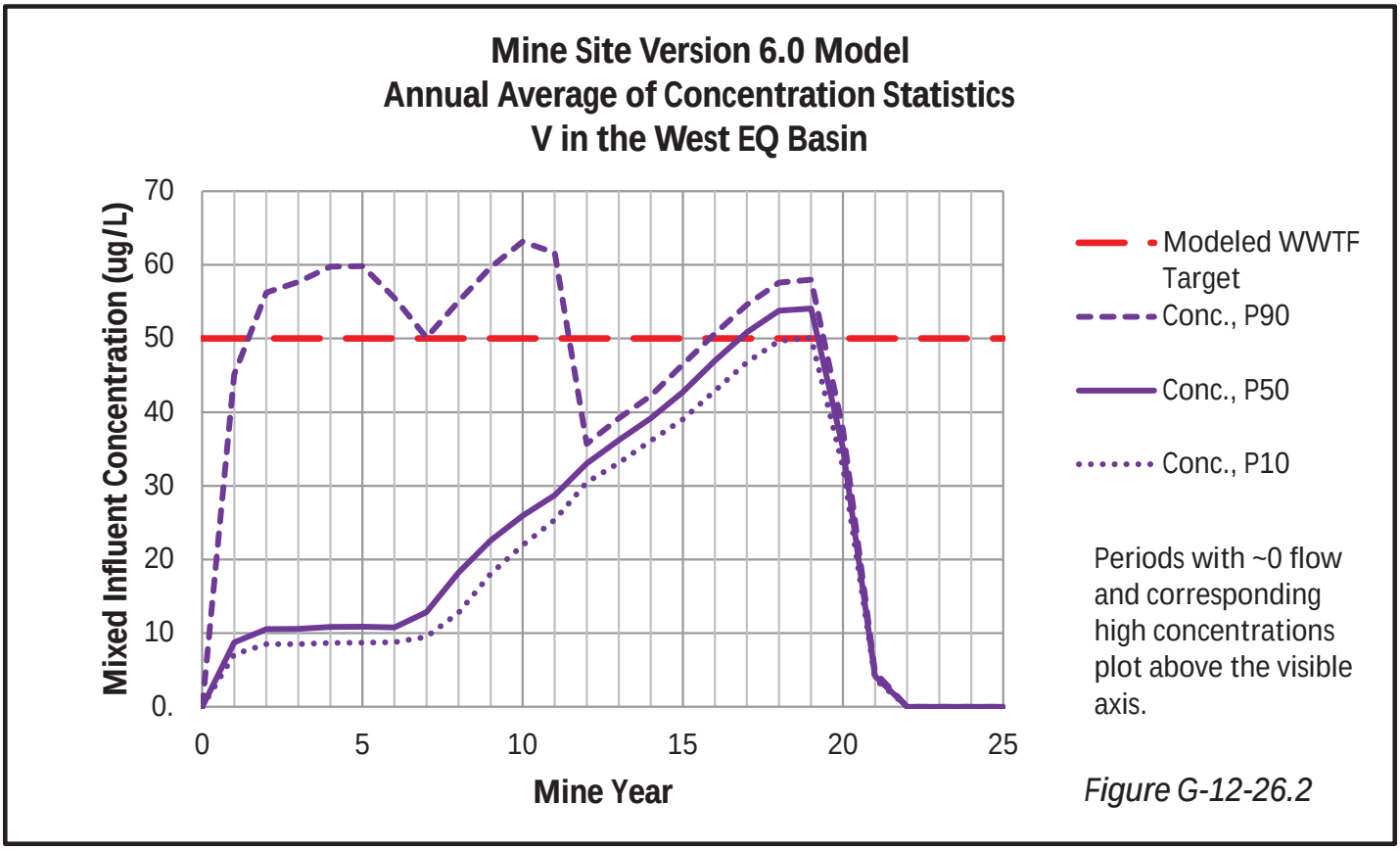
Conc., P90

Conc., P50

Conc., P10

Periods with ~0 flow and corresponding high concentrations plot above the visible axis.

Figure G-12-25.2



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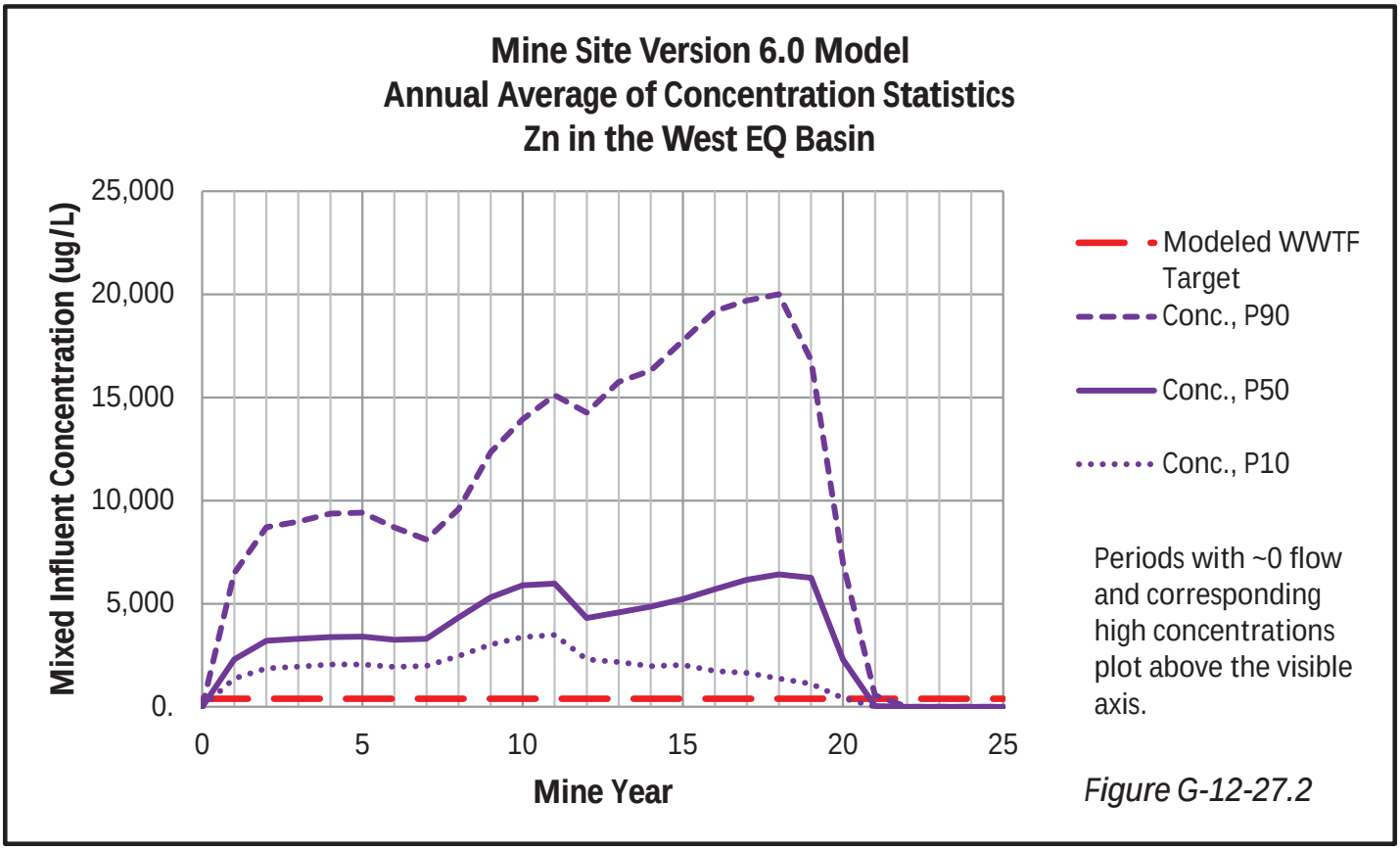
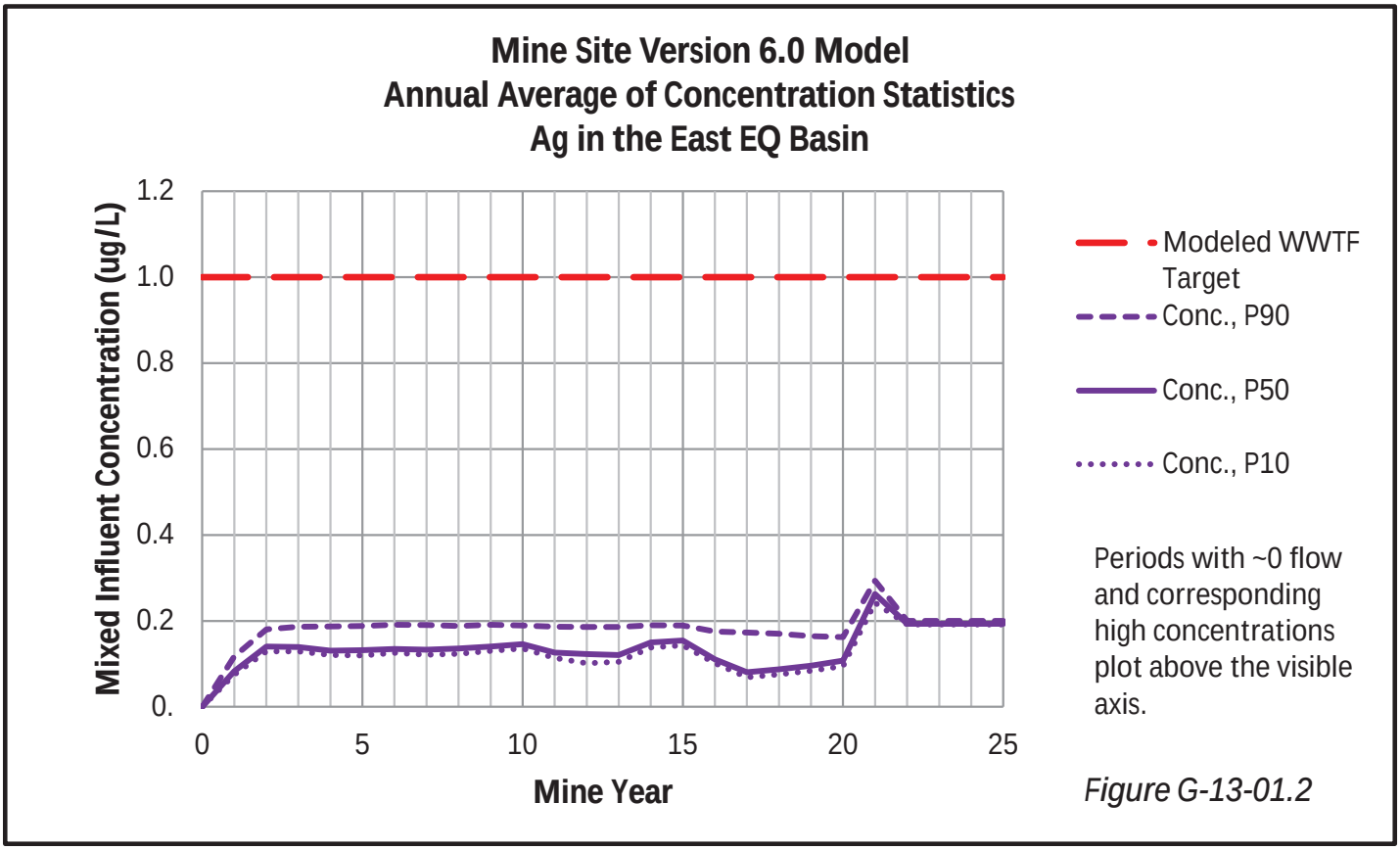


Figure G-12-27.2



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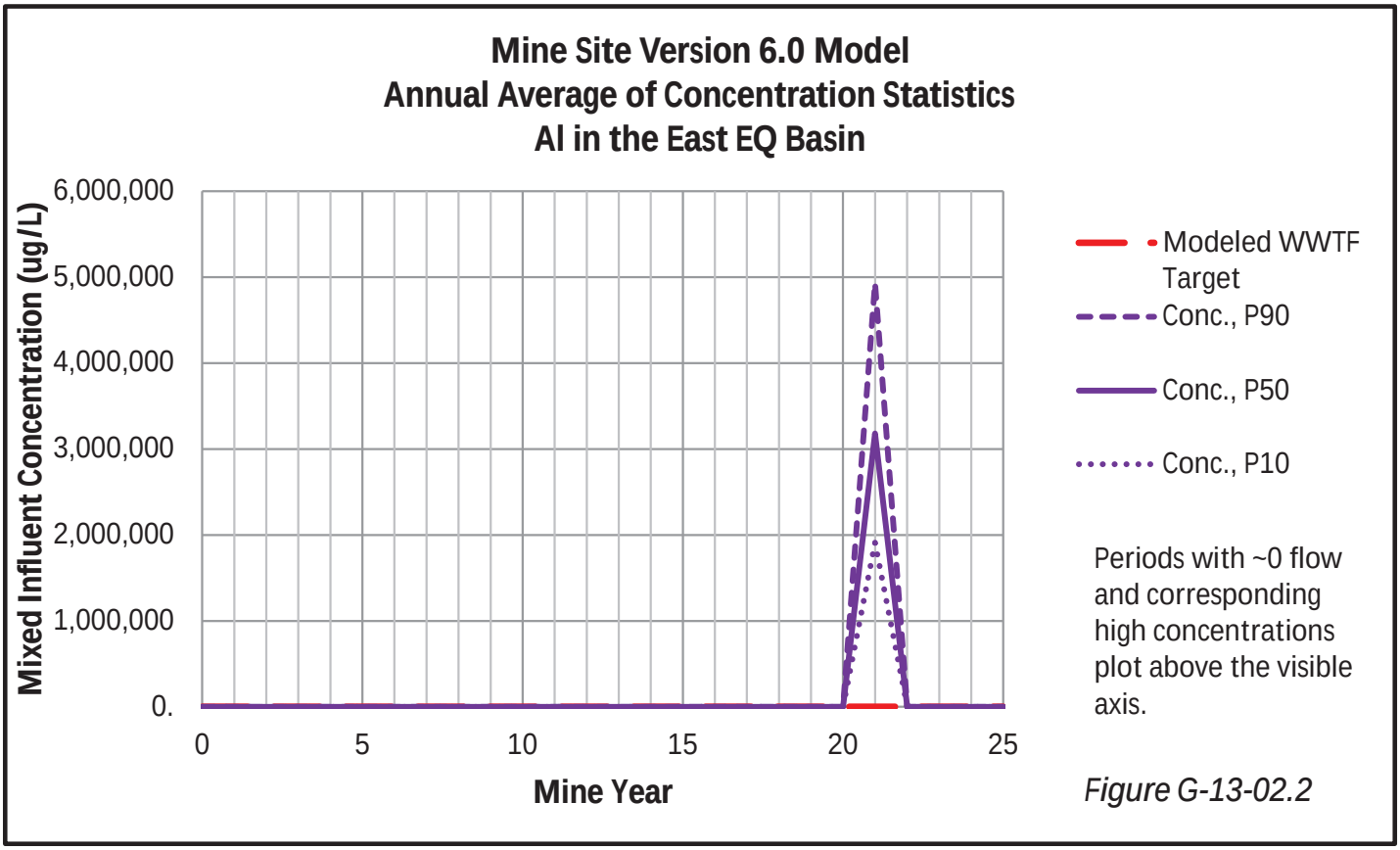

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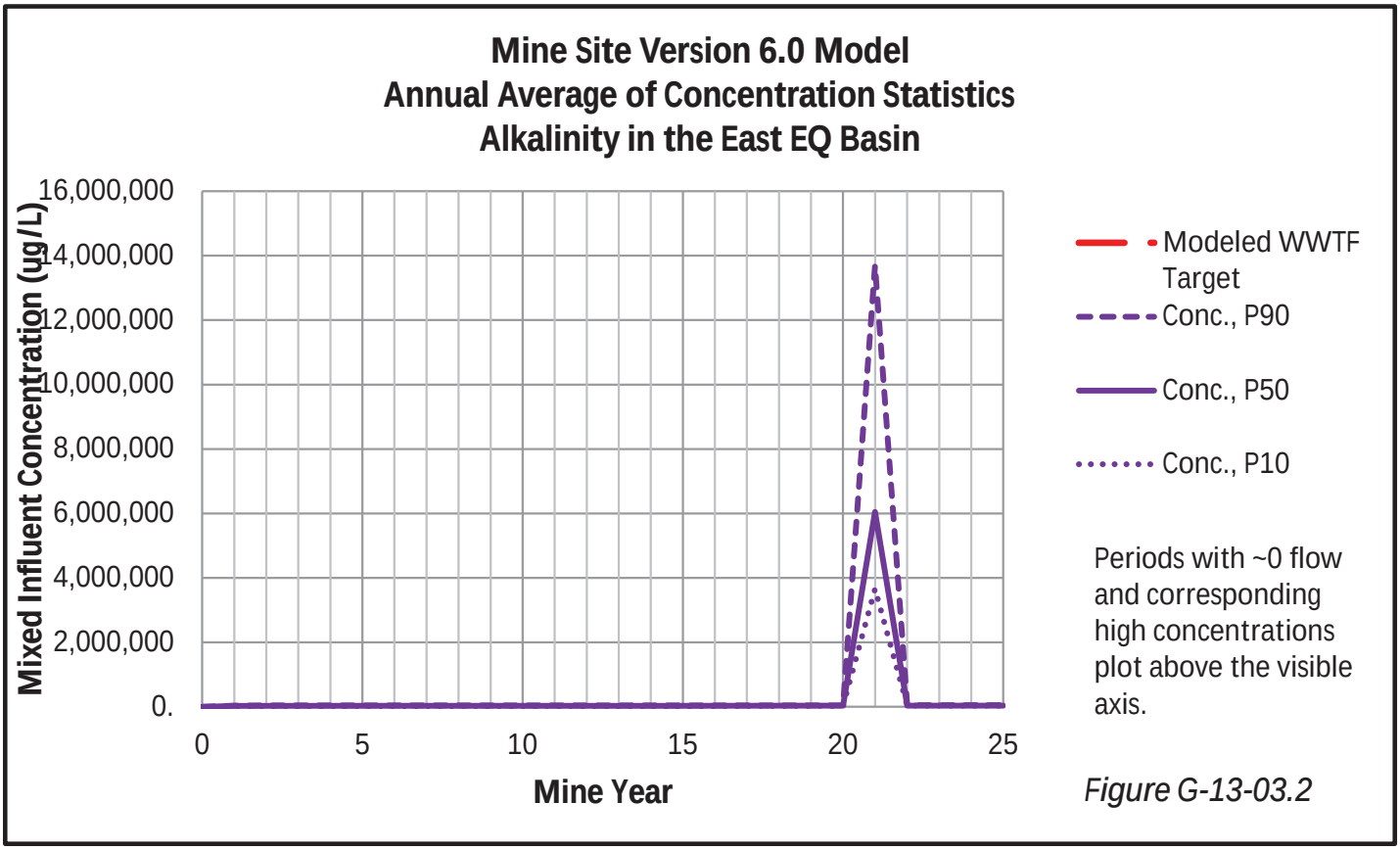

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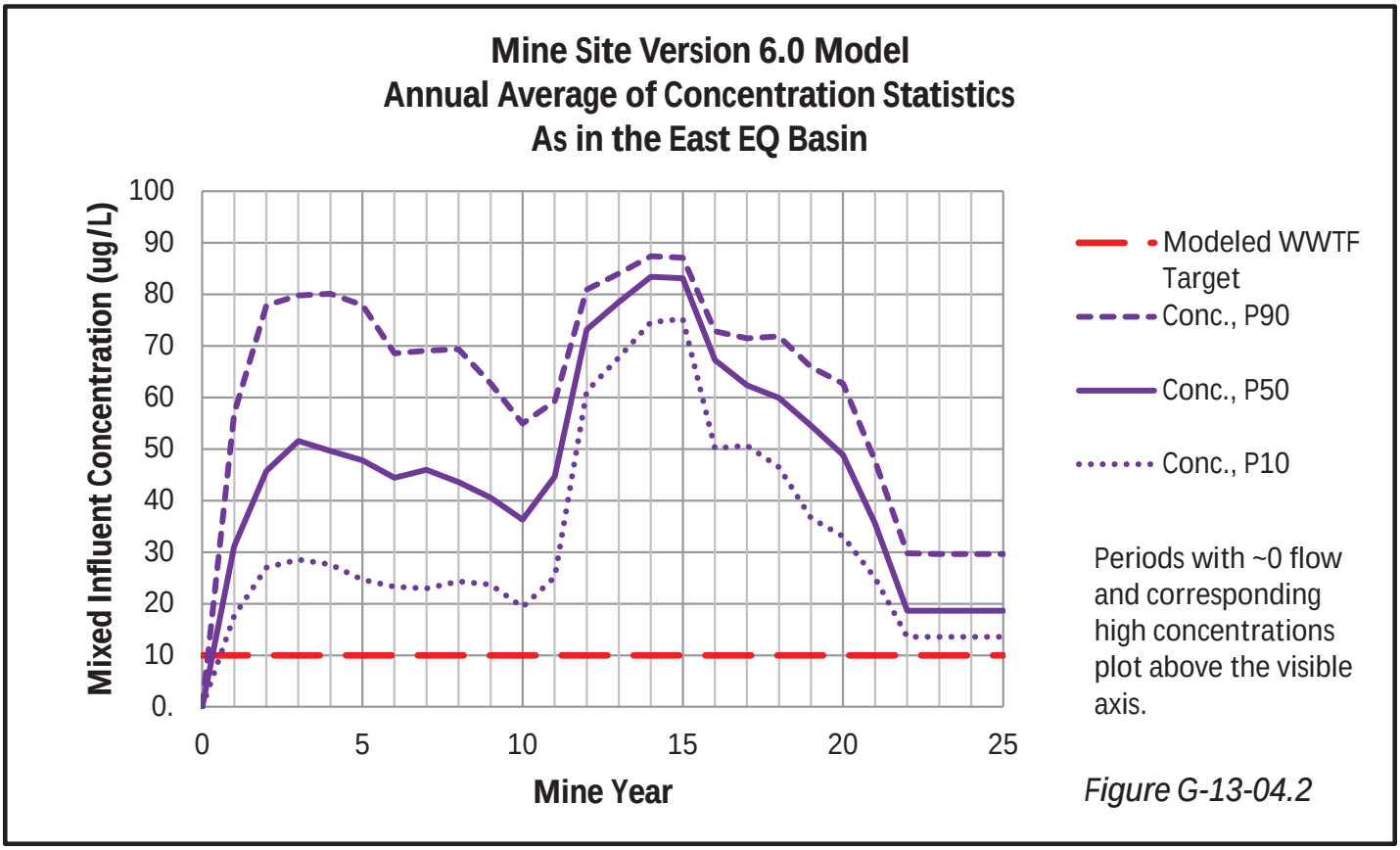
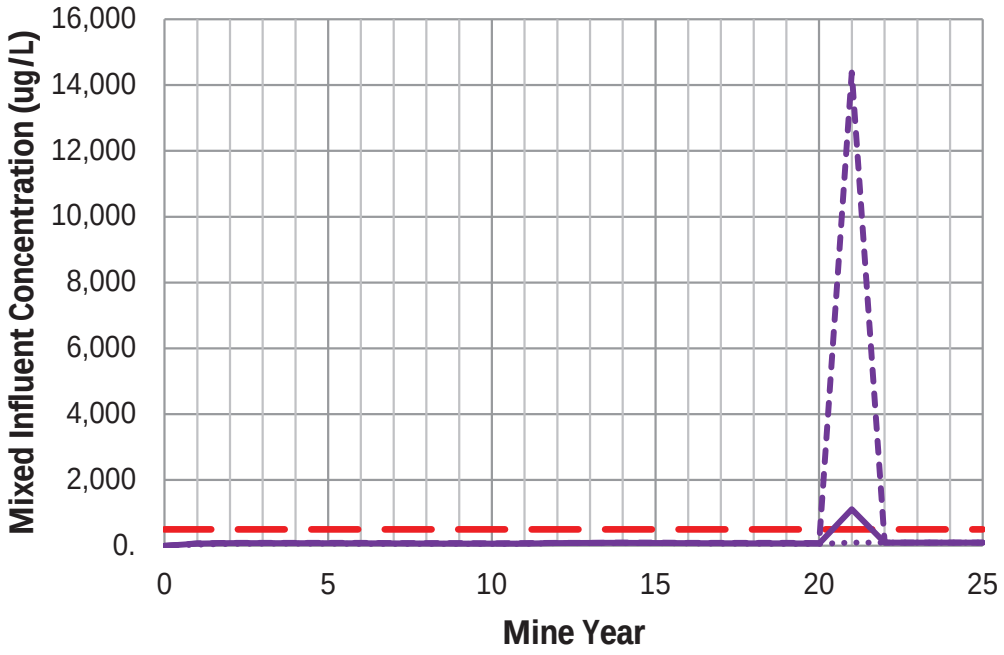


Figure G-13-04.2



Modeled WWTF Target

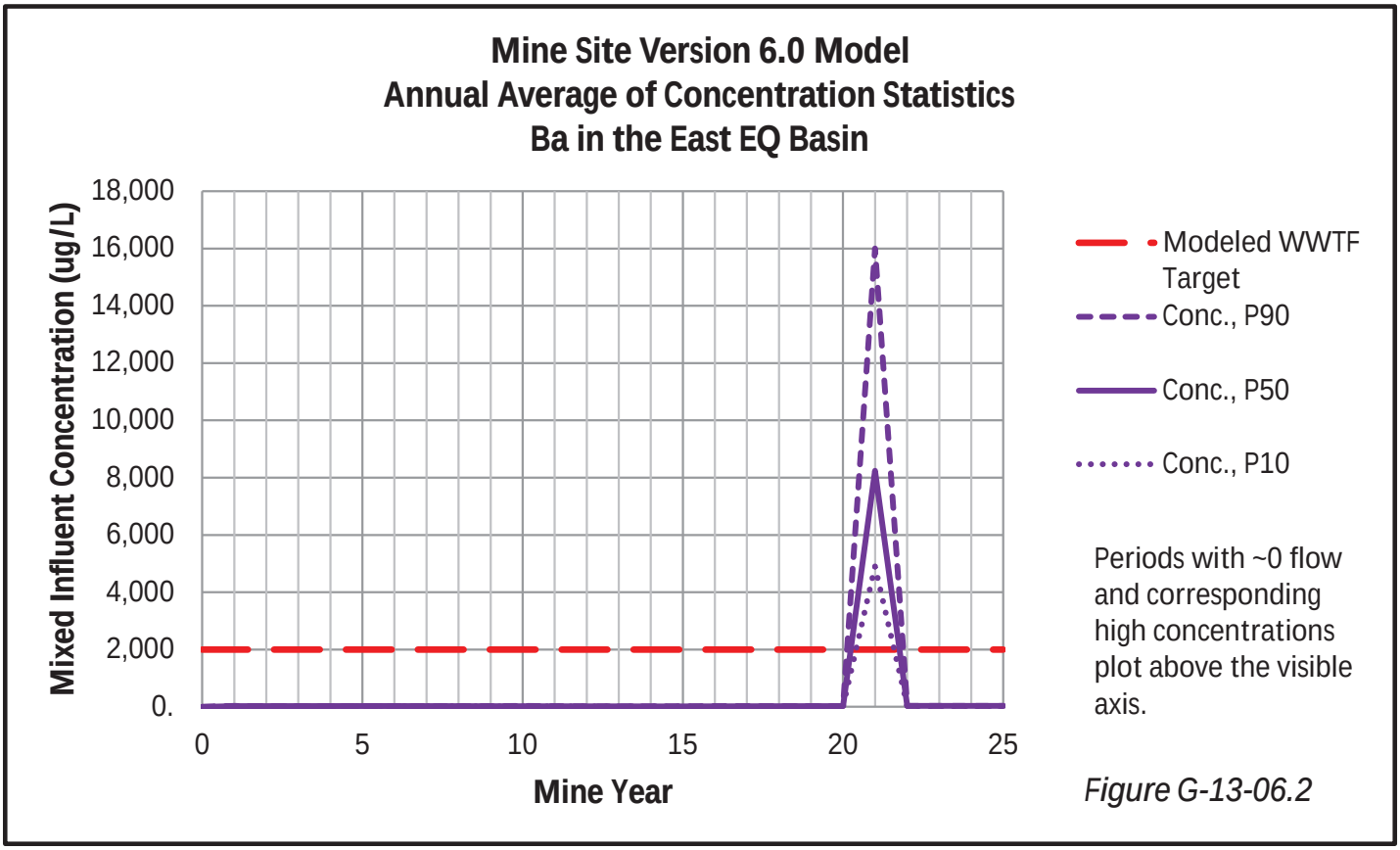
Conc., P90

Conc., P50

Conc., P10

Periods with ~0 flow and corresponding high concentrations plot above the visible axis.

Figure G-13-05.2



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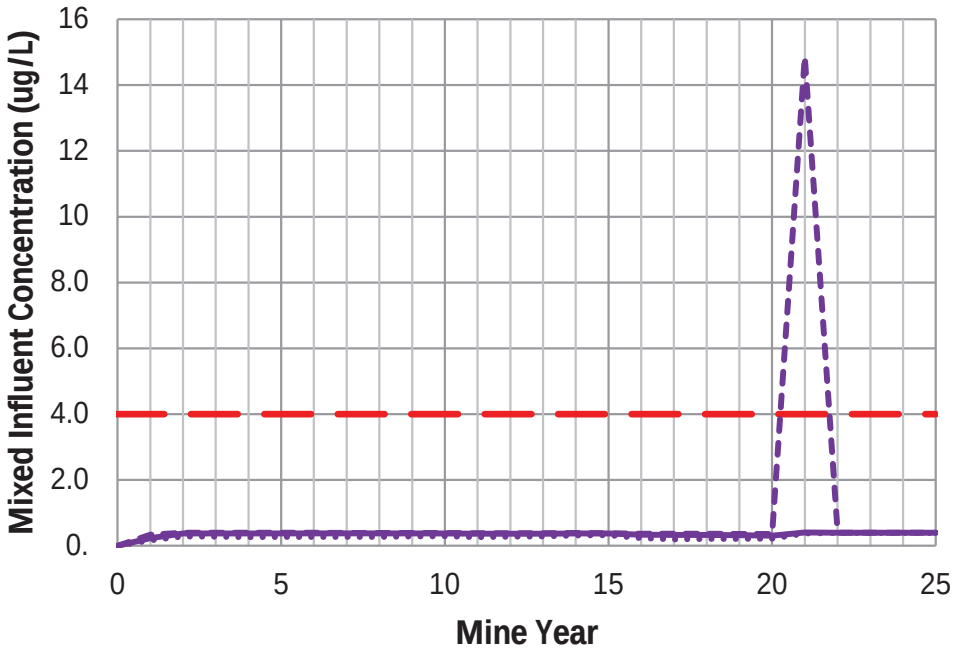

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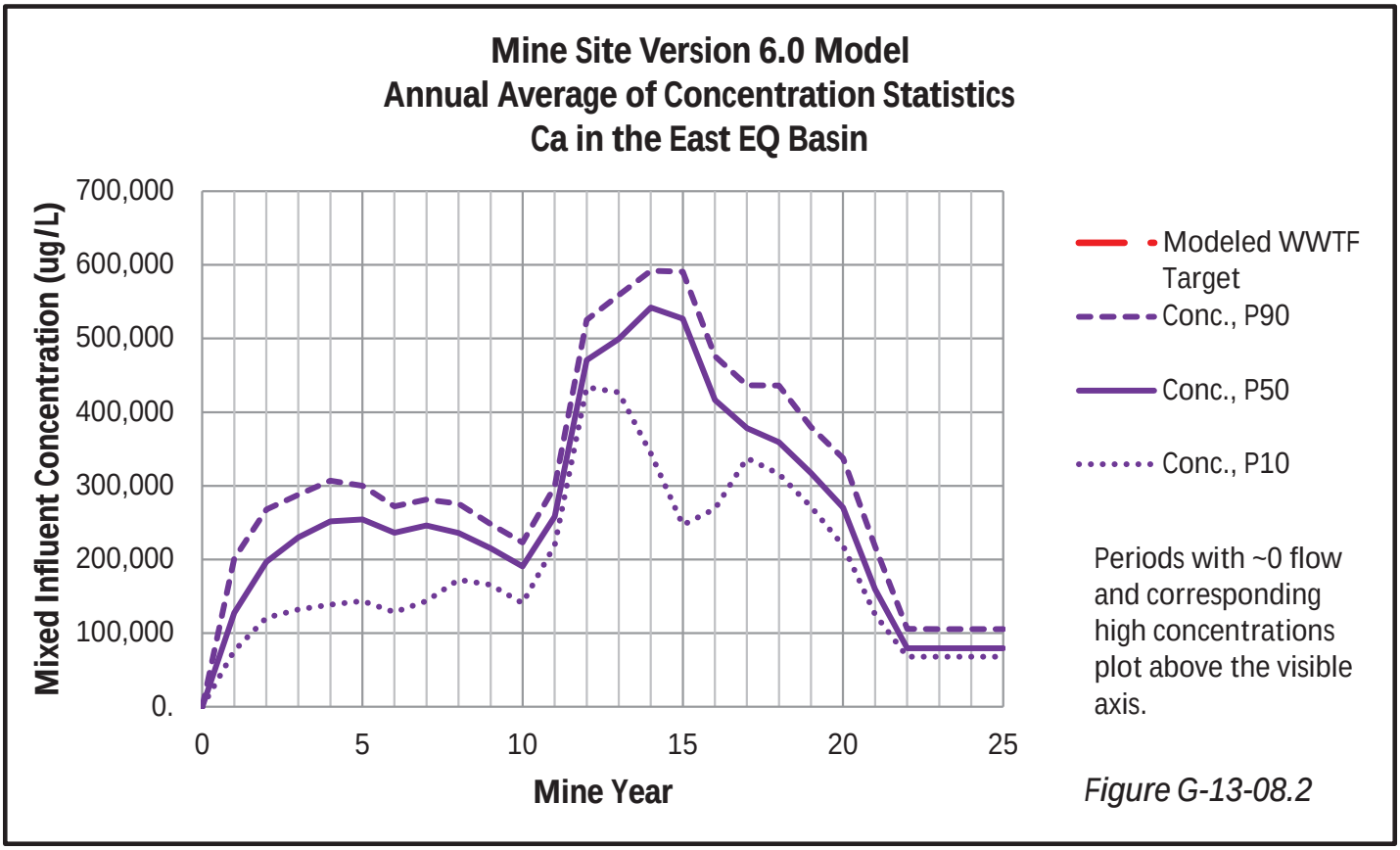

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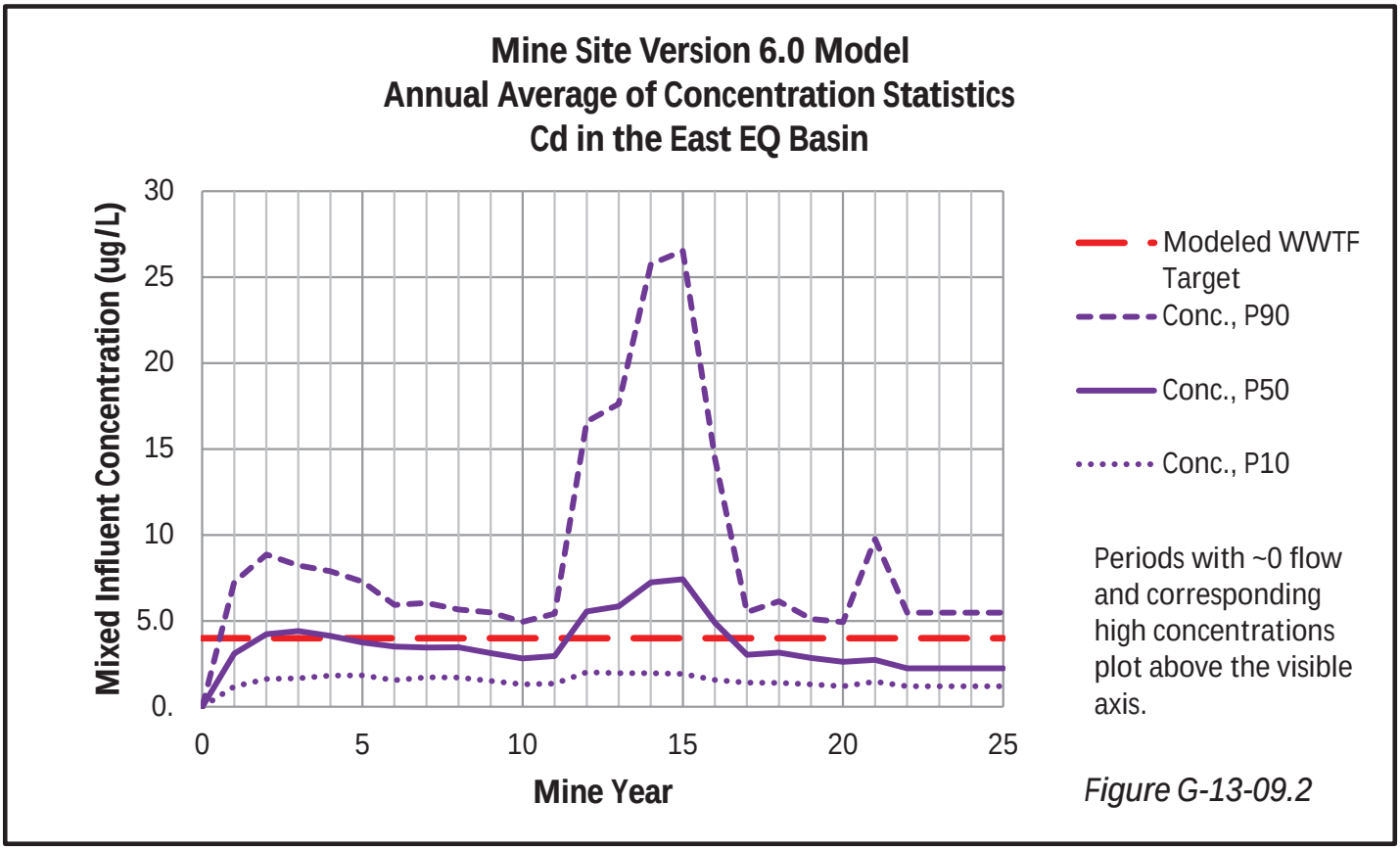

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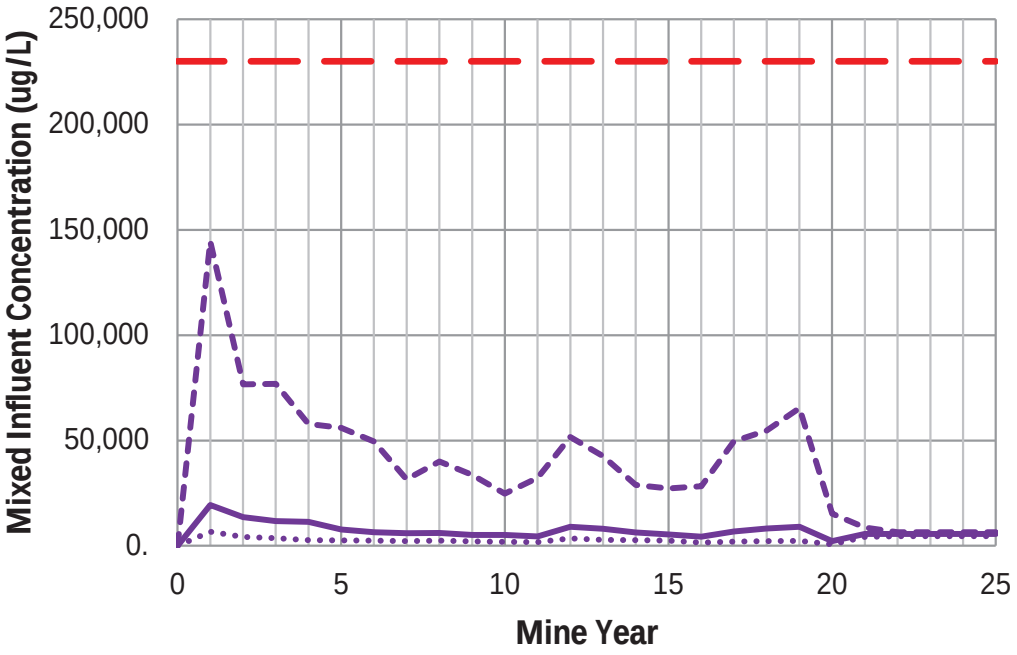
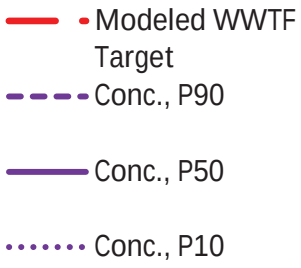




Periods with ~0 flow and corresponding high concentrations plot above the visible axis.

Figure G-13-10.2

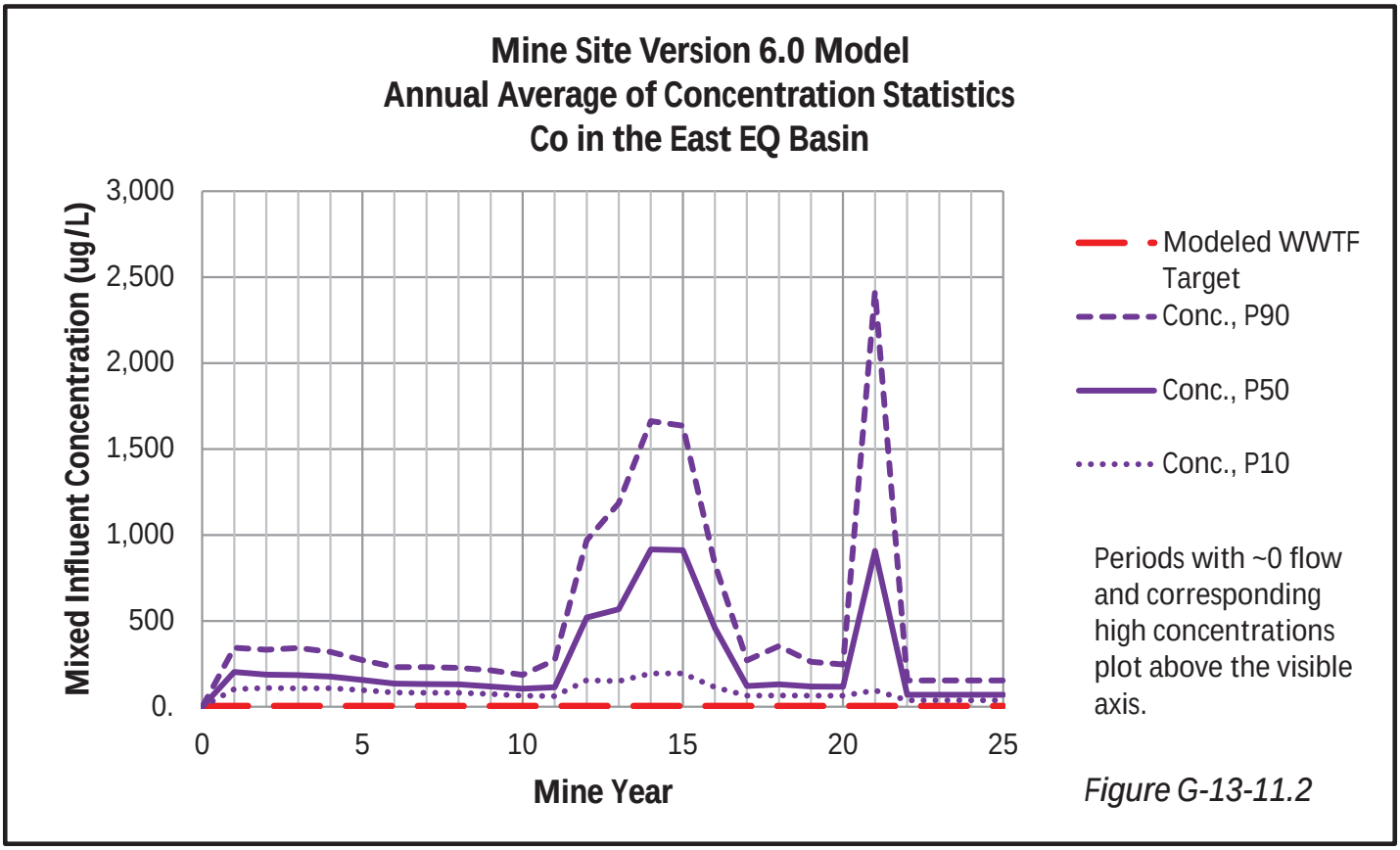
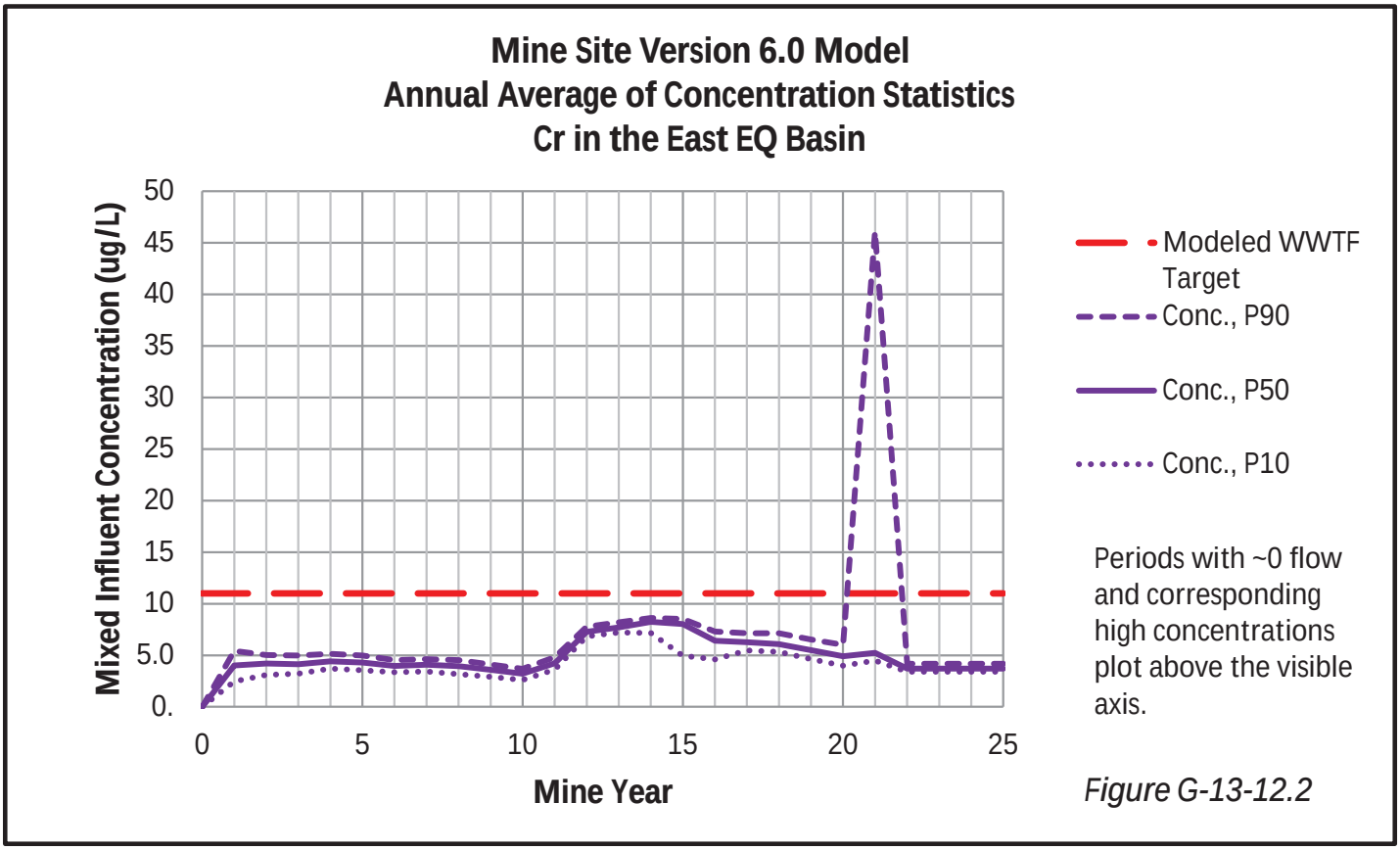


Figure G-13-11.2



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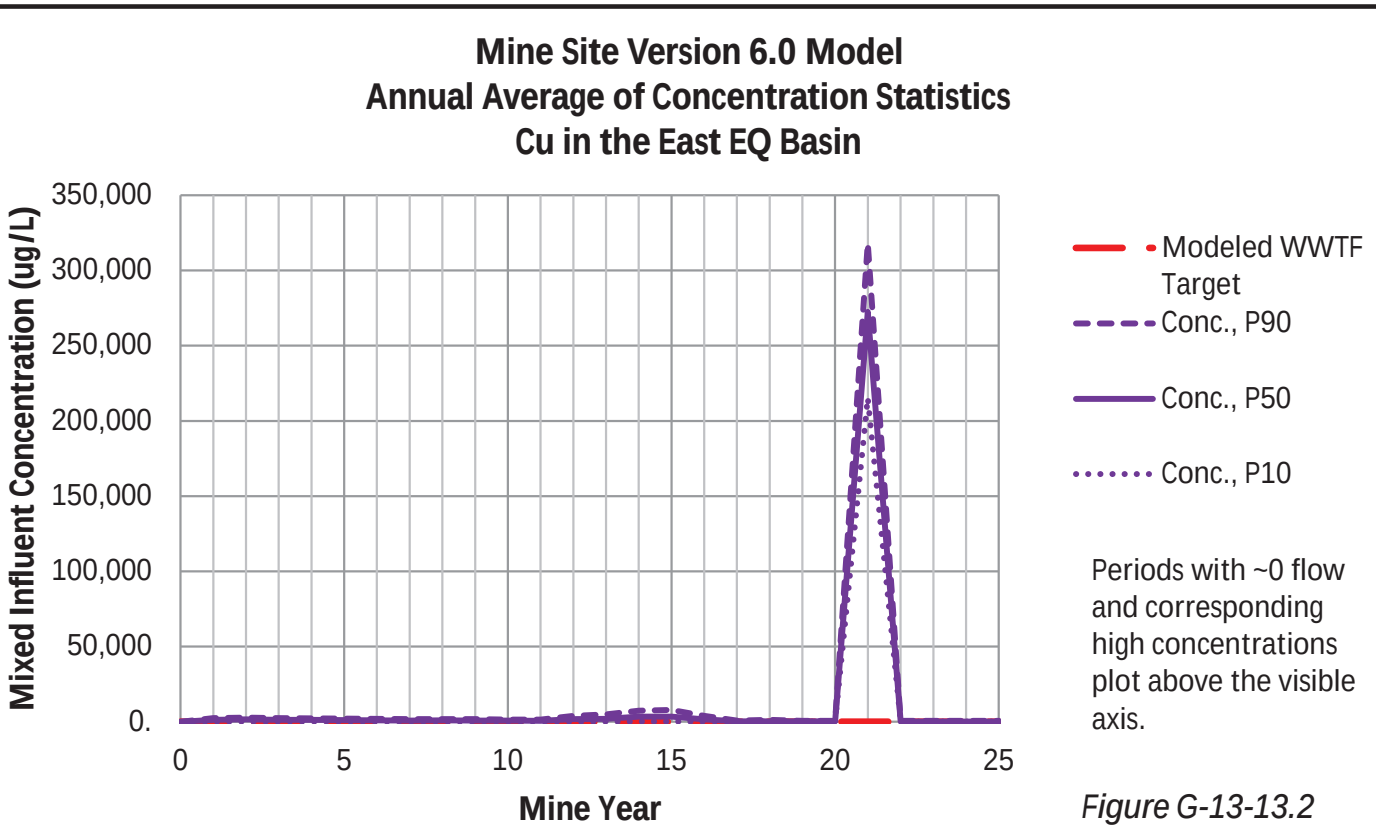


Figure G-13-13.2

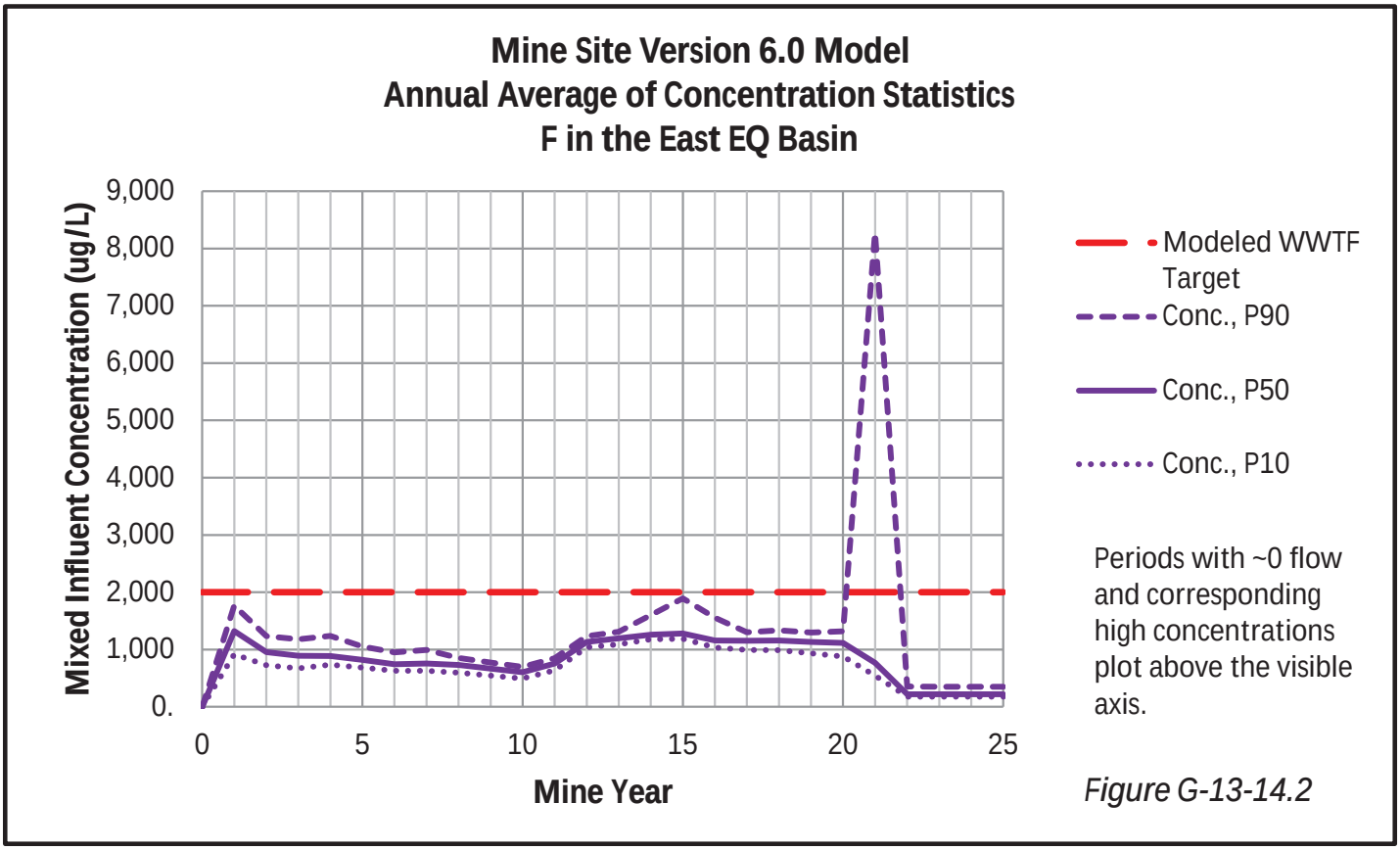
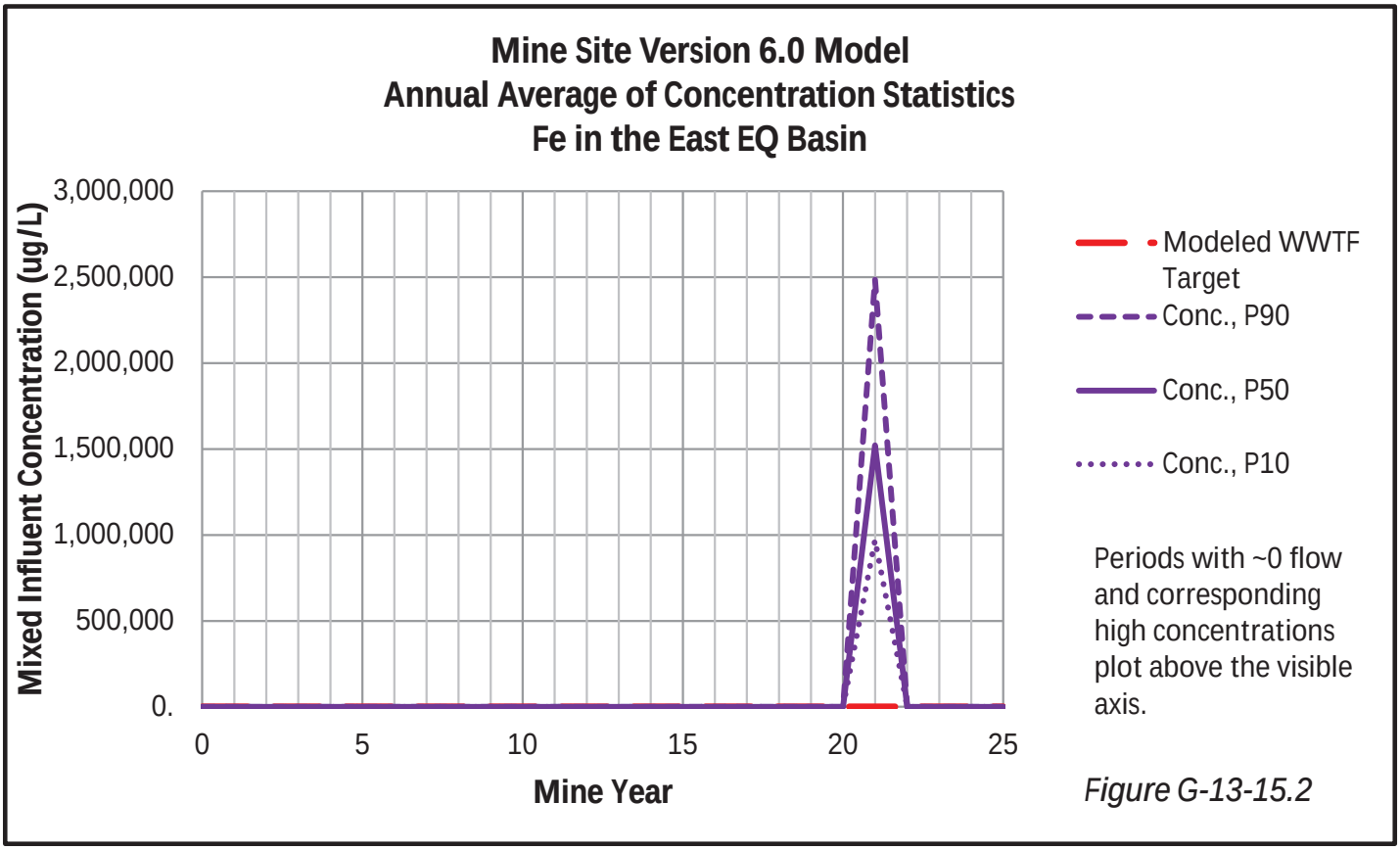


Figure G-13-14.2



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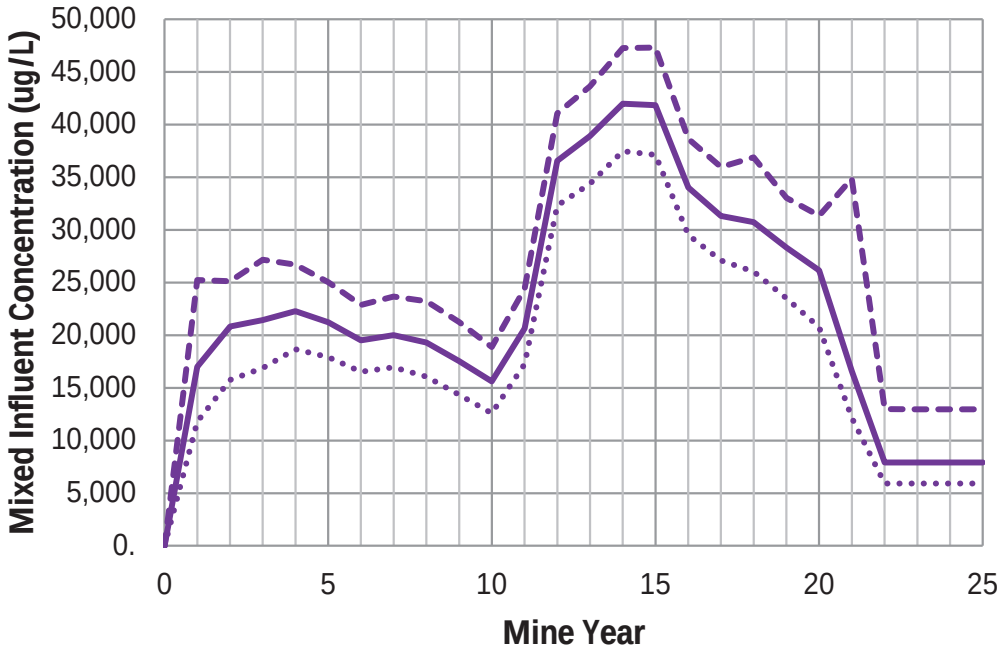


Modeled WWTF Target

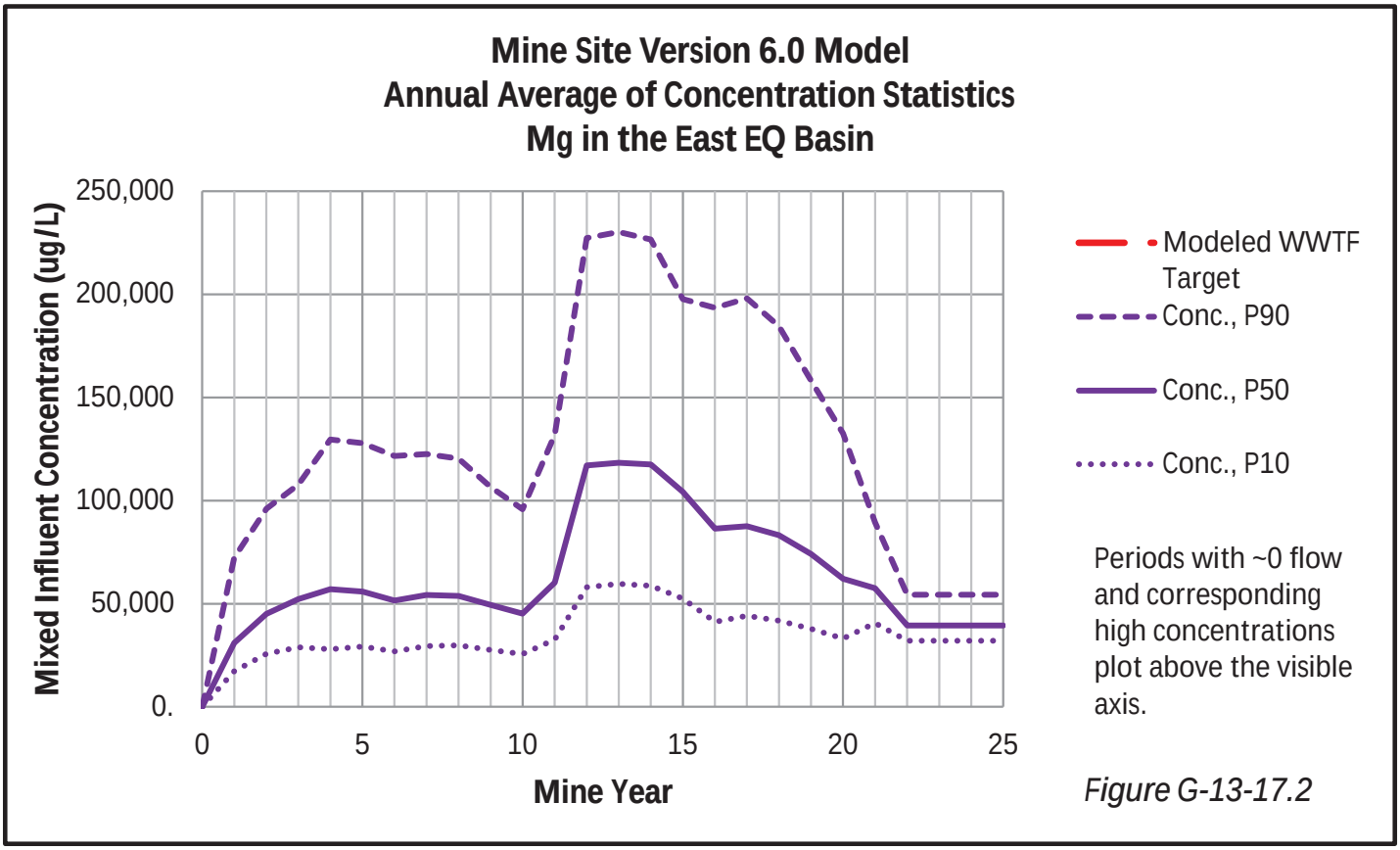
Conc., P90

Conc., P50

Conc., P10

Periods with ~0 flow and corresponding high concentrations plot above the visible axis.

Figure G-13-16.2



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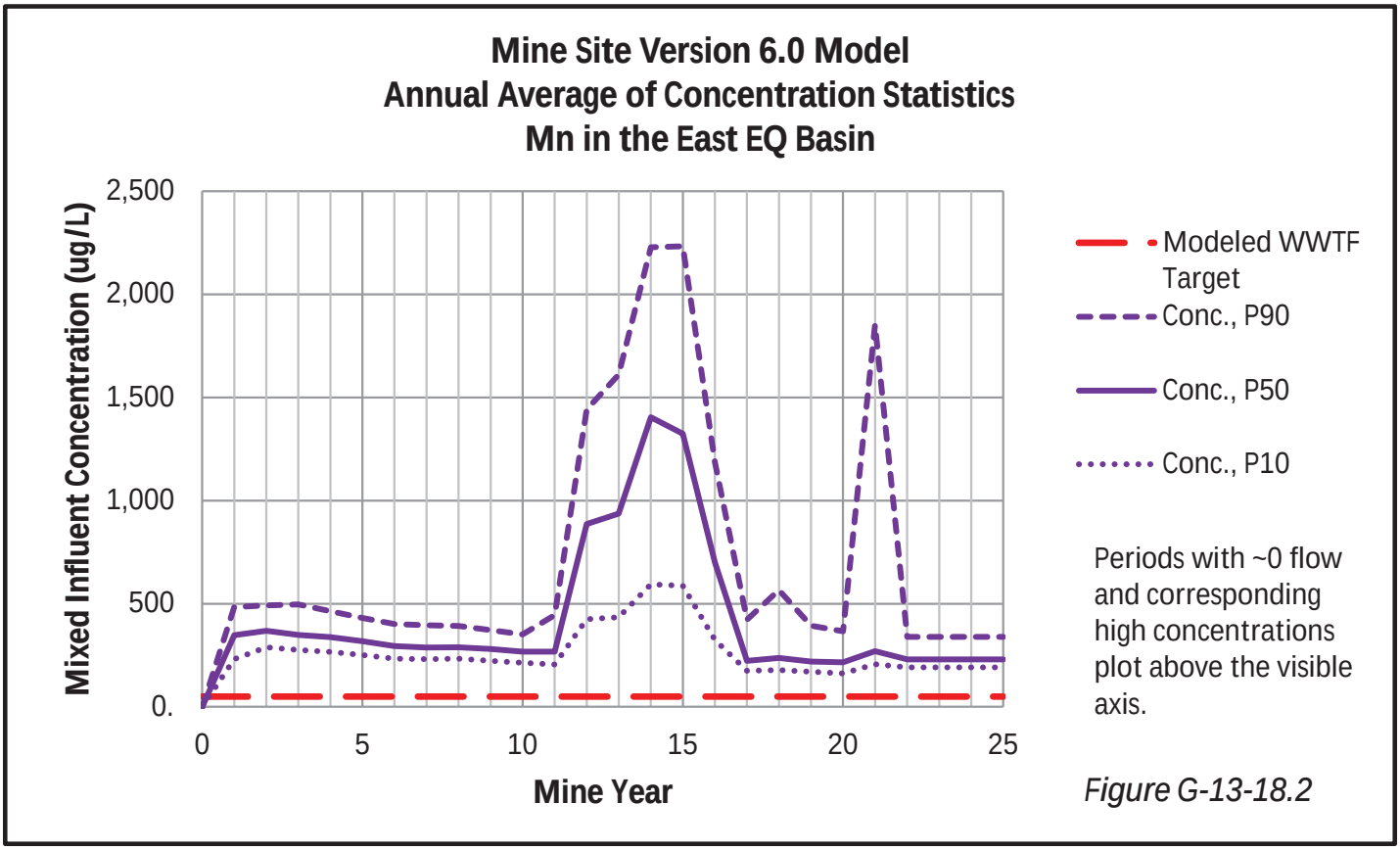


Figure G-13-18.2

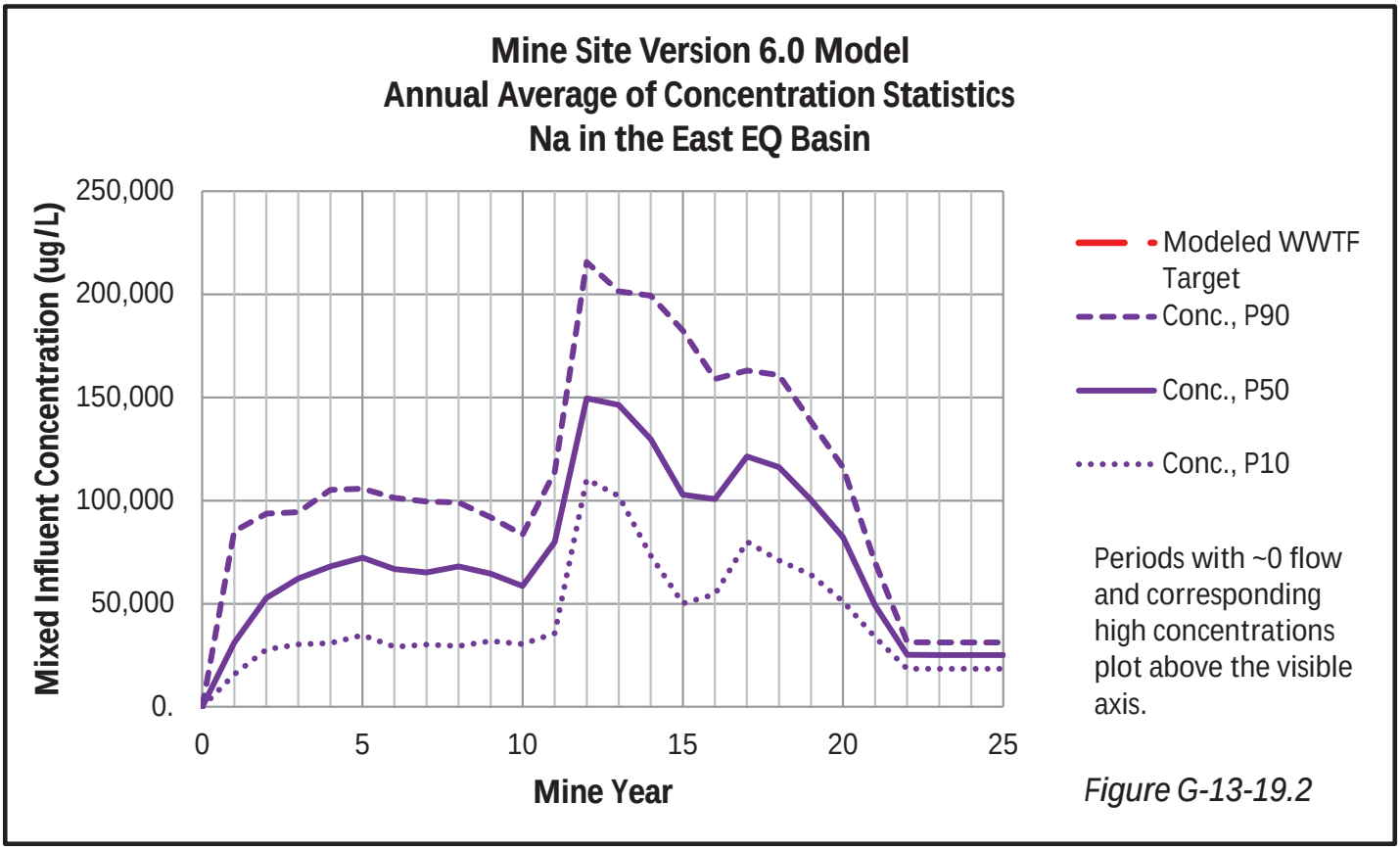
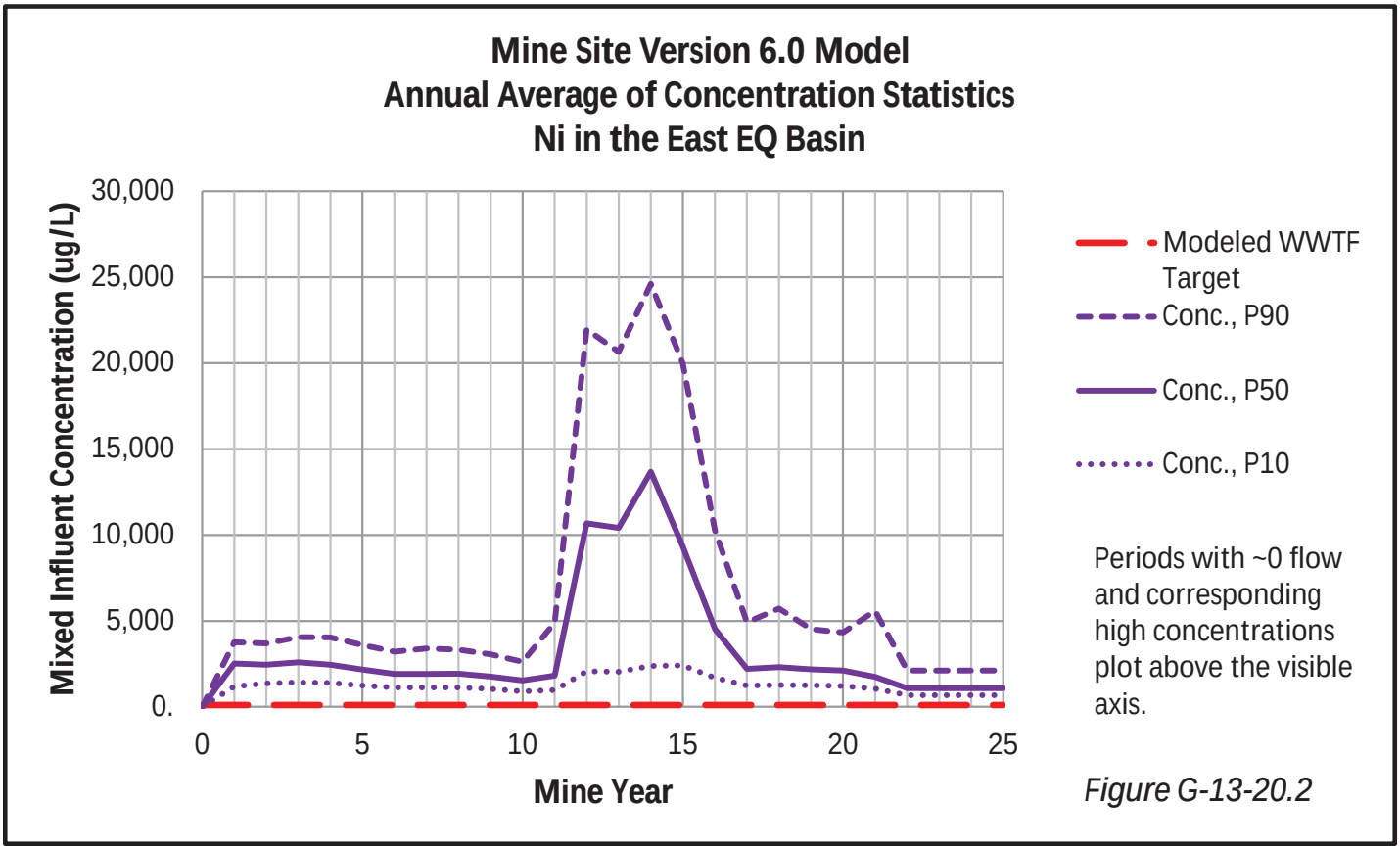


Figure G-13-19.2



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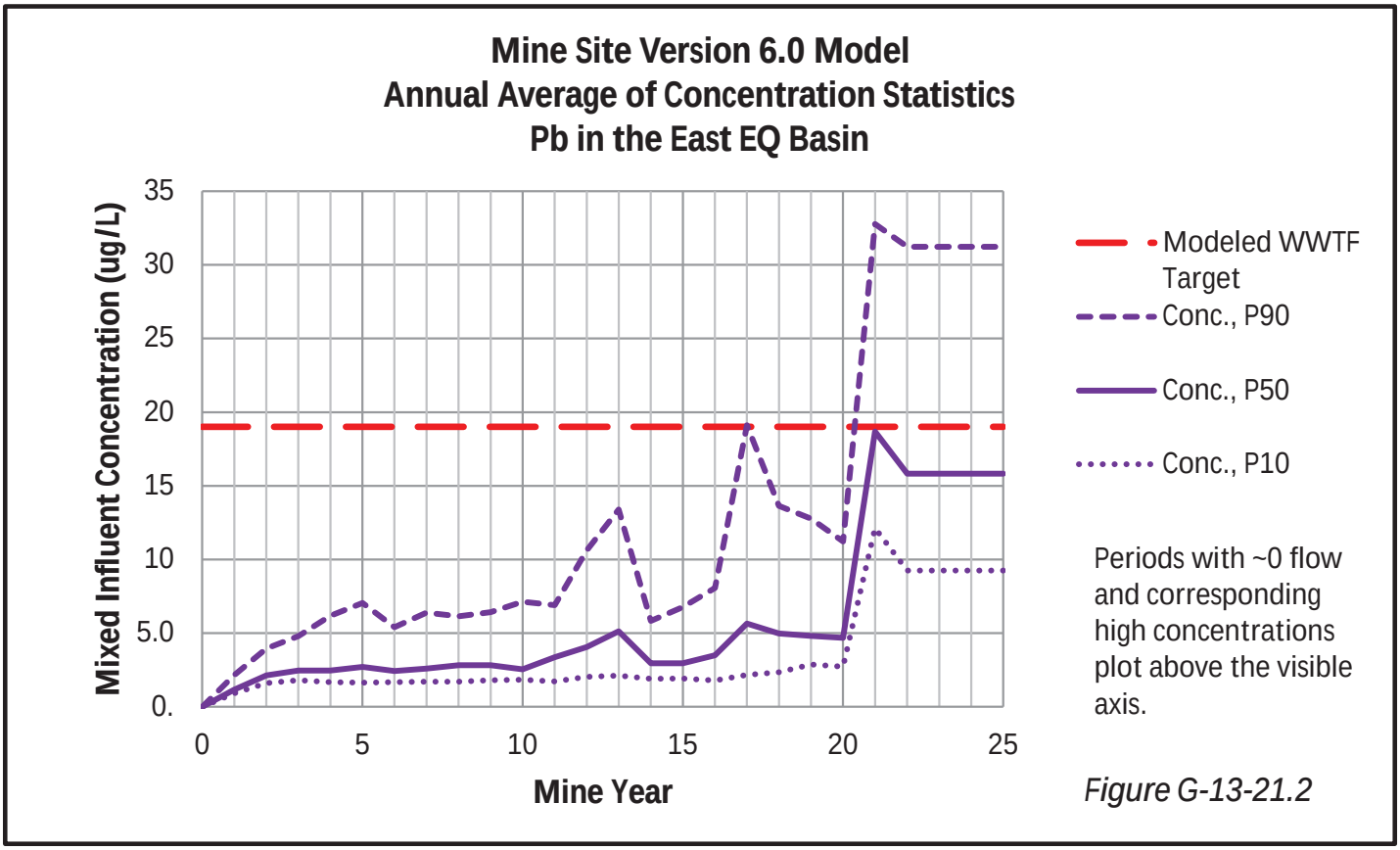

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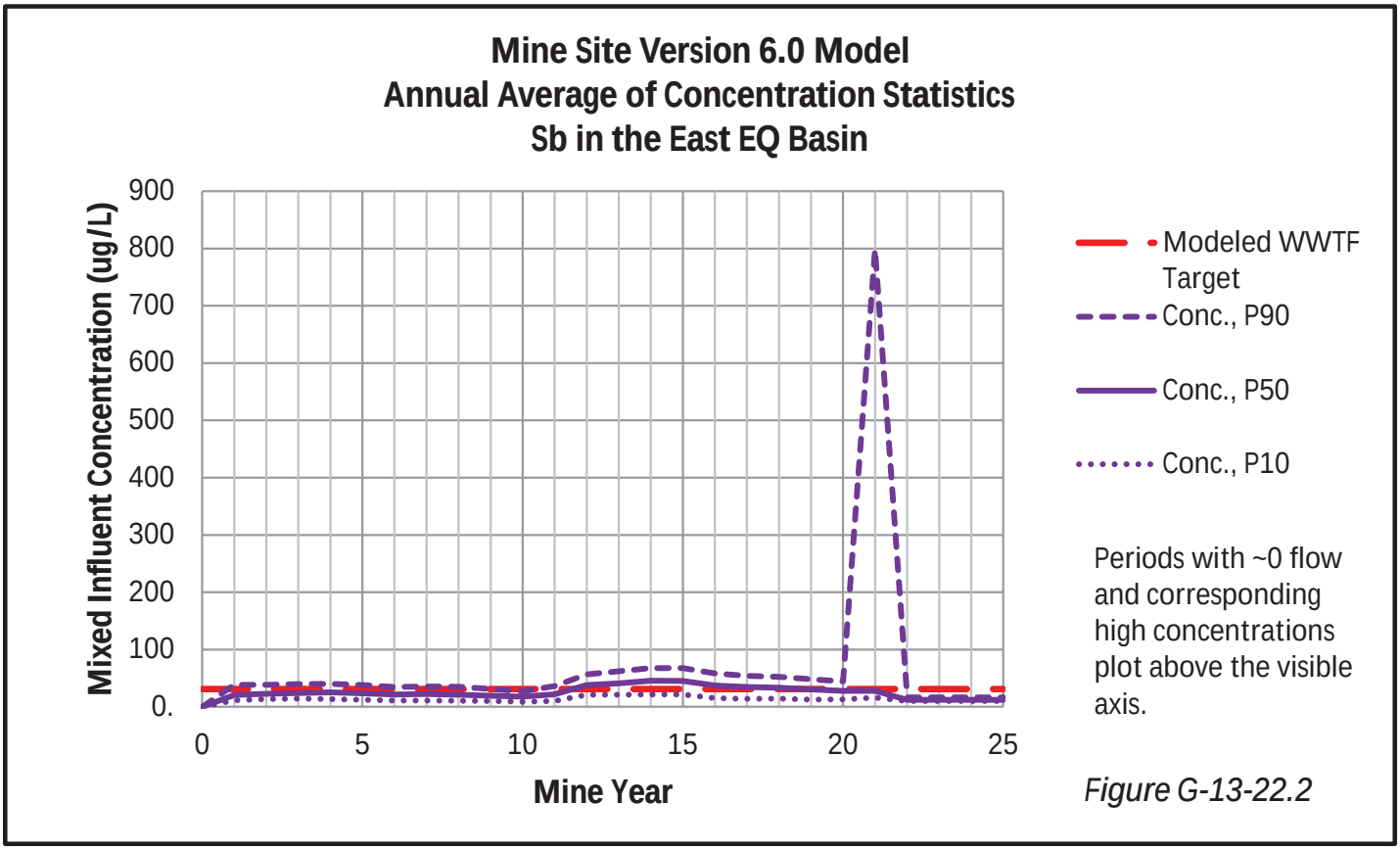

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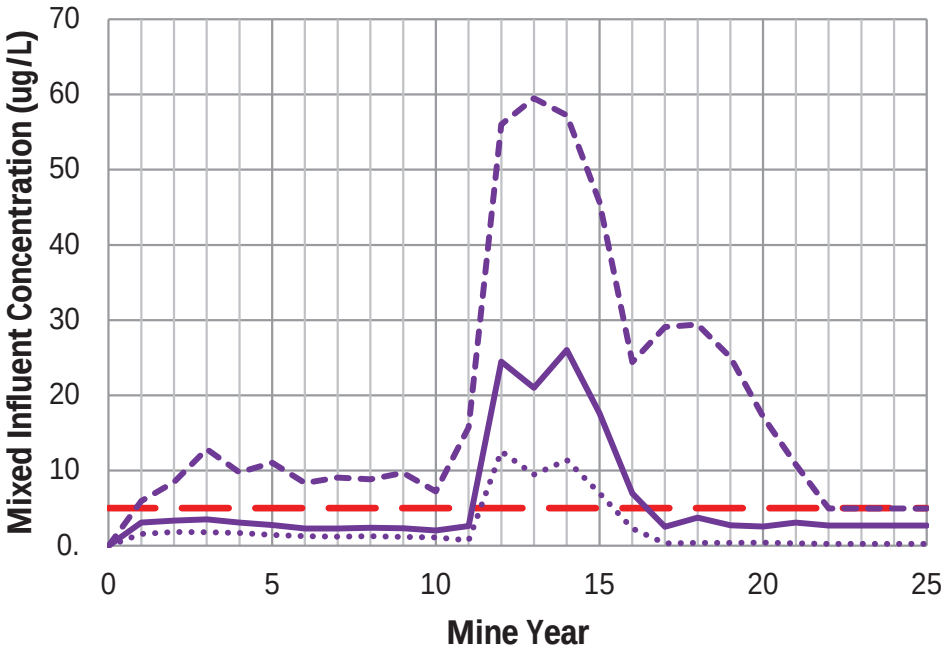
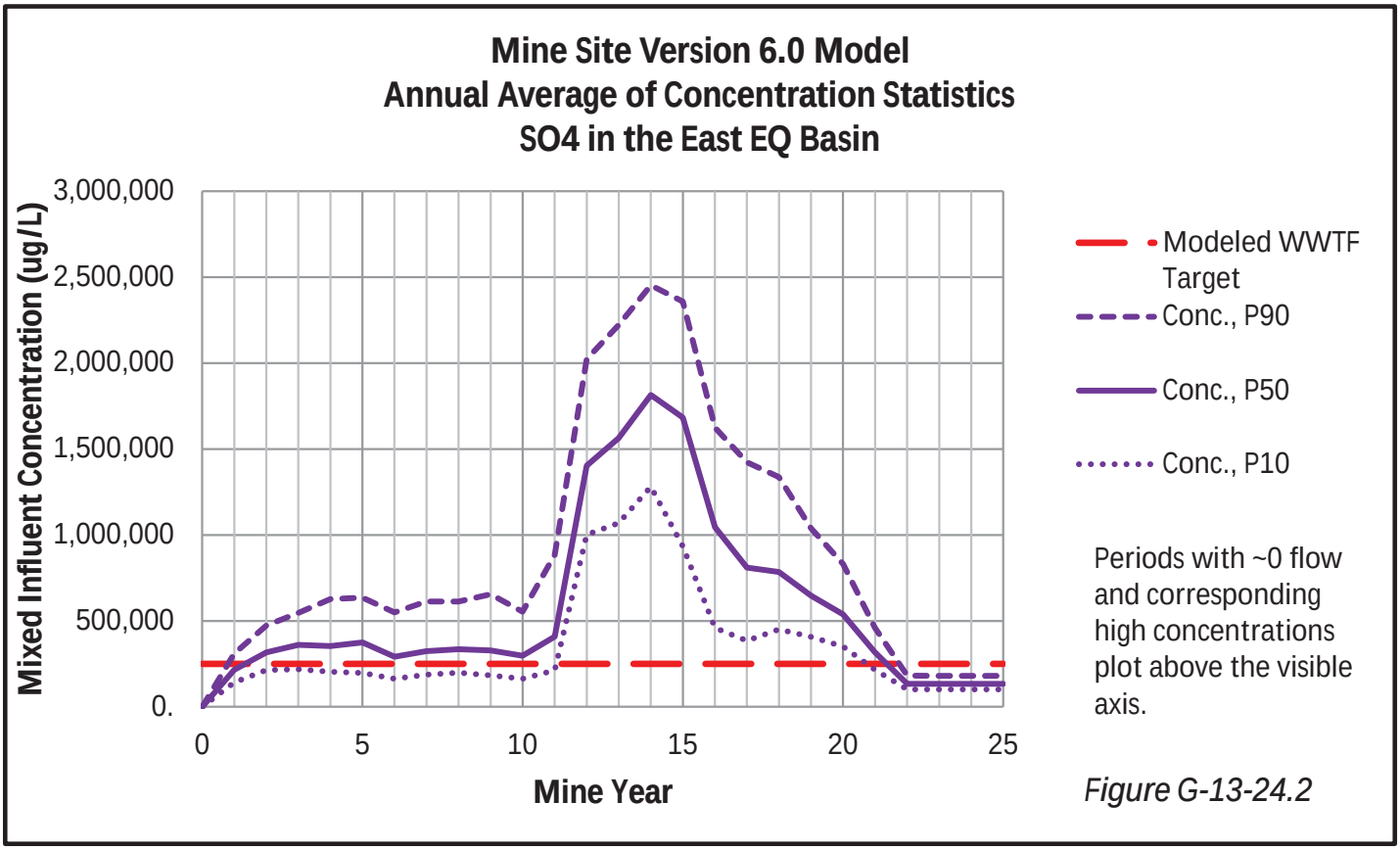


Periods with ~0 flow and corresponding high concentrations plot above the visible axis.

Figure G-13-23.2



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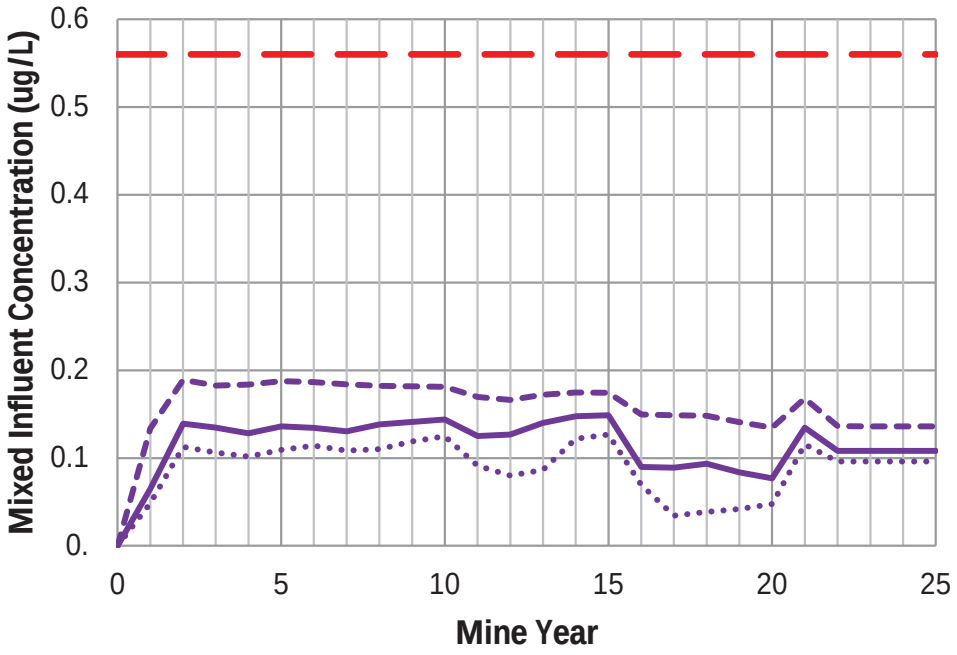


Modeled WWTF Target

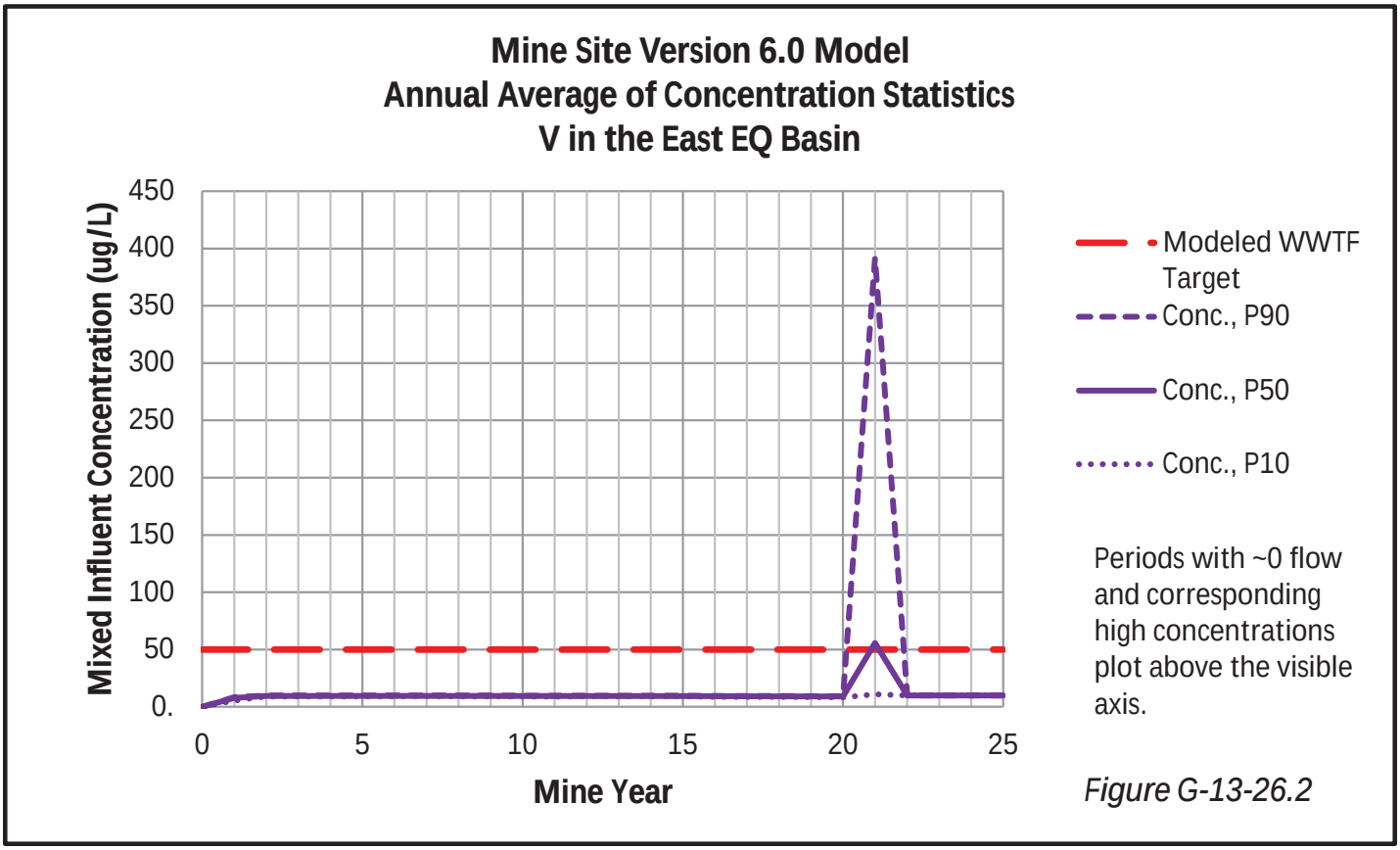
Conc., P90

Conc., P50

Conc., P10

Periods with ~0 flow and corresponding high concentrations plot above the visible axis.

Figure G-13-25.2



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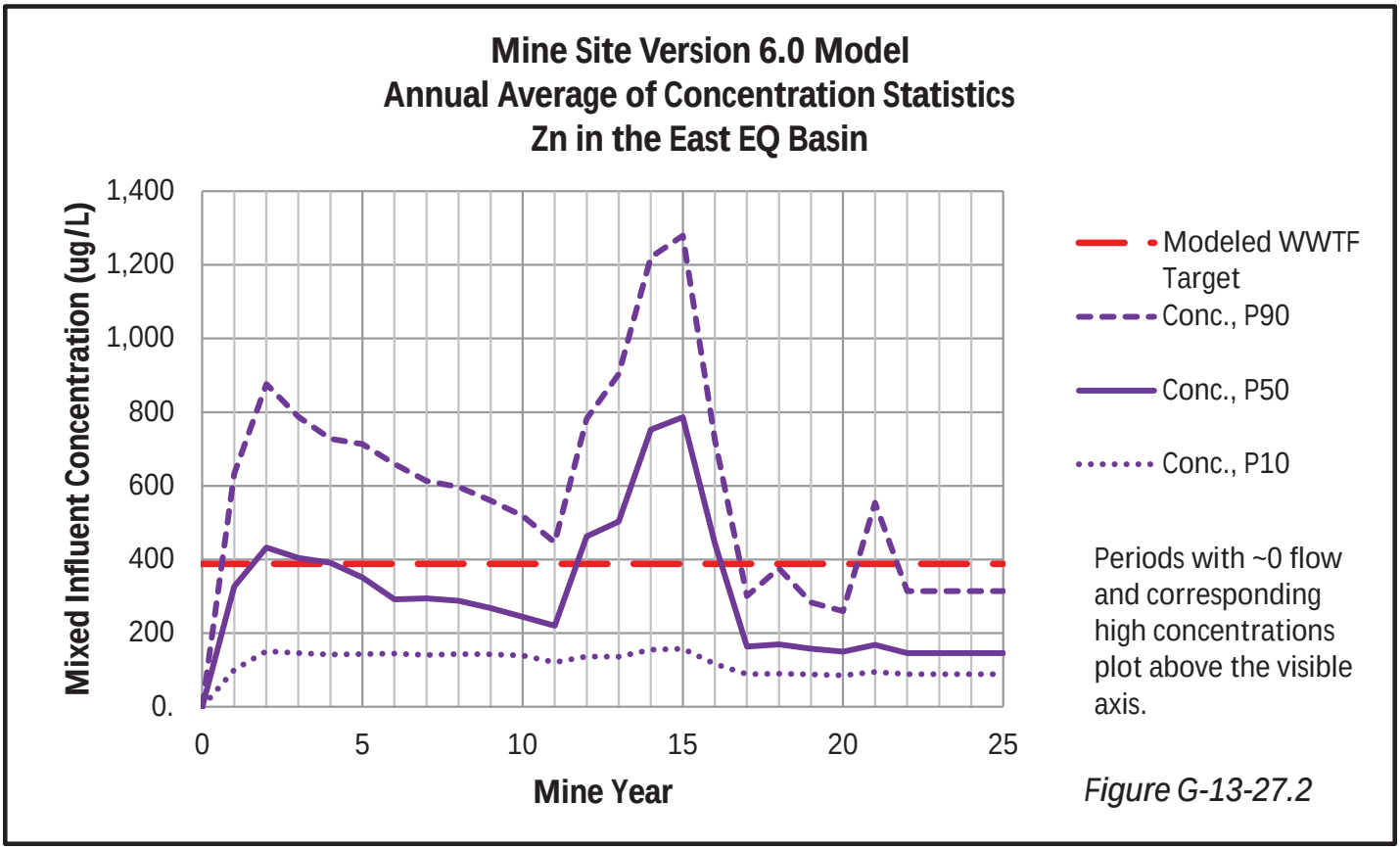

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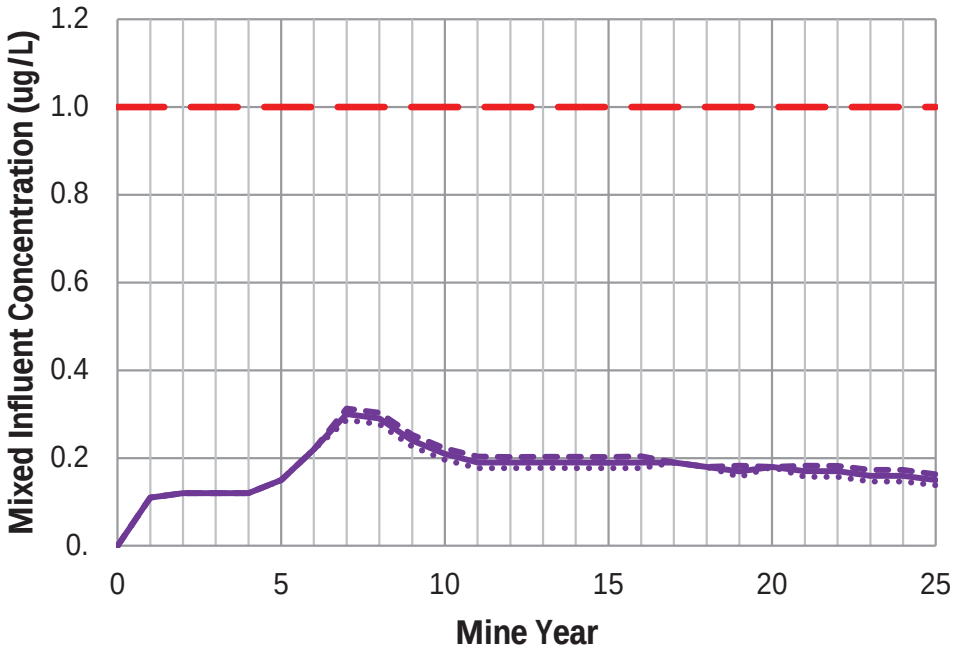


Modeled WWTF Target

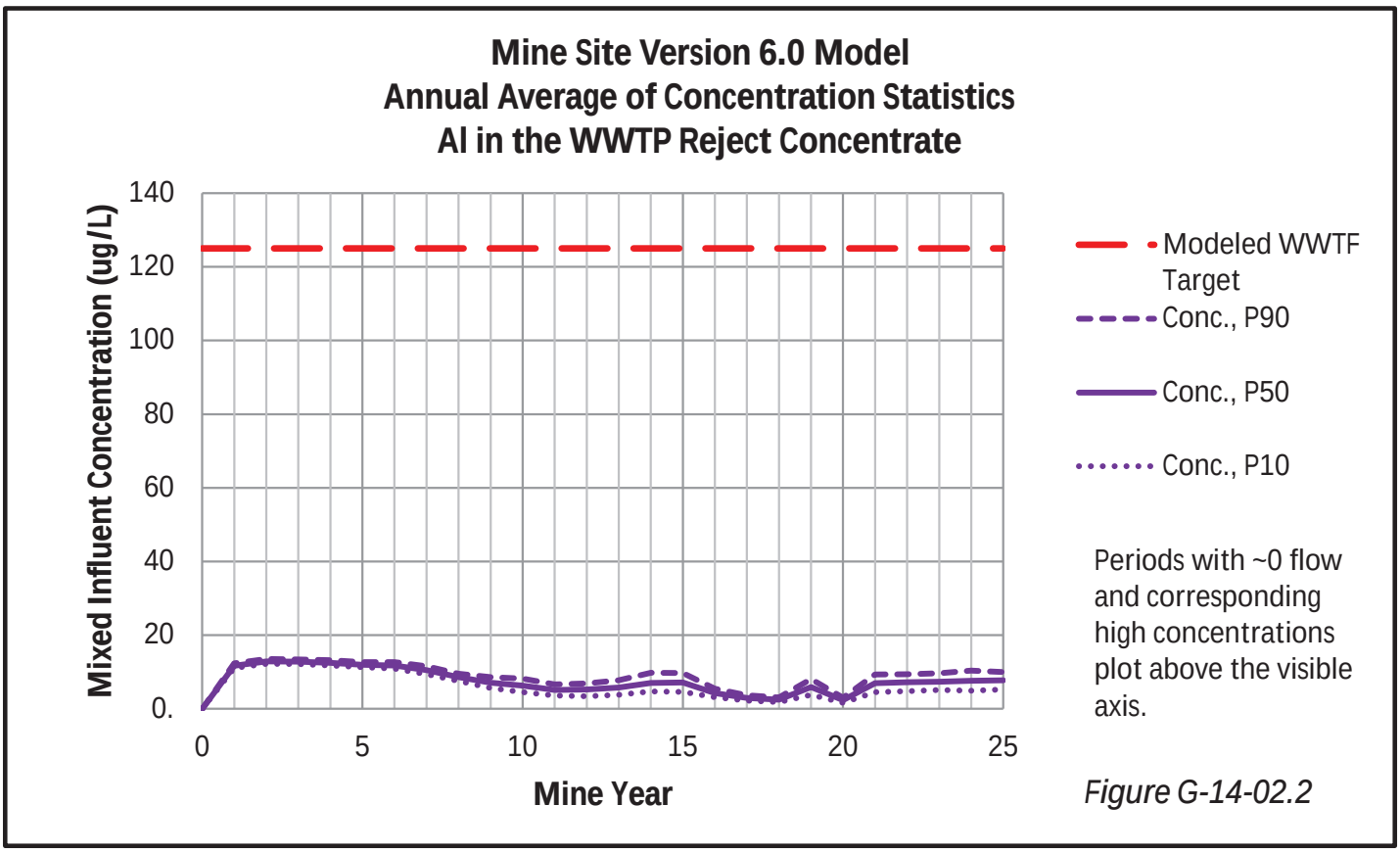
Conc., P90

Conc., P50

Conc., P10

Periods with ~0 flow and corresponding high concentrations plot above the visible axis.

Figure G-14-01.2



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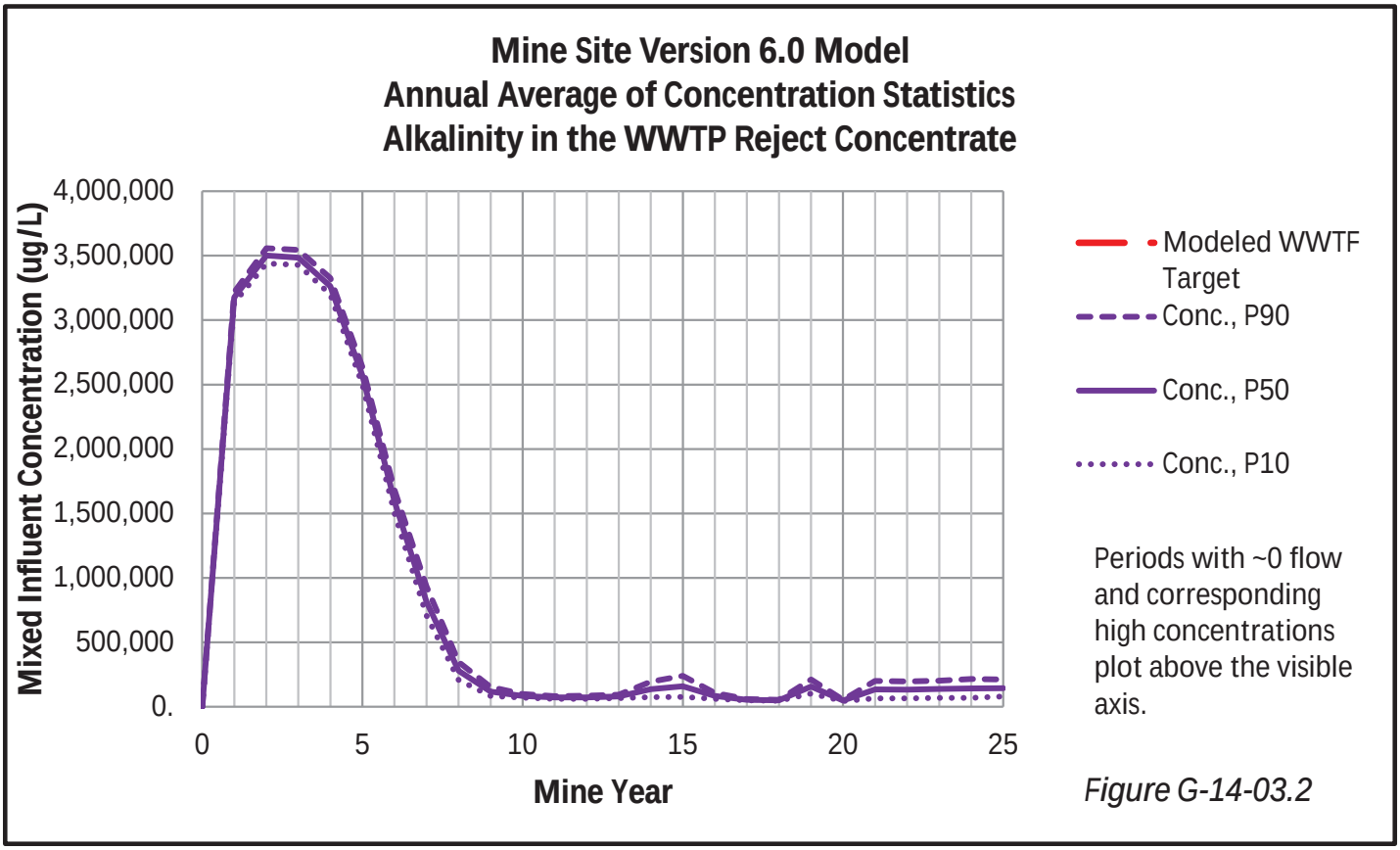

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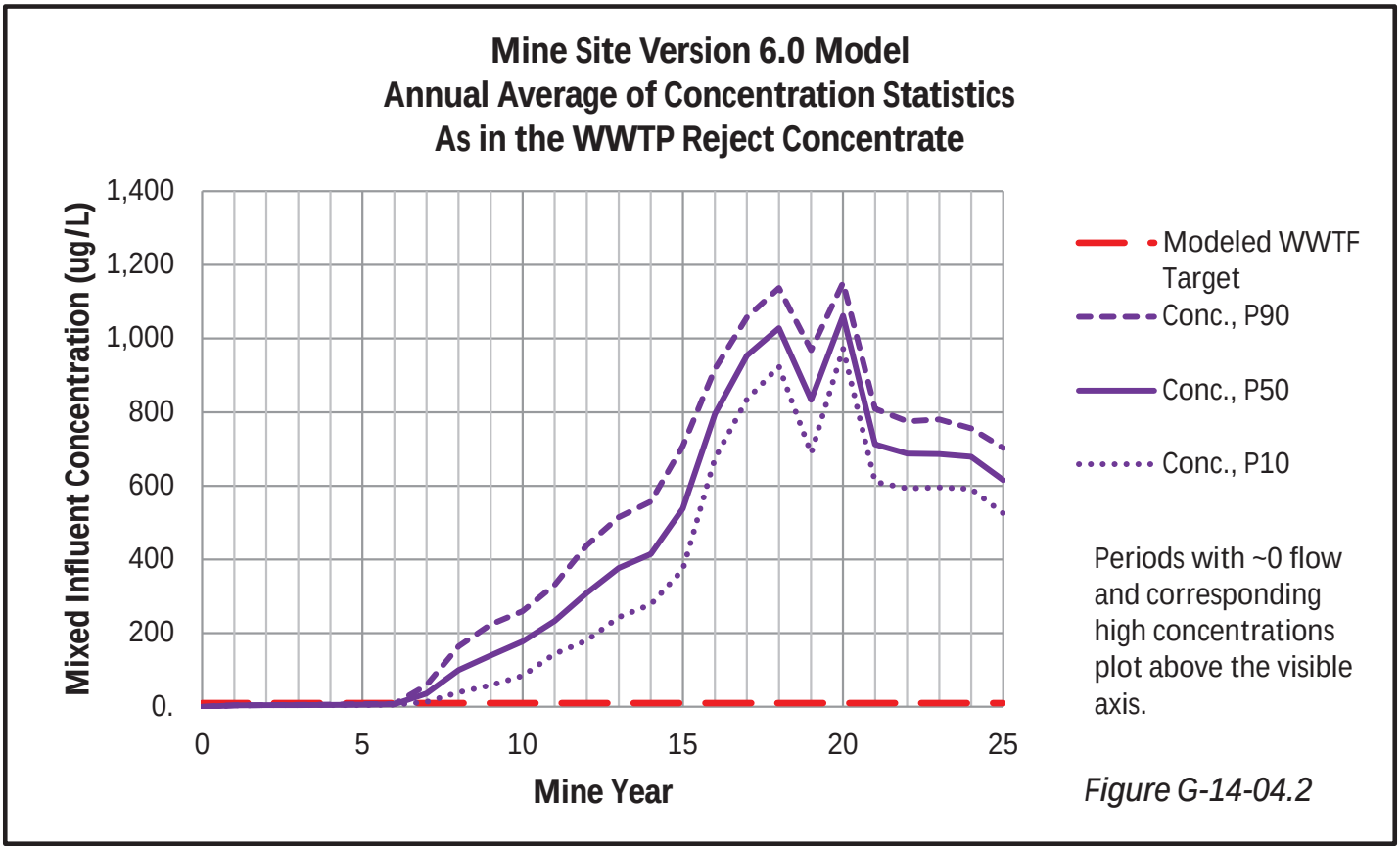
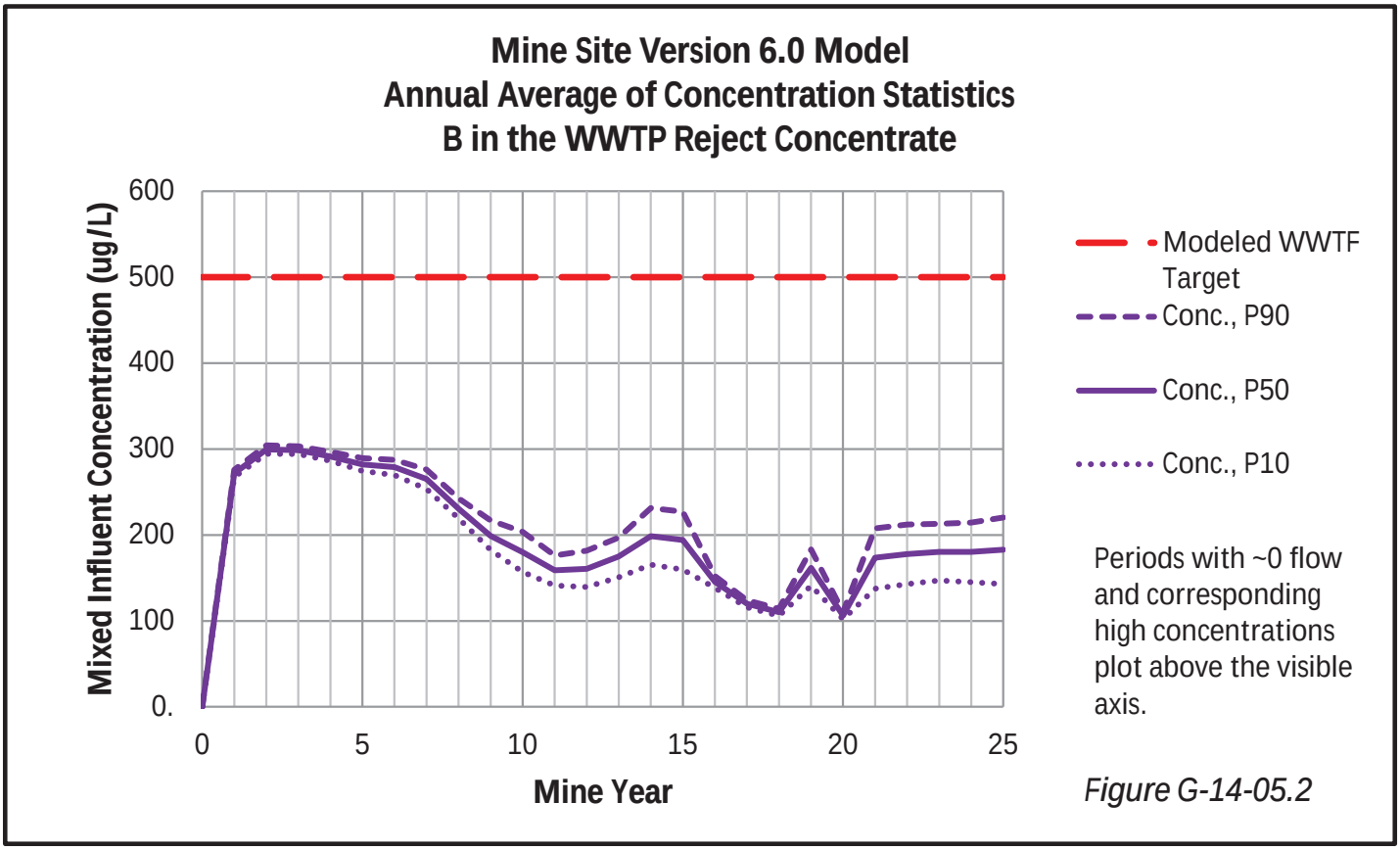


Figure G-14-04.2



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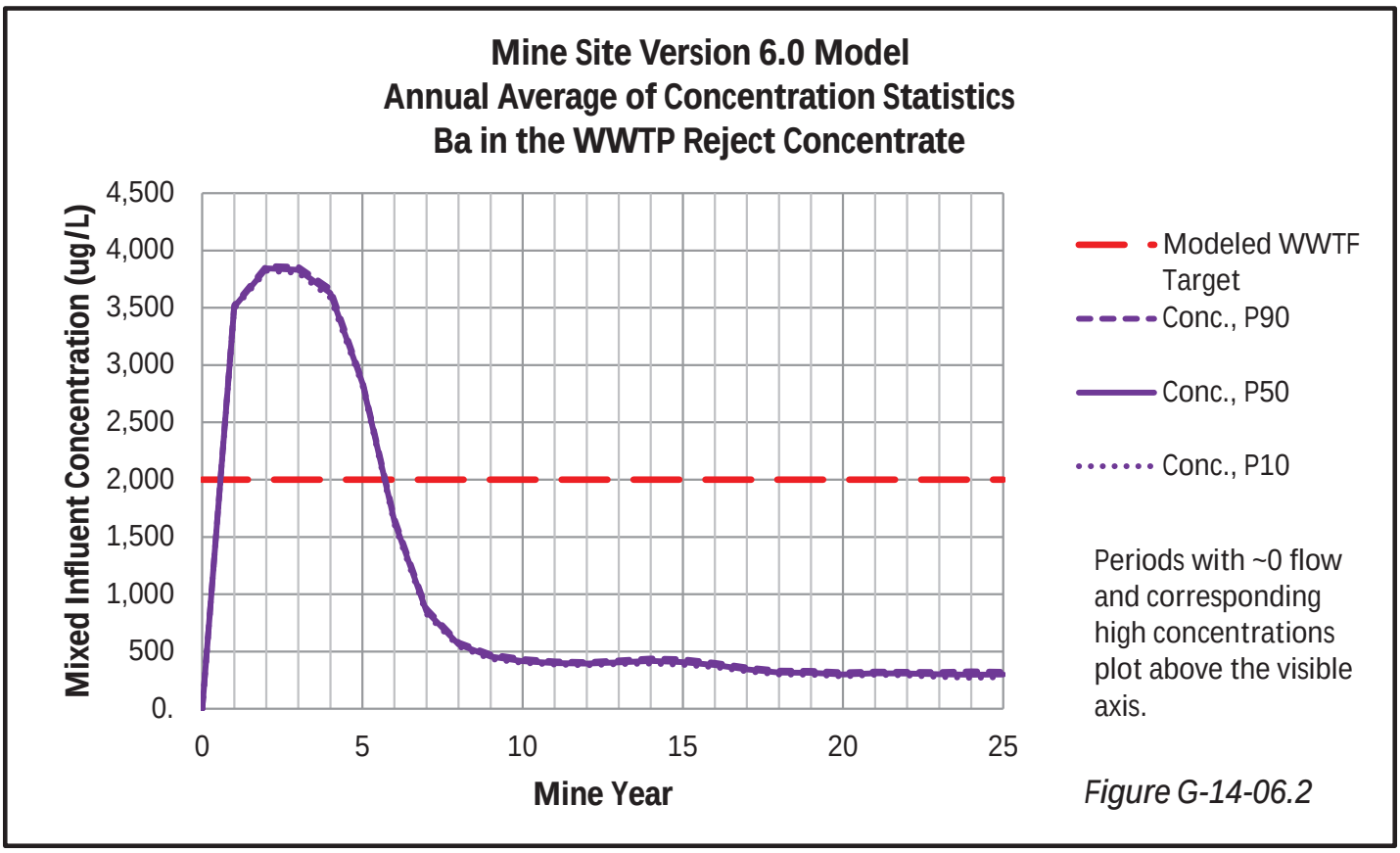

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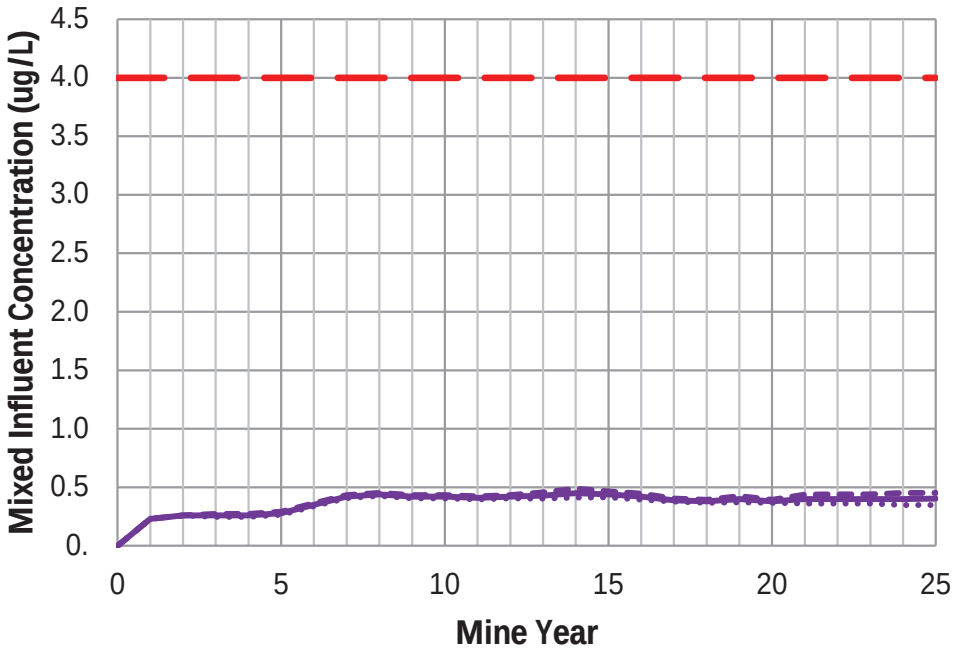


Modeled WWTF Target

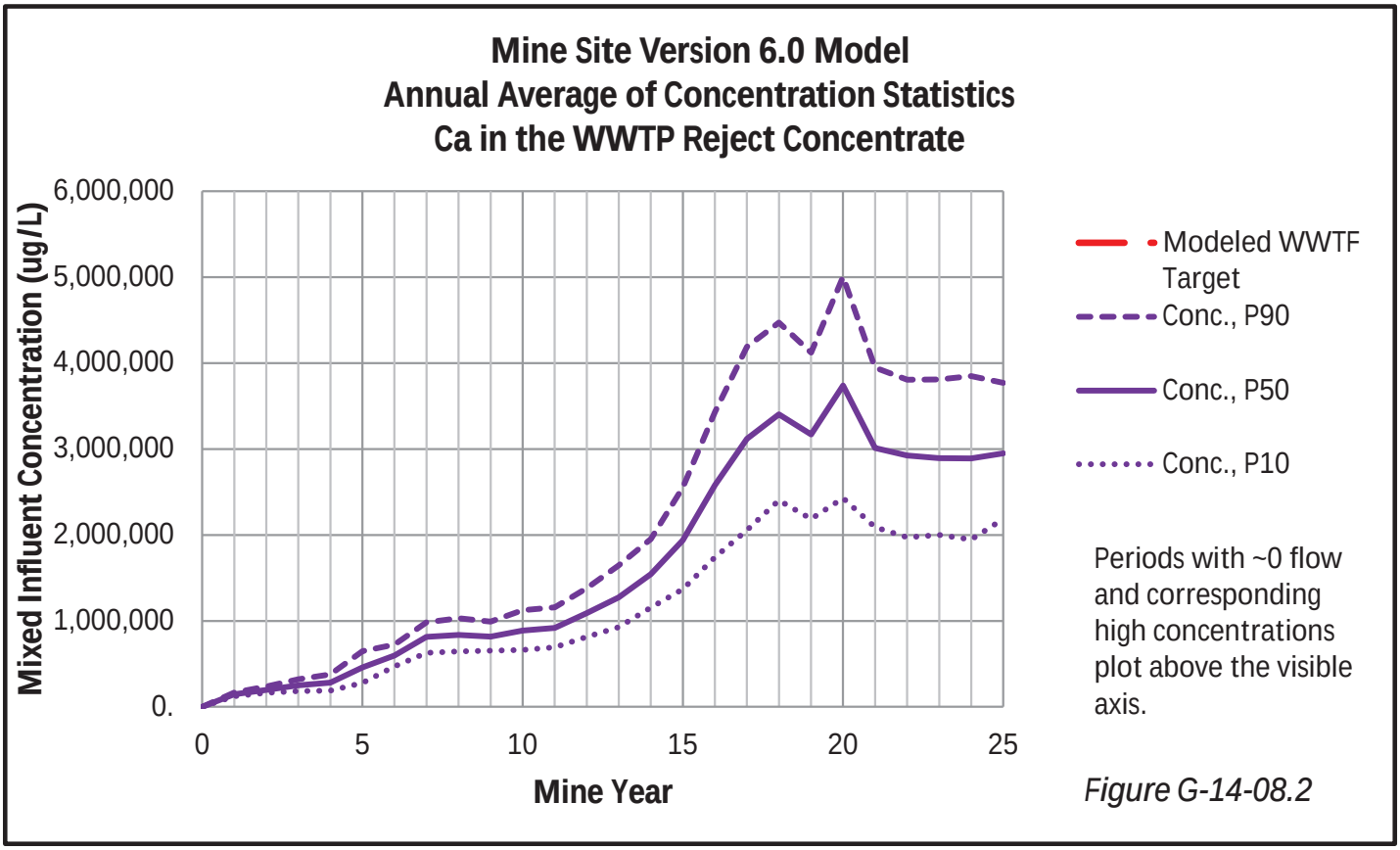
Conc., P90

Conc., P50

Conc., P10

Periods with ~0 flow and corresponding high concentrations plot above the visible axis.

Figure G-14-07.2



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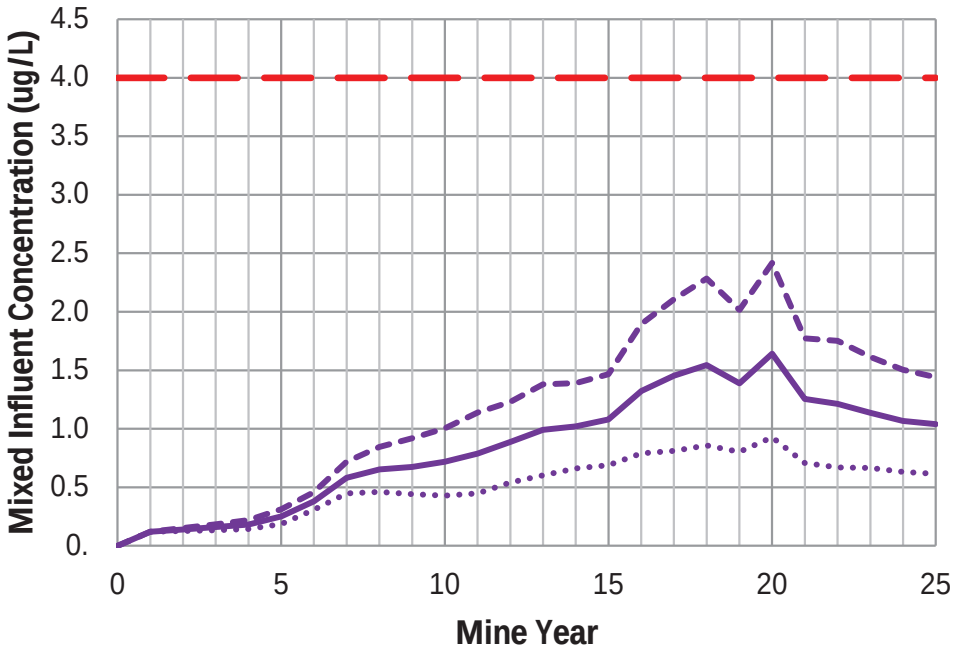


Modeled WWTF Target

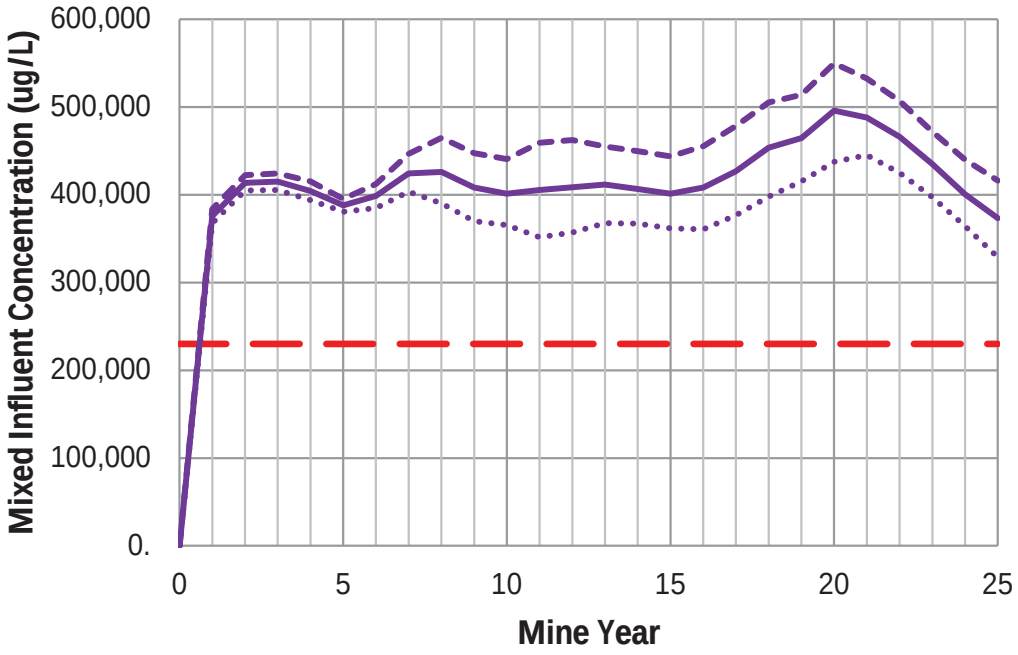
Conc., P90

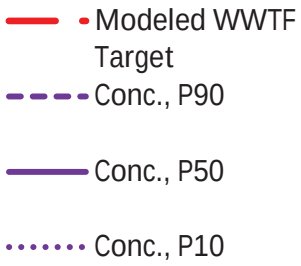
Conc., P50

Conc., P10

Periods with ~0 flow and corresponding high concentrations plot above the visible axis.

Figure G-14-09.2





Periods with ~0 flow and corresponding high concentrations plot above the visible axis.

Figure G-14-10.2

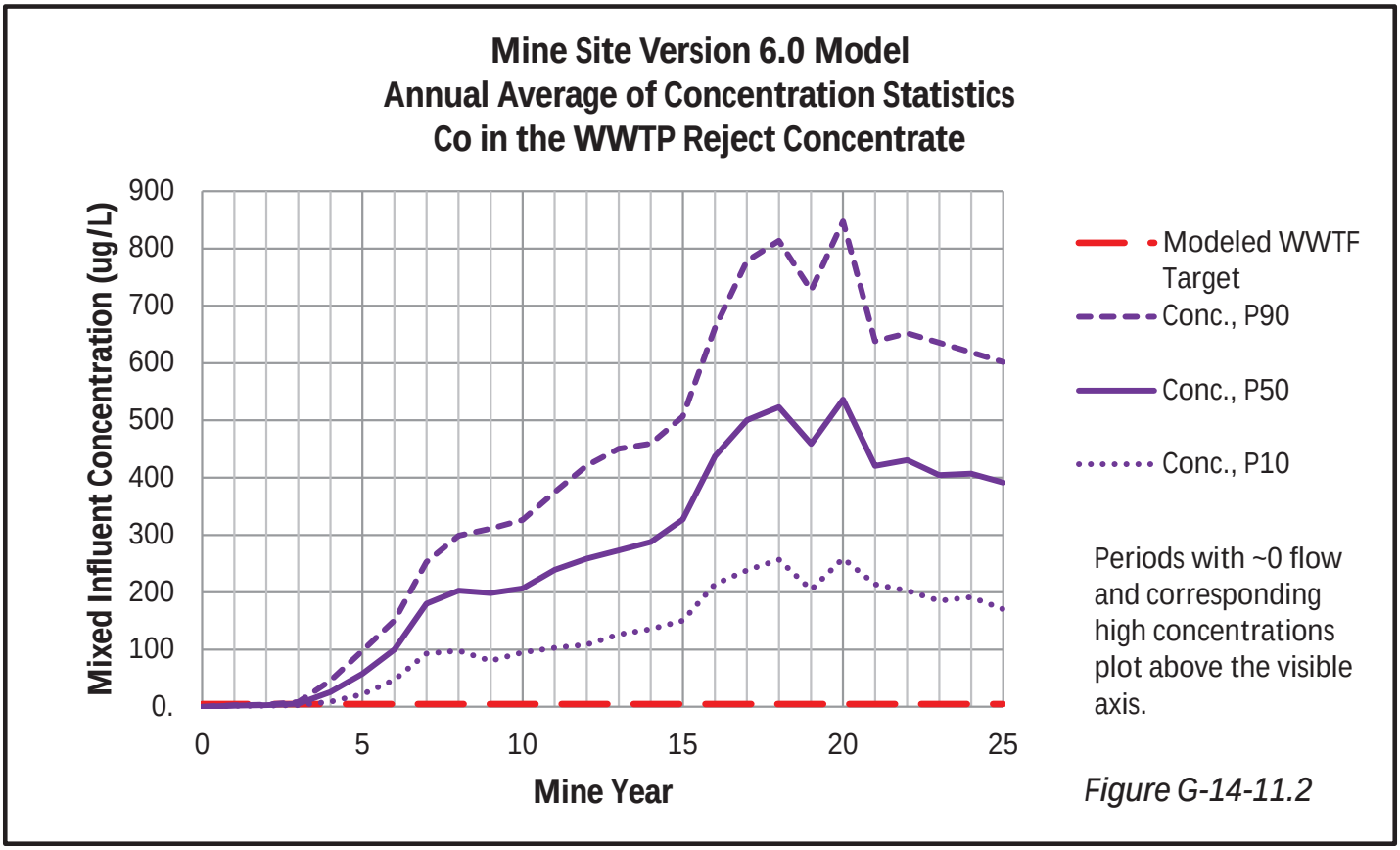
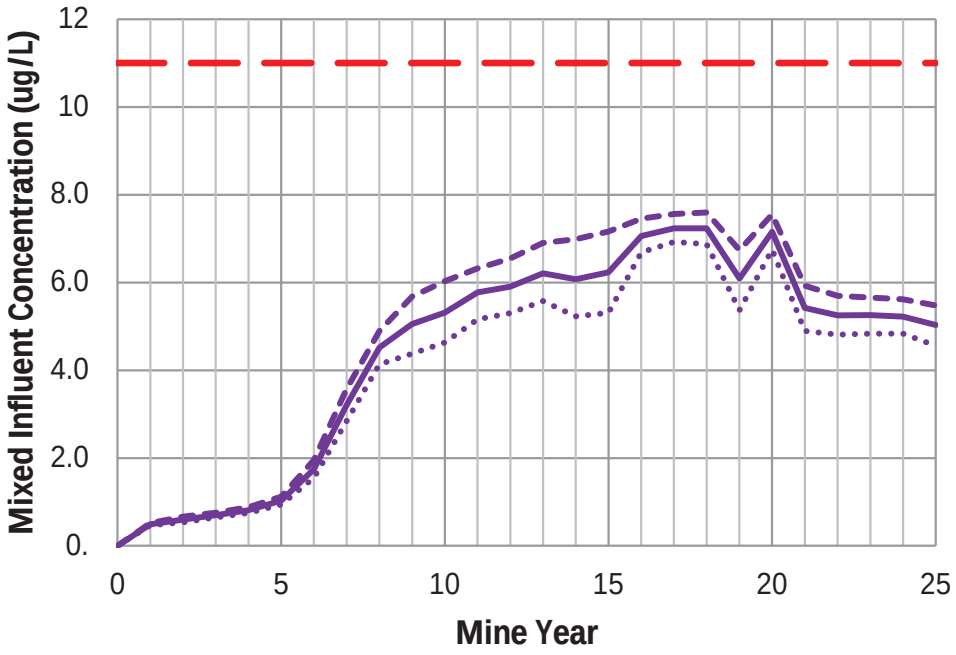


Figure G-14-11.2



Modeled WWTF Target

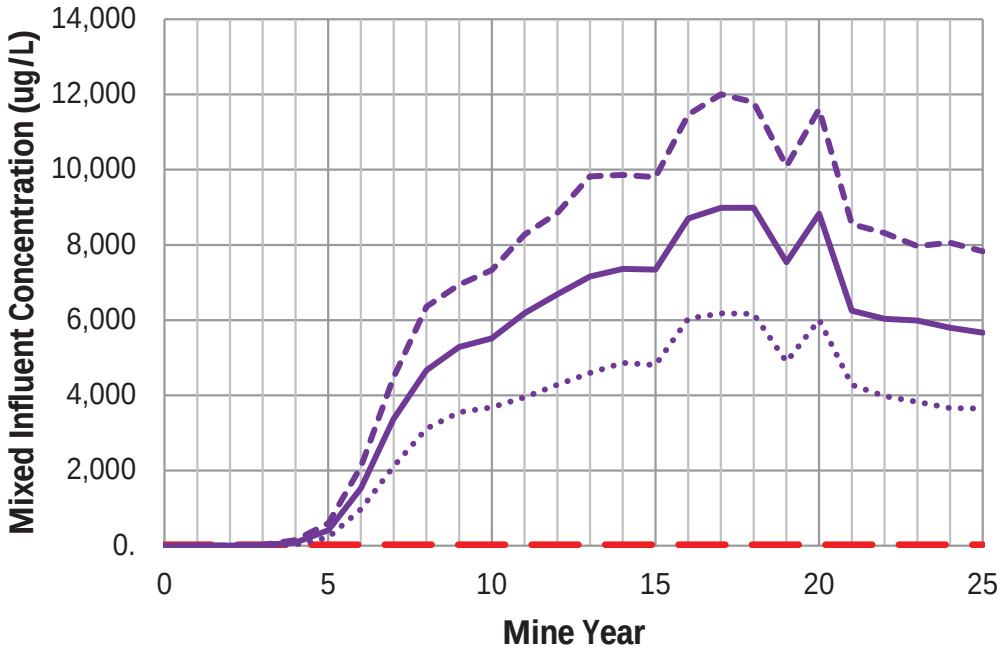
Conc., P90

Conc., P50

Conc., P10

Periods with ~0 flow and corresponding high concentrations plot above the visible axis.

Figure G-14-12.2



Periods with ~0 flow and corresponding high concentrations plot above the visible axis.

Figure G-14-13.2

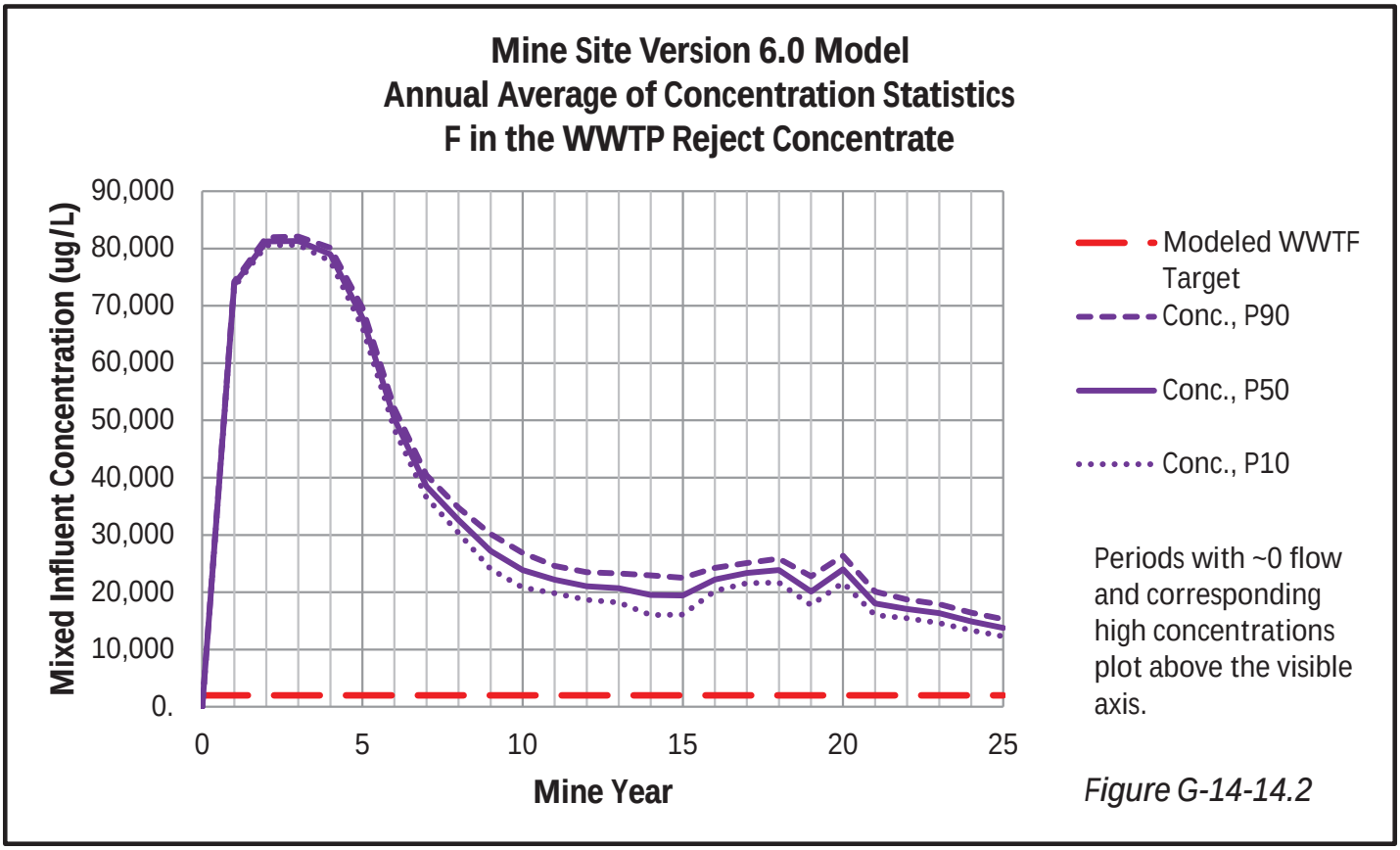
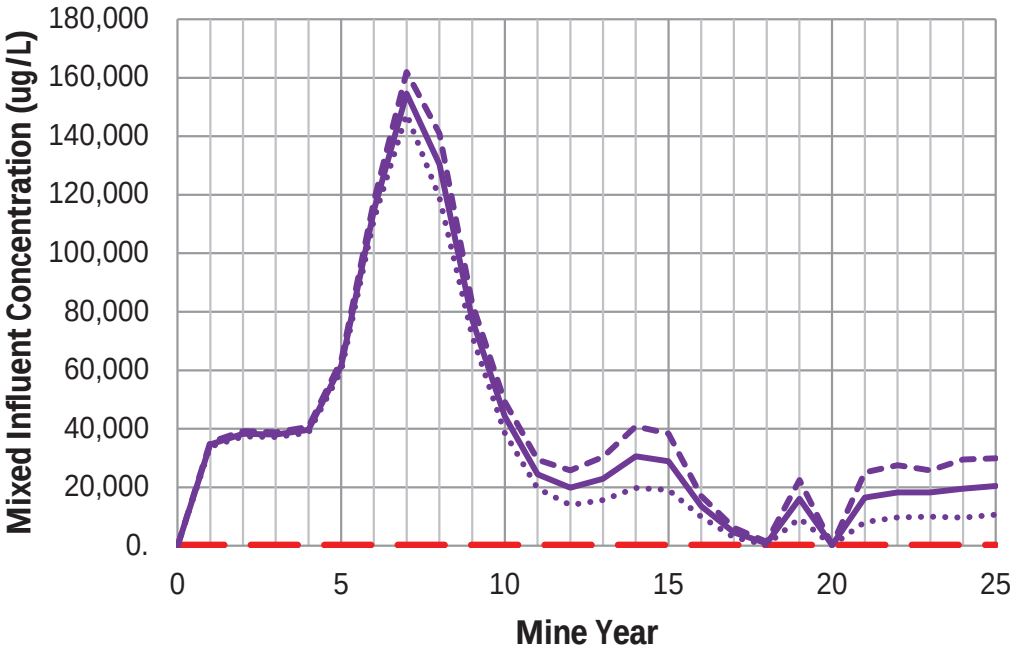


Figure G-14-14.2



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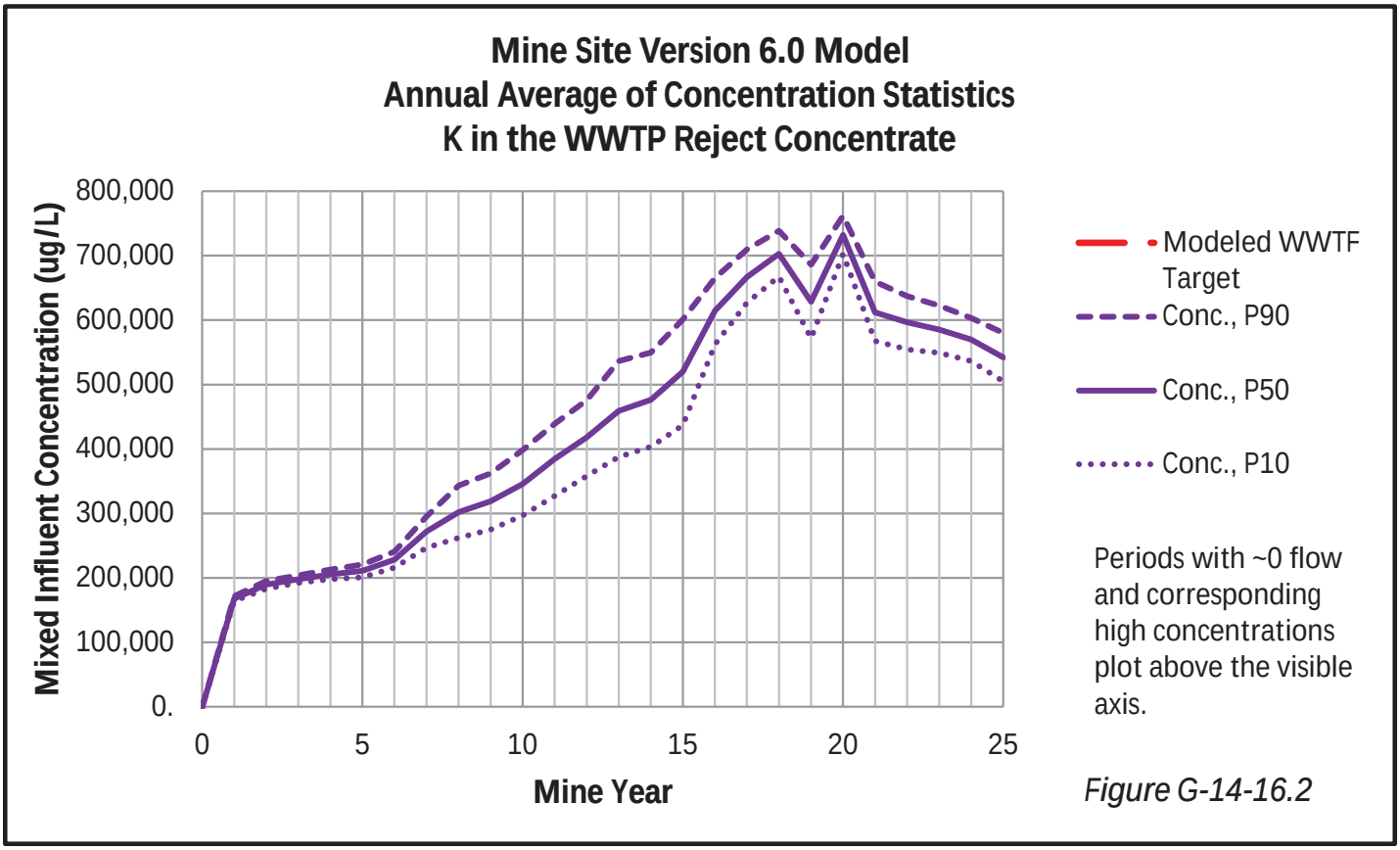

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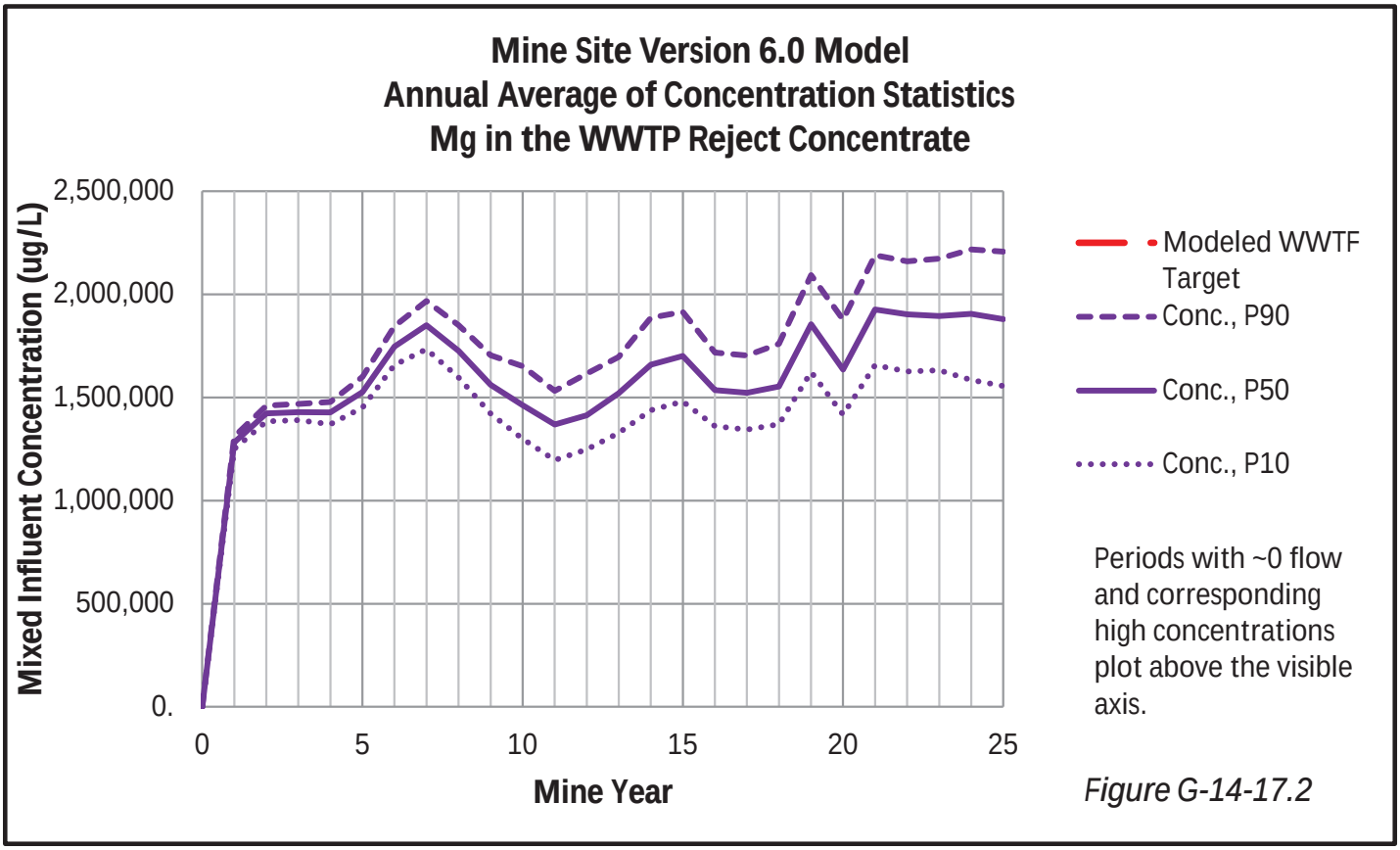

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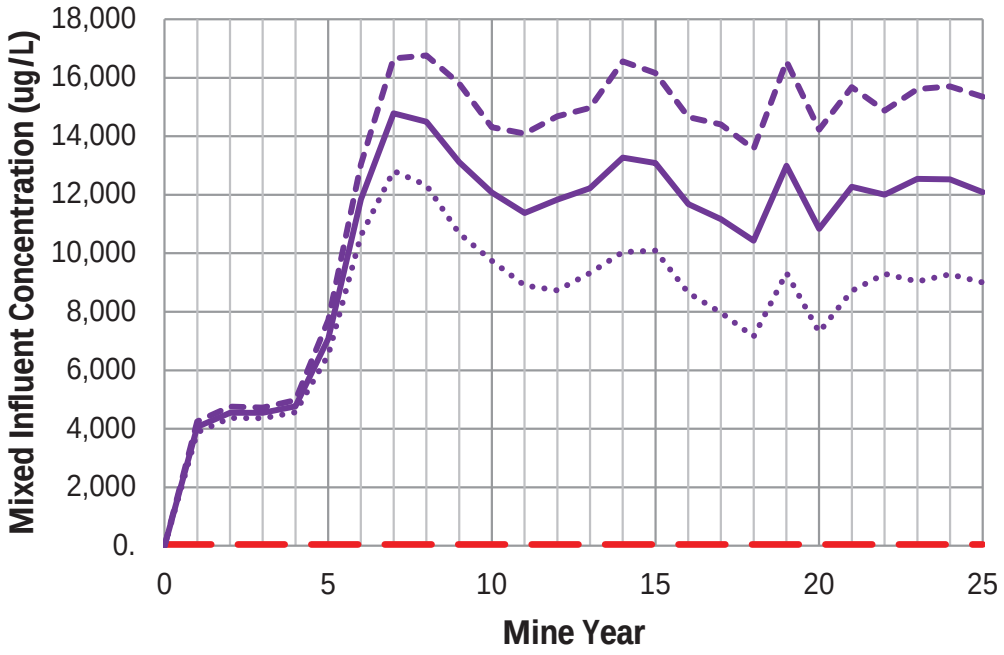


Modeled WWTF Target

Conc., P90

Conc., P50

Conc., P10

Periods with ~0 flow and corresponding high concentrations plot above the visible axis.

Figure G-14-18.2

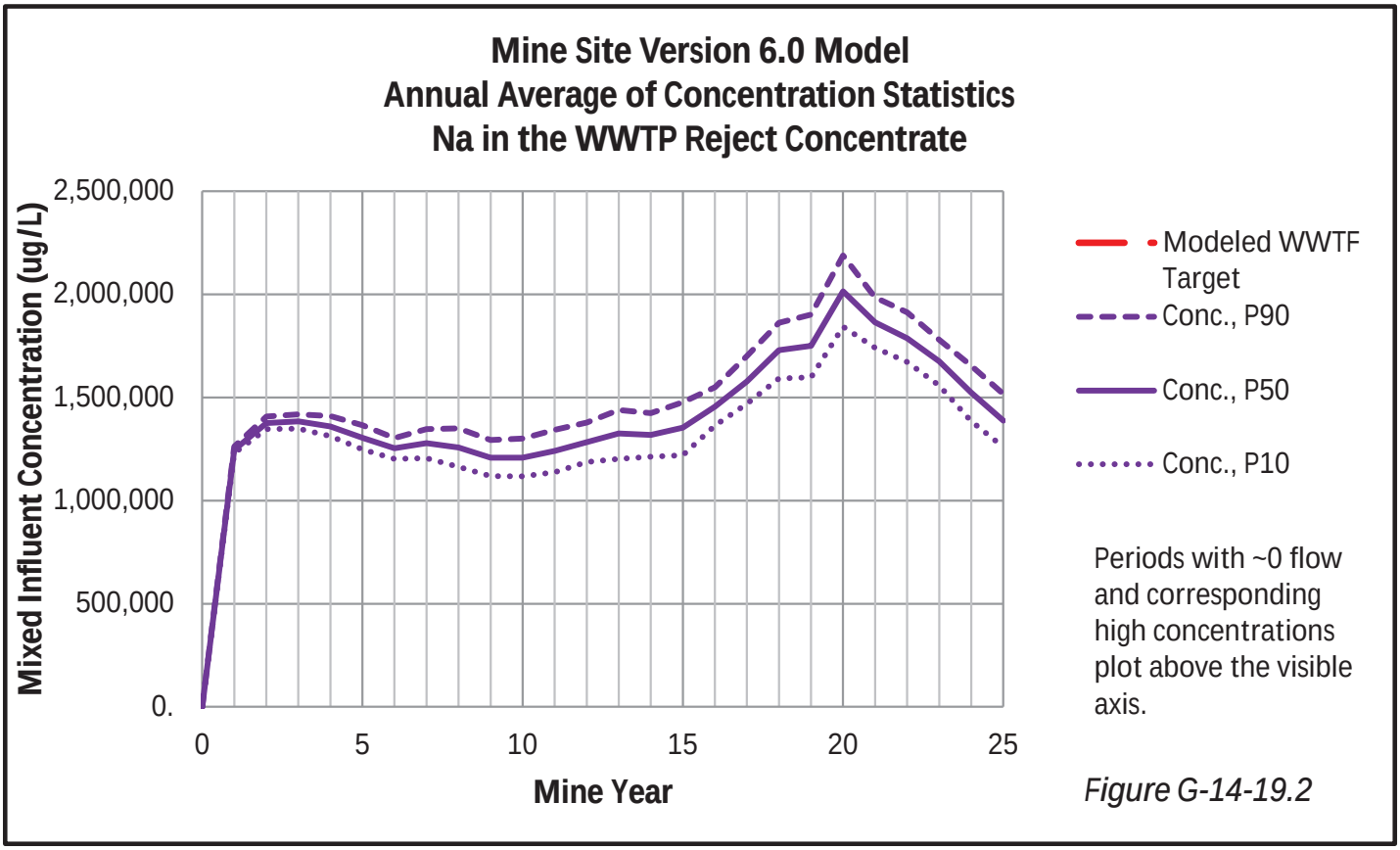


Figure G-14-19.2

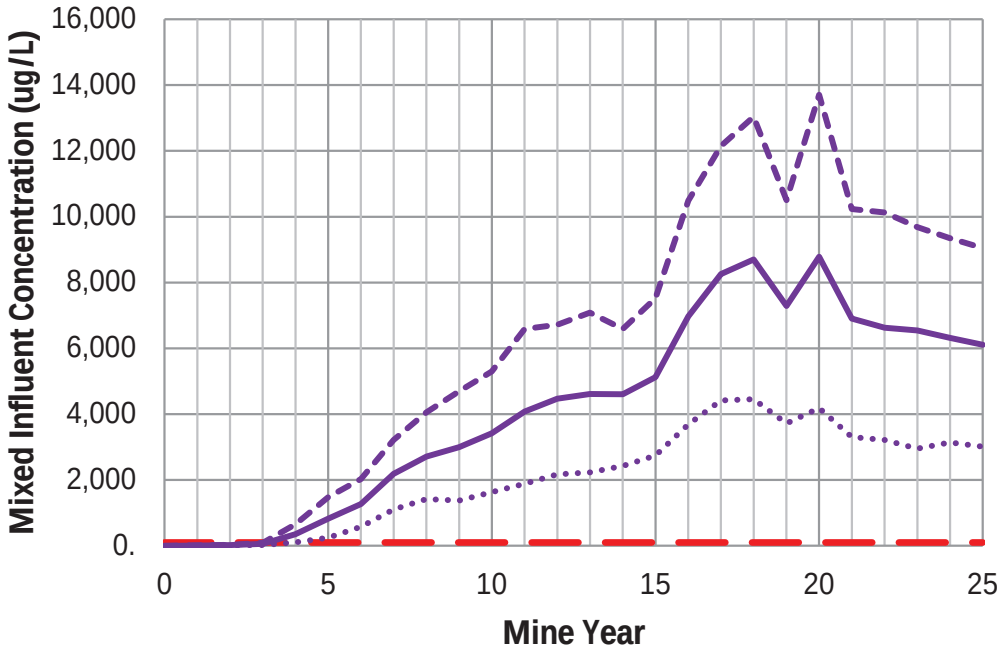


Figure G-14-20.2

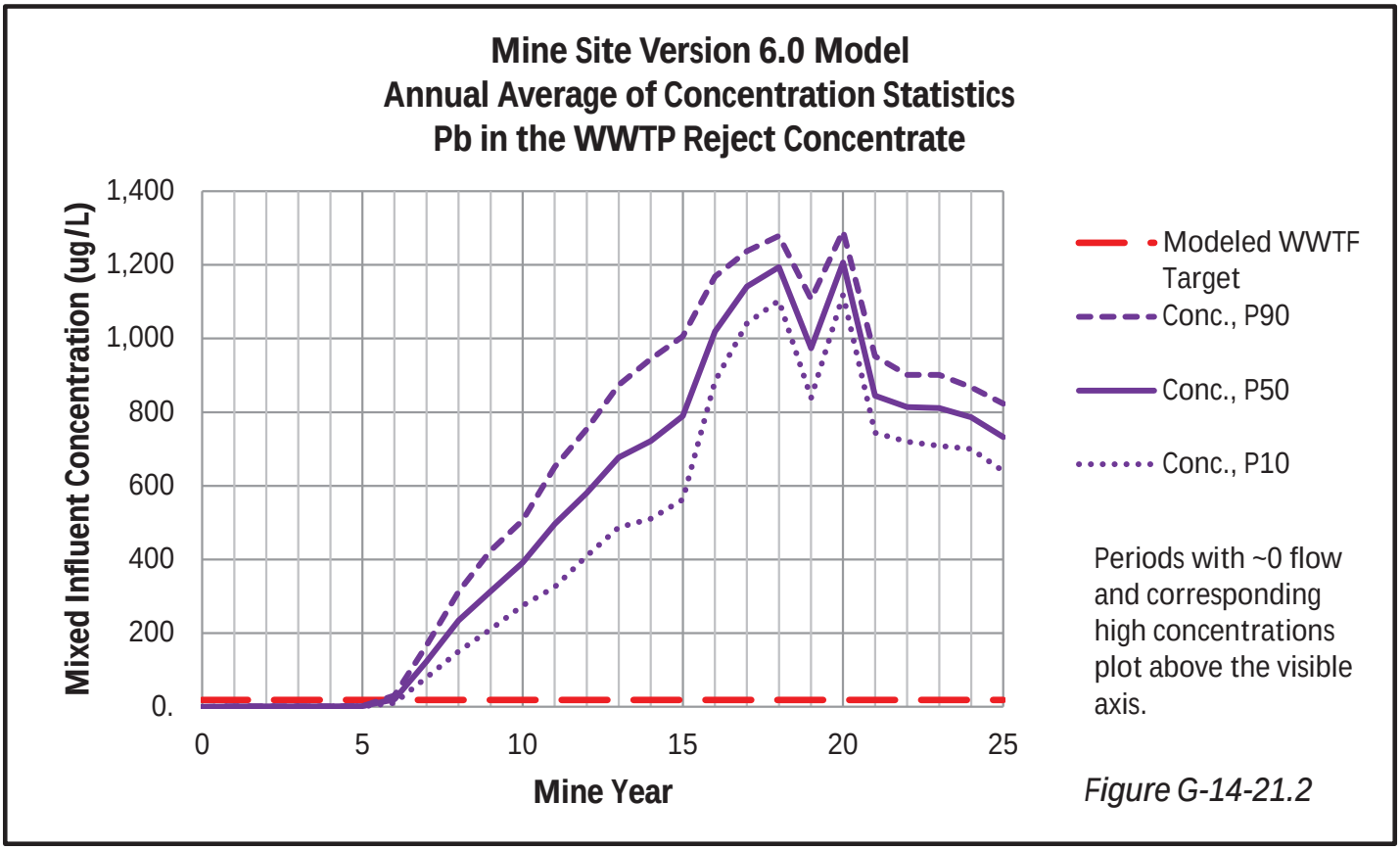
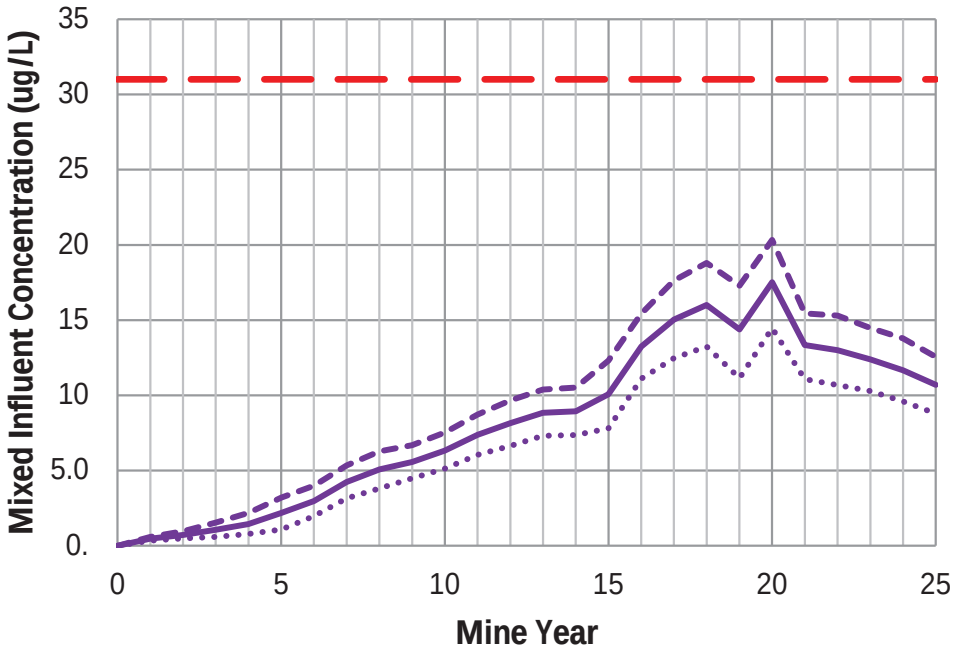
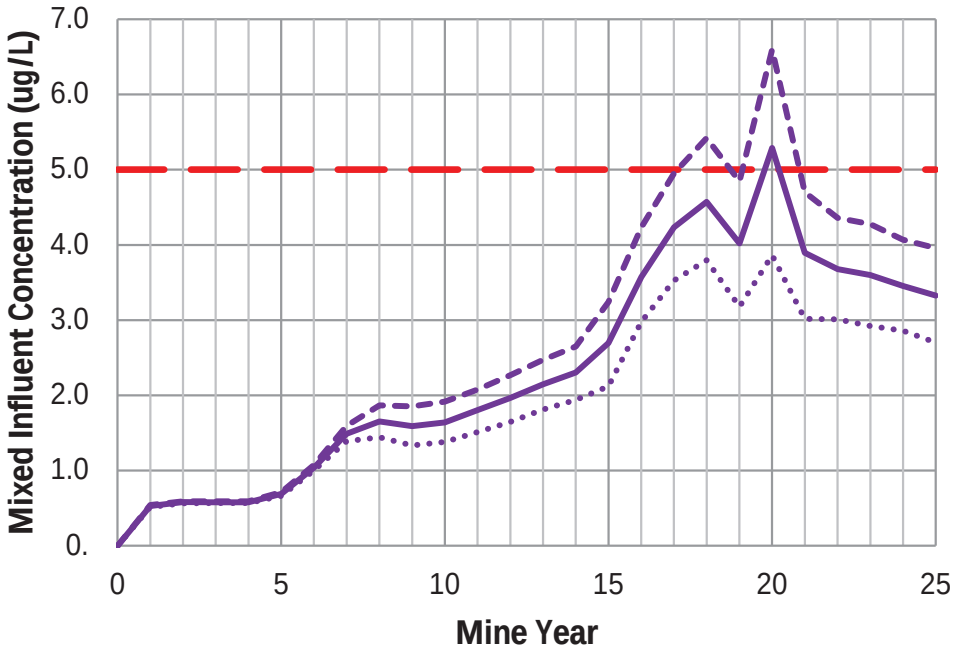


Figure G-14-21.2



Periods with ~0 flow and corresponding high concentrations plot above the visible axis.

Figure G-14-22.2



Modeled WWTF Target

Conc., P90

Conc., P50

Conc., P10

Periods with ~0 flow and corresponding high concentrations plot above the visible axis.

Figure G-14-23.2

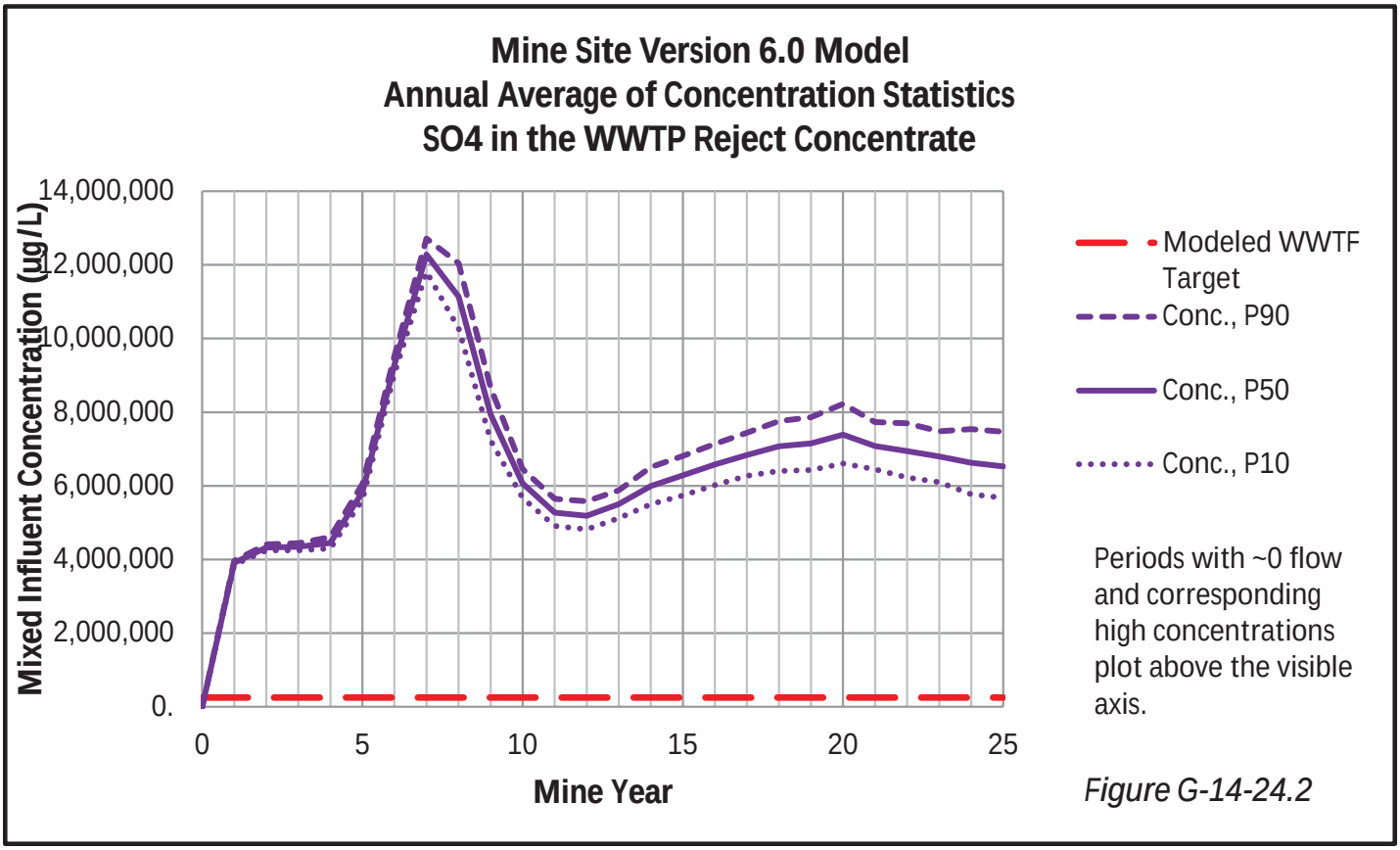
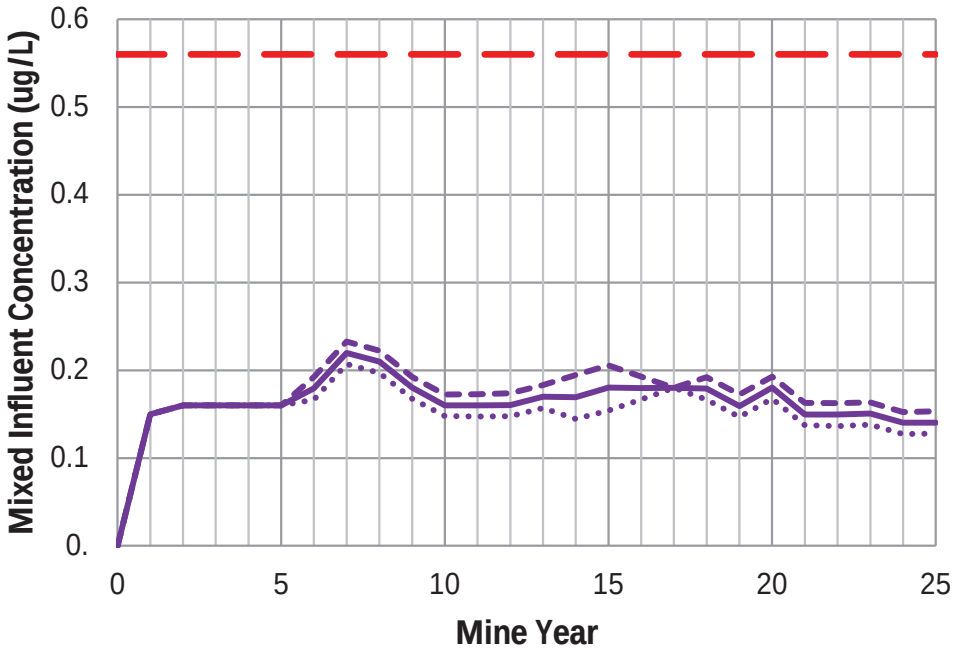


Figure G-14-24.2



Modeled WWTF Target

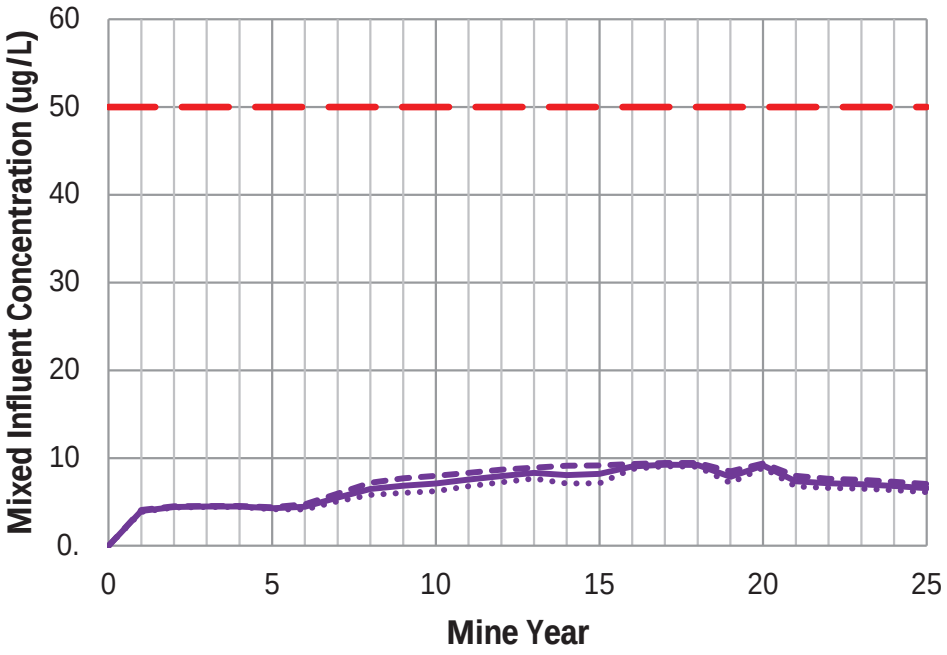
Conc., P90

Conc., P50

Conc., P10

Periods with ~0 flow and corresponding high concentrations plot above the visible axis.

Figure G-14-25.2



Modeled WWTF Target

Conc., P90

Conc., P50

Conc., P10

Periods with ~0 flow and corresponding high concentrations plot above the visible axis.

Figure G-14-26.2

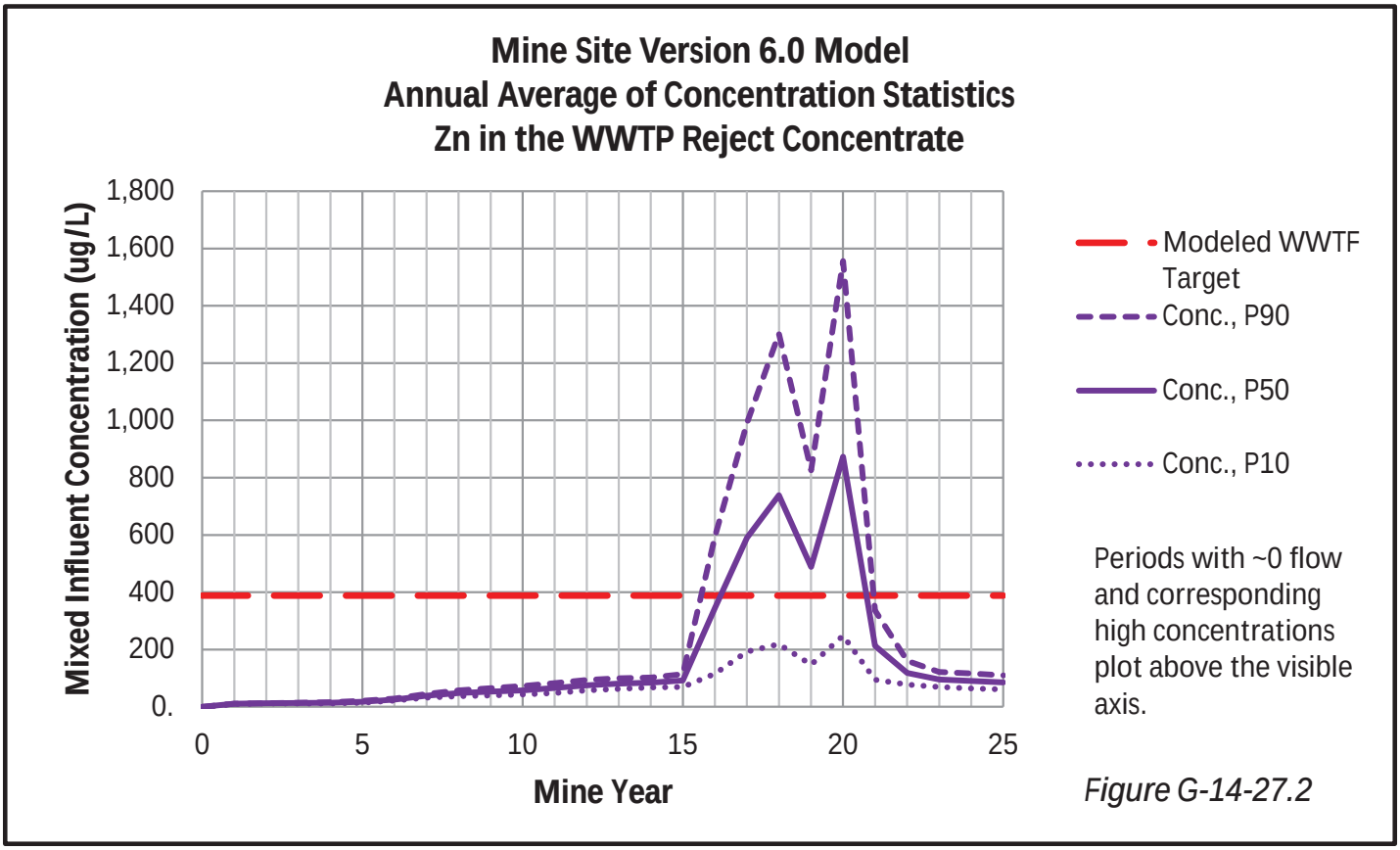


Figure G-14-27.2

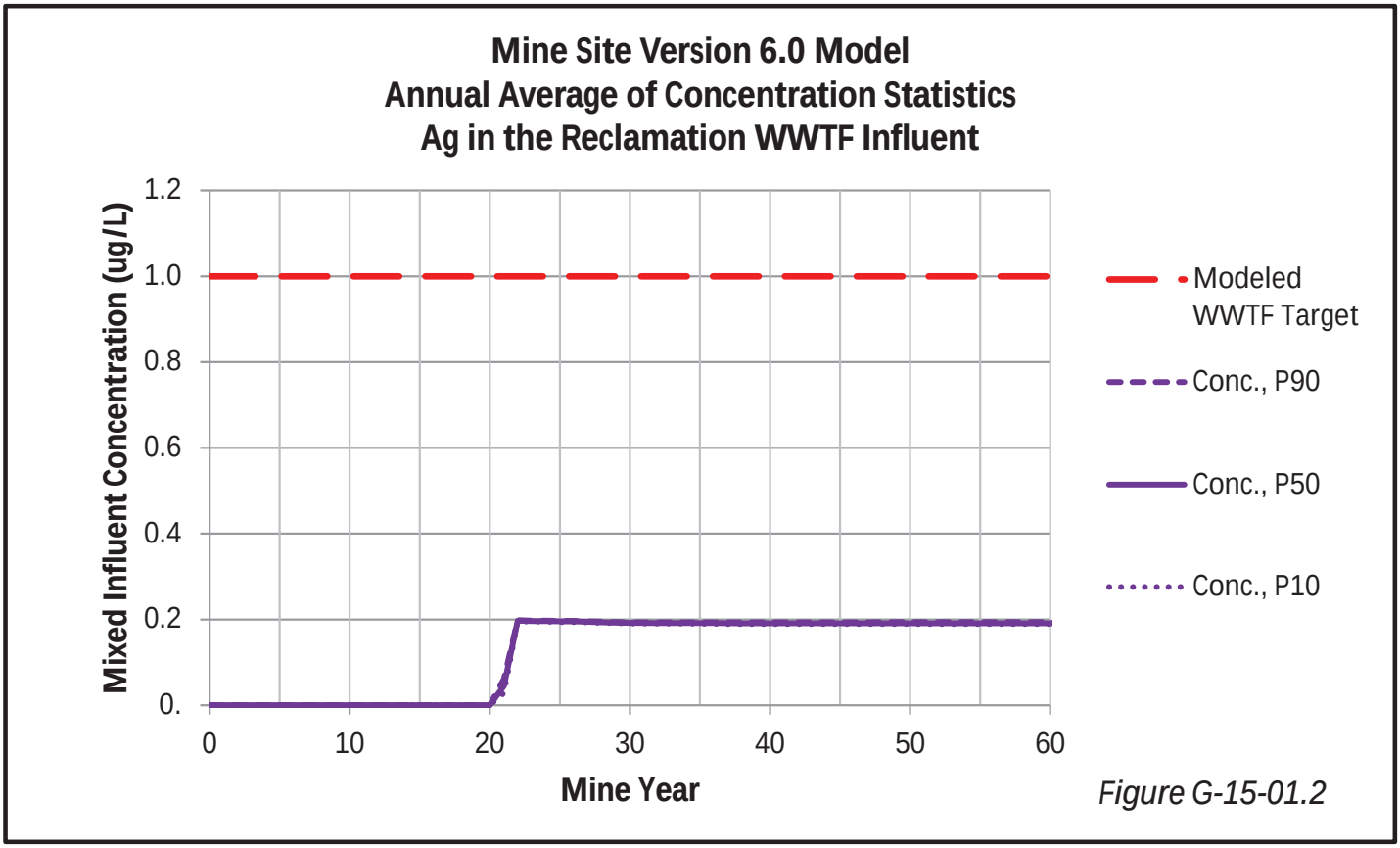
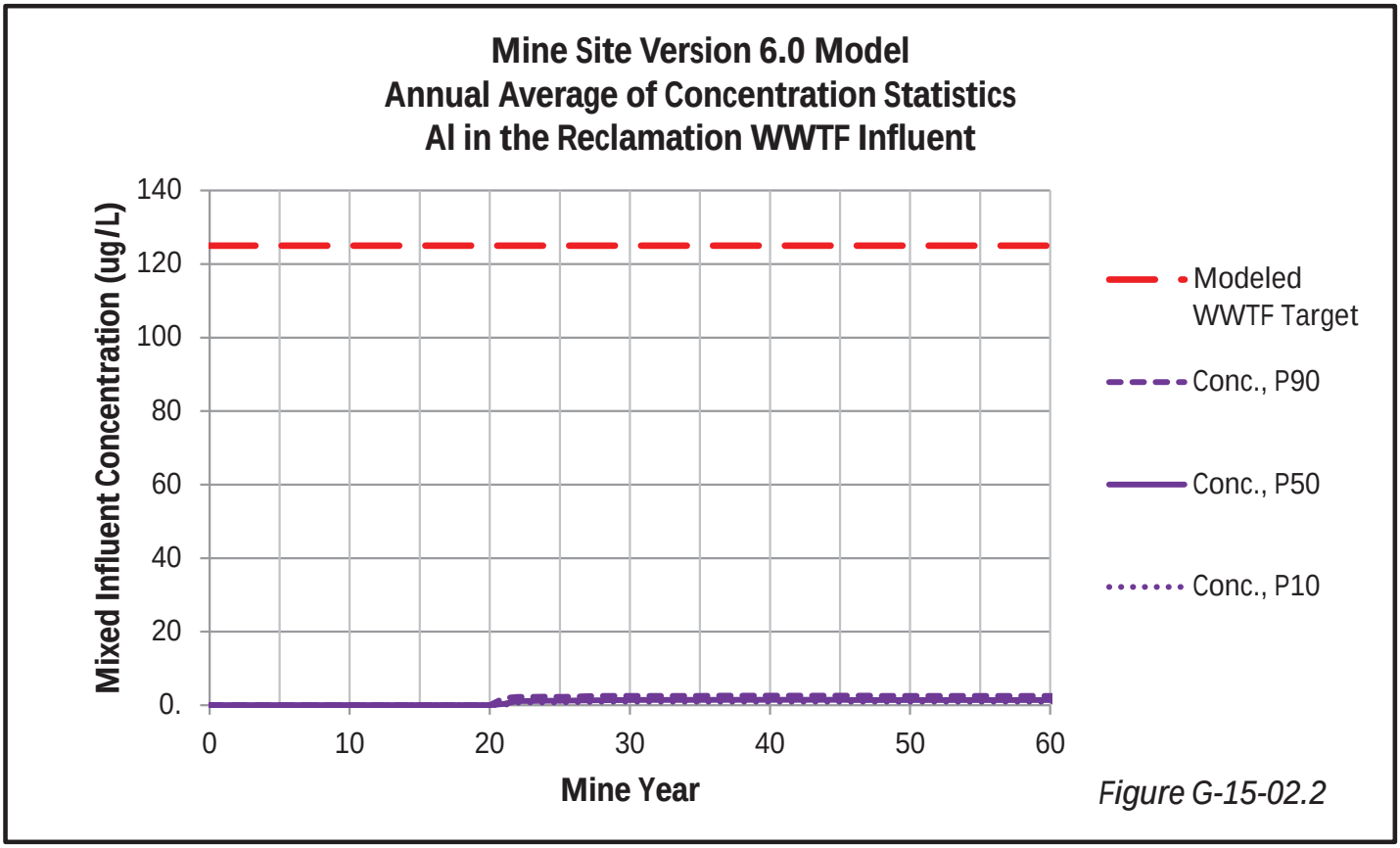


Figure G-15-01.2



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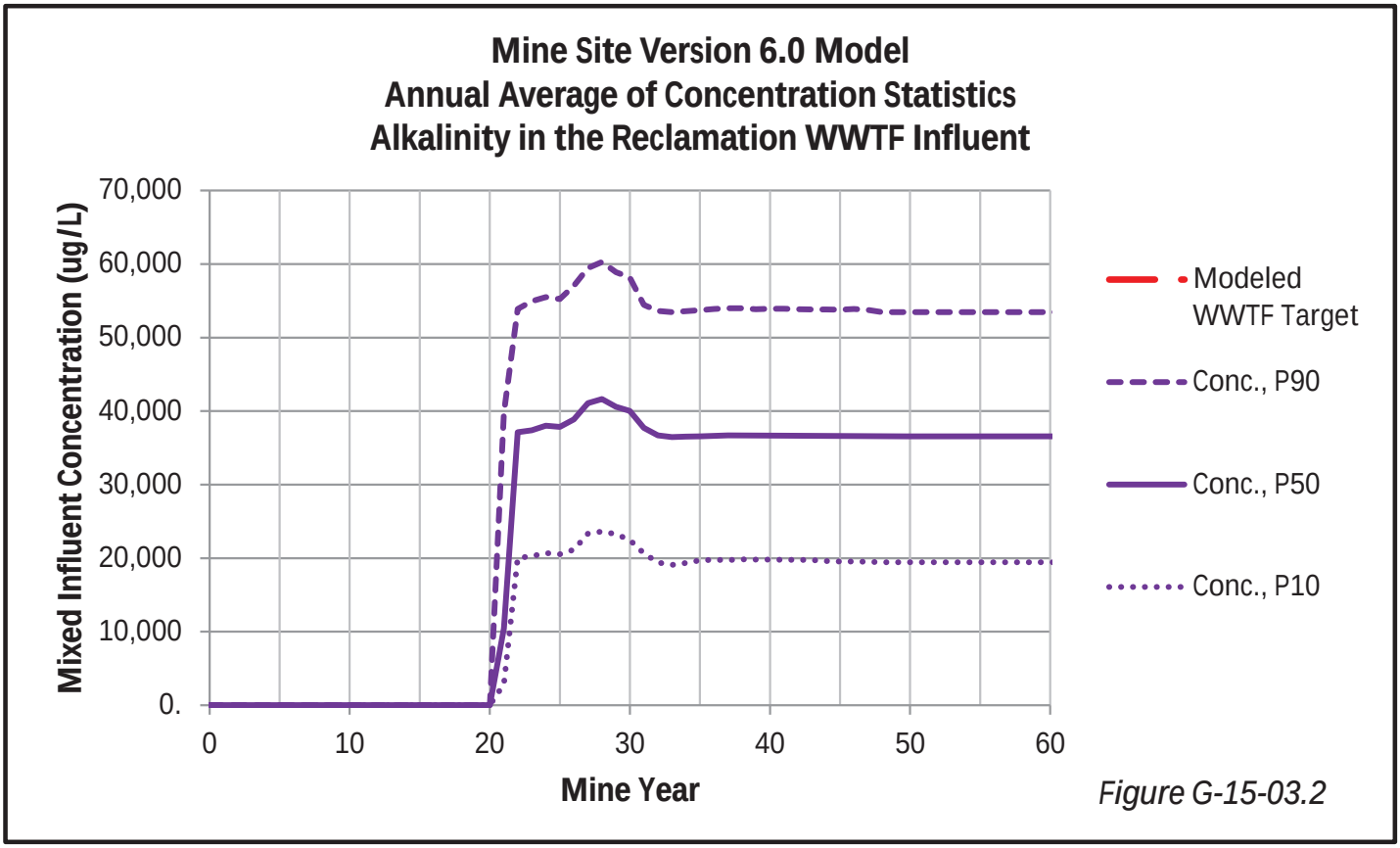

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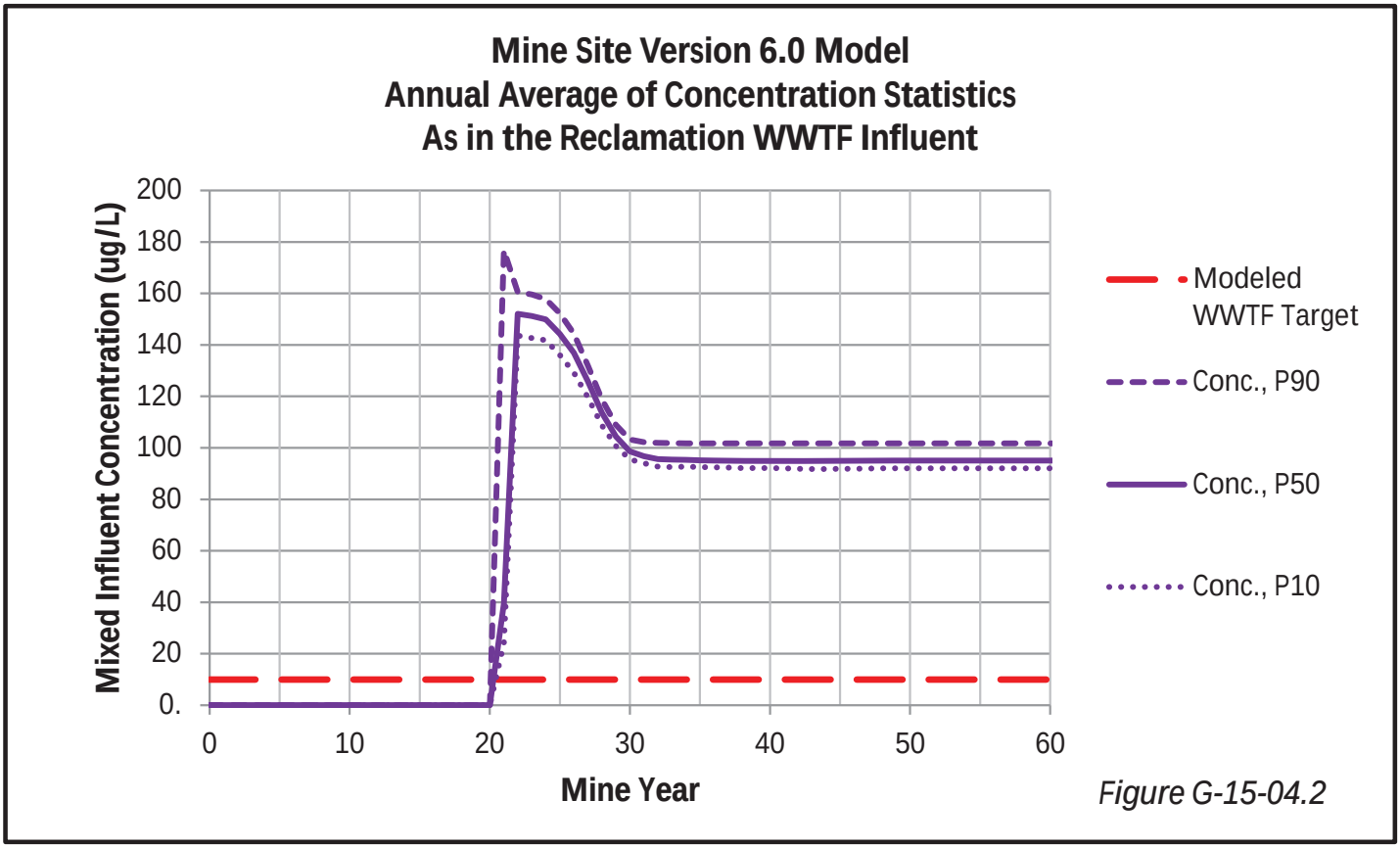

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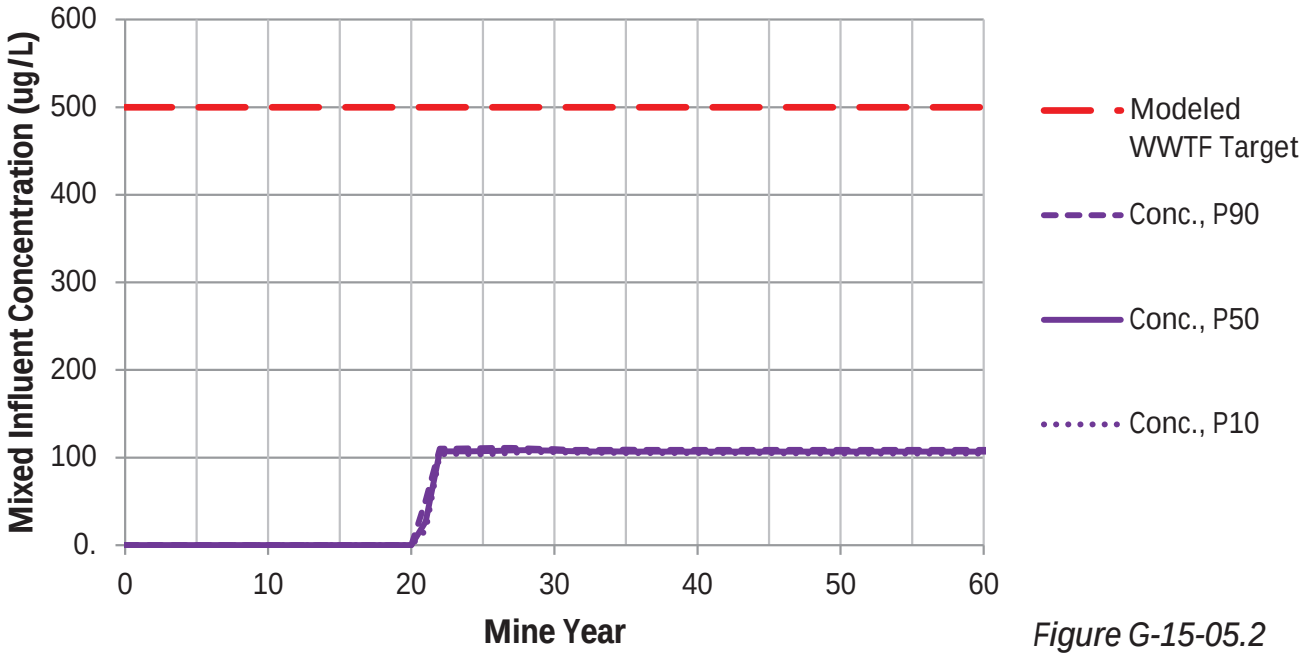

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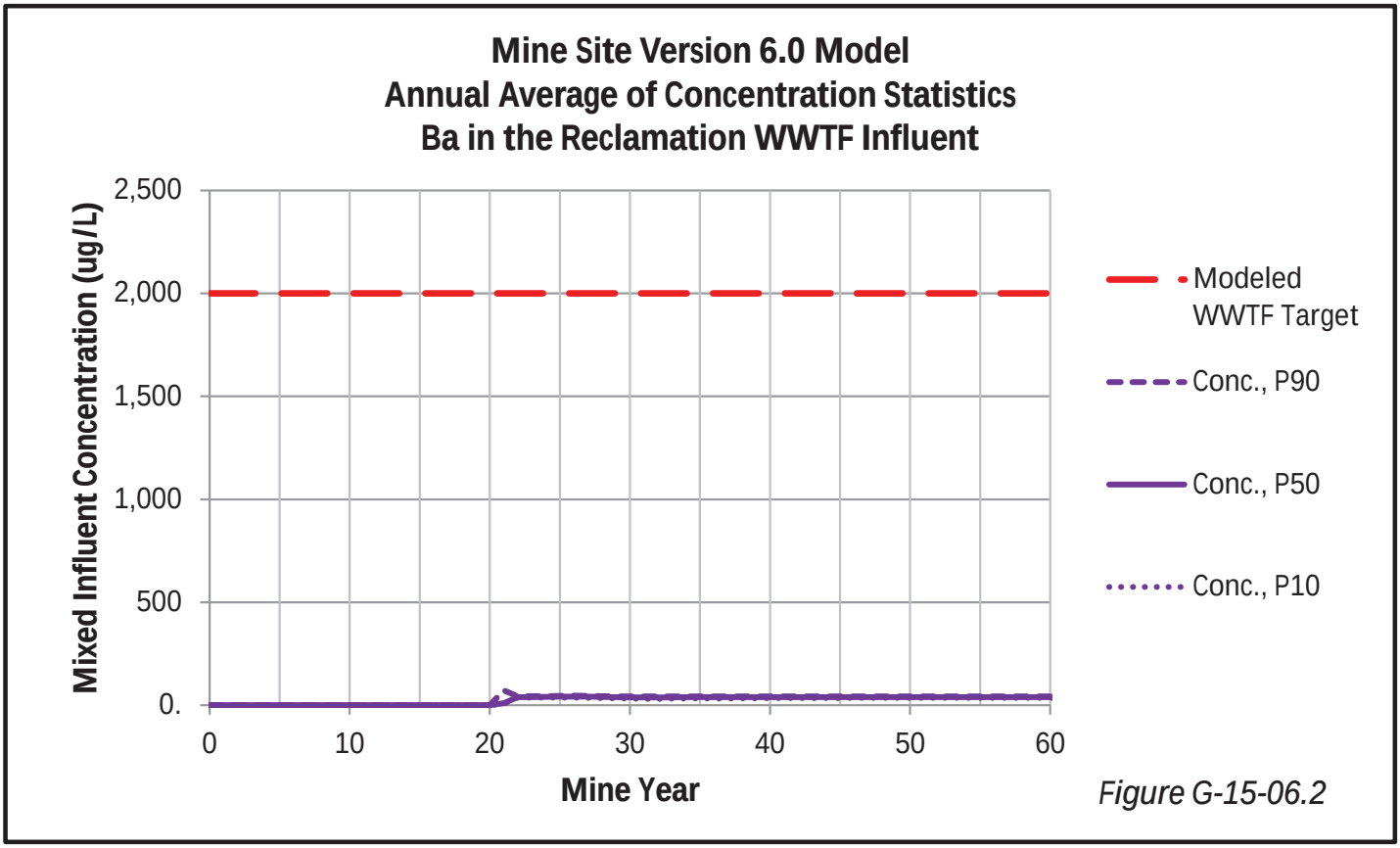

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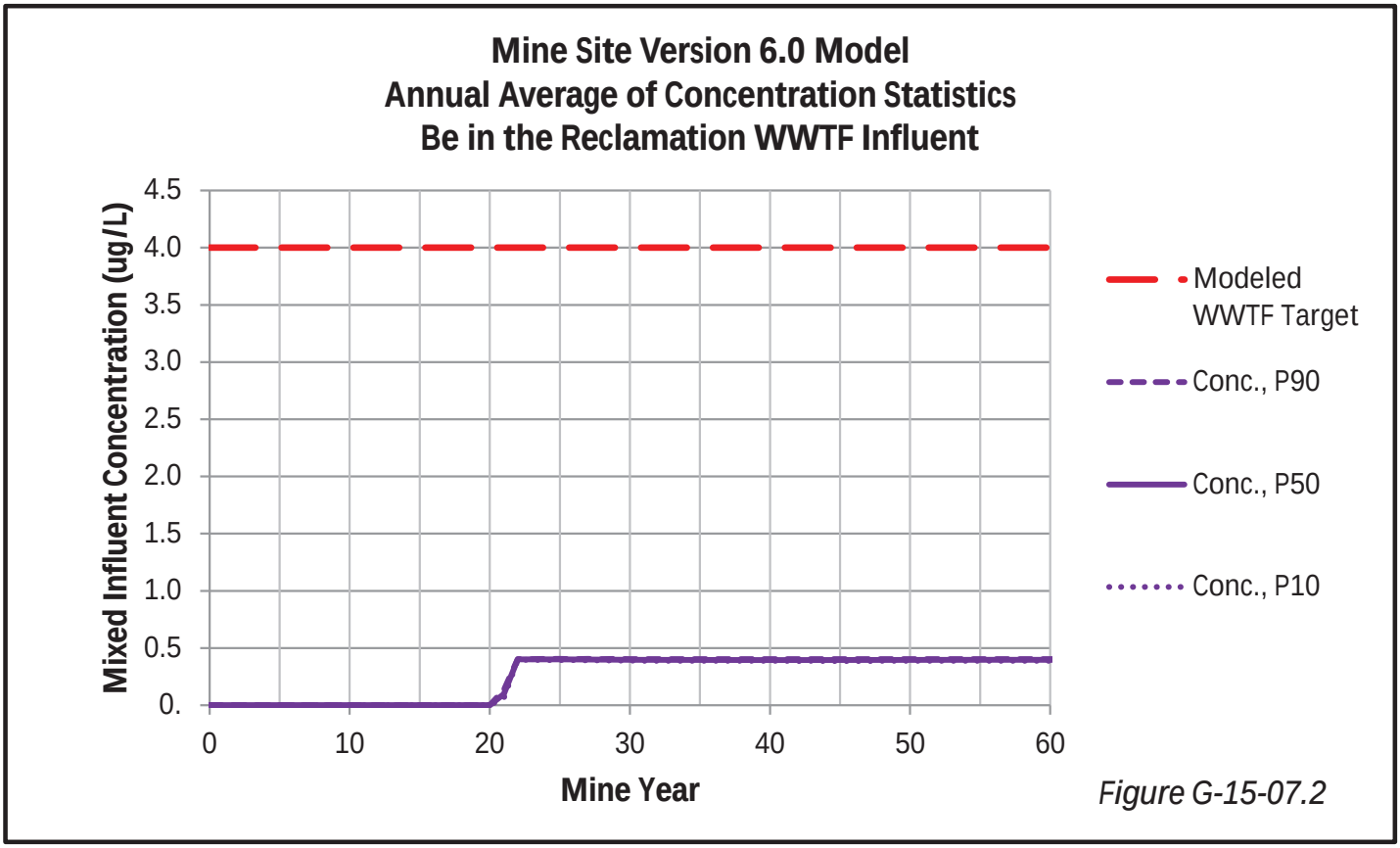


Figure G-15-07.2

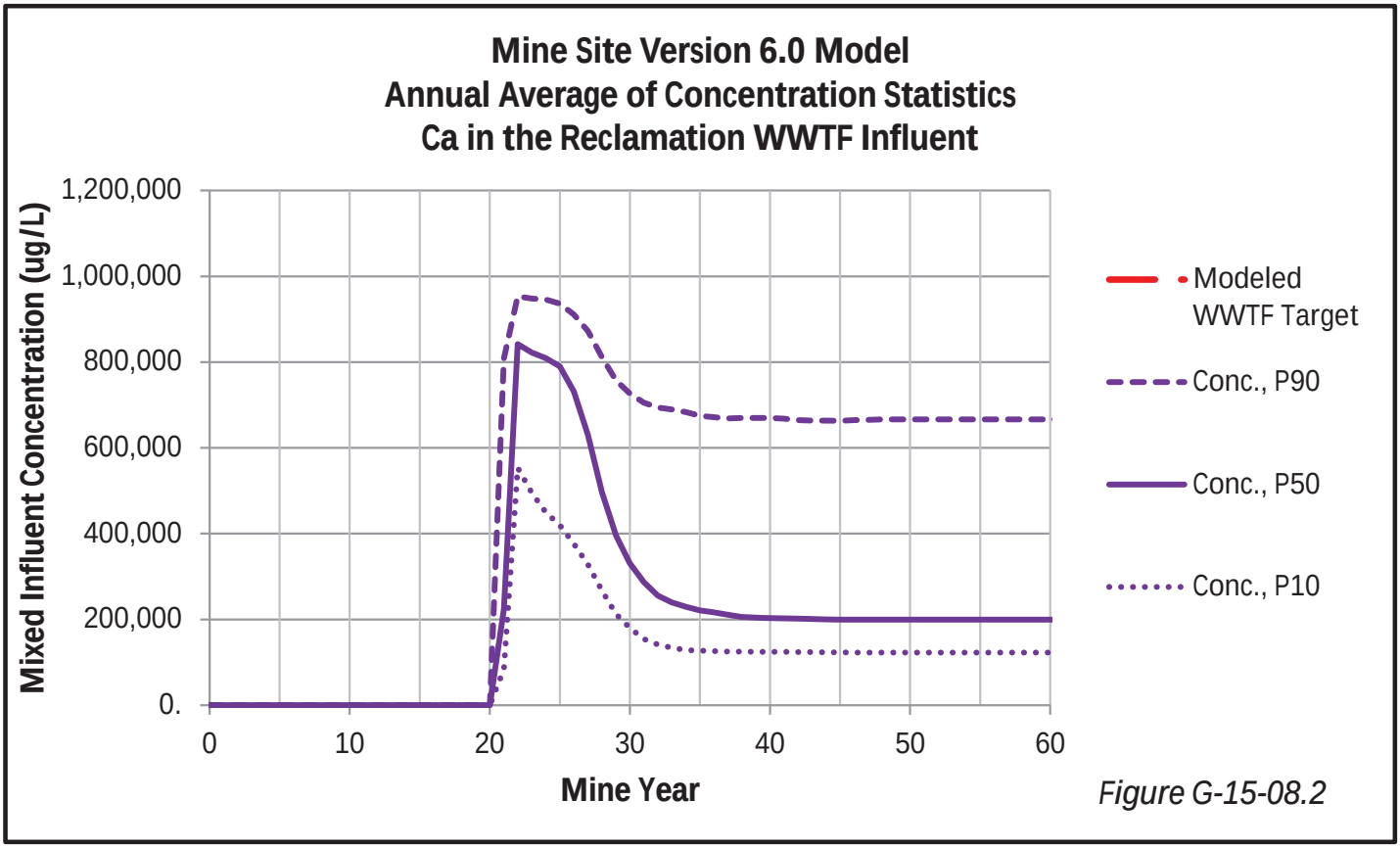


Figure G-15-08.2

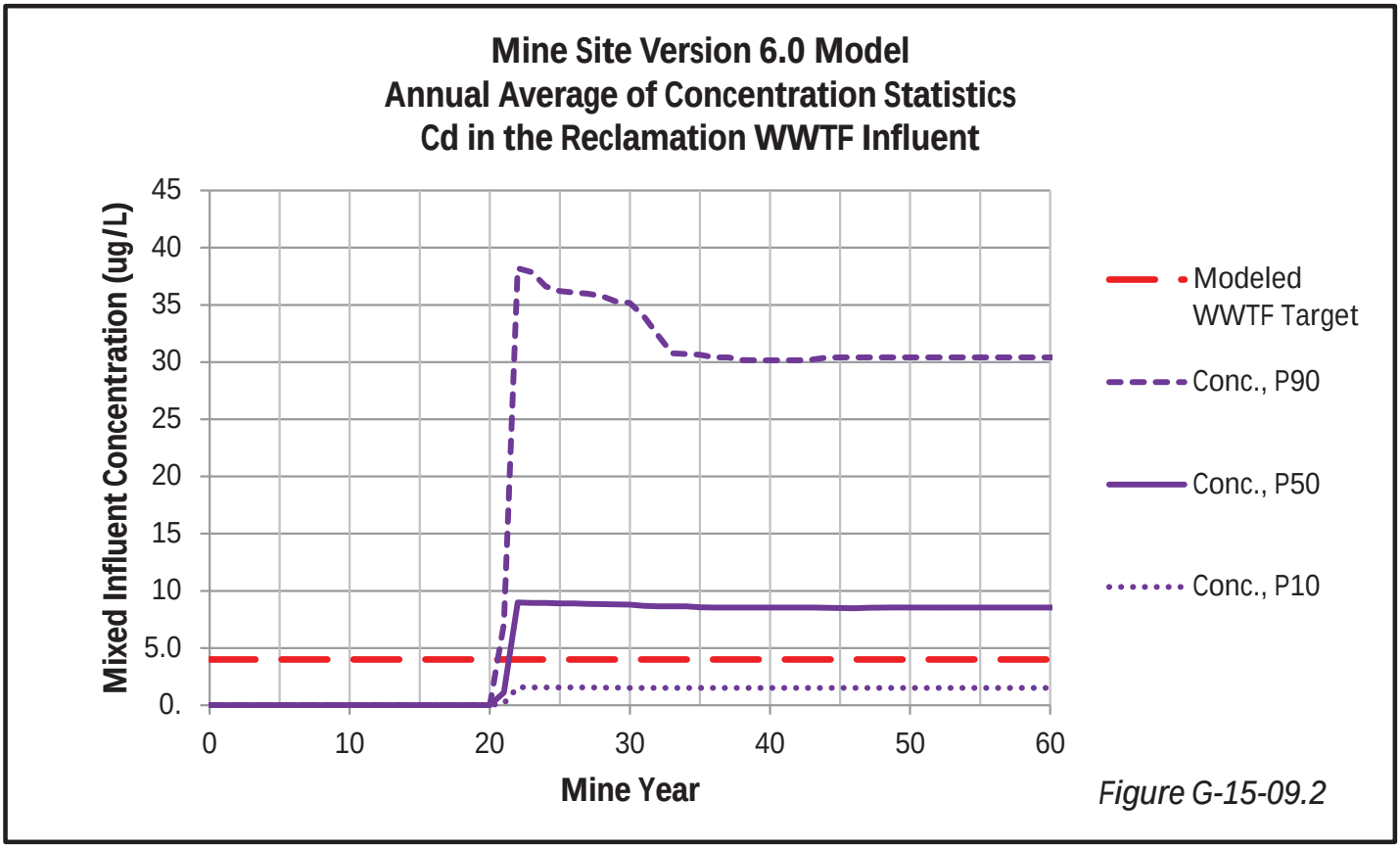
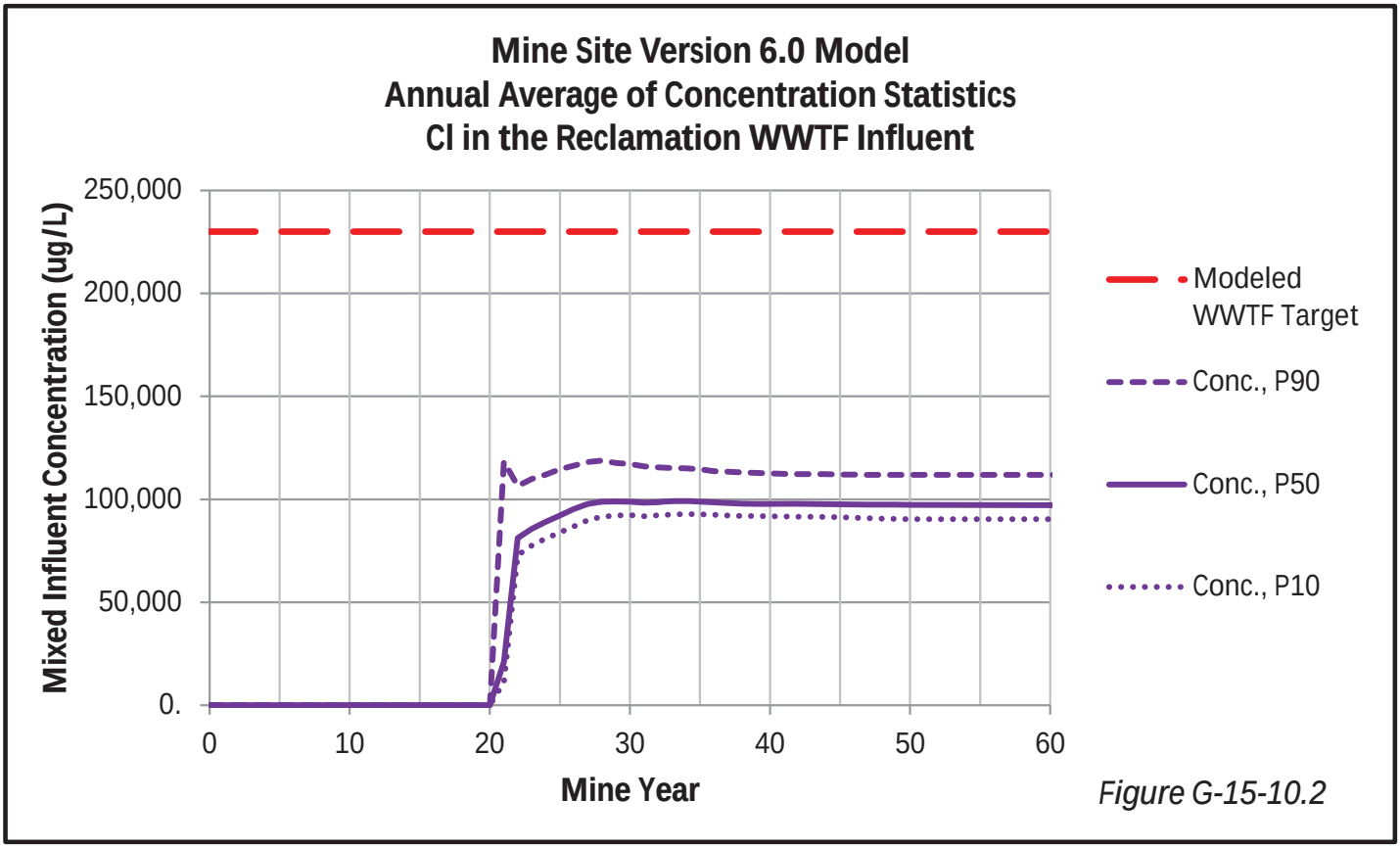


Figure G-15-09.2



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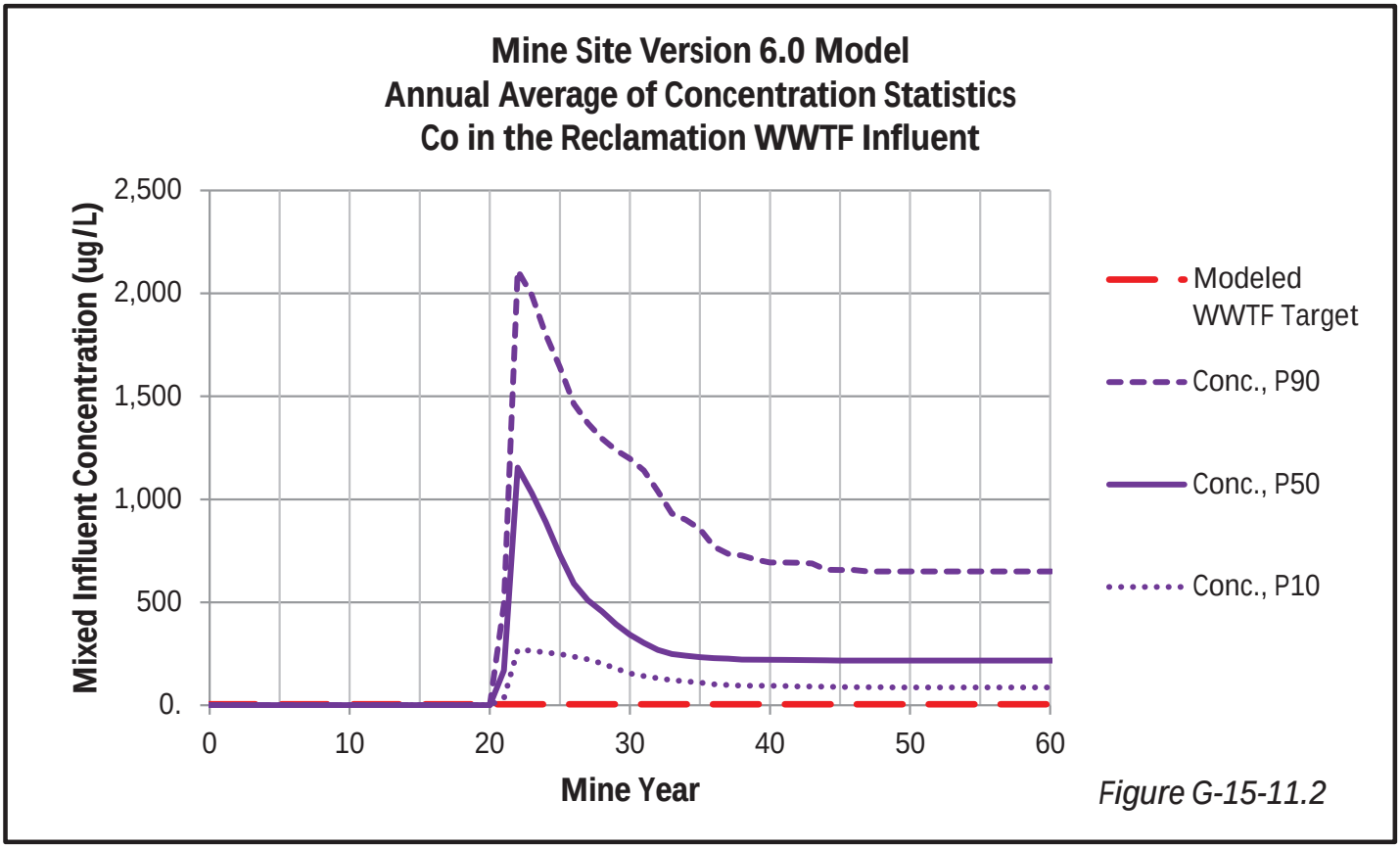

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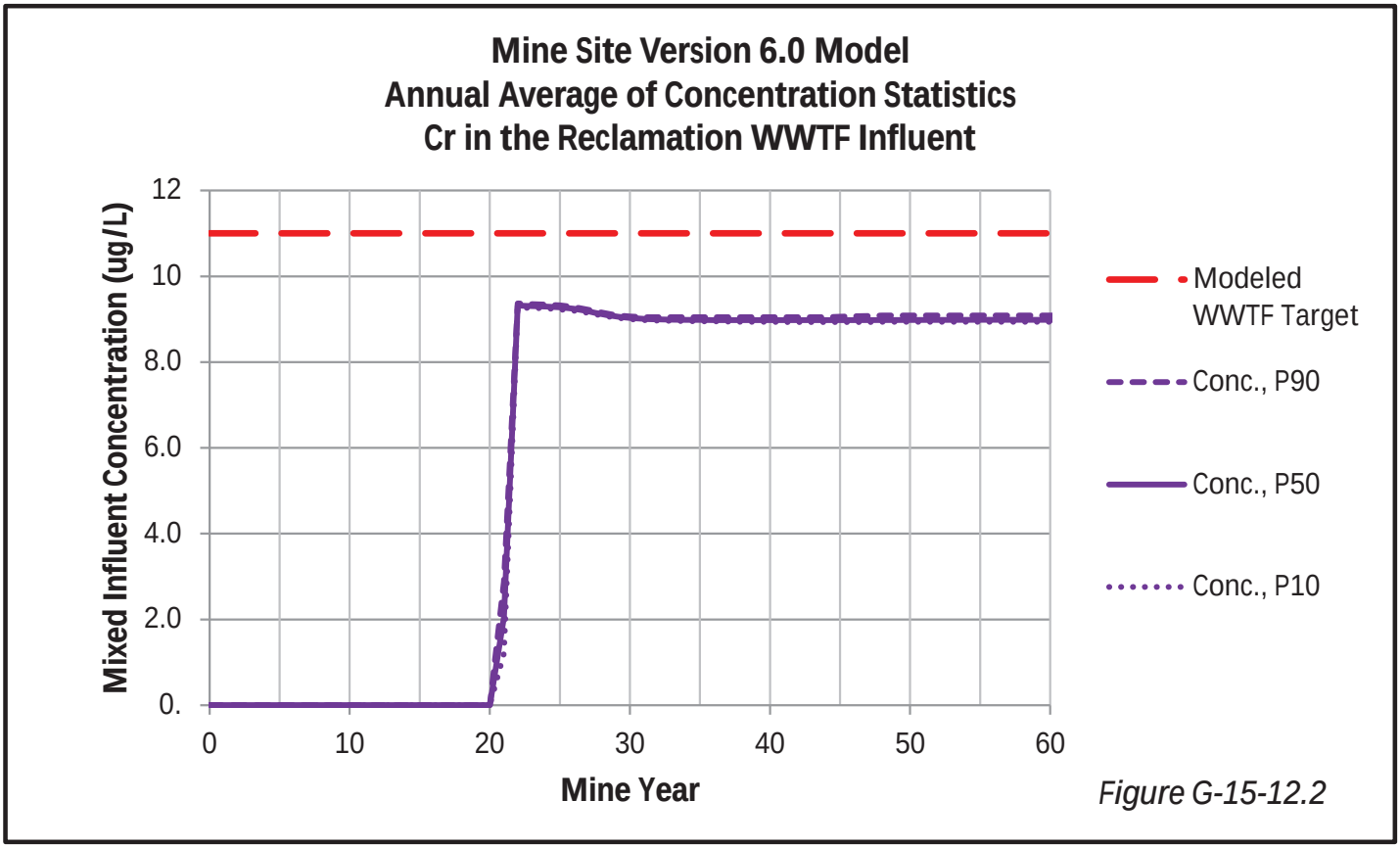

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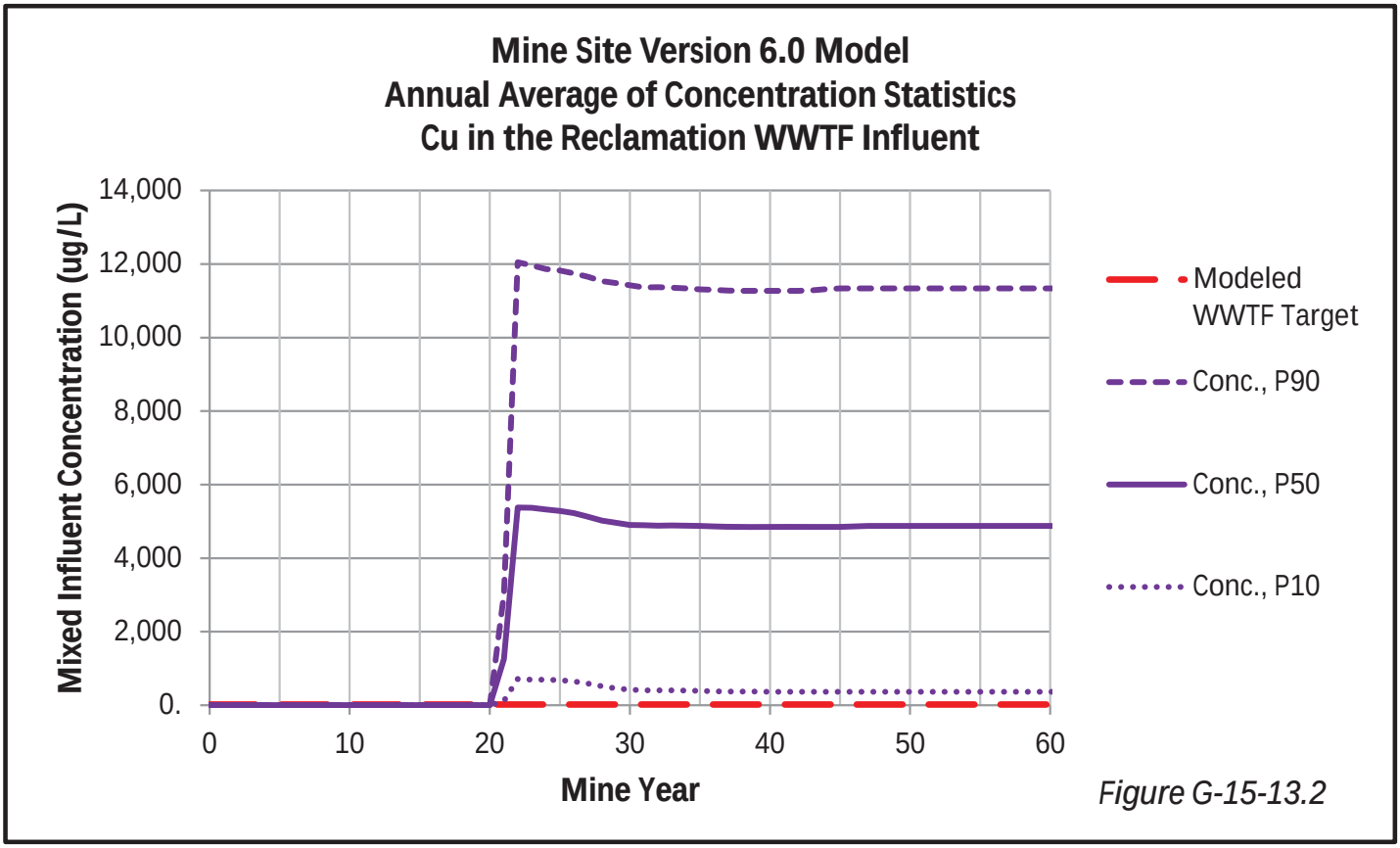


Figure G-15-13.2

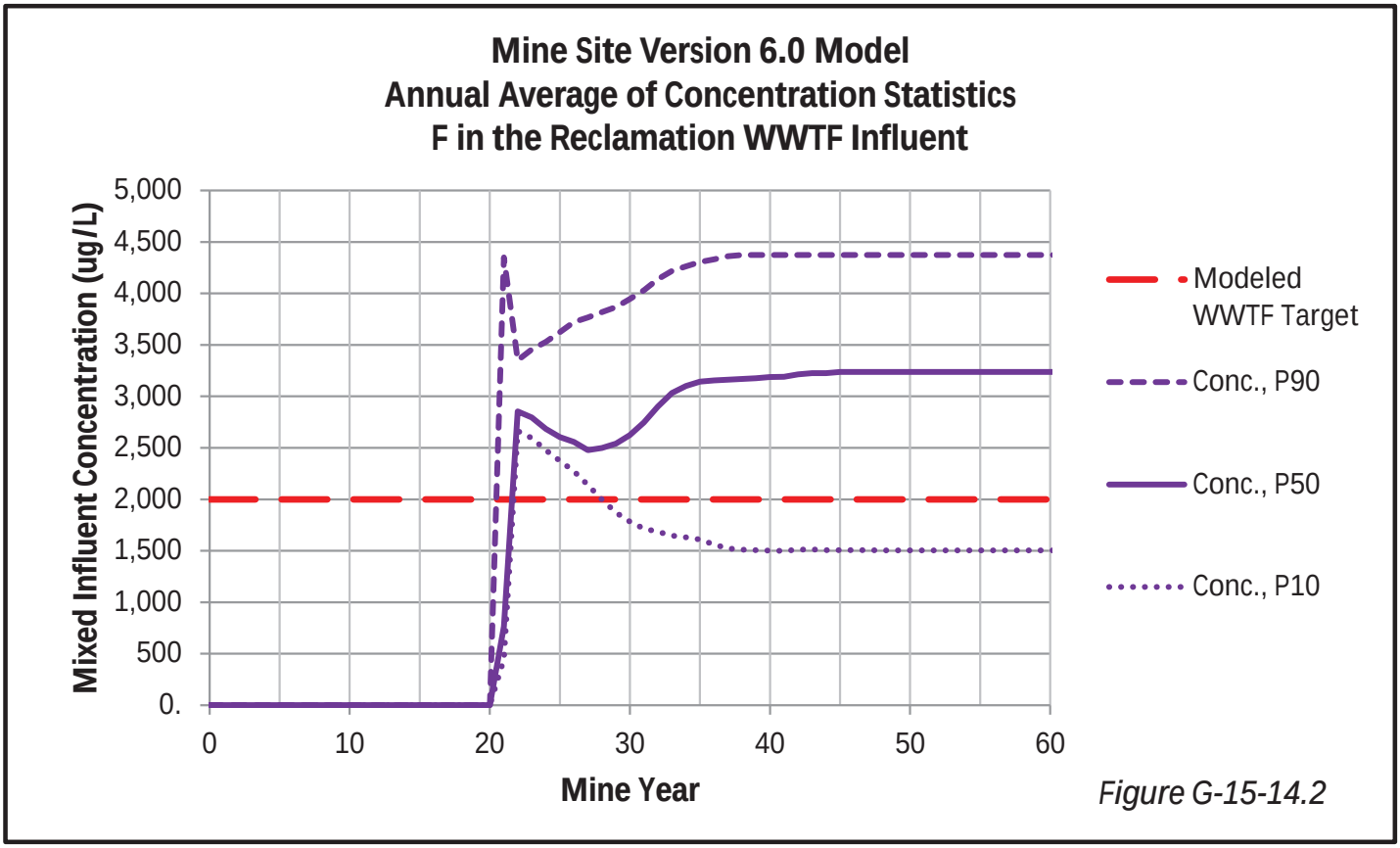


Figure G-15-14.2

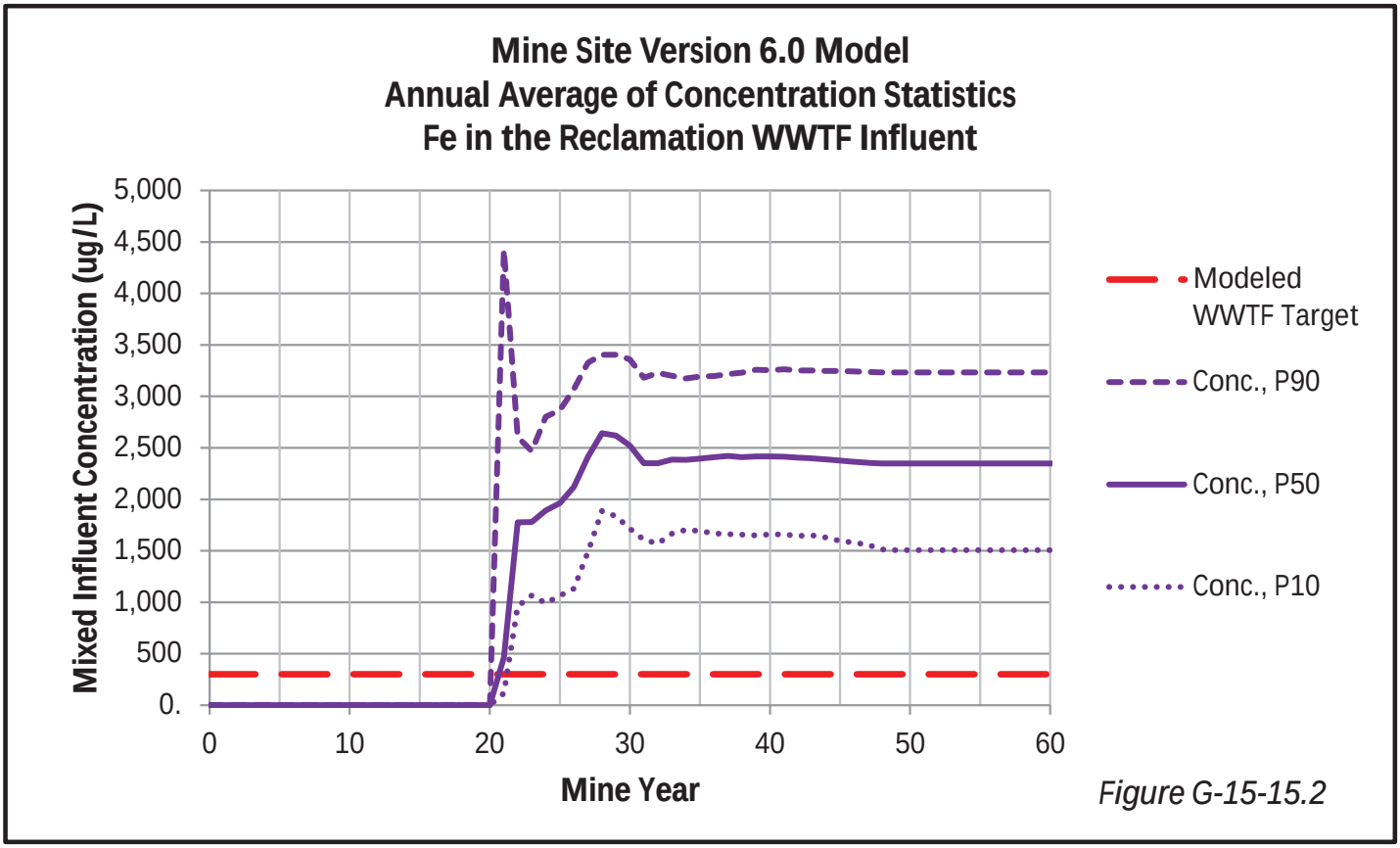
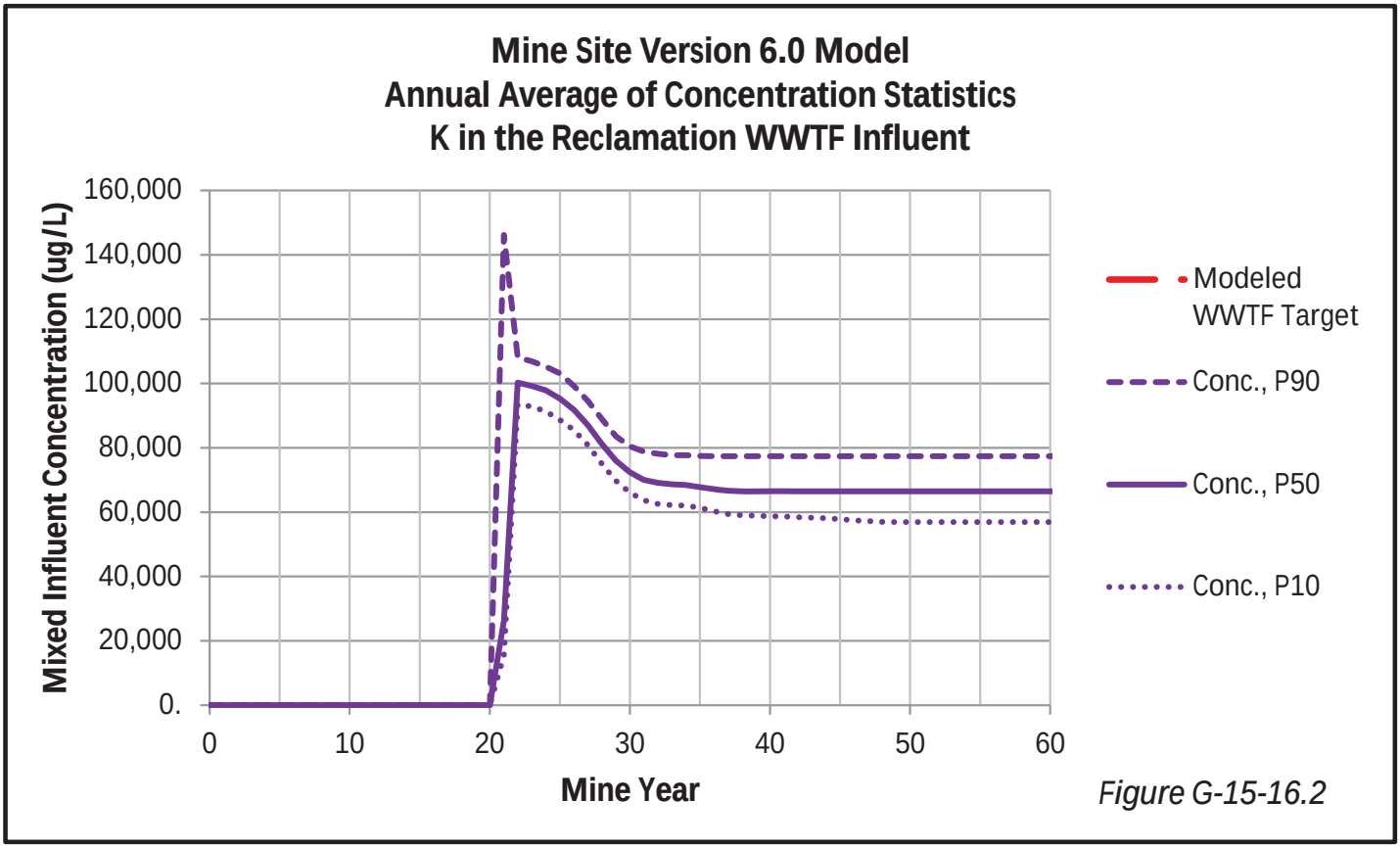


Figure G-15-15.2



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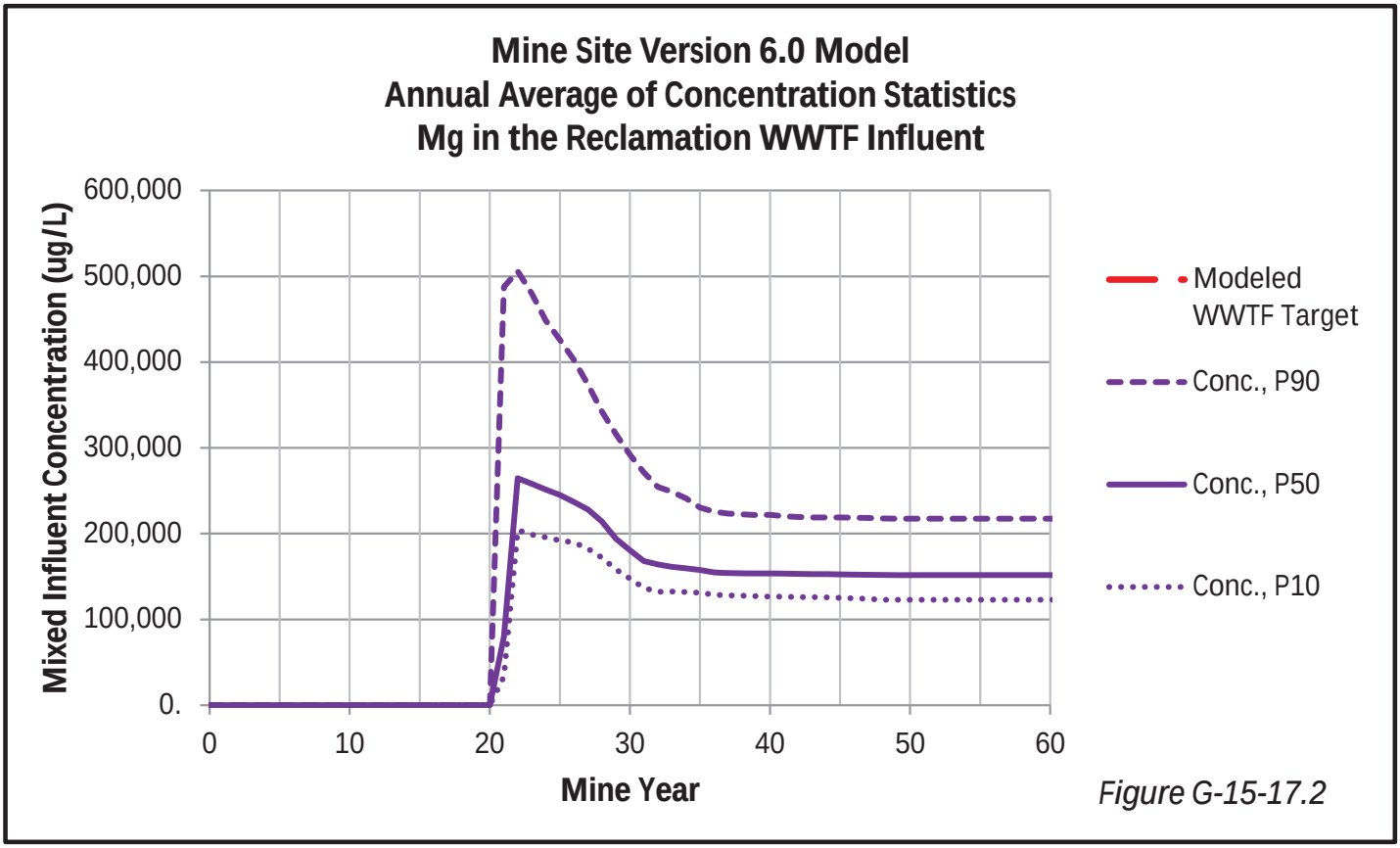

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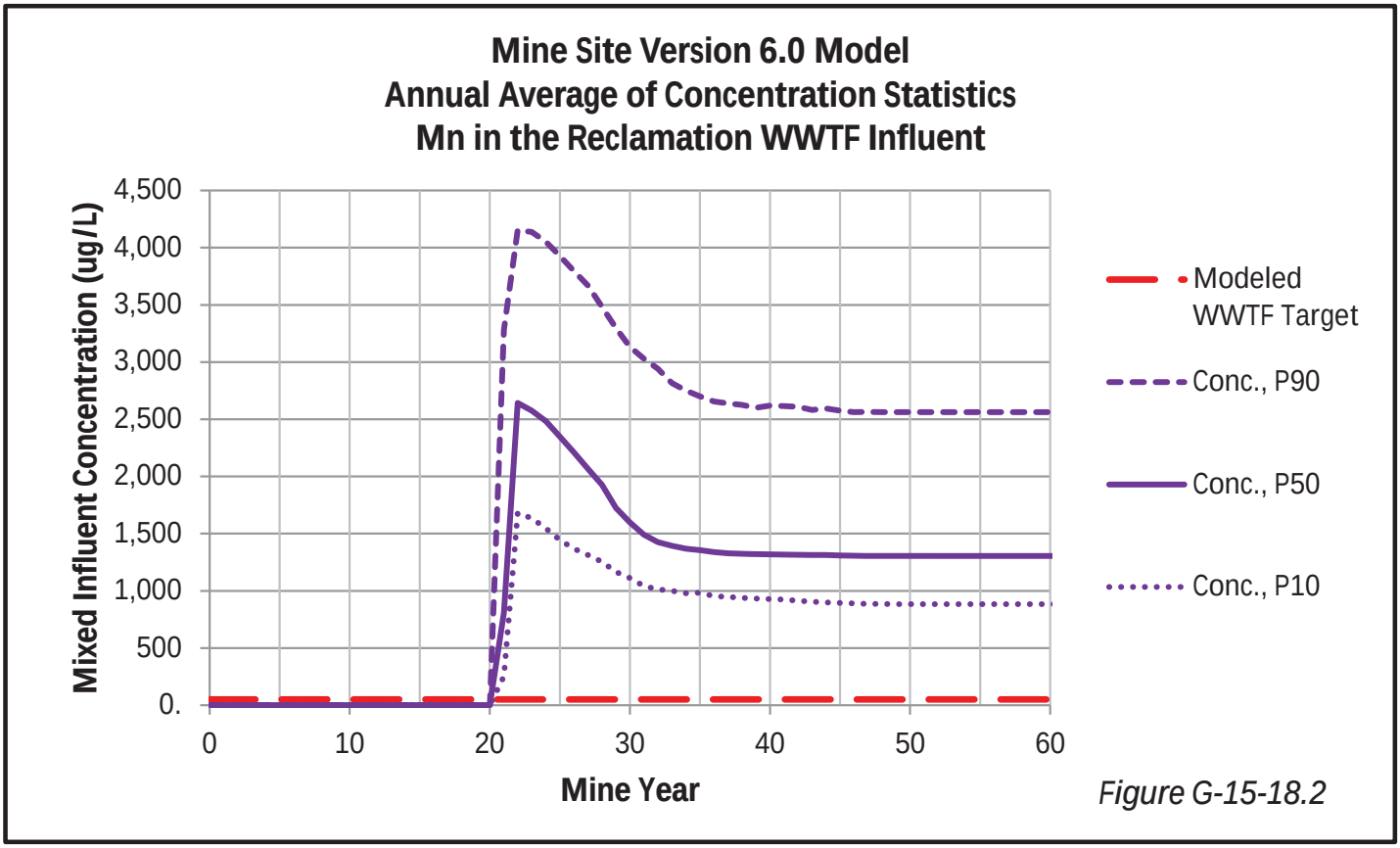

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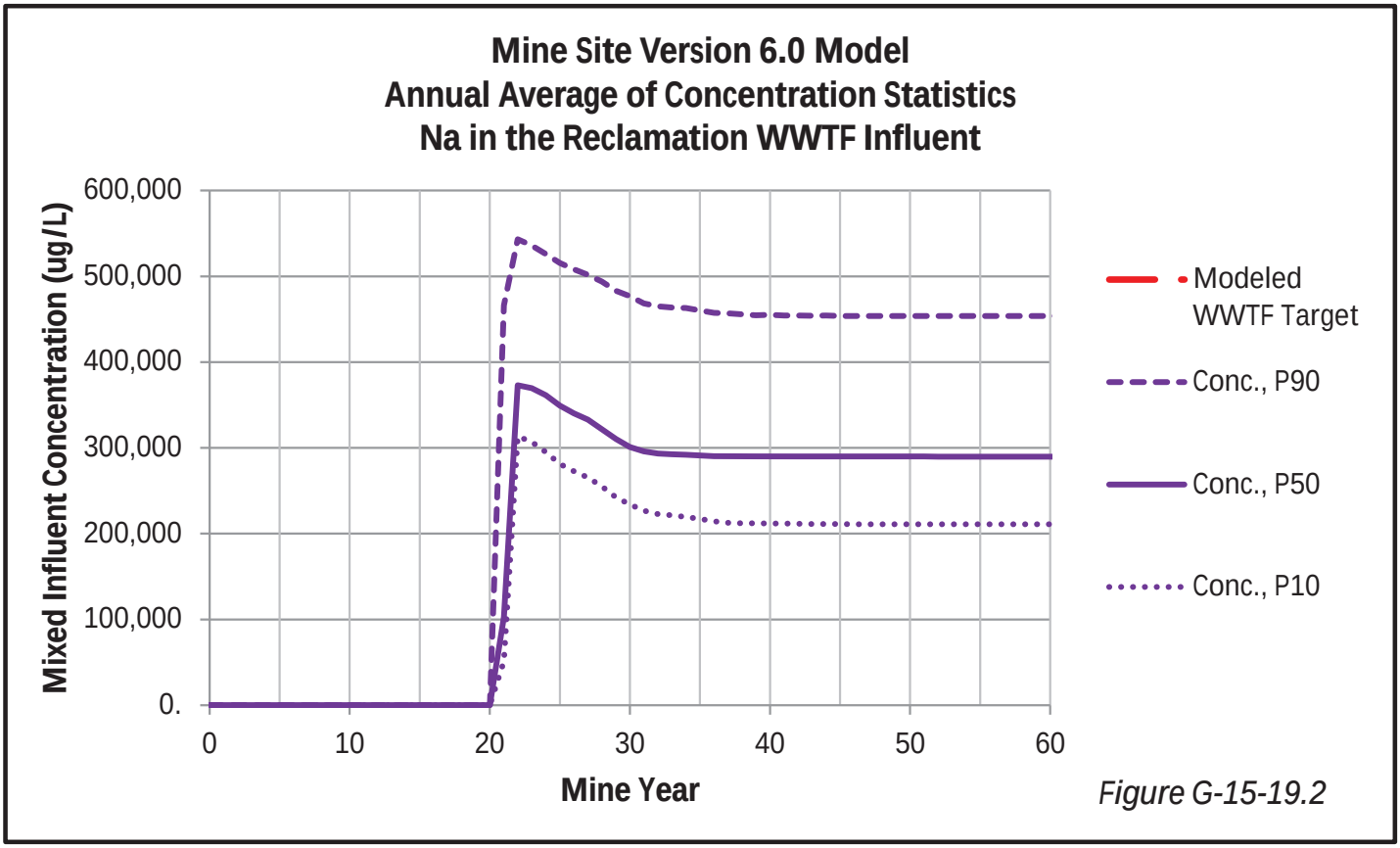

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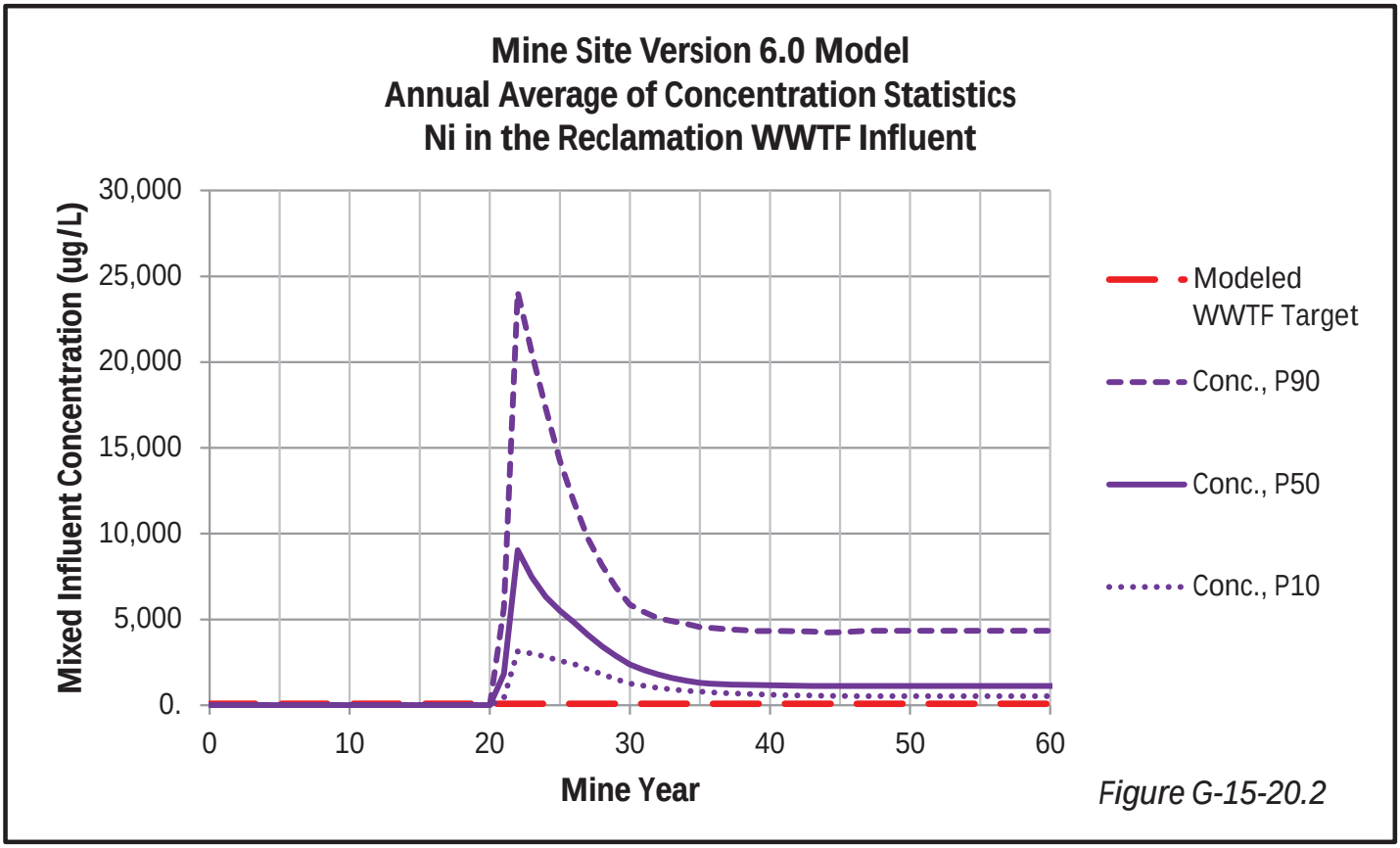

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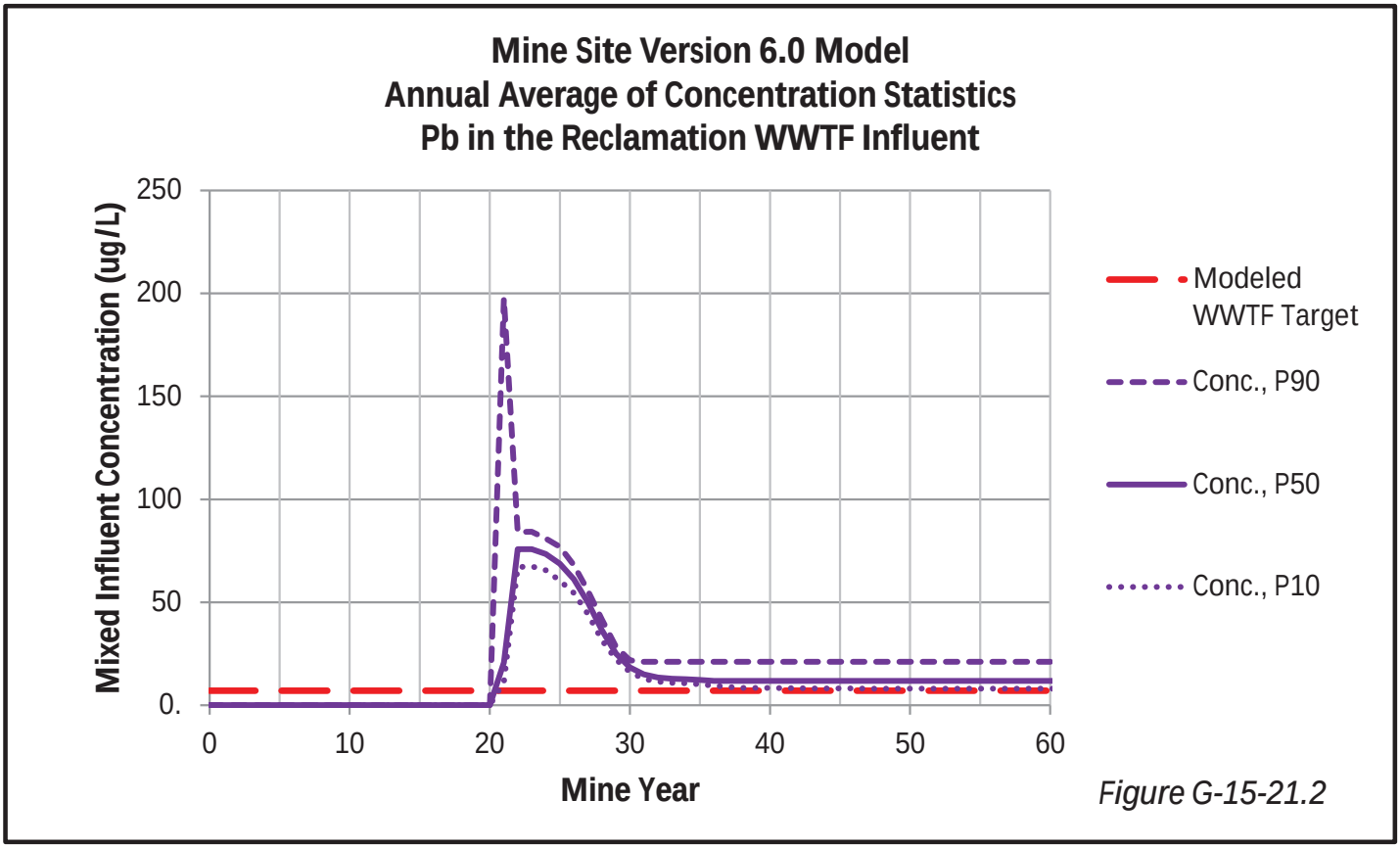

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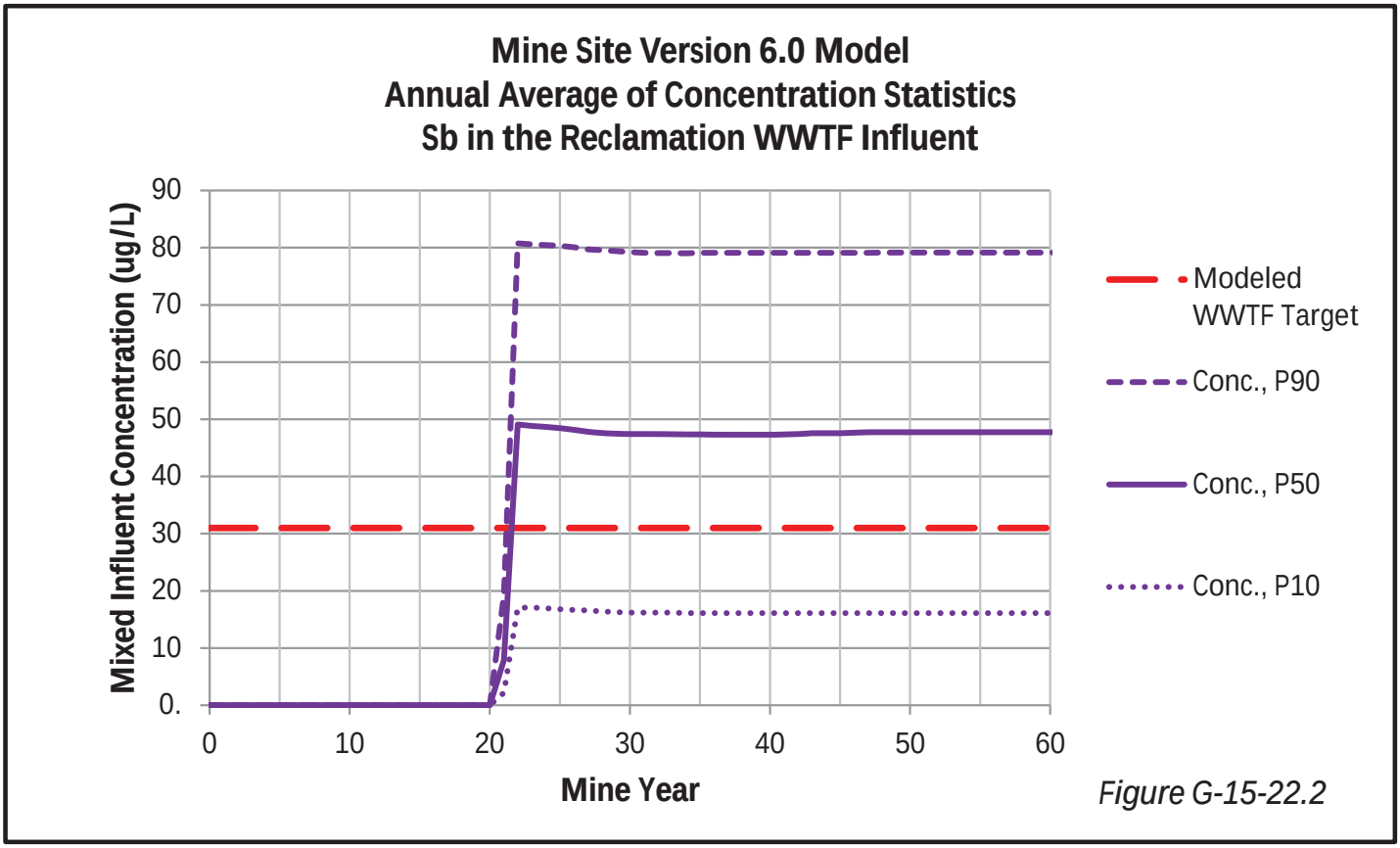

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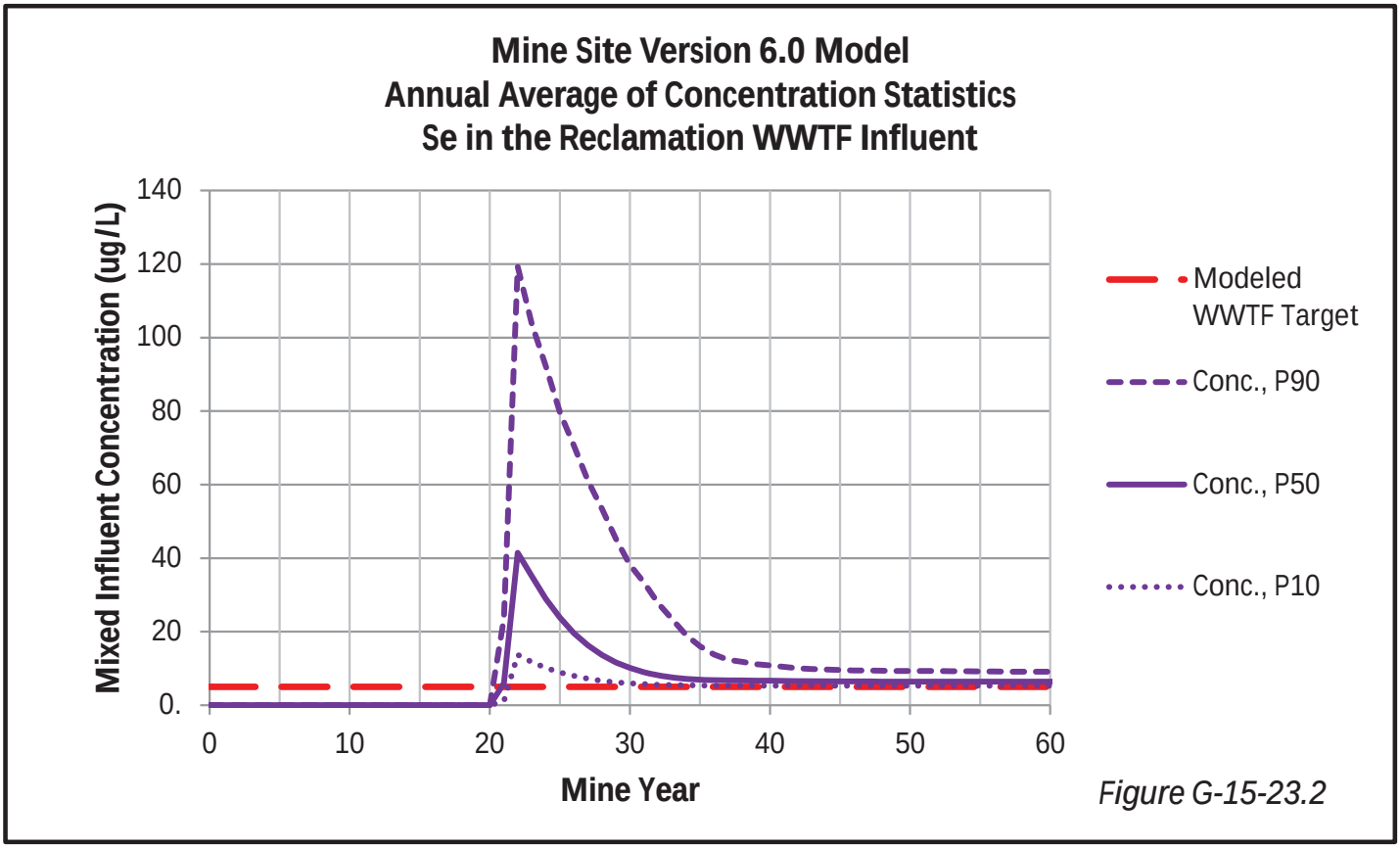

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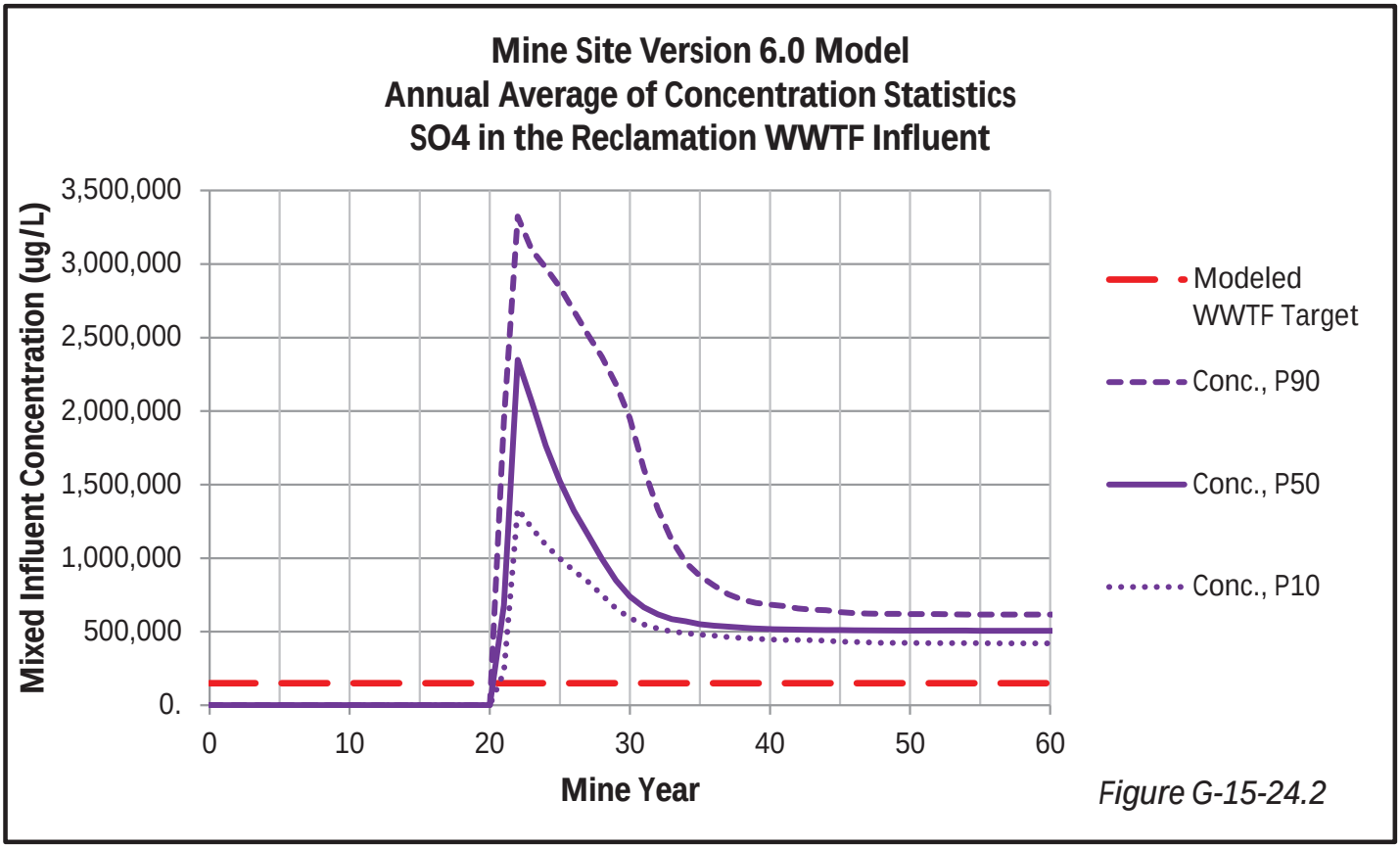

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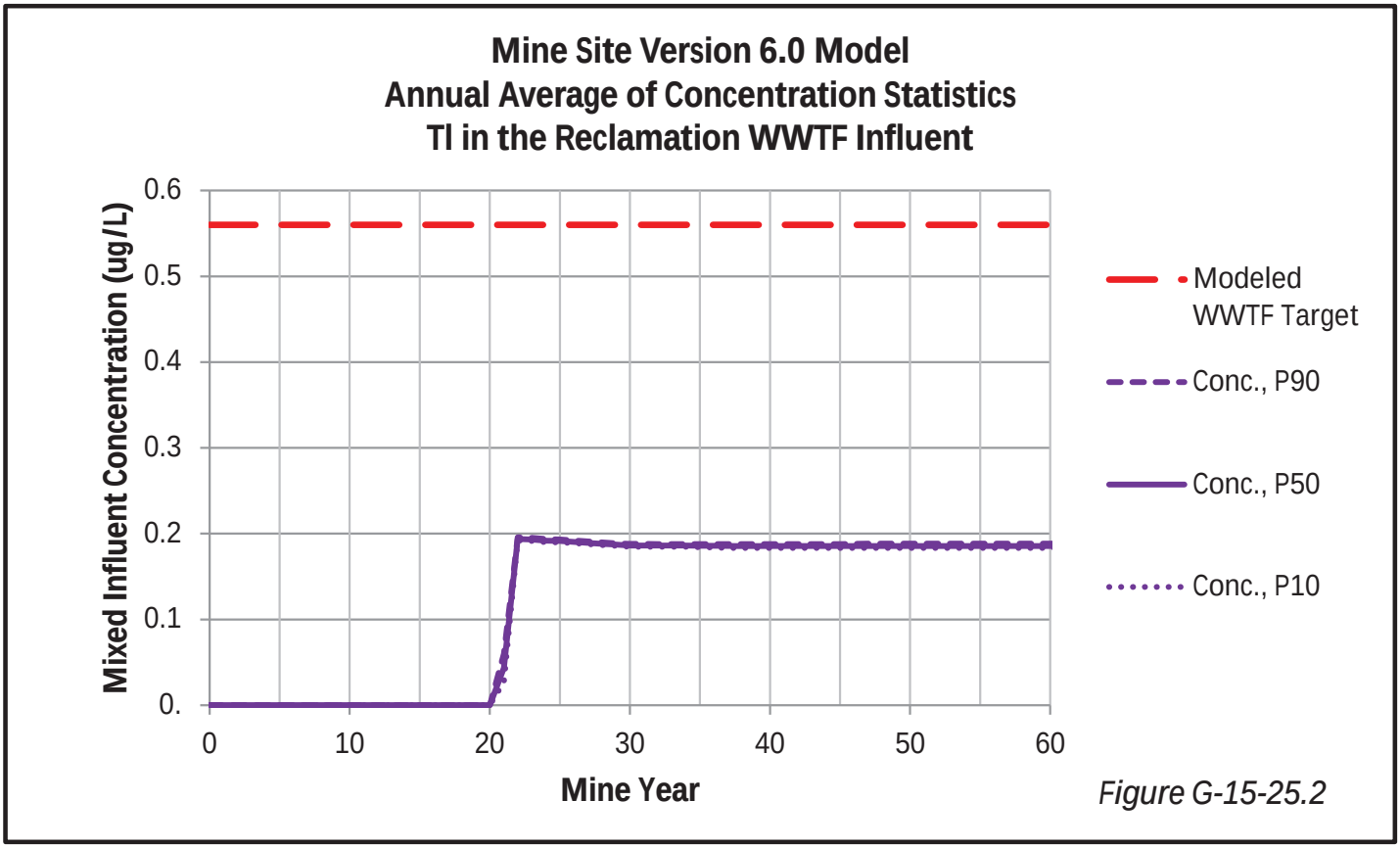

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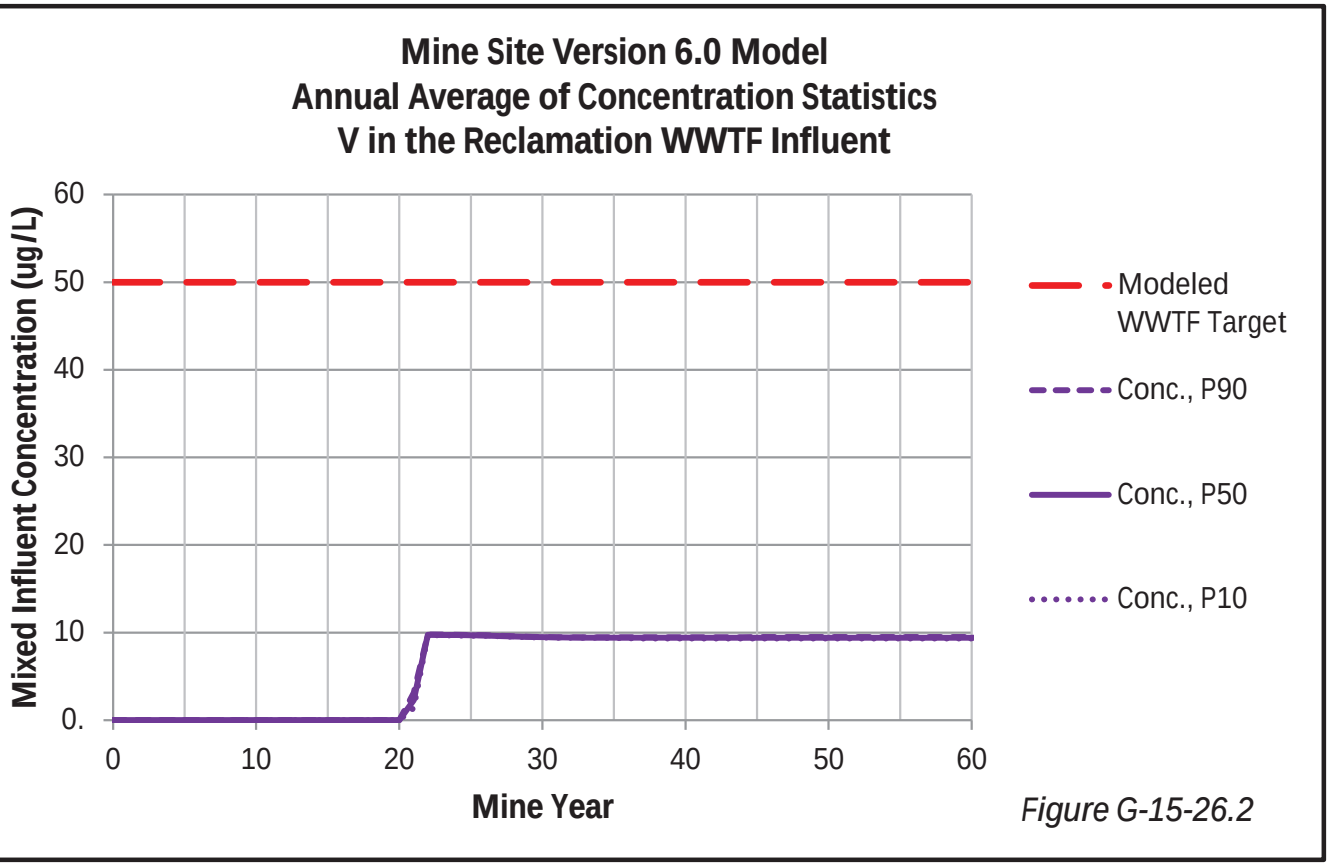

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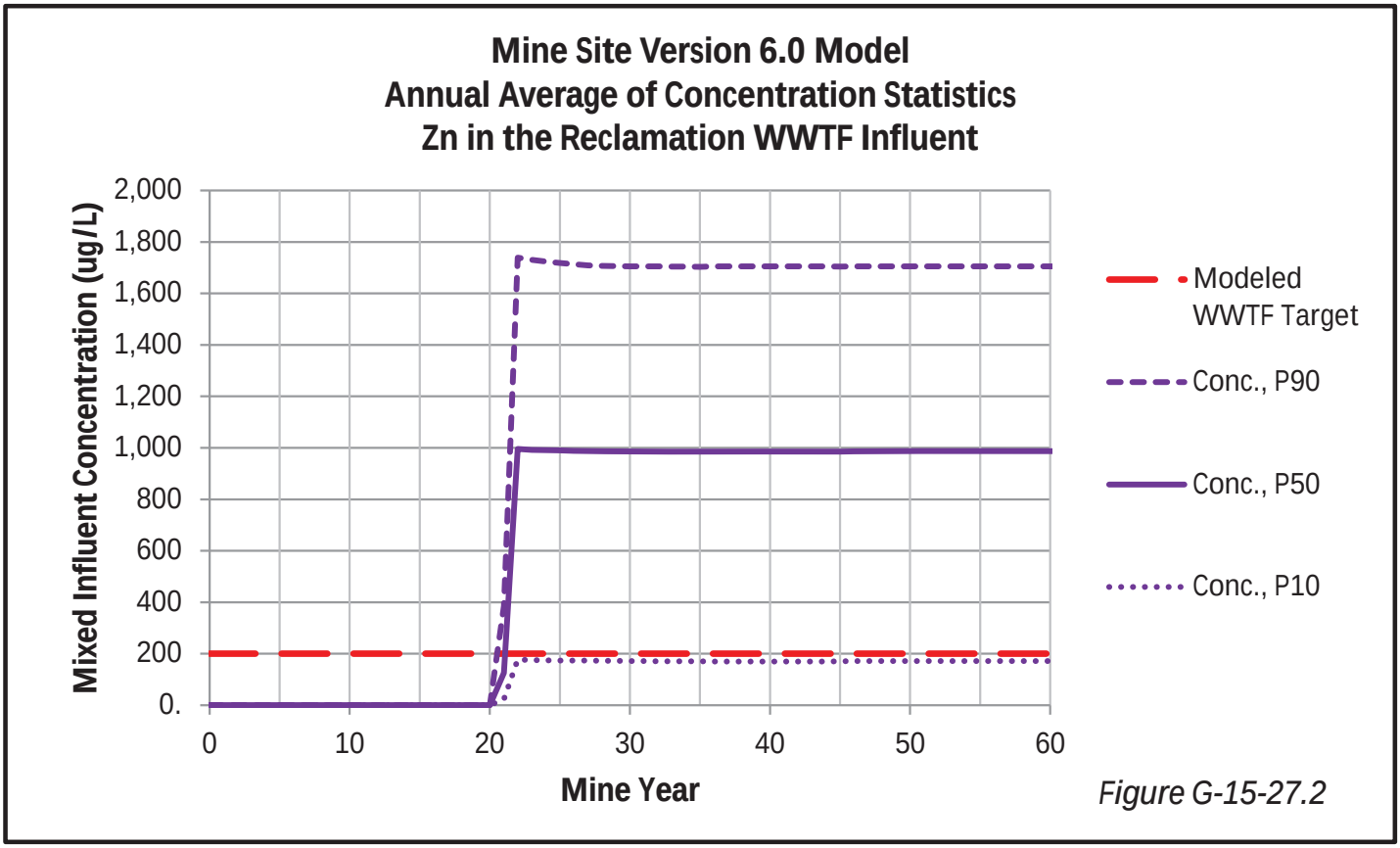

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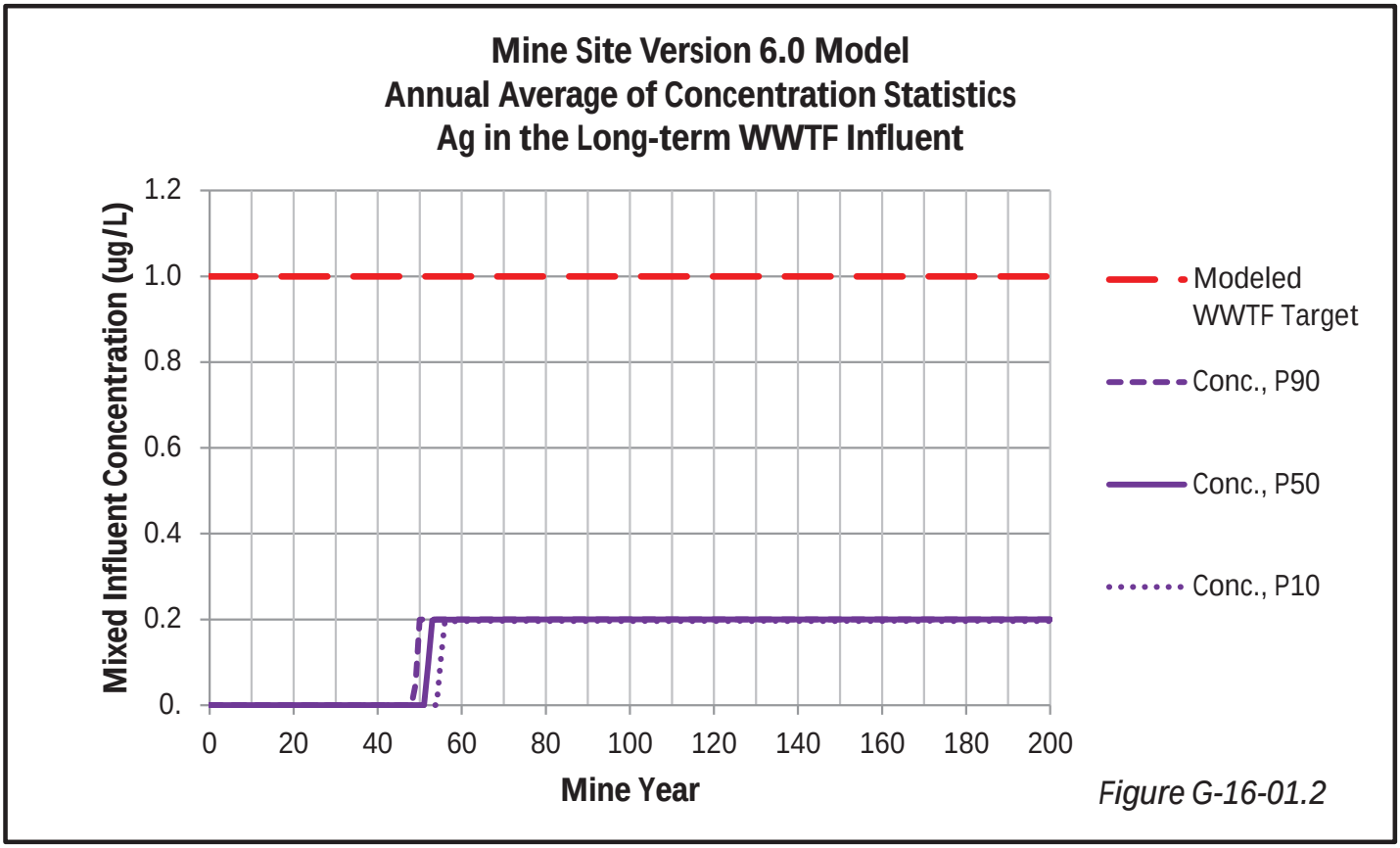

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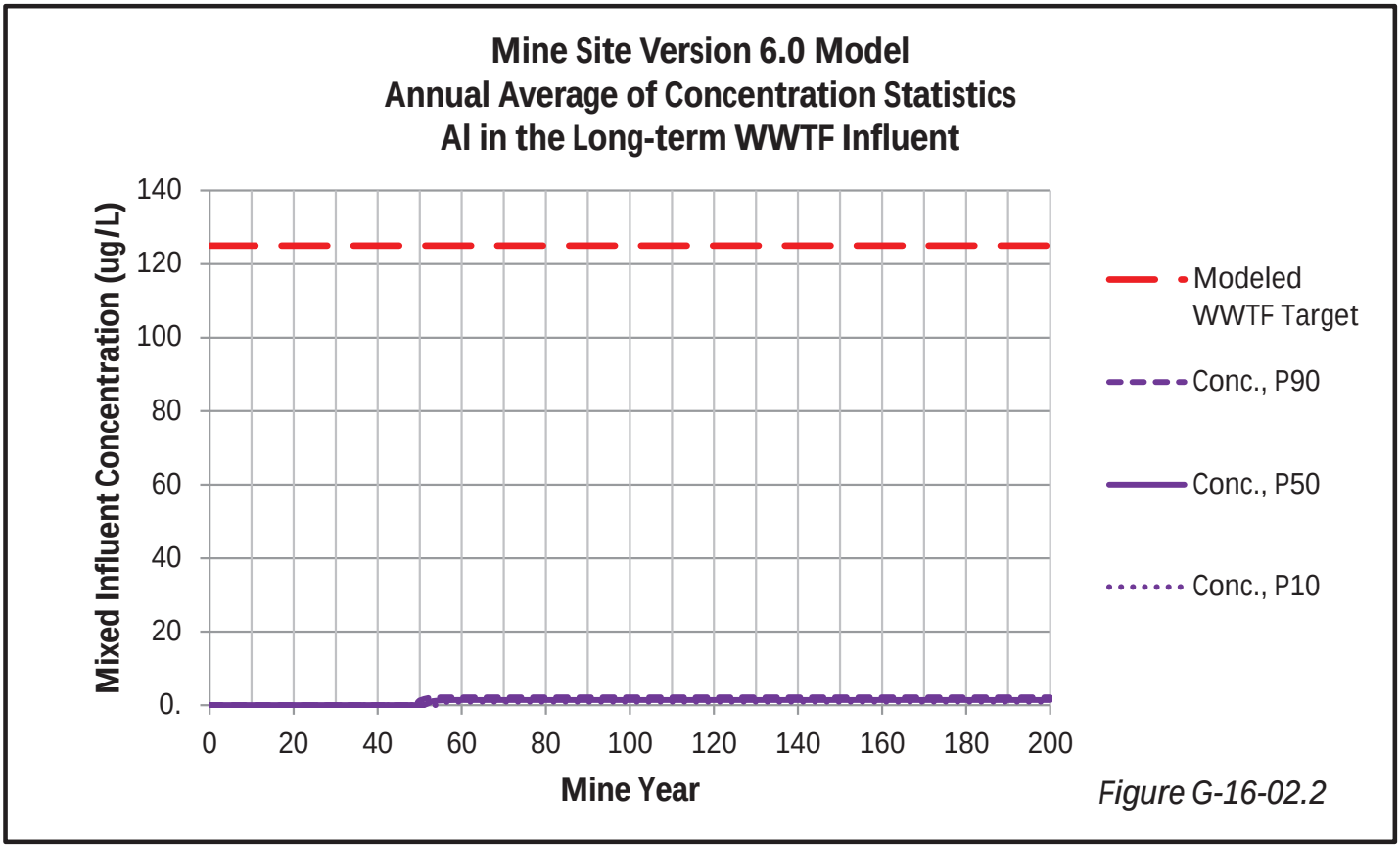

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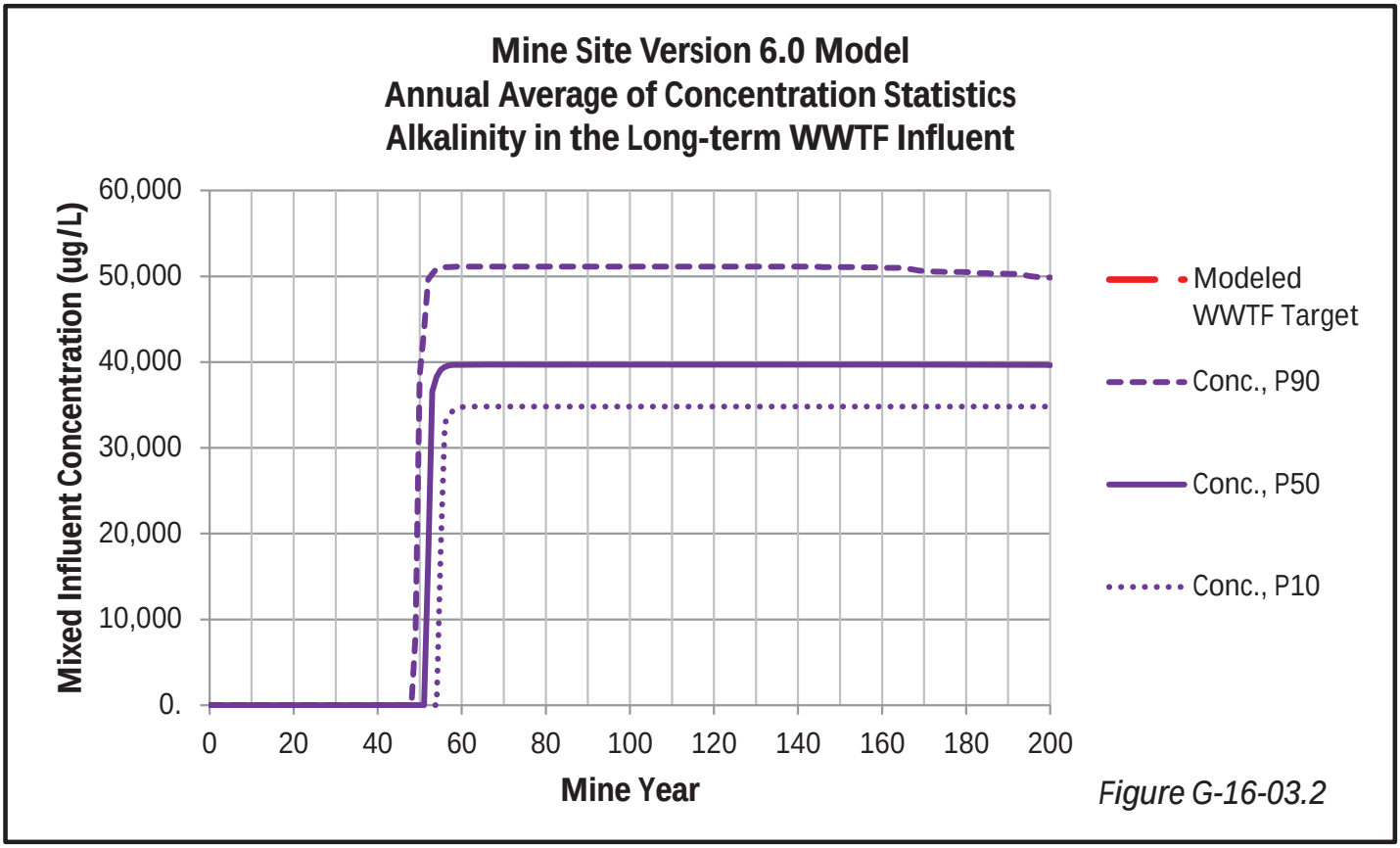

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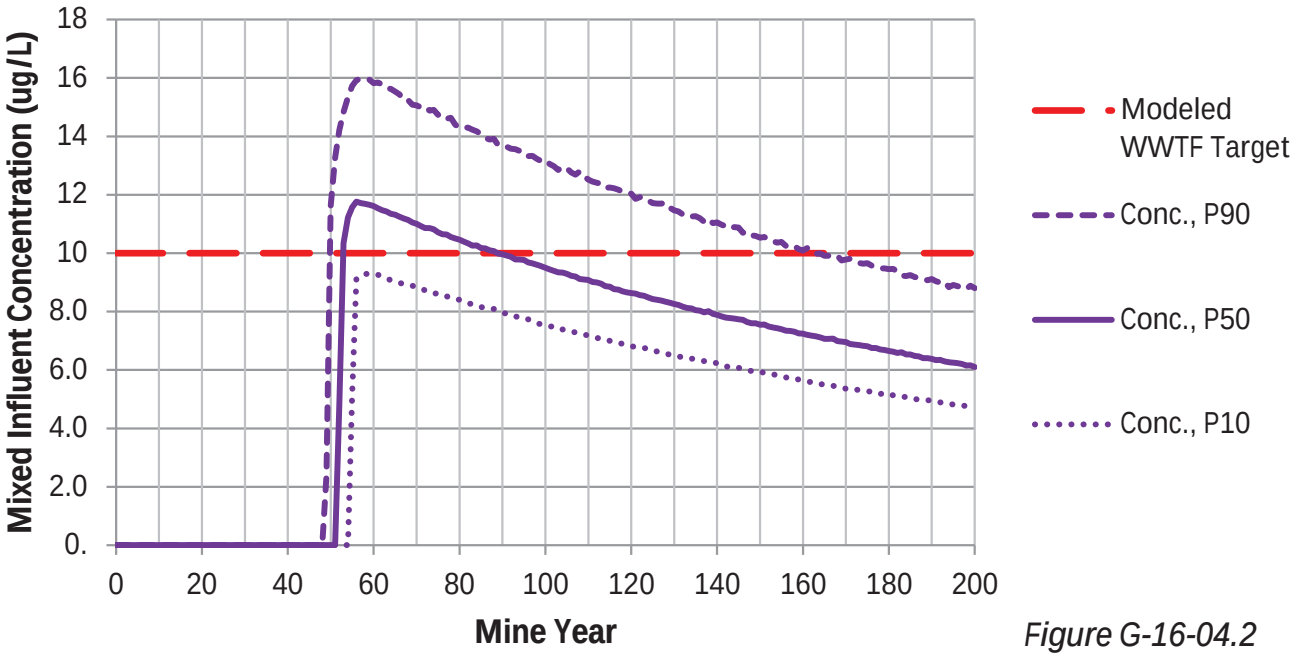

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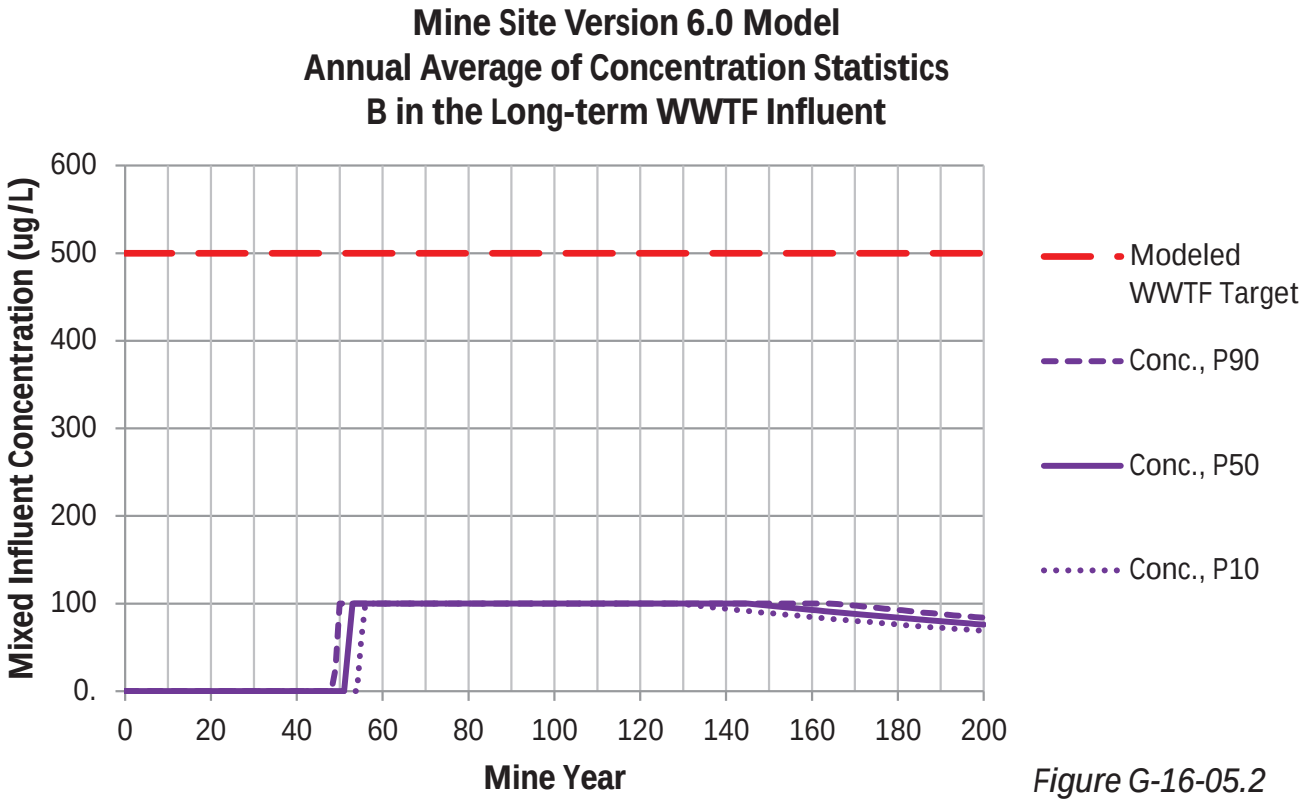

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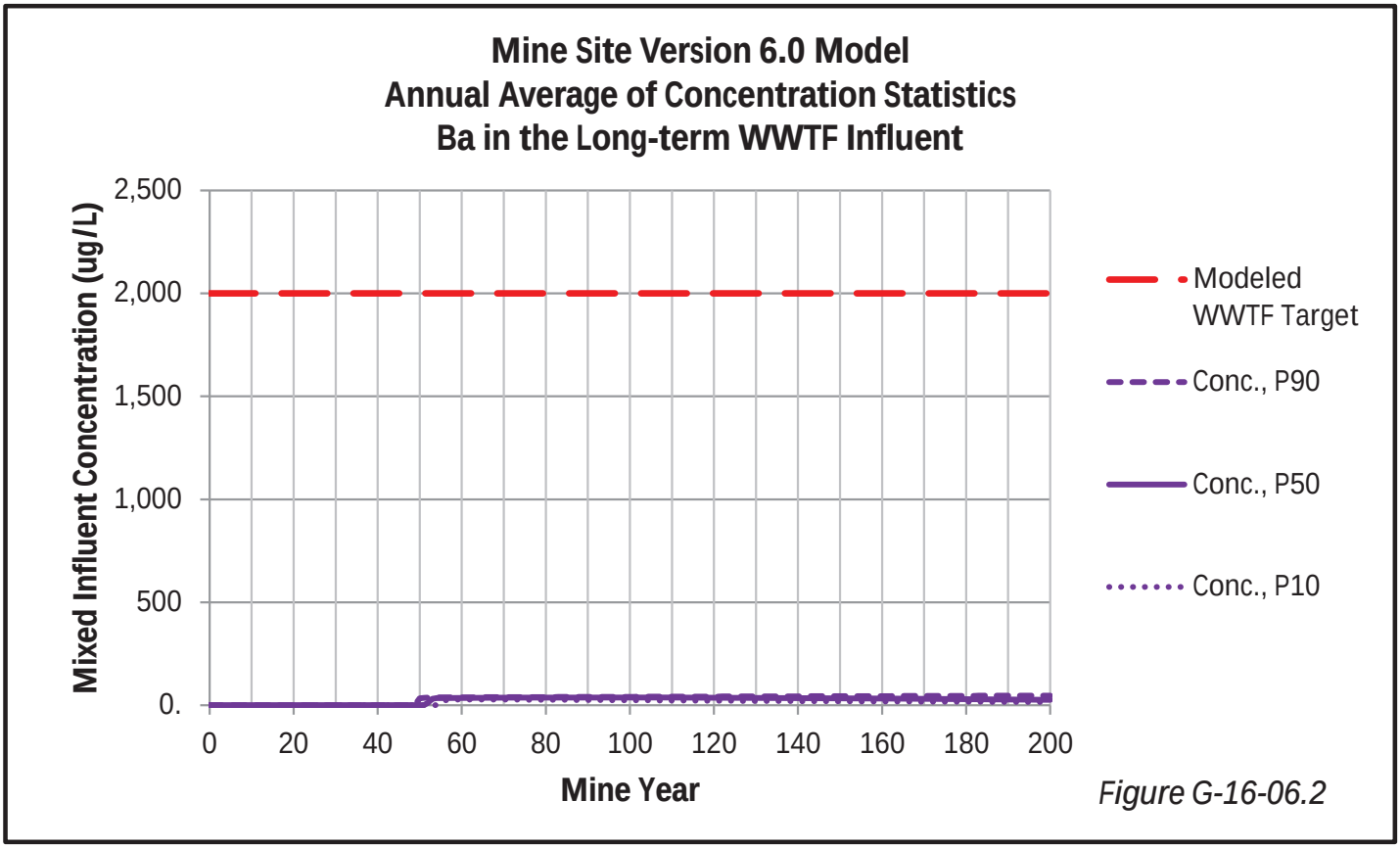

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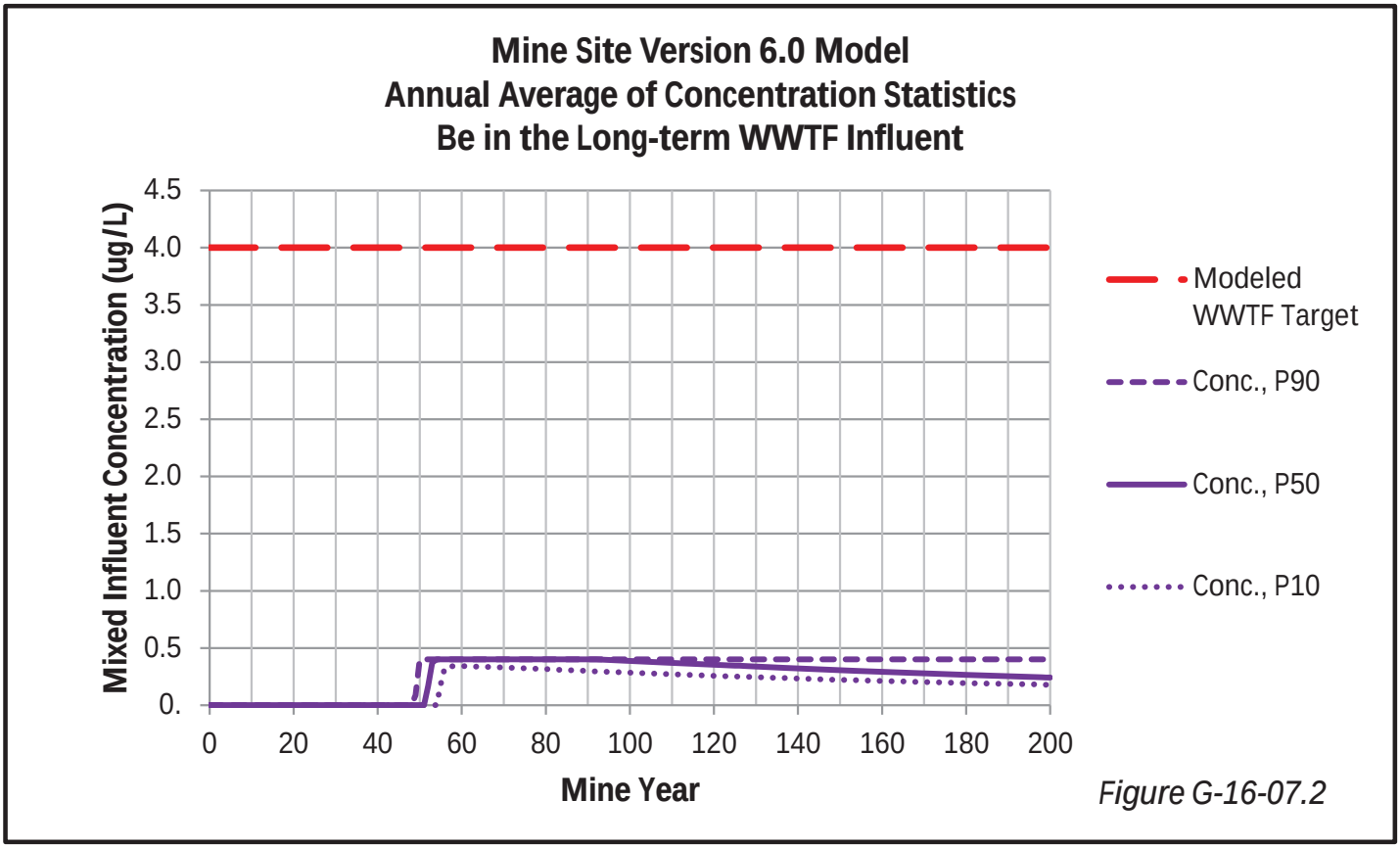

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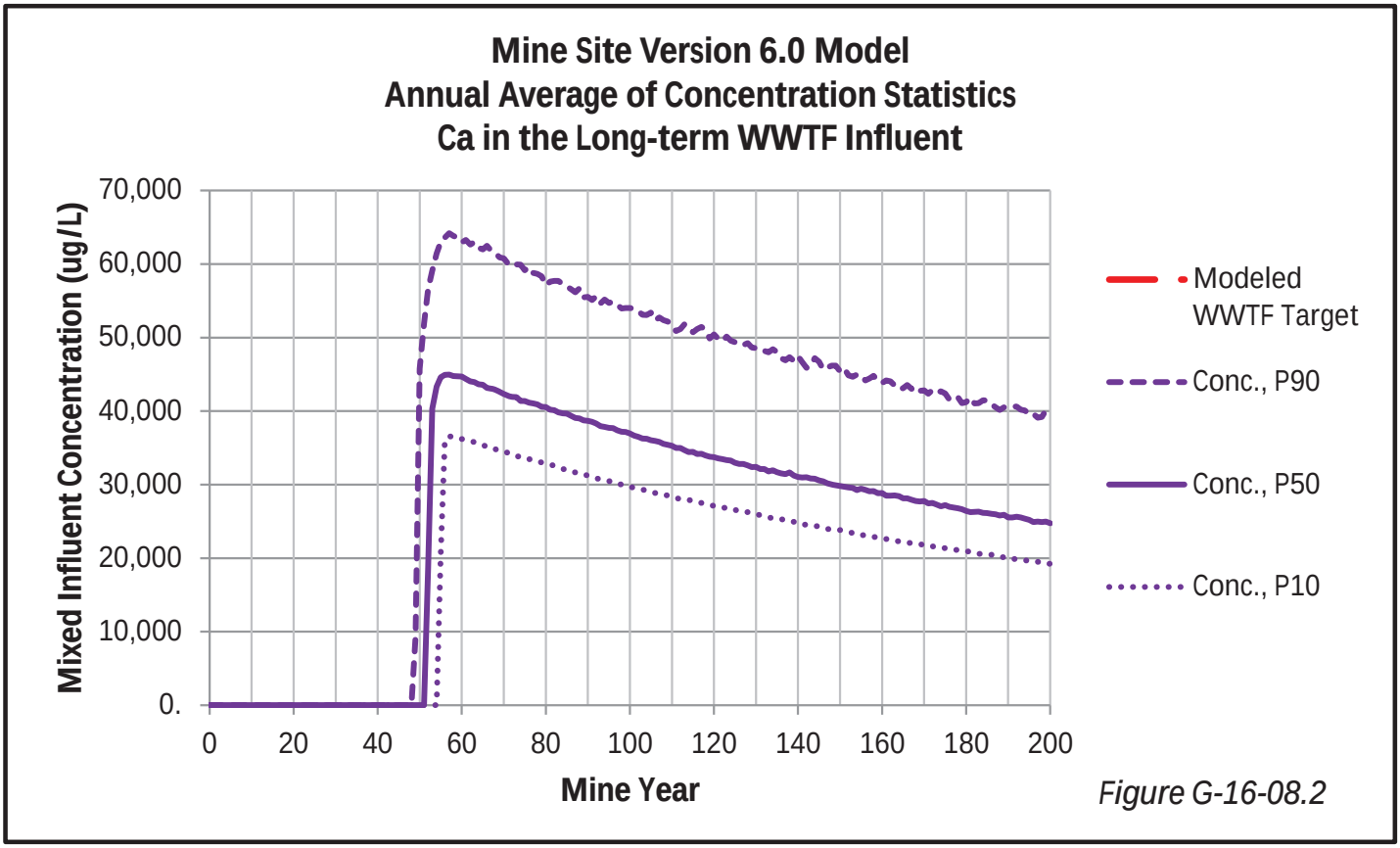

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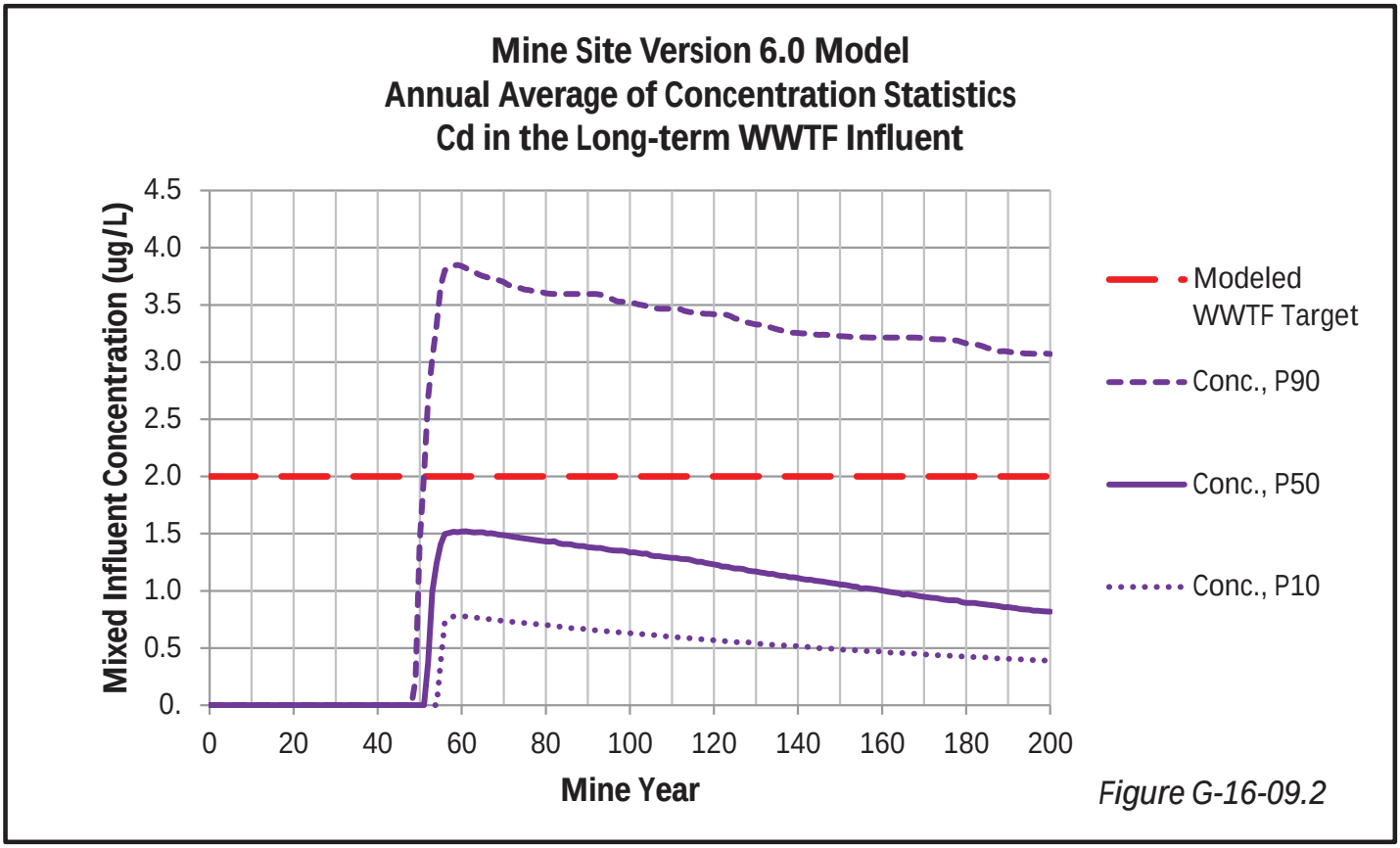

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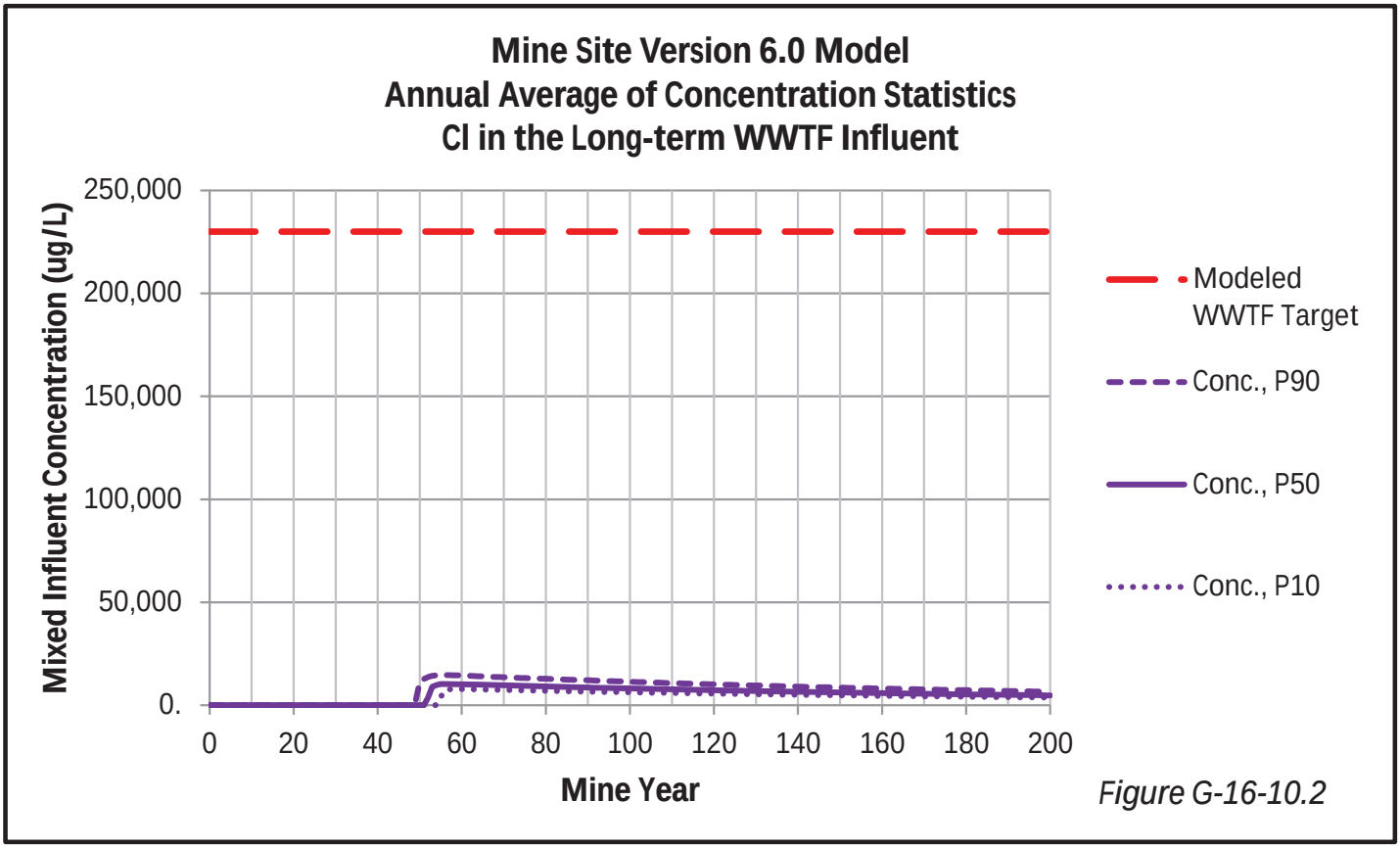

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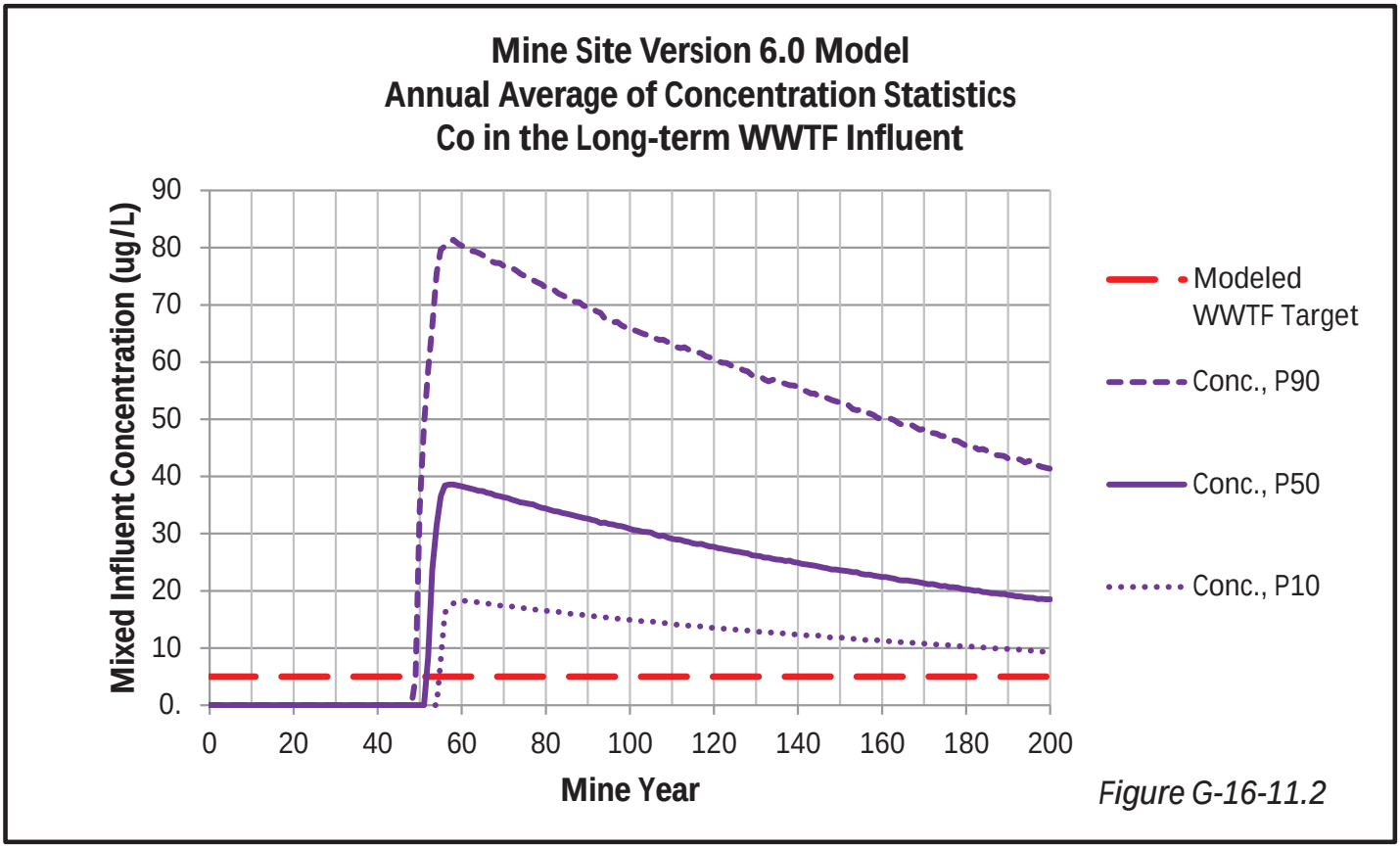

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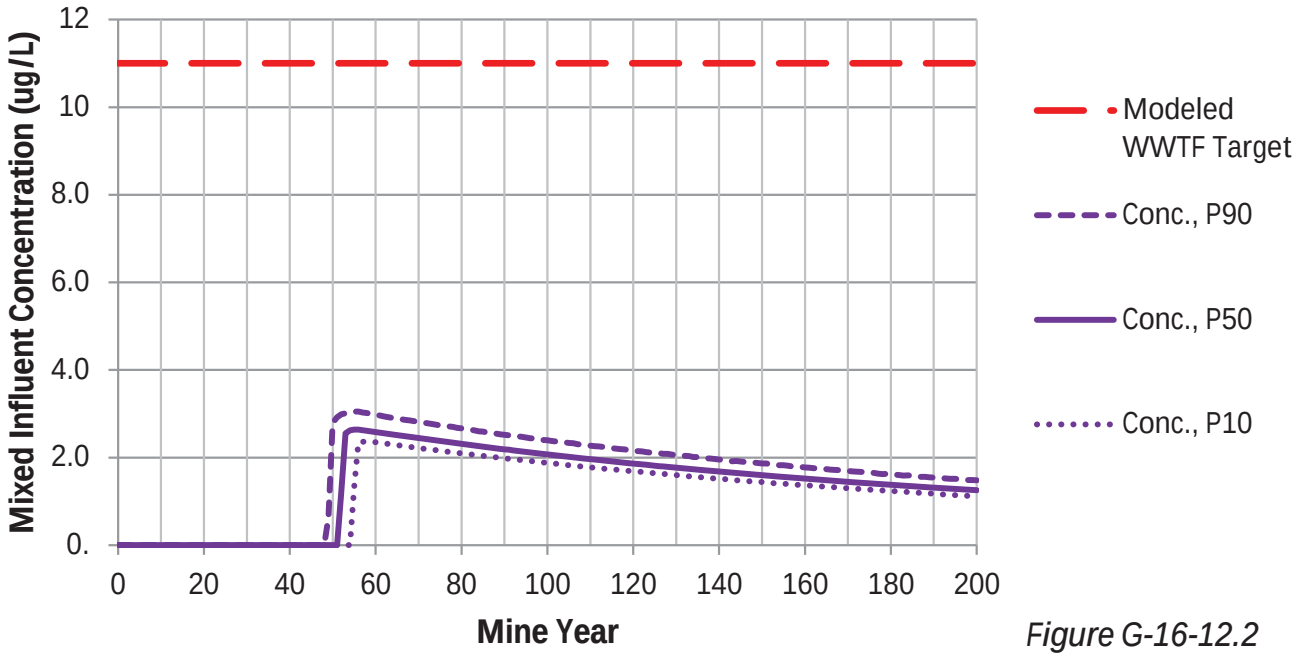

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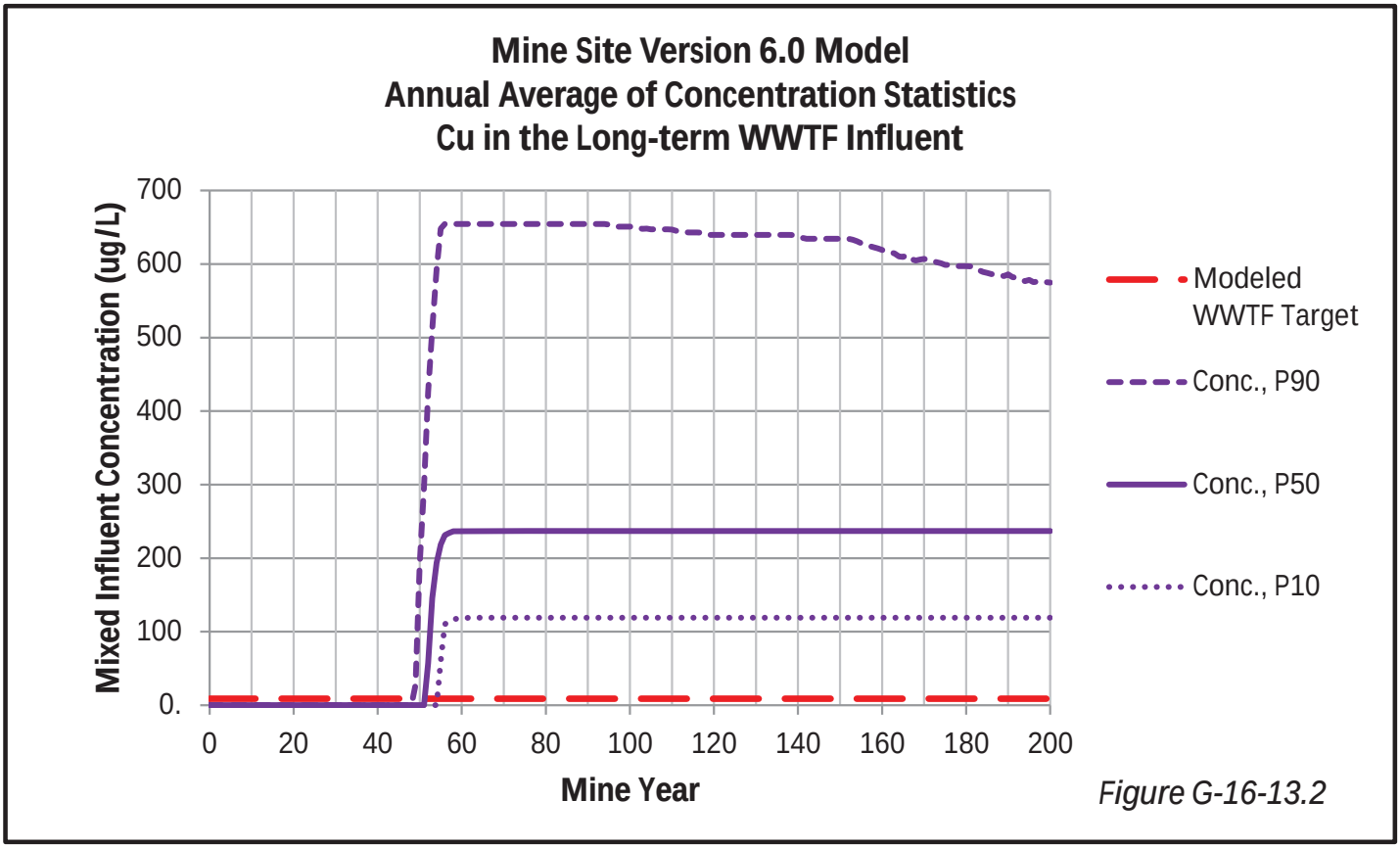

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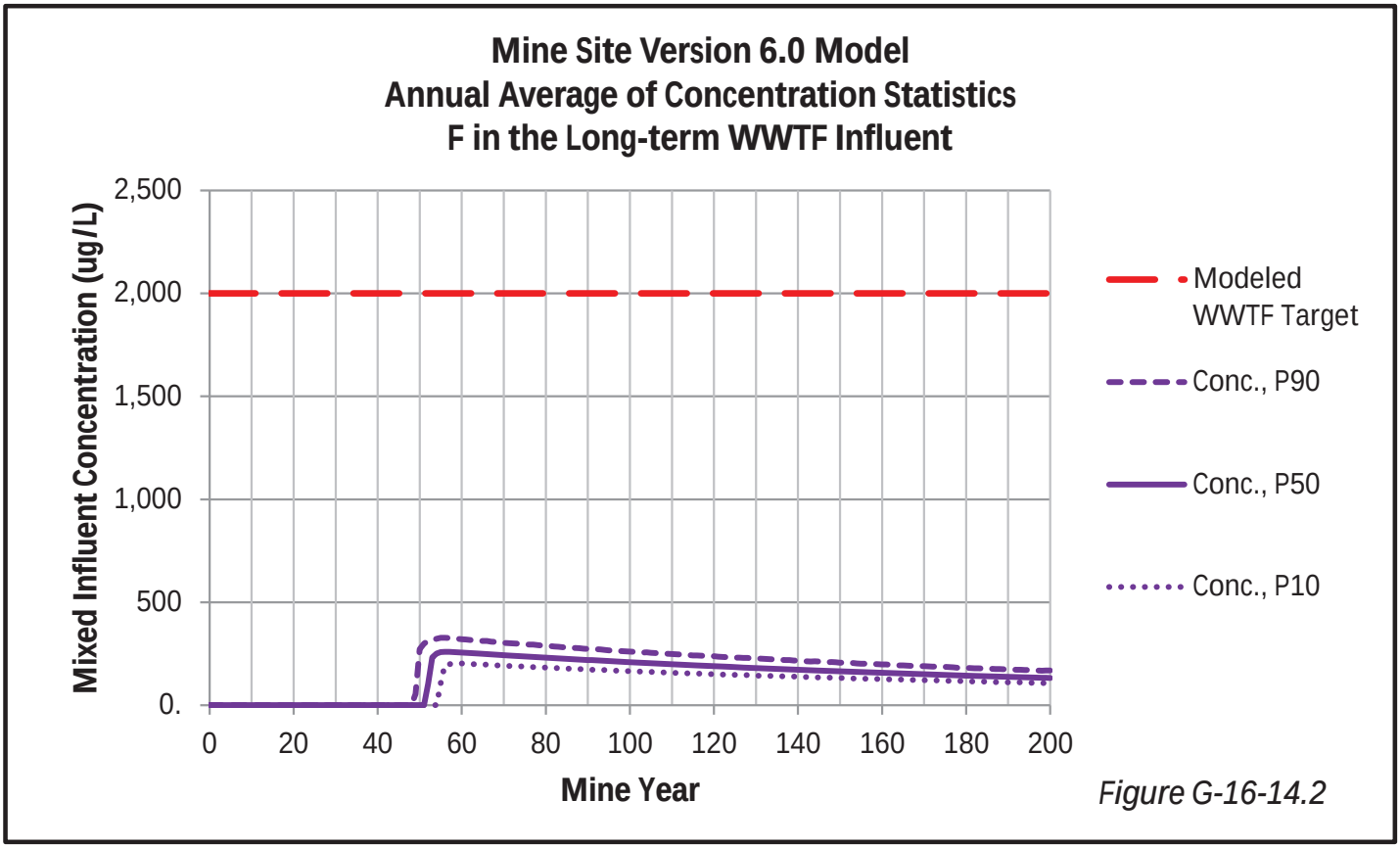

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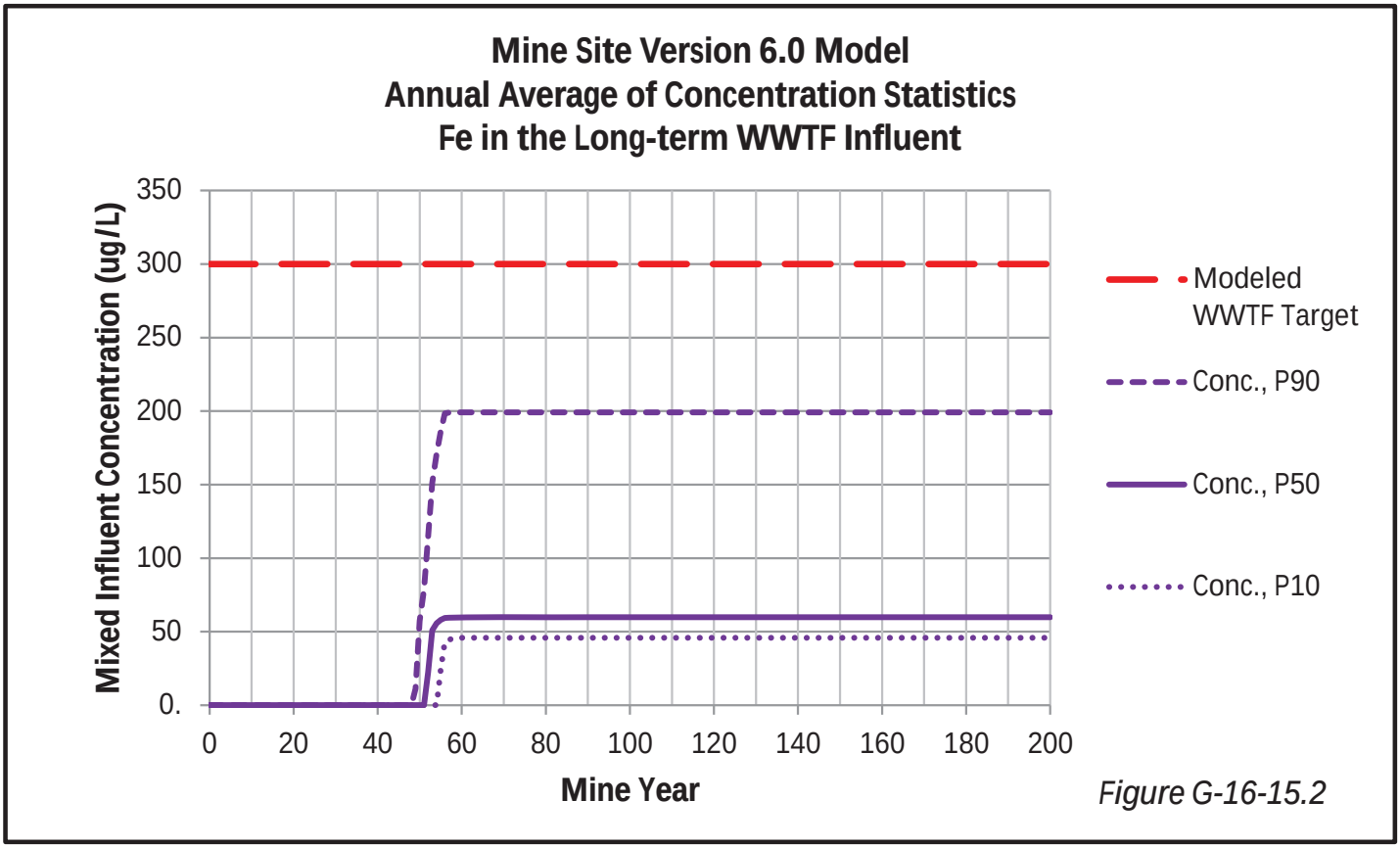

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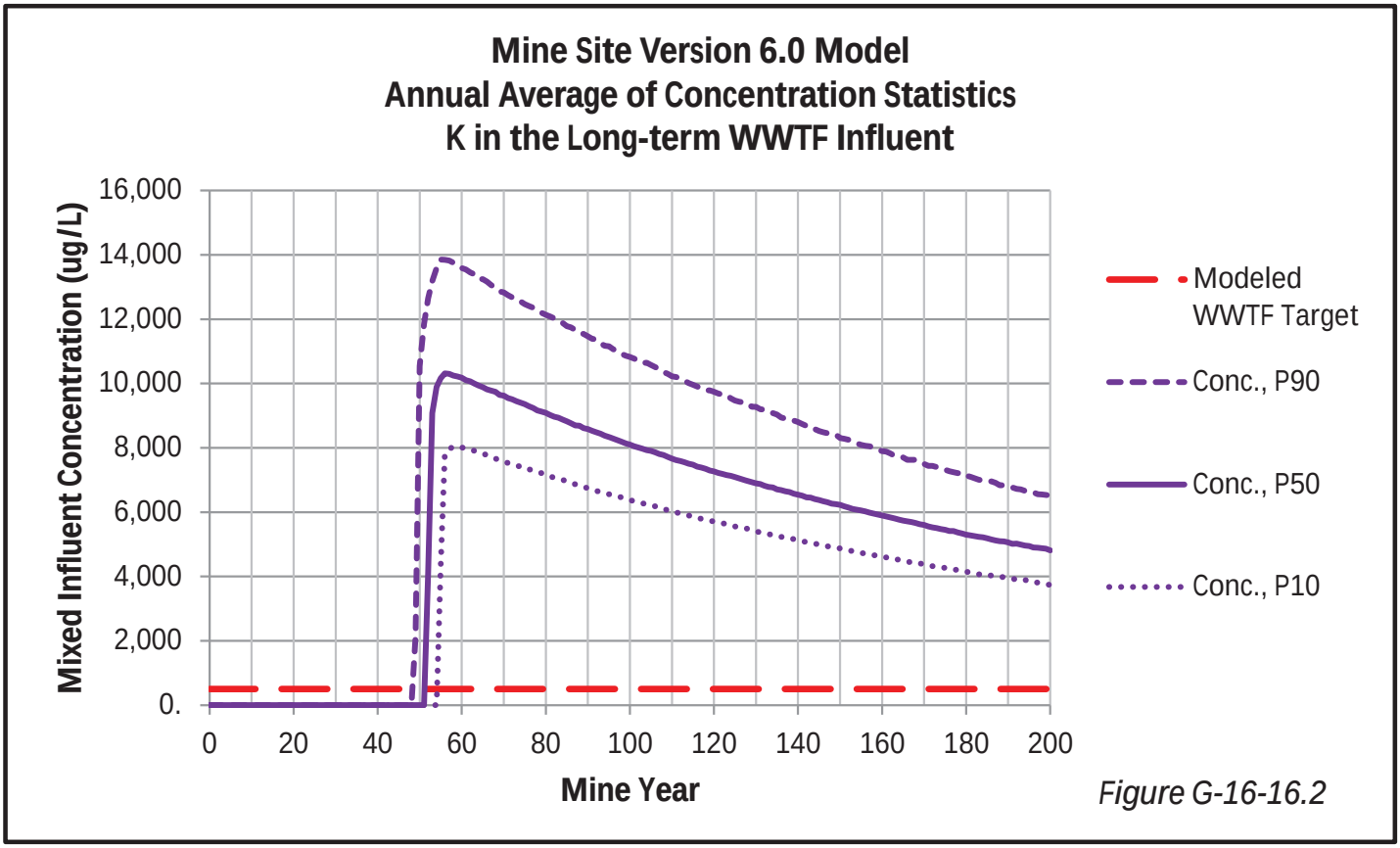

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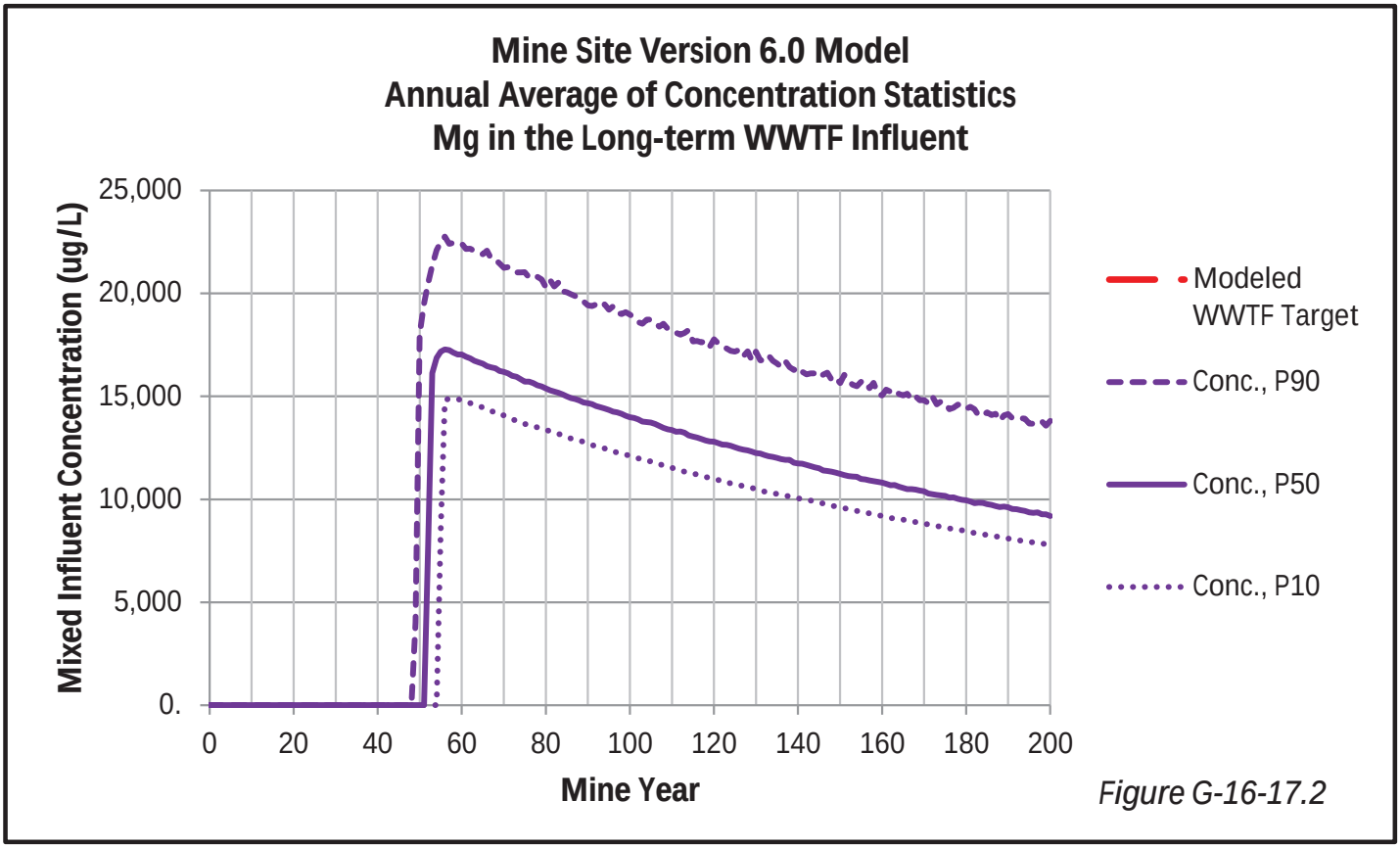

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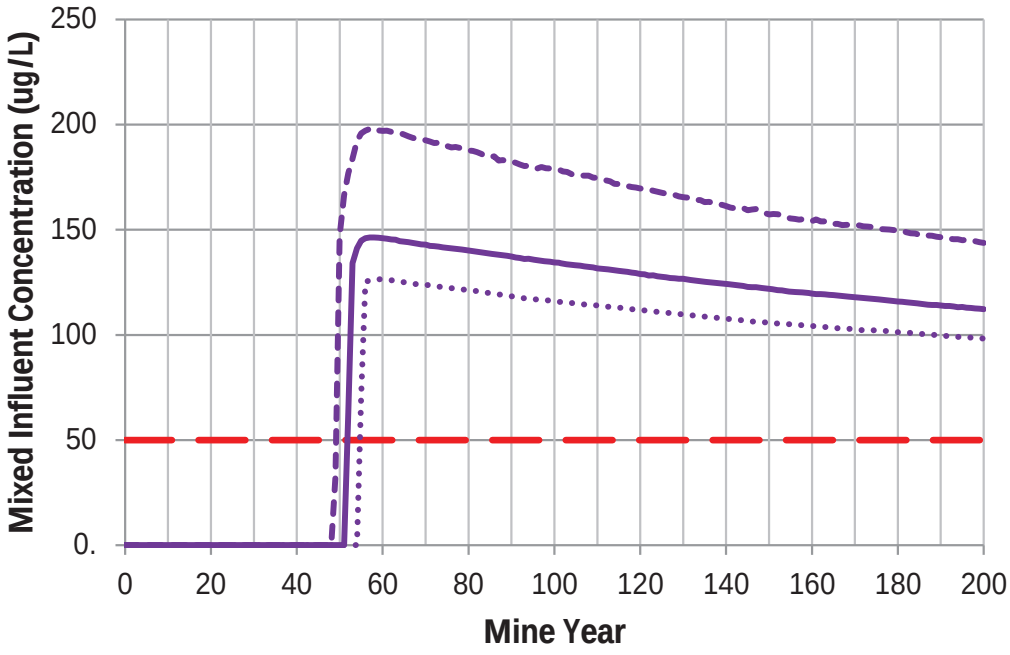

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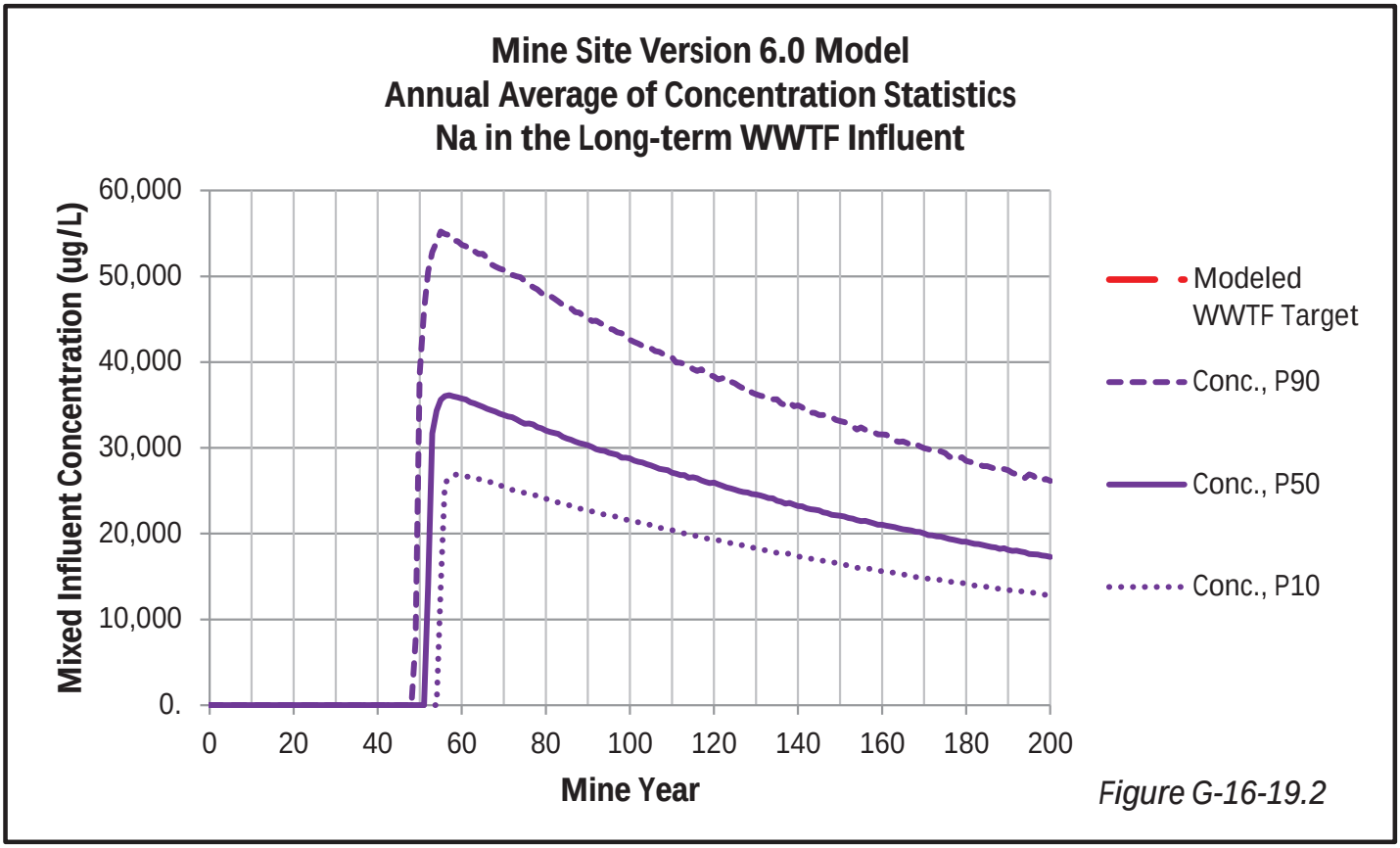

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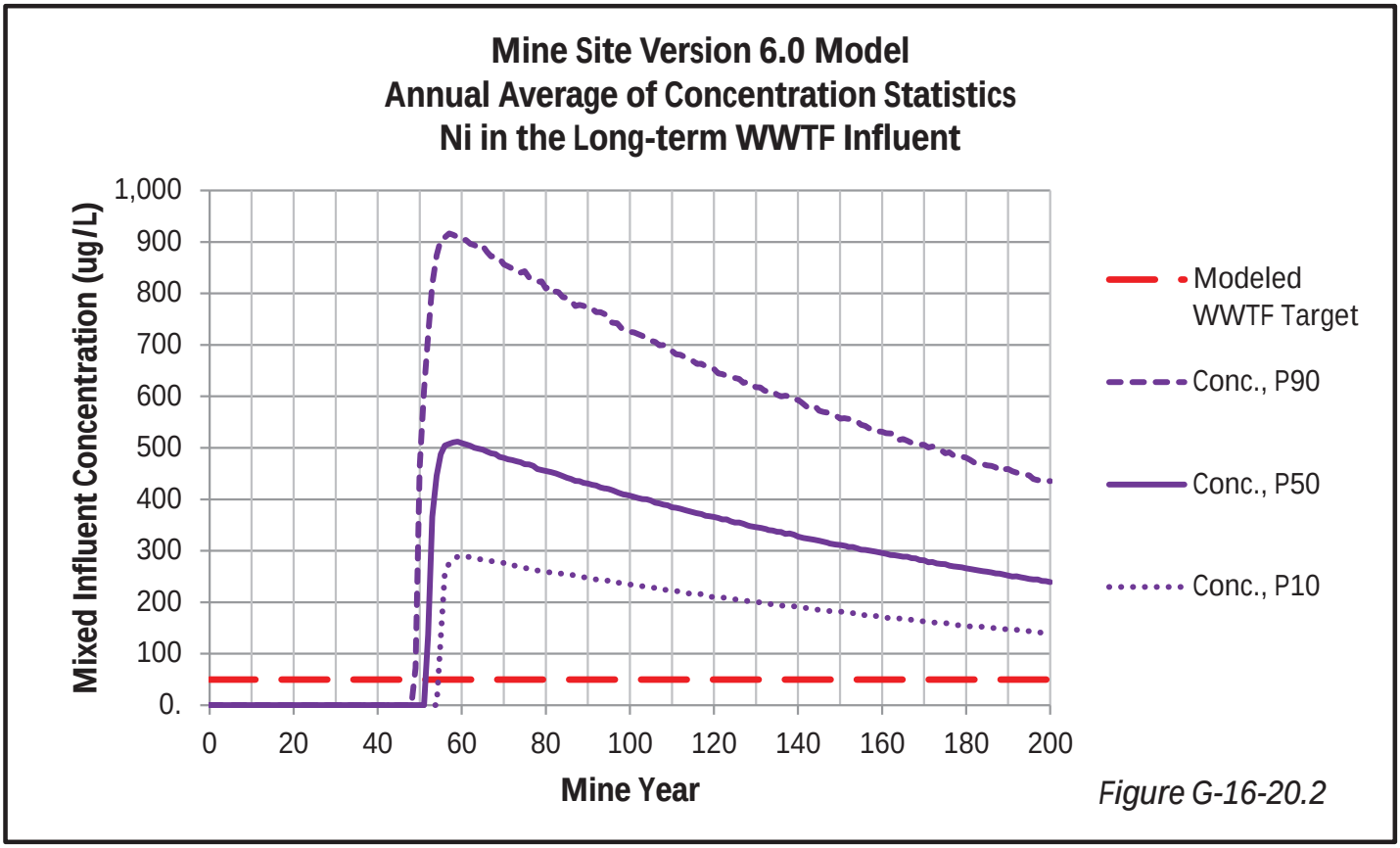

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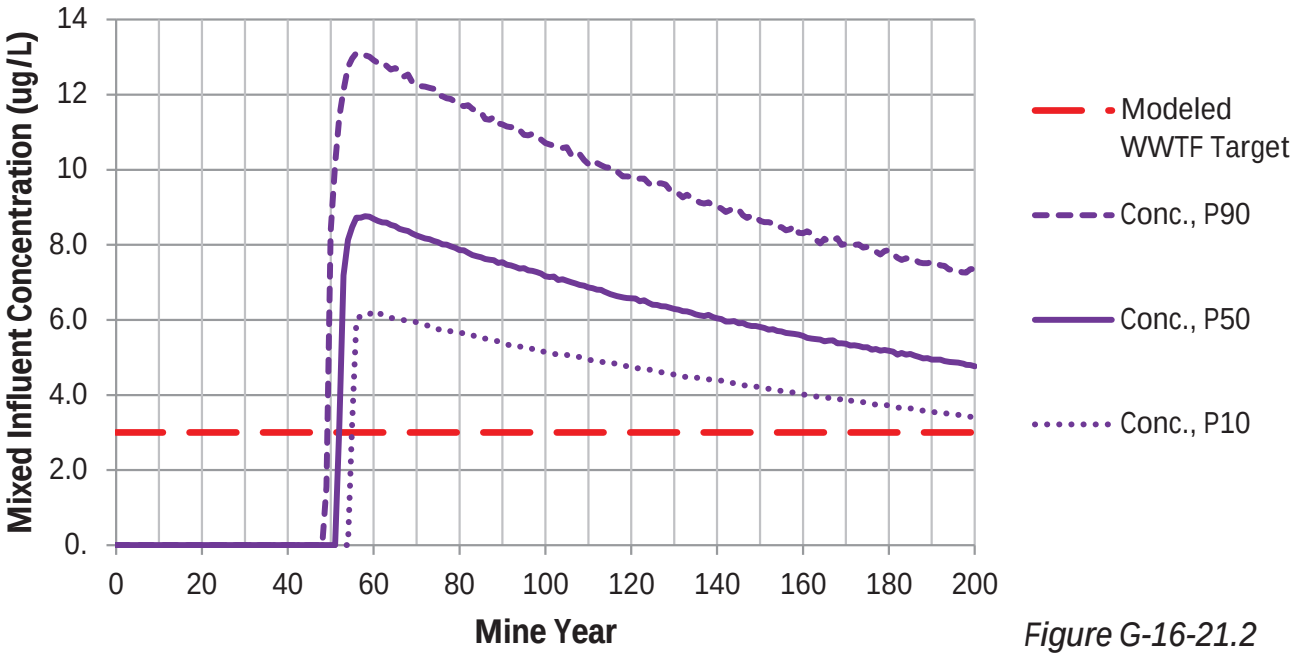

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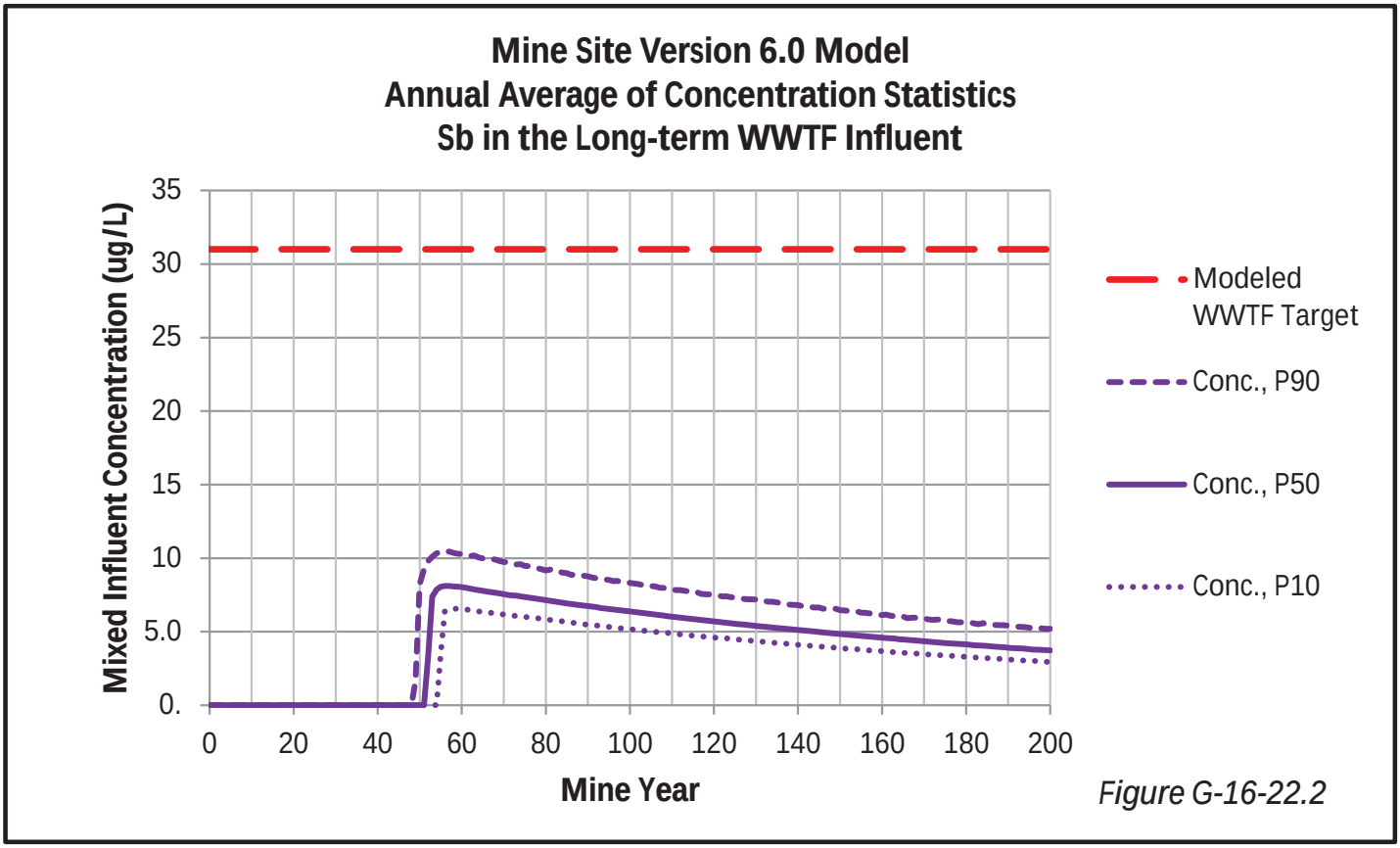

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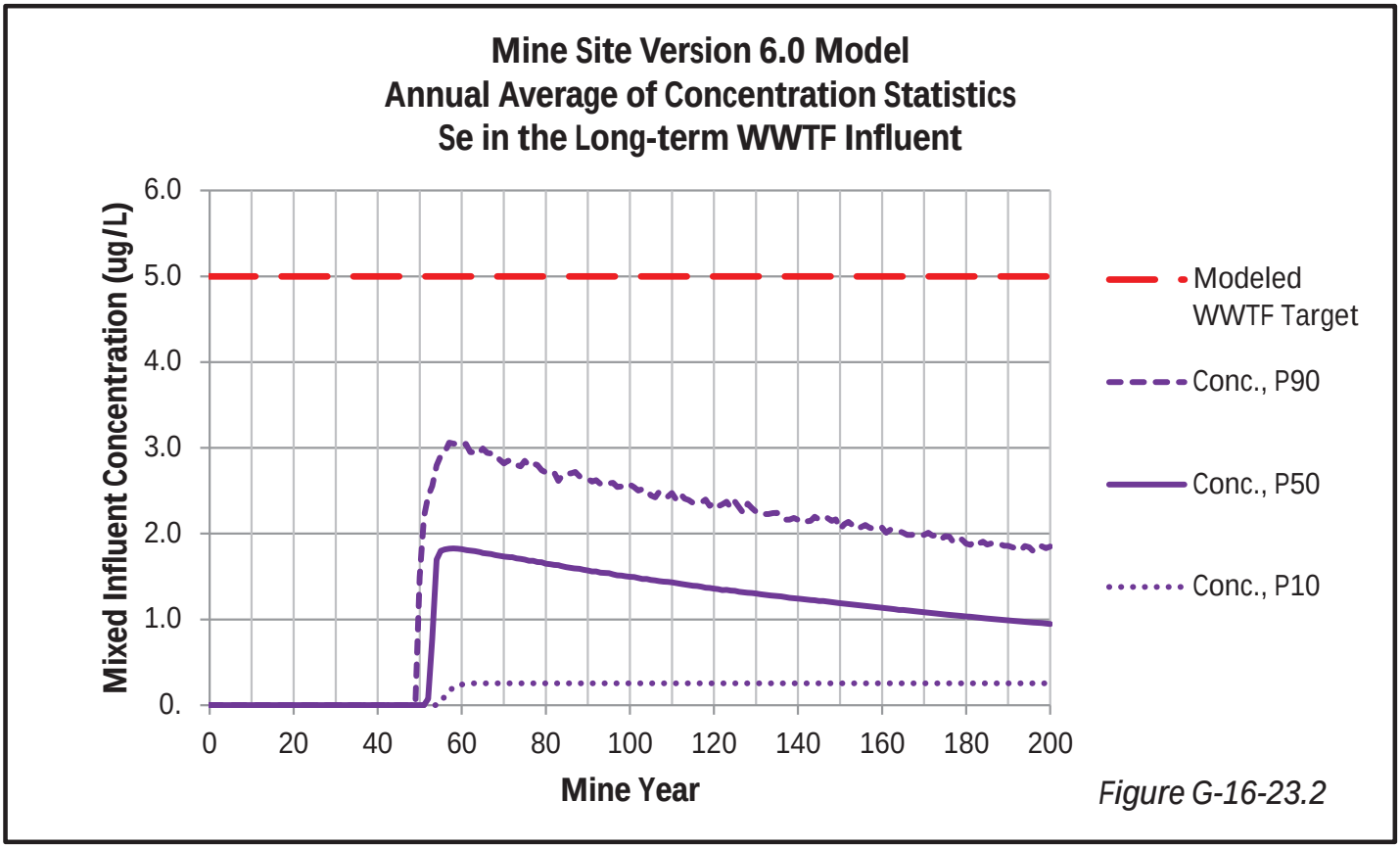

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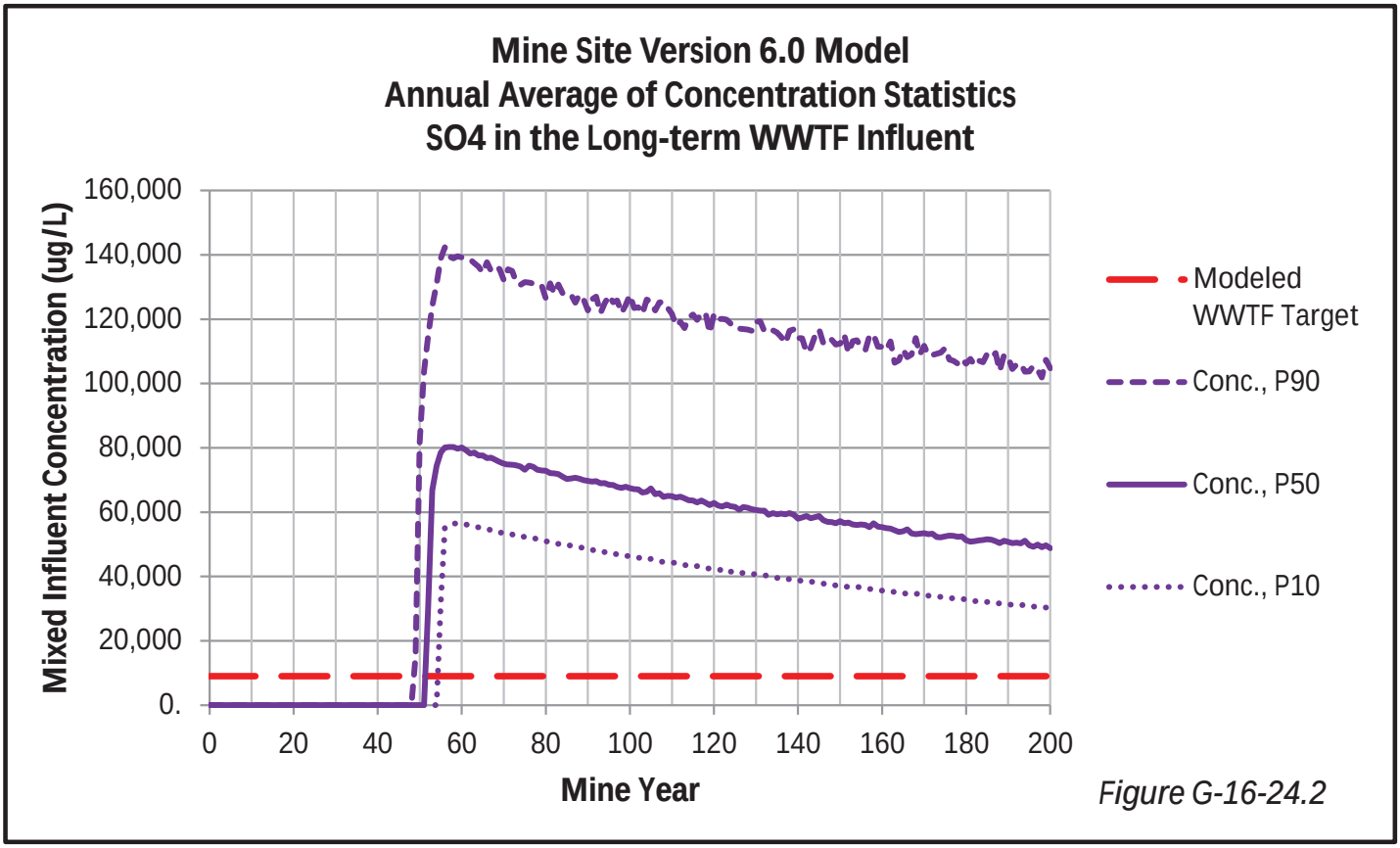

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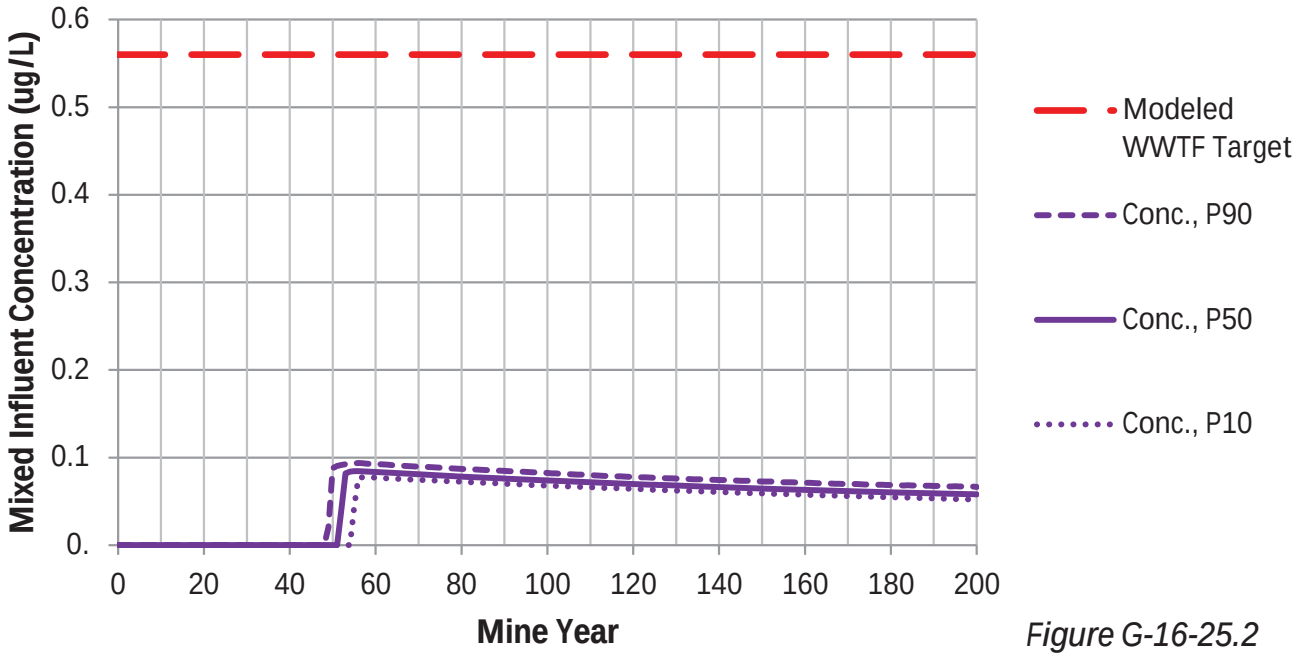

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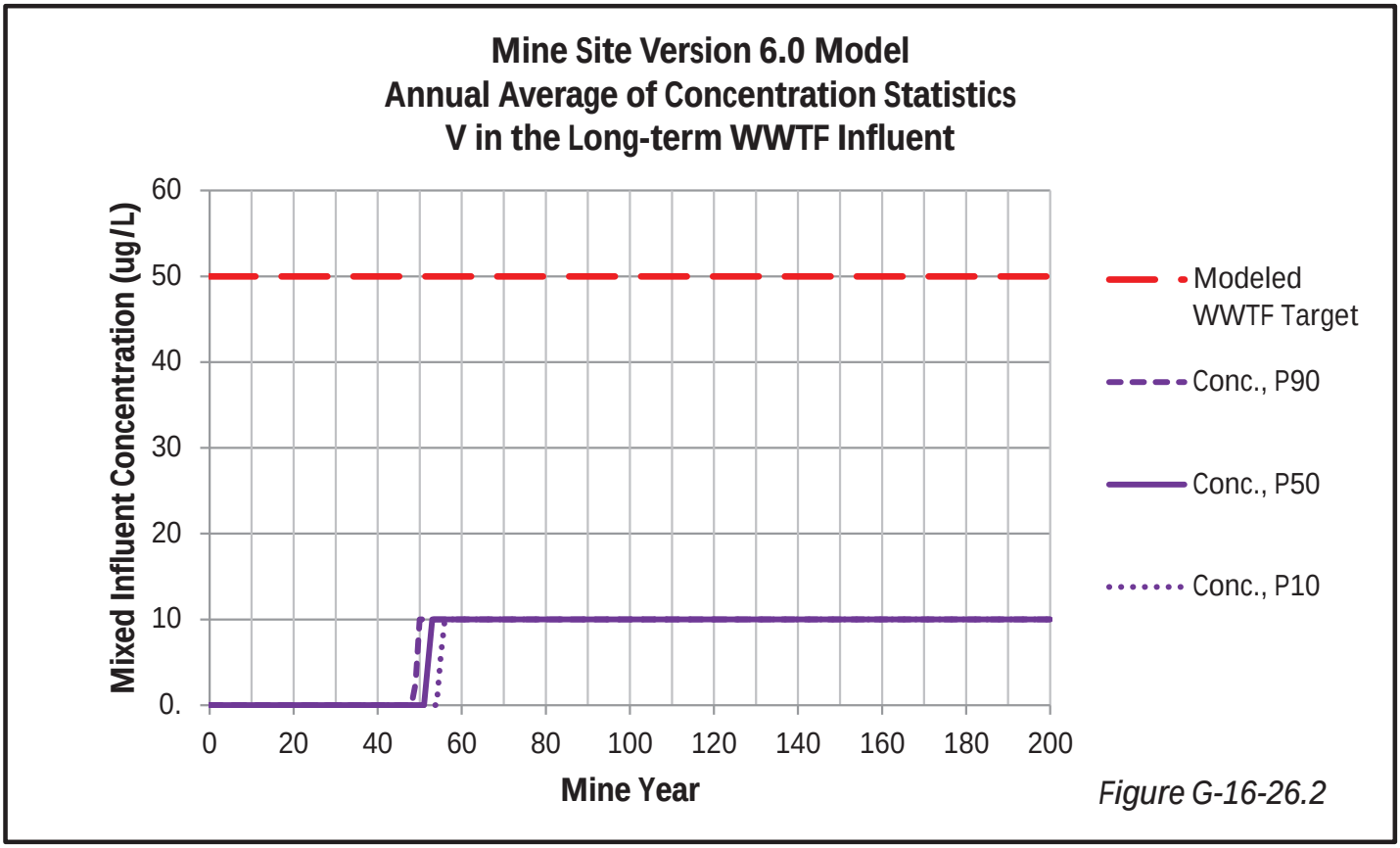

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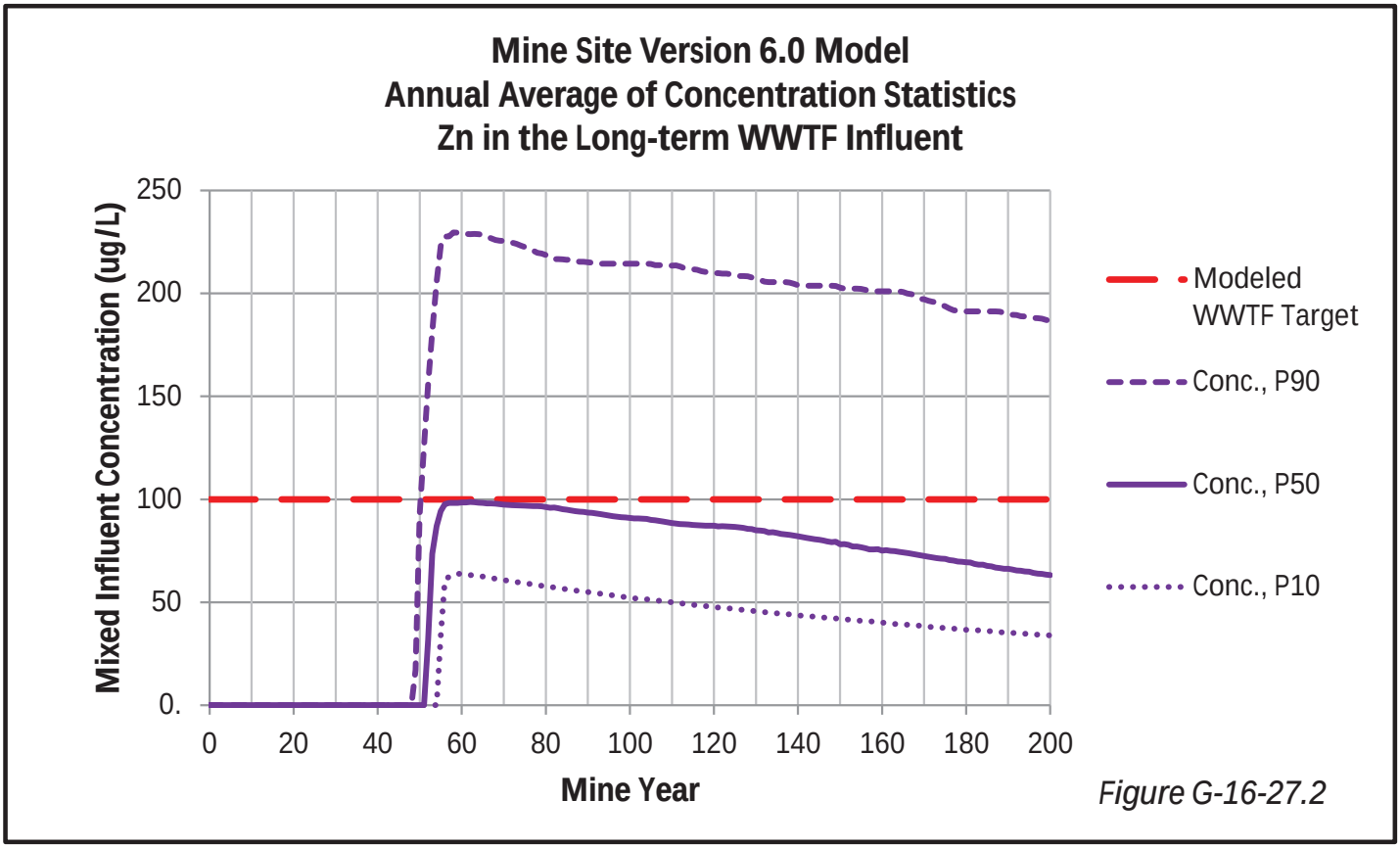


Figure G-16-27.2

Attachment H

Median Loading Rates to the Mine Pits (Culpability Analysis)

Attachment H Median Loading Rates to the Mine Pits (Culpability Analysis)

The plots in this attachment were created by taking the following steps:

- At any given time step, the mass loading rate (tonnes/yr) from every source contributing mass load to the East and West Pits is calculated and stored. These sources are itemized in the legend of each figure.

- Once the 500 realizations are complete, at every monthly time step the loading rates of a particular constituent from a particular source were sorted minimum to maximum and the median value (250th) was chosen. This step was performed for all sources and all constituents.

- The monthly median loading rates of each constituent from each source were annualized by taking the average of the twelve monthly median loading rates each year. This results in one representative average annual median loading rate of each constituent from each source.

- A stacked bar graph is used to directly compare the average annual median loading rates from each source for any constituent to the East and West Pits. The source (uniquely colored in each figure) which covers the most area of the graph at any given time is therefore the most culpable source. Showing a time series graph of loading rates also helps show how the culpable source may change through time.

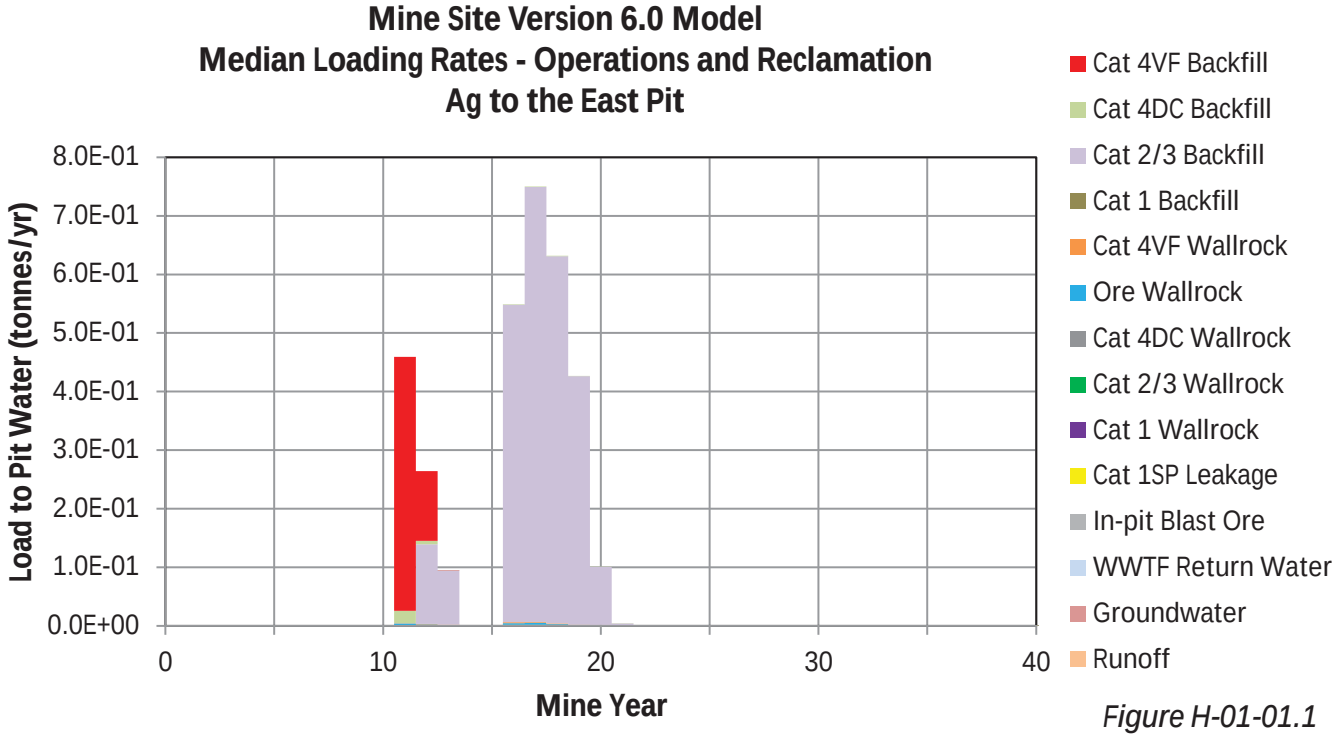
The figure numbering convention is "**Figure W-XX-YY.Z**" where:

- **W** indicates the Attachment.

- **XX** is a counter indicating the location; in this attachment "01" indicates the East Pit and "02" indicates the West Pit.

- **YY** is a counter indicating the constituent; in this attachment it will count from "01" to "27" to show the 27 independently modeled constituents.

- **Z** is a numerical value, 1 or 2. A value of 1 indicates that the plot extends from Mine Year 0 to 40, a value of 2 indicates that the plot extends from Mine Year 40 to 80.



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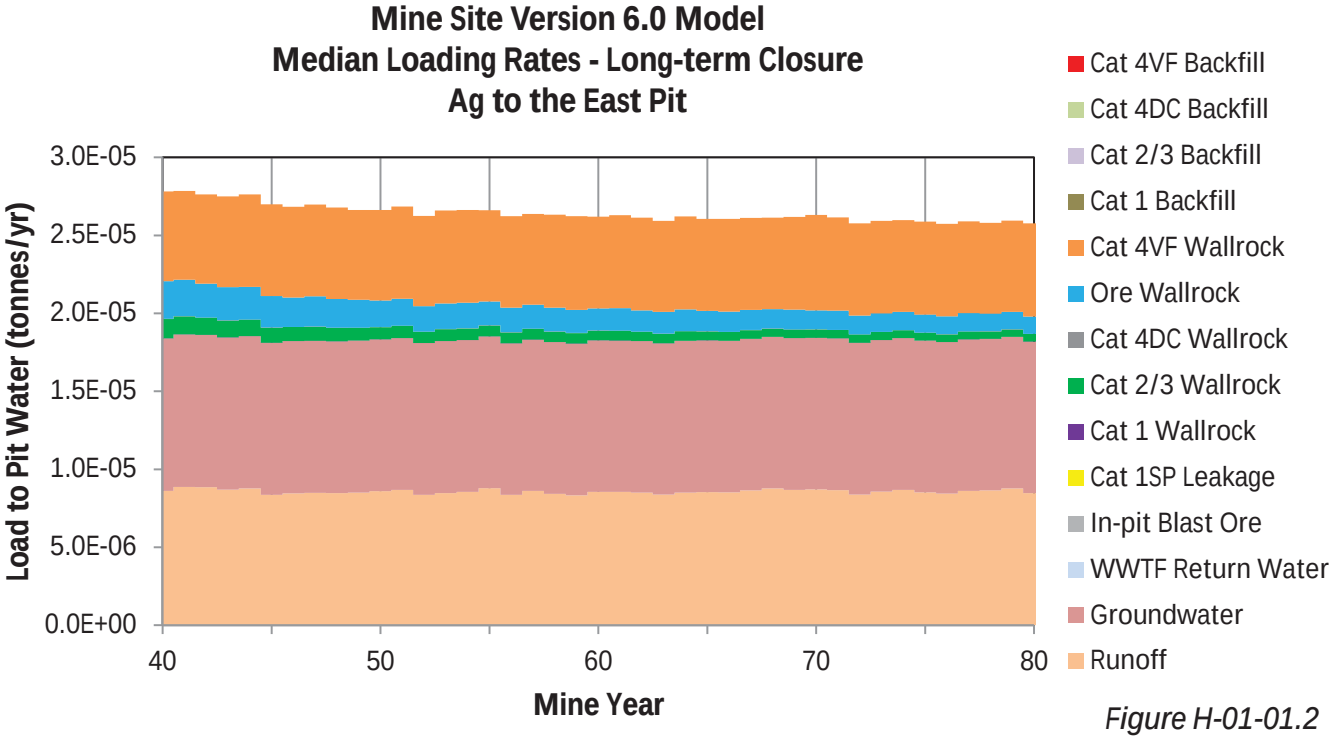

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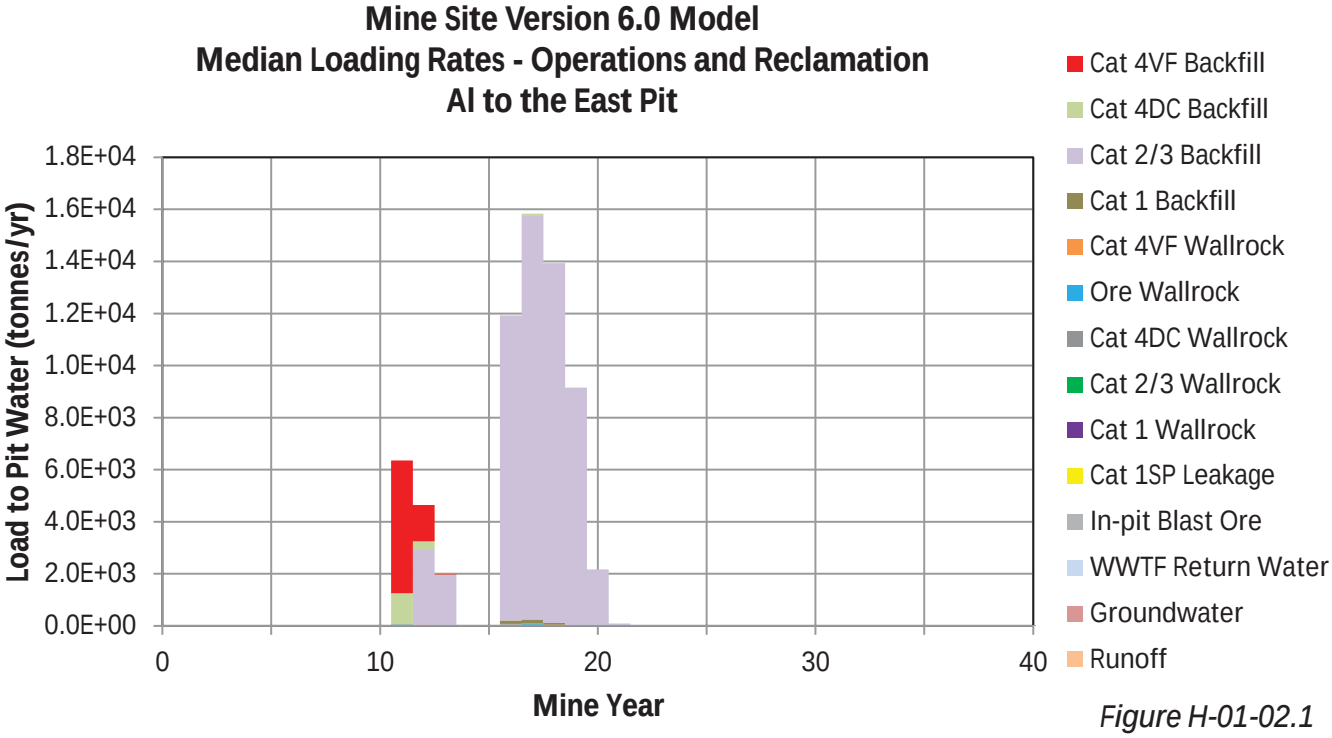

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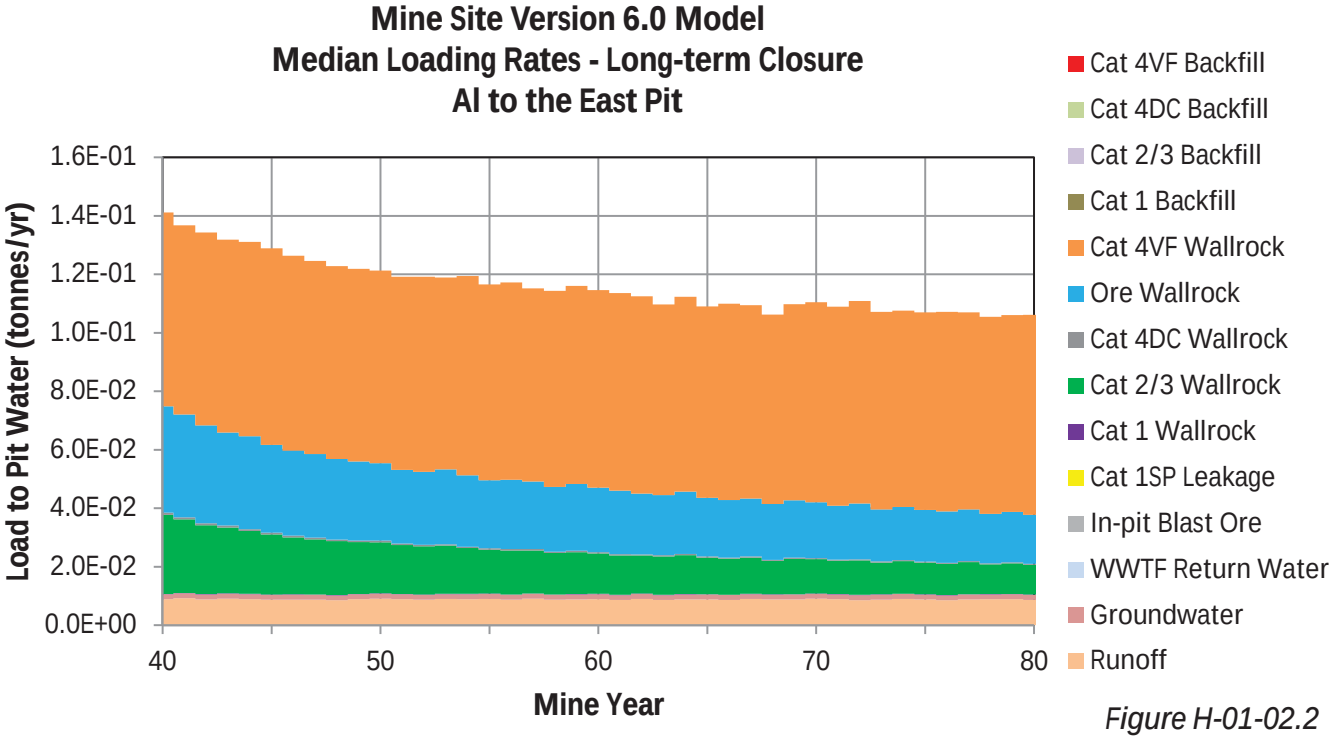

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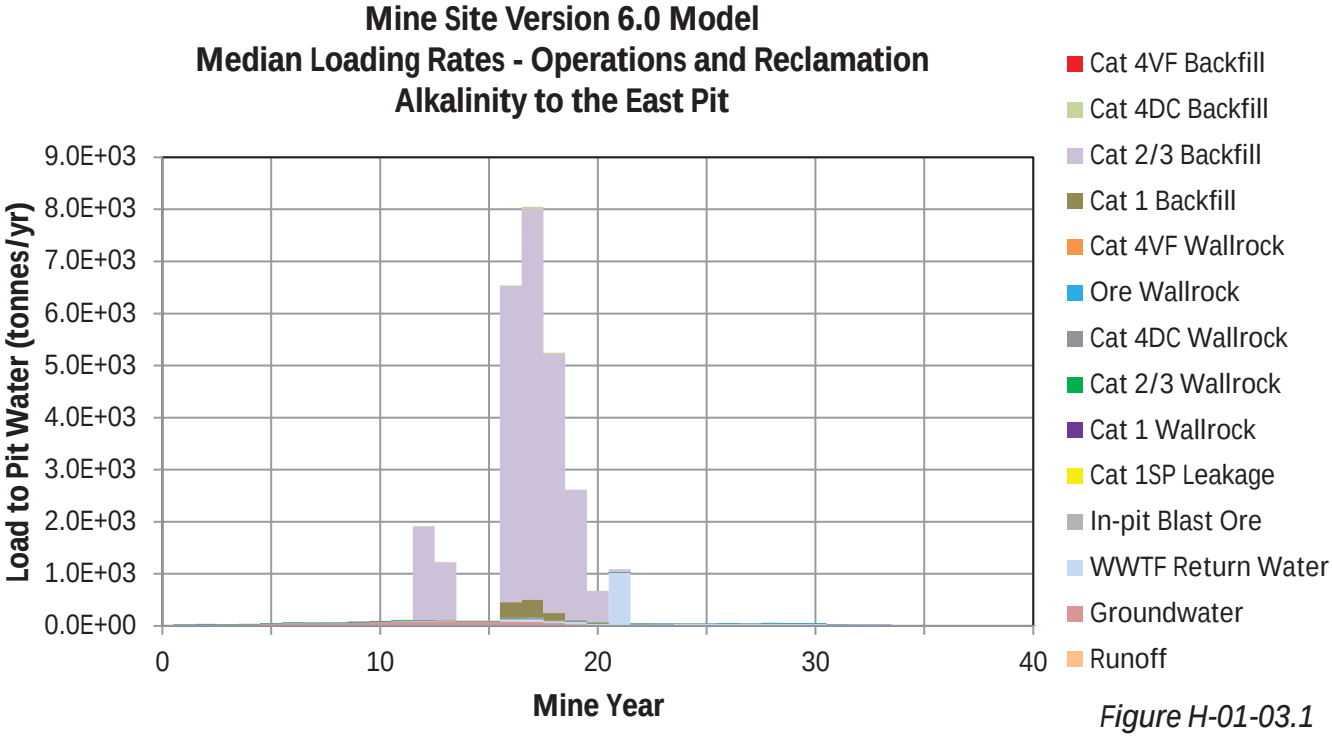

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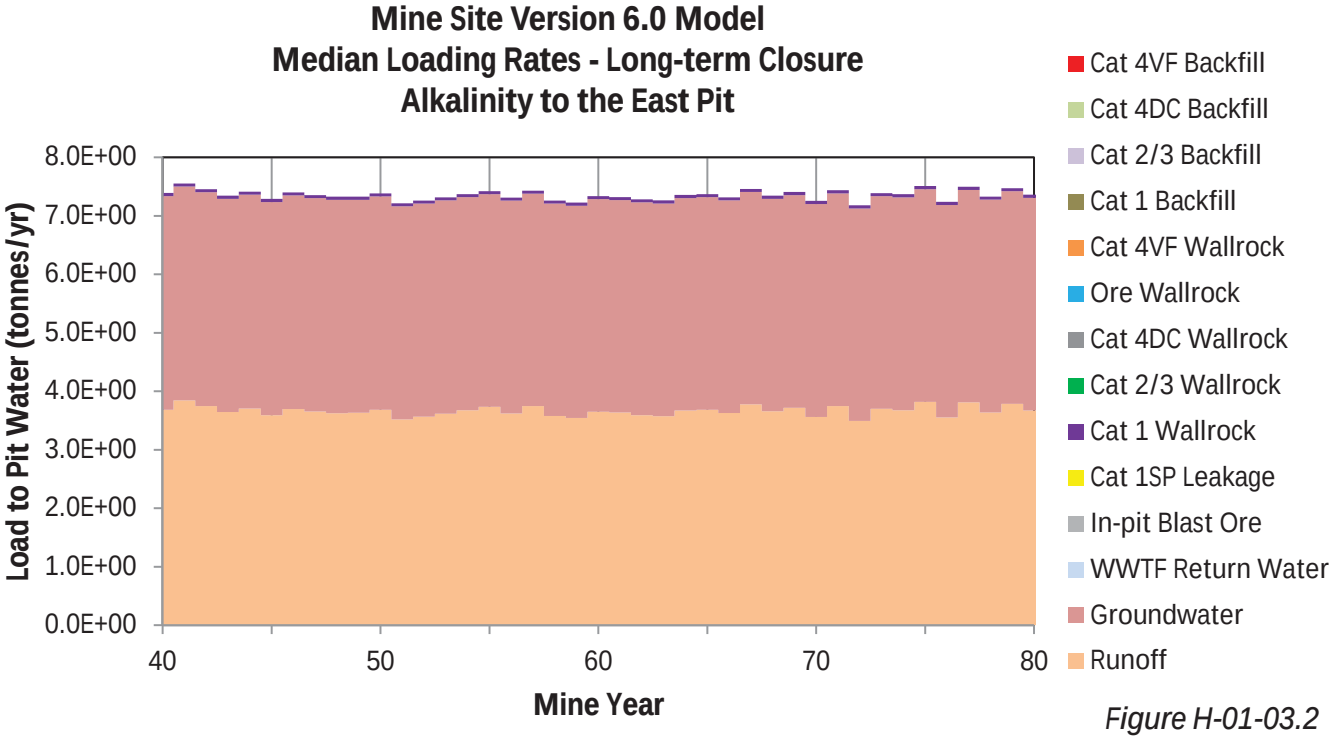

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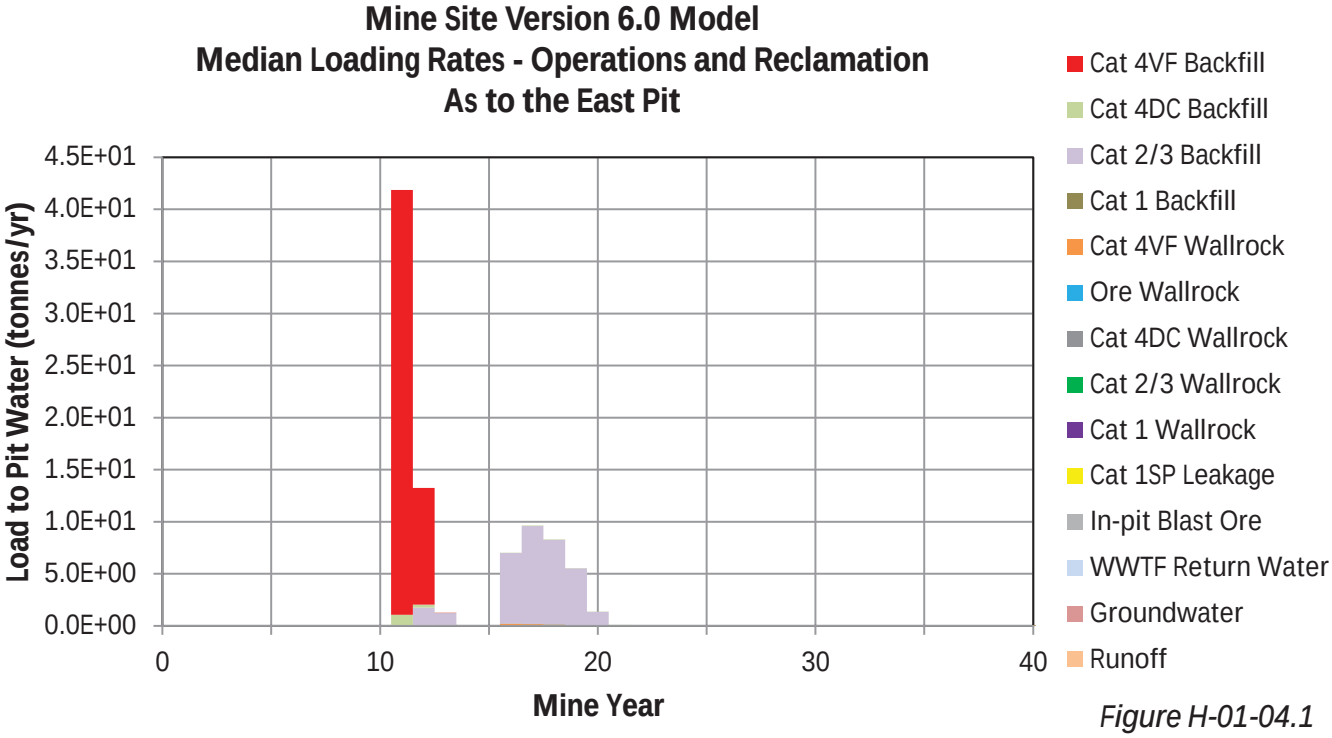

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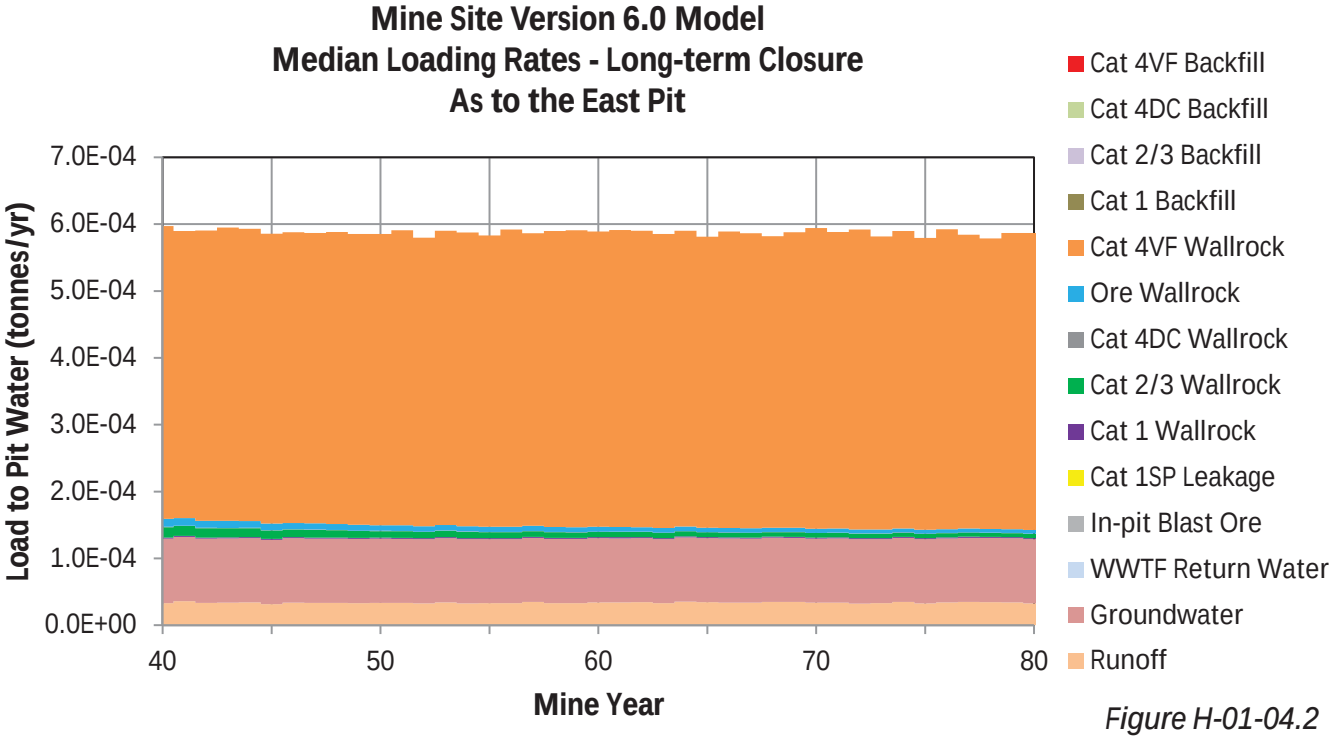

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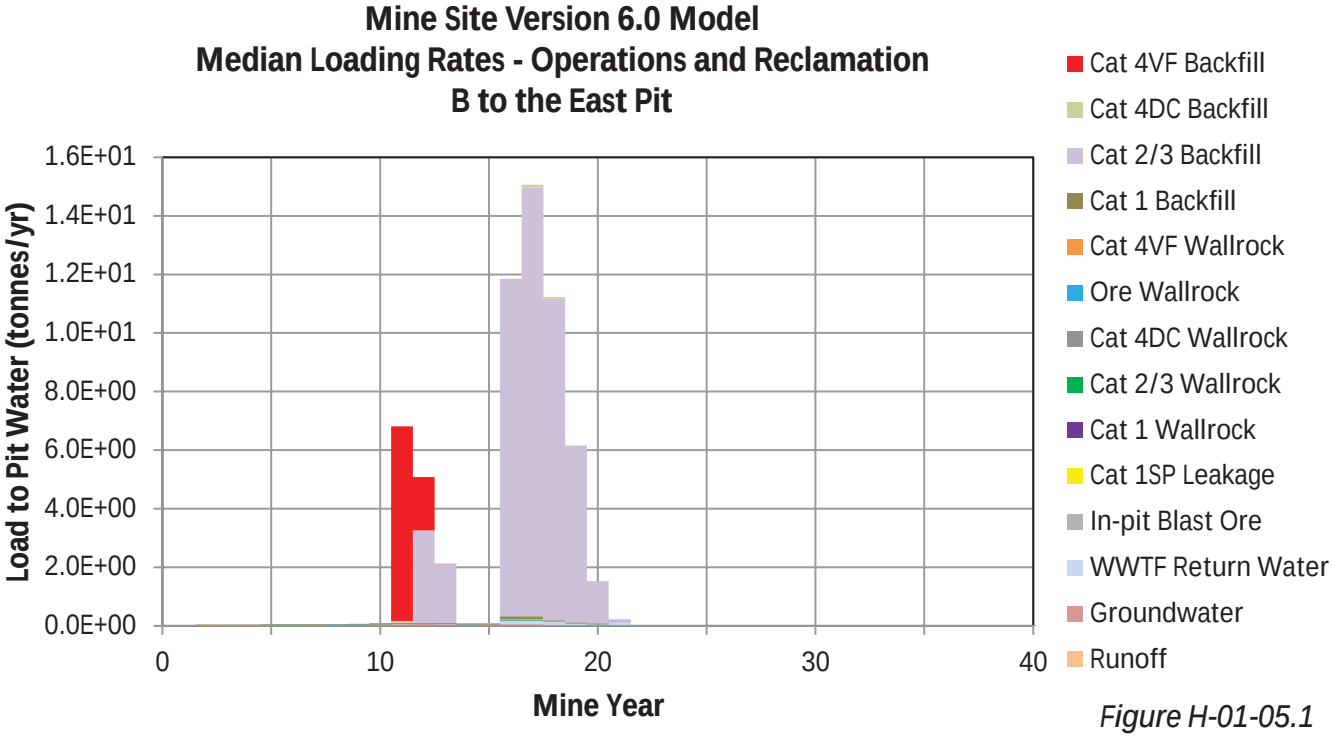

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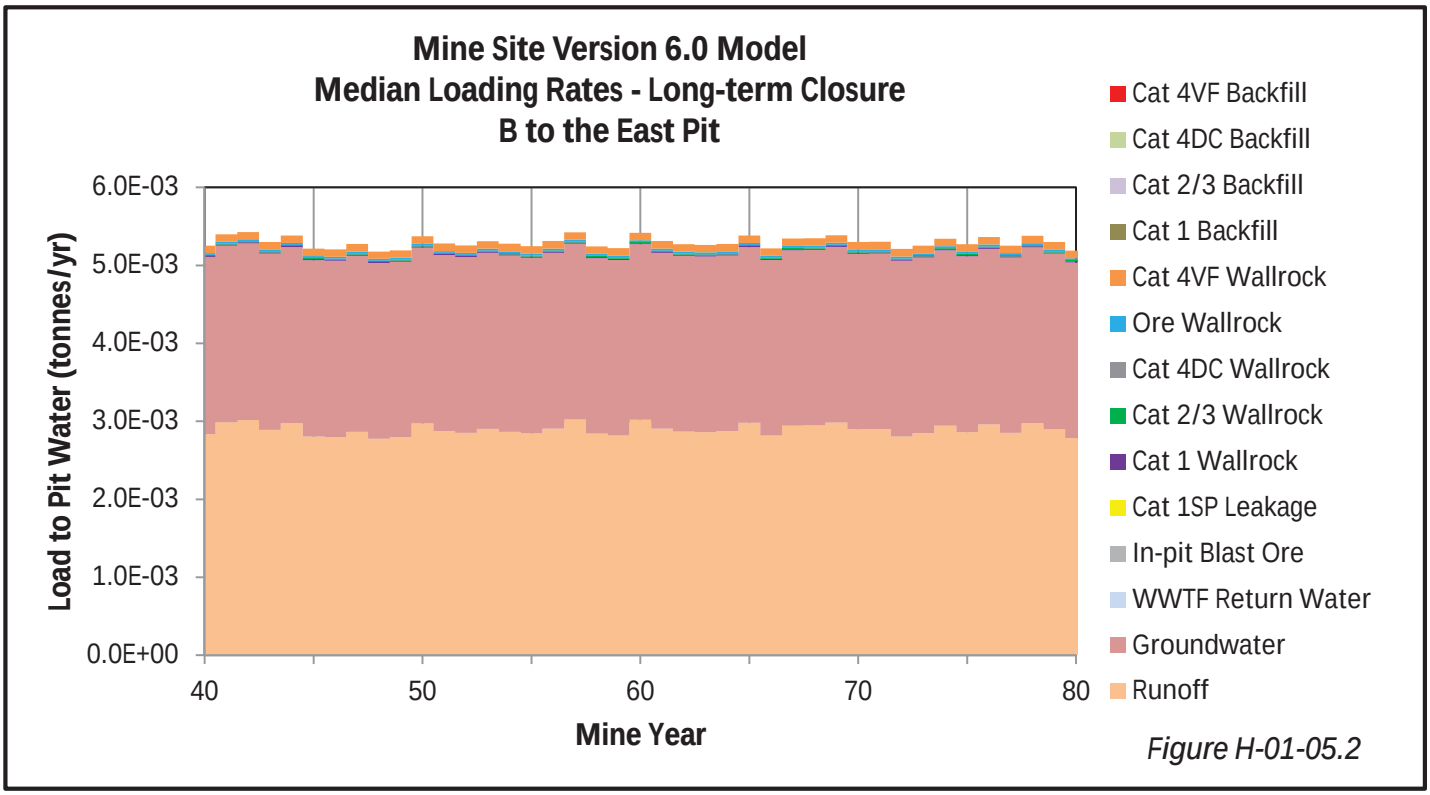

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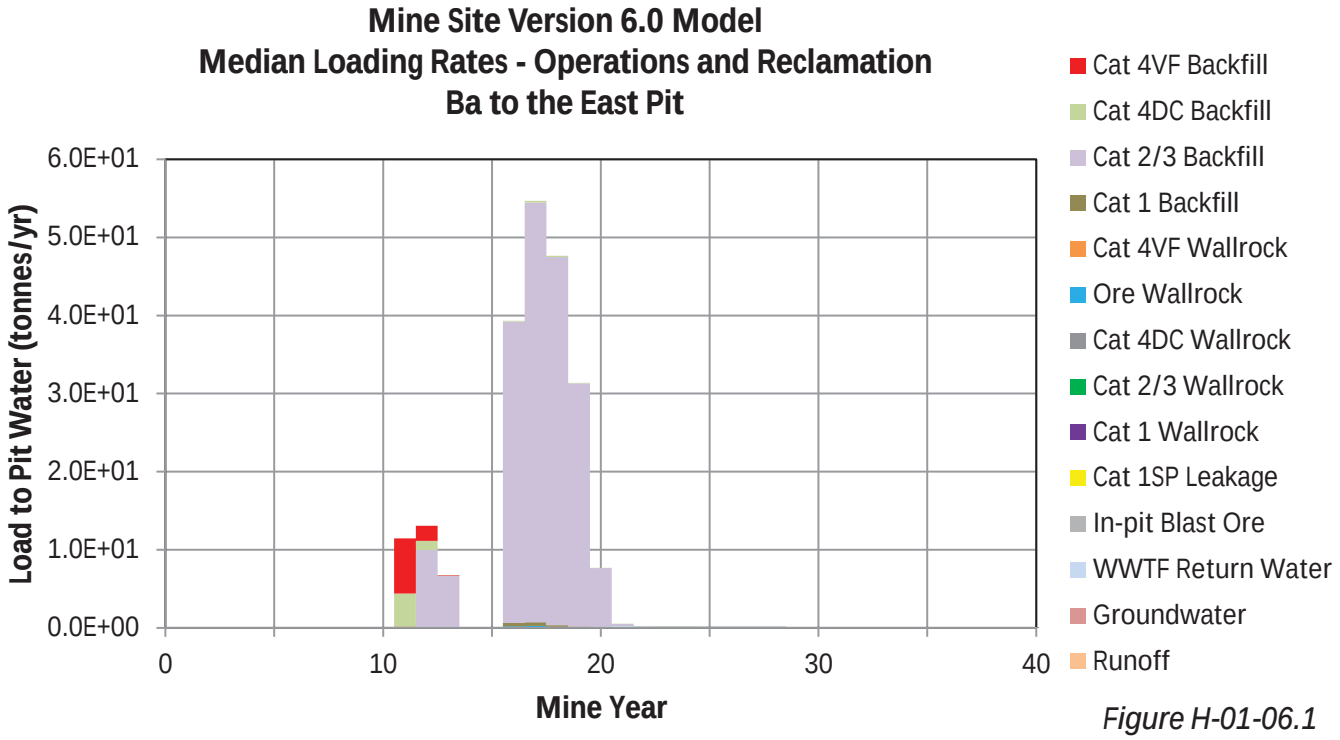

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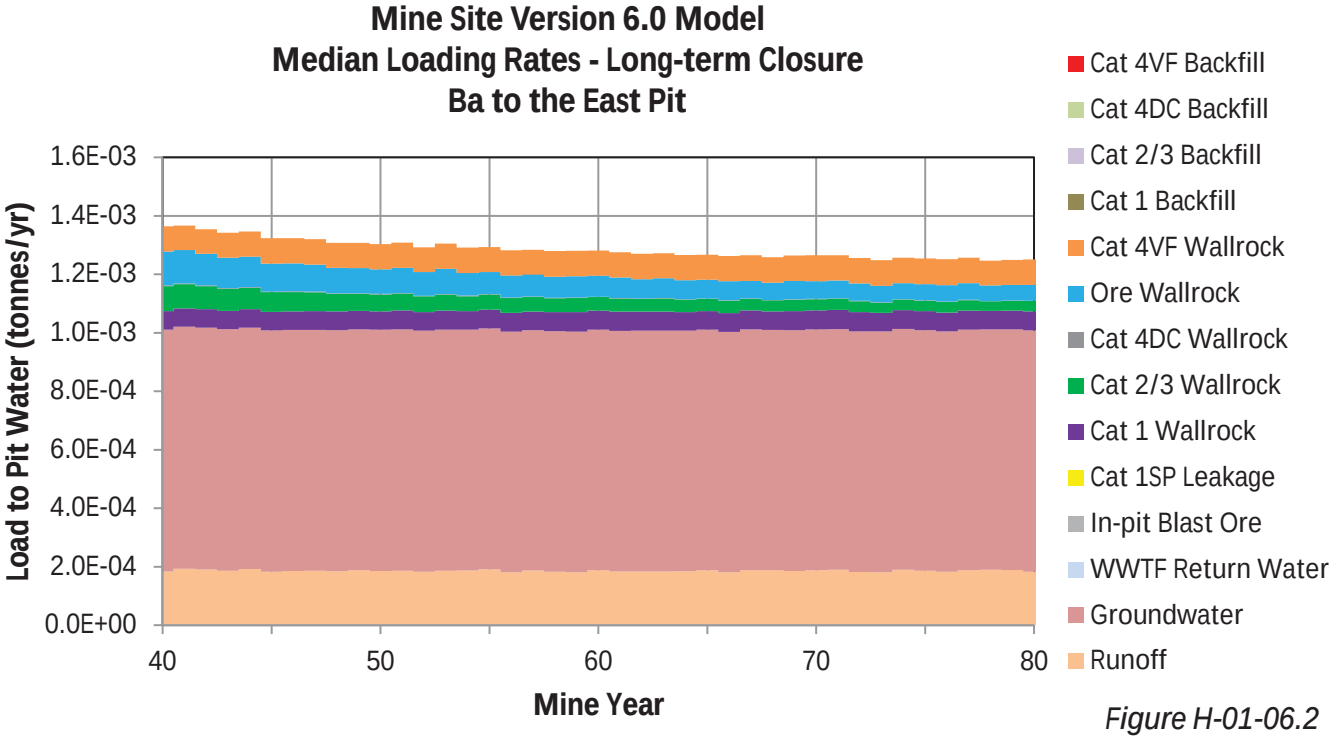
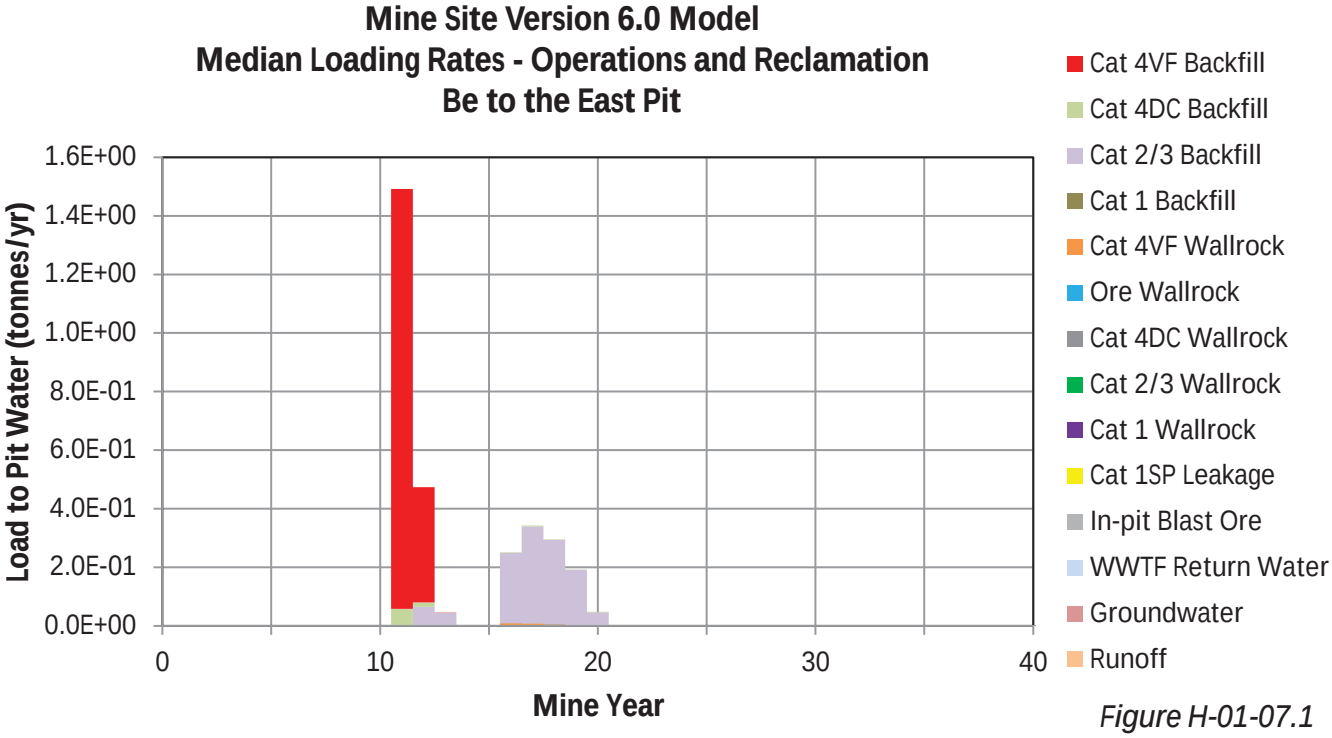


Figure H-01-06.2



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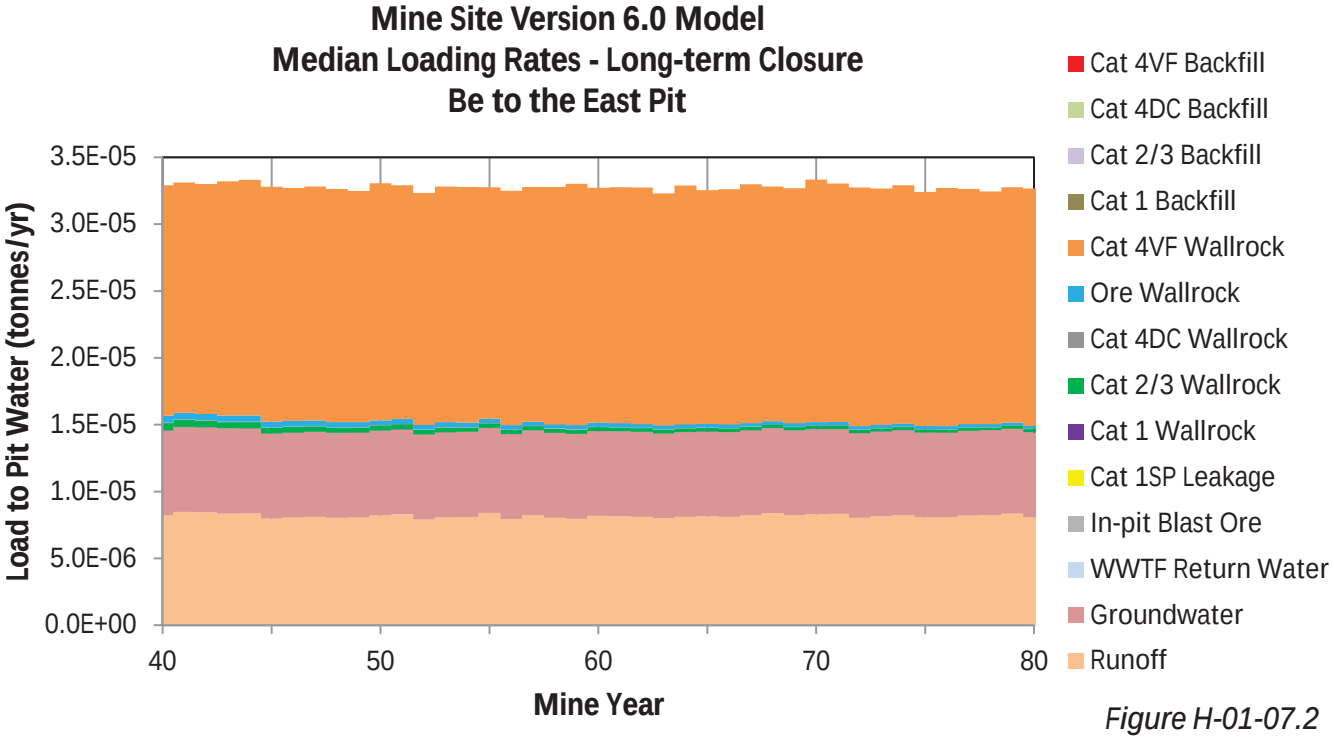

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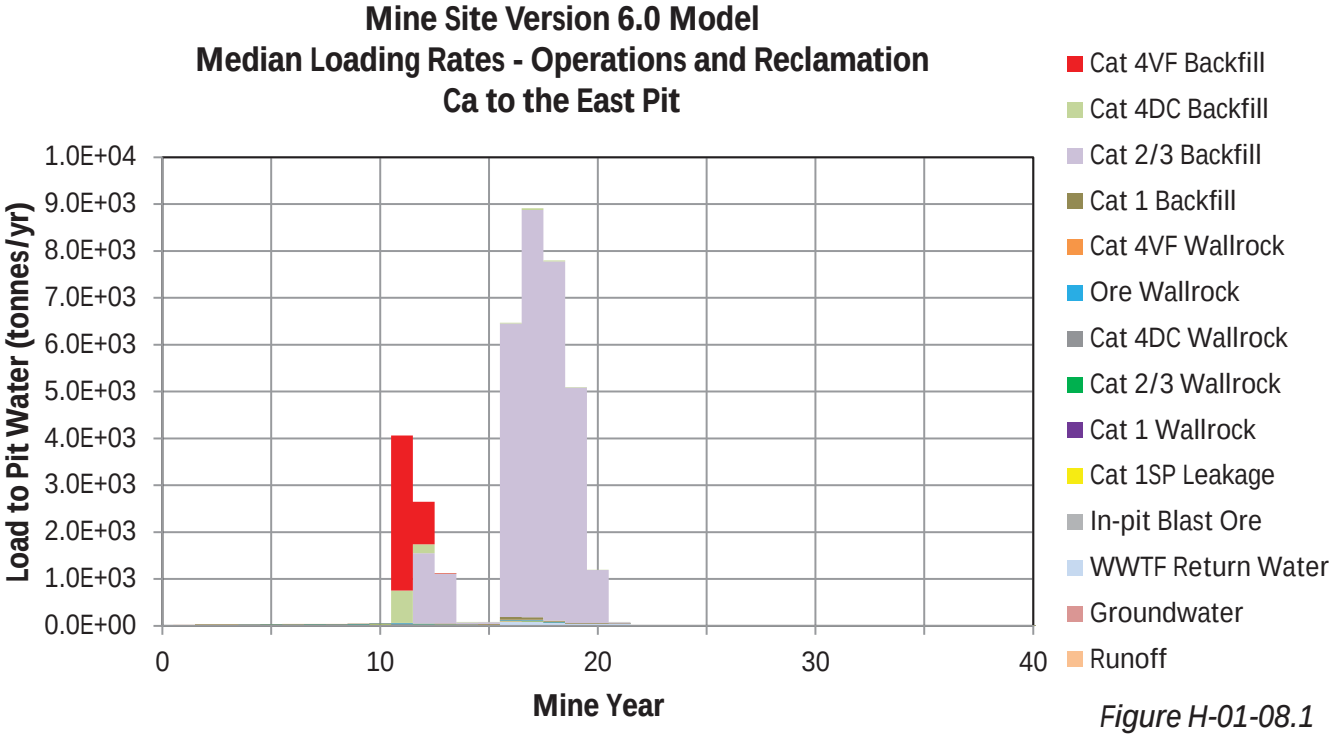

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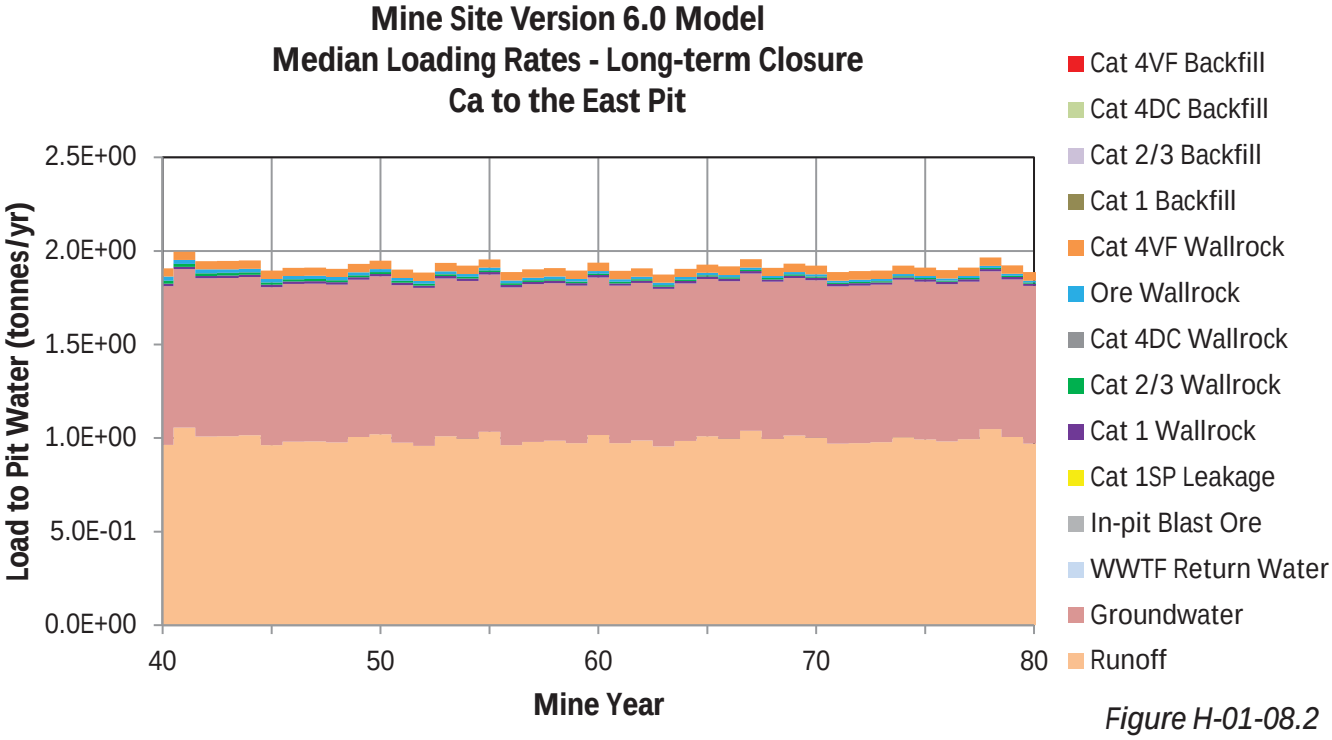

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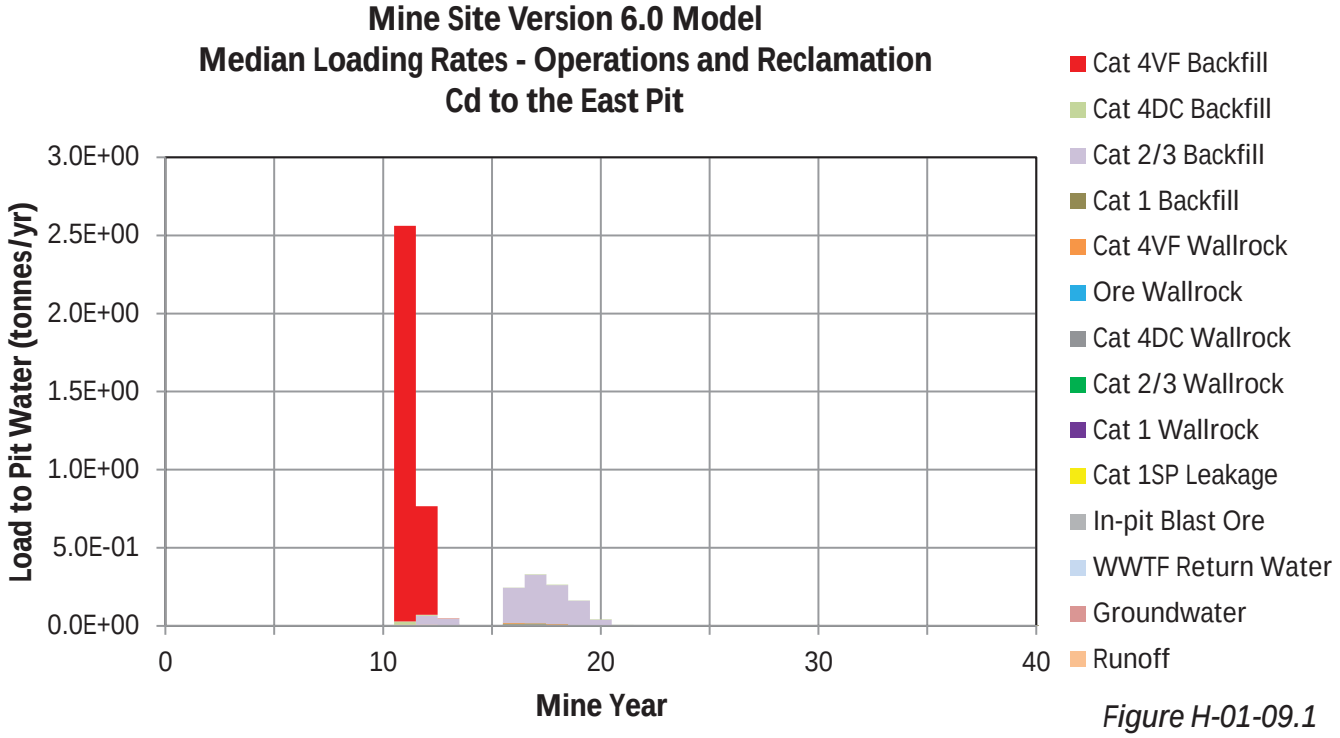

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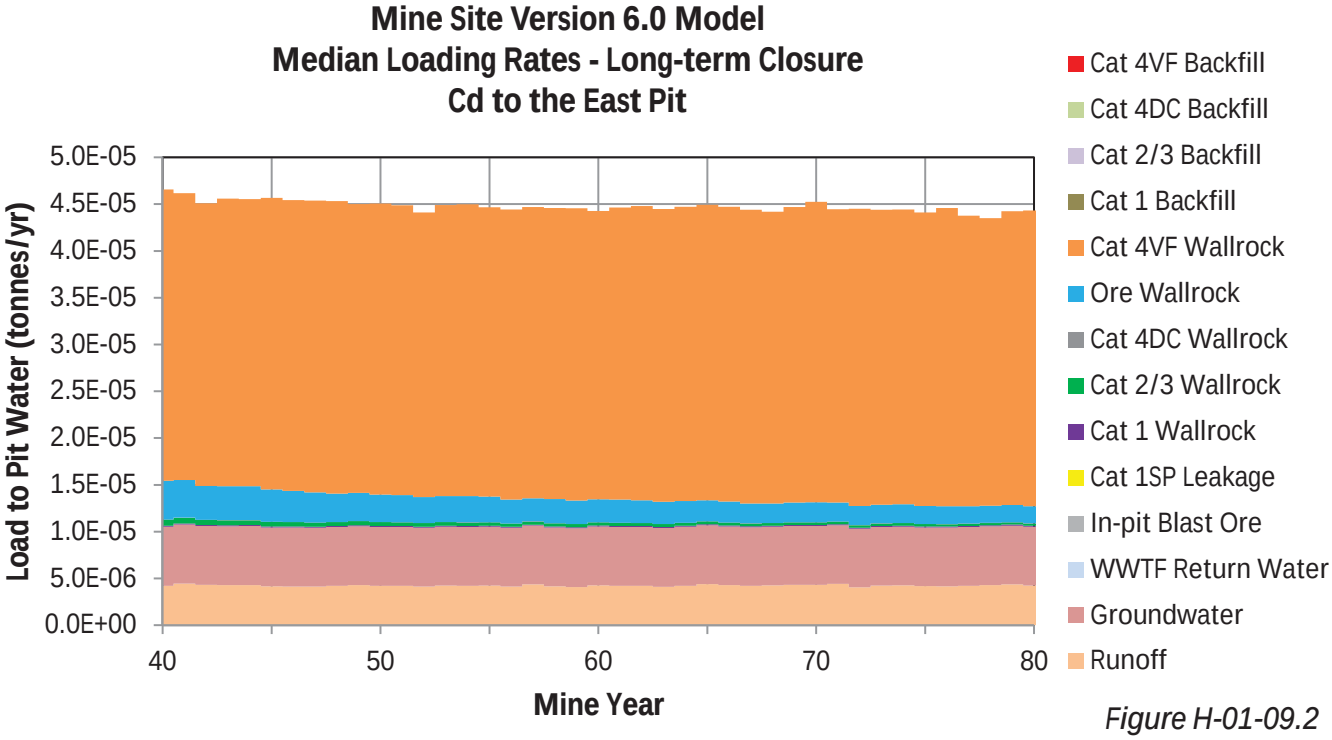

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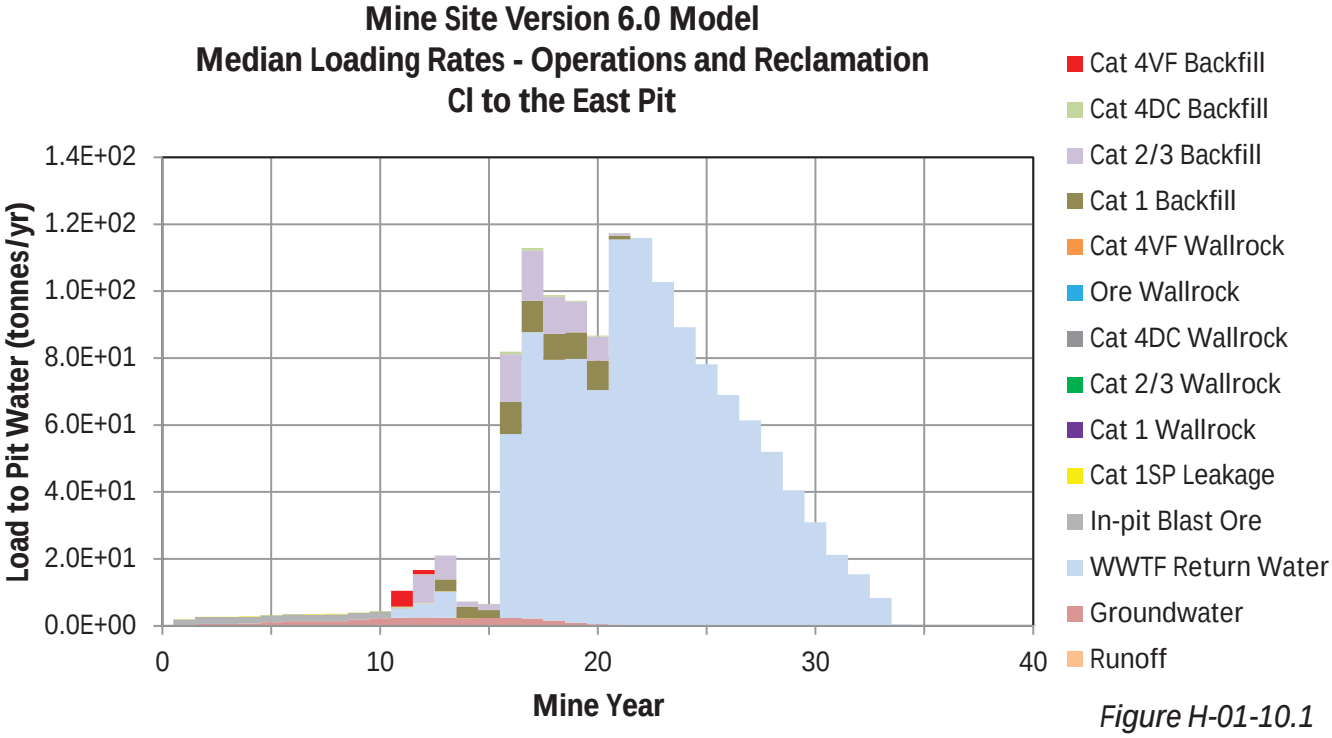

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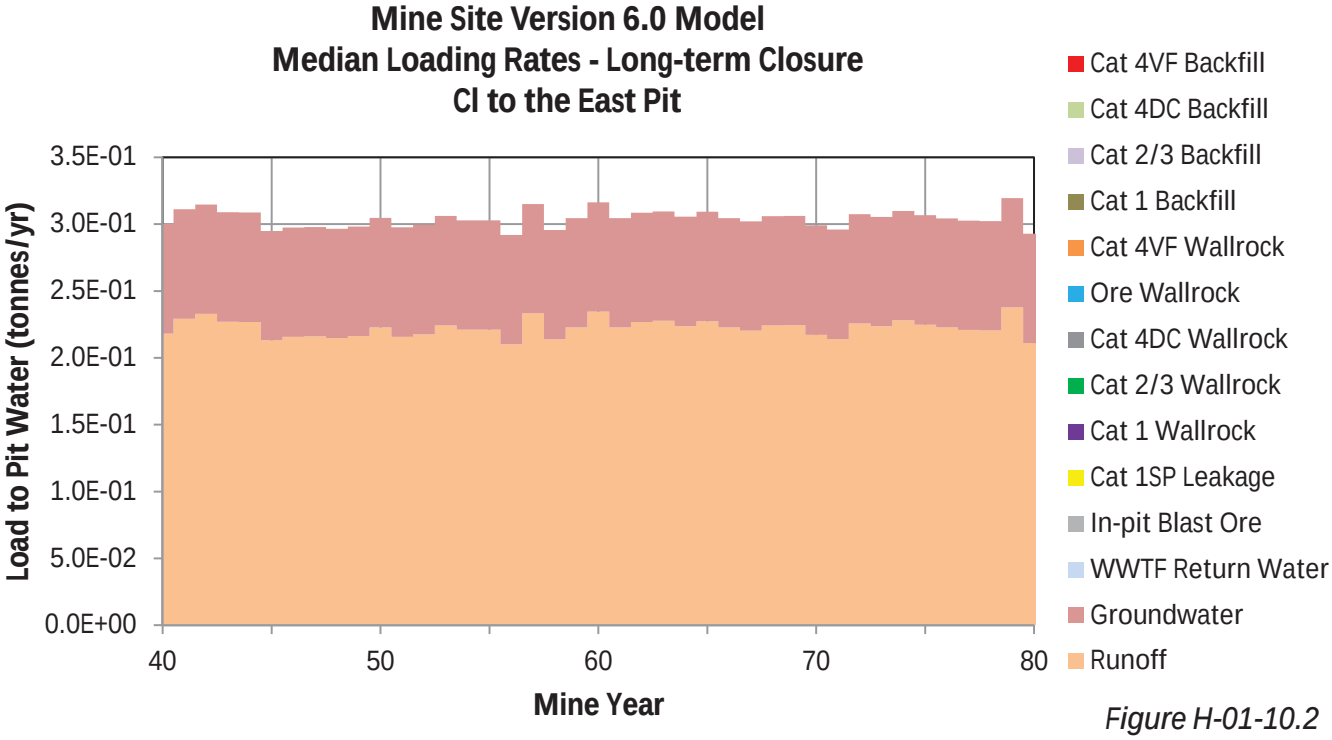

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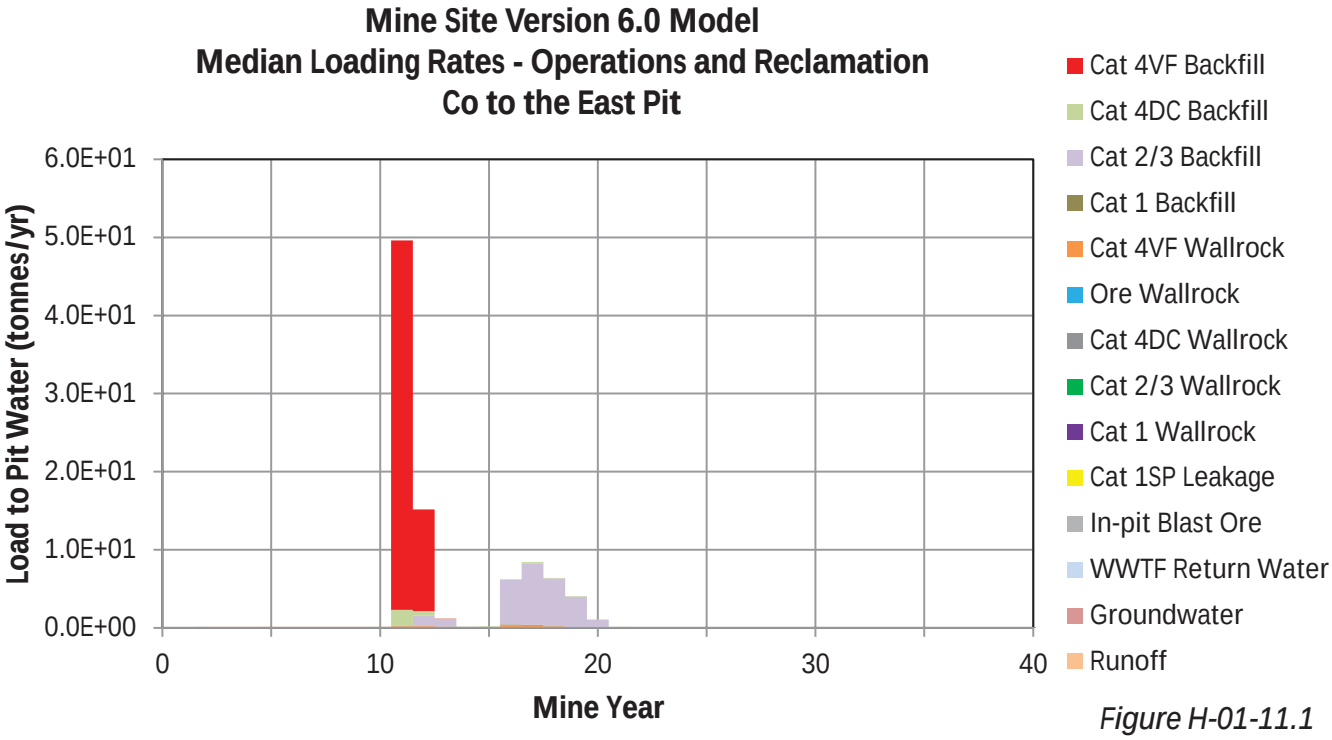

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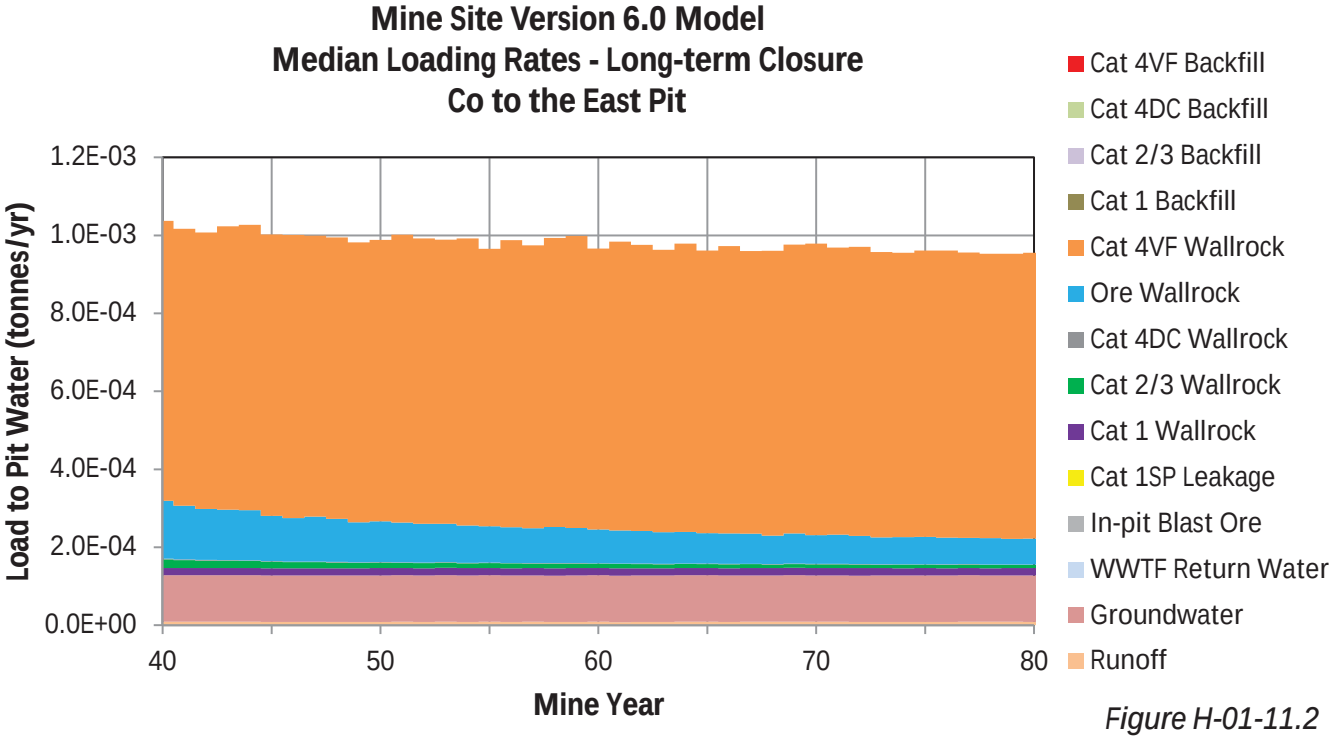

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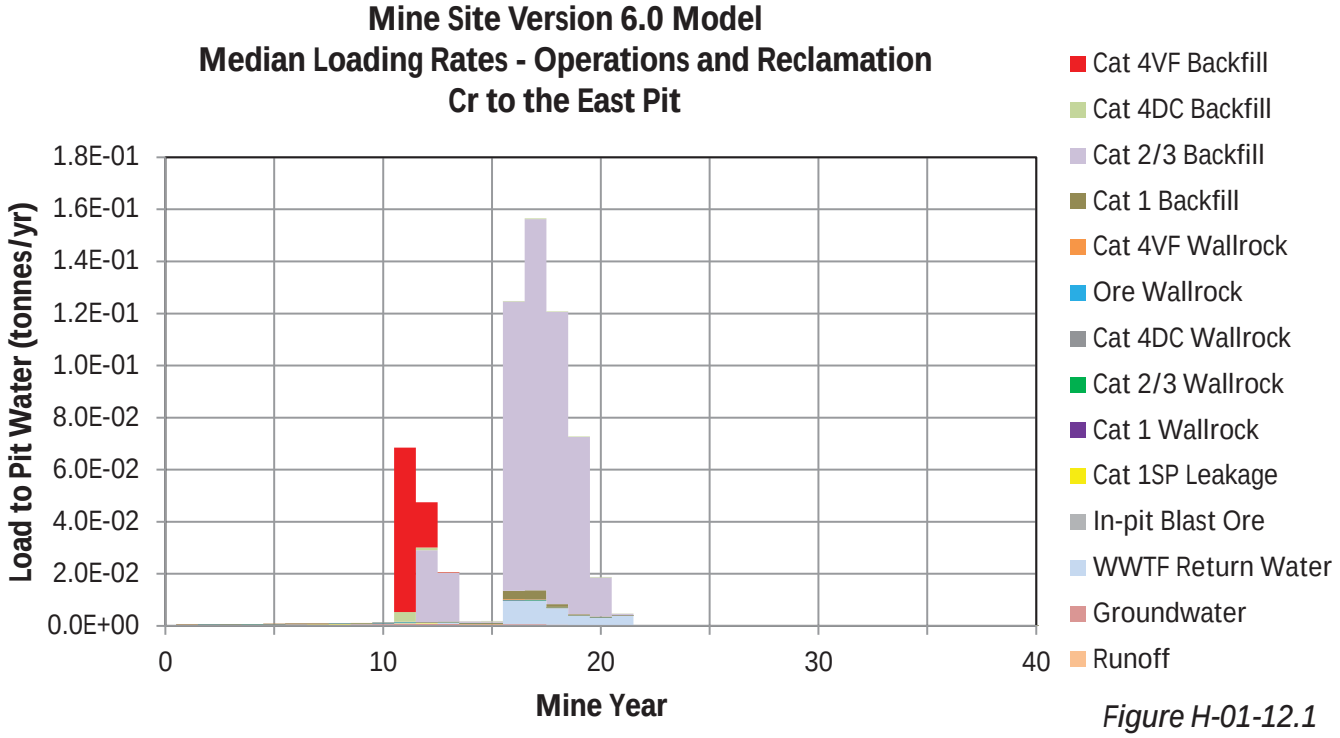

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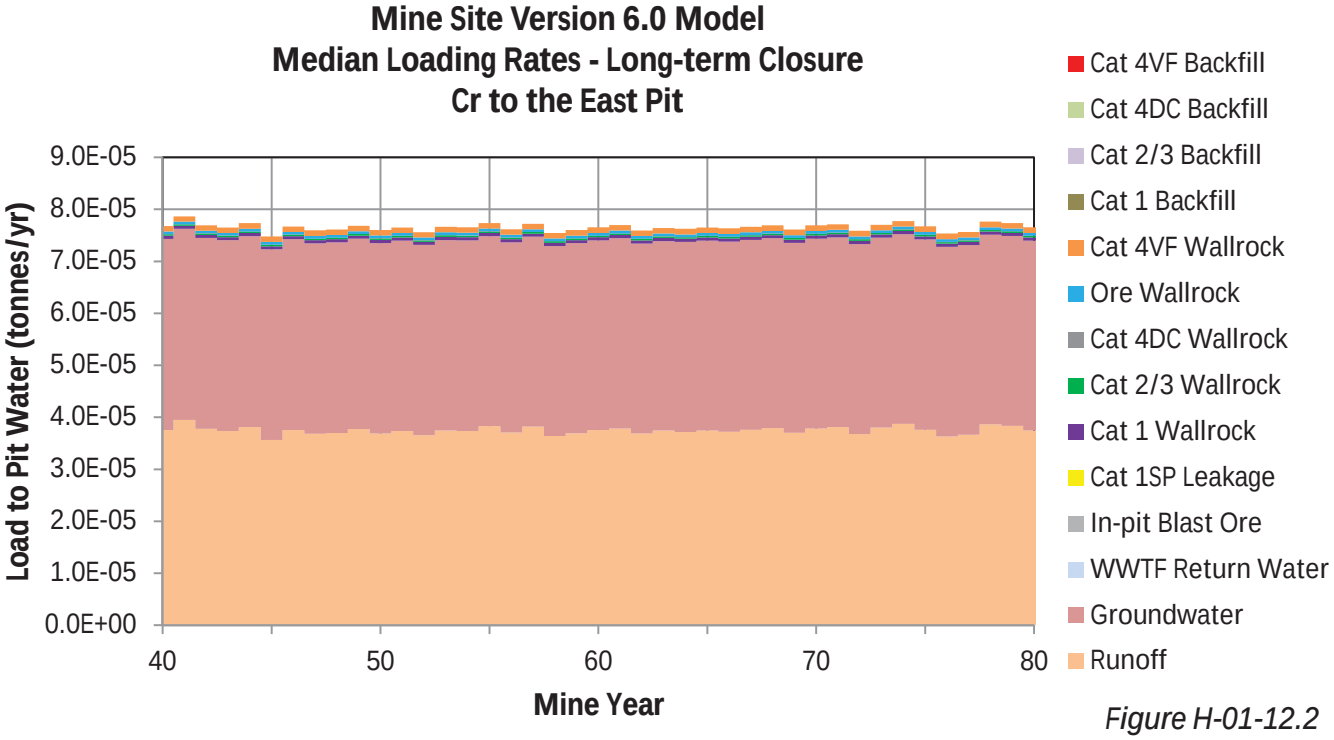

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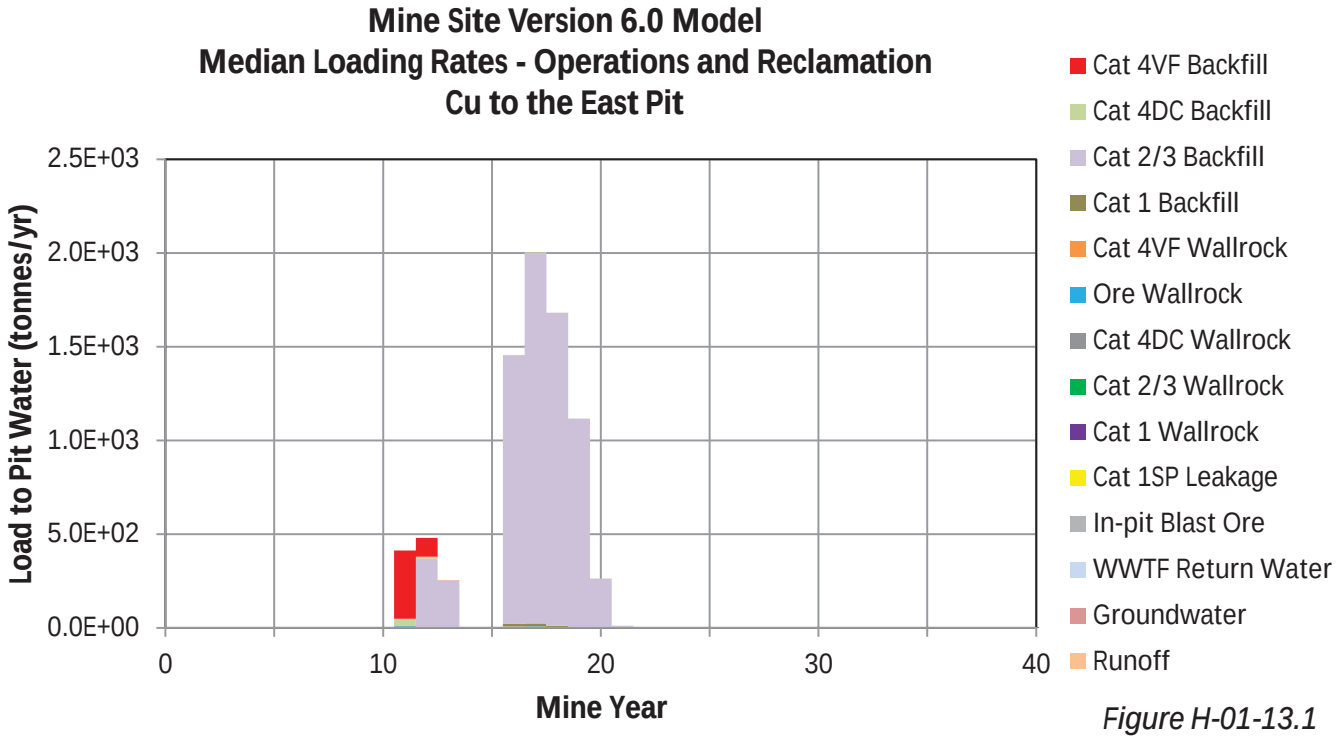

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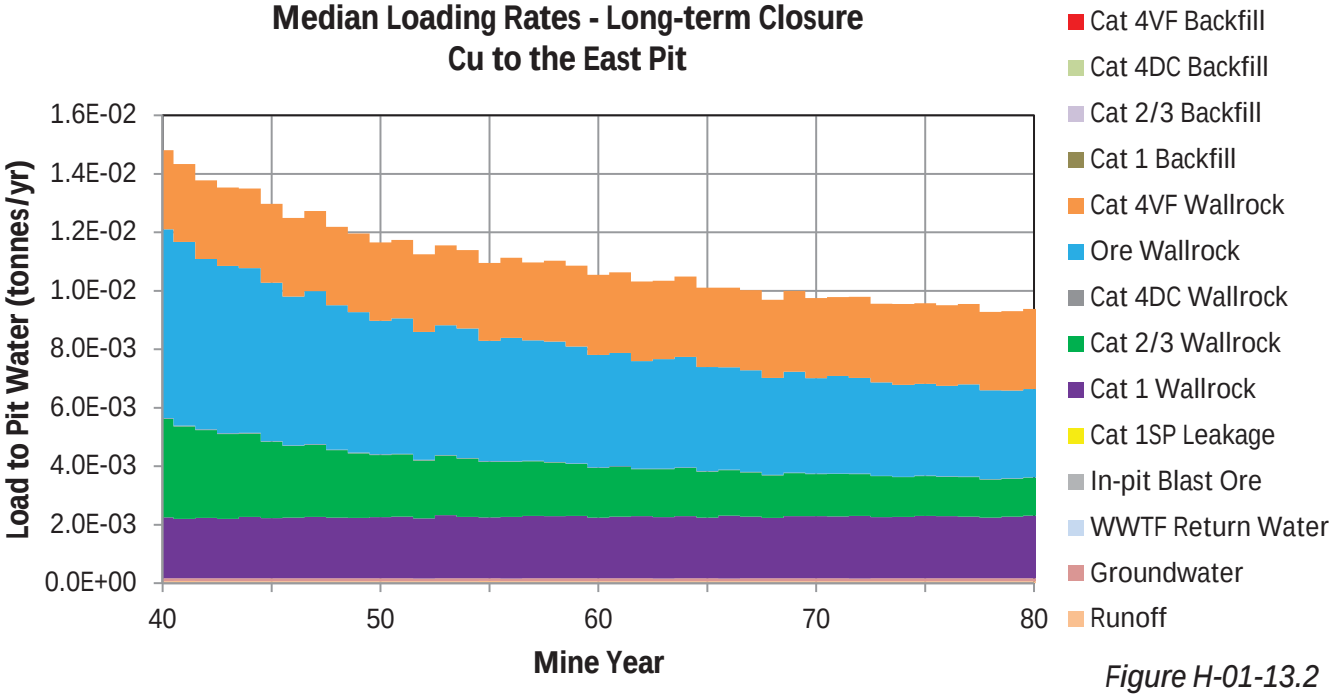

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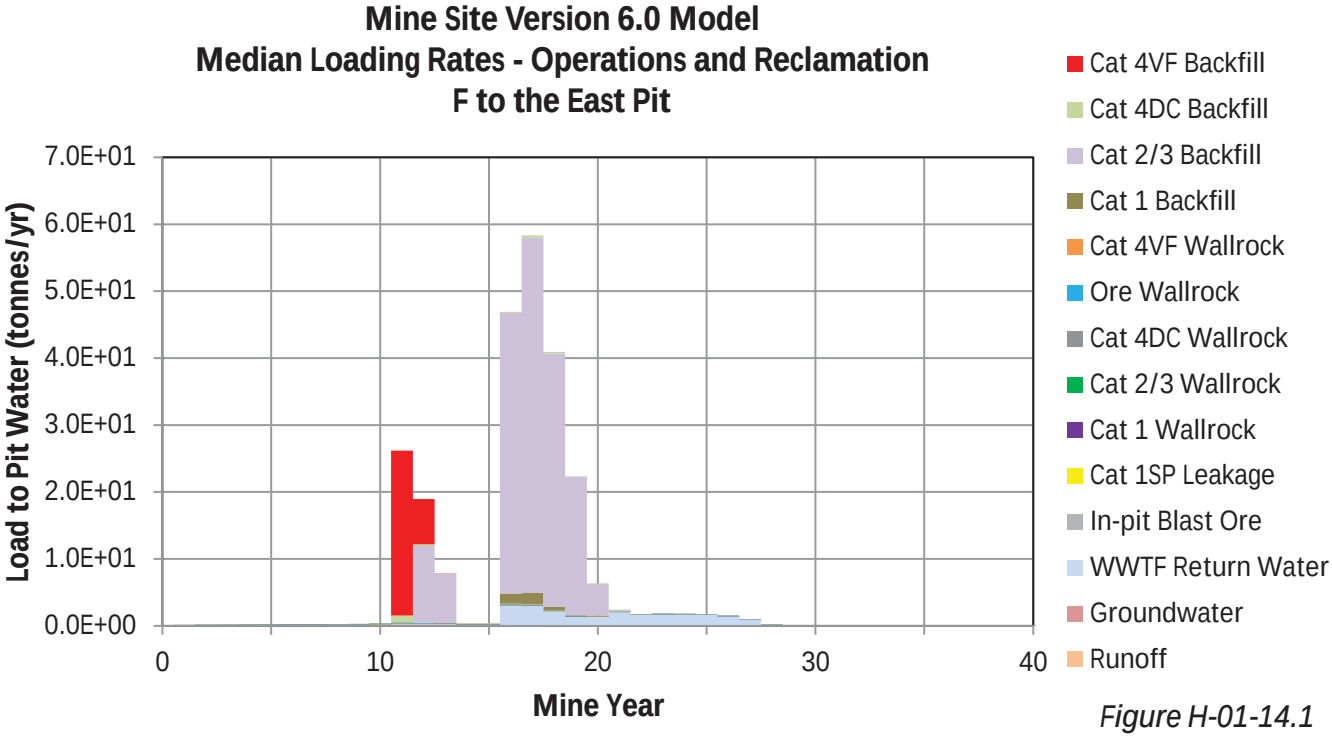

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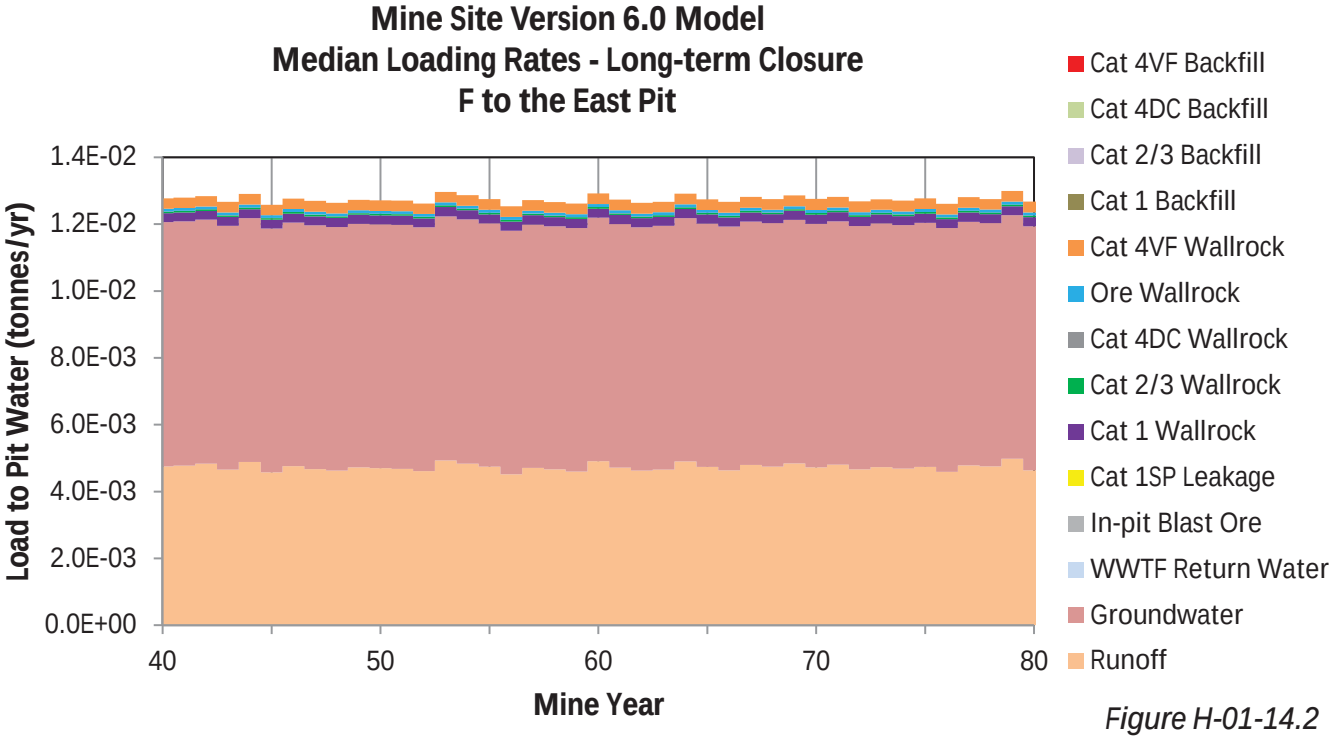

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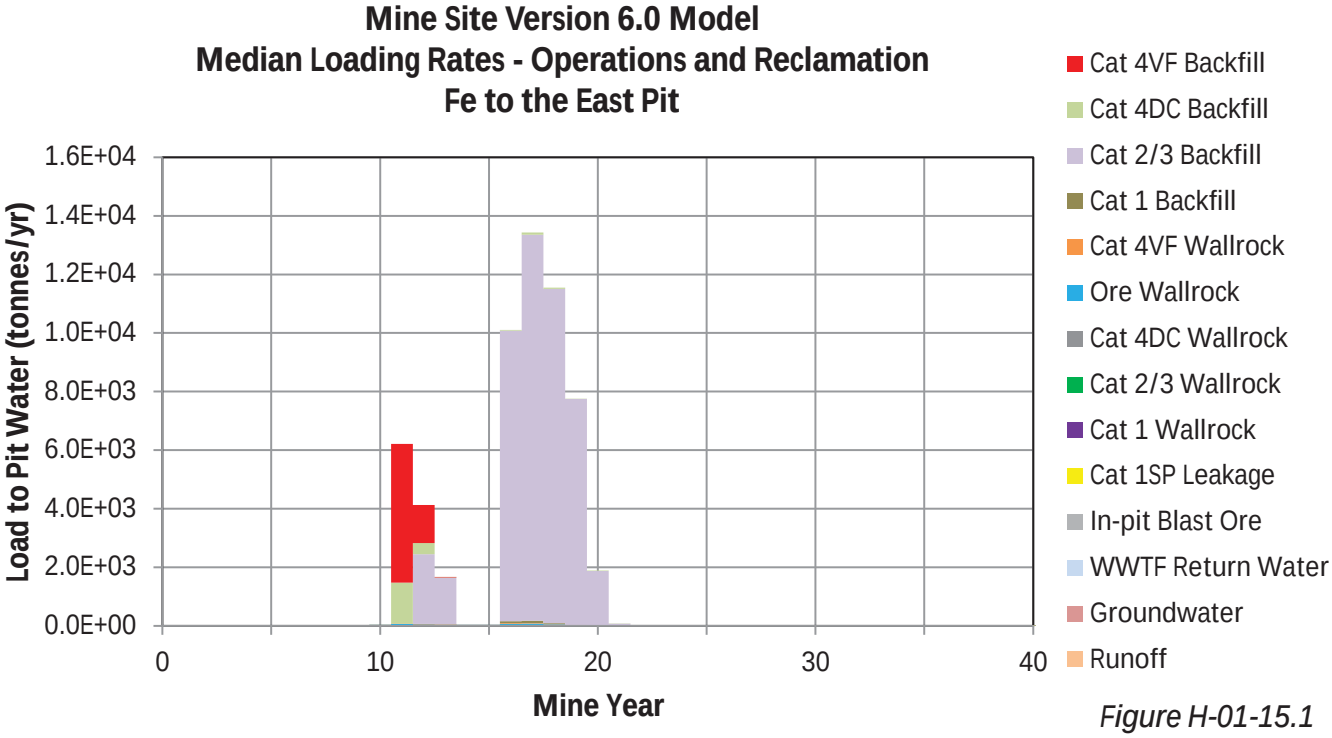

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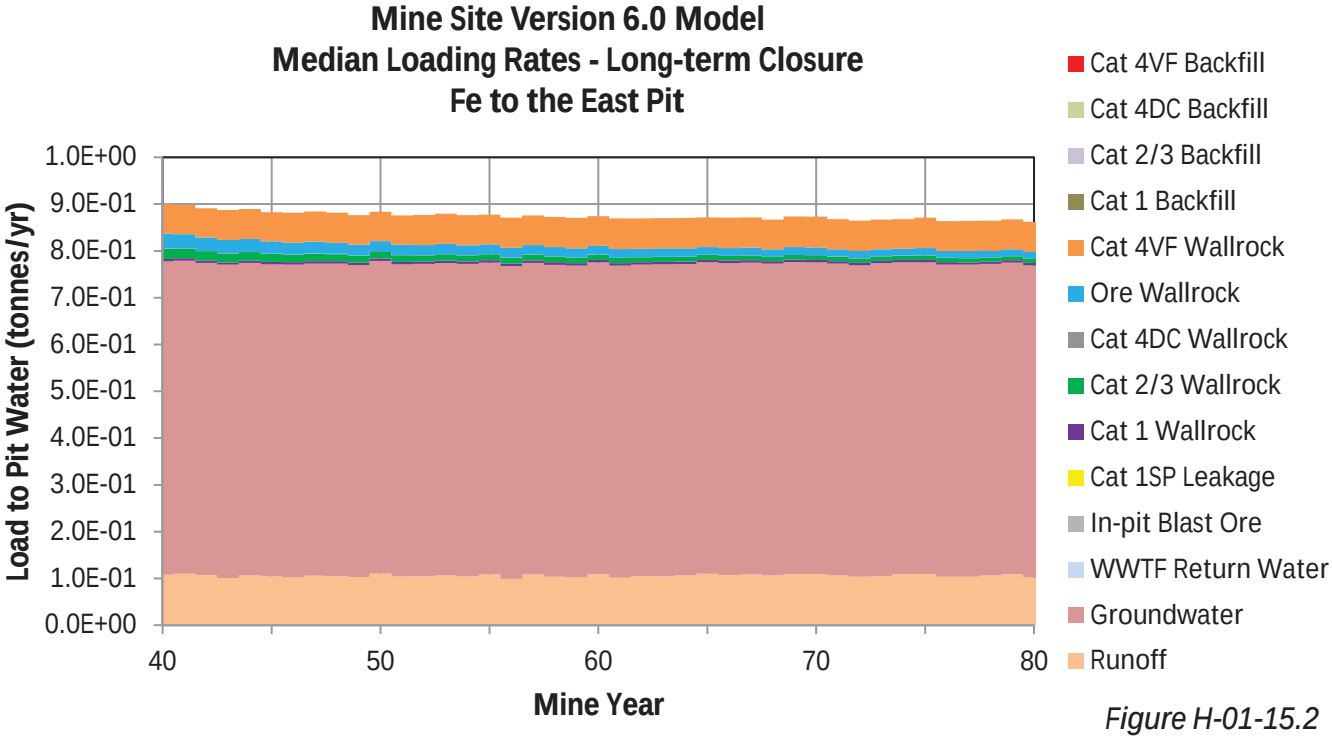

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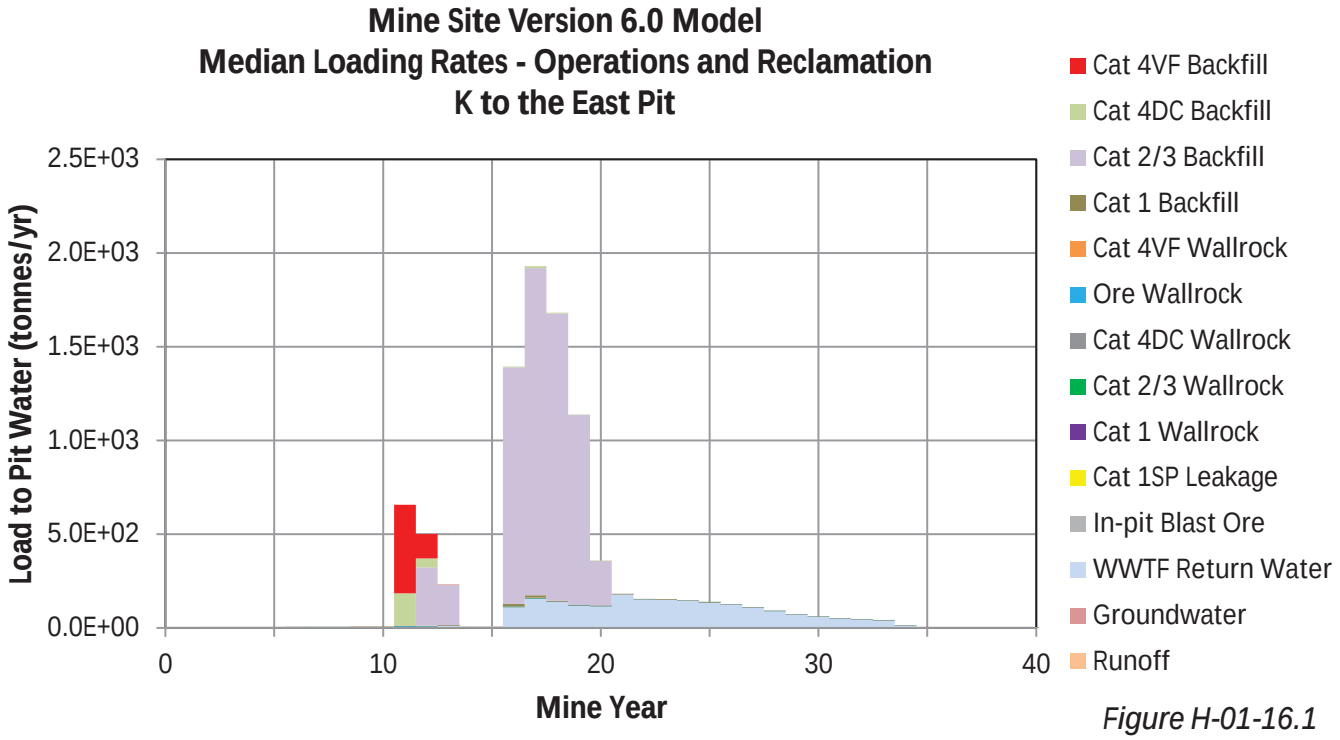

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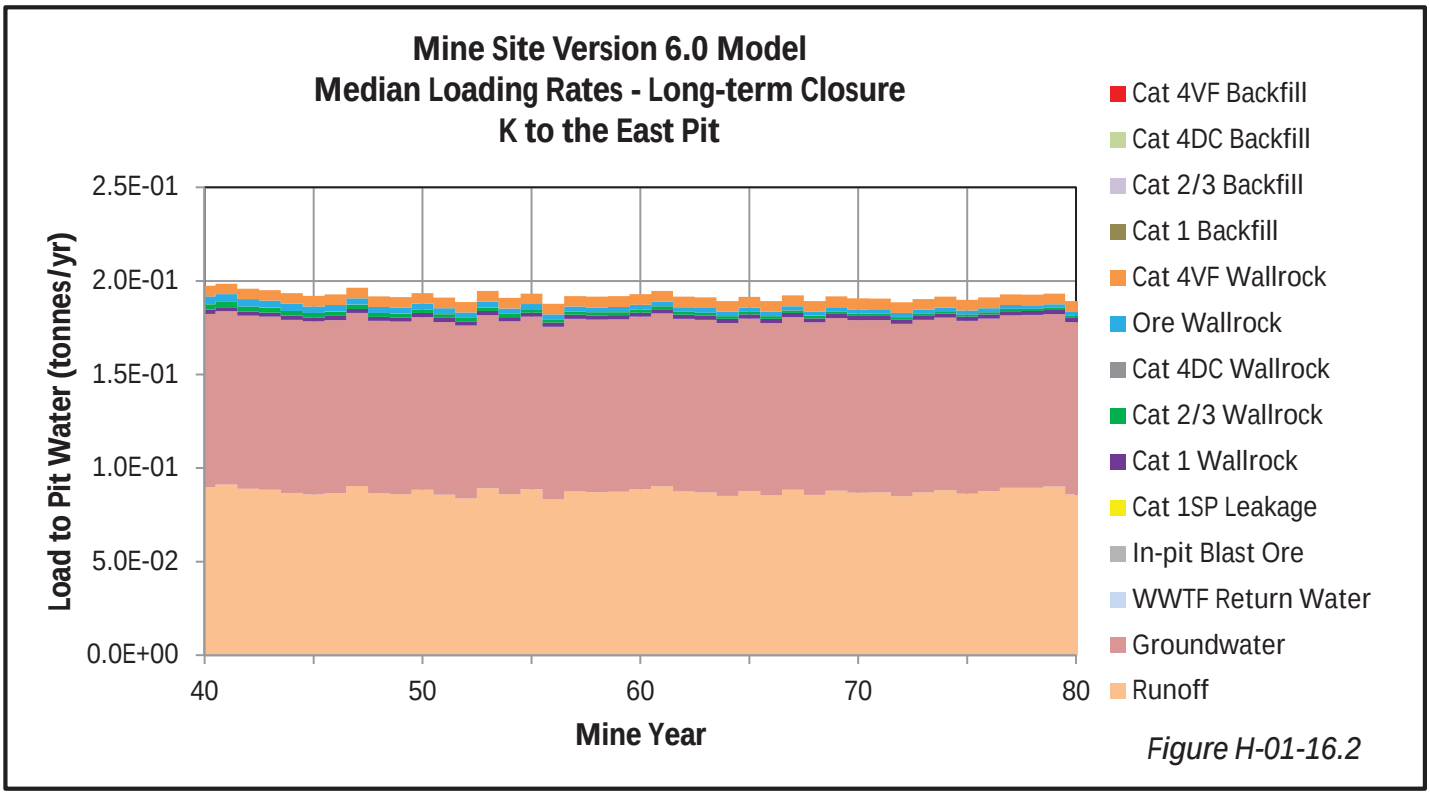

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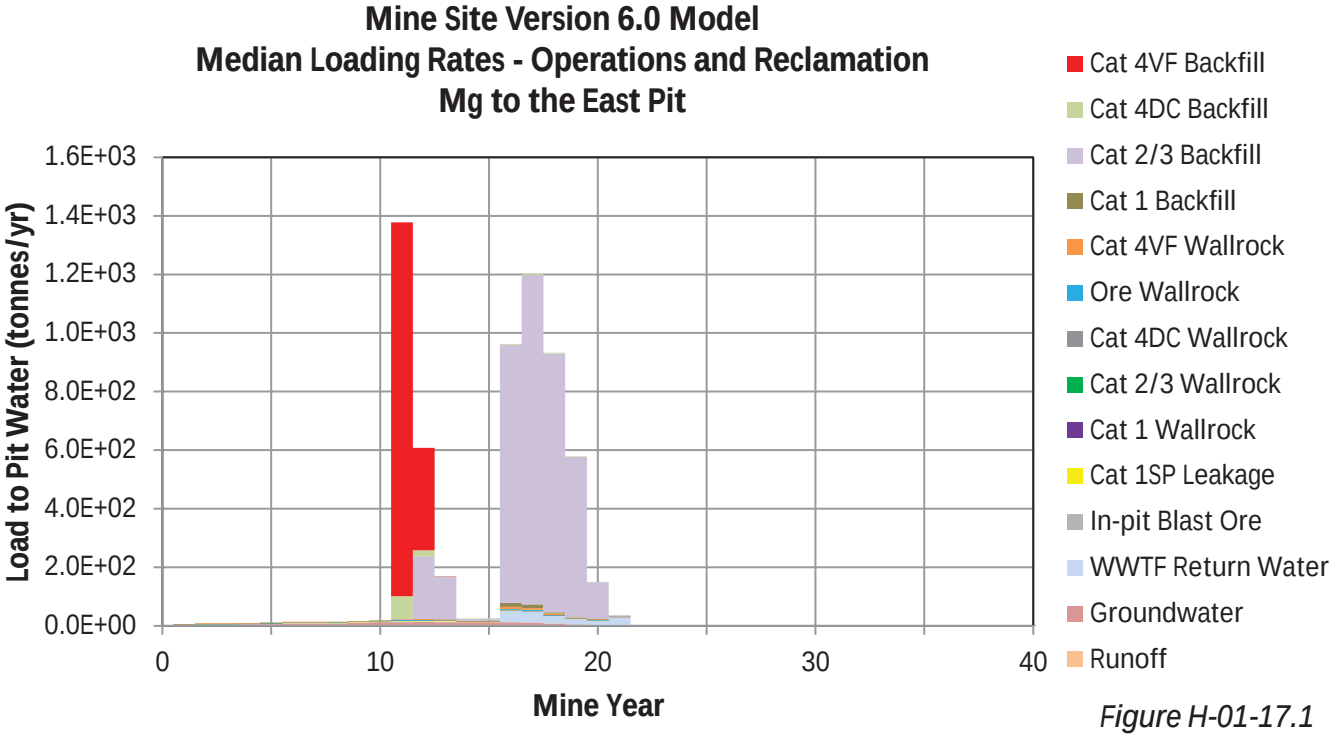

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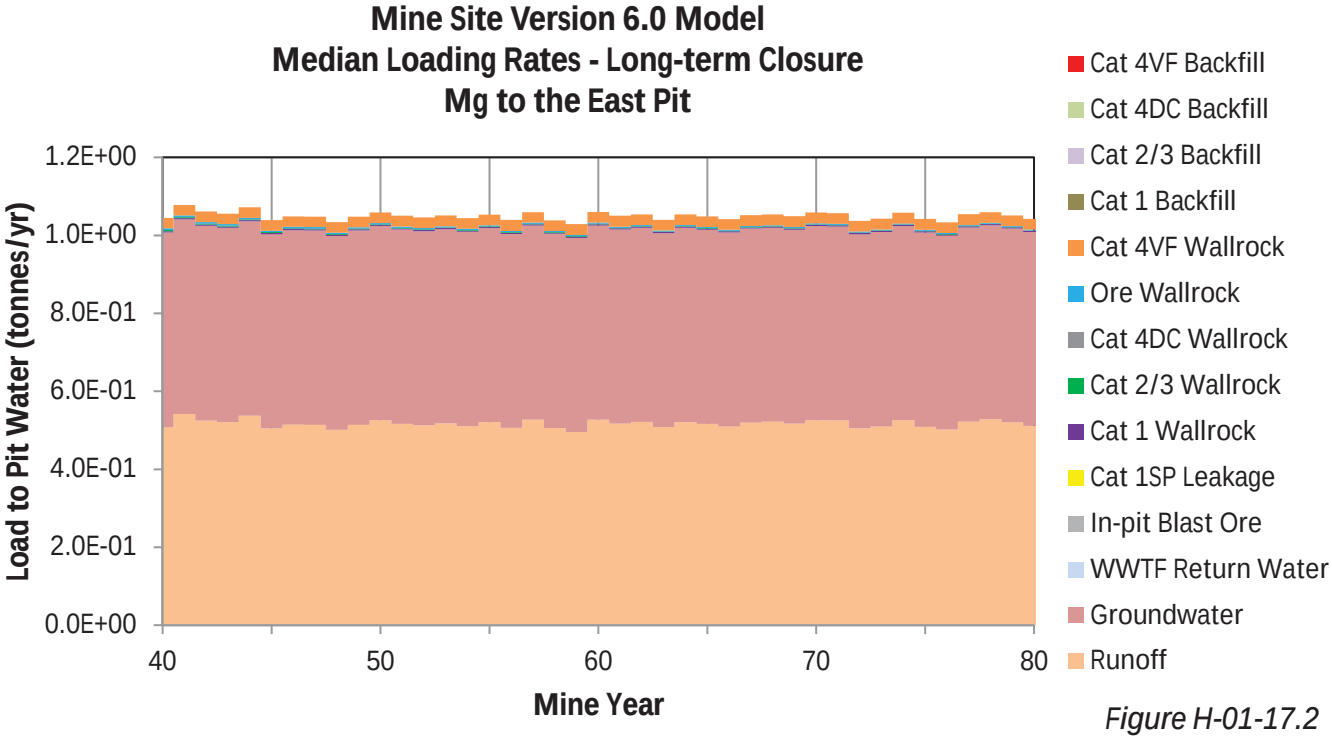

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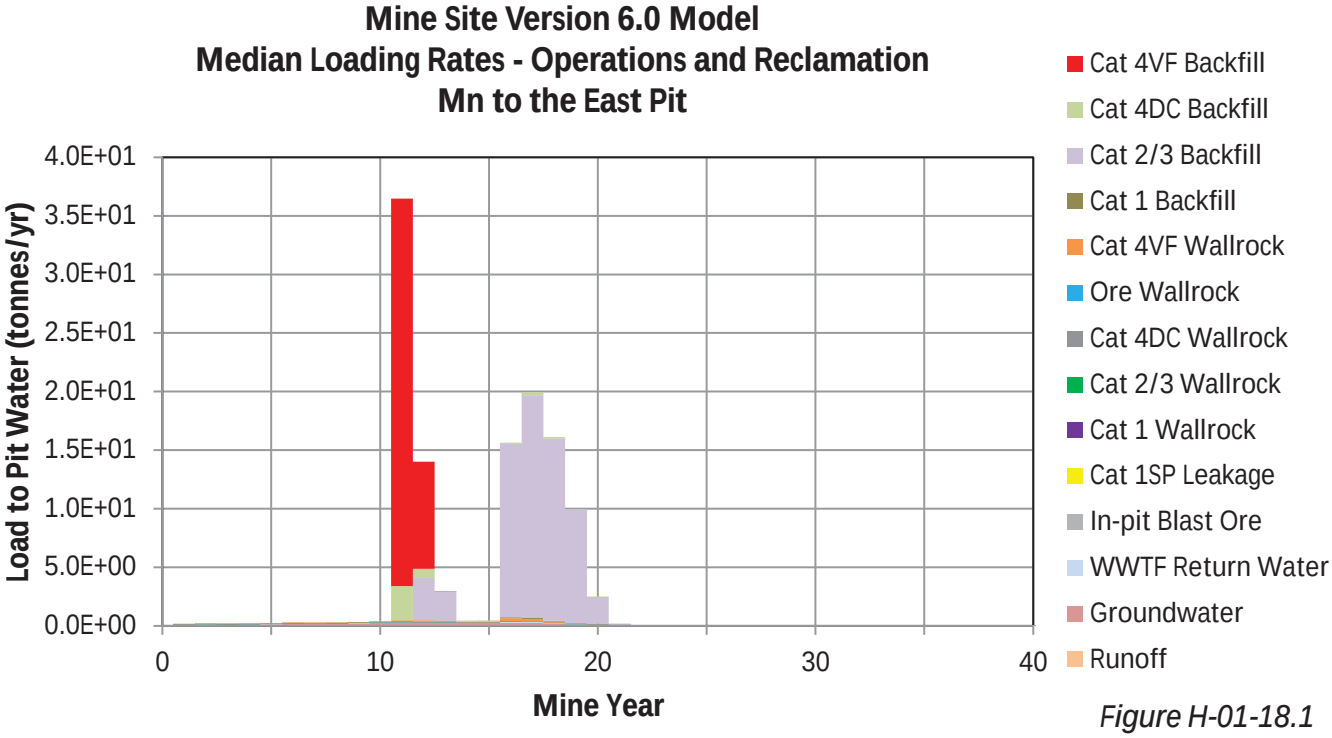

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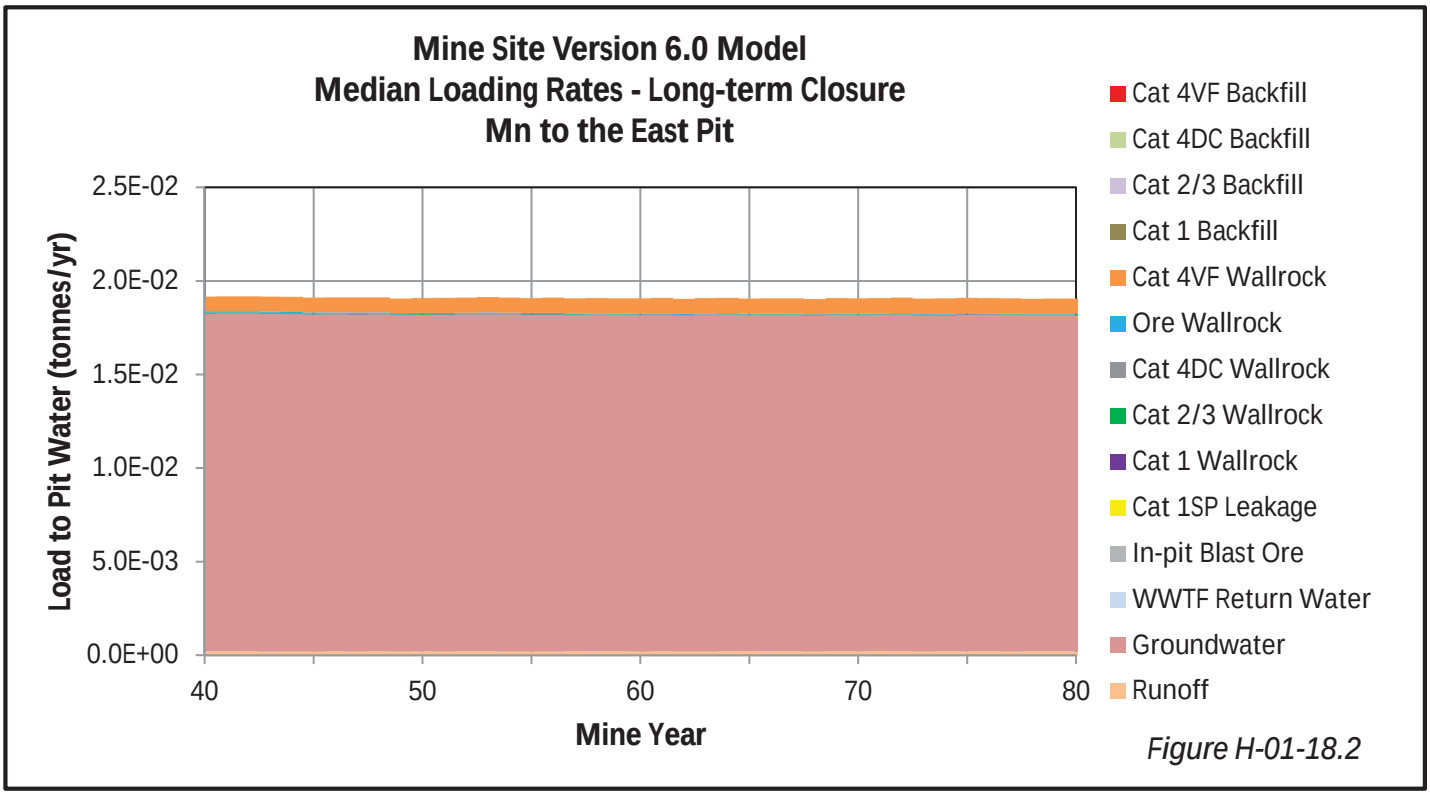

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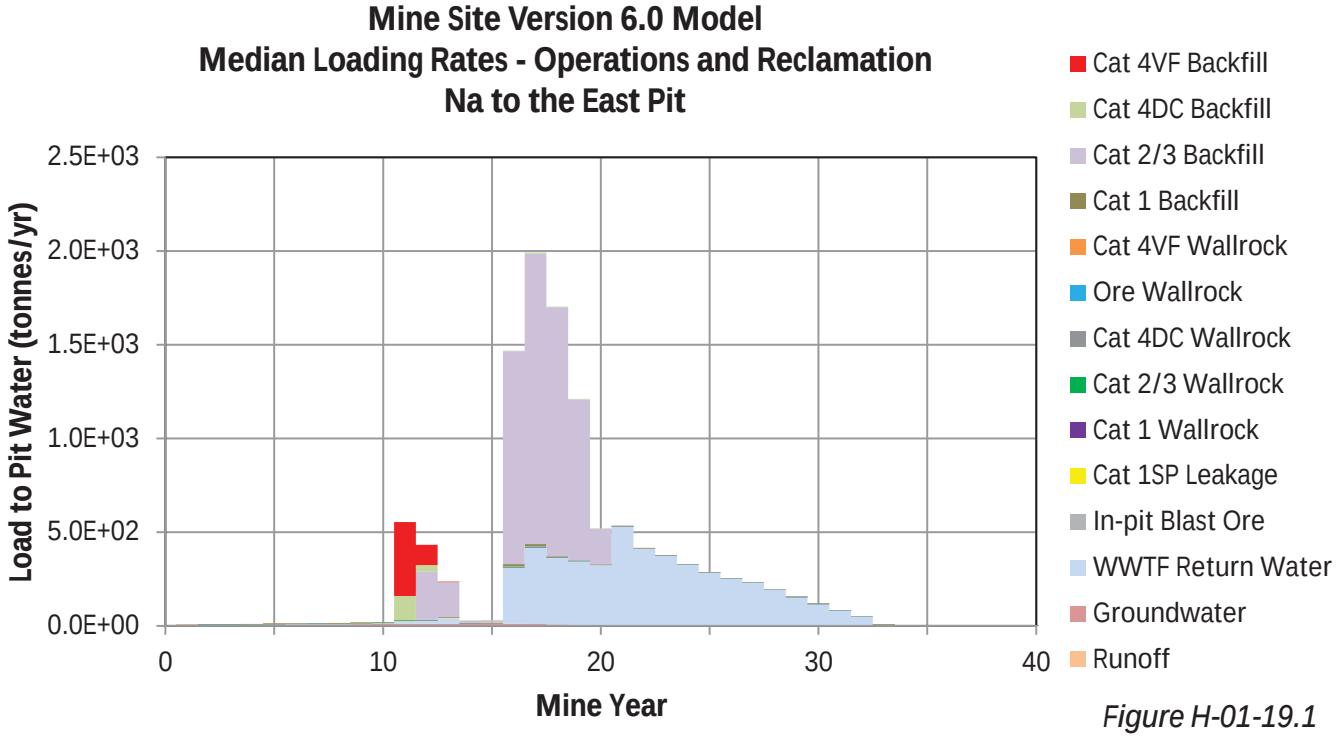

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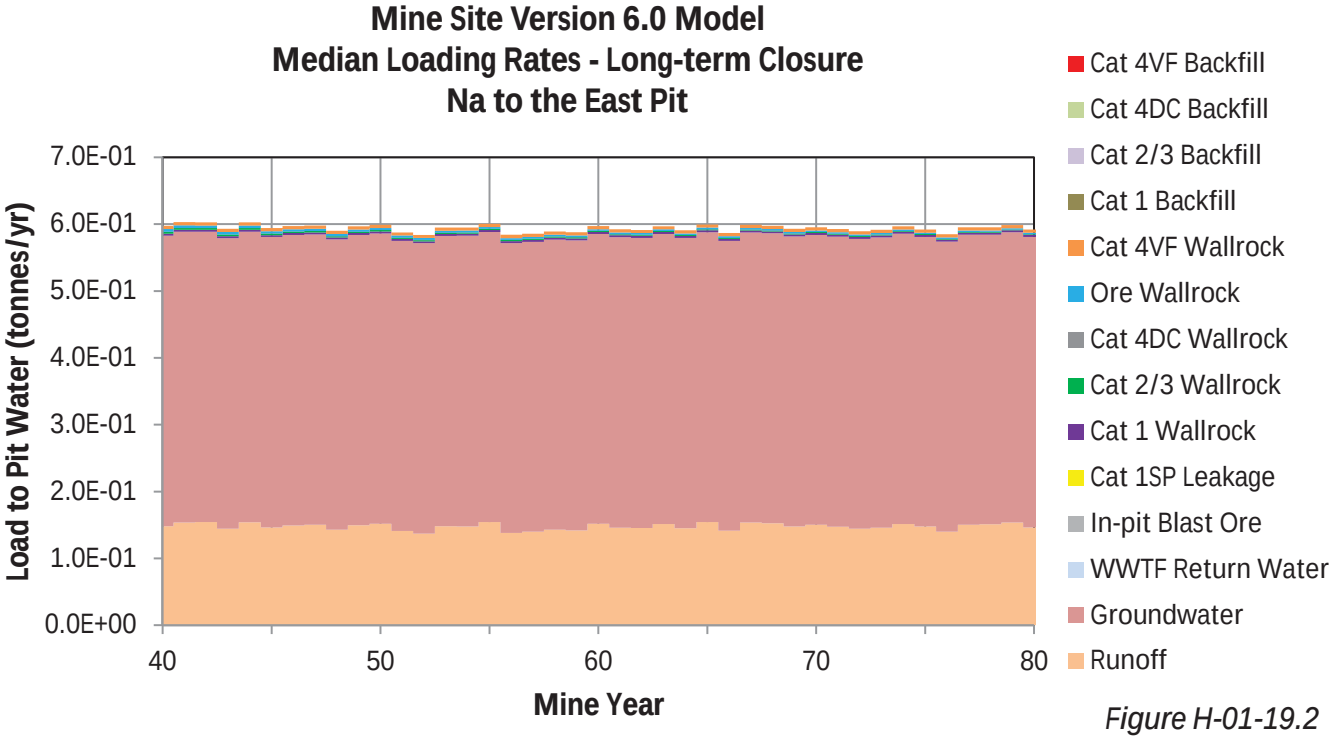

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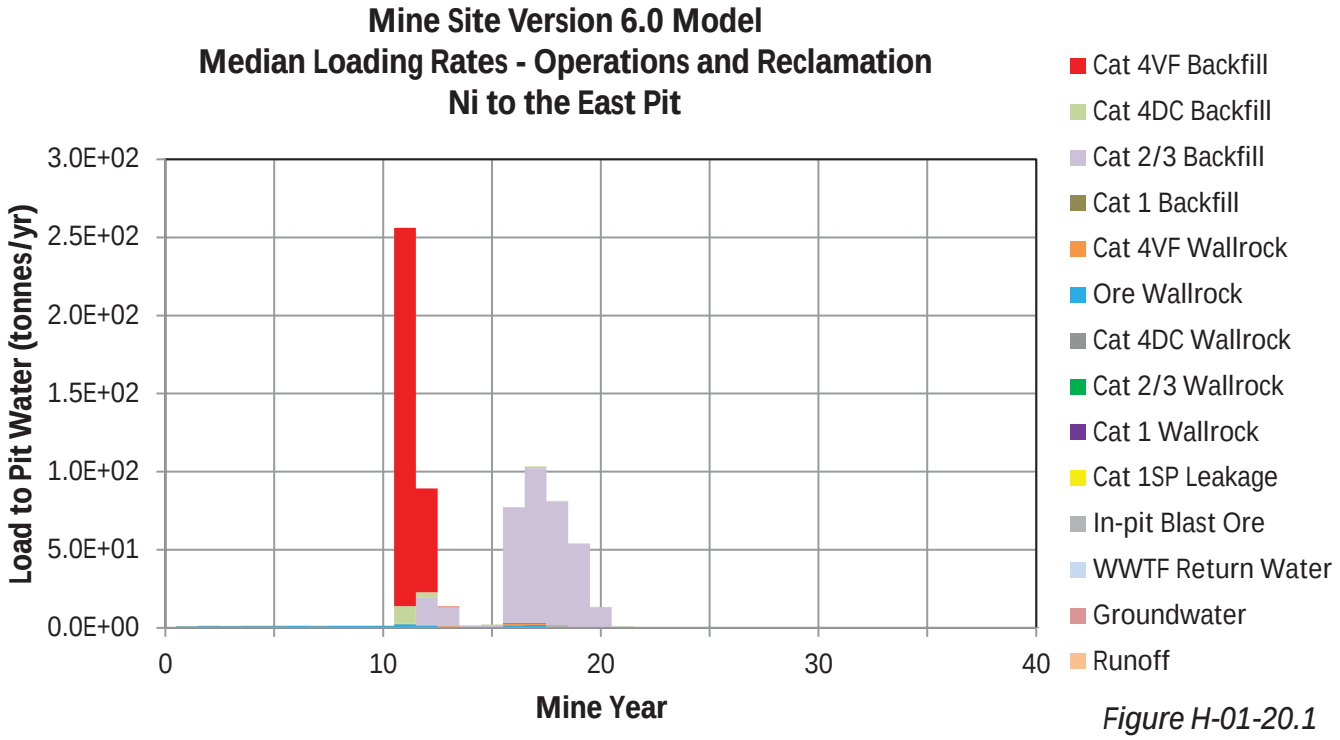

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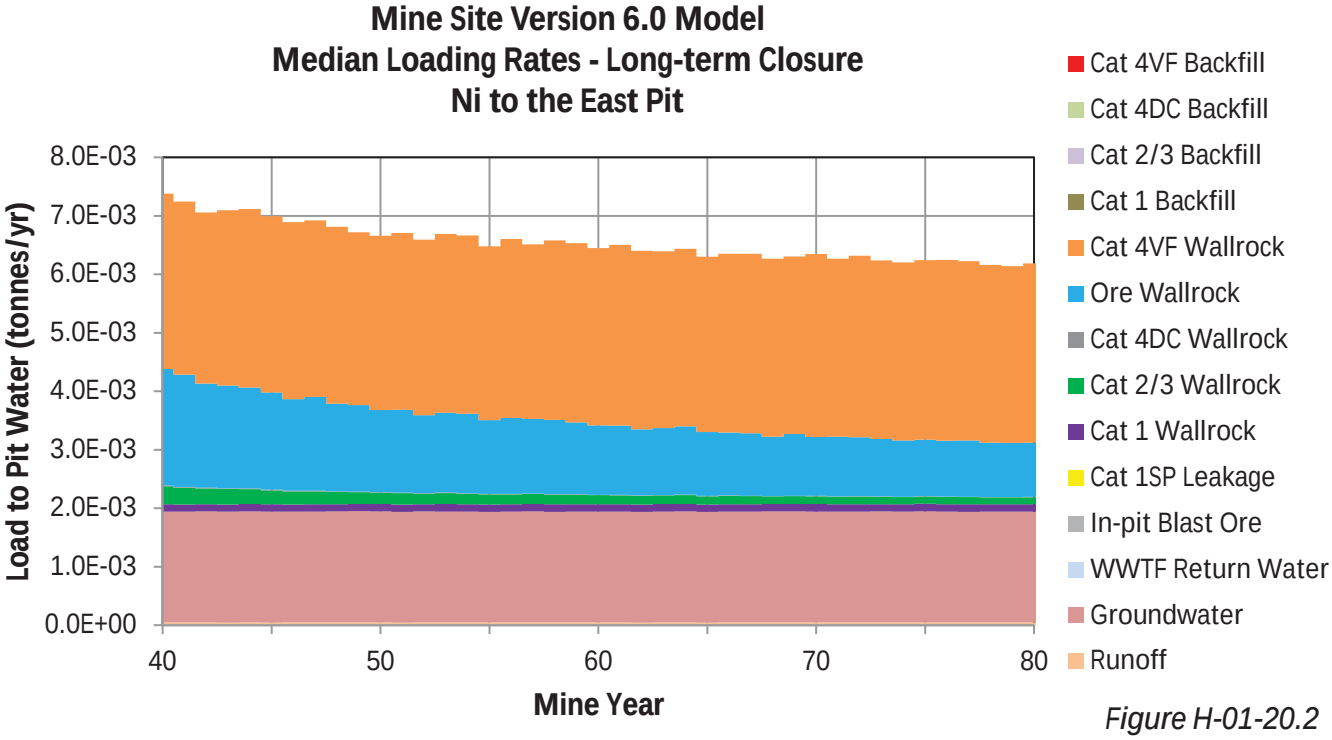

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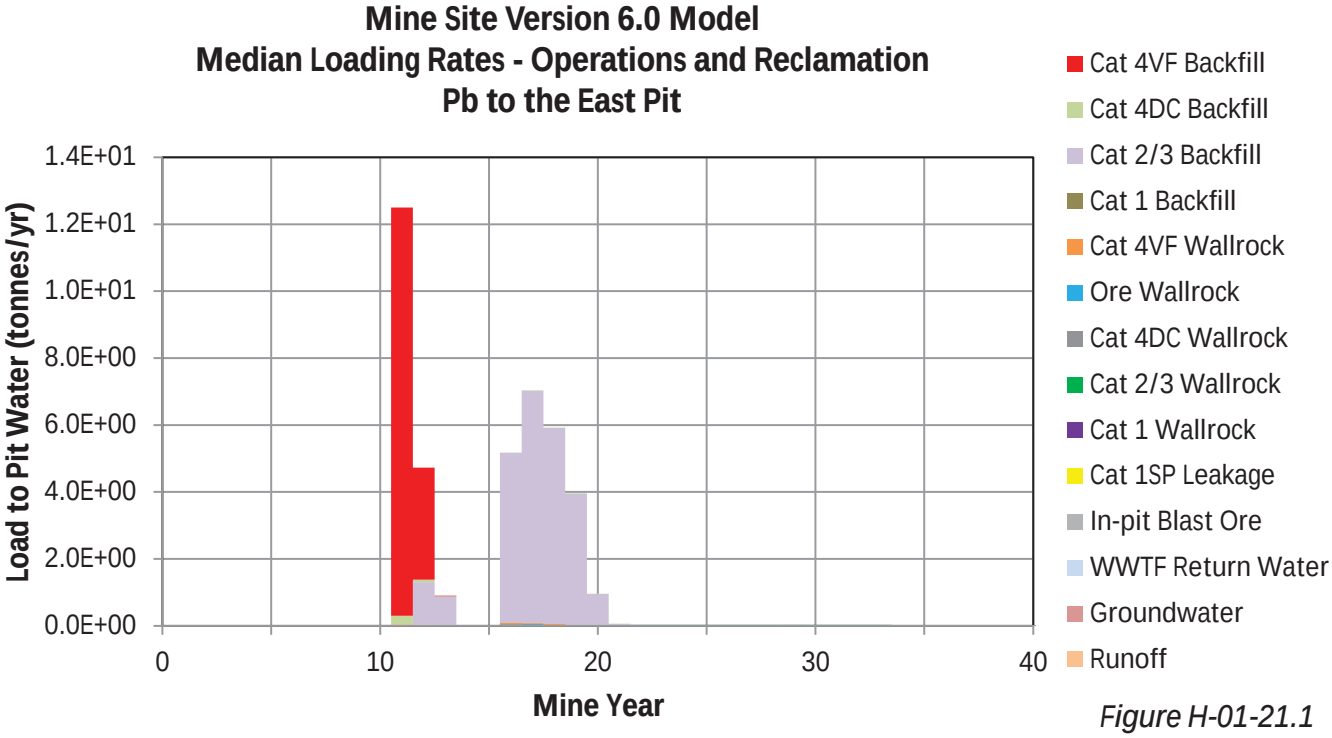

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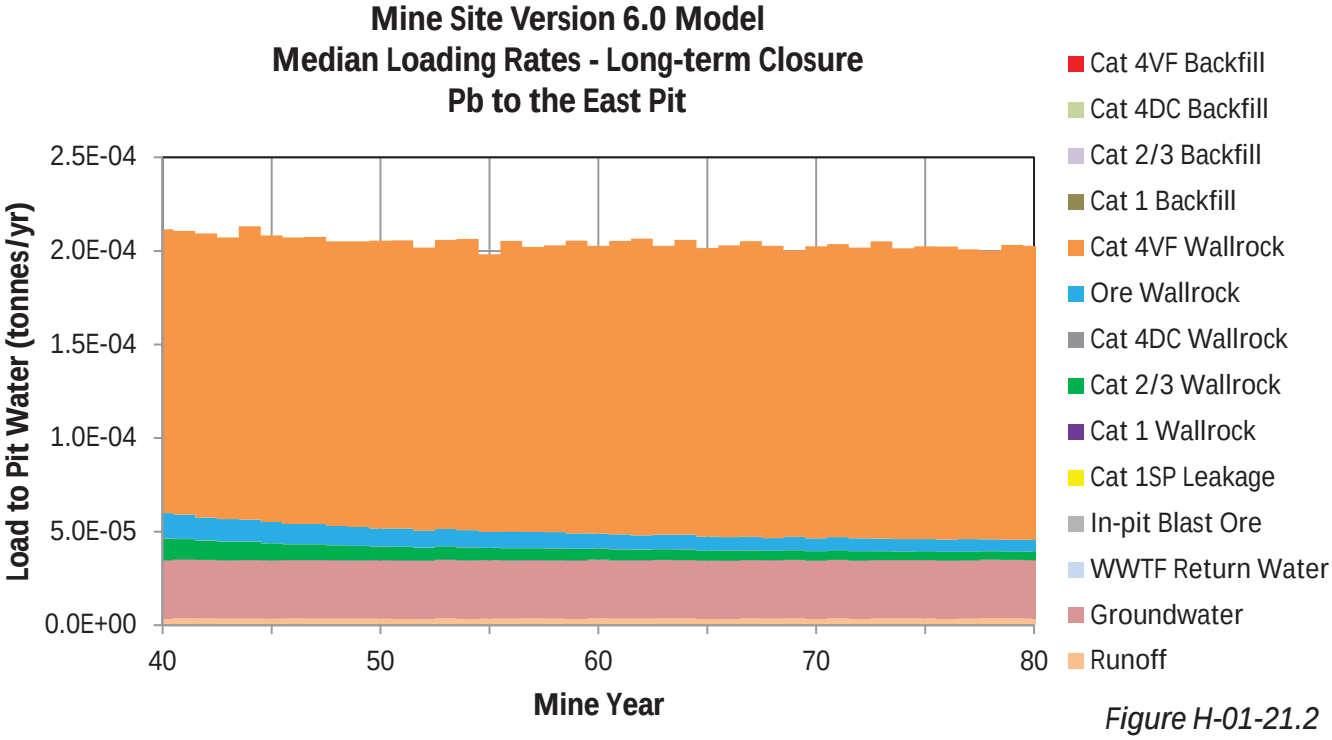

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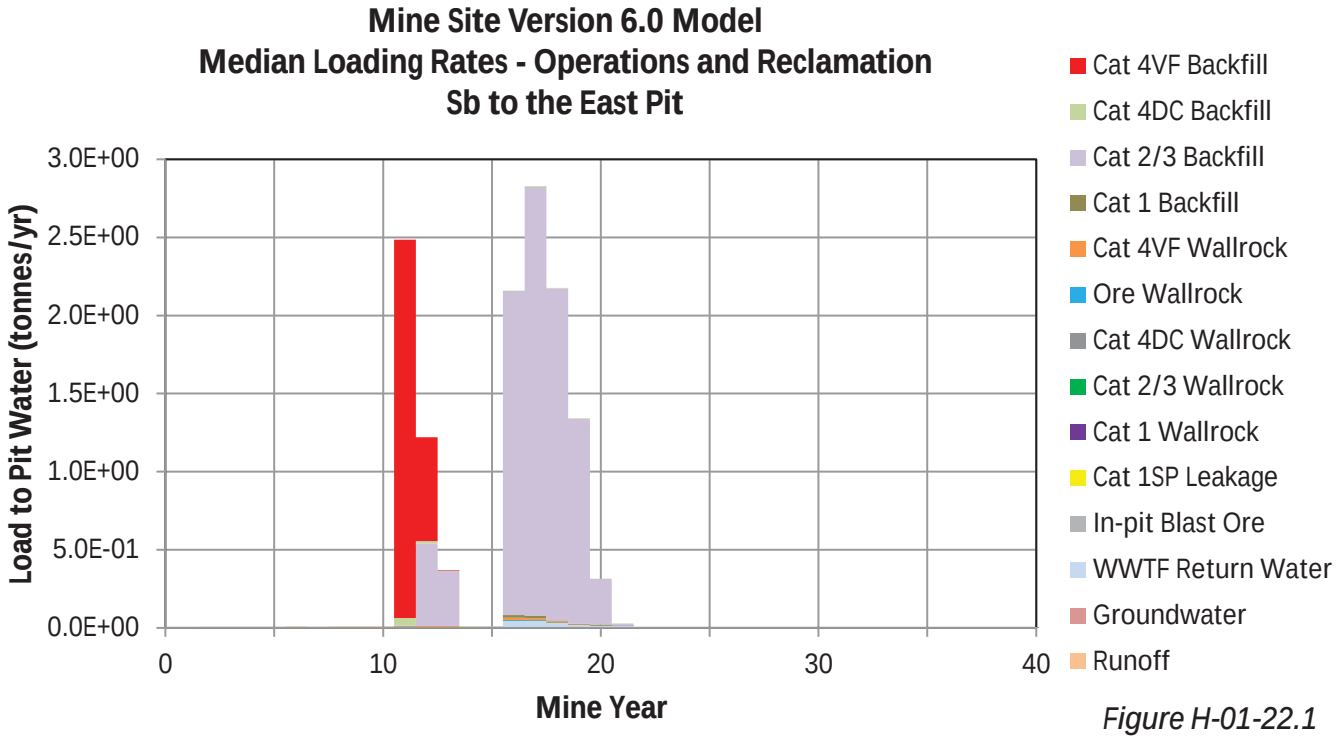

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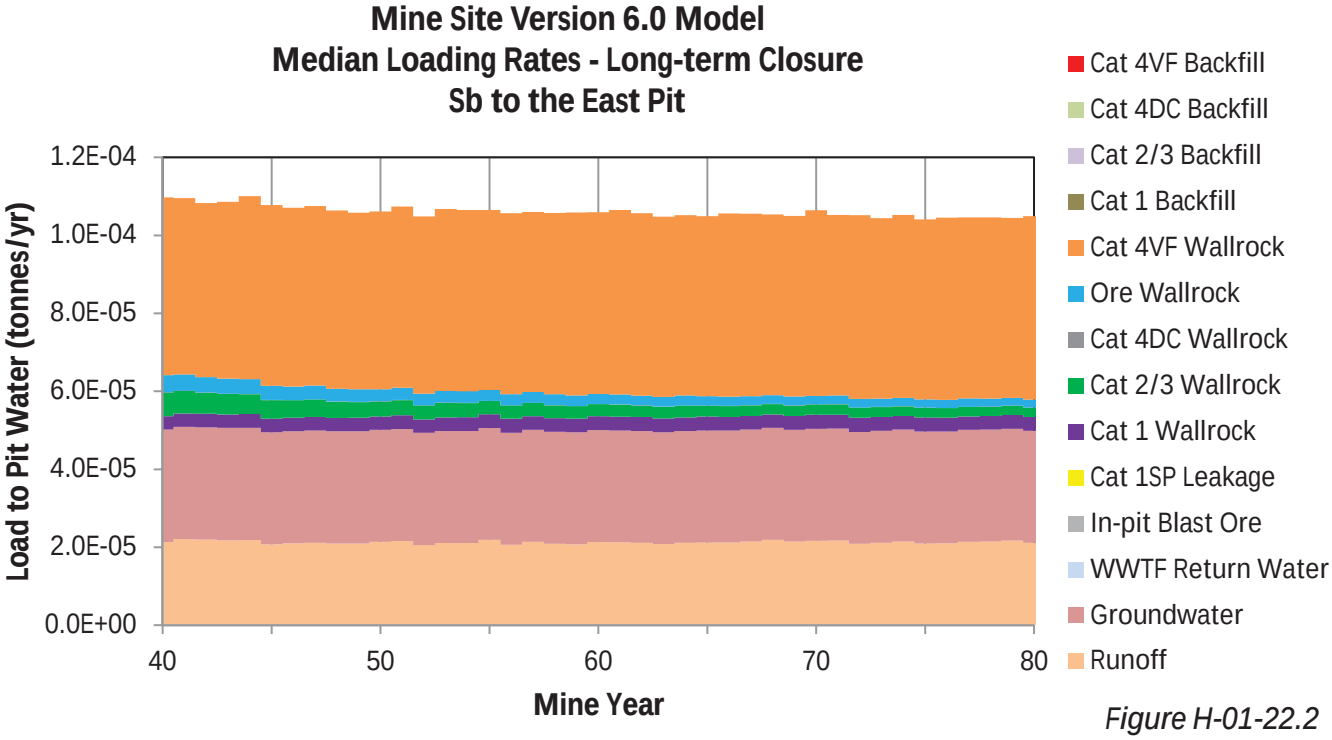

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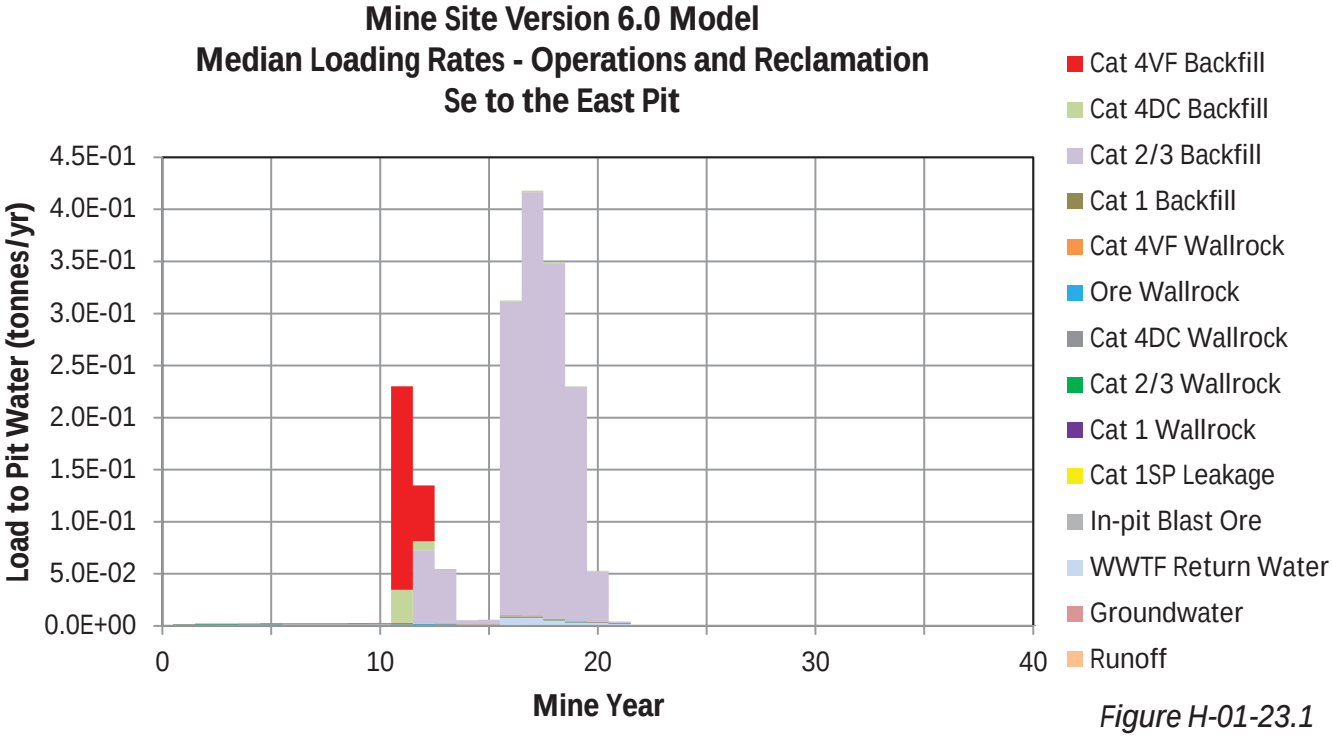

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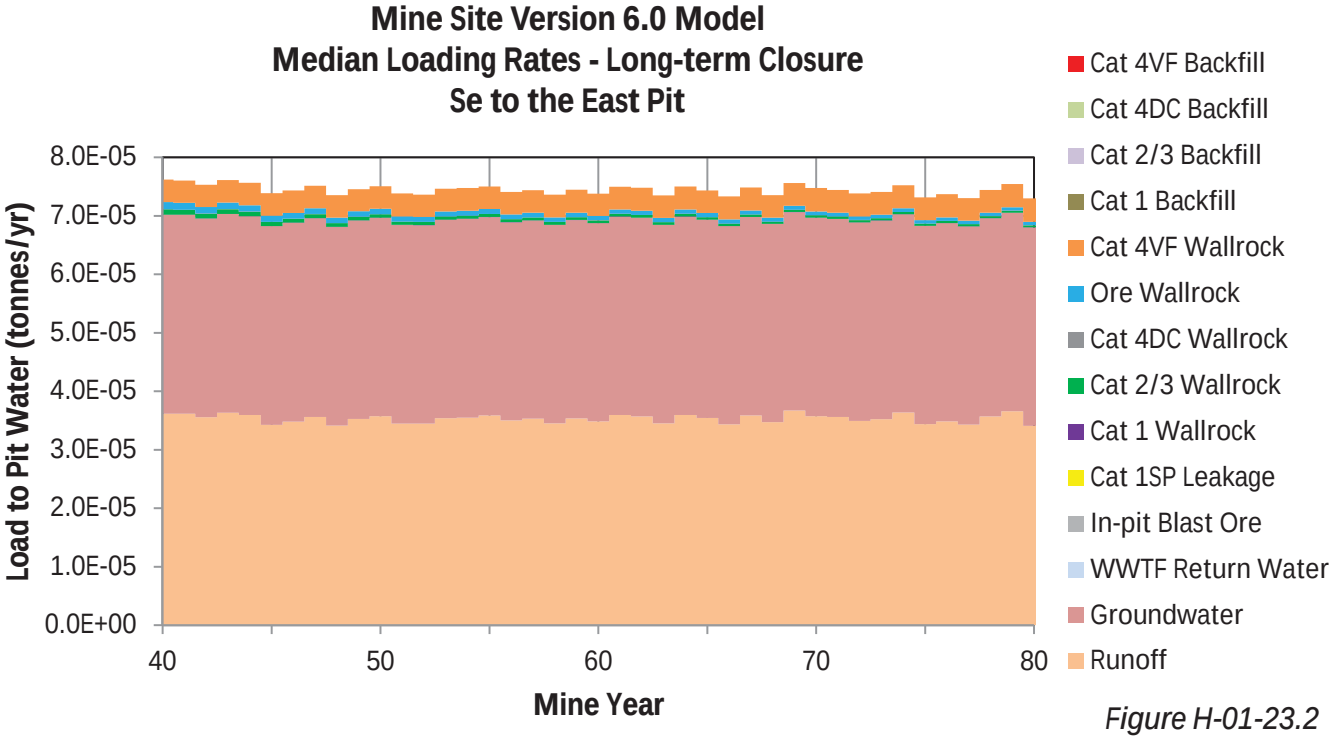

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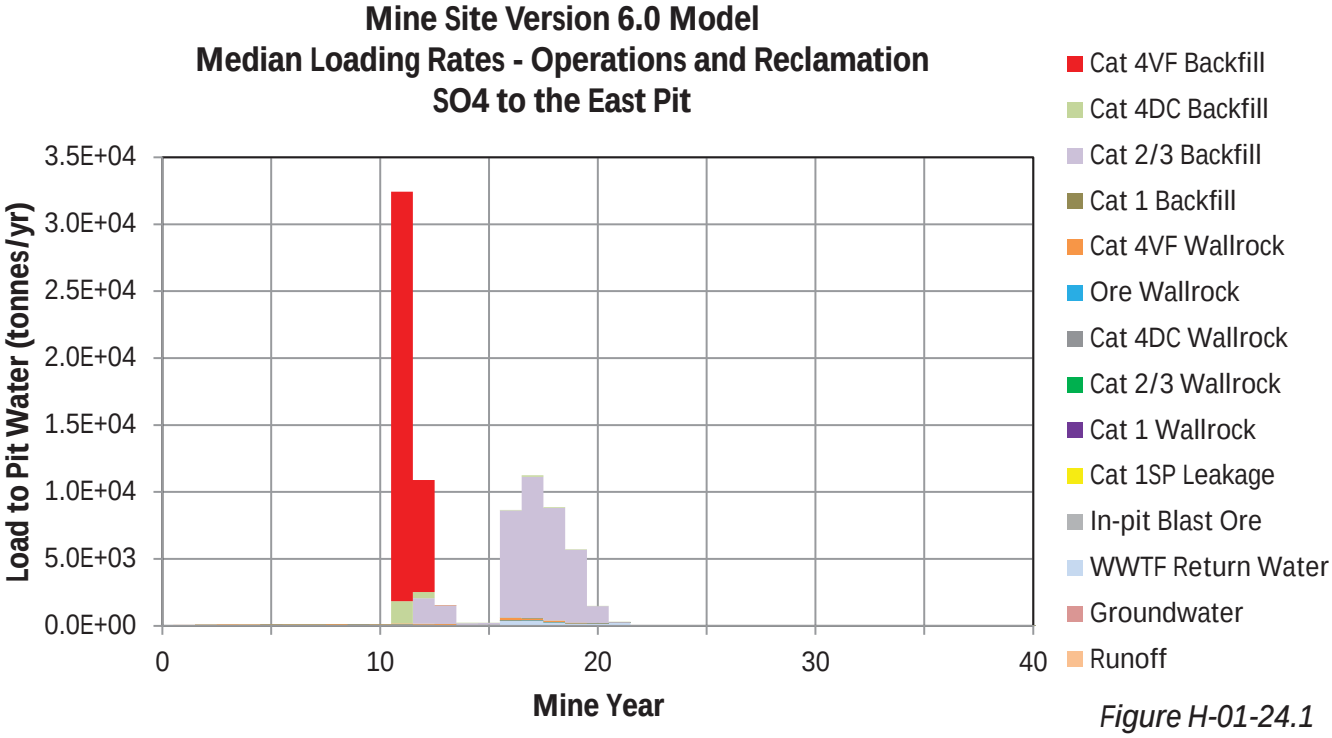

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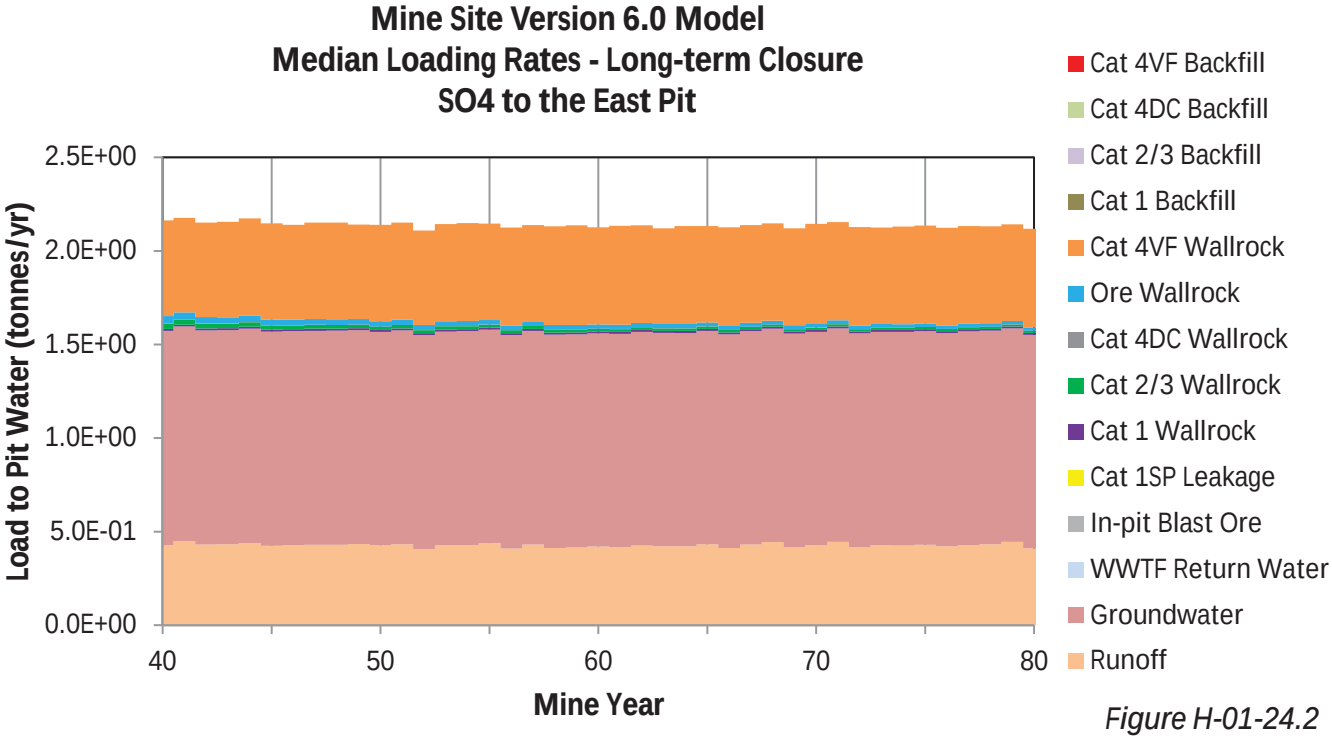

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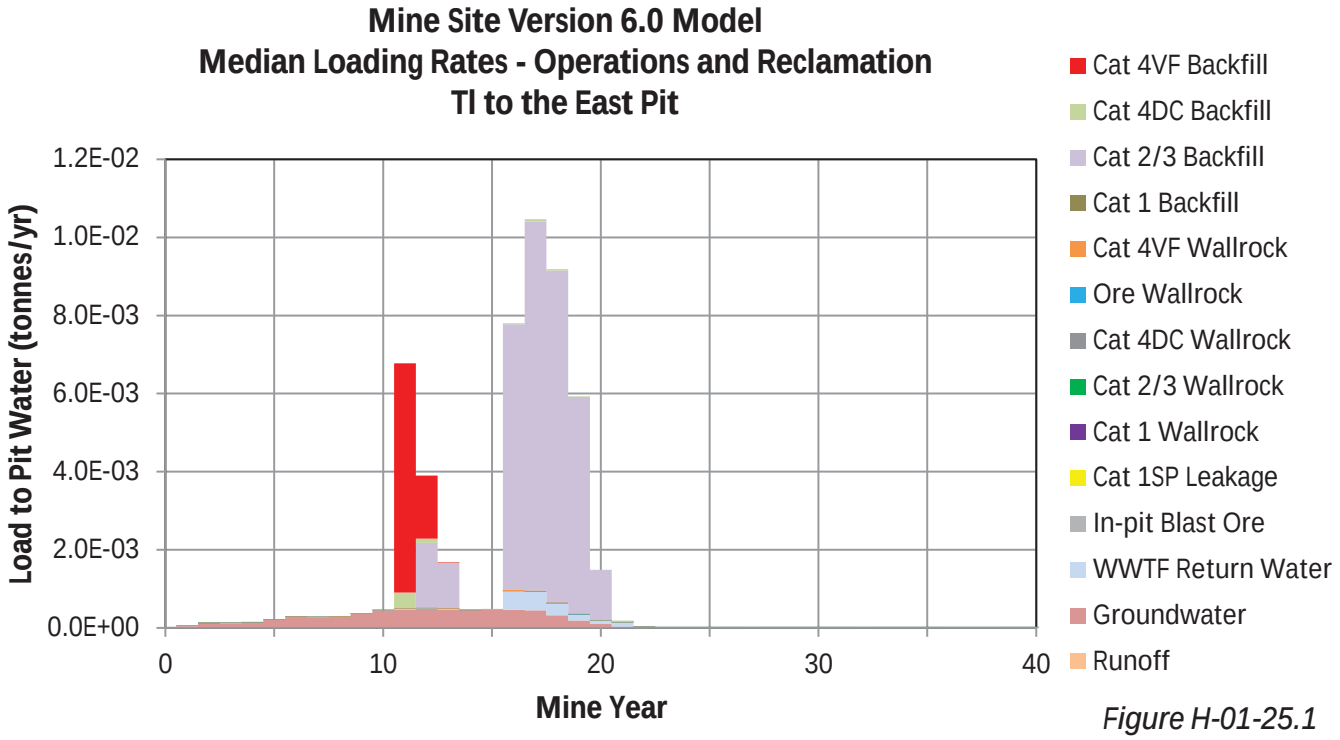

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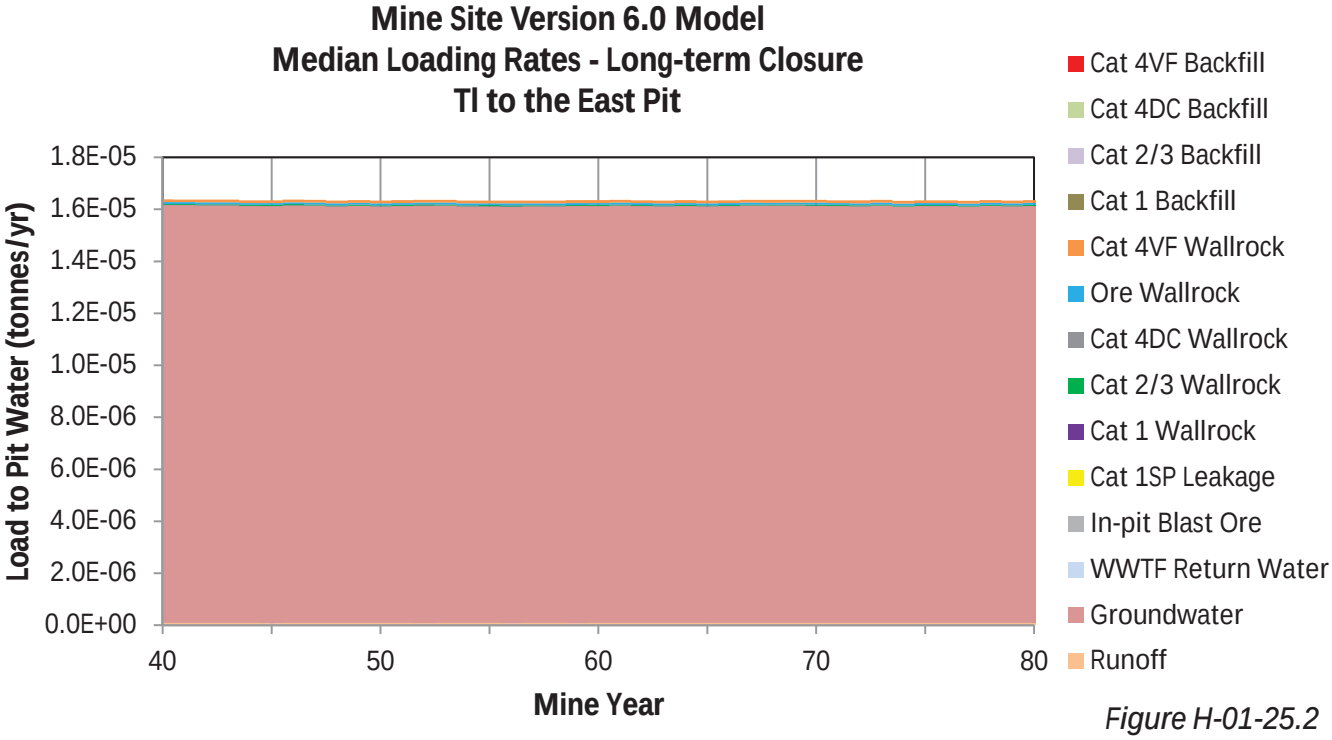

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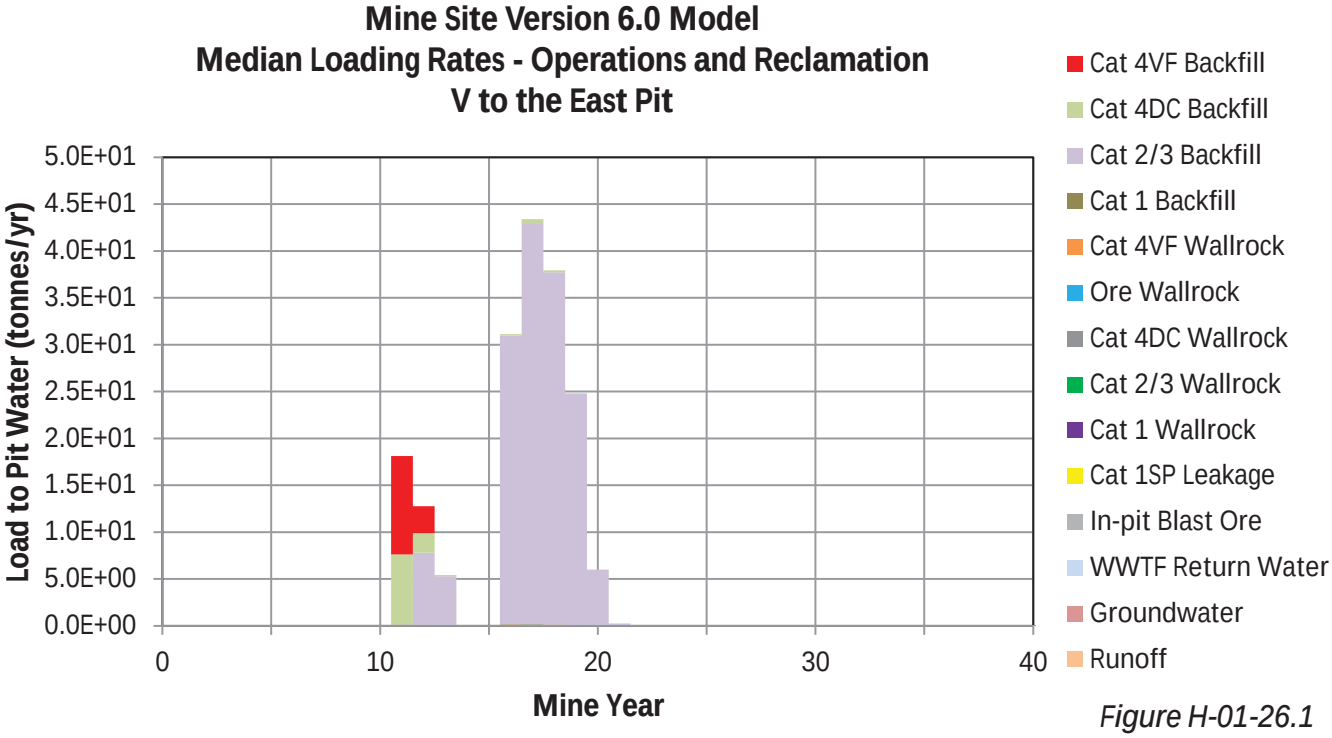

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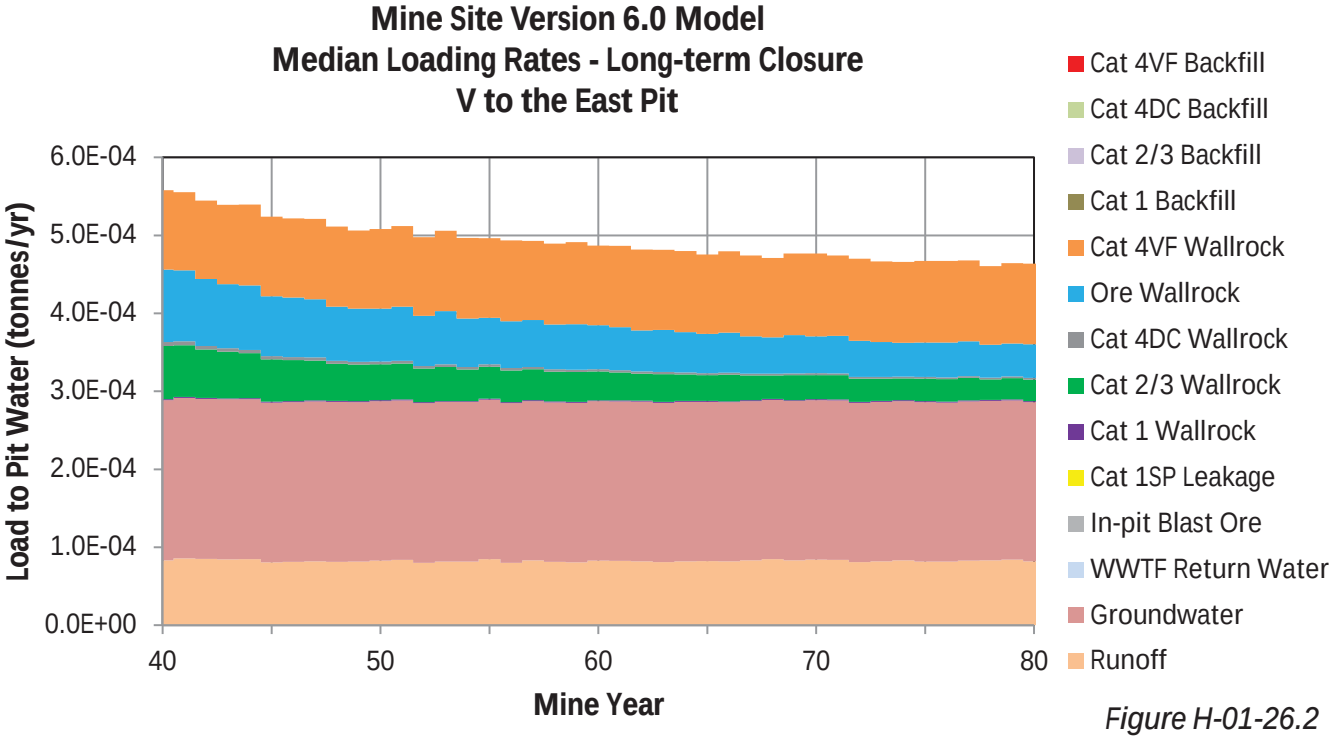

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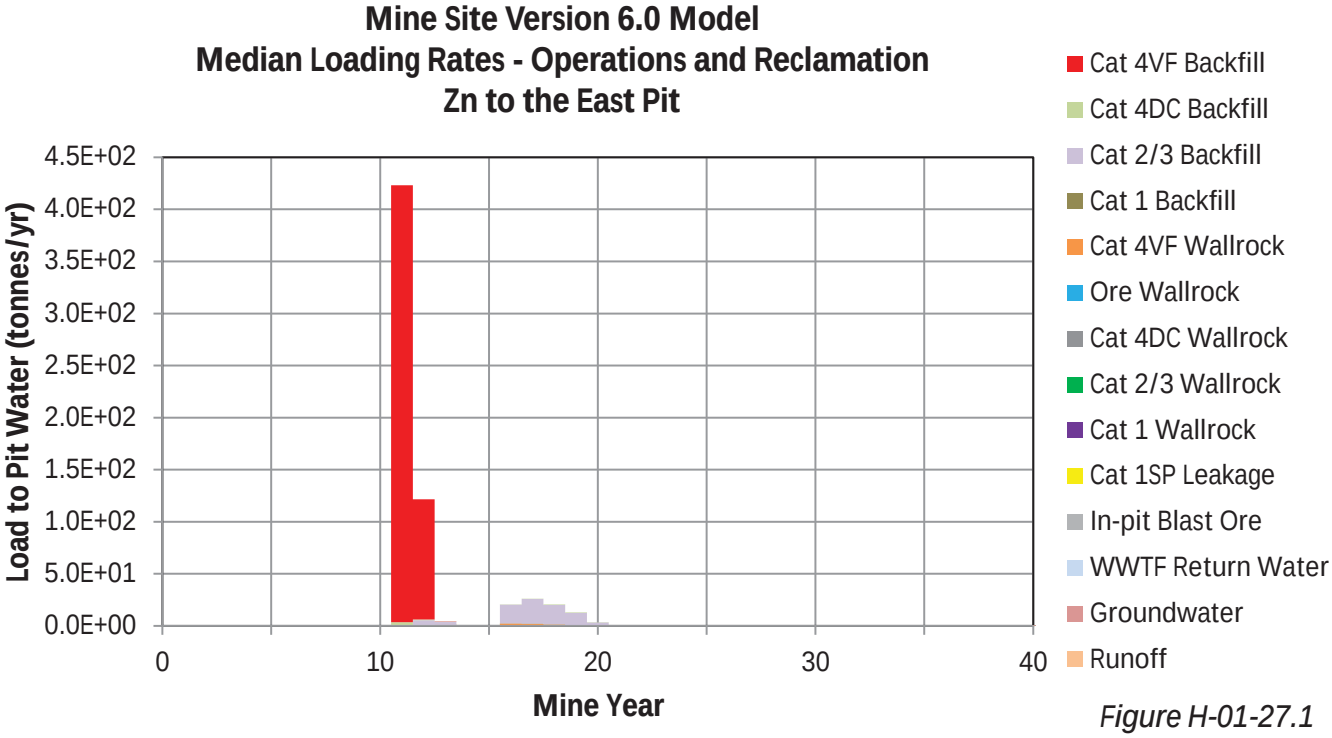

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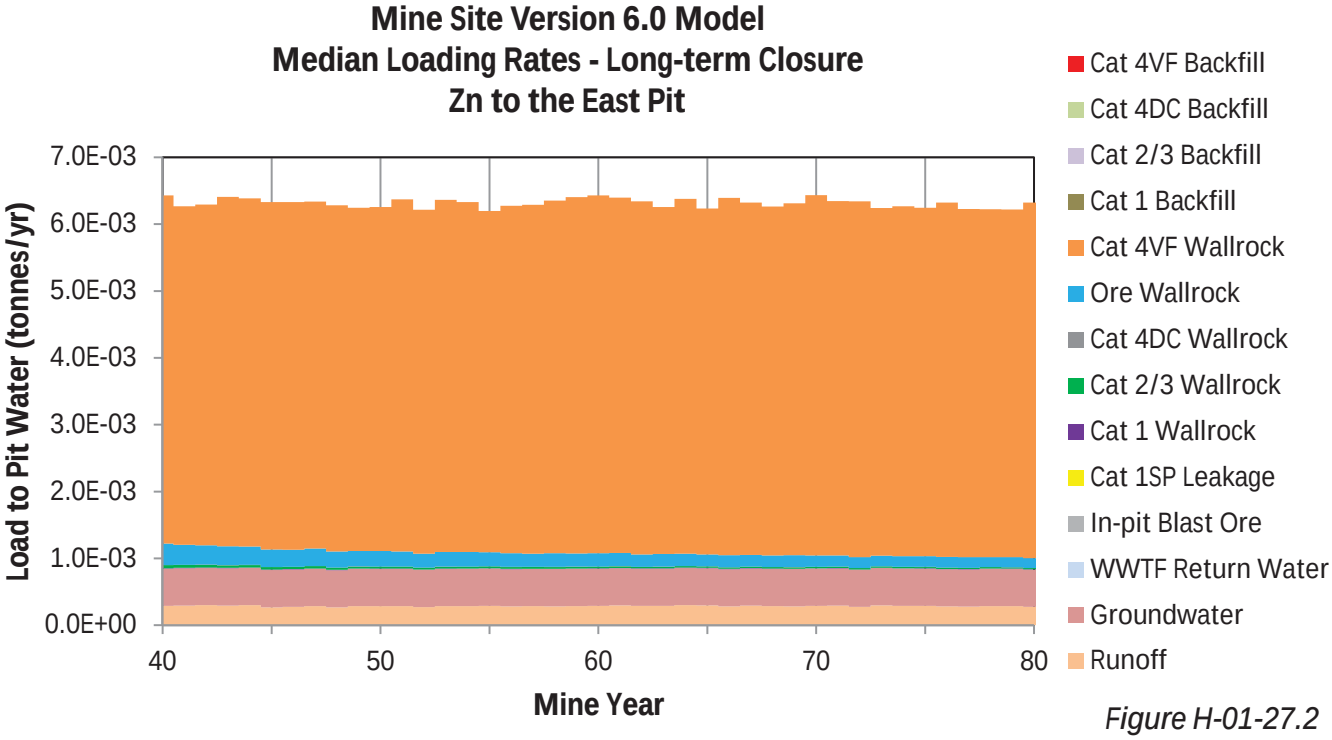

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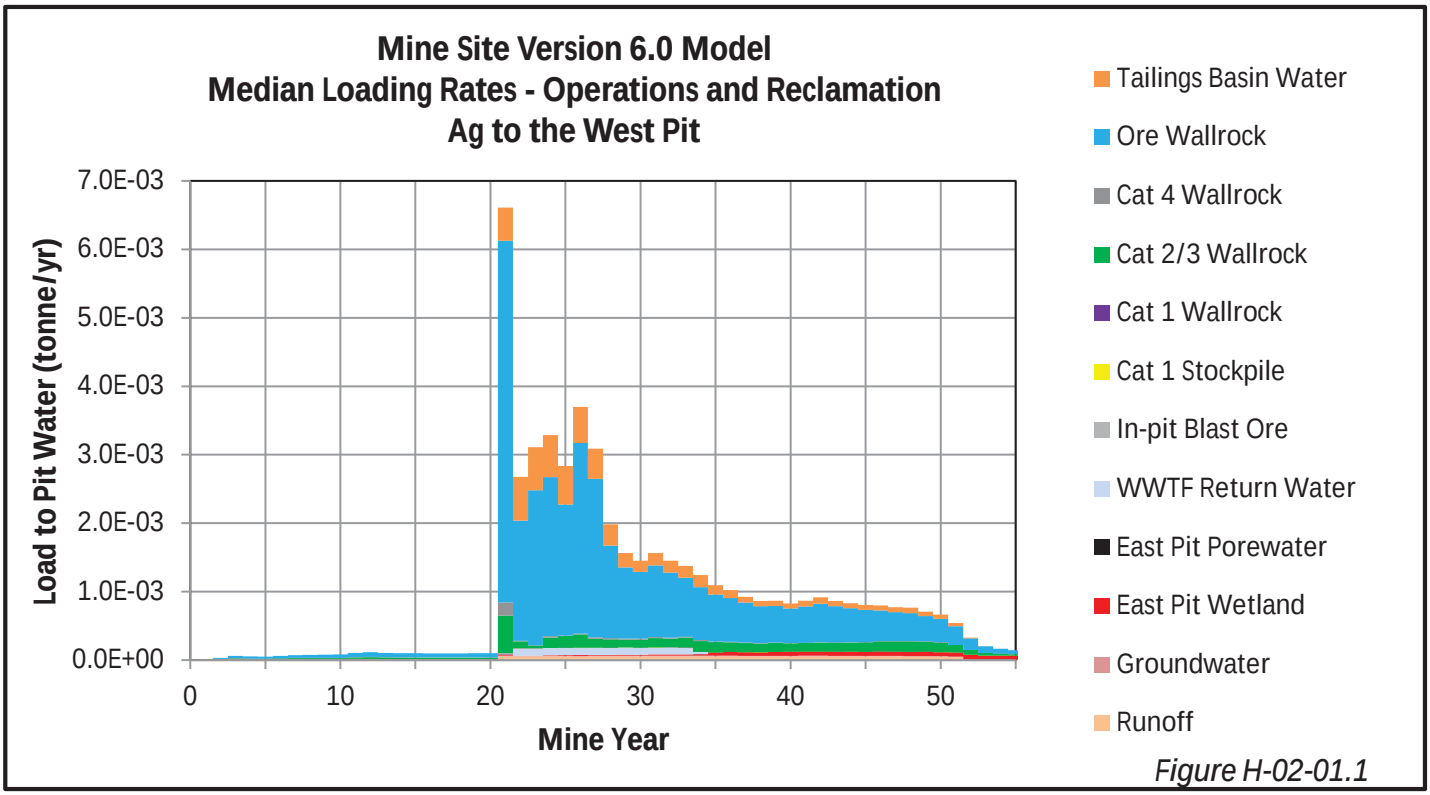

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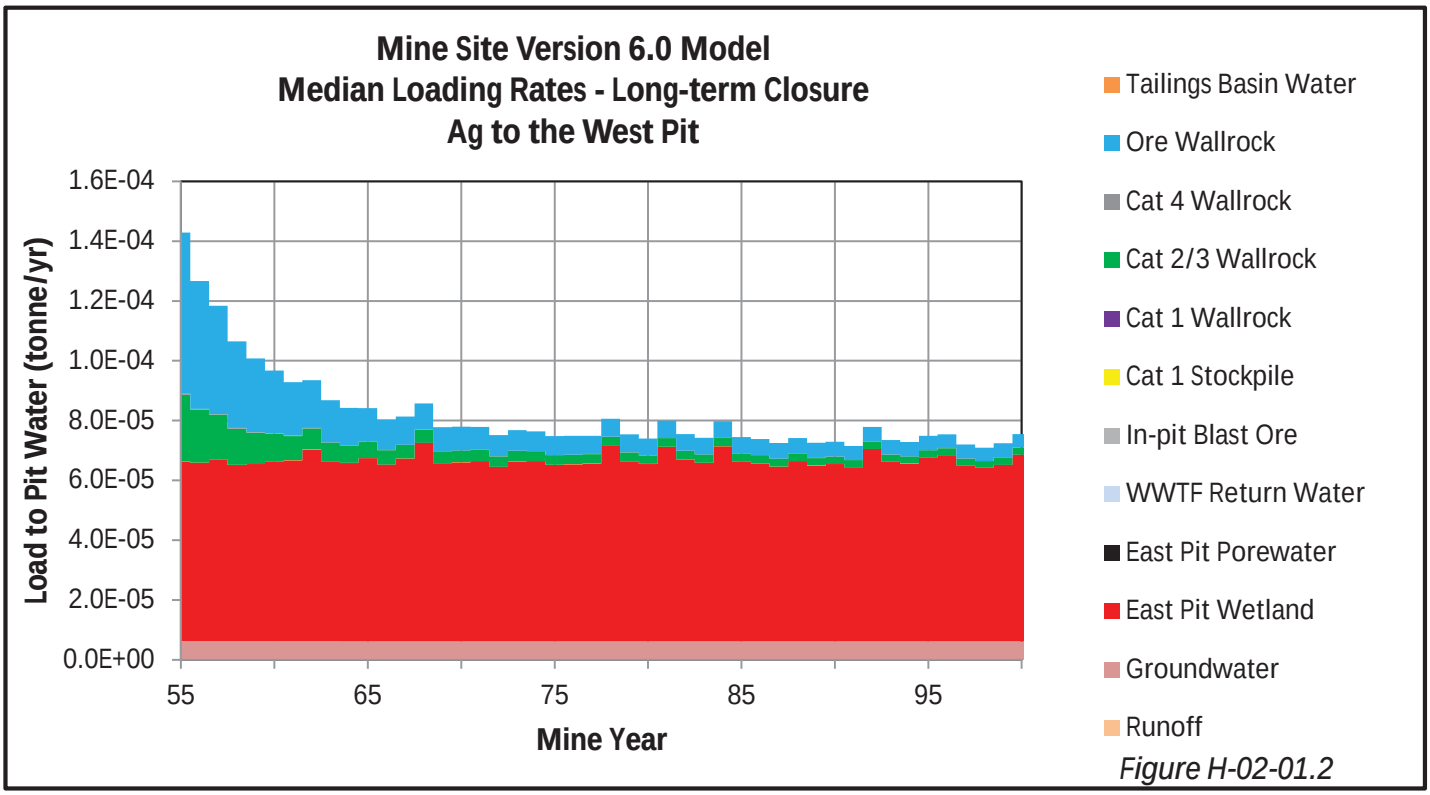

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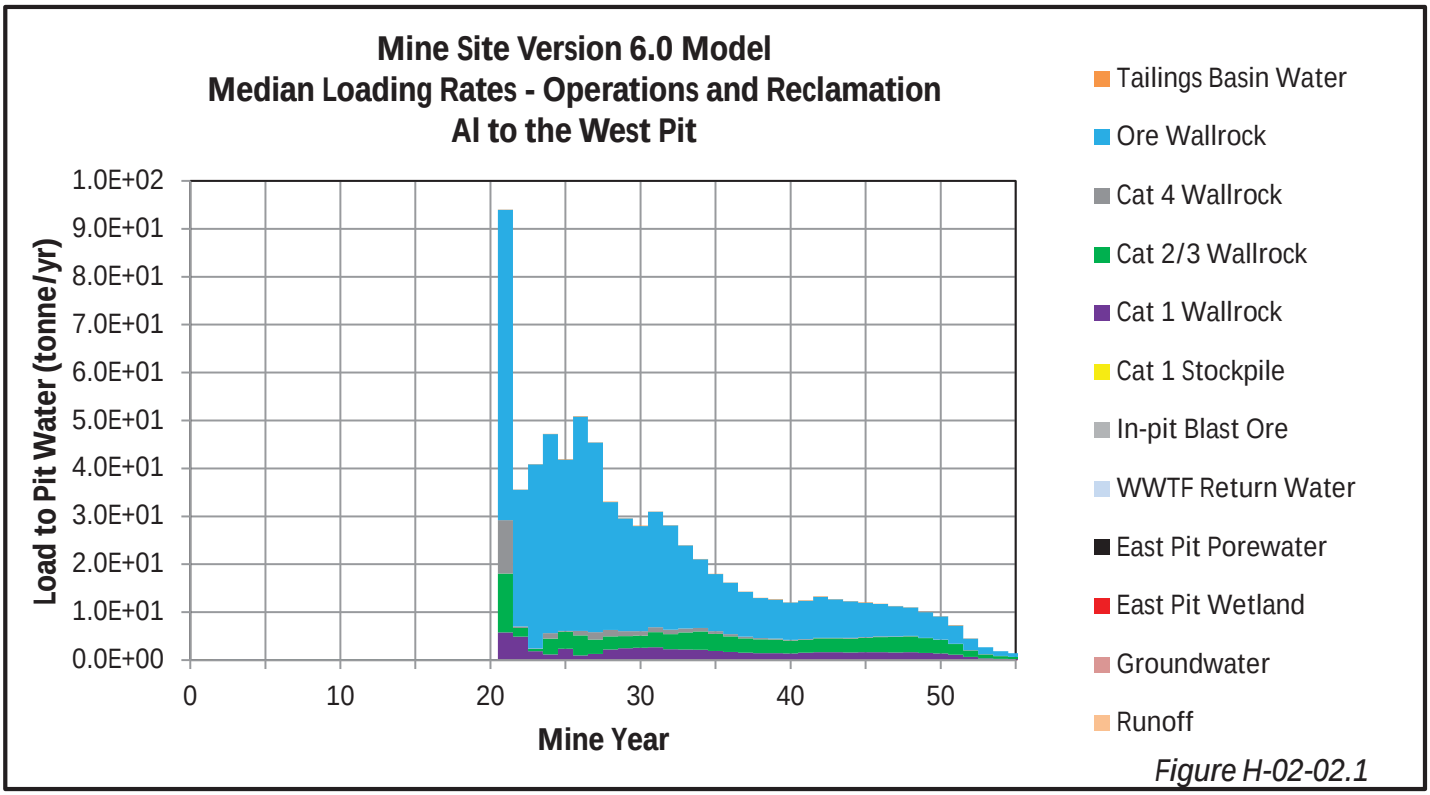

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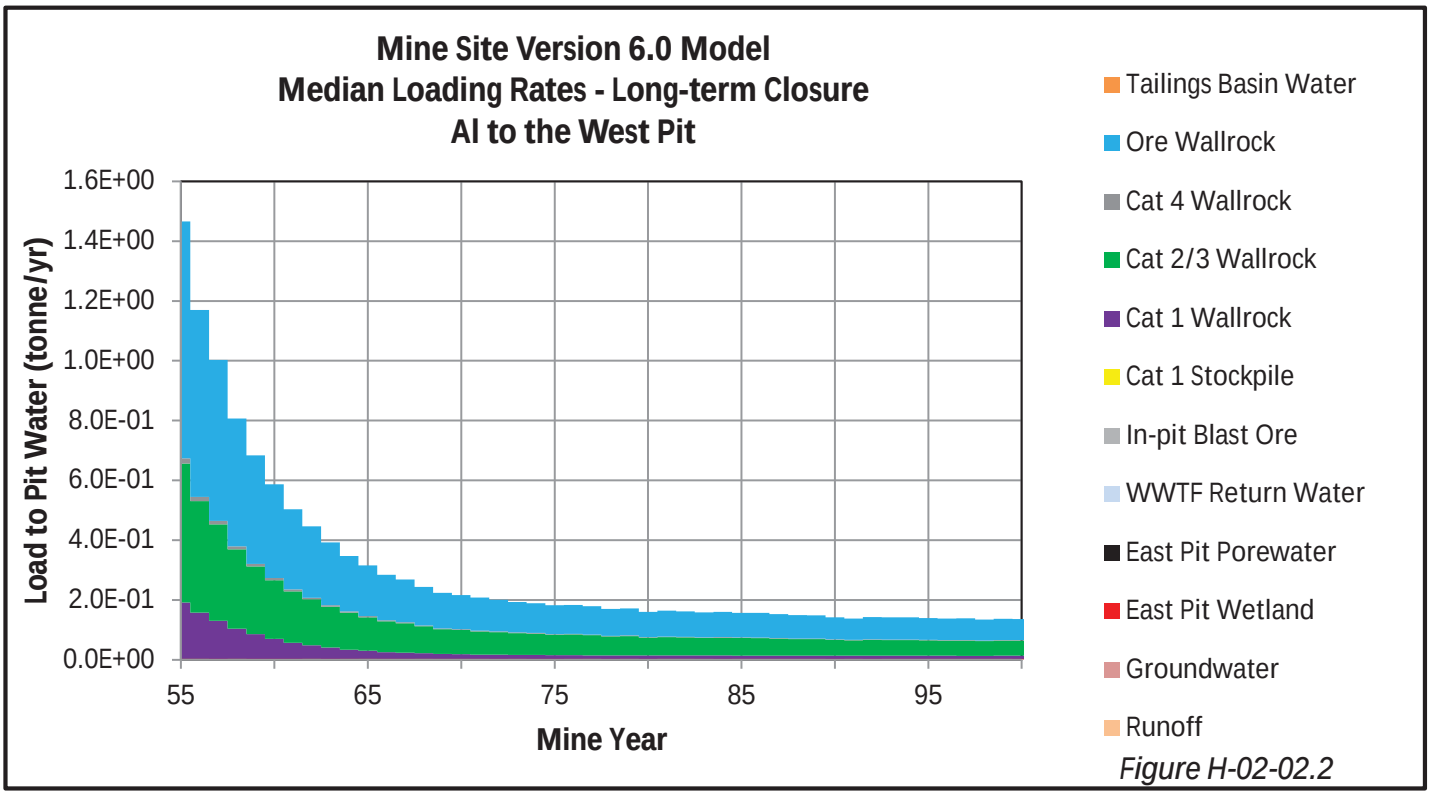

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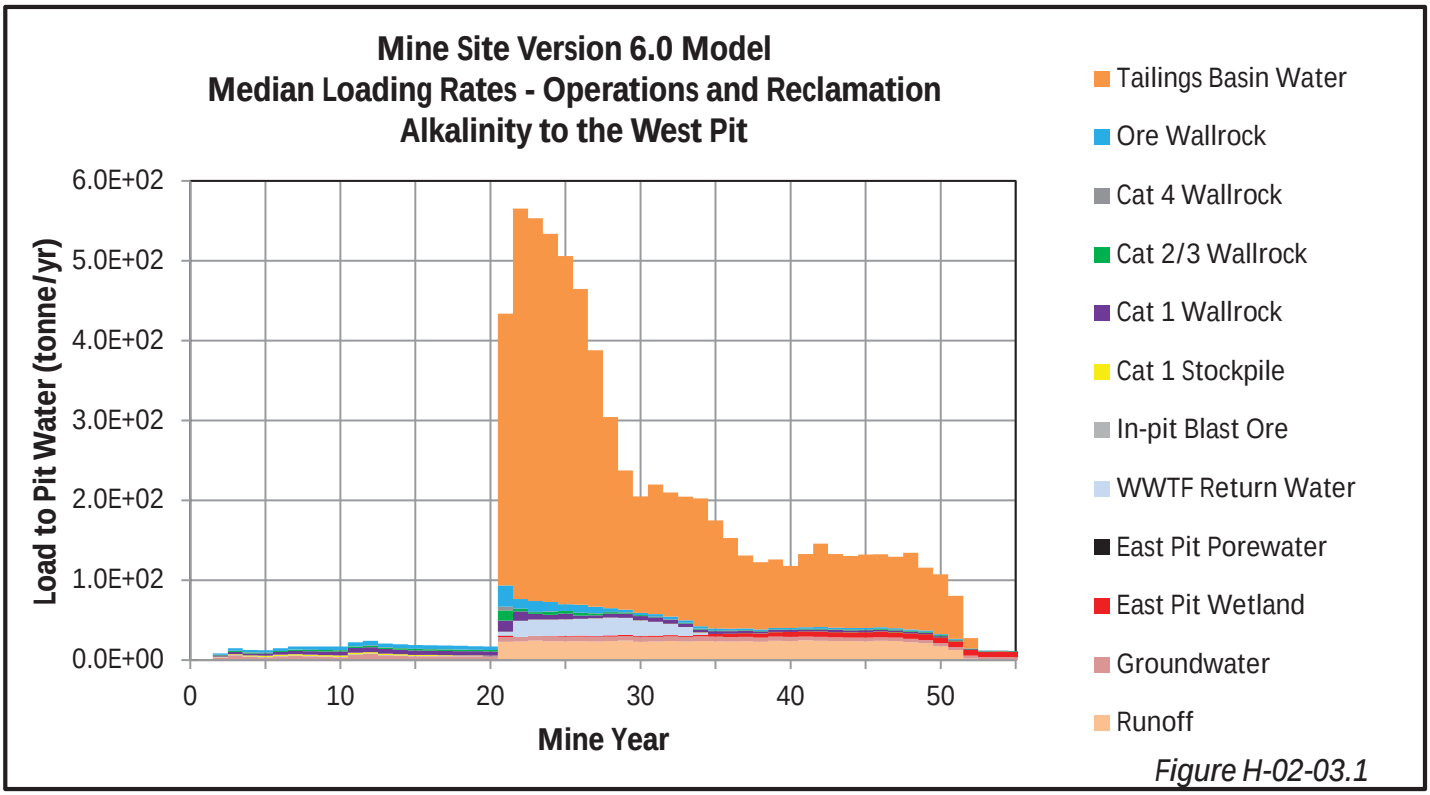

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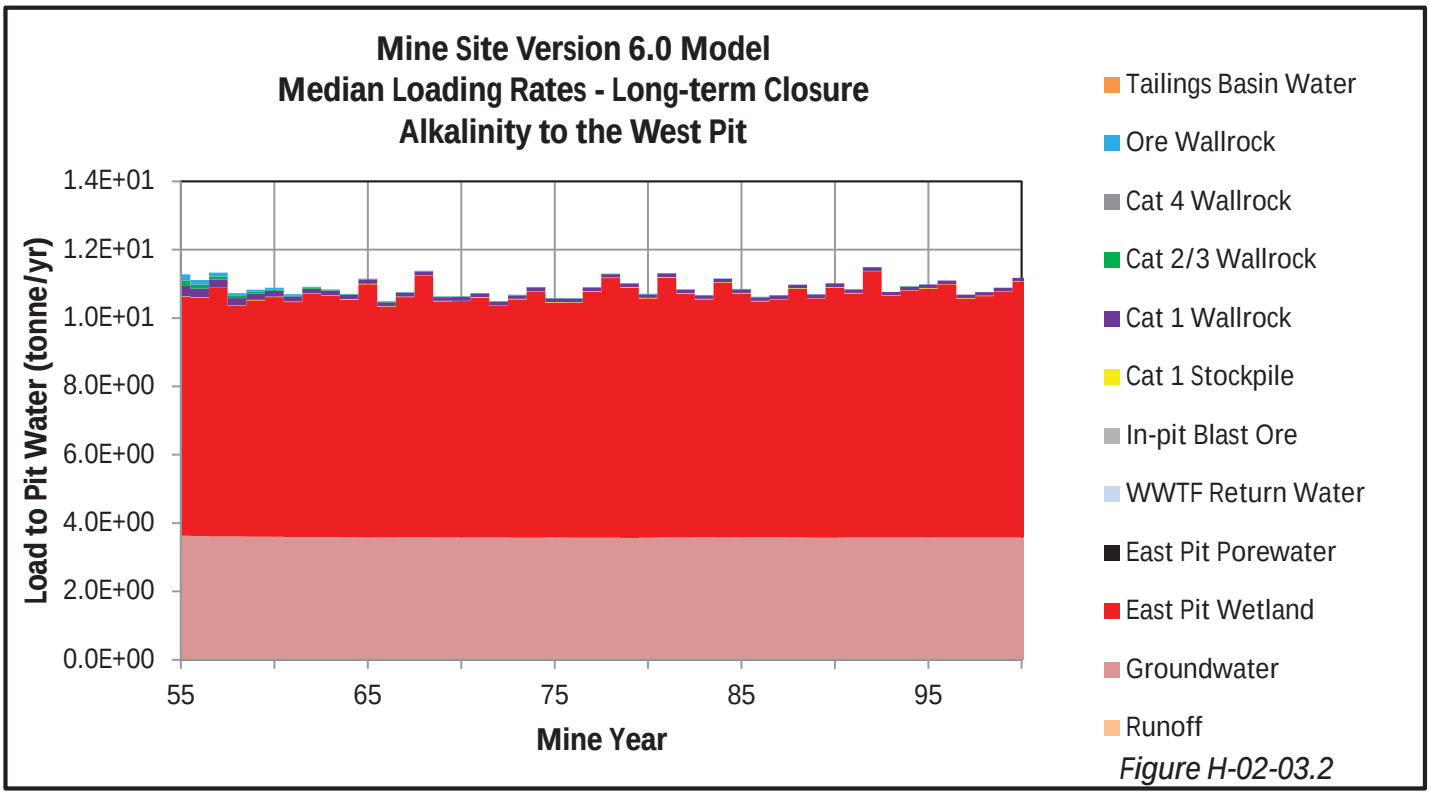

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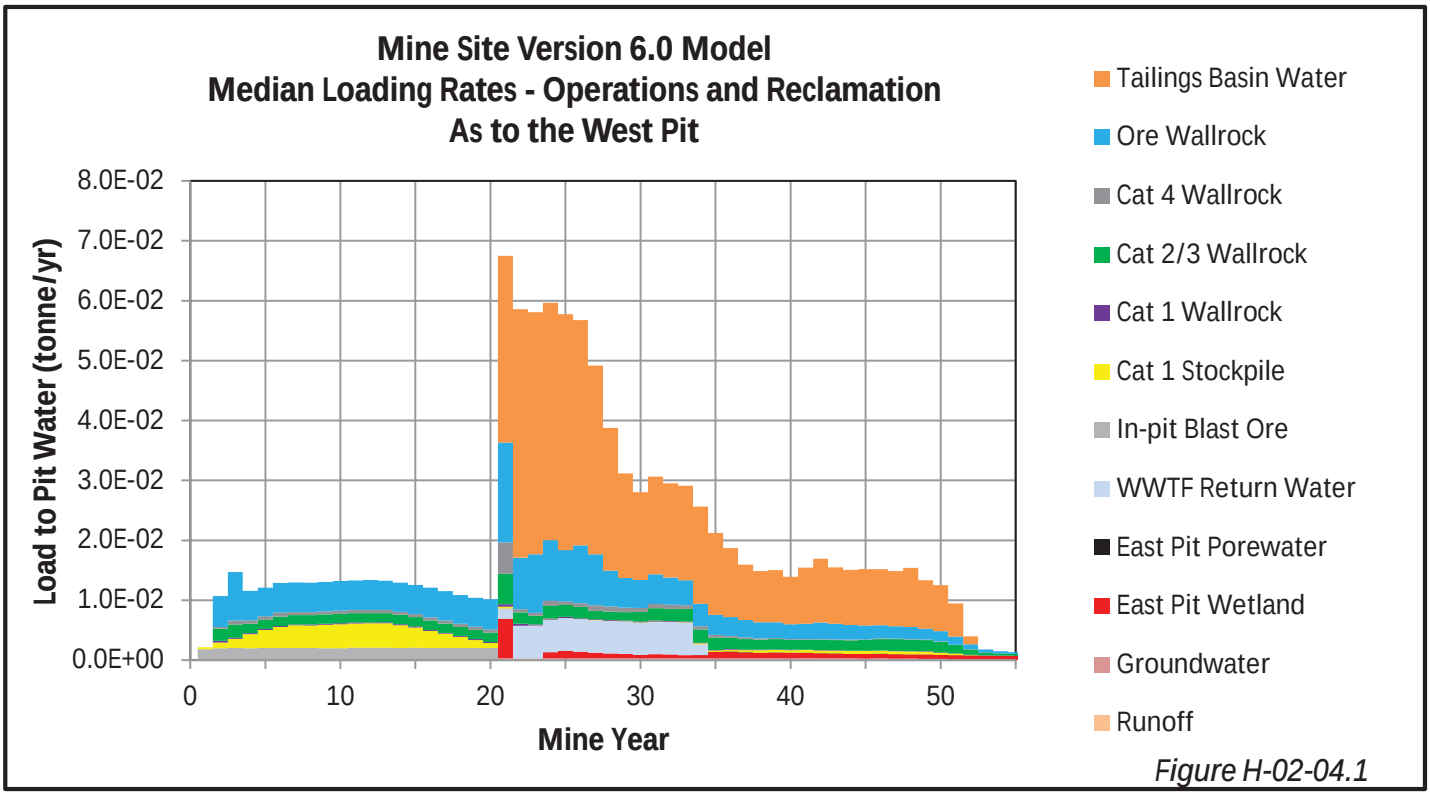

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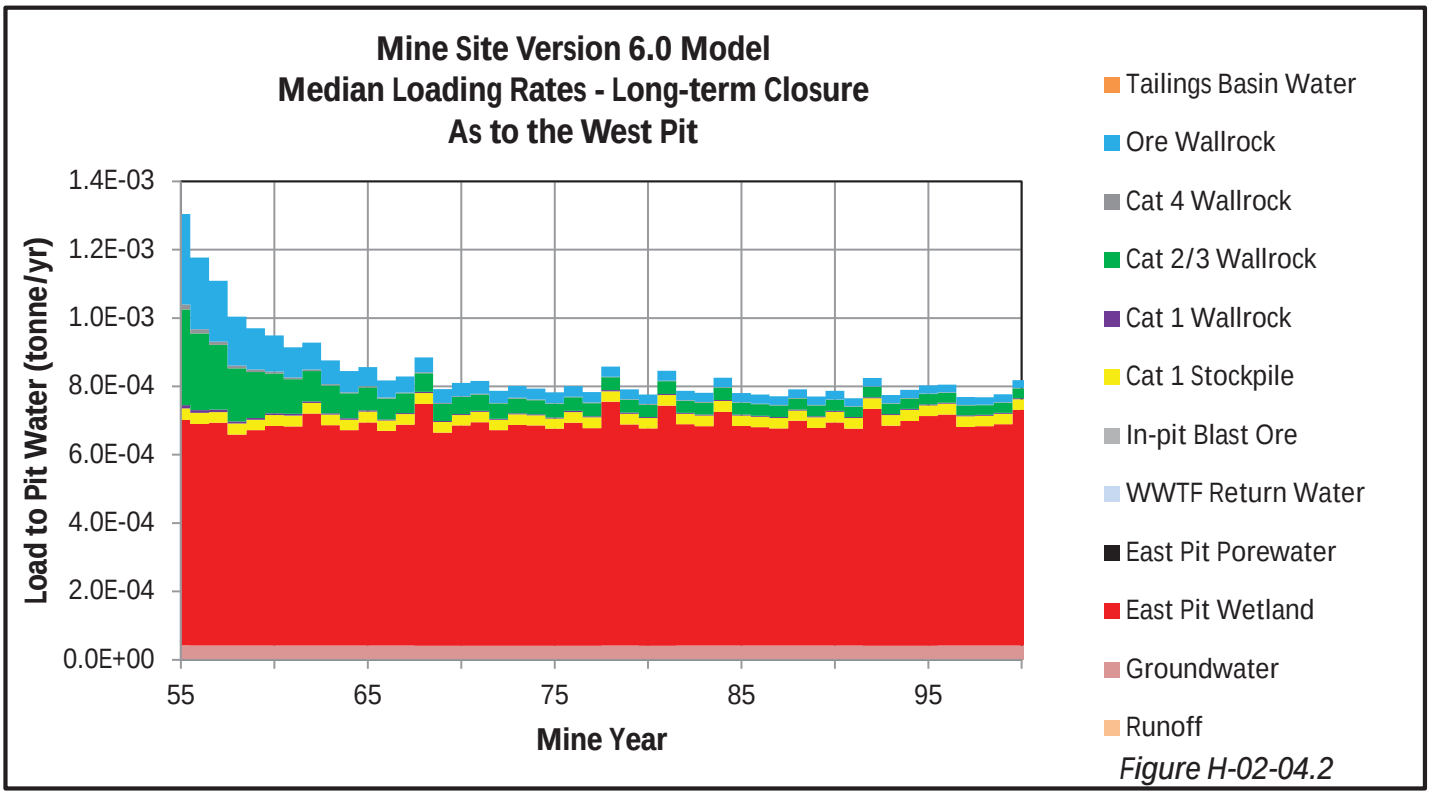

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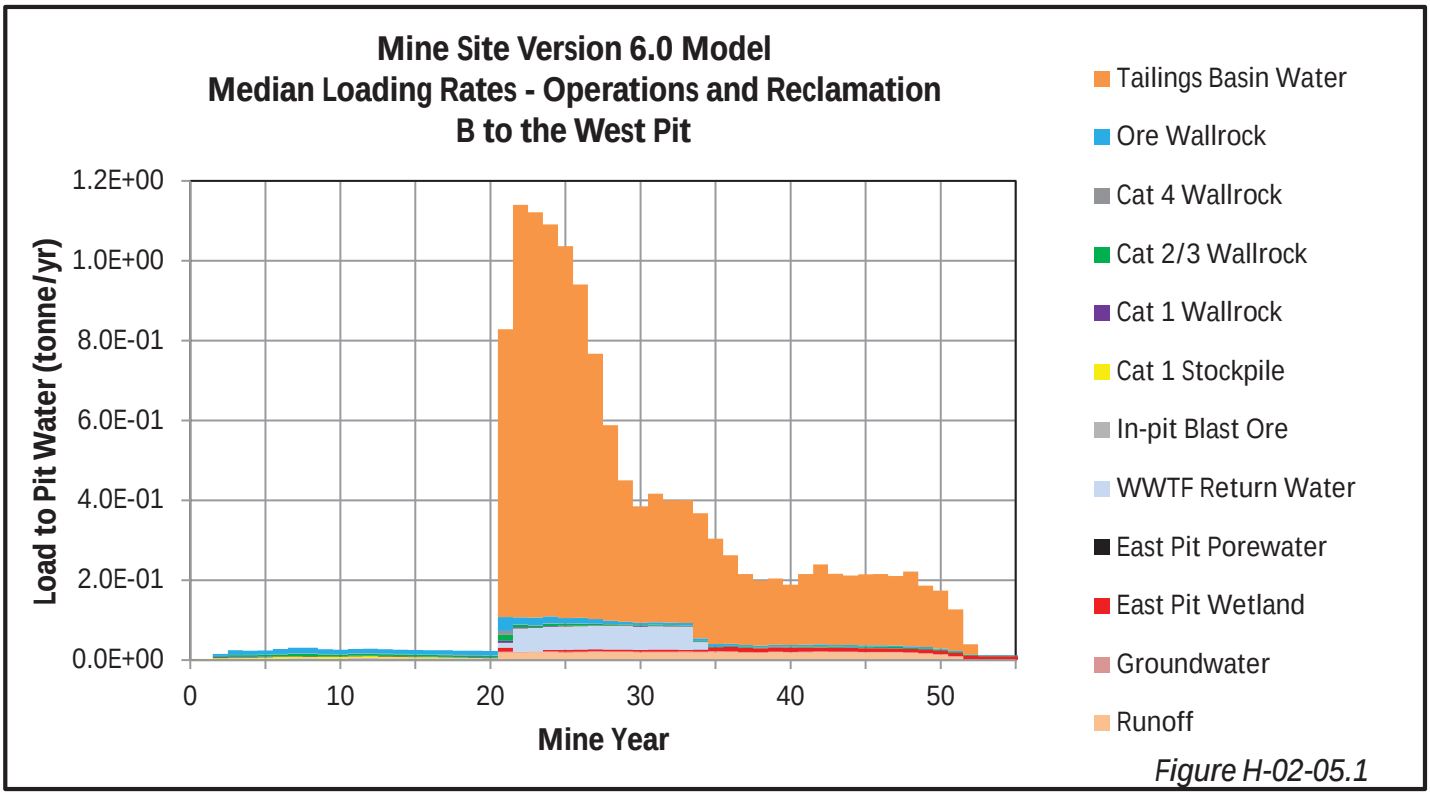

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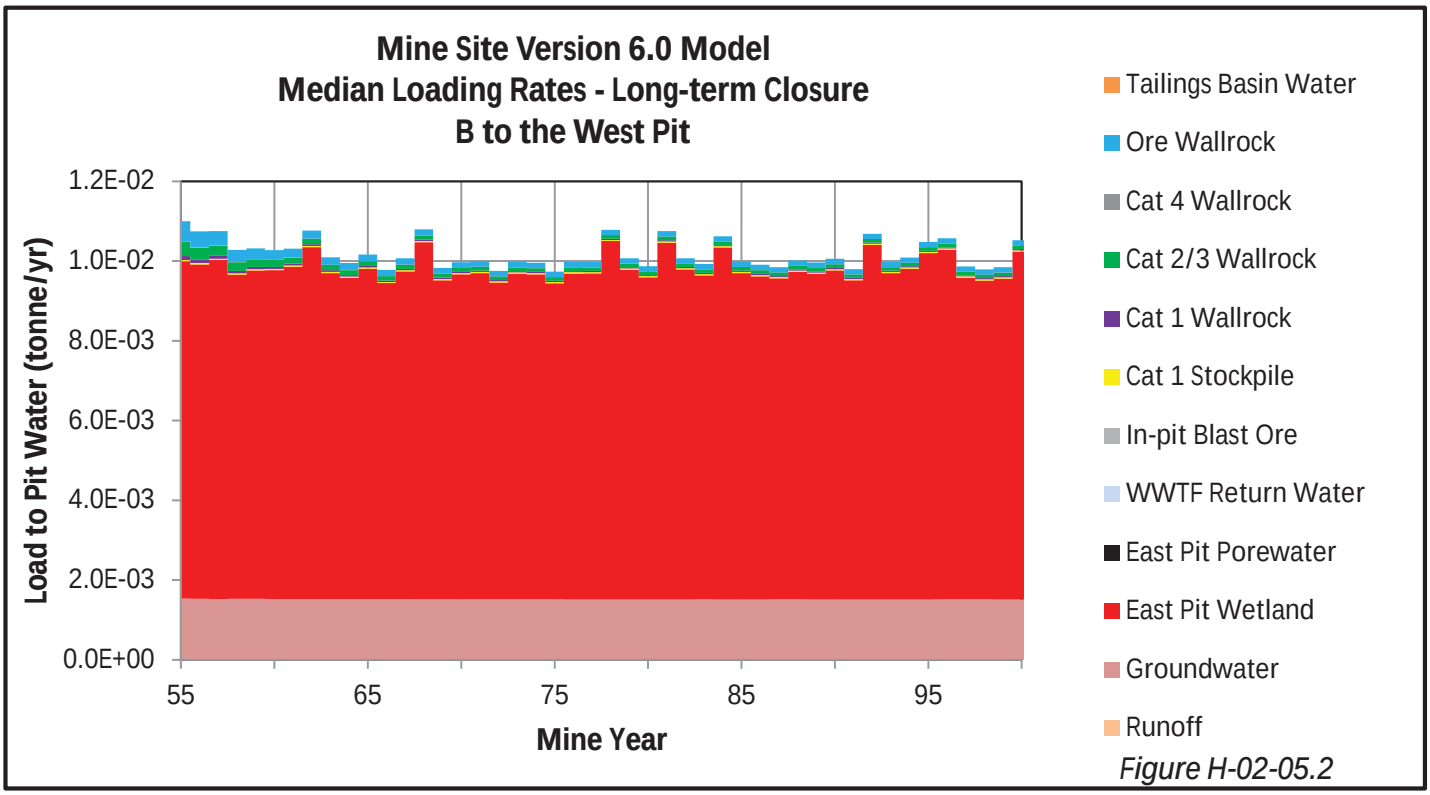

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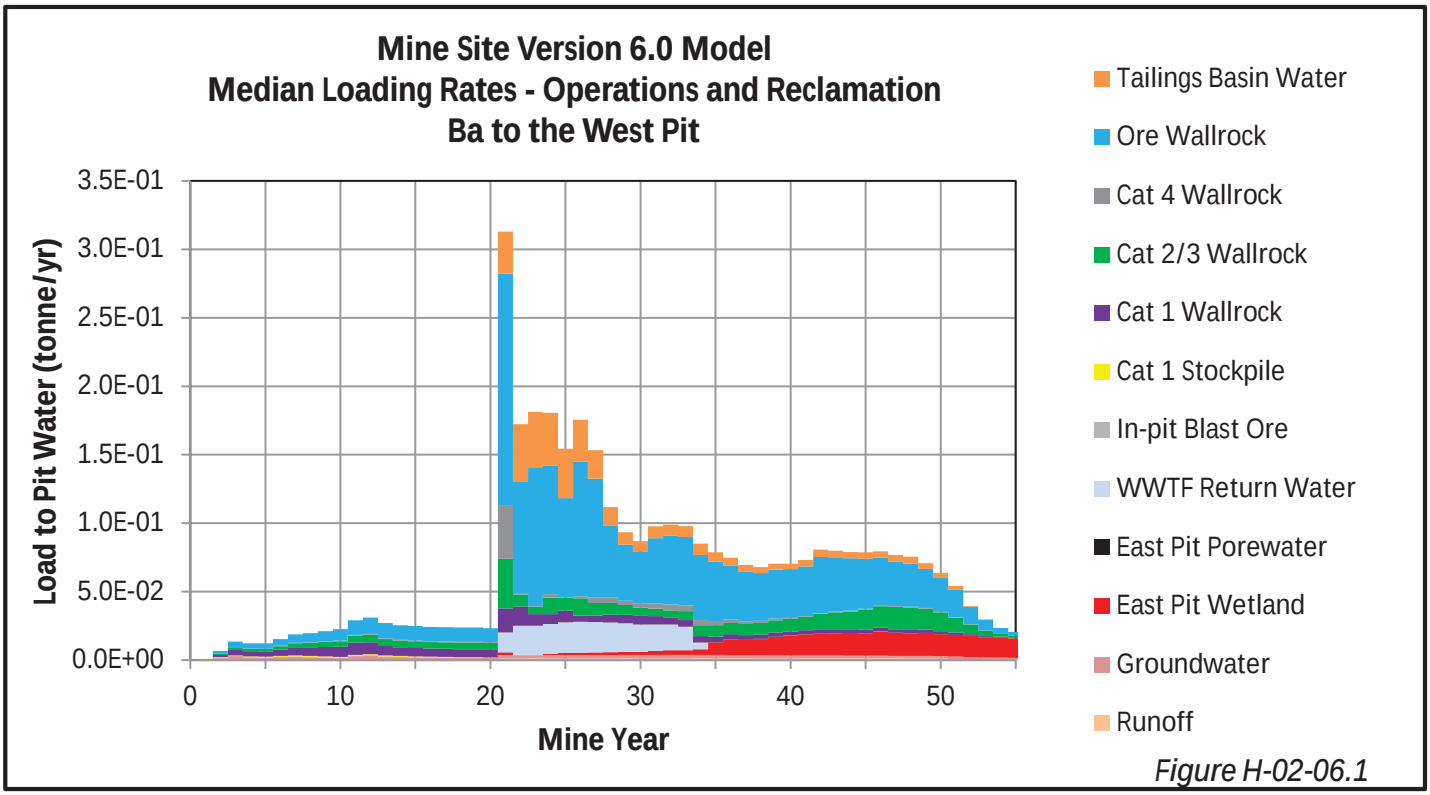

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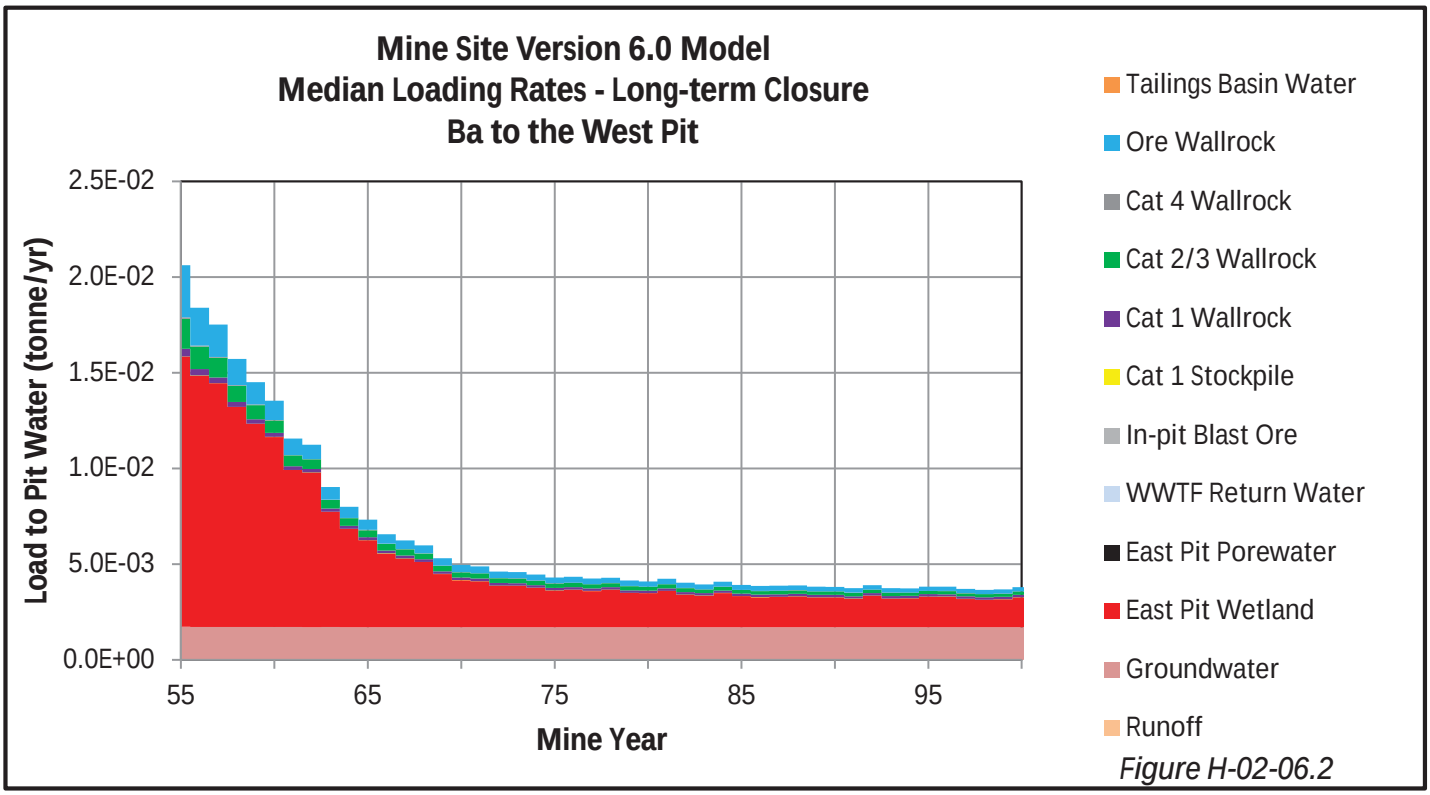

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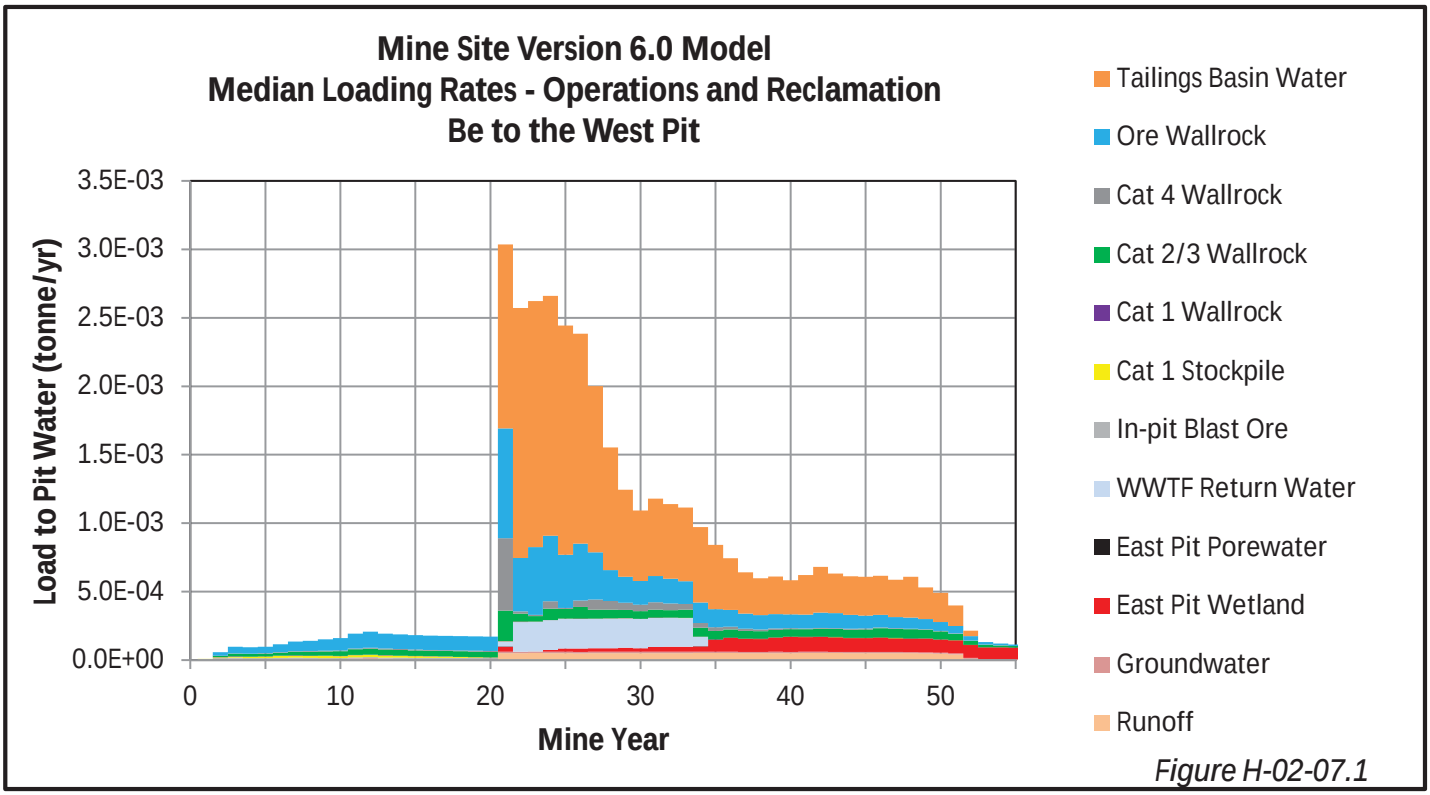

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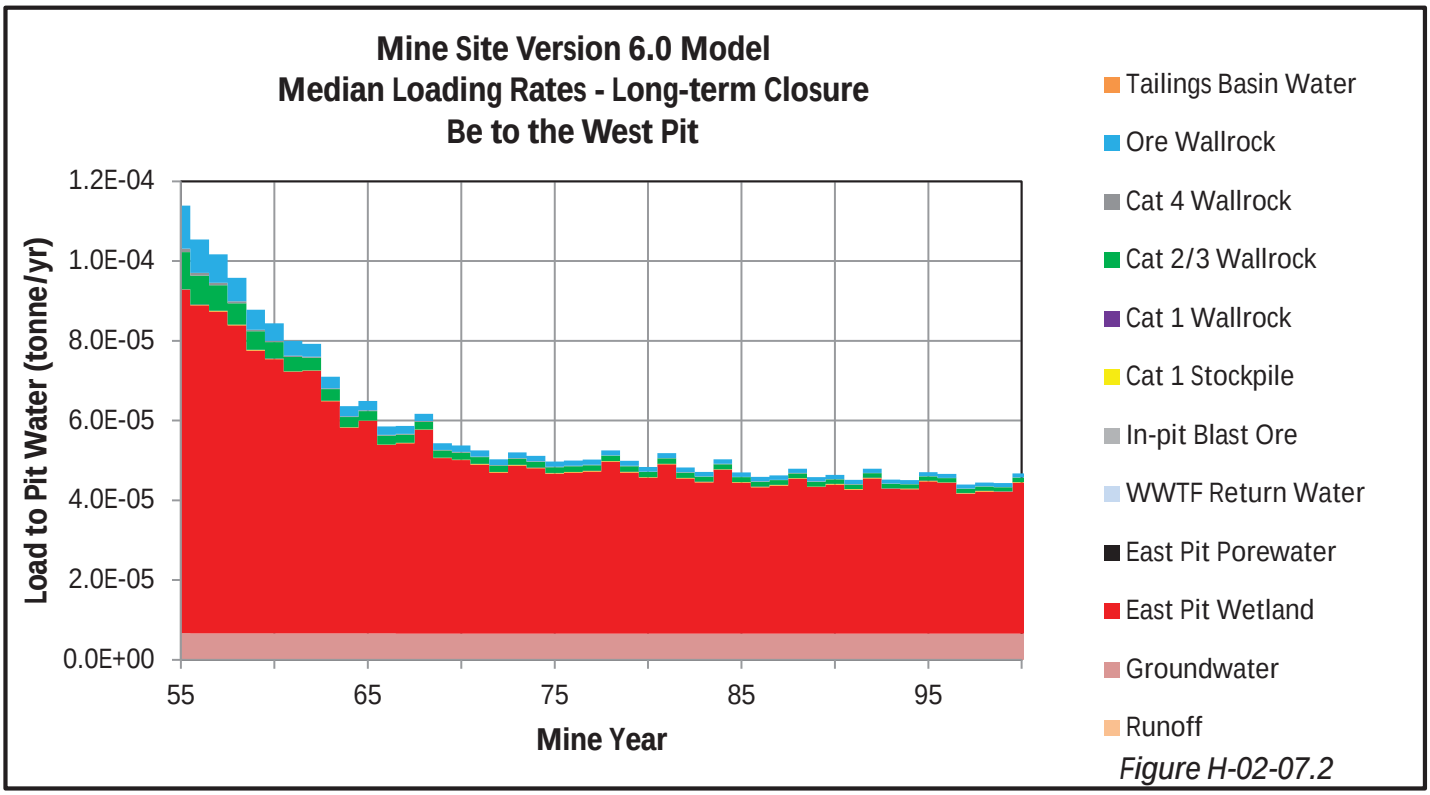

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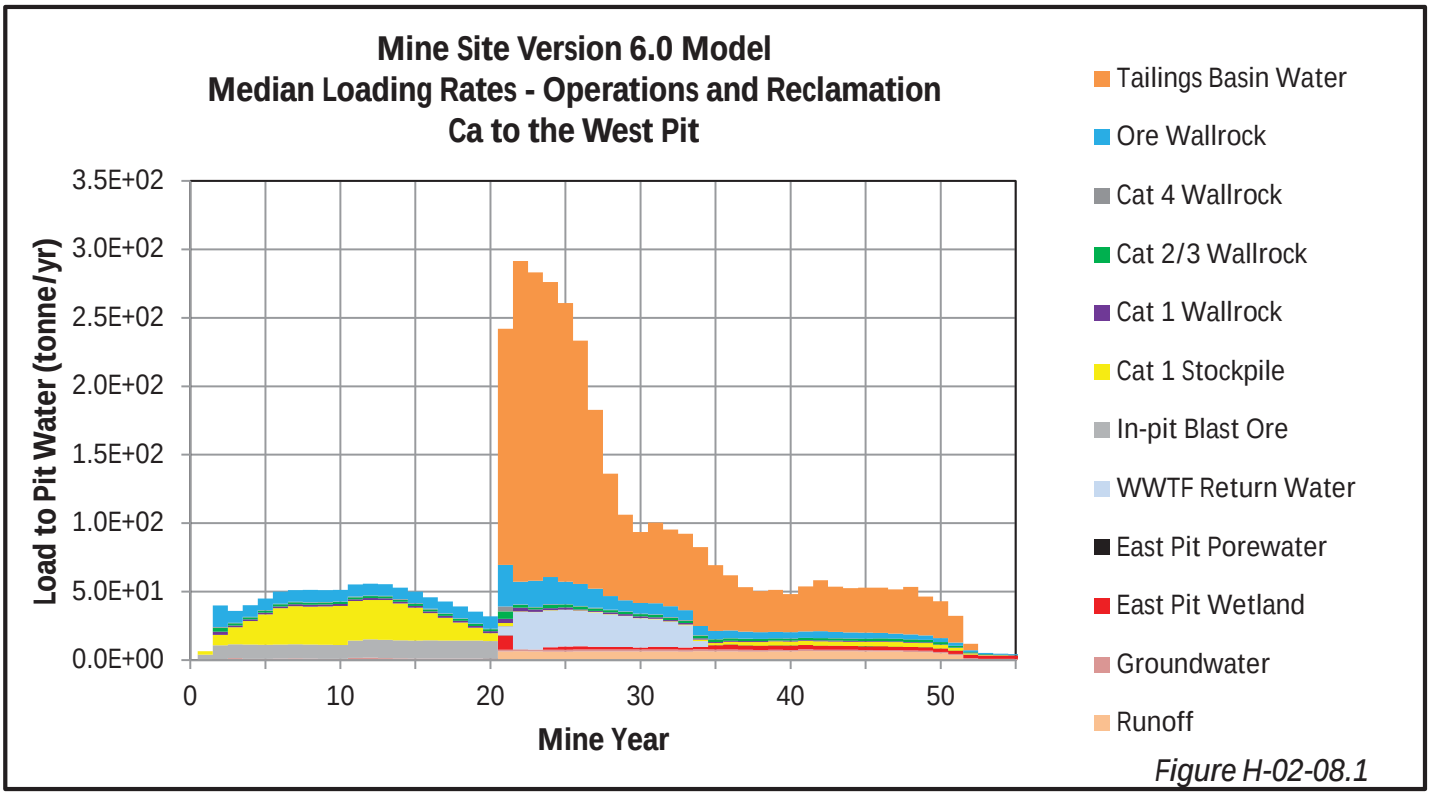

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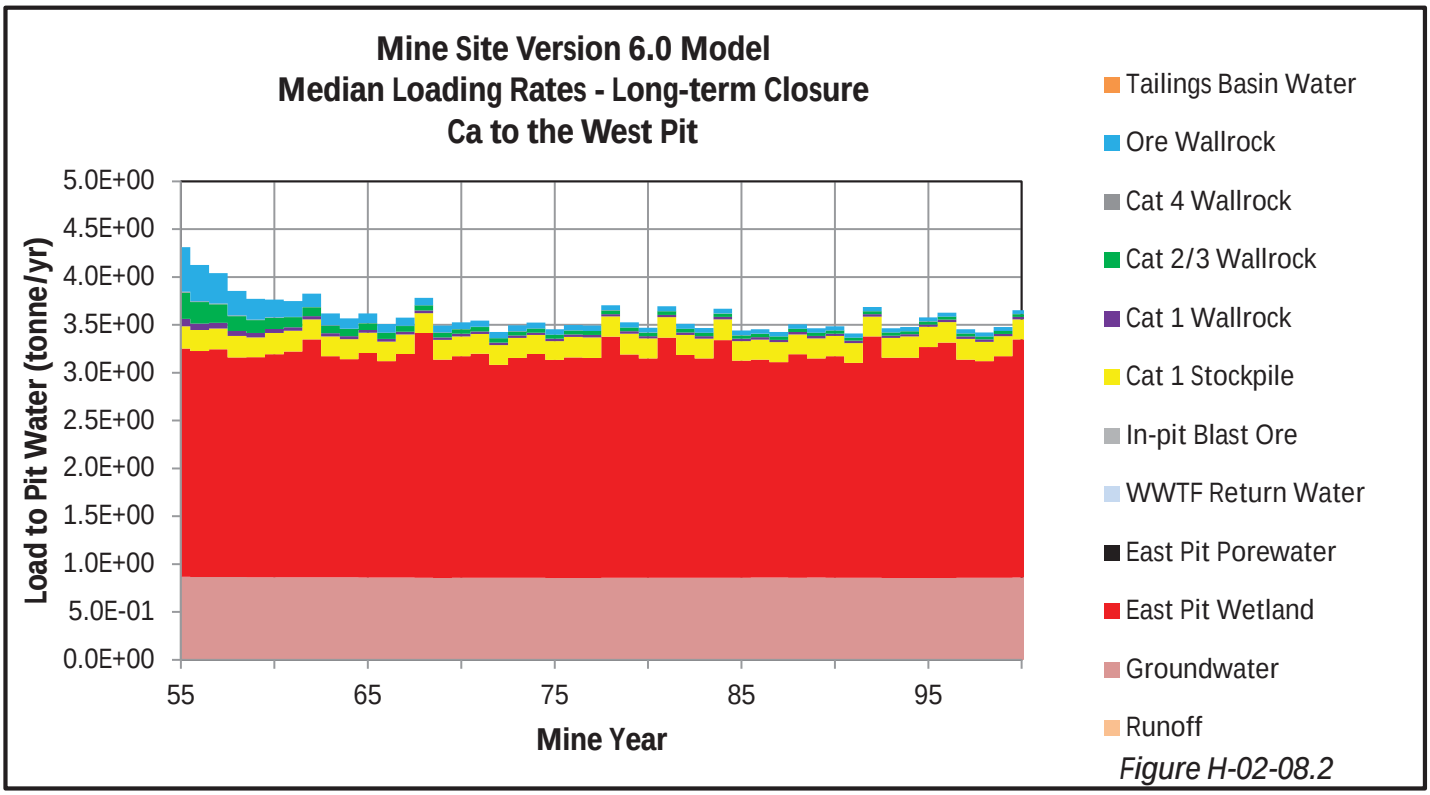

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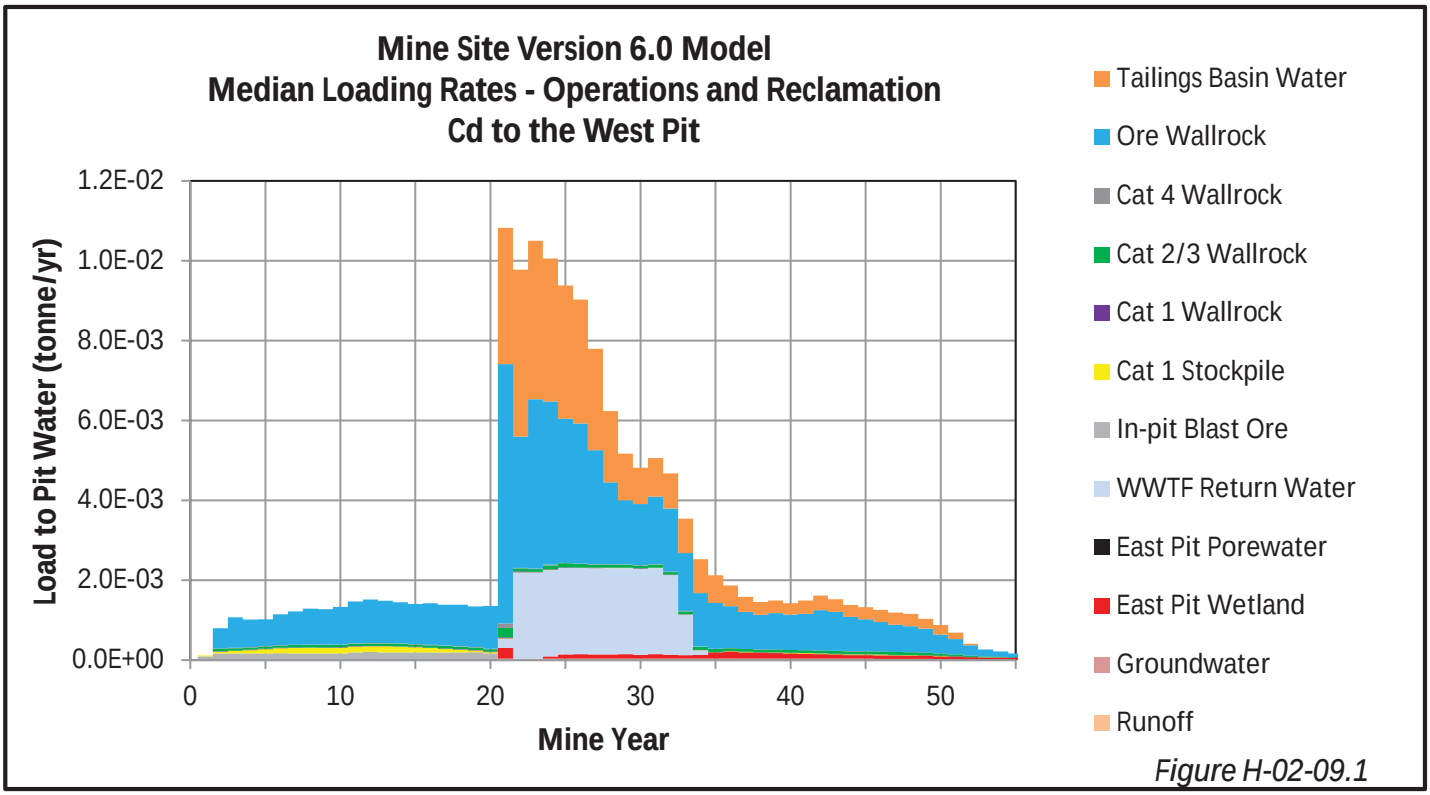

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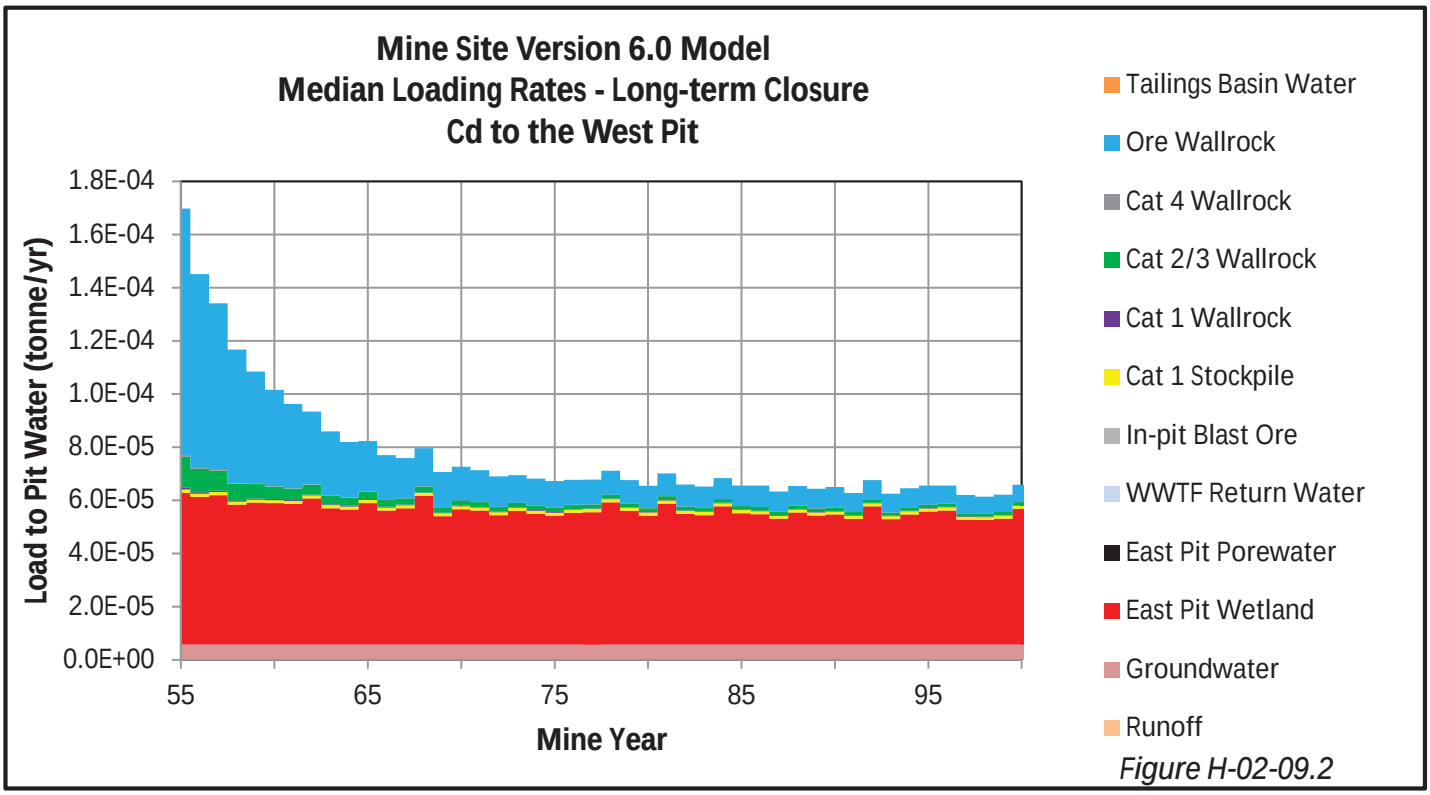

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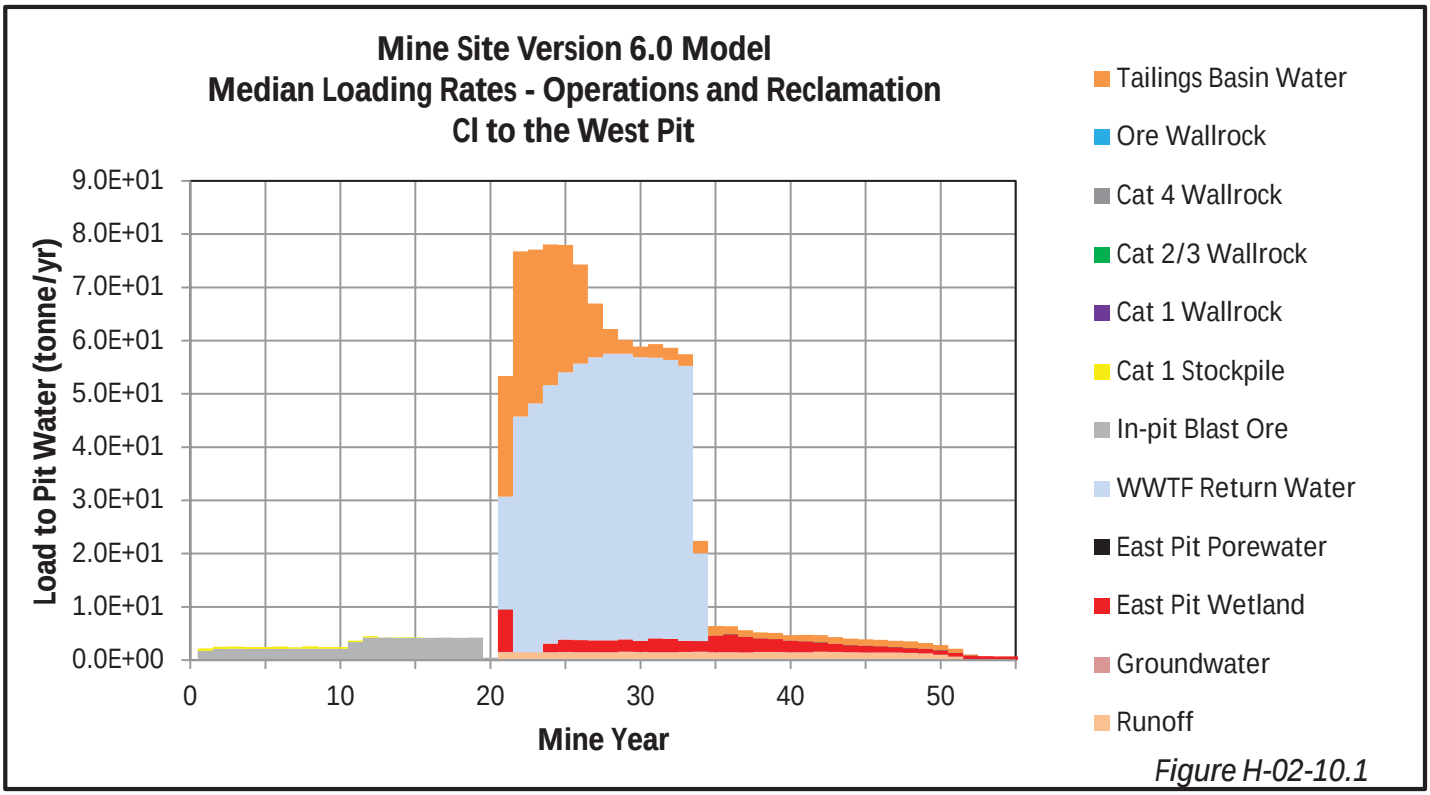

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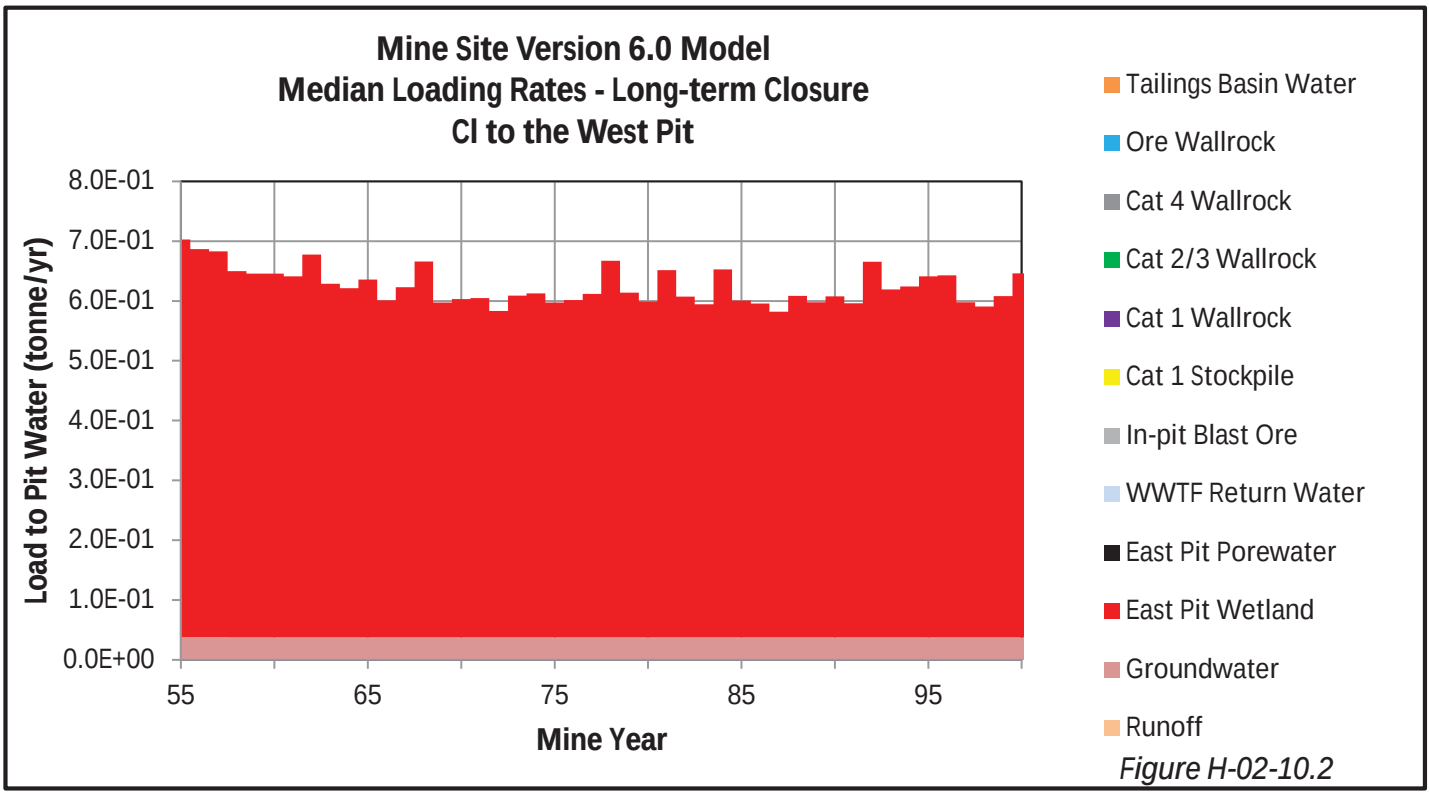

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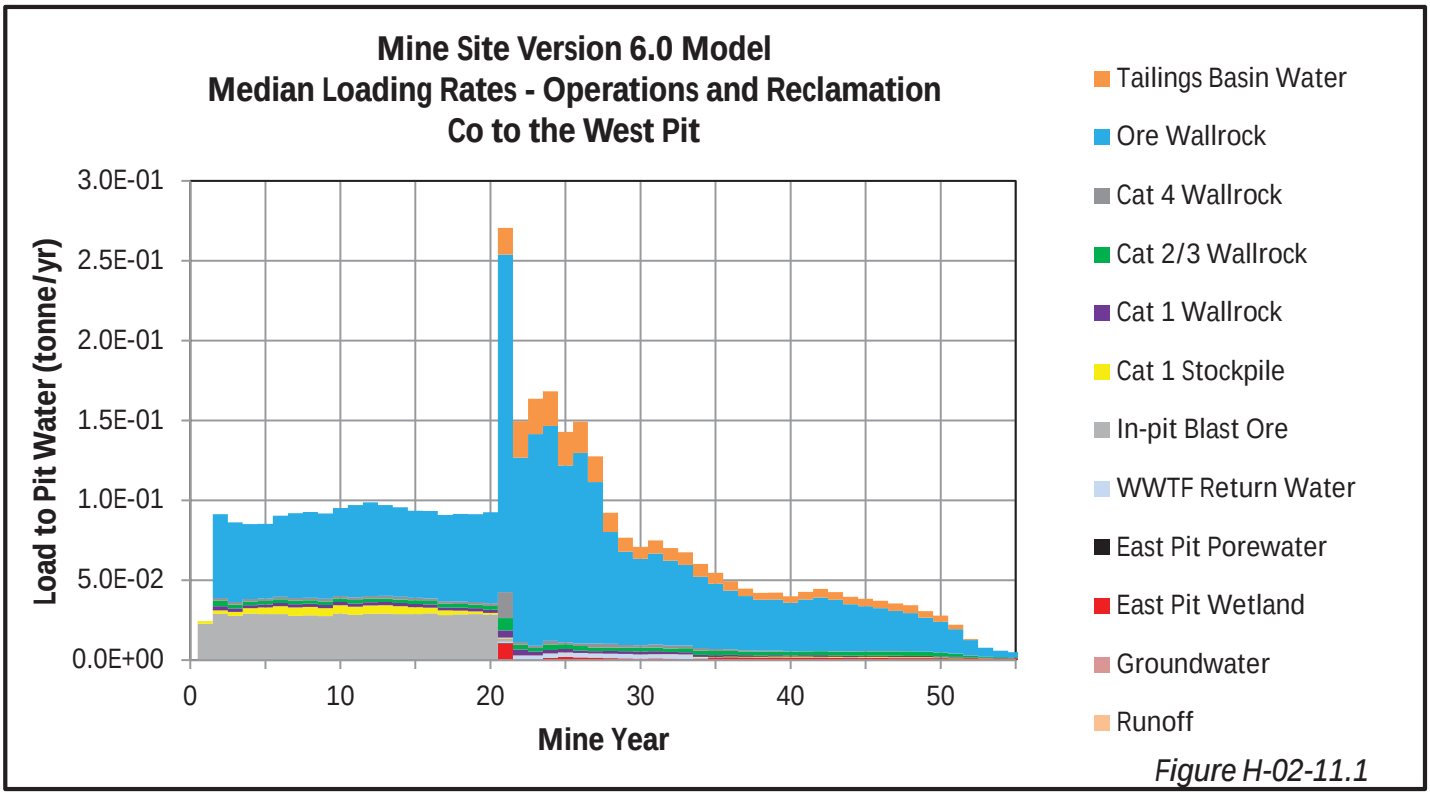

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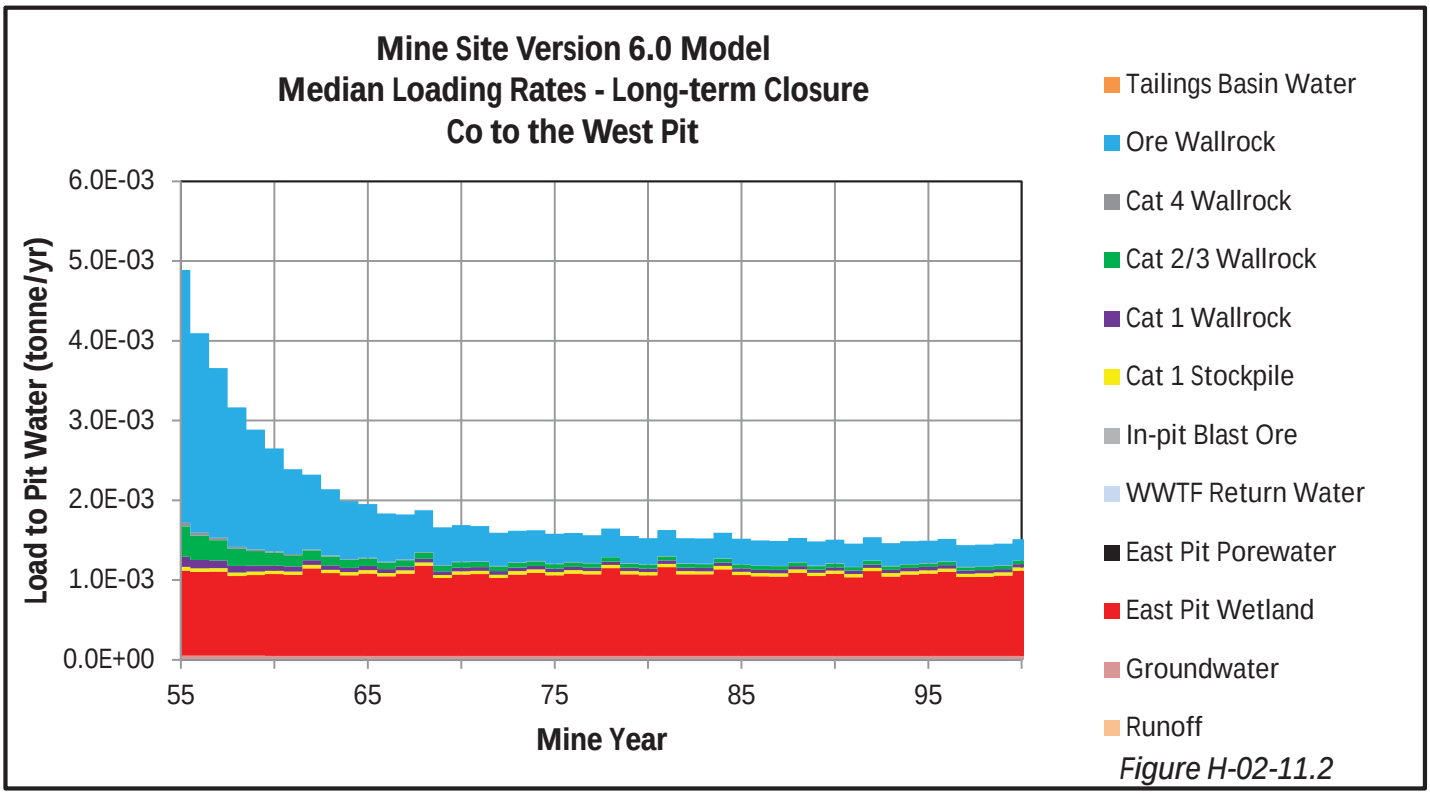

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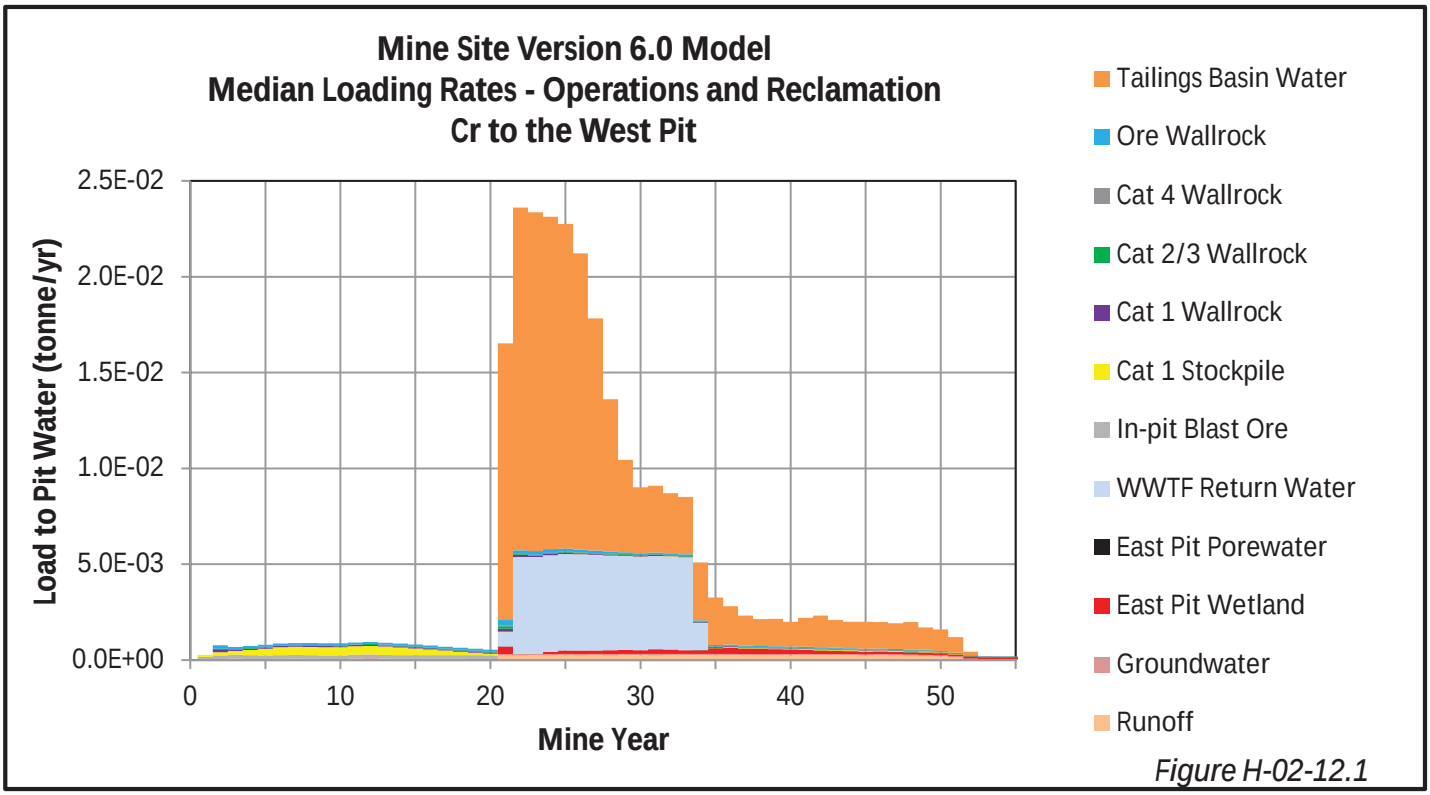

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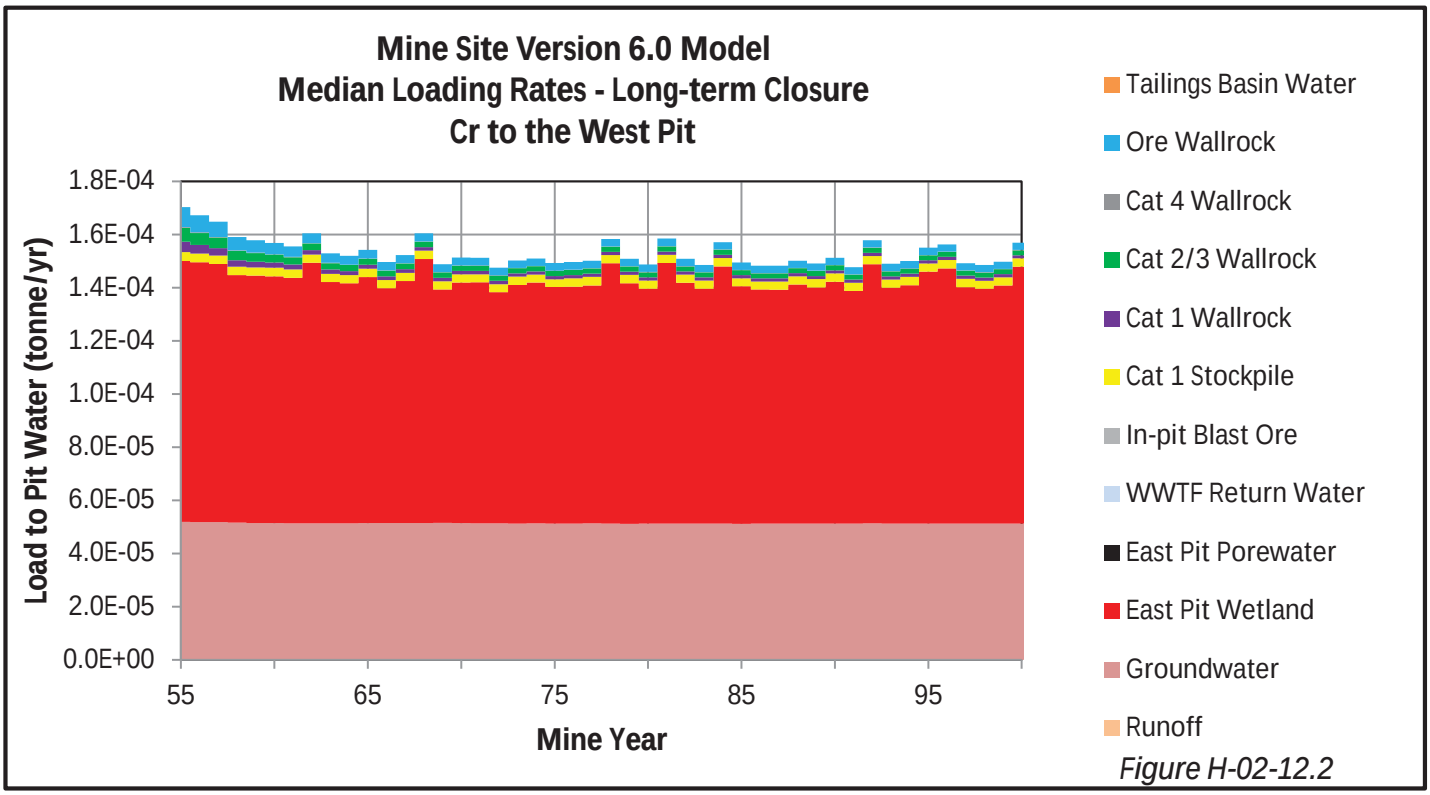

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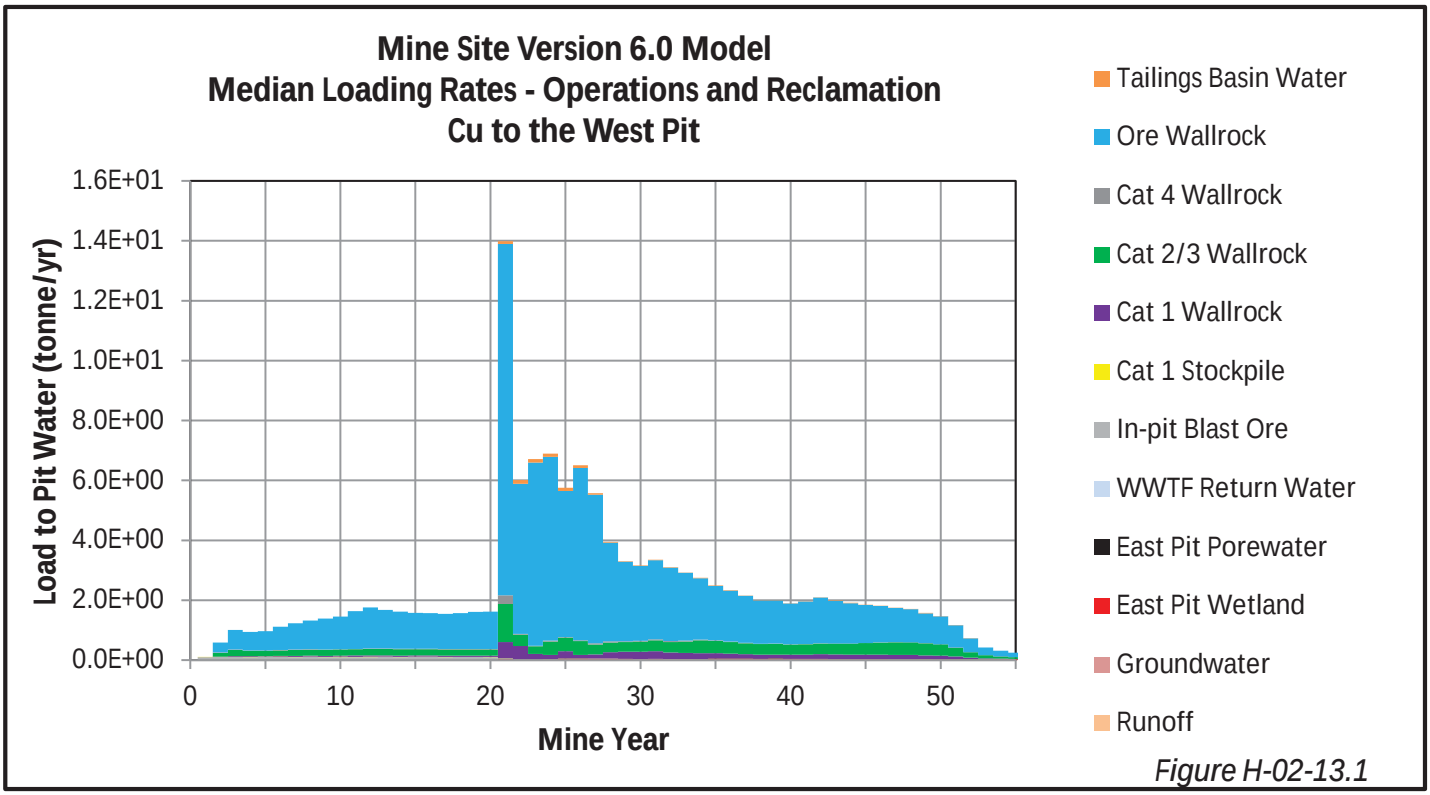

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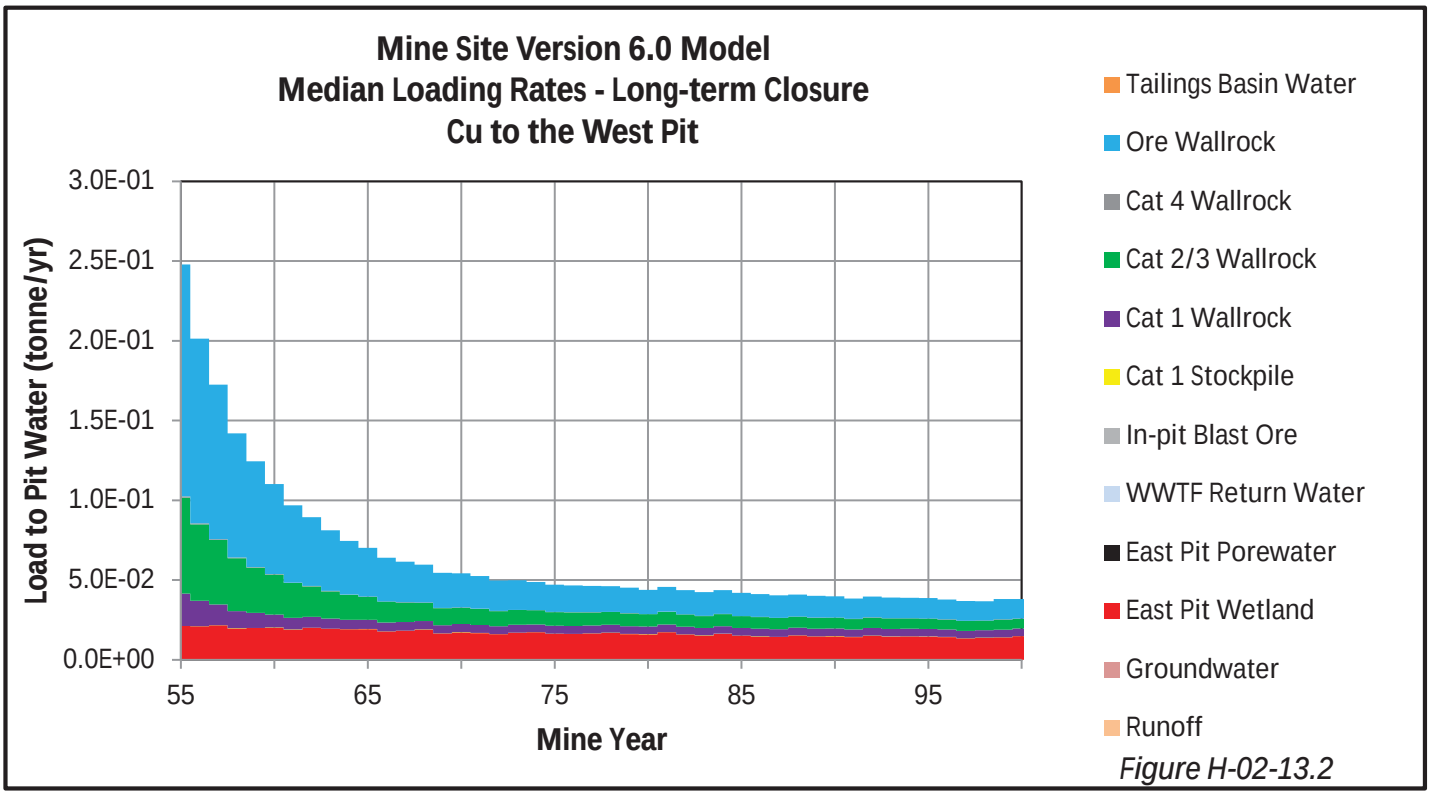

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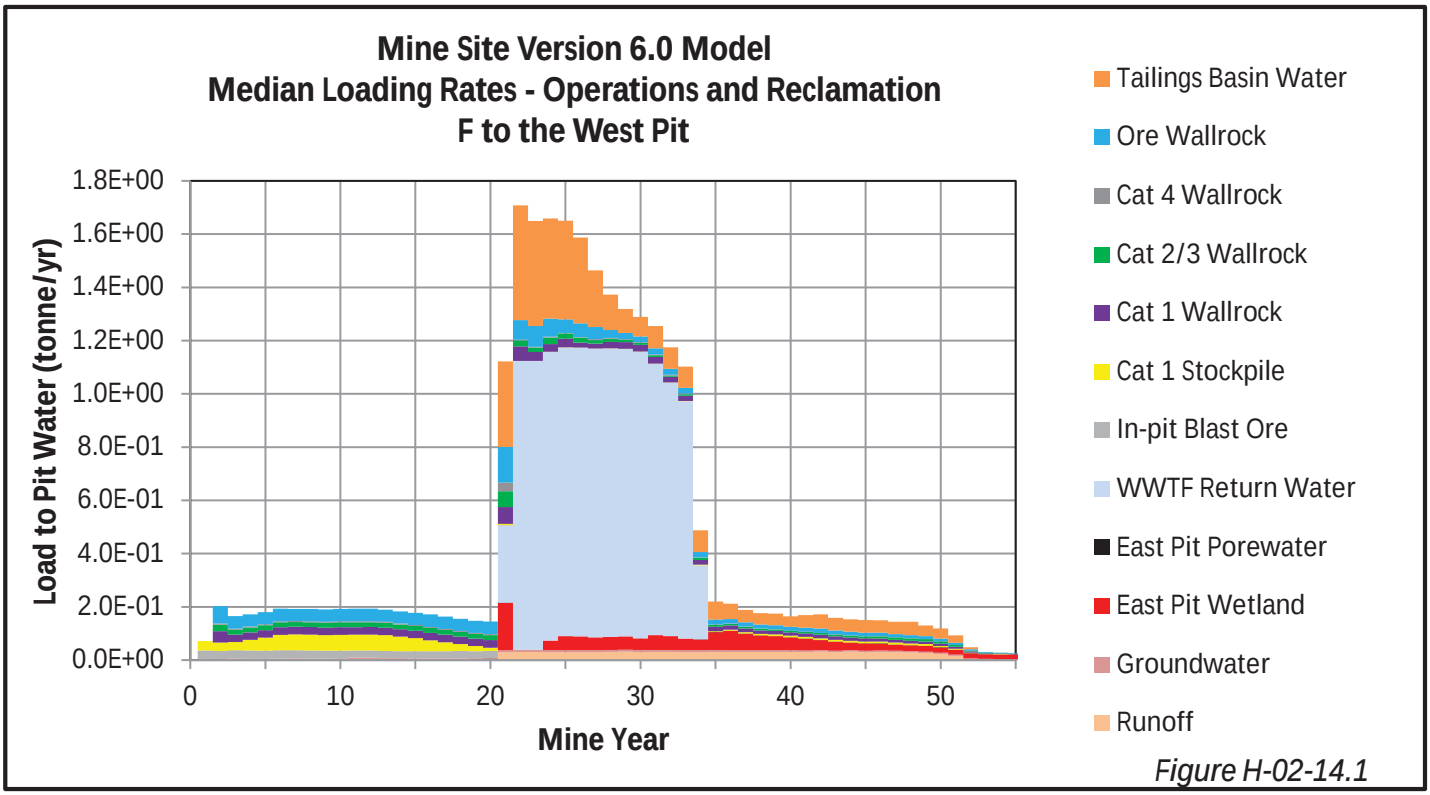

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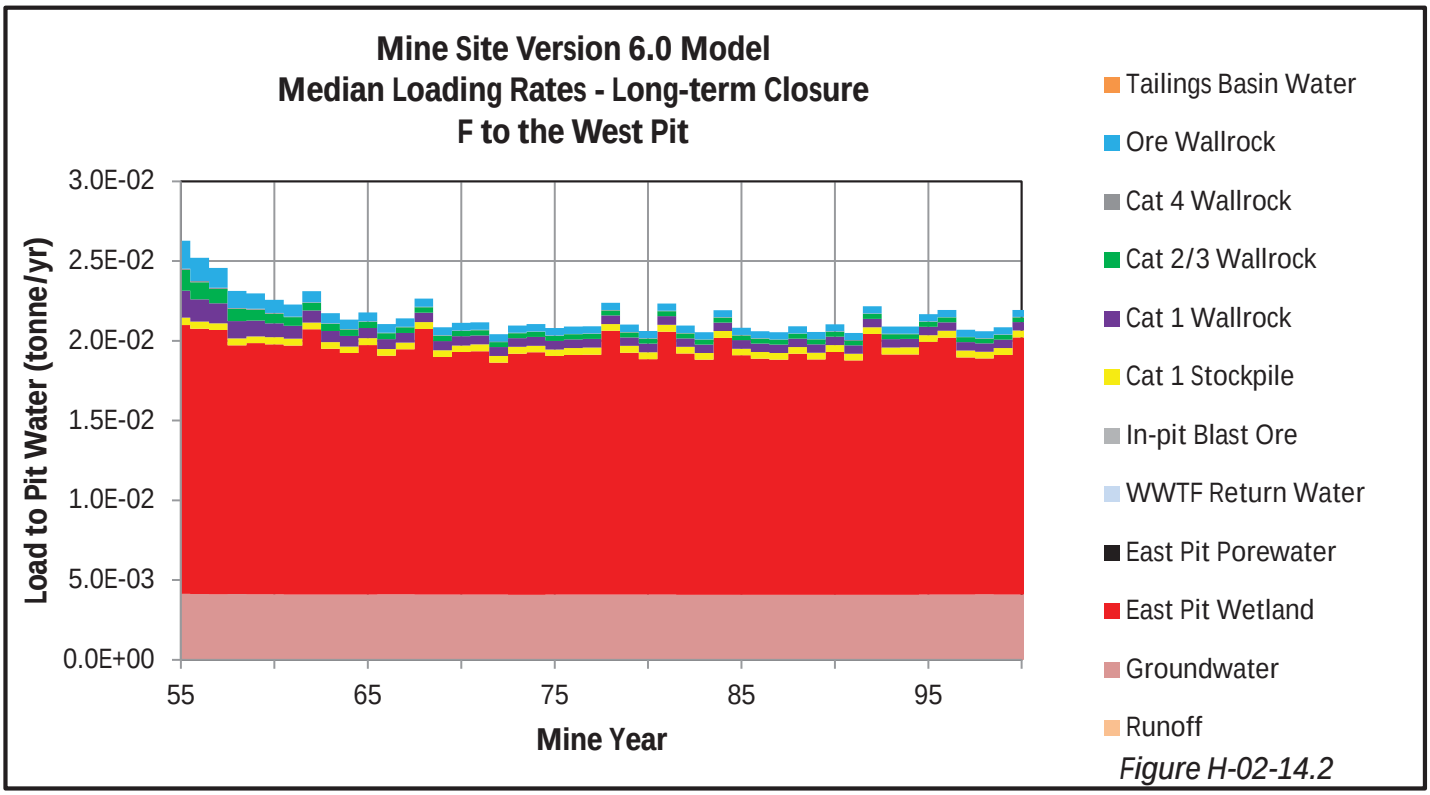

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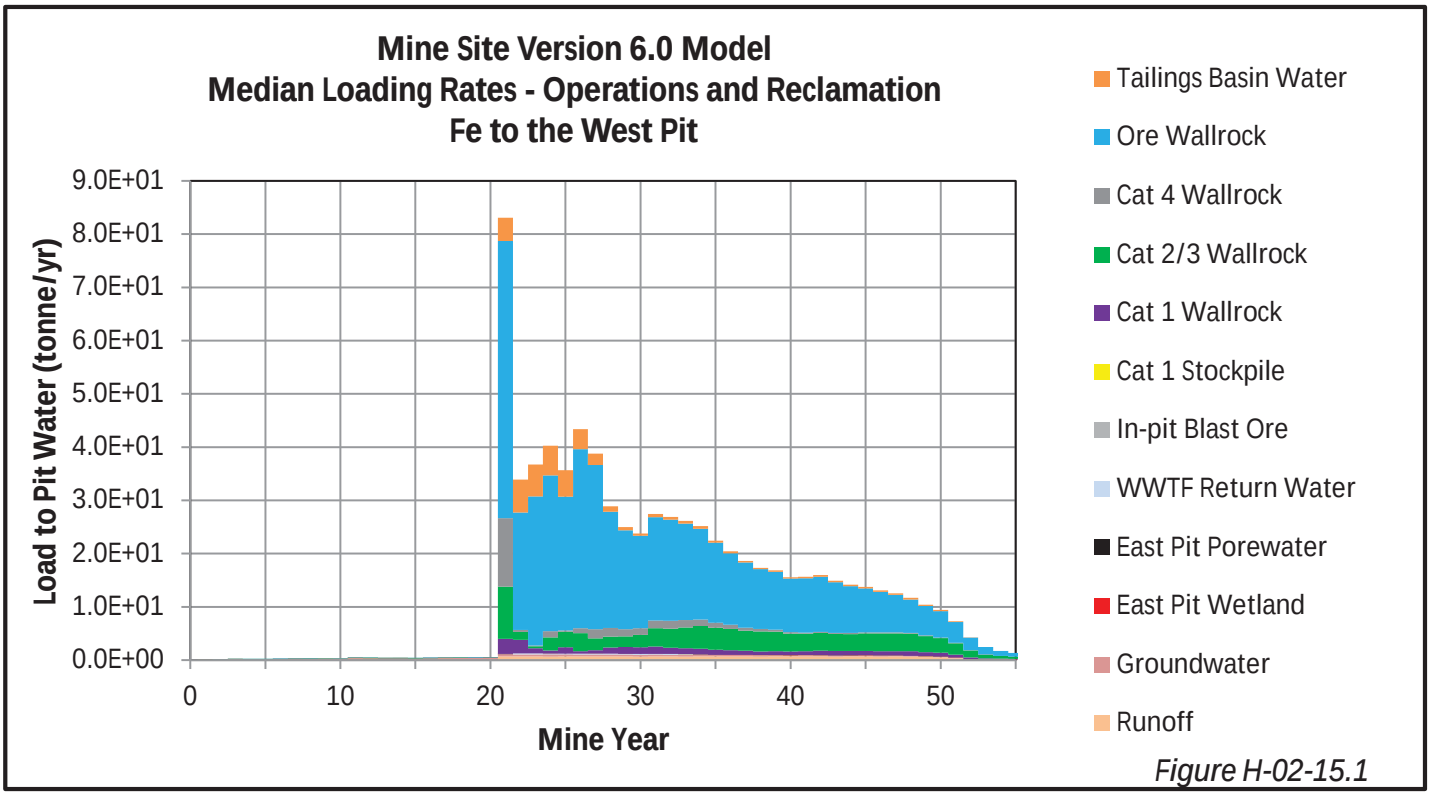

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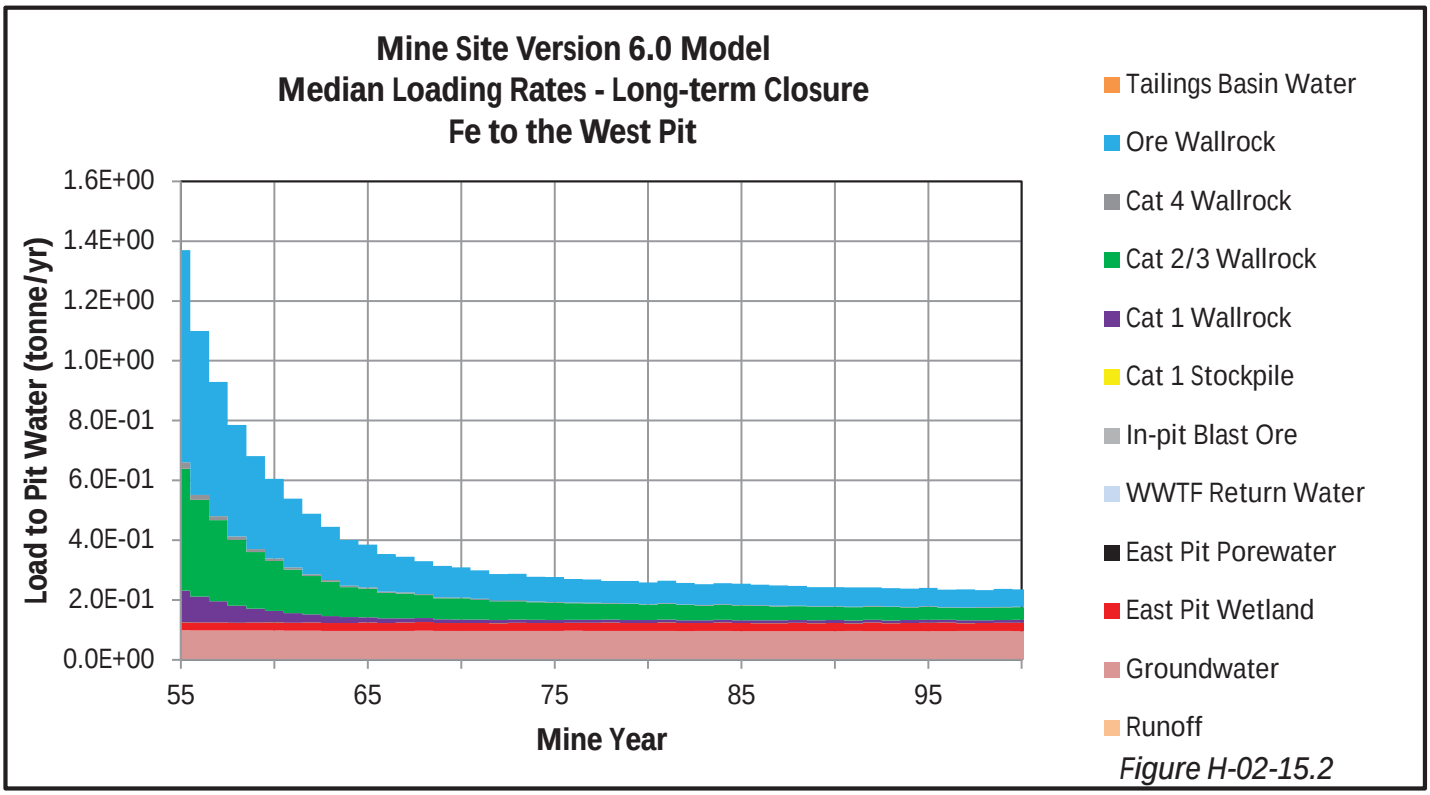

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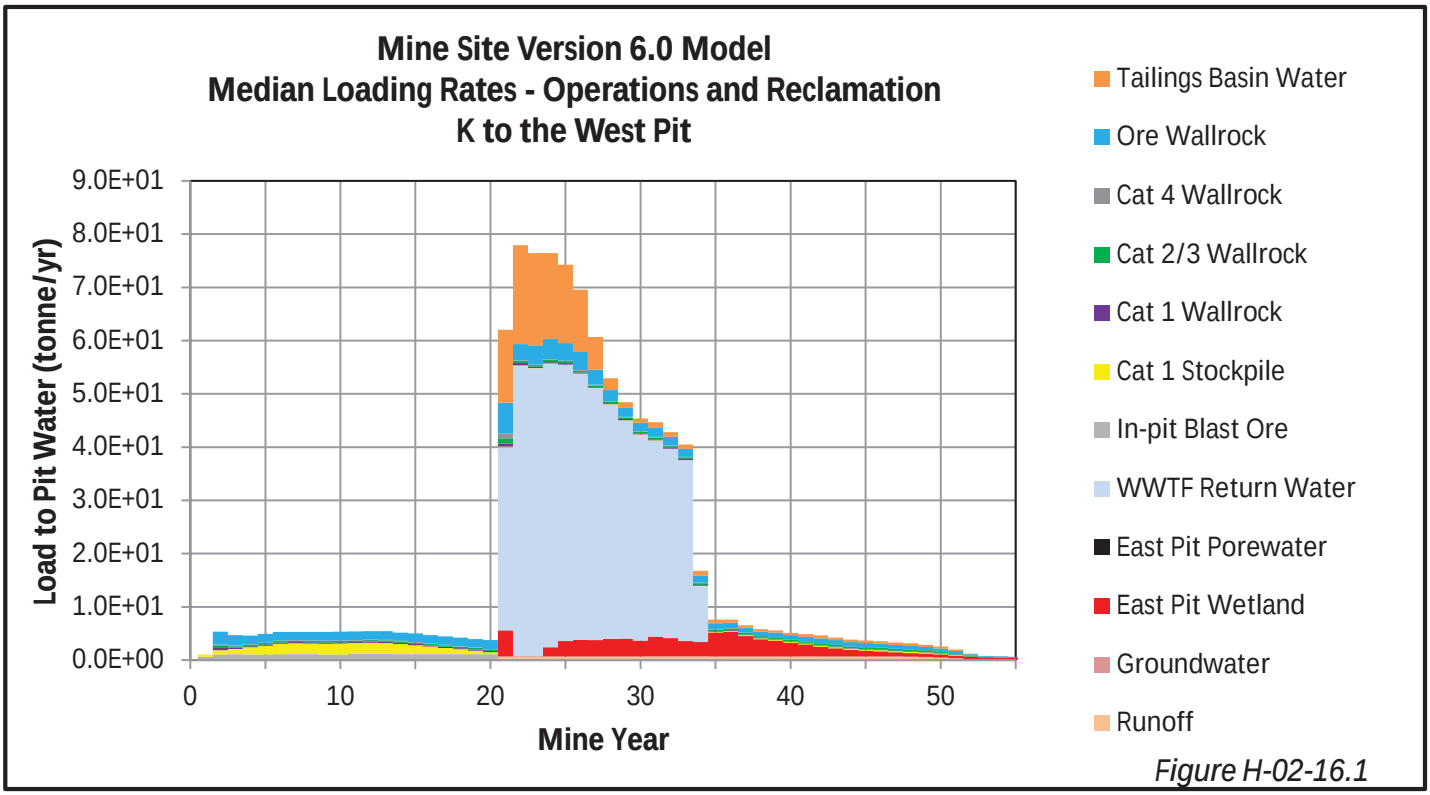

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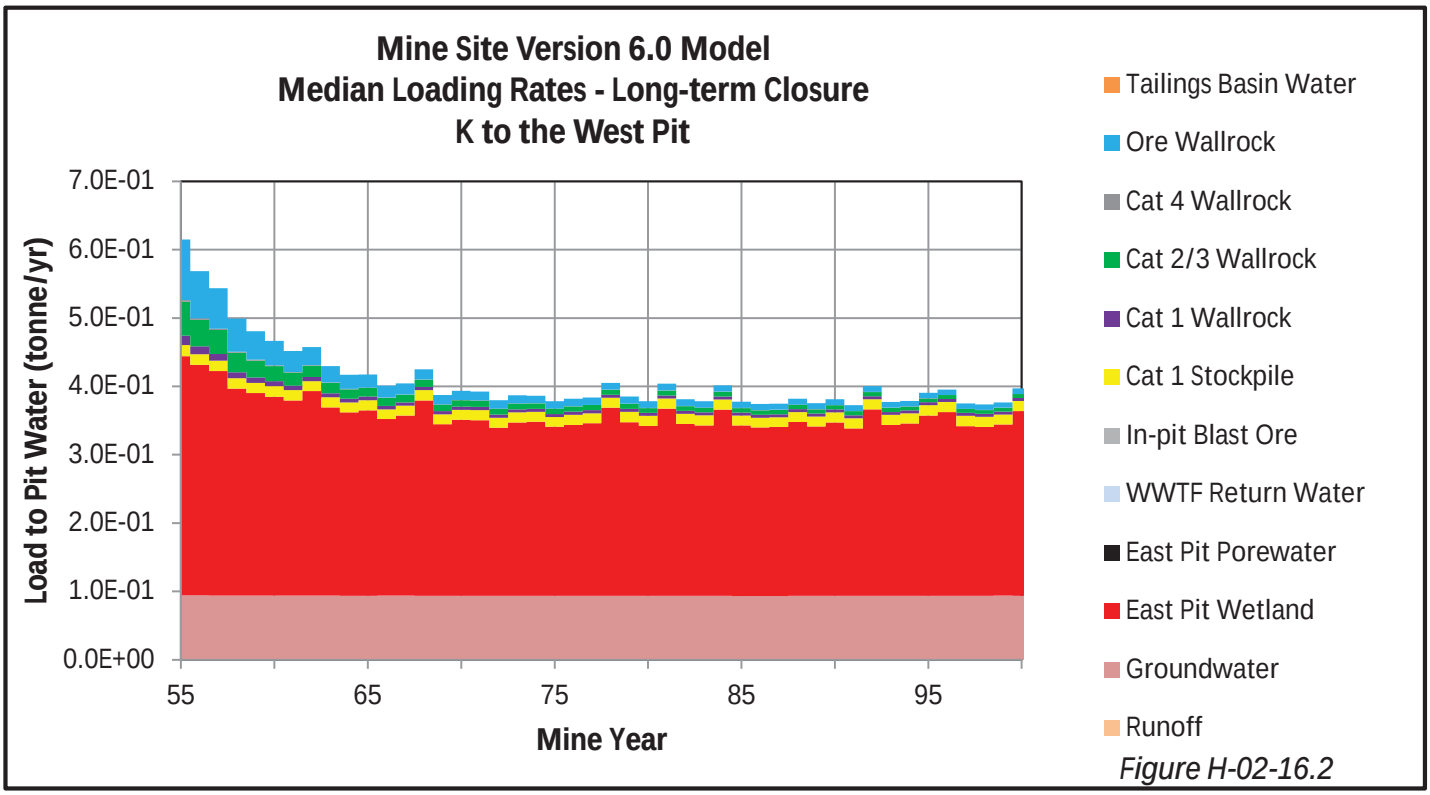

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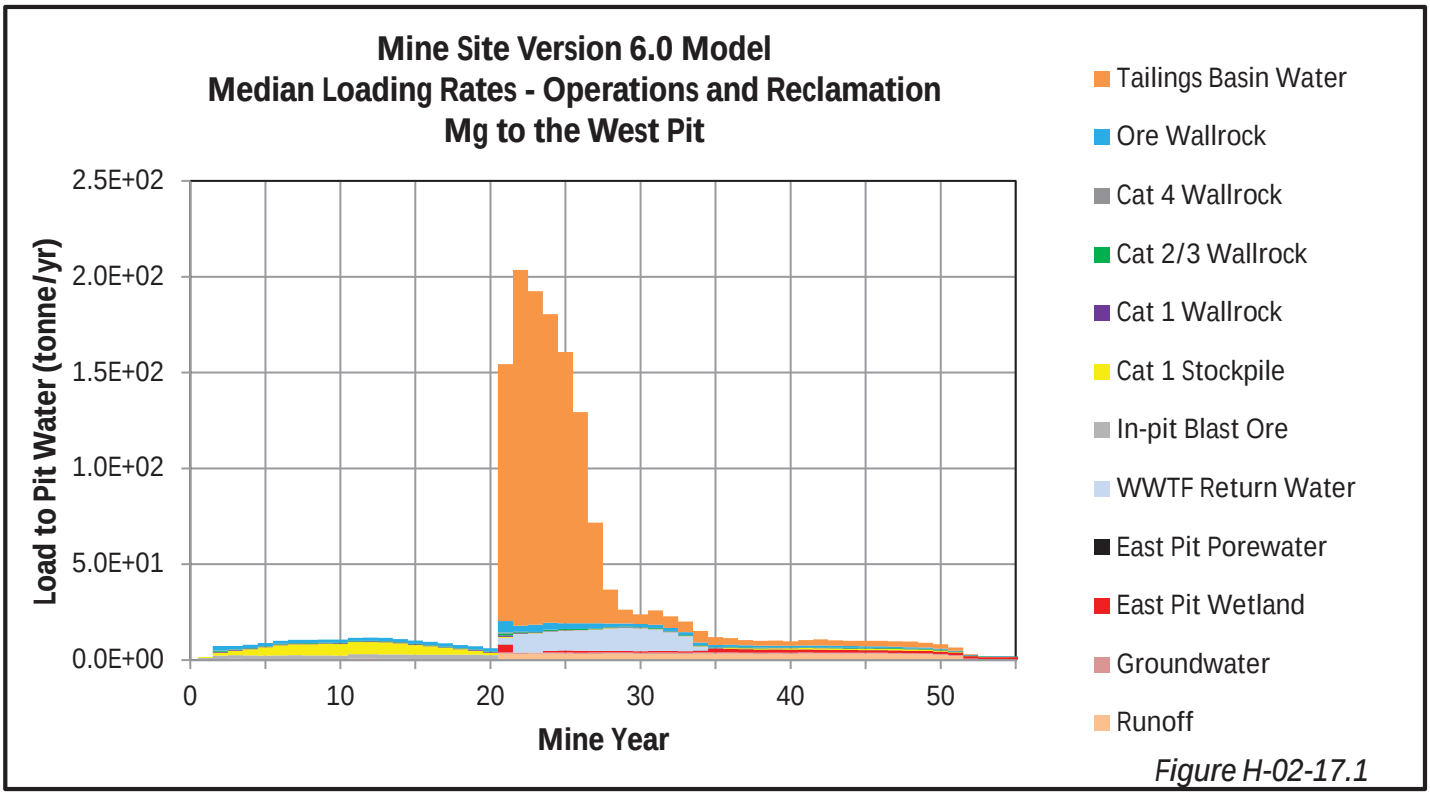

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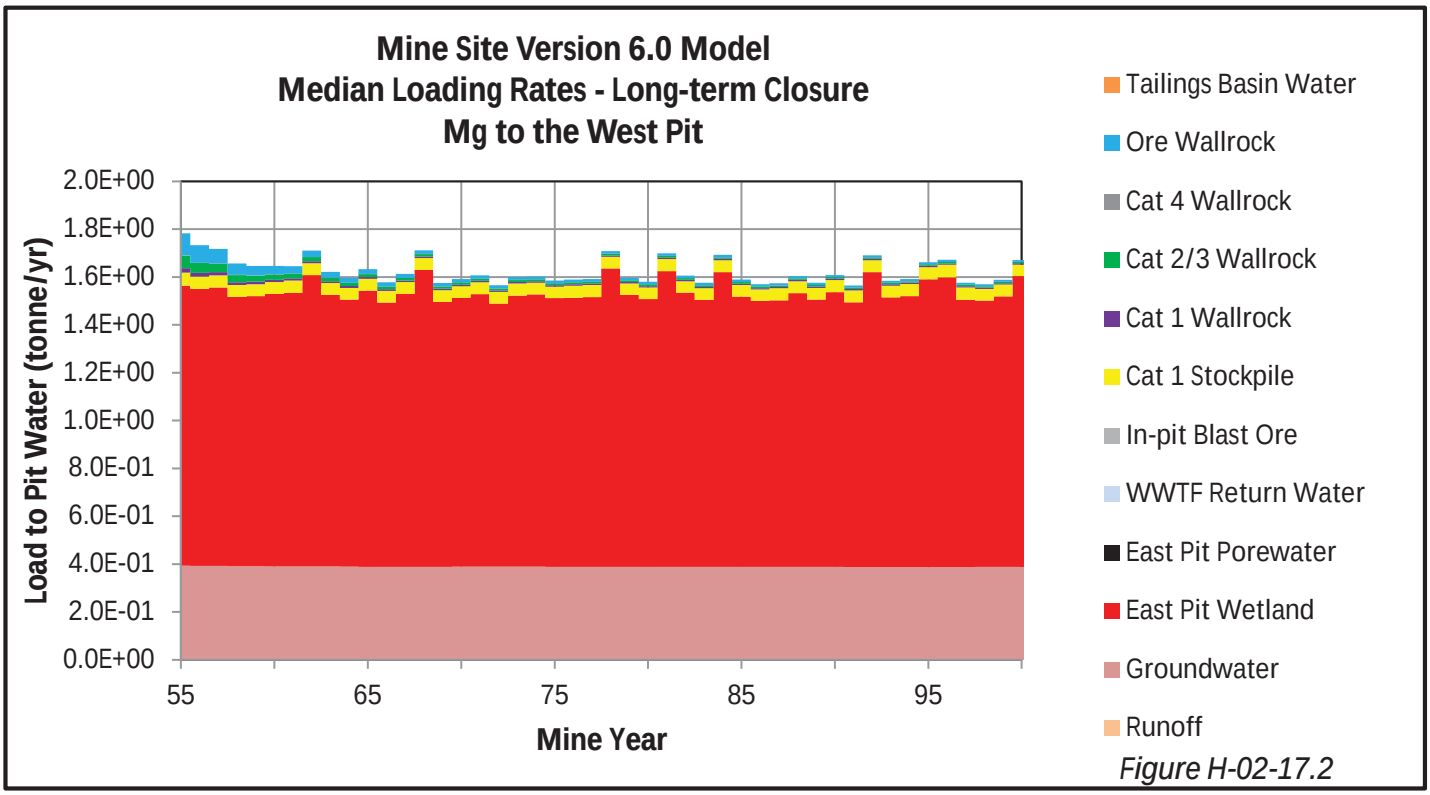

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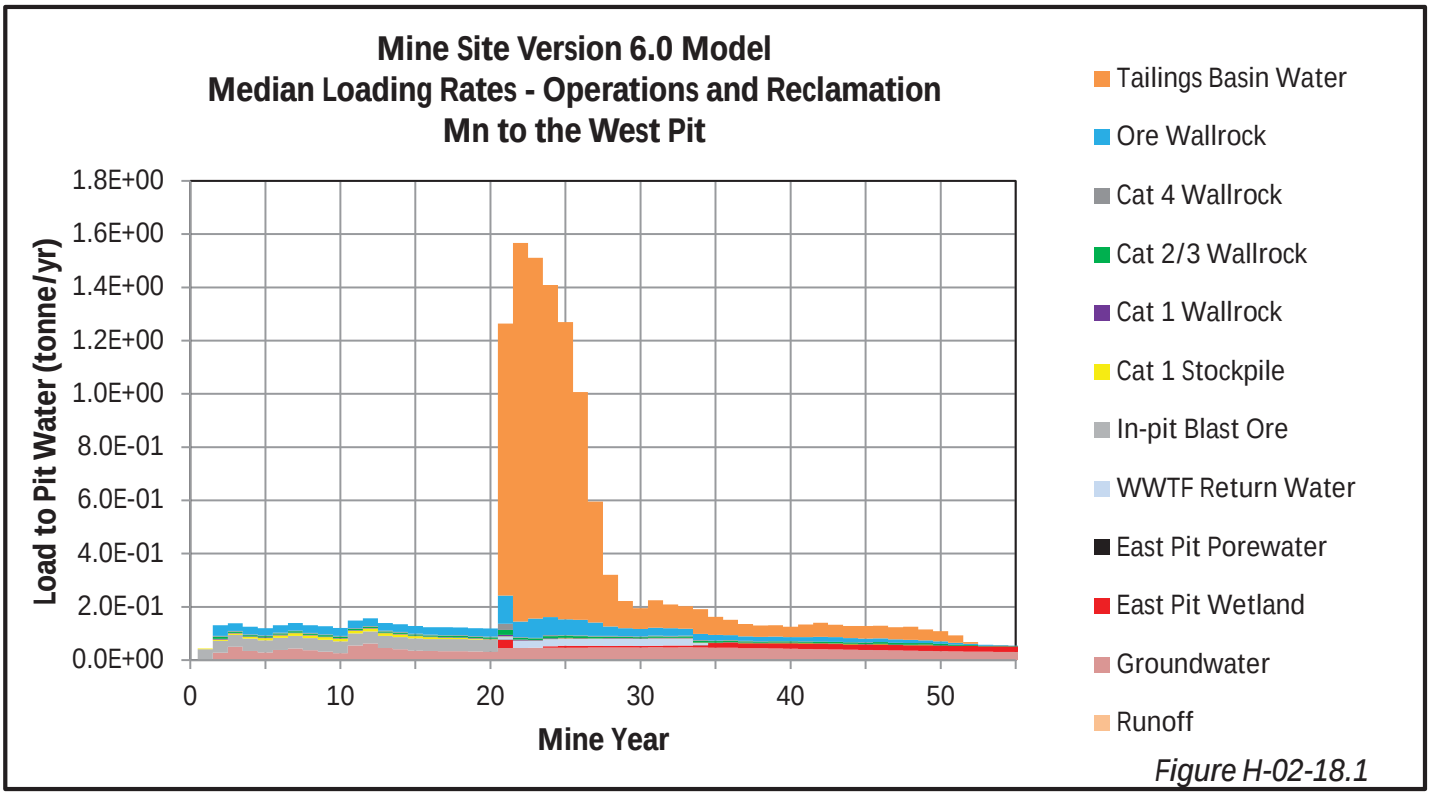

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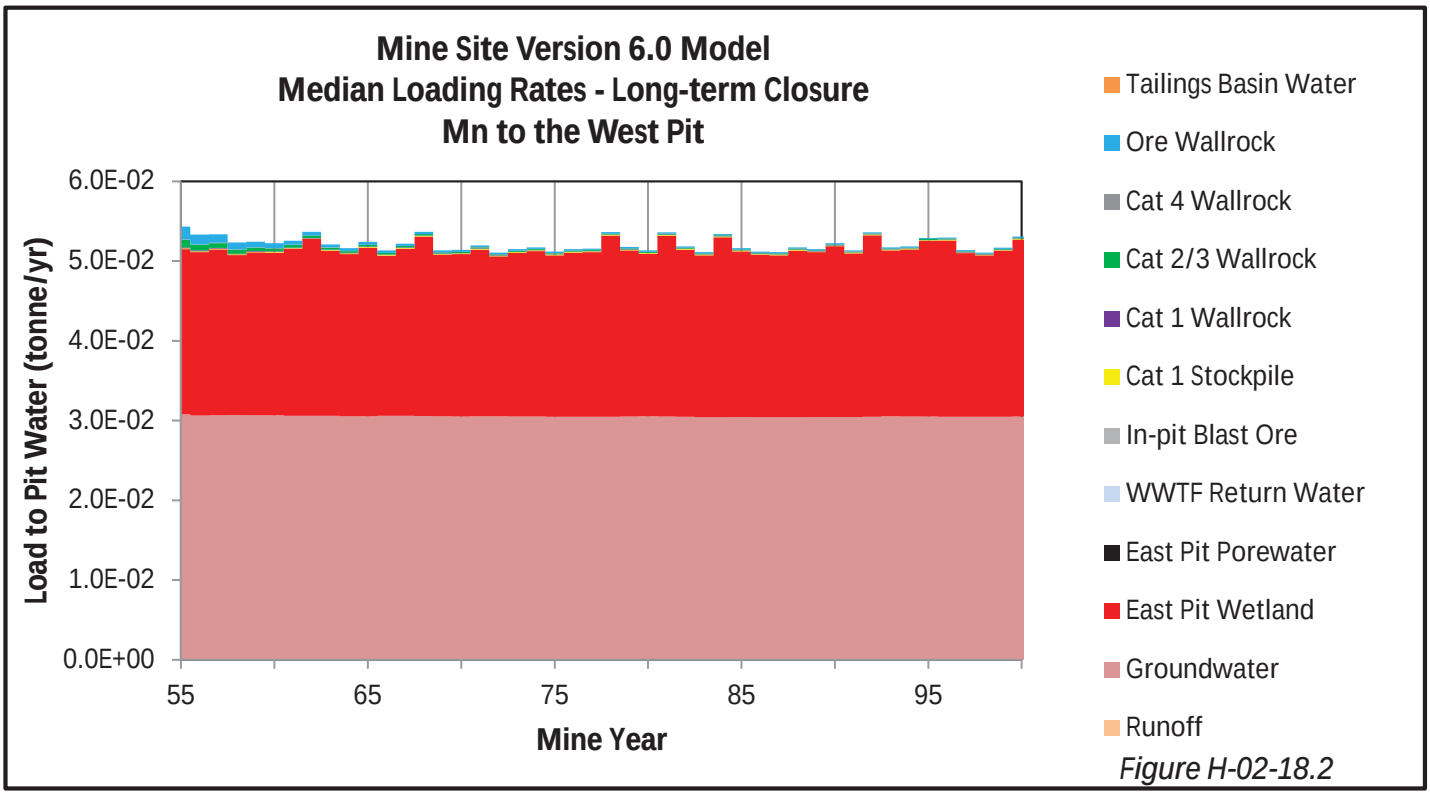

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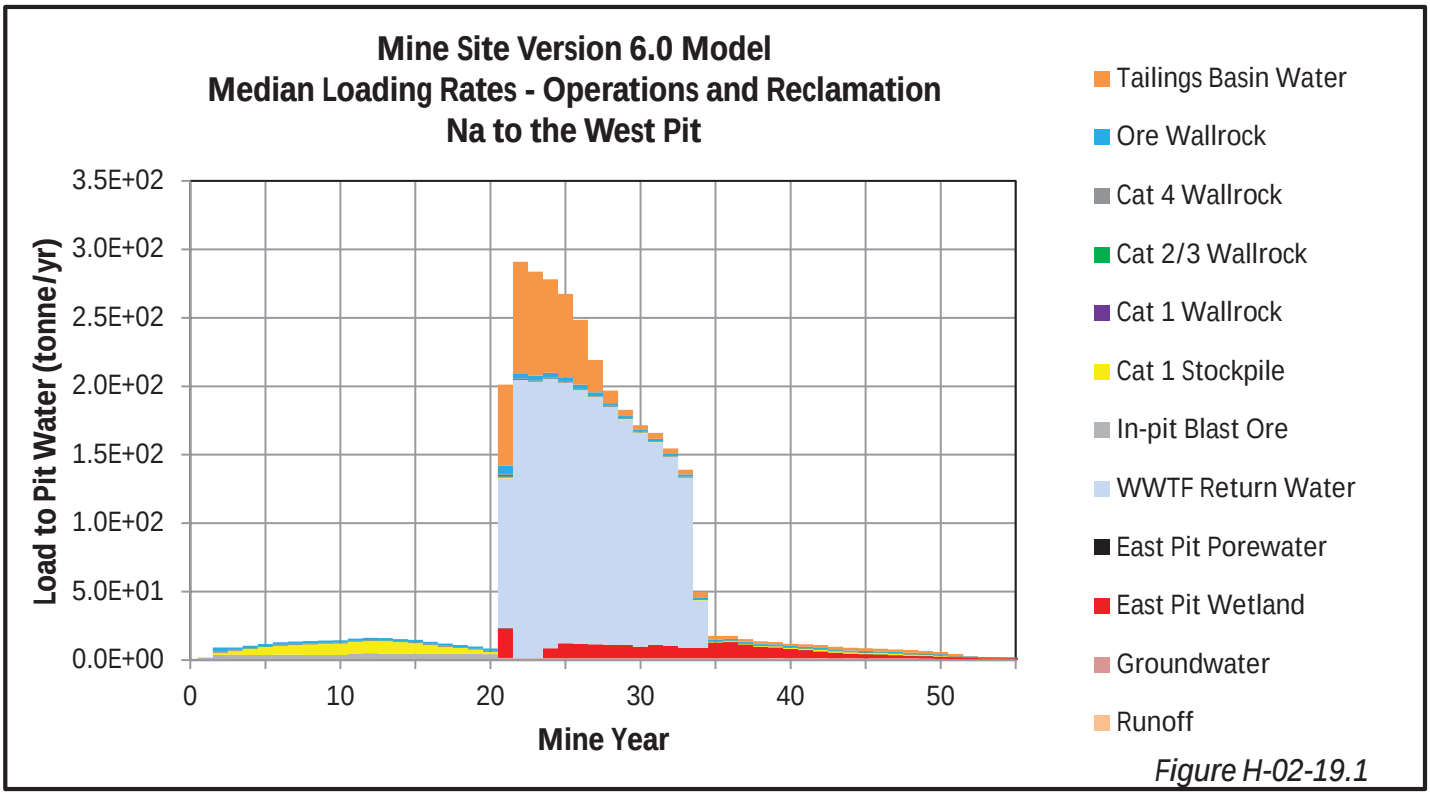

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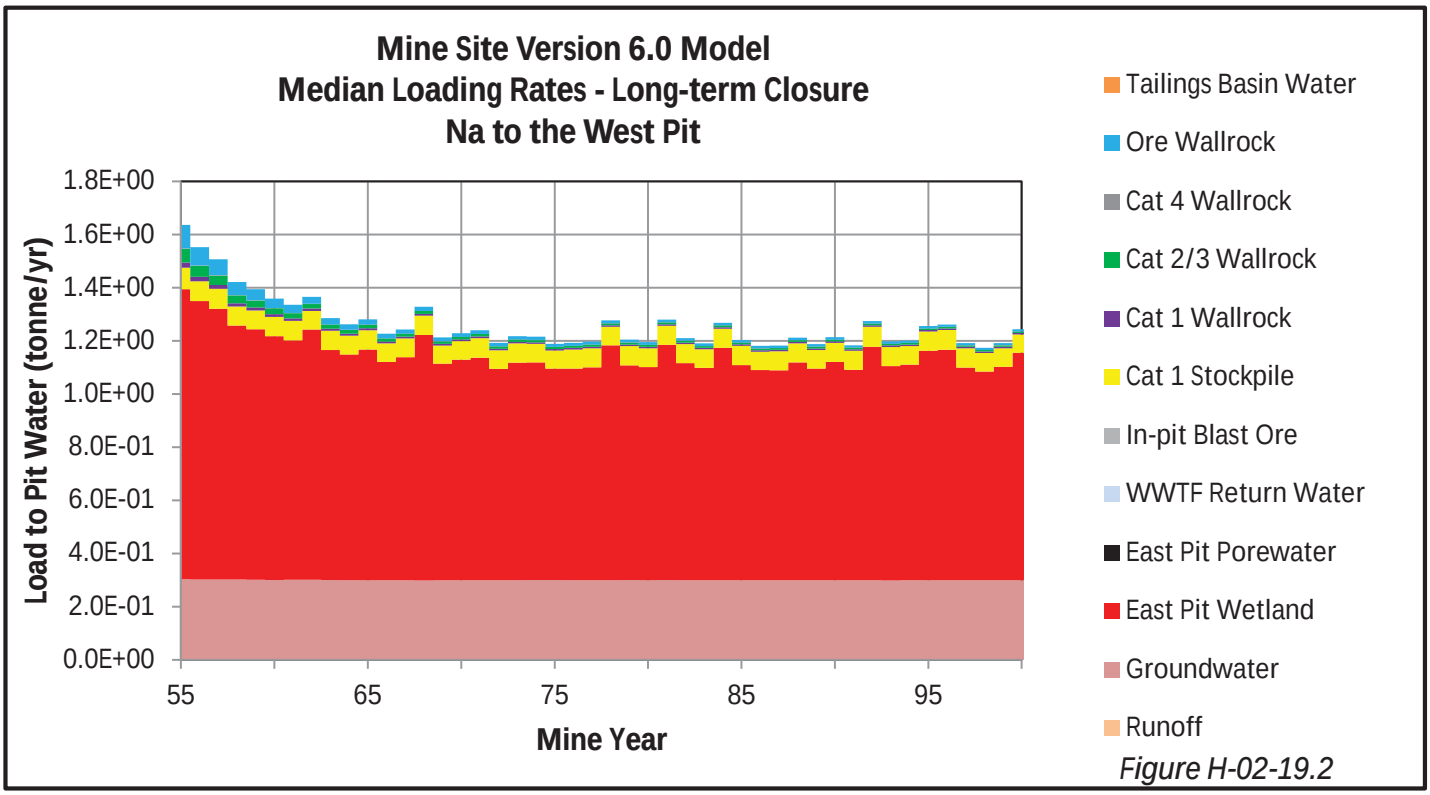

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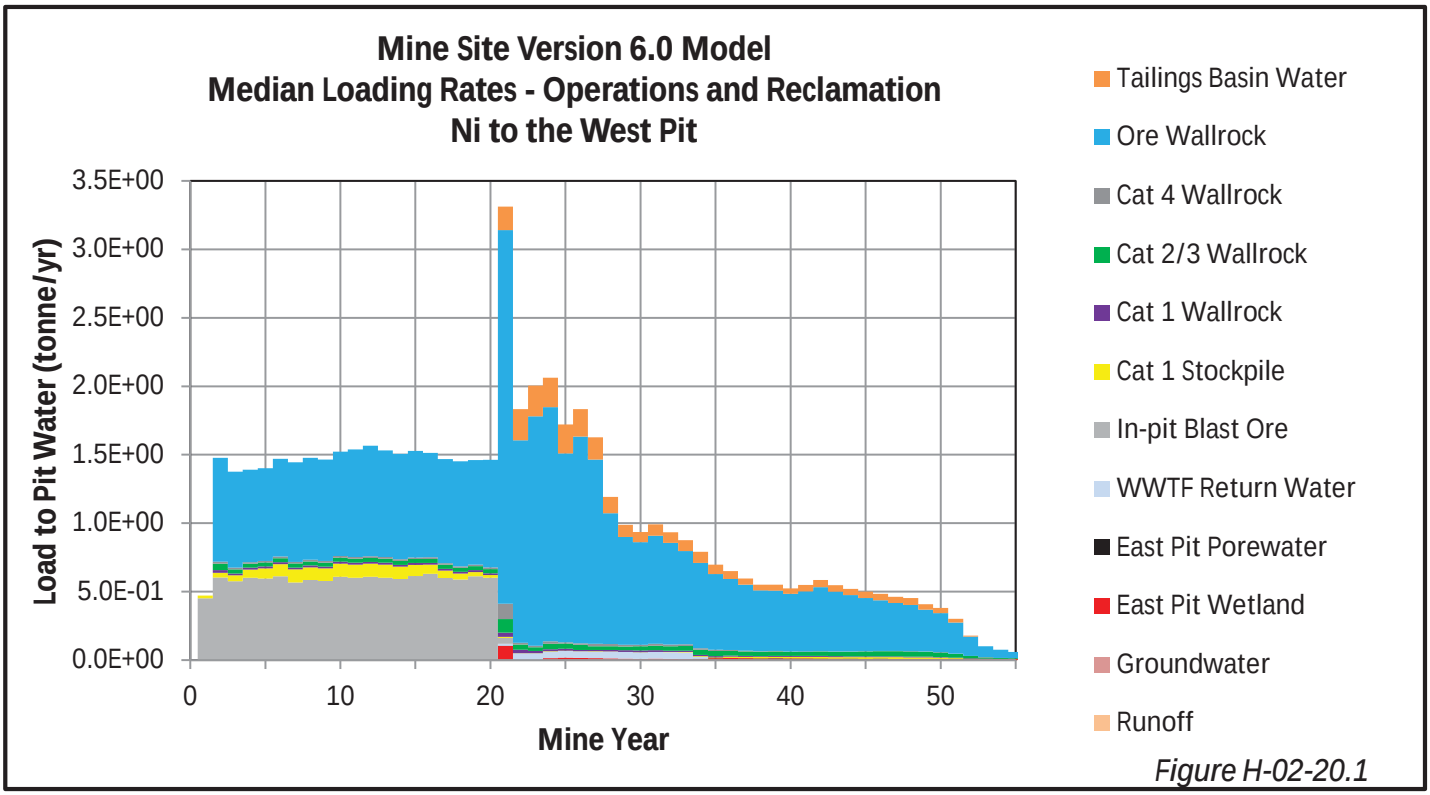

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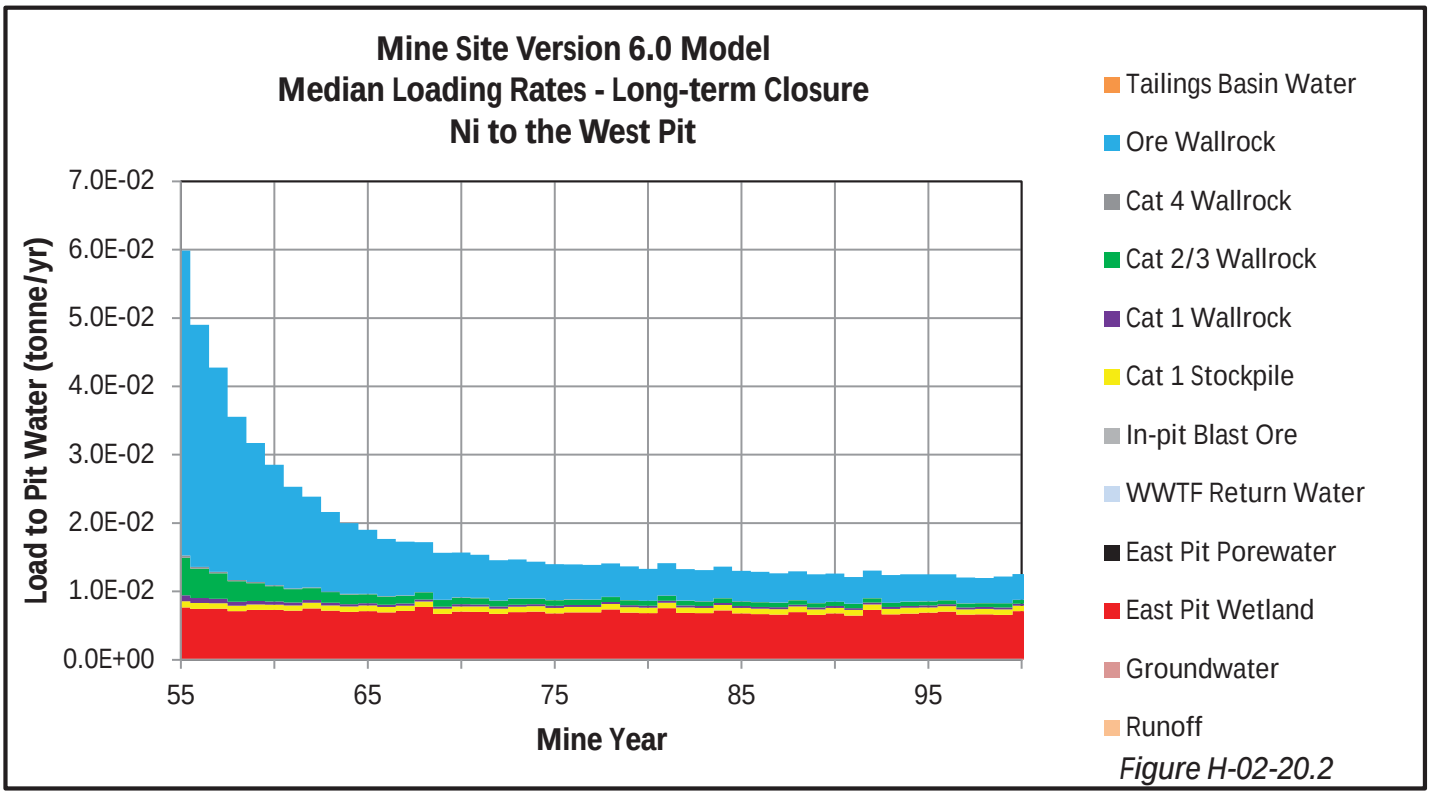

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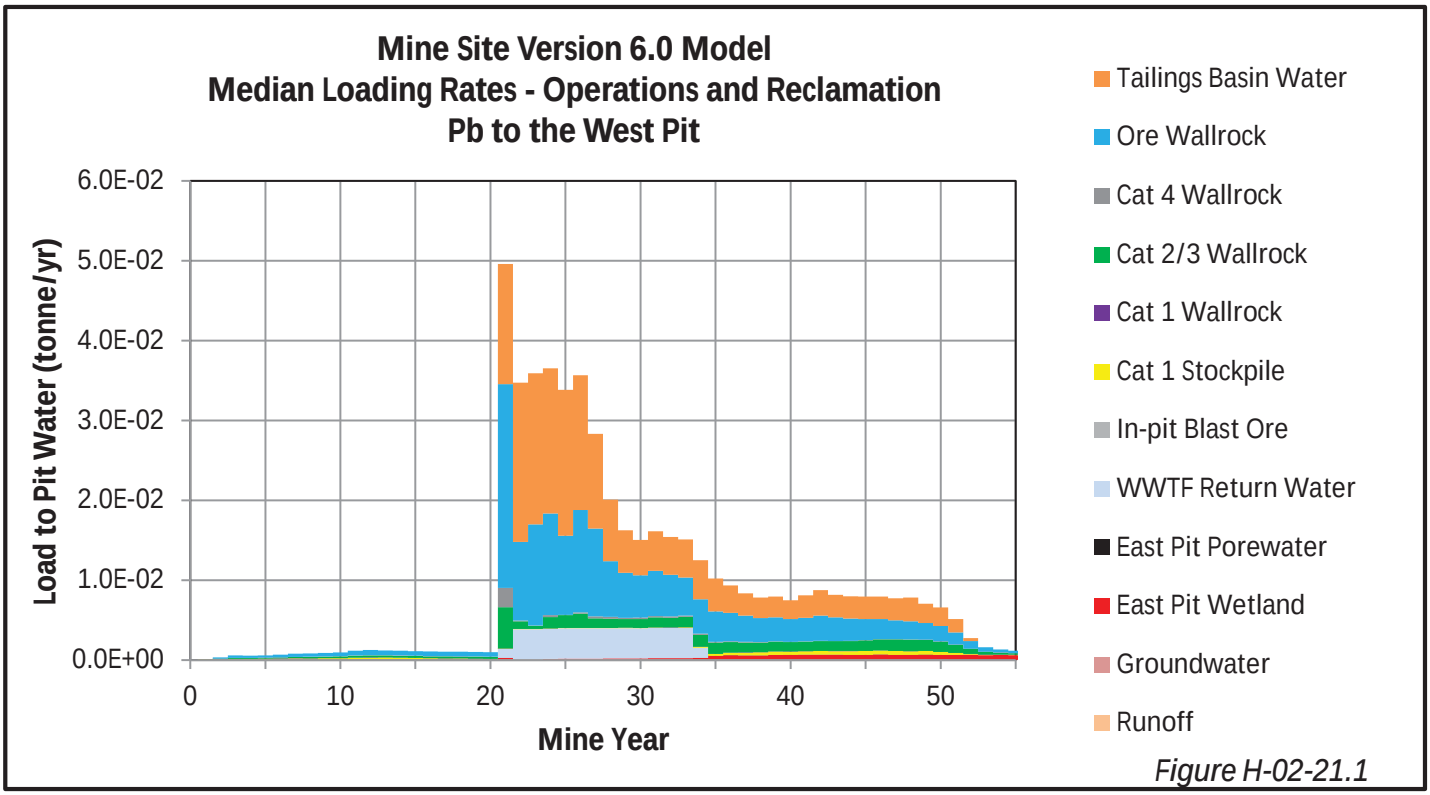

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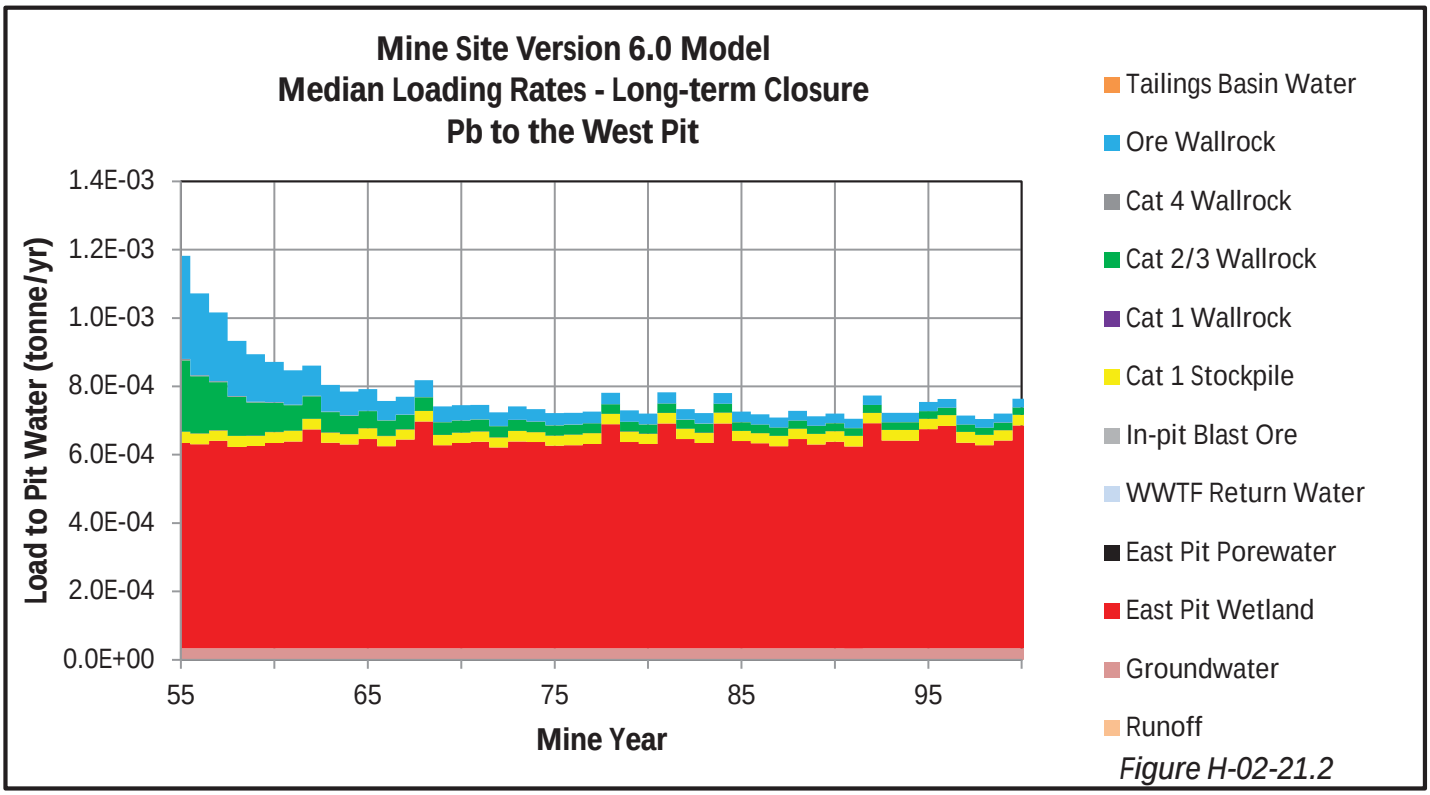

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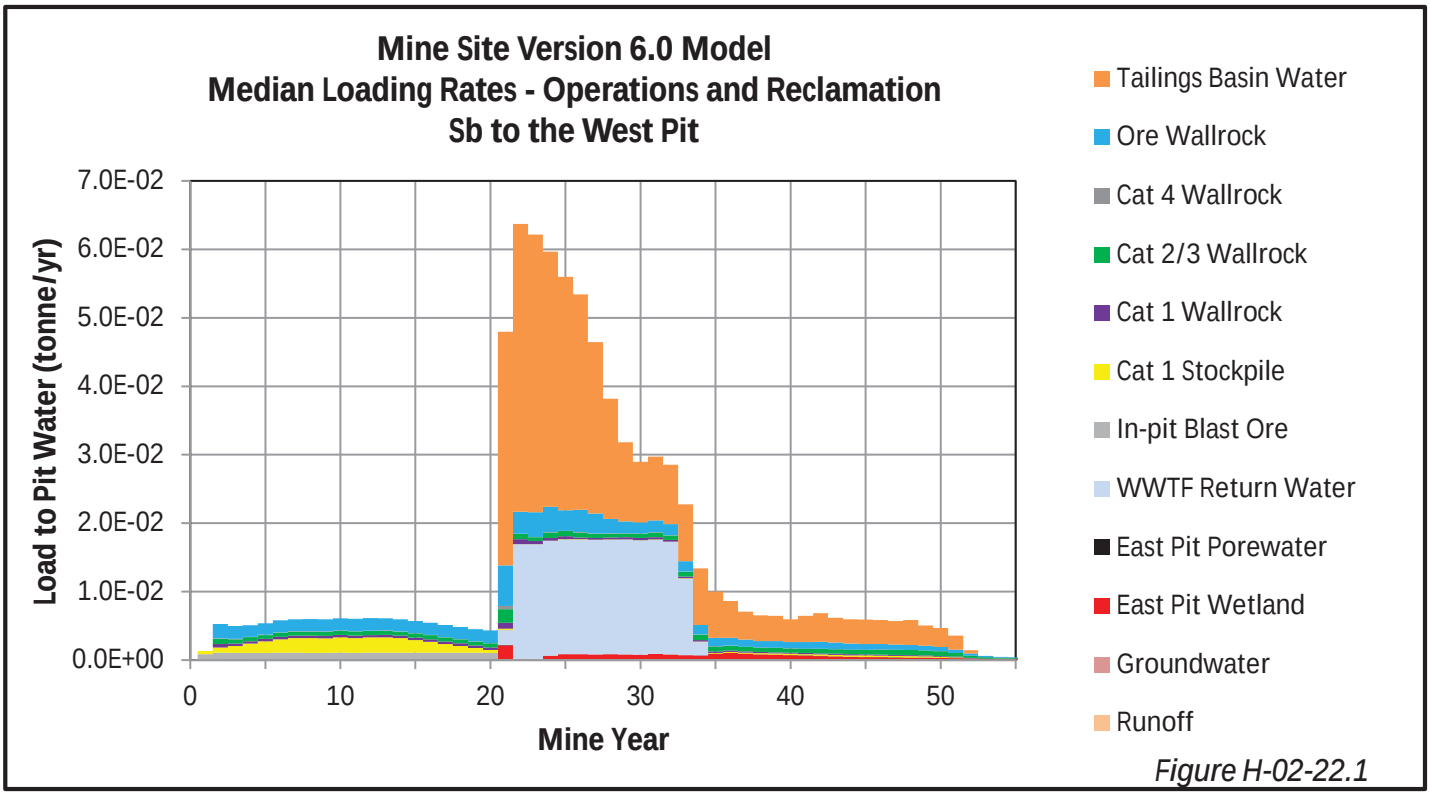

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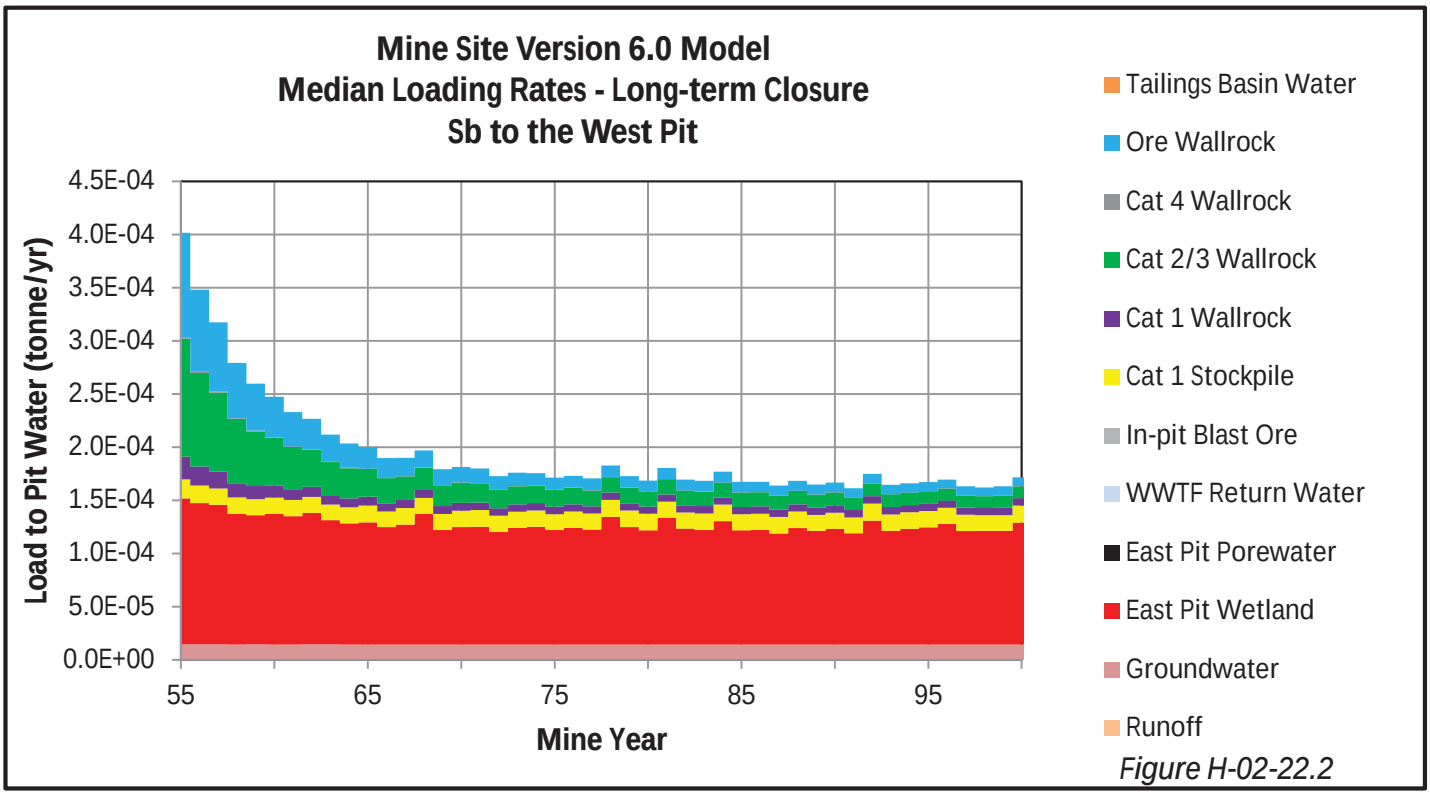

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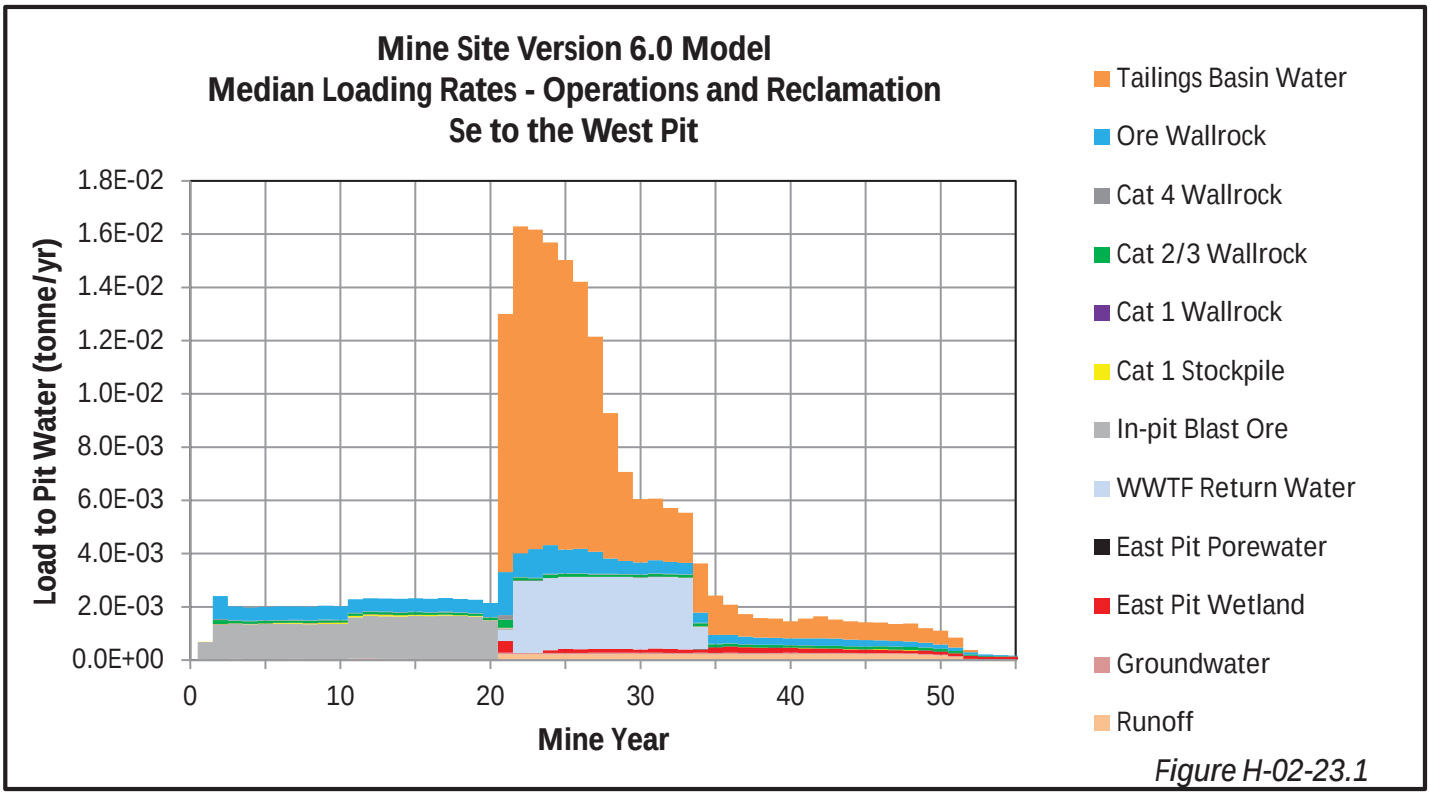

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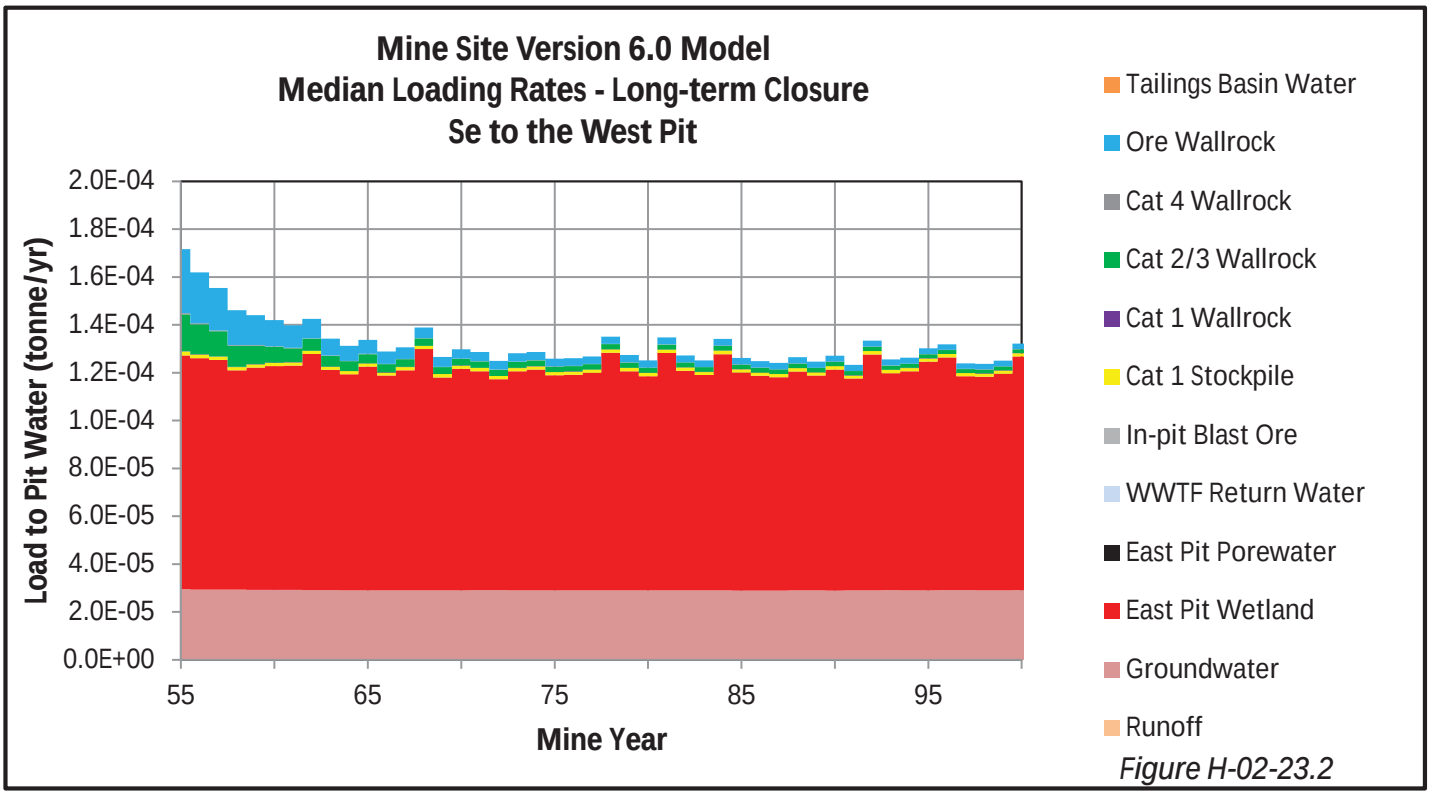

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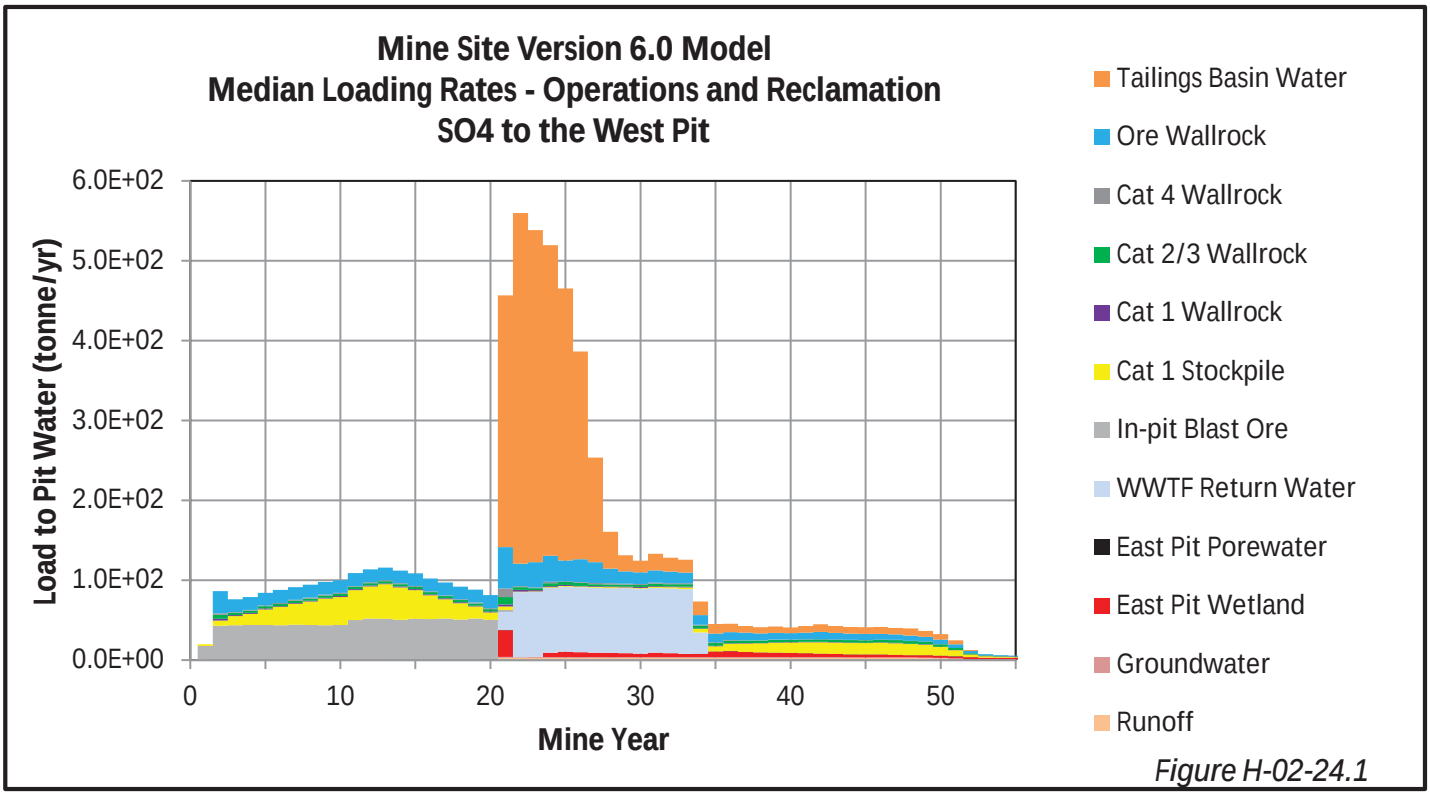

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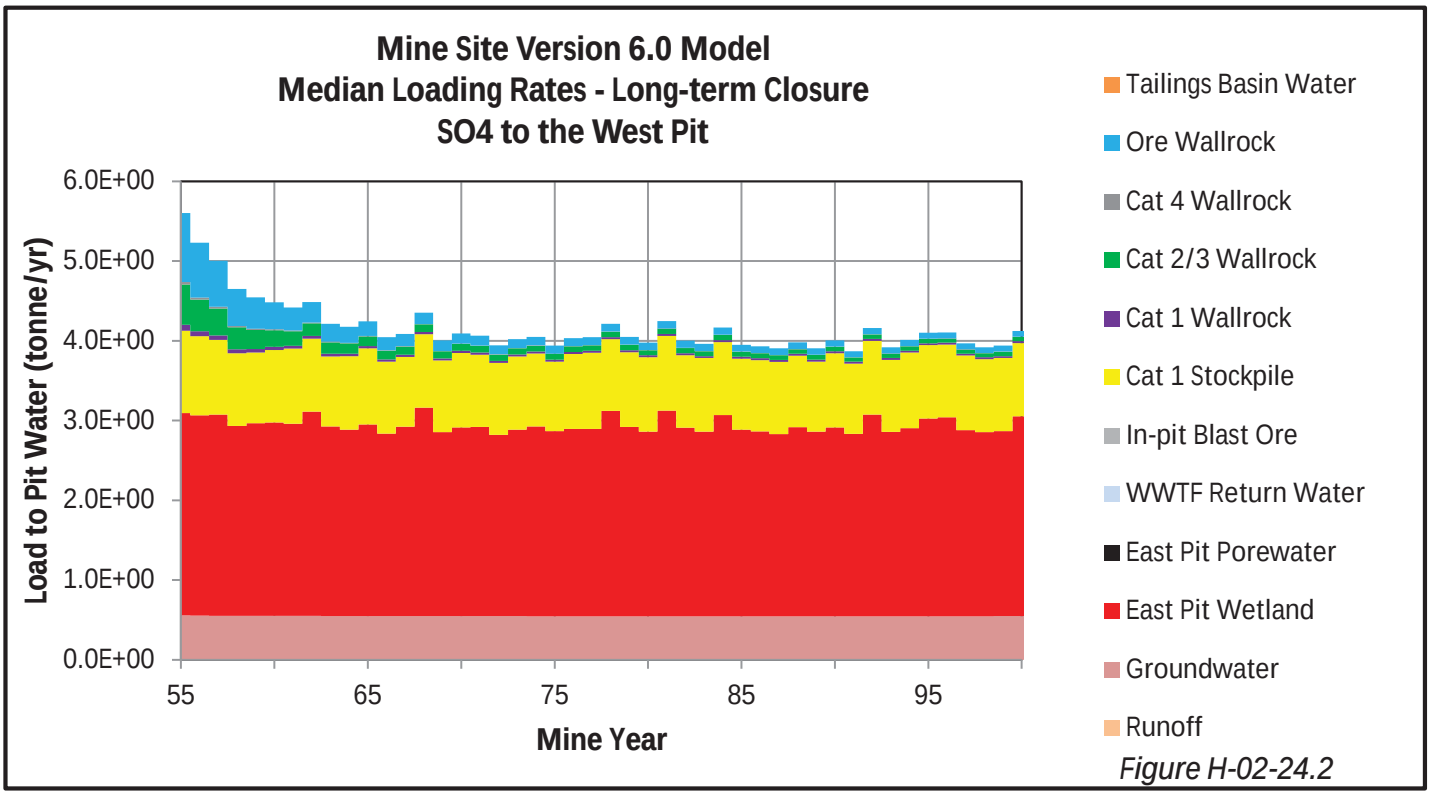

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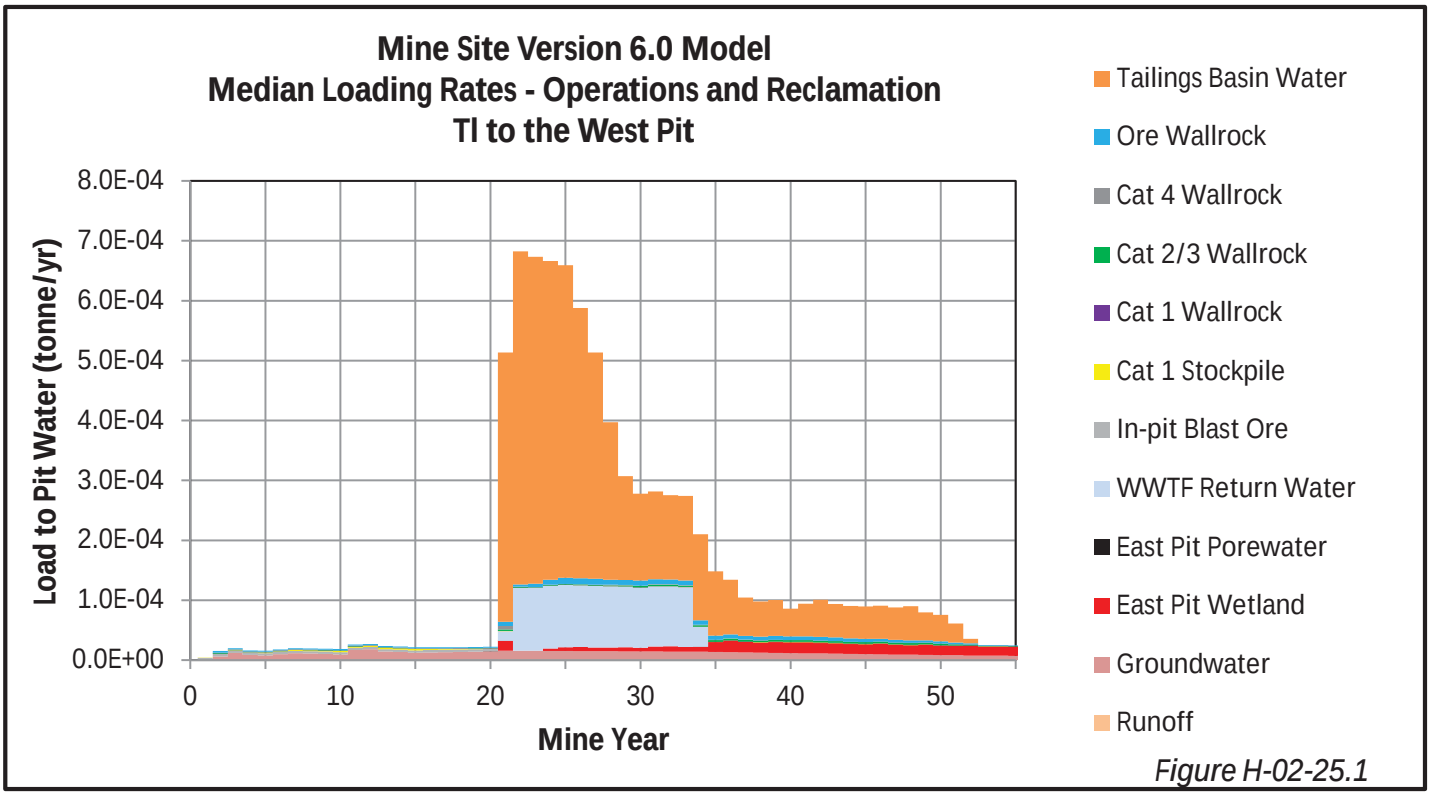

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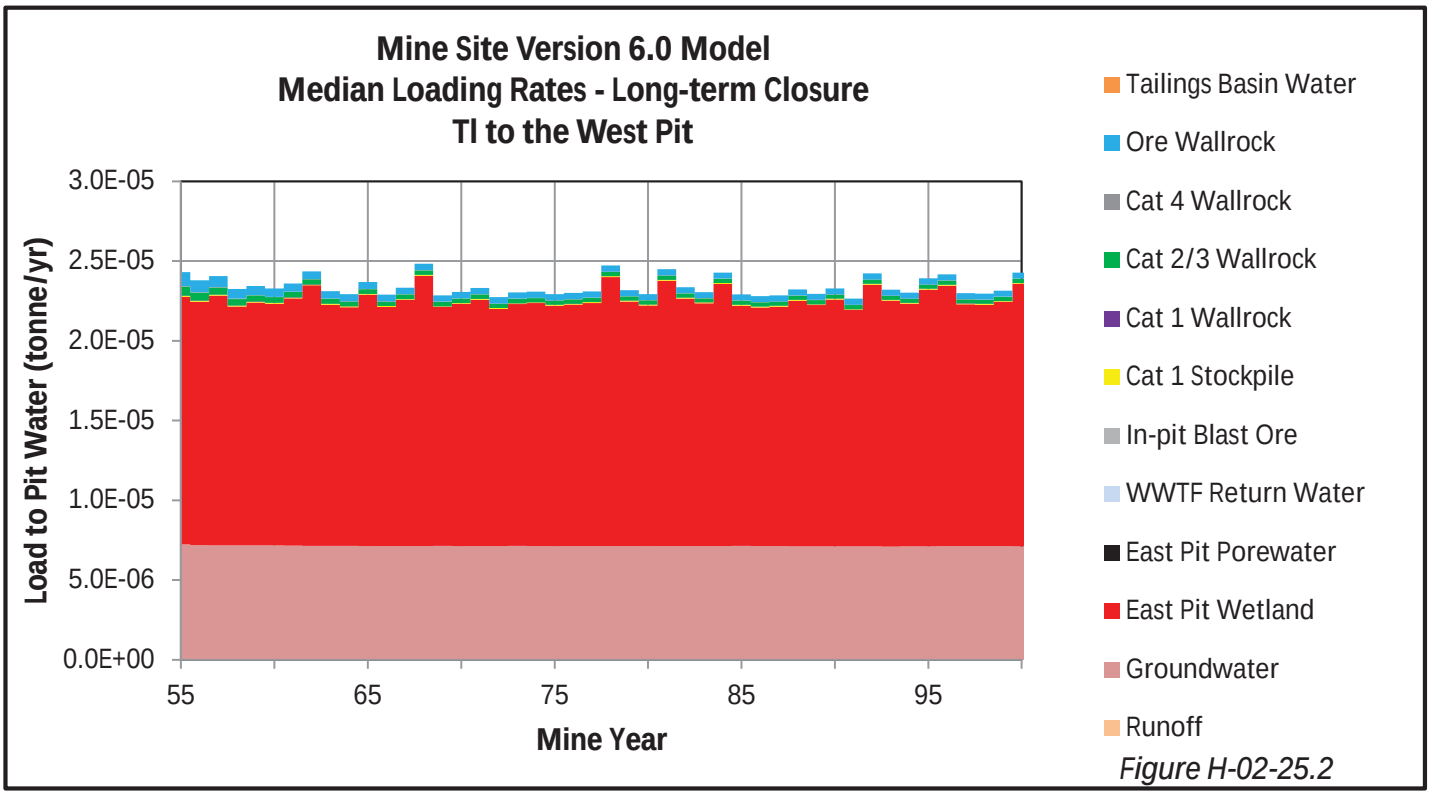

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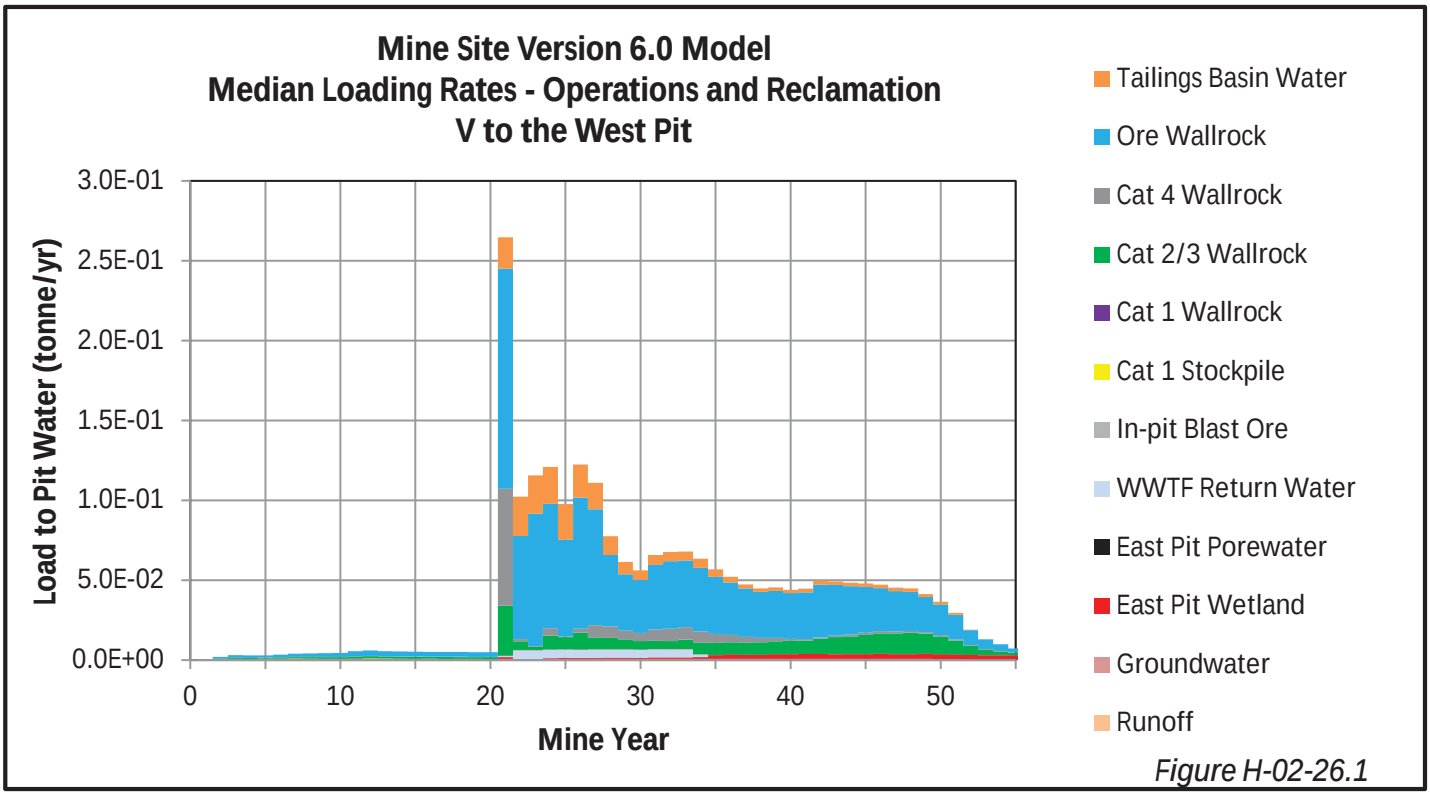

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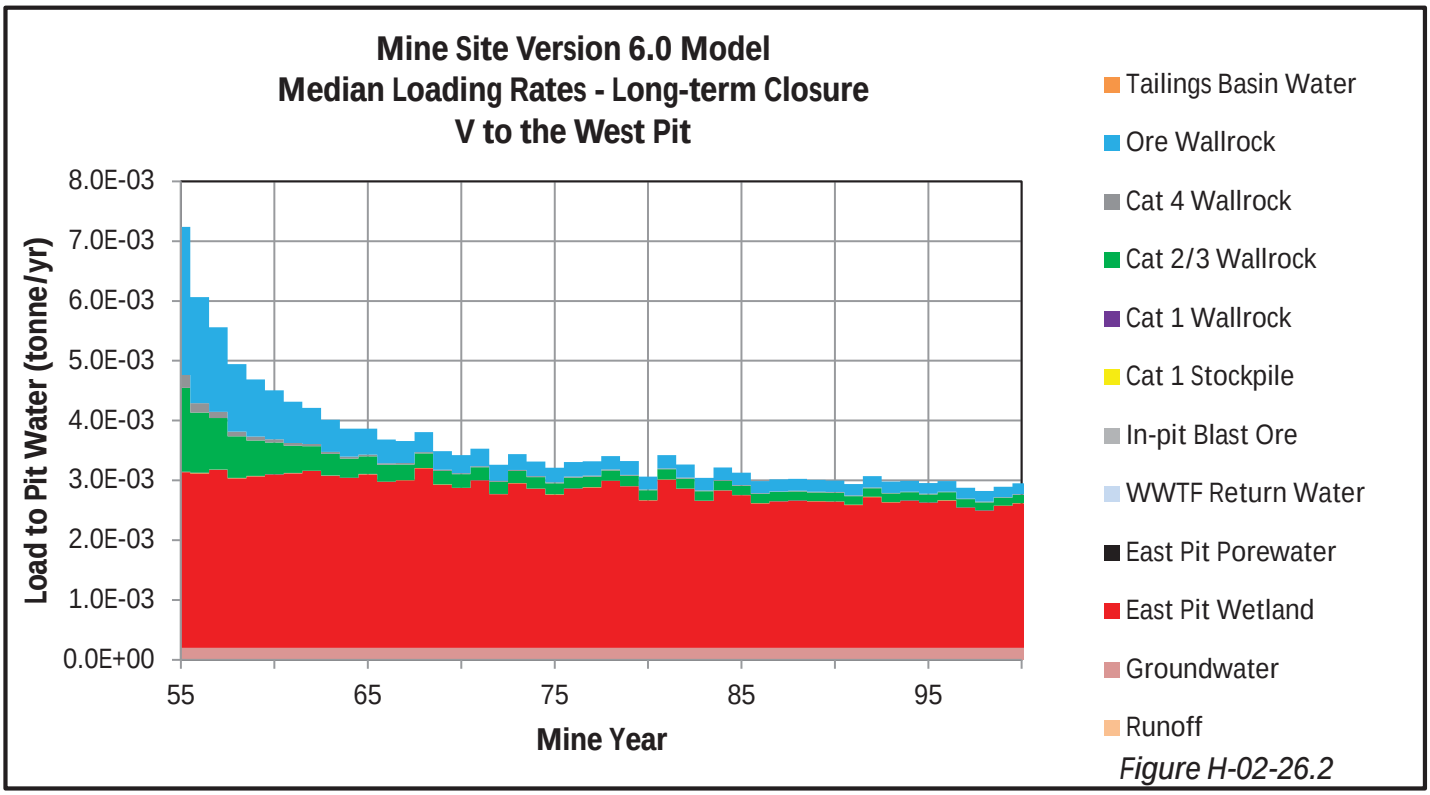

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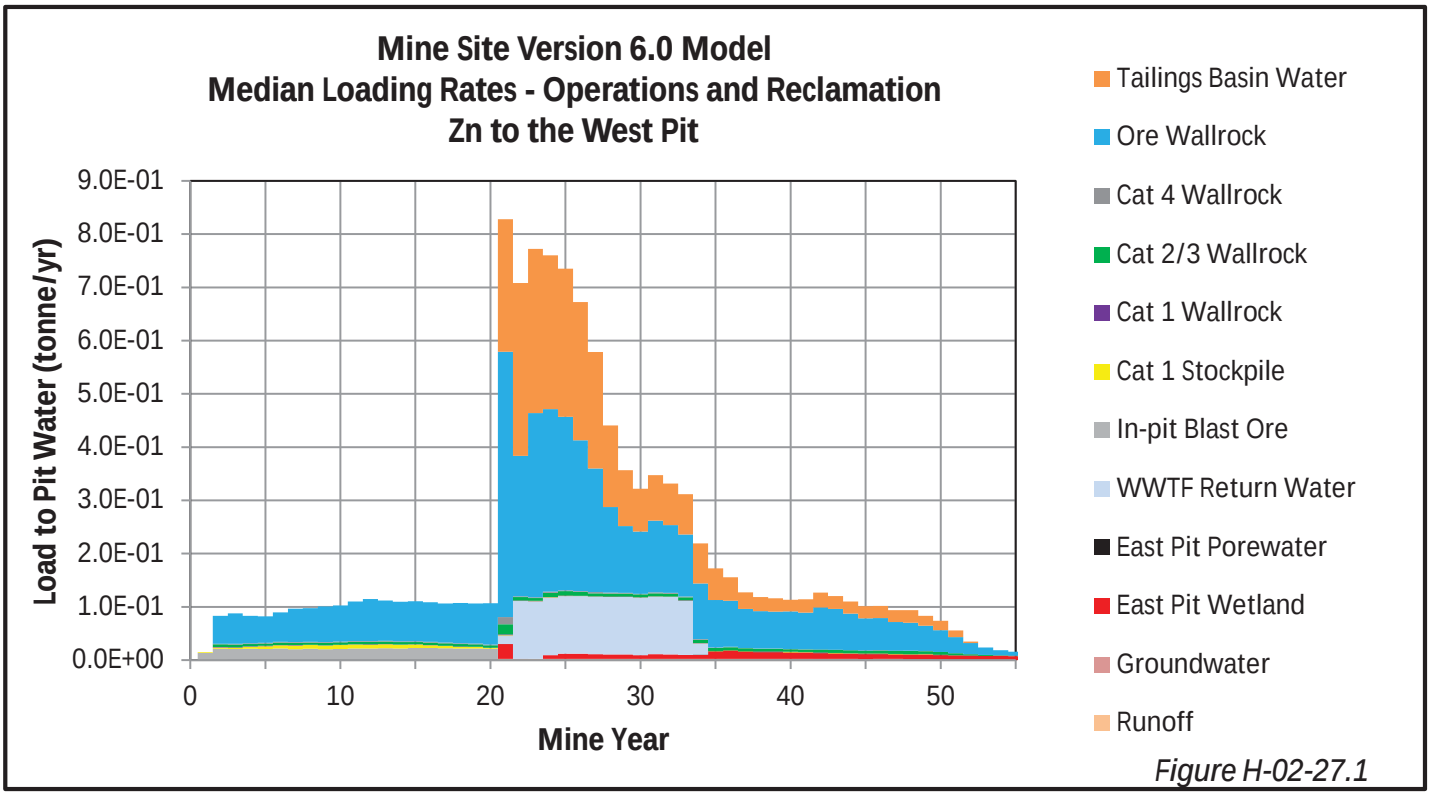

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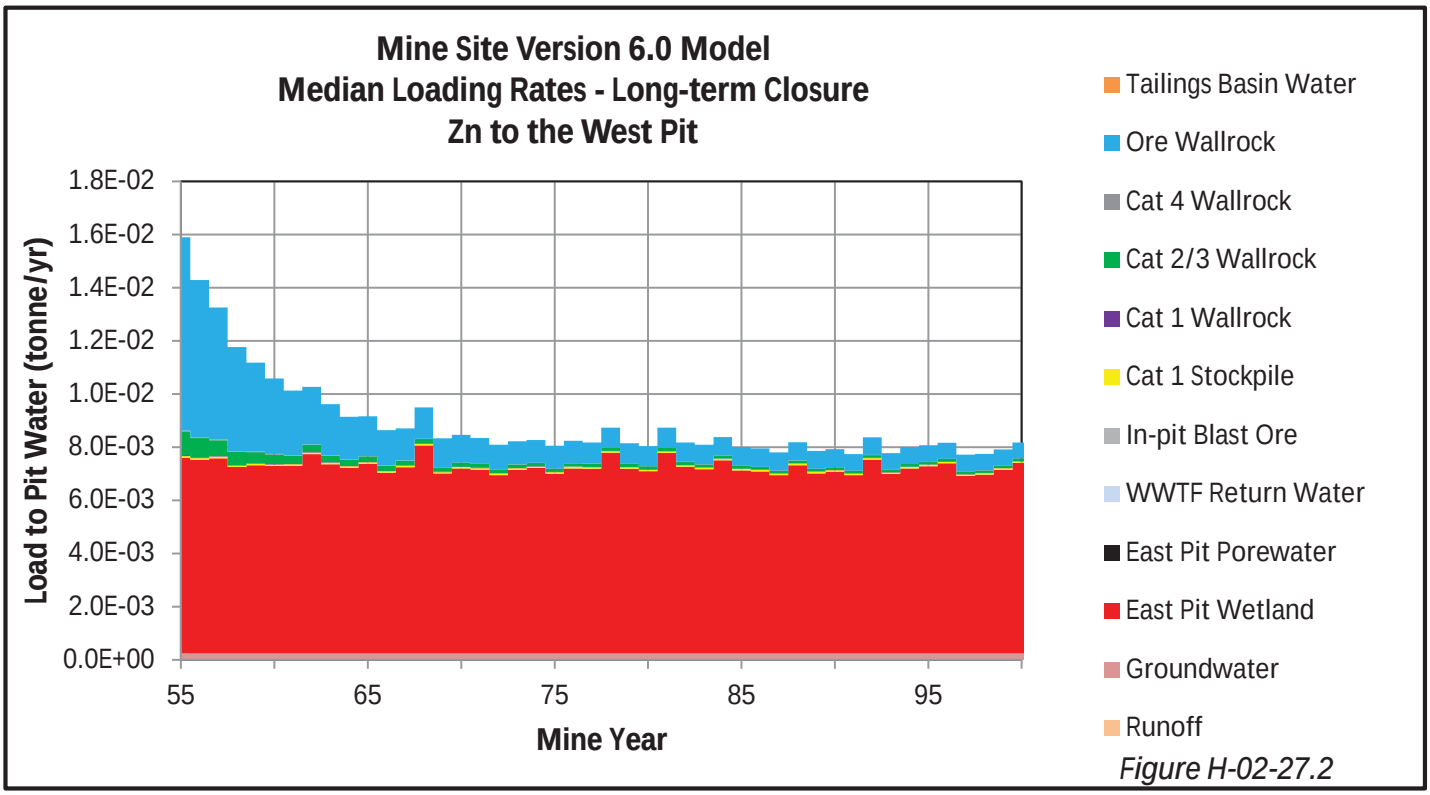


Figure H-02-27.2

Attachment I

Concentration Statistics at the Groundwater Evaluation Locations

Attachment I Concentration Statistics at the Groundwater Evaluation Locations

Estimated groundwater water quality is shown in this attachment using a series of concentration statistic plots. Data for these plots were created as follows:

- The probabilistic GoldSim model was run at monthly time steps for 200 years (2401 time steps including the initial time zero). At each time step, the concentration for each groundwater flow path for each constituent was individually recorded at each evaluation location.

- After one realization (i.e., one model run) was completed, the process was repeated until 500 model realizations were completed. The result is 500 estimated concentrations for each groundwater flow path of each constituent at every time step at each evaluation location.

- At every time step, and for every constituent, the 500 estimated concentrations were sorted smallest-to-largest and 3 single values were chosen to represent the statistics at that particular time step.

- From the 500 estimate concentrations, sorted smallest-to-largest, the 50th value was chosen to represent the 10th percentile (P10), the 250th value was chosen to represent the median (P50), and the 450th value was chosen to represent the 90th percentile (P90). This indicates that at any time, 10% of the model results are less than or equal to the P10 value, 50% are less than or equal to the P50 value, and 90% are less than or equal to the P90 value.

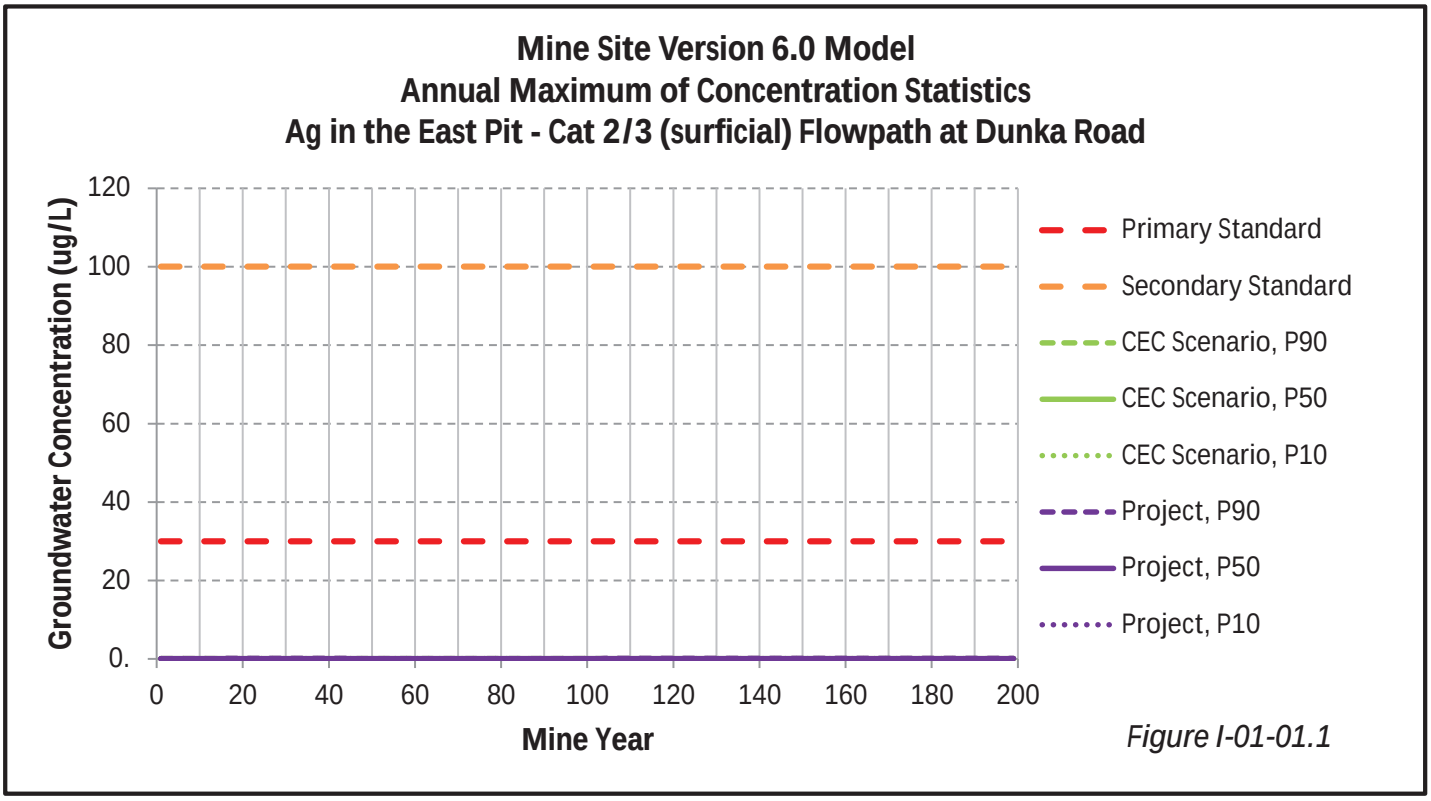
- This process was repeated for all time steps, resulting in 3 time series lines representing the 10th, 50th, and 90th percentiles of concentrations for each groundwater flow path at every time step (monthly results) at each evaluation location.

- For plotting the groundwater quality results over the entire 200 years of the simulation, the data was summarized by year to make the plots legible. The monthly model outputs for the 10th, 50th, and 90th percentiles are plotted on an annual basis by taking the maximum value of each percentile for a given year (i.e., the highest 90th percentile value). Because of the integrated nature of the groundwater concentrations, the annual maximum is not significantly different than the annual average.

The figure numbering convention is "**Figure W-XX-YY.Z**" where:

- **W** indicates the Attachment.
- **XX** is a counter indicating the groundwater flow path, numbered according to the table below.
- **YY** is a counter indicating the constituent; in this attachment it will count from "01" to "27" to show the 27 independently modeled constituents.
- **Z** is a numerical value, indicating the evaluation location. A value of 1 indicates the Dunka Road evaluation location (surficial flow paths only) and a value of 2 indicates the Property Boundary or the Partridge River, whichever is nearer.

Flow Path	Number
East Pit - Category 2/3 (surficial)	01
East Pit (bedrock)	02
Ore Surge Pile (surficial)	03
WWTF (surficial)	04
Overburden Storage and Laydown Area (surficial)	05
West Pit (surficial)	06
West Pit (bedrock to SW004)	07
West Pit (bedrock to SW004a)	08



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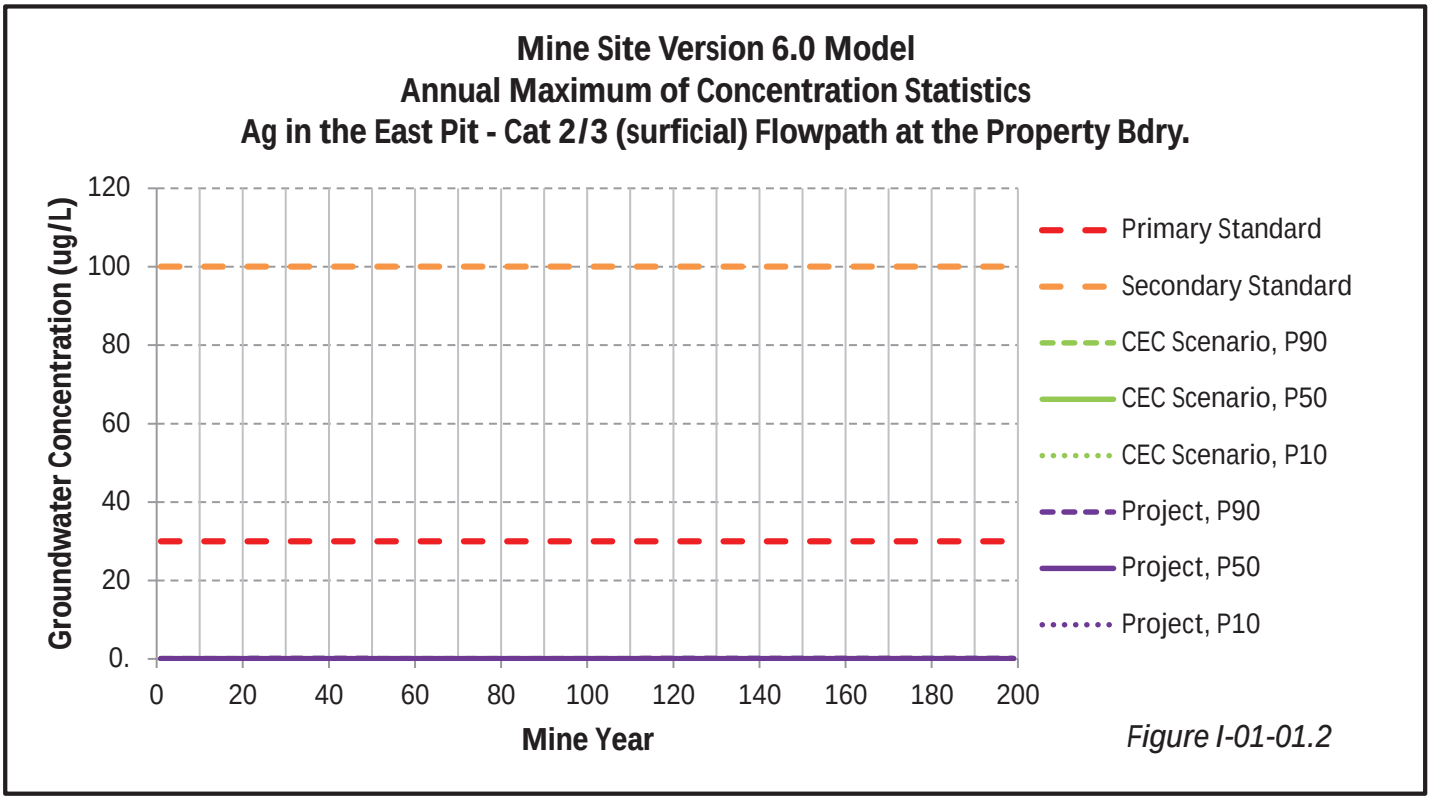

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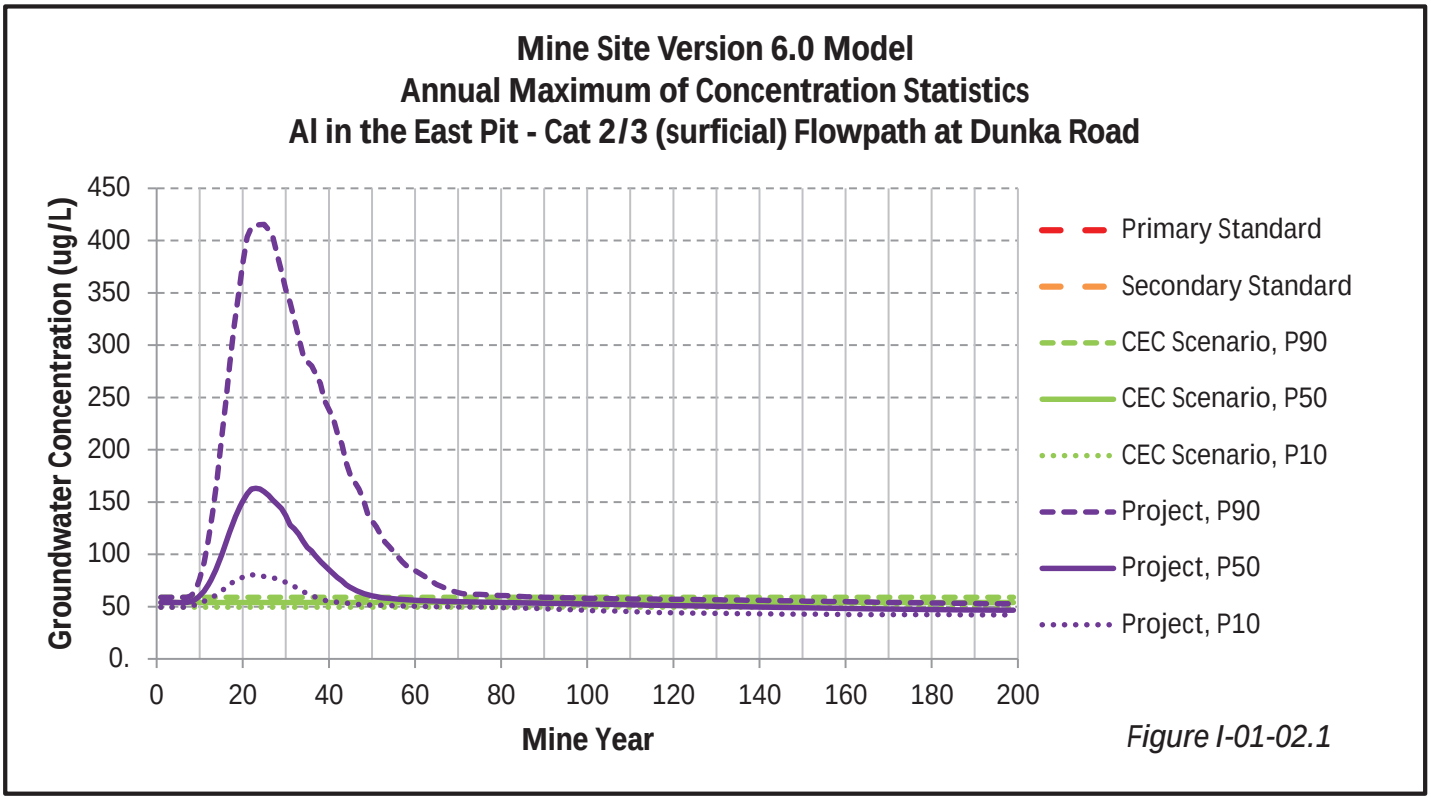

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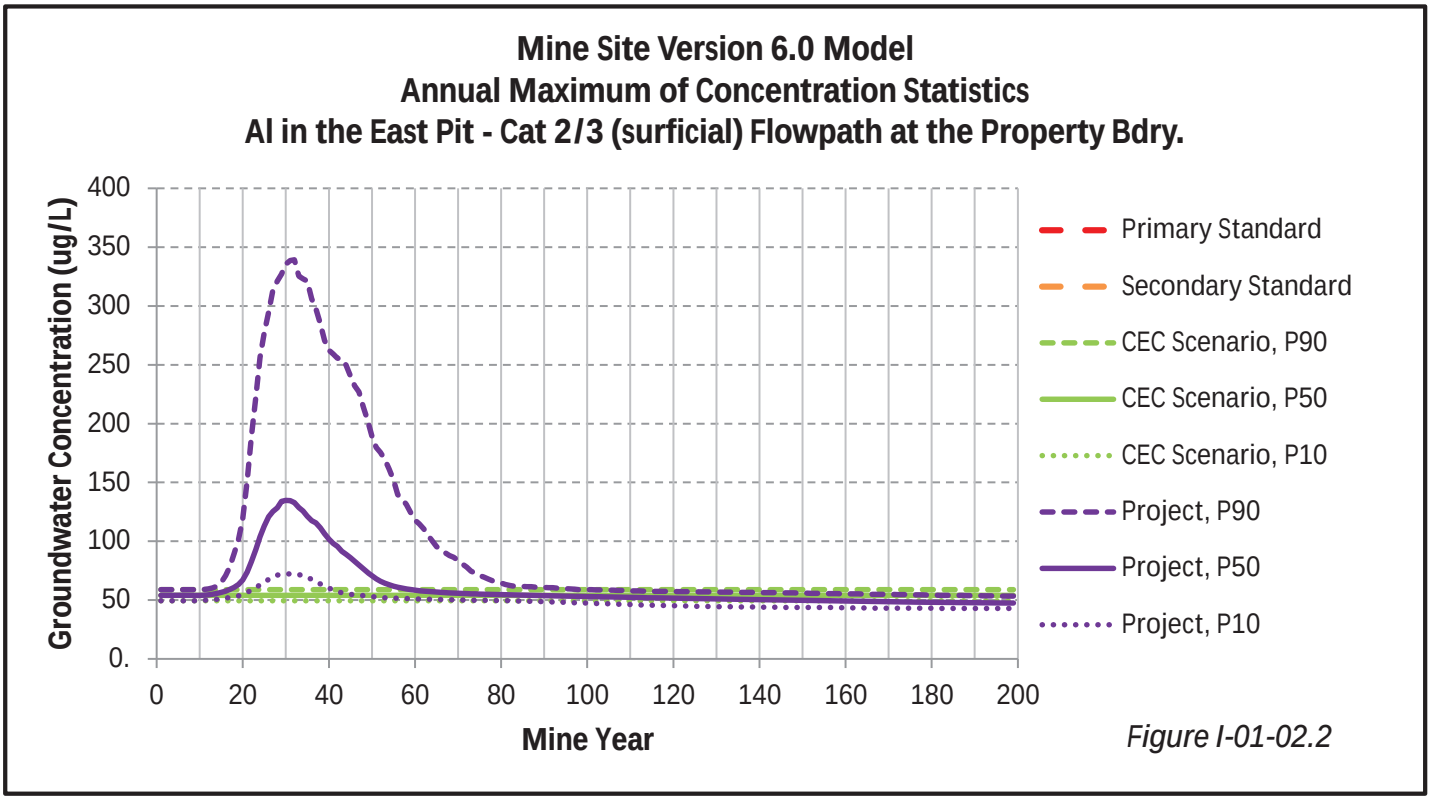

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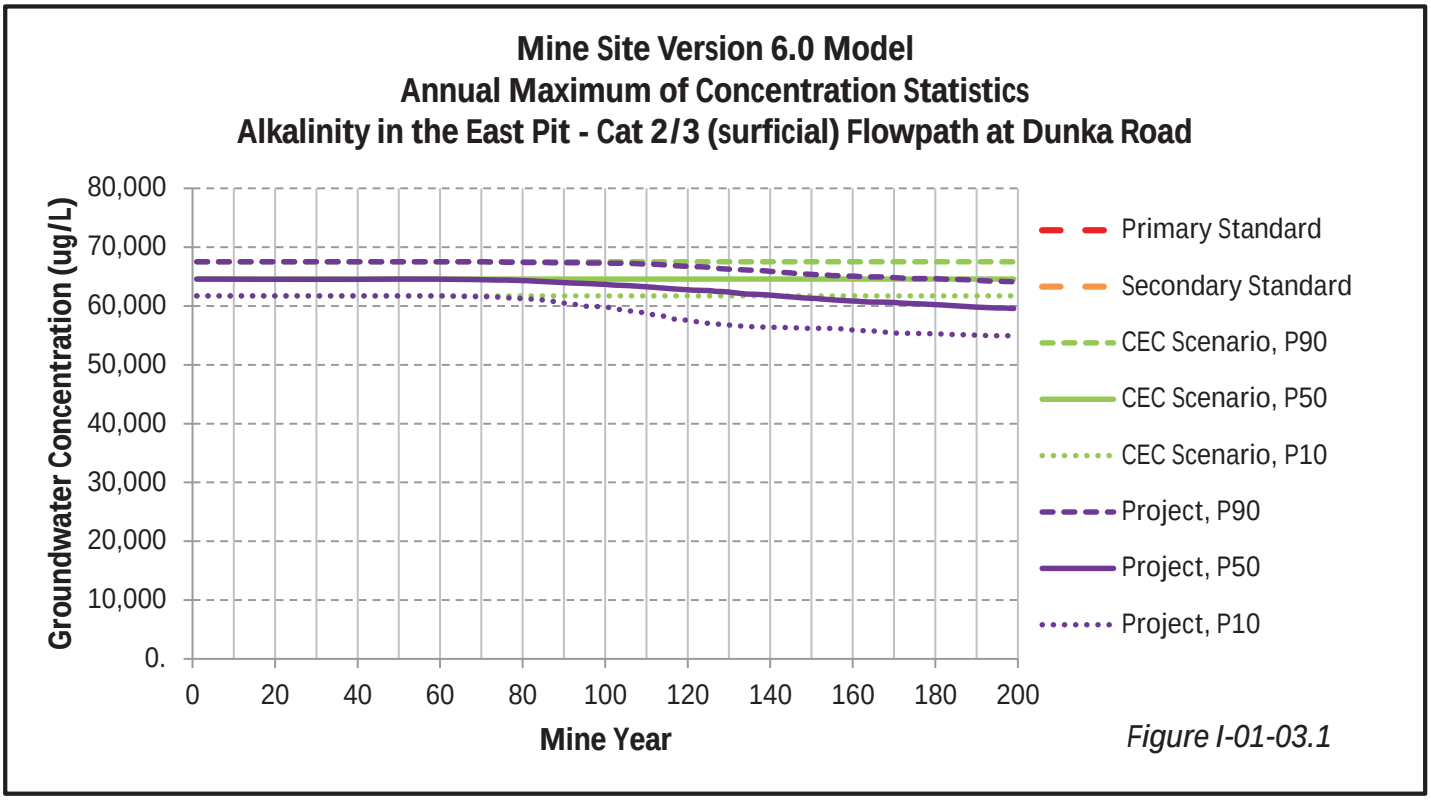

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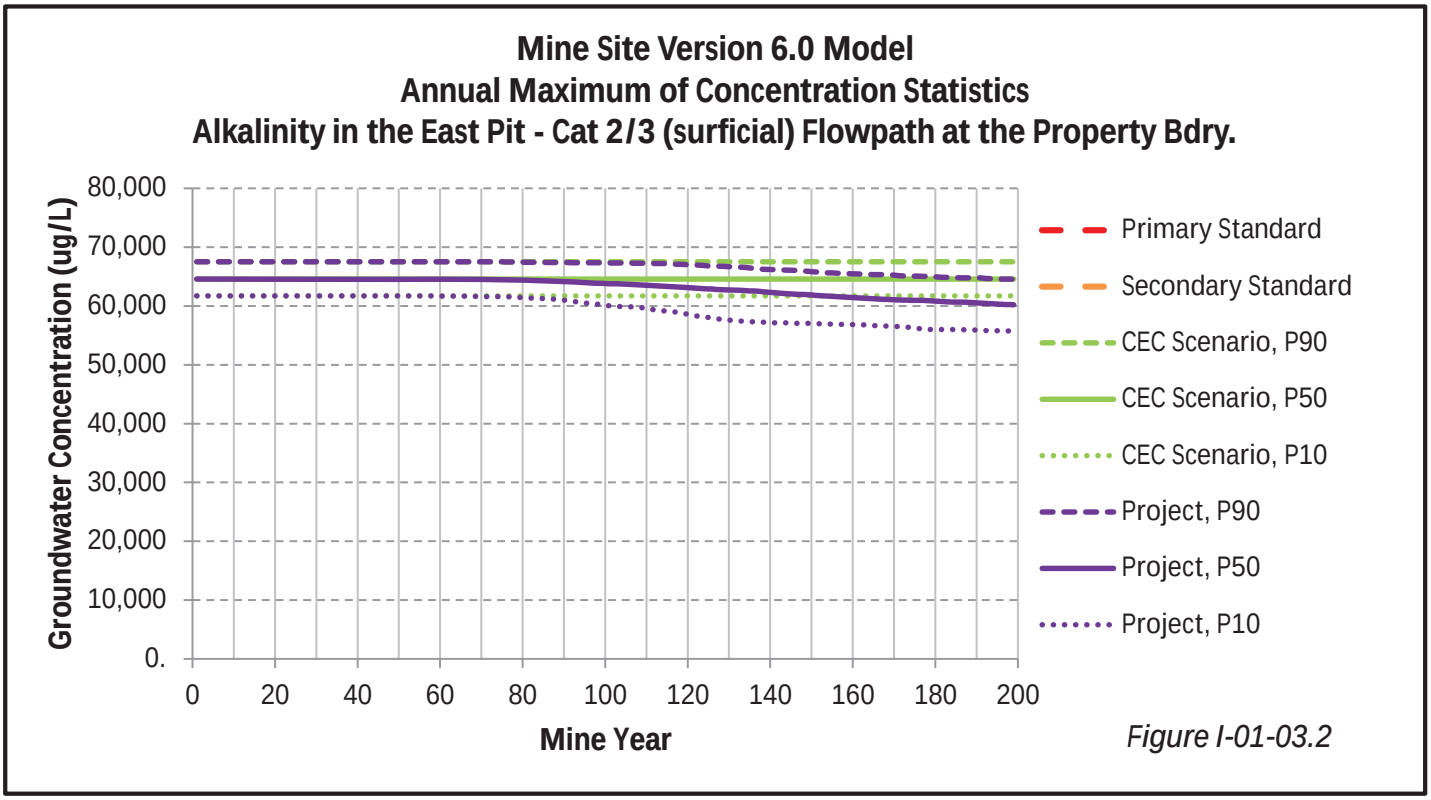

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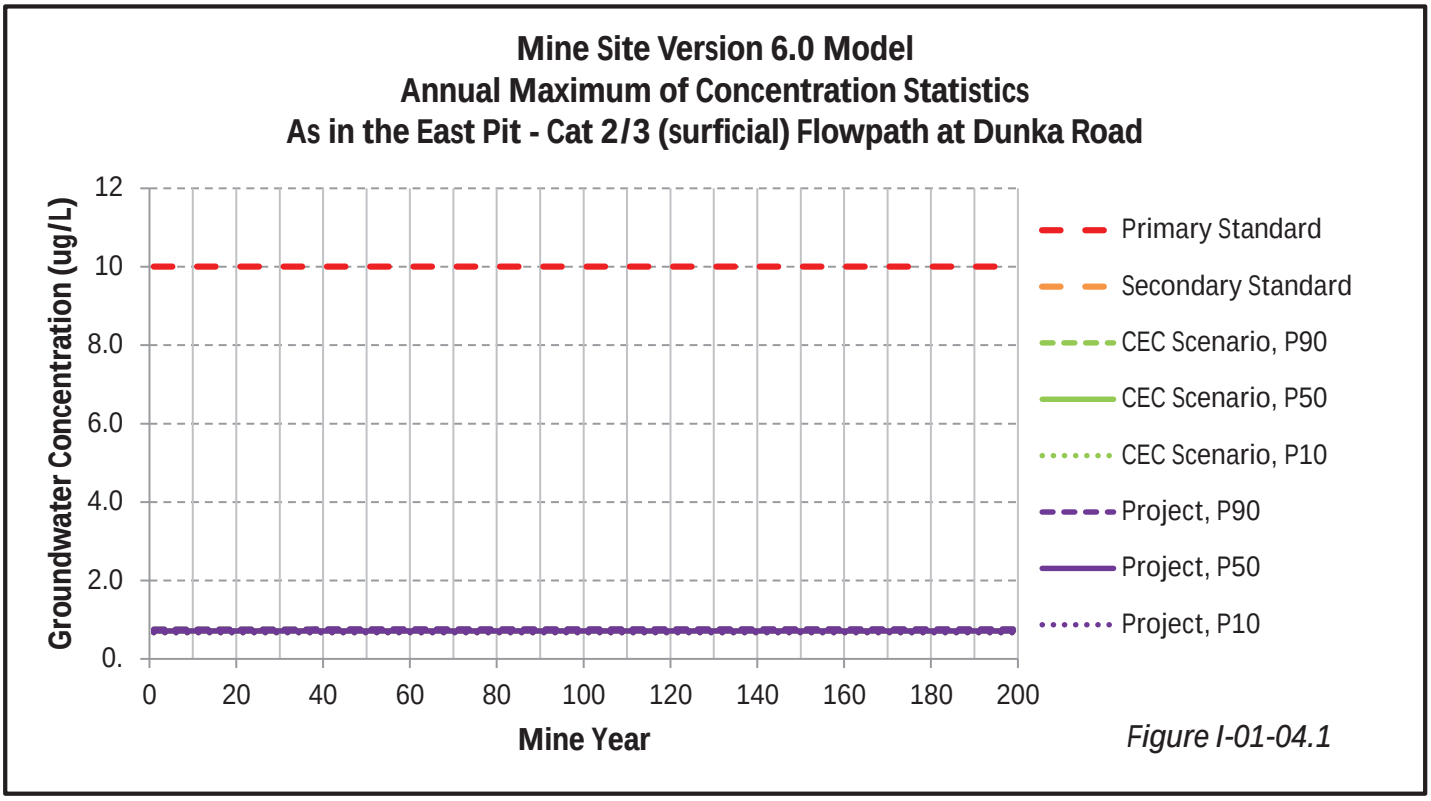

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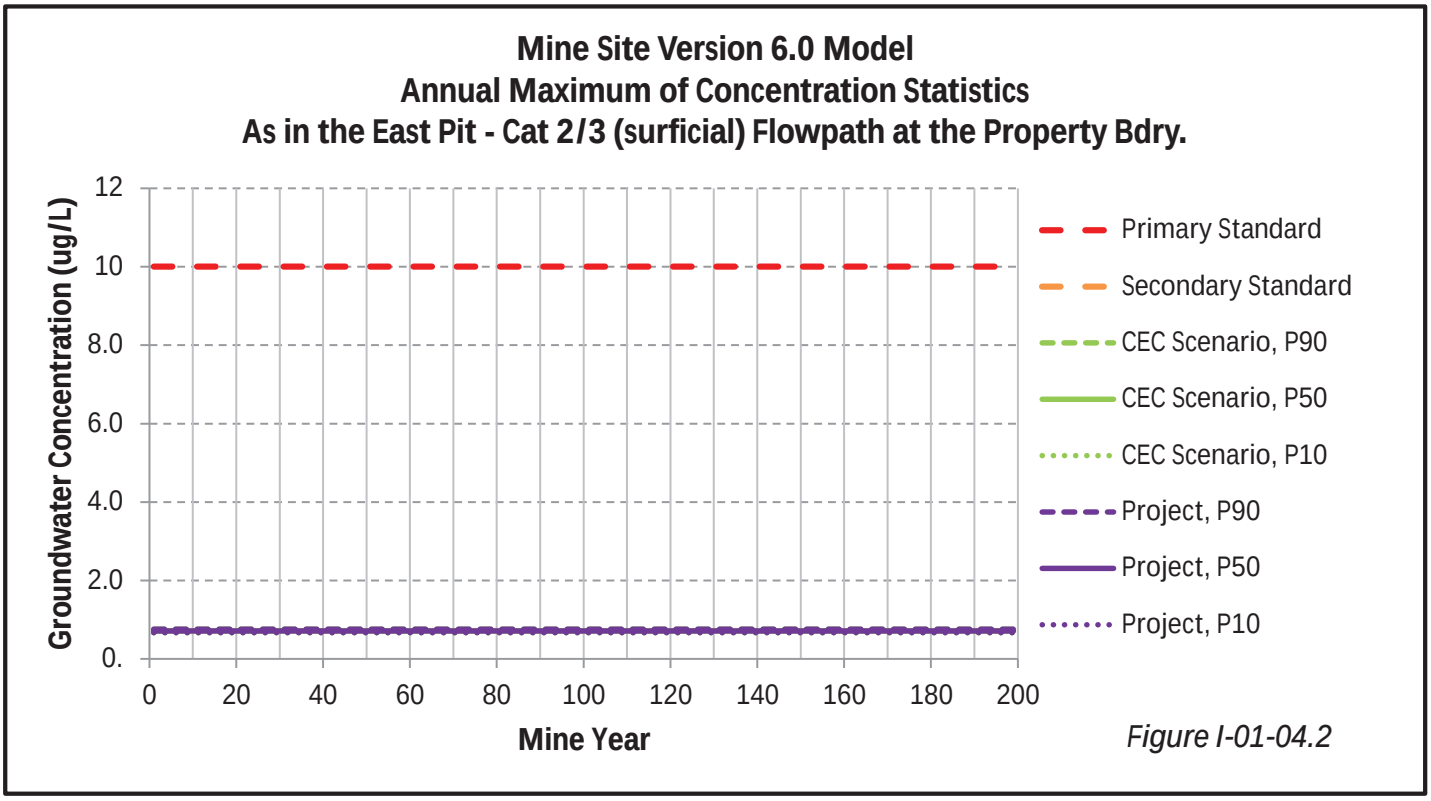

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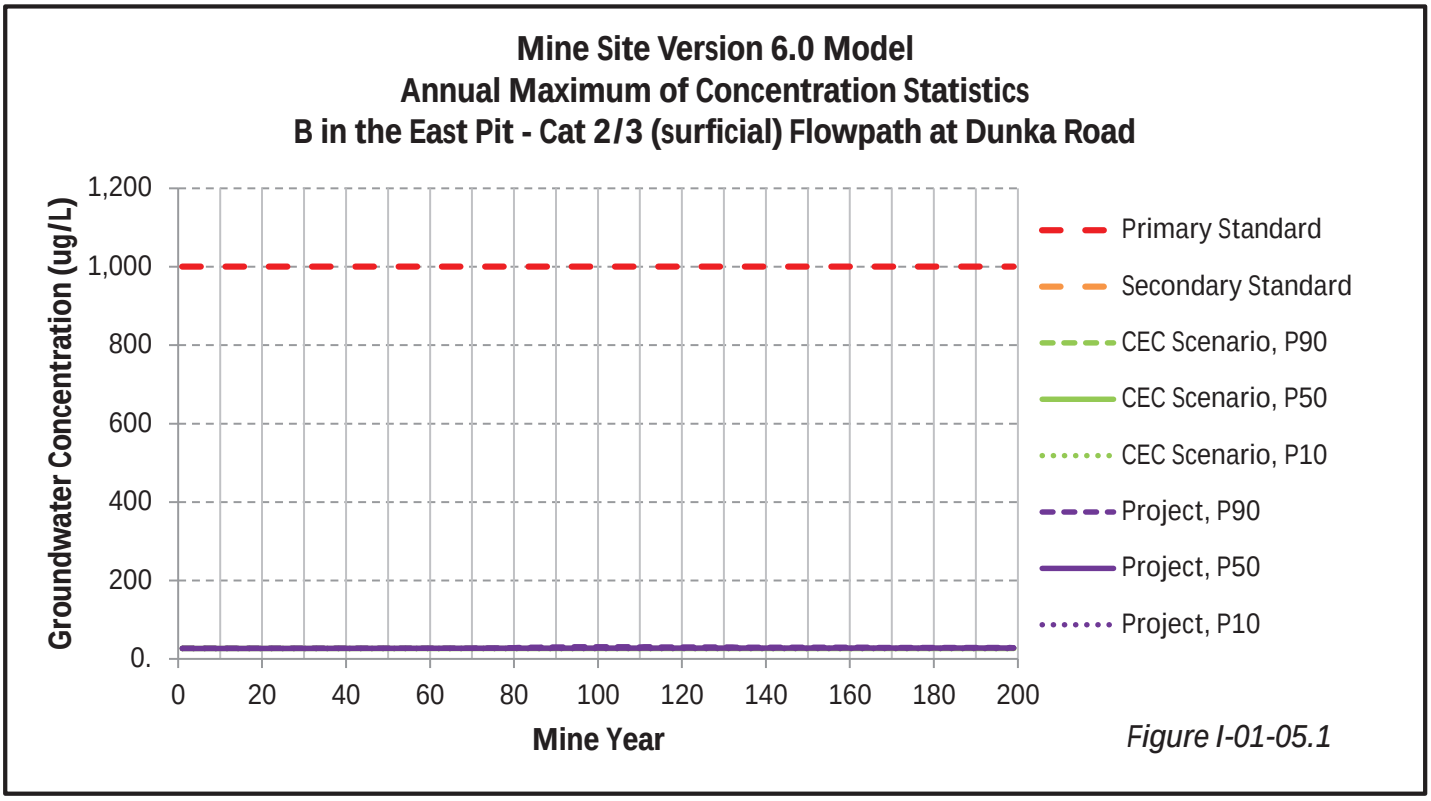

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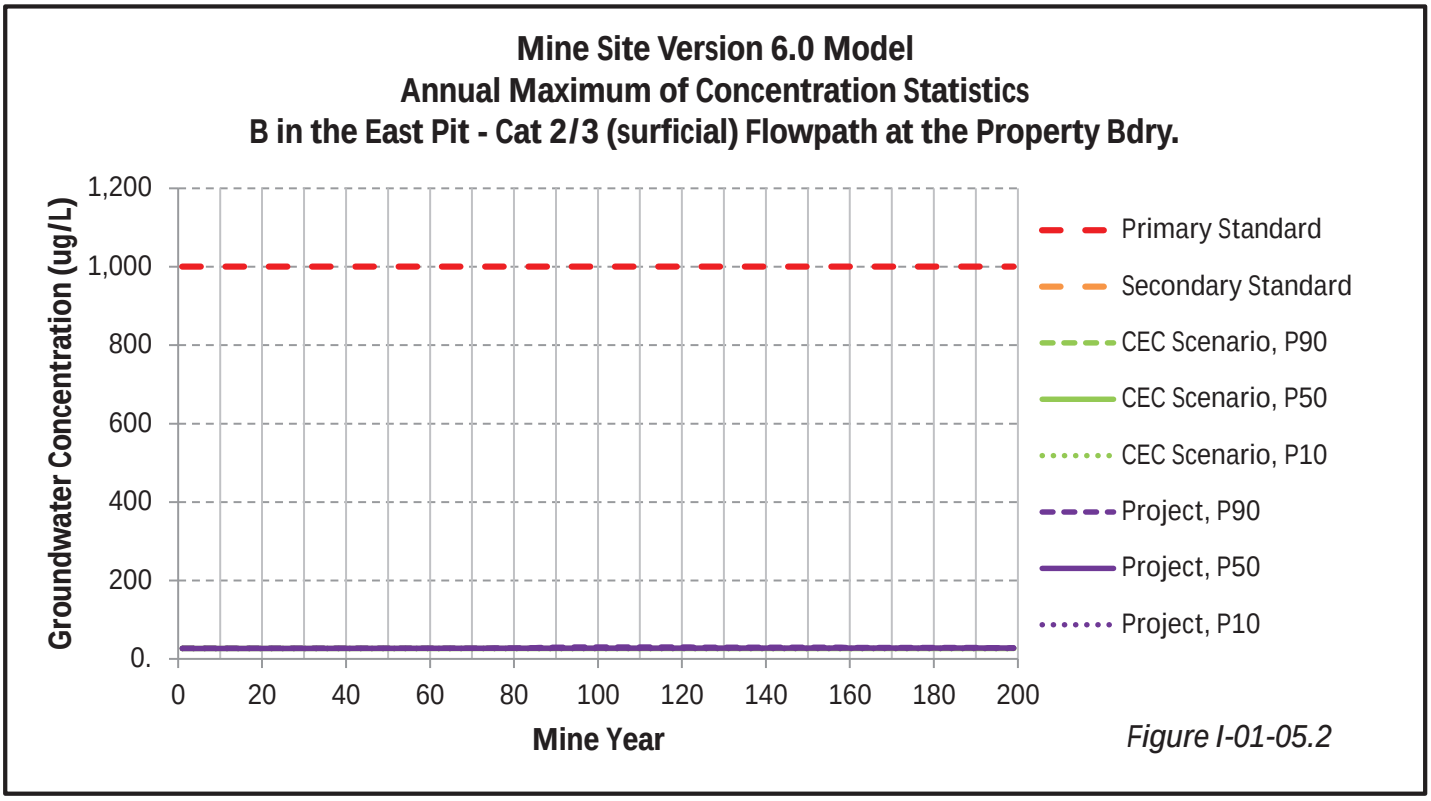

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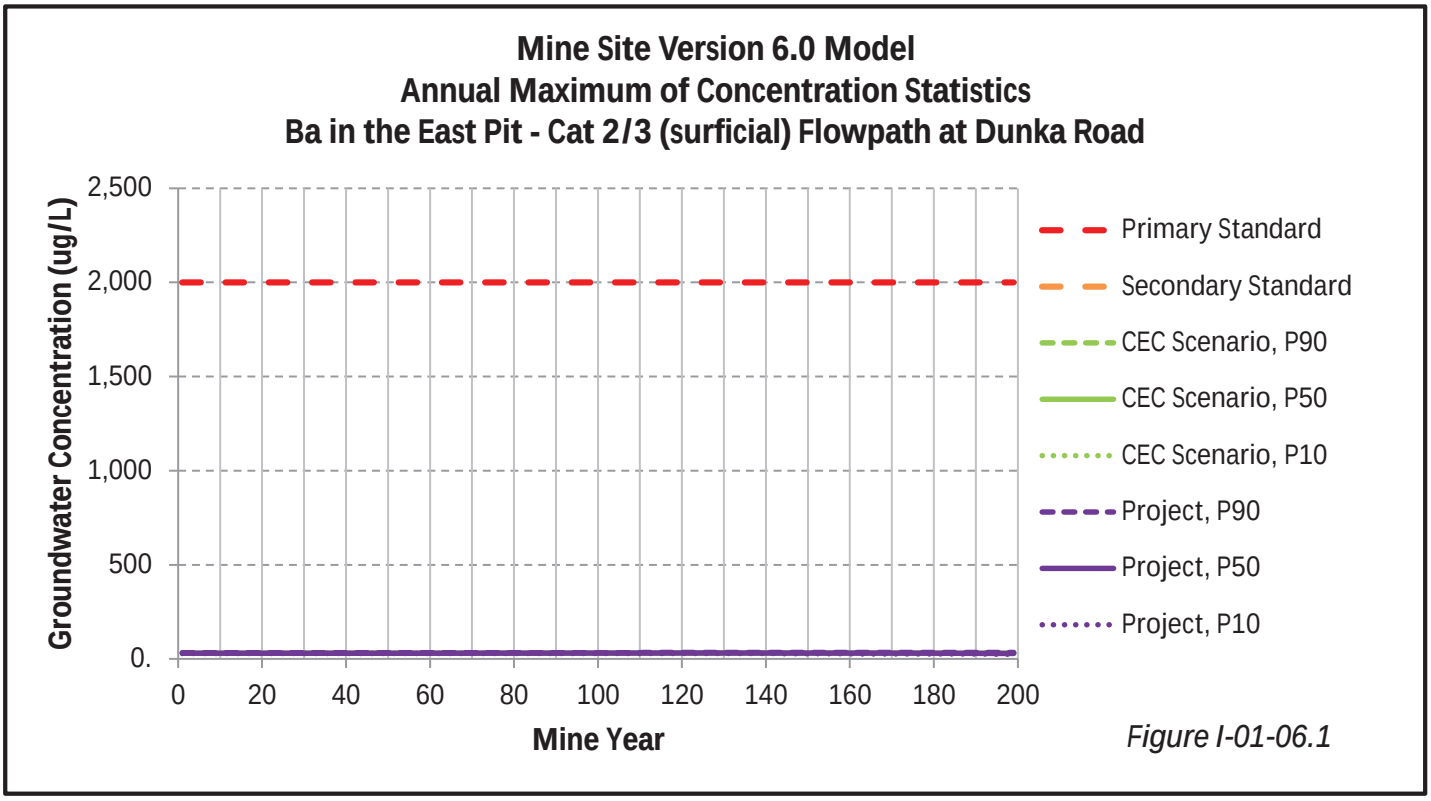

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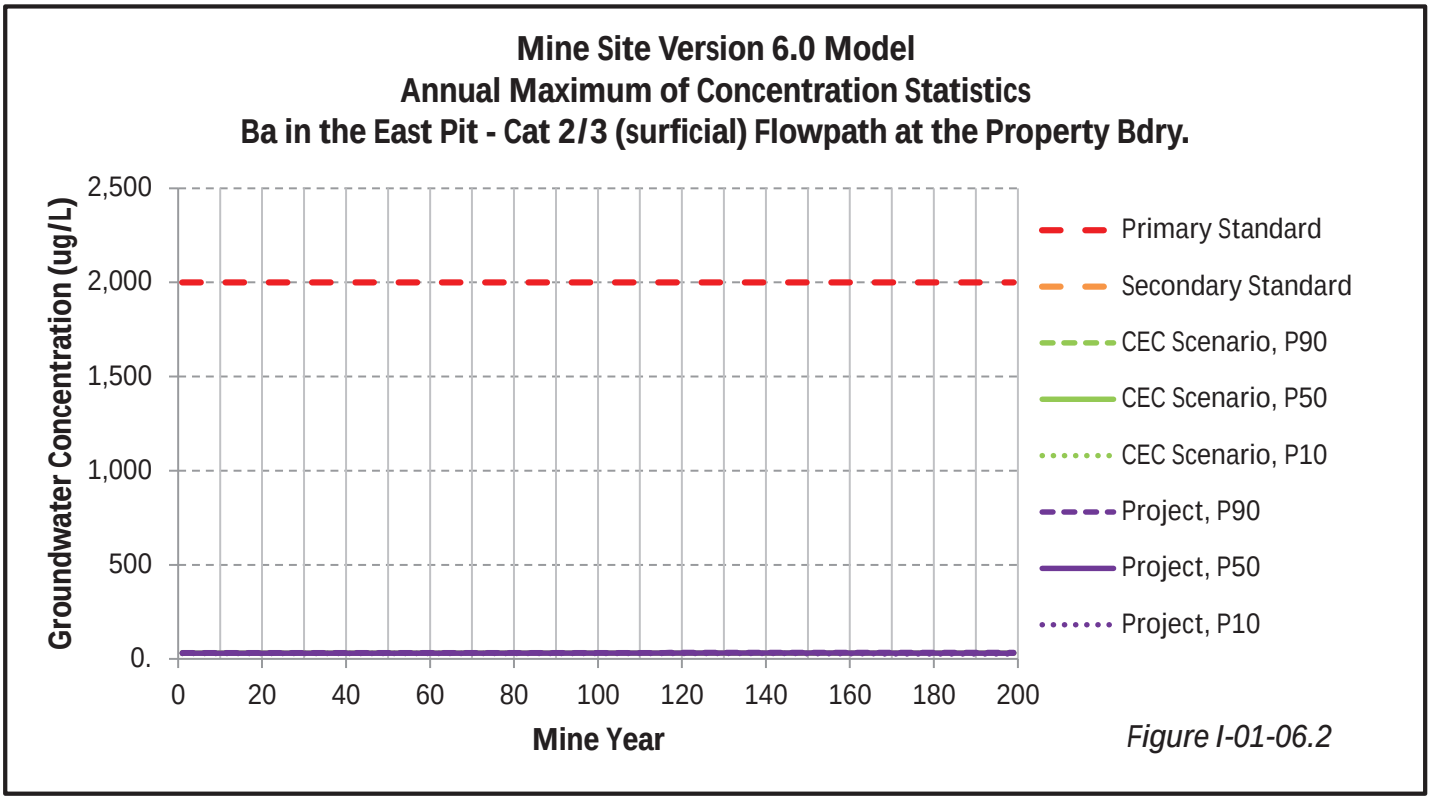

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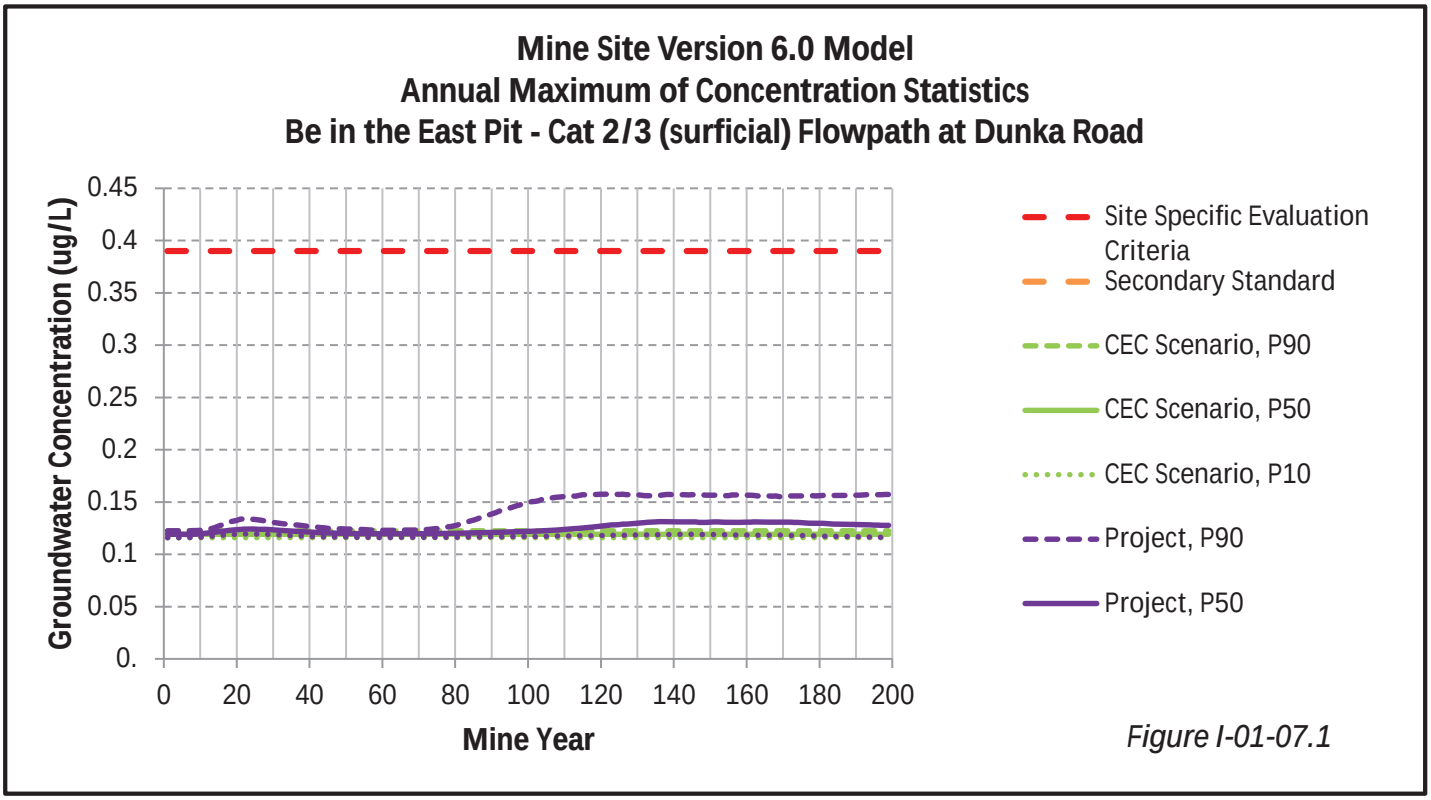
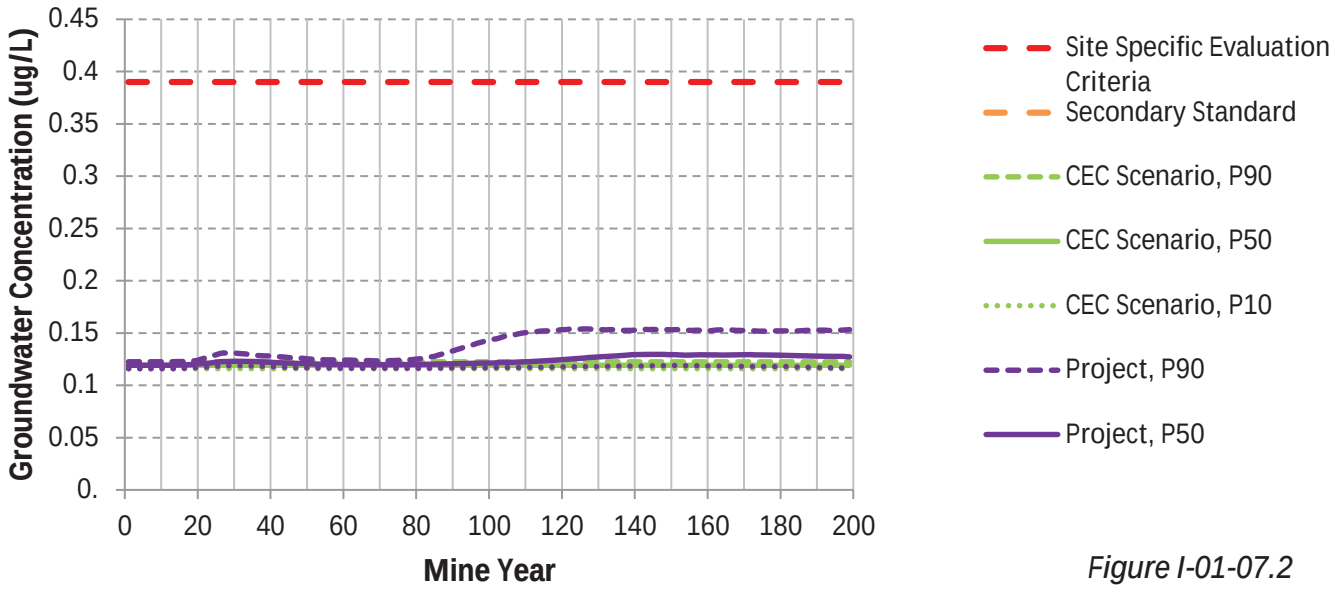


Figure I-01-07.1

Mine Site Version 6.0 Model
Annual Maximum of Concentration Statistics
Be in the East Pit - Cat 2/3 (surficial) Flowpath at the Property Bdry.



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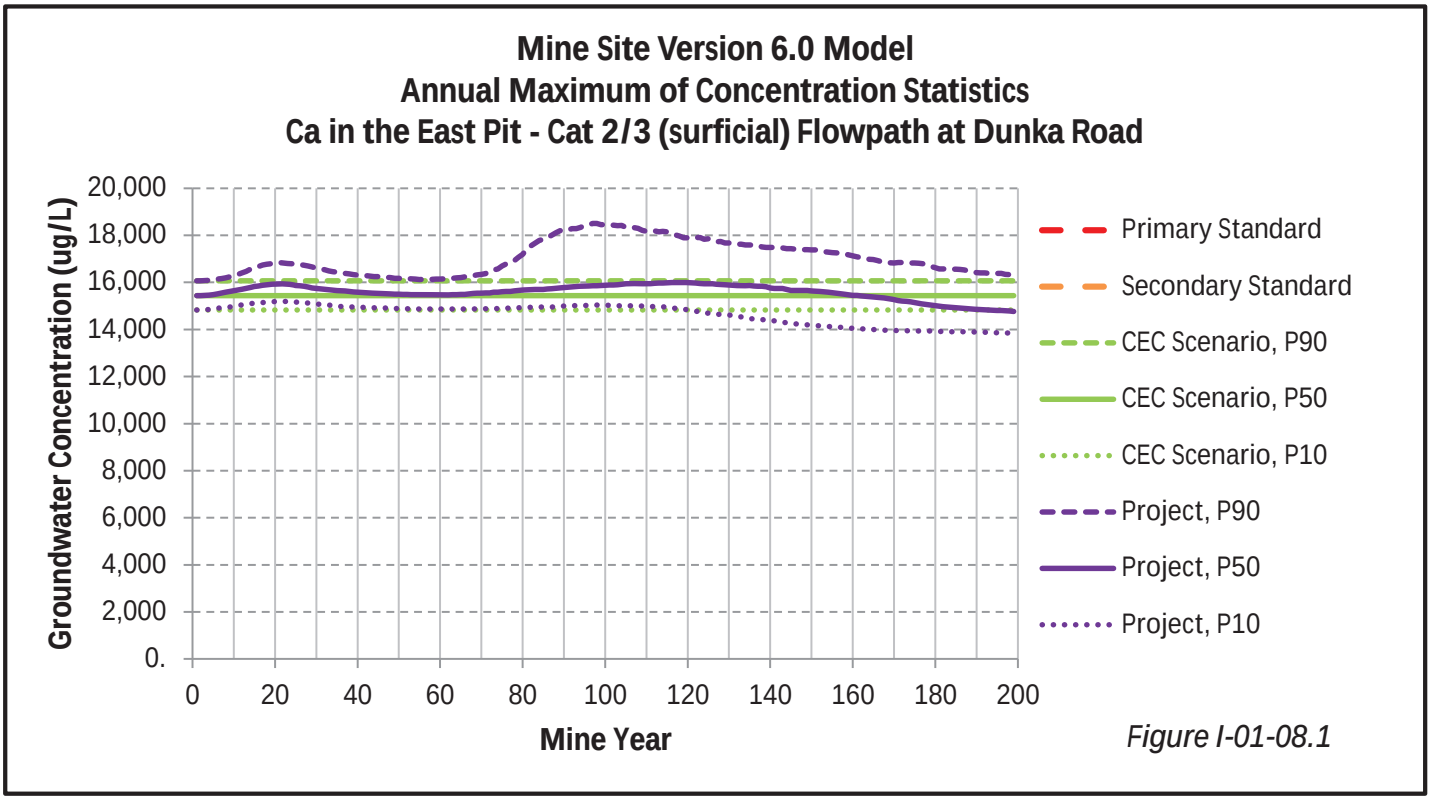

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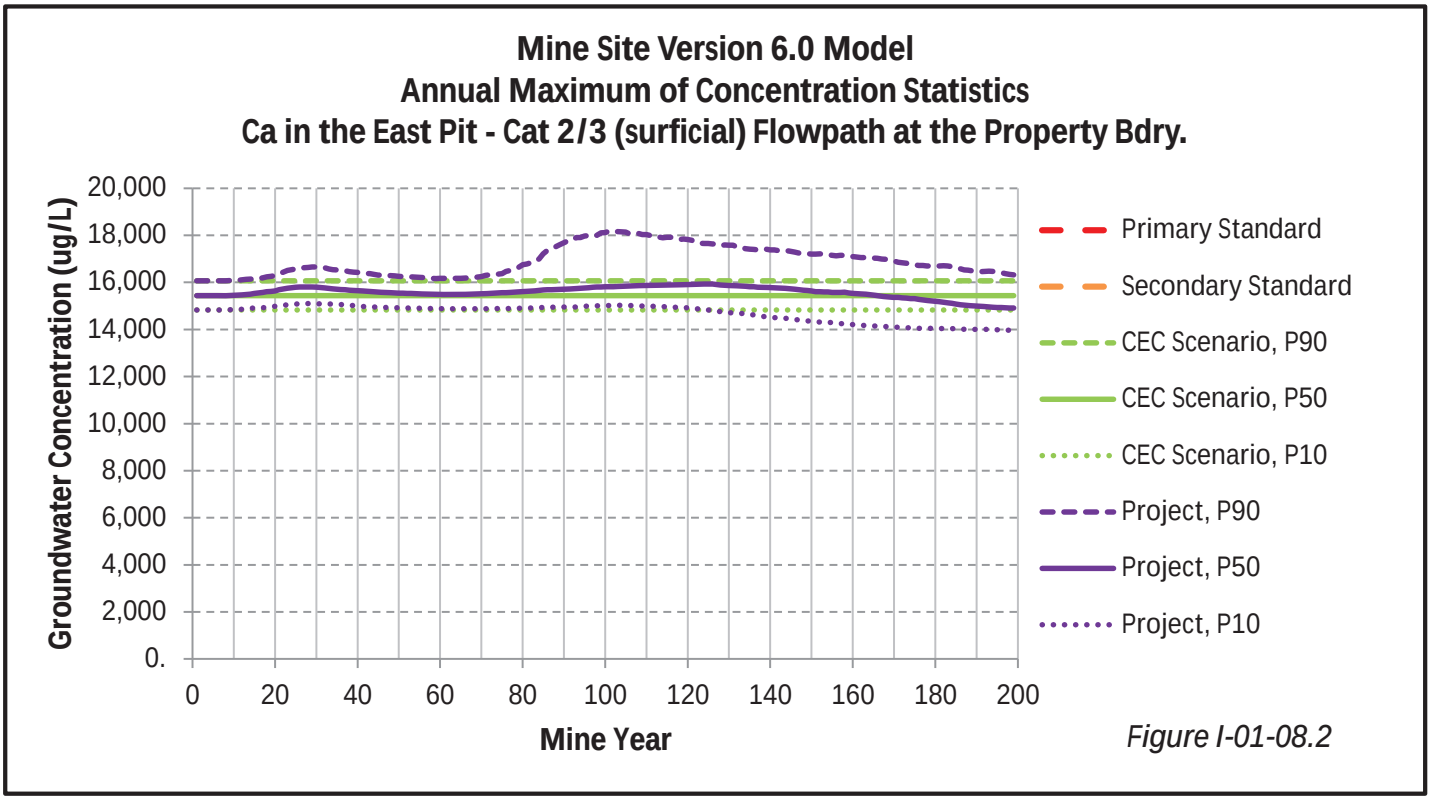

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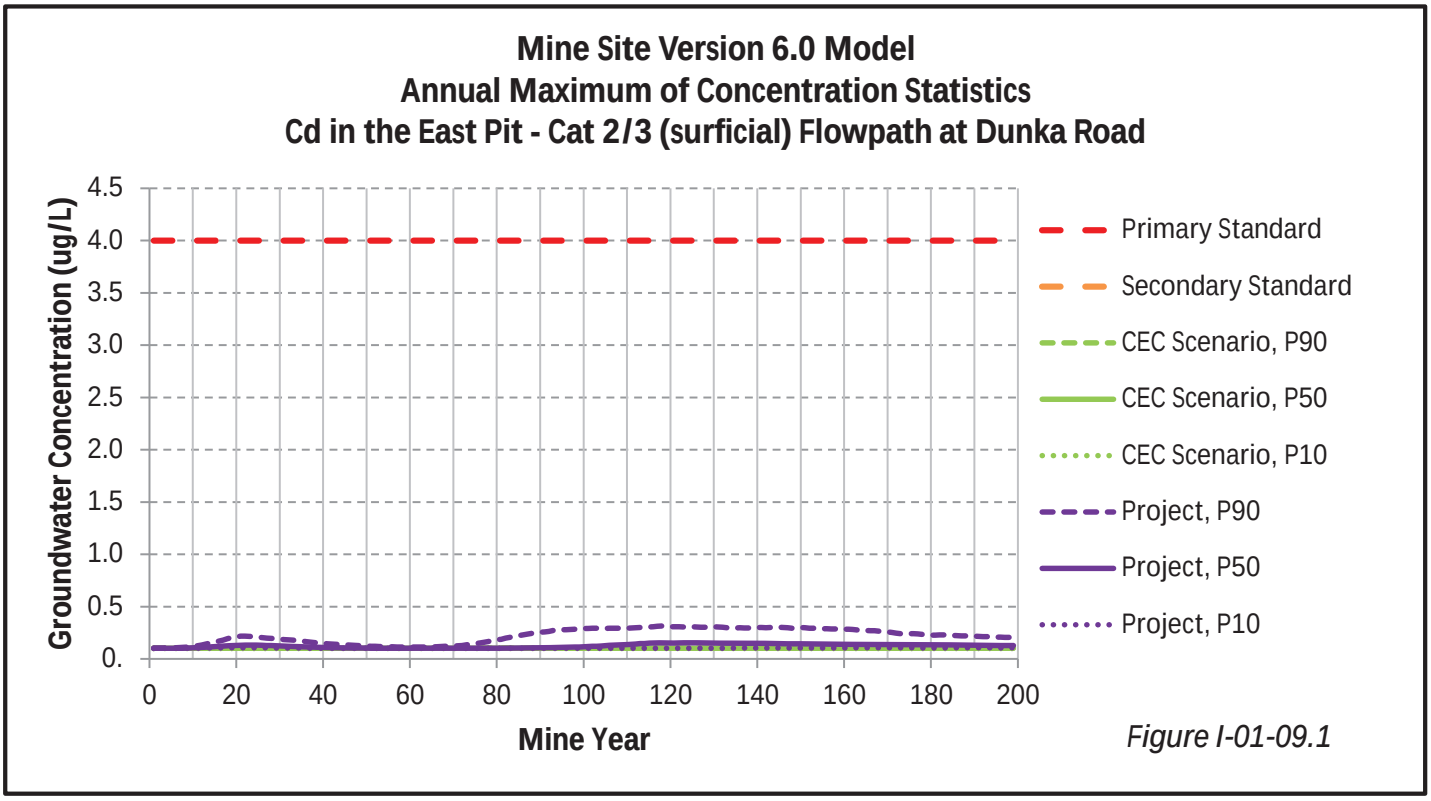

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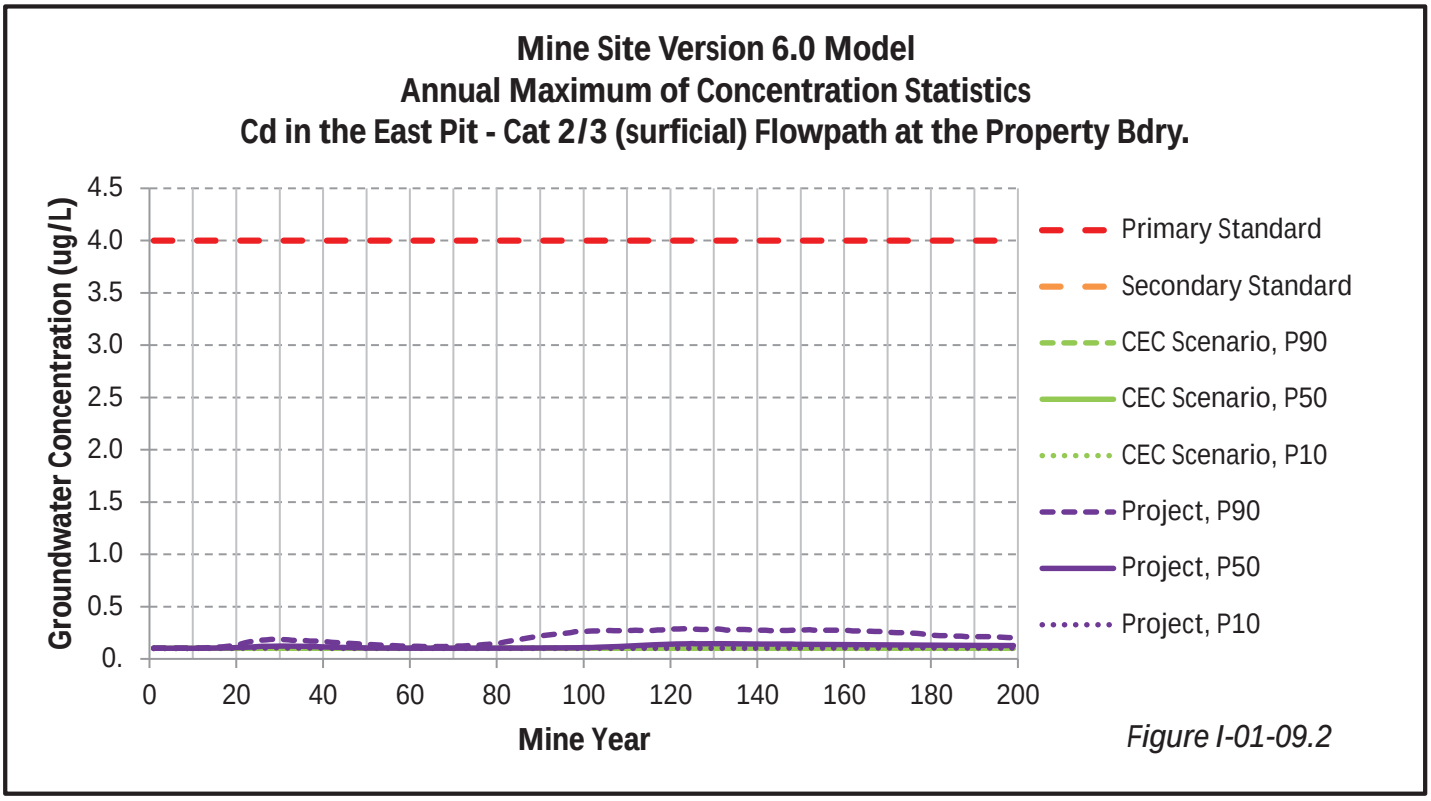

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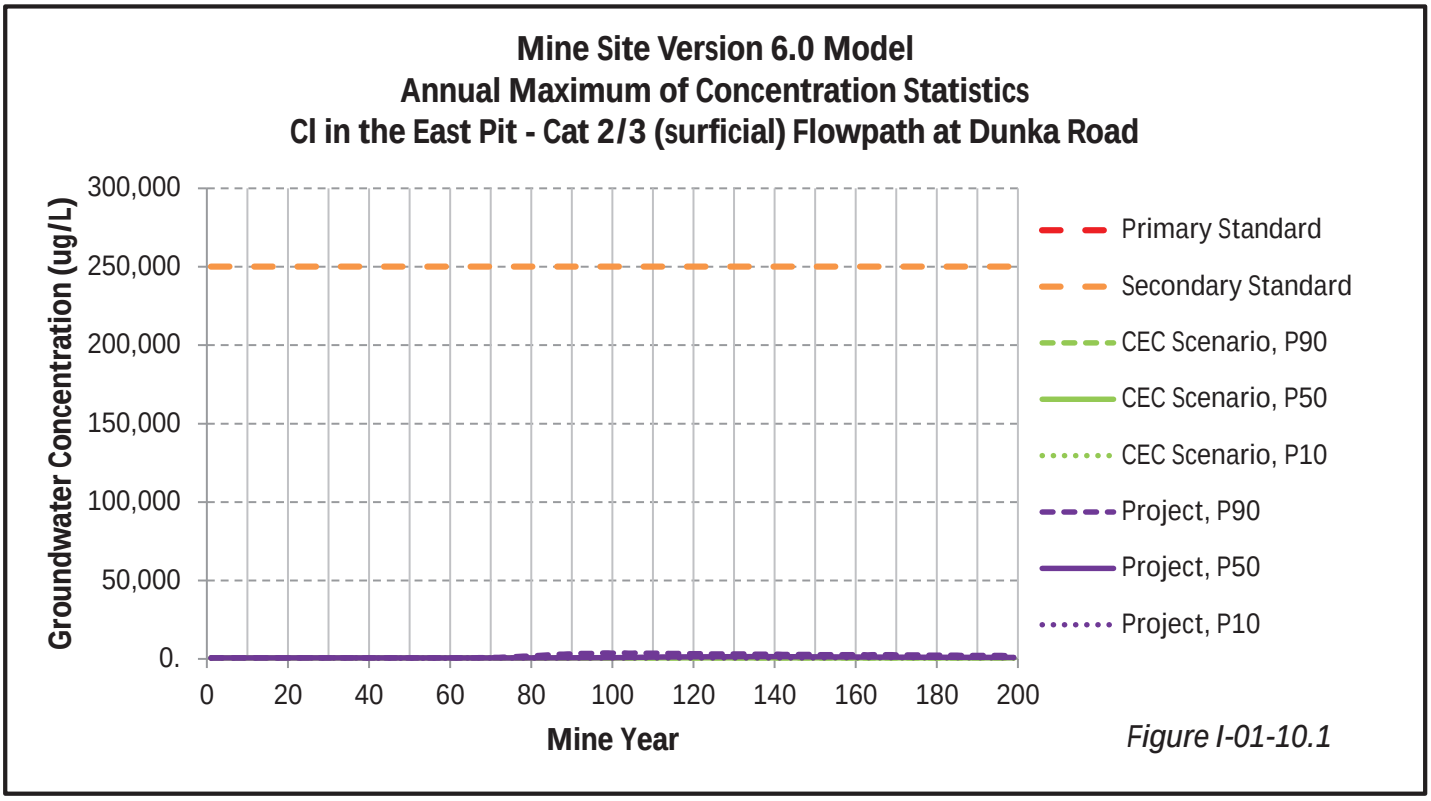

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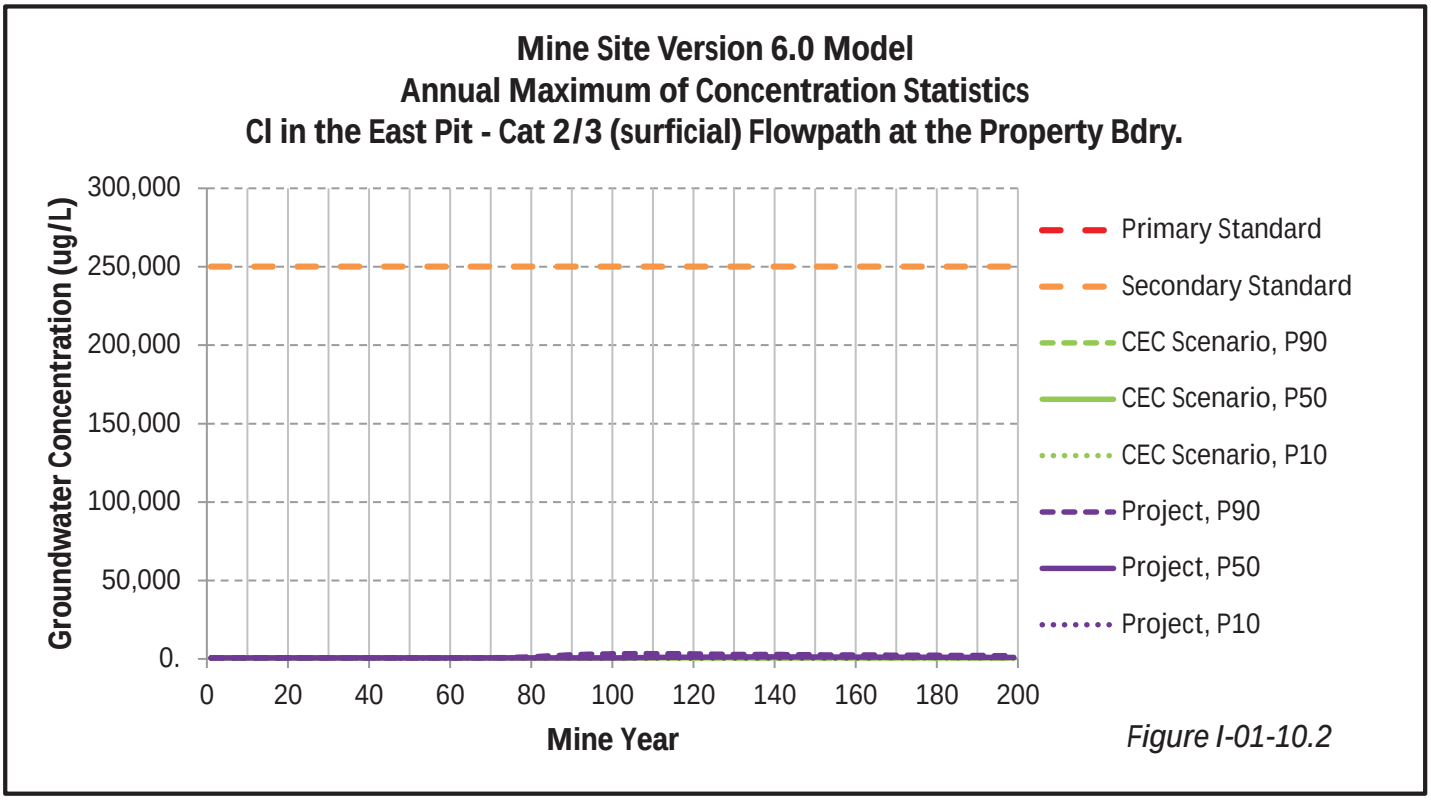

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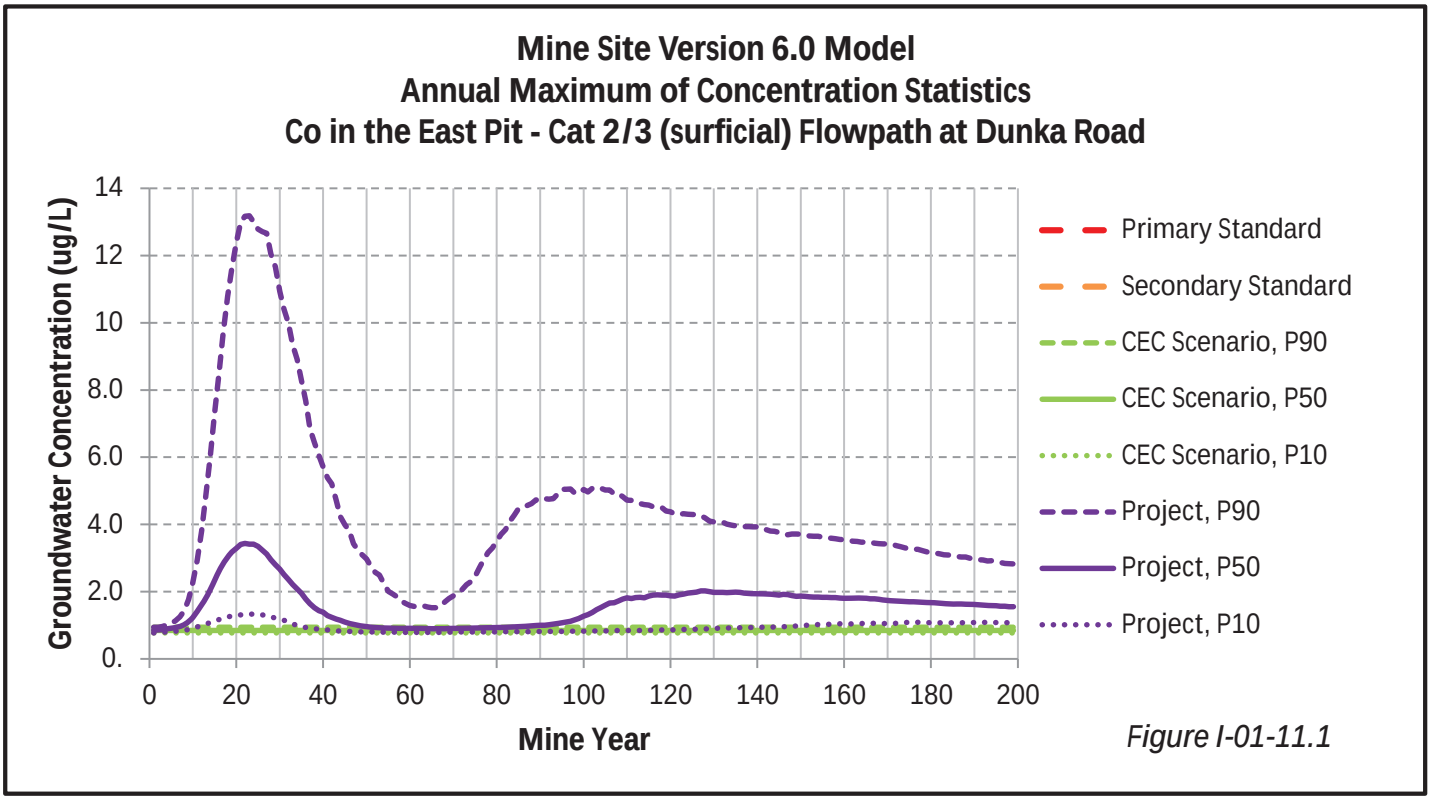

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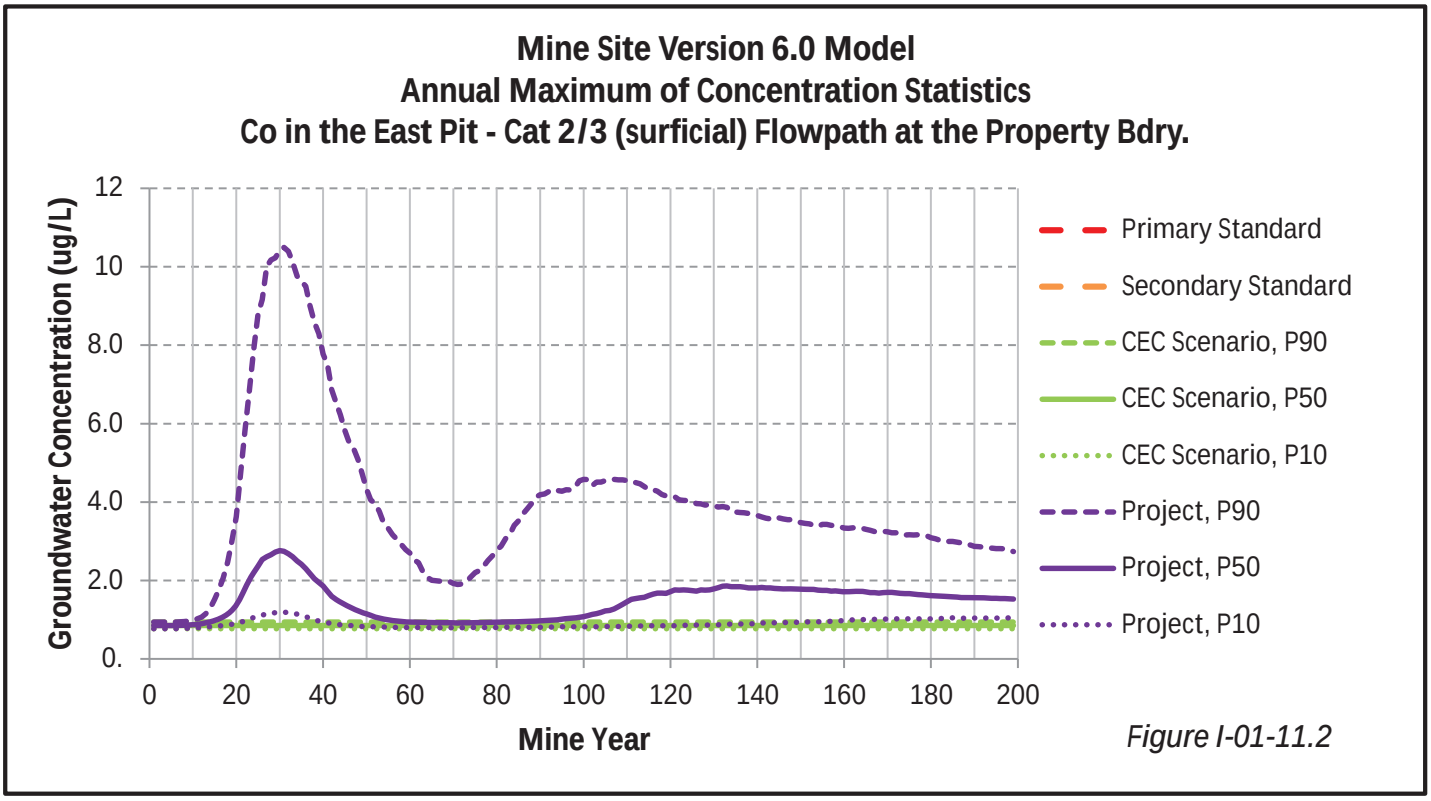

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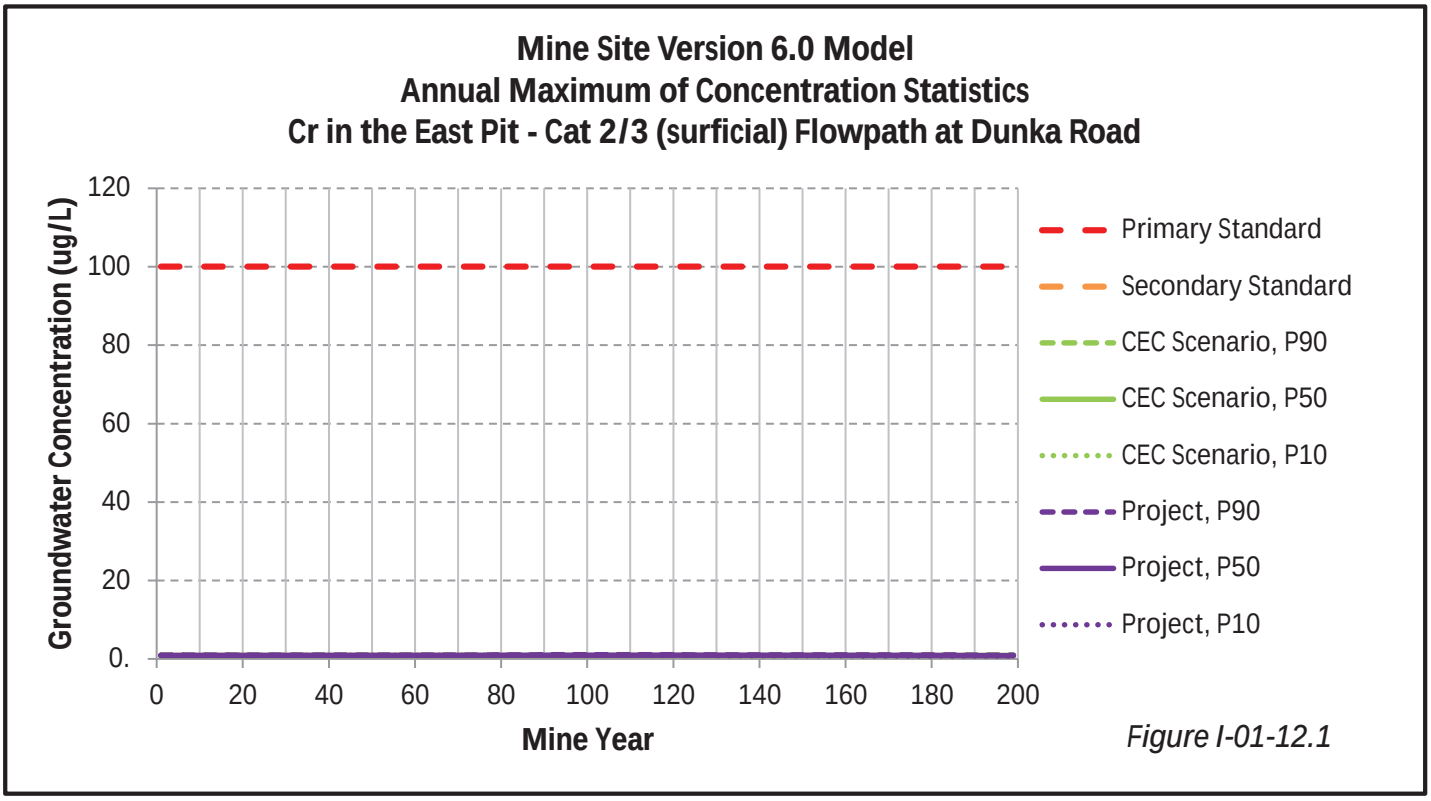

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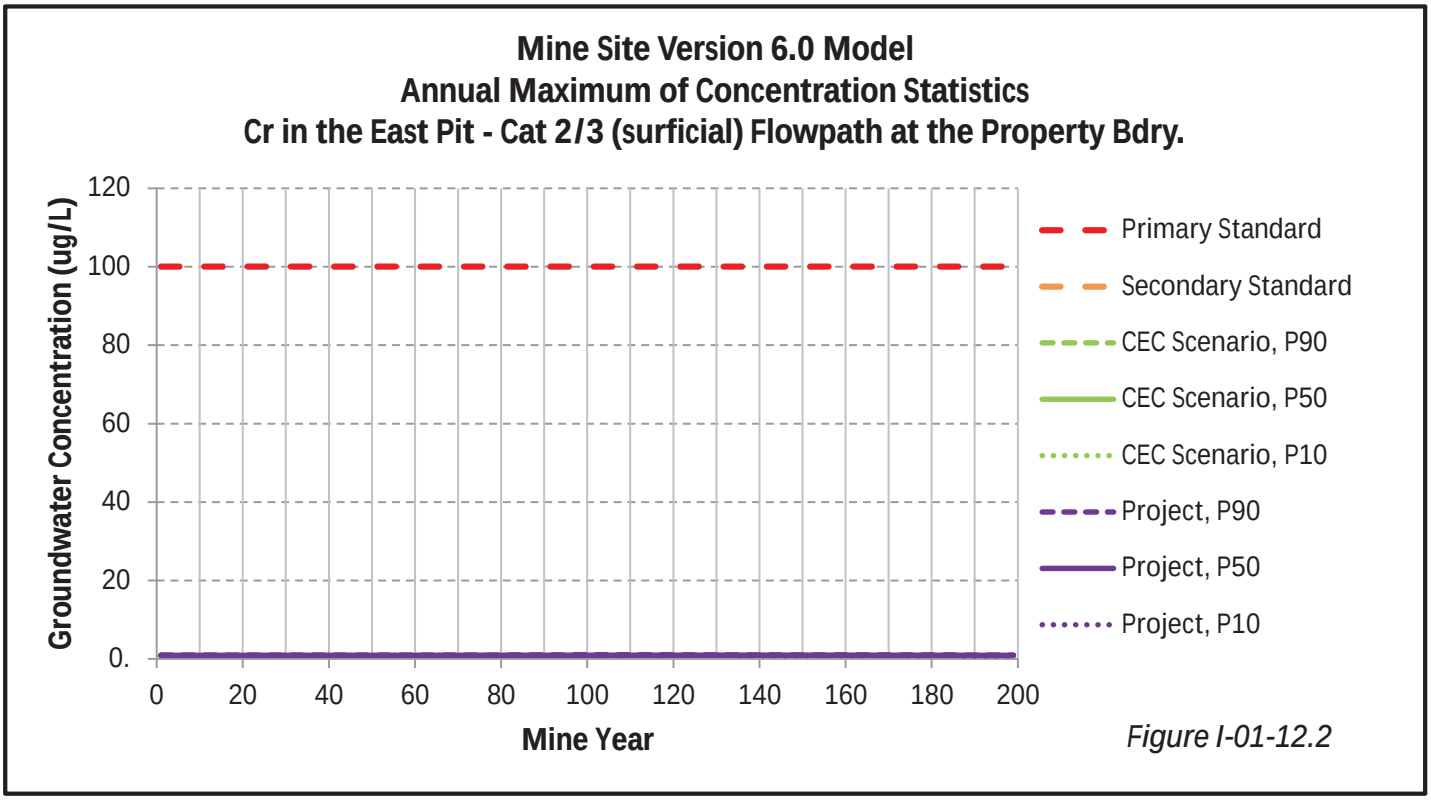

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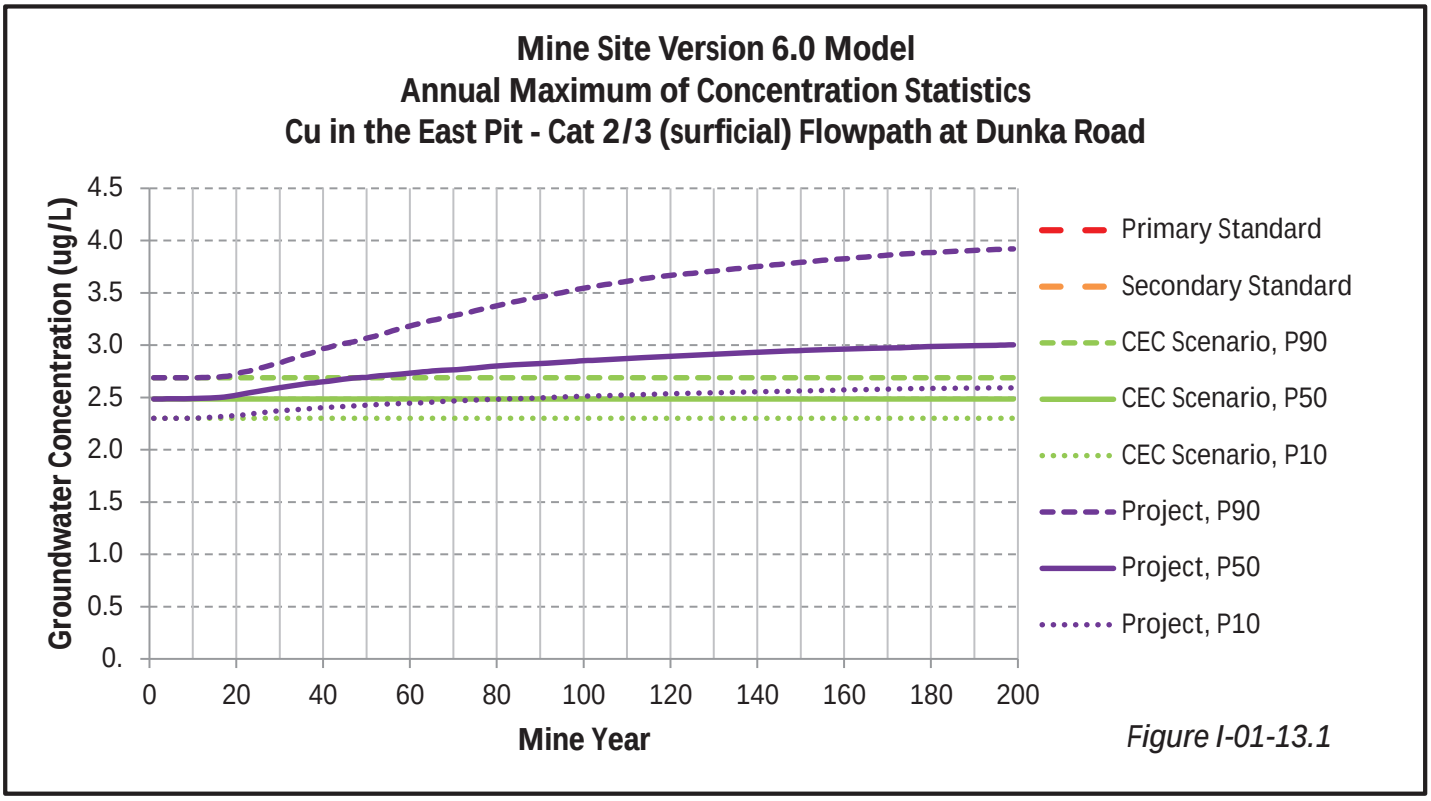

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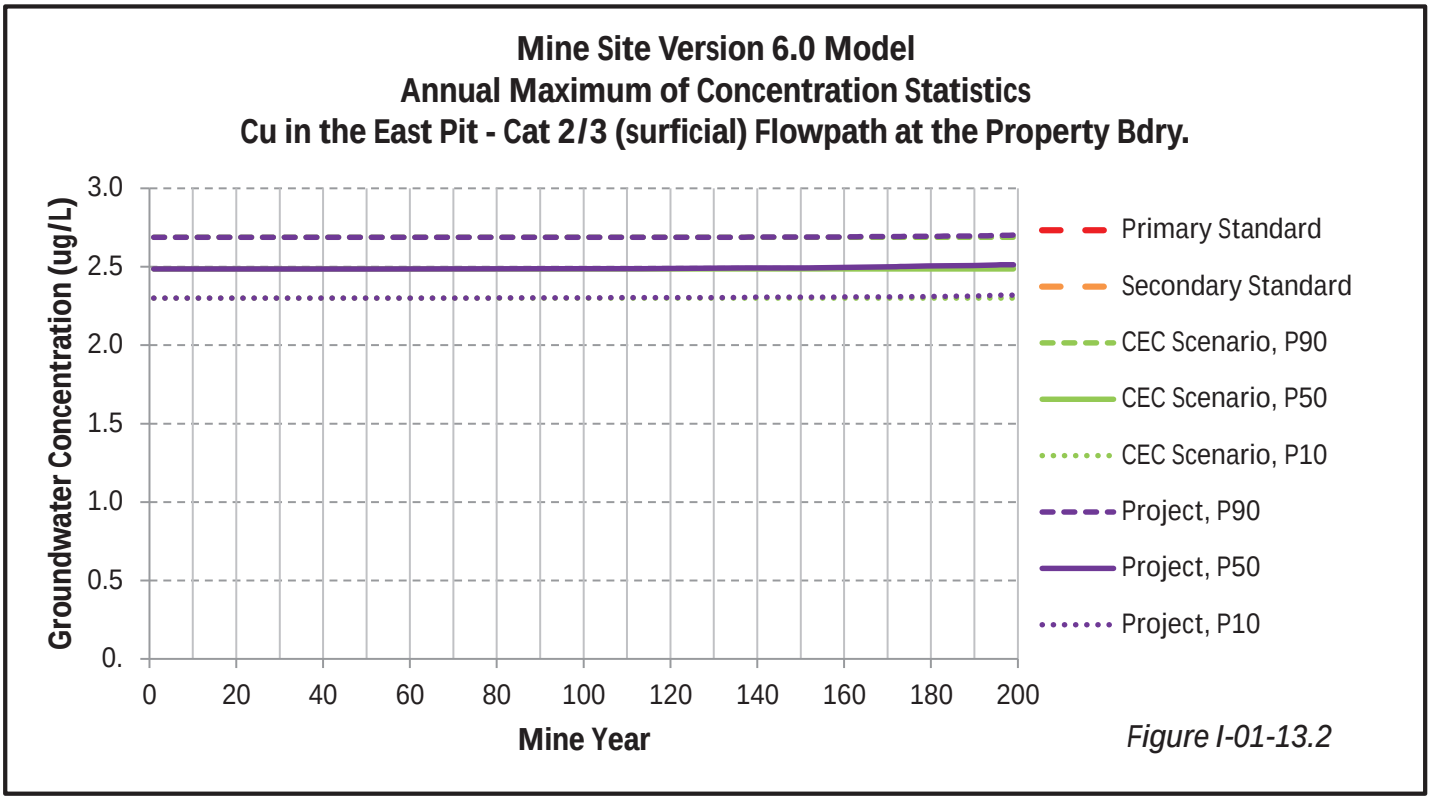

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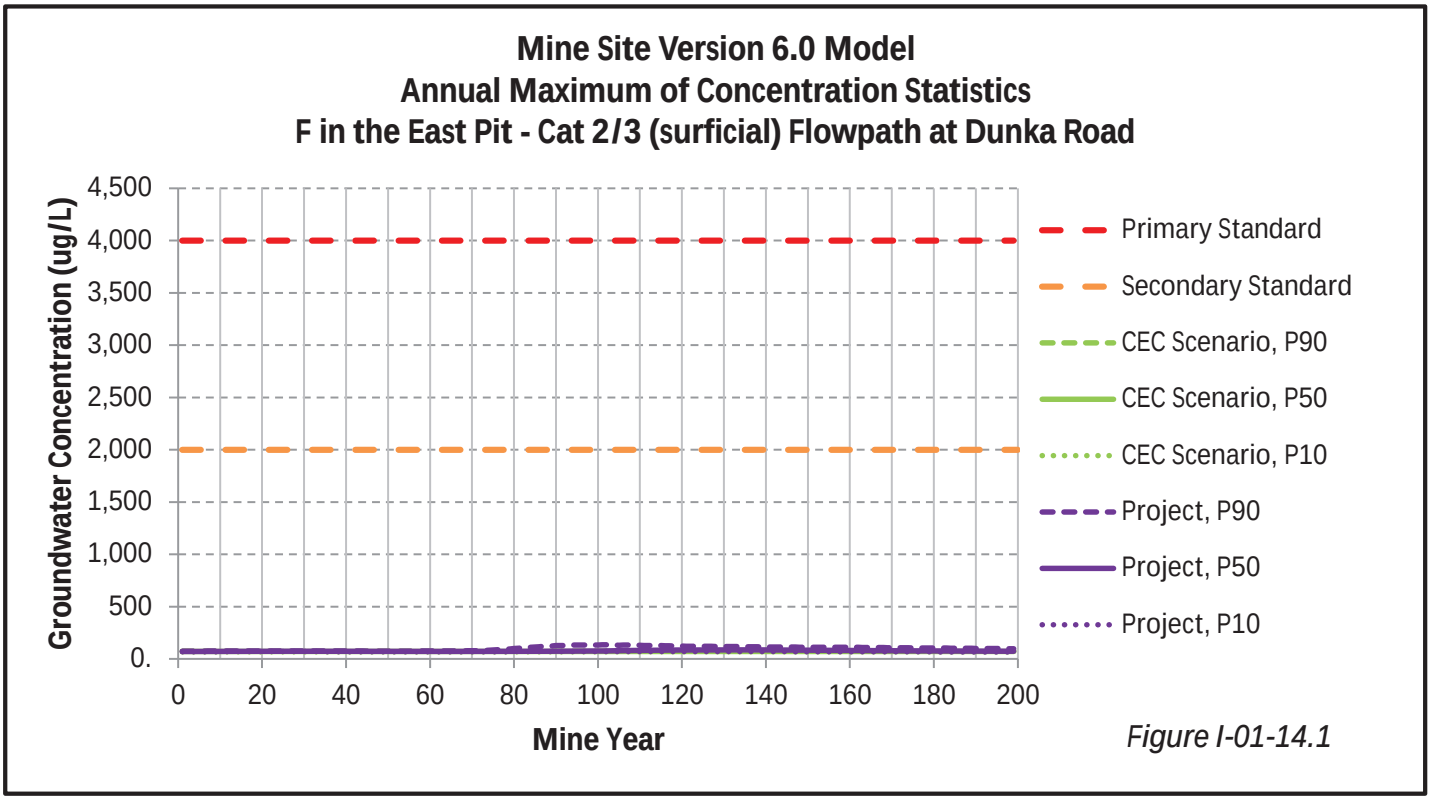

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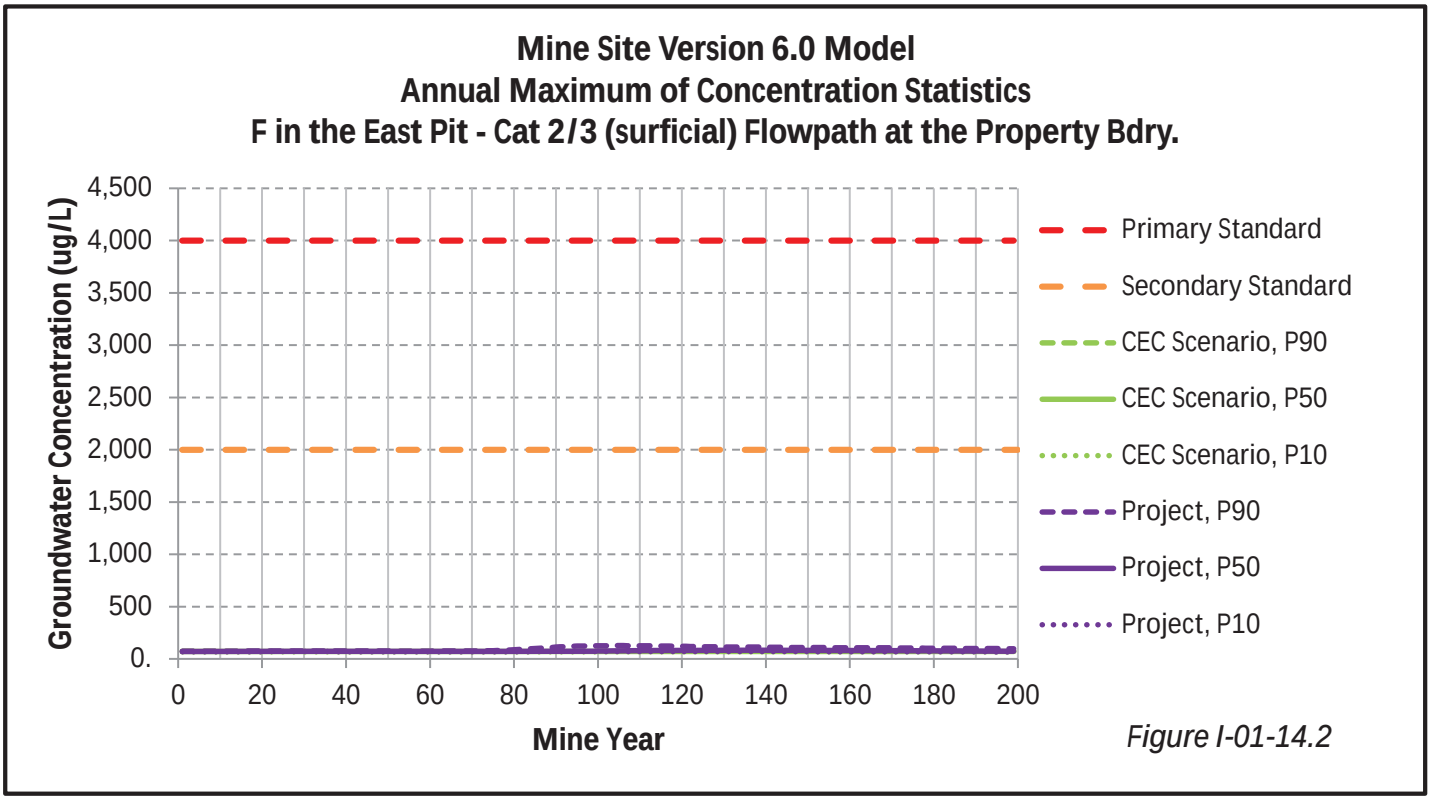

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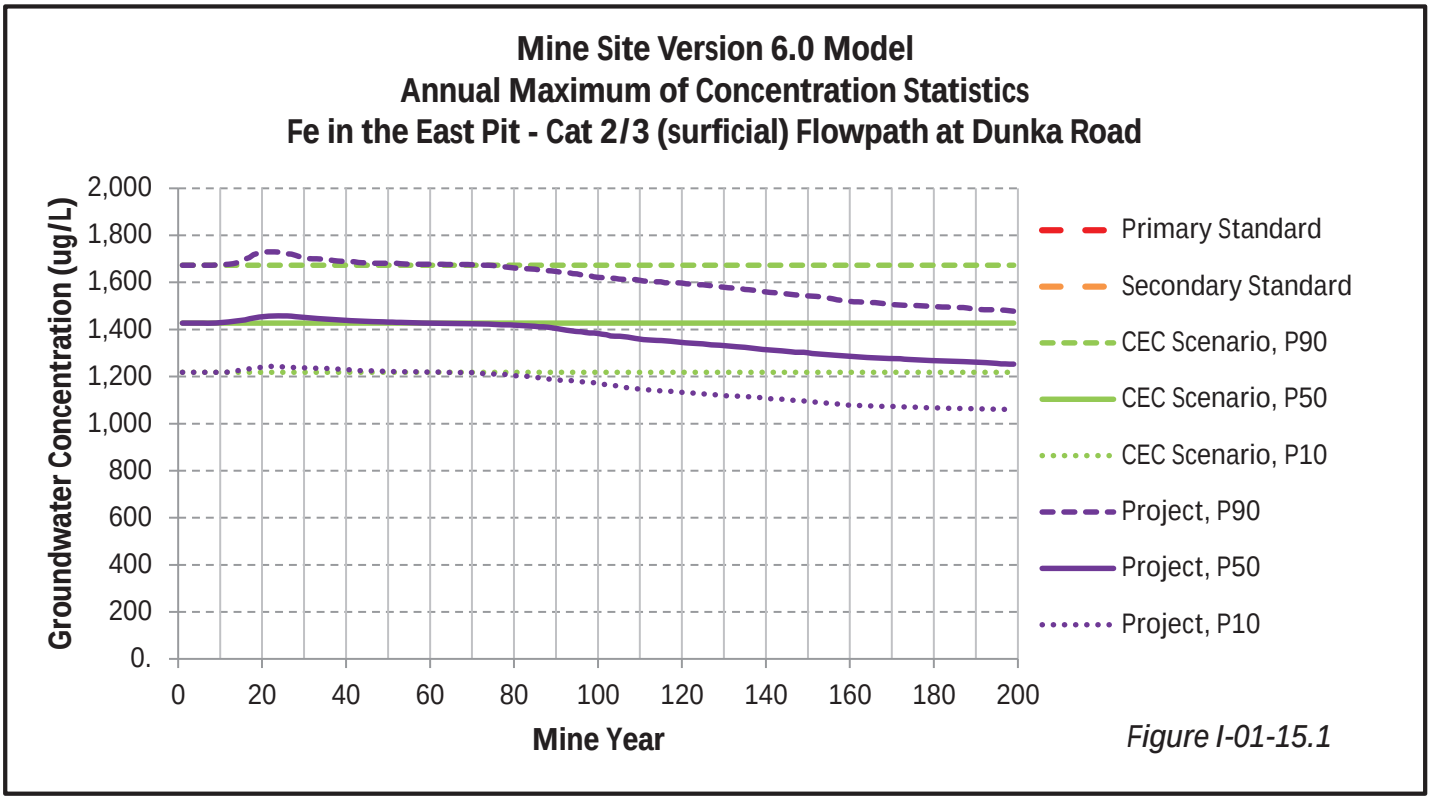

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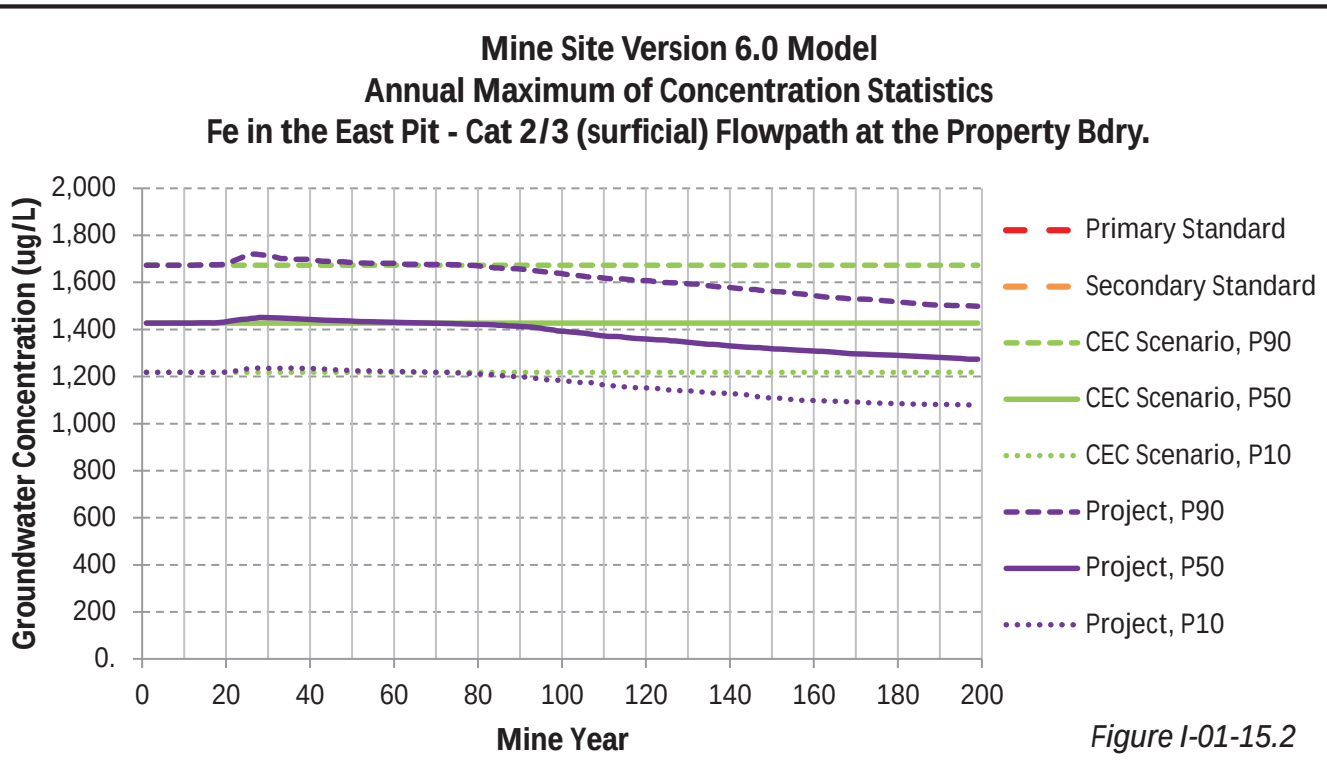

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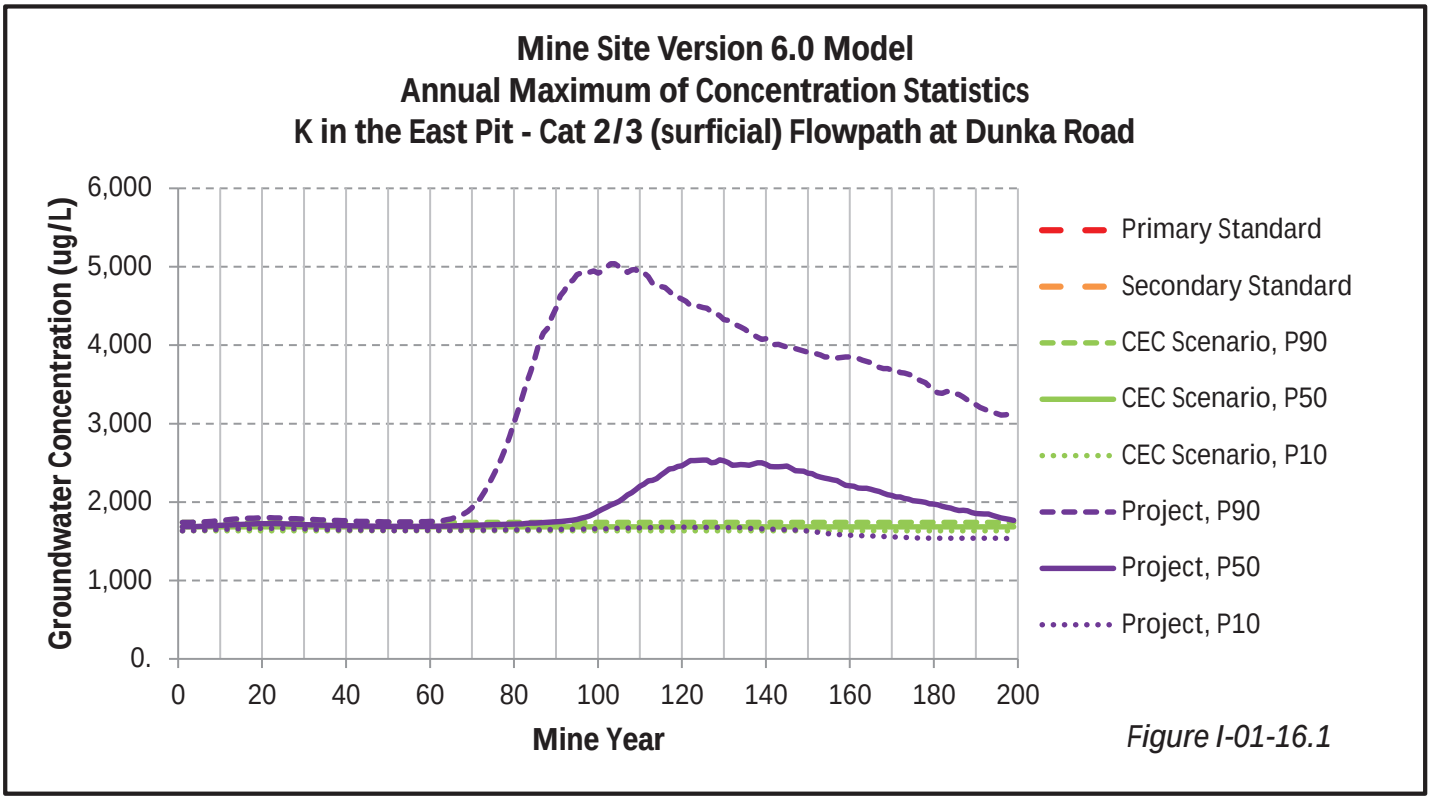

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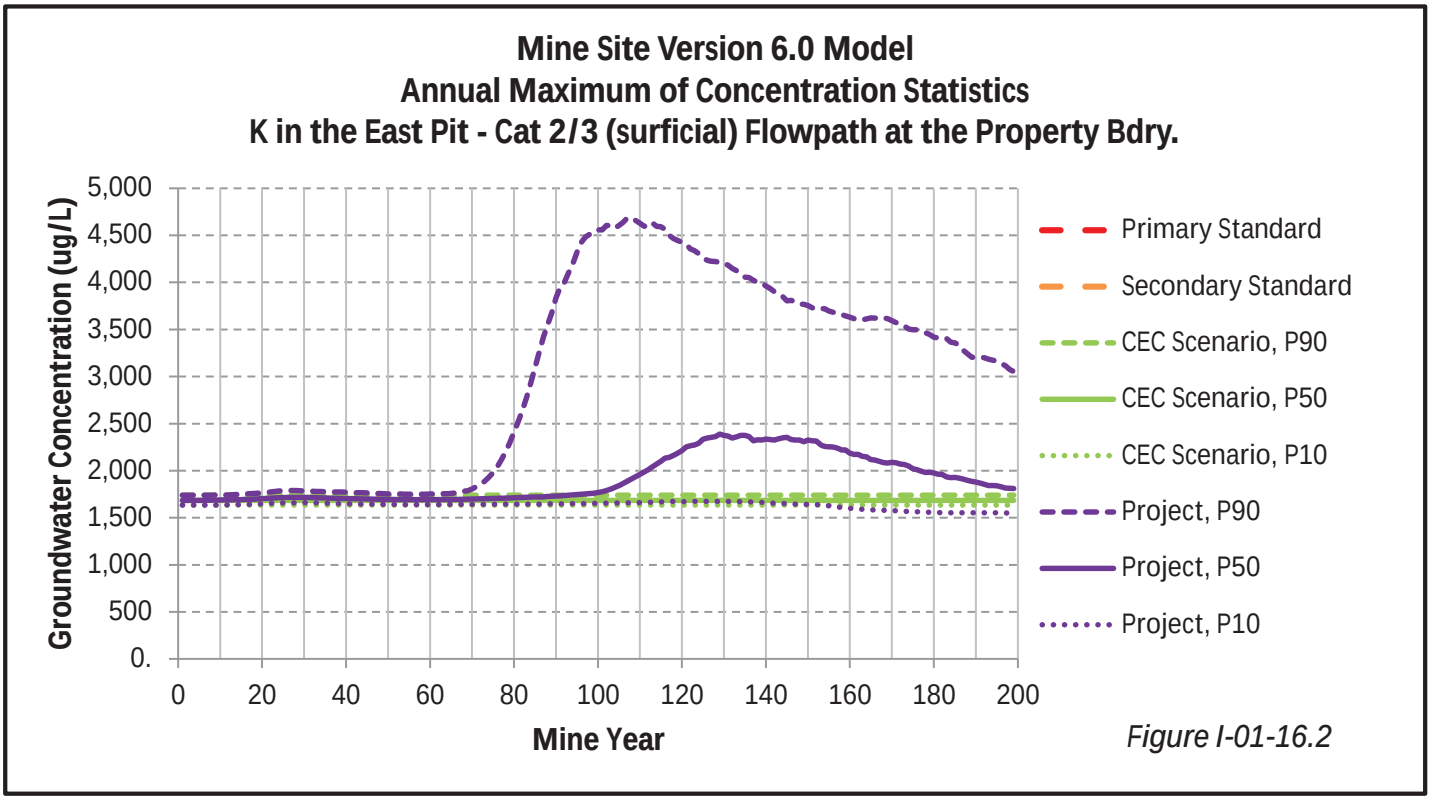

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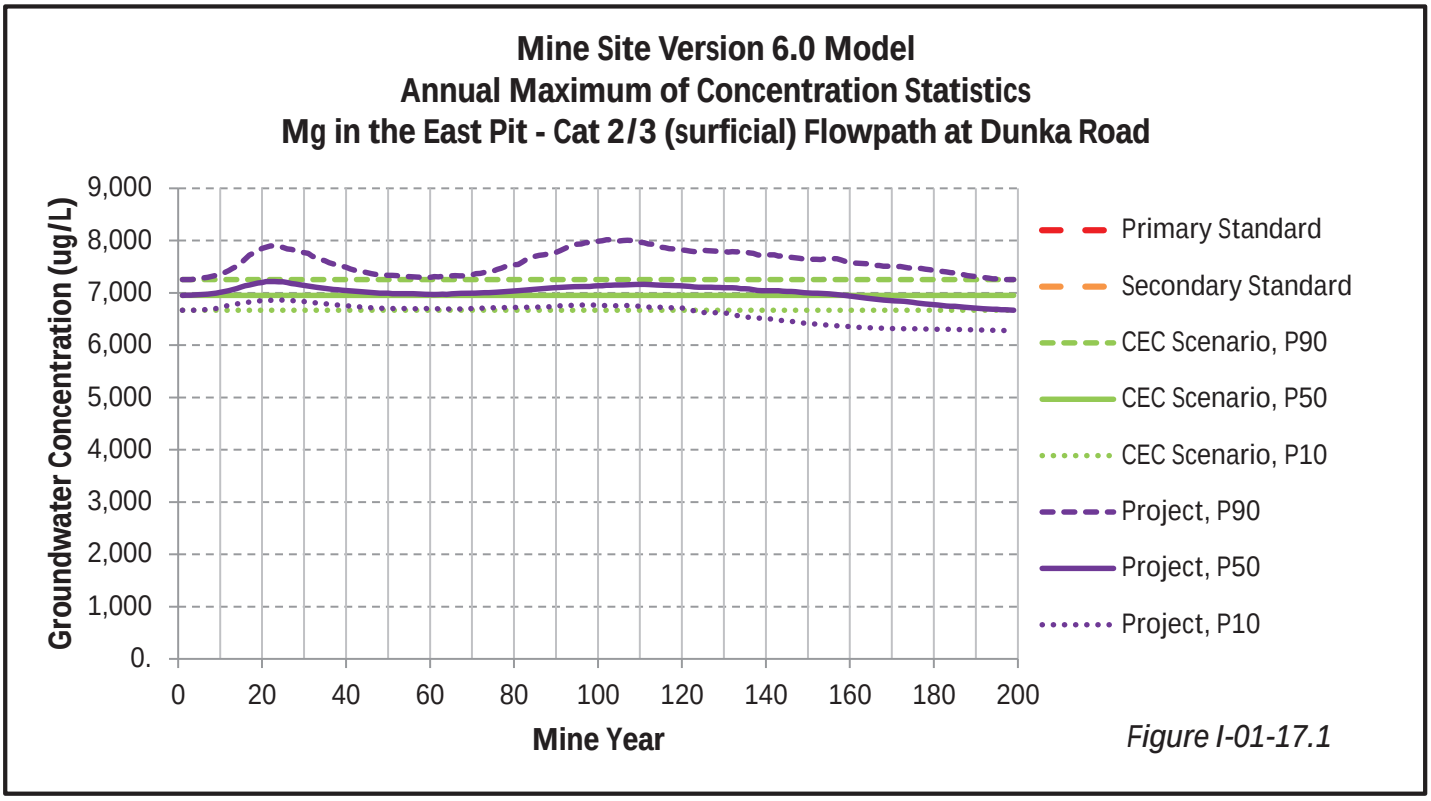

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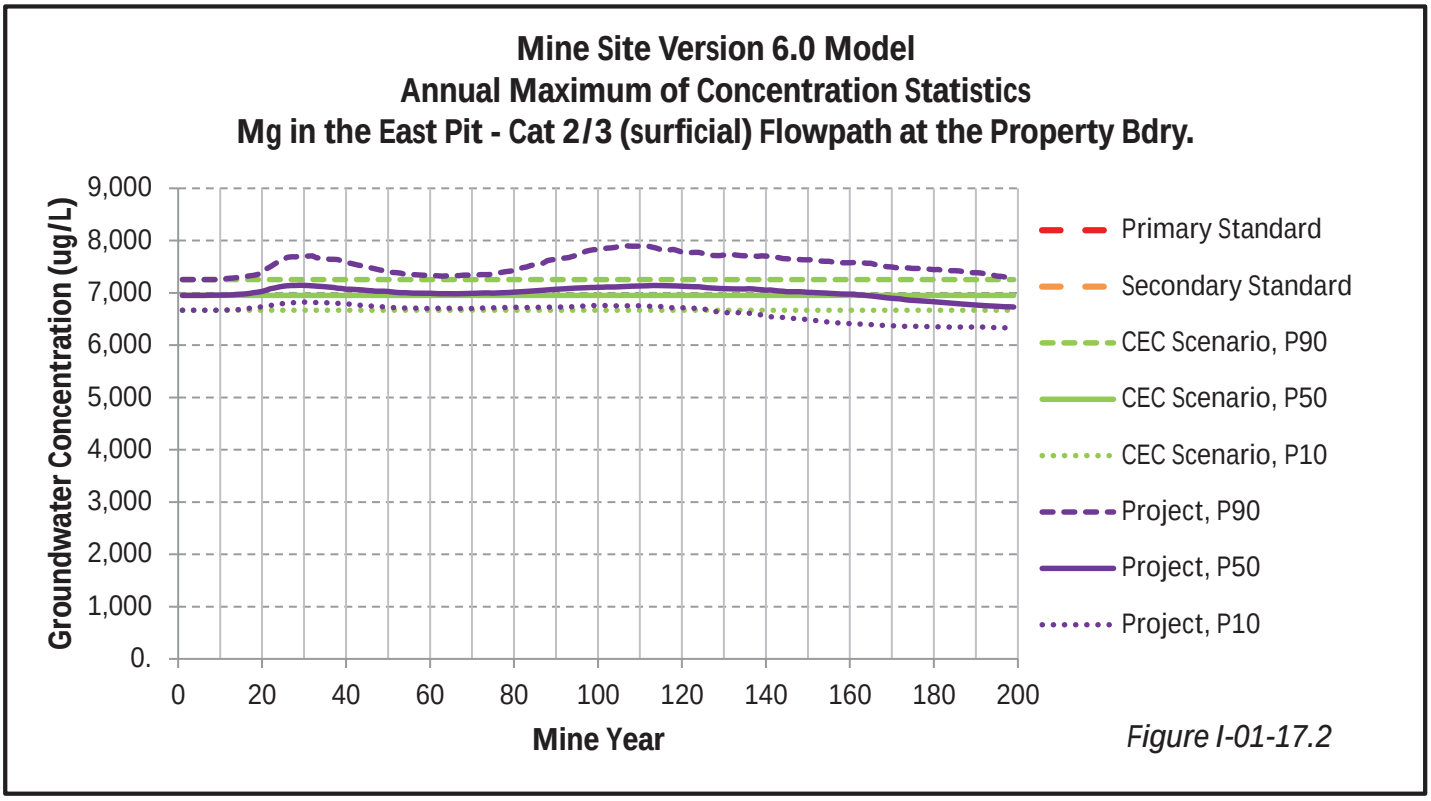

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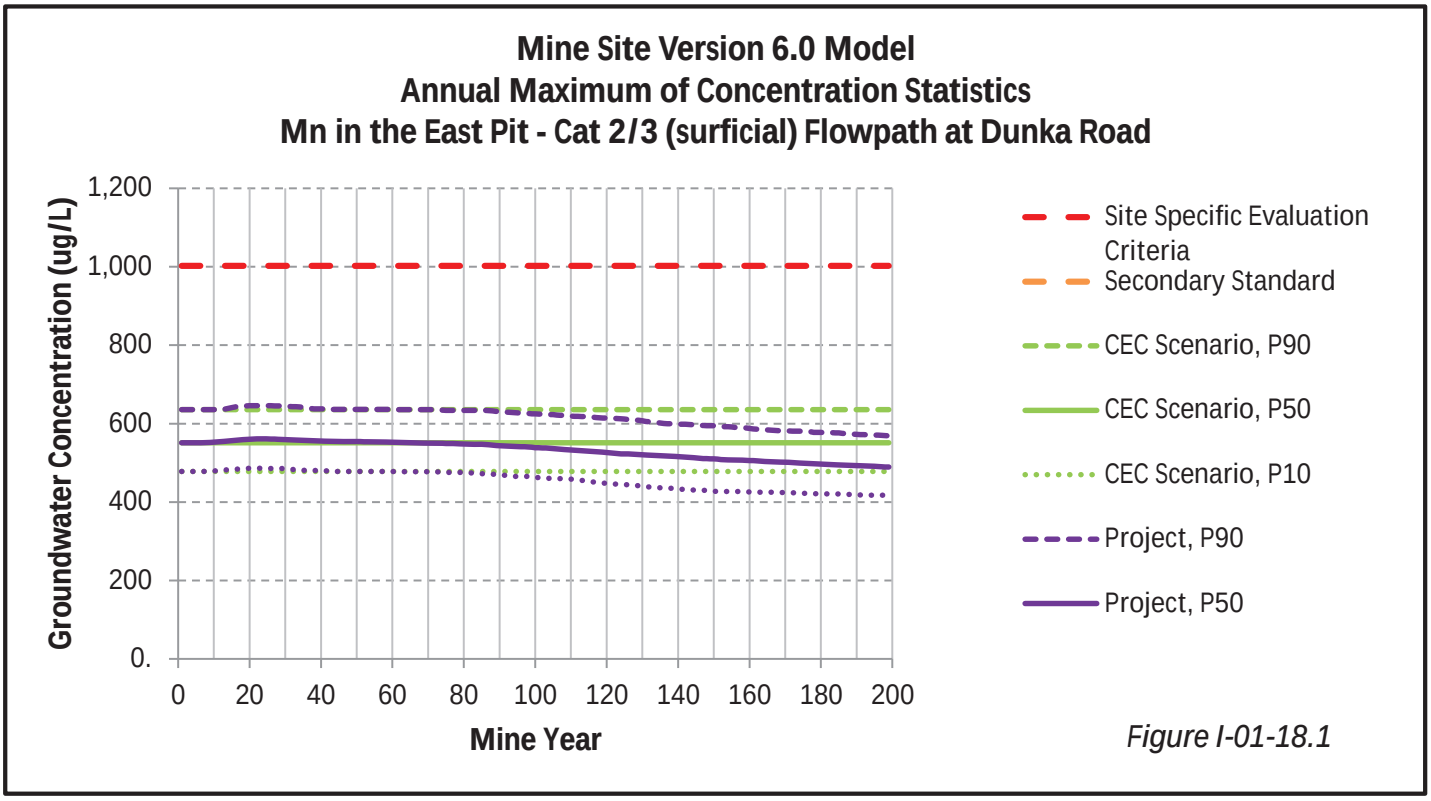

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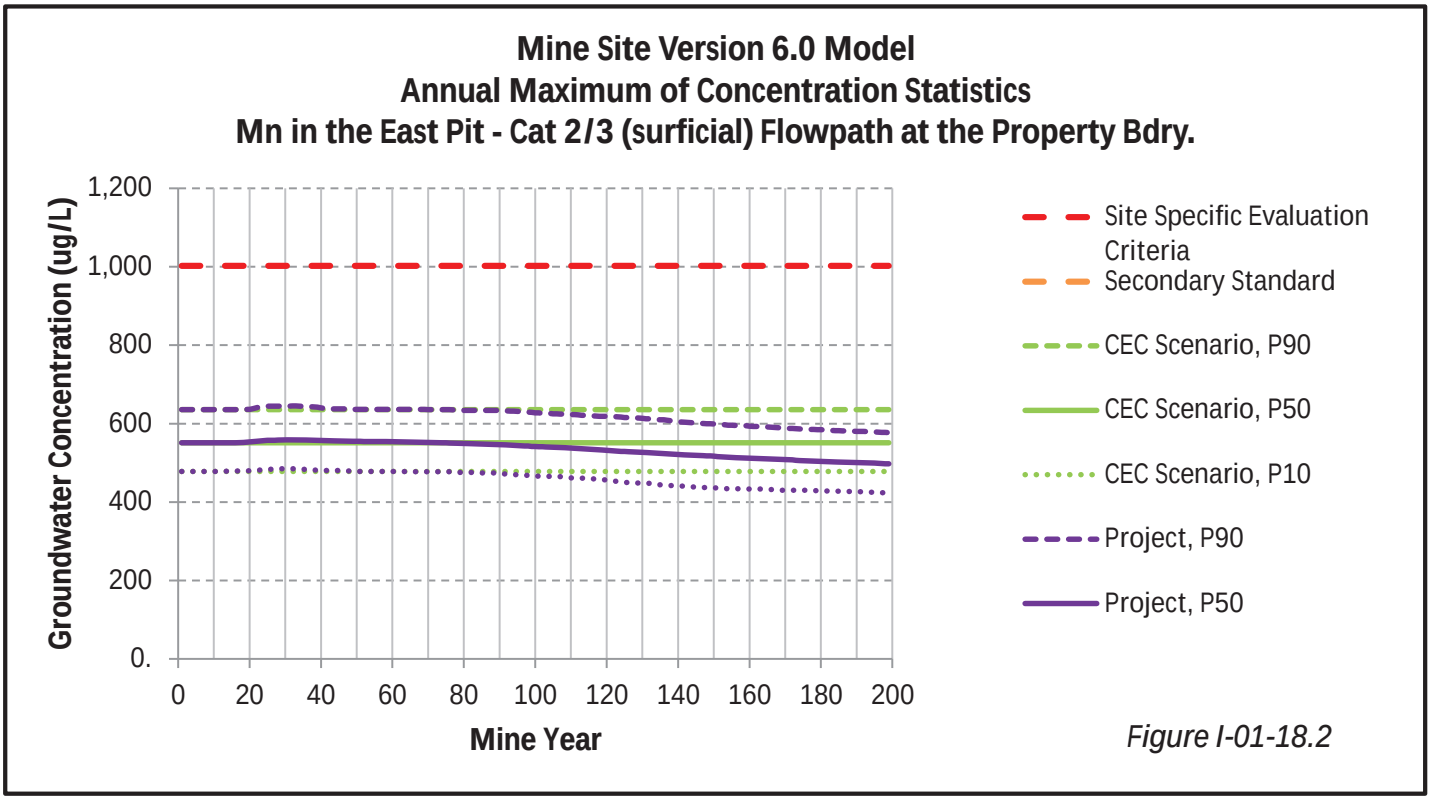

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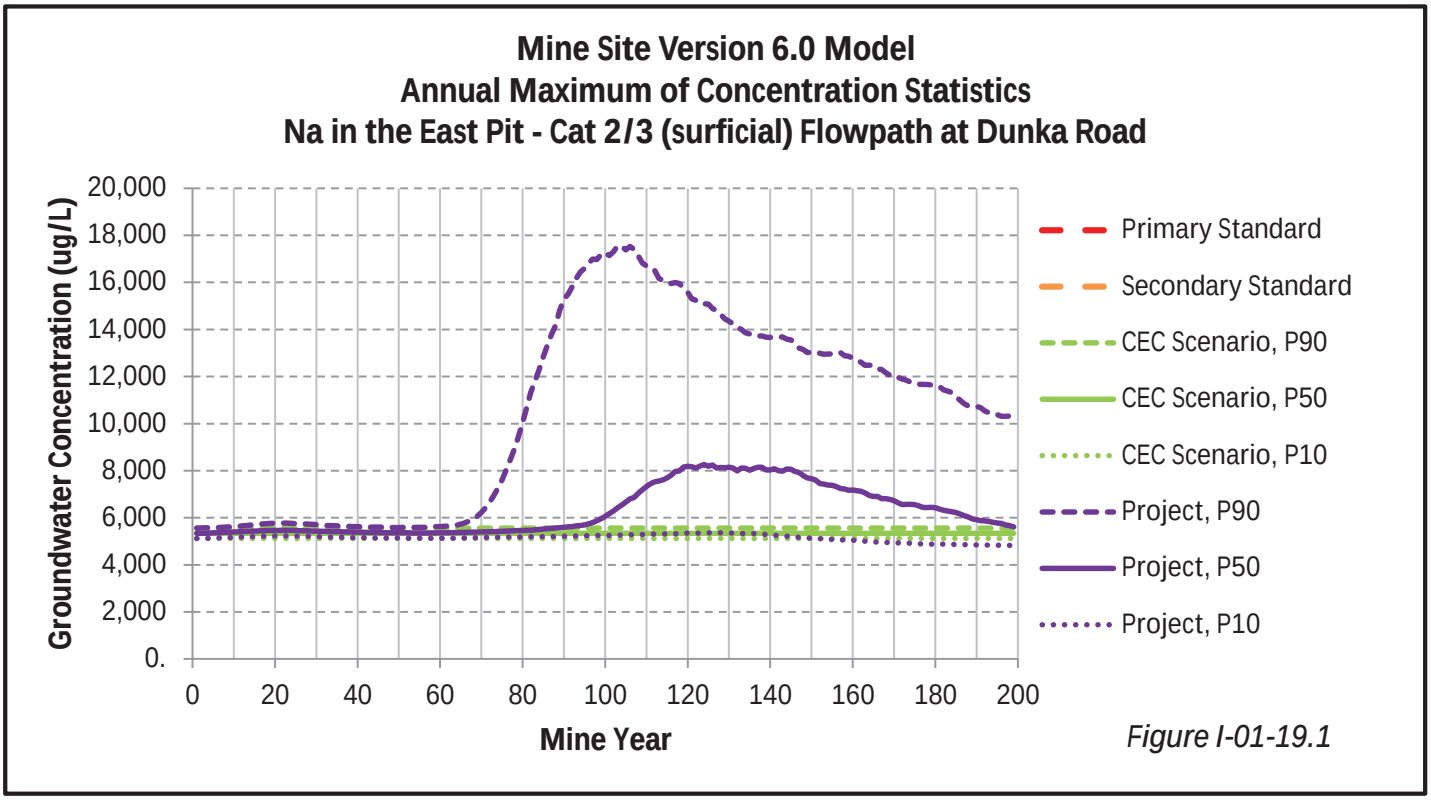

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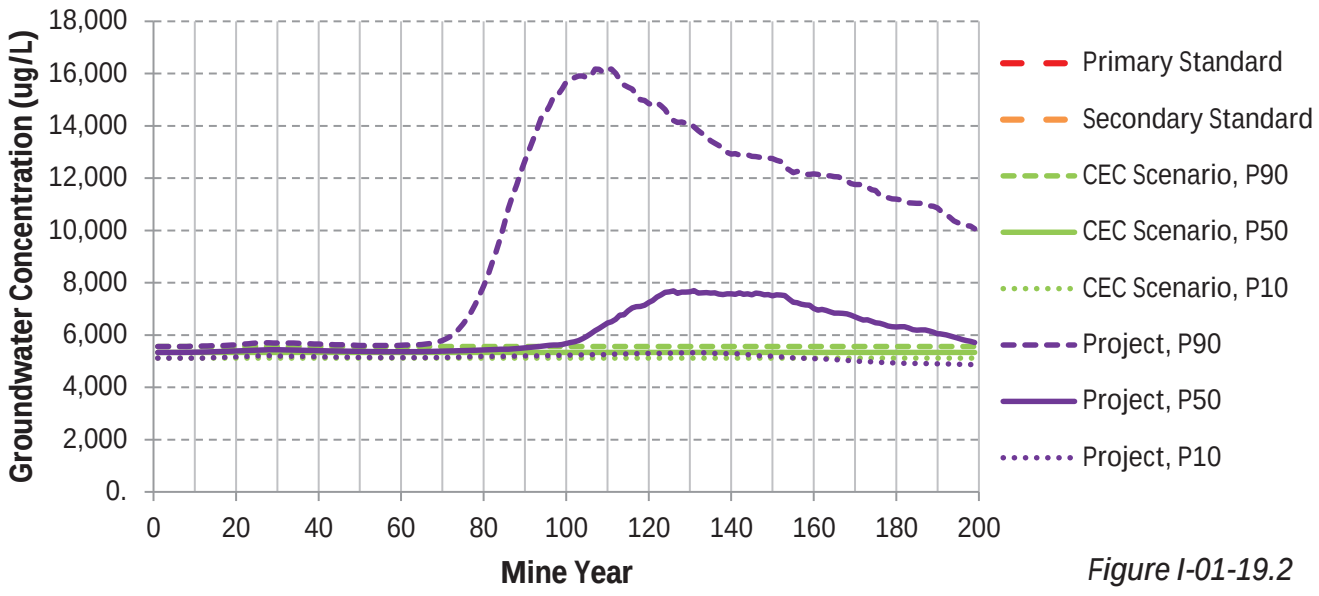

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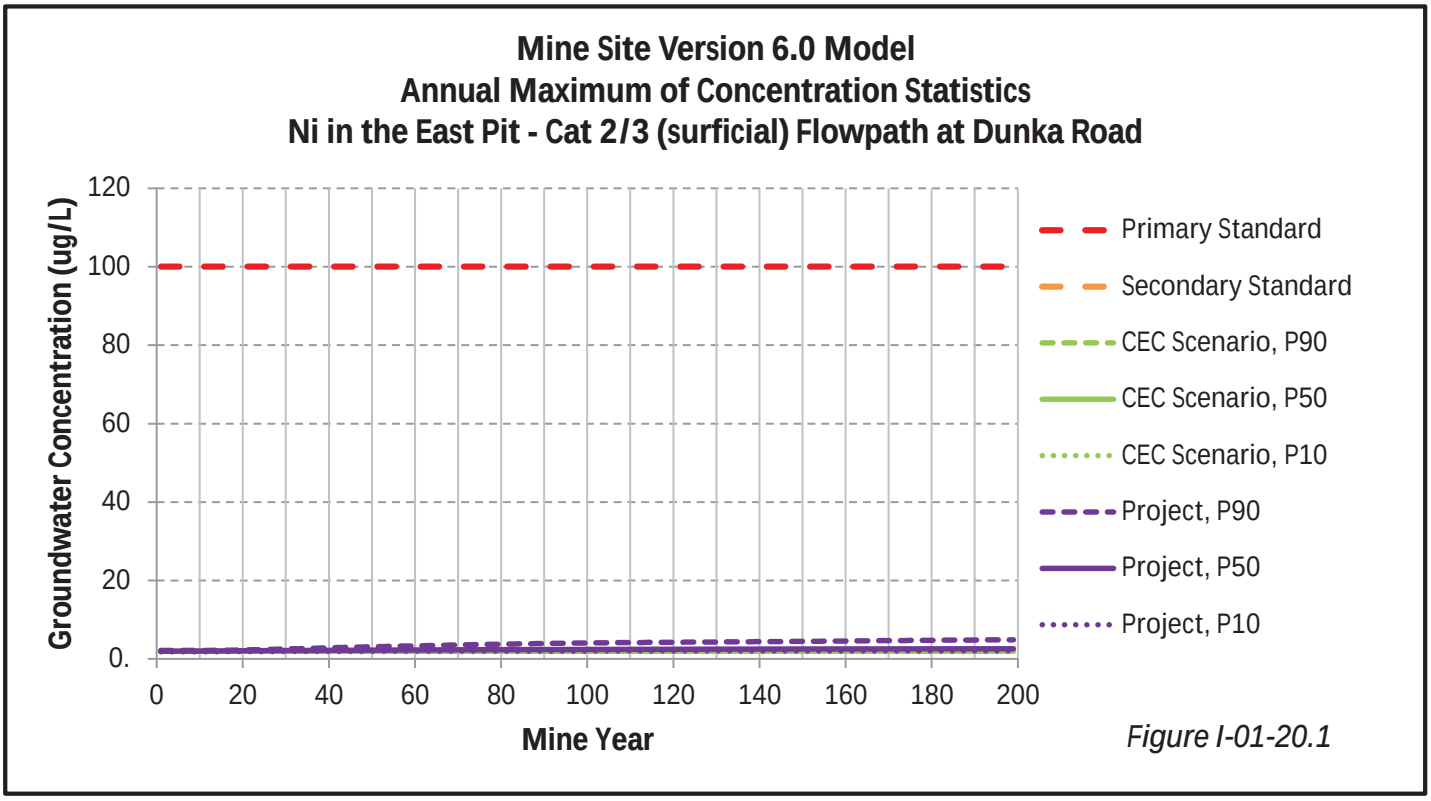

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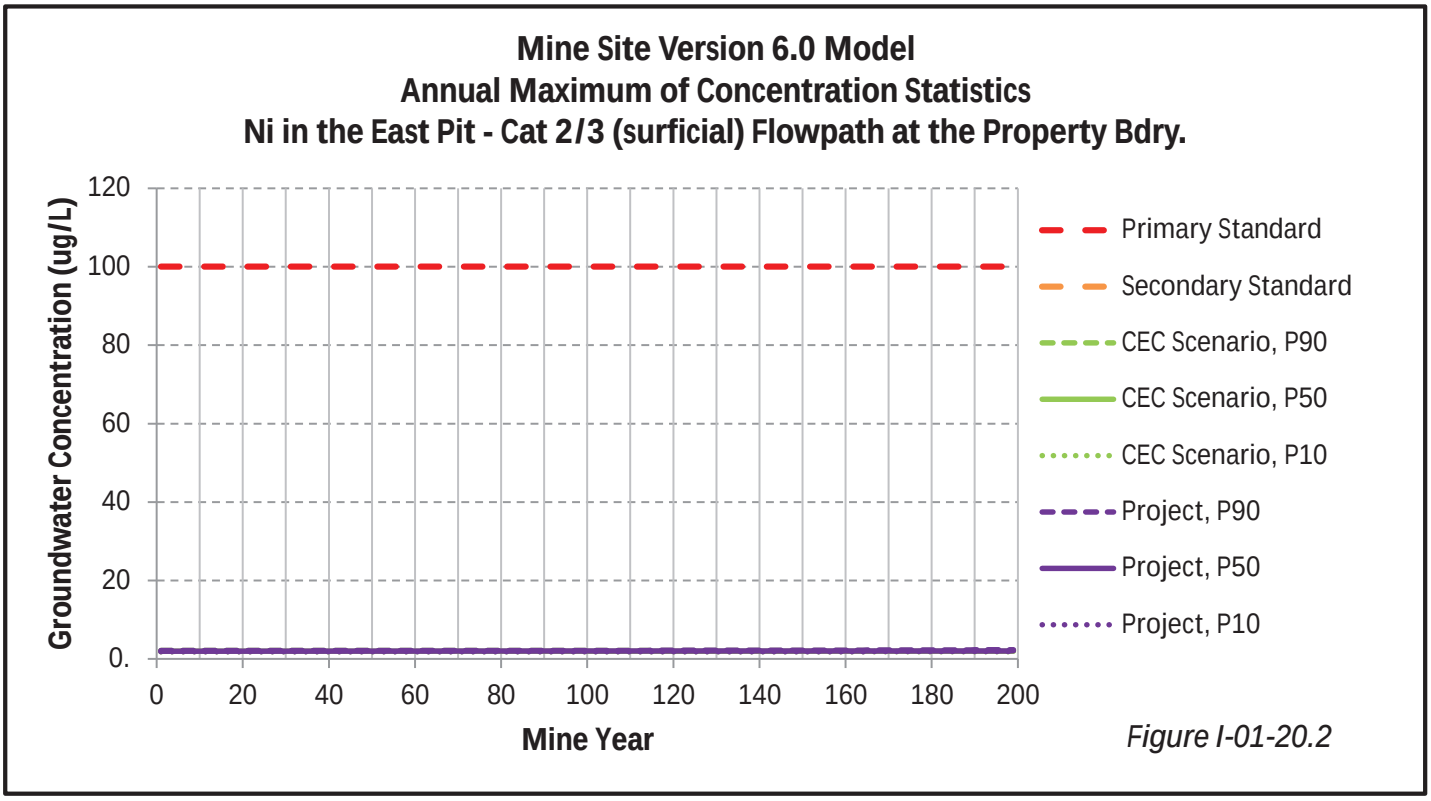

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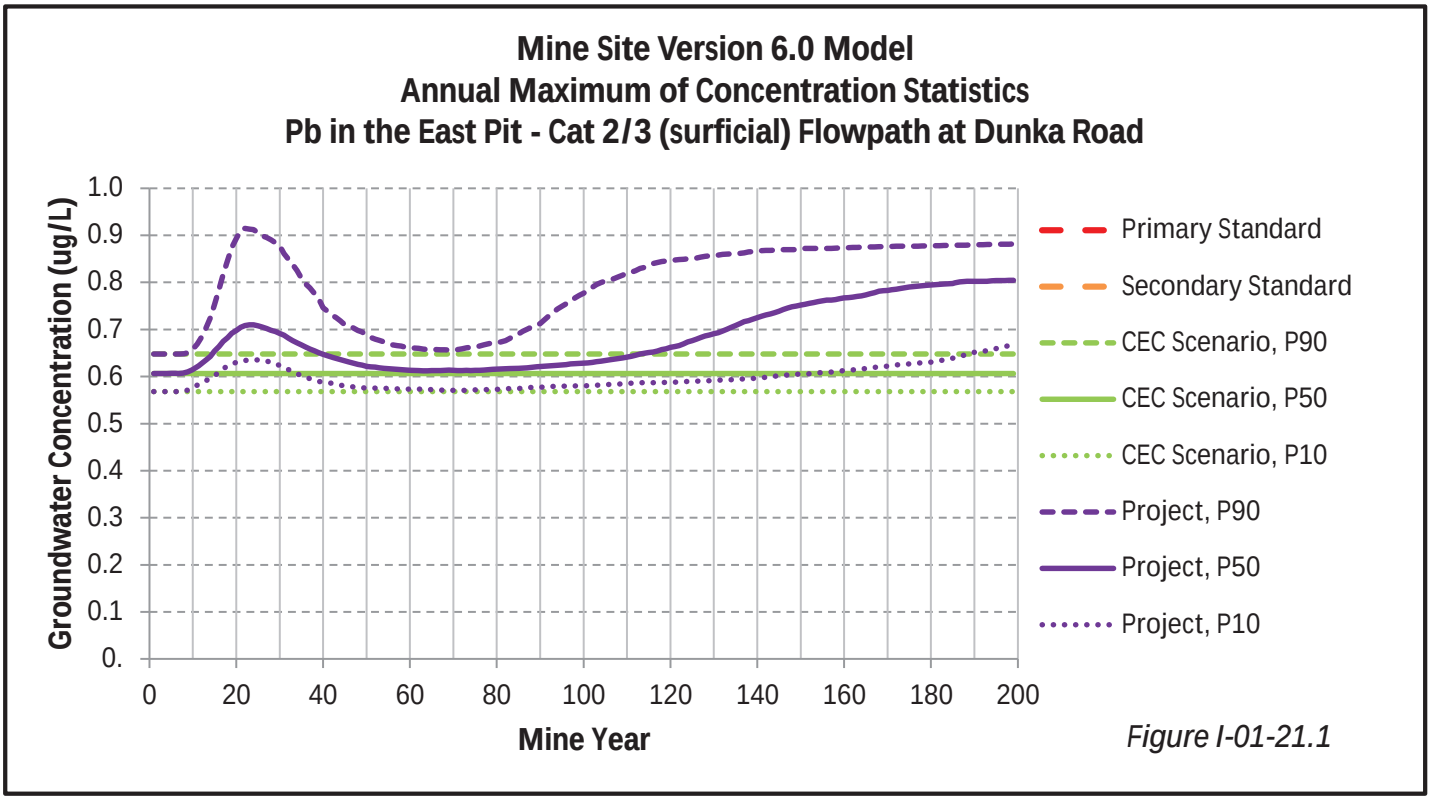

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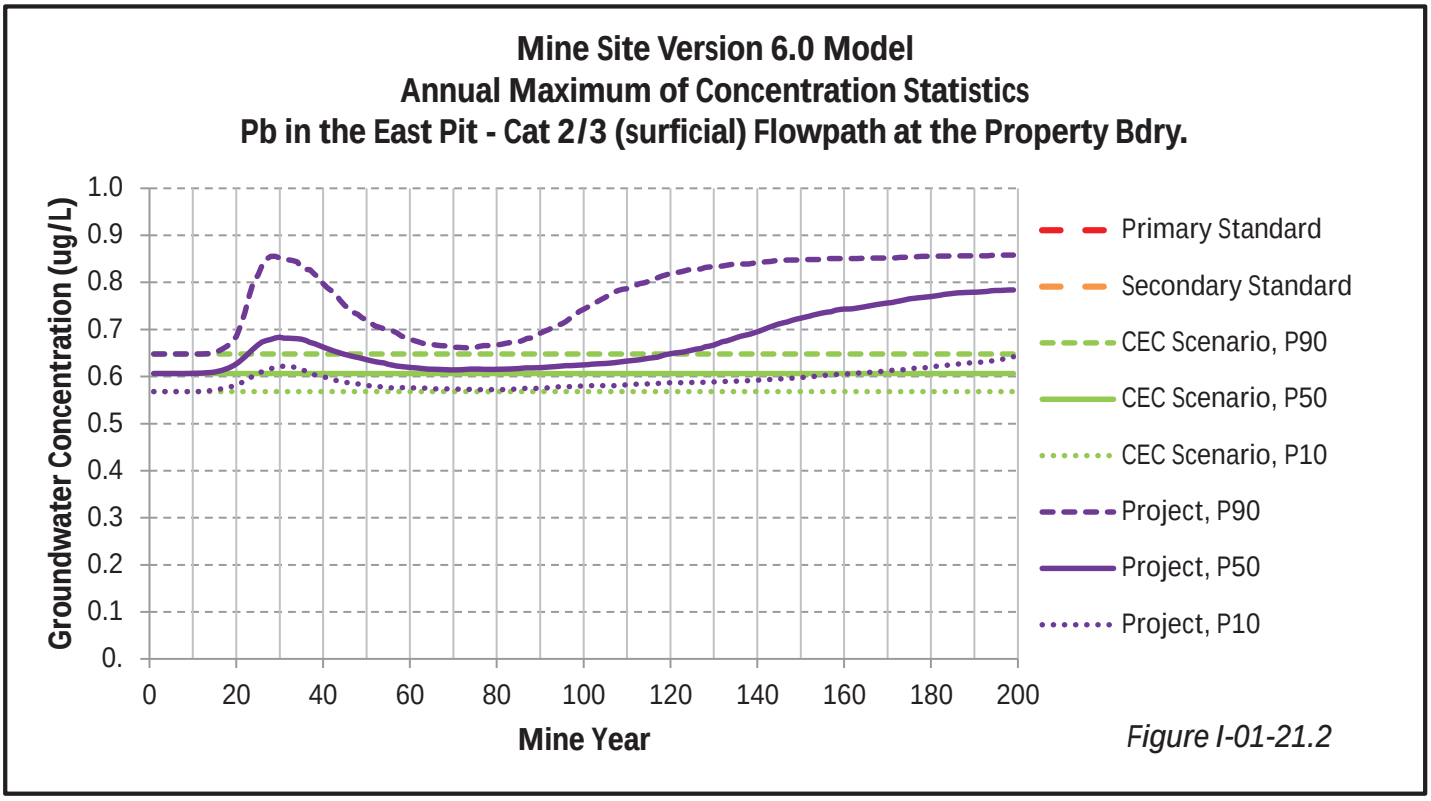

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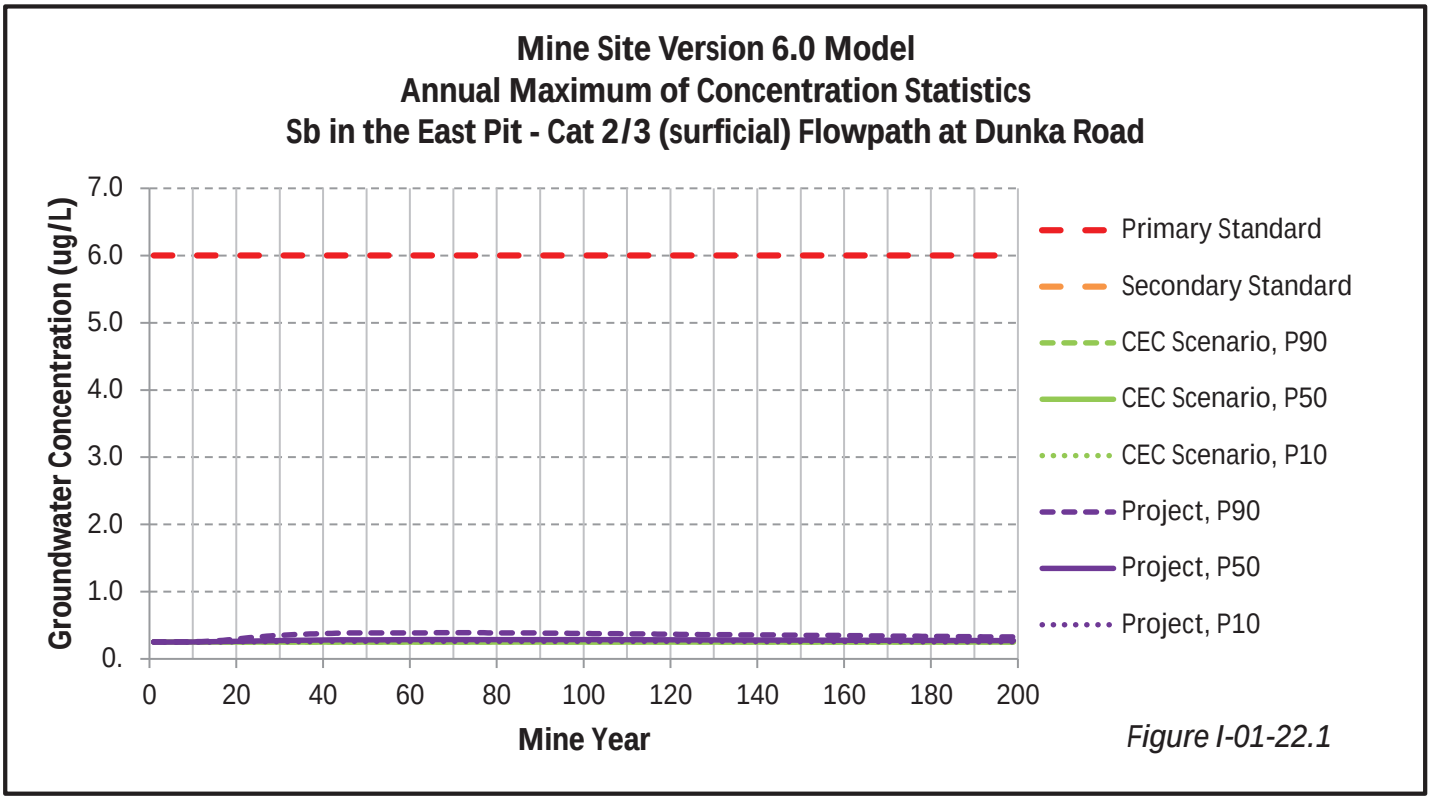

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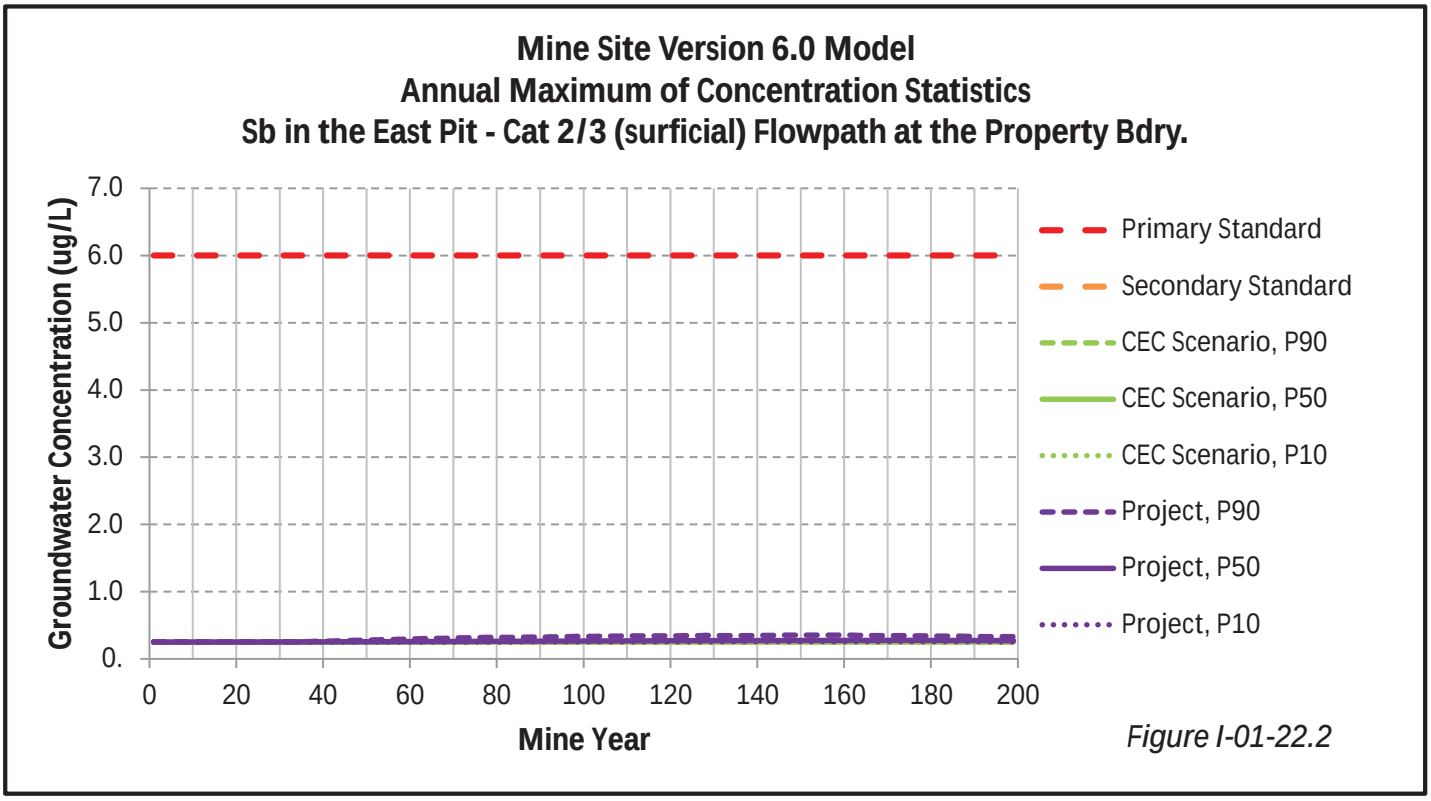

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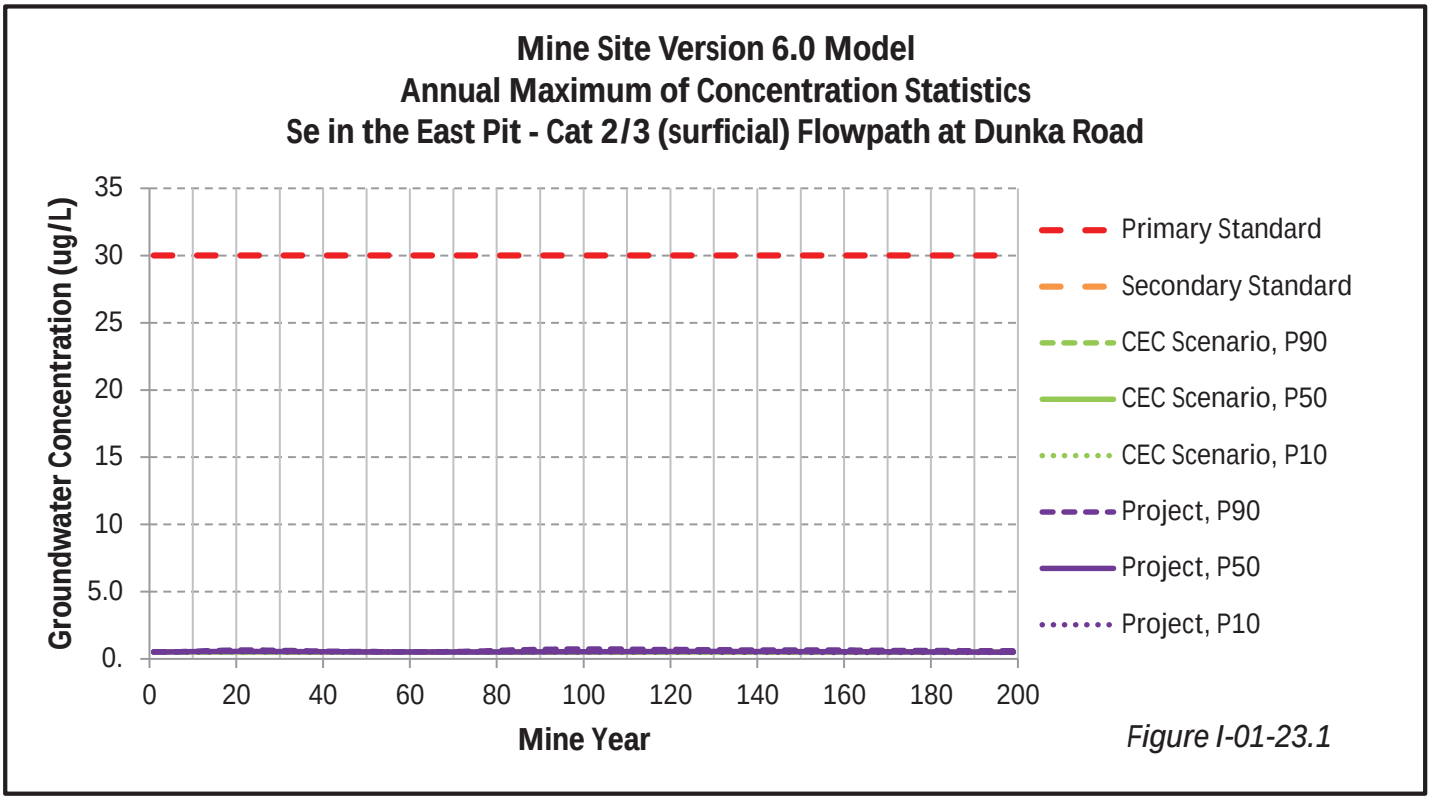

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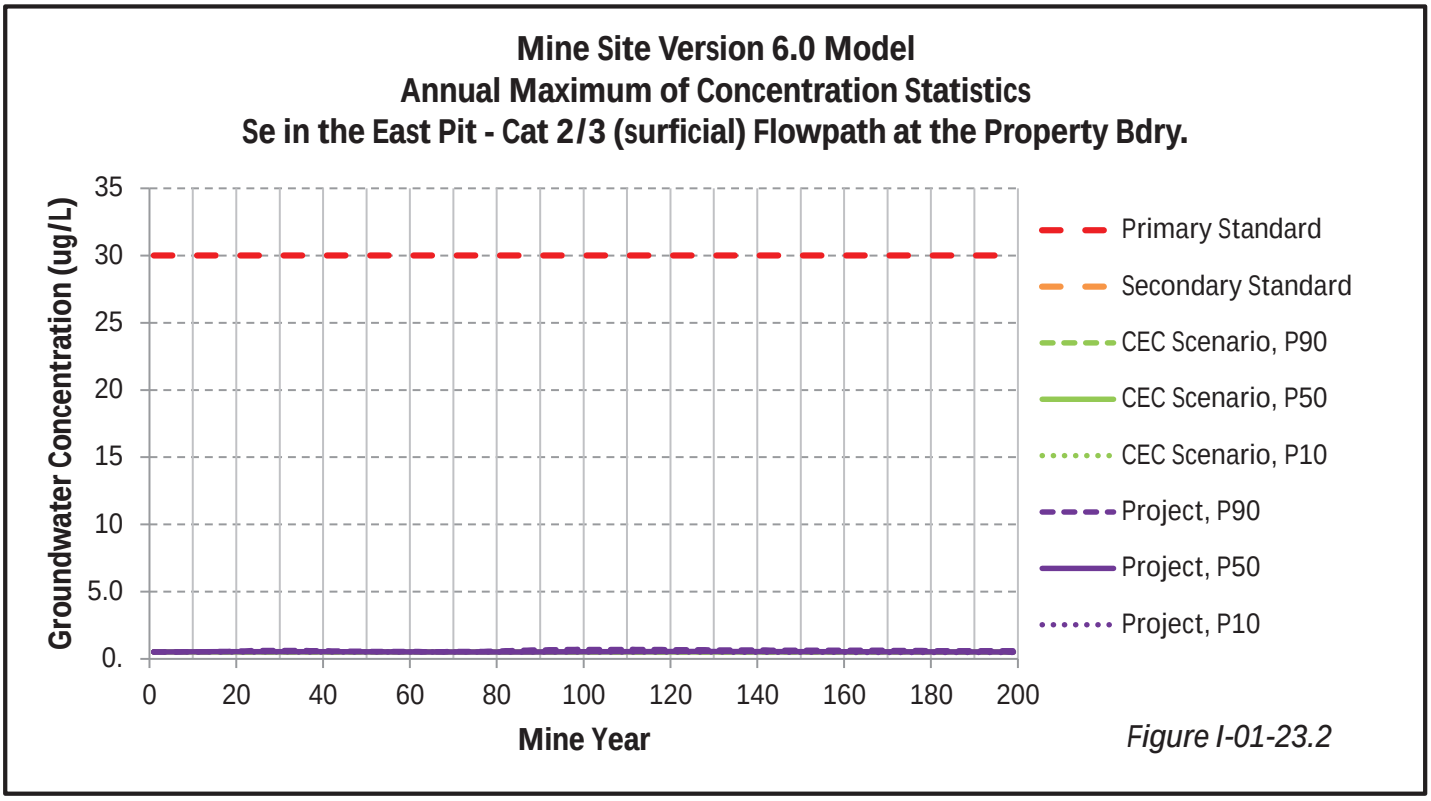

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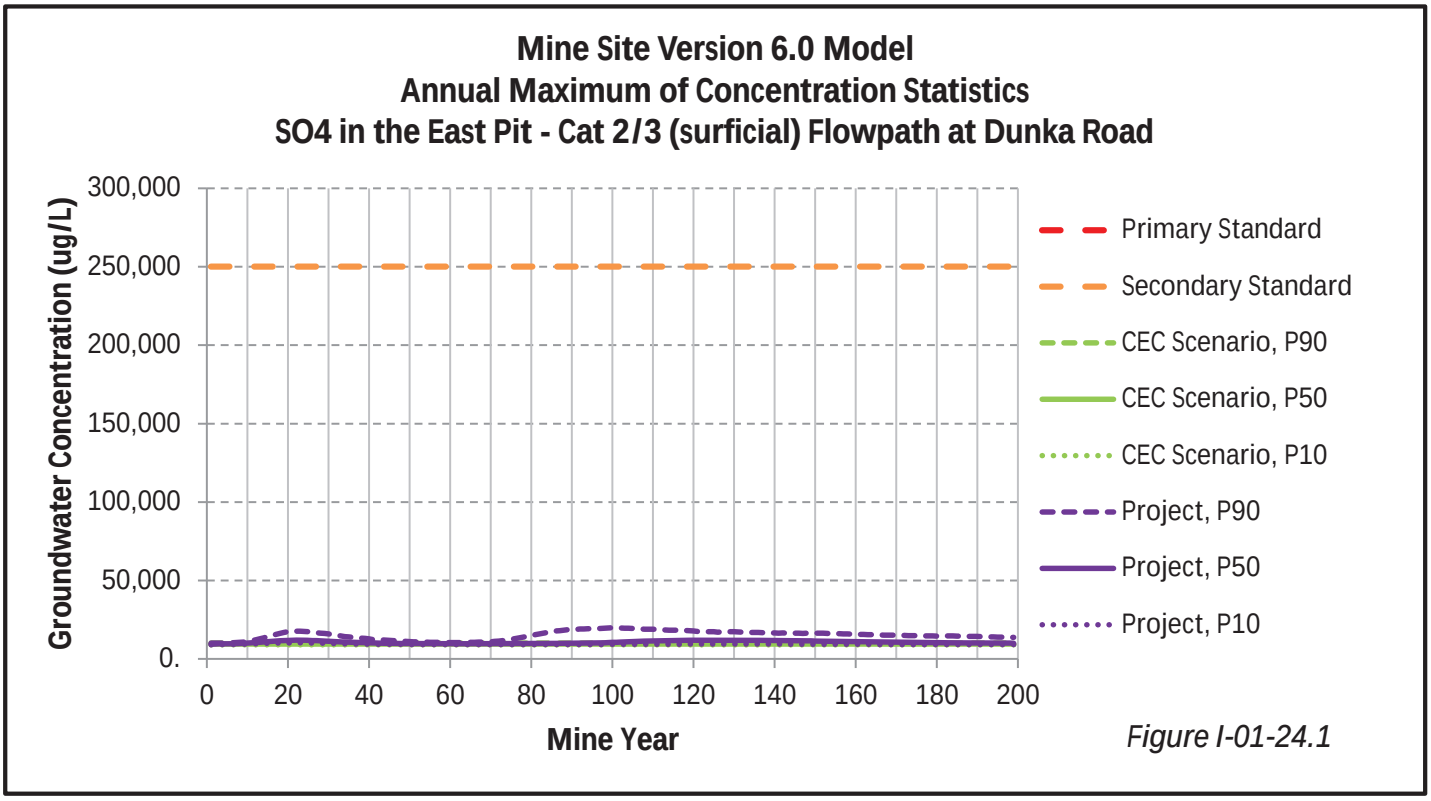

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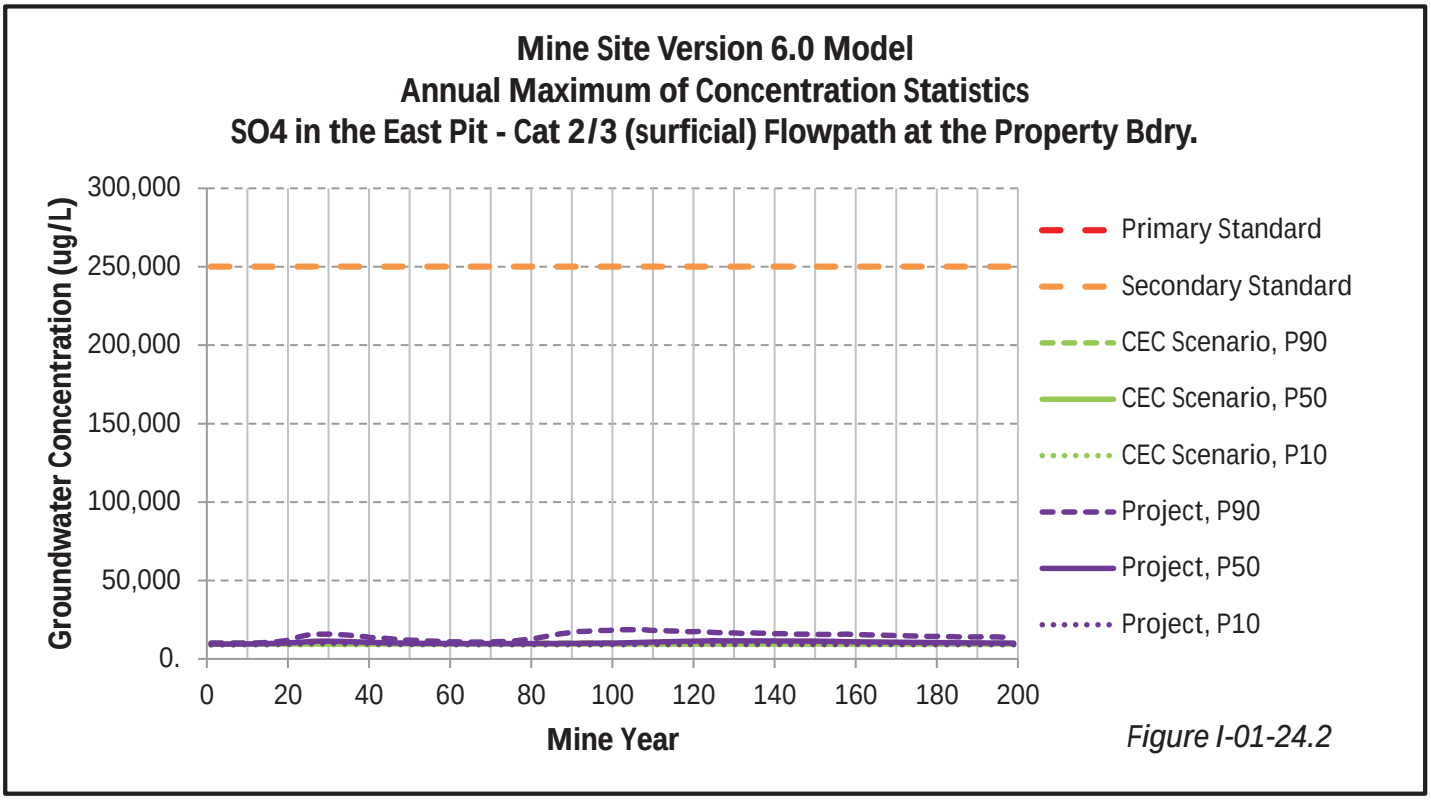

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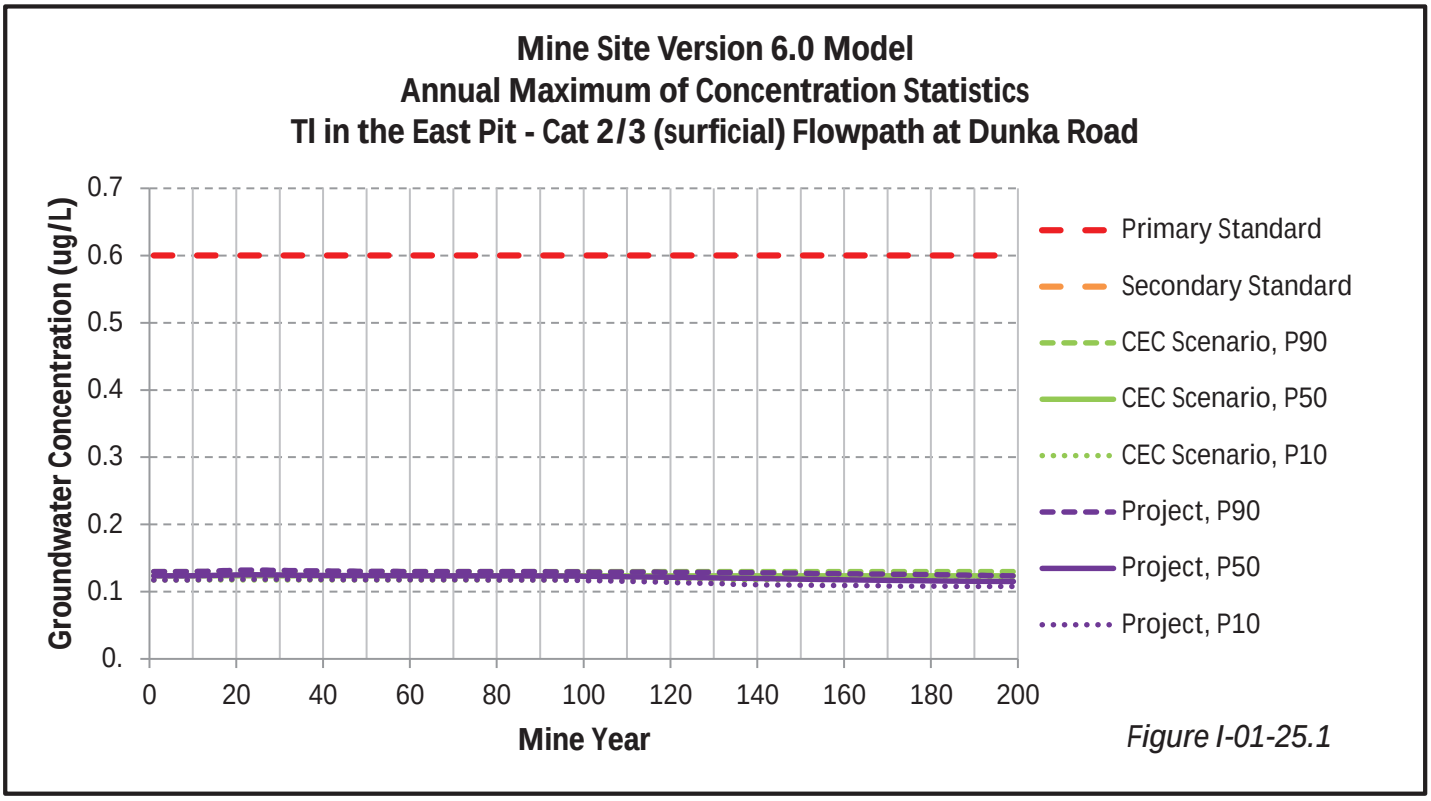

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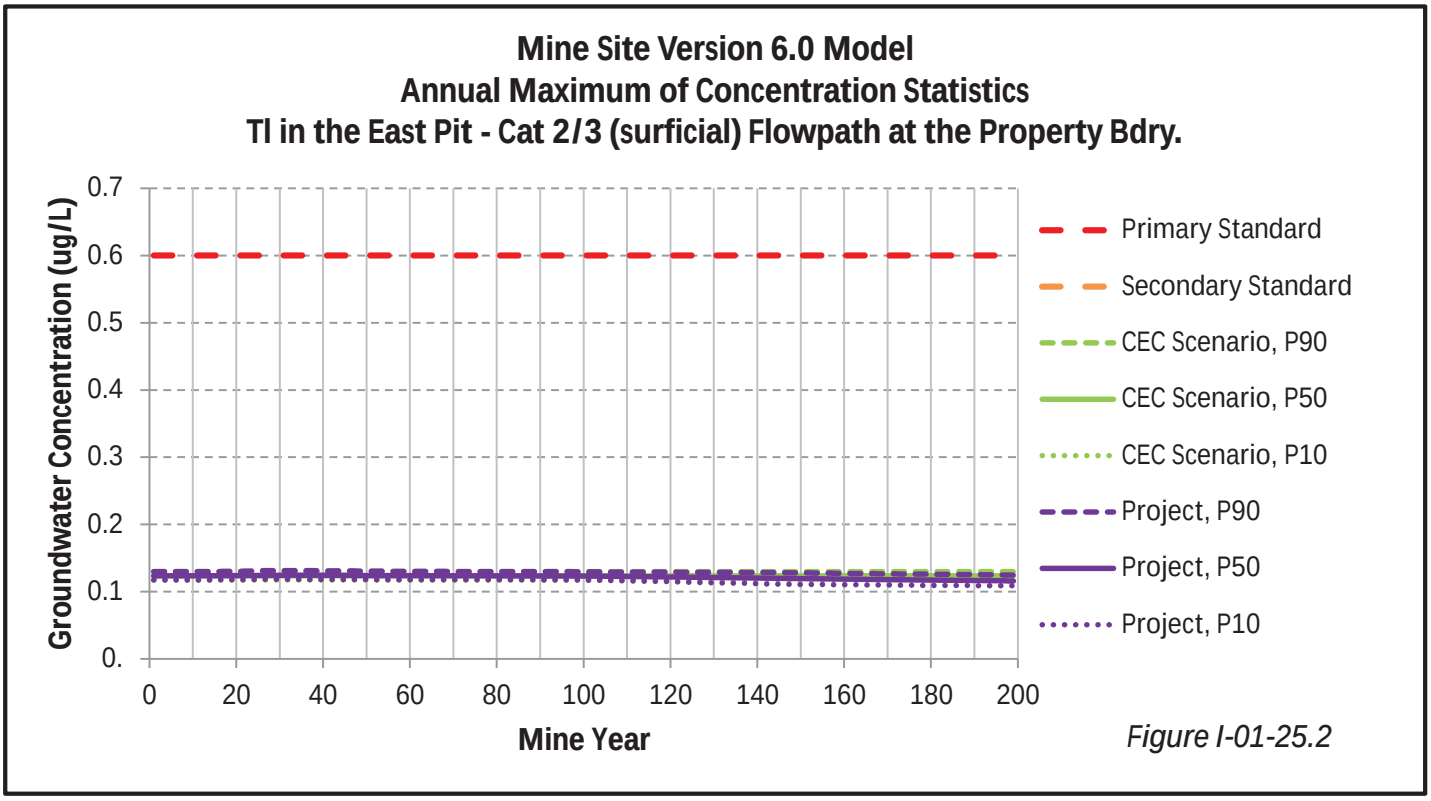

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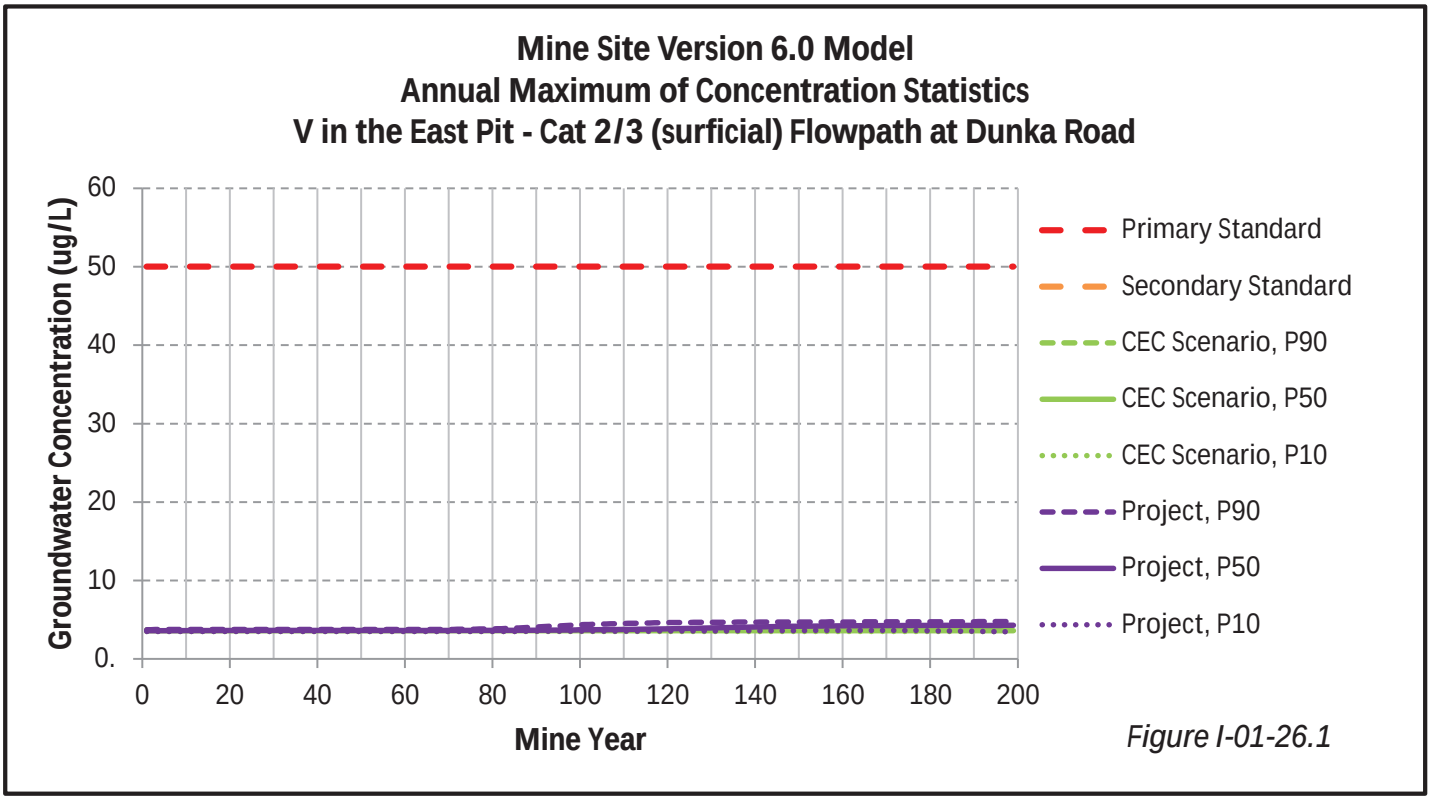

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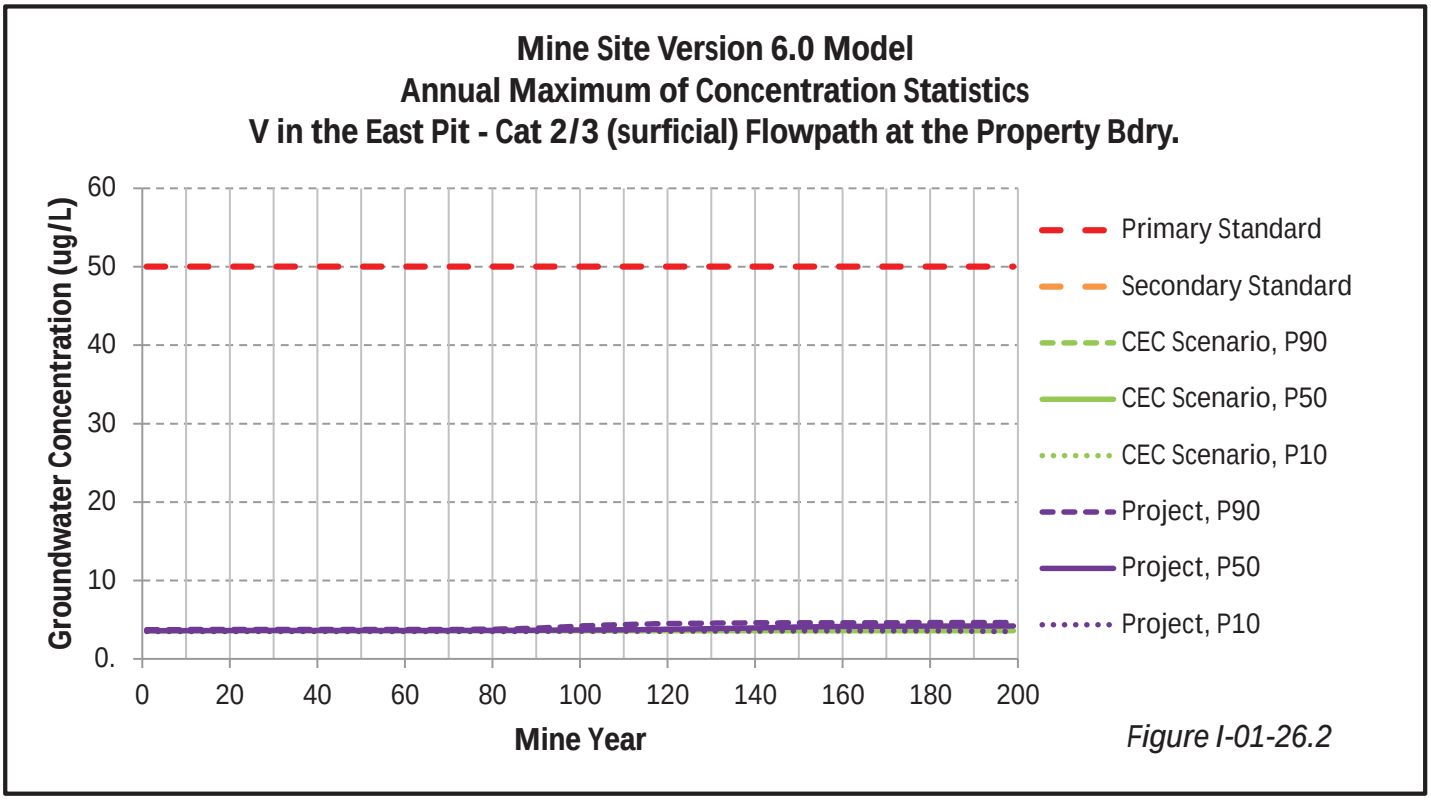

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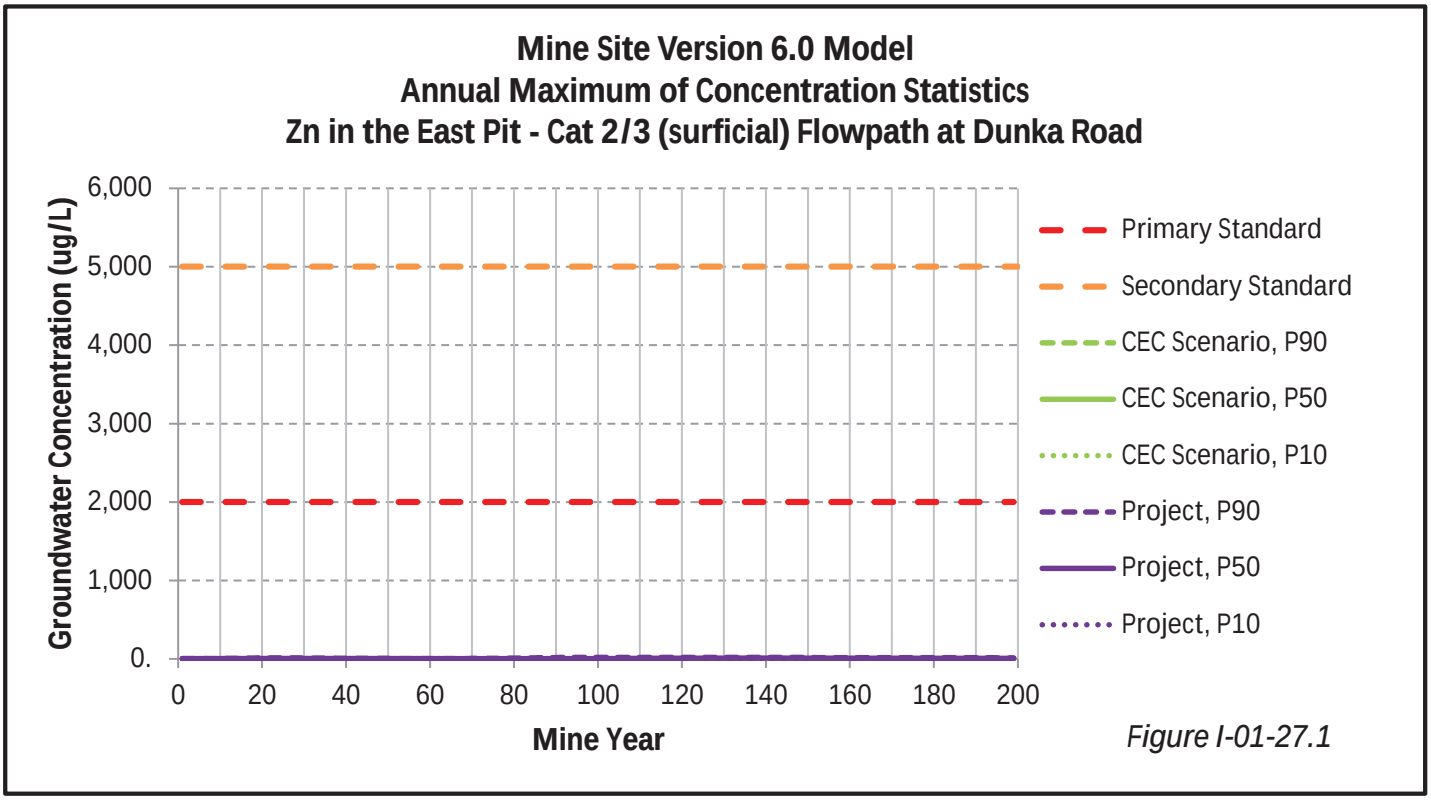

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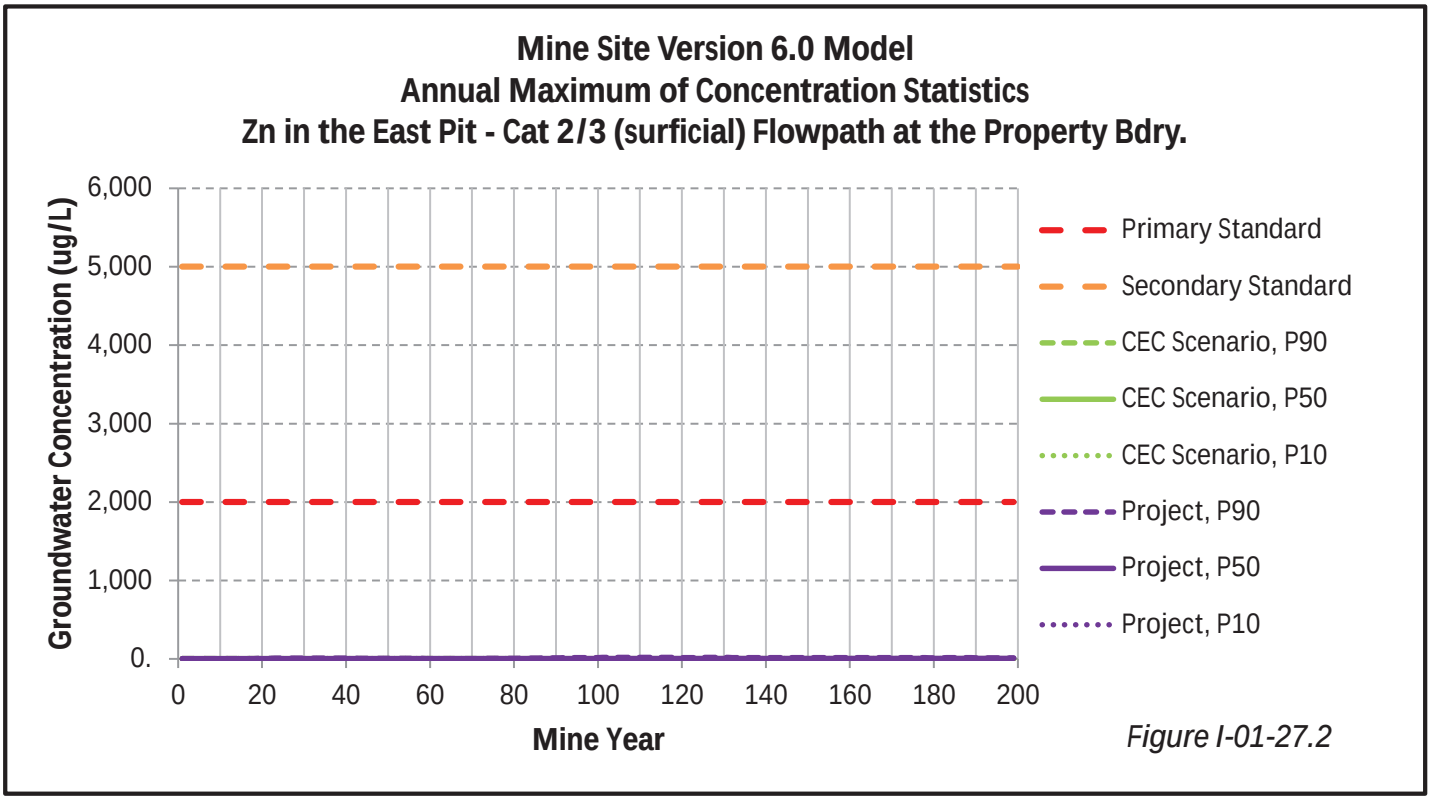

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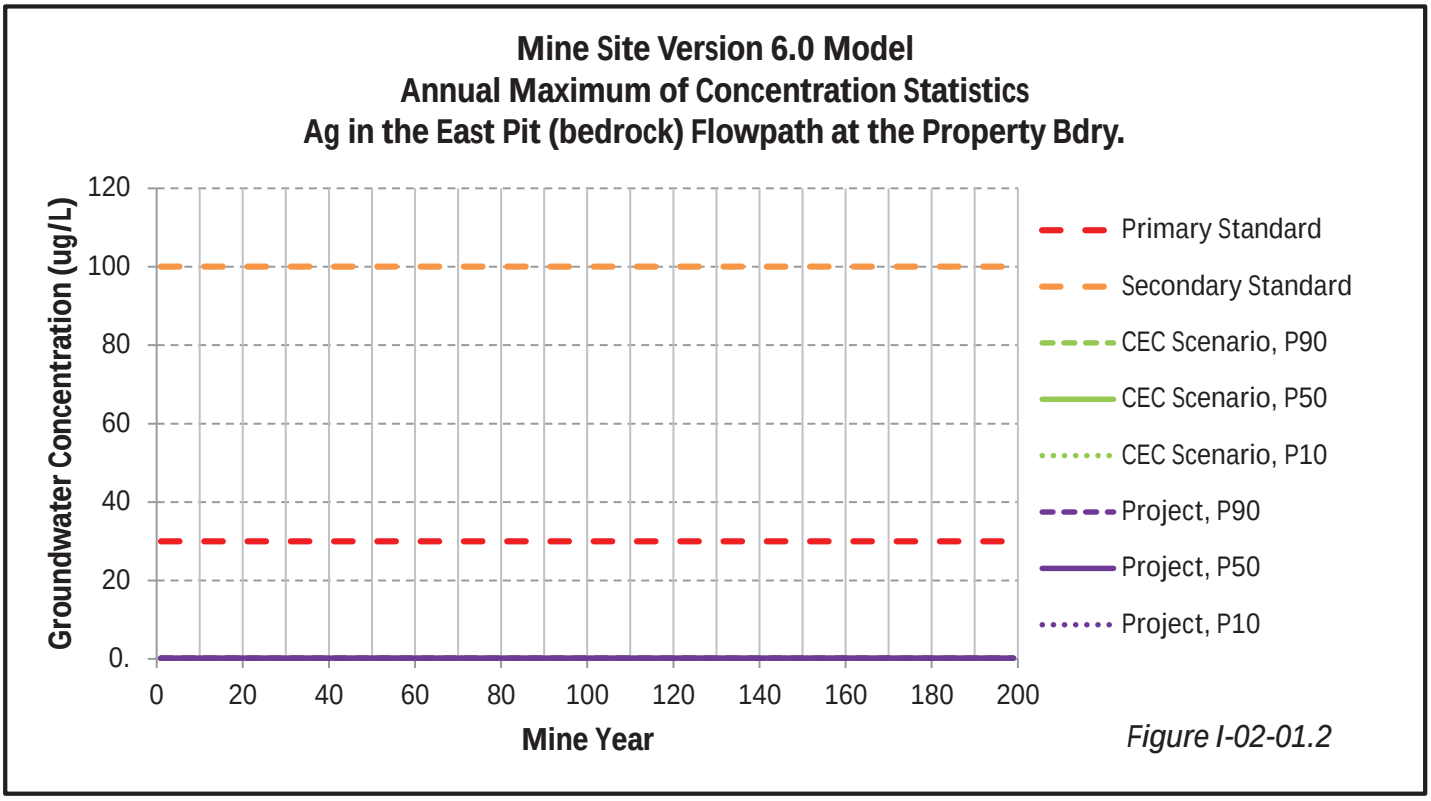

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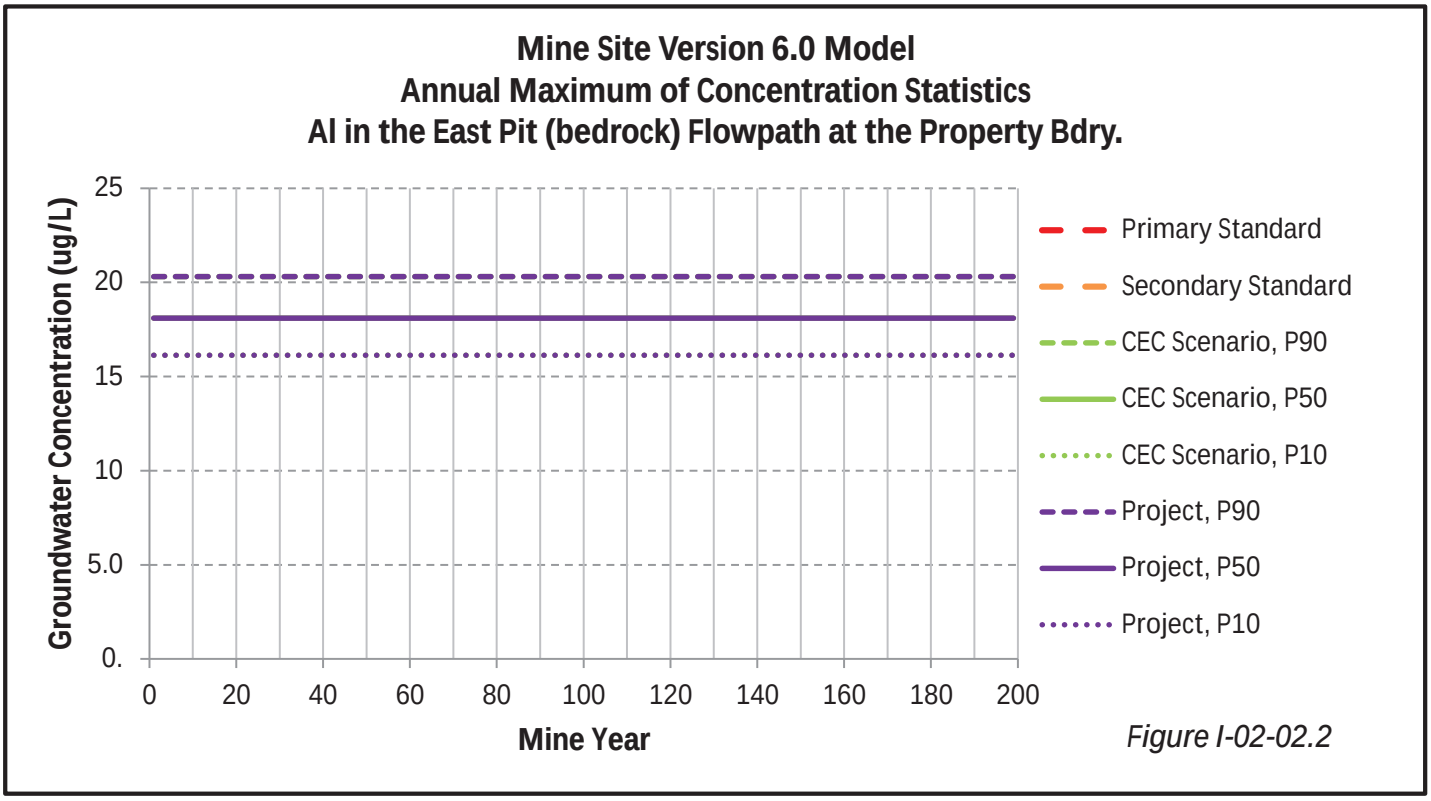

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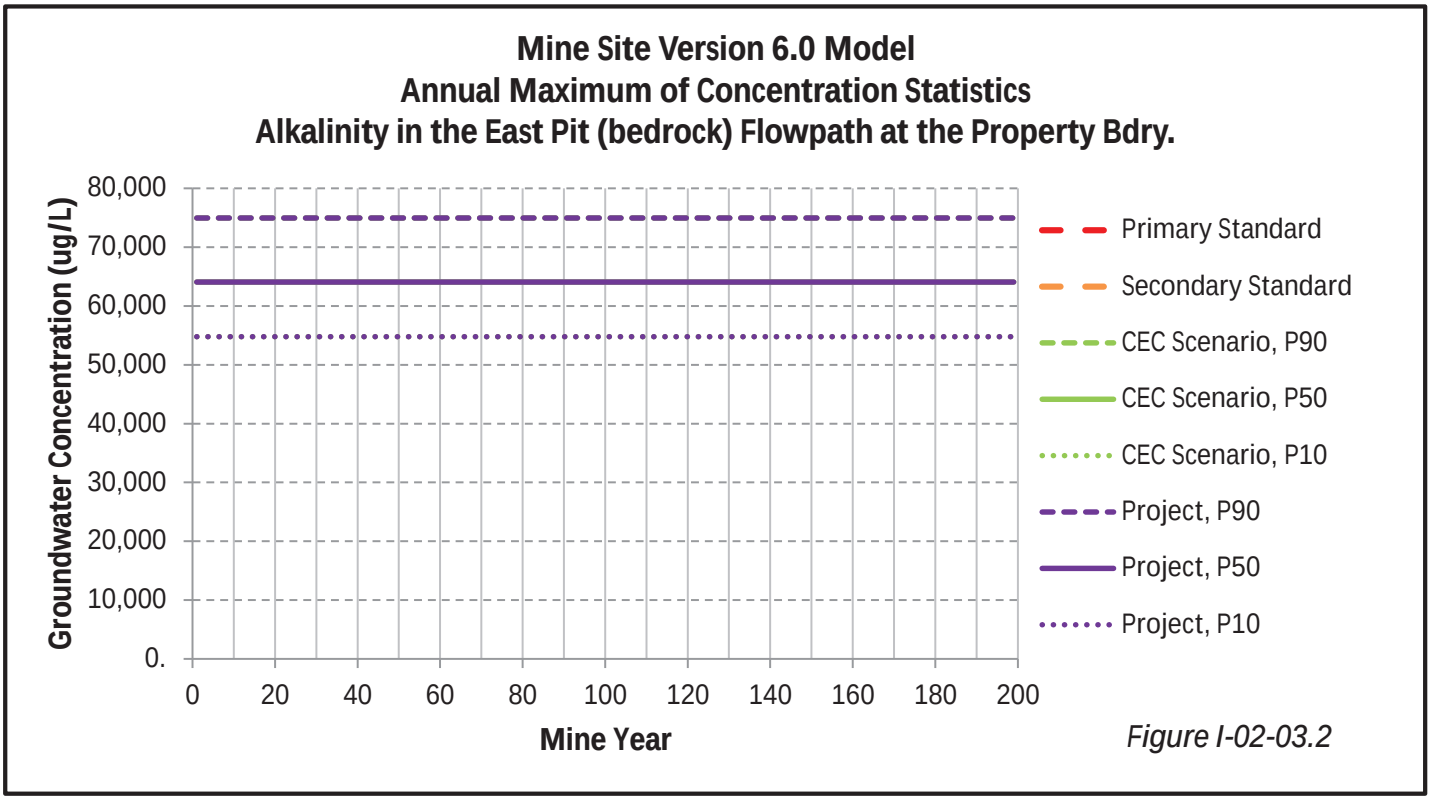

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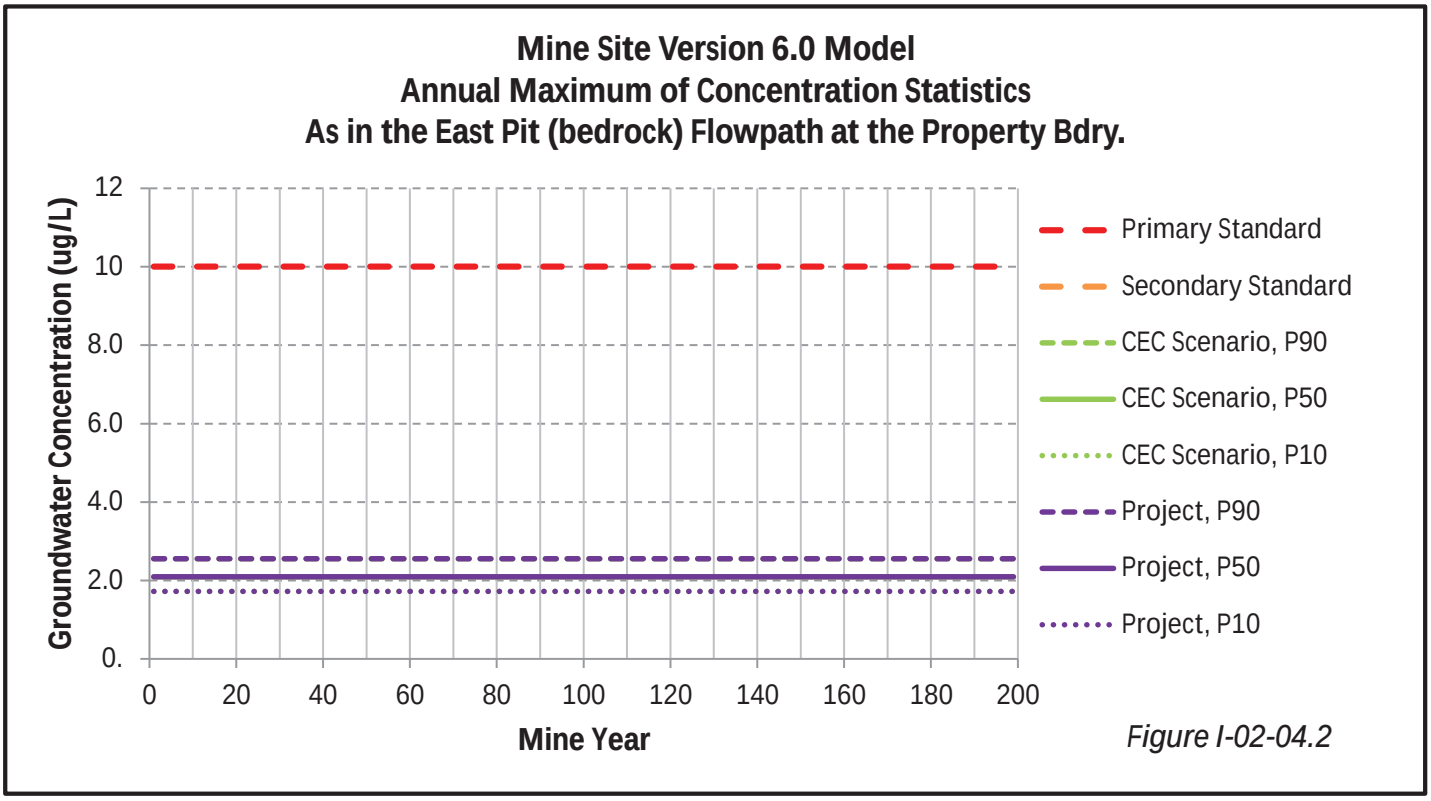

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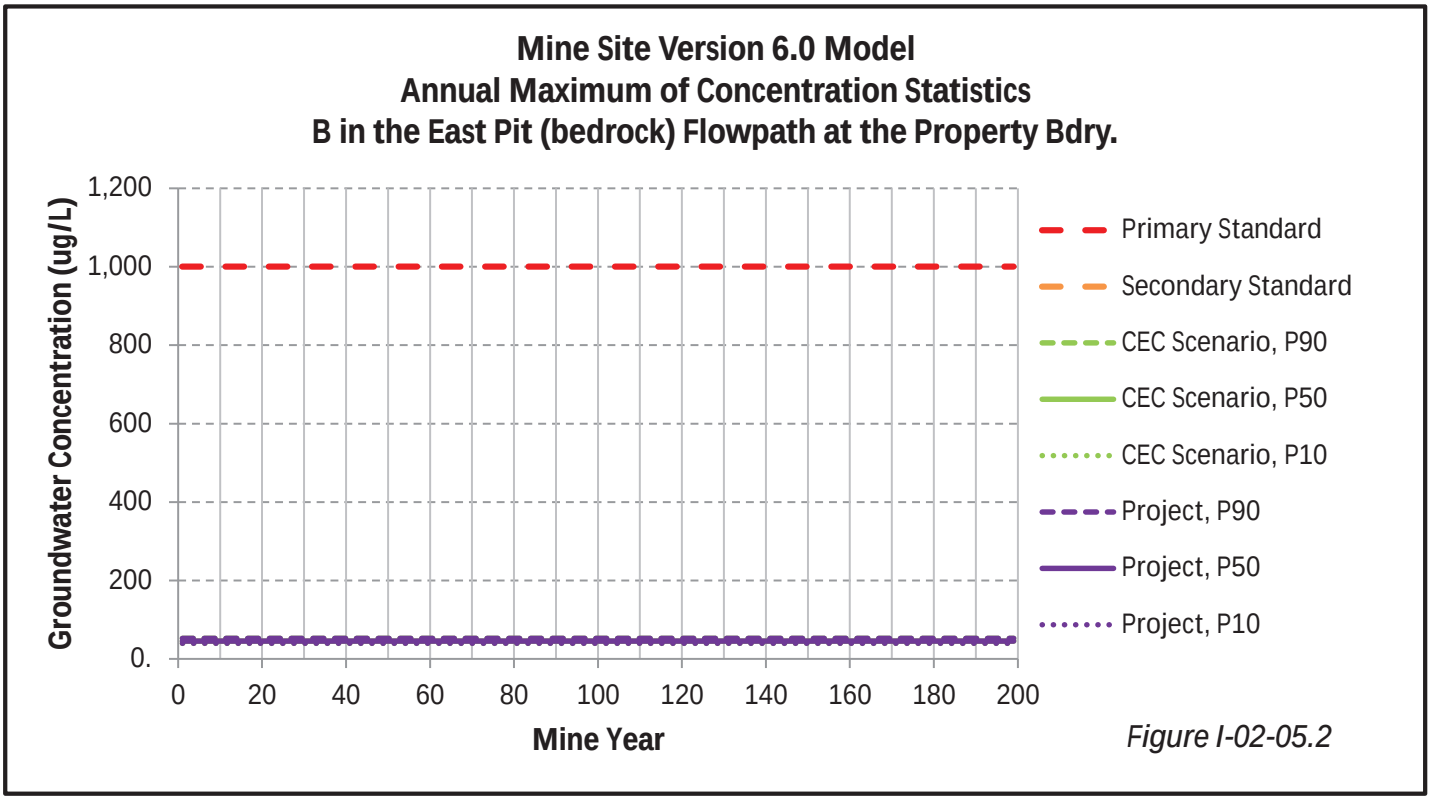

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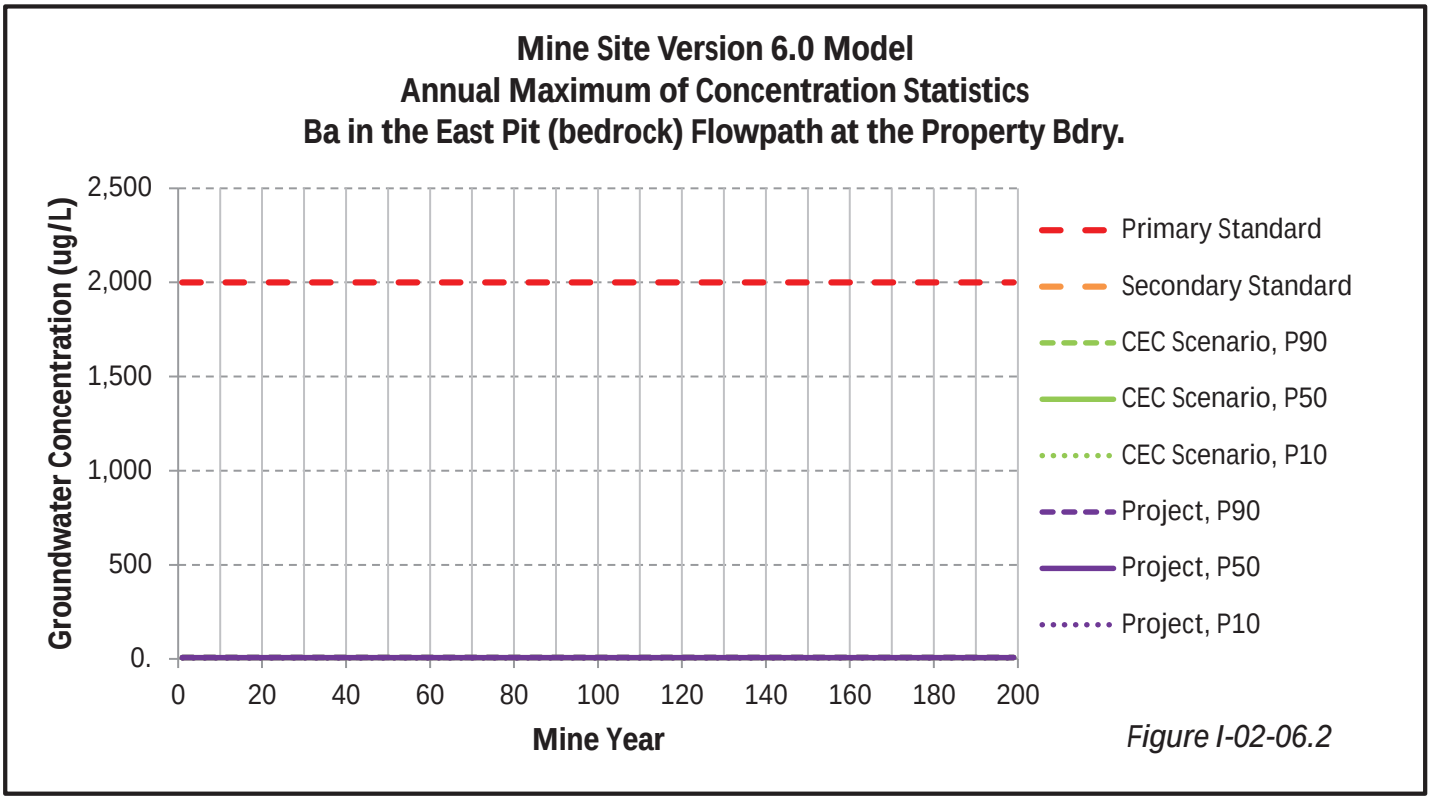

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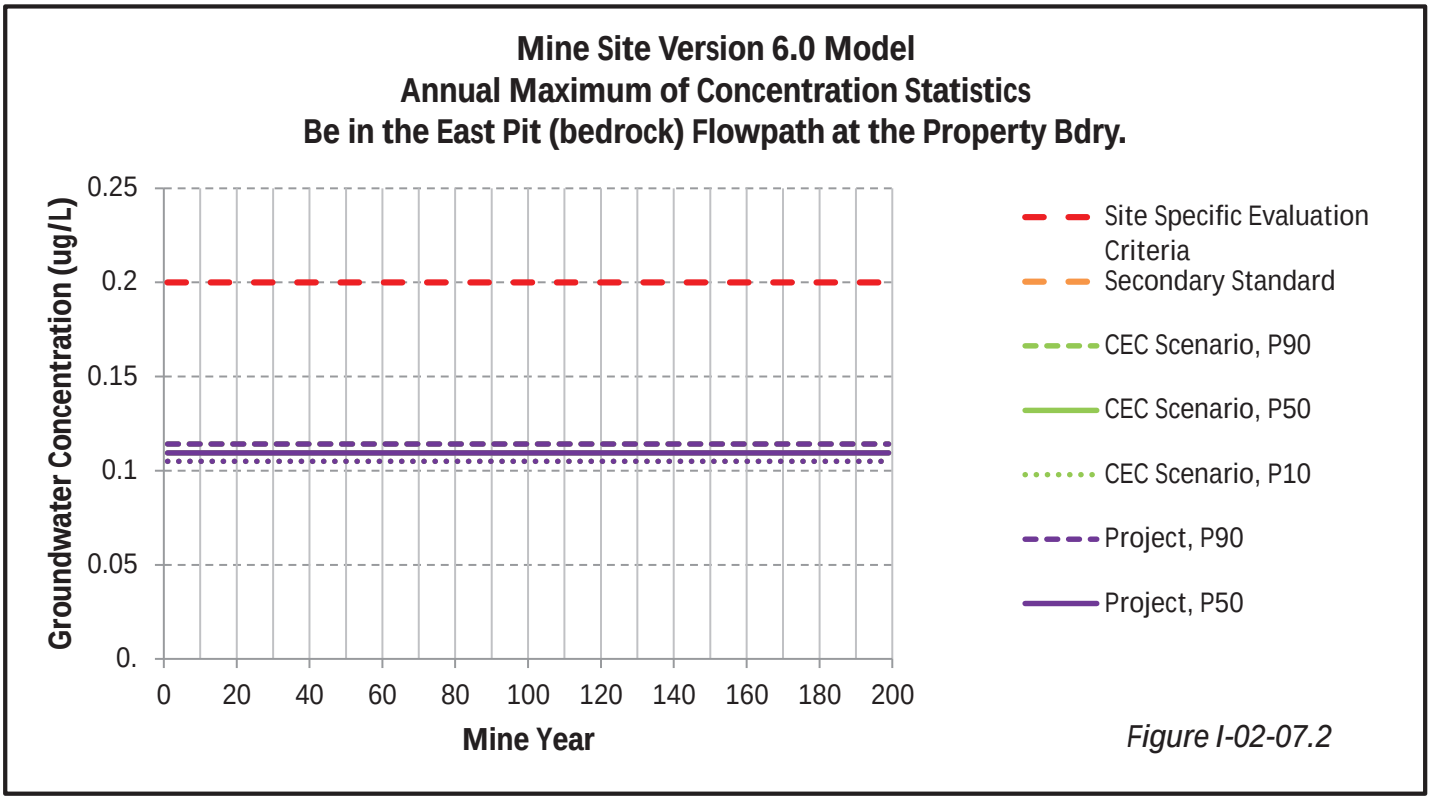

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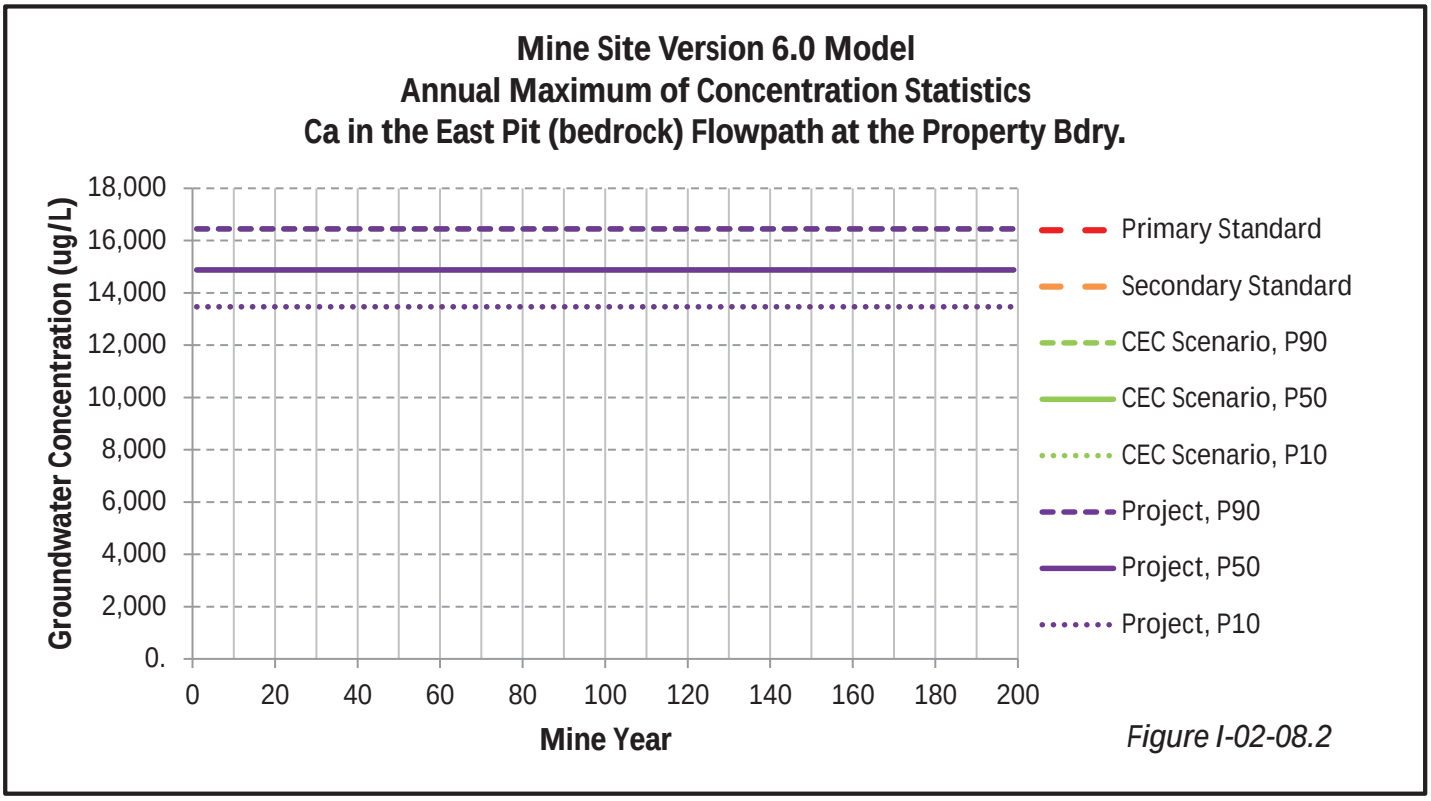

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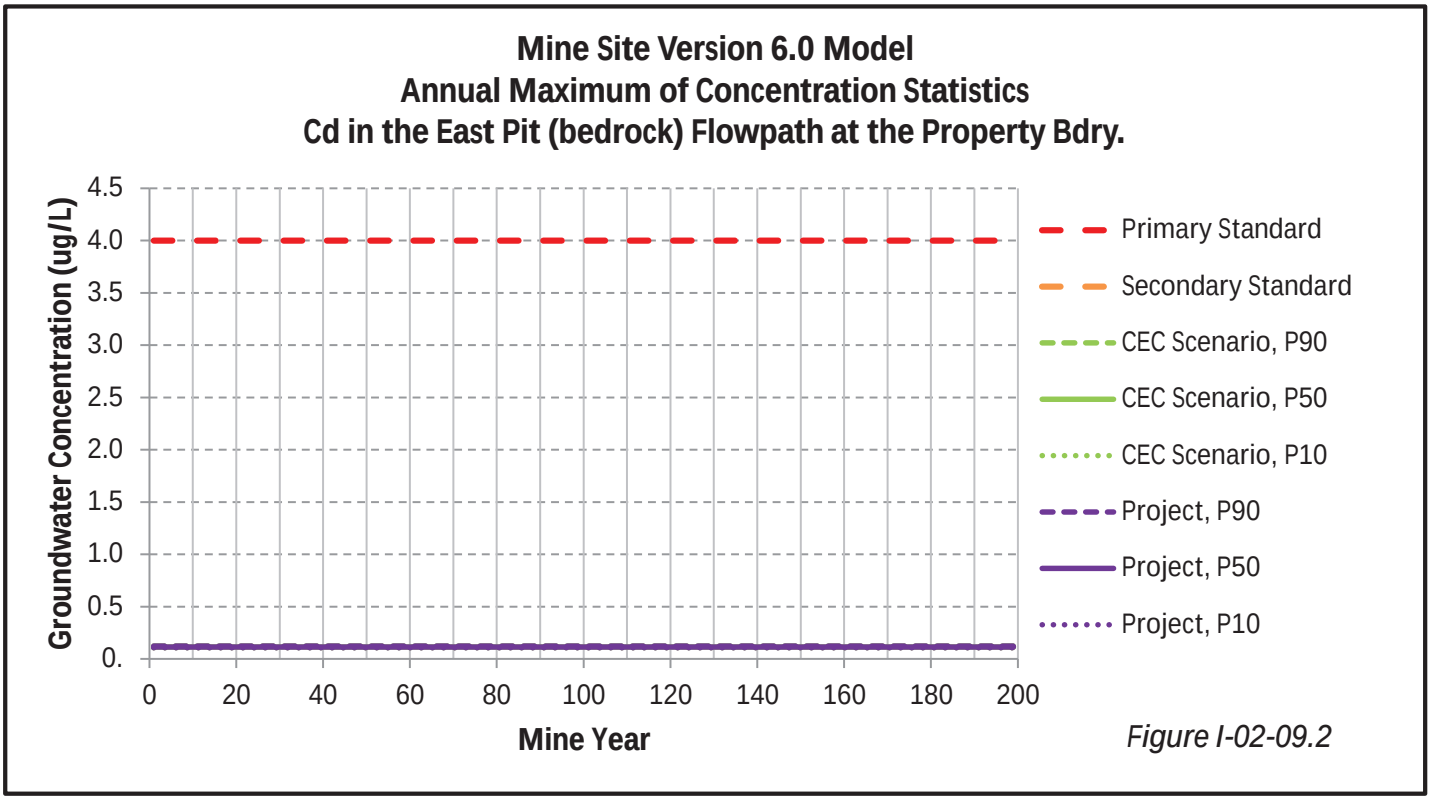

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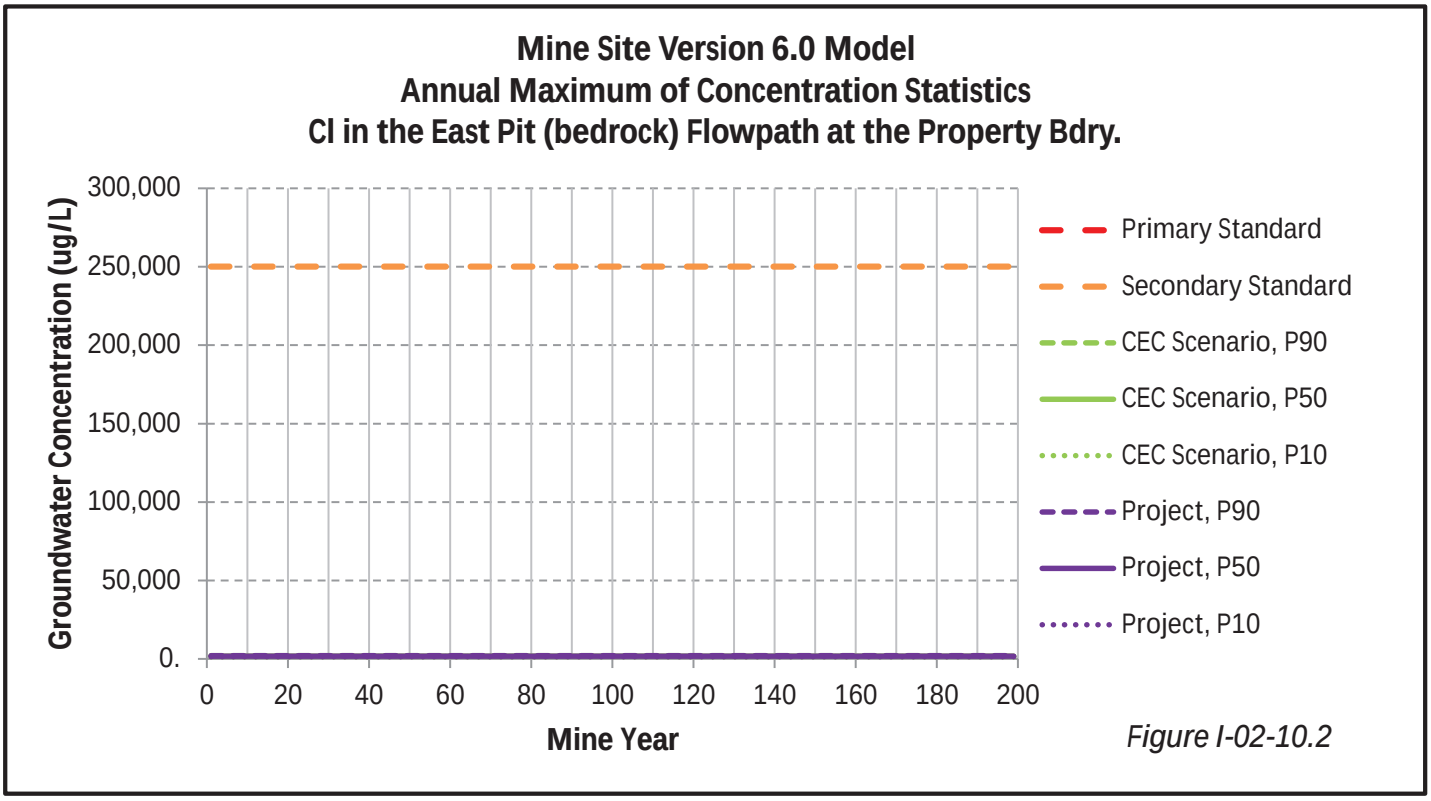

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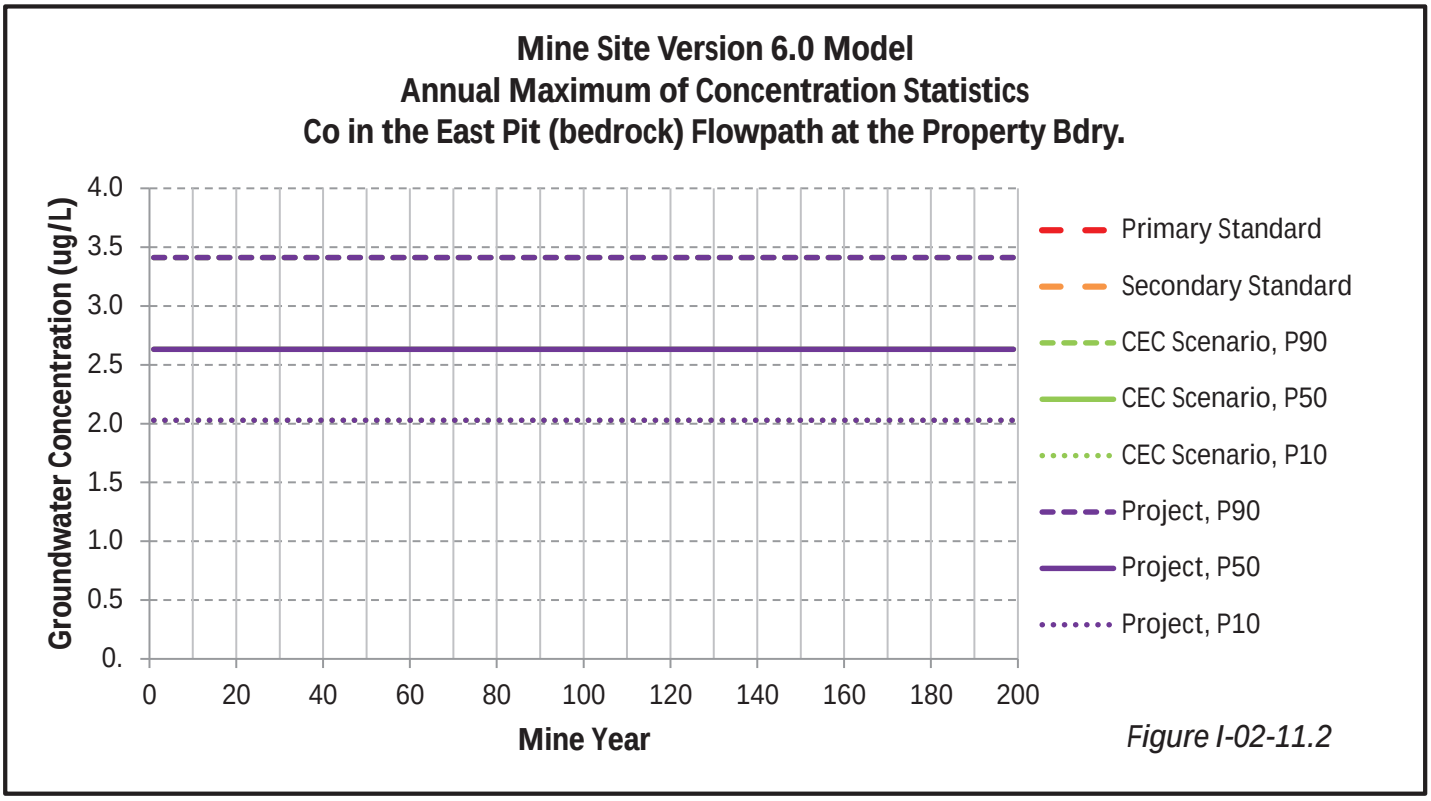

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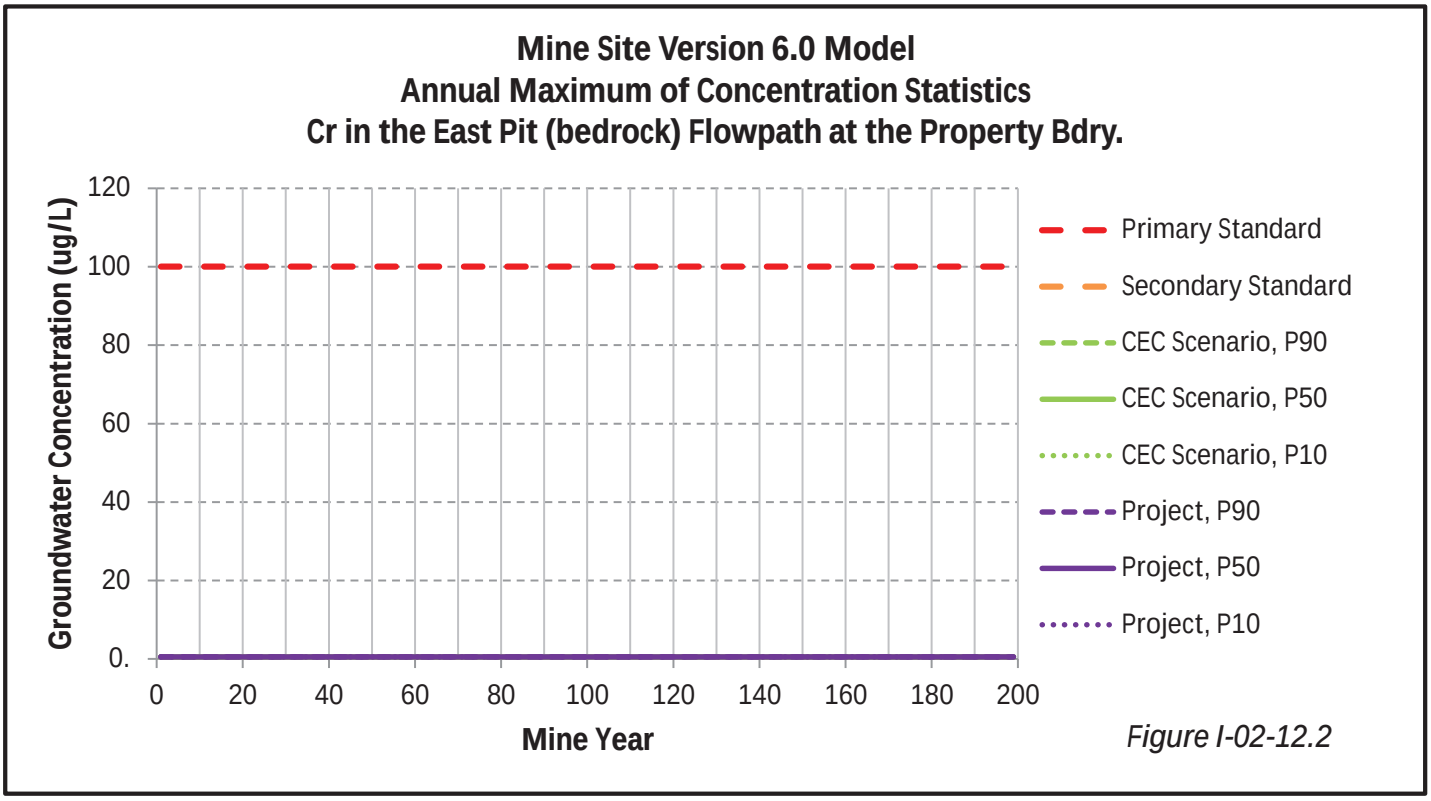

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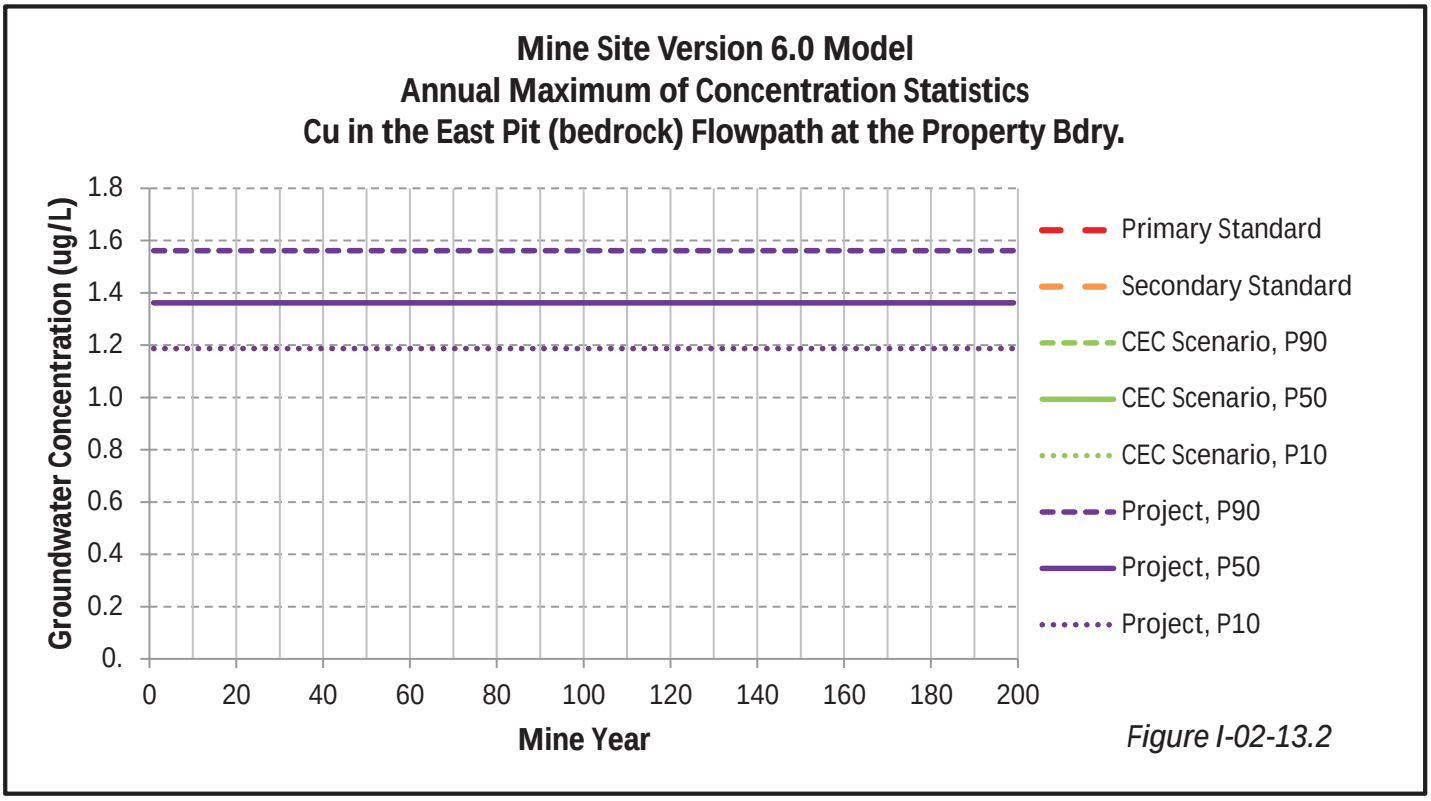

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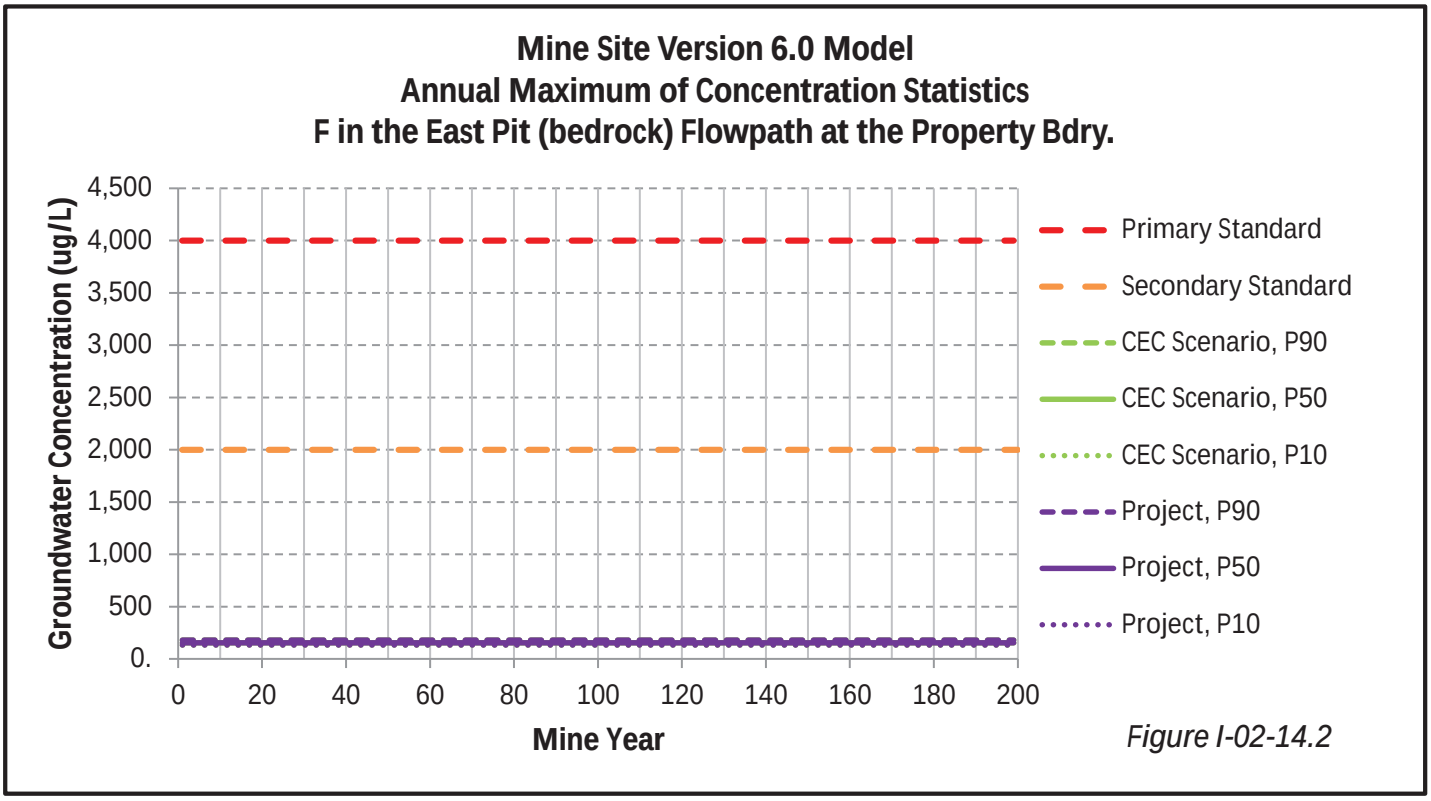

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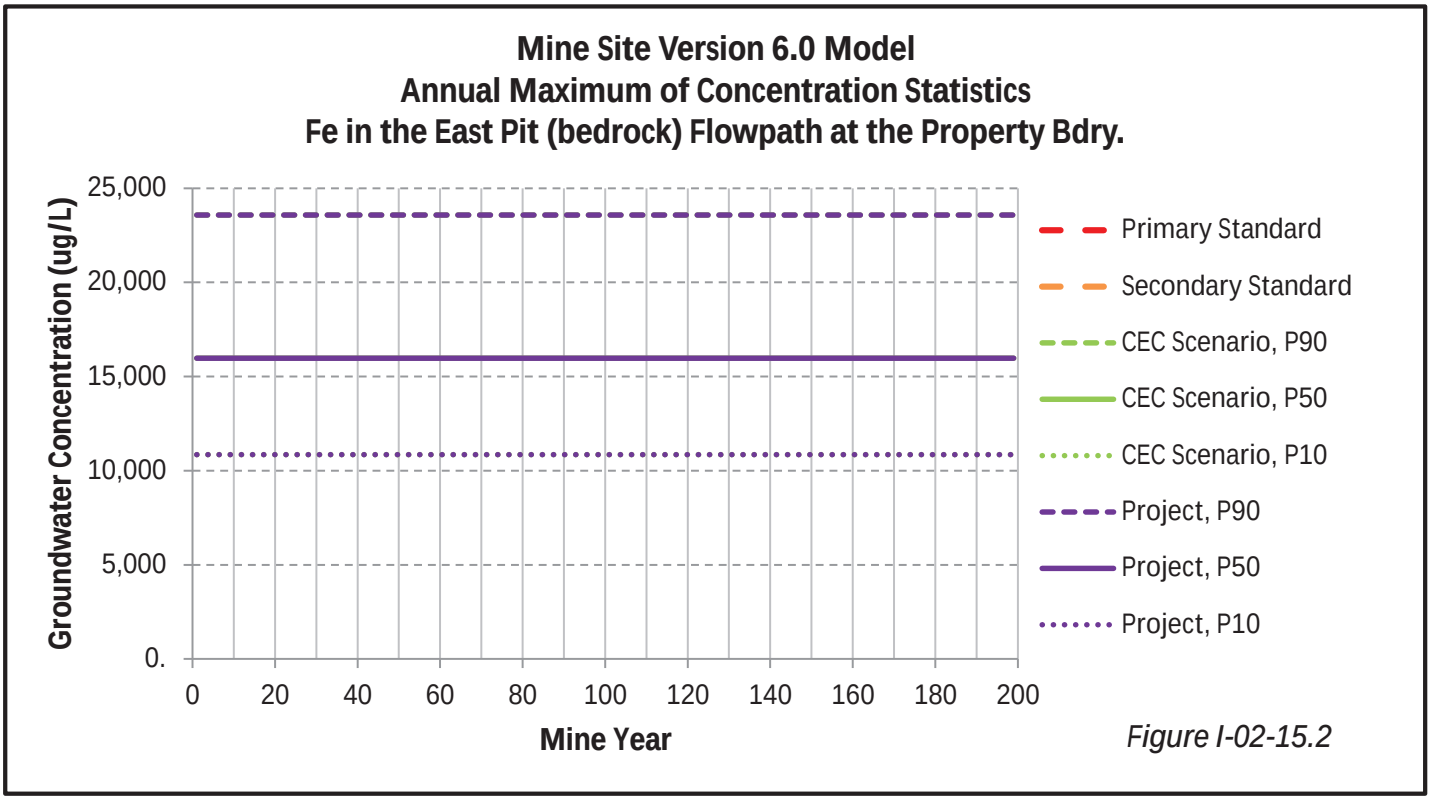

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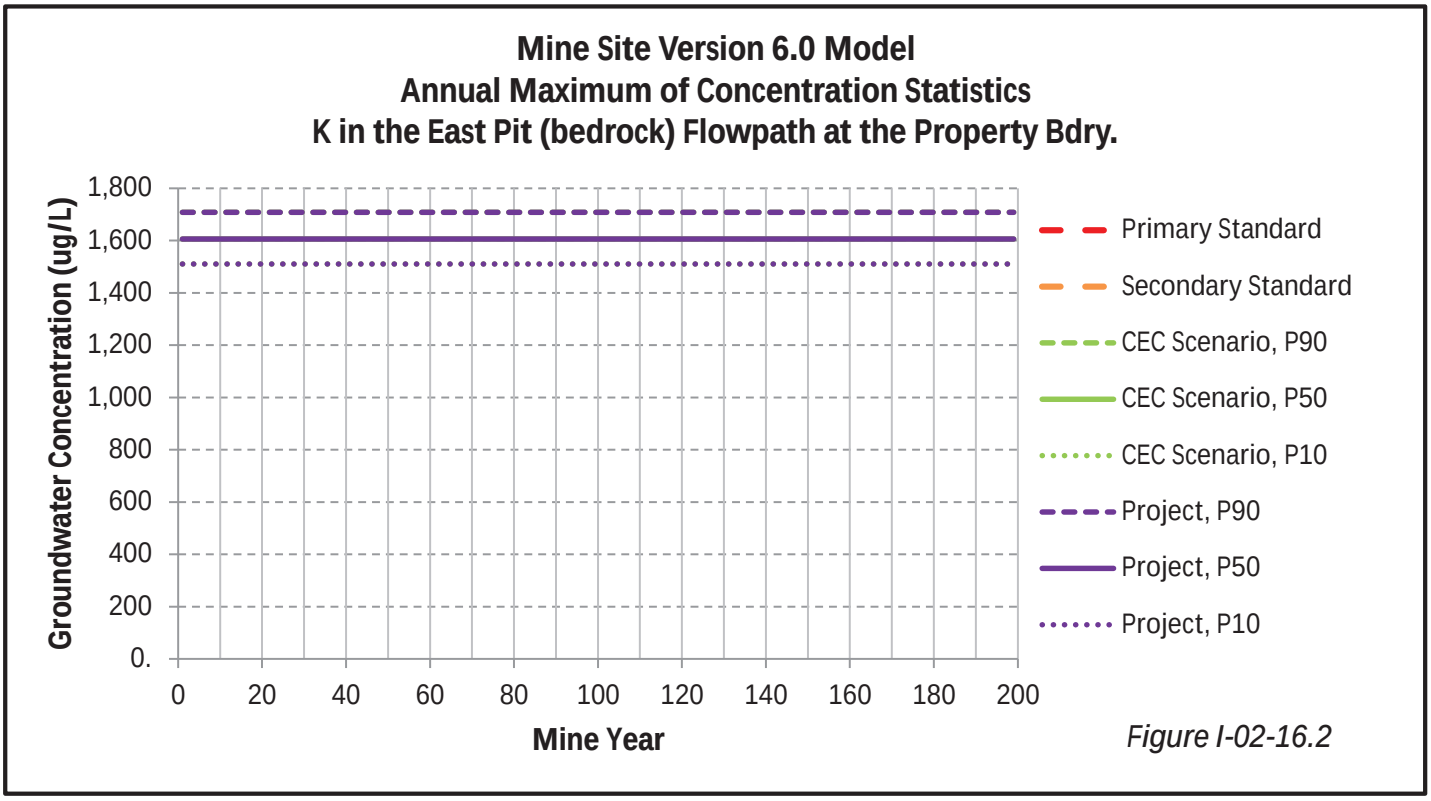

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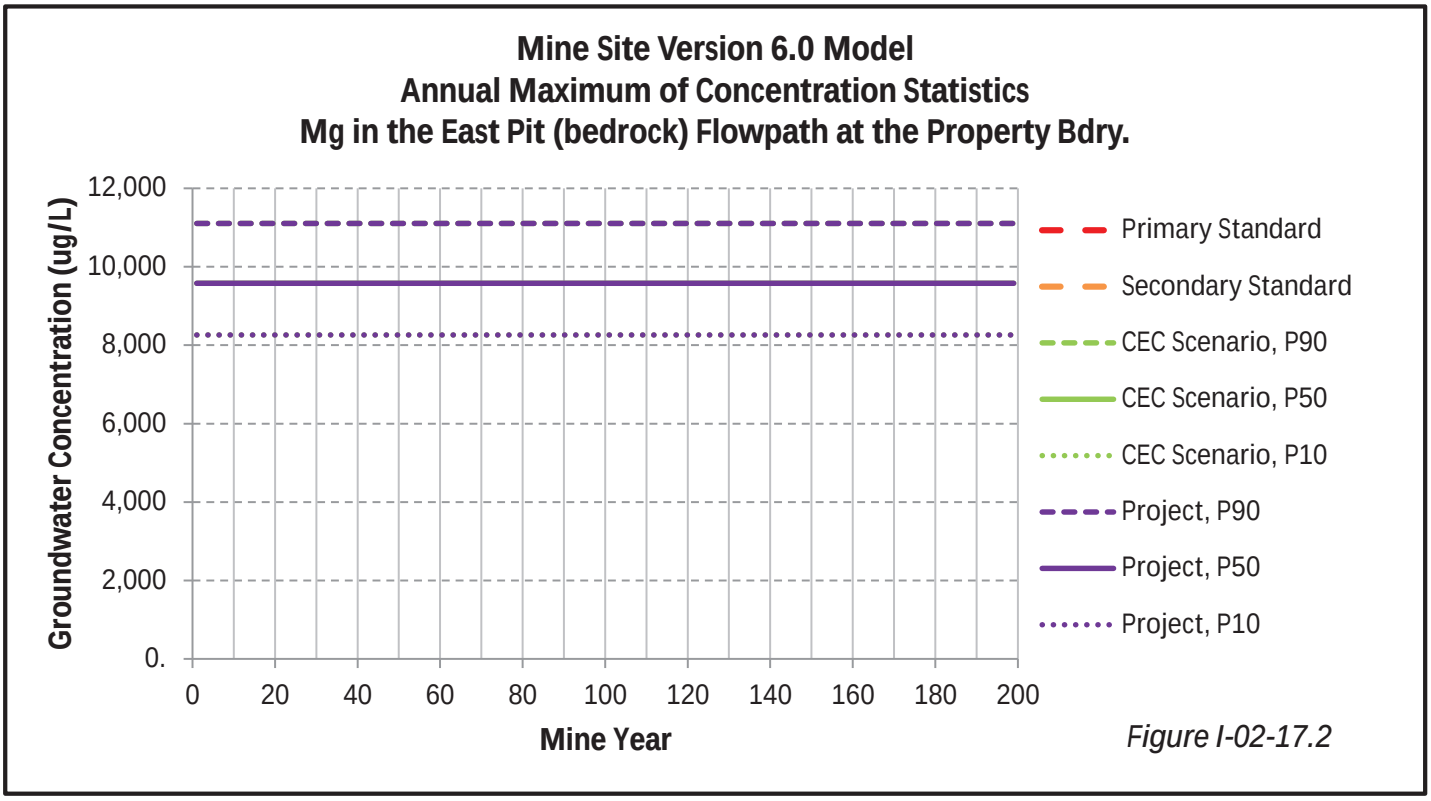

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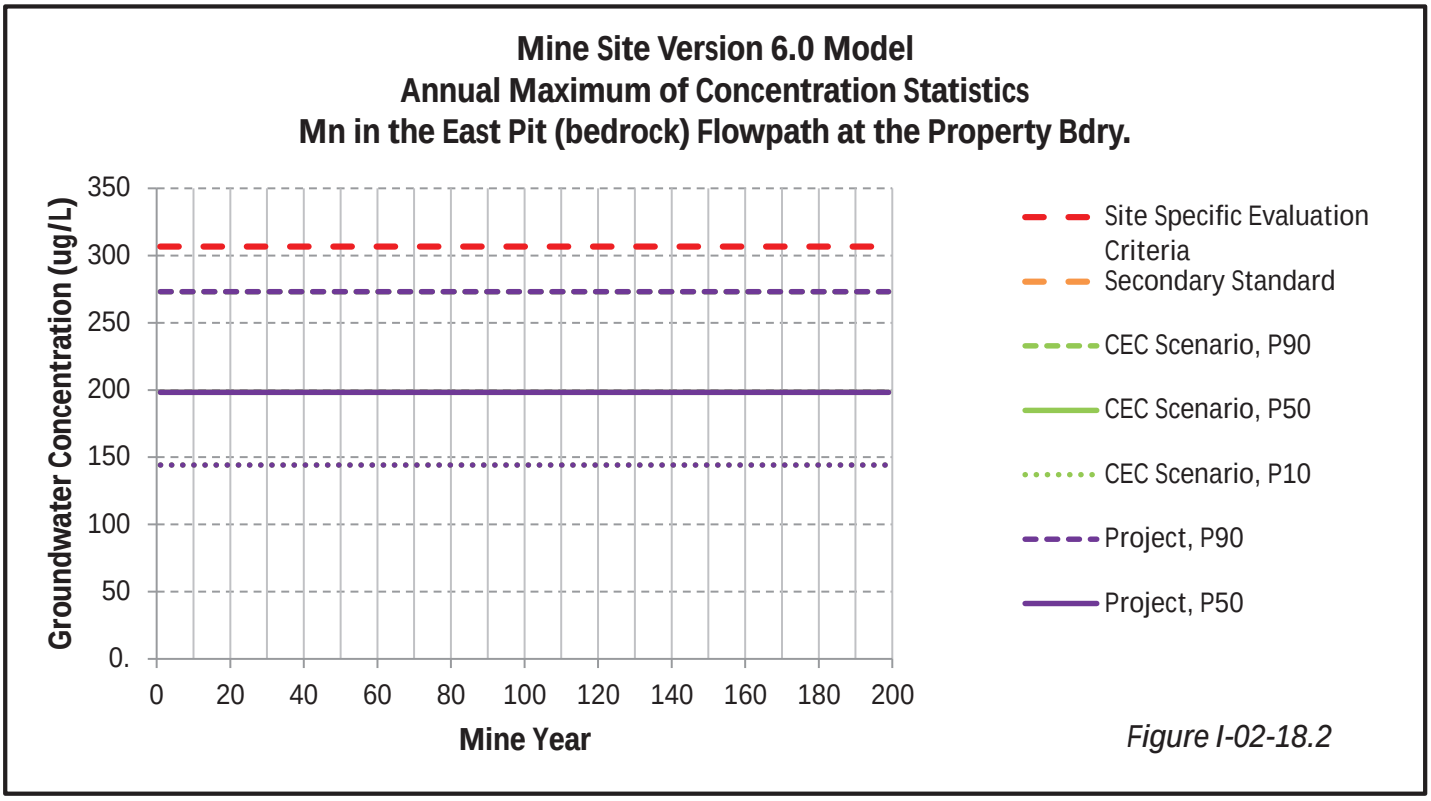

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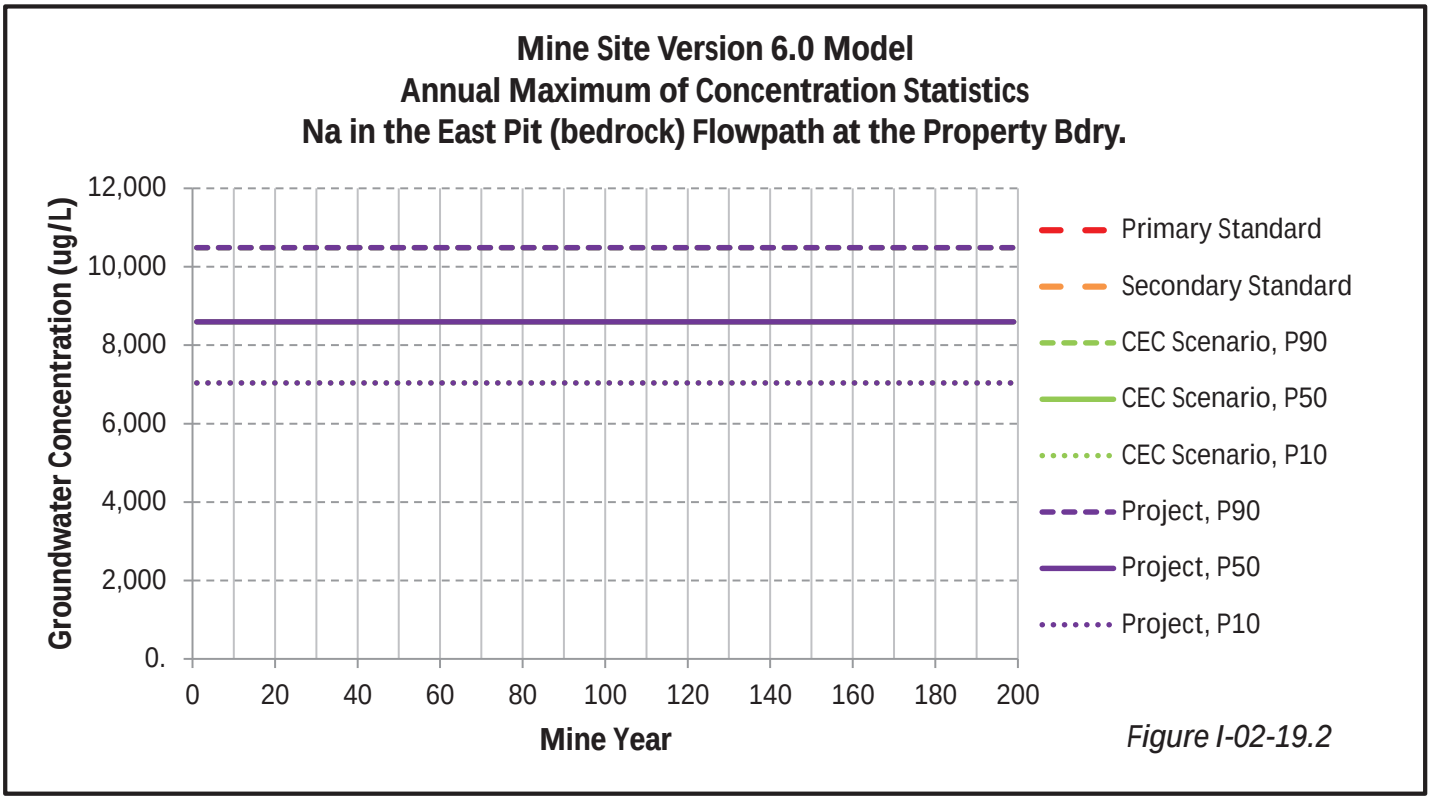

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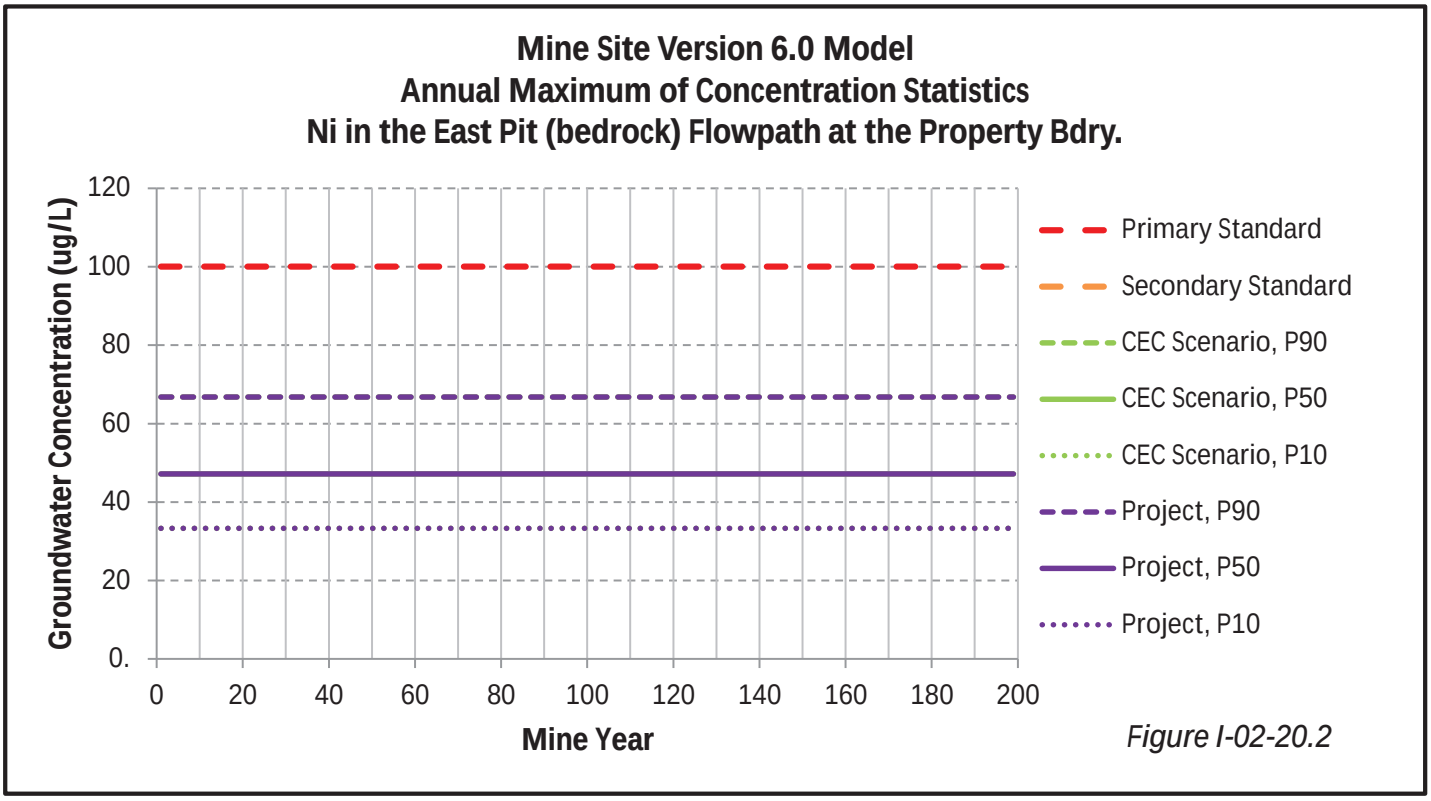

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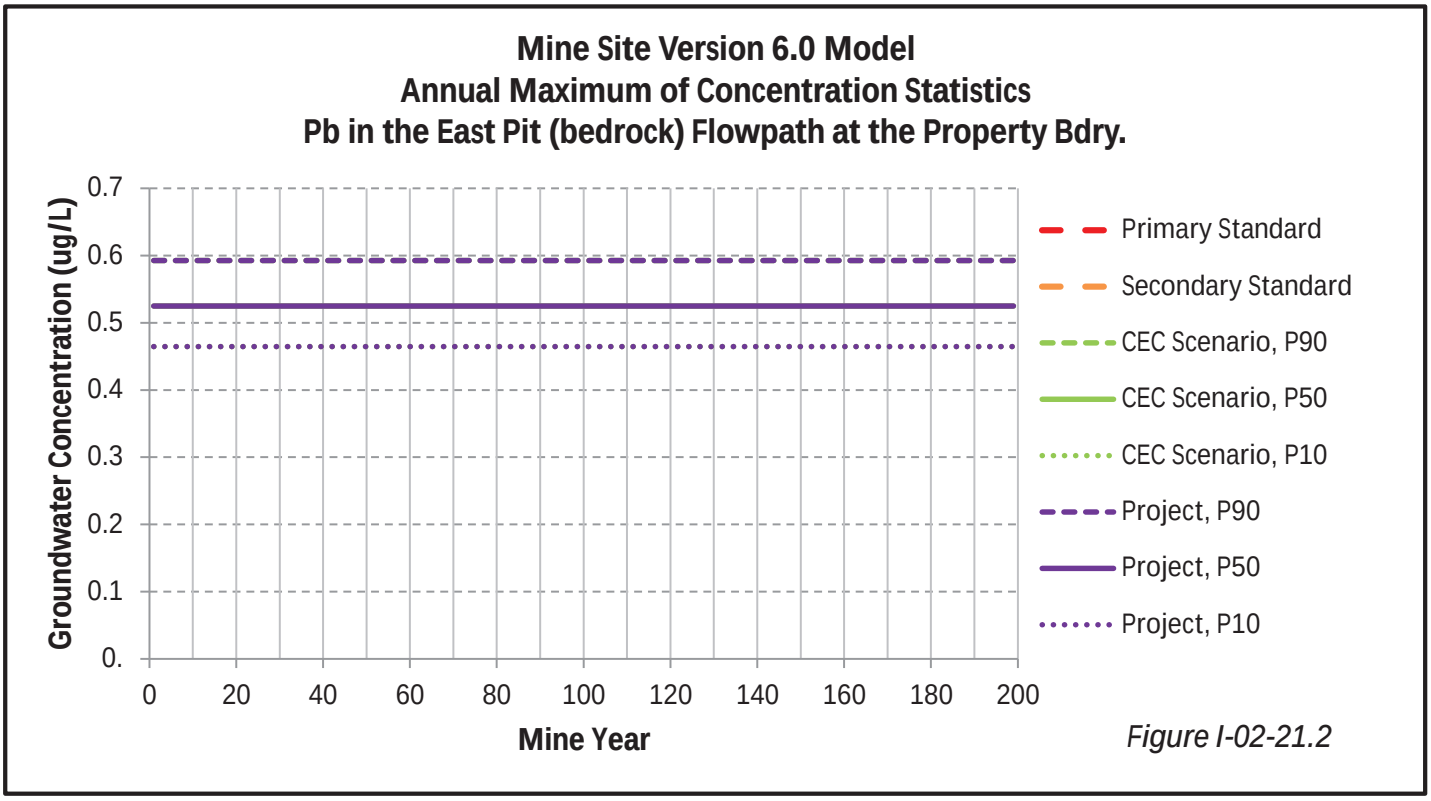

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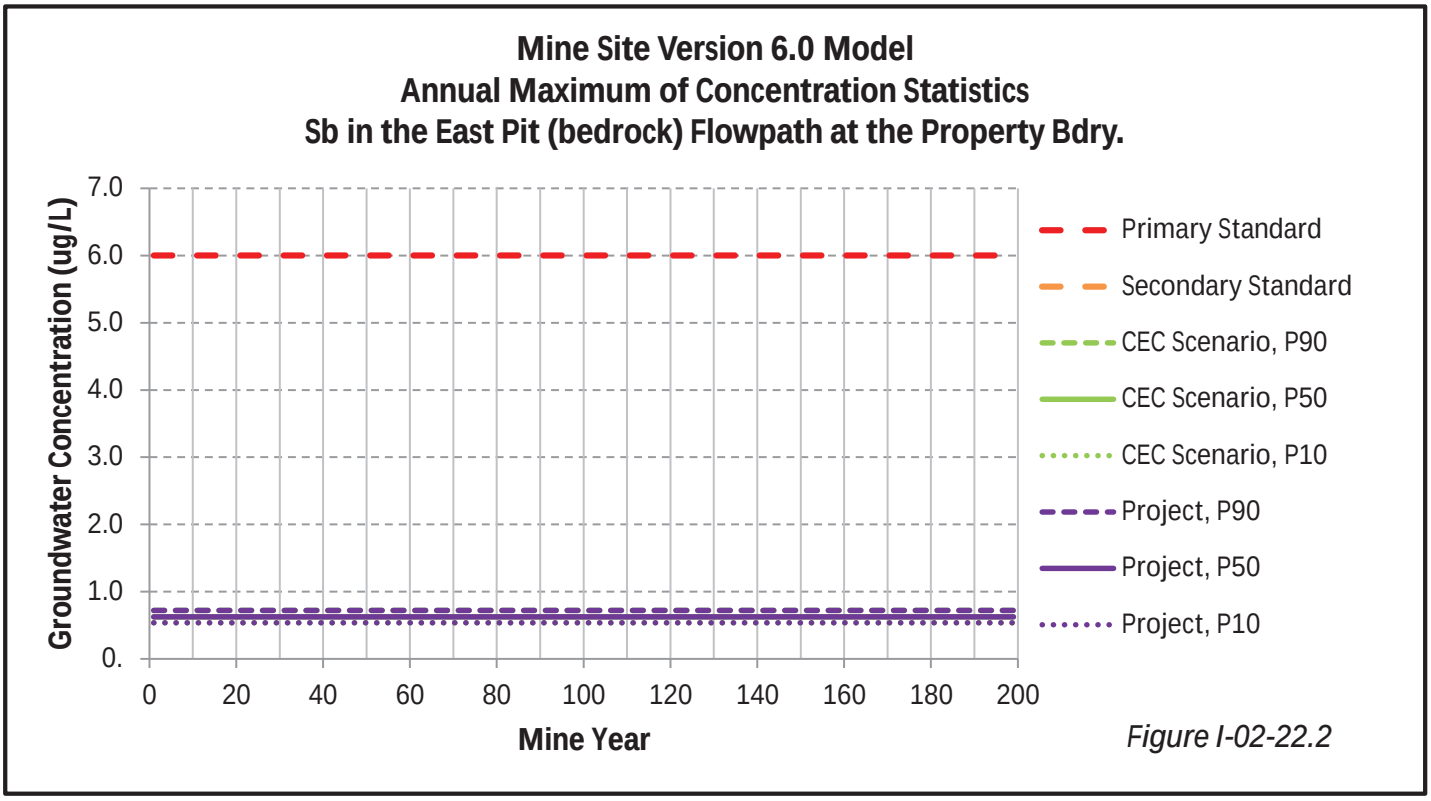

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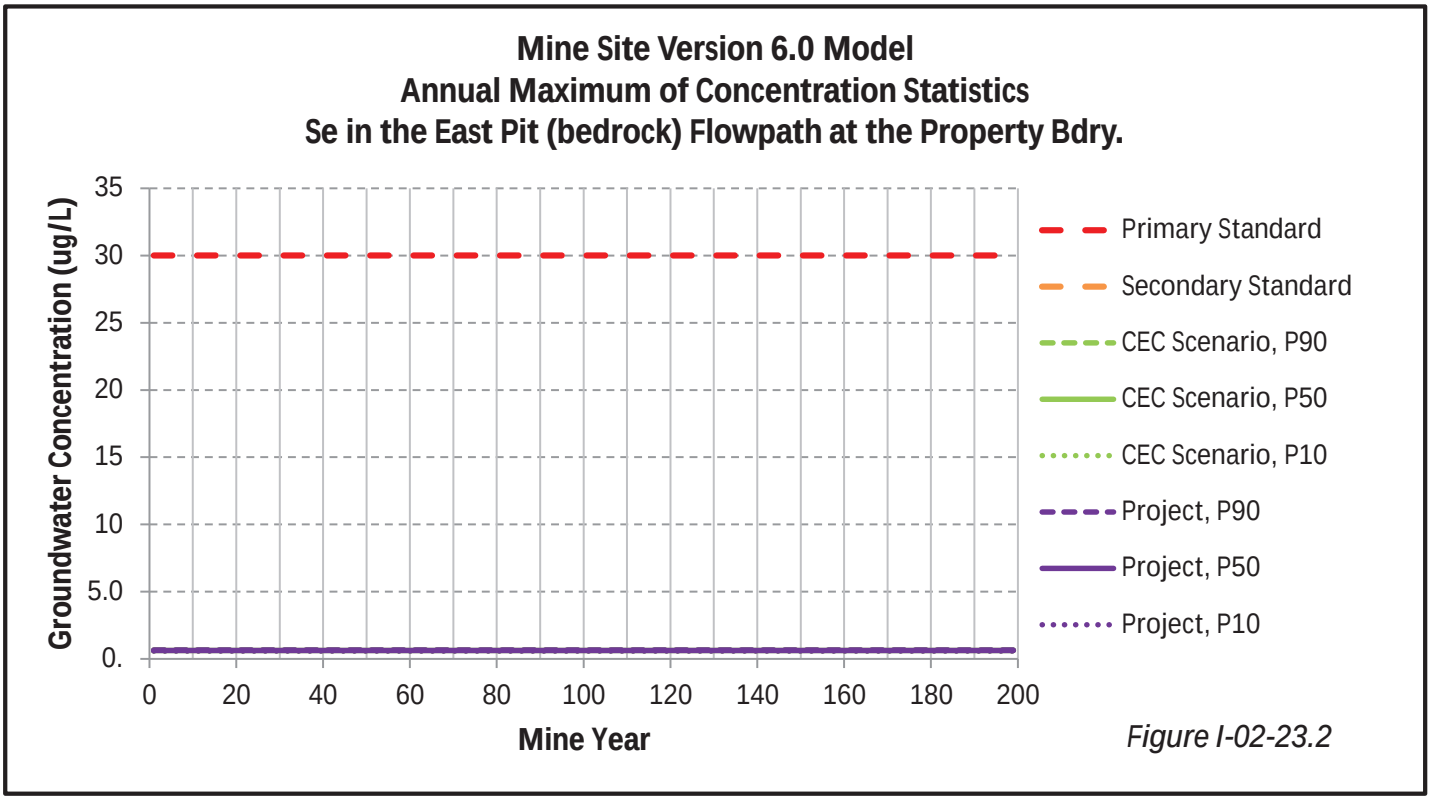

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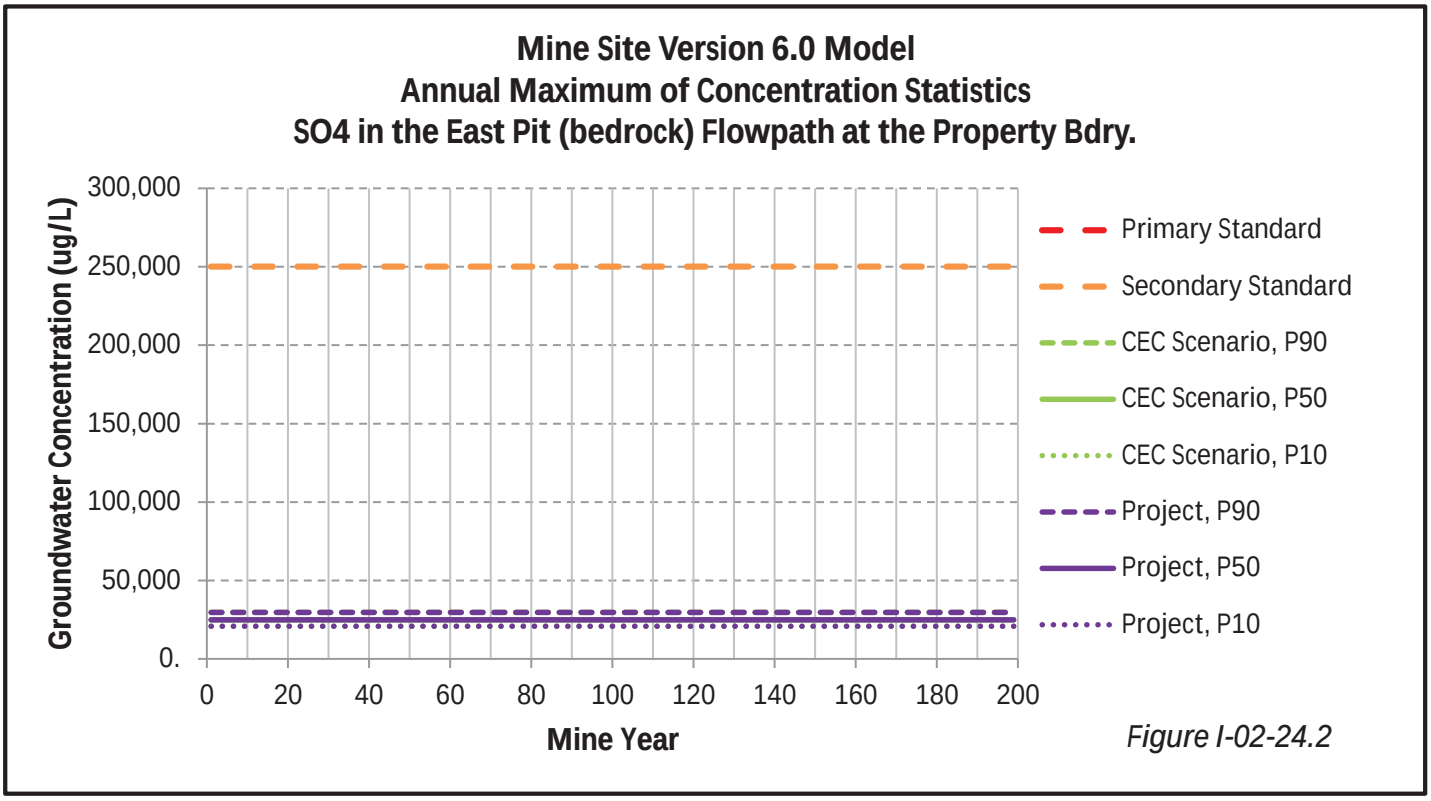

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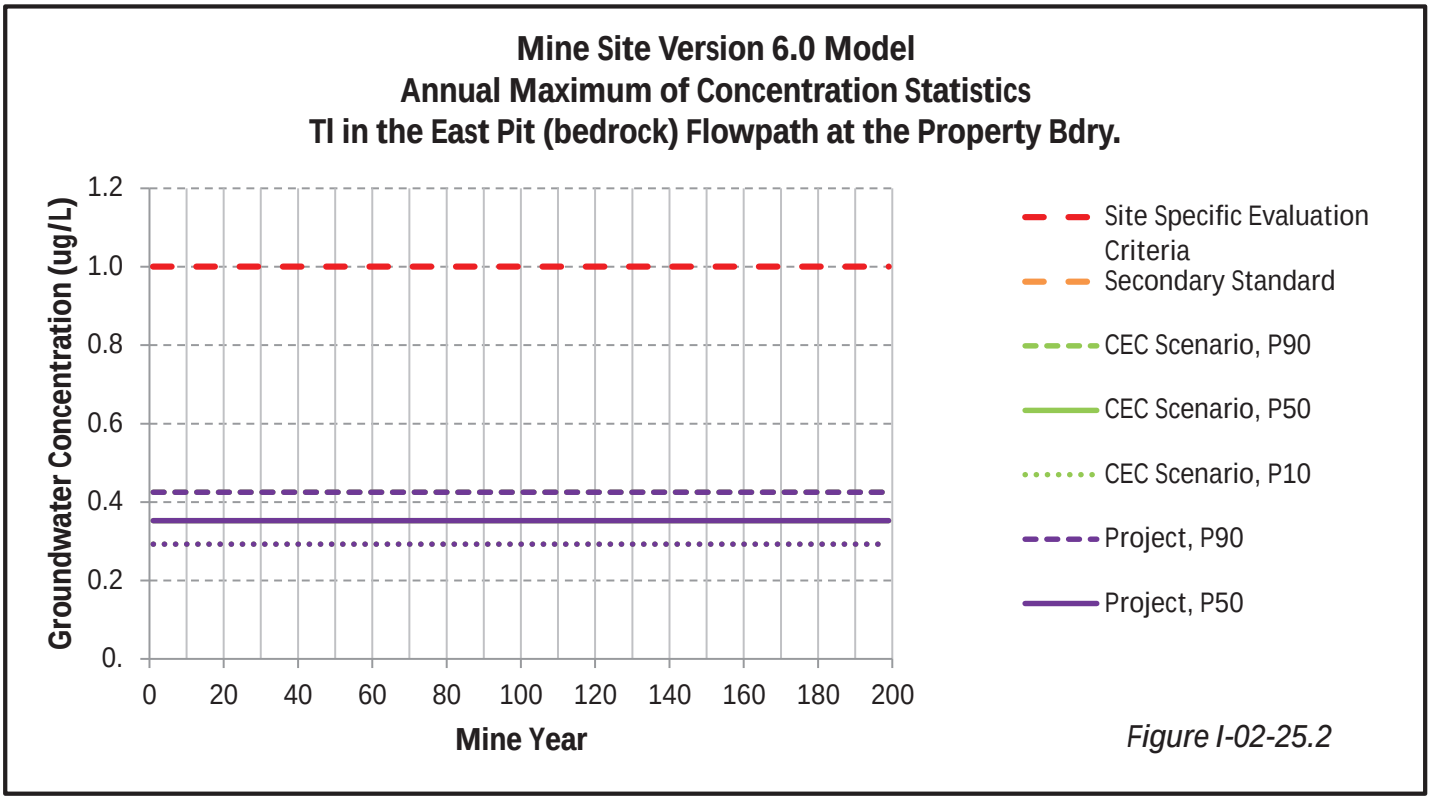

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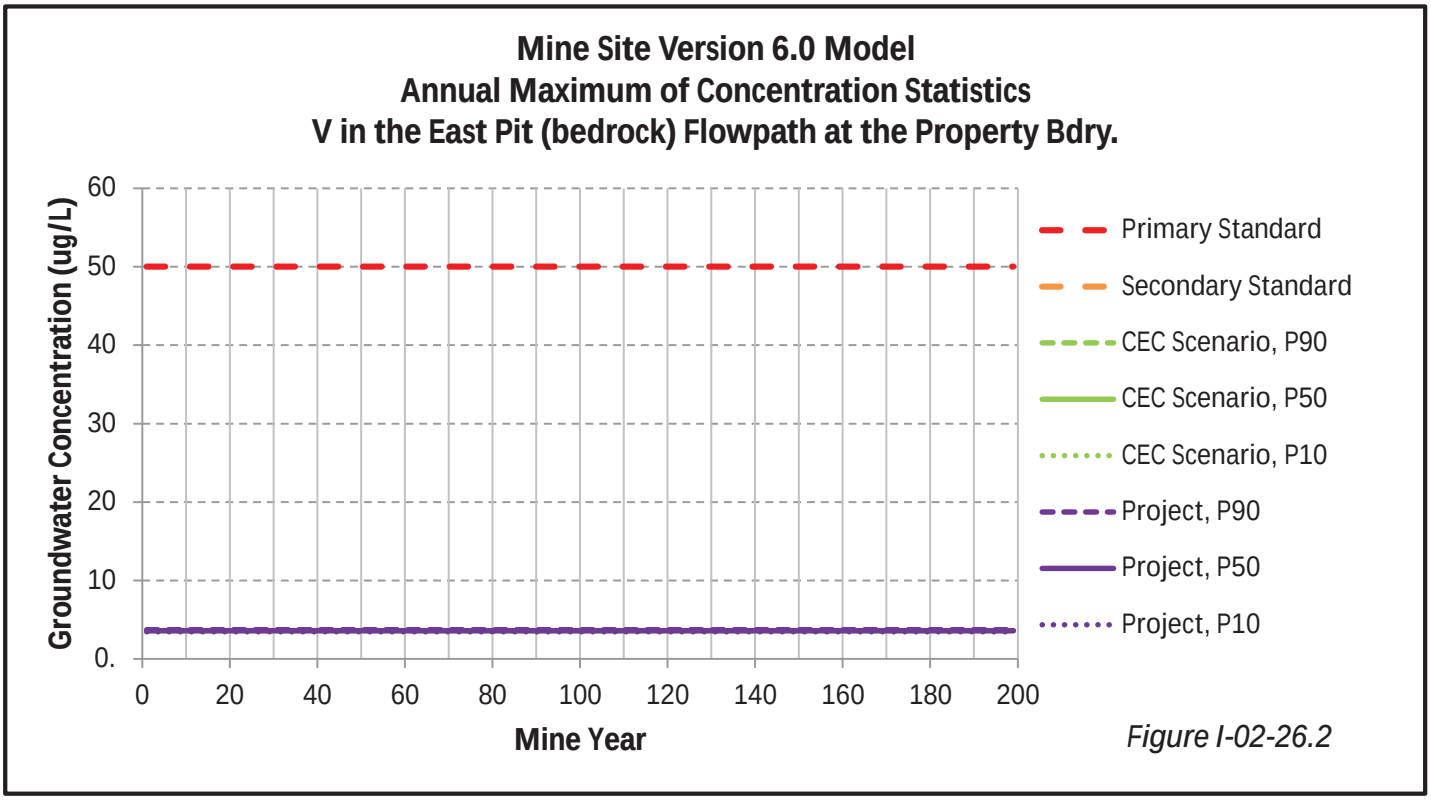

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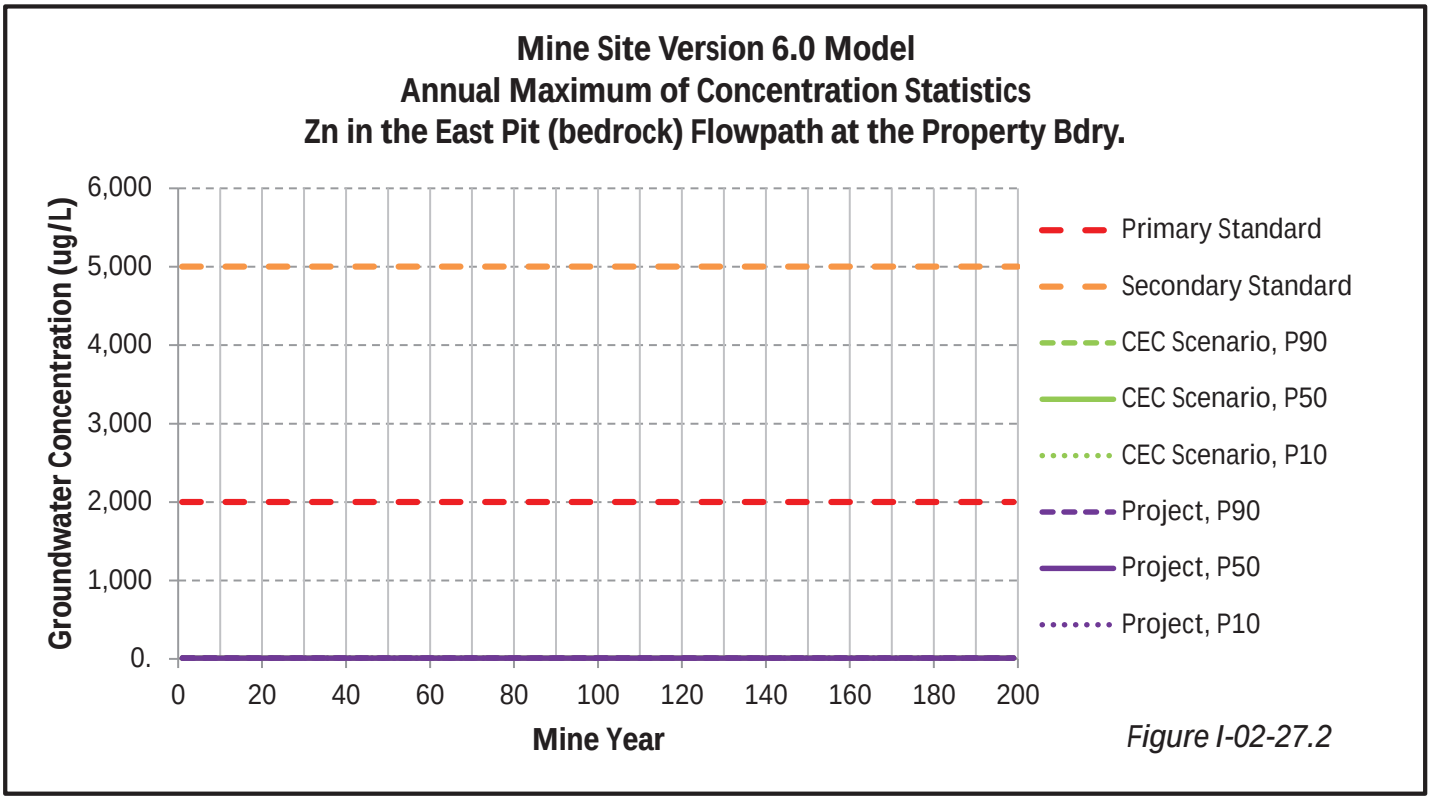

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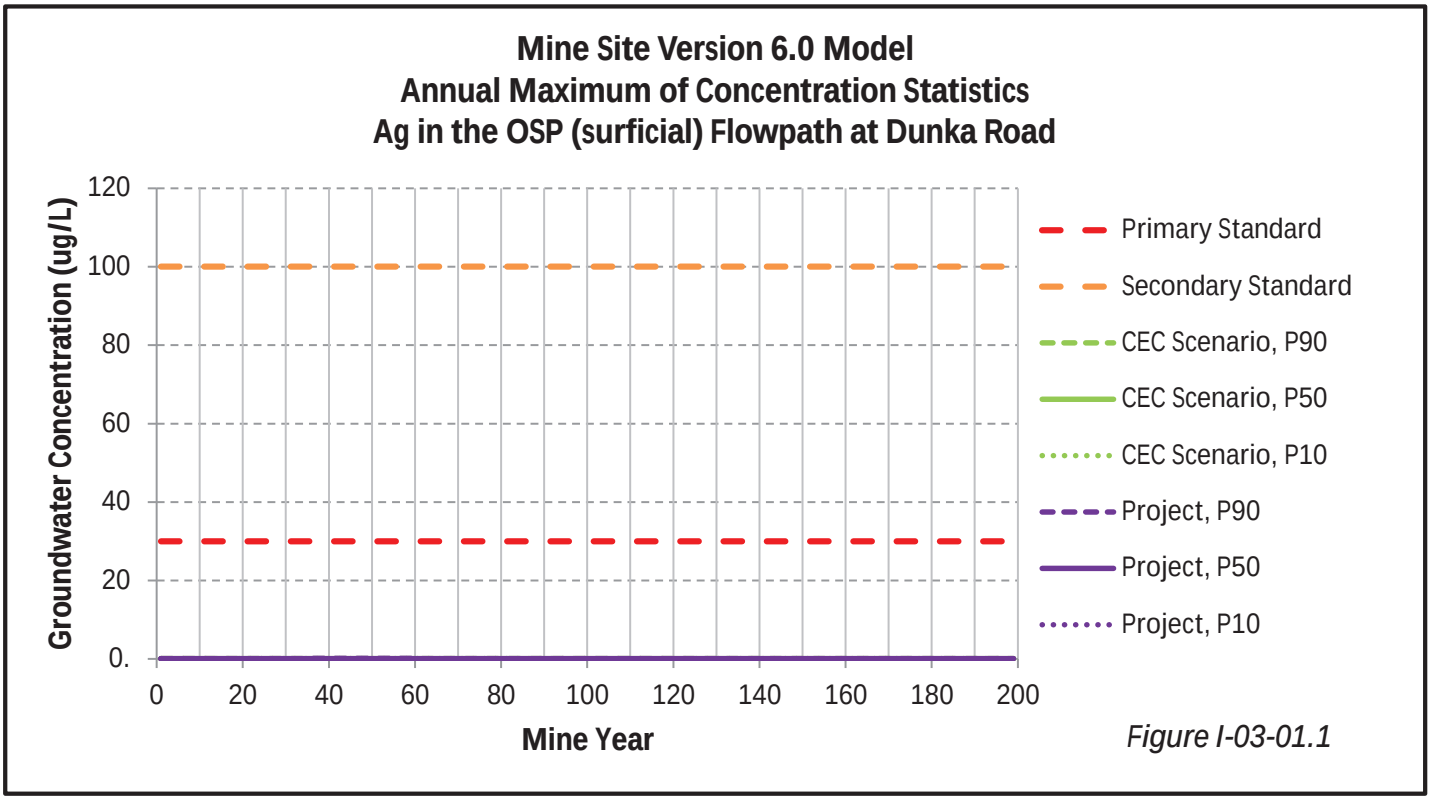

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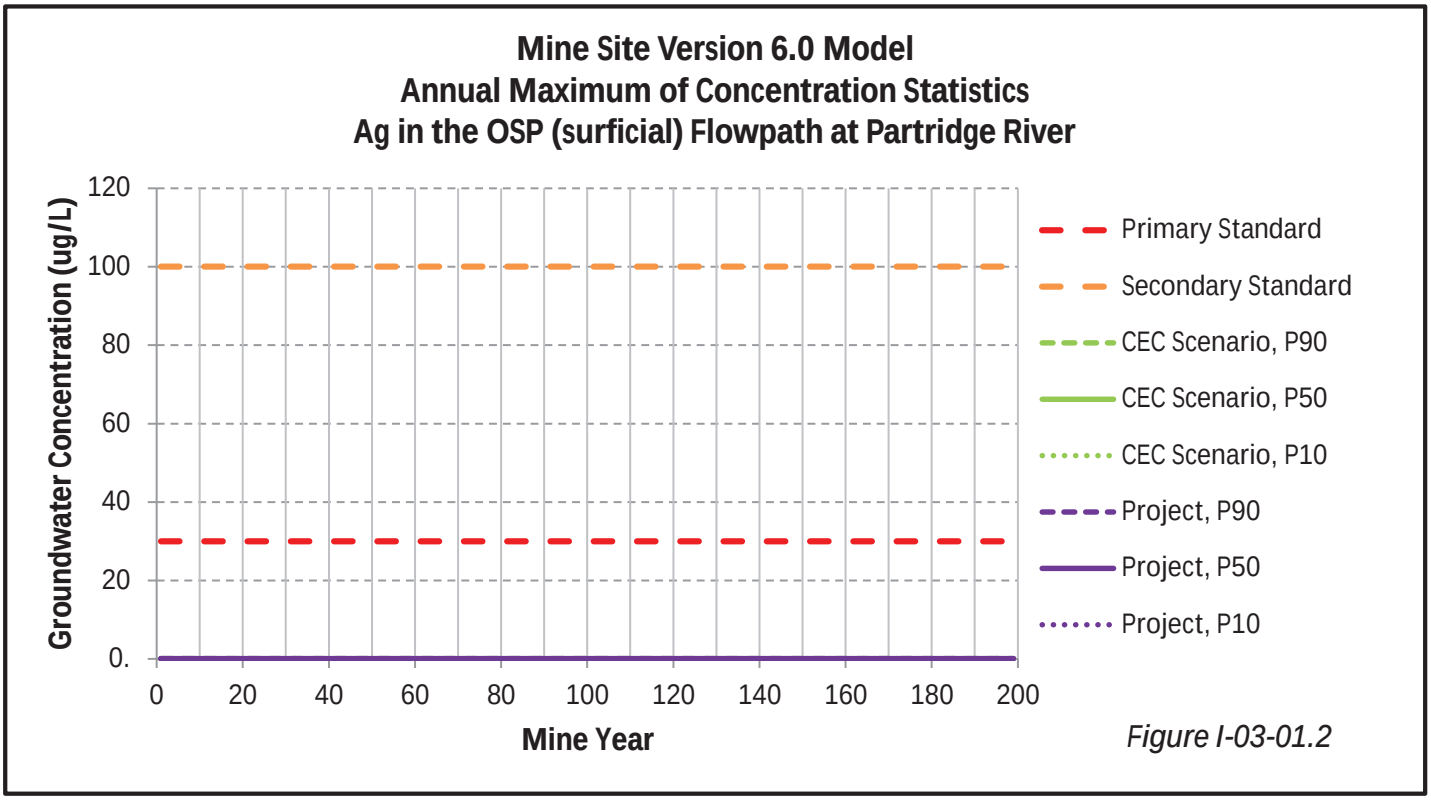

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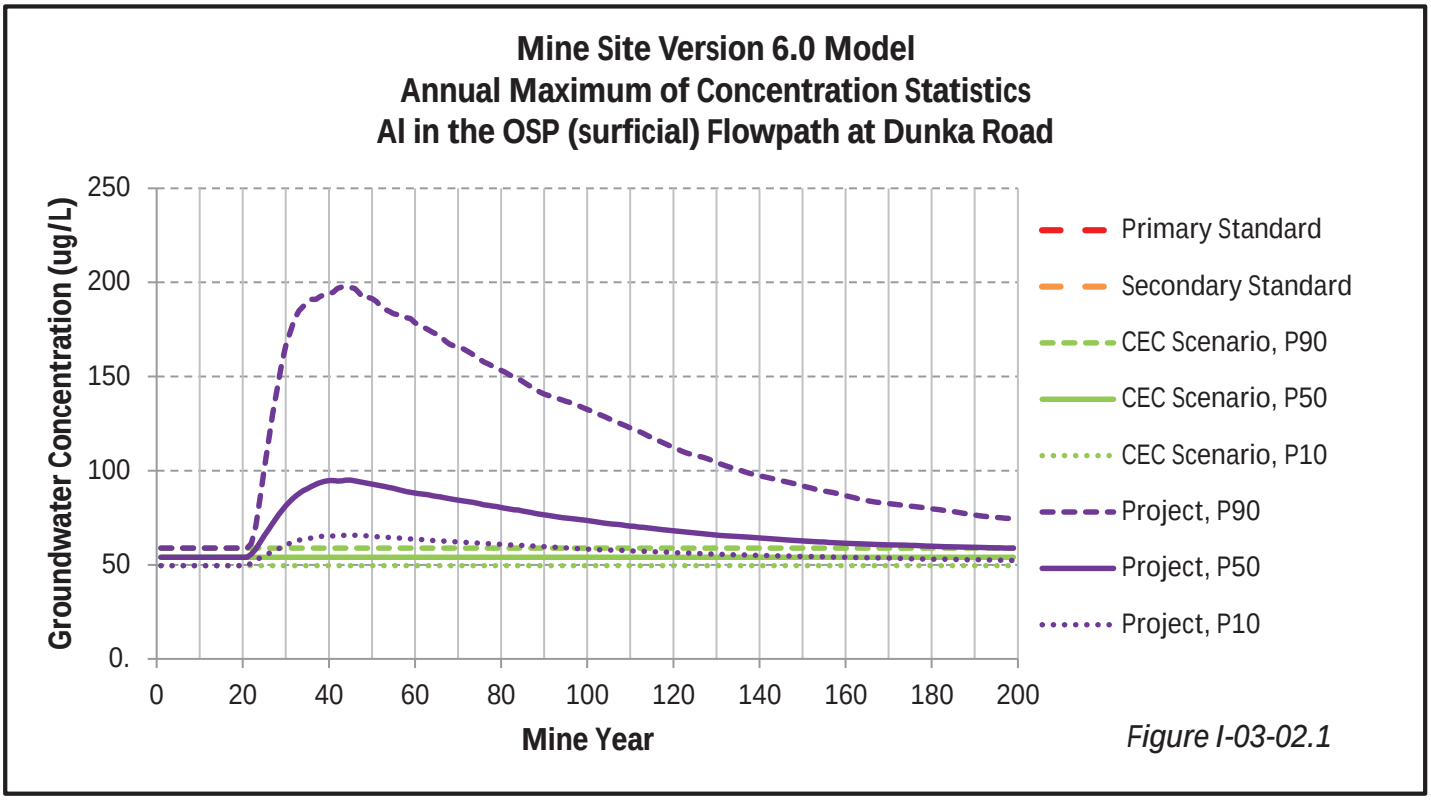

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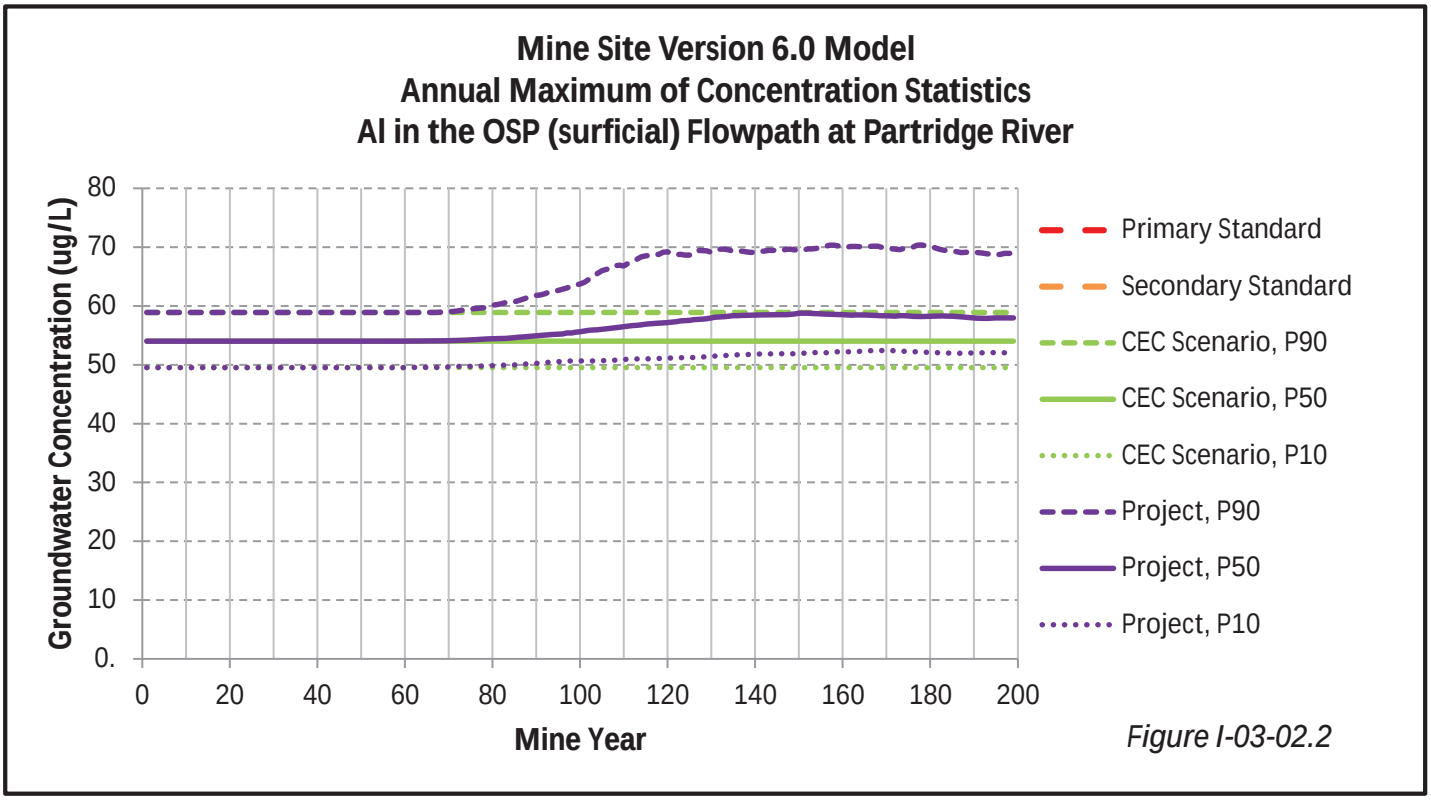

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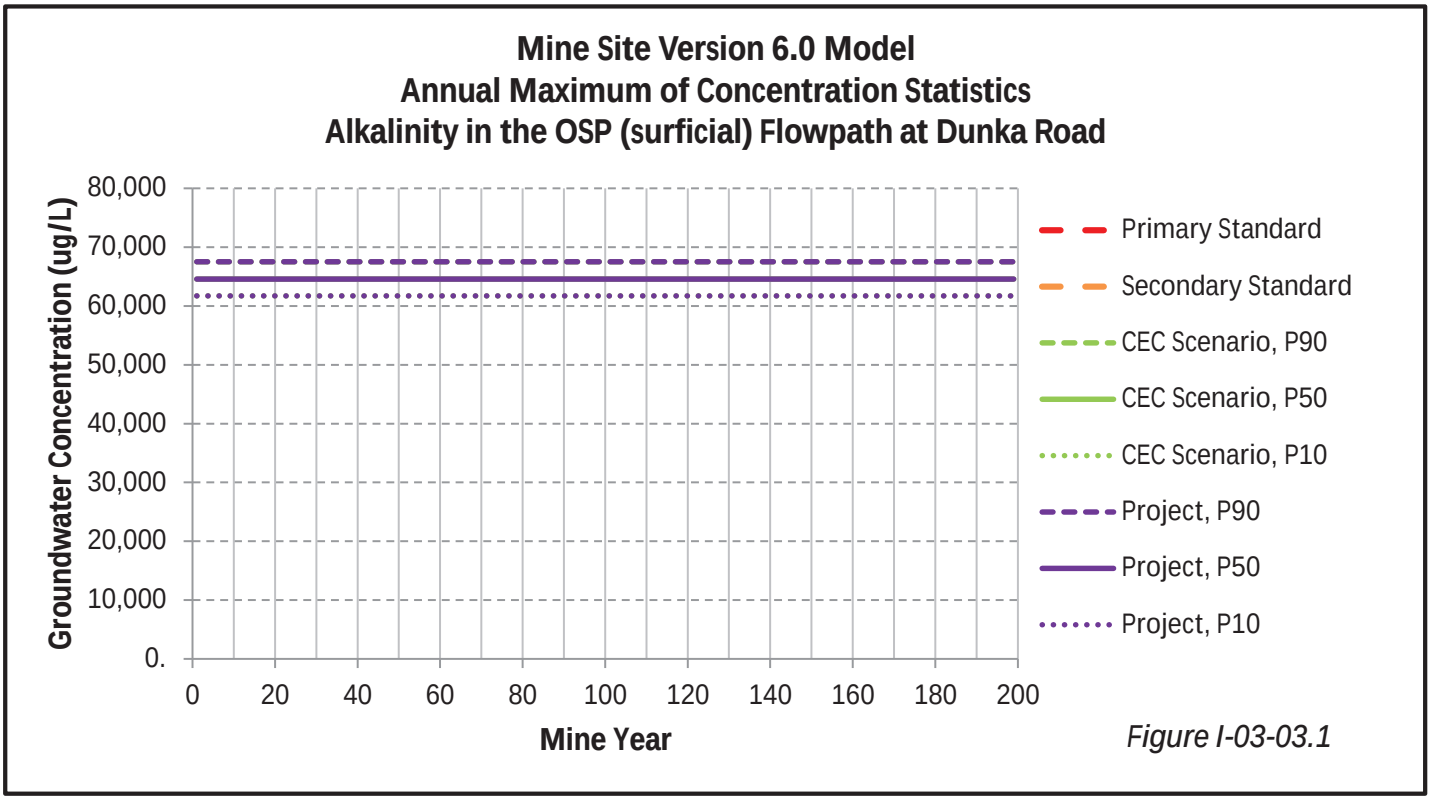

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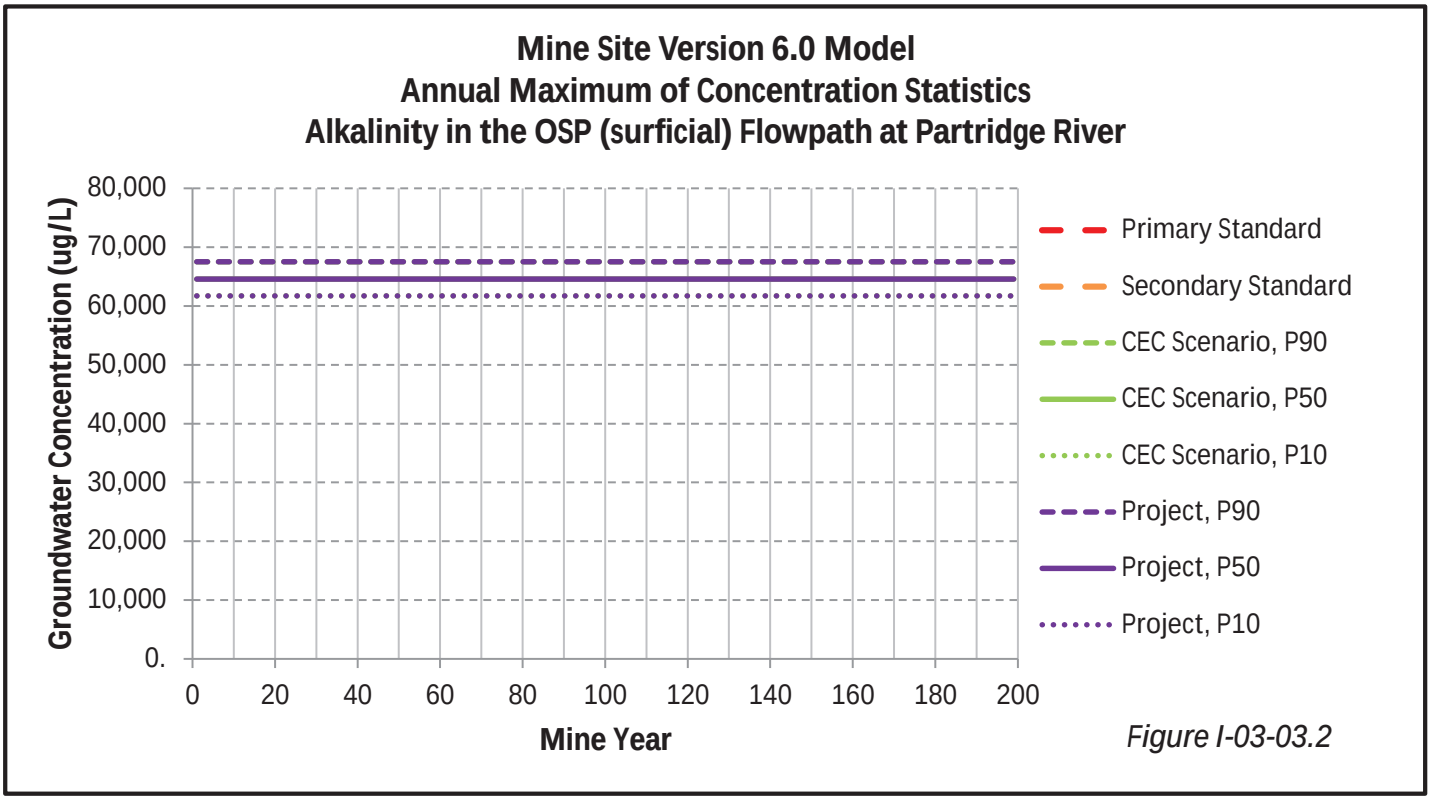

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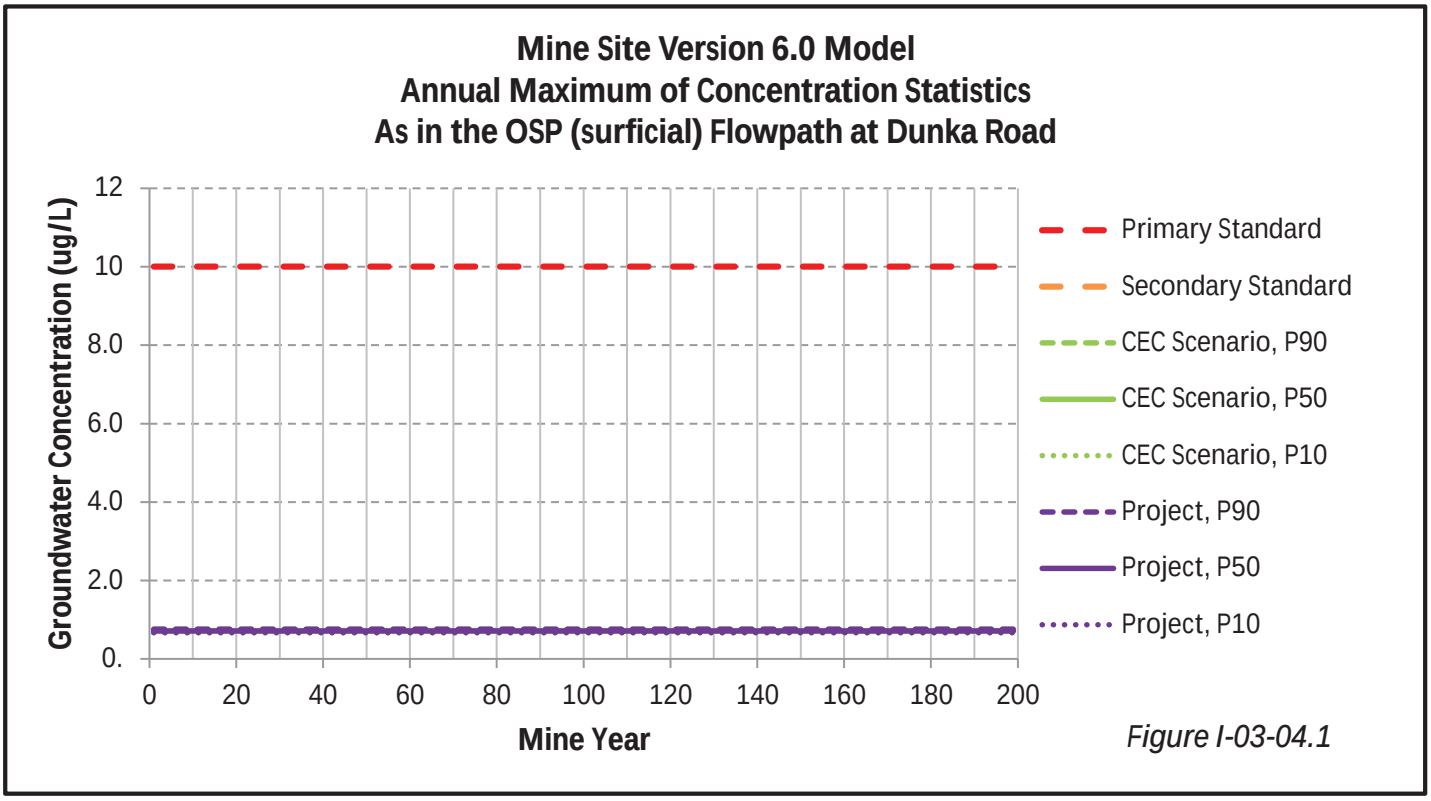

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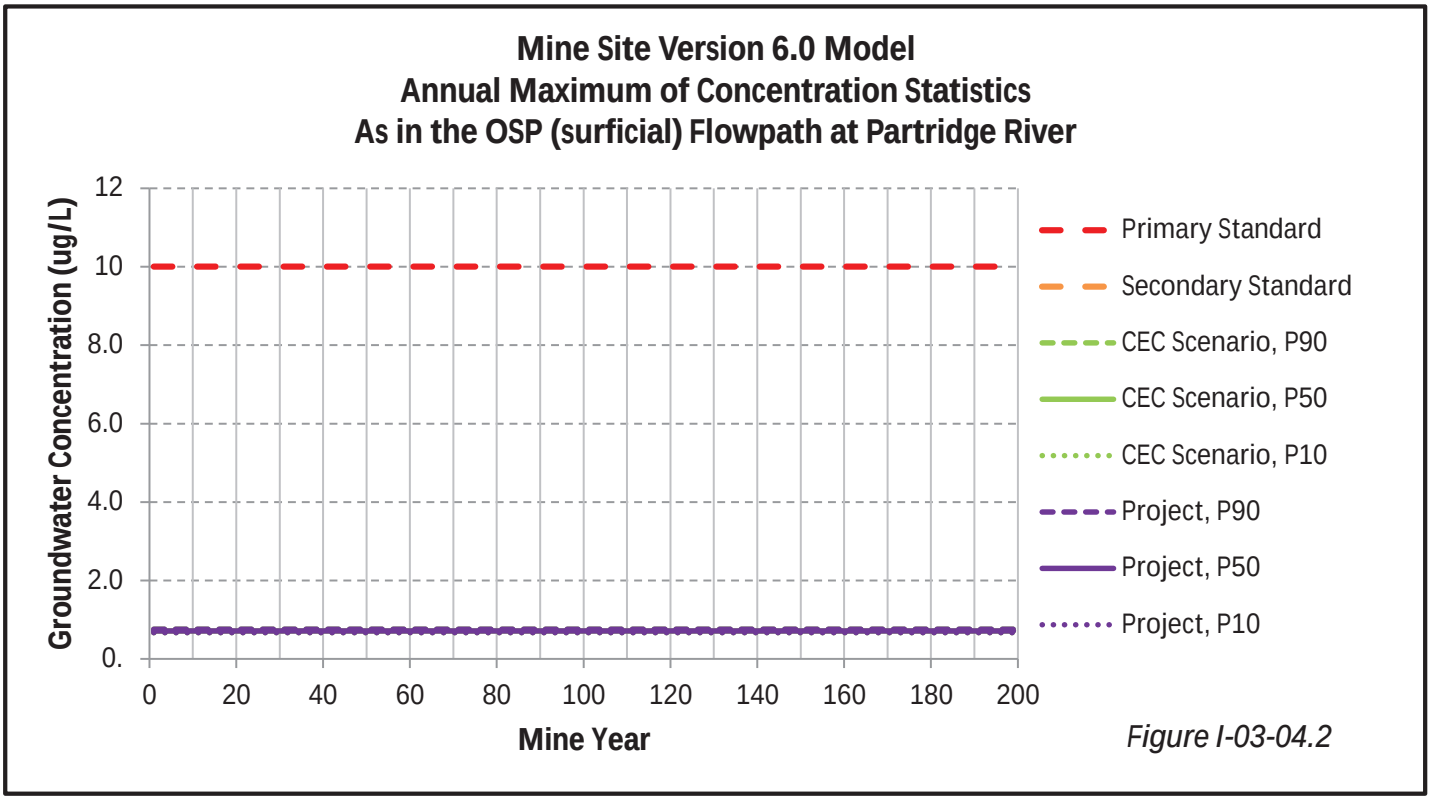

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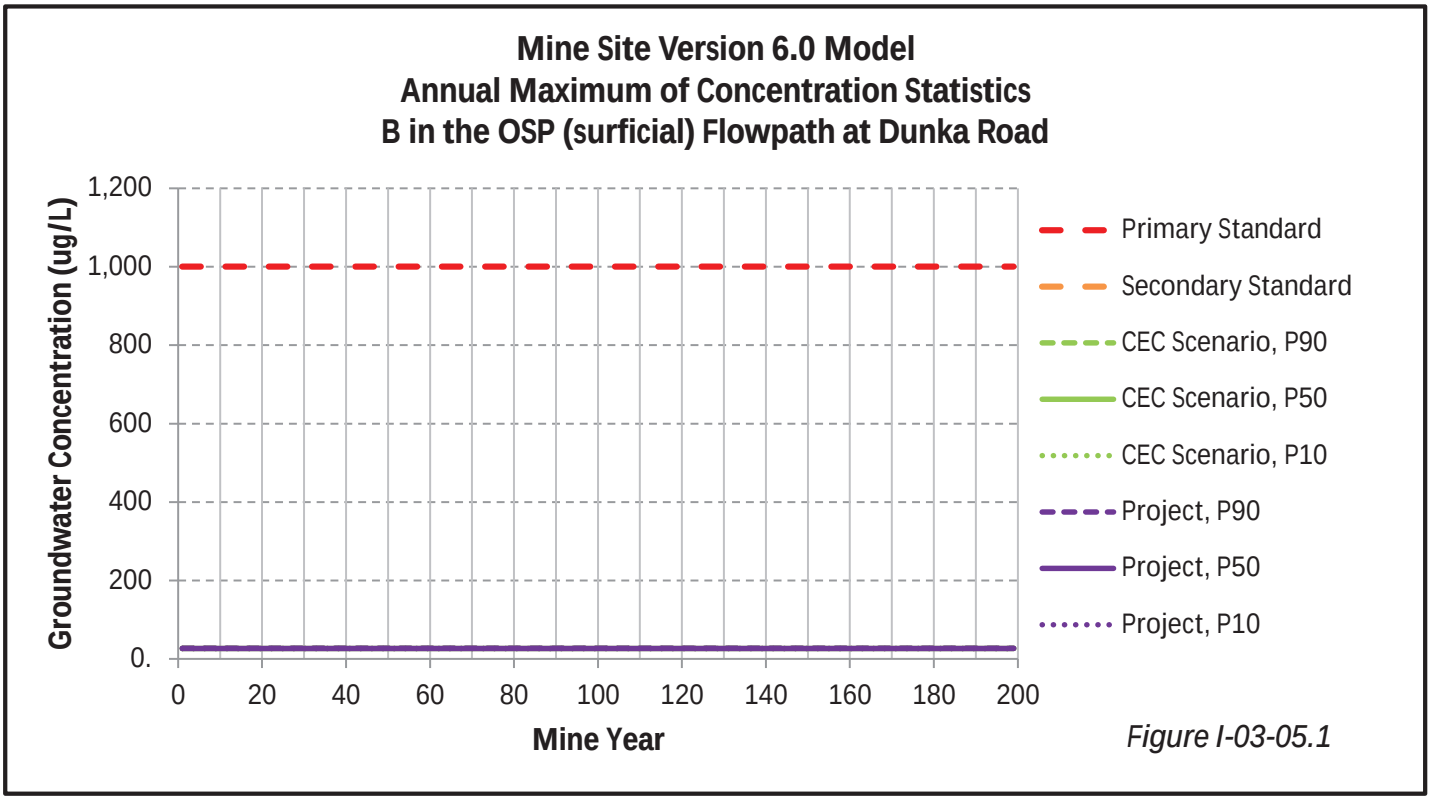

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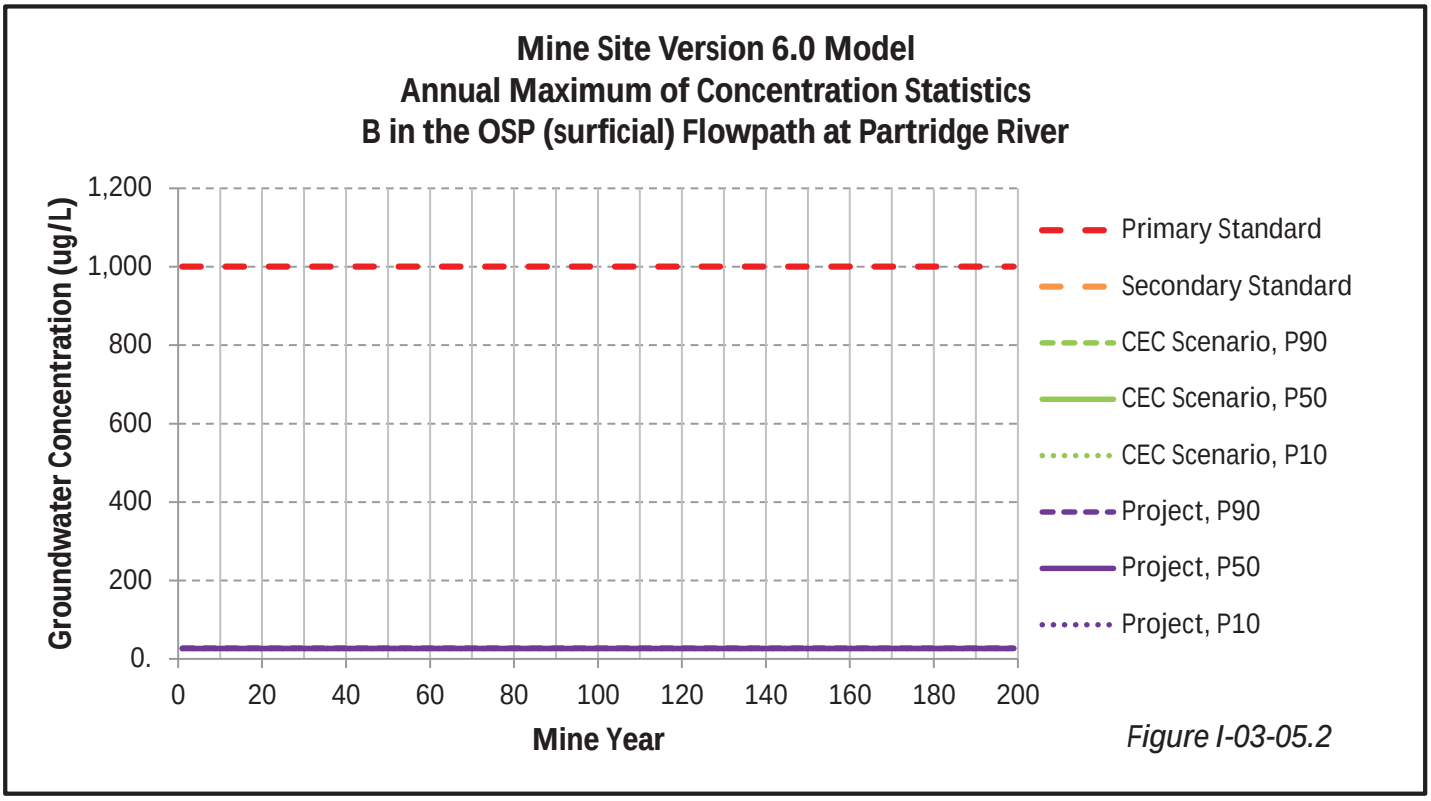

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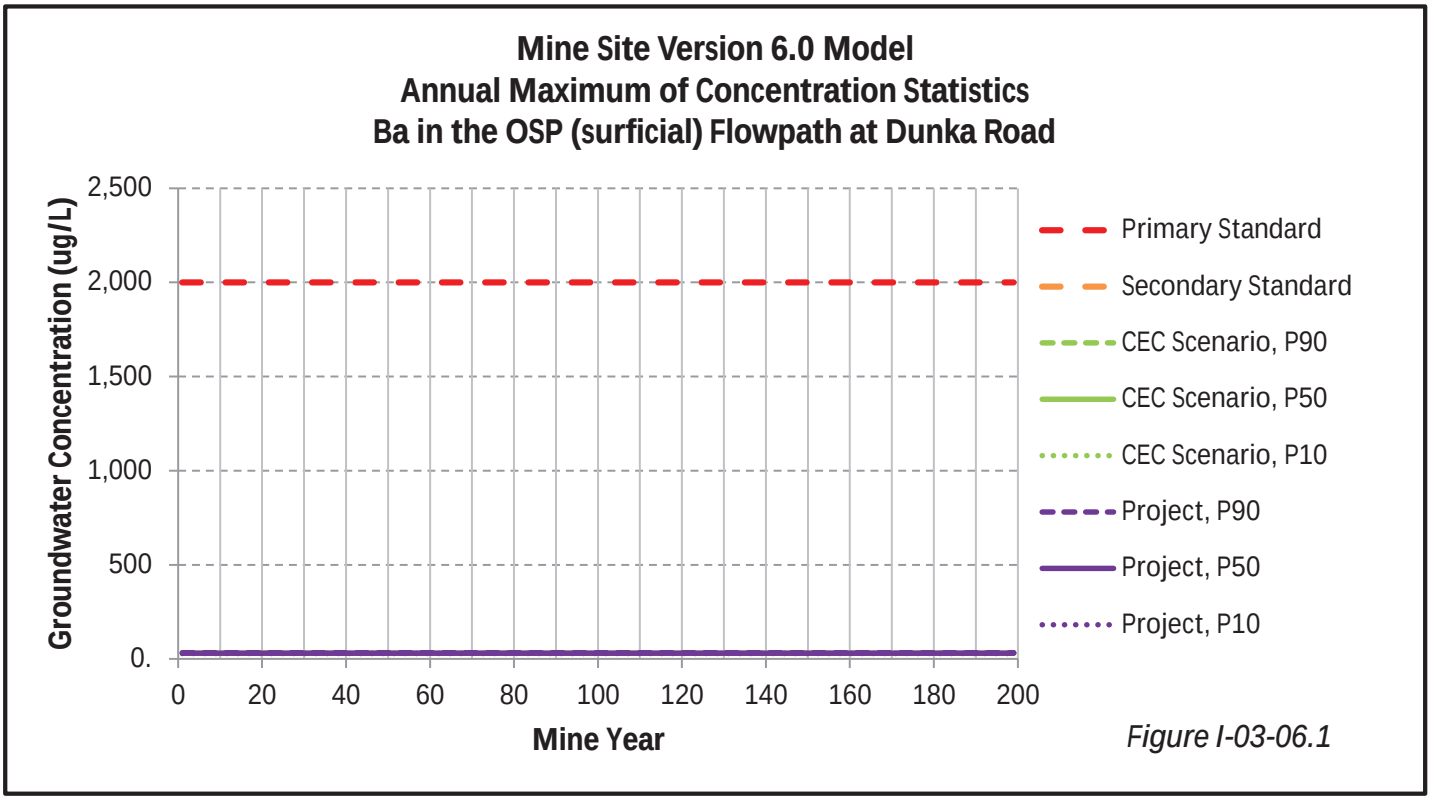

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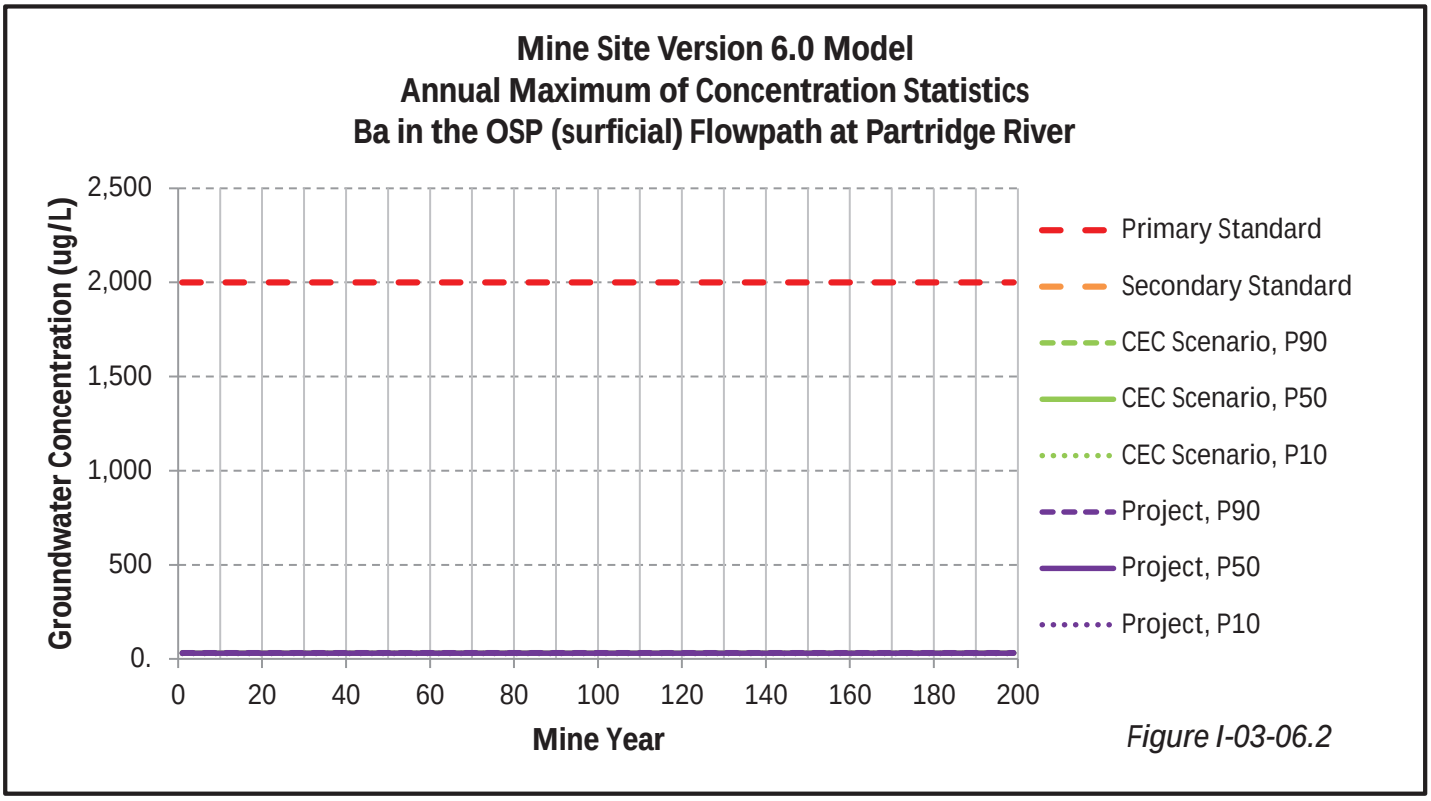

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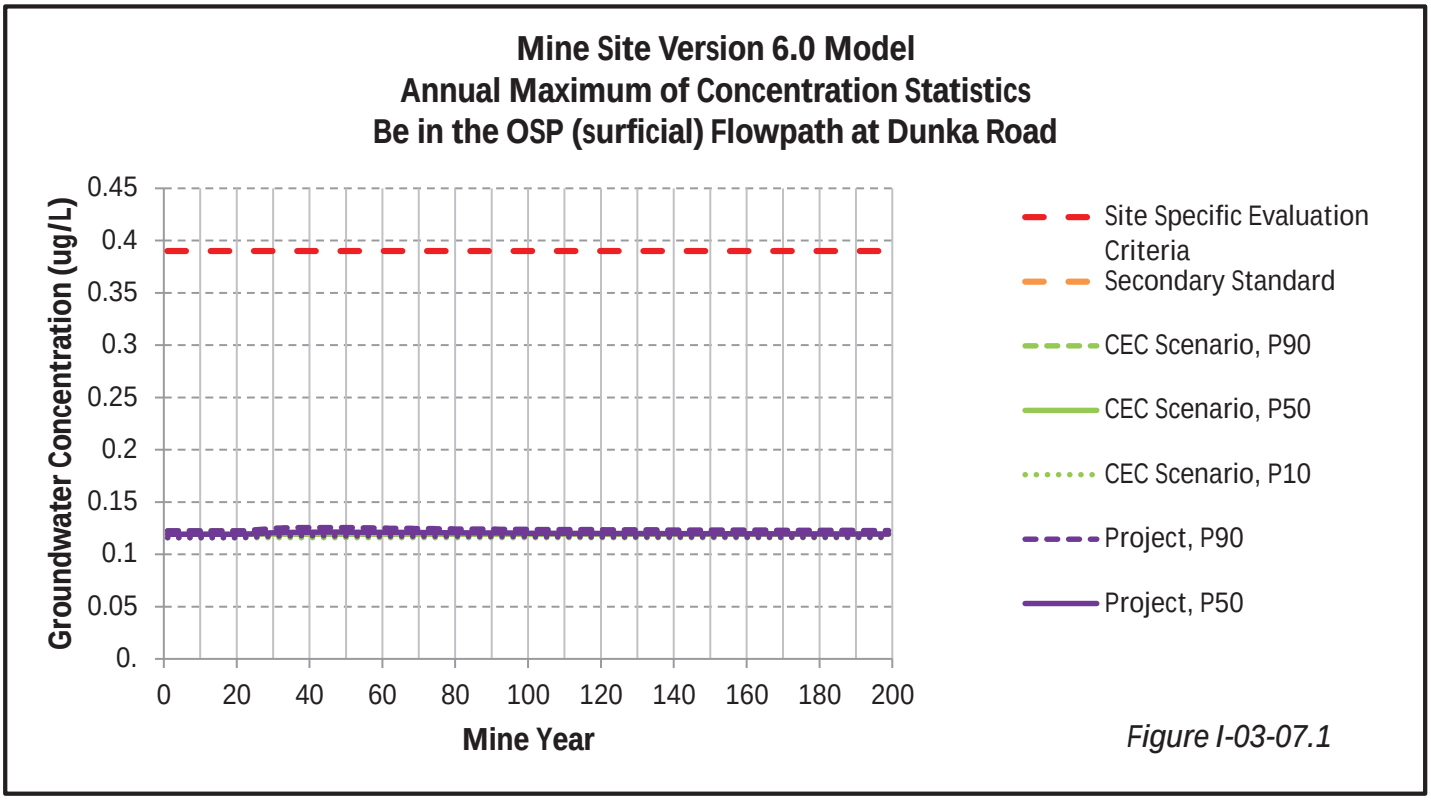

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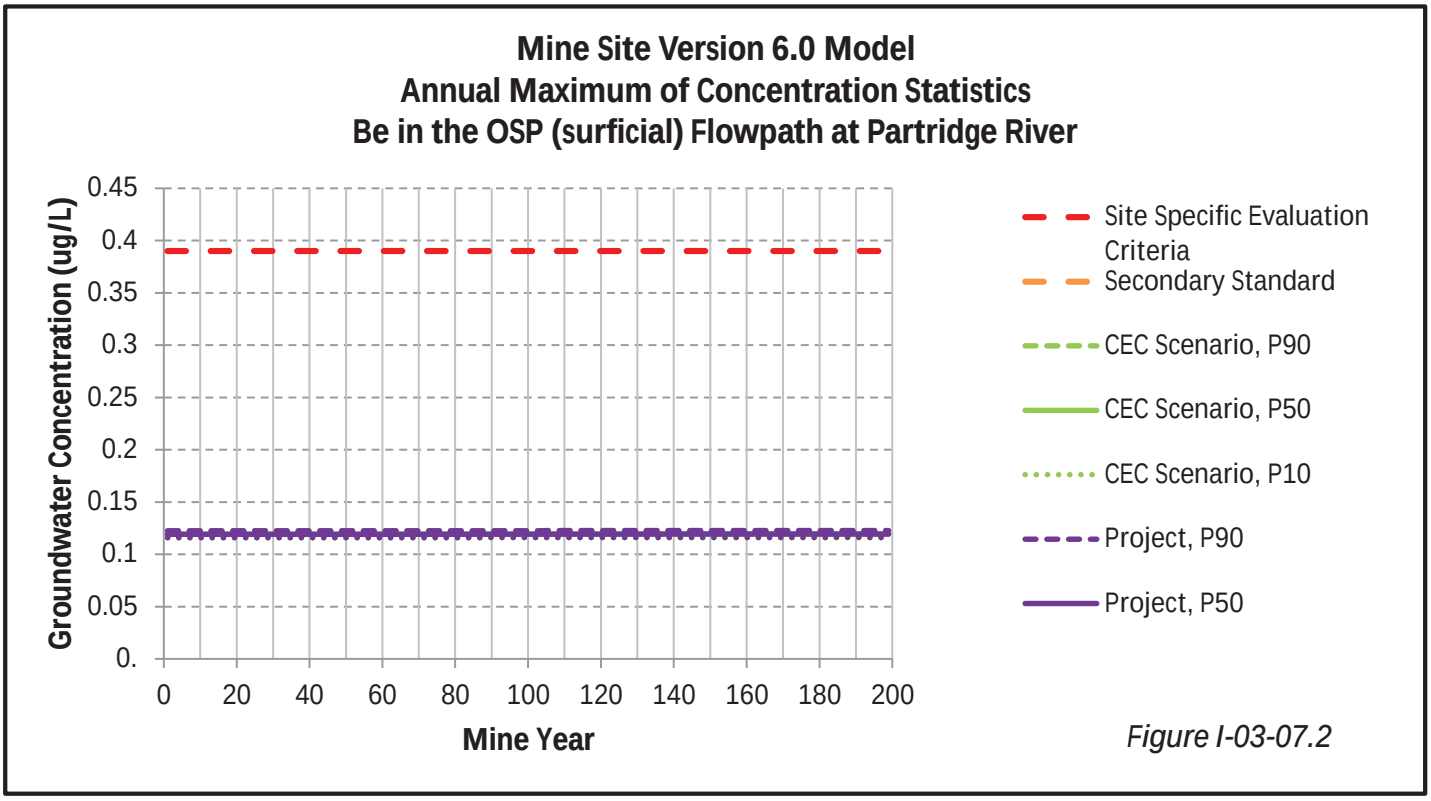

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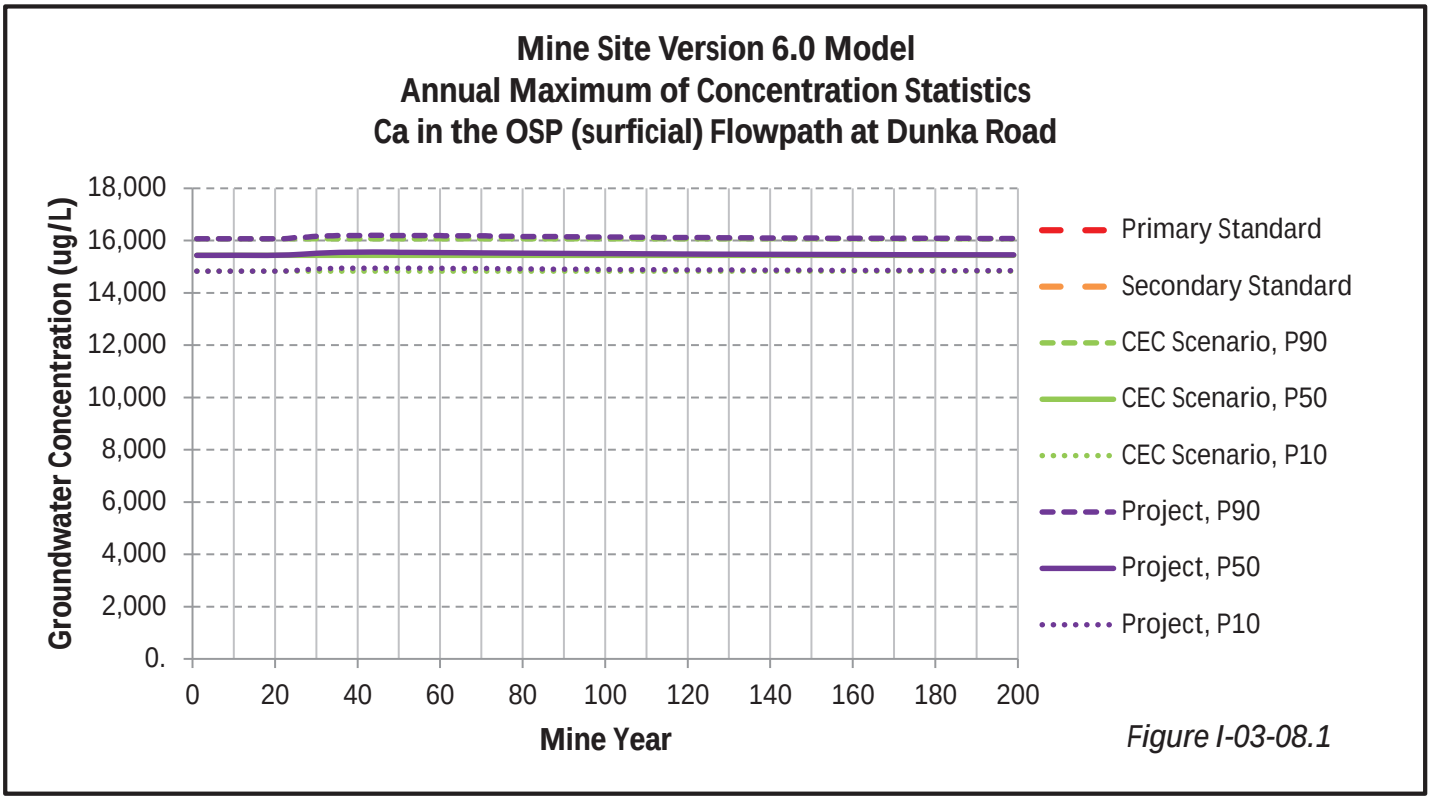

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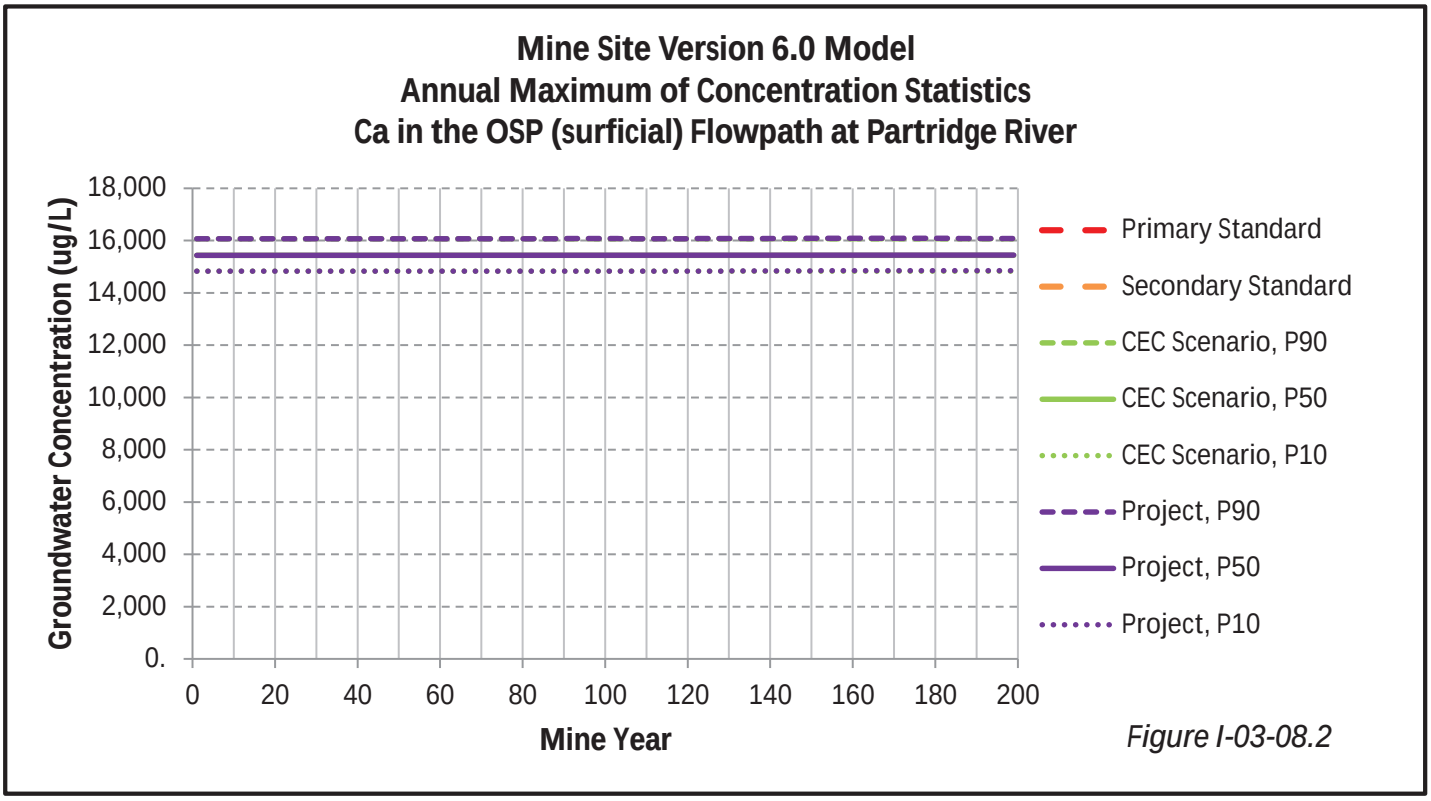

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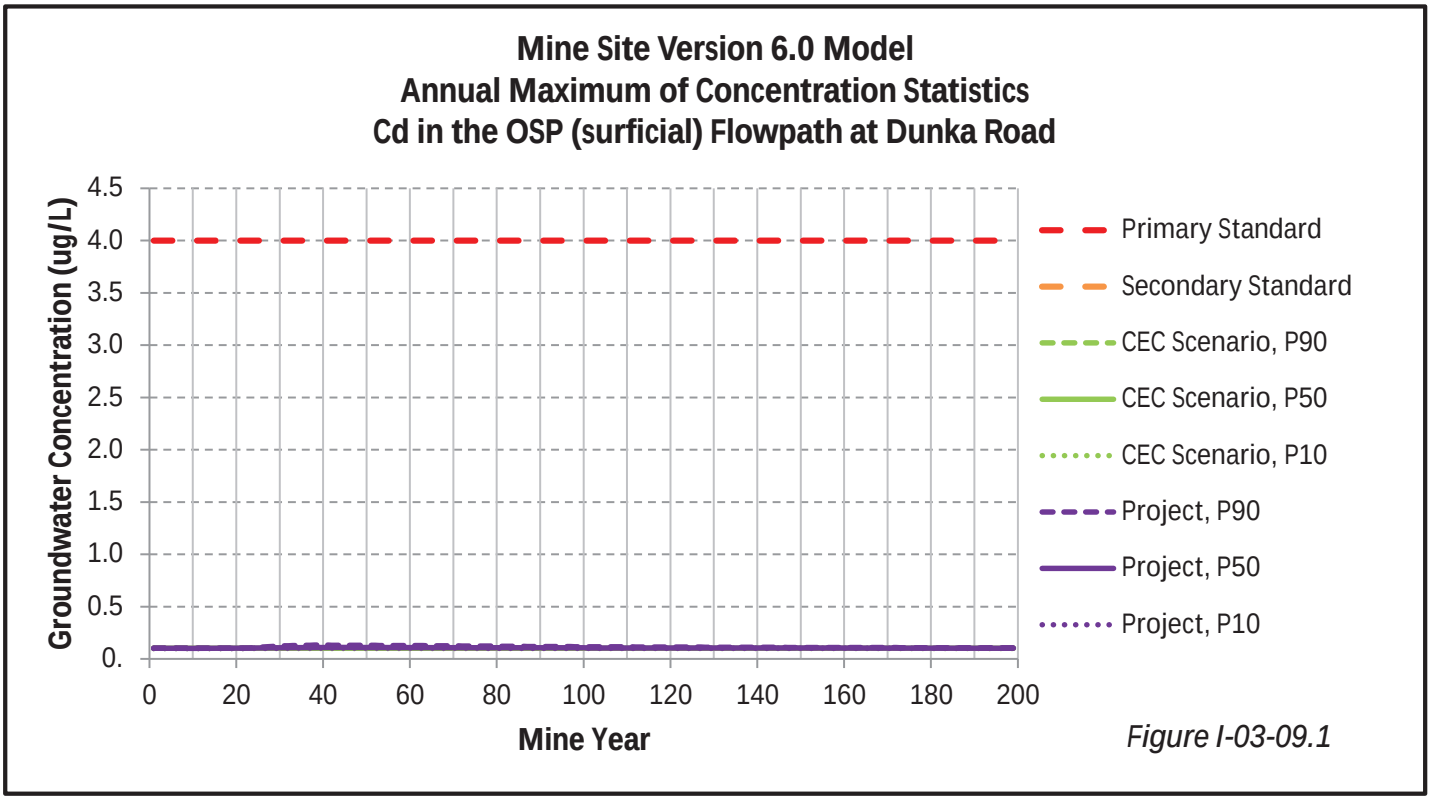

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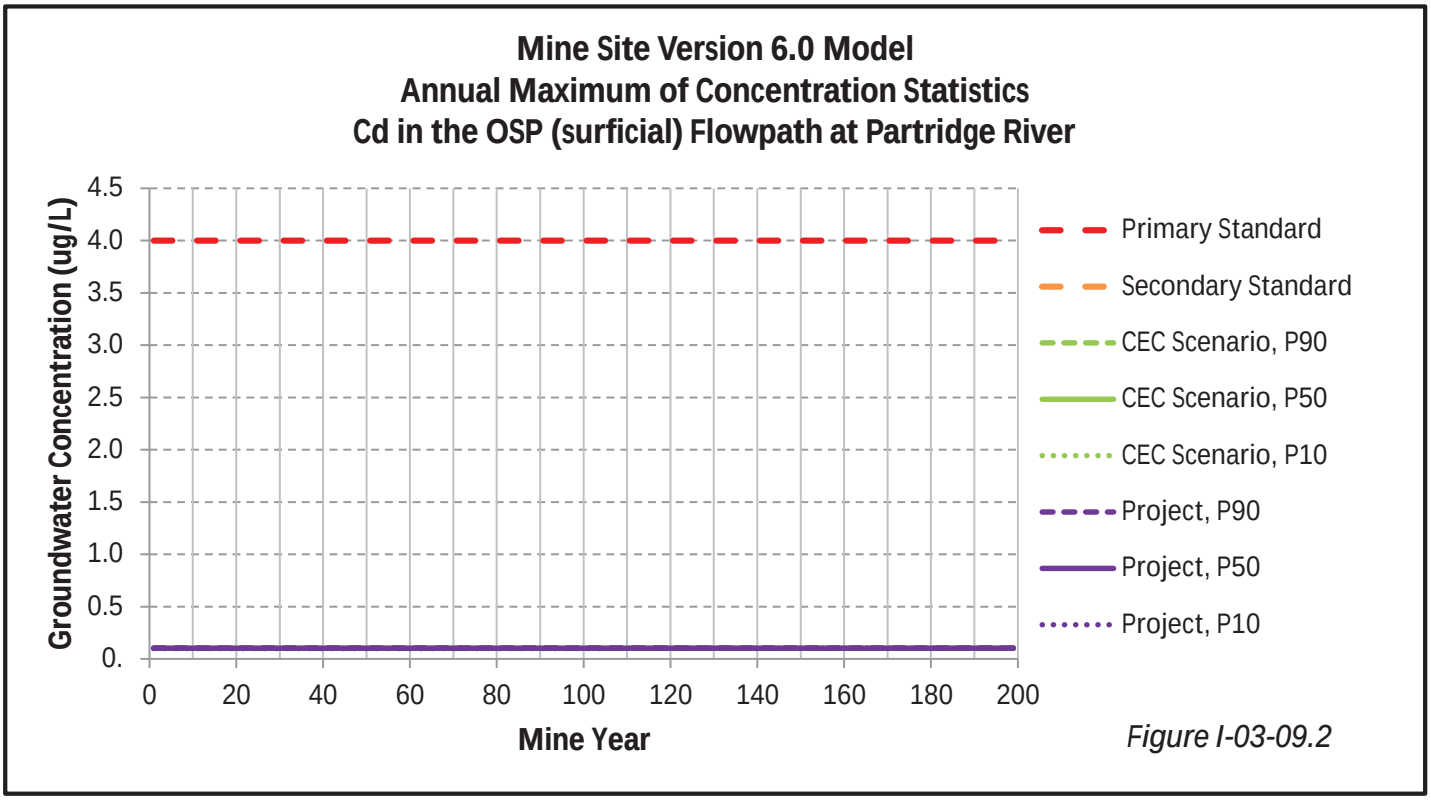

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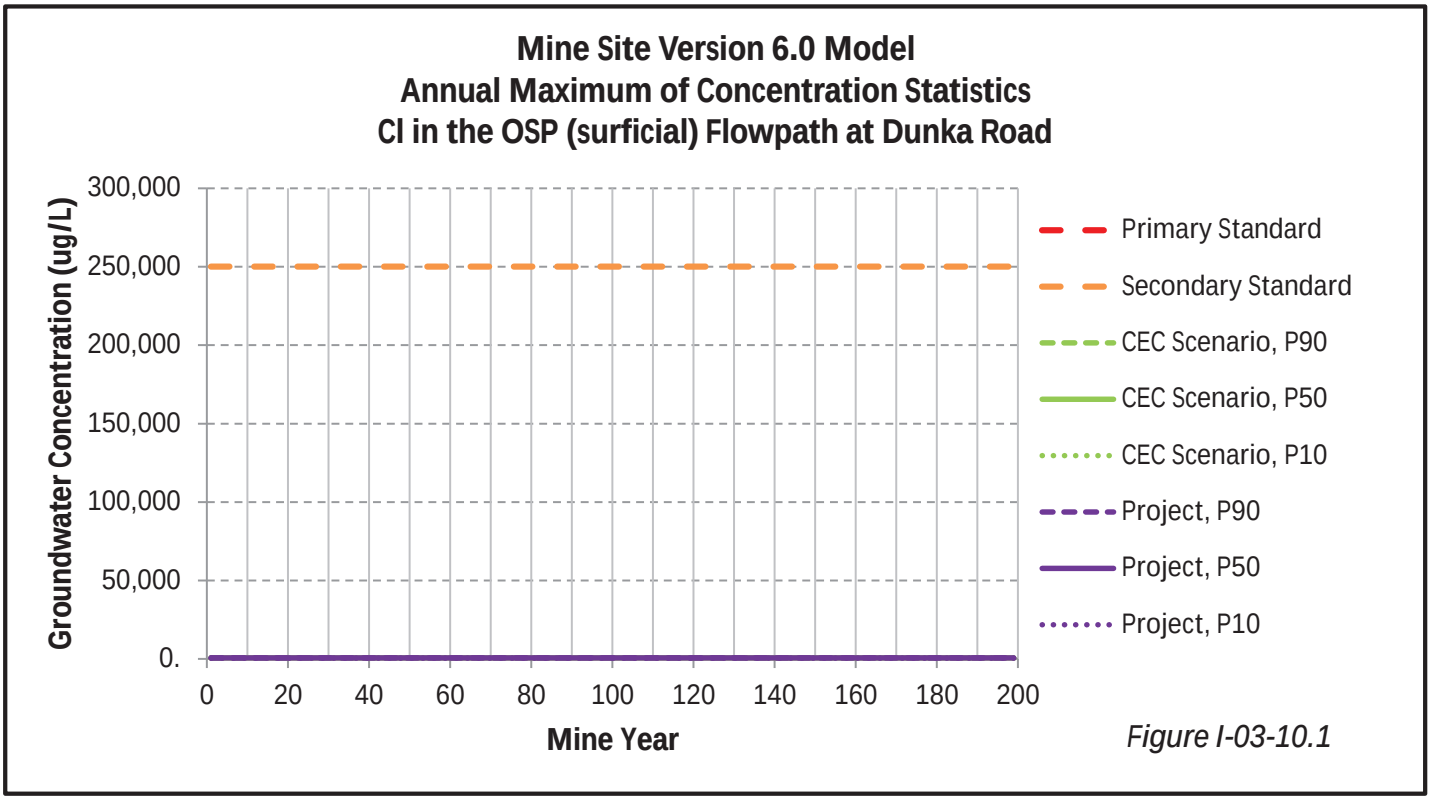

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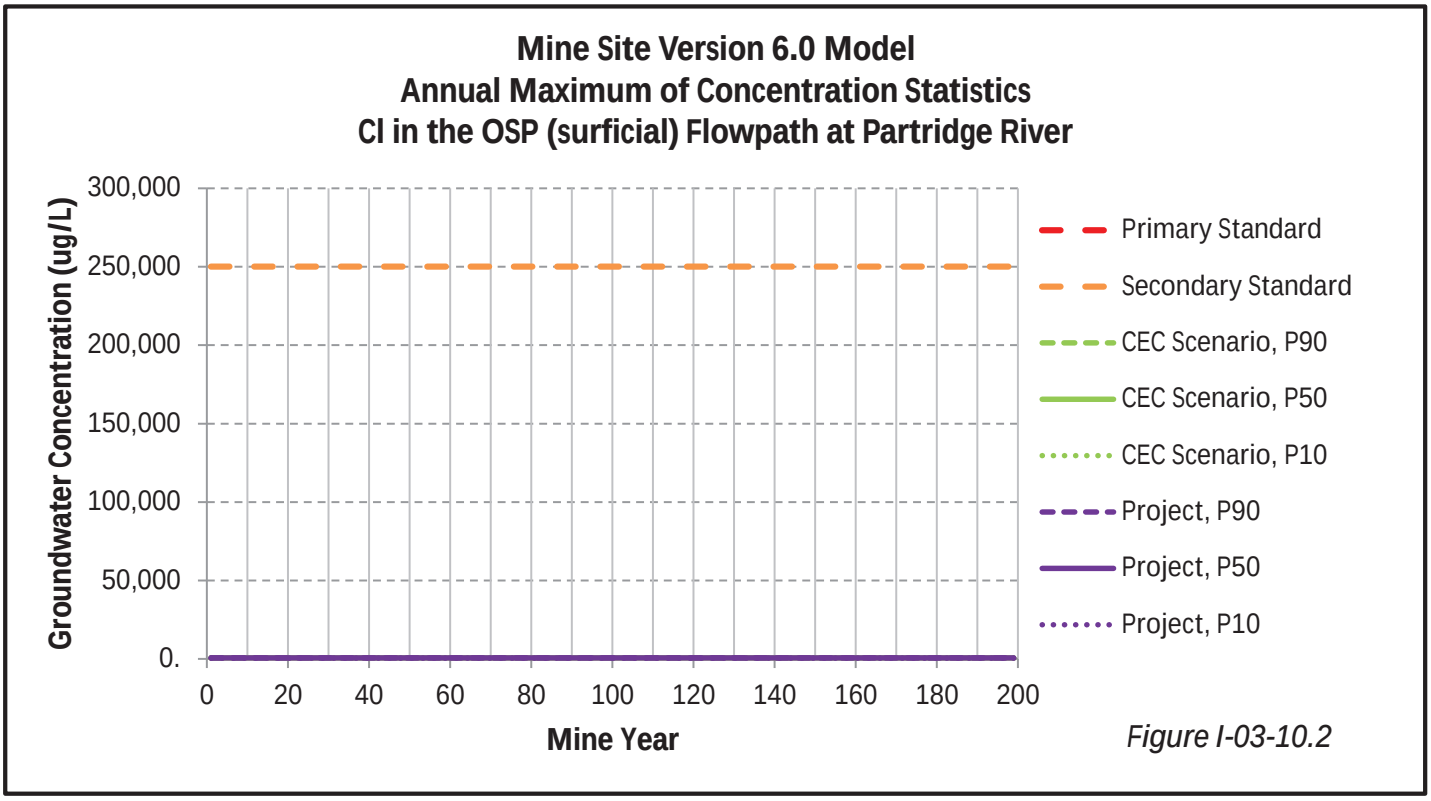

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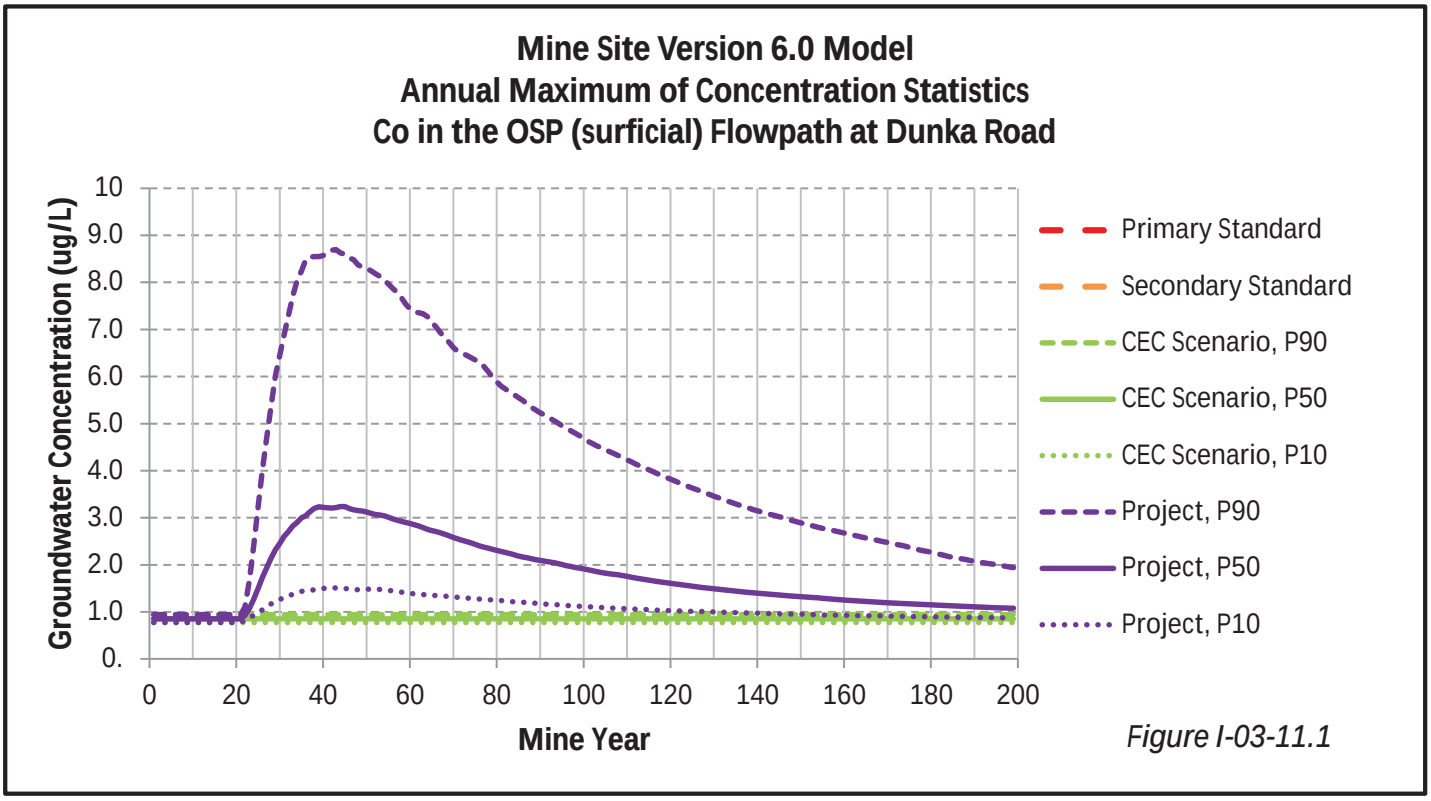

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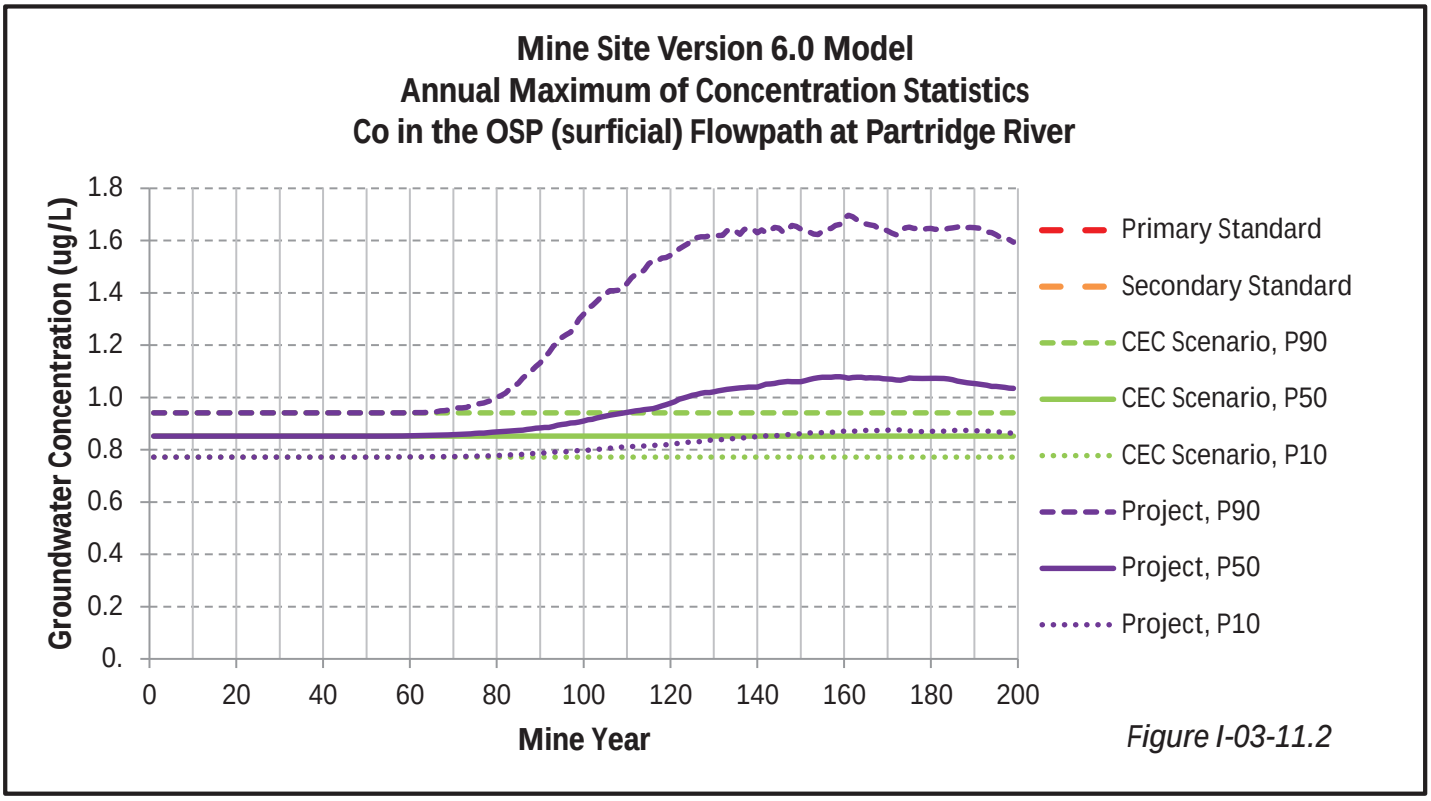

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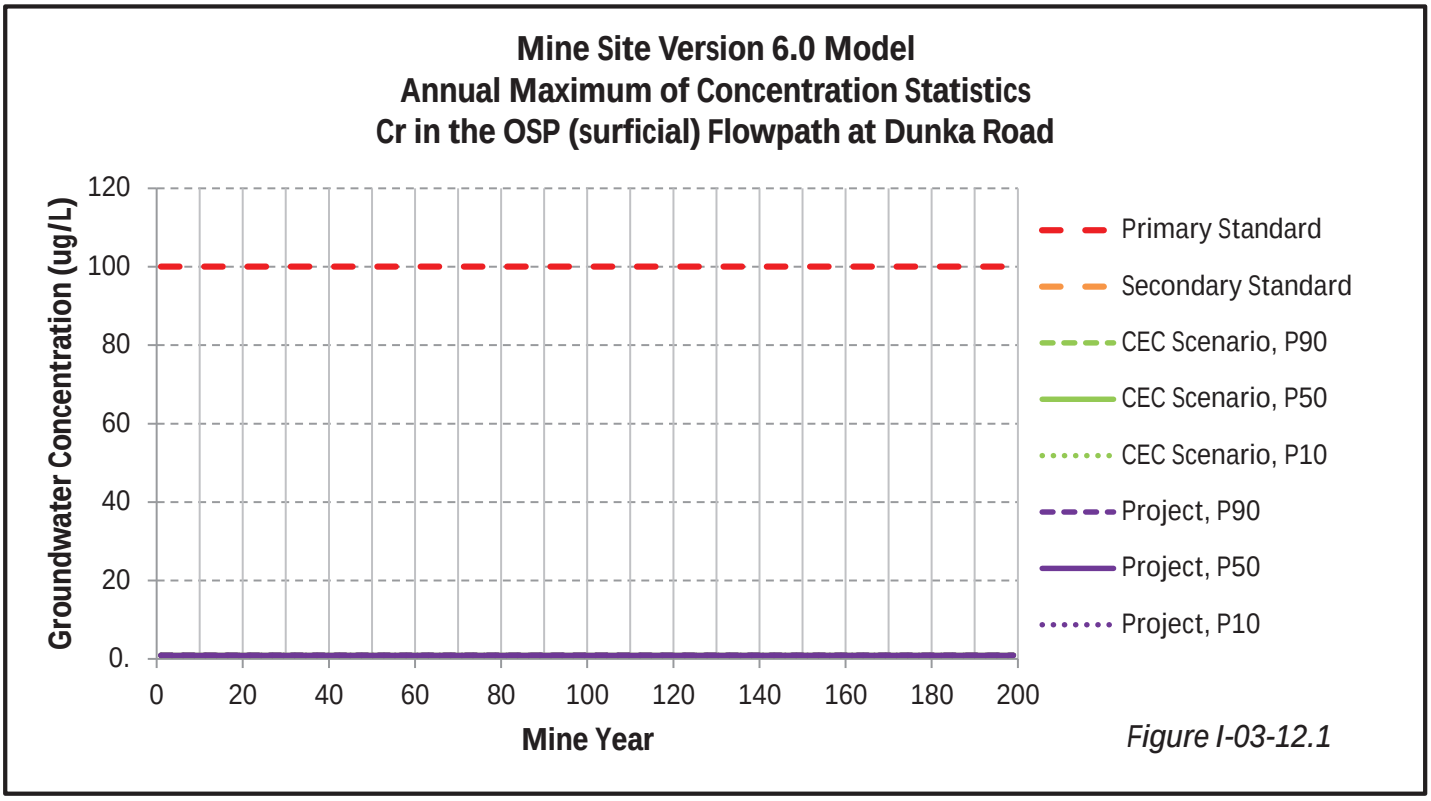

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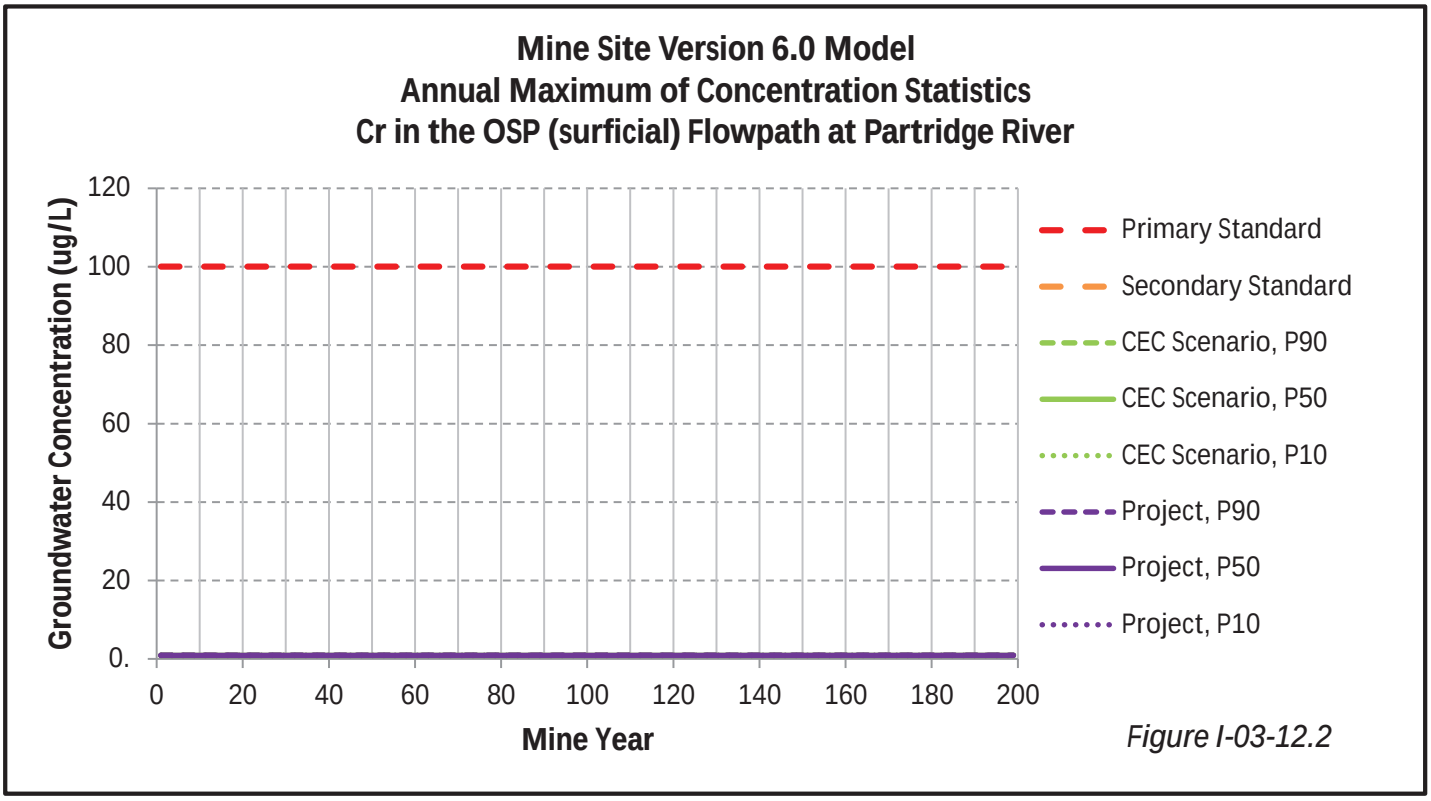

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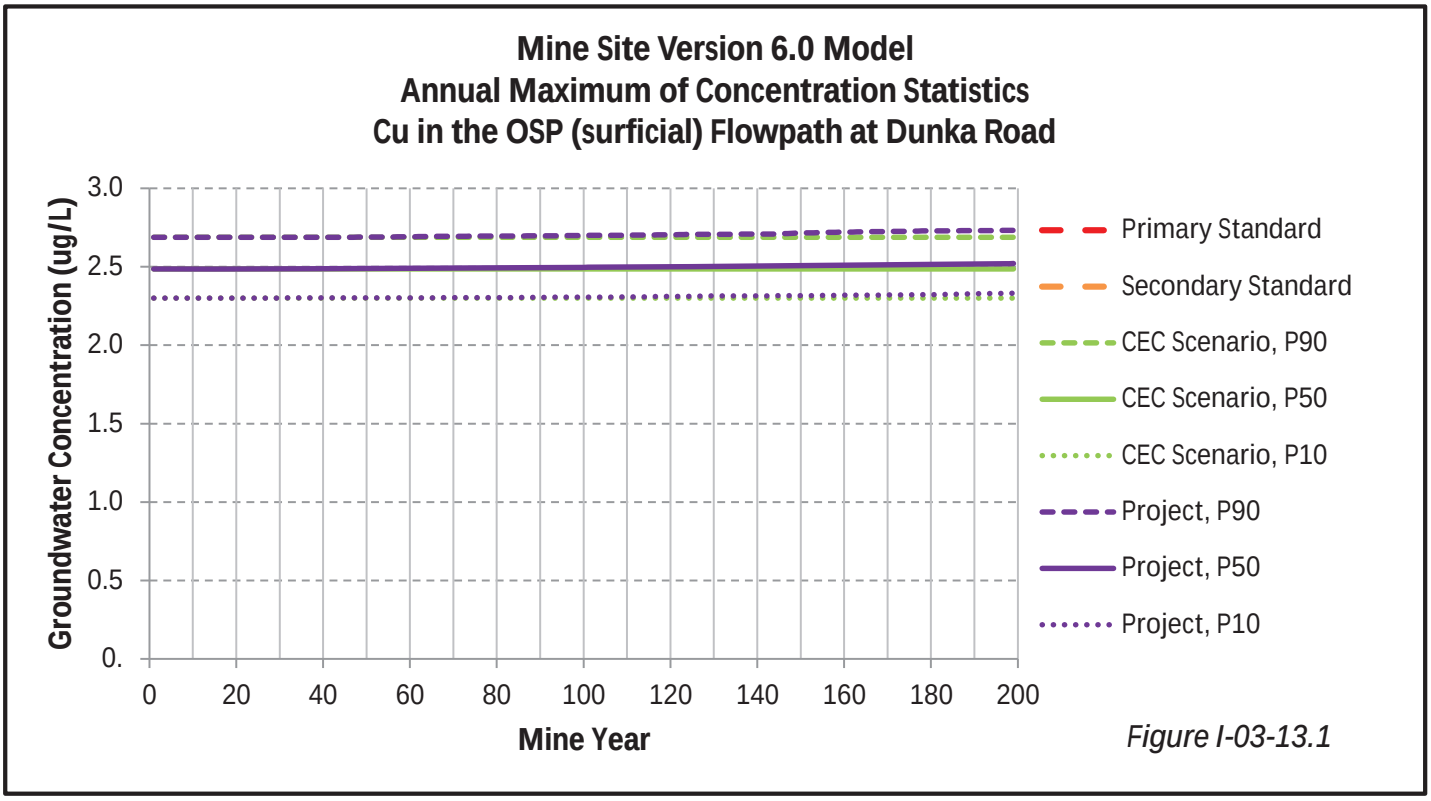

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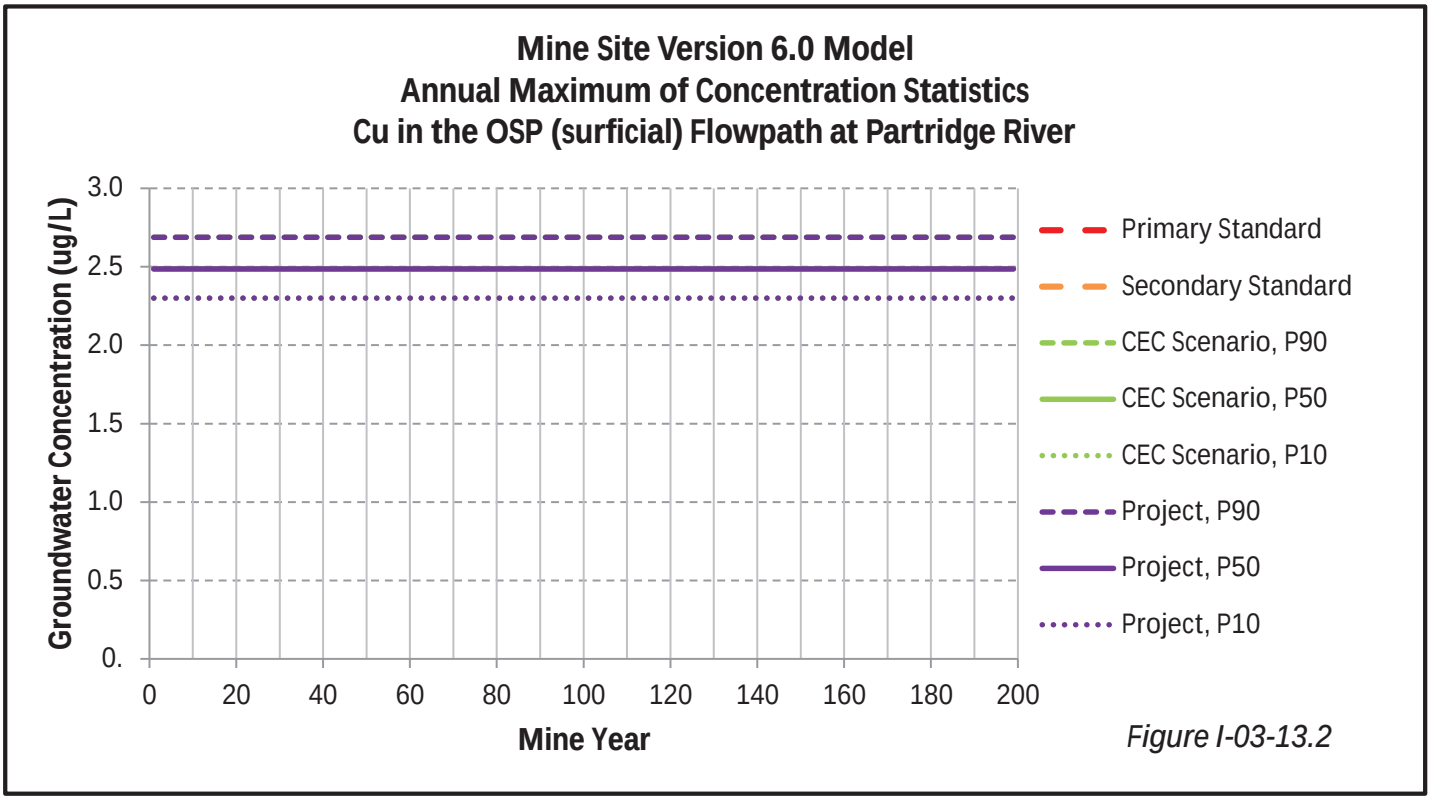

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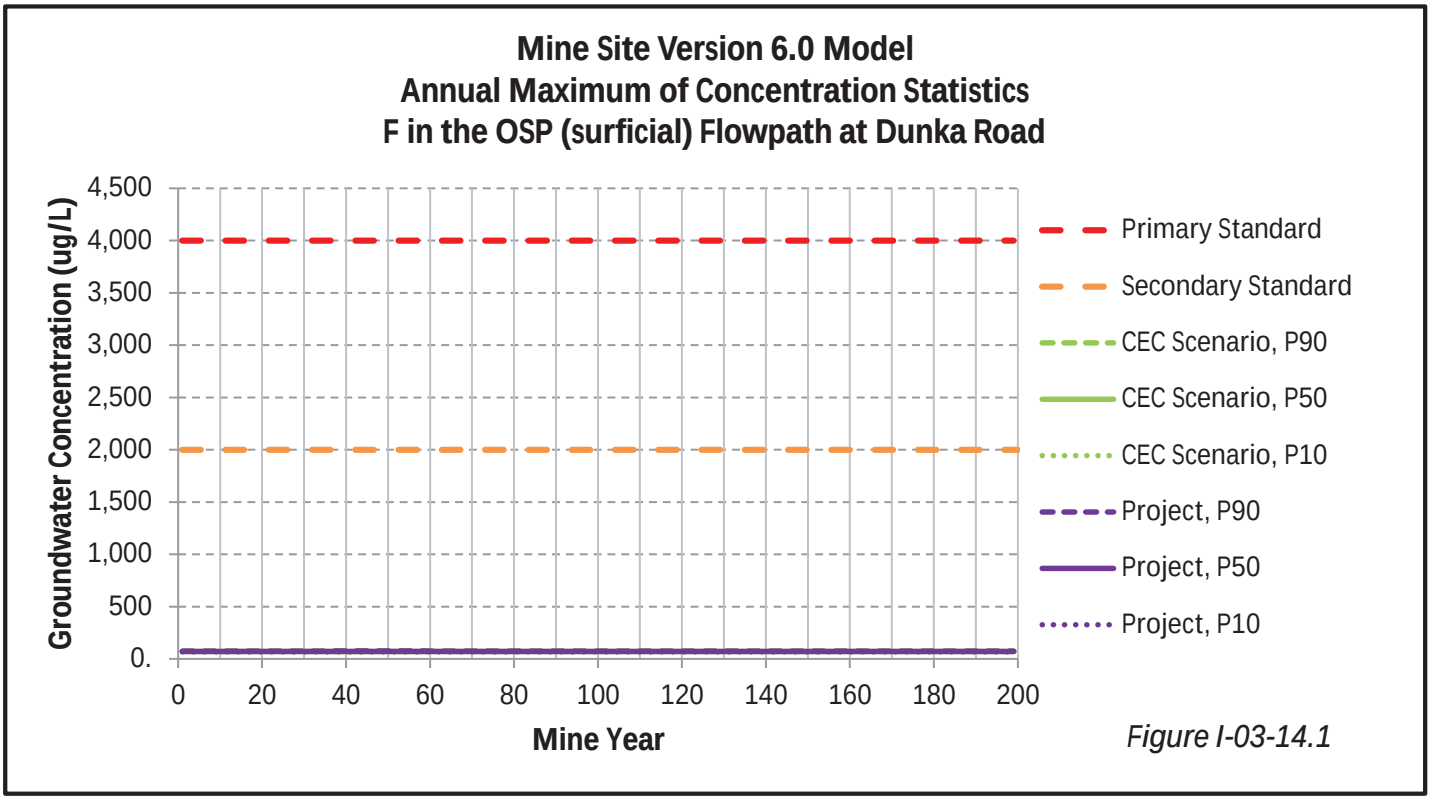

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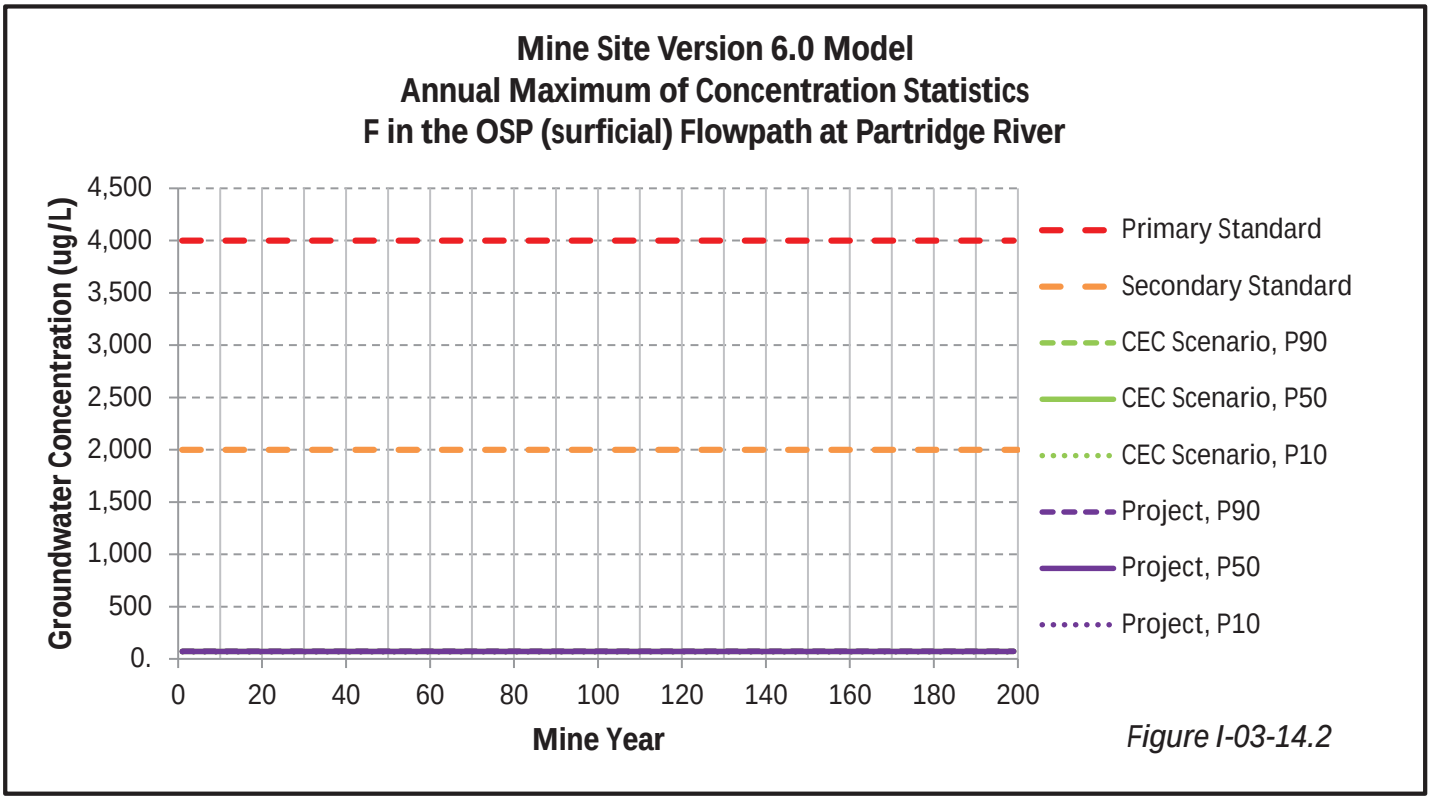

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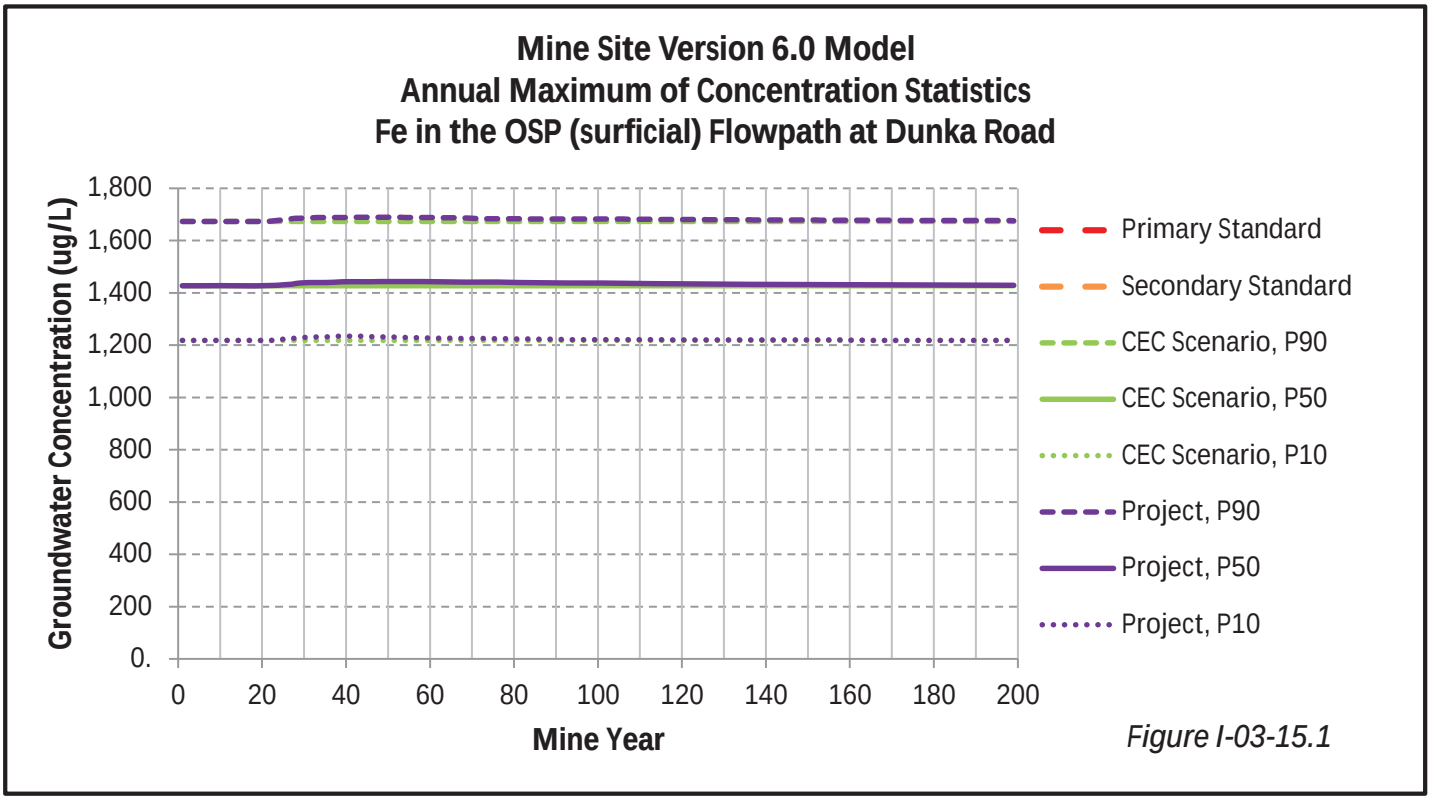

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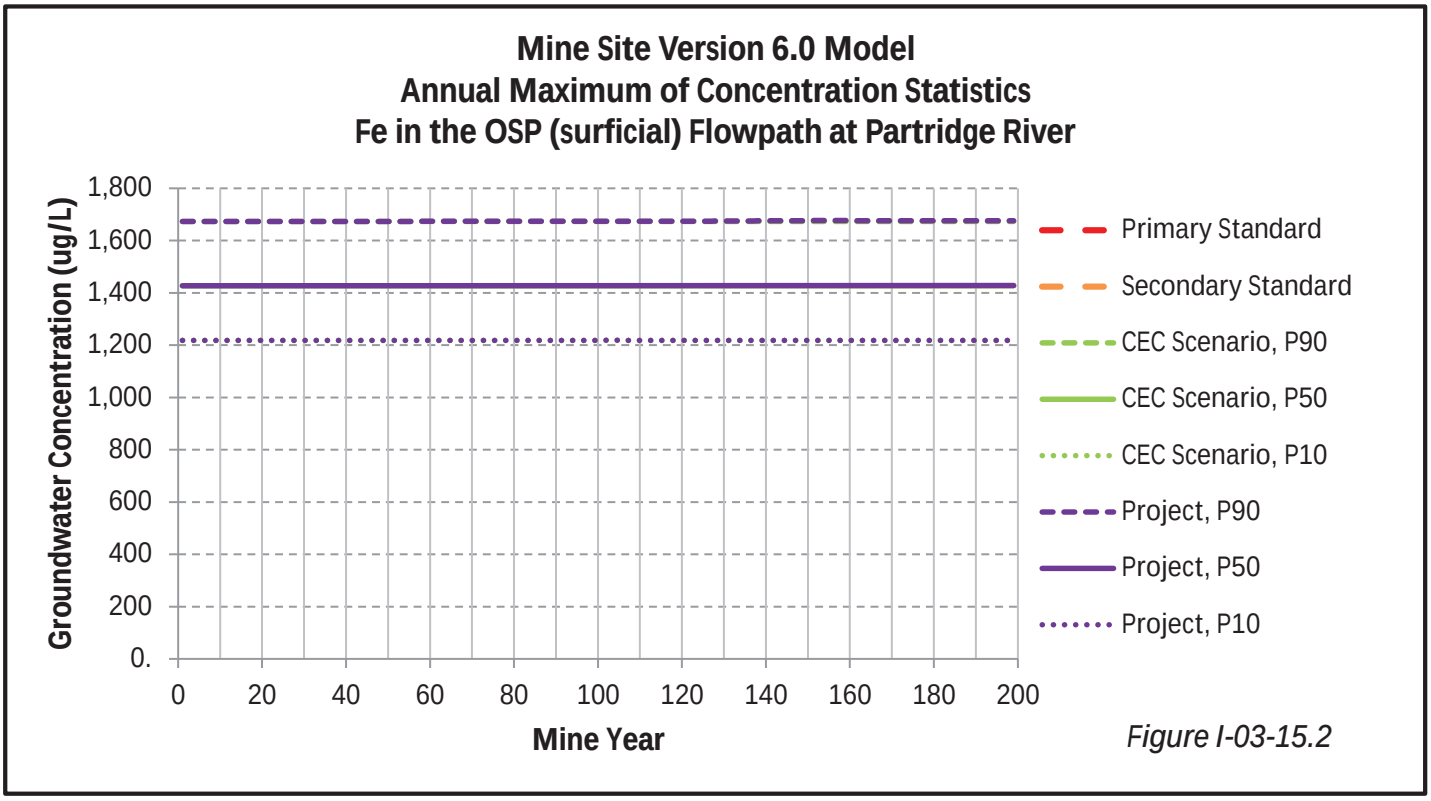

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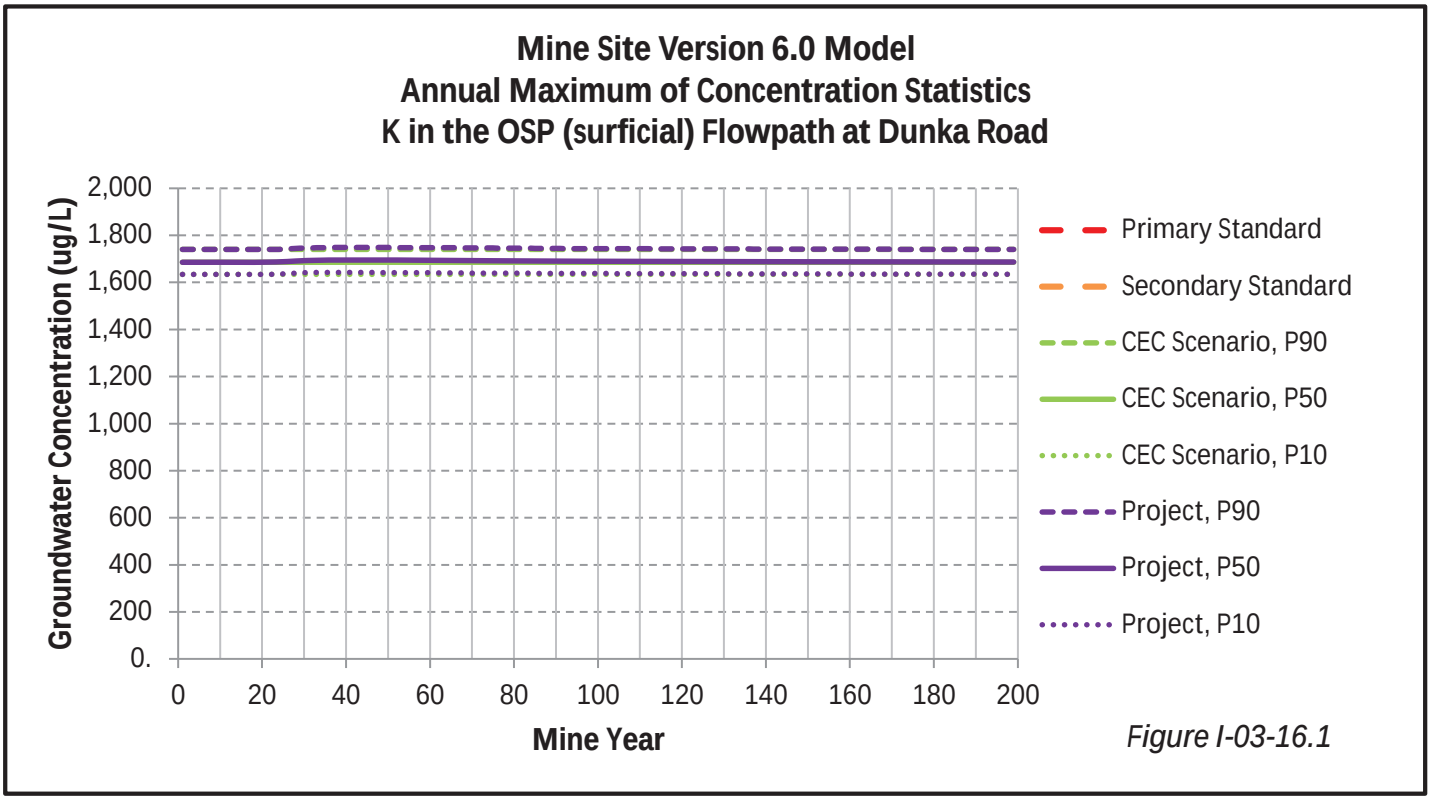

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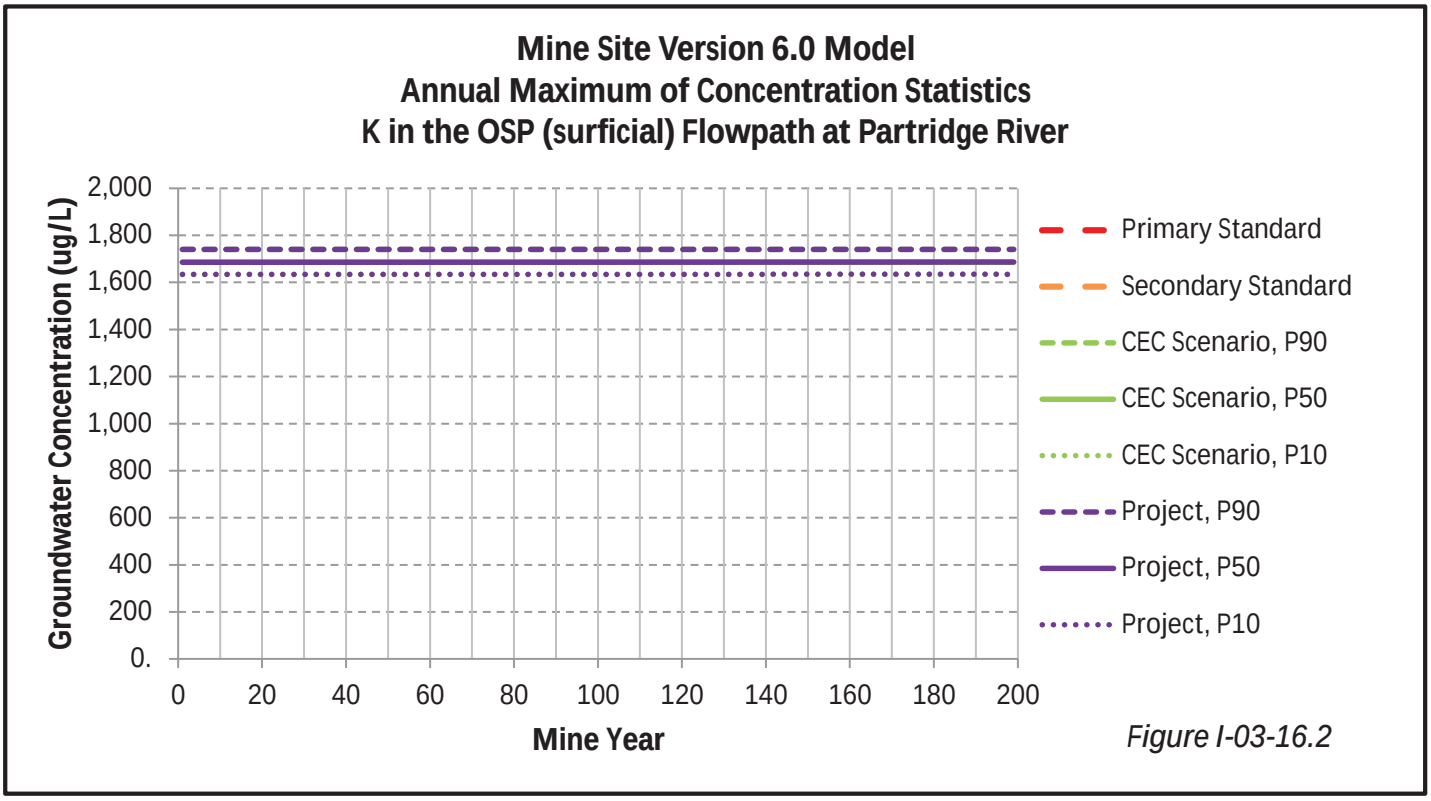

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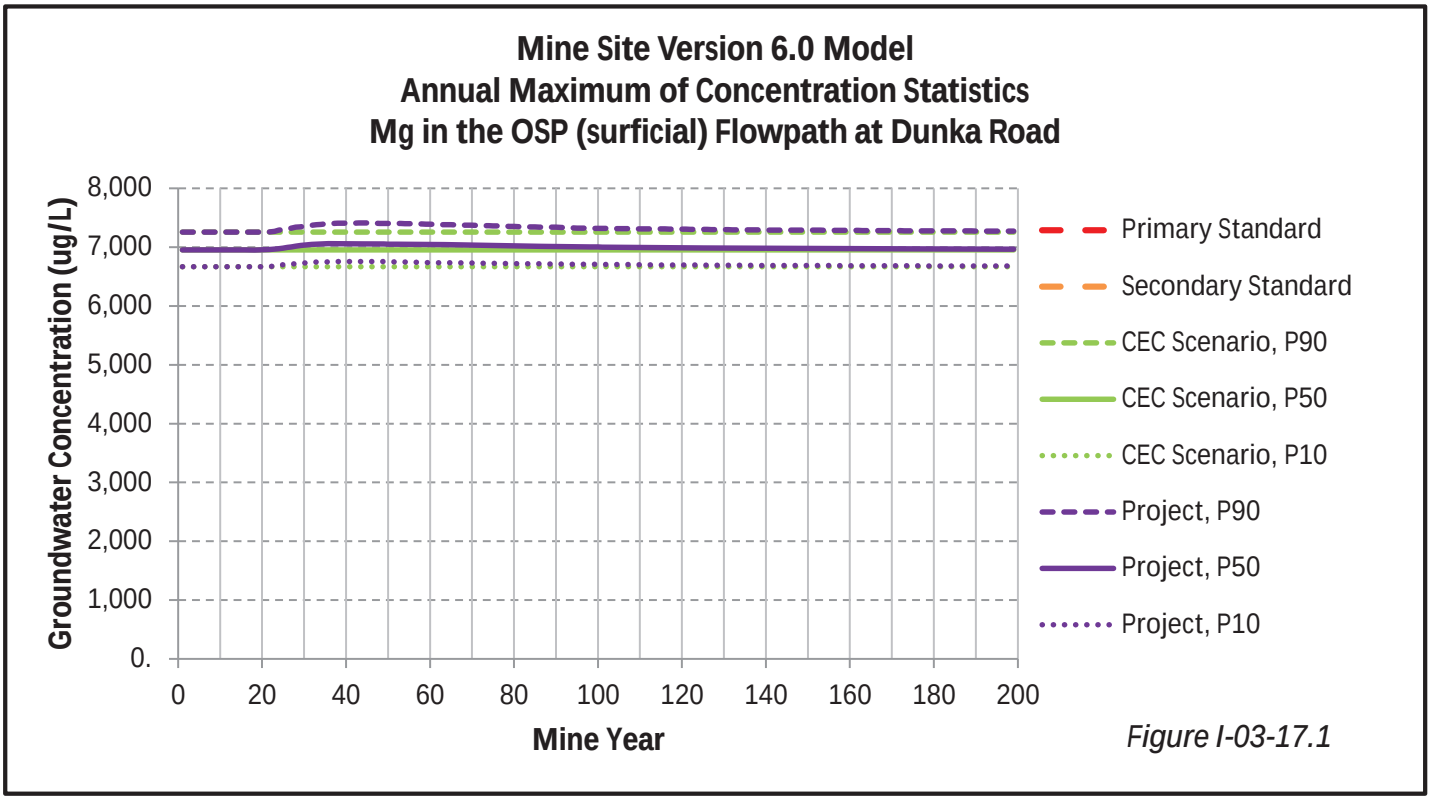

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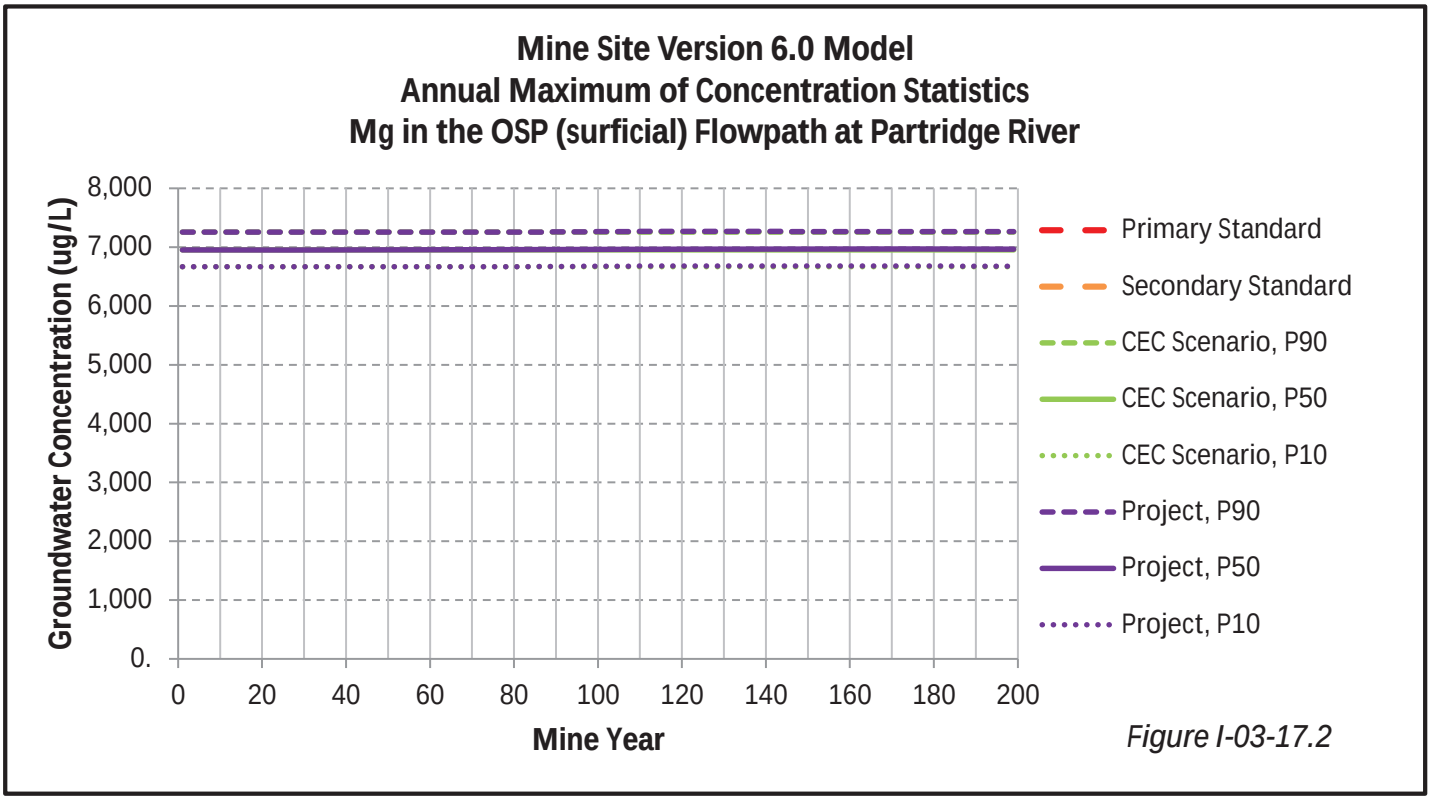

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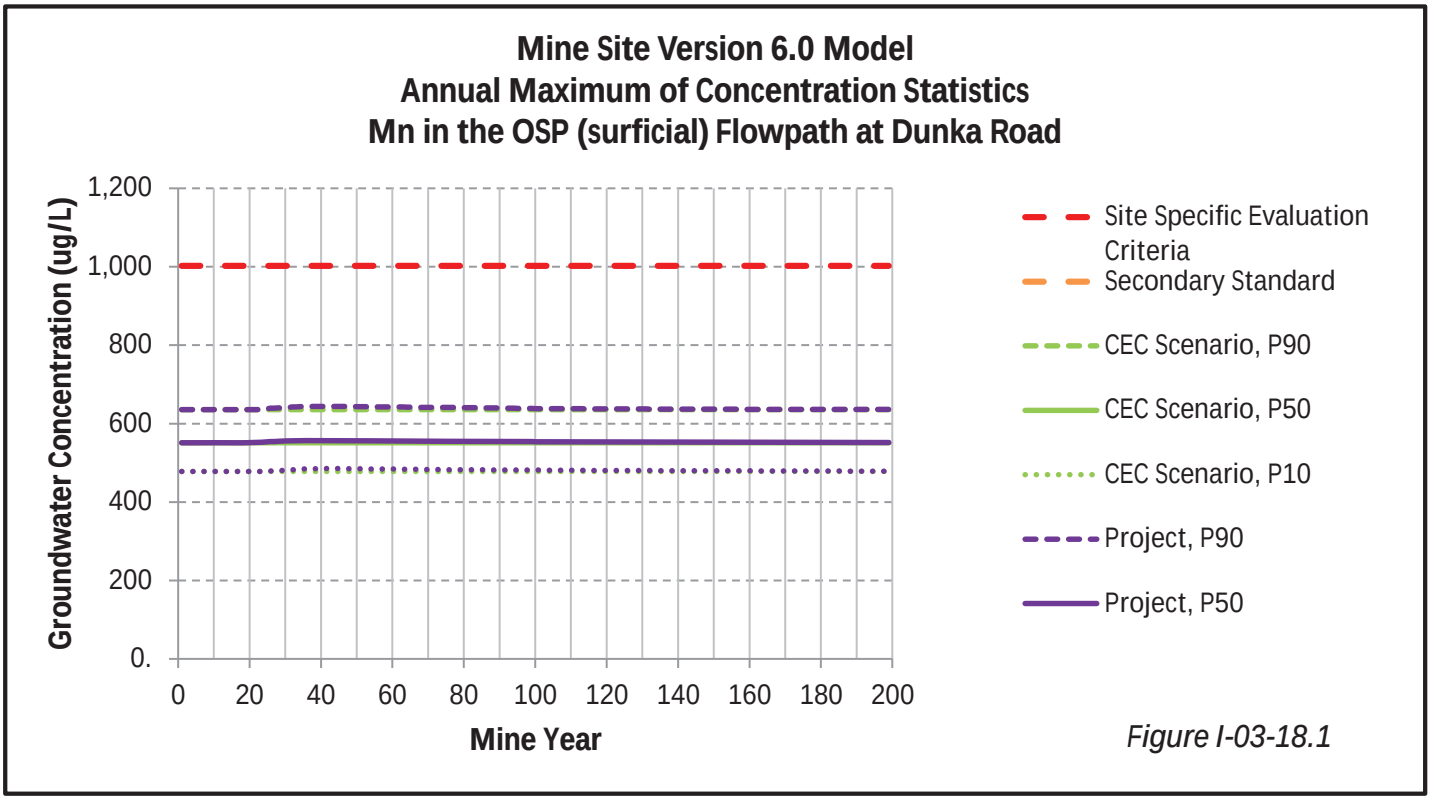

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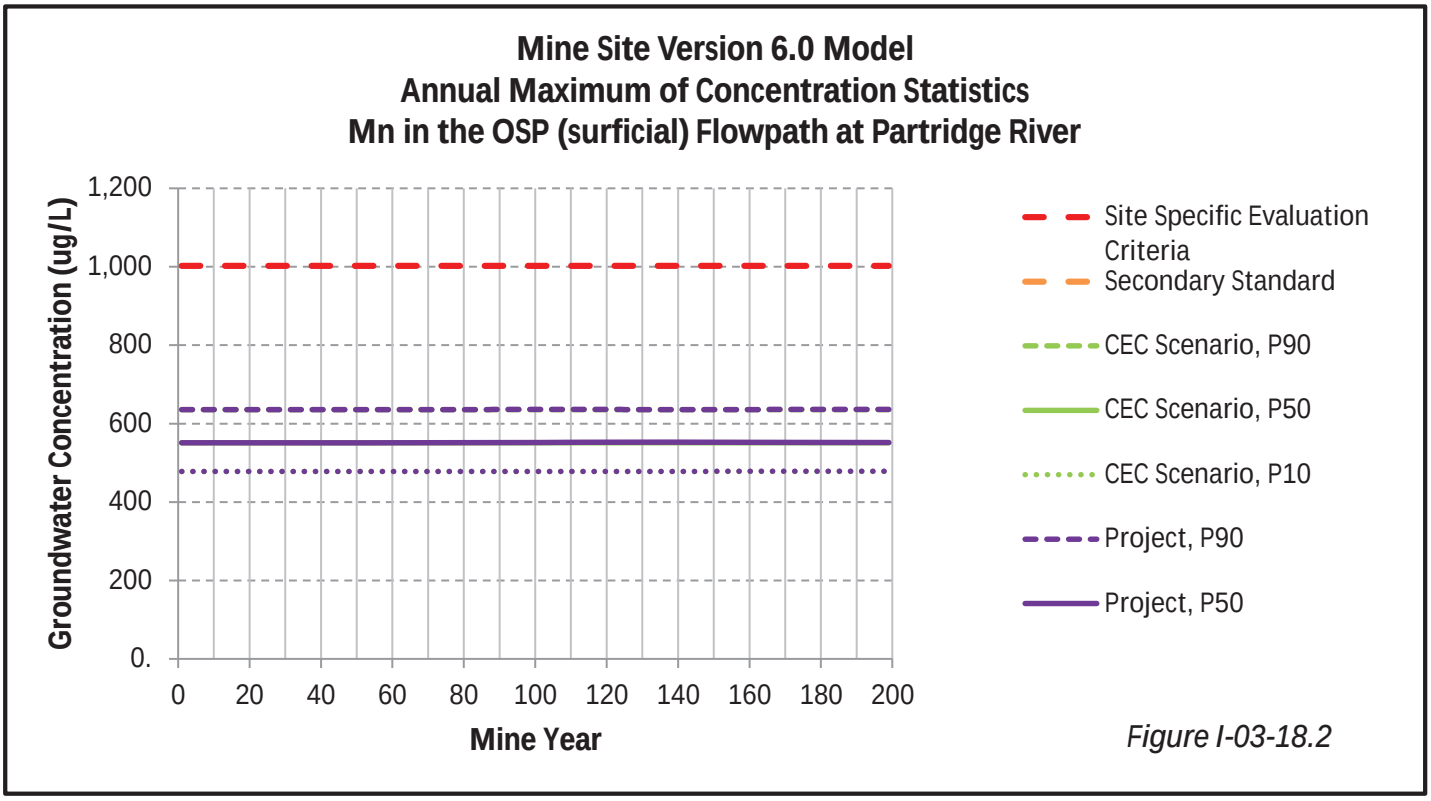

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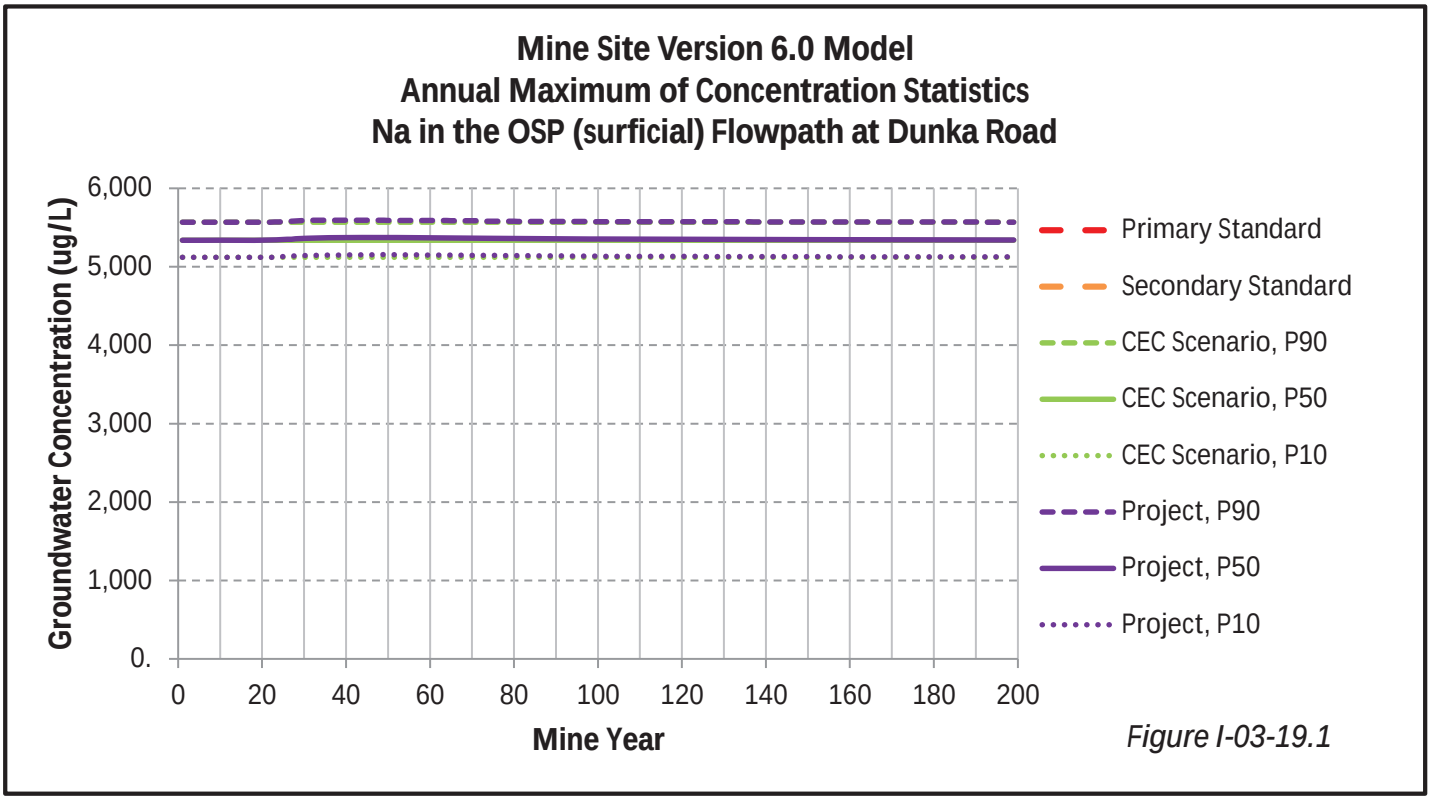

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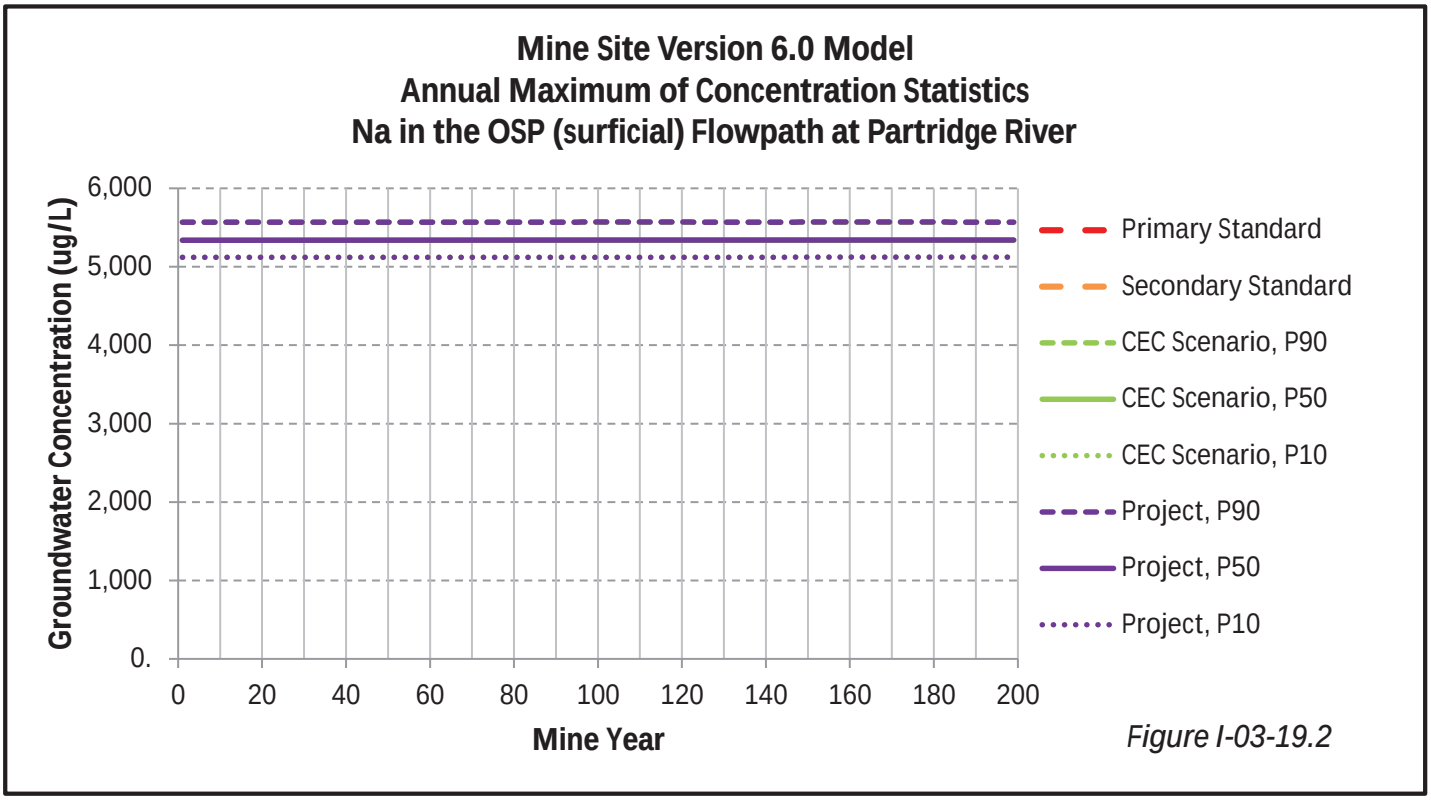

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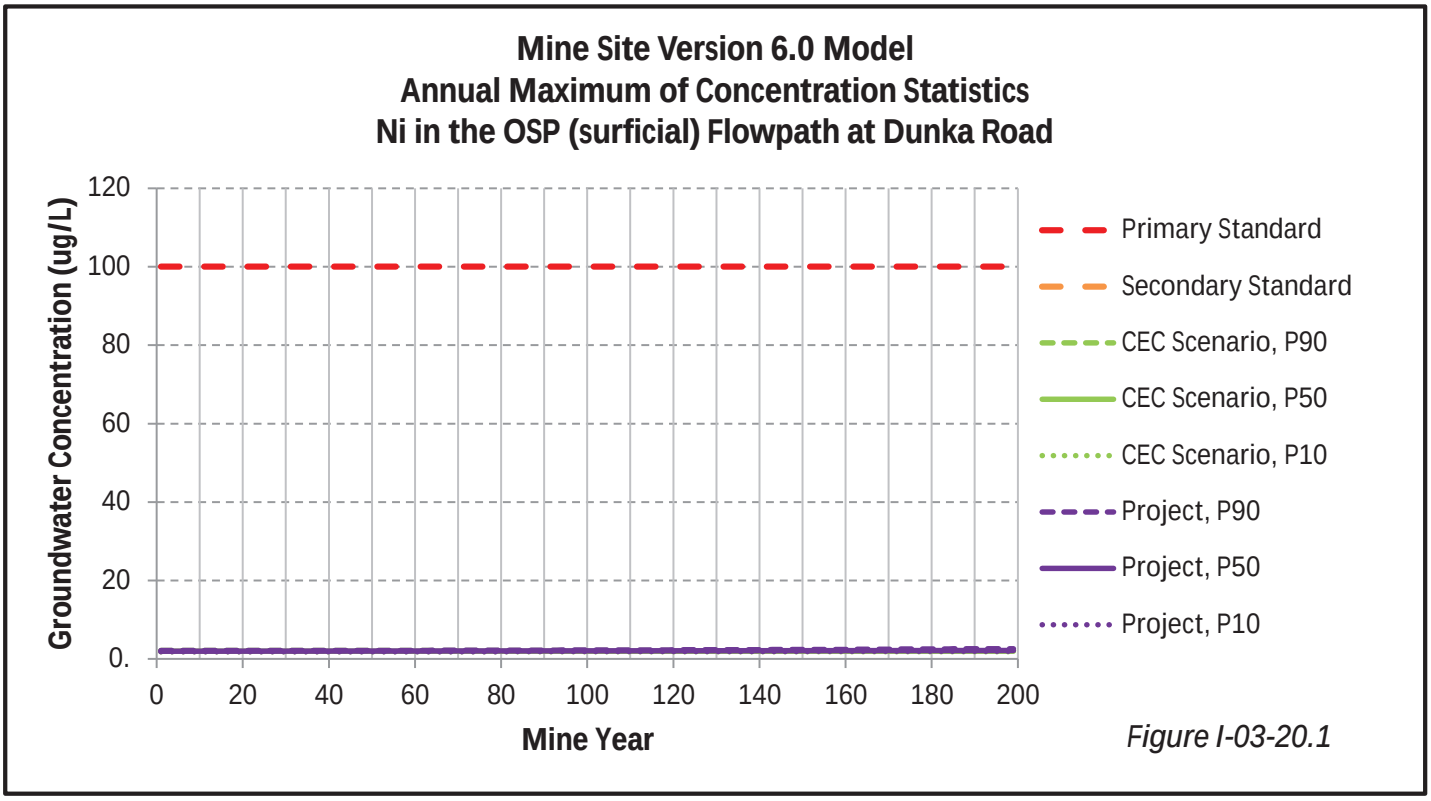

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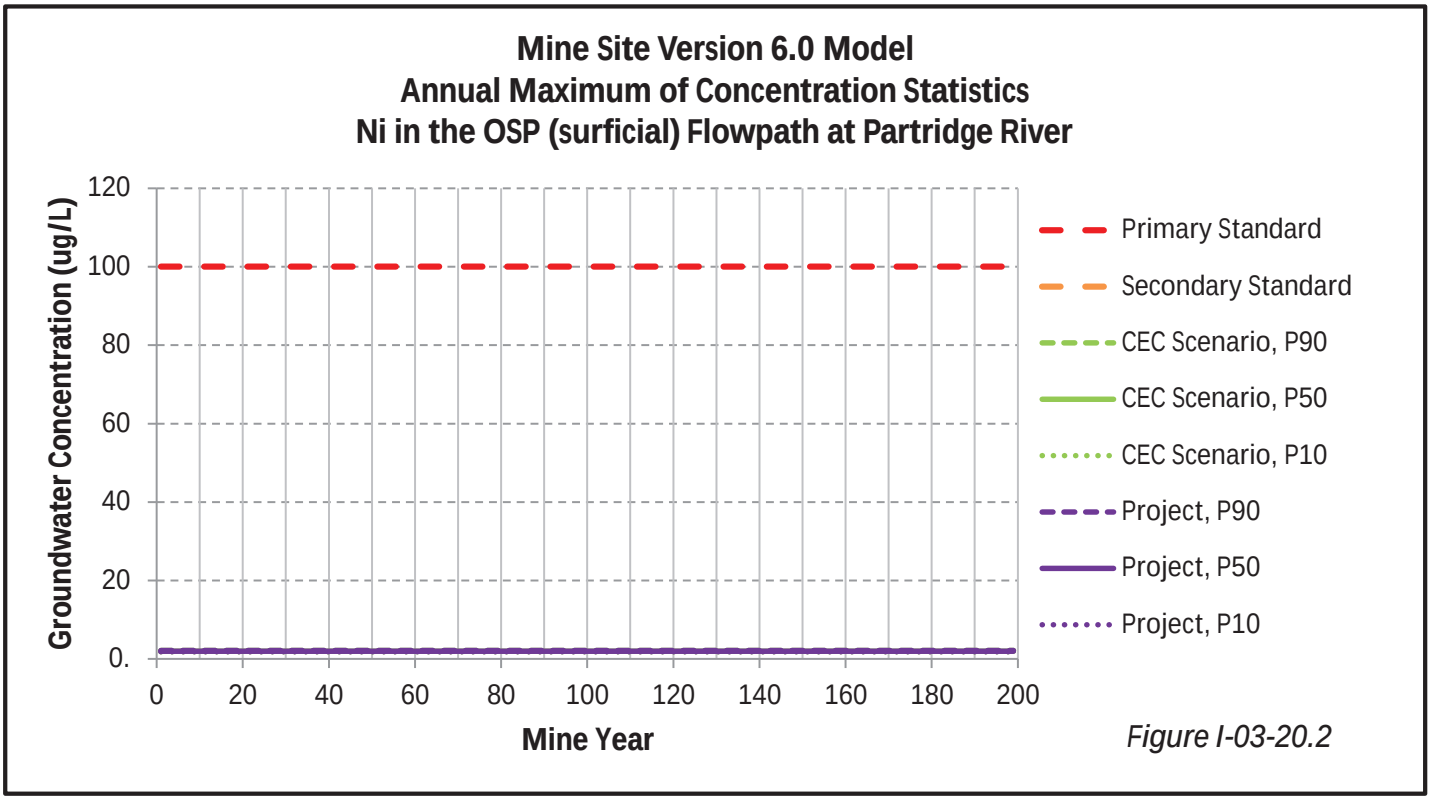

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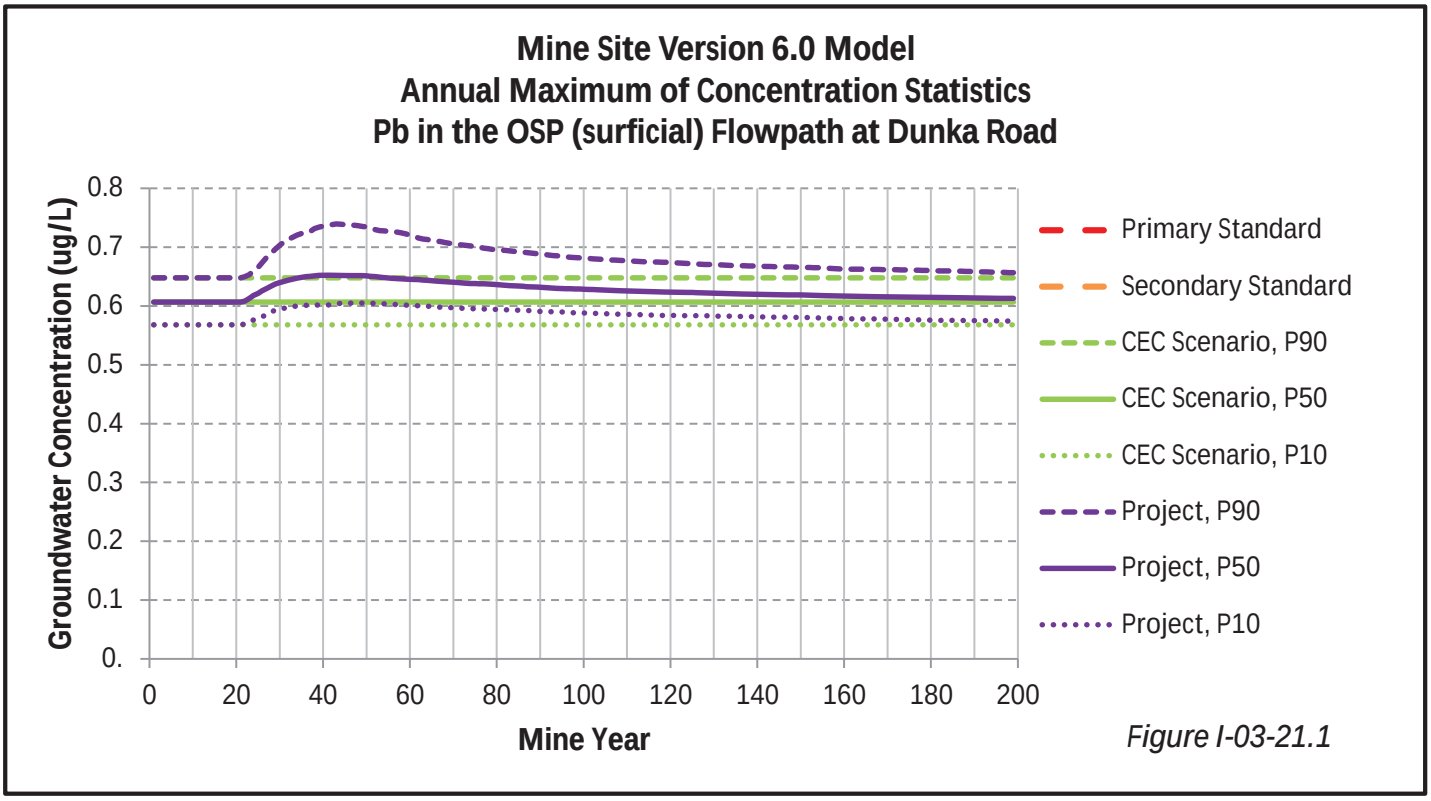

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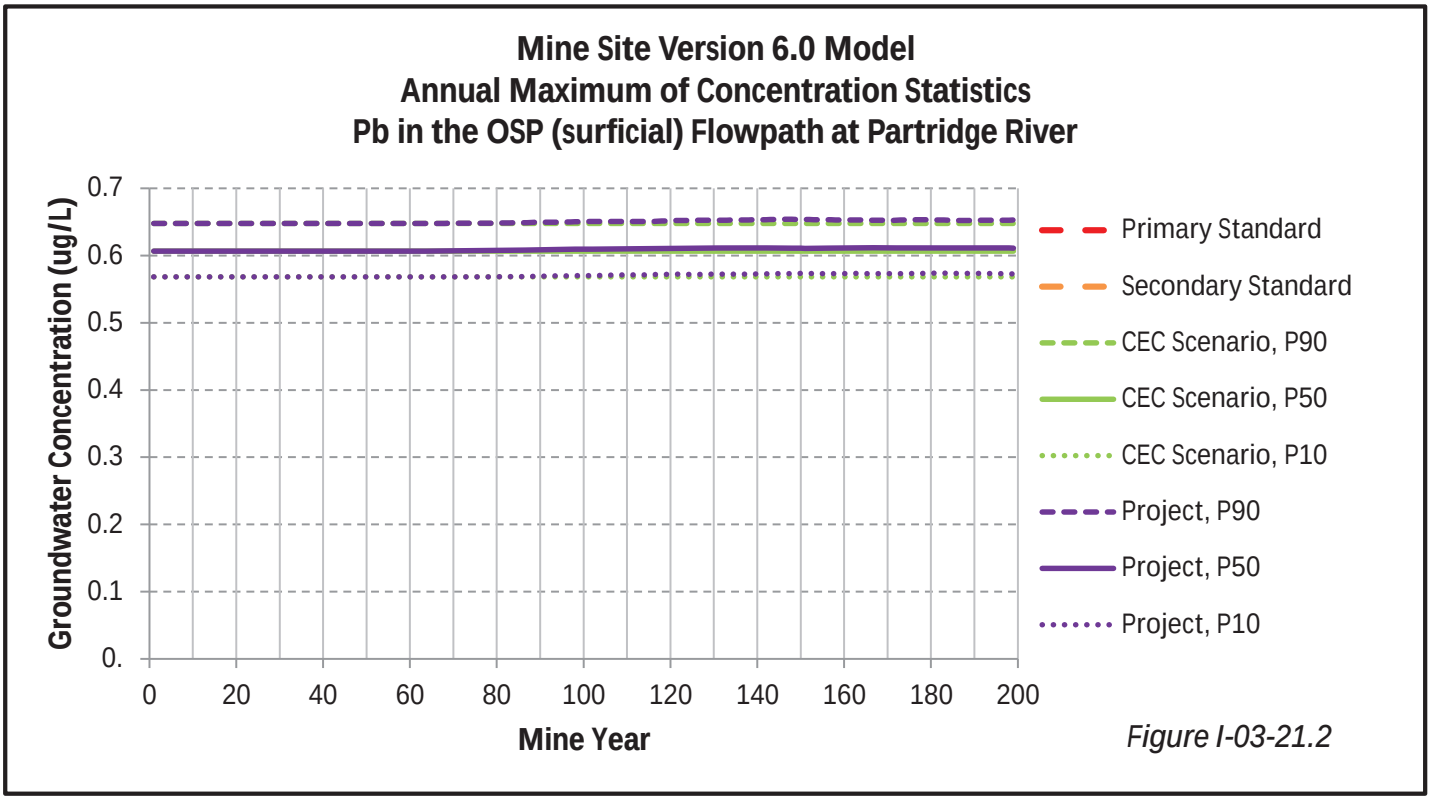

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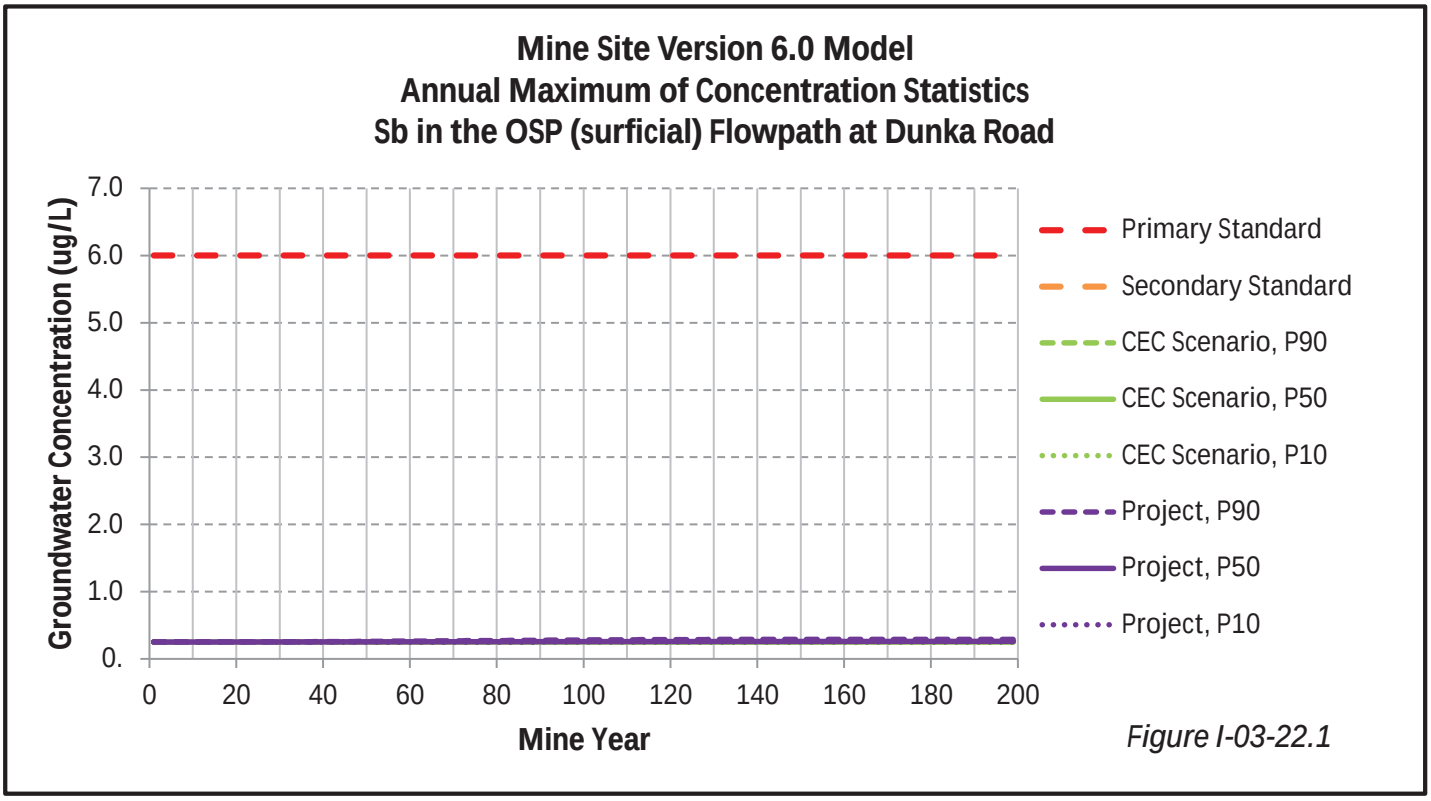

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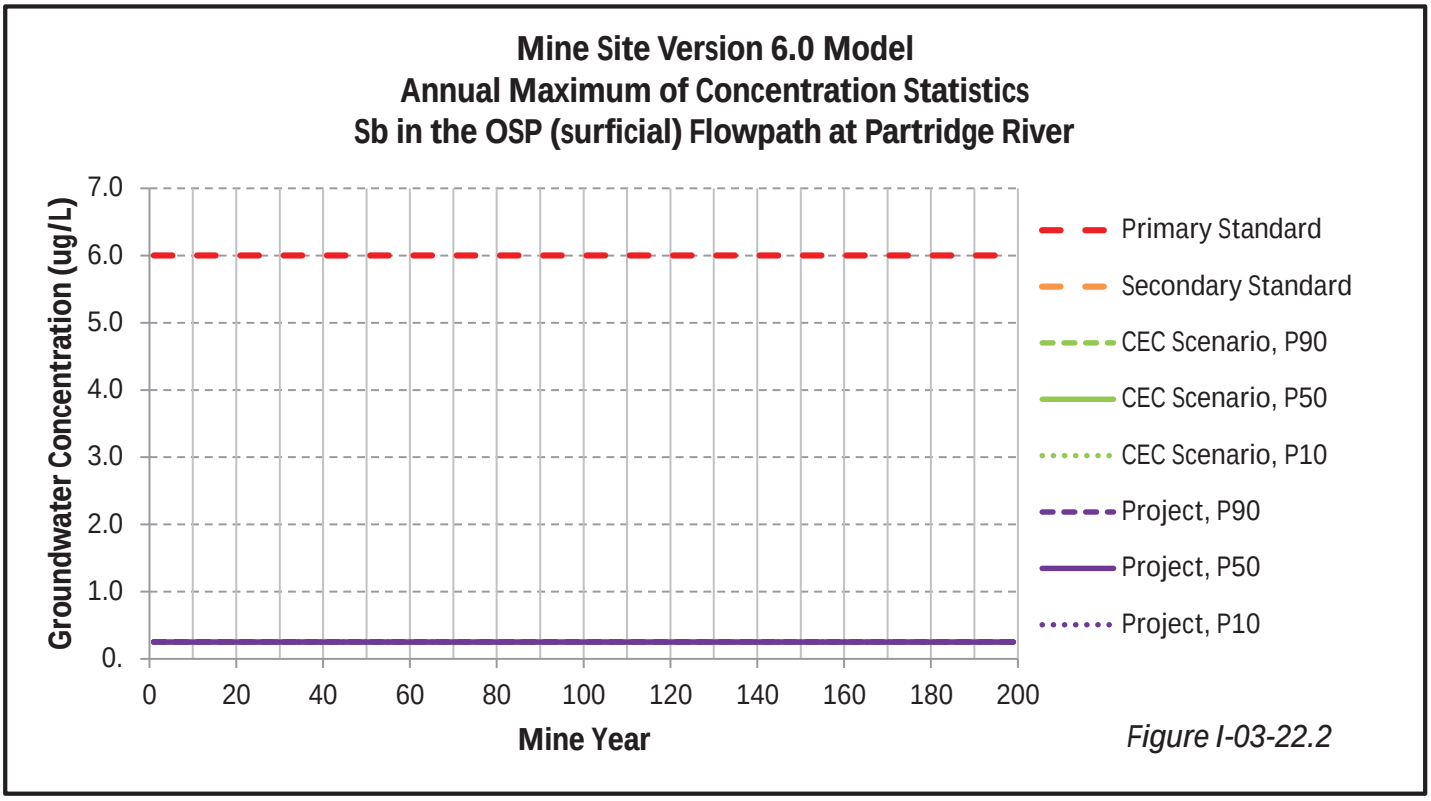

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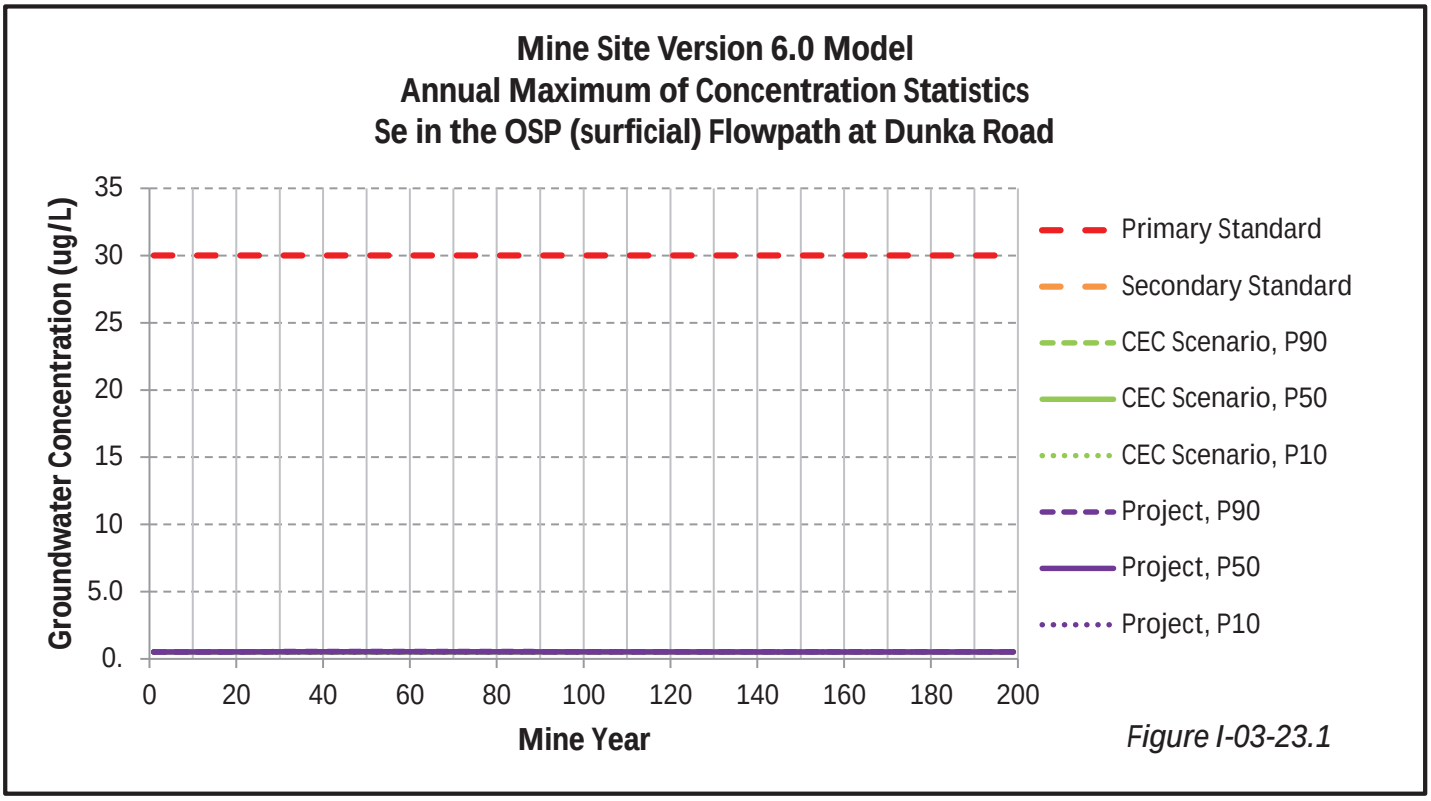

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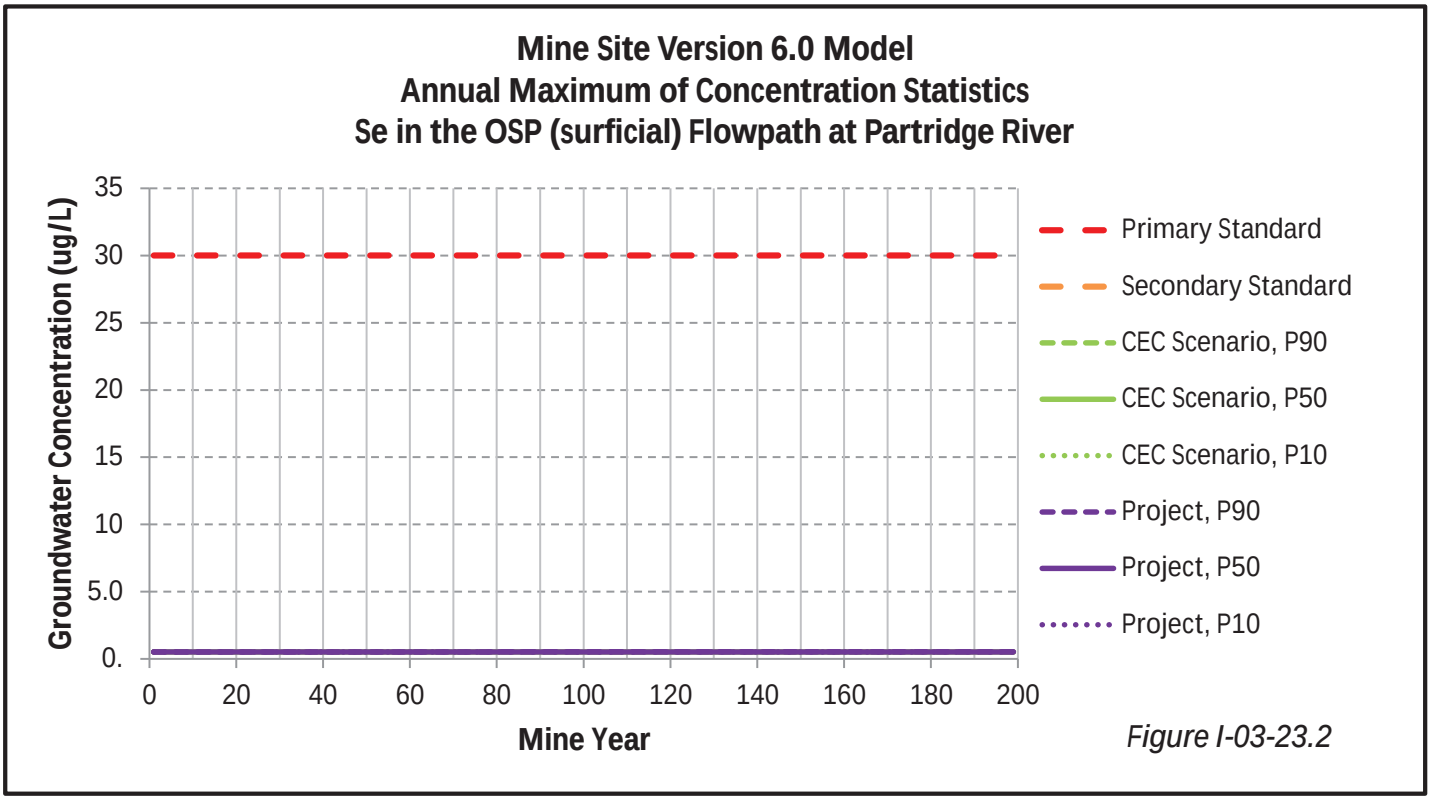

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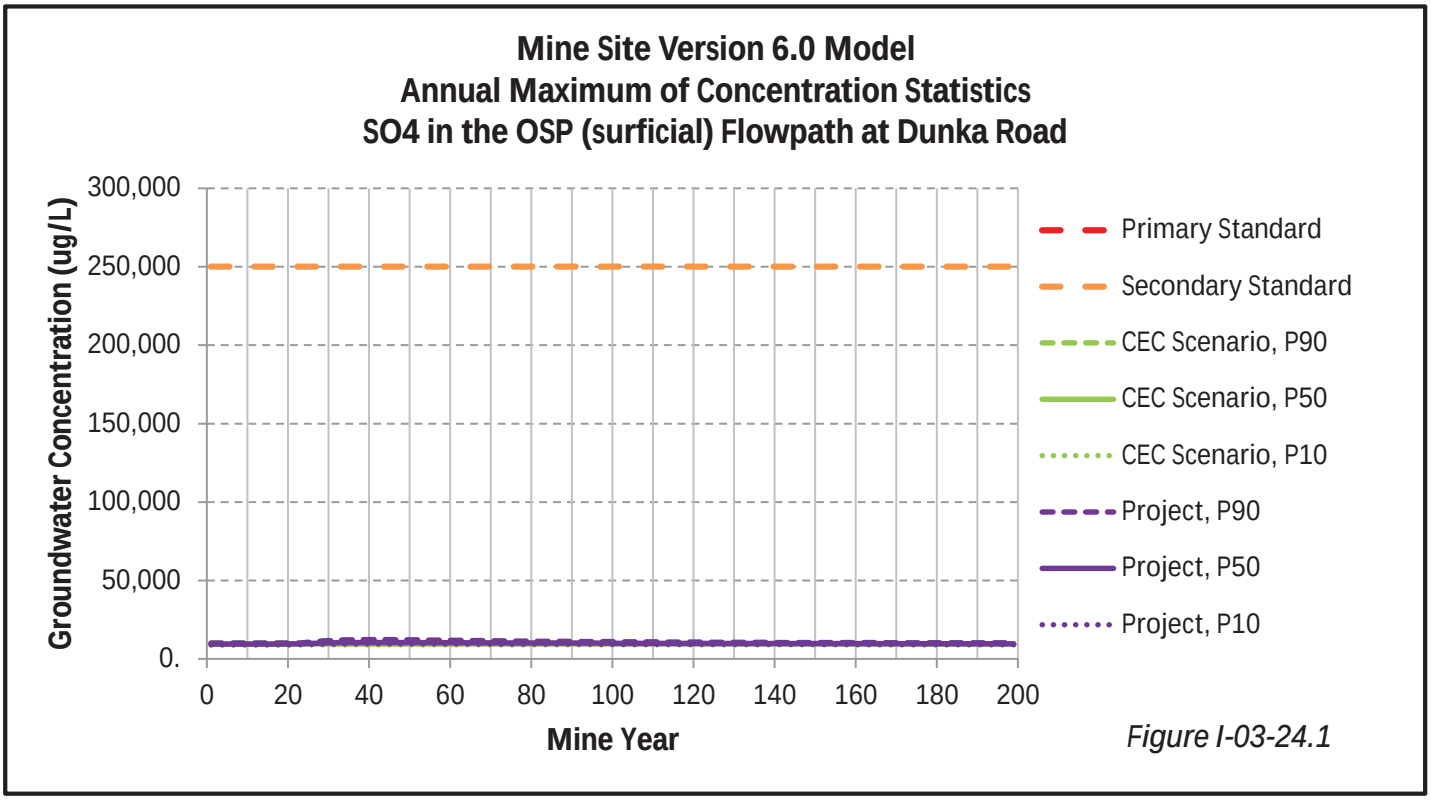

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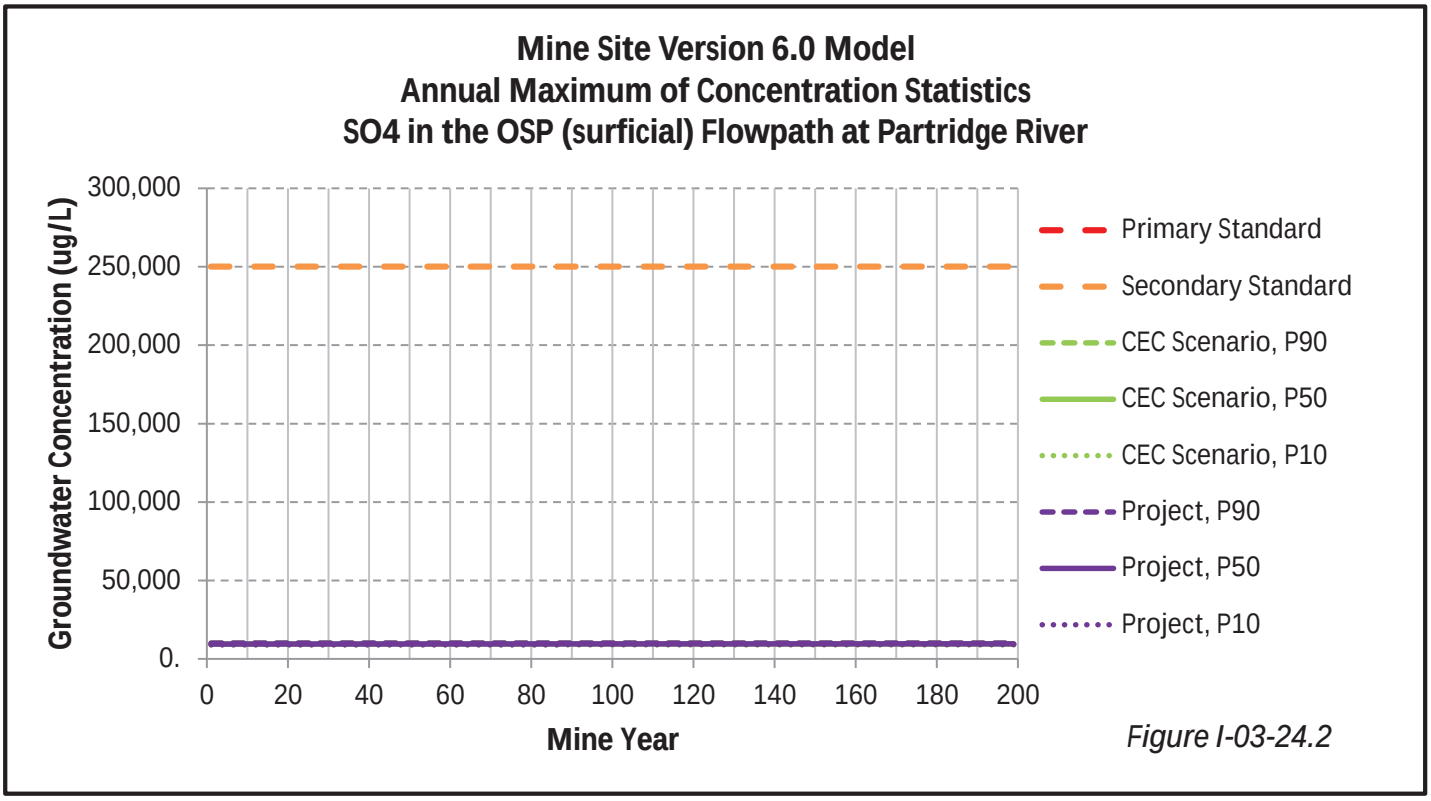

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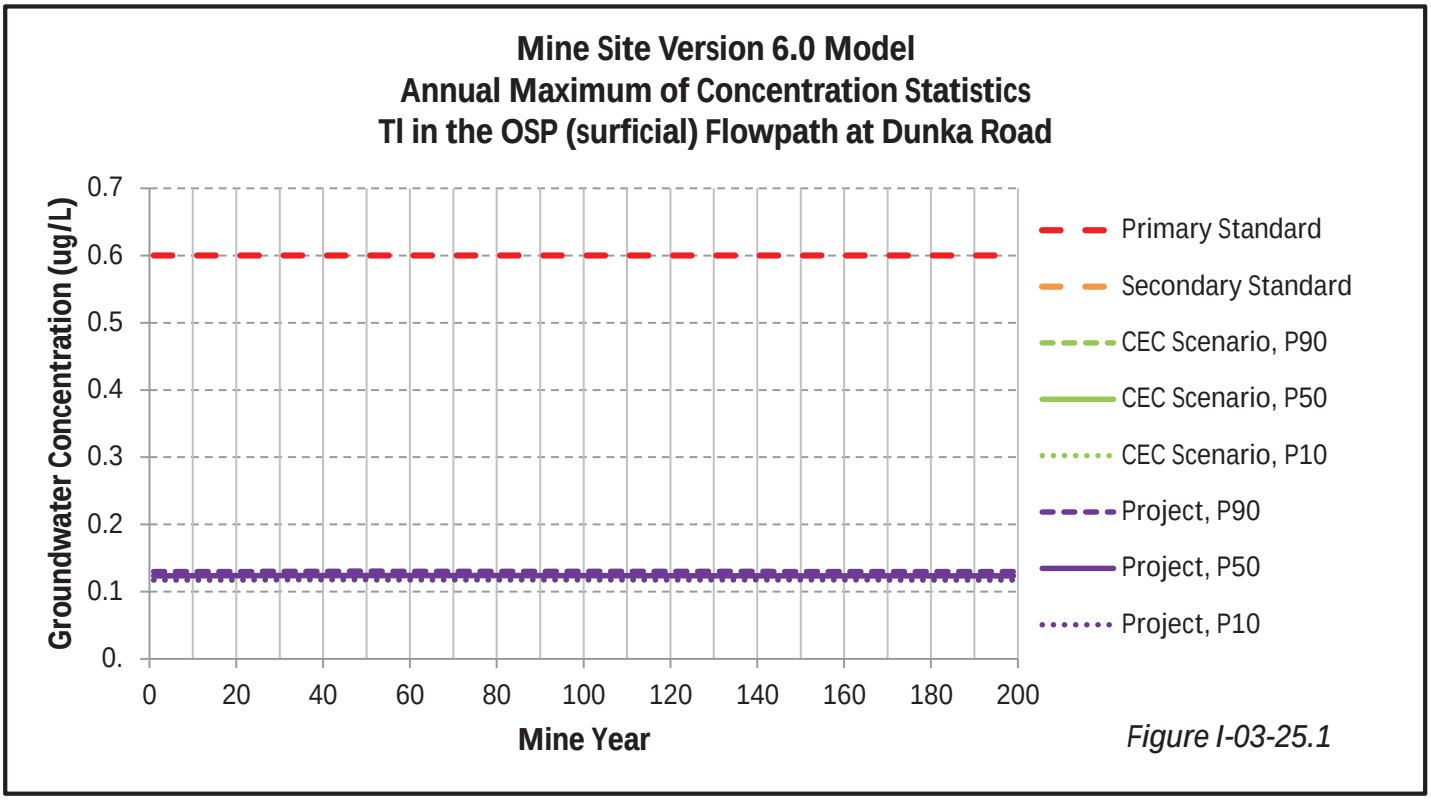

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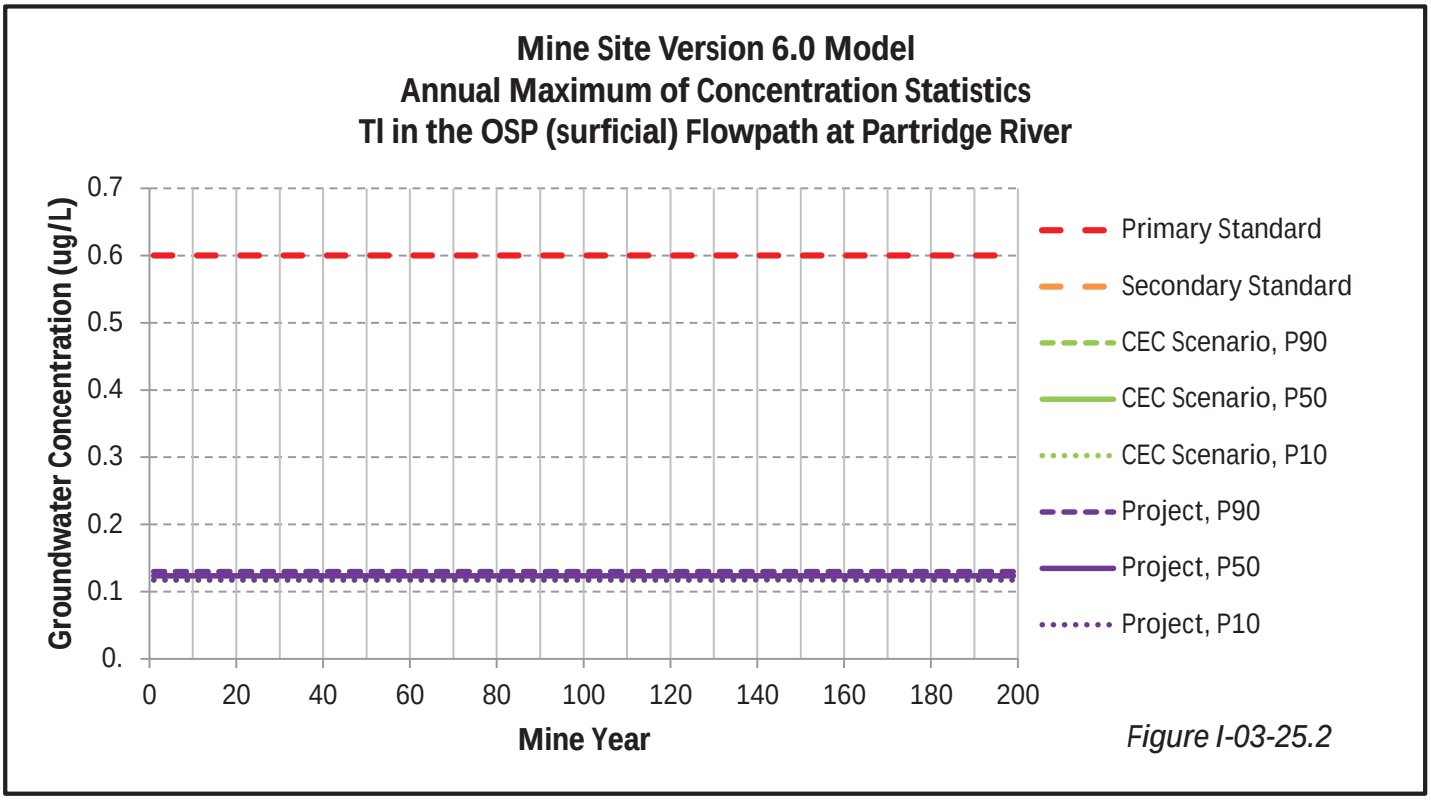

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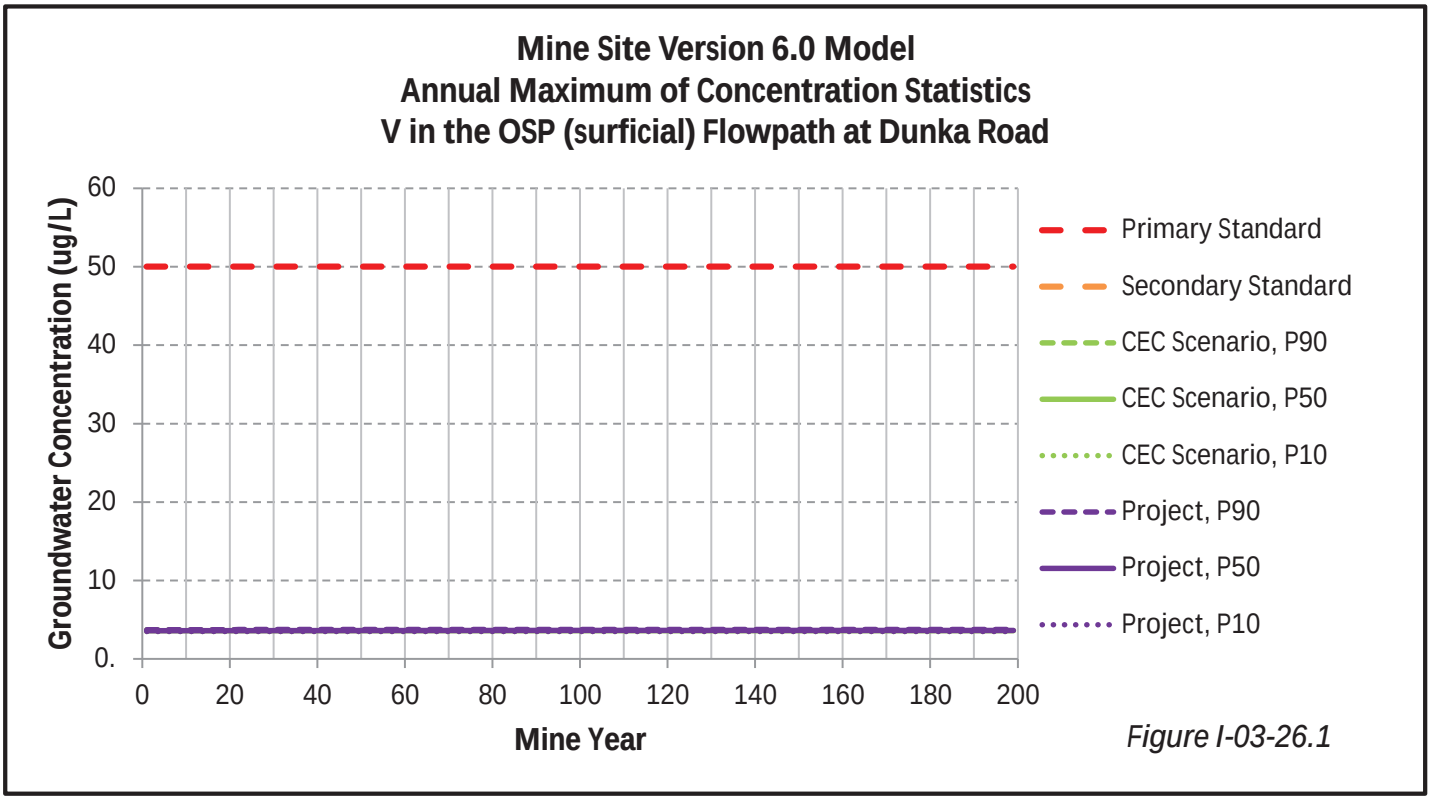

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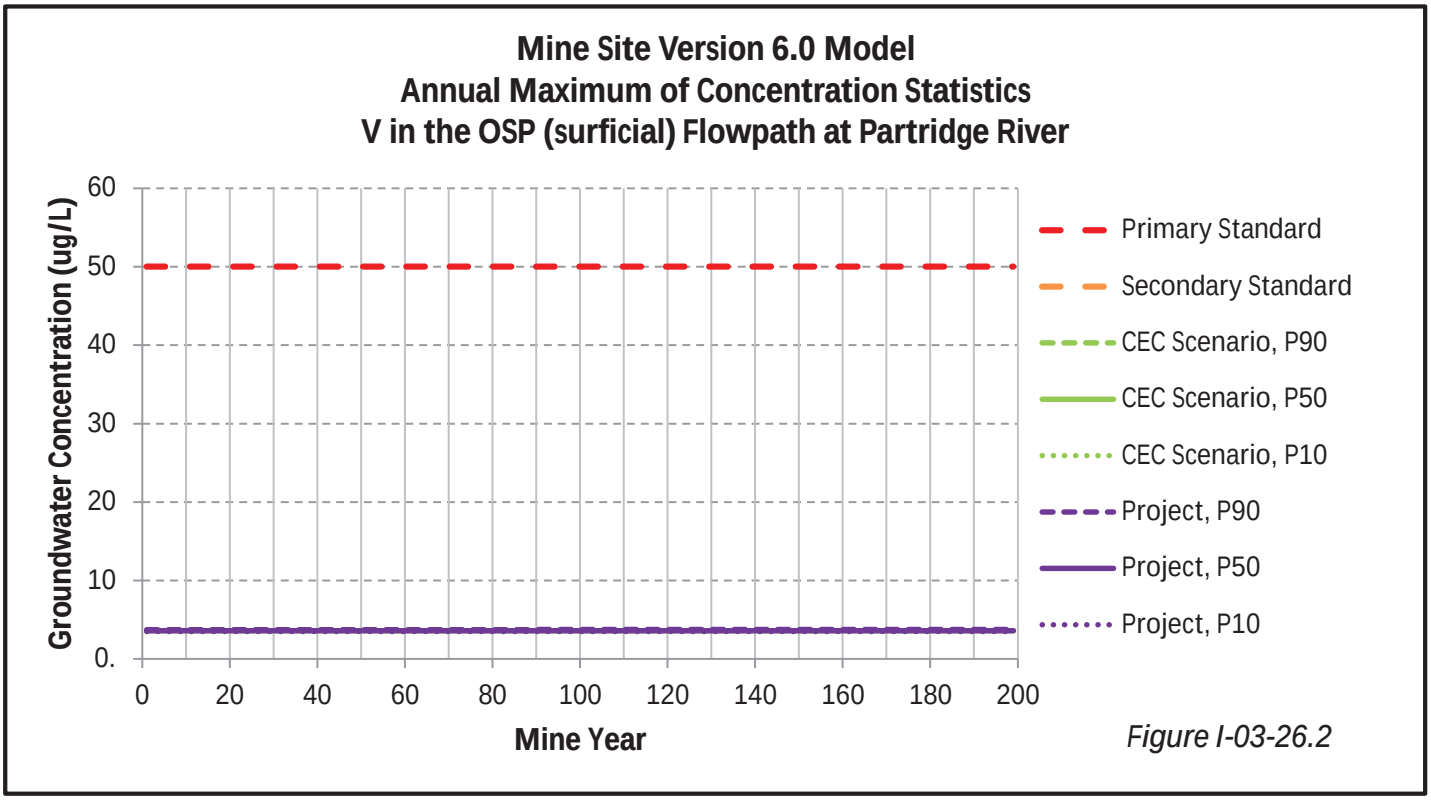

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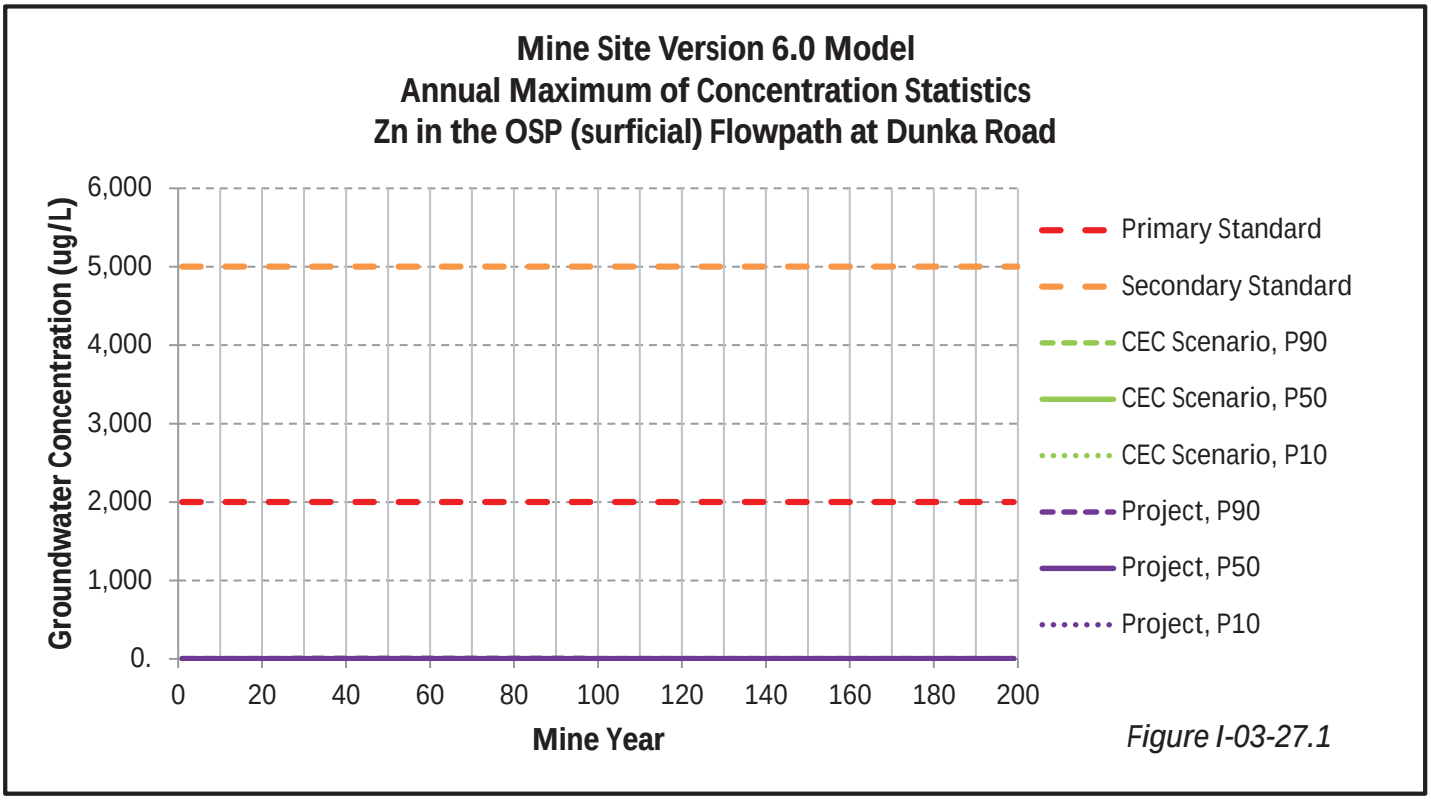

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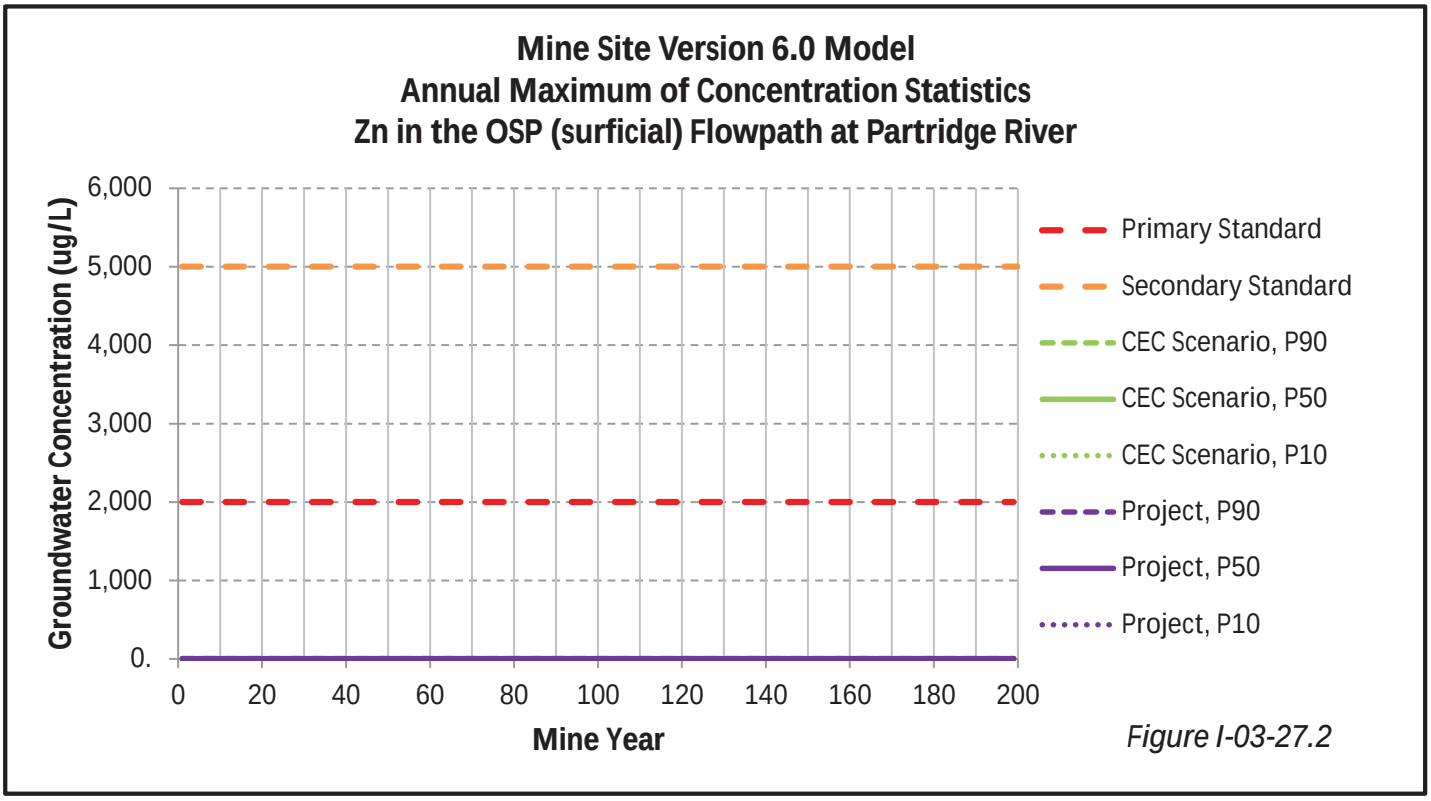

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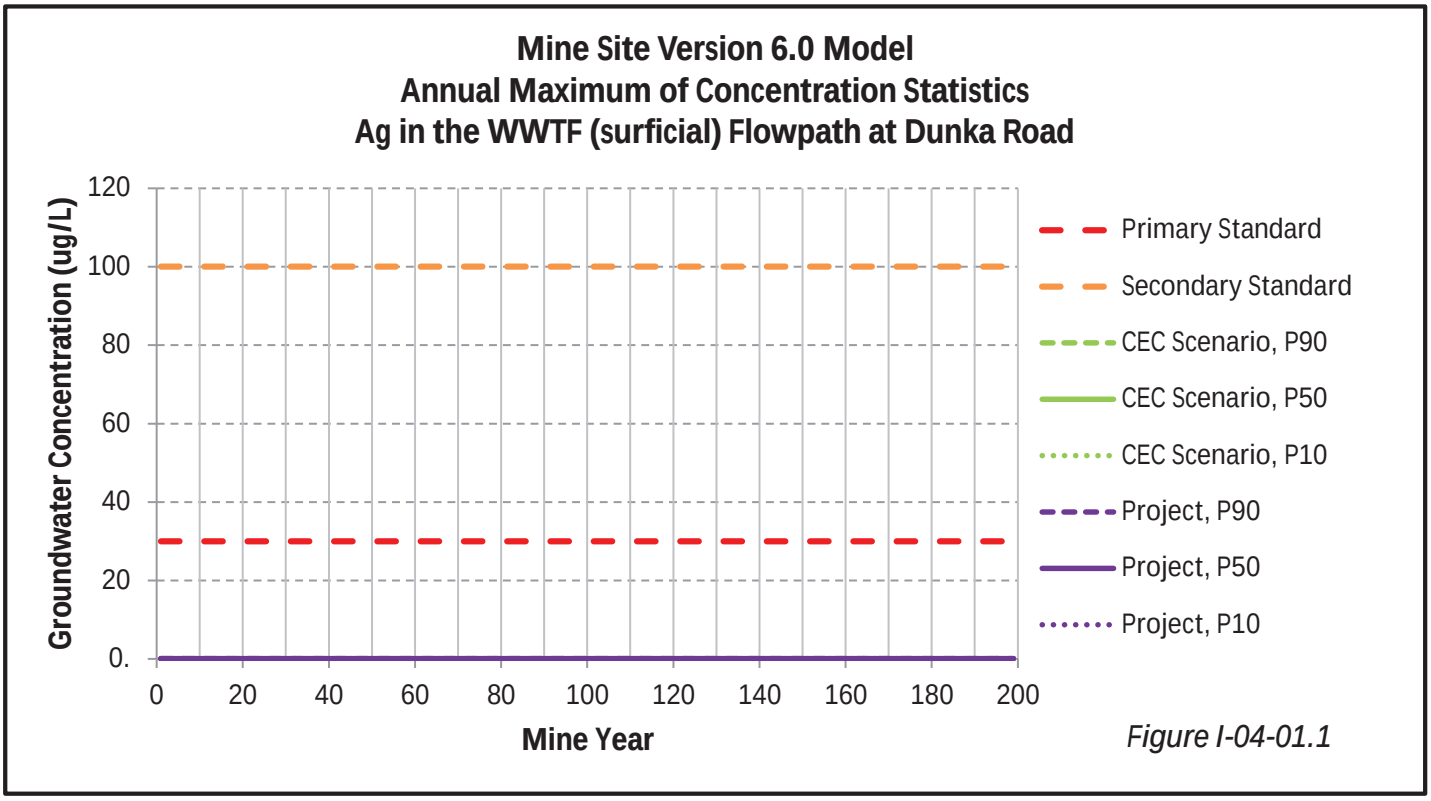

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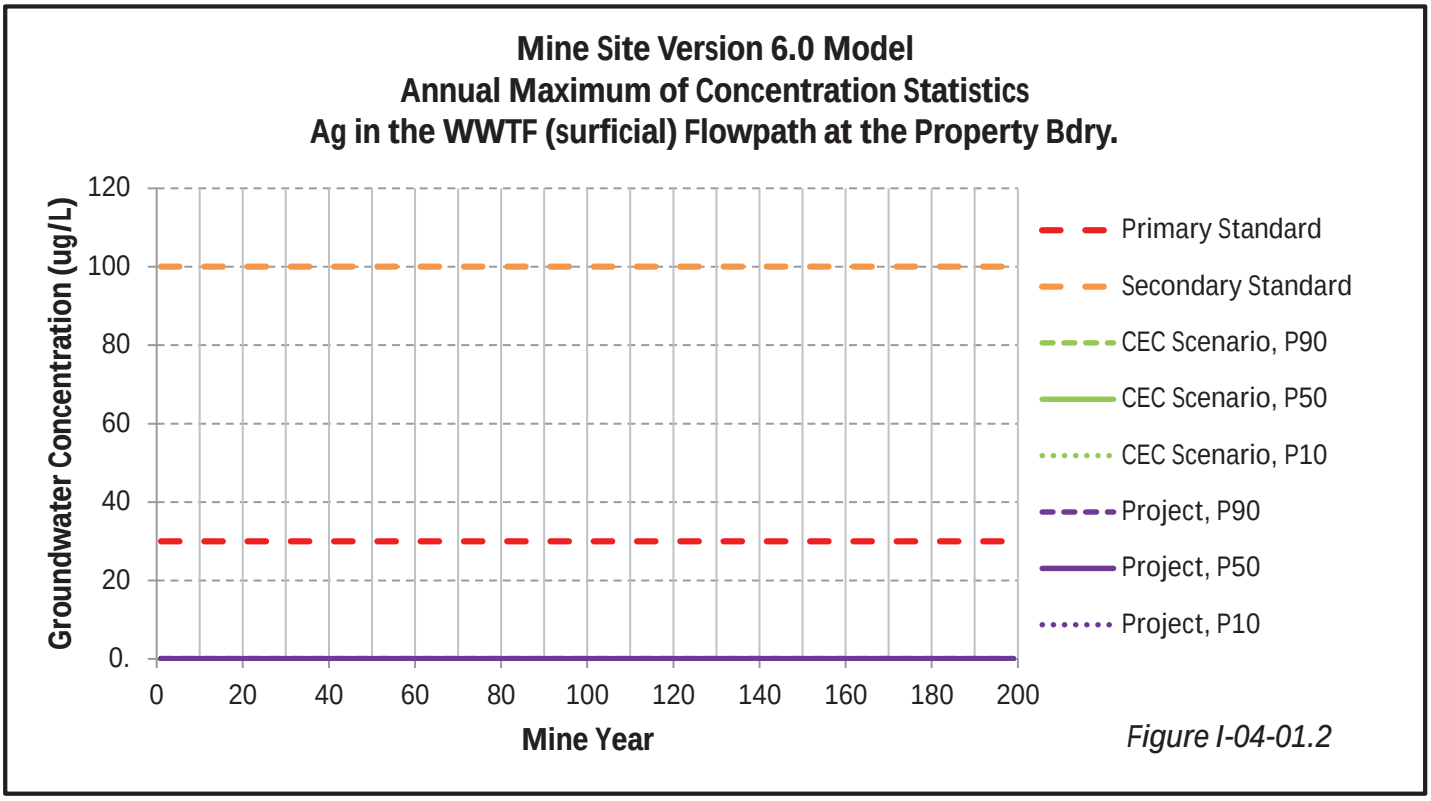

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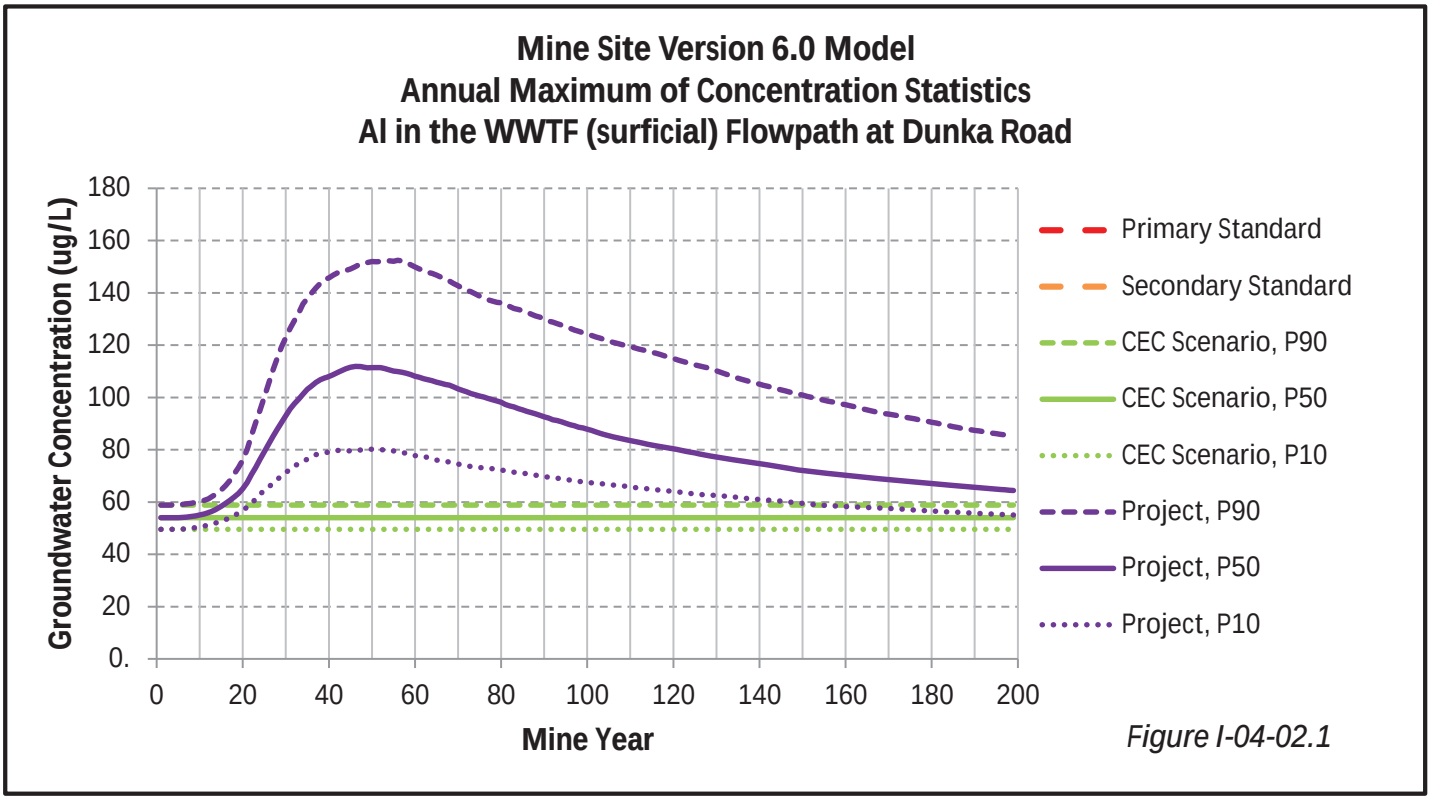

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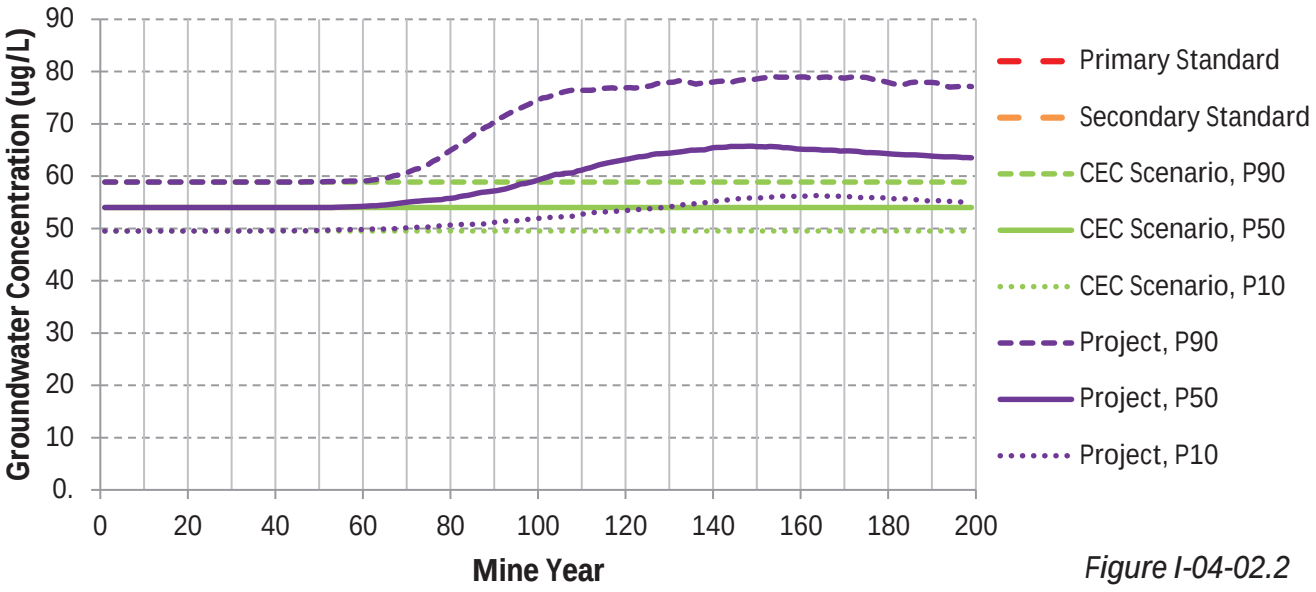

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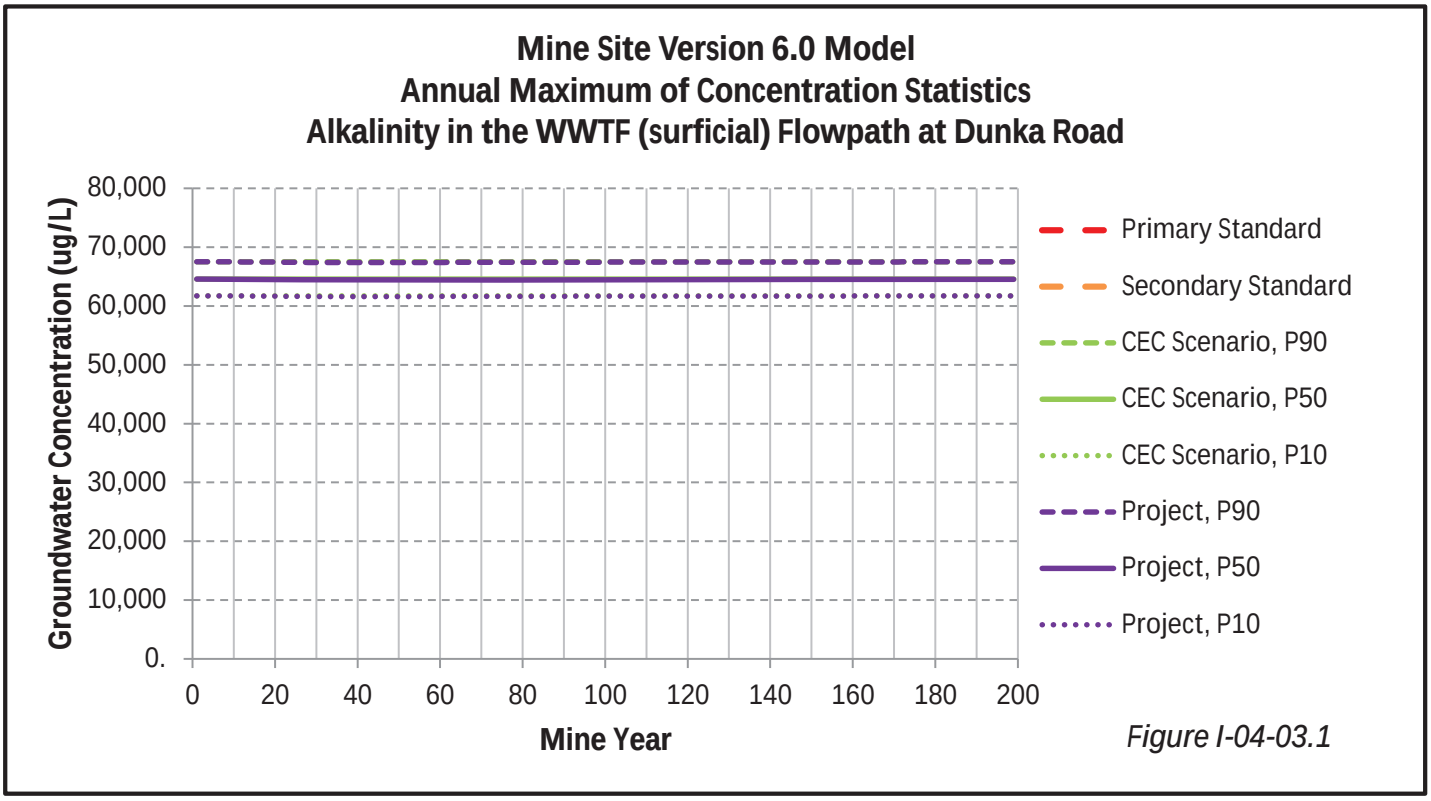

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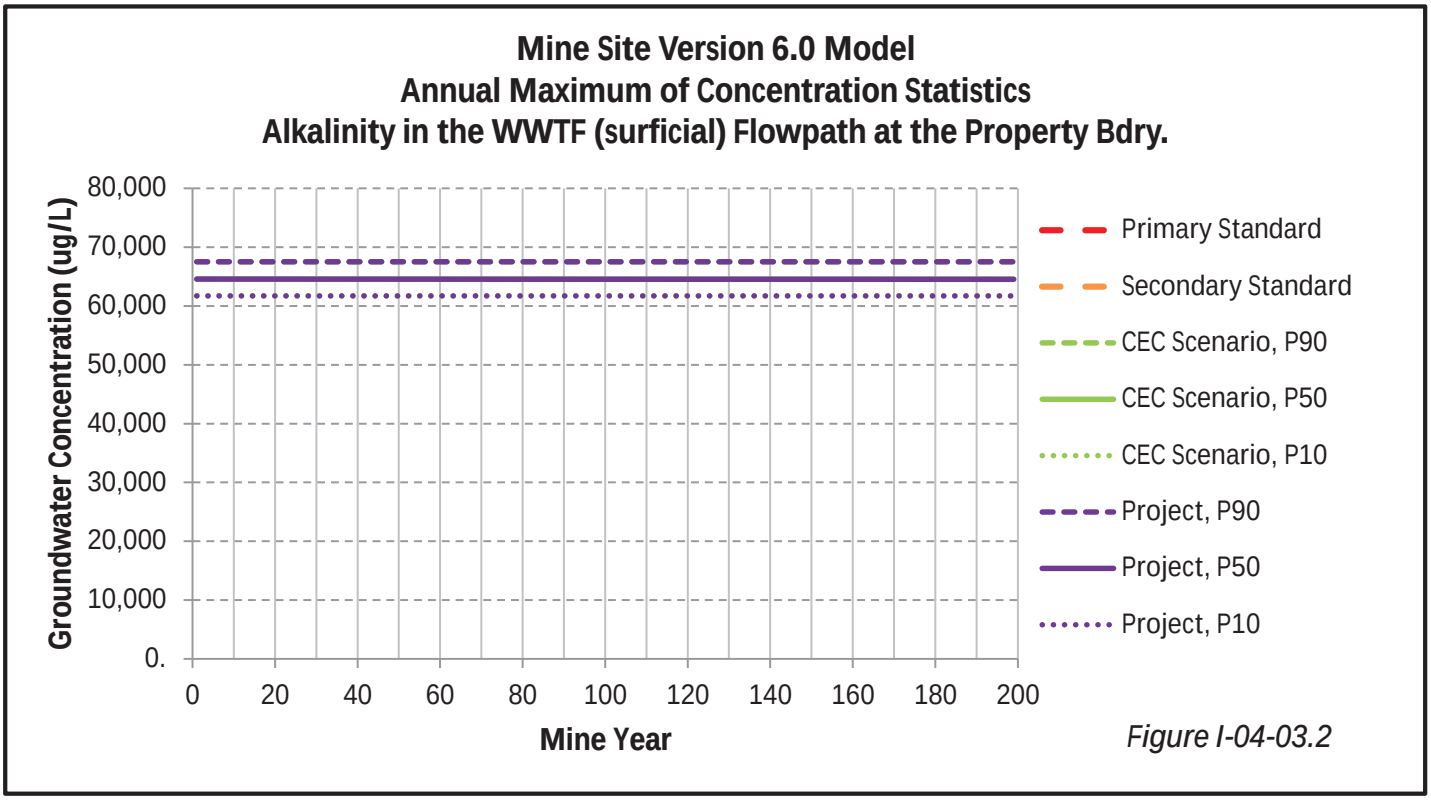

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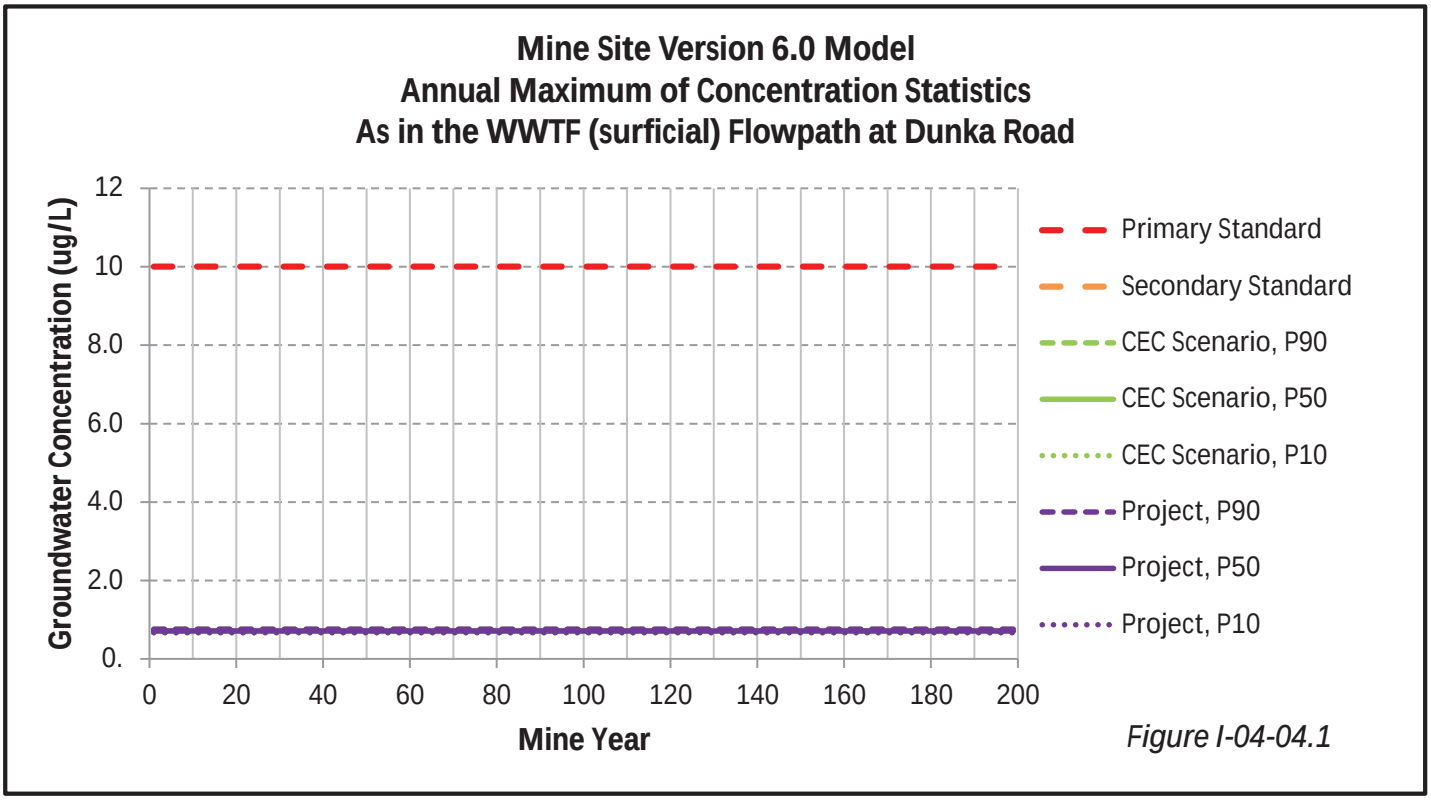

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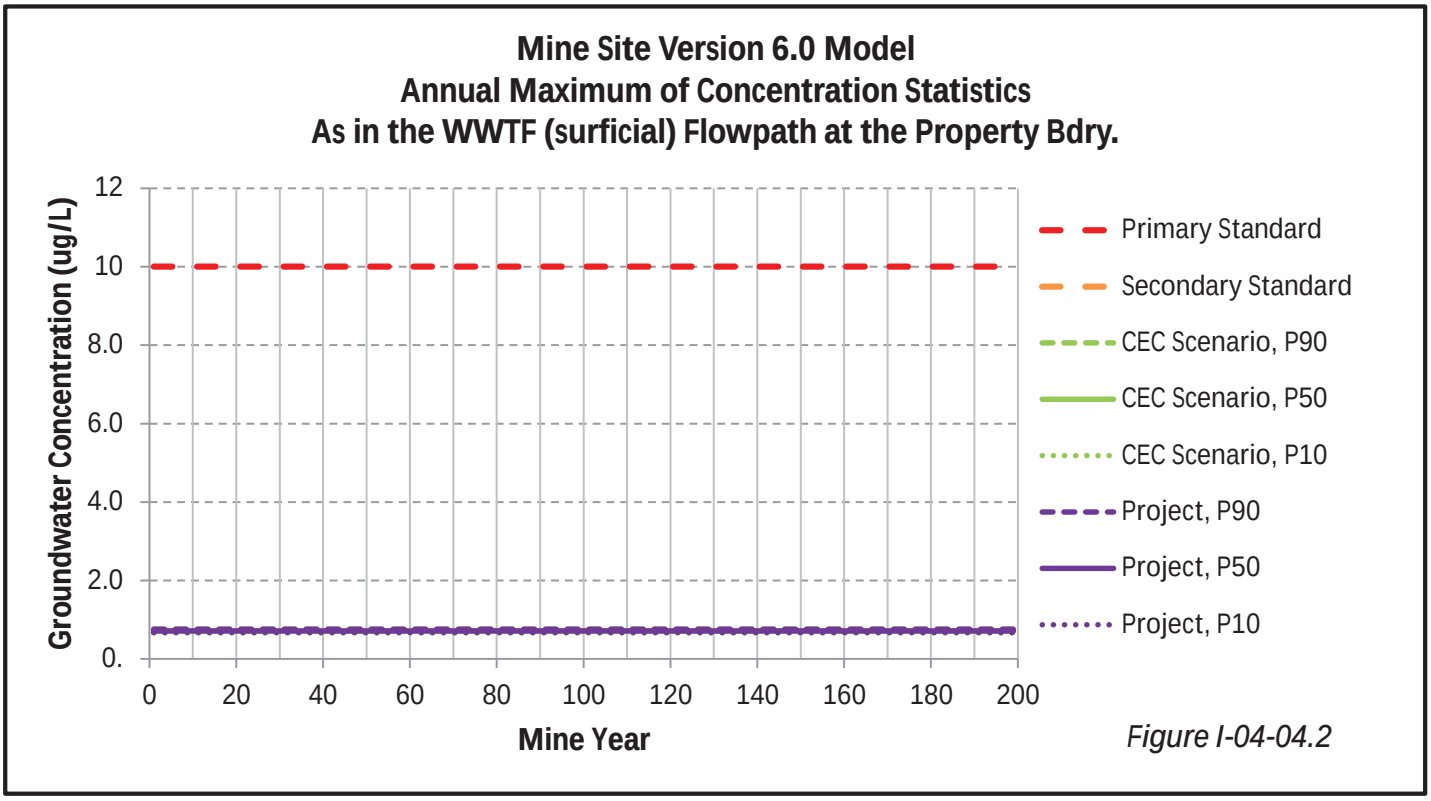

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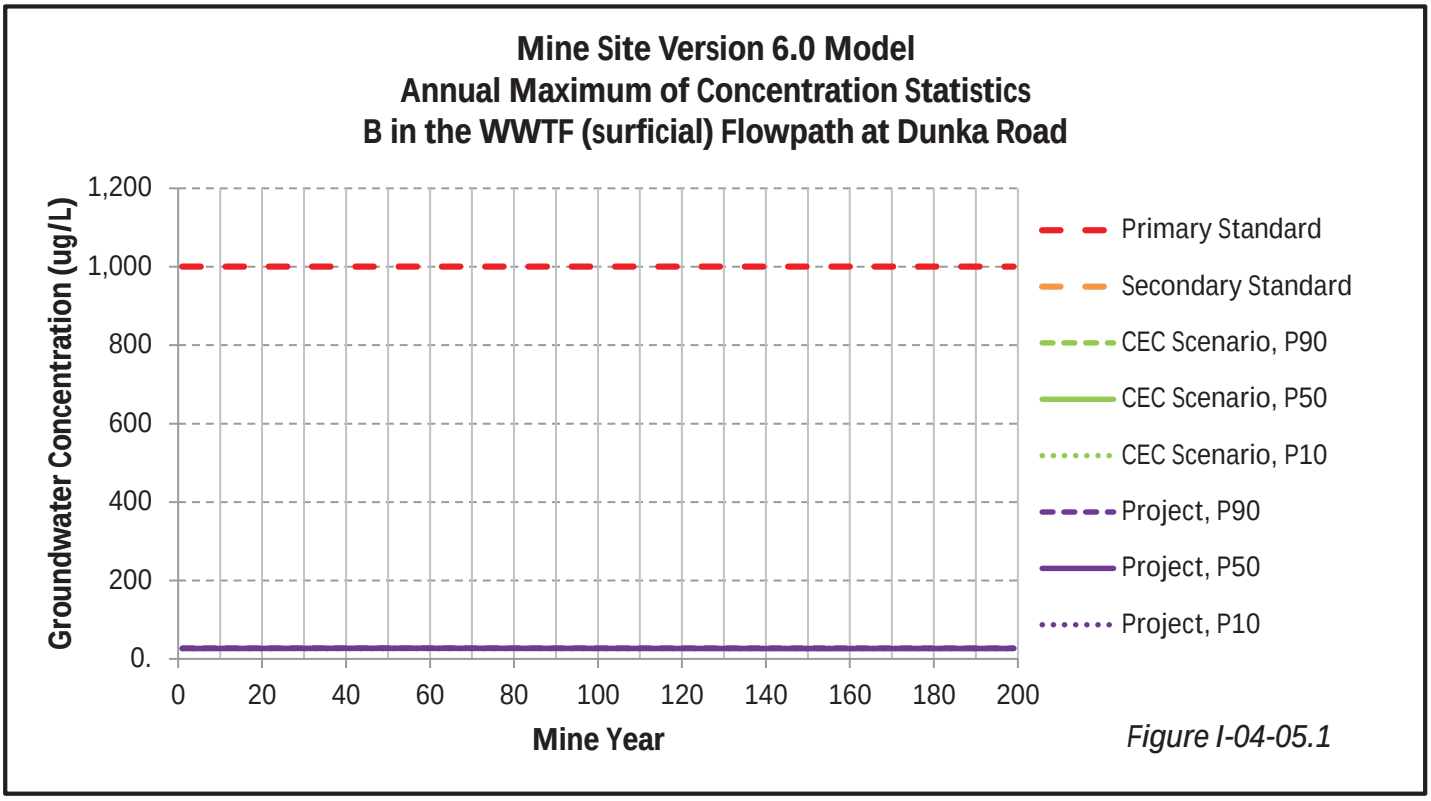

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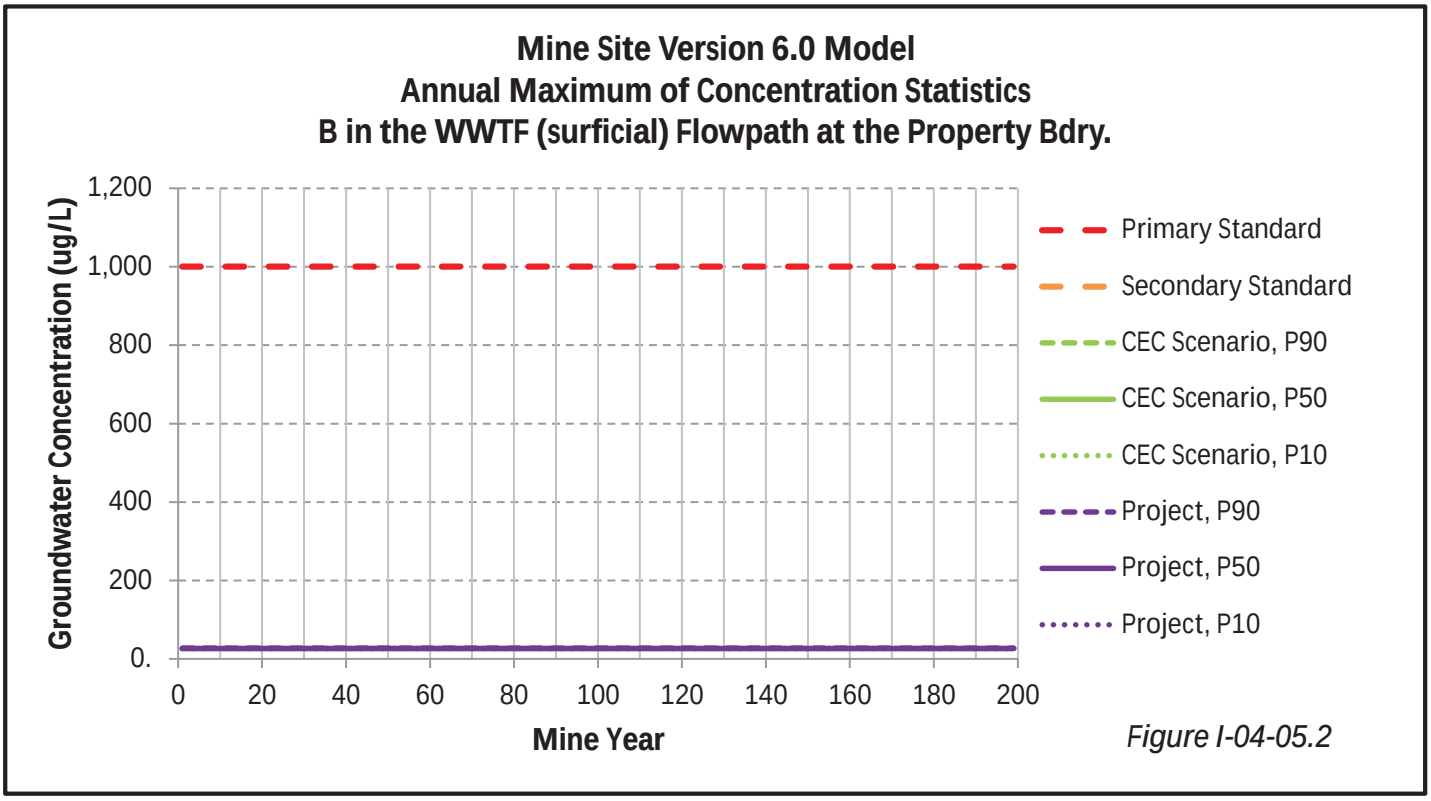

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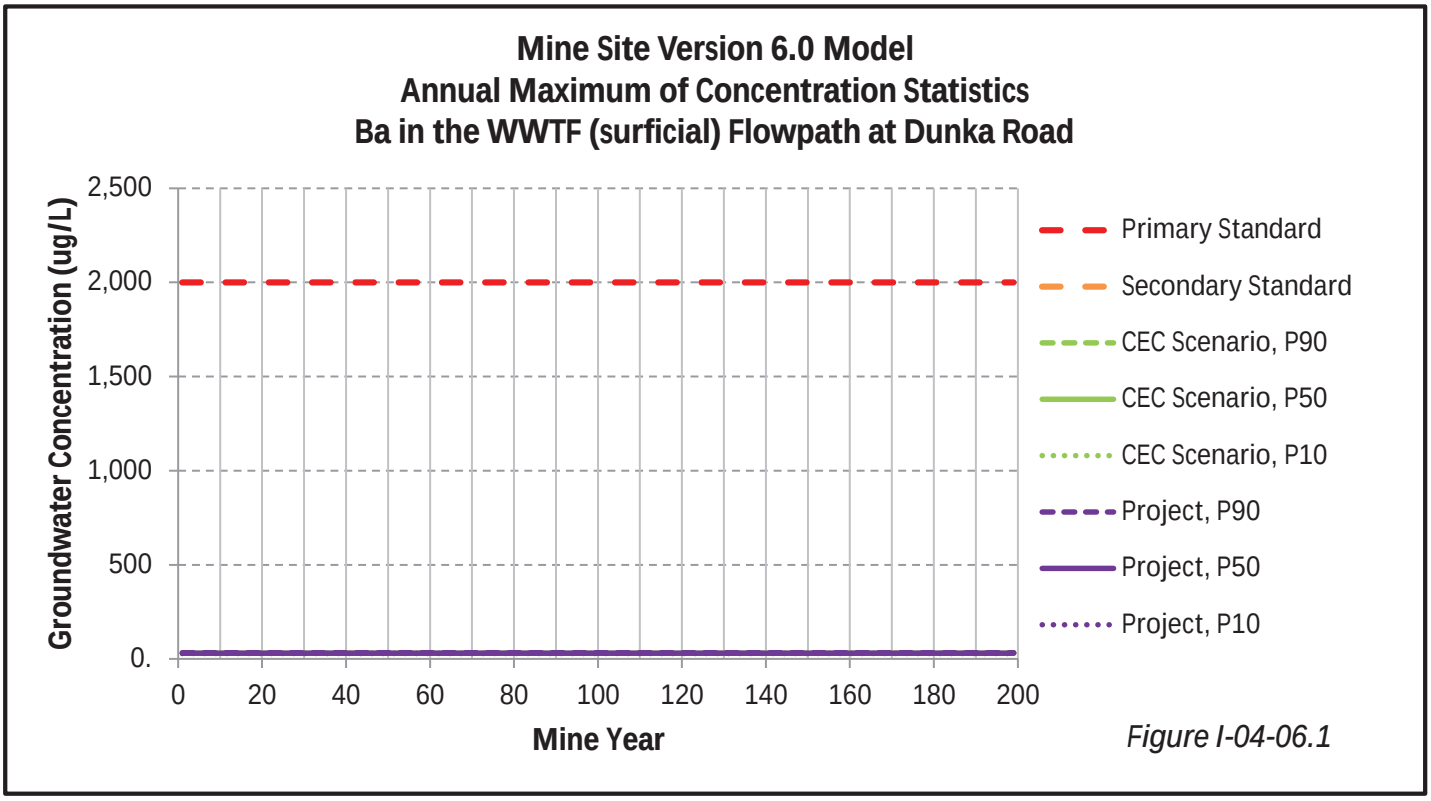

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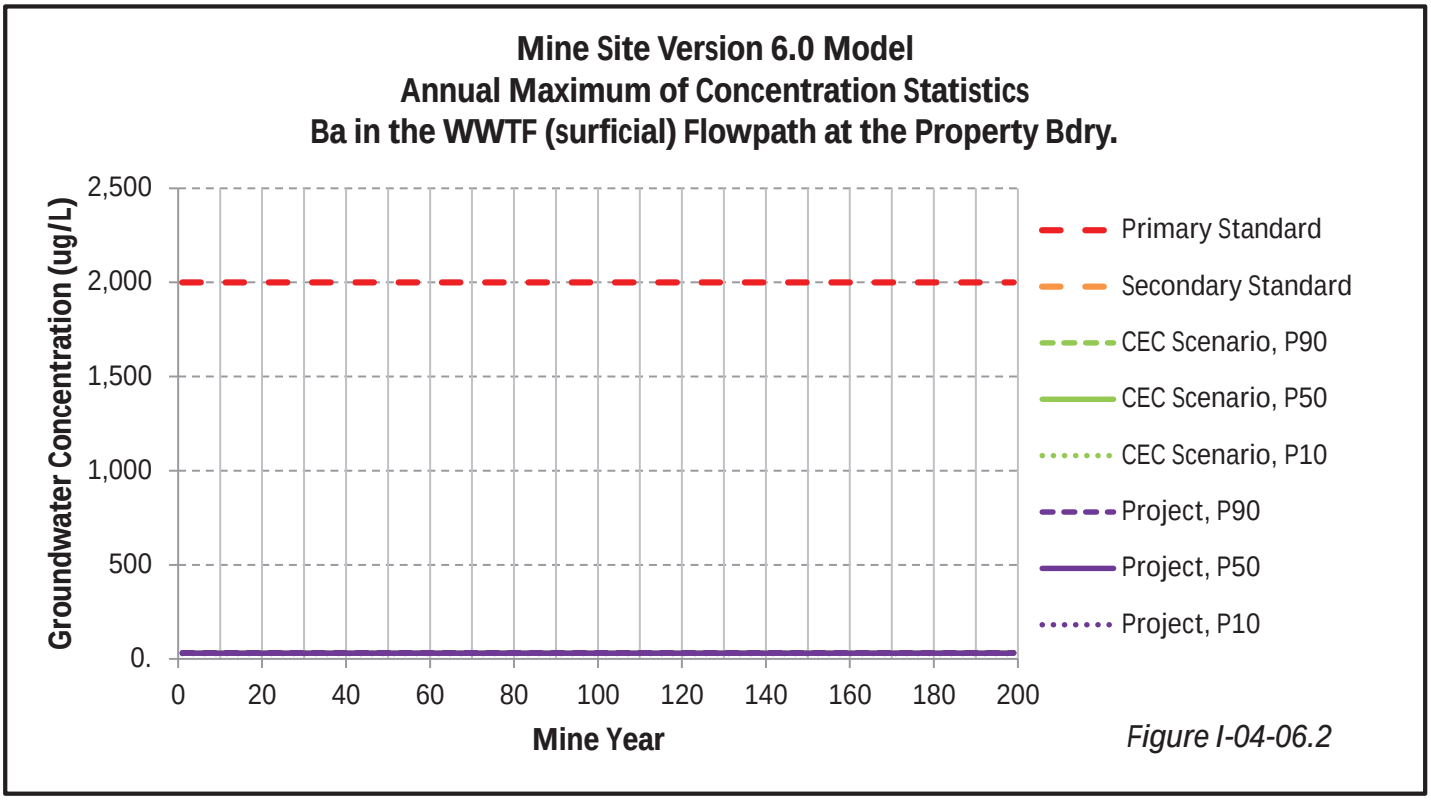

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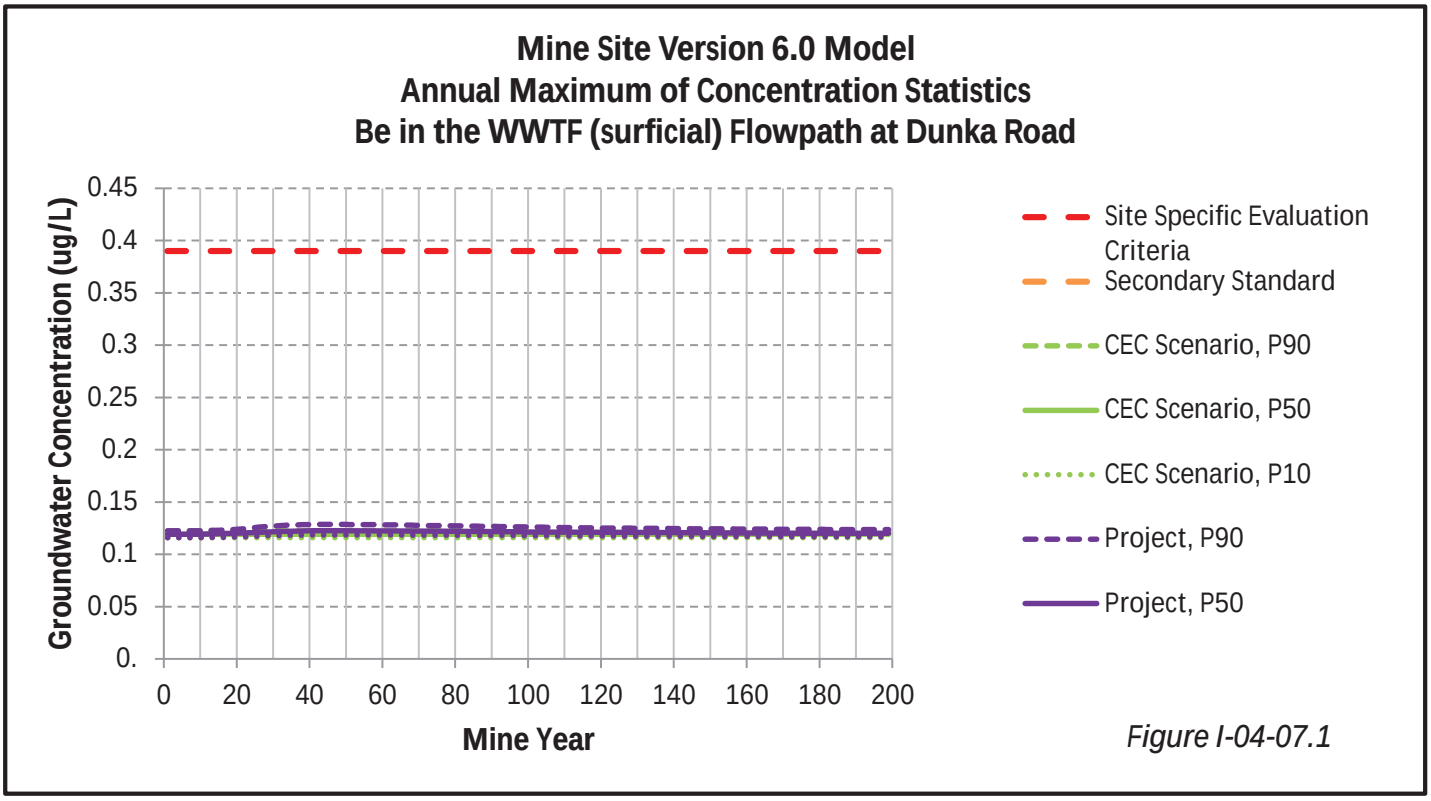

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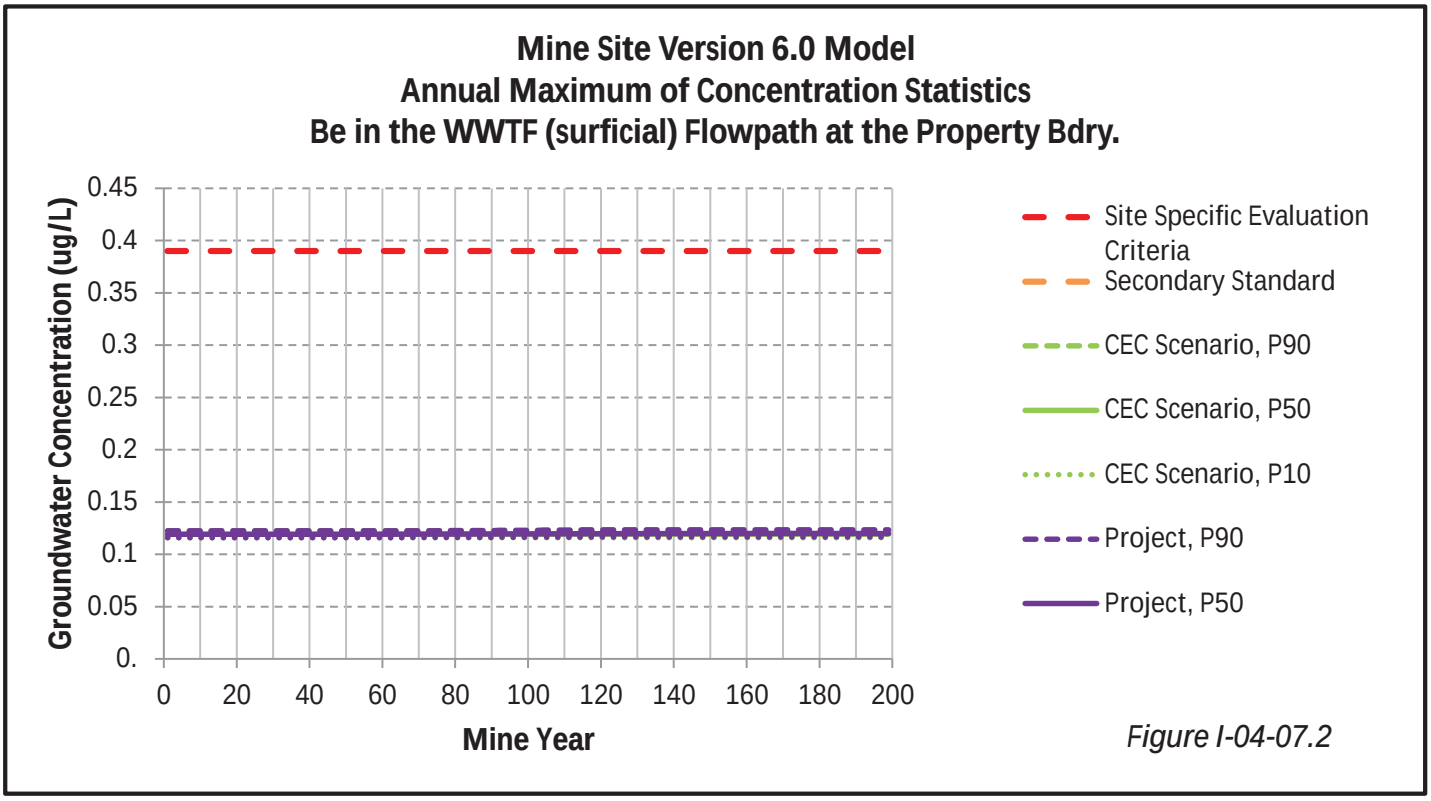

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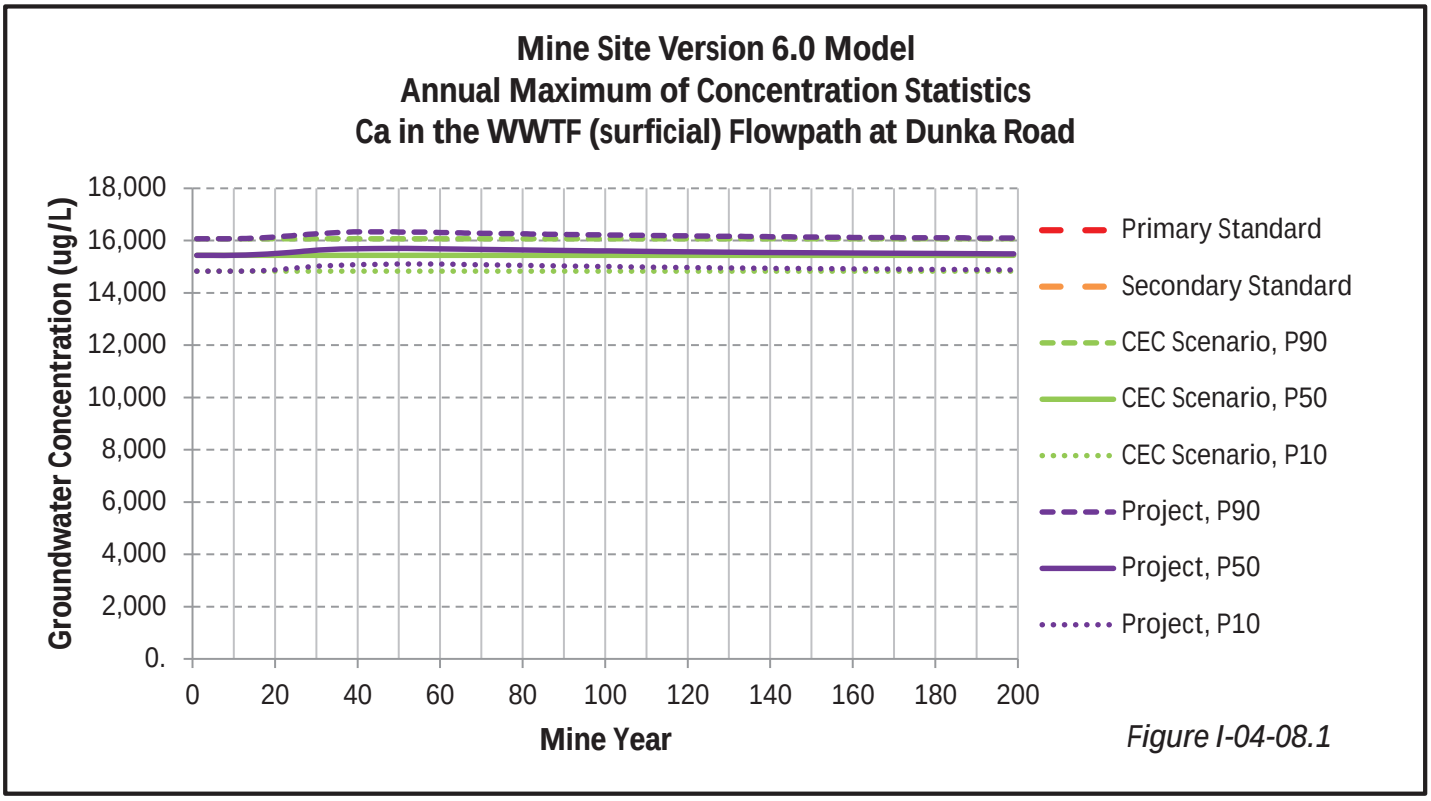

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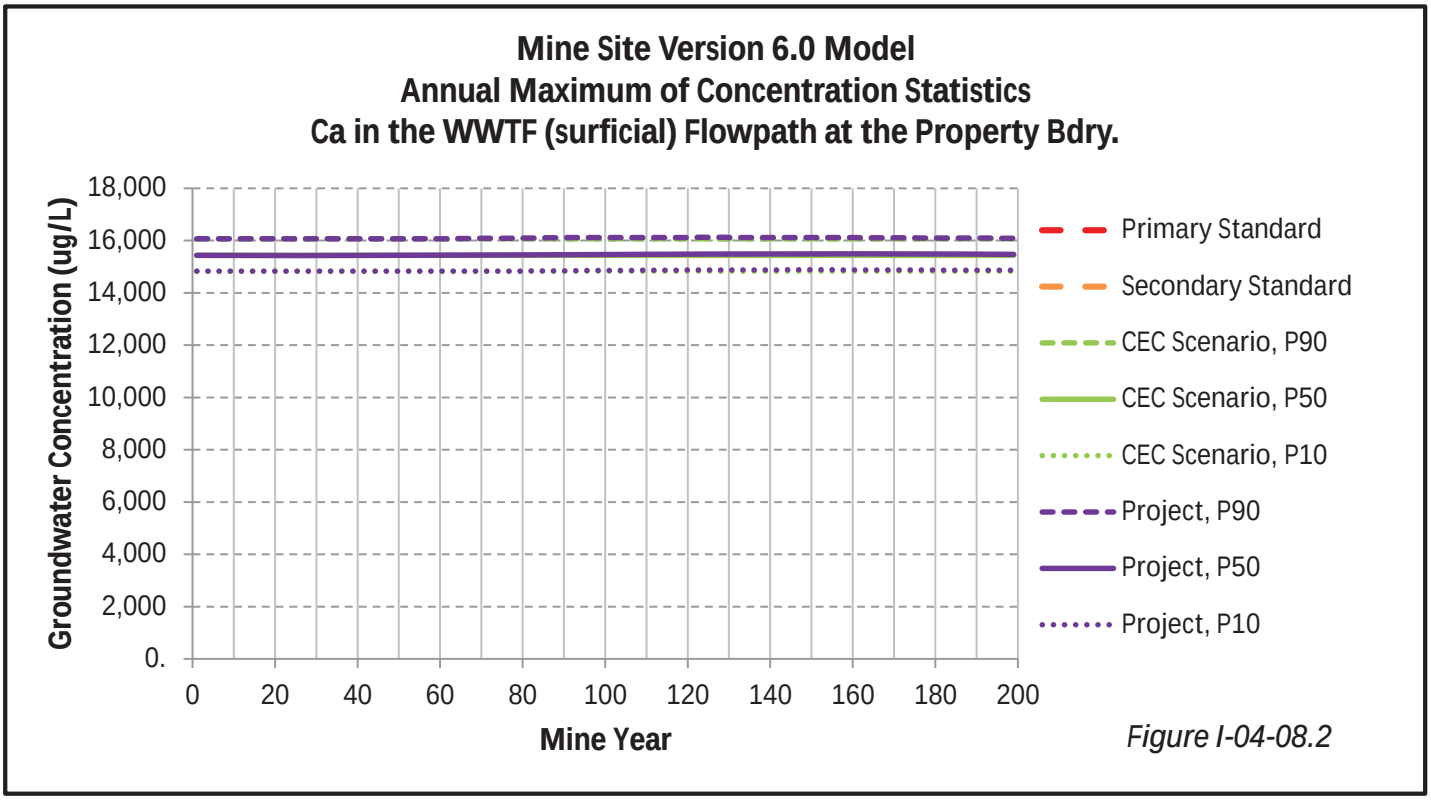

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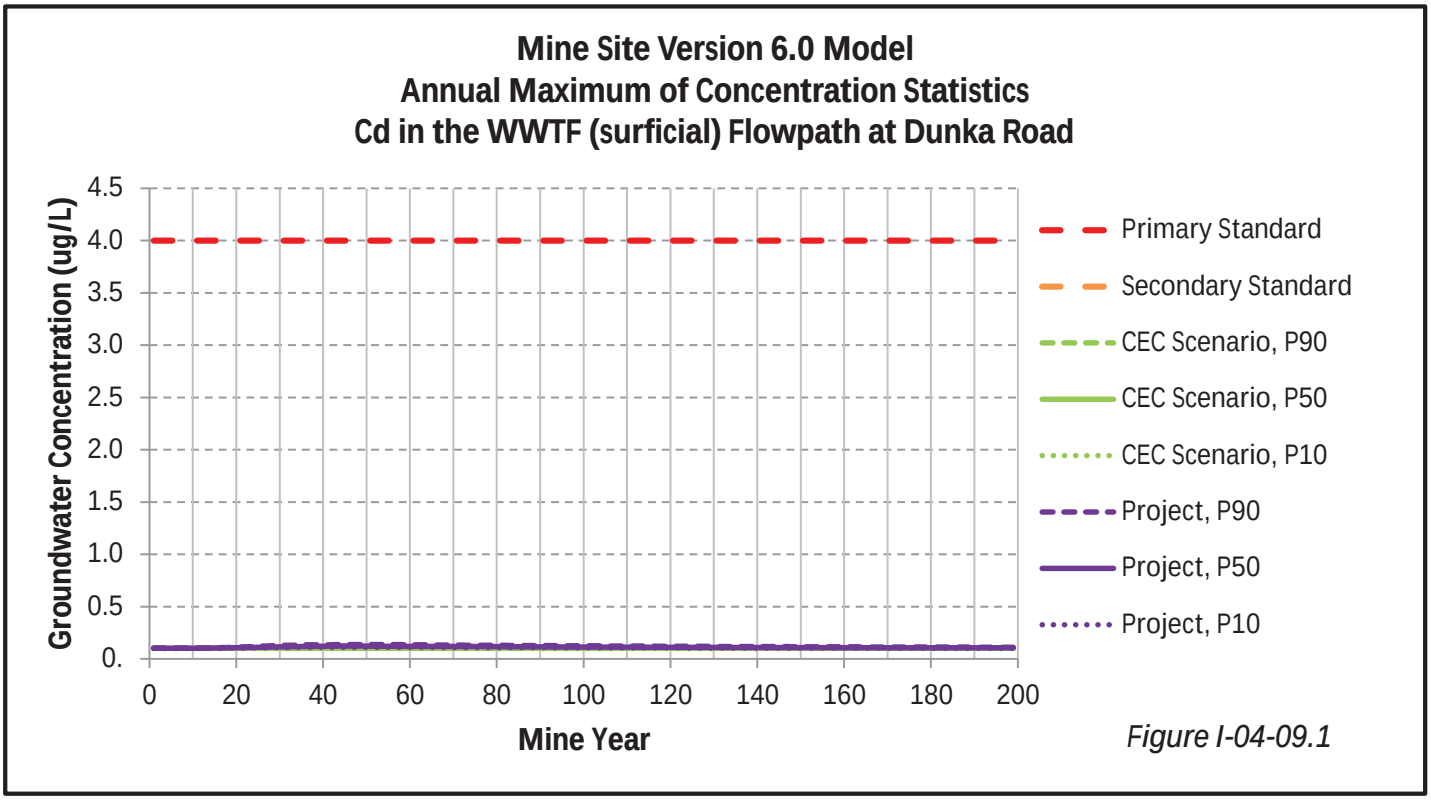

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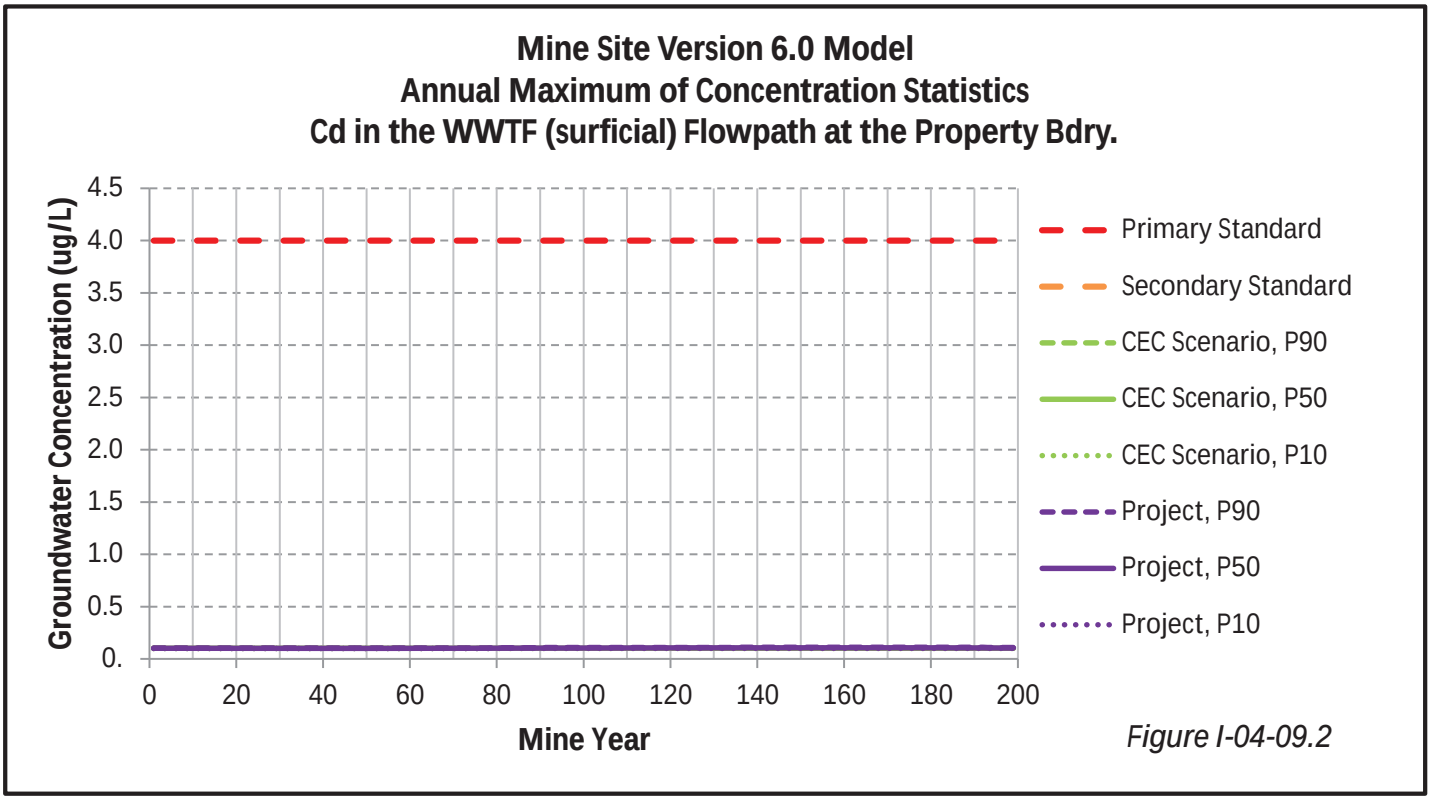

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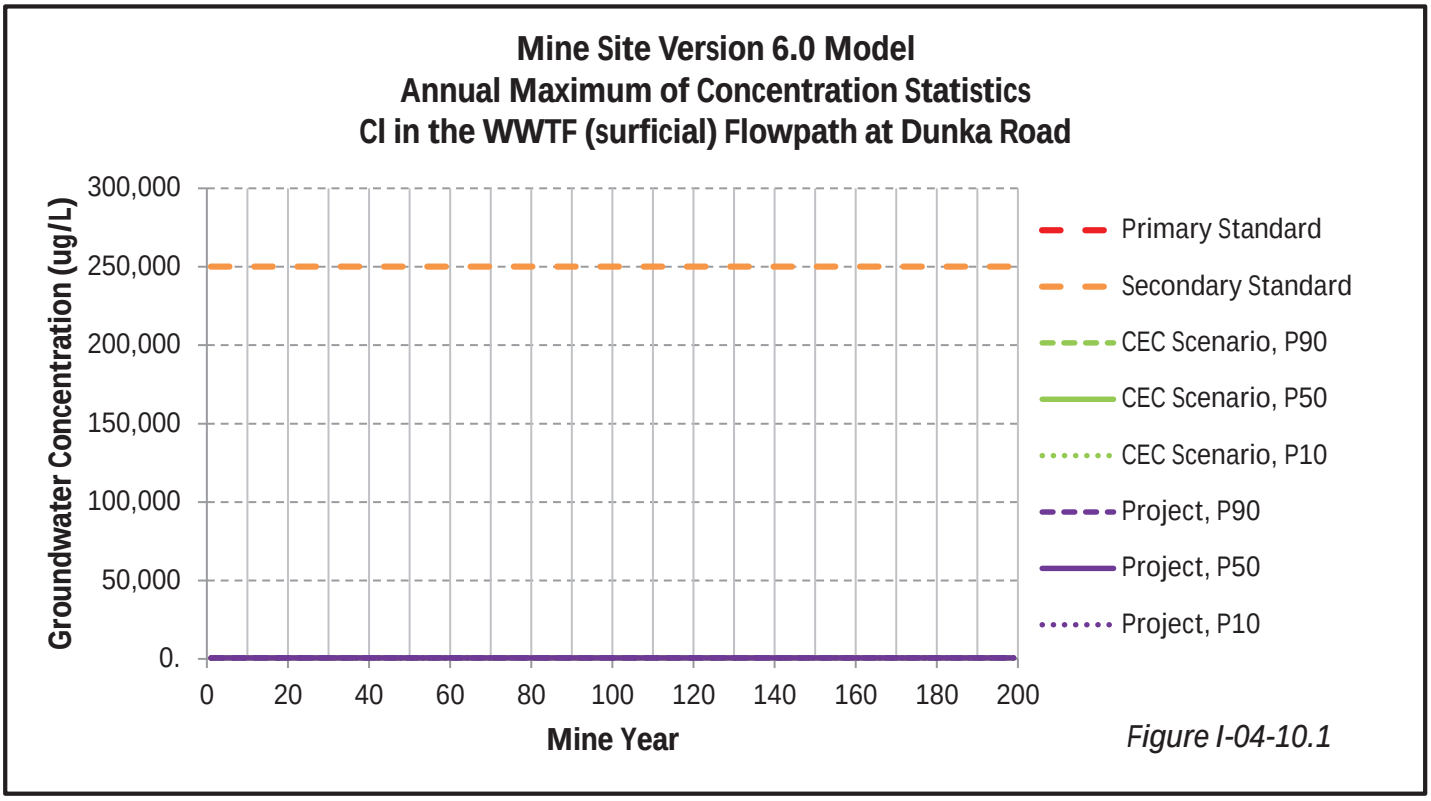

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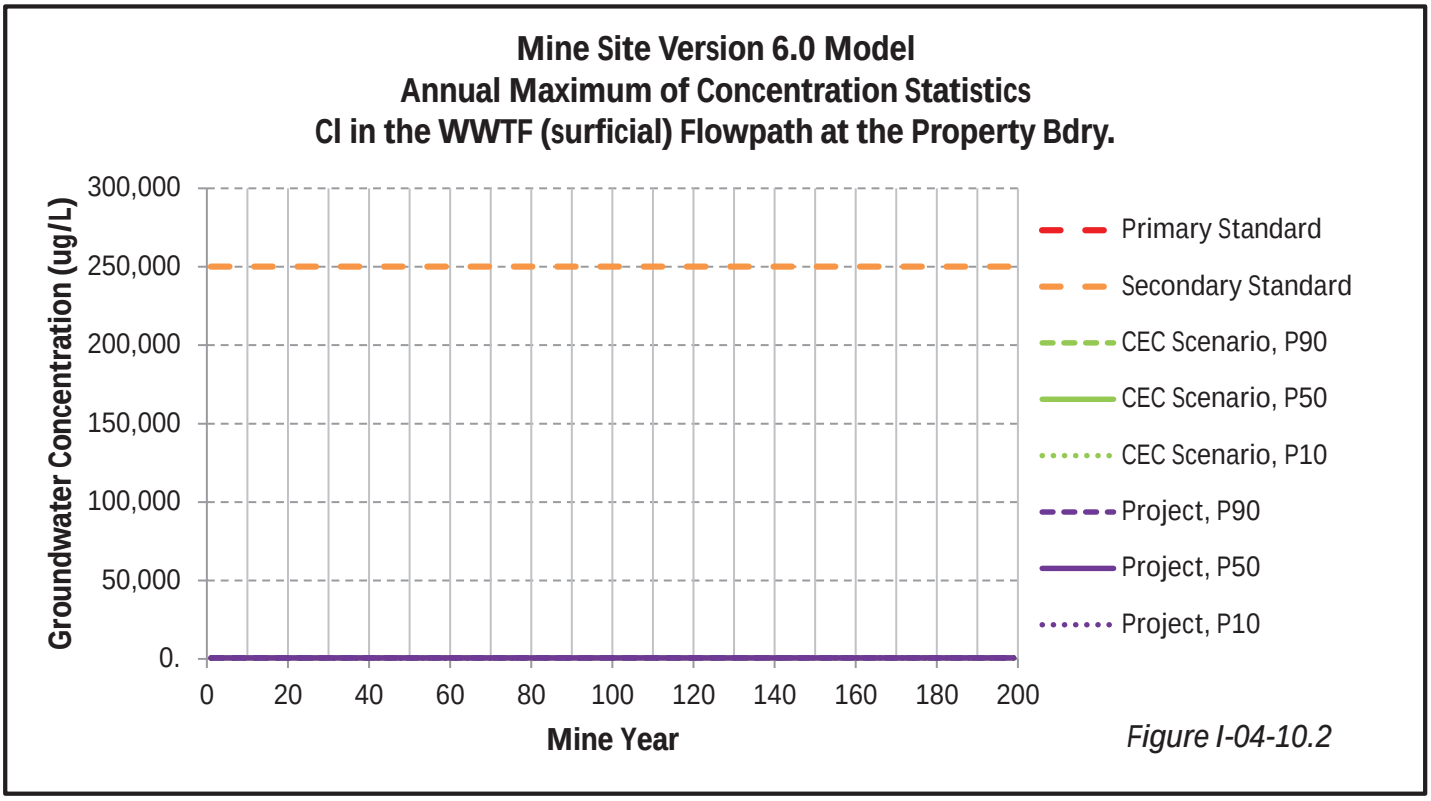

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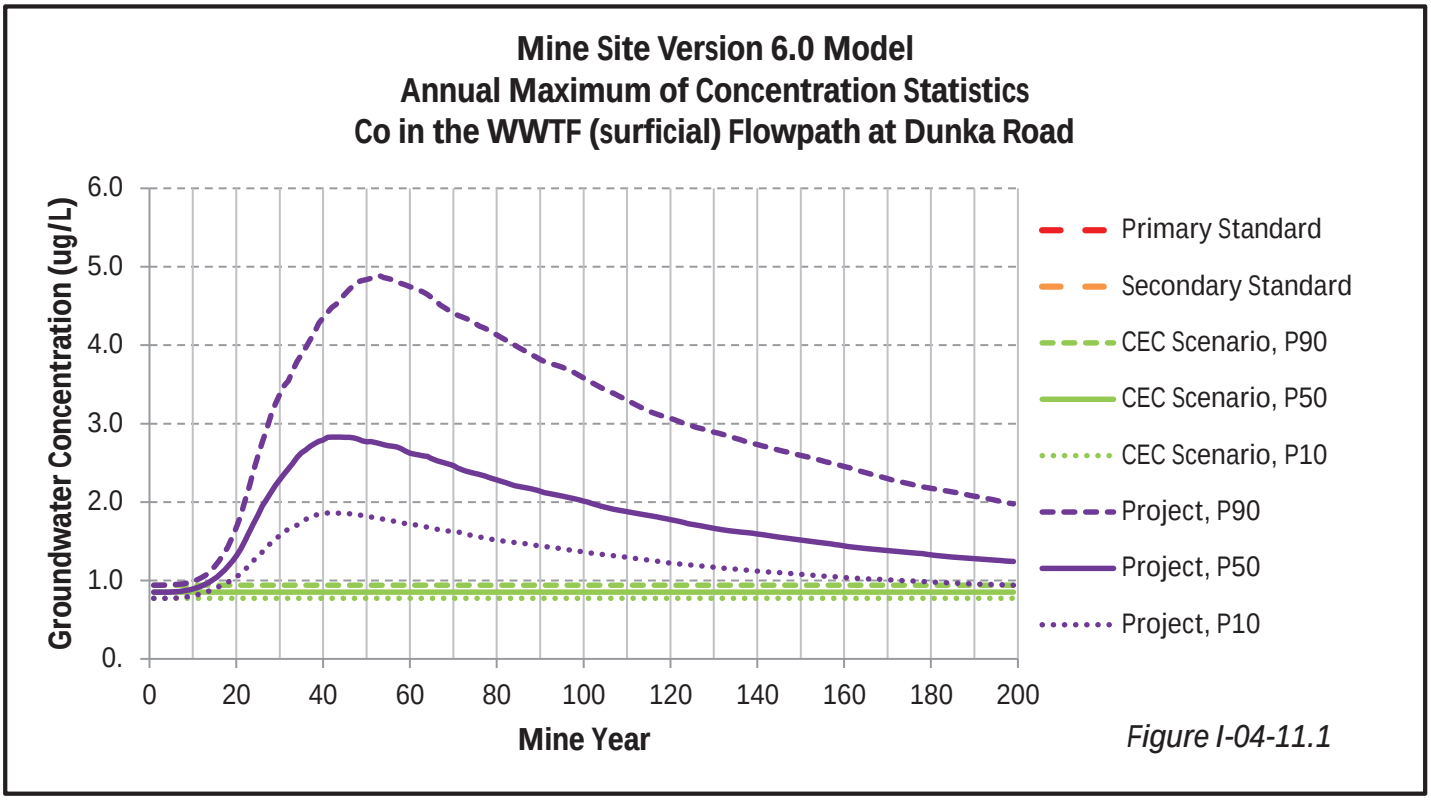

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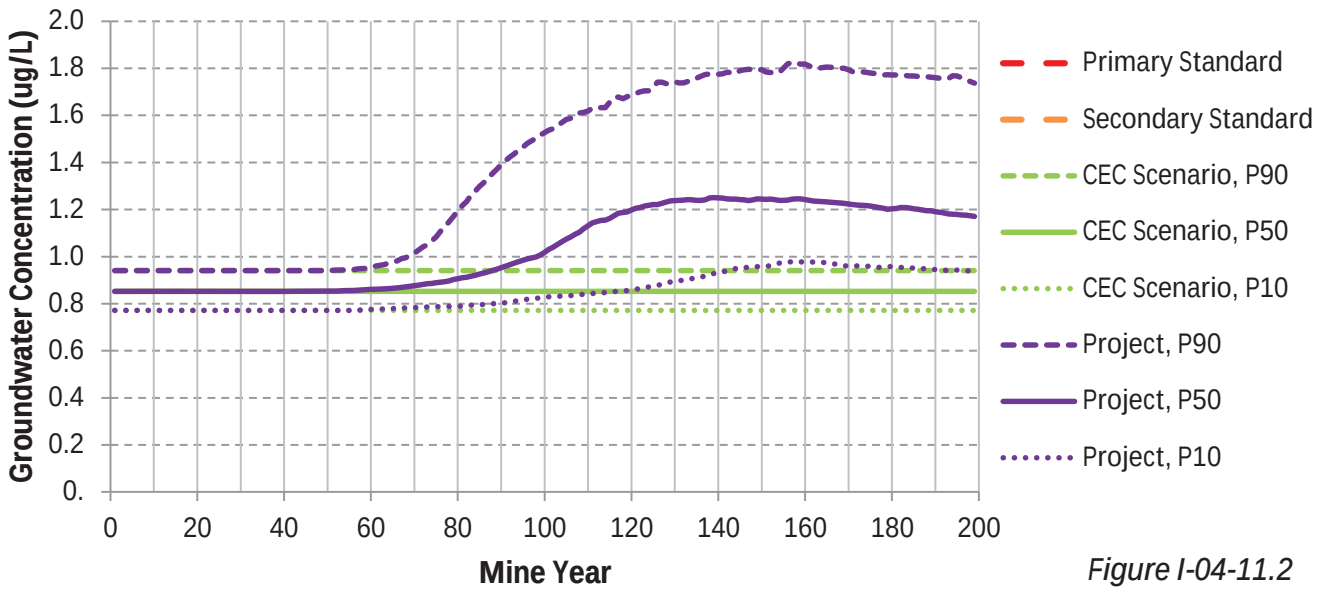

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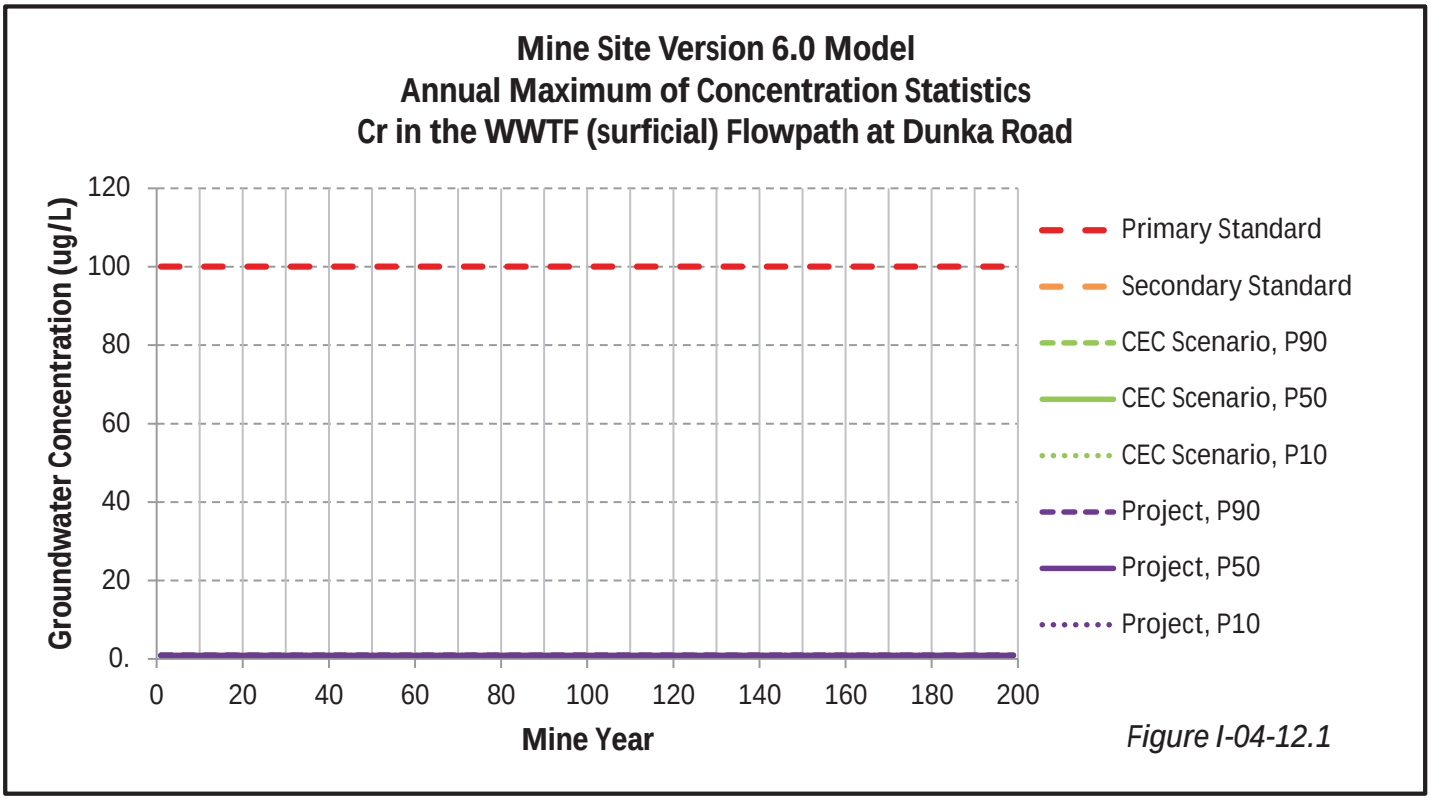

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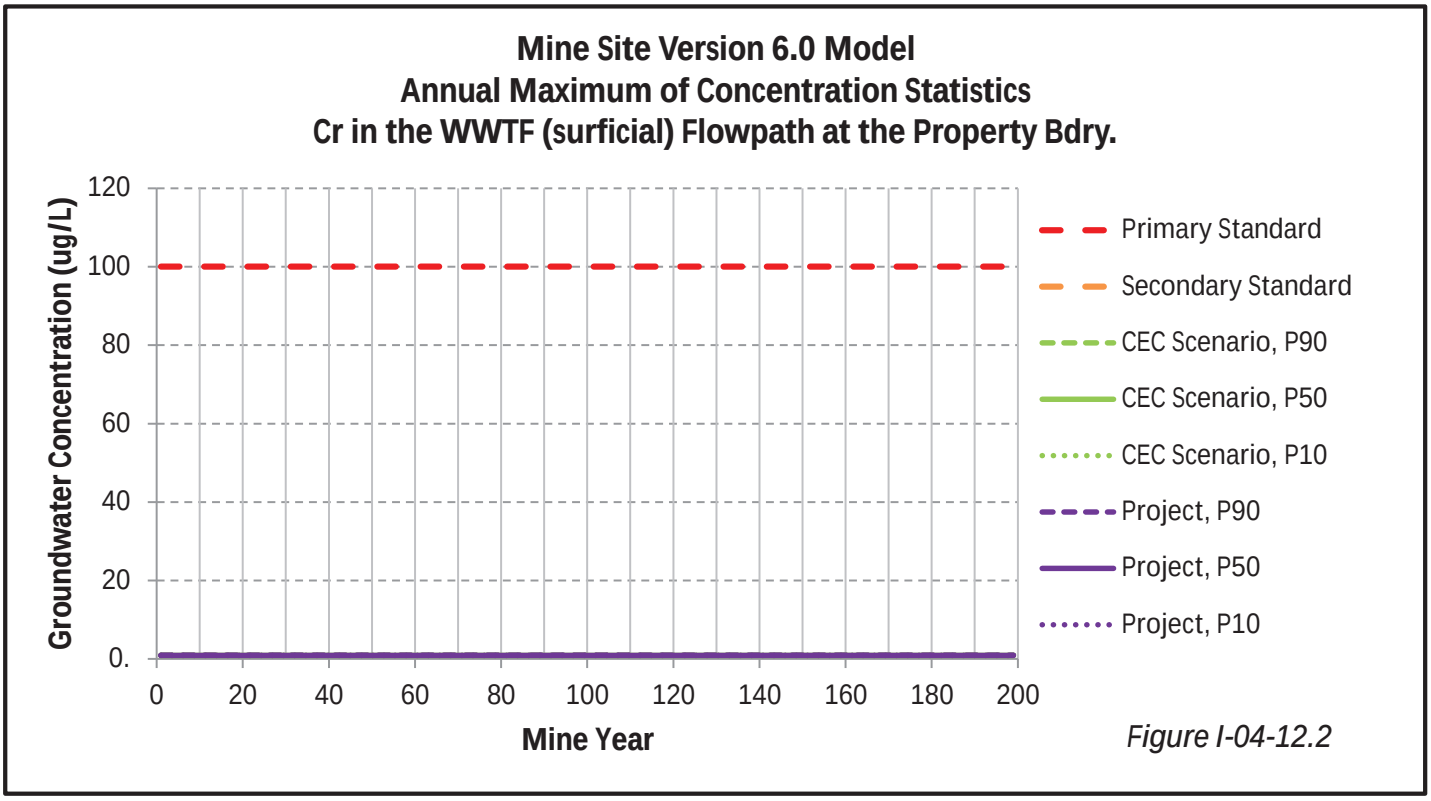

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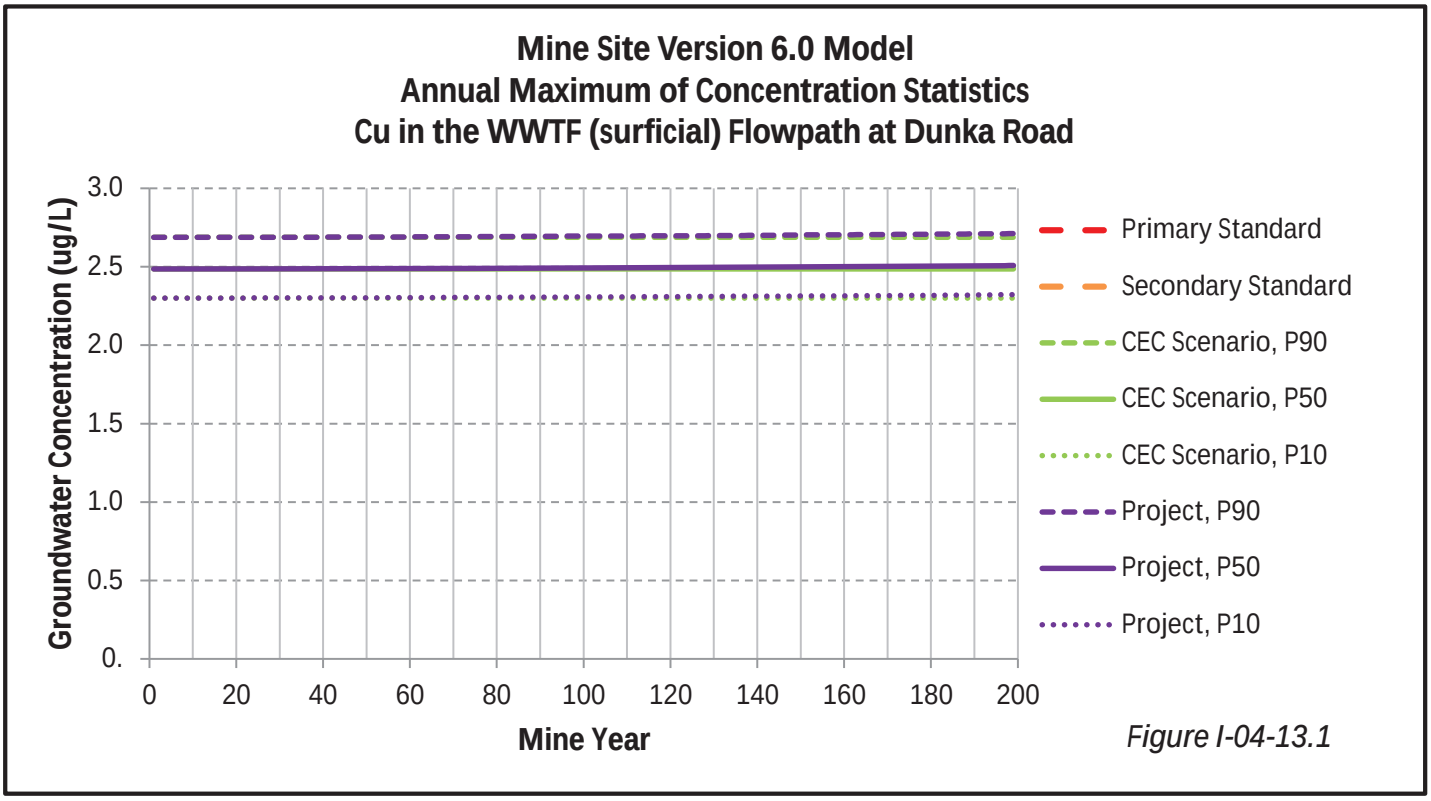

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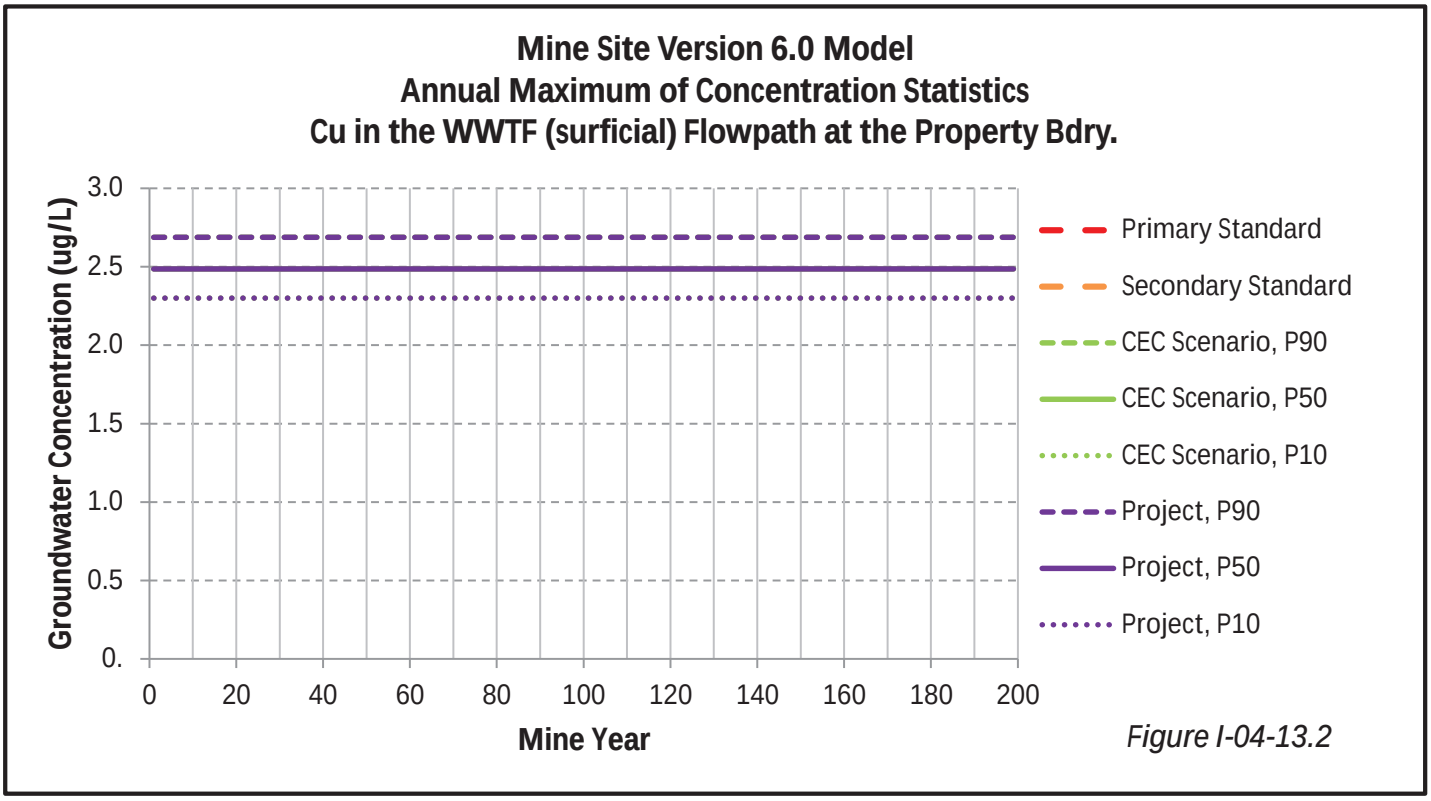

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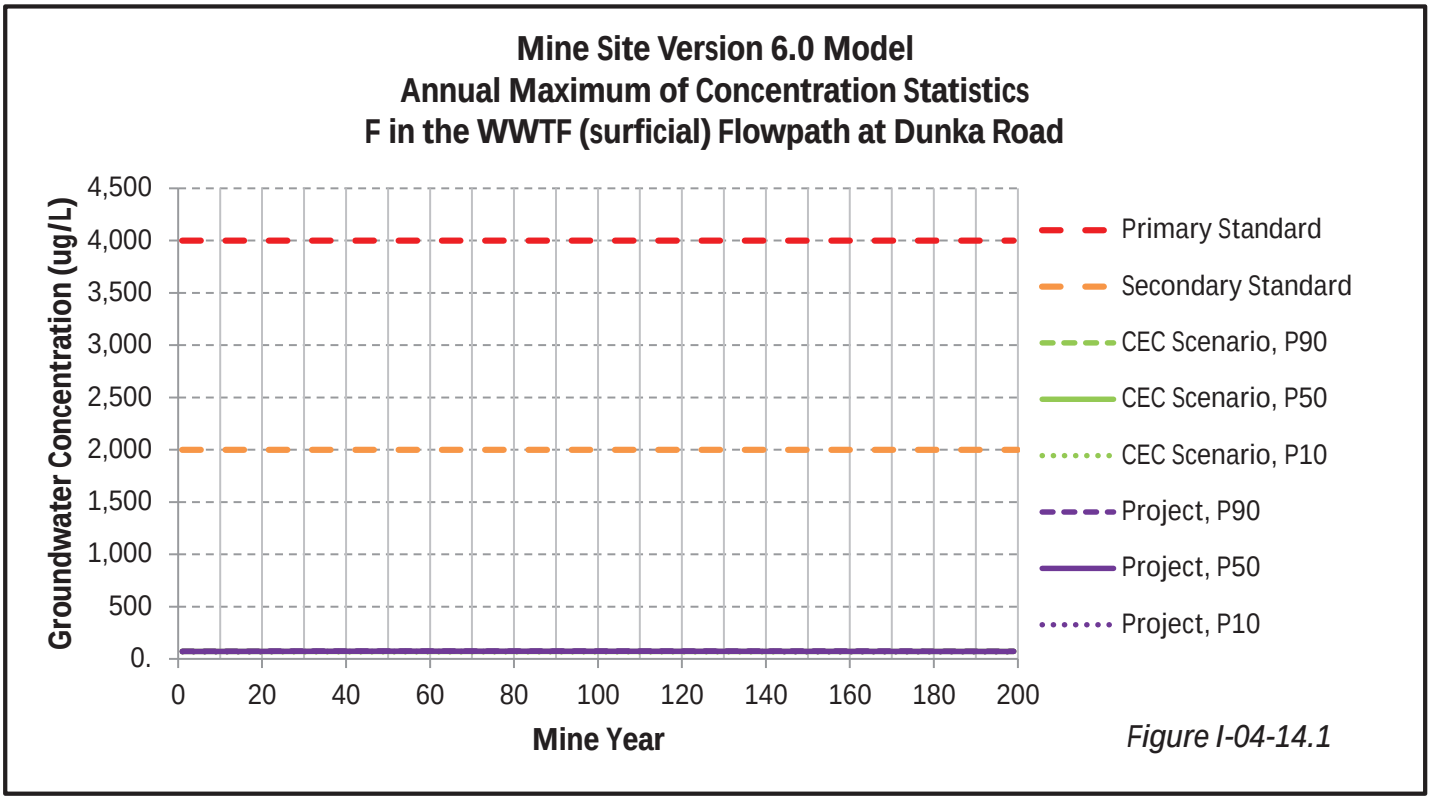

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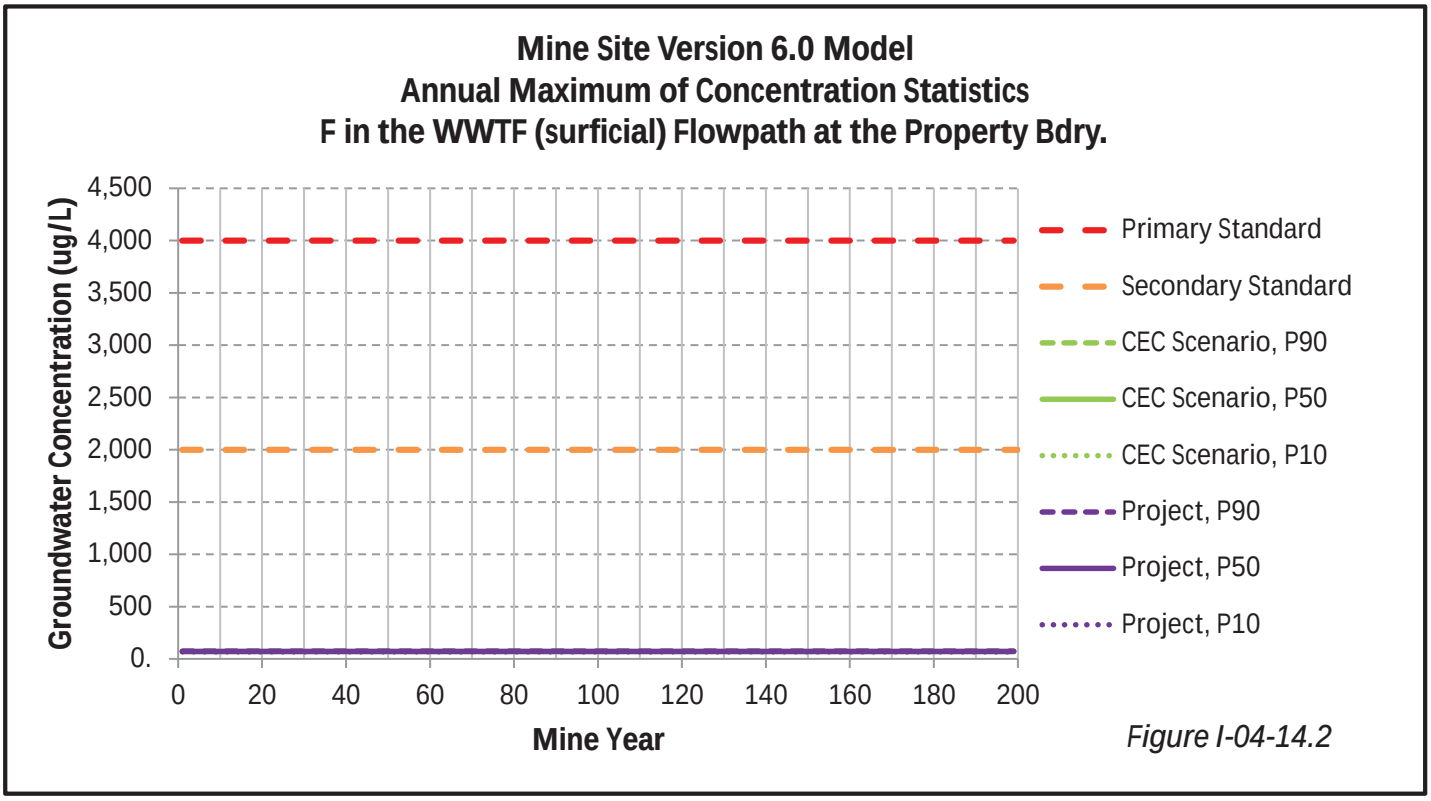

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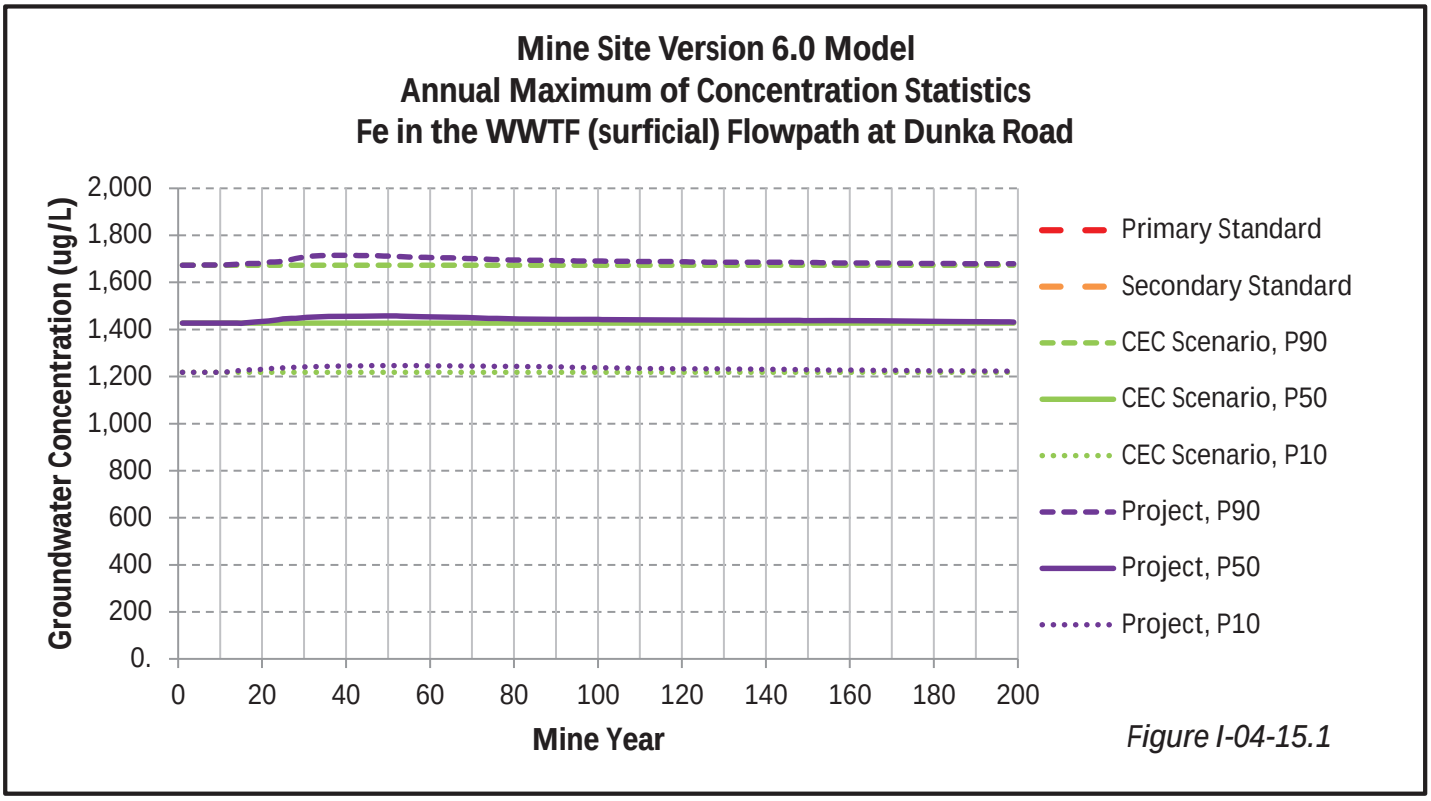

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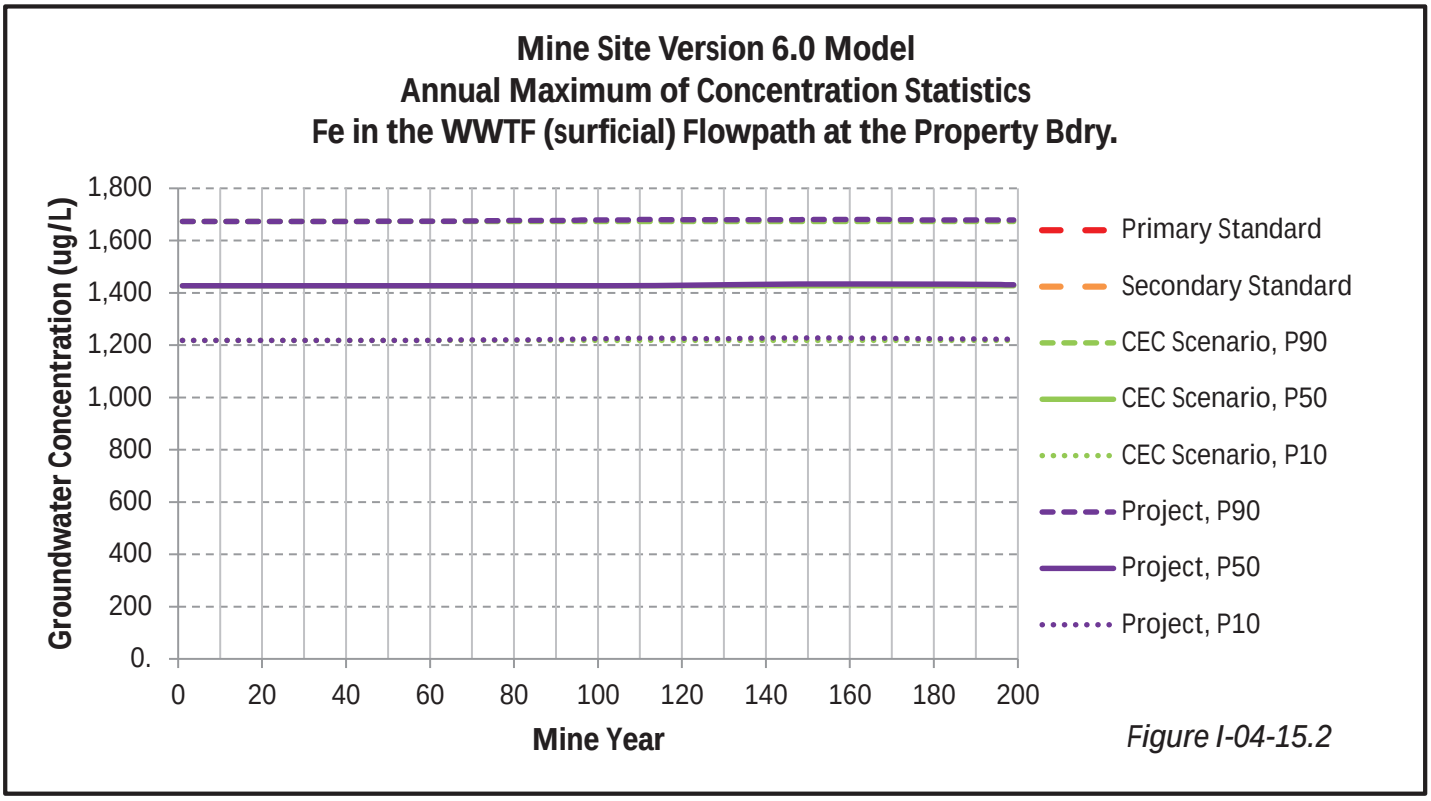

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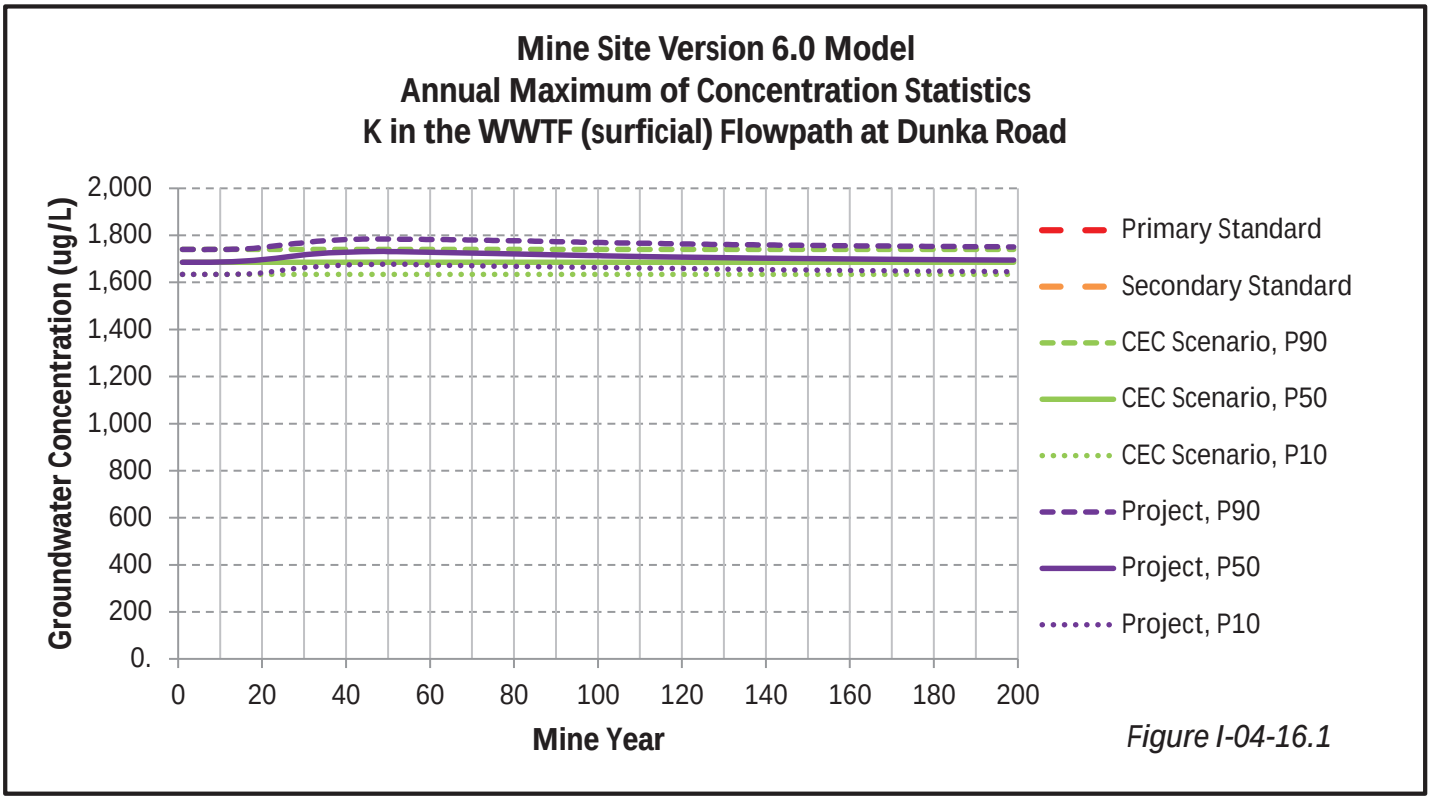

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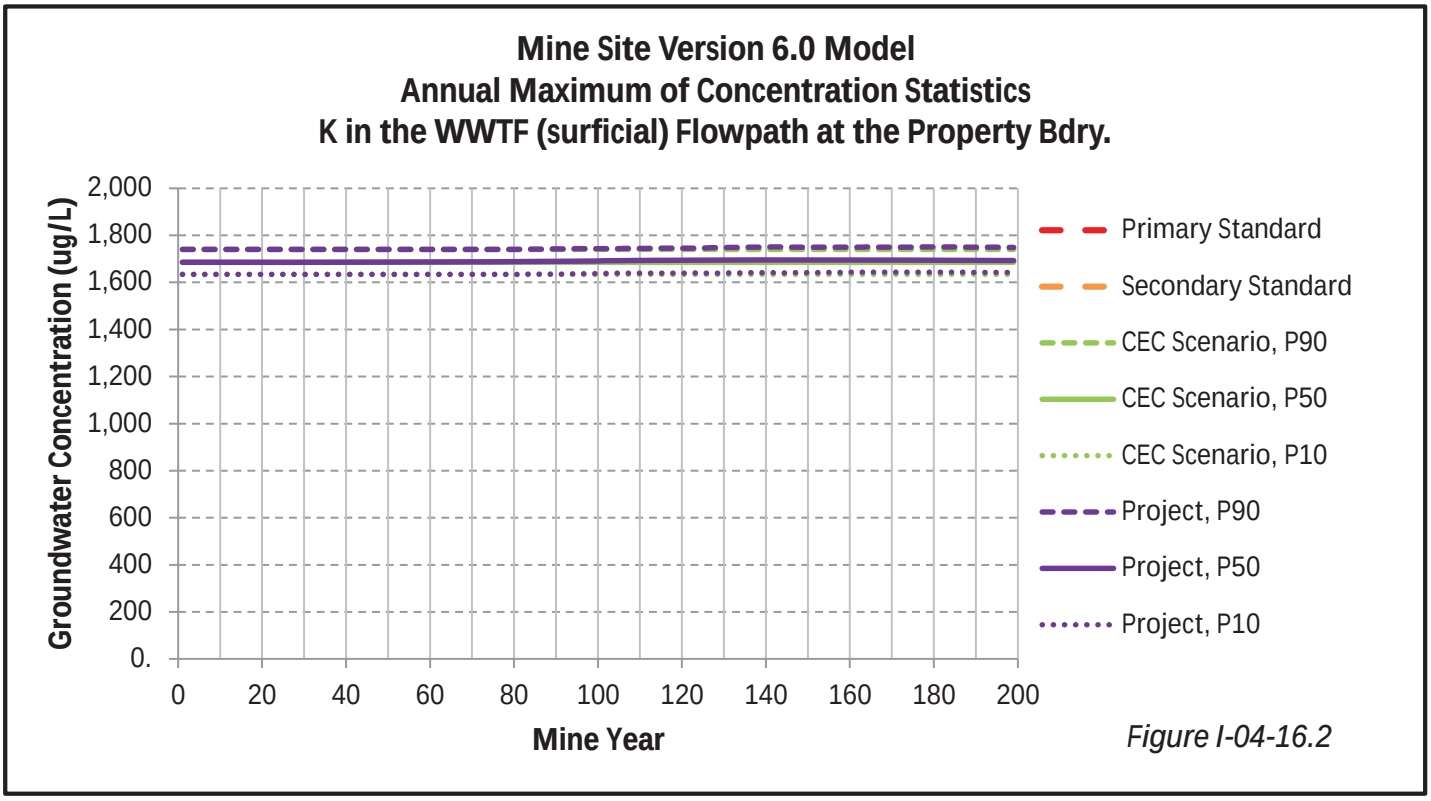

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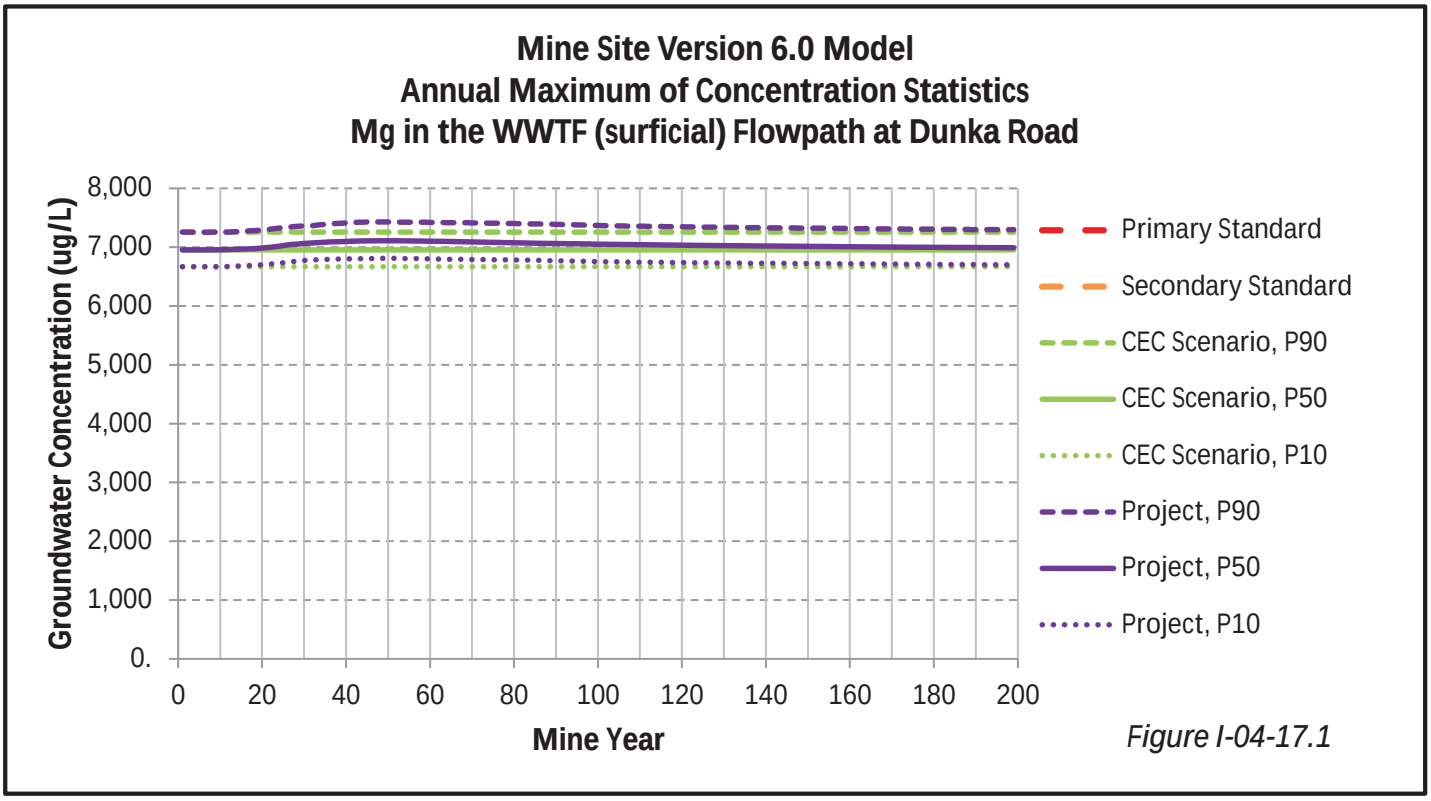

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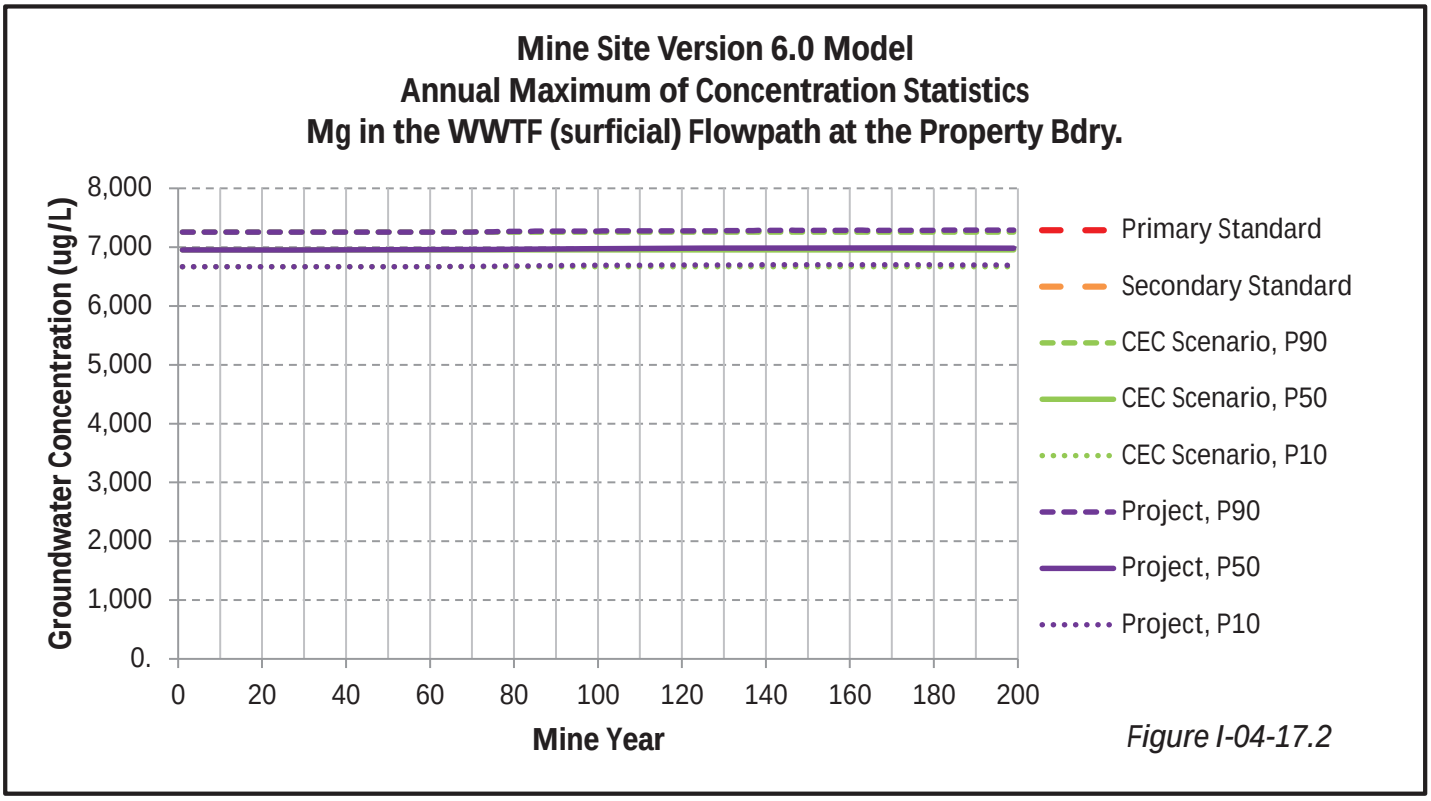

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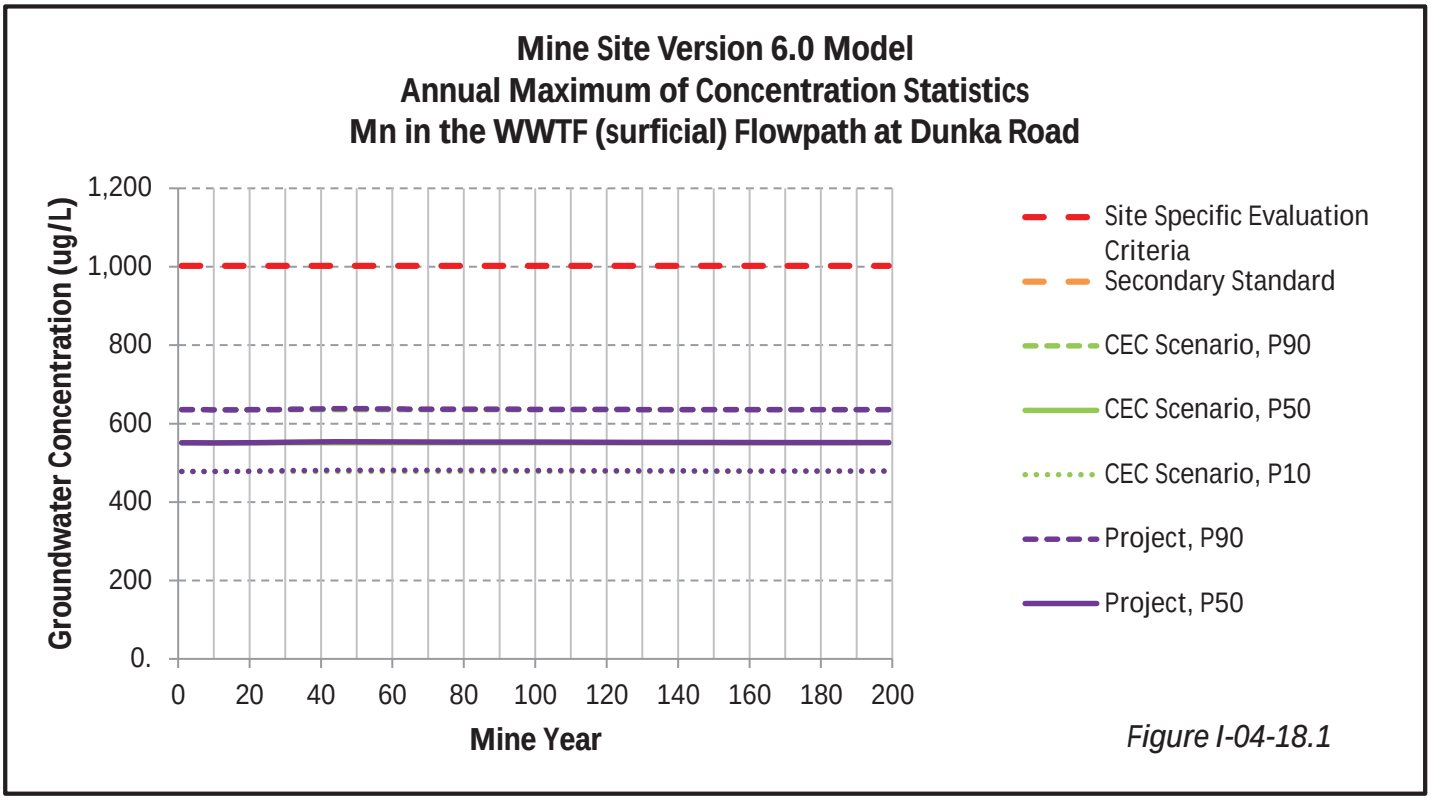

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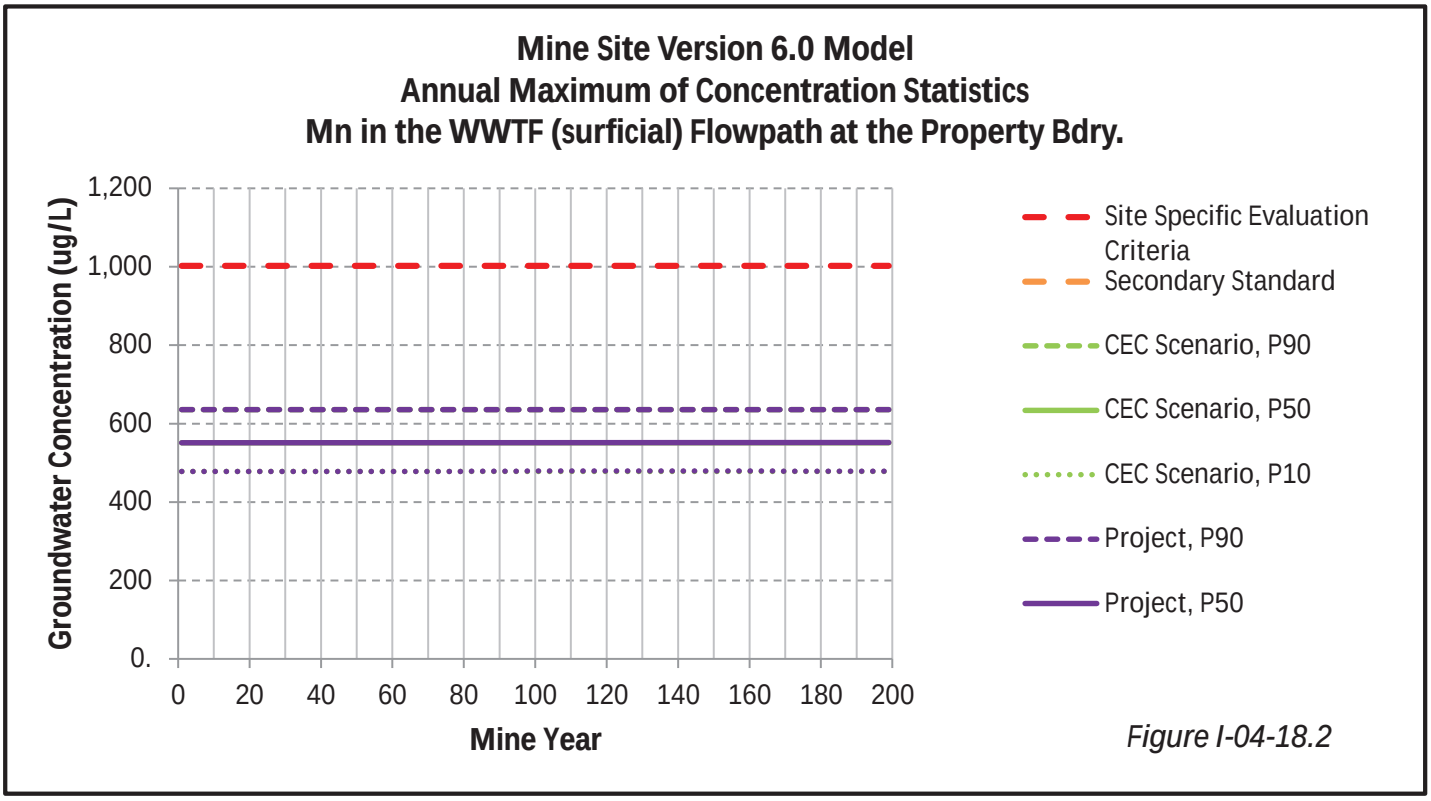

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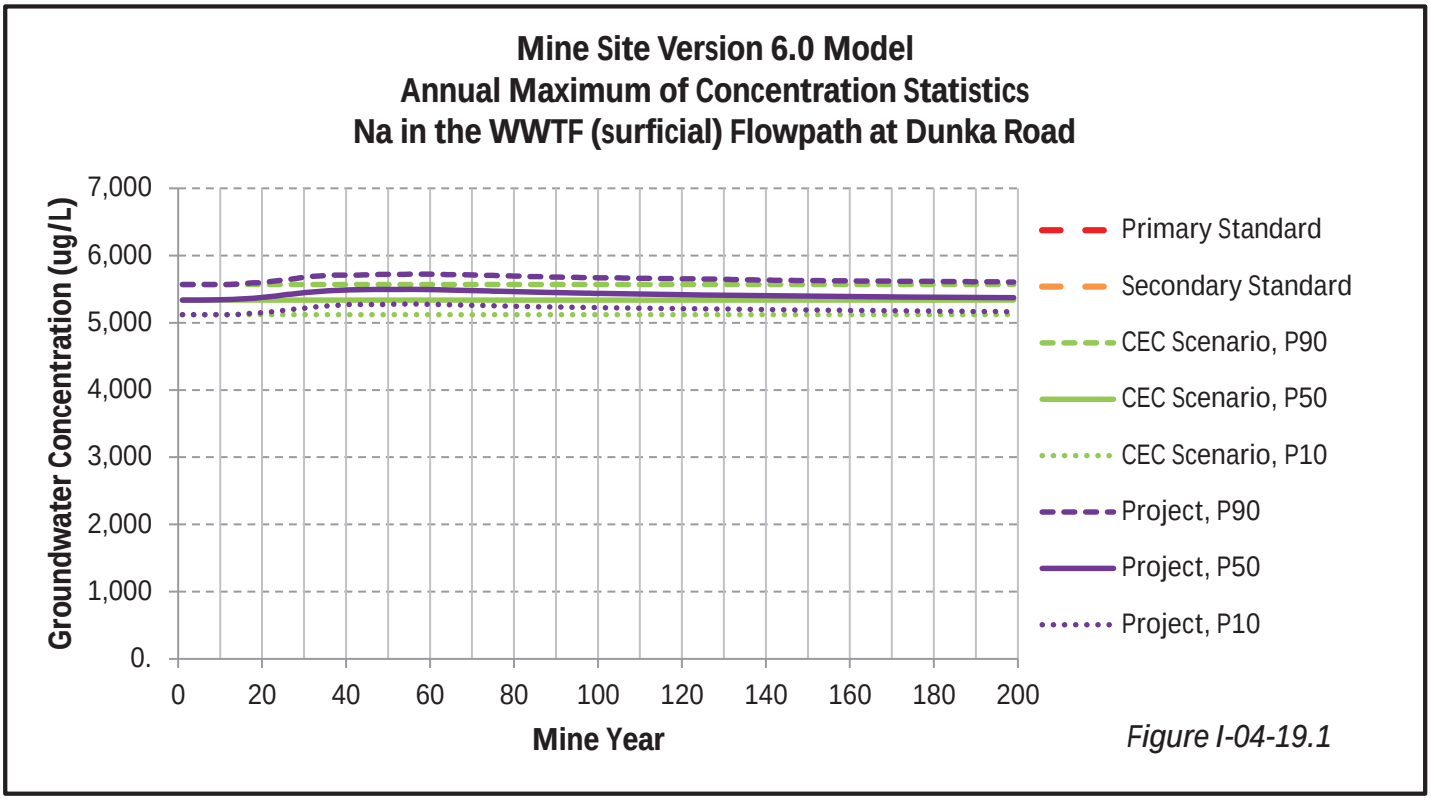

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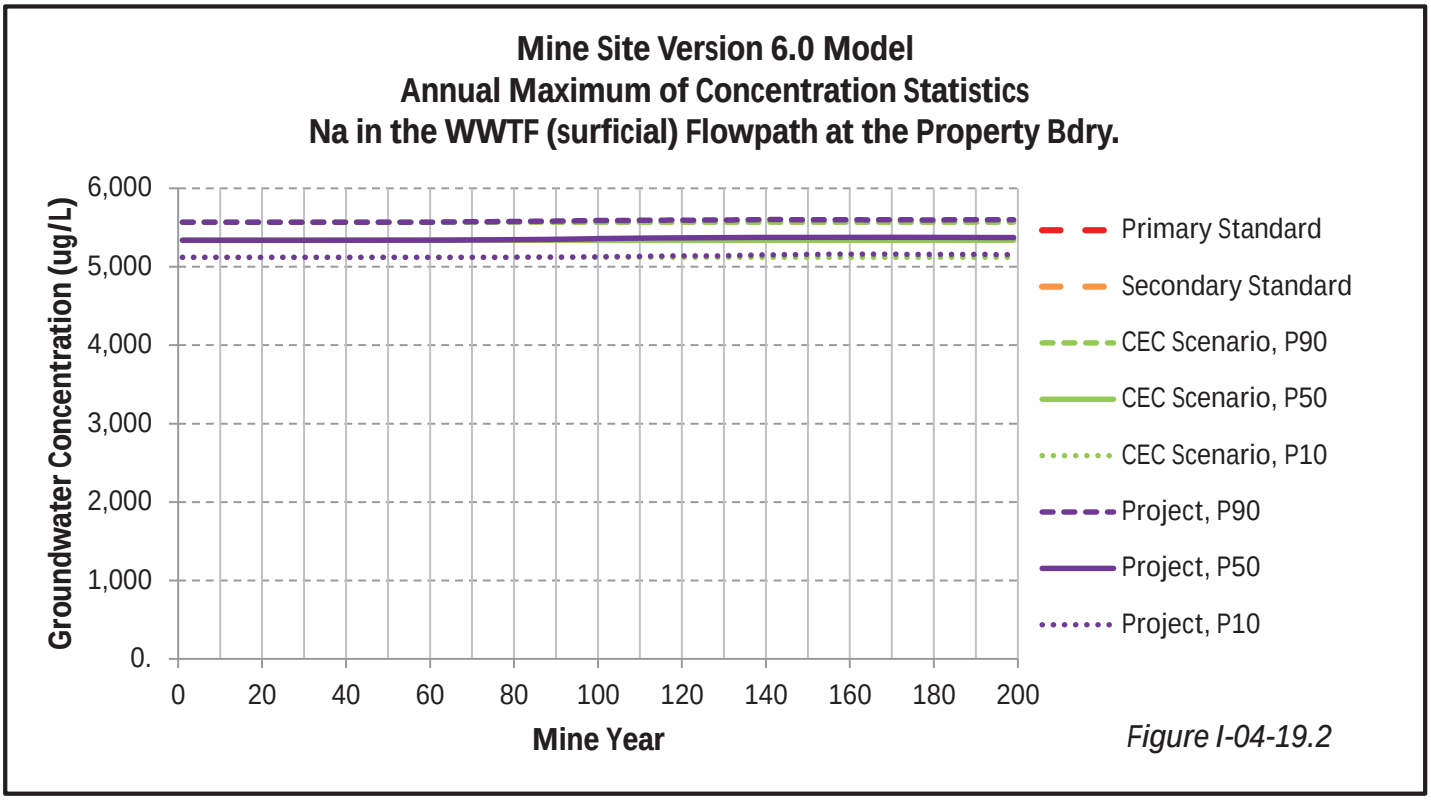

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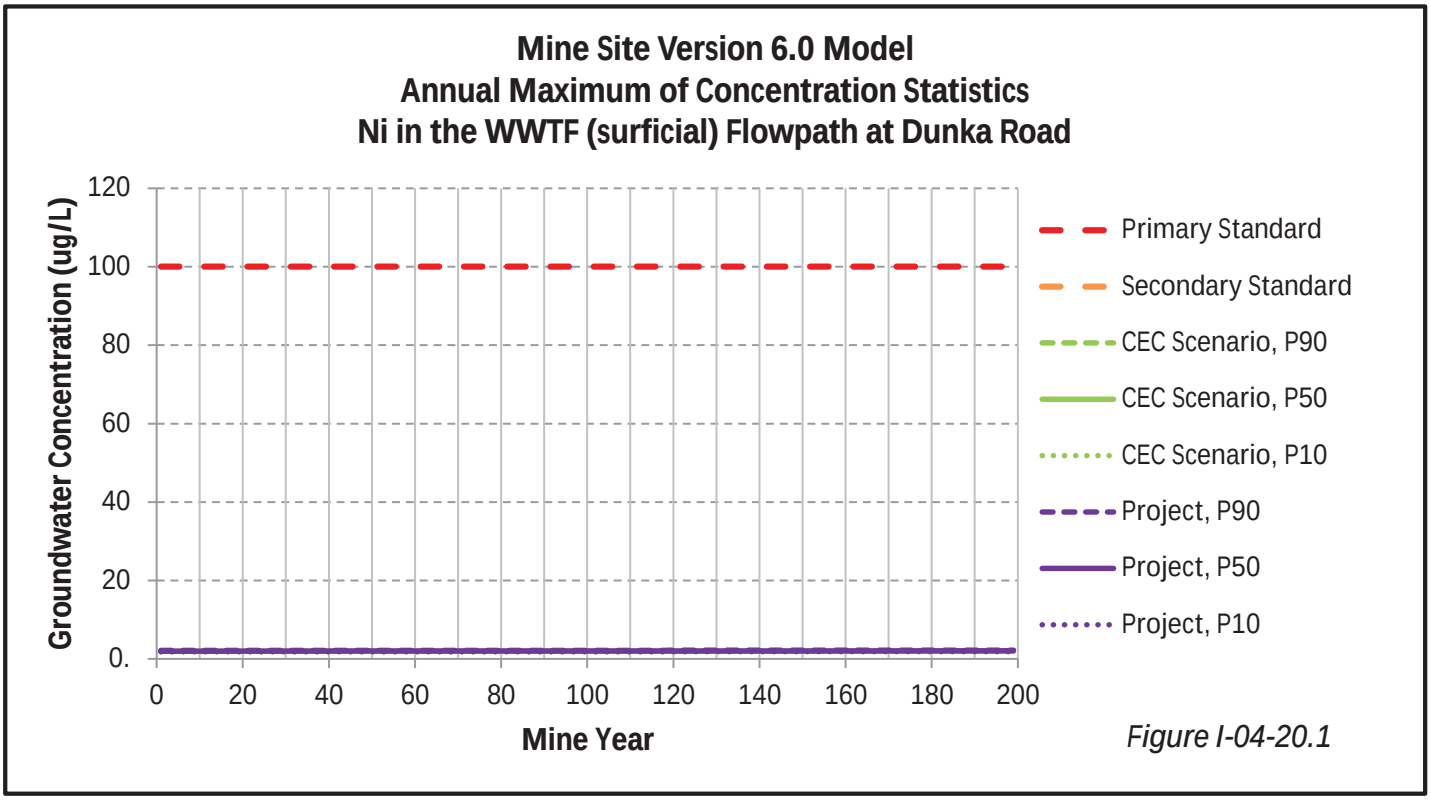

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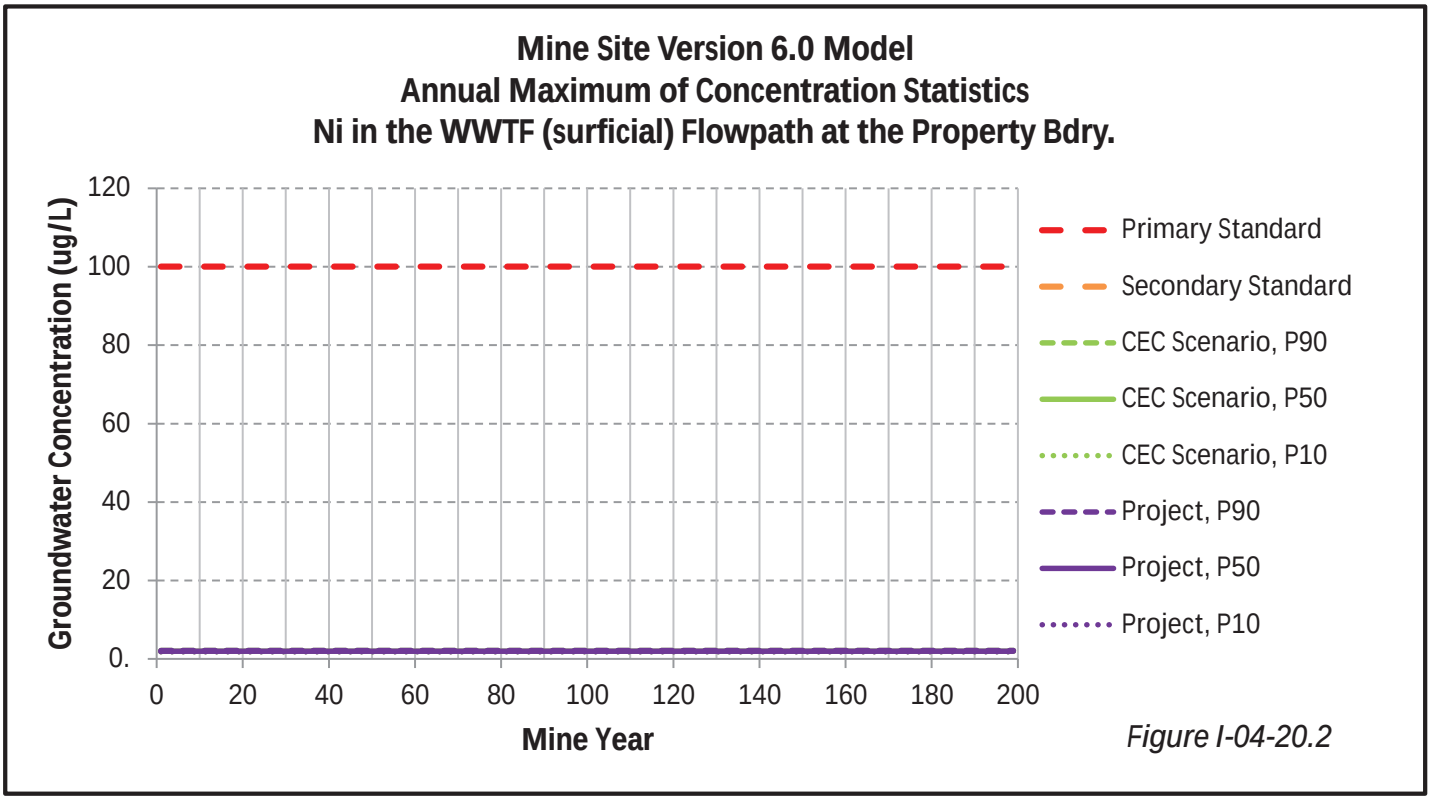

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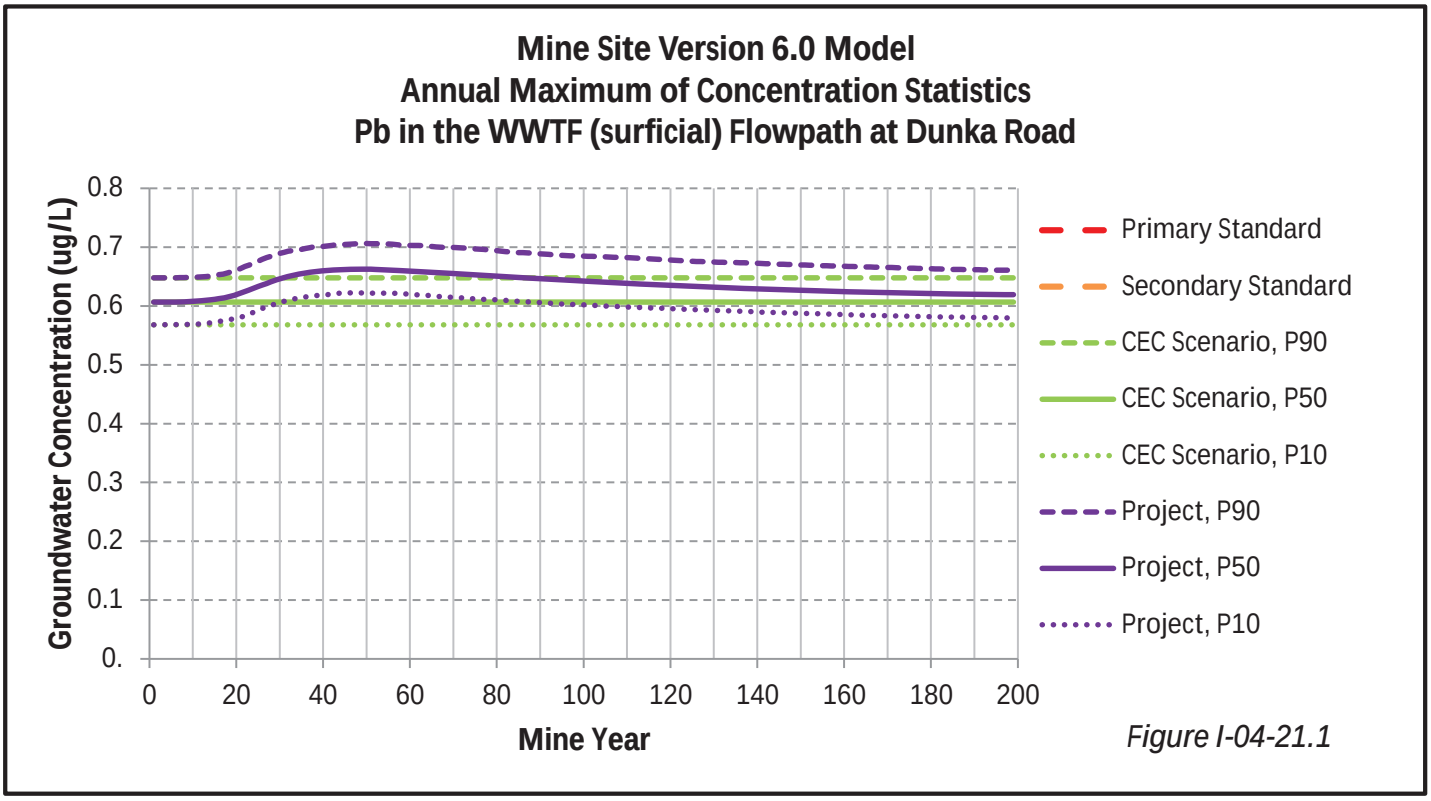

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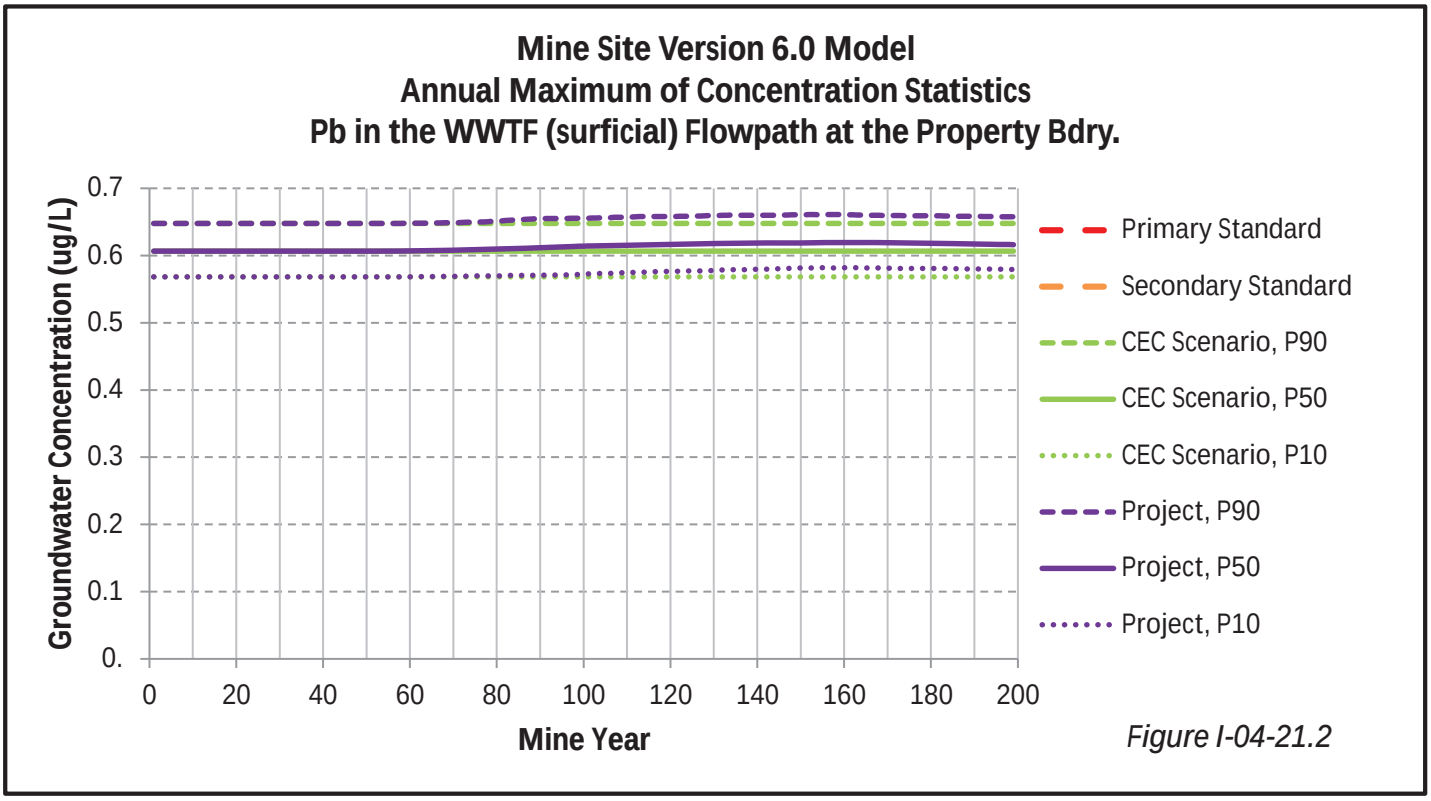

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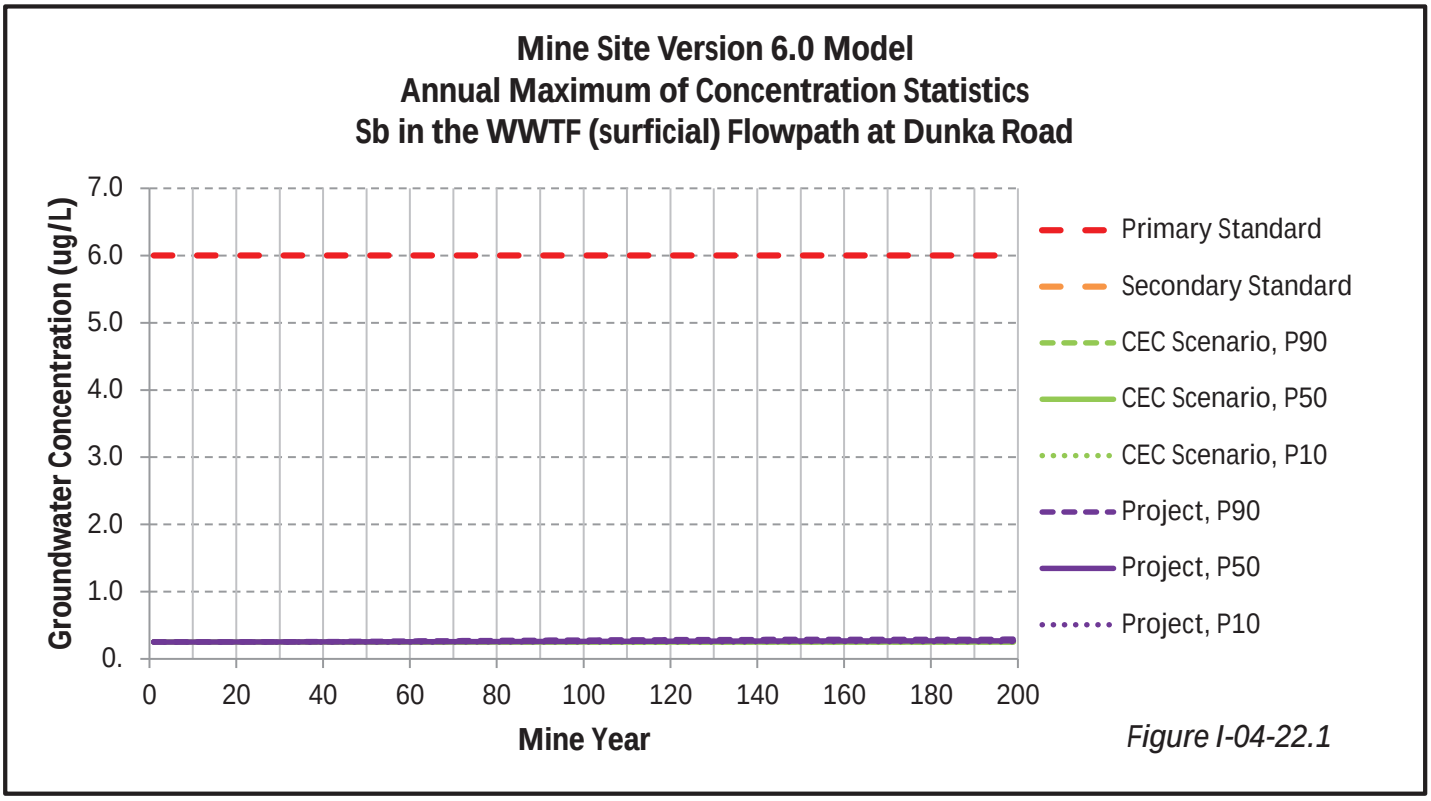

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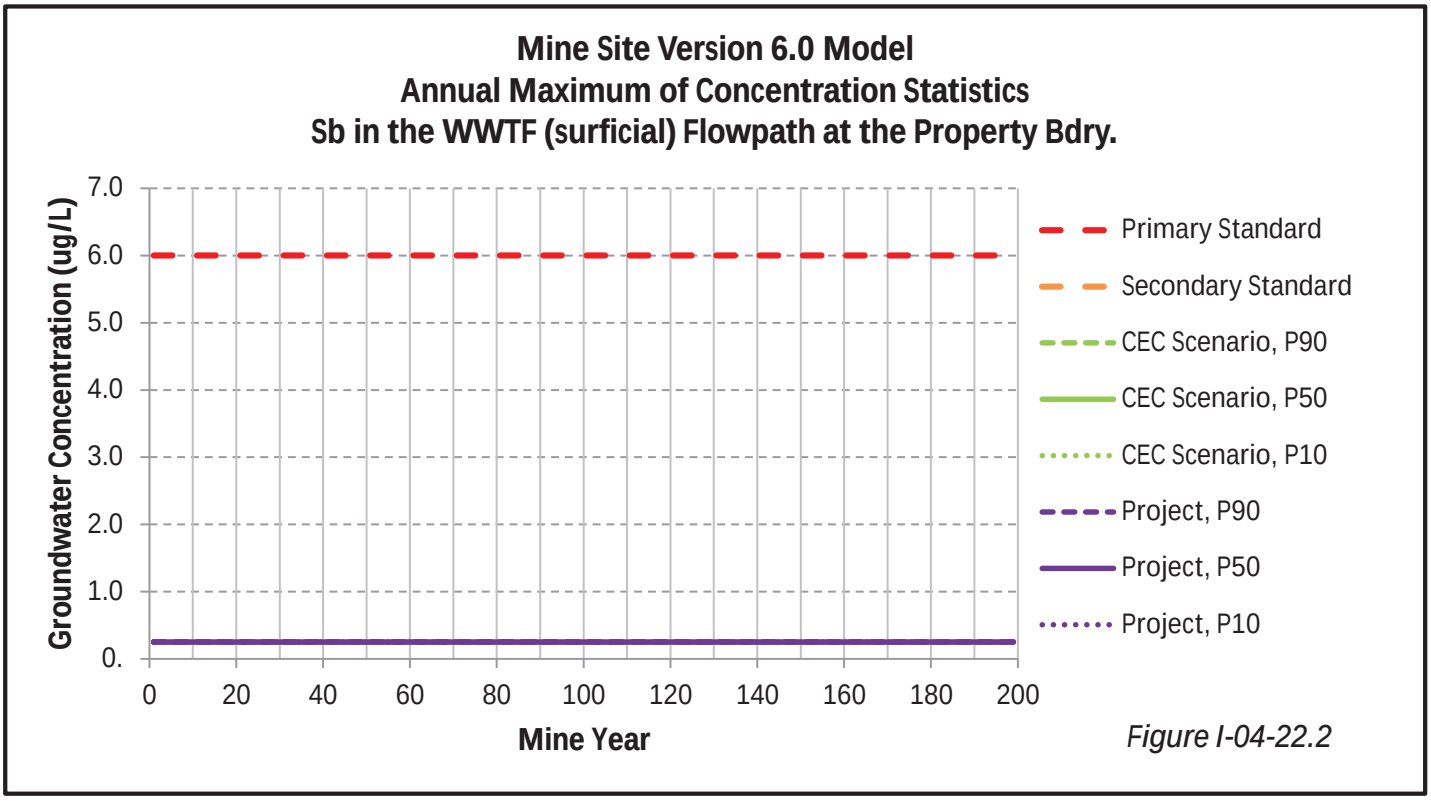

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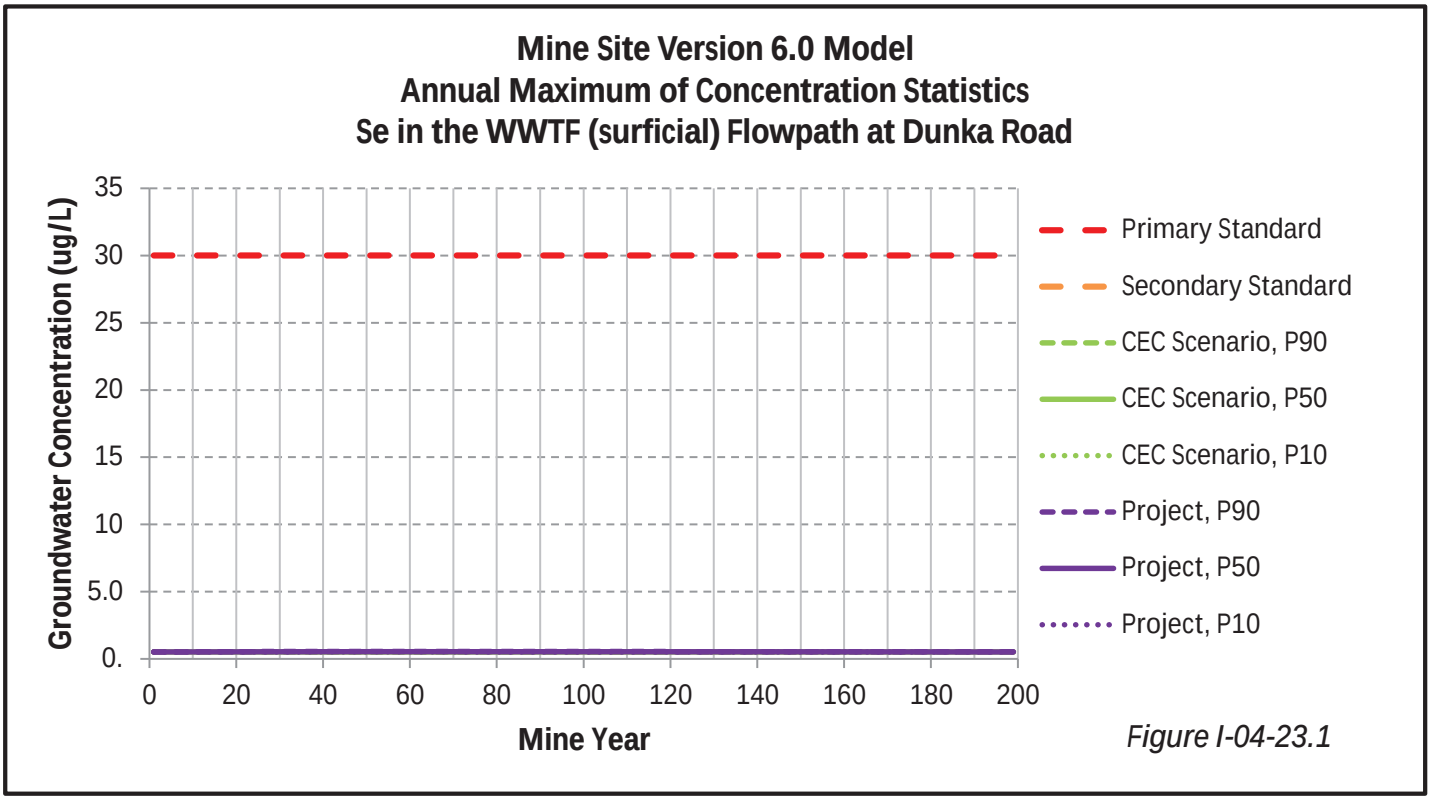

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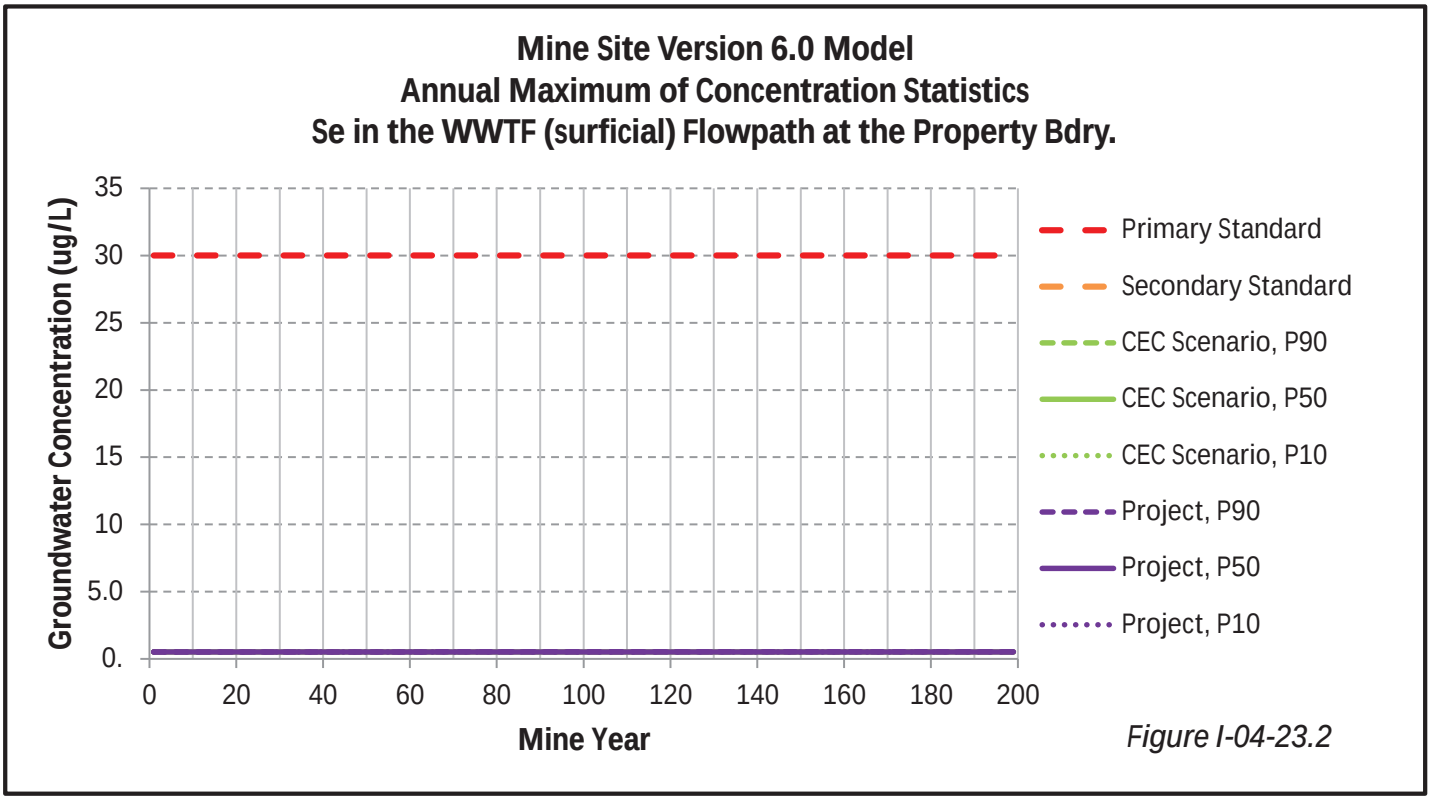

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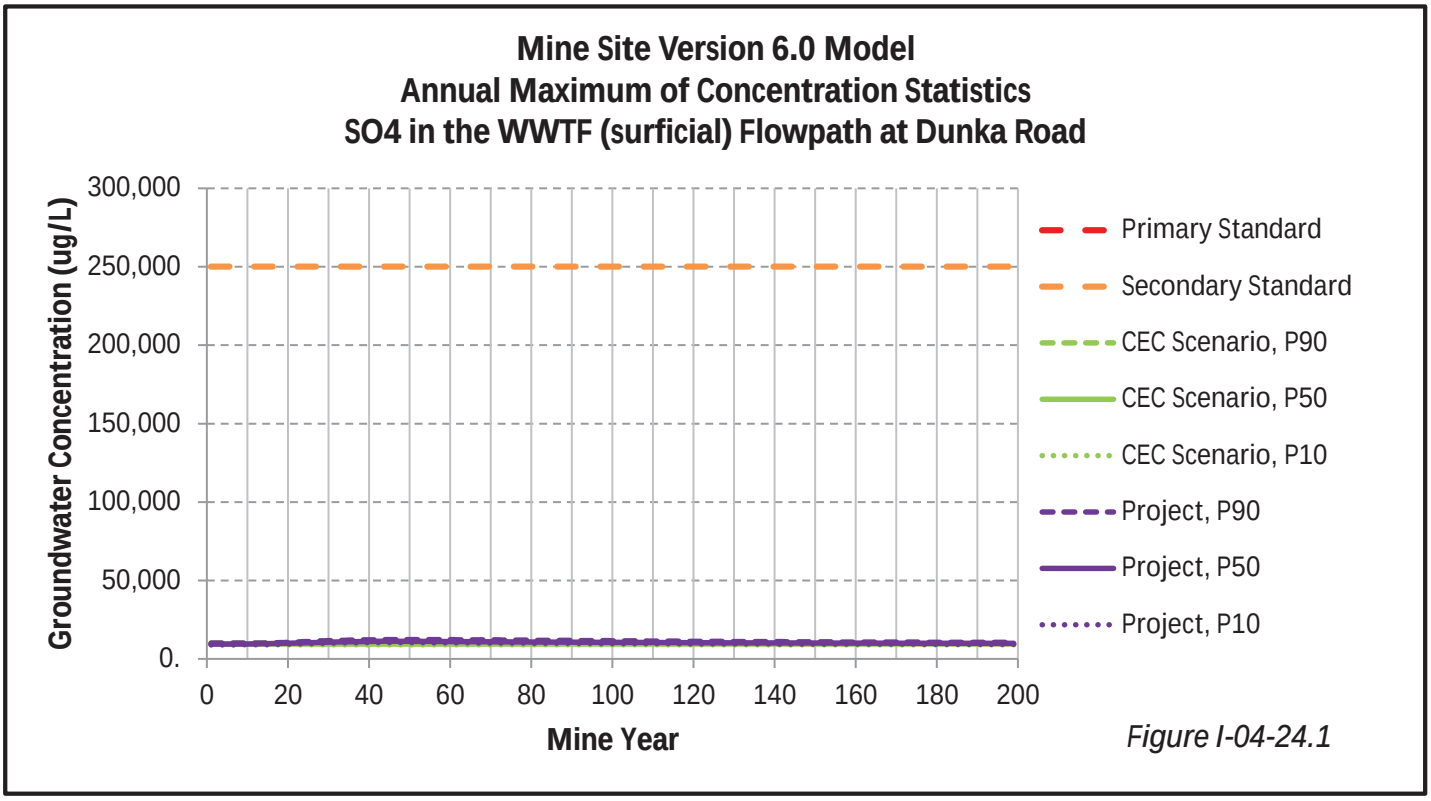

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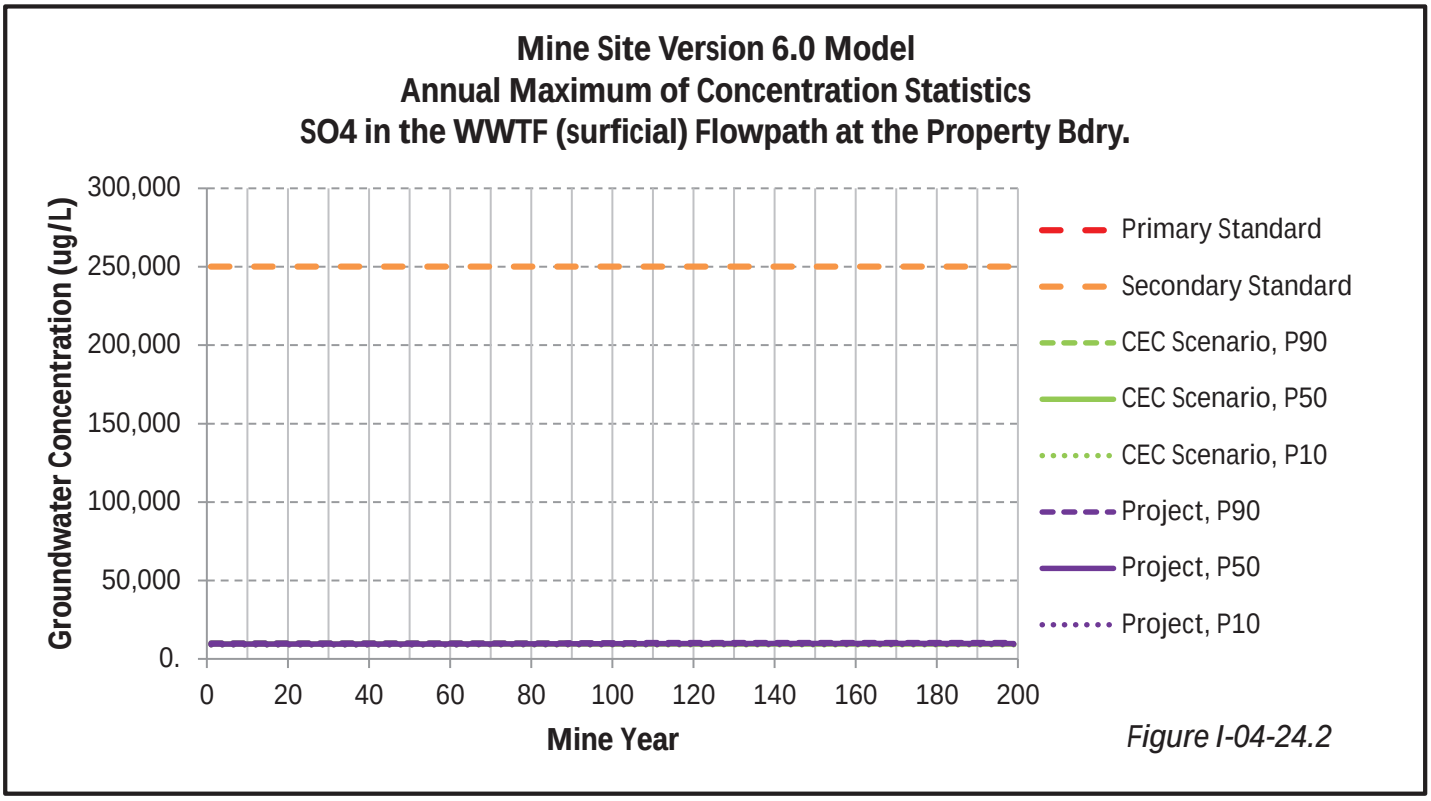

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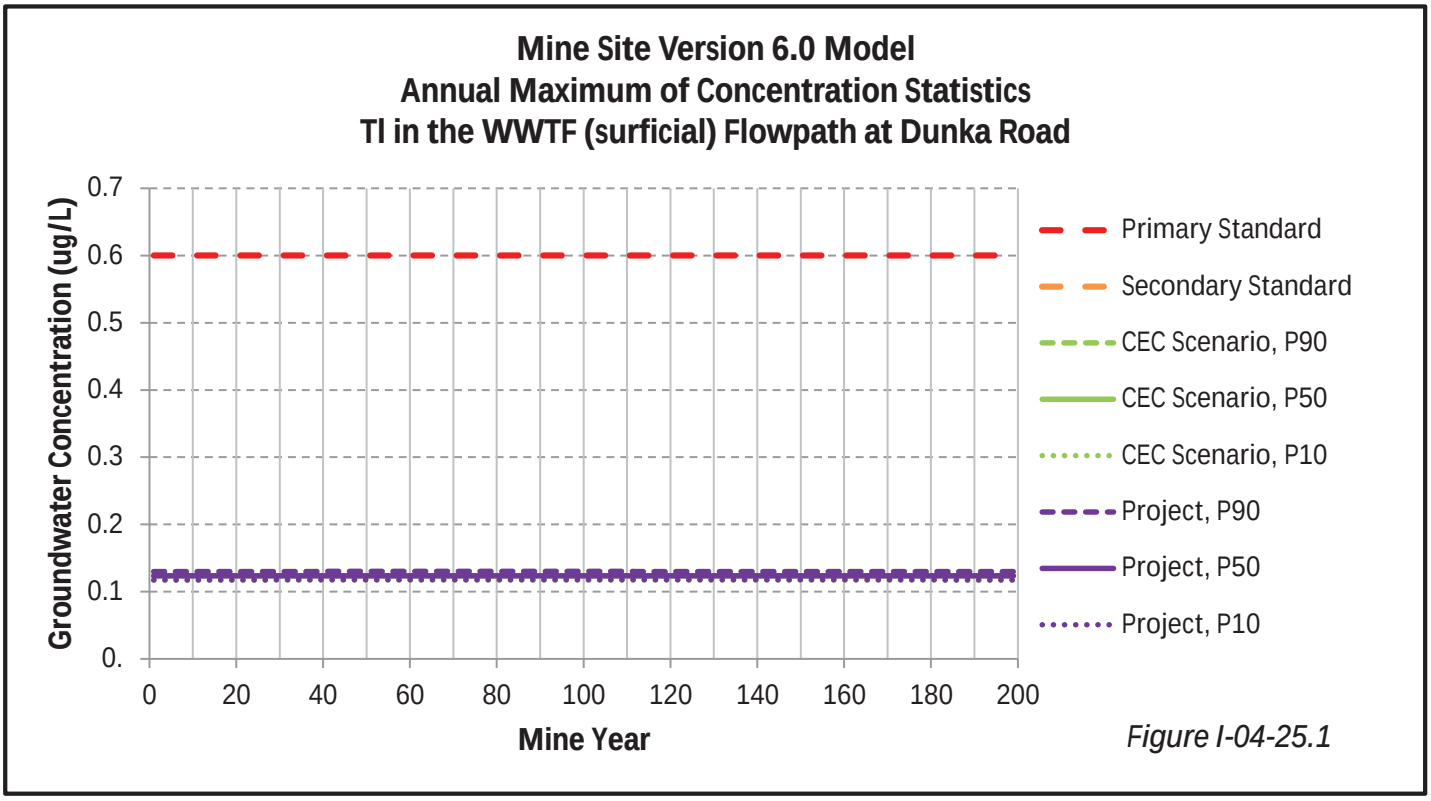

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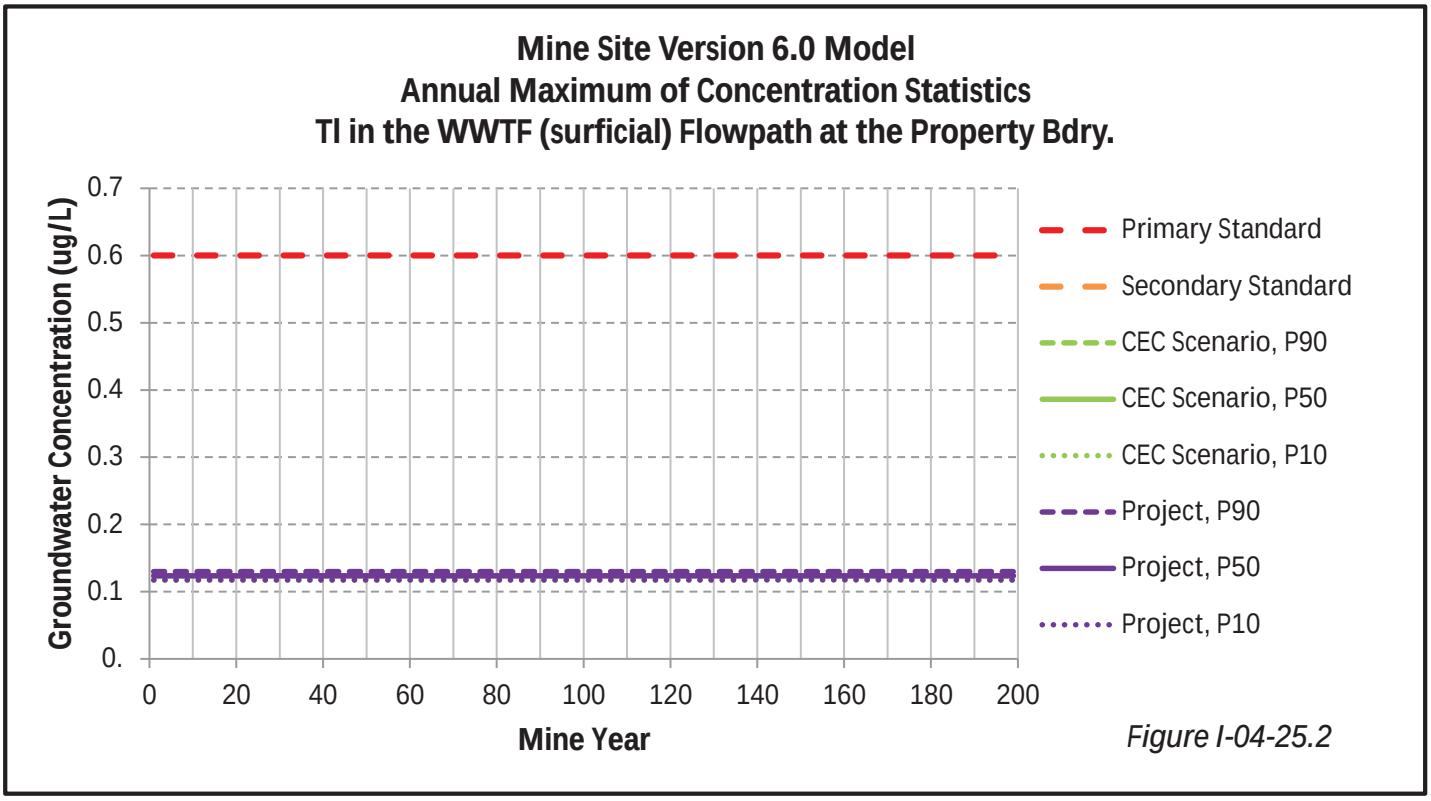

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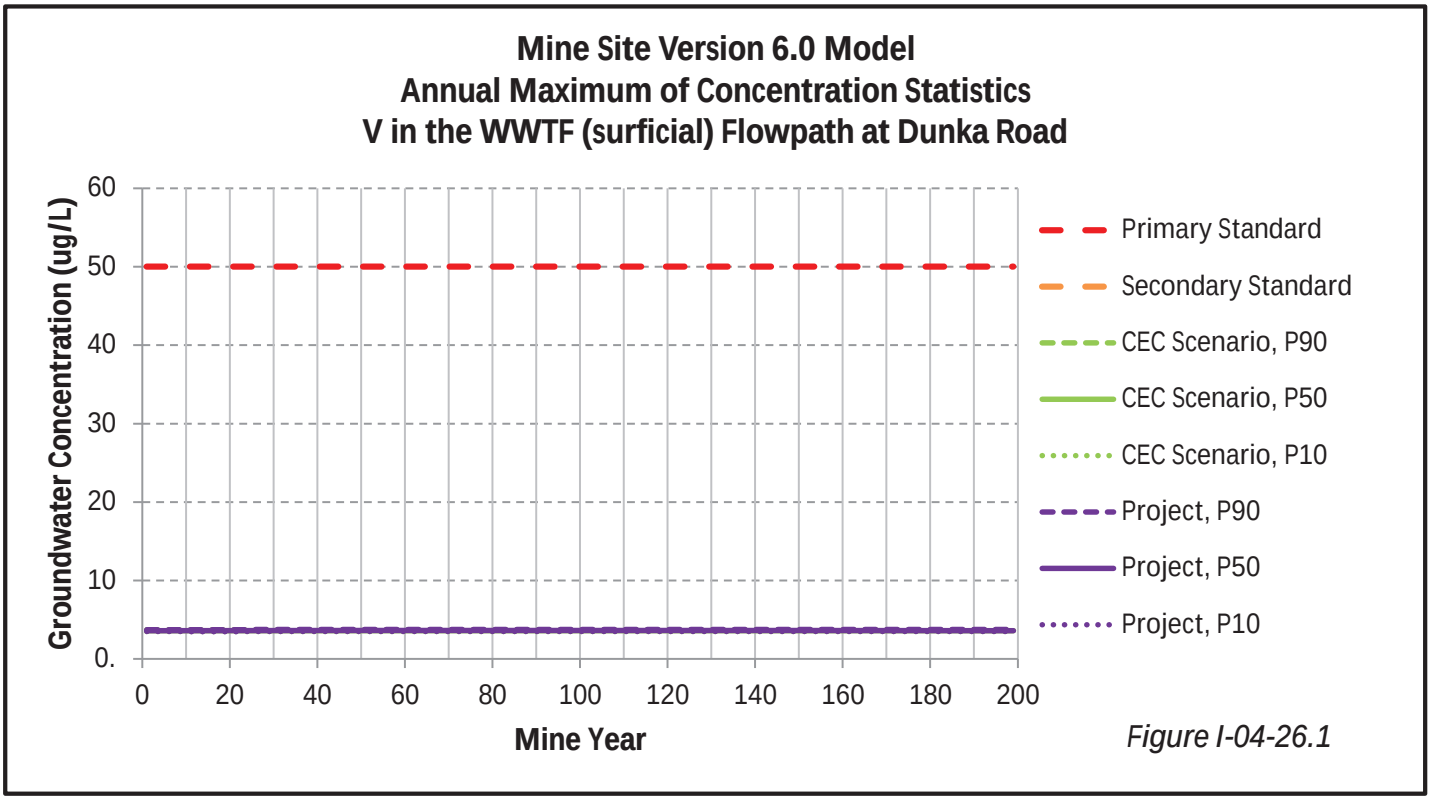

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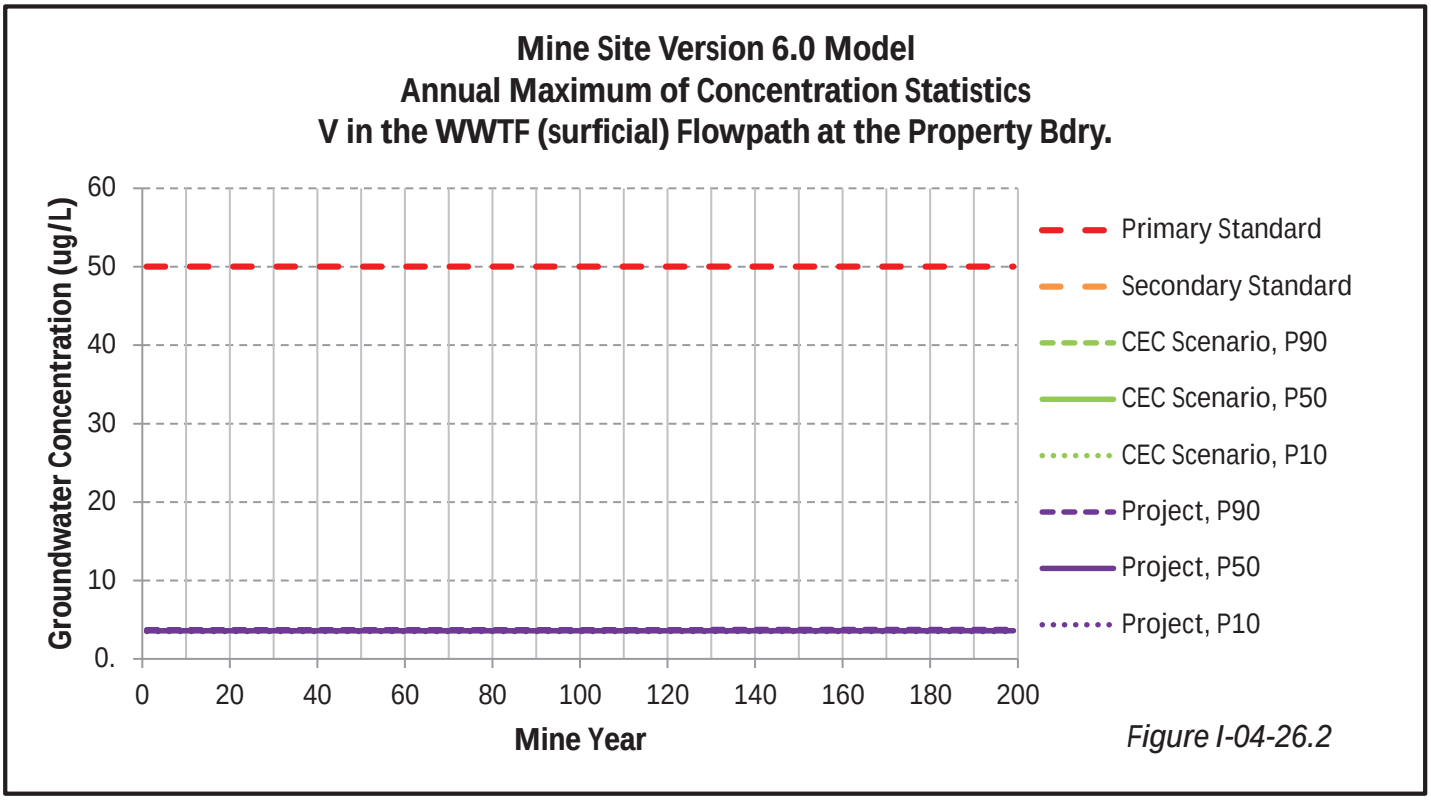

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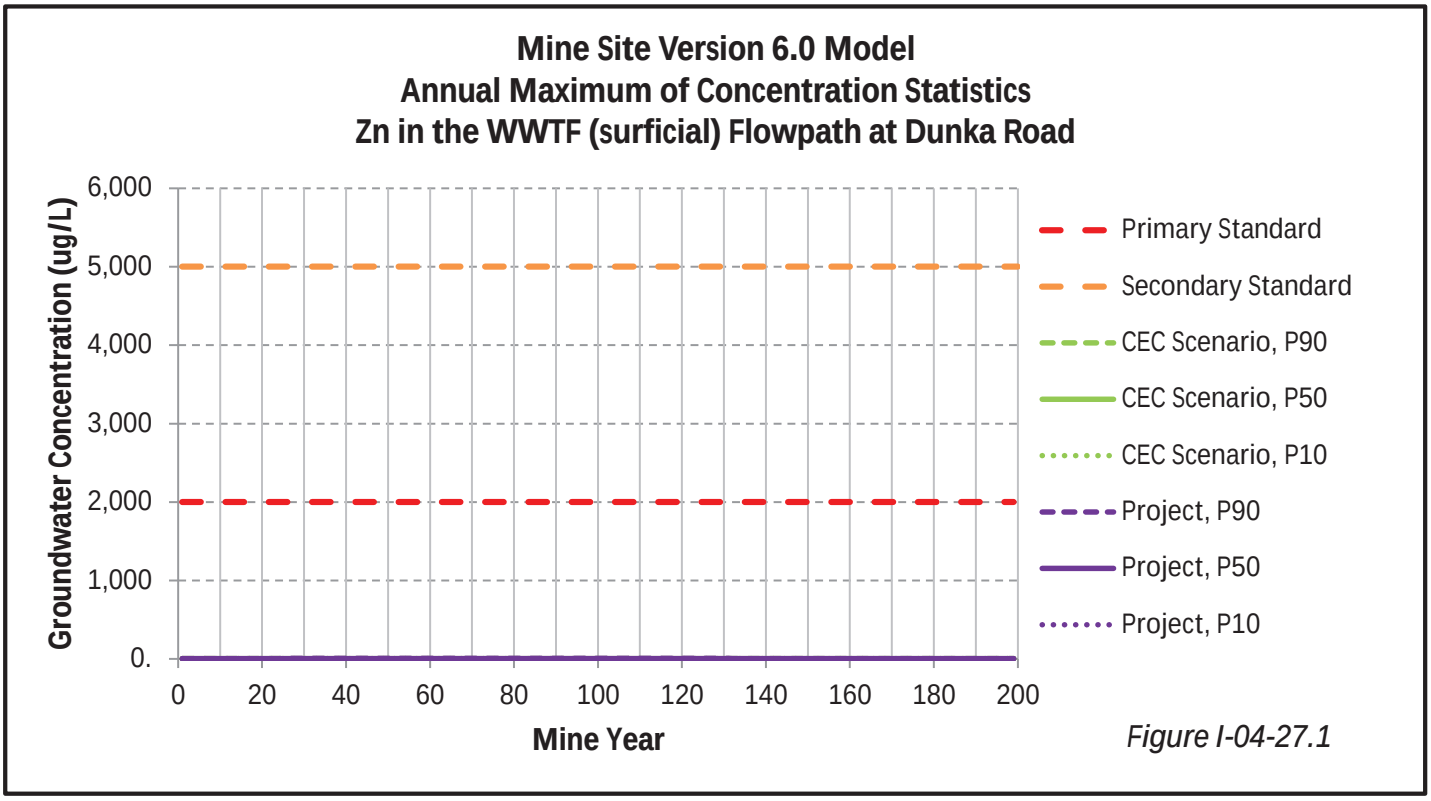

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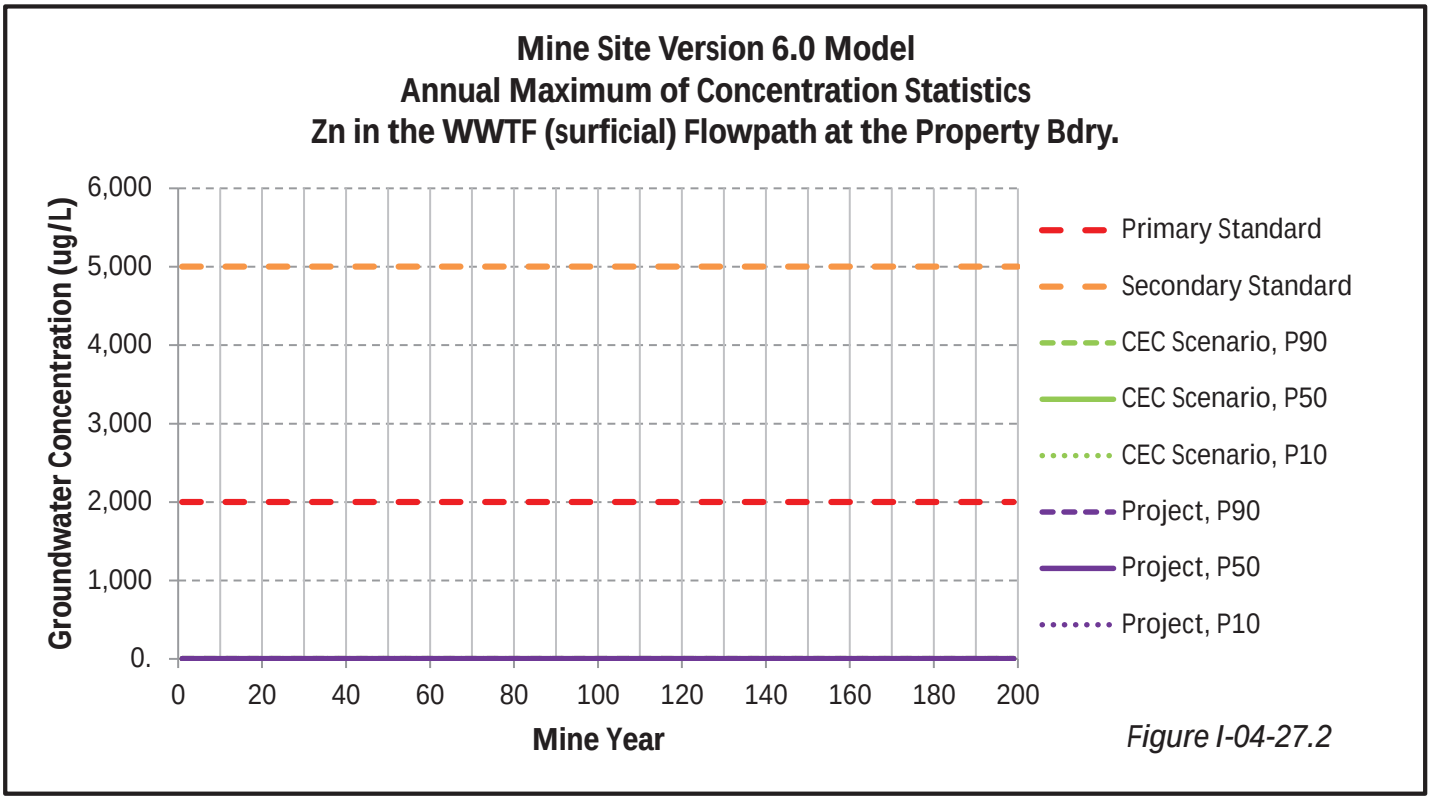

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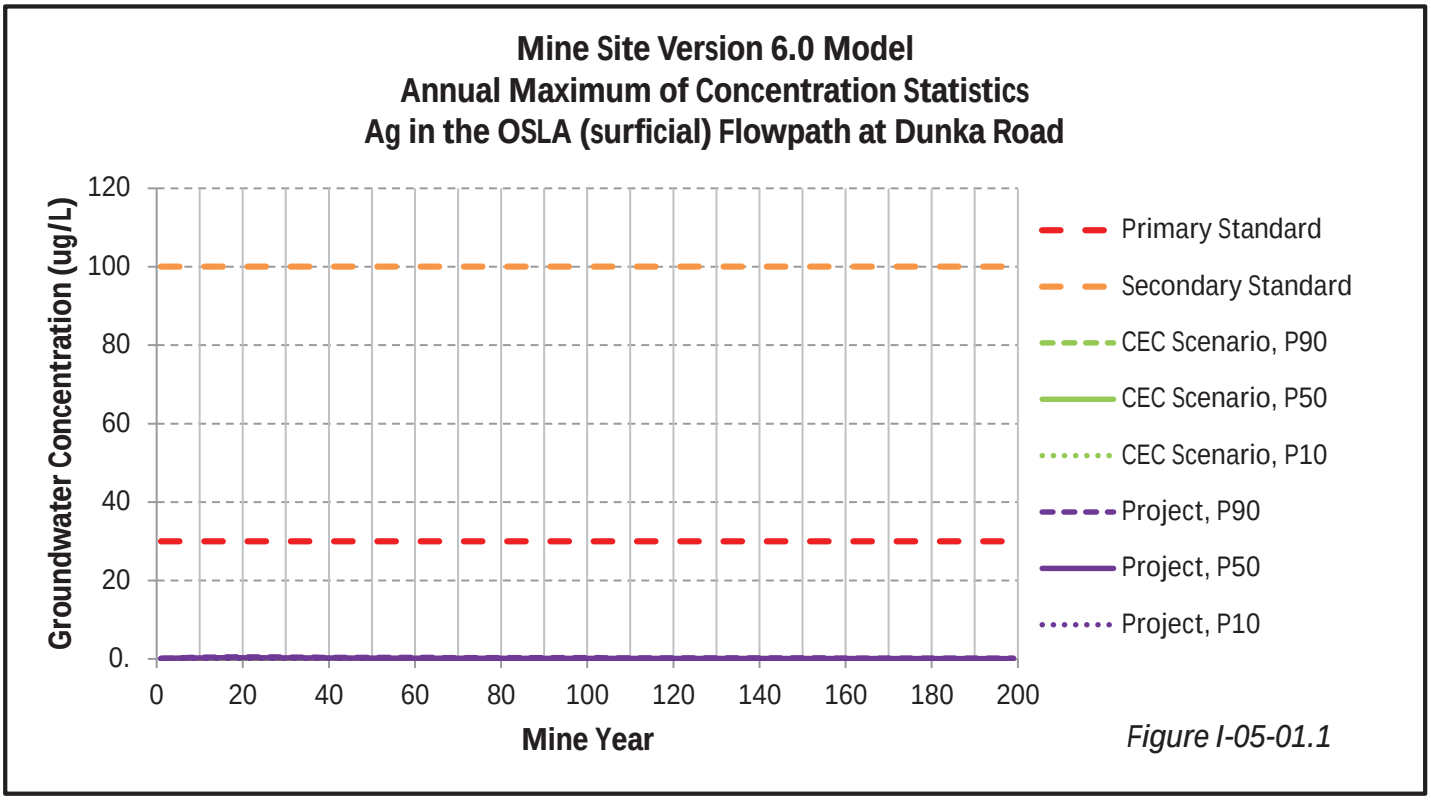

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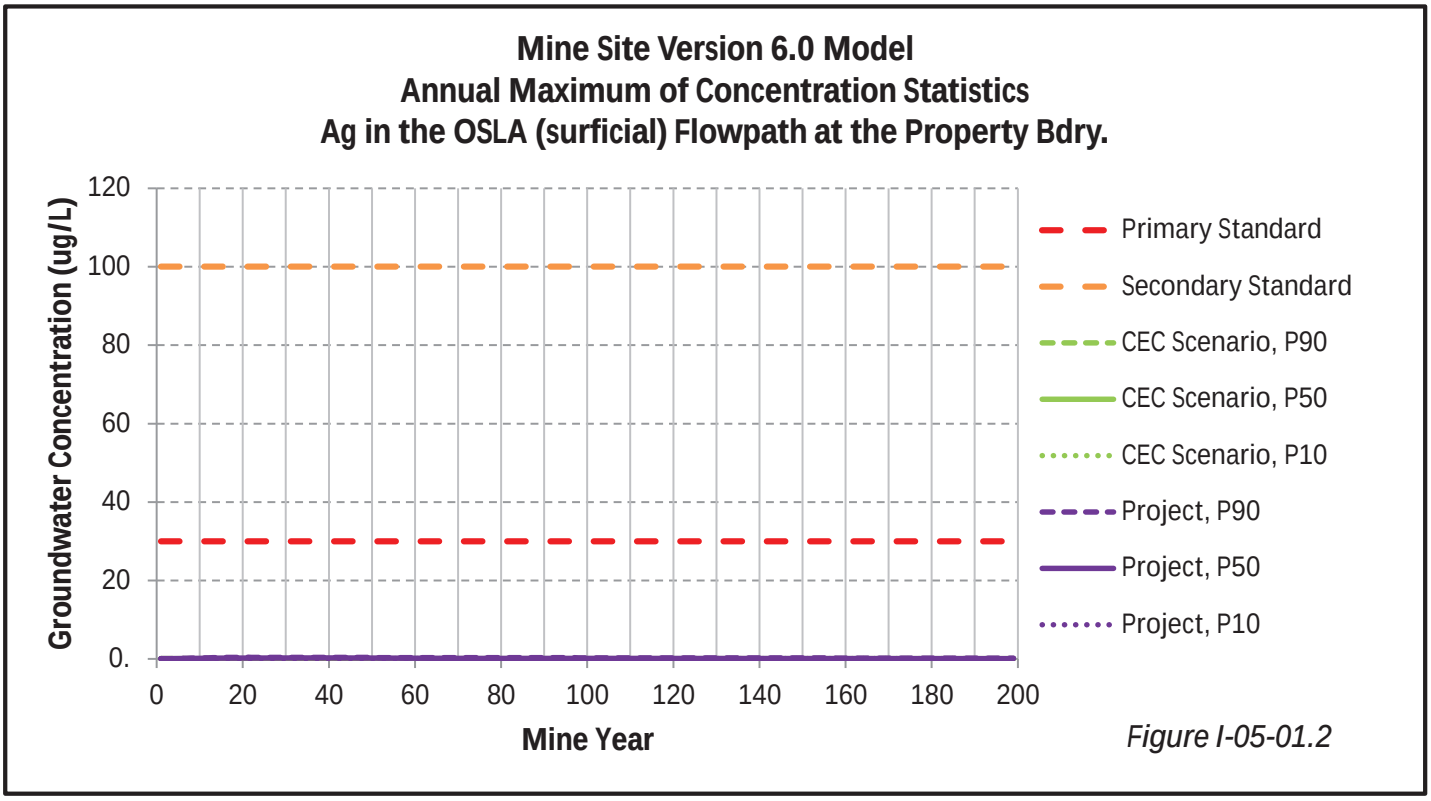

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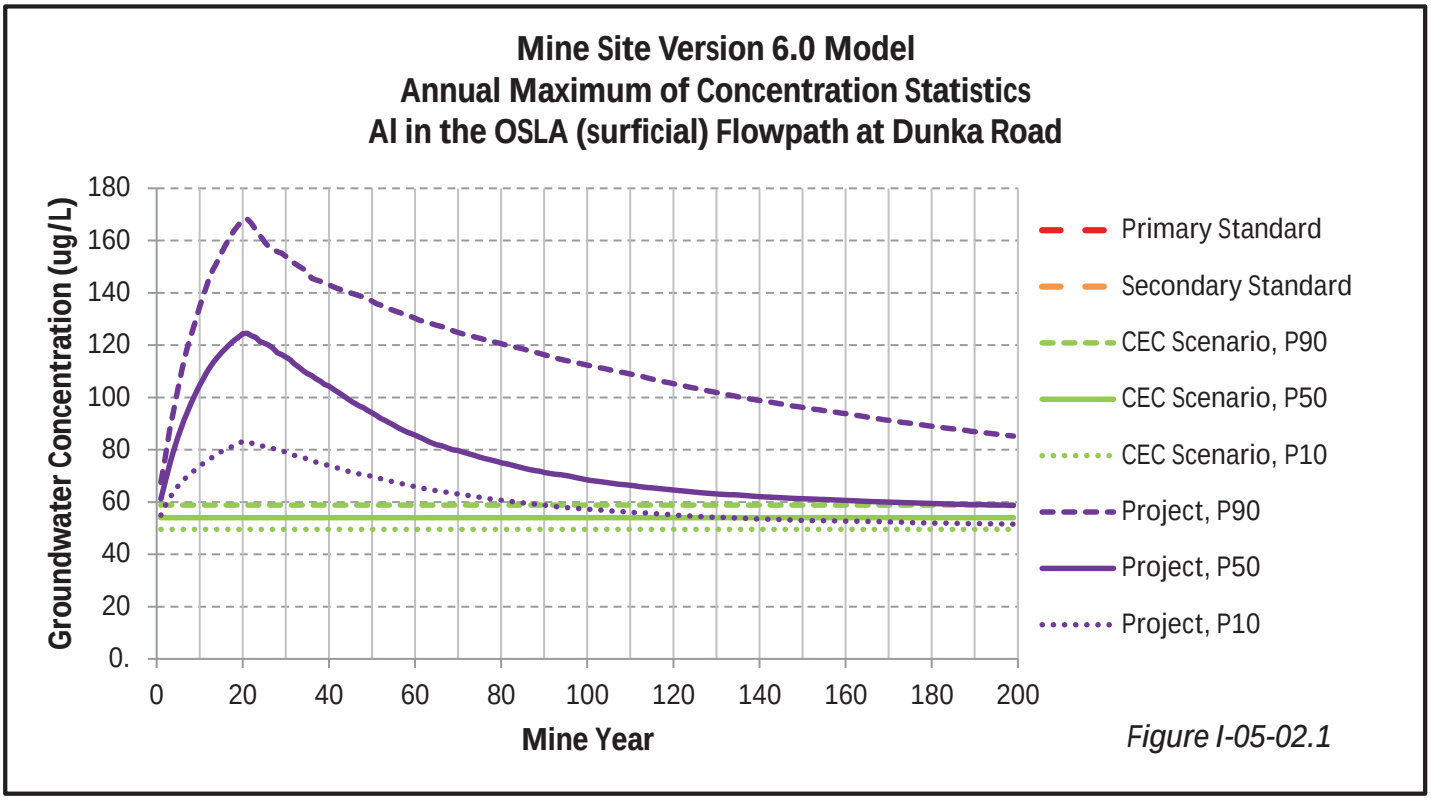

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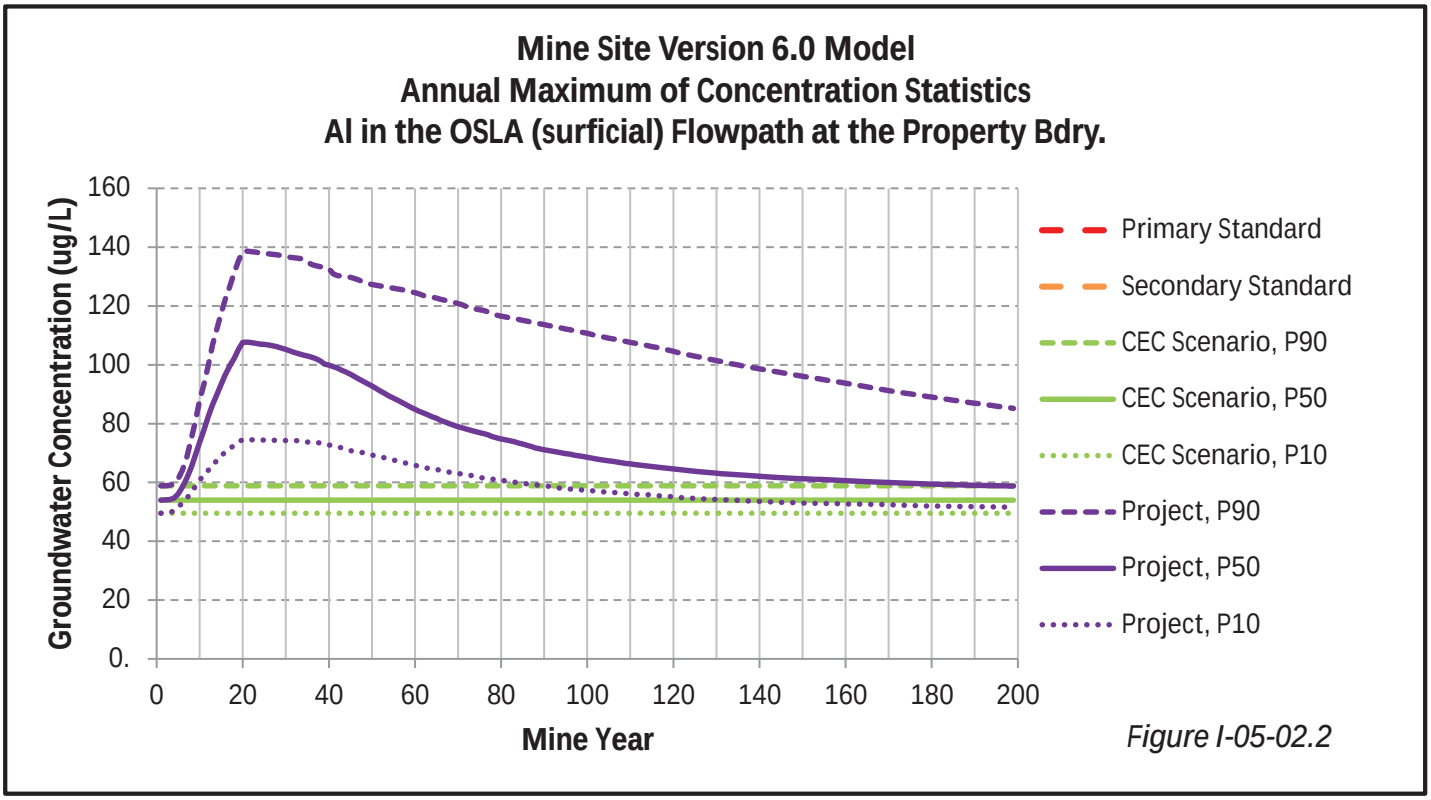

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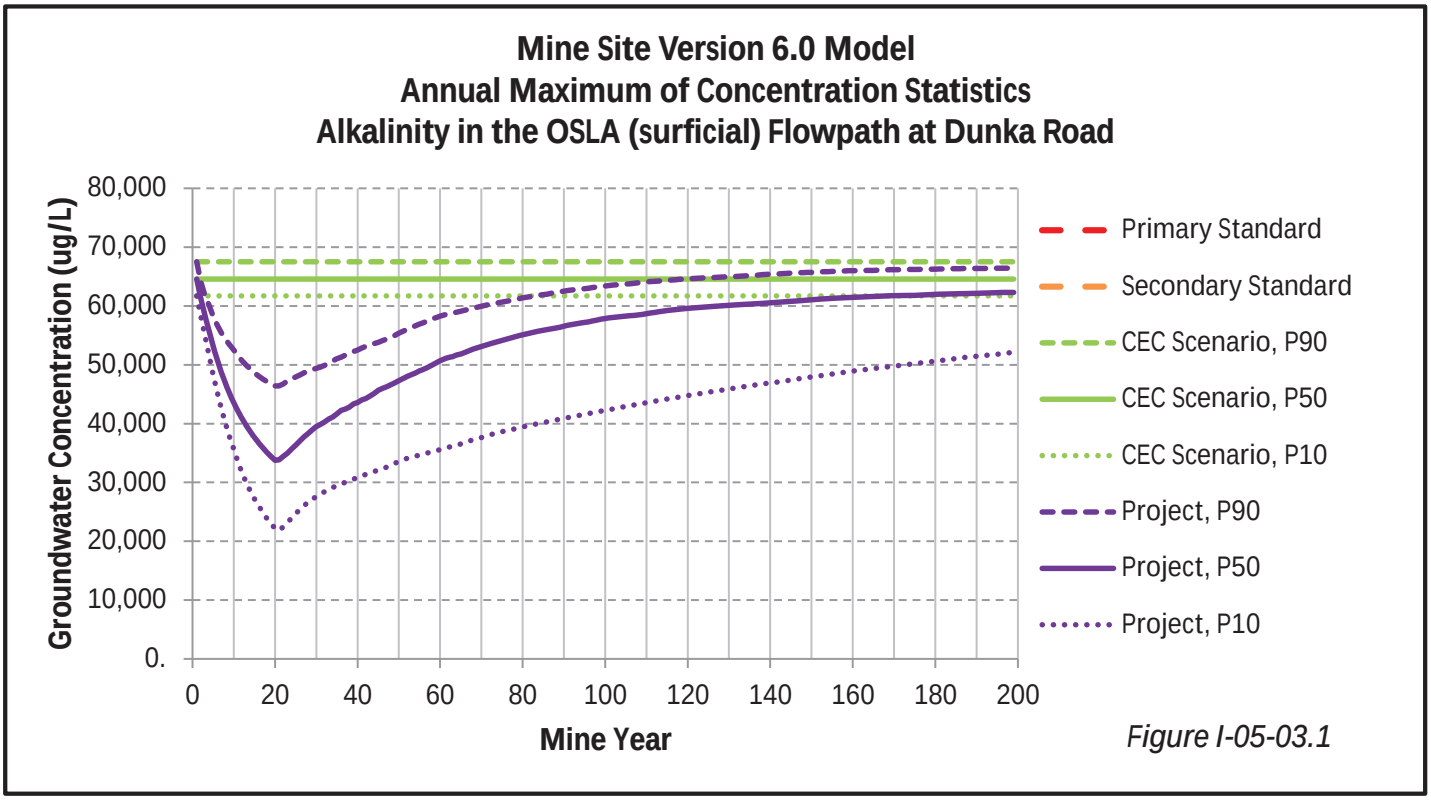

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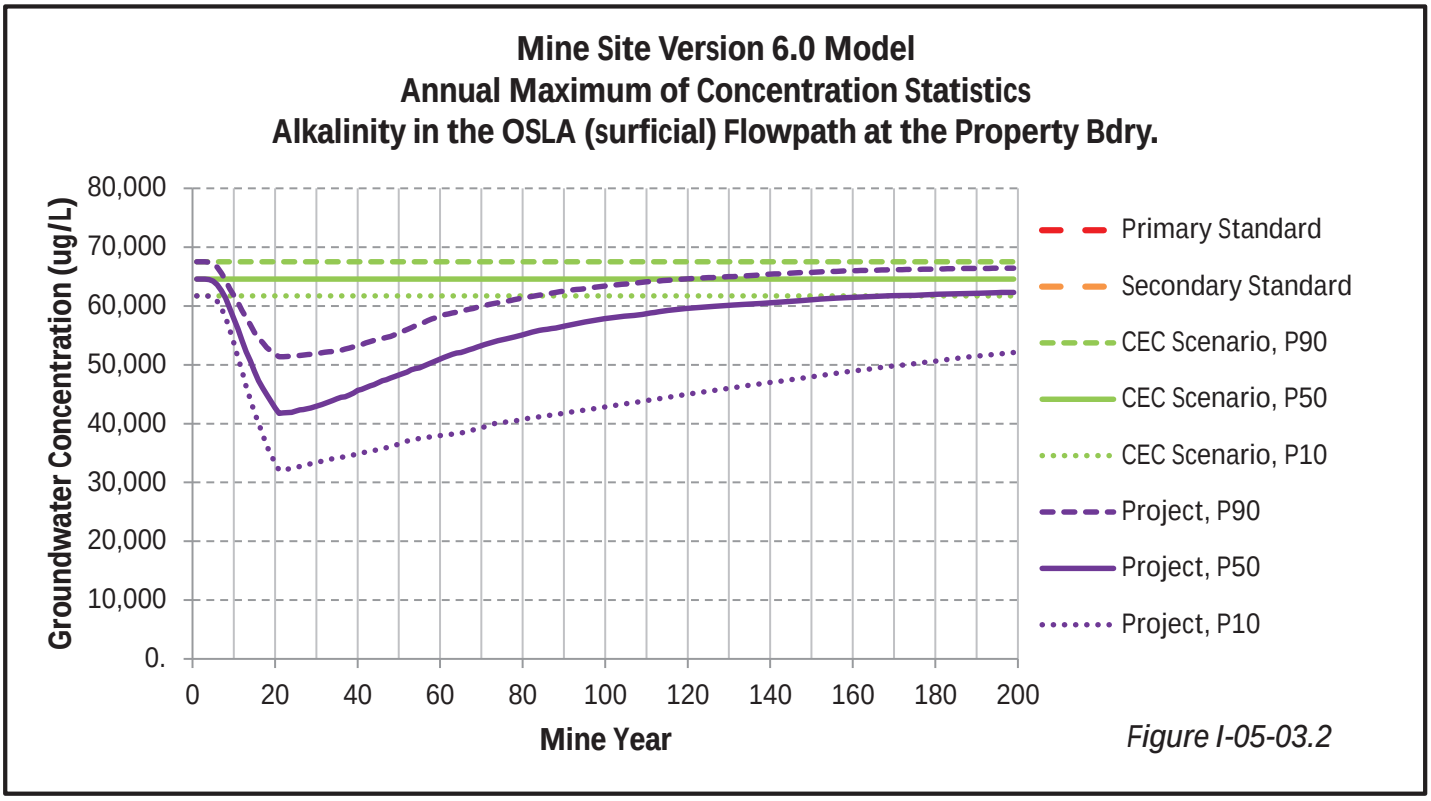

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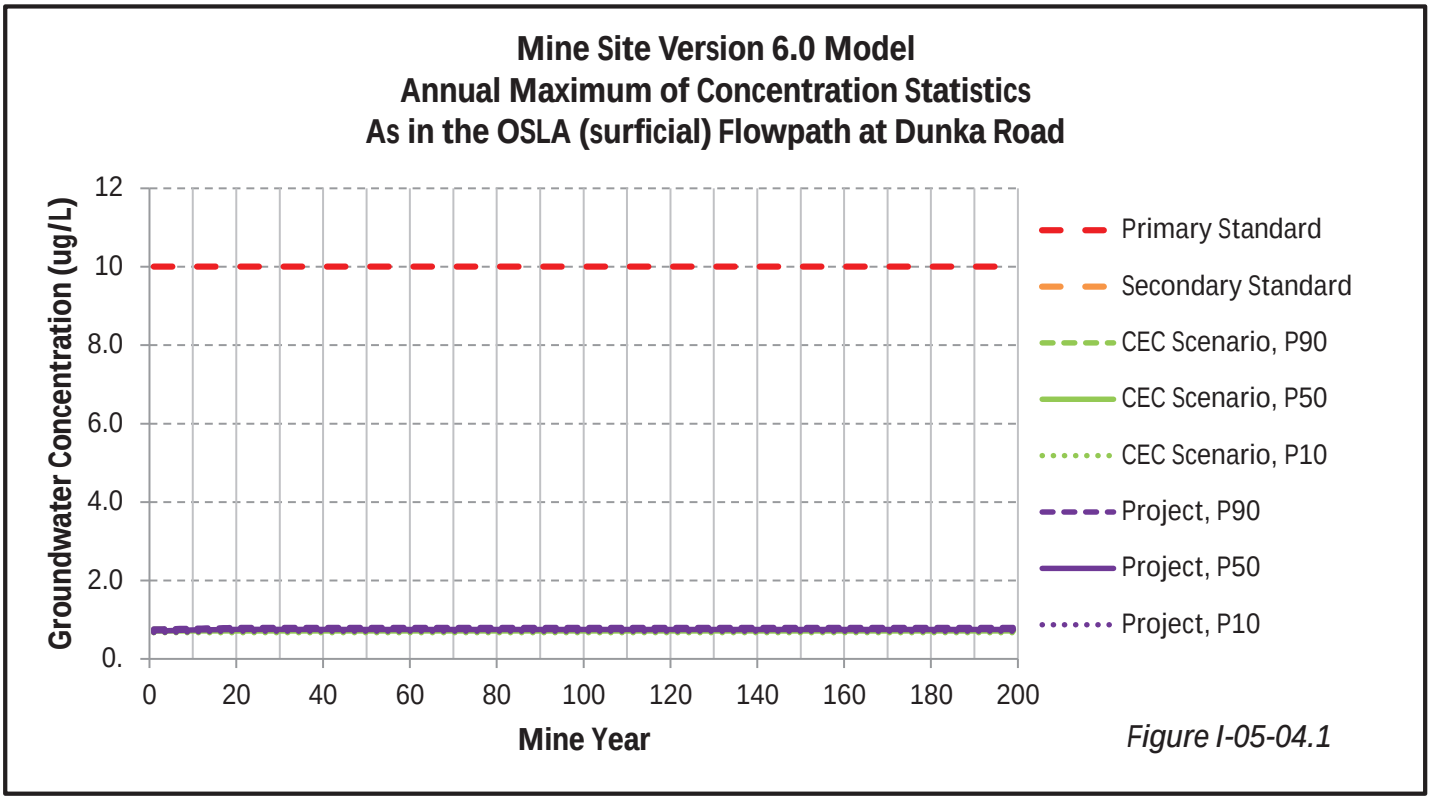

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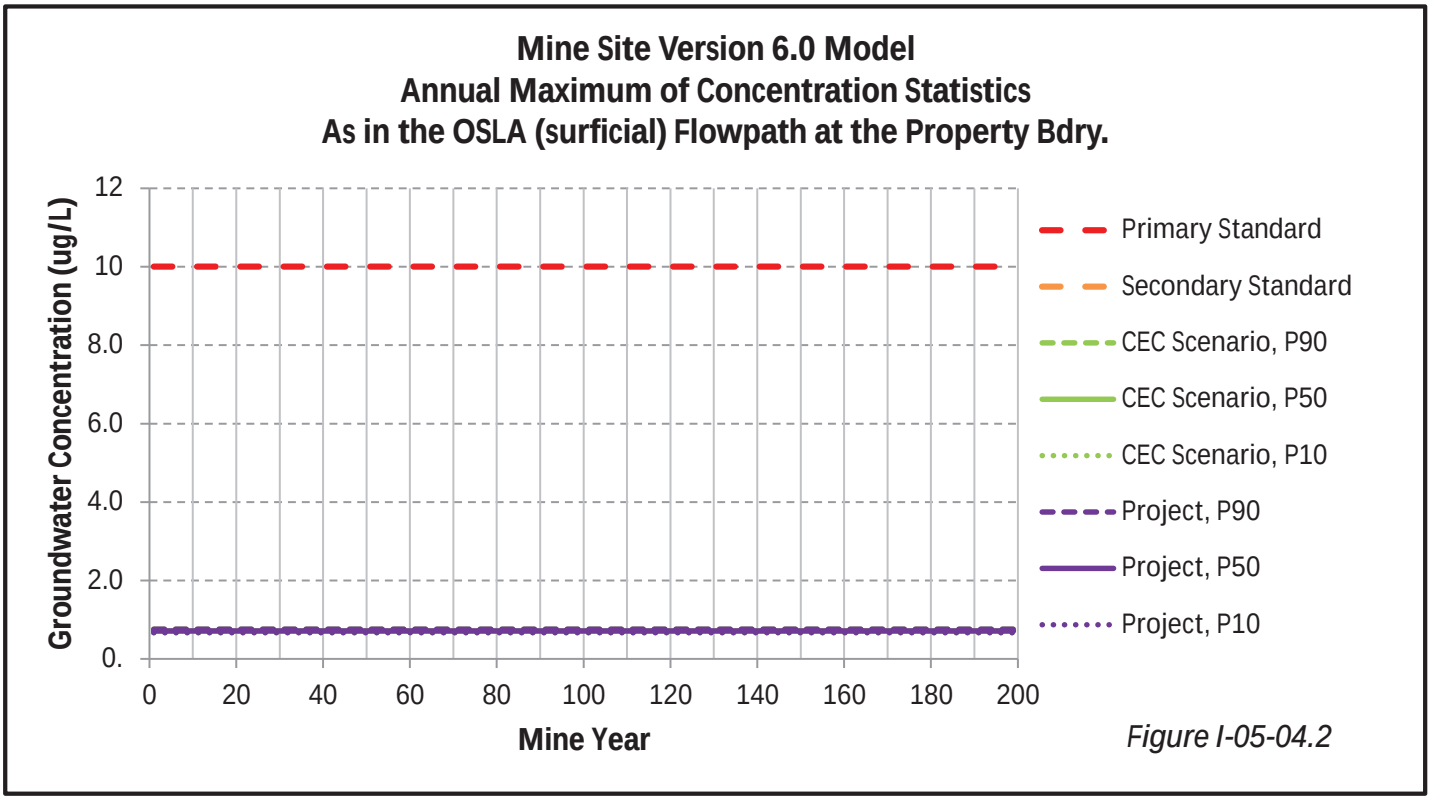

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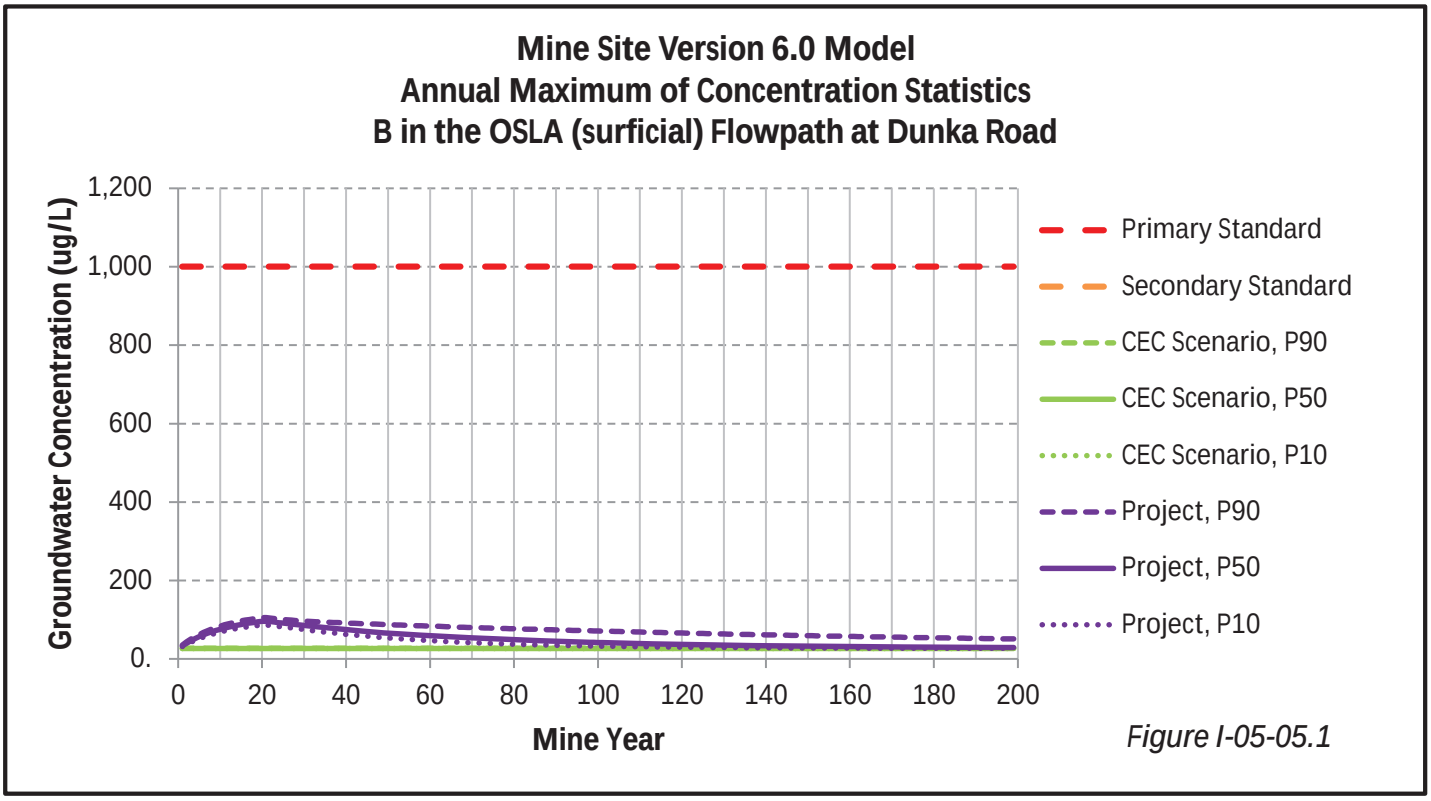

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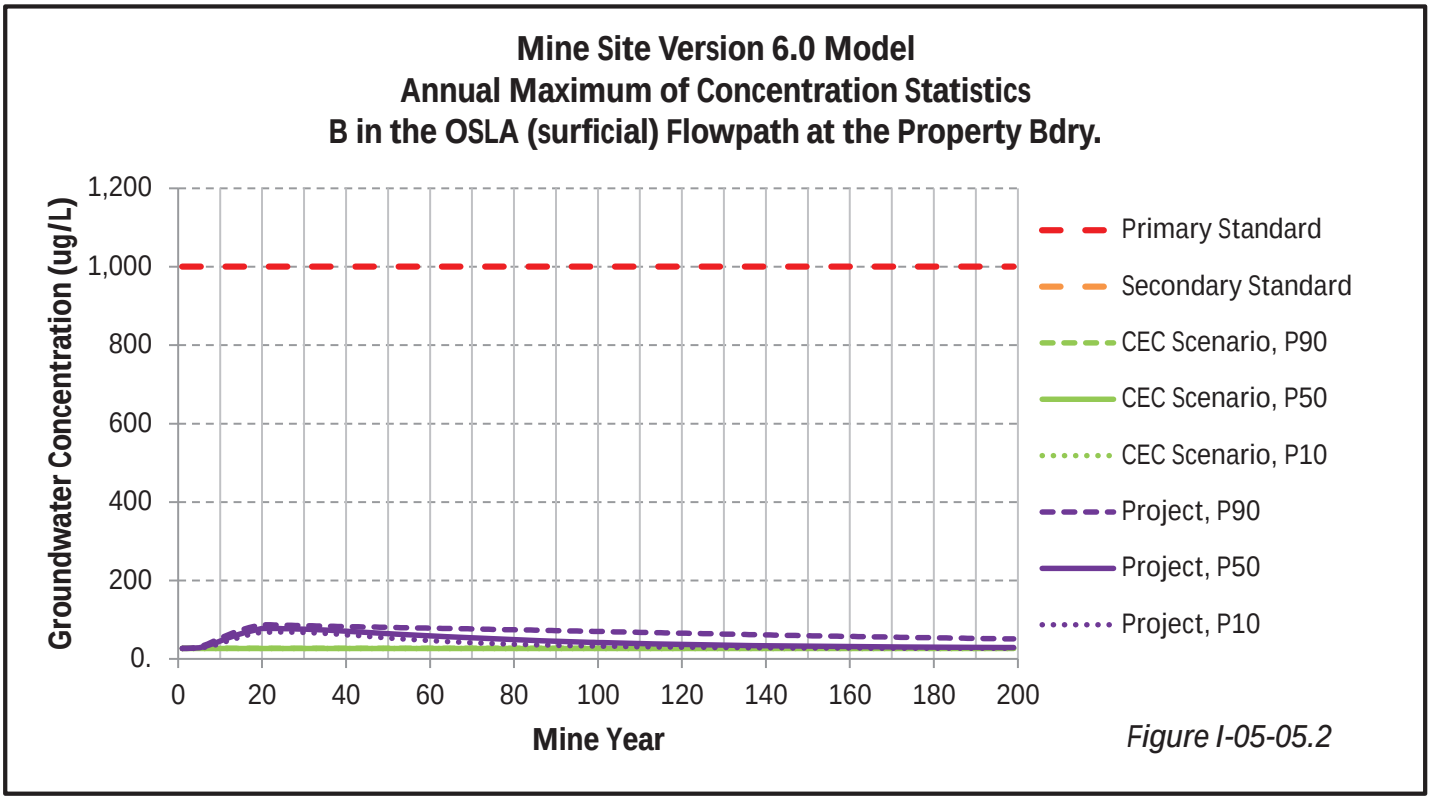

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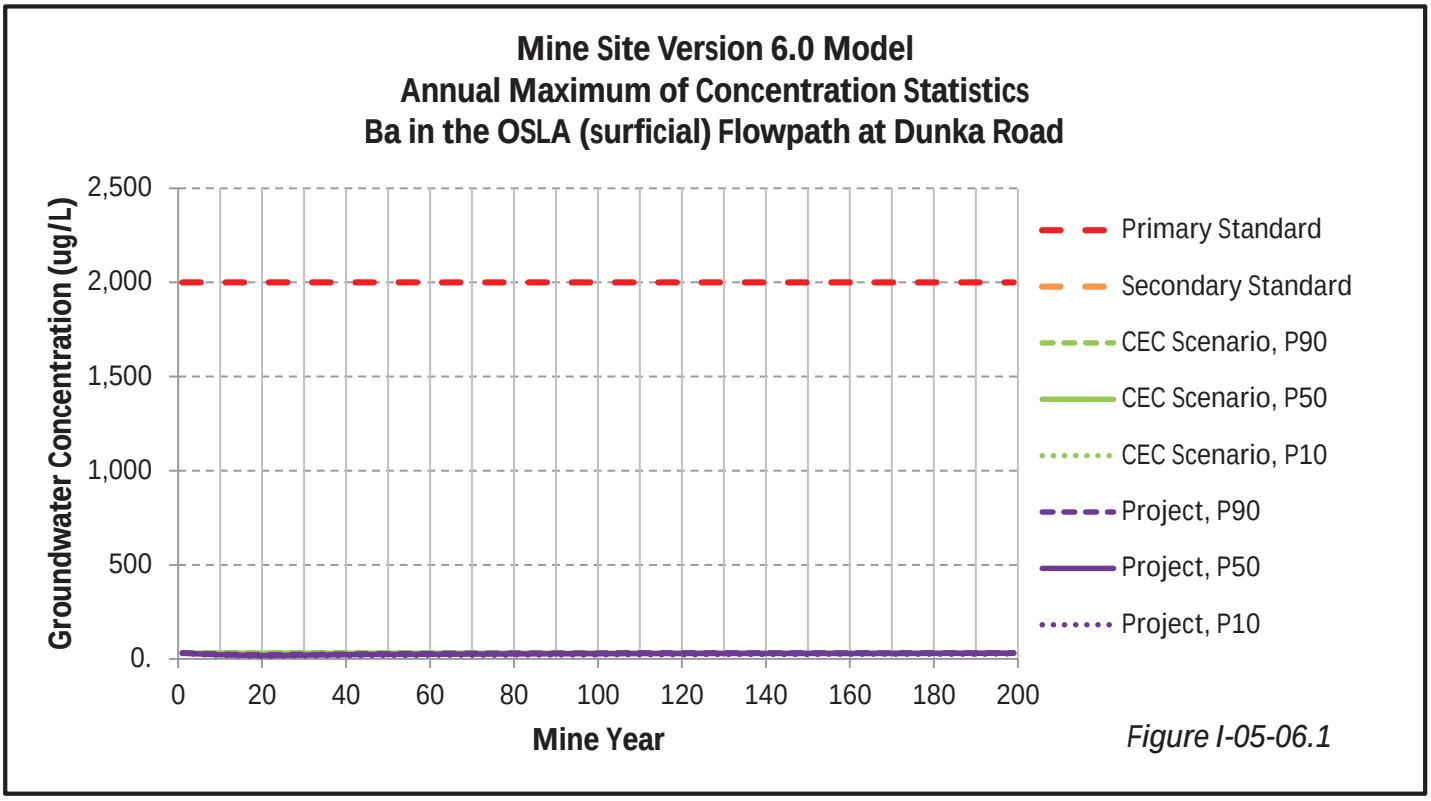

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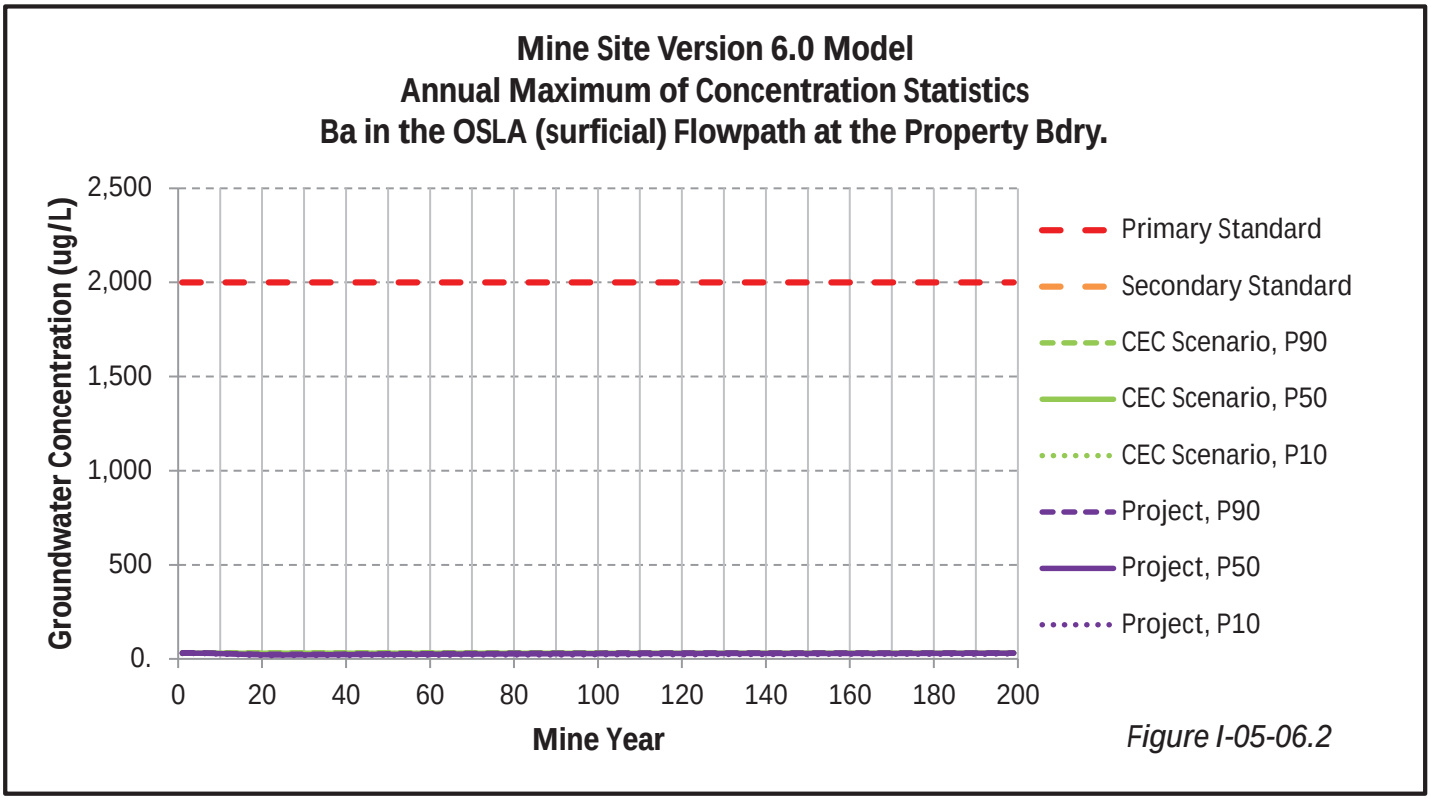

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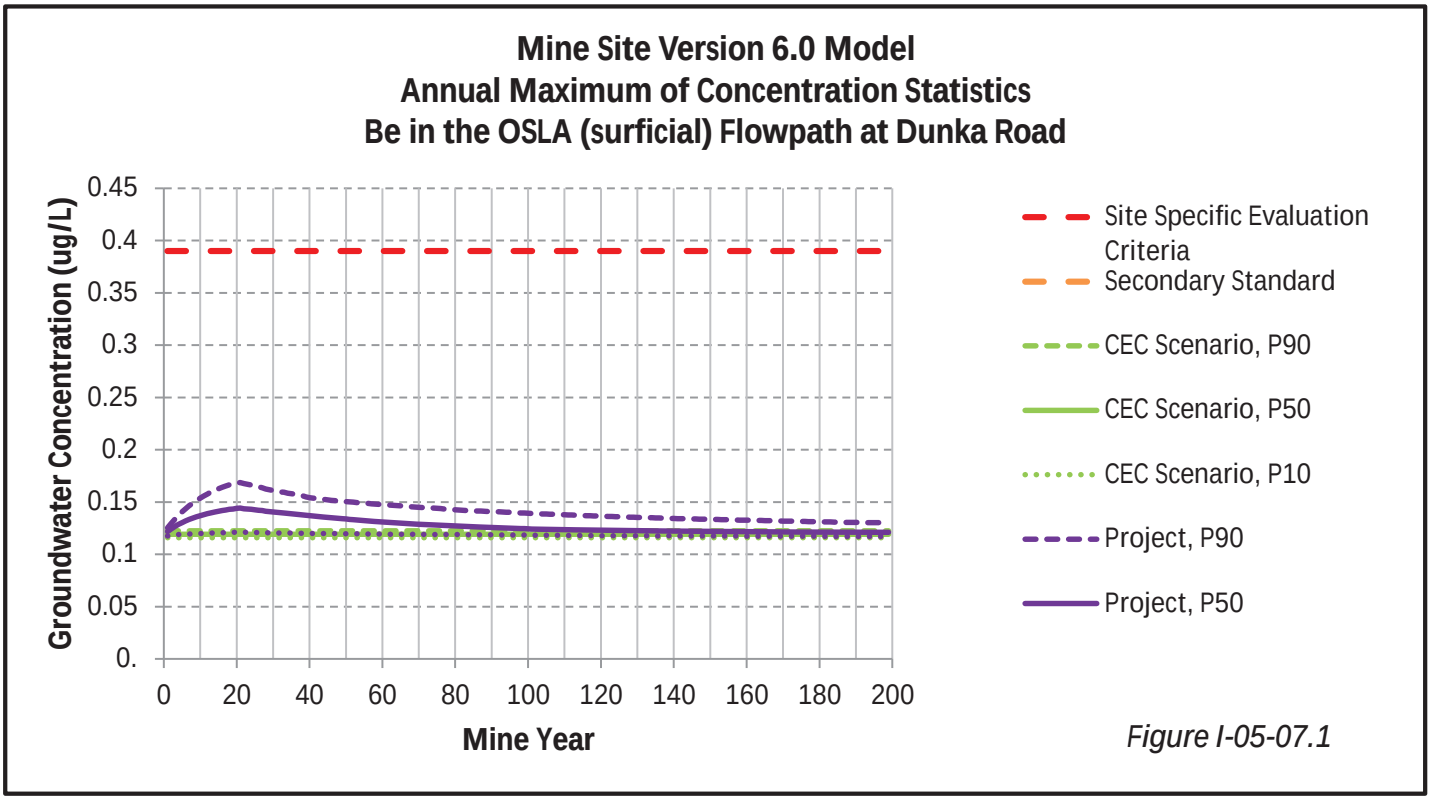

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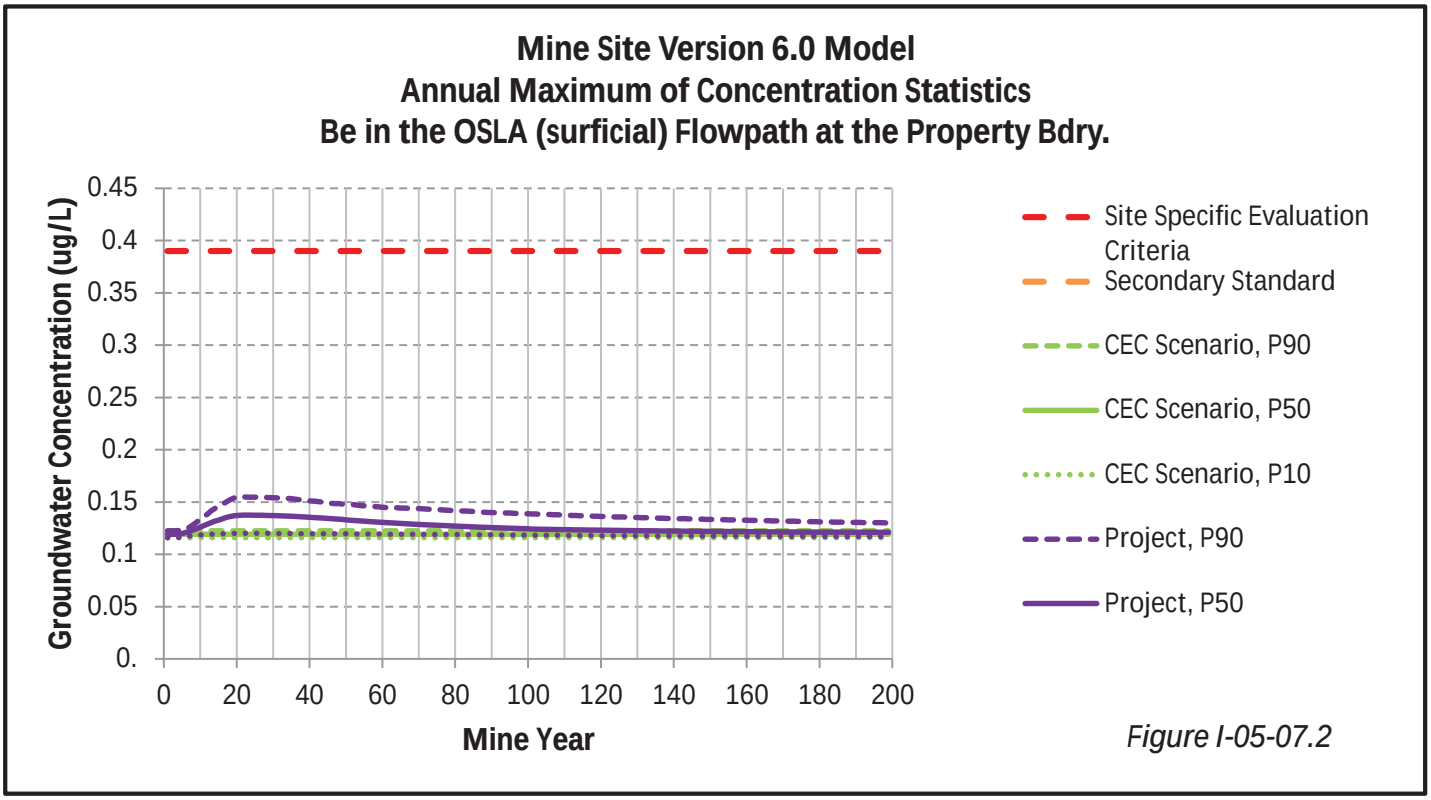

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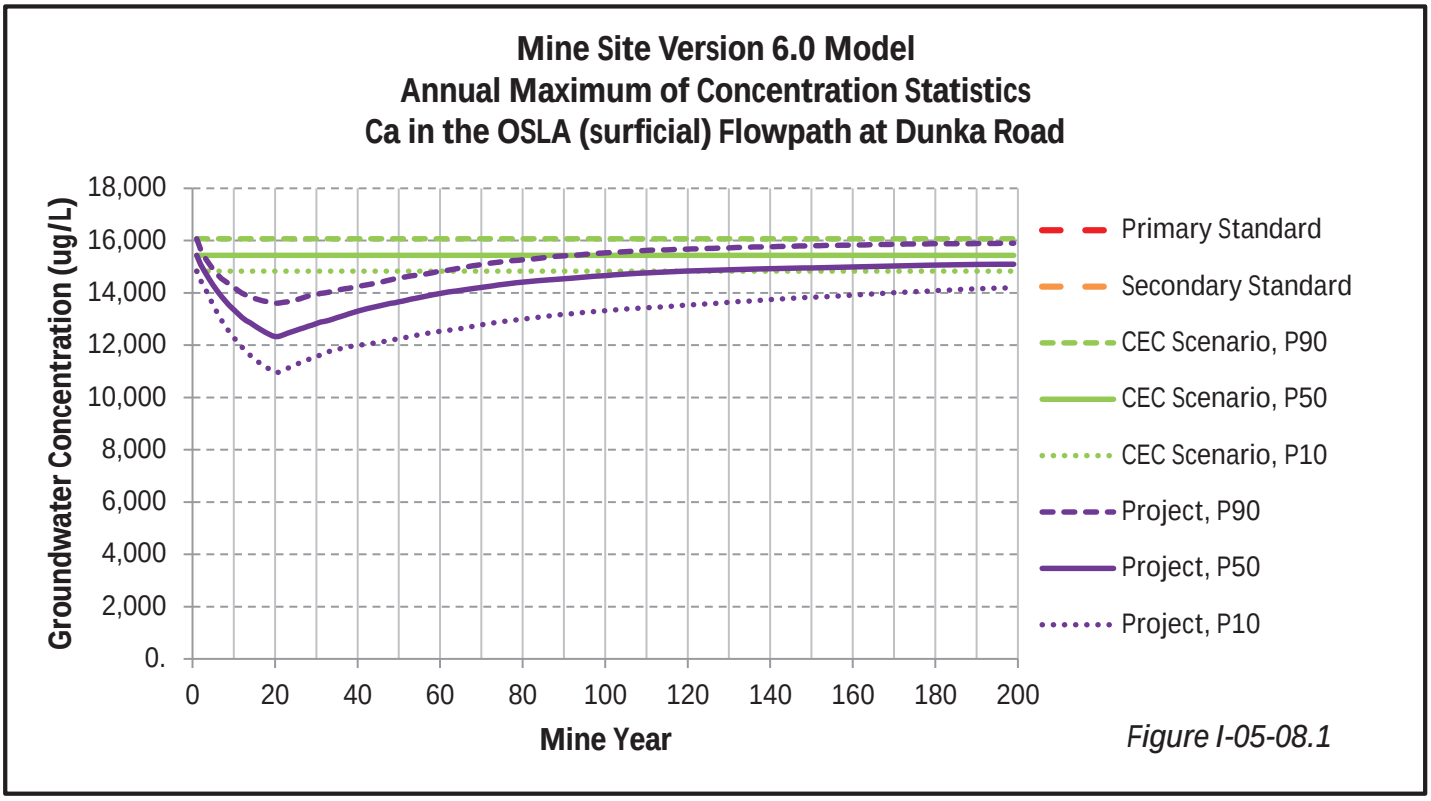

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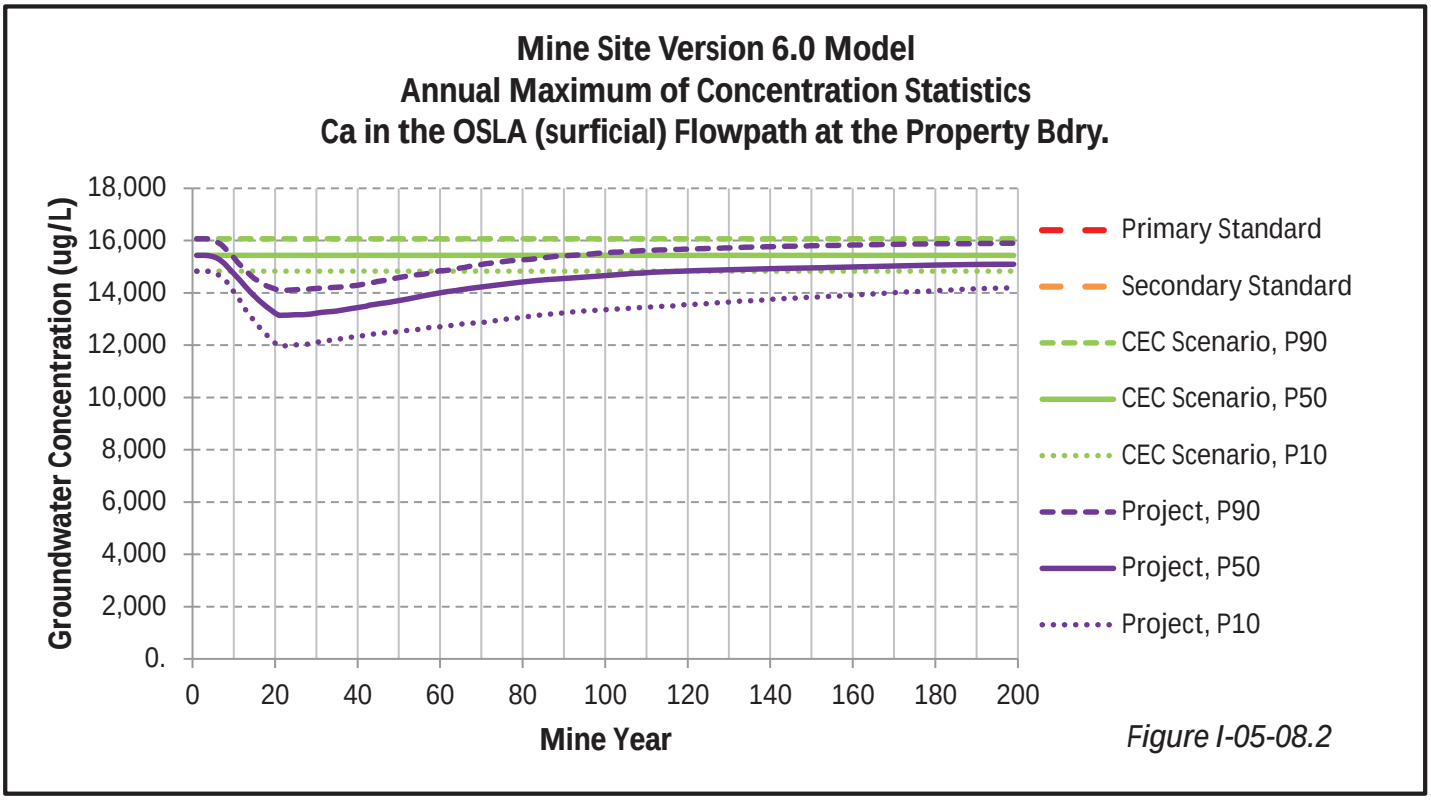

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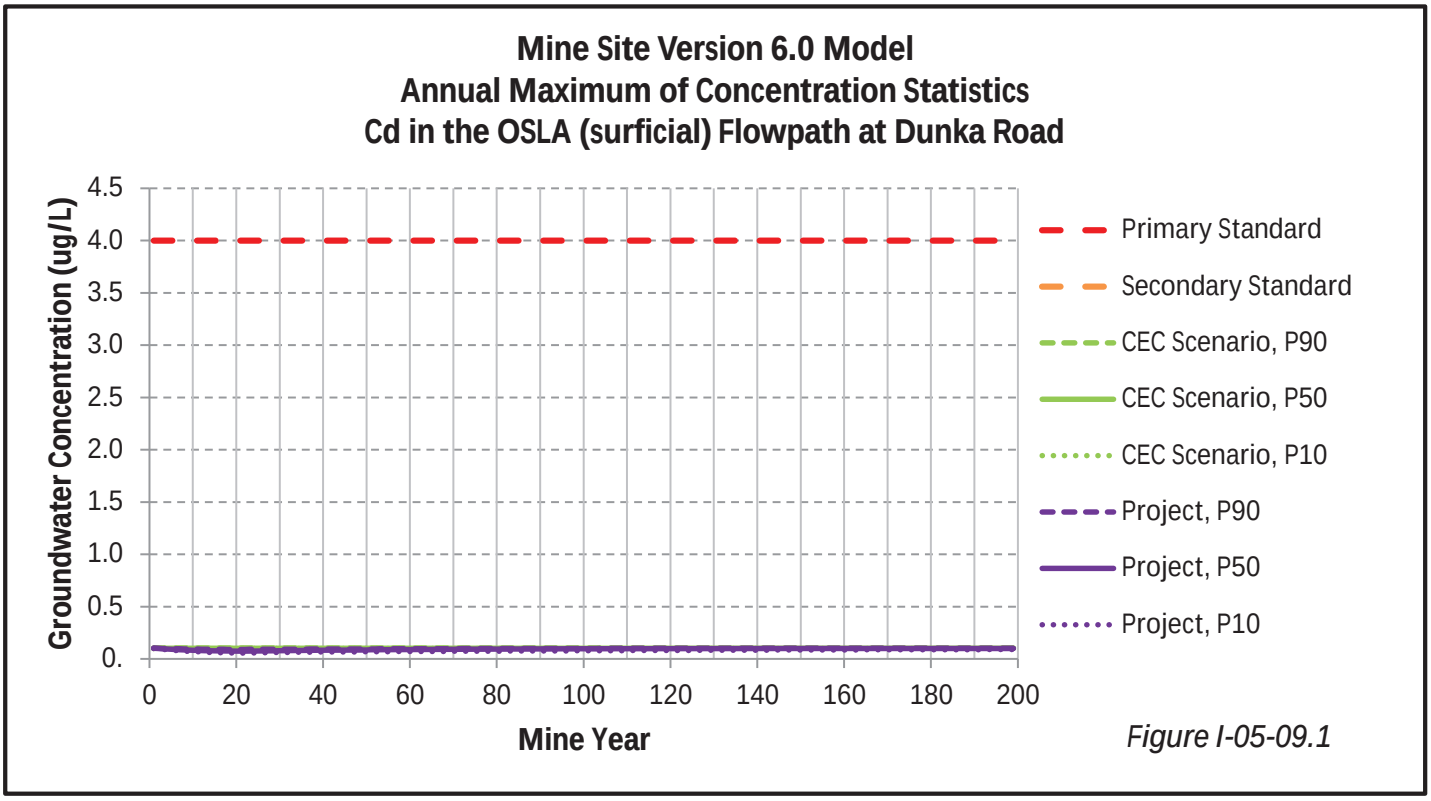

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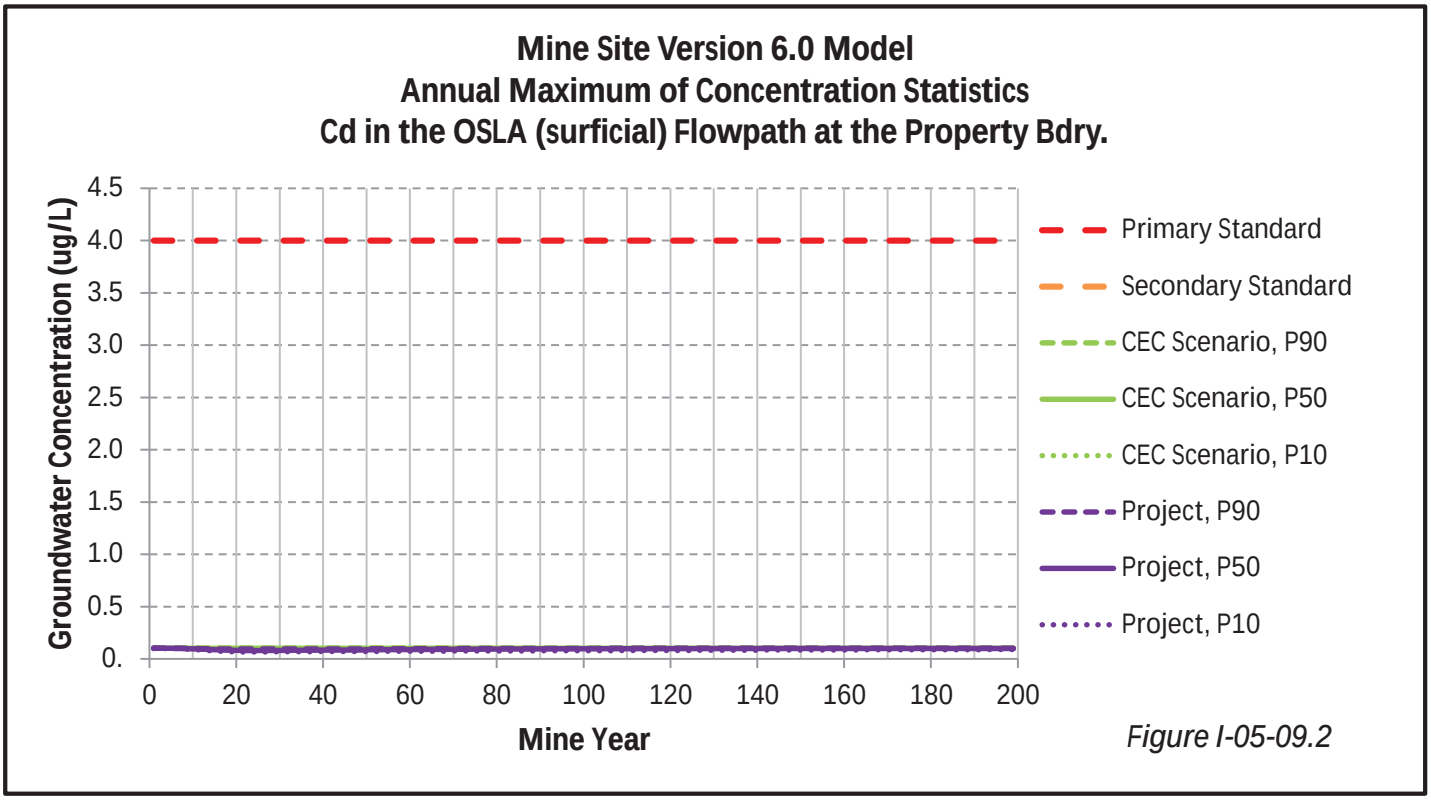

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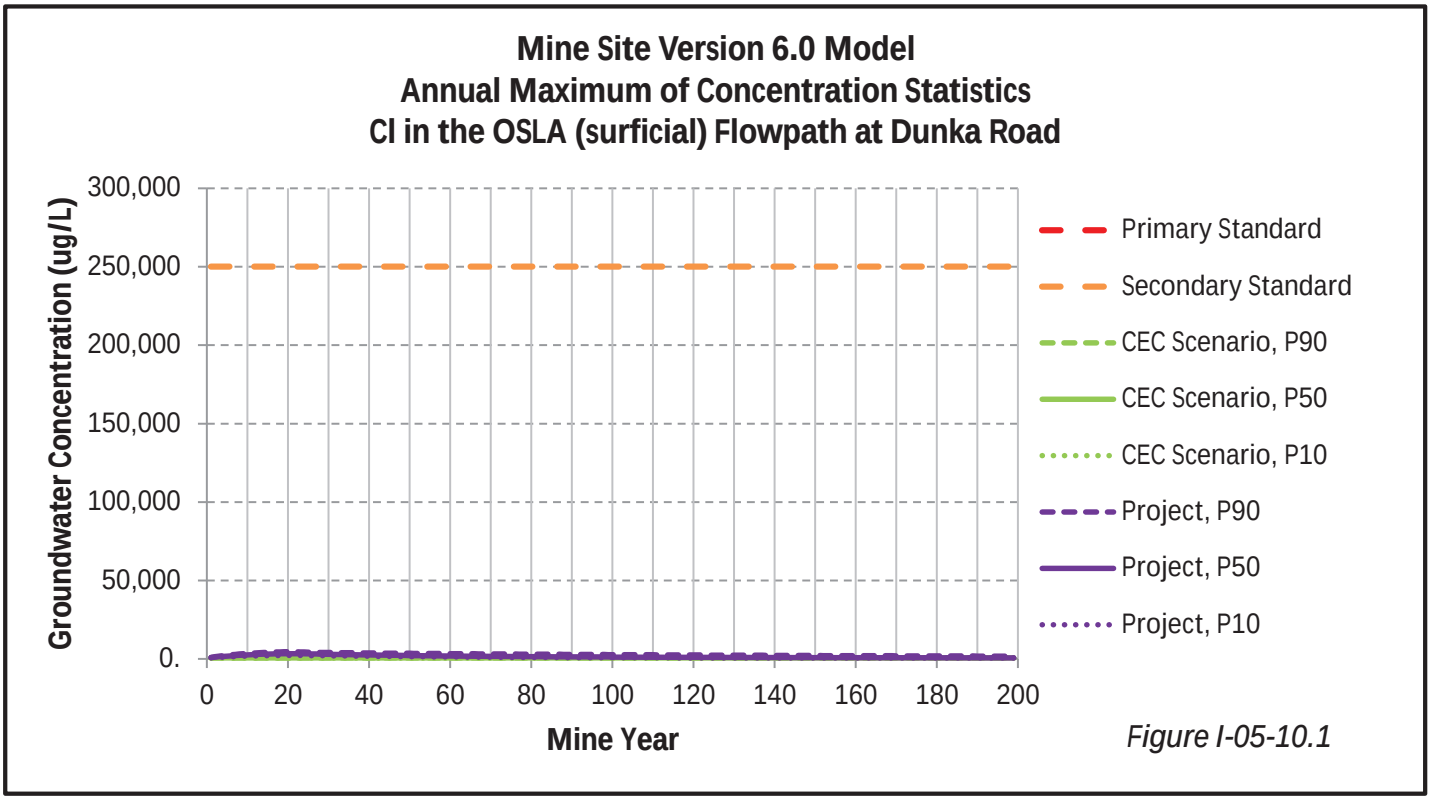

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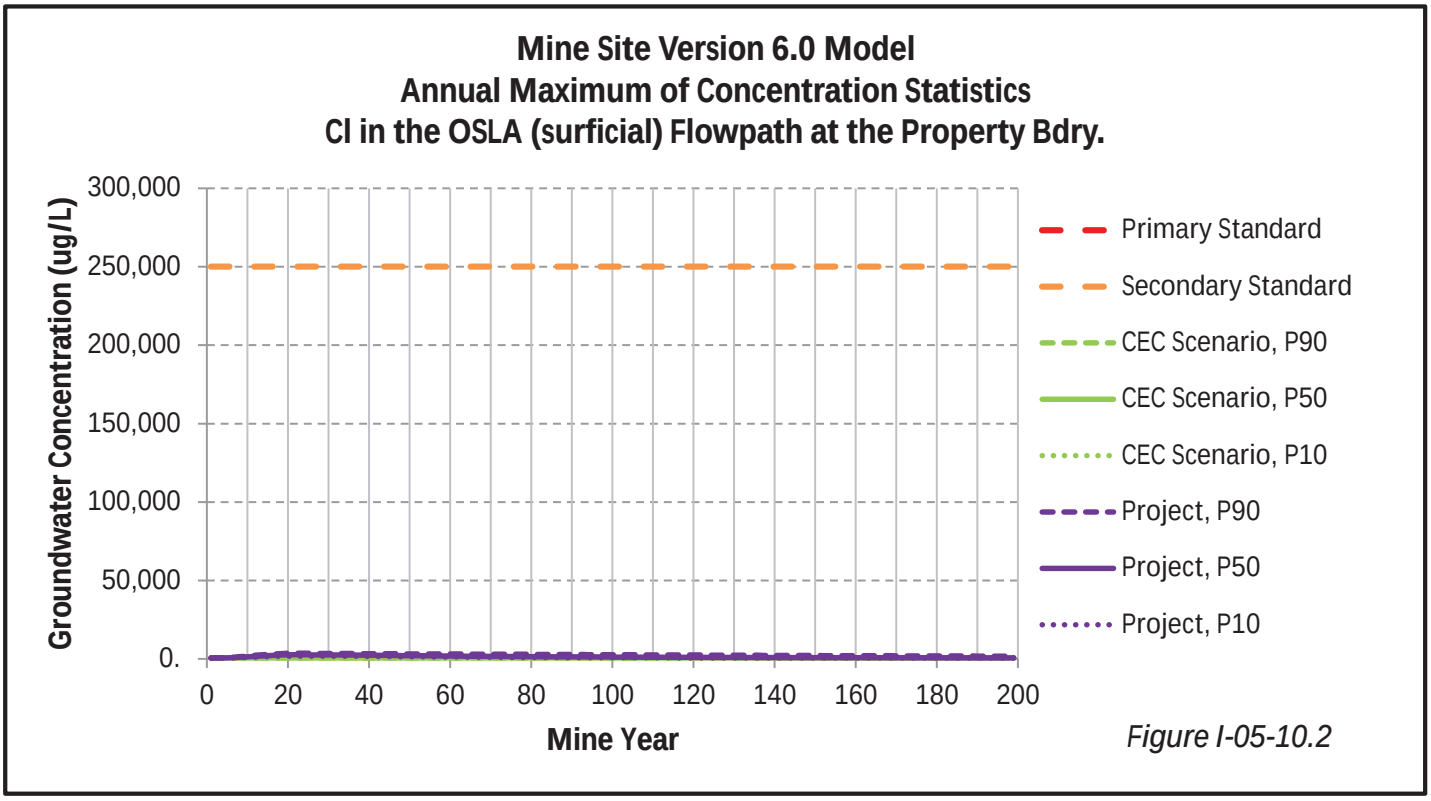

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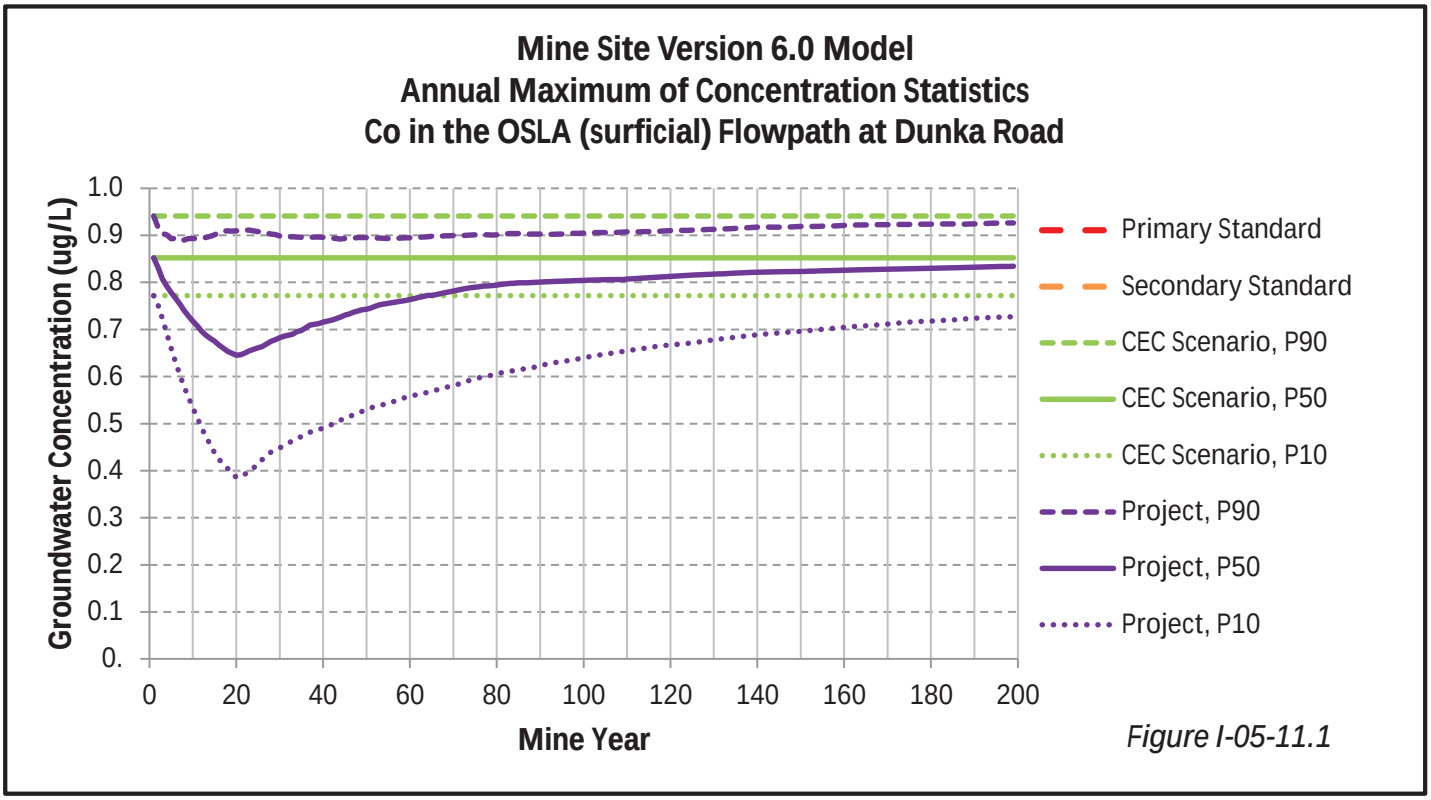

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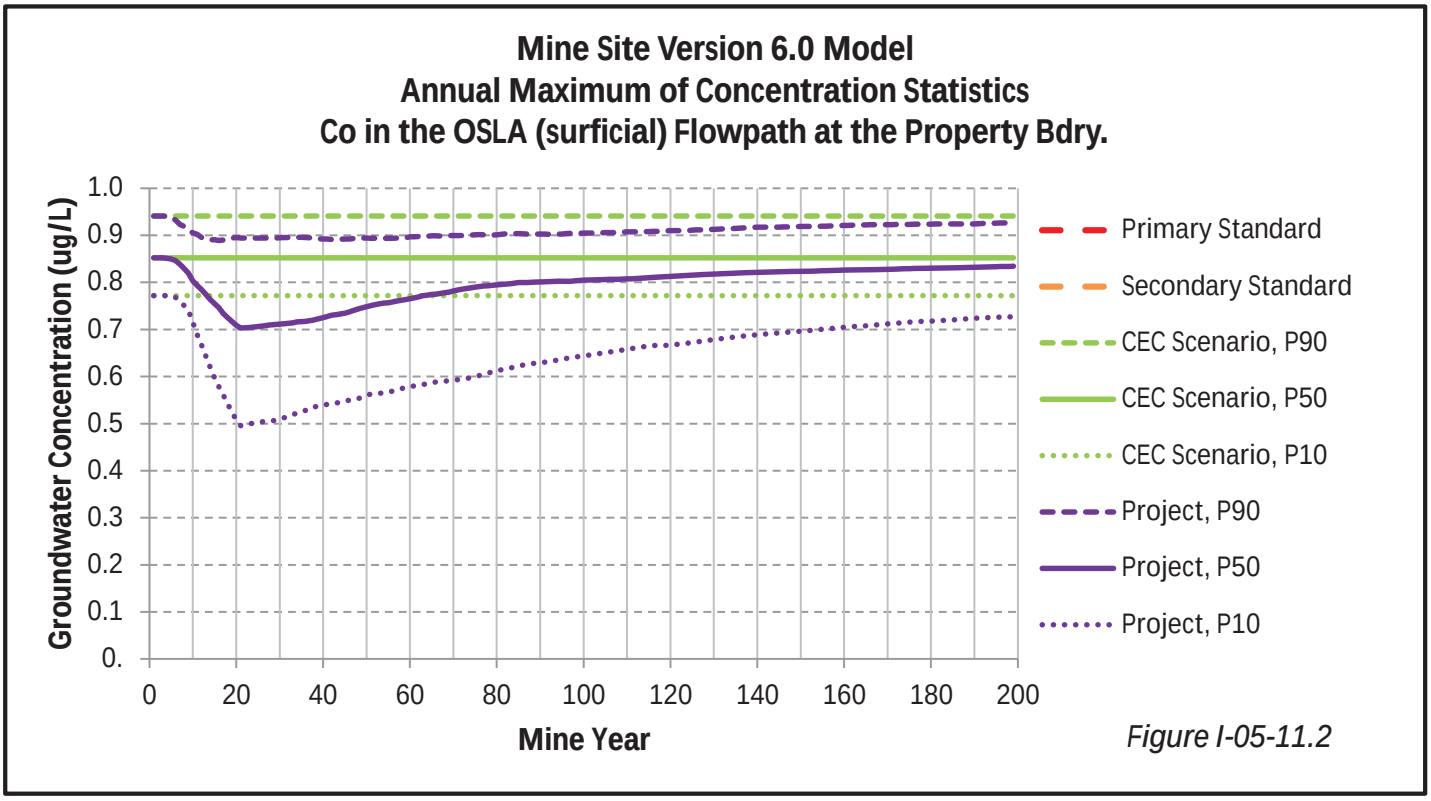

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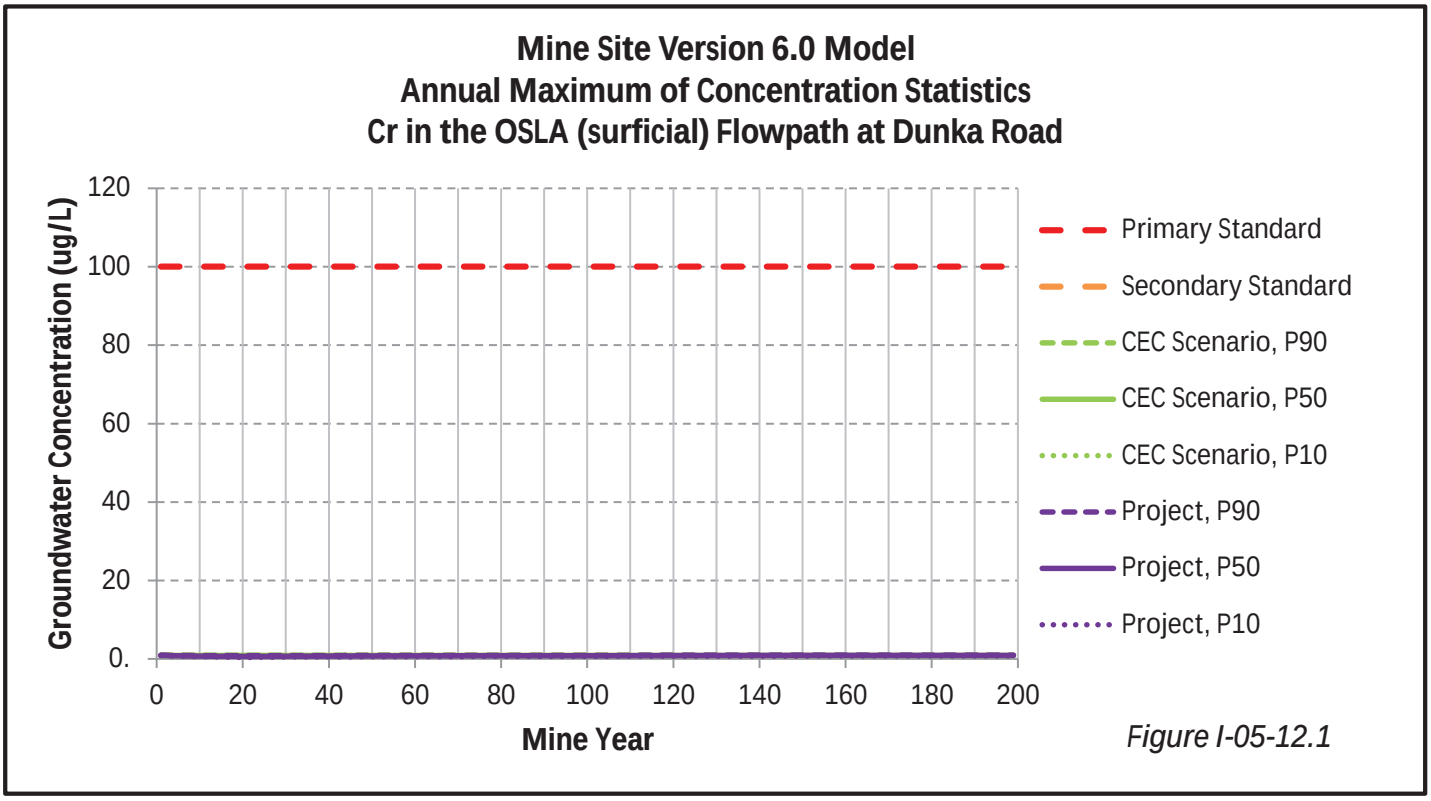

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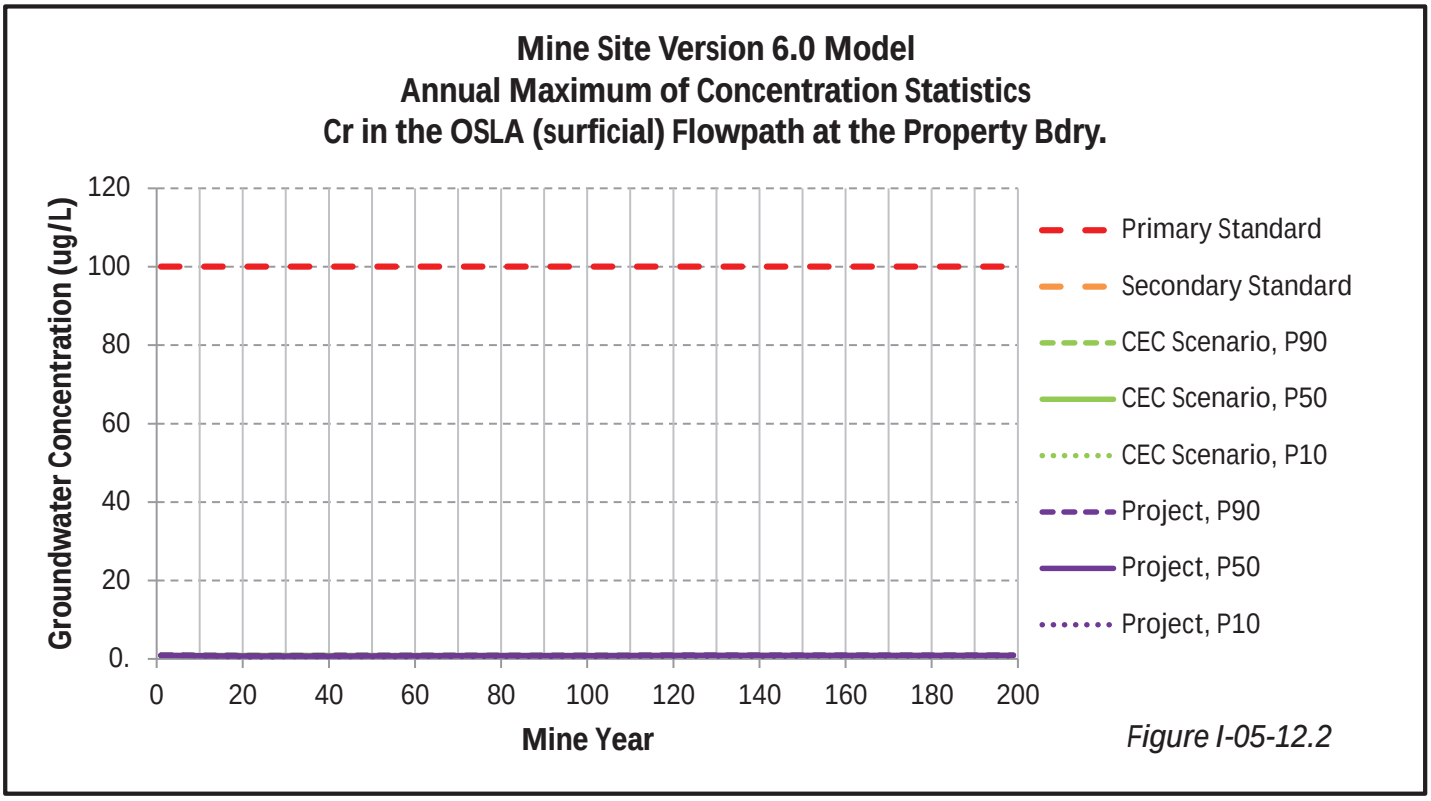

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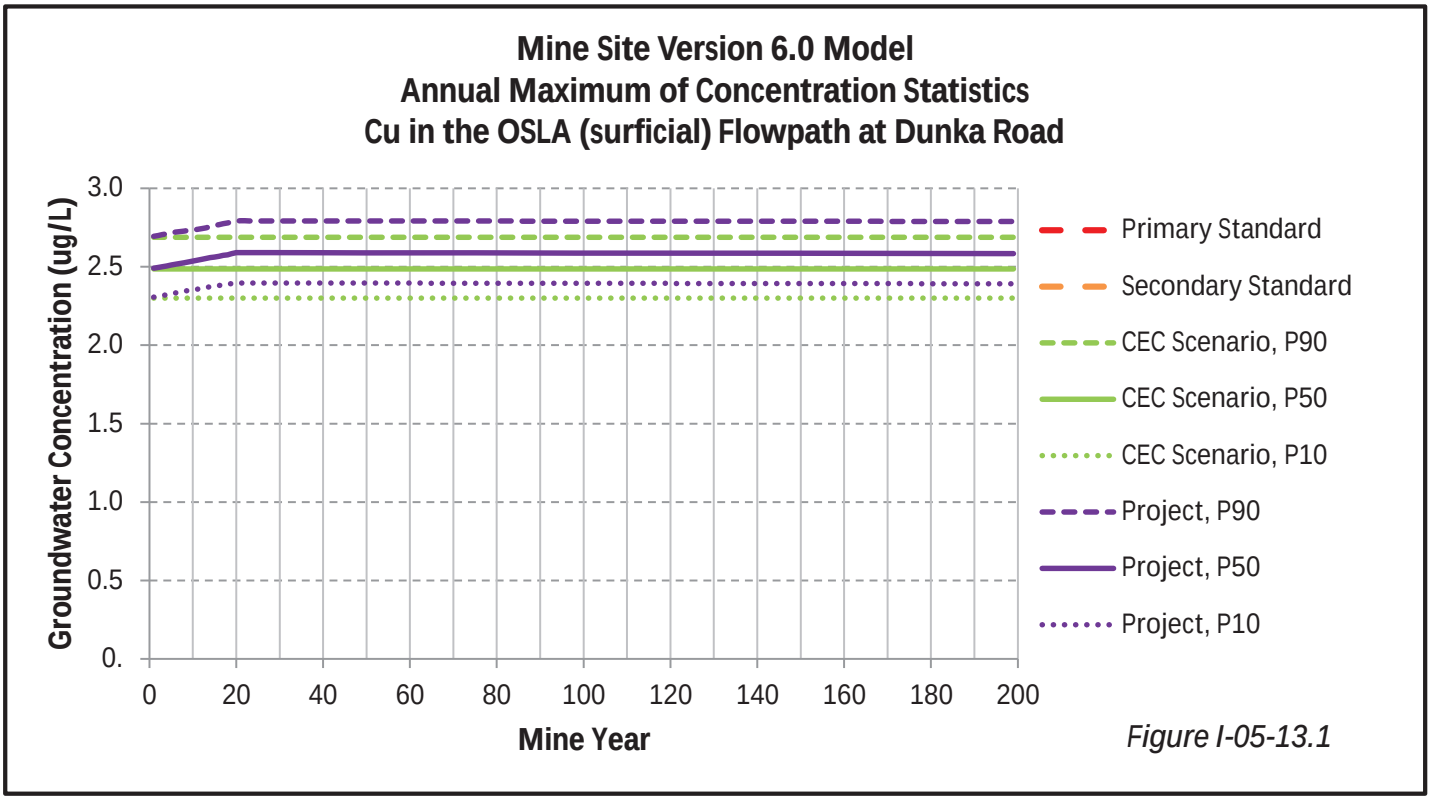

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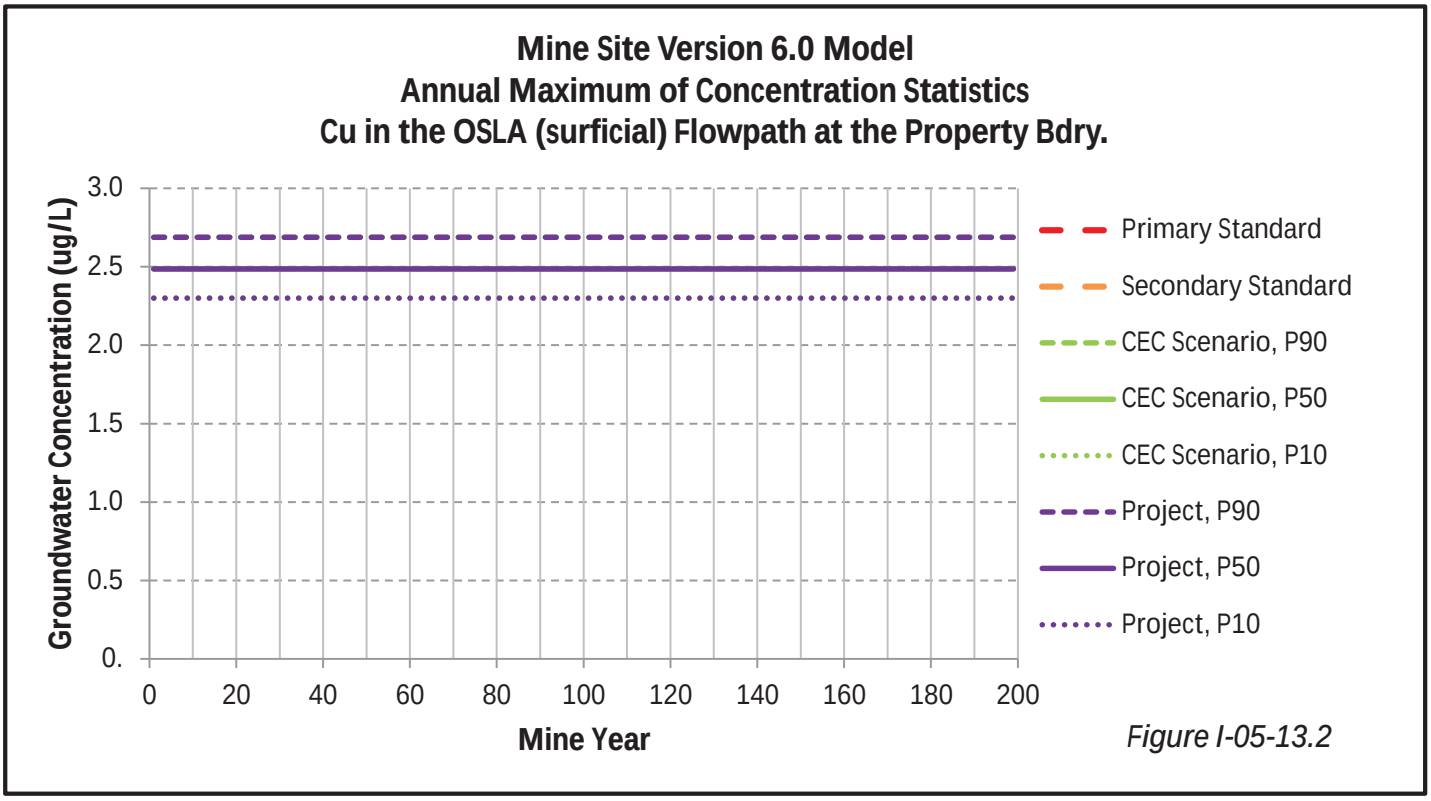

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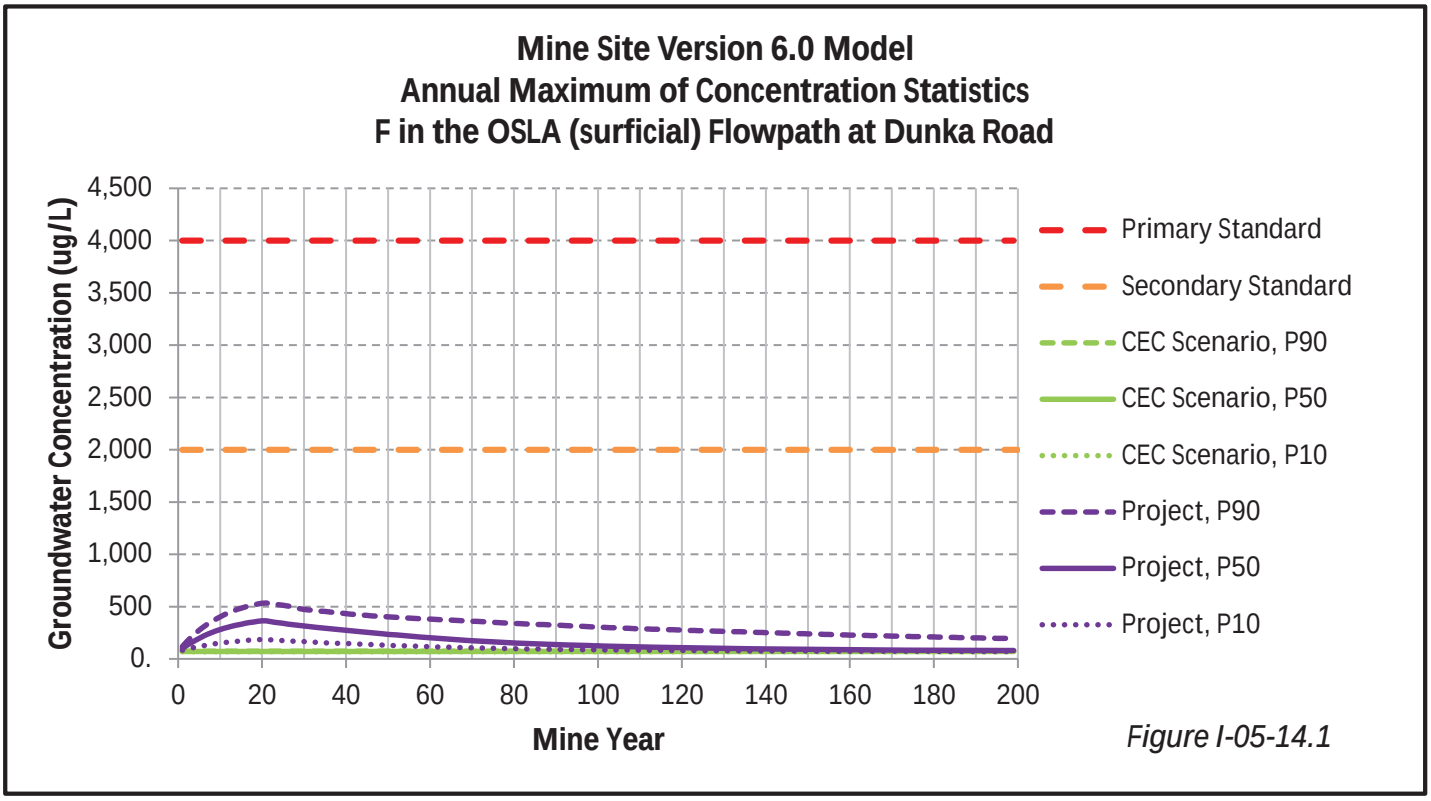

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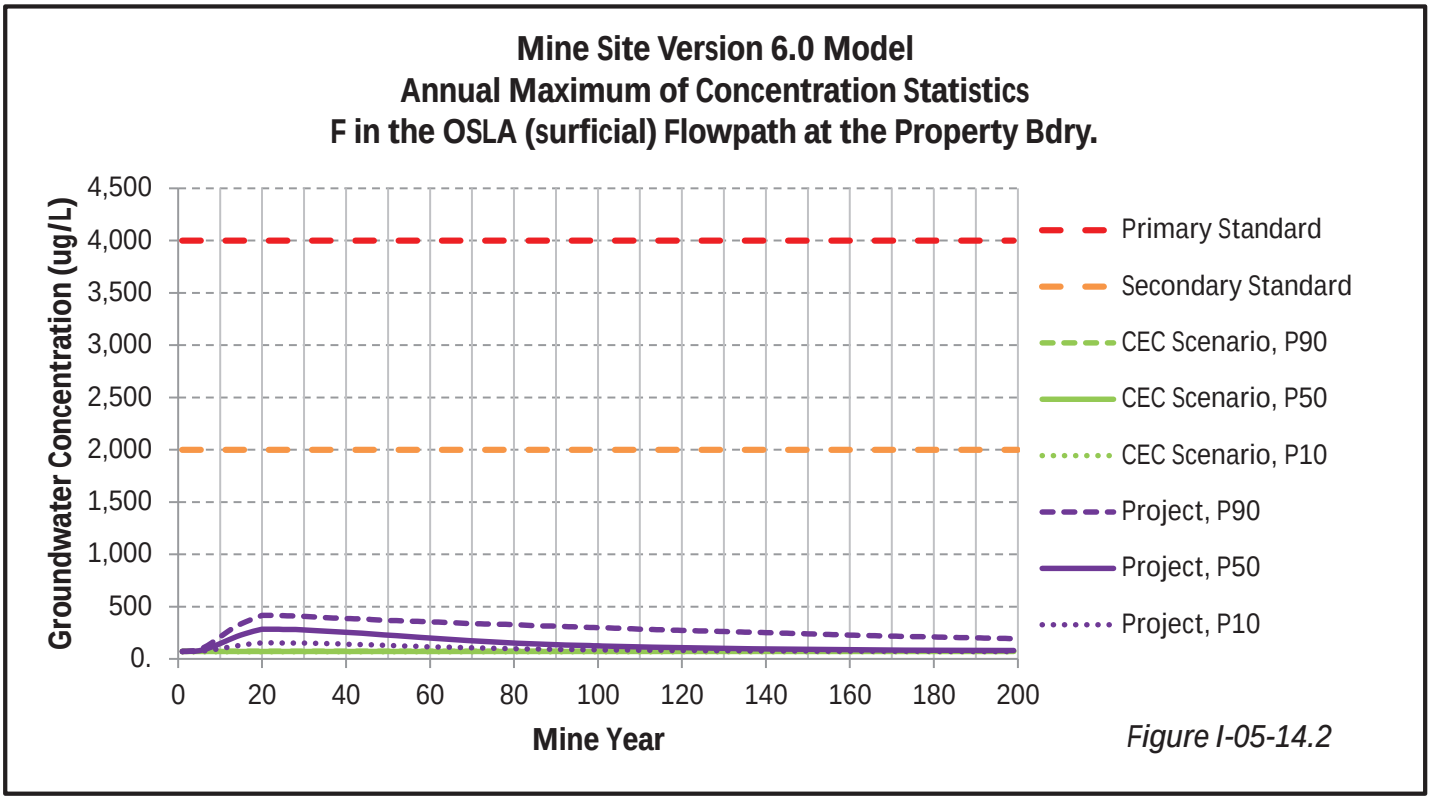

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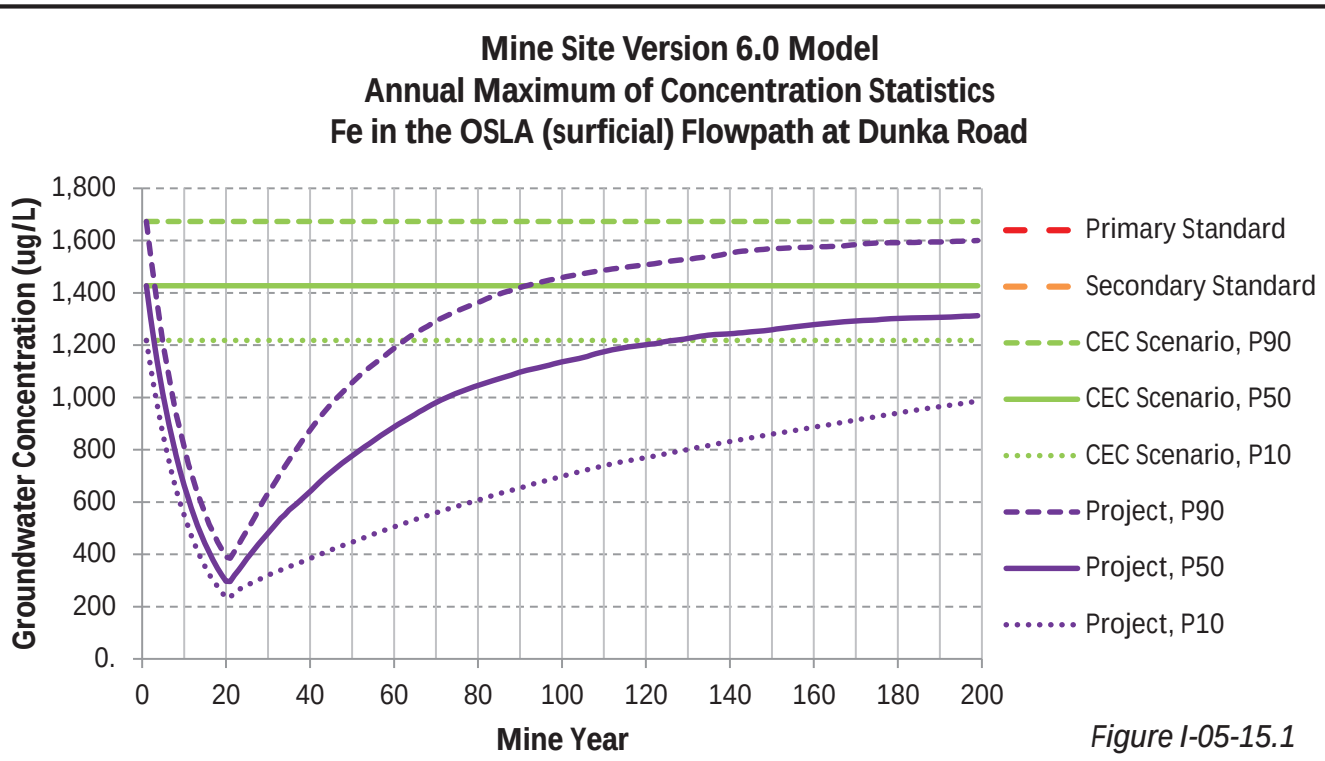

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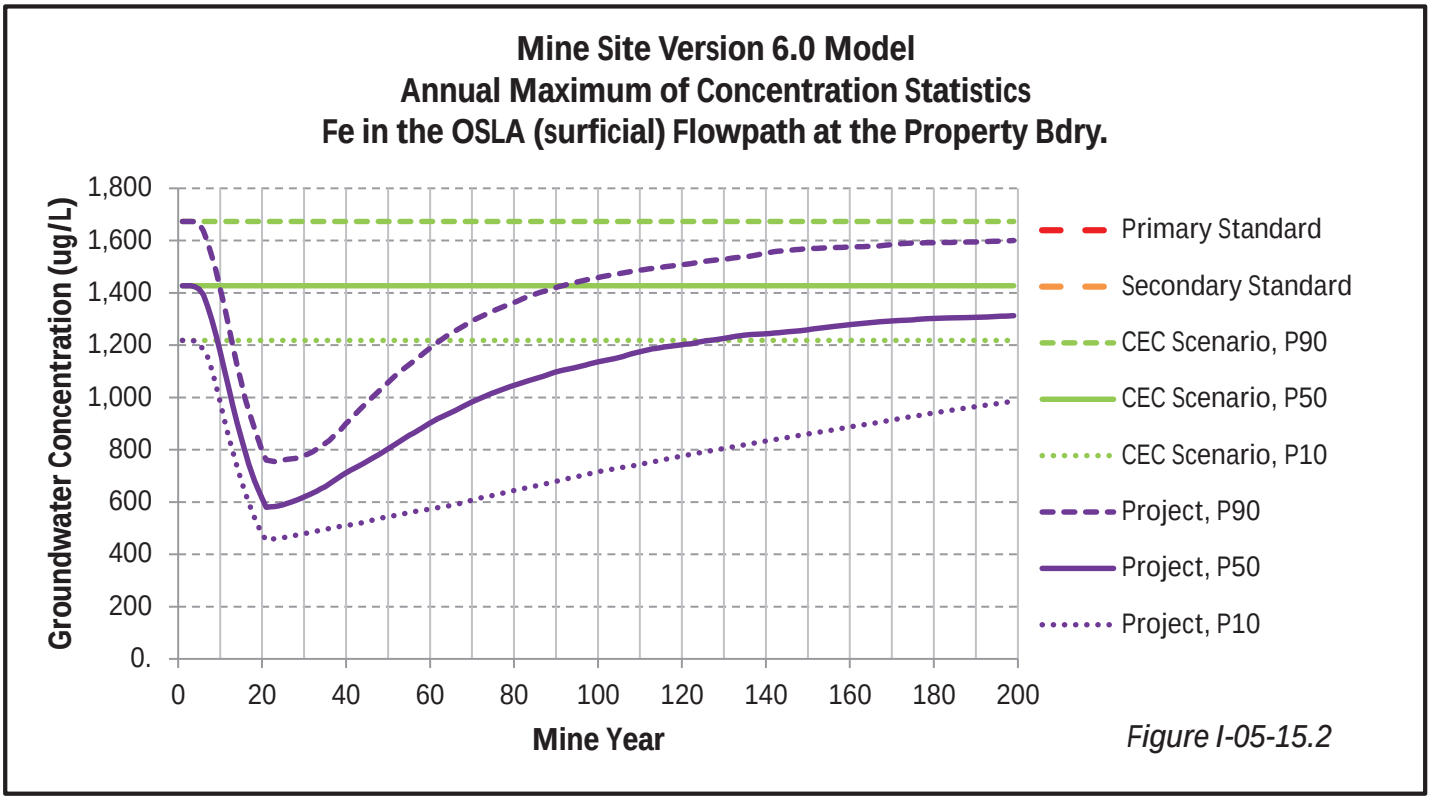

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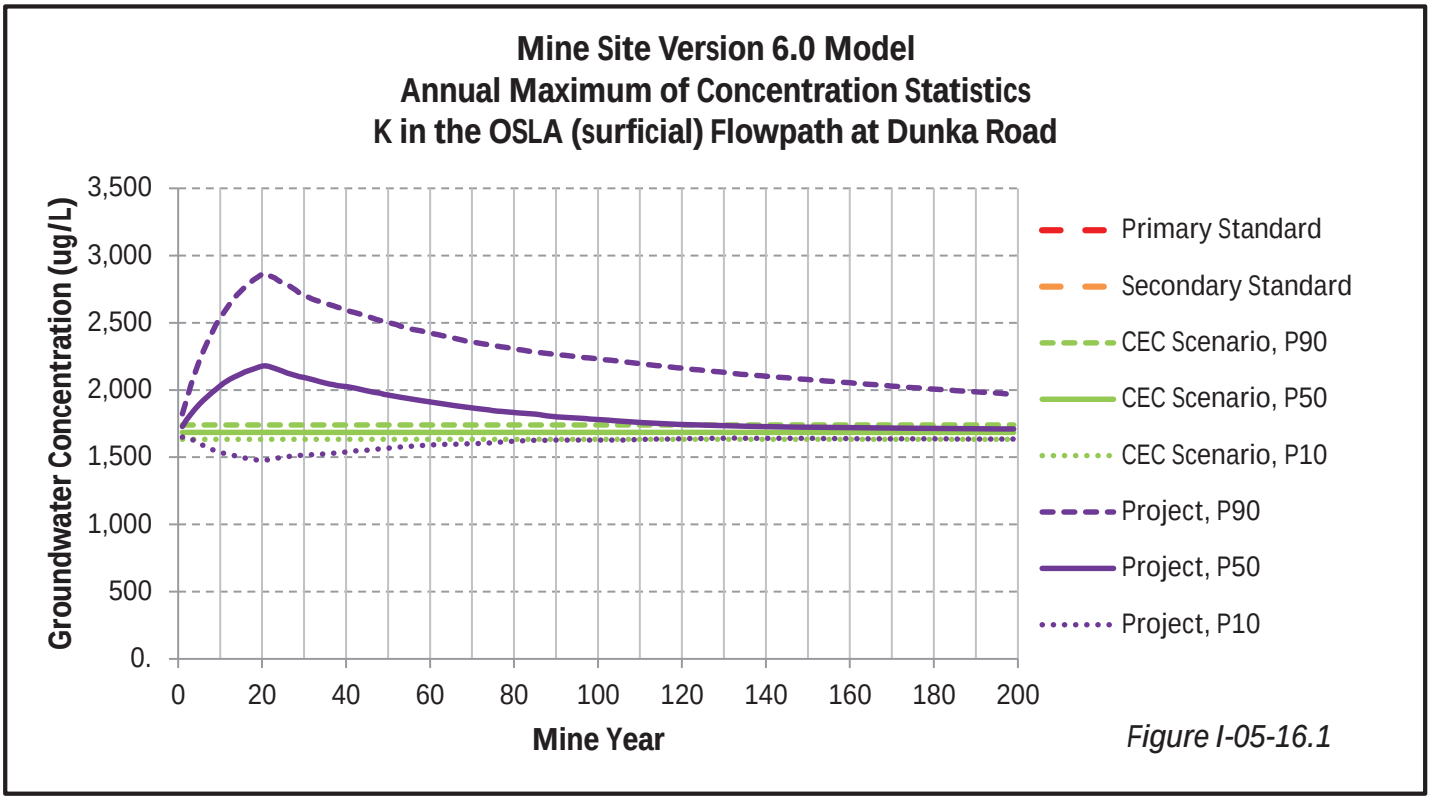

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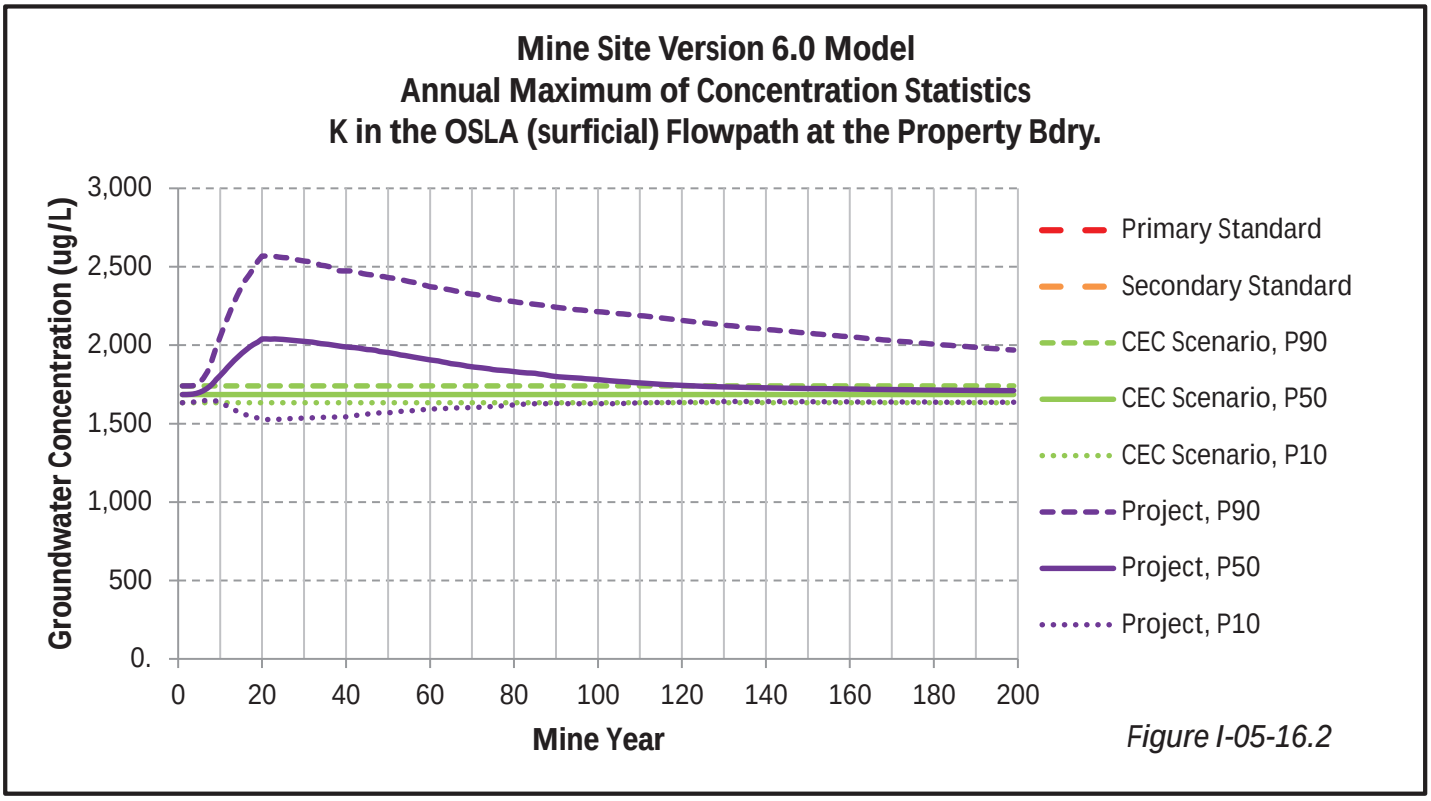

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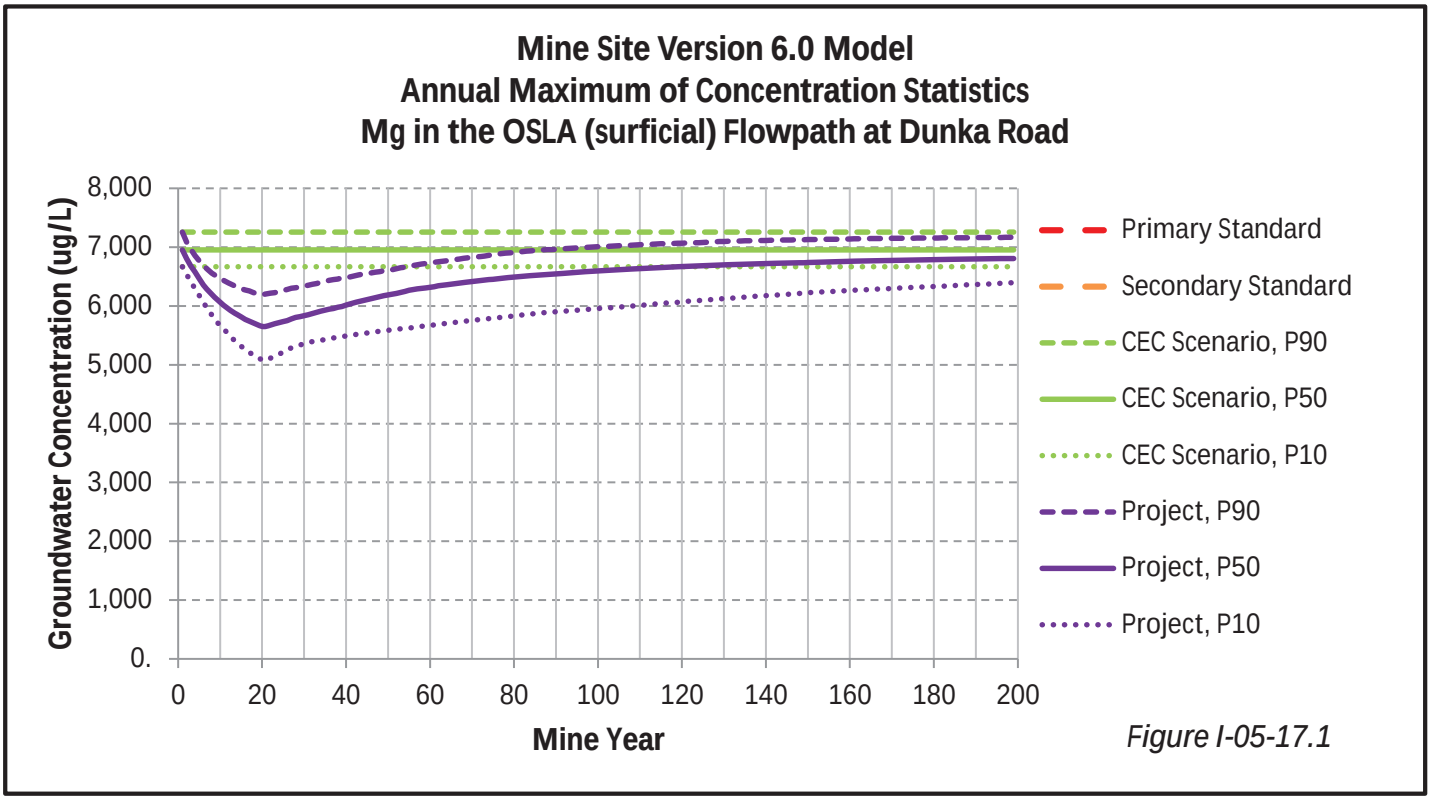

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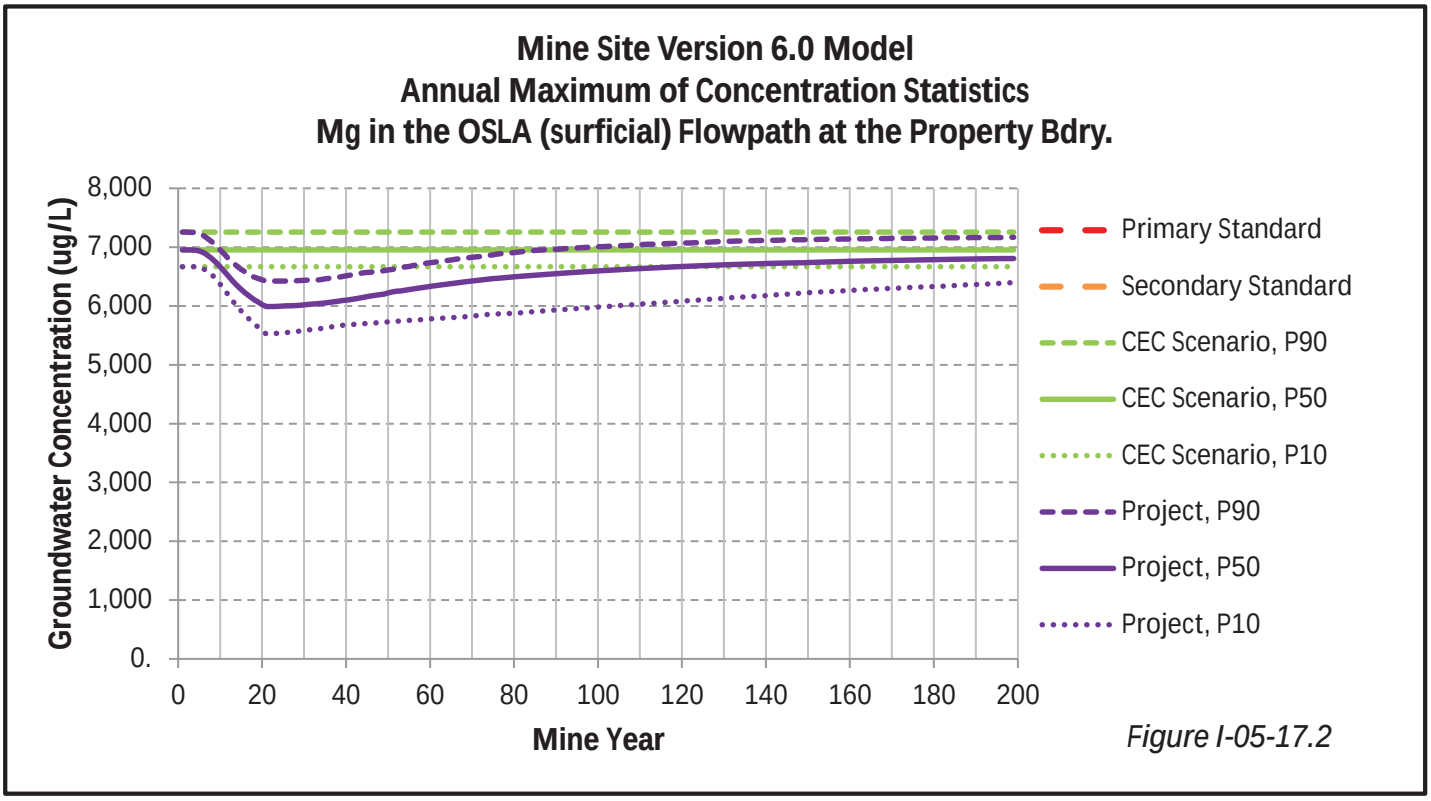

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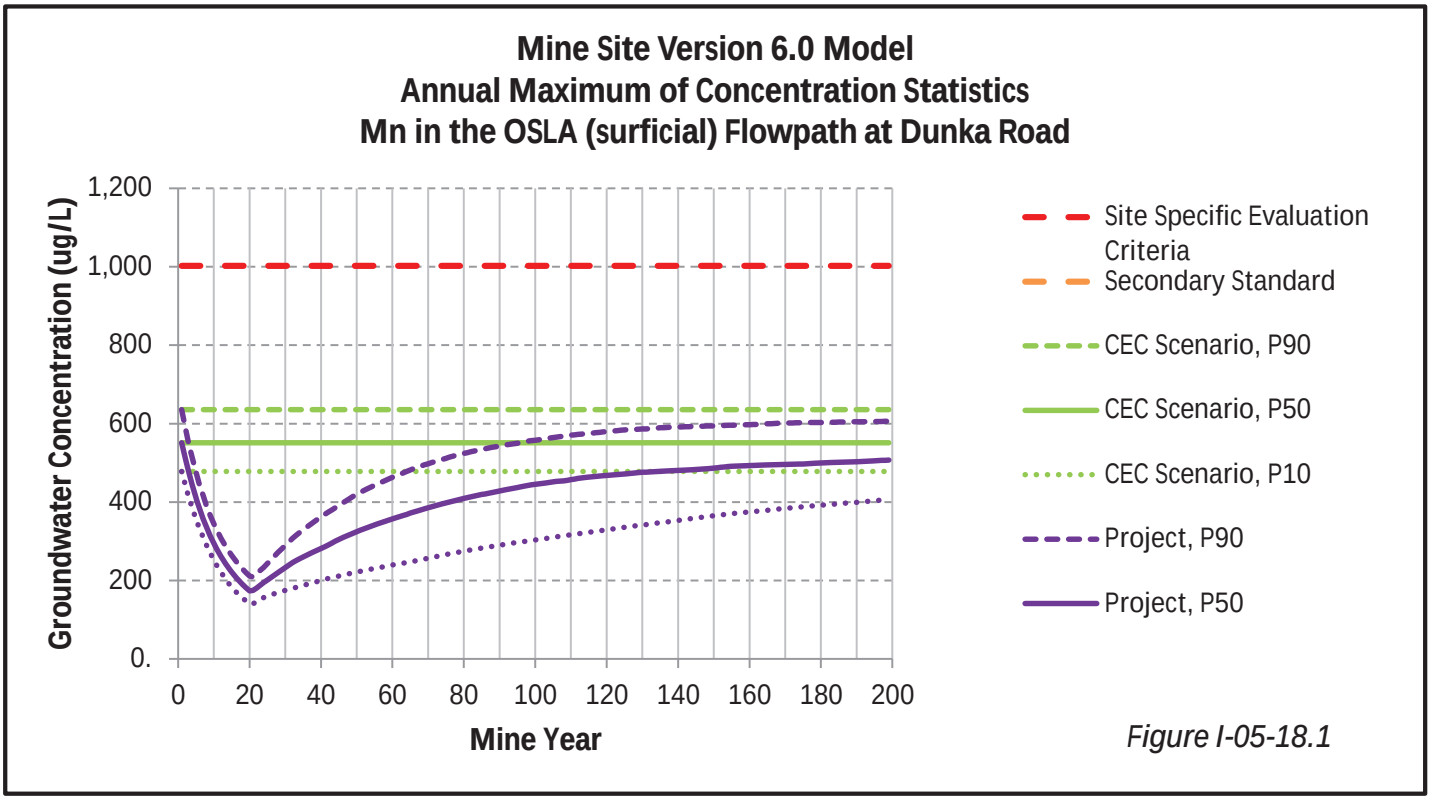

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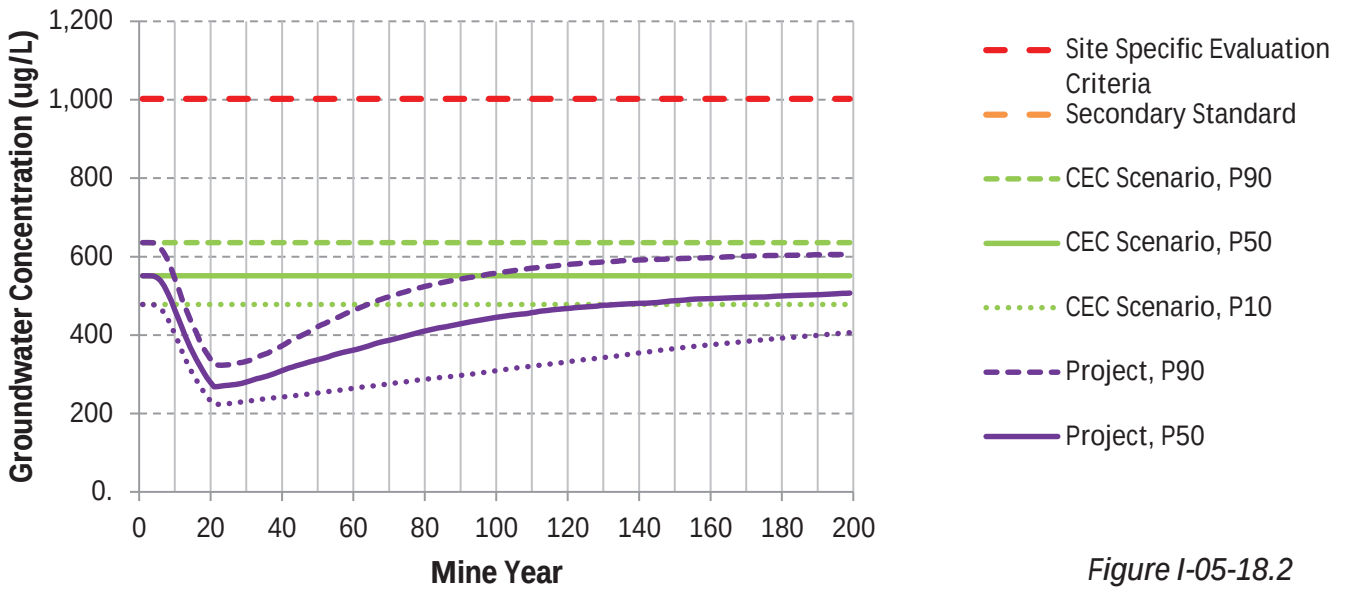

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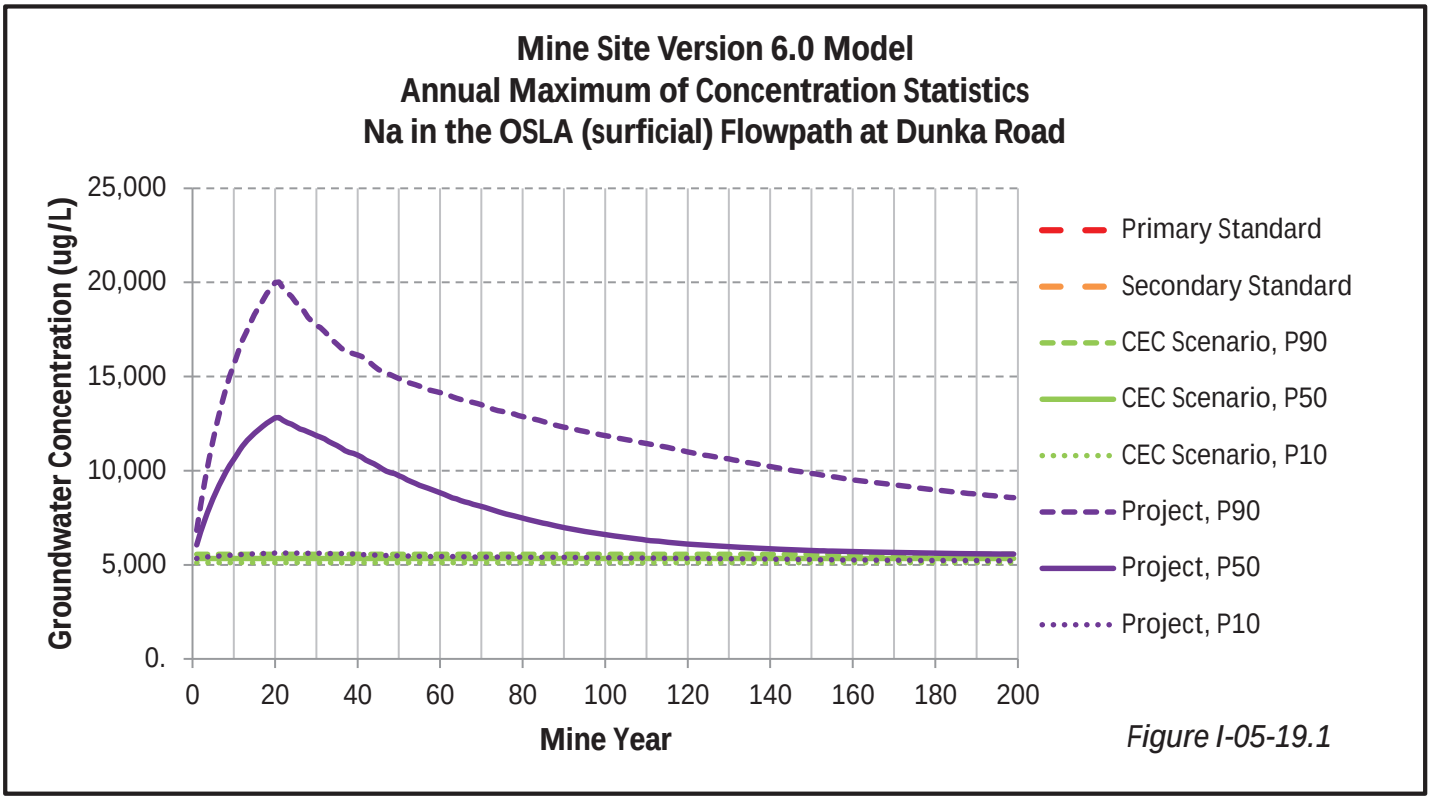

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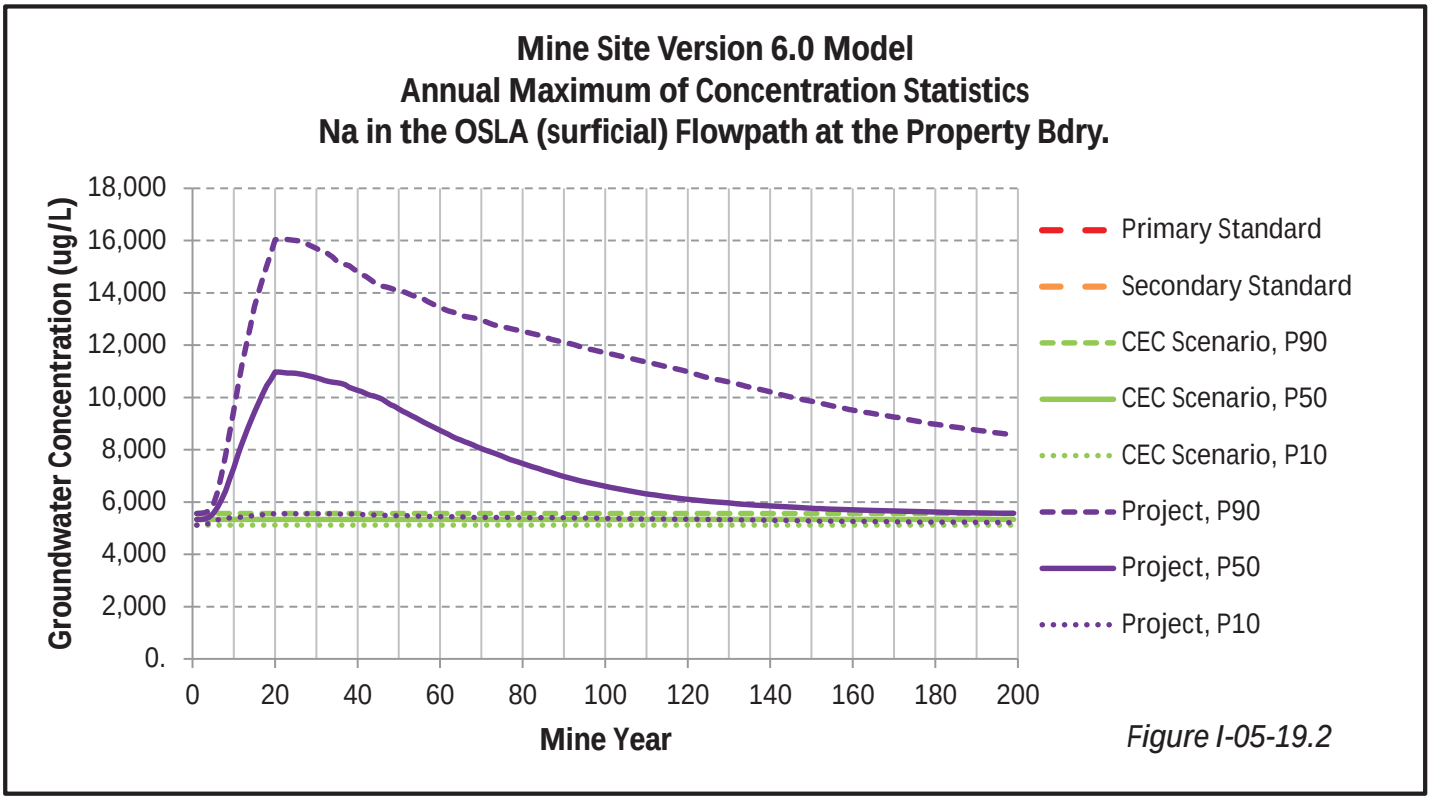

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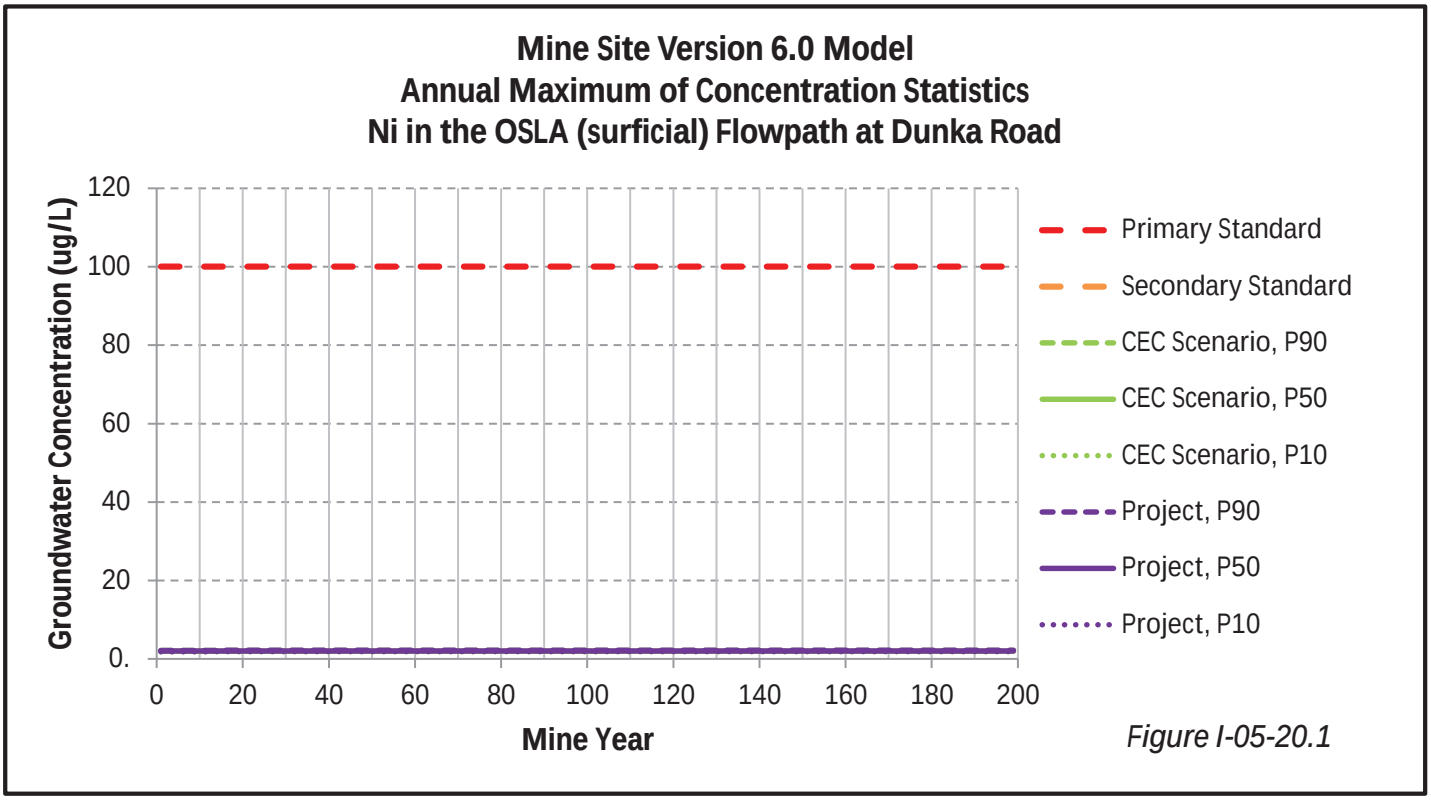

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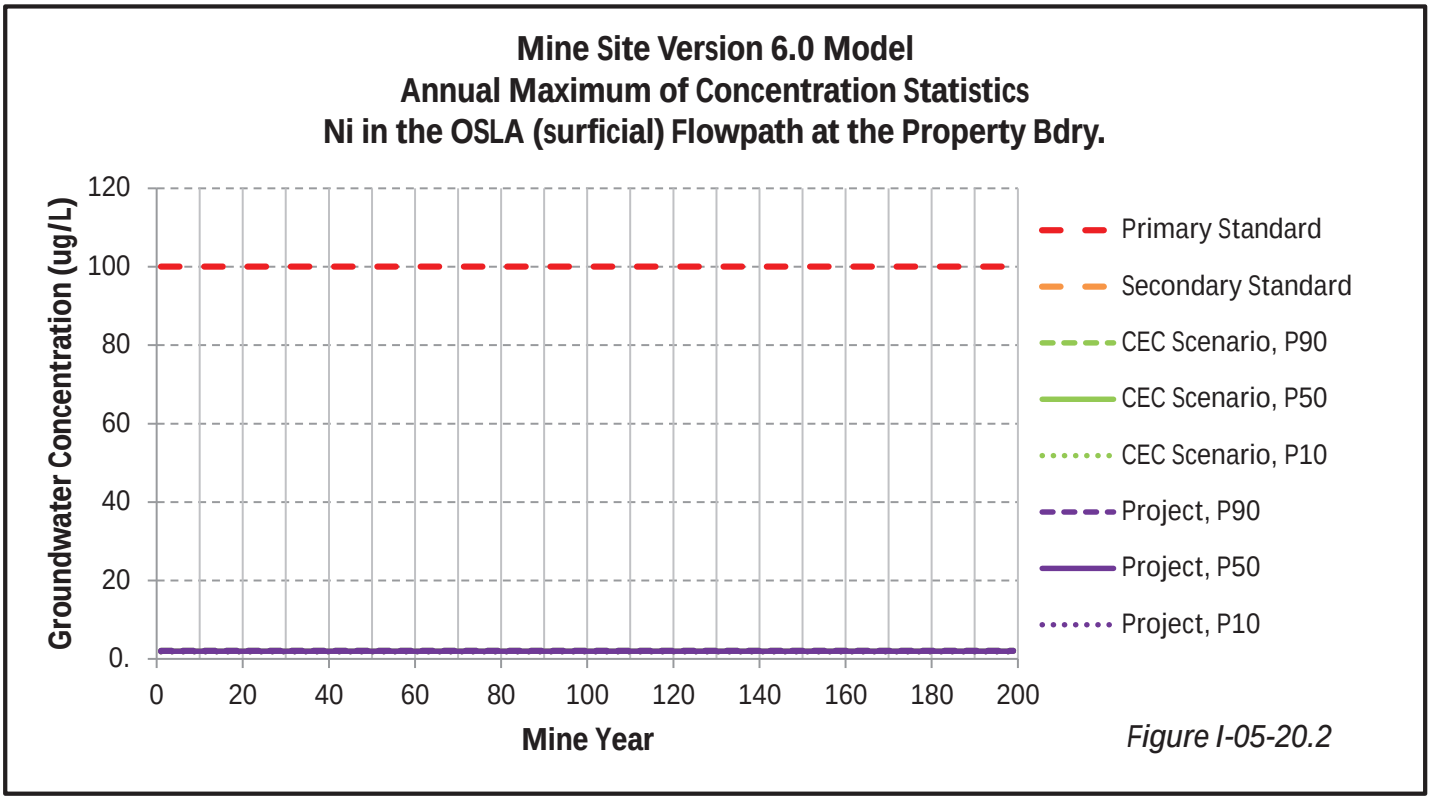

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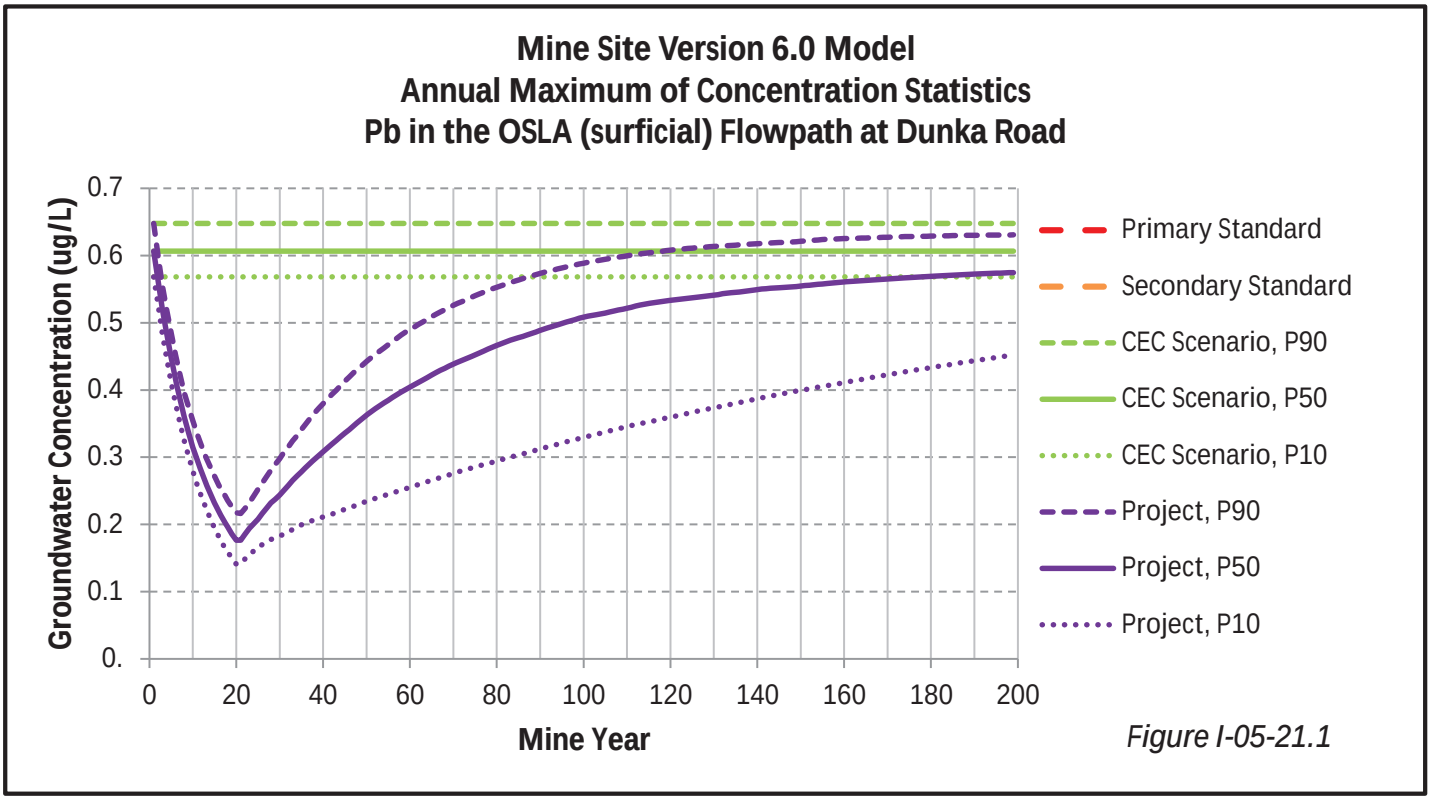

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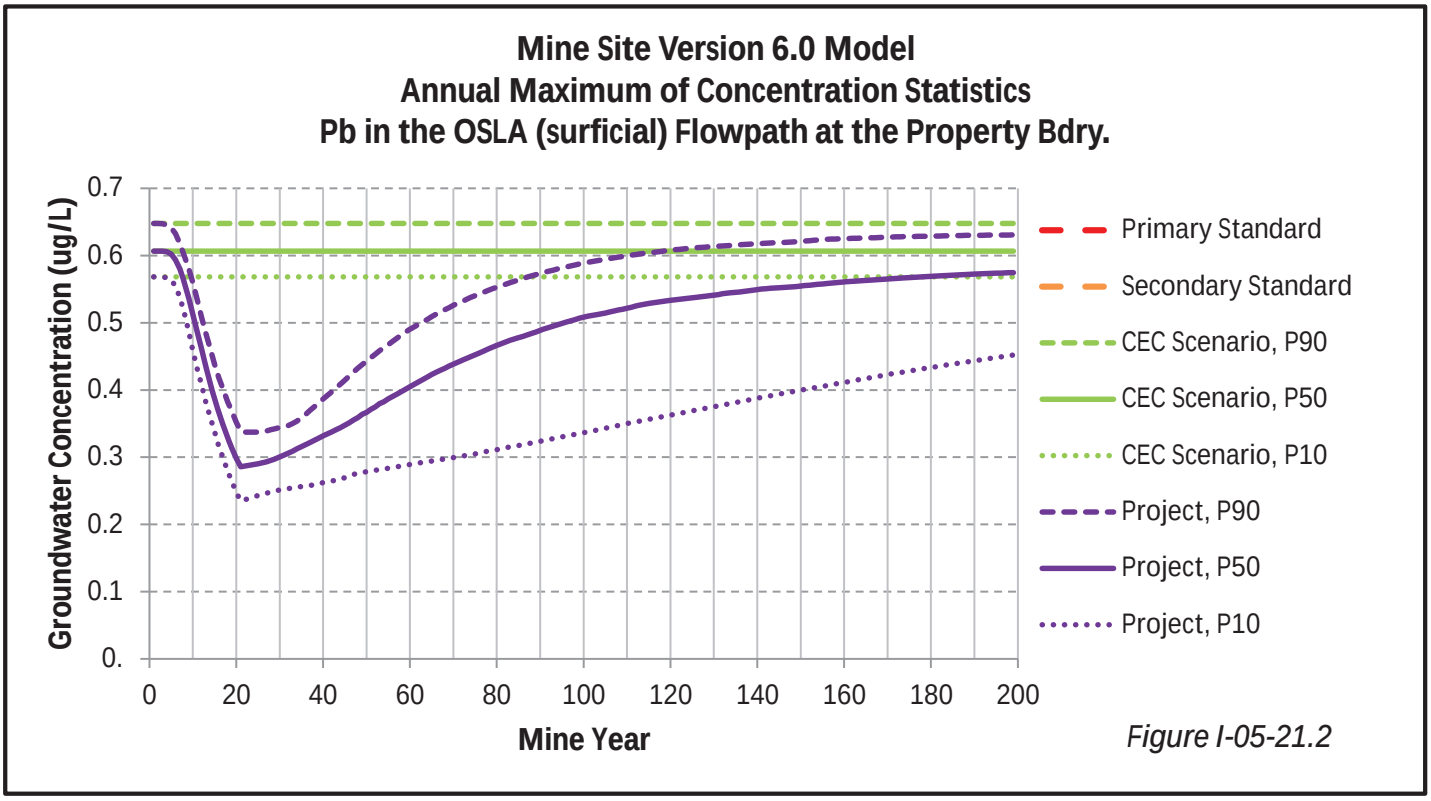

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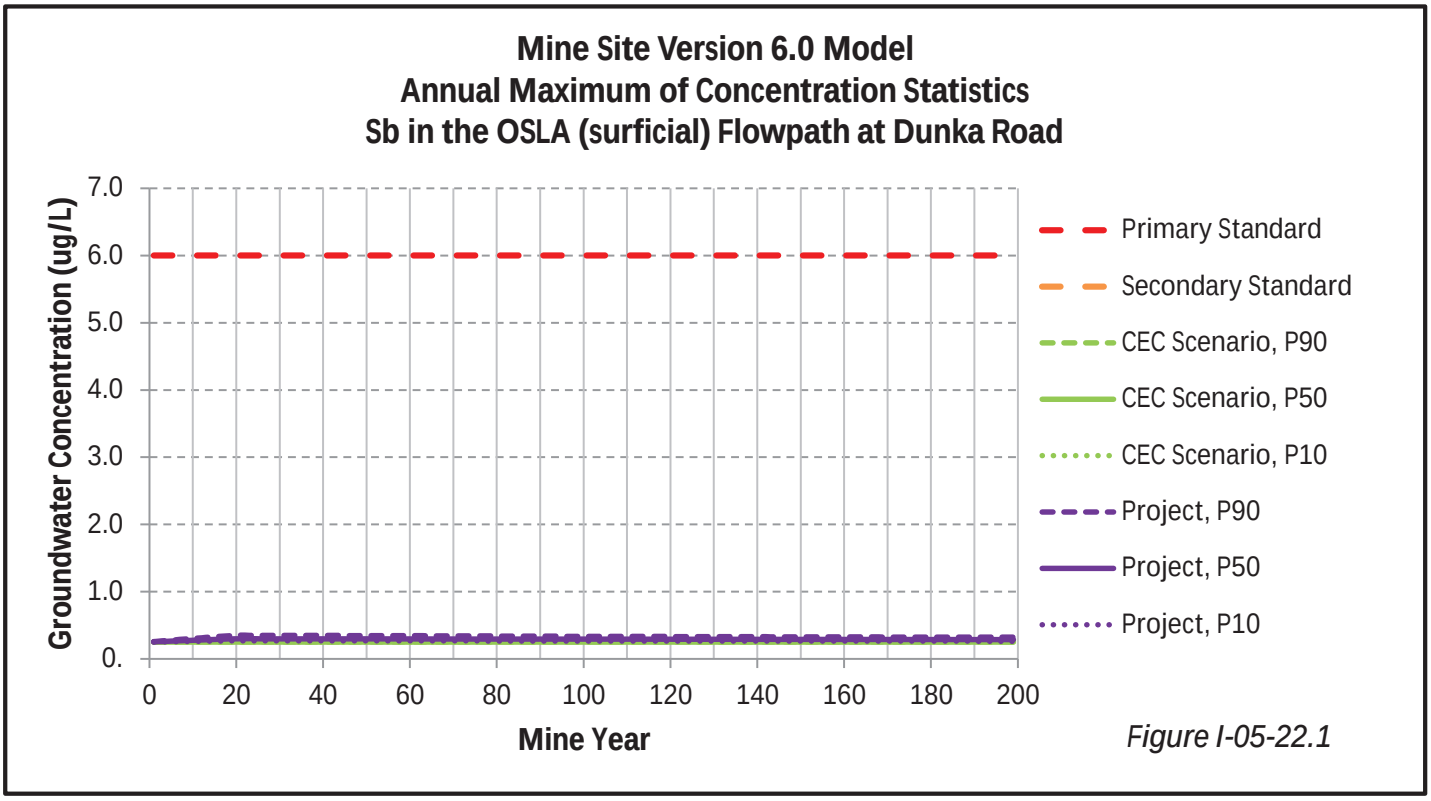

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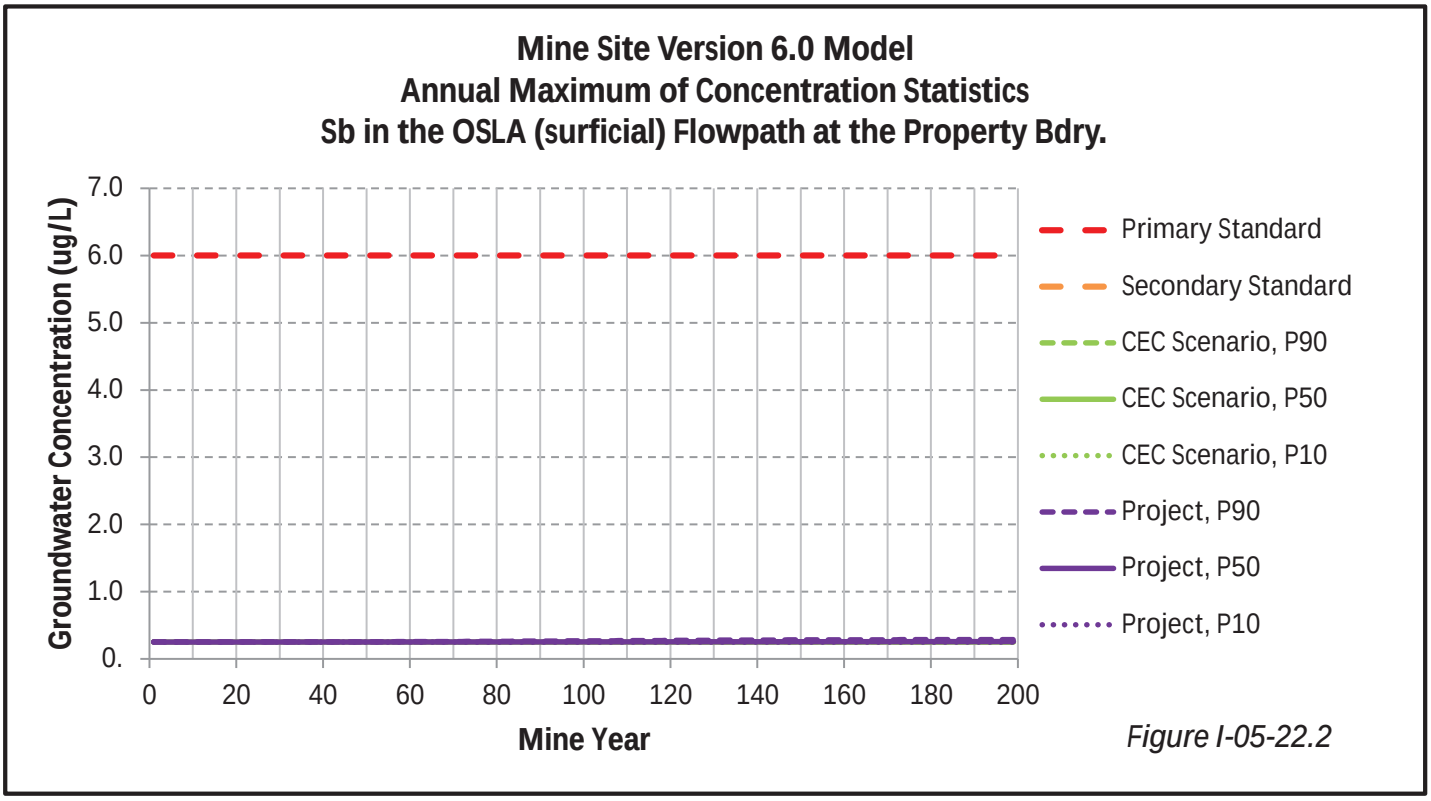

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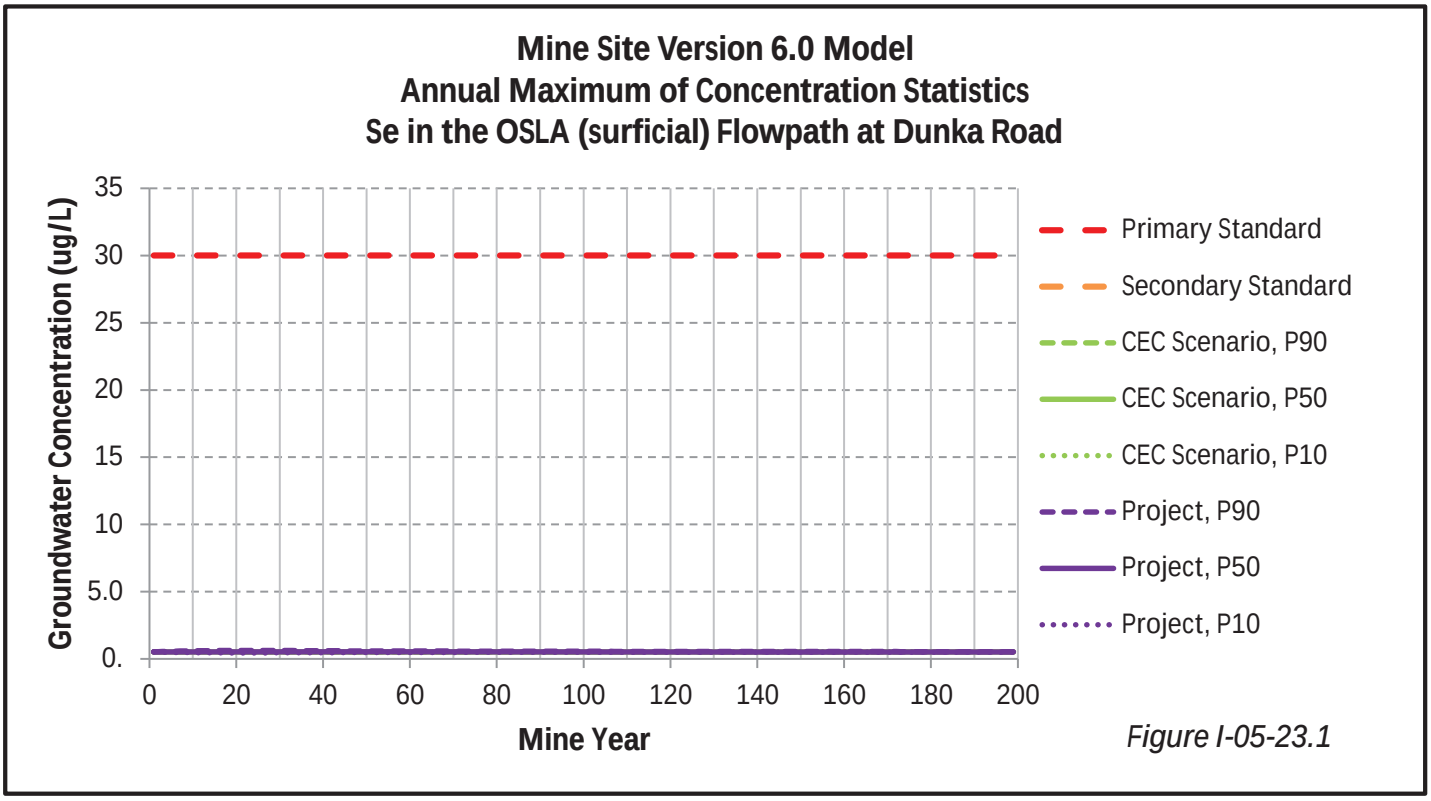

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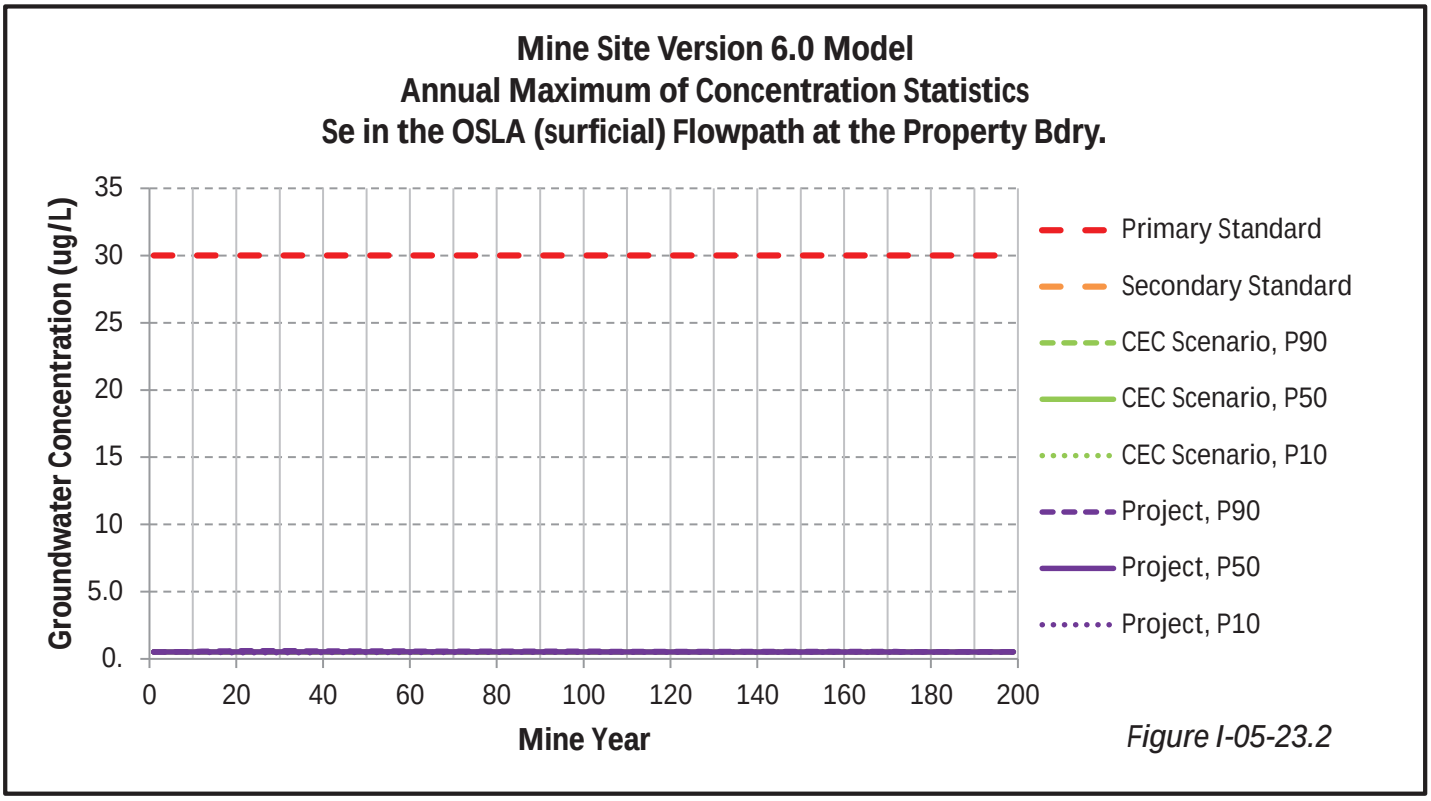

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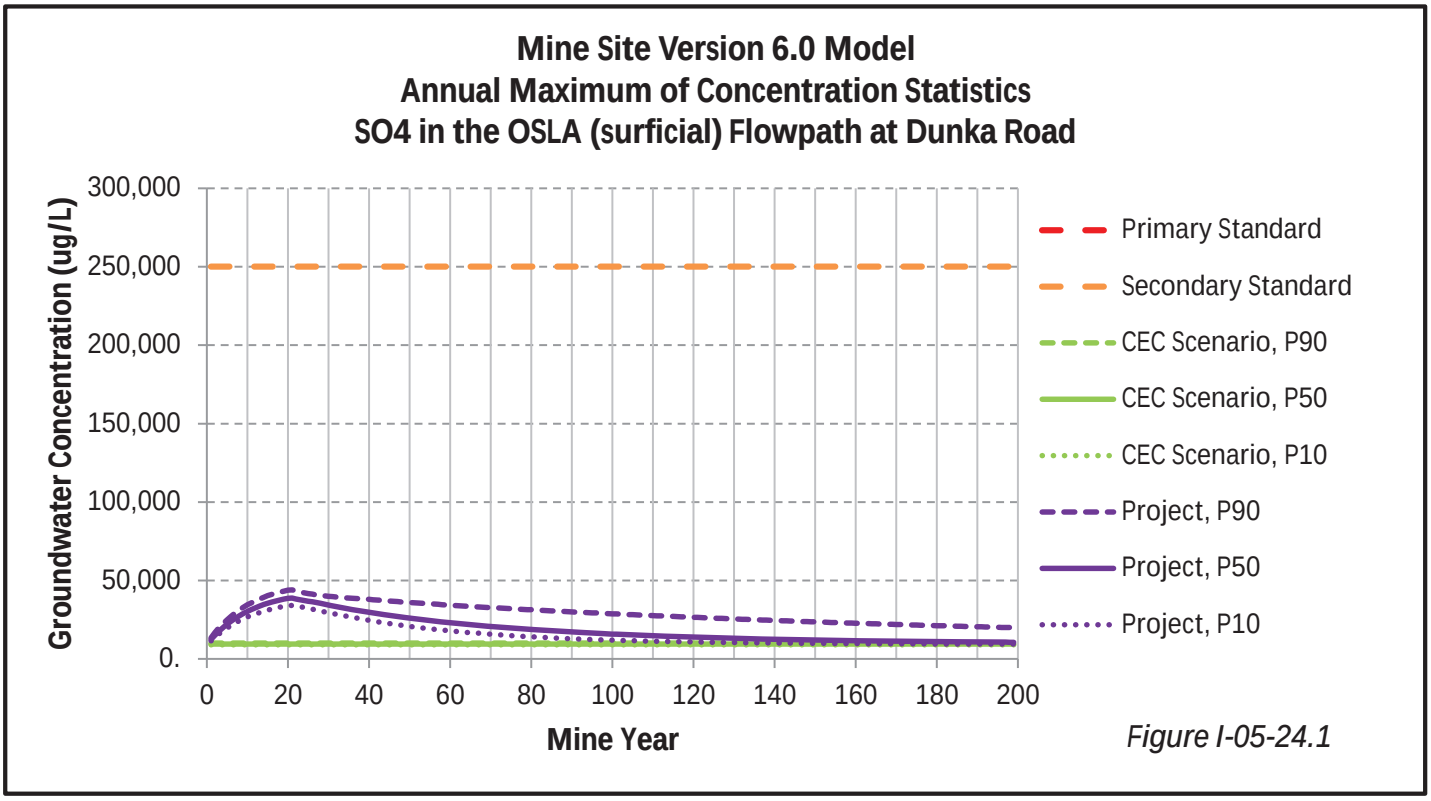

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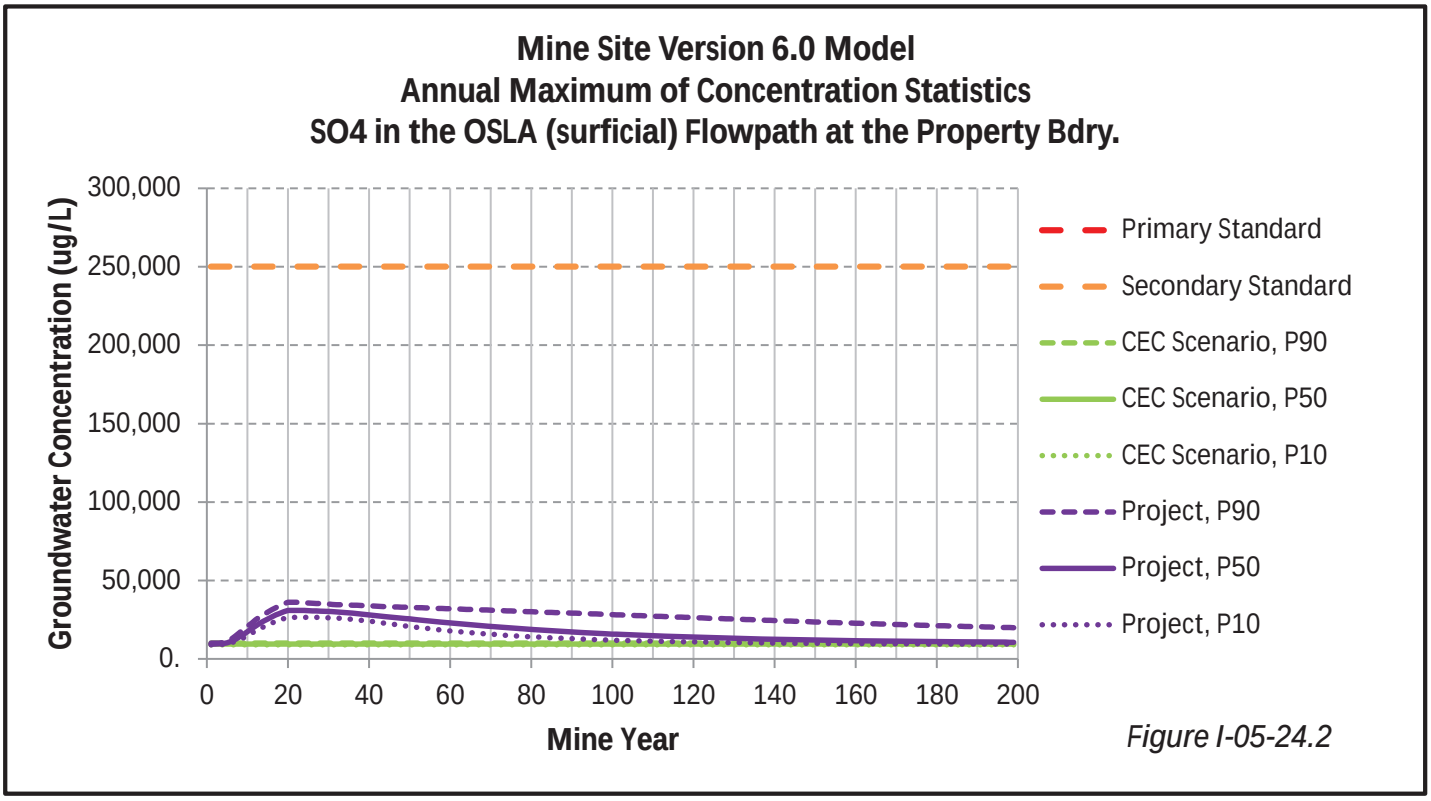

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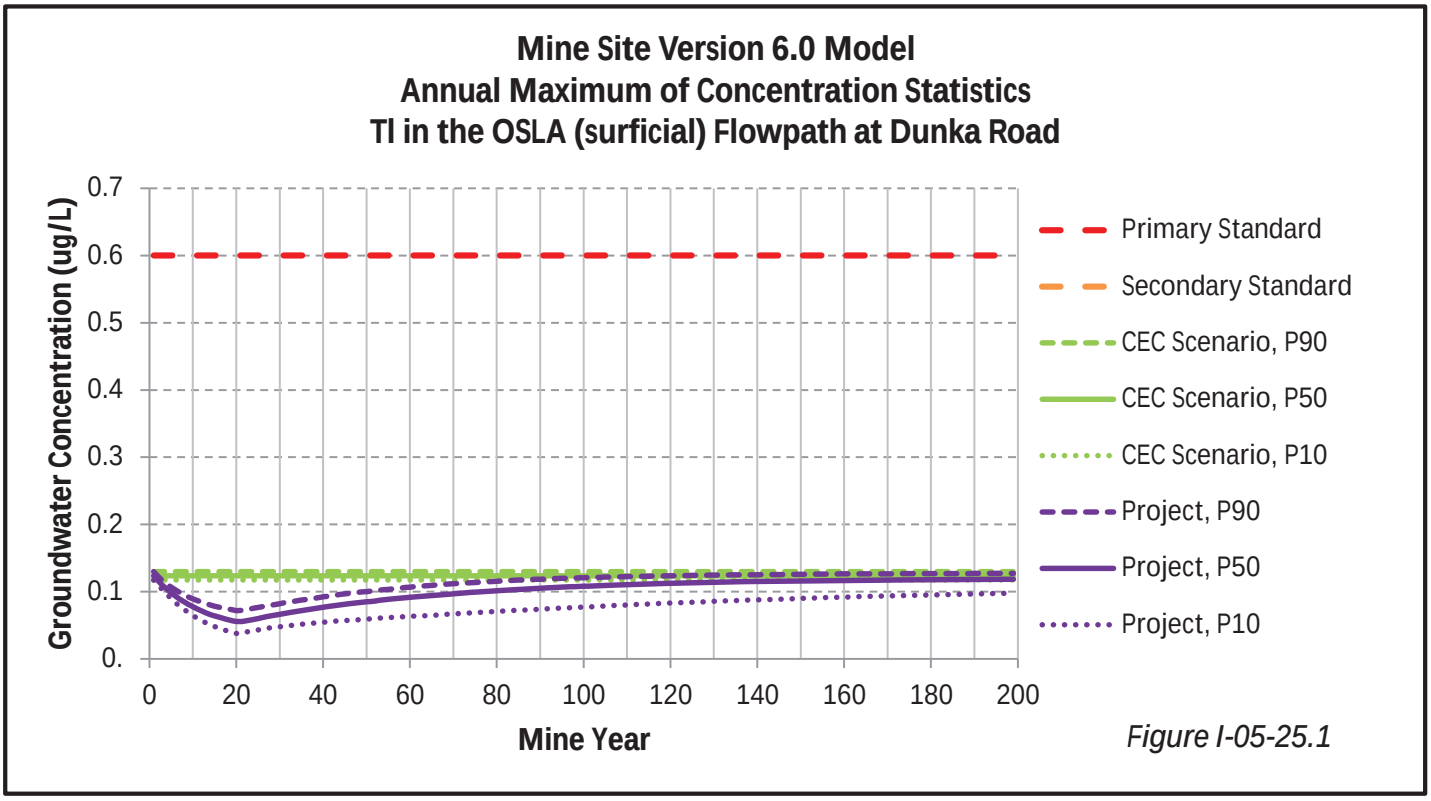

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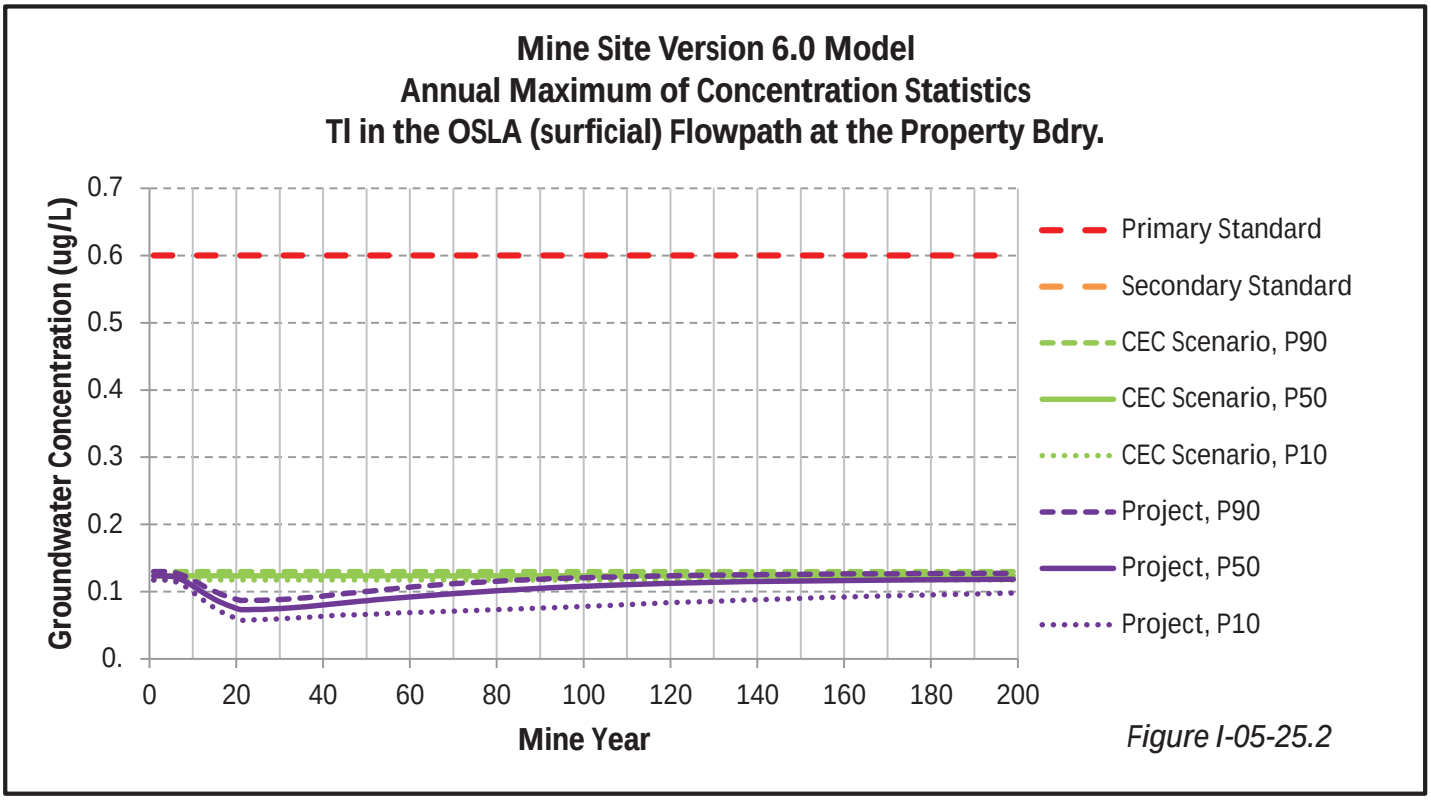

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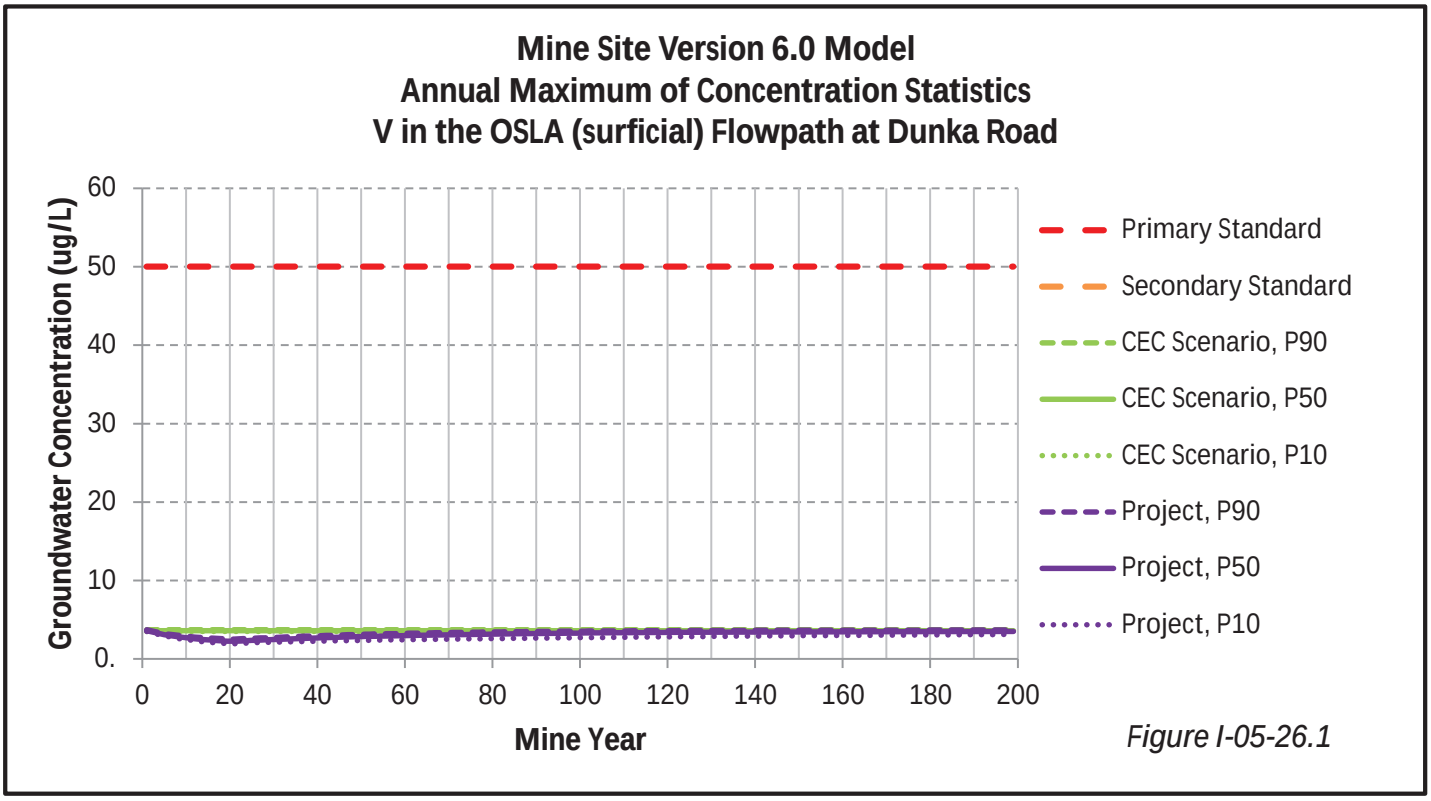

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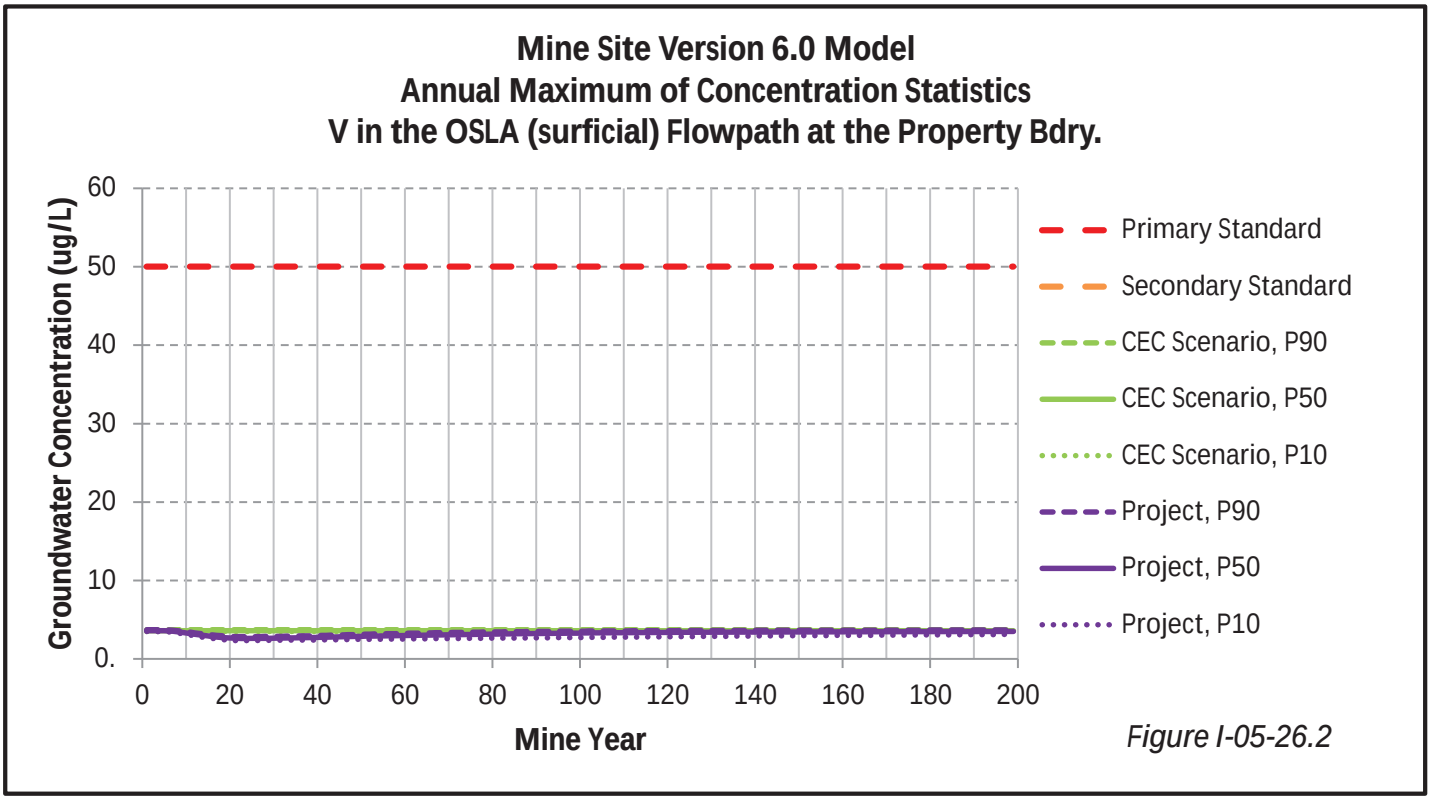

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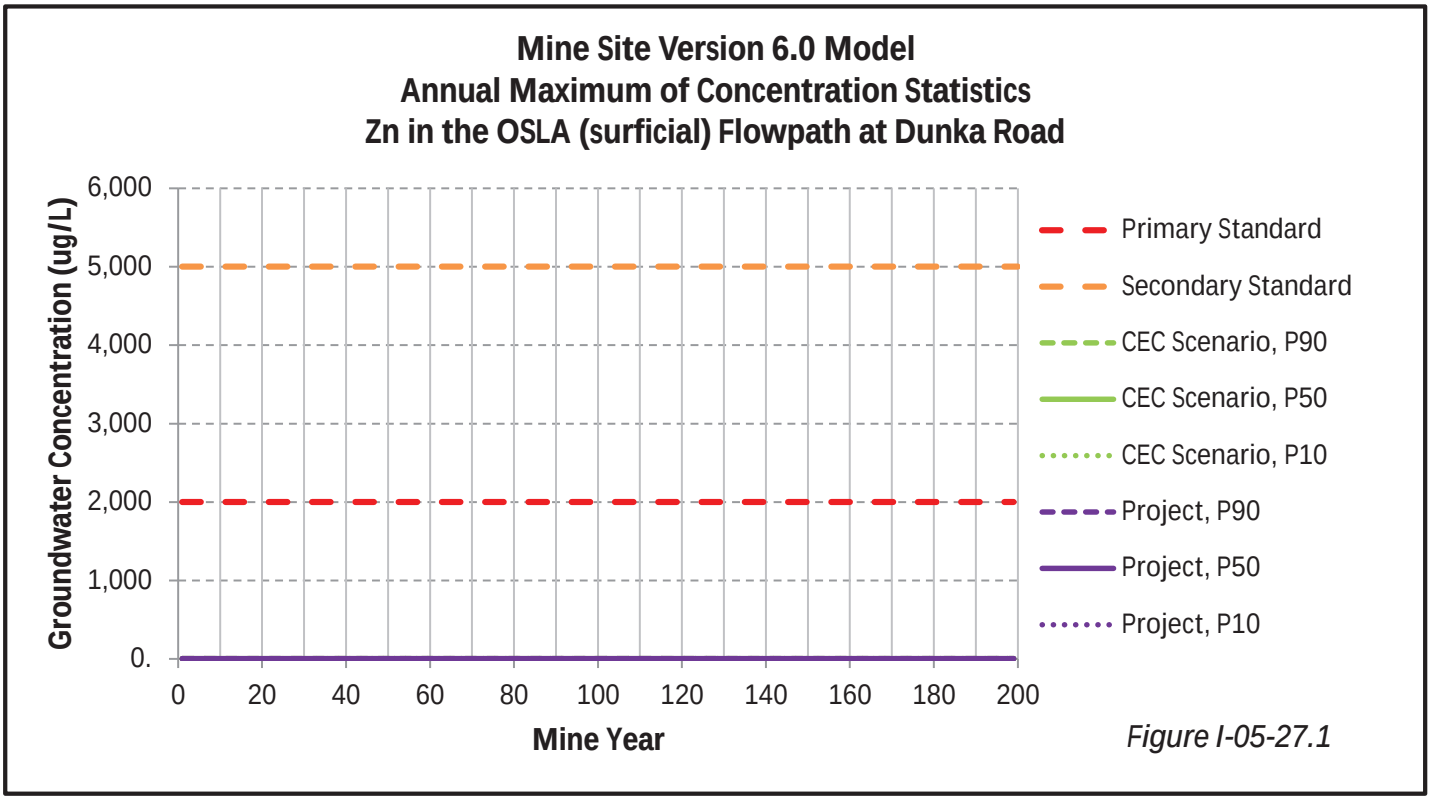

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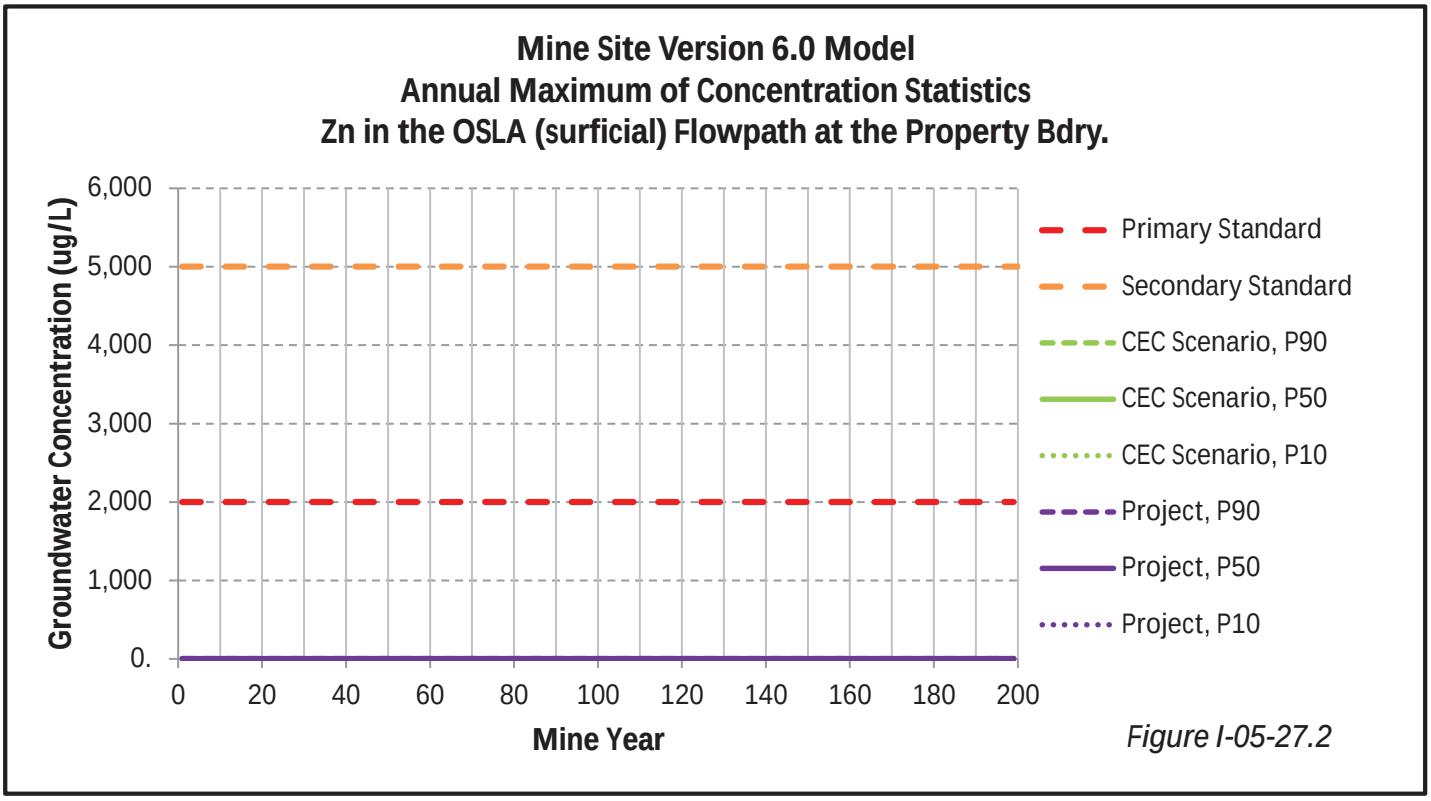

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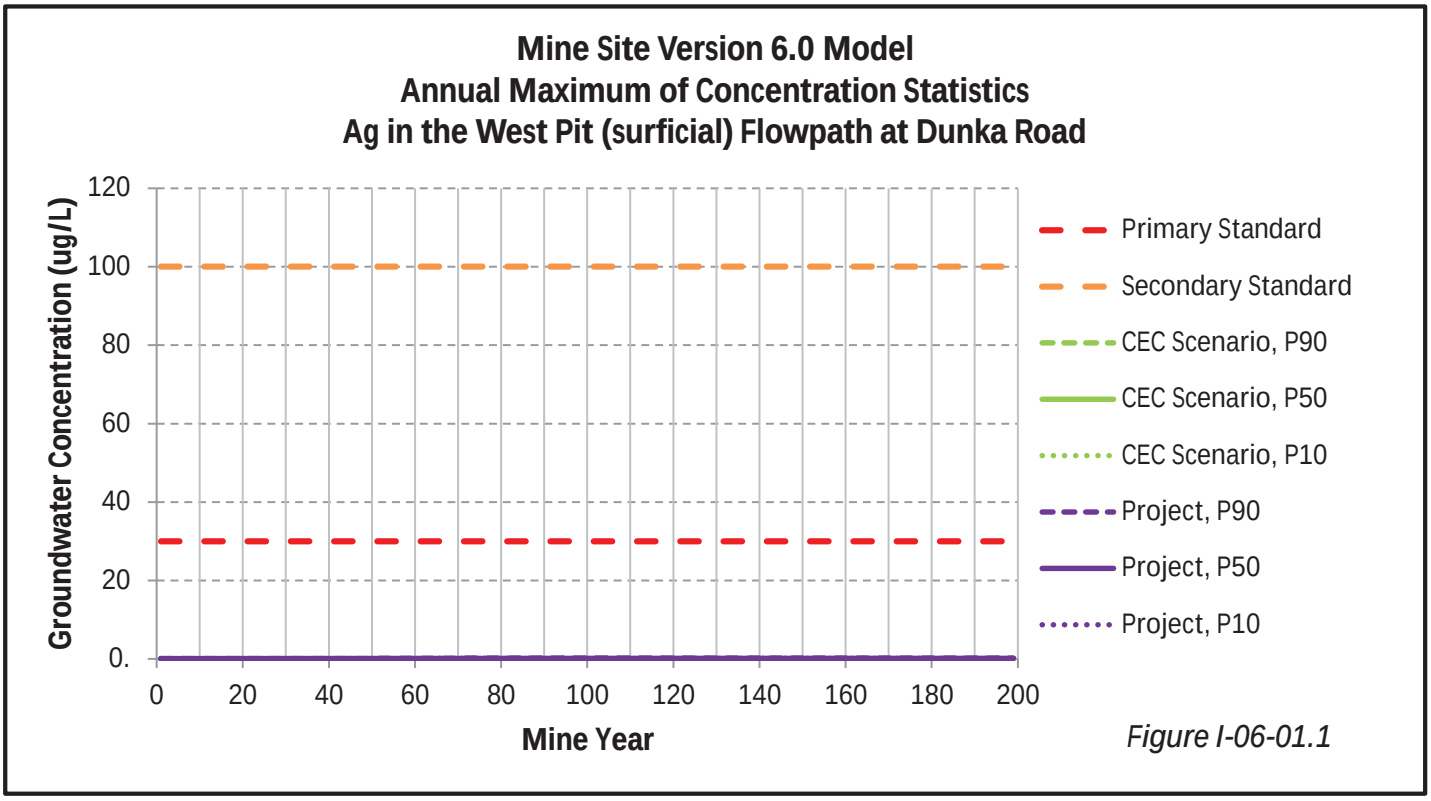

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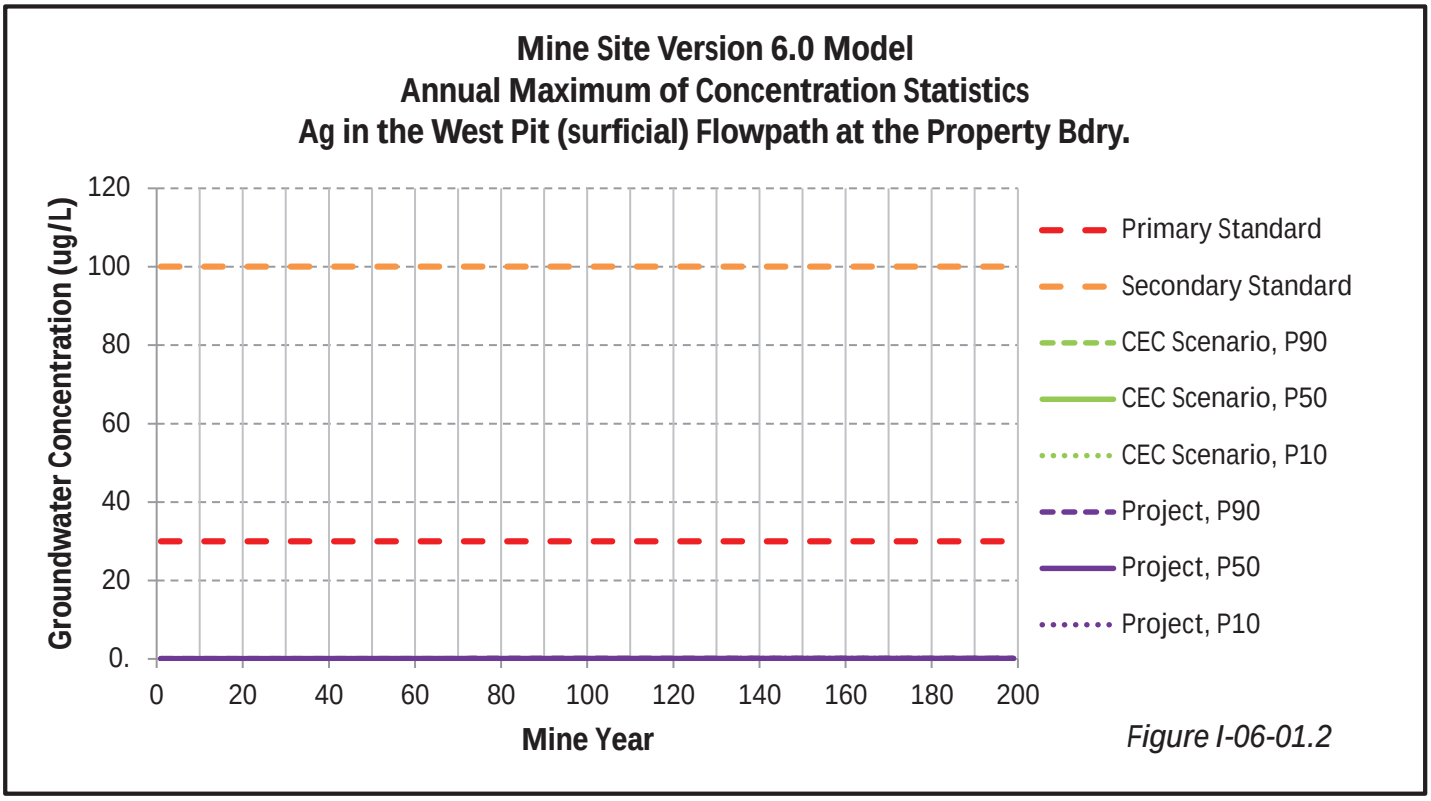

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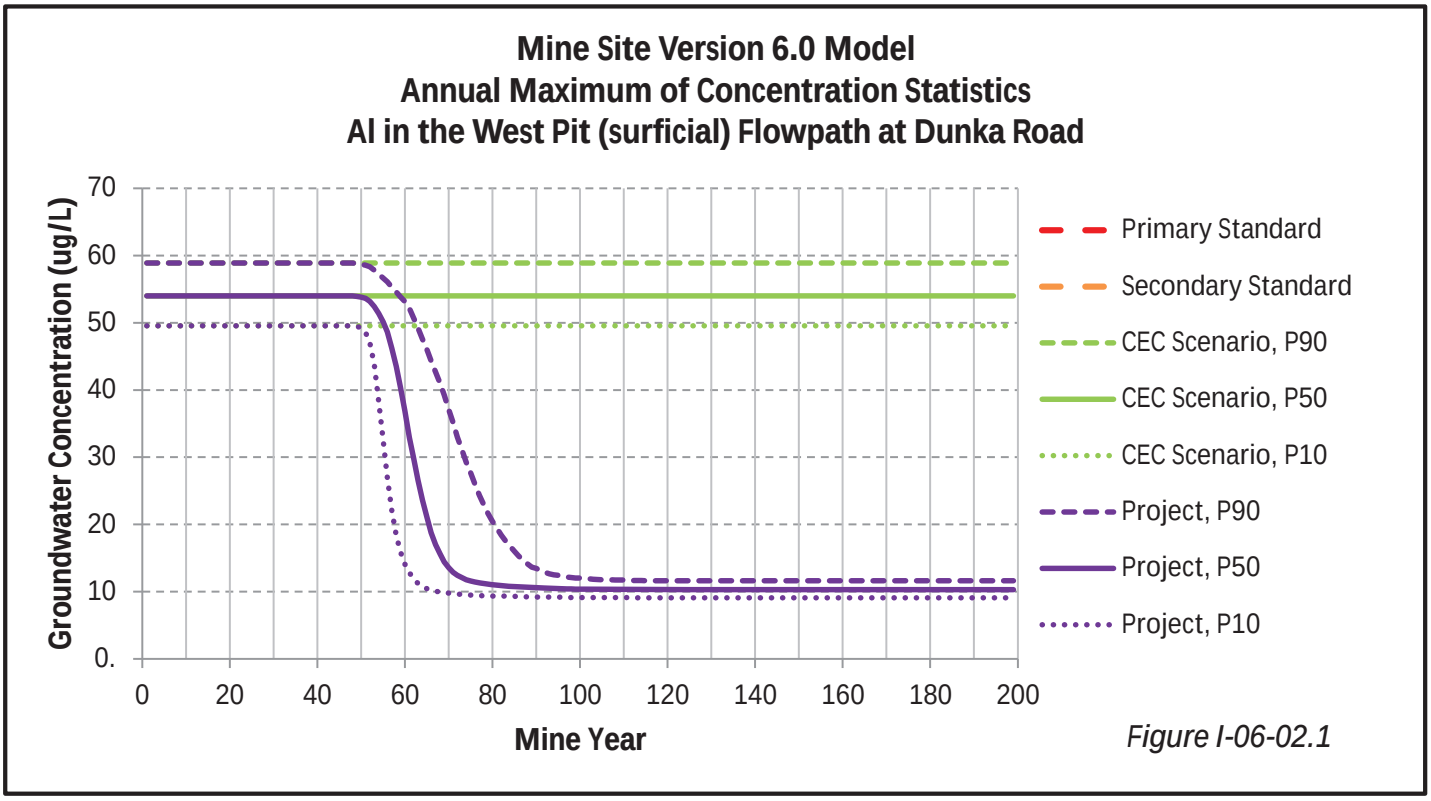

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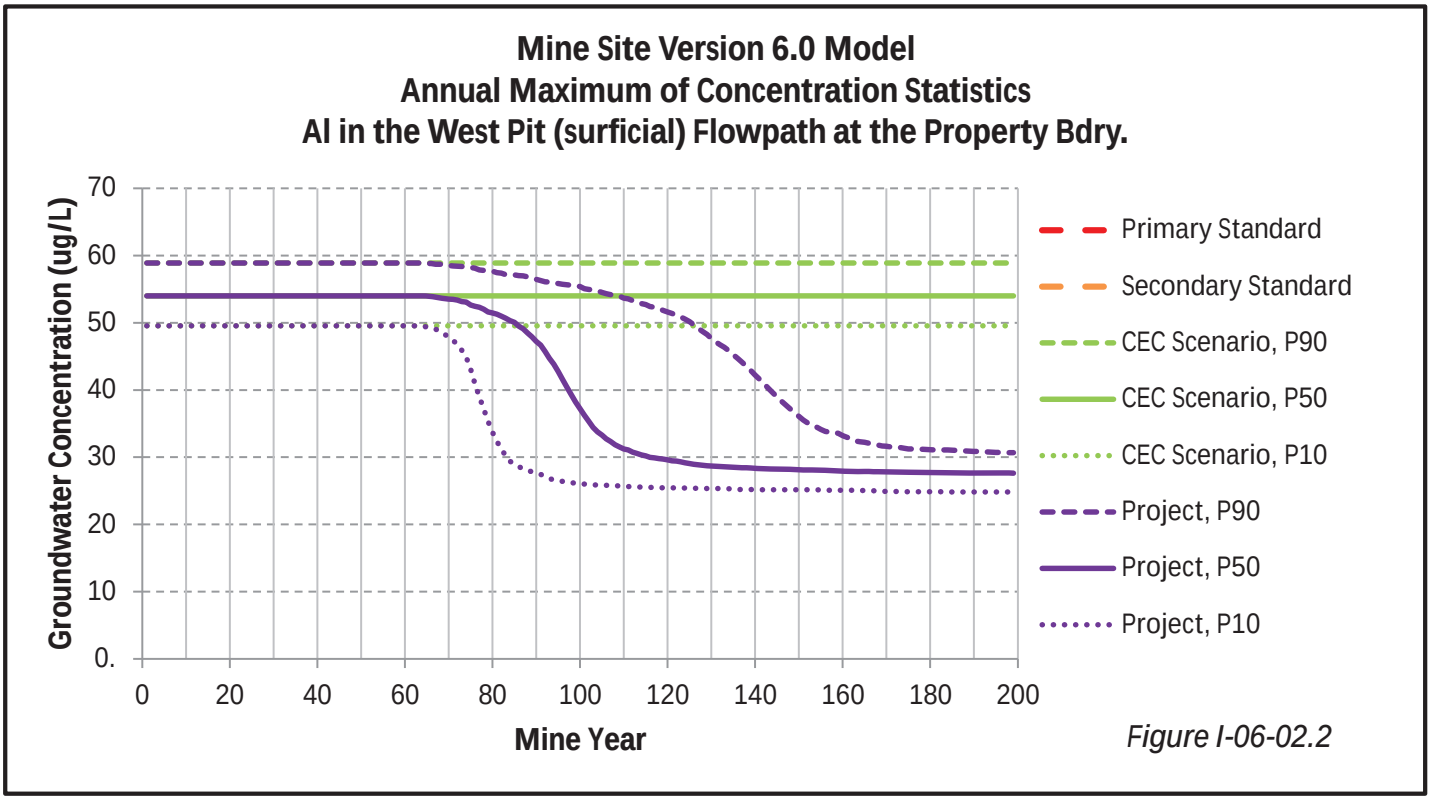

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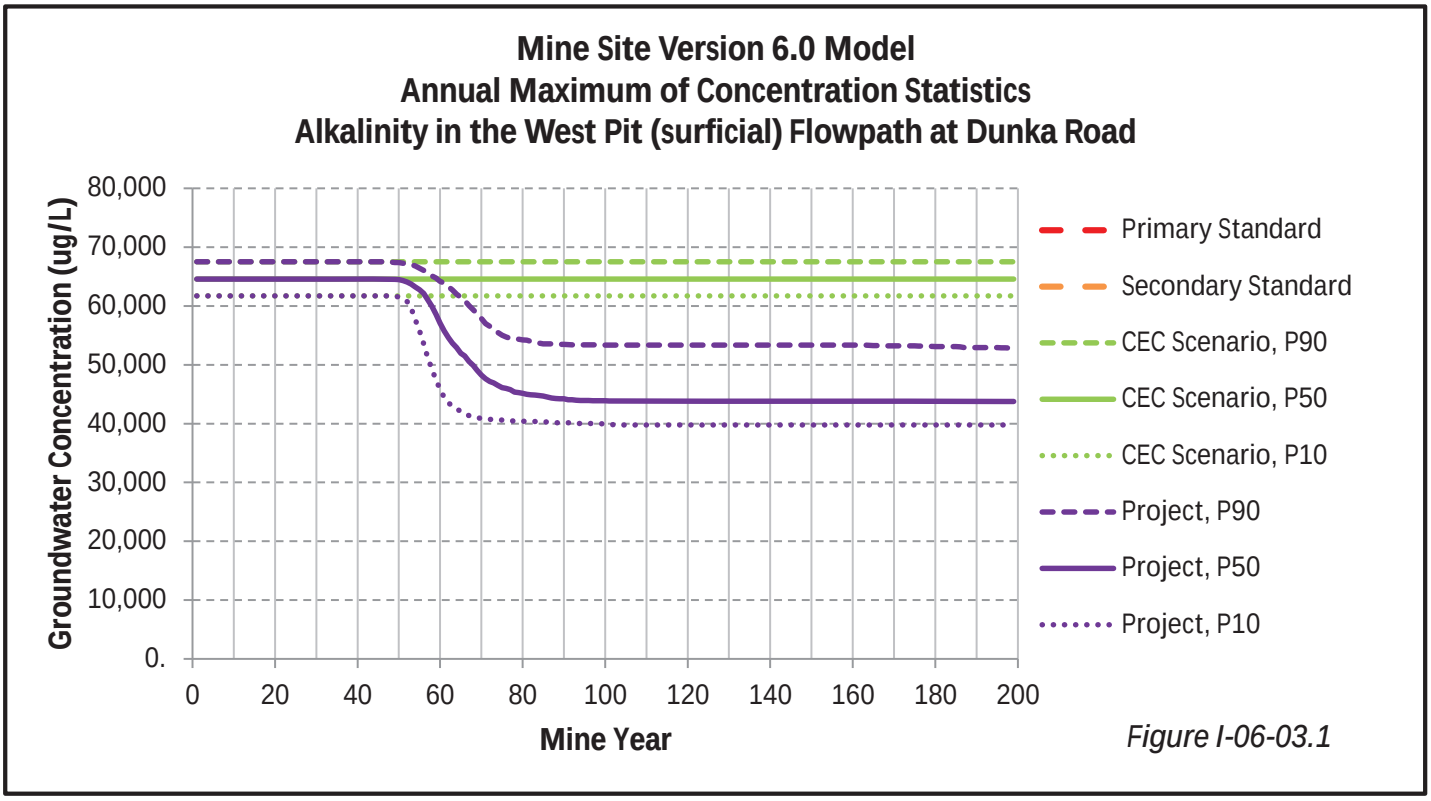

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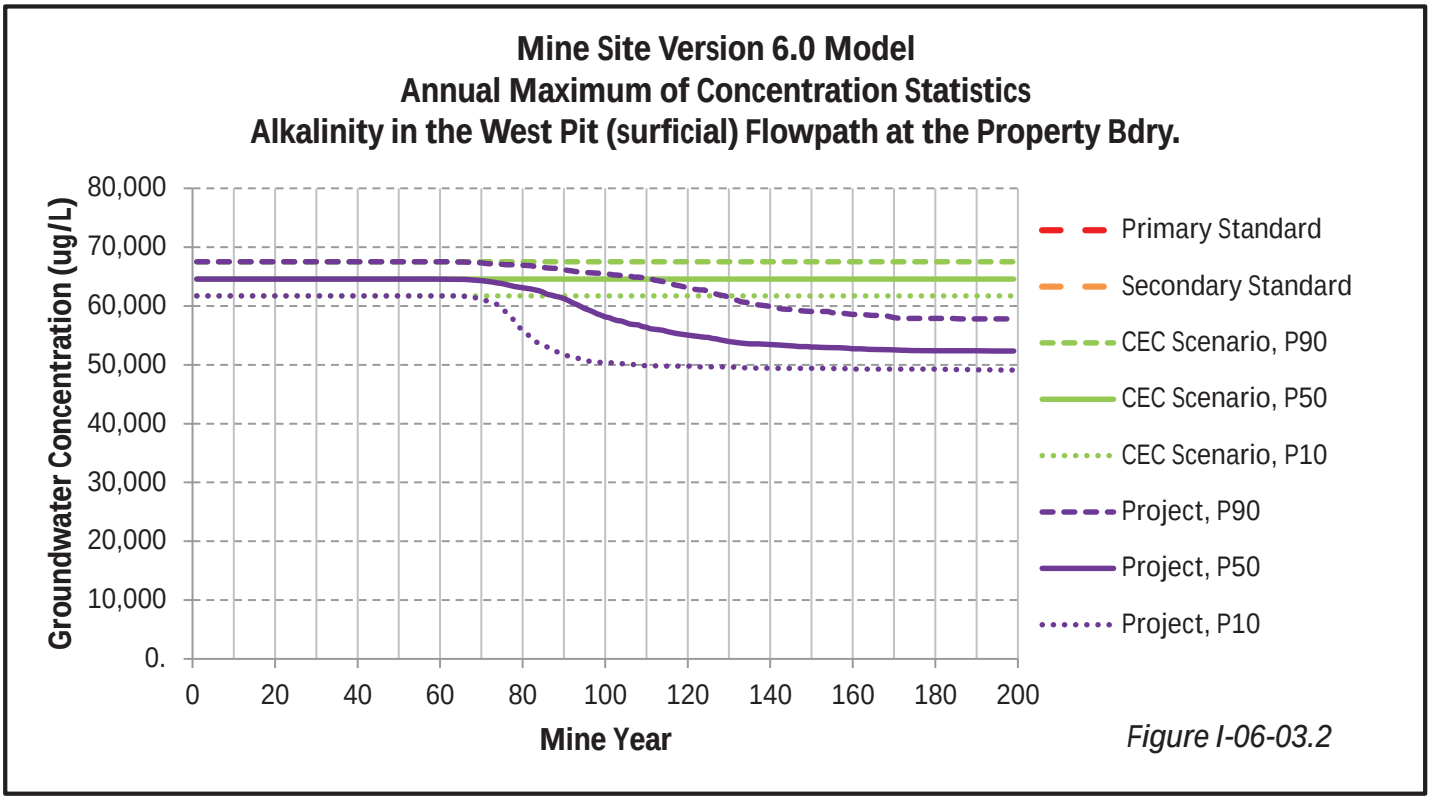

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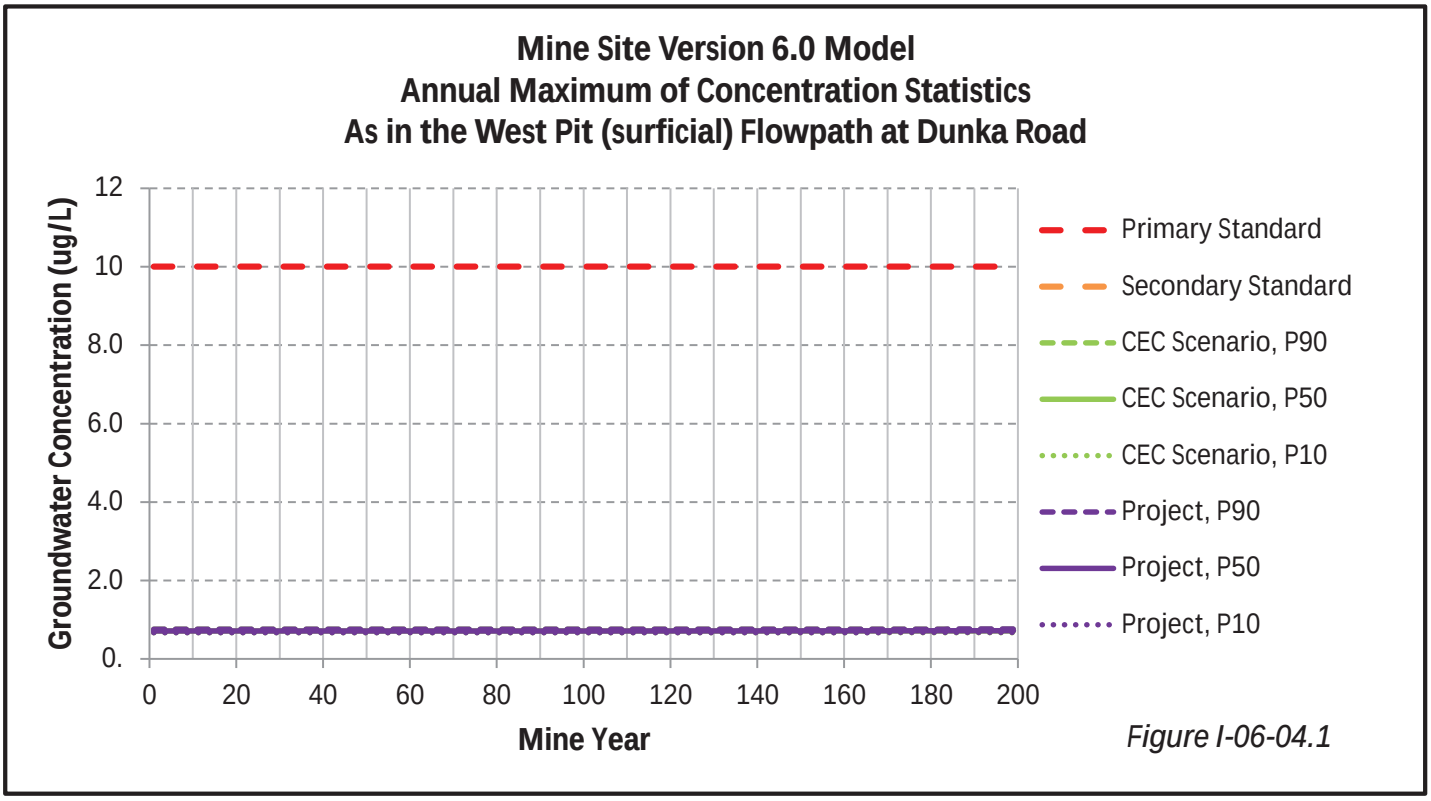

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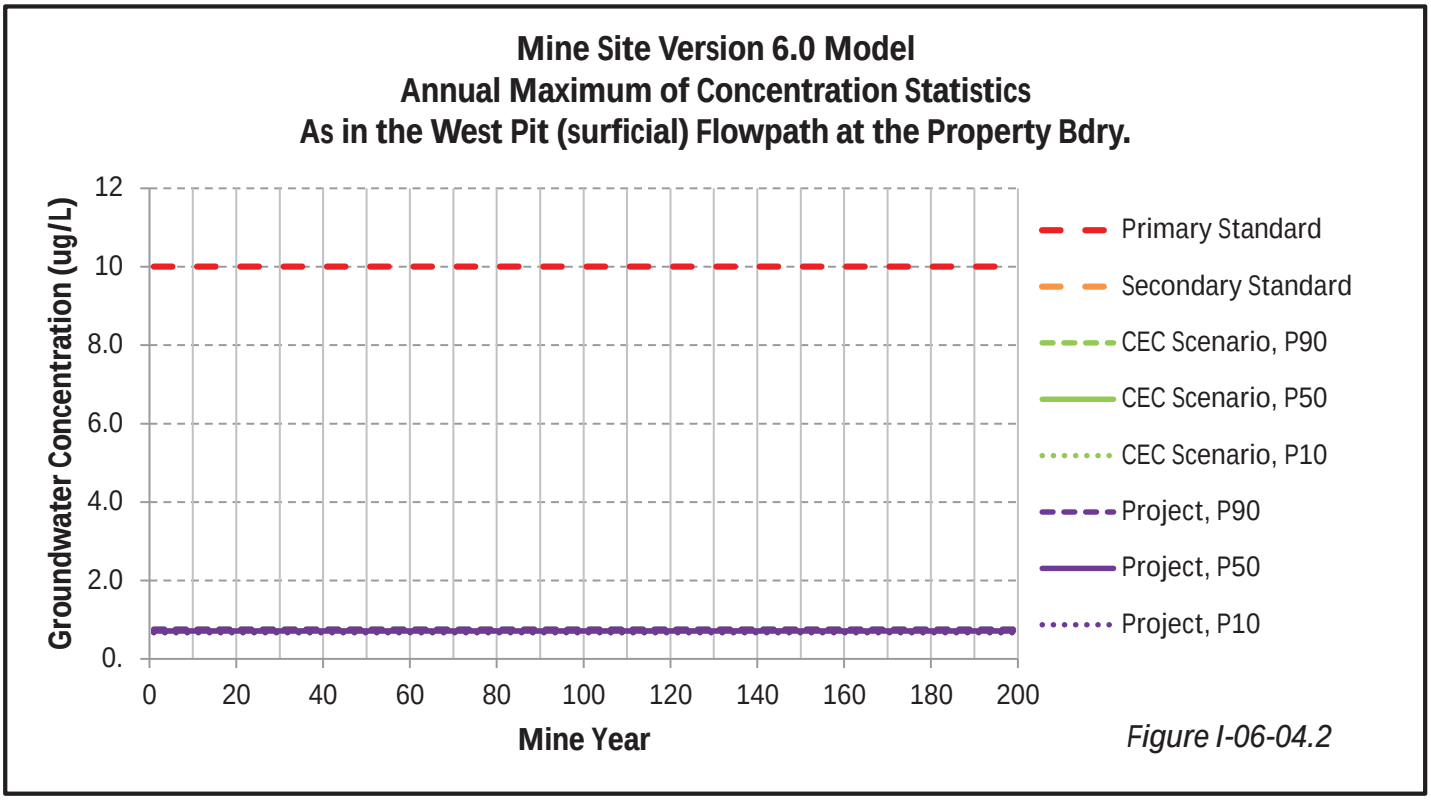

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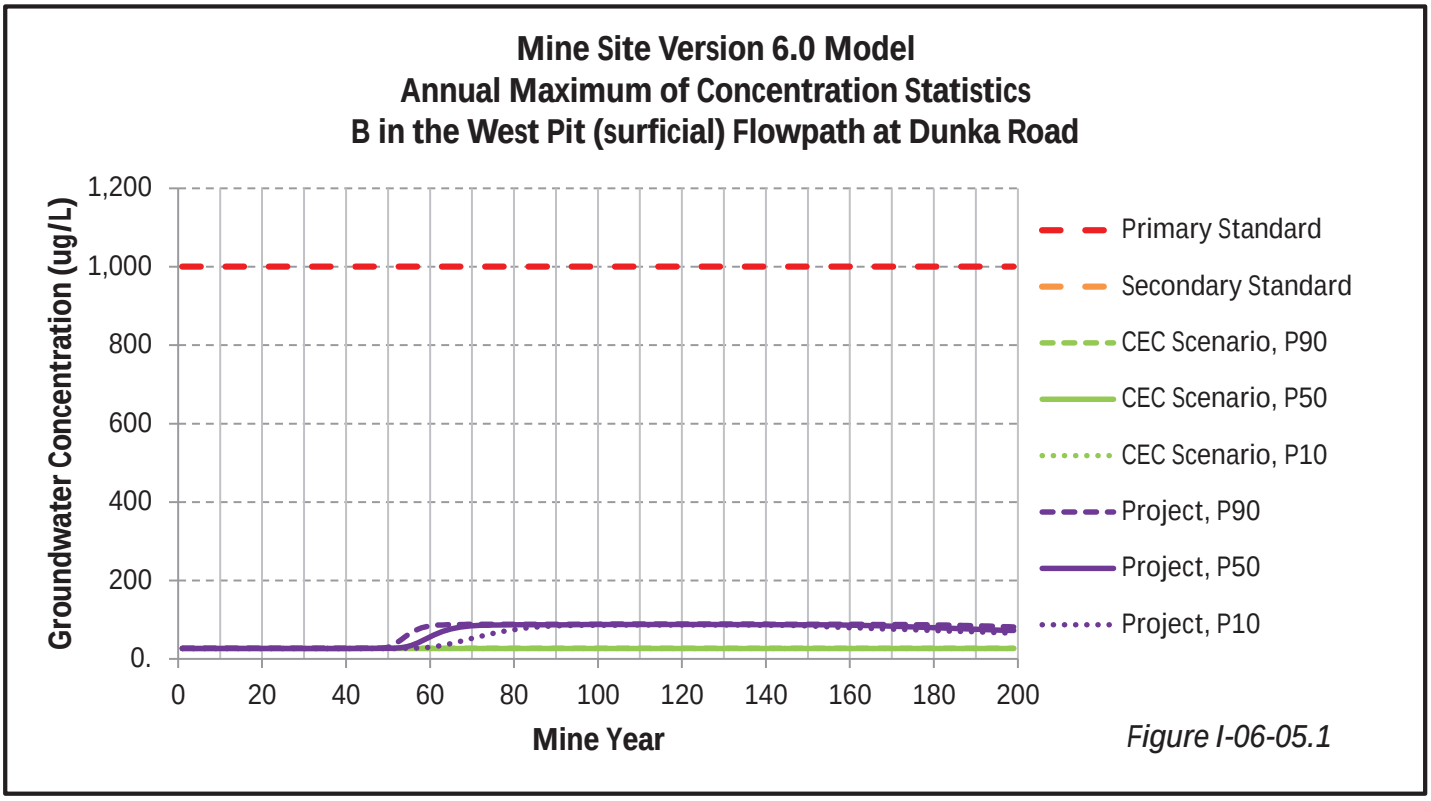

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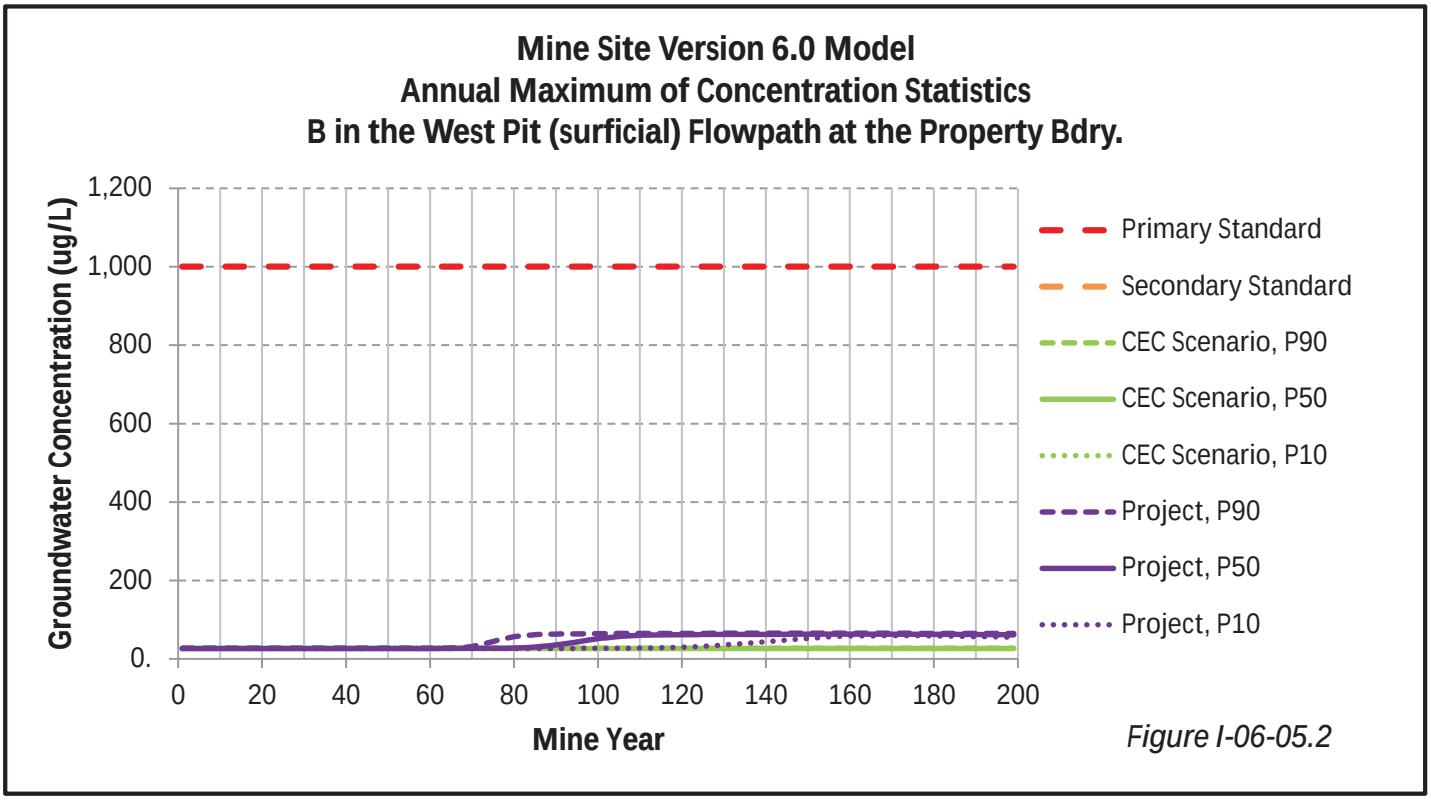

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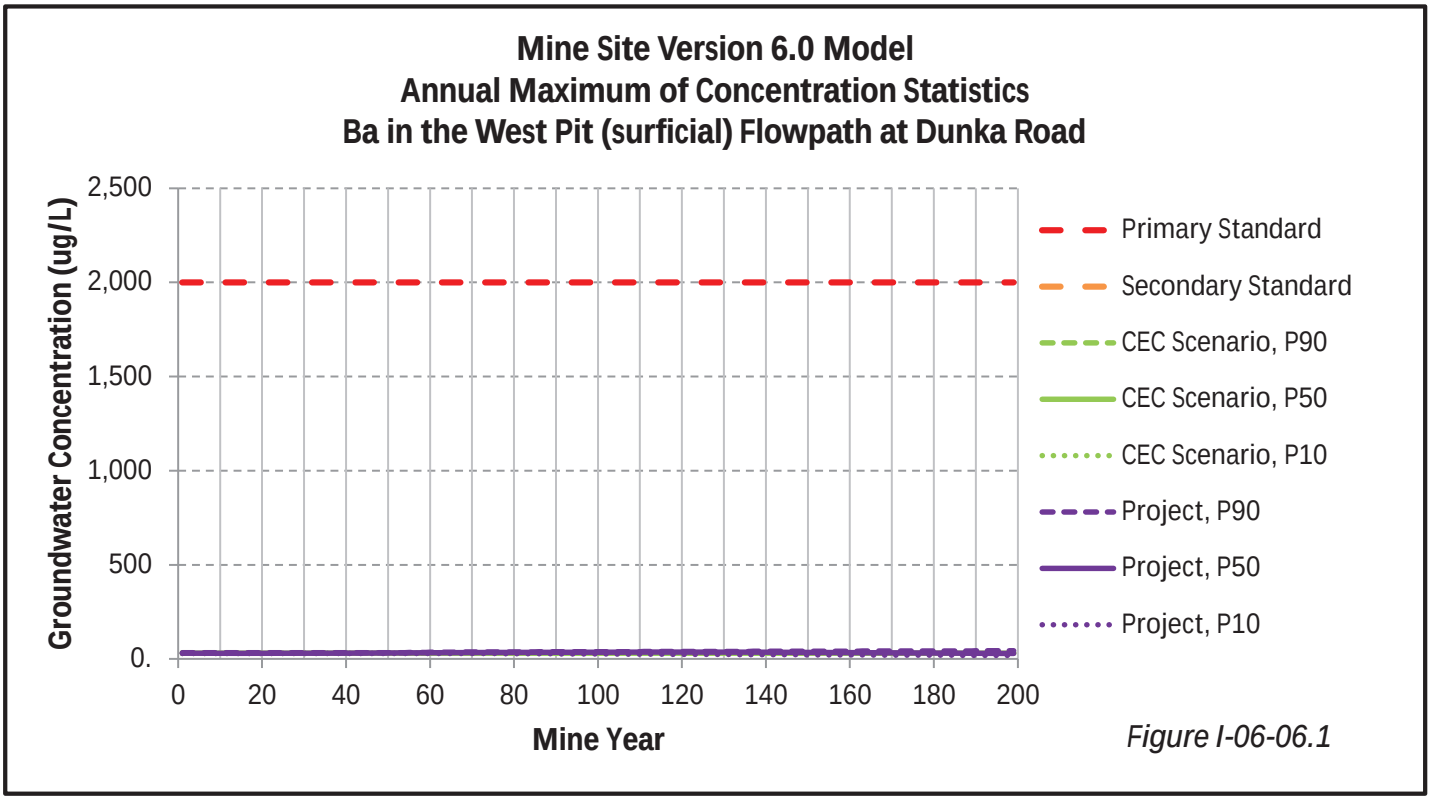

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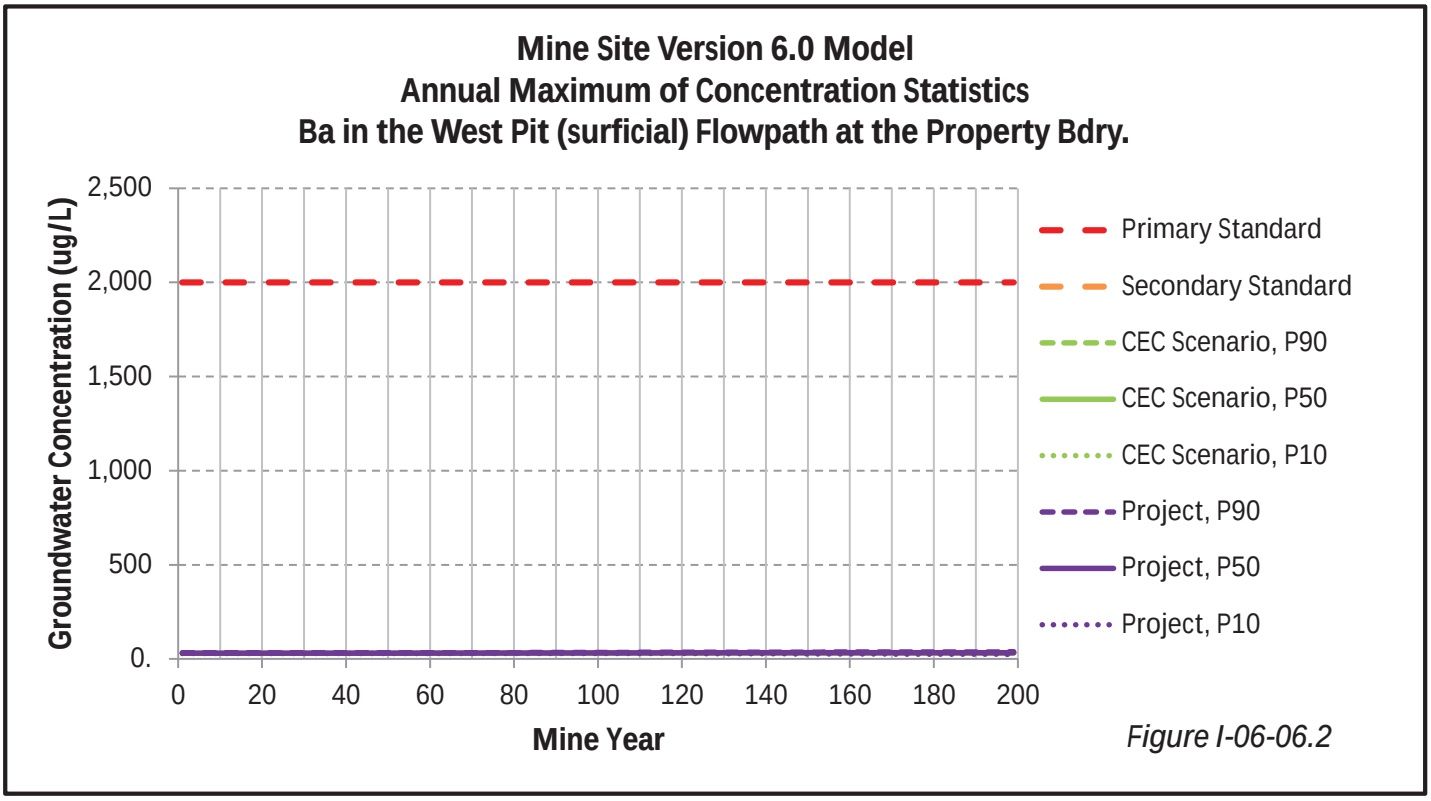

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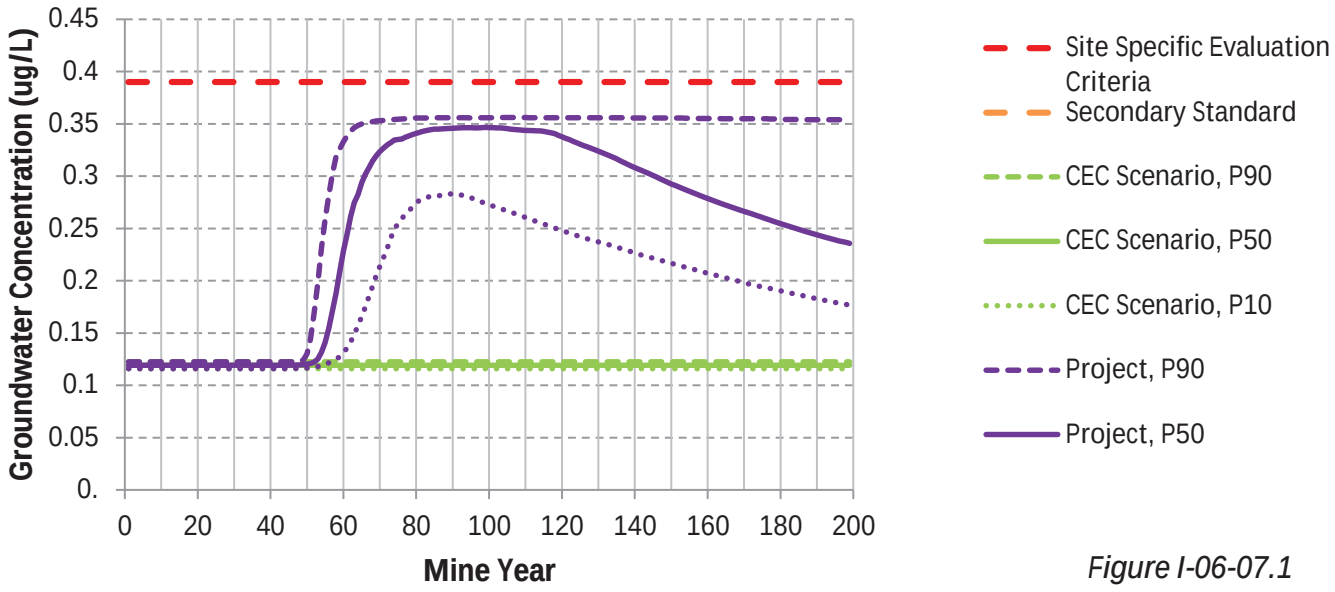
Mine Site Version 6.0 Model
Annual Maximum of Concentration Statistics
Be in the West Pit (surficial) Flowpath at Dunka Road



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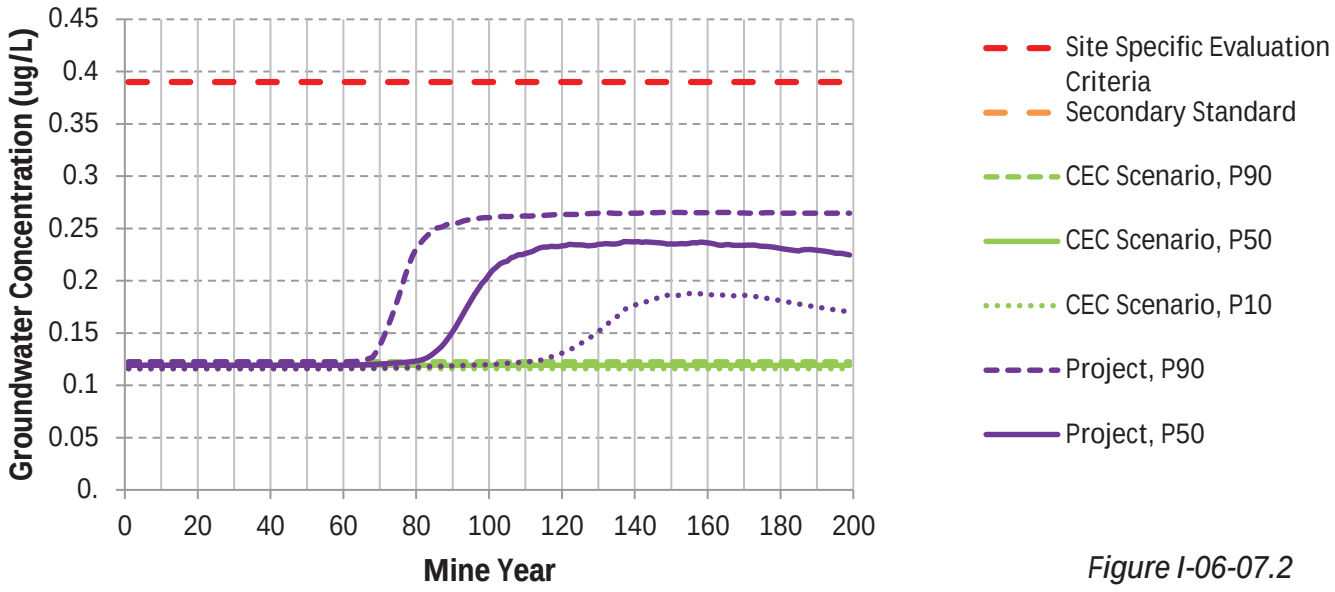
Mine Site Version 6.0 Model
Annual Maximum of Concentration Statistics
Be in the West Pit (surficial) Flowpath at the Property Bdry.



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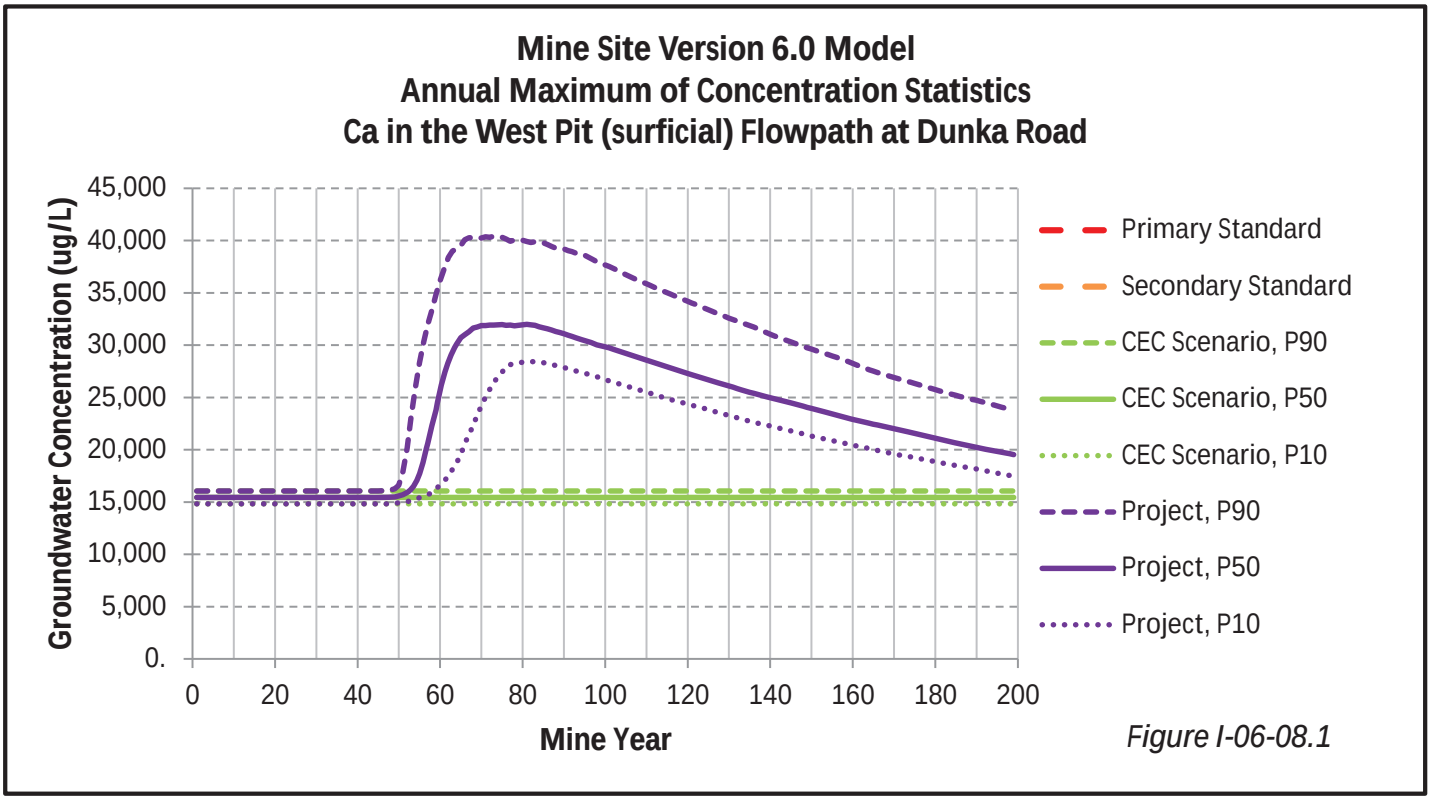

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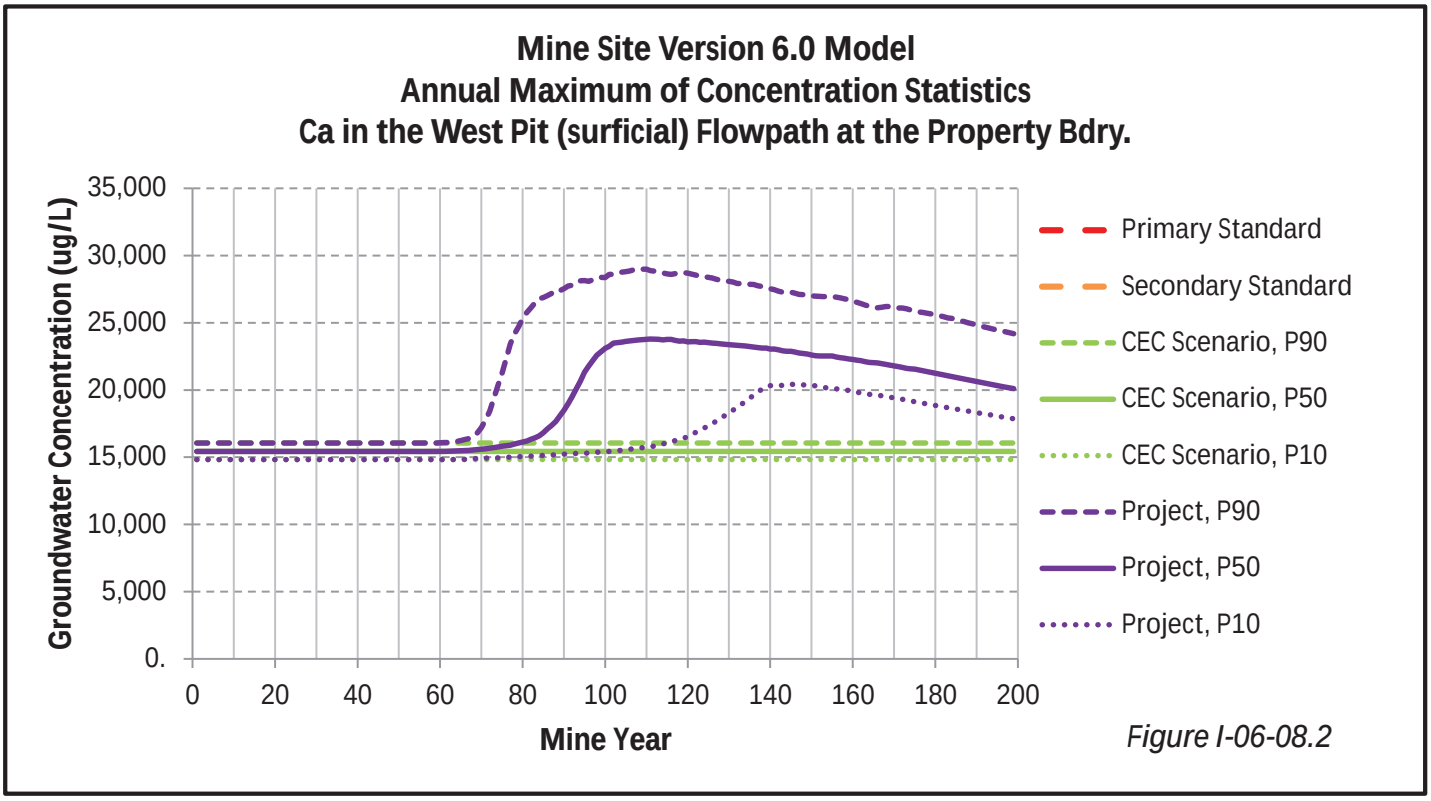

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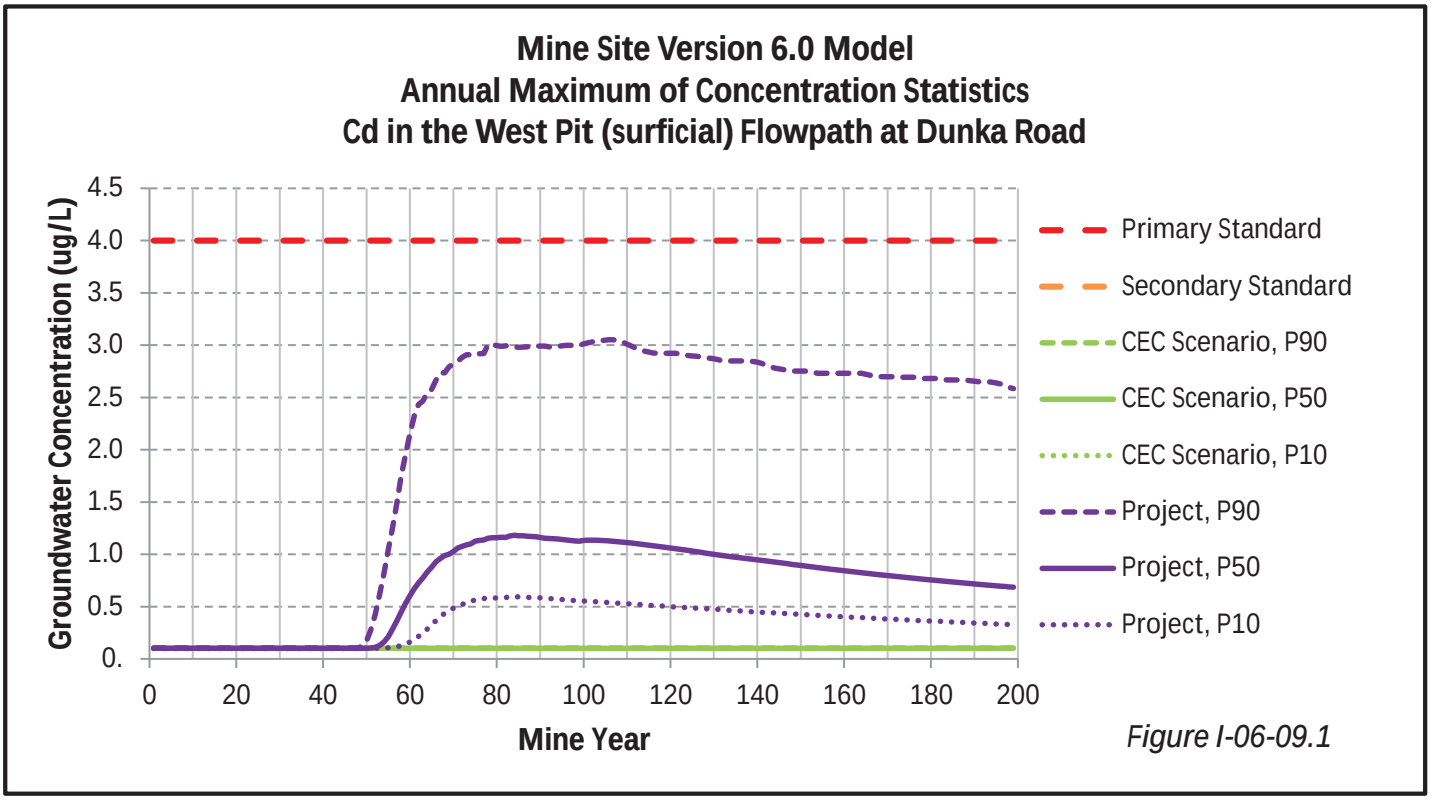

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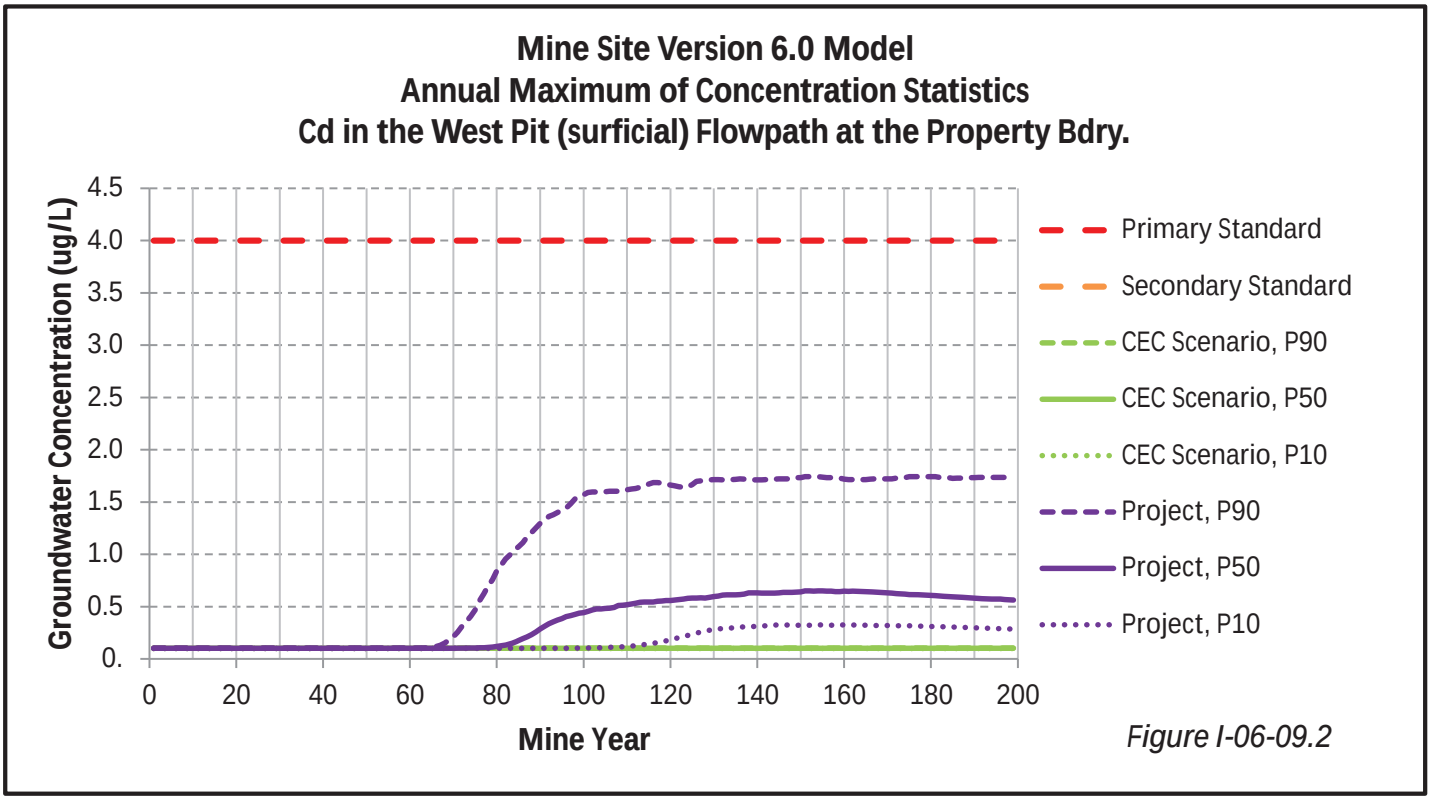

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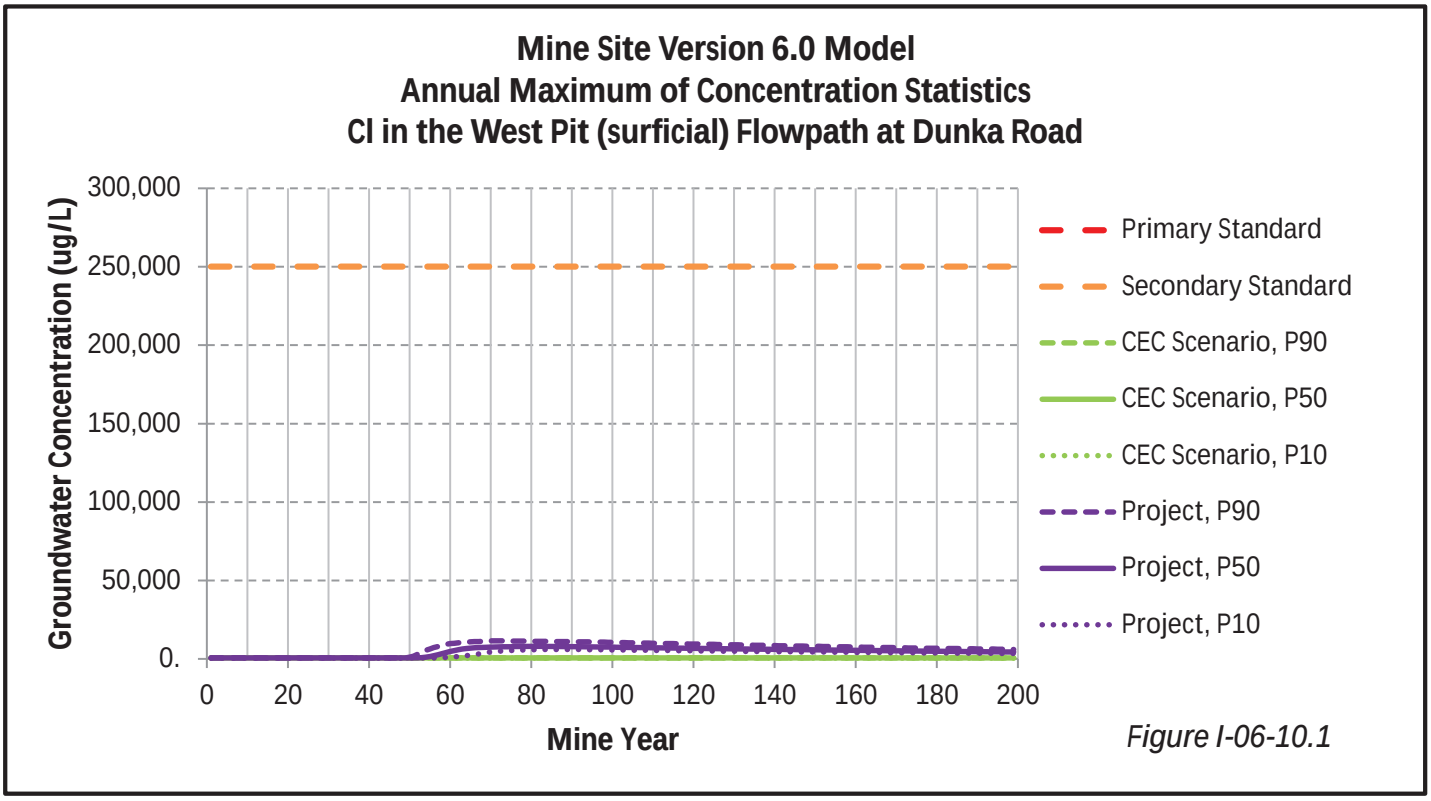

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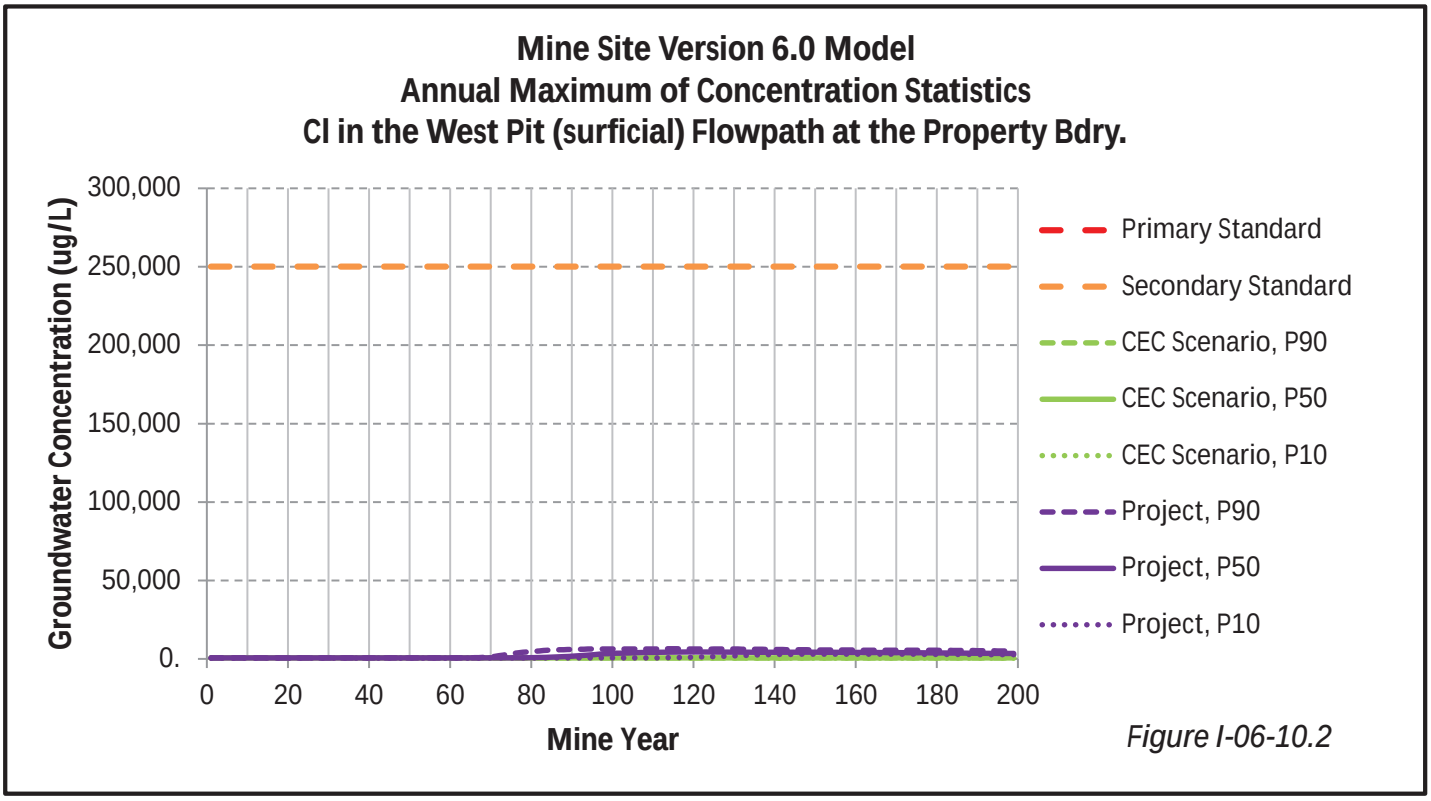

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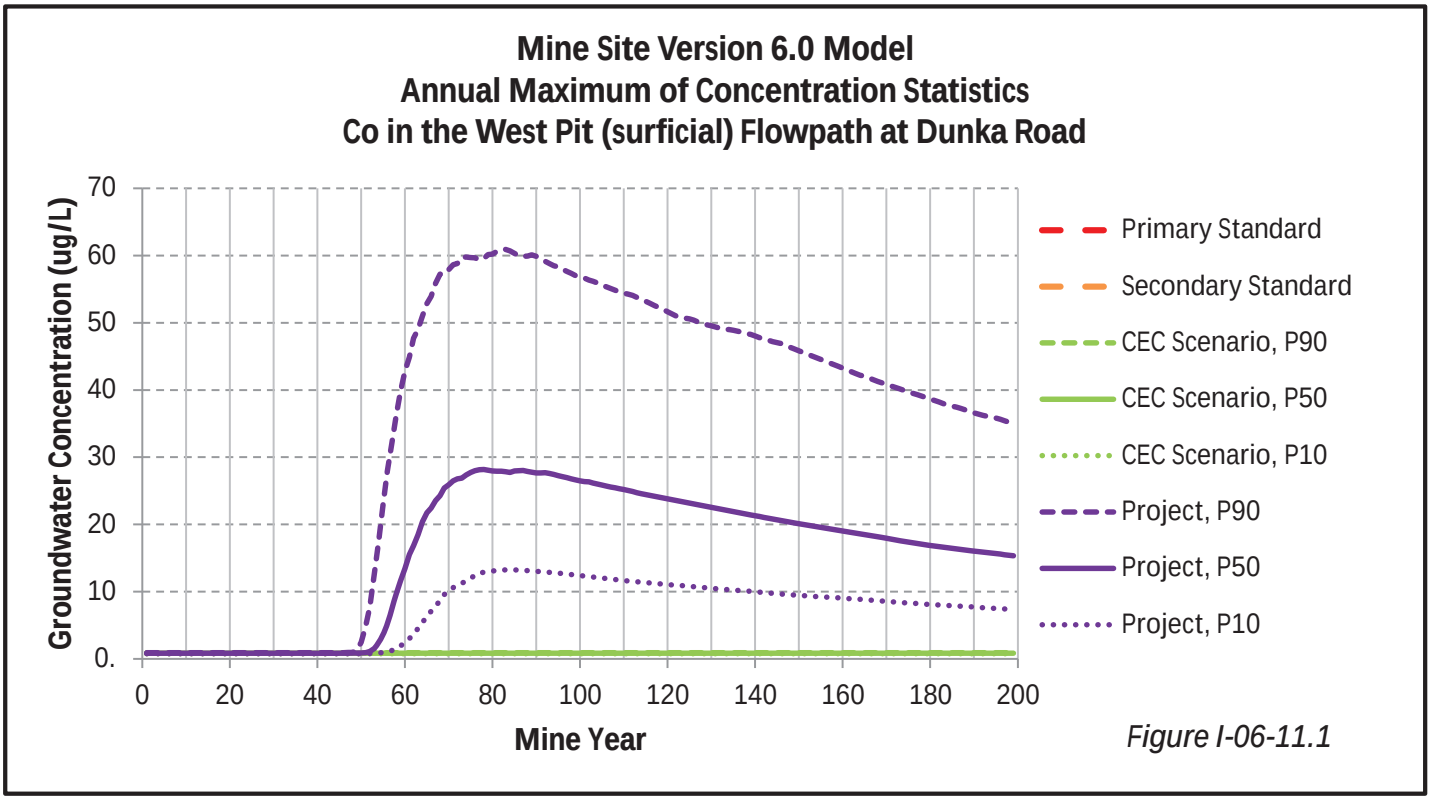

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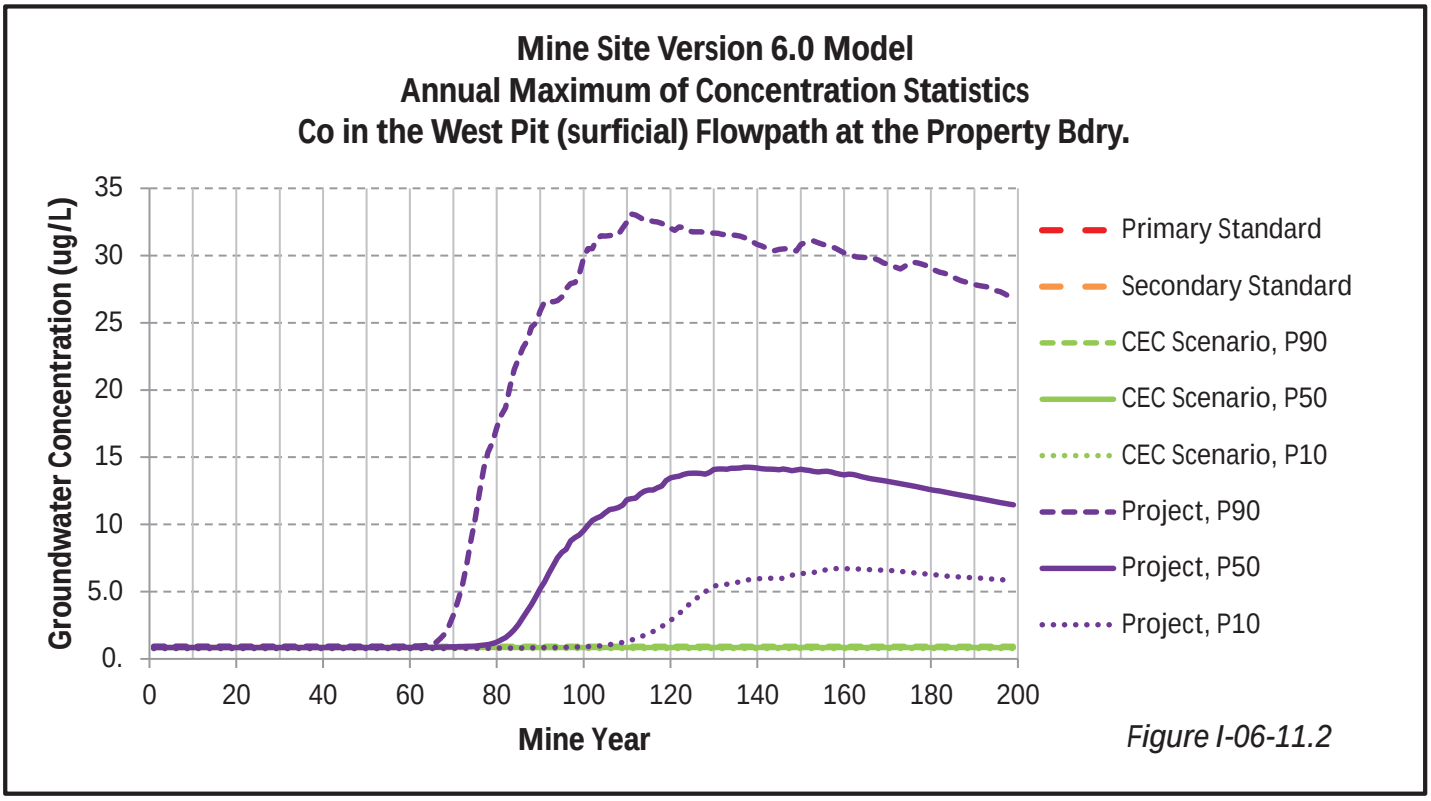

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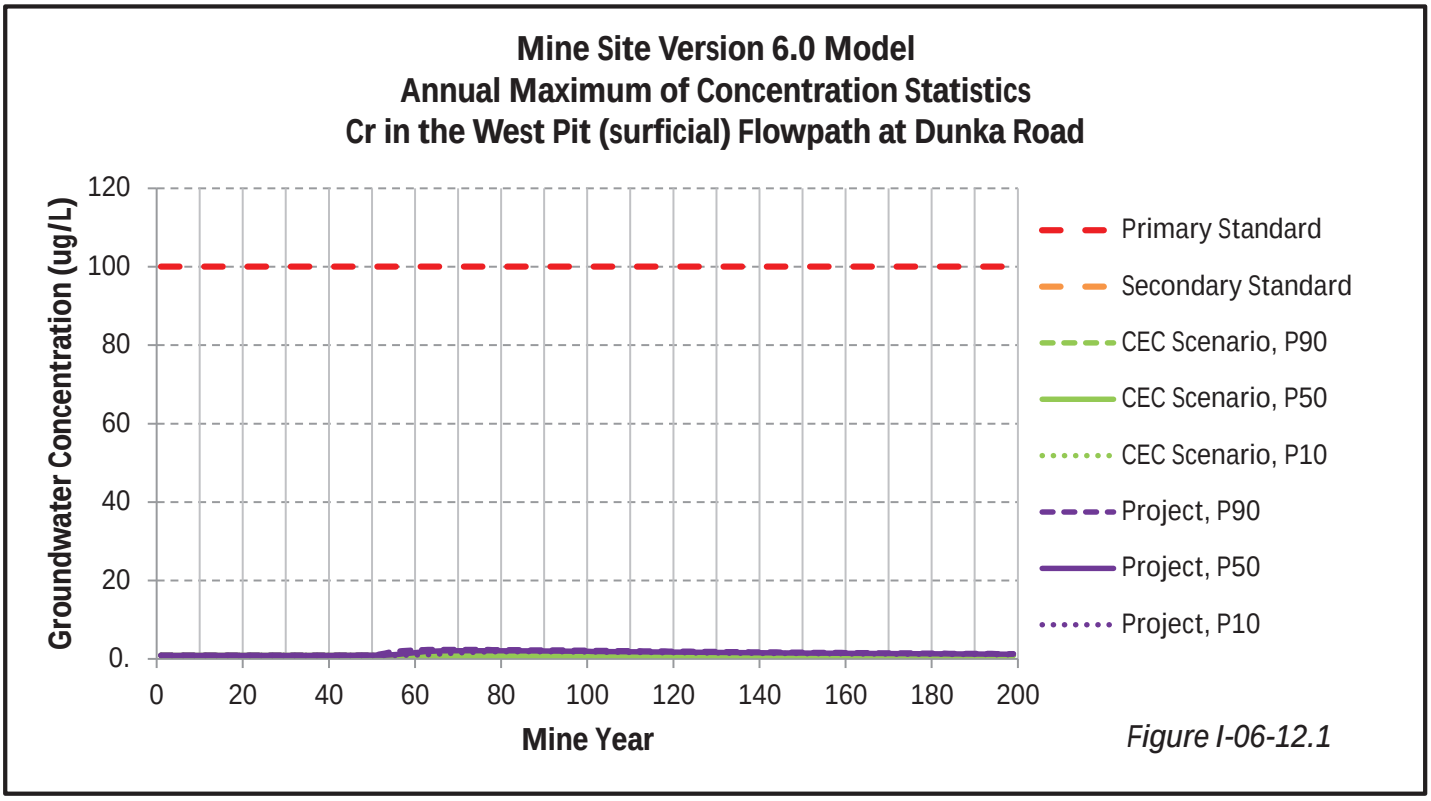

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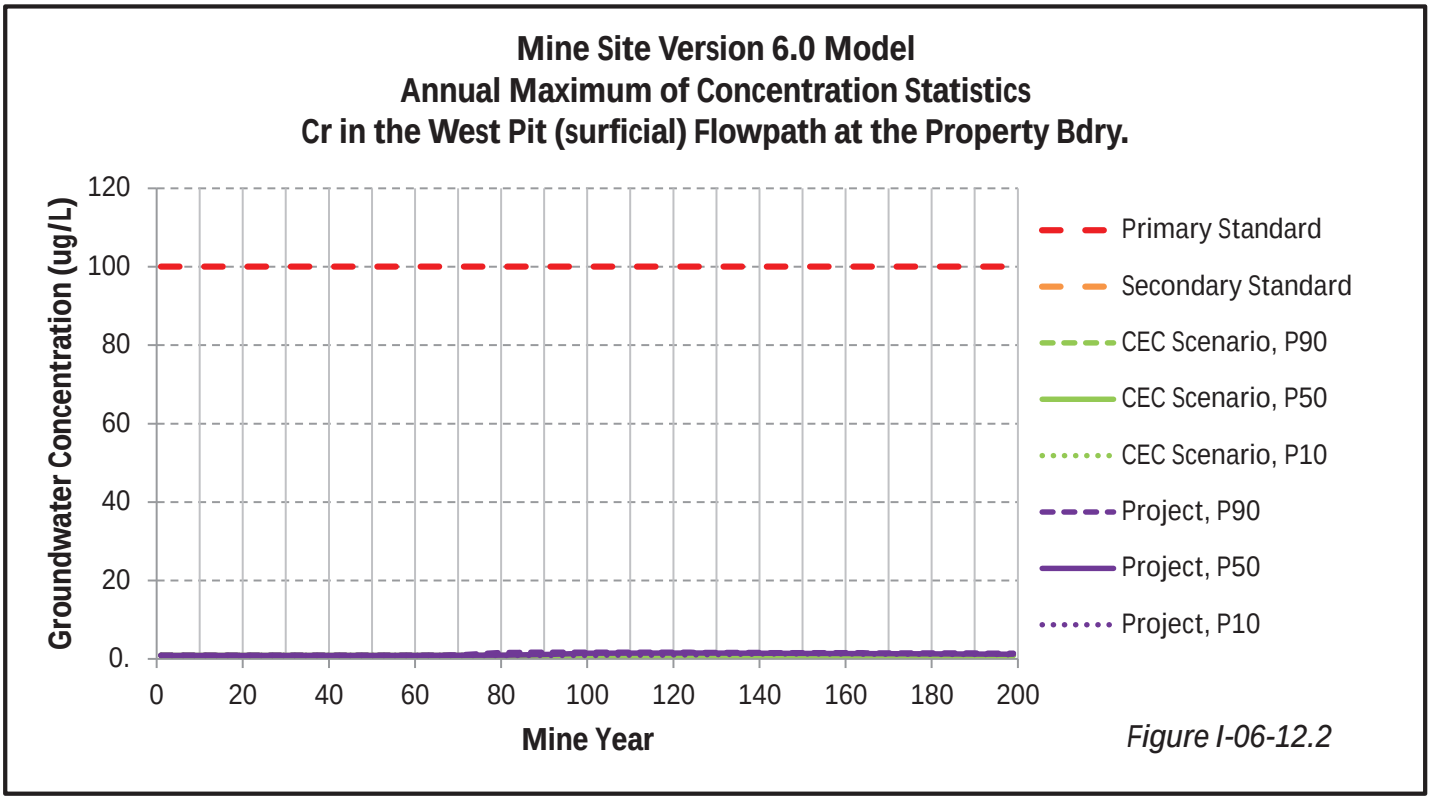

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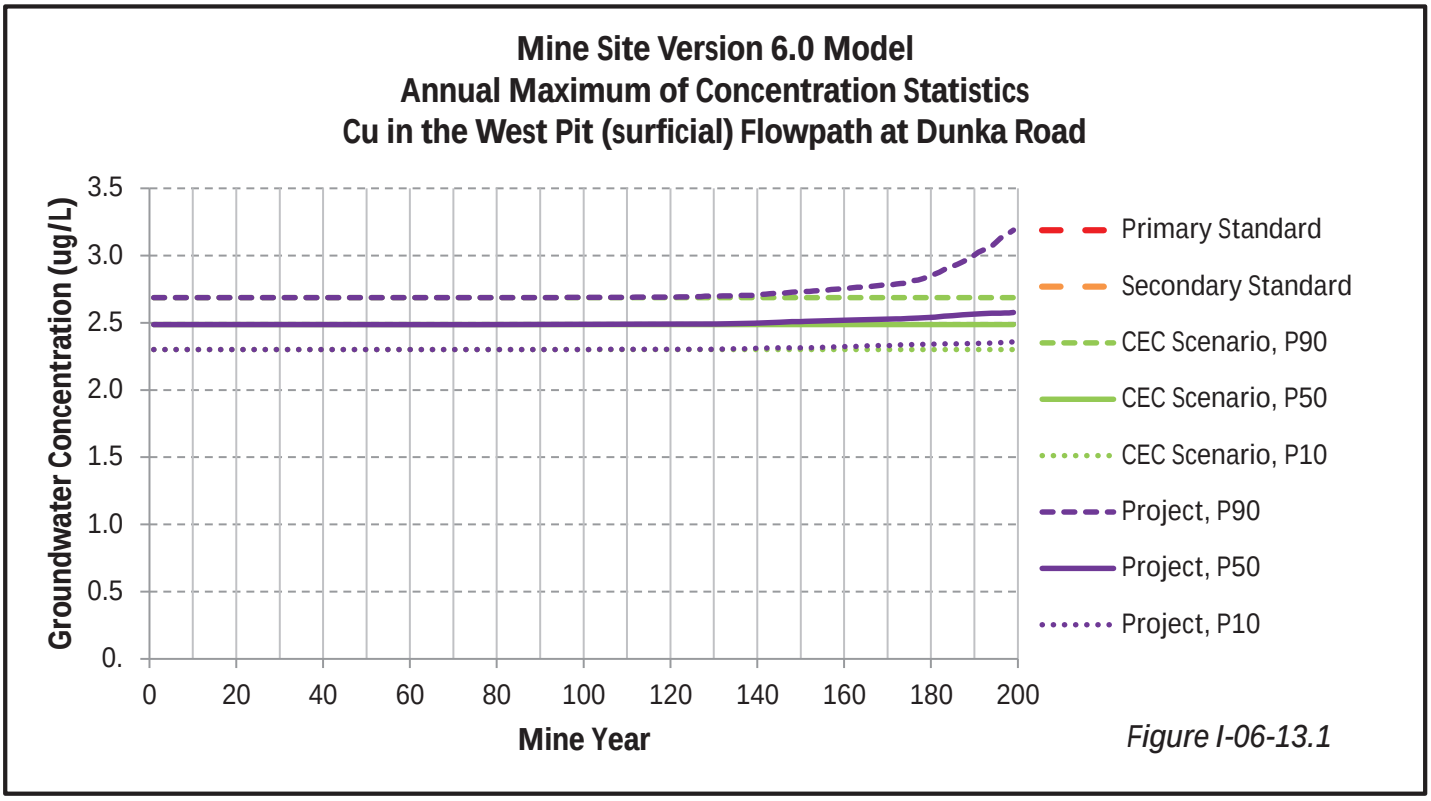

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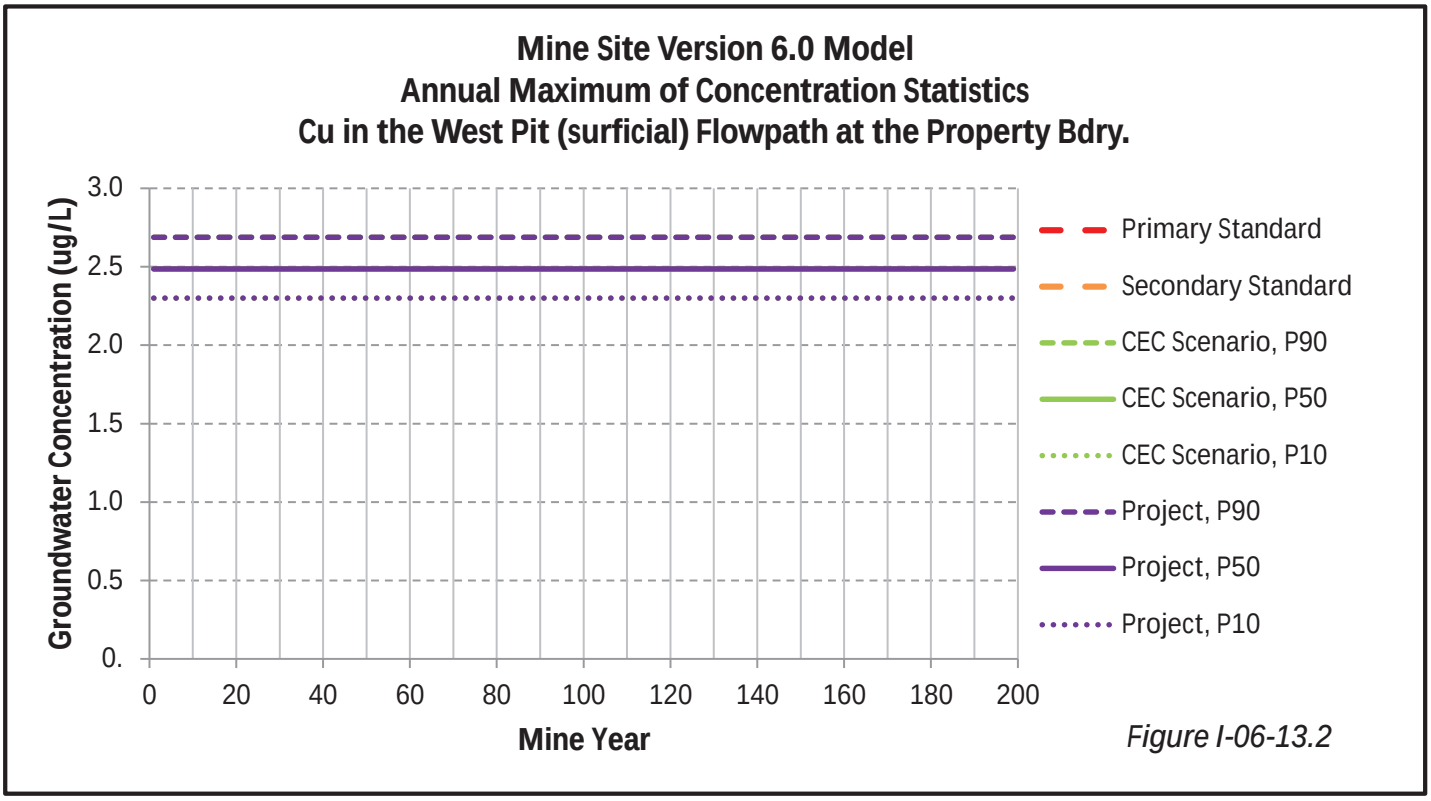

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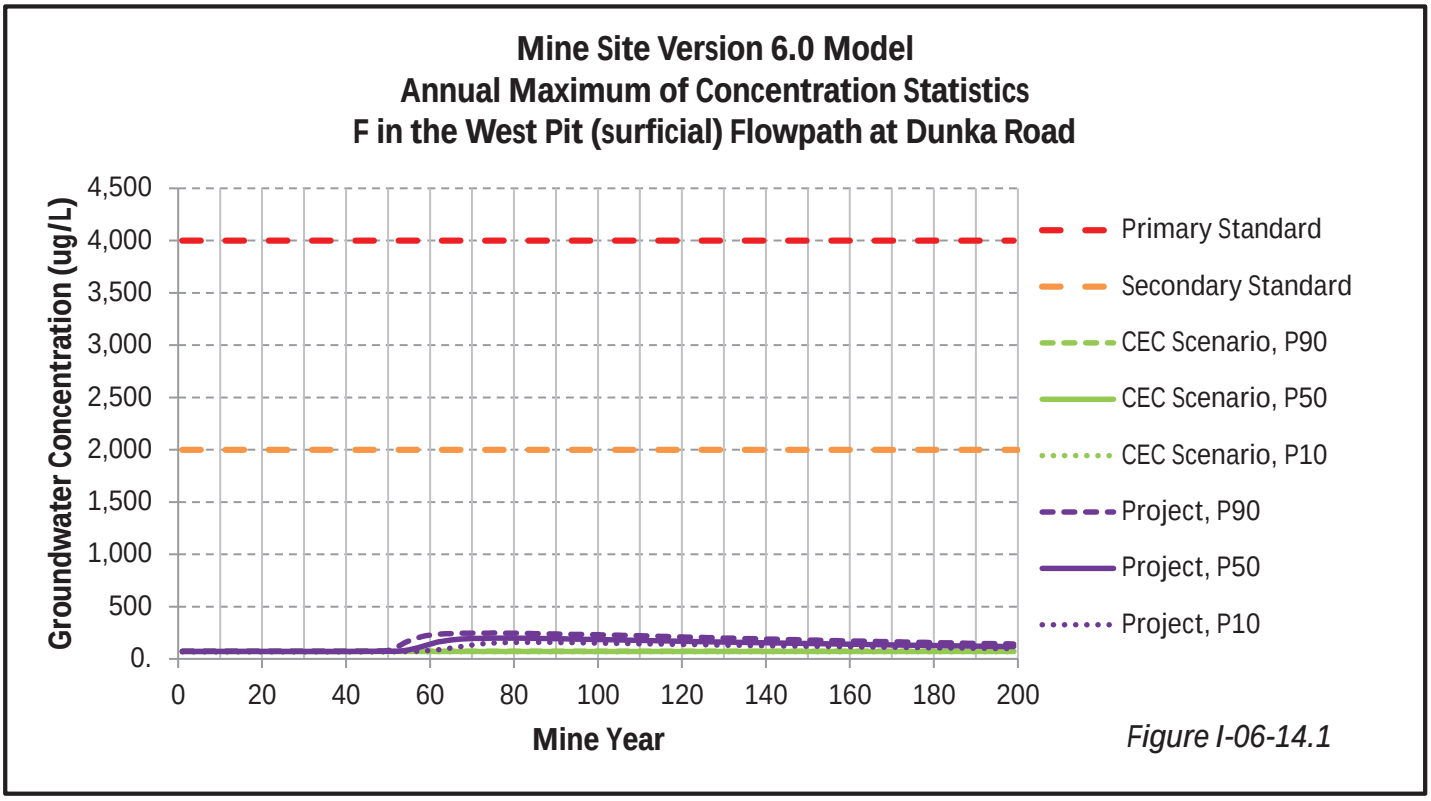

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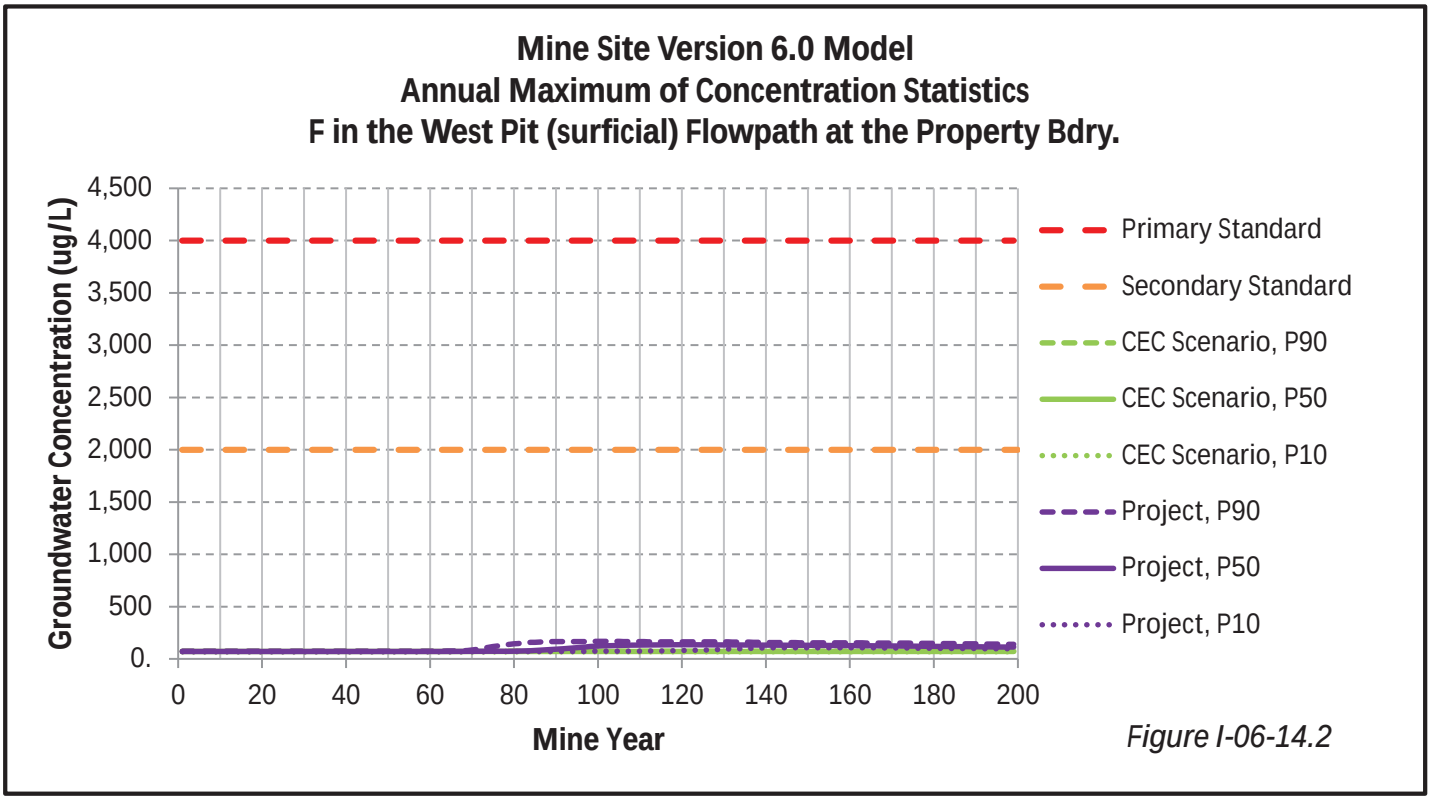

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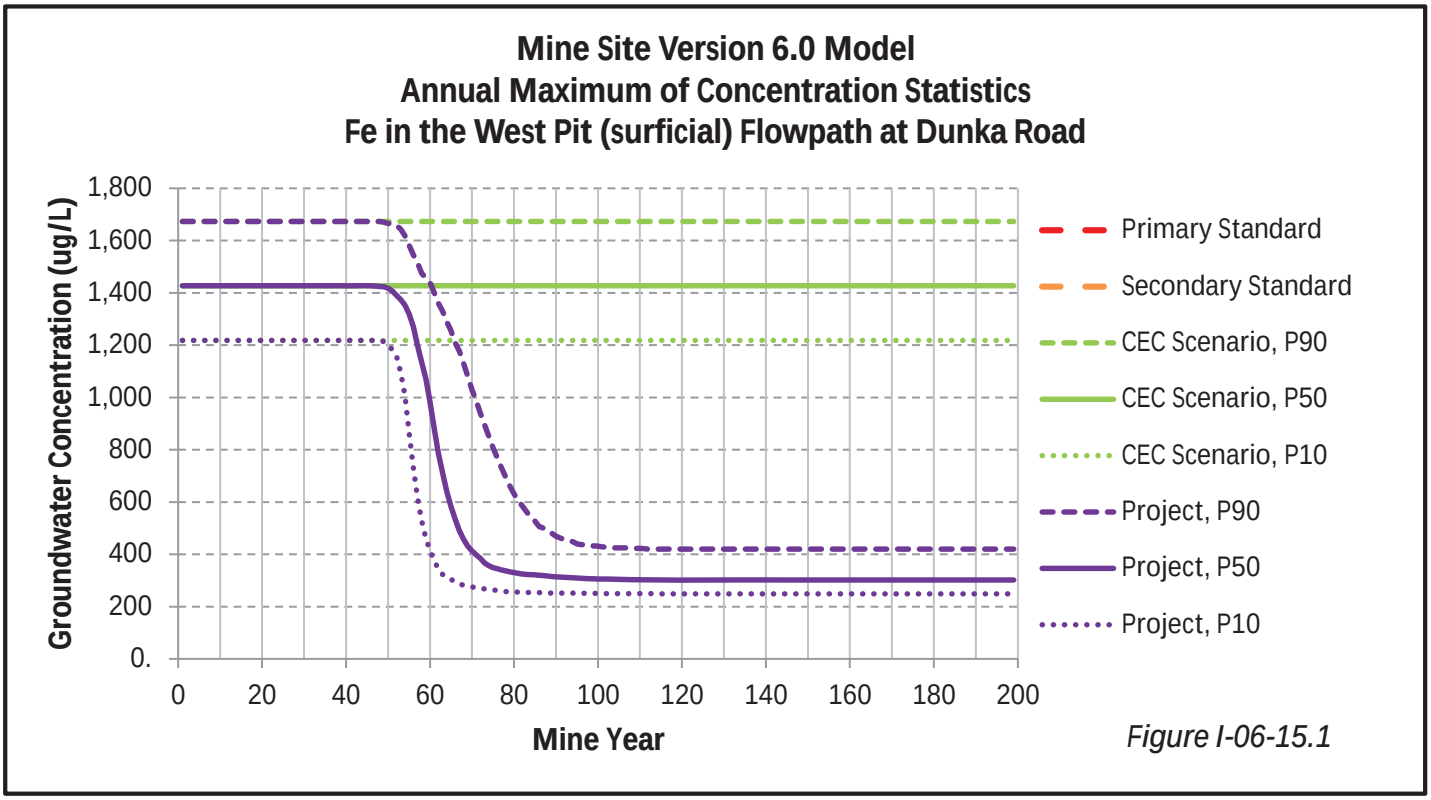

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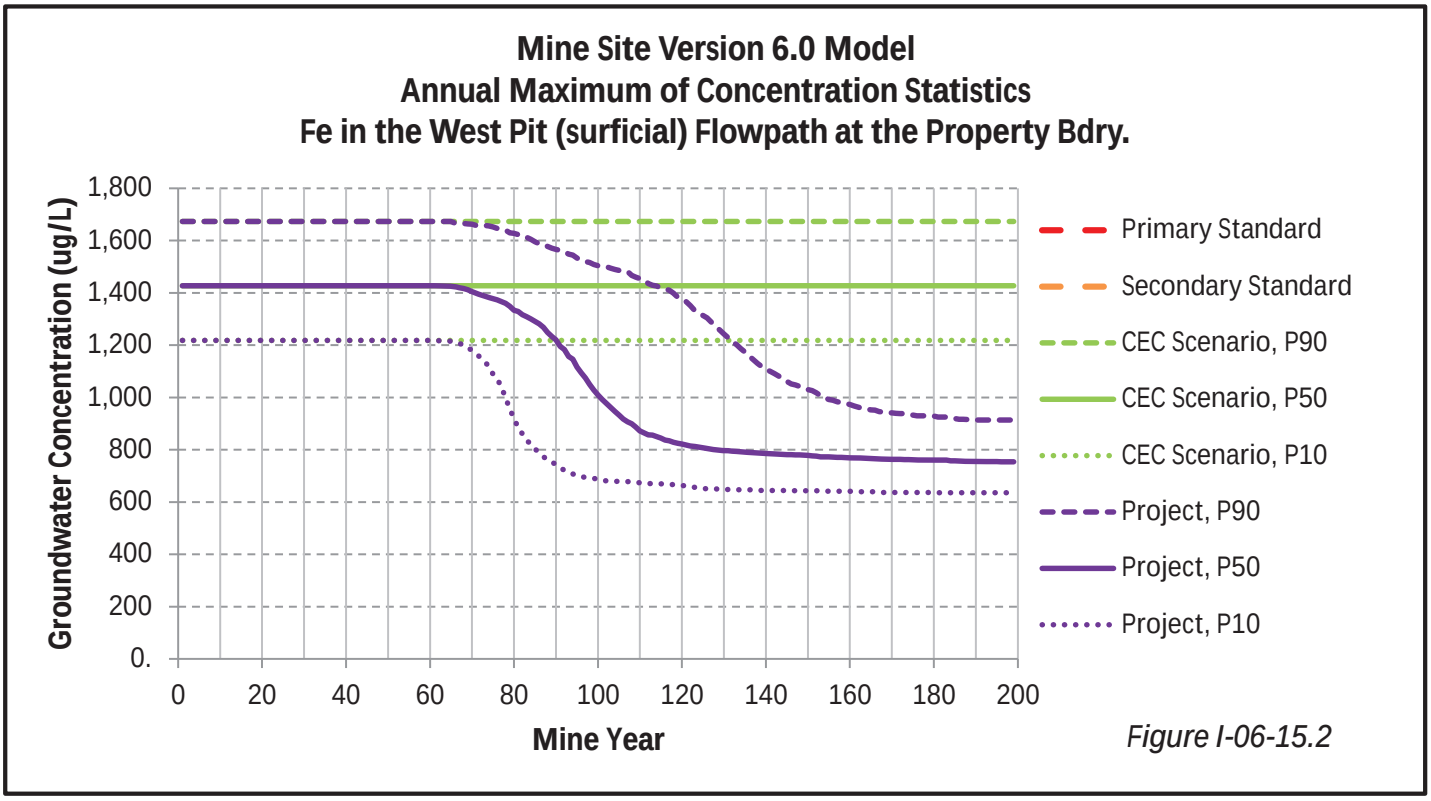

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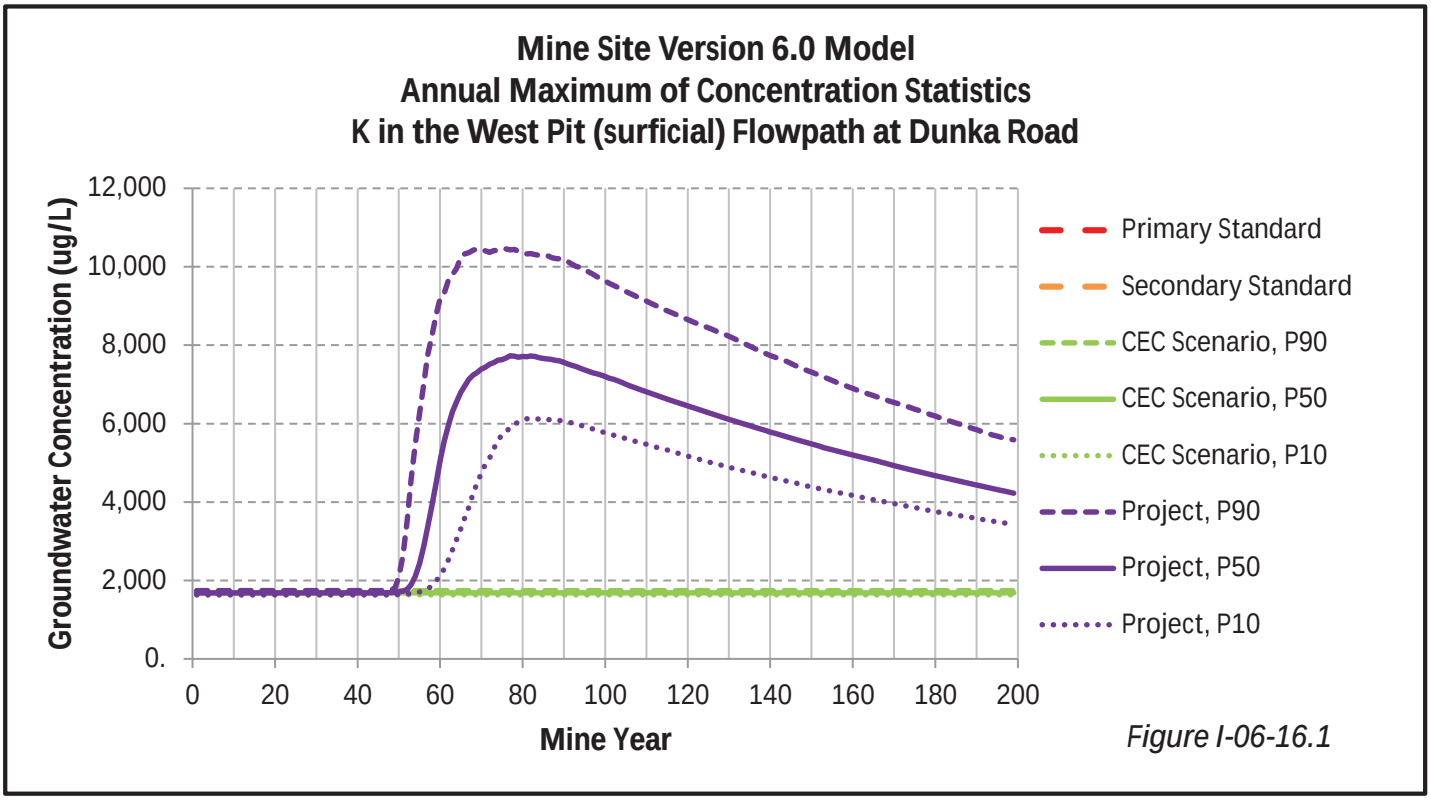

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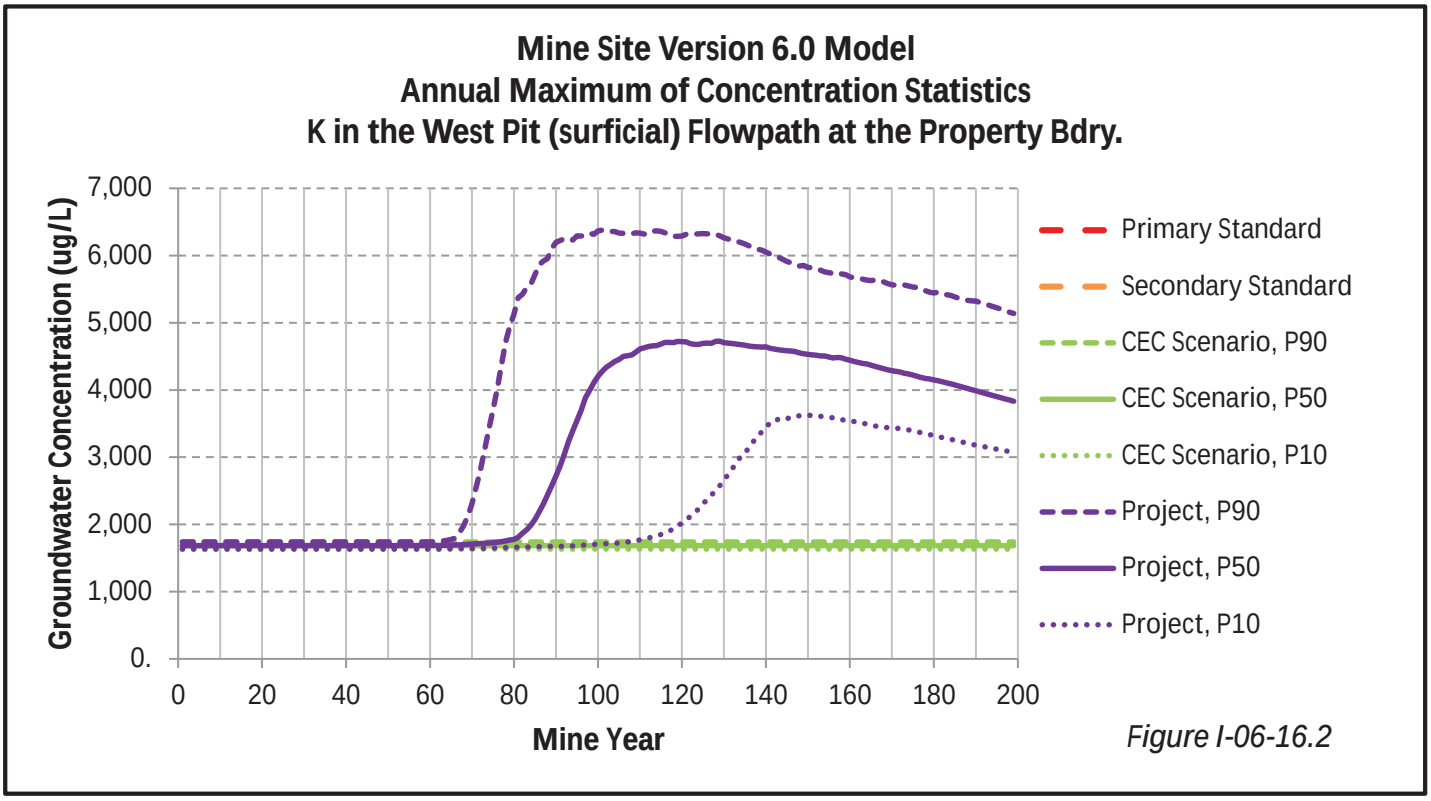

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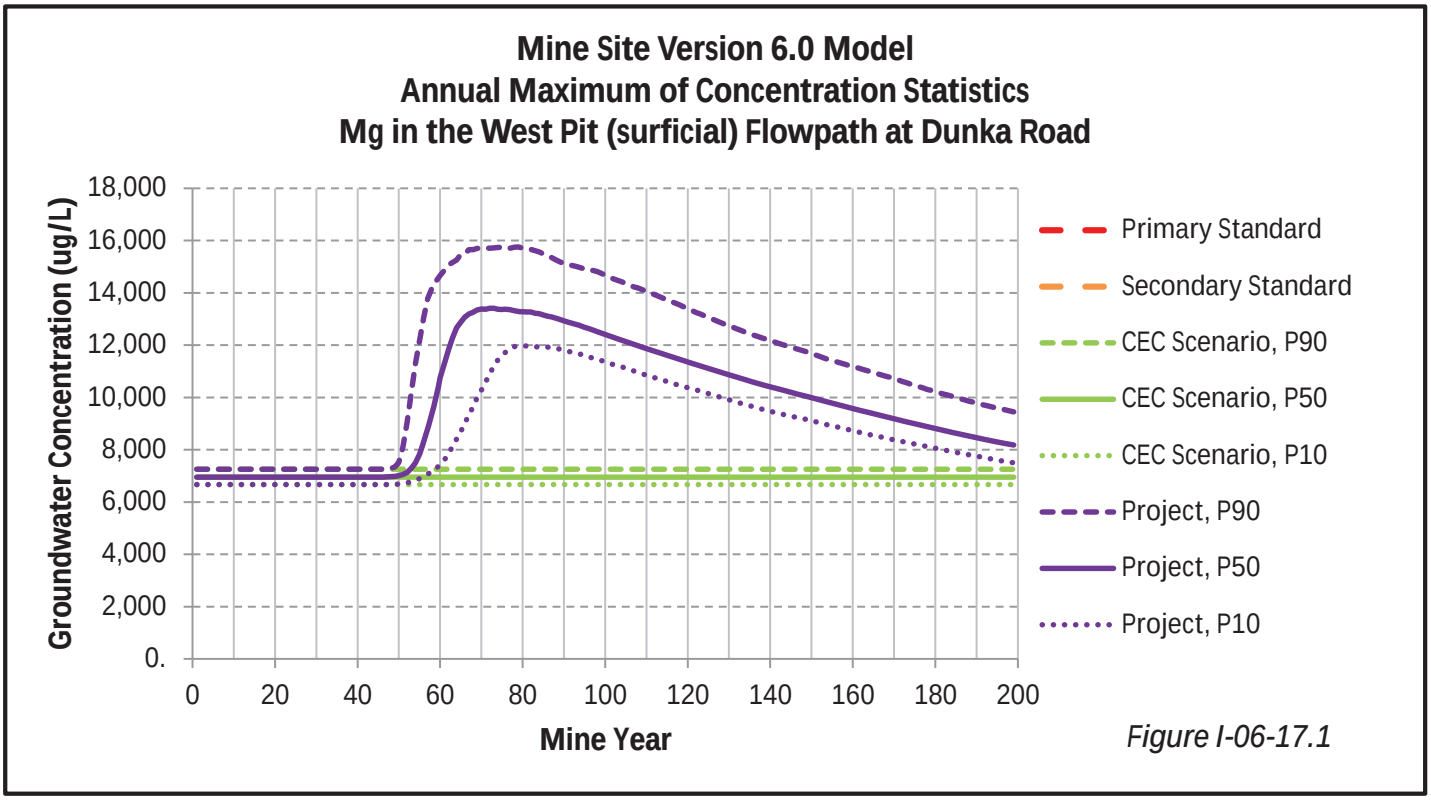

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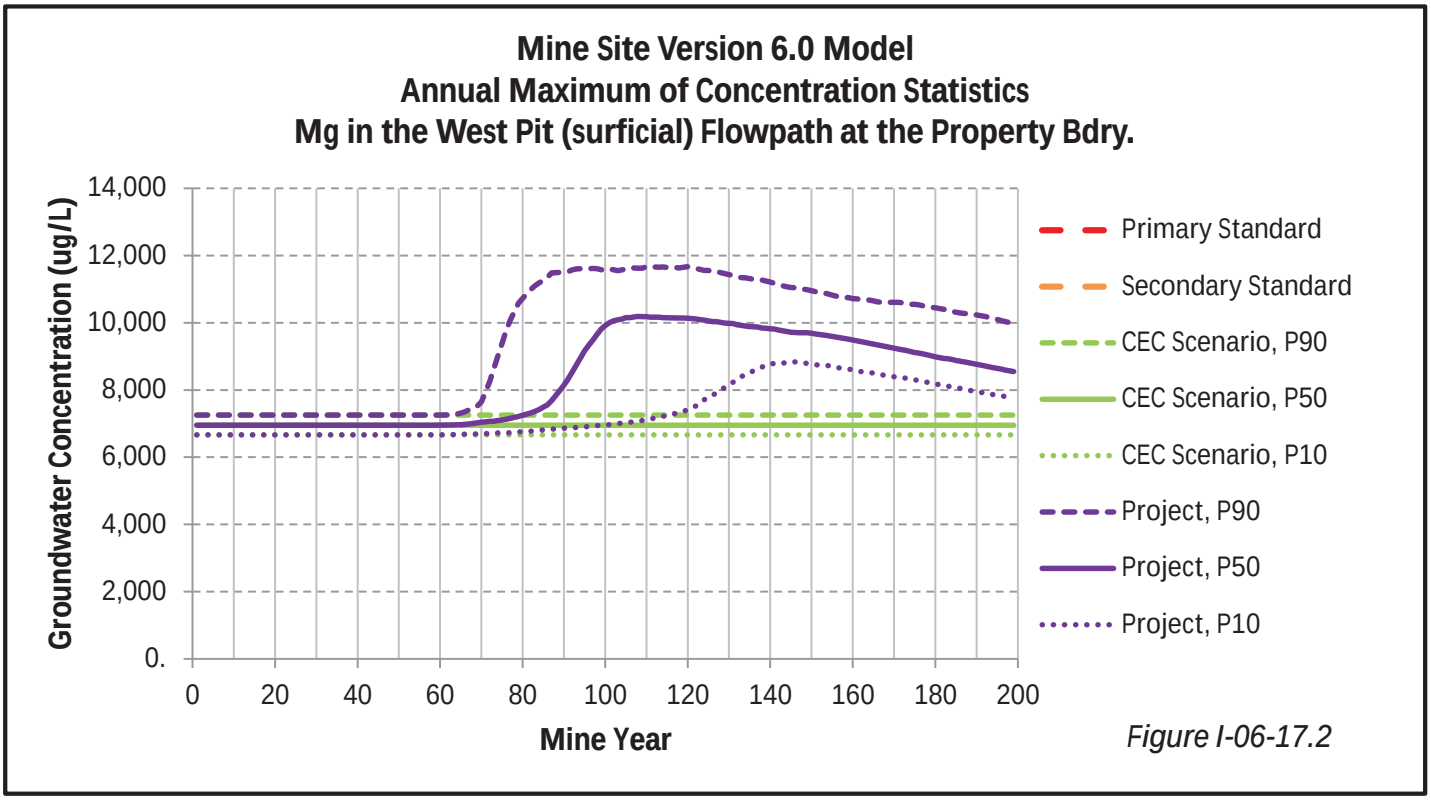

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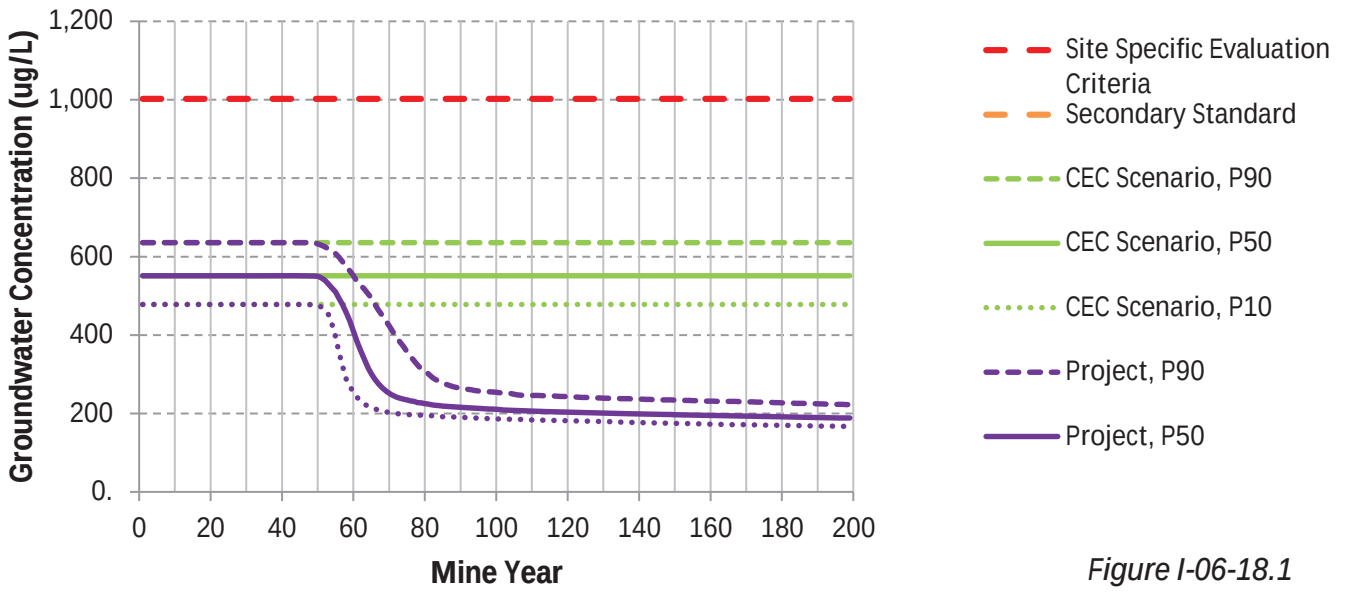

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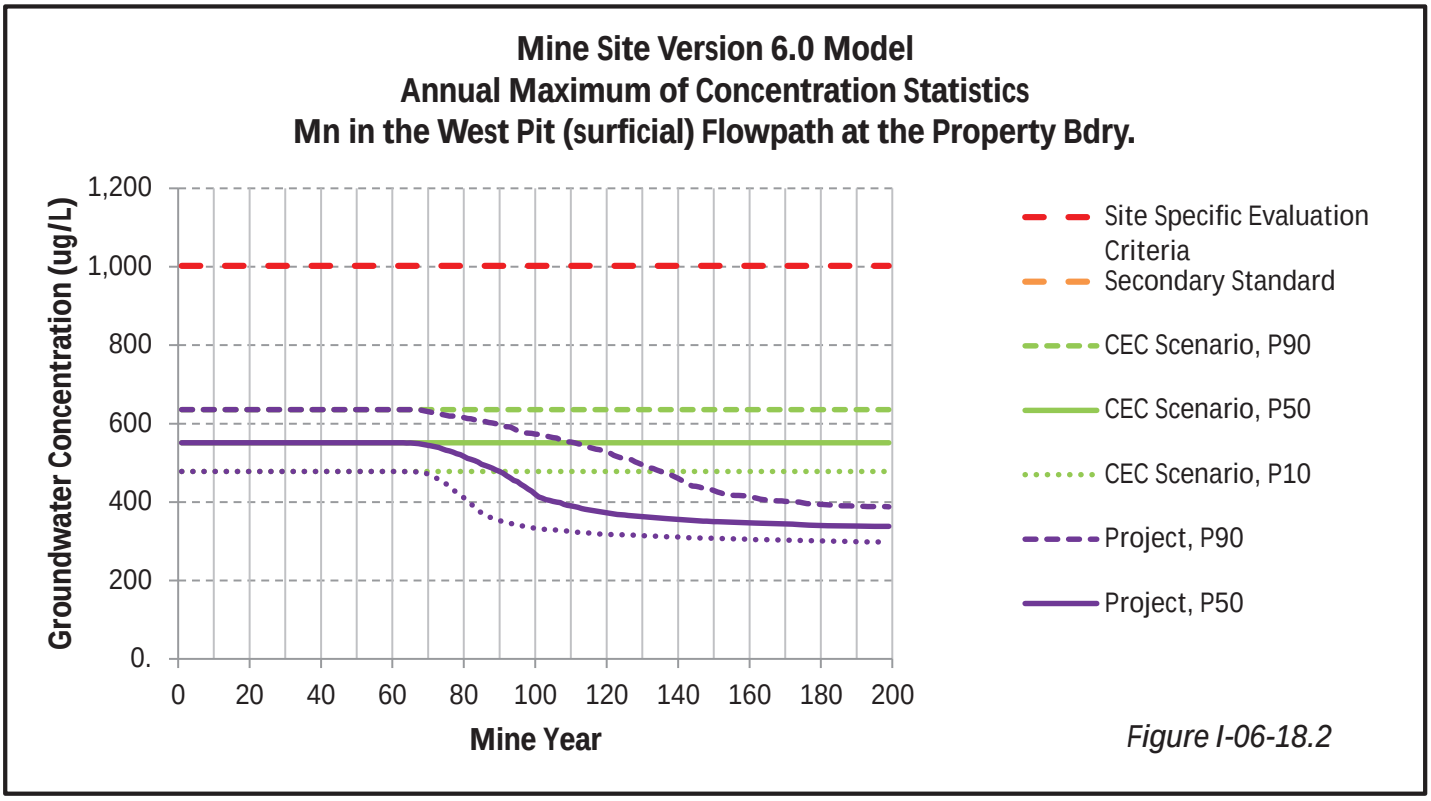

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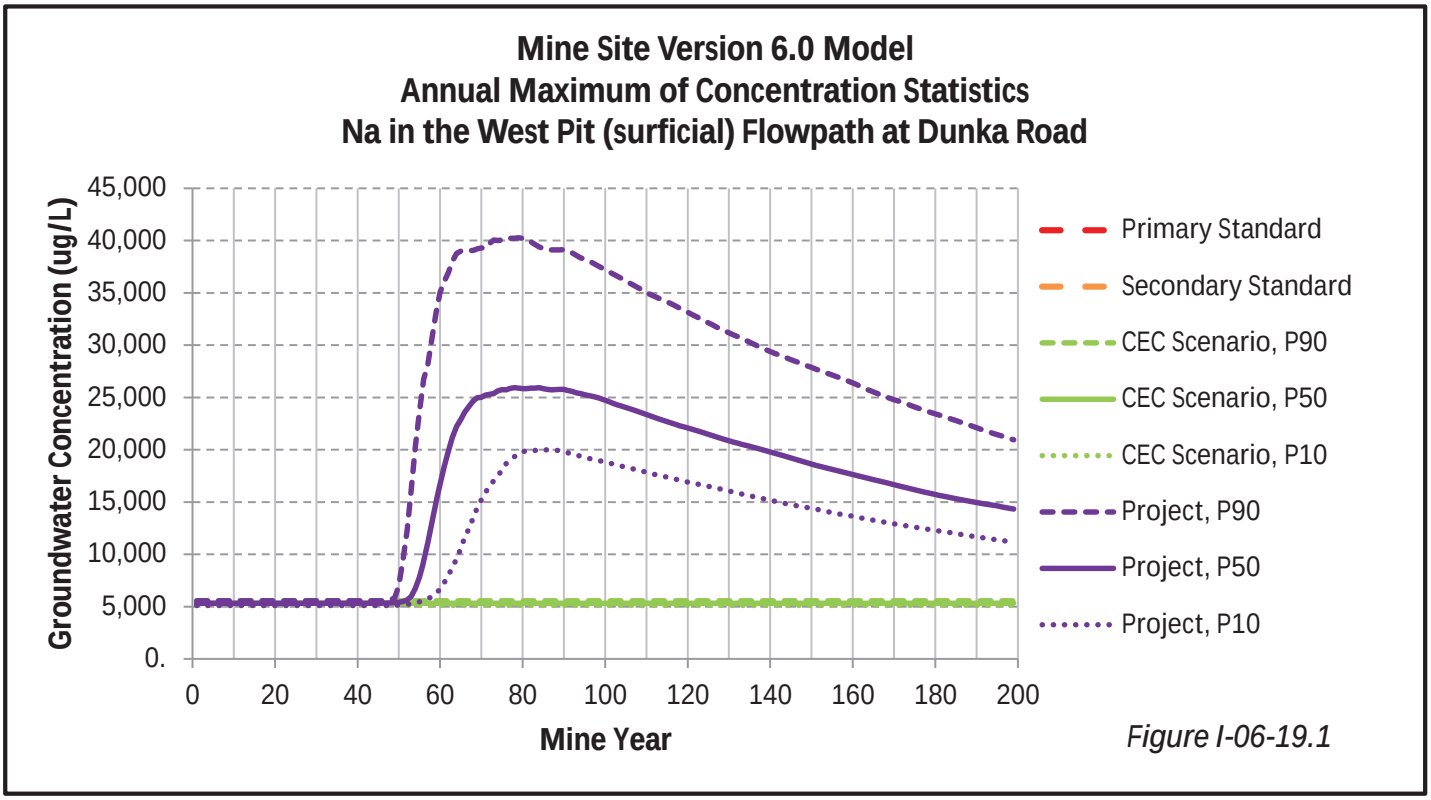

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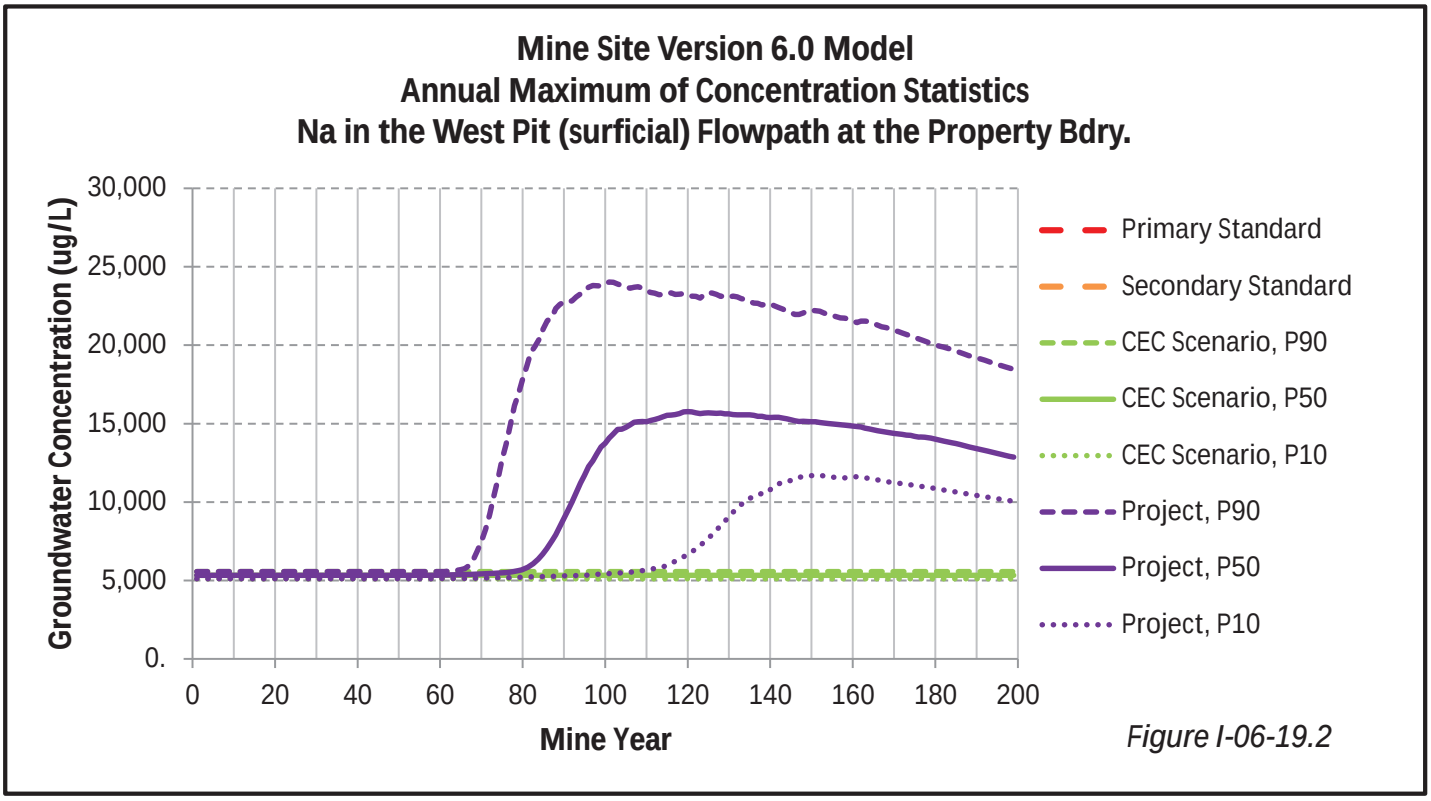

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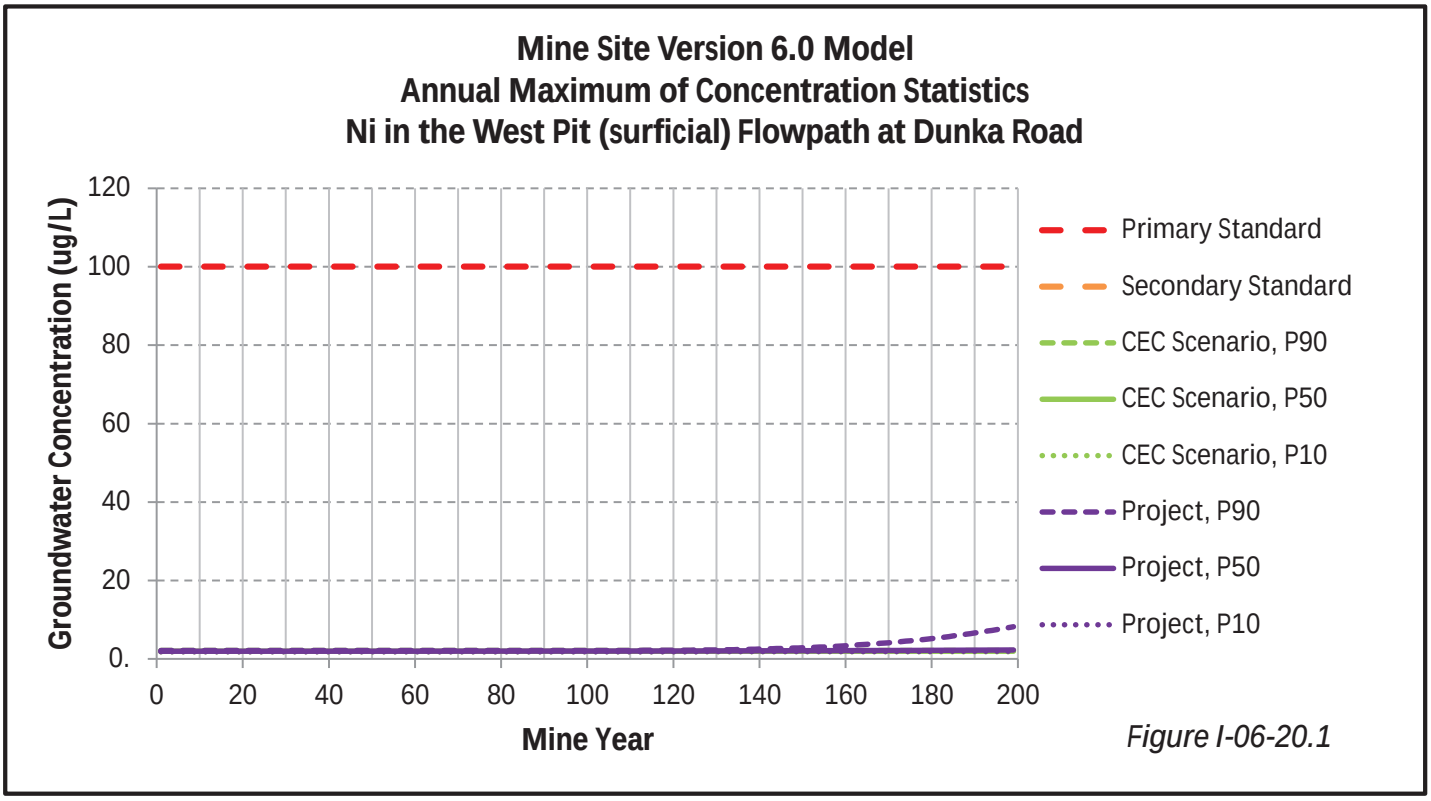

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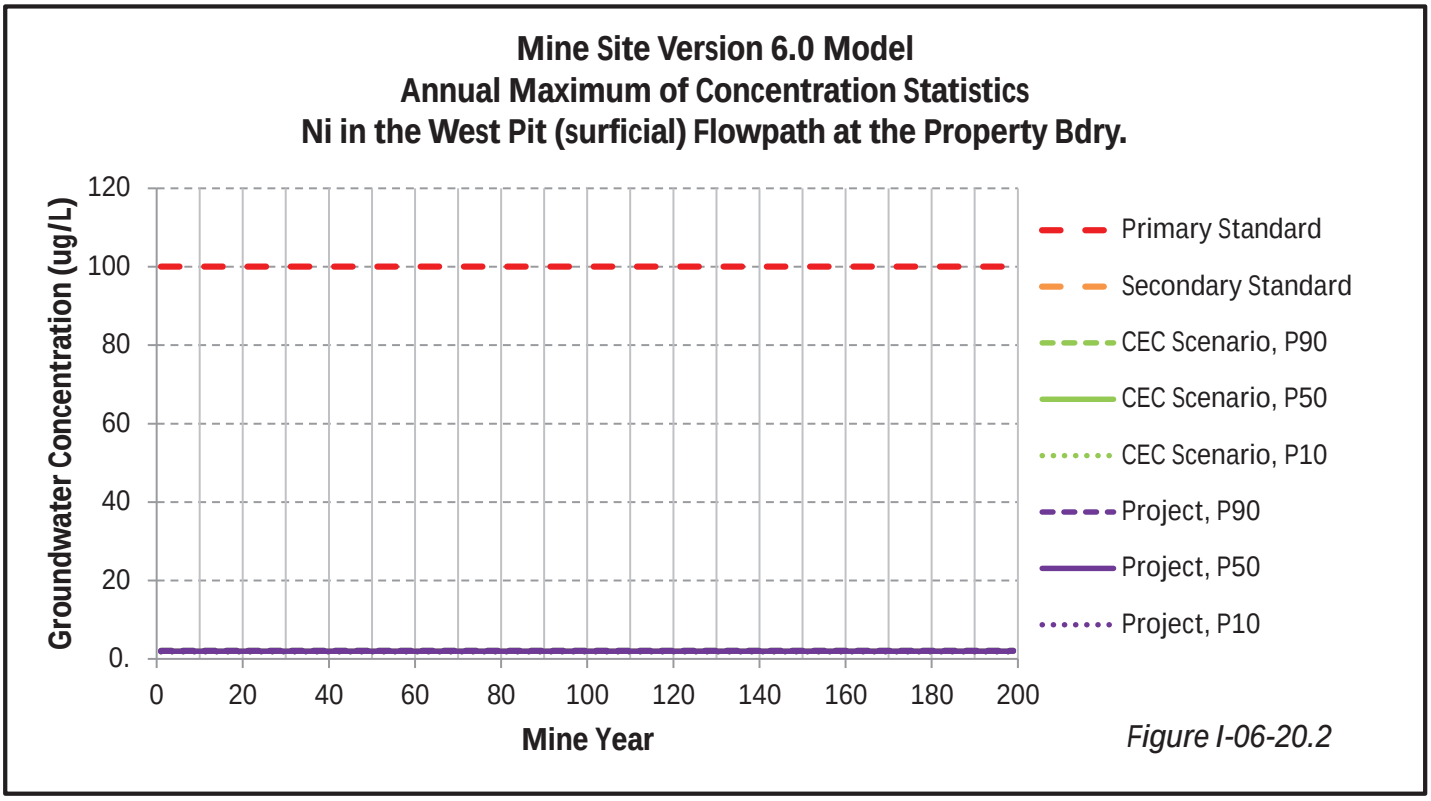

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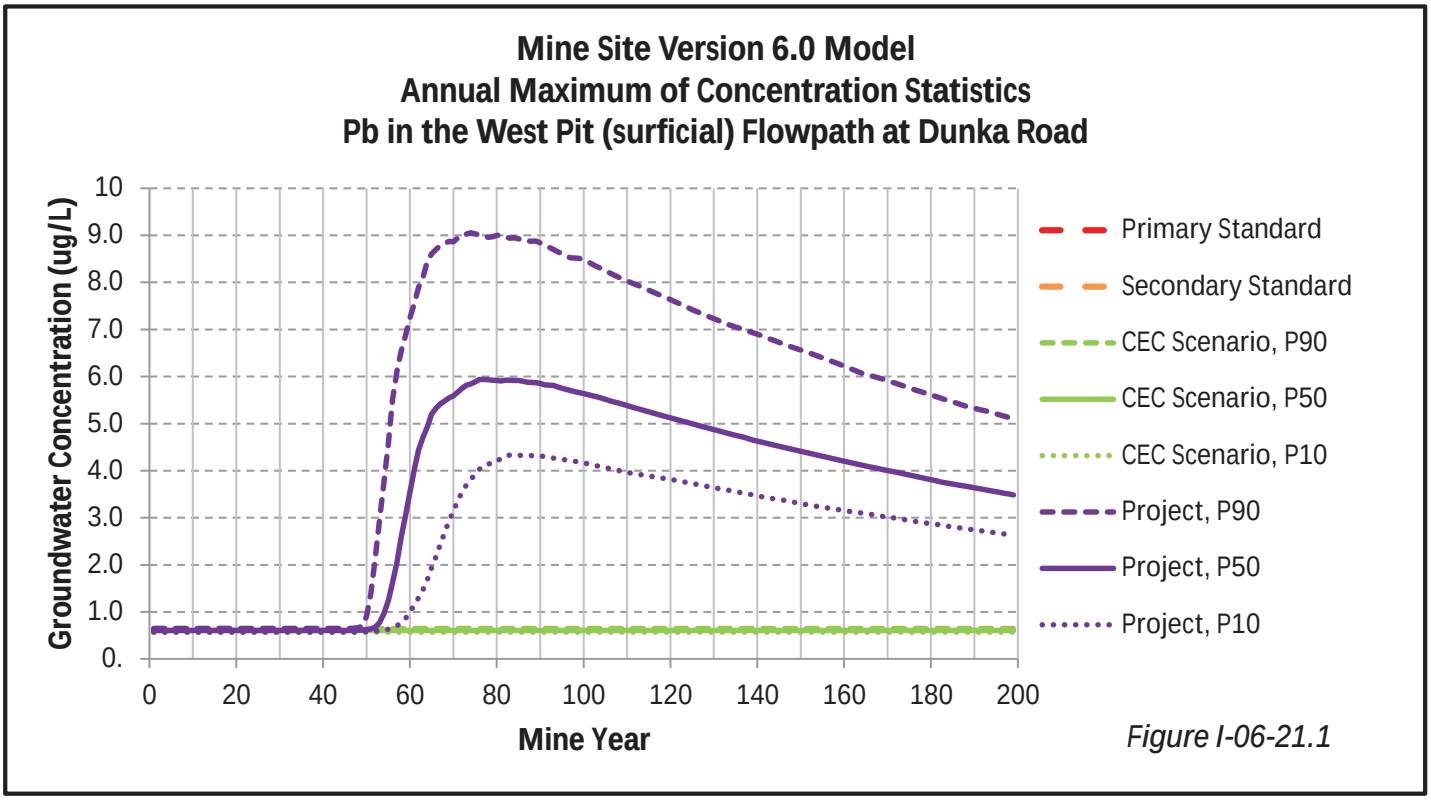

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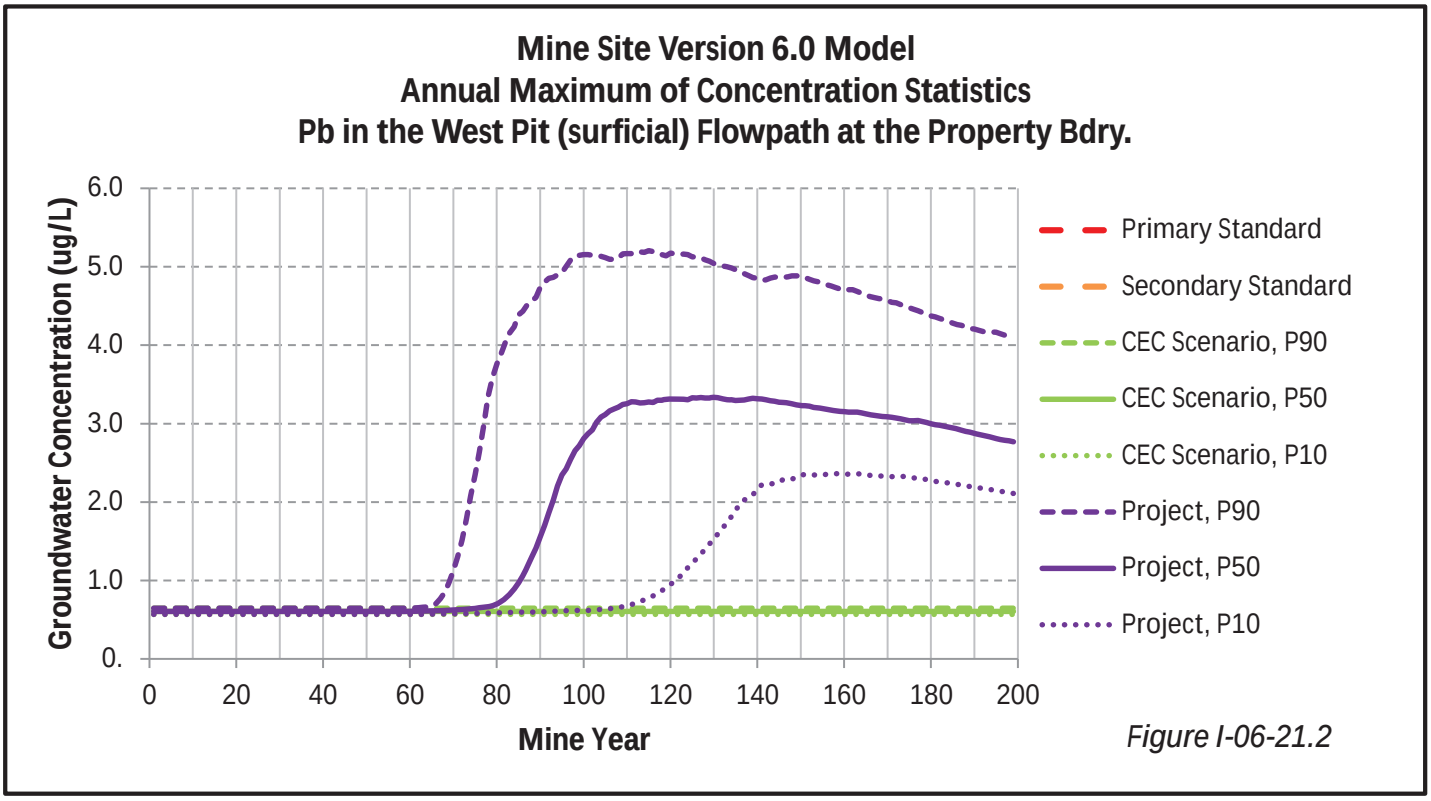

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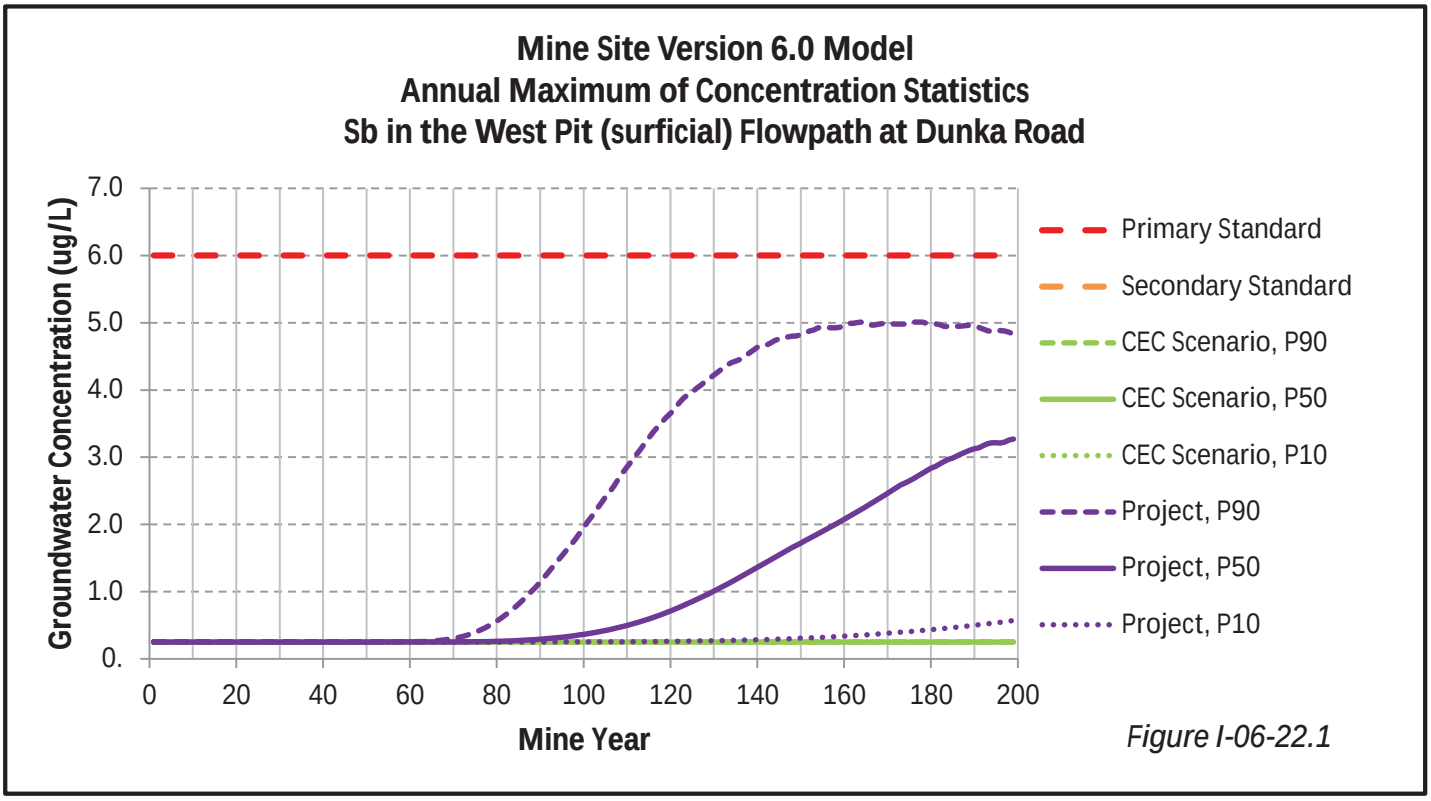

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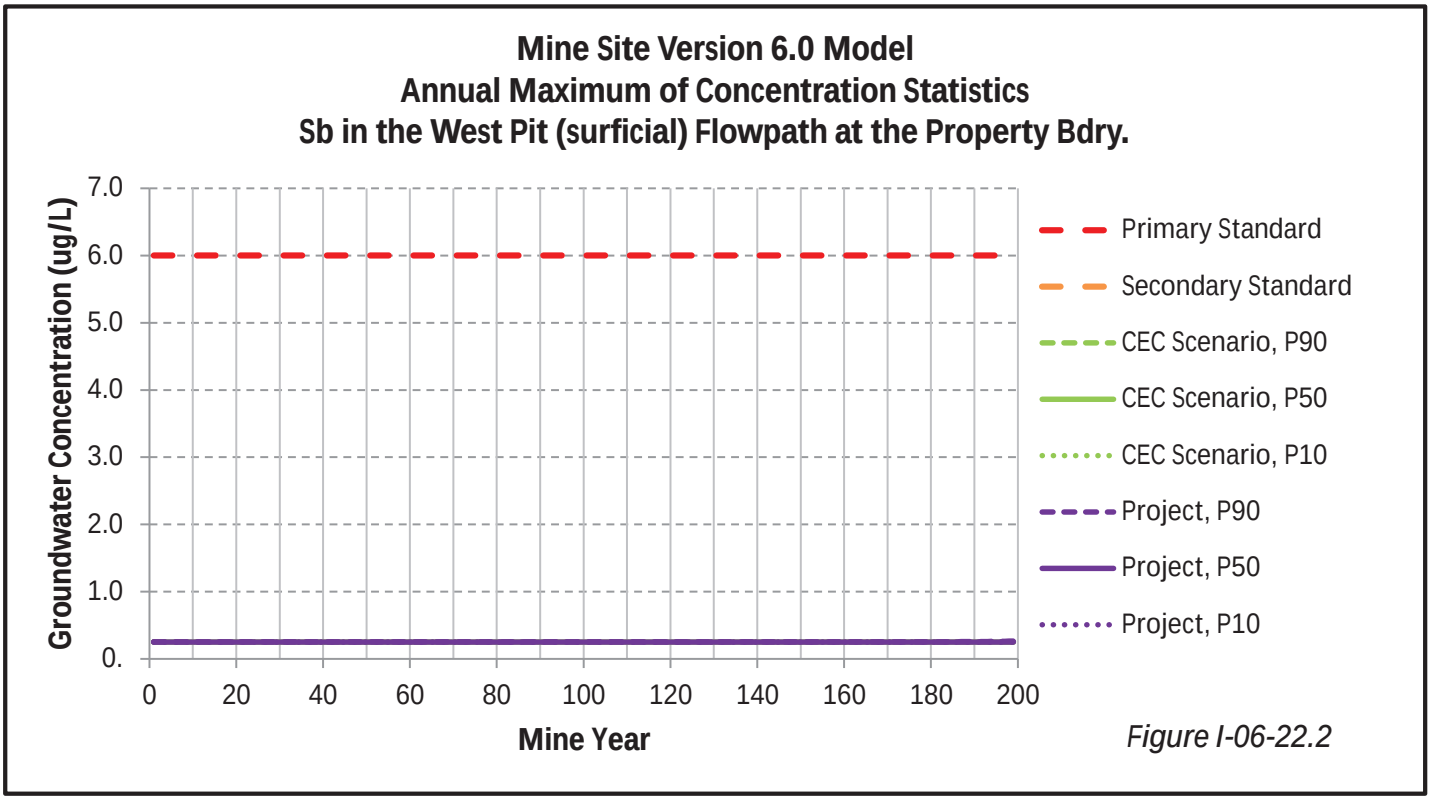

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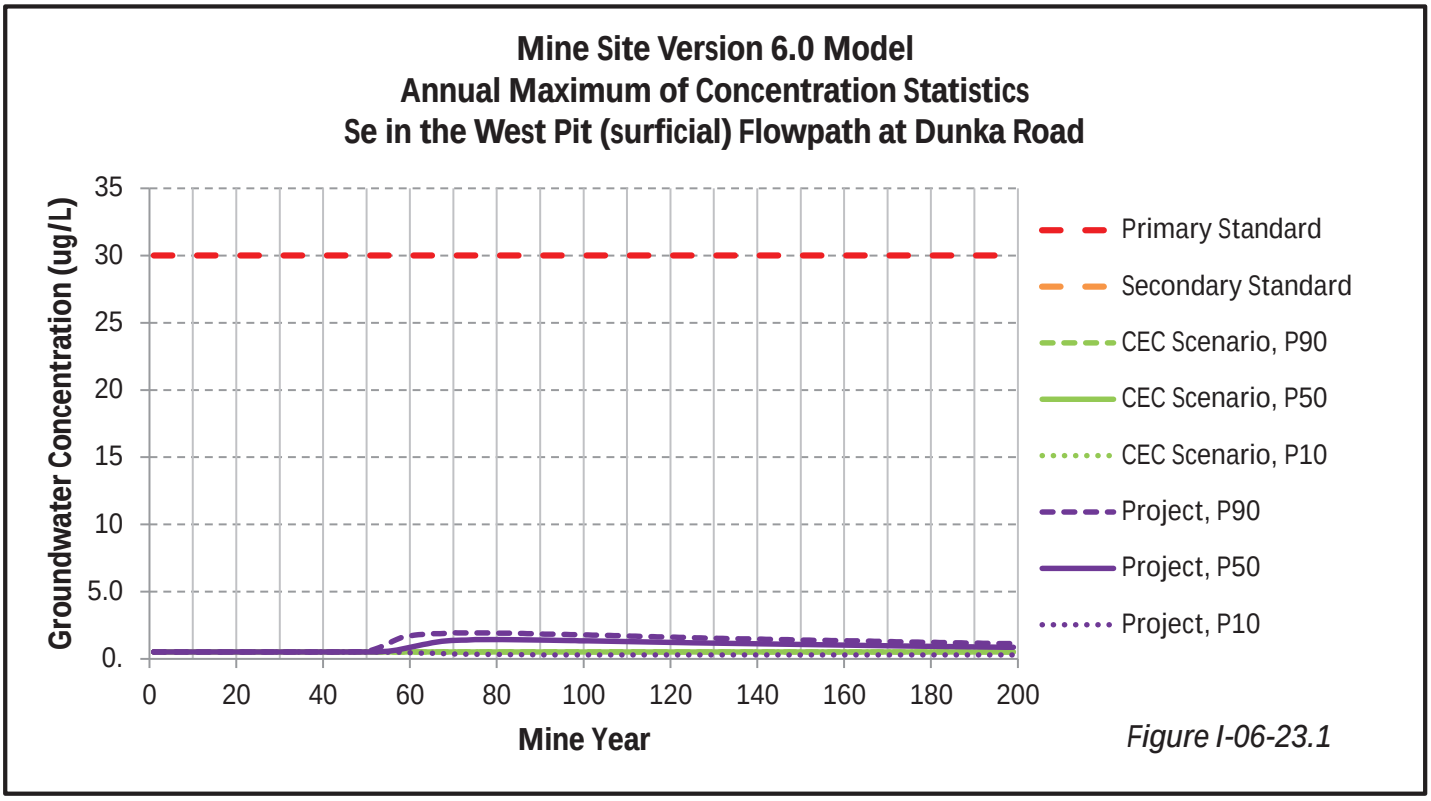

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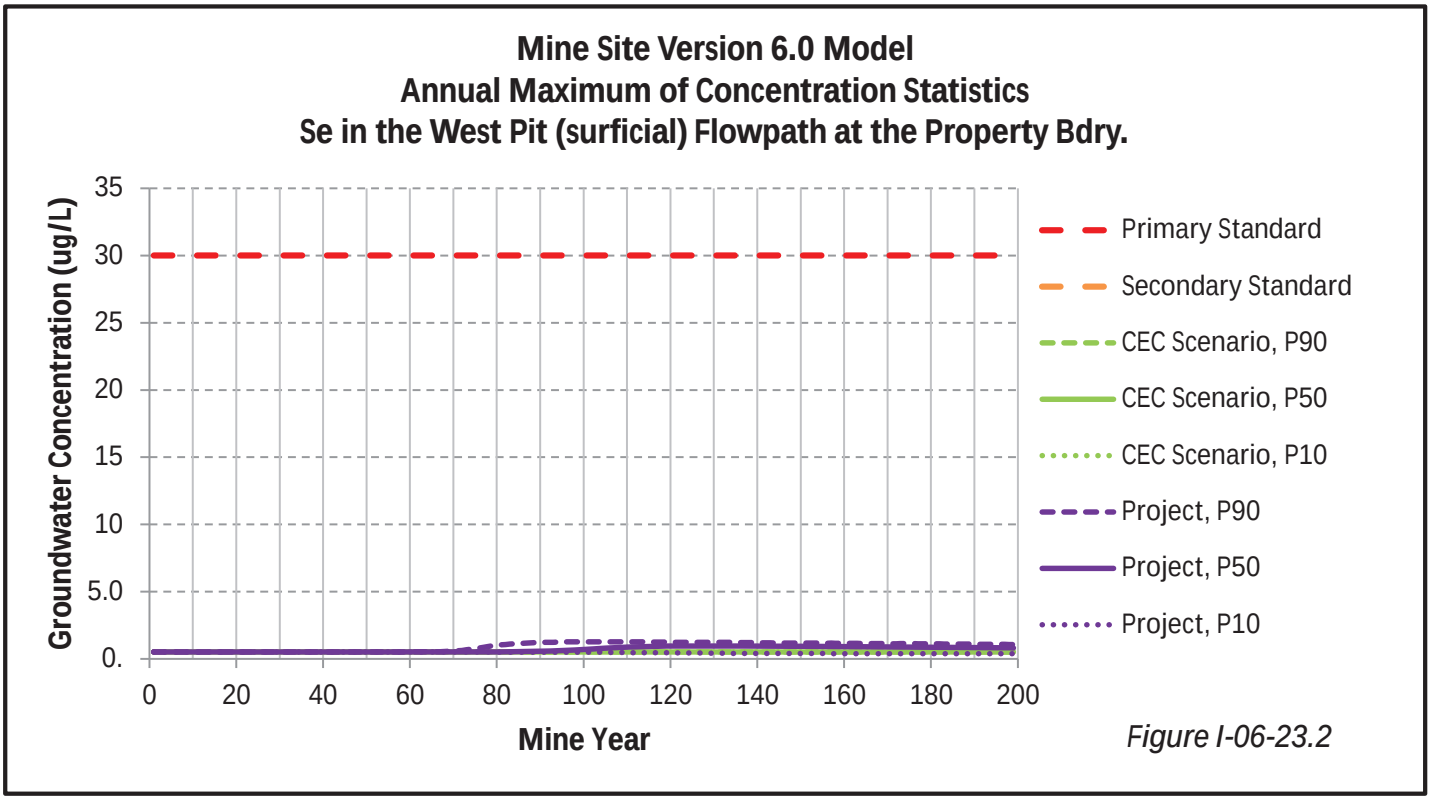

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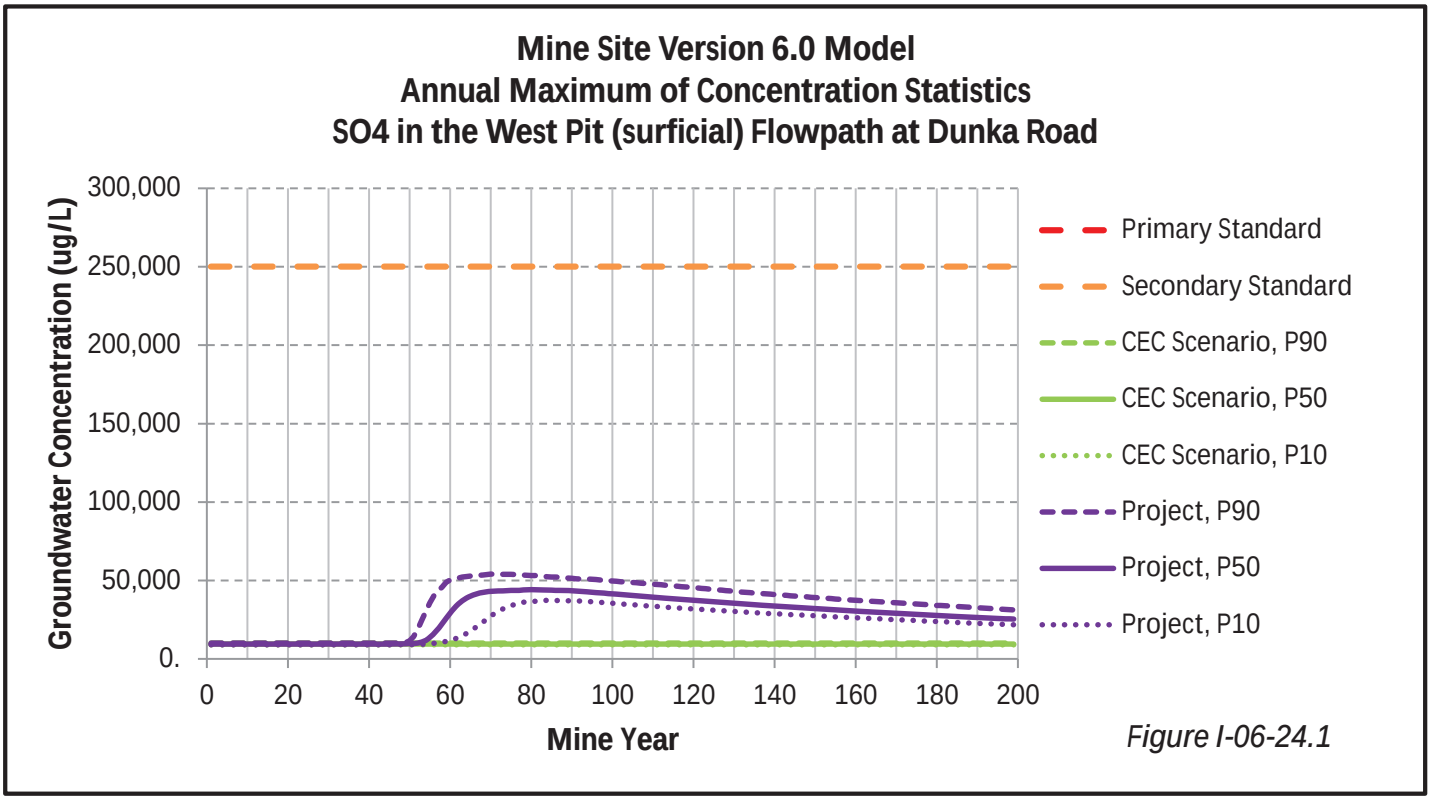

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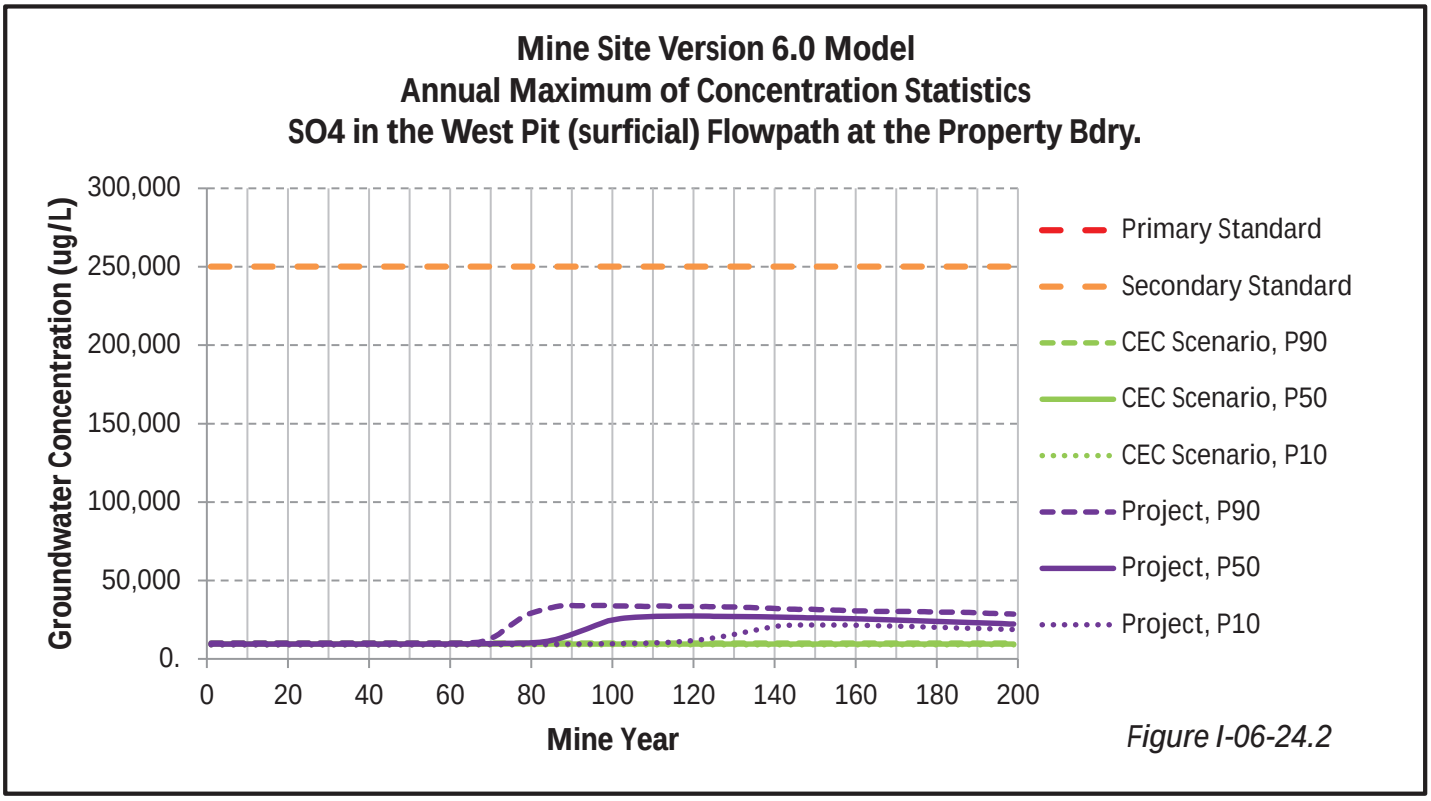

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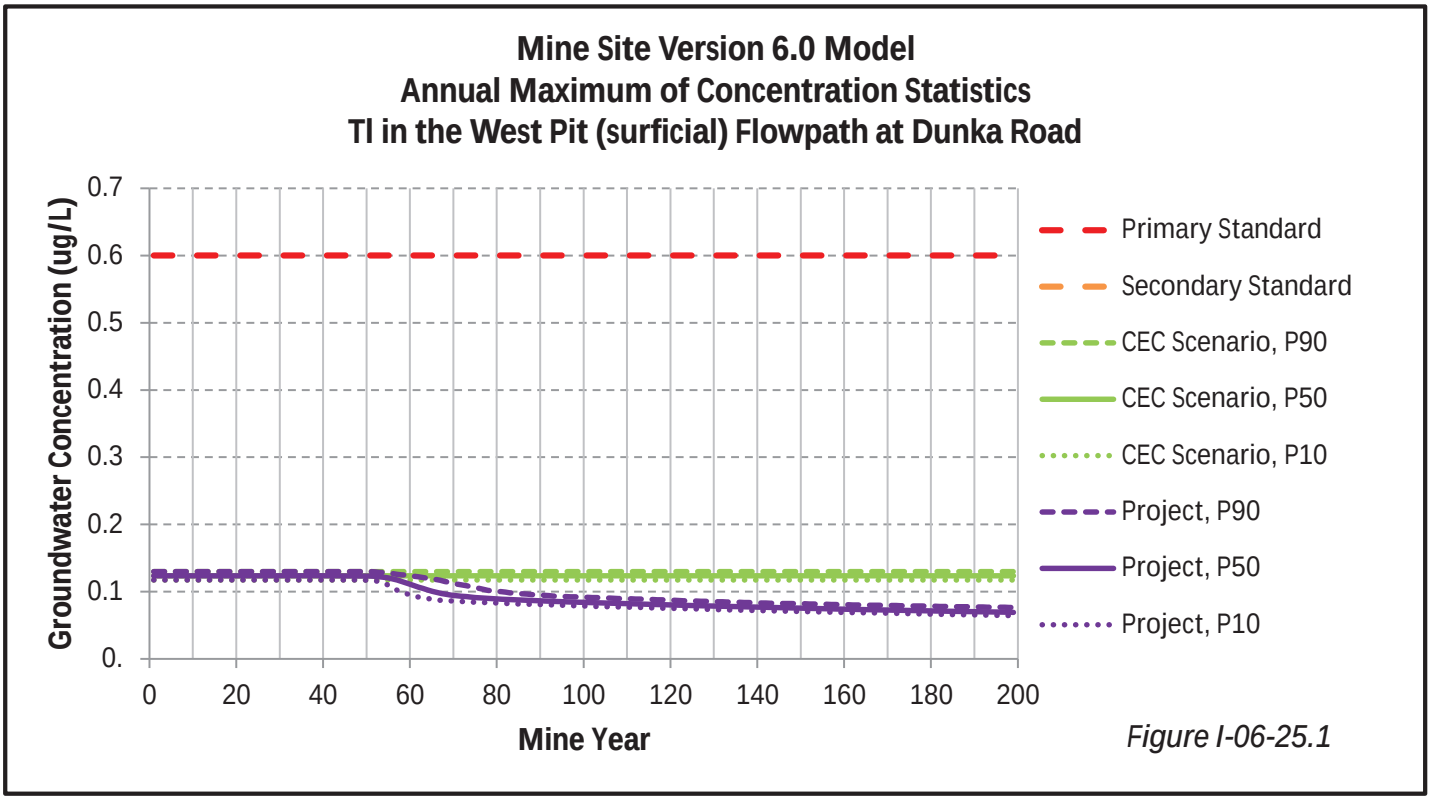

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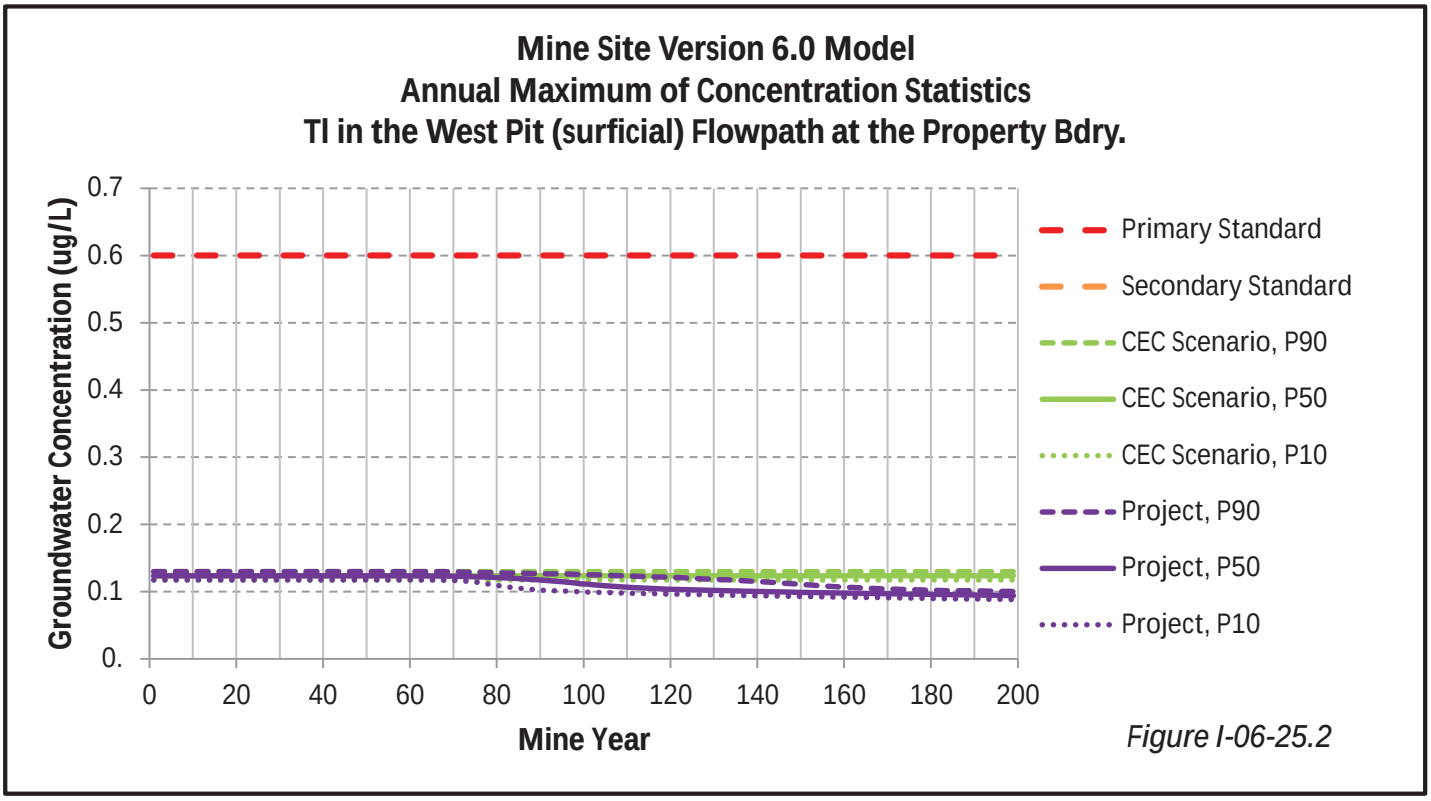

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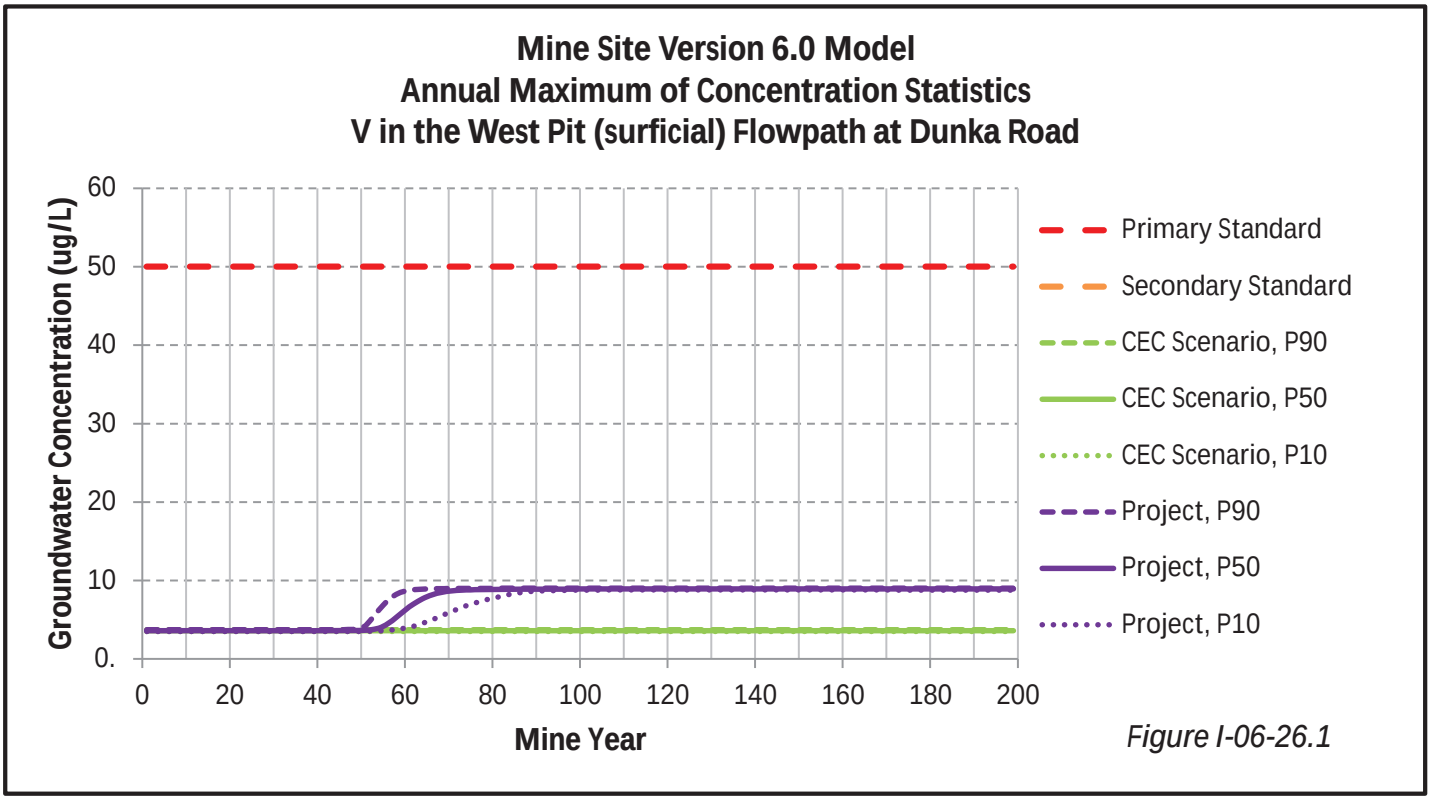

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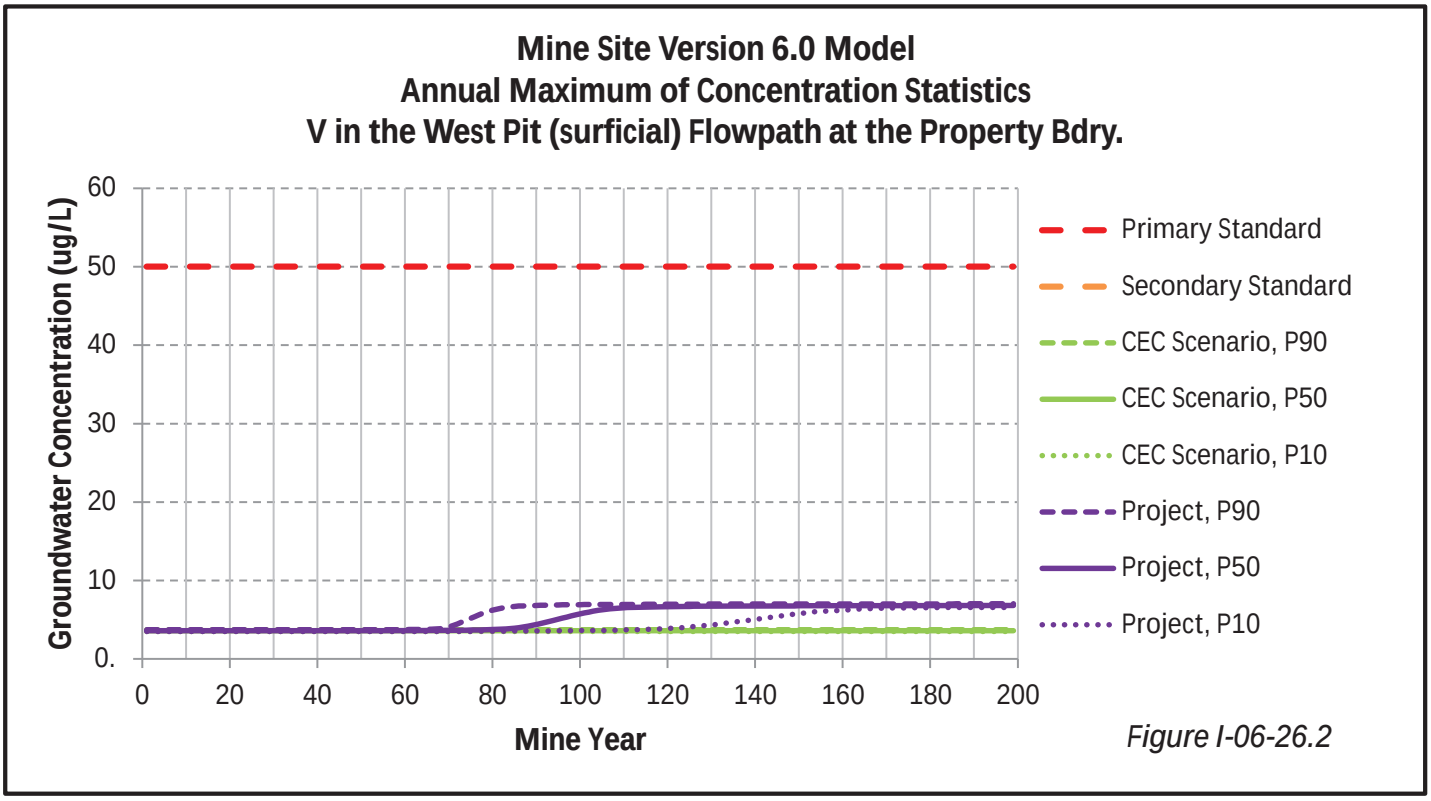

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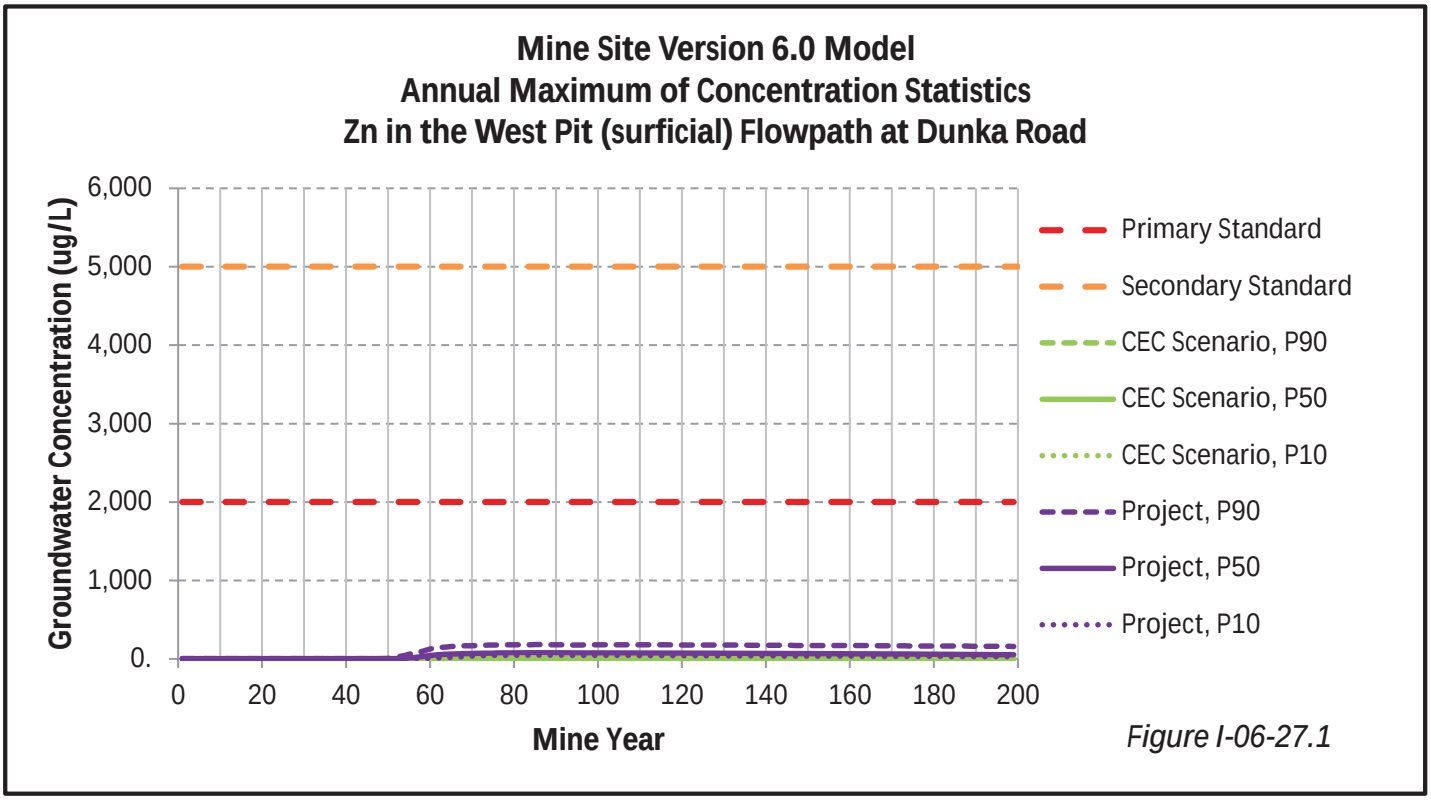

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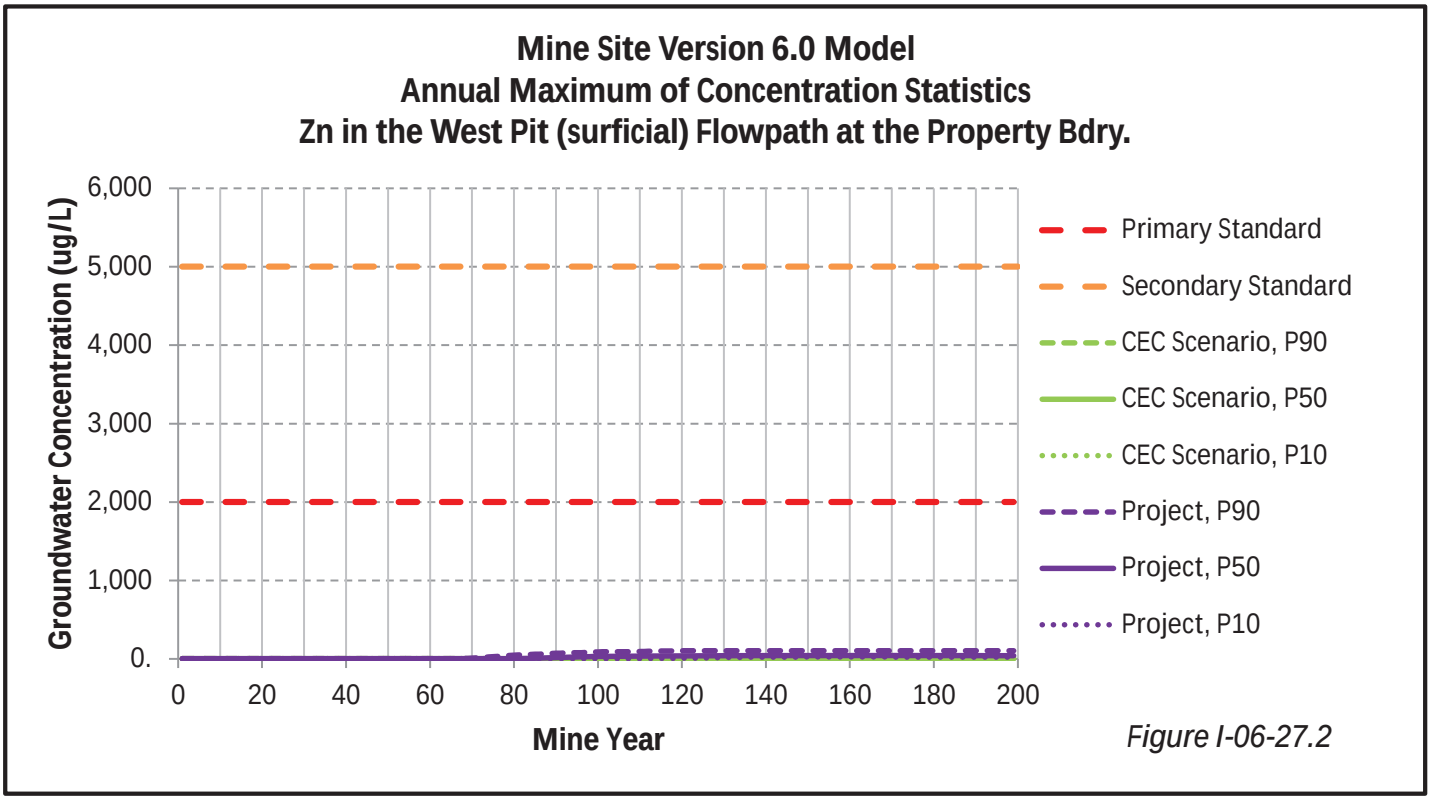

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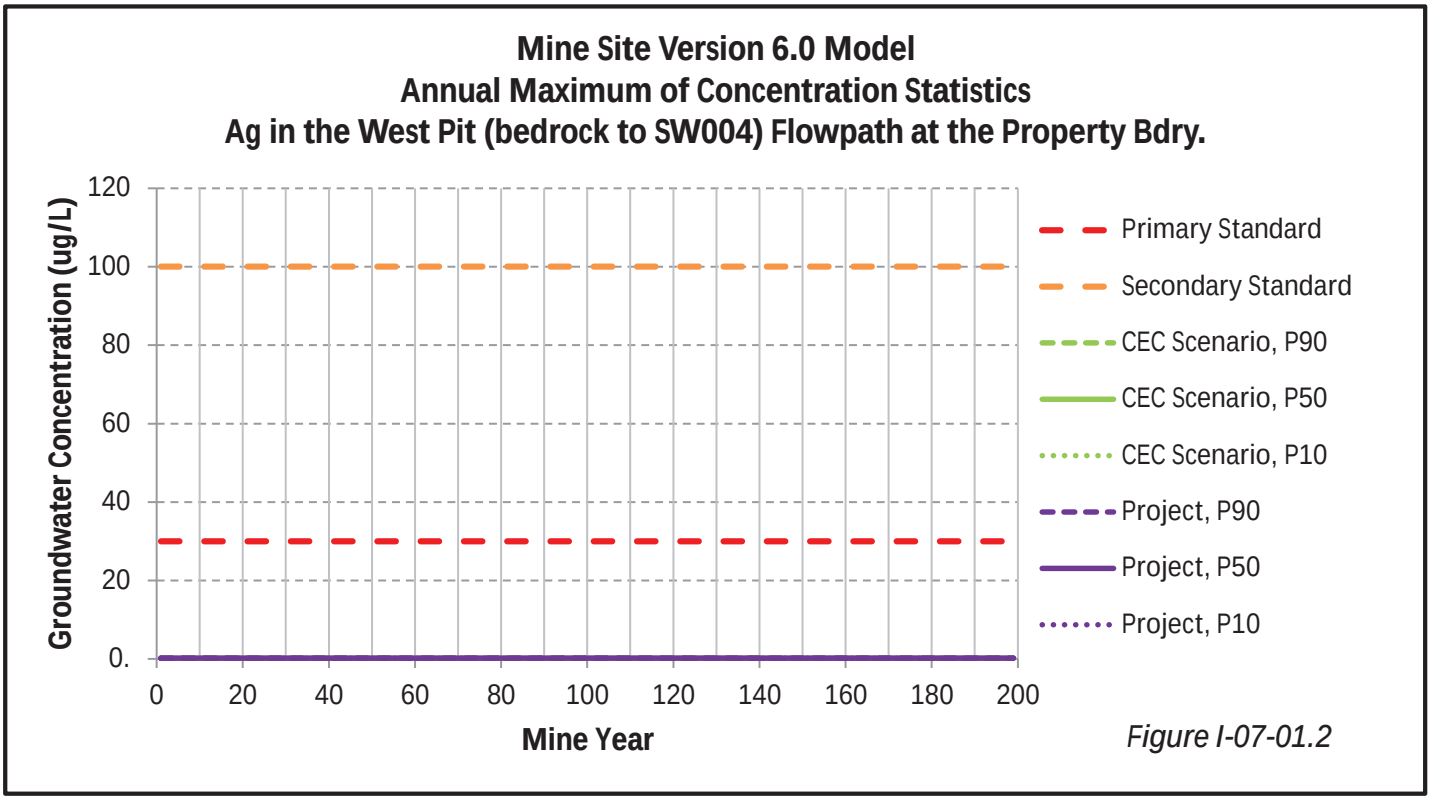

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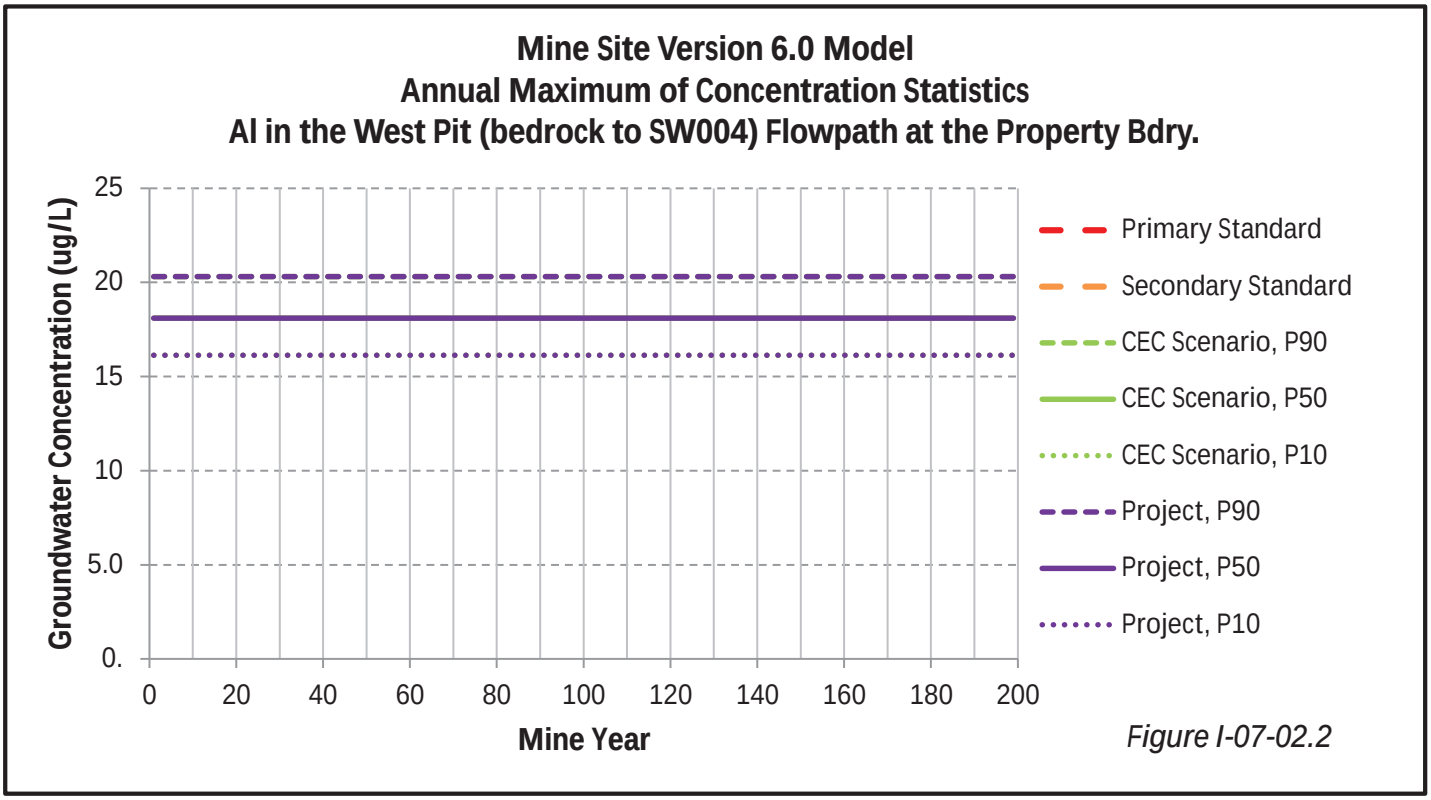

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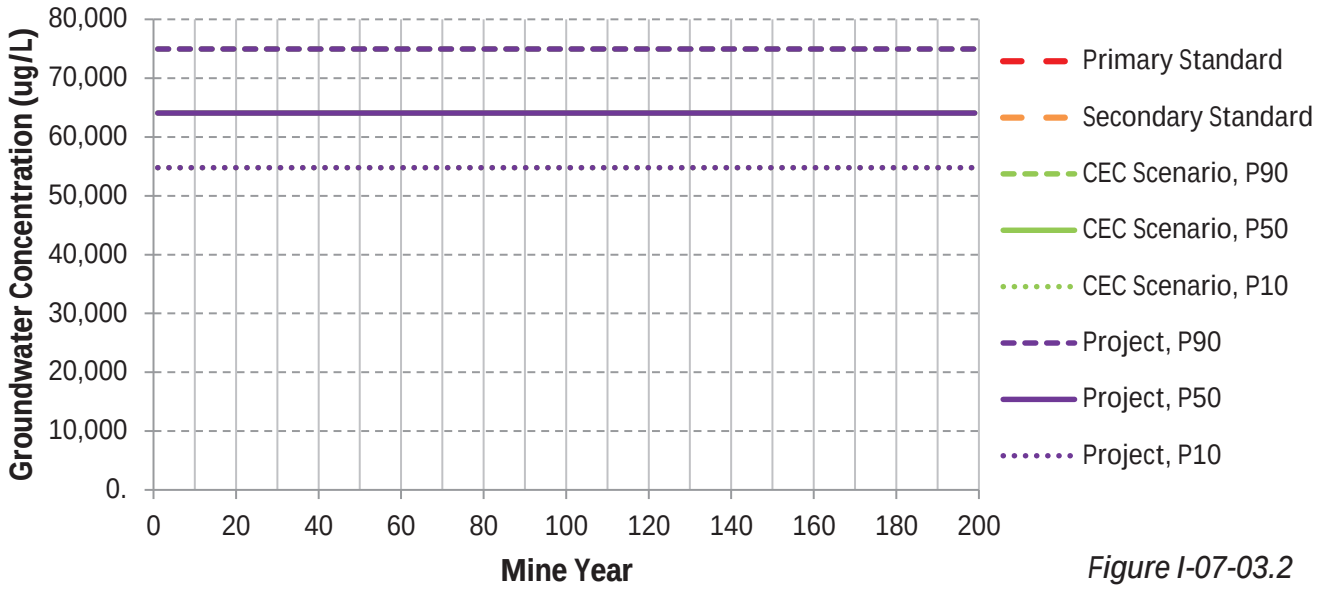
Mine Site Version 6.0 Model
Annual Maximum of Concentration Statistics
Alkalinity in the West Pit (bedrock to SW004) Flowpath at the Property Bdry.



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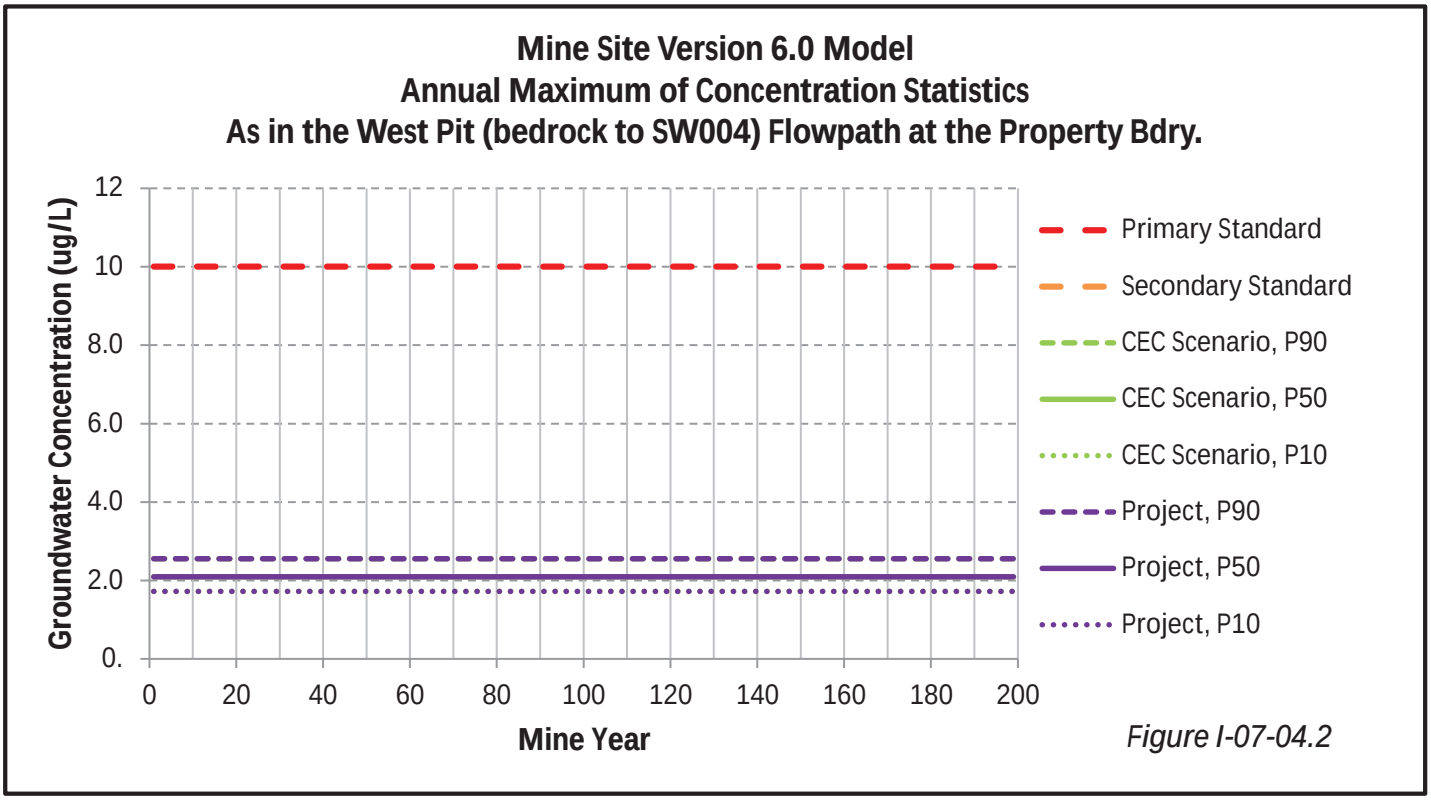

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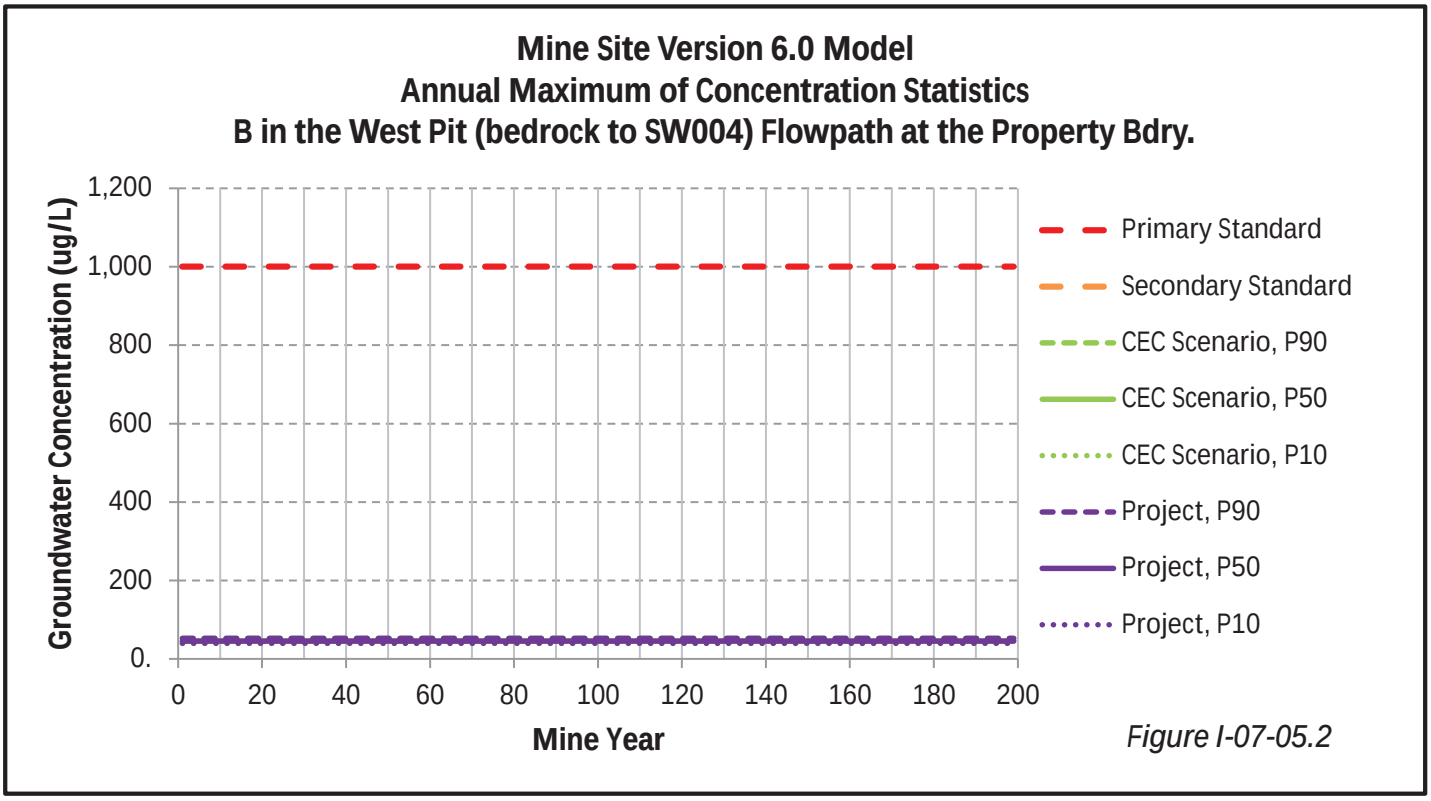

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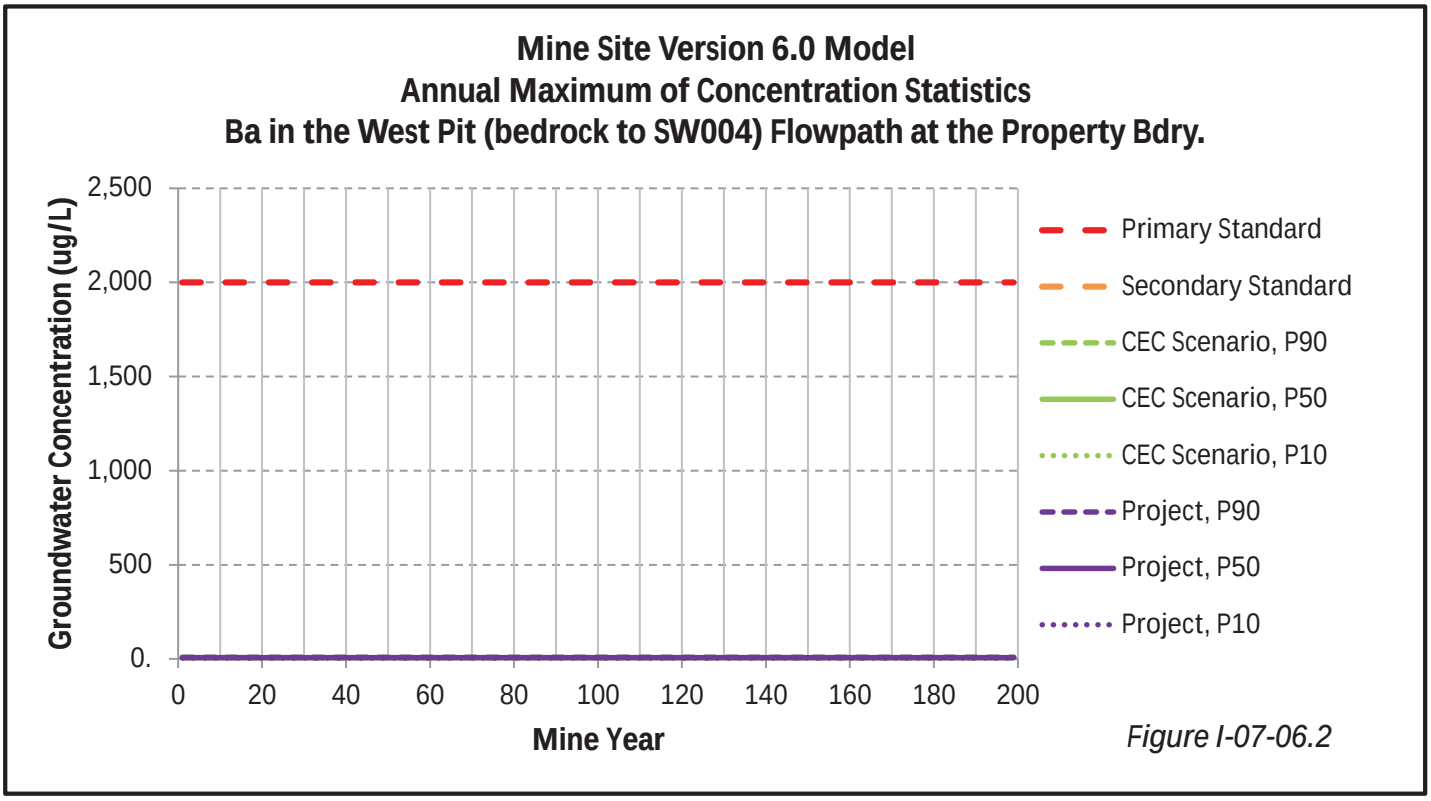

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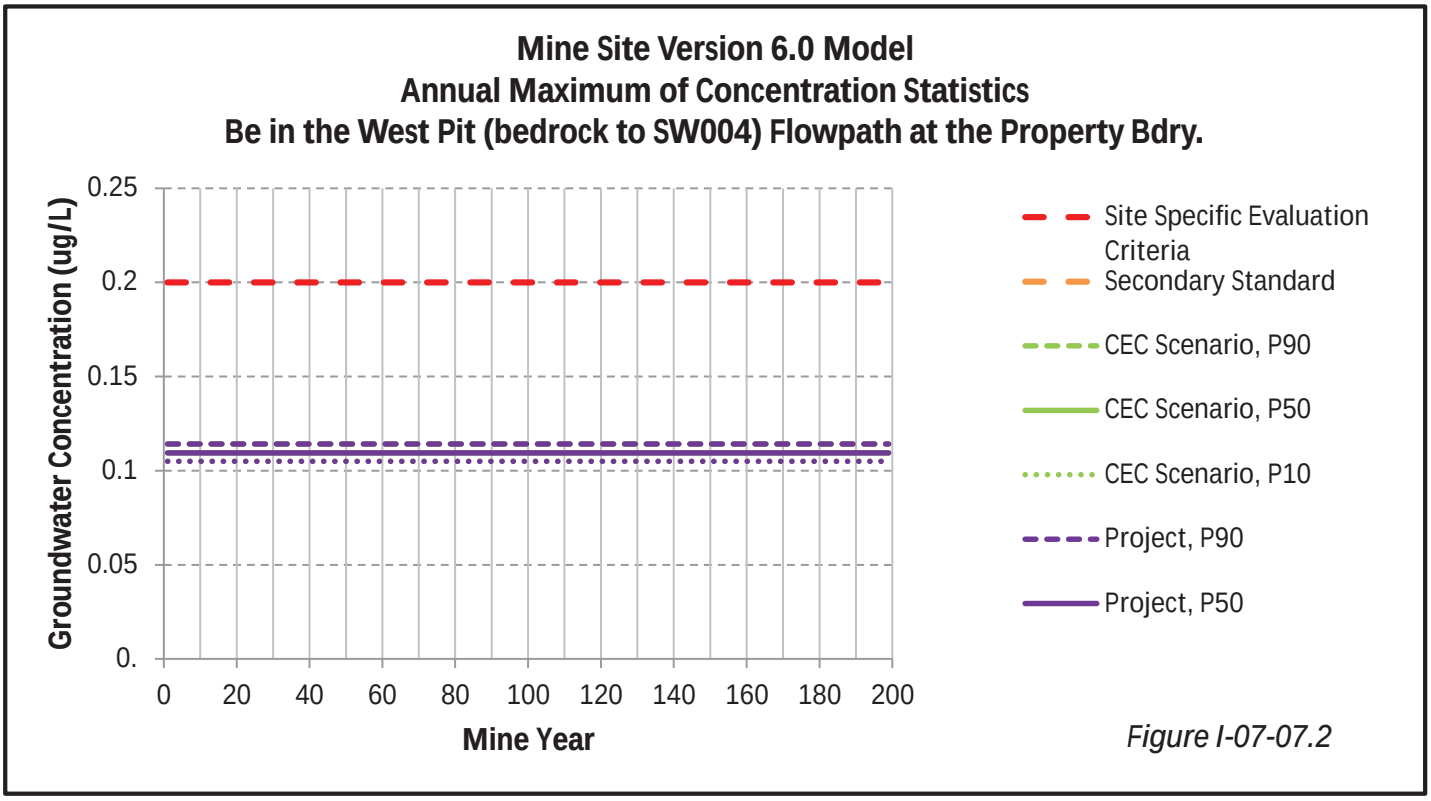

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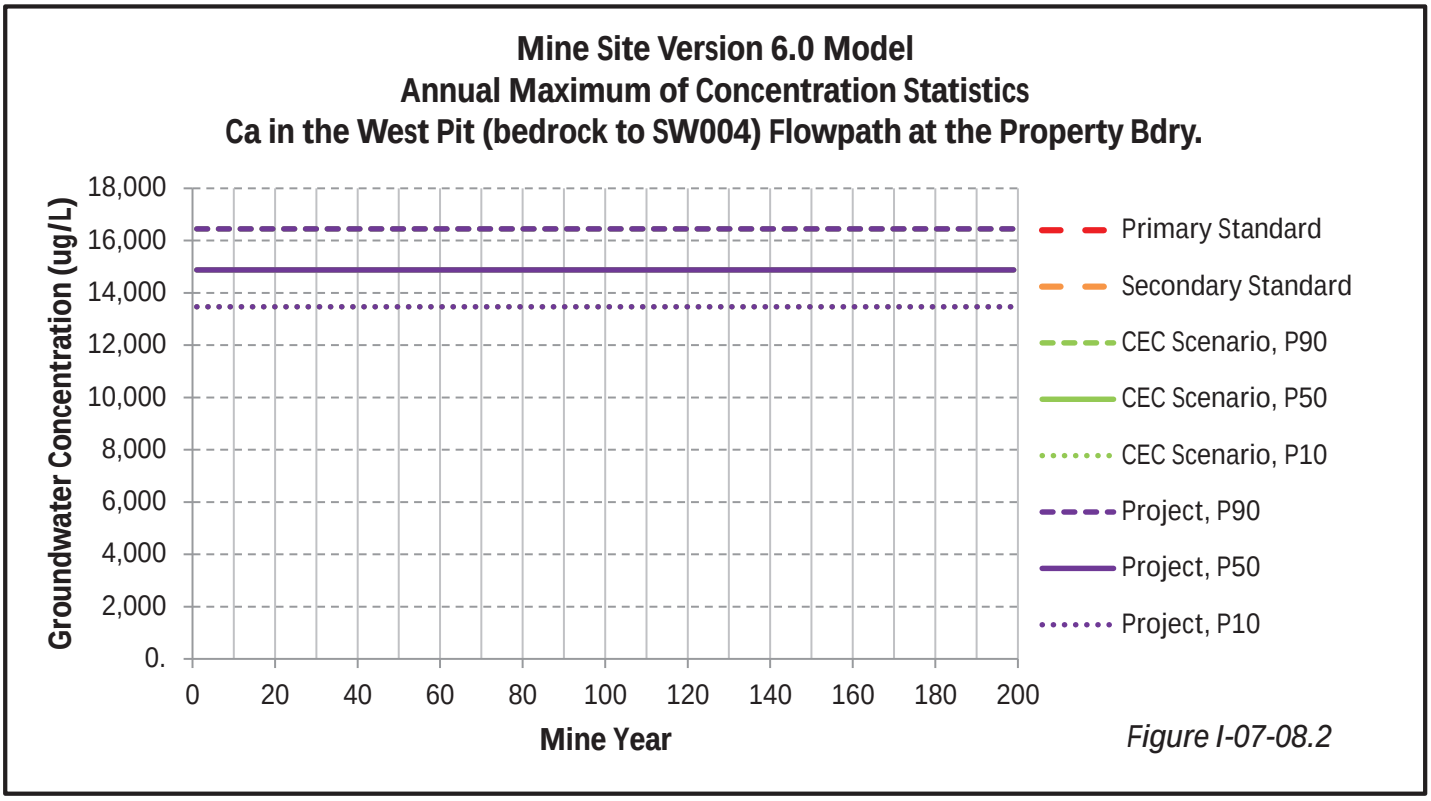

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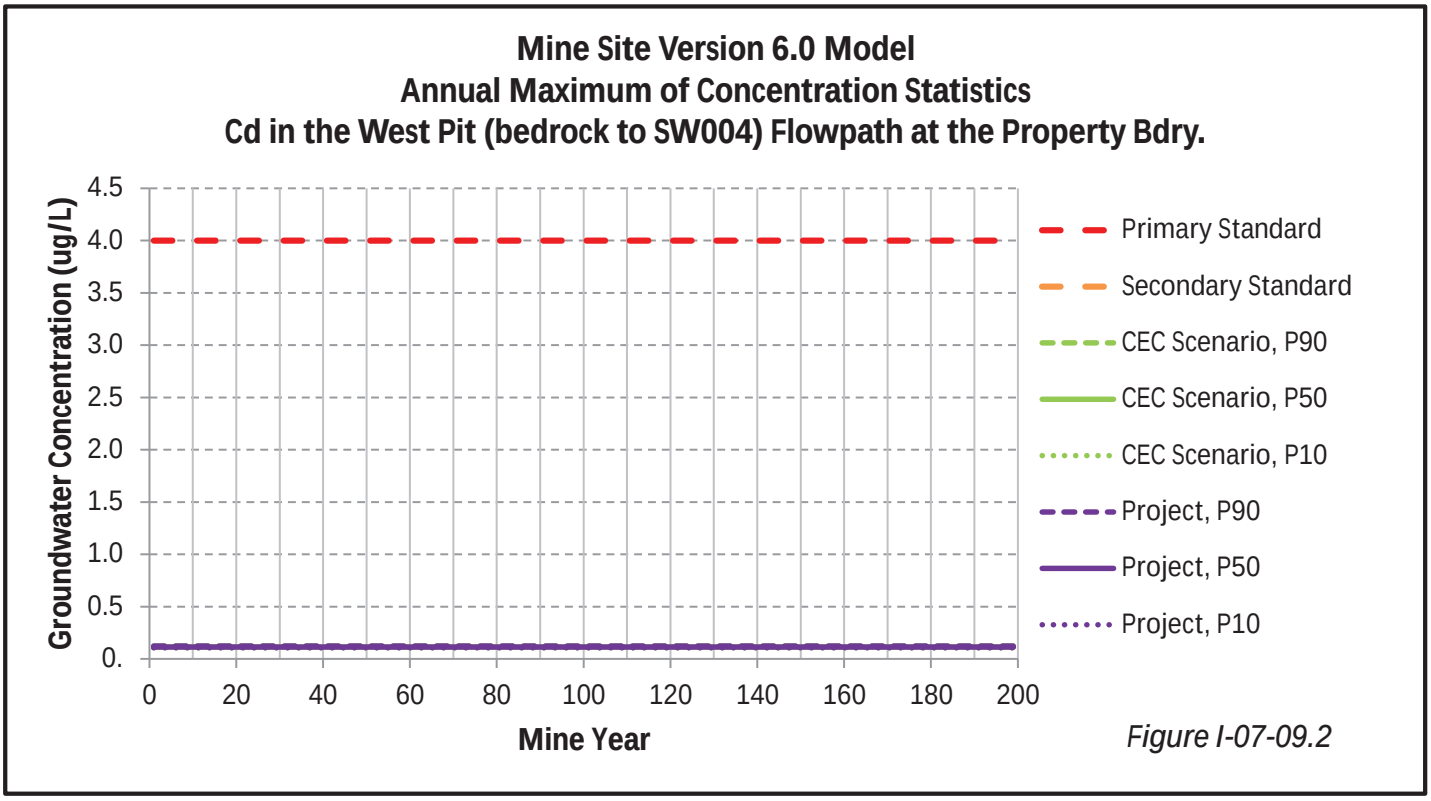

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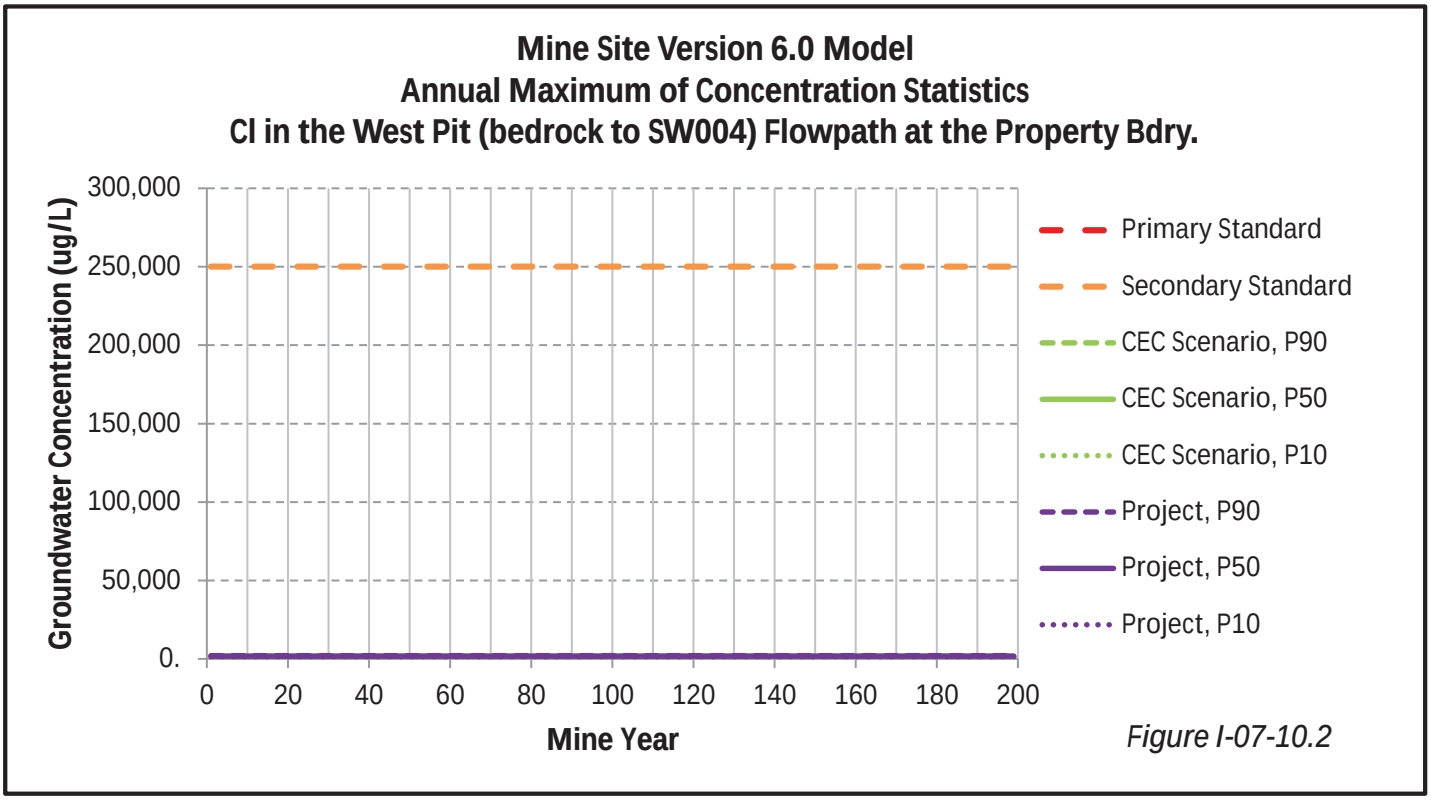

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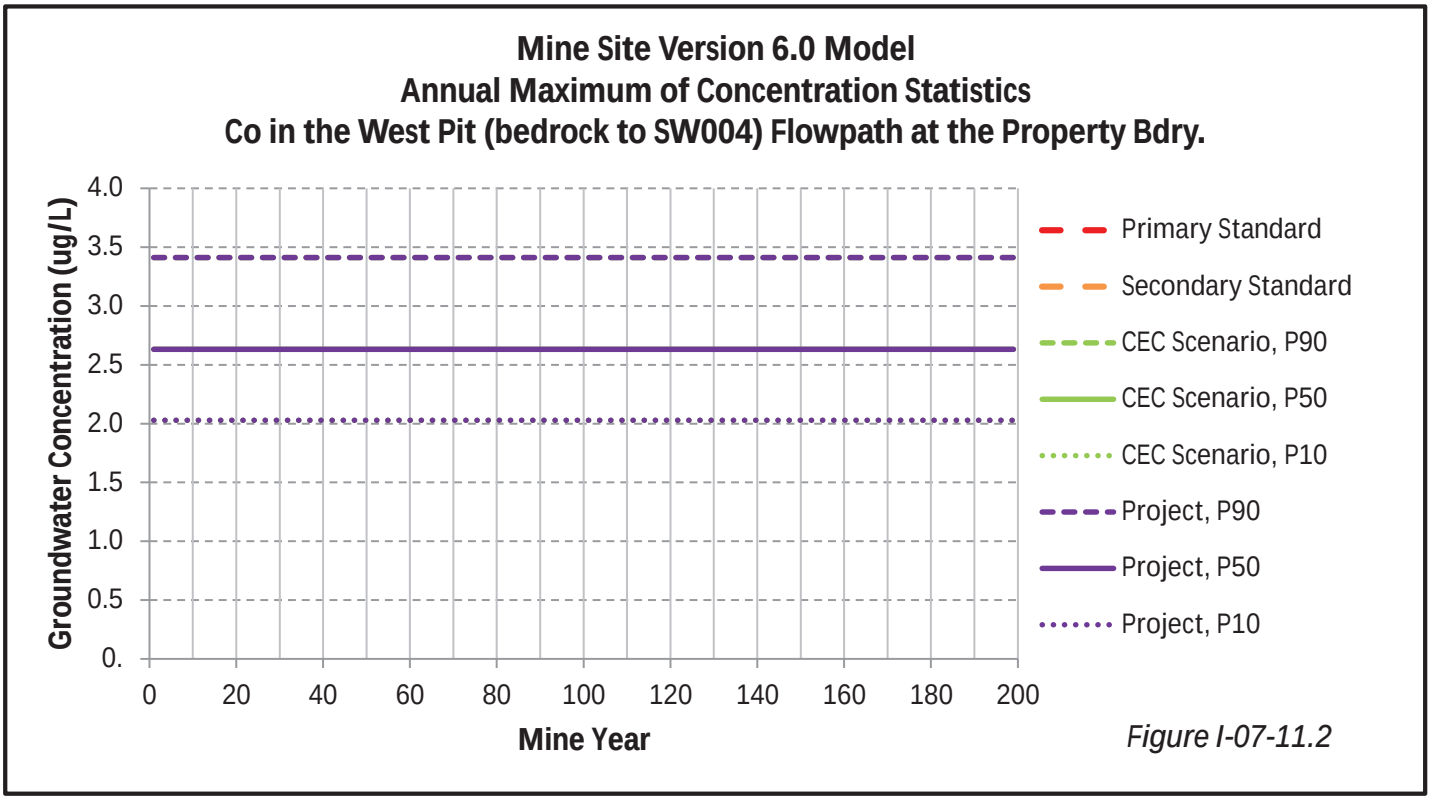

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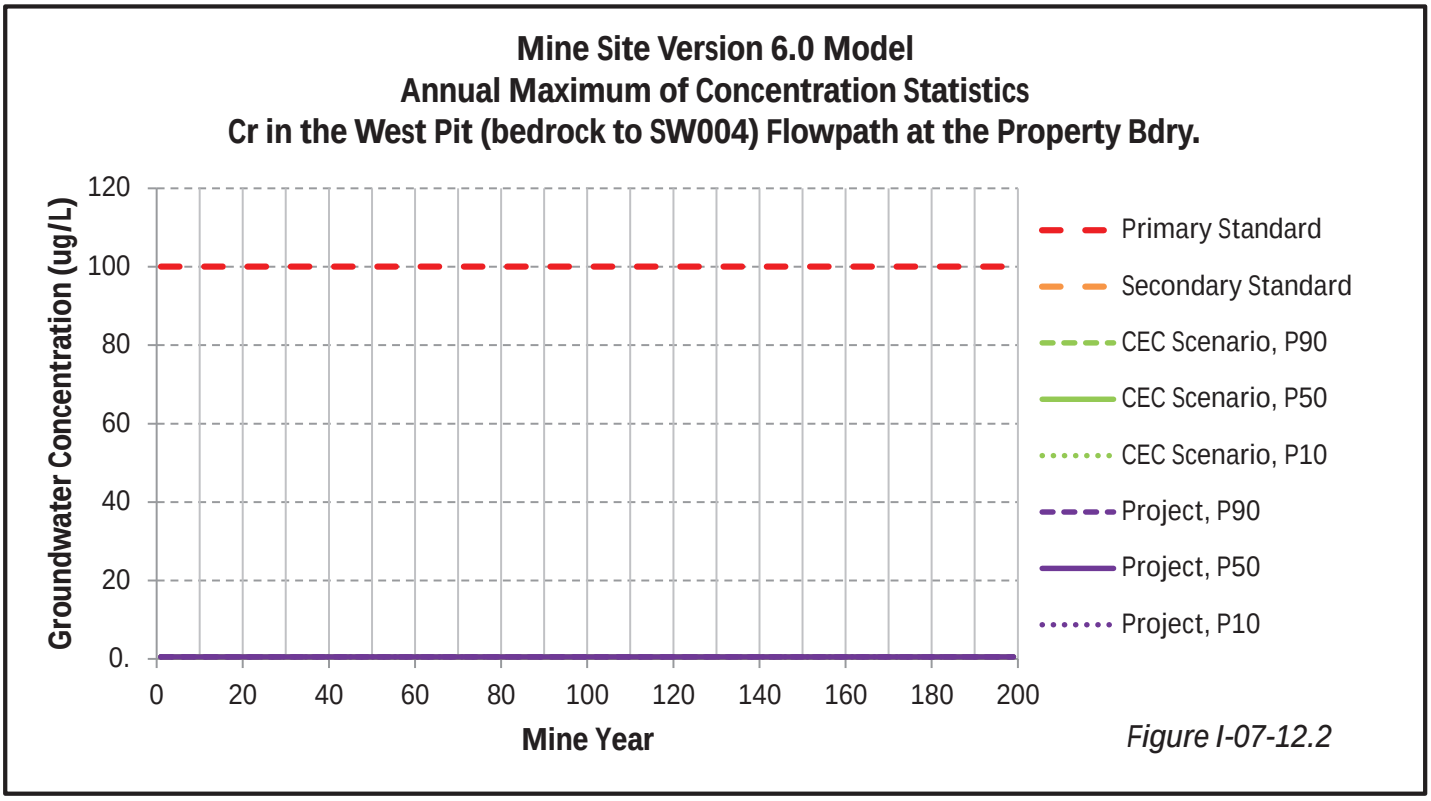

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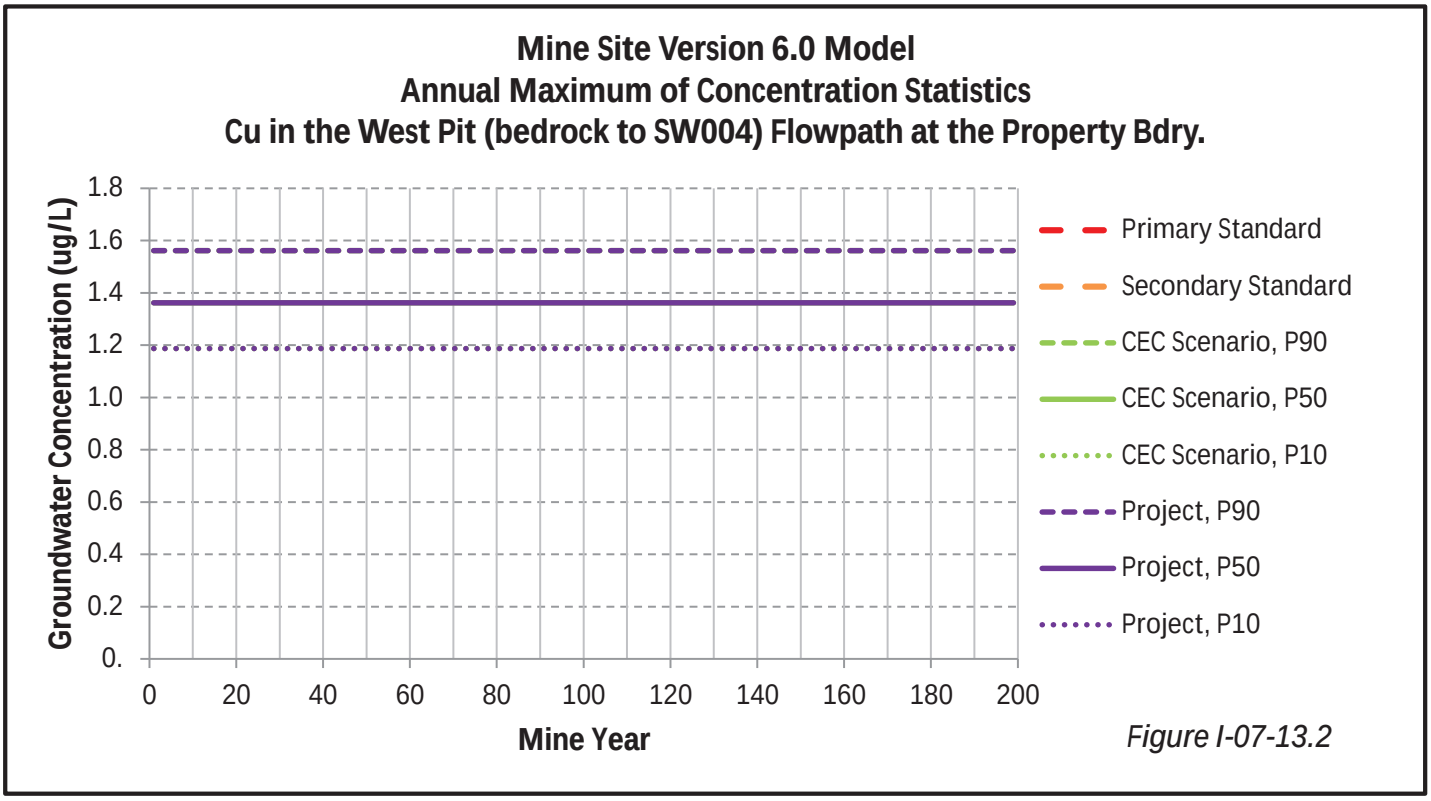

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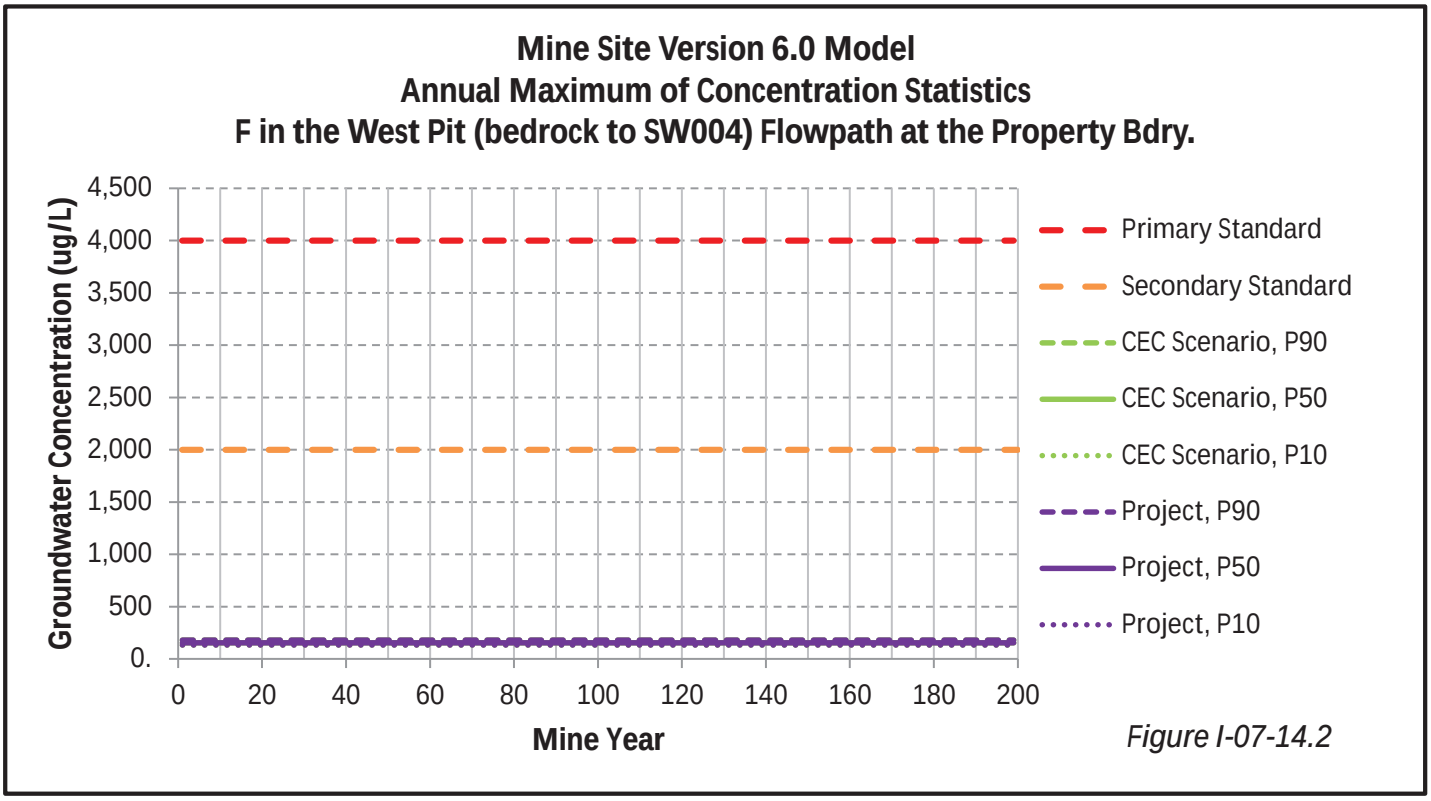

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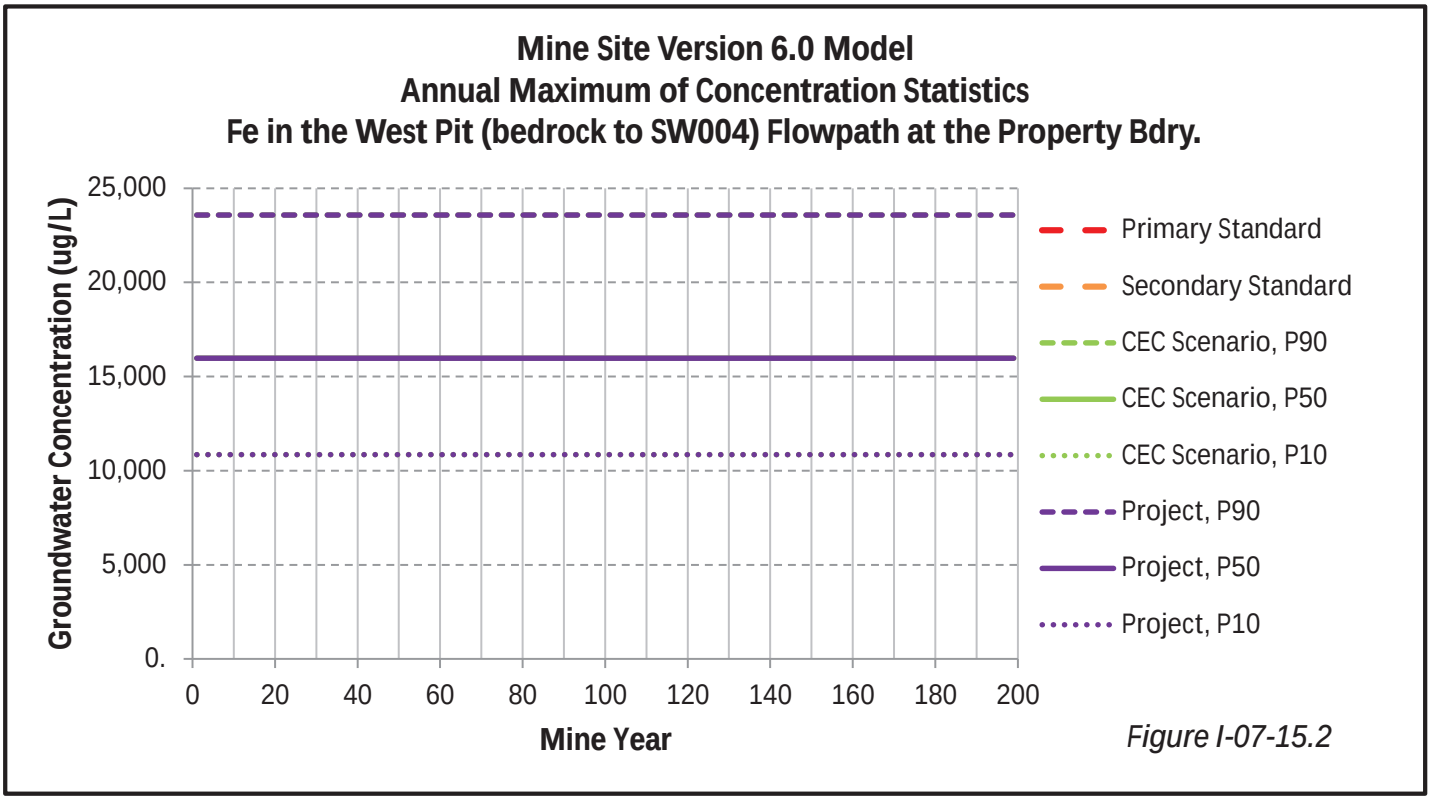

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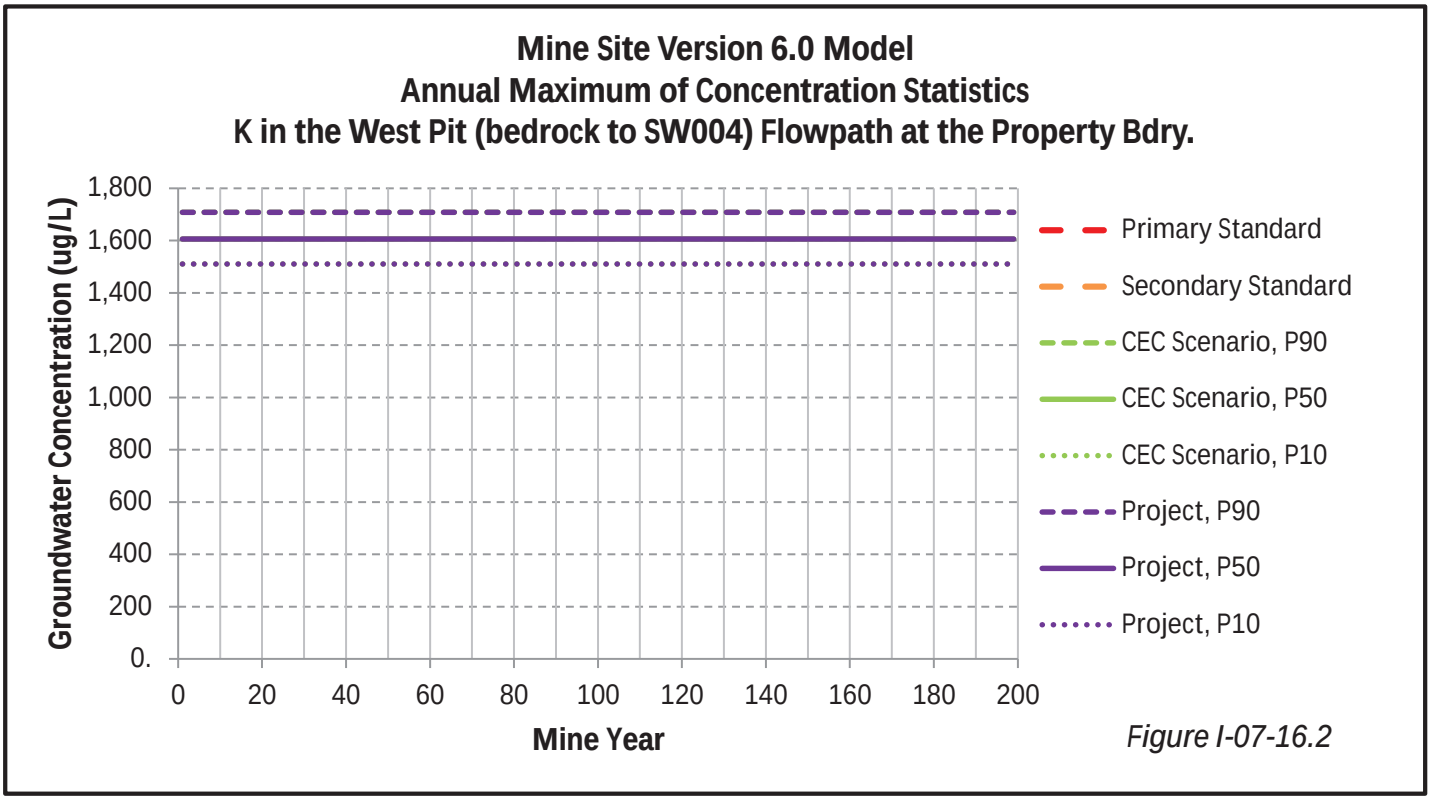

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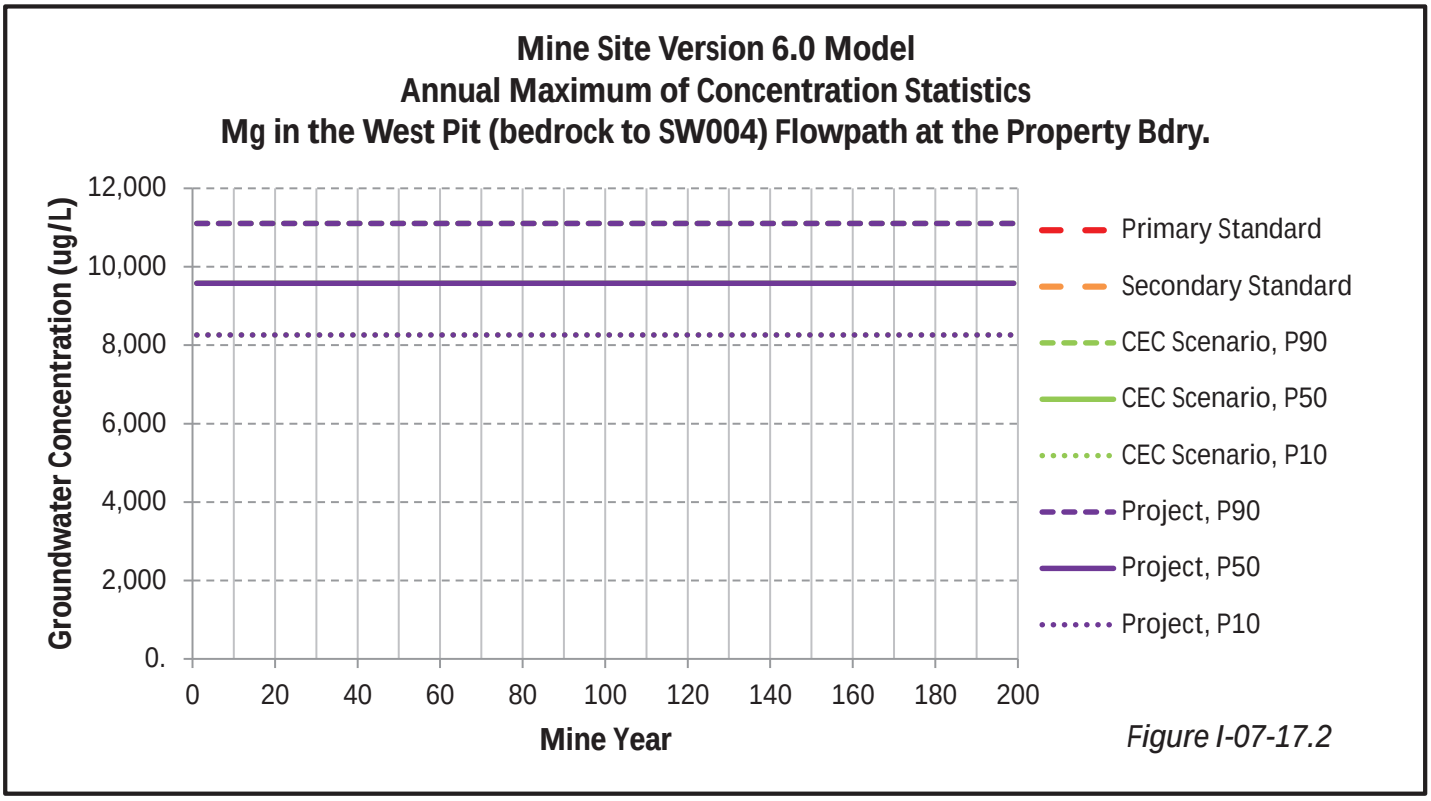

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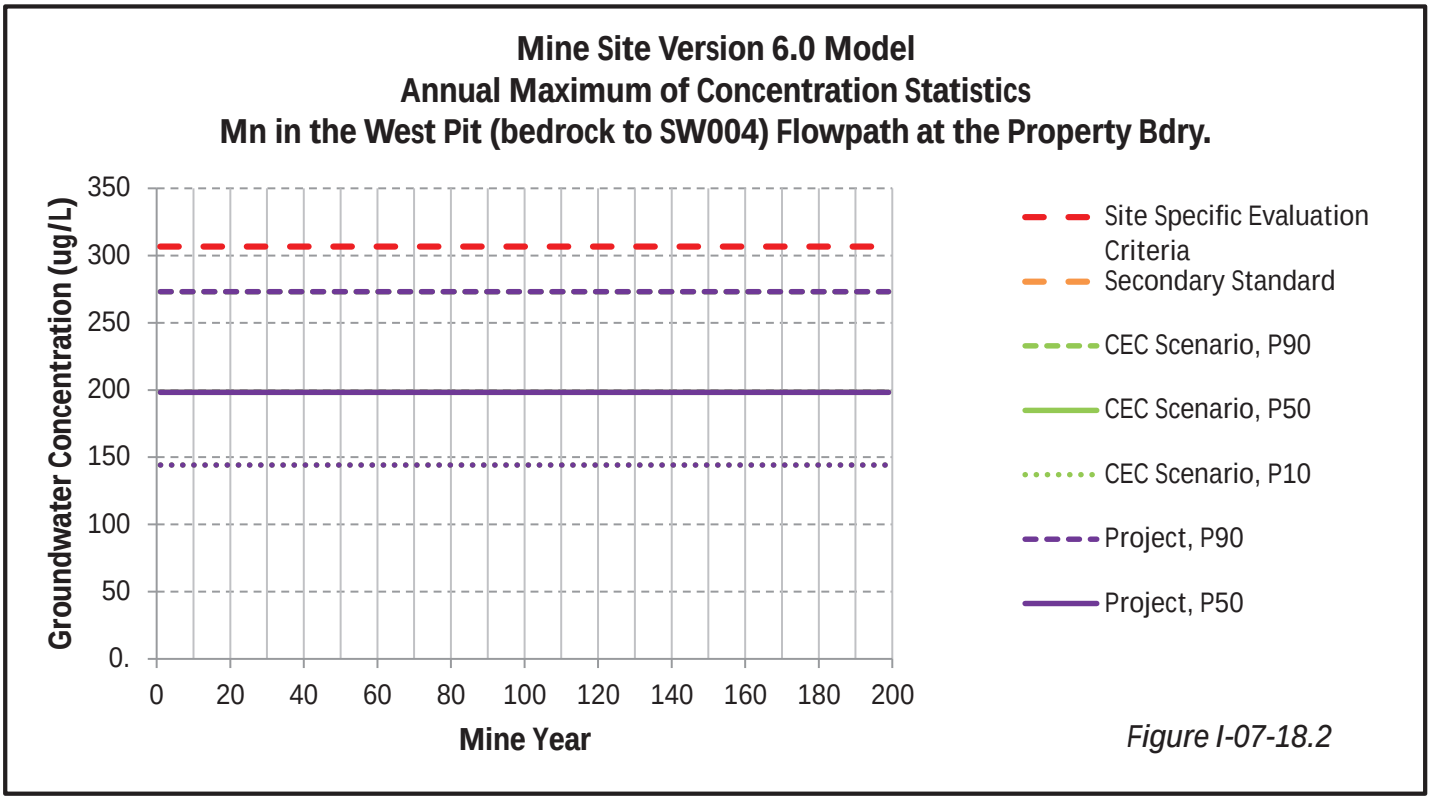

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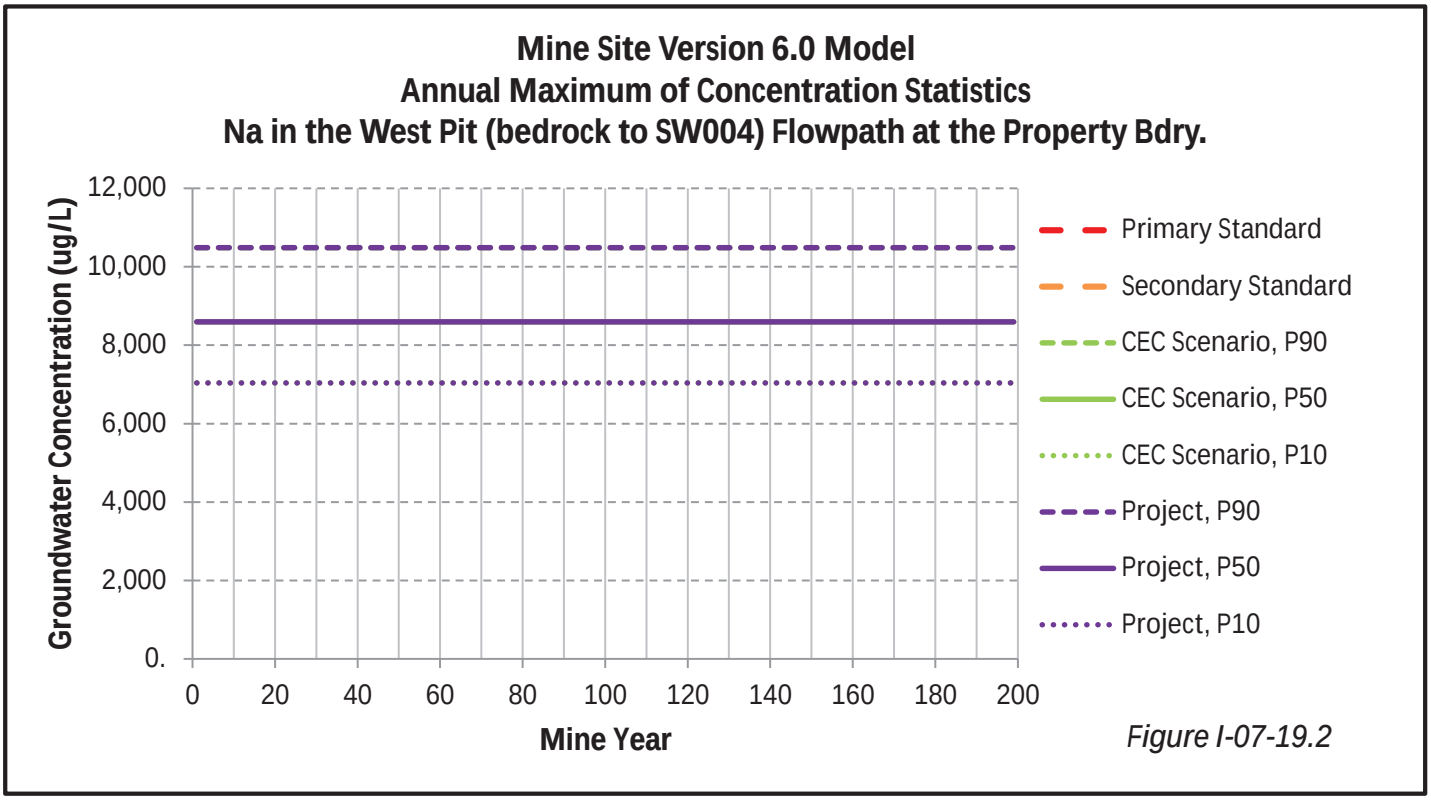

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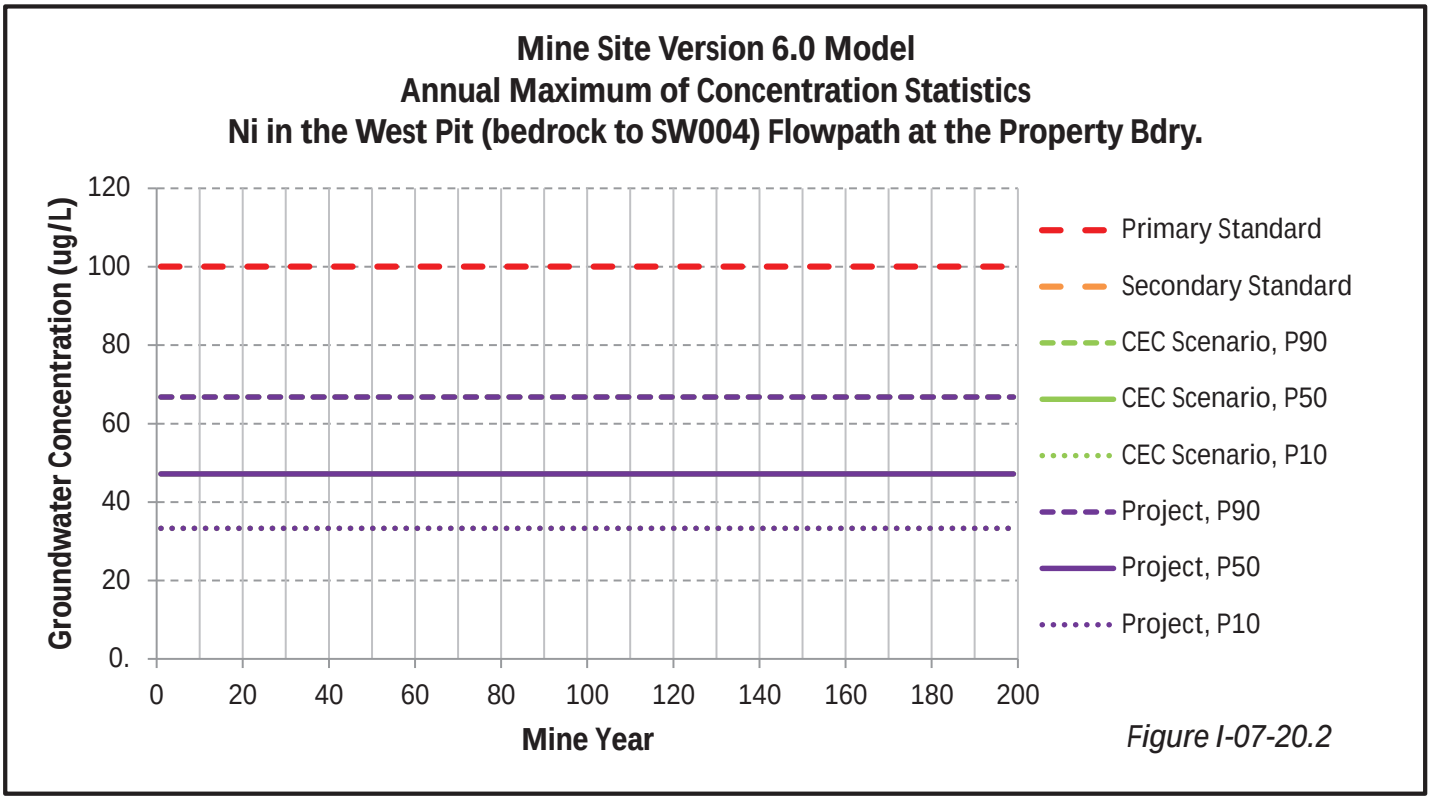

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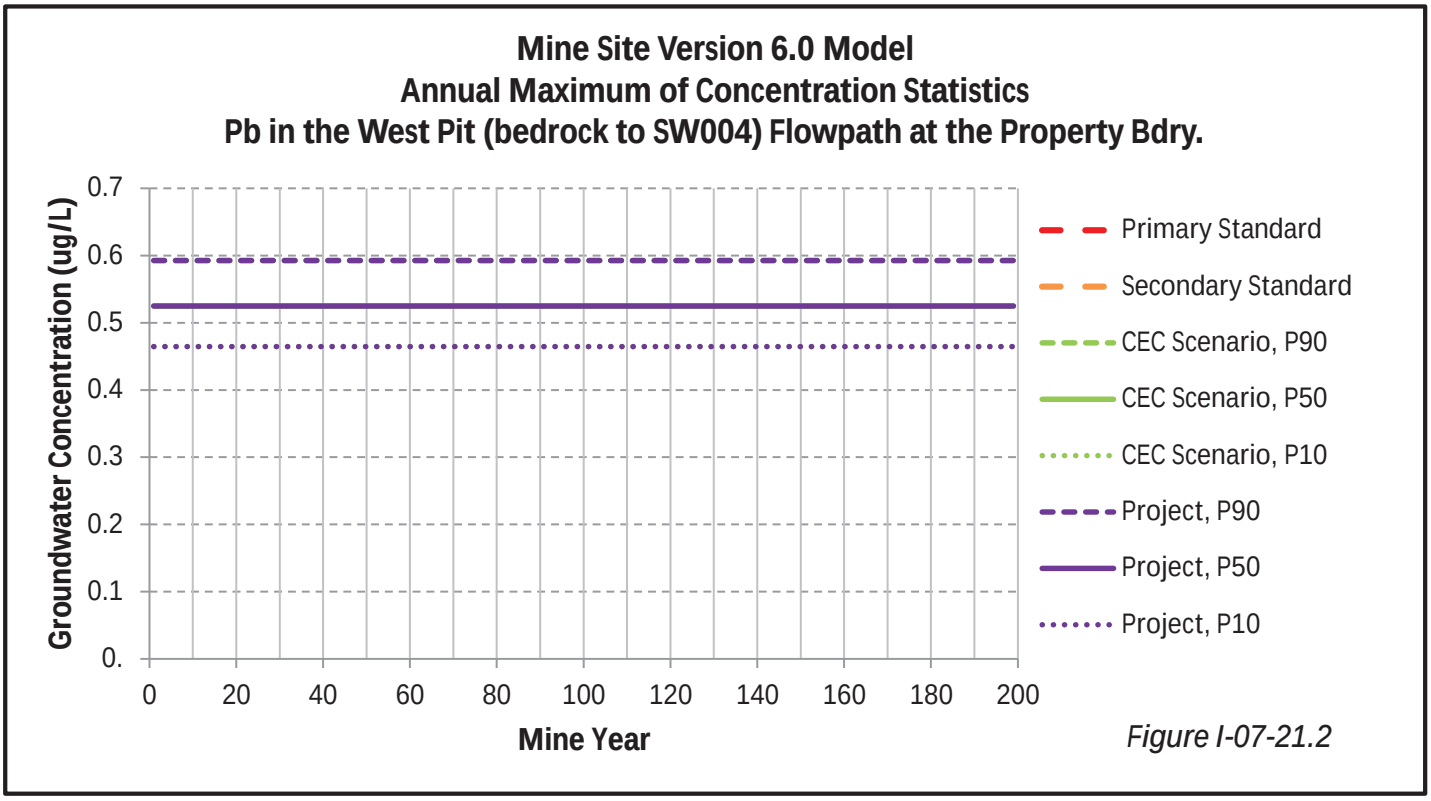

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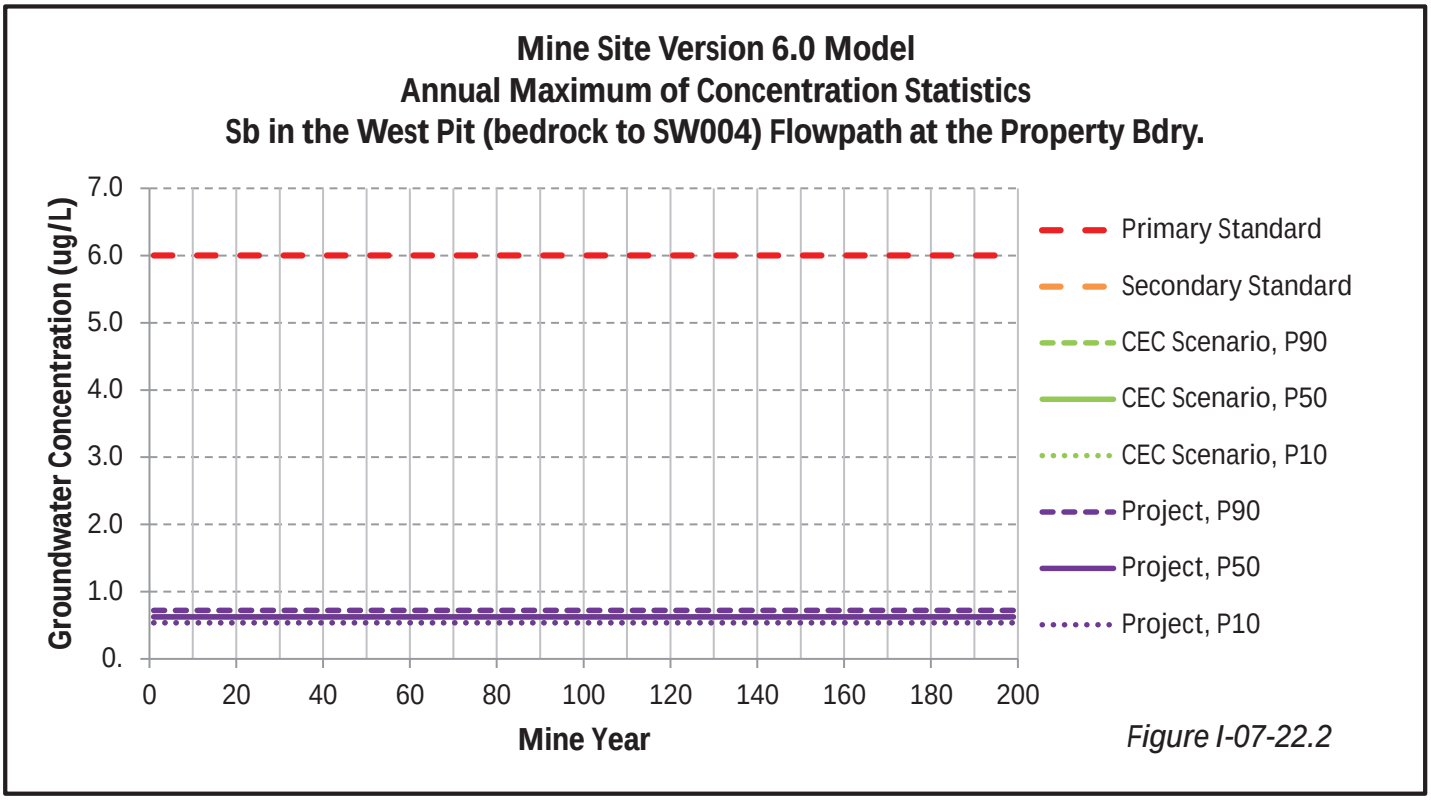

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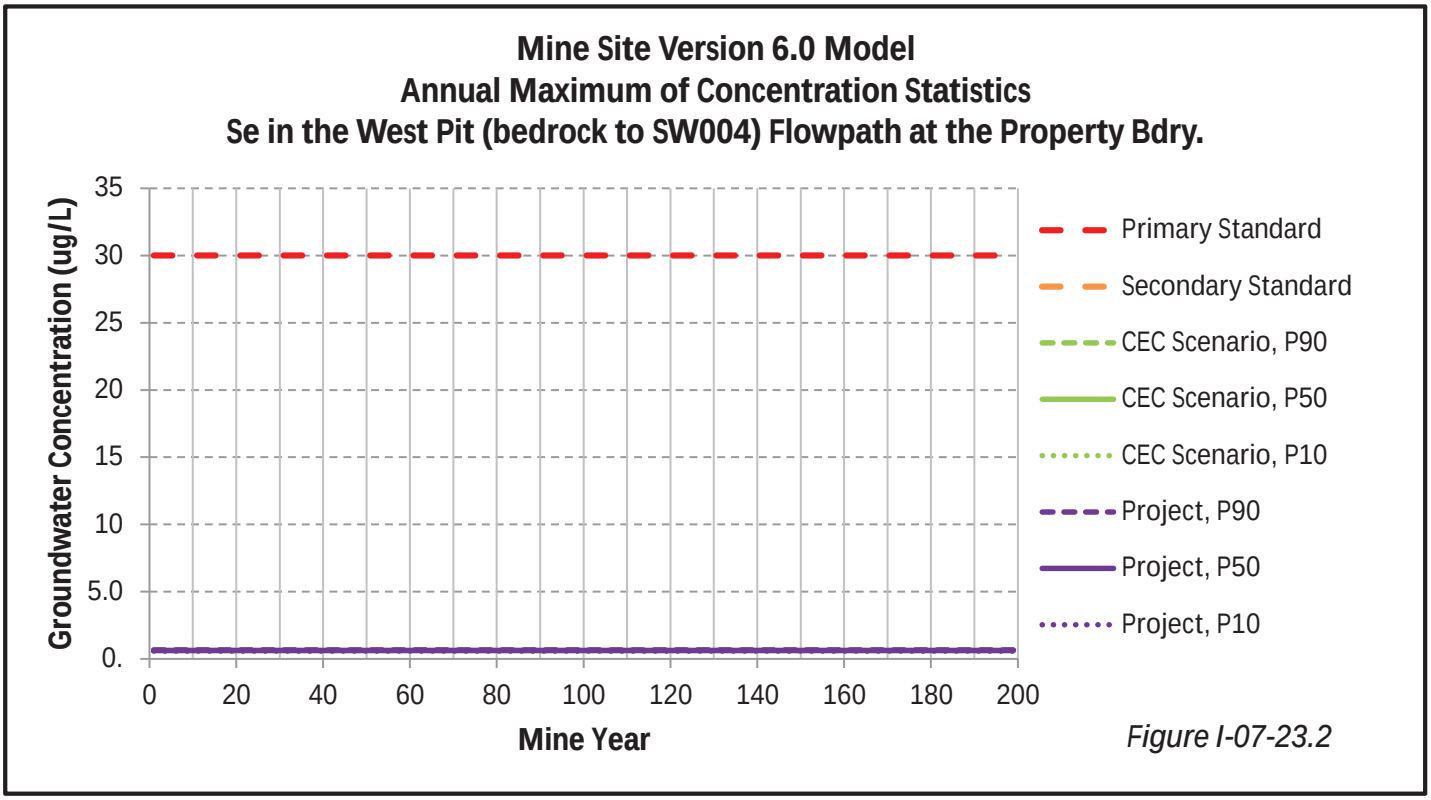

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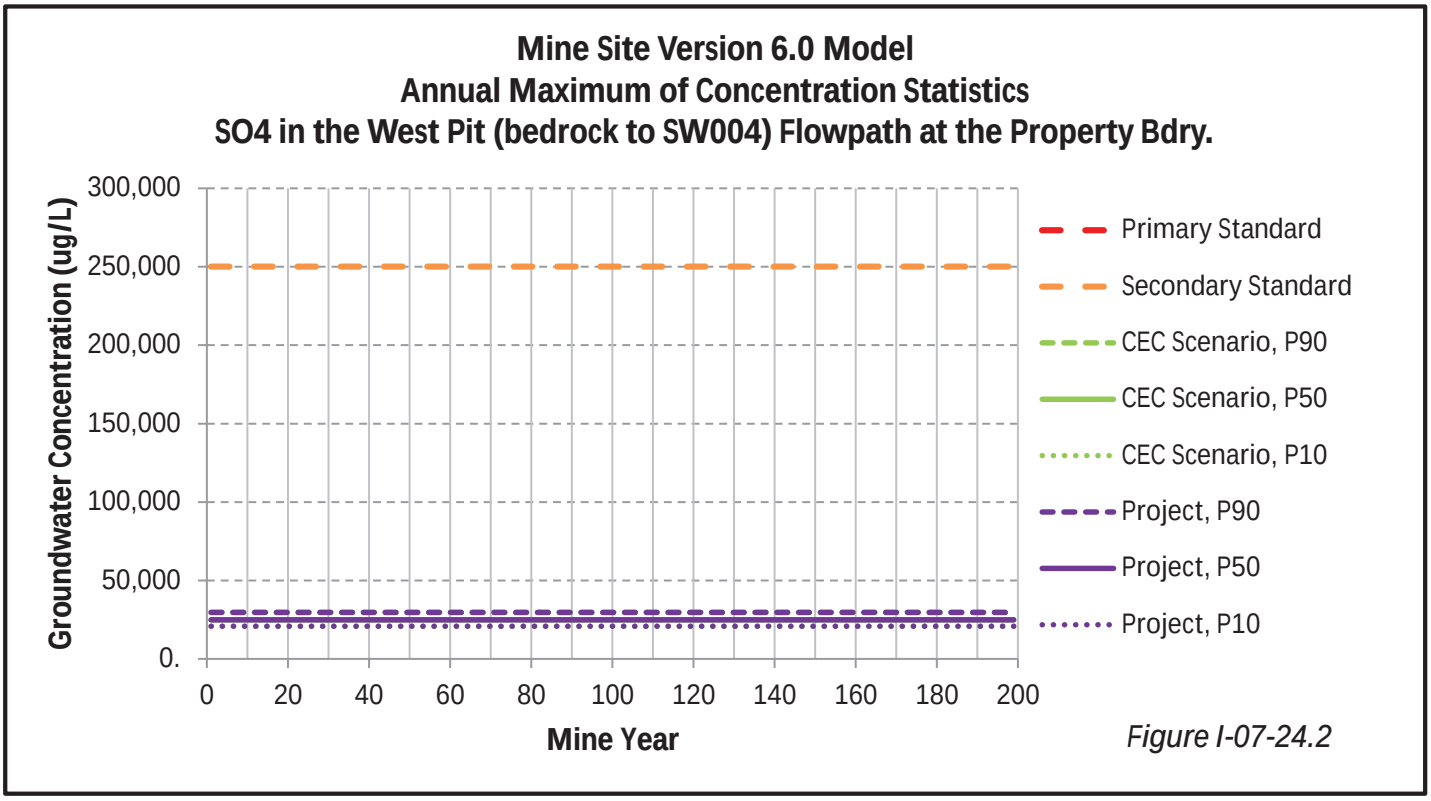

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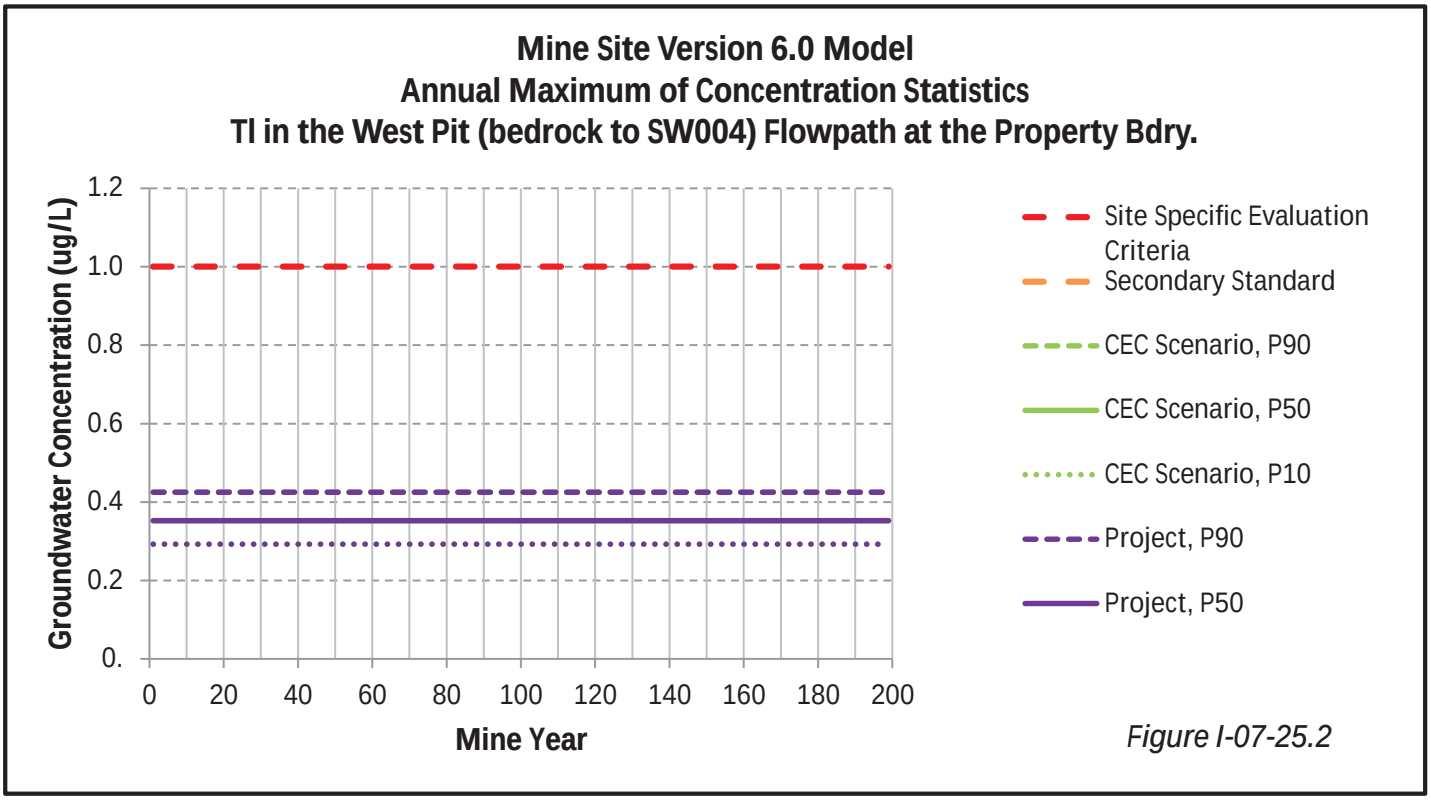

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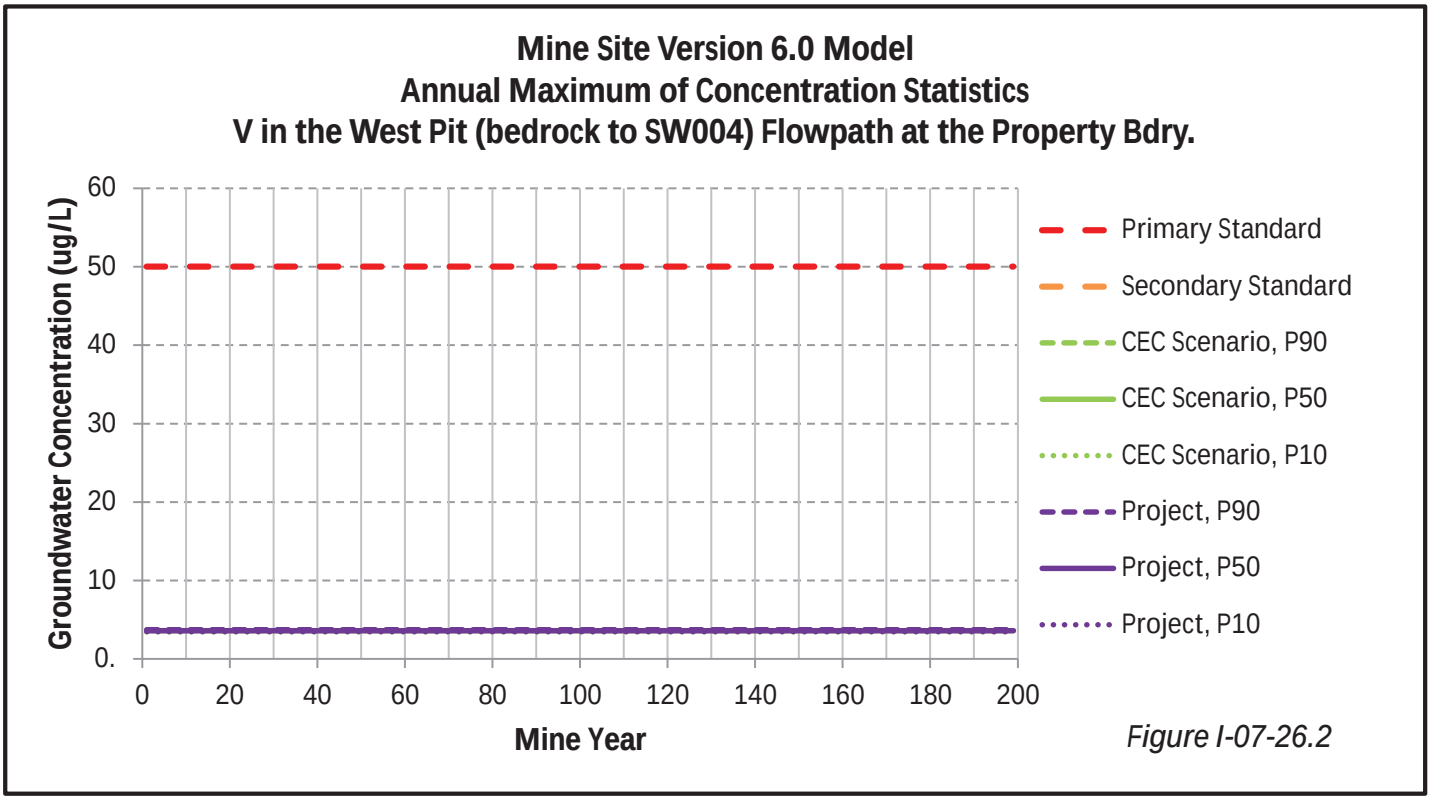

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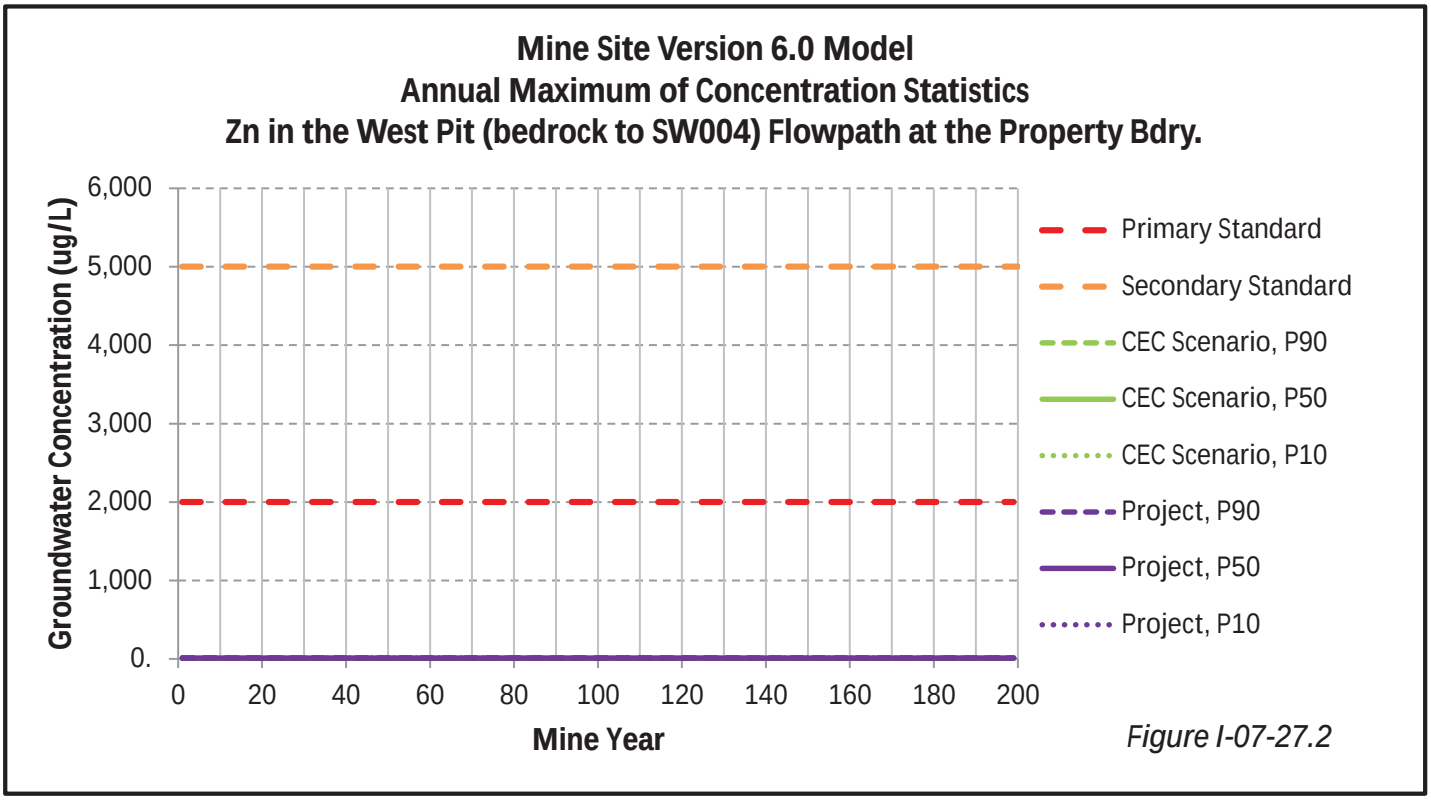

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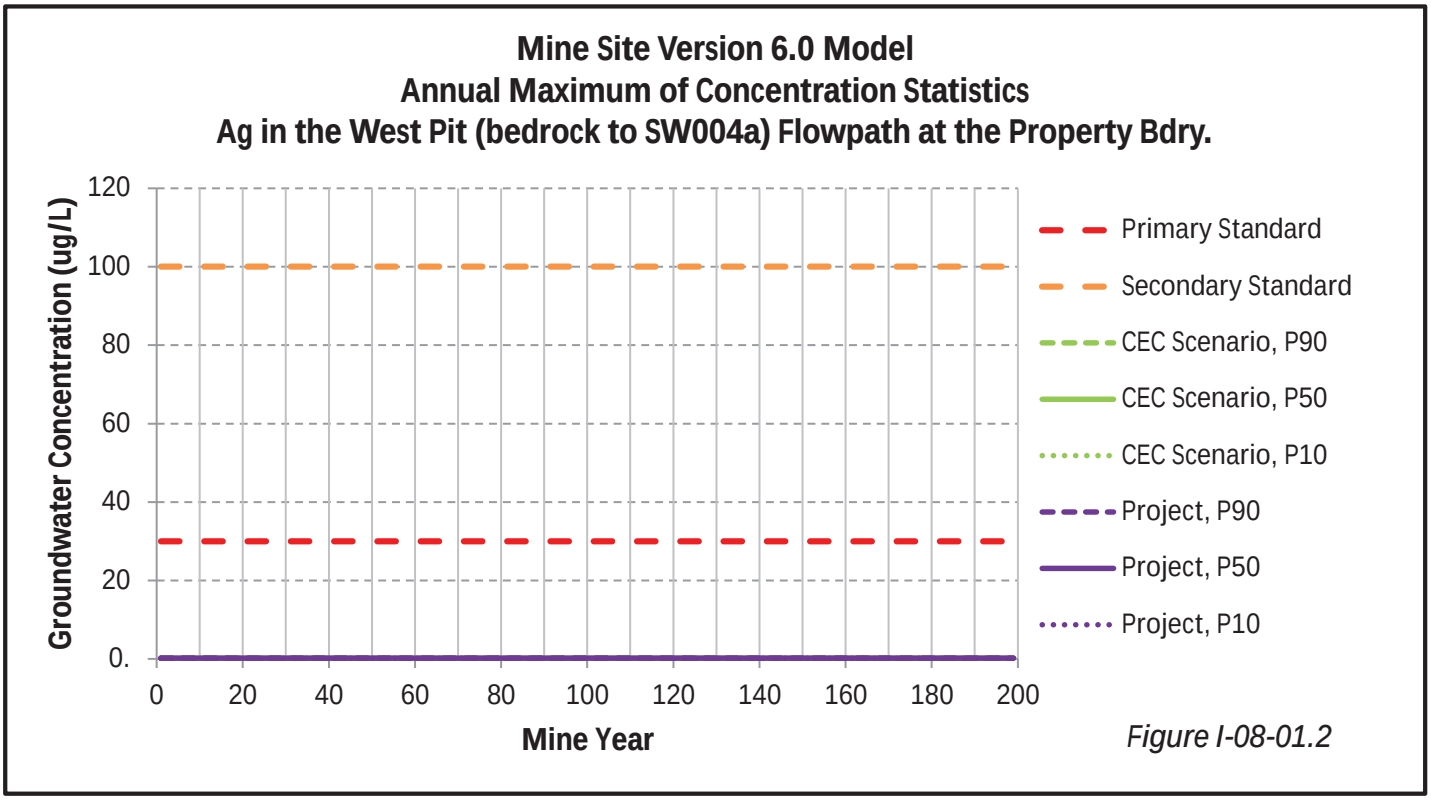

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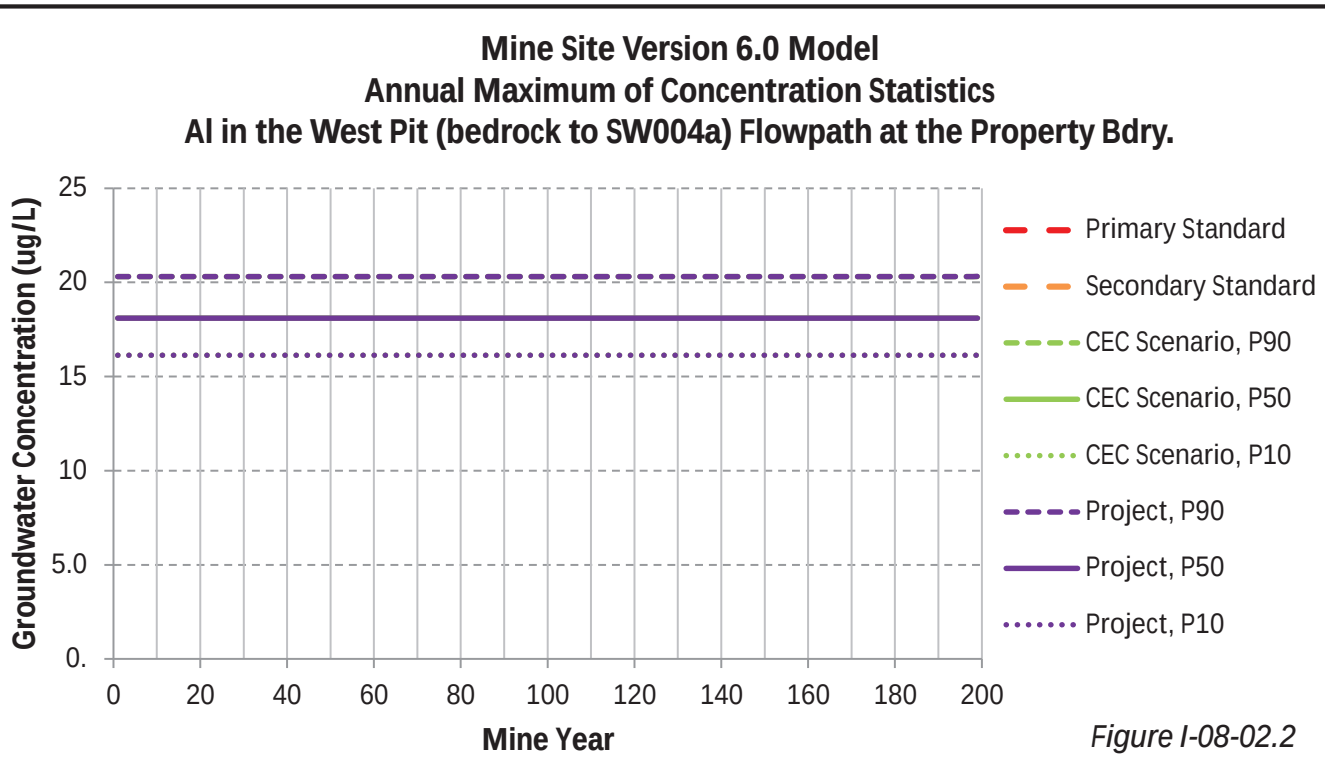
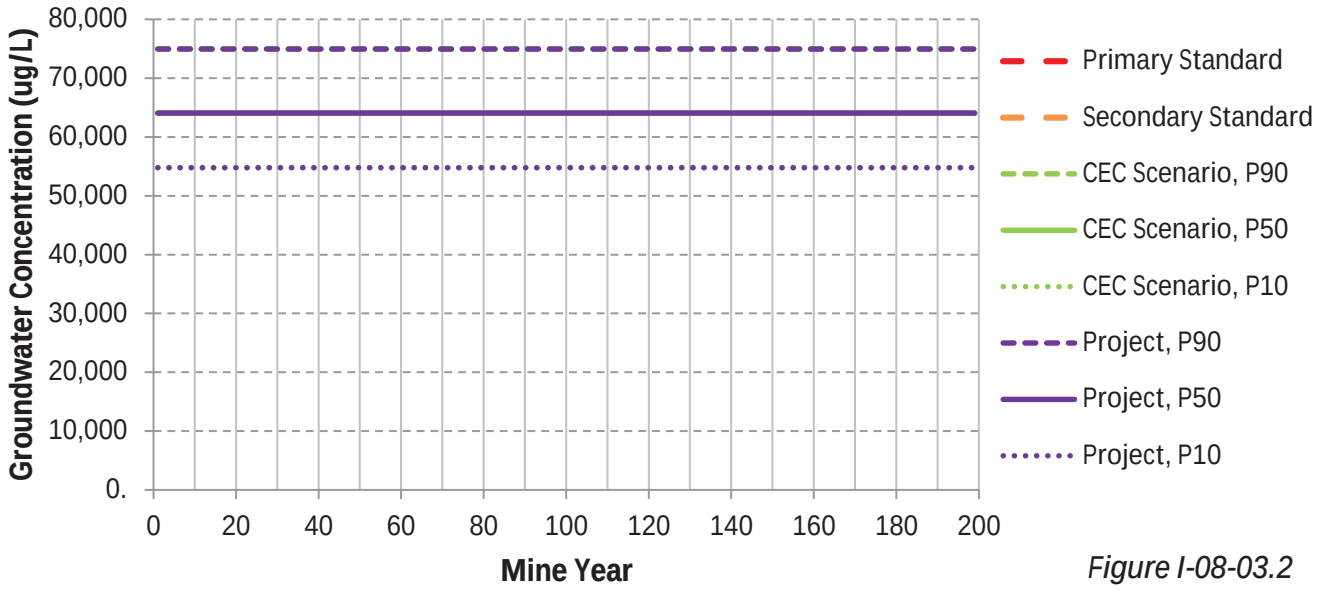


Figure I-08-02.2

Mine Site Version 6.0 Model
Annual Maximum of Concentration Statistics
Alkalinity in the West Pit (bedrock to SW004a) Flowpath at the Property Bdry.



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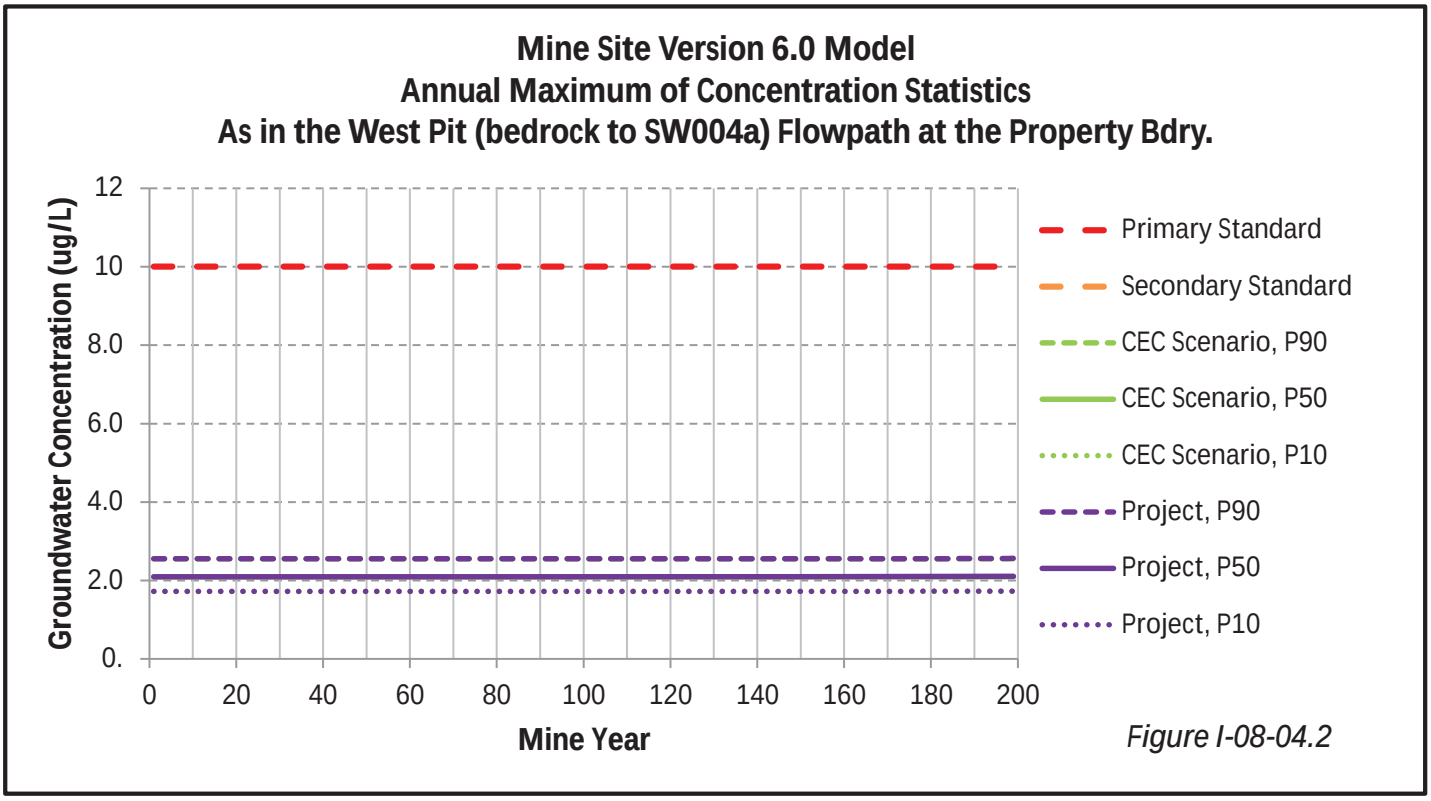

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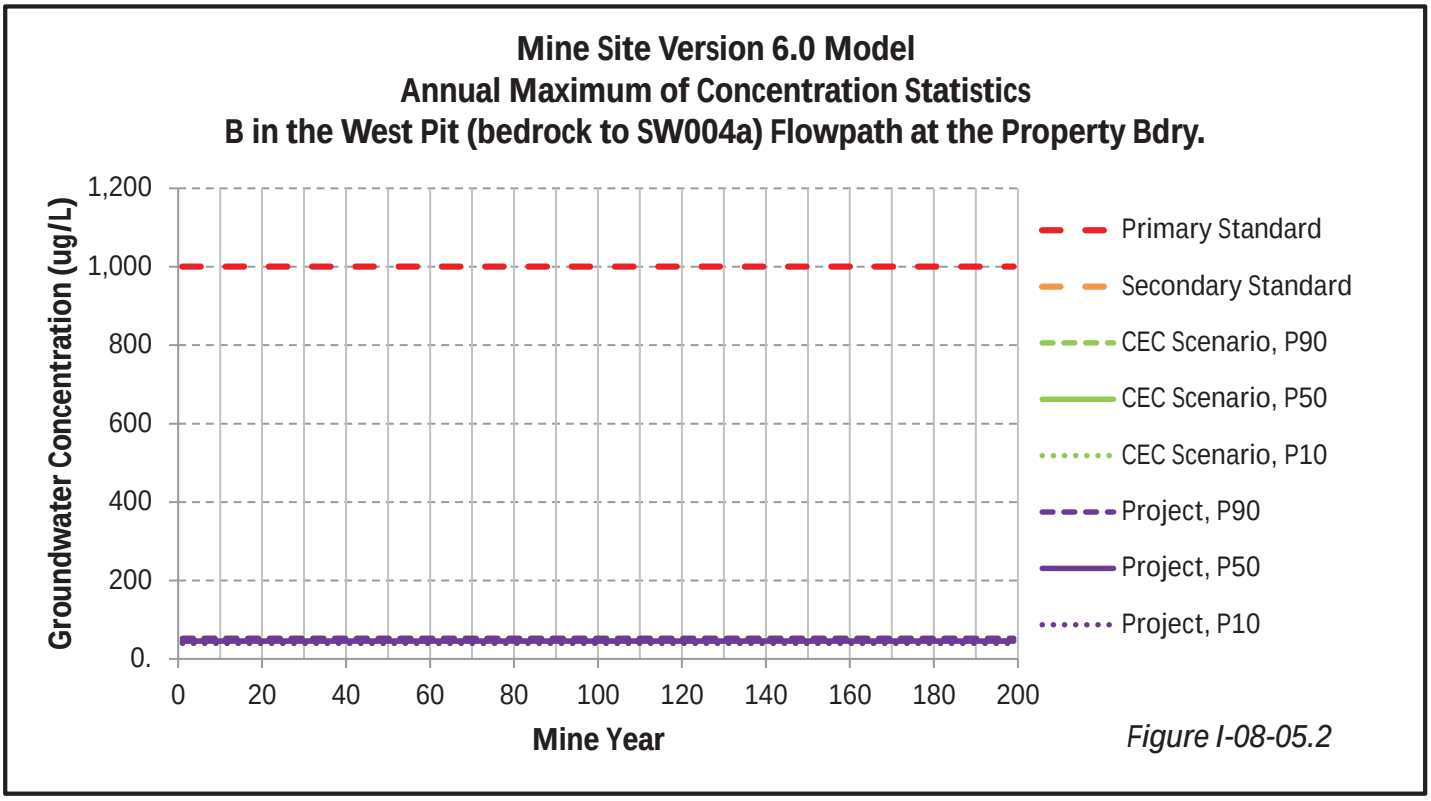

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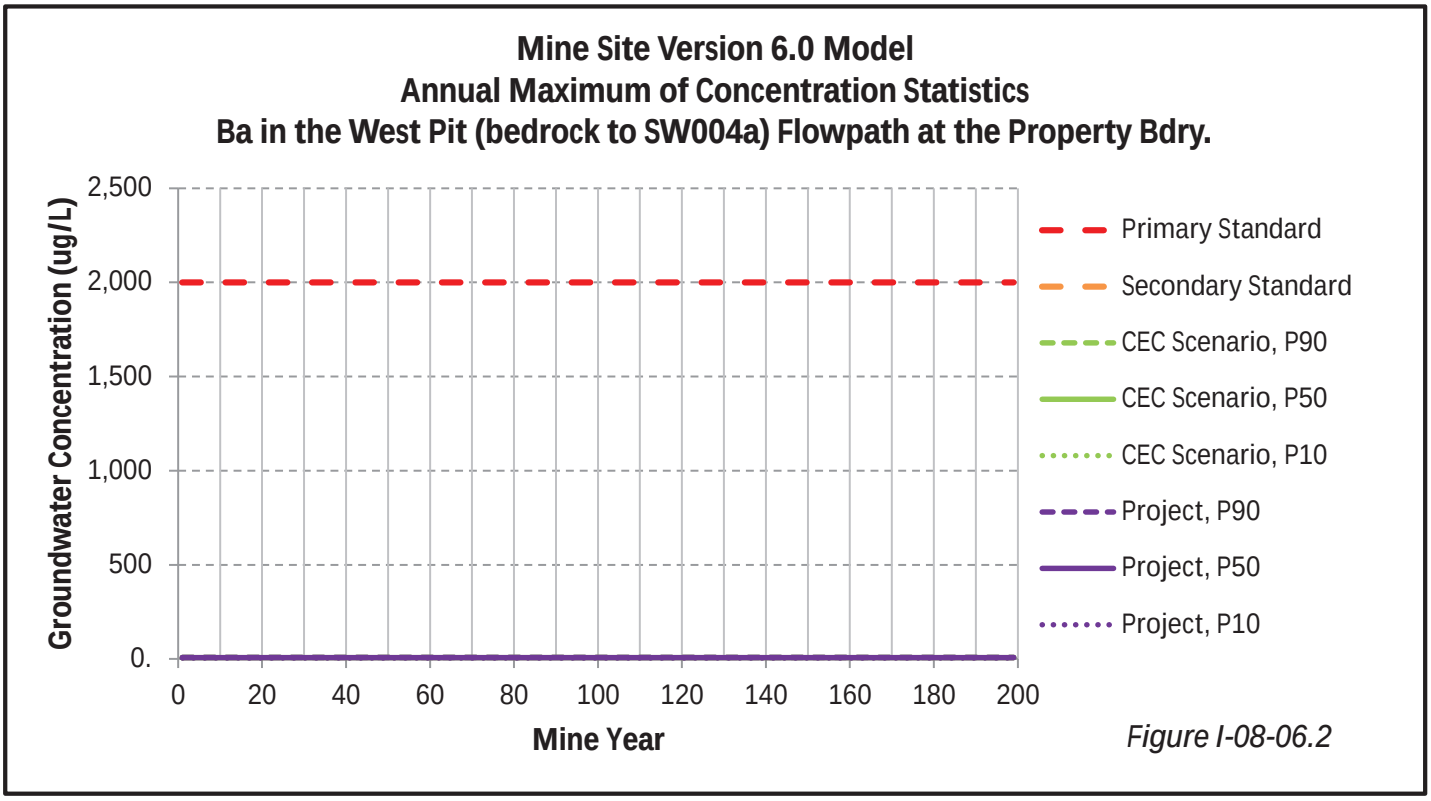

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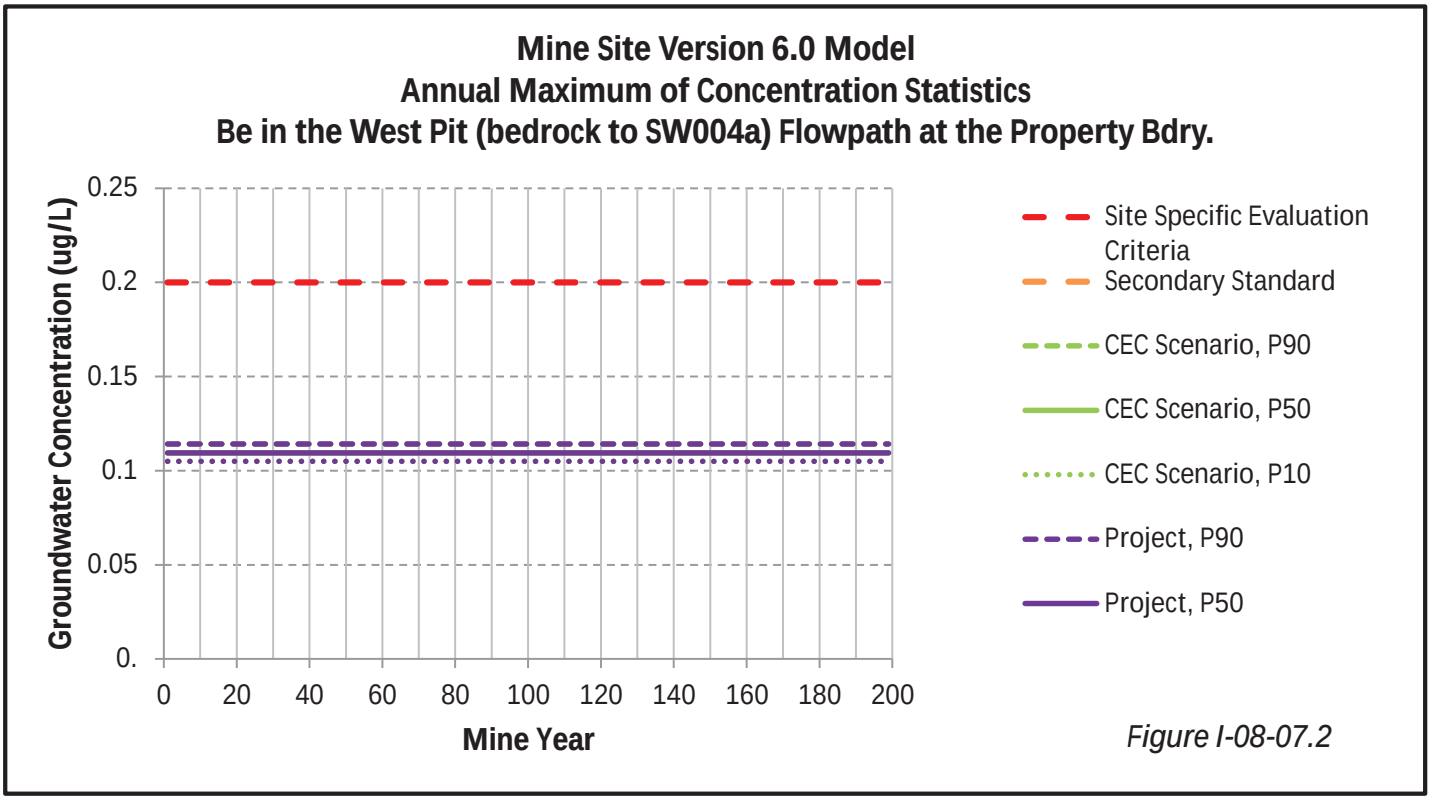

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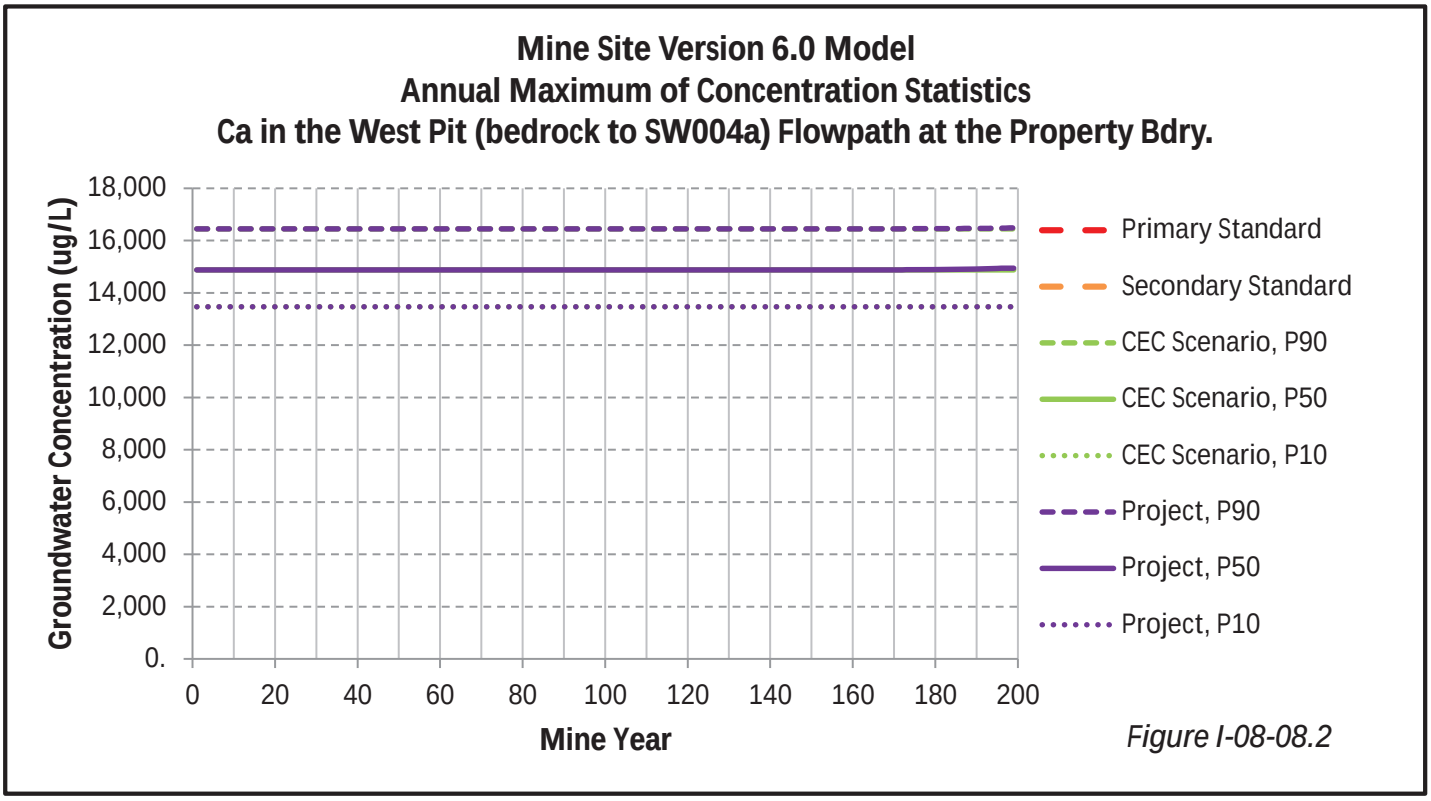

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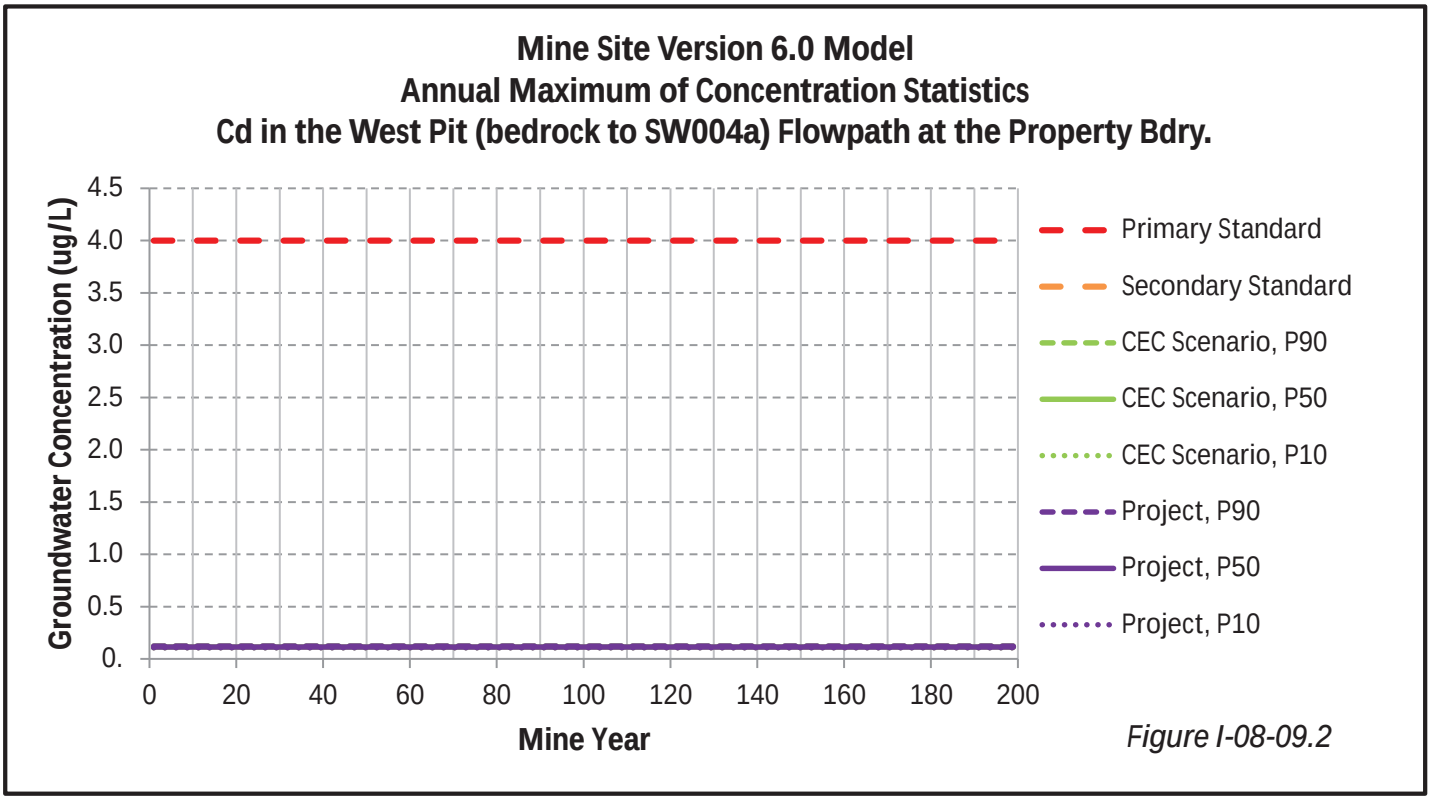

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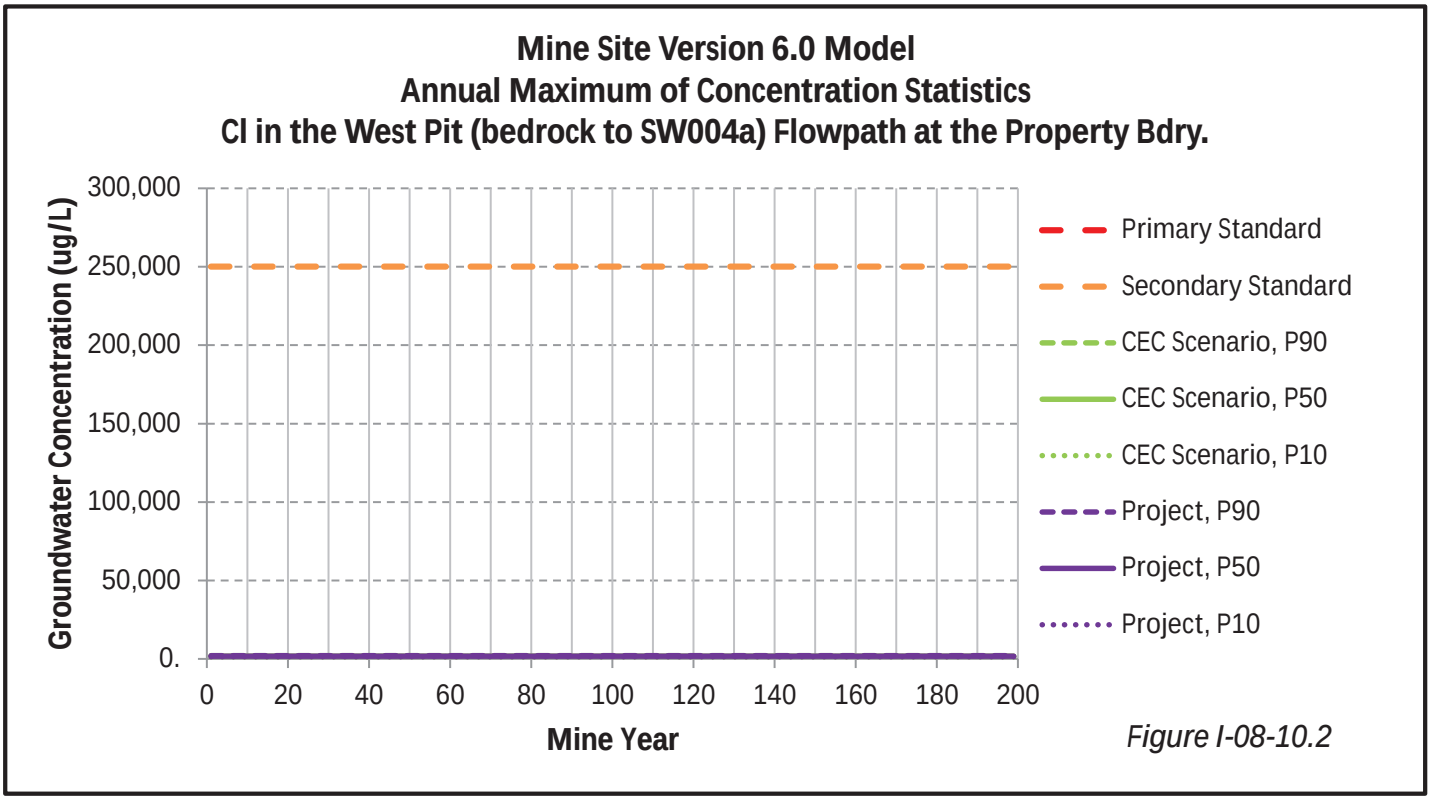

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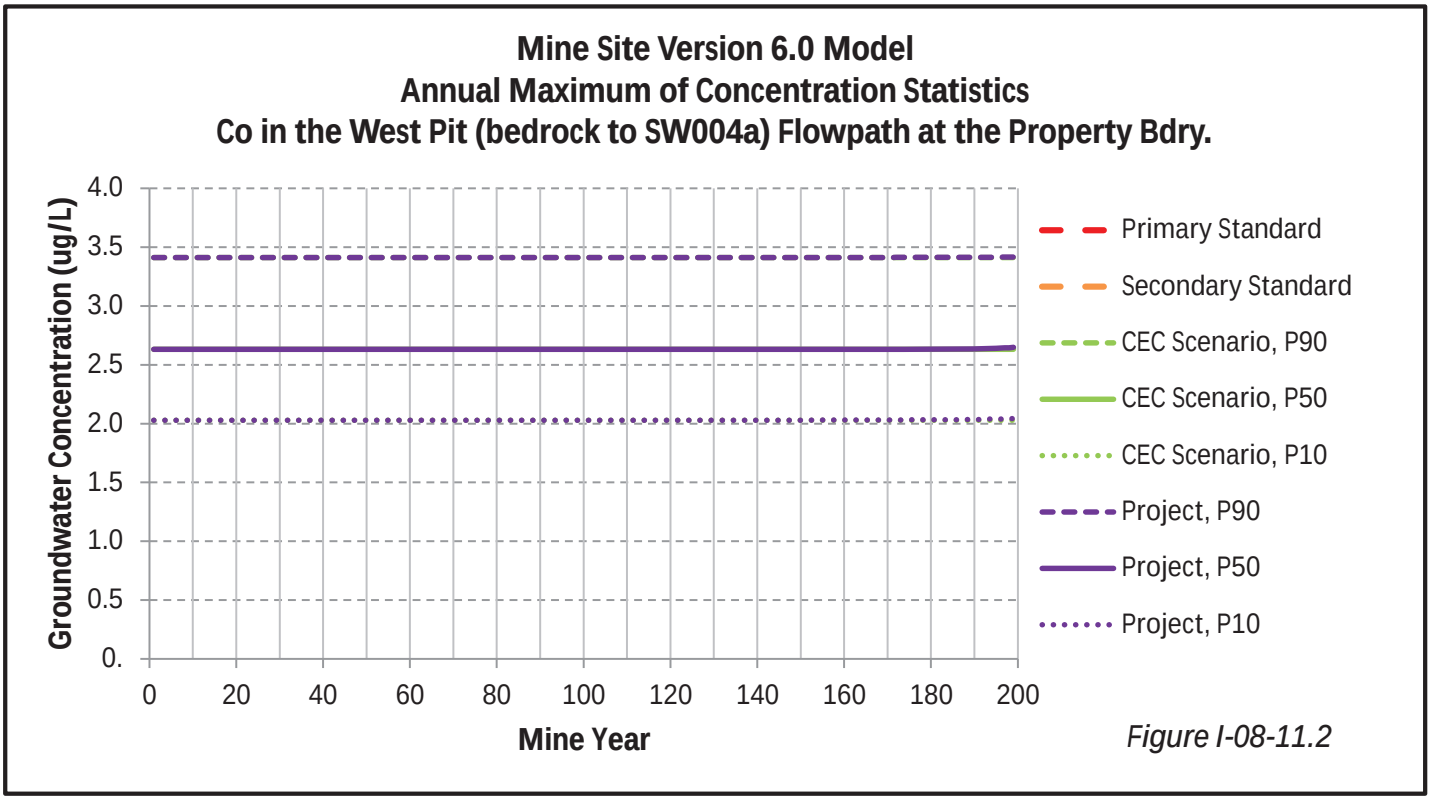

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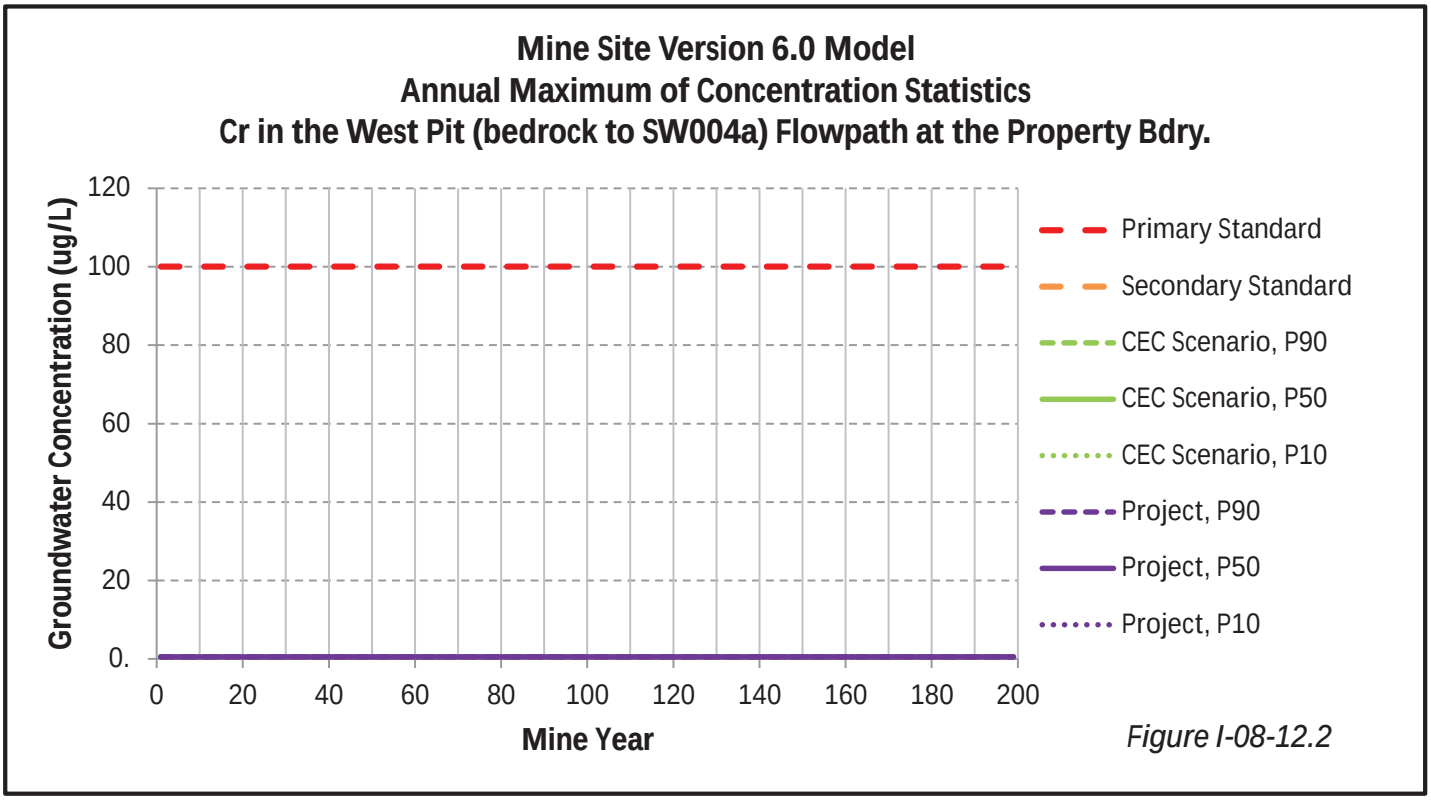

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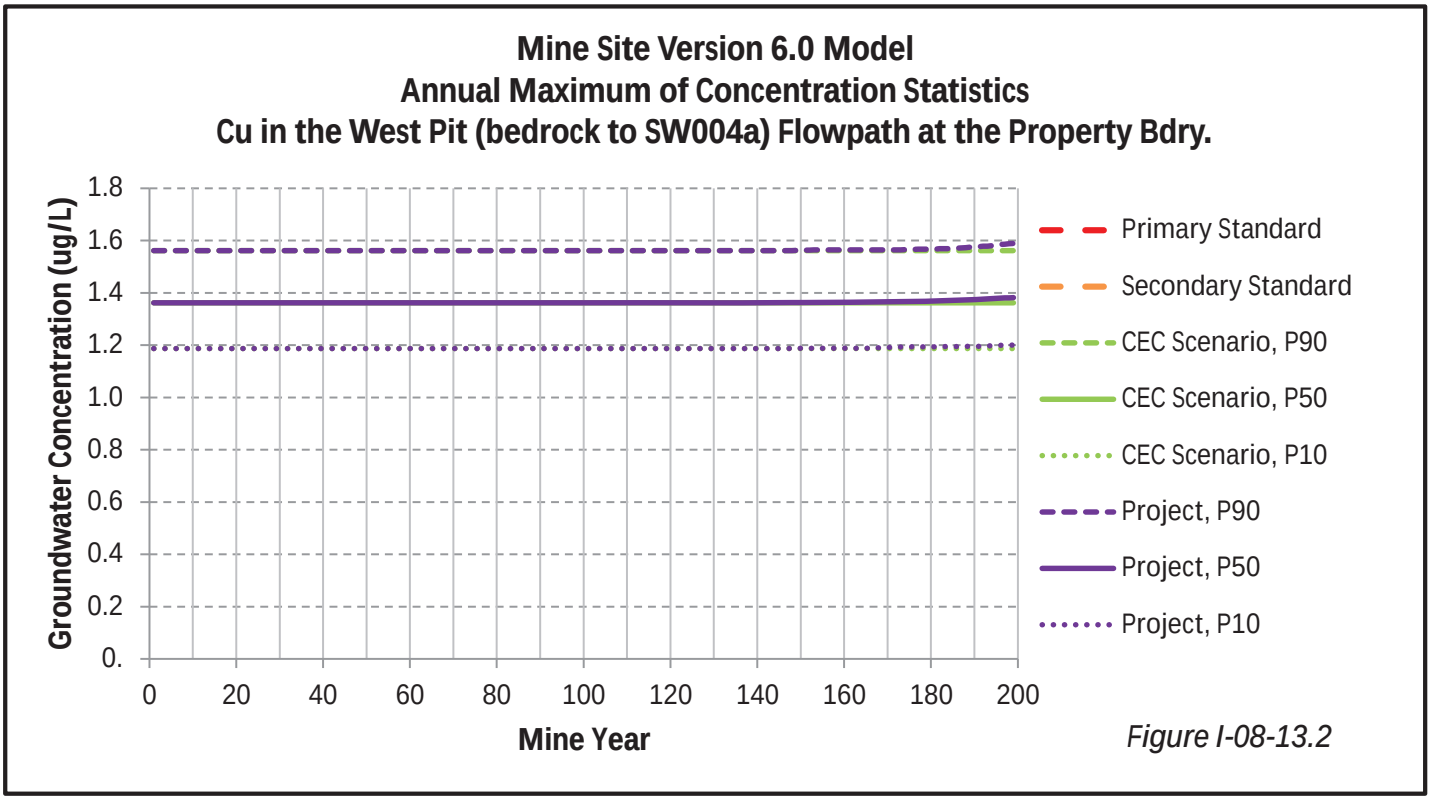

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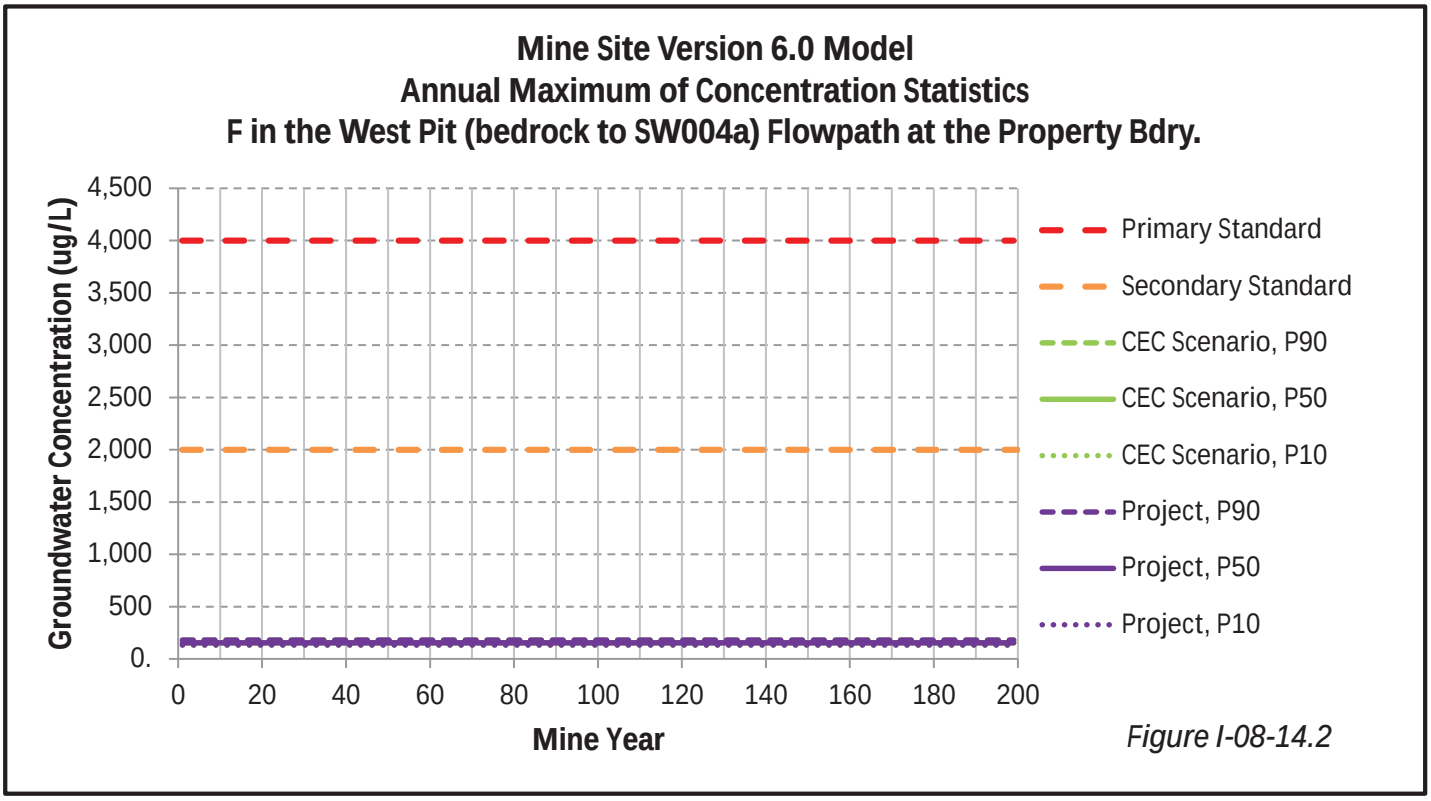

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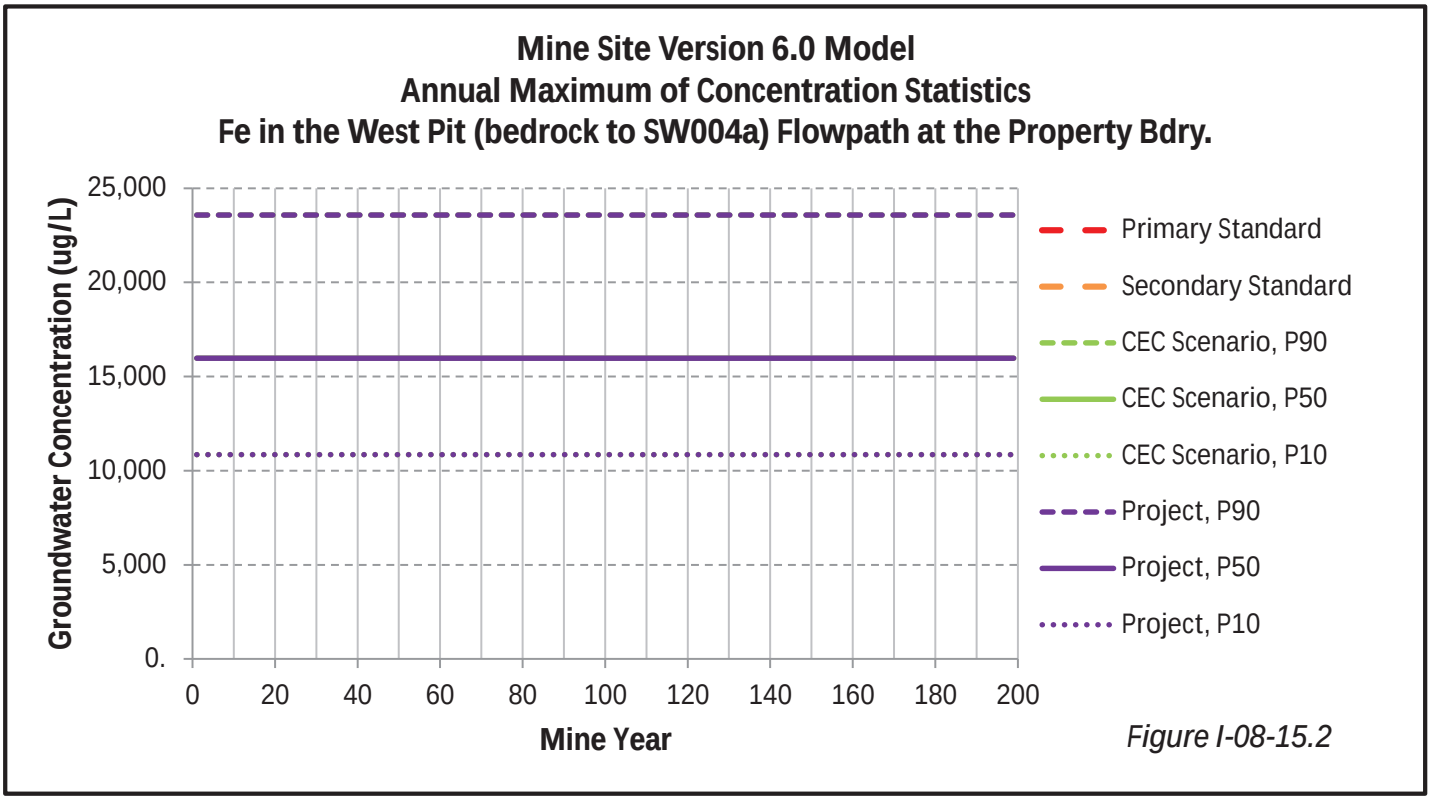

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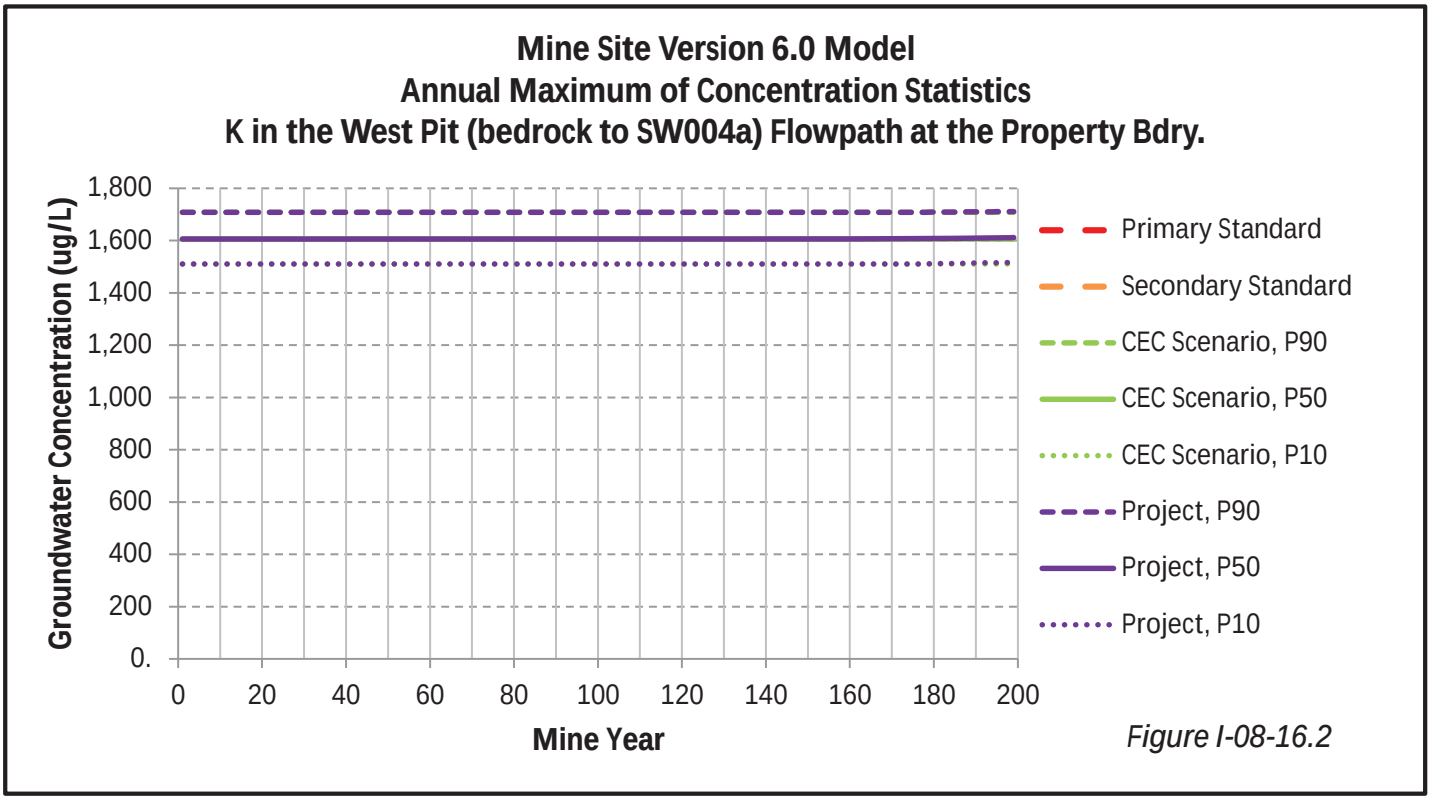

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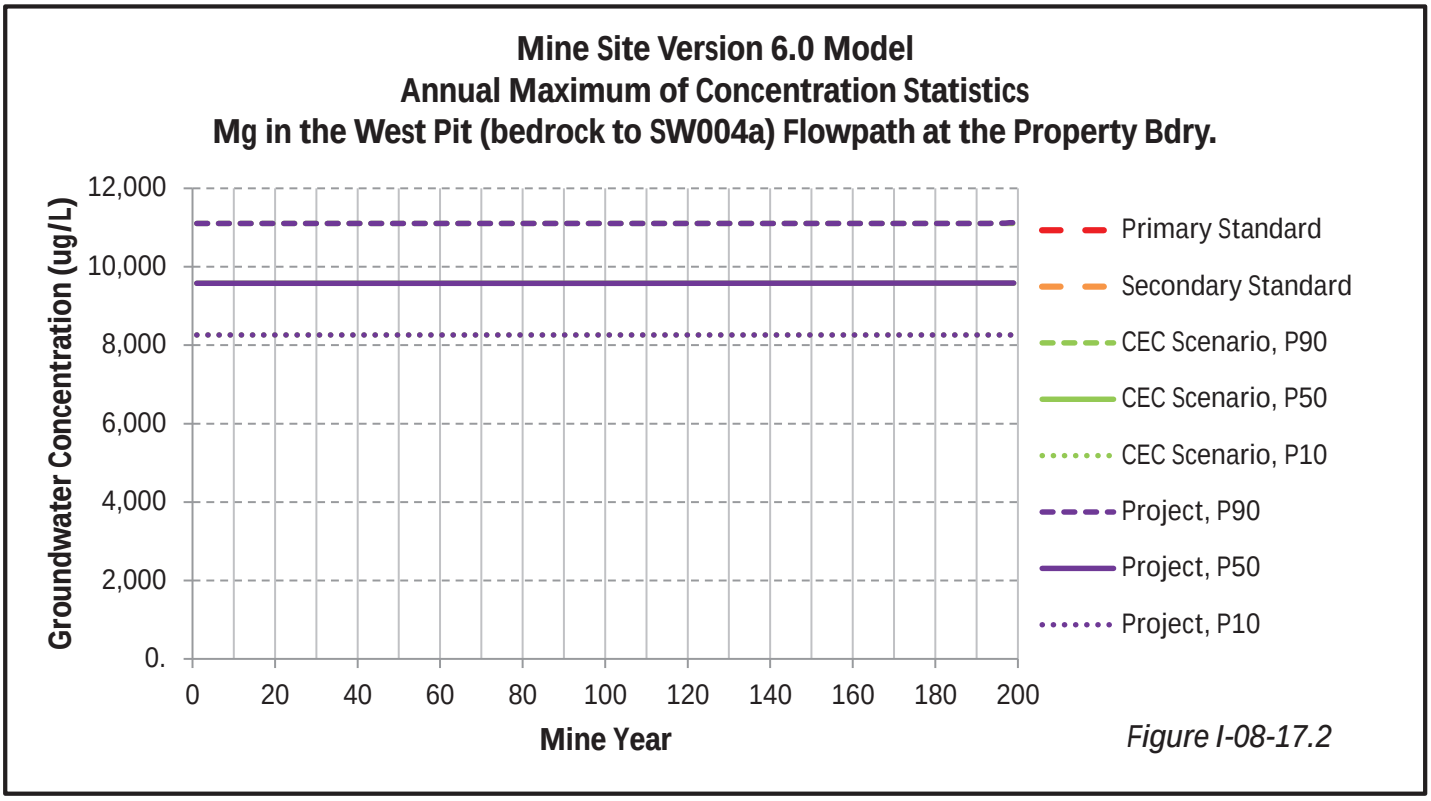

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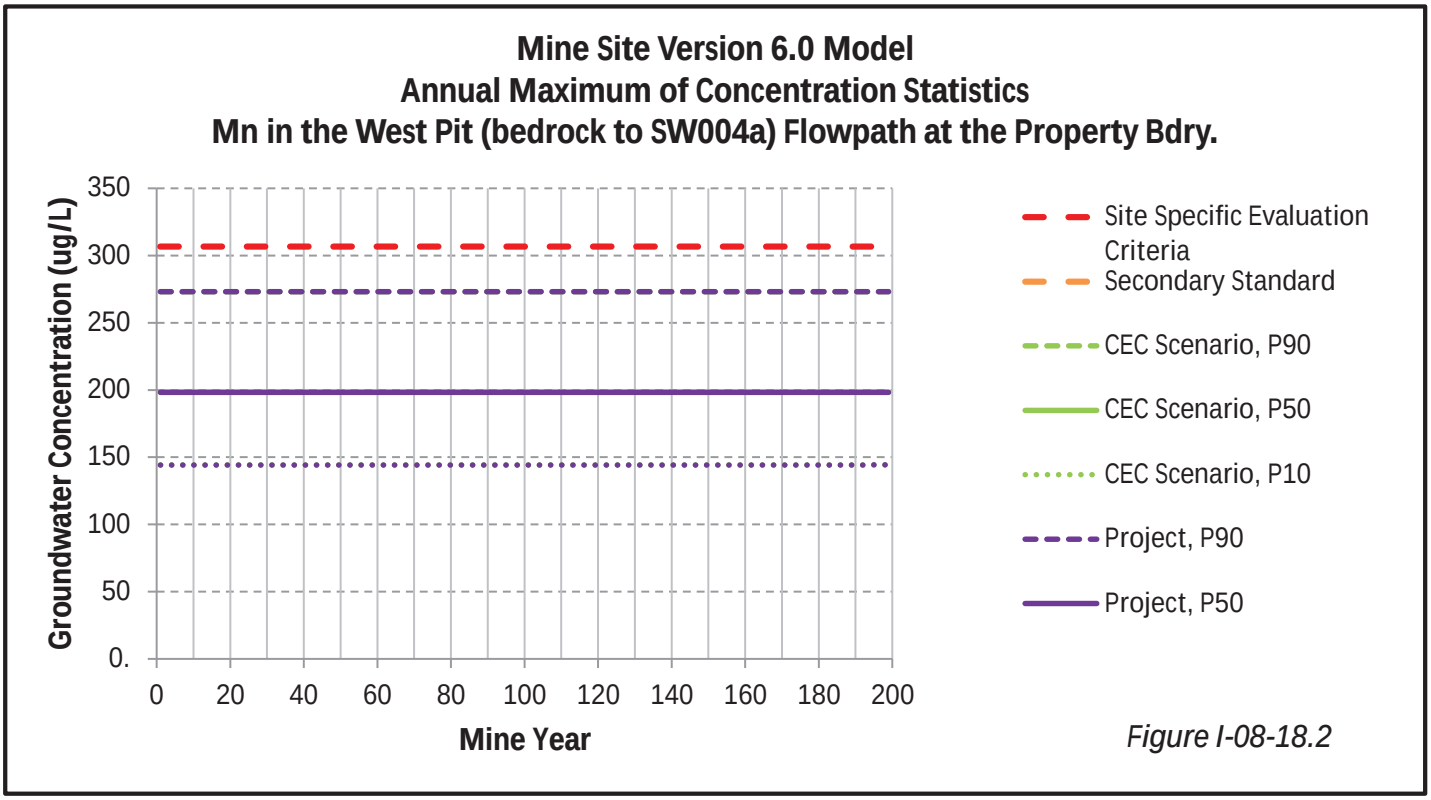

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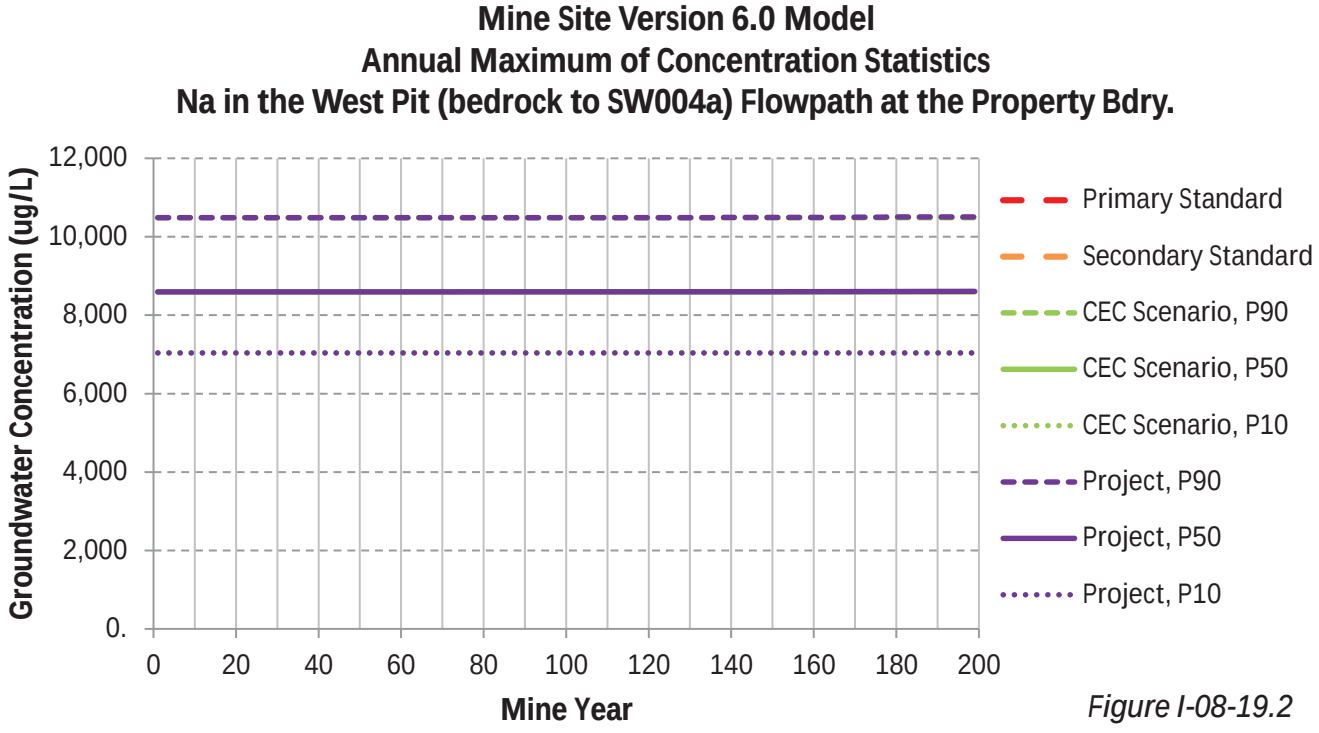

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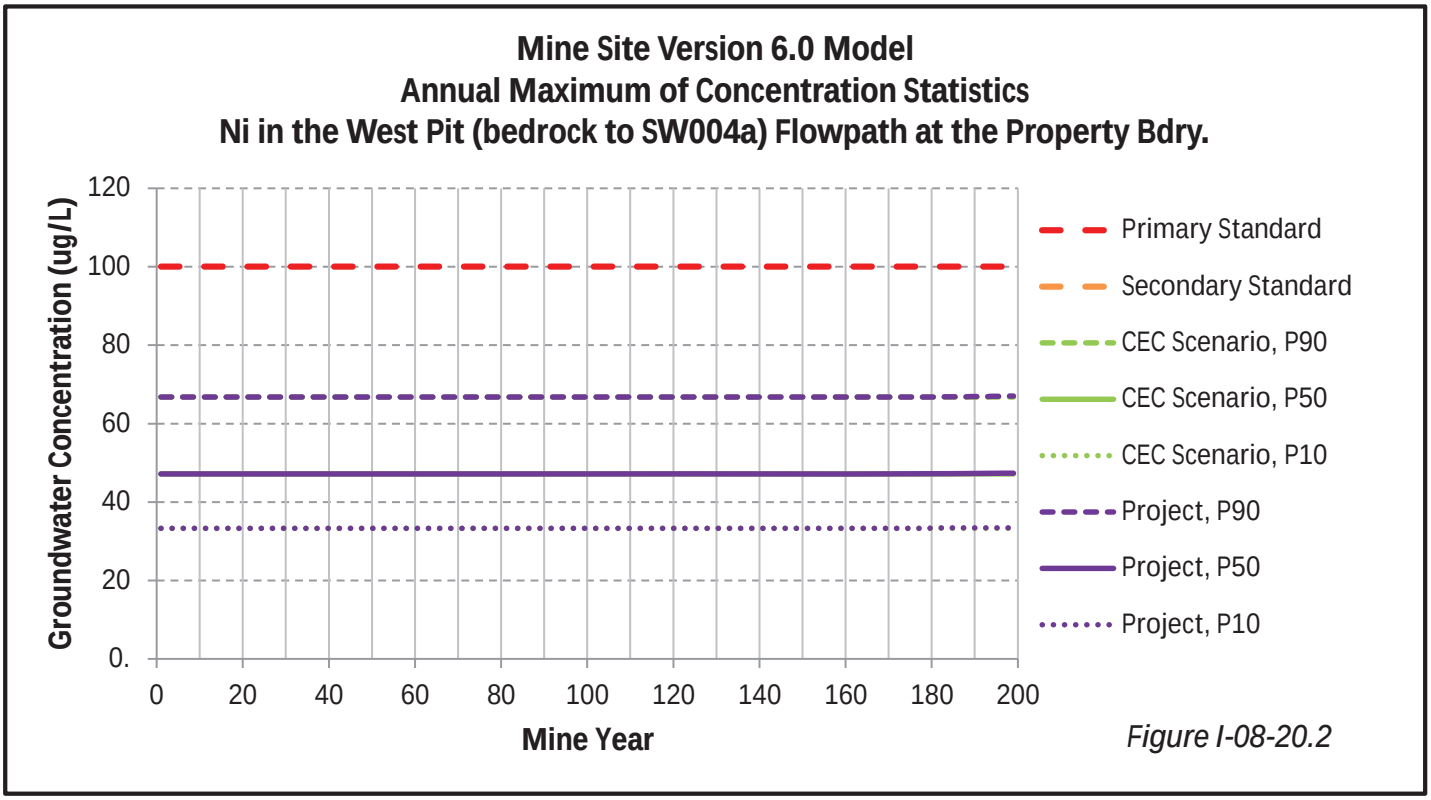

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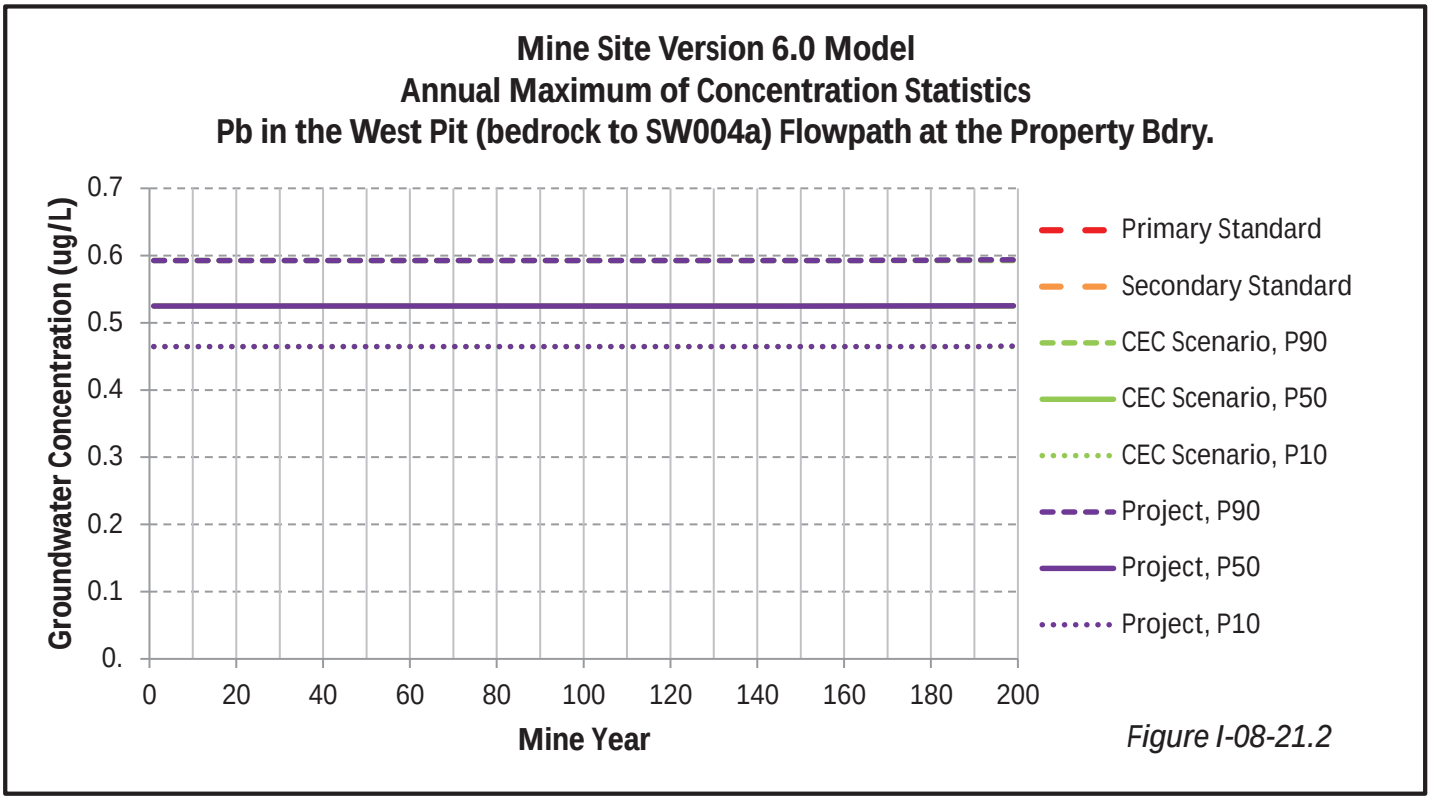

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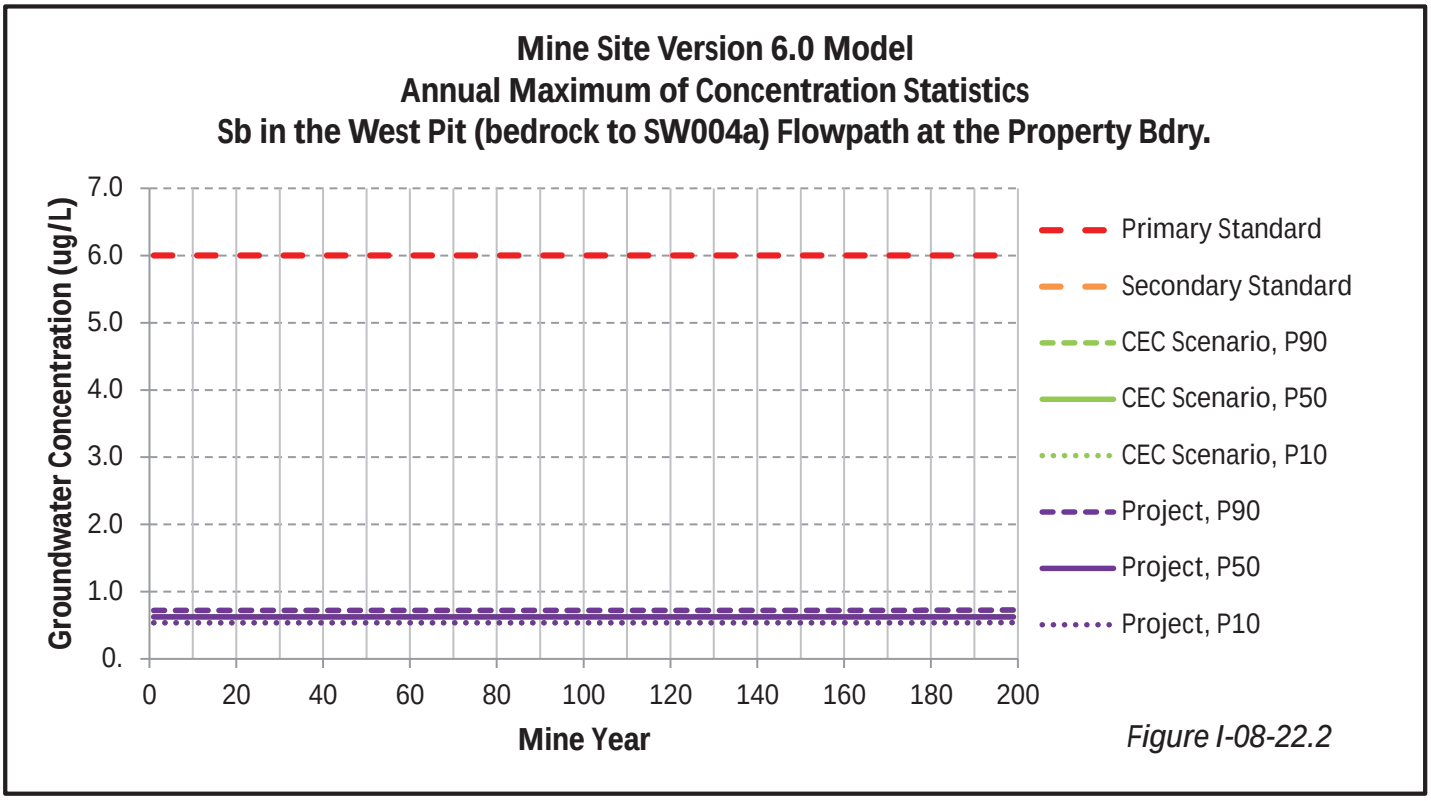

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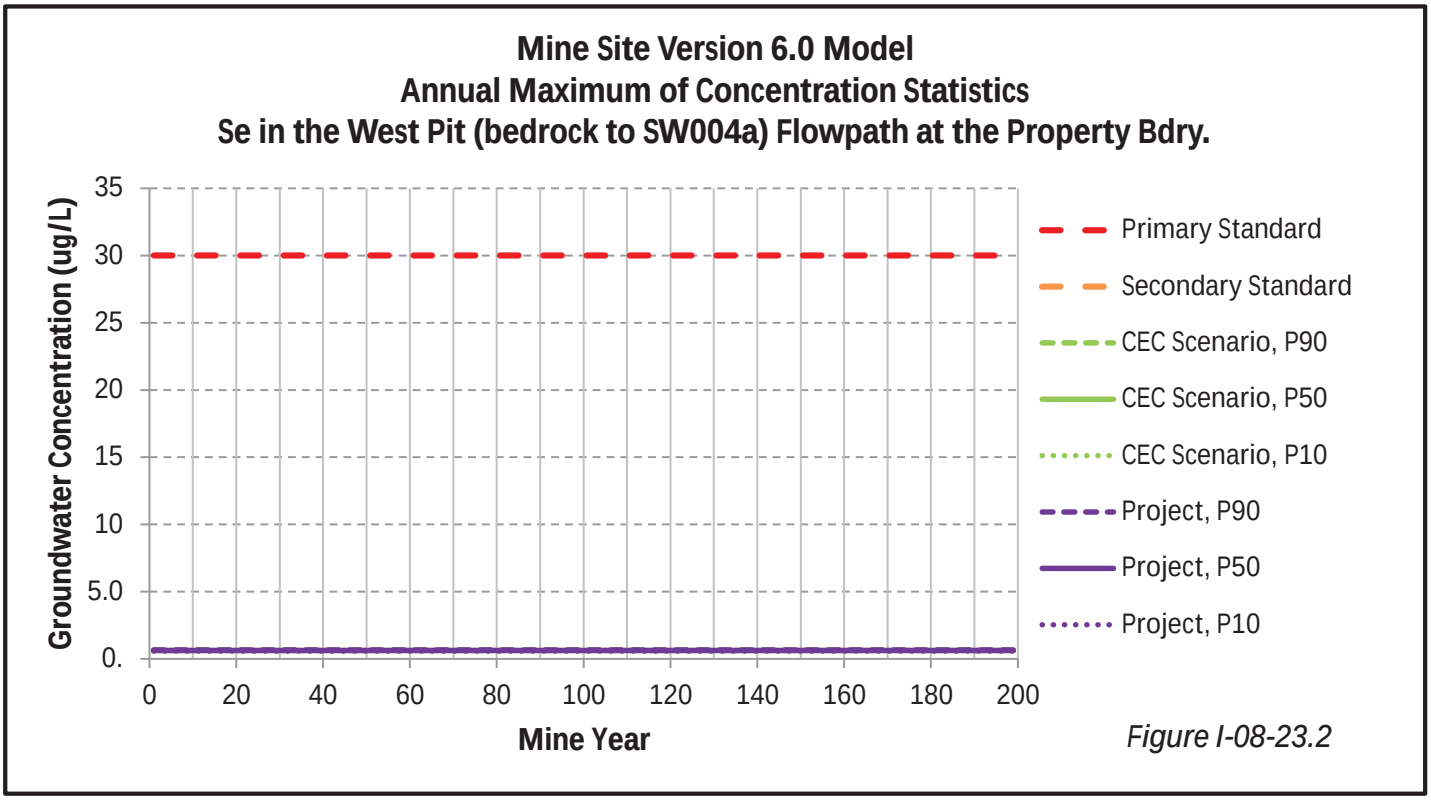

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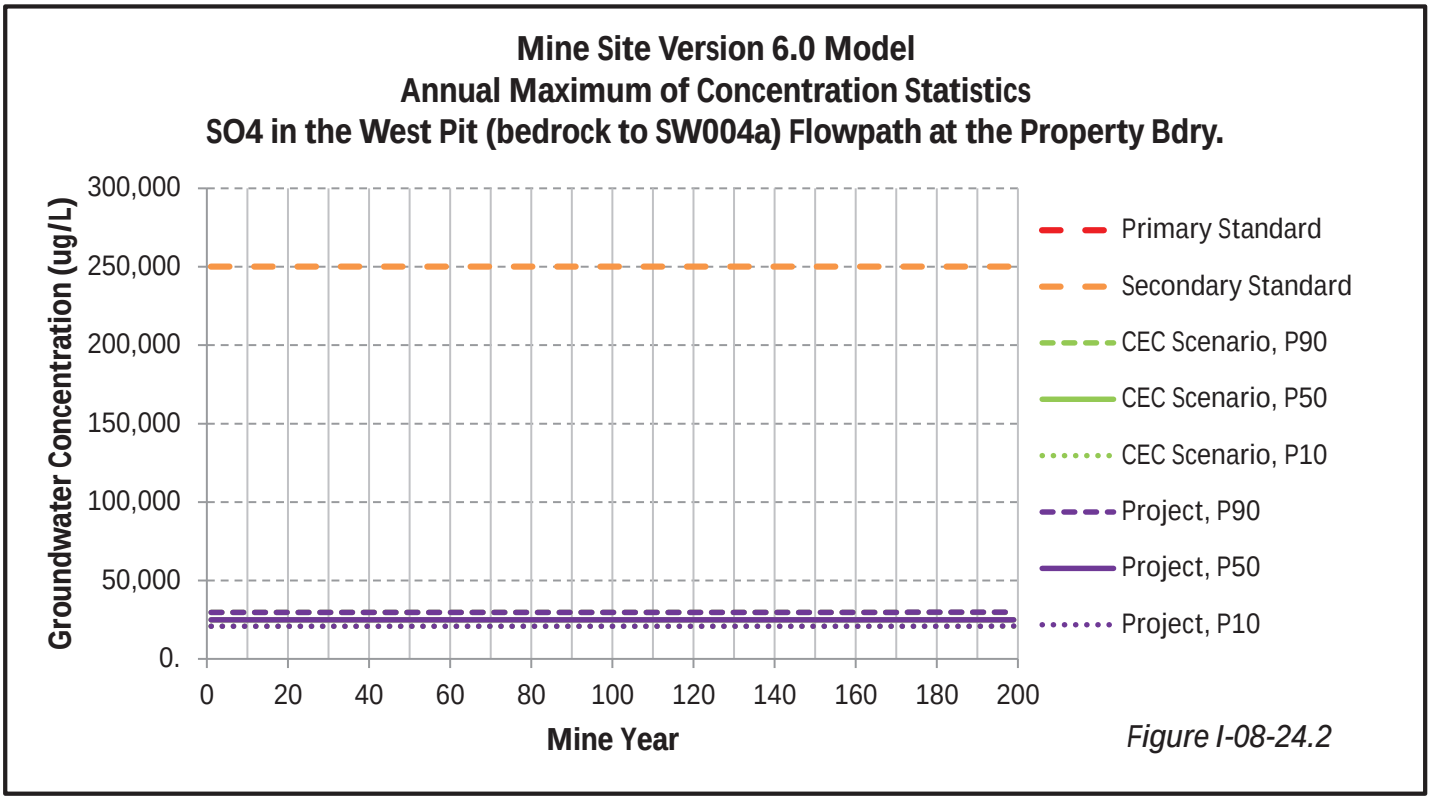

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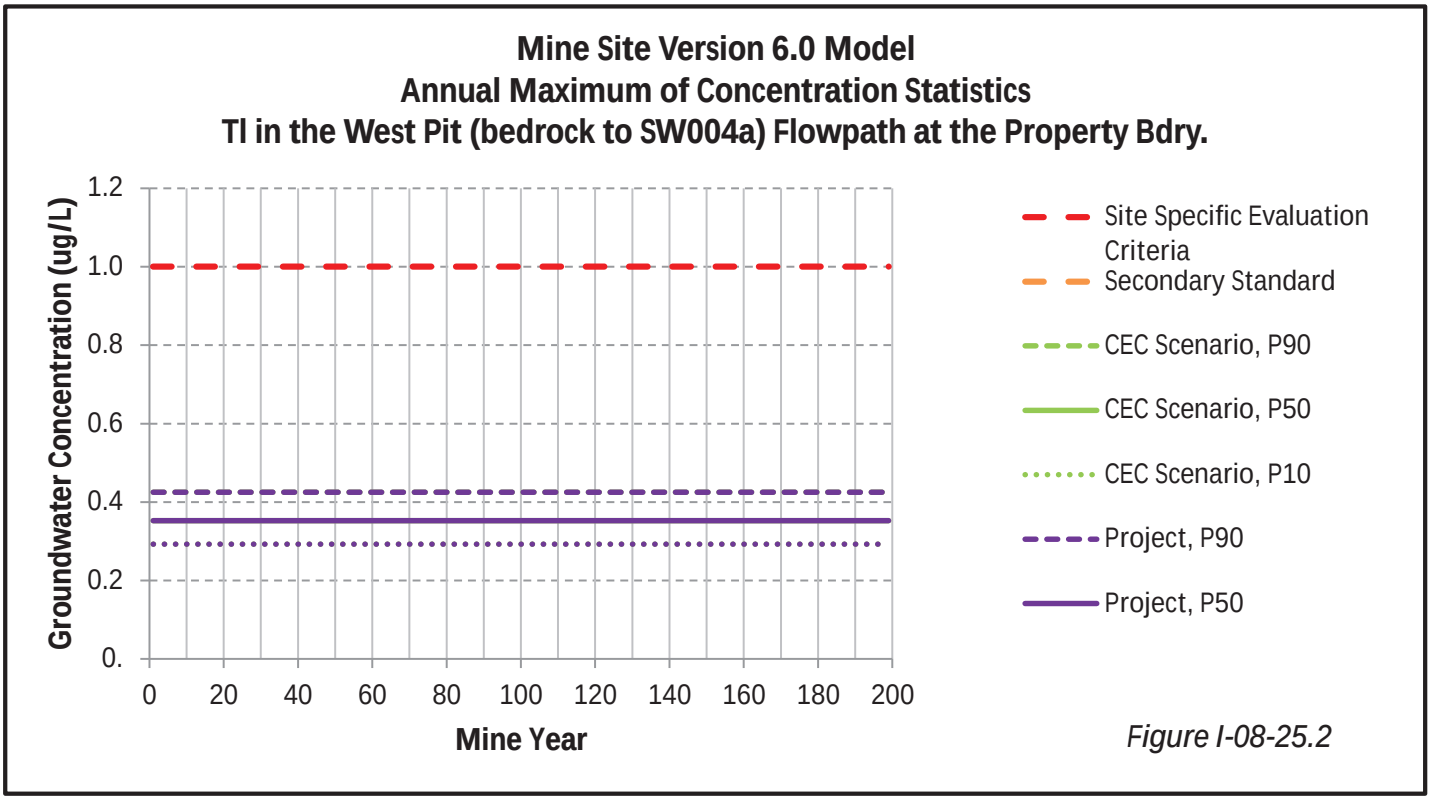

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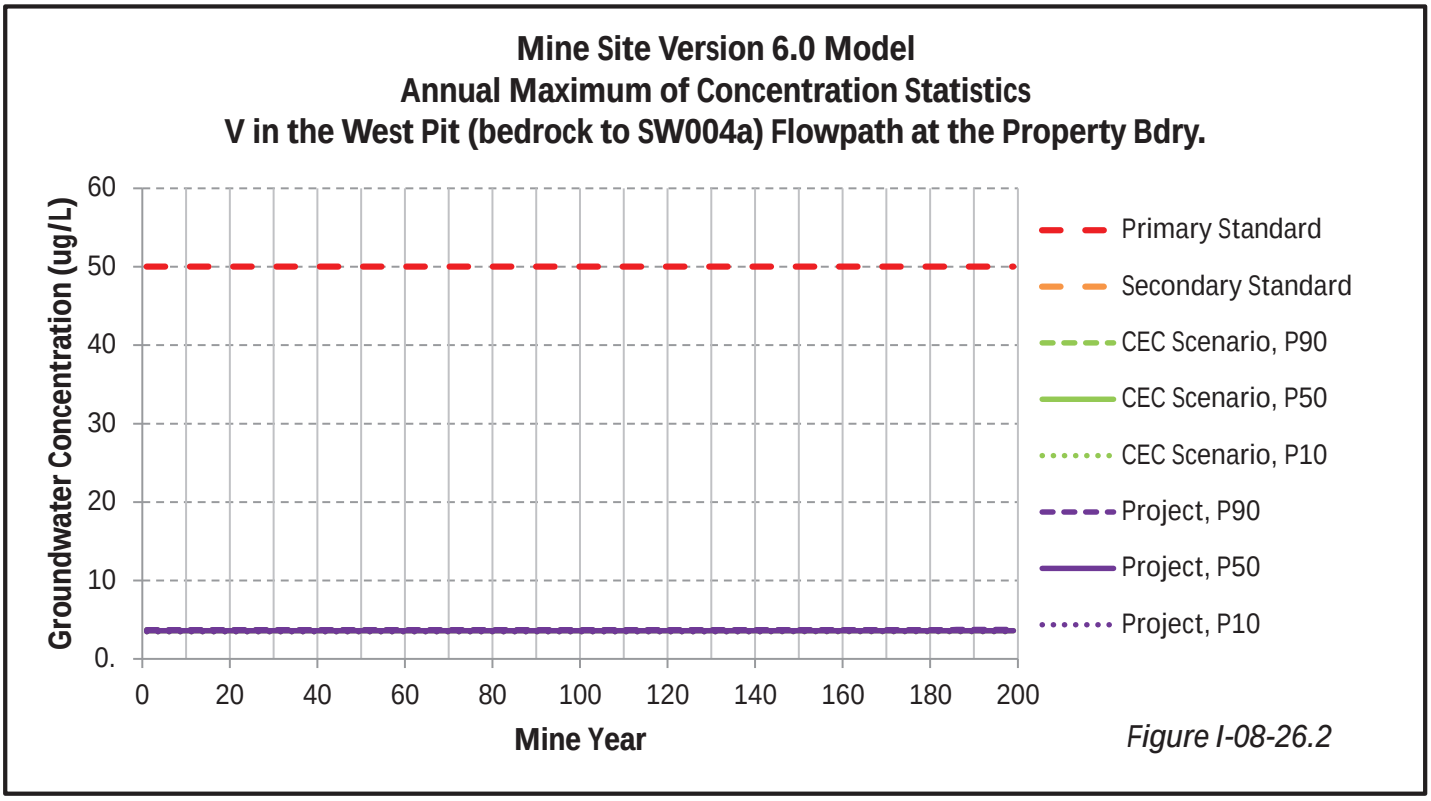

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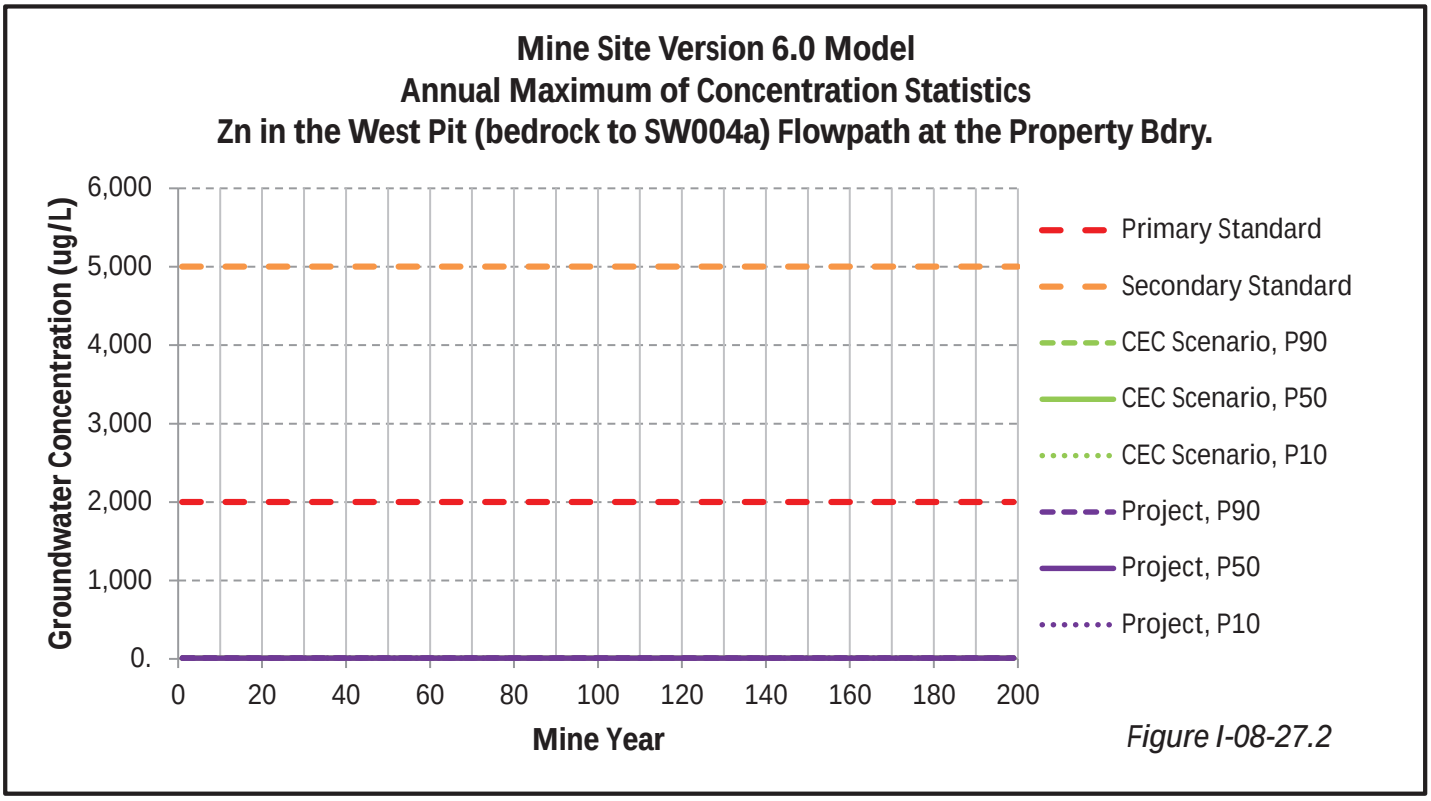


Figure I-08-27.2

Attachment J

Partridge River Hydrologic Impact Assessment Results

Table 1 - Richter Statistics for Location SW002 (based on USGS-adjusted XP-SWMM Results)

Statistic (Unit)	SW002						
	Existing Conditions	Year 1	Year 2	Year 11	Year 20	West Pit Filling	Long-term Closure
Annual Daily Mean (cfs)	6.09	5.84	5.84	5.79	6.12	6.09	6.09
October Mean (cfs)	22.76	21.81	21.83	21.63	22.86	22.75	22.75
November Mean (cfs)	4.59	4.33	4.32	4.27	4.47	4.46	4.46
December Mean (cfs)	1.70	1.64	1.64	1.62	1.71	1.70	1.70
January Mean (cfs)	0.57	0.54	0.54	0.54	0.56	0.56	0.56
February Mean (cfs)	1.06	1.01	1.01	1.00	1.06	1.05	1.05
March Mean (cfs)	1.44	1.38	1.38	1.37	1.45	1.44	1.44
April Mean (cfs)	30.58	29.23	29.24	28.96	30.56	30.41	30.42
May Mean (cfs)	7.36	7.04	7.06	7.01	7.46	7.43	7.43
June Mean (cfs)	11.55	11.15	11.17	11.08	11.70	11.65	11.65
July Mean (cfs)	5.97	5.78	5.78	5.74	6.06	6.04	6.04
August Mean (cfs)	3.00	2.89	2.89	2.87	3.03	3.03	3.03
September Mean (cfs)	8.93	8.62	8.61	8.52	9.02	8.97	8.97
Average Annual 1-day Max (cfs)	82.15	79.02	79.32	78.65	83.06	82.60	82.62
Average Annual 3-day Max (cfs)	71.62	68.68	68.88	68.29	72.16	71.81	71.82
Average Annual 7-day Max (cfs)	54.13	51.77	51.83	51.35	54.22	53.97	53.98
Average Annual 30-day Max (cfs)	23.59	22.58	22.60	22.39	23.67	23.57	23.58
Average Annual 90-day Max (cfs)	13.71	13.14	13.14	13.02	13.77	13.71	13.71
Average Annual 1-day Min (cfs)	0.40	0.38	0.38	0.38	0.40	0.40	0.40
Average Annual 3-day Min (cfs)	0.39	0.37	0.37	0.37	0.39	0.39	0.39
Average Annual 7-day Min (cfs)	0.40	0.38	0.38	0.37	0.39	0.39	0.39
Average Annual 30-day Min (cfs)	0.41	0.39	0.39	0.38	0.40	0.40	0.40
Average Annual 90-day Min (cfs)	0.63	0.60	0.60	0.60	0.62	0.62	0.62
Date of Max 1-day Mean (cfs)	168.85	168.85	168.85	168.85	168.75	168.75	168.75
Date of Min 1-day Mean (cfs)	211.94	211.94	211.94	211.94	211.94	211.94	211.94
Number of Zero Flow Days/year	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7-day Minimum/Annual Mean	0.06	0.06	0.06	0.06	0.06	0.06	0.06
No of High Pulses/yr	15.17	15.17	15.34	15.43	15.34	15.43	15.43
Mean Duration of High Pulses (days)	4.97	4.97	4.90	4.88	4.90	4.88	4.88
Total High Pulse Duration/yr (days)	69.23	69.23	69.16	69.16	69.16	69.16	69.16
No of Low Pulses/yr	3.63	3.63	3.63	3.63	3.63	3.63	3.63
Mean Duration of Low Pulses (days)	19.04	19.06	19.06	19.06	19.06	19.06	19.06
Total Low Pulse Duration/yr (days)	70.89	70.98	70.98	70.98	70.98	70.98	70.98
Avg. Hydrograph Increase (cfs/day)	3.94	3.84	3.85	3.86	4.04	4.03	4.01
Avg. Hydrograph Decrease (cfs/day)	1.49	1.44	1.45	1.44	1.52	1.51	1.51
No of Flow Reversals/yr	54.84	53.51	53.63	53.14	53.26	53.02	53.32

Table 2 - Richter Statistics for Location SW003 (based on USGS-adjusted XP-SWMM Results)

Statistic (Unit)	SW003						
	Existing Conditions	Year 1	Year 2	Year 11	Year 20	West Pit Filling	Long-term Closure
Annual Daily Mean (cfs)	7.35	7.27	7.27	7.21	7.54	7.52	7.52
October Mean (cfs)	27.58	27.20	27.23	27.00	28.23	28.15	28.15
November Mean (cfs)	5.80	5.31	5.30	5.25	5.46	5.44	5.44
December Mean (cfs)	2.29	2.03	2.03	2.01	2.09	2.09	2.09
January Mean (cfs)	0.73	0.67	0.67	0.67	0.69	0.69	0.69
February Mean (cfs)	1.27	1.26	1.26	1.25	1.30	1.30	1.30
March Mean (cfs)	1.70	1.73	1.73	1.72	1.80	1.80	1.80
April Mean (cfs)	36.89	36.34	36.35	36.03	37.64	37.53	37.54
May Mean (cfs)	9.05	8.87	8.90	8.84	9.28	9.27	9.27
June Mean (cfs)	13.54	13.75	13.78	13.68	14.31	14.26	14.26
July Mean (cfs)	7.09	7.14	7.14	7.10	7.42	7.40	7.40
August Mean (cfs)	3.57	3.59	3.57	3.56	3.71	3.72	3.72
September Mean (cfs)	10.84	10.70	10.72	10.63	11.13	11.07	11.07
Average Annual 1-day Max (cfs)	93.30	95.93	96.27	95.67	100.50	100.25	100.25
Average Annual 3-day Max (cfs)	82.84	85.36	85.60	84.98	89.00	88.78	88.78
Average Annual 7-day Max (cfs)	63.57	64.56	64.66	64.14	67.09	66.91	66.92
Average Annual 30-day Max (cfs)	28.25	28.17	28.20	27.97	29.26	29.20	29.20
Average Annual 90-day Max (cfs)	16.52	16.38	16.39	16.25	16.99	16.95	16.96
Average Annual 1-day Min (cfs)	0.52	0.50	0.50	0.49	0.51	0.51	0.51
Average Annual 3-day Min (cfs)	0.51	0.48	0.48	0.48	0.50	0.50	0.50
Average Annual 7-day Min (cfs)	0.51	0.49	0.49	0.48	0.51	0.50	0.50
Average Annual 30-day Min (cfs)	0.51	0.49	0.49	0.48	0.50	0.50	0.50
Average Annual 90-day Min (cfs)	0.80	0.74	0.74	0.73	0.76	0.76	0.76
Date of Max 1-day Mean (cfs)	168.85	168.75	168.75	168.65	168.65	168.55	168.55
Date of Min 1-day Mean (cfs)	211.94	211.94	211.94	211.94	211.94	211.94	211.94
Number of Zero Flow Days/year	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7-day Minimum/Annual Mean	0.06	0.06	0.06	0.06	0.06	0.06	0.06
No of High Pulses/yr	13.80	15.26	15.34	15.43	15.34	15.43	15.43
Mean Duration of High Pulses (days)	5.46	4.94	4.91	4.88	4.90	4.88	4.88
Total High Pulse Duration/yr (days)	69.31	69.23	69.23	69.16	69.16	69.16	69.16
No of Low Pulses/yr	3.57	3.60	3.60	3.57	3.60	3.60	3.60
Mean Duration of Low Pulses (days)	19.15	19.16	19.16	19.30	19.16	19.16	19.16
Total Low Pulse Duration/yr (days)	70.27	70.81	70.81	70.81	70.81	70.81	70.81
Avg. Hydrograph Increase (cfs/day)	4.69	4.52	4.54	4.54	4.81	4.84	4.83
Avg. Hydrograph Decrease (cfs/day)	1.63	1.71	1.72	1.72	1.81	1.80	1.80
No of Flow Reversals/yr	49.75	53.87	54.29	54.11	53.99	53.63	53.81

Table 3 - Richter Statistics for Location SW004 (based on USGS-adjusted XP-SWMM Results)

Statistic (Unit)	SW004						
	Existing Conditions	Year 1	Year 2	Year 11	Year 20	West Pit Filling	Long-term Closure
Annual Daily Mean (cfs)	13.97	13.51	13.52	13.37	13.70	14.08	14.07
October Mean (cfs)	52.43	50.60	50.64	50.07	51.26	52.74	52.73
November Mean (cfs)	11.68	10.77	10.77	10.66	10.91	11.16	11.16
December Mean (cfs)	4.43	4.02	4.02	3.97	4.06	4.16	4.16
January Mean (cfs)	1.37	1.26	1.26	1.25	1.28	1.31	1.31
February Mean (cfs)	2.40	2.32	2.32	2.30	2.35	2.42	2.42
March Mean (cfs)	3.10	3.04	3.04	3.01	3.08	3.18	3.18
April Mean (cfs)	71.41	68.77	68.80	68.04	69.66	71.58	71.58
May Mean (cfs)	17.52	16.90	16.92	16.74	17.17	17.66	17.66
June Mean (cfs)	25.56	25.32	25.38	25.11	25.78	26.45	26.45
July Mean (cfs)	13.54	13.23	13.22	13.10	13.43	13.75	13.75
August Mean (cfs)	6.40	6.41	6.39	6.33	6.48	6.67	6.67
September Mean (cfs)	20.14	19.47	19.43	19.24	19.70	20.19	20.18
Average Annual 1-day Max (cfs)	156.05	153.39	153.80	152.09	156.44	160.64	160.75
Average Annual 3-day Max (cfs)	149.39	146.54	146.80	145.18	149.12	153.25	153.30
Average Annual 7-day Max (cfs)	120.31	117.54	117.64	116.34	119.22	122.58	122.58
Average Annual 30-day Max (cfs)	54.01	52.46	52.49	51.91	53.19	54.70	54.70
Average Annual 90-day Max (cfs)	31.66	30.66	30.66	30.33	31.07	31.95	31.94
Average Annual 1-day Min (cfs)	0.85	0.79	0.79	0.78	0.81	0.83	0.83
Average Annual 3-day Min (cfs)	0.84	0.78	0.78	0.78	0.79	0.82	0.81
Average Annual 7-day Min (cfs)	0.86	0.81	0.81	0.80	0.82	0.84	0.84
Average Annual 30-day Min (cfs)	0.92	0.86	0.86	0.85	0.87	0.89	0.89
Average Annual 90-day Min (cfs)	1.46	1.35	1.35	1.34	1.36	1.39	1.39
Date of Max 1-day Mean (cfs)	169.26	169.26	169.26	169.26	169.26	169.26	169.26
Date of Min 1-day Mean (cfs)	195.10	195.29	195.29	195.29	195.29	195.29	195.29
Number of Zero Flow Days/year	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7-day Minimum/Annual Mean	0.05	0.05	0.05	0.05	0.05	0.05	0.05
No of High Pulses/yr	10.54	10.71	10.80	10.80	10.71	10.71	10.71
Mean Duration of High Pulses (days)	7.15	7.03	6.98	6.98	7.03	7.03	7.03
Total High Pulse Duration/yr (days)	69.23	69.23	69.23	69.23	69.23	69.23	69.23
No of Low Pulses/yr	2.72	2.64	2.64	2.64	2.67	2.72	2.72
Mean Duration of Low Pulses (days)	26.30	27.13	27.13	27.13	26.86	26.30	26.30
Total Low Pulse Duration/yr (days)	73.46	73.55	73.55	73.55	73.55	73.46	73.46
Avg. Hydrograph Increase (cfs/day)	6.93	6.91	6.96	6.89	7.14	7.40	7.40
Avg. Hydrograph Decrease (cfs/day)	2.46	2.49	2.50	2.47	2.56	2.64	2.65
No of Flow Reversals/yr	38.43	40.73	40.73	40.37	40.49	40.86	40.79

Table 4 - Richter Statistics for Location SW004a (based on USGS-adjusted XP-SWMM Results)

Statistic (Unit)	SW004a						
	Existing Conditions	Year 1	Year 2	Year 11	Year 20	West Pit Filling	Long-term Closure
Annual Daily Mean (cfs)	38.33	37.74	37.62	36.66	37.32	37.10	38.72
October Mean (cfs)	144.03	141.74	141.25	137.55	140.03	139.19	143.92
November Mean (cfs)	31.61	30.45	30.35	29.68	30.14	30.02	31.64
December Mean (cfs)	12.85	12.33	12.29	12.02	12.19	12.13	13.80
January Mean (cfs)	3.95	3.83	3.81	3.72	3.78	3.76	4.60
February Mean (cfs)	6.59	6.48	6.46	6.29	6.41	6.37	7.02
March Mean (cfs)	8.50	8.42	8.39	8.15	8.32	8.26	8.59
April Mean (cfs)	200.60	197.10	196.46	191.58	194.90	193.79	198.90
May Mean (cfs)	49.01	48.33	48.20	46.98	47.88	47.55	49.58
June Mean (cfs)	67.75	67.46	67.23	65.54	66.77	66.44	69.71
July Mean (cfs)	35.56	35.14	34.92	34.04	34.67	34.46	36.68
August Mean (cfs)	16.71	16.64	16.75	16.32	16.62	16.53	17.48
September Mean (cfs)	52.93	51.97	51.64	50.26	51.20	50.83	53.44
Average Annual 1-day Max (cfs)	467.64	466.18	465.61	453.52	460.44	460.57	469.00
Average Annual 3-day Max (cfs)	423.15	419.69	418.77	408.40	415.28	414.08	422.12
Average Annual 7-day Max (cfs)	337.99	334.01	333.02	324.65	330.25	328.68	335.74
Average Annual 30-day Max (cfs)	150.46	148.47	148.21	144.46	147.03	146.24	149.90
Average Annual 90-day Max (cfs)	87.78	86.48	86.26	84.06	85.58	85.07	87.62
Average Annual 1-day Min (cfs)	2.08	2.00	1.99	1.91	1.95	1.93	2.89
Average Annual 3-day Min (cfs)	2.05	1.97	1.96	1.89	1.93	1.90	2.83
Average Annual 7-day Min (cfs)	2.11	2.04	2.02	1.94	1.99	1.96	2.86
Average Annual 30-day Min (cfs)	2.44	2.38	2.36	2.30	2.33	2.32	2.98
Average Annual 90-day Min (cfs)	3.87	3.76	3.73	3.64	3.70	3.68	4.50
Date of Max 1-day Mean (cfs)	168.95	168.95	168.95	168.95	168.95	168.95	168.95
Date of Min 1-day Mean (cfs)	201.64	201.64	201.64	201.64	201.64	201.64	201.64
Number of Zero Flow Days/year	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7-day Minimum/Annual Mean	0.05	0.05	0.05	0.05	0.05	0.05	0.07
No of High Pulses/yr	9.00	9.17	9.17	9.26	9.17	9.17	9.17
Mean Duration of High Pulses (days)	8.42	8.25	8.25	8.17	8.25	8.25	8.25
Total High Pulse Duration/yr (days)	69.61	69.53	69.53	69.53	69.53	69.53	69.53
No of Low Pulses/yr	2.61	2.61	2.61	2.61	2.64	2.64	2.64
Mean Duration of Low Pulses (days)	27.34	27.38	27.38	27.41	27.13	27.13	27.10
Total Low Pulse Duration/yr (days)	73.38	73.46	73.46	73.55	73.55	73.55	73.46
Avg. Hydrograph Increase (cfs/day)	20.61	20.82	20.87	20.17	20.47	20.65	20.92
Avg. Hydrograph Decrease (cfs/day)	7.06	7.18	7.19	7.04	7.13	7.18	7.25
No of Flow Reversals/yr	38.49	39.46	39.34	39.22	39.22	39.34	39.22

Table 5 - Richter Stastics for Location SW004b (based on USGS-adjusted XP-SWMM Results)

Statistic (Unit)	SW004b						
	Existing Conditions	Year 1	Year 2	Year 11	Year 20	West Pit Filling	Long-term Closure
Annual Daily Mean (cfs)	57.61	57.19	57.08	56.11	56.78	56.55	58.16
October Mean (cfs)	216.09	214.29	213.80	210.09	212.58	211.72	216.46
November Mean (cfs)	49.19	47.86	47.76	47.07	47.54	47.41	49.04
December Mean (cfs)	19.71	19.16	19.11	18.84	19.02	18.95	20.62
January Mean (cfs)	5.97	5.85	5.84	5.75	5.81	5.79	6.62
February Mean (cfs)	9.88	9.79	9.77	9.60	9.72	9.68	10.33
March Mean (cfs)	12.50	12.49	12.46	12.23	12.39	12.33	12.66
April Mean (cfs)	300.54	297.38	296.74	291.83	295.16	294.04	299.18
May Mean (cfs)	75.47	75.16	75.02	73.80	74.70	74.37	76.38
June Mean (cfs)	101.13	101.44	101.20	99.47	100.72	100.38	103.61
July Mean (cfs)	54.55	54.32	54.09	53.21	53.85	53.63	55.79
August Mean (cfs)	24.79	24.87	24.97	24.54	24.85	24.75	25.68
September Mean (cfs)	79.31	79.03	78.70	77.33	78.25	77.90	80.45
Average Annual 1-day Max (cfs)	630.96	626.68	626.15	614.71	621.43	621.57	629.37
Average Annual 3-day Max (cfs)	593.08	588.77	587.87	577.77	584.47	583.46	591.19
Average Annual 7-day Max (cfs)	490.93	487.64	486.62	478.18	483.84	482.15	489.36
Average Annual 30-day Max (cfs)	223.95	222.55	222.28	218.50	221.09	220.27	223.97
Average Annual 90-day Max (cfs)	131.81	130.86	130.63	128.43	129.95	129.43	131.98
Average Annual 1-day Min (cfs)	3.36	3.29	3.28	3.20	3.24	3.21	4.17
Average Annual 3-day Min (cfs)	3.30	3.23	3.22	3.14	3.18	3.16	4.08
Average Annual 7-day Min (cfs)	3.38	3.31	3.30	3.22	3.26	3.24	4.13
Average Annual 30-day Min (cfs)	3.81	3.75	3.73	3.67	3.70	3.69	4.34
Average Annual 90-day Min (cfs)	5.87	5.76	5.74	5.65	5.70	5.68	6.50
Date of Max 1-day Mean (cfs)	169.16	169.16	169.16	169.16	169.16	169.16	169.16
Date of Min 1-day Mean (cfs)	208.29	205.30	205.30	205.30	205.30	205.30	201.55
Number of Zero Flow Days/year	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7-day Minimum/Annual Mean	0.05	0.05	0.05	0.05	0.05	0.05	0.06
No of High Pulses/yr	8.23	8.49	8.49	8.49	8.49	8.49	8.57
Mean Duration of High Pulses (days)	9.19	8.92	8.92	8.92	8.92	8.92	8.83
Total High Pulse Duration/yr (days)	69.53	69.53	69.53	69.53	69.53	69.53	69.53
No of Low Pulses/yr	2.72	2.69	2.69	2.69	2.67	2.67	2.61
Mean Duration of Low Pulses (days)	26.37	26.66	26.66	26.66	26.93	26.93	27.44
Total Low Pulse Duration/yr (days)	73.64	73.73	73.73	73.73	73.73	73.73	73.64
Avg. Hydrograph Increase (cfs/day)	28.11	28.75	28.83	28.06	28.44	28.50	28.65
Avg. Hydrograph Decrease (cfs/day)	9.38	9.41	9.41	9.25	9.34	9.38	9.48
No of Flow Reversals/yr	38.80	39.04	39.04	39.04	38.92	38.92	38.80

Table 6 - Richter Statistics for Location SW005 (based on USGS-adjusted XP-SWMM Results)

Statistic (Unit)	SW005						
	Existing Conditions	Year 1	Year 2	Year 11	Year 20	West Pit Filling	Long-term Closure
Annual Daily Mean (cfs)	74.77	74.40	73.76	73.33	73.99	73.76	75.34
October Mean (cfs)	278.61	276.50	274.04	272.47	274.87	274.04	278.63
November Mean (cfs)	66.08	64.88	64.32	63.96	64.50	64.32	66.08
December Mean (cfs)	26.61	25.97	25.76	25.64	25.82	25.76	27.40
January Mean (cfs)	7.73	7.60	7.54	7.50	7.56	7.54	8.36
February Mean (cfs)	12.73	12.66	12.55	12.48	12.59	12.55	13.21
March Mean (cfs)	15.16	15.17	15.03	14.94	15.08	15.03	15.34
April Mean (cfs)	390.47	387.72	384.30	382.09	385.46	384.30	389.50
May Mean (cfs)	102.88	102.28	101.54	100.94	101.83	101.54	103.41
June Mean (cfs)	127.93	129.70	128.52	127.68	128.96	128.52	131.77
July Mean (cfs)	75.93	75.81	75.16	74.67	75.36	75.16	77.17
August Mean (cfs)	31.89	31.98	31.86	31.67	31.96	31.86	32.74
September Mean (cfs)	103.64	103.00	101.90	101.35	102.23	101.90	104.34
Average Annual 1-day Max (cfs)	737.26	741.32	732.14	726.43	734.54	732.14	743.98
Average Annual 3-day Max (cfs)	722.50	720.70	714.13	708.87	715.96	714.13	723.14
Average Annual 7-day Max (cfs)	623.57	620.65	614.98	611.14	616.77	614.98	622.40
Average Annual 30-day Max (cfs)	288.80	287.67	285.35	283.63	286.21	285.35	289.08
Average Annual 90-day Max (cfs)	170.99	170.15	168.73	167.74	169.24	168.73	171.26
Average Annual 1-day Min (cfs)	4.32	4.25	4.18	4.16	4.20	4.18	5.07
Average Annual 3-day Min (cfs)	4.28	4.21	4.14	4.12	4.16	4.14	4.99
Average Annual 7-day Min (cfs)	4.32	4.25	4.18	4.17	4.20	4.18	5.01
Average Annual 30-day Min (cfs)	4.91	4.85	4.79	4.77	4.81	4.79	5.40
Average Annual 90-day Min (cfs)	7.61	7.51	7.43	7.40	7.45	7.43	8.21
Date of Max 1-day Mean (cfs)	169.77	169.77	169.77	169.77	169.77	169.77	169.77
Date of Min 1-day Mean (cfs)	203.28	203.28	203.28	203.28	203.28	203.28	210.98
Number of Zero Flow Days/year	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7-day Minimum/Annual Mean	0.05	0.05	0.05	0.05	0.05	0.05	0.06
No of High Pulses/yr	6.51	6.77	6.77	6.77	6.77	6.77	6.77
Mean Duration of High Pulses (days)	11.61	11.15	11.15	11.15	11.15	11.15	11.14
Total High Pulse Duration/yr (days)	69.53	69.38	69.38	69.38	69.38	69.38	69.31
No of Low Pulses/yr	1.97	1.89	1.89	1.89	1.92	1.89	2.03
Mean Duration of Low Pulses (days)	37.26	38.88	38.88	38.88	38.34	38.88	36.07
Total Low Pulse Duration/yr (days)	75.50	75.59	75.59	75.59	75.59	75.59	75.06
Avg. Hydrograph Increase (cfs/day)	24.65	24.97	24.72	24.50	24.75	24.72	24.86
Avg. Hydrograph Decrease (cfs/day)	10.19	10.32	10.21	10.11	10.24	10.21	10.42
No of Flow Reversals/yr	34.02	34.50	34.74	34.50	34.98	34.74	34.02

Table 7 - Richter Statistics for Location SW006 (based on USGS-adjusted XP-SWMM Results)

Statistic (Unit)	SW006						
	Existing Conditions	Year 1	Year 2	Year 11	Year 20	West Pit Filling	Long-term Closure
Annual Daily Mean (cfs)	78.87	78.61	78.49	77.54	78.20	77.97	79.55
October Mean (cfs)	294.02	292.24	291.76	288.21	290.61	289.79	294.37
November Mean (cfs)	68.93	67.65	67.53	66.72	67.26	67.08	68.84
December Mean (cfs)	27.72	27.11	27.07	26.79	26.97	26.91	28.55
January Mean (cfs)	8.11	7.98	7.96	7.88	7.93	7.91	8.74
February Mean (cfs)	13.42	13.37	13.35	13.18	13.30	13.26	13.92
March Mean (cfs)	16.12	16.18	16.15	15.94	16.09	16.03	16.34
April Mean (cfs)	410.56	407.95	407.29	402.31	405.68	404.53	409.72
May Mean (cfs)	108.04	107.72	107.56	106.37	107.27	106.98	108.84
June Mean (cfs)	135.19	137.45	137.25	135.42	136.70	136.27	139.52
July Mean (cfs)	80.42	80.41	80.20	79.27	79.96	79.76	81.77
August Mean (cfs)	33.98	34.16	34.26	33.85	34.14	34.05	34.93
September Mean (cfs)	110.01	109.69	109.38	108.03	108.92	108.59	111.03
Average Annual 1-day Max (cfs)	761.75	761.34	760.12	746.35	754.49	752.03	763.99
Average Annual 3-day Max (cfs)	748.85	745.11	743.98	732.86	740.09	738.05	747.64
Average Annual 7-day Max (cfs)	651.79	648.17	647.07	638.52	644.20	642.29	649.90
Average Annual 30-day Max (cfs)	303.66	302.74	302.47	298.69	301.28	300.41	304.17
Average Annual 90-day Max (cfs)	180.10	179.42	179.19	177.01	178.51	178.00	180.53
Average Annual 1-day Min (cfs)	4.69	4.62	4.61	4.53	4.58	4.55	5.45
Average Annual 3-day Min (cfs)	4.65	4.57	4.56	4.49	4.53	4.50	5.36
Average Annual 7-day Min (cfs)	4.68	4.61	4.60	4.52	4.56	4.54	5.37
Average Annual 30-day Min (cfs)	5.28	5.21	5.20	5.14	5.17	5.16	5.77
Average Annual 90-day Min (cfs)	8.10	7.99	7.97	7.88	7.94	7.92	8.71
Date of Max 1-day Mean (cfs)	169.77	169.77	169.77	169.77	169.77	169.77	169.77
Date of Min 1-day Mean (cfs)	200.39	200.39	200.39	200.39	200.39	200.39	208.09
Number of Zero Flow Days/year	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7-day Minimum/Annual Mean	0.05	0.05	0.05	0.05	0.05	0.05	0.06
No of High Pulses/yr	6.34	6.43	6.43	6.34	6.43	6.34	6.43
Mean Duration of High Pulses (days)	11.93	11.77	11.77	11.93	11.77	11.93	11.77
Total High Pulse Duration/yr (days)	69.53	69.53	69.53	69.53	69.53	69.53	69.53
No of Low Pulses/yr	1.97	2.13	2.13	2.11	2.13	2.13	2.11
Mean Duration of Low Pulses (days)	37.31	34.63	34.63	35.11	34.67	34.67	34.74
Total Low Pulse Duration/yr (days)	75.59	75.86	75.86	75.95	75.95	75.95	75.15
Avg. Hydrograph Increase (cfs/day)	26.33	26.49	26.44	25.88	26.22	26.17	26.71
Avg. Hydrograph Decrease (cfs/day)	10.23	10.27	10.27	10.09	10.21	10.18	10.33
No of Flow Reversals/yr	38.86	39.58	39.58	39.71	39.58	39.46	39.83

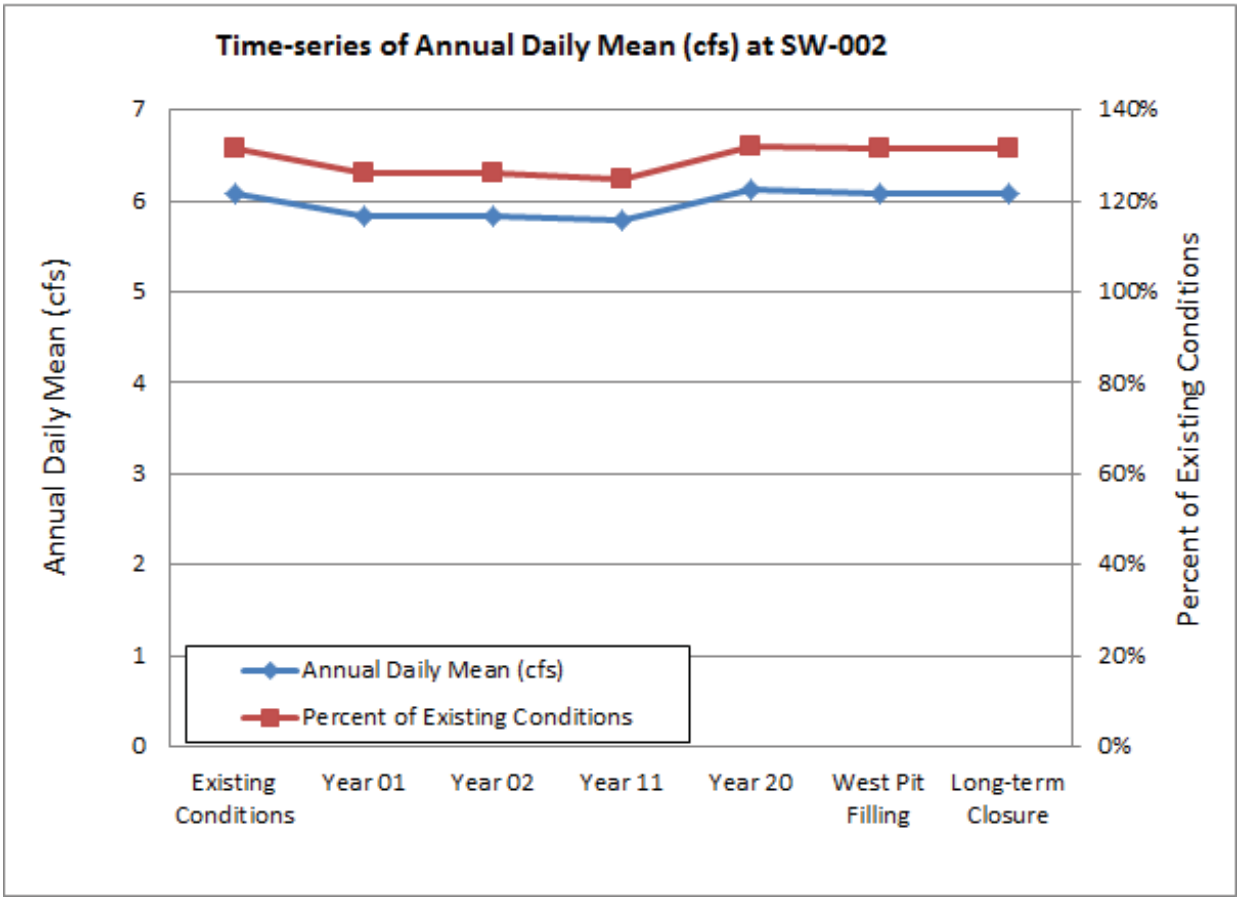


Figure 1 Time Series of Average Annual Flow – SW002

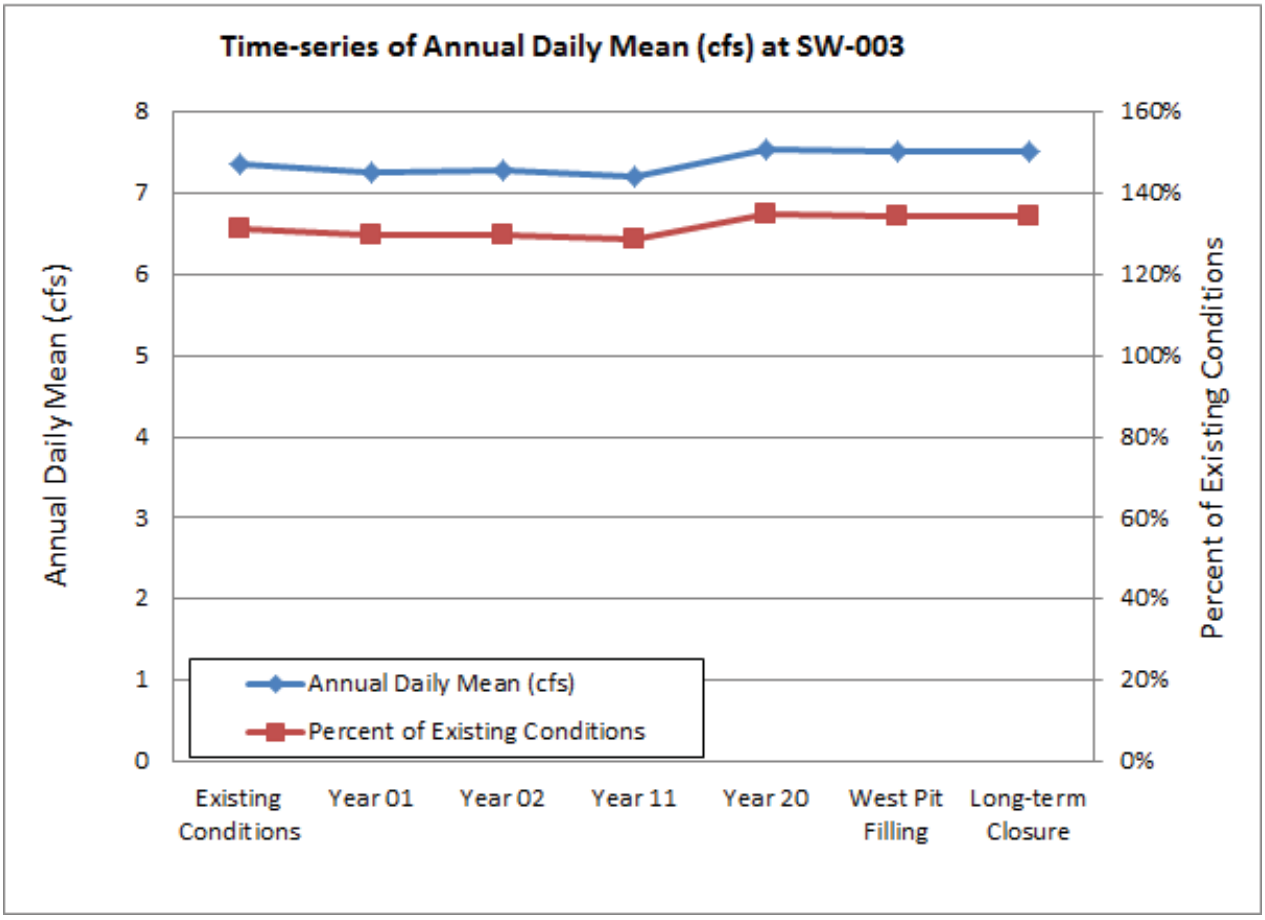


Figure 2 Time Series of Average Annual Flow – SW003

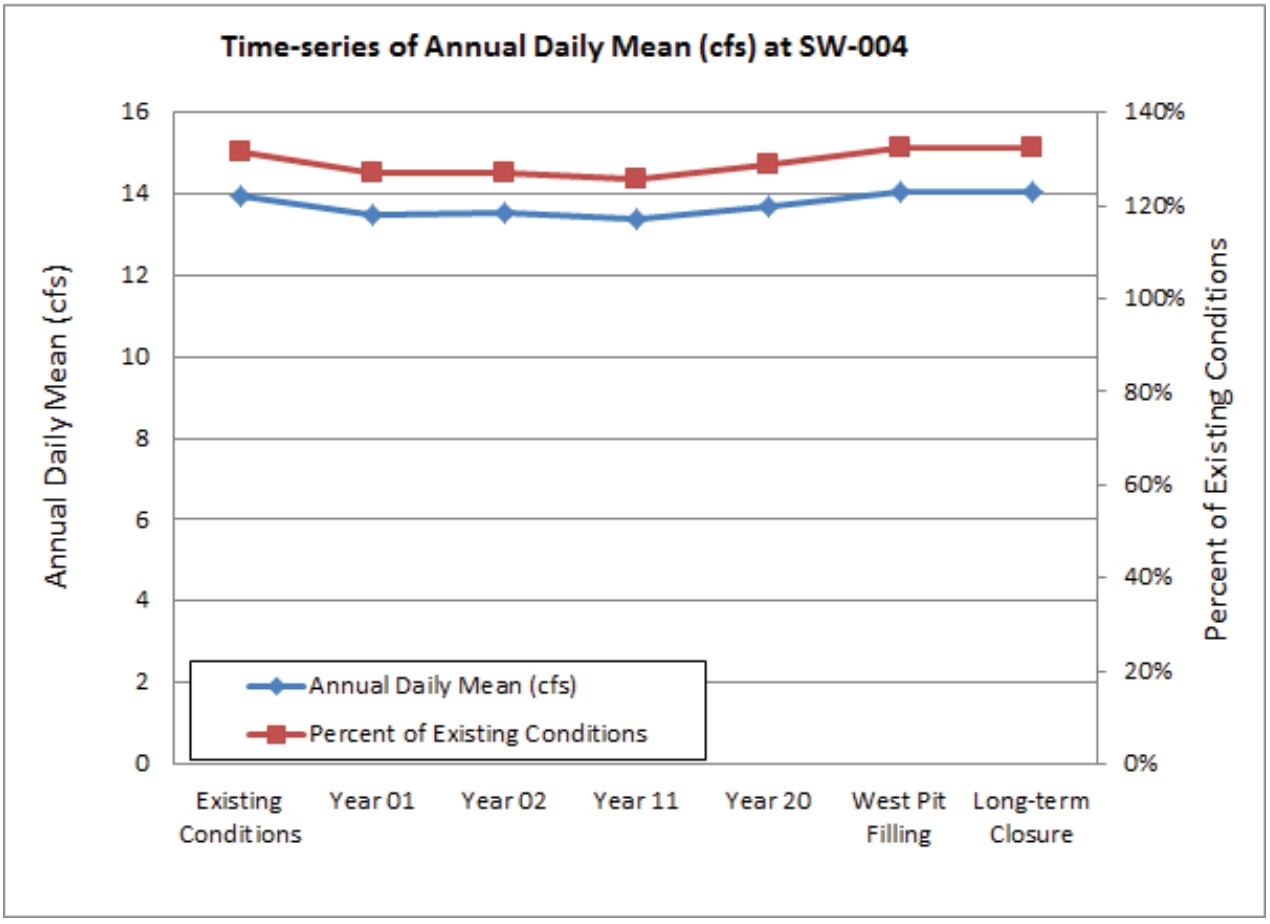


Figure 3 **Time Series of Average Annual Flow – SW004**

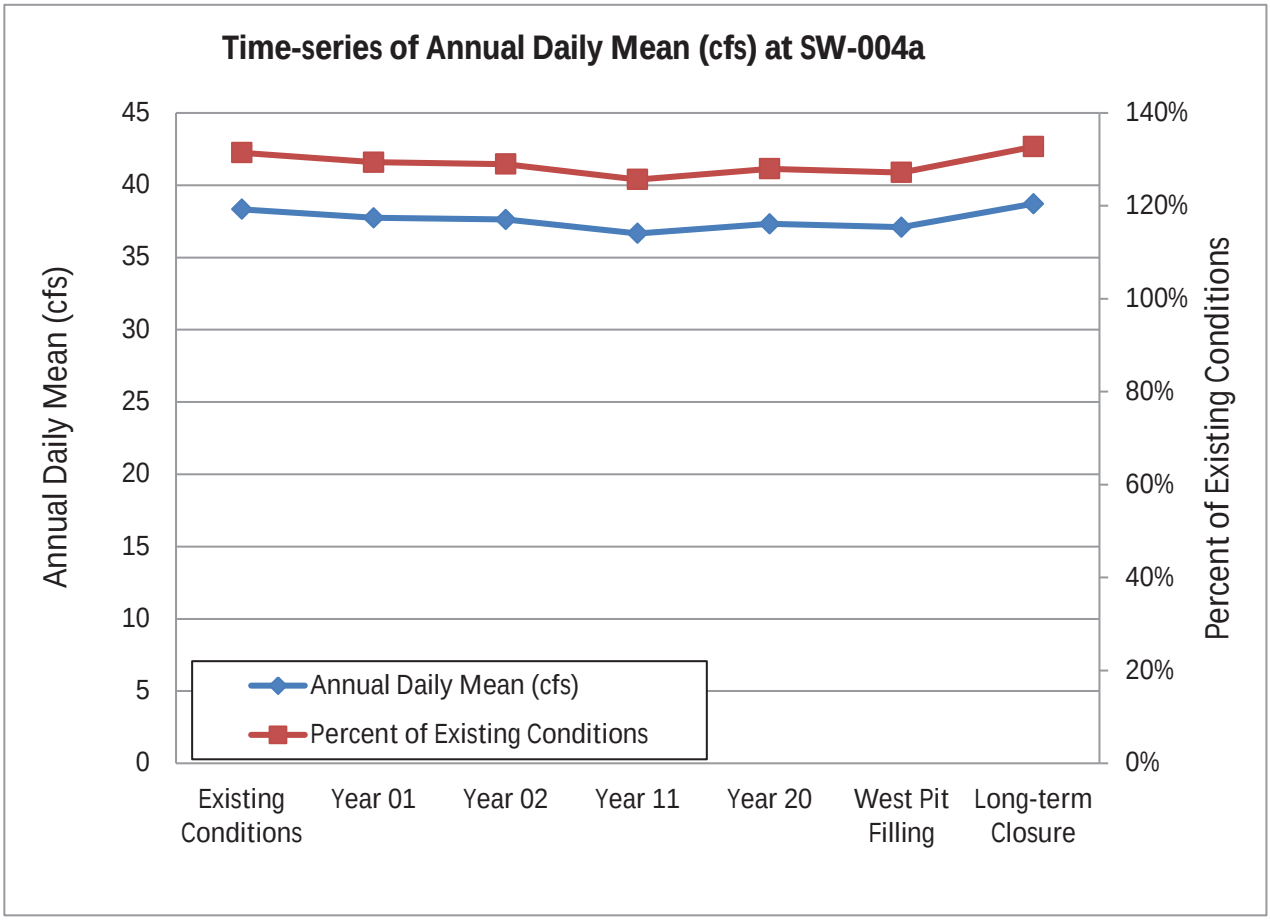


Figure 4 **Time Series of Average Annual Flow – SW004a**

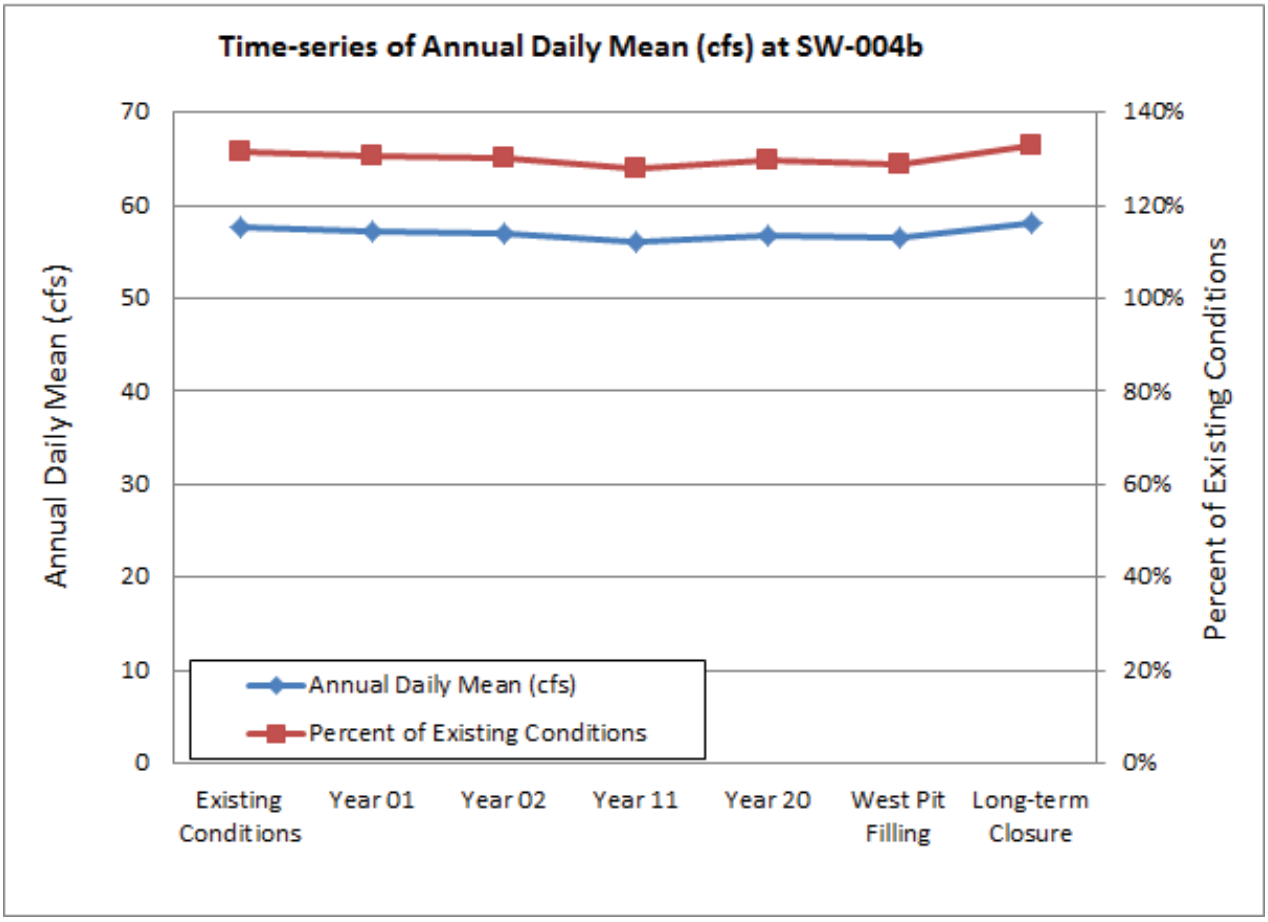


Figure 5 **Time Series of Average Annual Flow – SW004b**

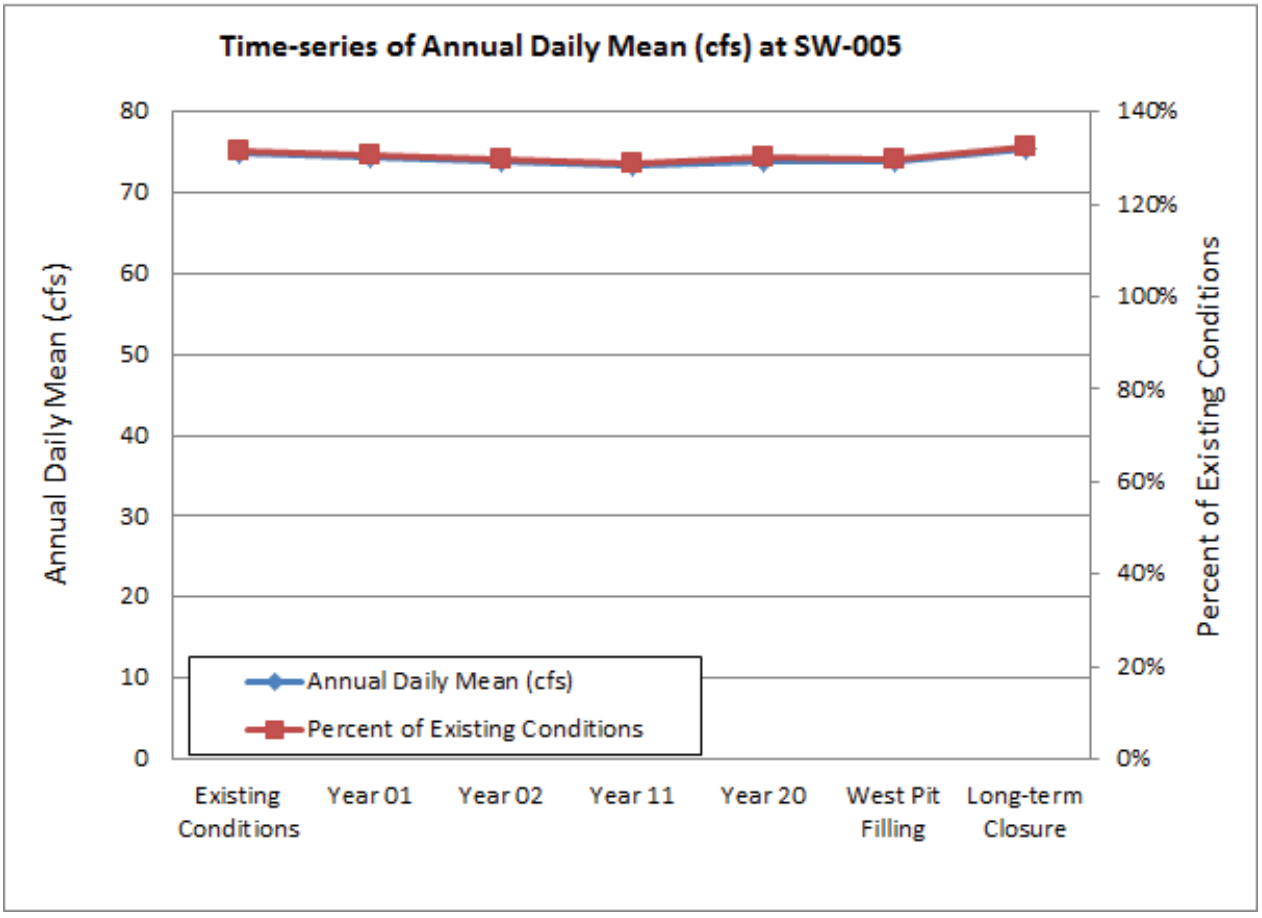


Figure 6 **Time Series of Average Annual Flow – SW005**

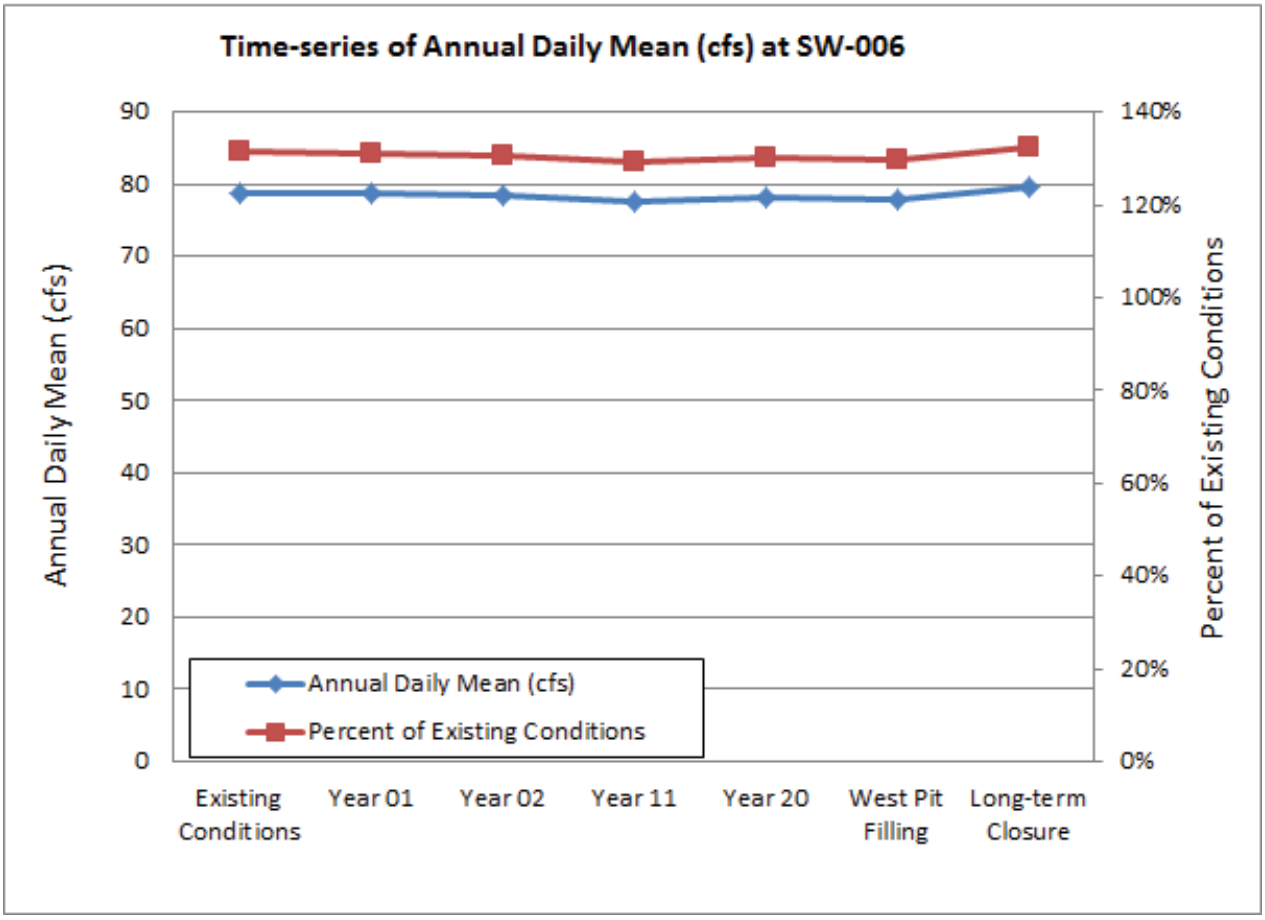


Figure 7 **Time Series of Average Annual Flow – SW006**

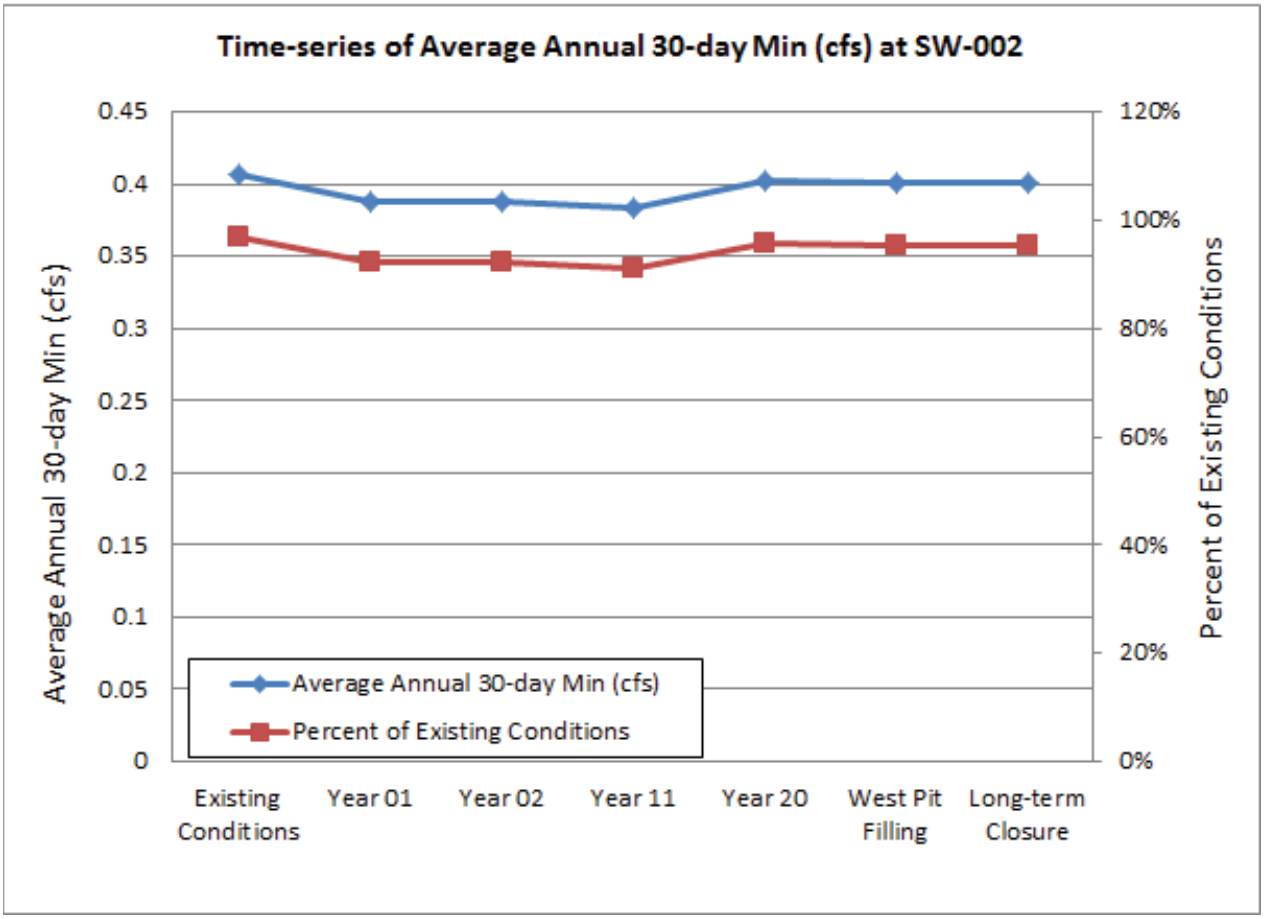


Figure 8 **Time Series of Average Annual 30-day Minimum Flow – SW002**

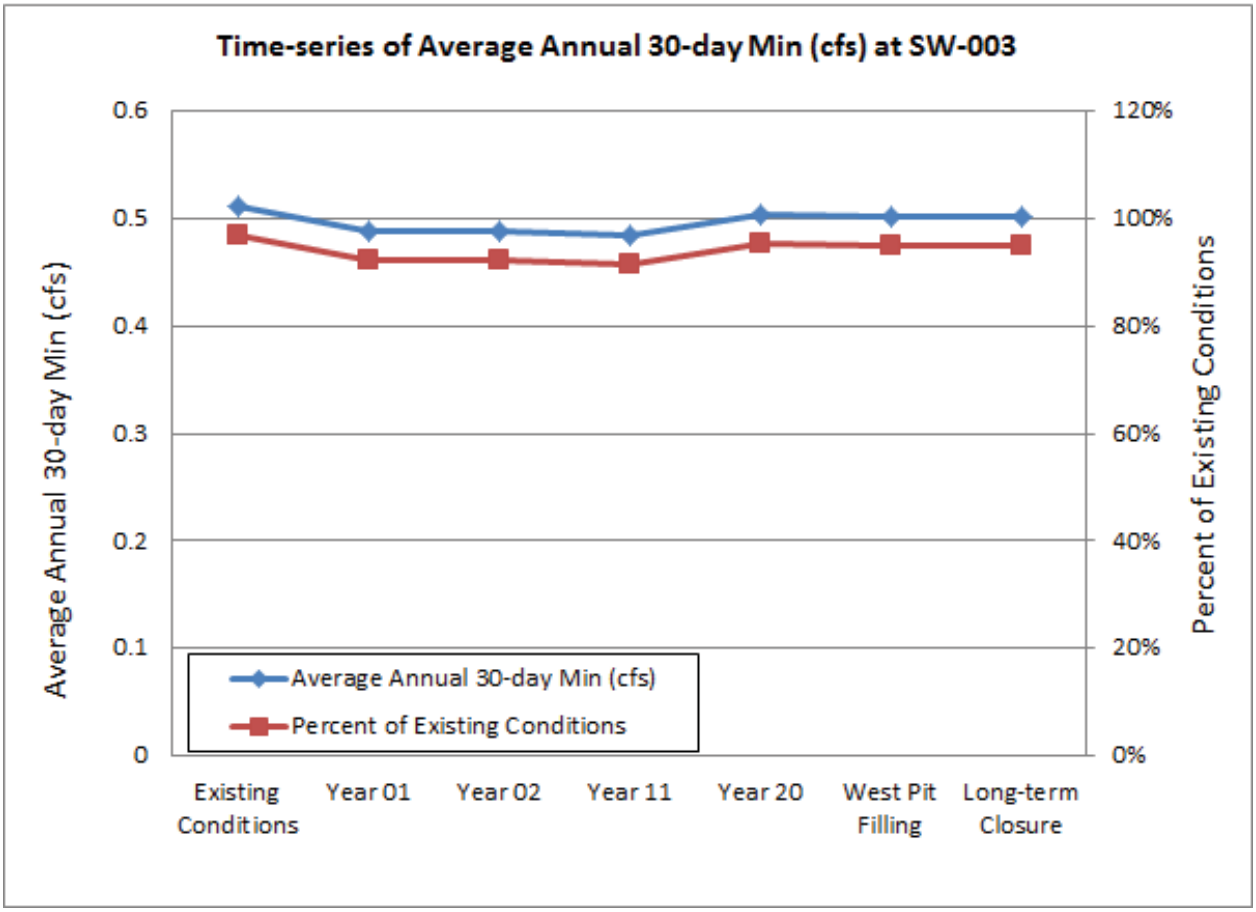


Figure 9 **Time Series of Average Annual 30-day Minimum Flow – SW003**

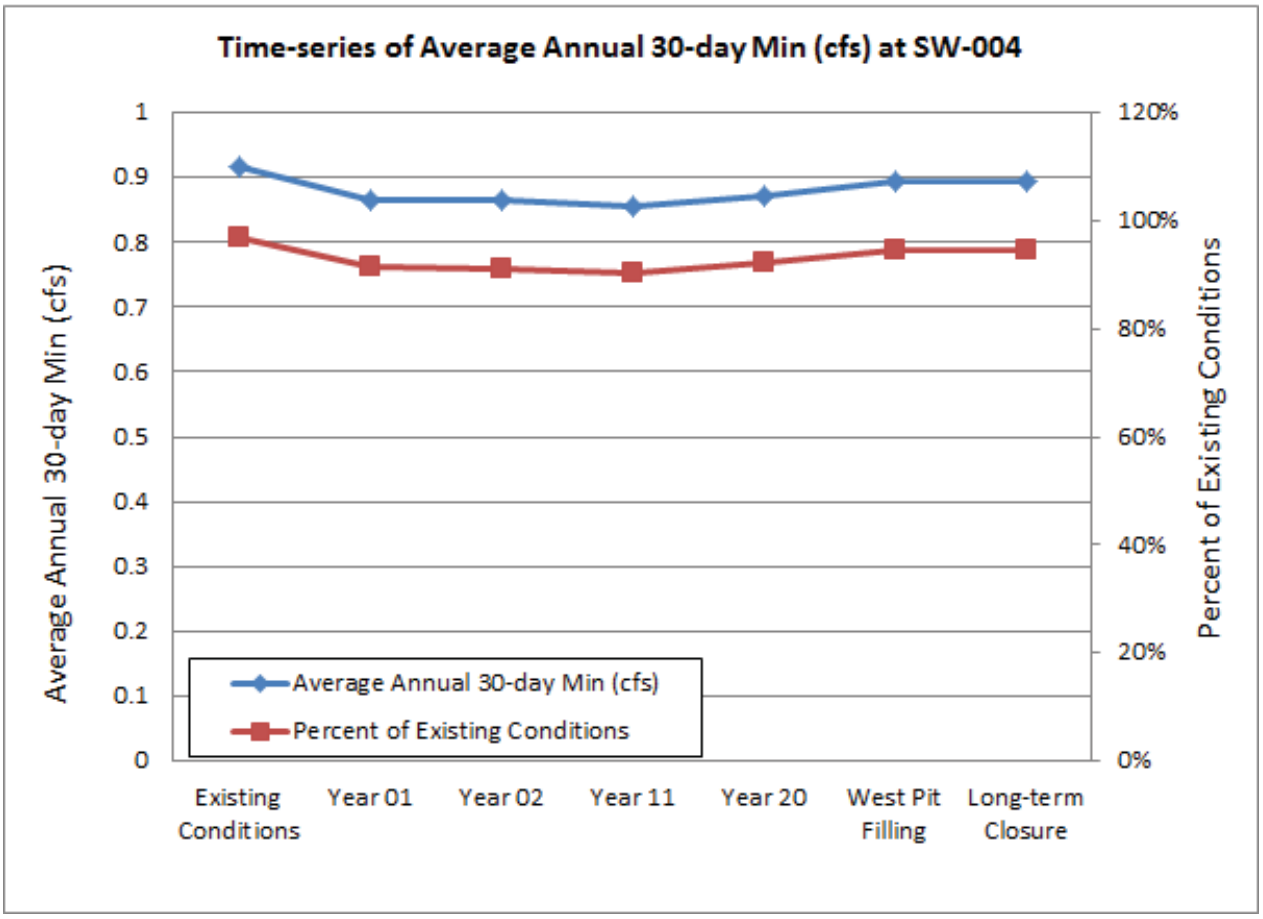


Figure 10 **Time Series of Average Annual 30-day Minimum Flow – SW004**

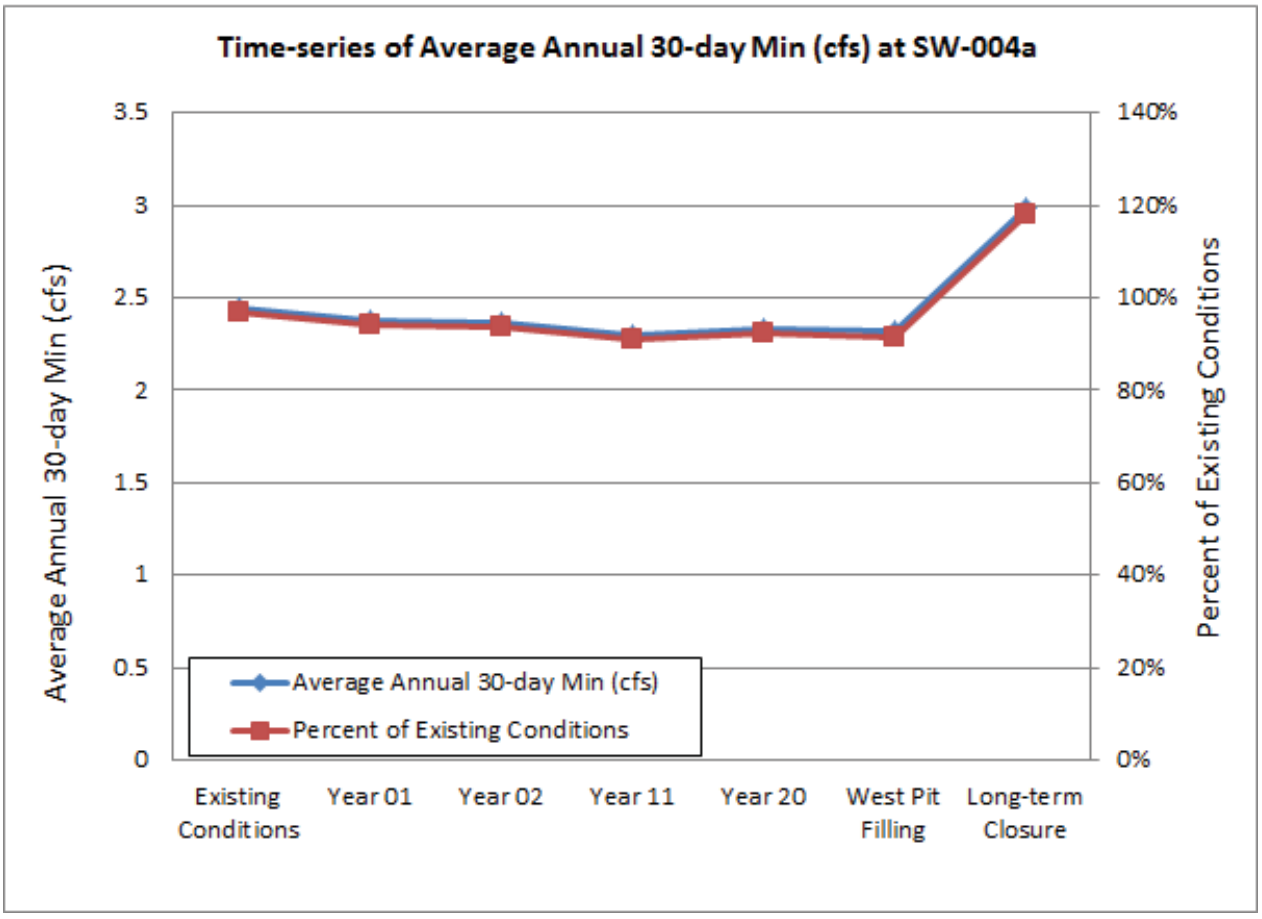


Figure 11 **Time Series of Average Annual 30-day Minimum Flow – SW004a**

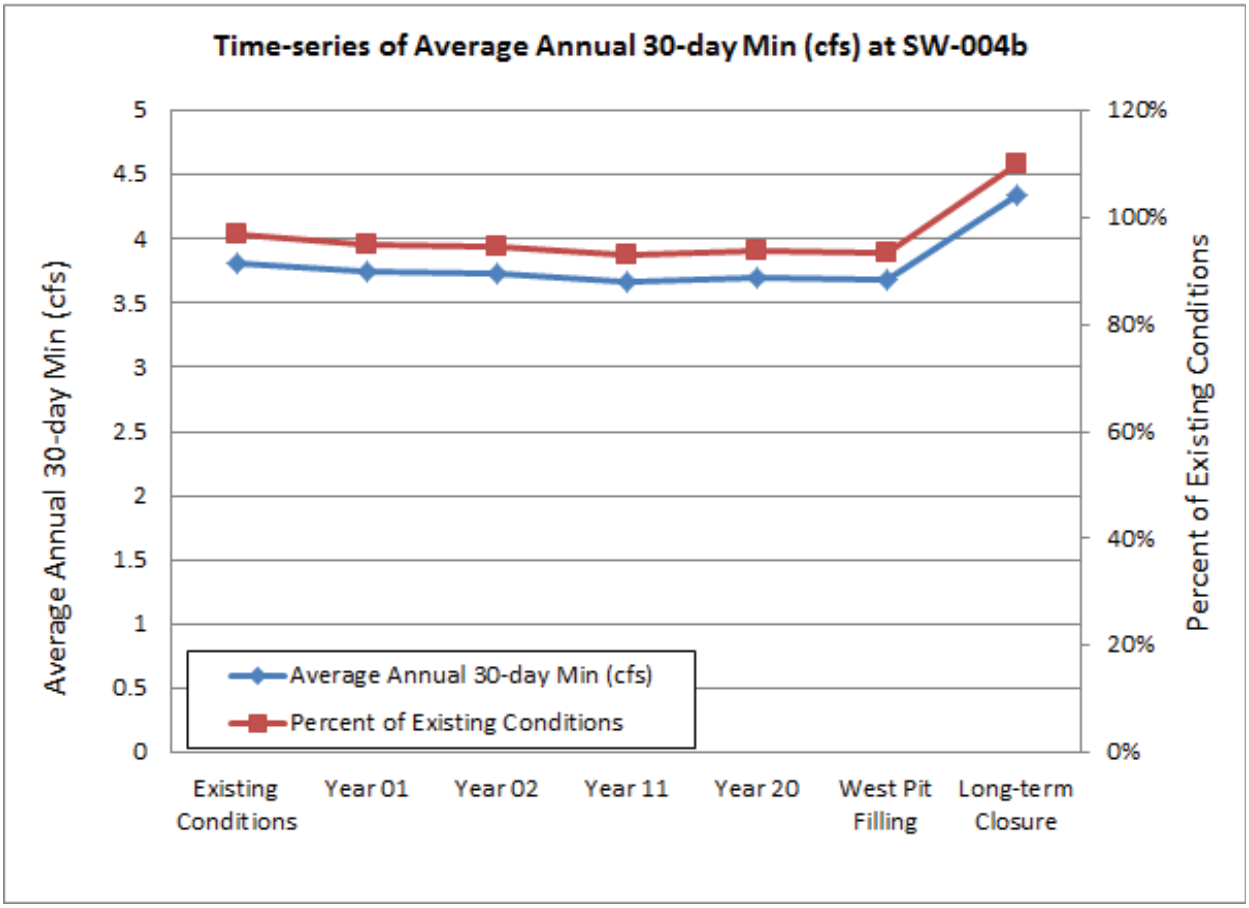


Figure 12 **Time Series of Average Annual 30-day Minimum Flow – SW004b**

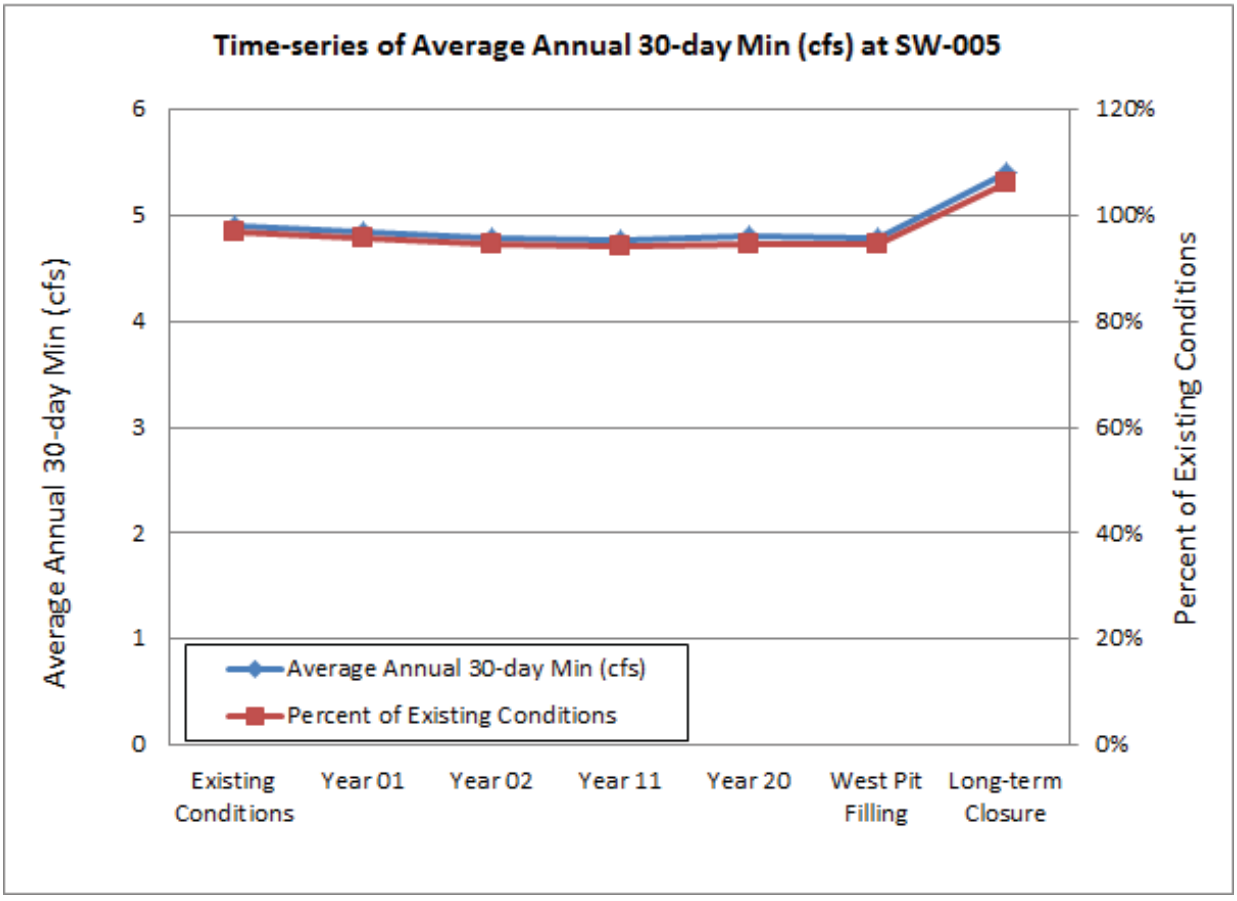


Figure 13 **Time Series of Average Annual 30-day Minimum Flow – SW005**

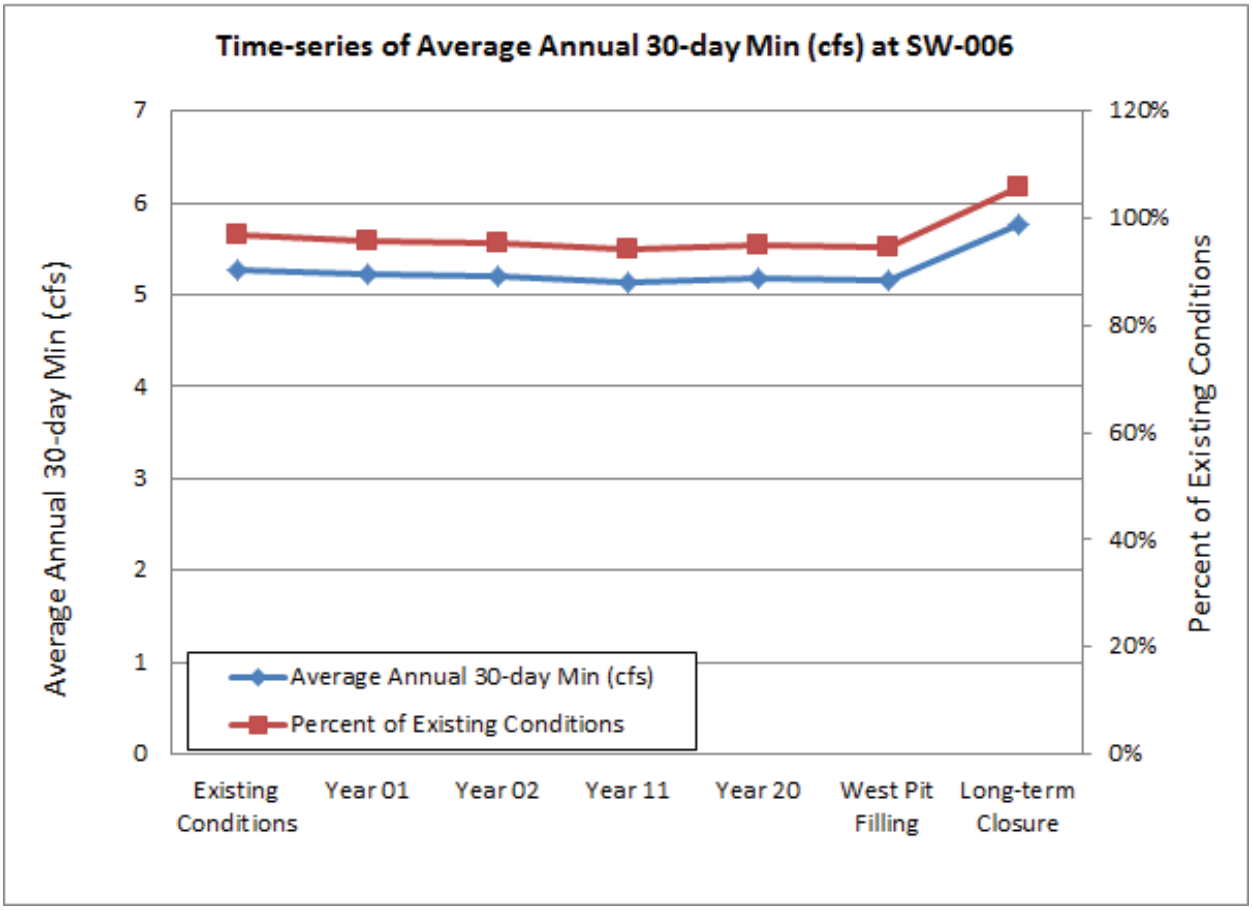


Figure 14 **Time Series of Average Annual 30-day Minimum Flow – SW006**

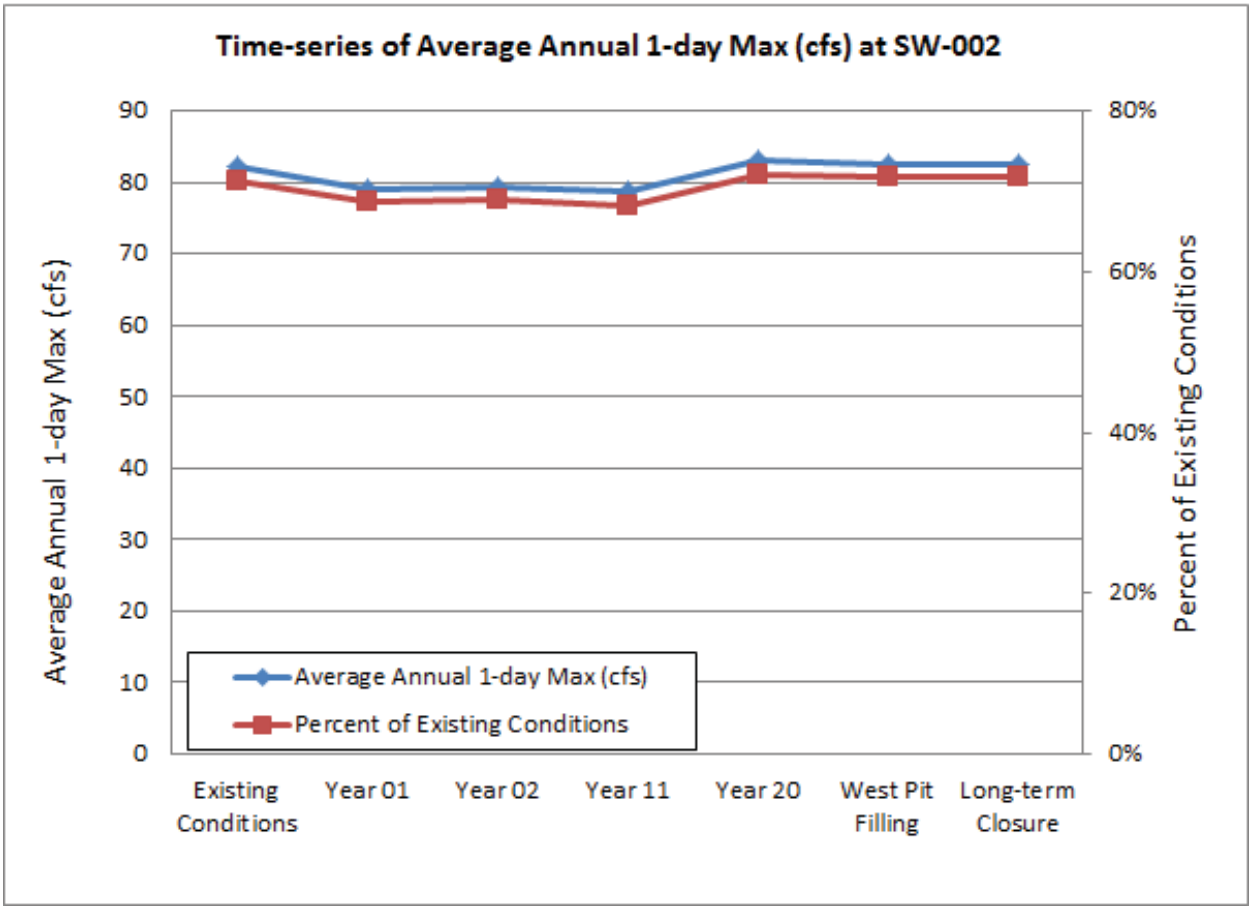


Figure 15 Time Series of Average Annual 1-day Maximum Flow – SW002

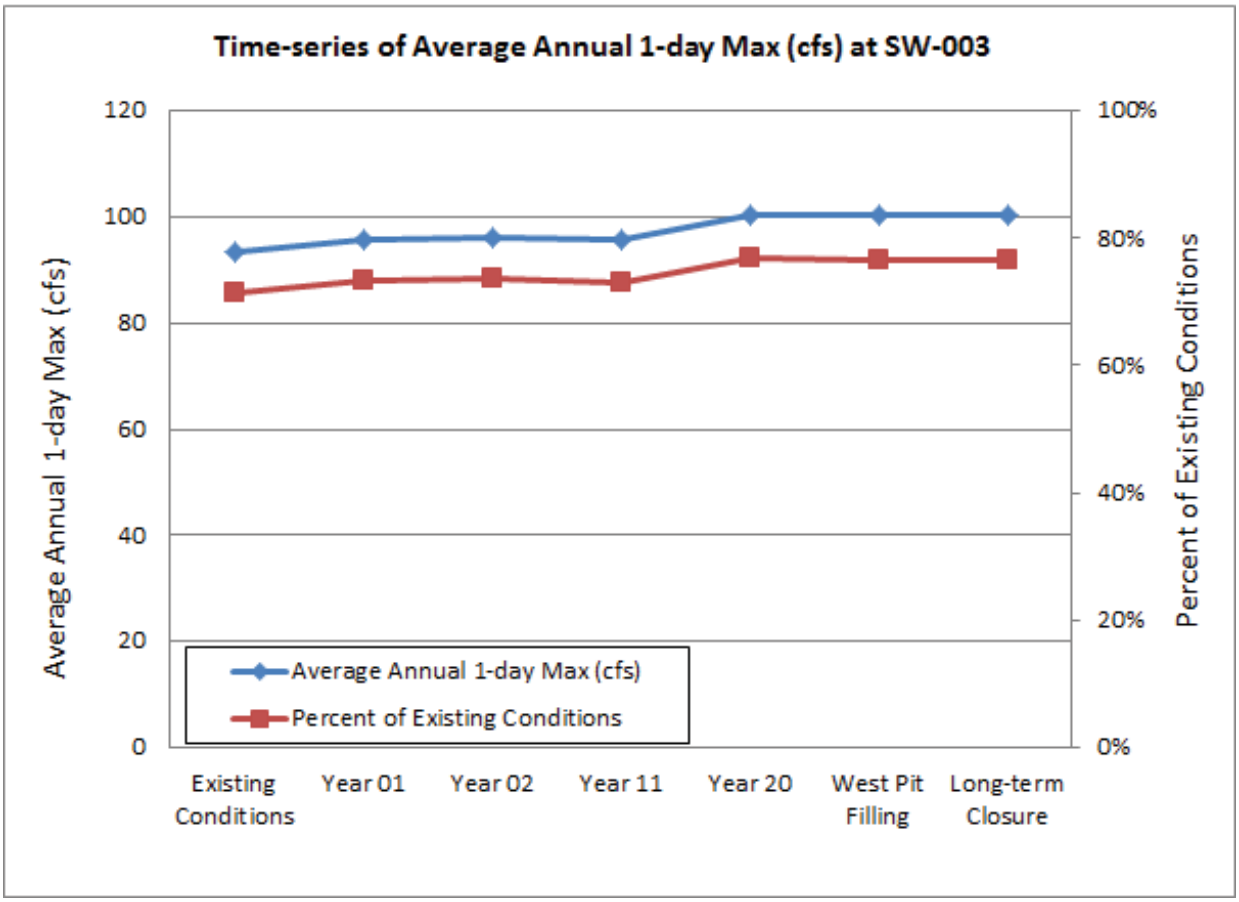


Figure 16 **Time Series of Average Annual 1-day Maximum Flow – SW003**

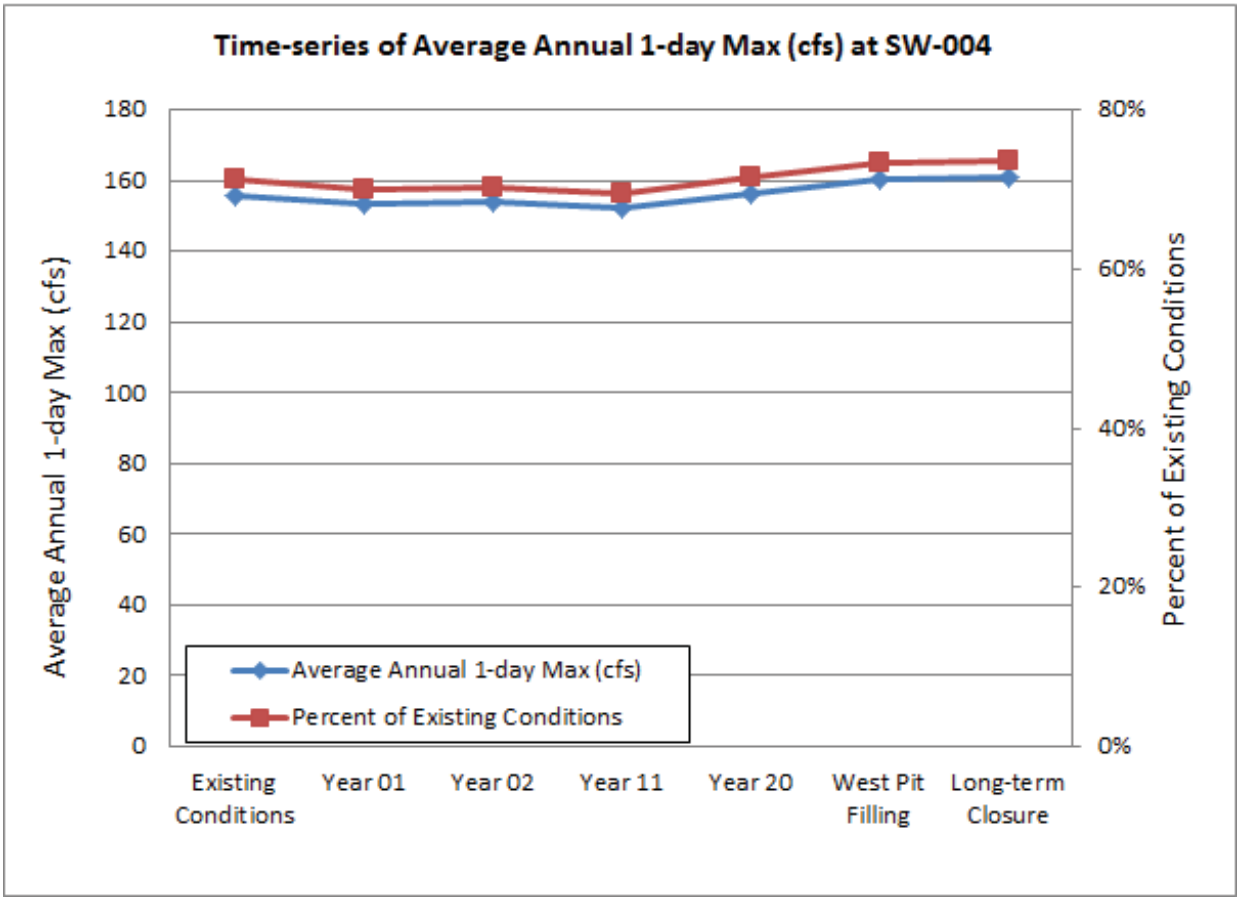


Figure 17 **Time Series of Average Annual 1-day Maximum Flow – SW004**

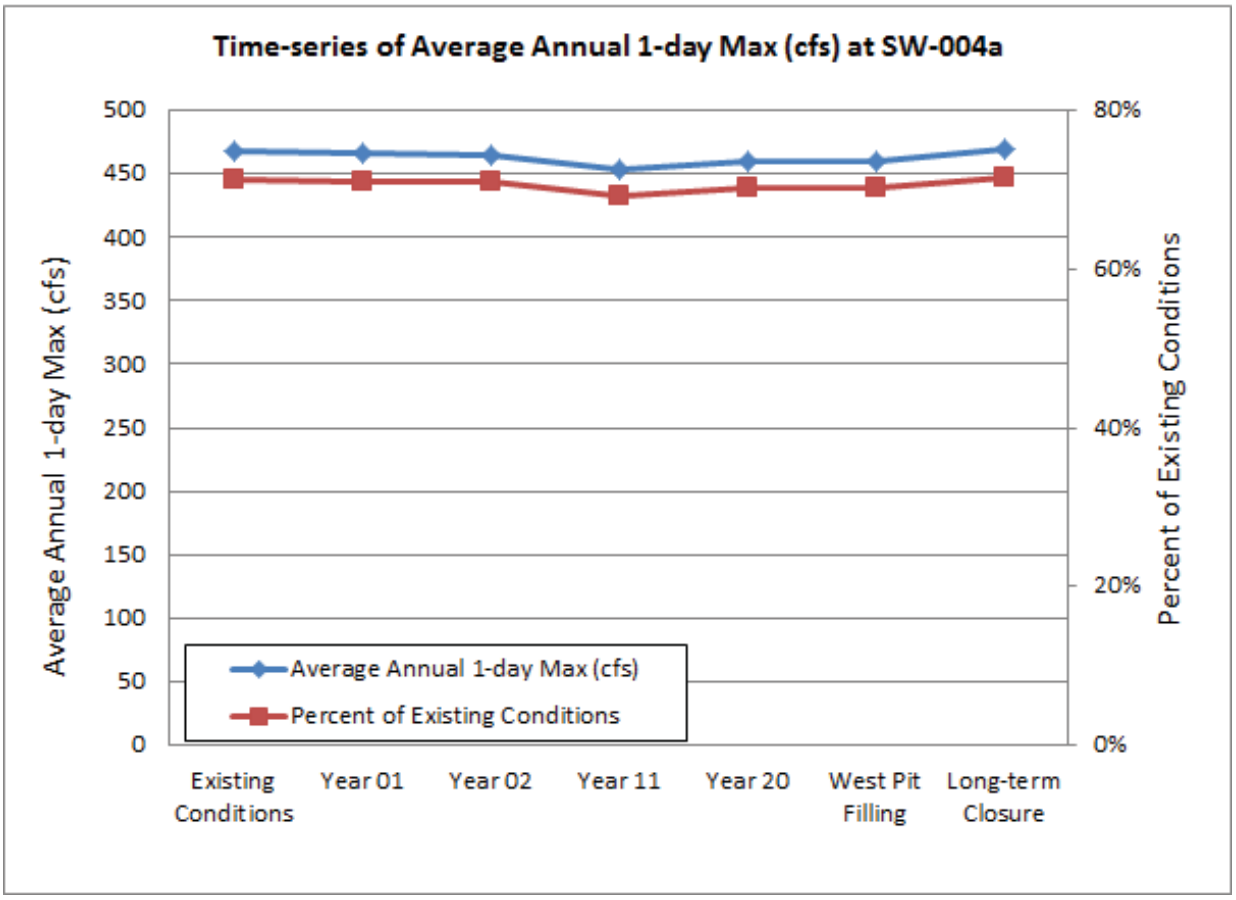


Figure 18 **Time Series of Average Annual 1-day Maximum Flow – SW004a**

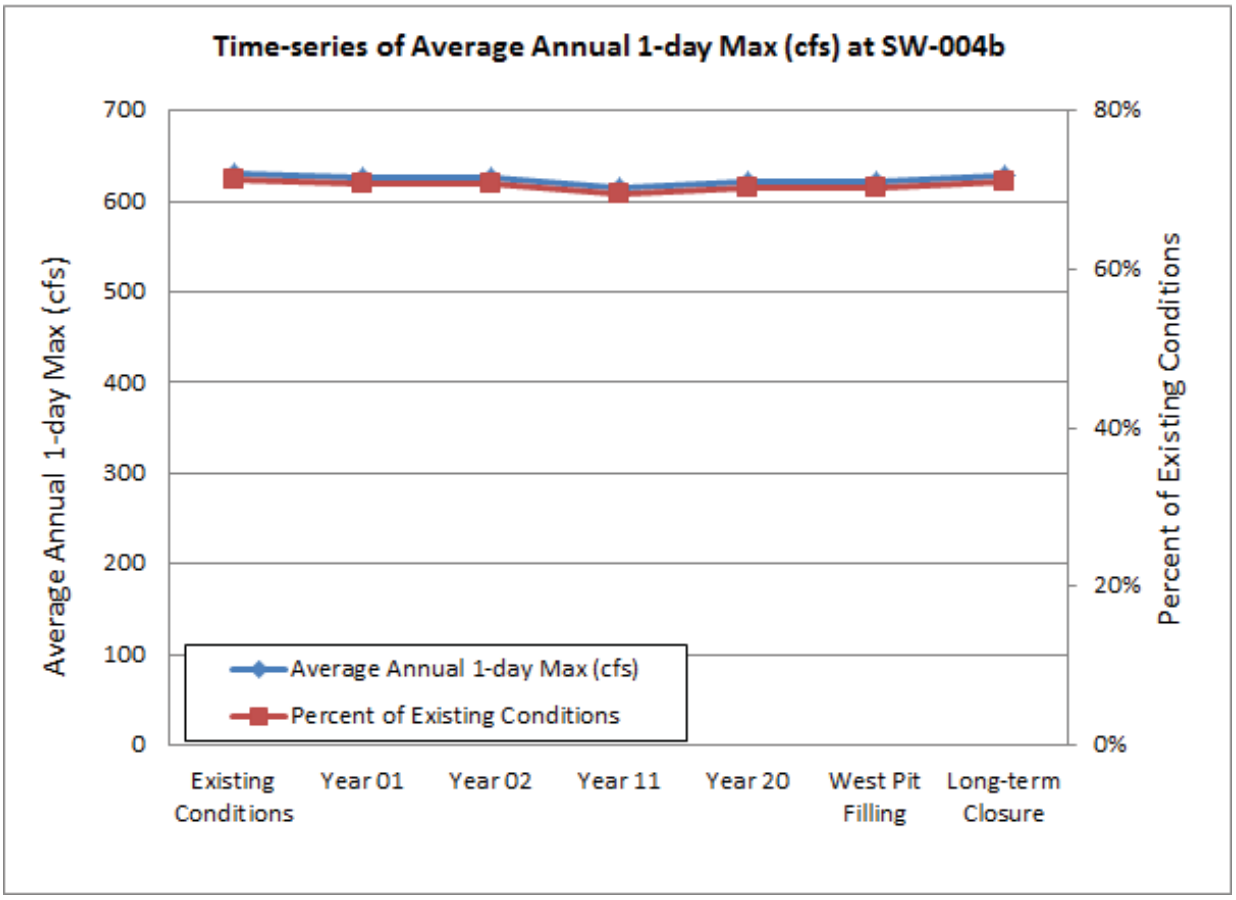


Figure 19 **Time Series of Average Annual 1-day Maximum Flow – SW004b**

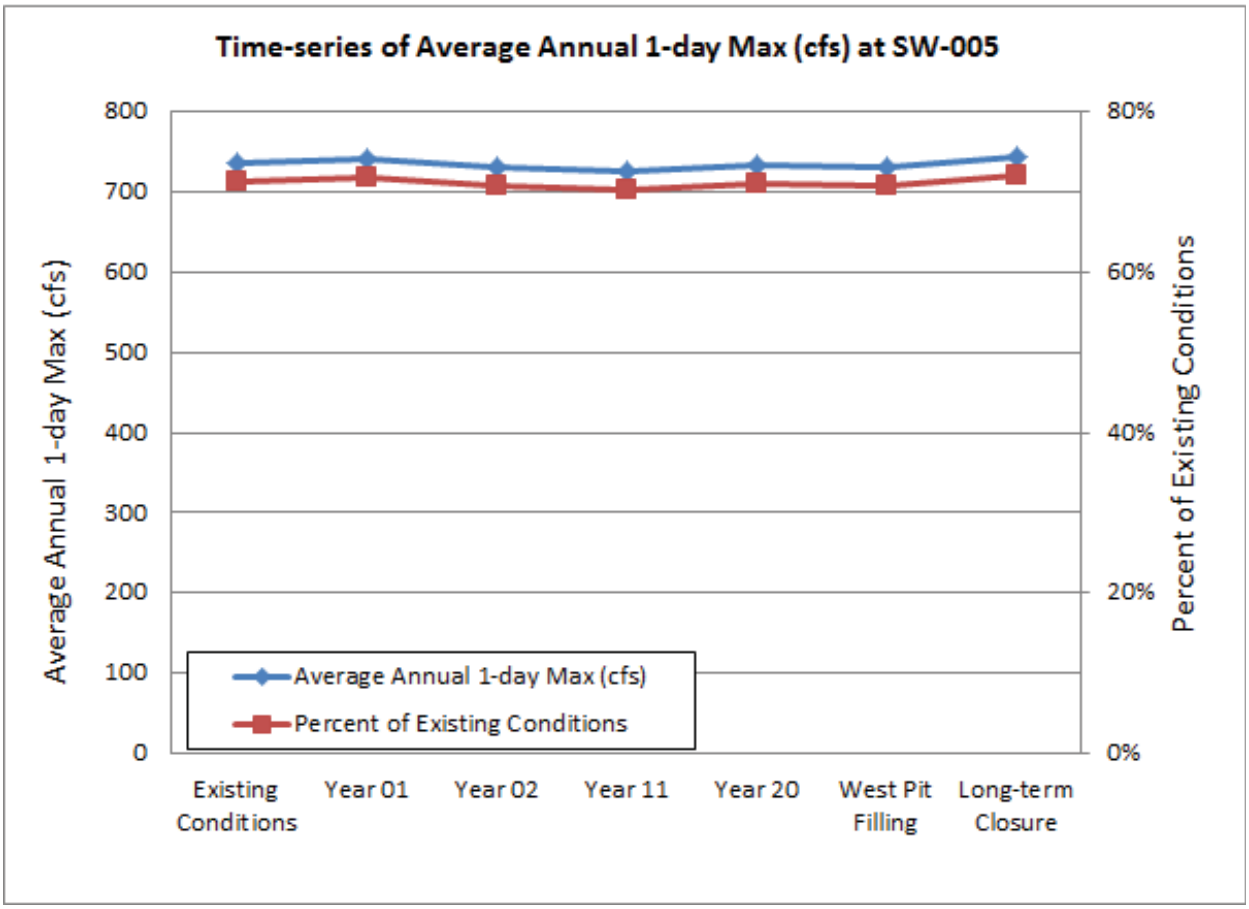


Figure 20 **Time Series of Average Annual 1-day Maximum Flow – SW005**

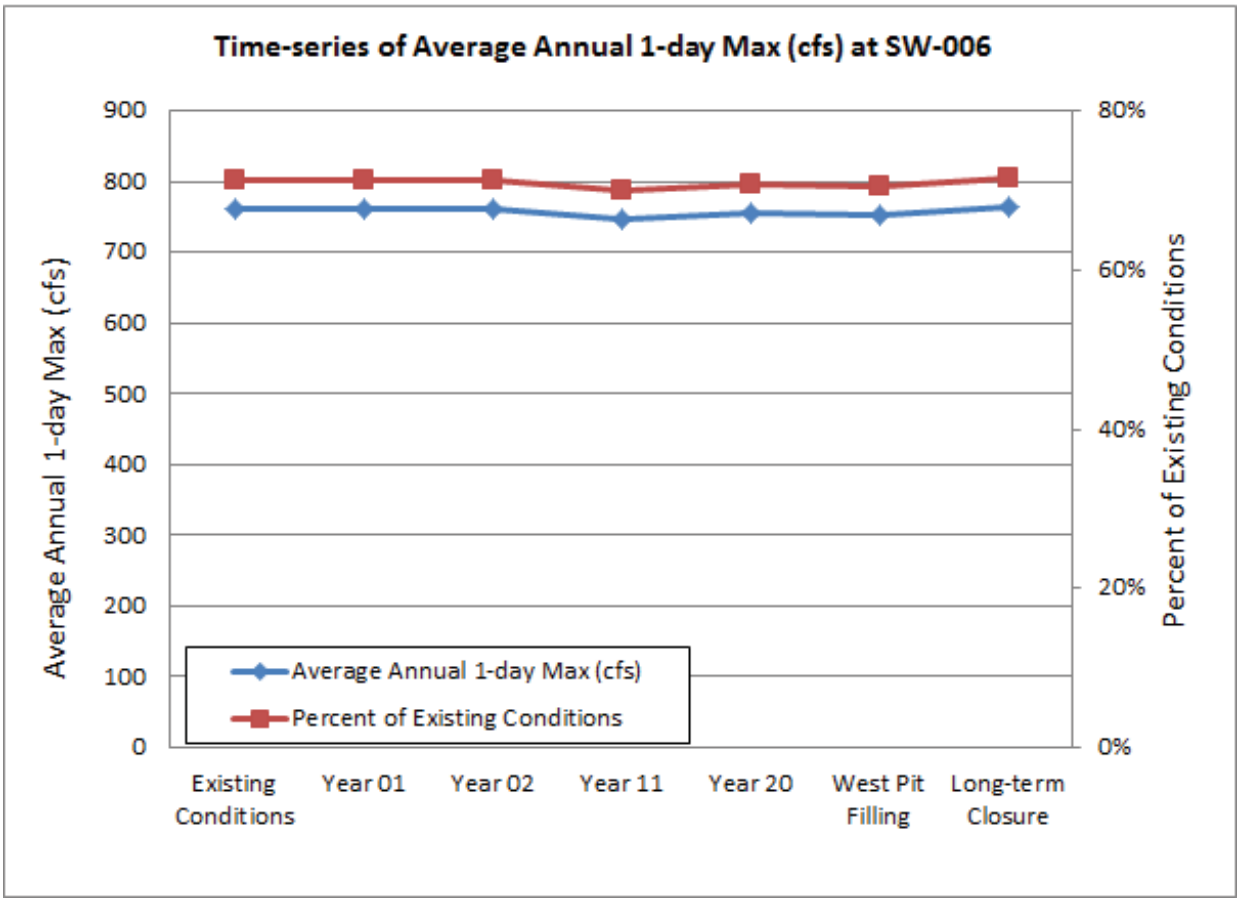


Figure 21 **Time Series of Average Annual 1-day Maximum Flow – SW006**

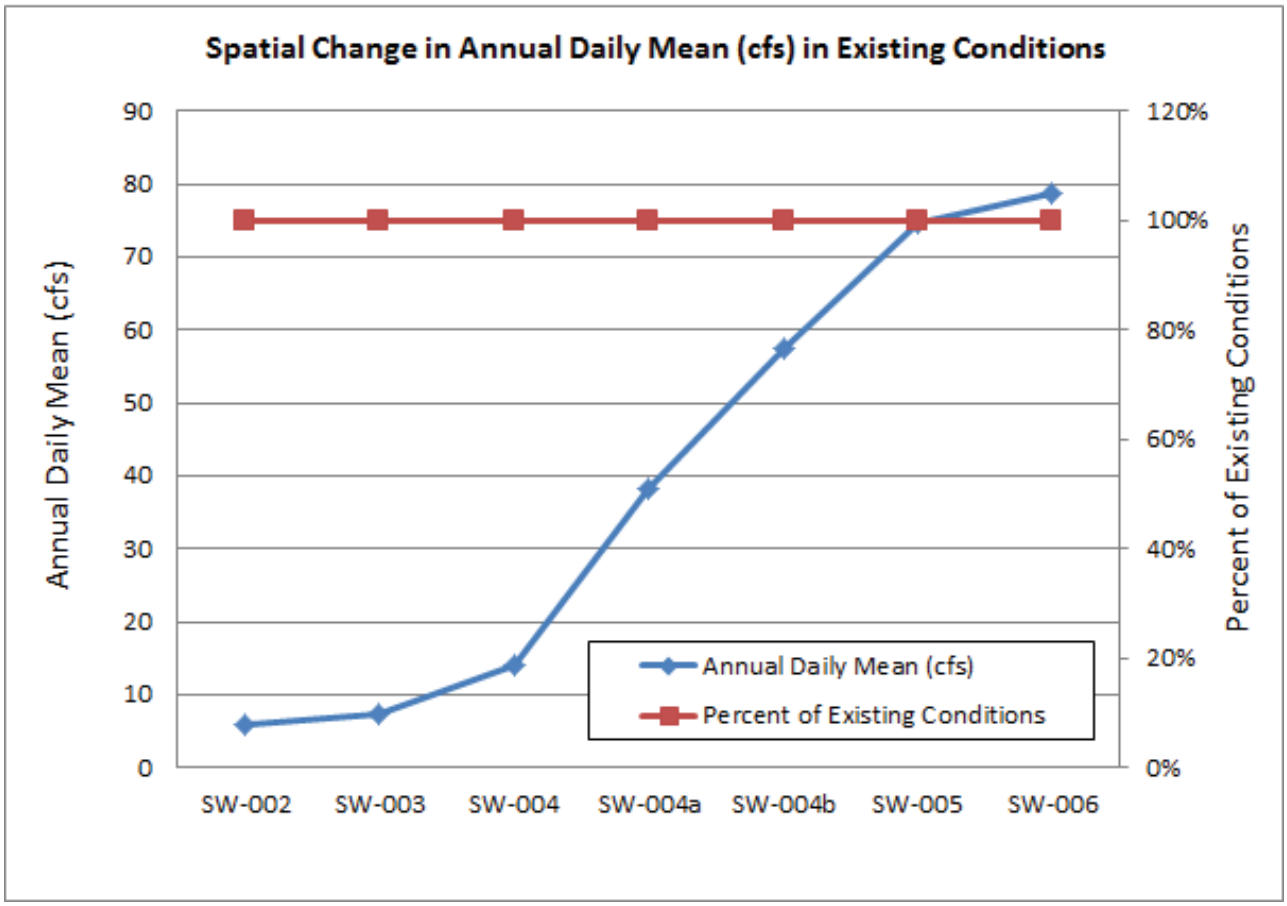


Figure 22 **Spatial Variation of Average Annual Flow – Existing Conditions**

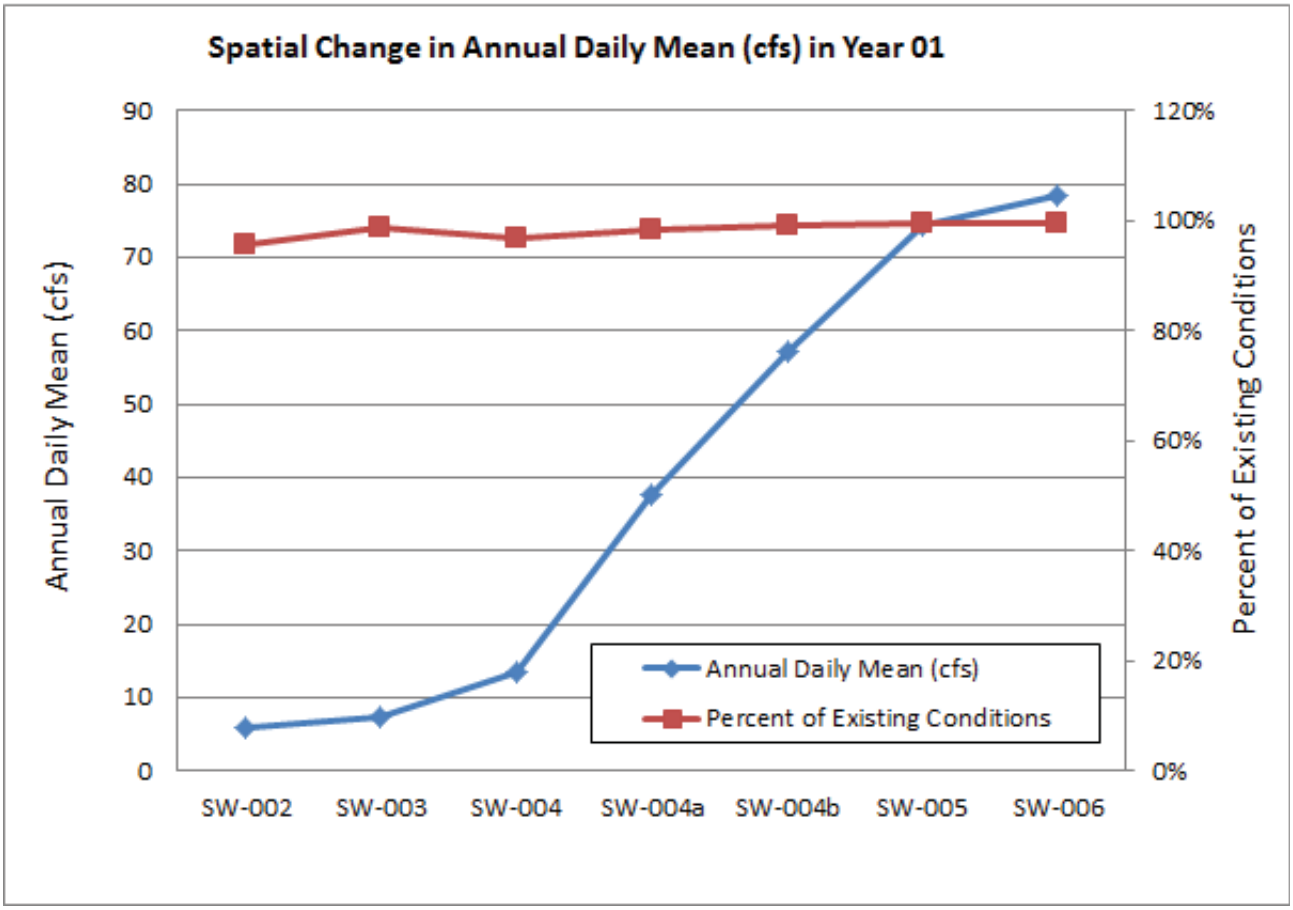


Figure 23 Spatial Variation of Average Annual Flow – Year 1

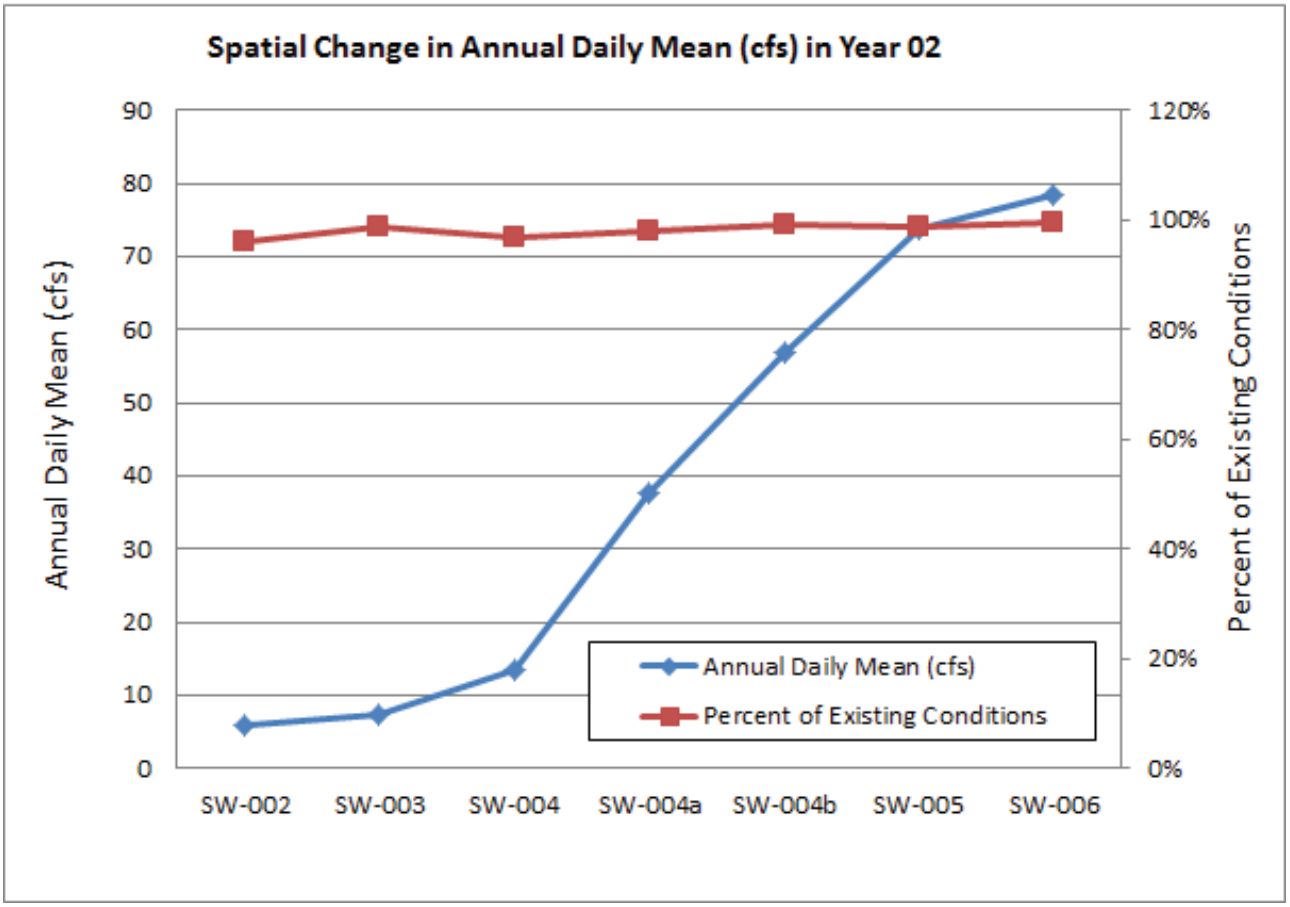


Figure 24 Spatial Variation of Average Annual Flow – Year 2

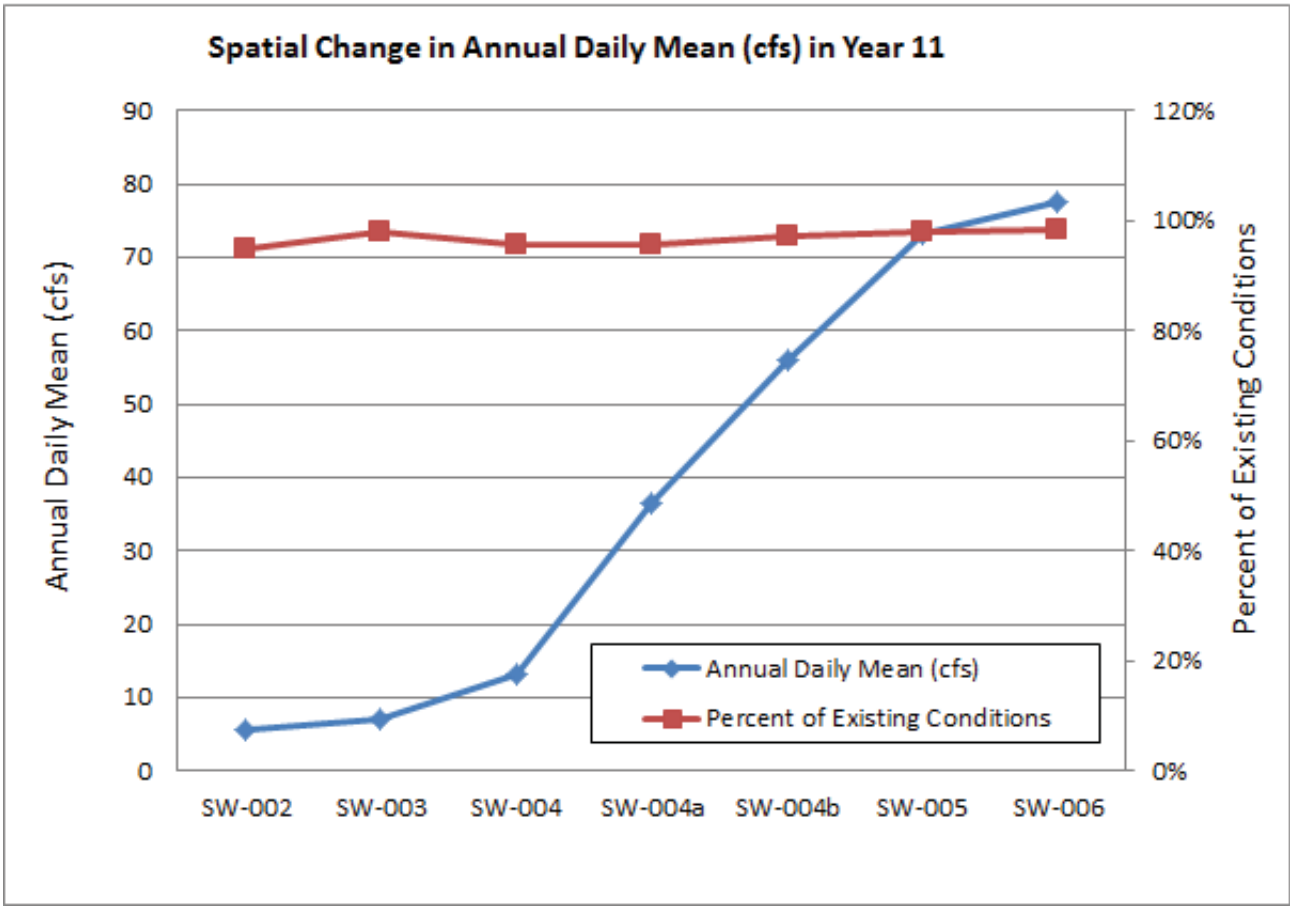


Figure 25 Spatial Variation of Average Annual Flow – Year 11

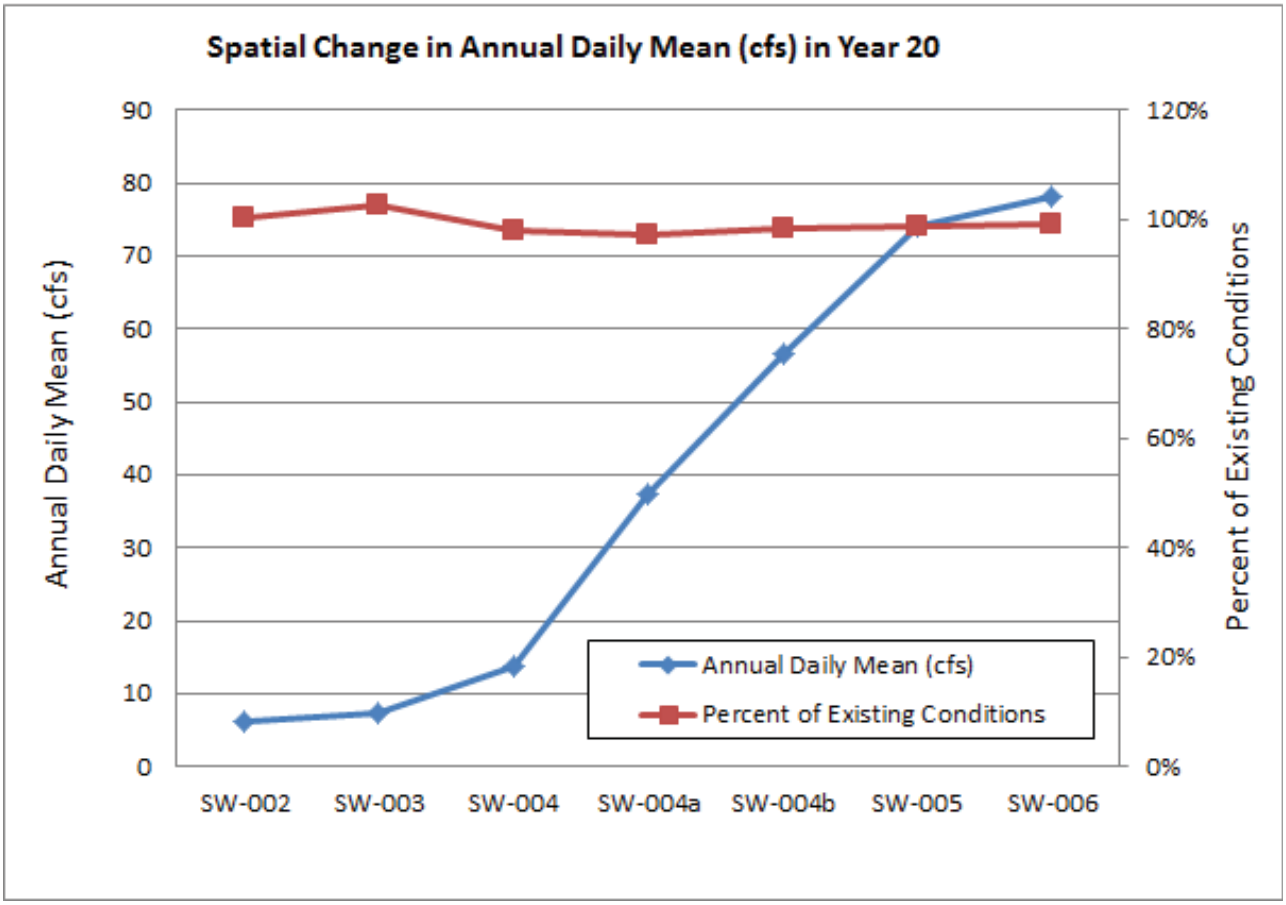


Figure 26 **Spatial Variation of Average Annual Flow – Year 20**

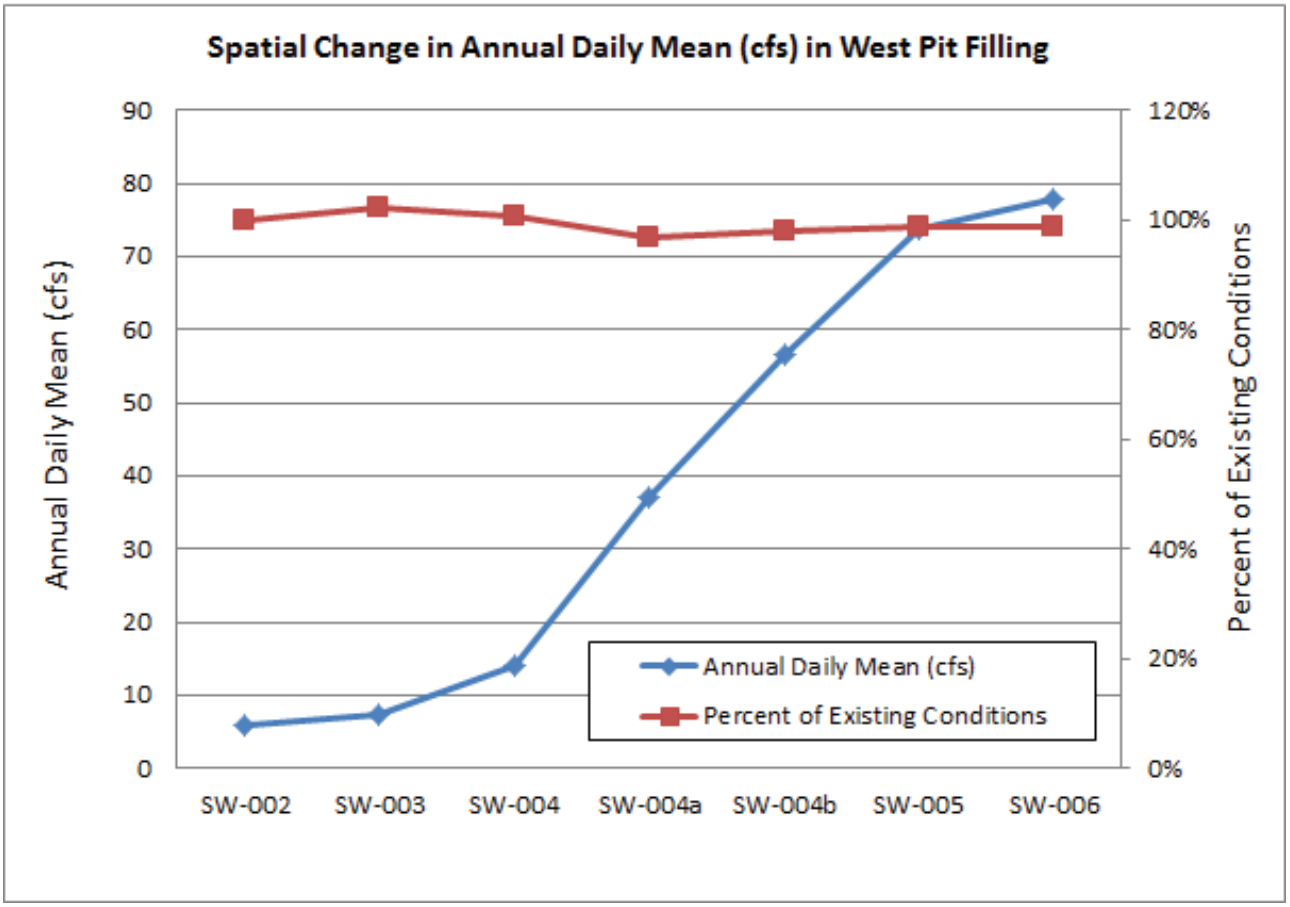


Figure 27 **Spatial Variation of Average Annual Flow – West Pit Filling**

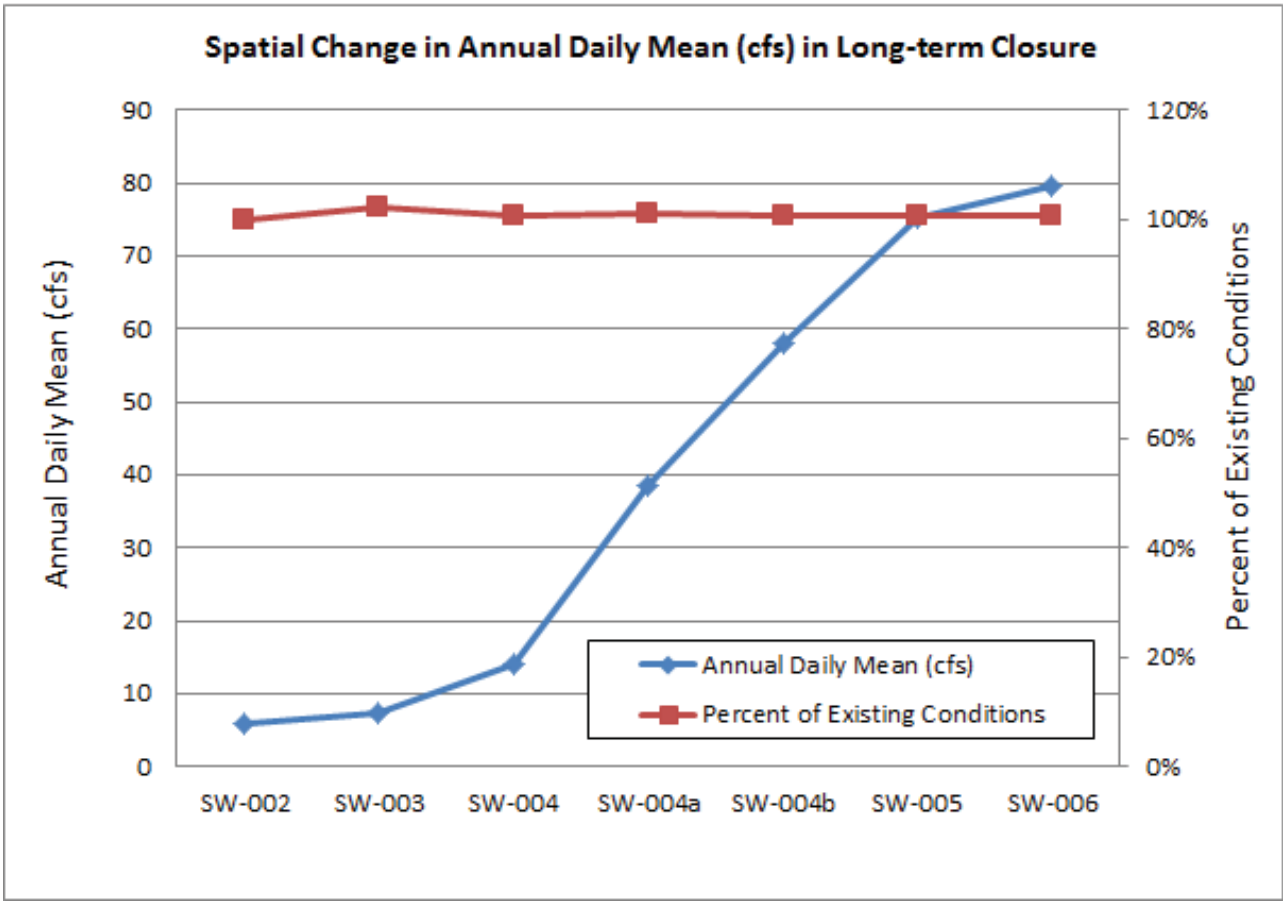


Figure 28 **Spatial Variation of Average Annual Flow – Long-term Closure**

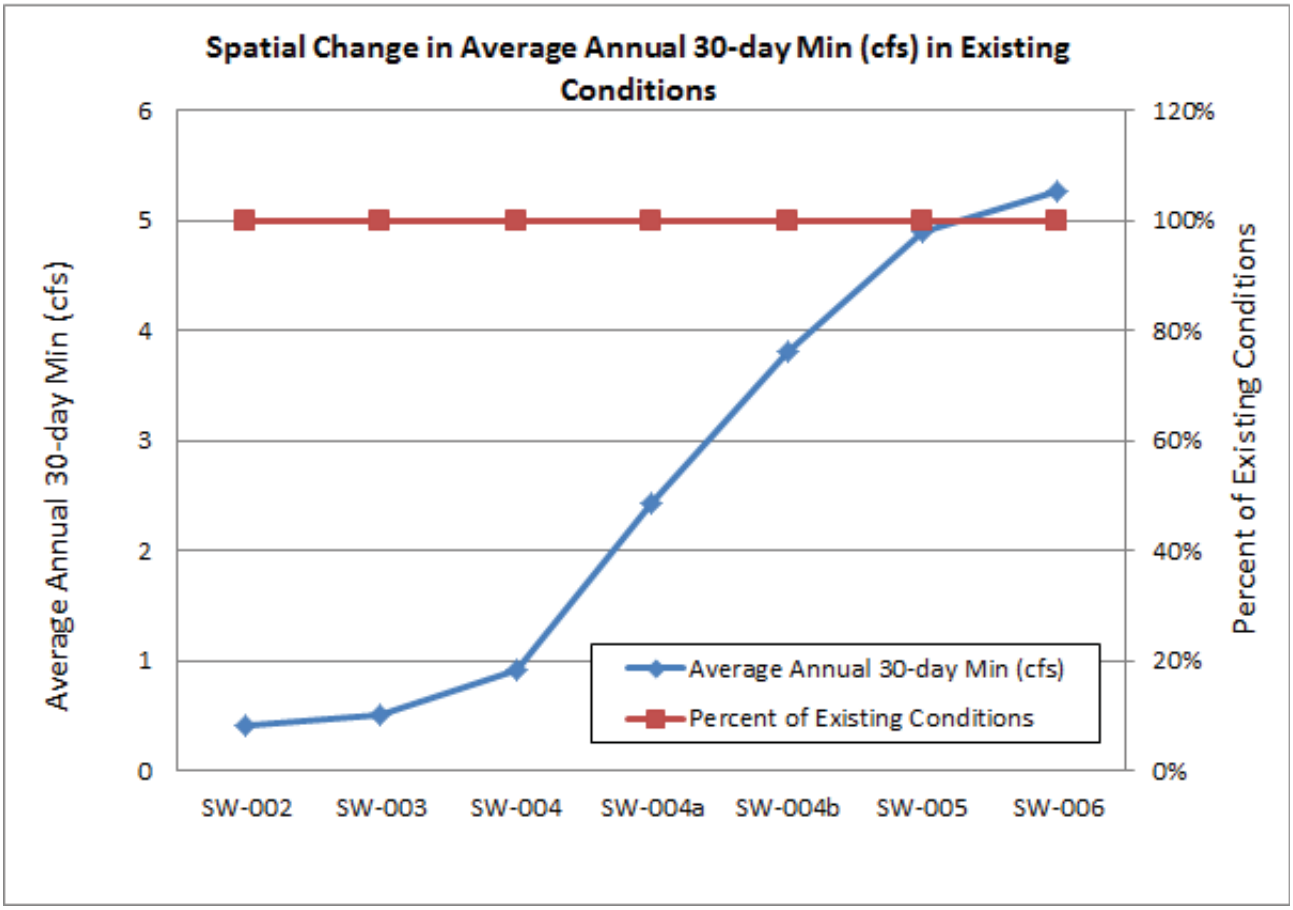


Figure 29 **Spatial Variation of Average Annual 30-day Minimum Flow – Existing Conditions**

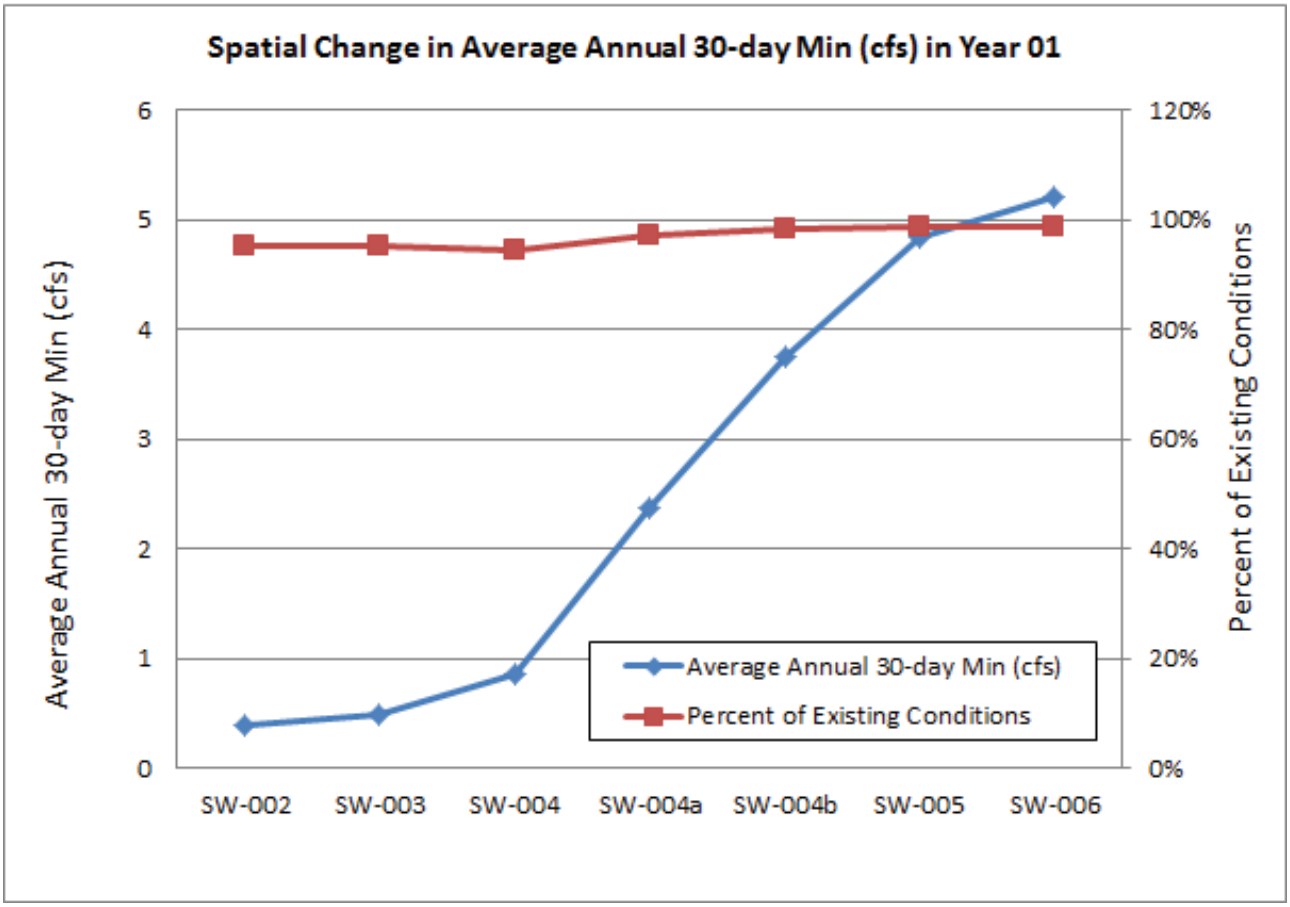


Figure 30 **Spatial Variation of Average Annual 30-day Minimum Flow – Year 1**

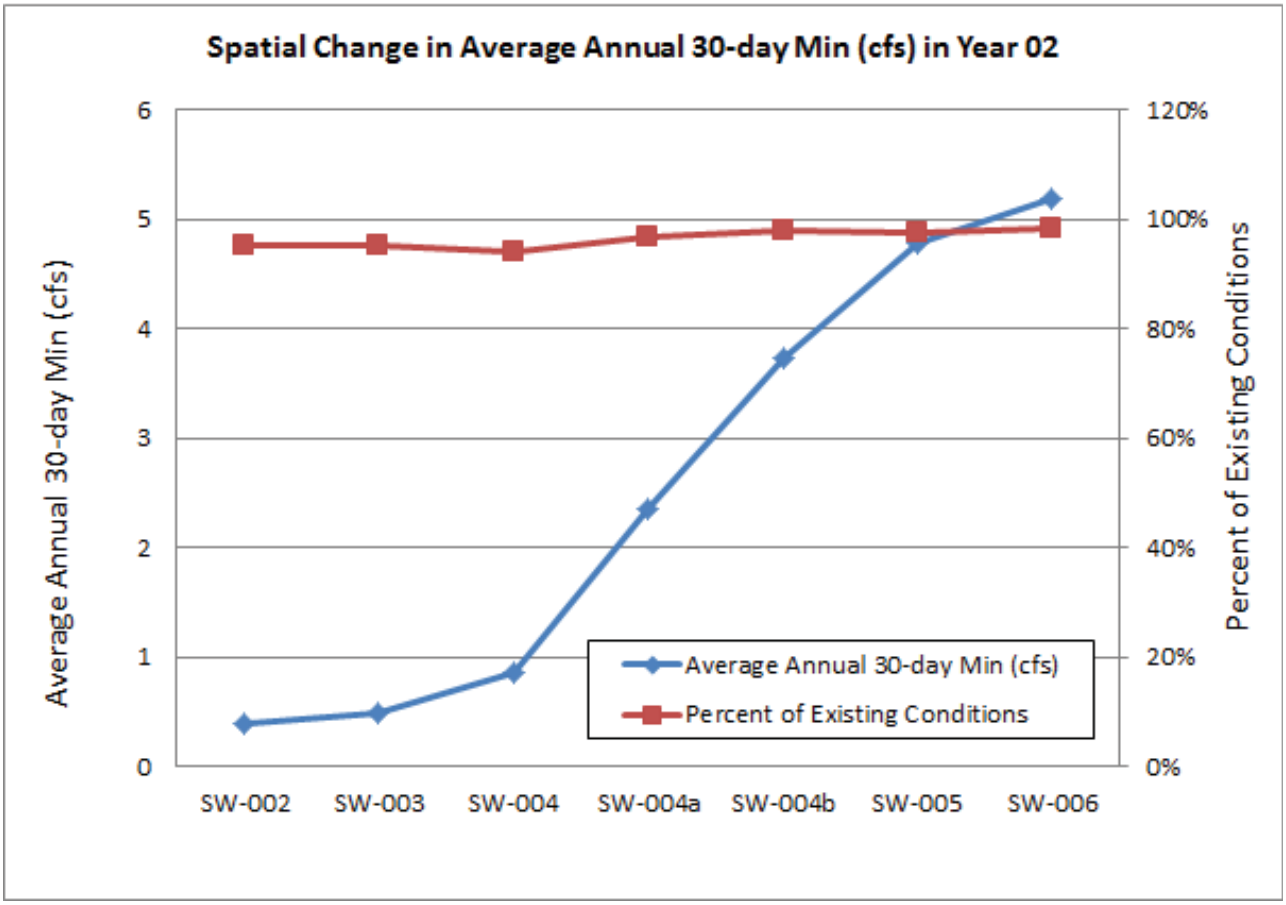


Figure 31 **Spatial Variation of Average Annual 30-day Minimum Flow – Year 2**

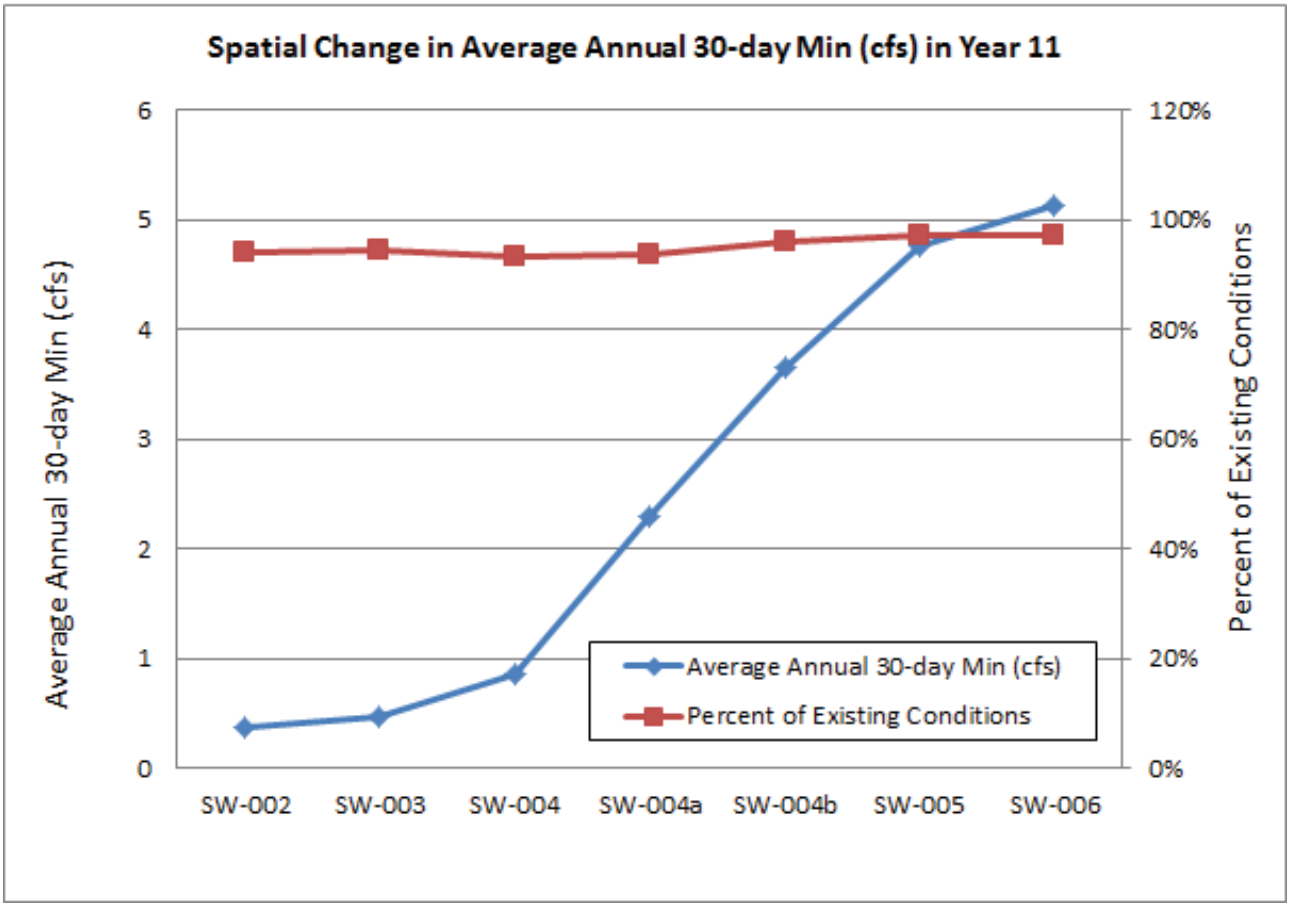


Figure 32 **Spatial Variation of Average Annual 30-day Minimum Flow – Year 11**

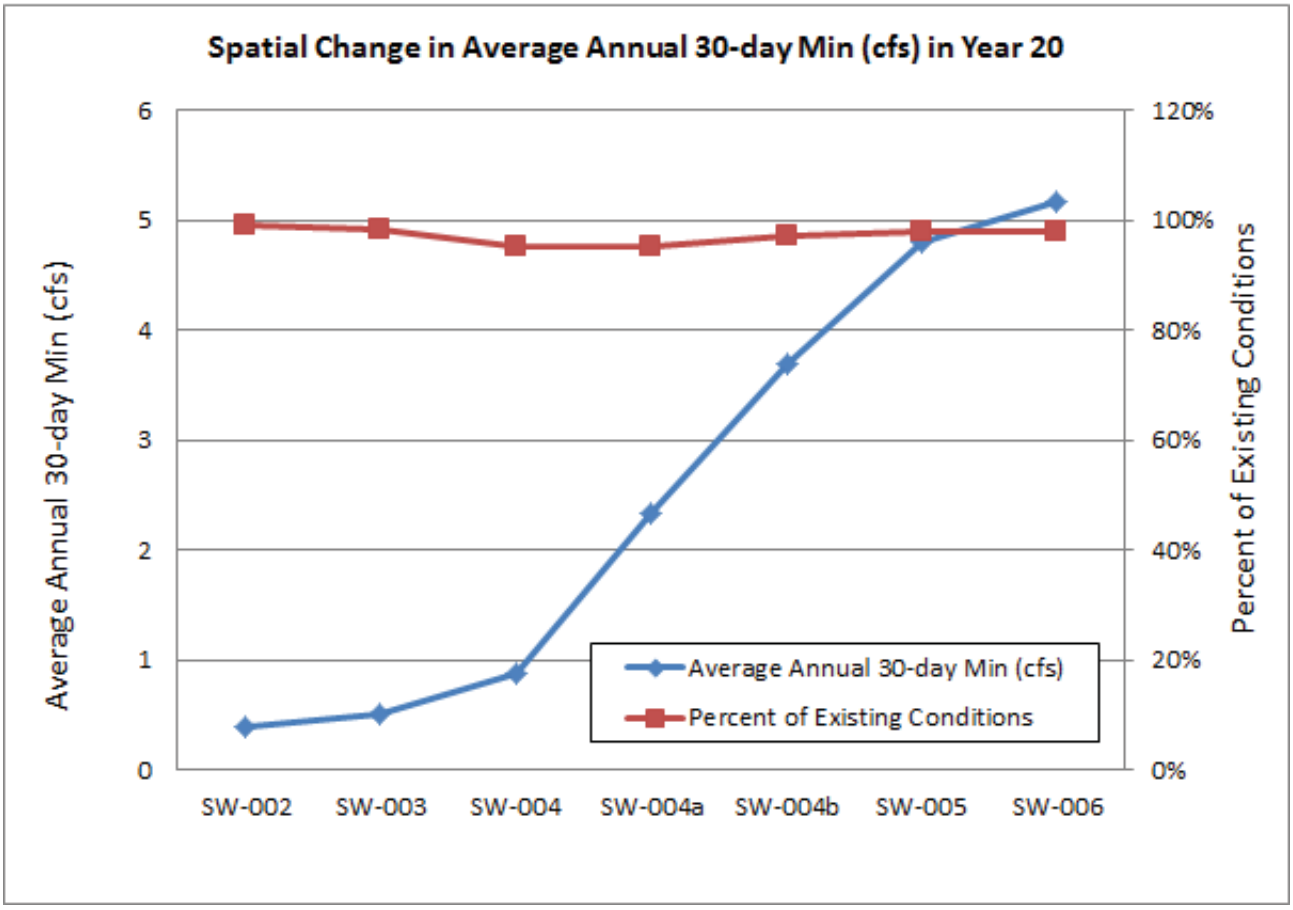


Figure 33 **Spatial Variation of Average Annual 30-day Minimum Flow – Year 20**

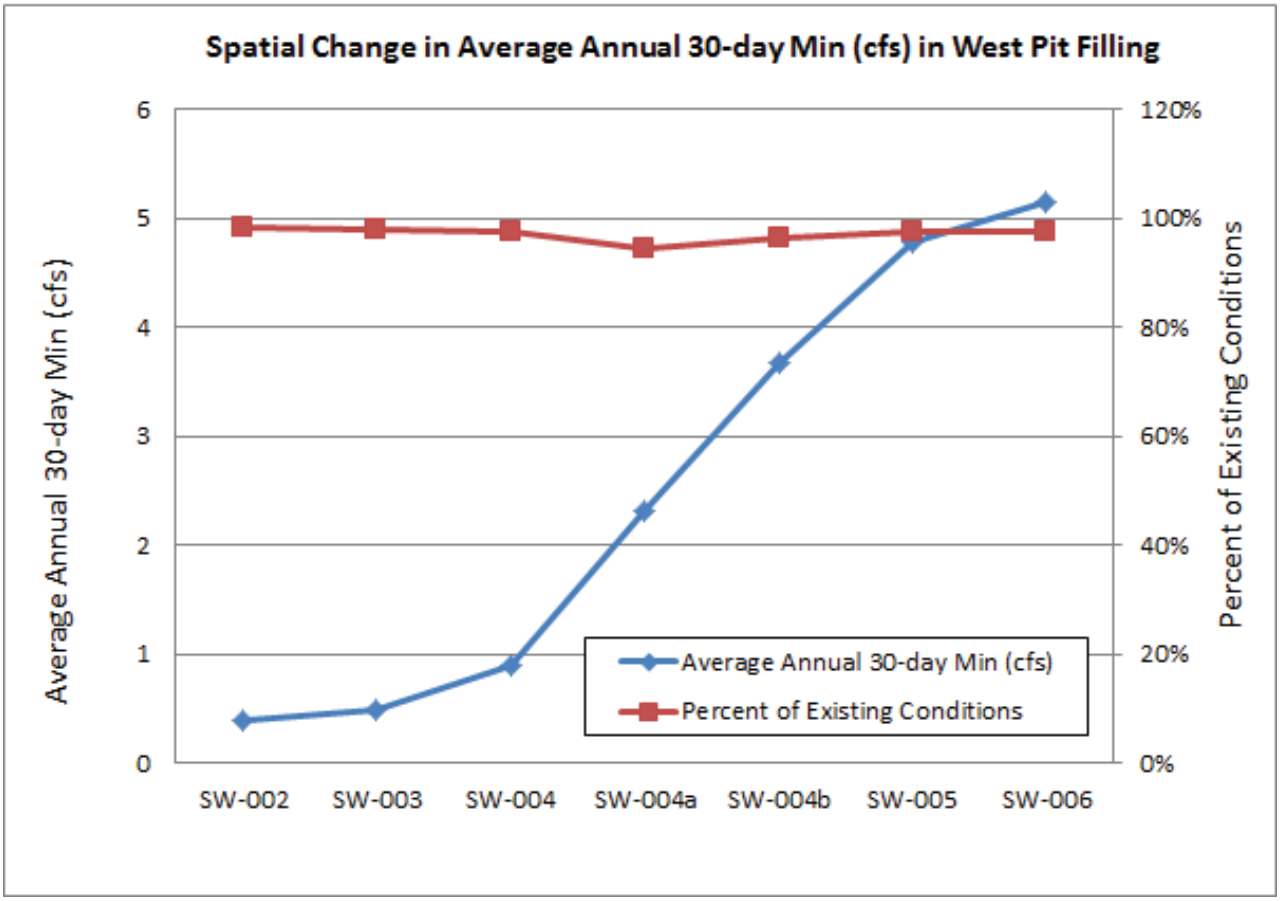


Figure 34 **Spatial Variation of Average Annual 30-day Minimum Flow – West Pit Filling**

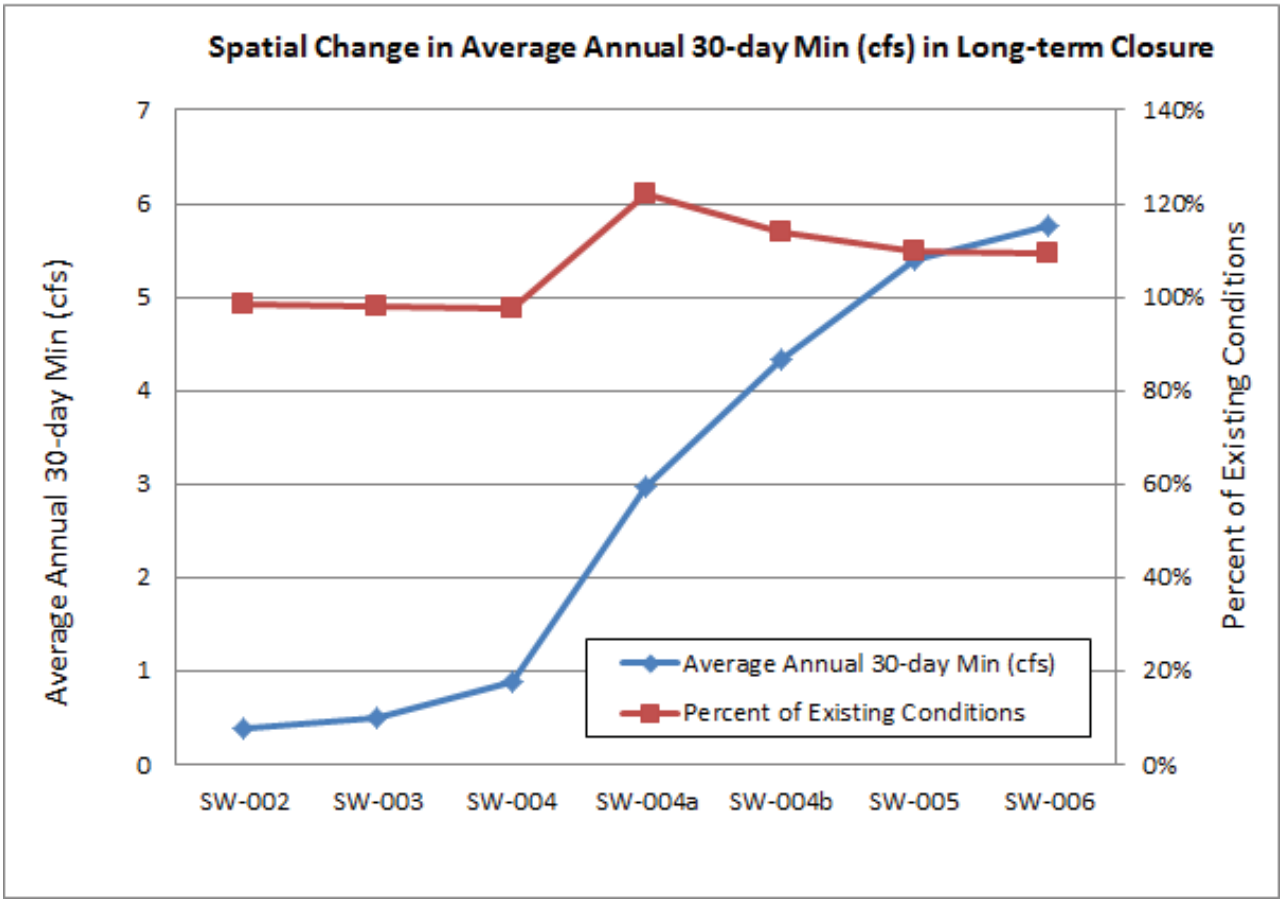


Figure 35 **Spatial Variation of Average Annual 30-day Minimum Flow – Long-term Closure**

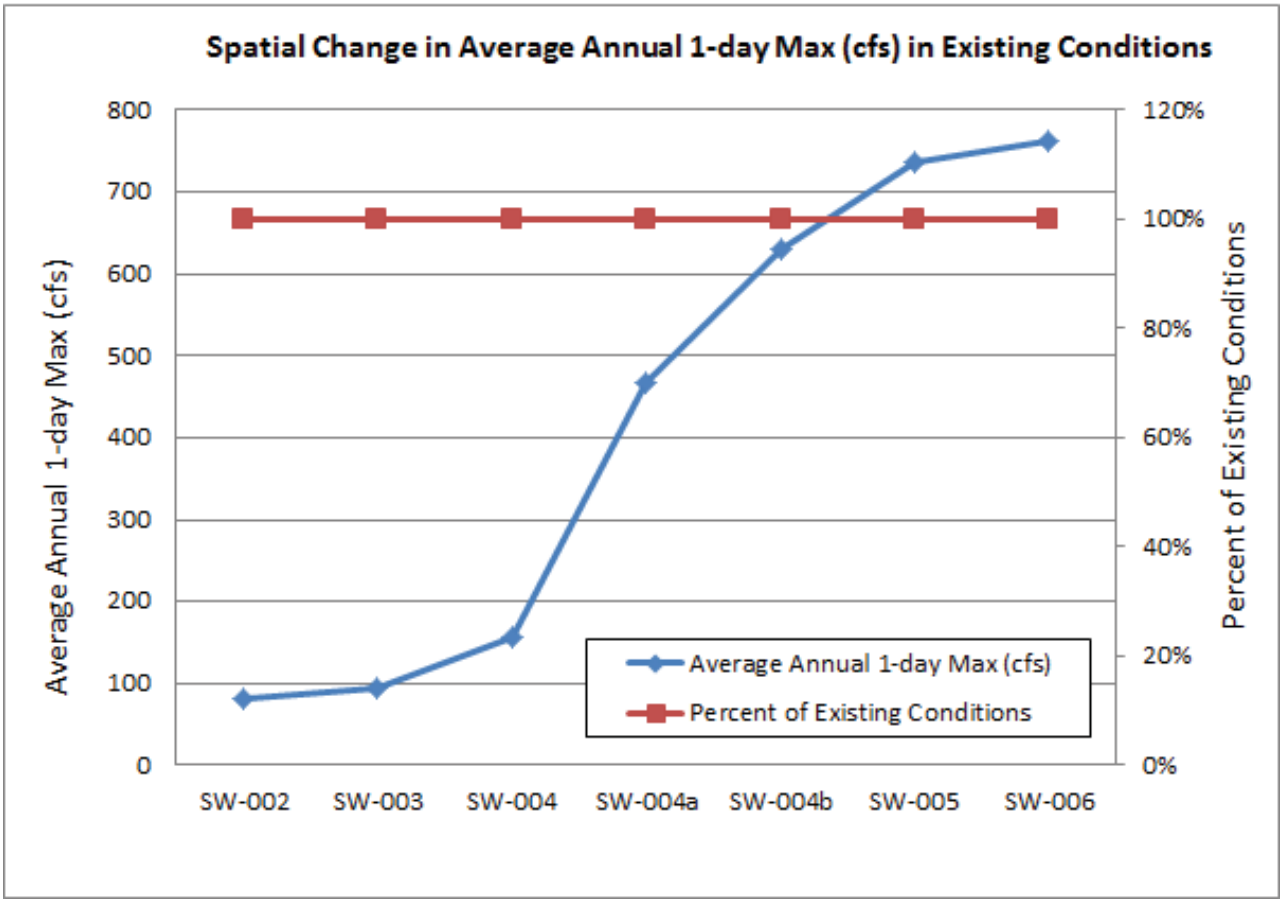


Figure 36 **Spatial Variation of Average Annual 1-day Maximum Flow – Existing Conditions**

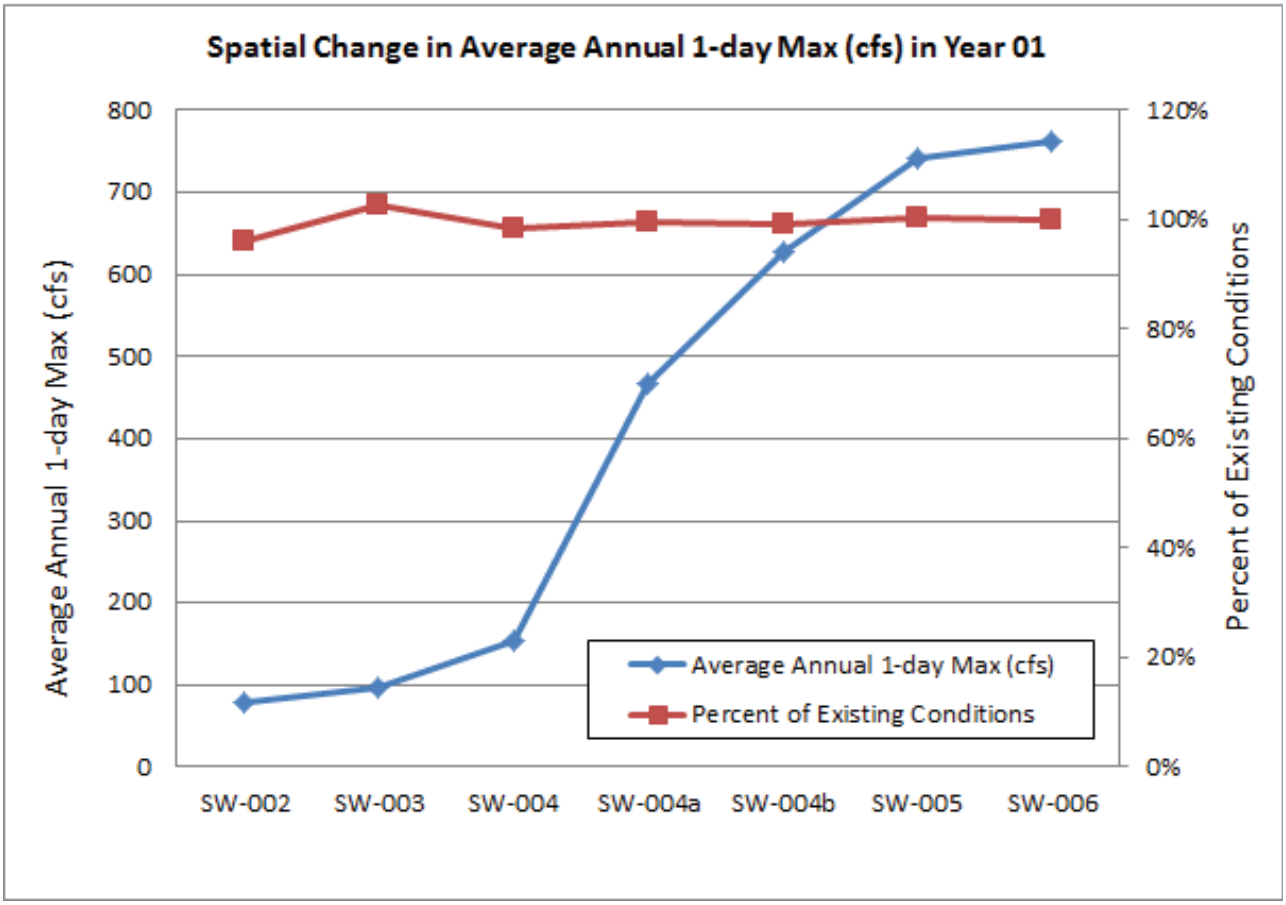


Figure 37 Spatial Variation of Average Annual 1-day Maximum Flow – Year 1

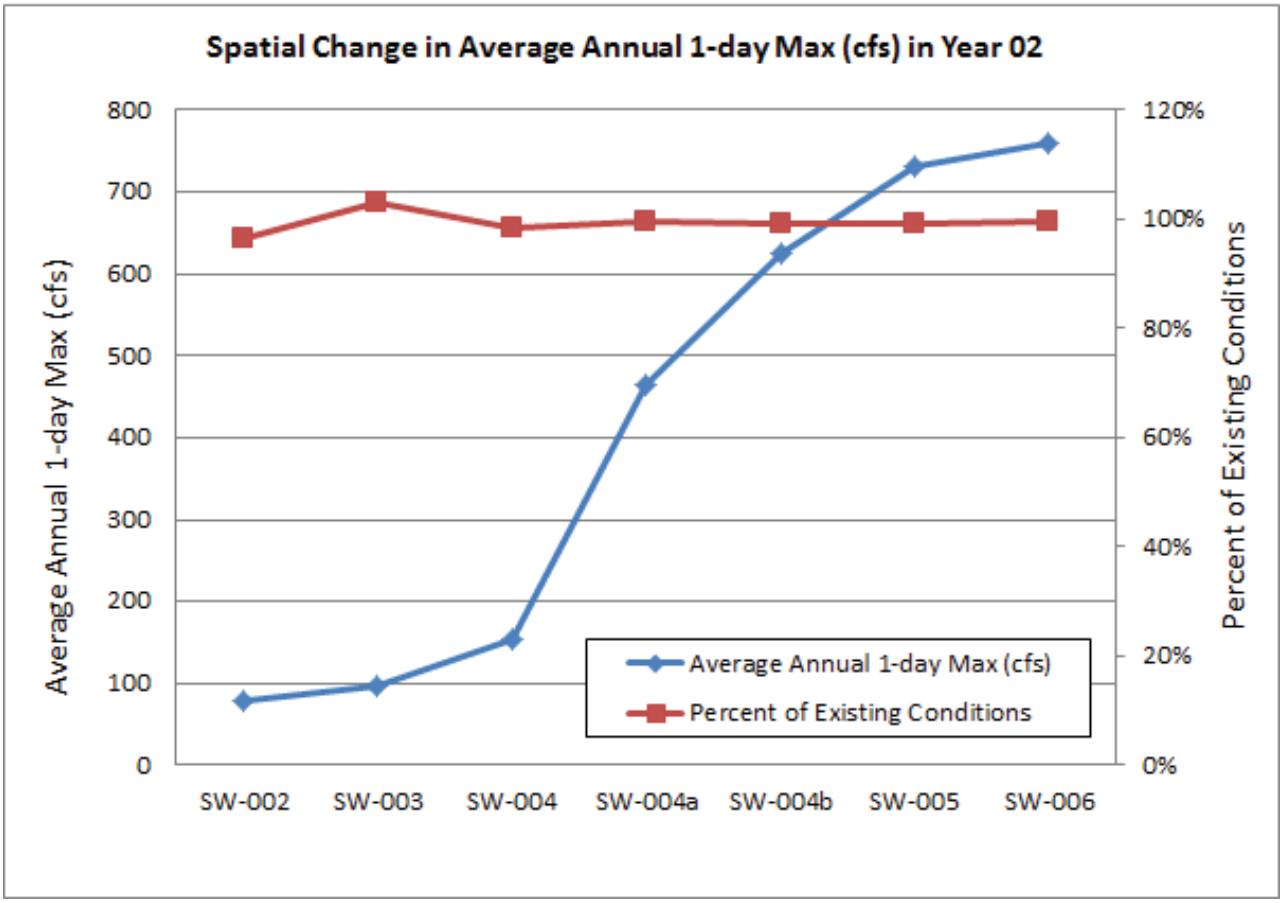


Figure 38 **Spatial Variatio of Average Annual 1-day Maximum Flow – Year 2**

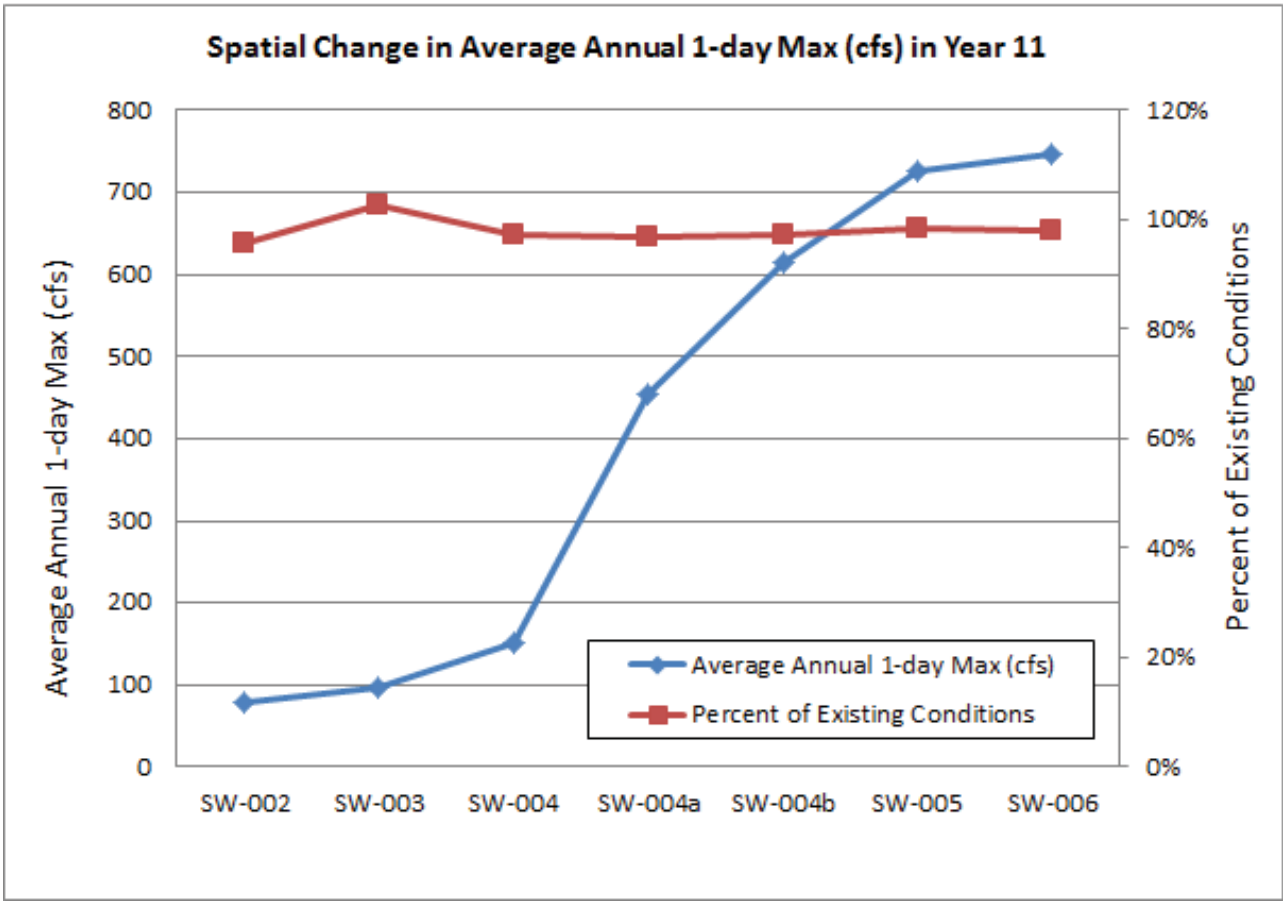


Figure 39 **Spatial Variation of Average Annual 1-day Maximum Flow – Year 11**

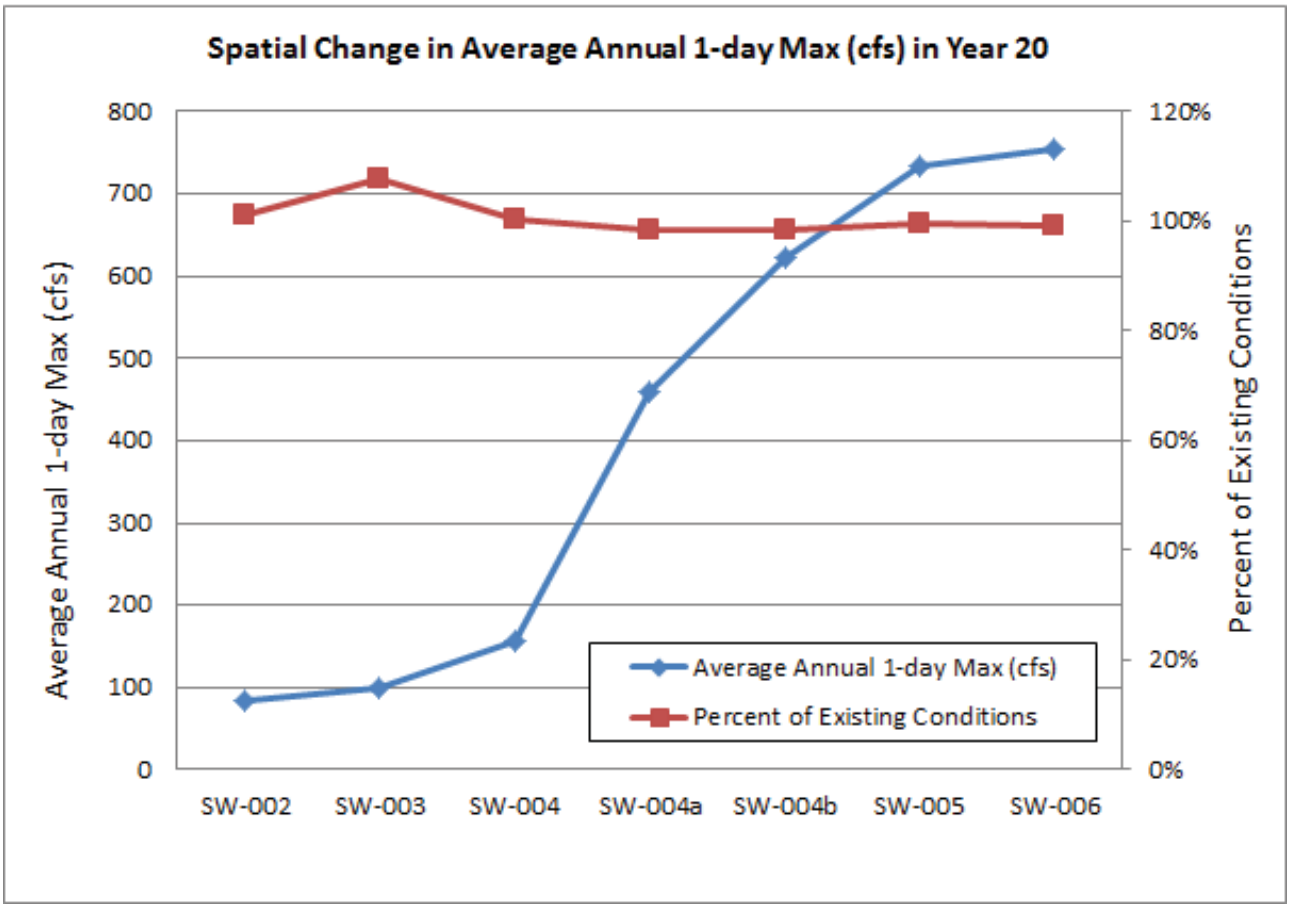


Figure 40 **Spatial Variation of Average Annual 1-day Maximum Flow – Year 20**

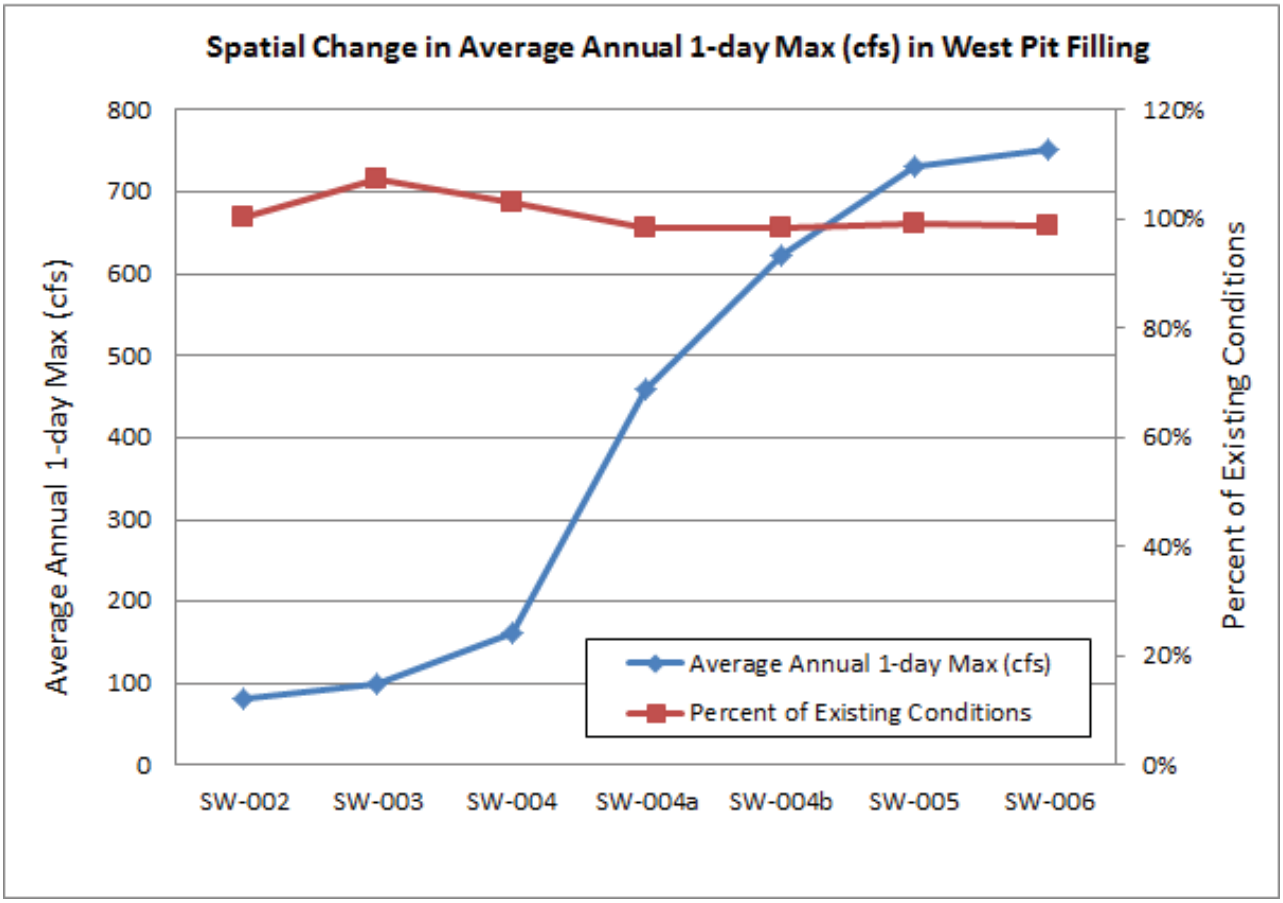


Figure 41 **Spatial Variation of Average Annual 1-day Maximum Flow – West Pit Filling**

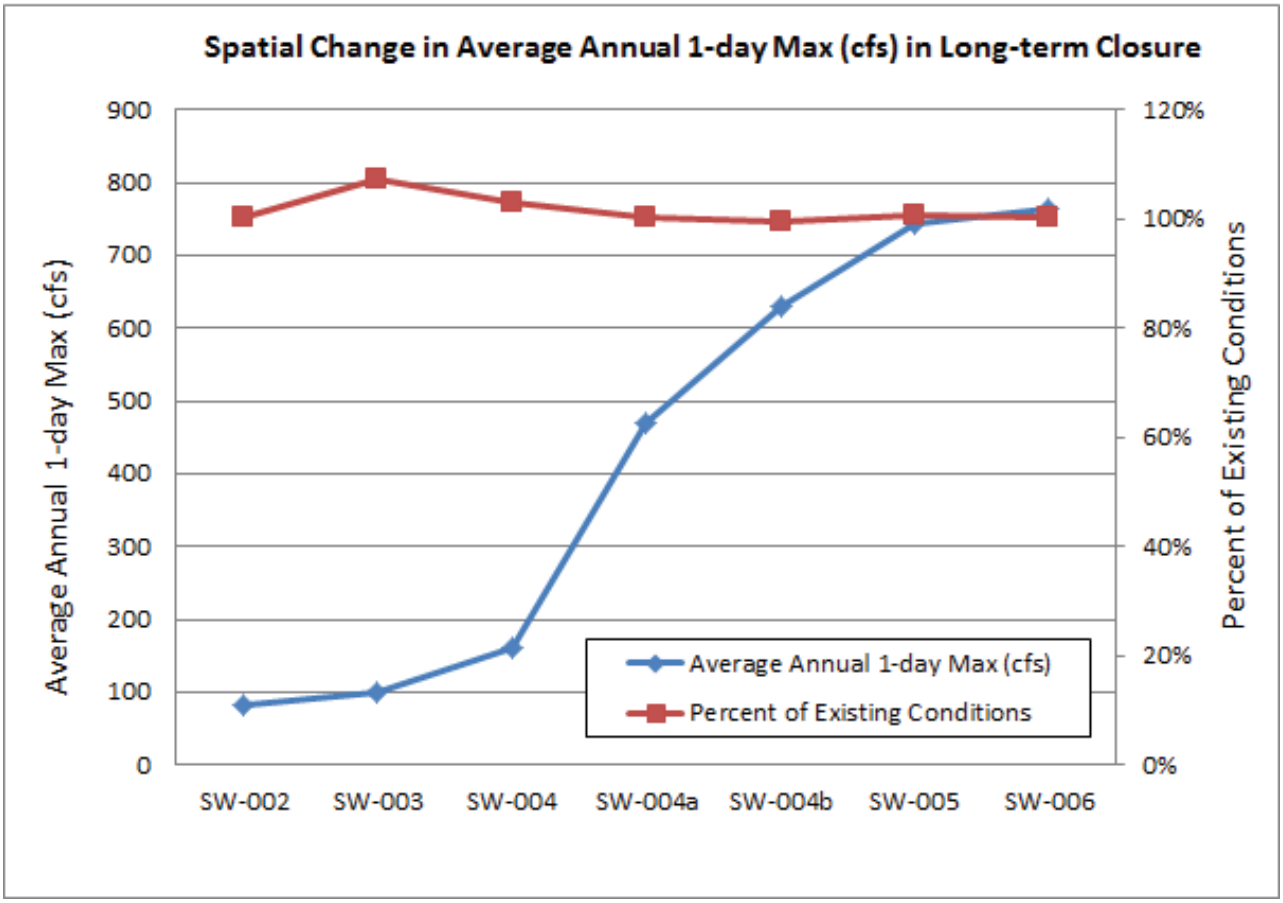


Figure 42 **Spatial Variation of Average Annual 1-day Maximum Flow – Long-term Closure**

Attachment K

Concentration Statistics at the Surface Water Evaluation Locations

Attachment K Concentration Statistics at the Surface Water Evaluation Locations

Estimated surface water quality is shown in this attachment using a series of concentration statistic plots. Data for these plots were created as follows:

- The probabilistic GoldSim model was run at monthly time steps for 200 years (2401 time steps including the initial time zero). At each time step, the concentration at each surface water evaluation location for each constituent was individually recorded.

- After one realization (i.e., one model run) was completed, the process was repeated until 500 model realizations were completed. The result is 500 estimated concentrations of each constituent at each surface water evaluation location at every time step.

- At every time step, and for every constituent, the 500 estimated concentrations were sorted smallest-to-largest and 3 single values were chosen to represent the statistics at that particular time step. This step was performed at each surface water evaluation location.

- From the 500 estimate concentrations, sorted smallest-to-largest, the 50th value was chosen to represent the 10th percentile (P10), the 250th value was chosen to represent the median (P50), and the 450th value was chosen to represent the 90th percentile (P90). This indicates that at any time, 10% of the model results are less than or equal to the P10 value, 50% are less than or equal to the P50 value, and 90% are less than or equal to the P90 value.

- This process was repeated for all constituents at each surface water evaluation location, resulting in 3 time series lines representing the 10th, 50th, and 90th percentiles of concentrations at every time step (monthly results).

- For plotting the results over the entire 200 years of the simulation, the data was summarized by year to make the plots legible. The monthly model outputs for the 10th, 50th, and 90th percentiles are plotted on an annual basis by either

    - Taking the maximum value of each percentile for a given year (i.e., the highest 90th percentile value), or

    - Taking the average value of each percentile for a given year (i.e., the average of the twelve 90th percentile values).

The figure numbering convention is "**Figure W-XX-YY.Z**" where:

- **W** indicates the Attachment.
- **XX** is a counter indicating the location; in this attachment it will count from "01" to "08" to account for the surface water evaluation locations in order from upstream (SW002) to downstream (Colby Lake).
- **YY** is a counter indicating the constituent; in this attachment it will count from "01" to "28" to show the 27 independently modeled constituents and the calculated hardness.
- **Z** is a numerical value, 1 or 2. A value of 1 indicates that the annual maximum has been plotted and a value of 2 indicates that the annual average has been plotted.

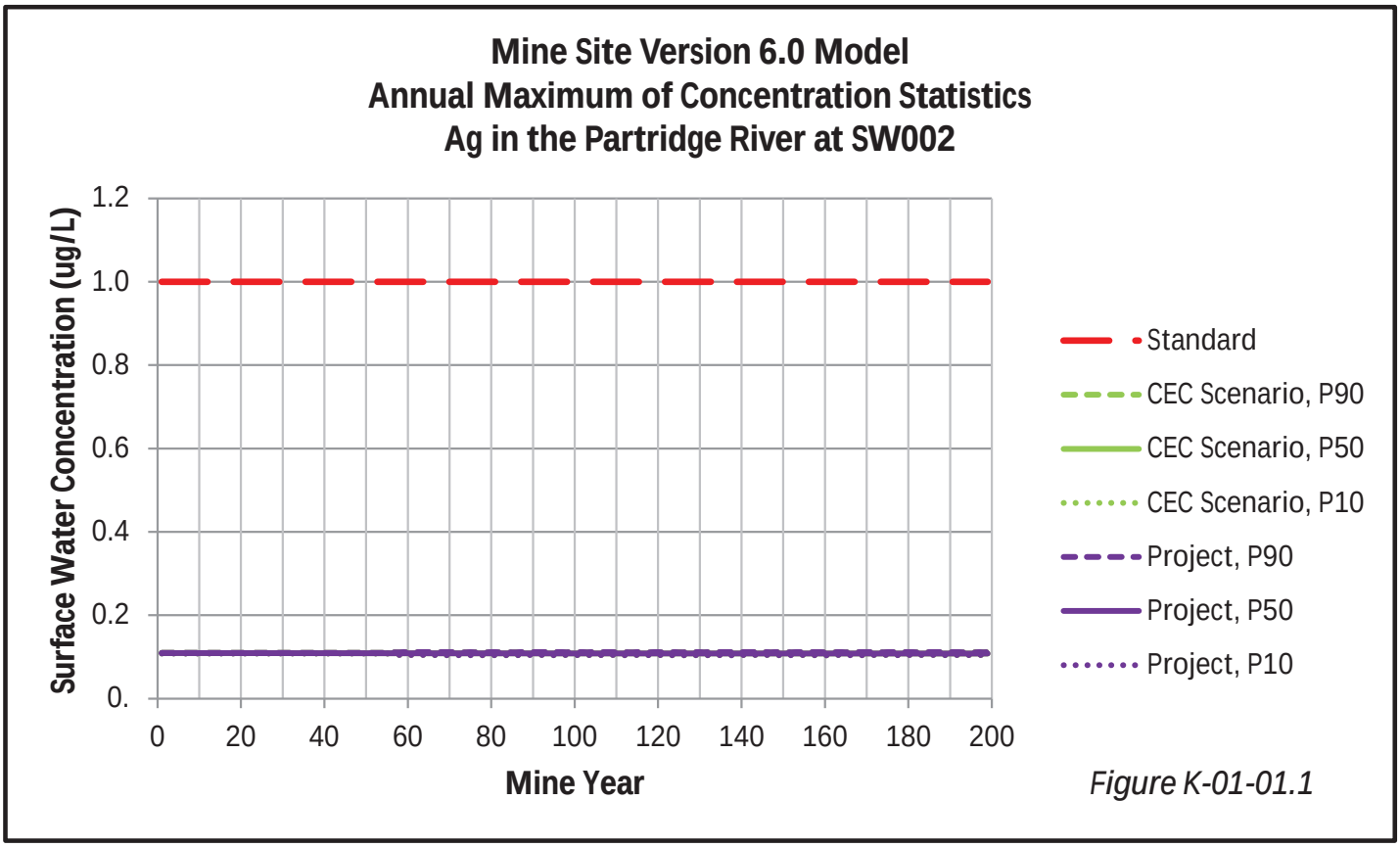
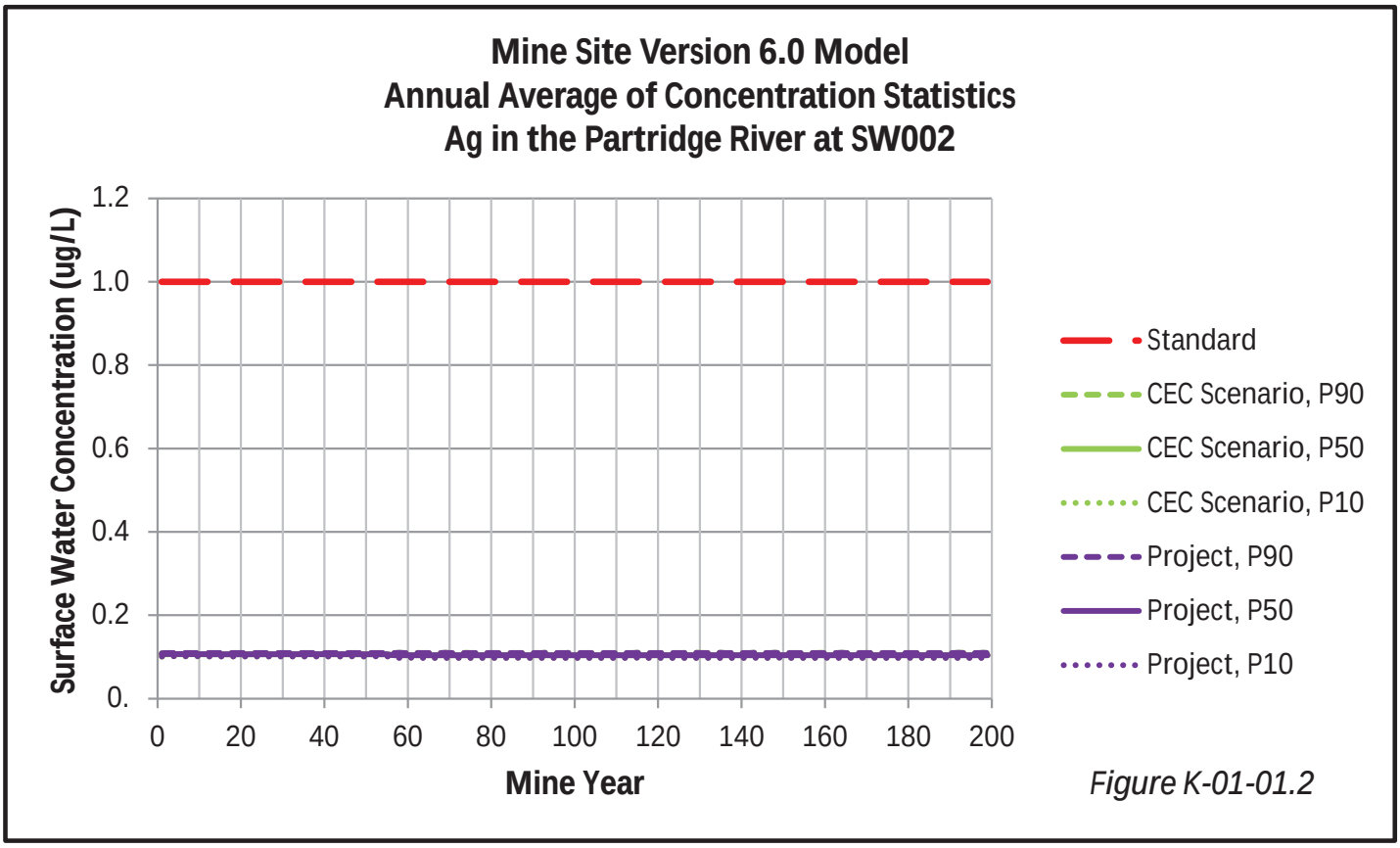


Figure K-01-01.1



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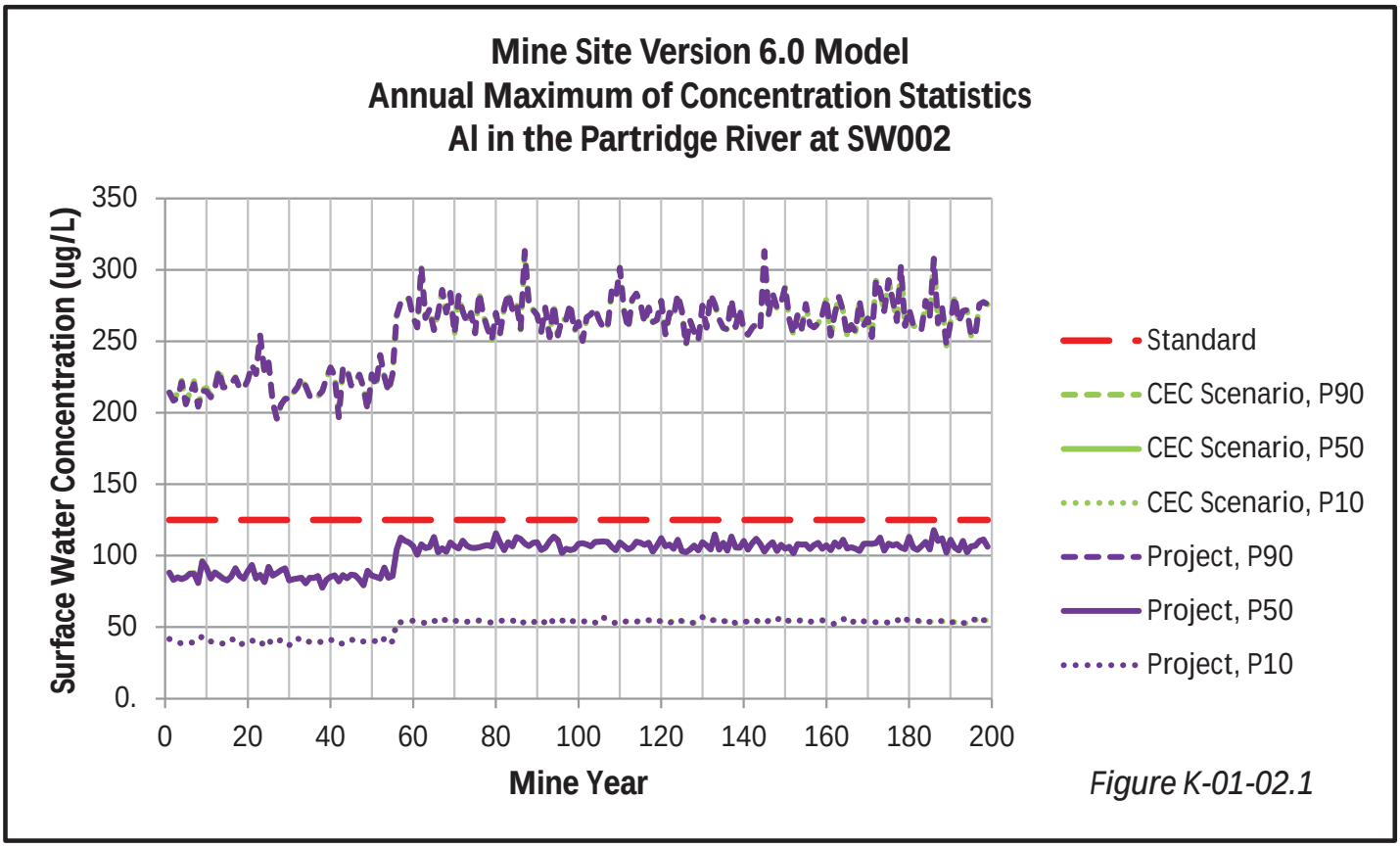


Figure K-01-02.1

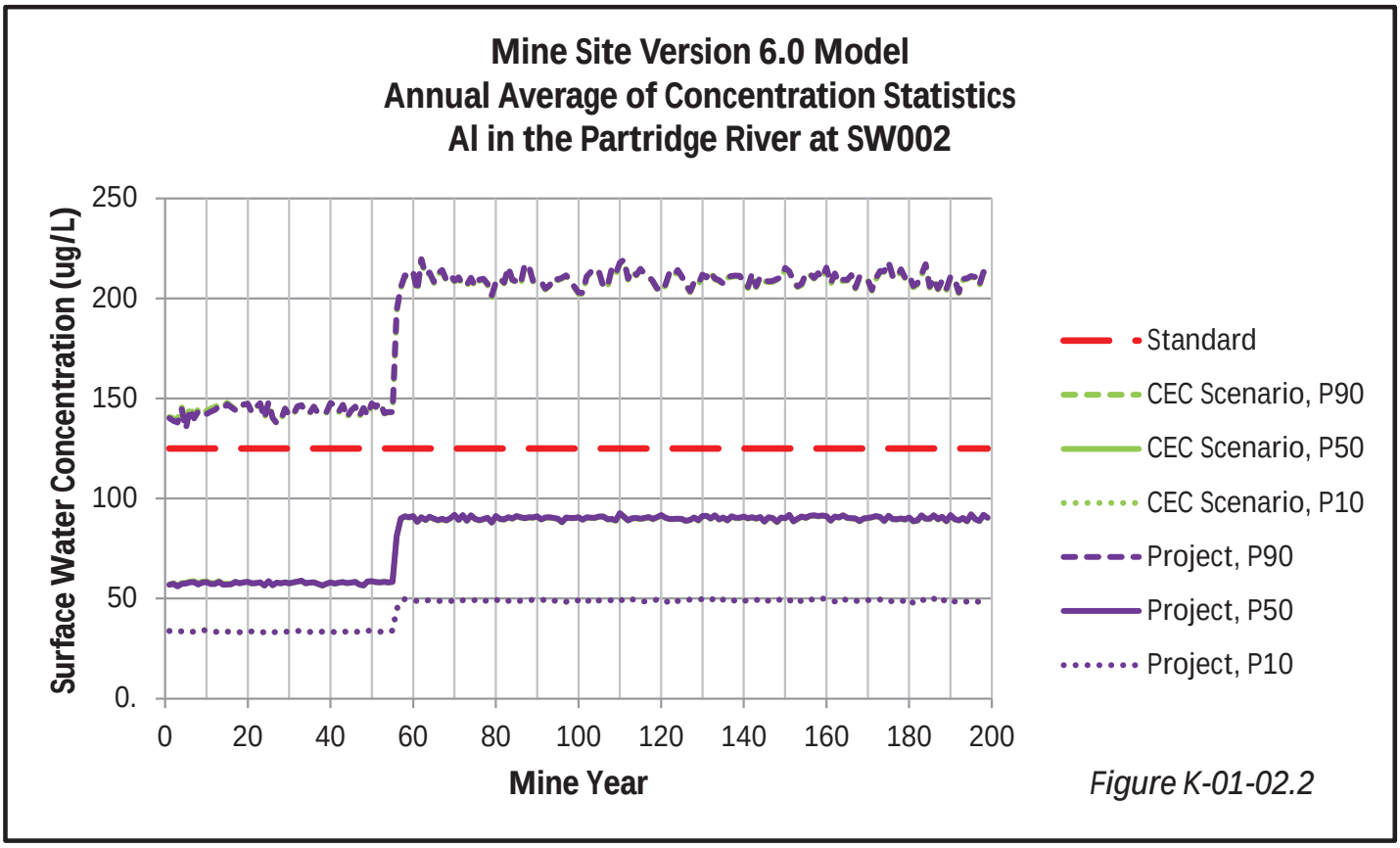


Figure K-01-02.2

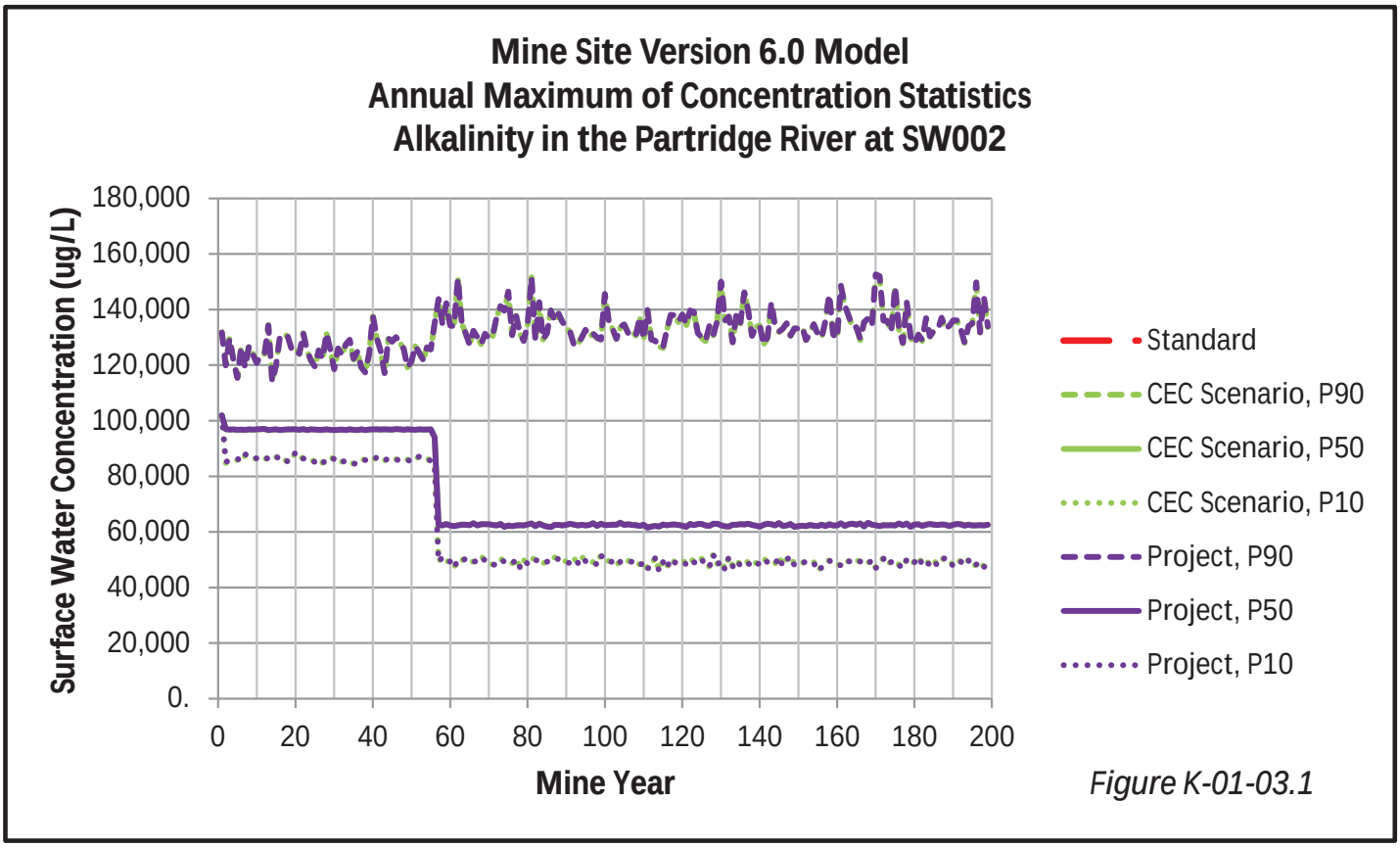
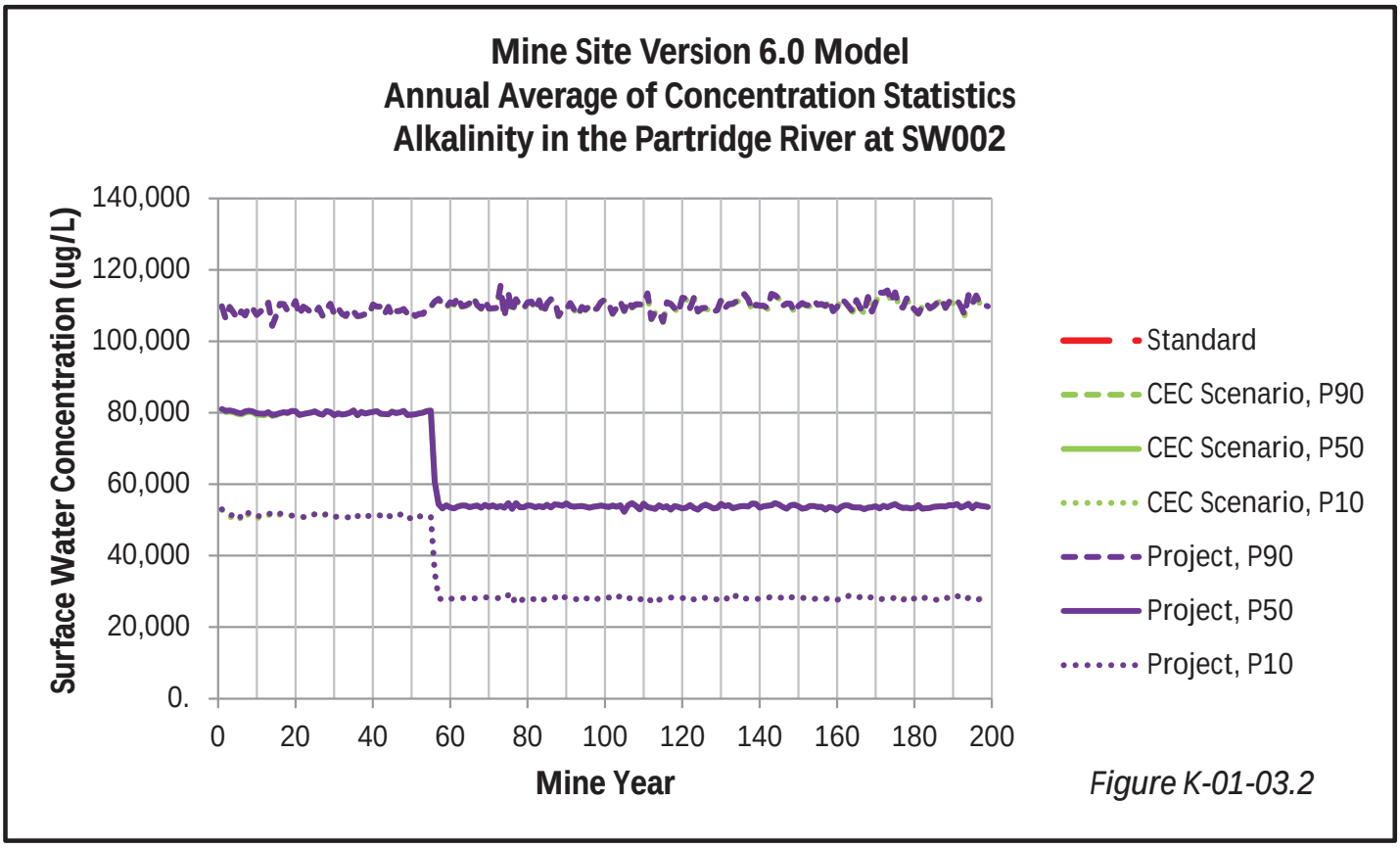


Figure K-01-03.1



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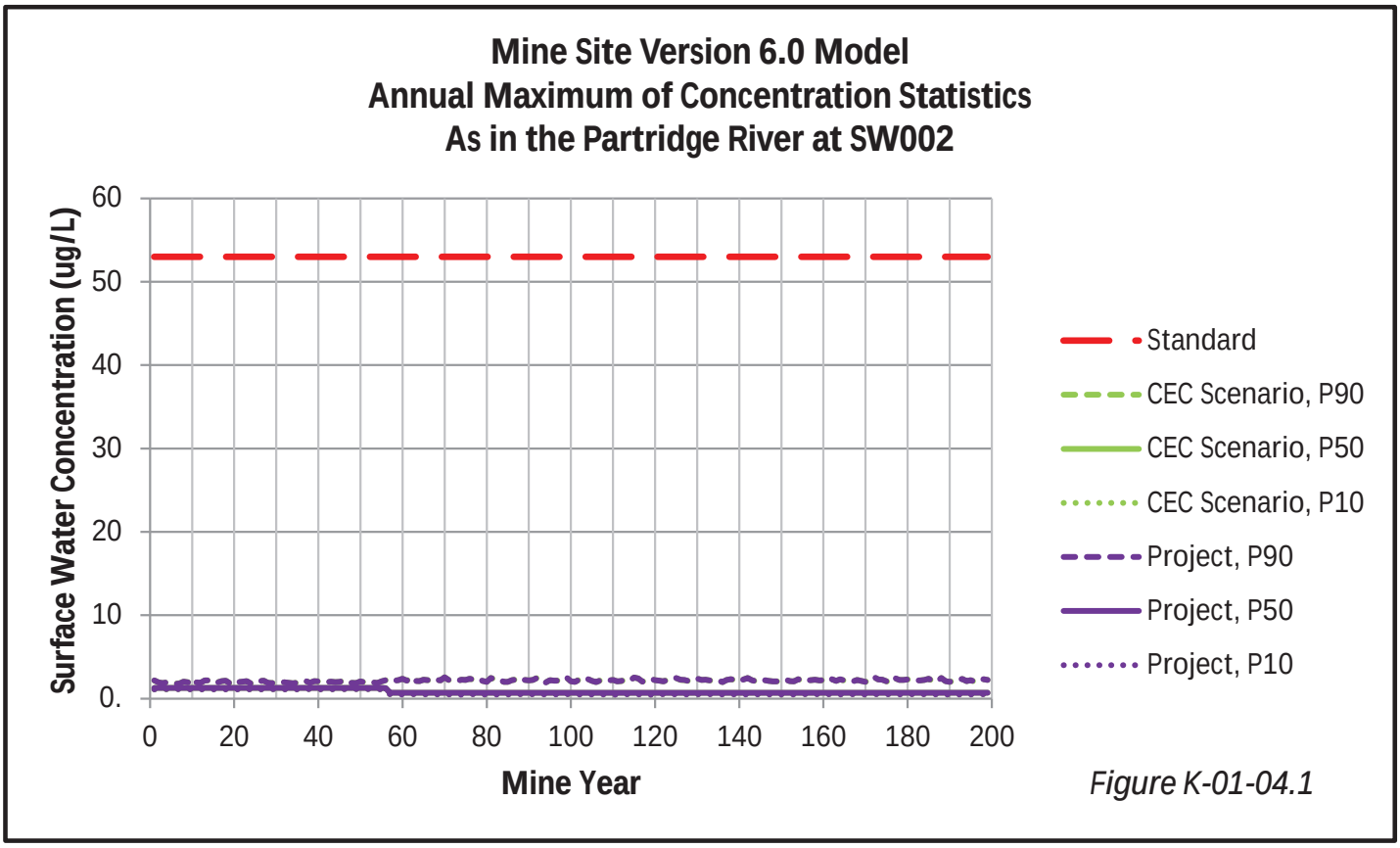


Figure K-01-04.1

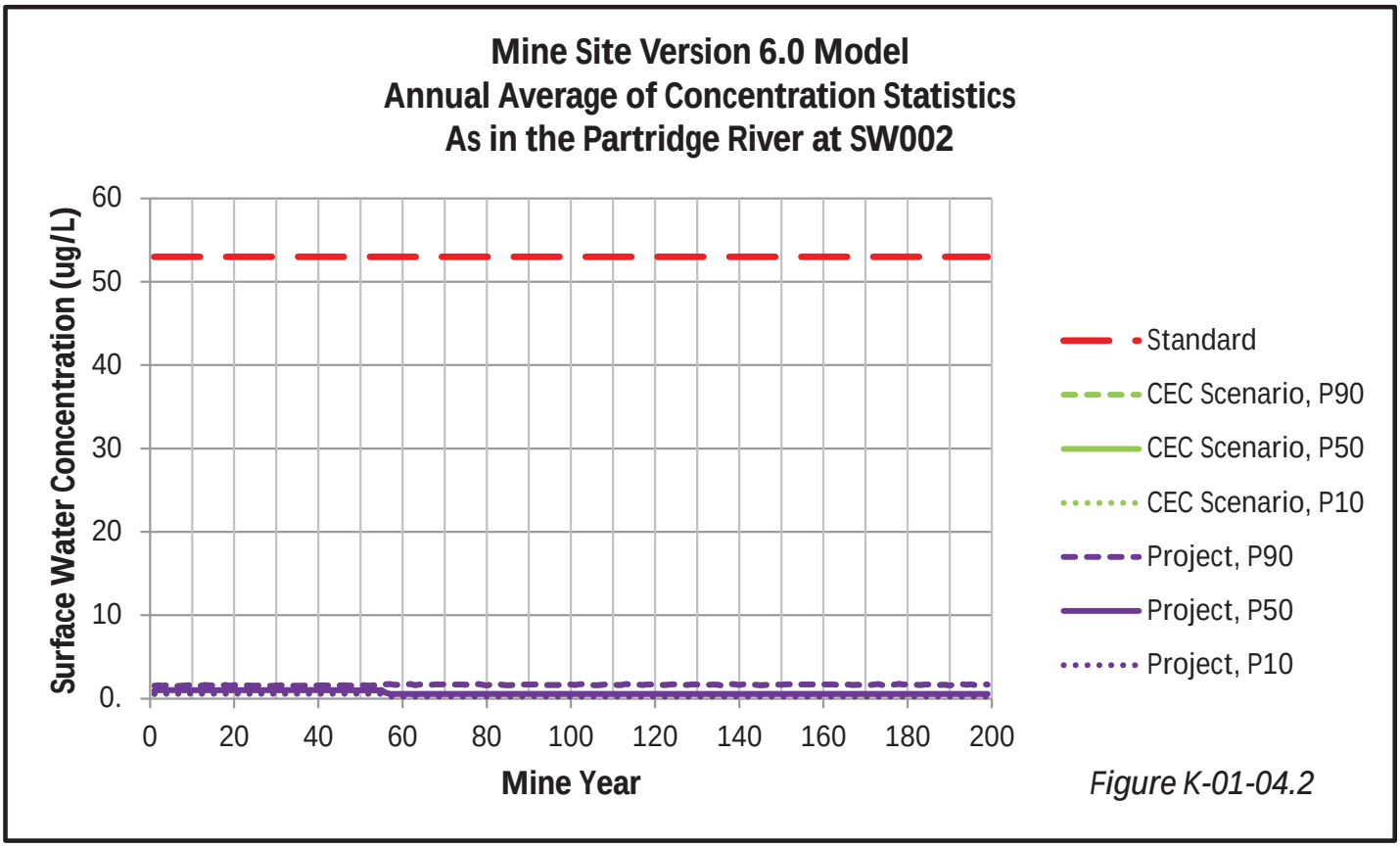
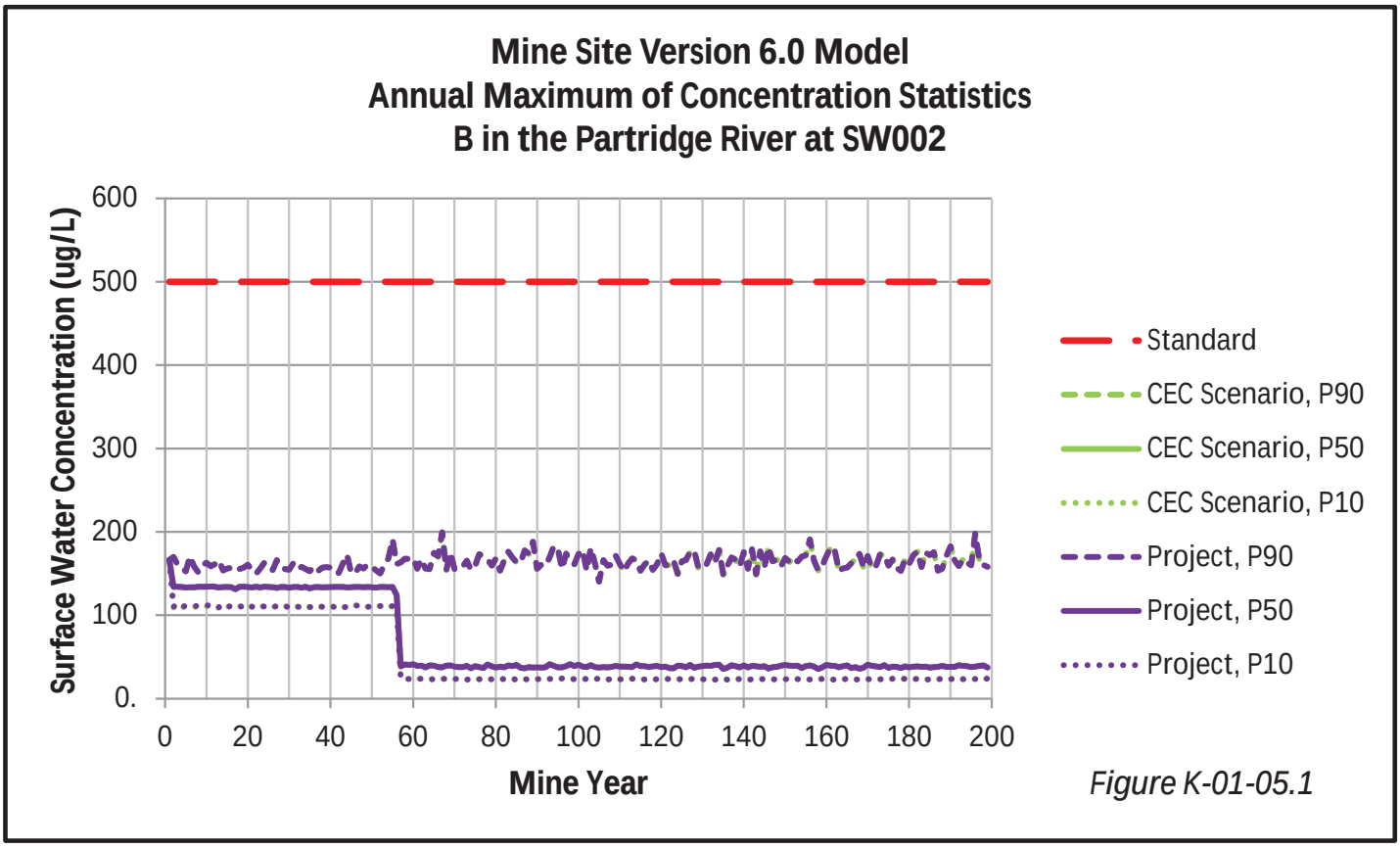


Figure K-01-04.2



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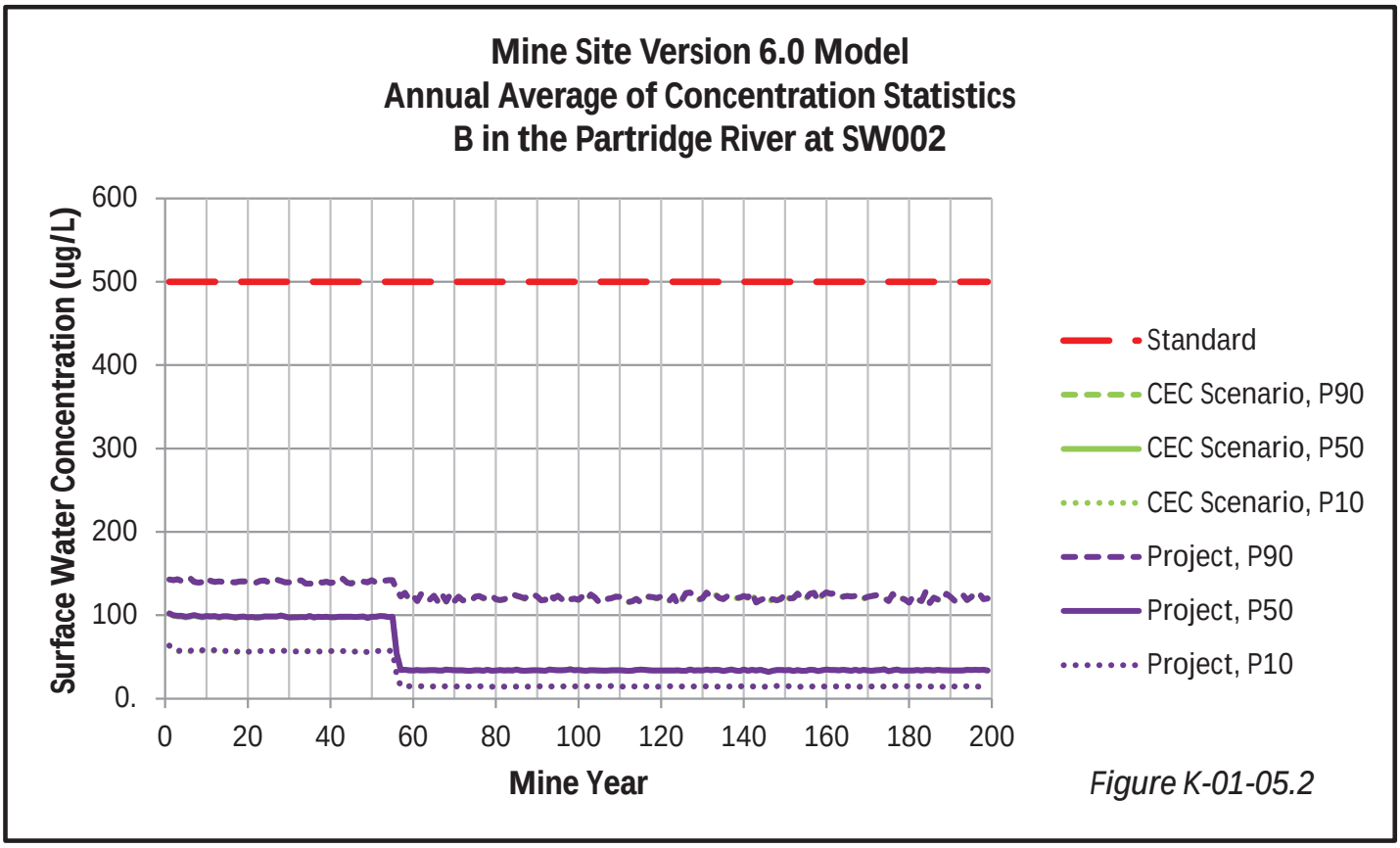

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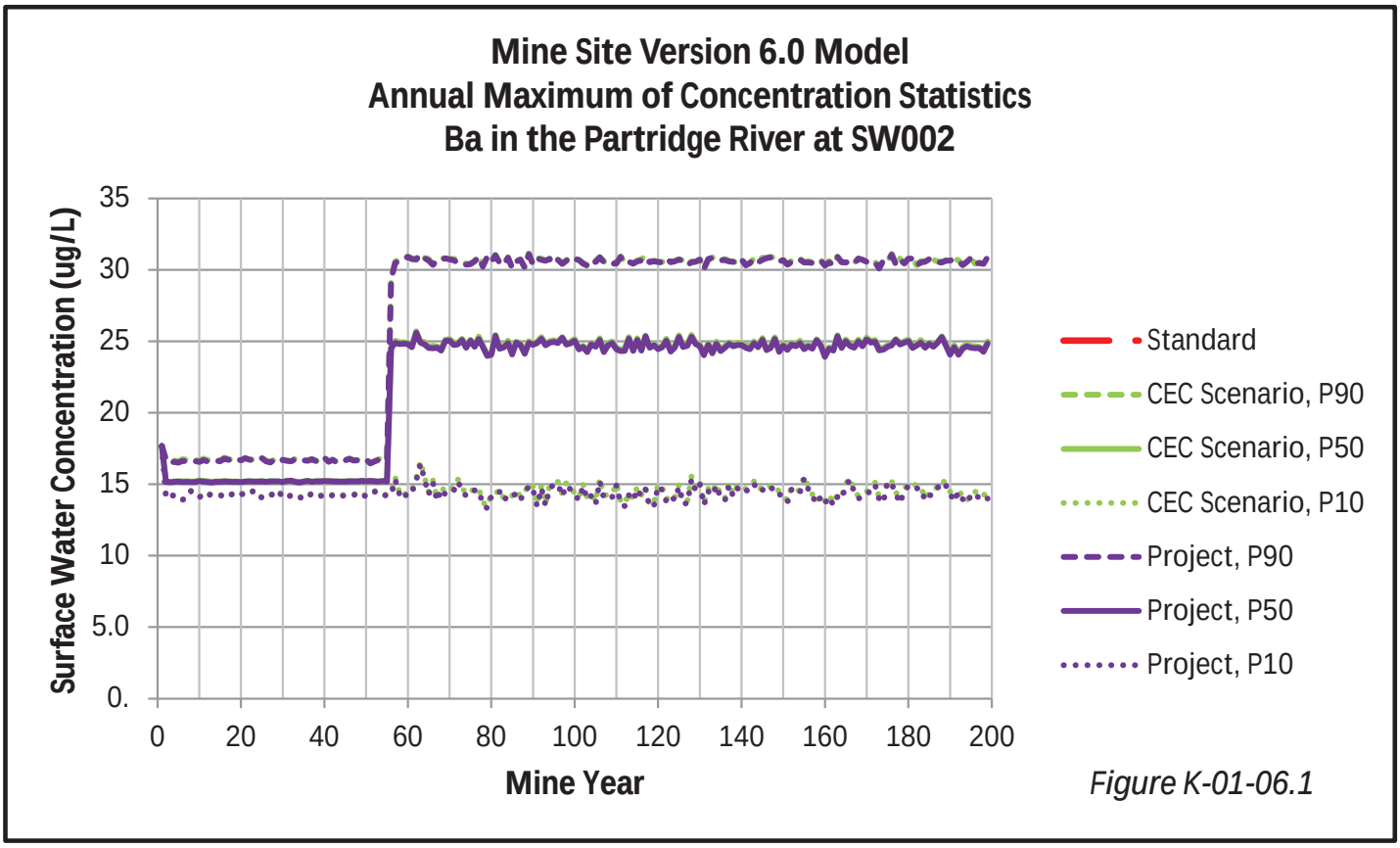


Figure K-01-06.1

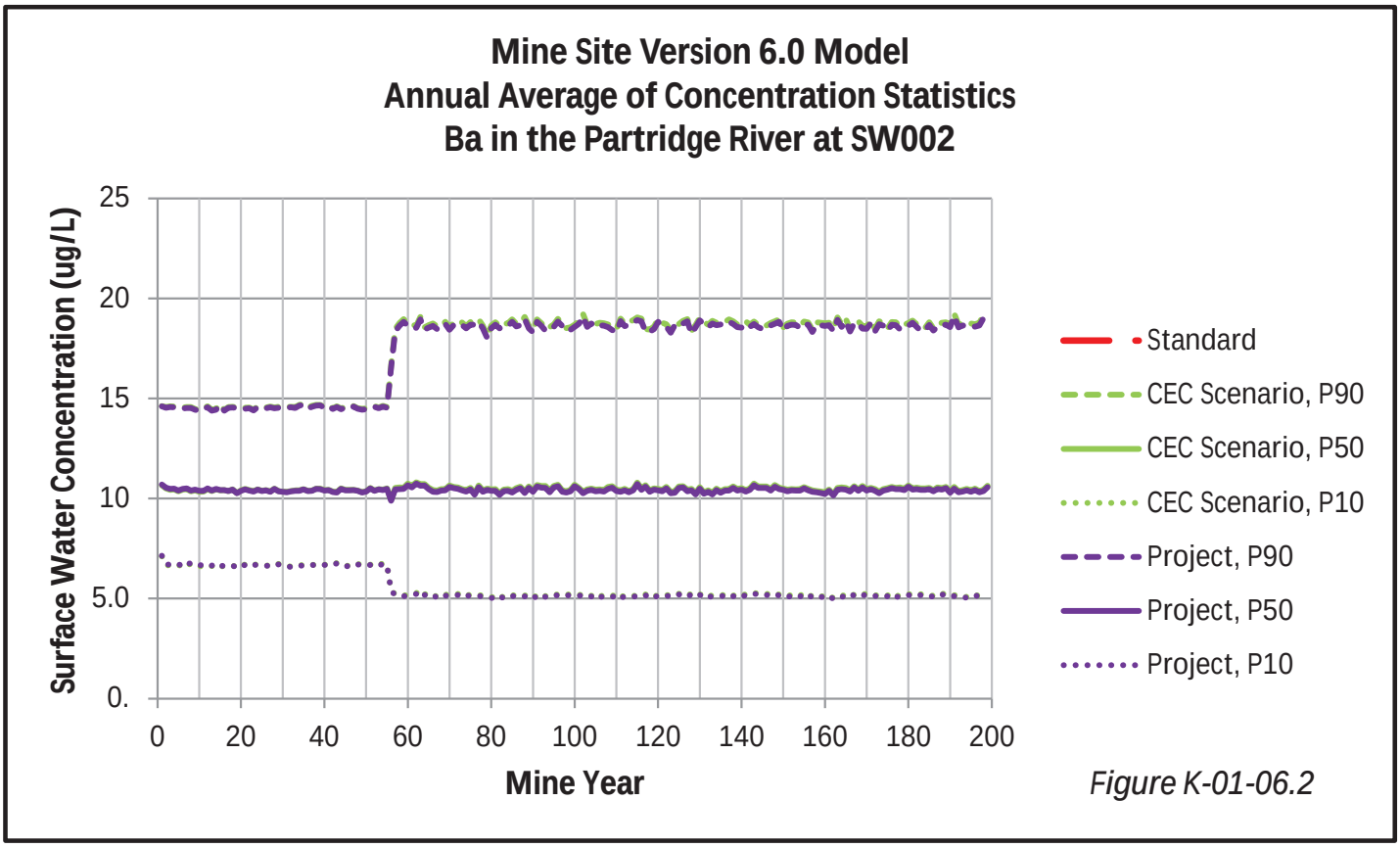
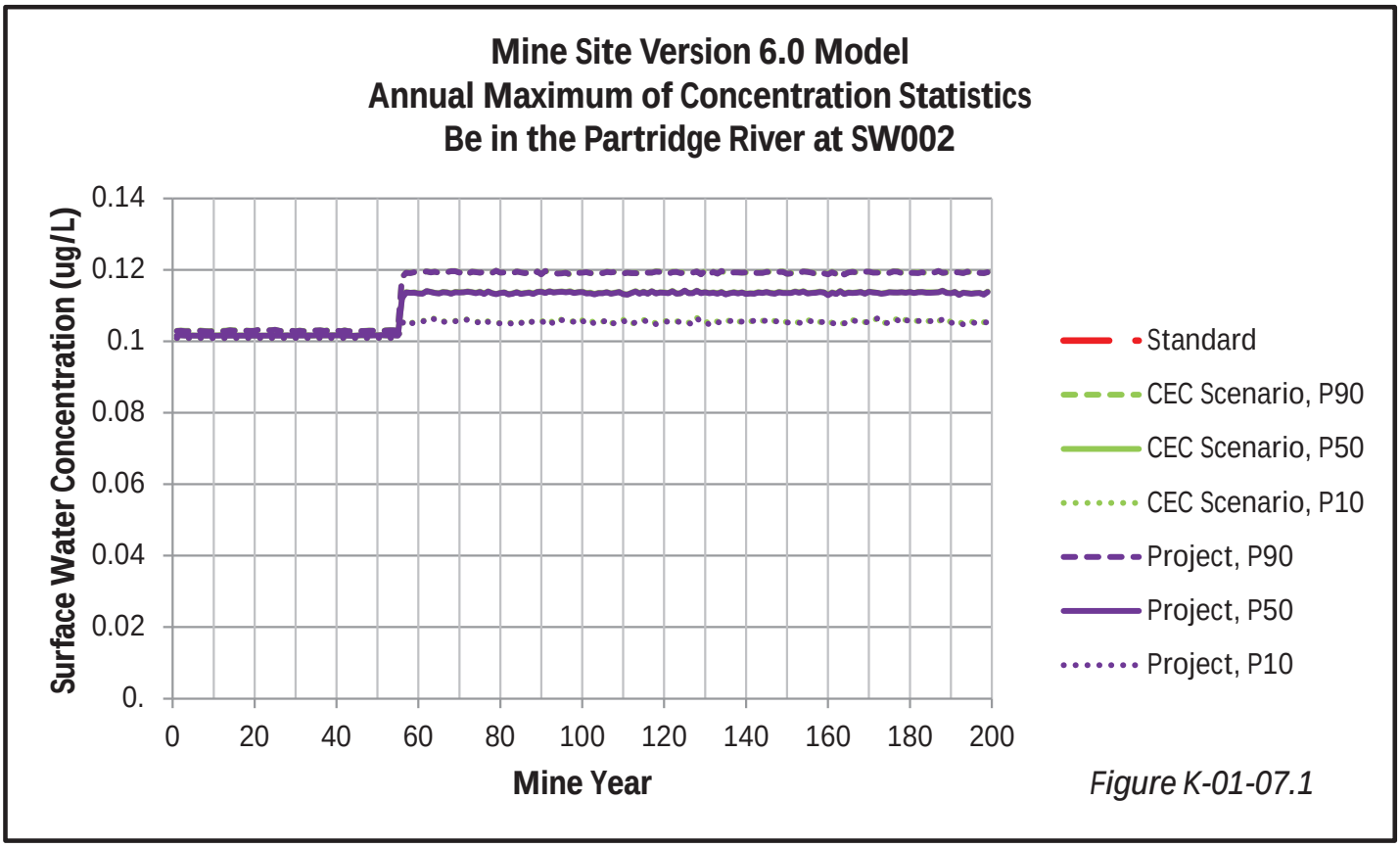


Figure K-01-06.2



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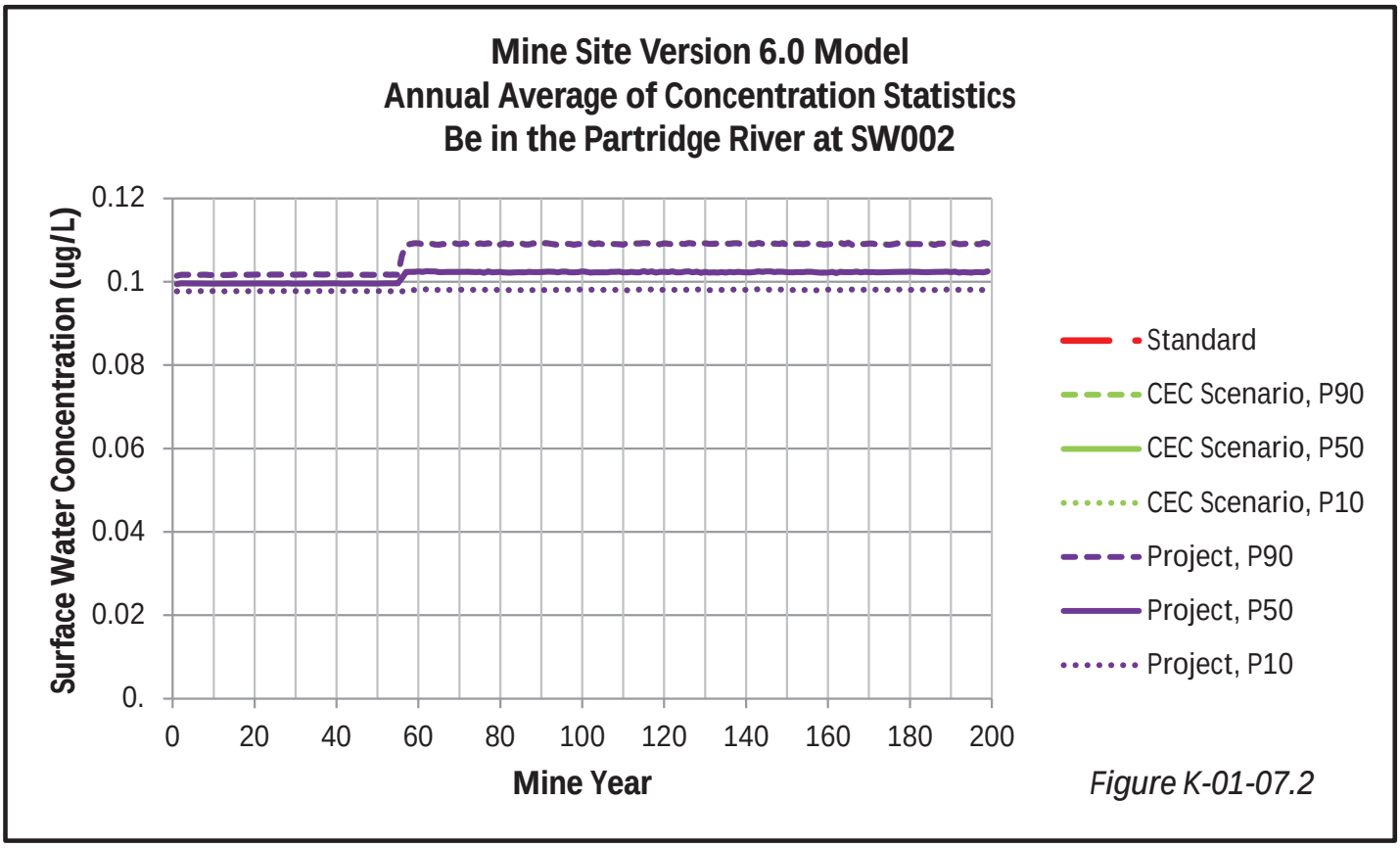

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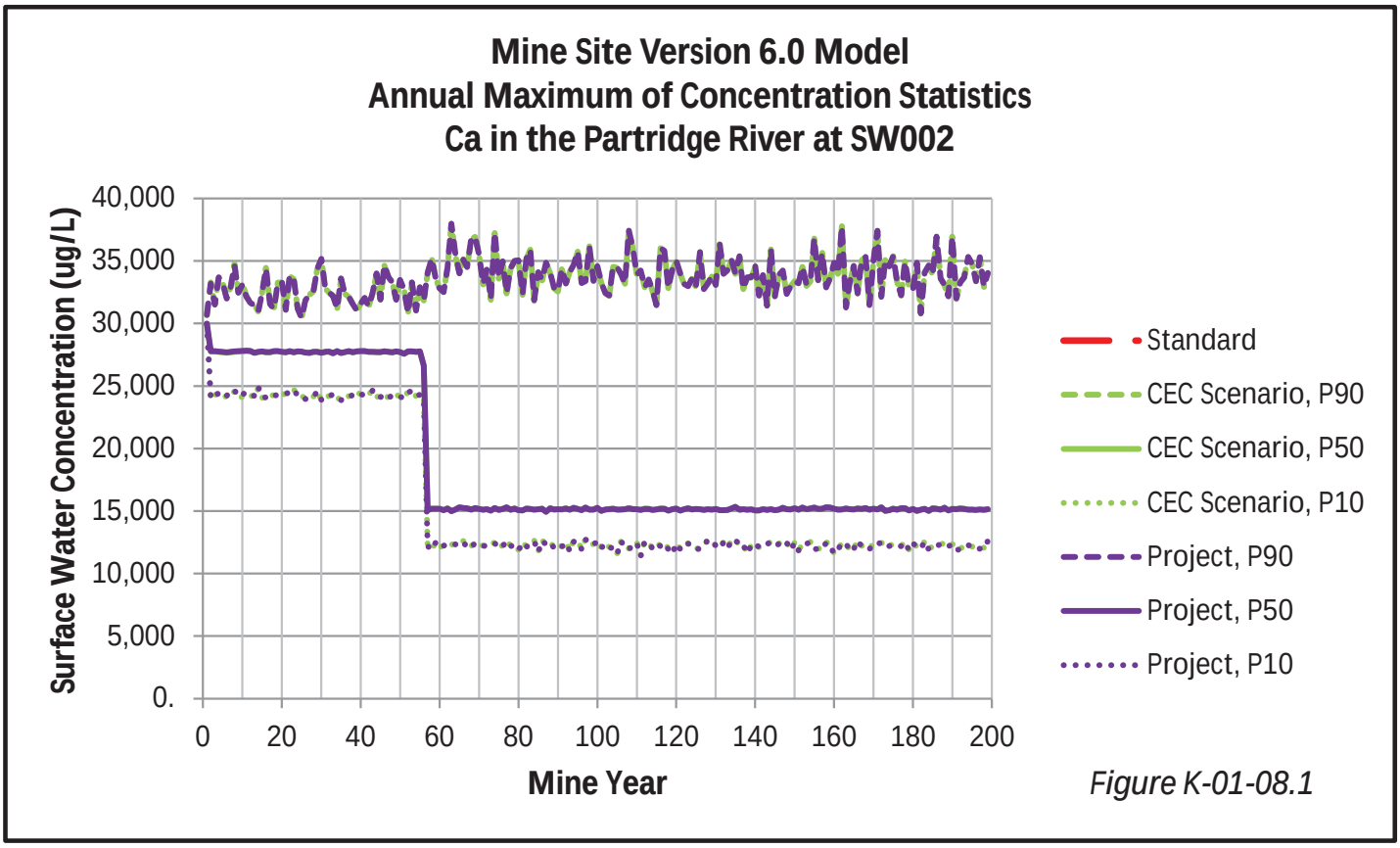

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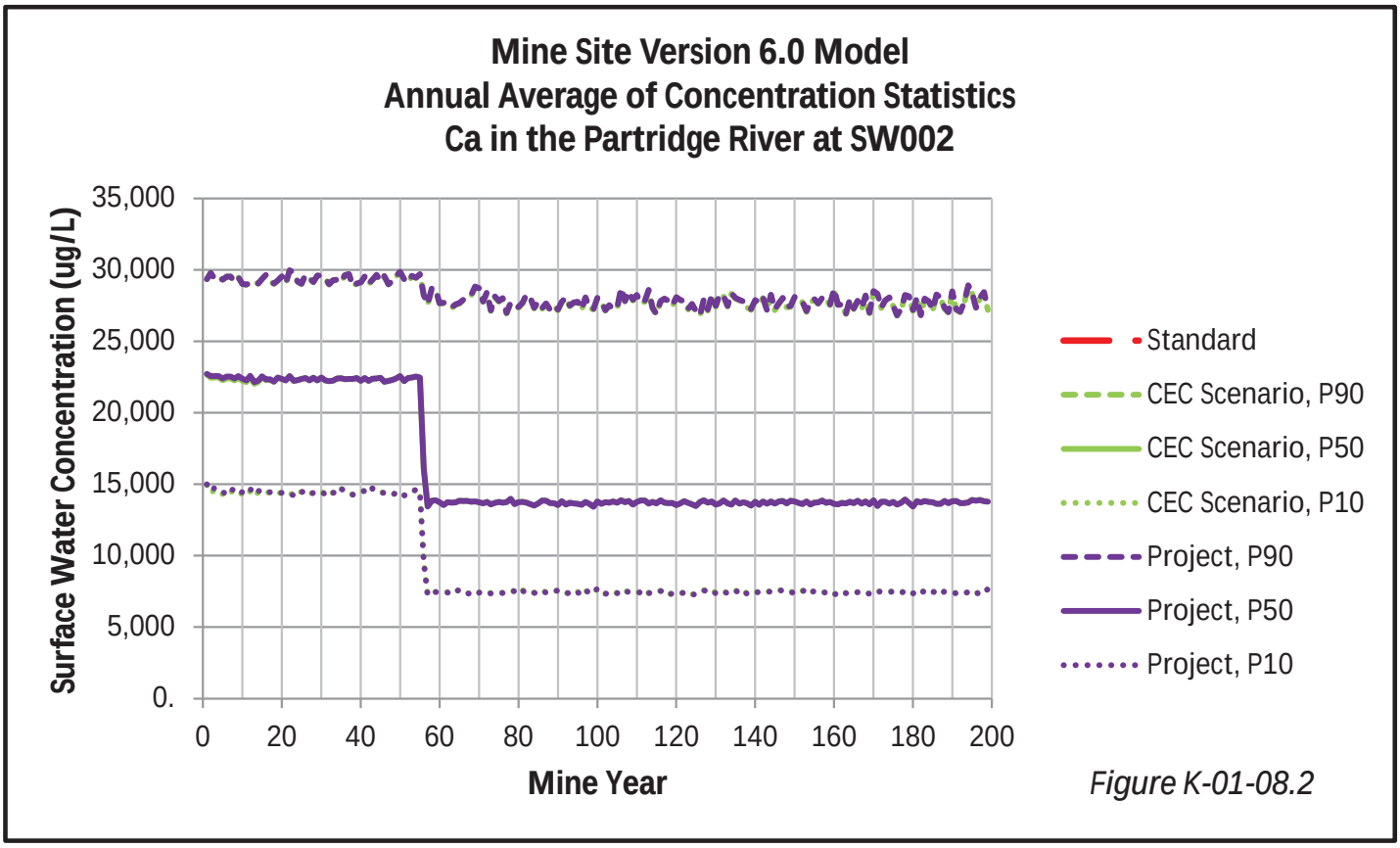

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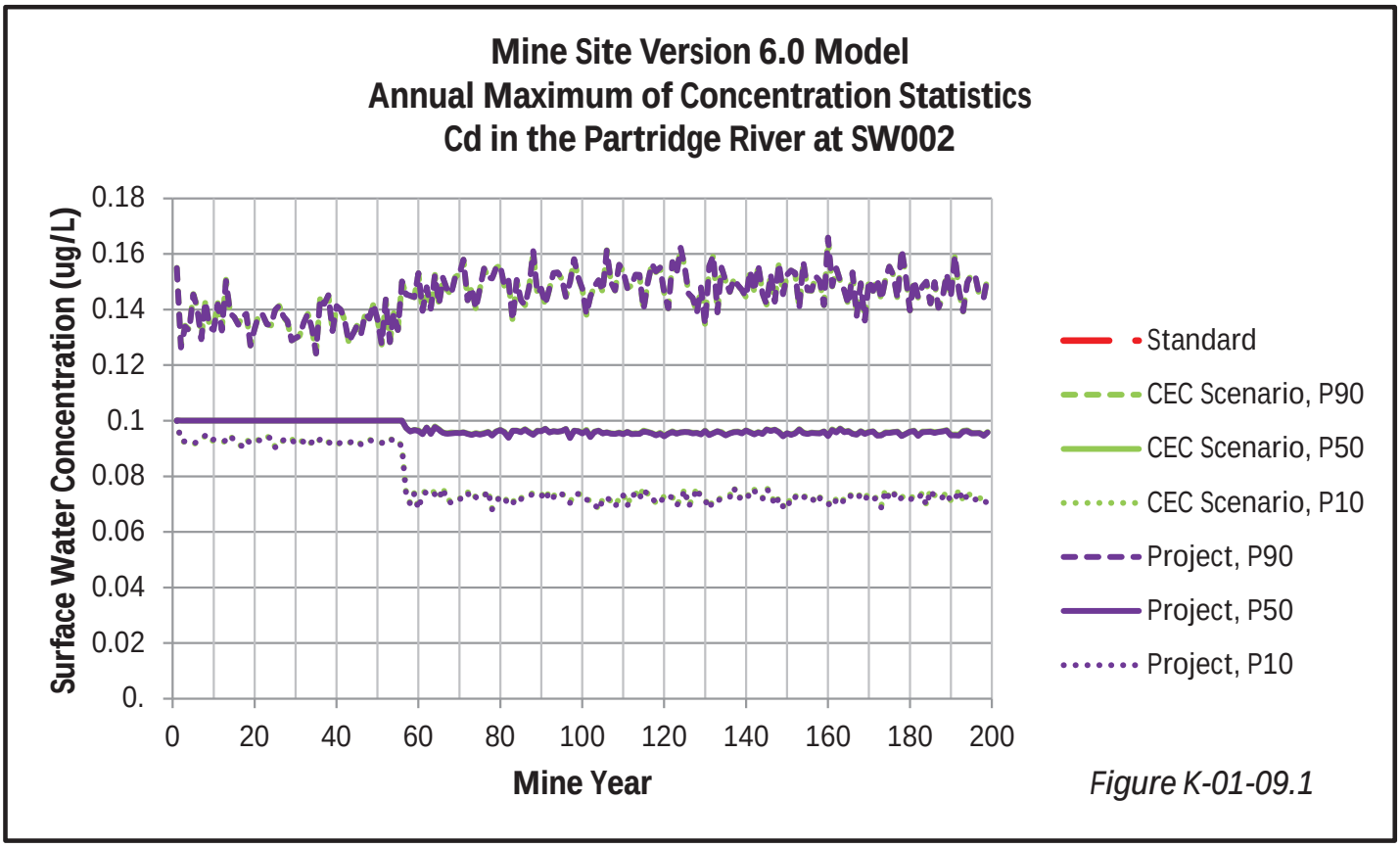

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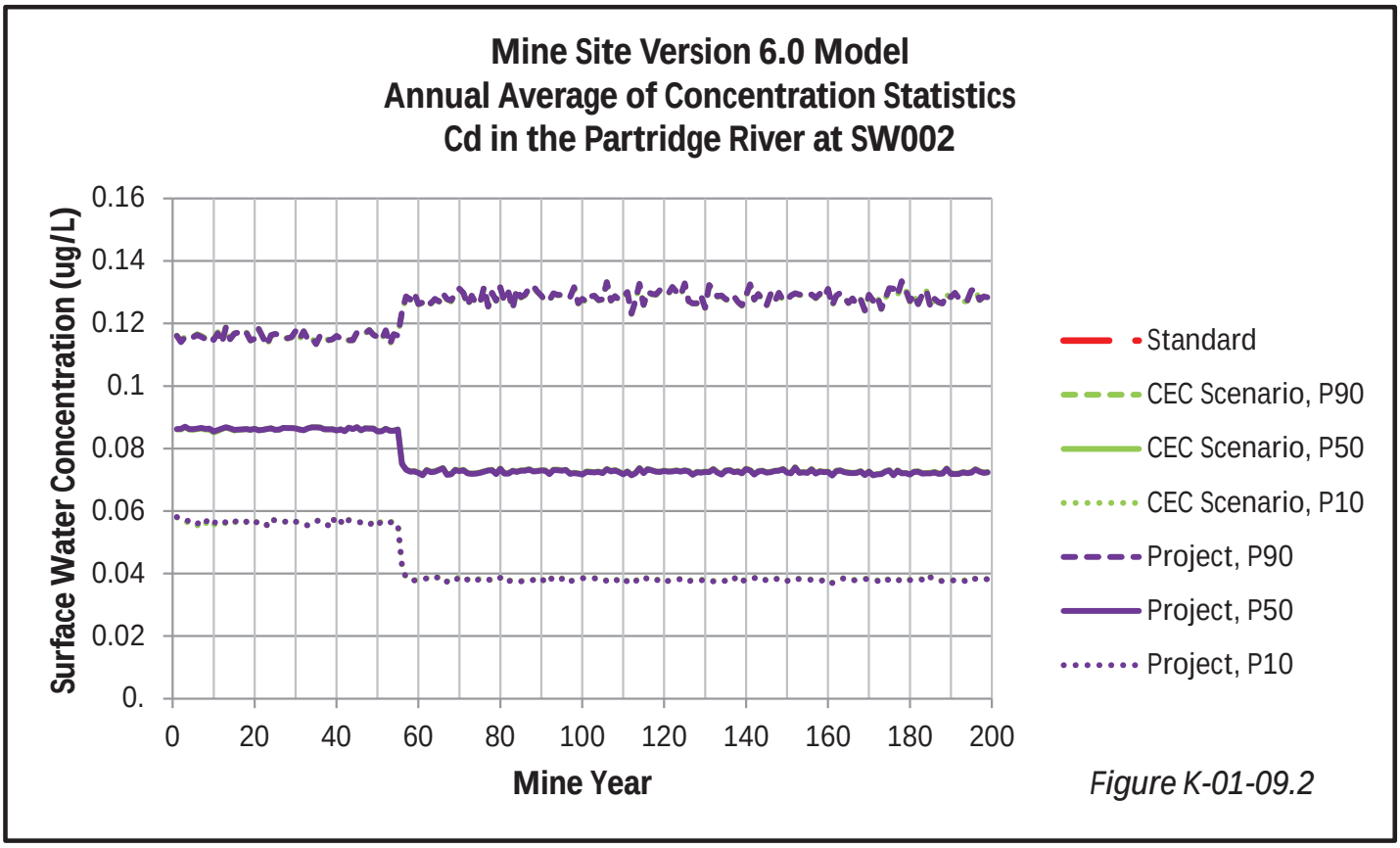

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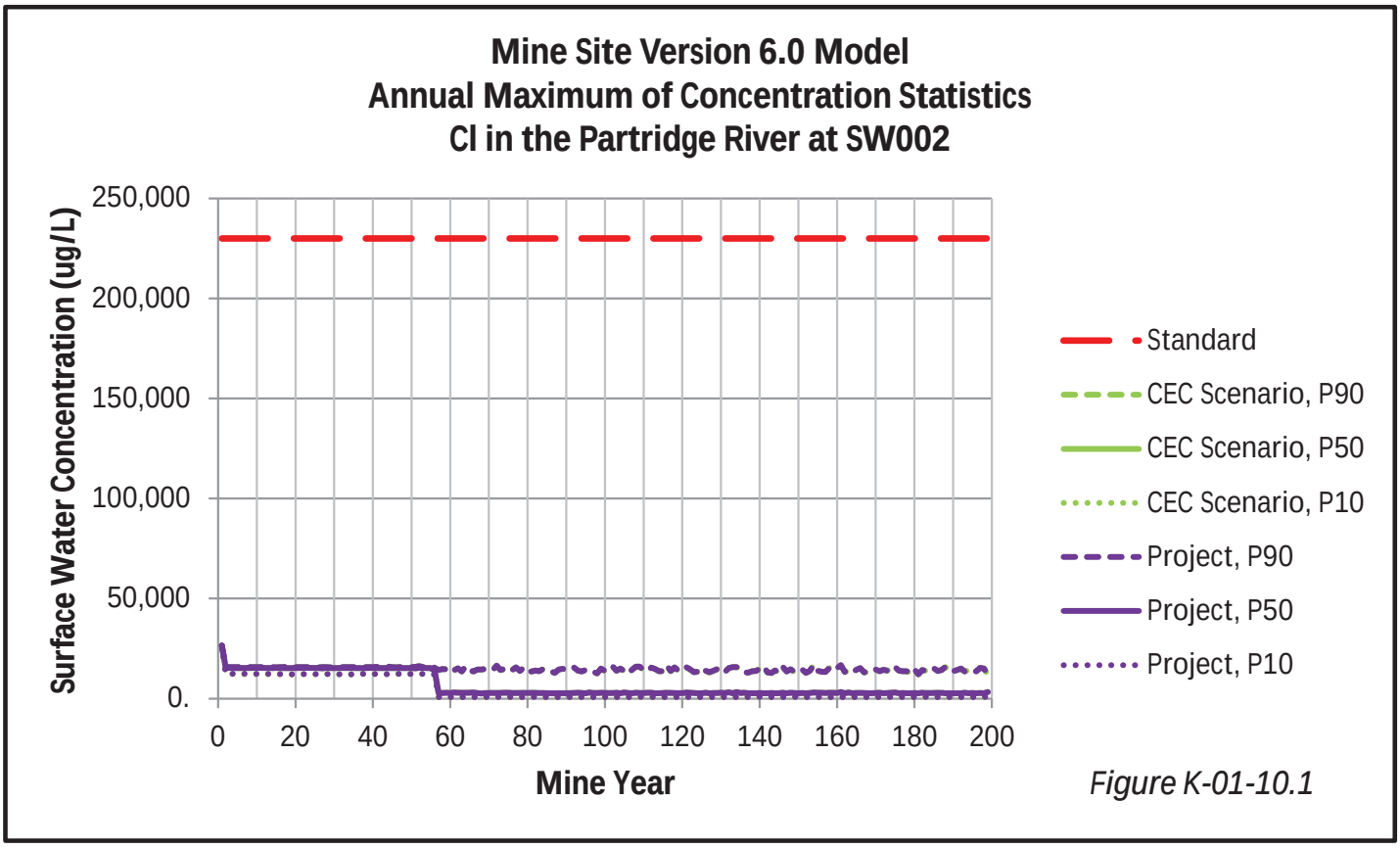

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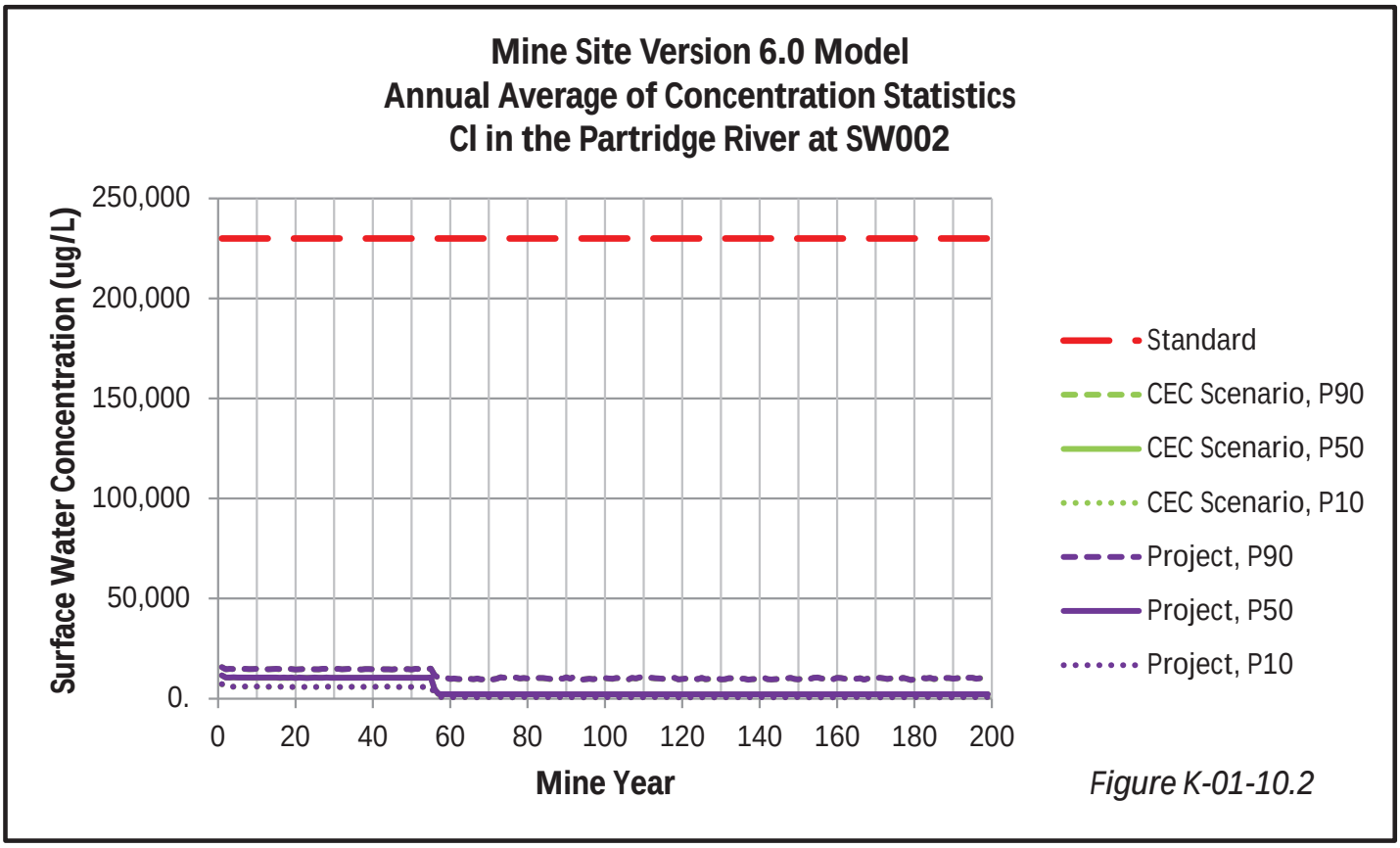

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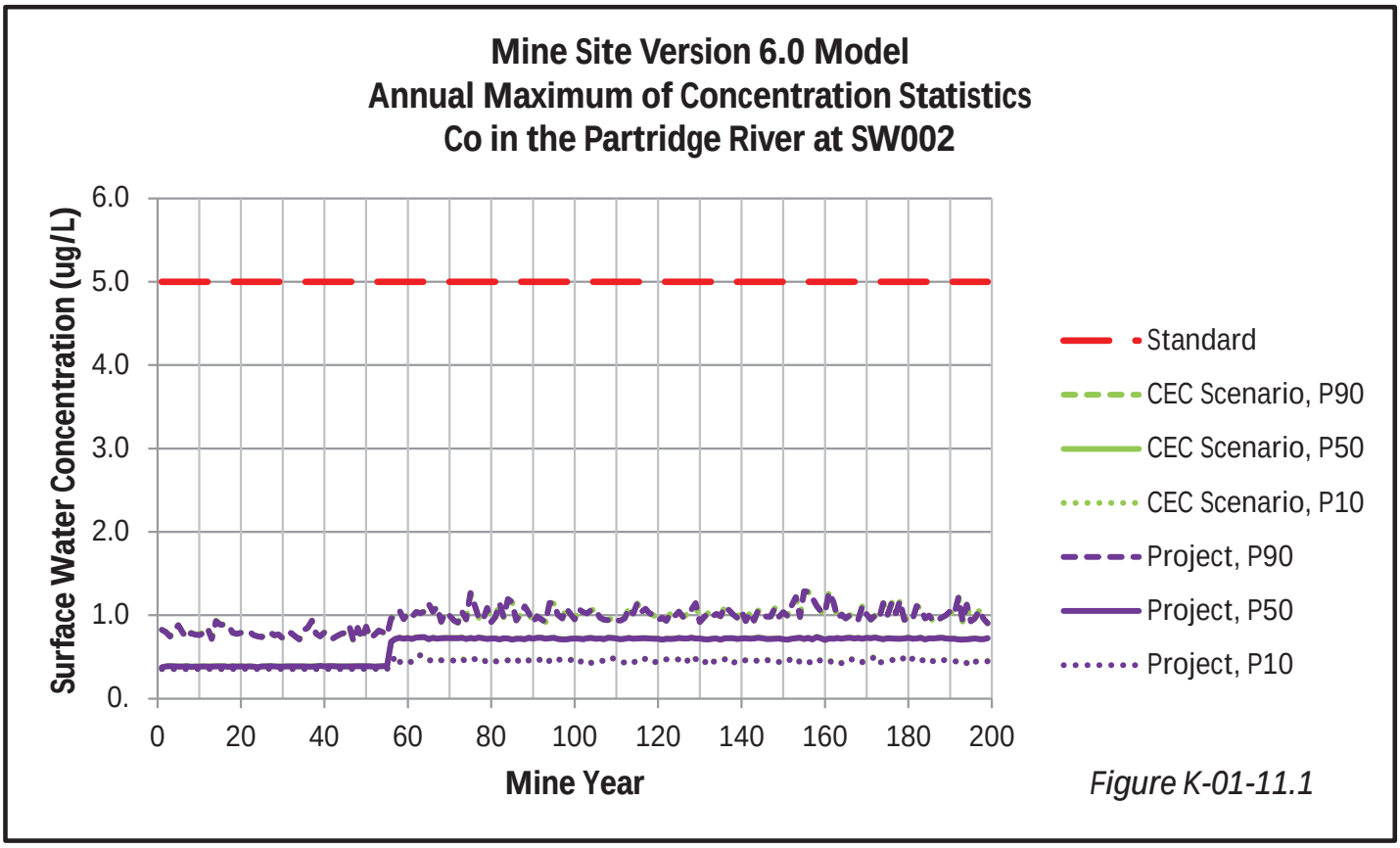

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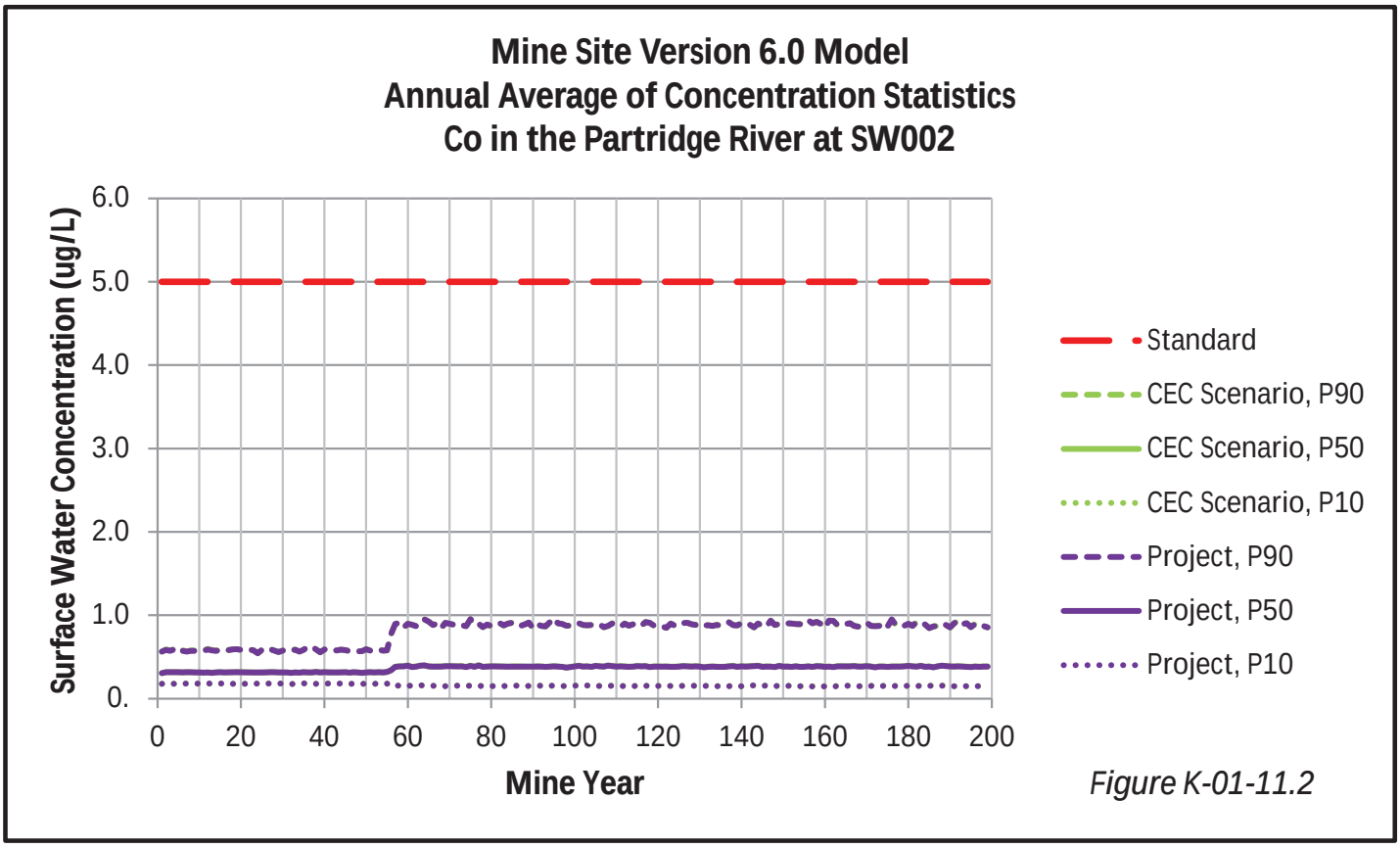

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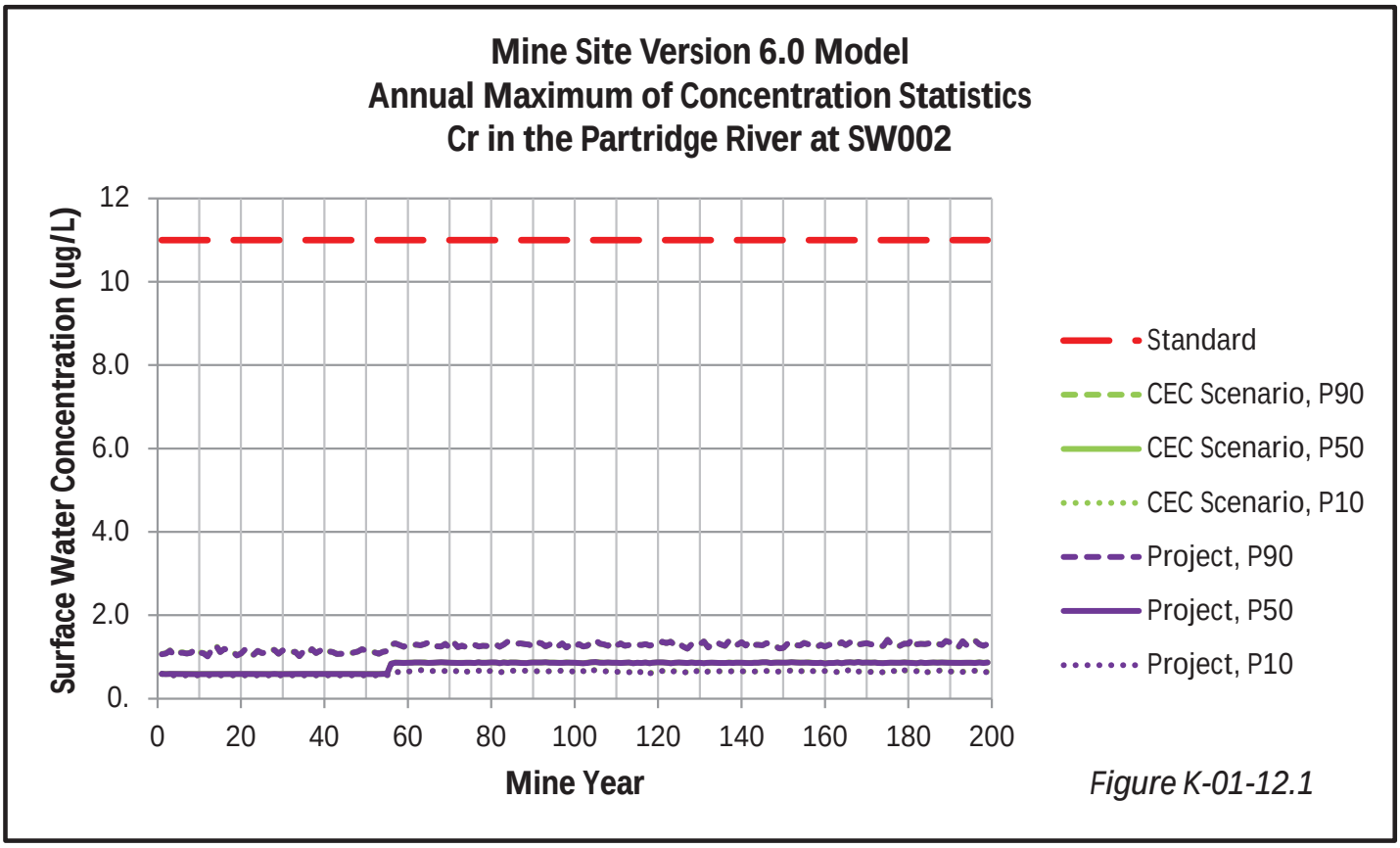

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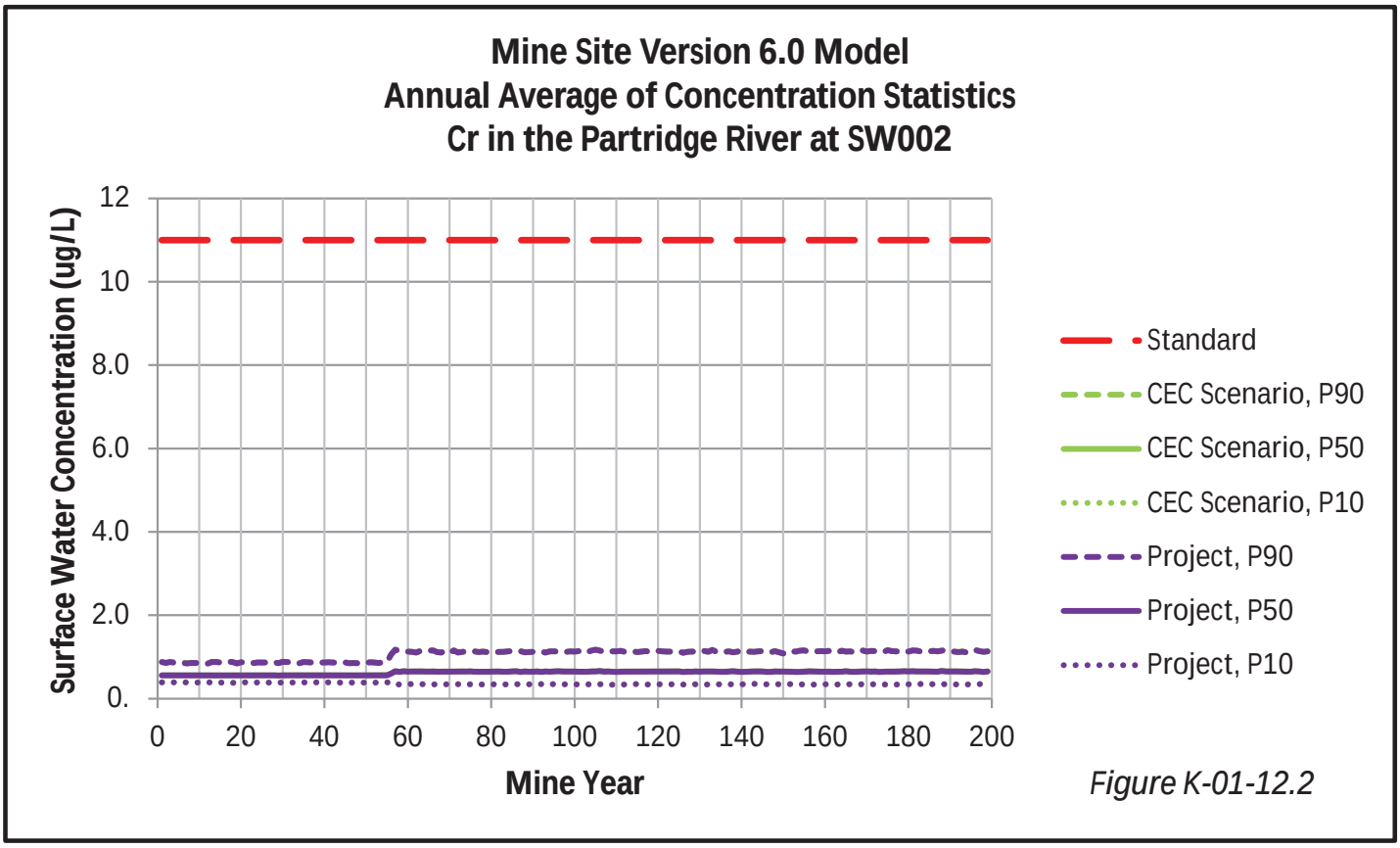

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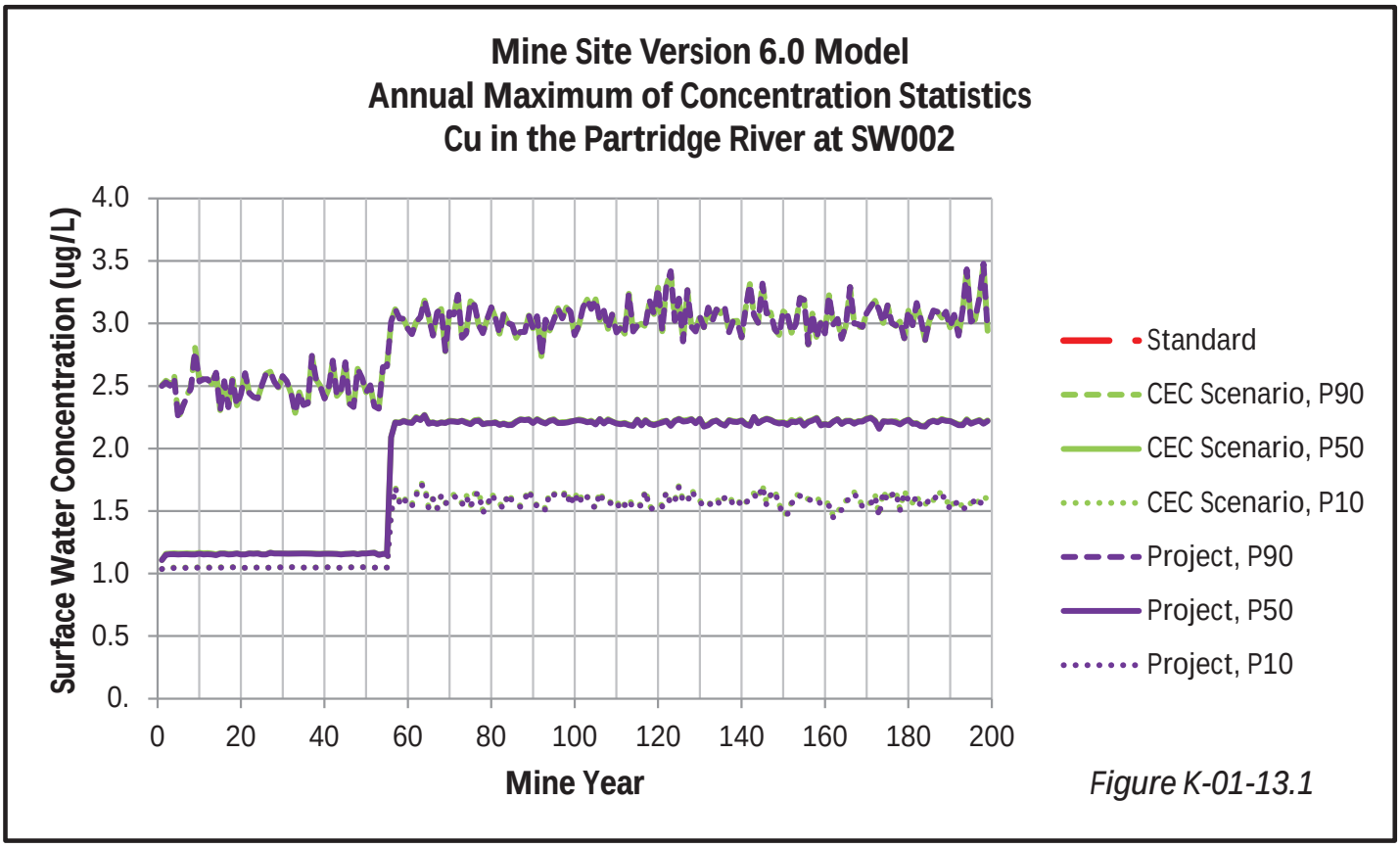

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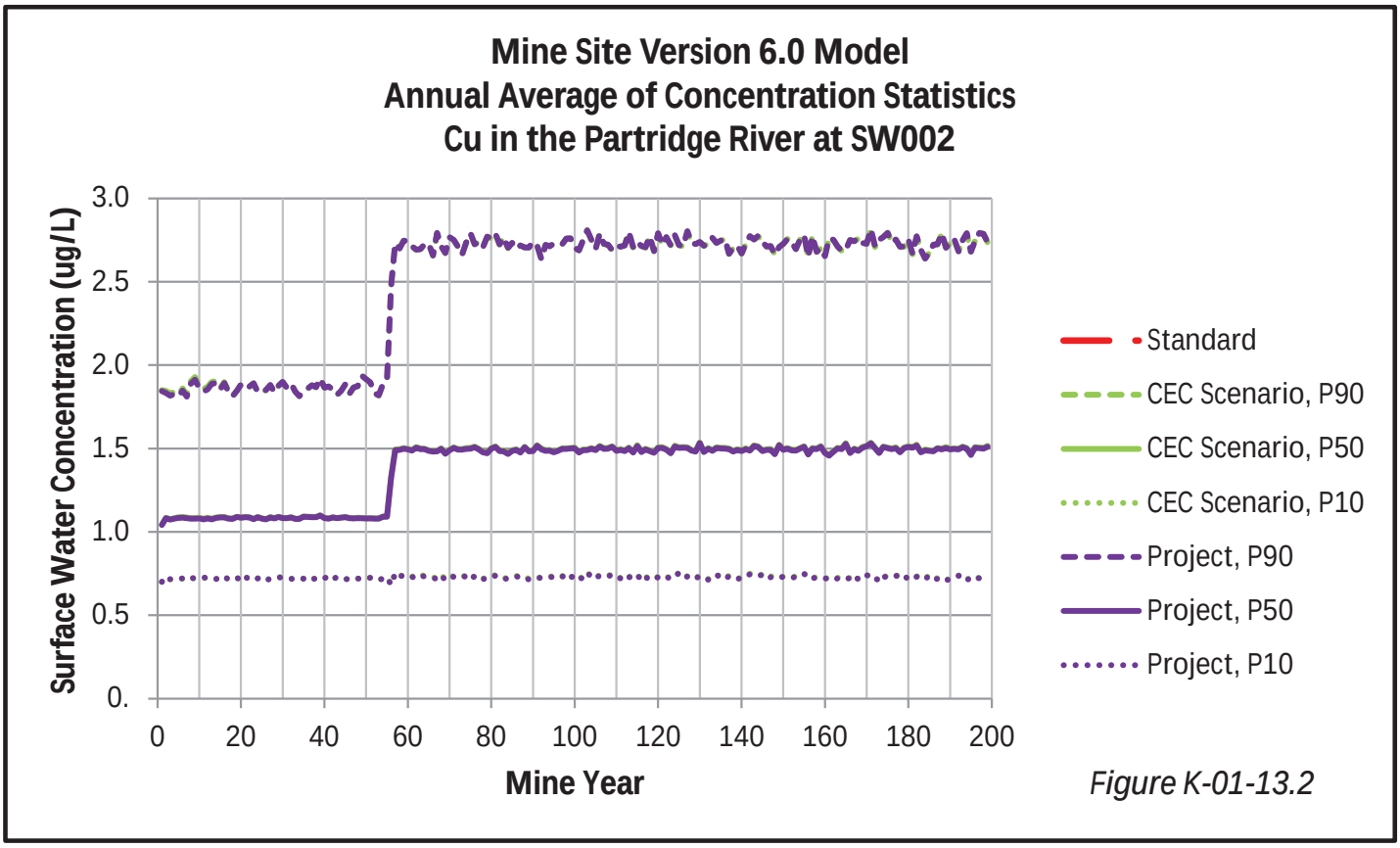

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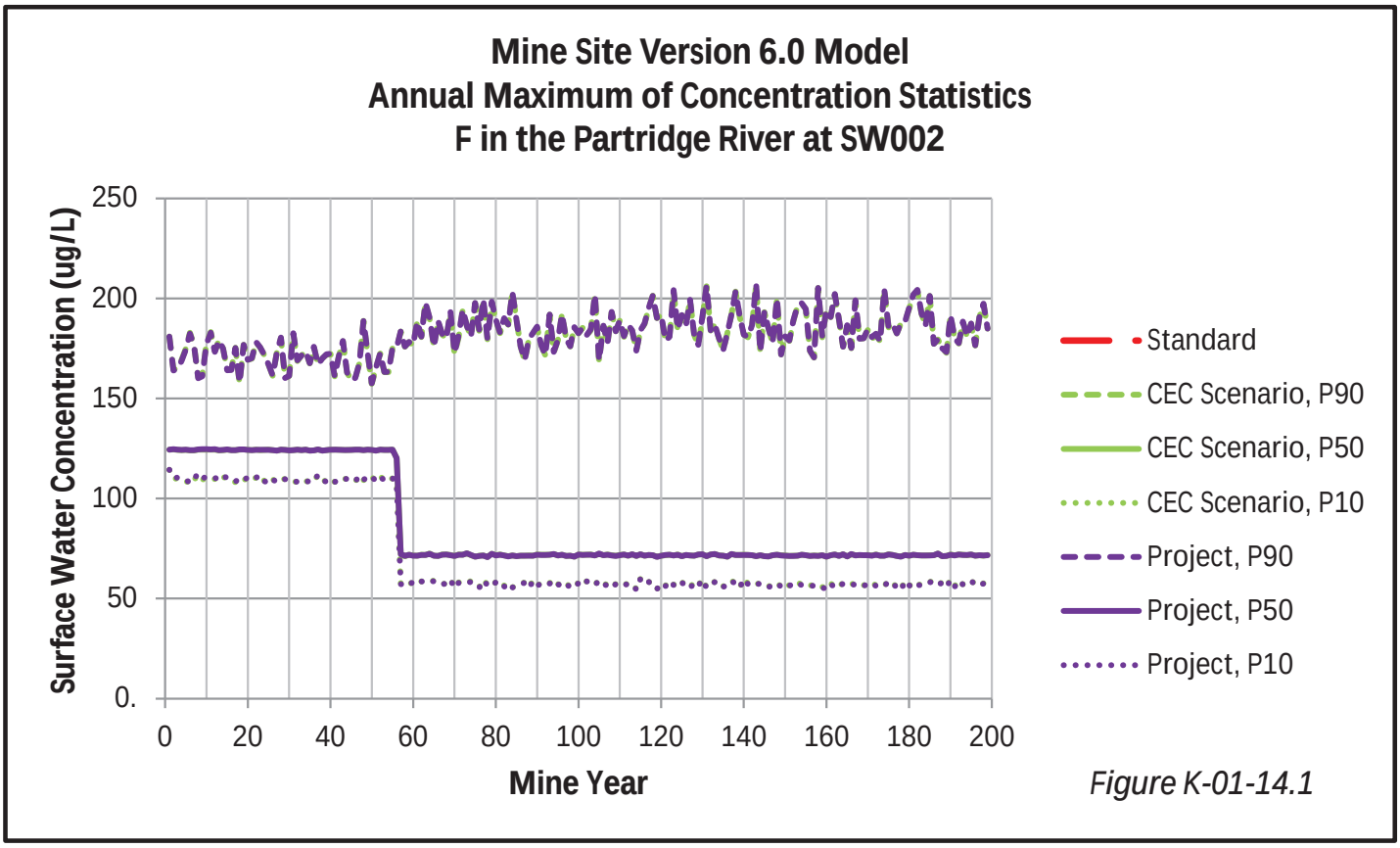

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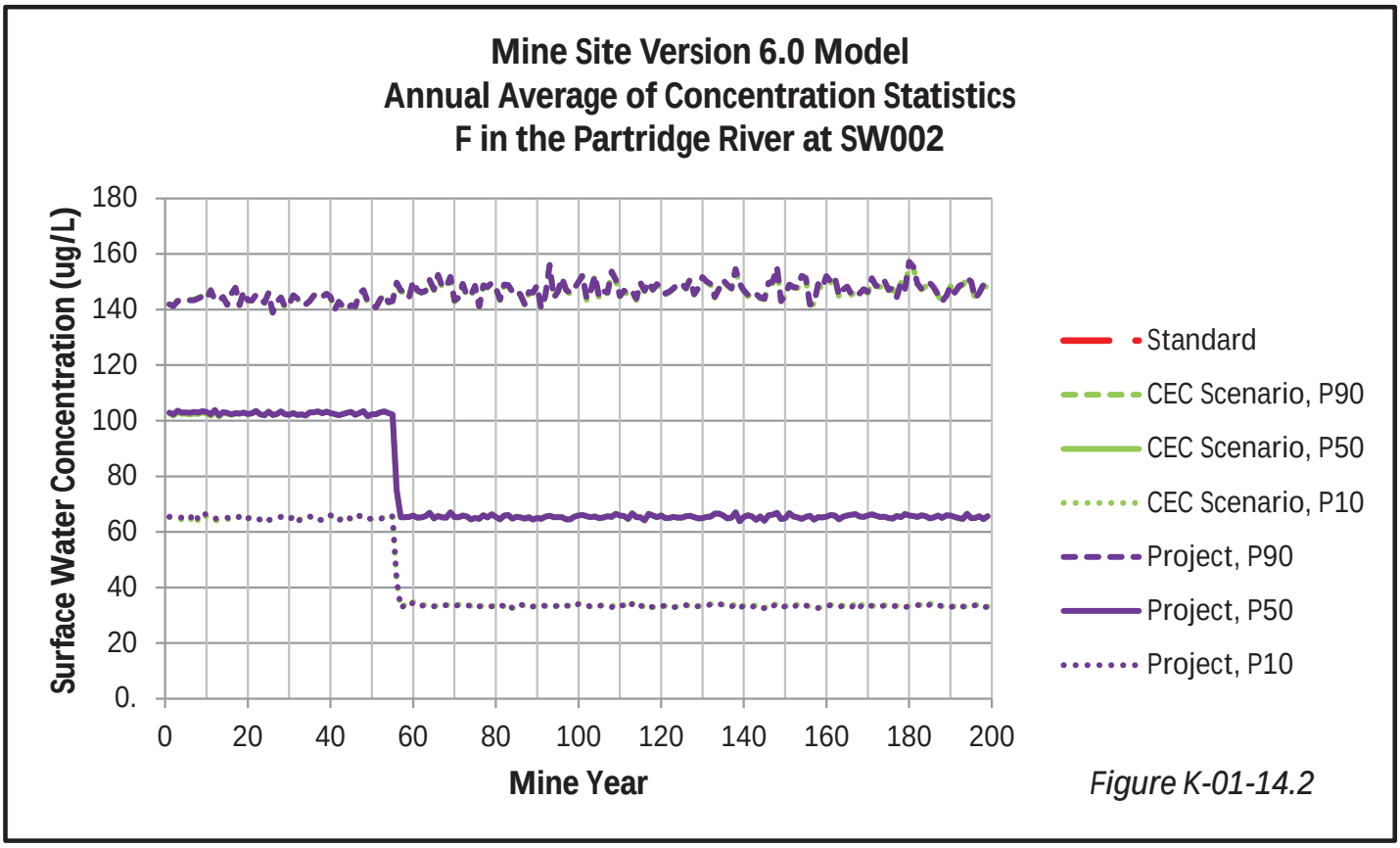

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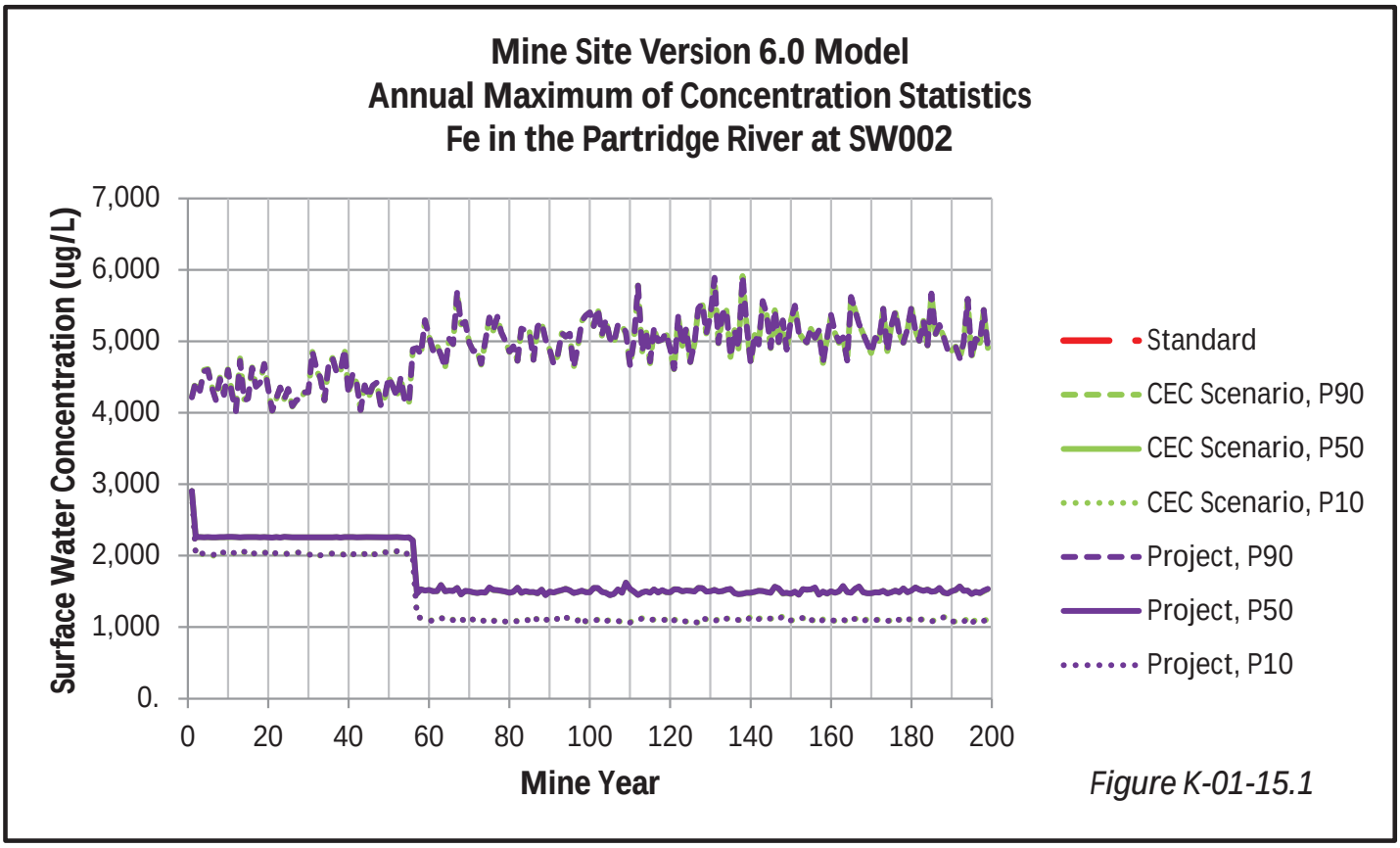

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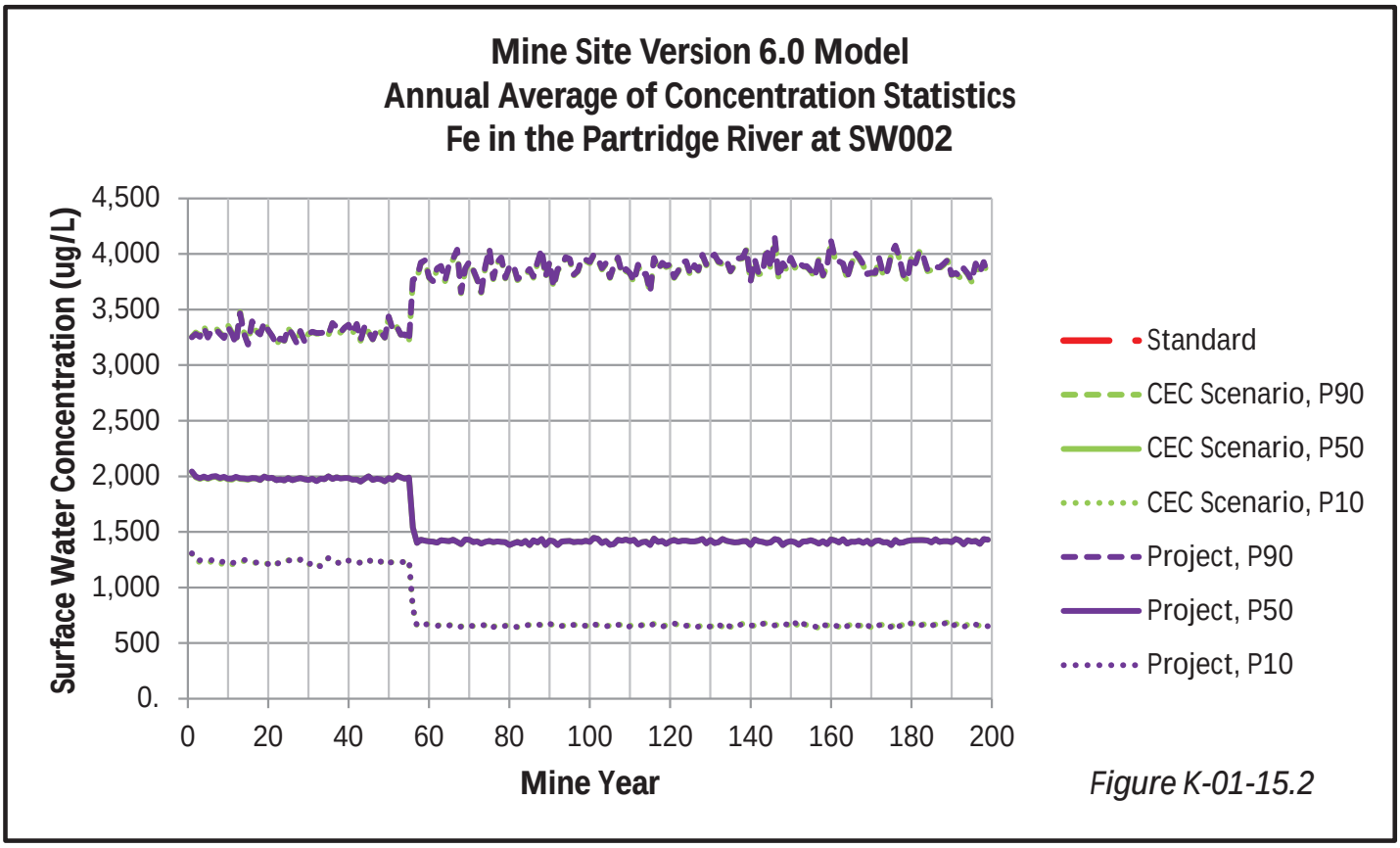

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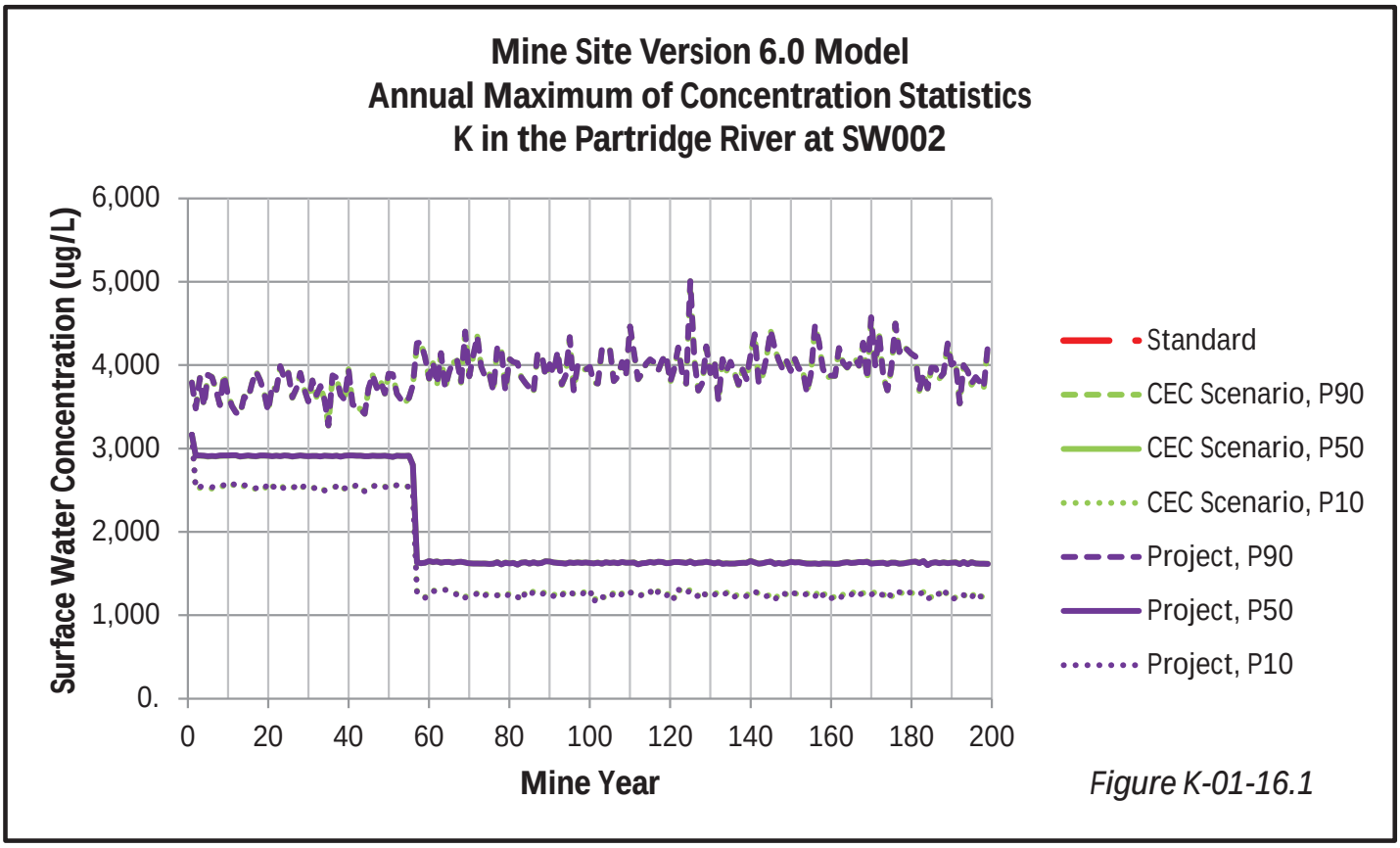

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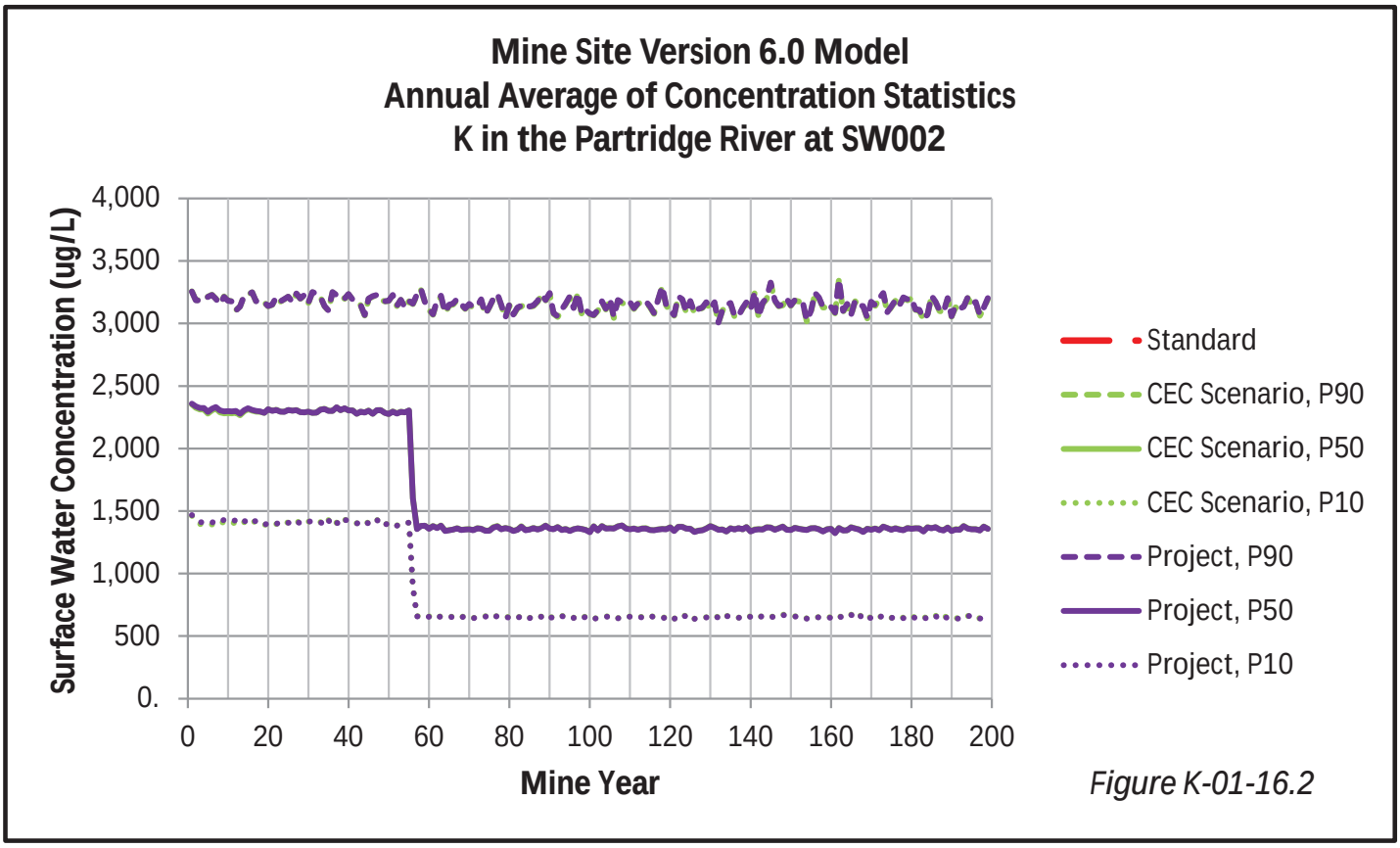

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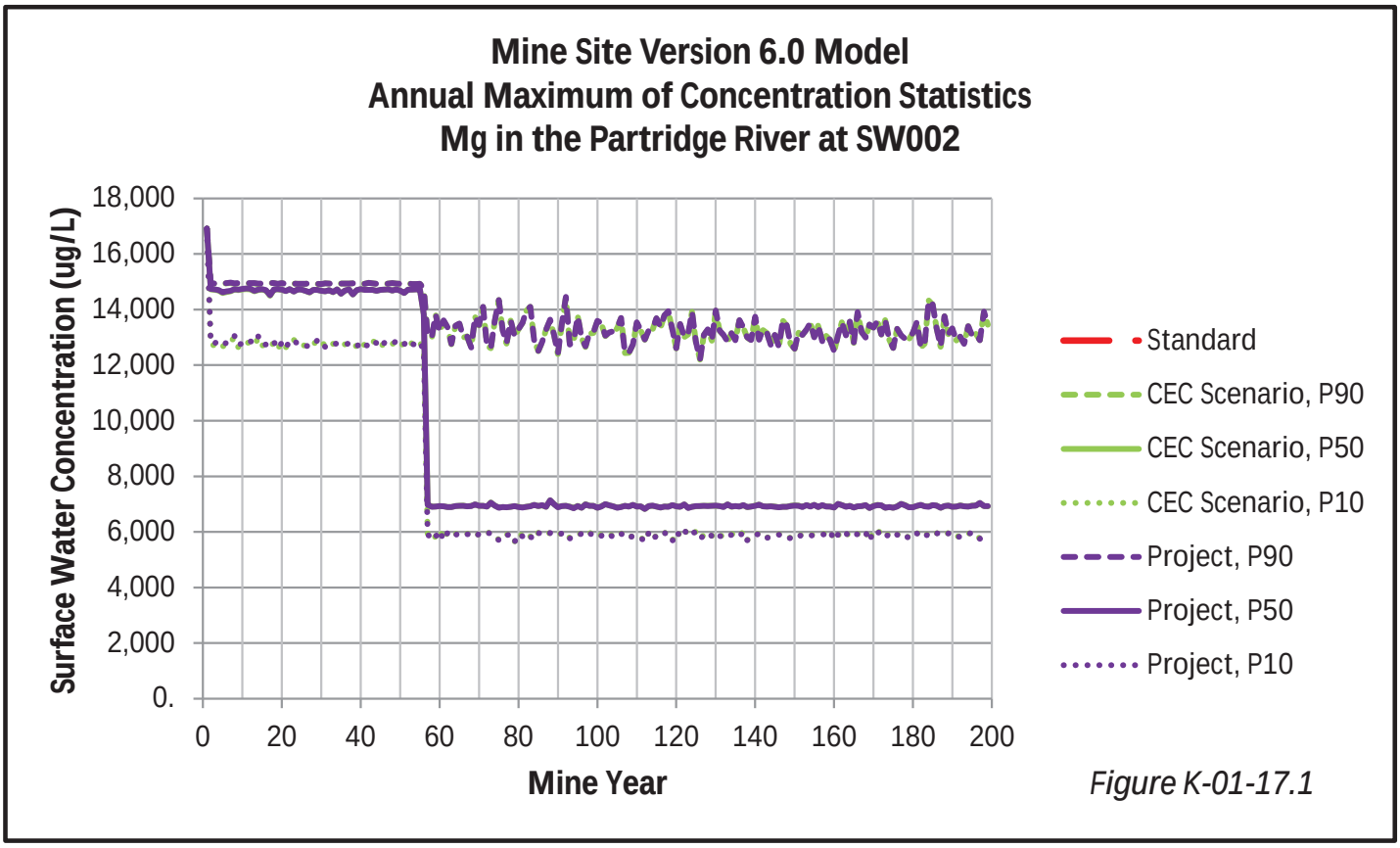

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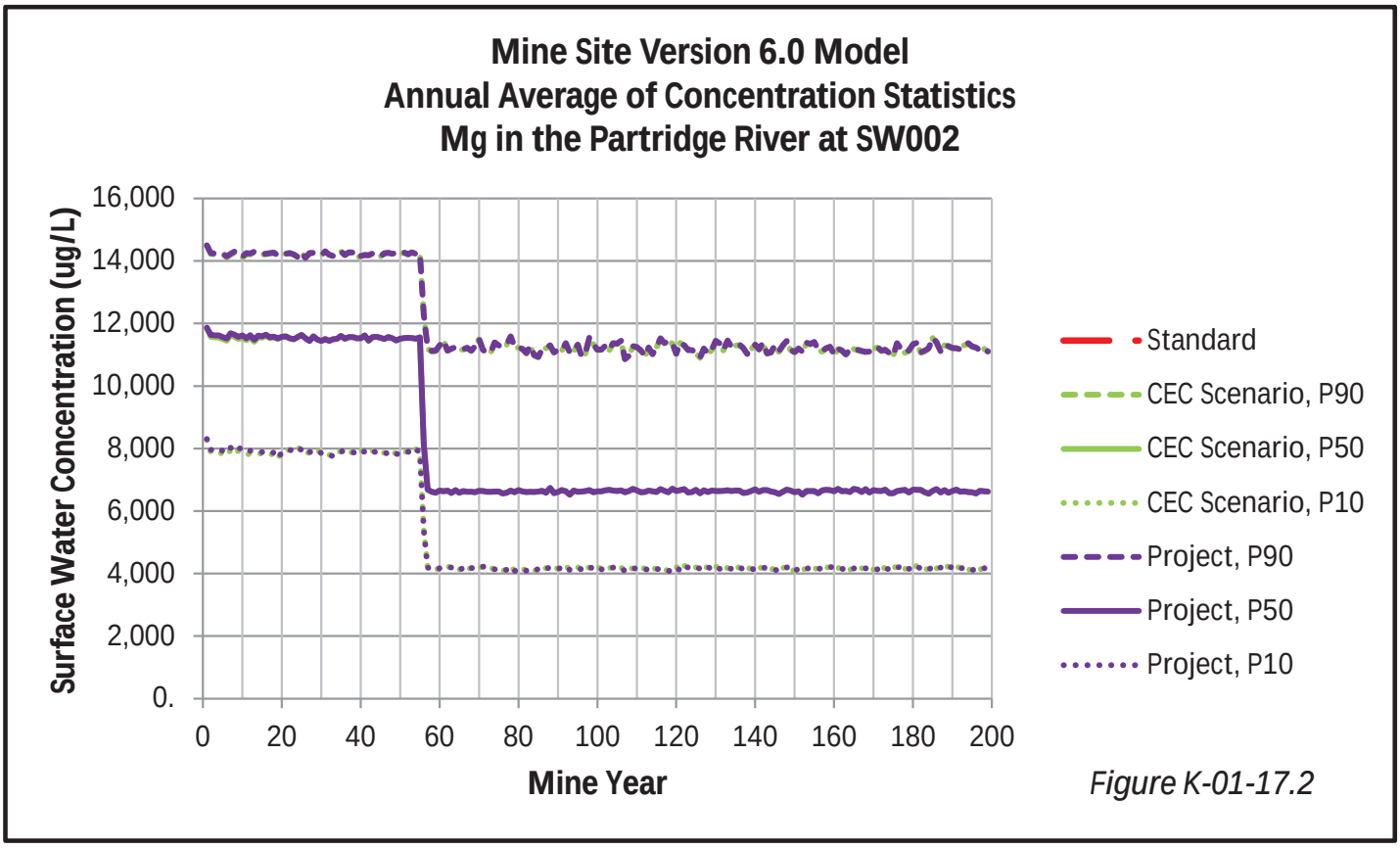

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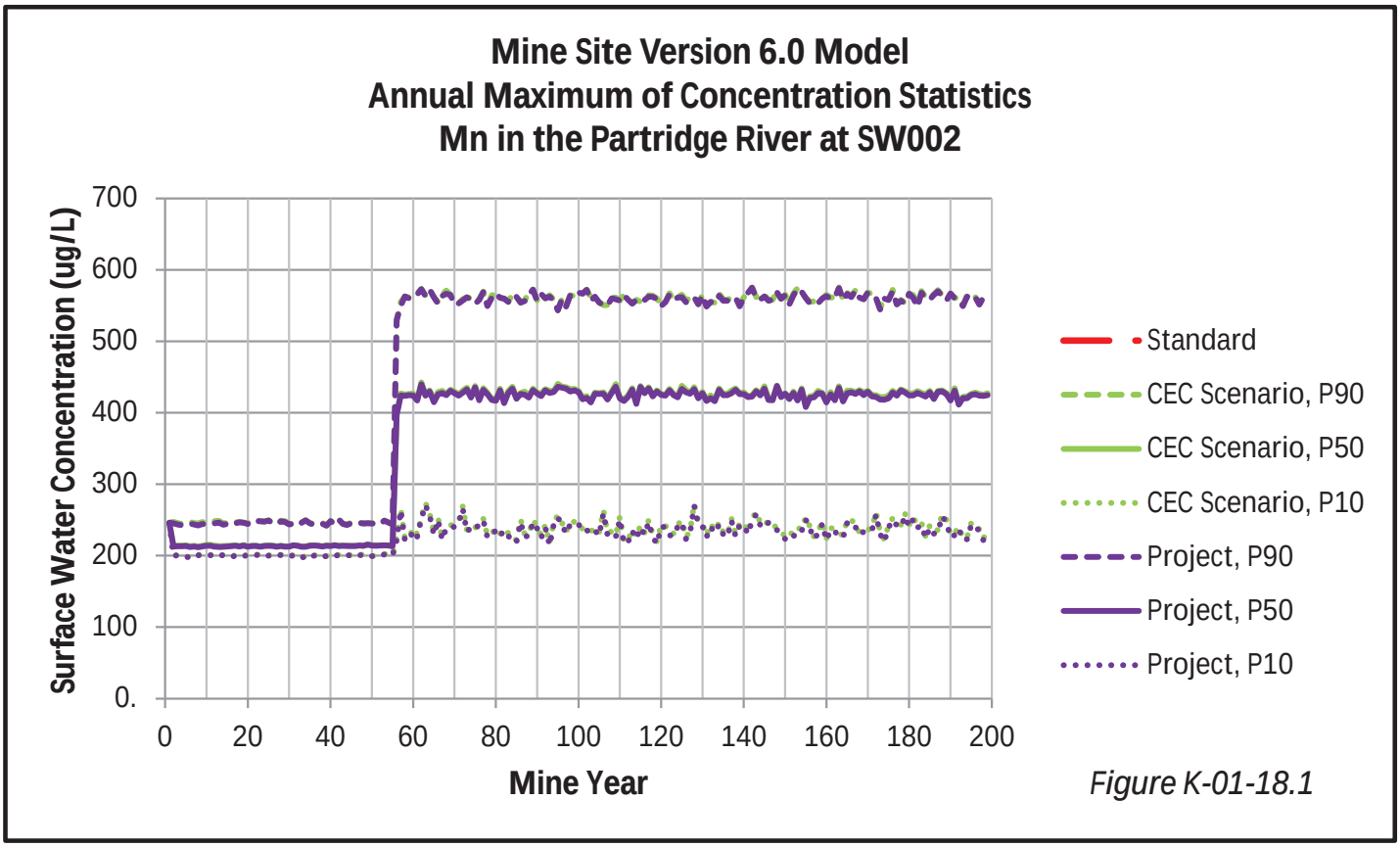

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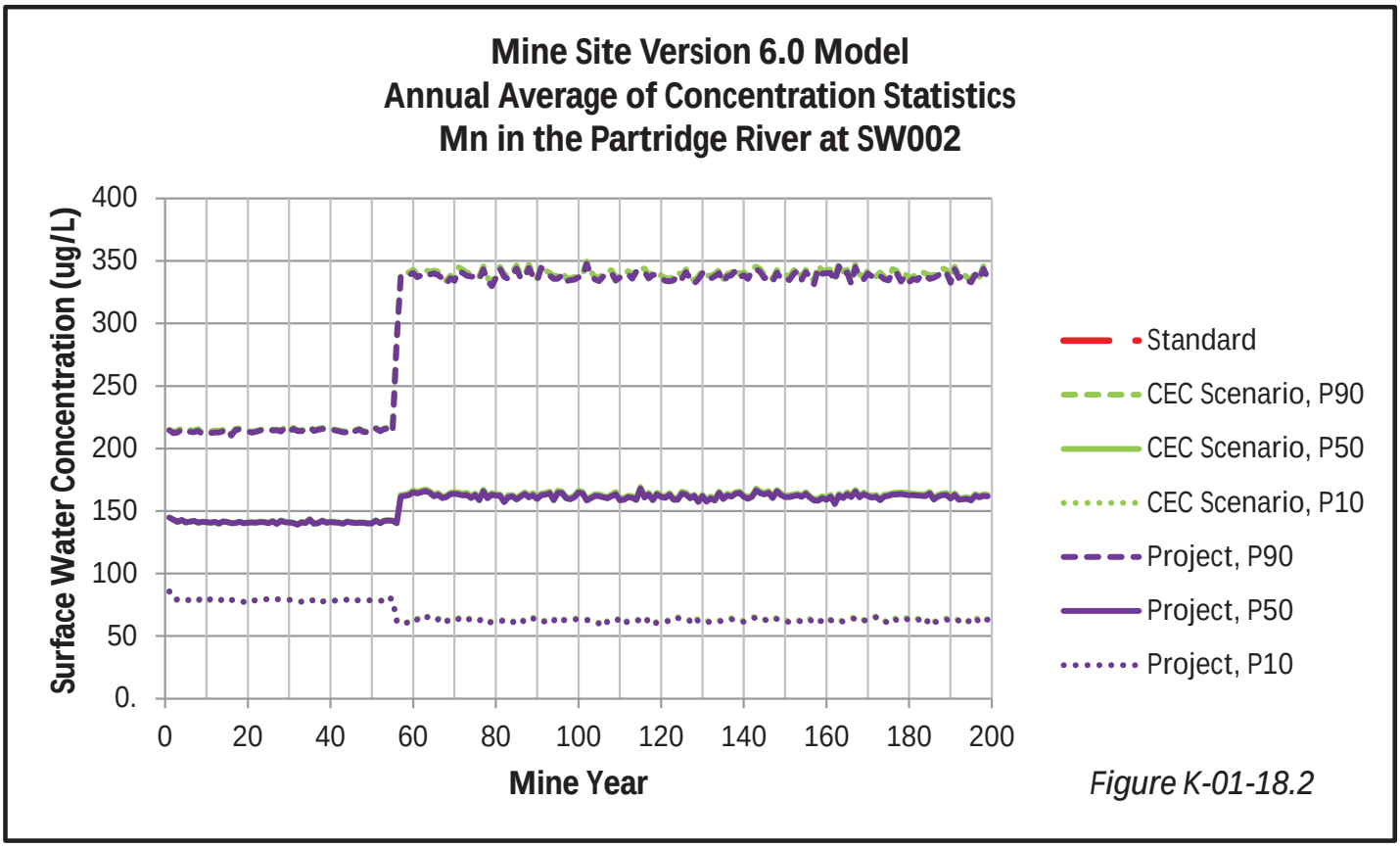

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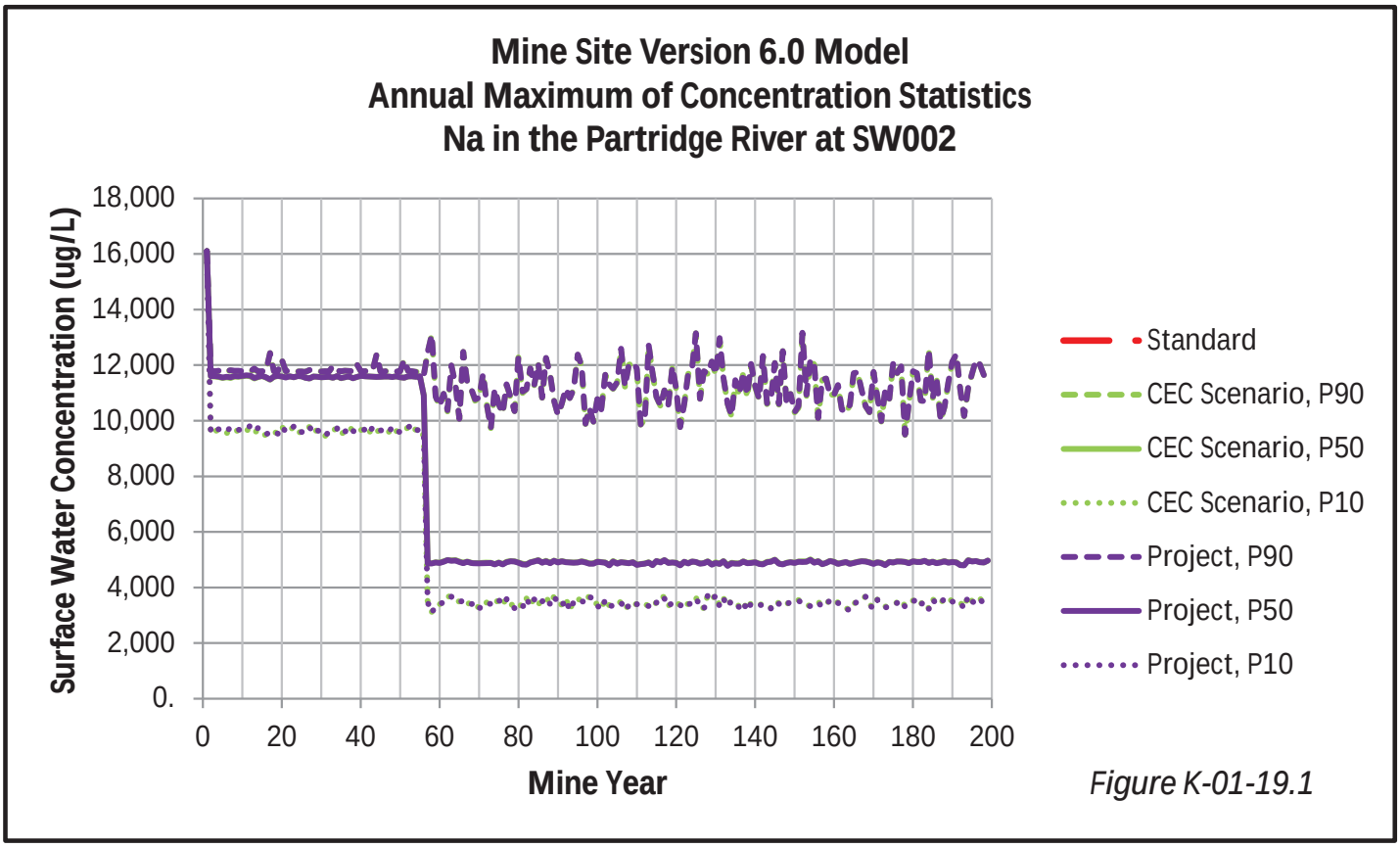

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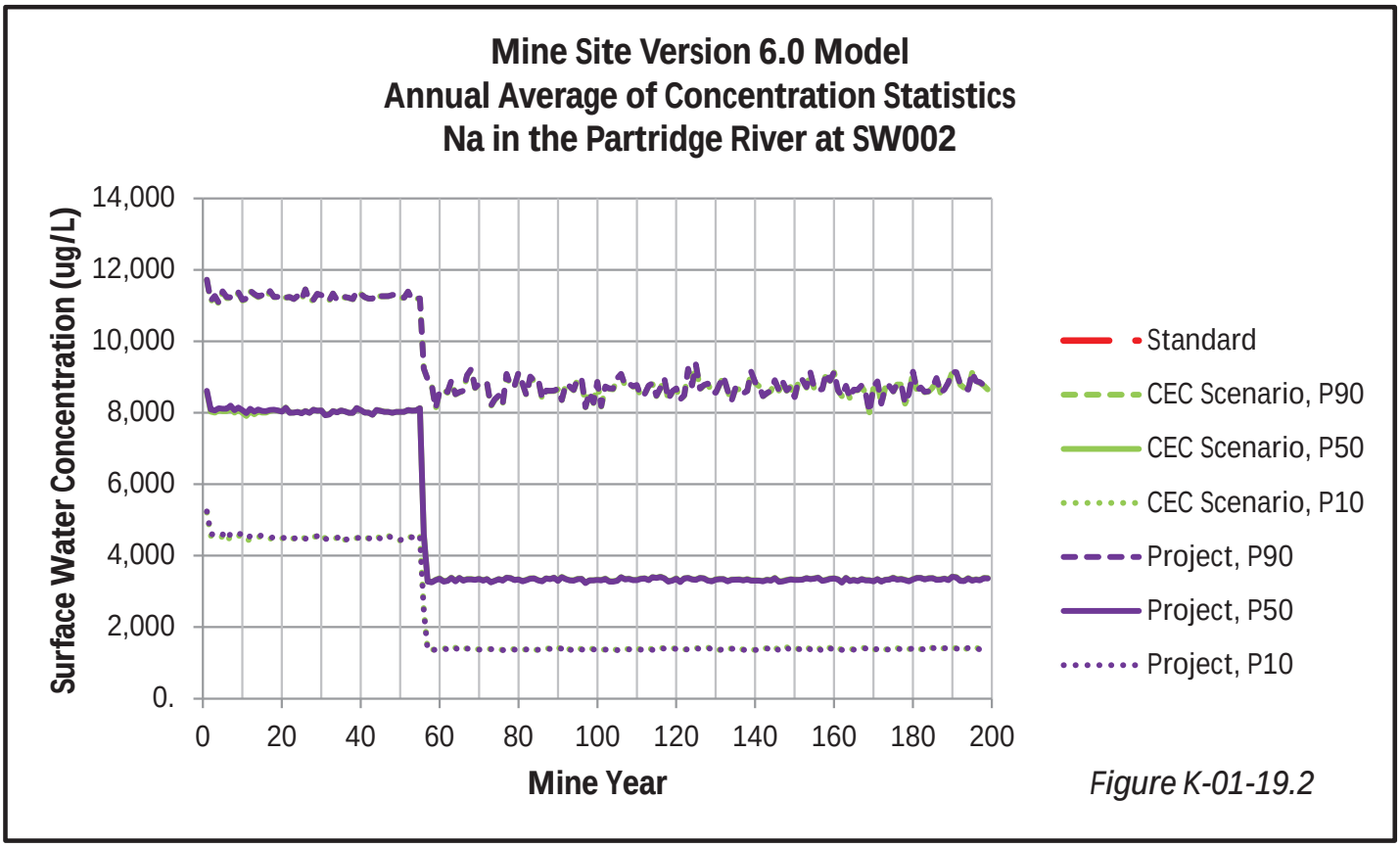

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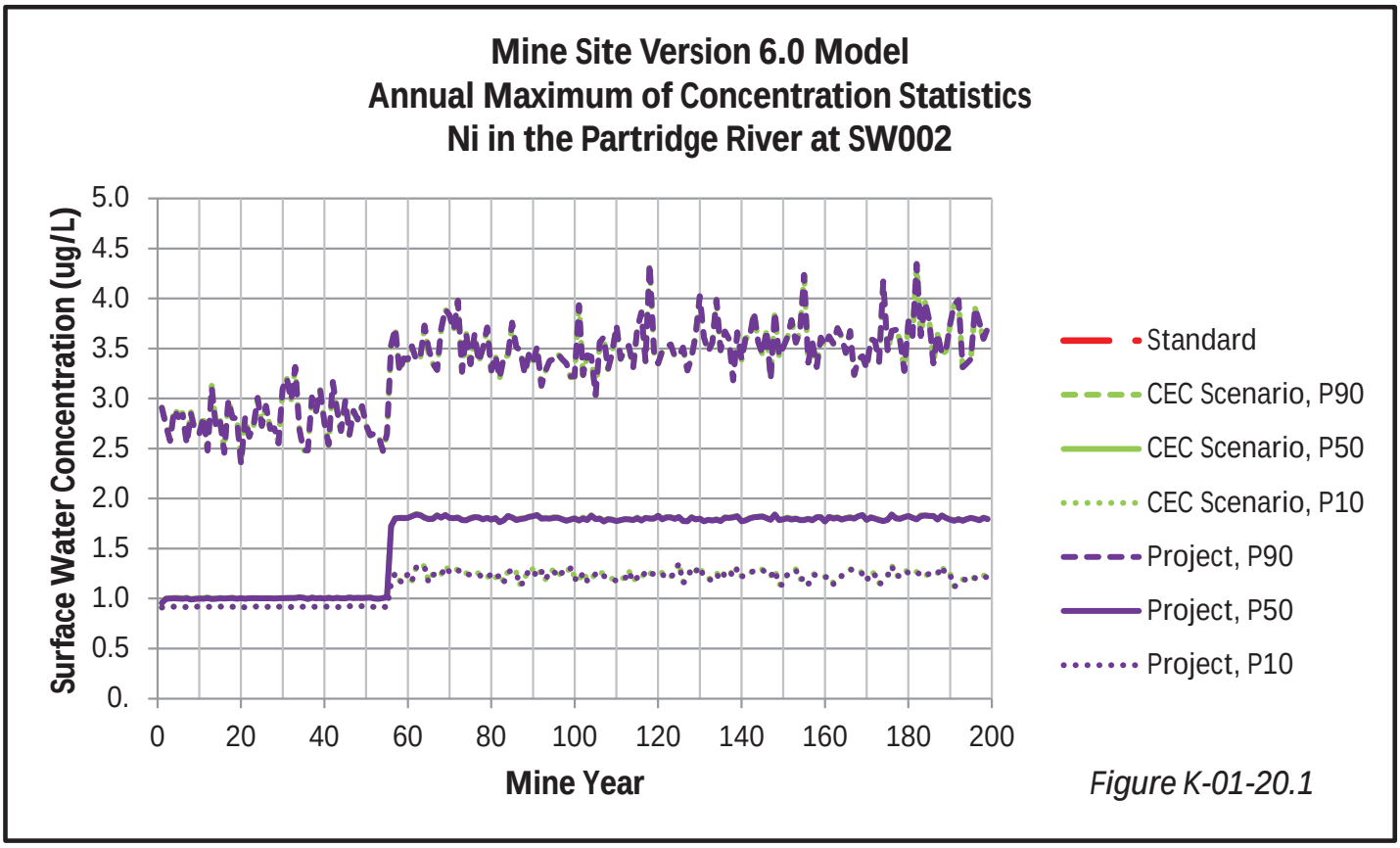

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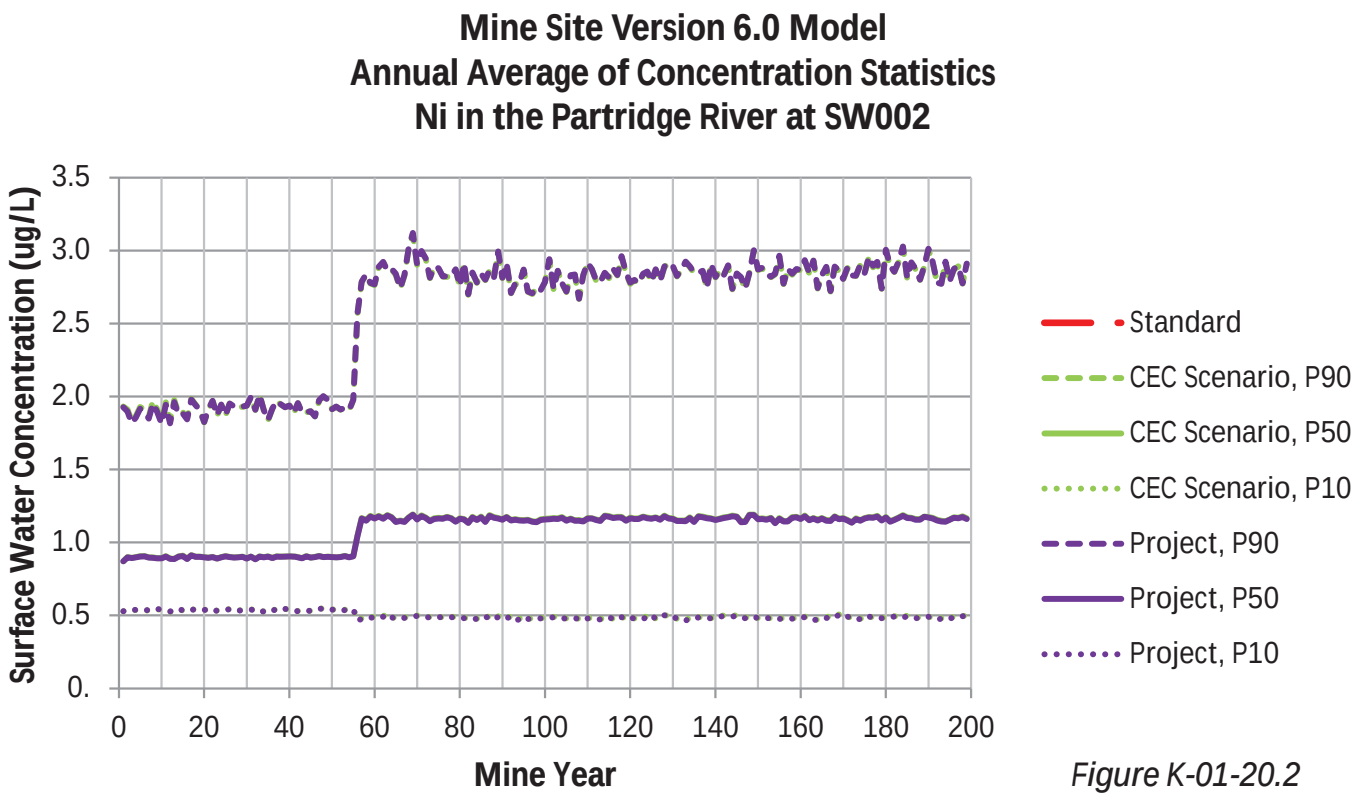

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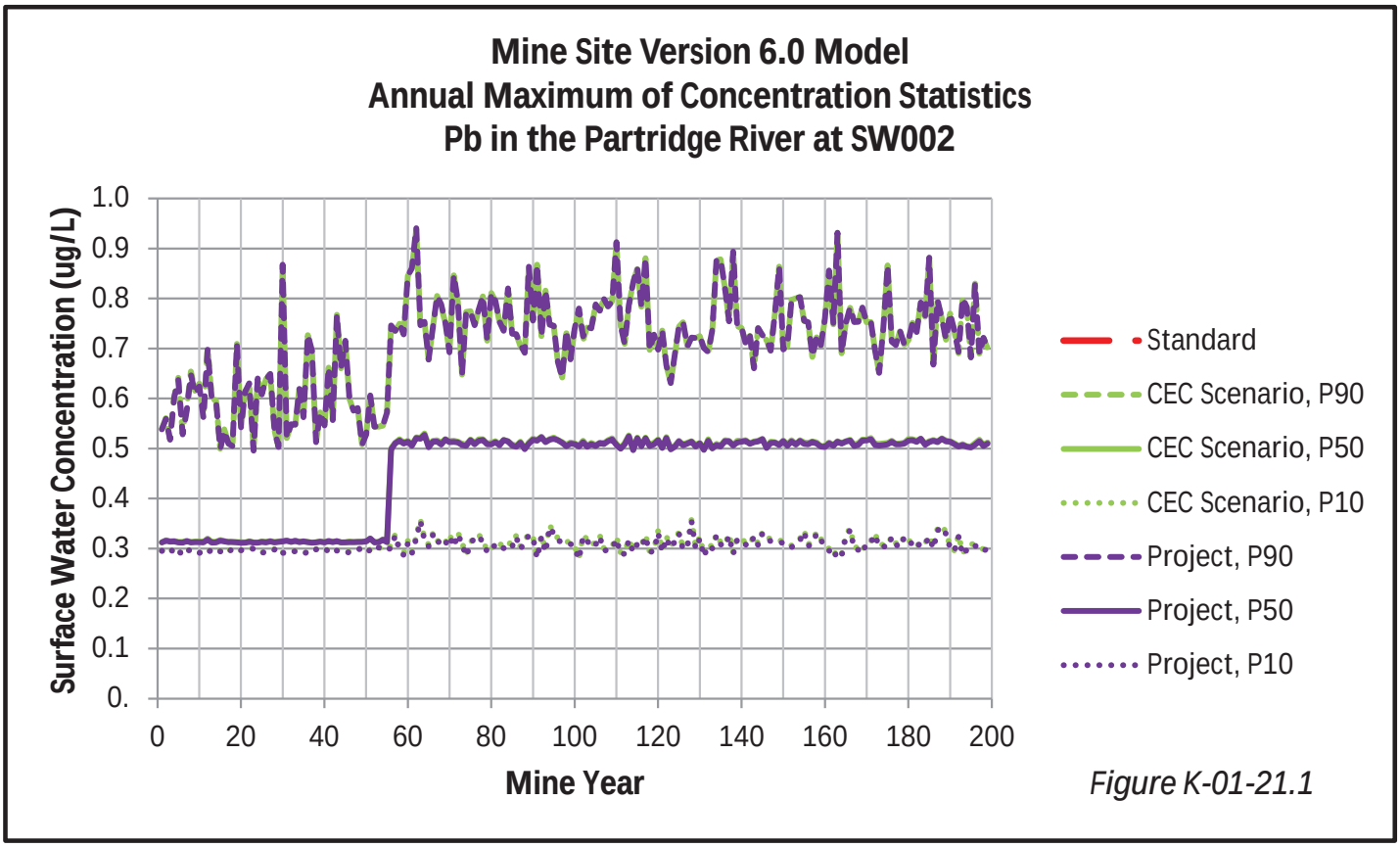

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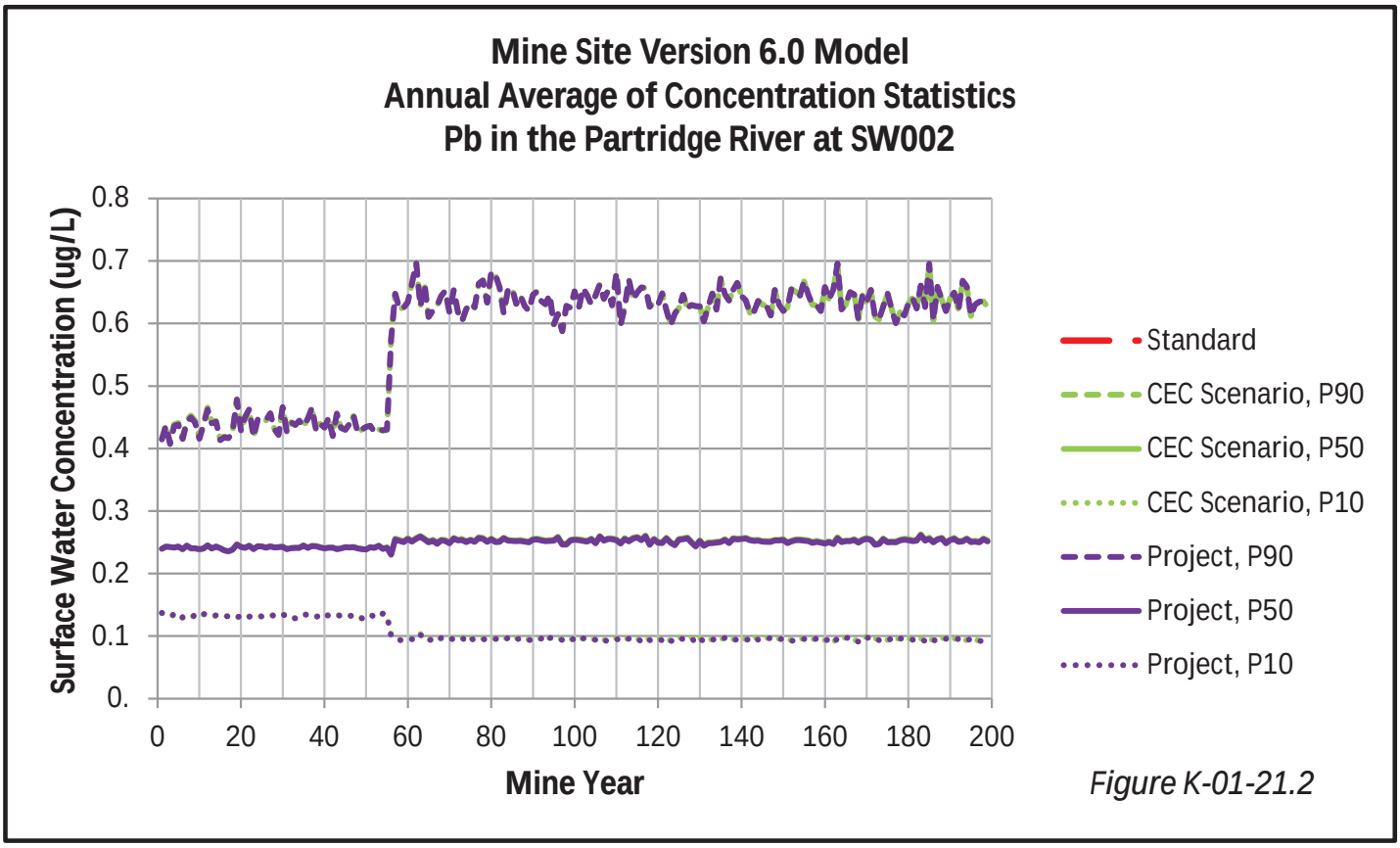

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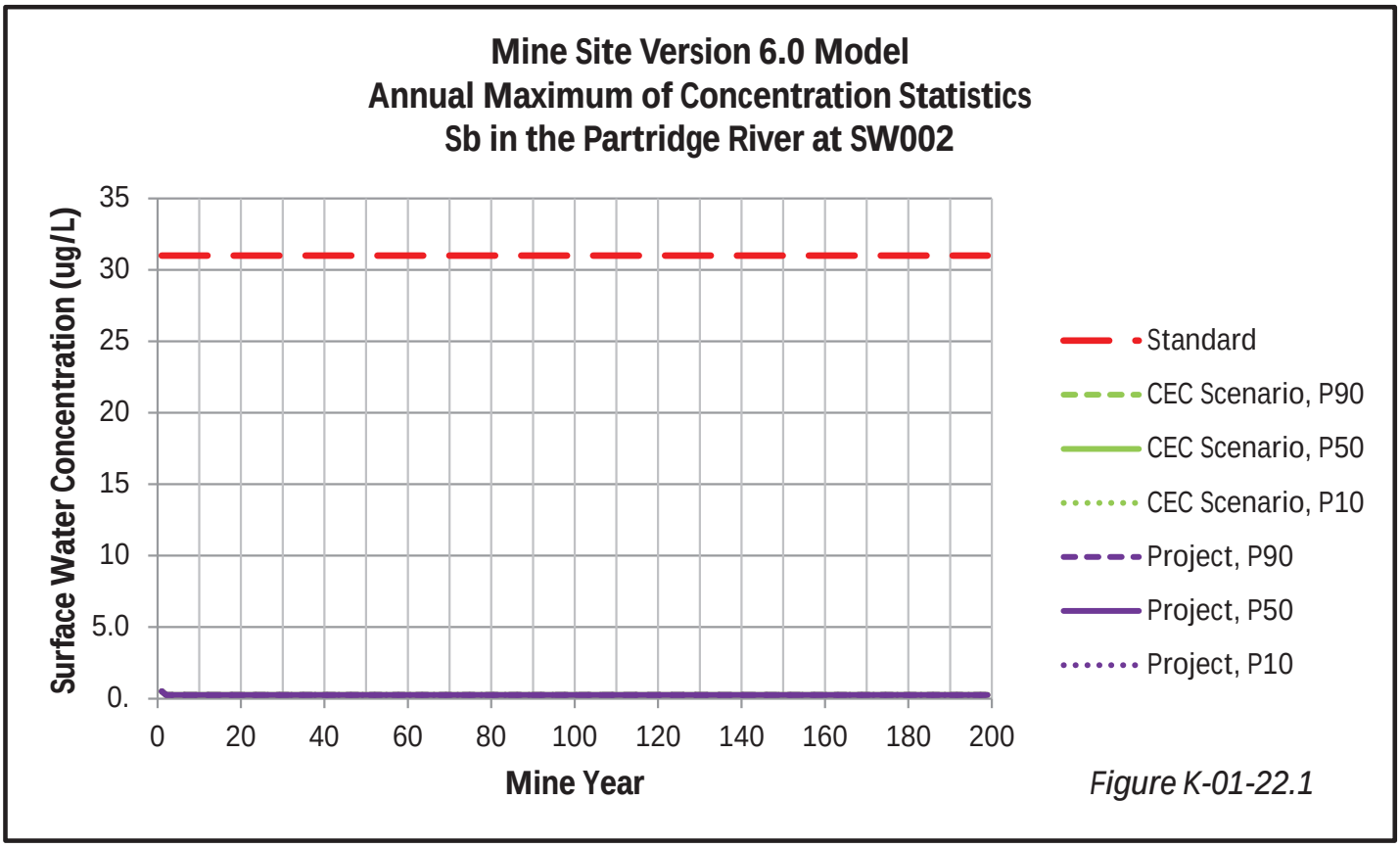

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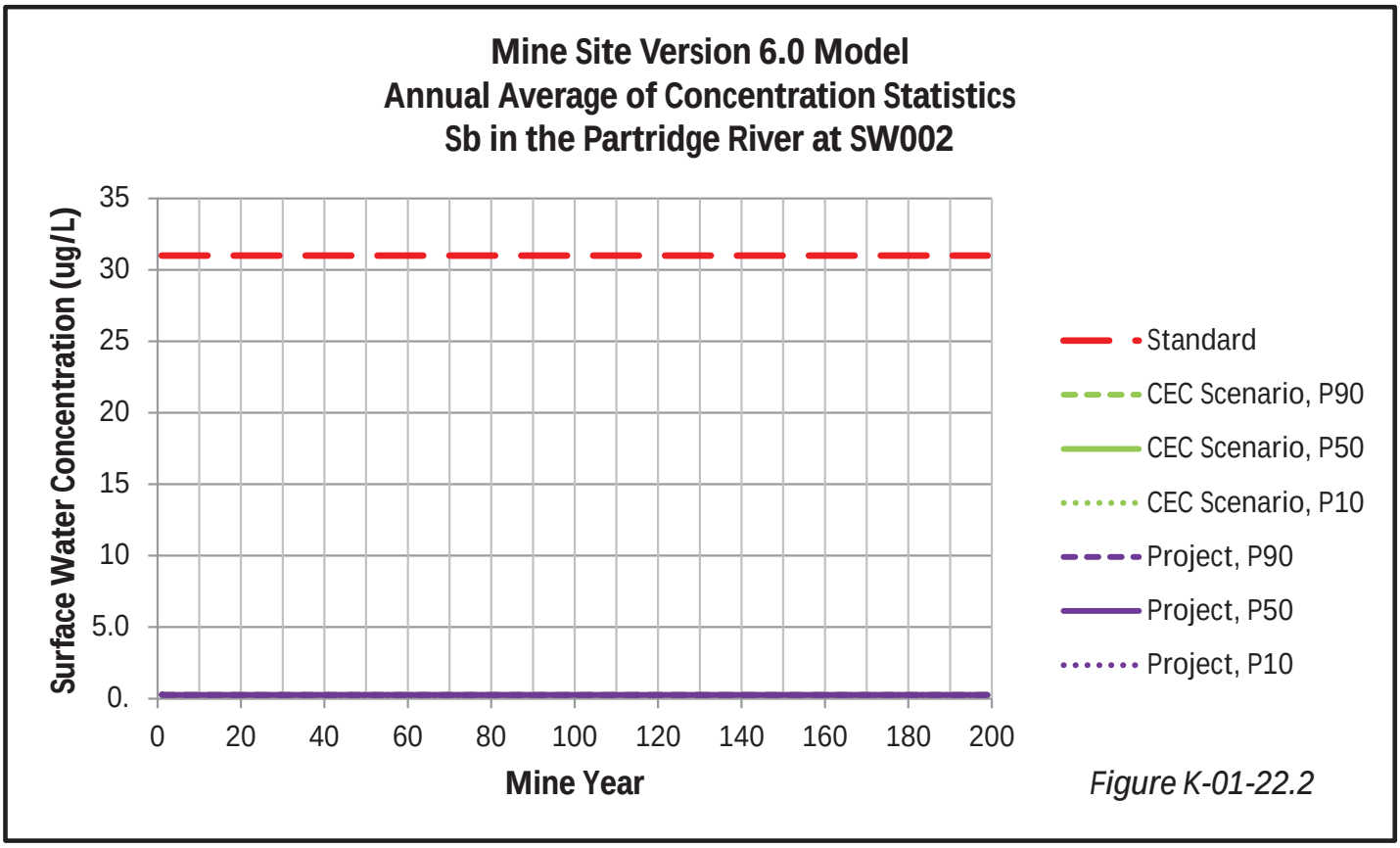

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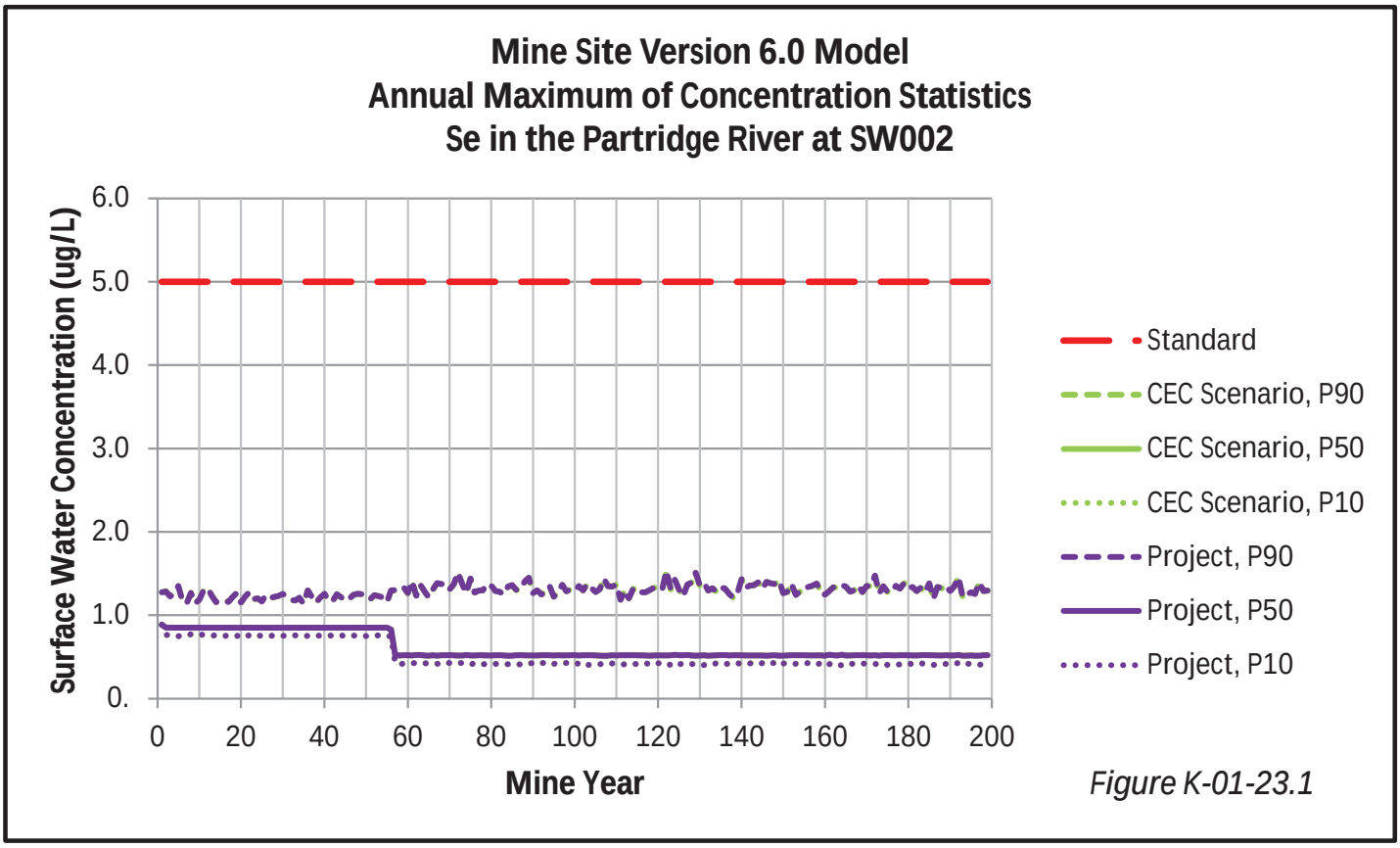

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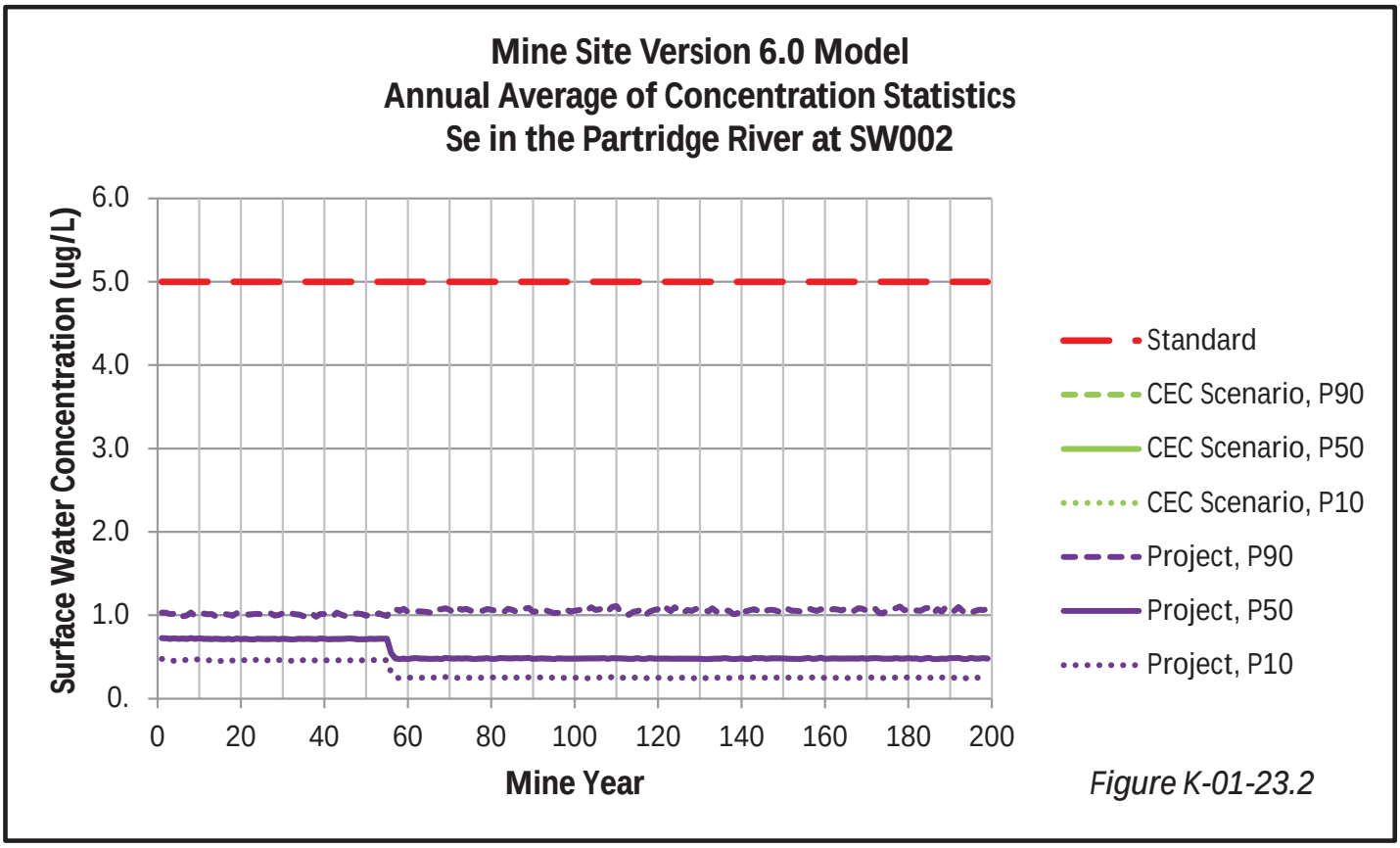

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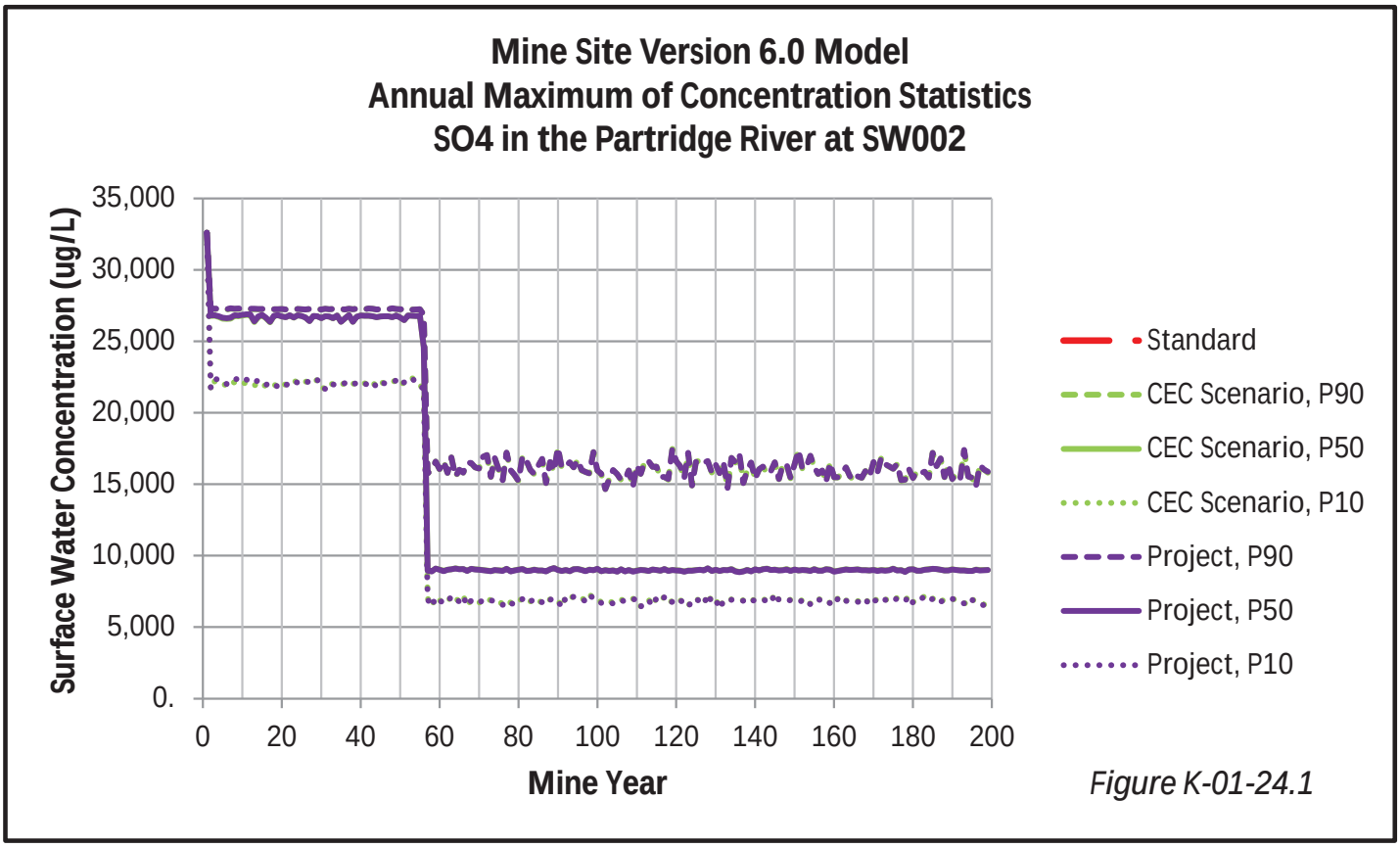

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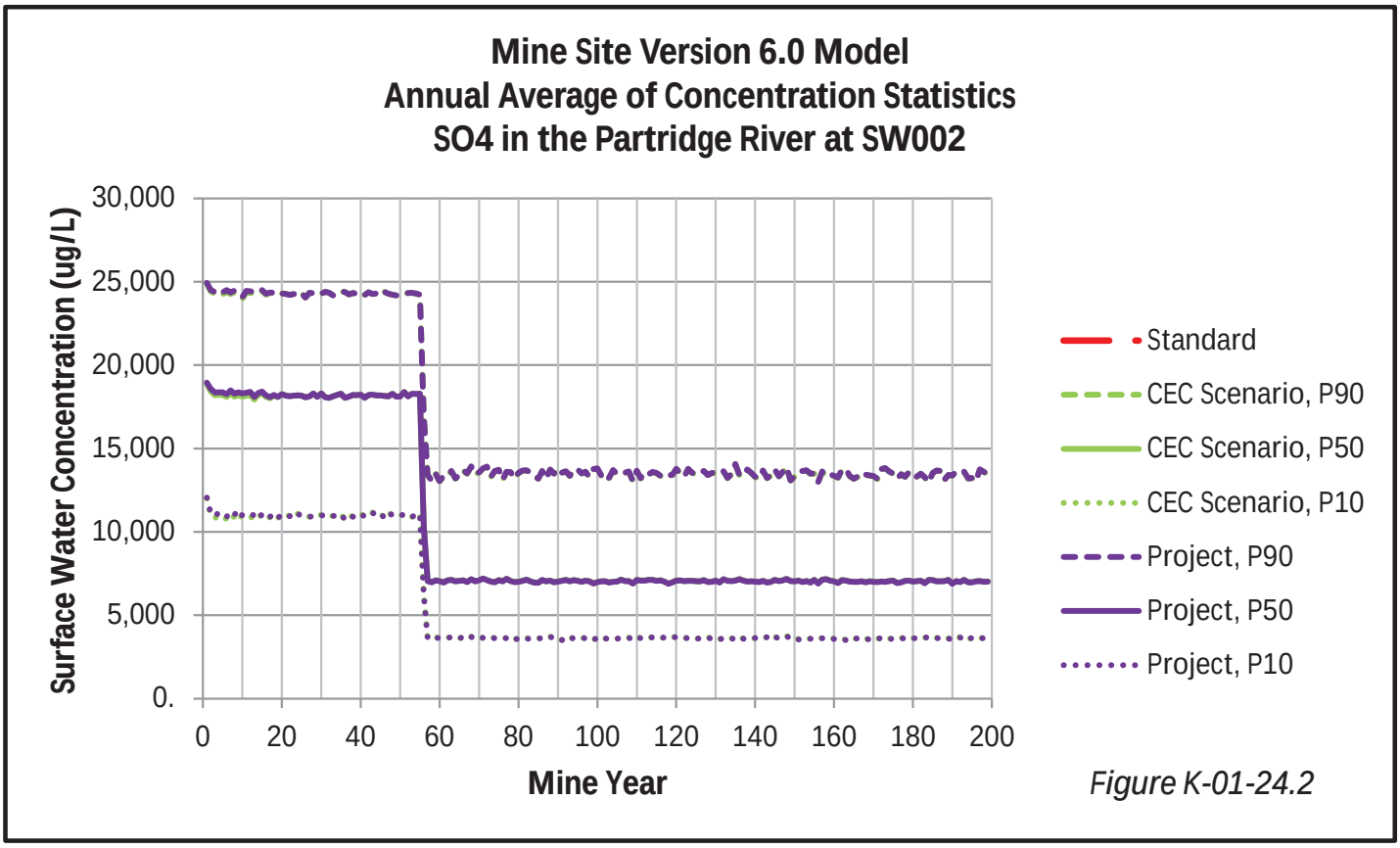

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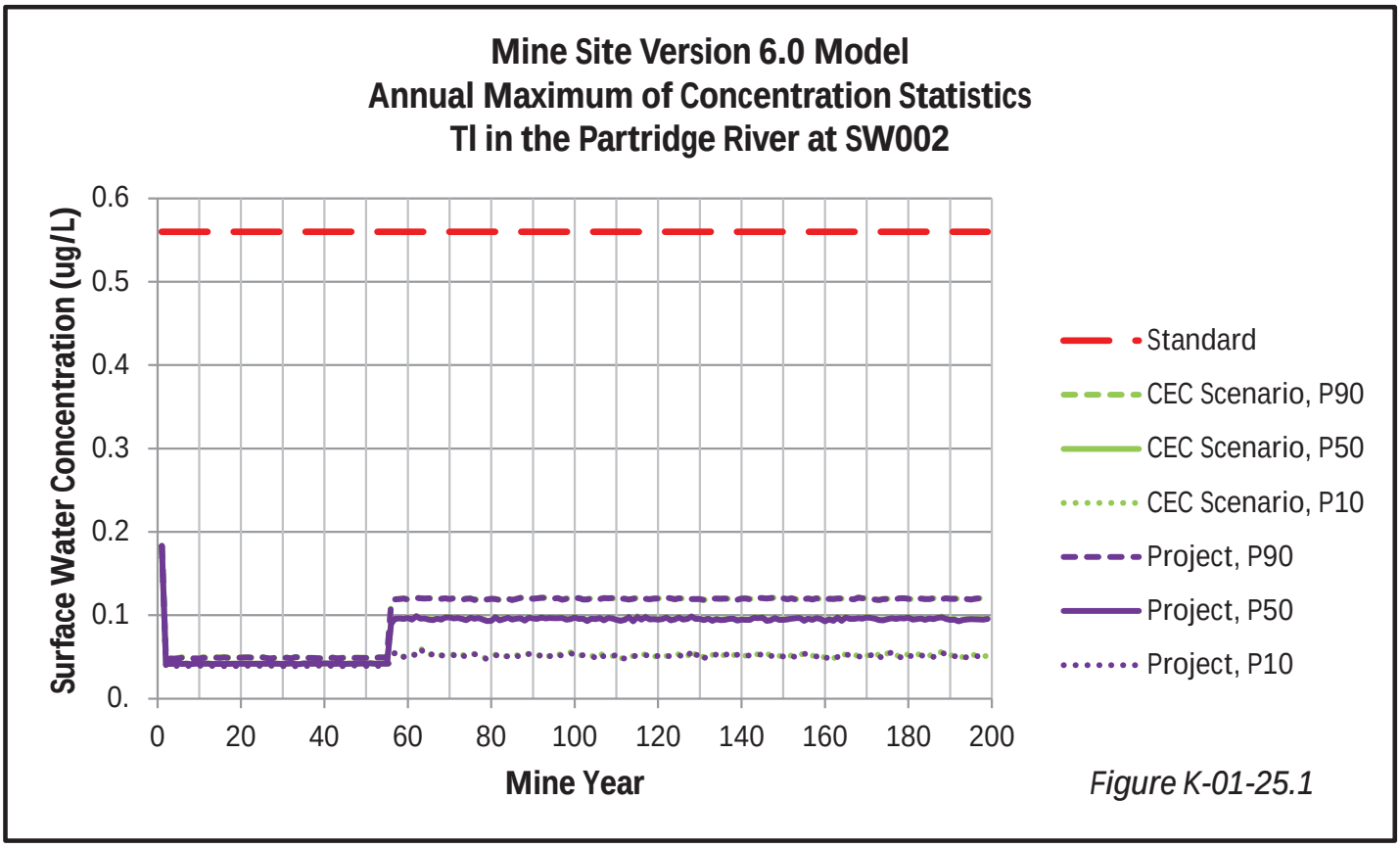

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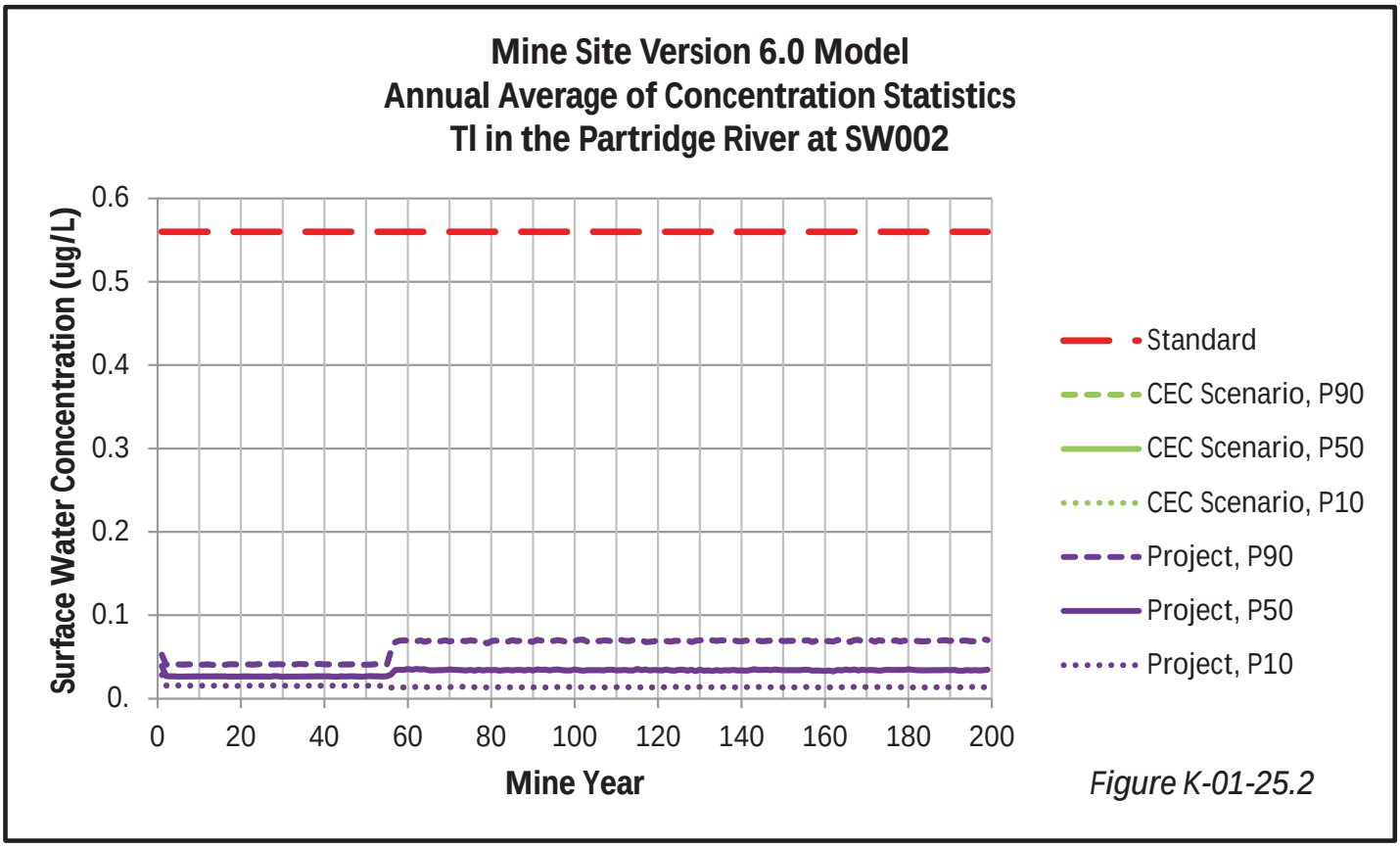

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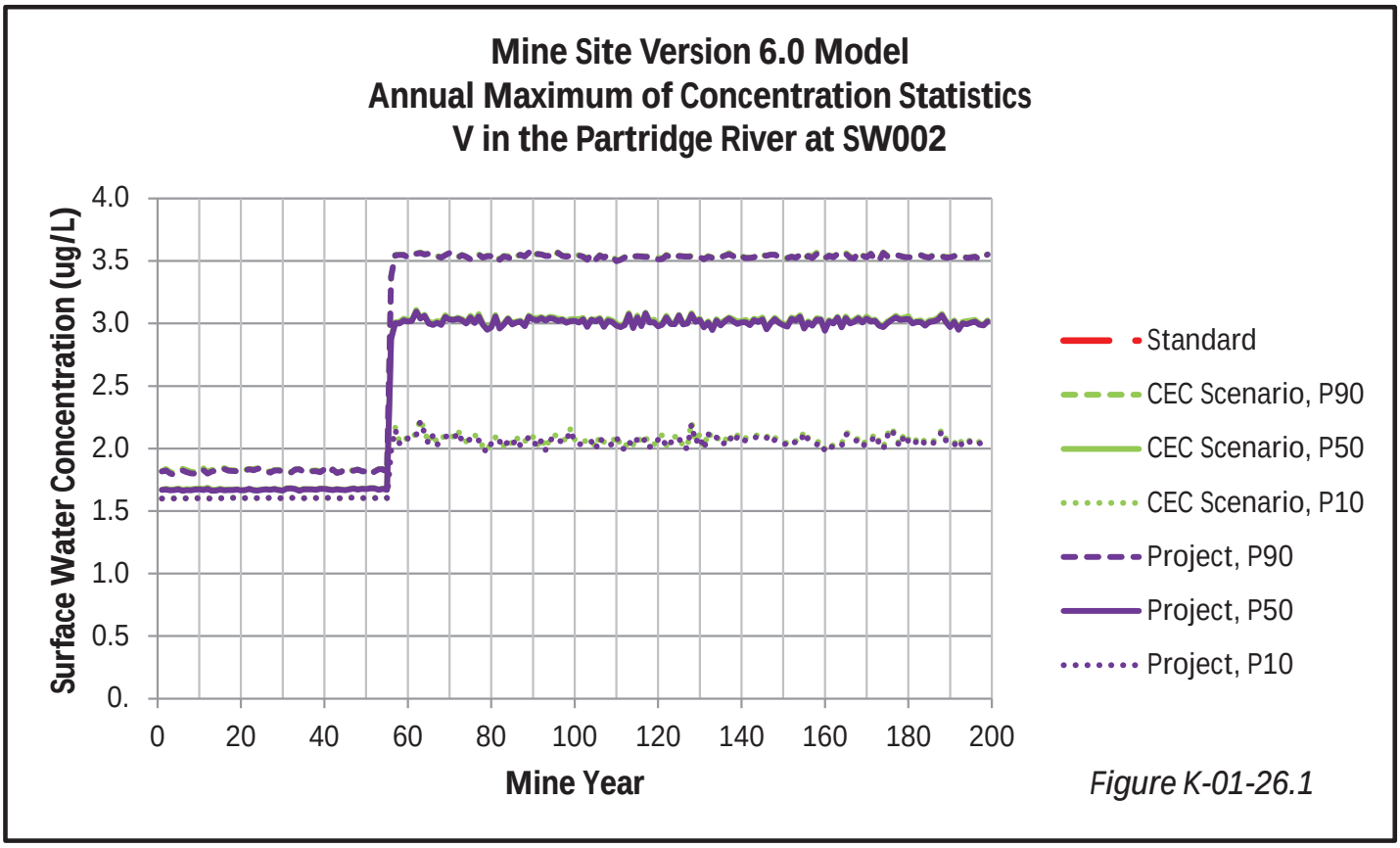

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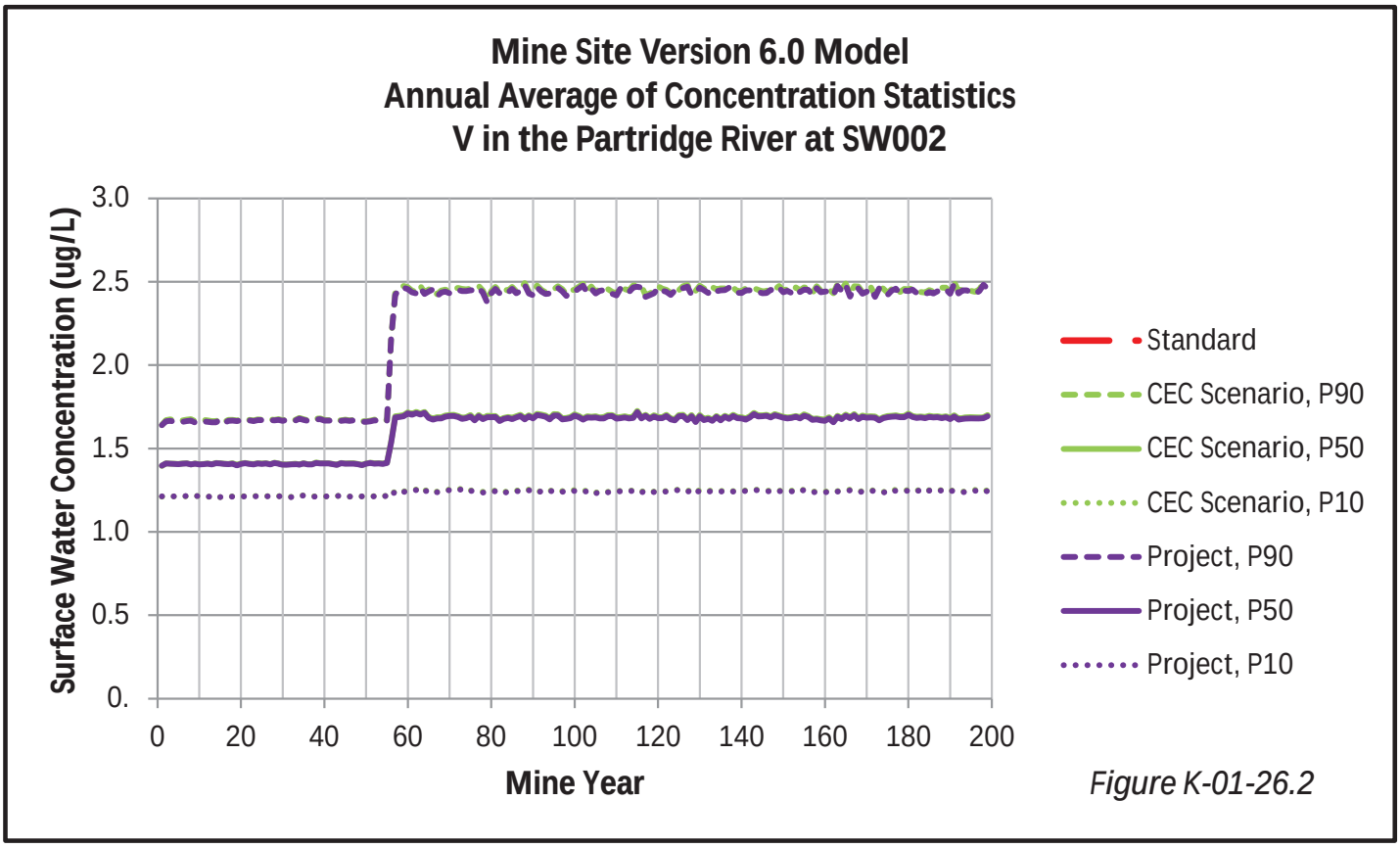

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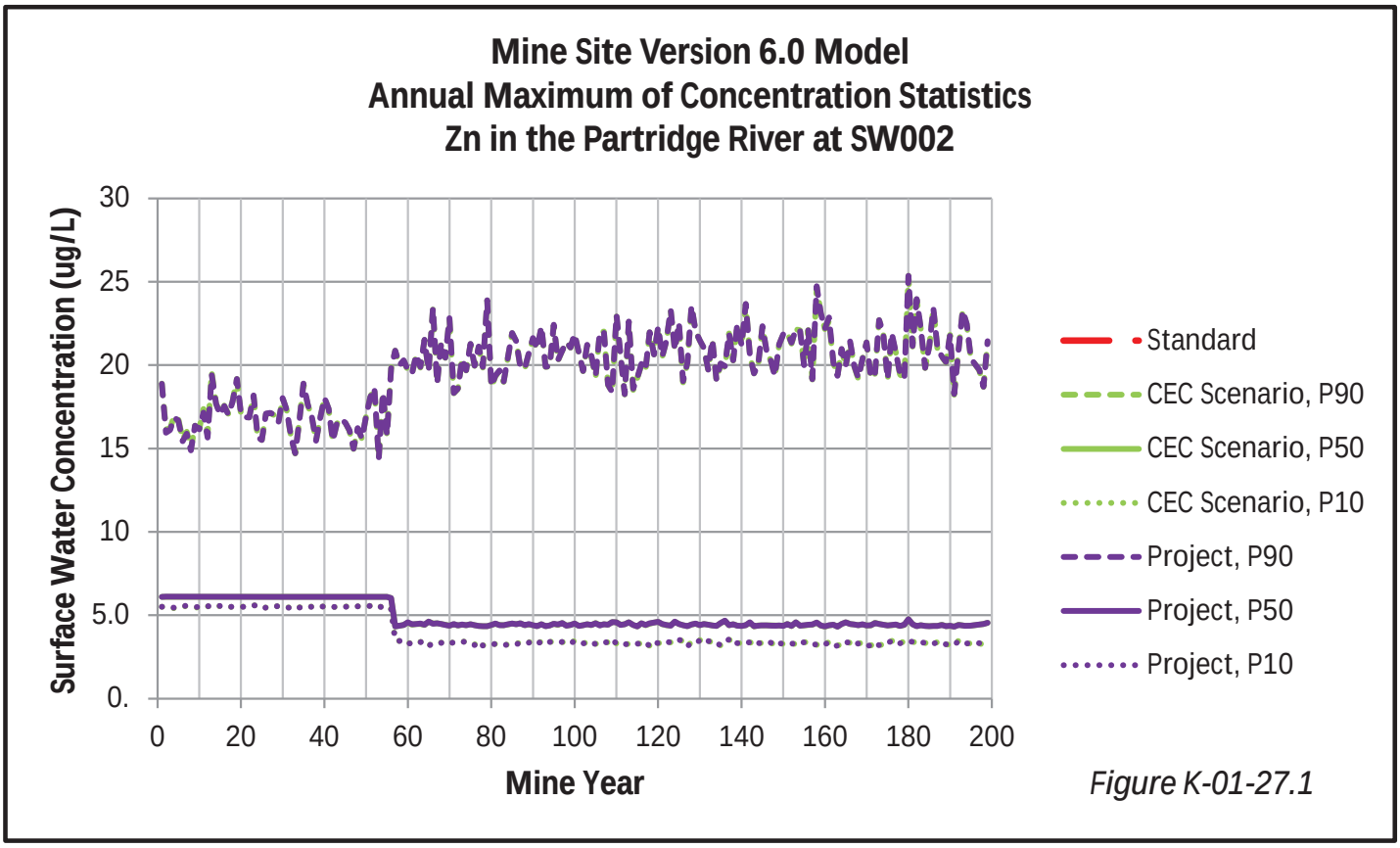

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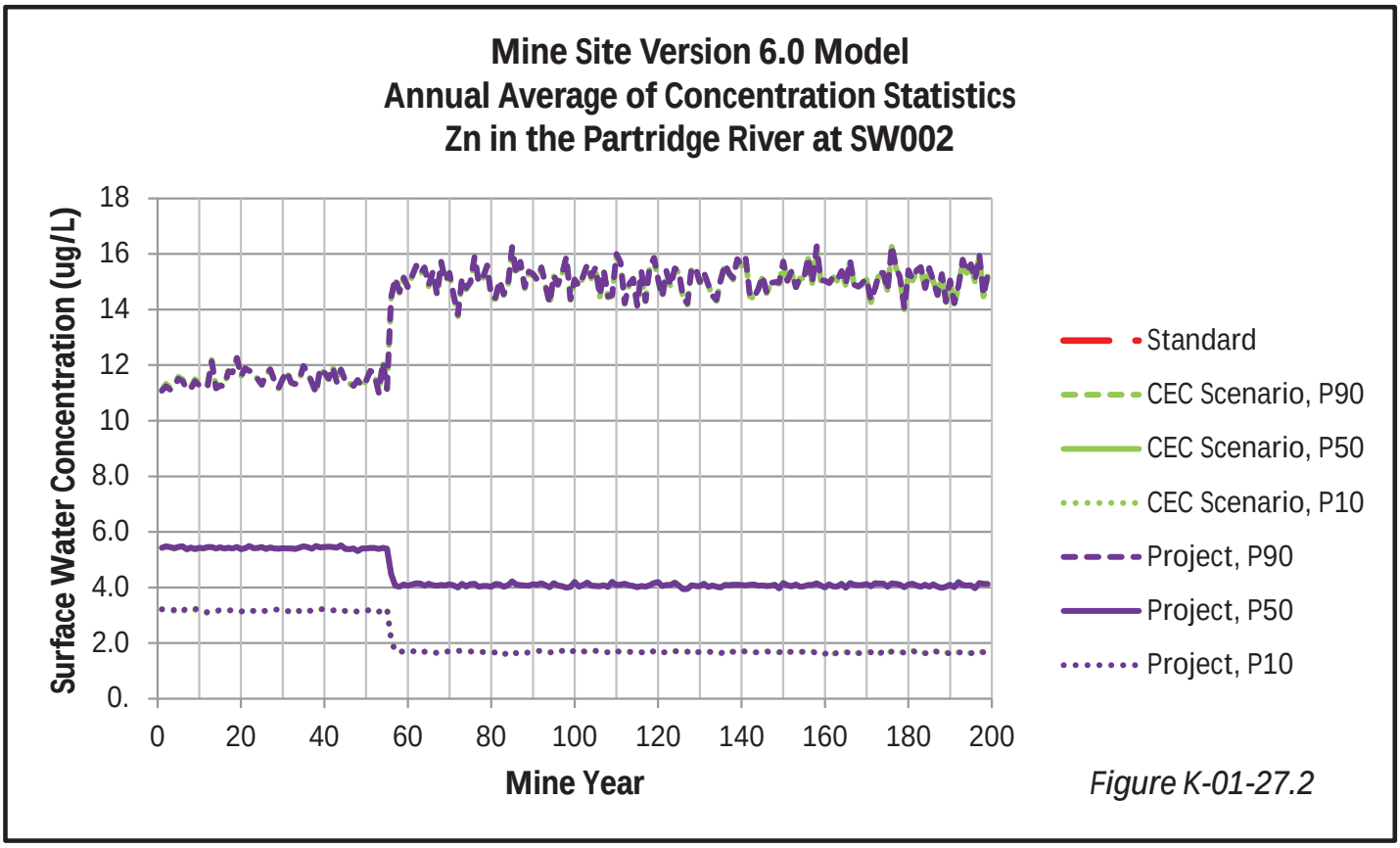

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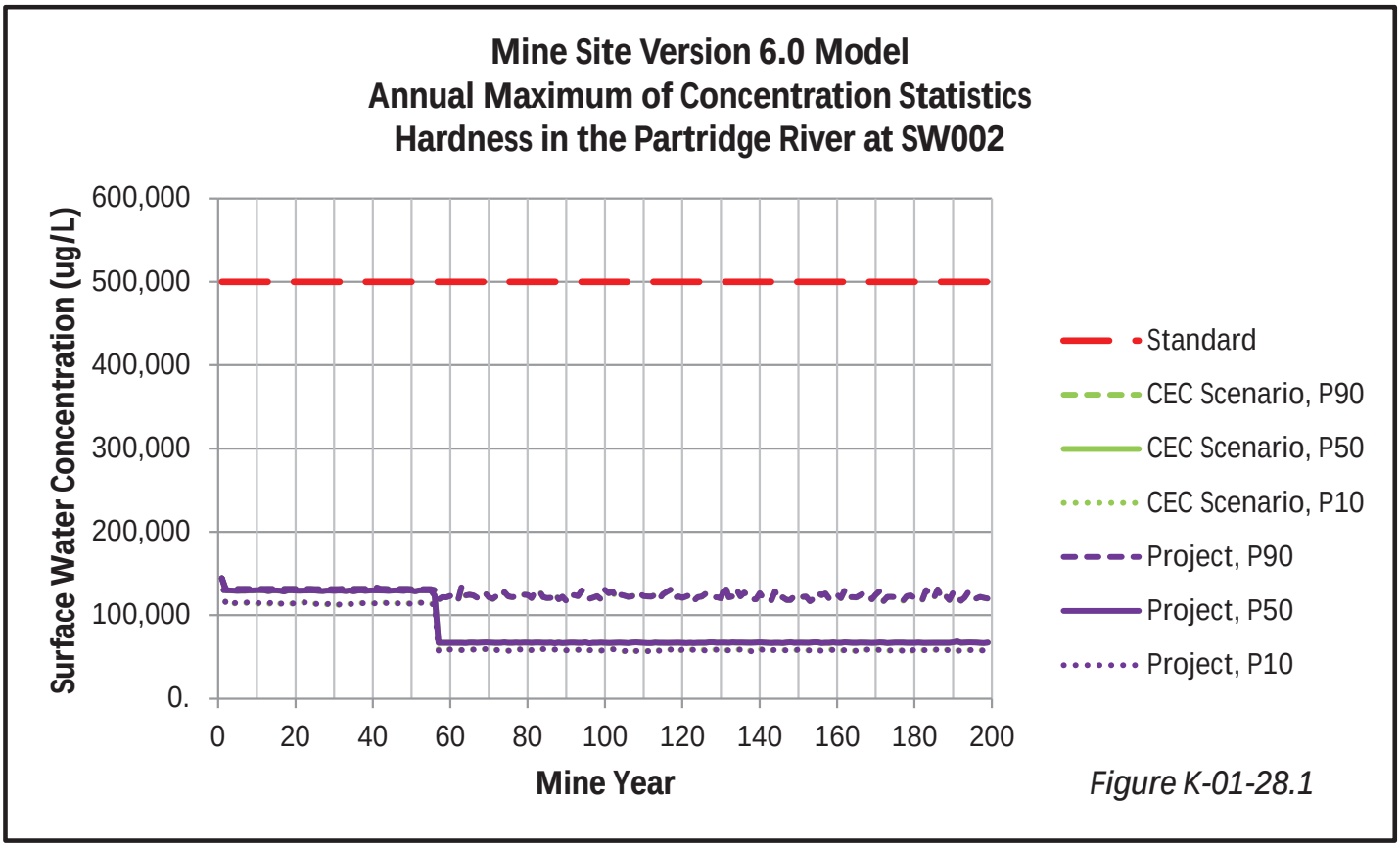

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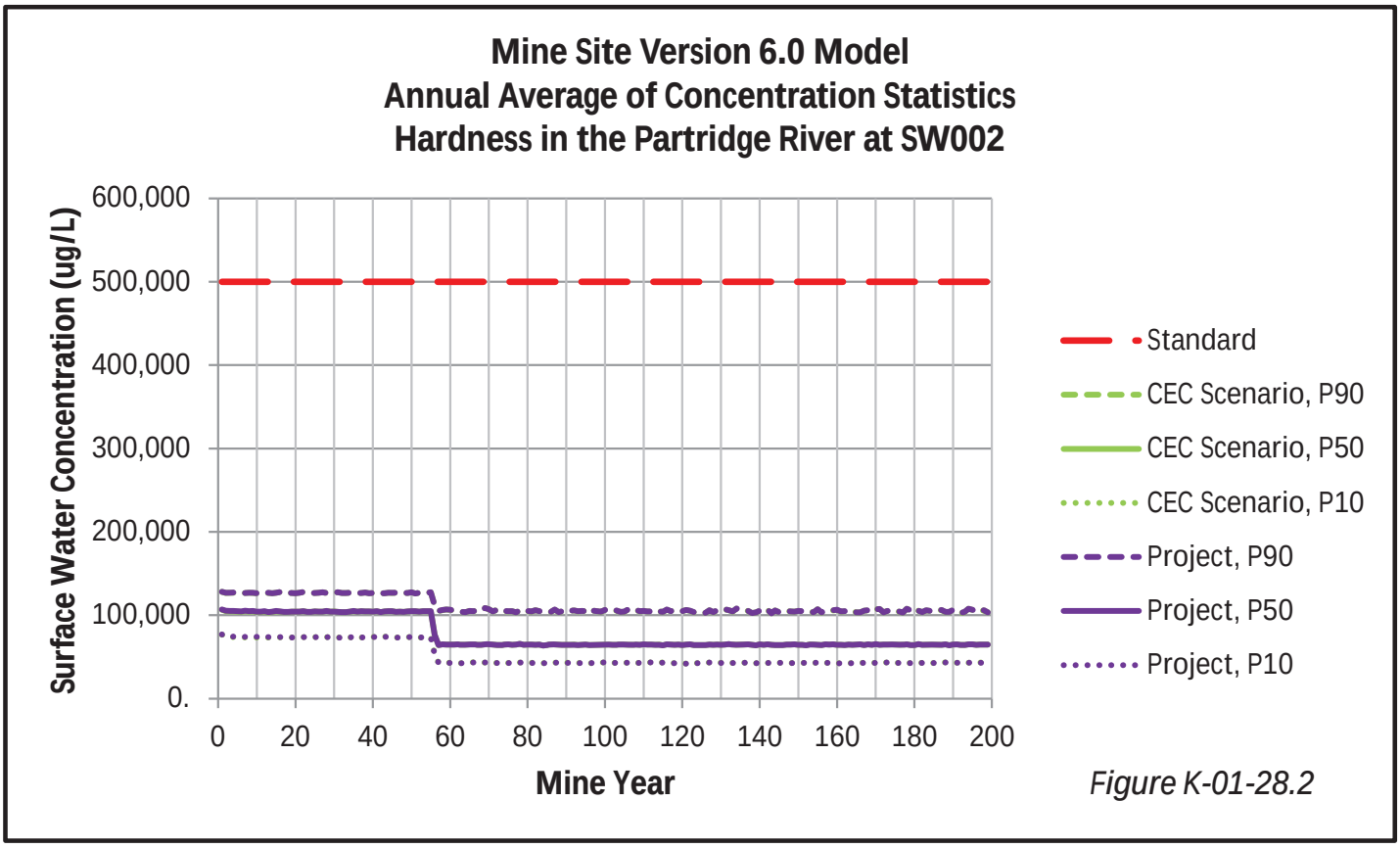

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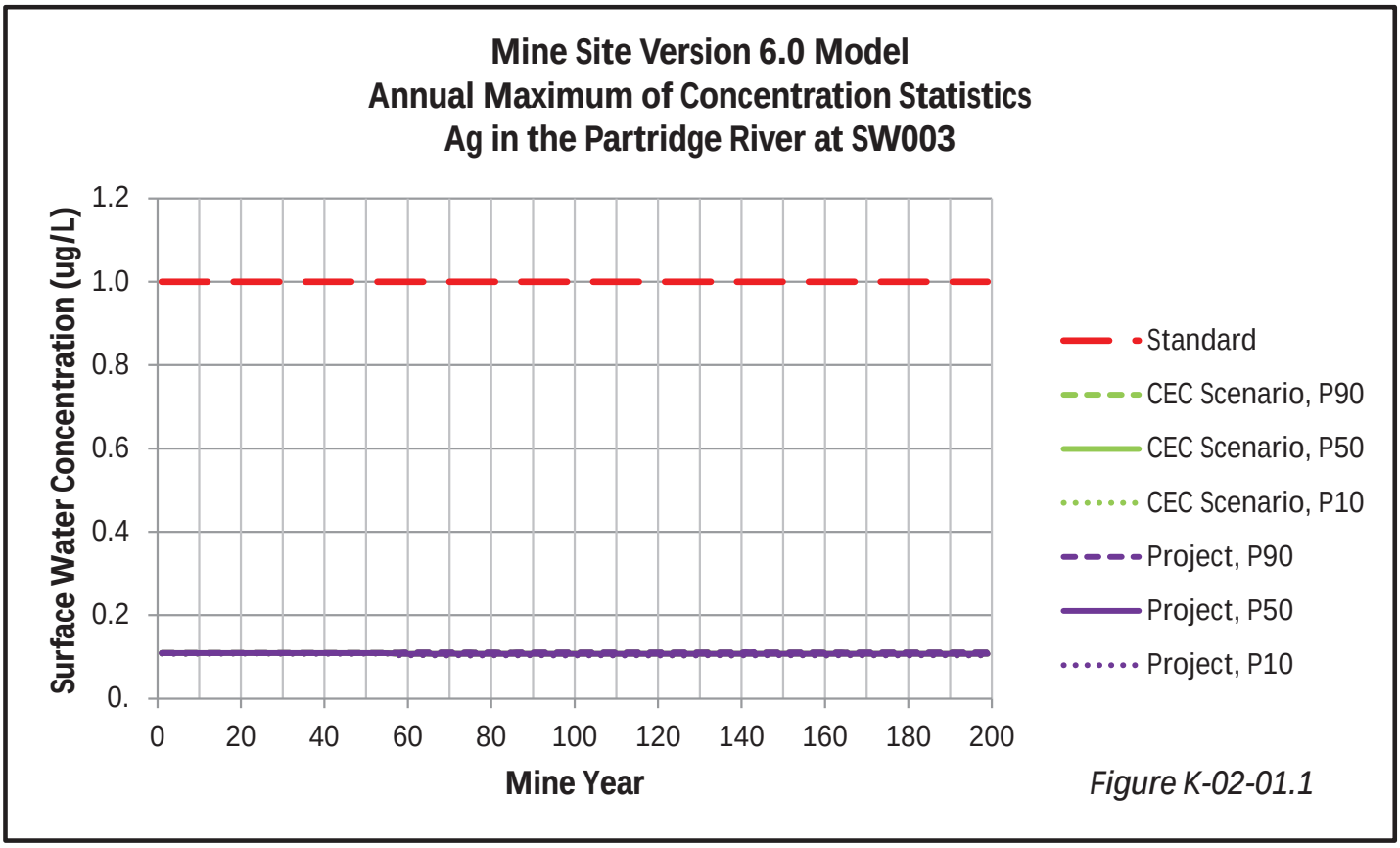

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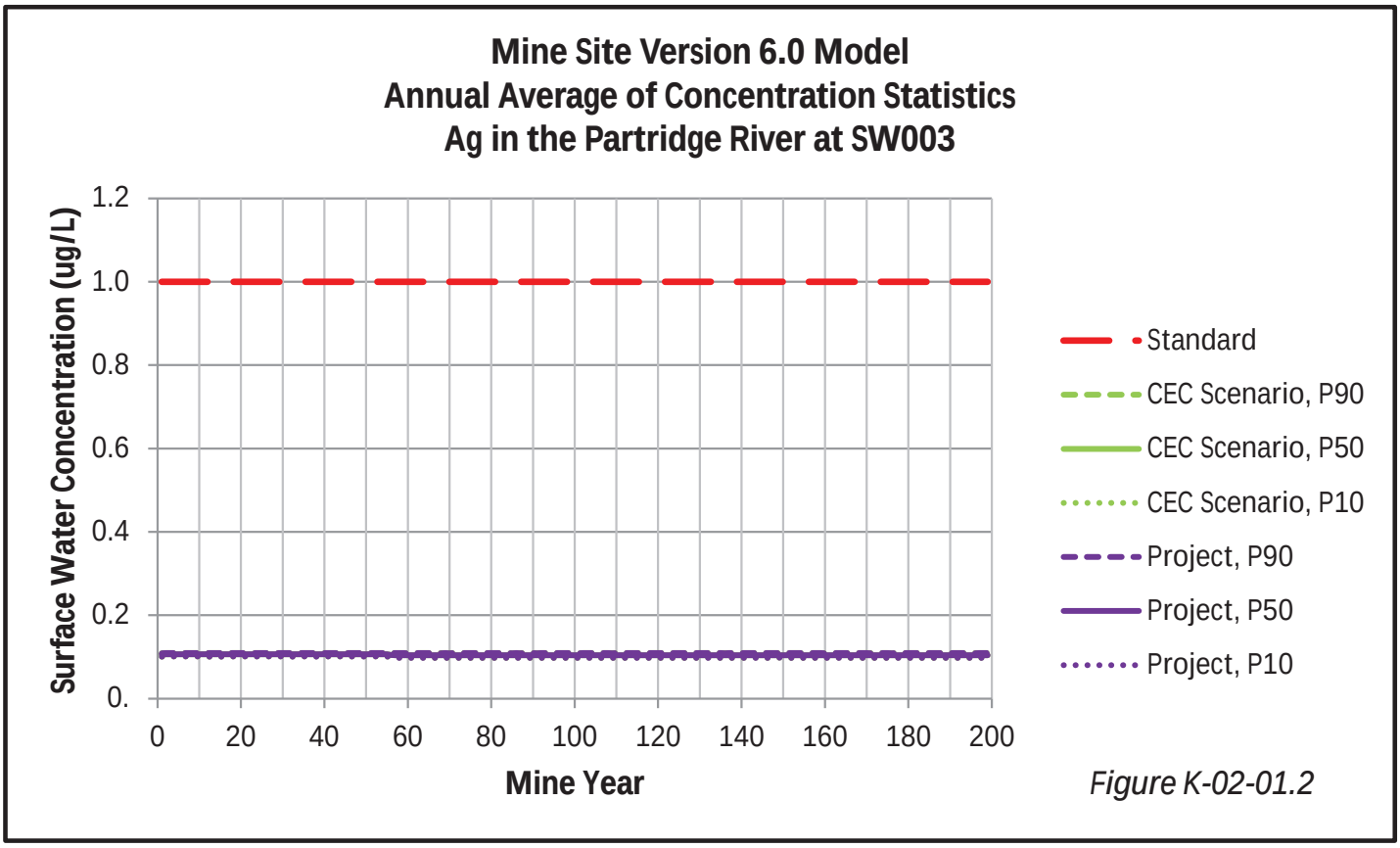

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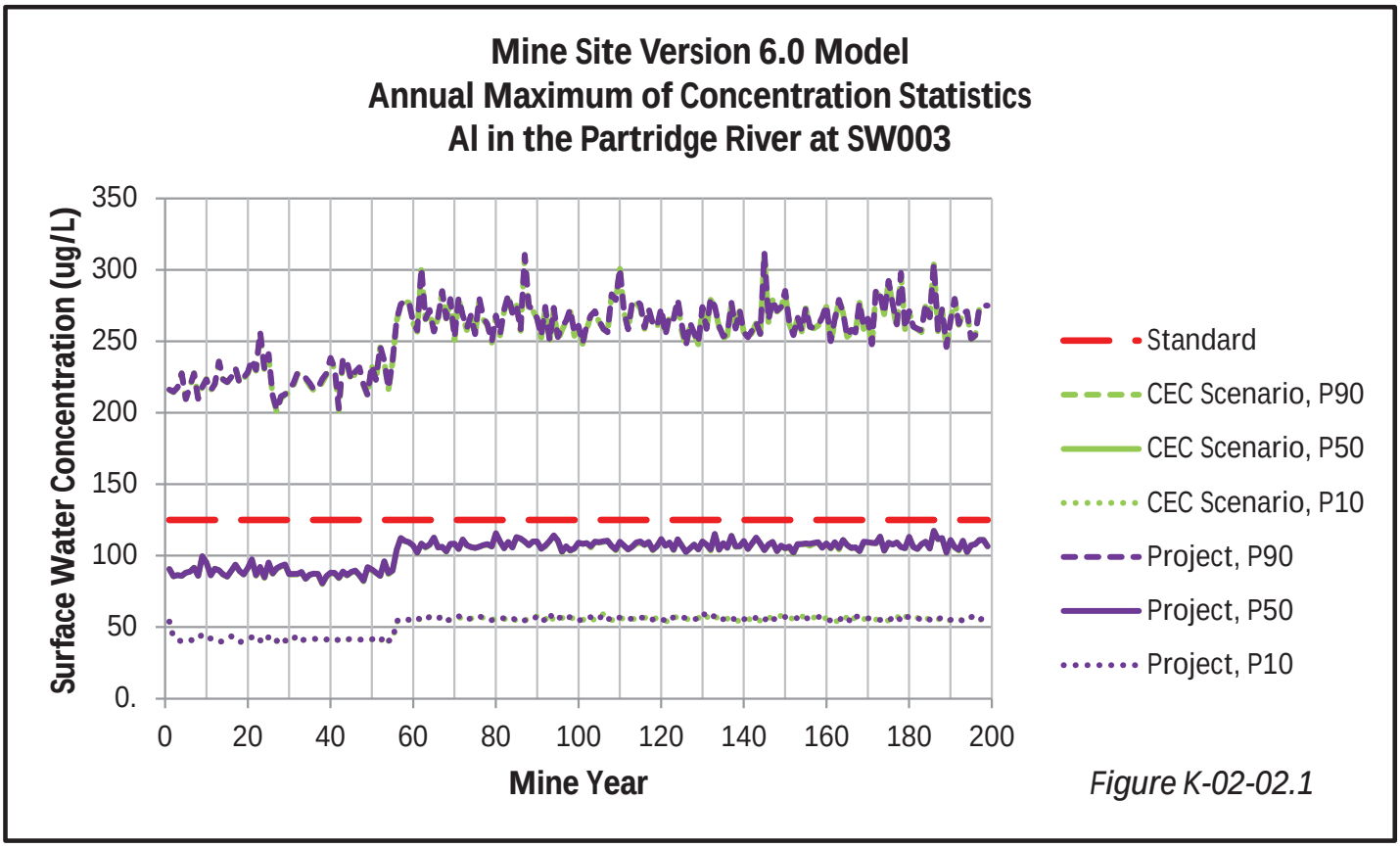

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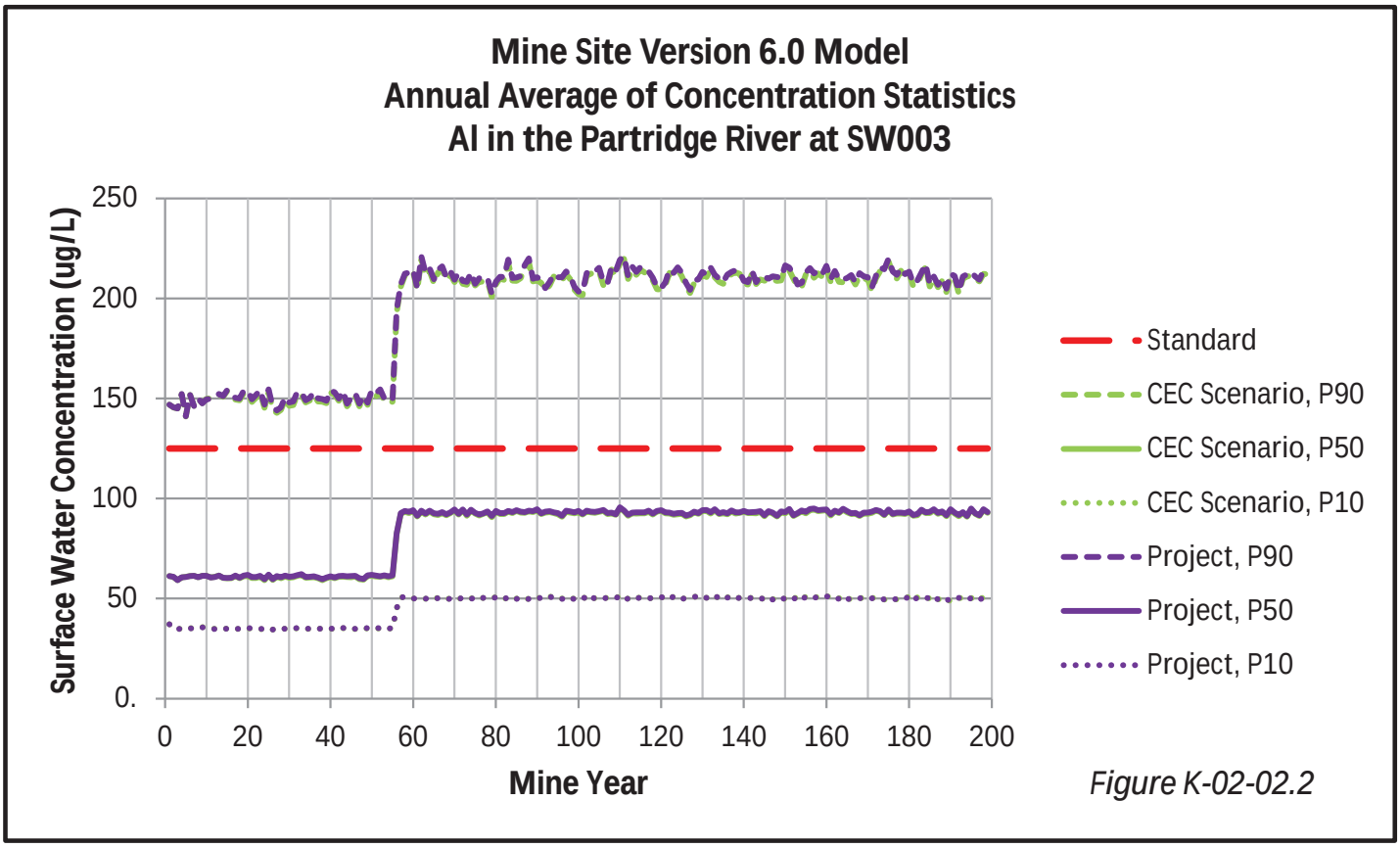

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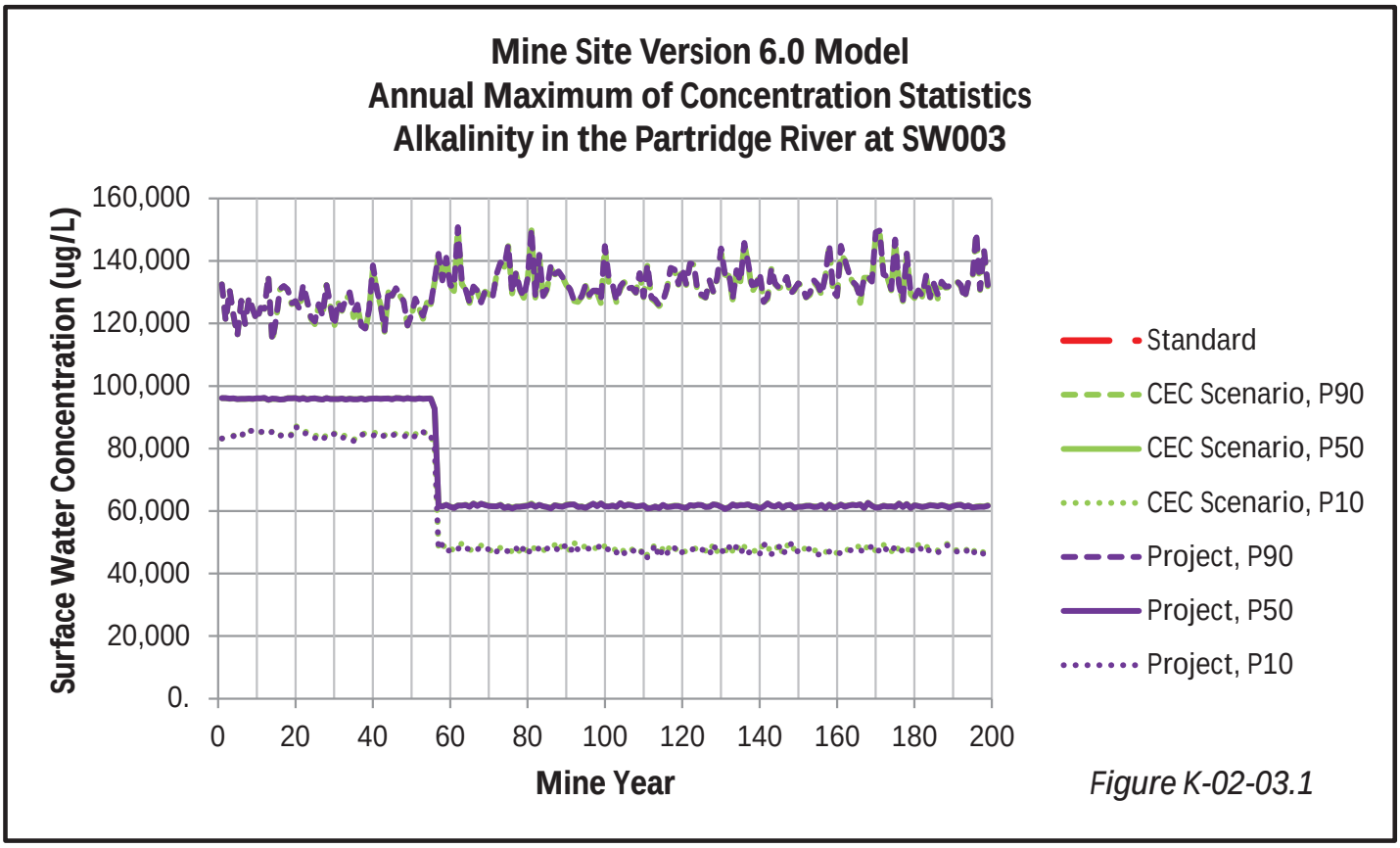

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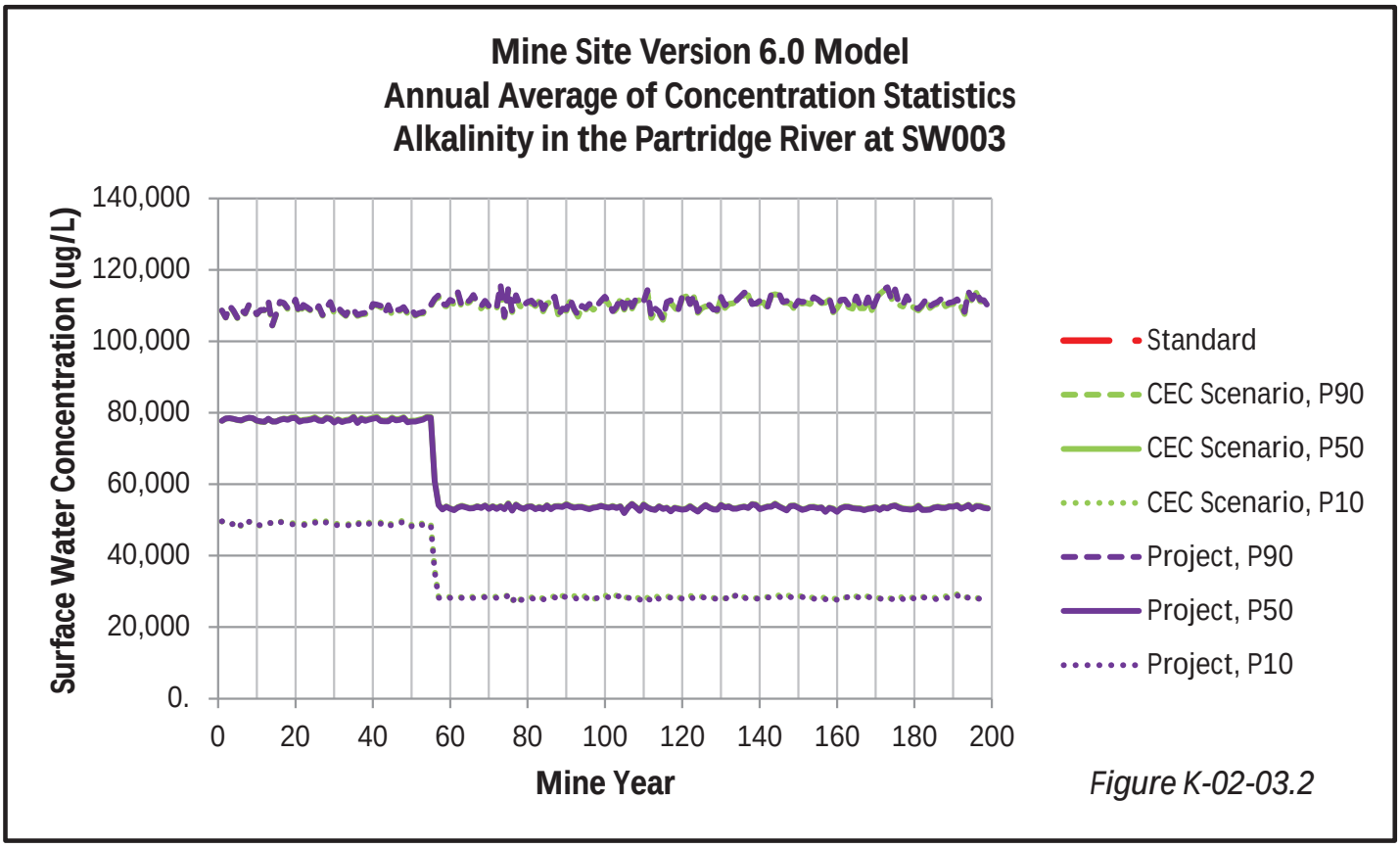

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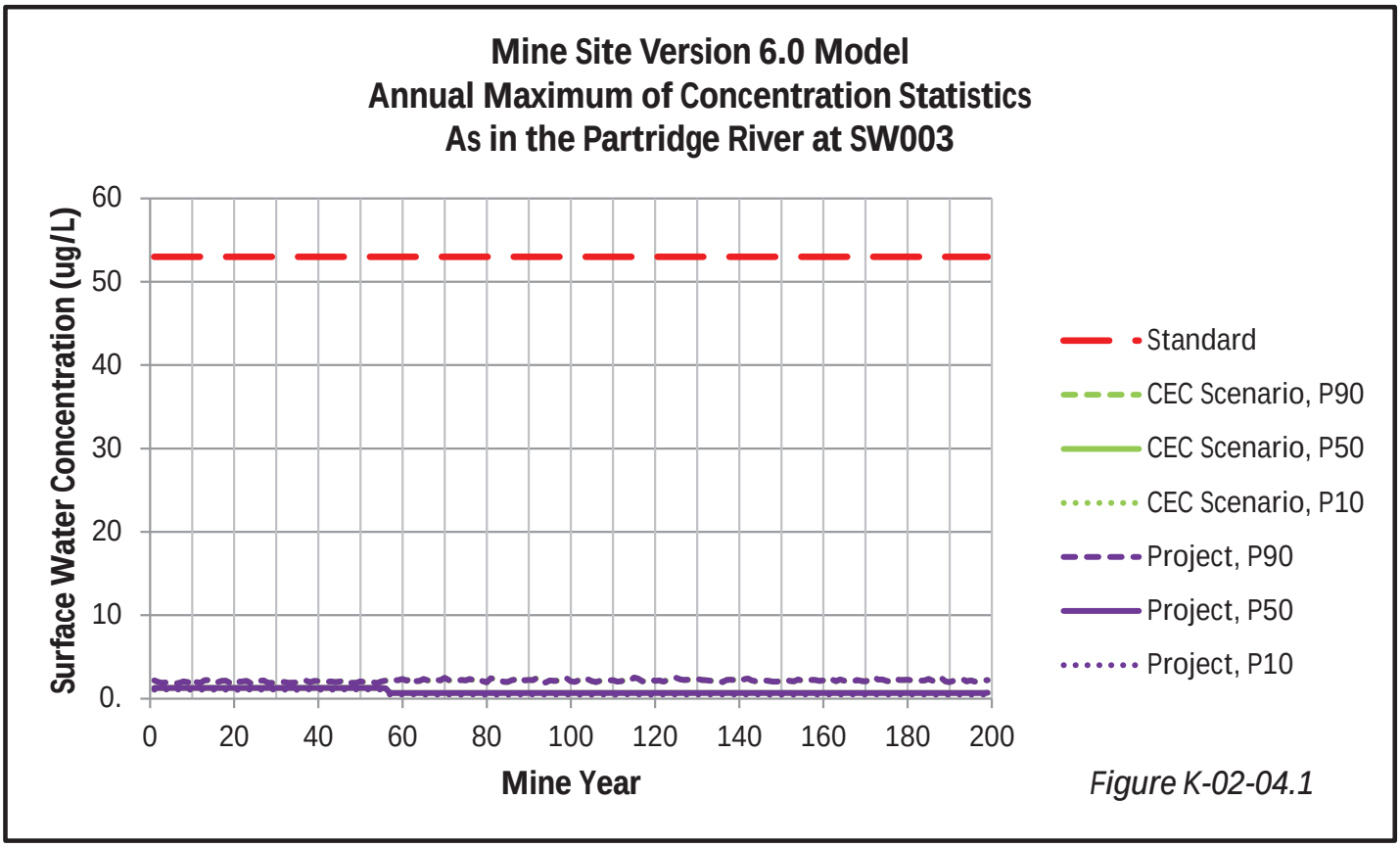

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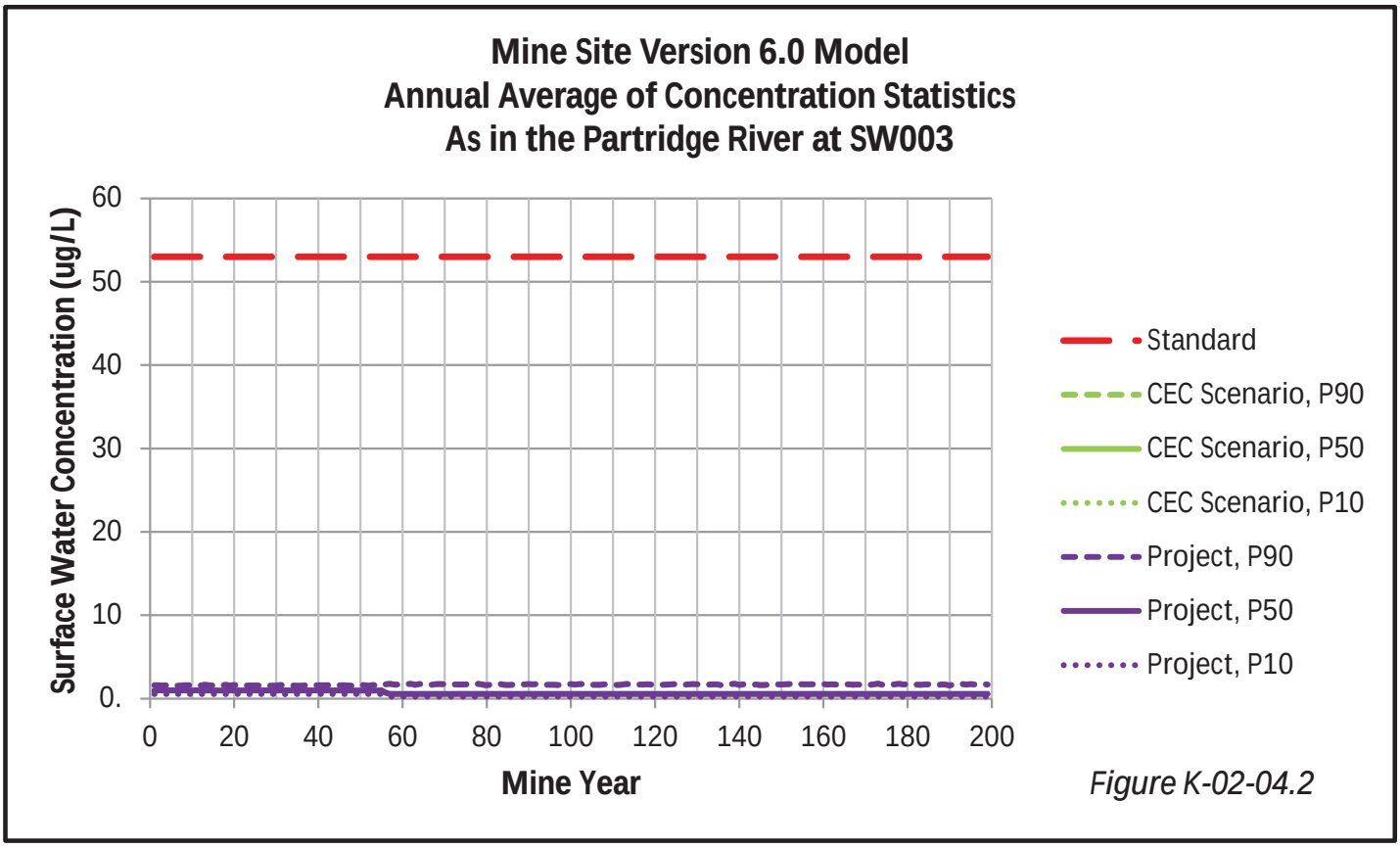

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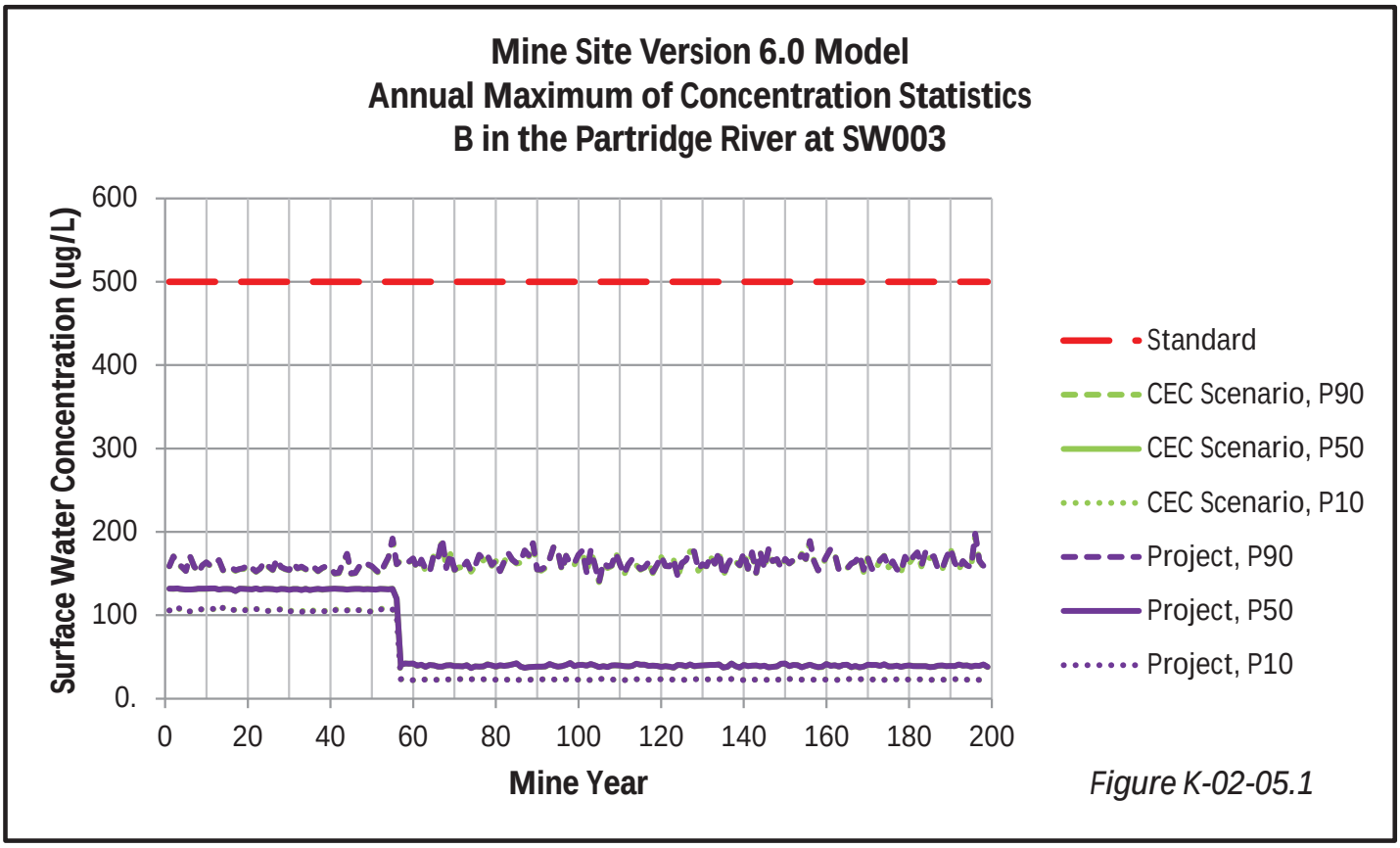

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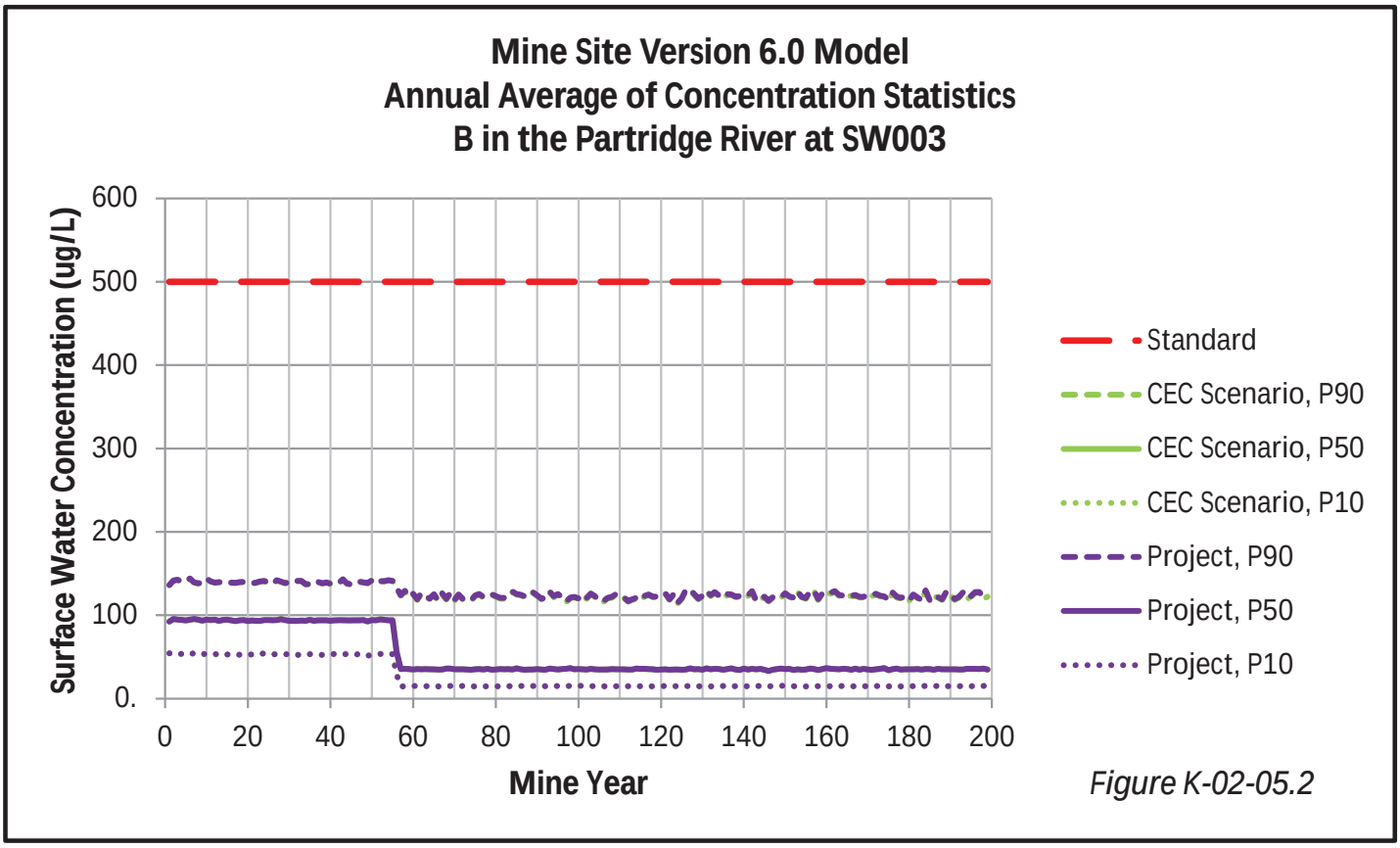

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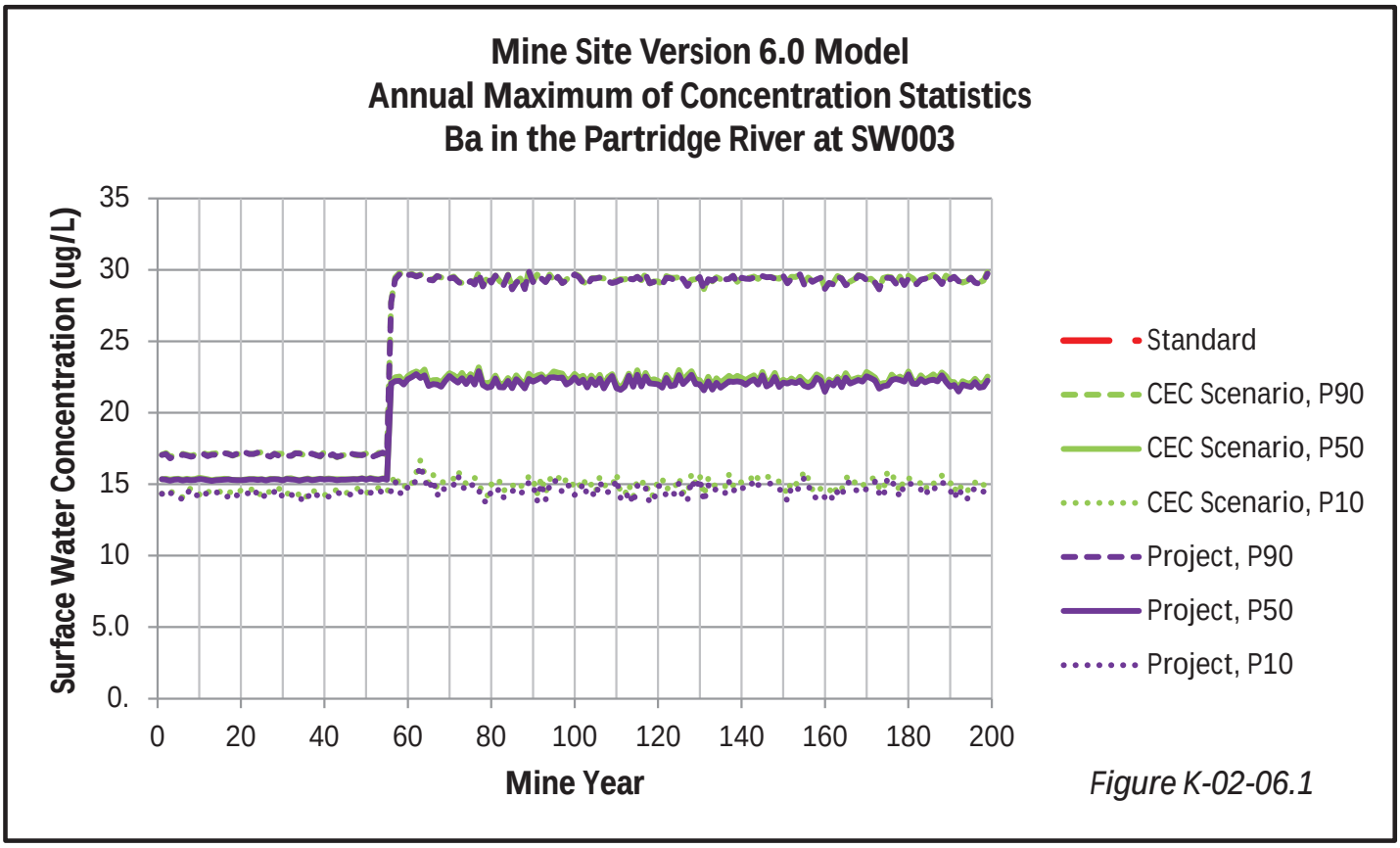

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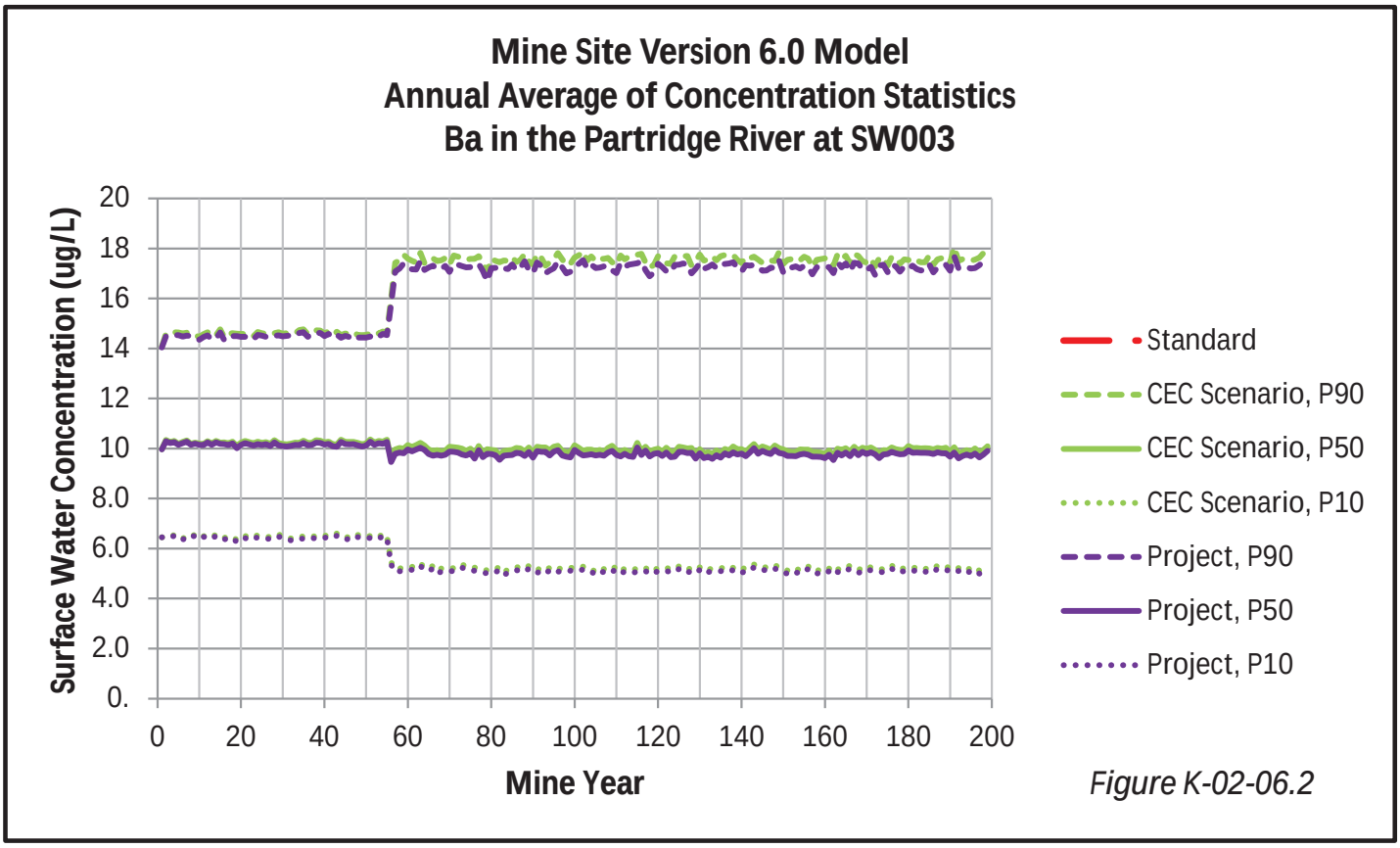

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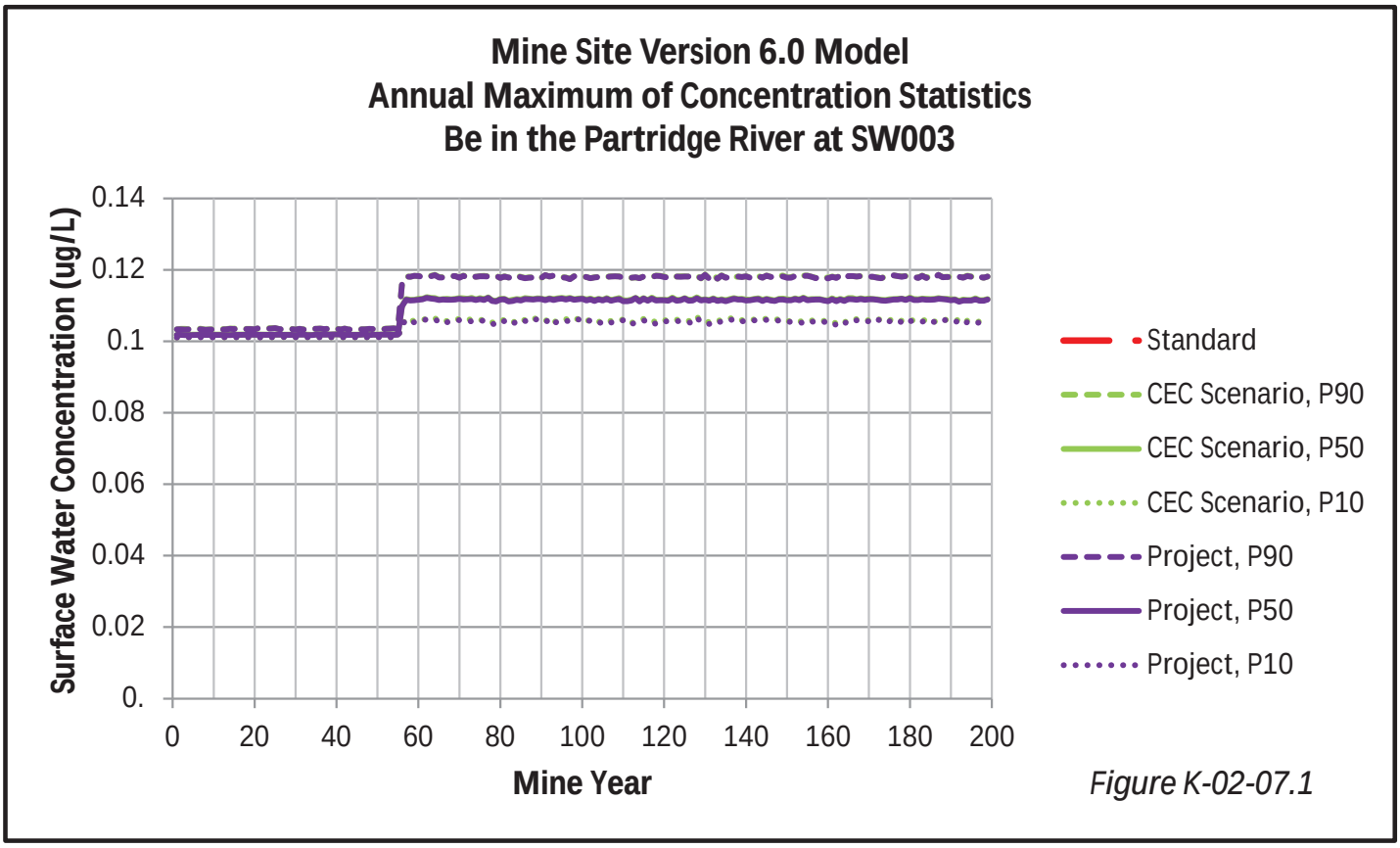

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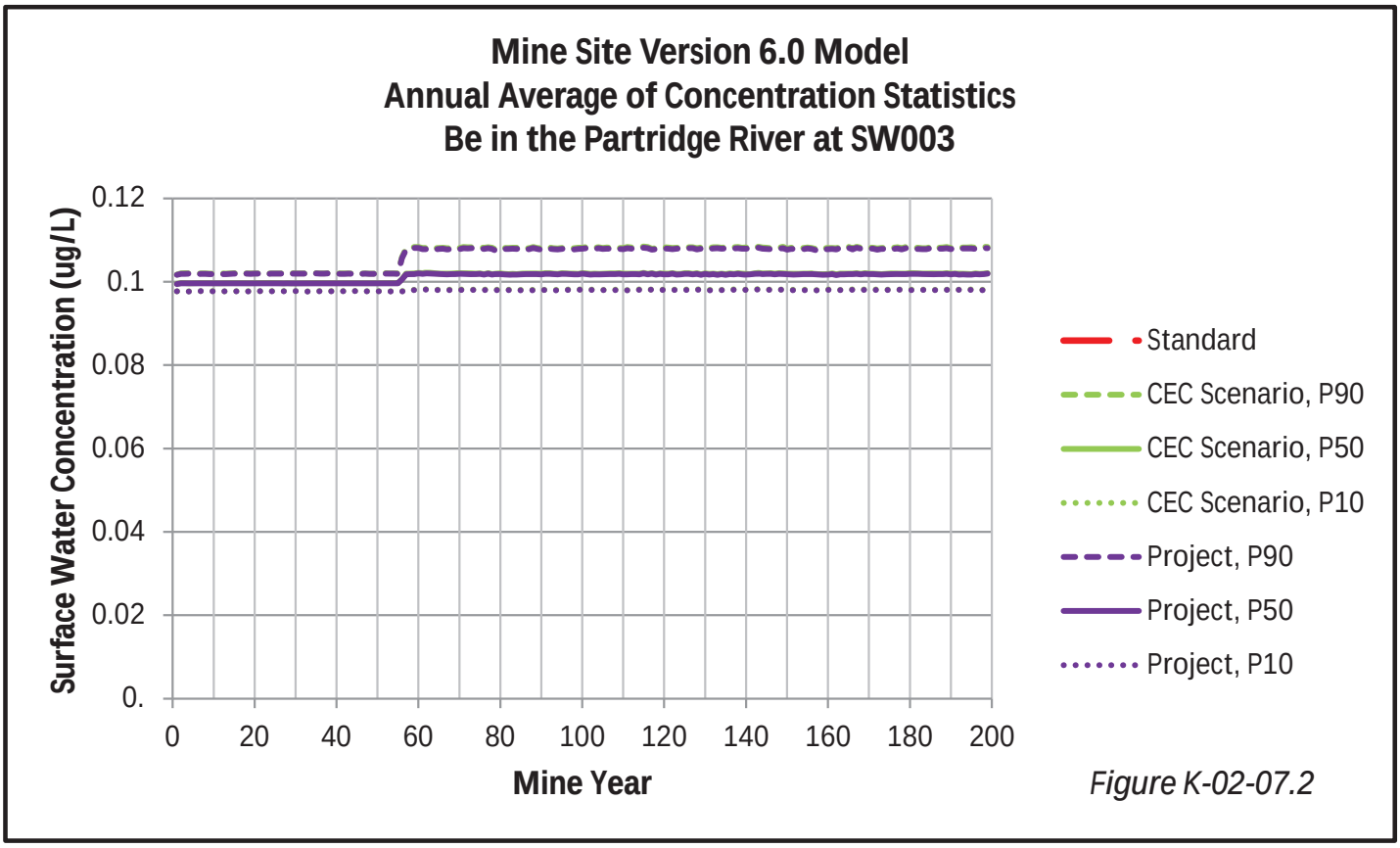

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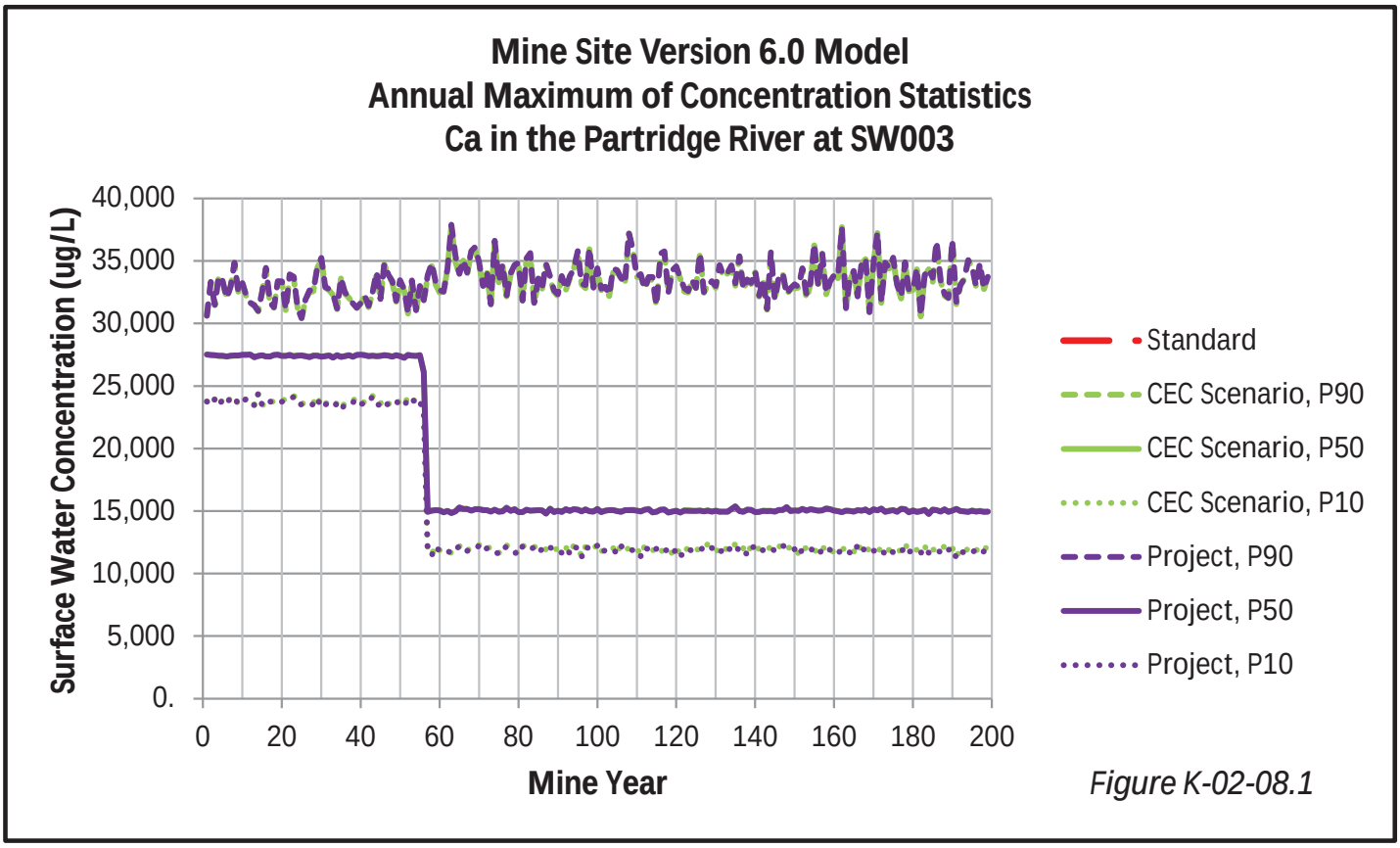

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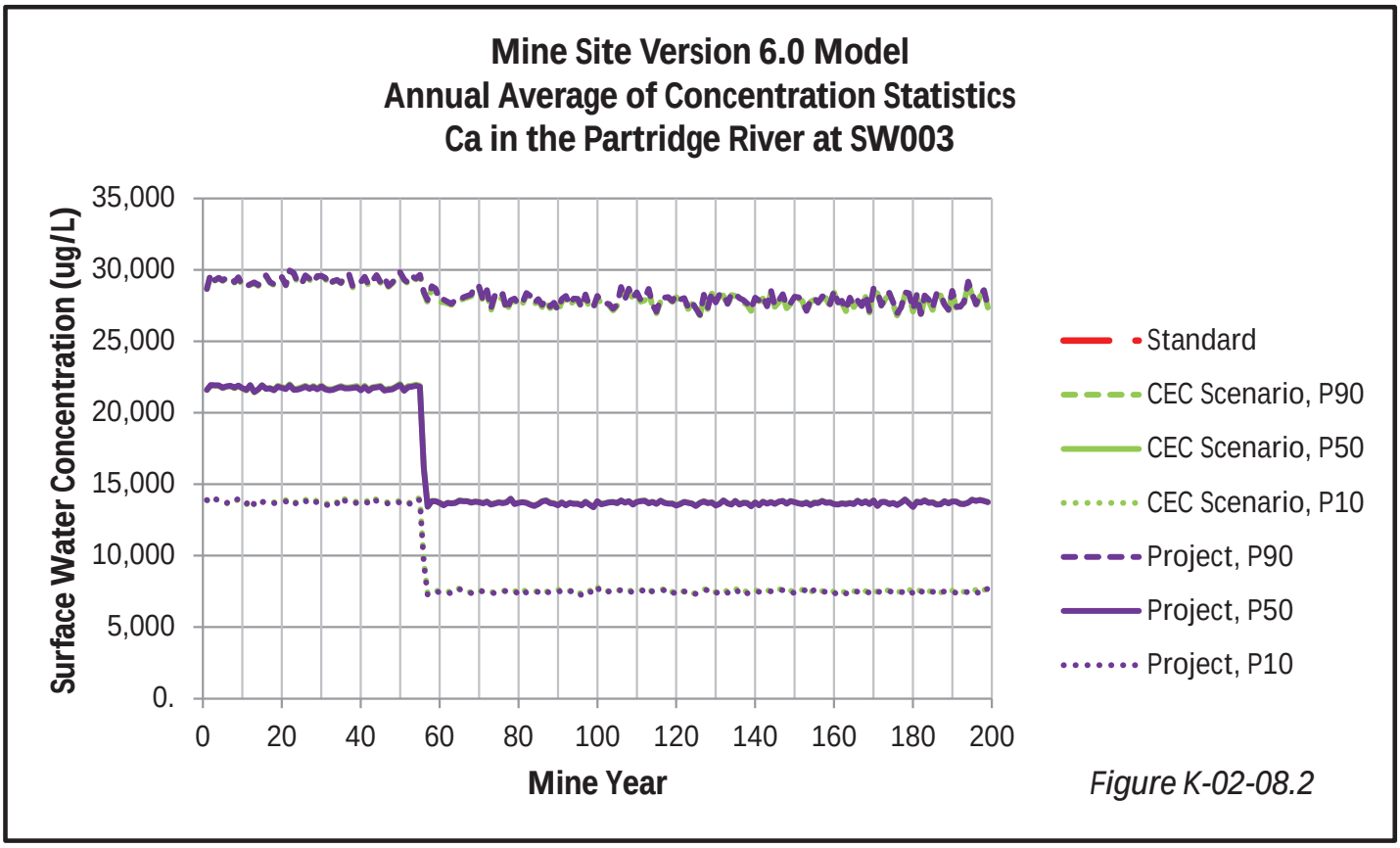

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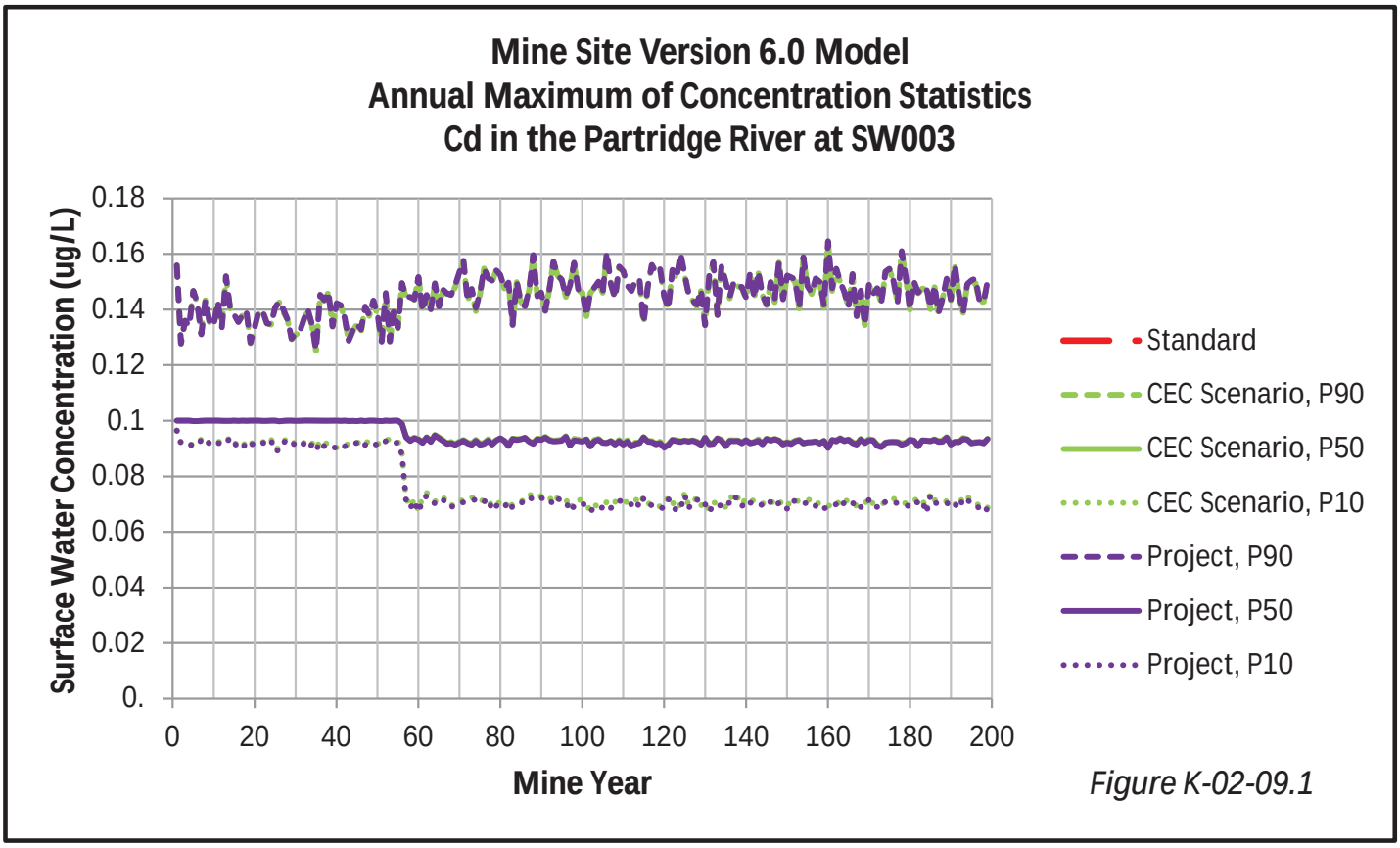

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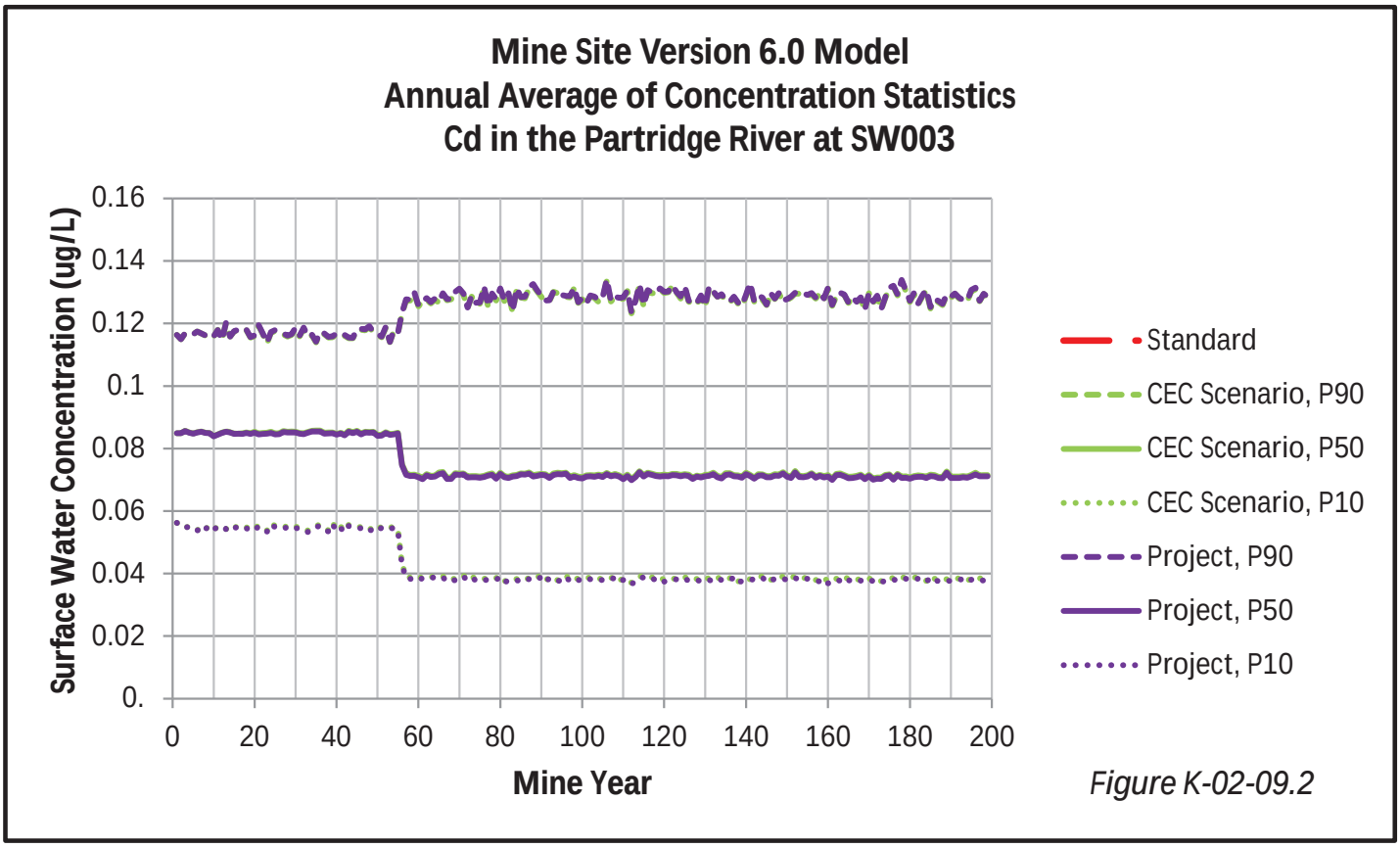

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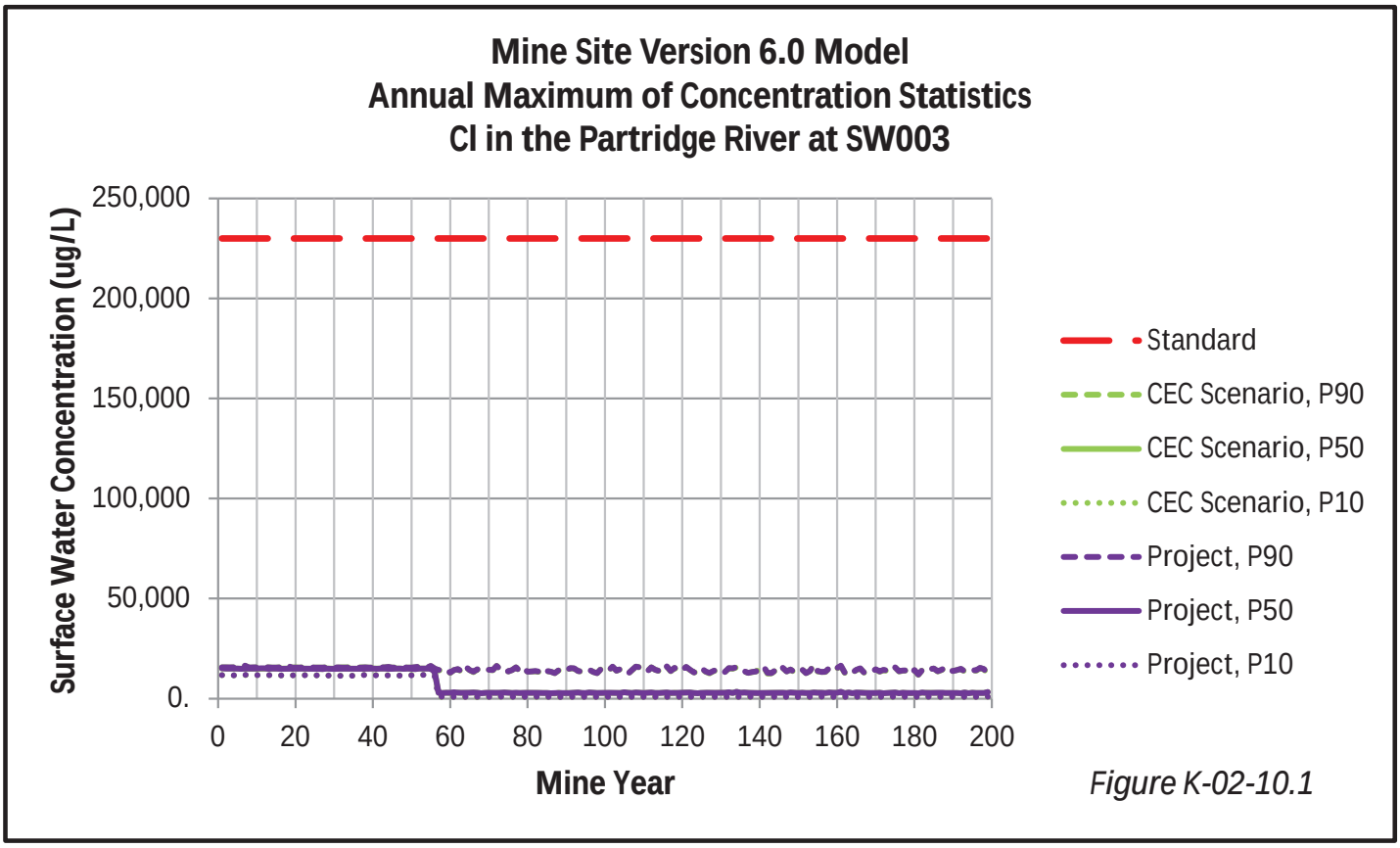

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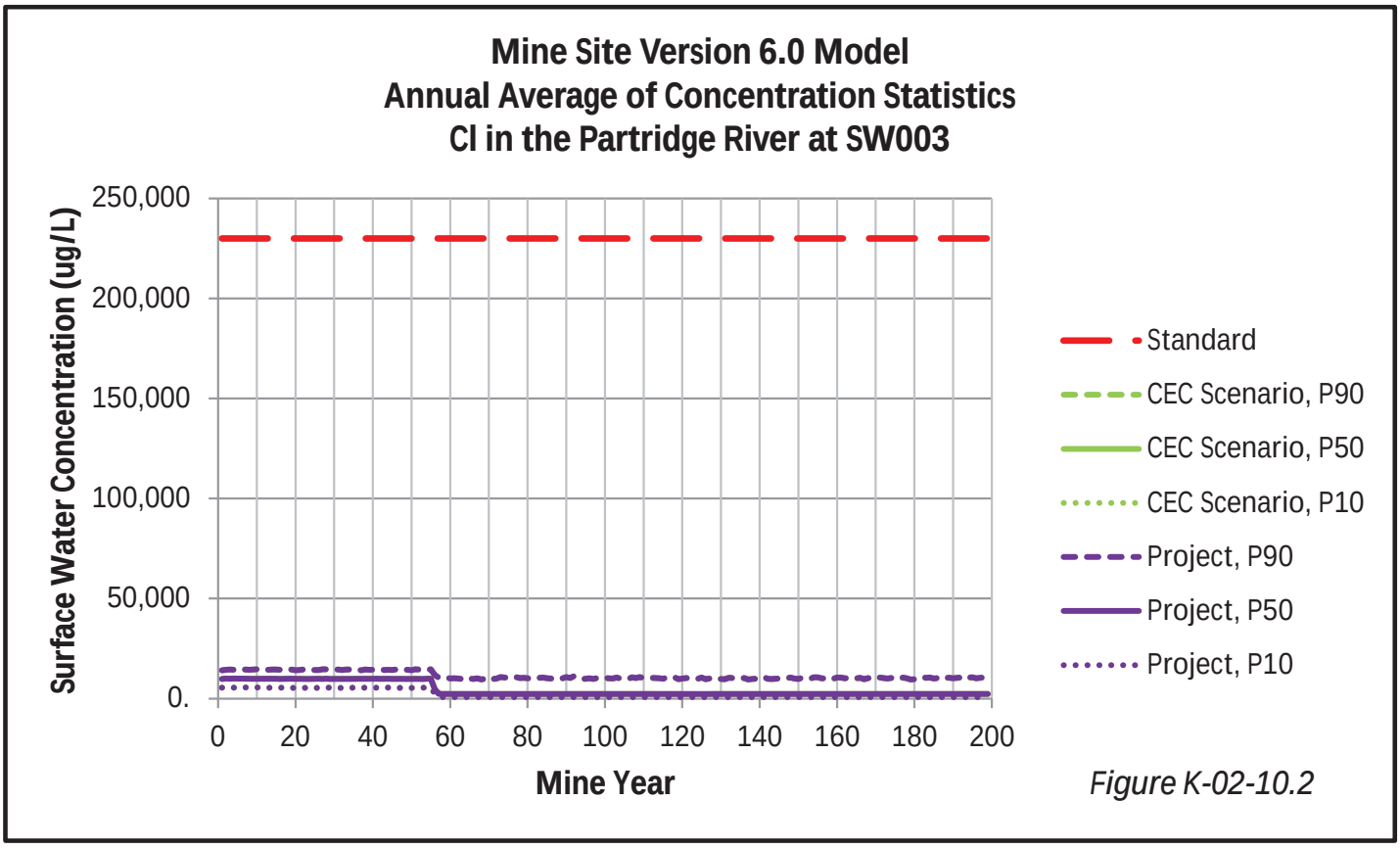

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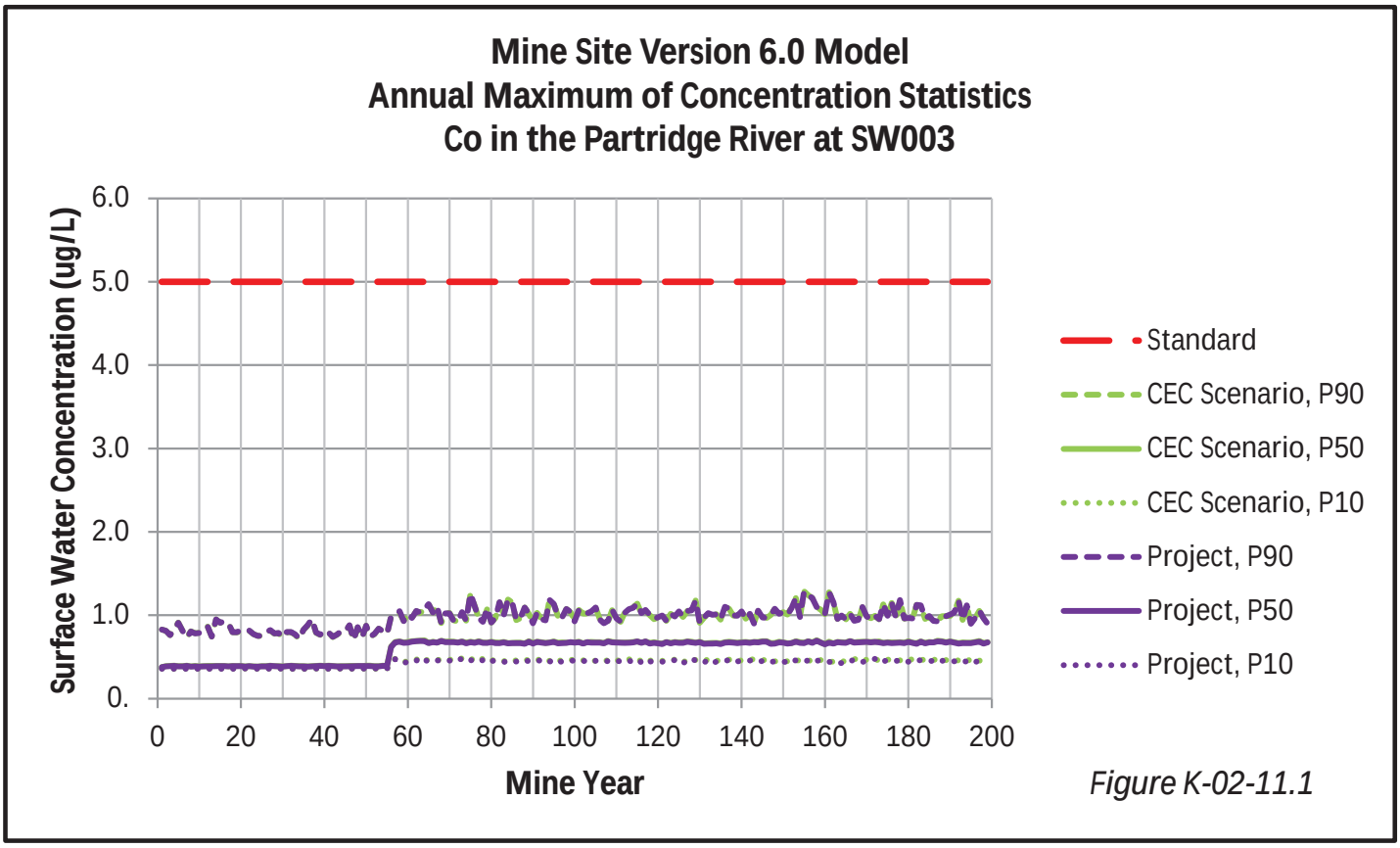

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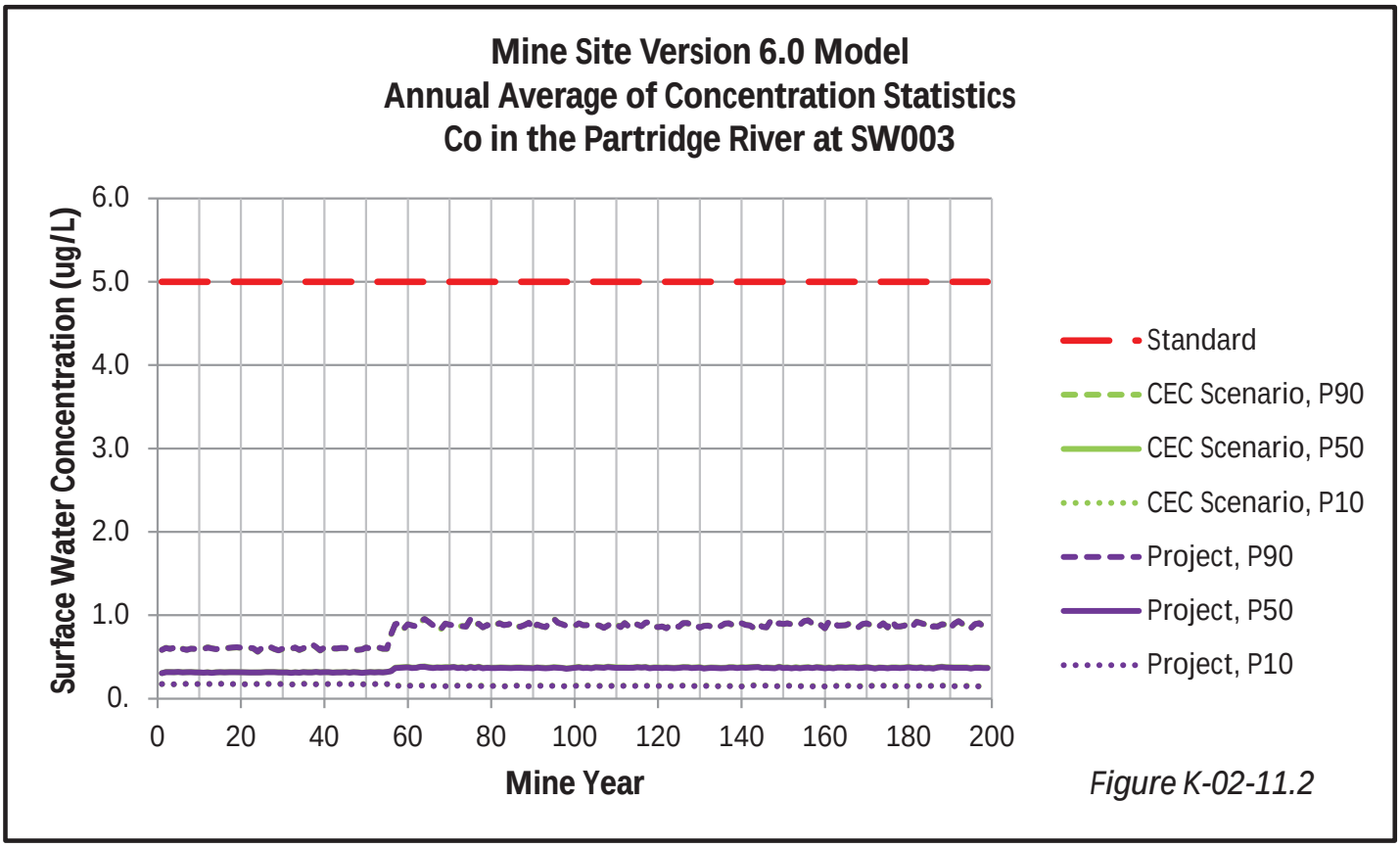

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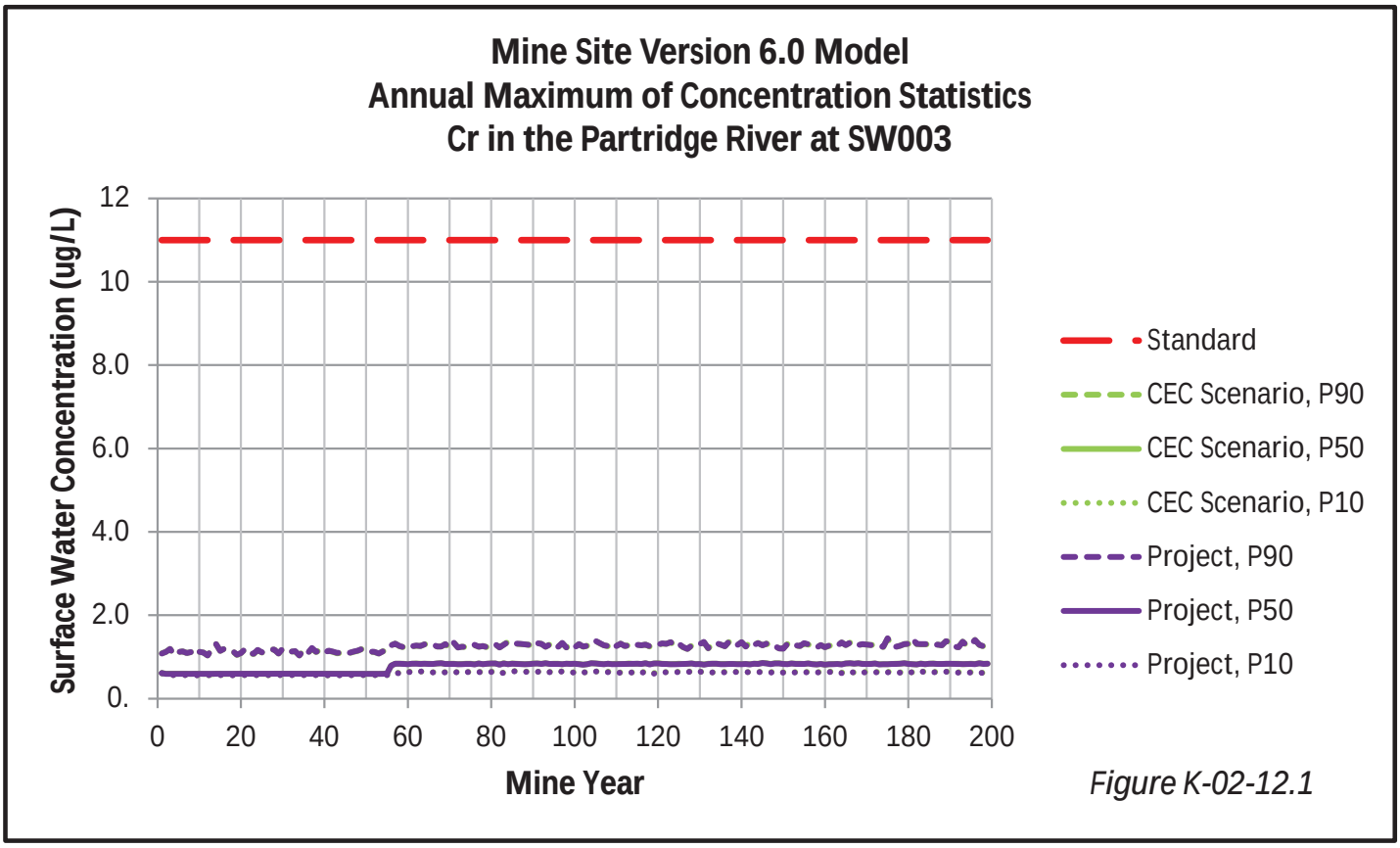

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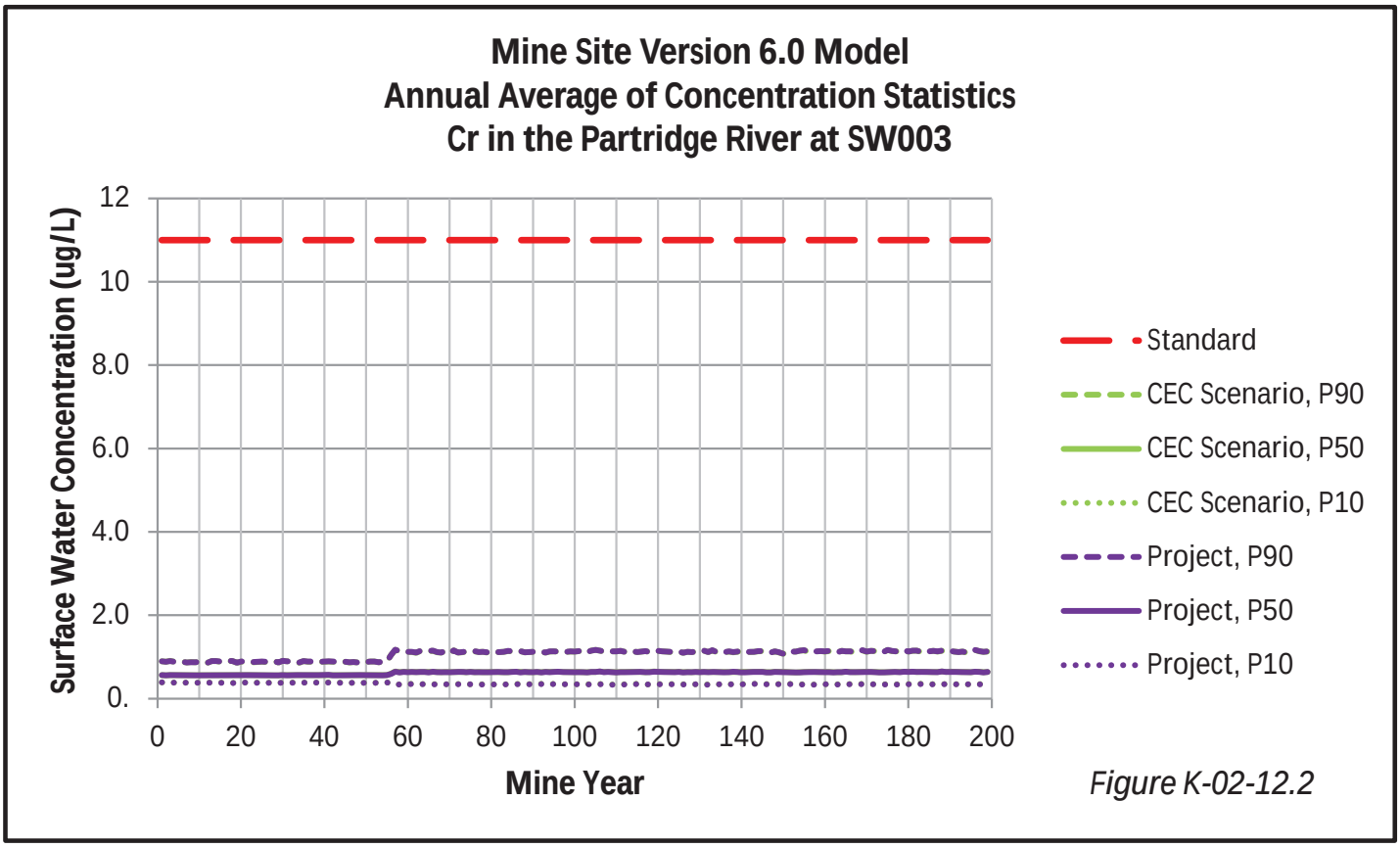

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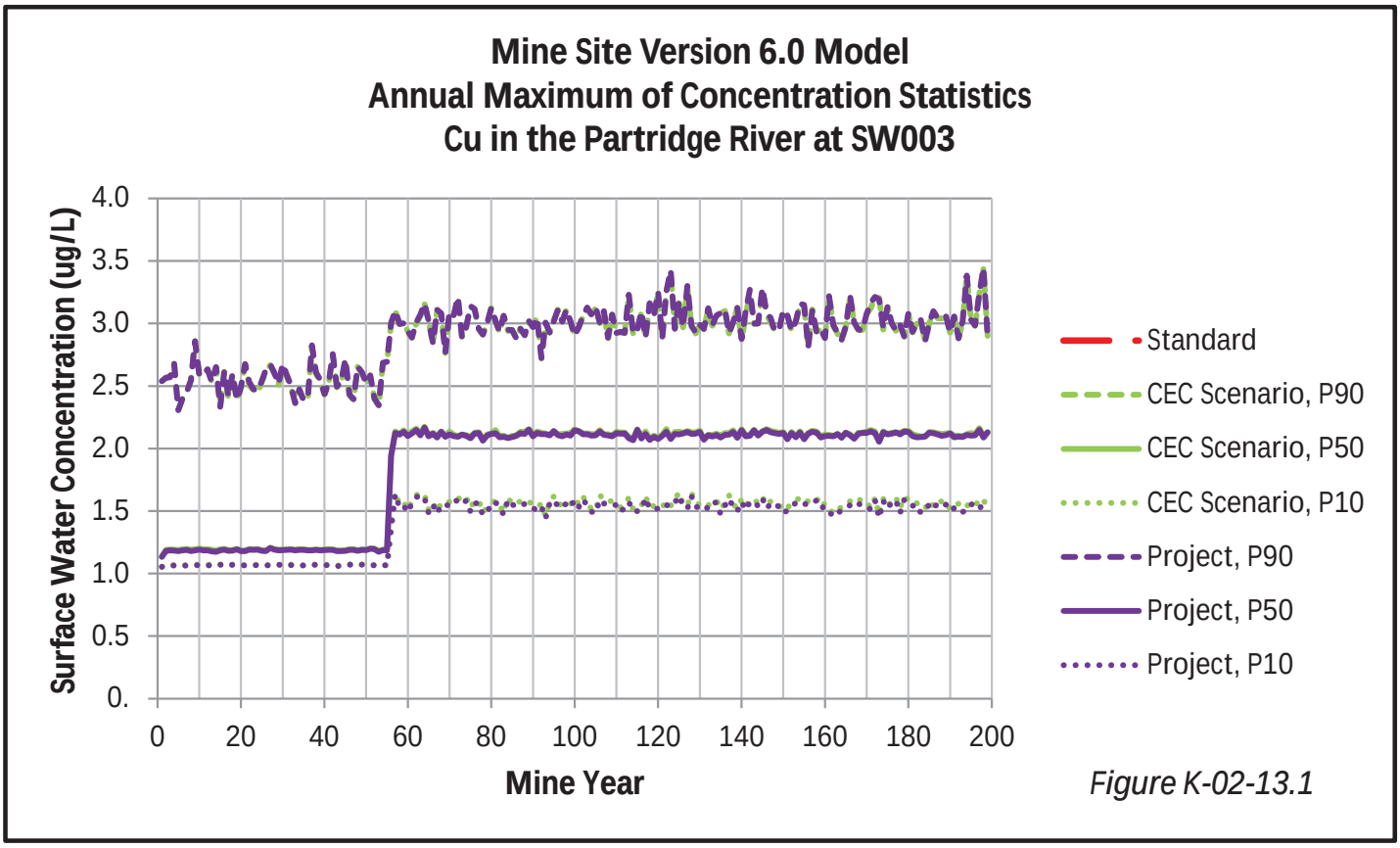

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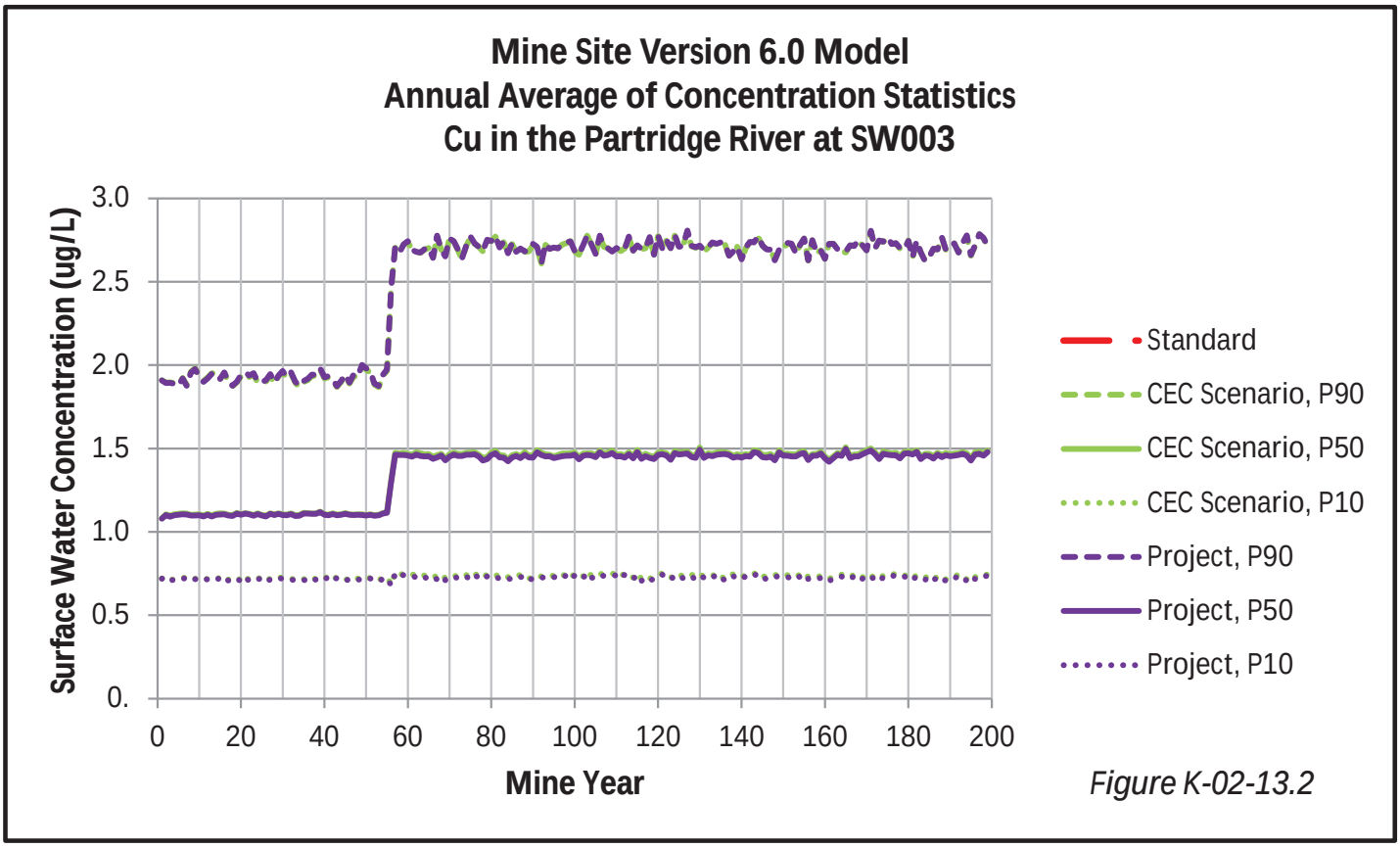

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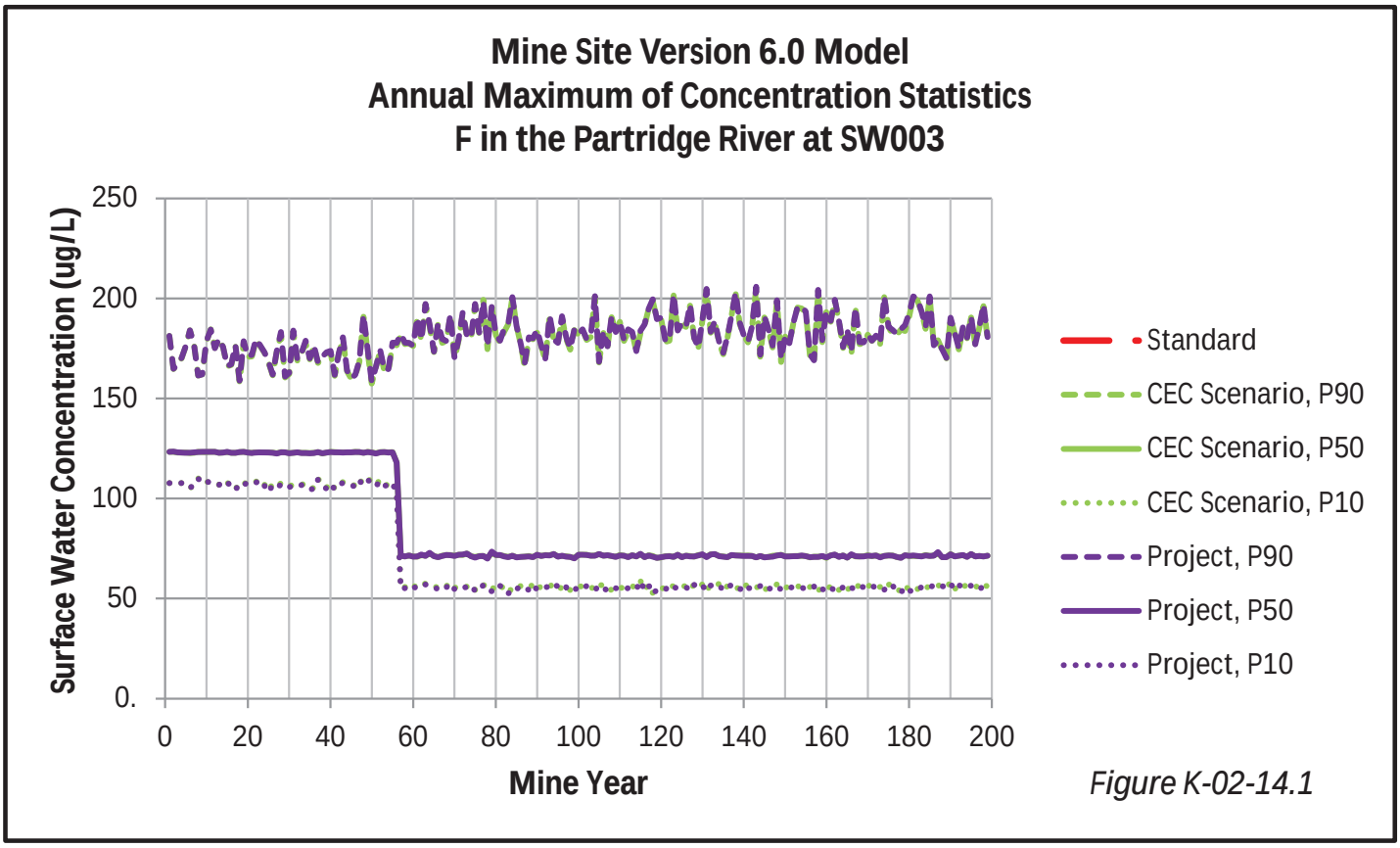

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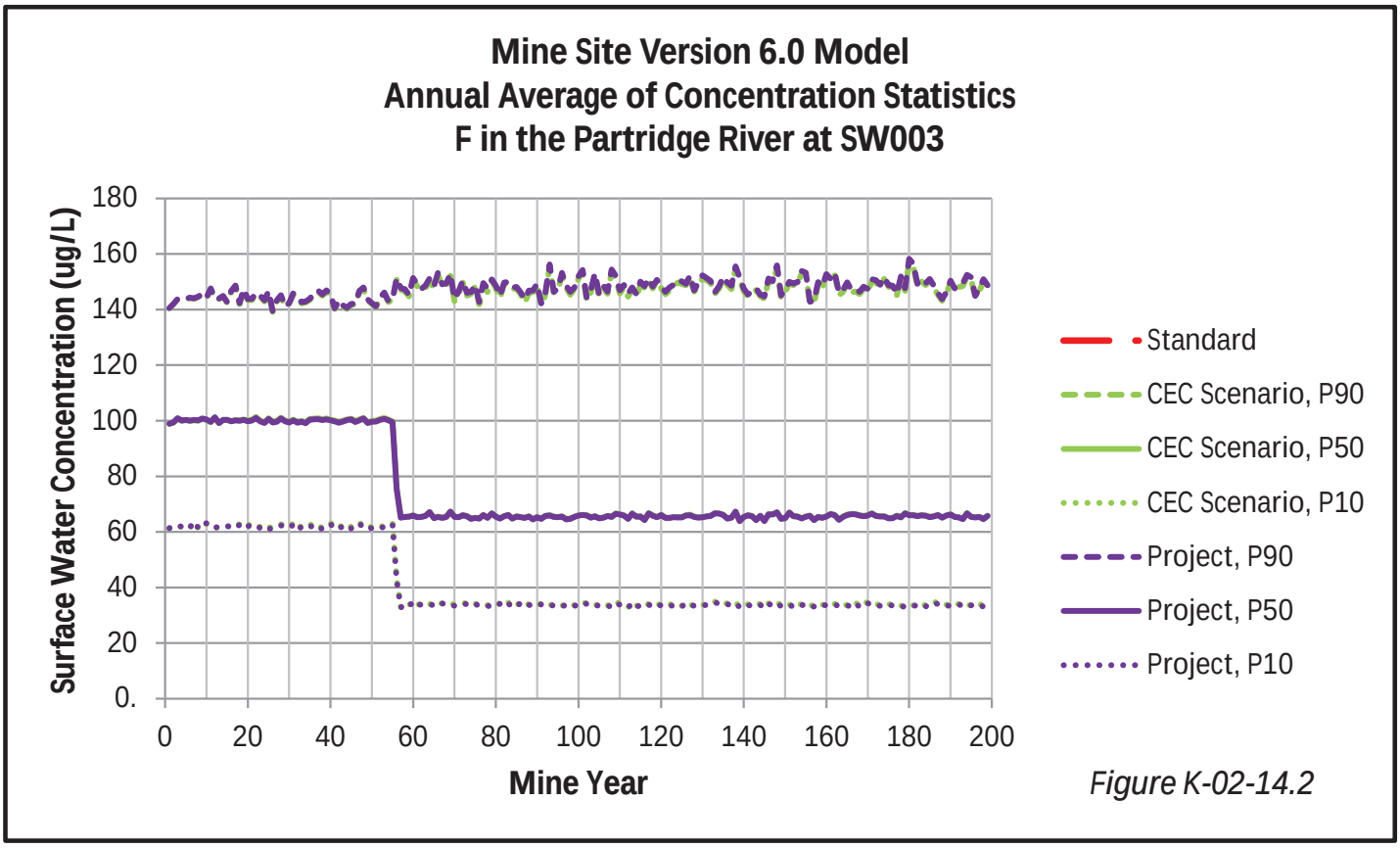

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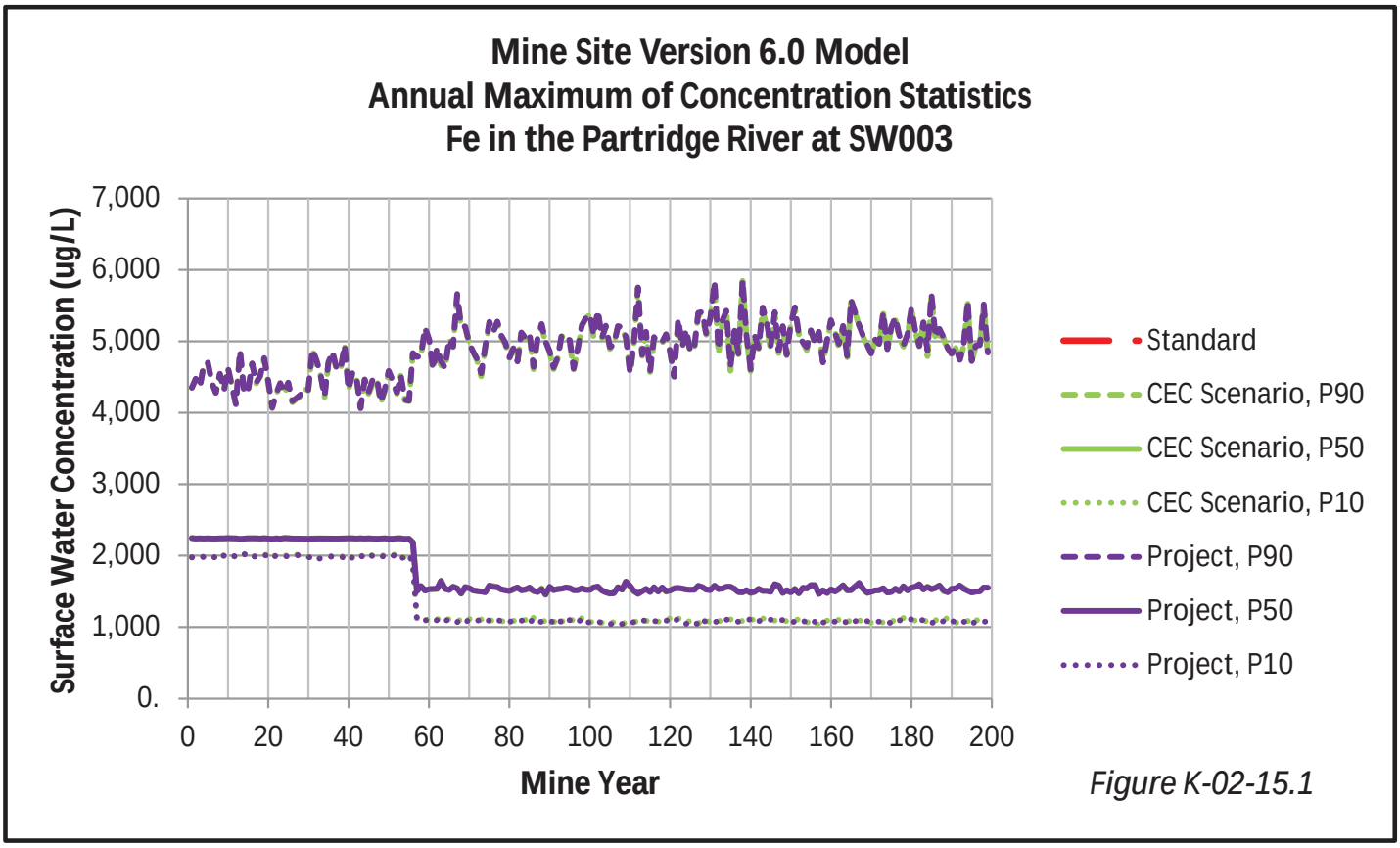

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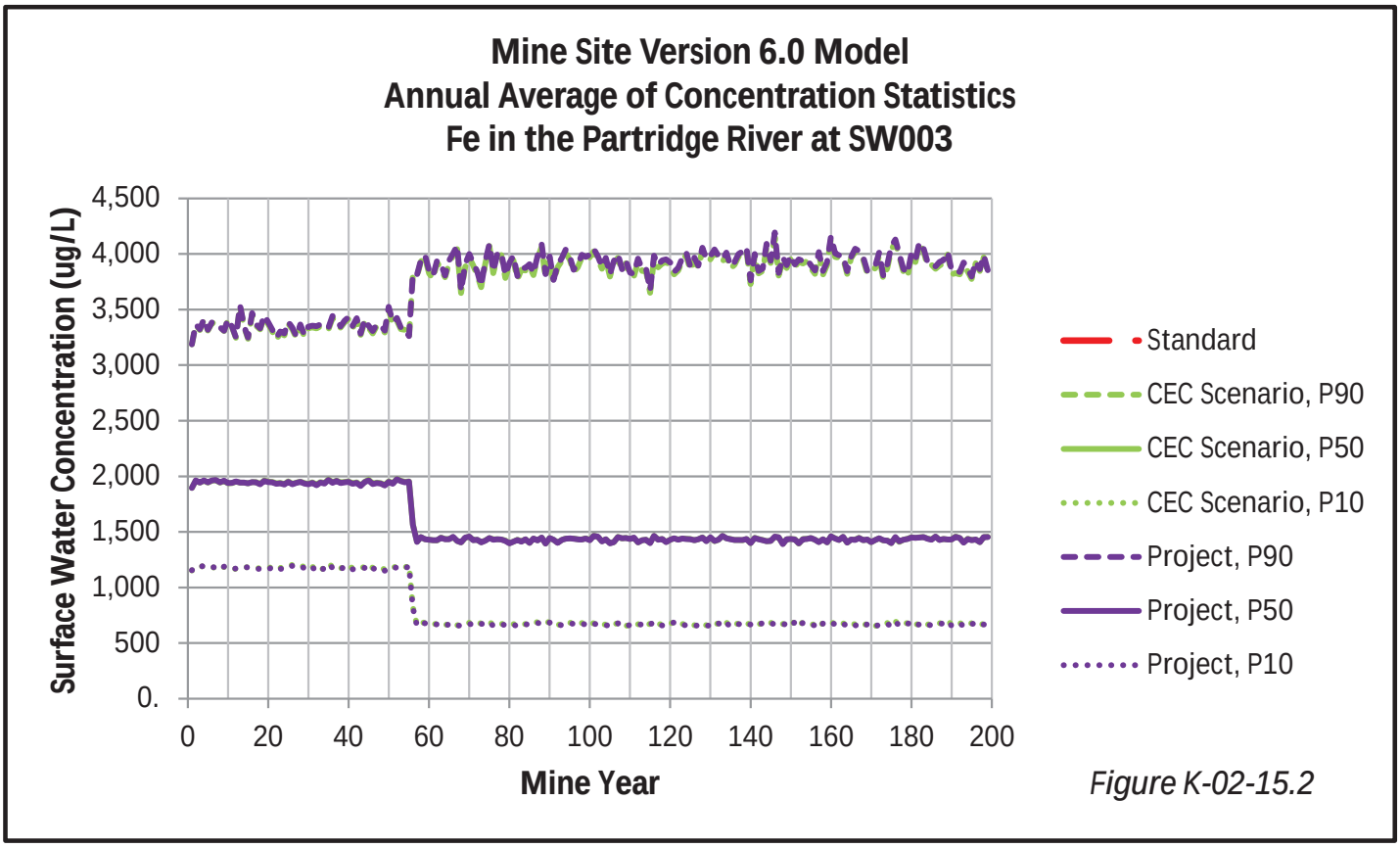

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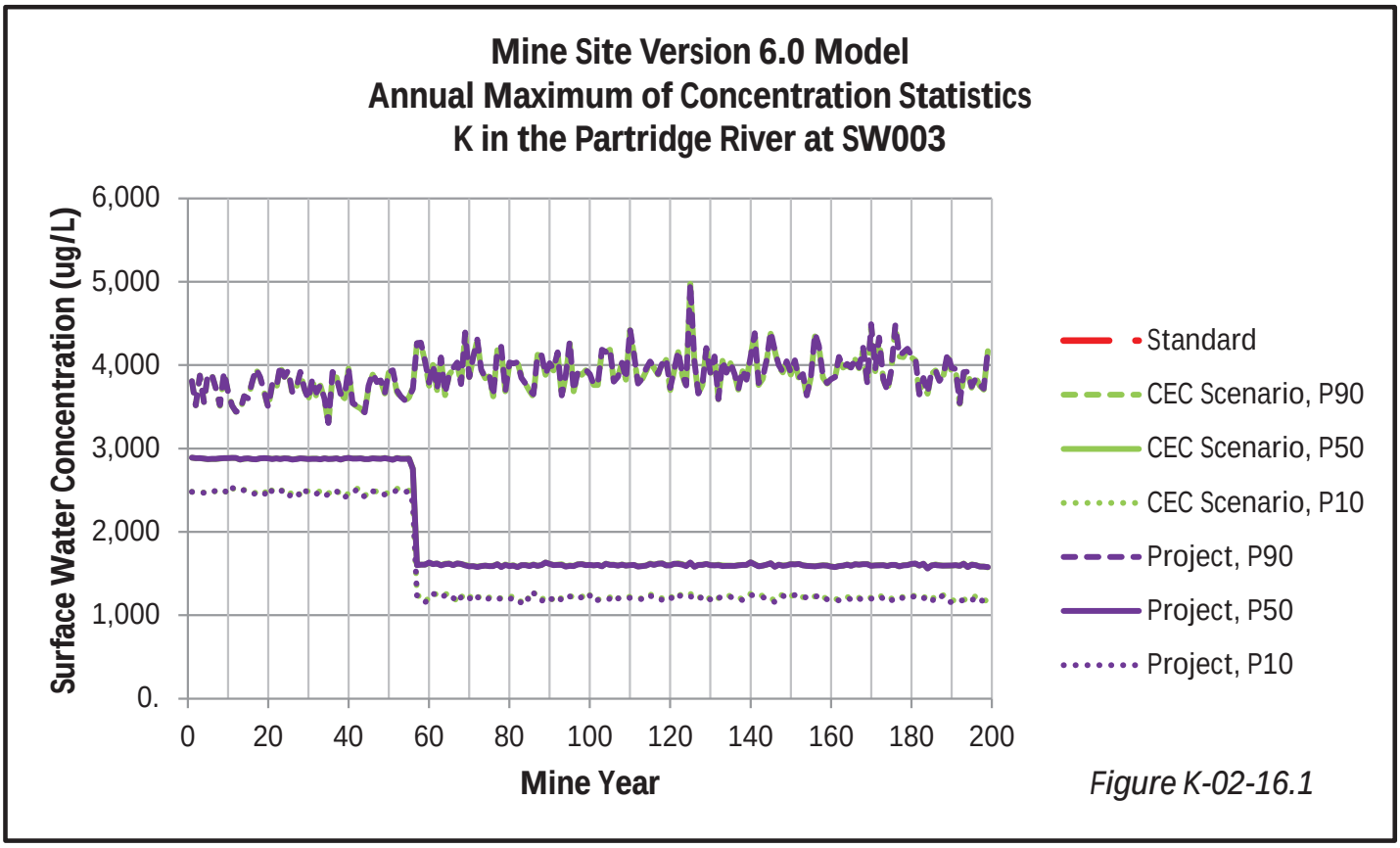

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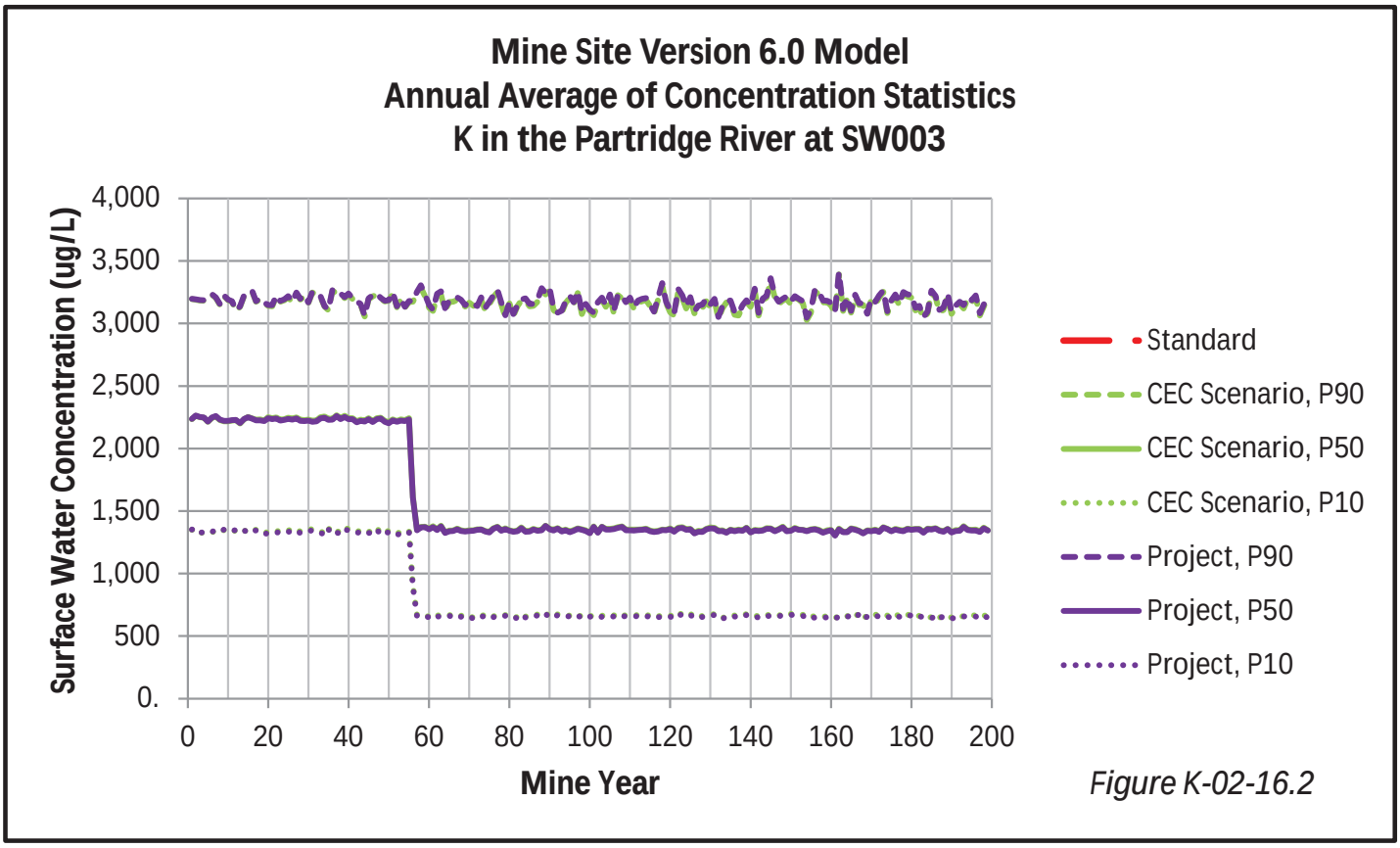

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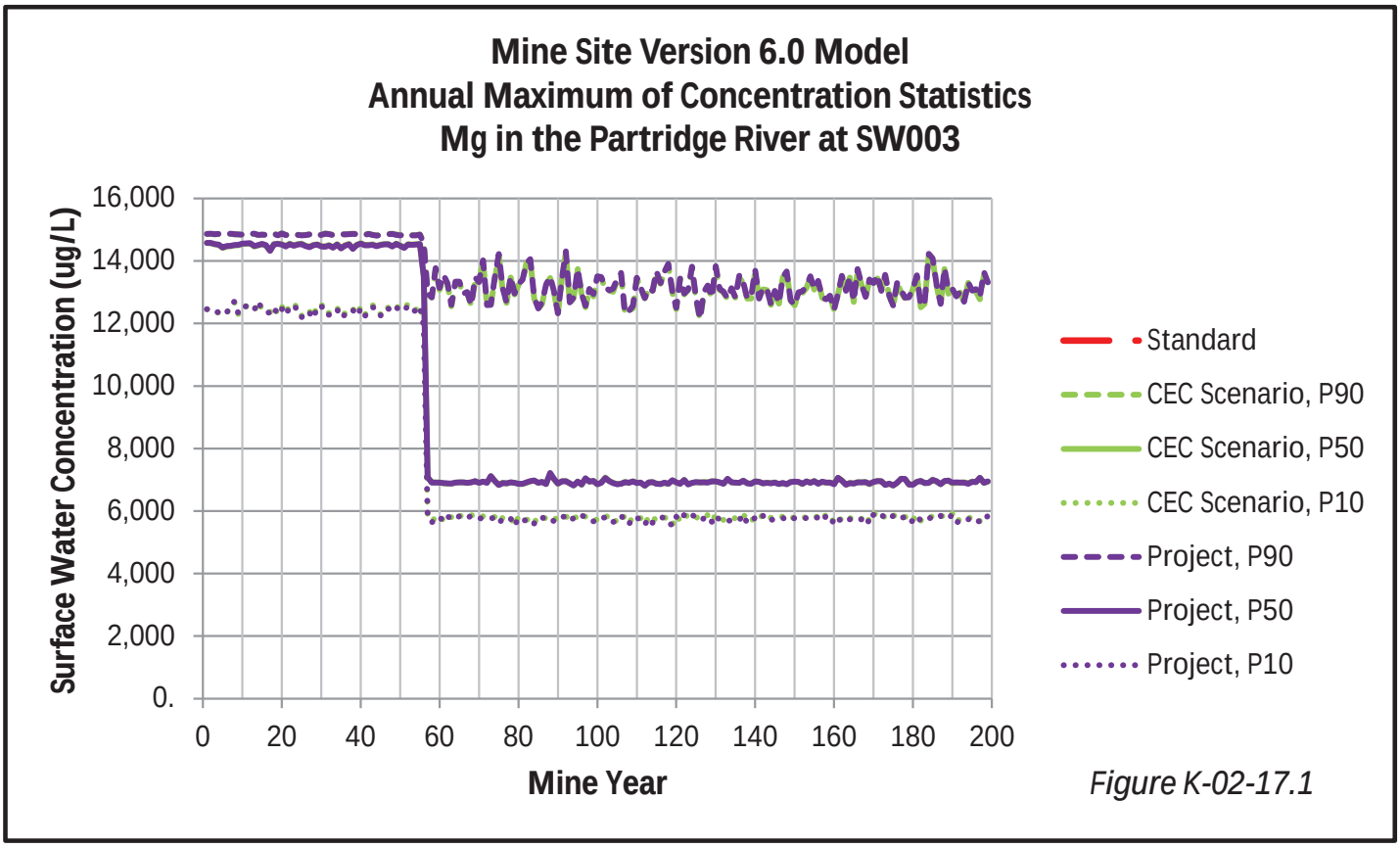

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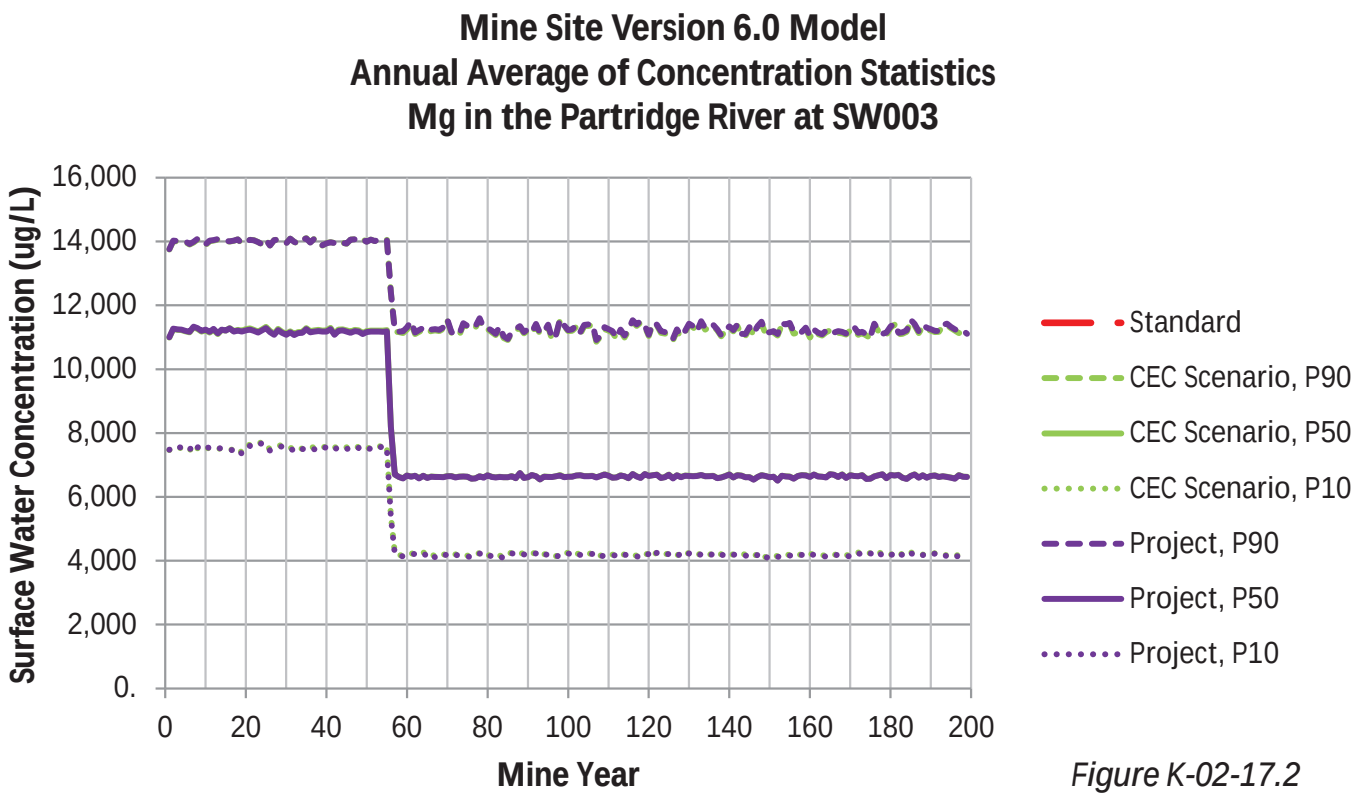

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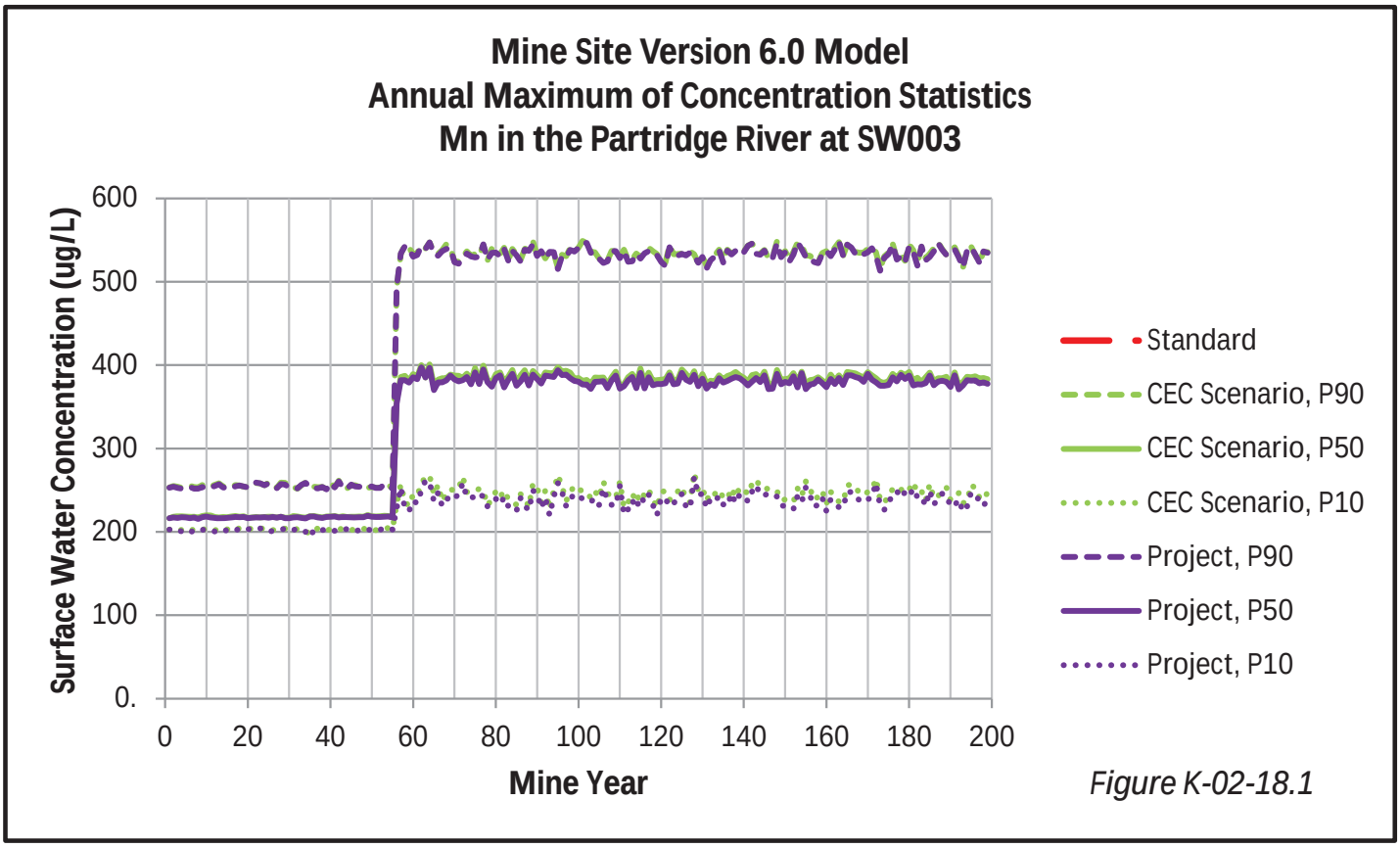

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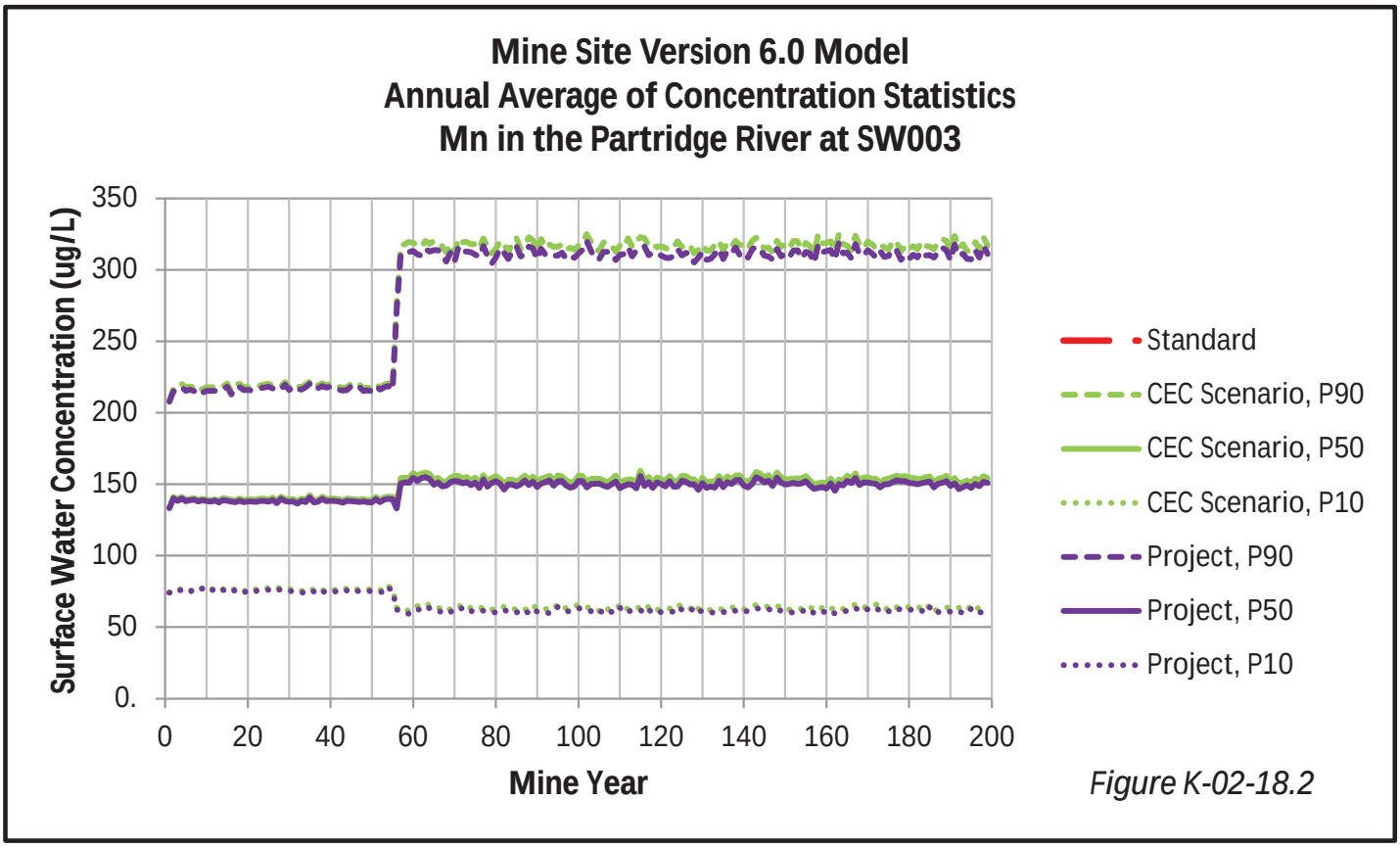

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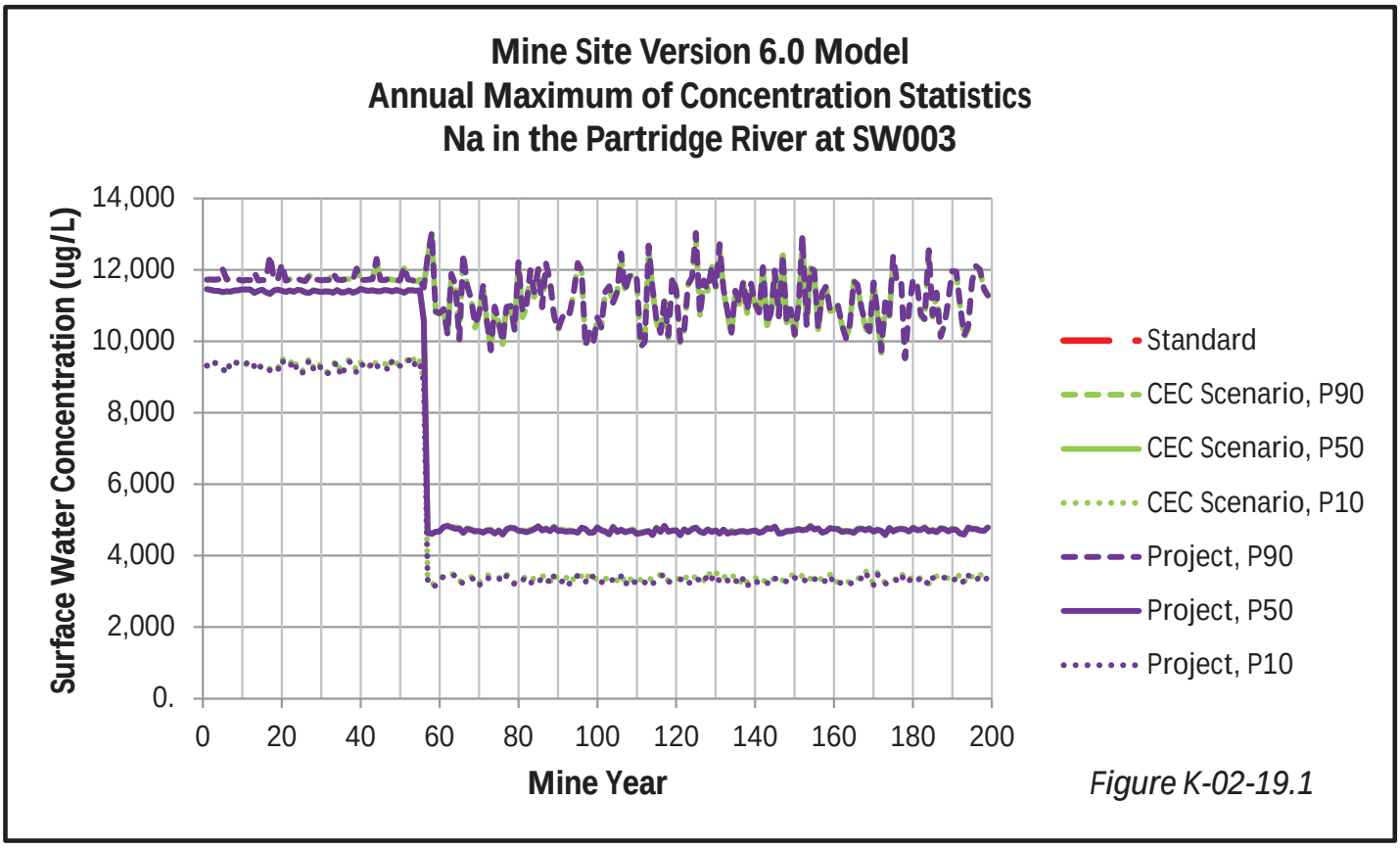

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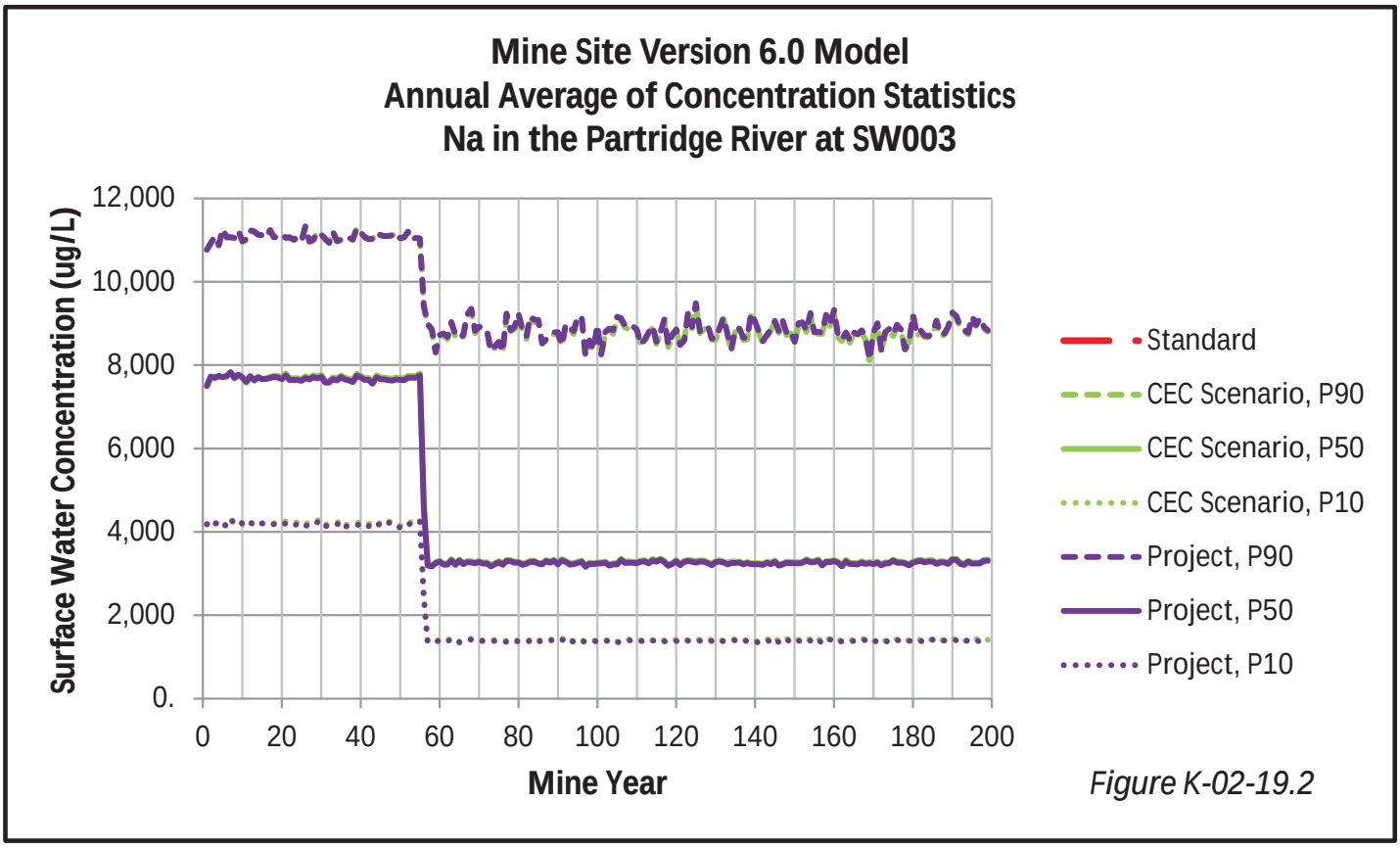

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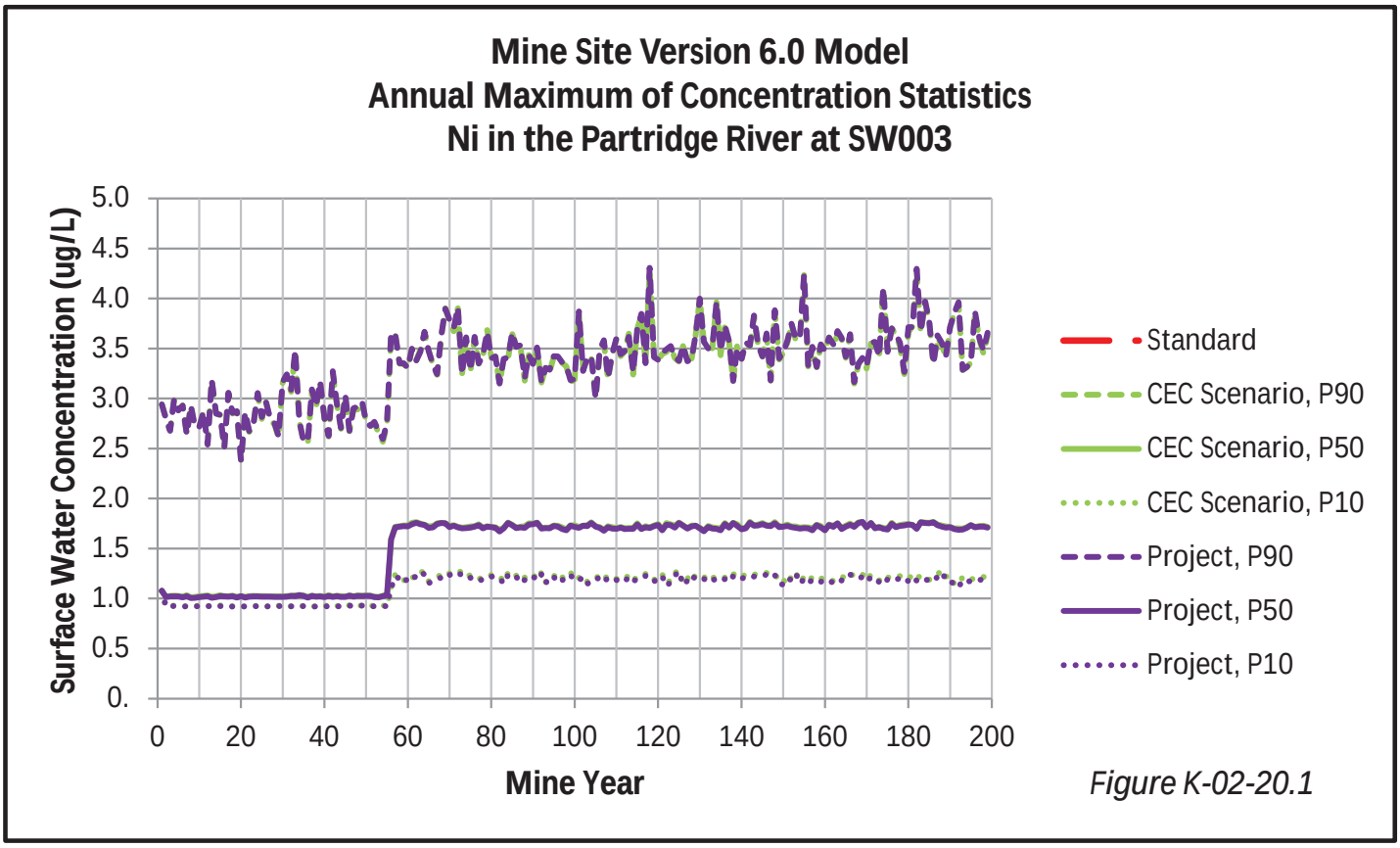

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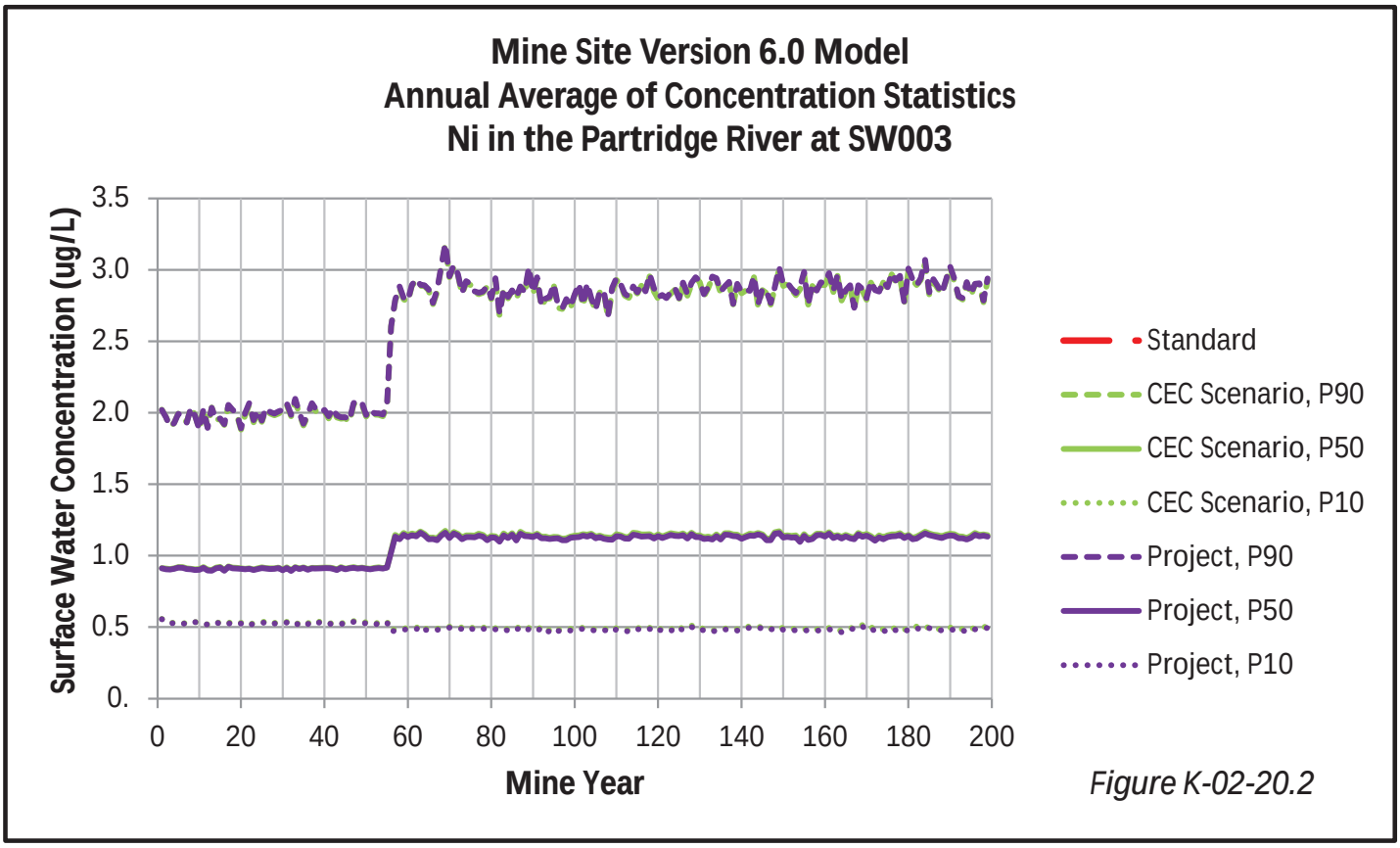

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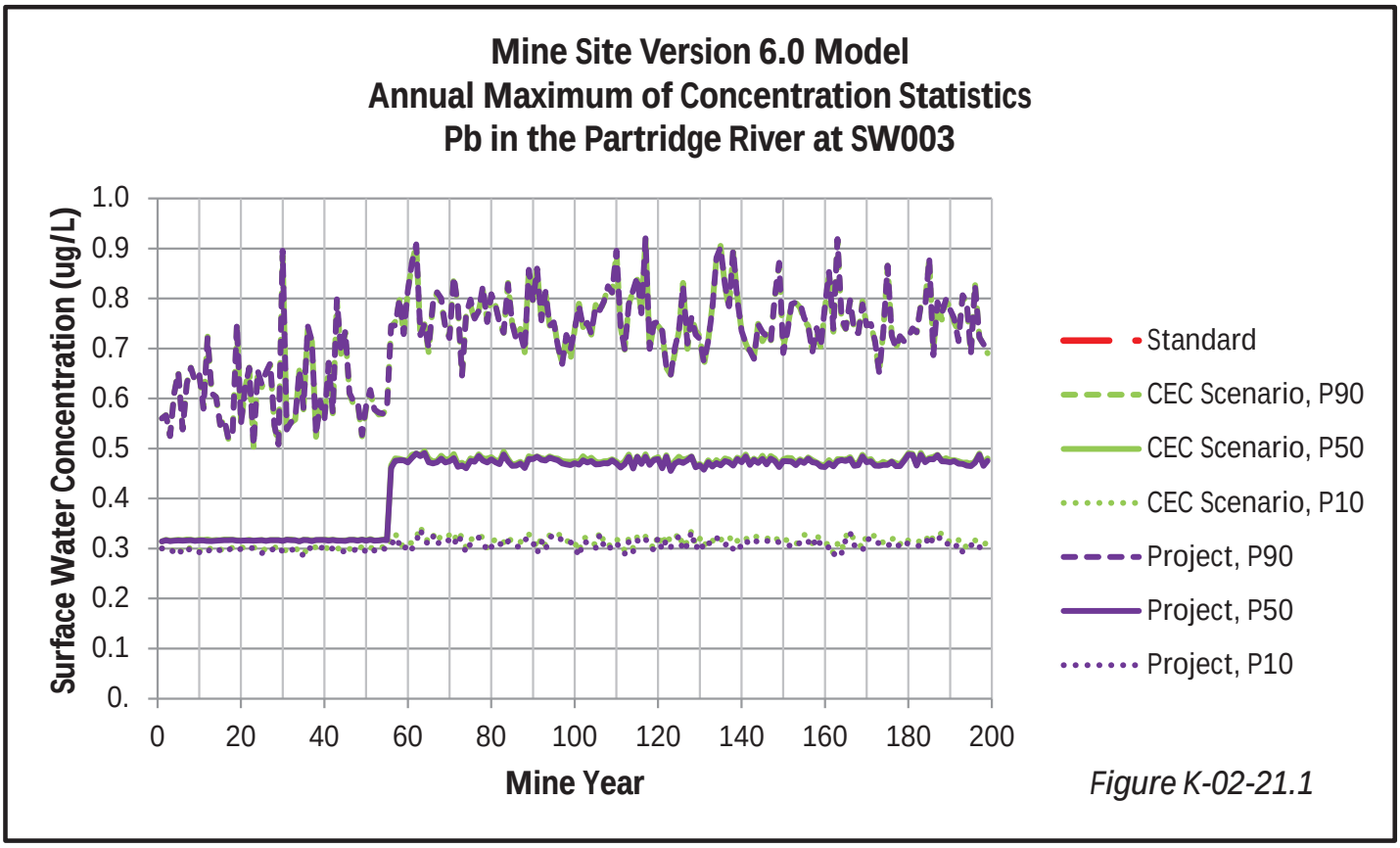

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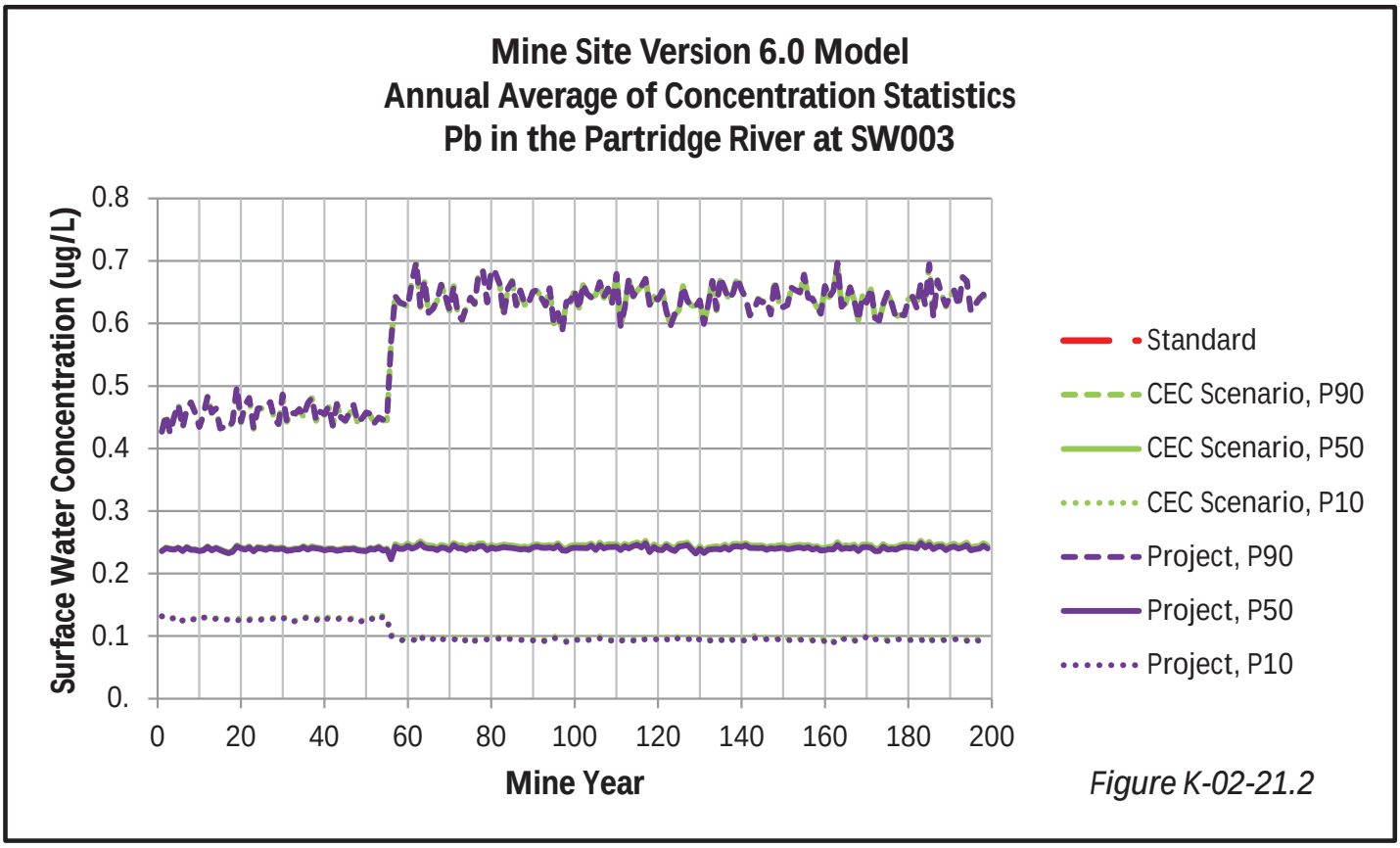

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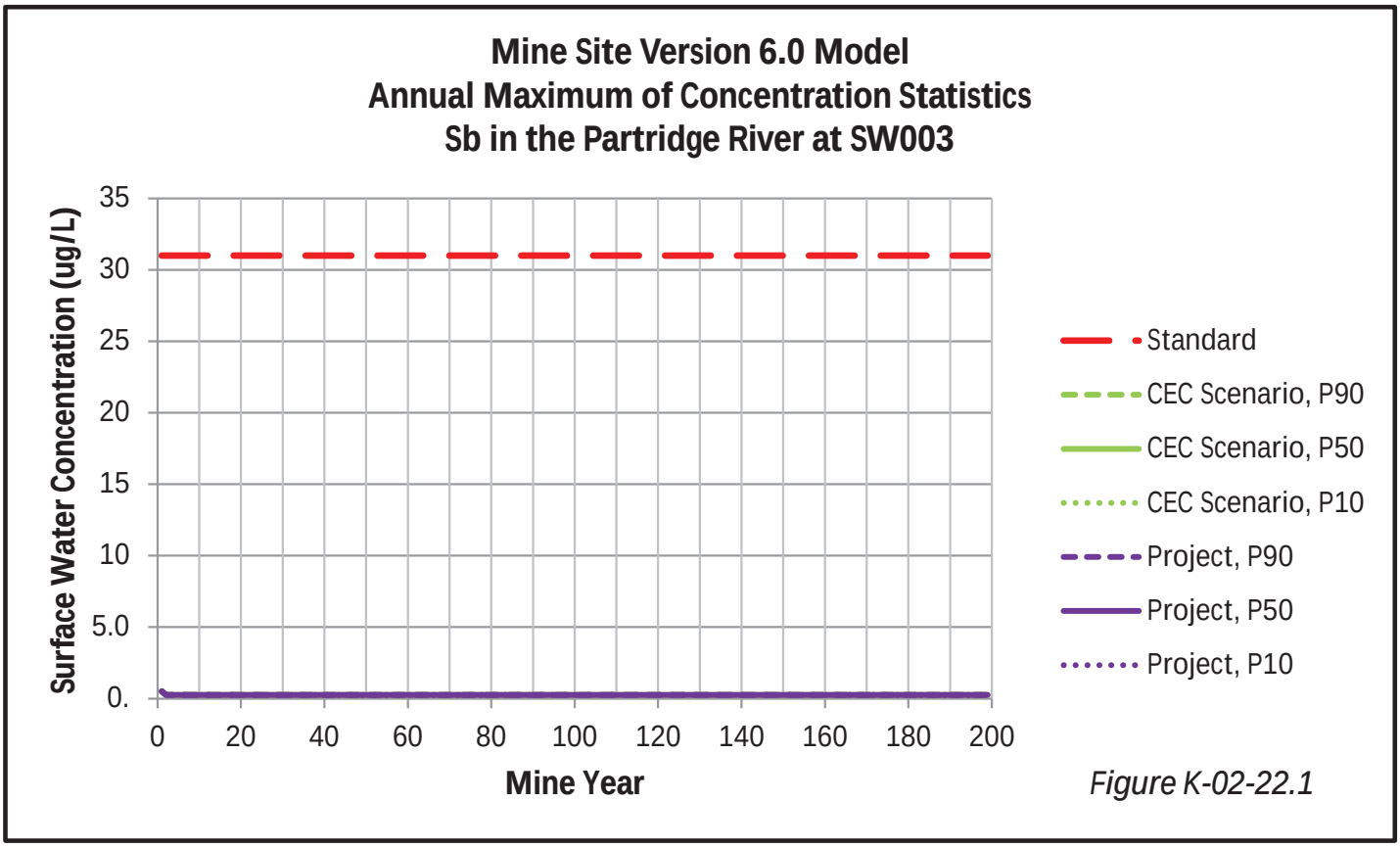

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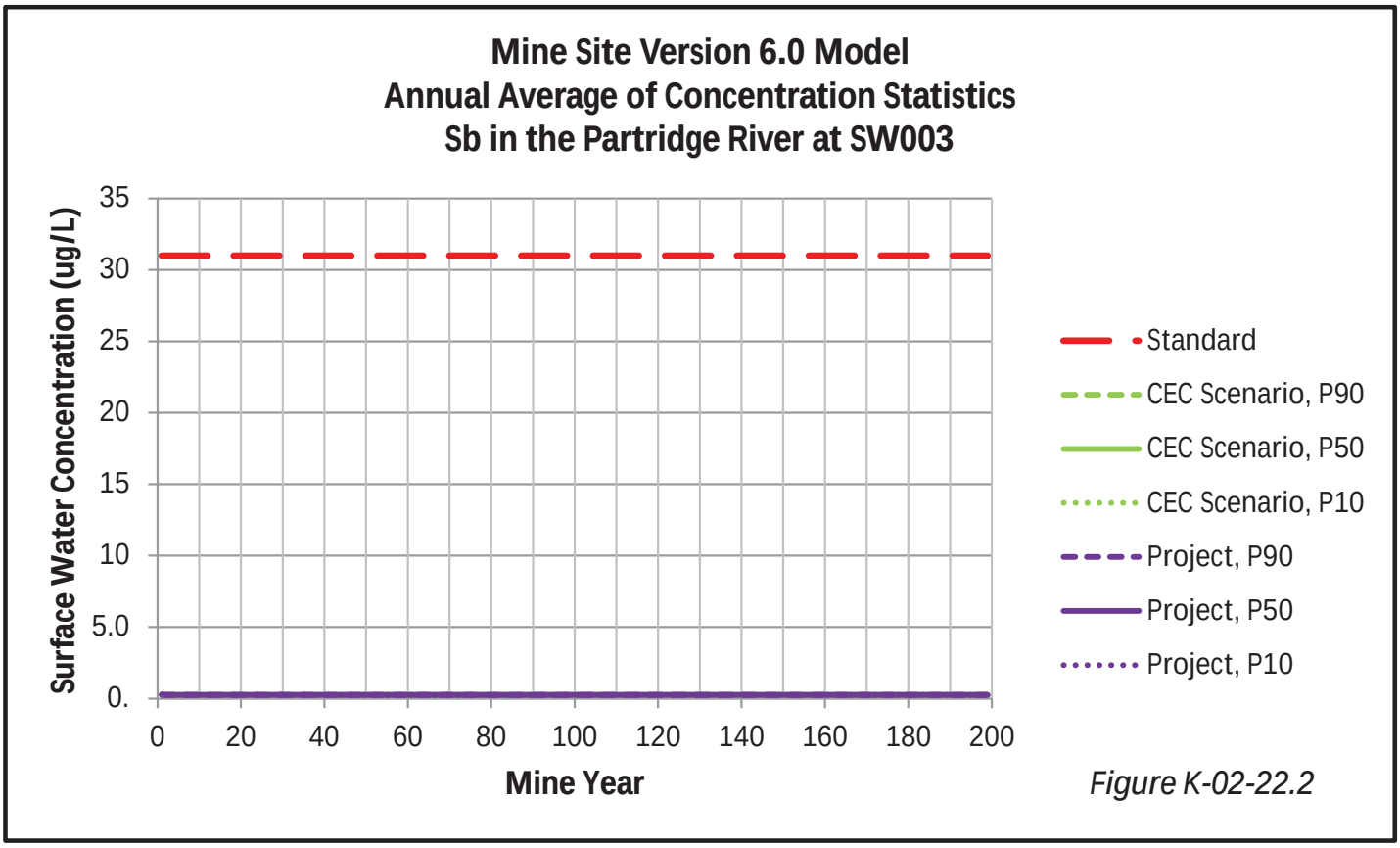

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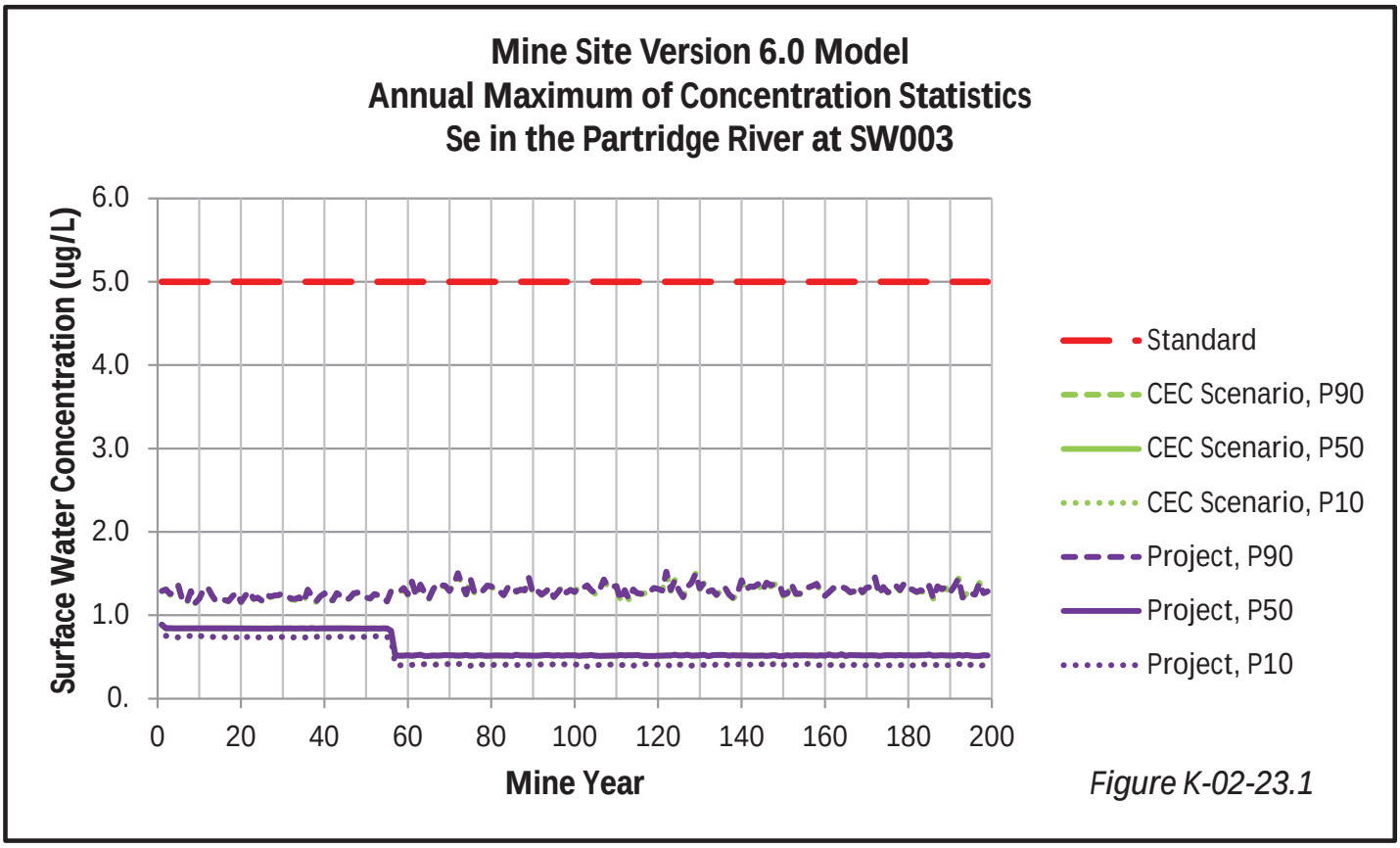

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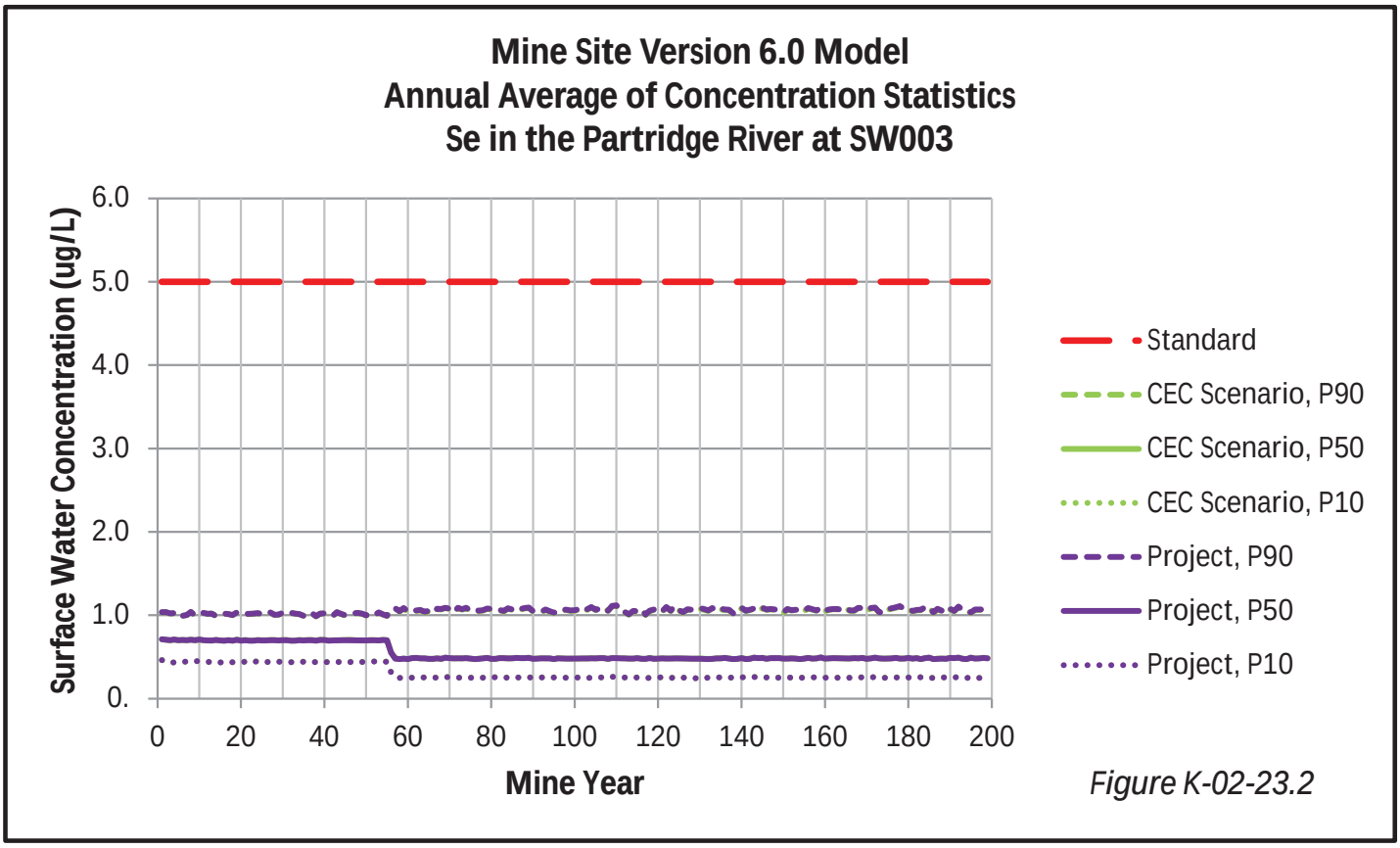

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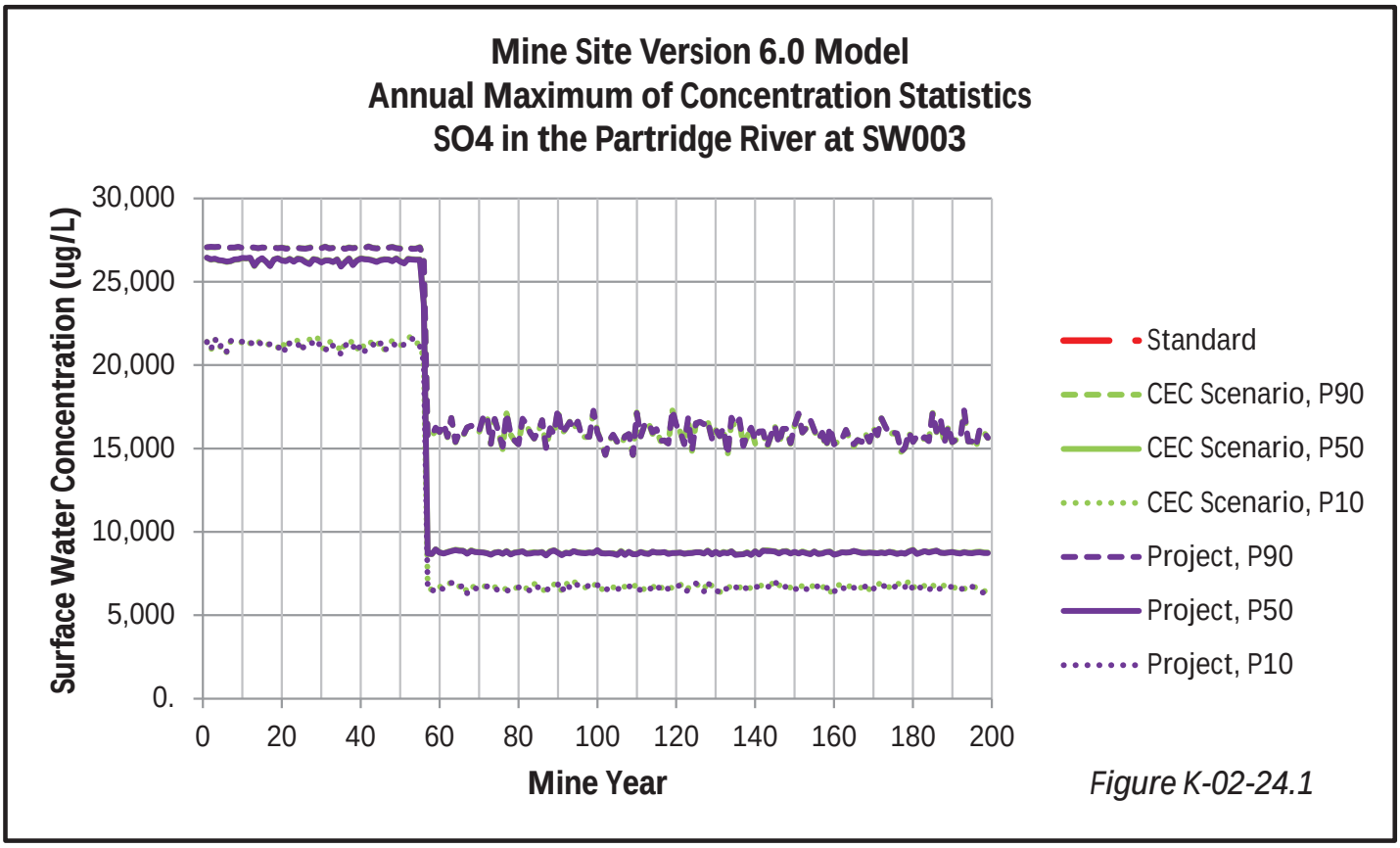

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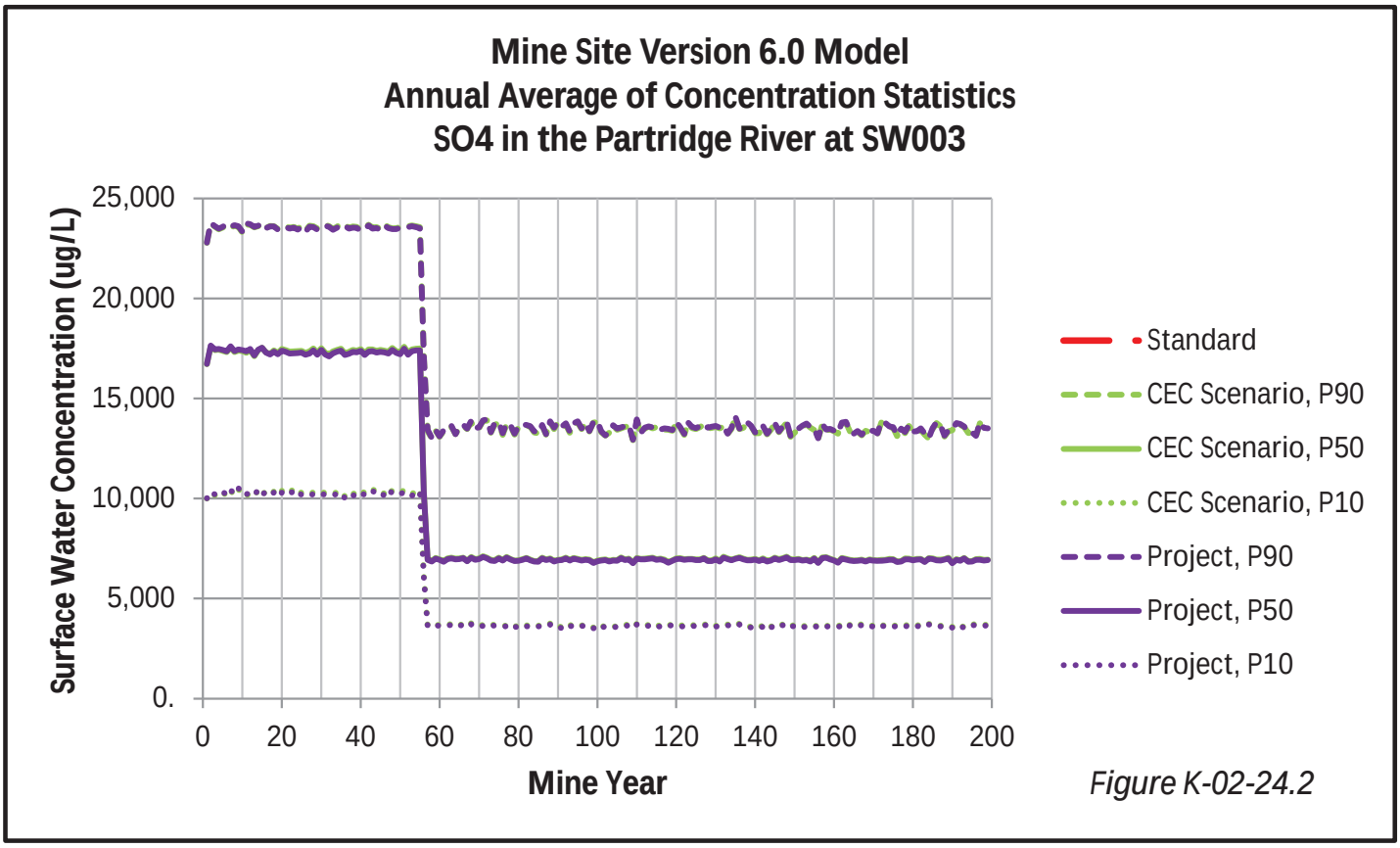

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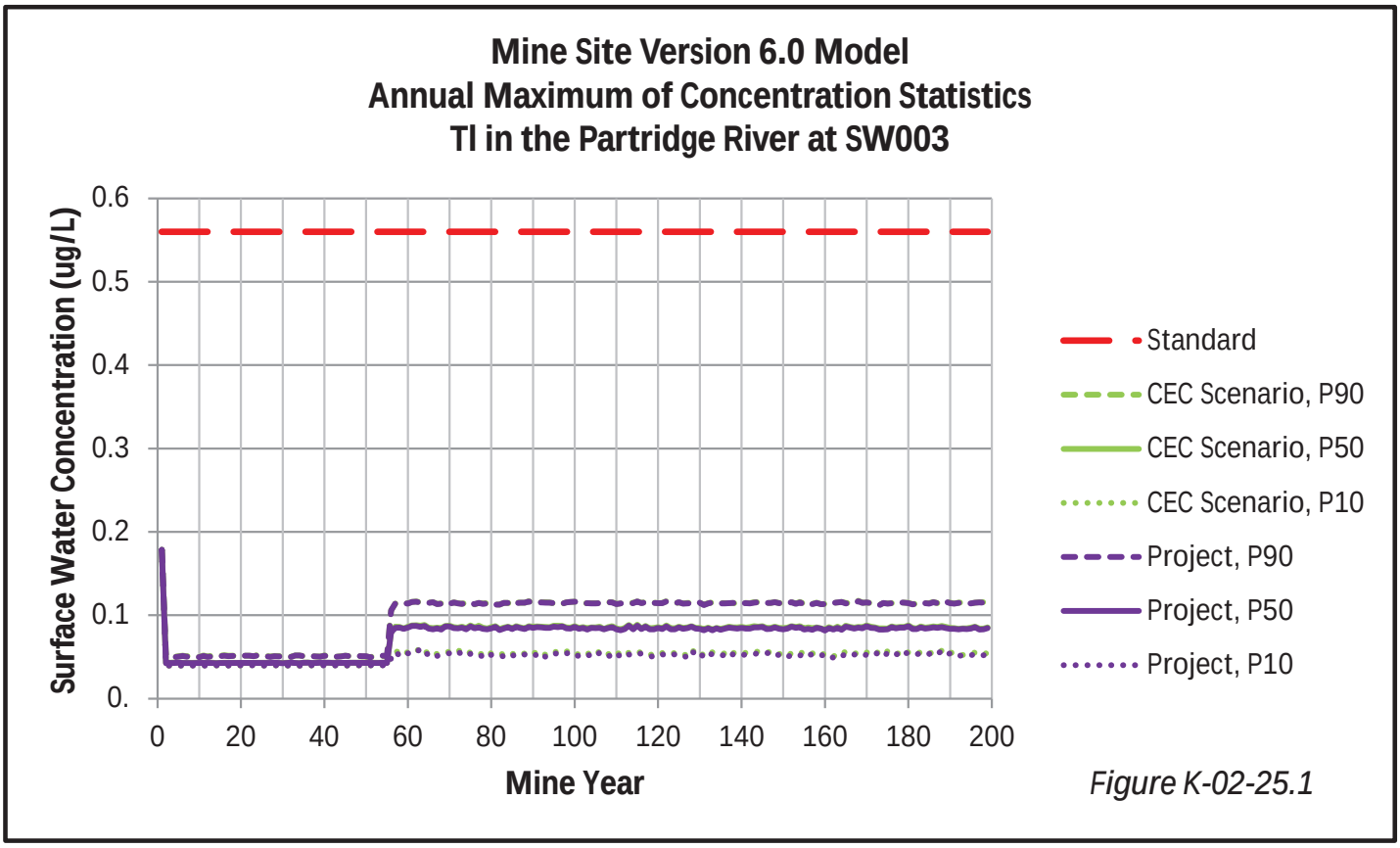

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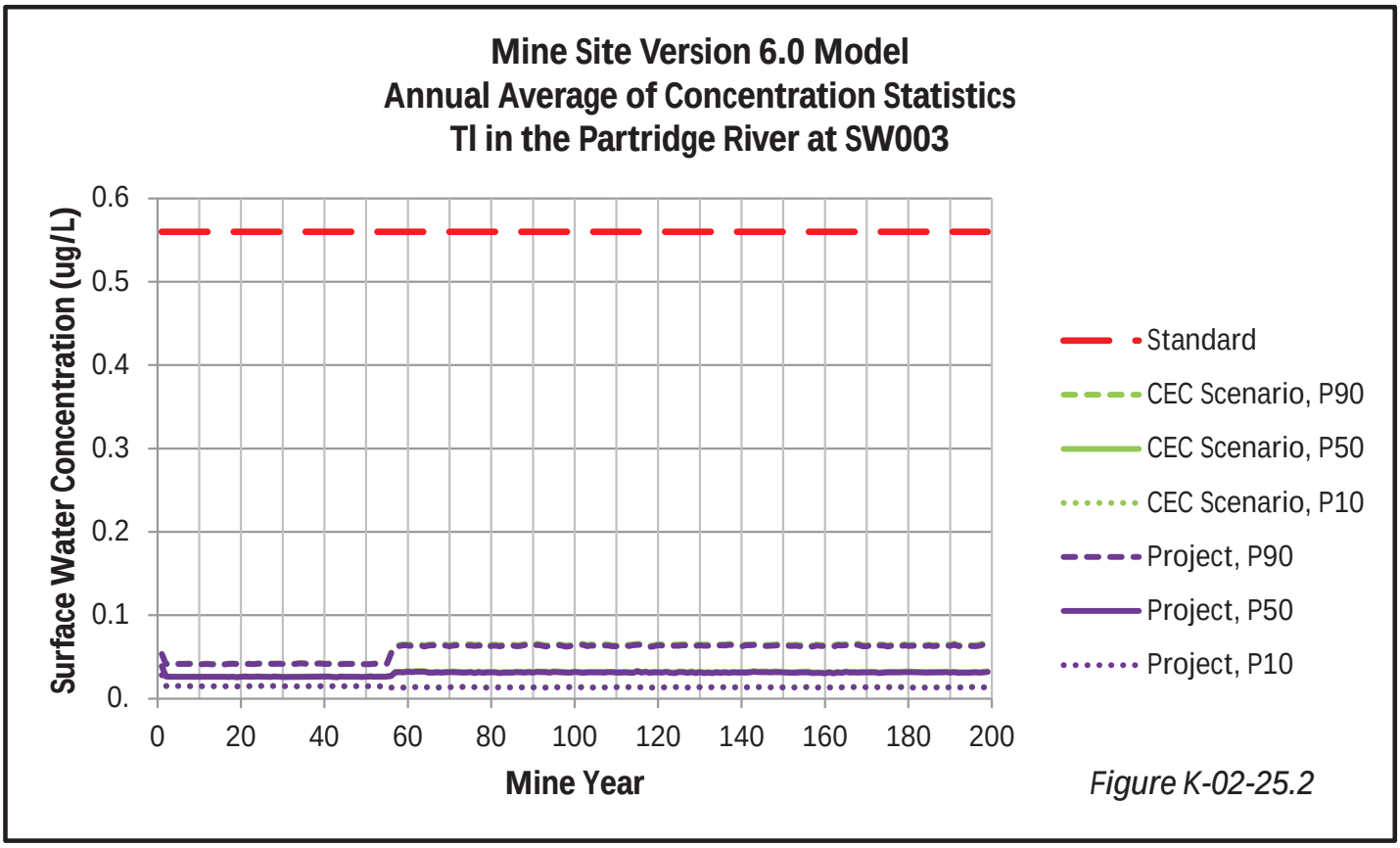

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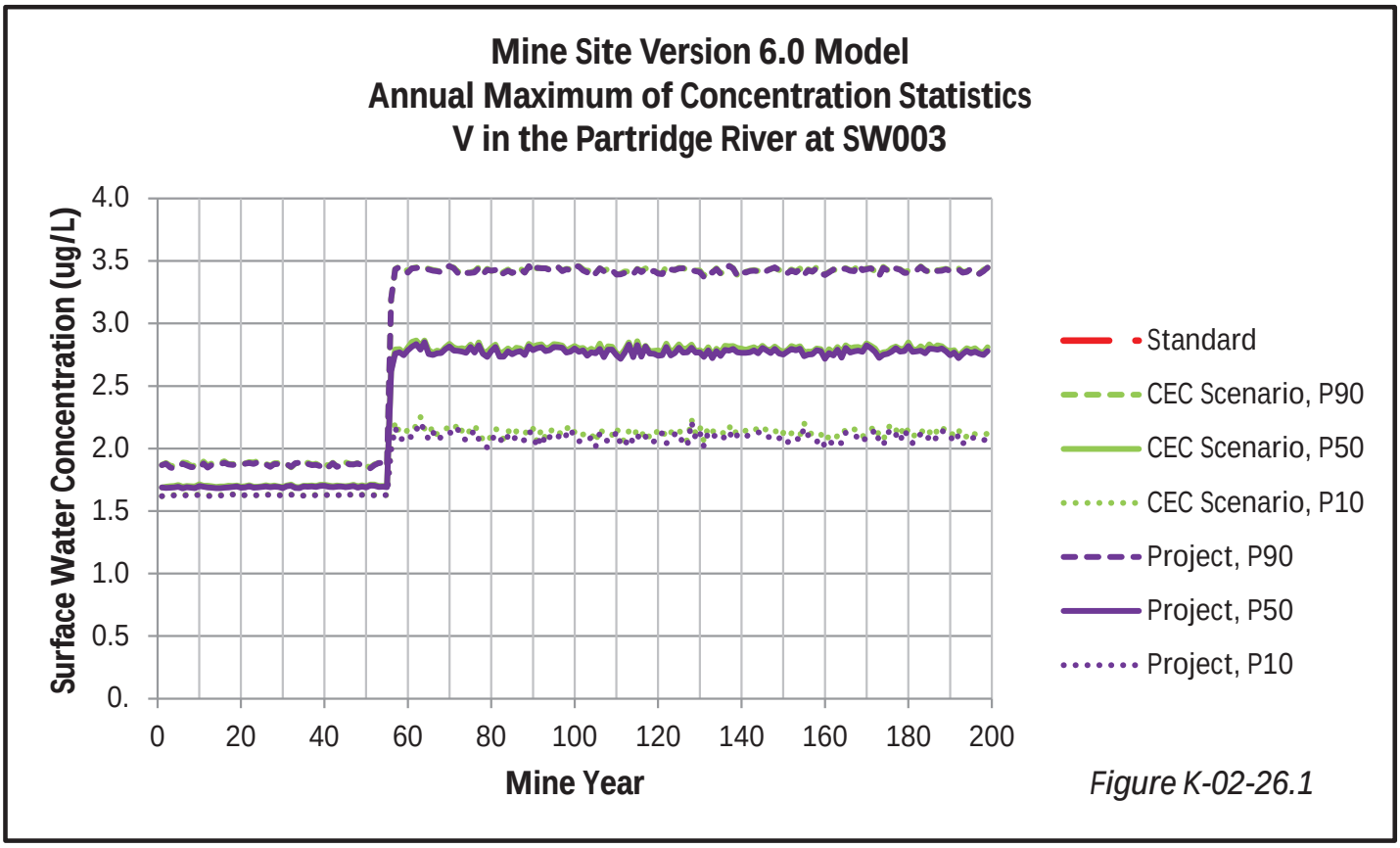

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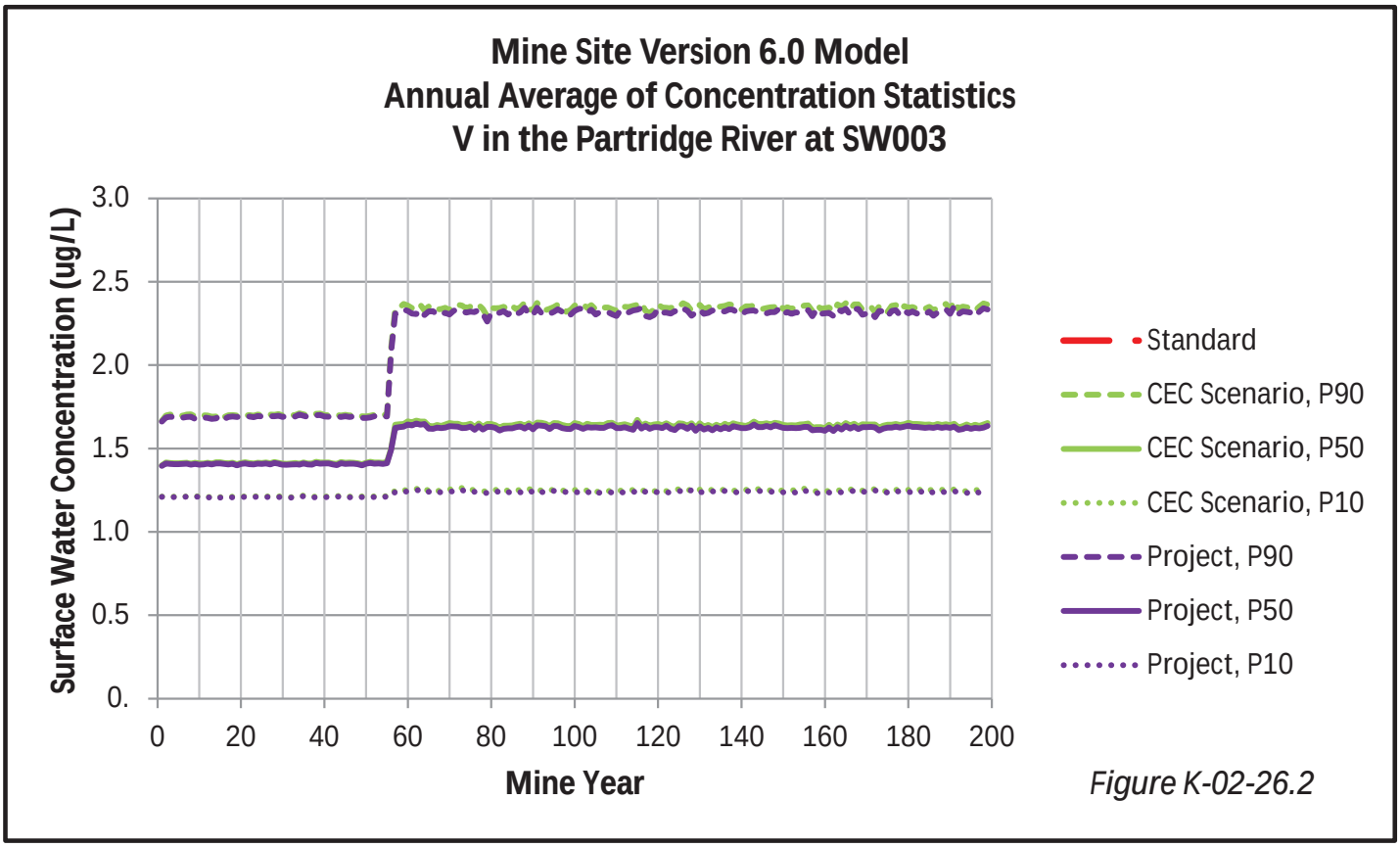

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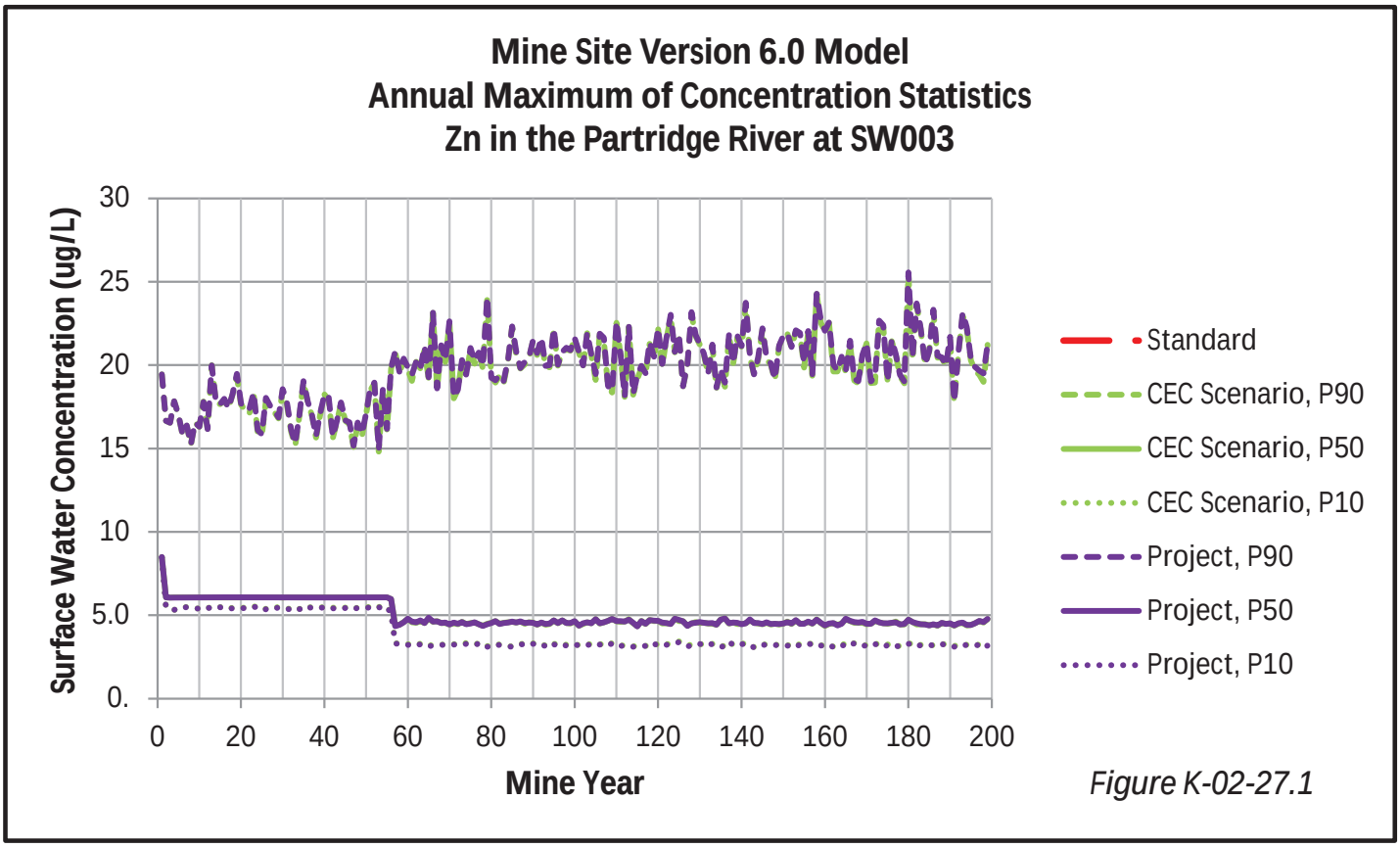

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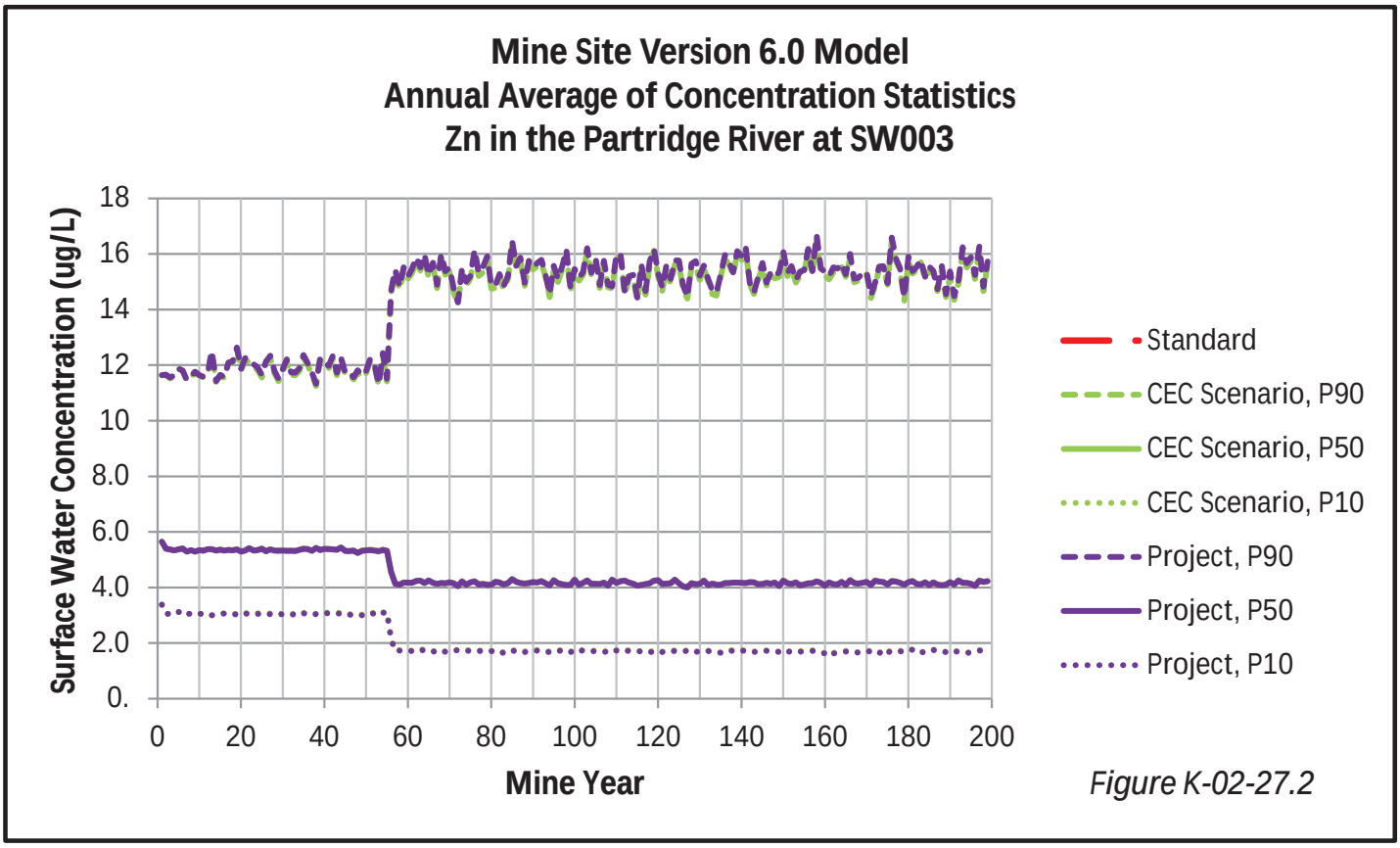

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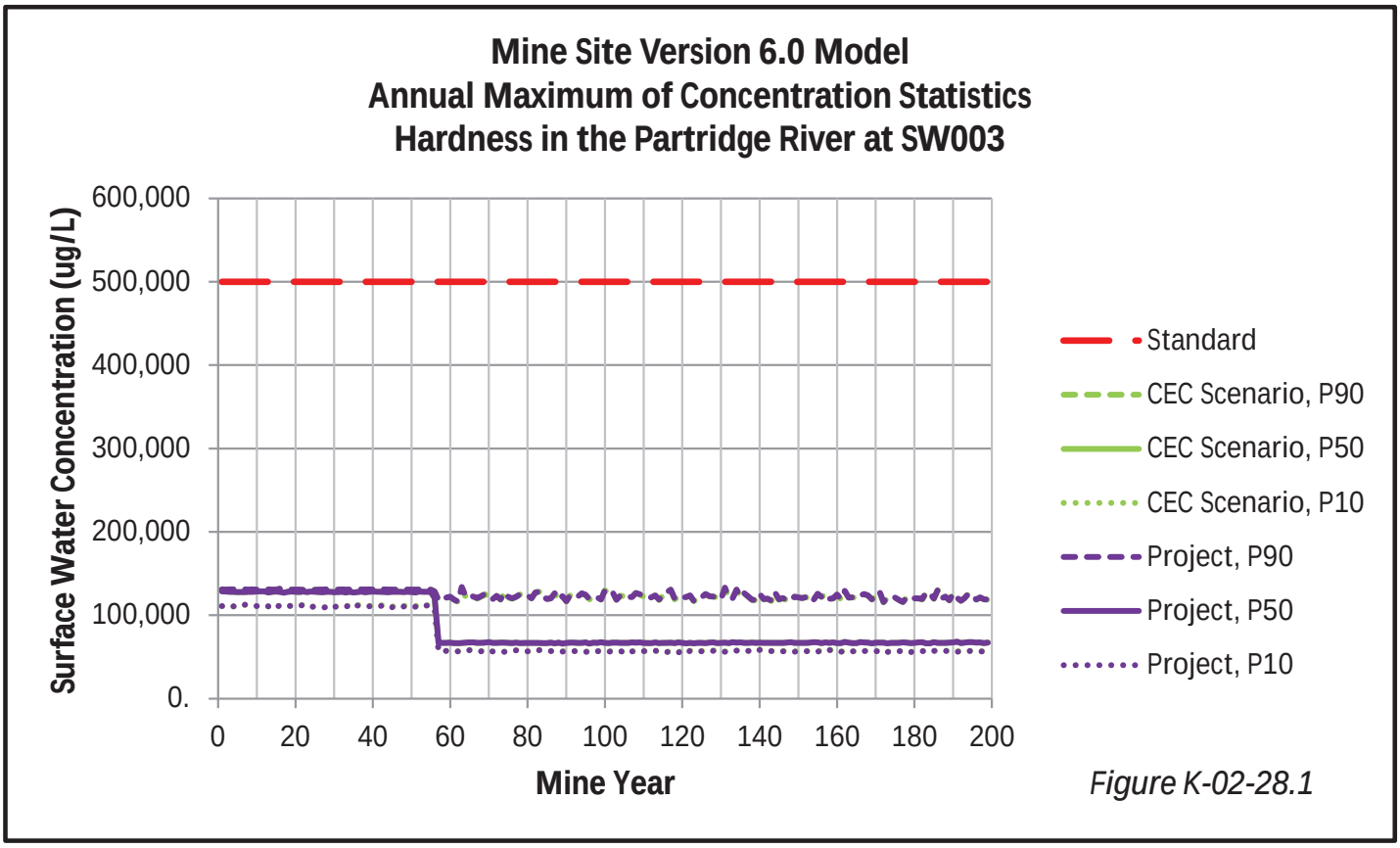

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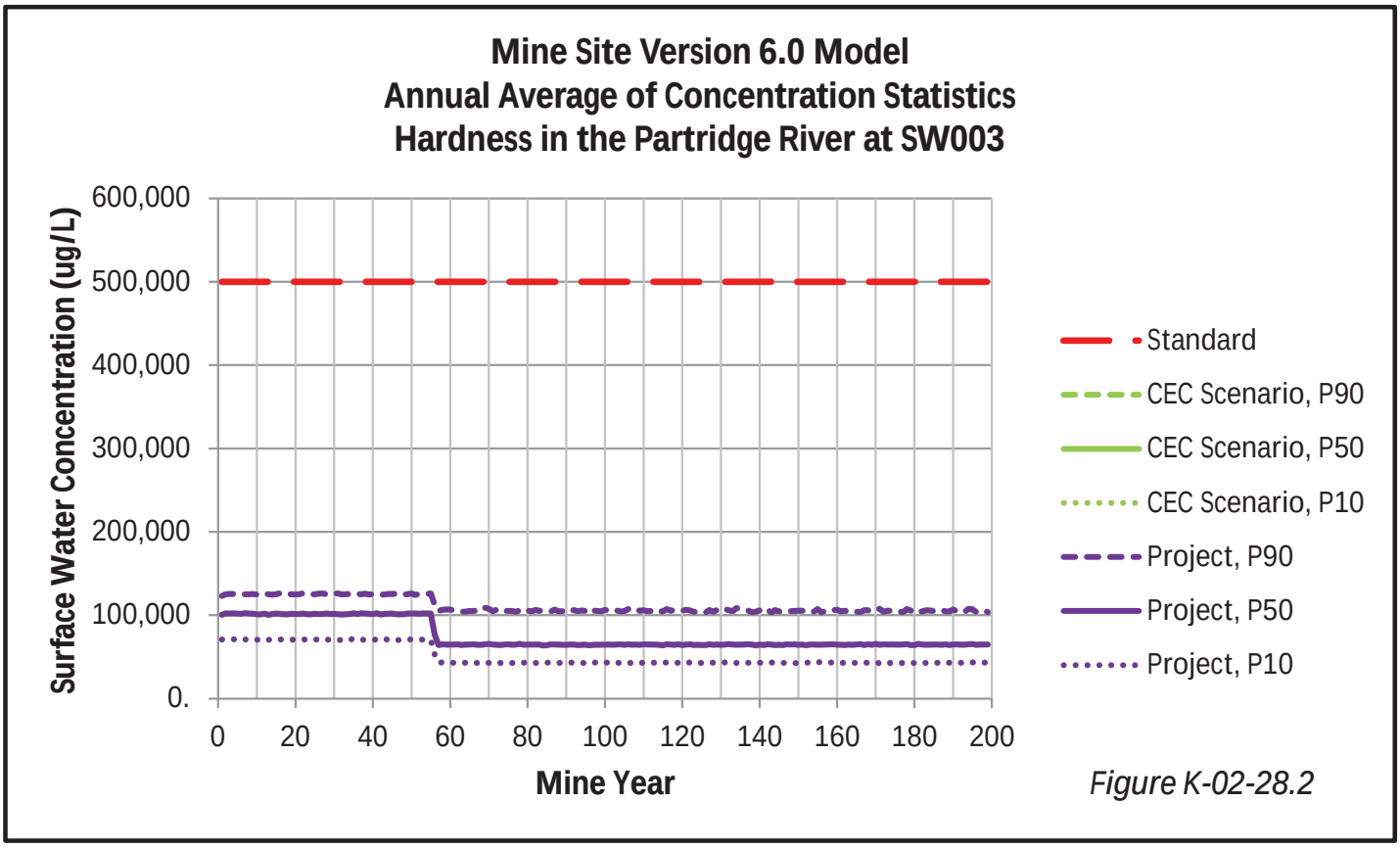

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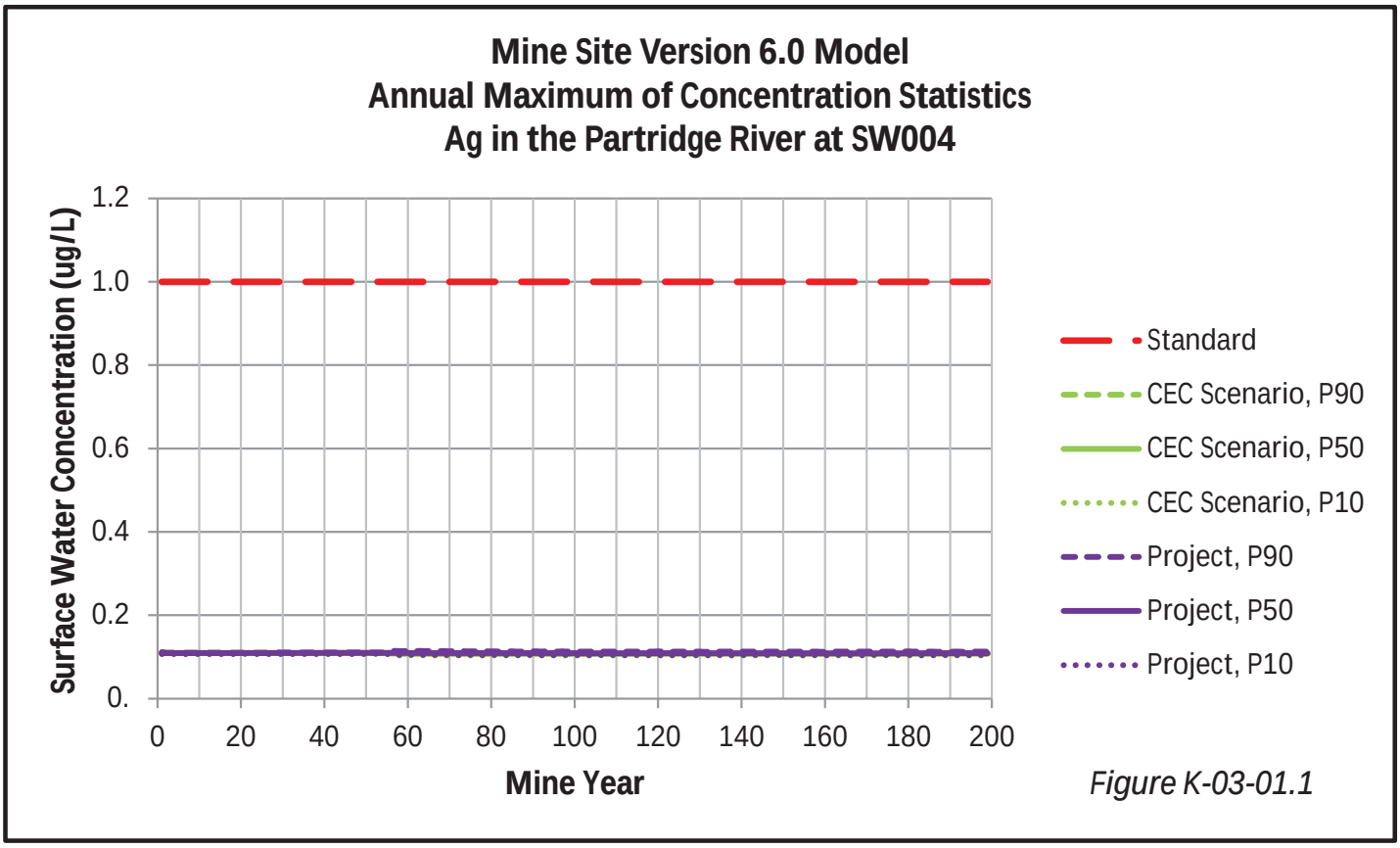

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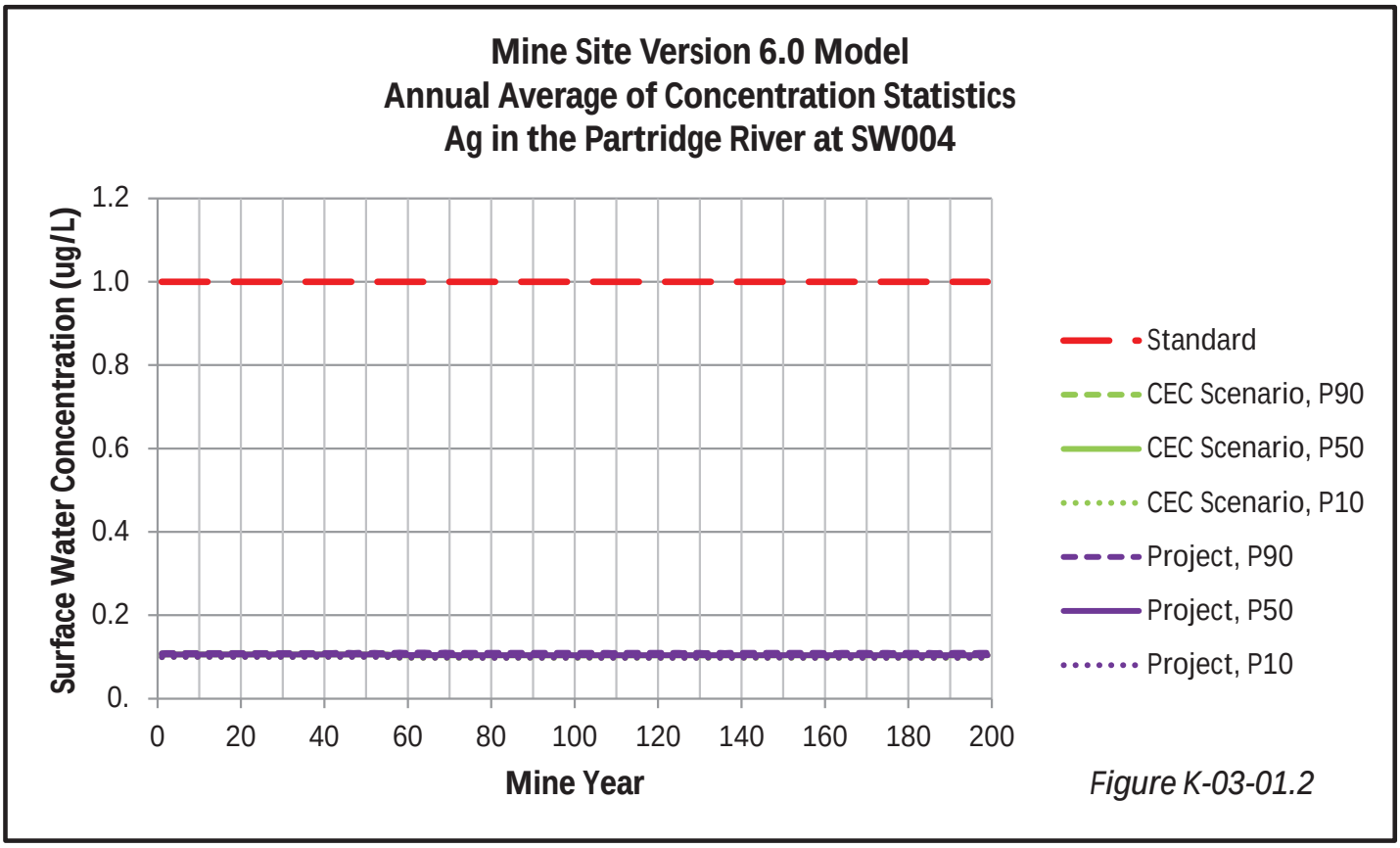

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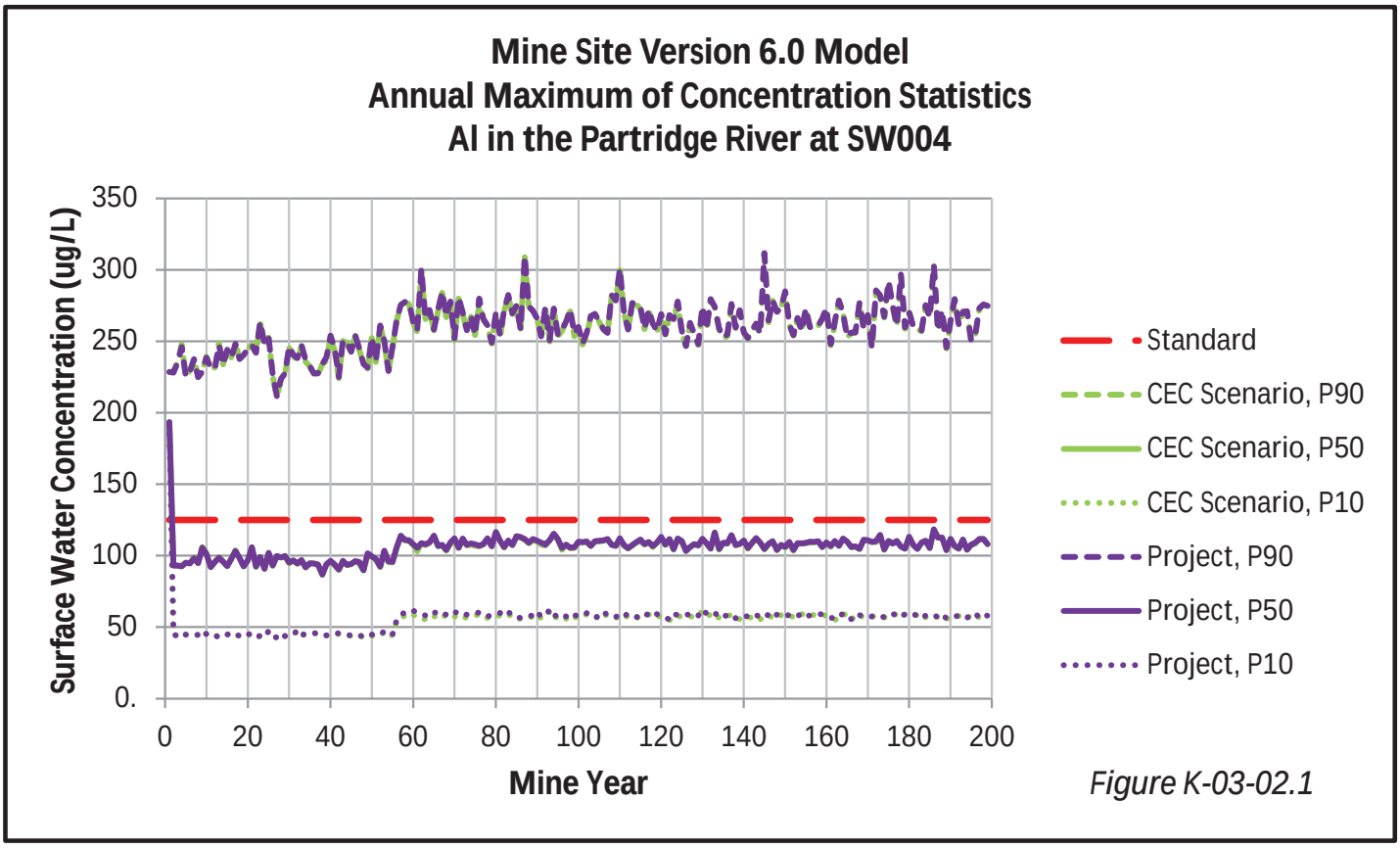

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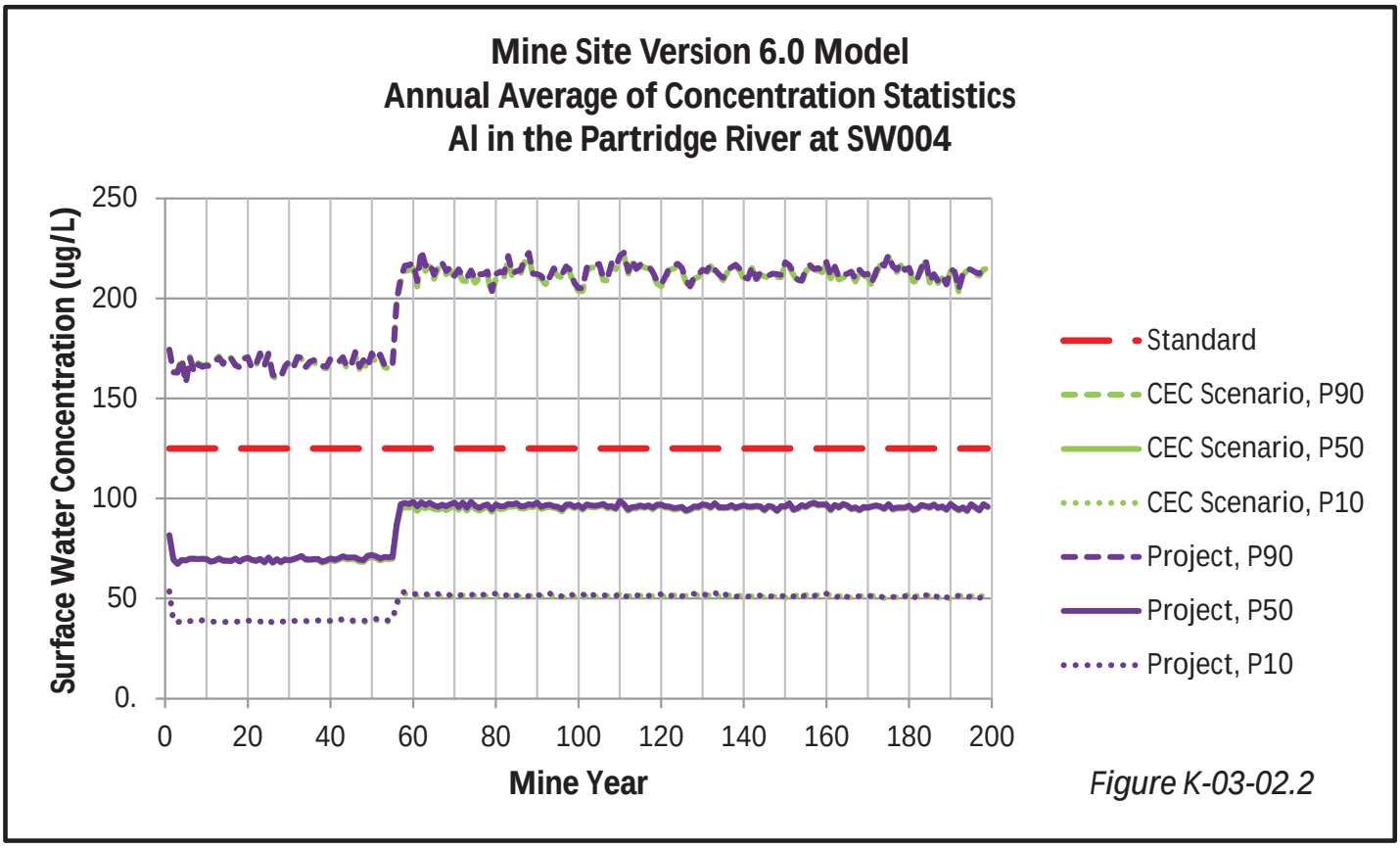

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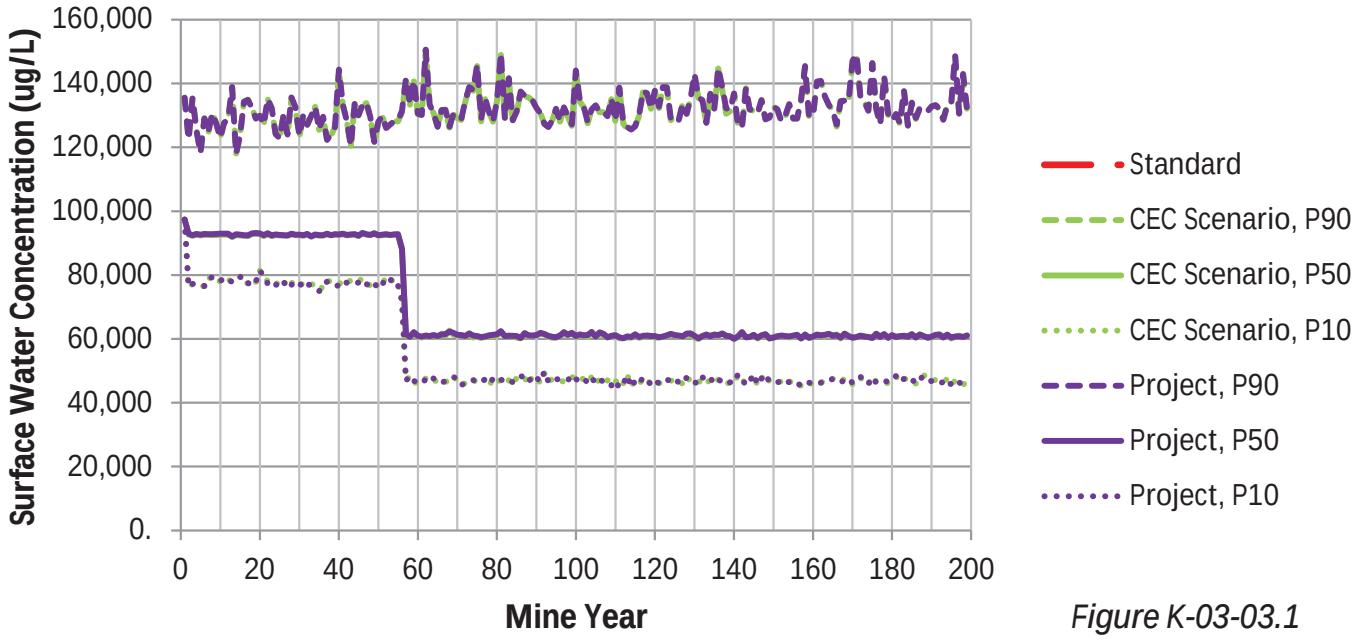

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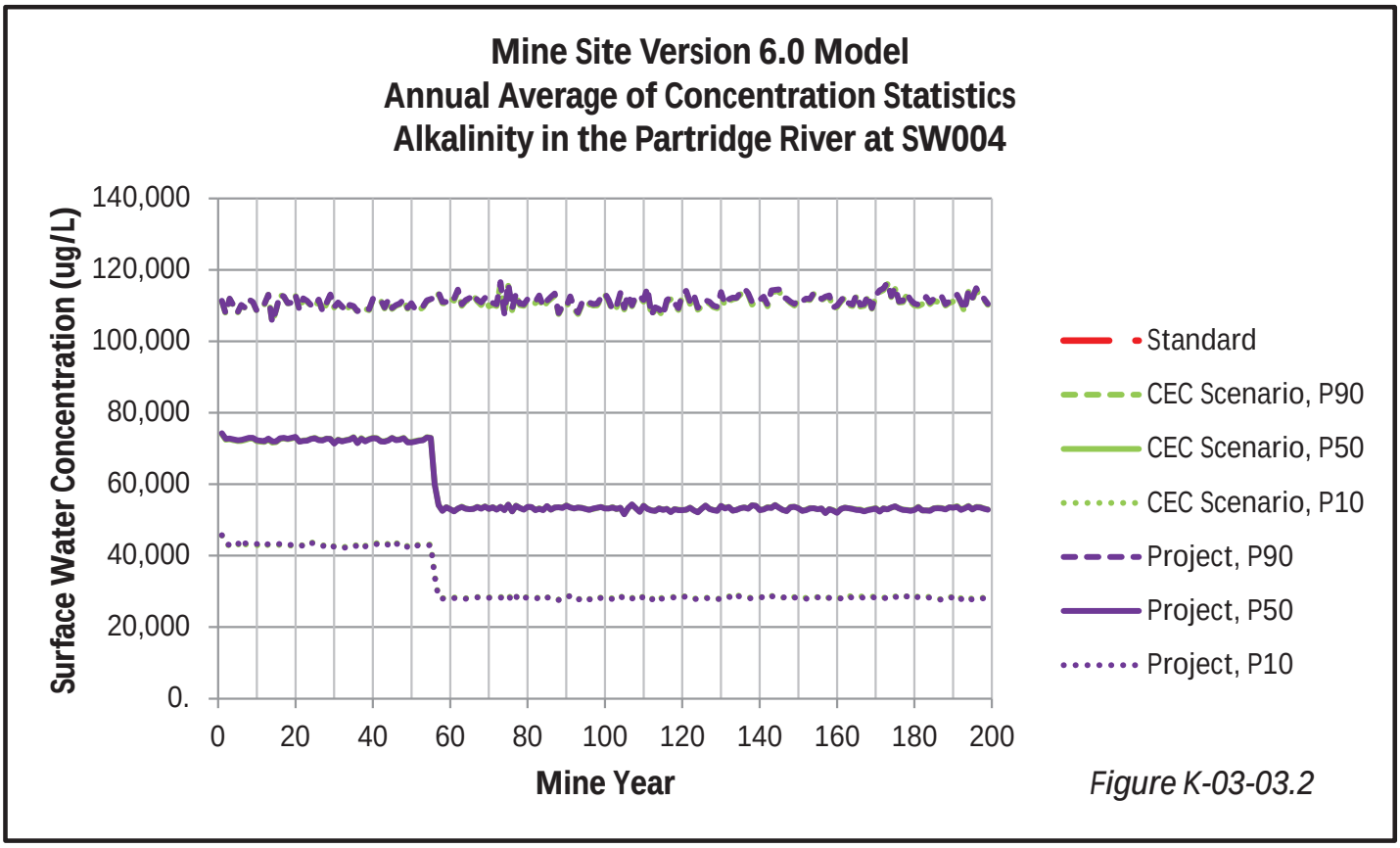

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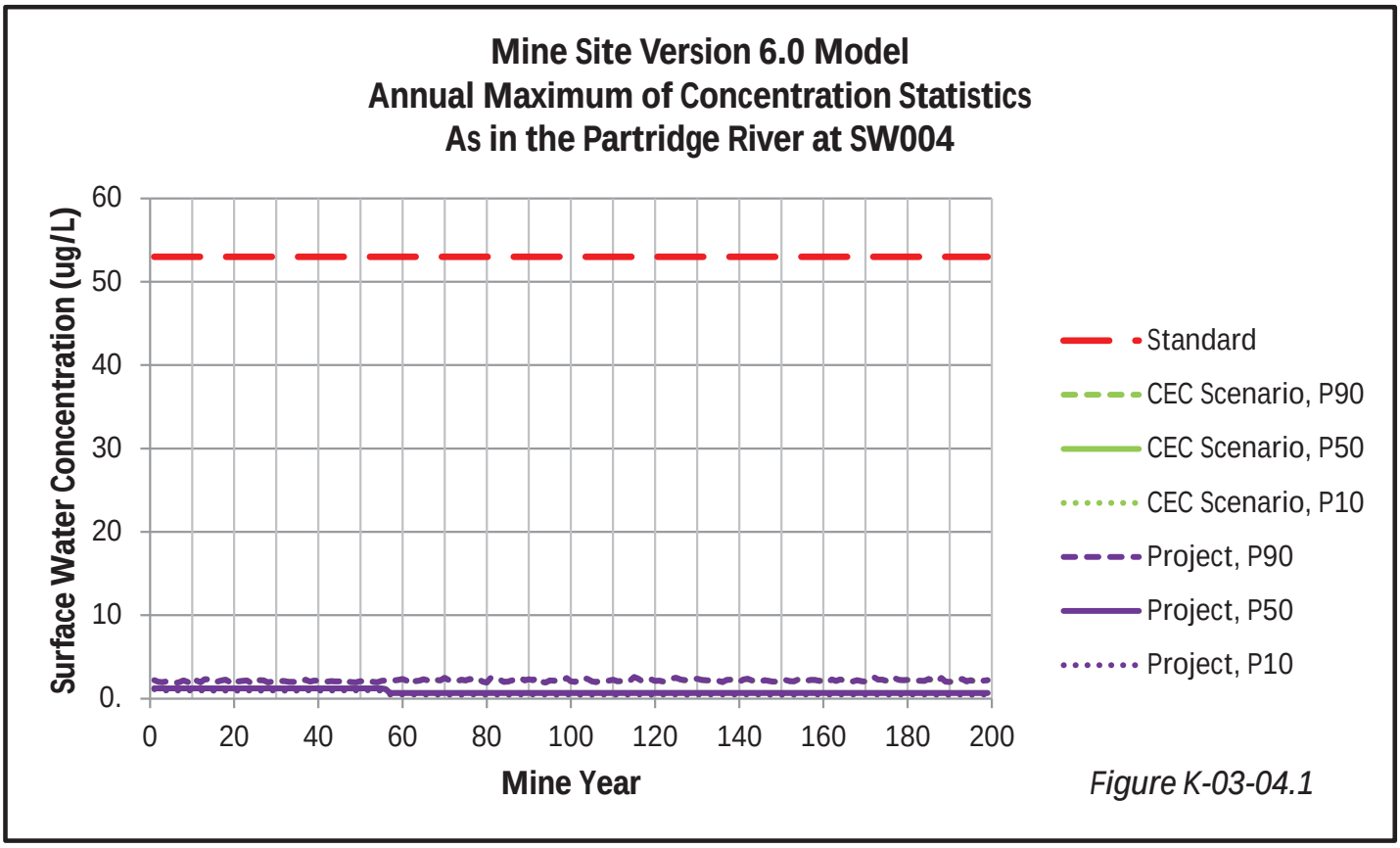

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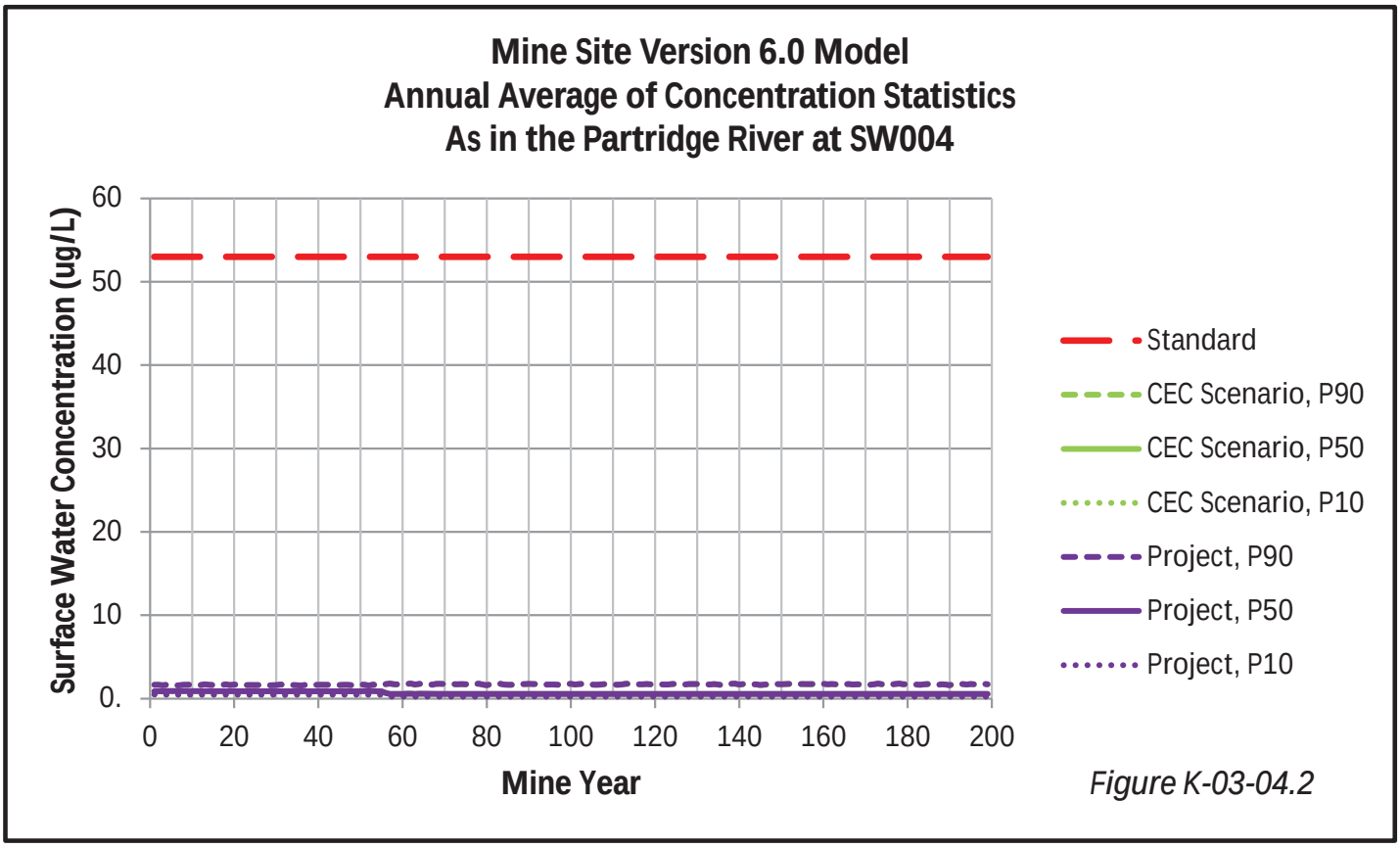

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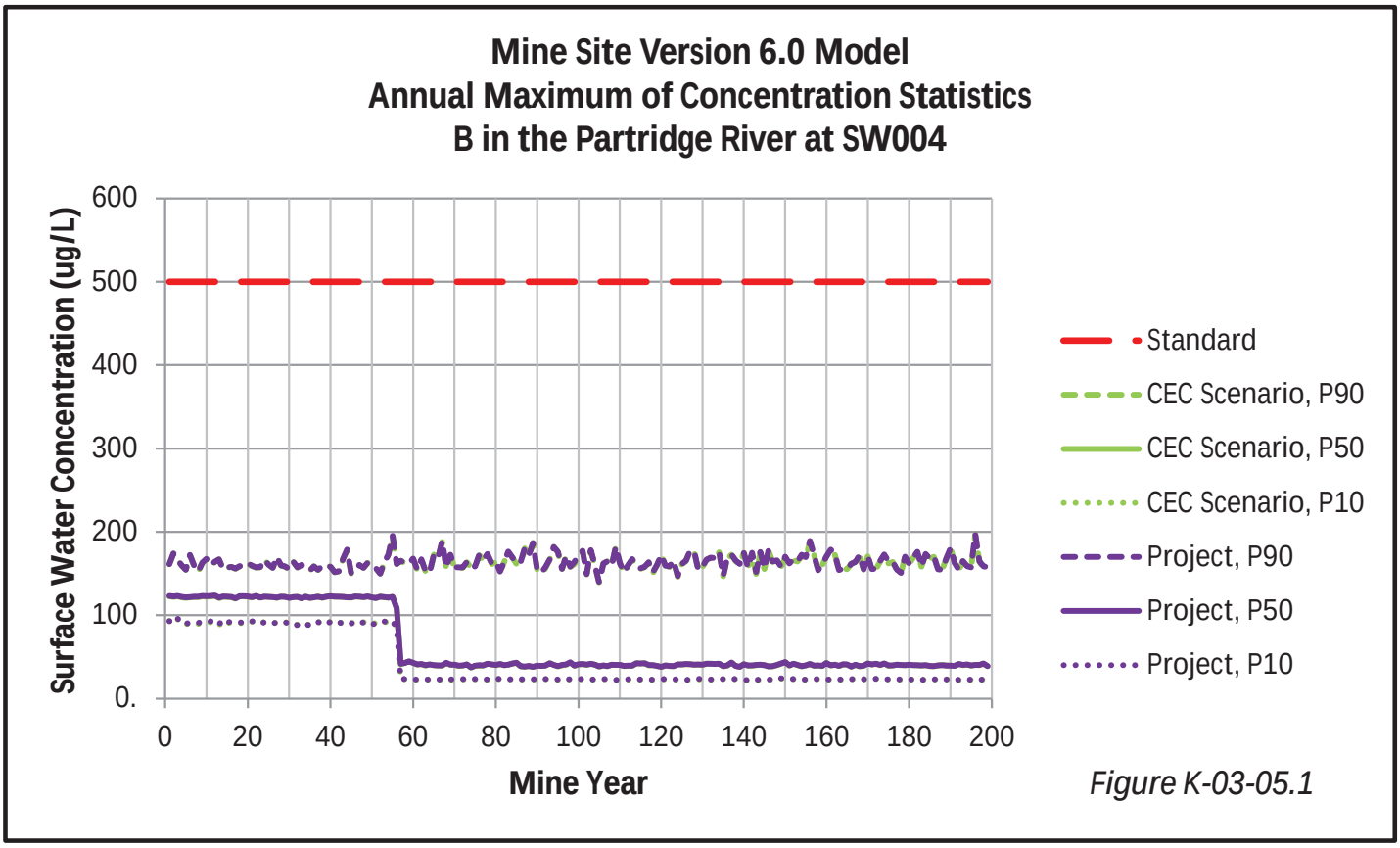

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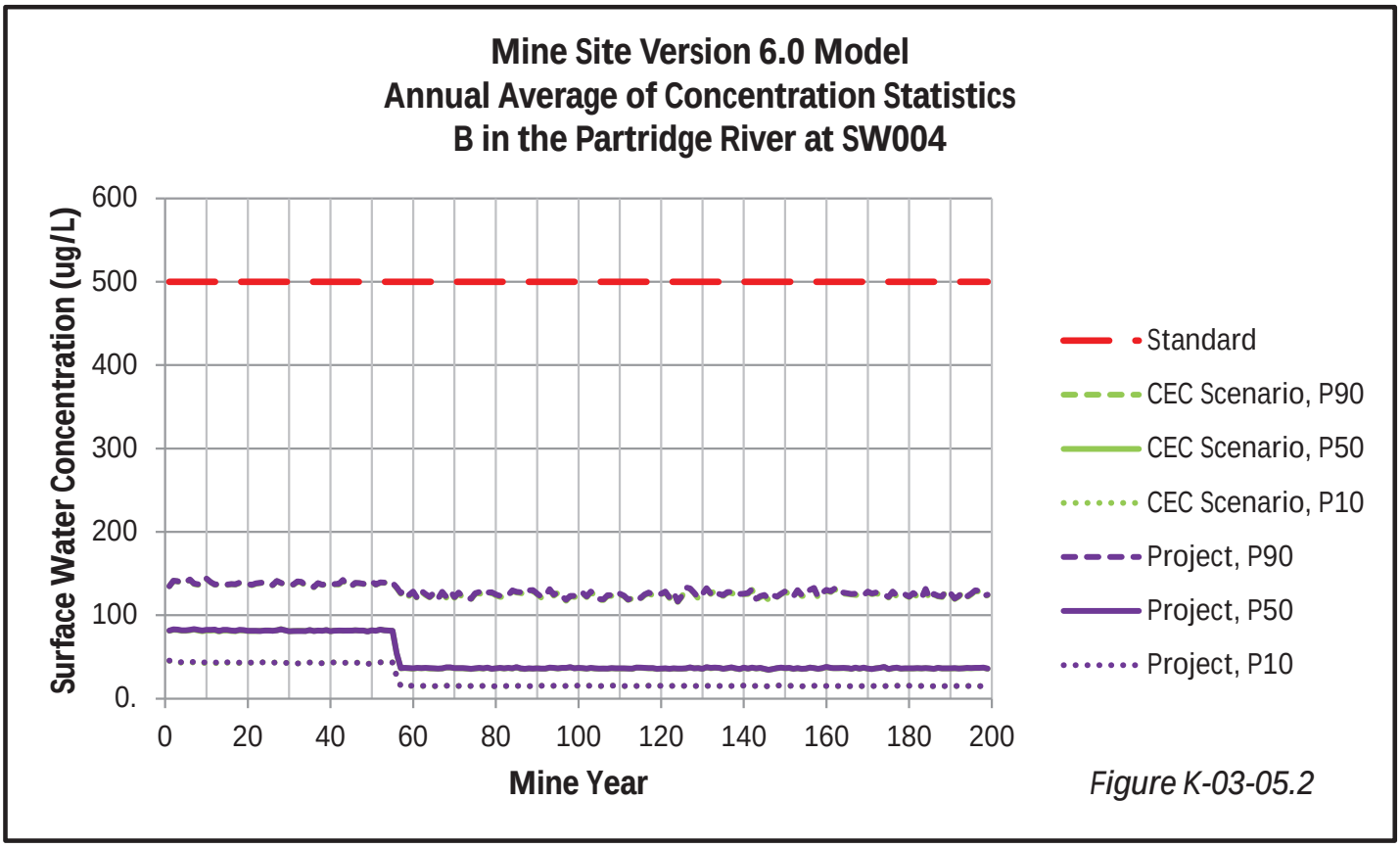

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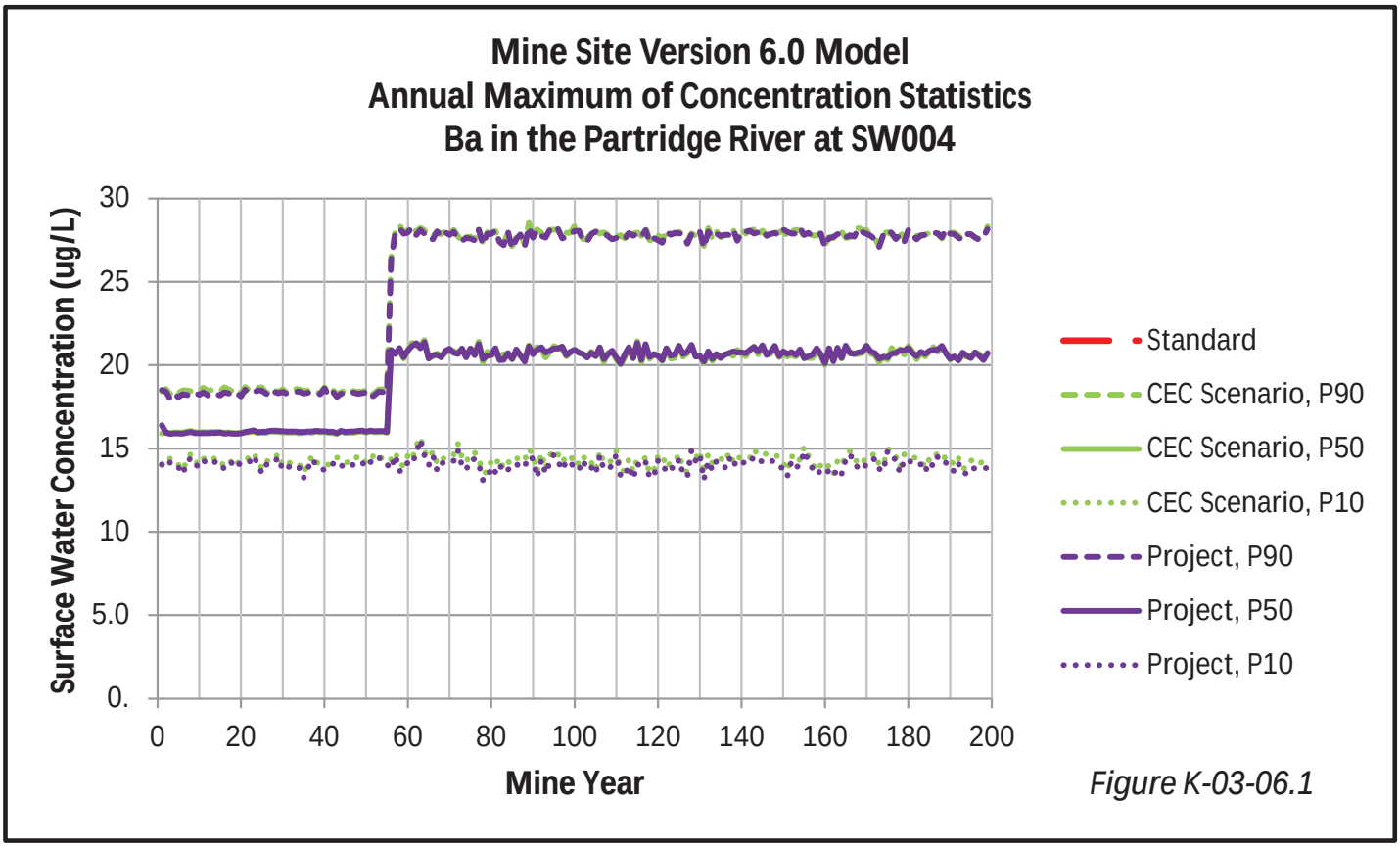

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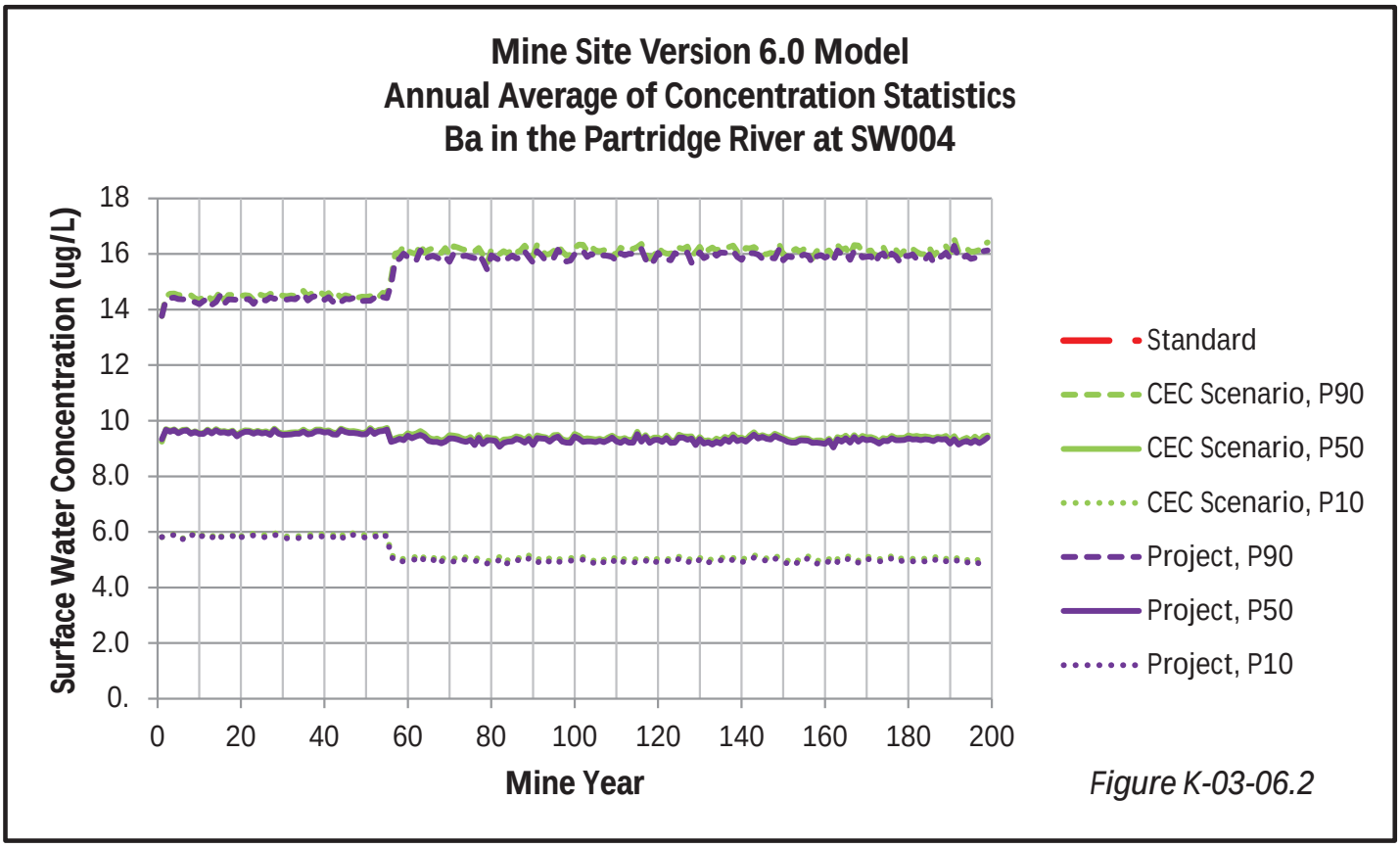

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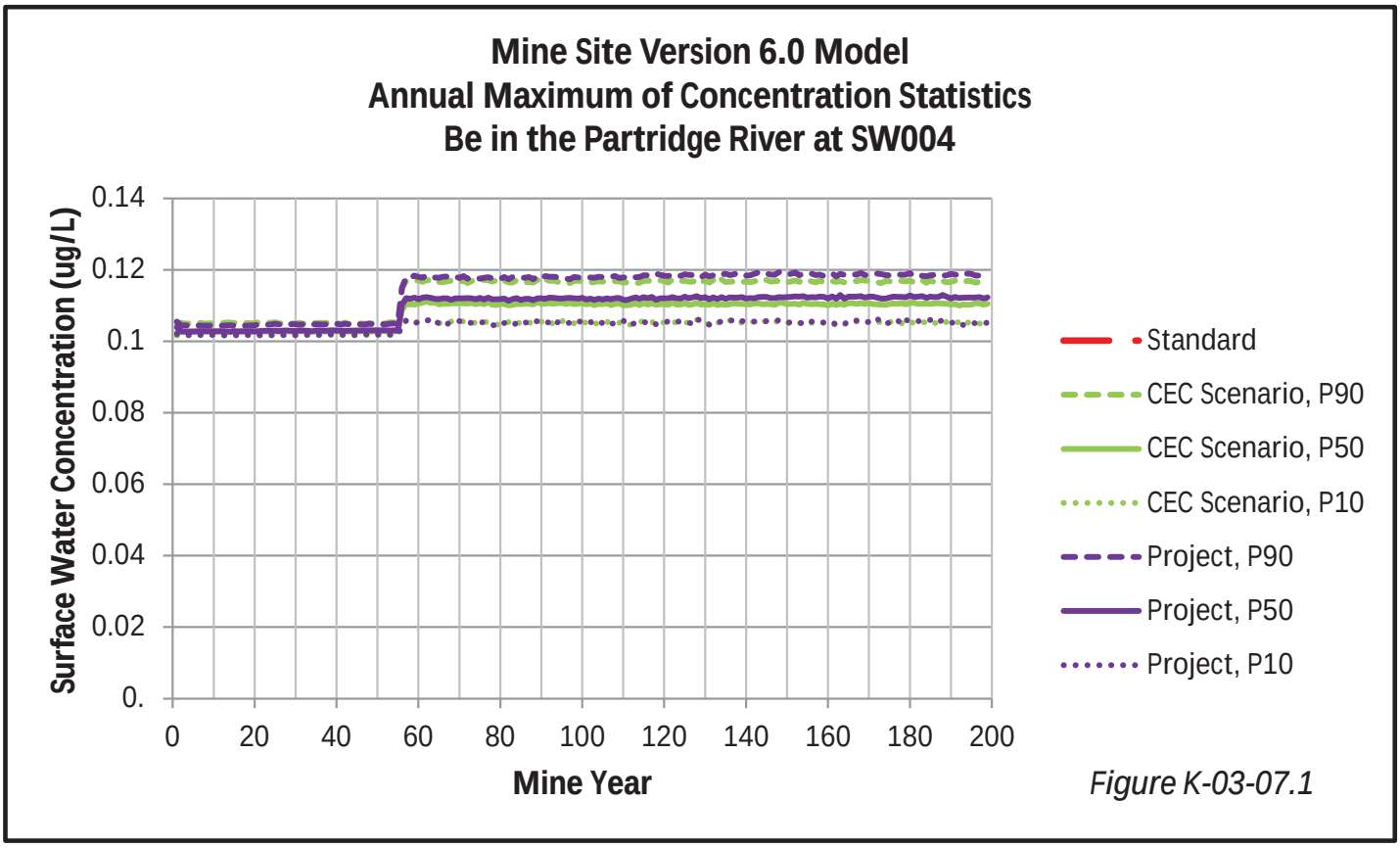

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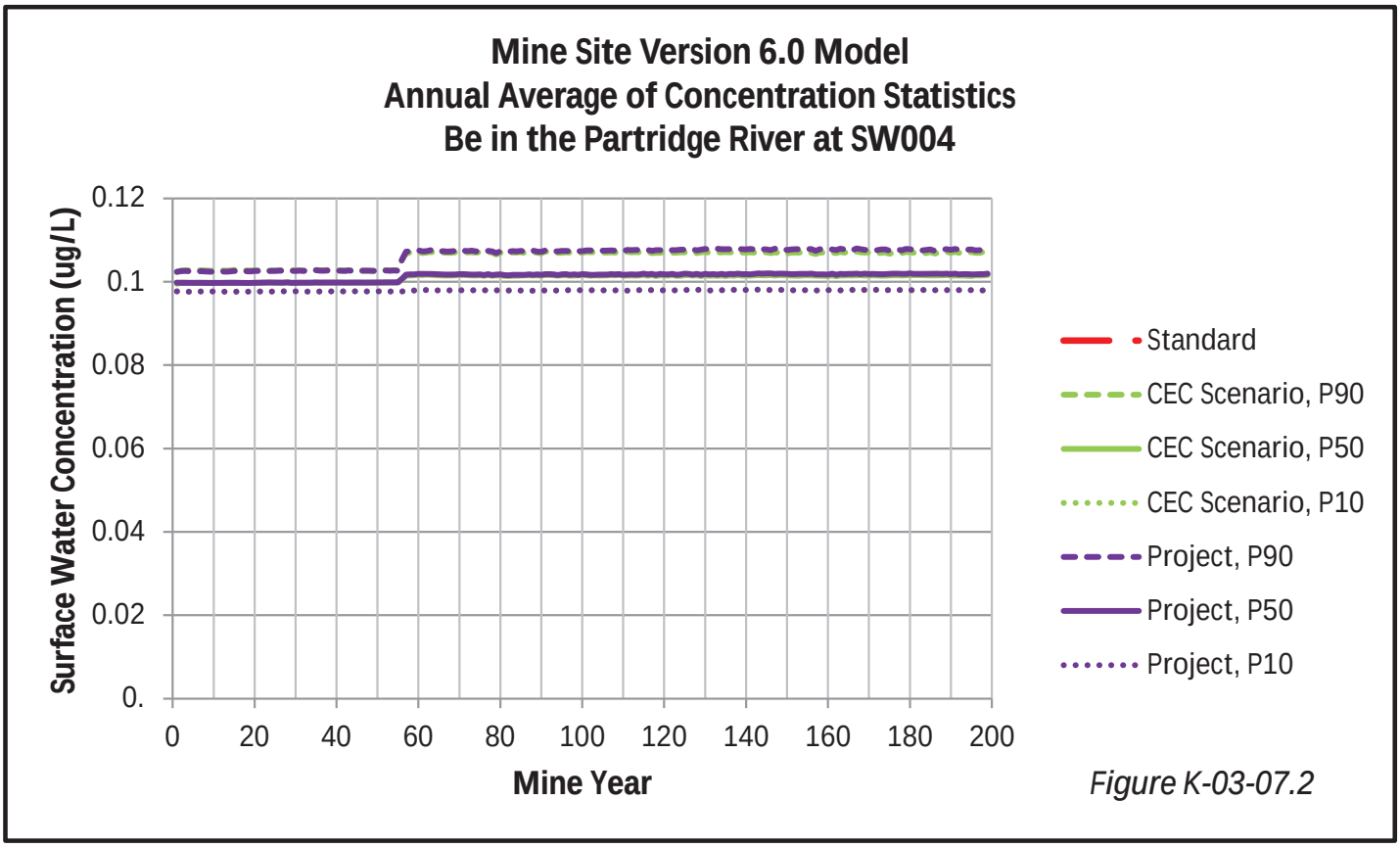

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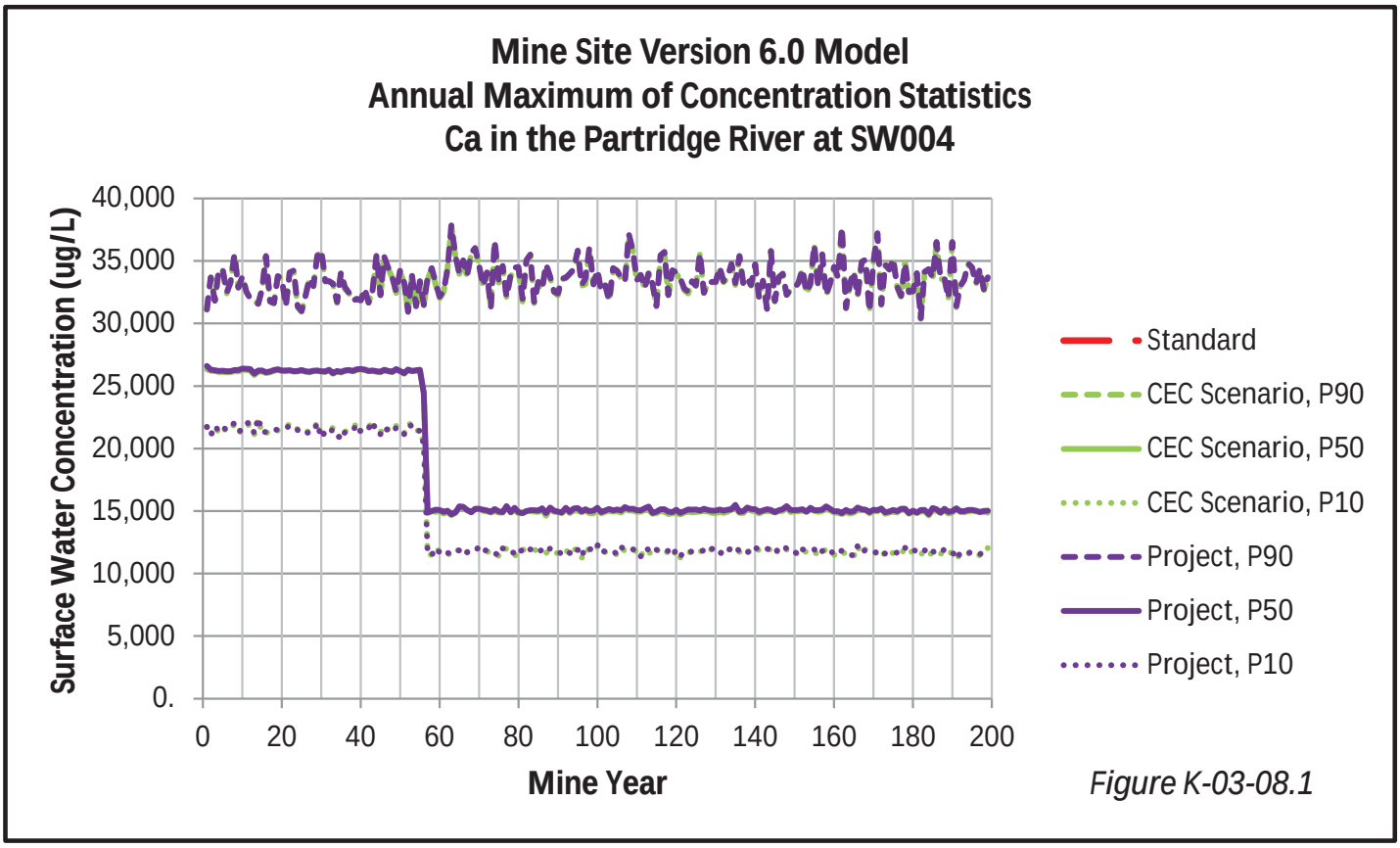

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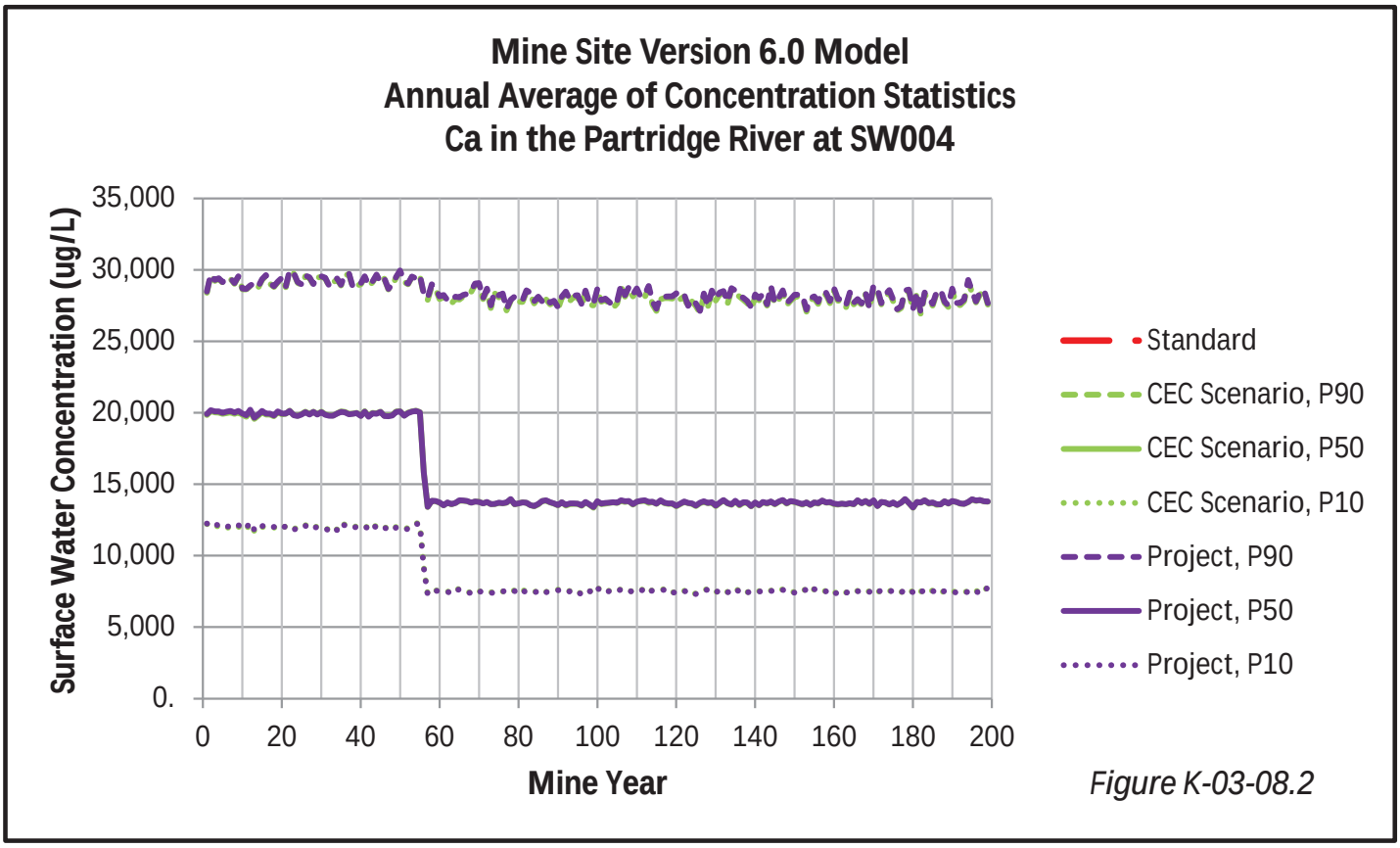

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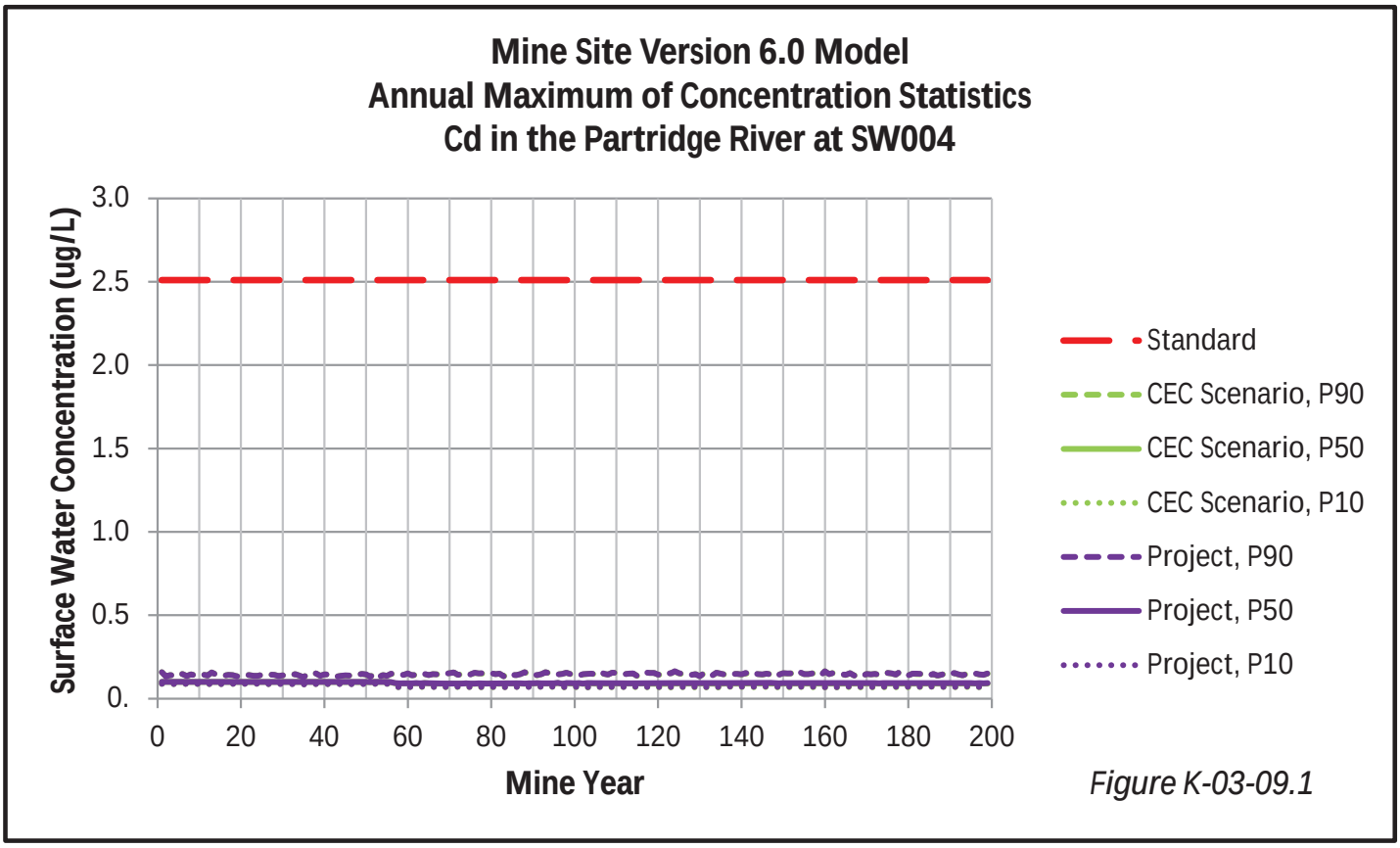

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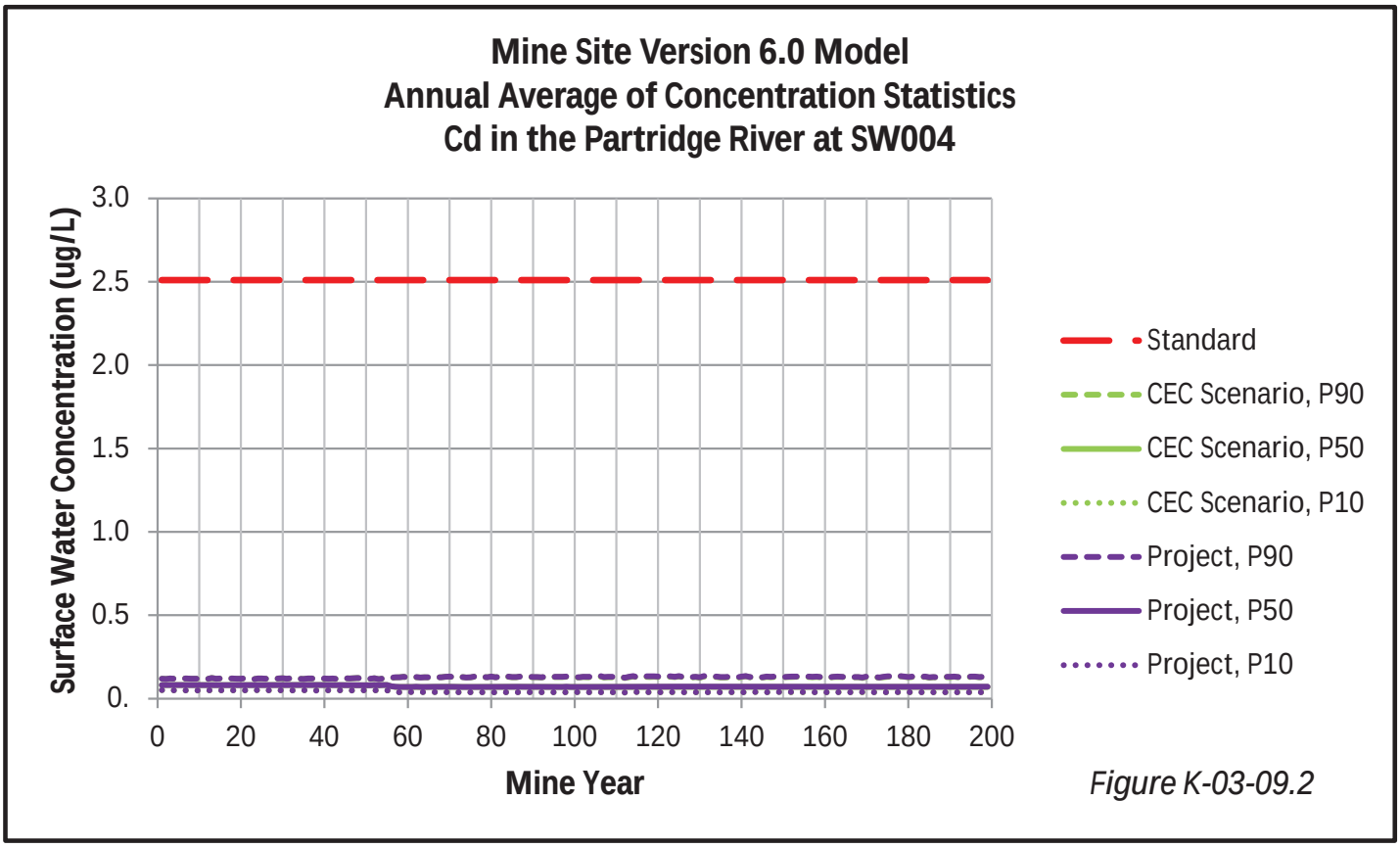

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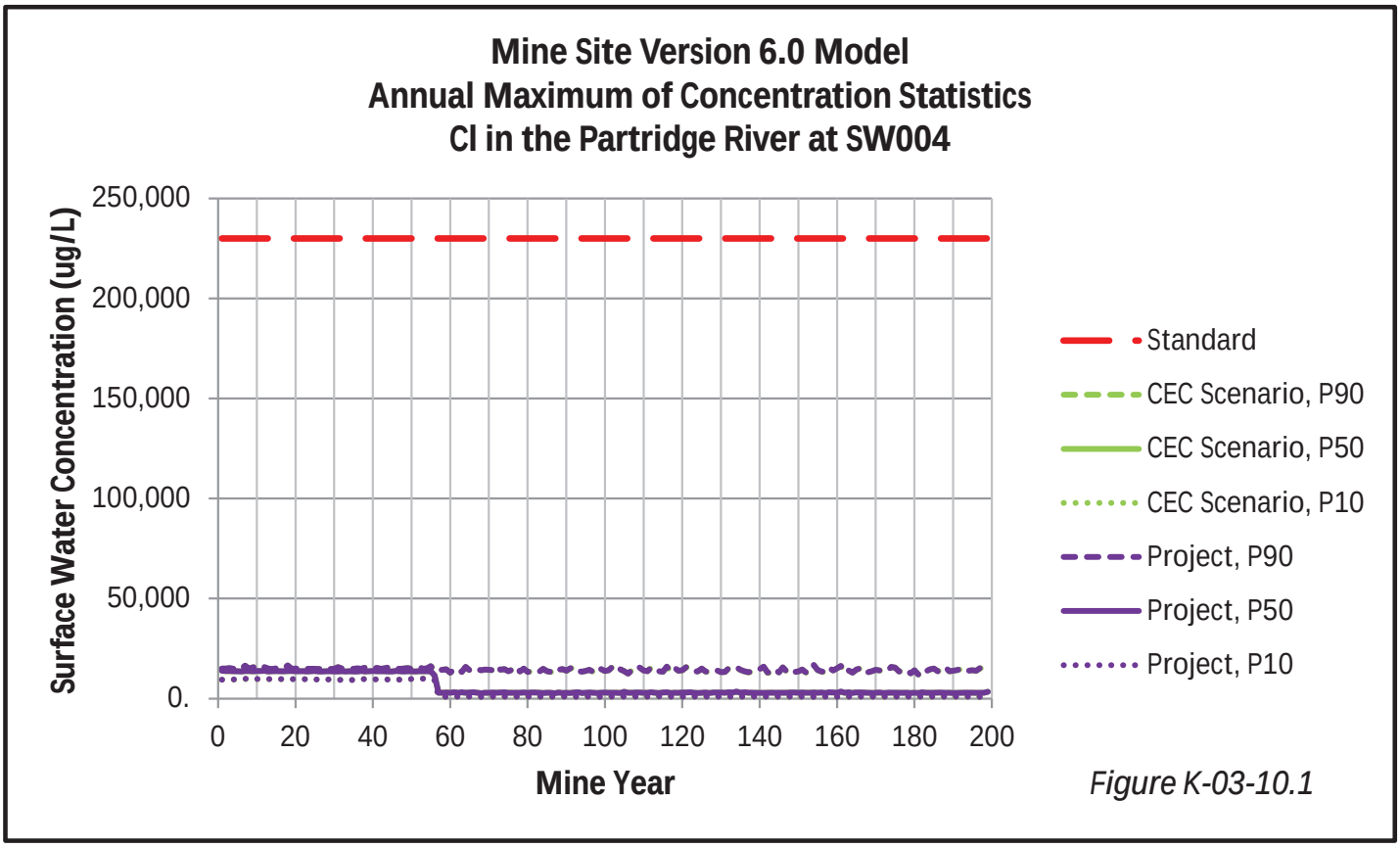

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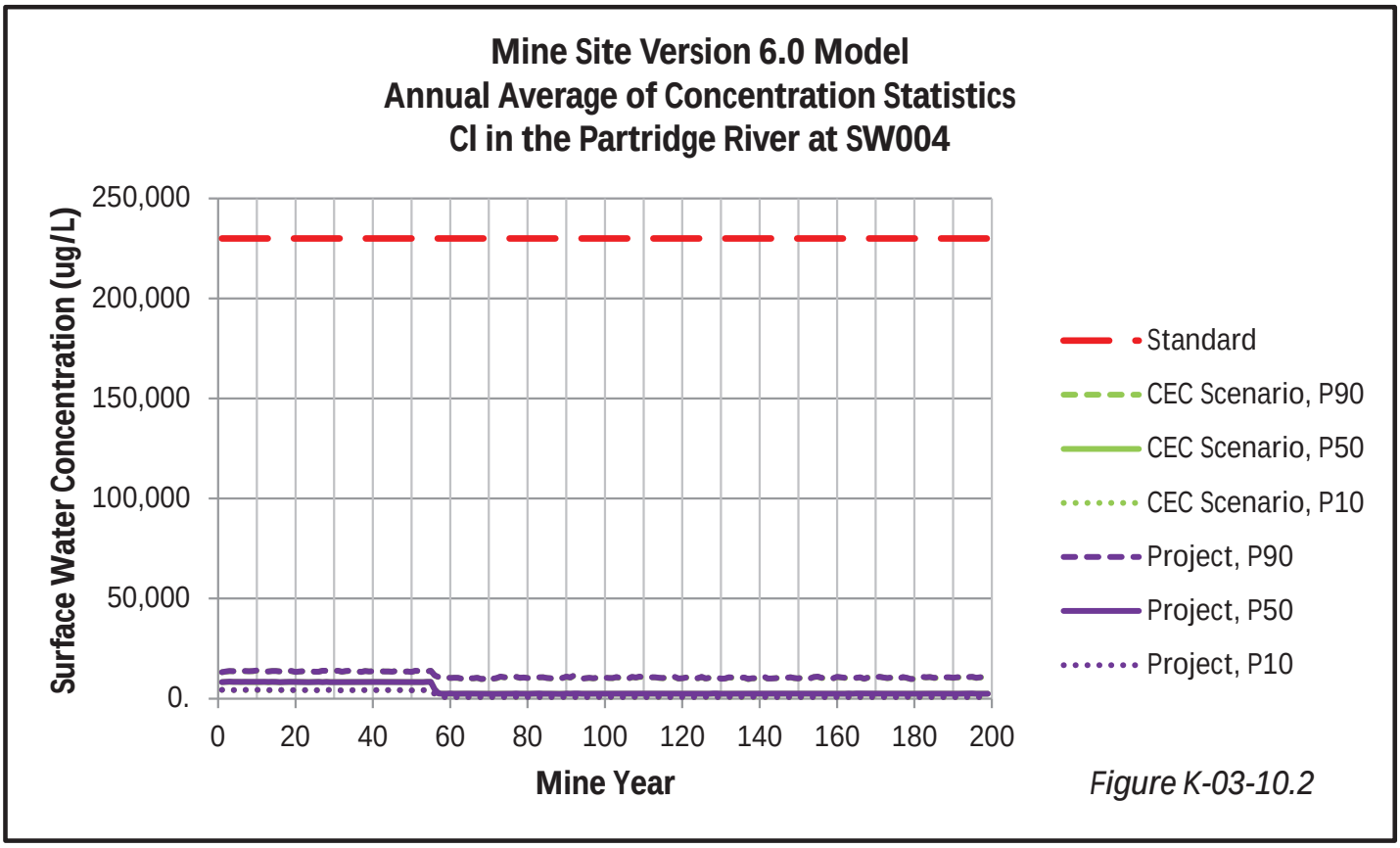

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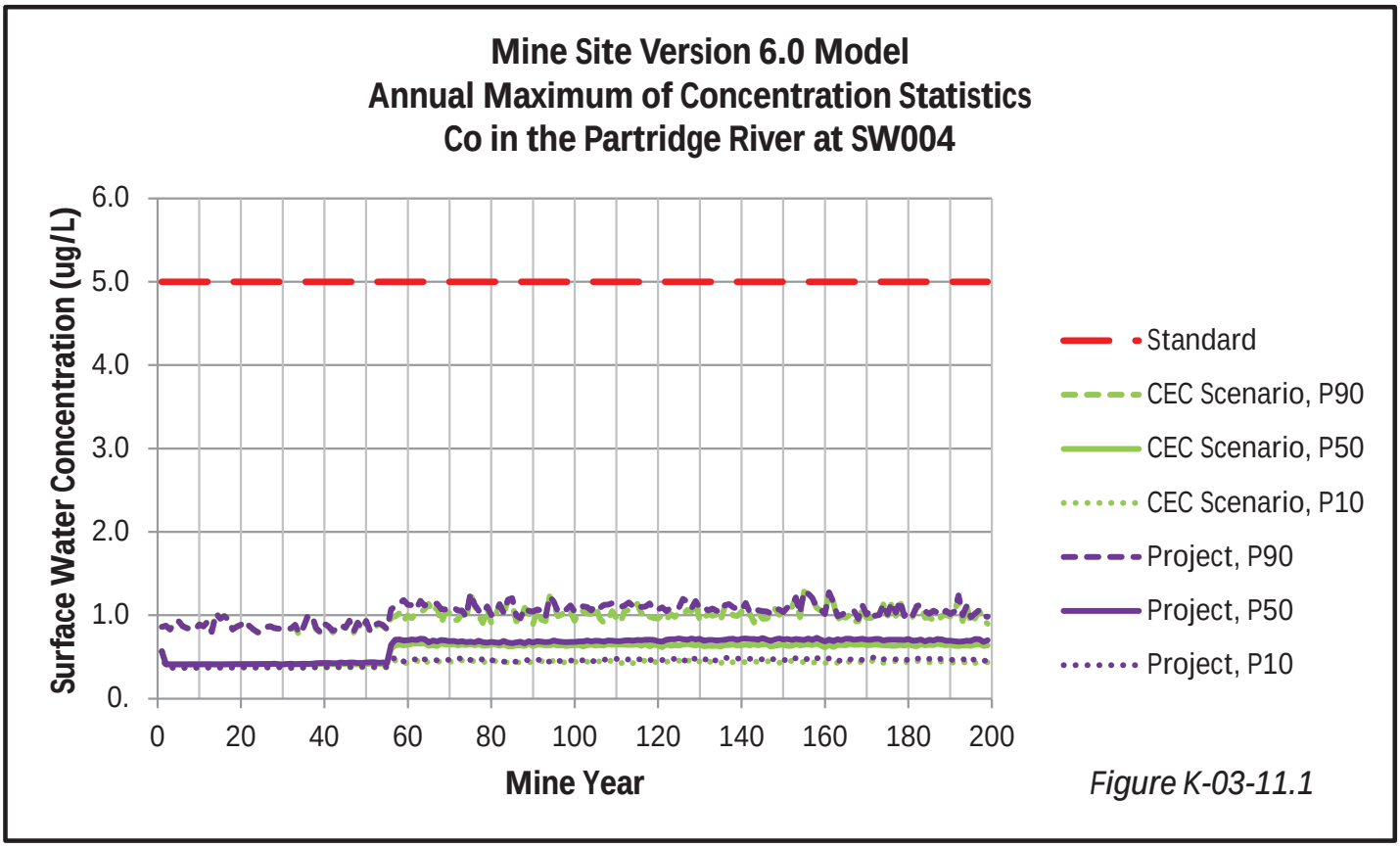

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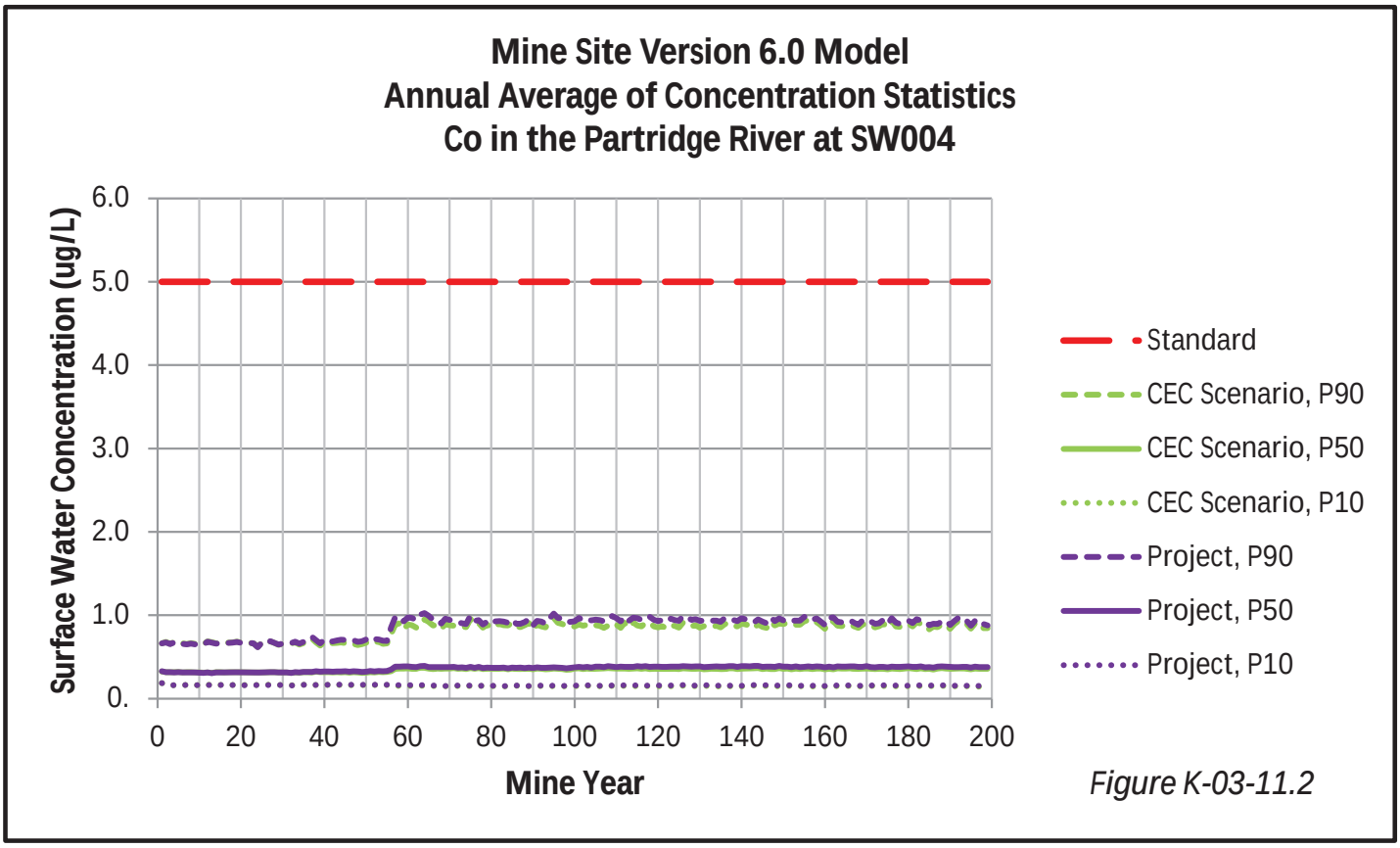

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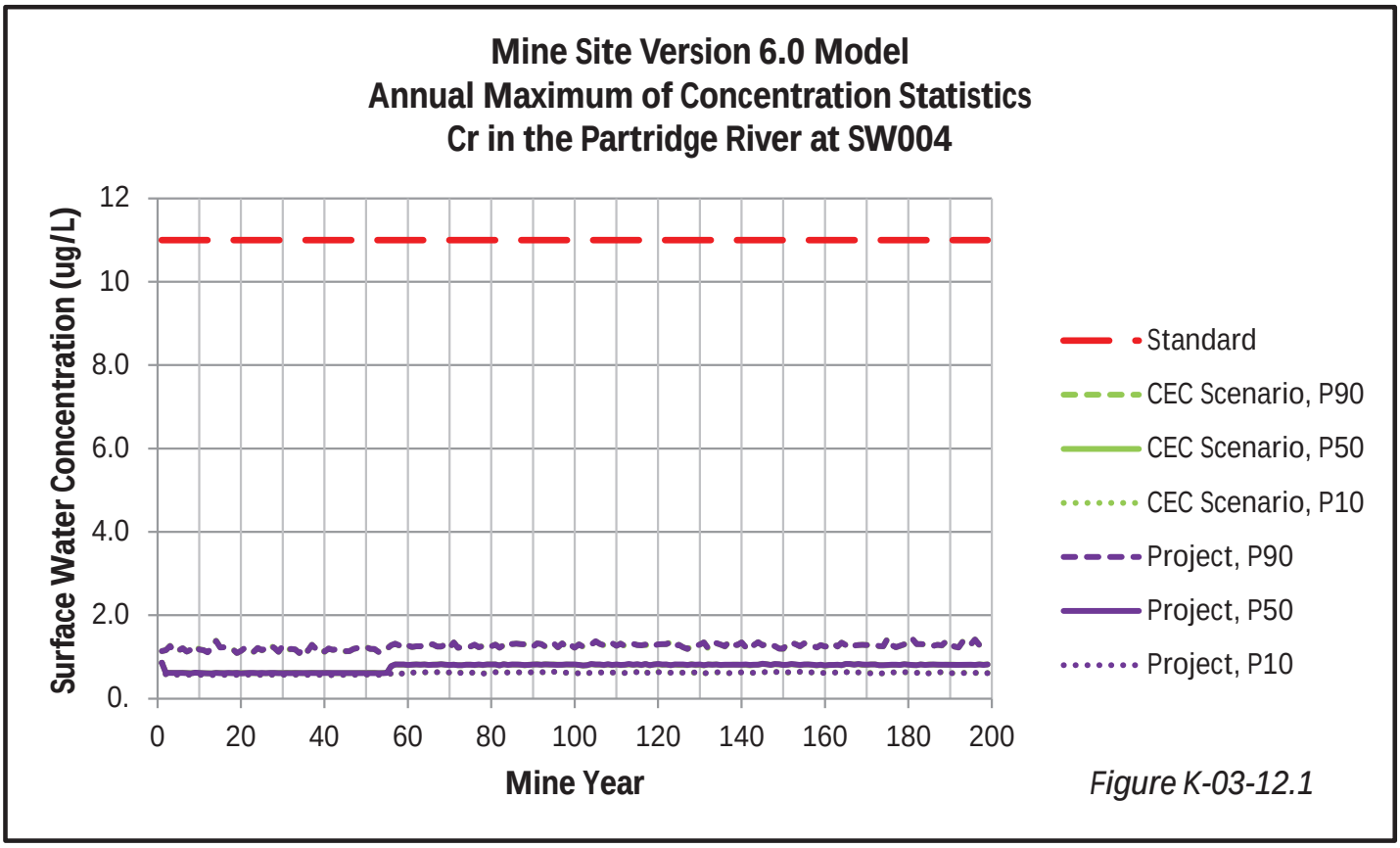

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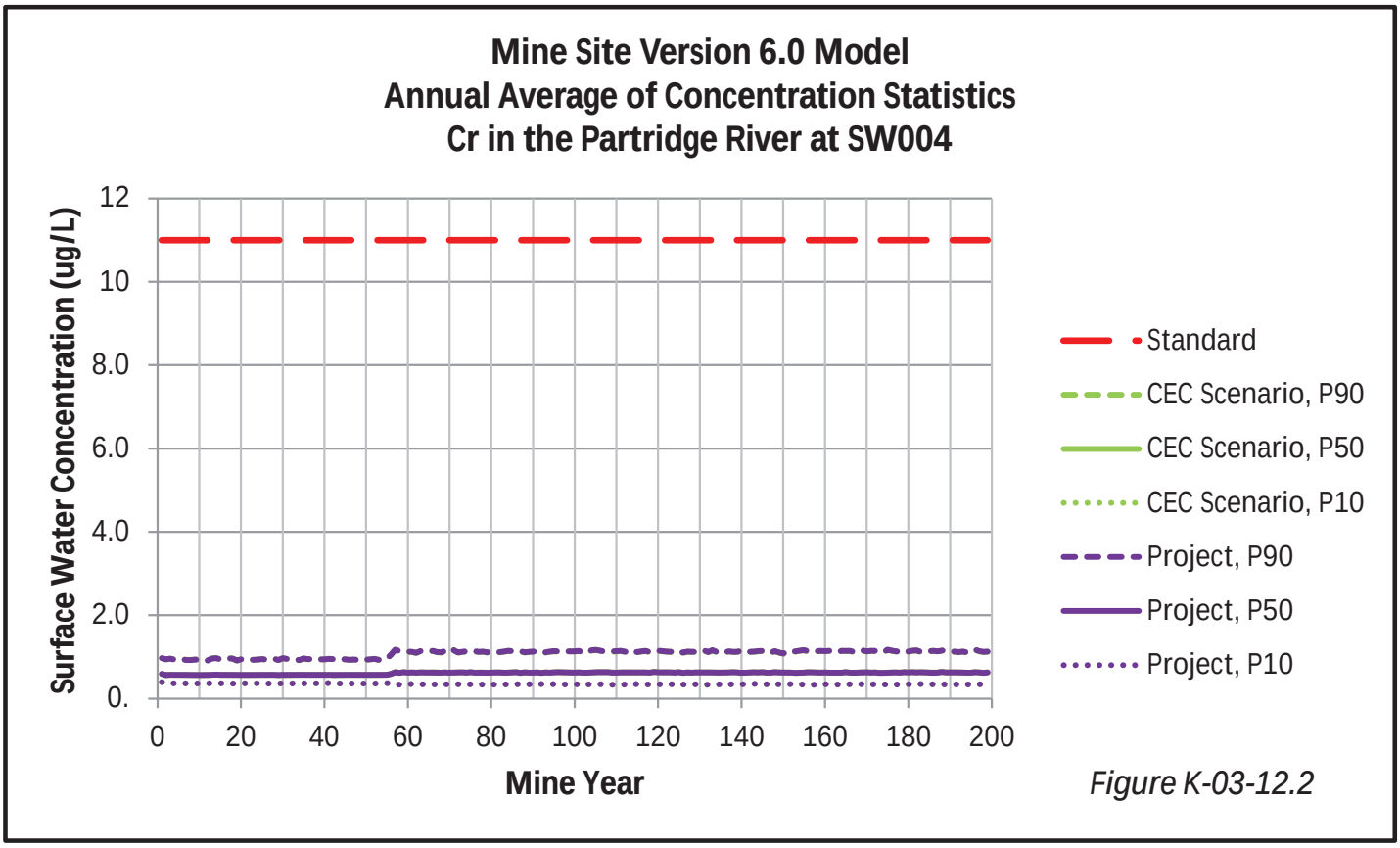

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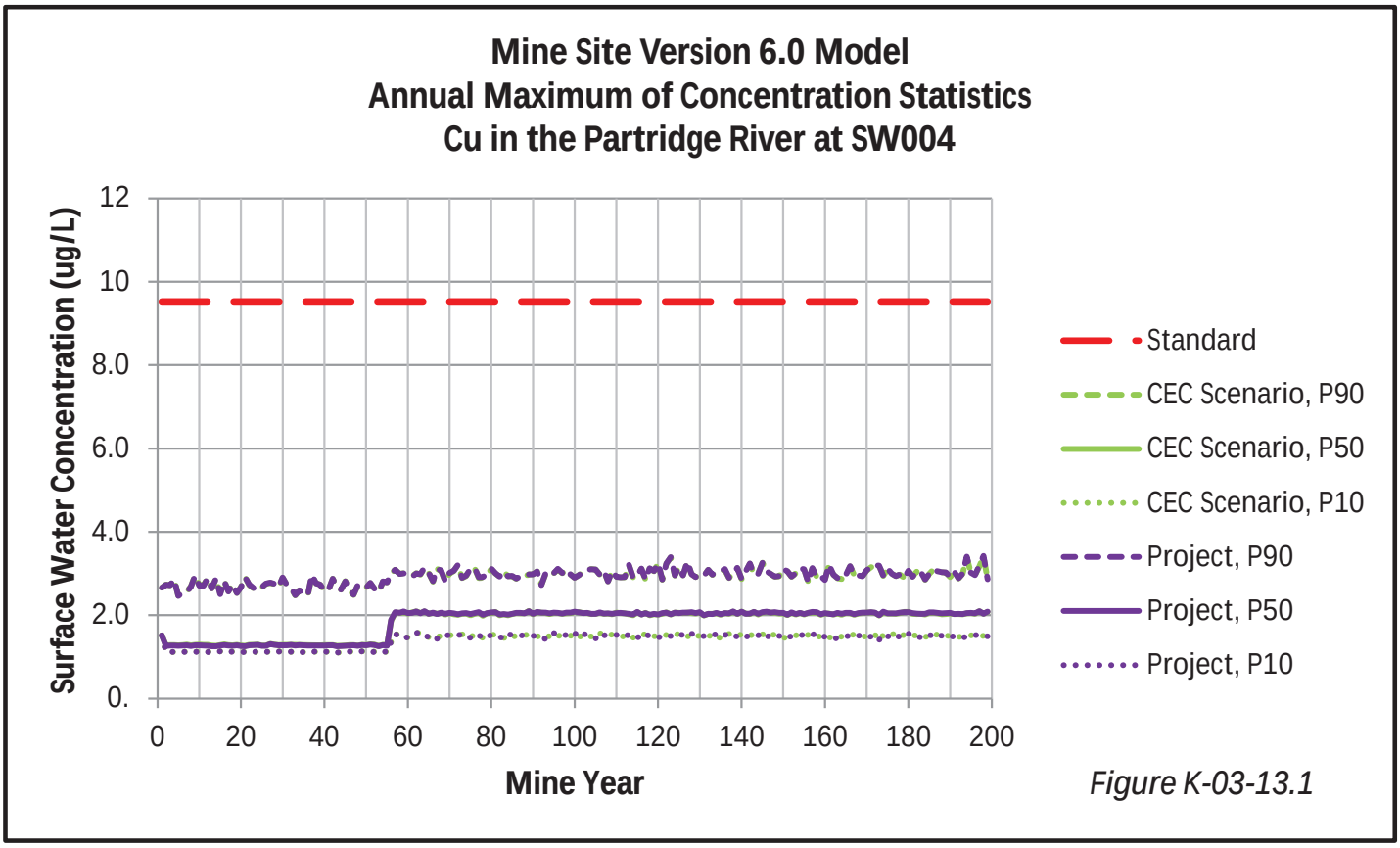

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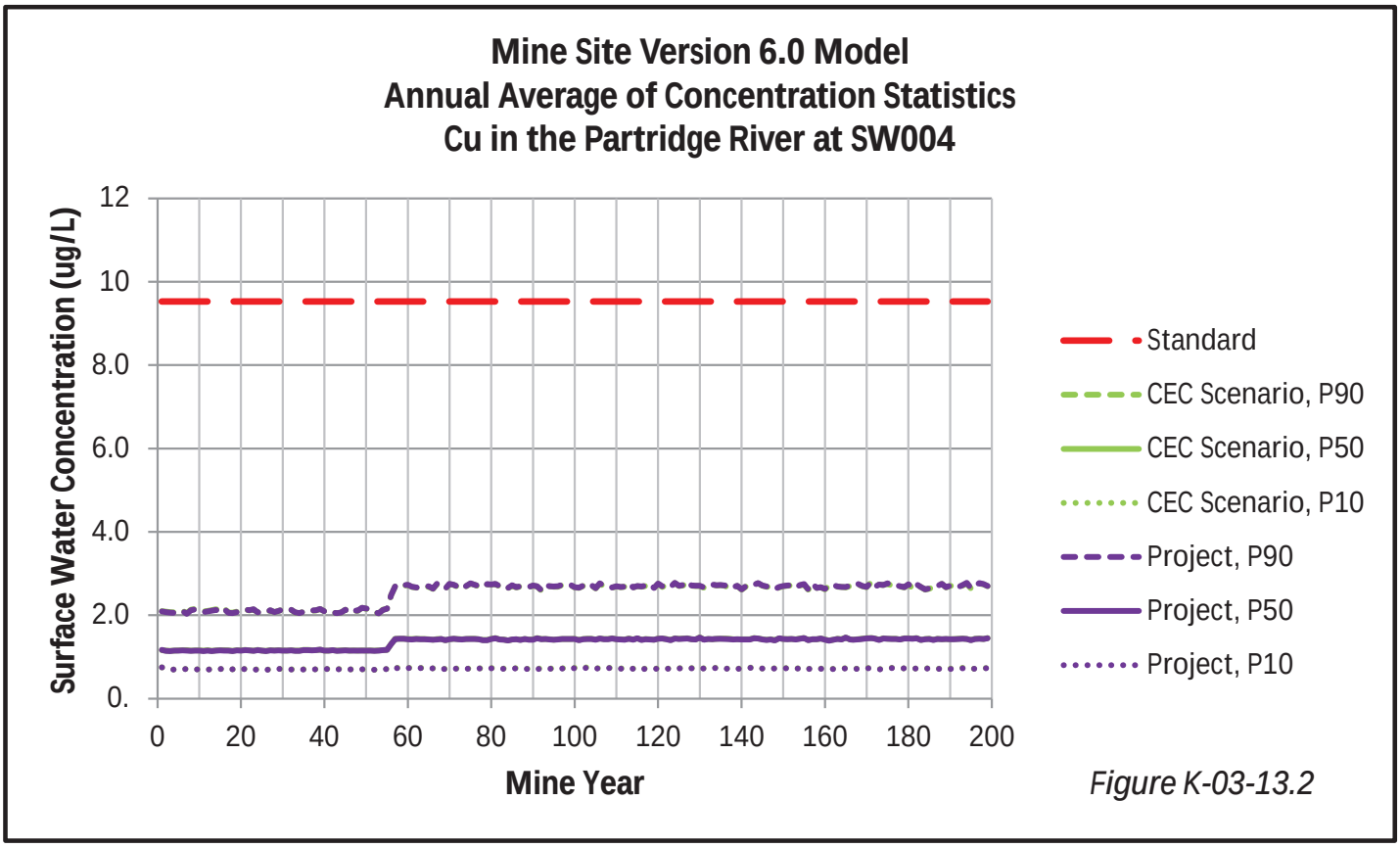

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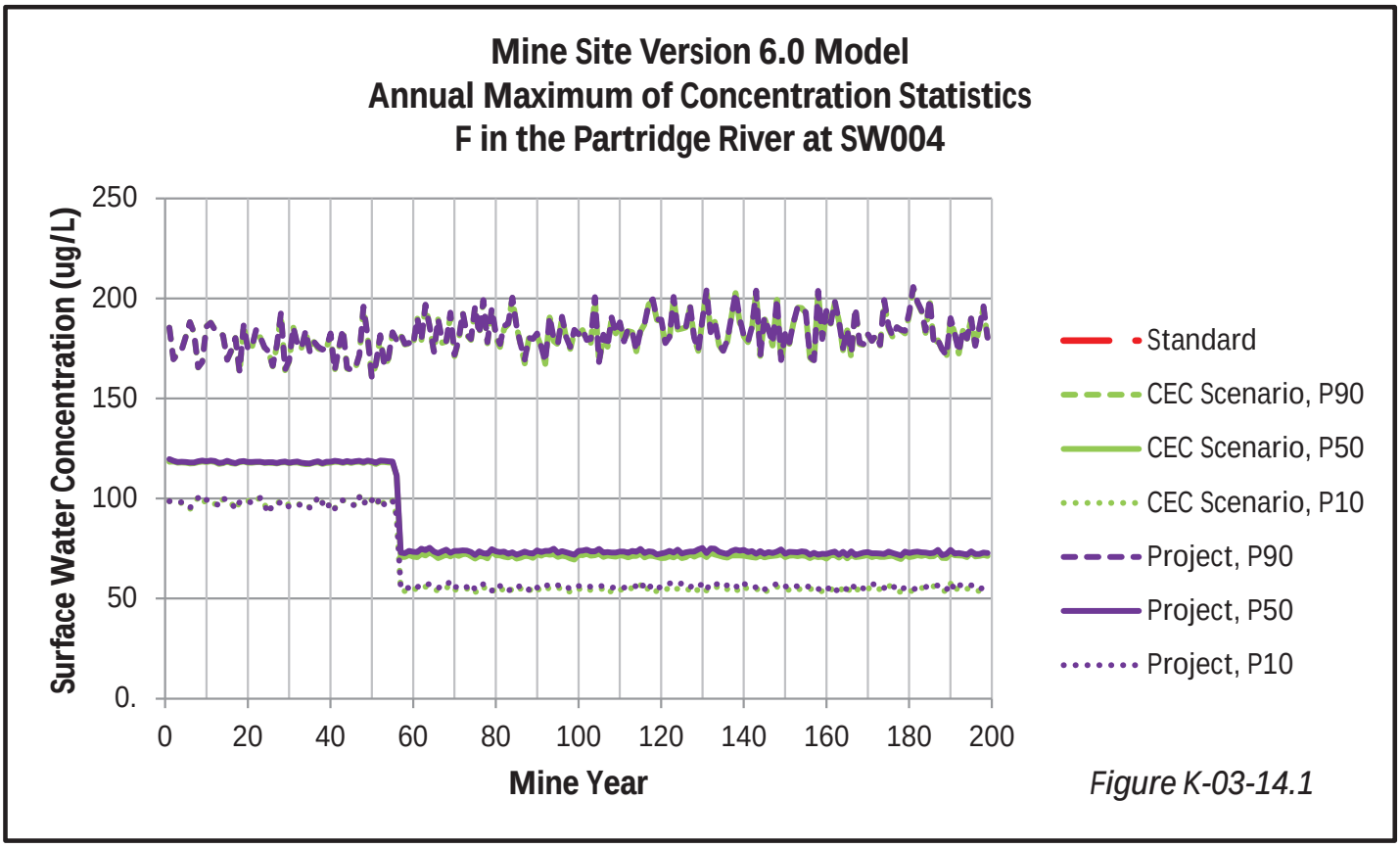

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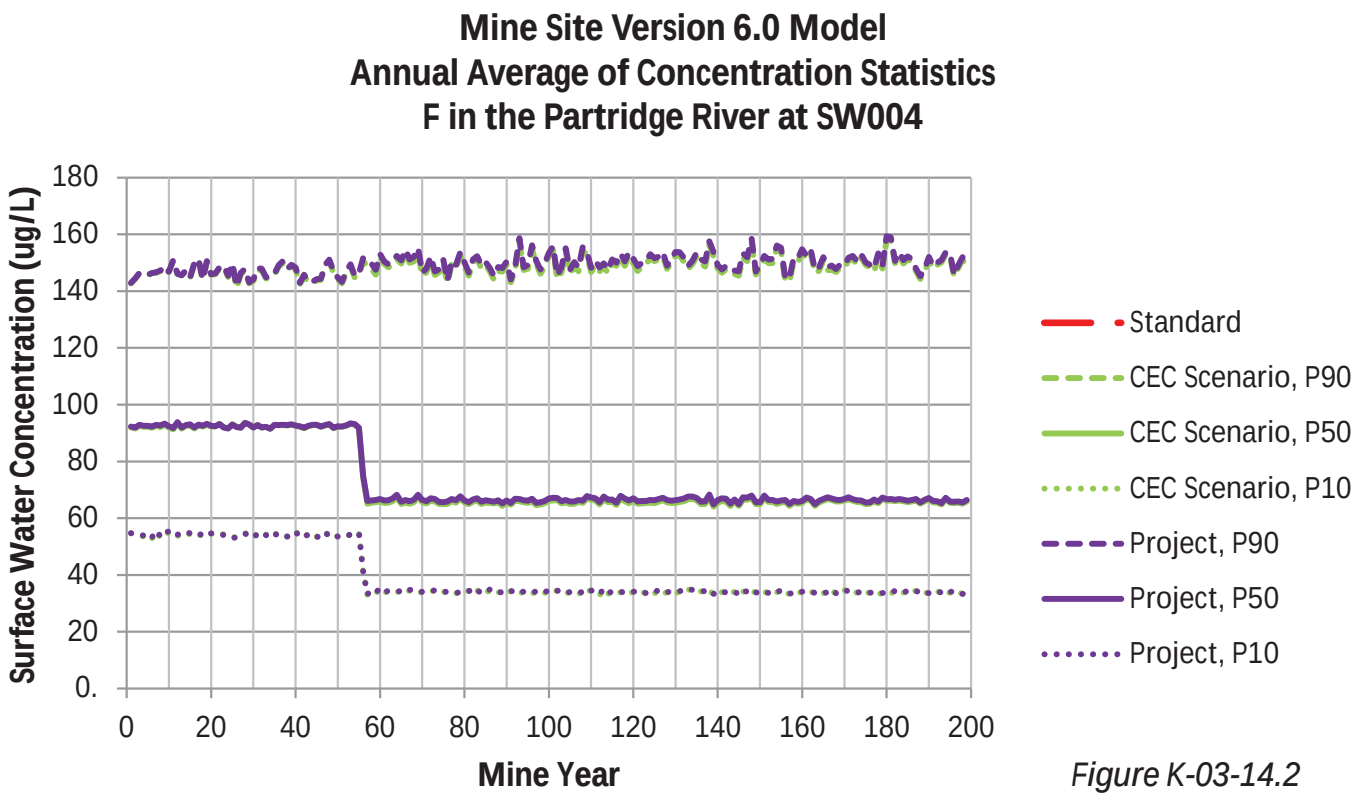

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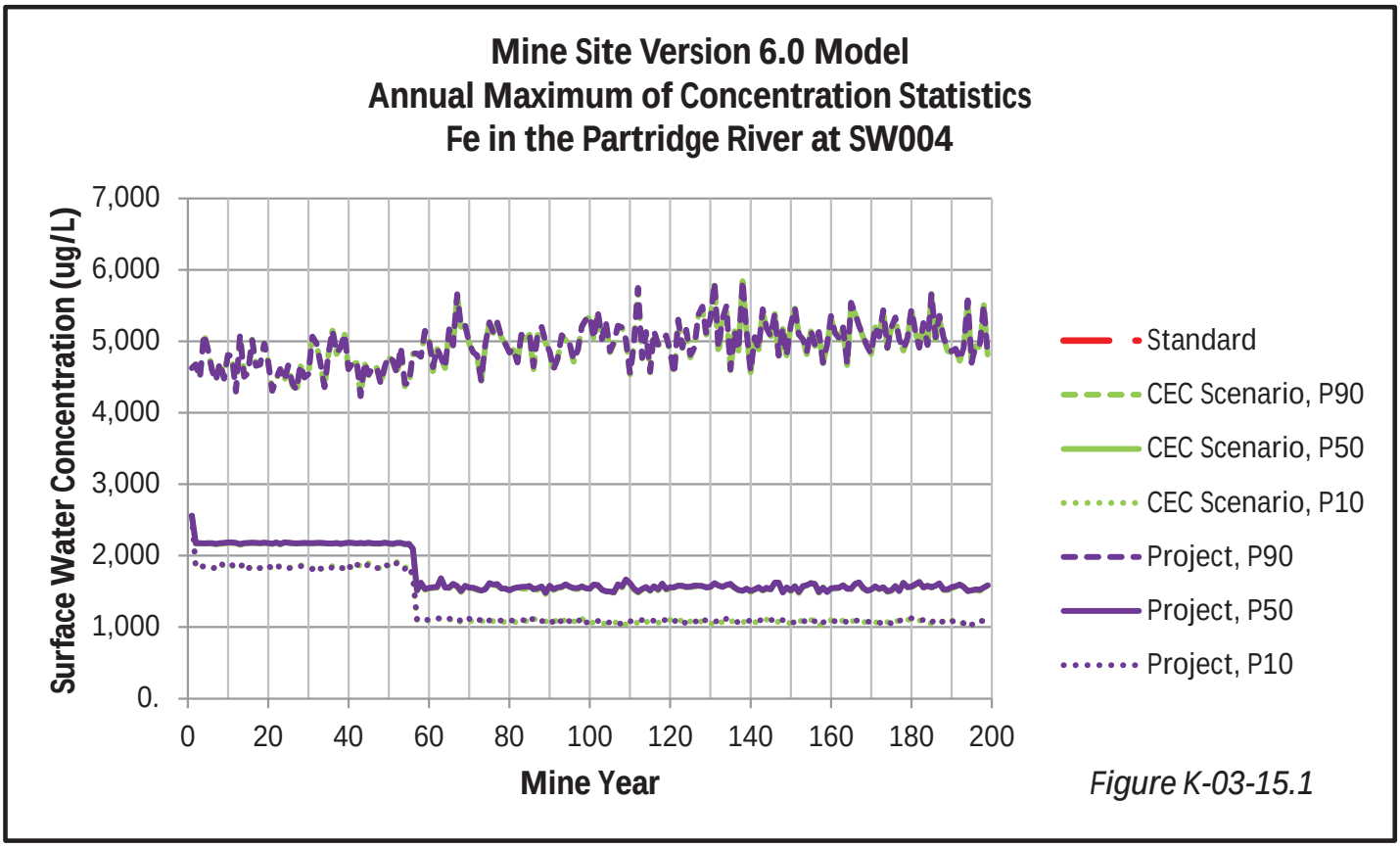

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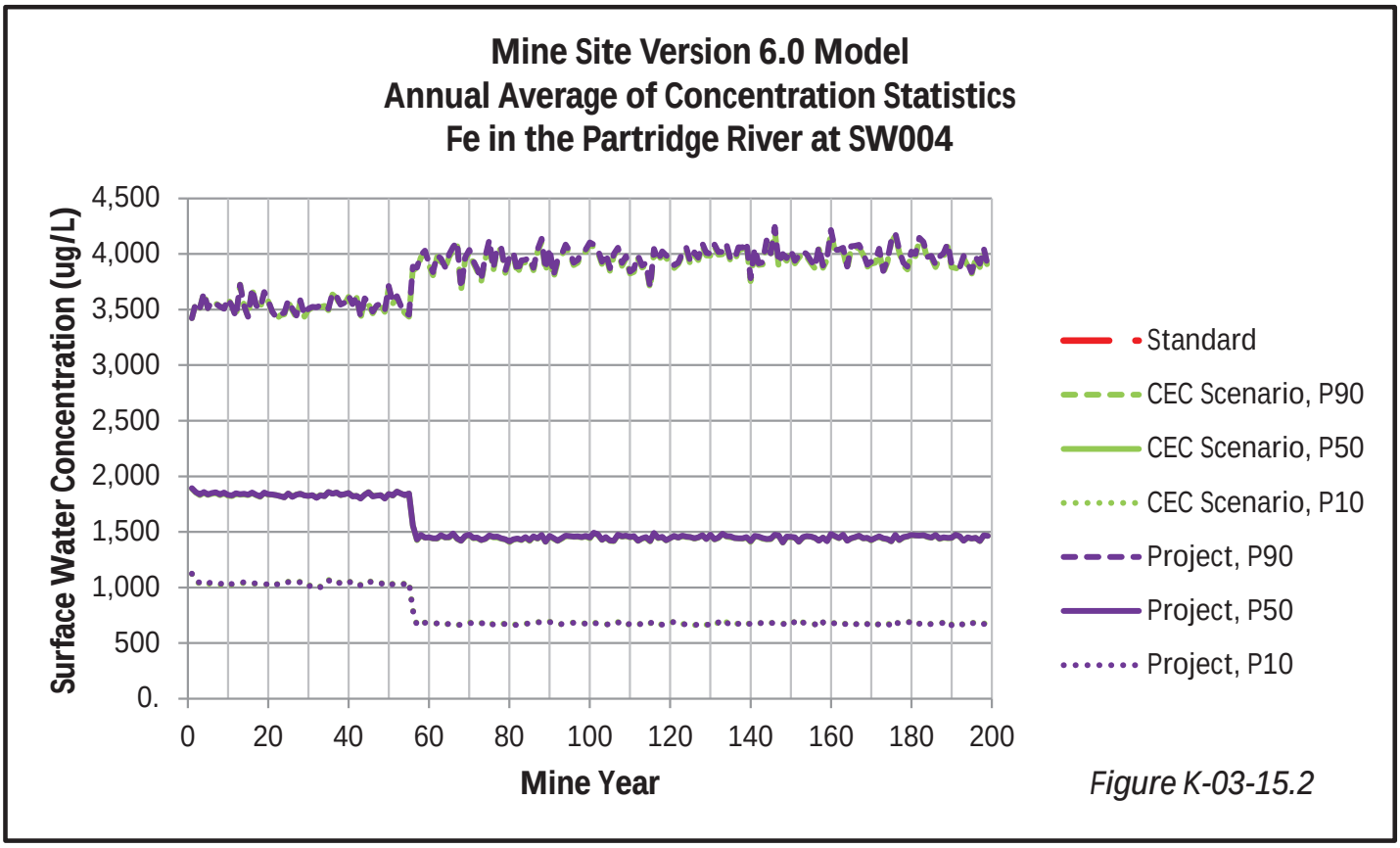

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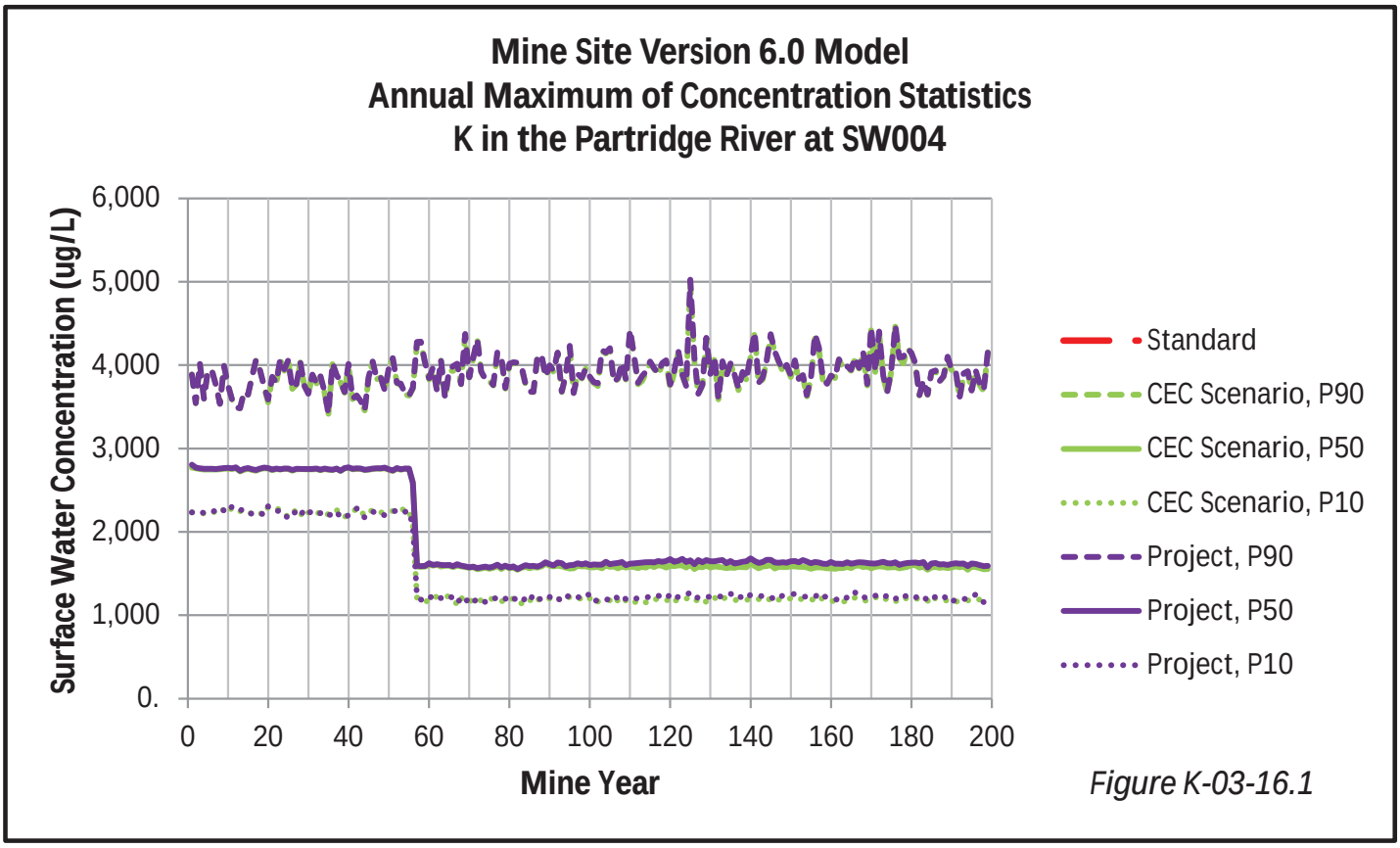

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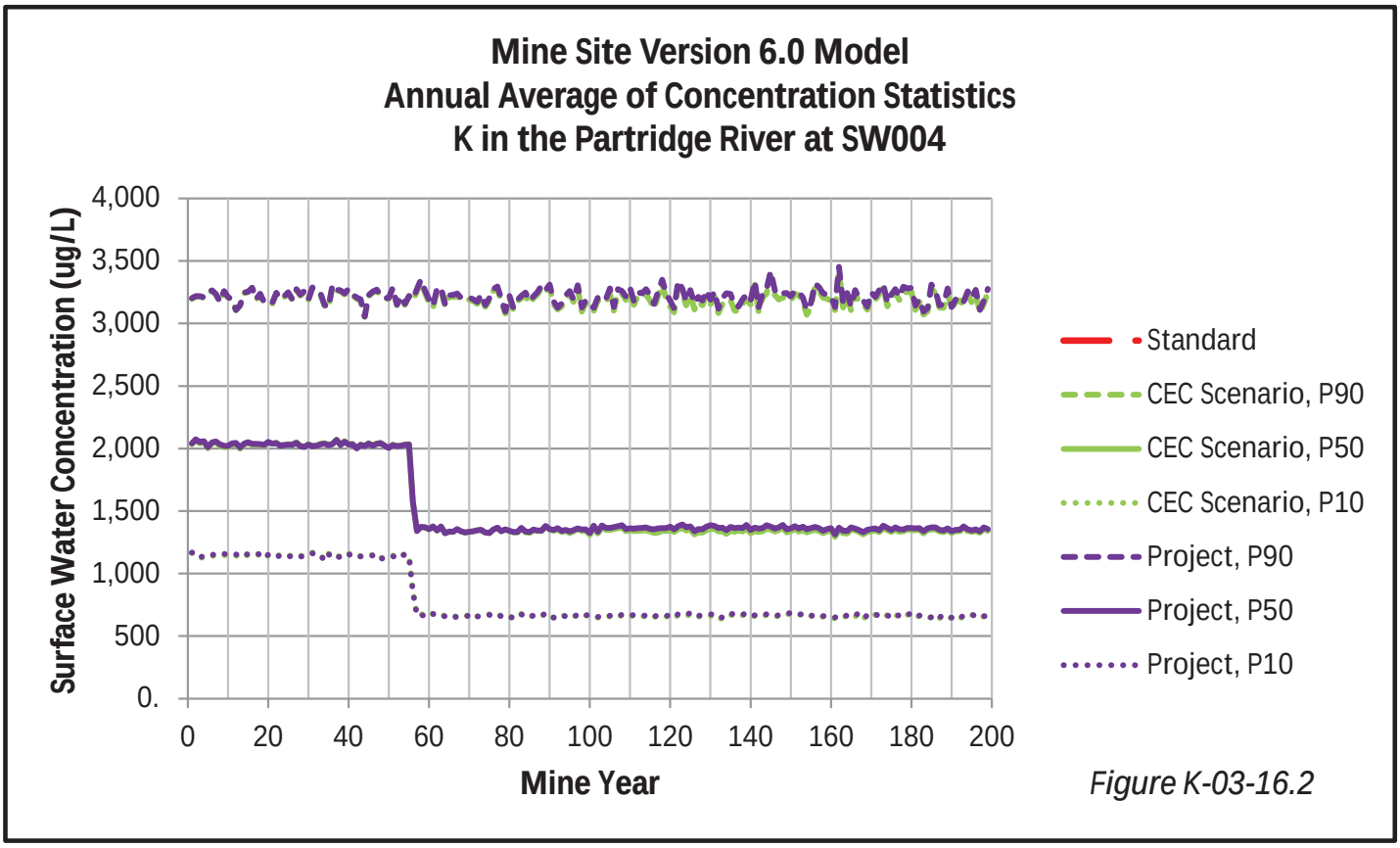

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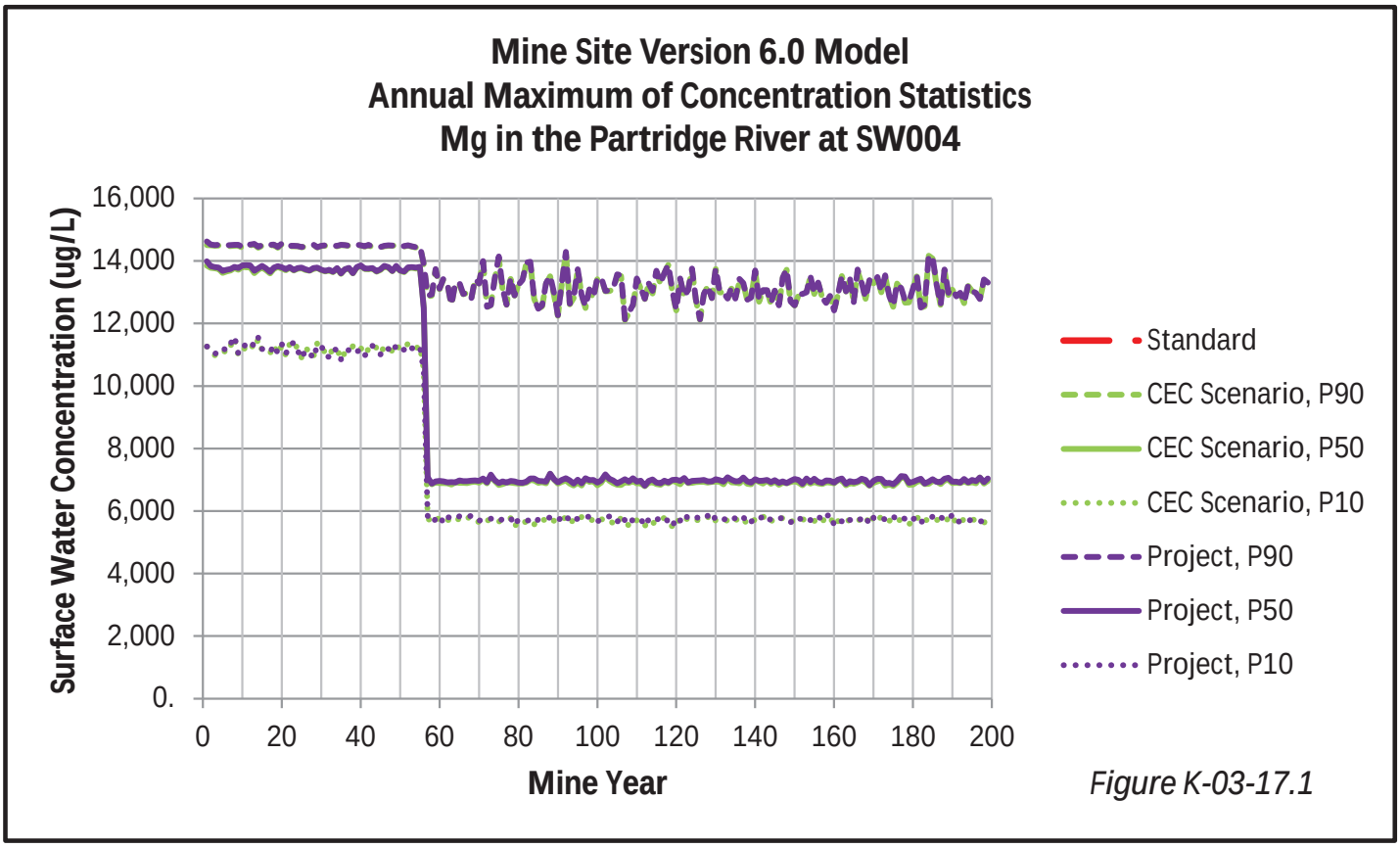

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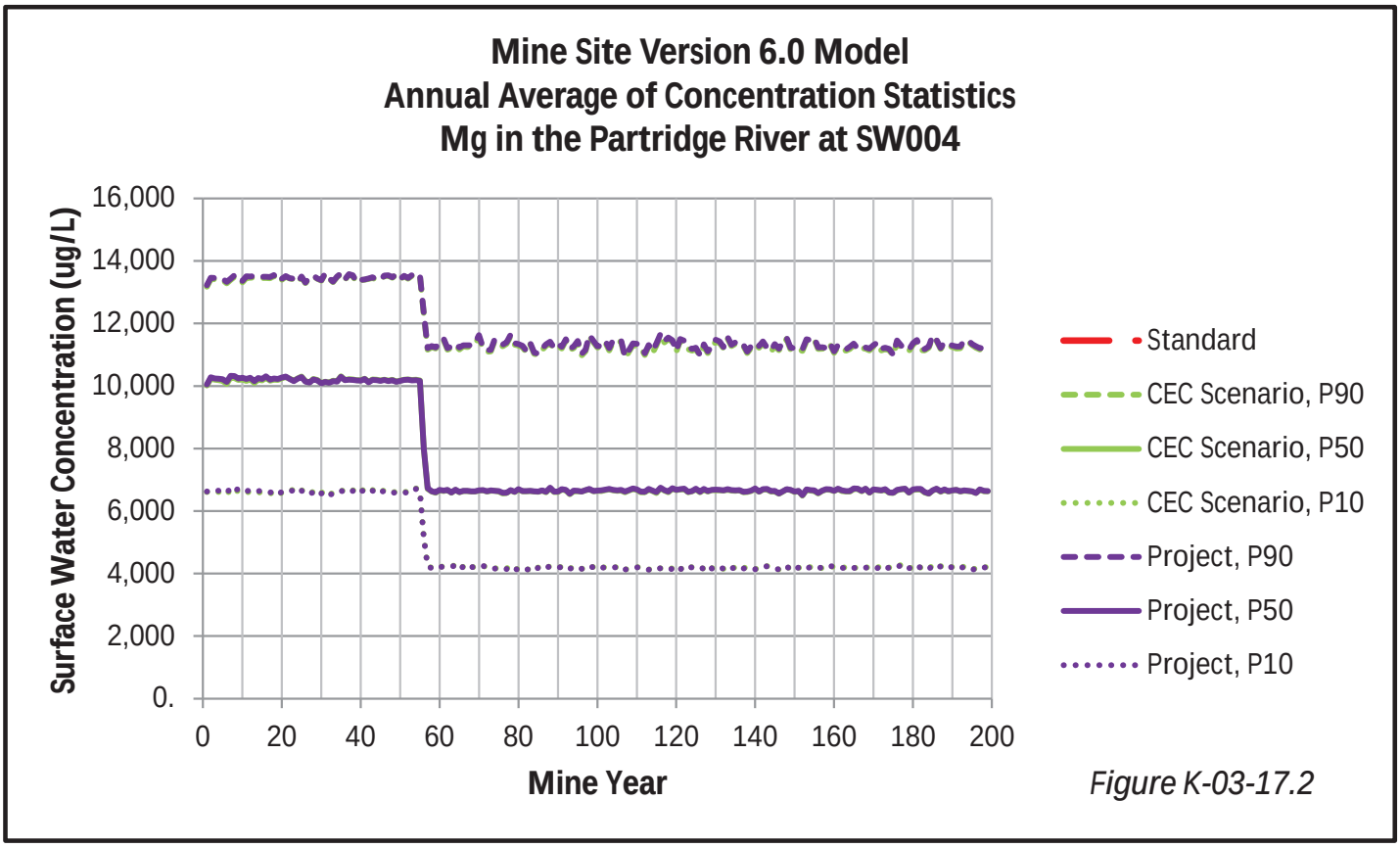

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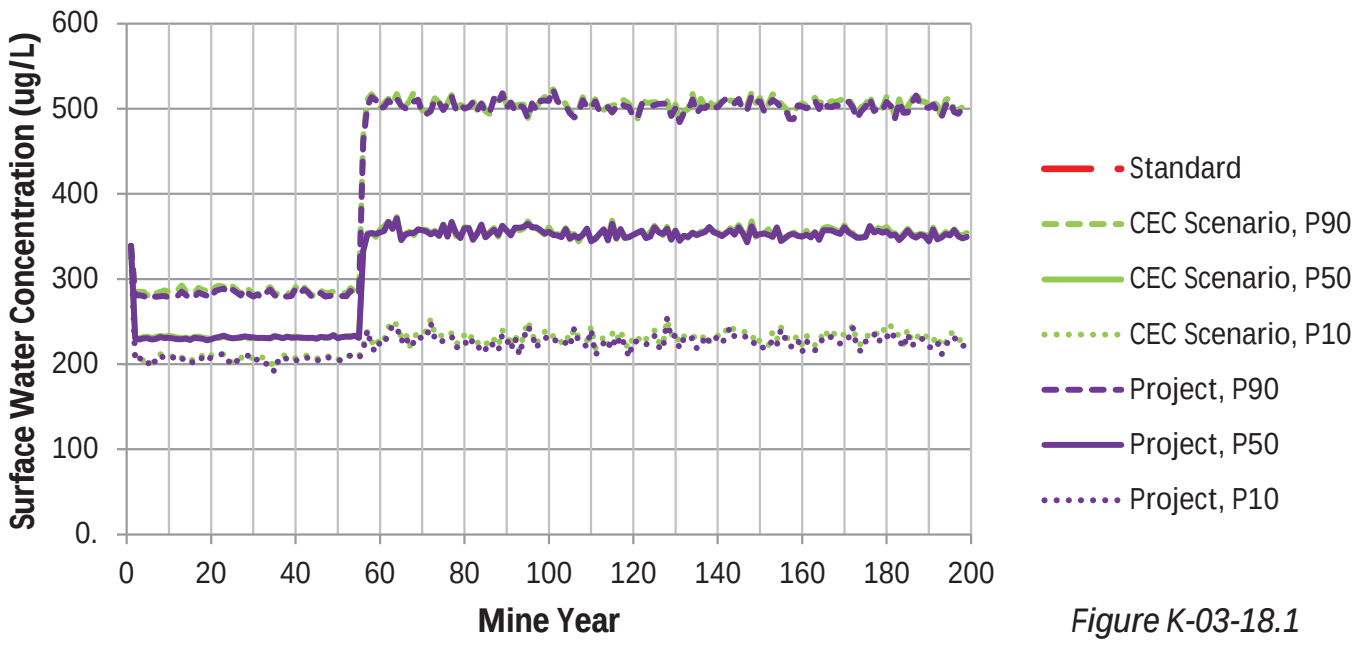

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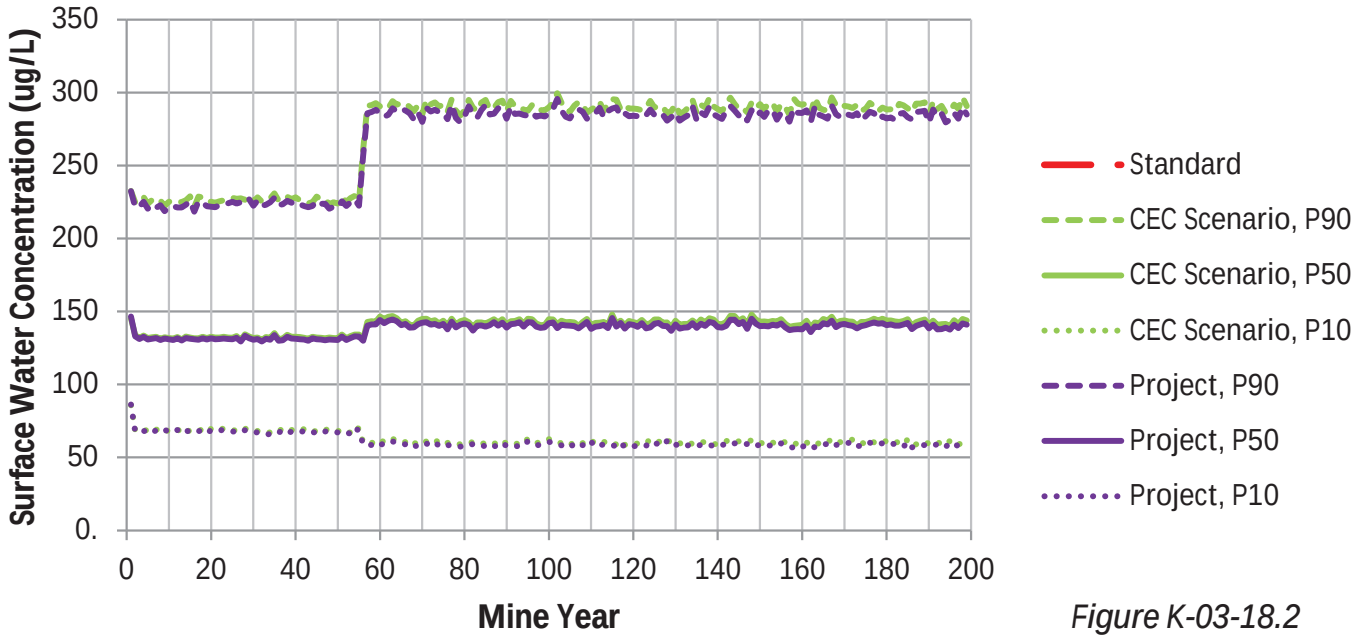

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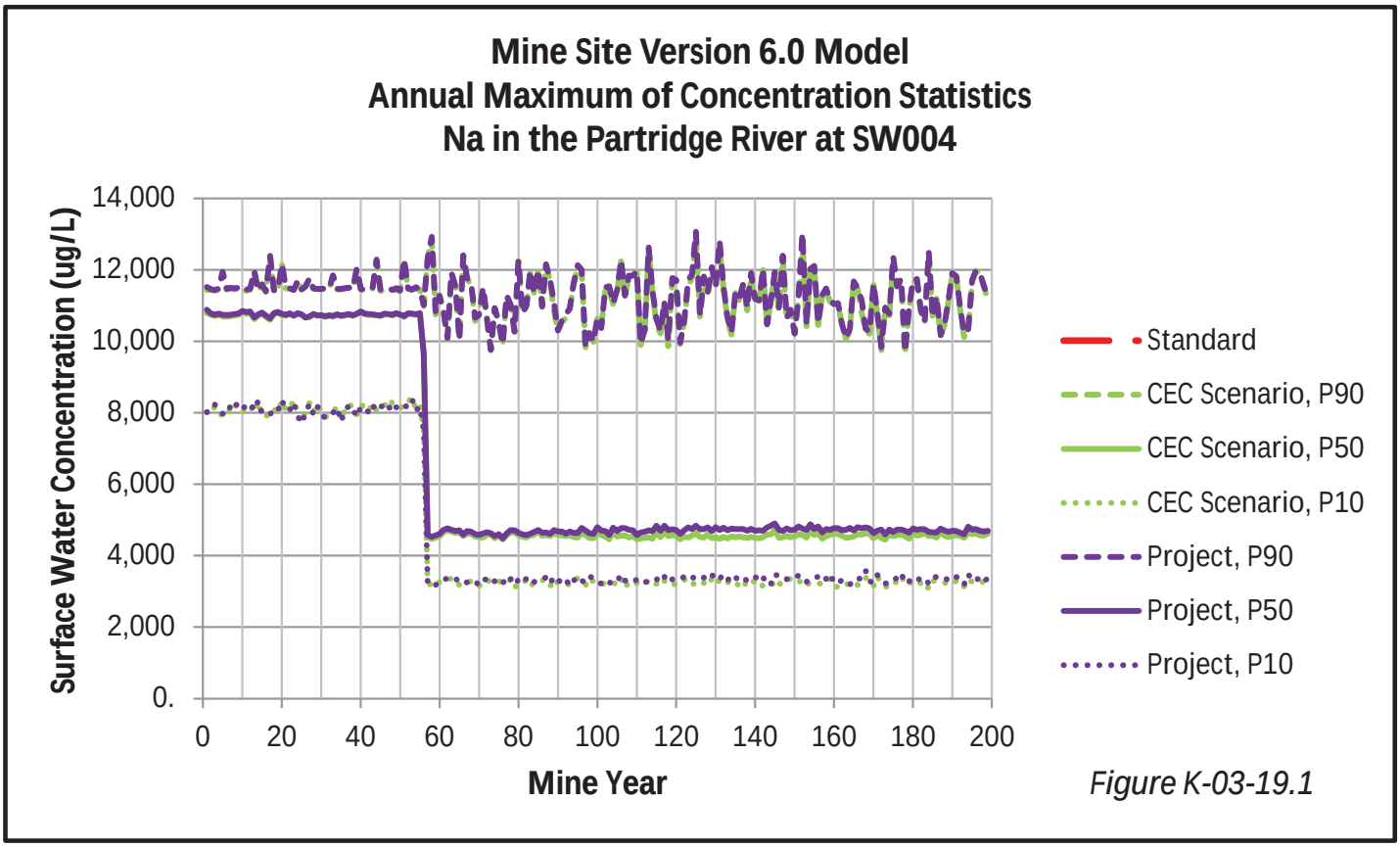

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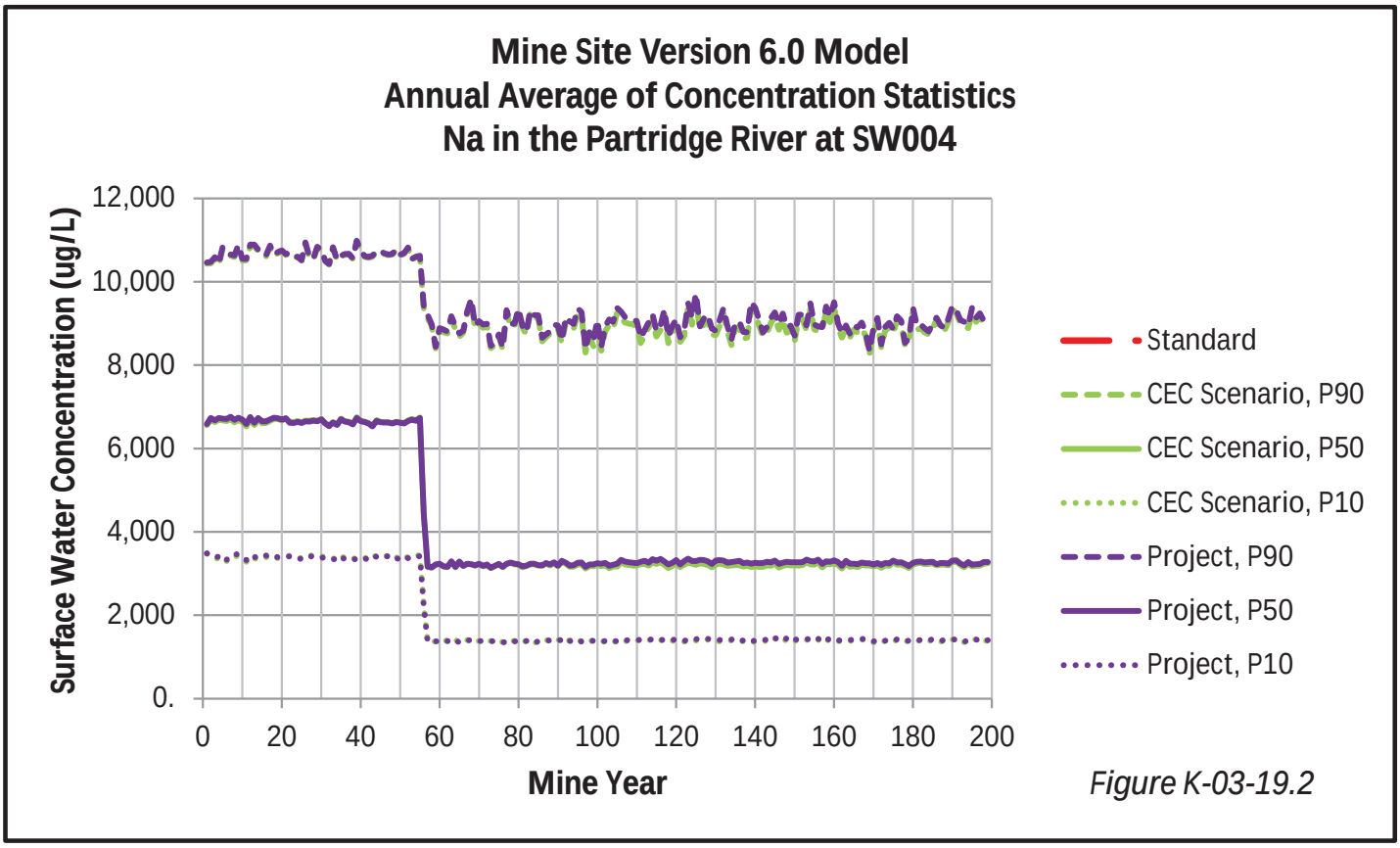

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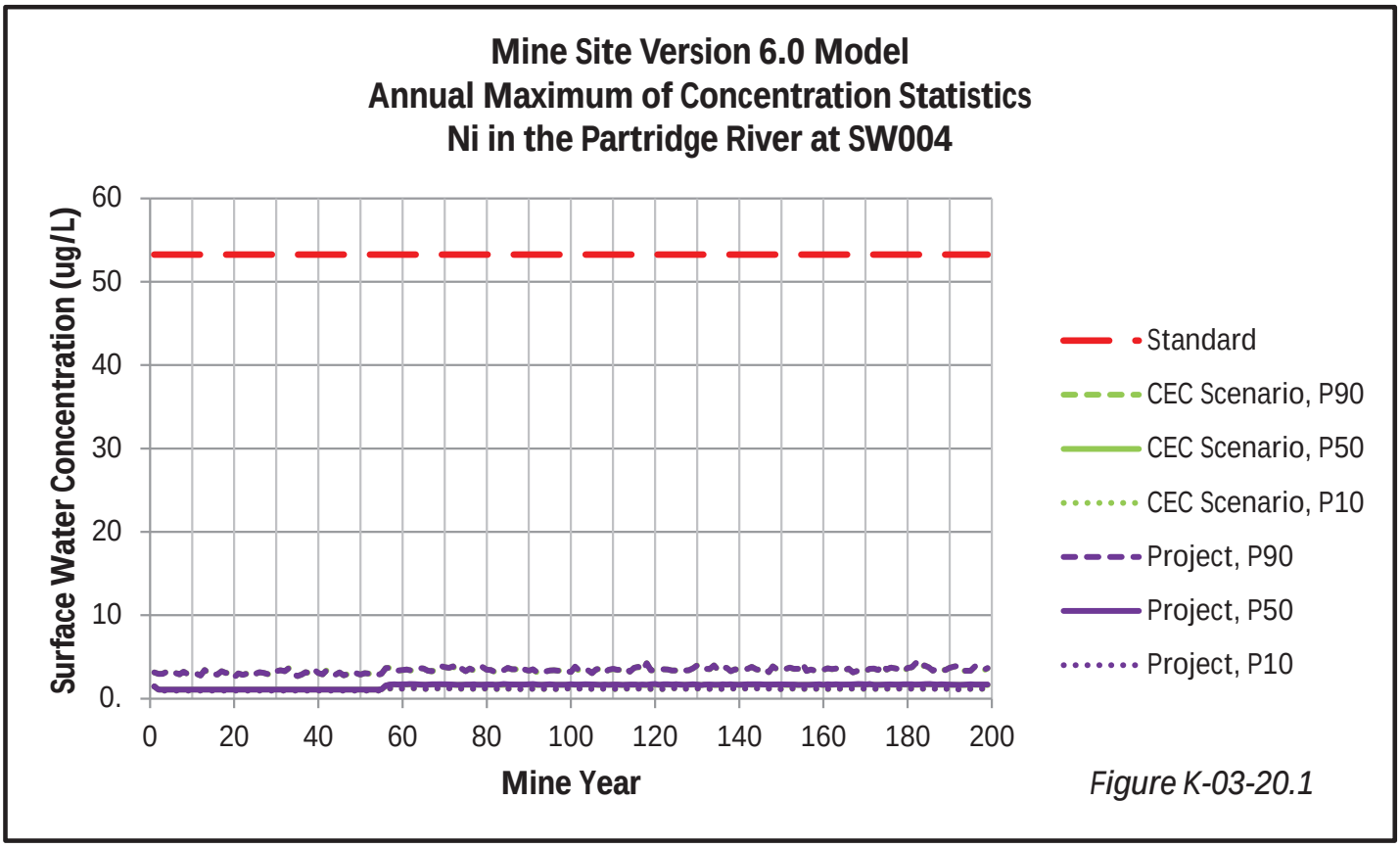

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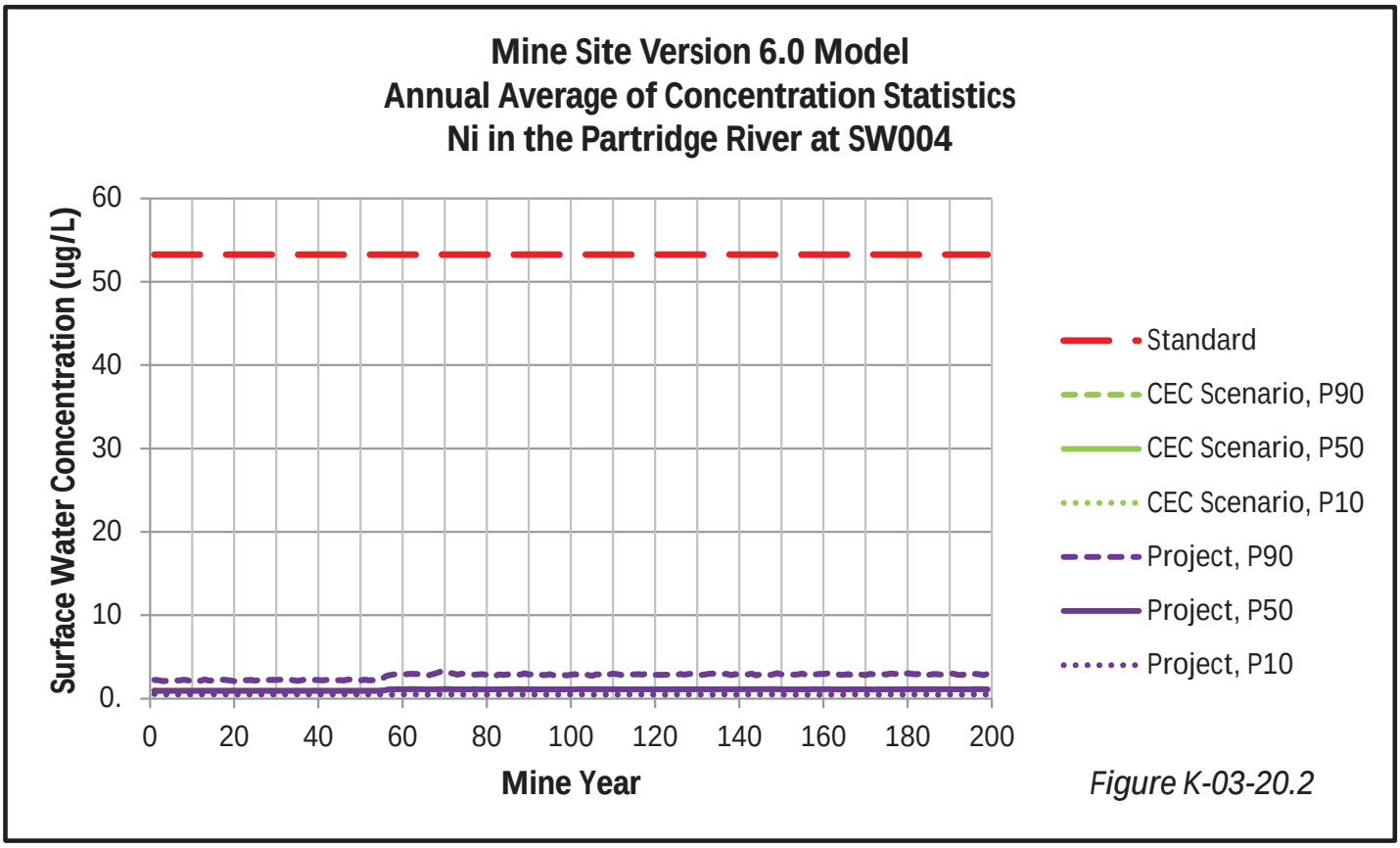

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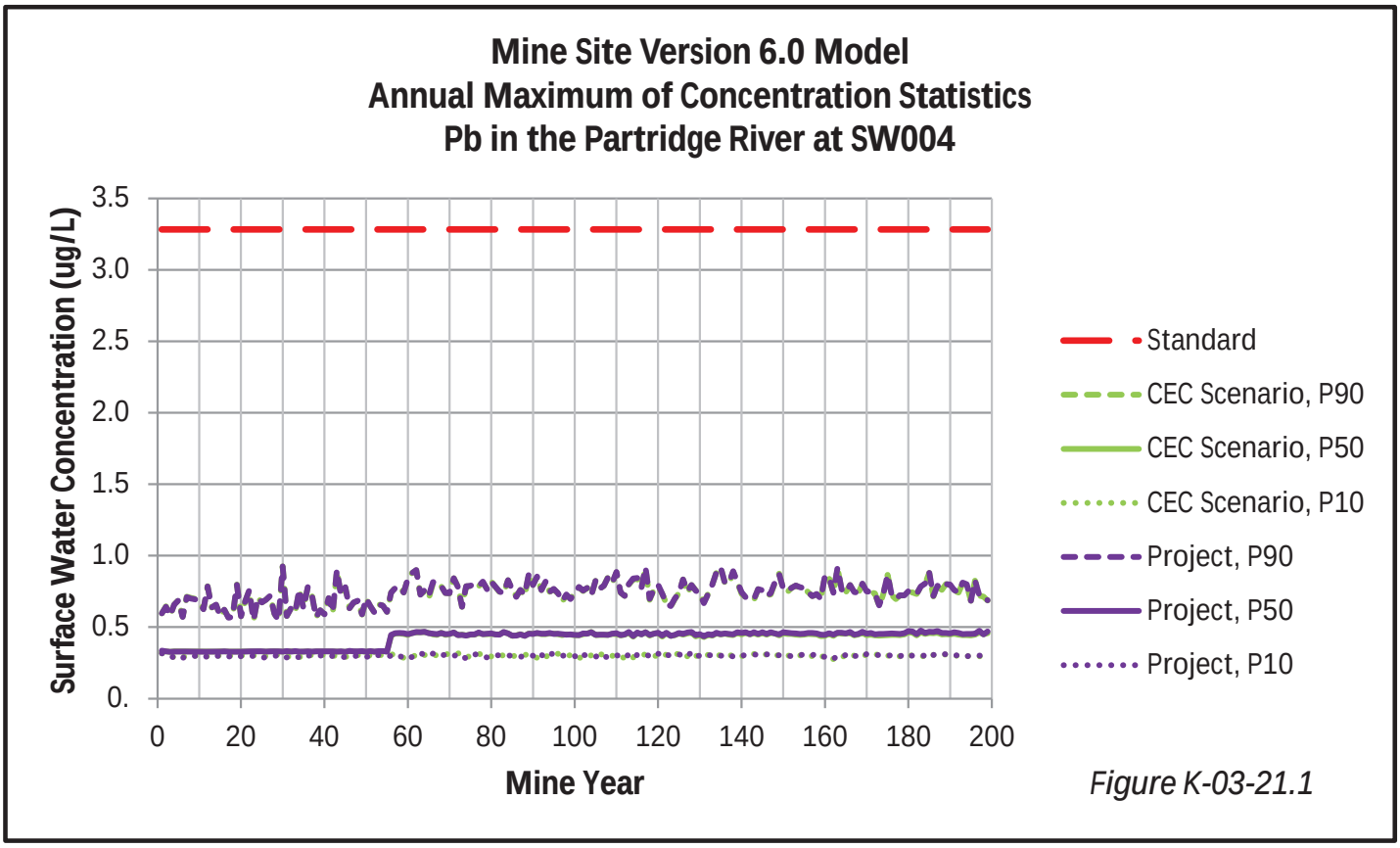

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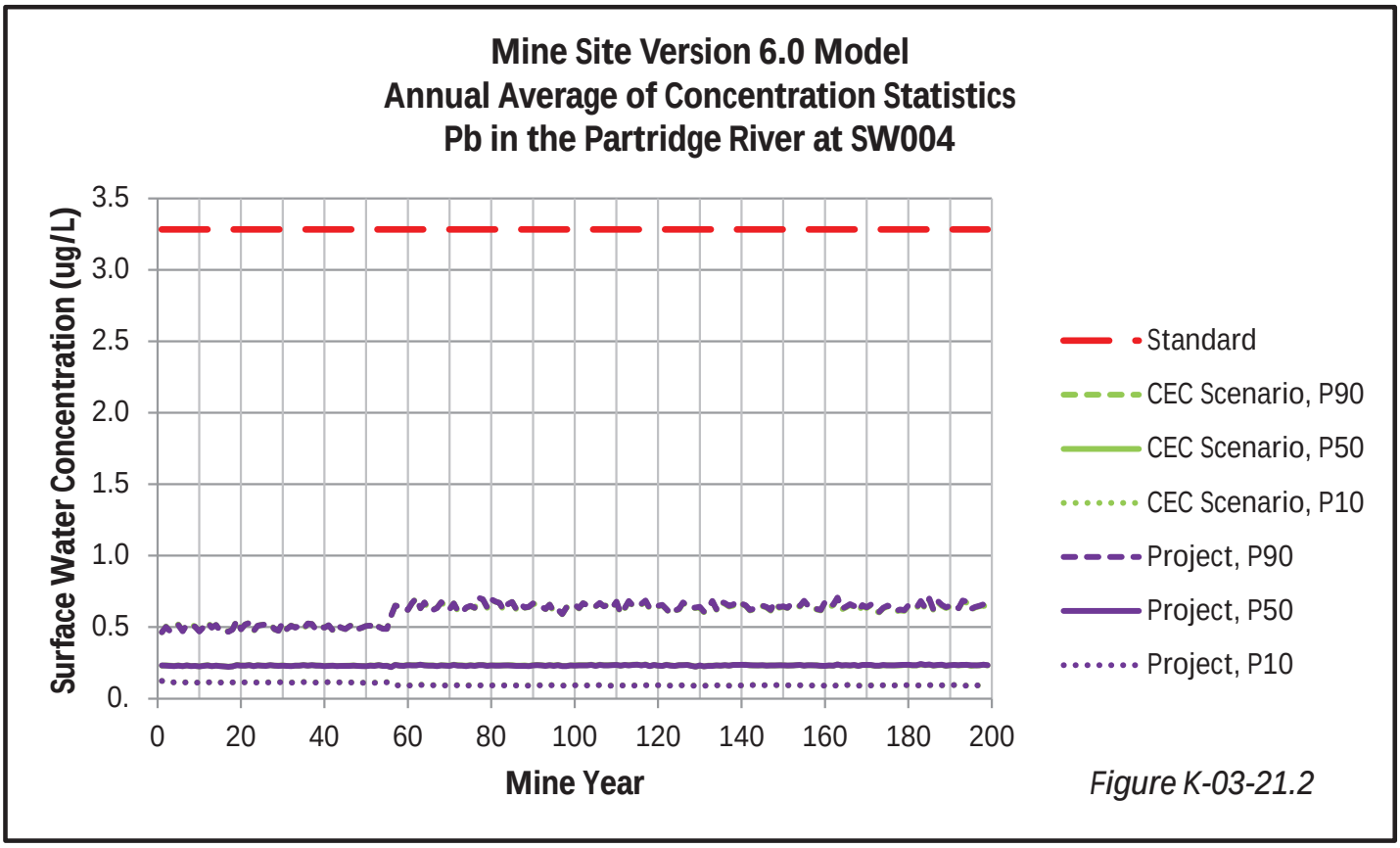

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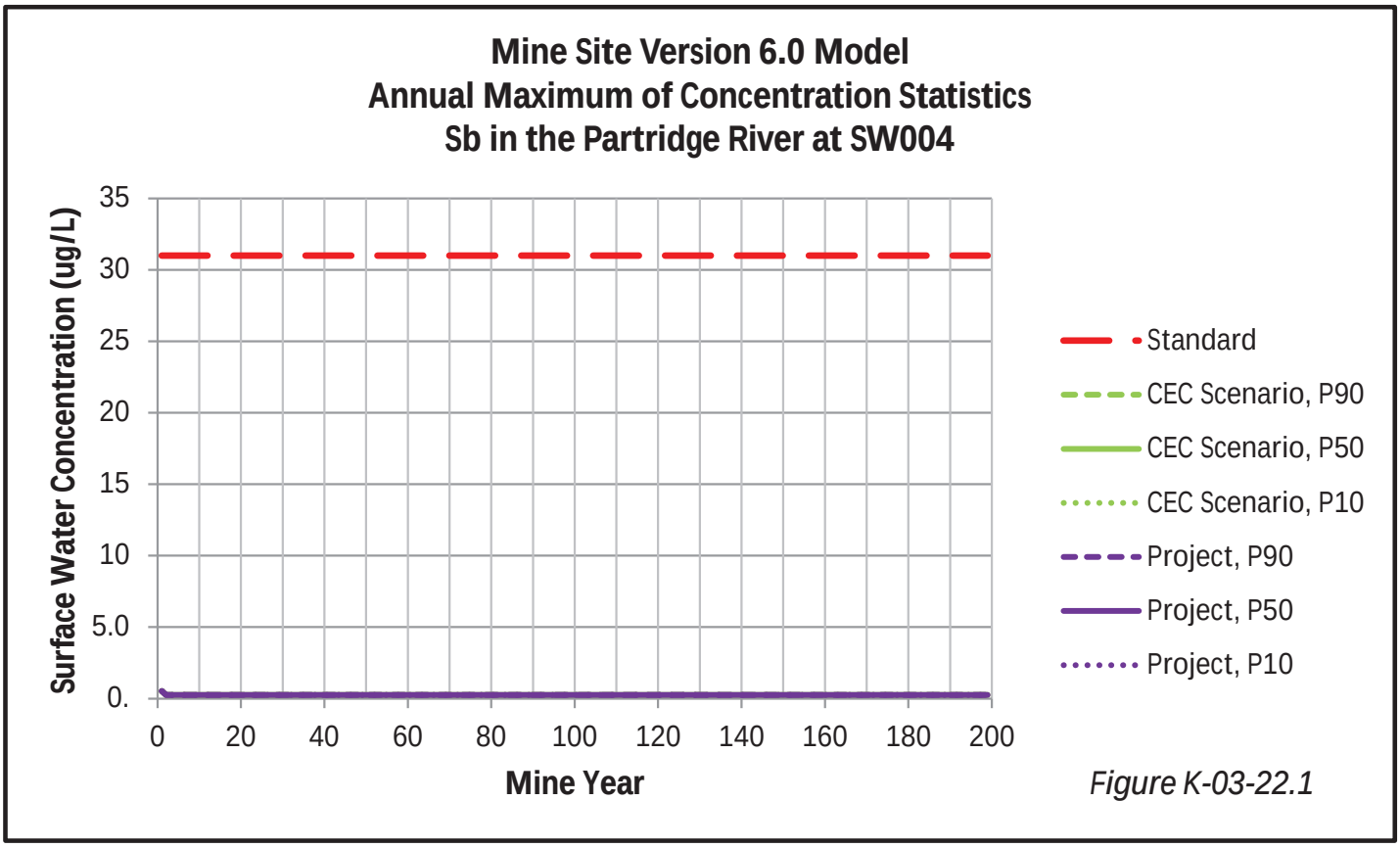

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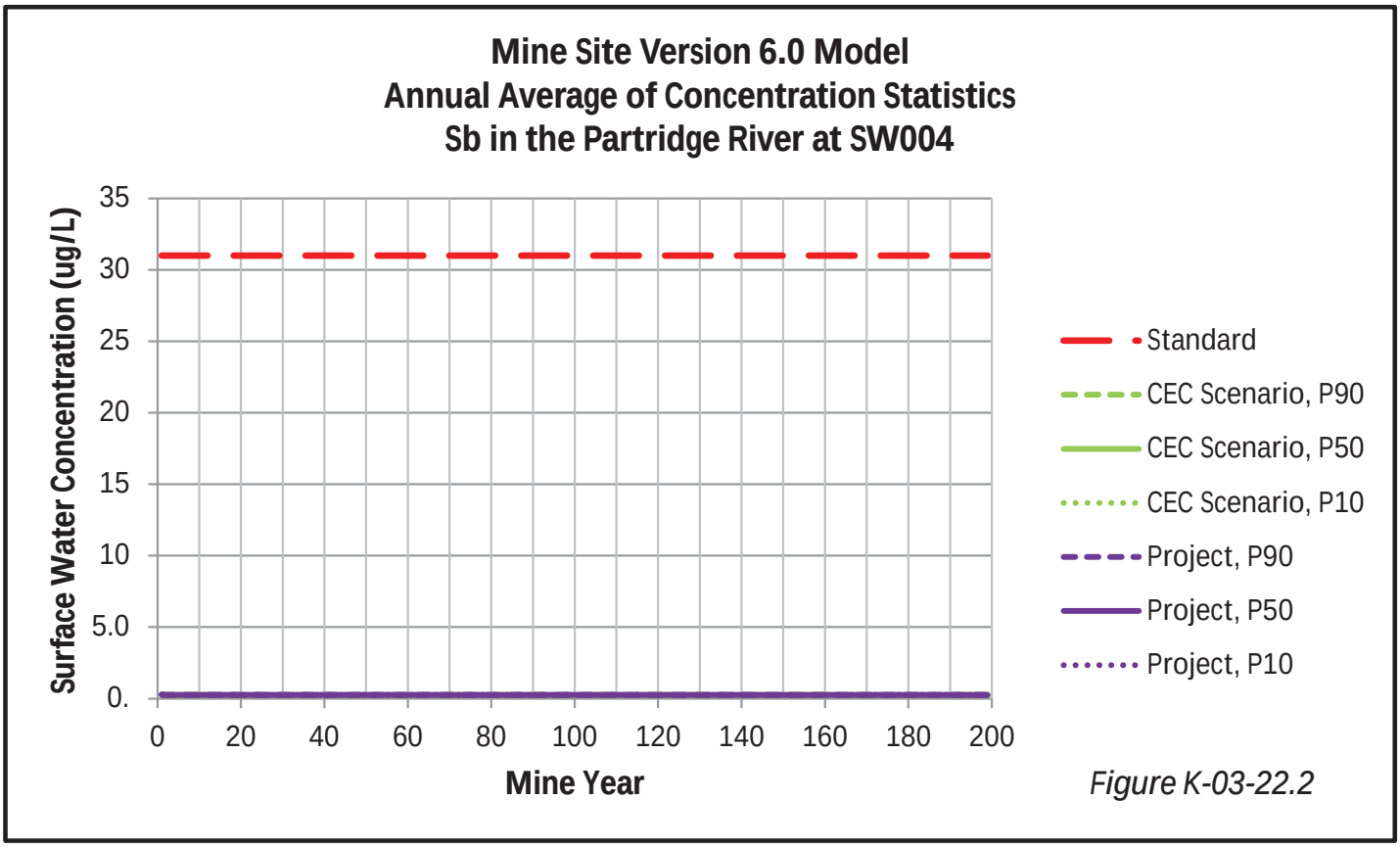

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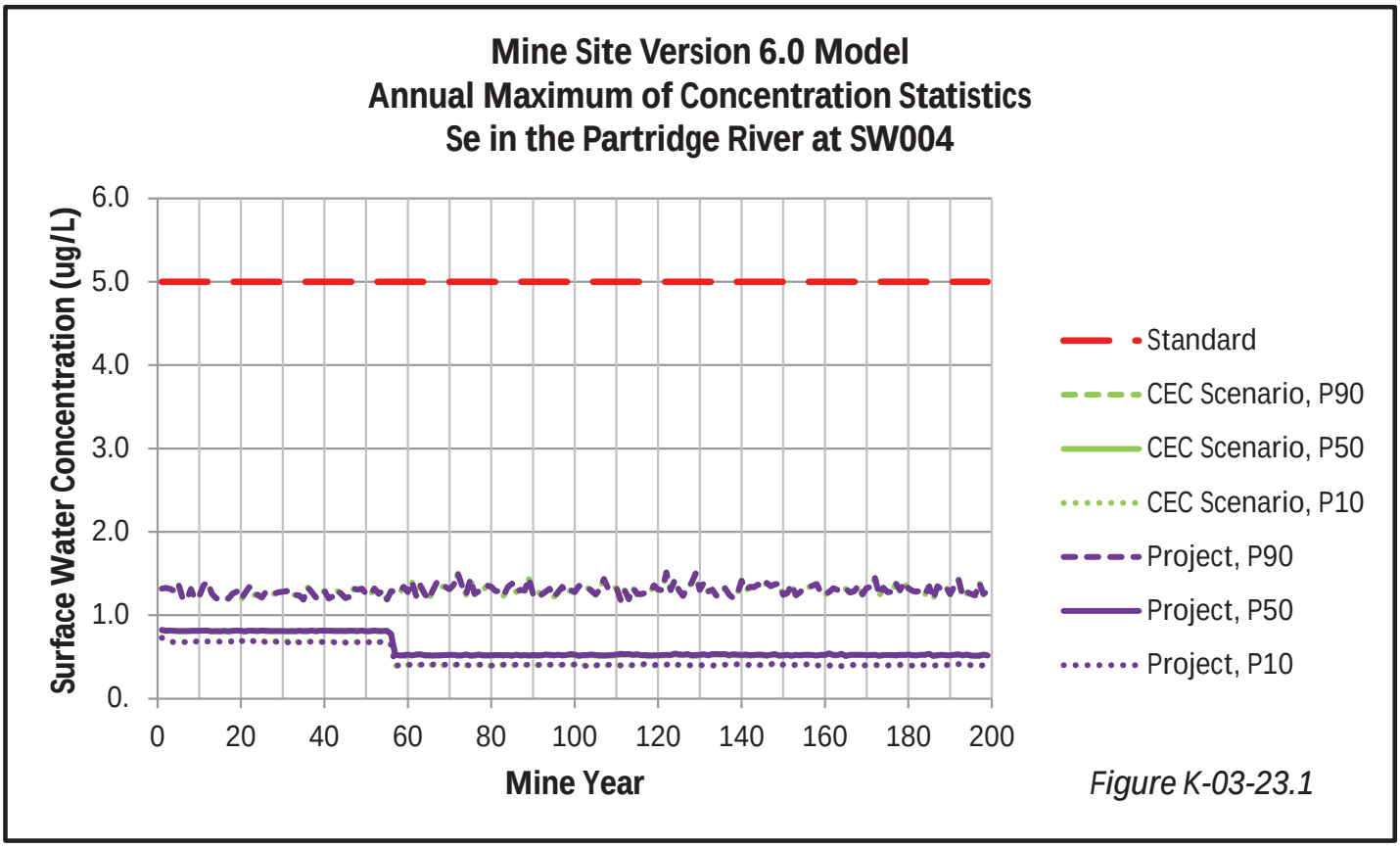

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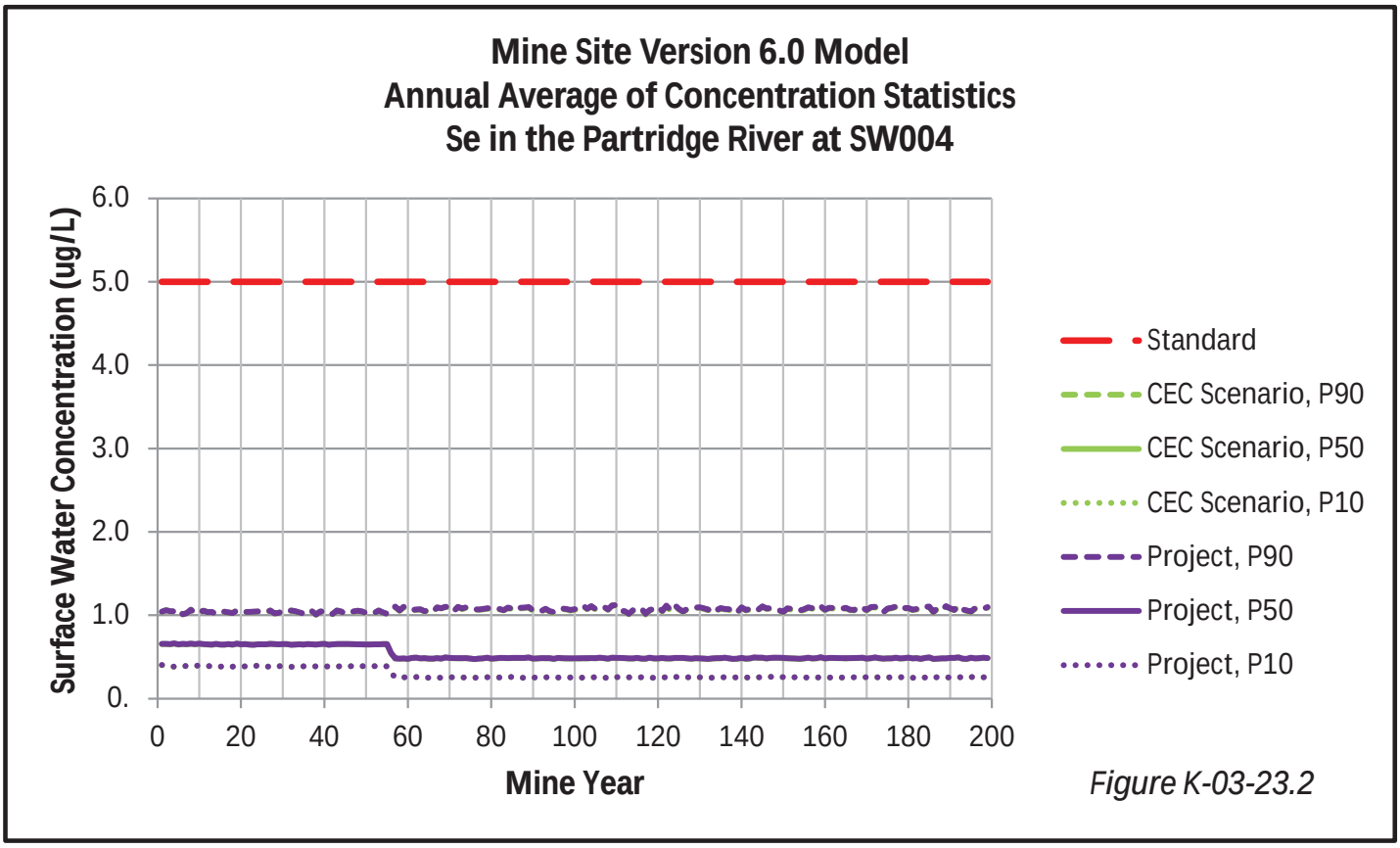

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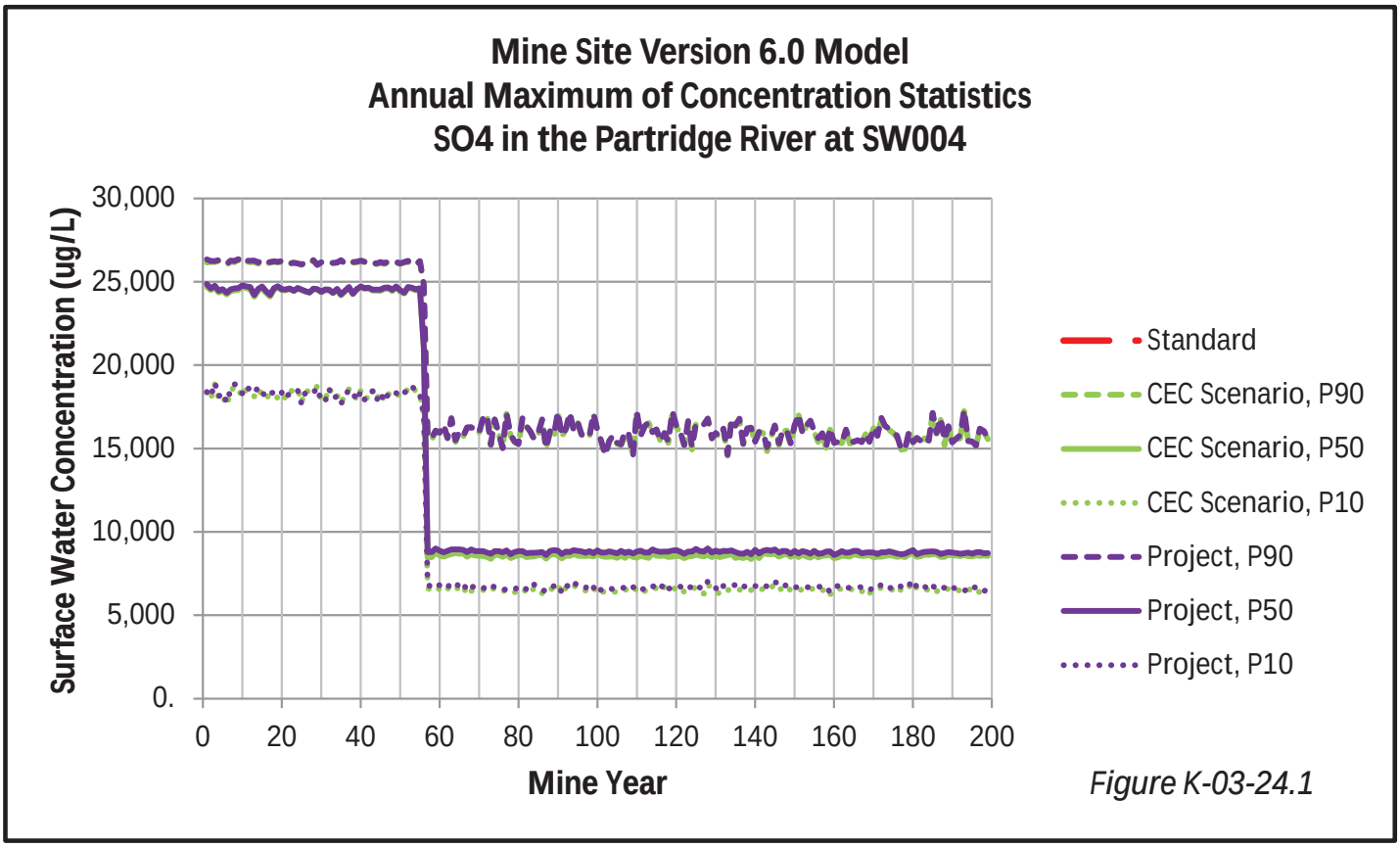

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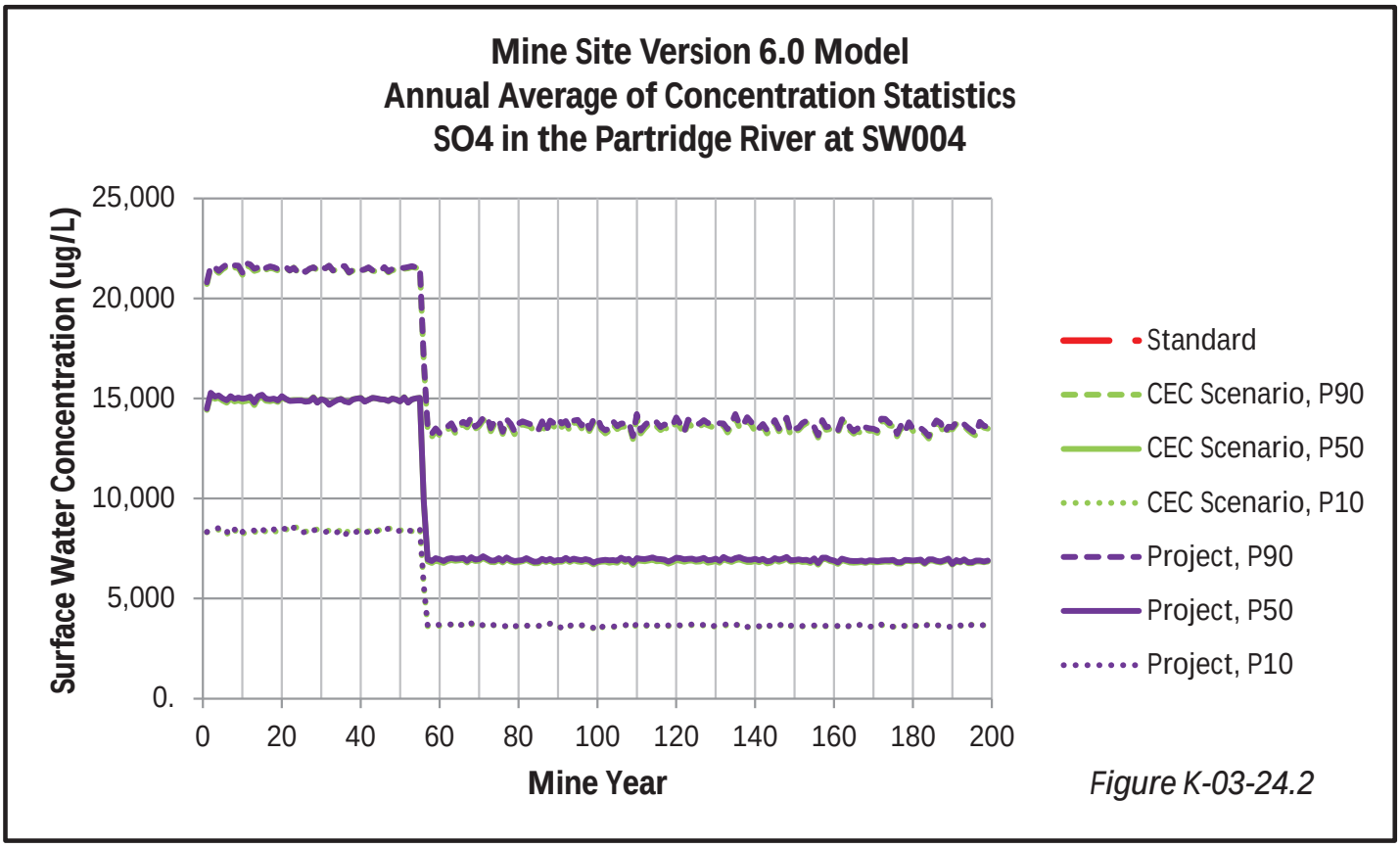

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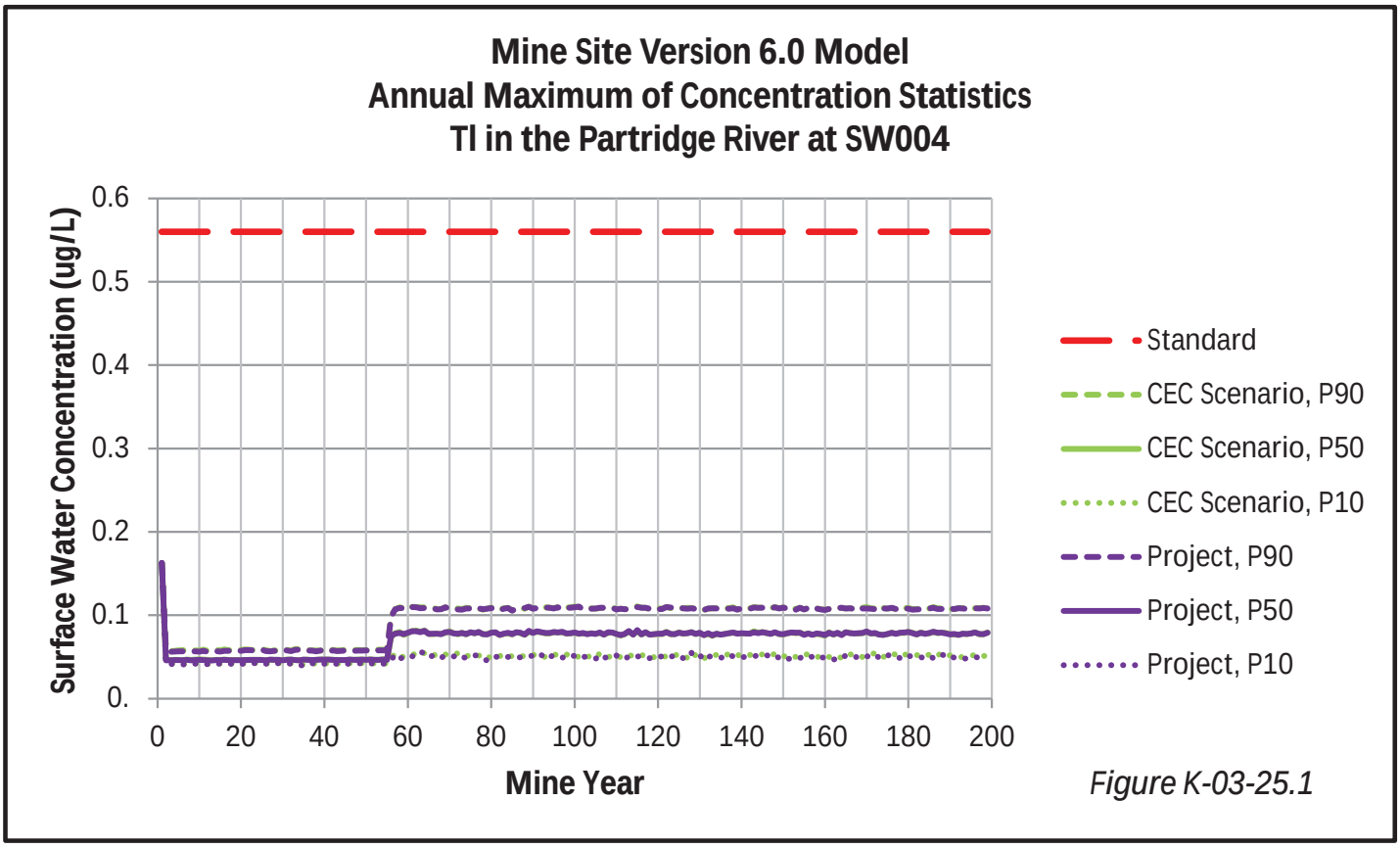

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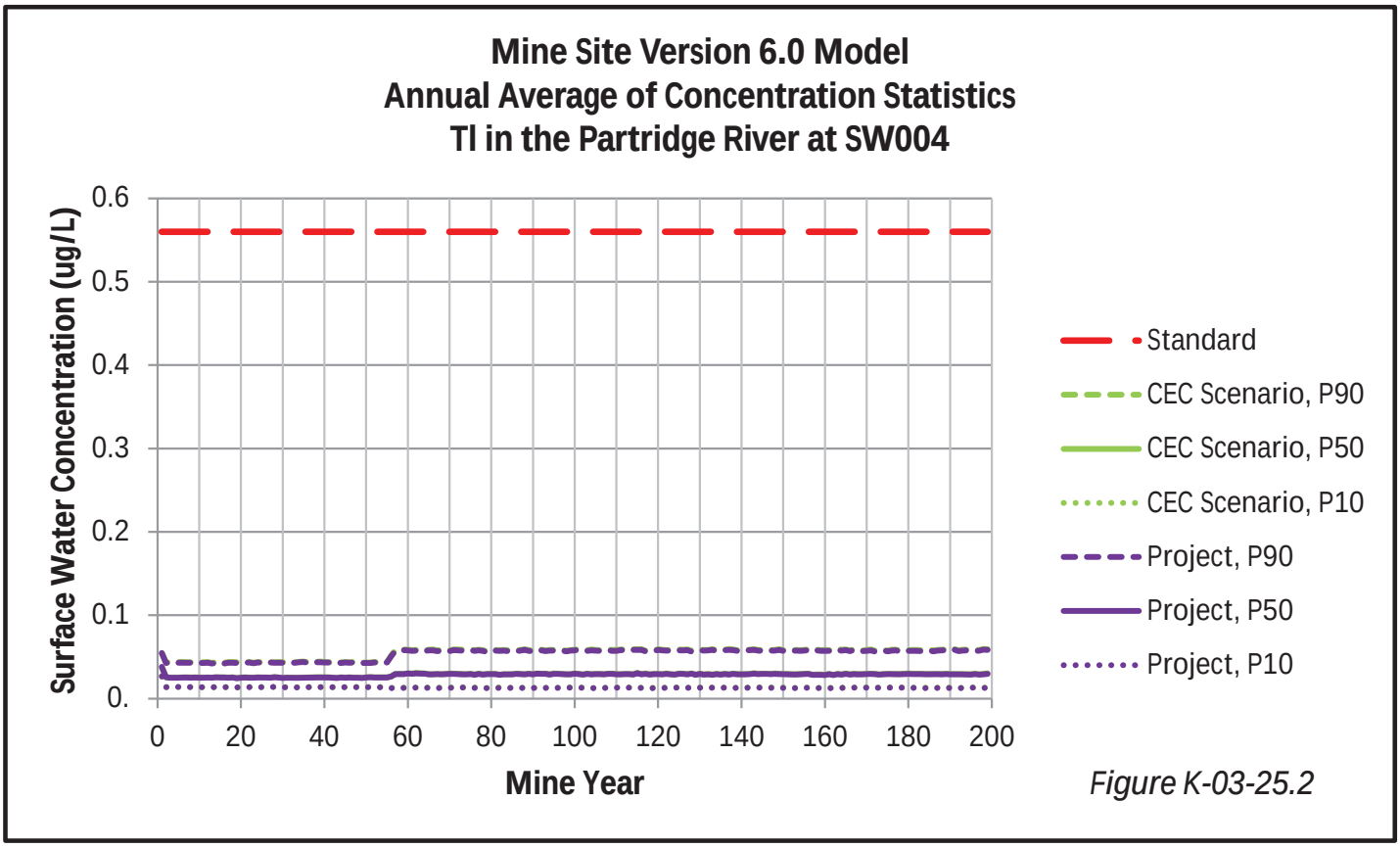

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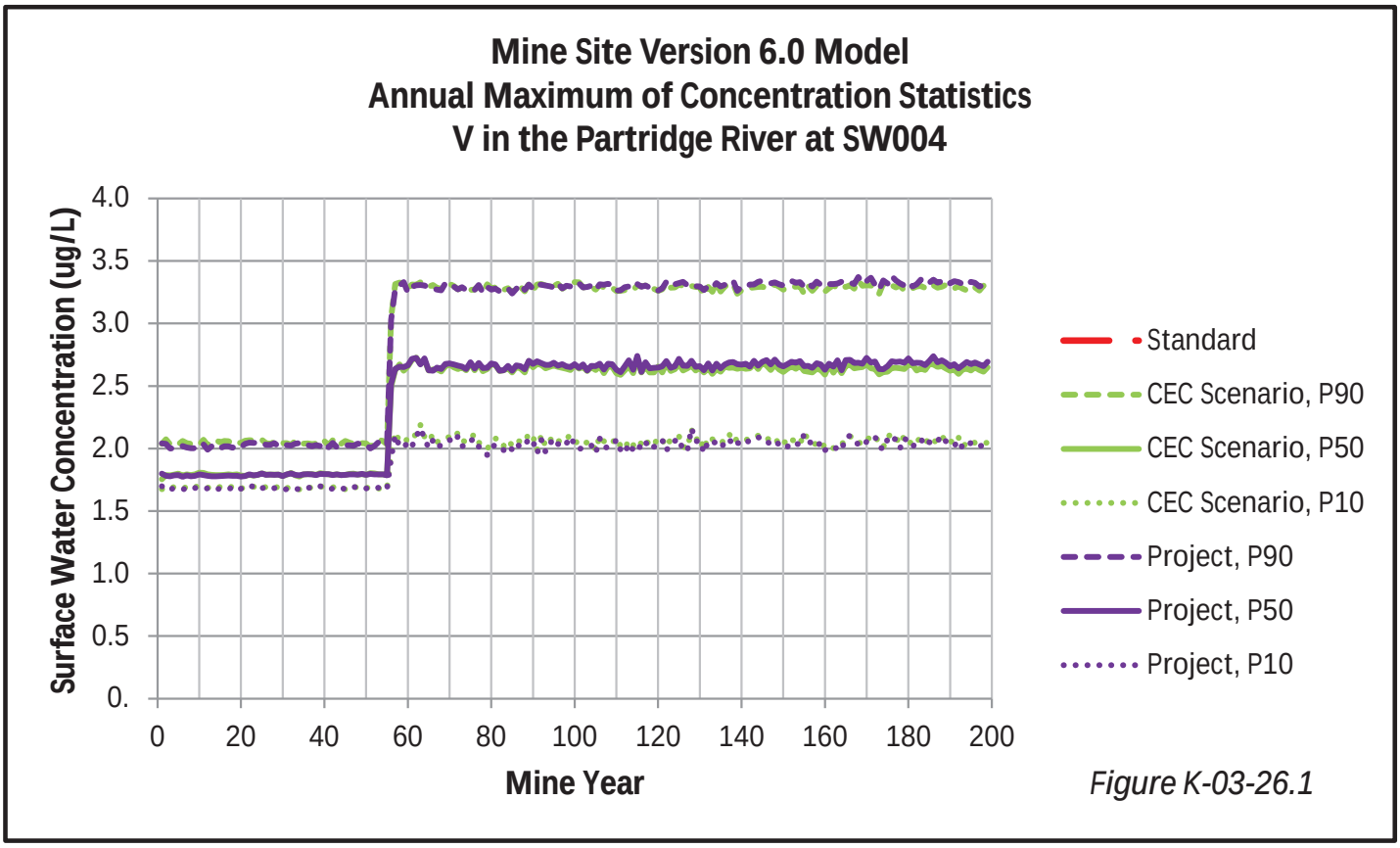

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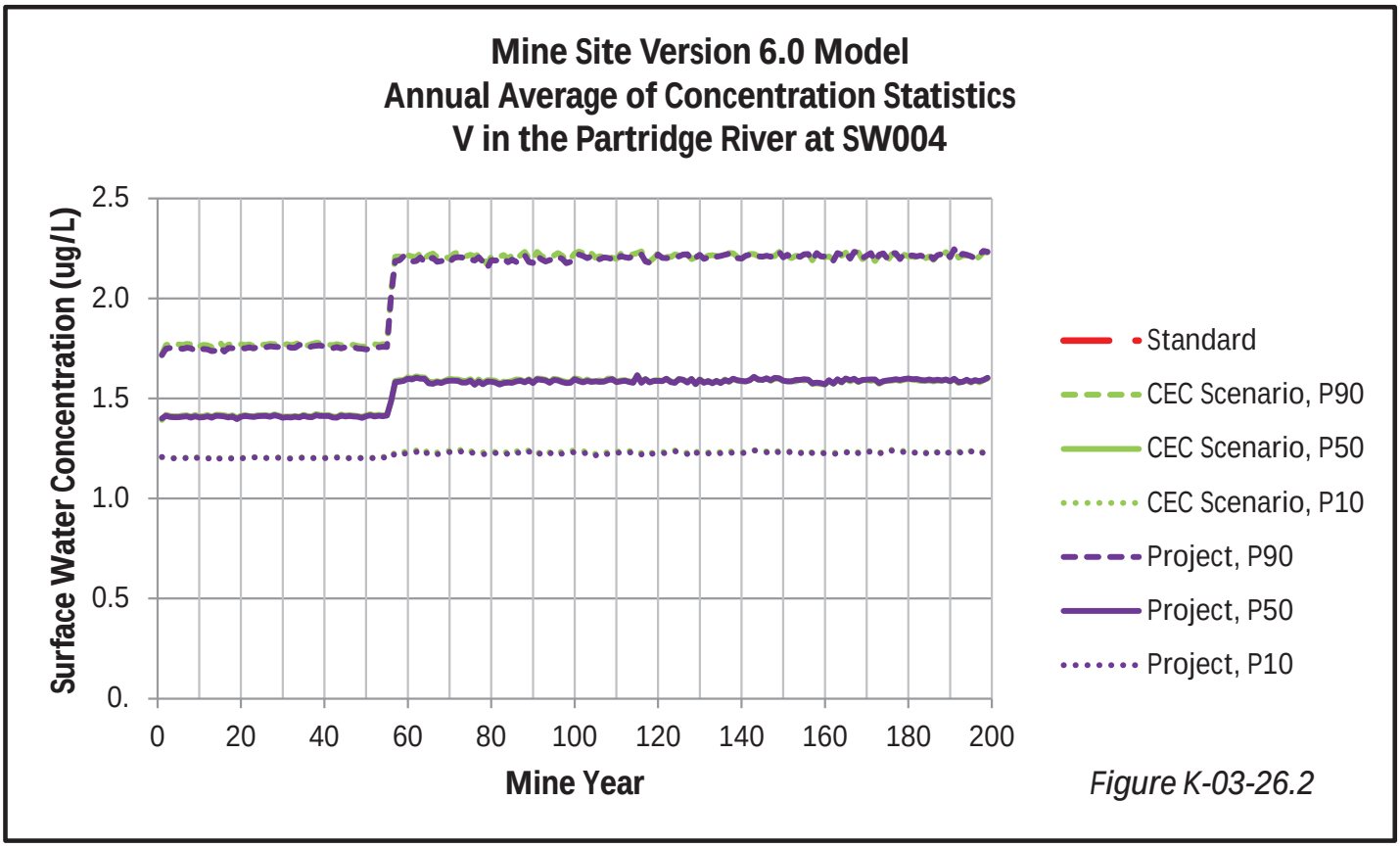

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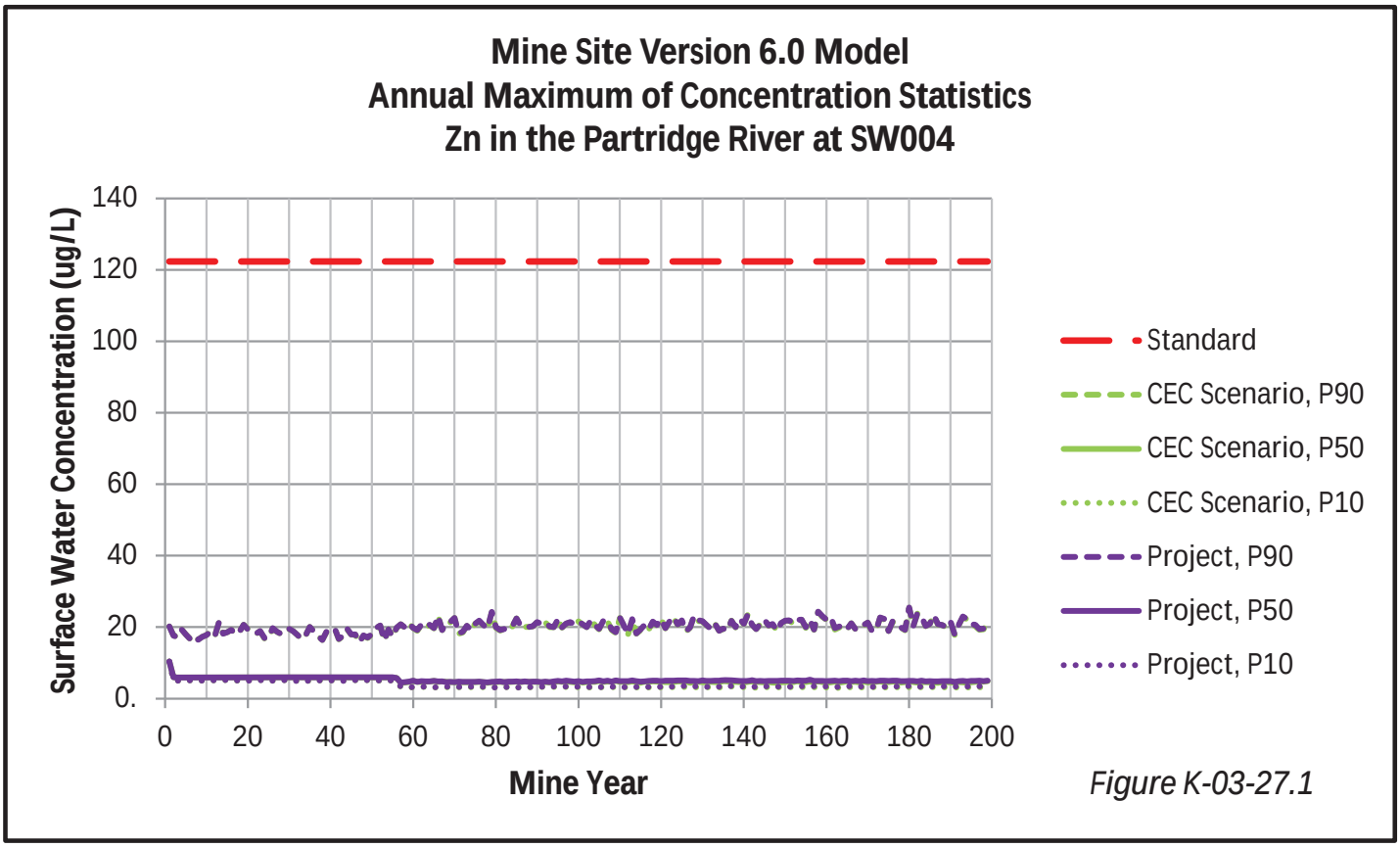

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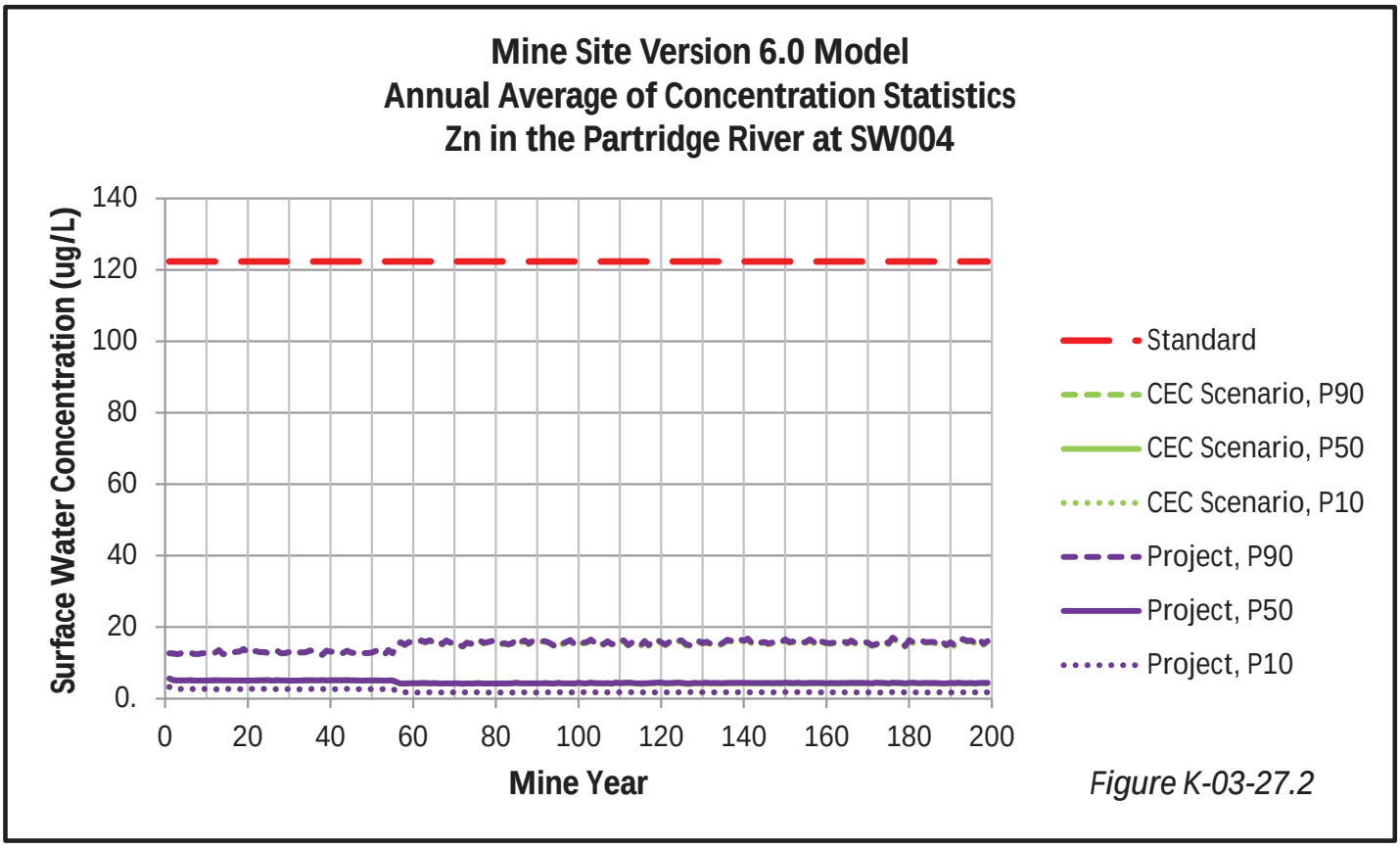

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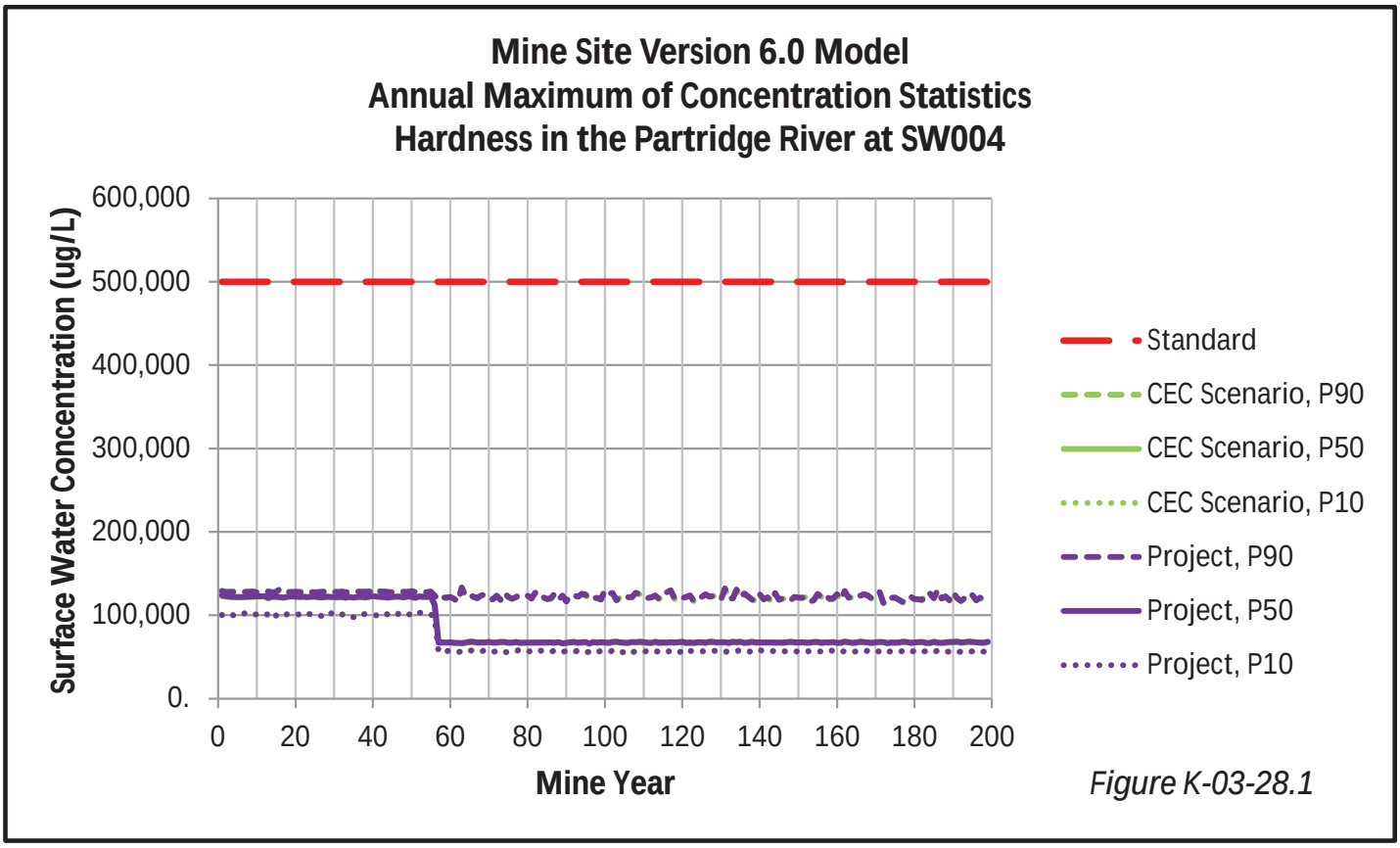

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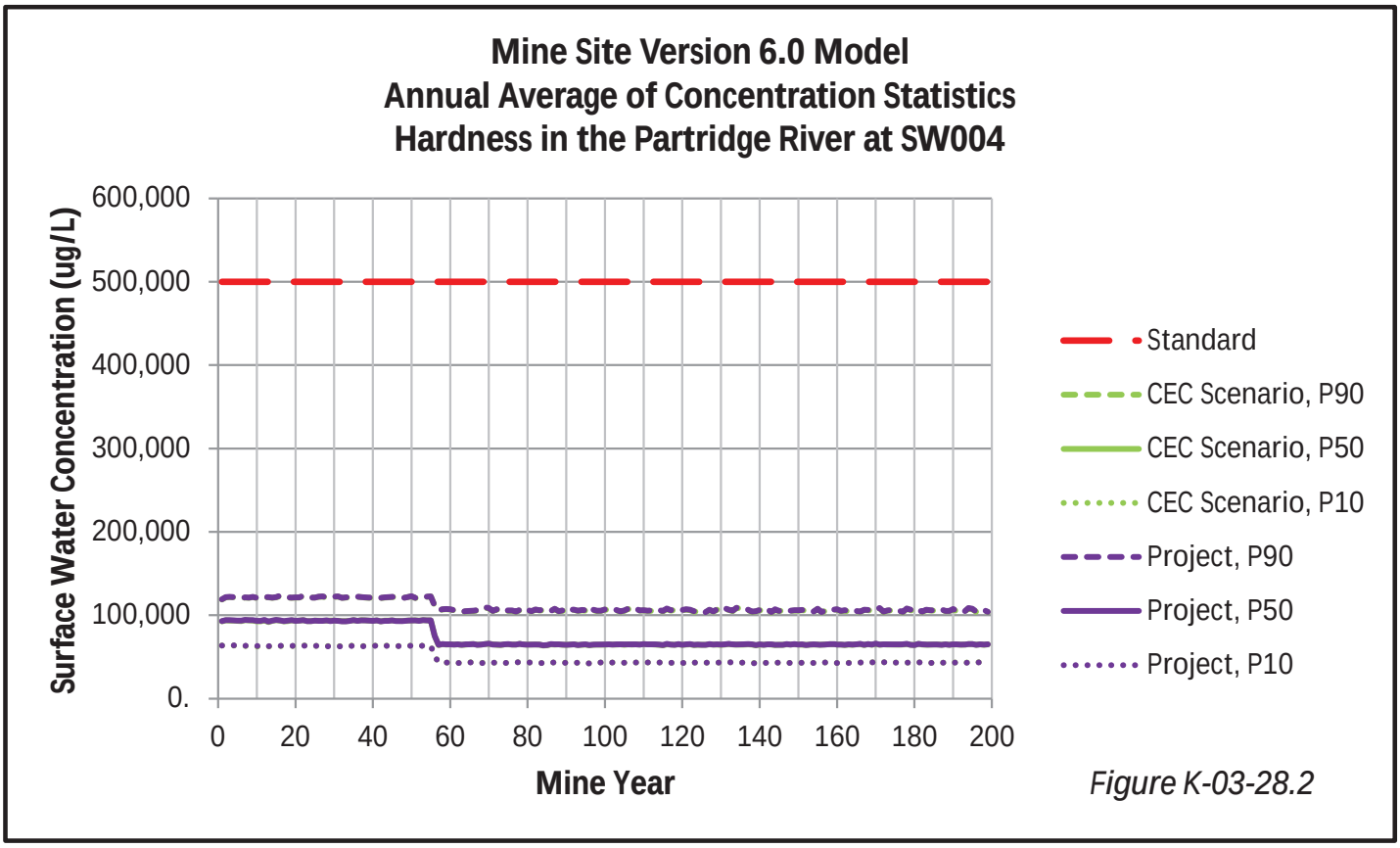

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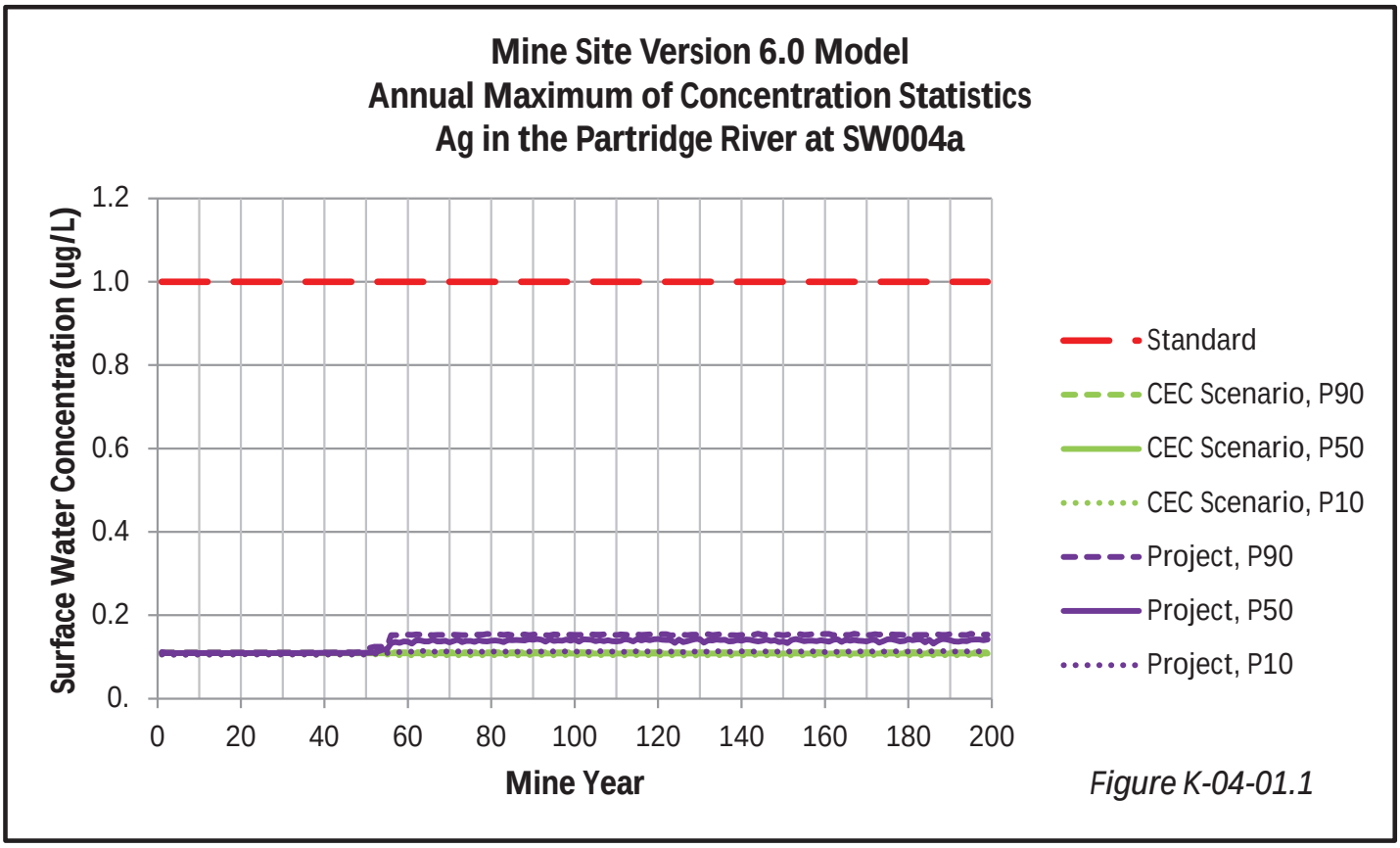

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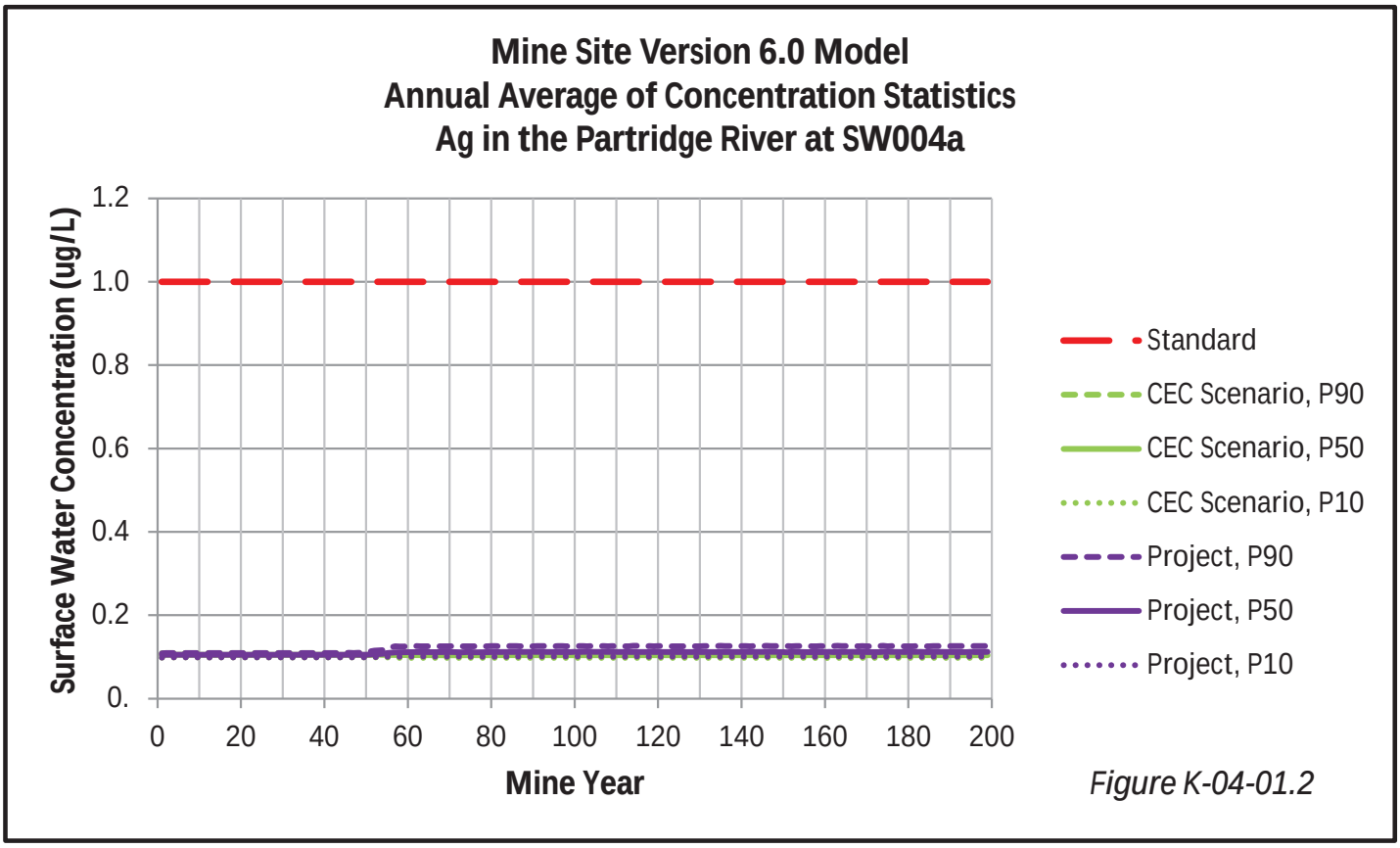

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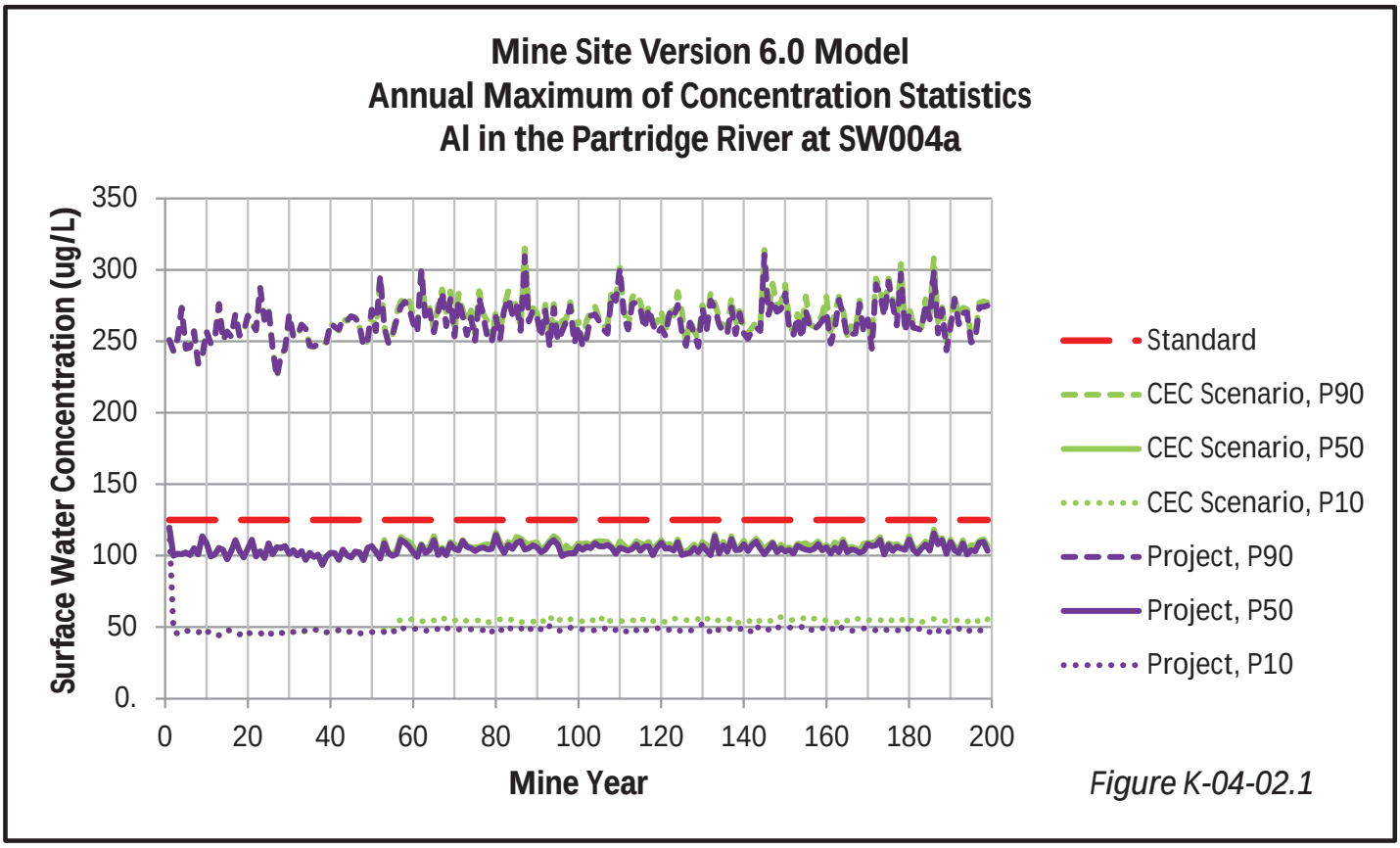

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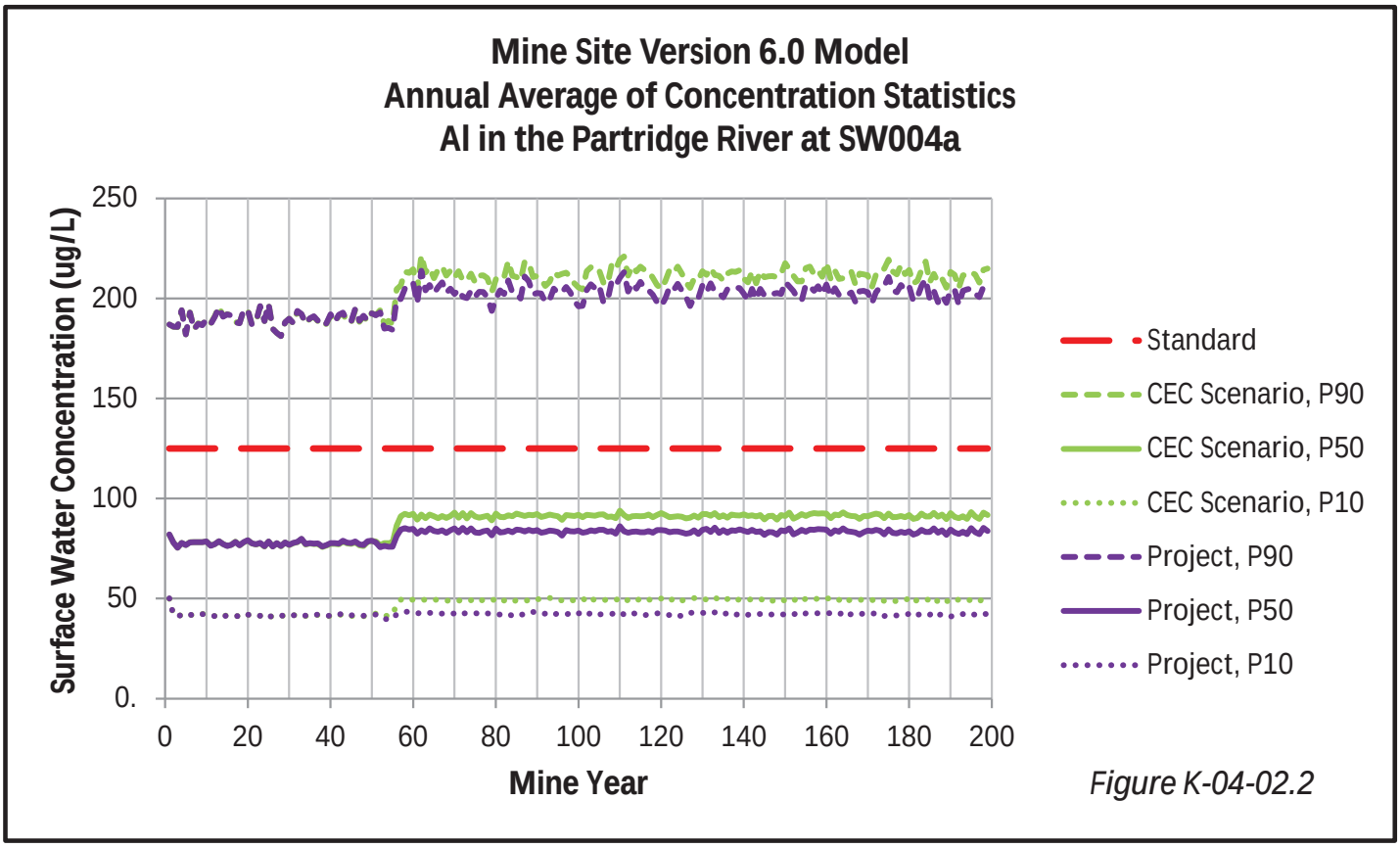

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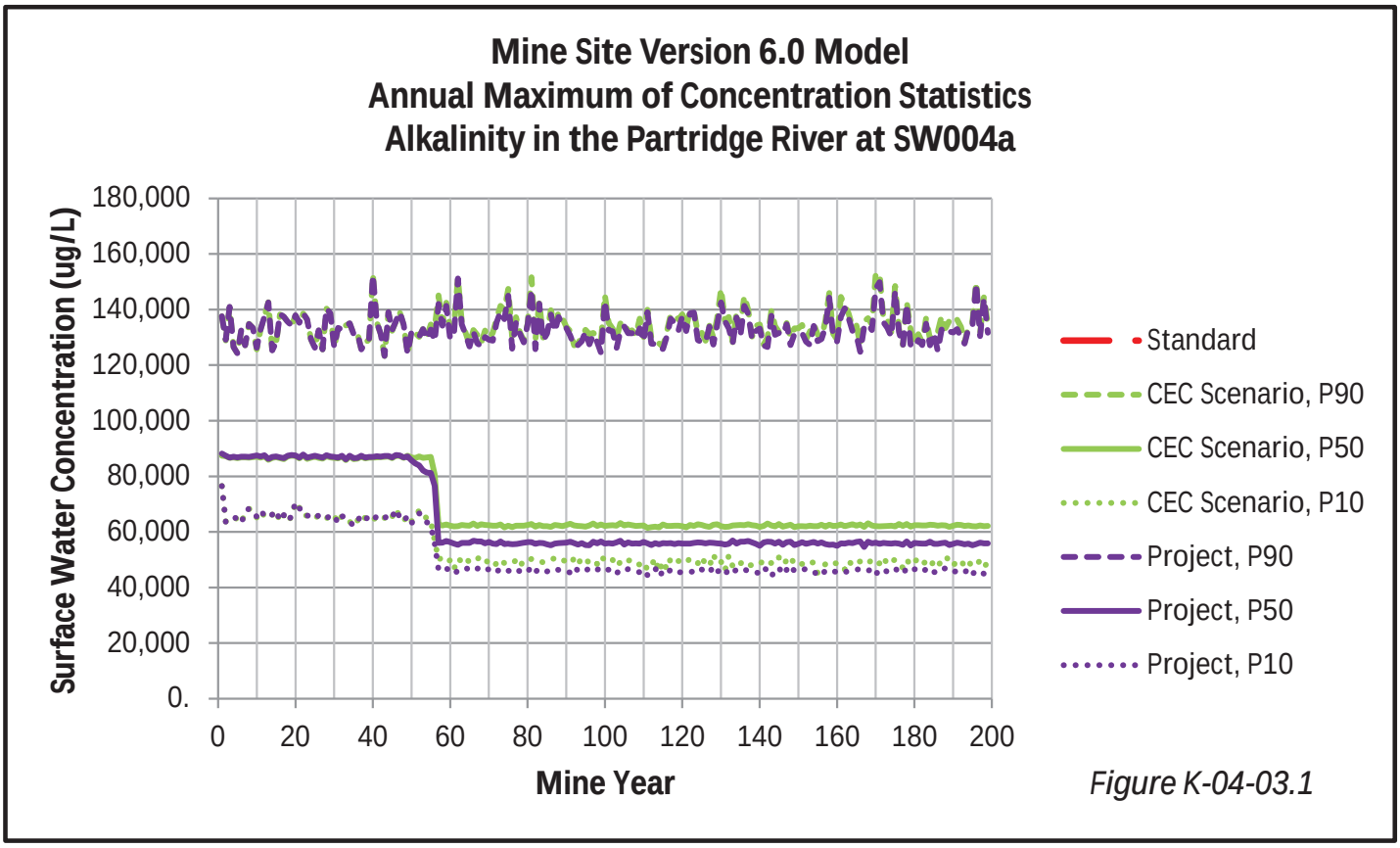

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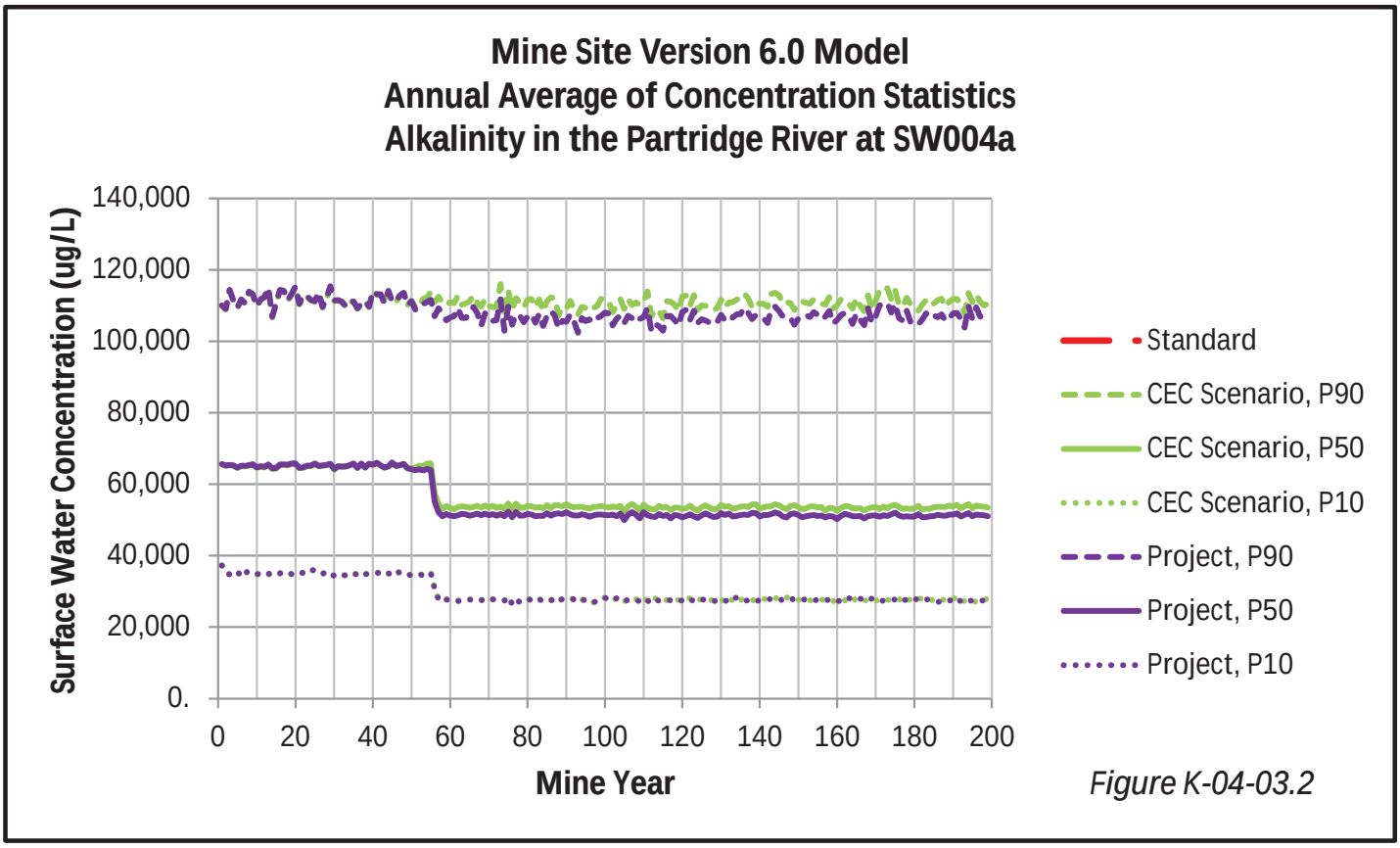

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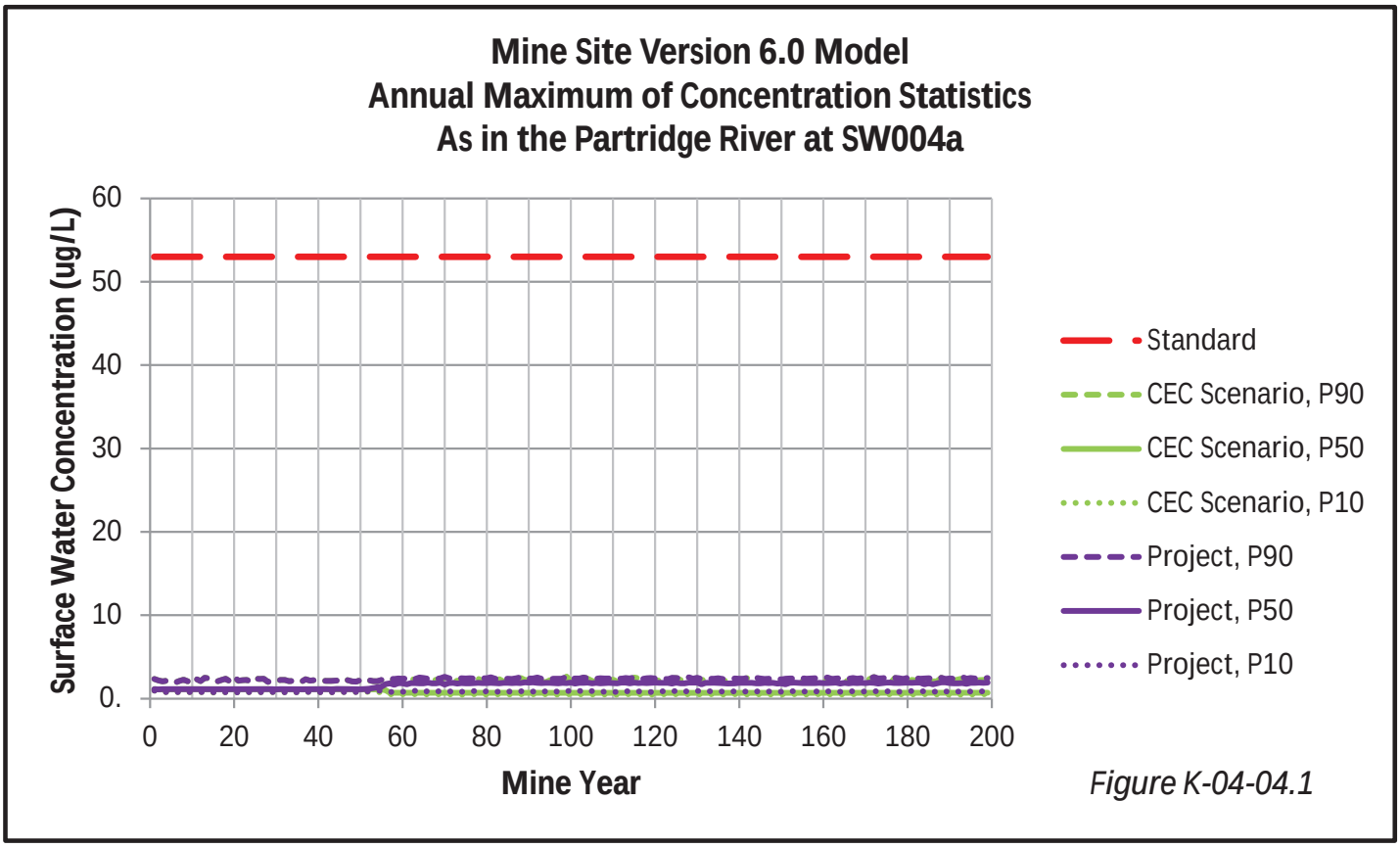

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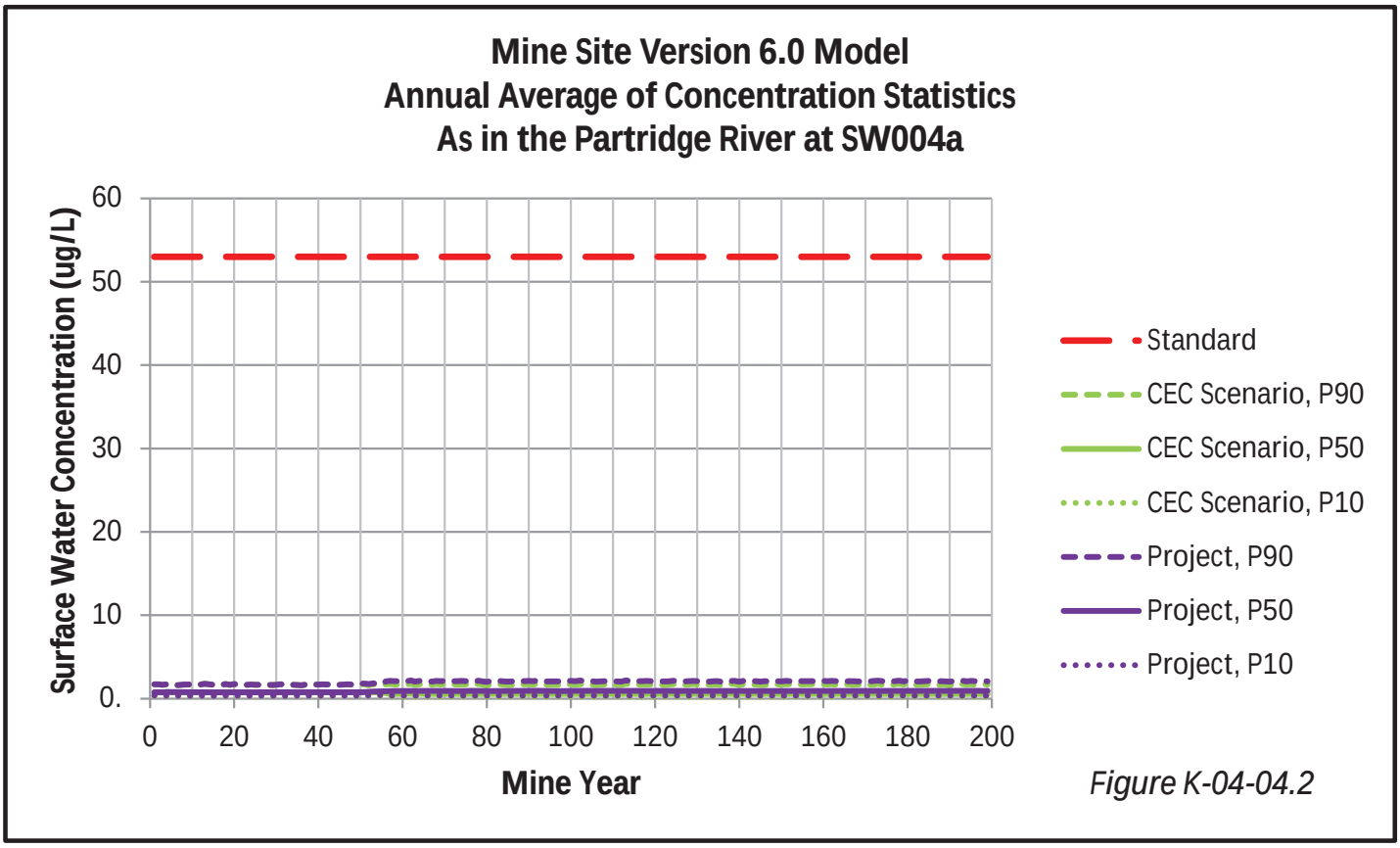

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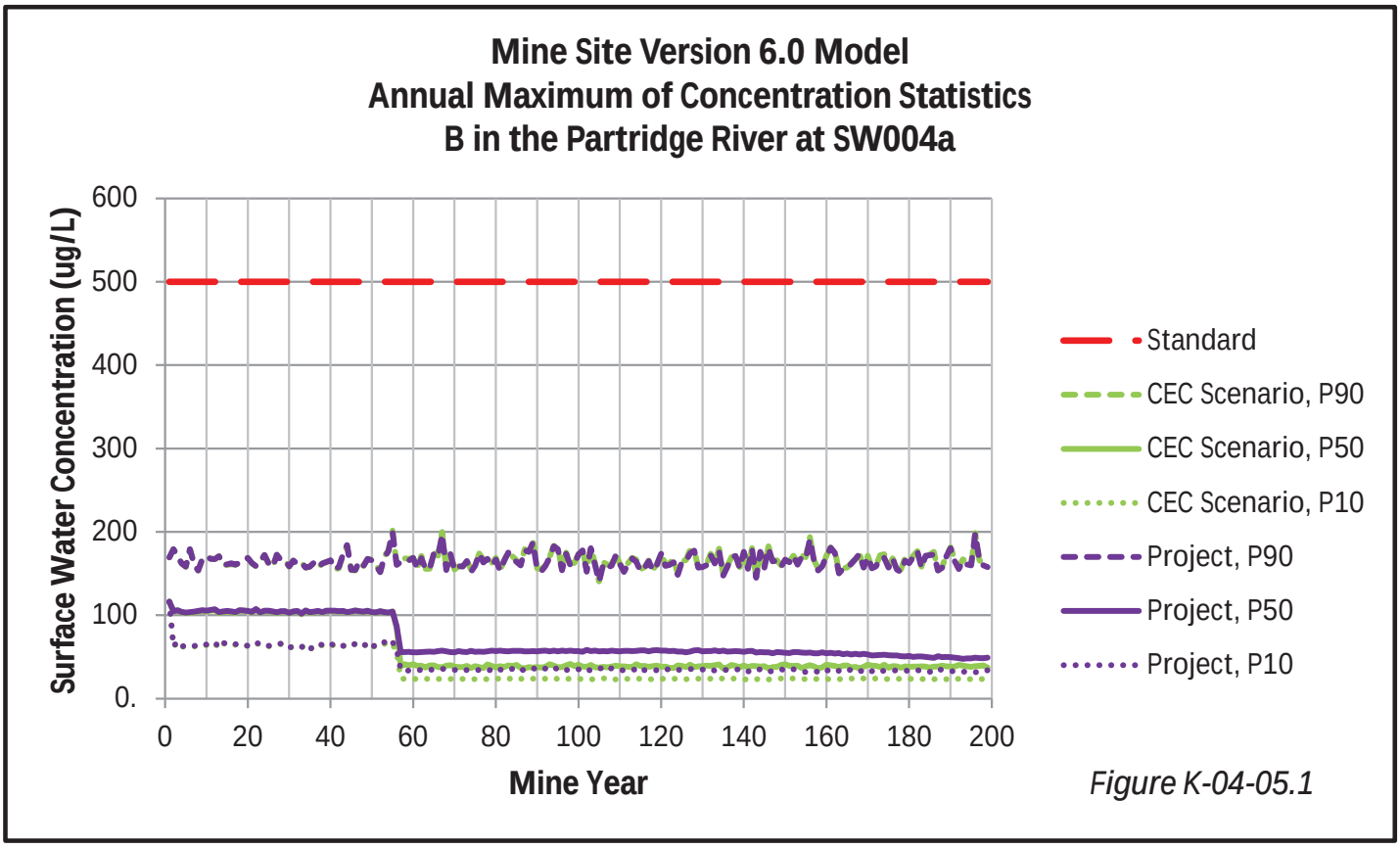

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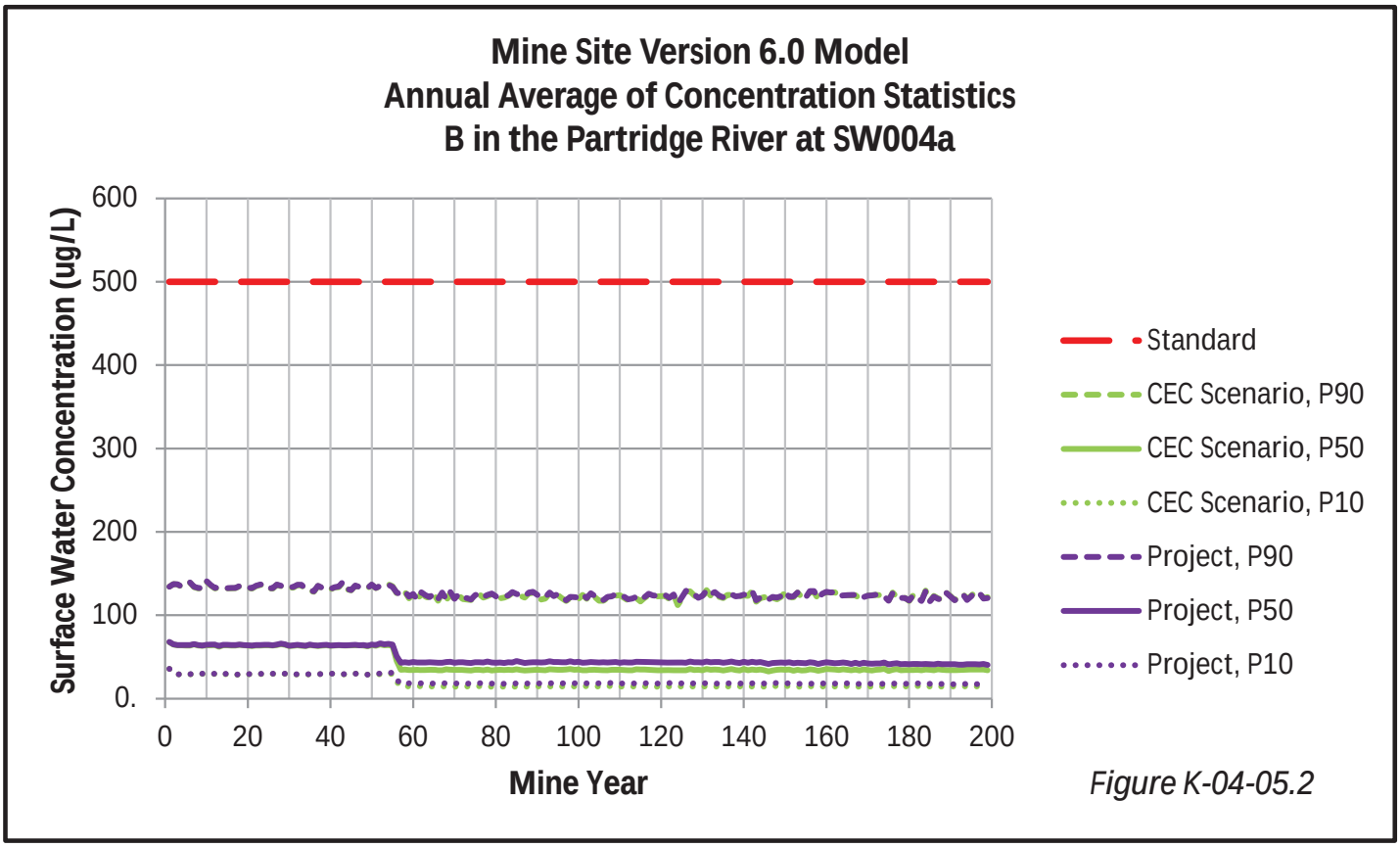

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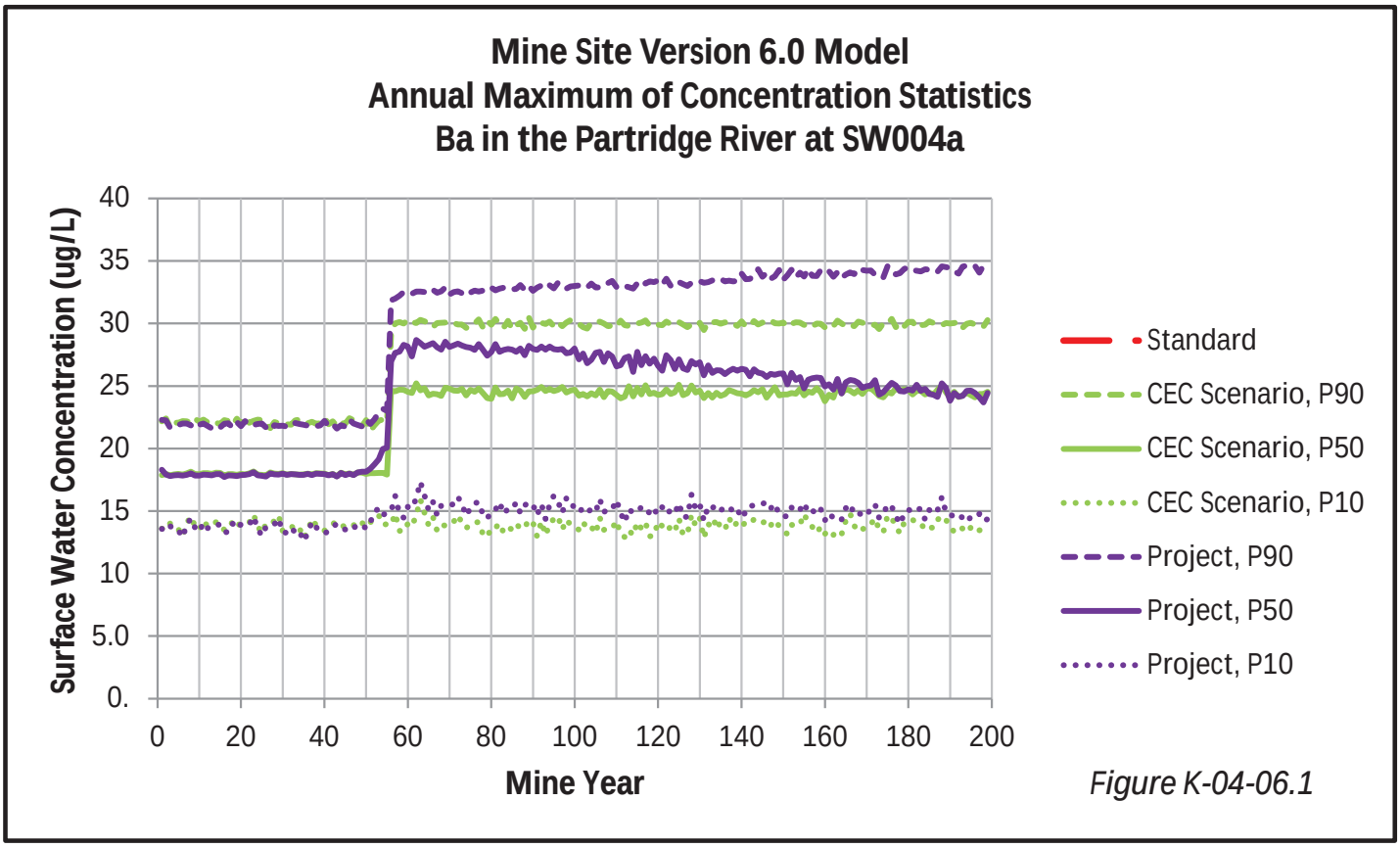

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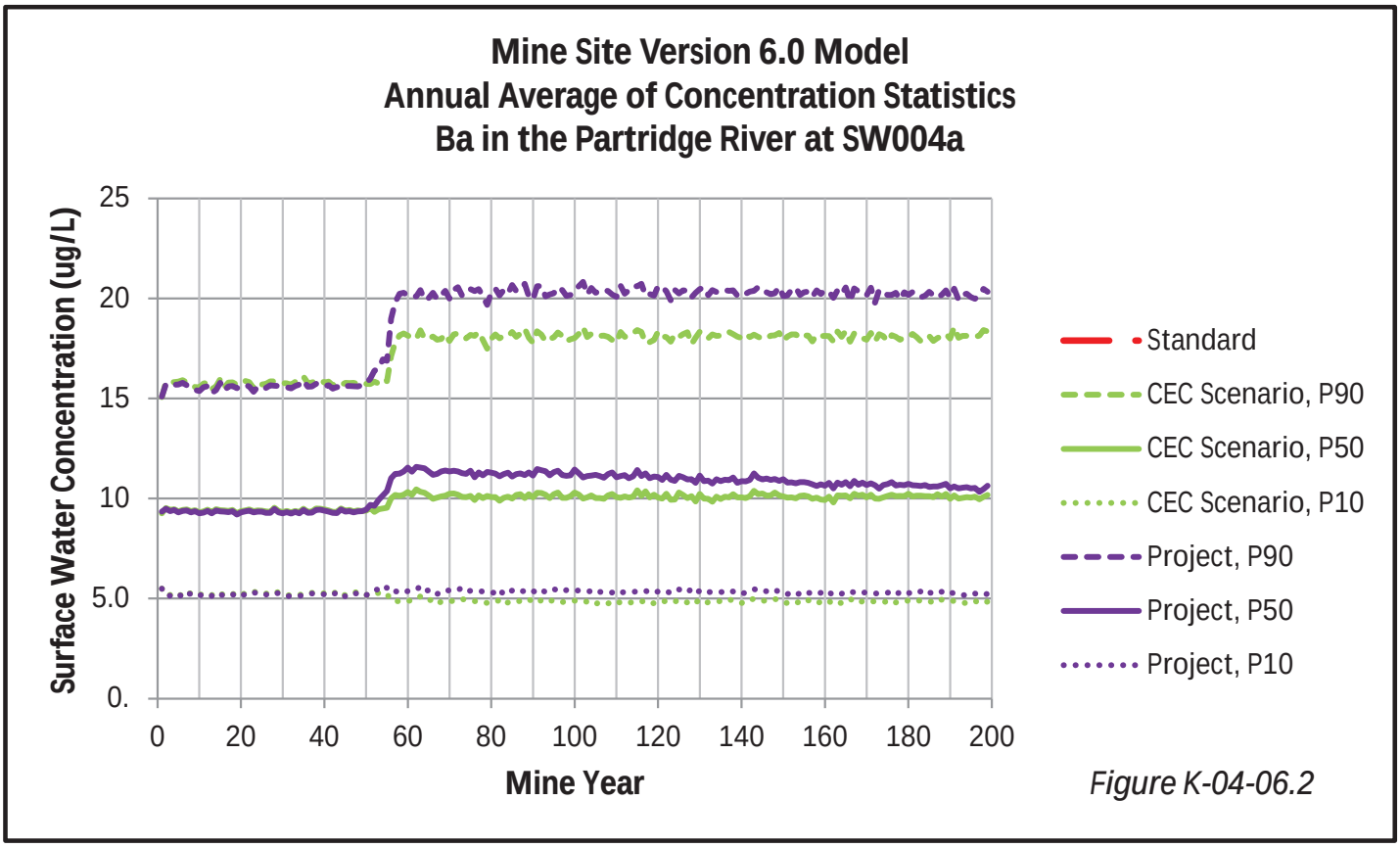

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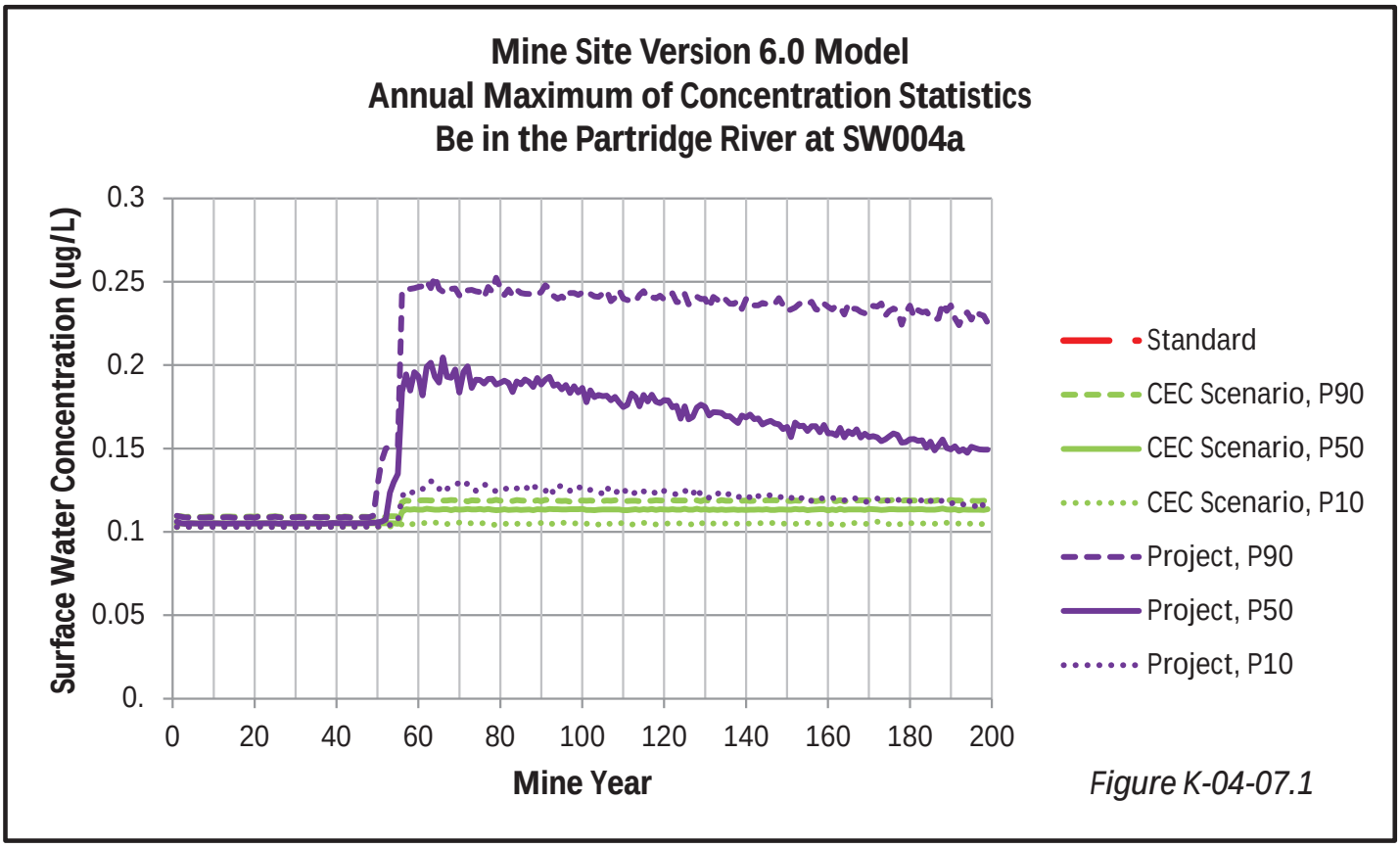

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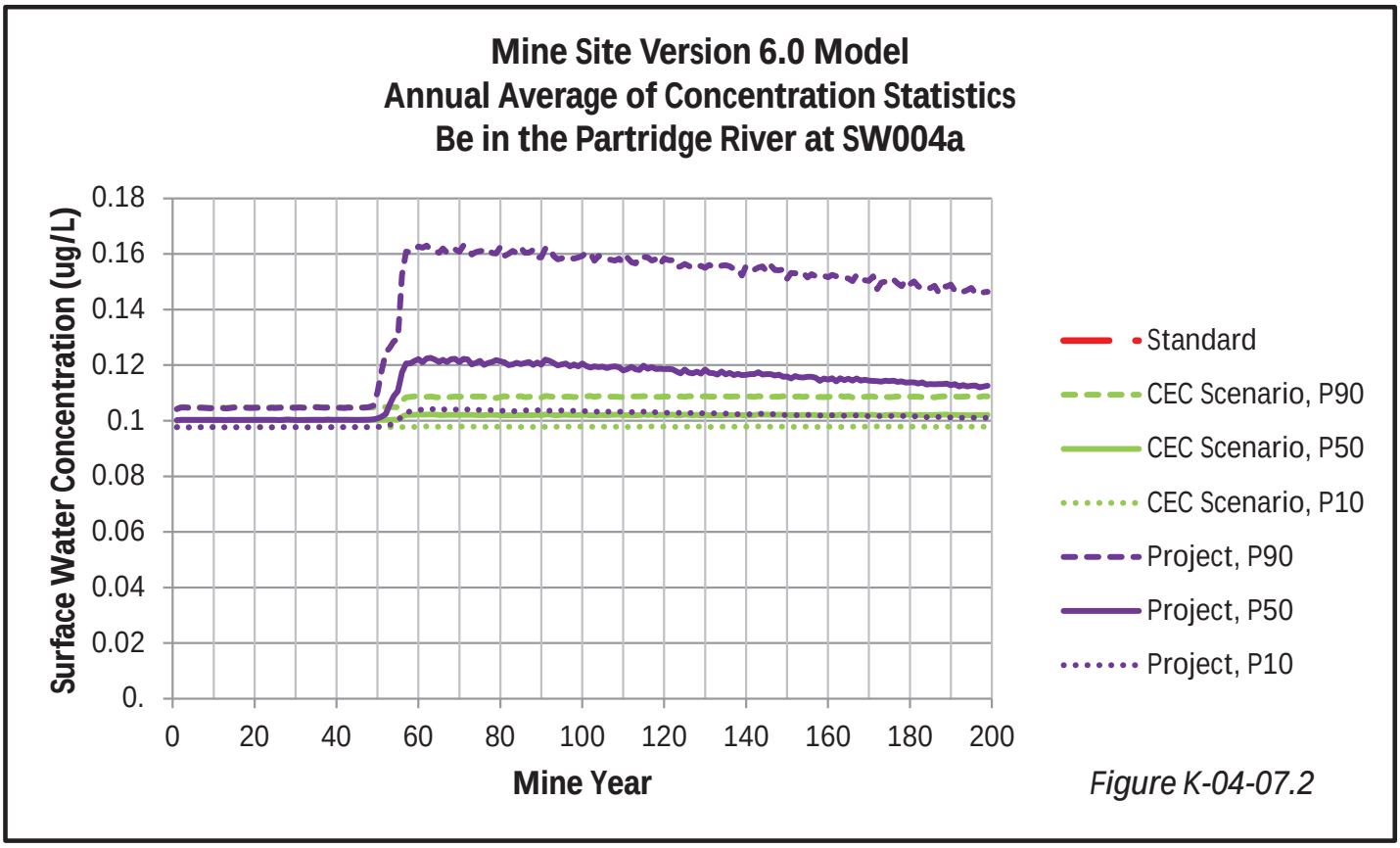

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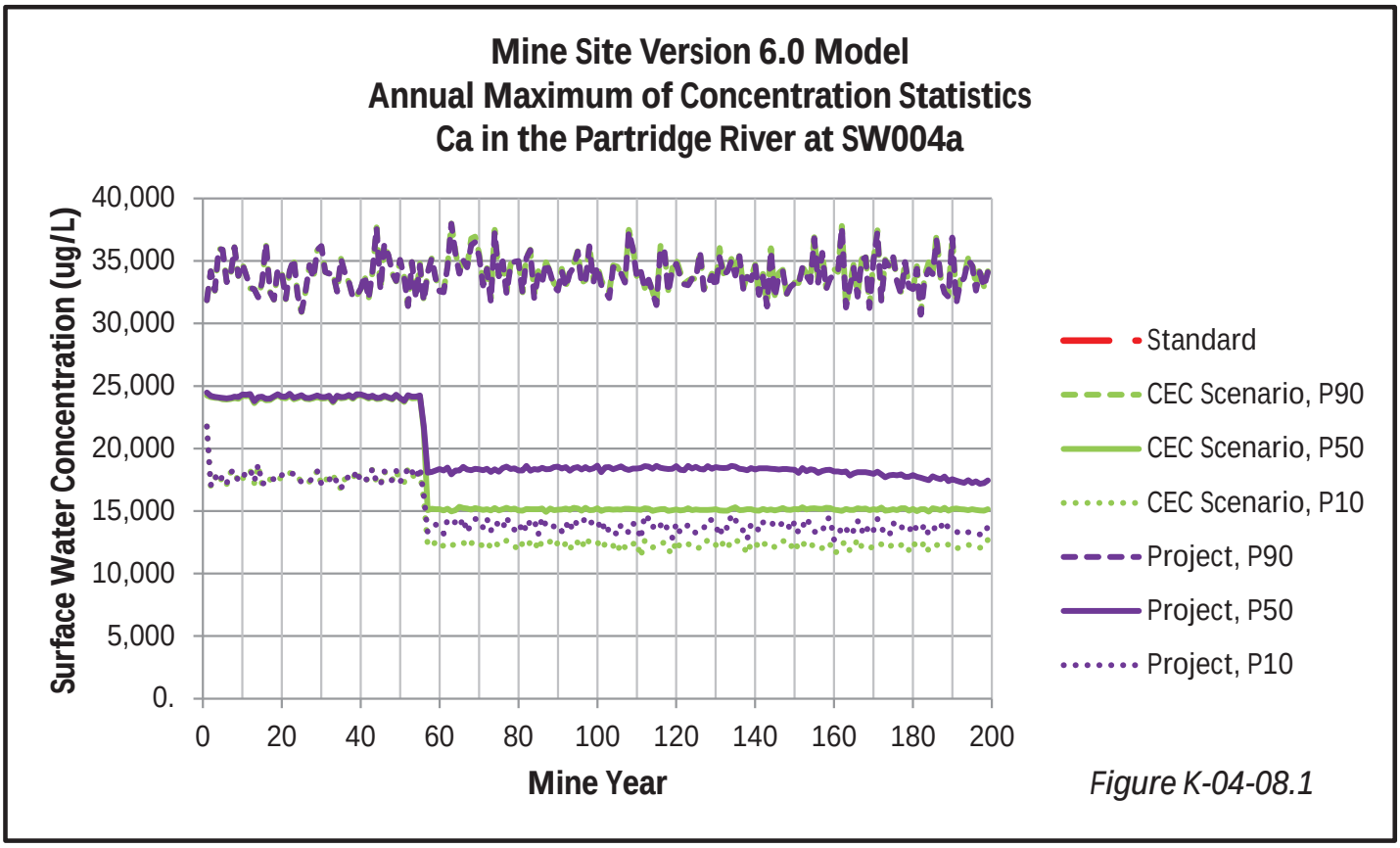

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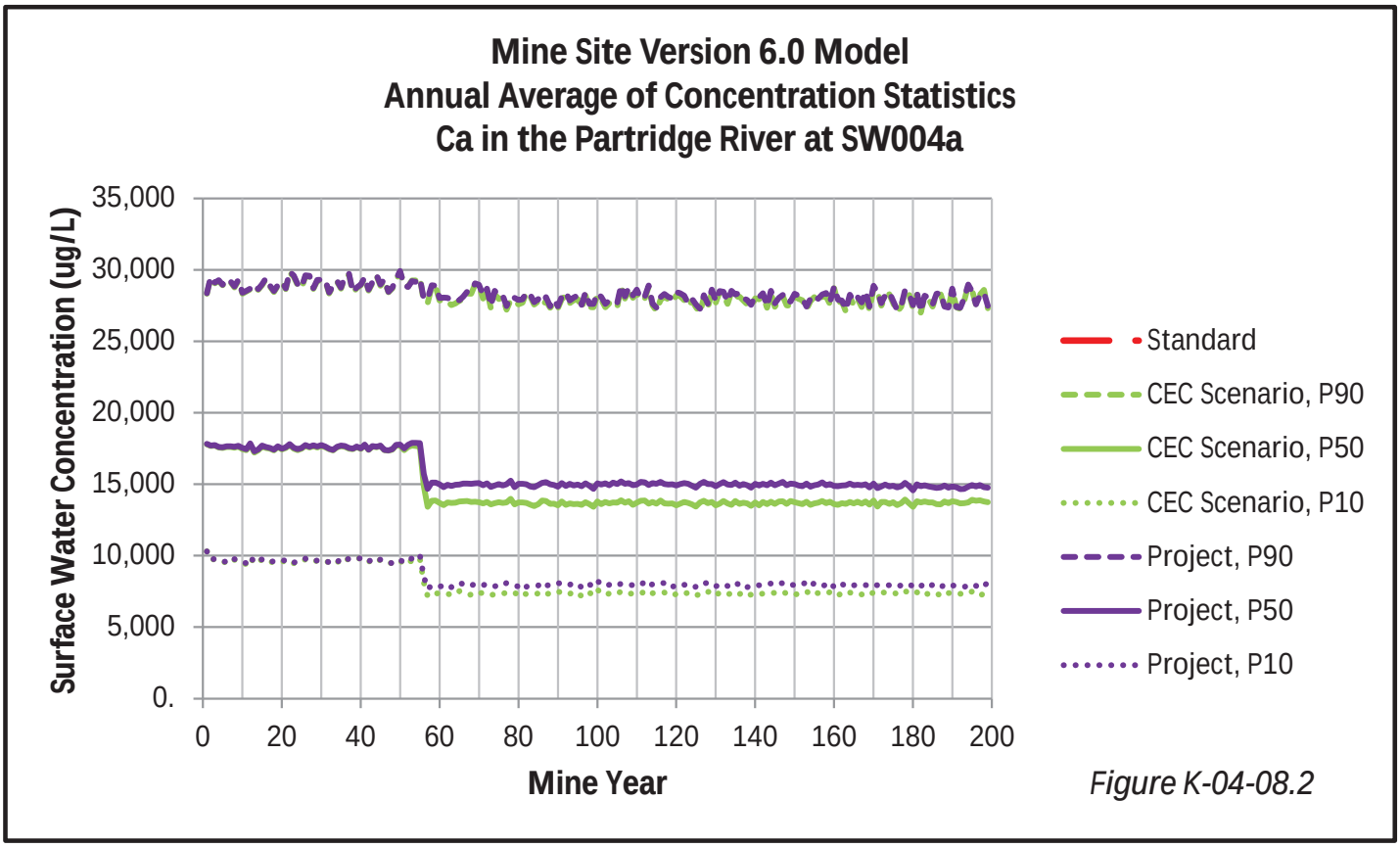

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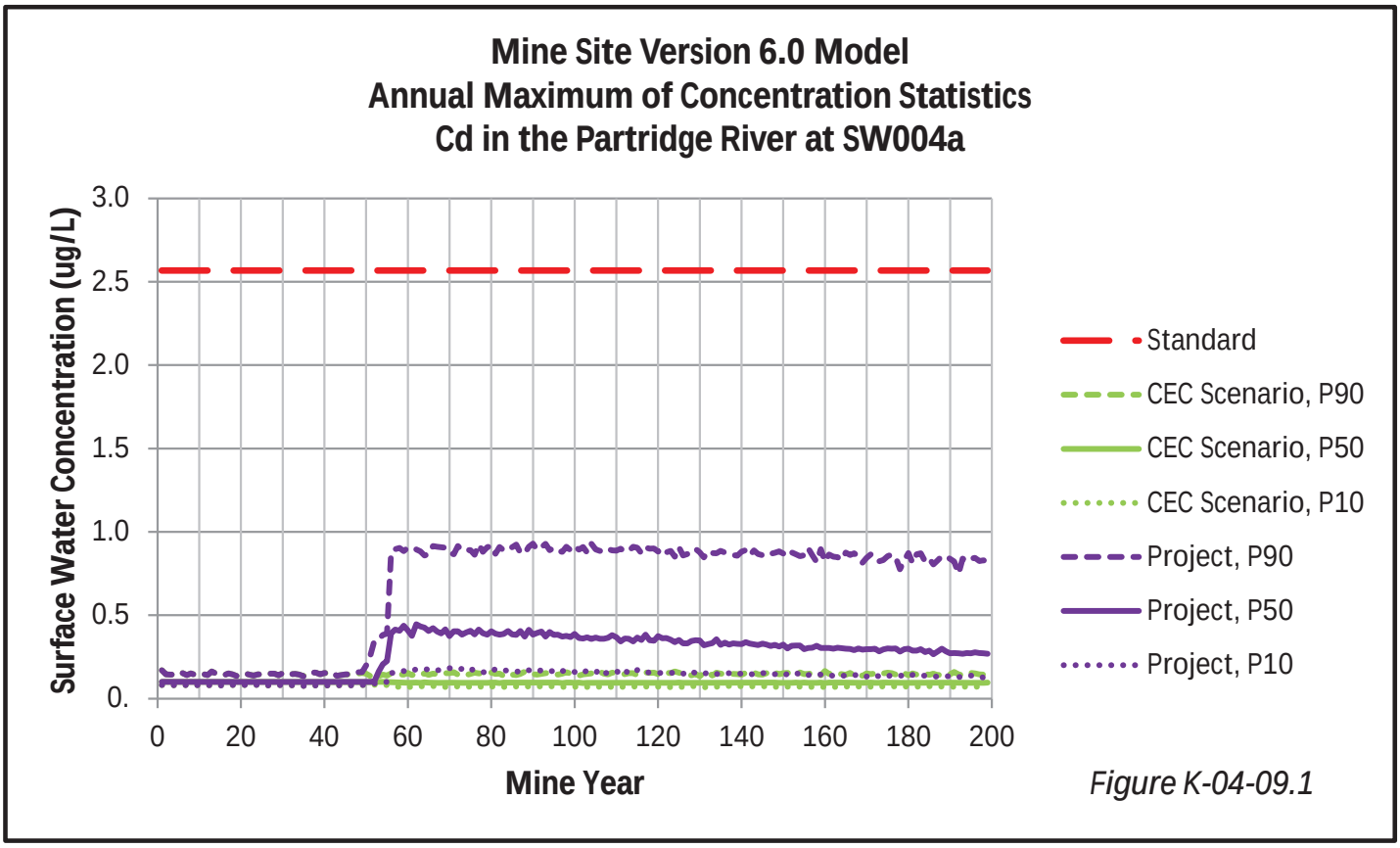

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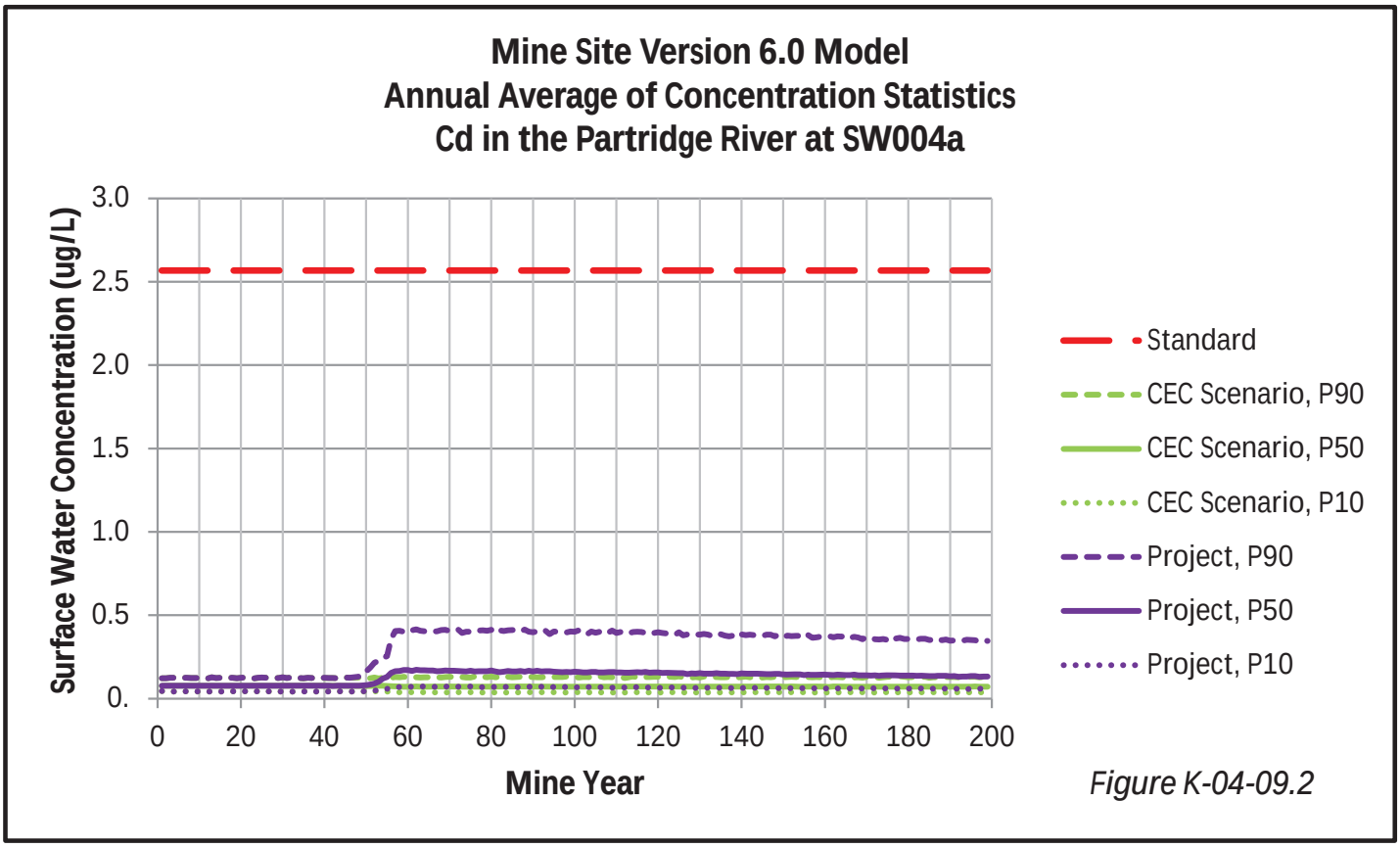

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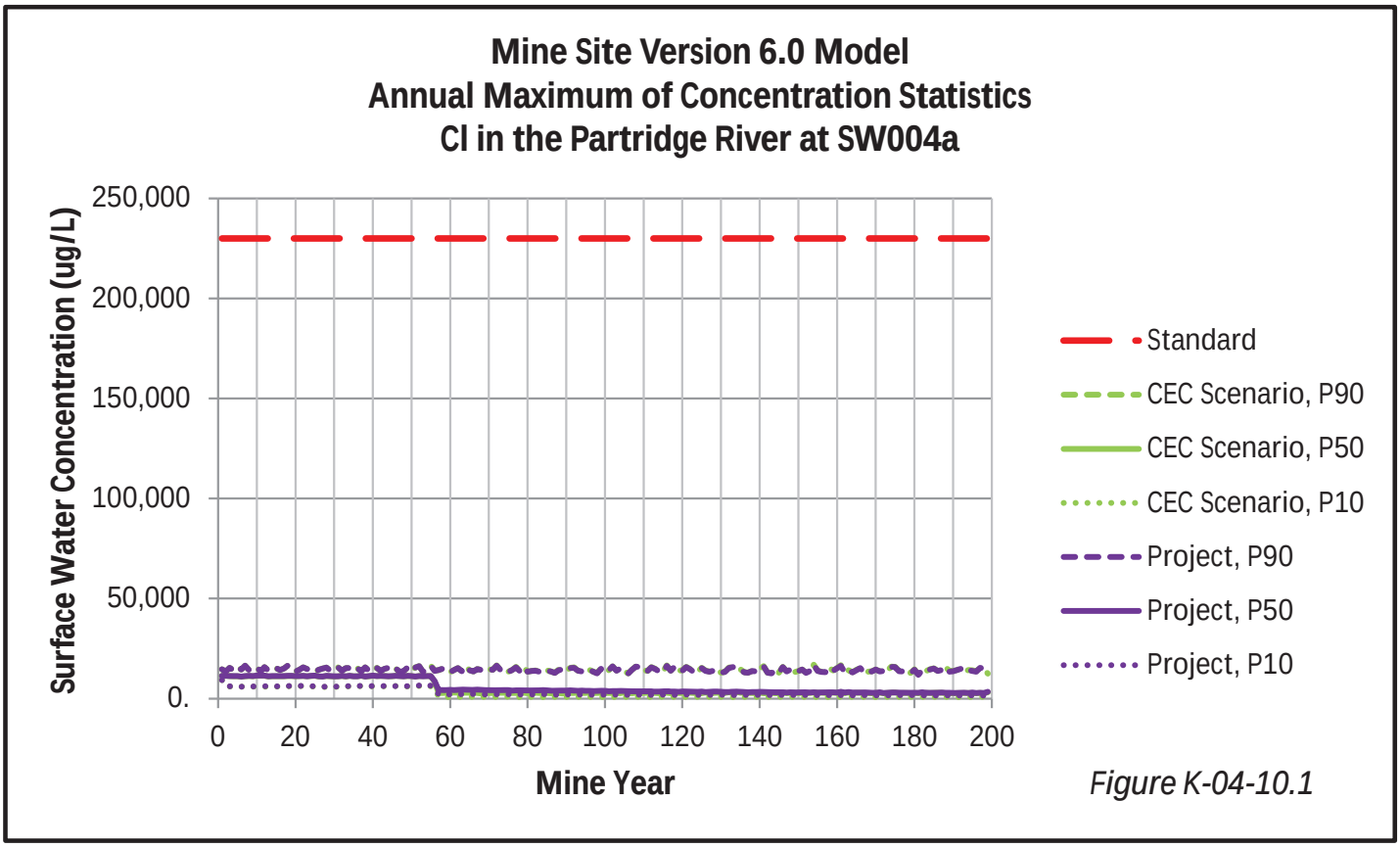

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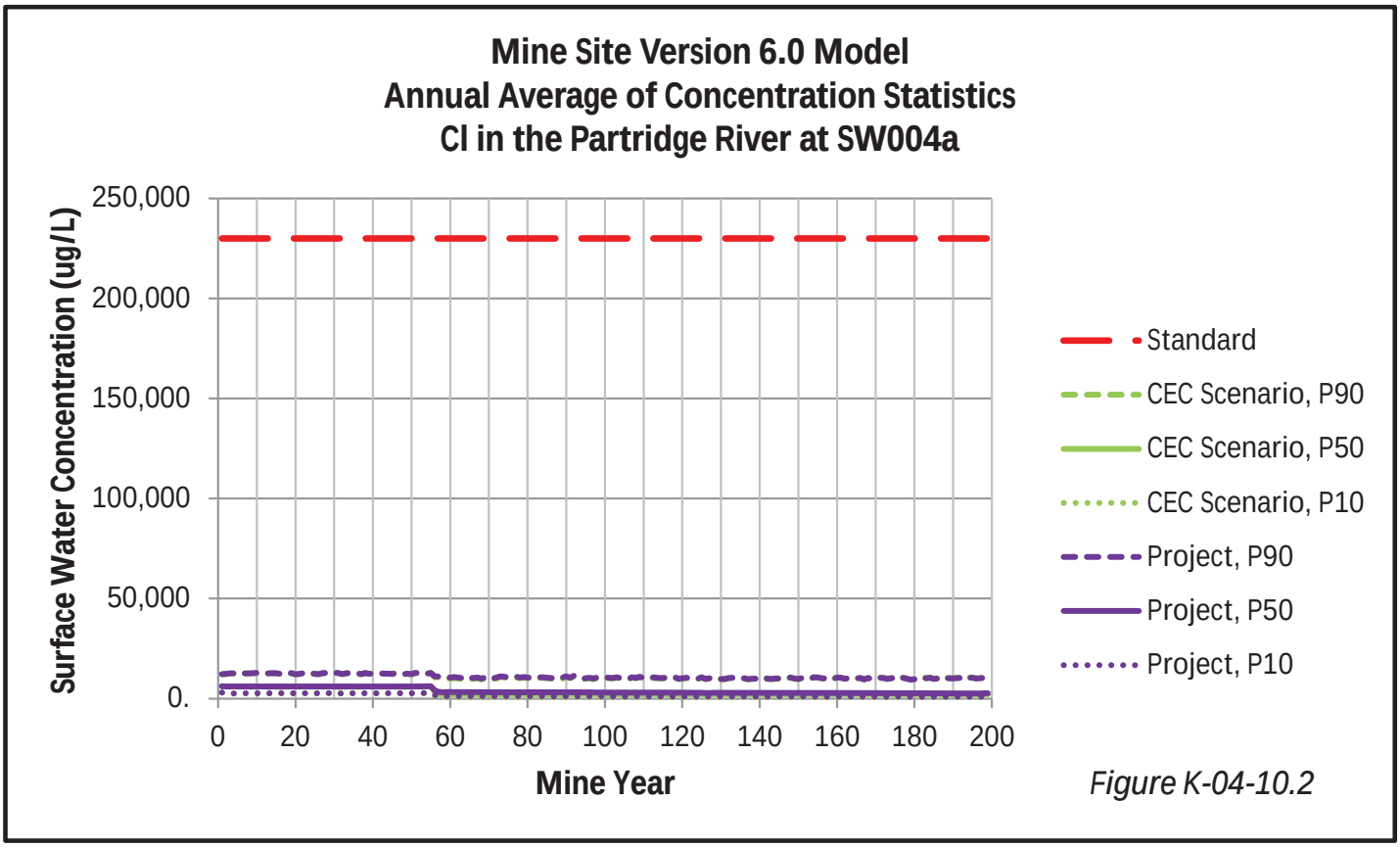

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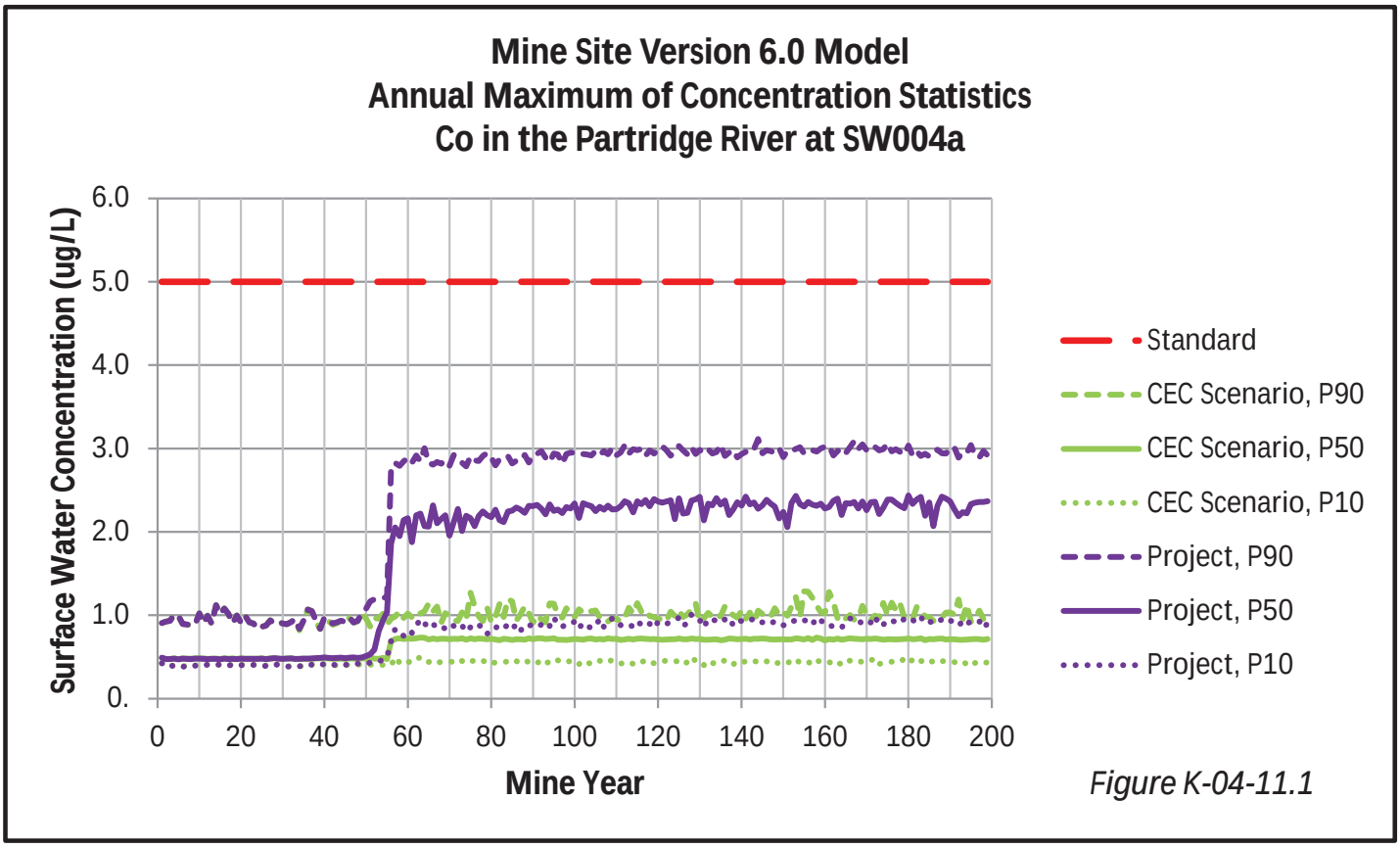

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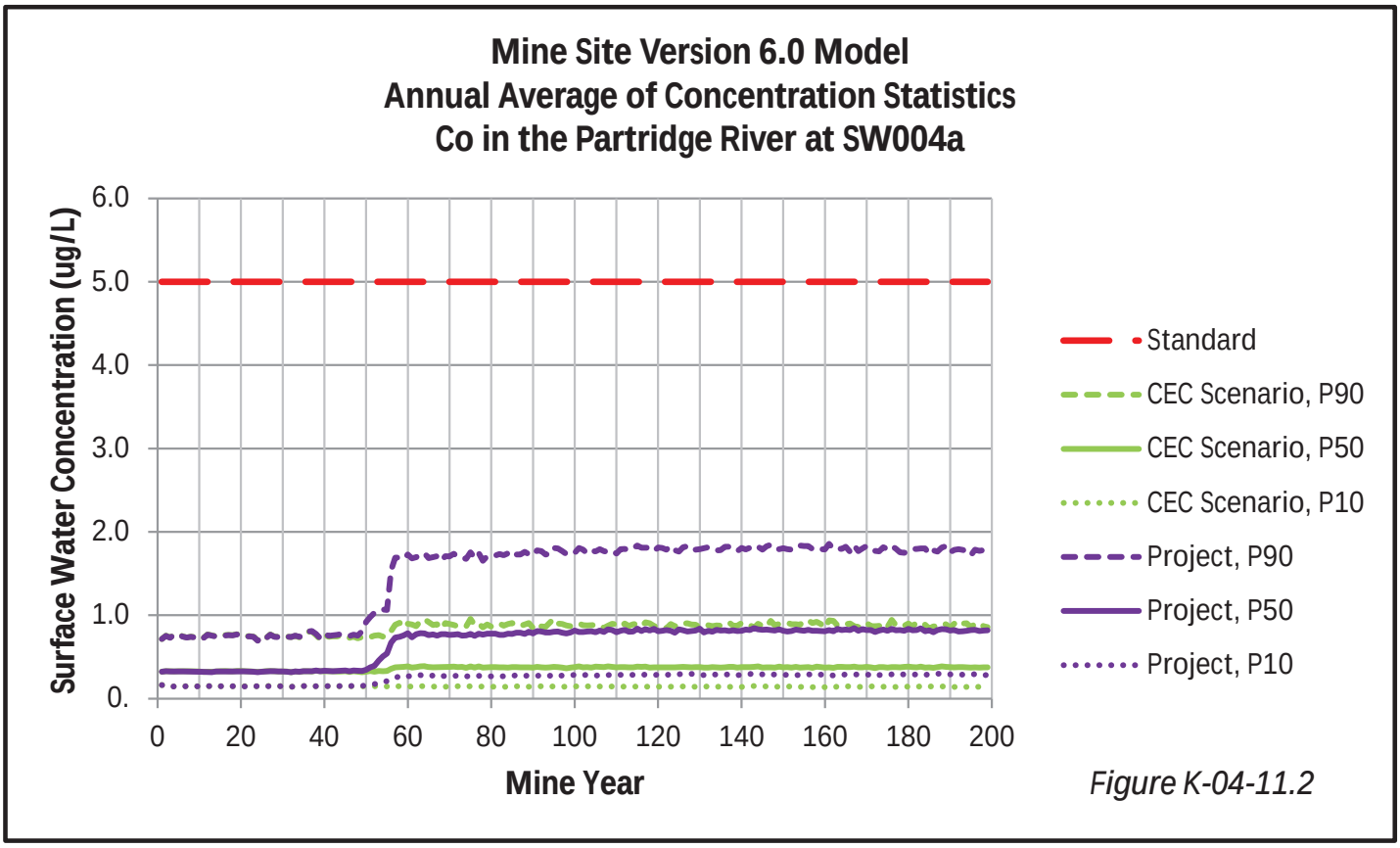

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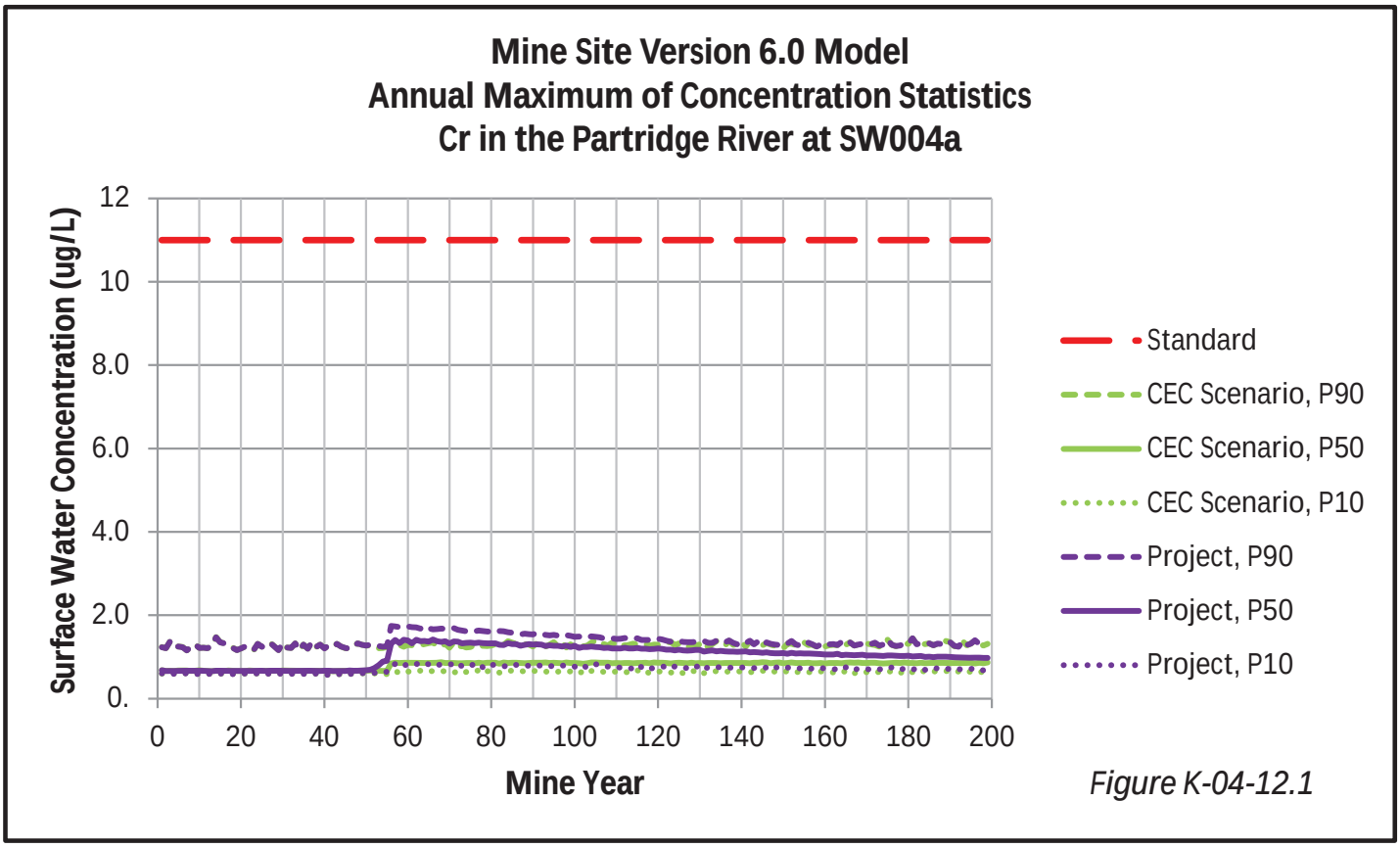

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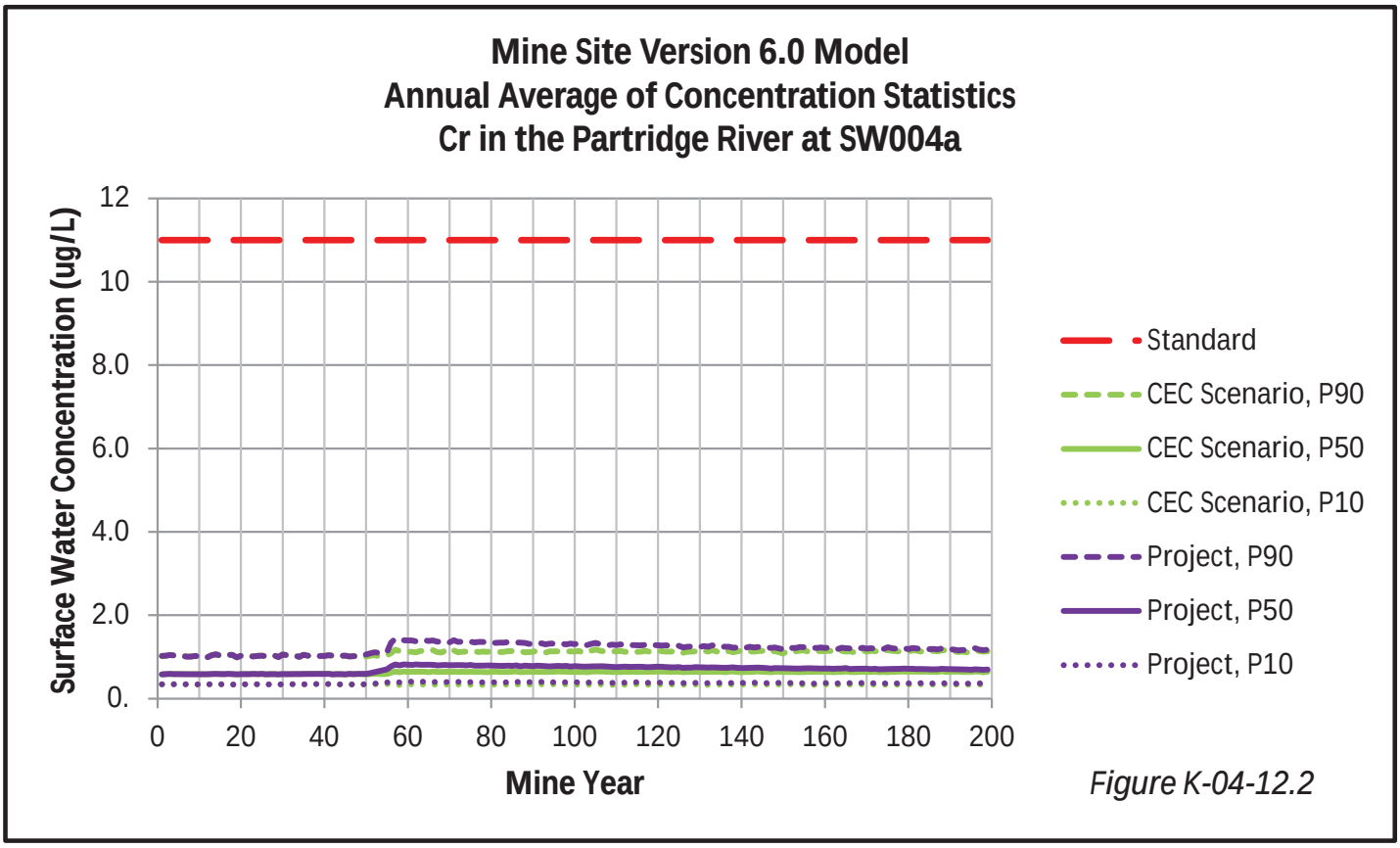

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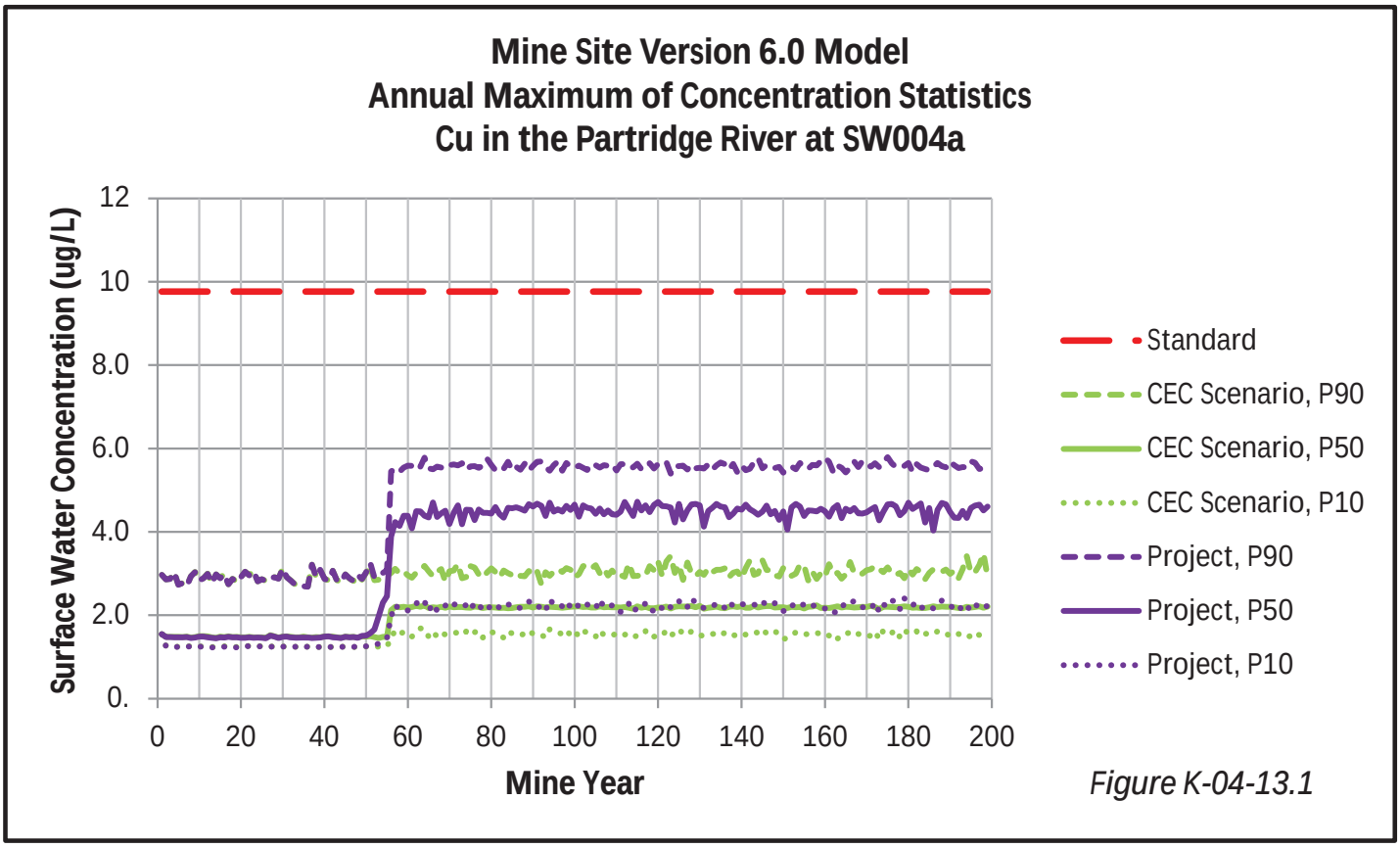

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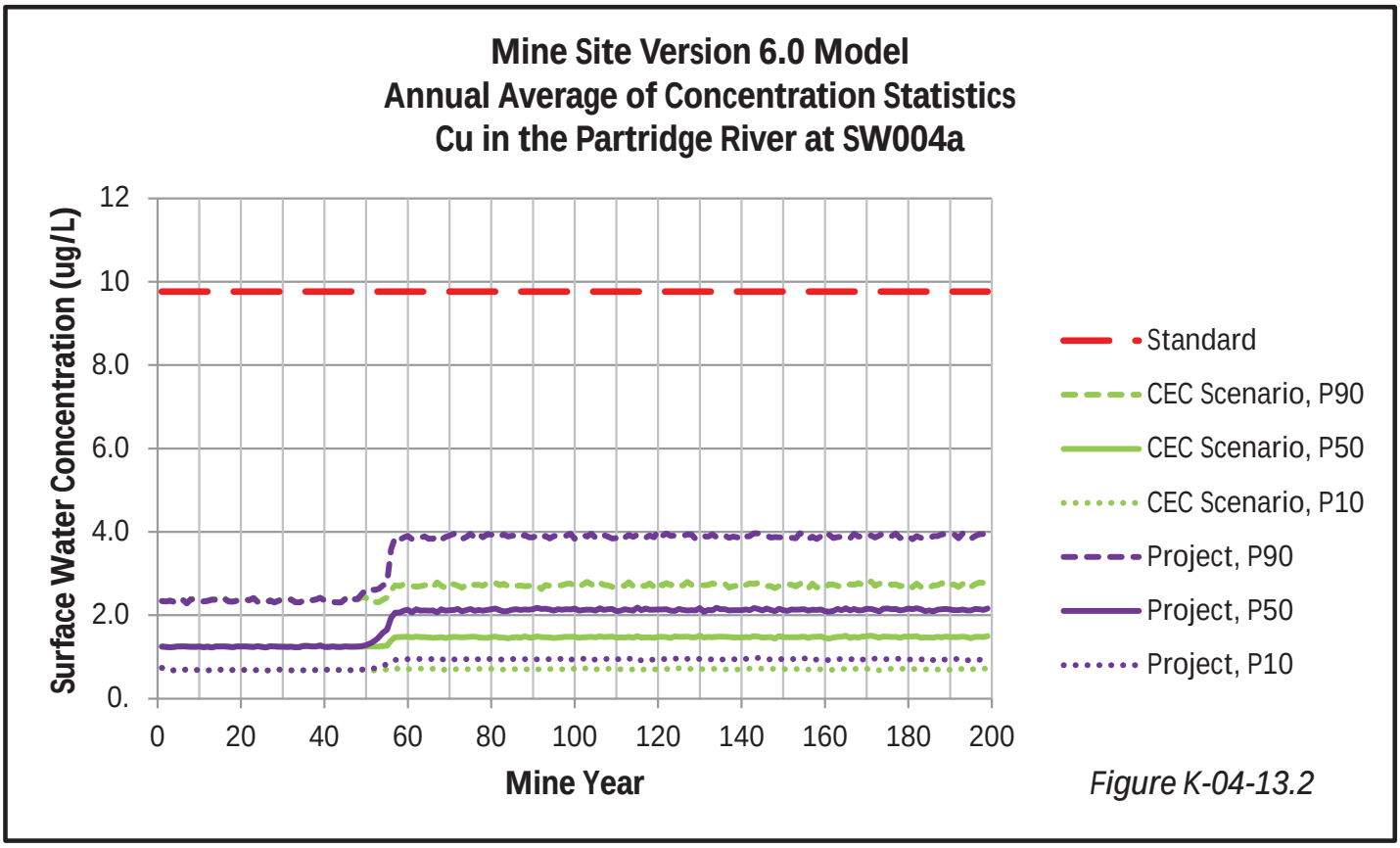

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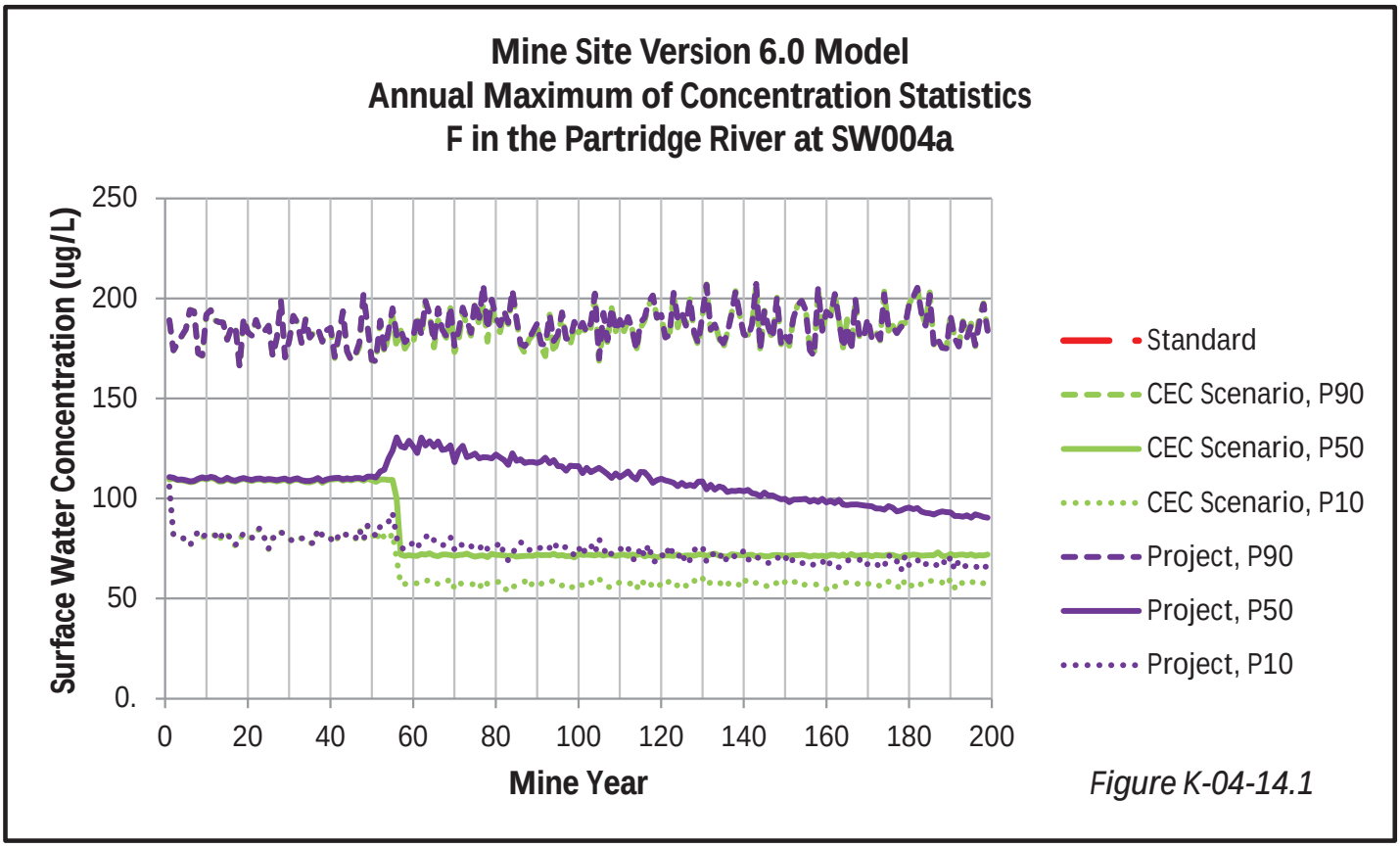

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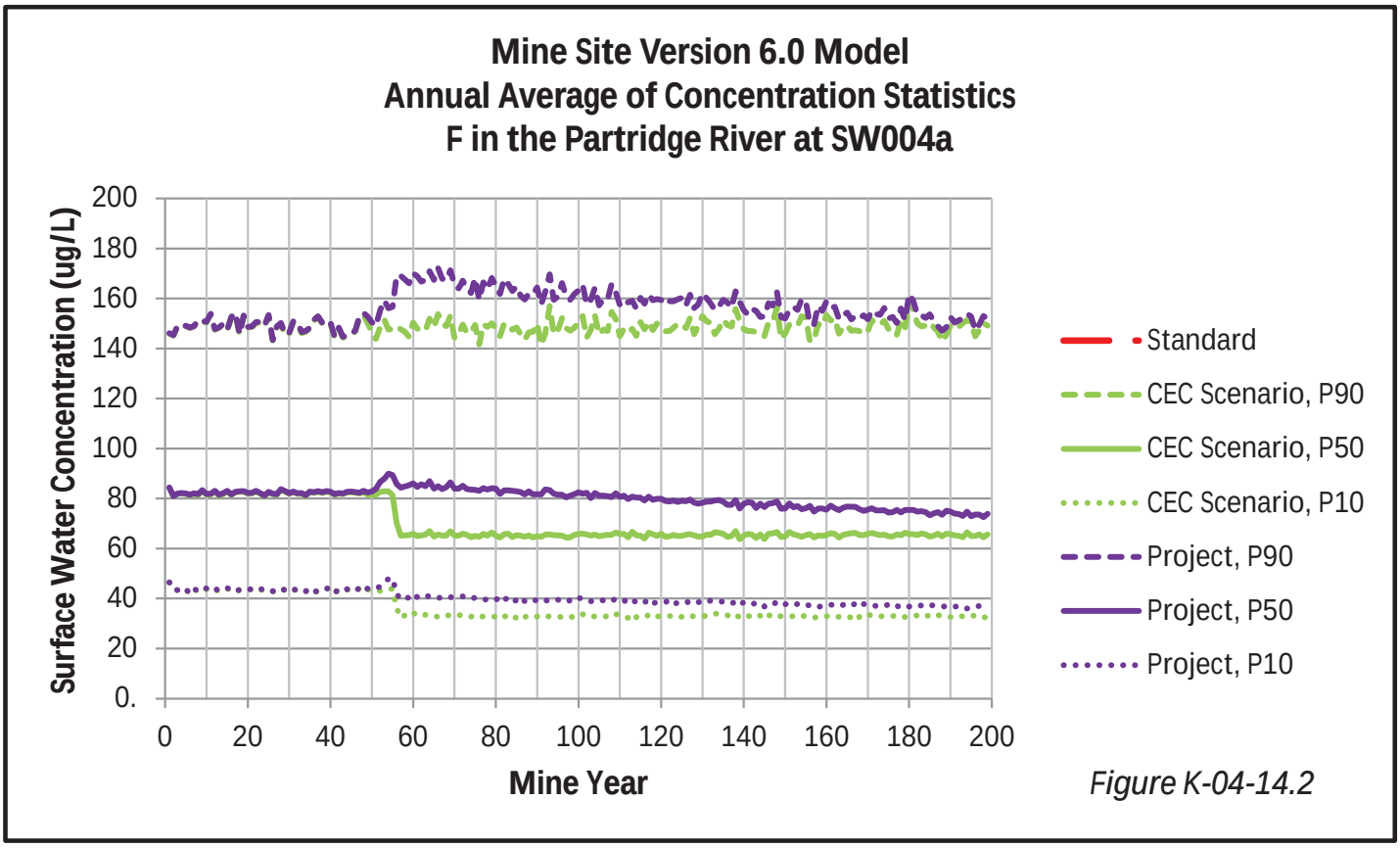

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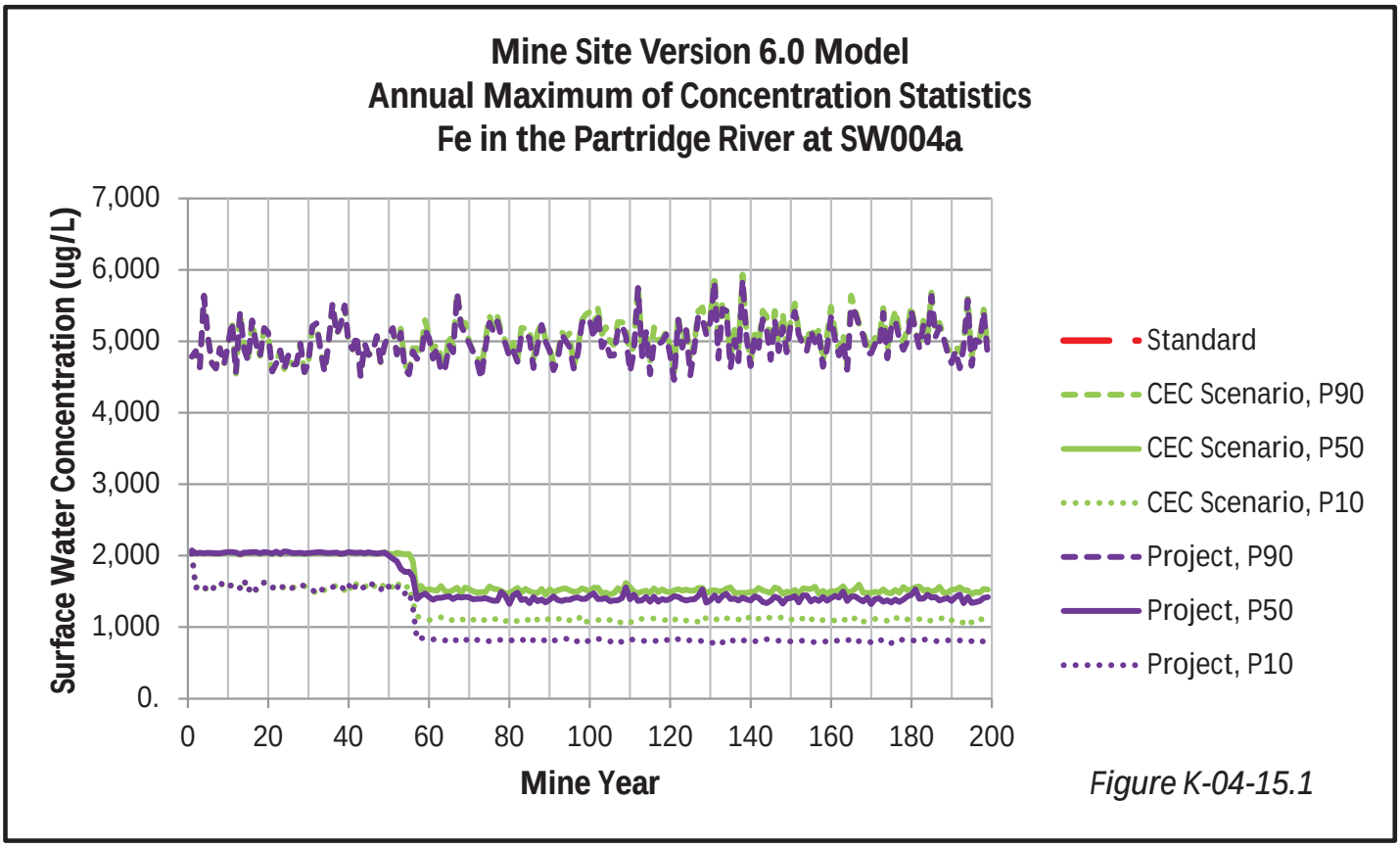

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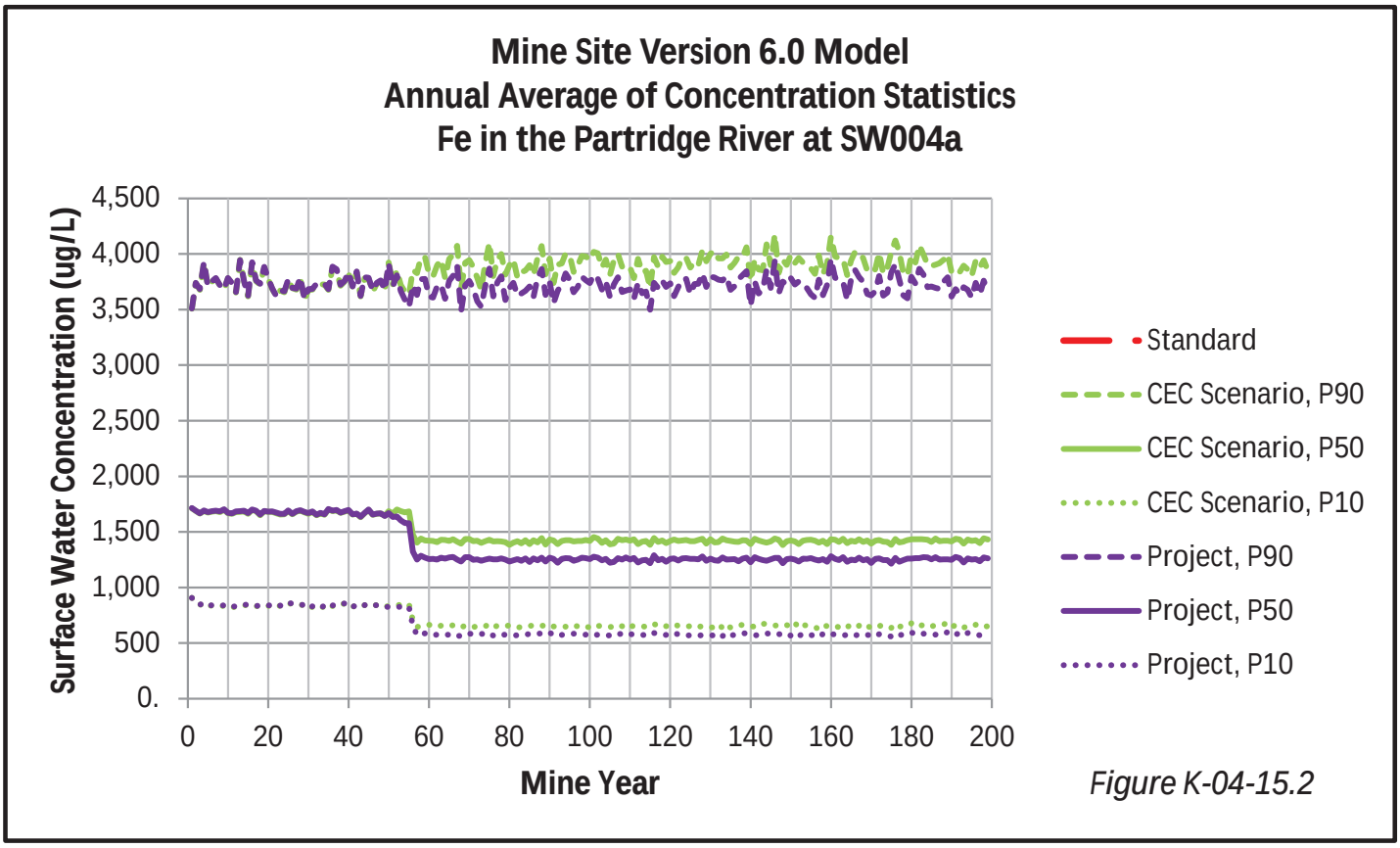

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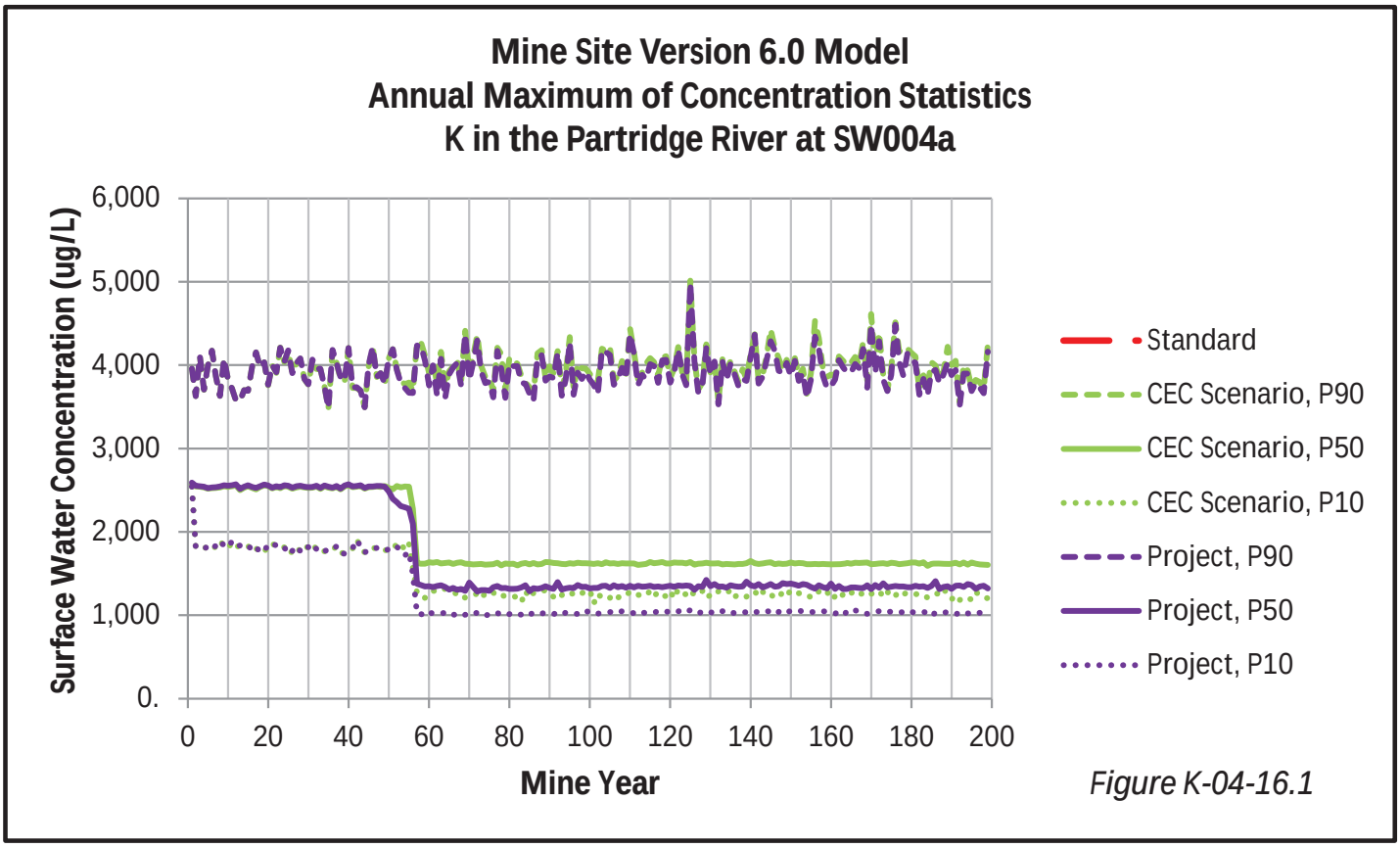

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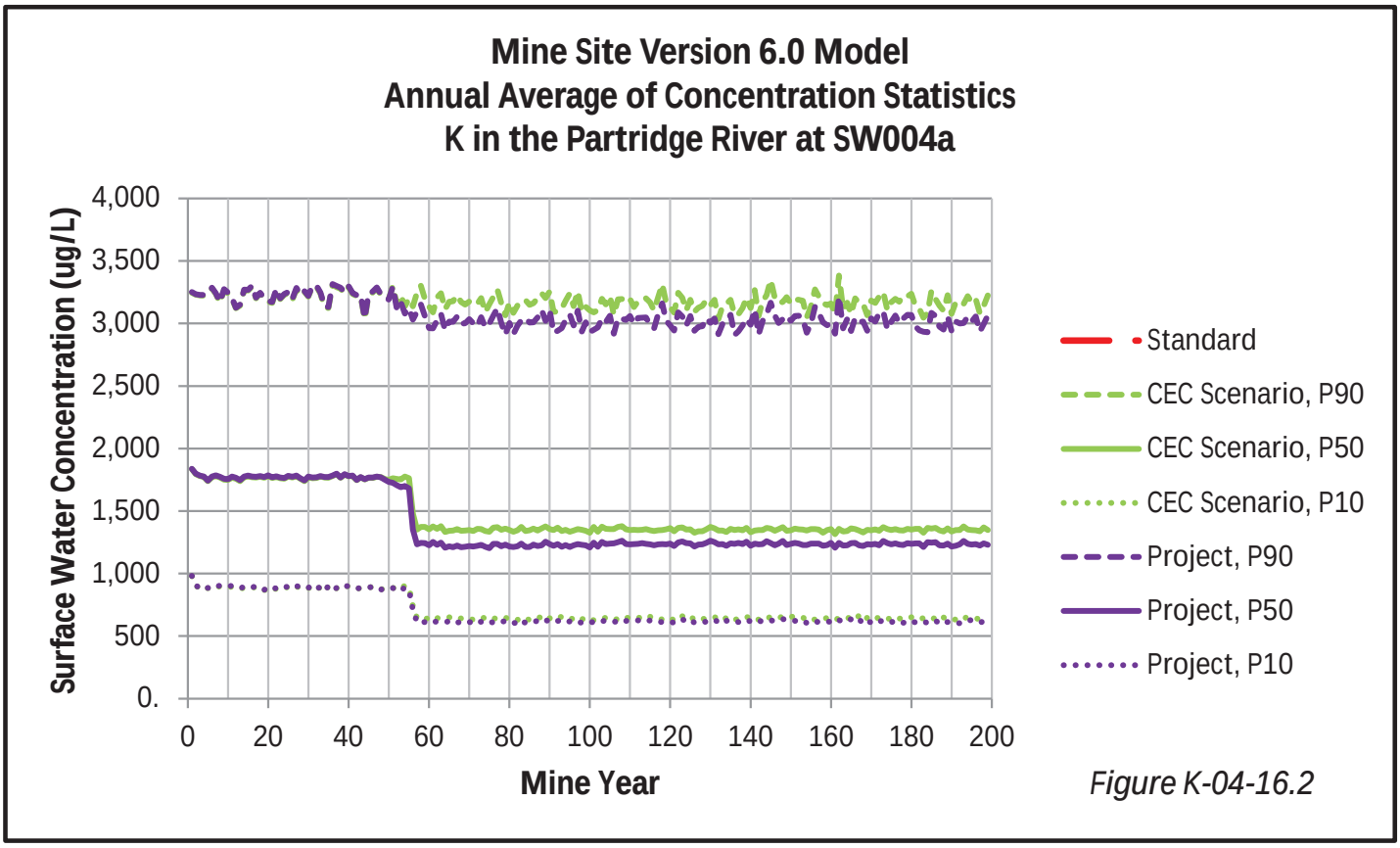

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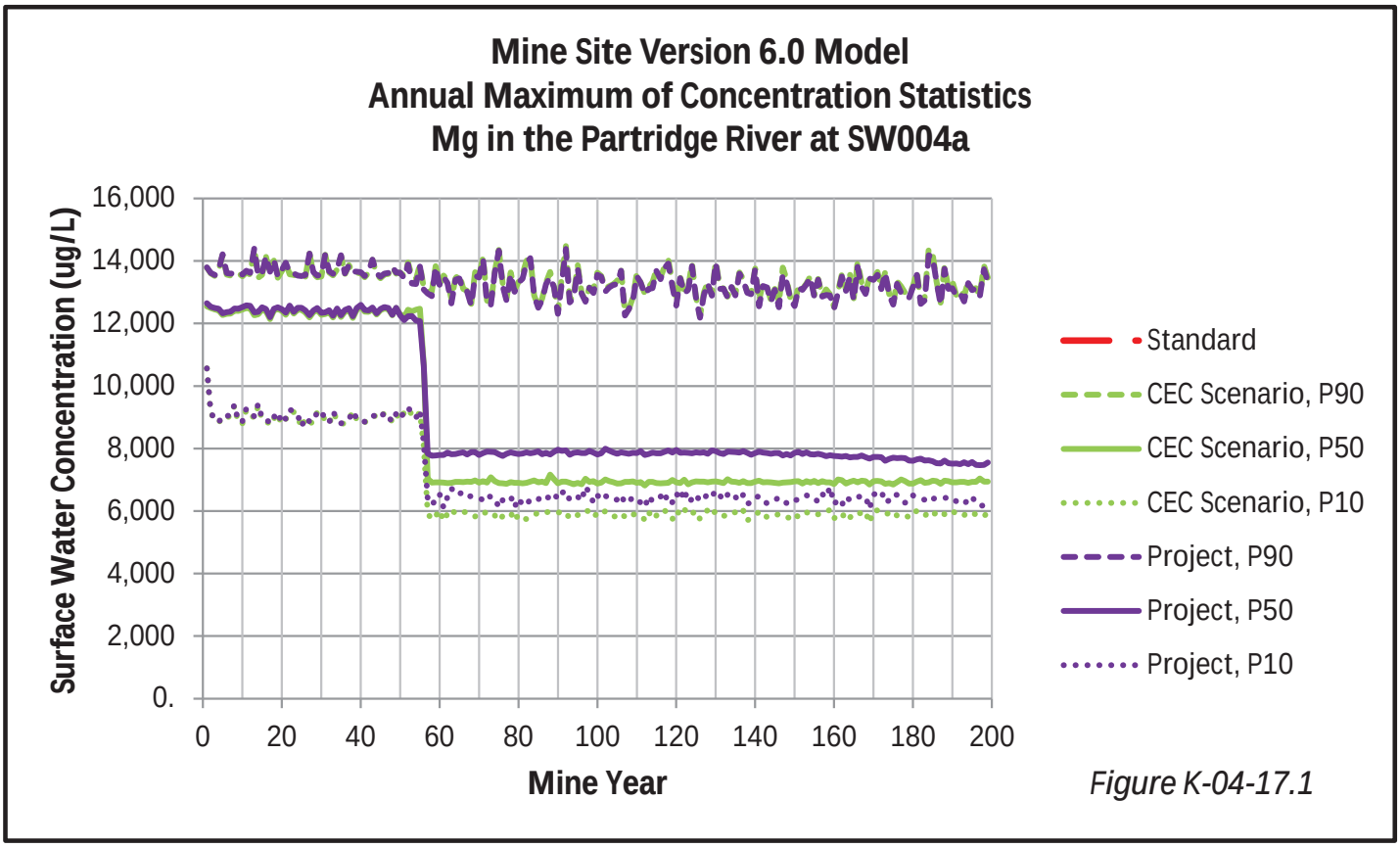

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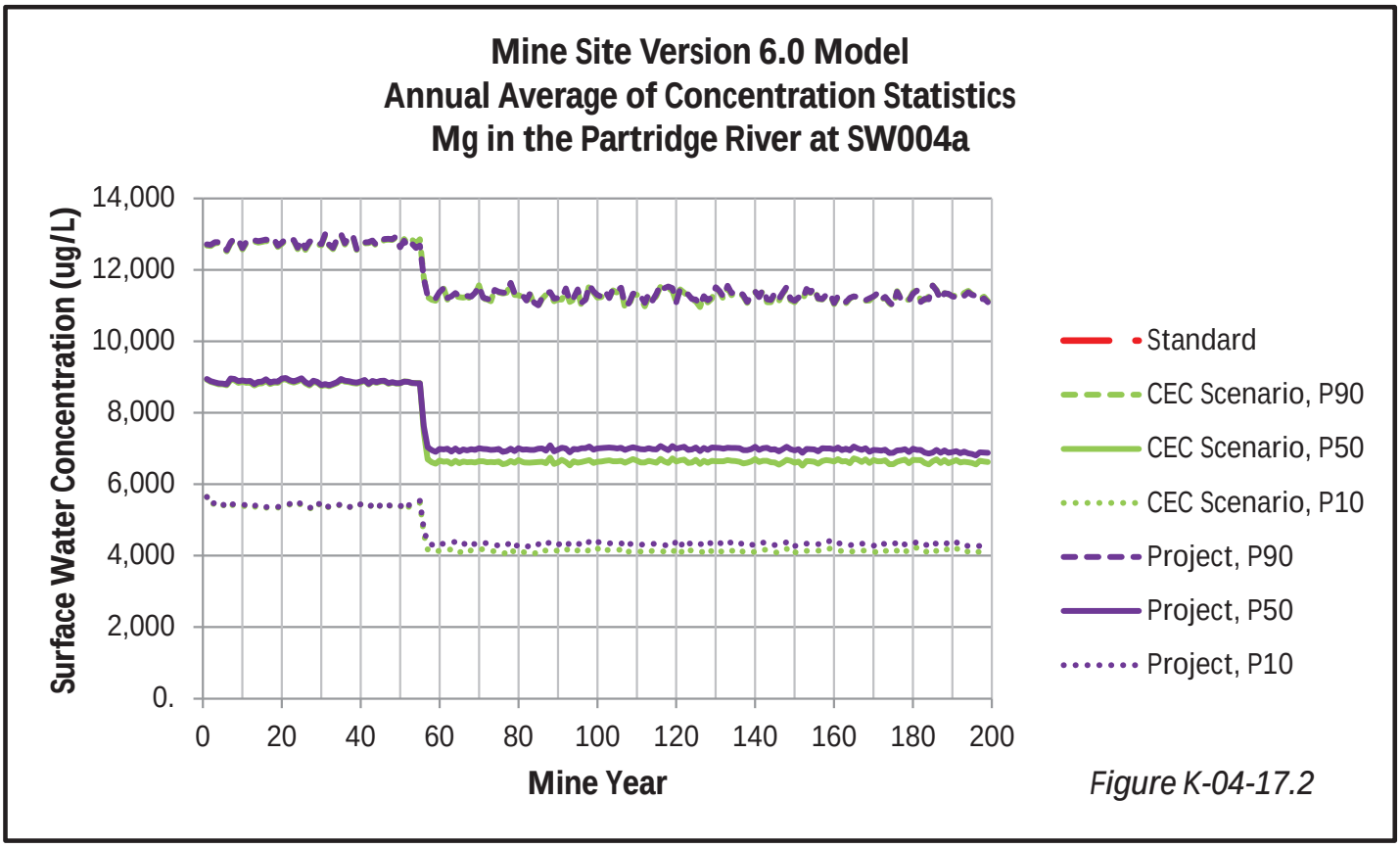

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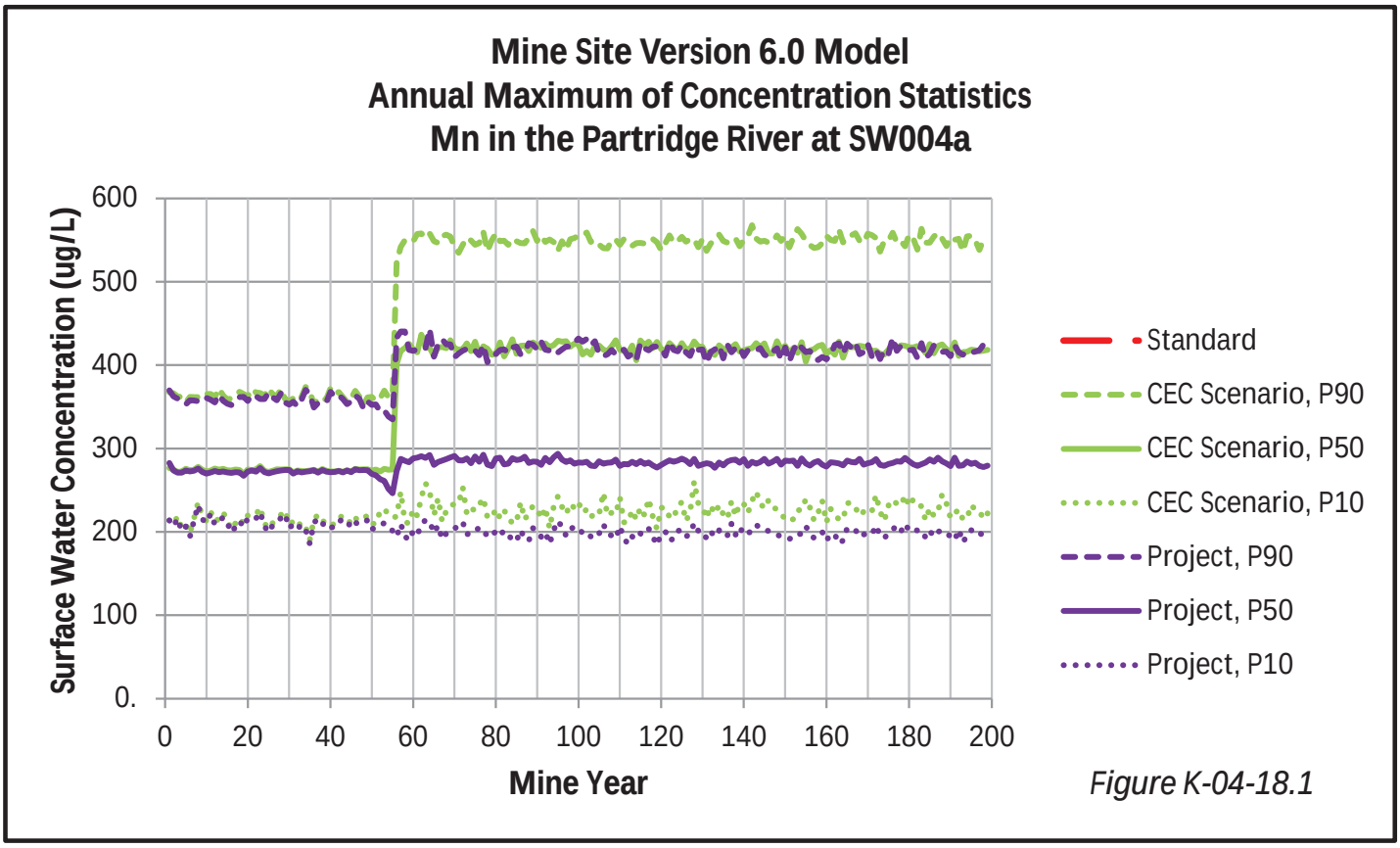

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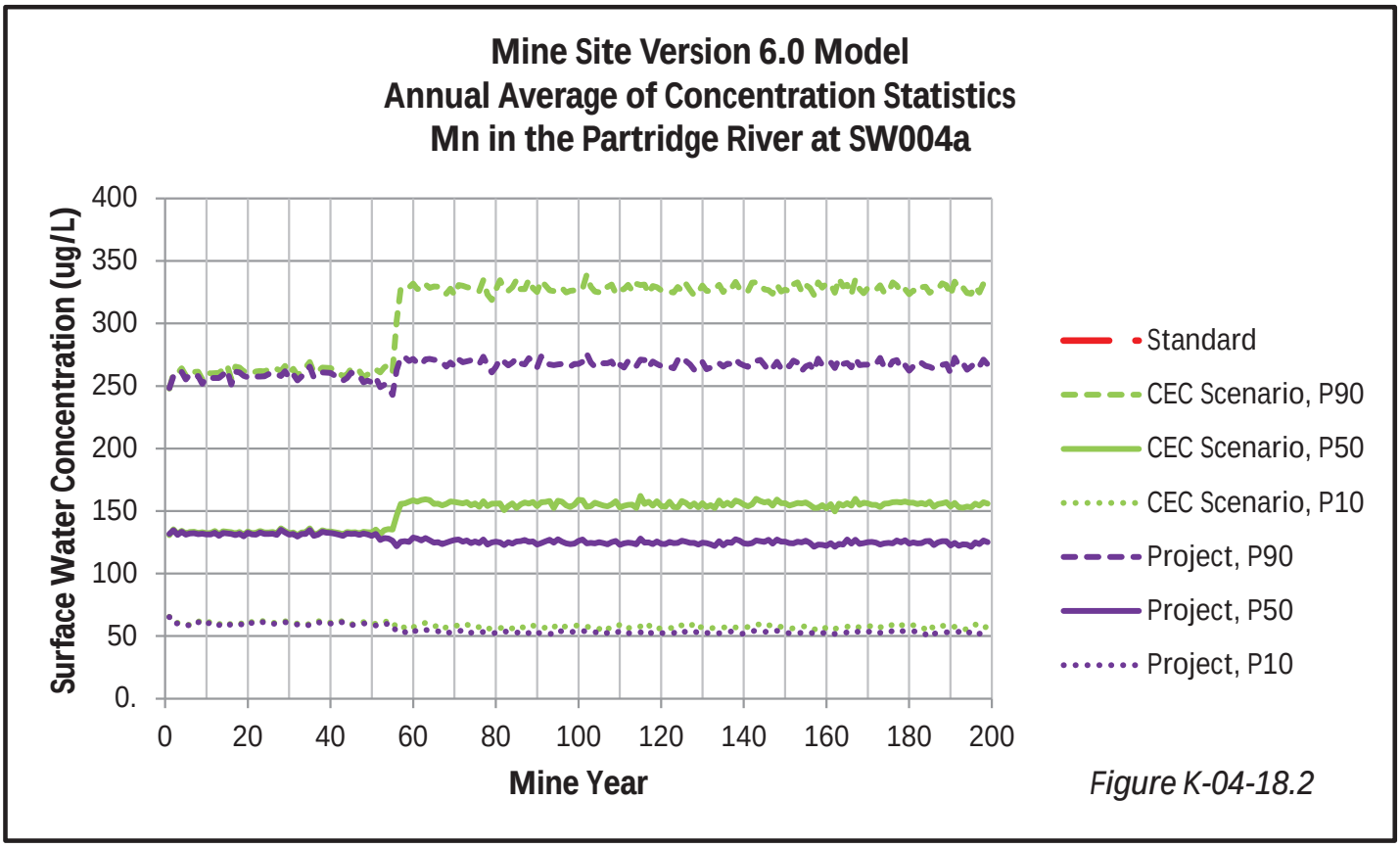

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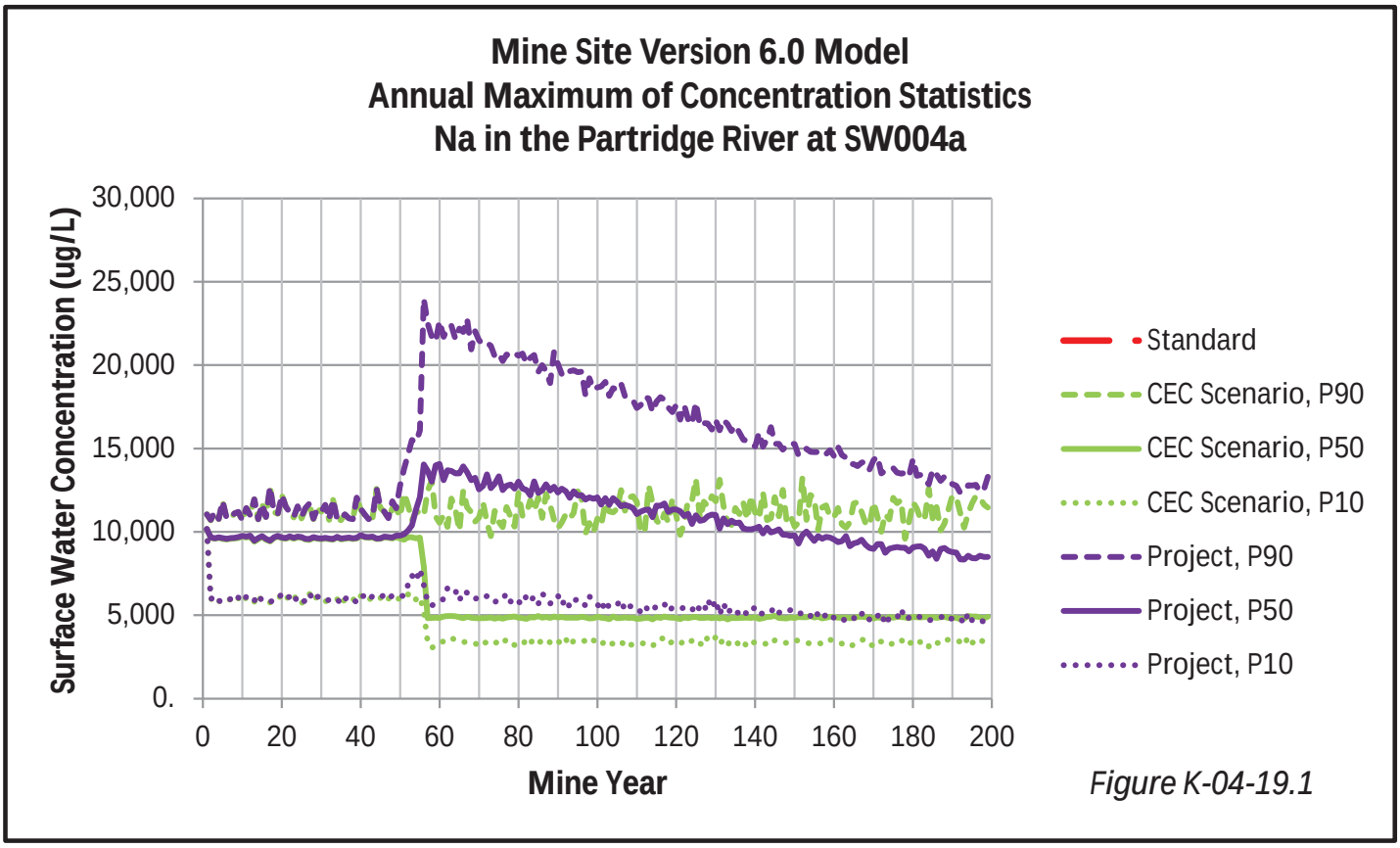

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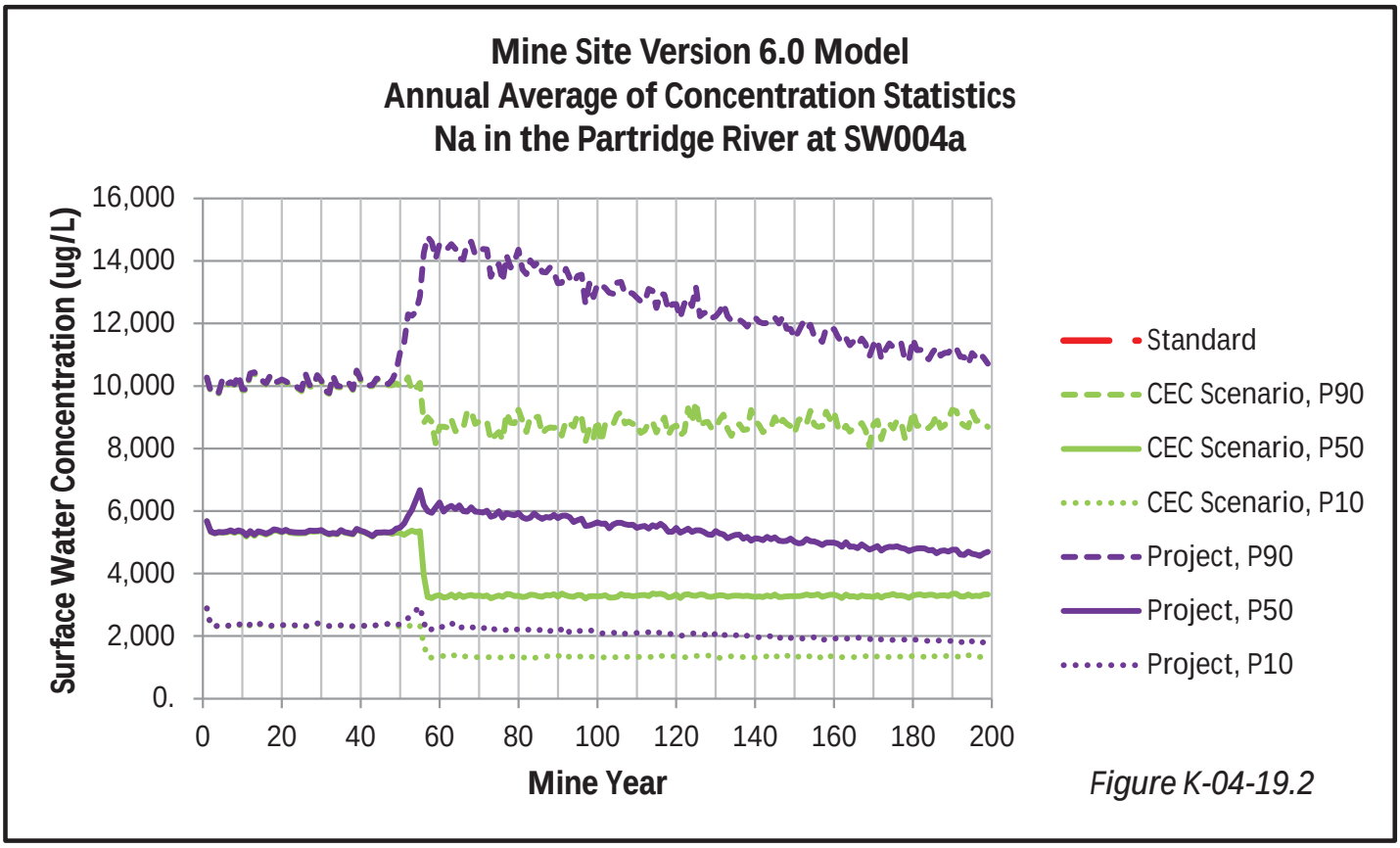

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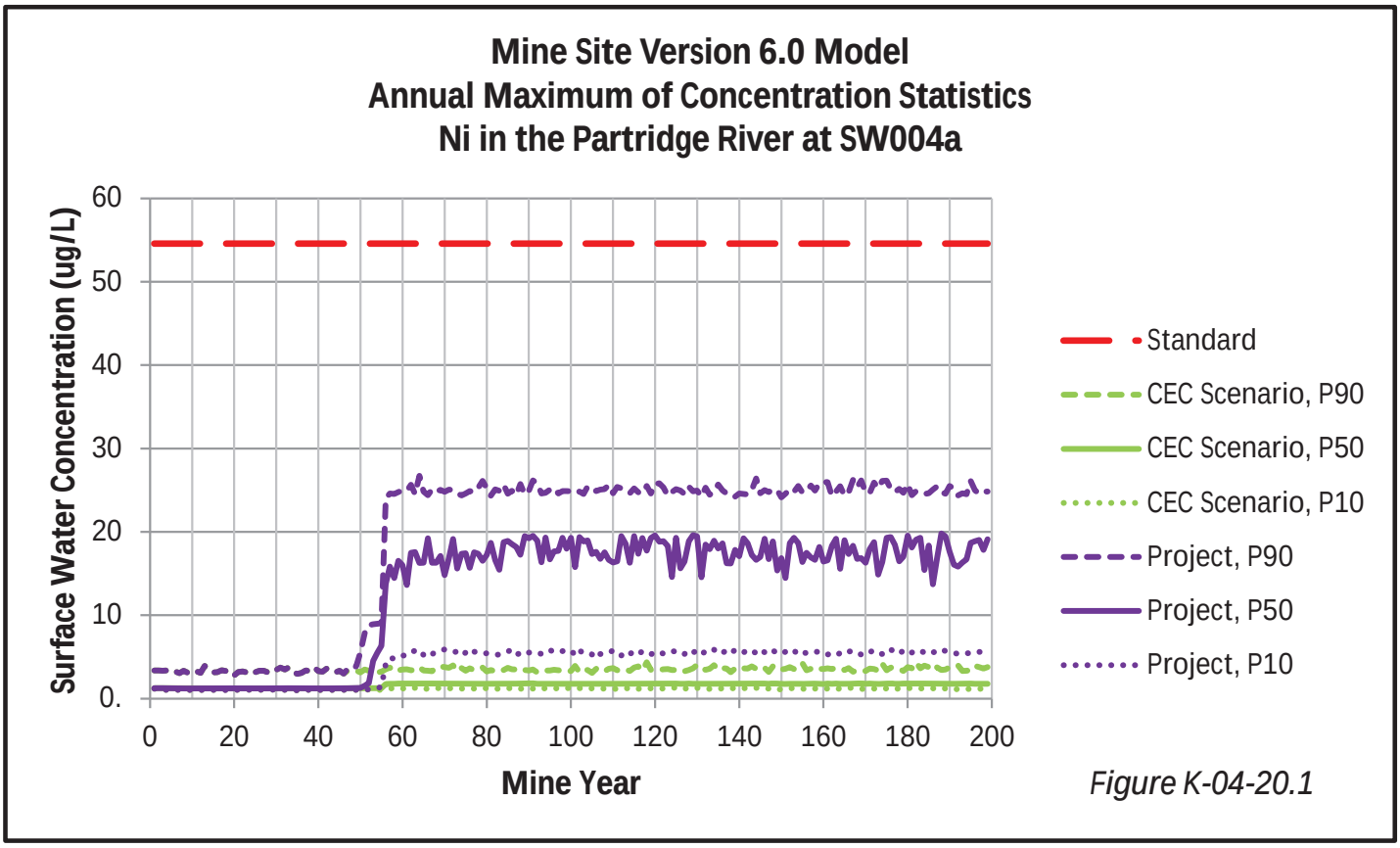

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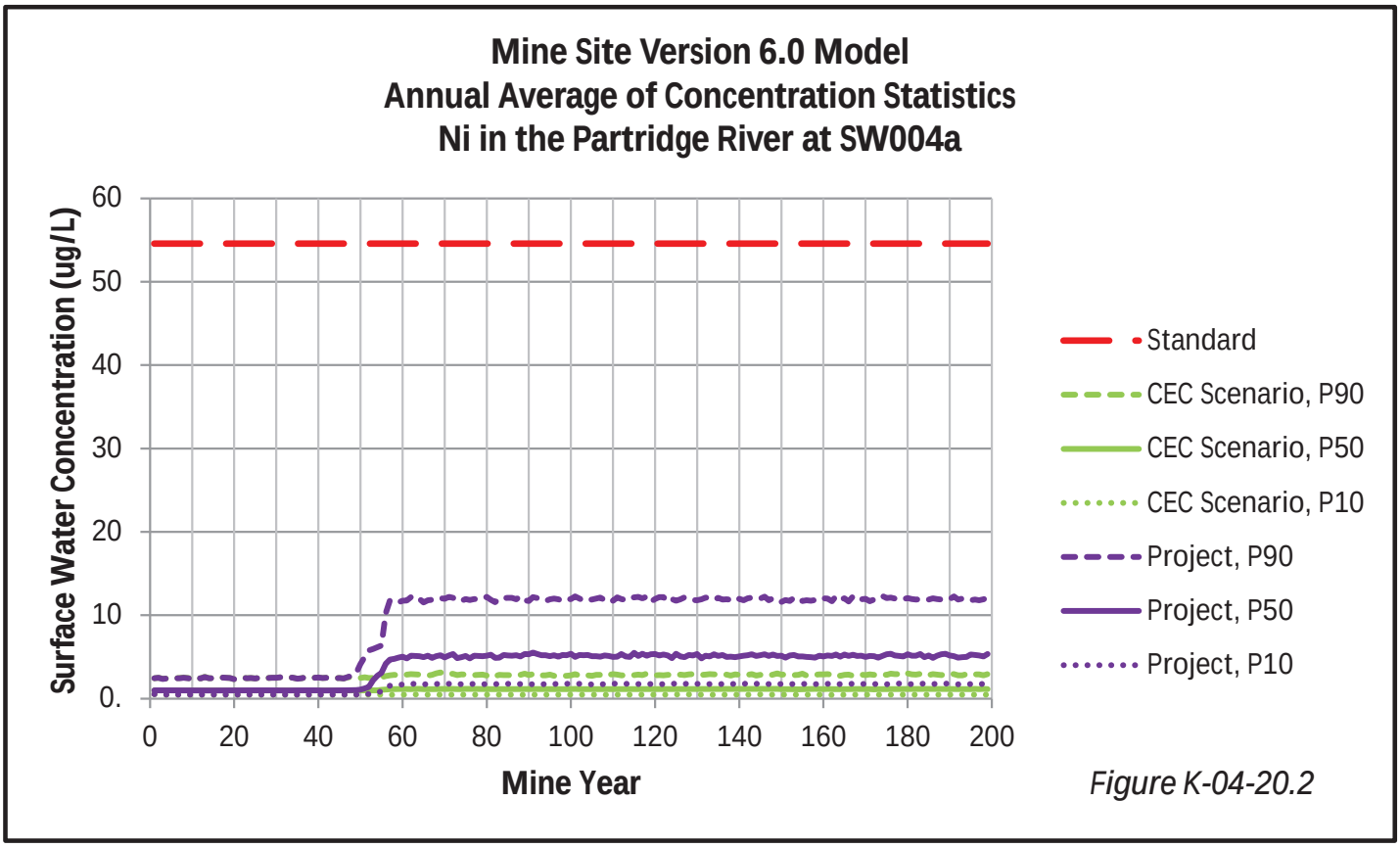

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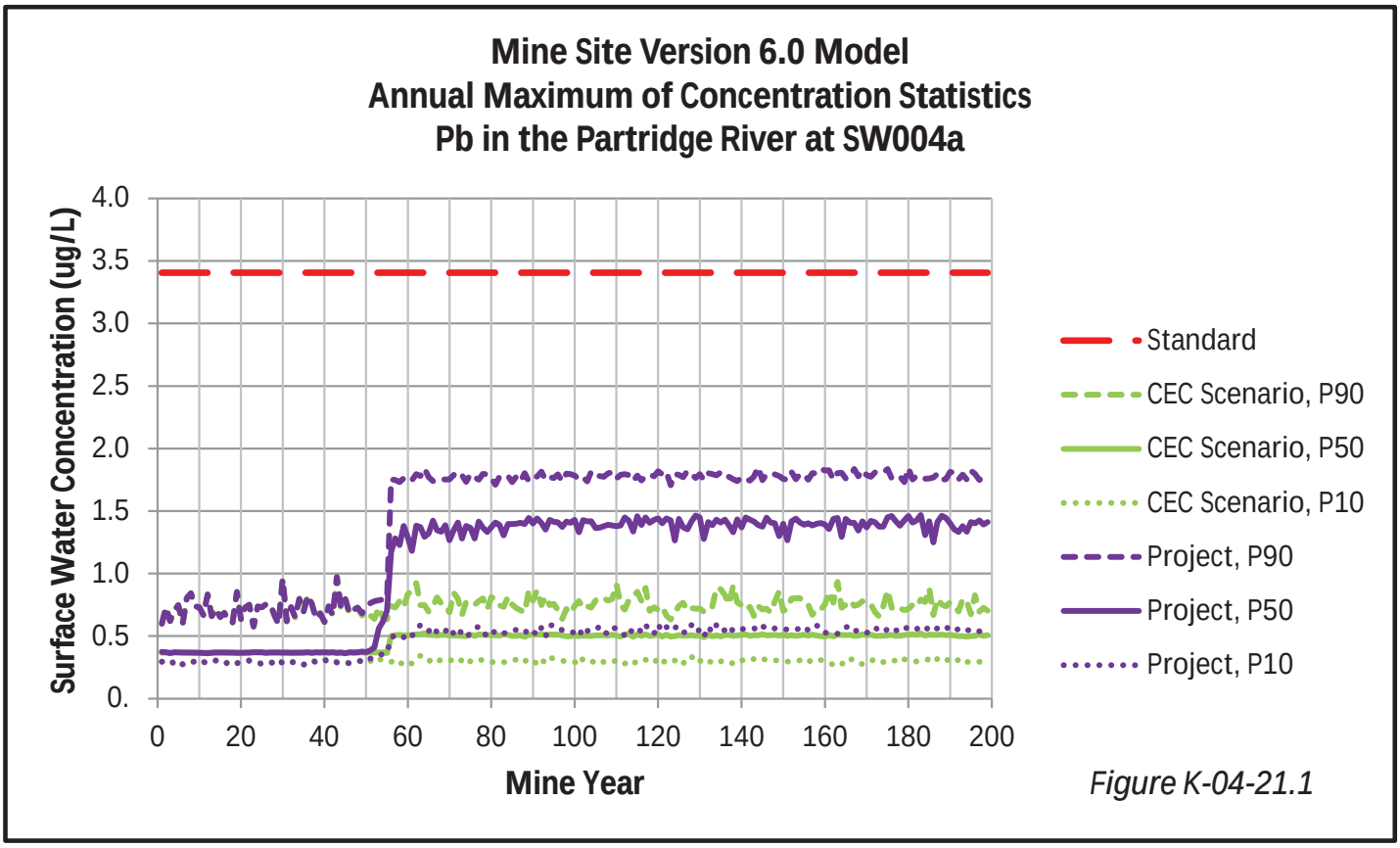

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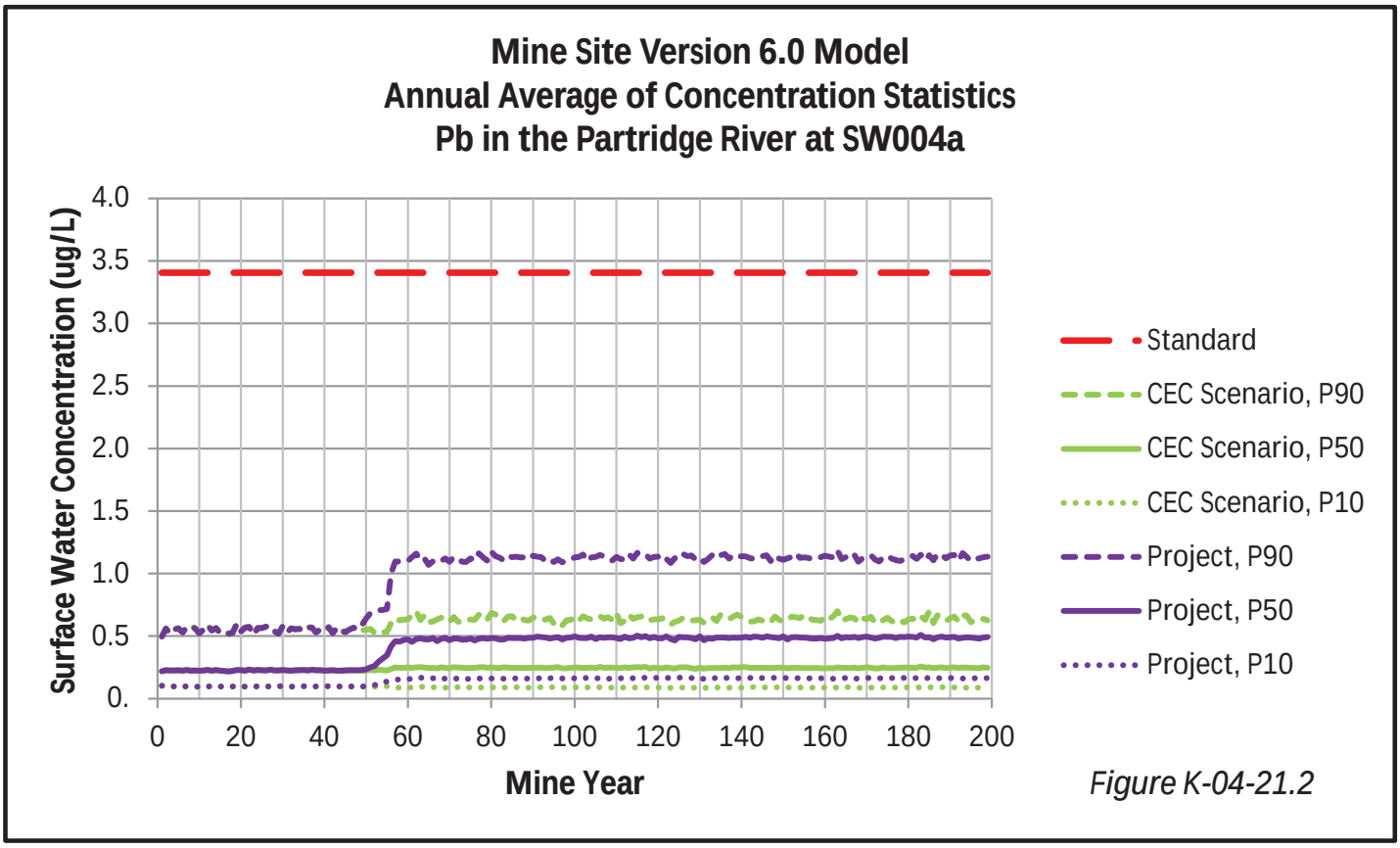

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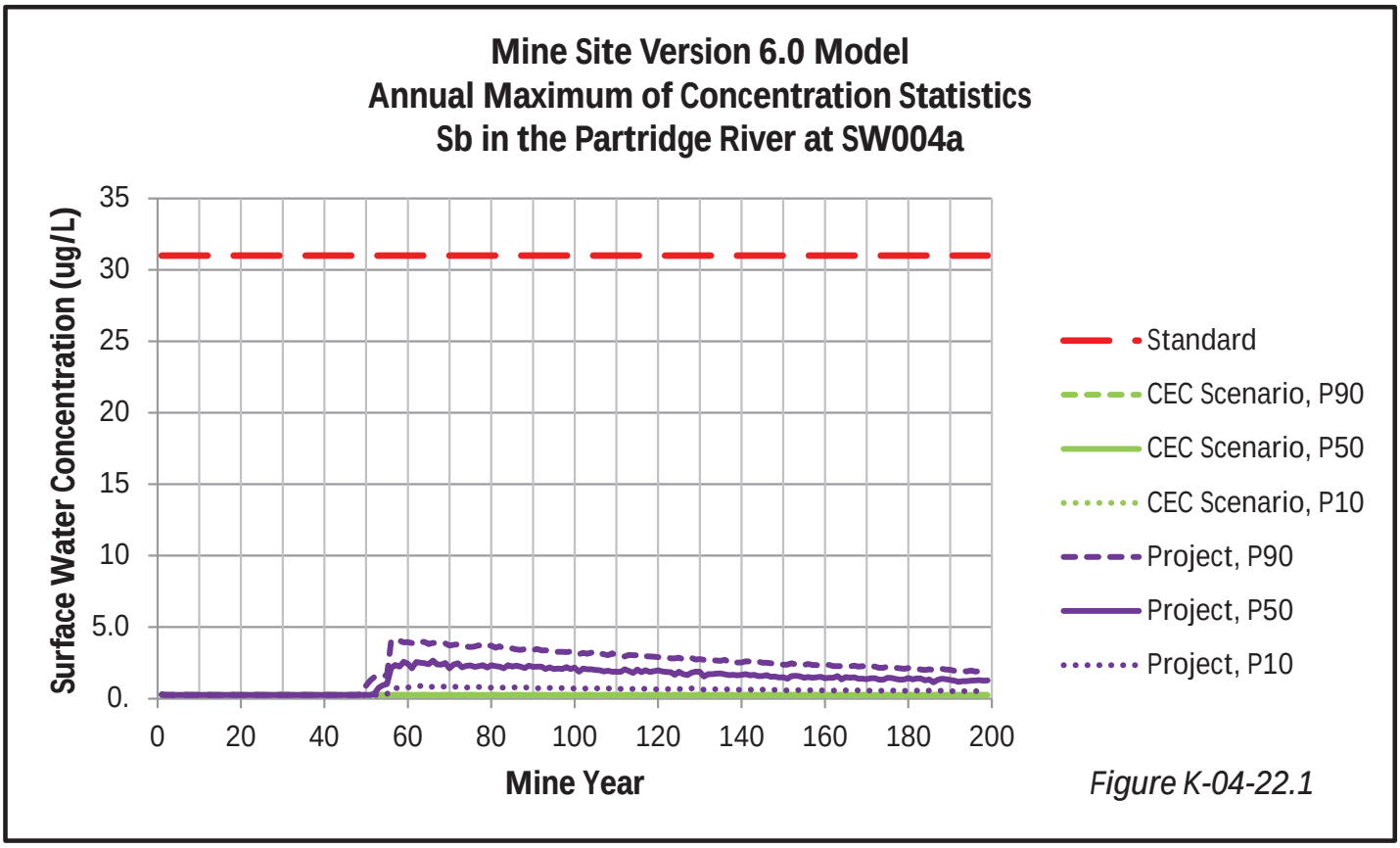

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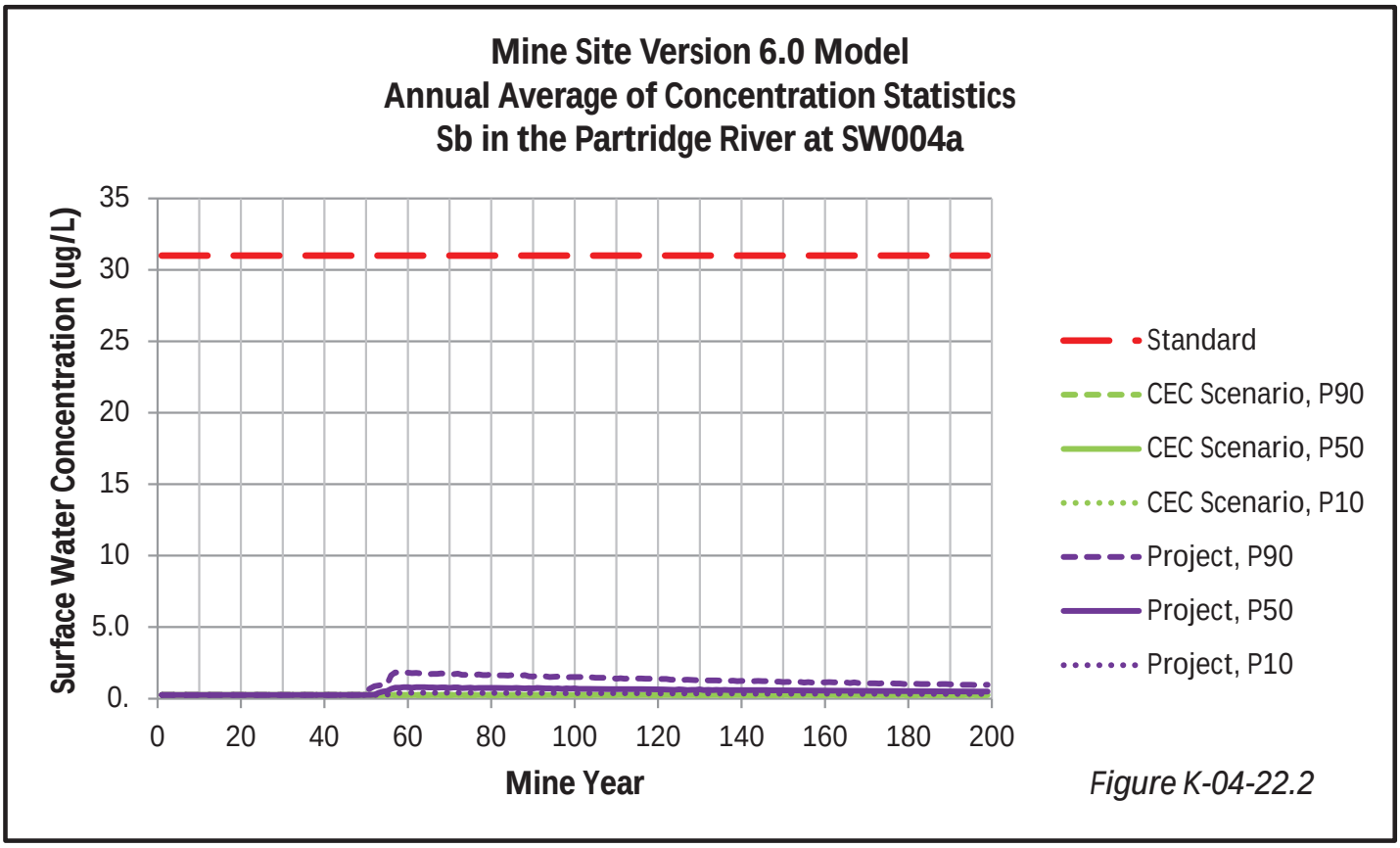

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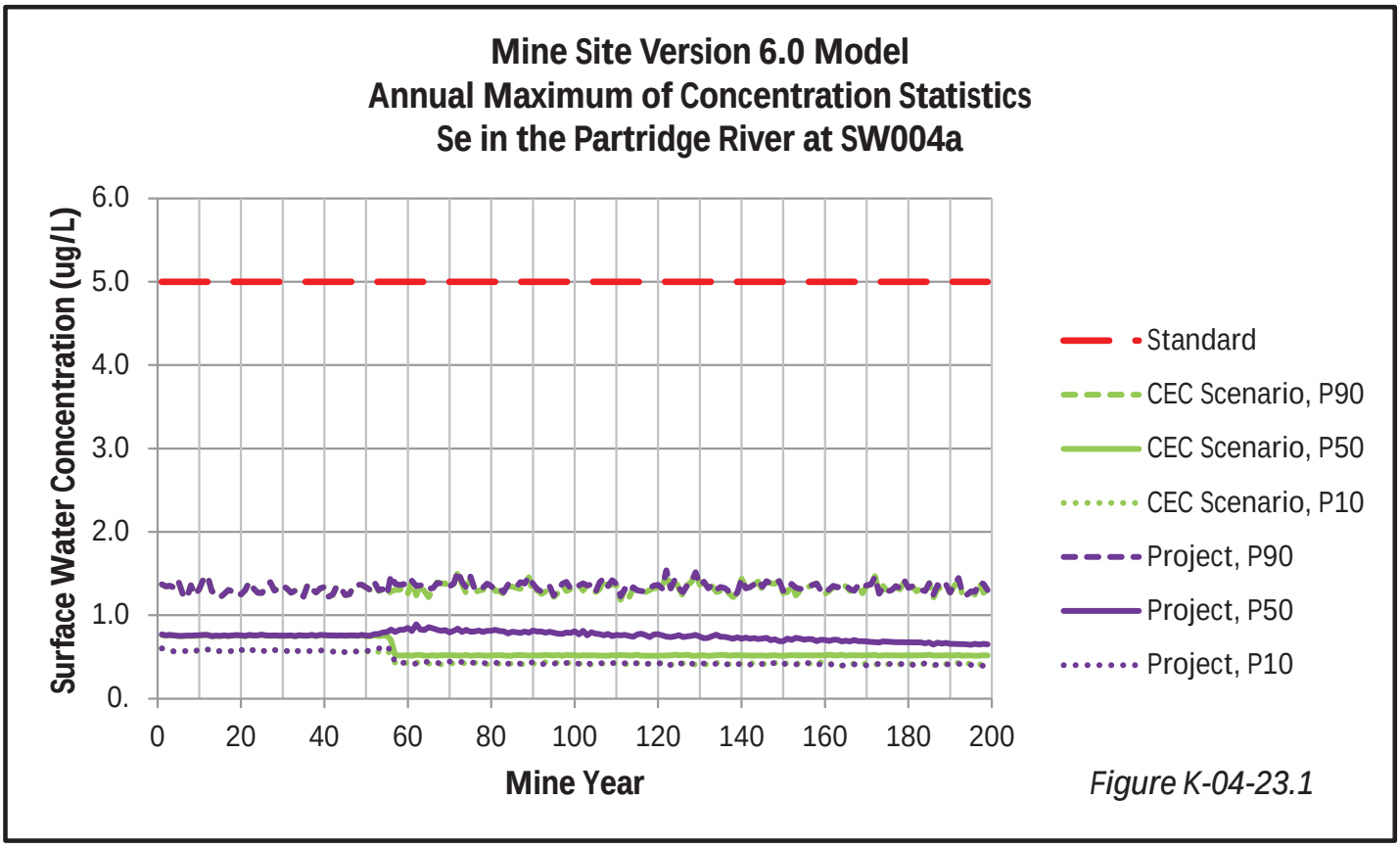

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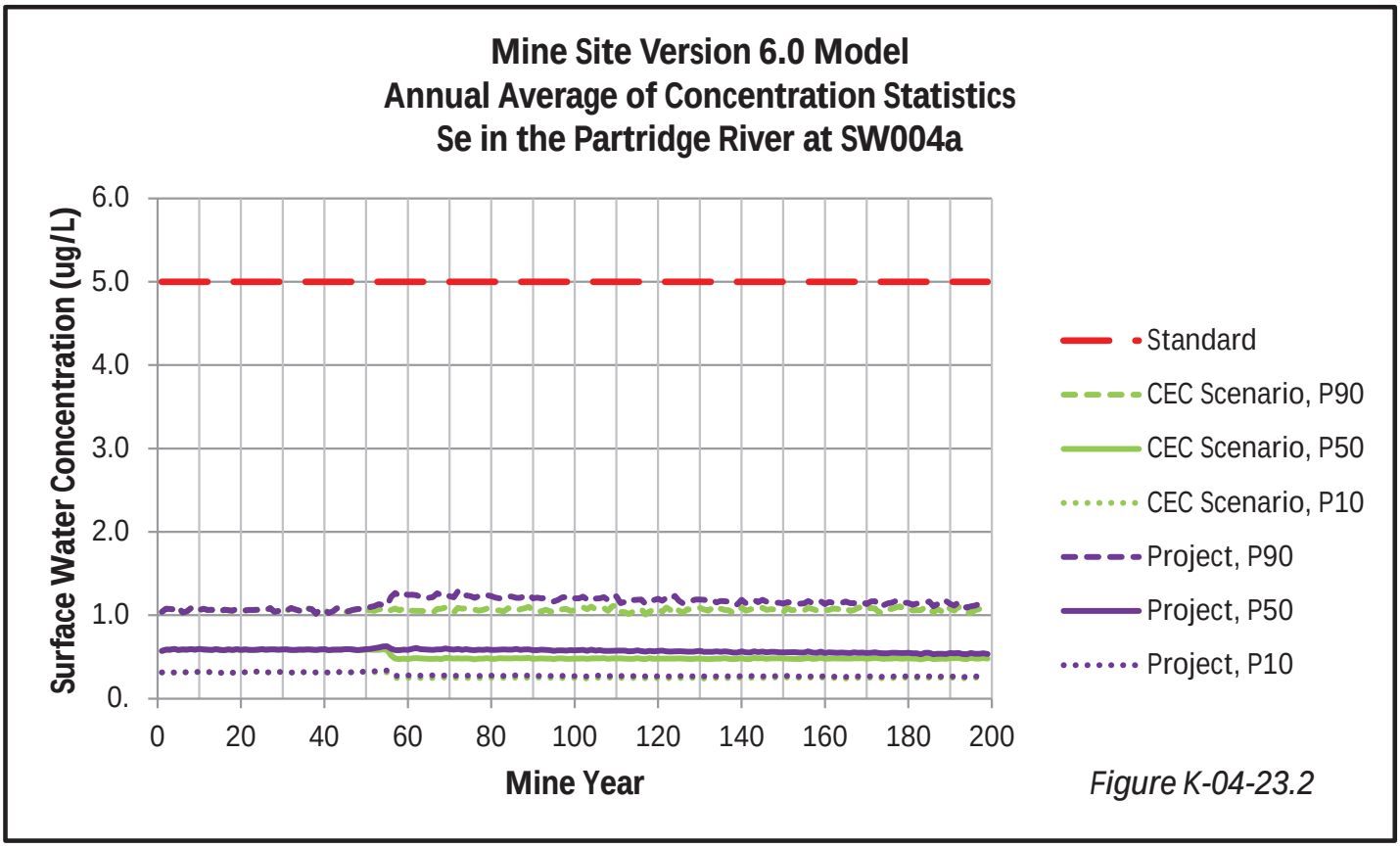

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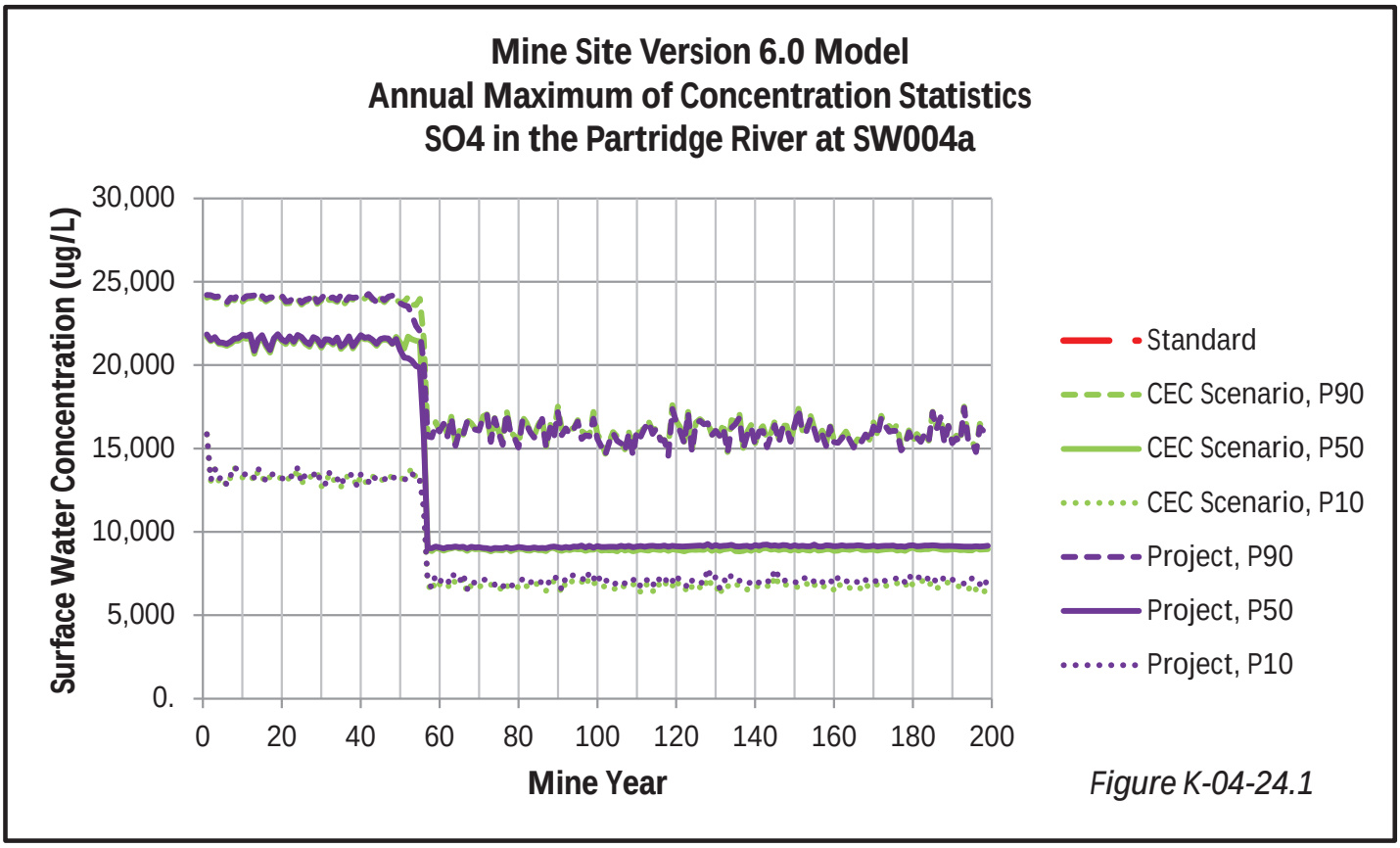

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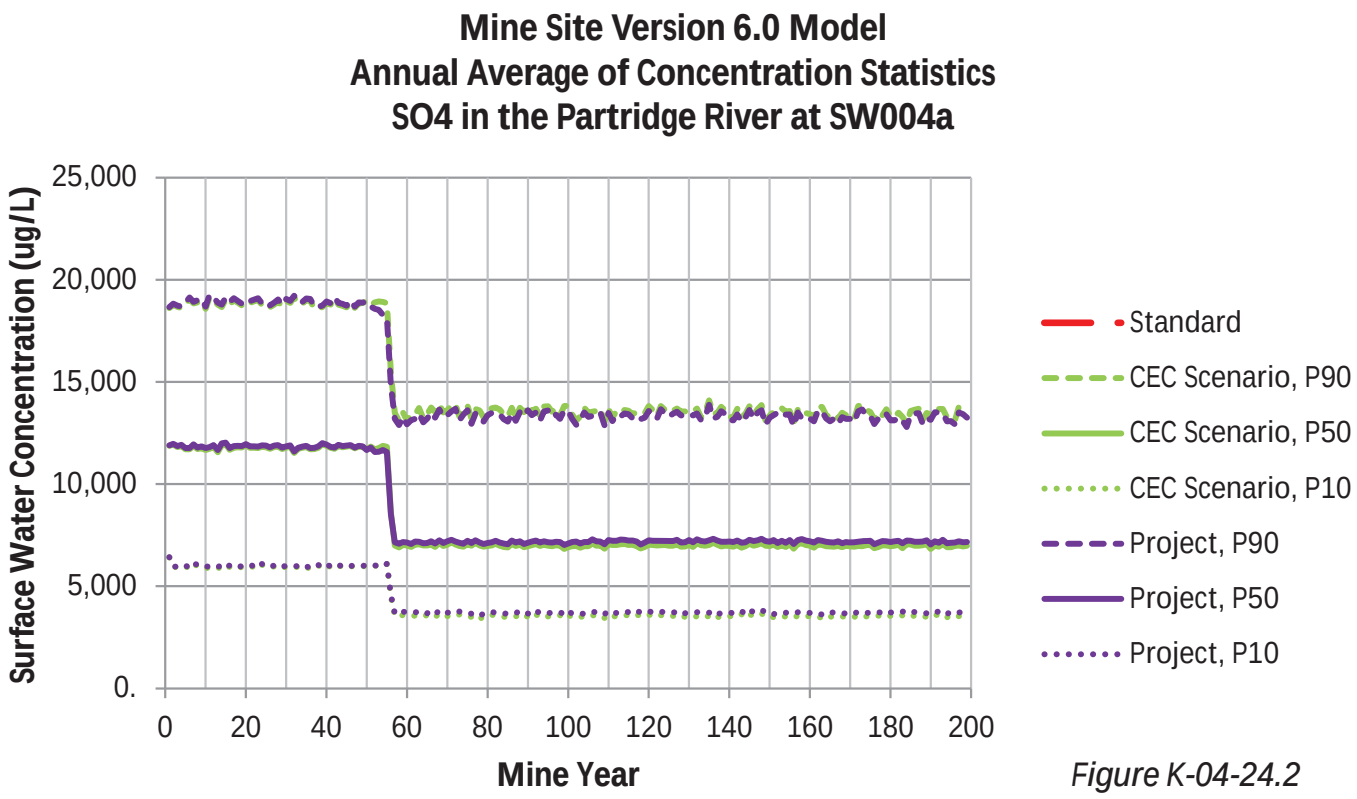

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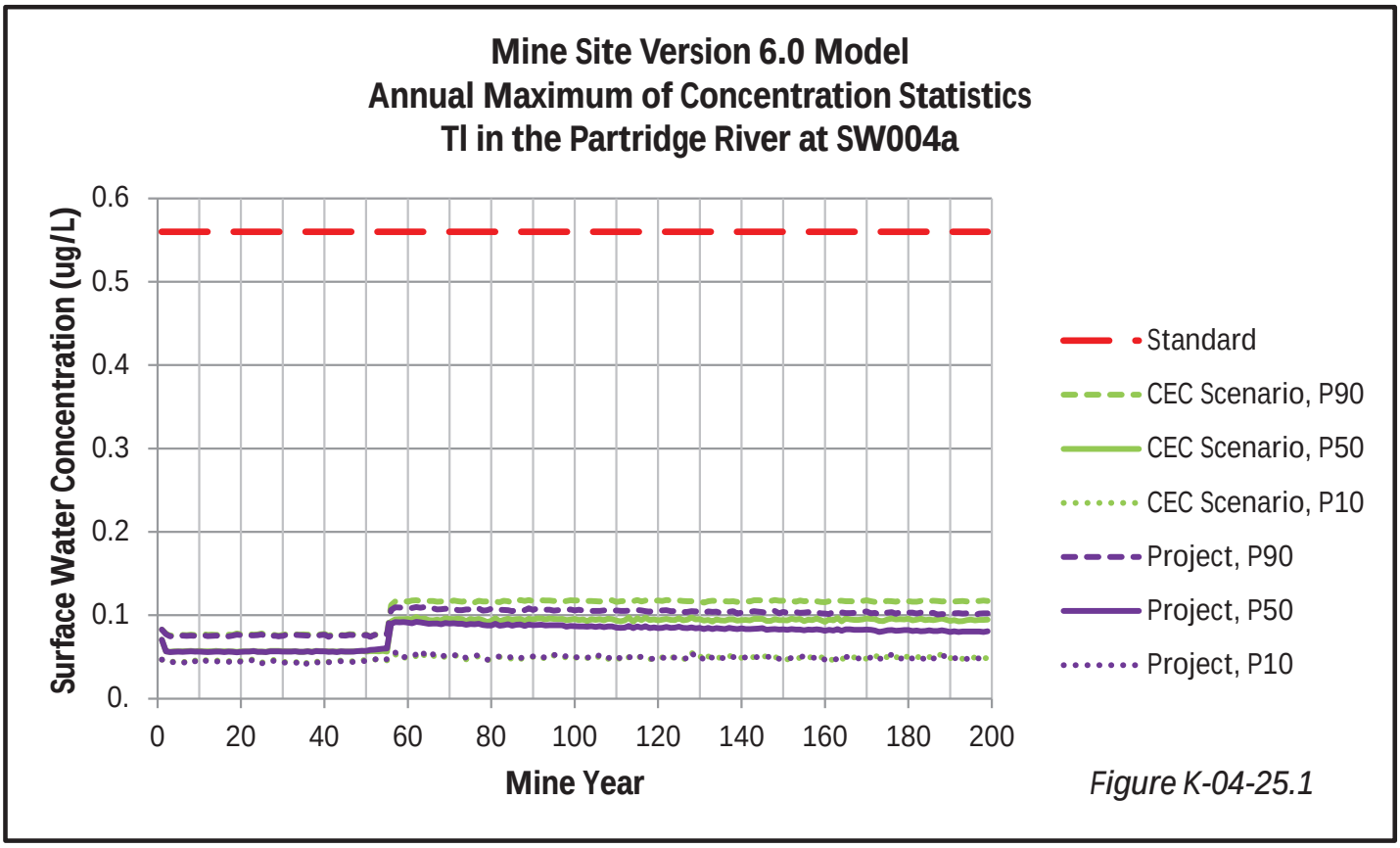

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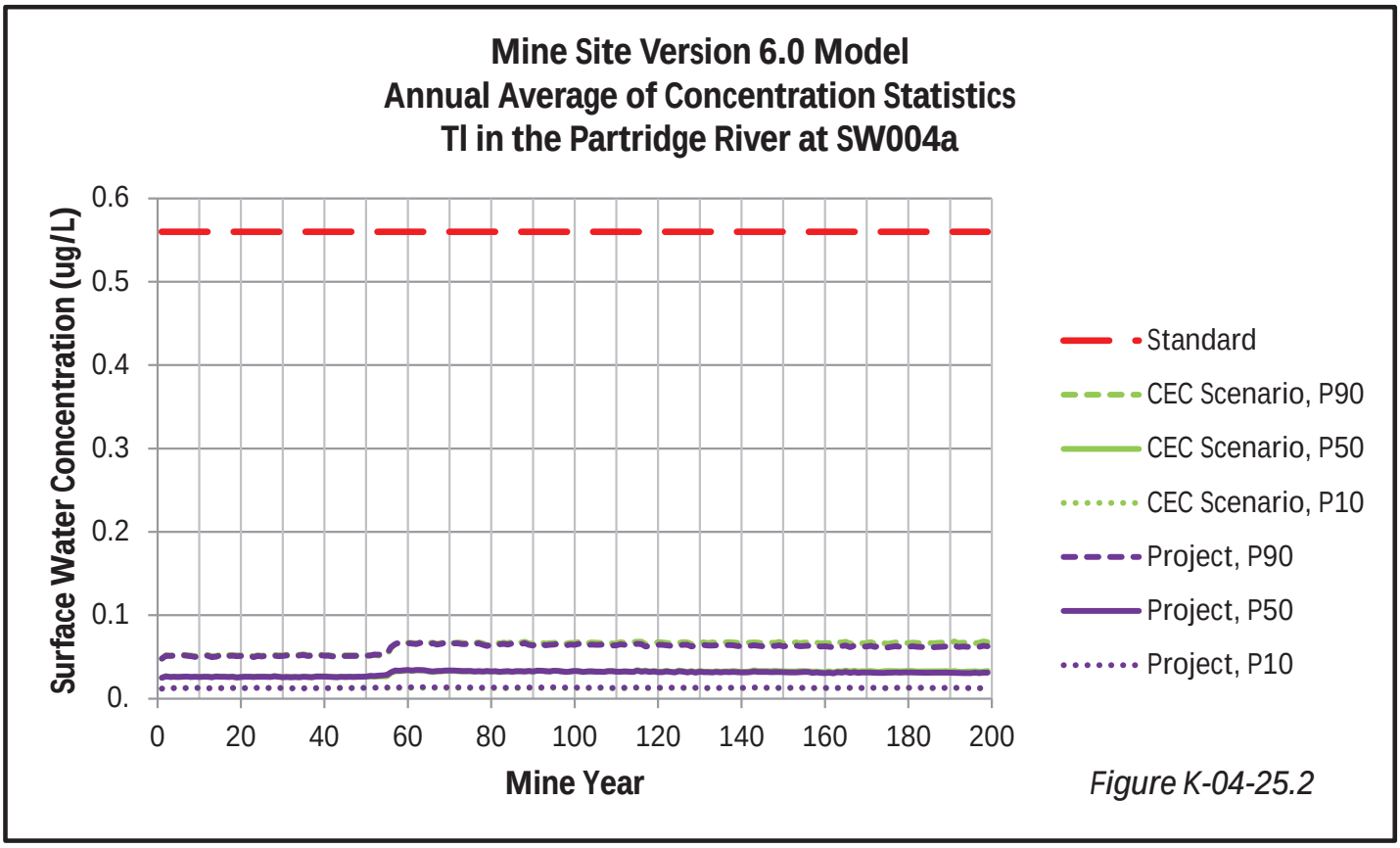

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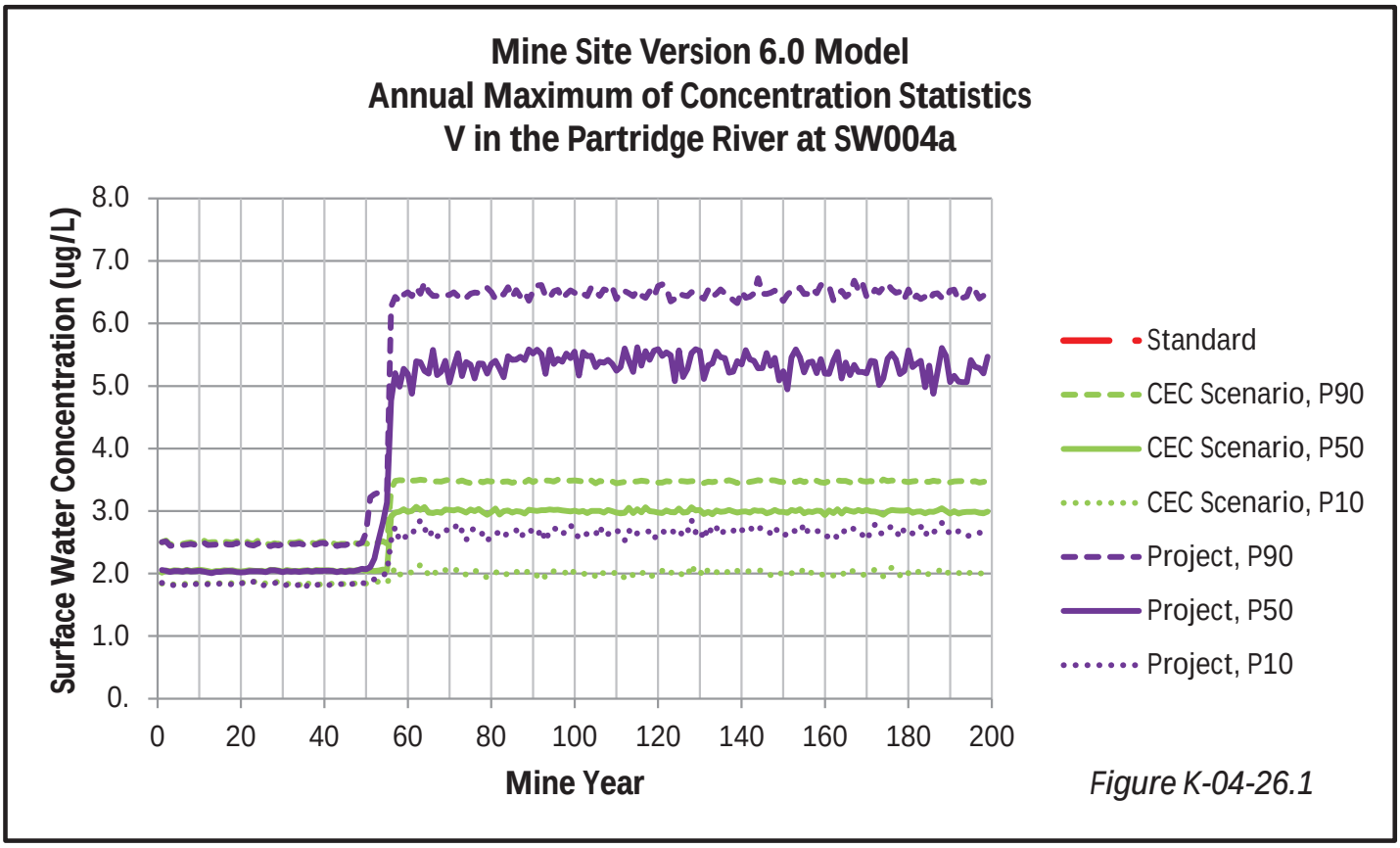

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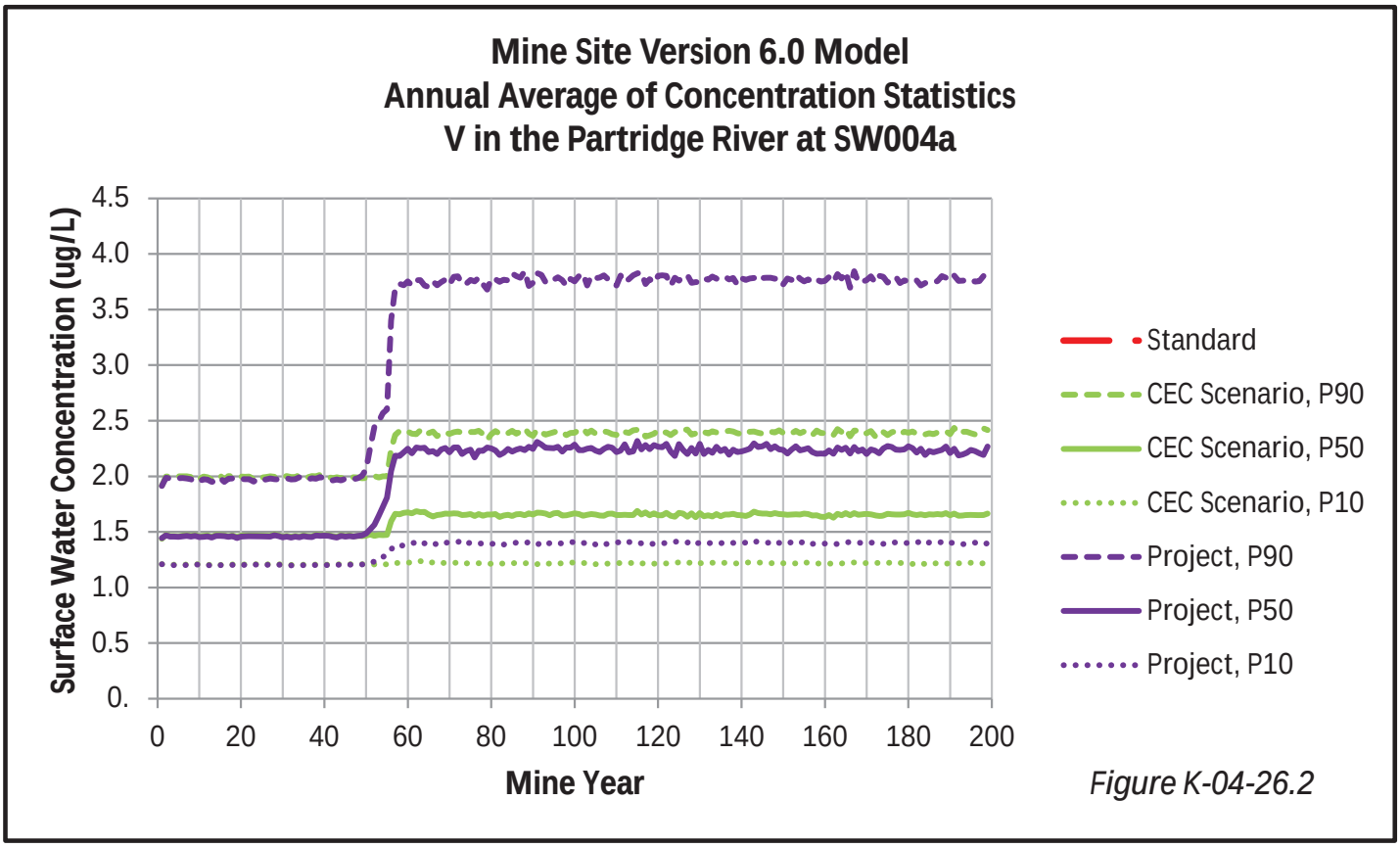

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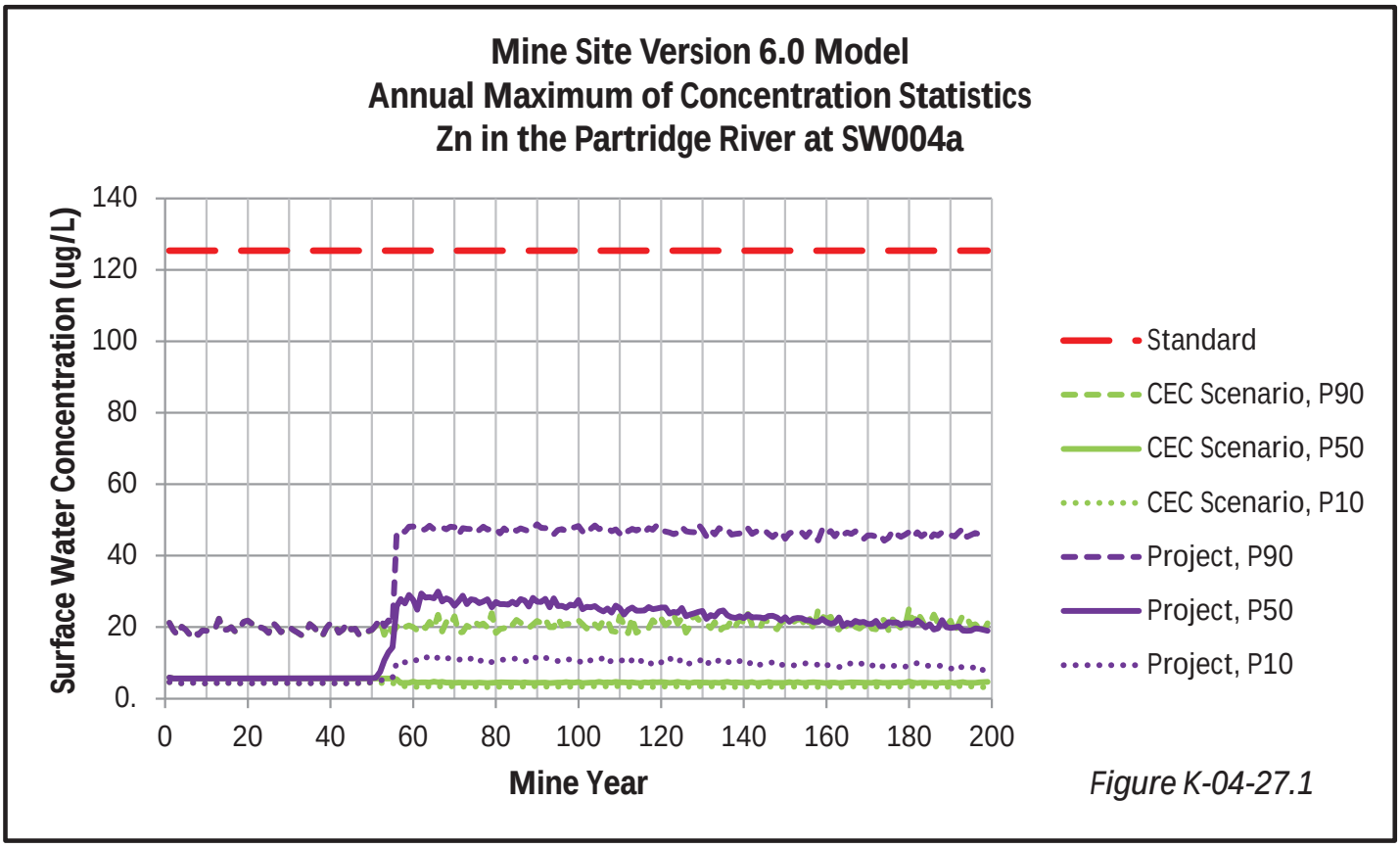

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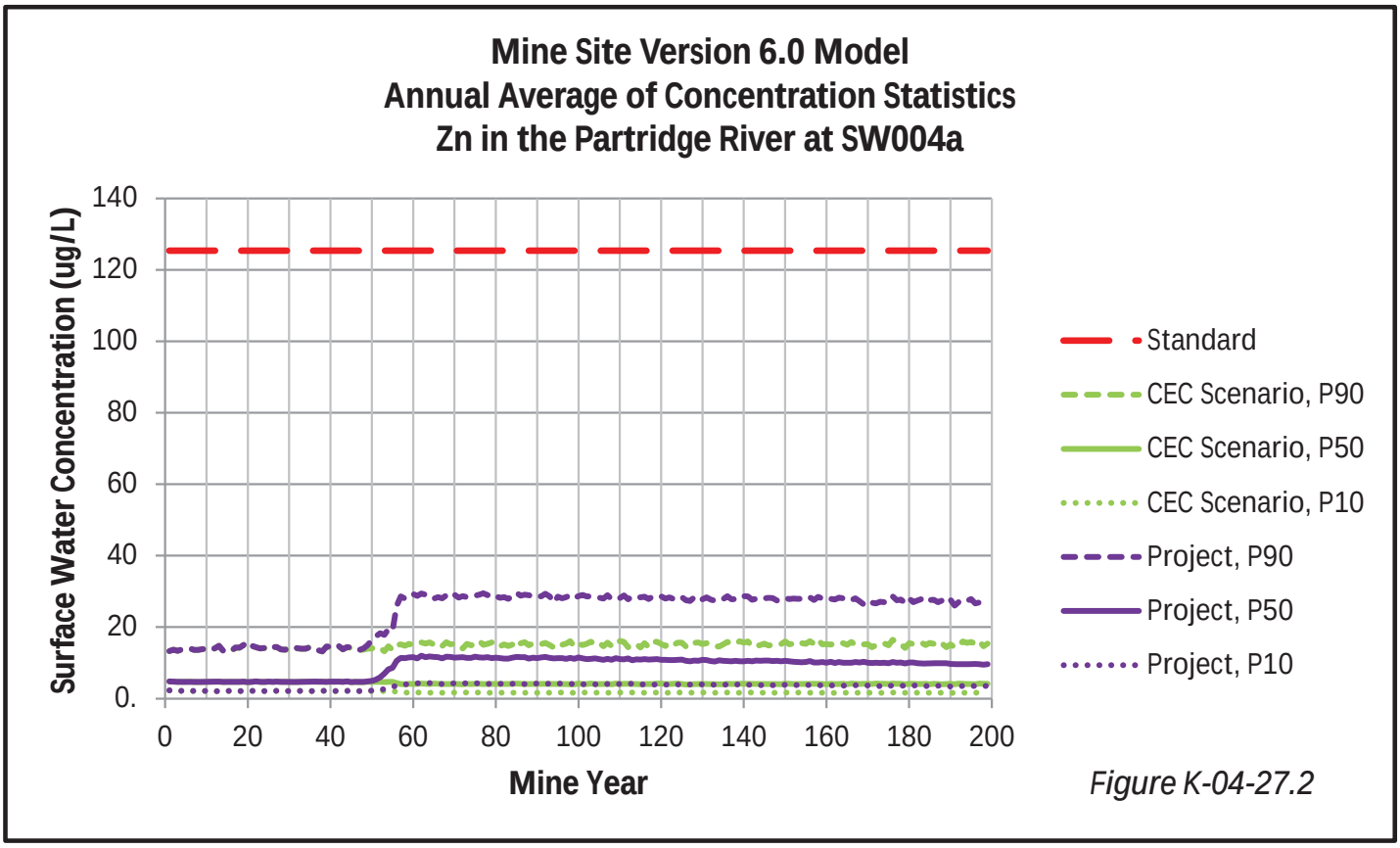

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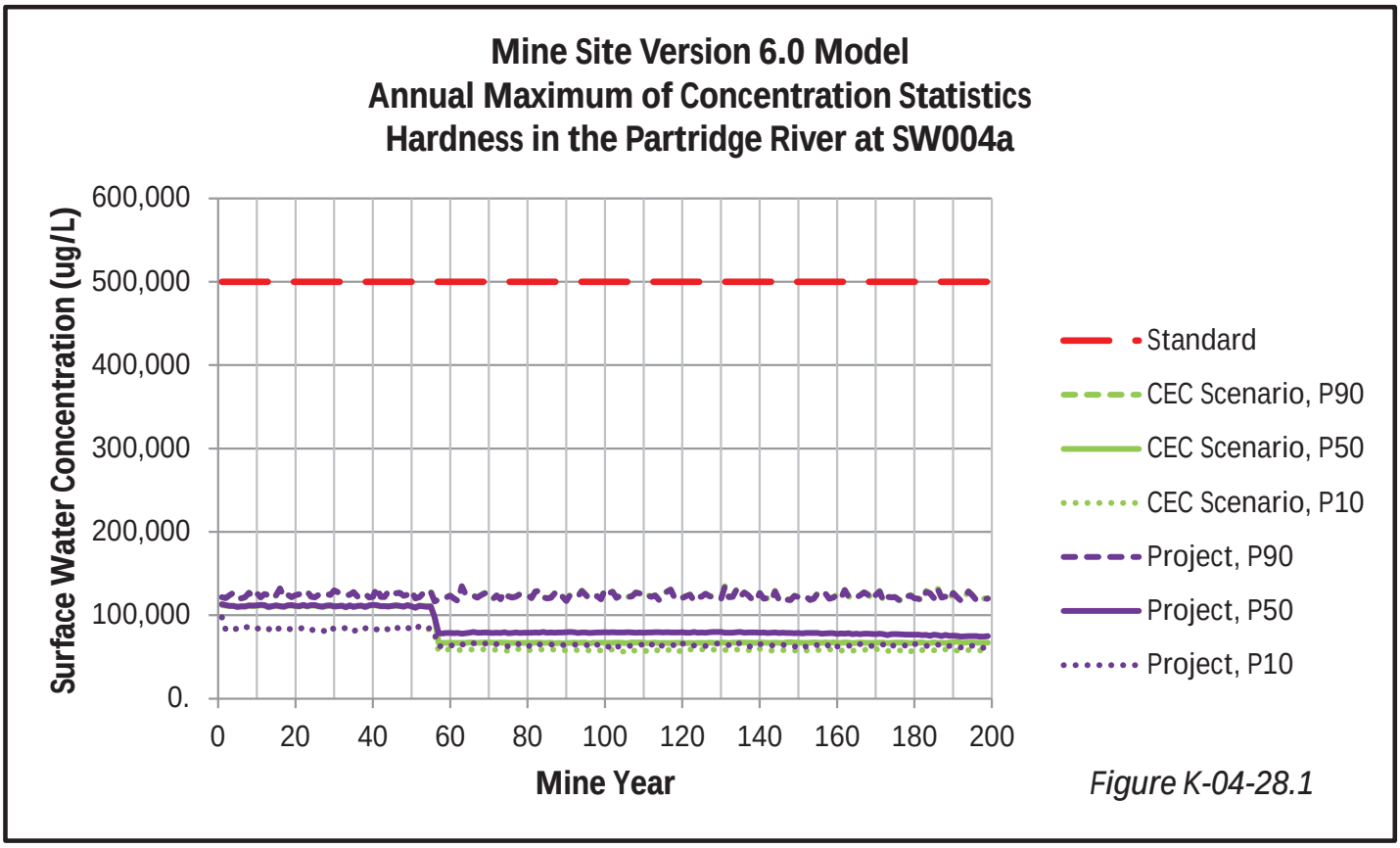

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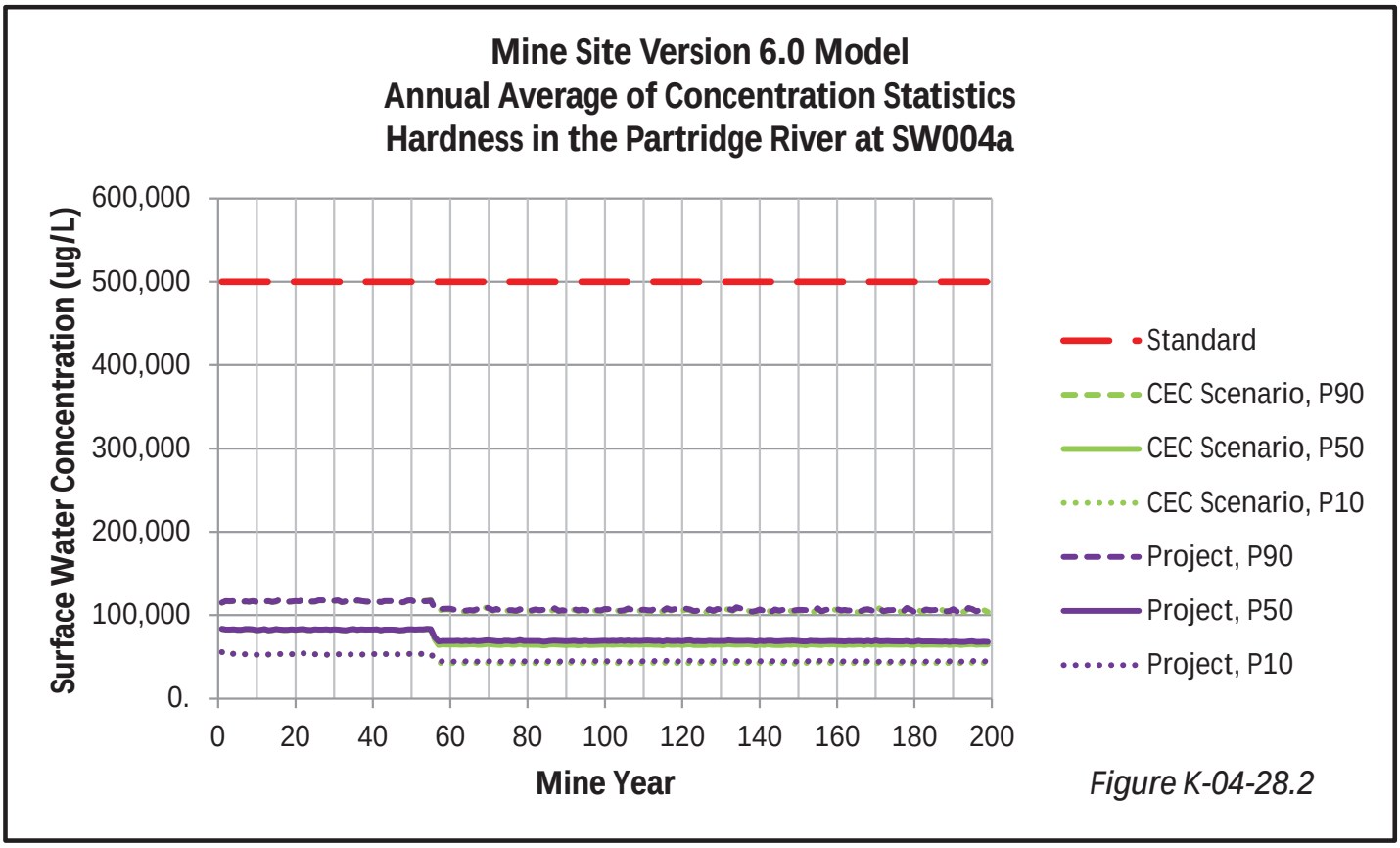

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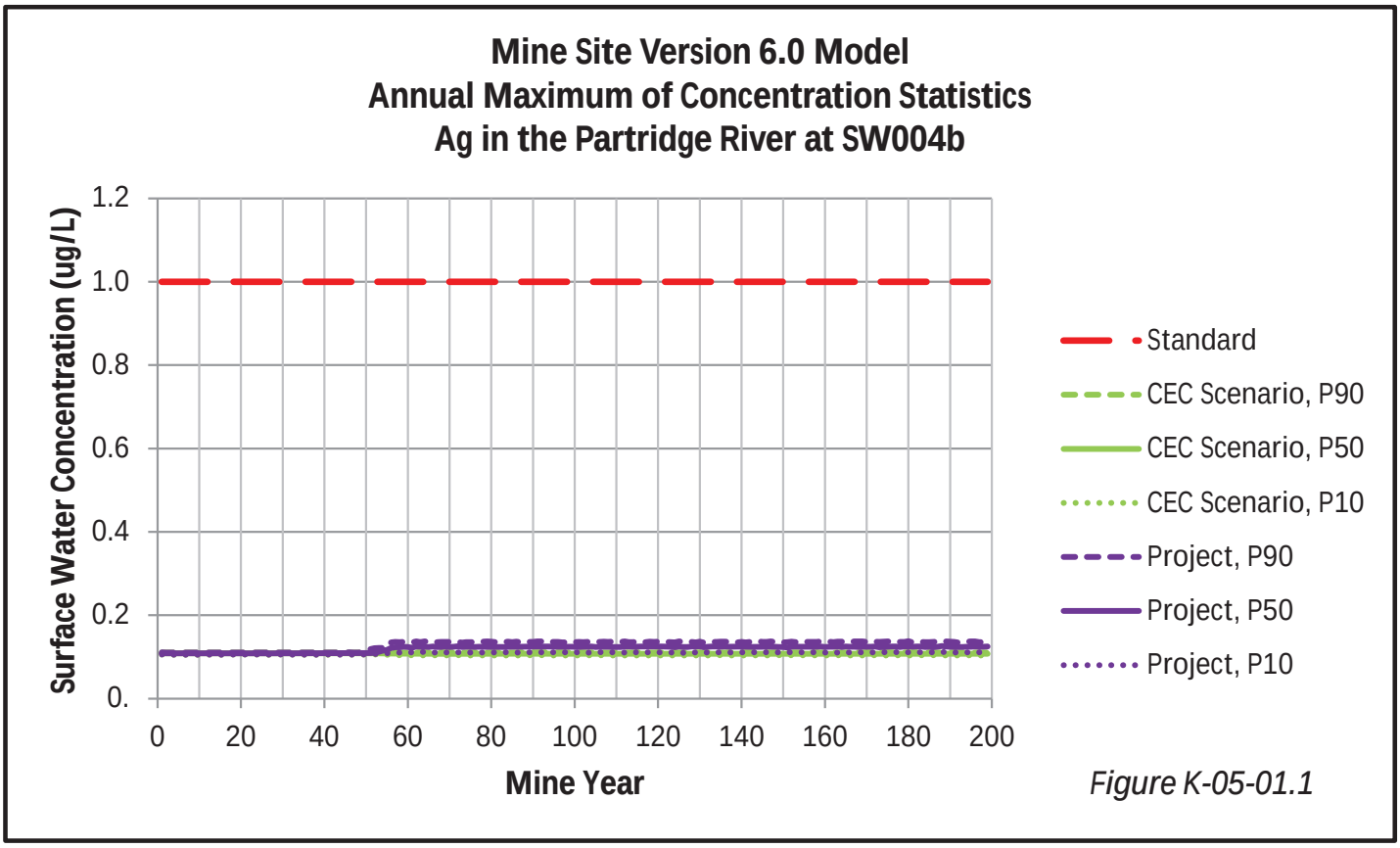

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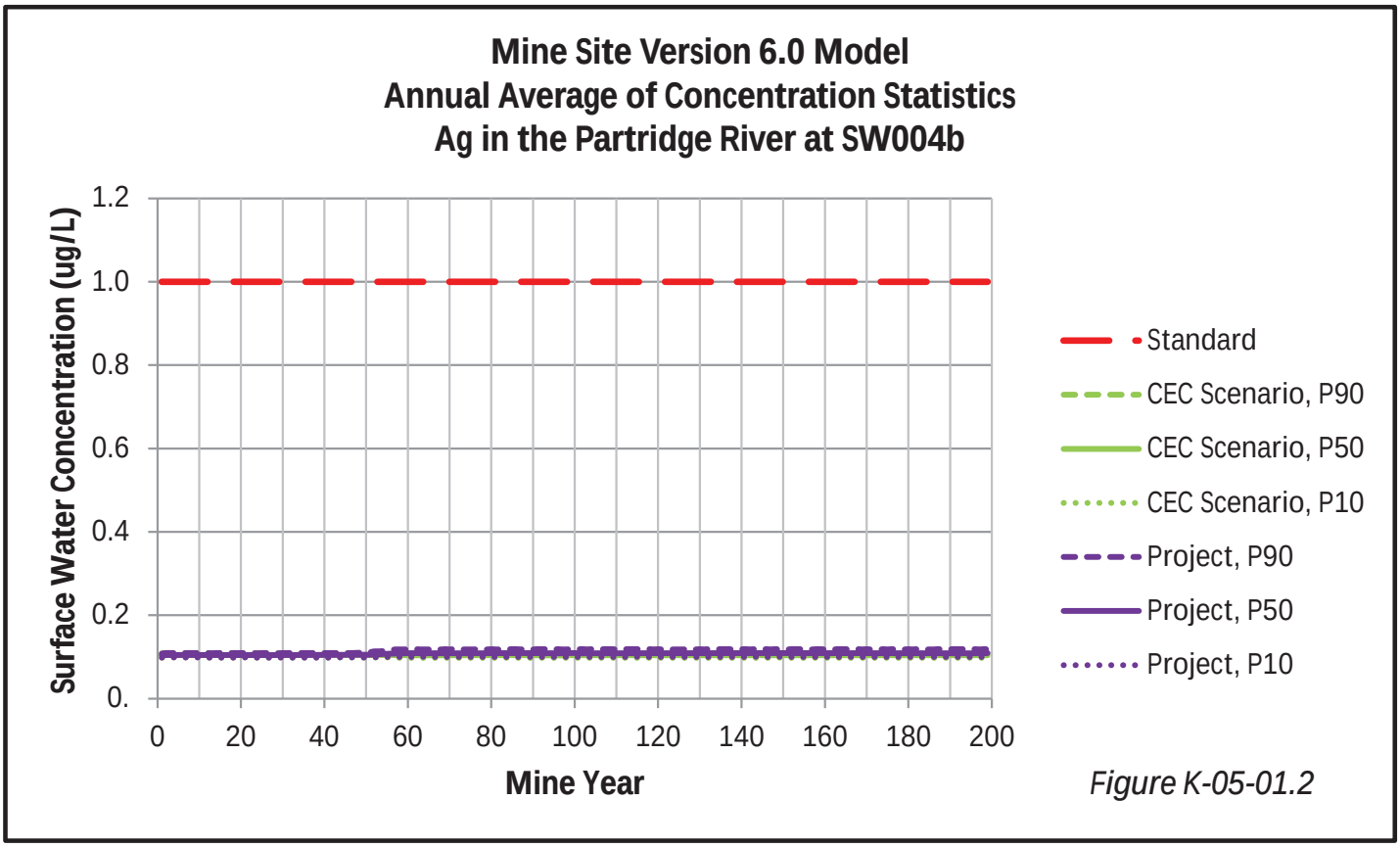

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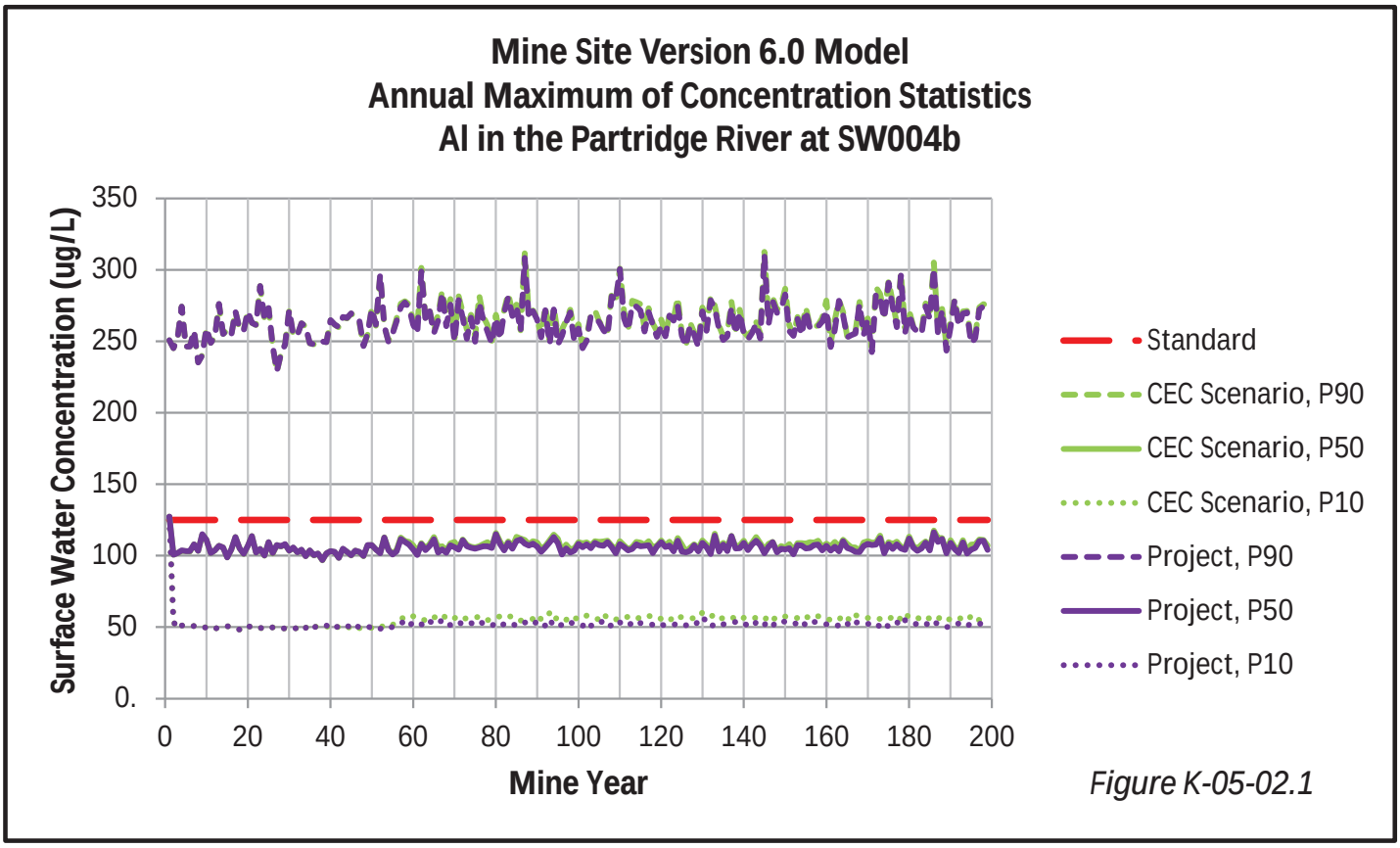

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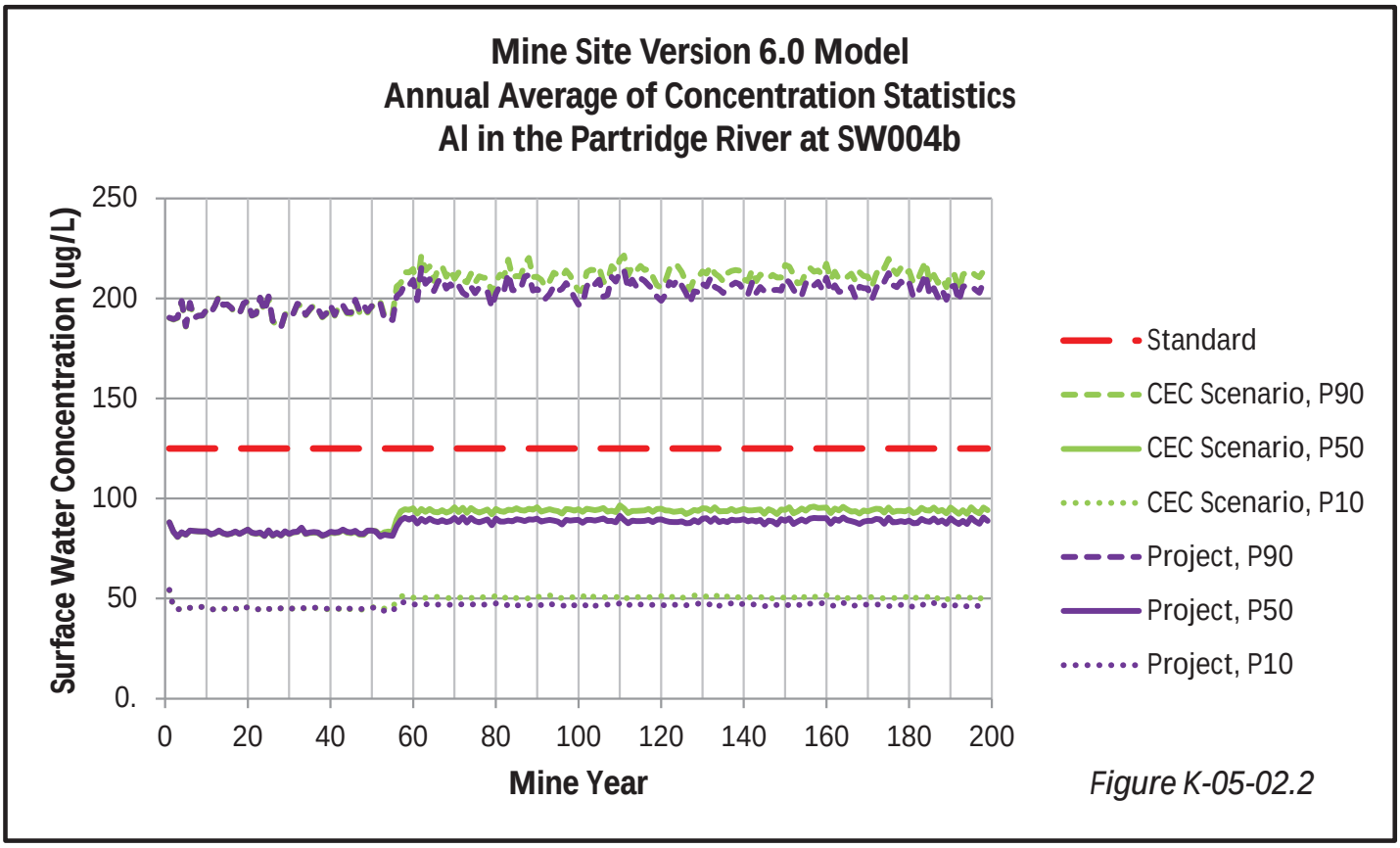

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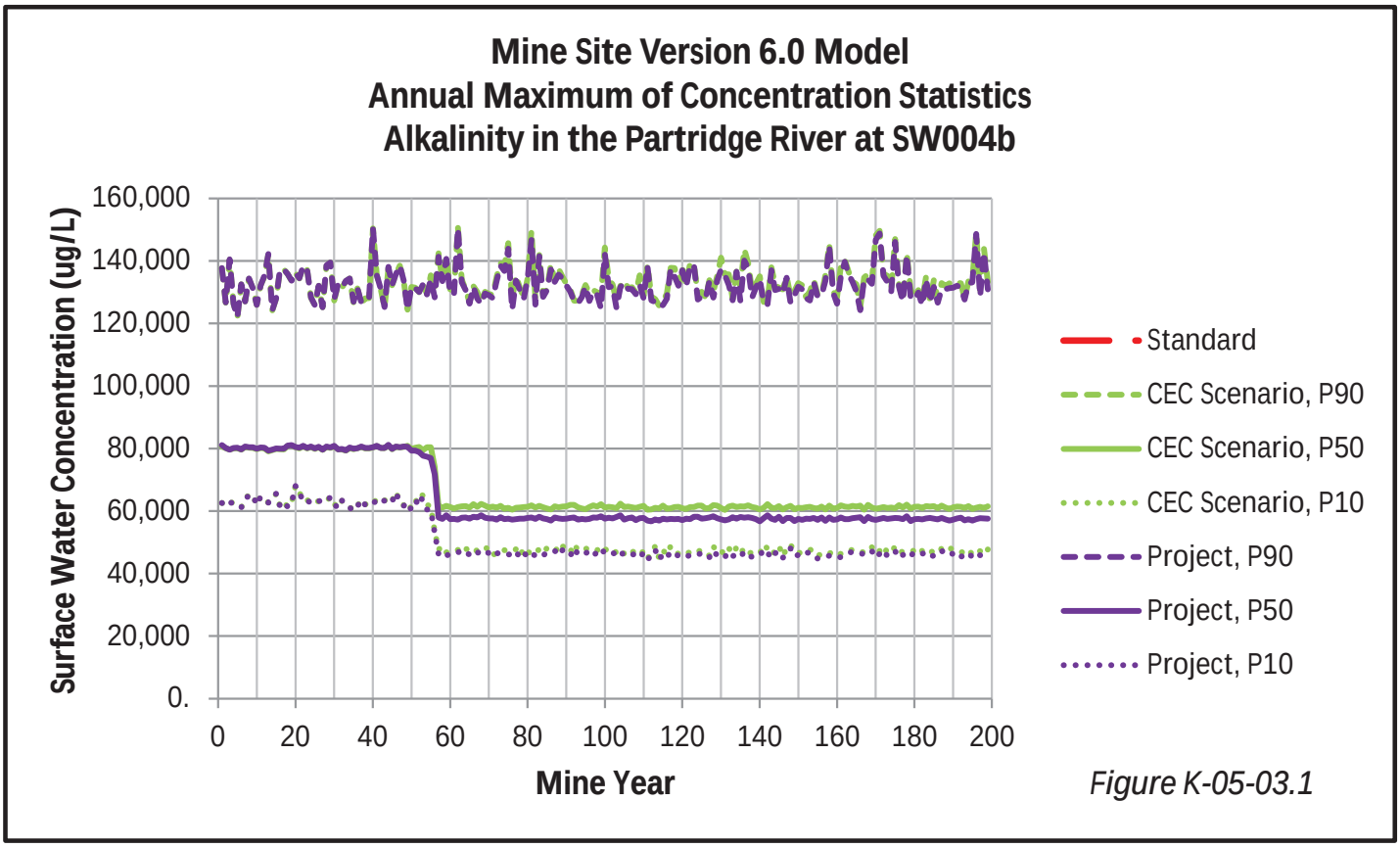

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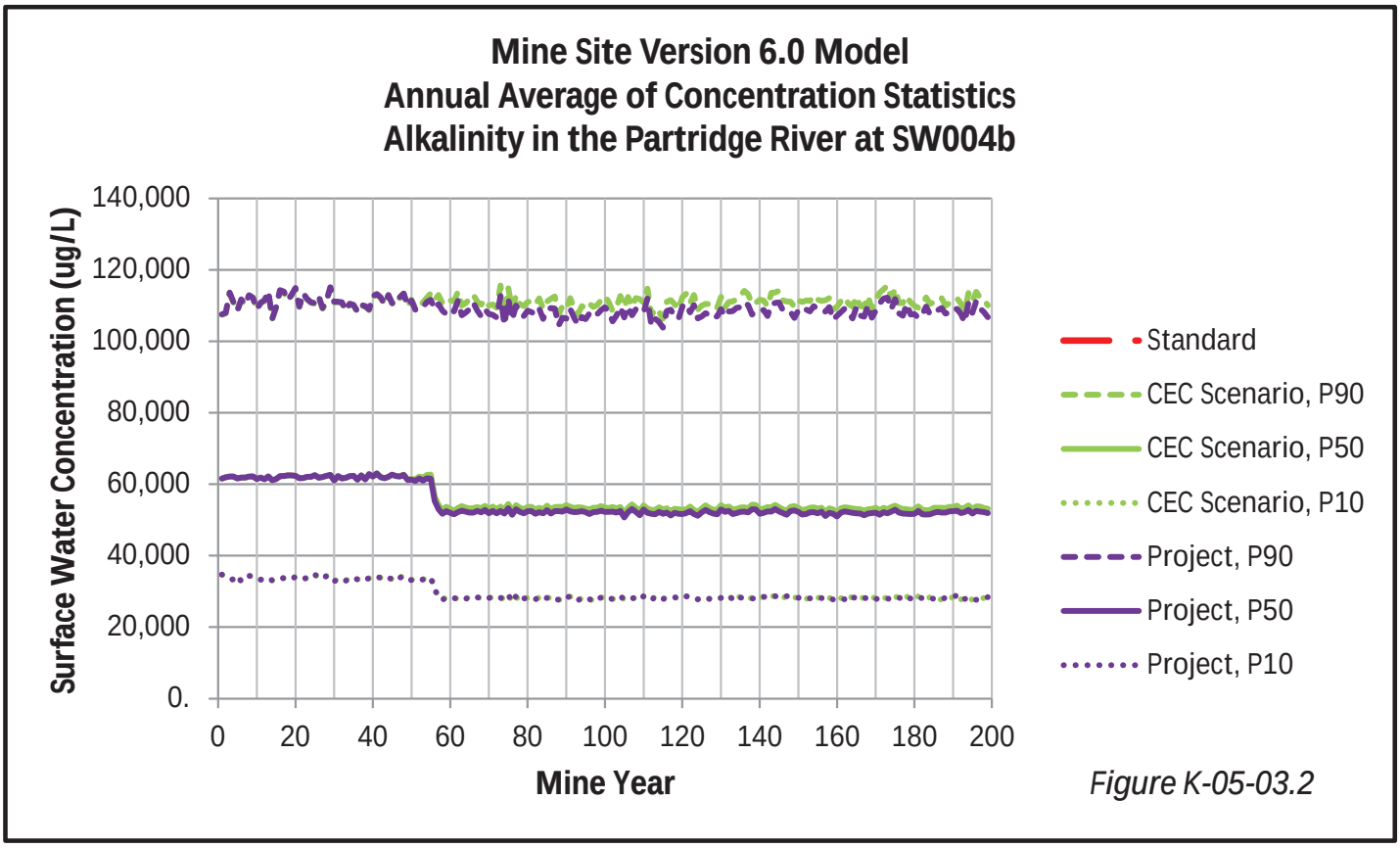

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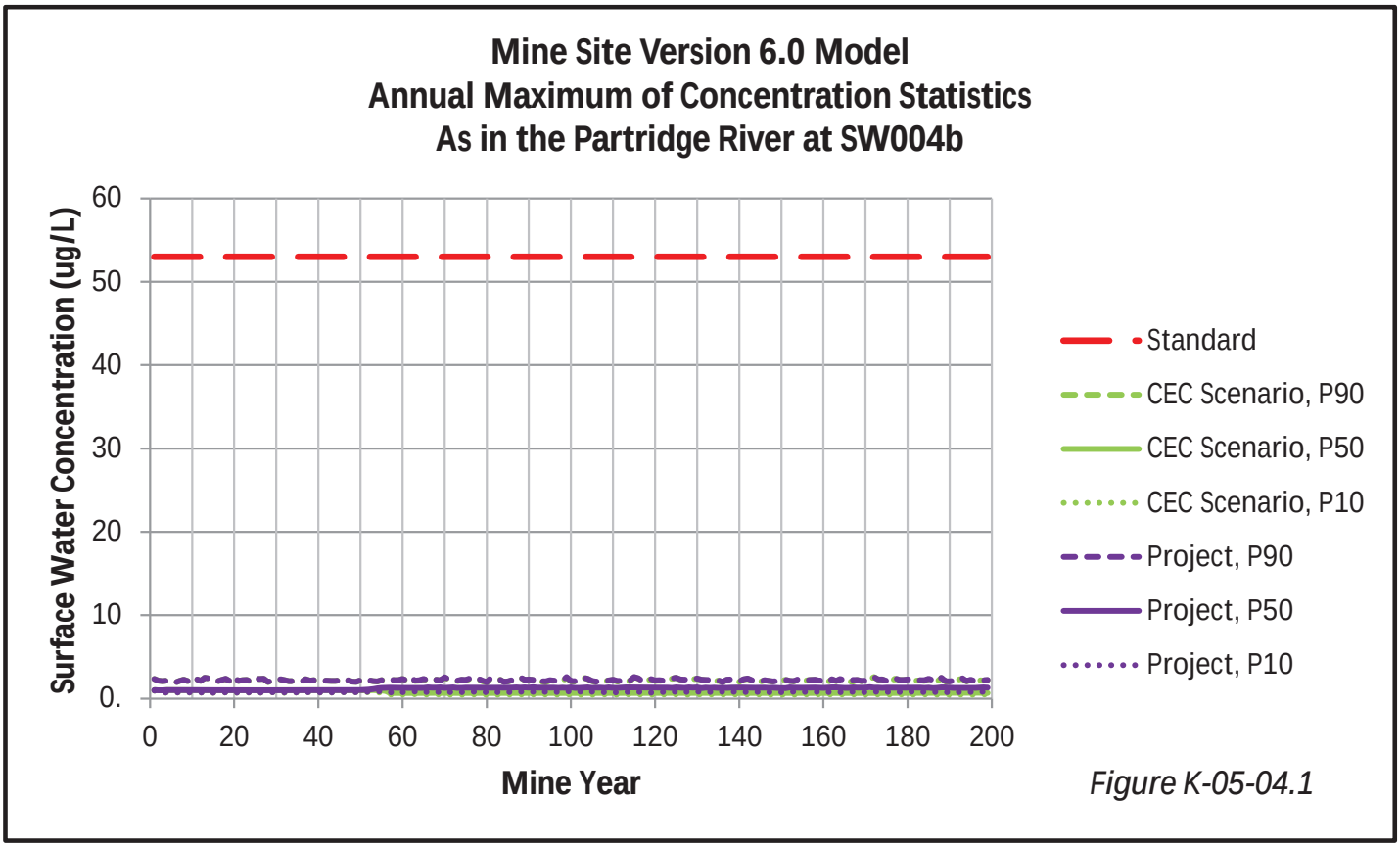

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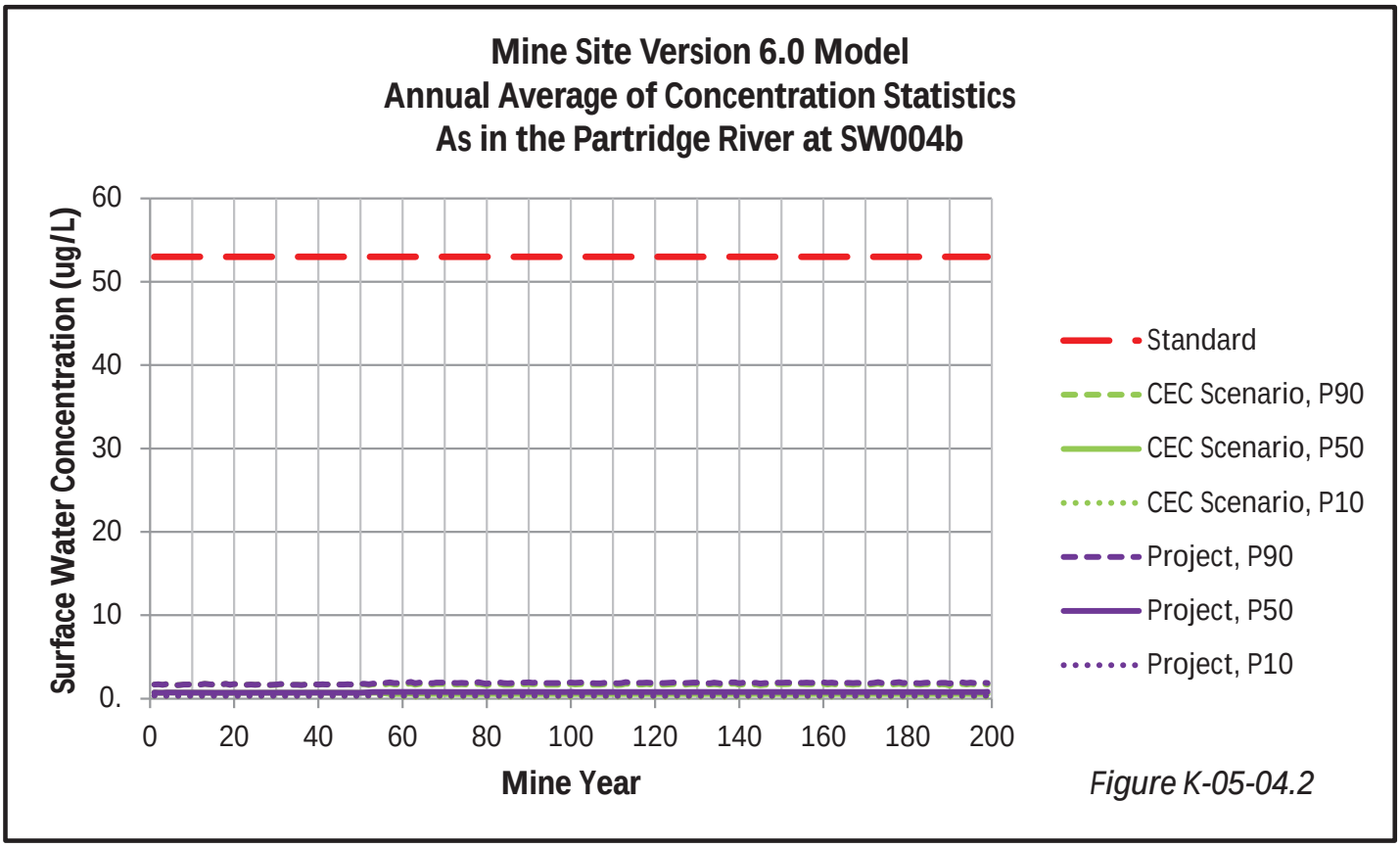

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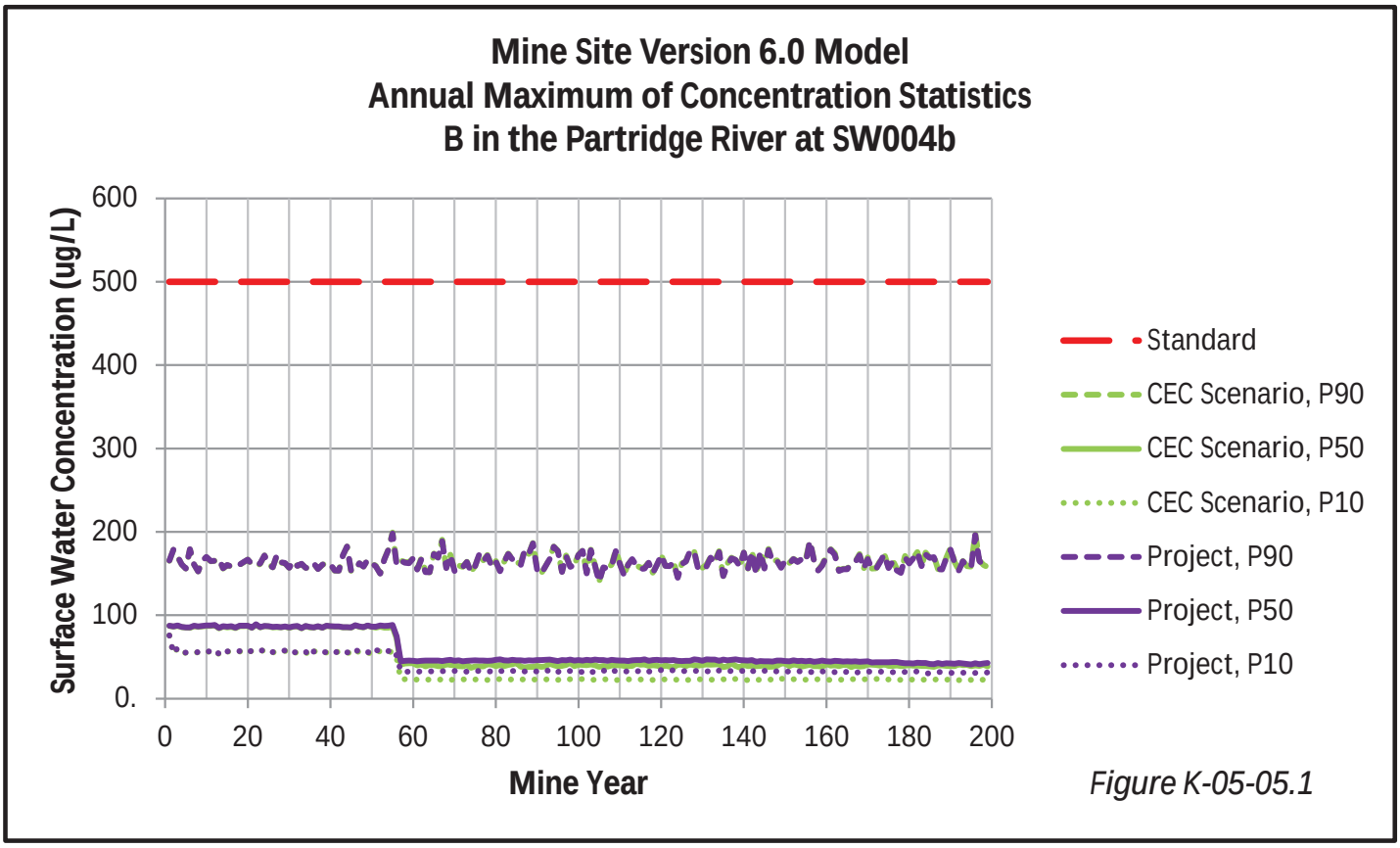

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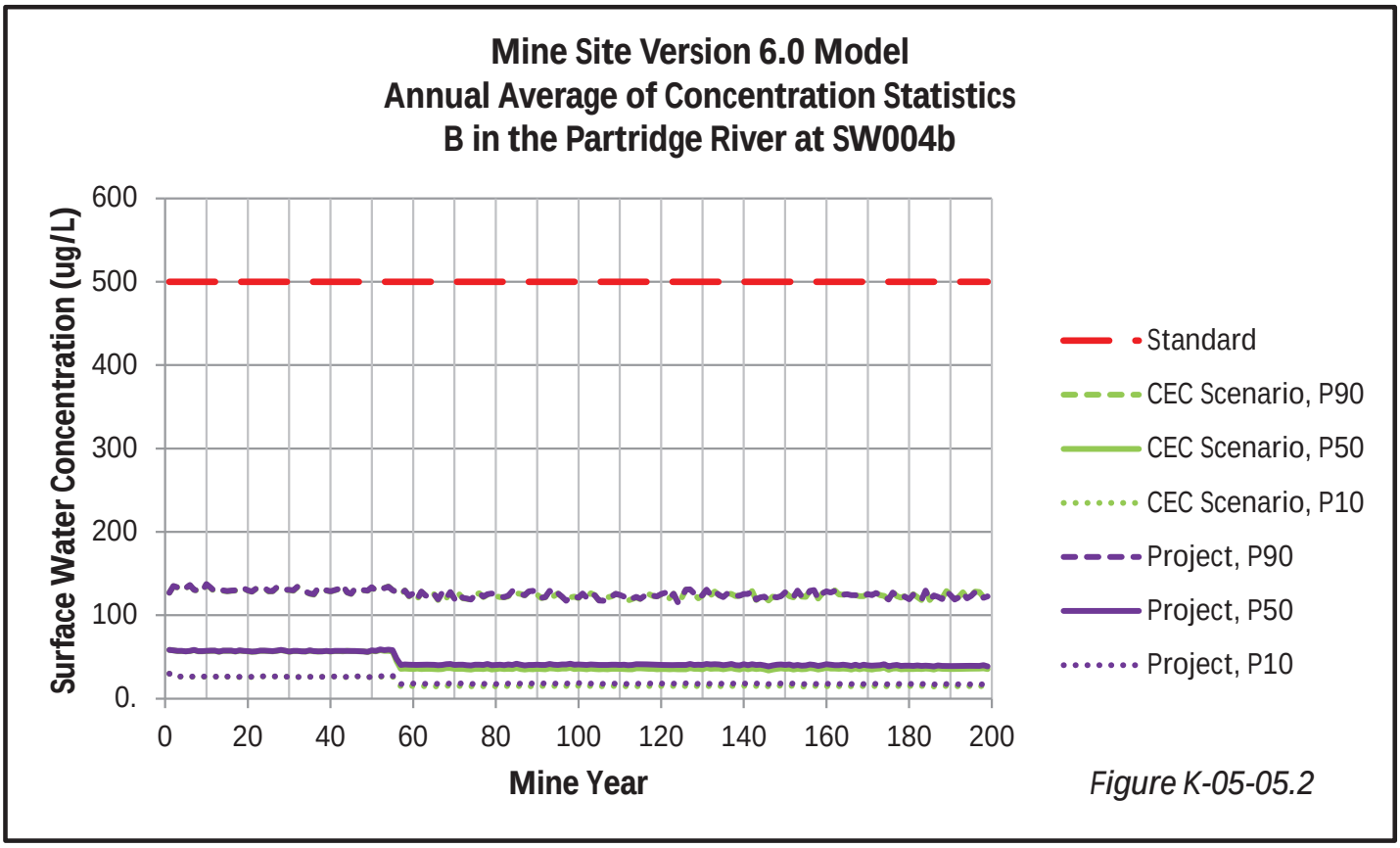

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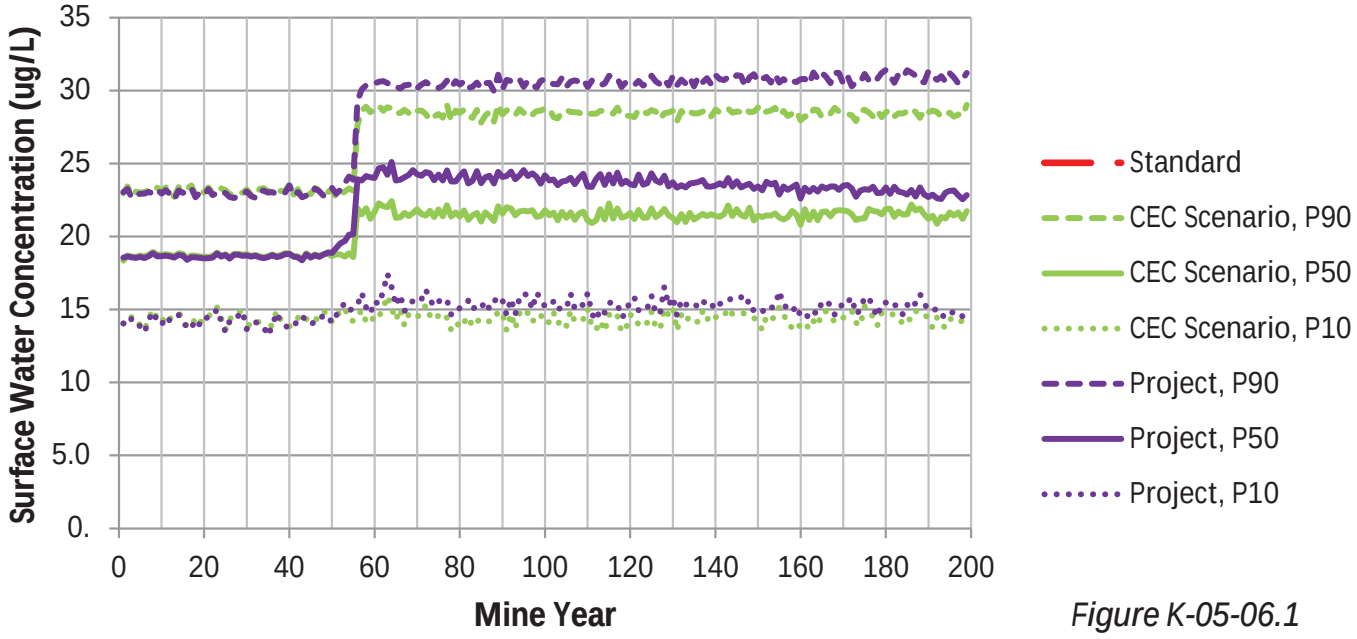

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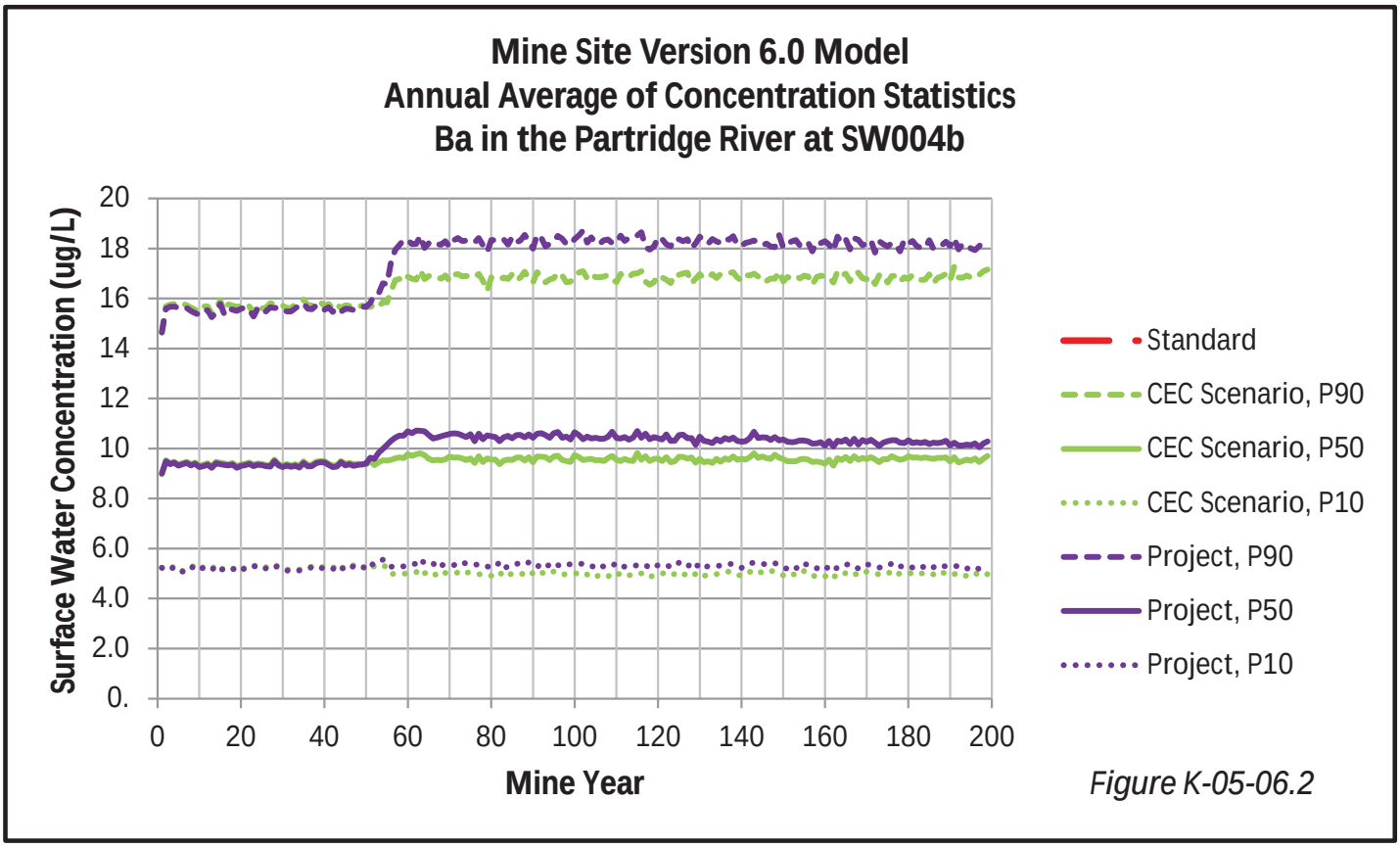

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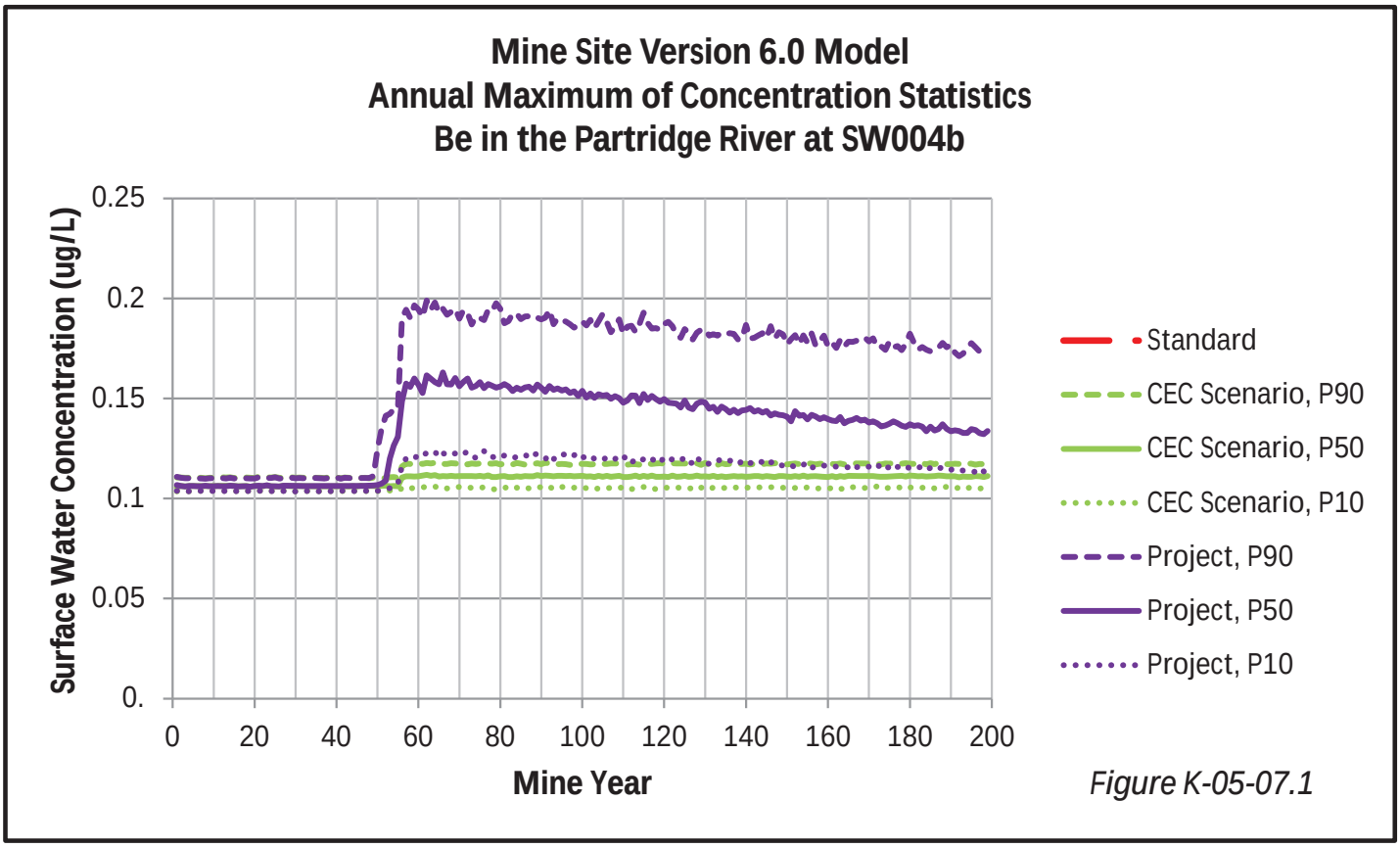

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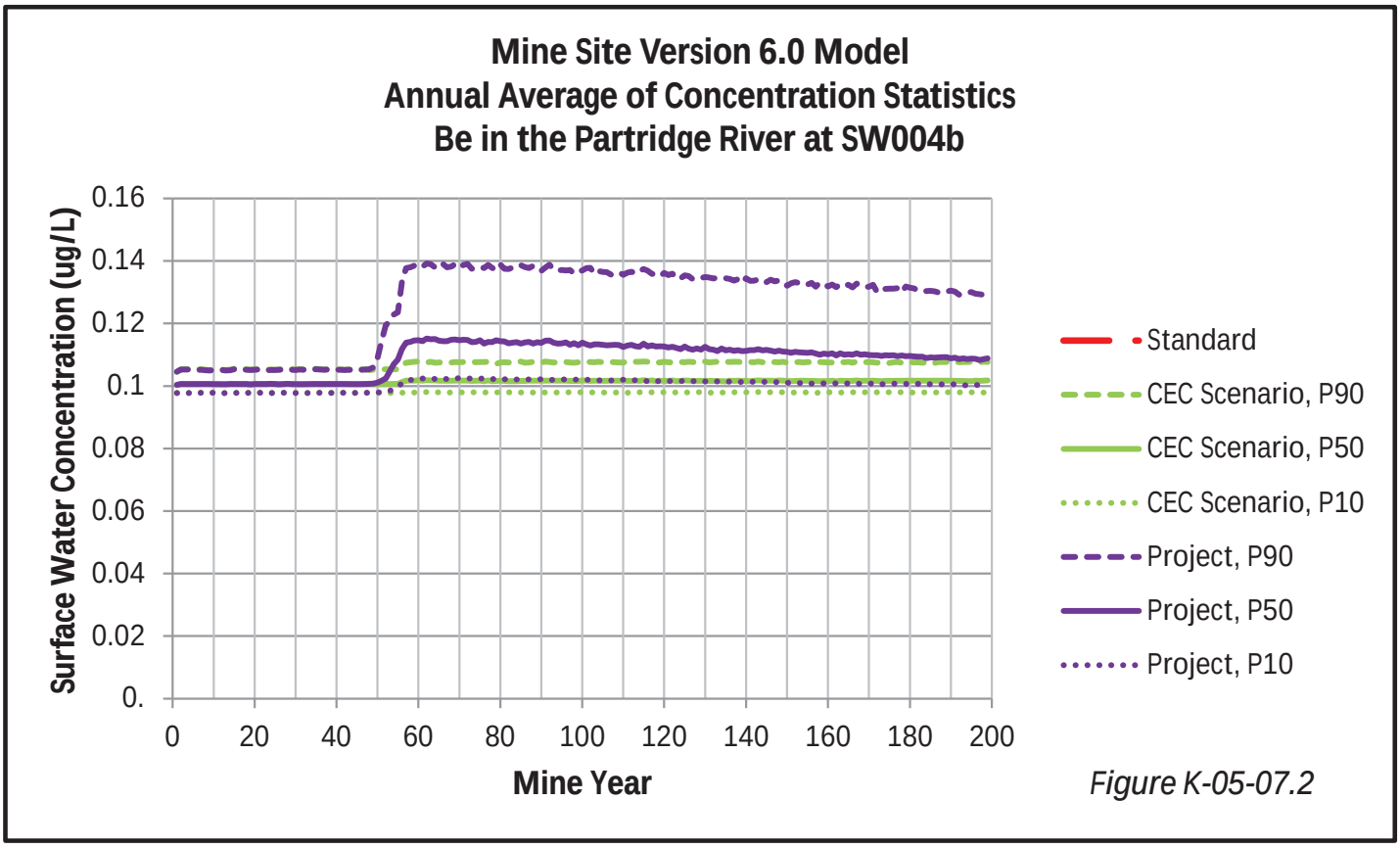

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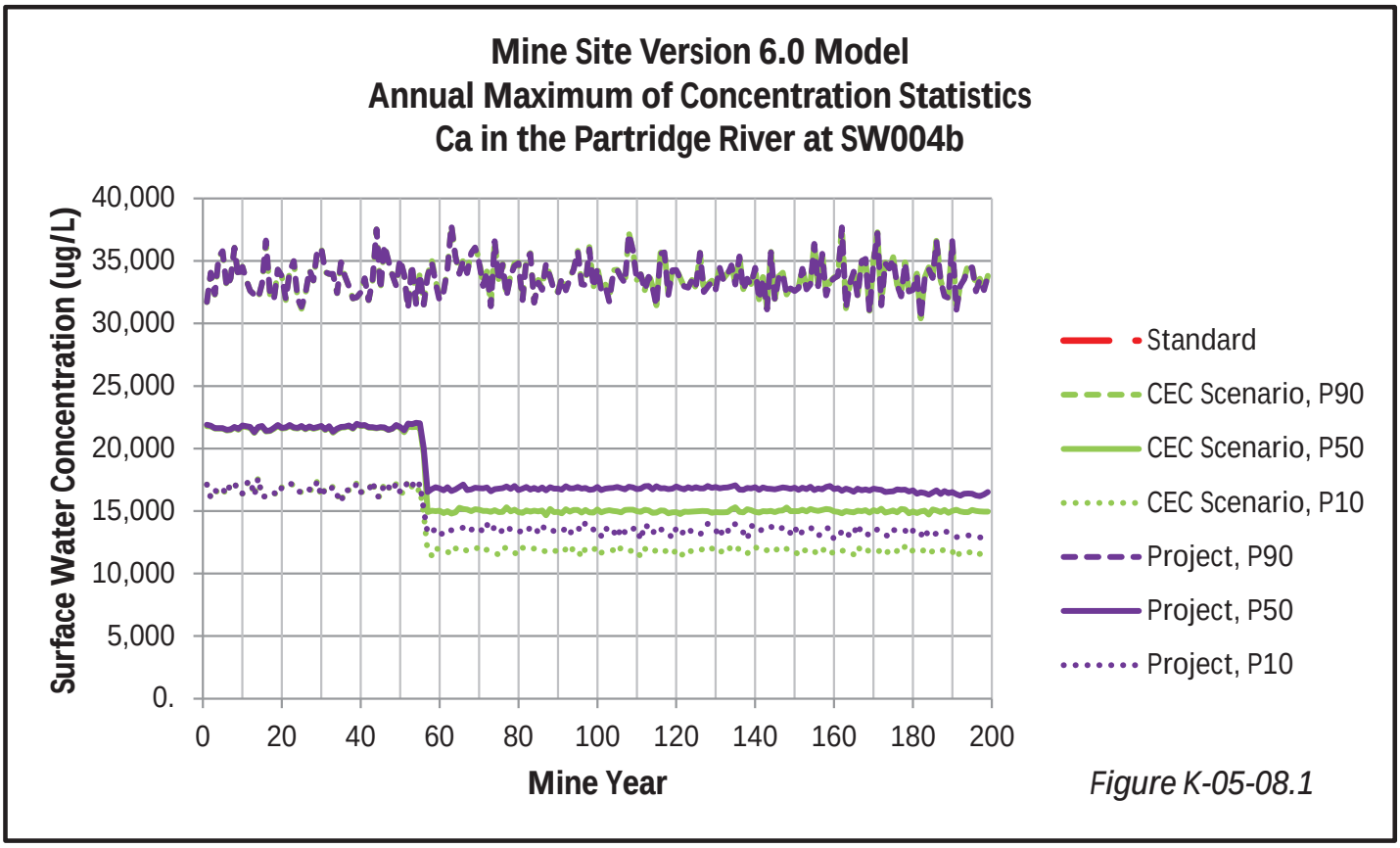

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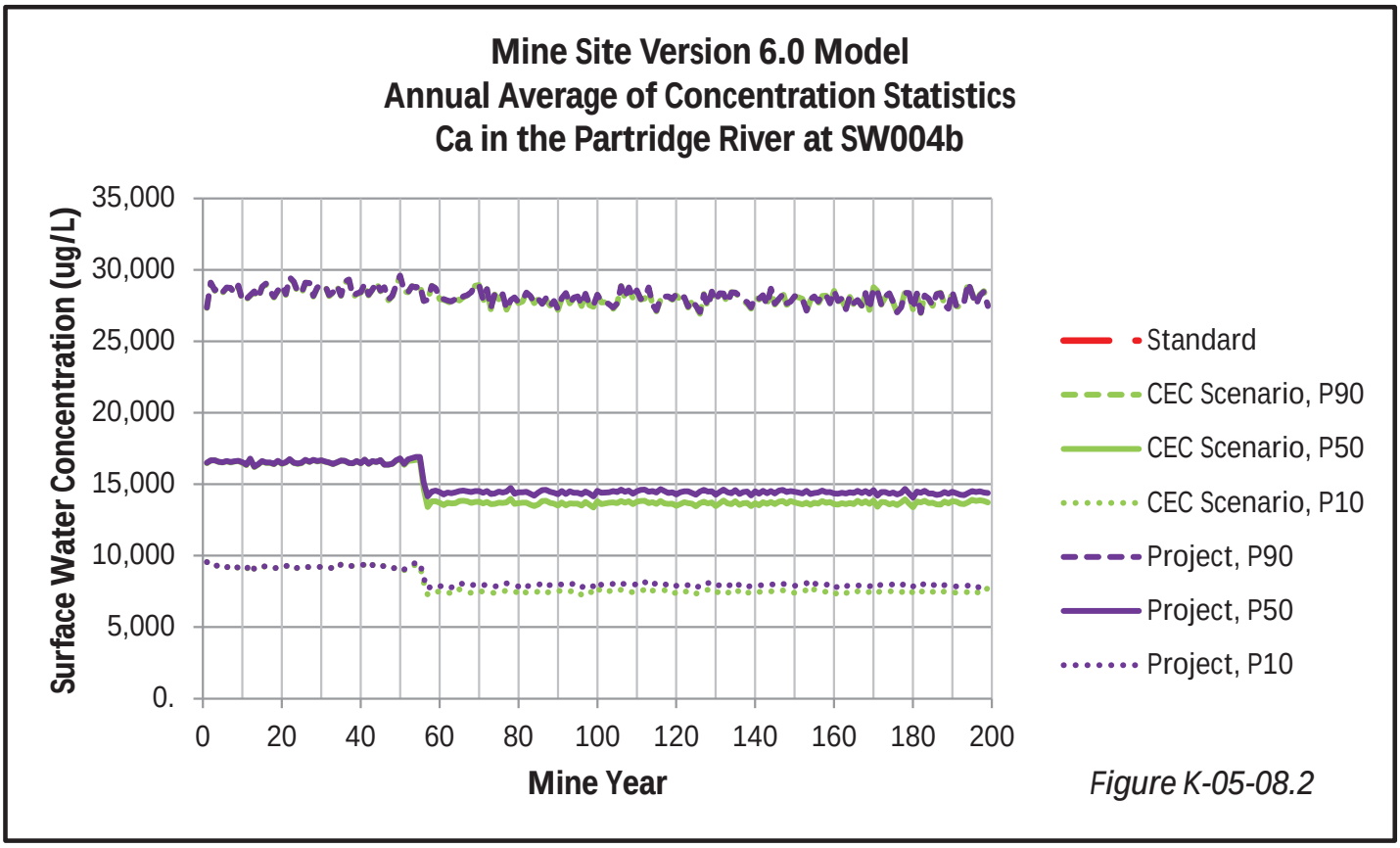

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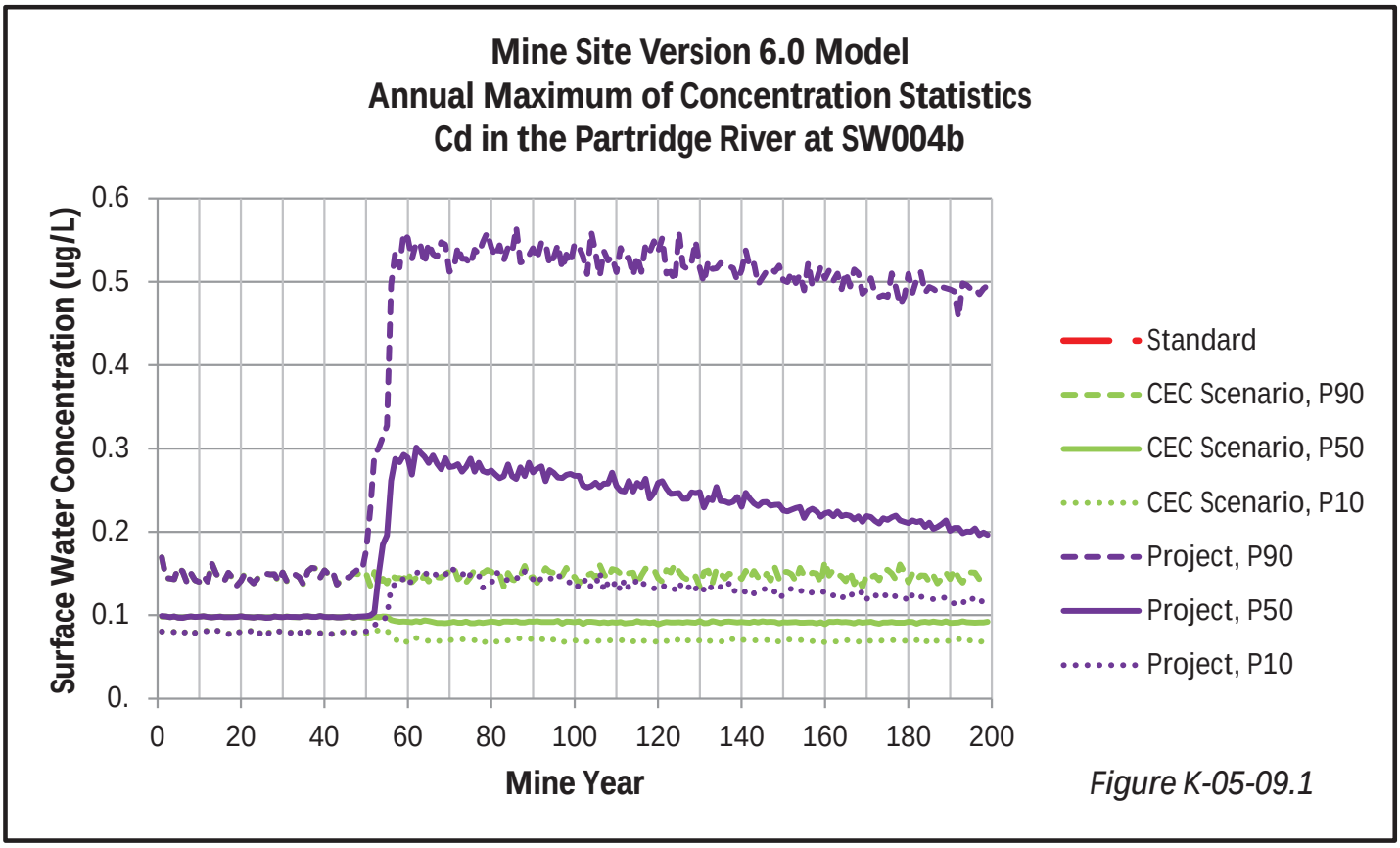

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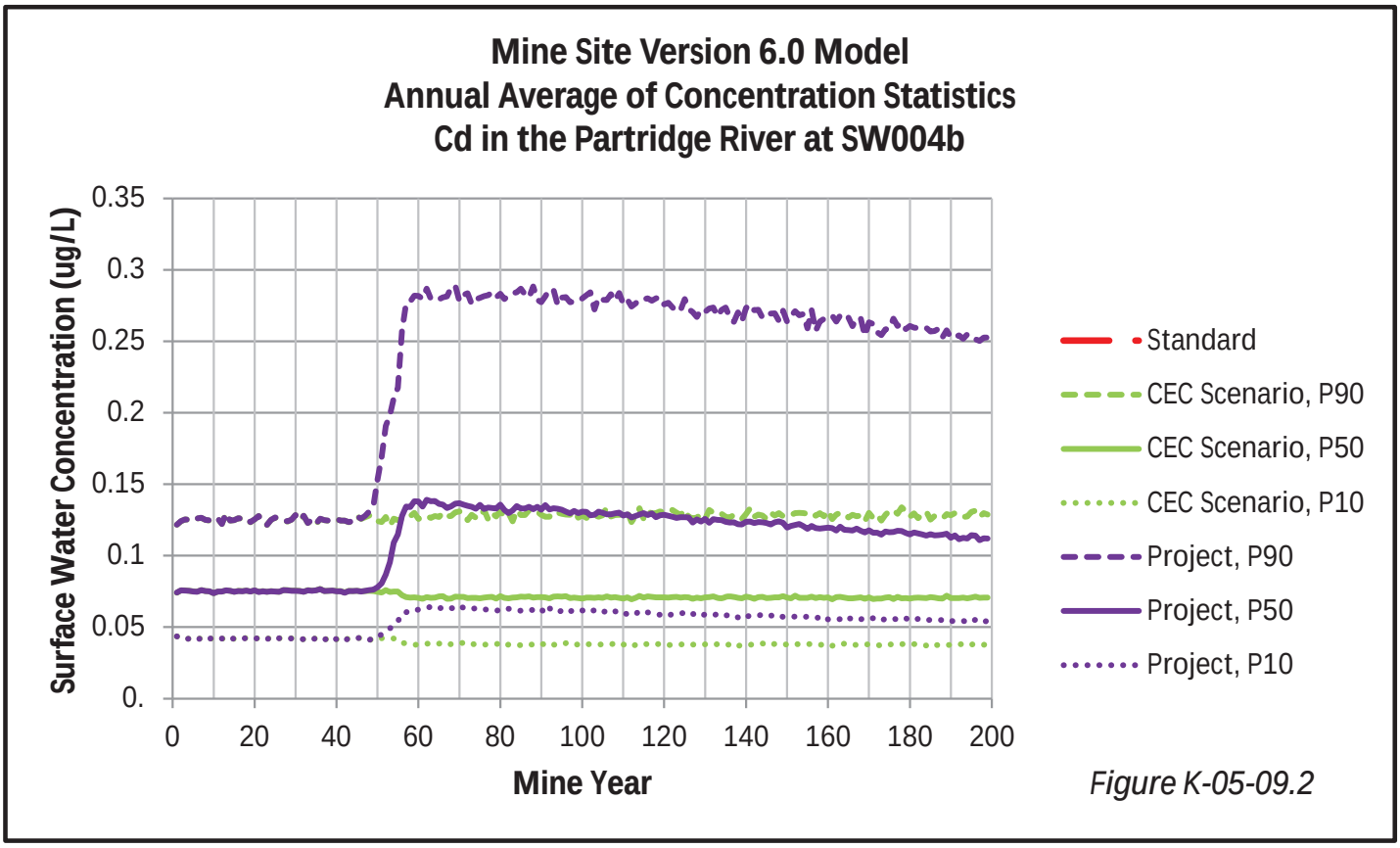

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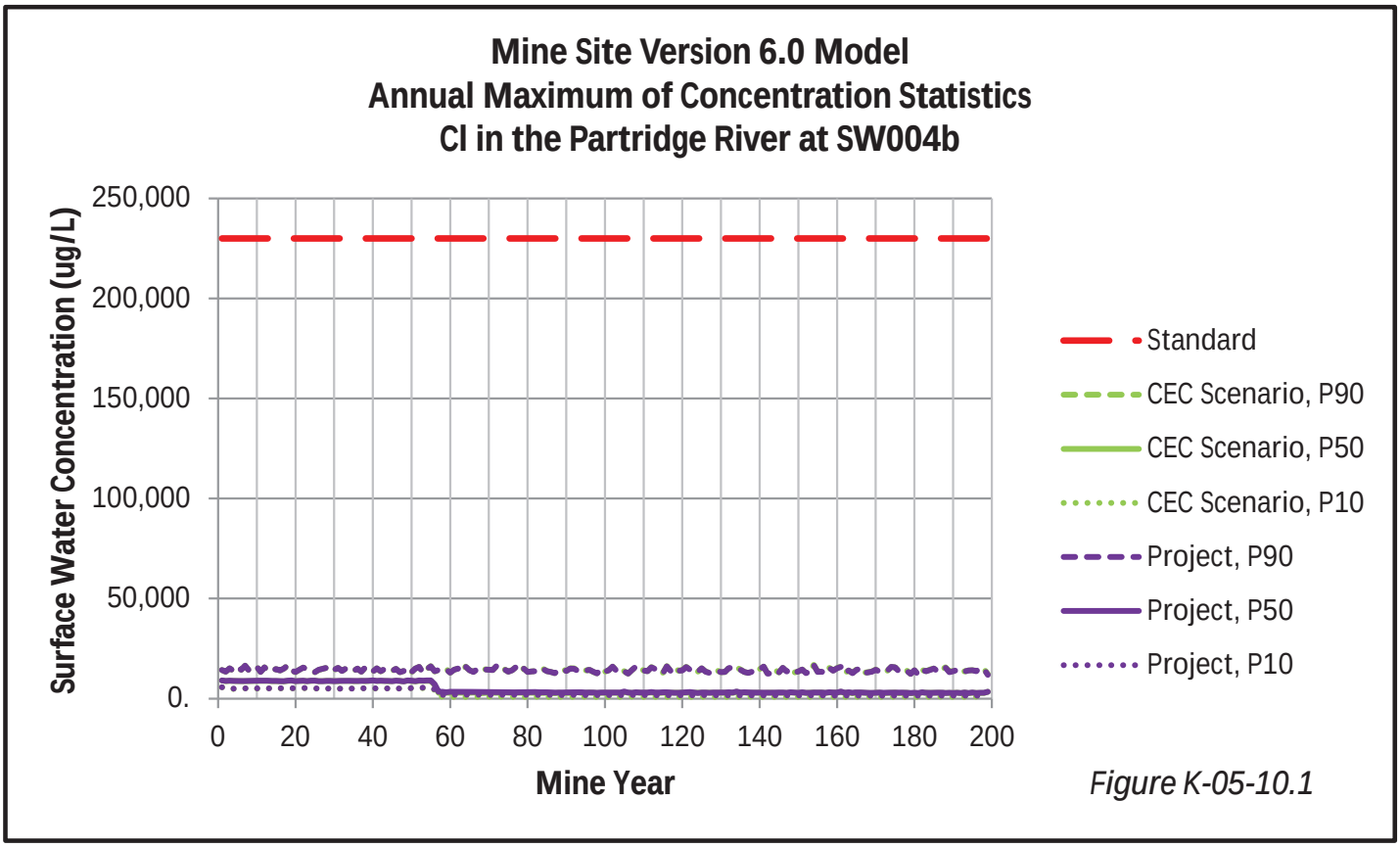

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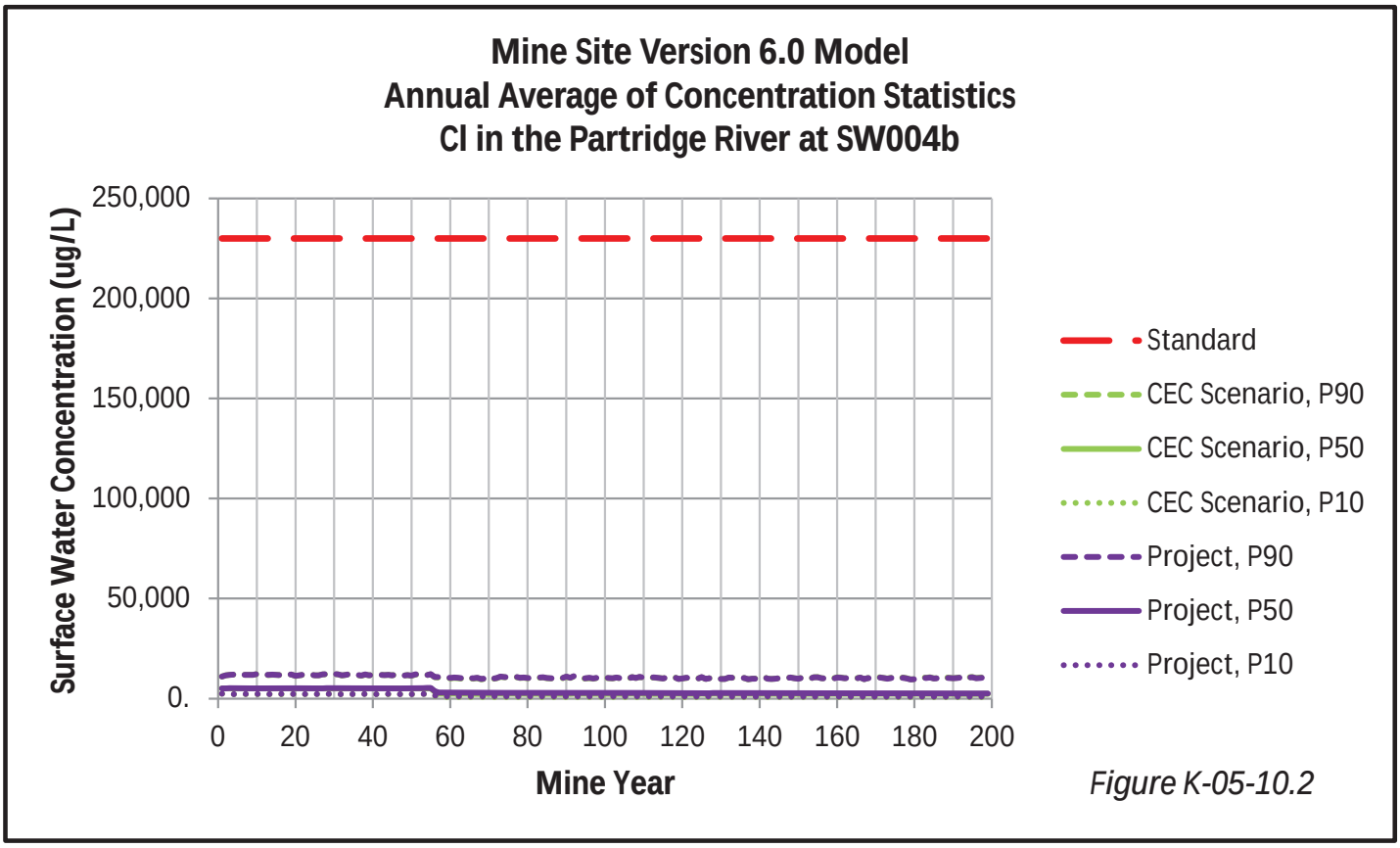

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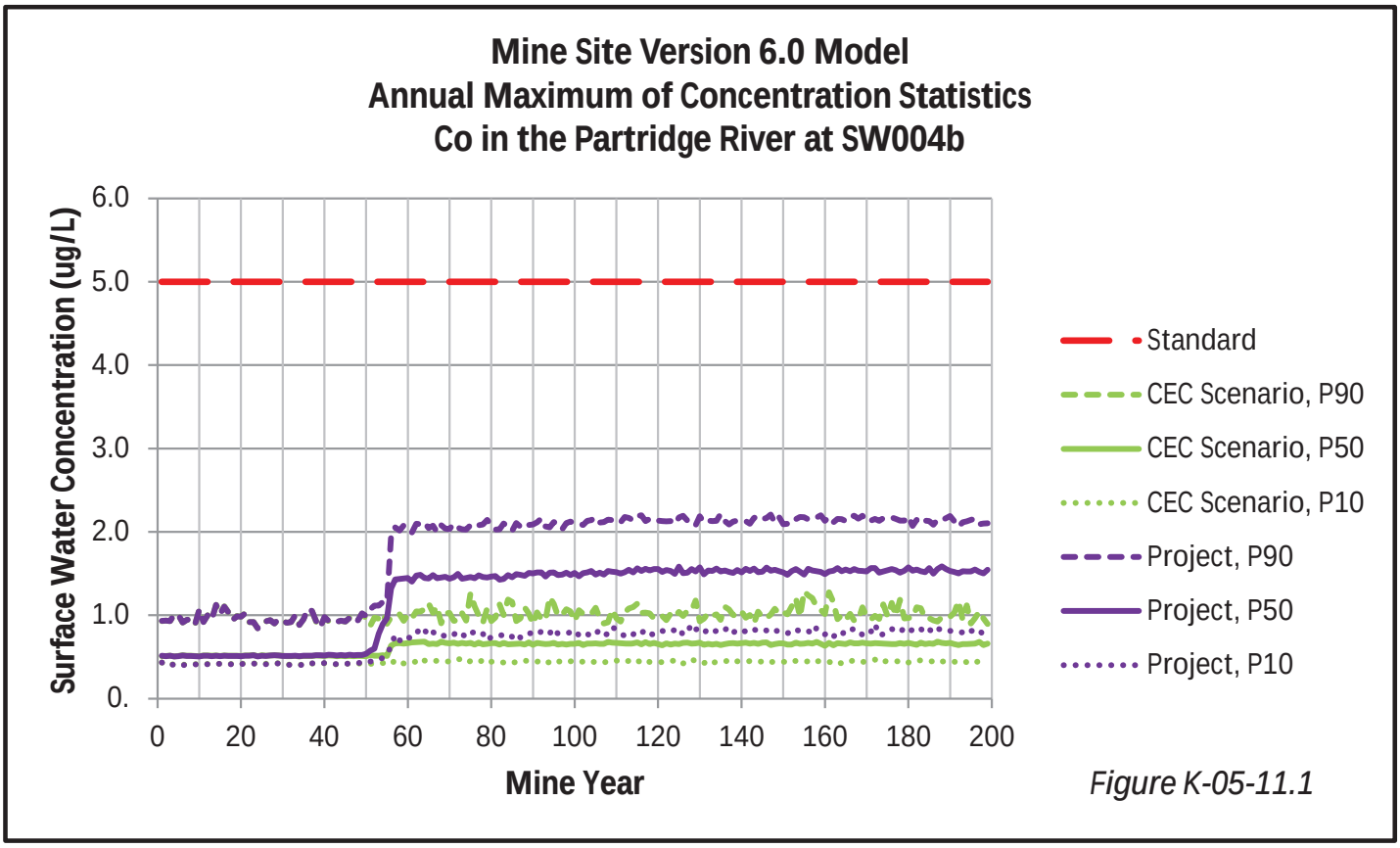

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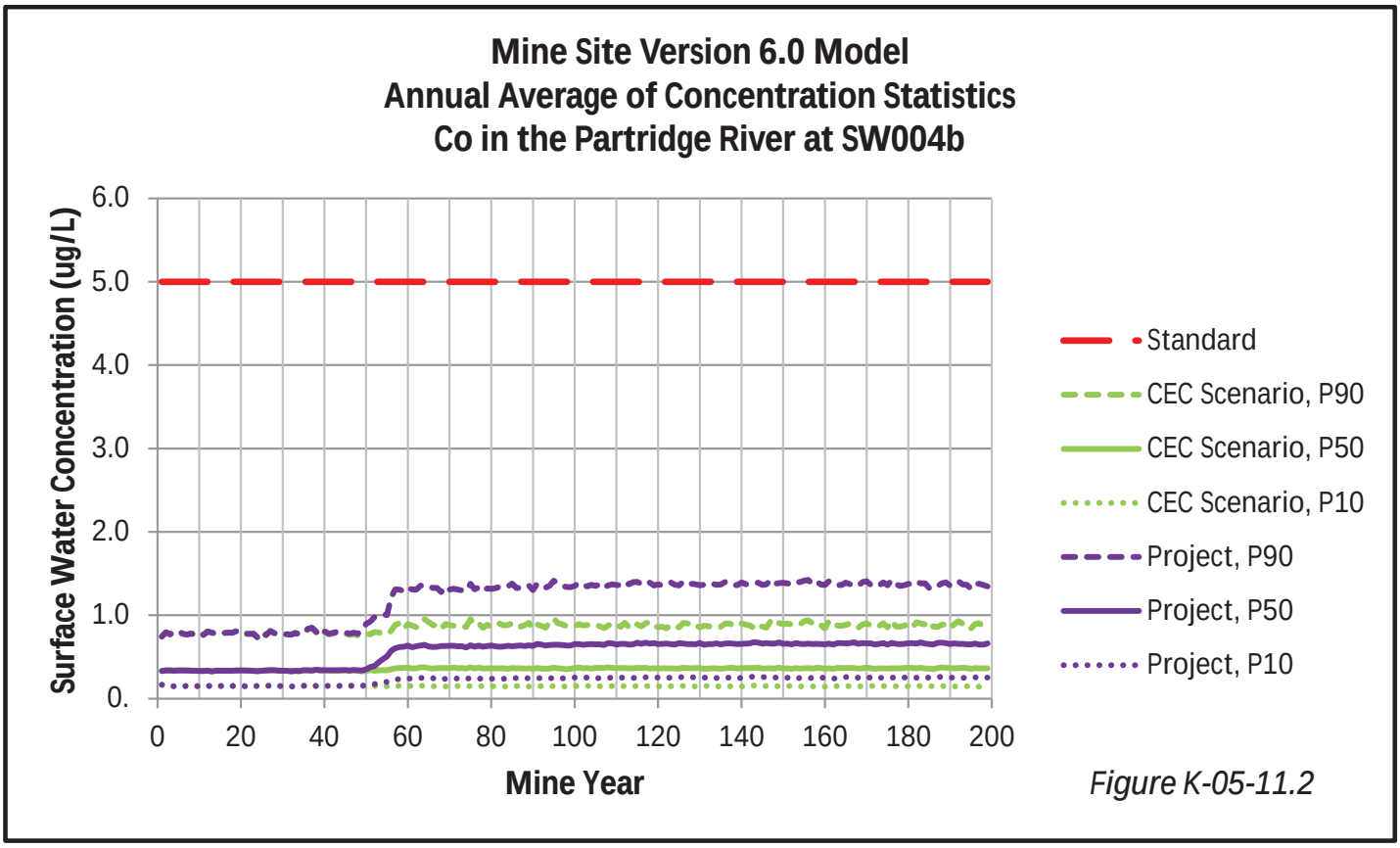

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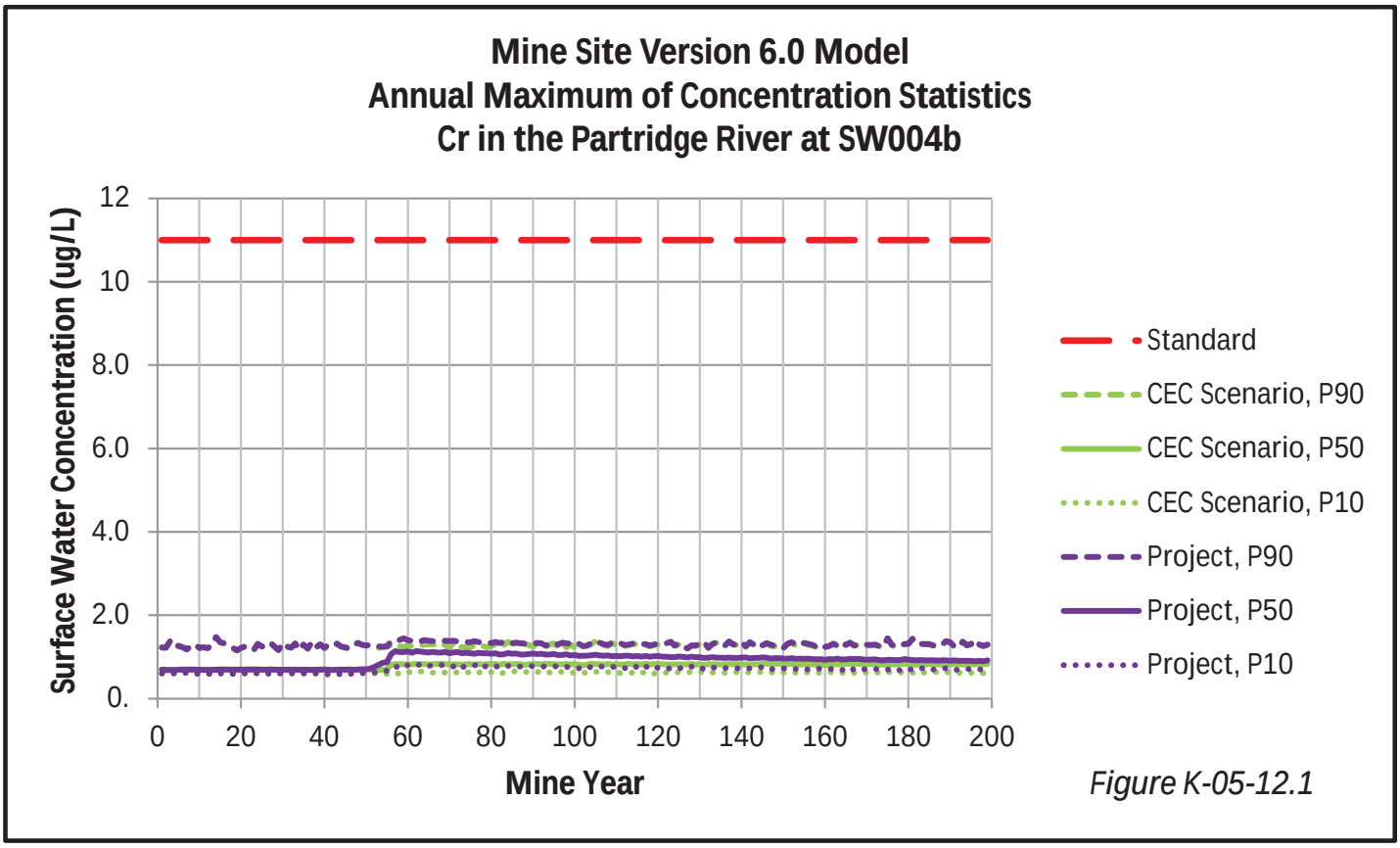

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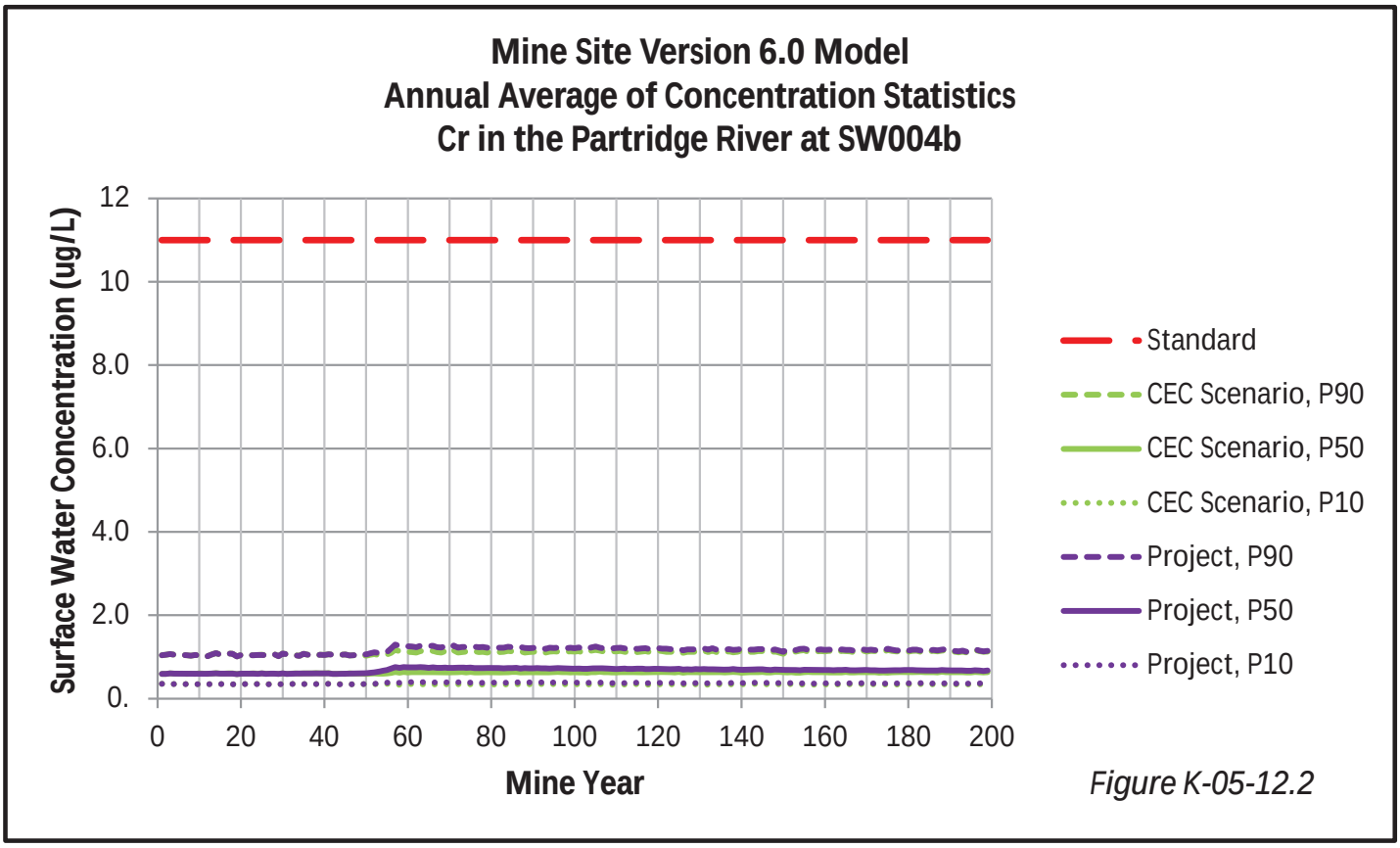

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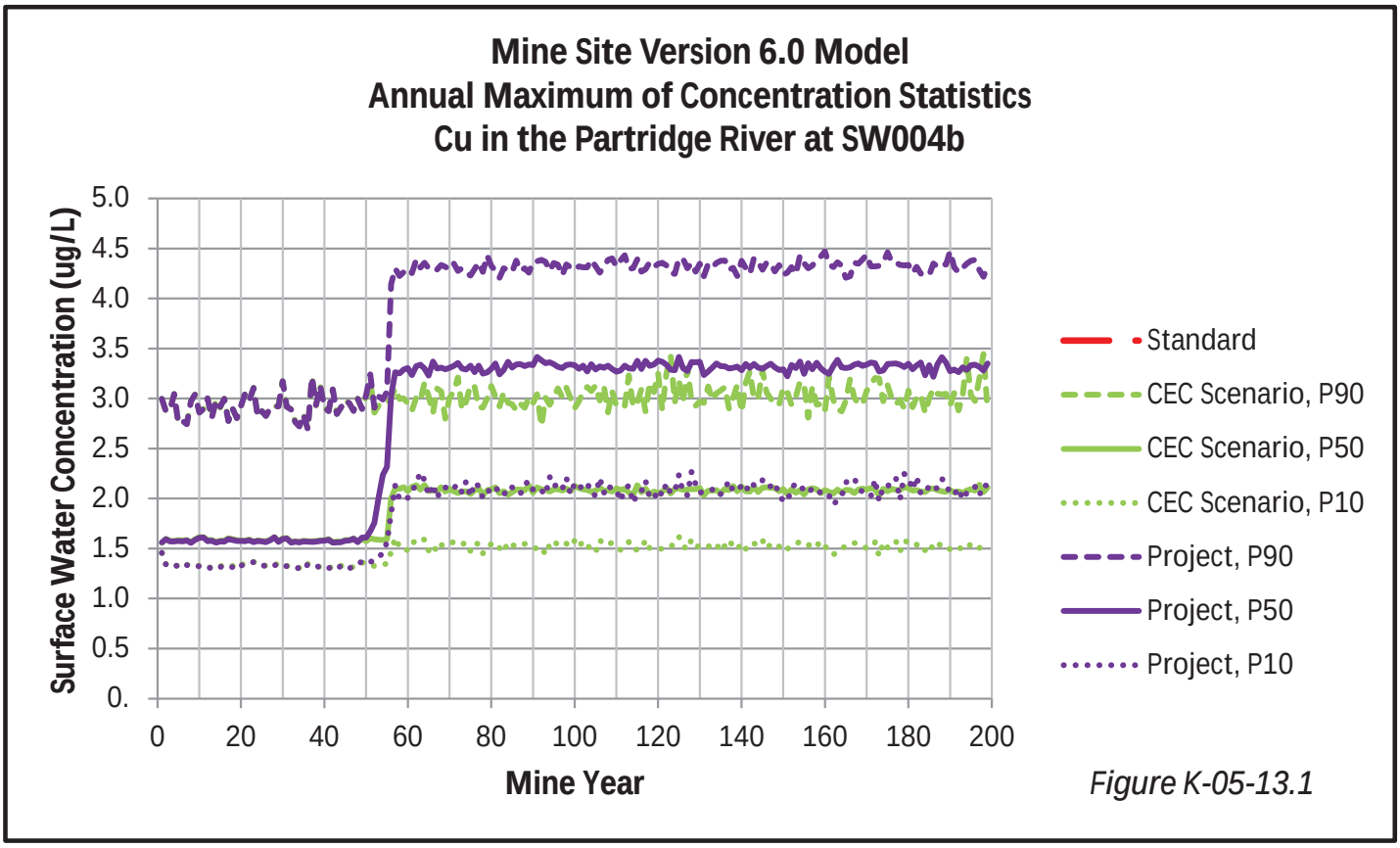

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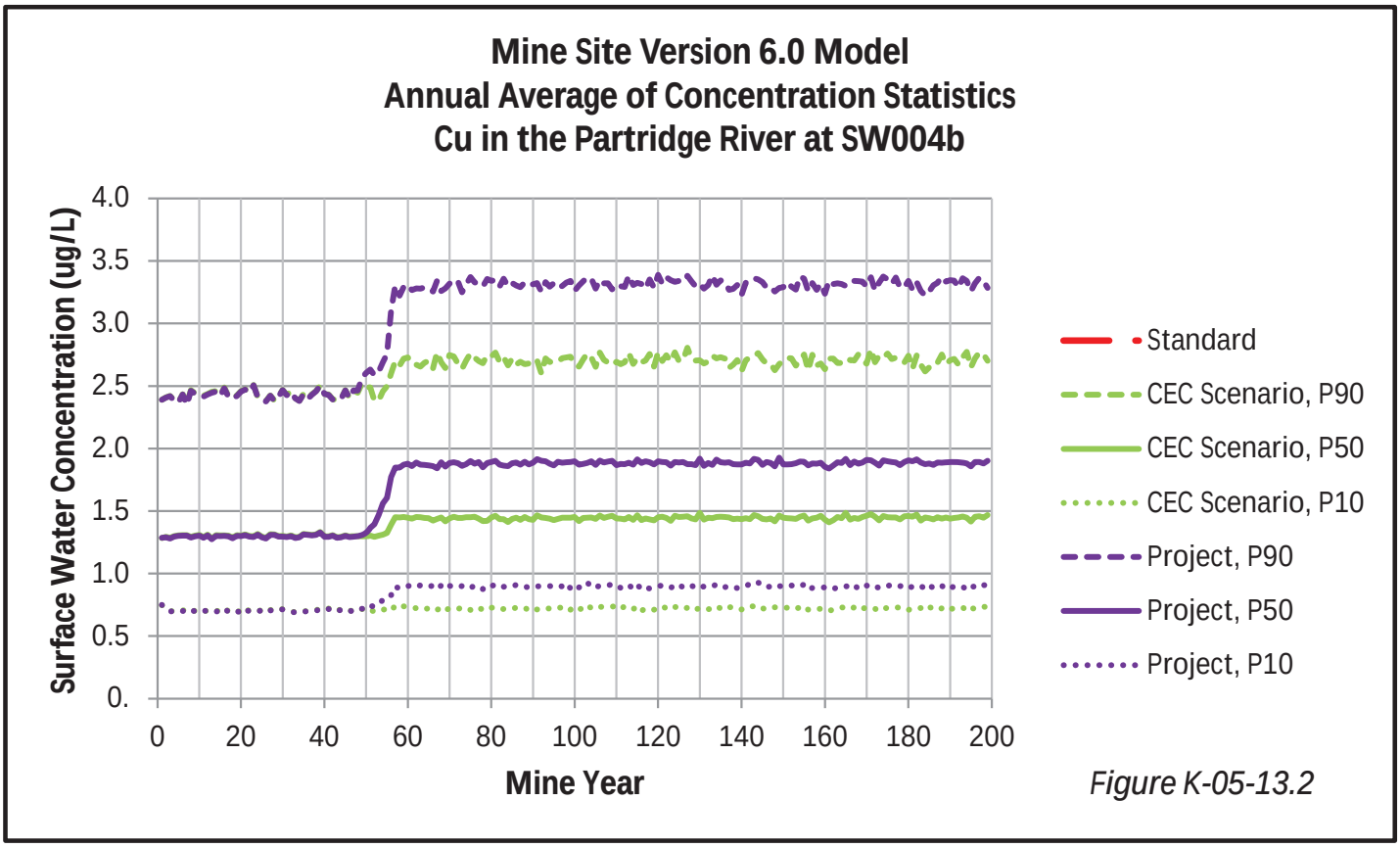

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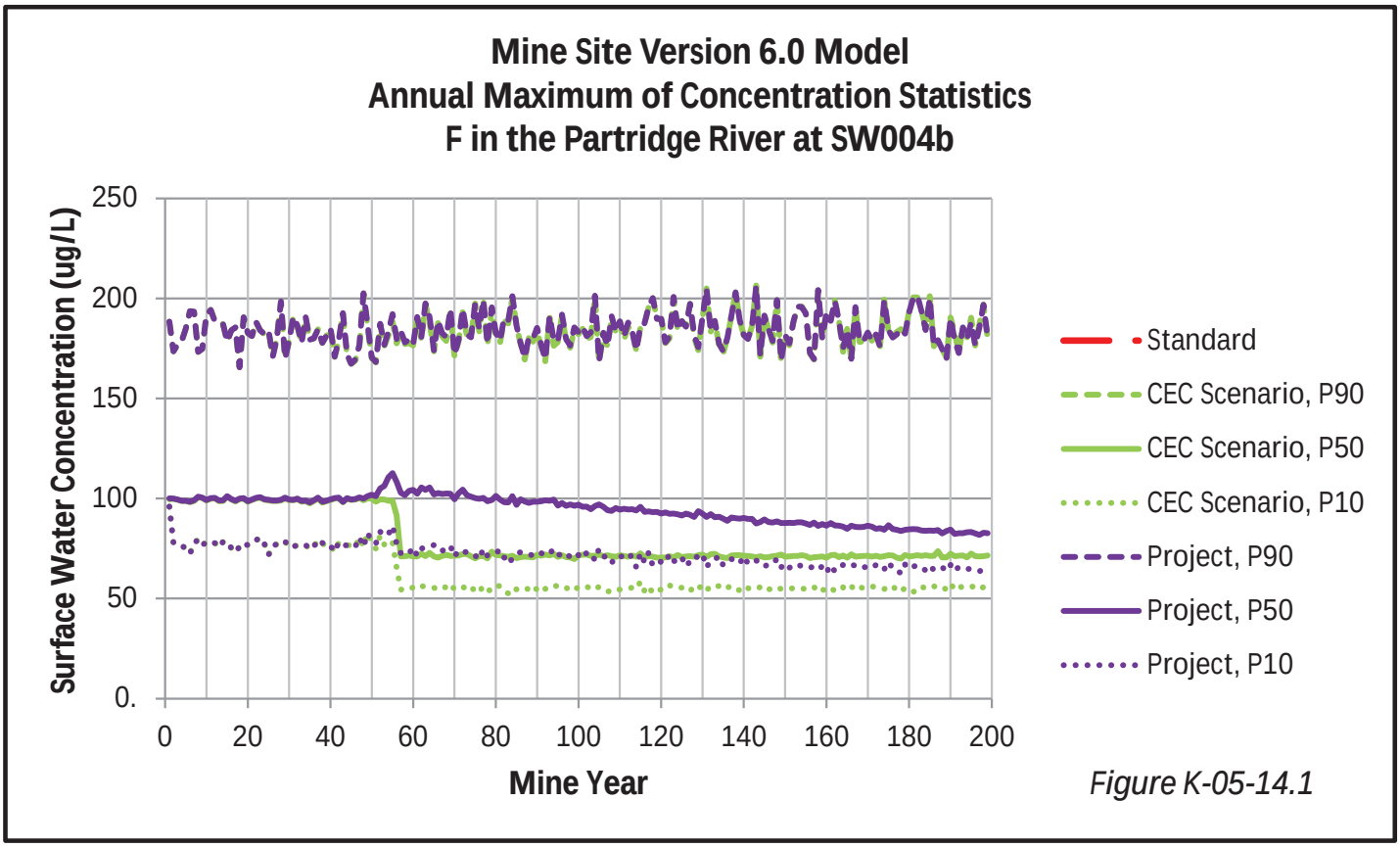

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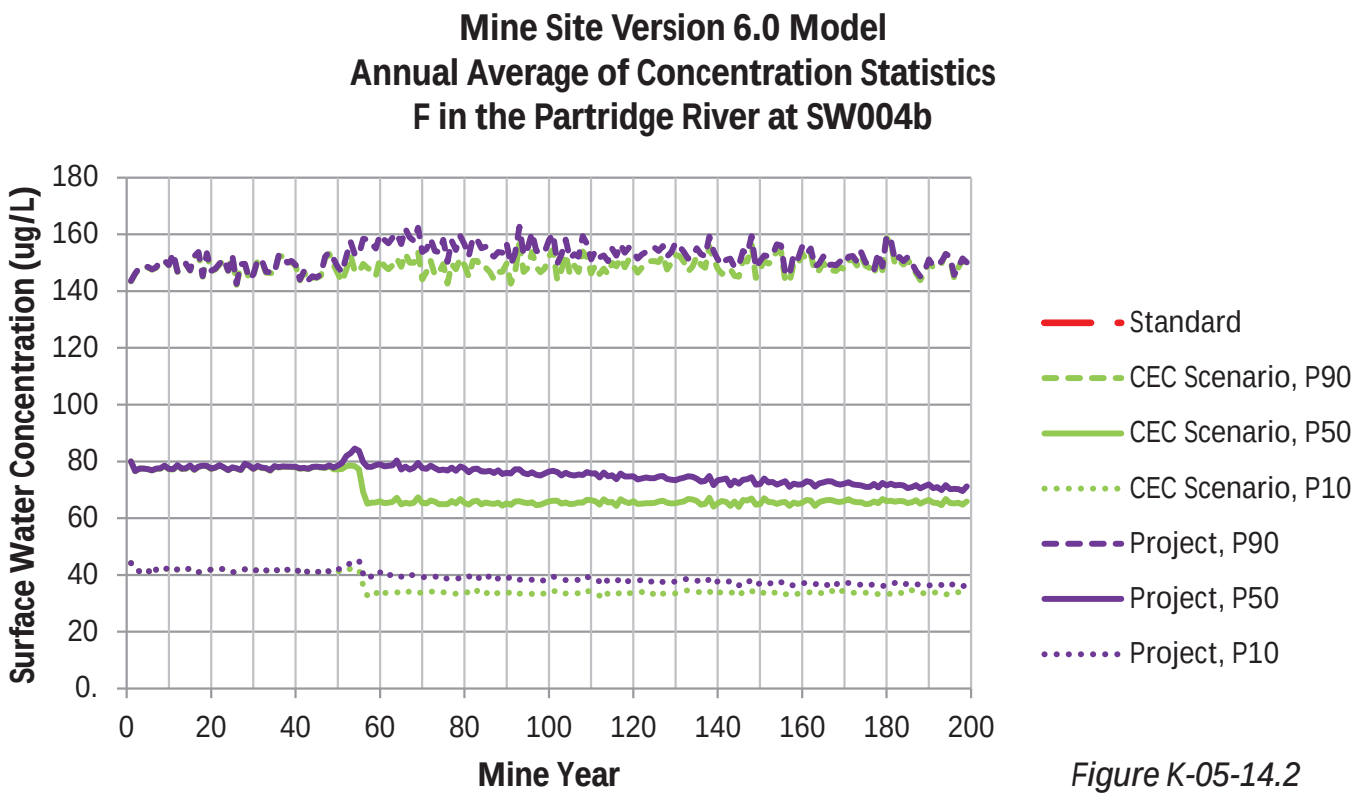

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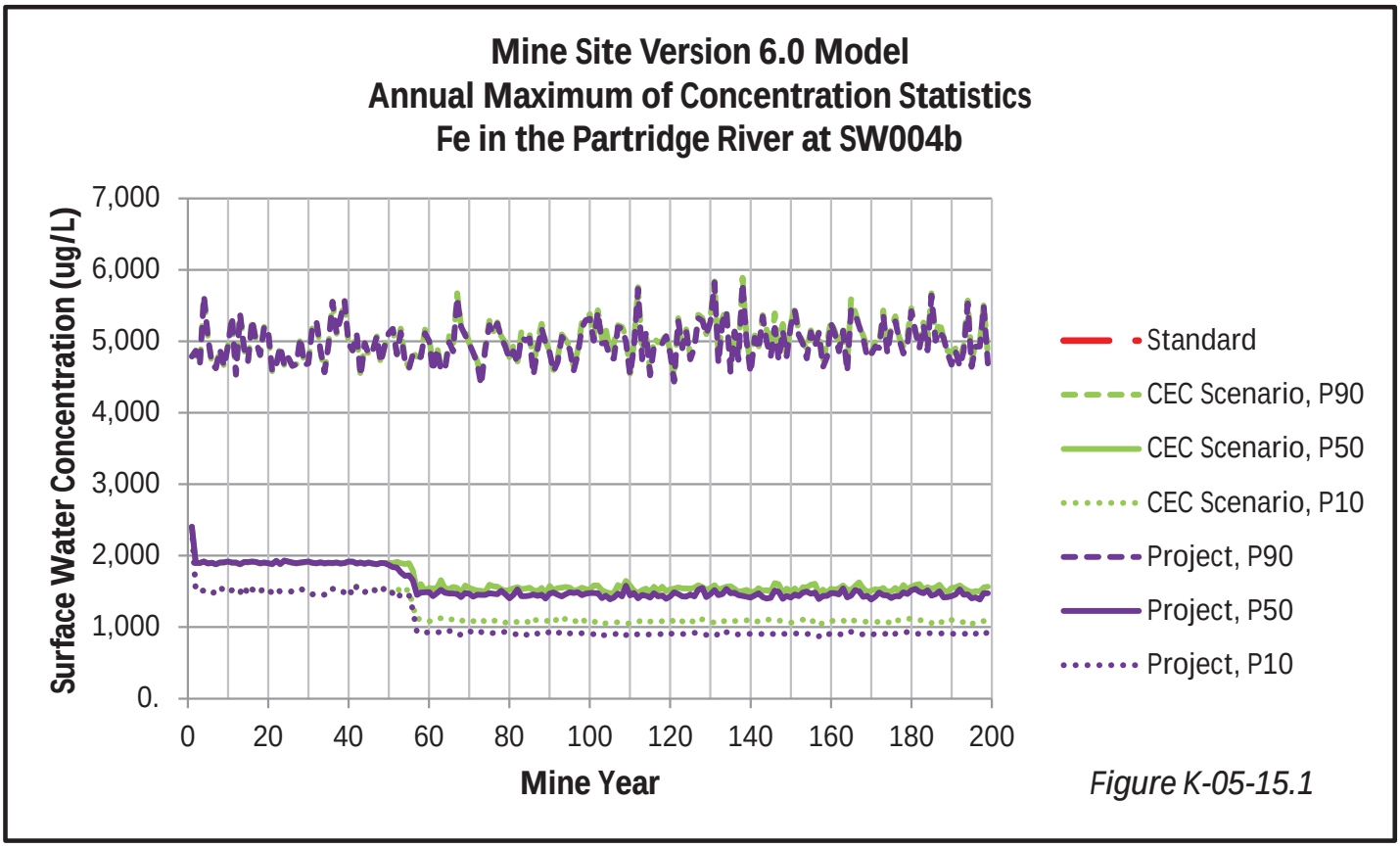

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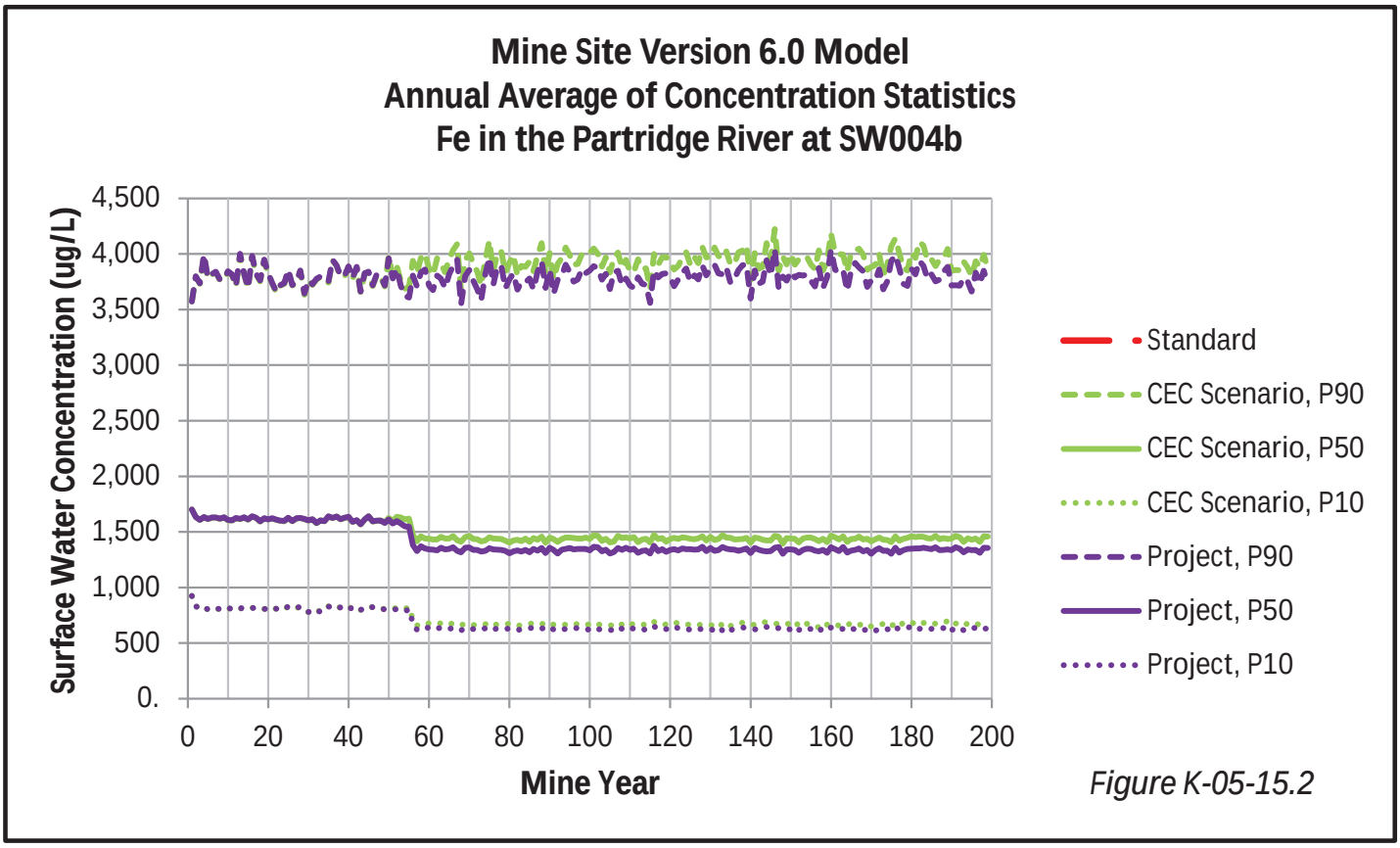

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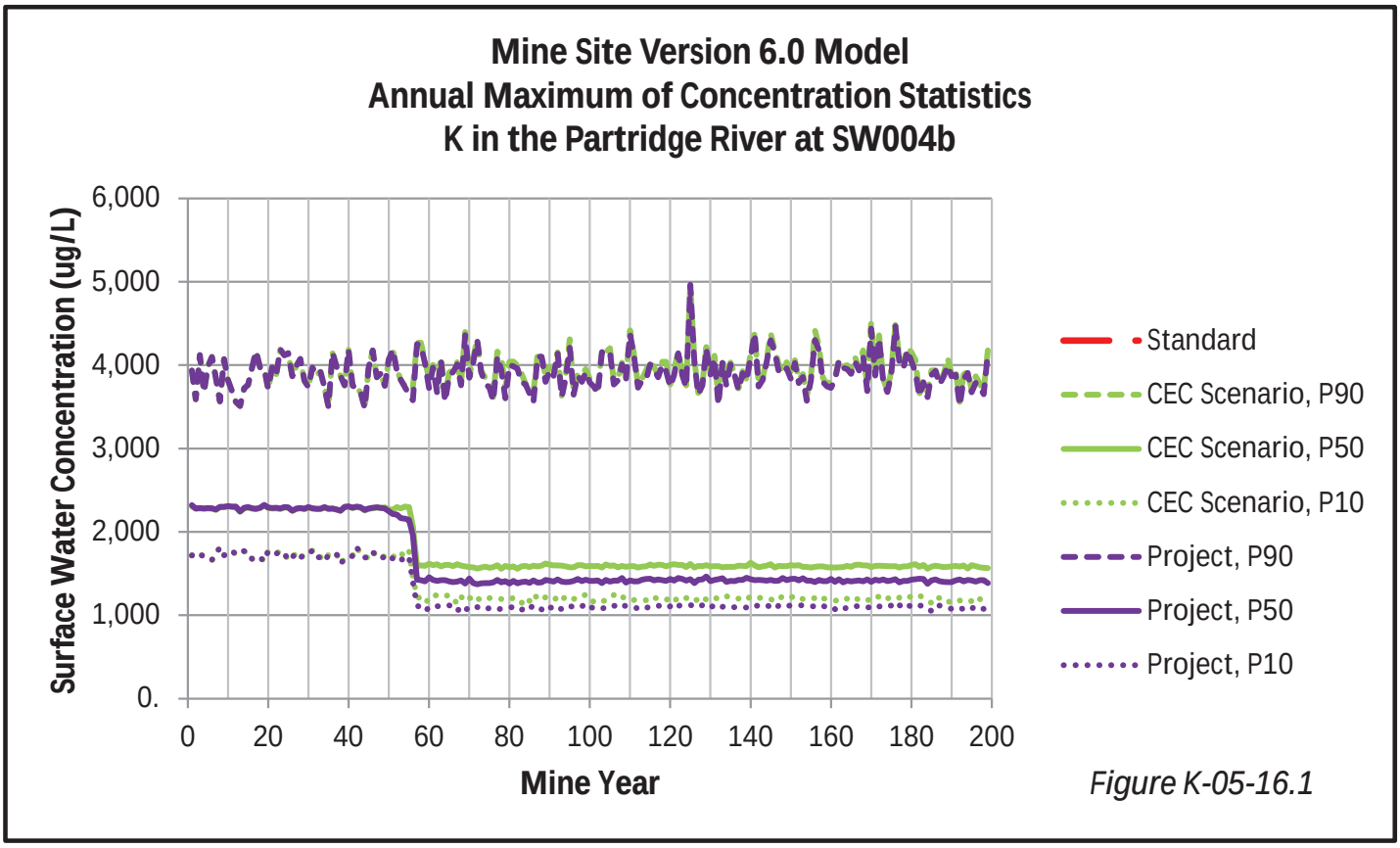

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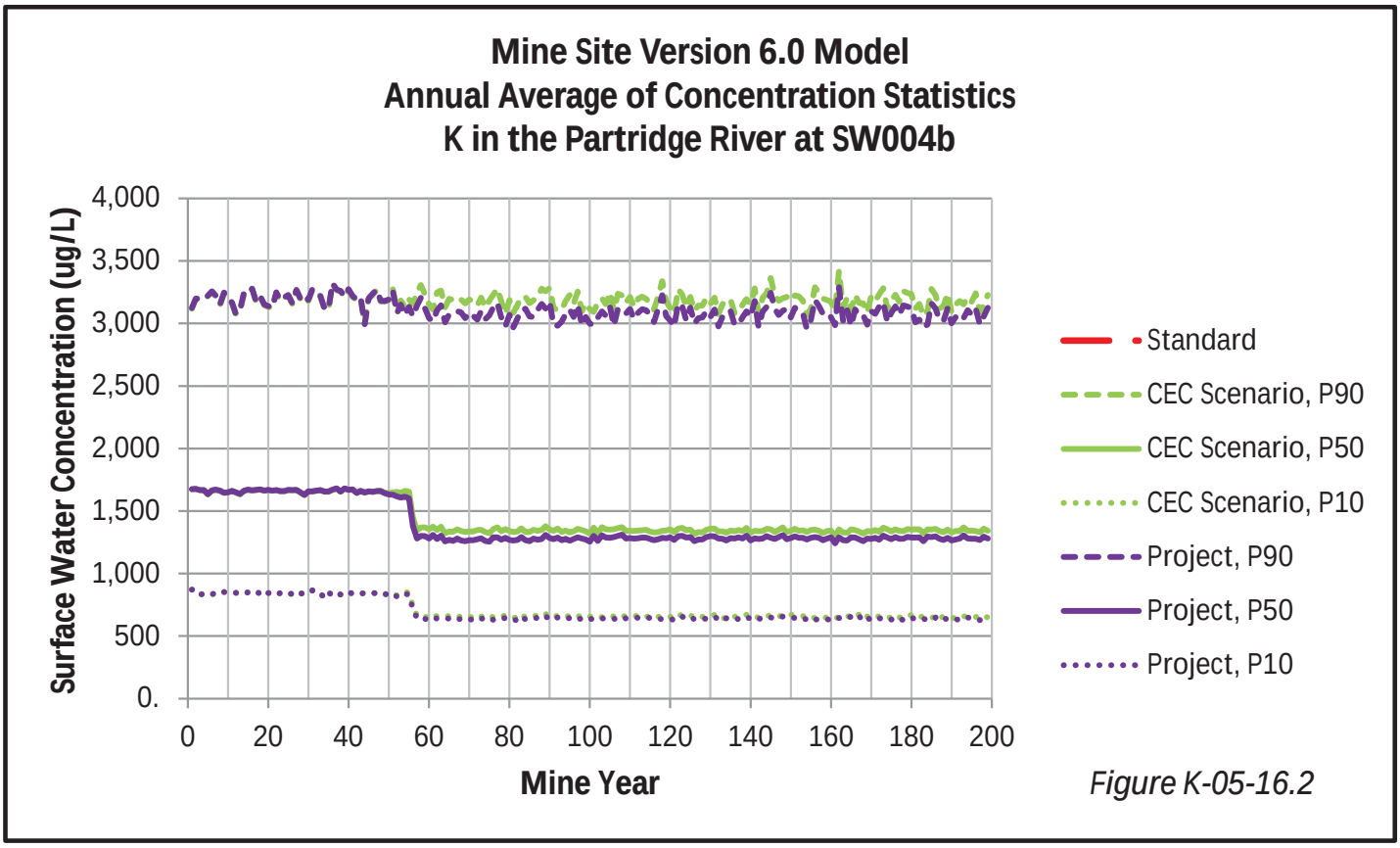

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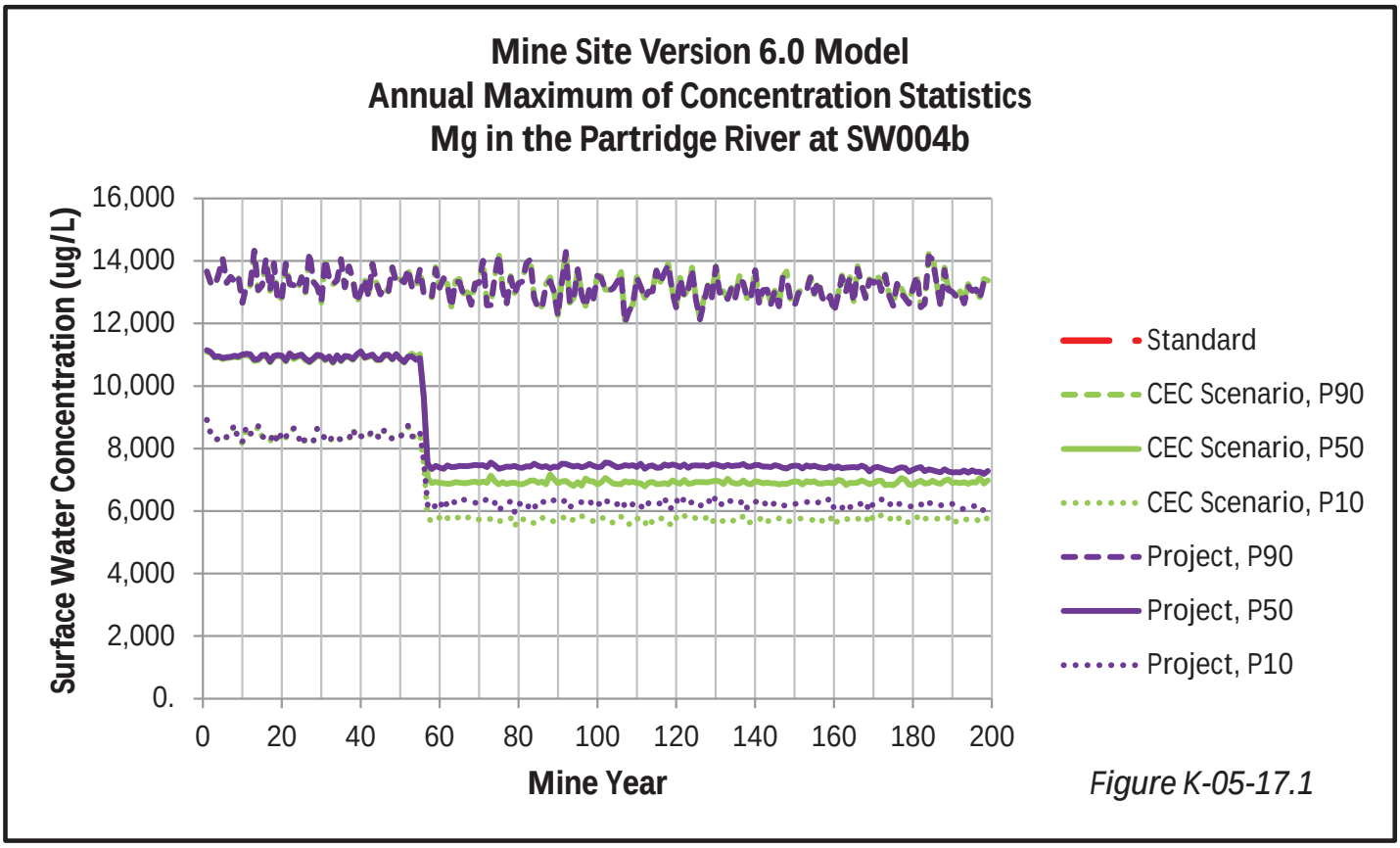

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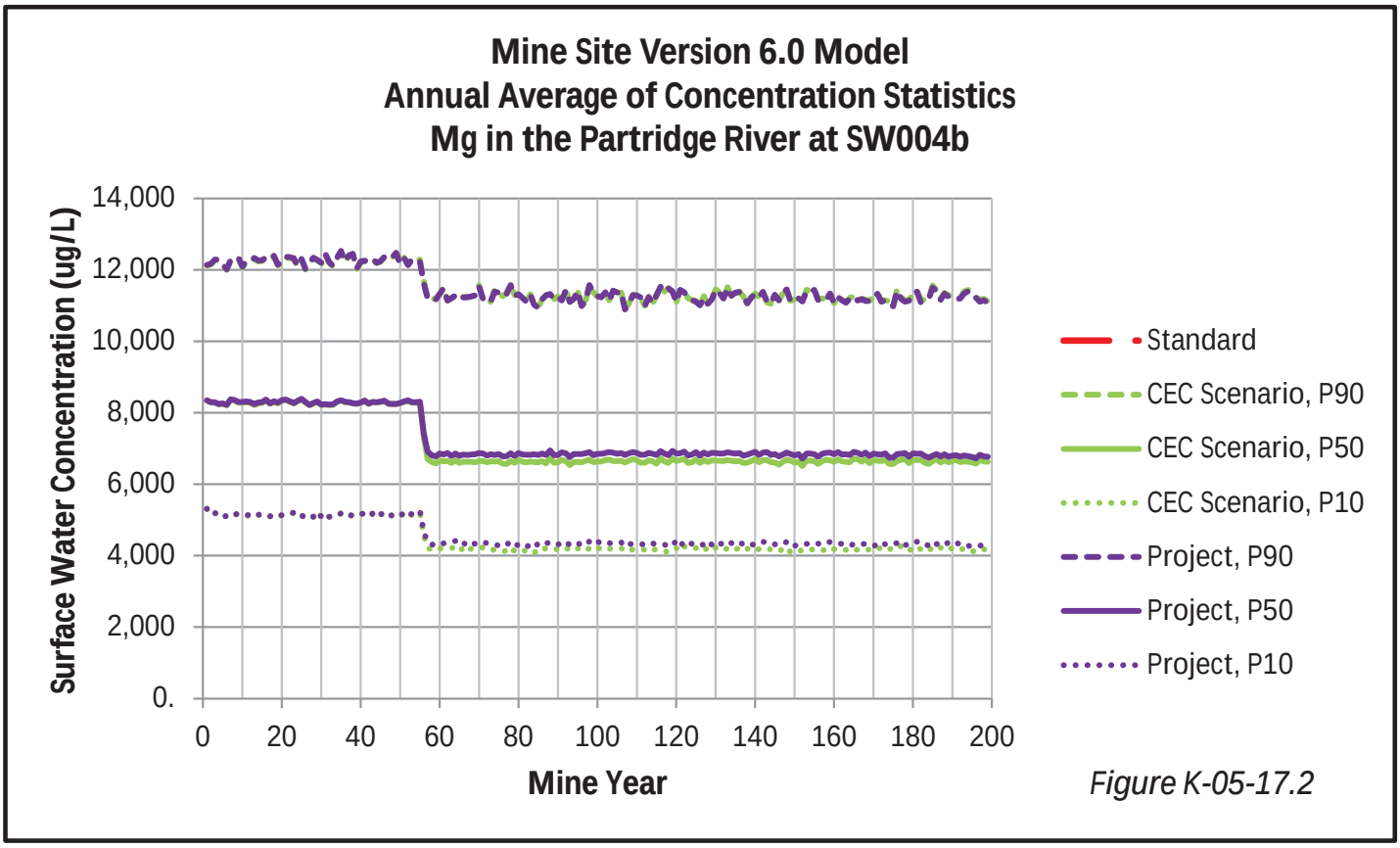

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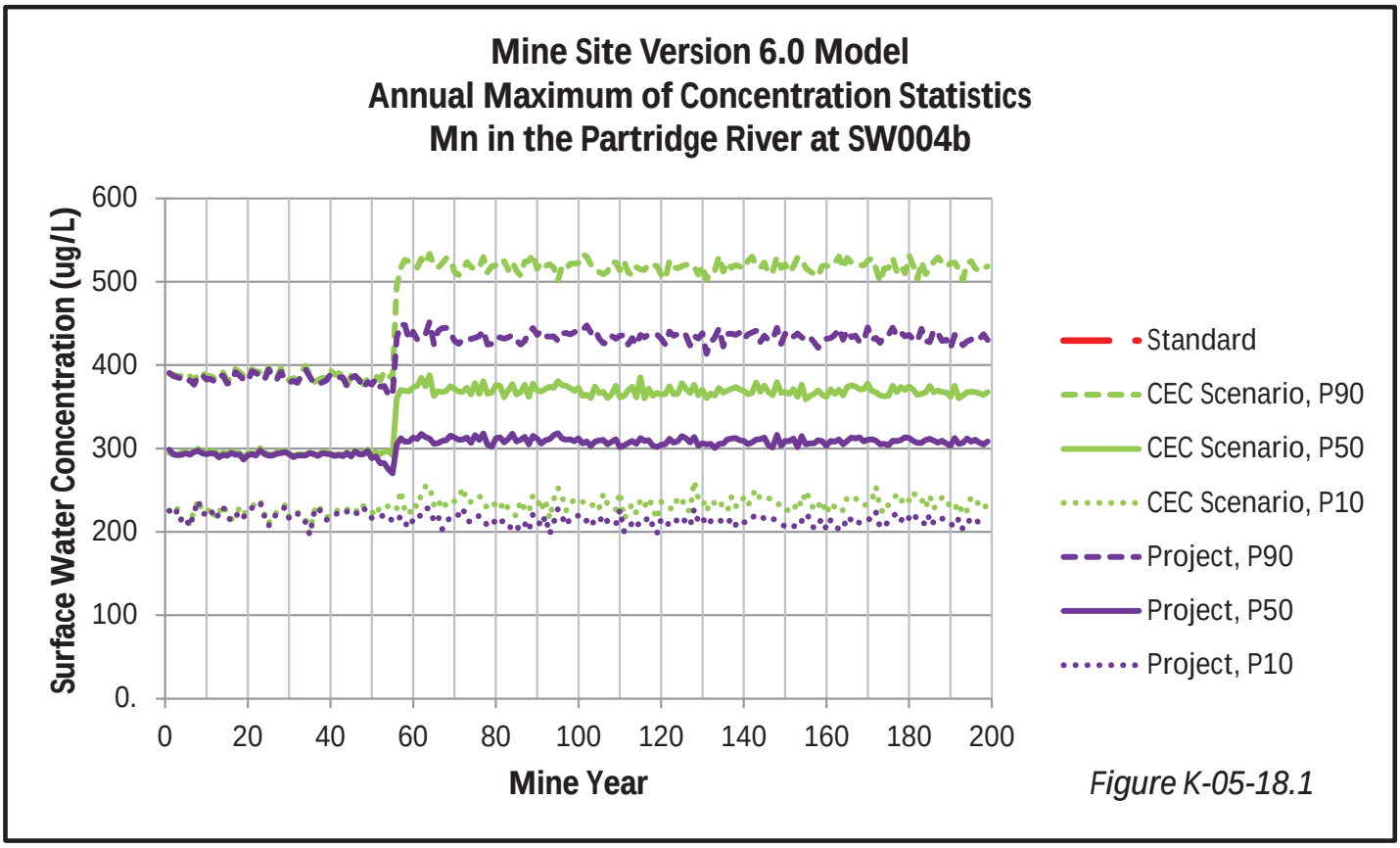

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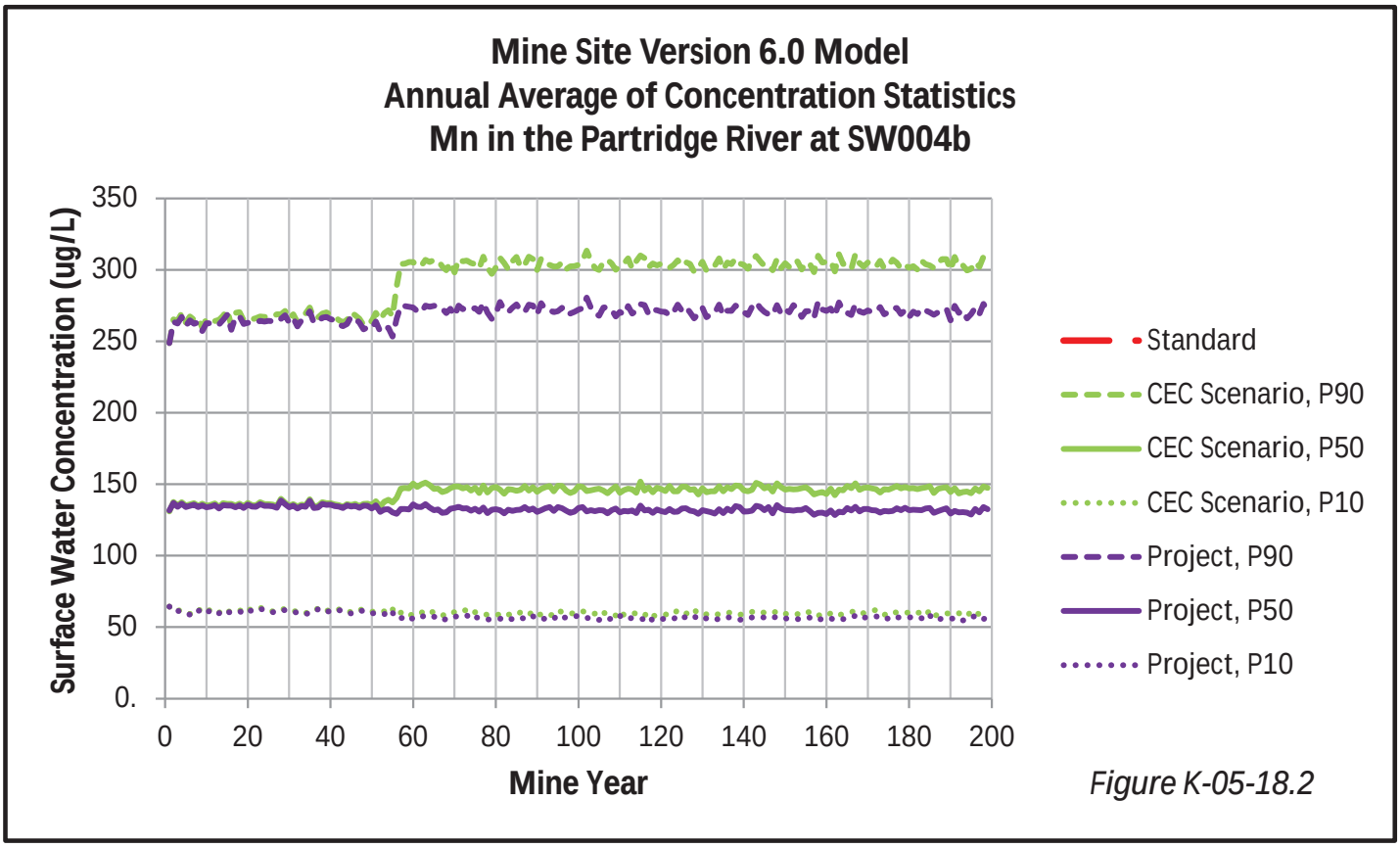

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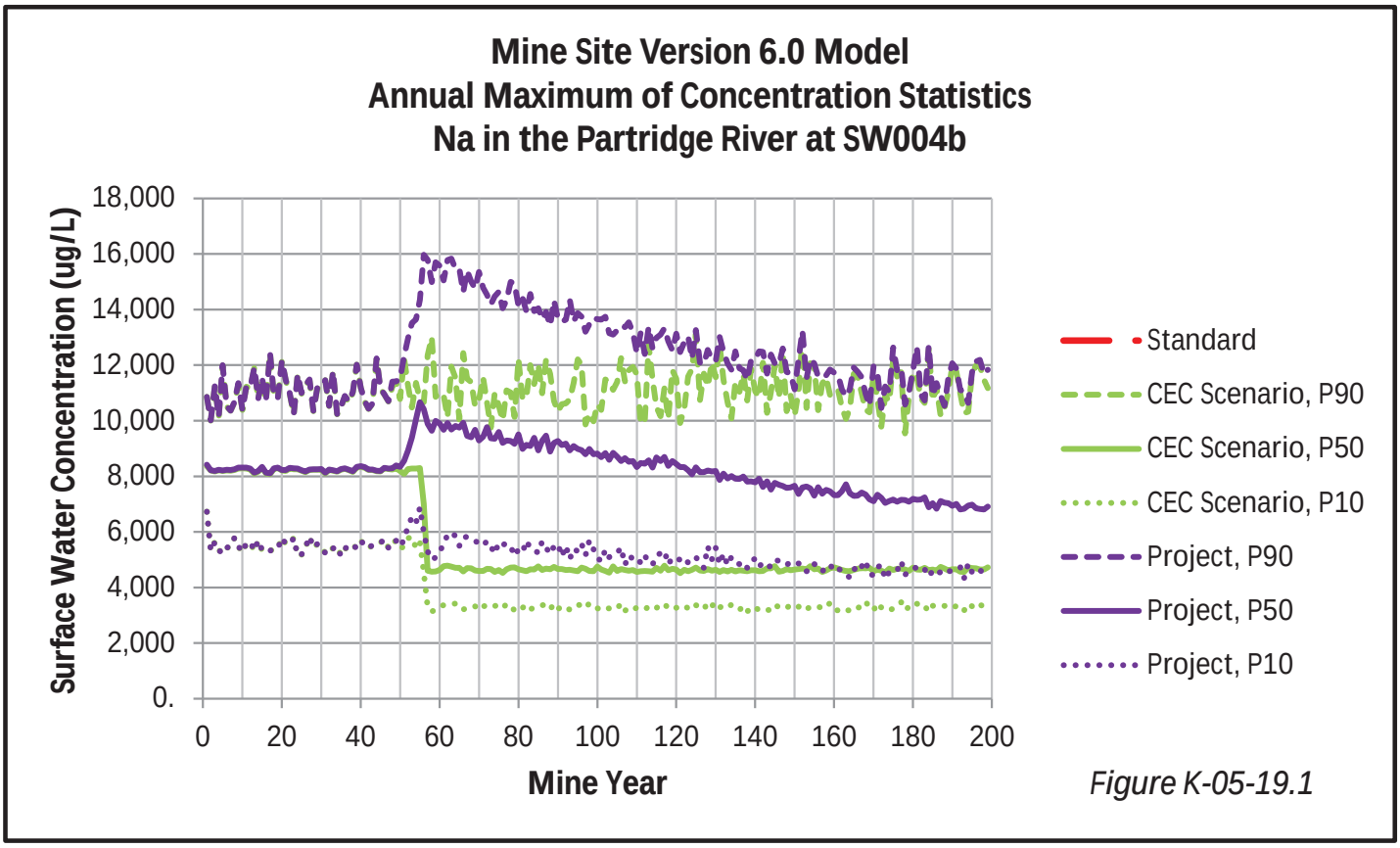

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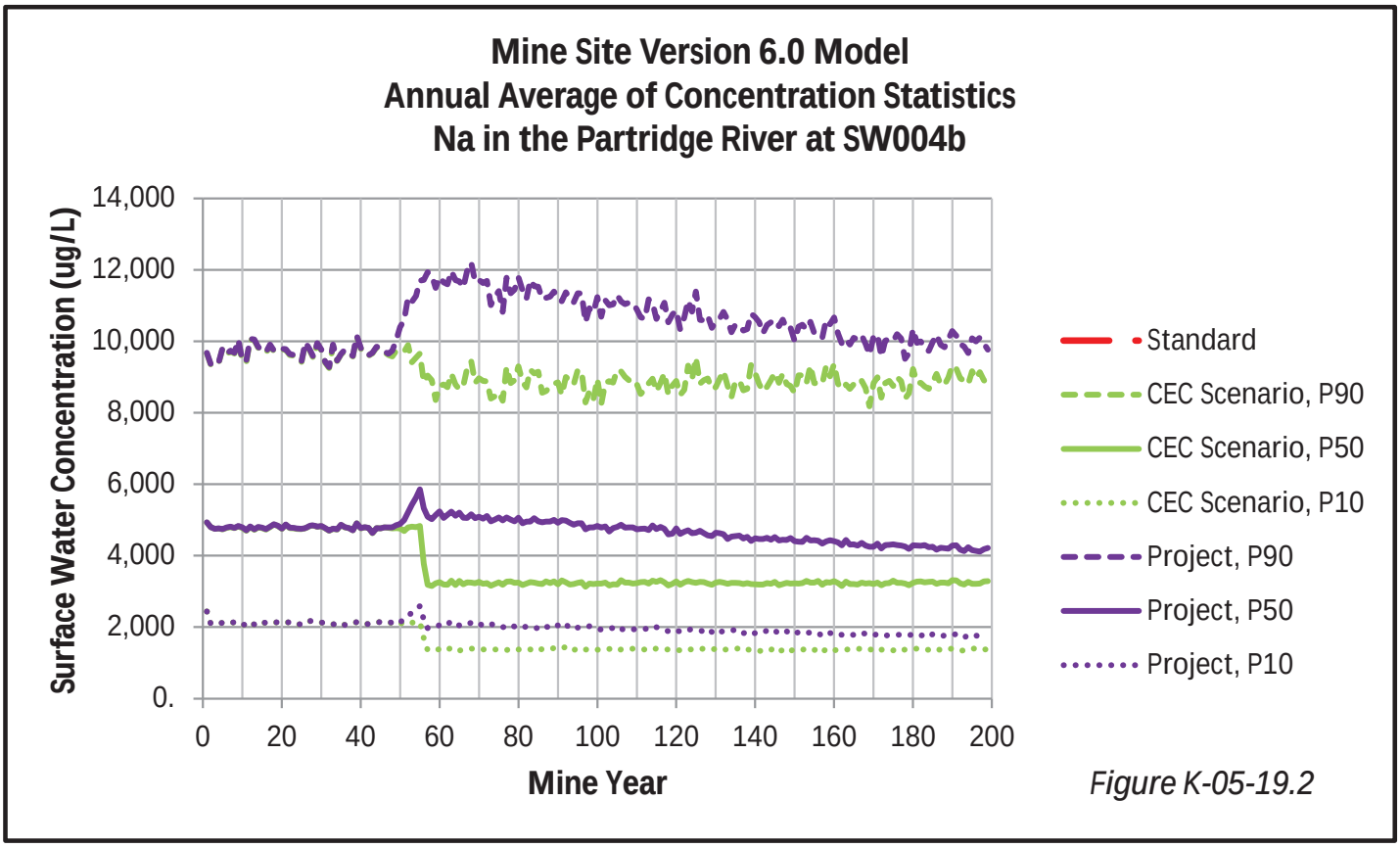

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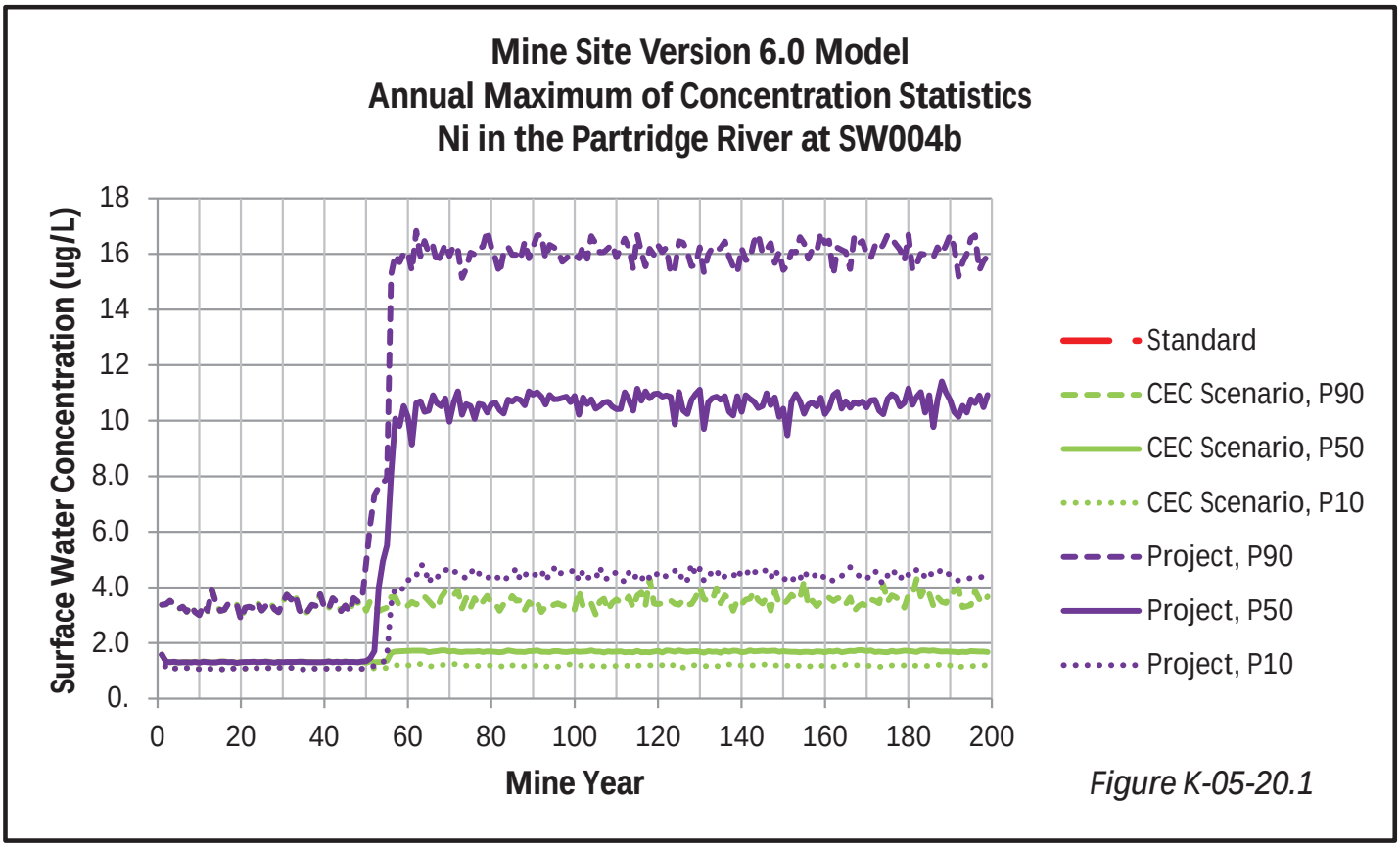

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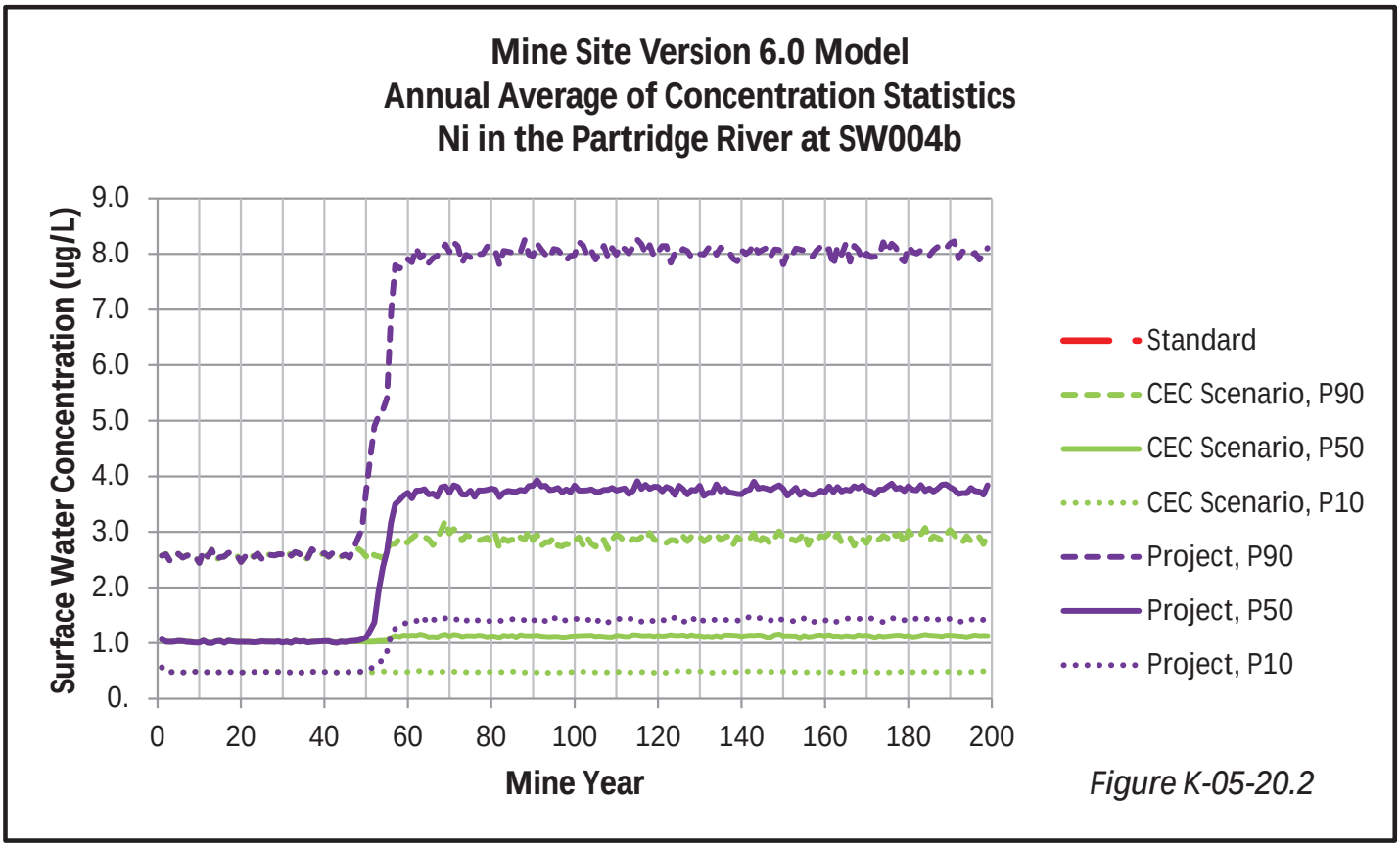

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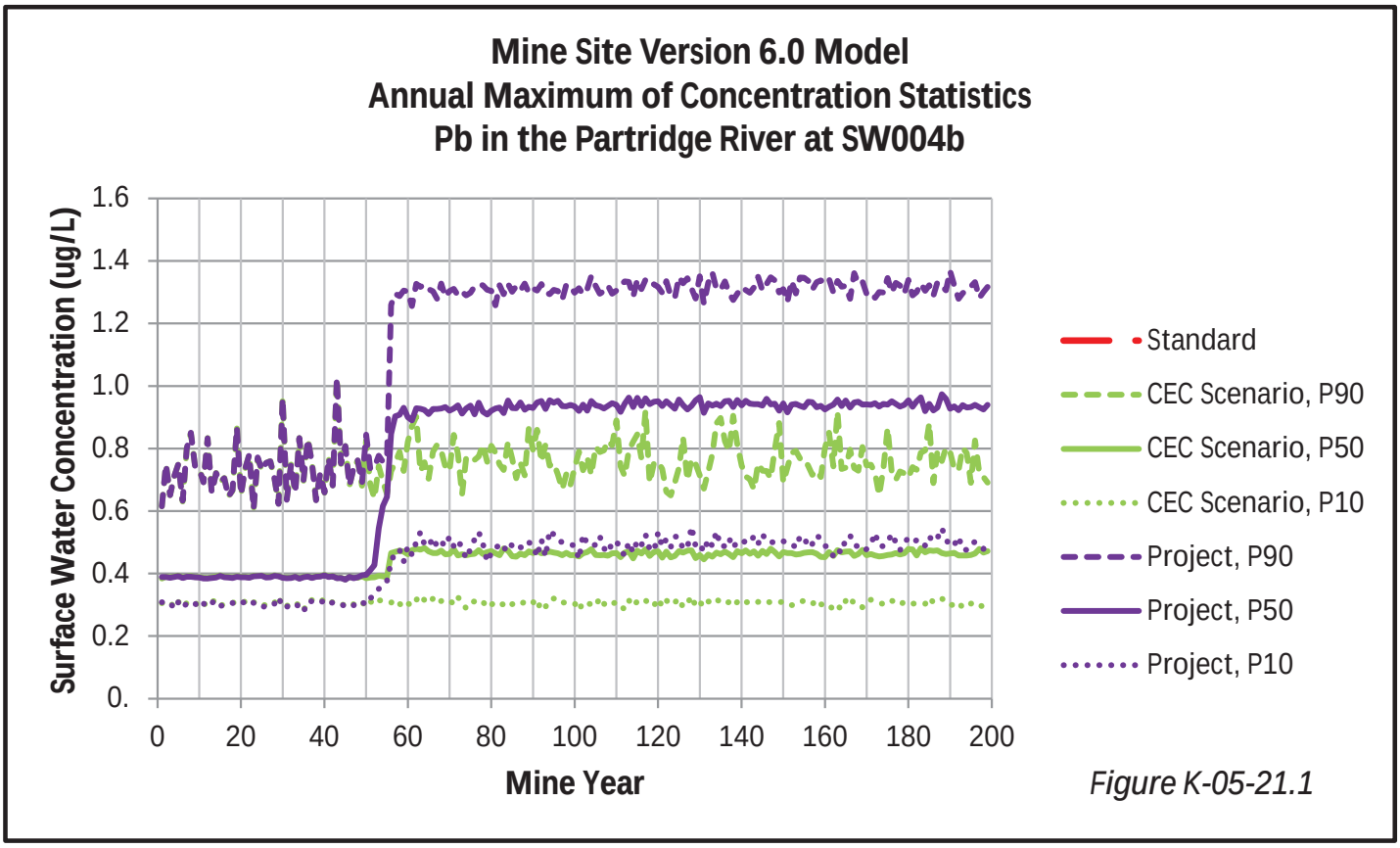

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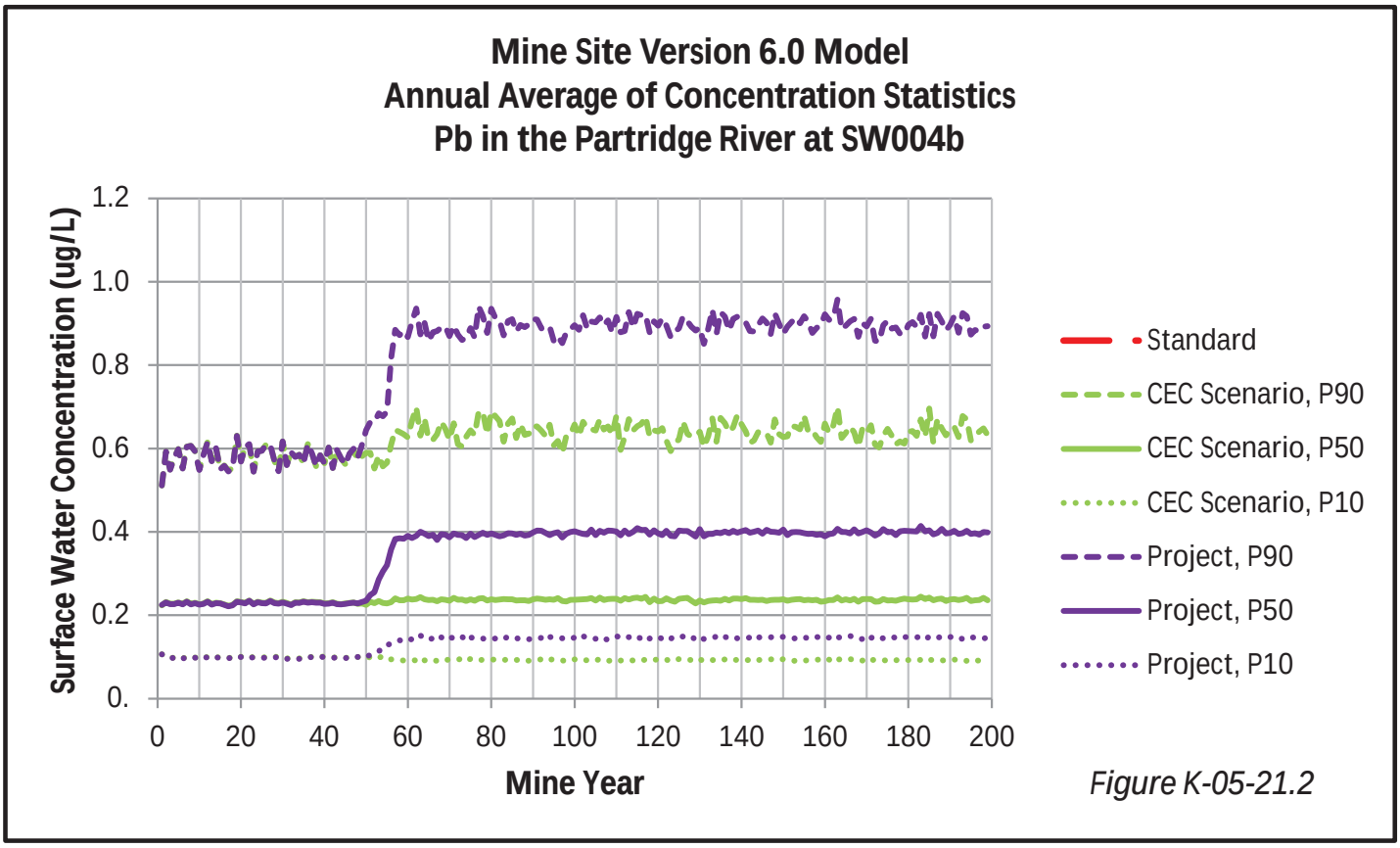

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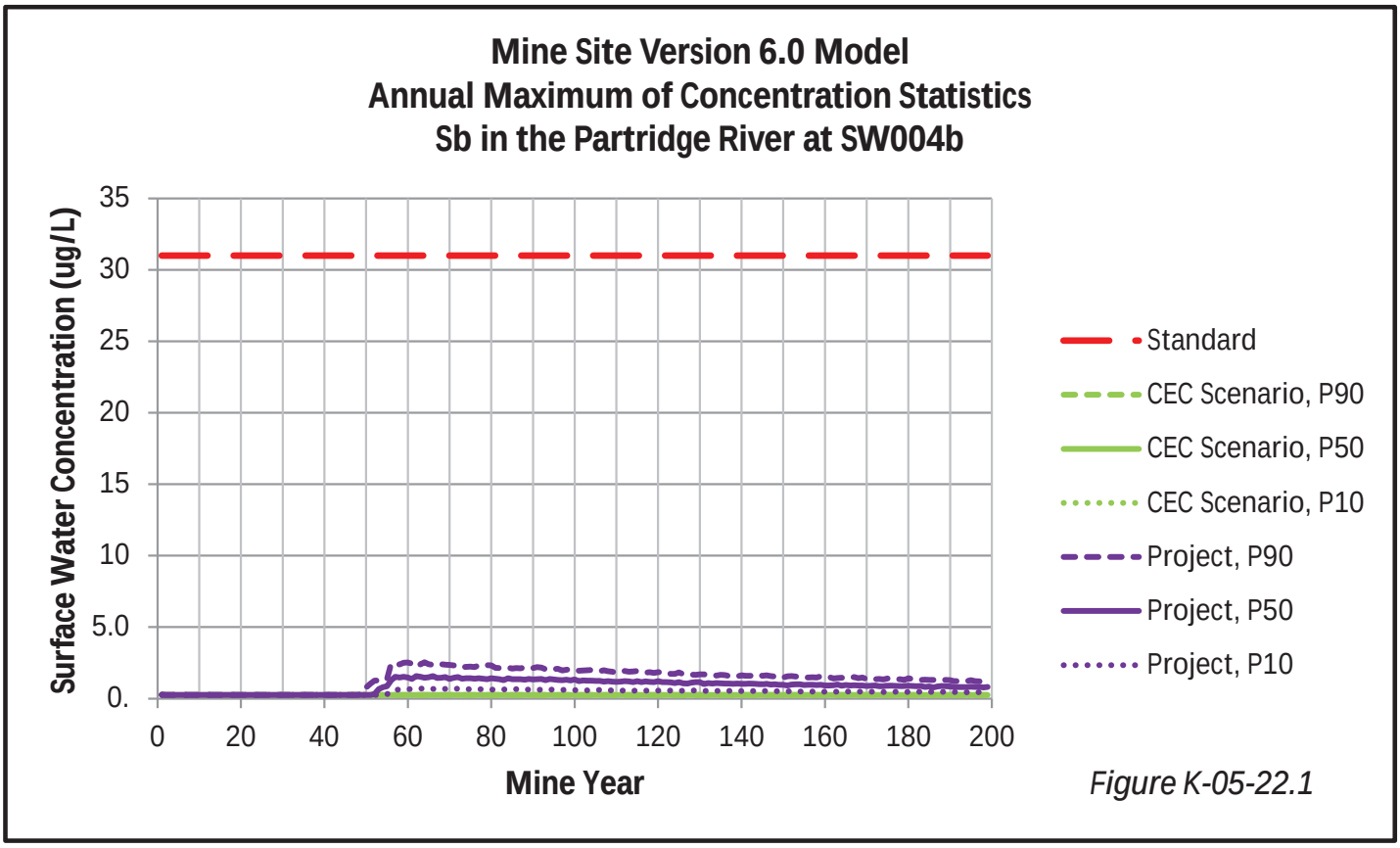

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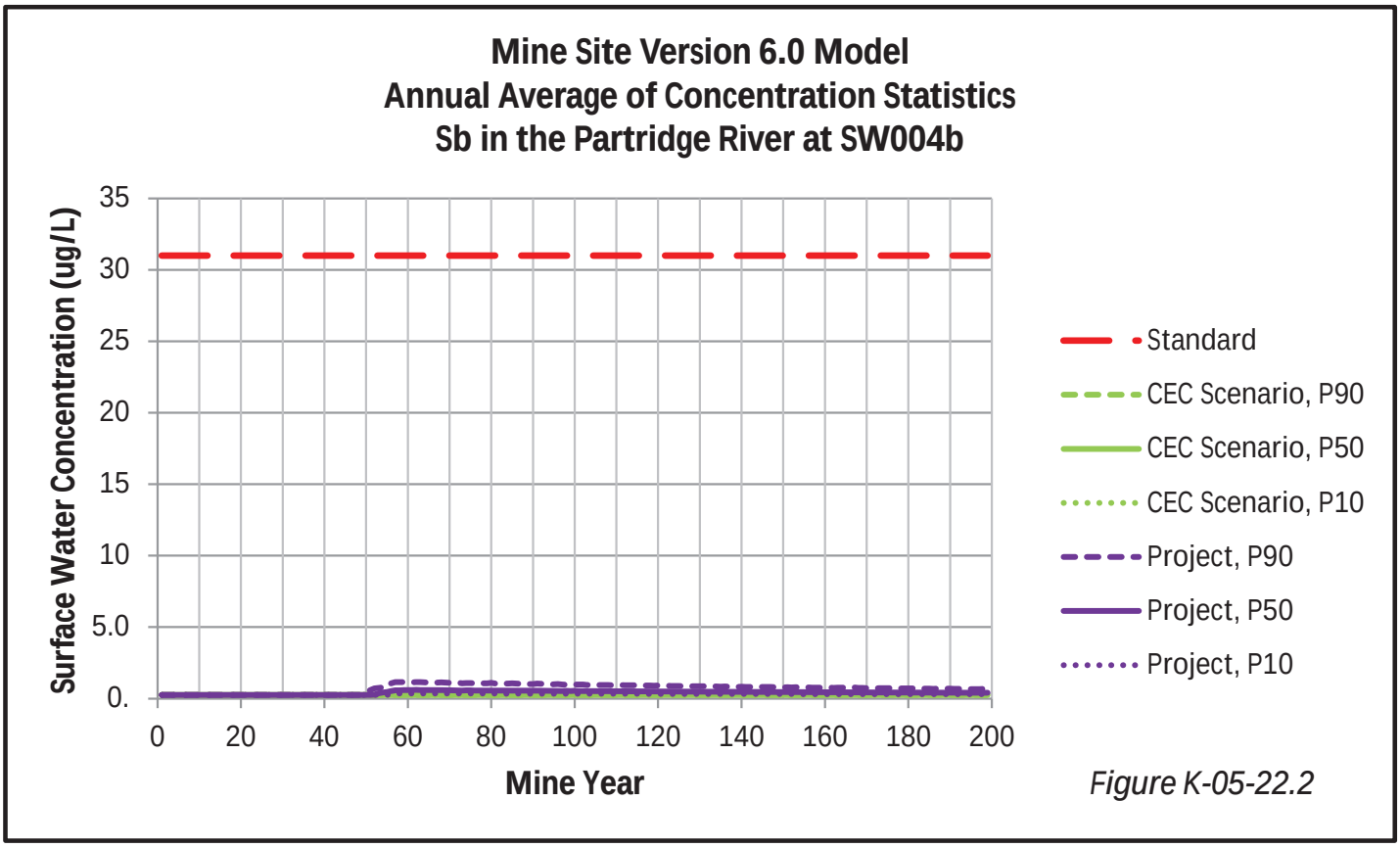

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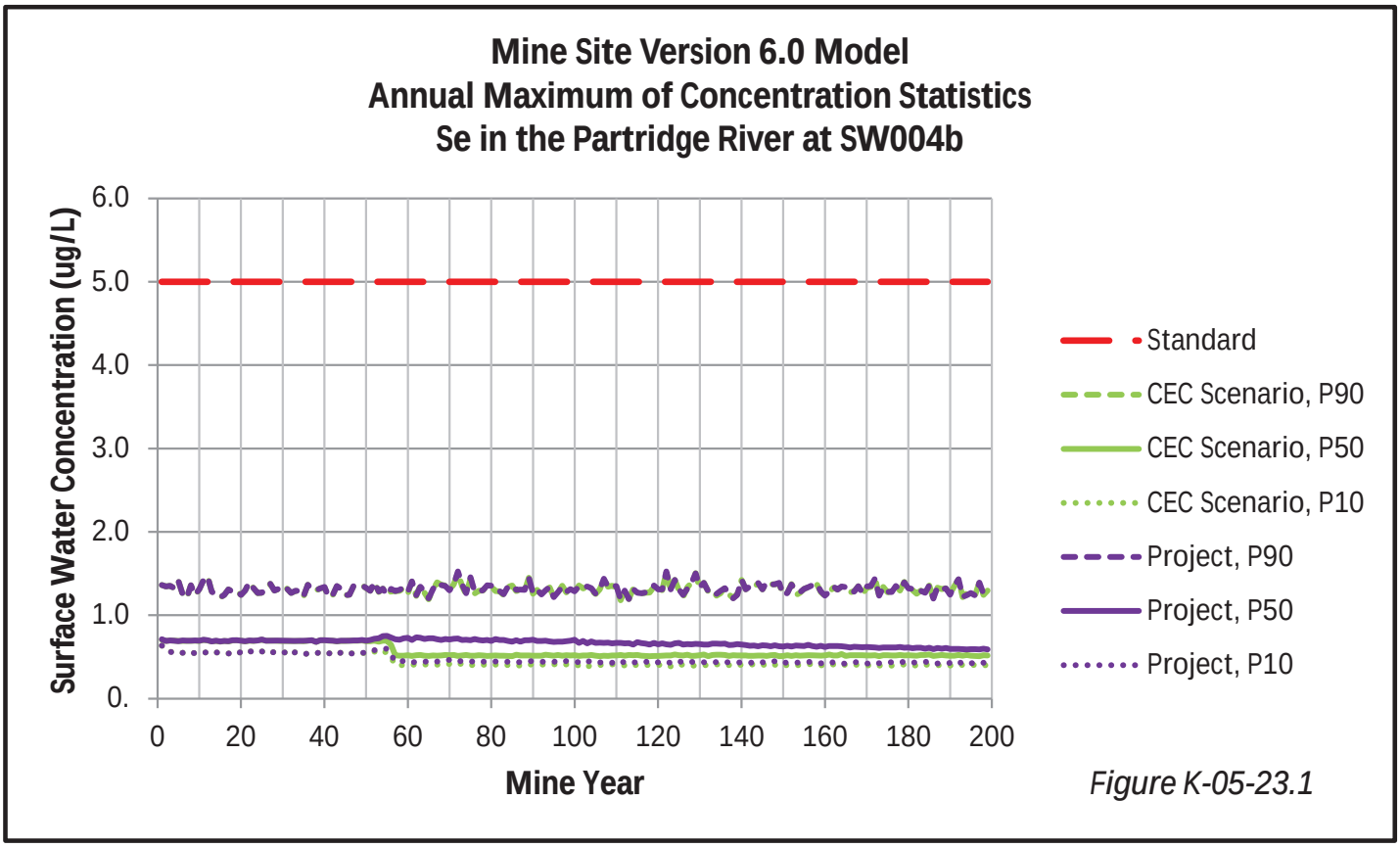

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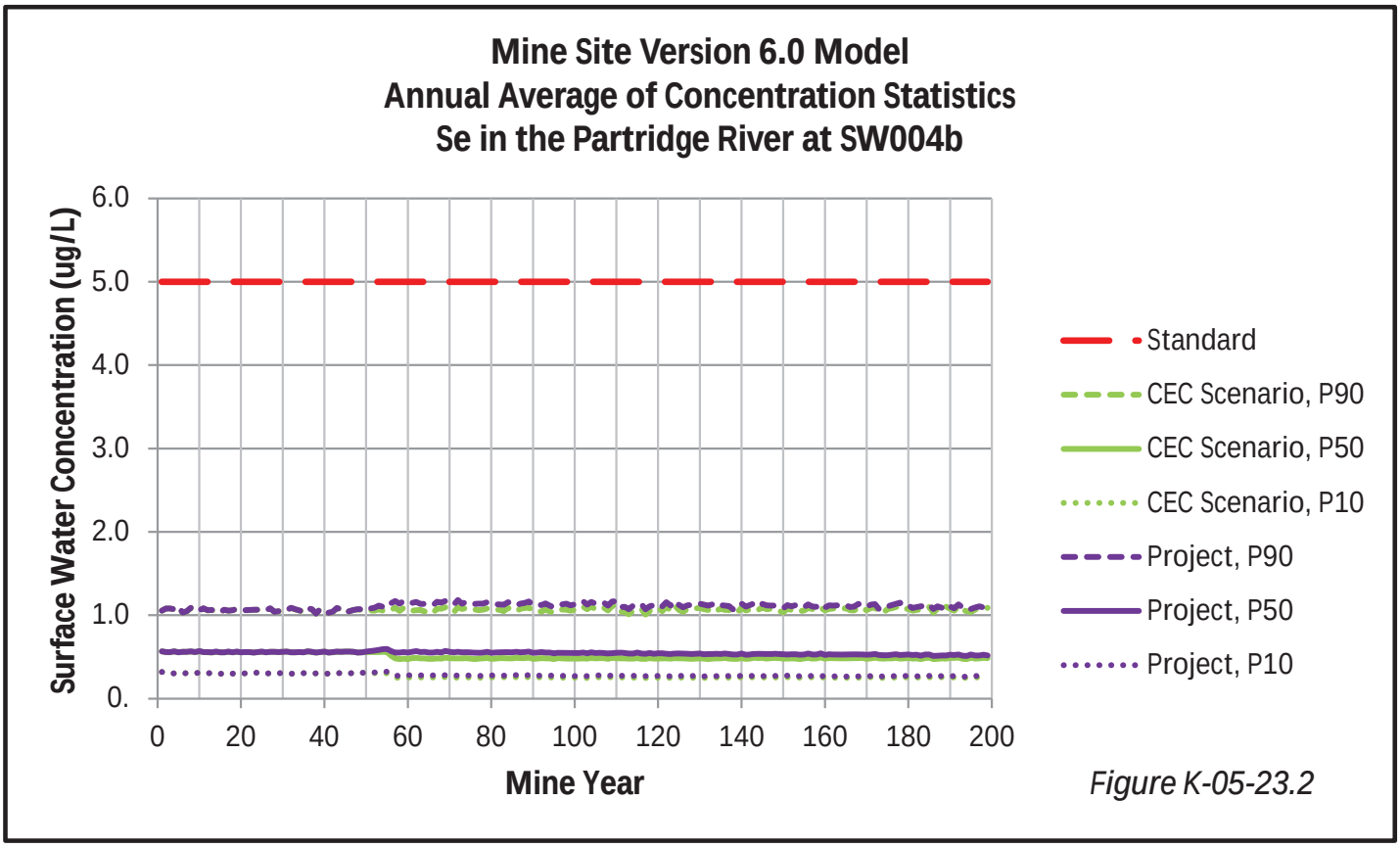

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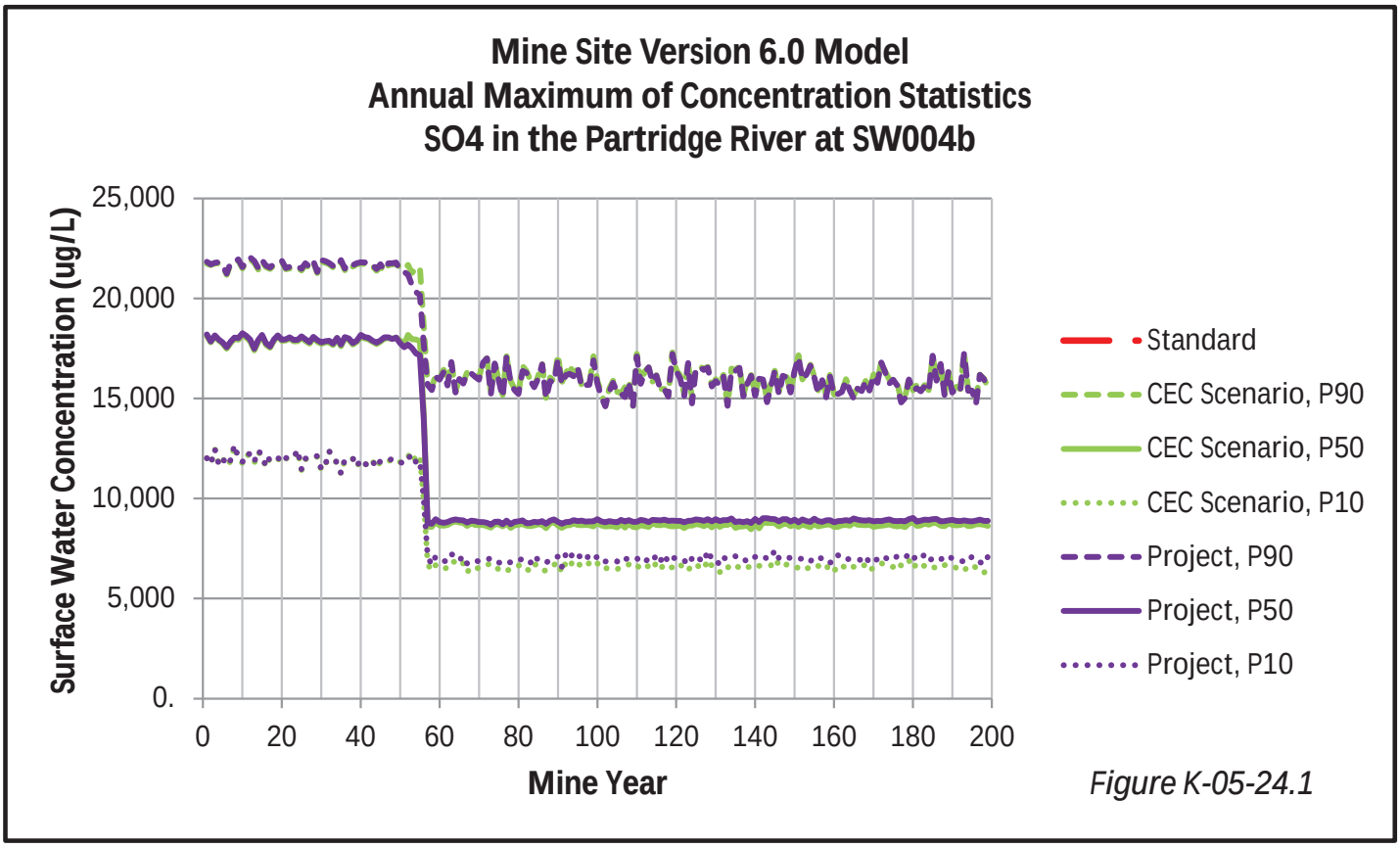

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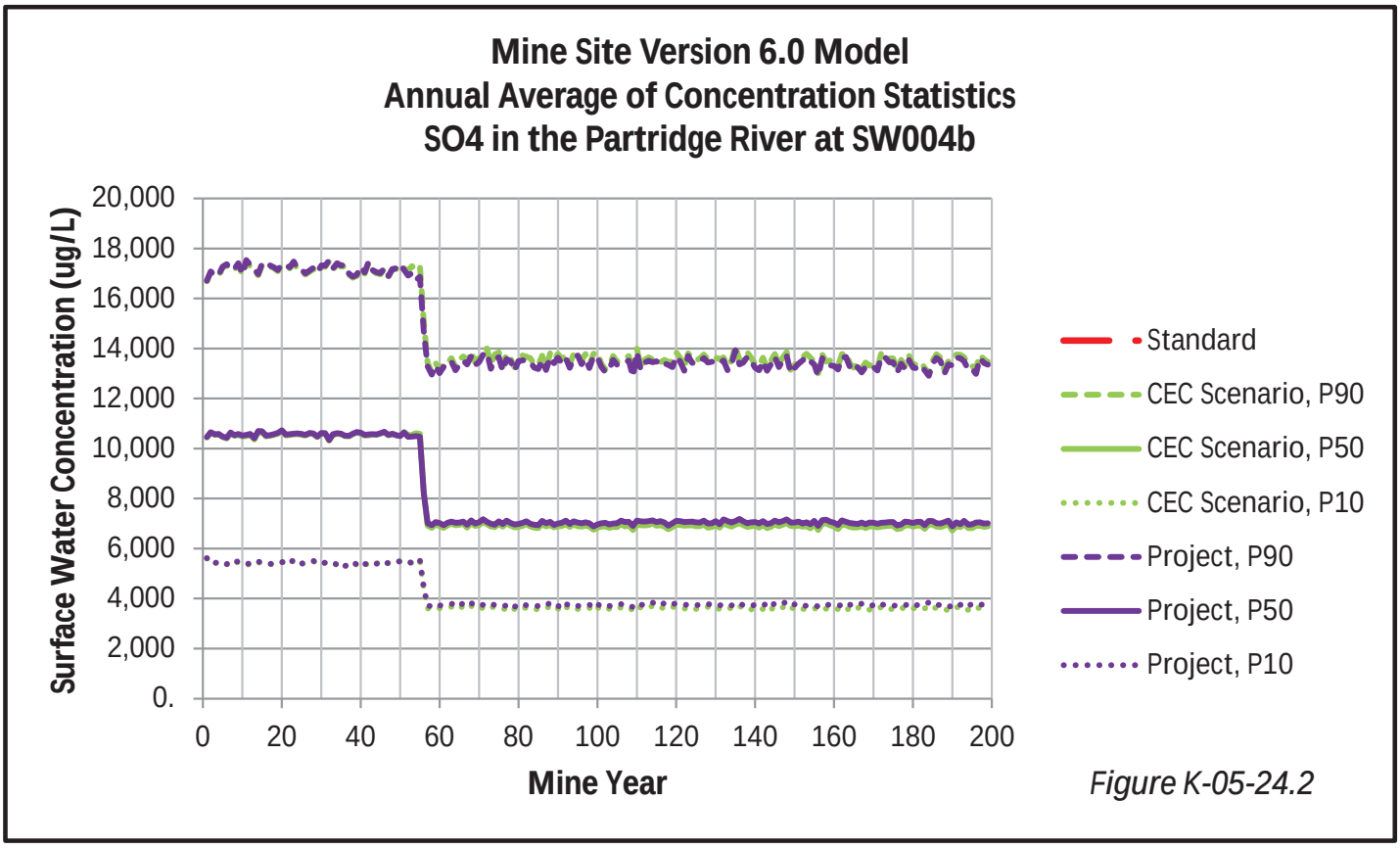

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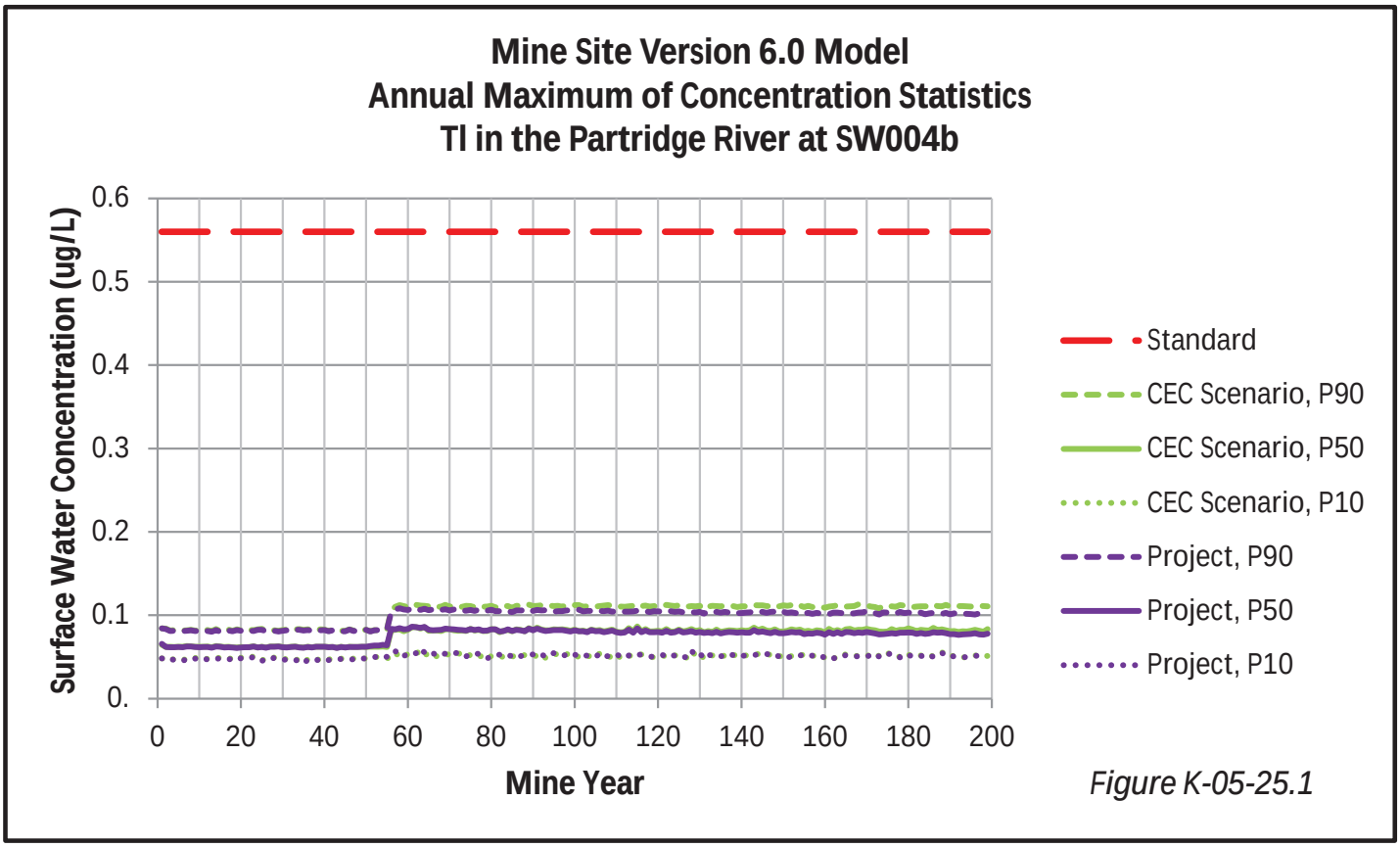

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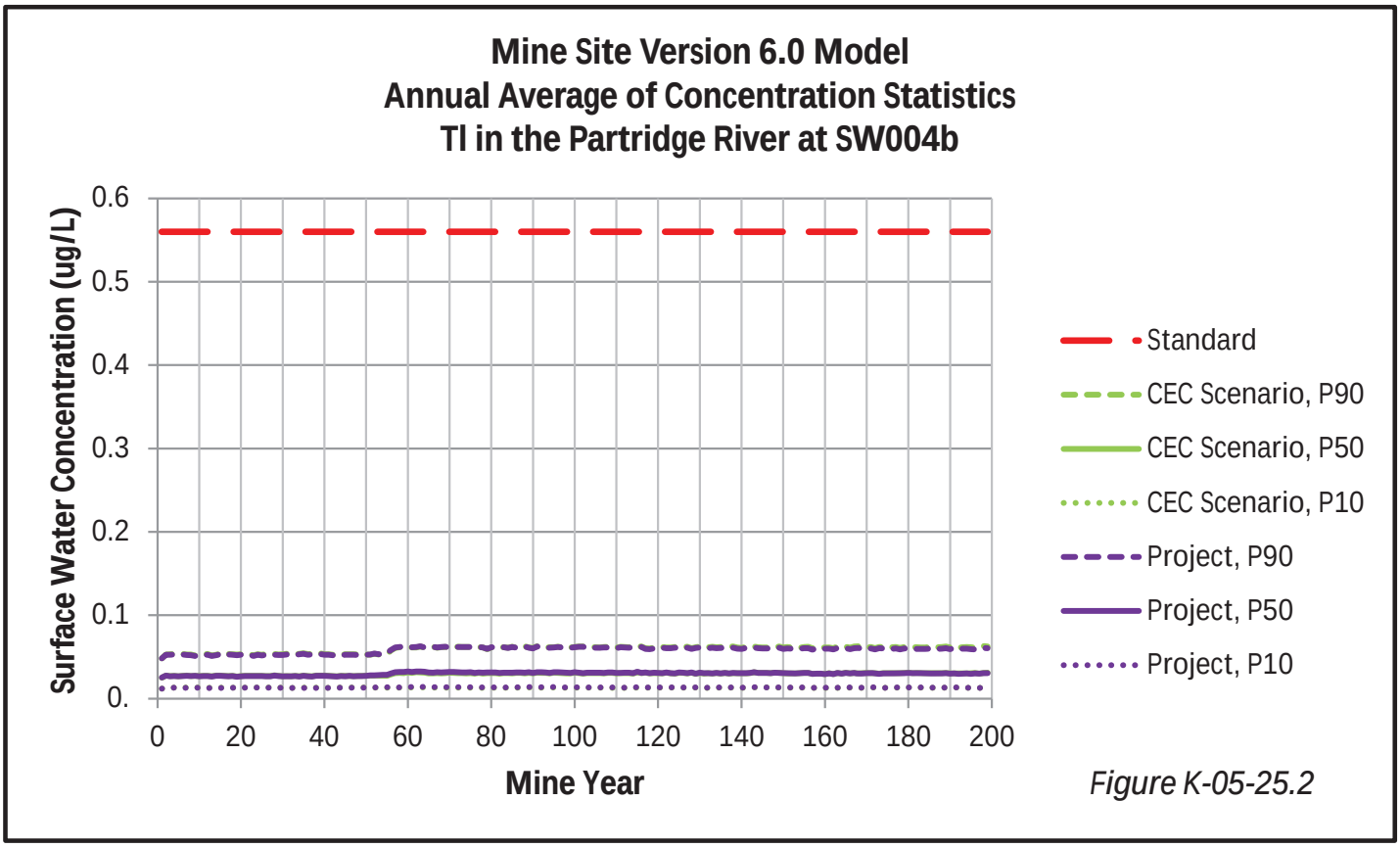

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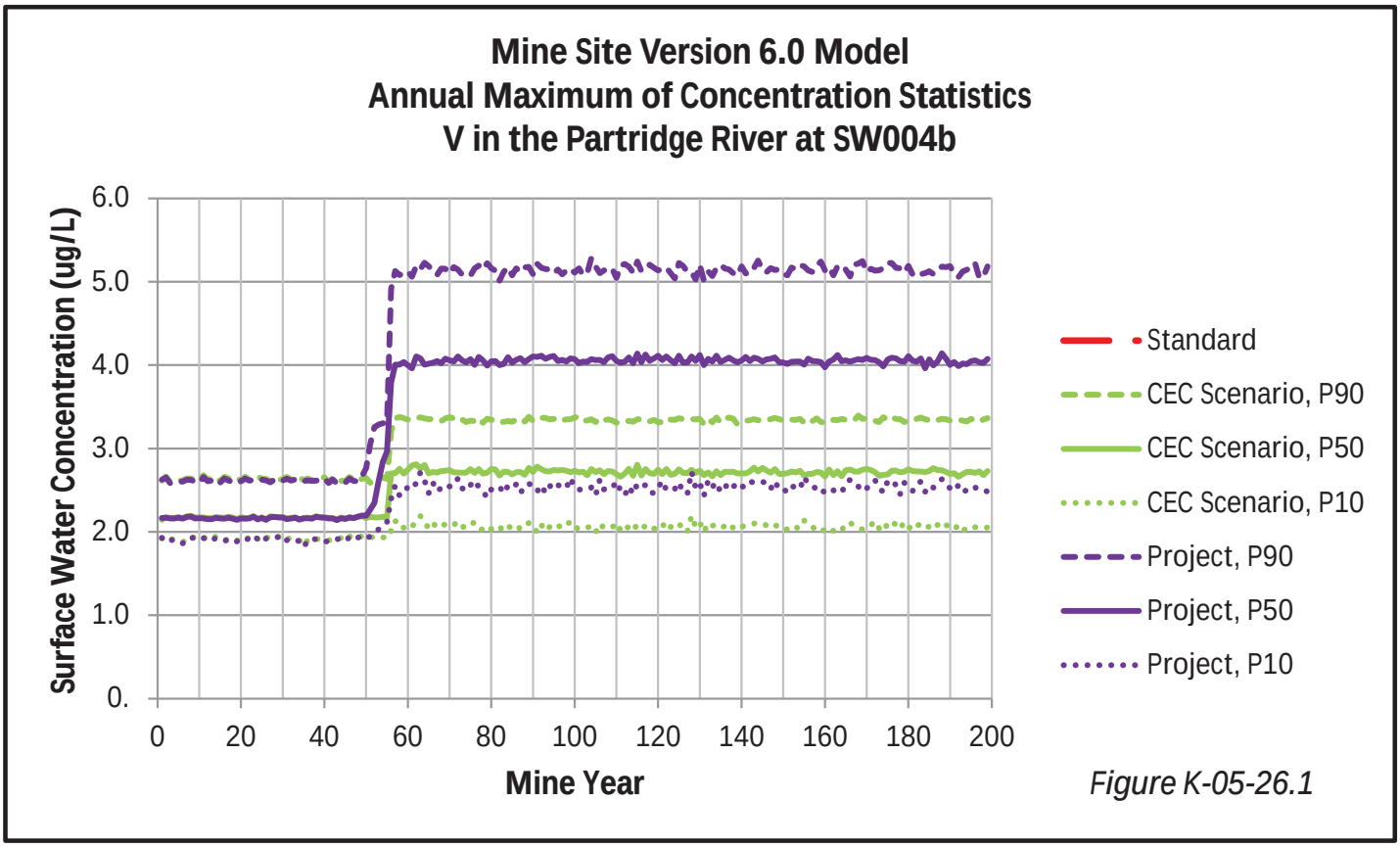

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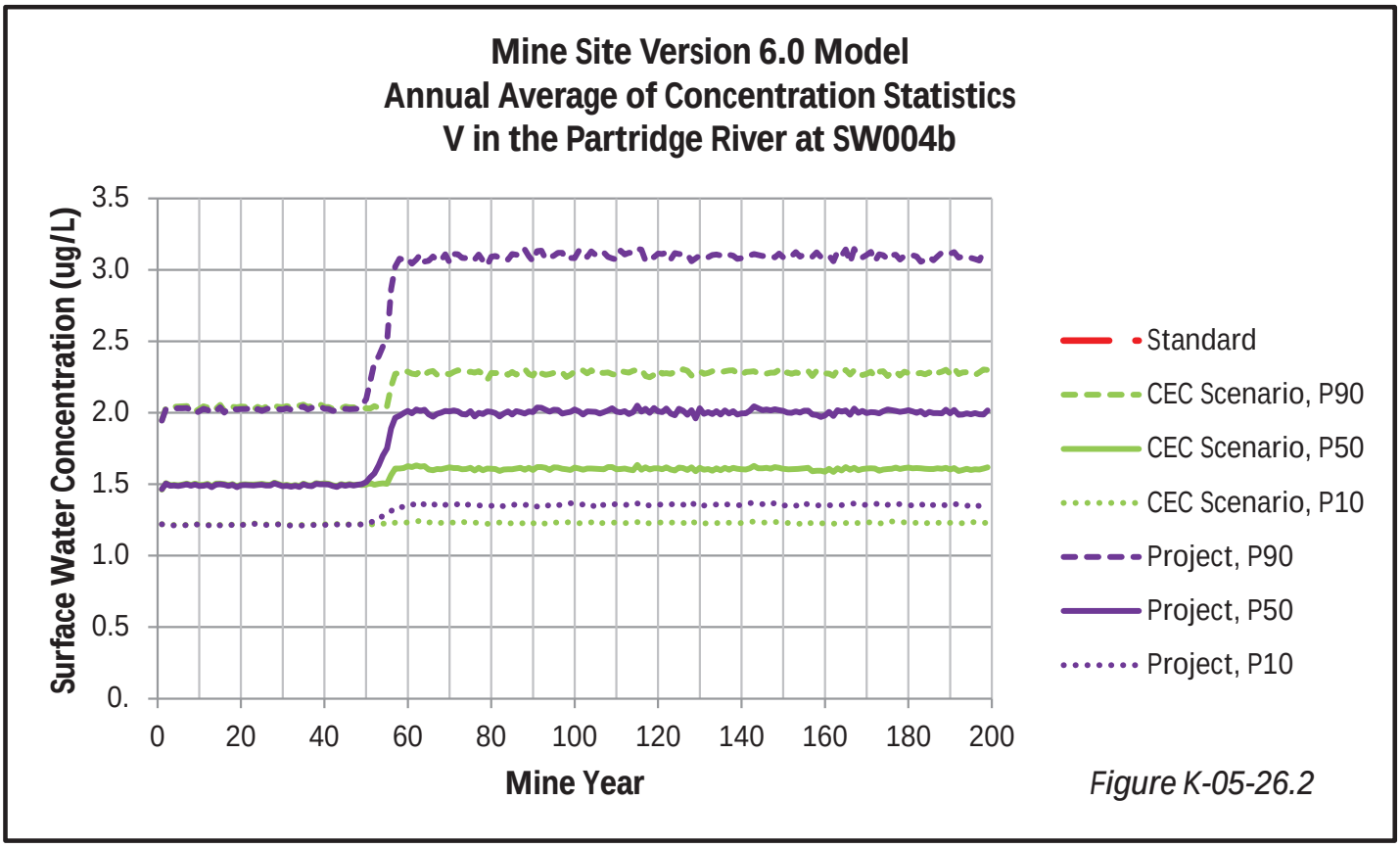

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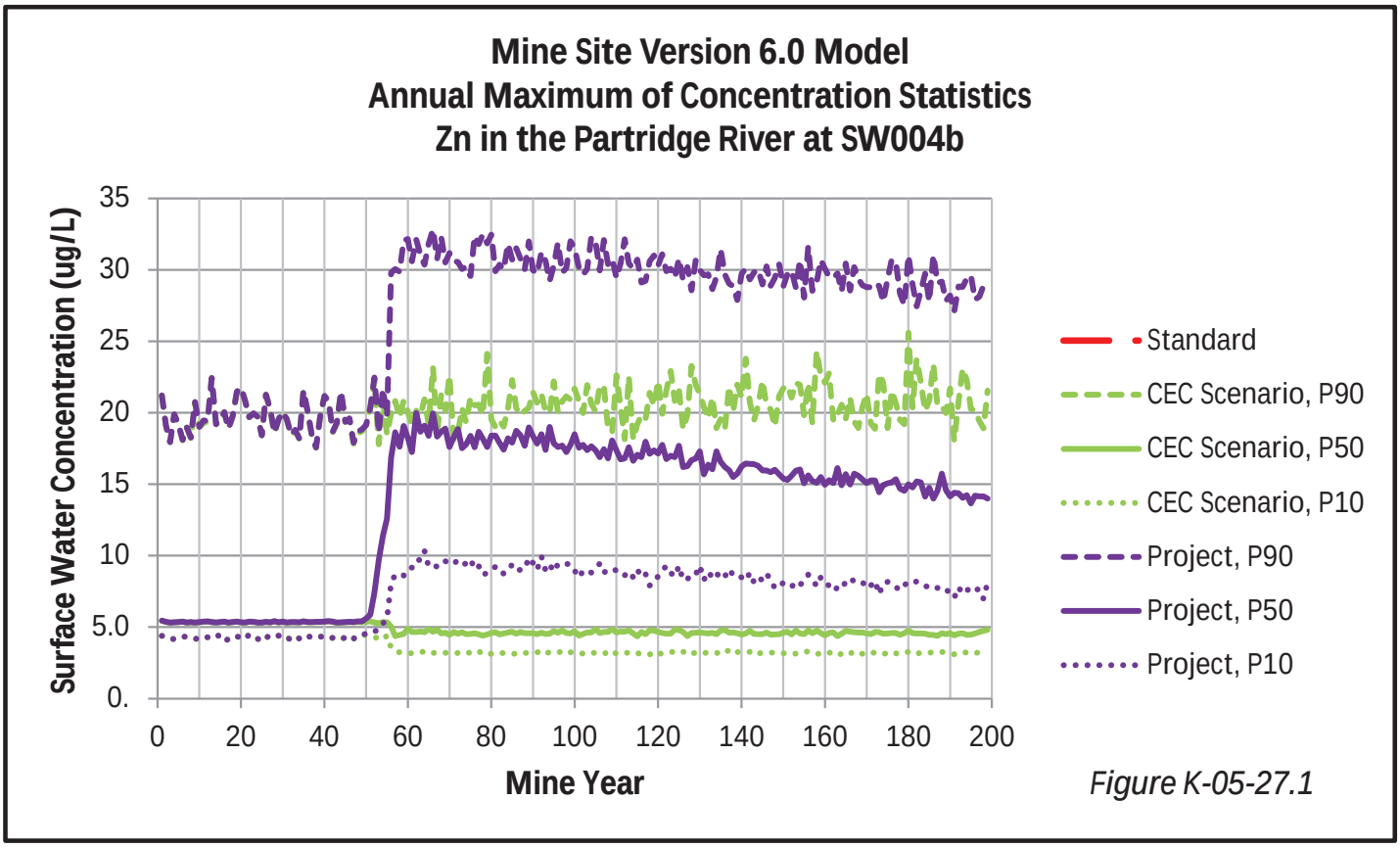

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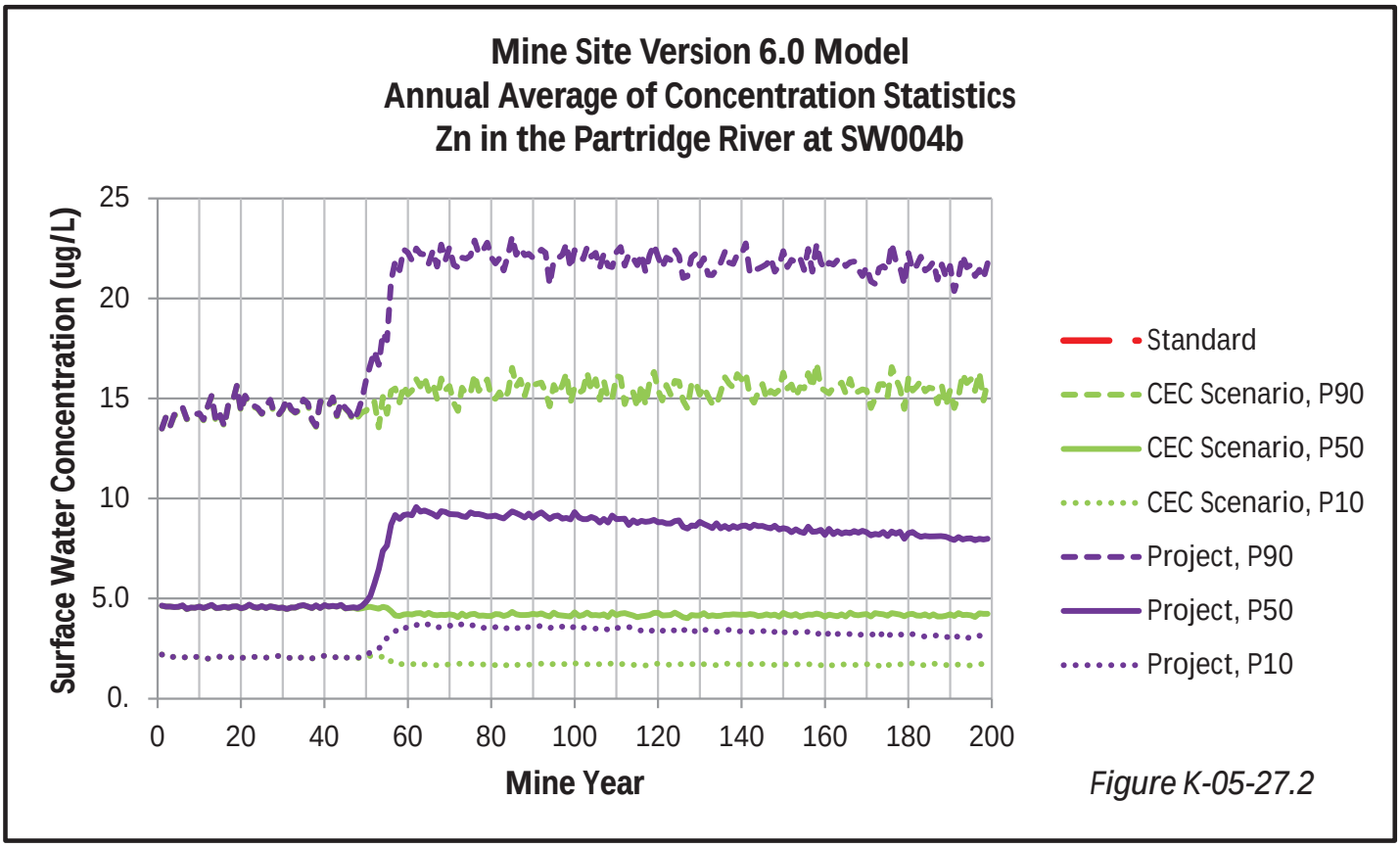

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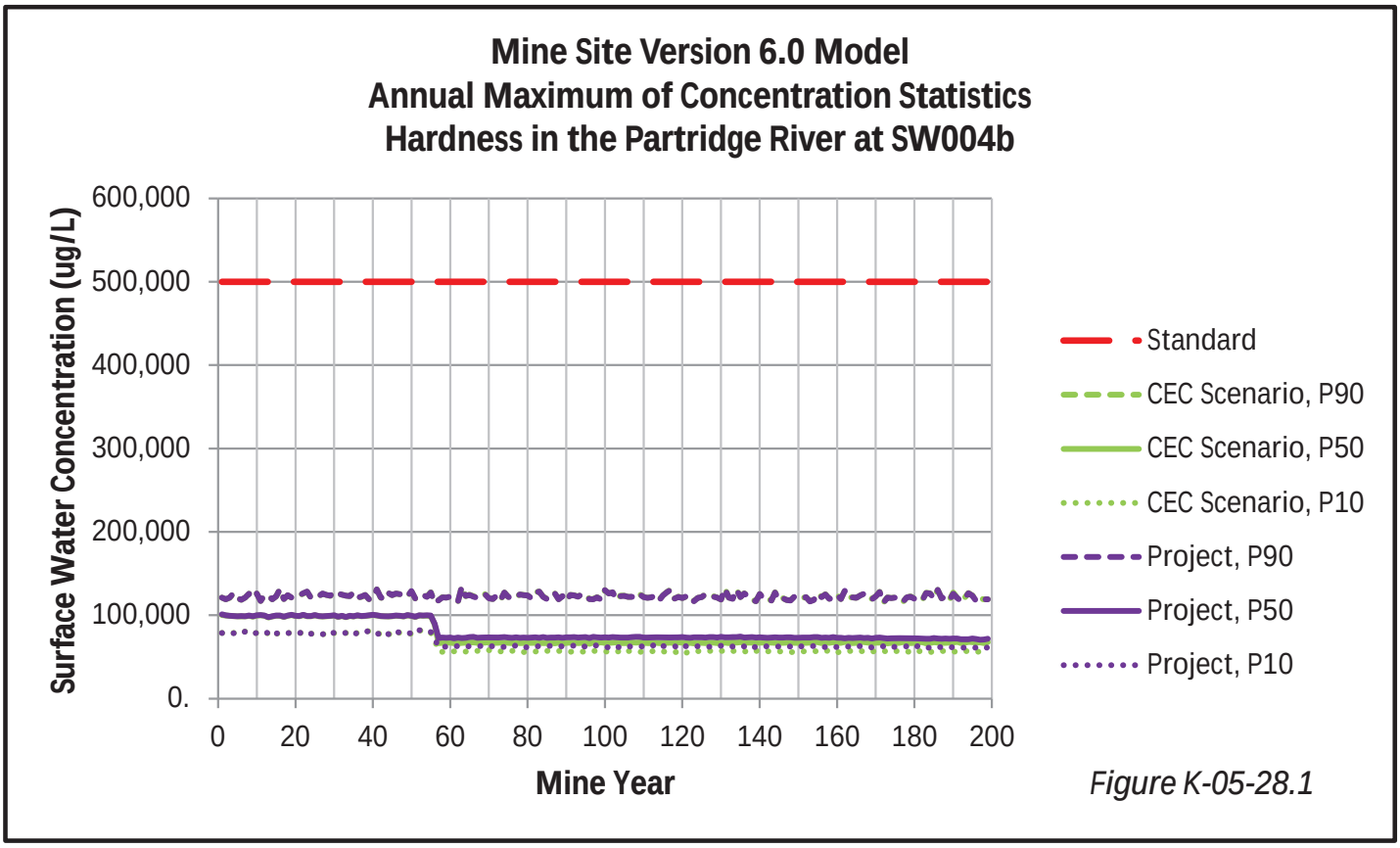

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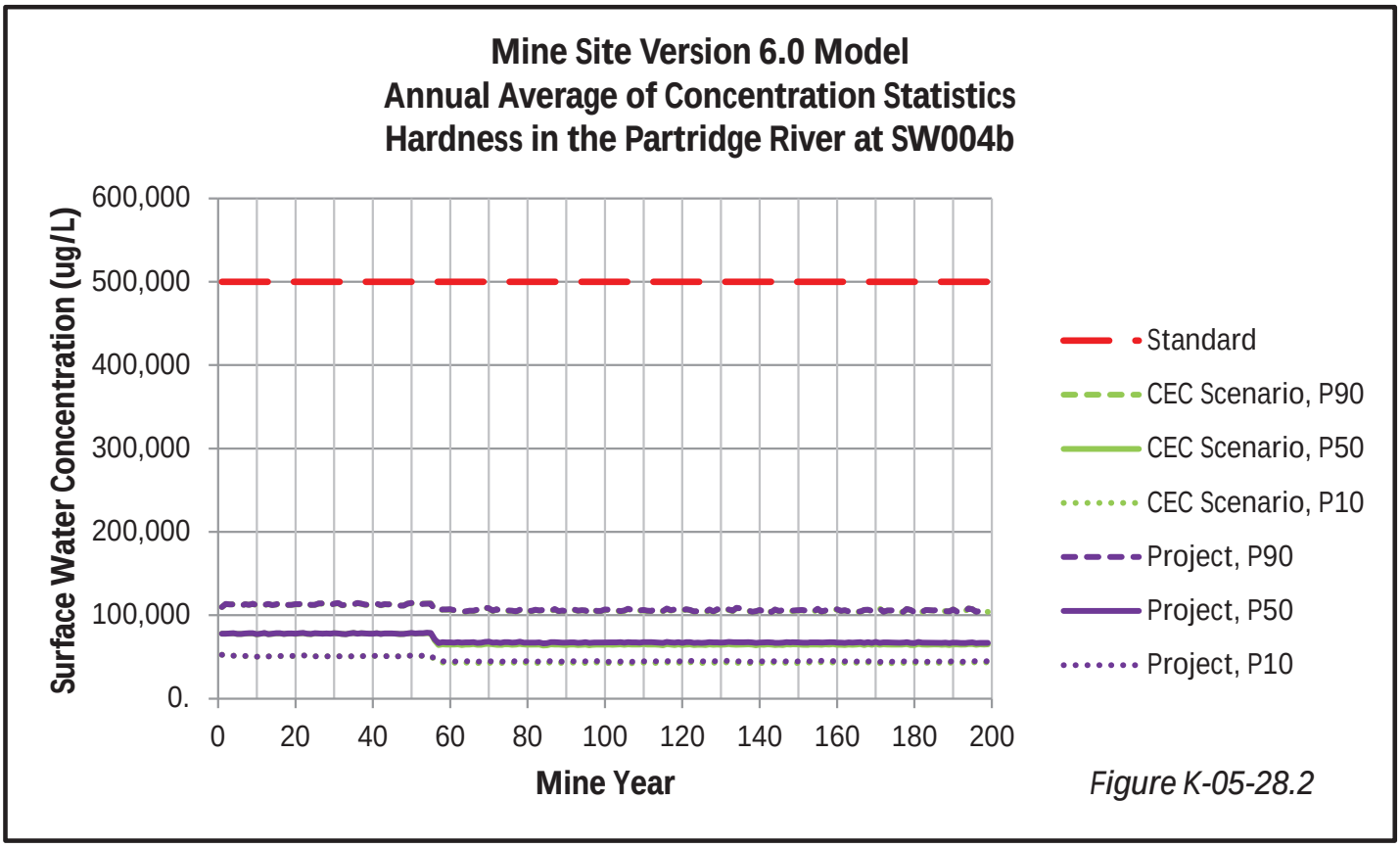

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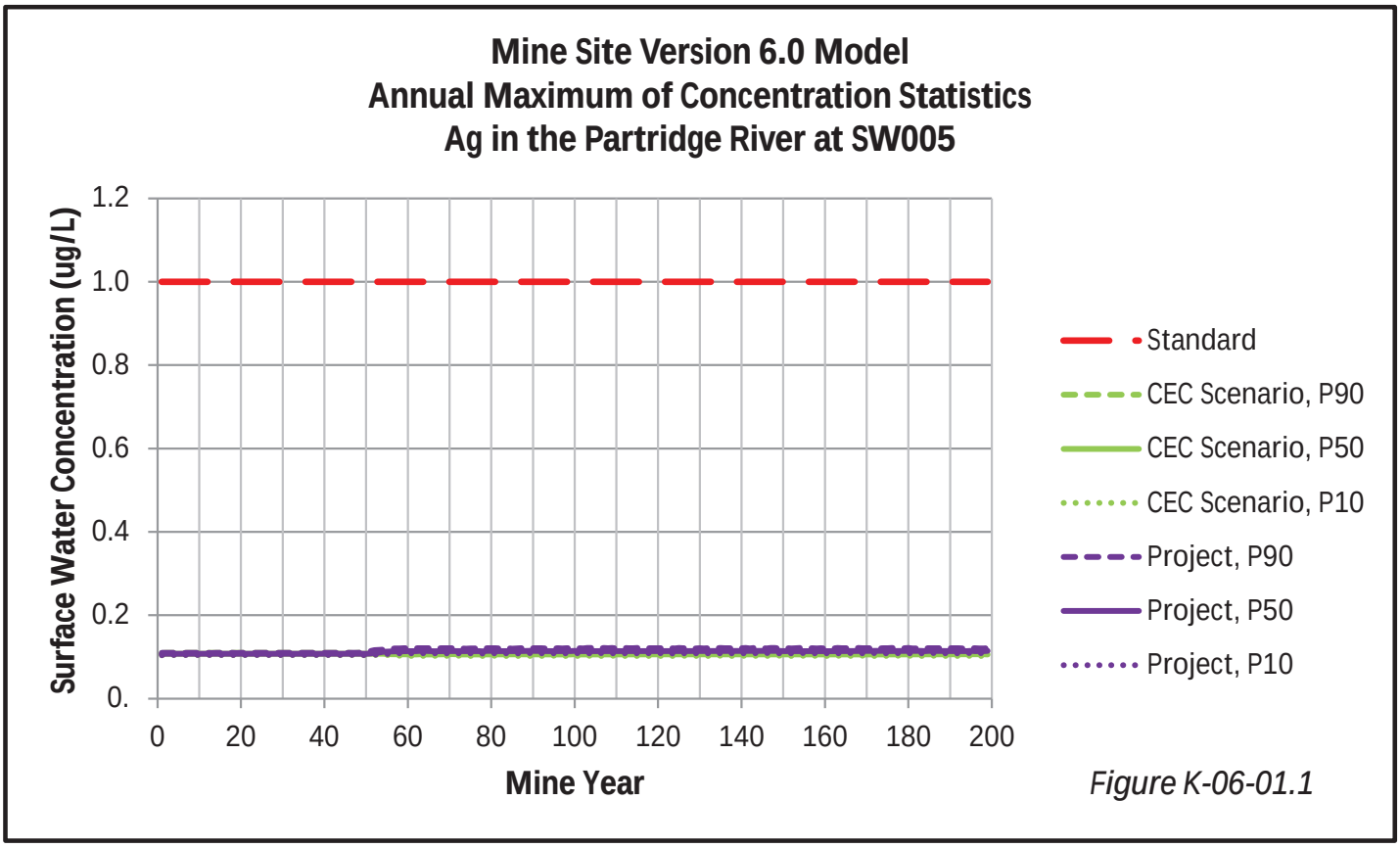

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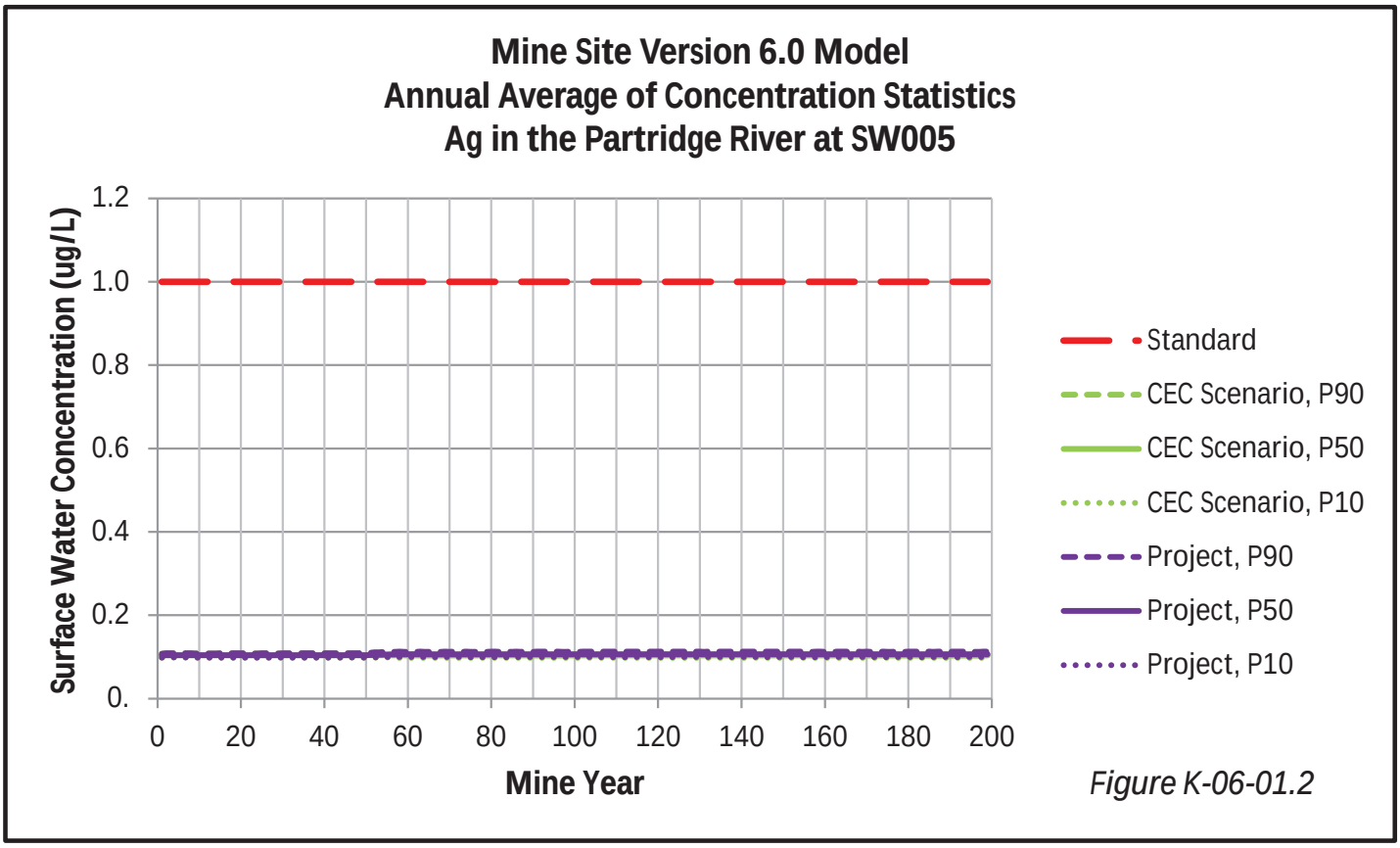

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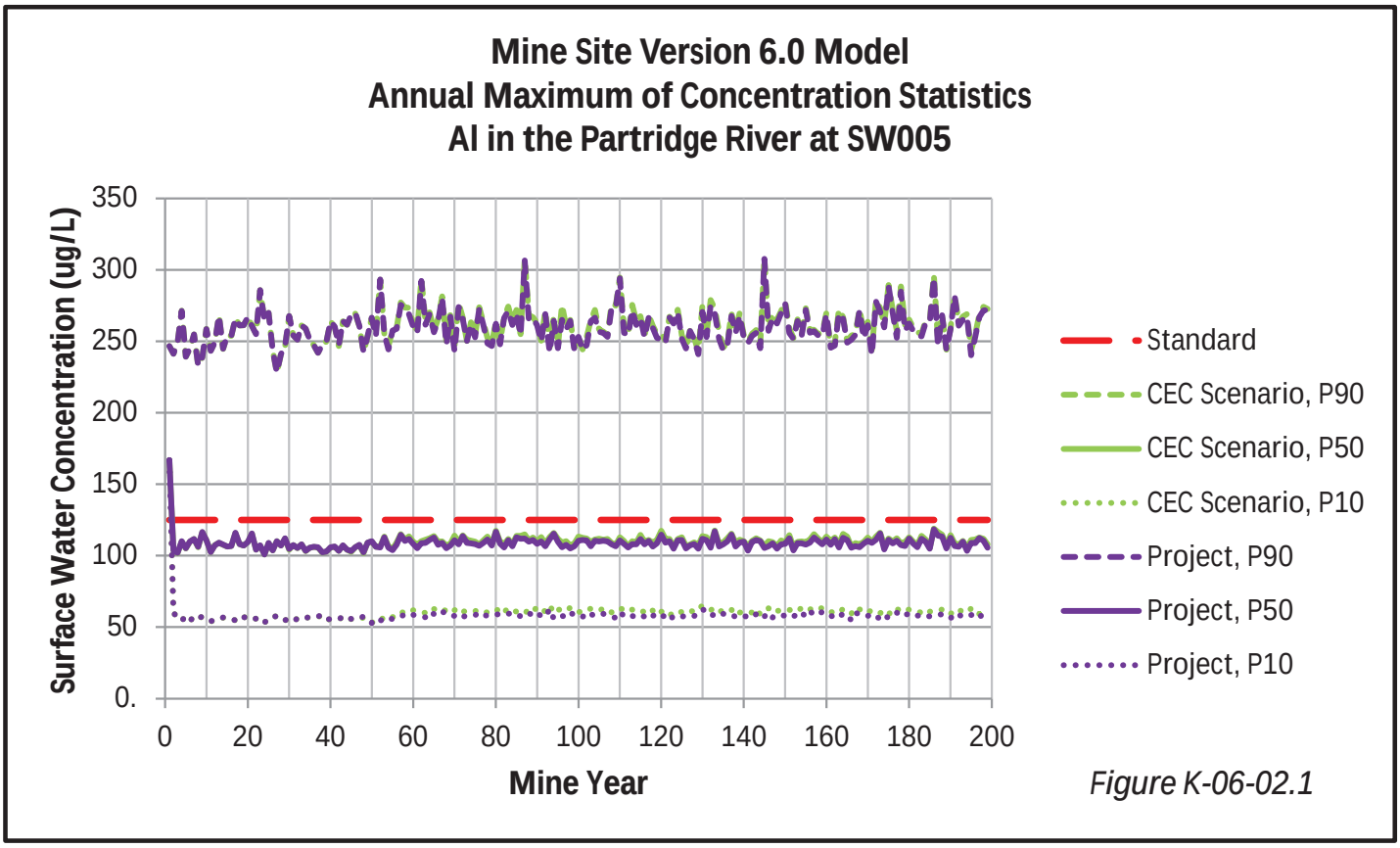

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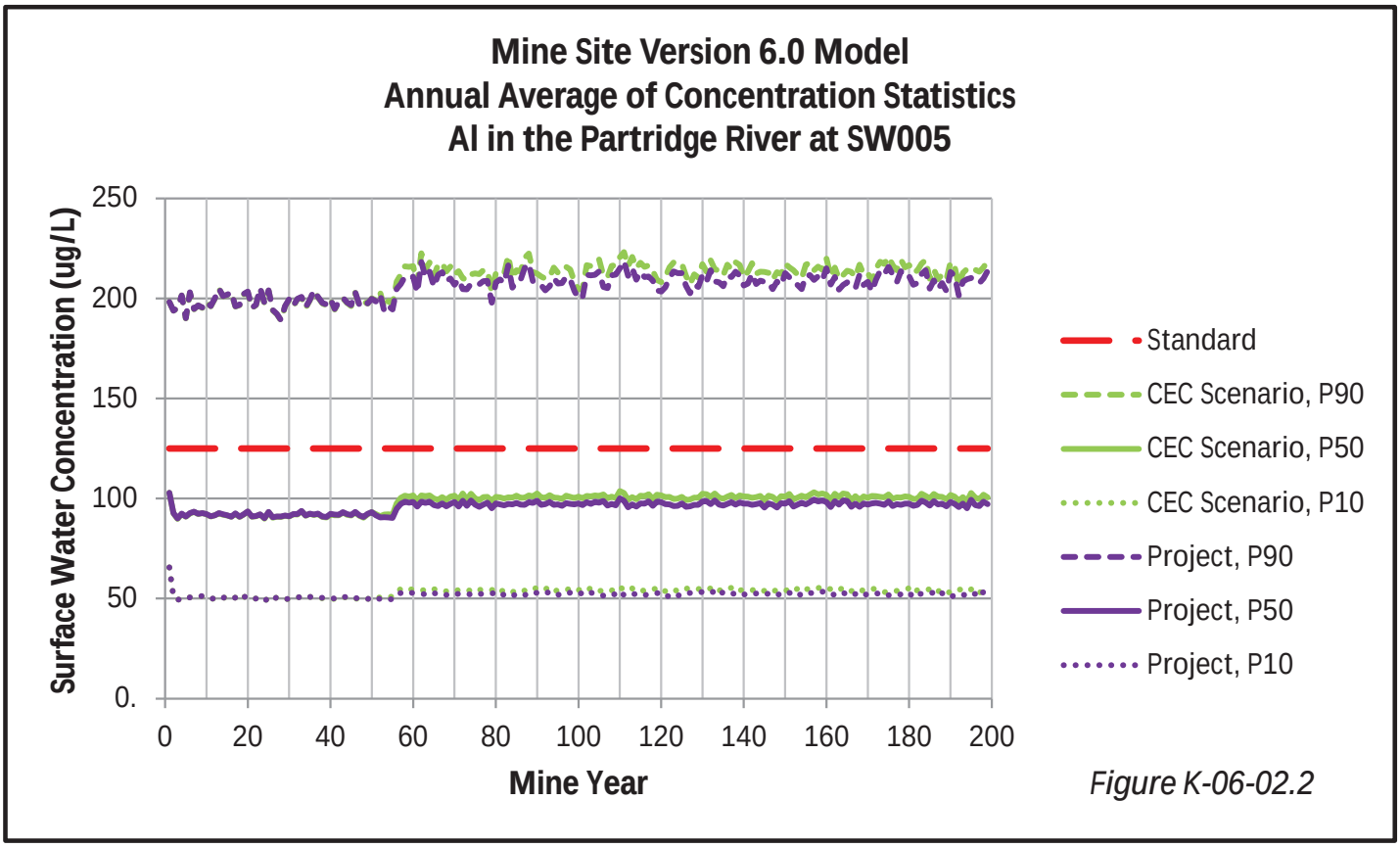

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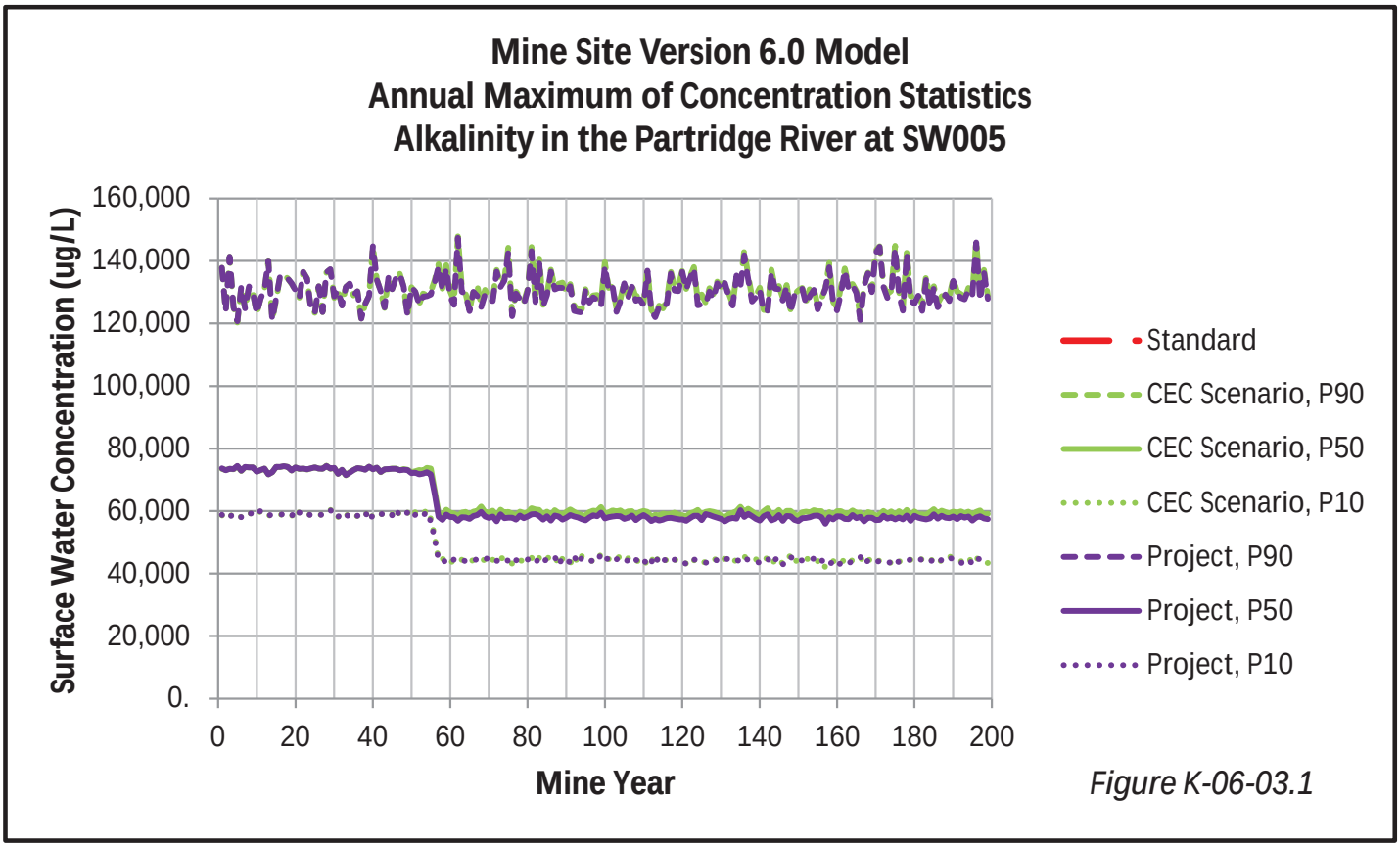

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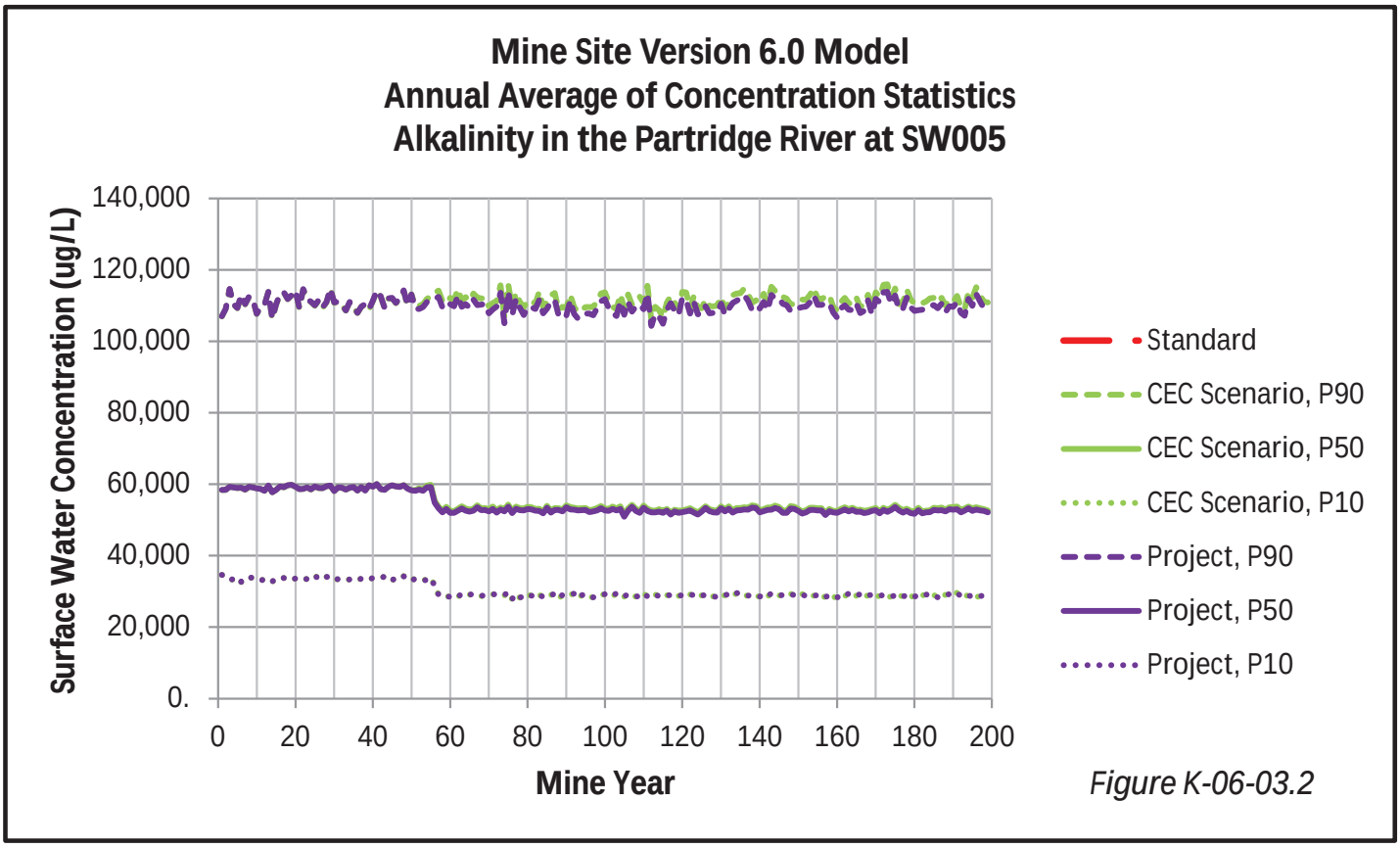

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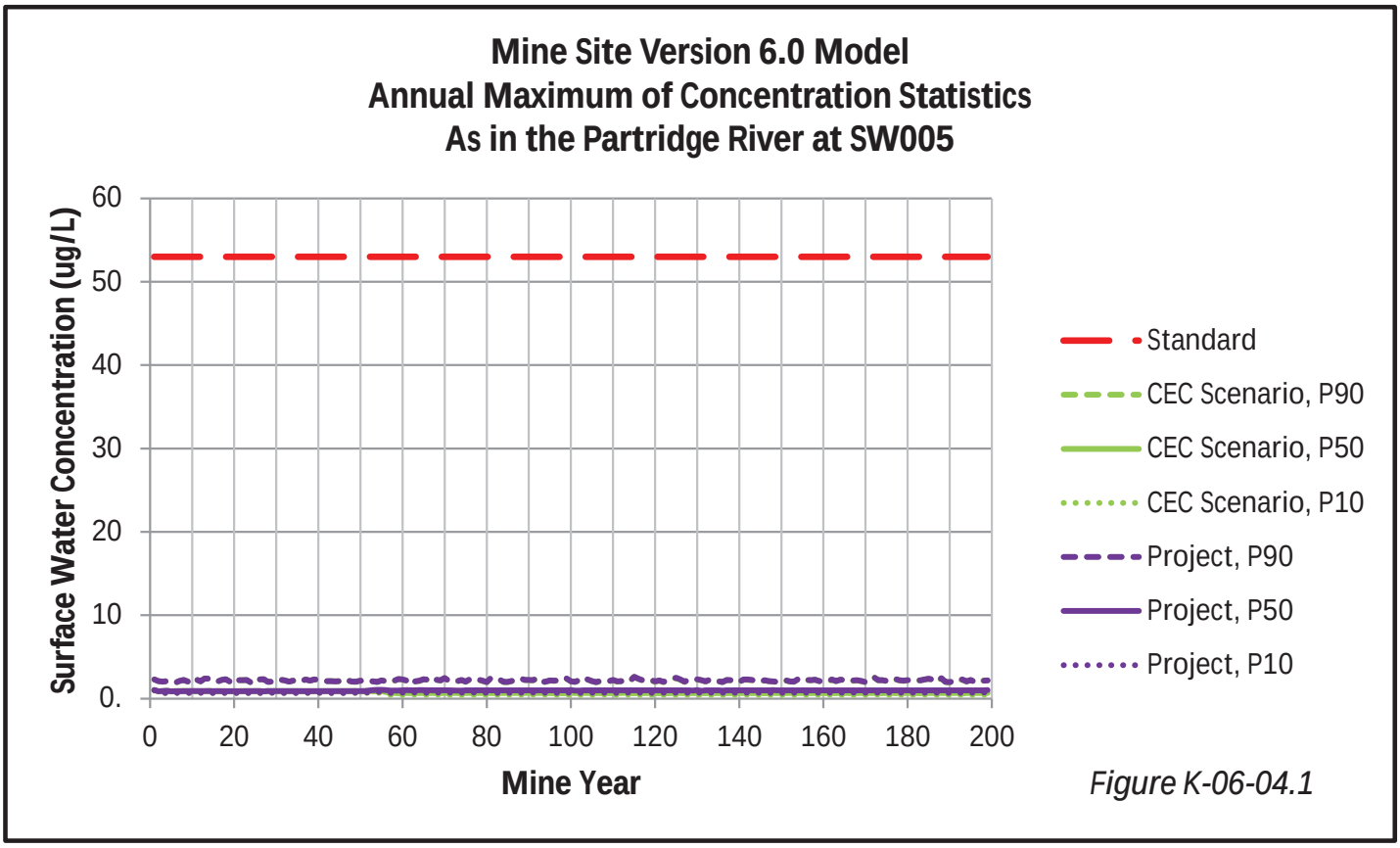

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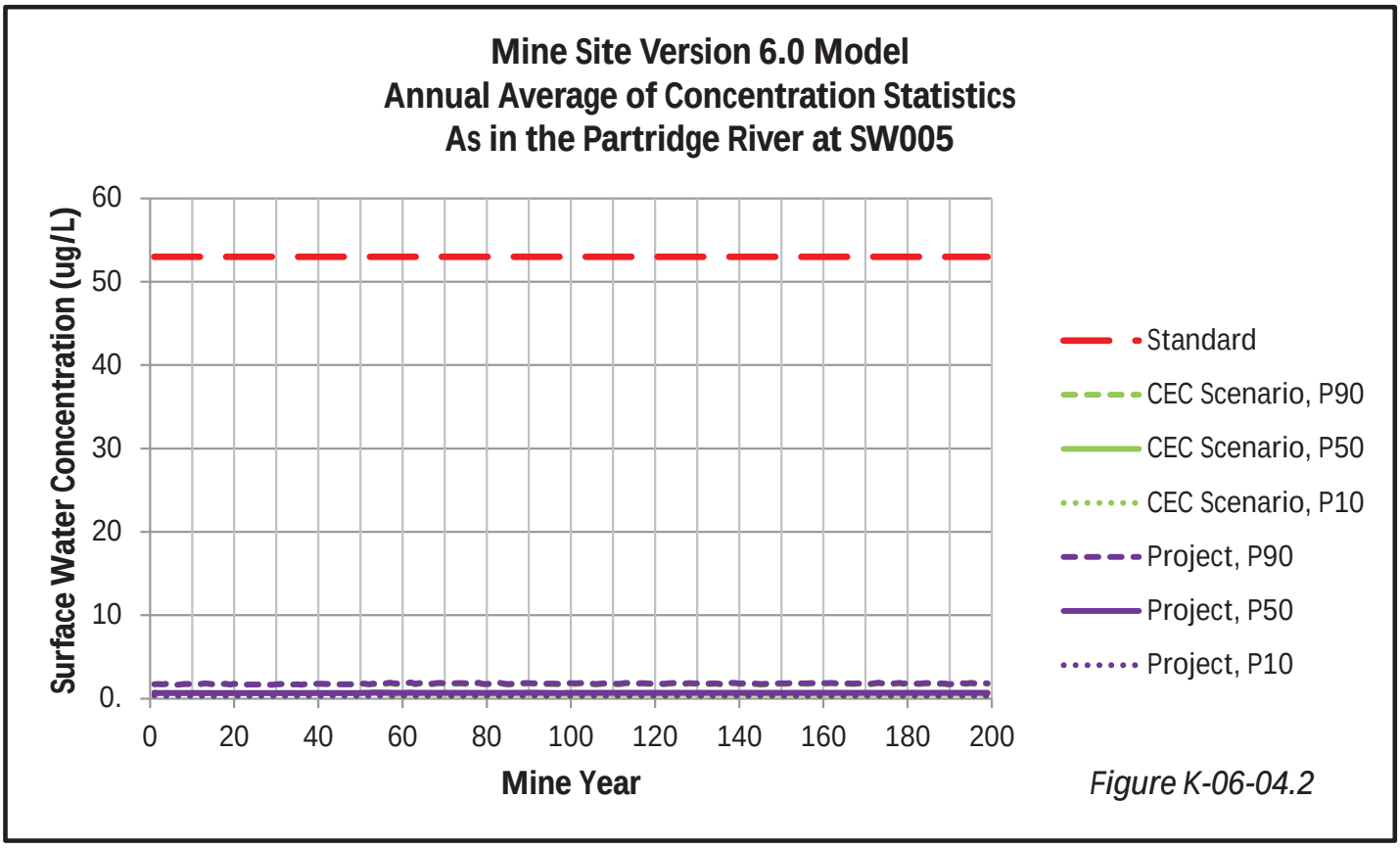

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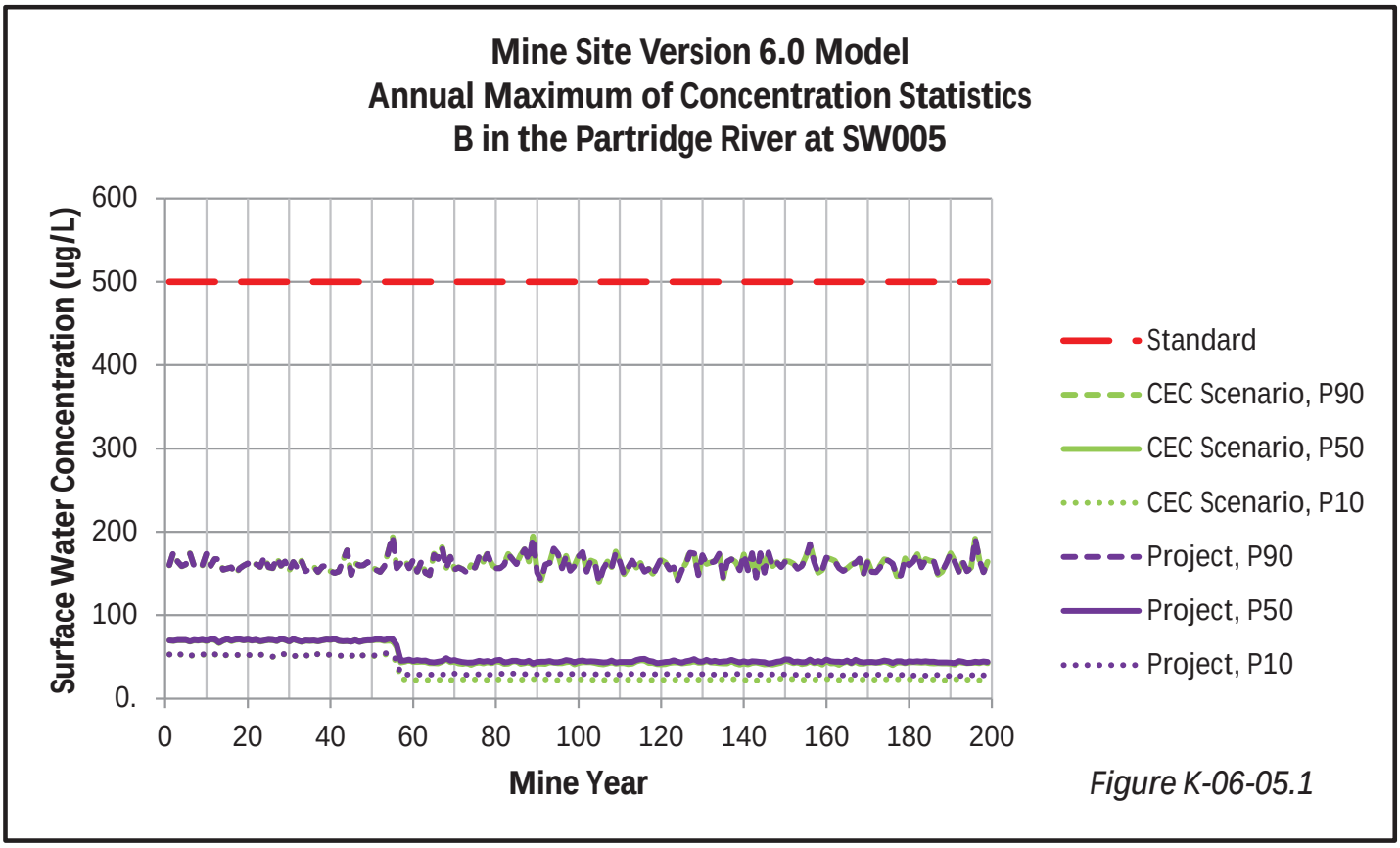

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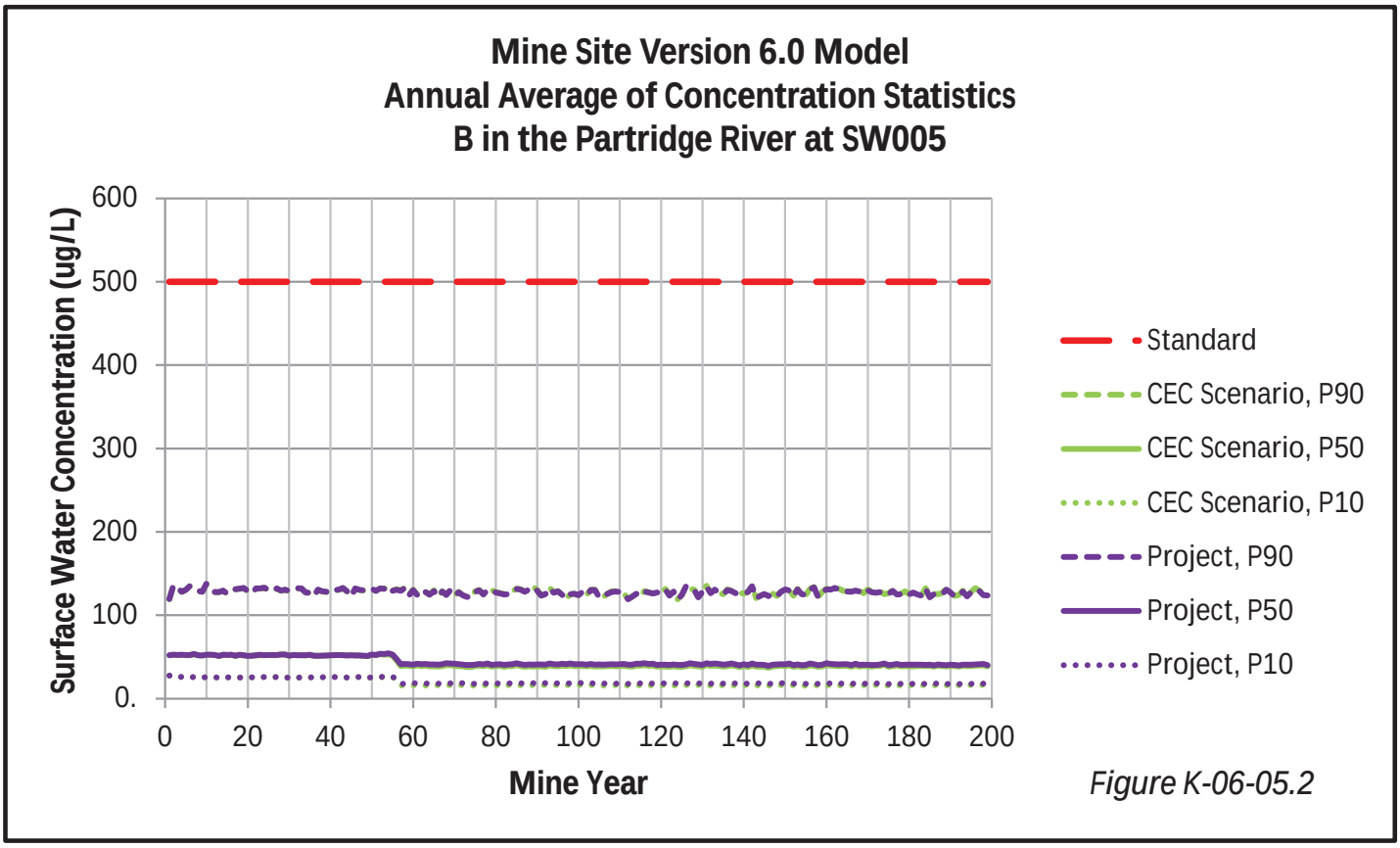

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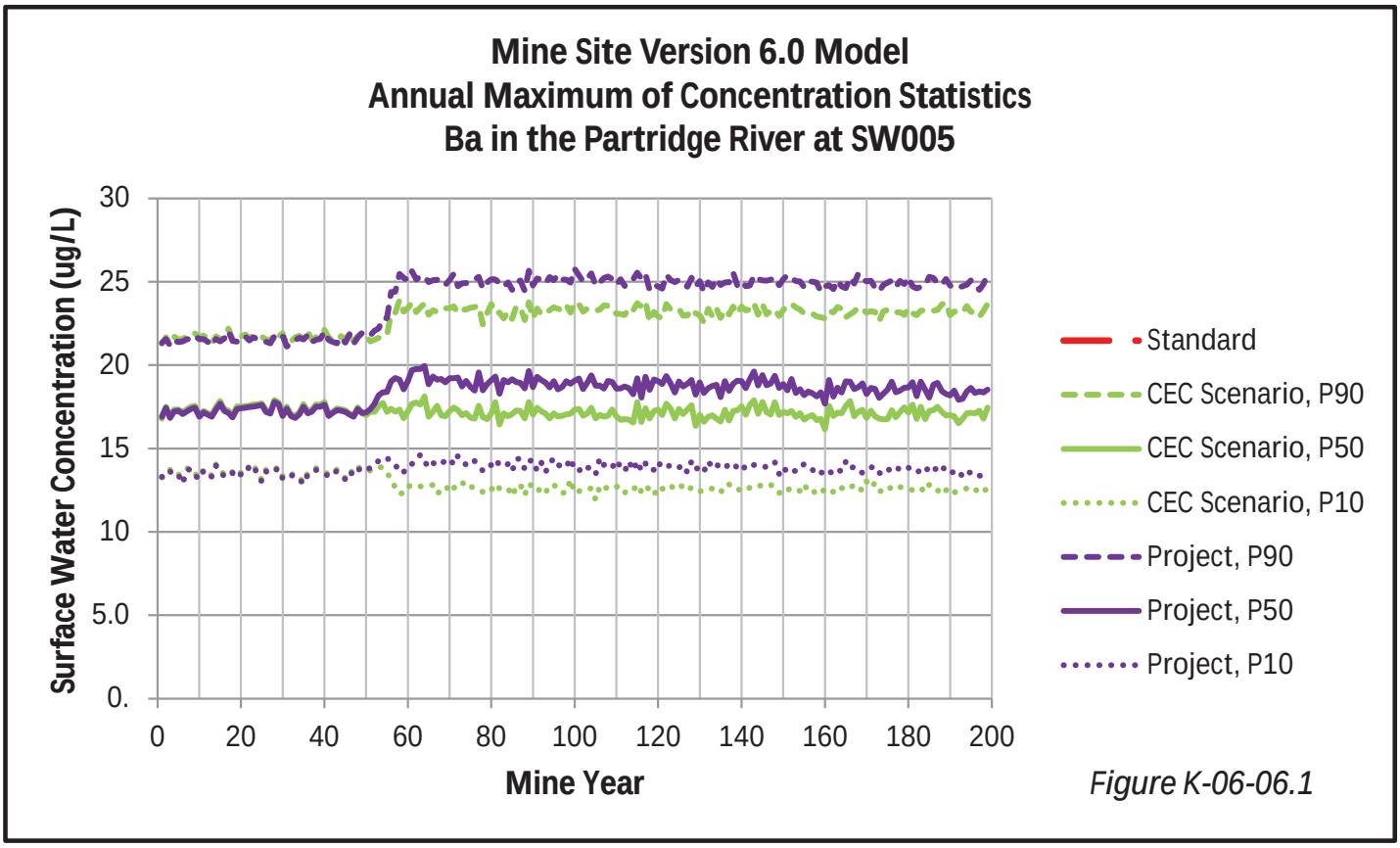

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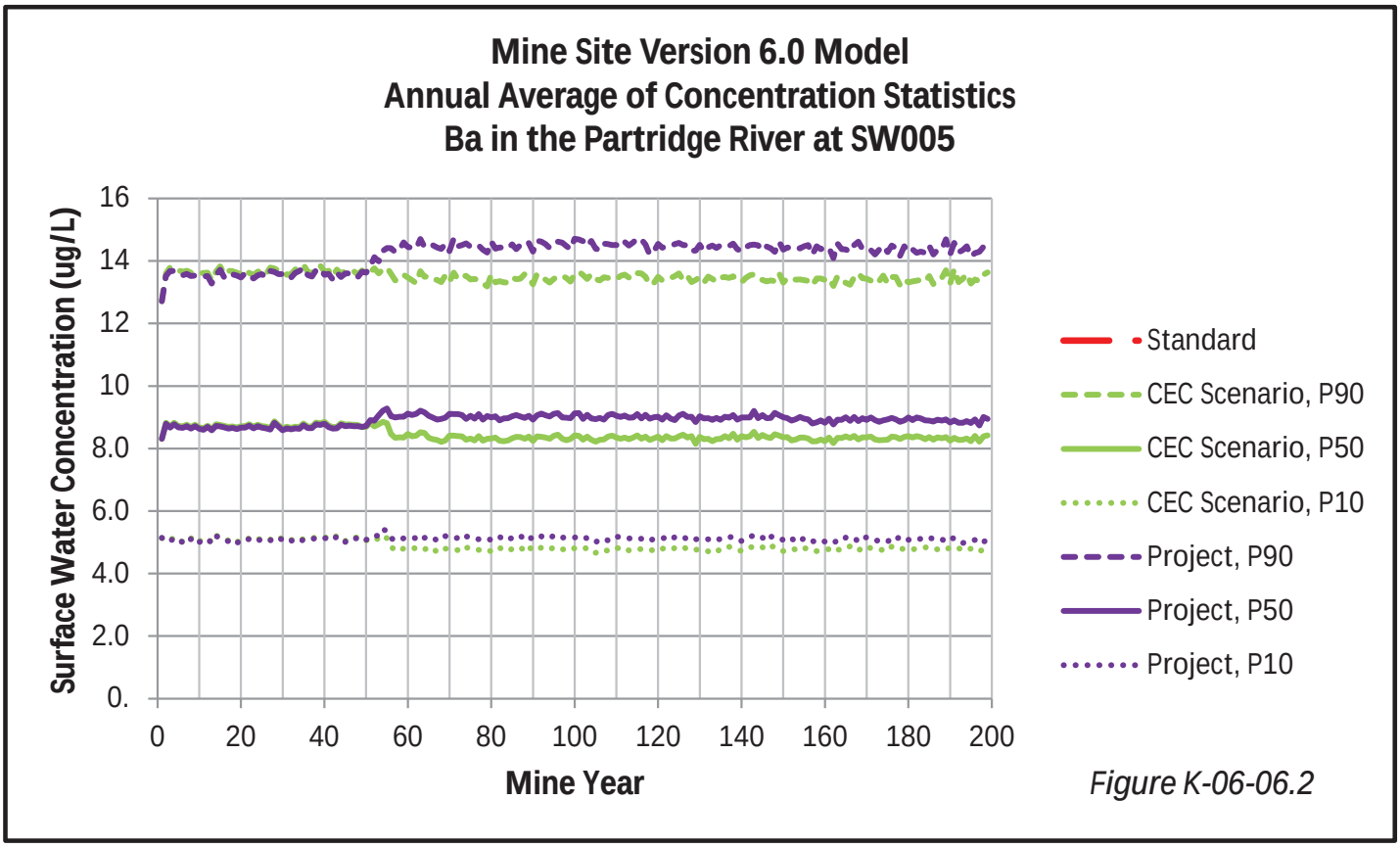

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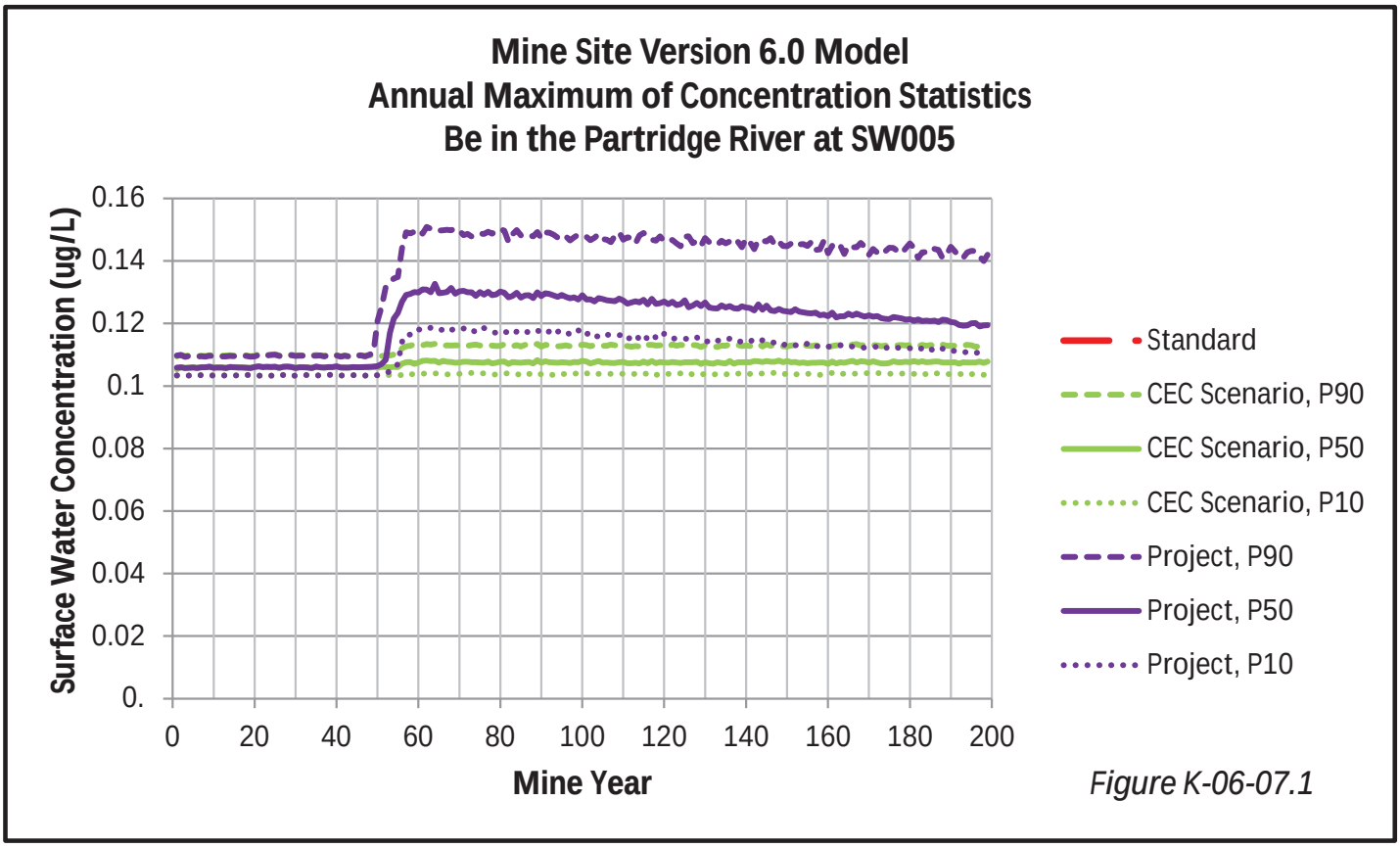

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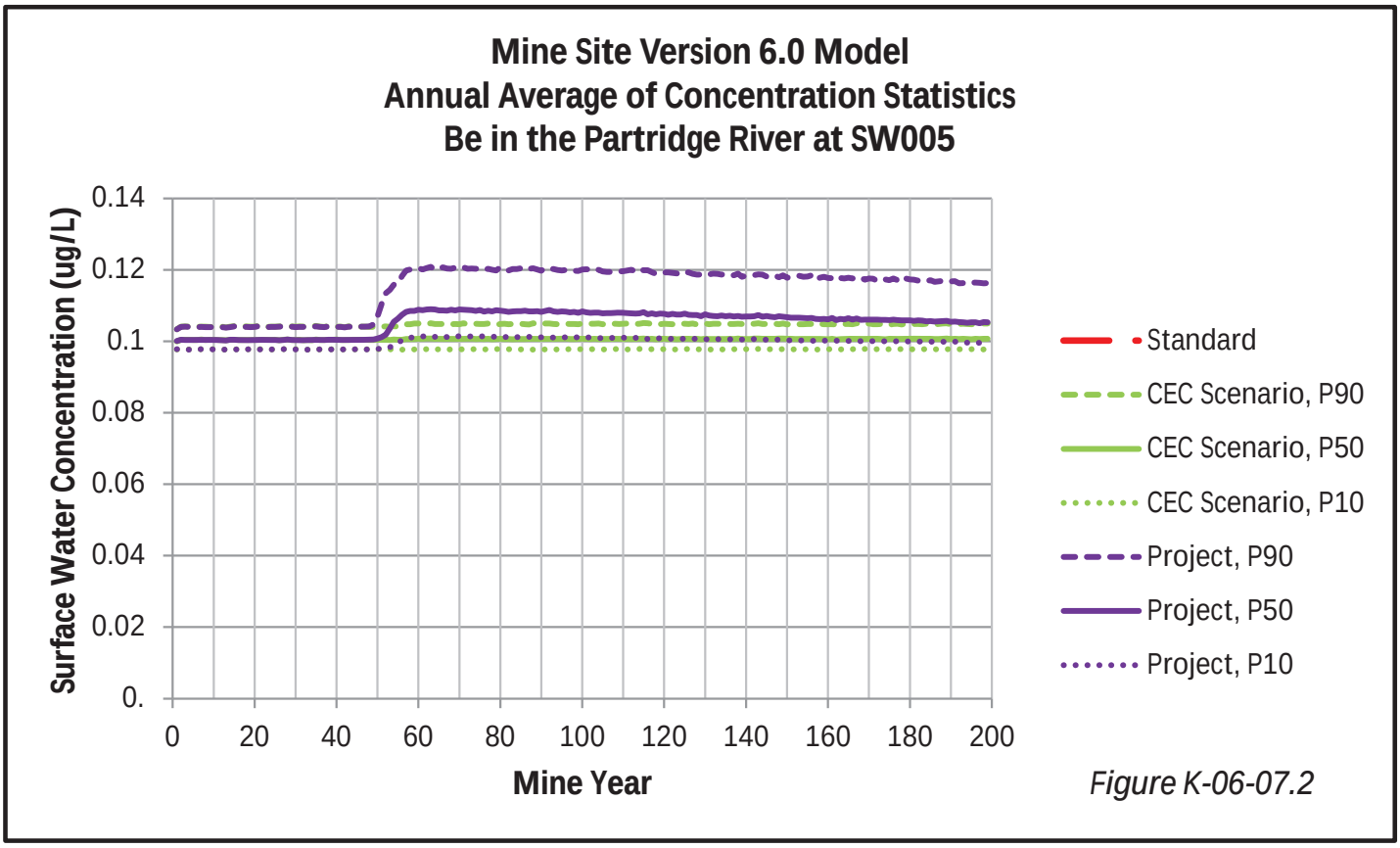

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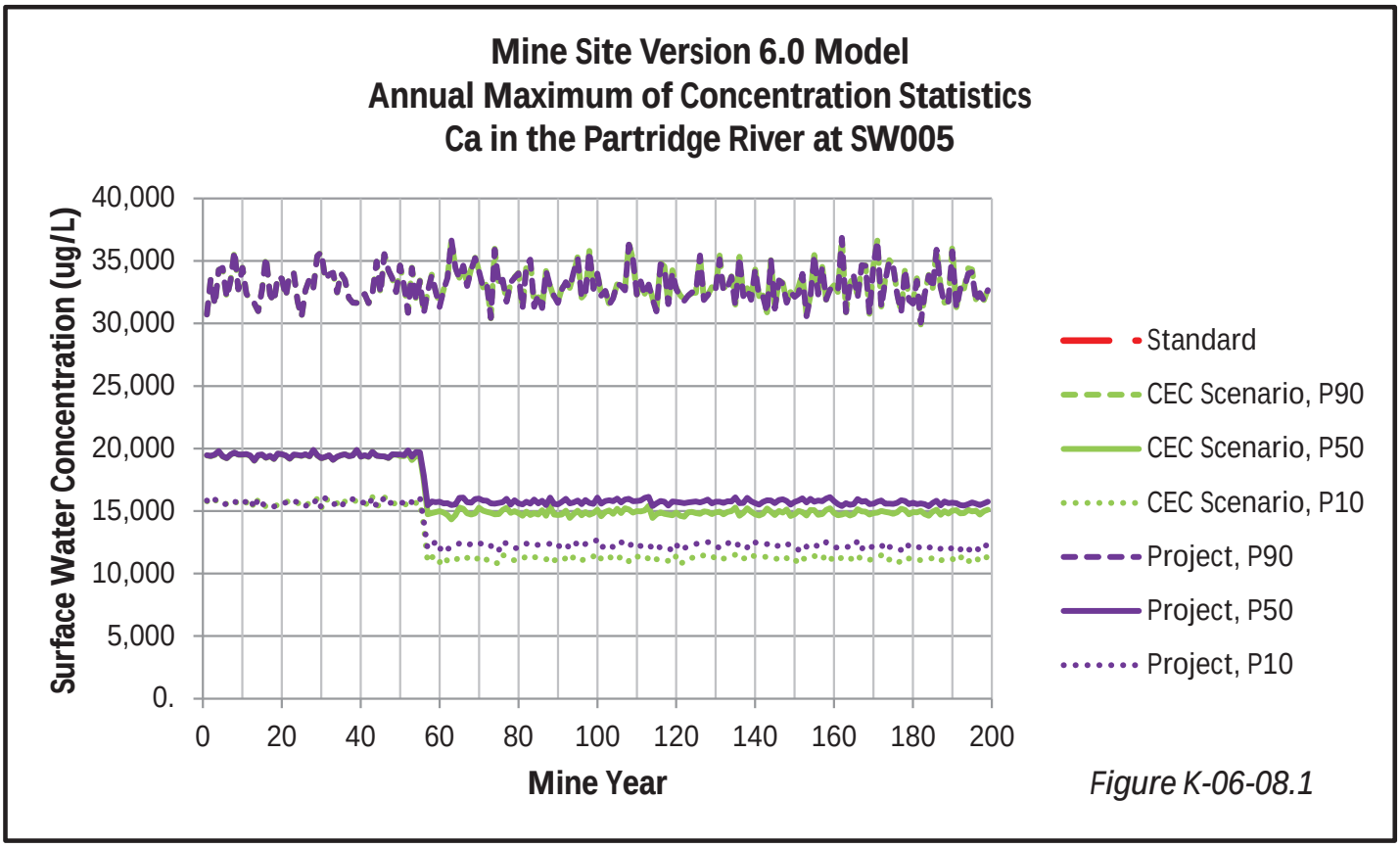

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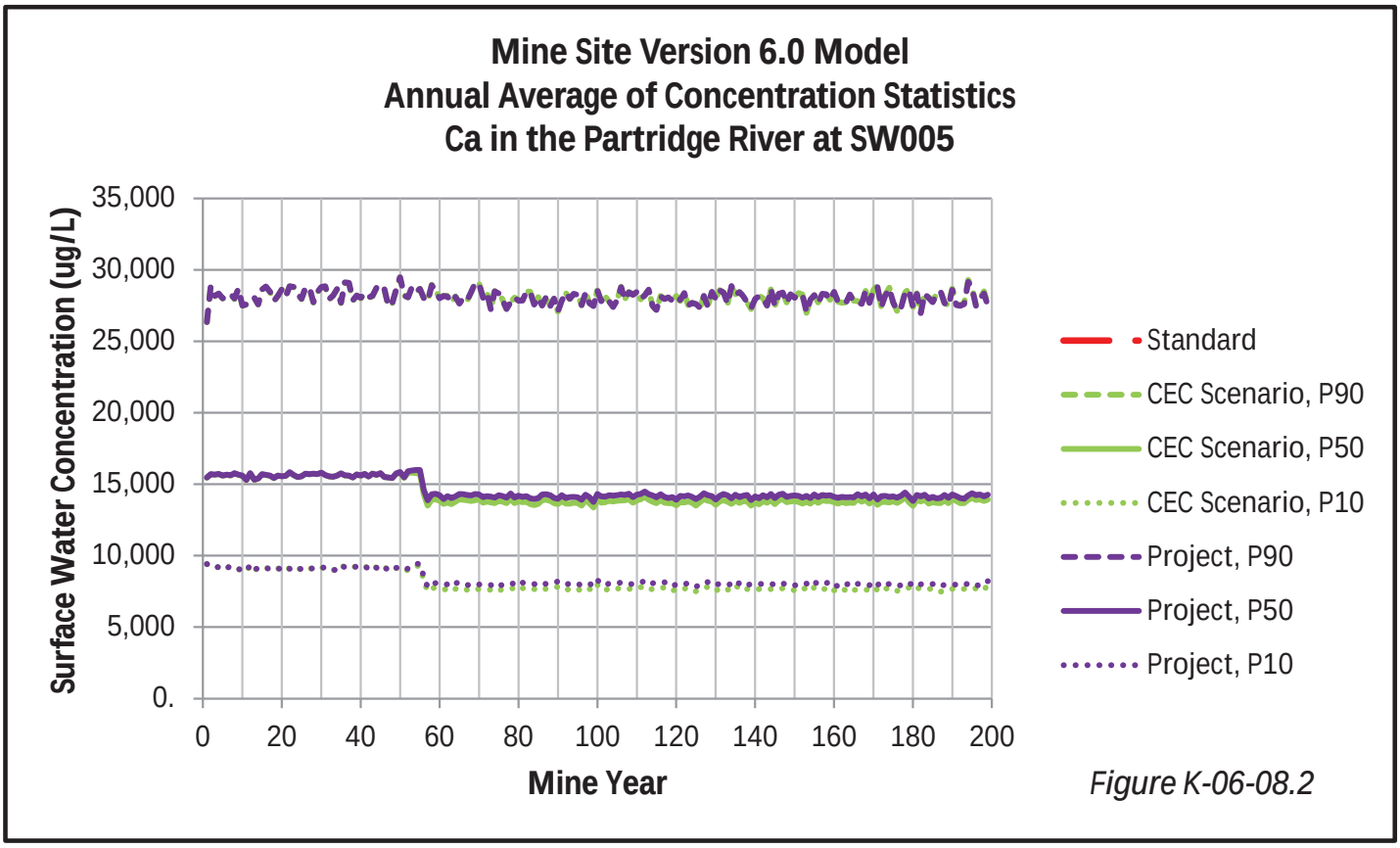

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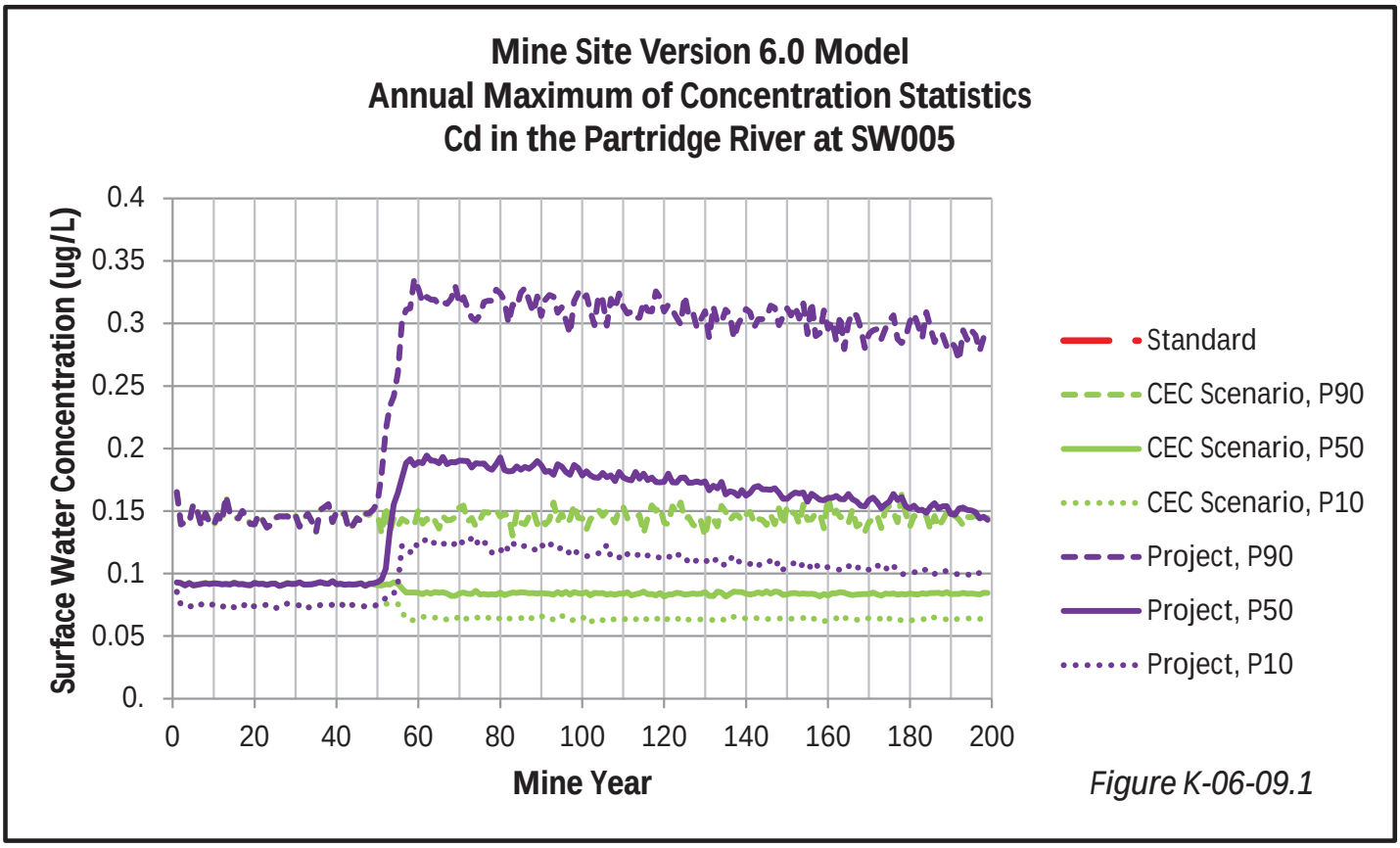

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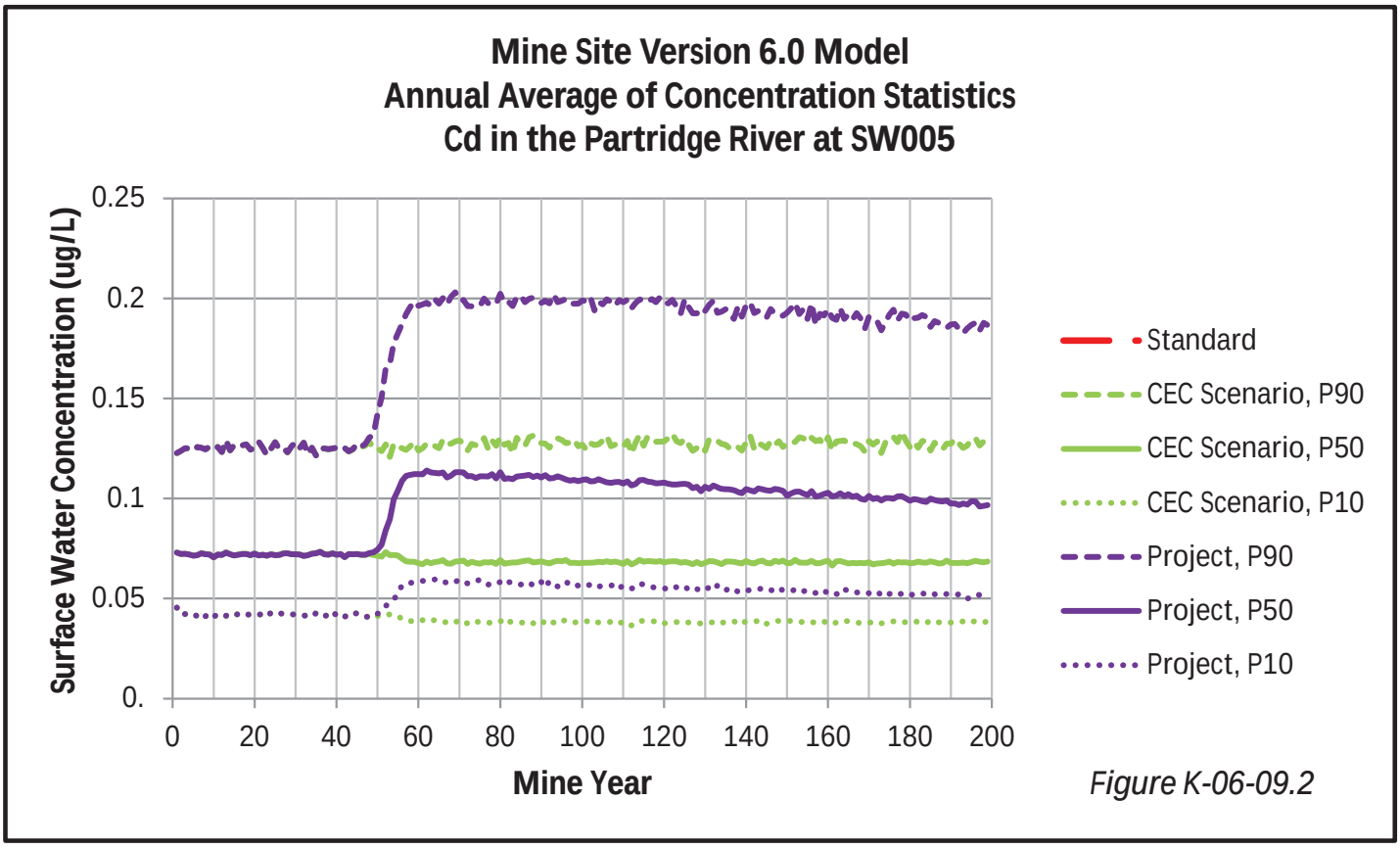

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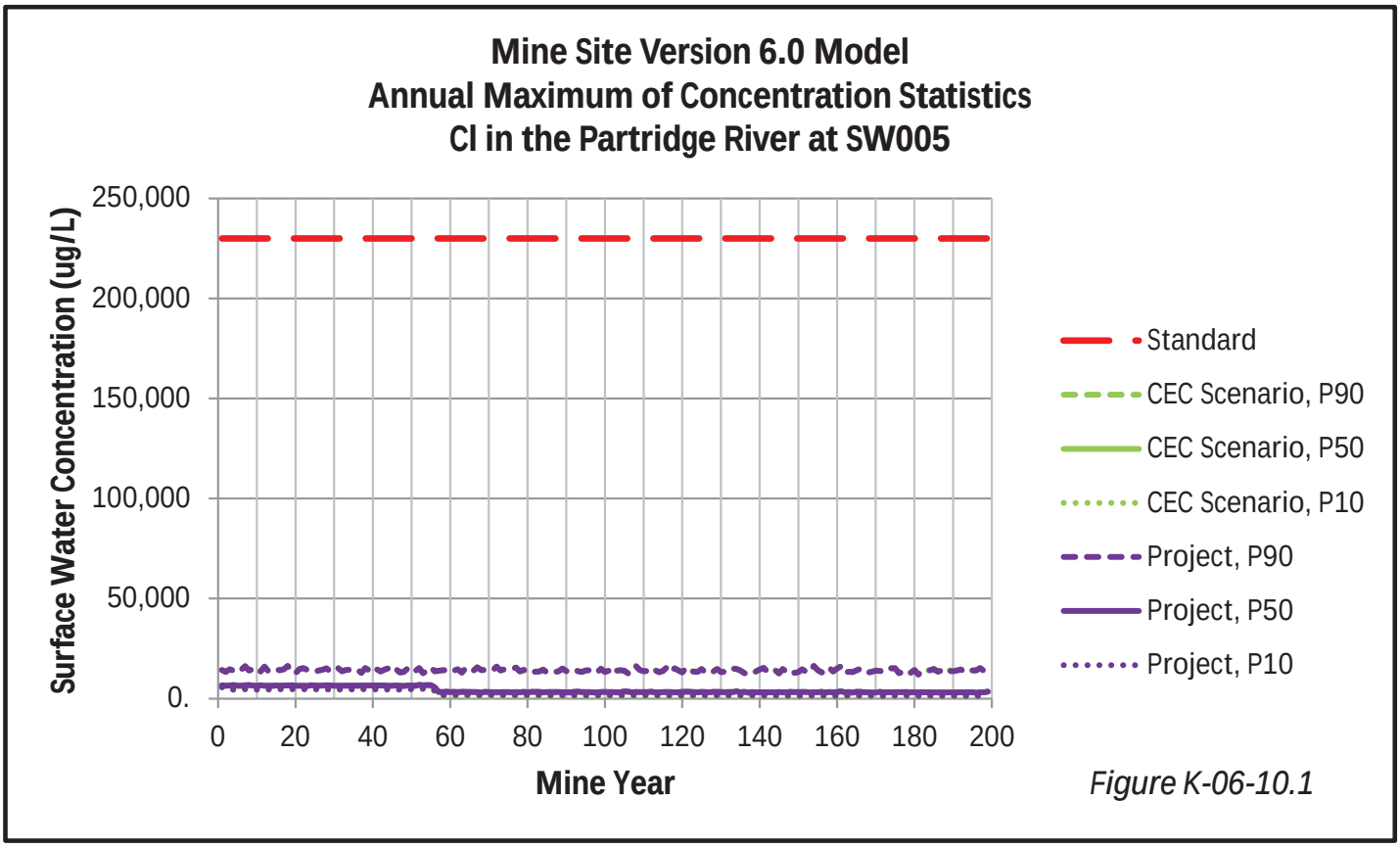

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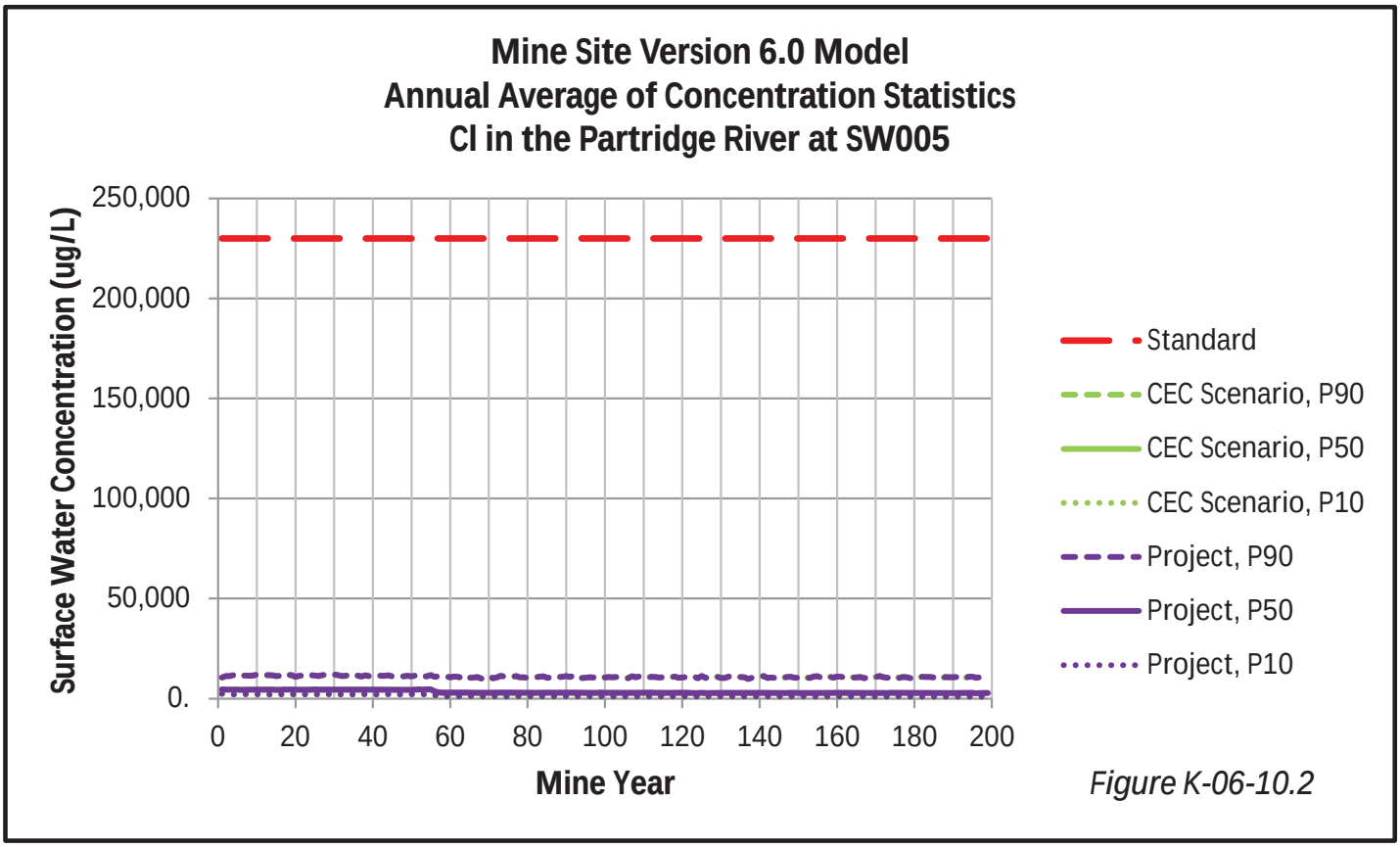

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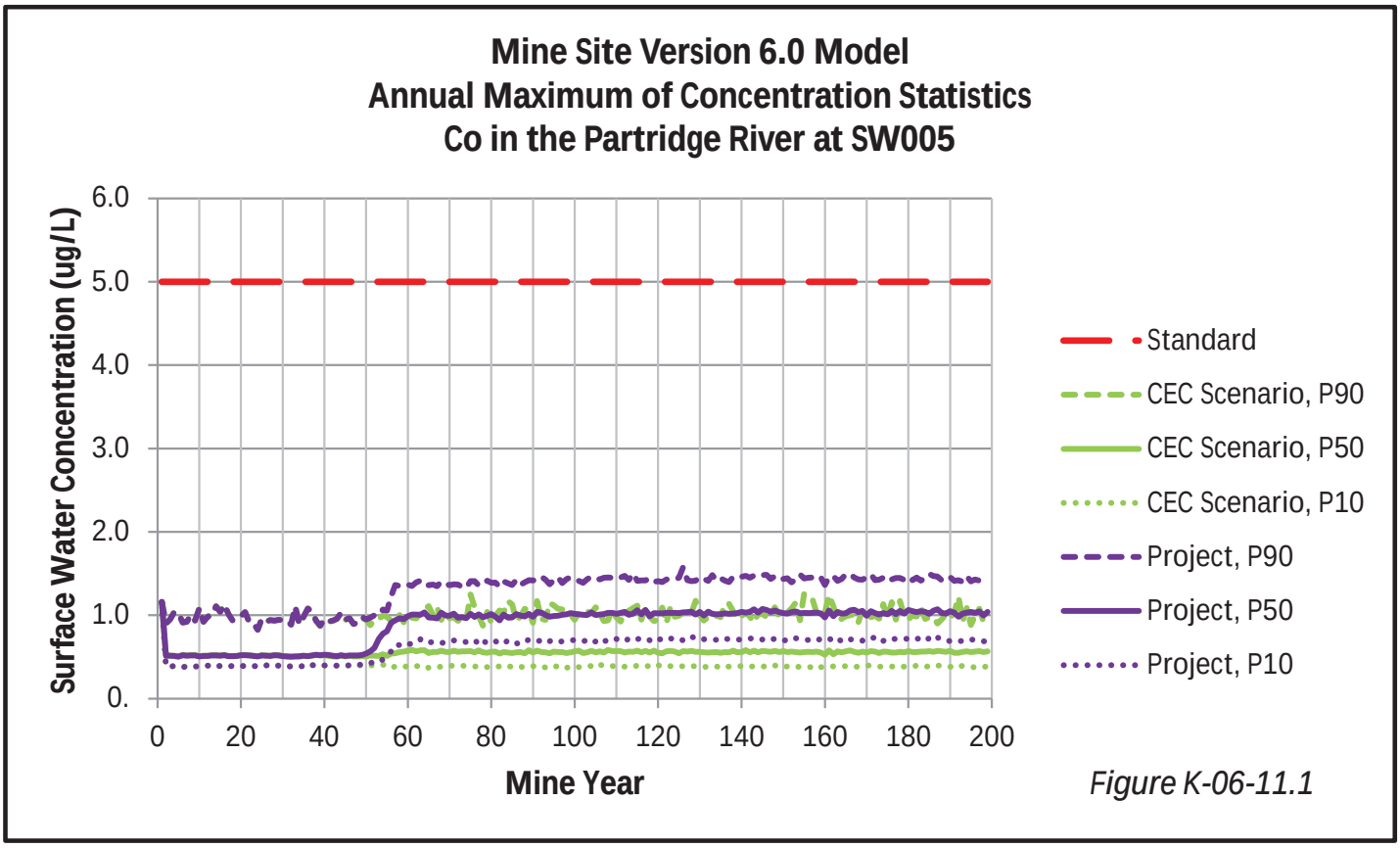

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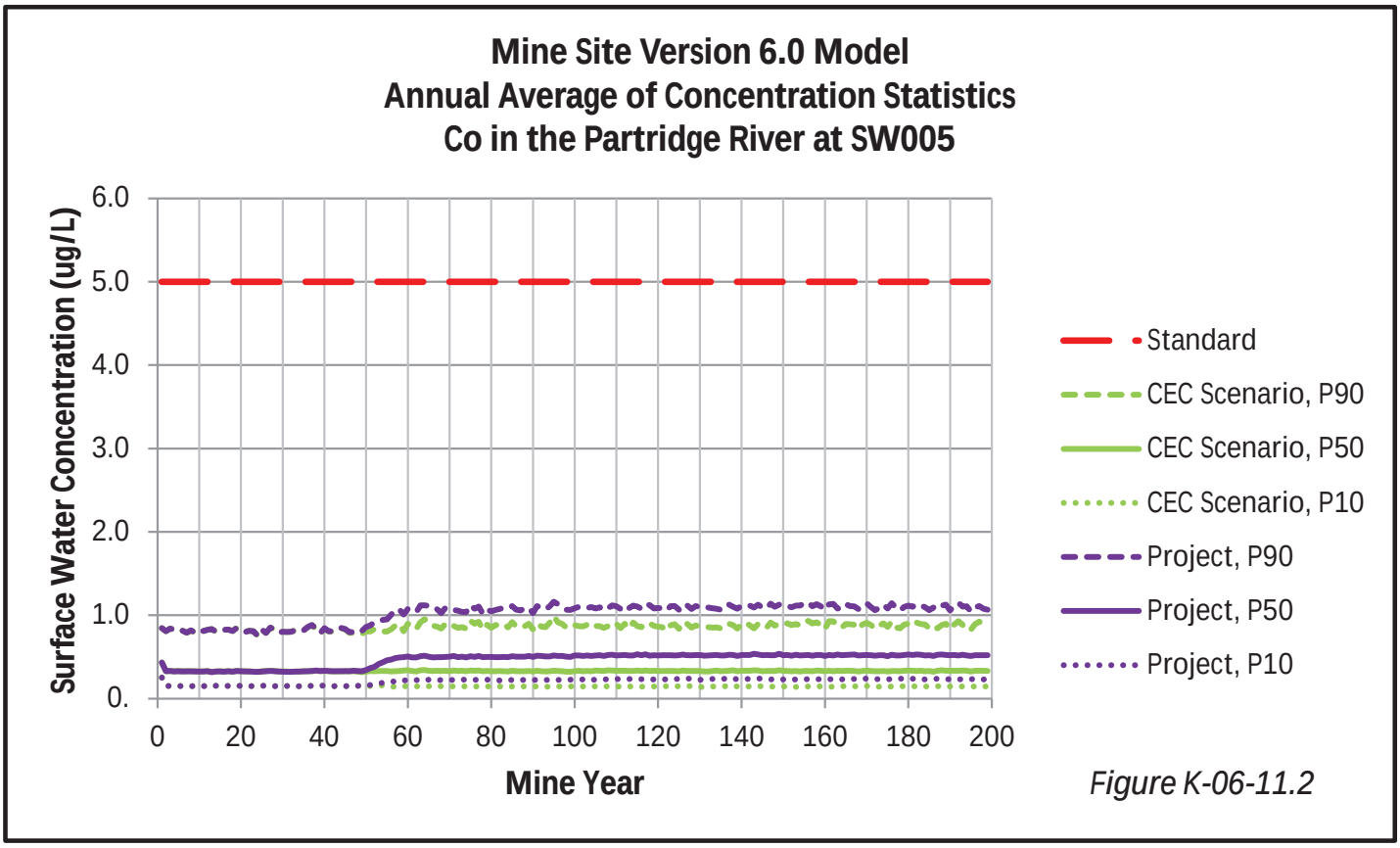

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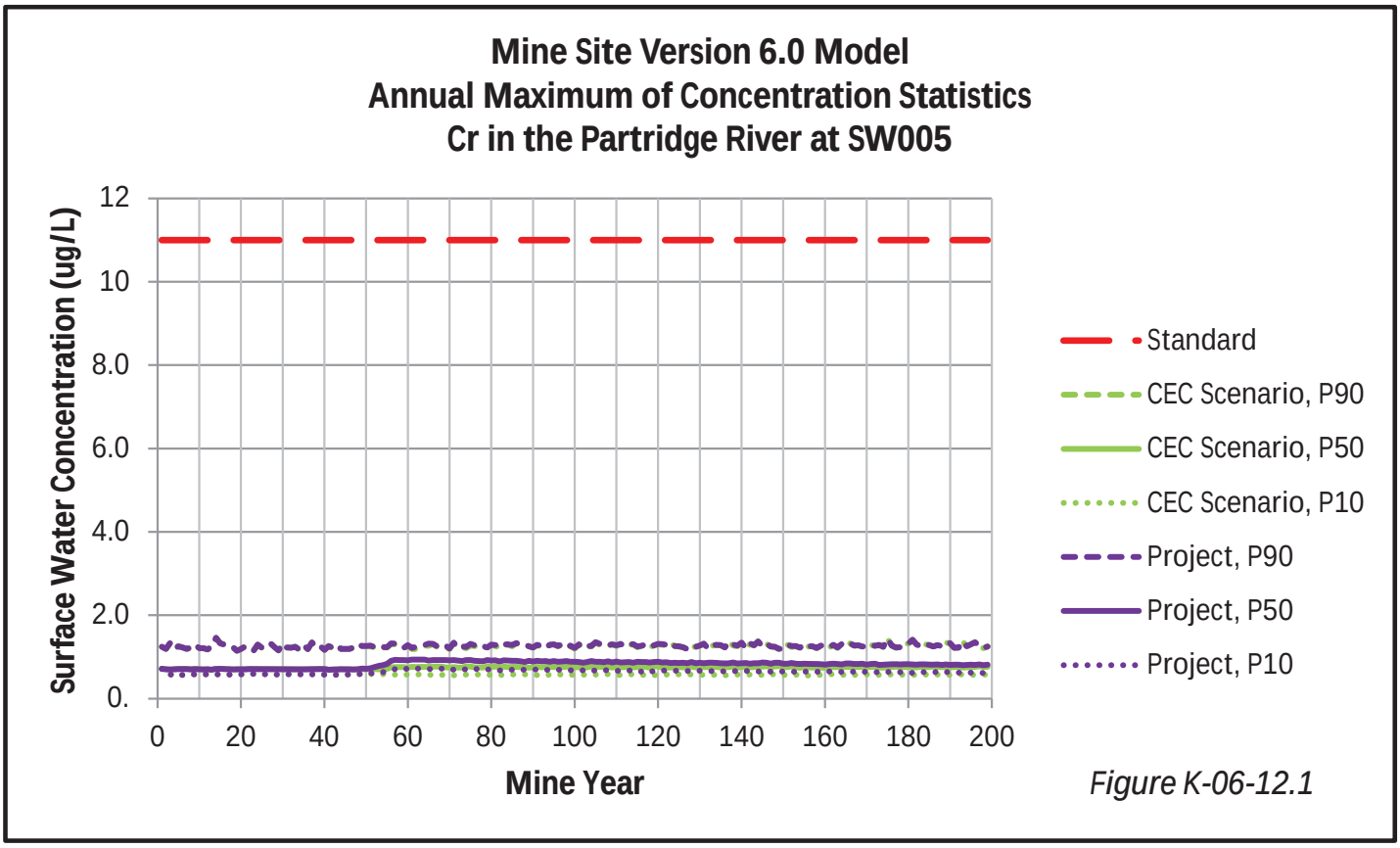

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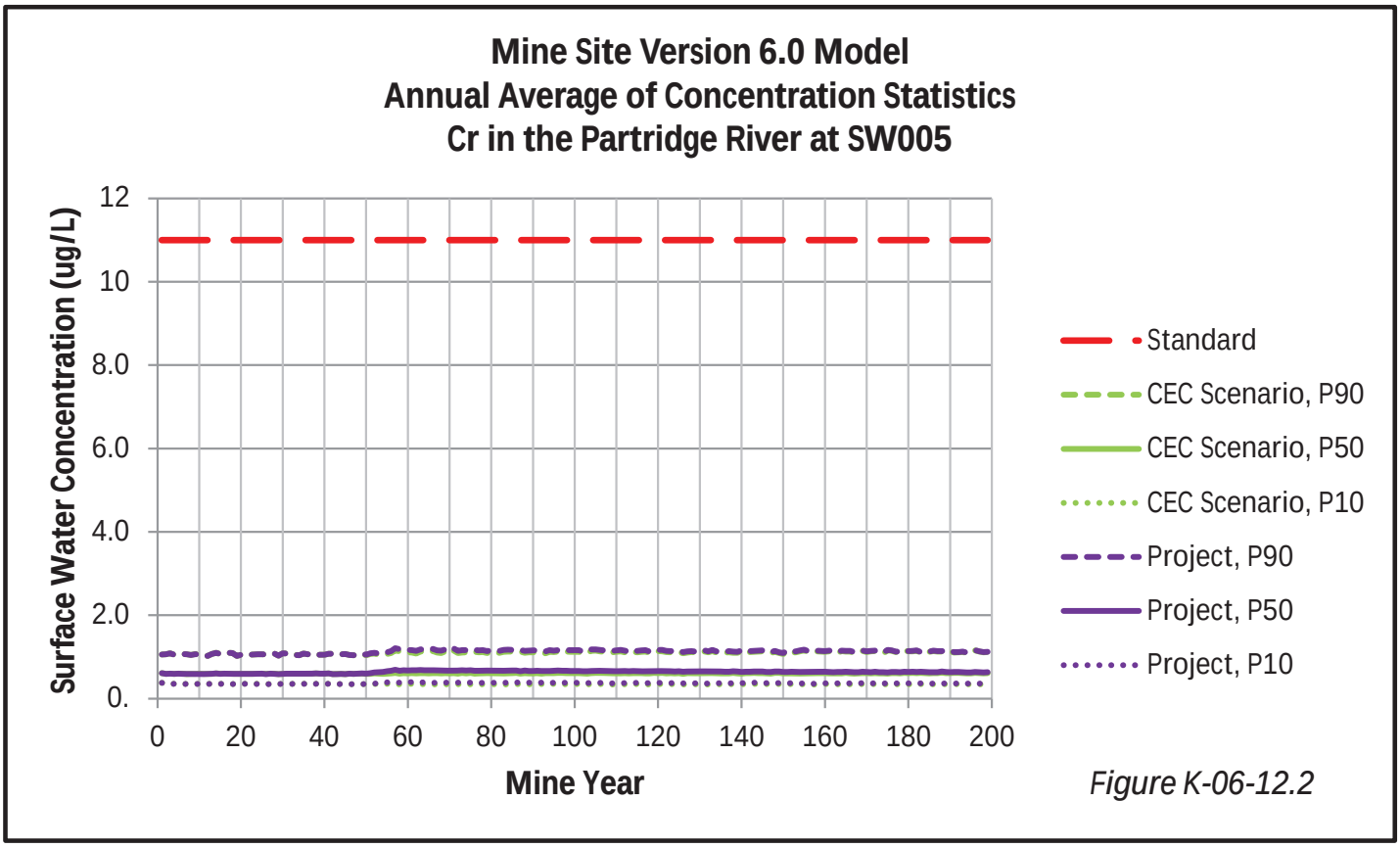

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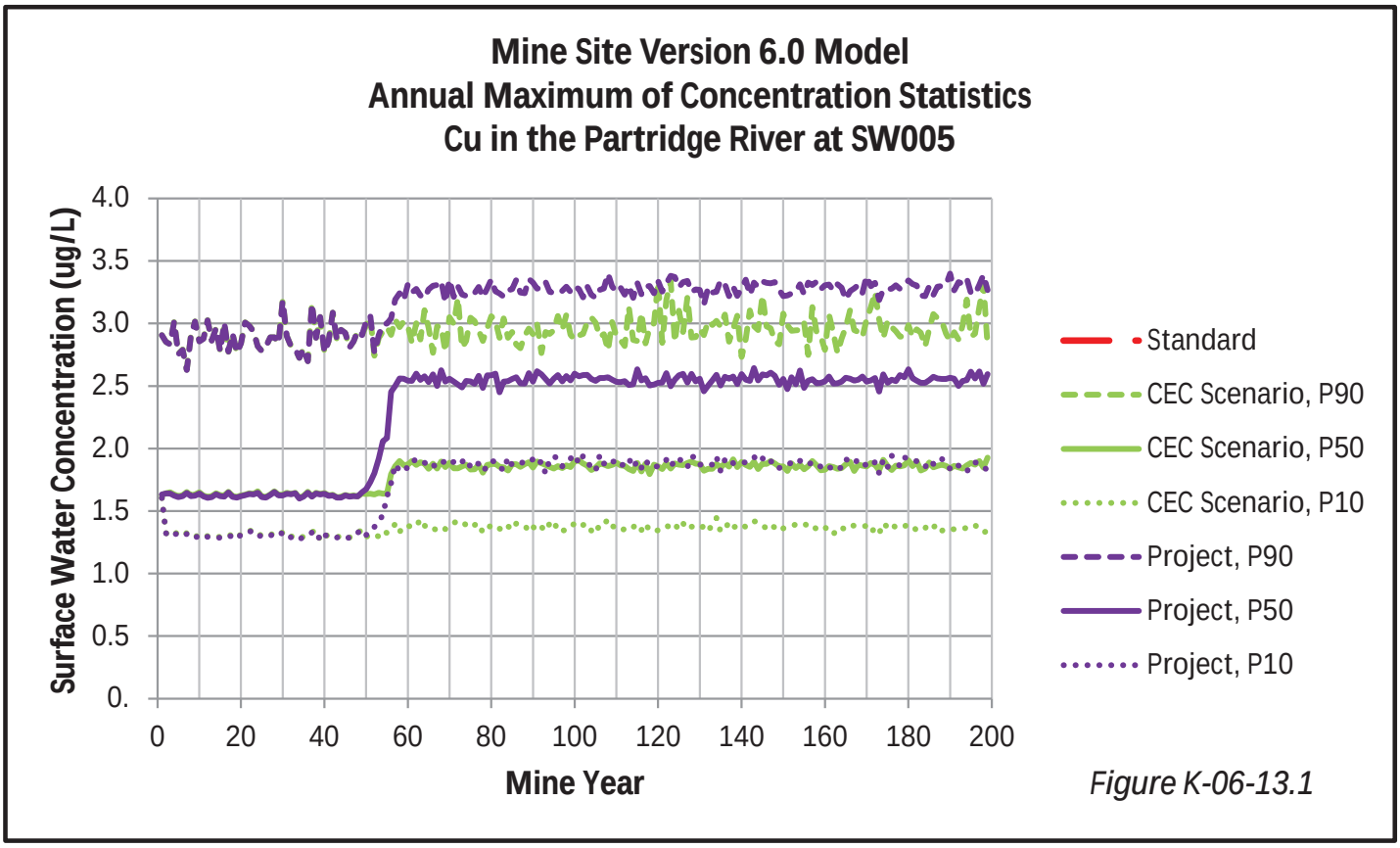

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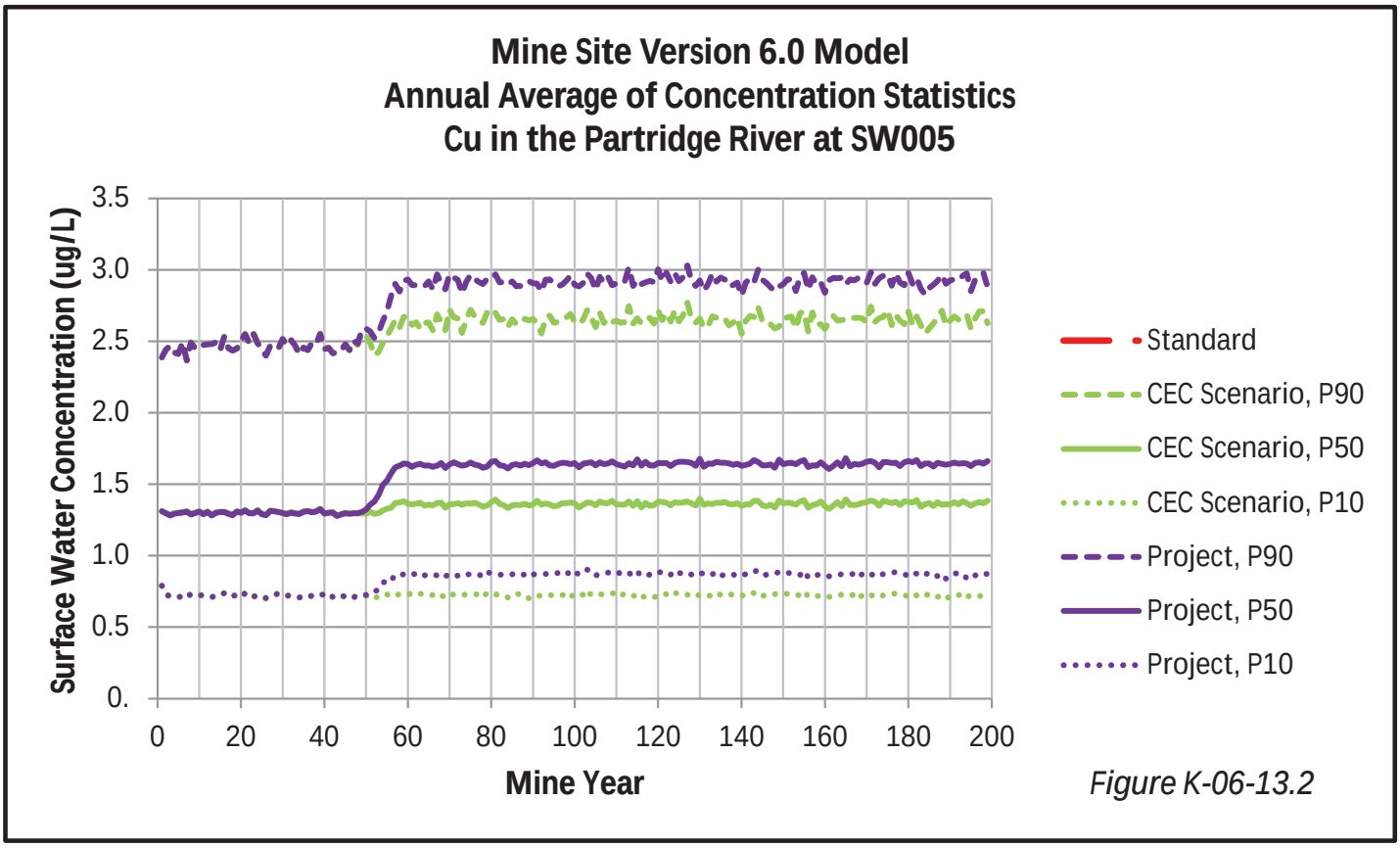

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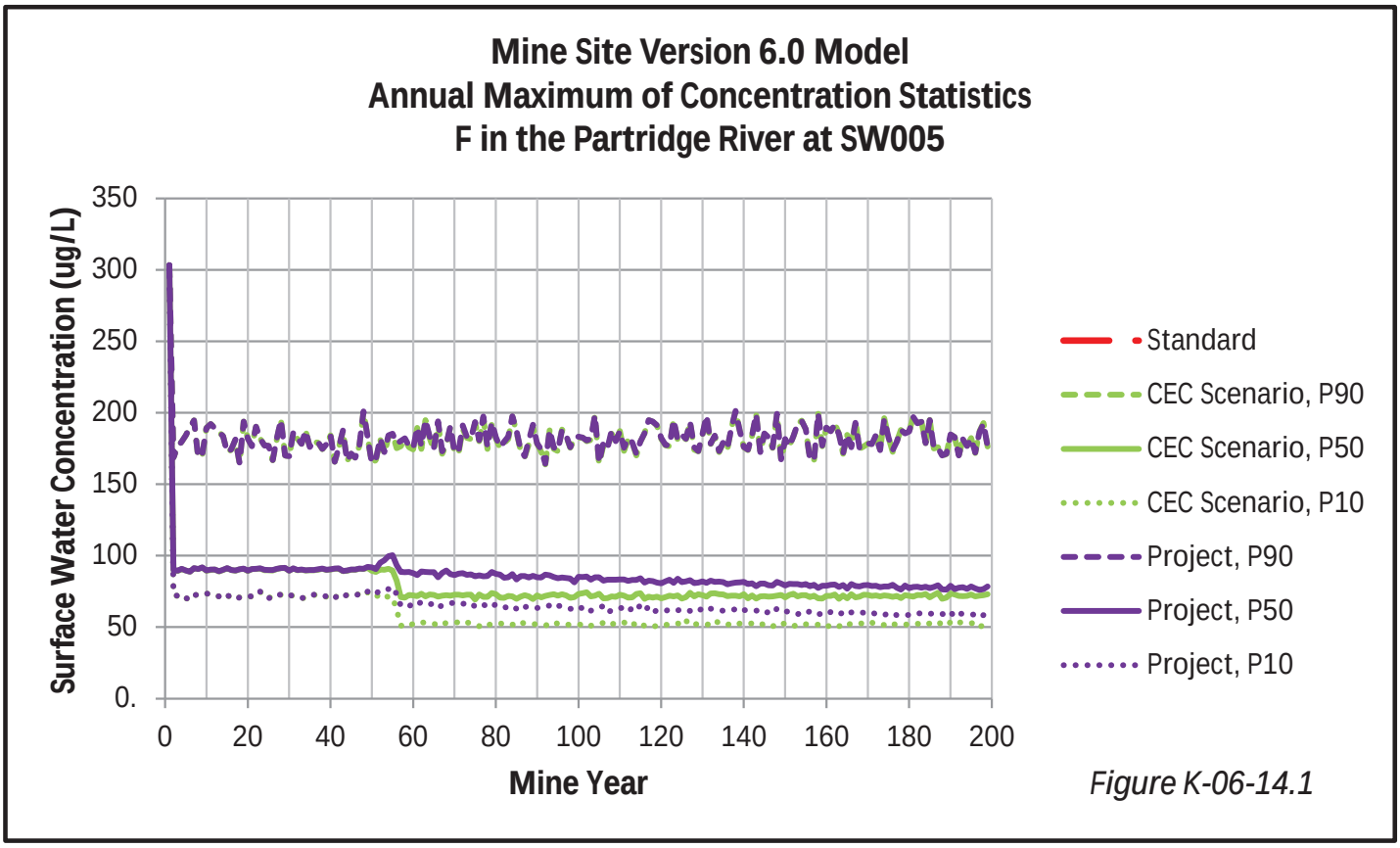

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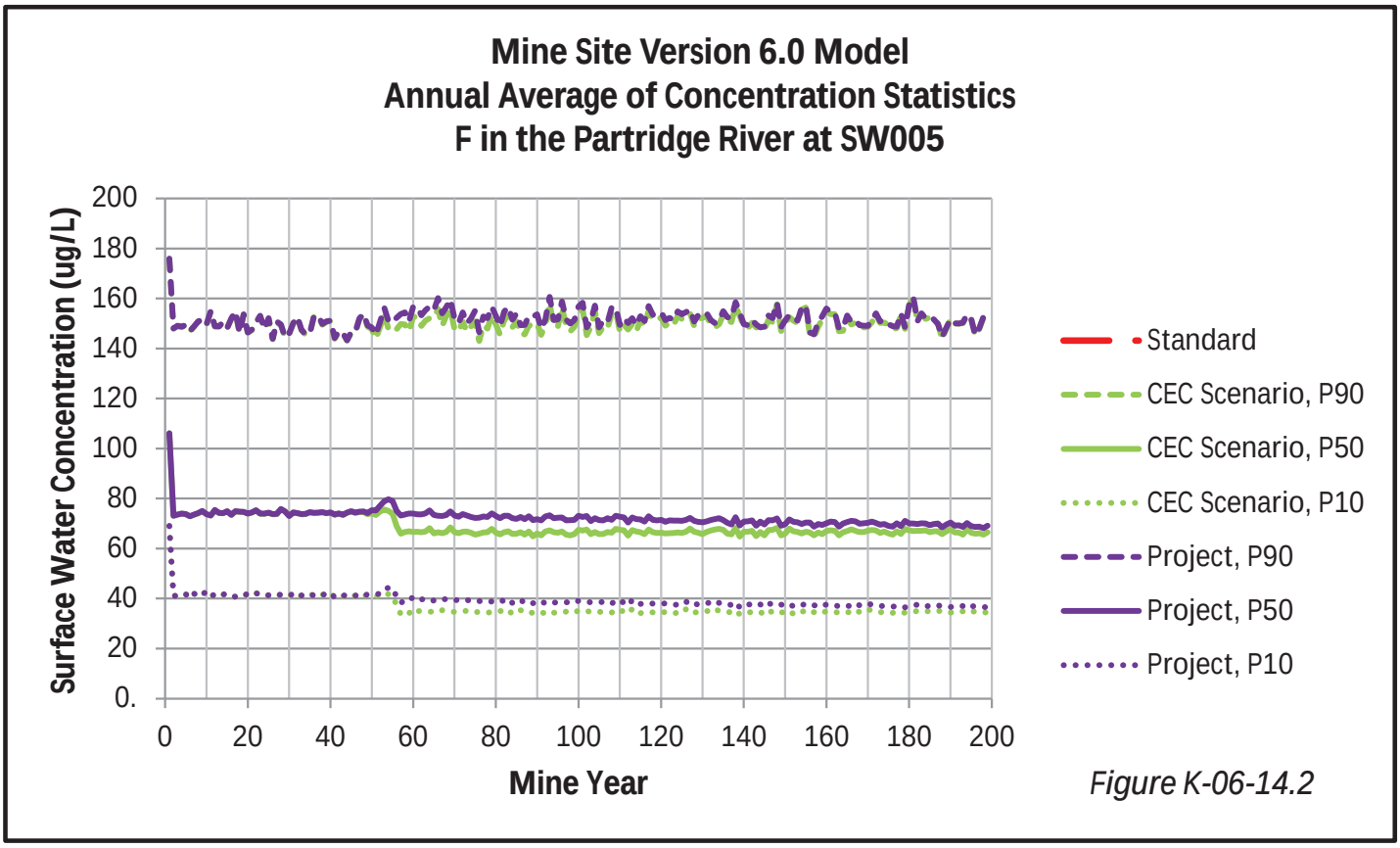

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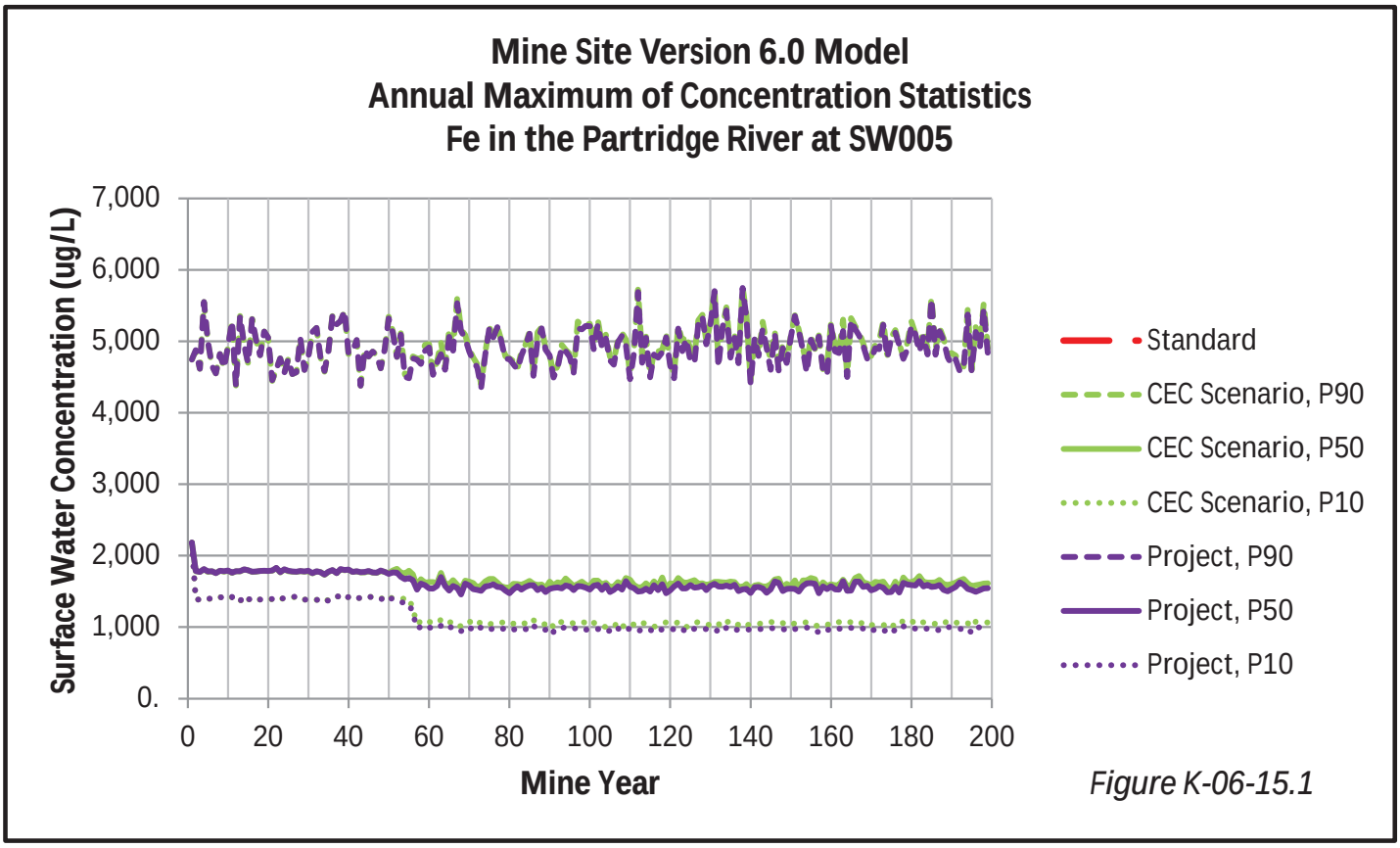

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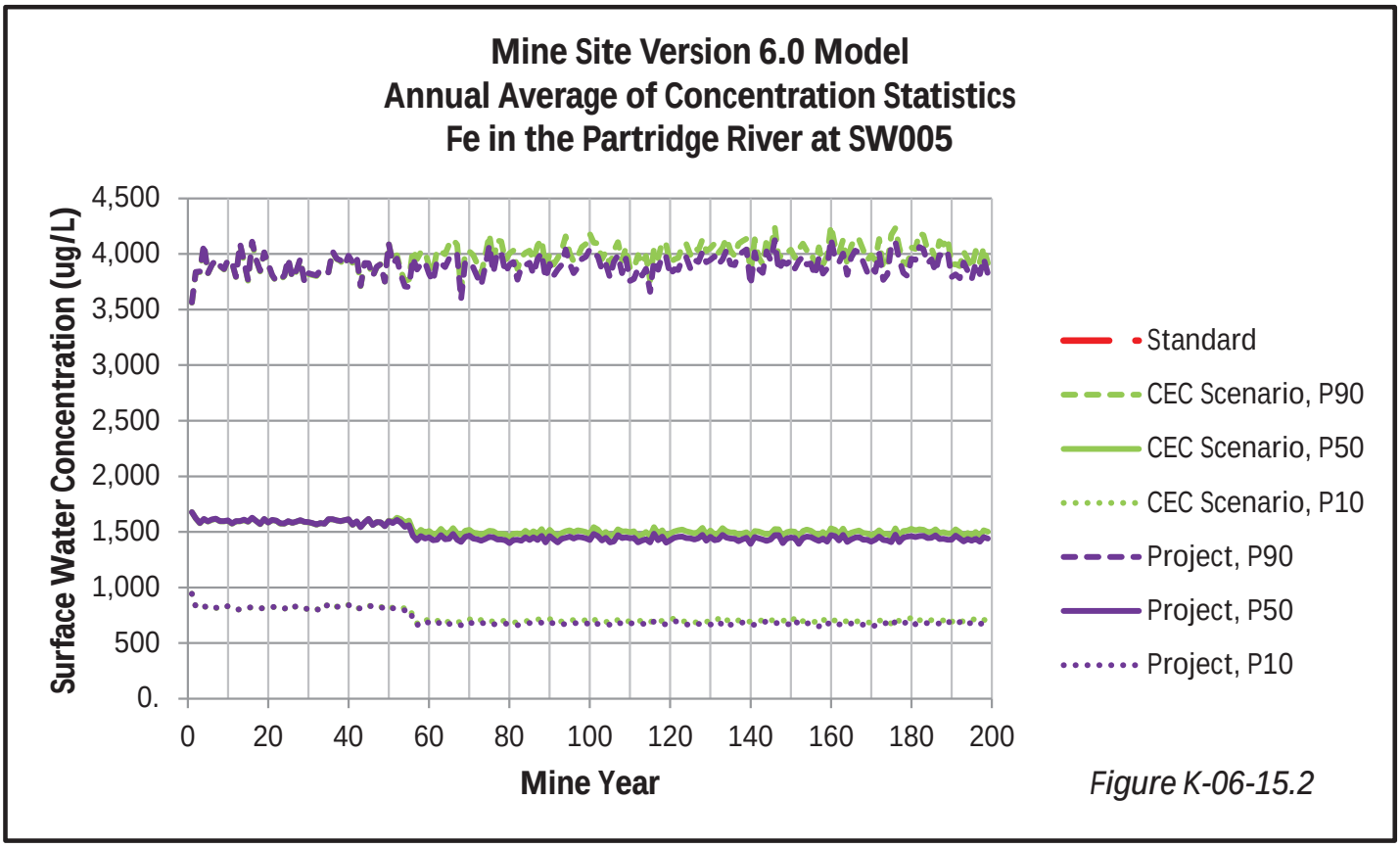

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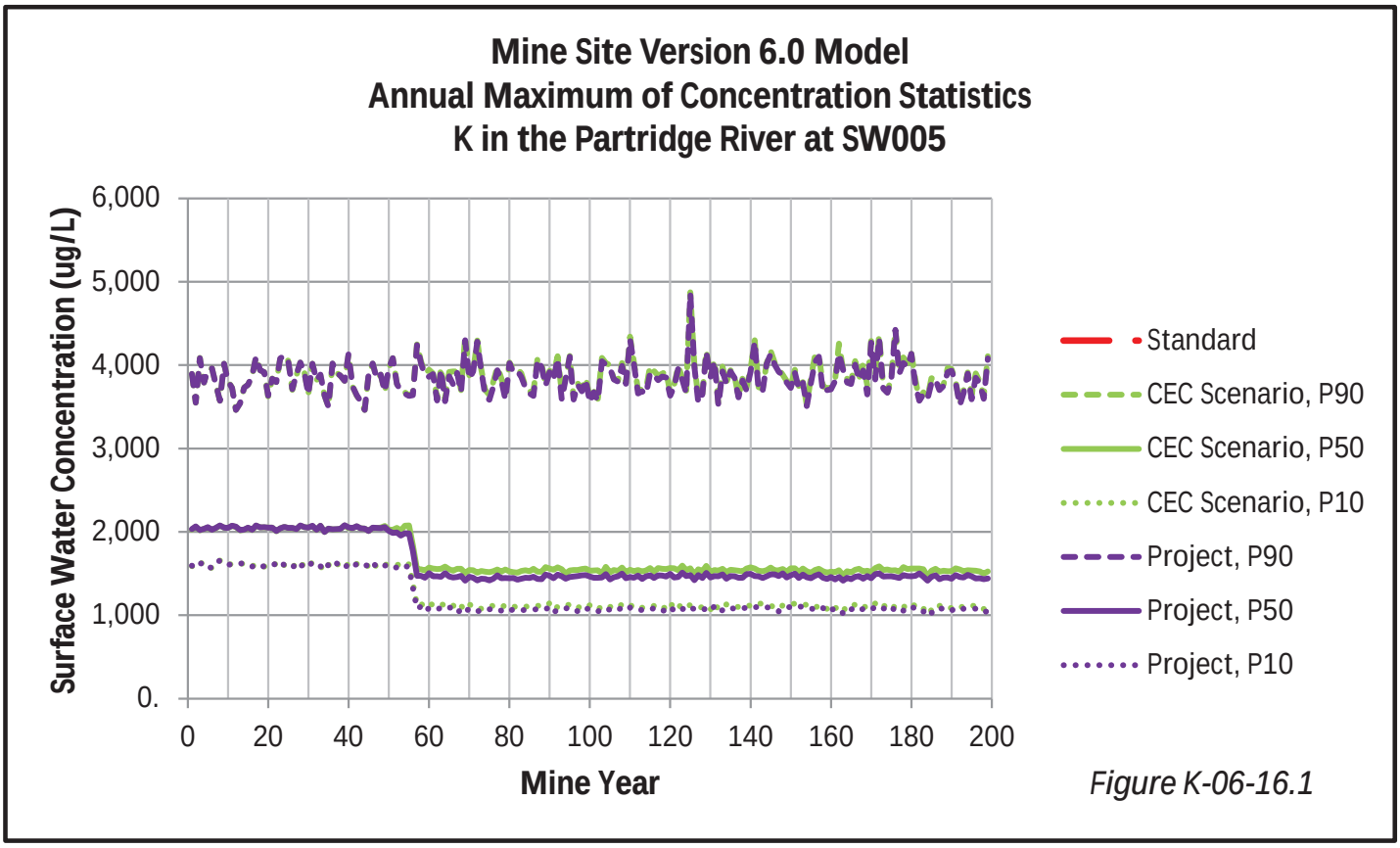

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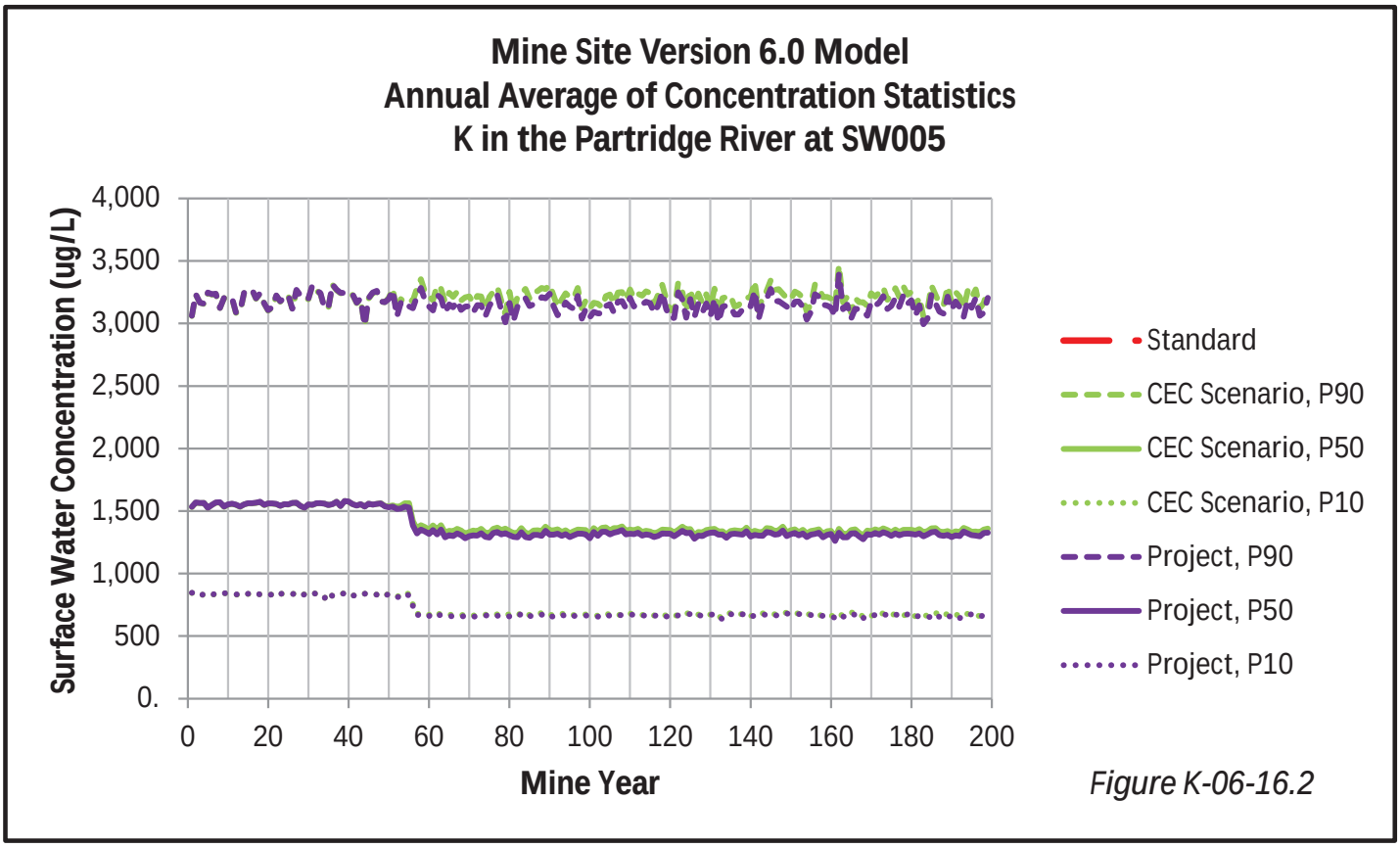

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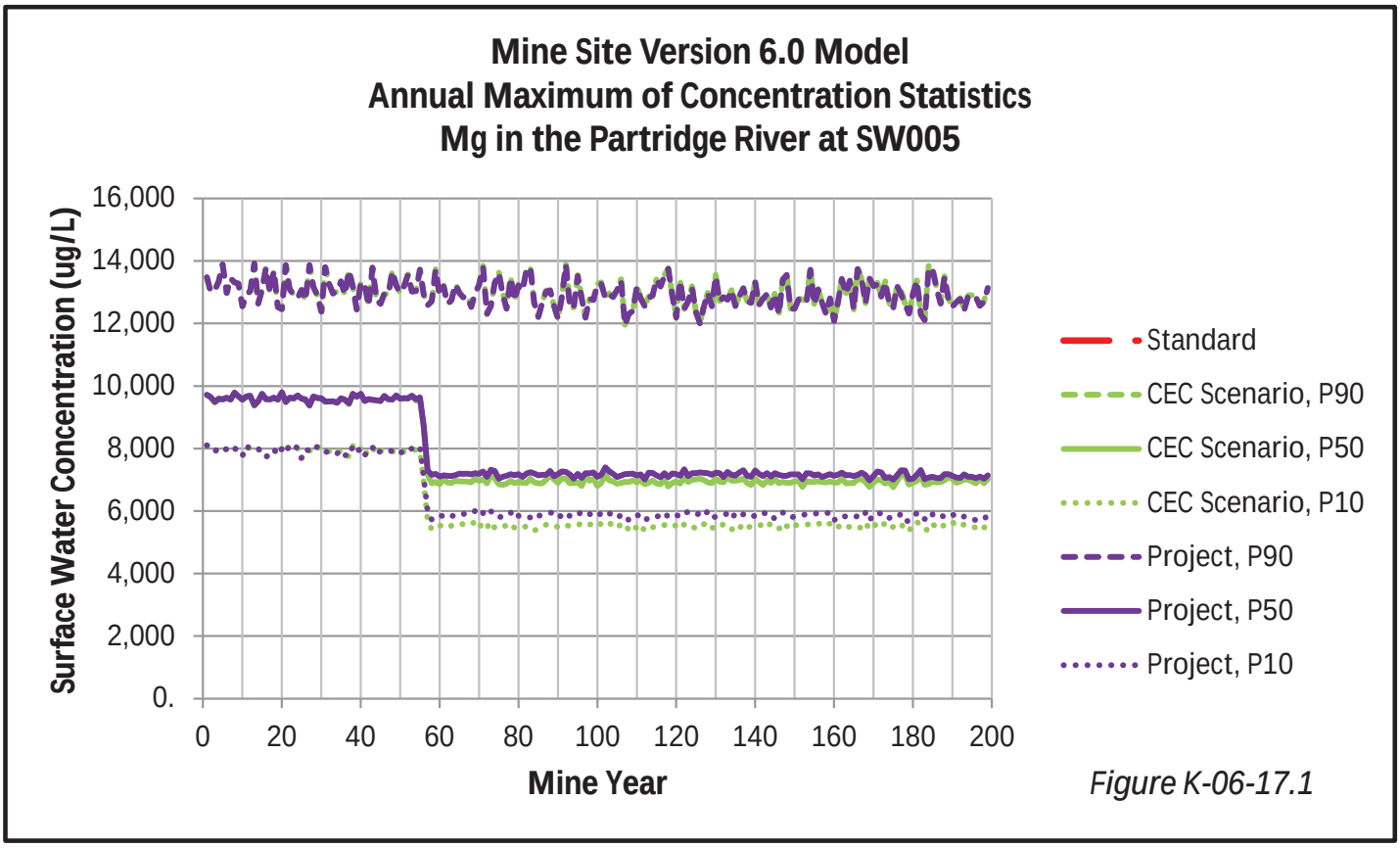

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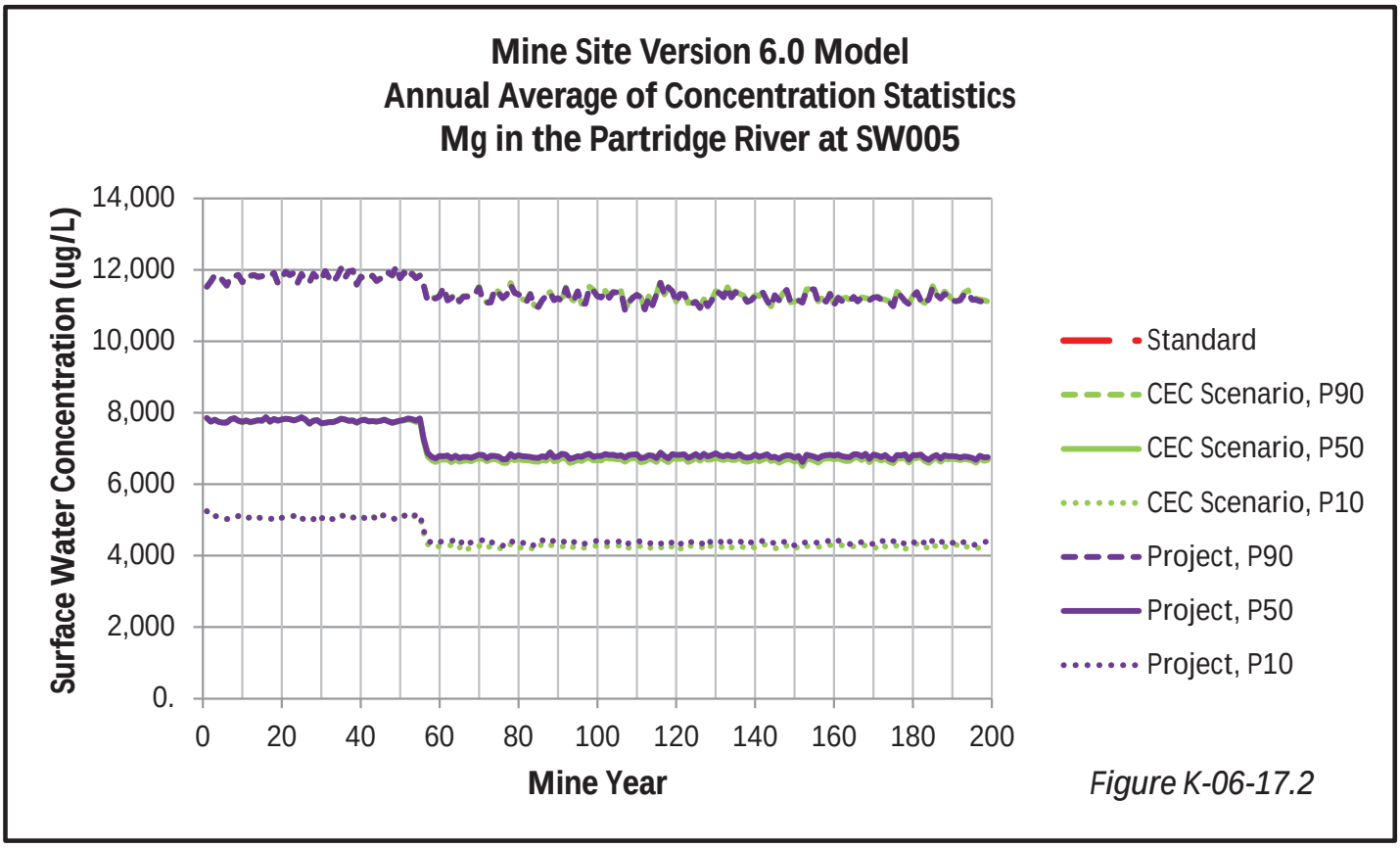

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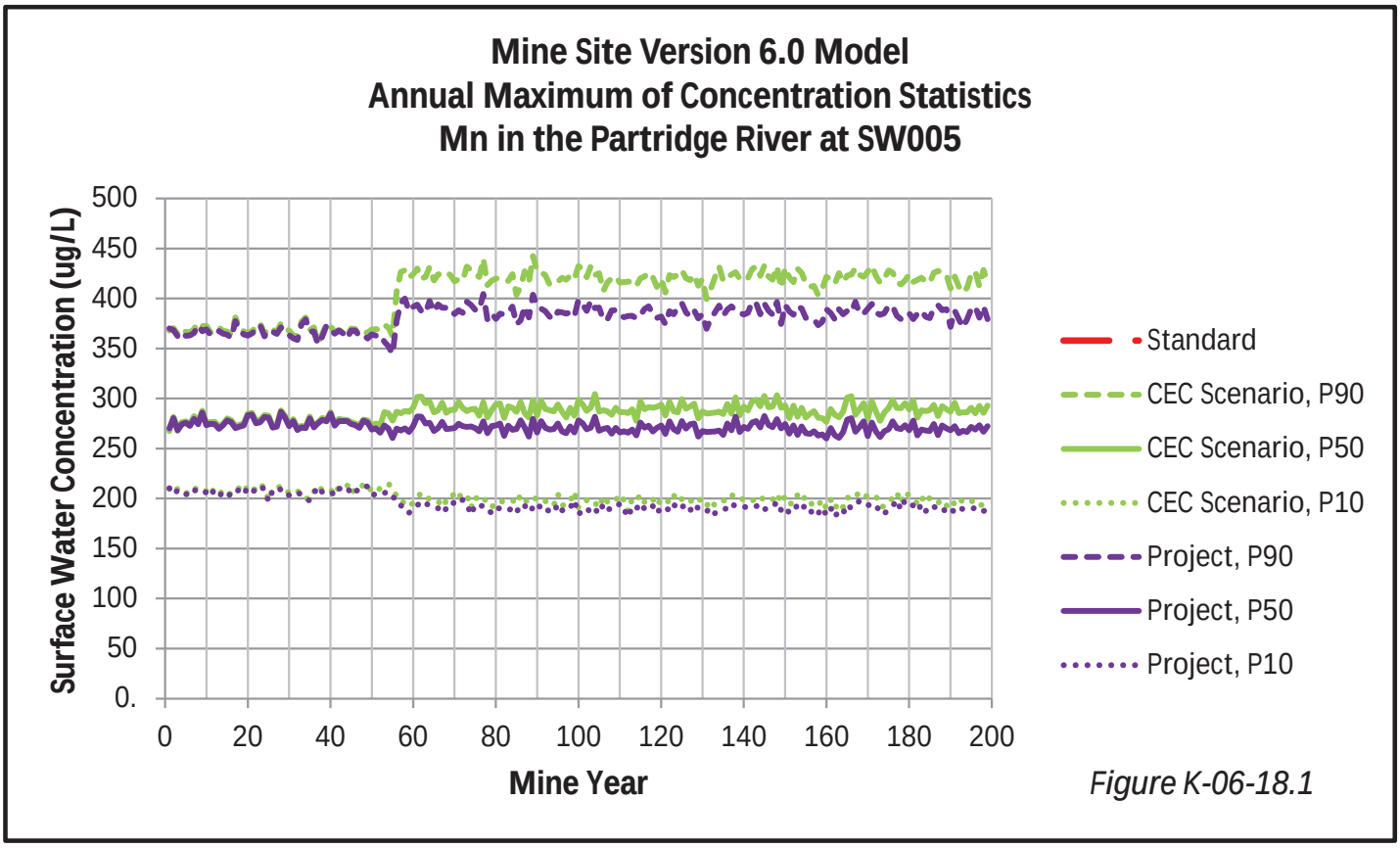

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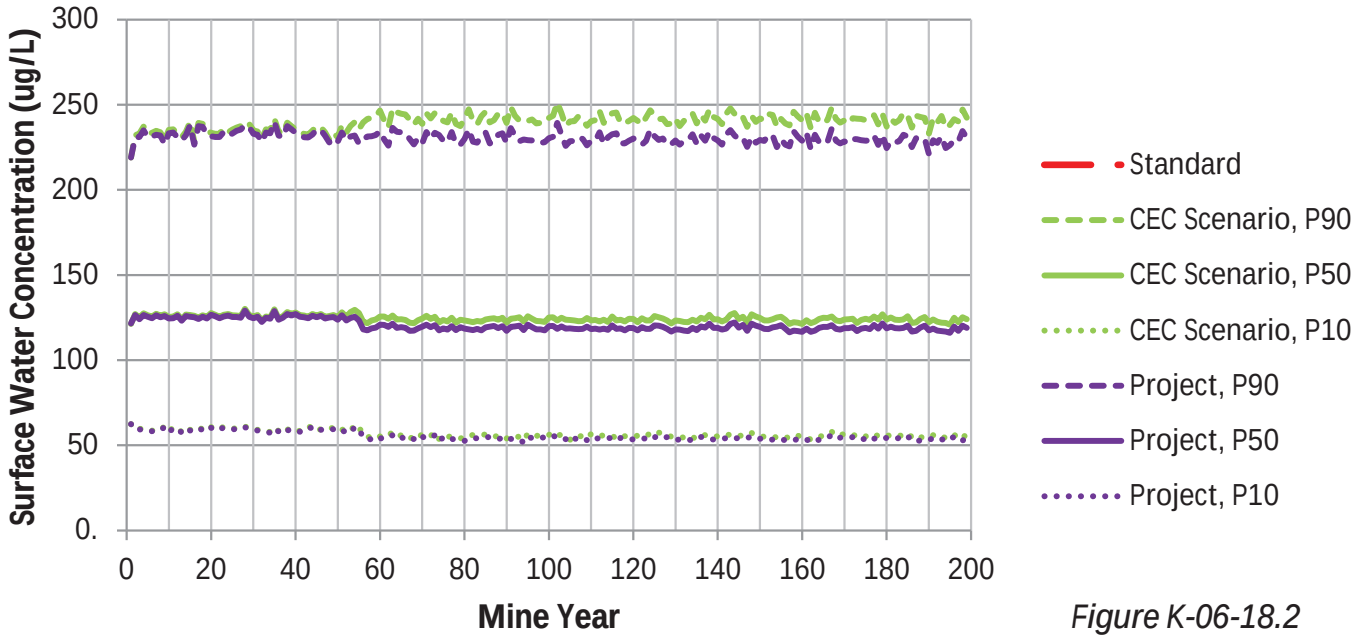

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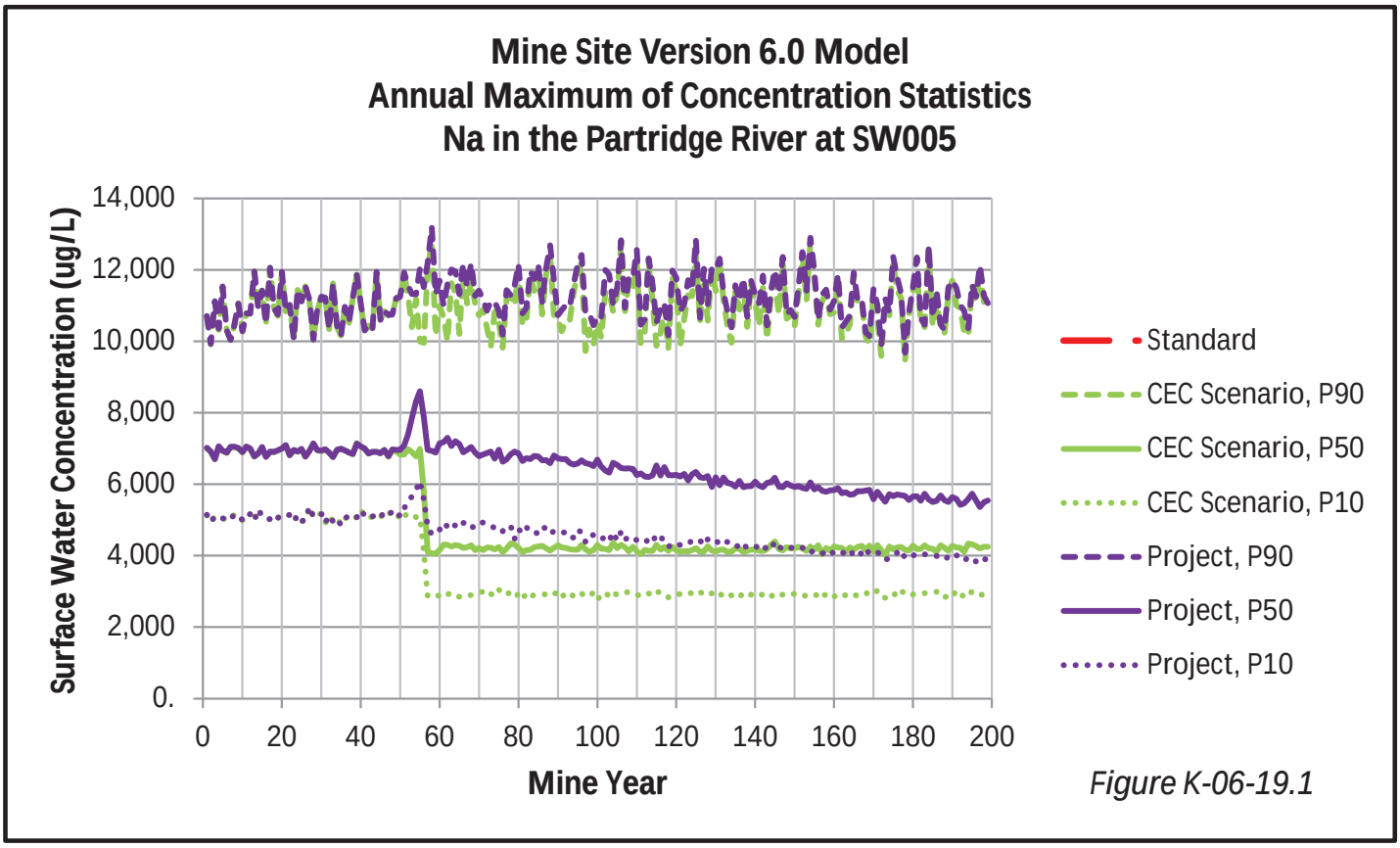

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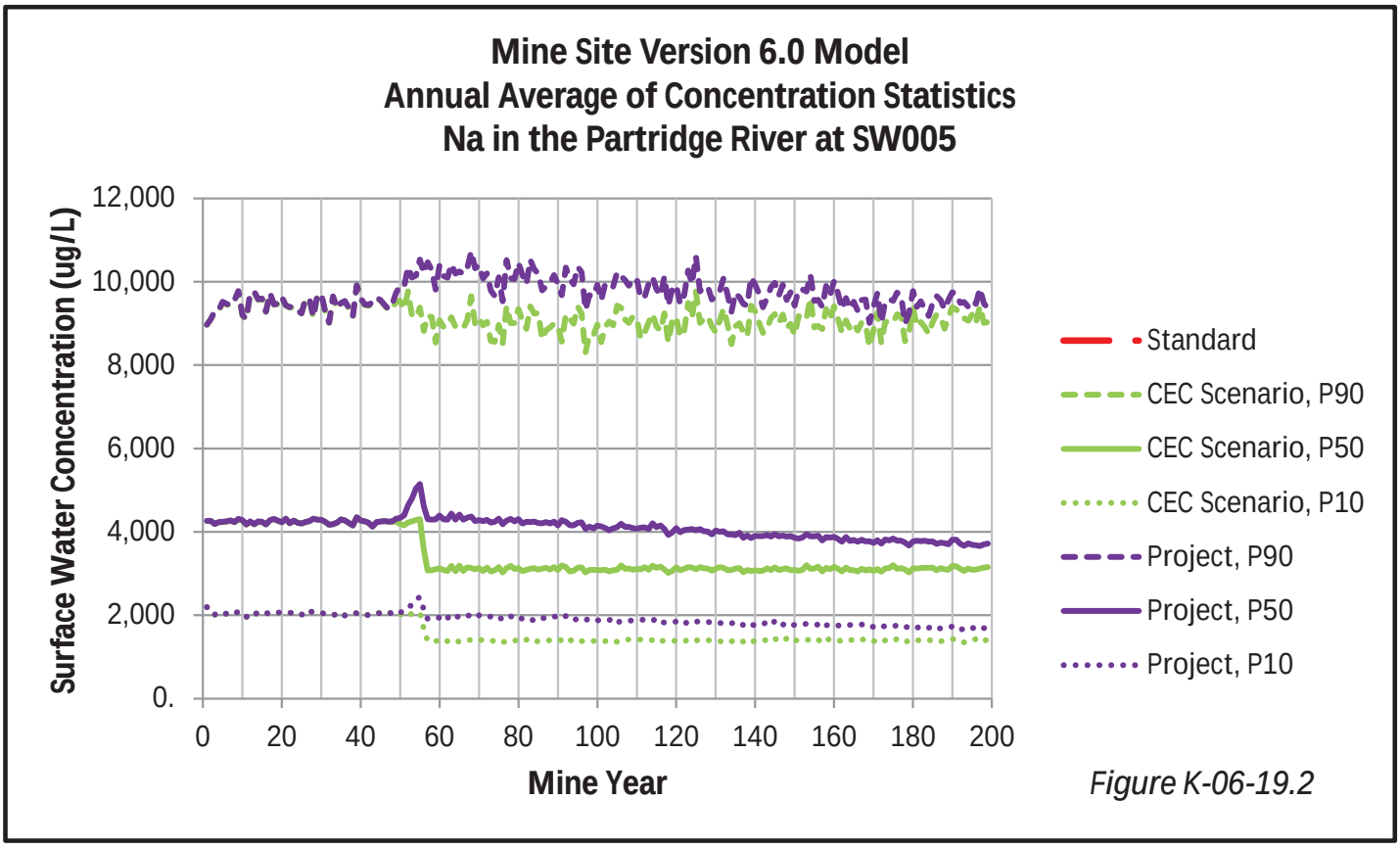

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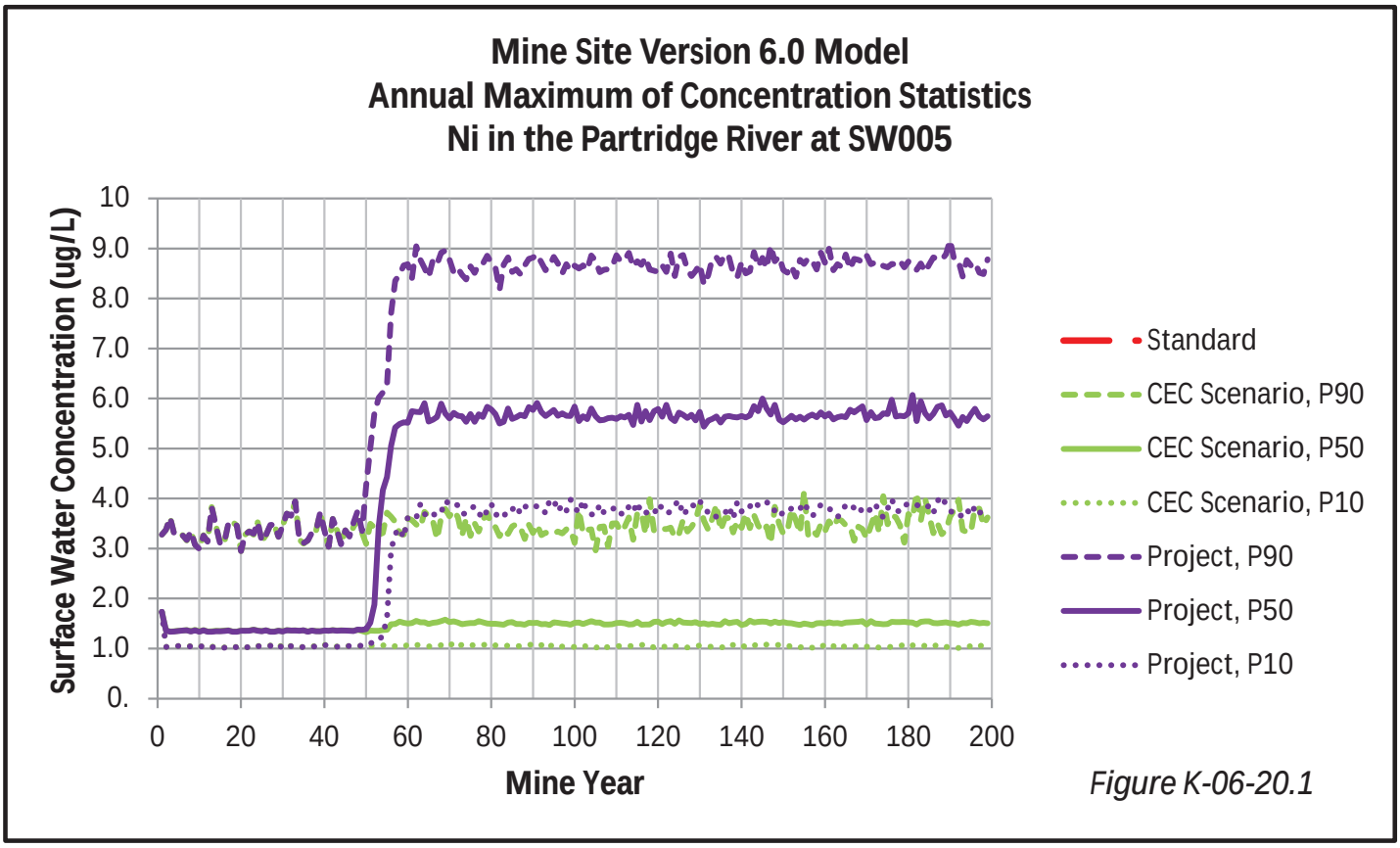

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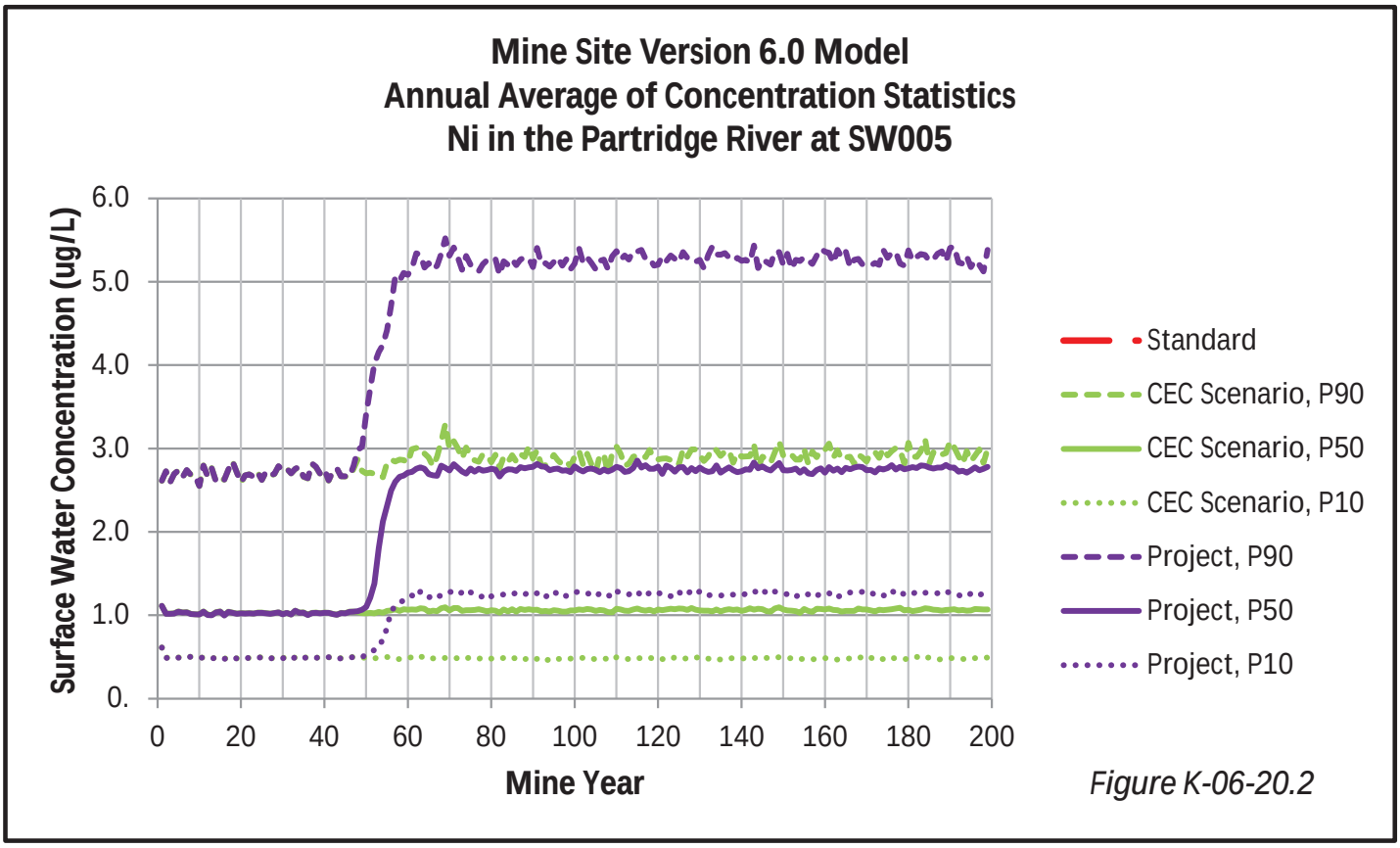

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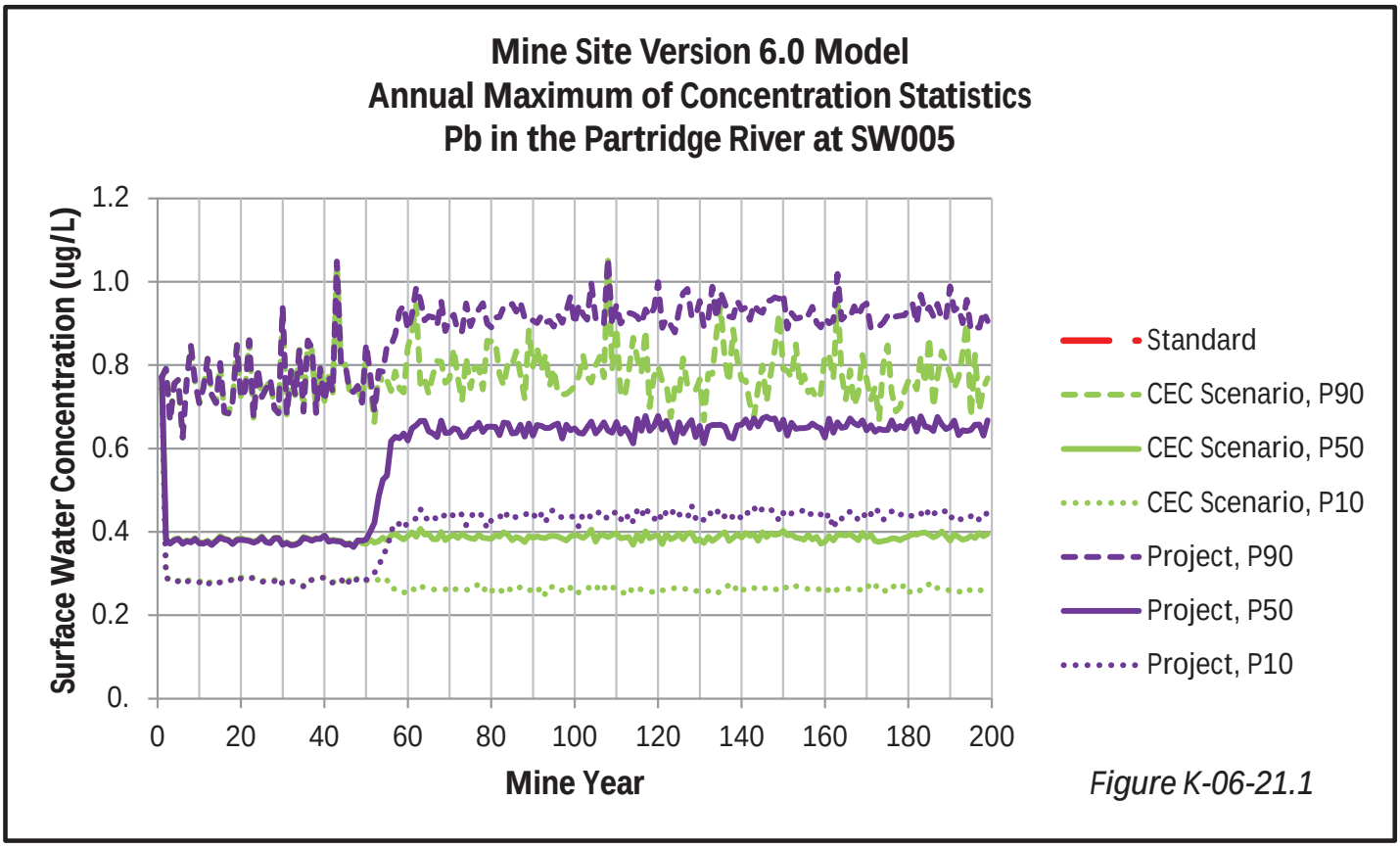

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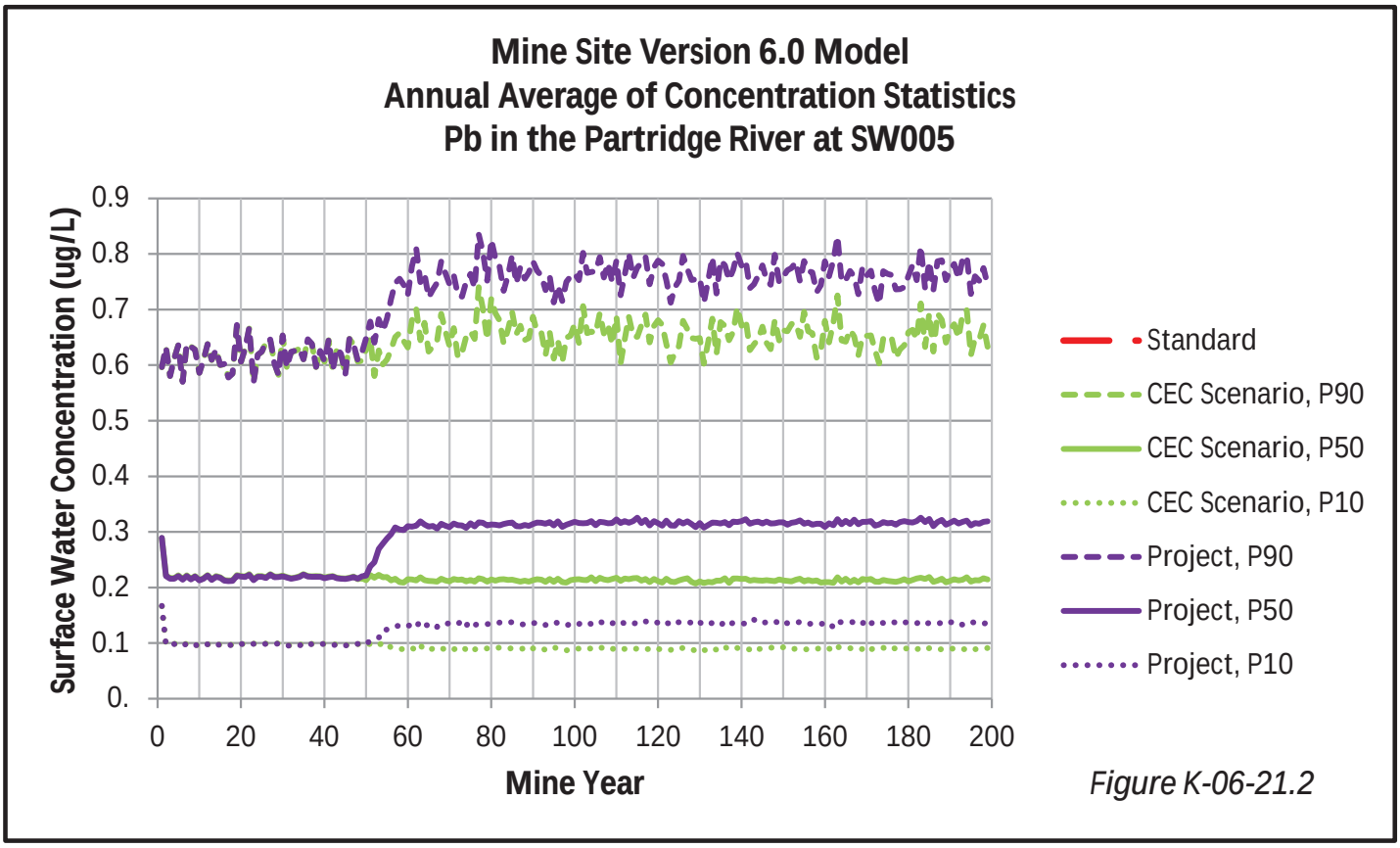

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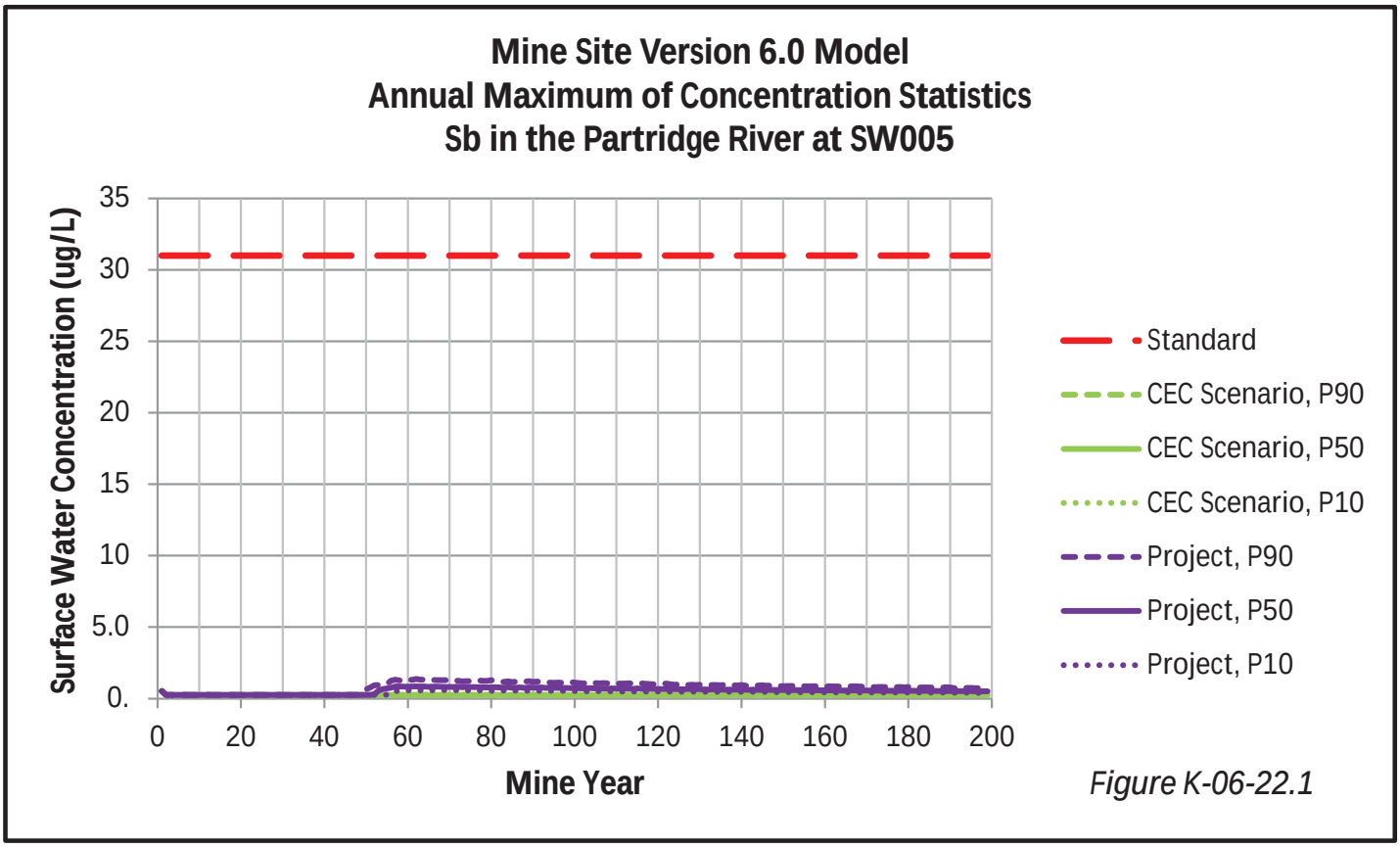

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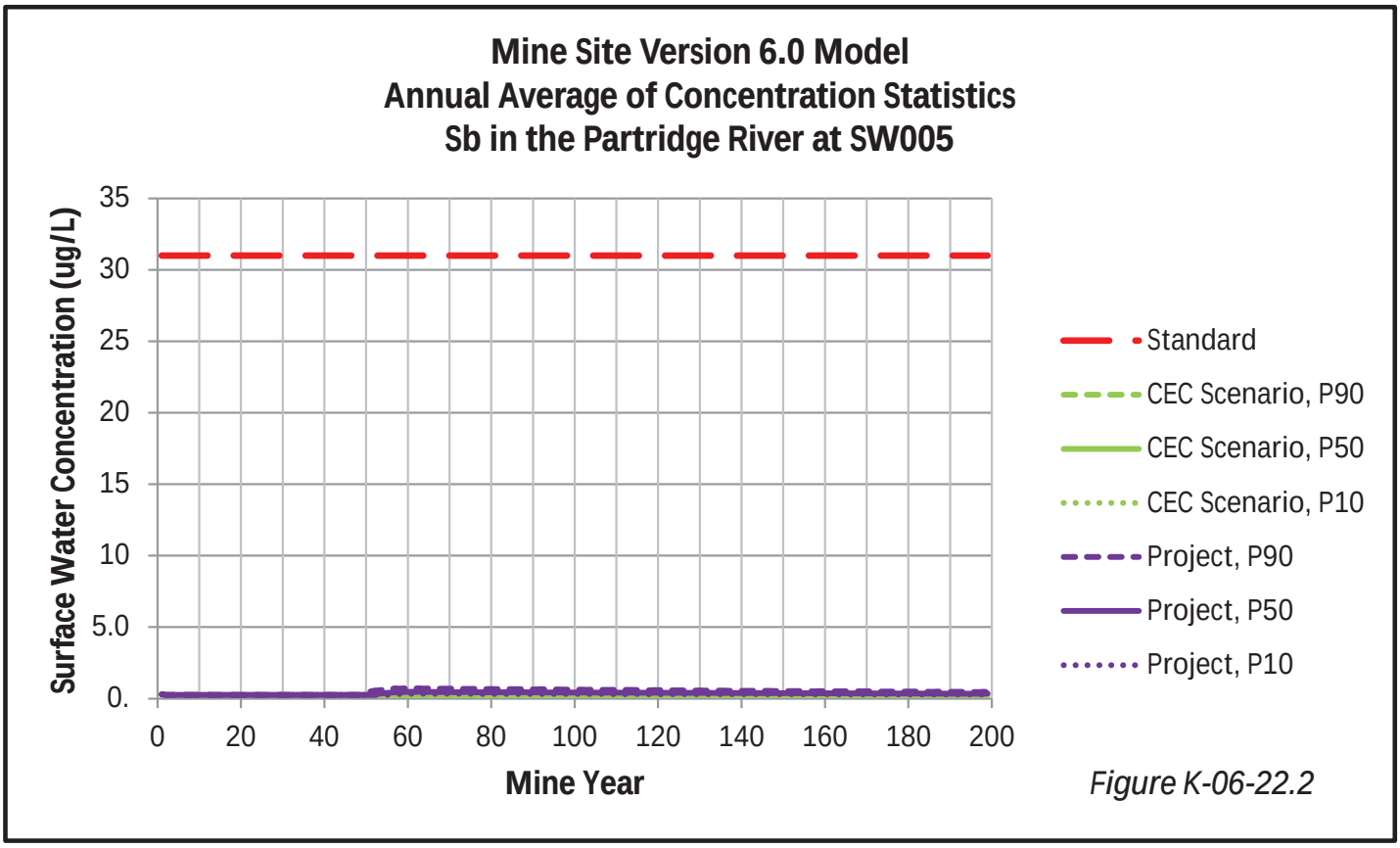

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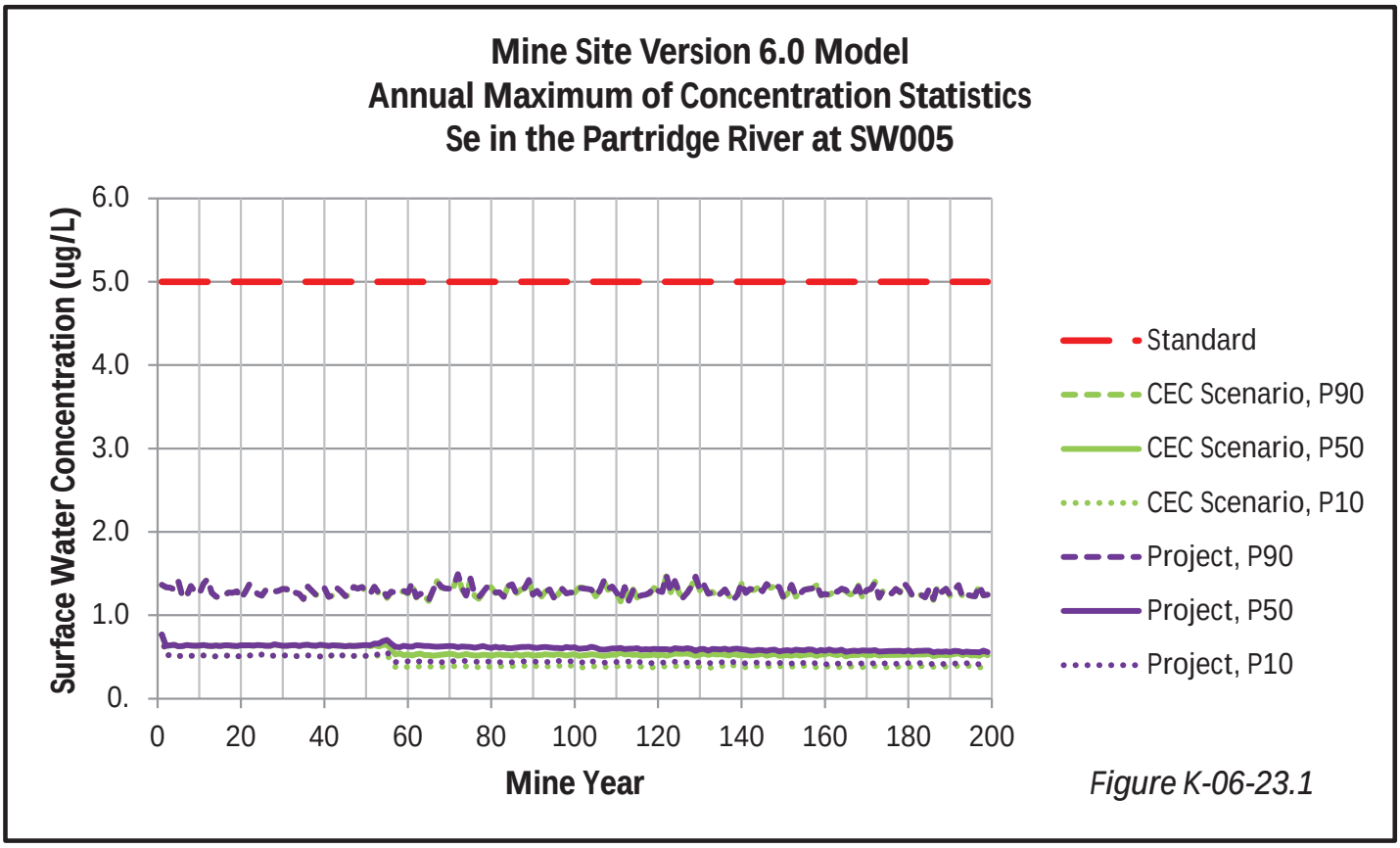

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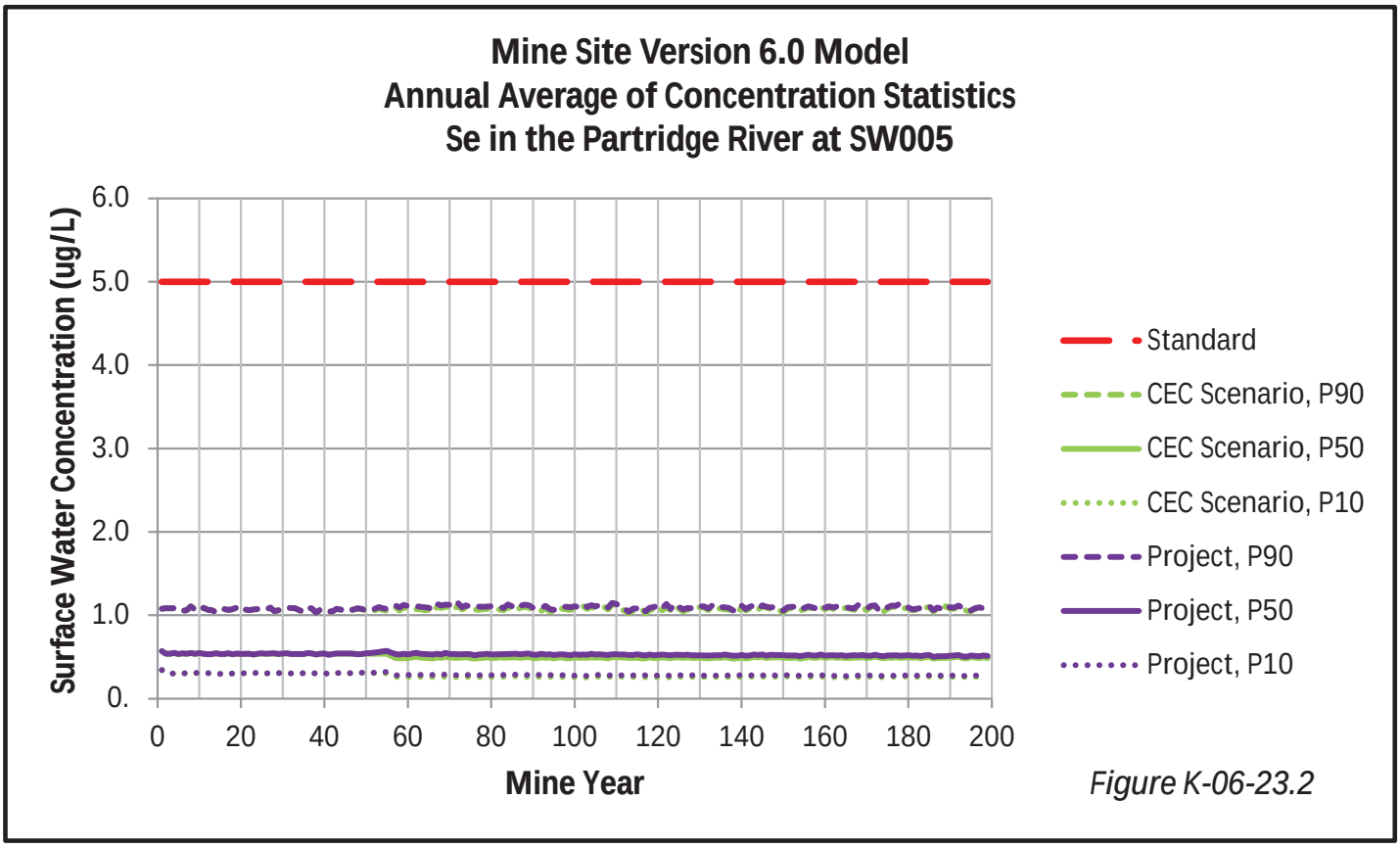

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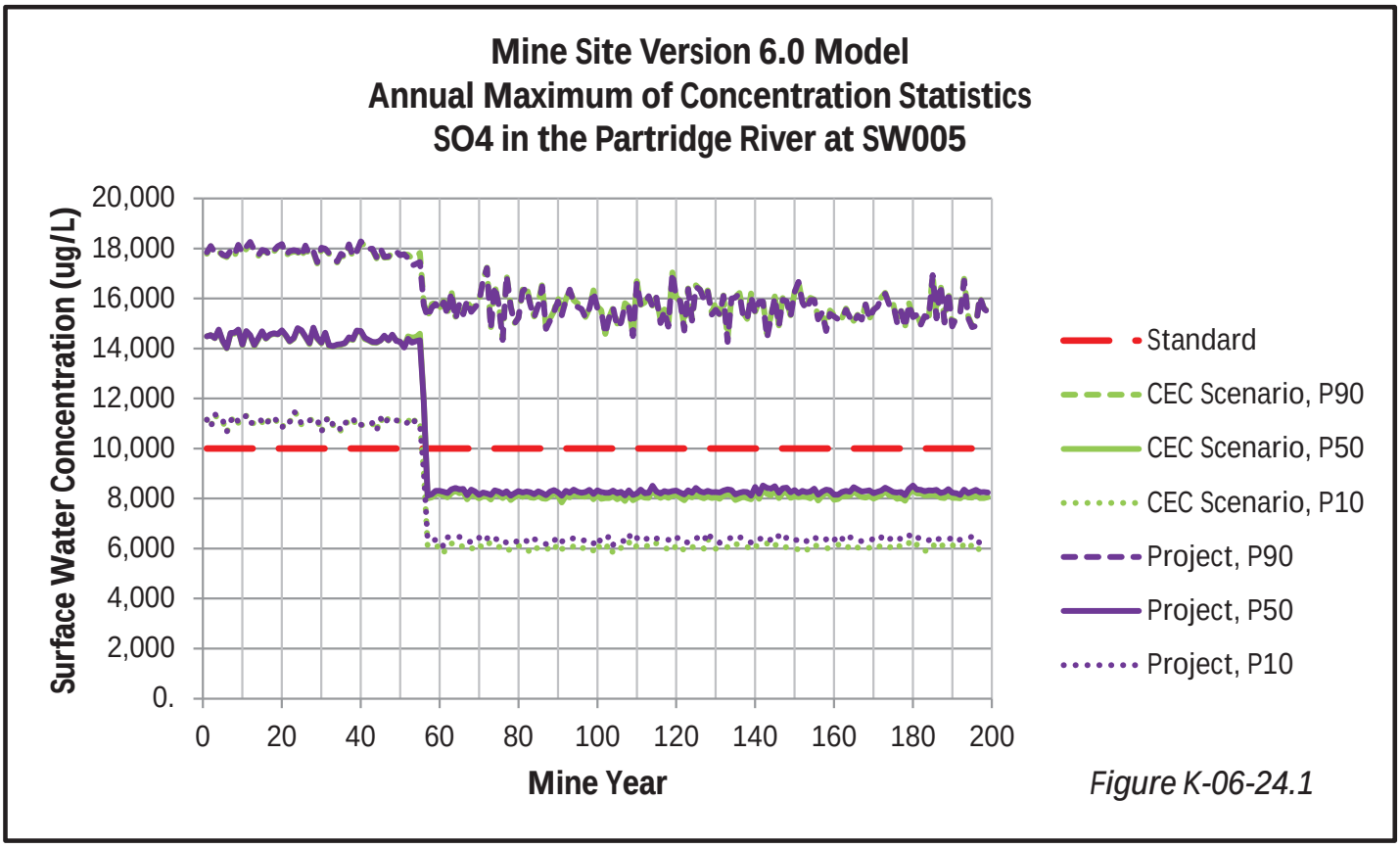

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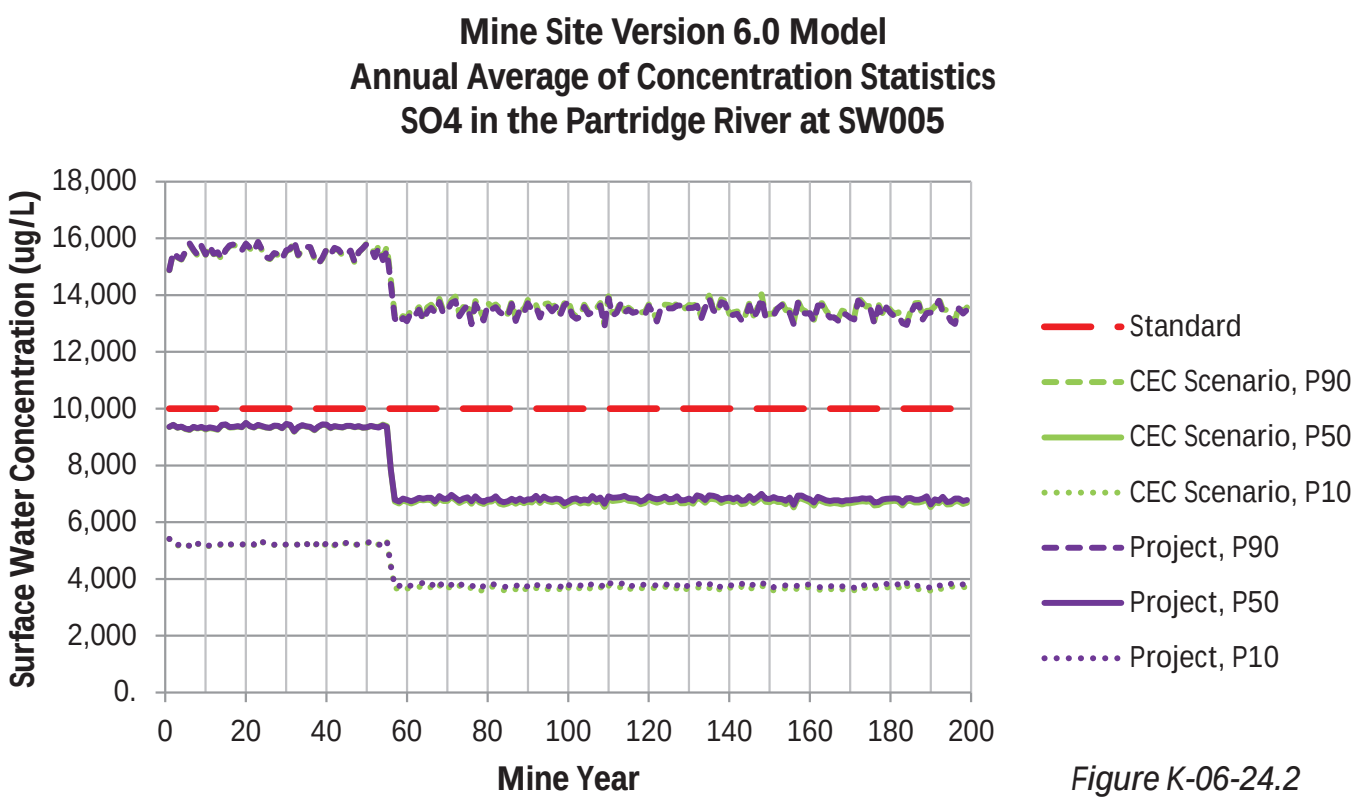

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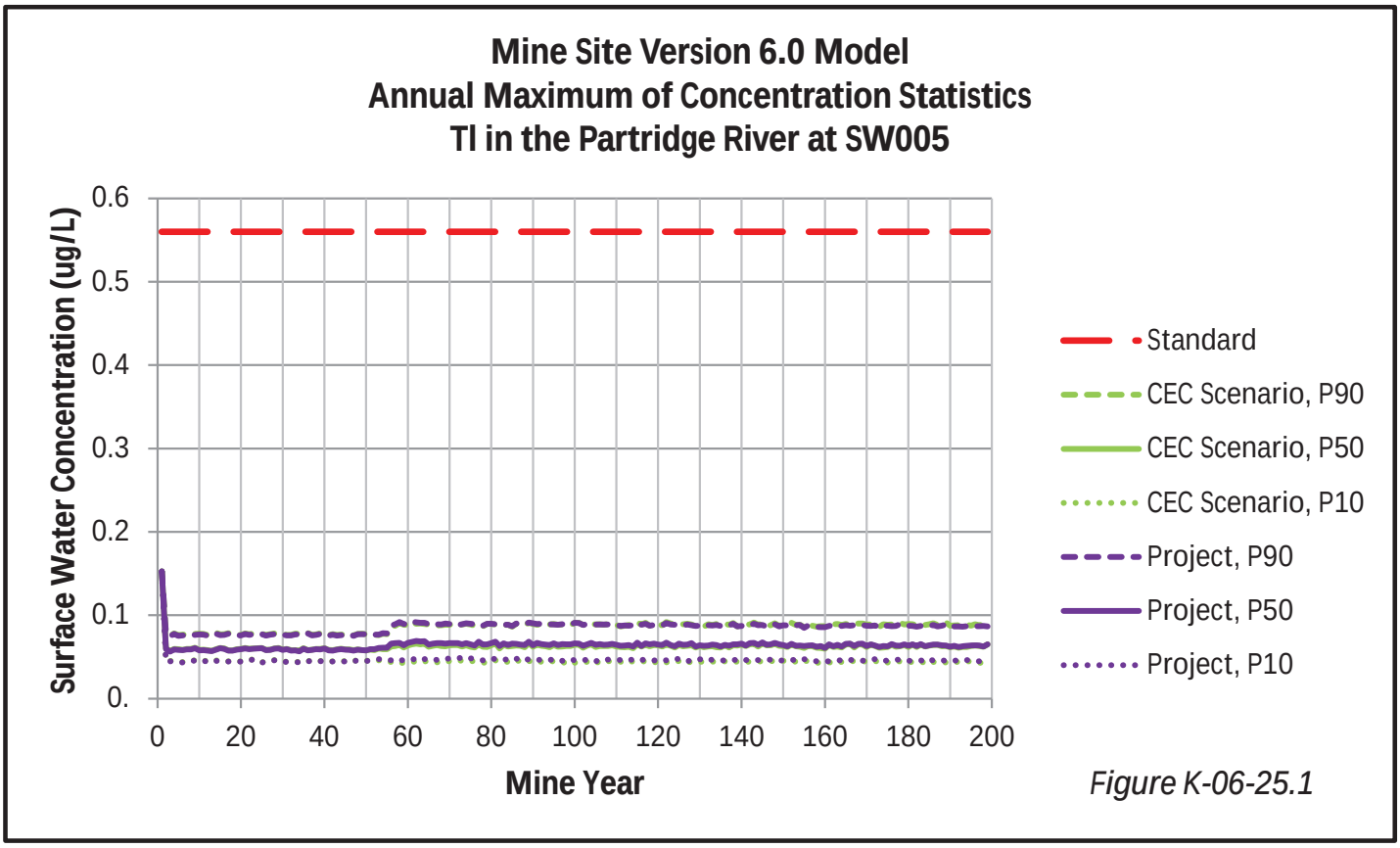

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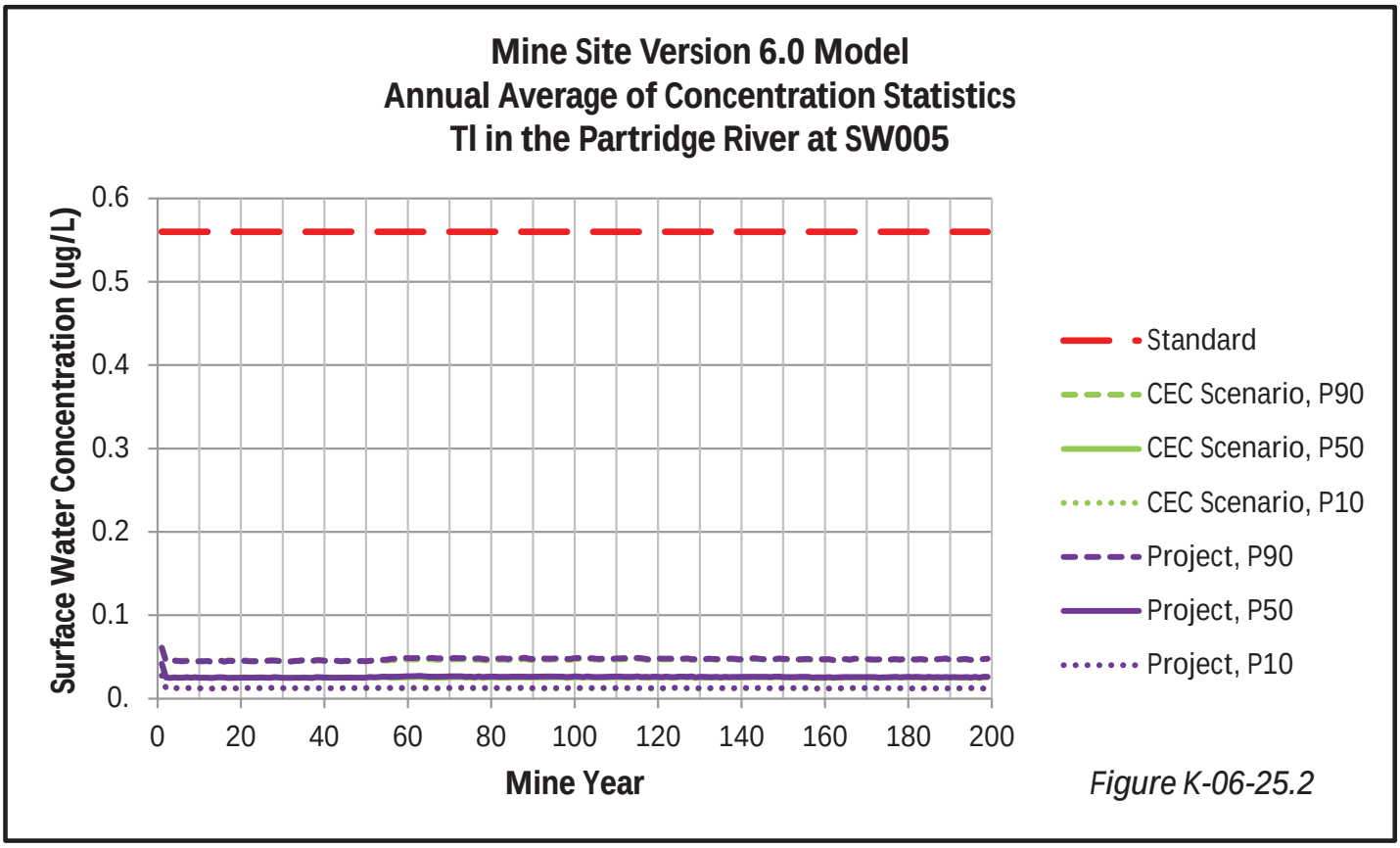

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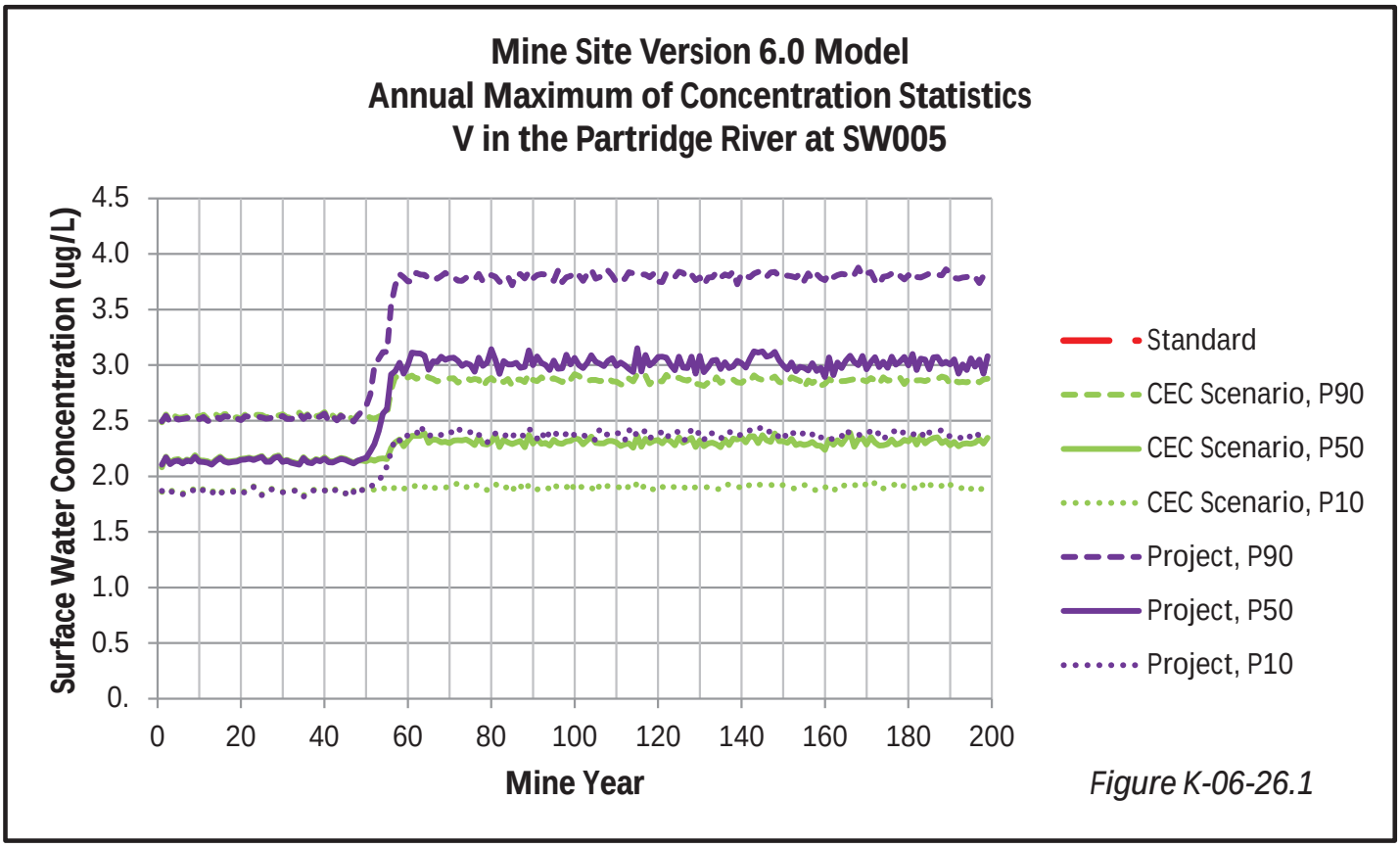

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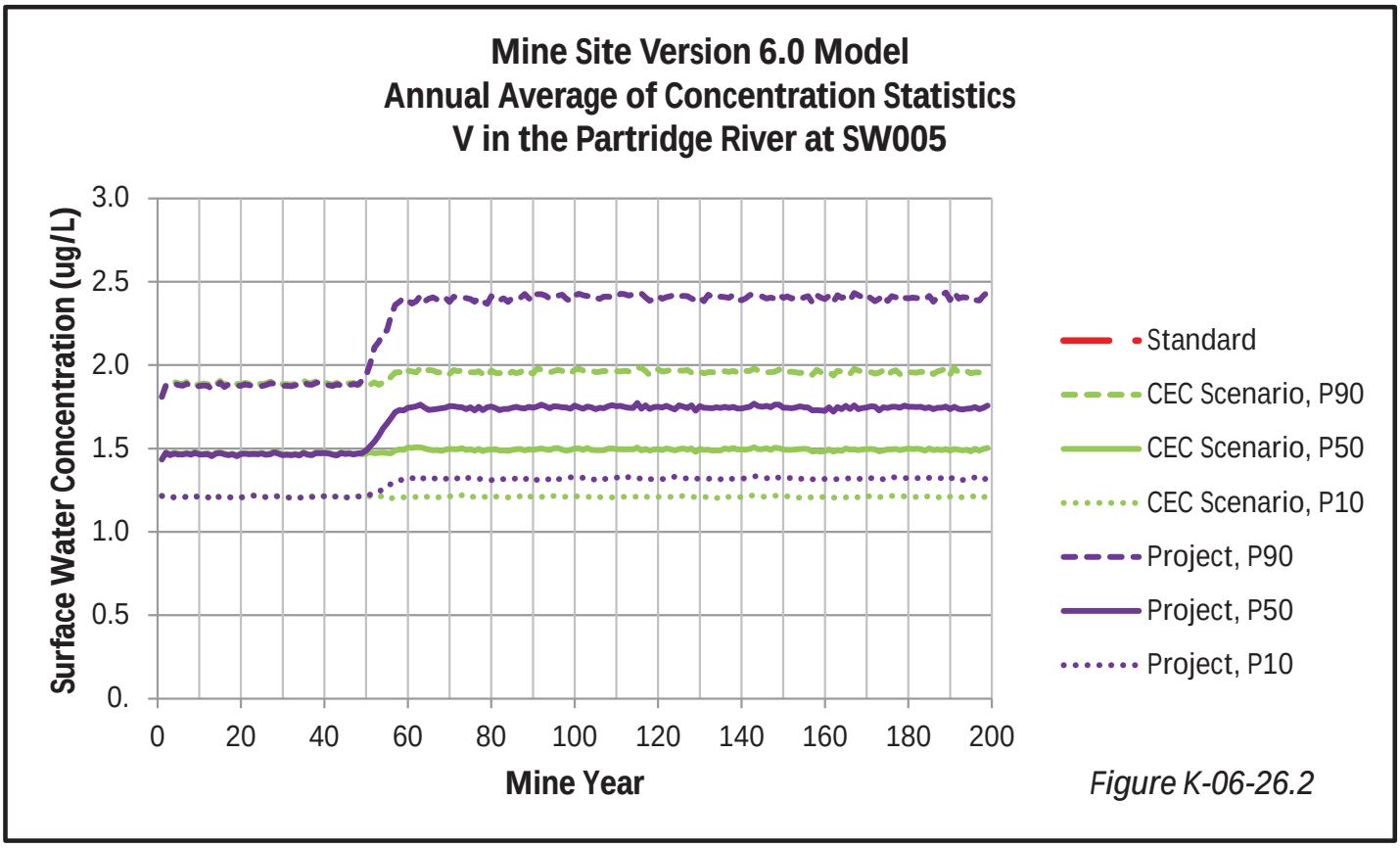

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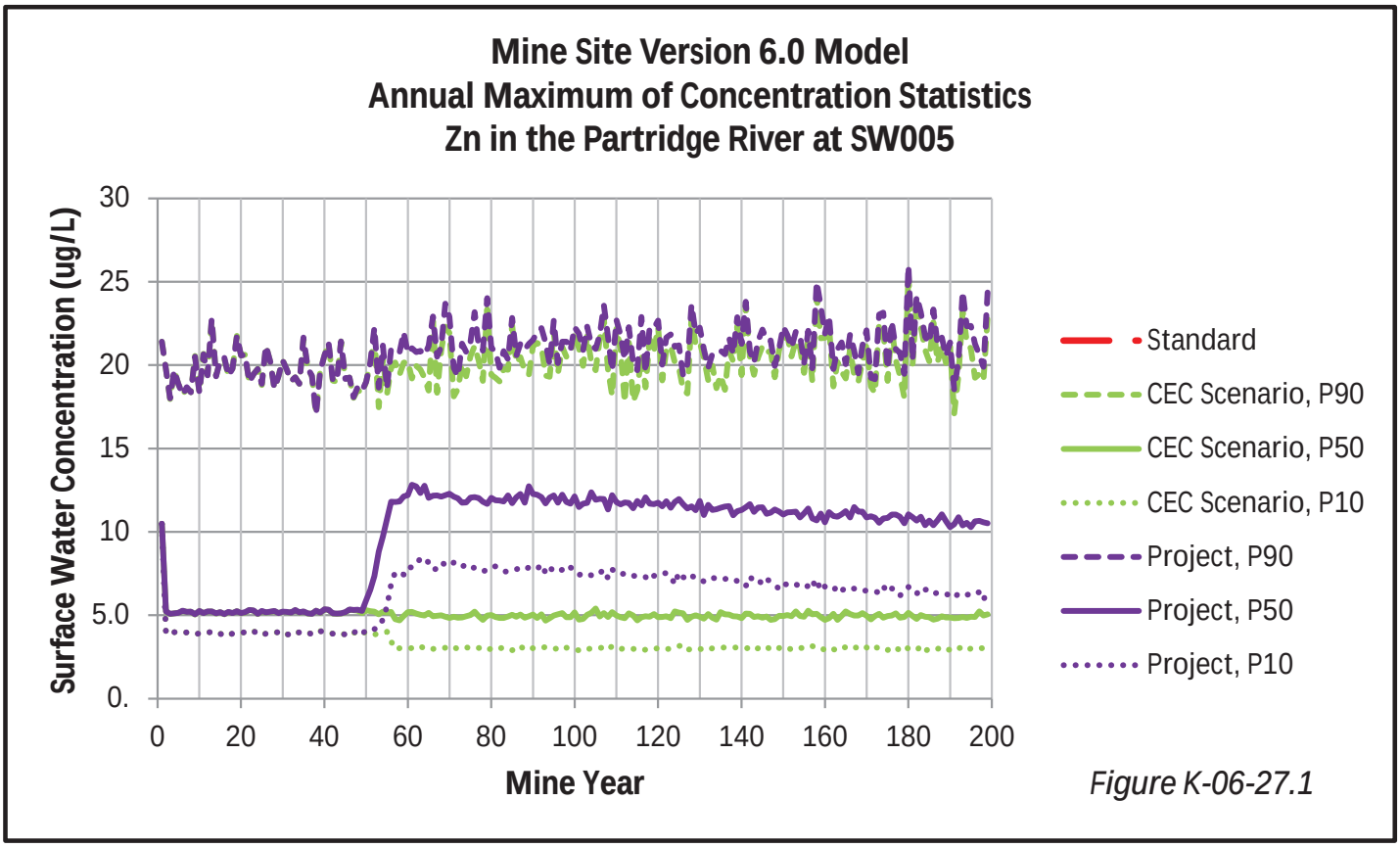

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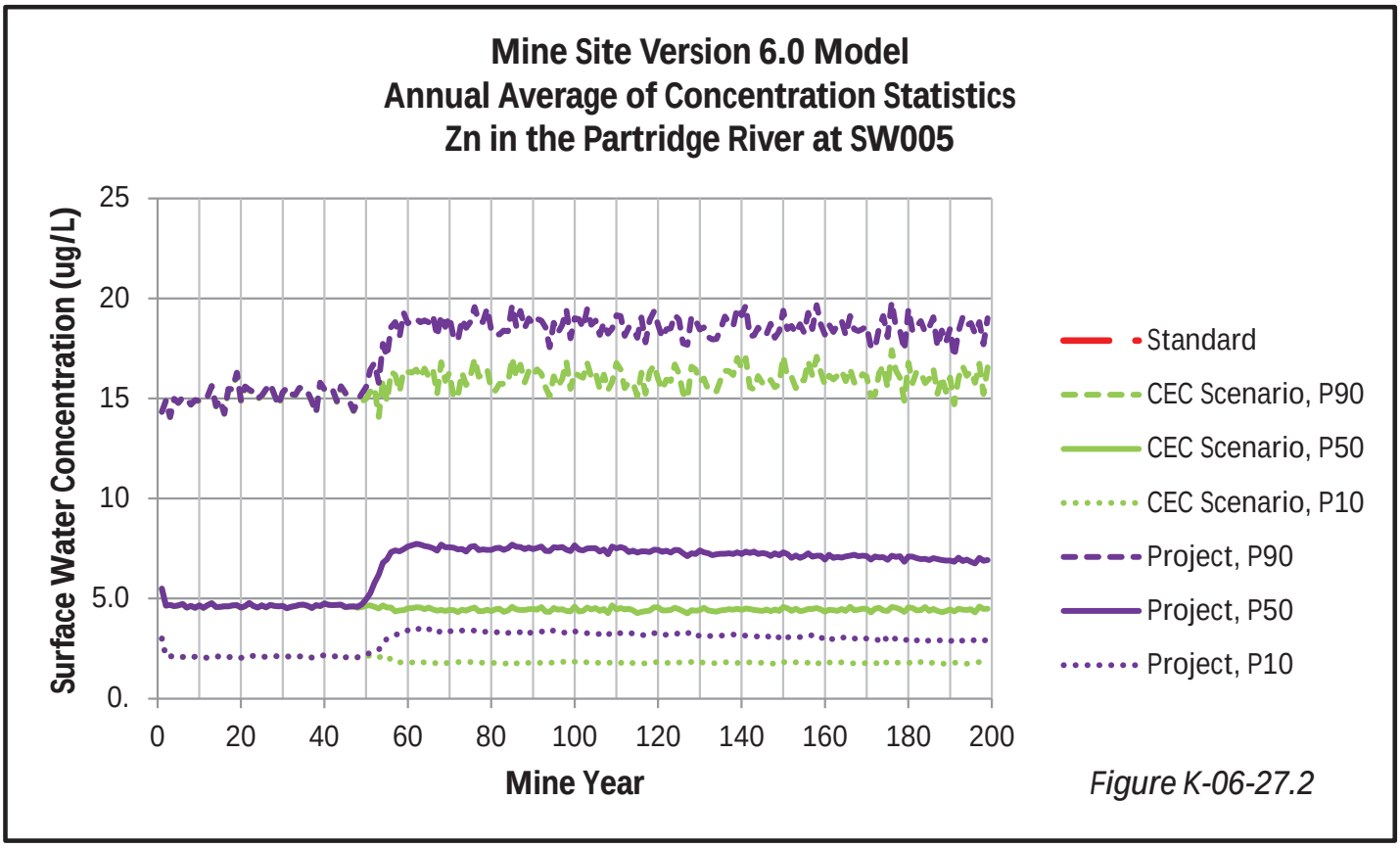

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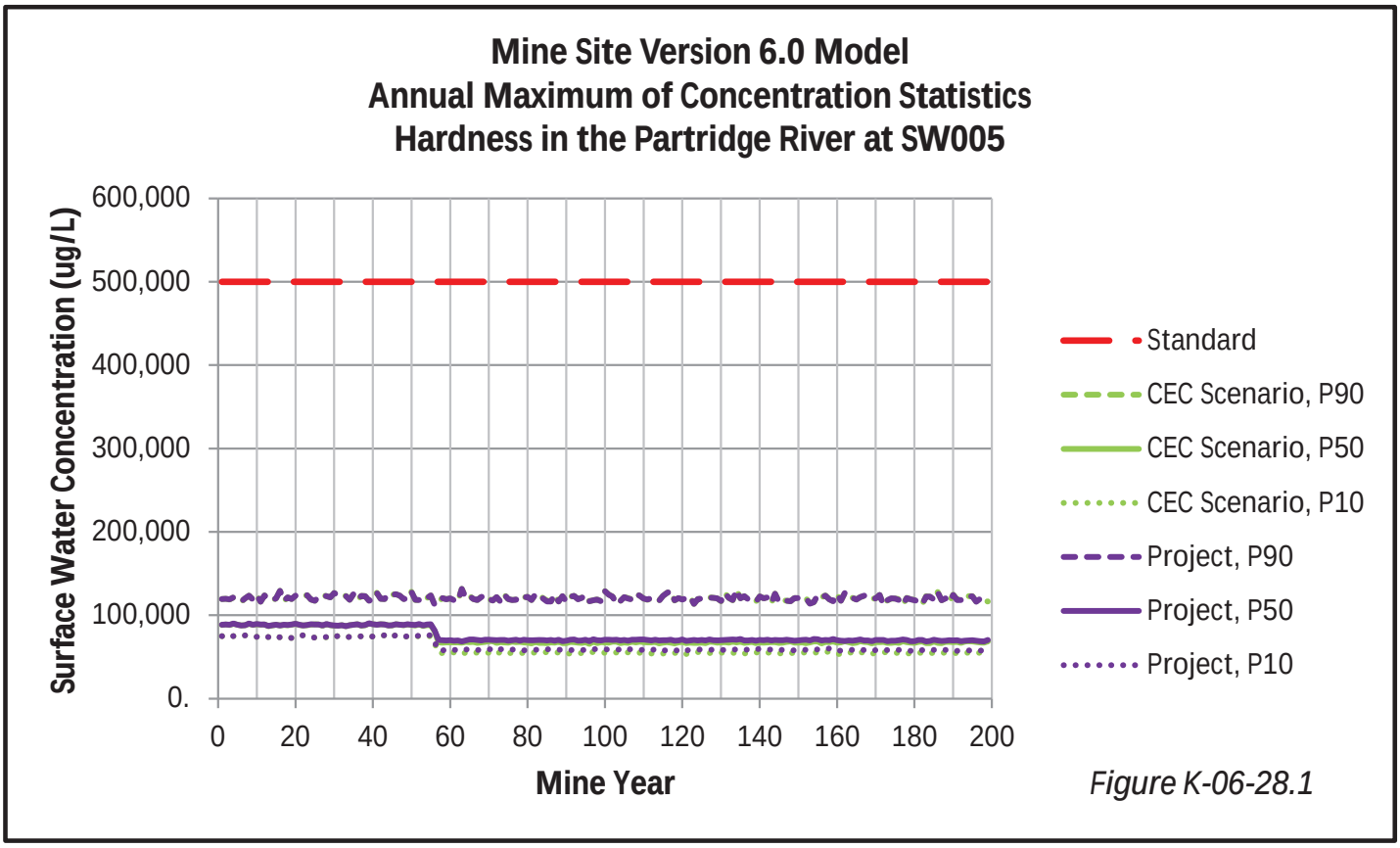

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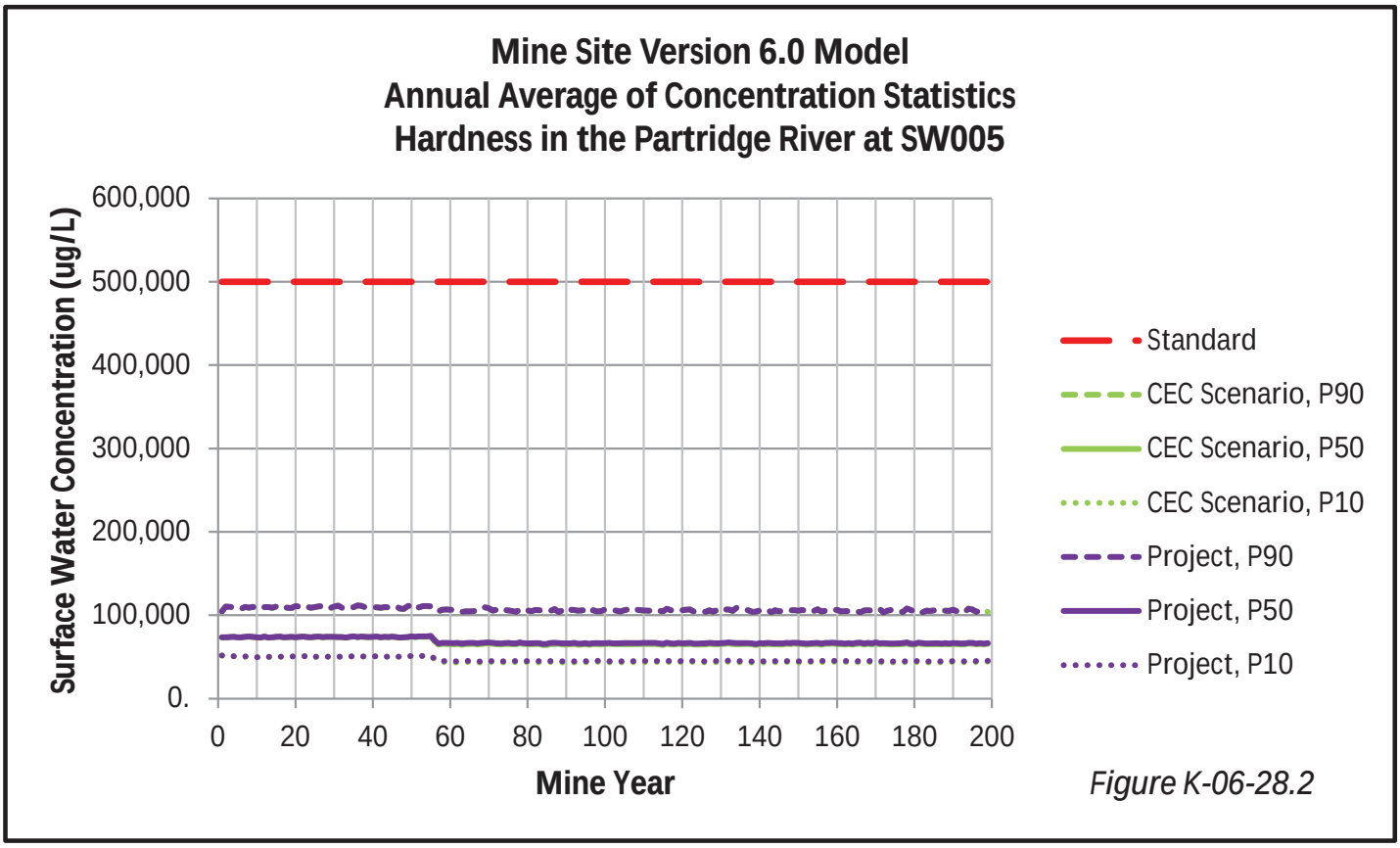

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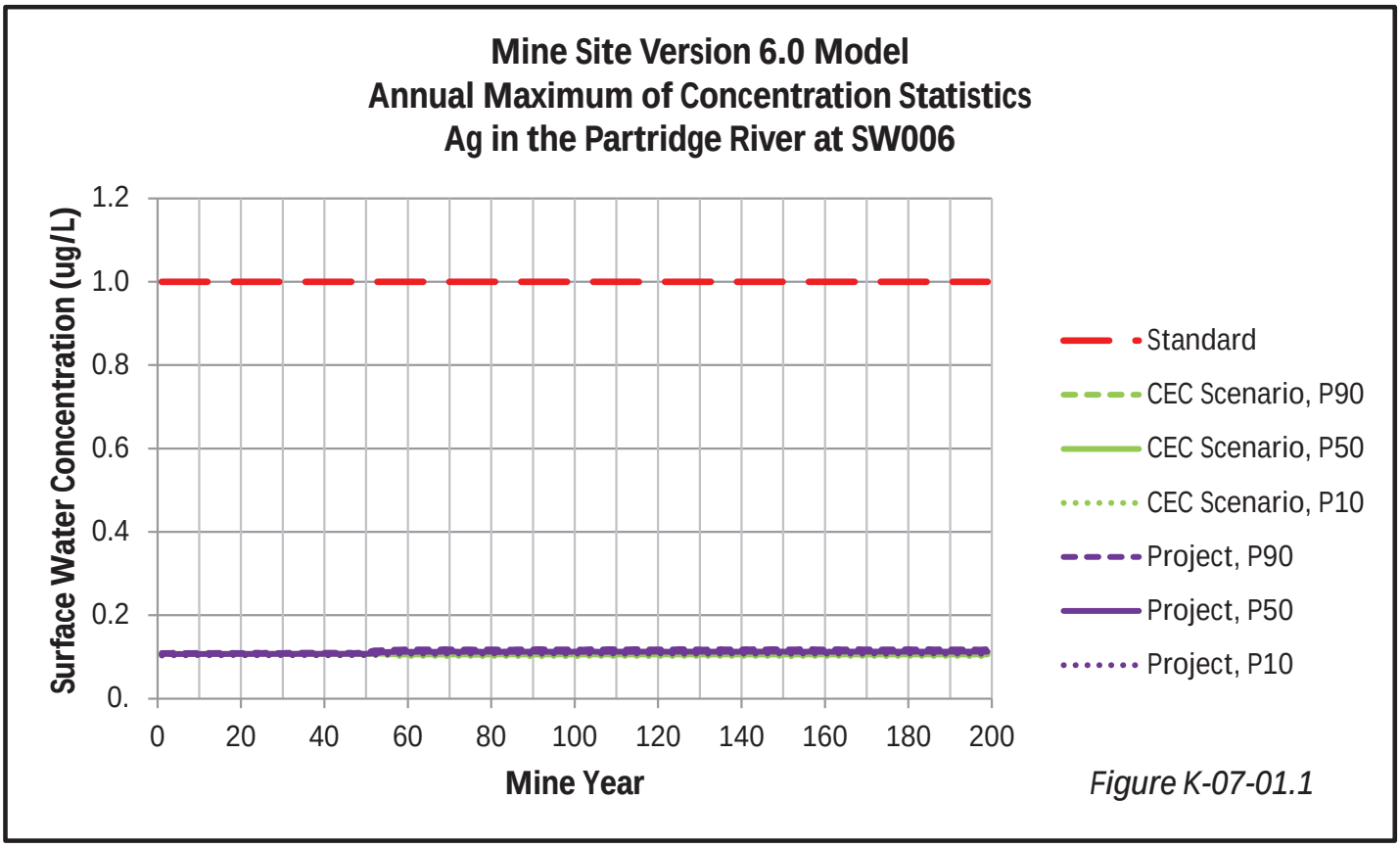

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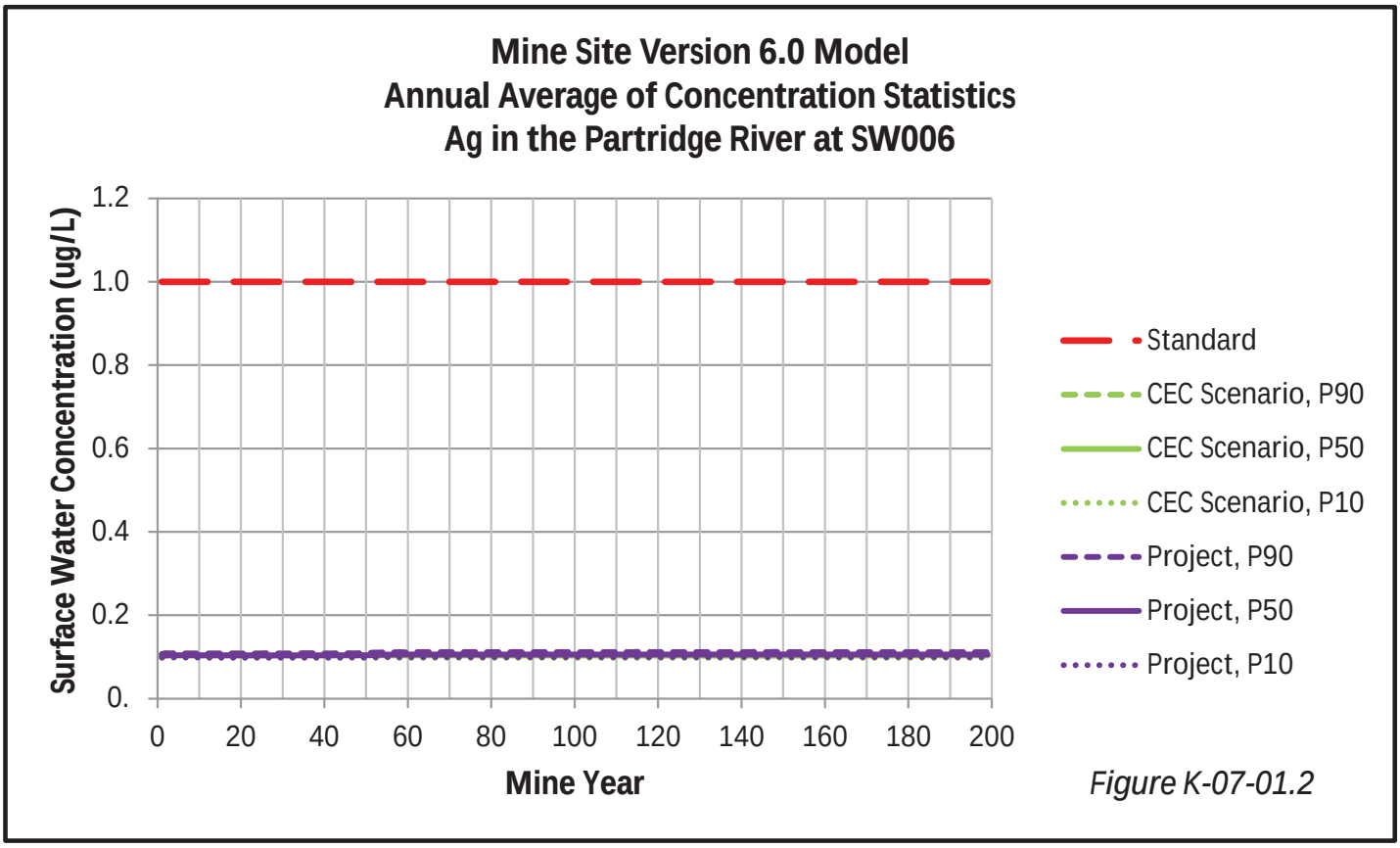

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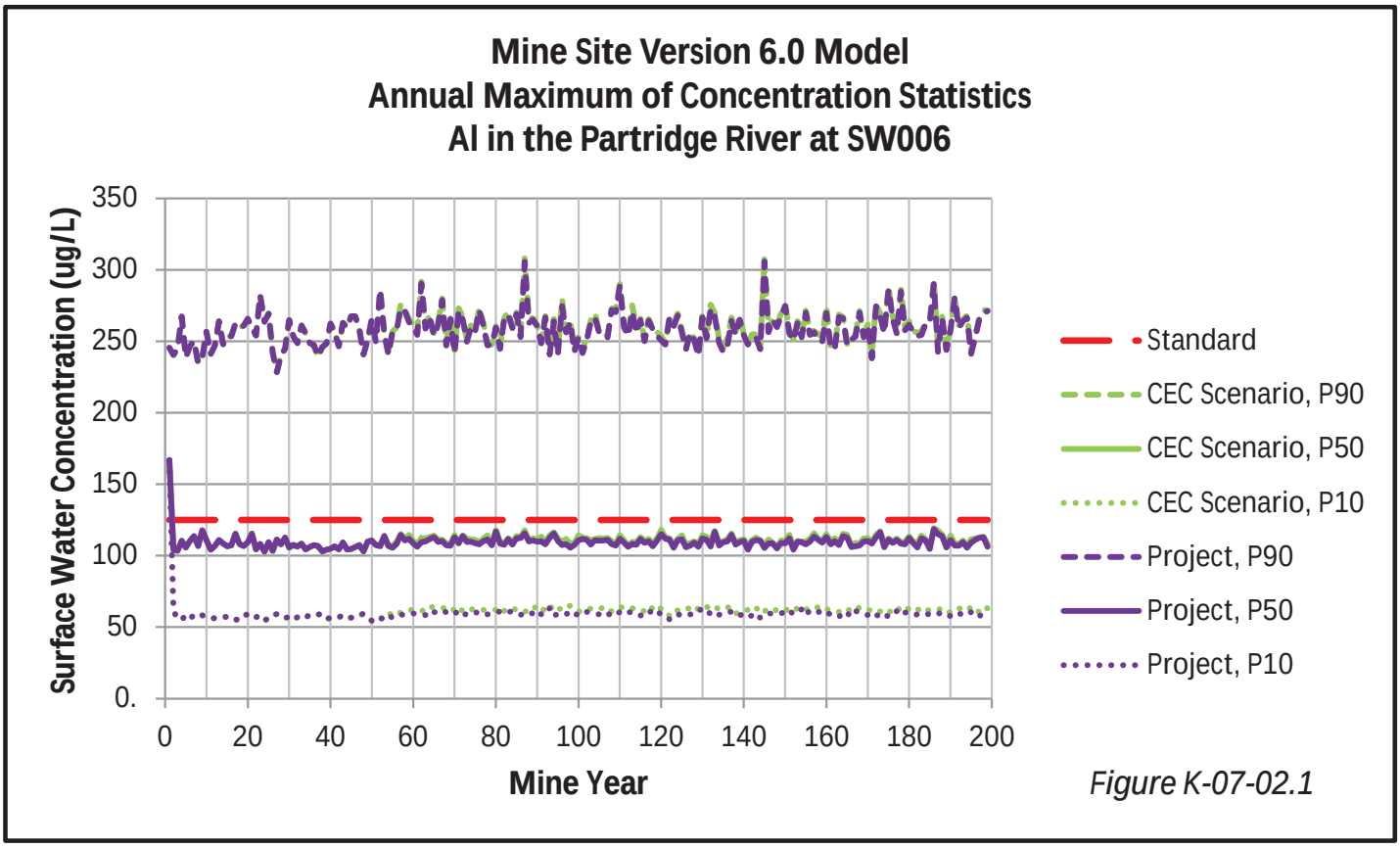

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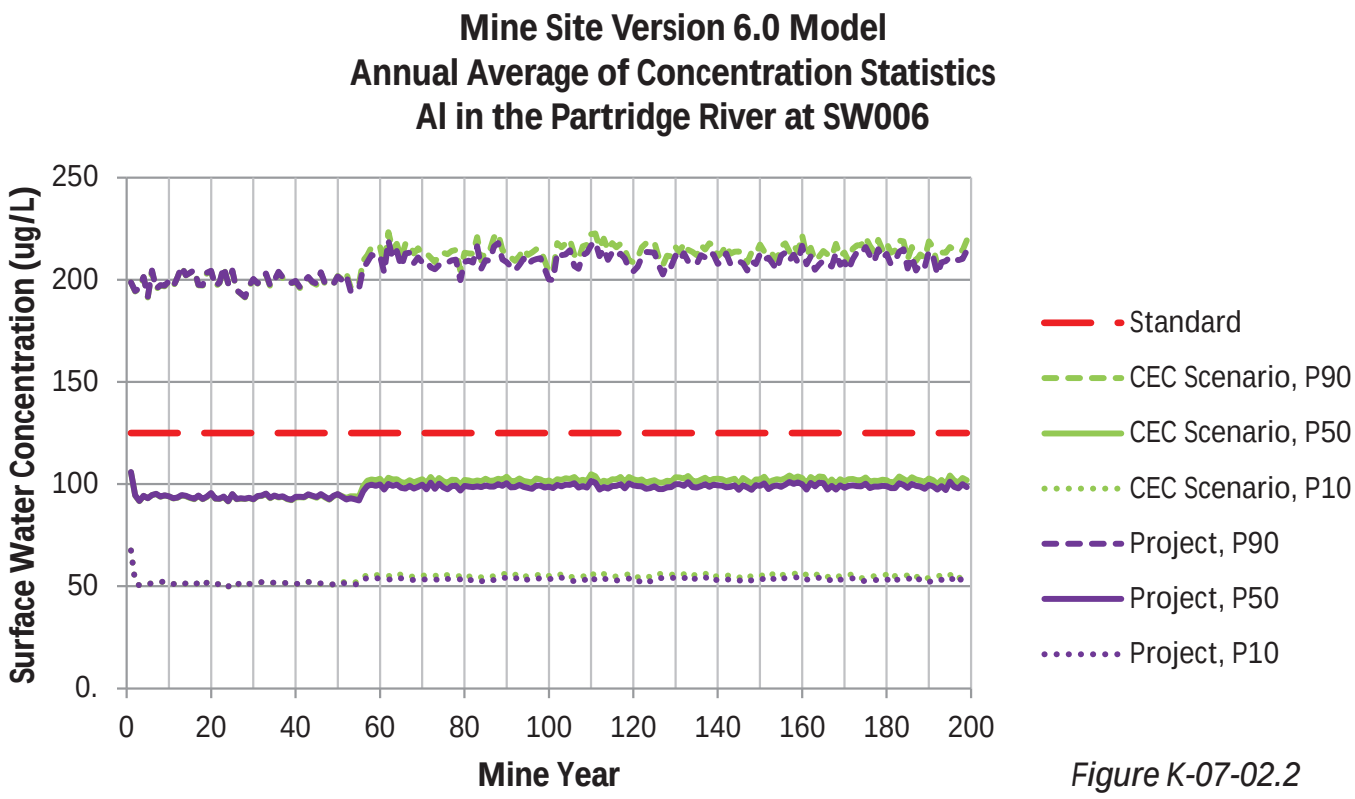

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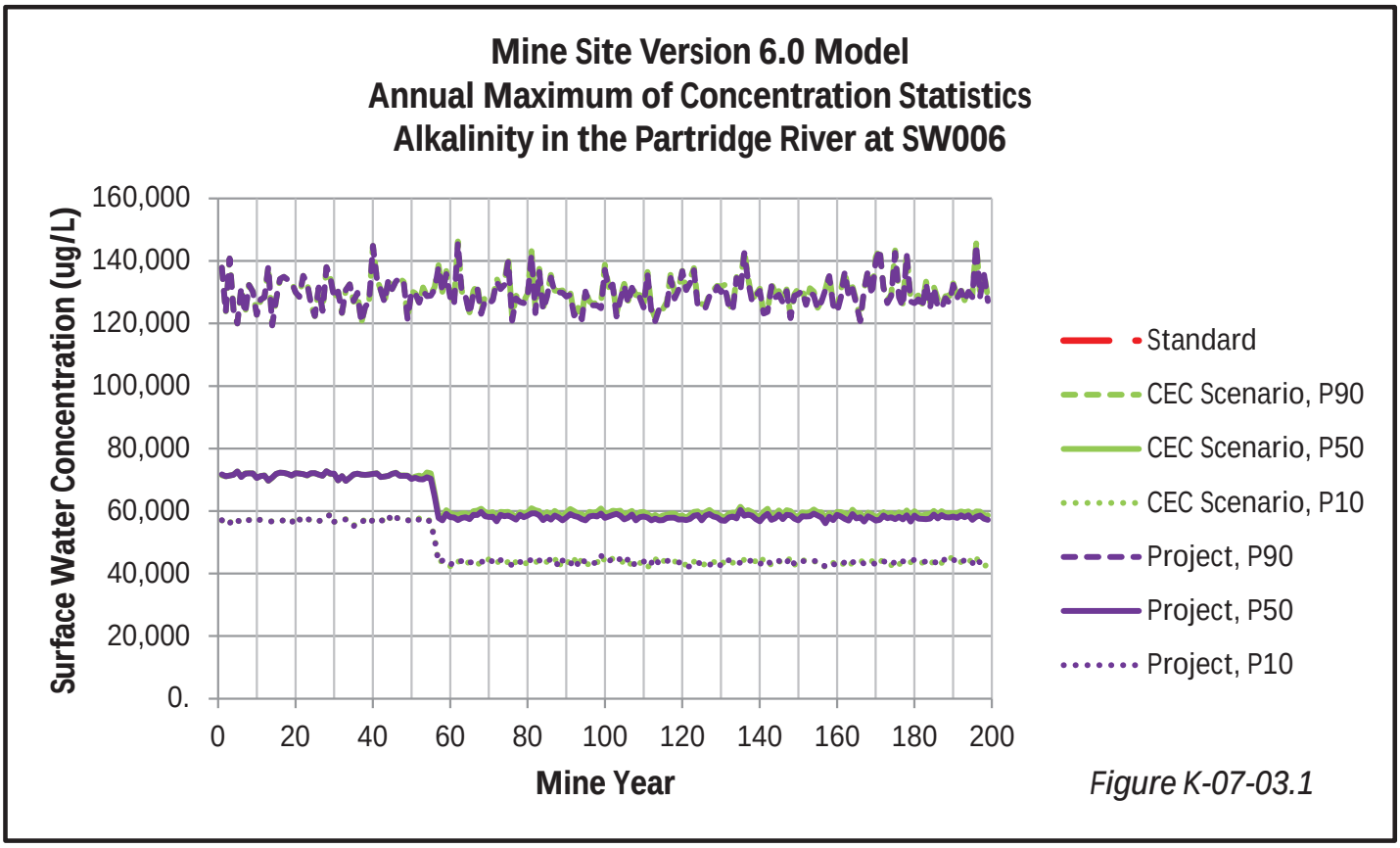

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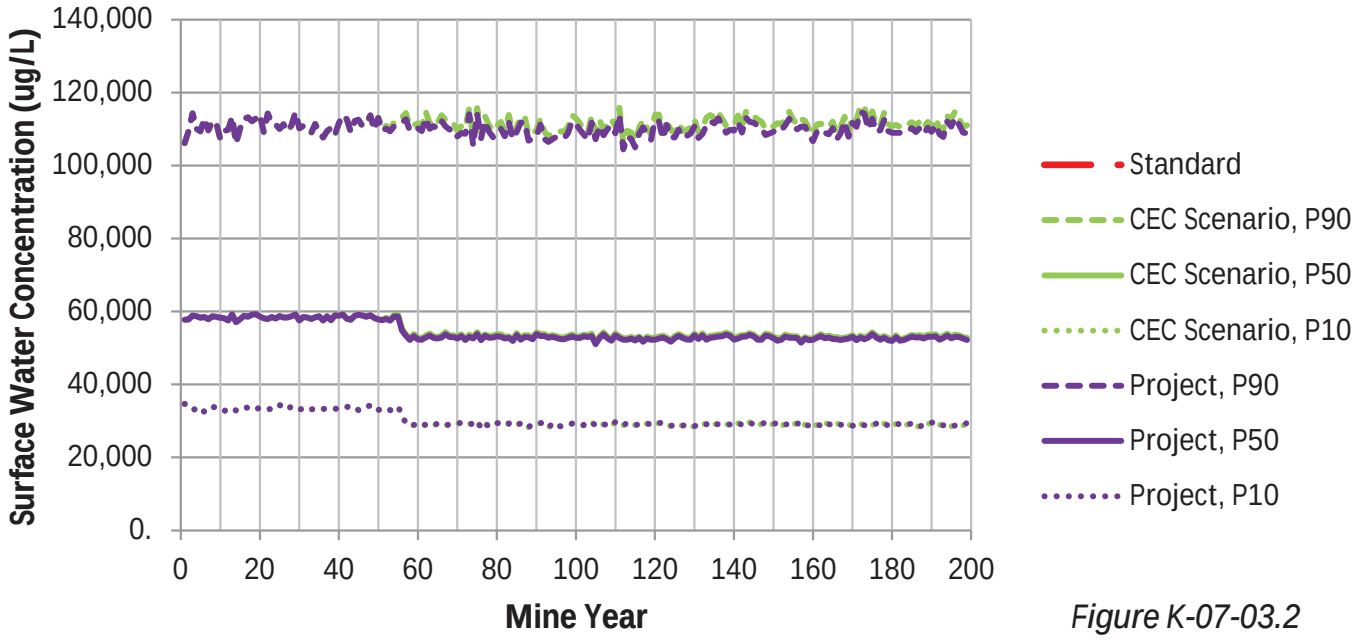

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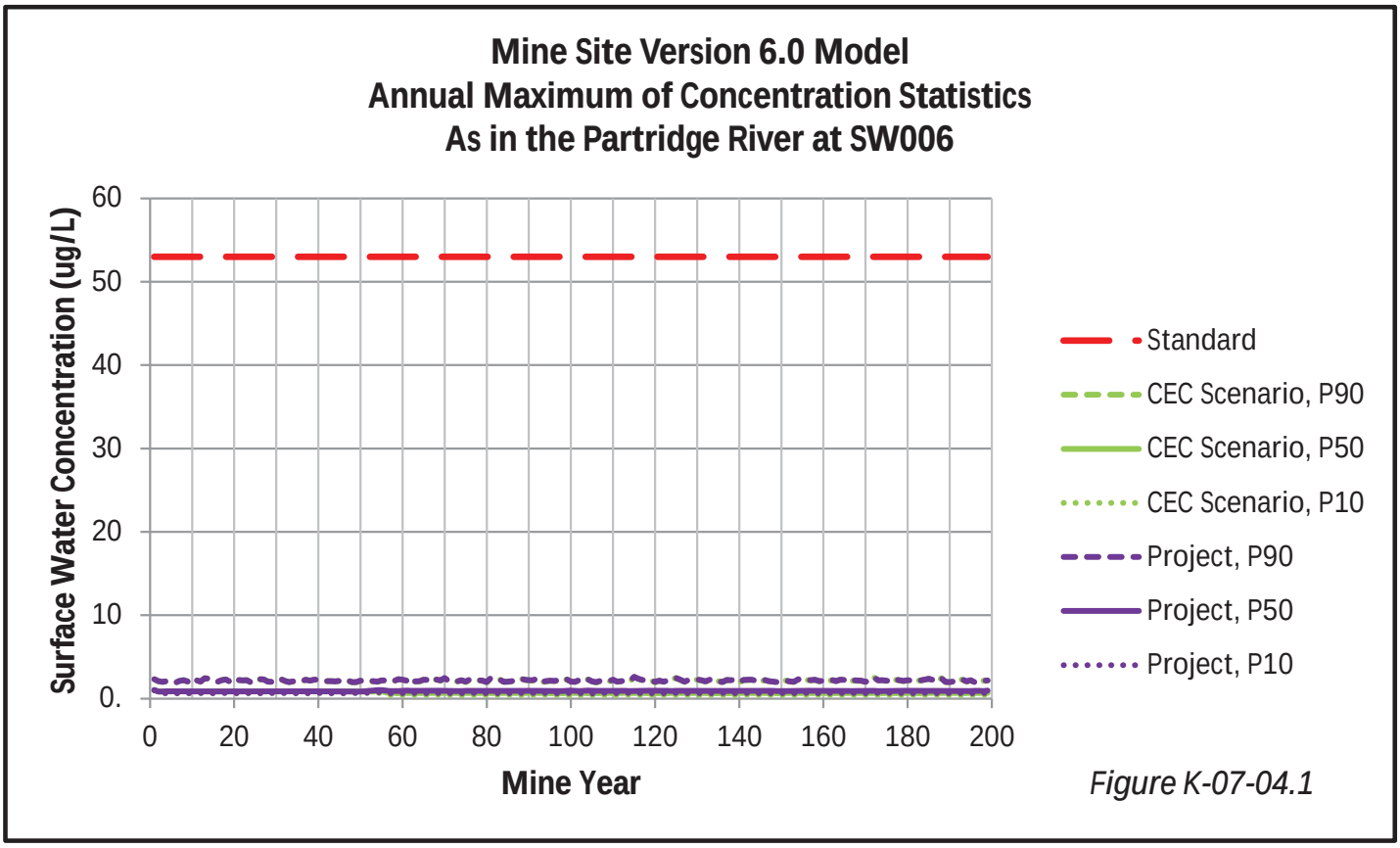

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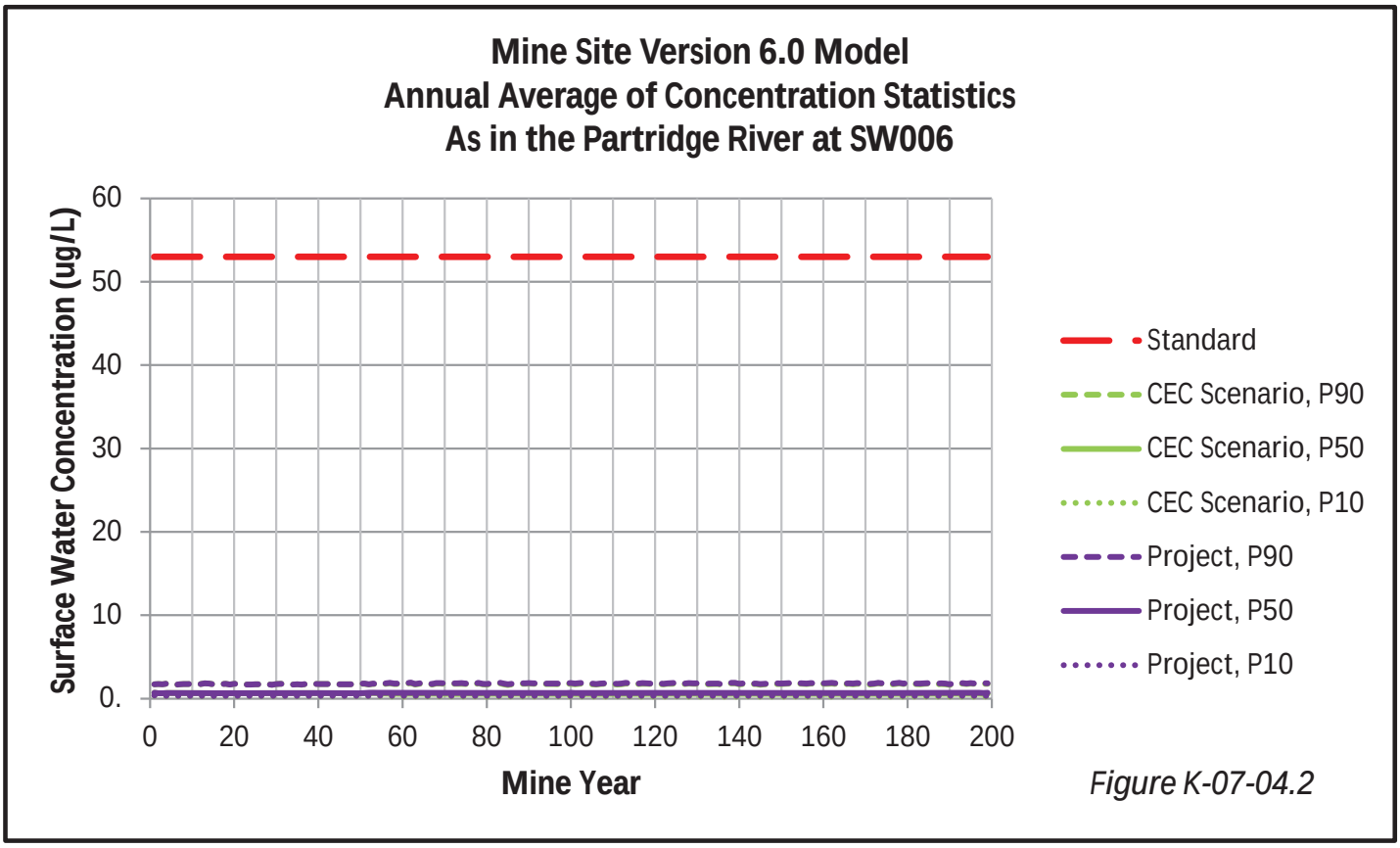

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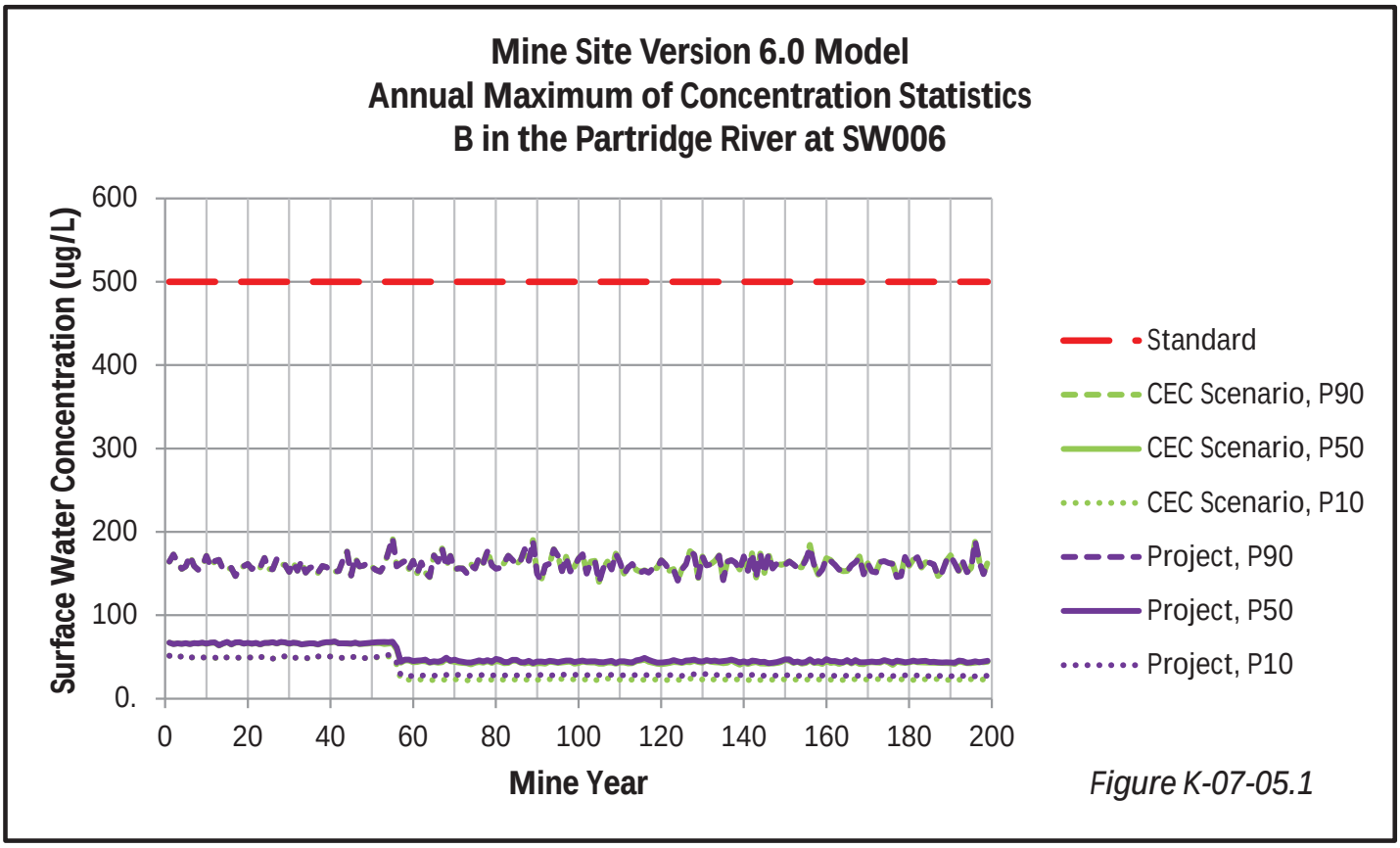

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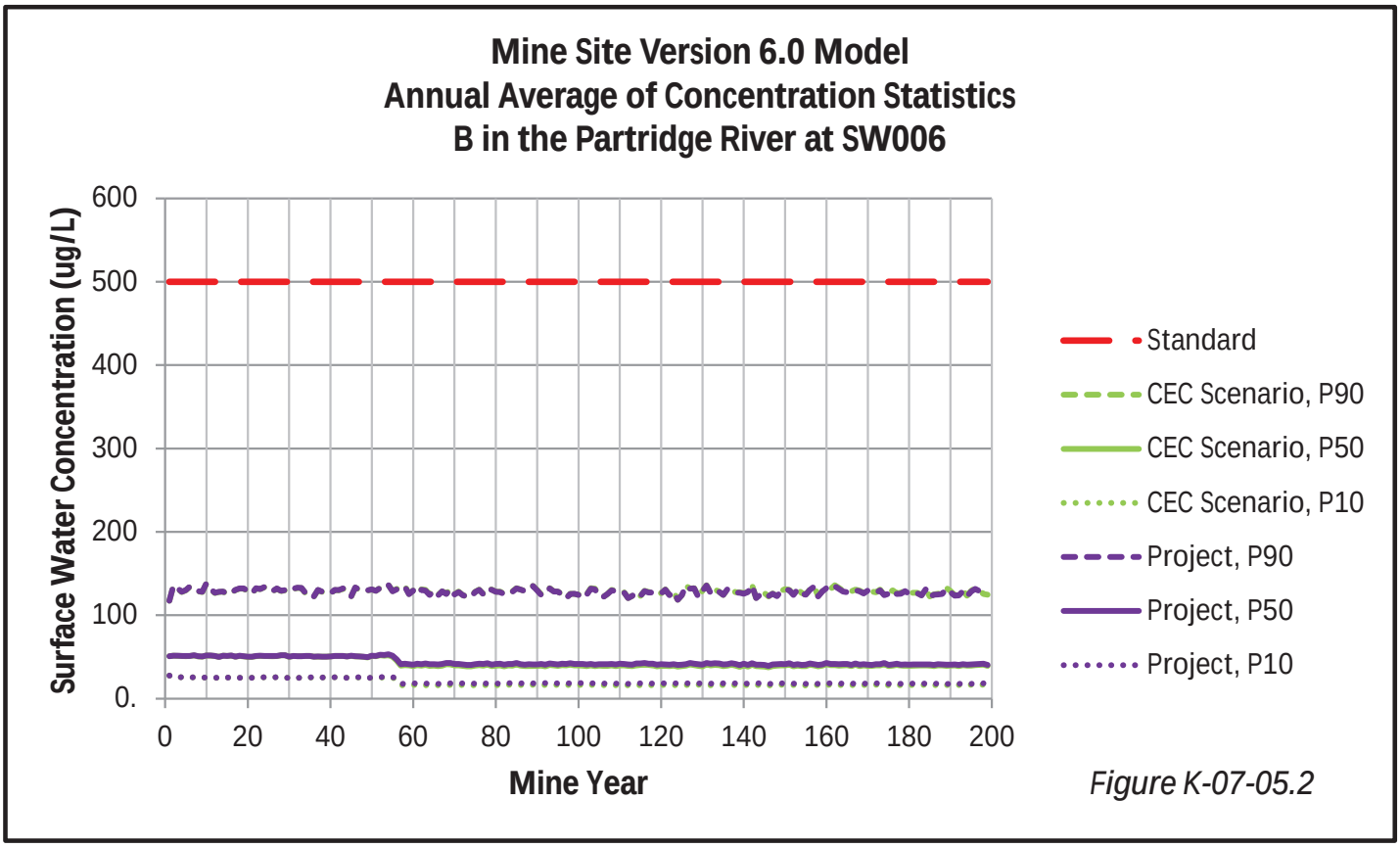

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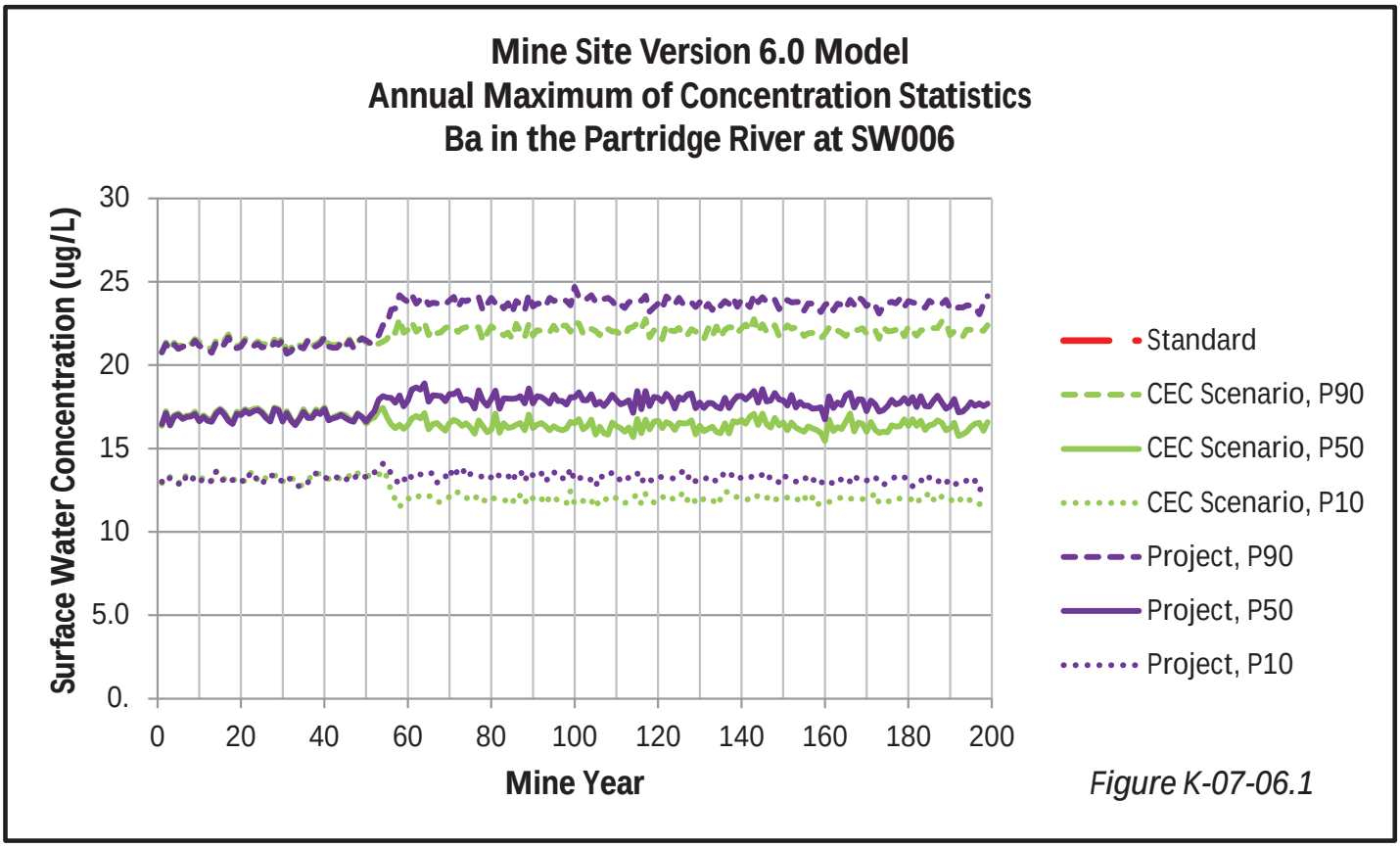

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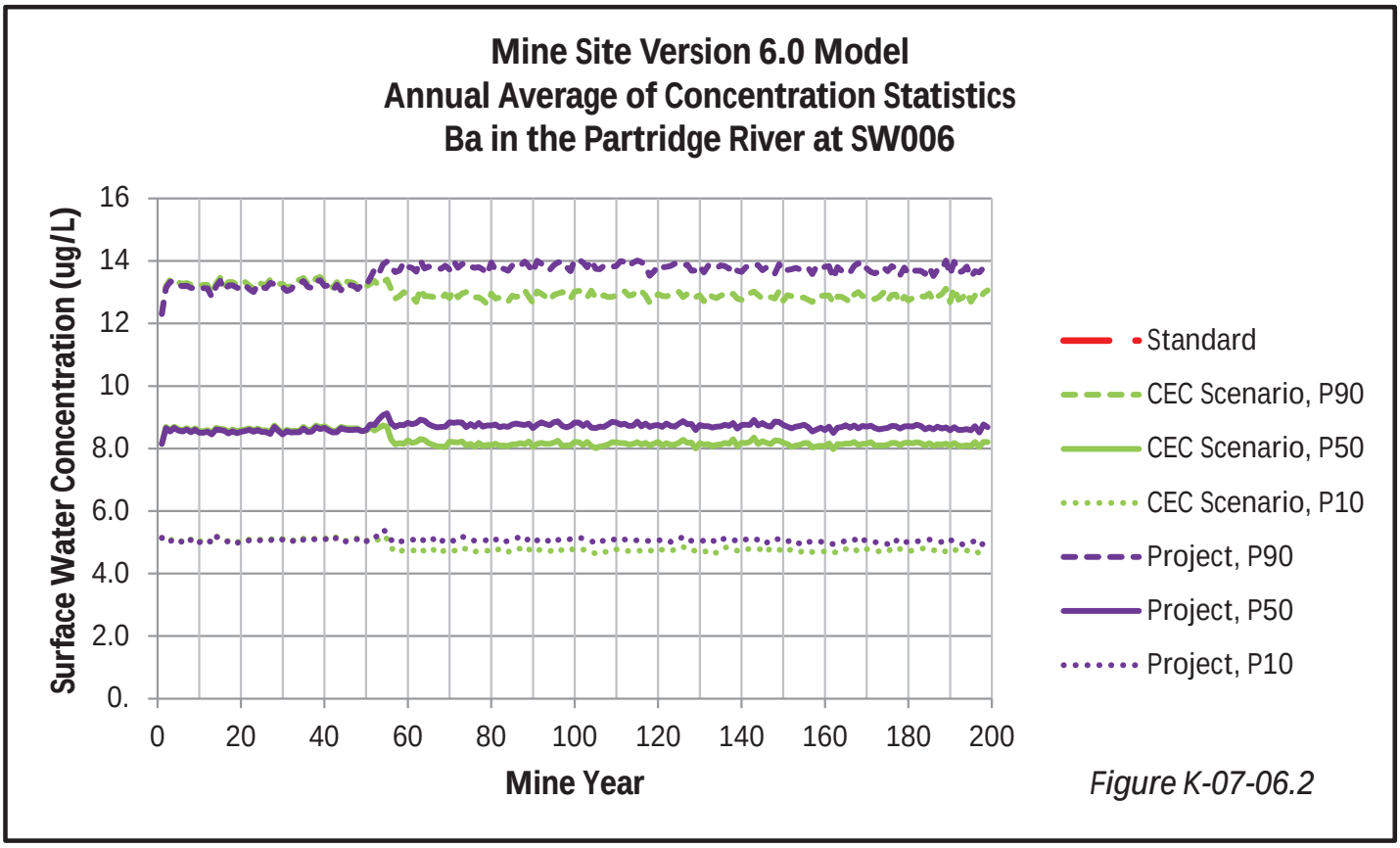

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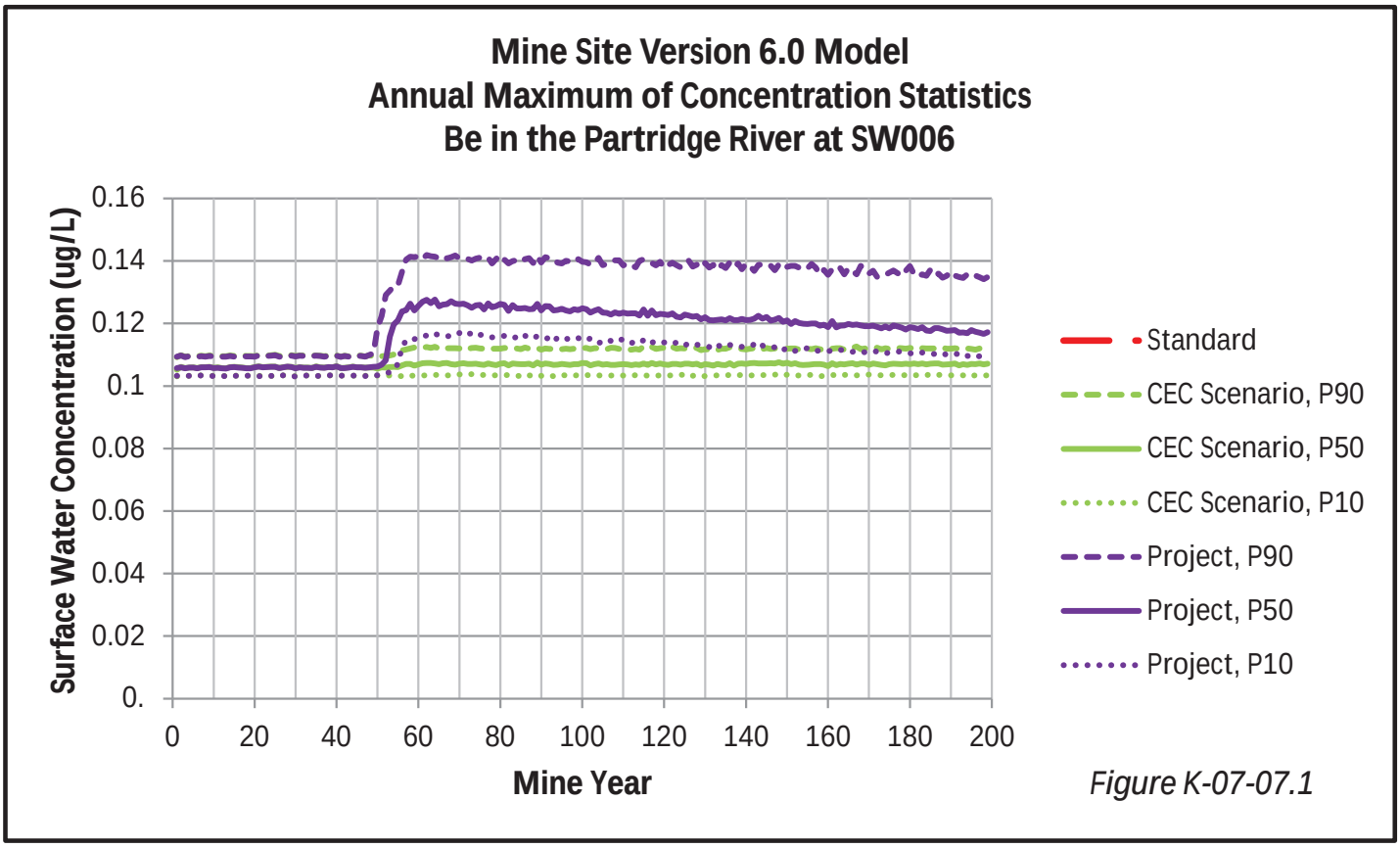

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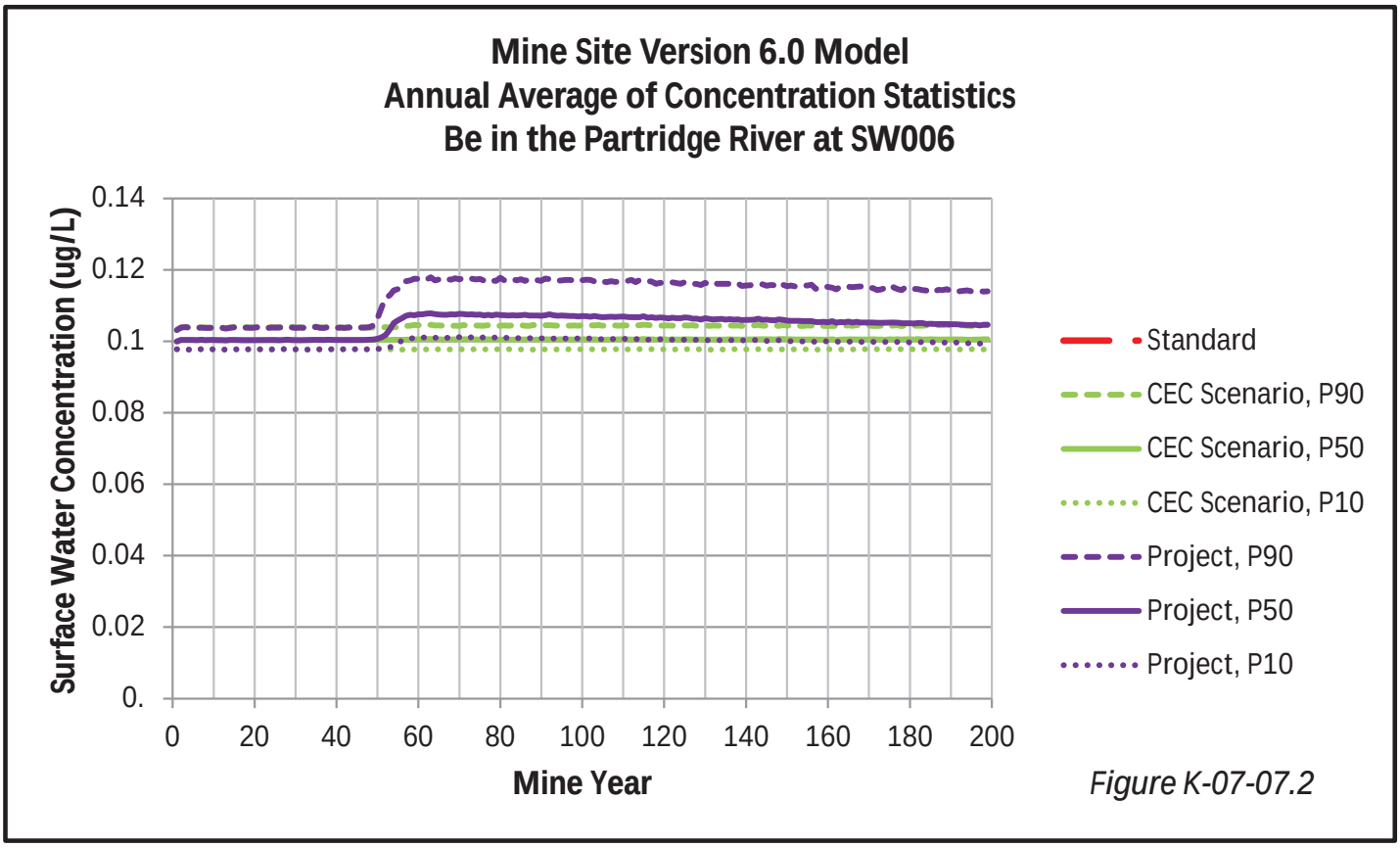

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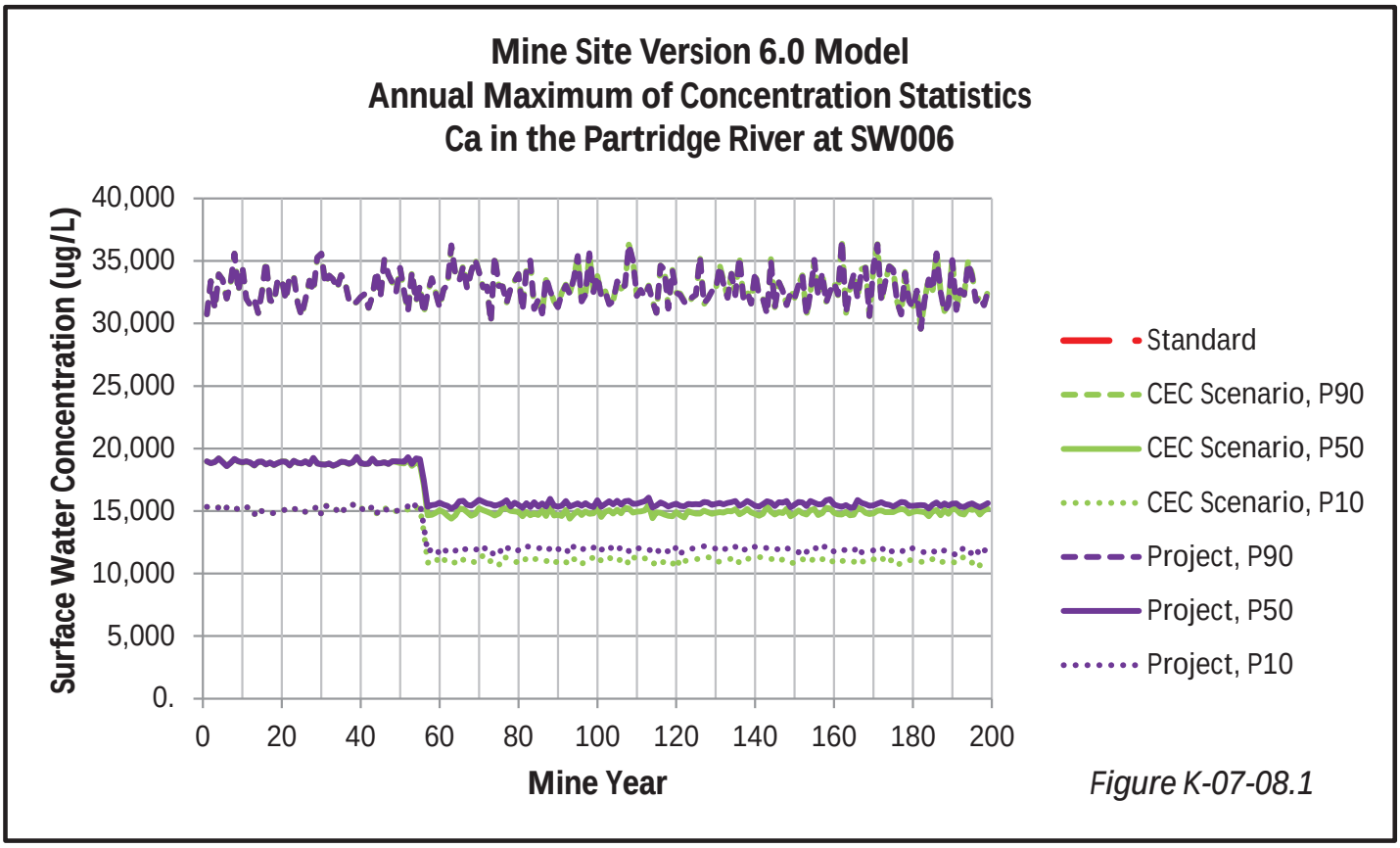

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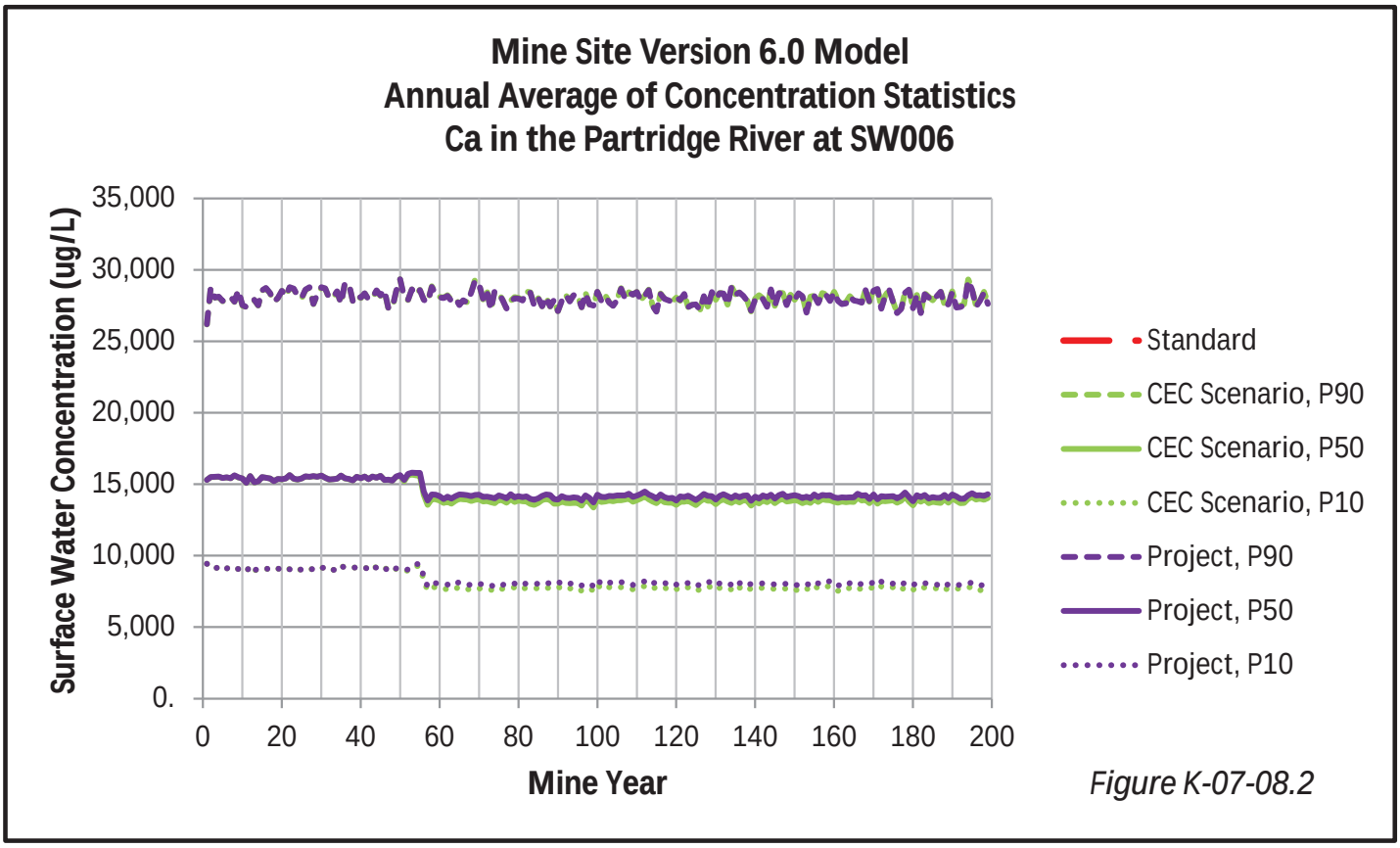

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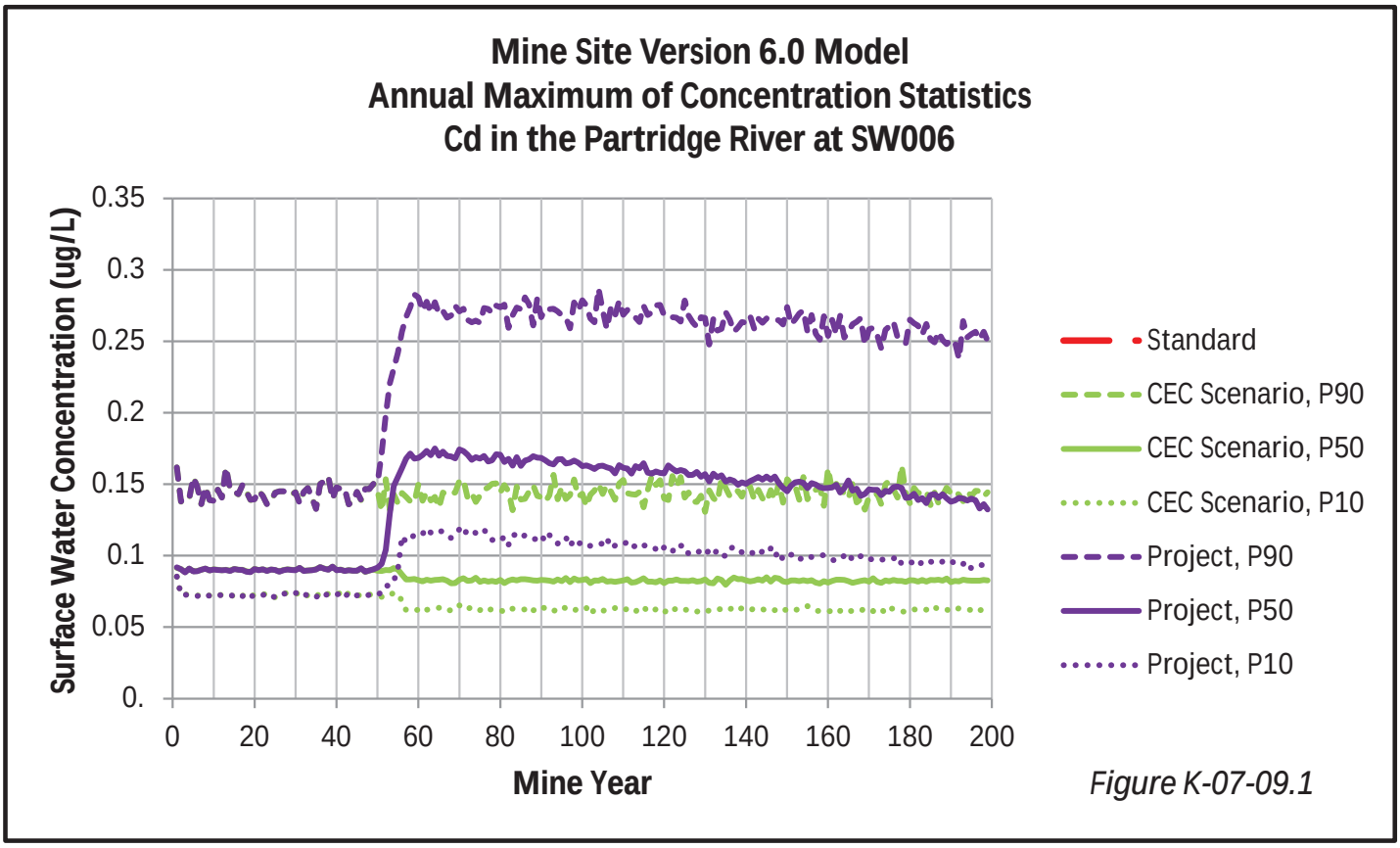

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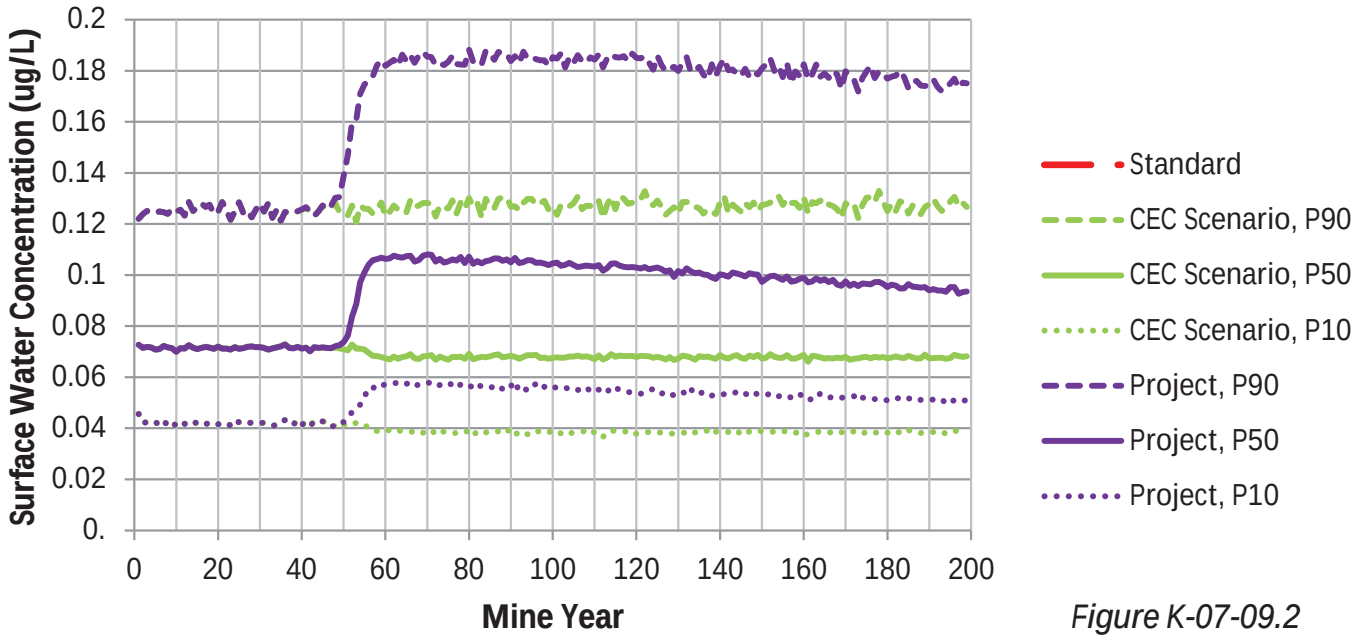

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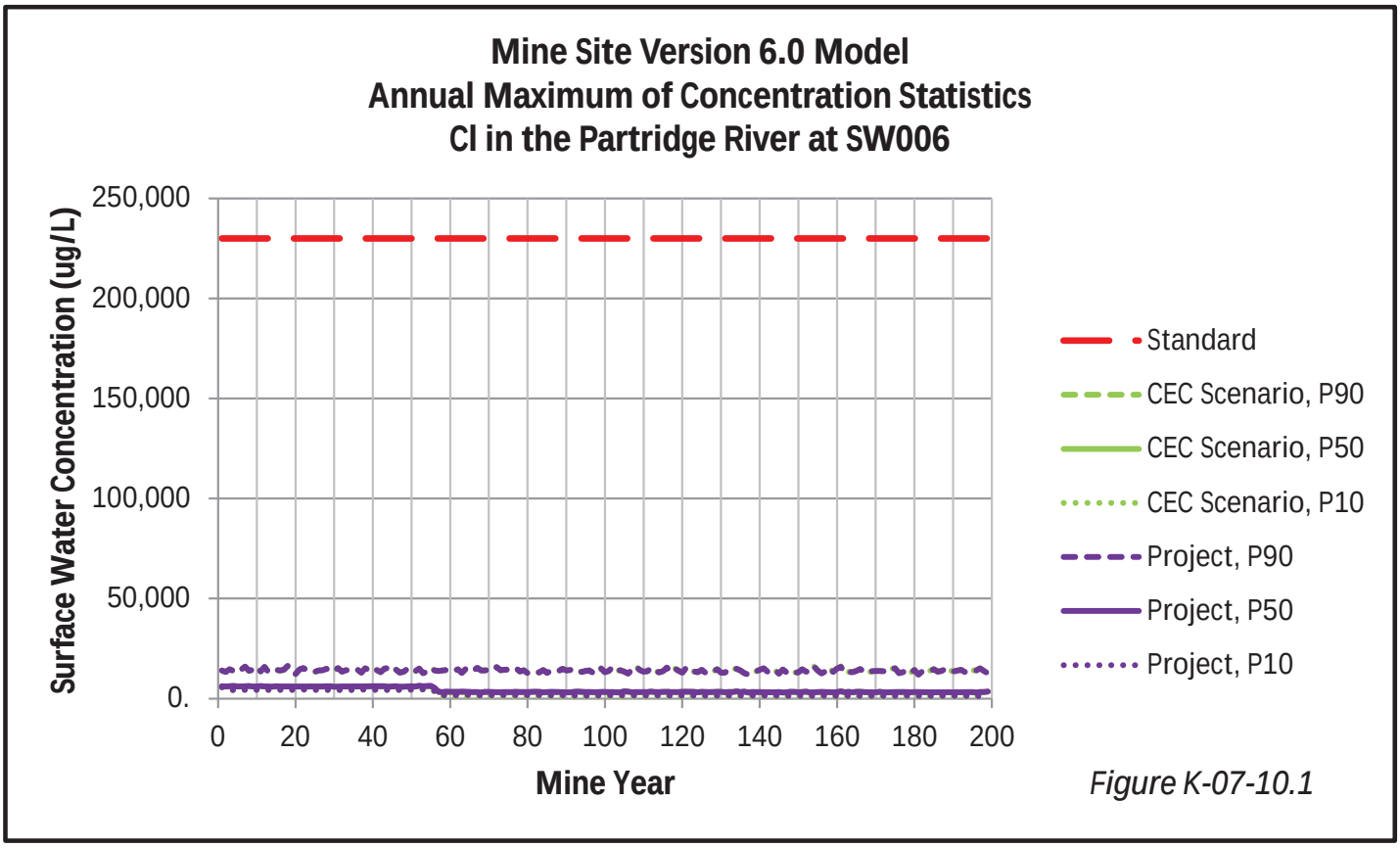

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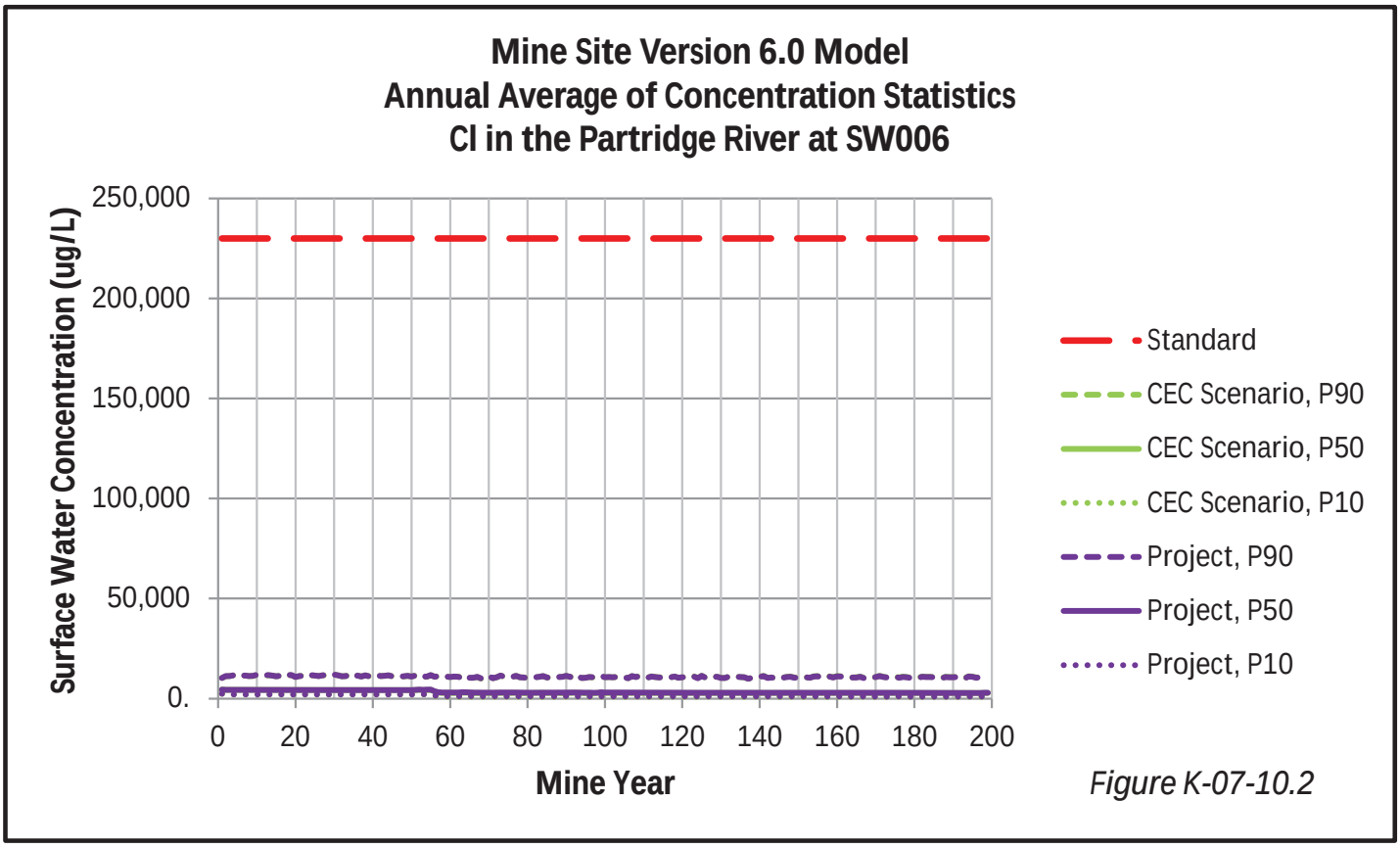

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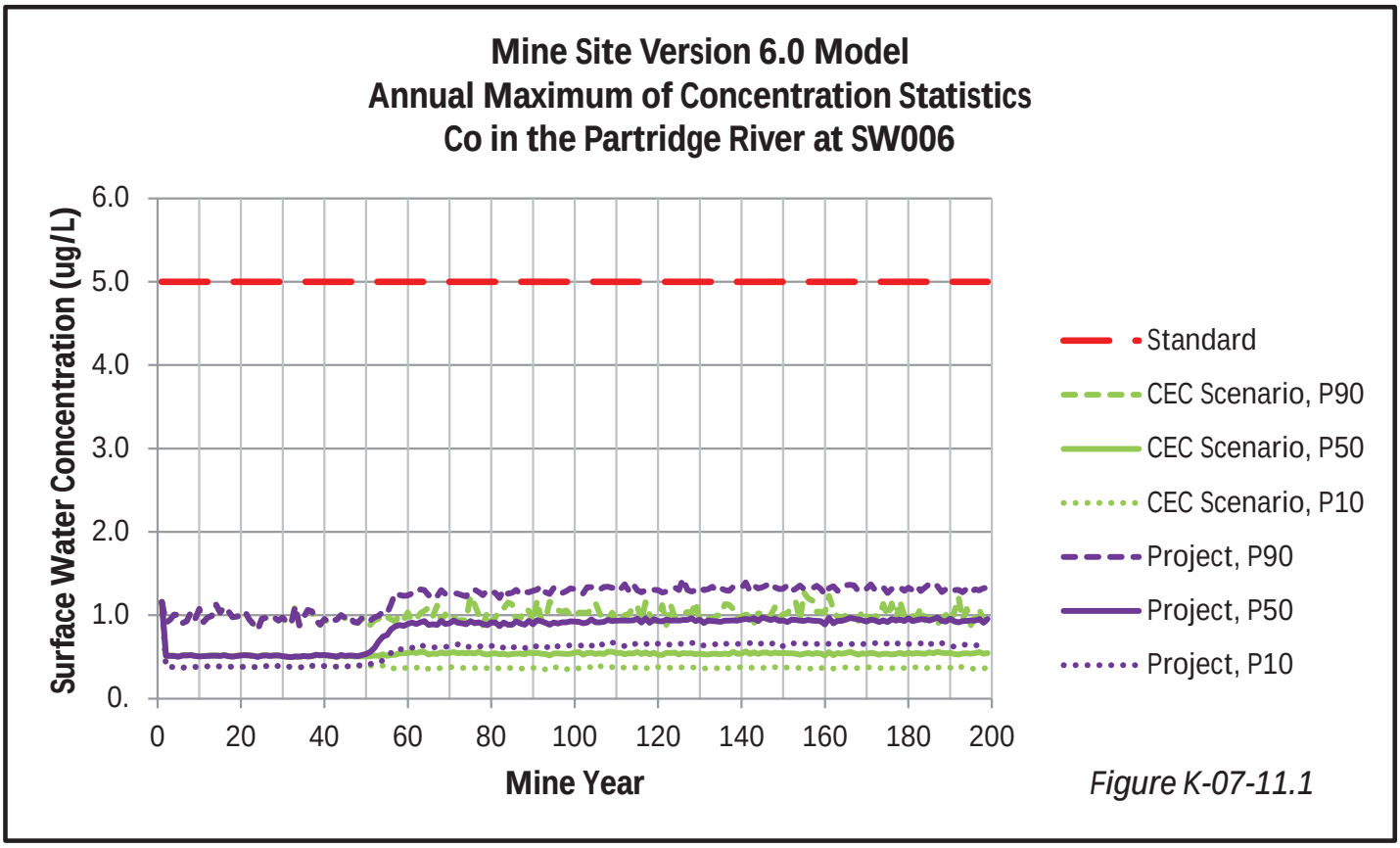

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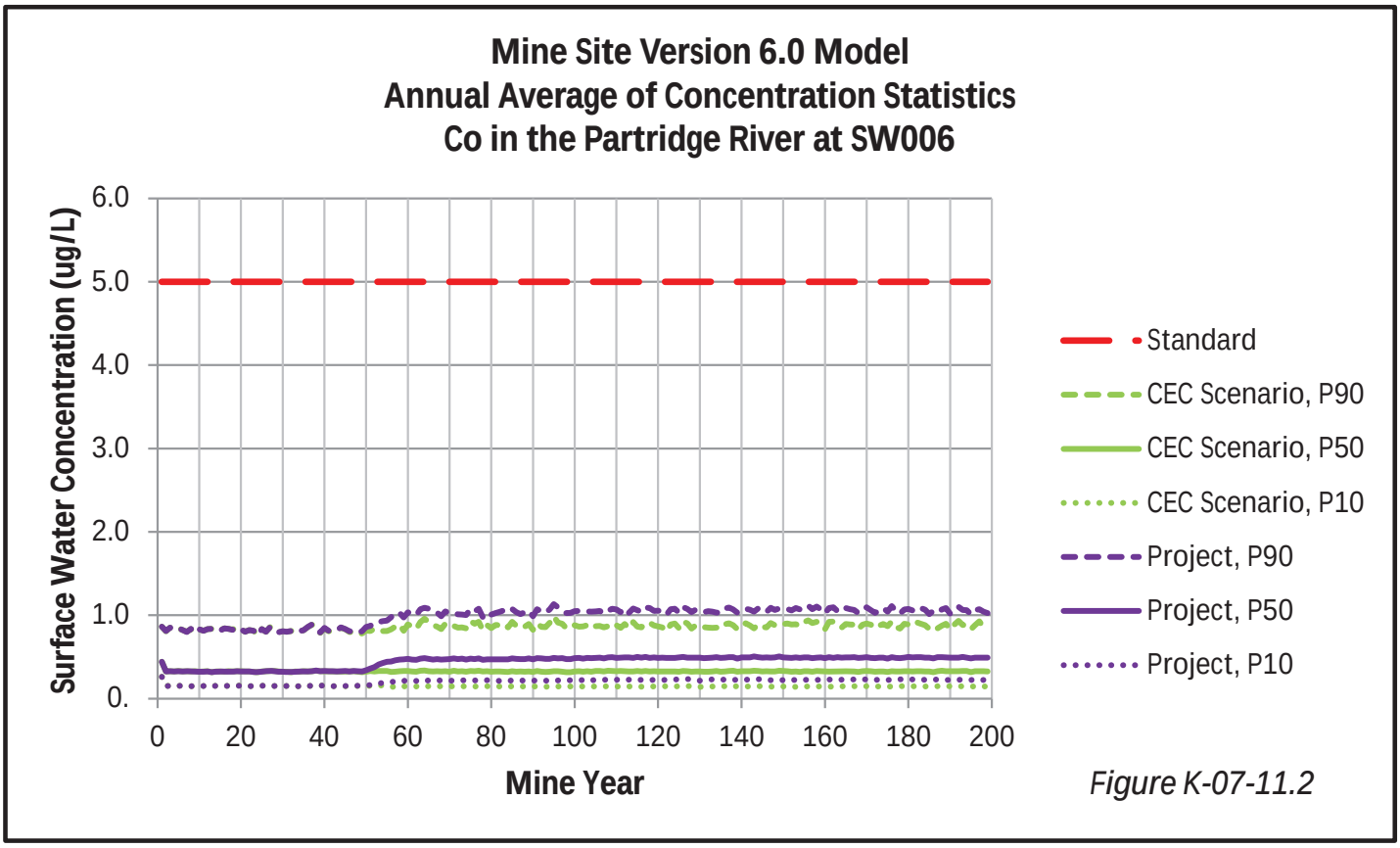

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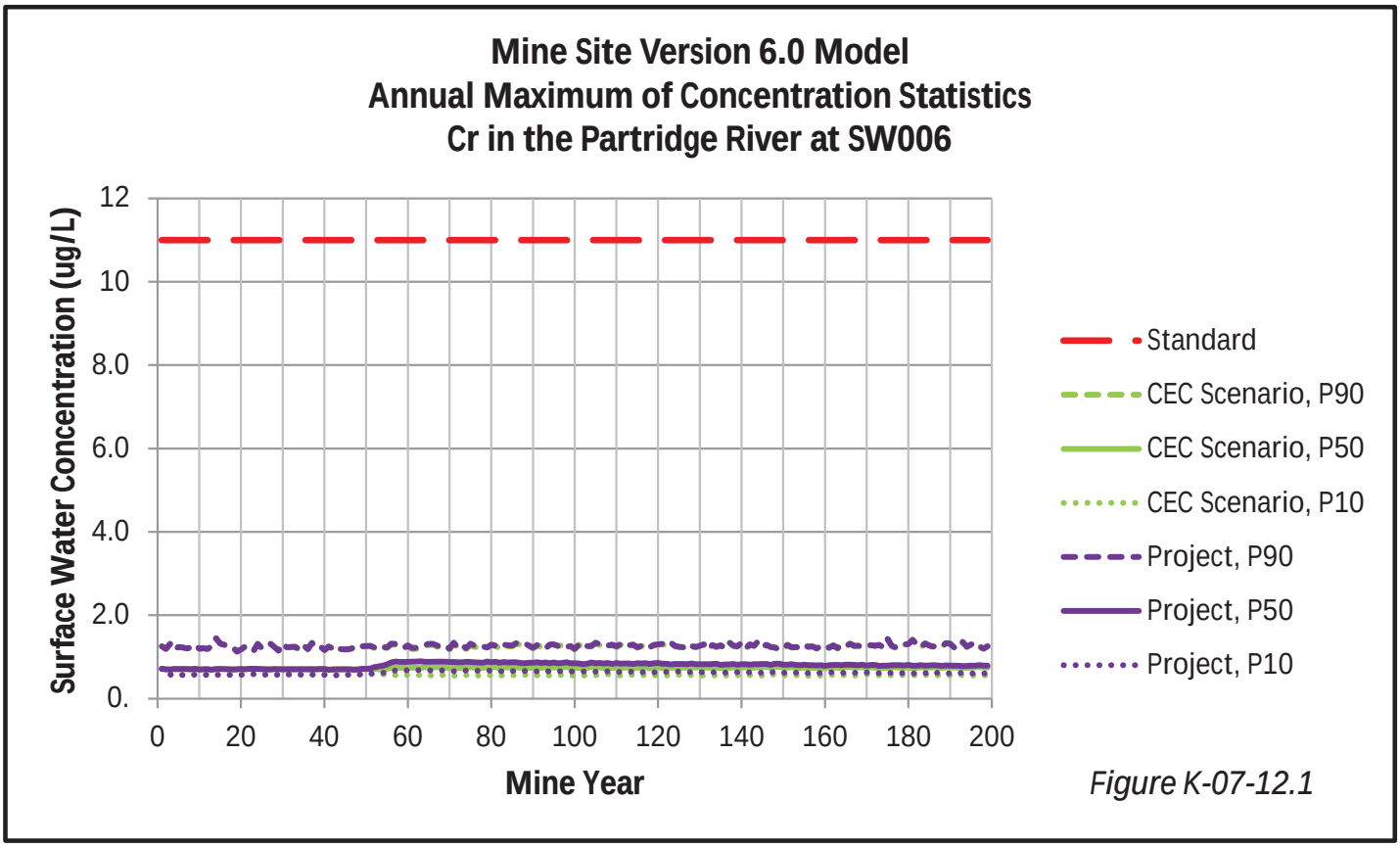

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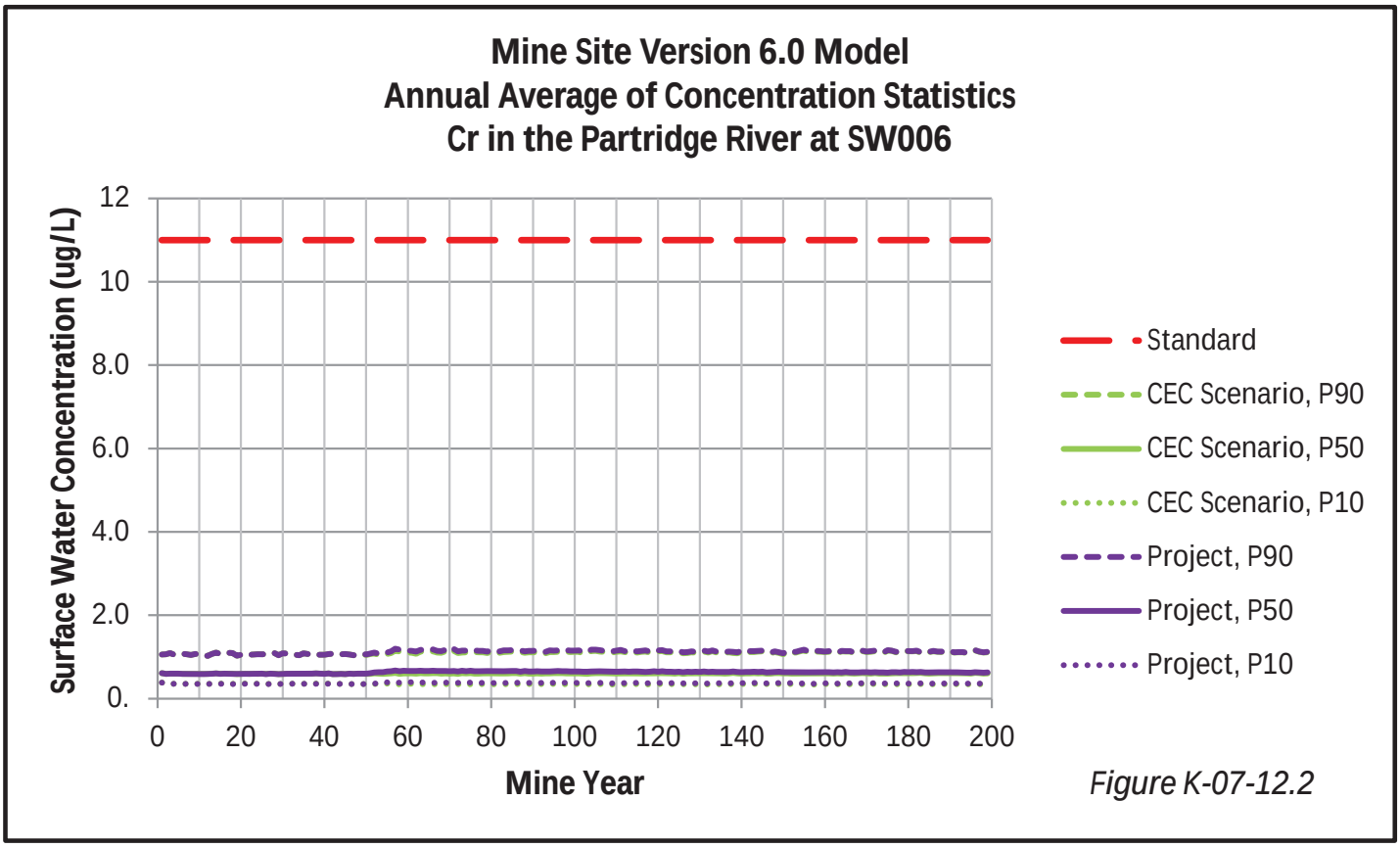

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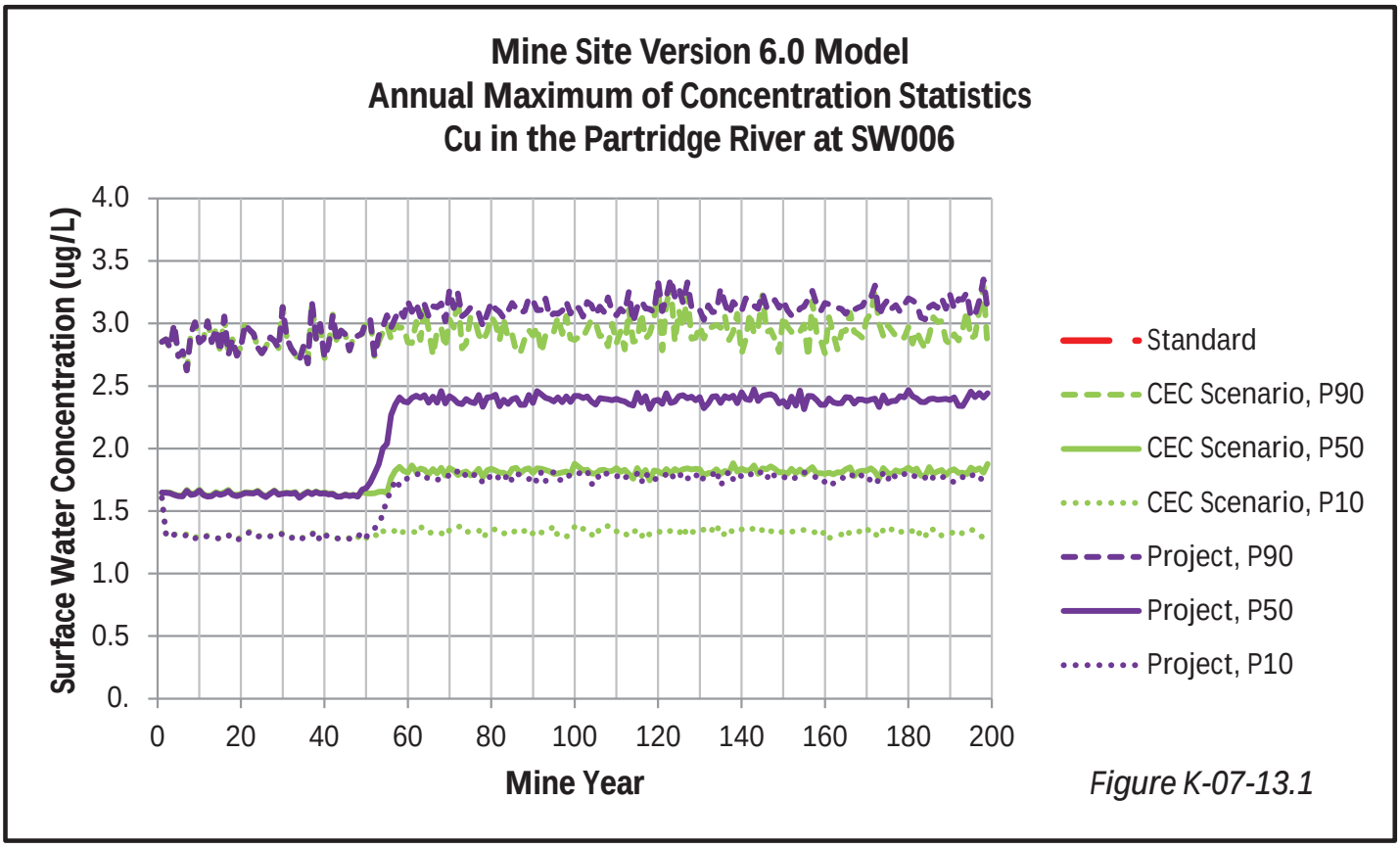

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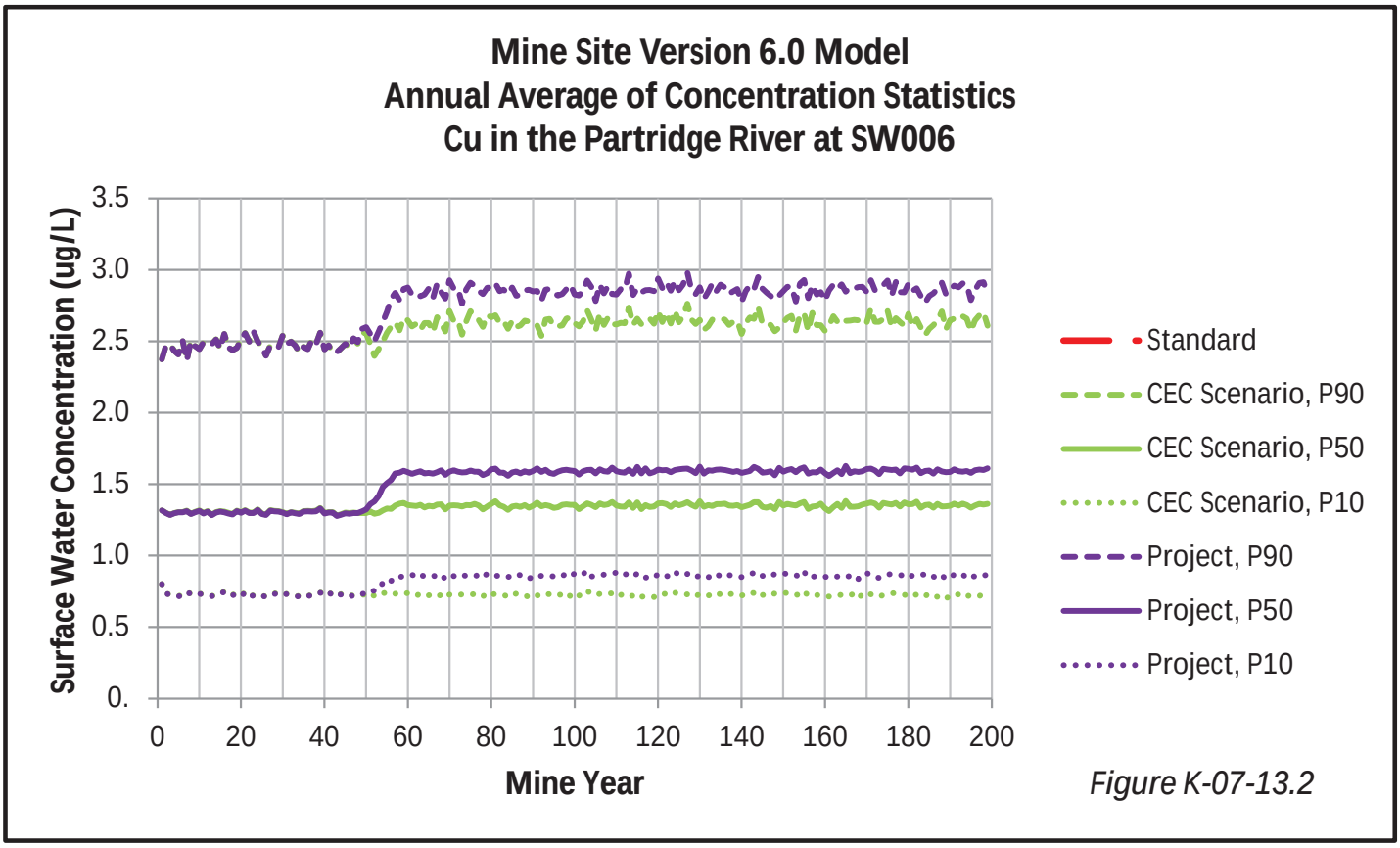

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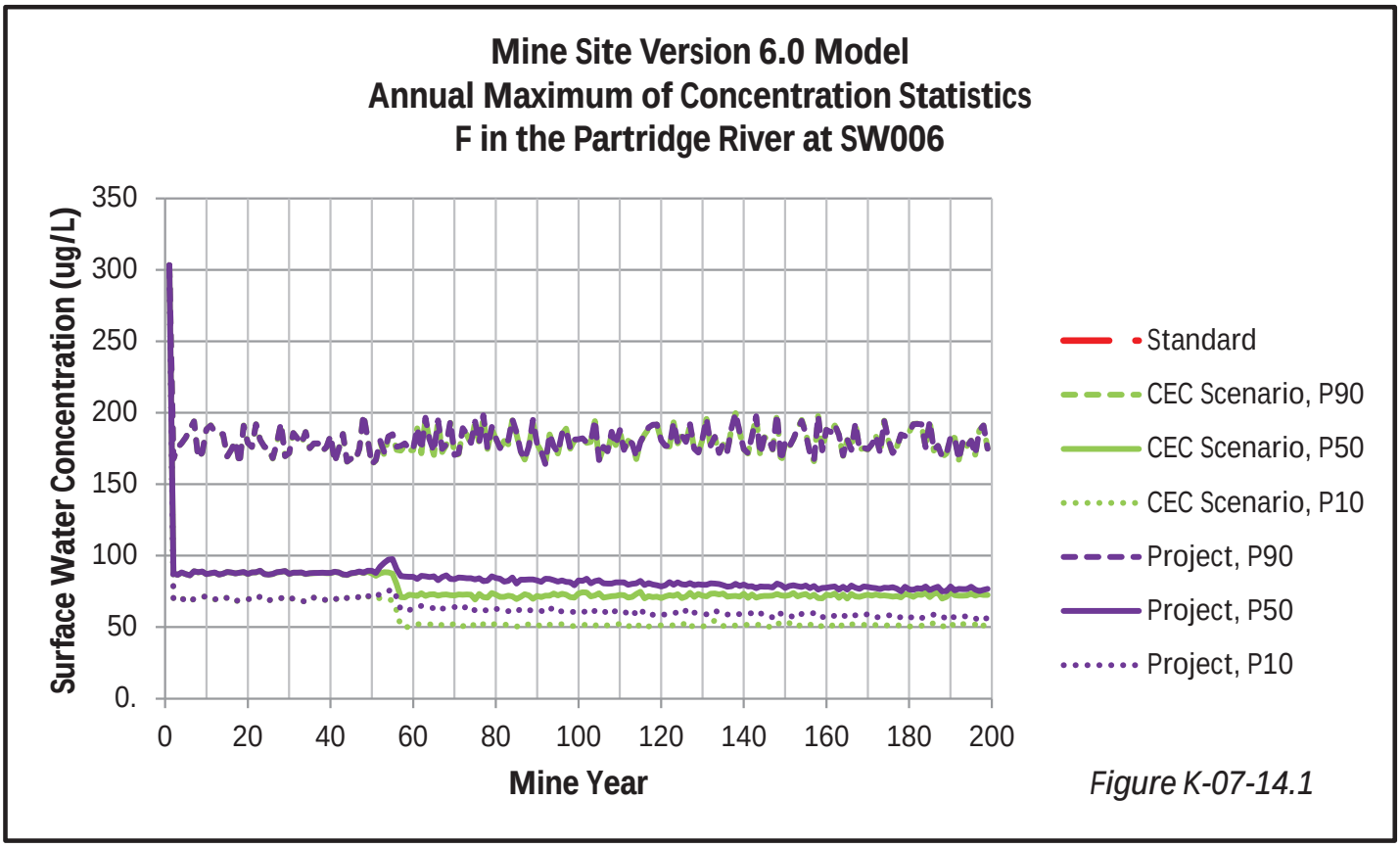

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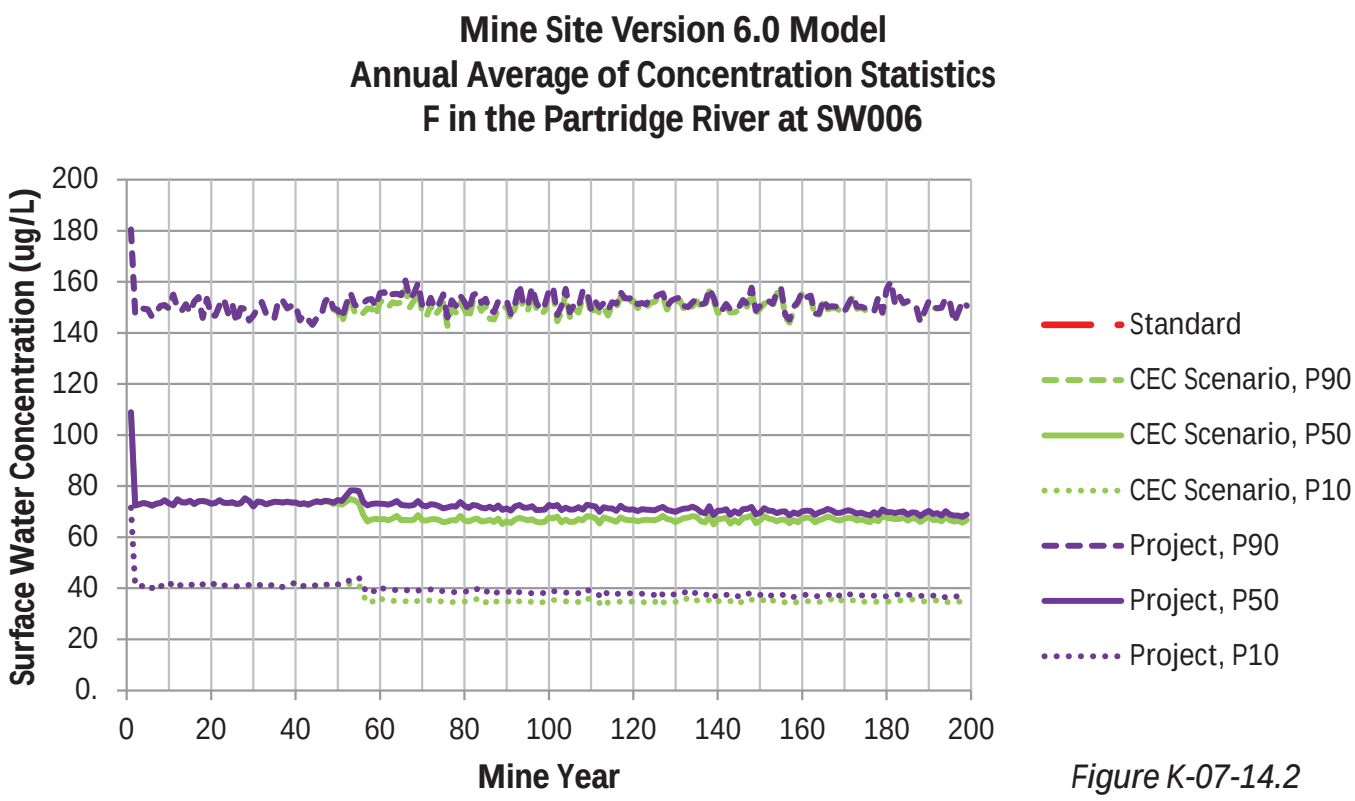

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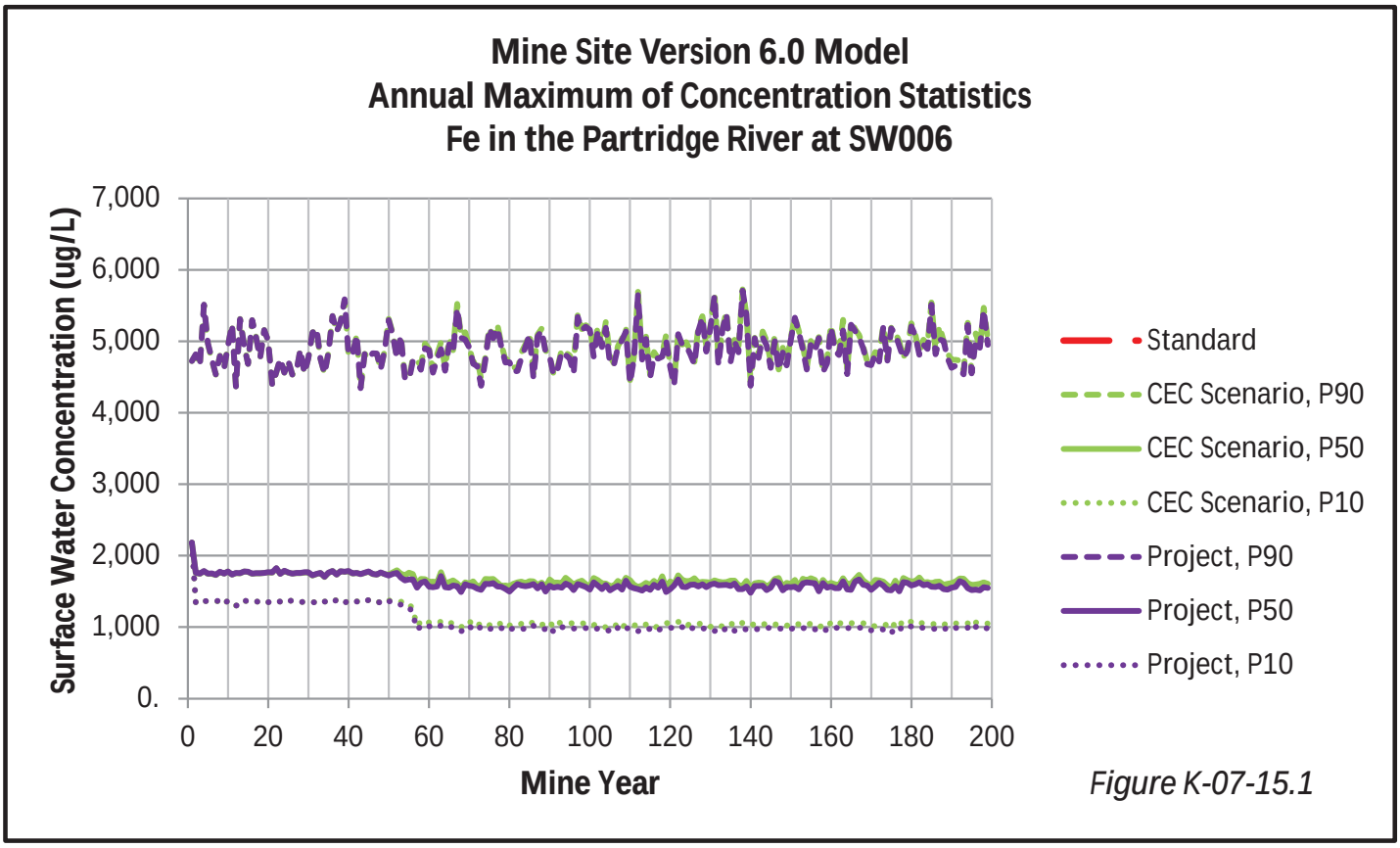

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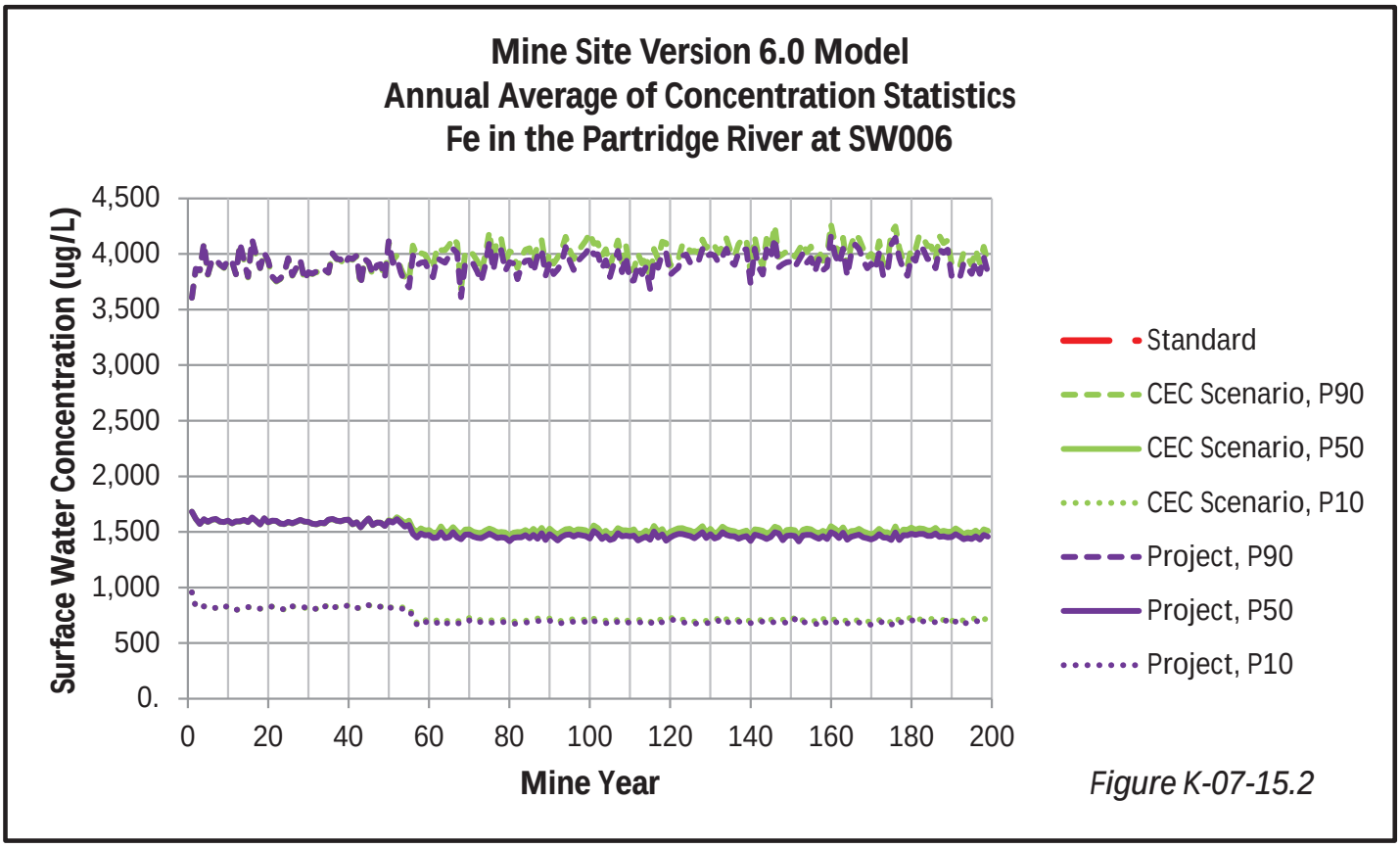

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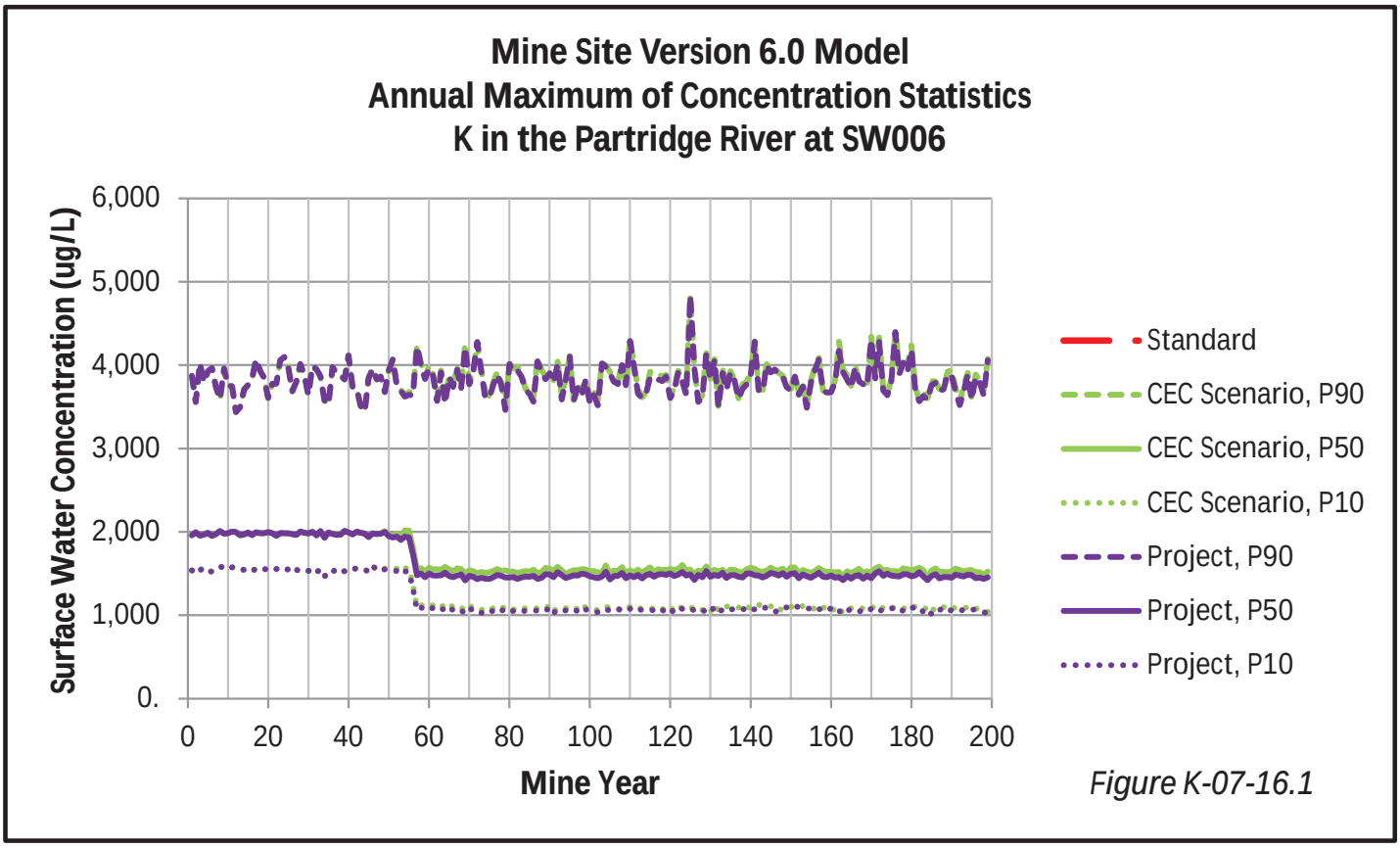

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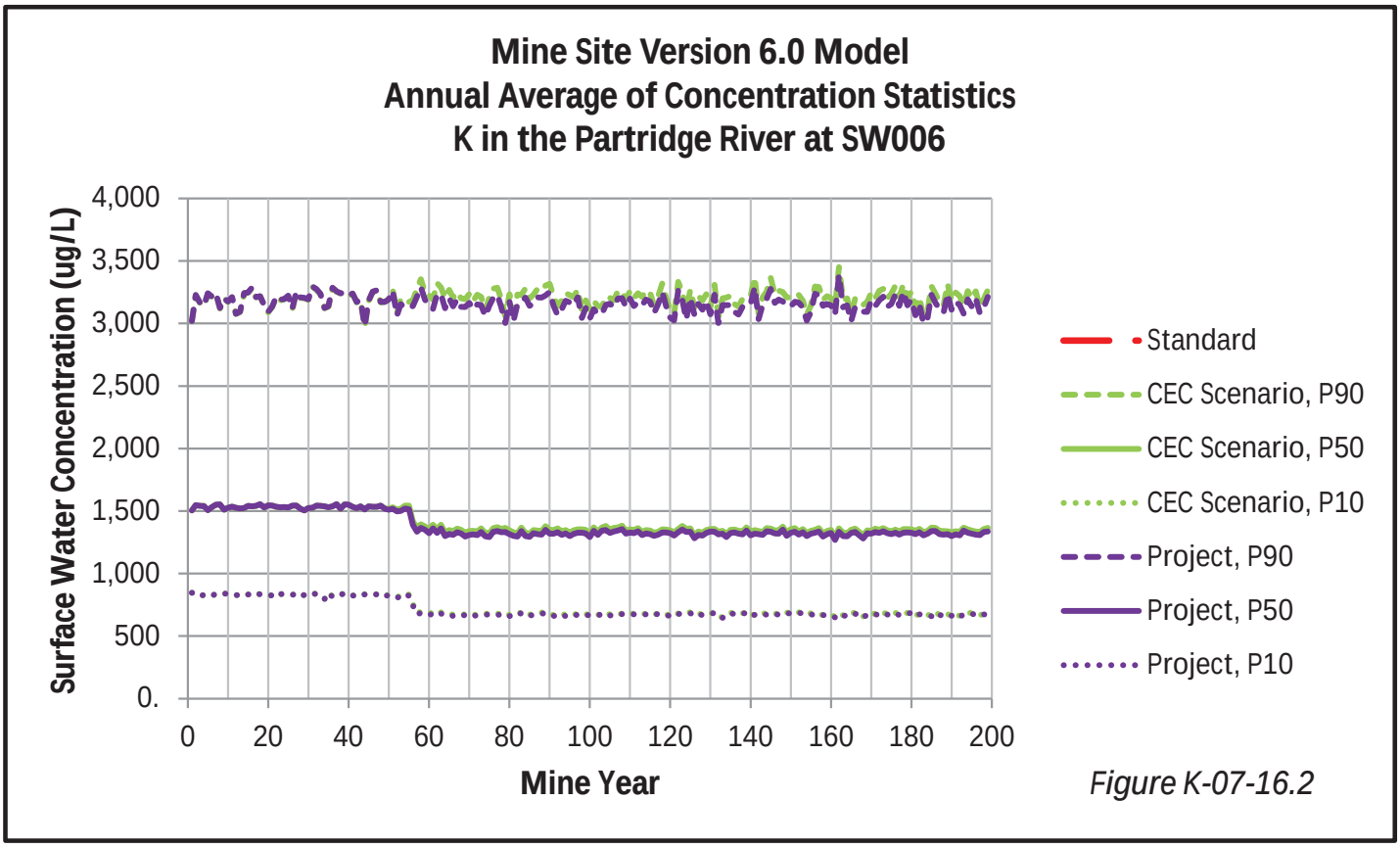

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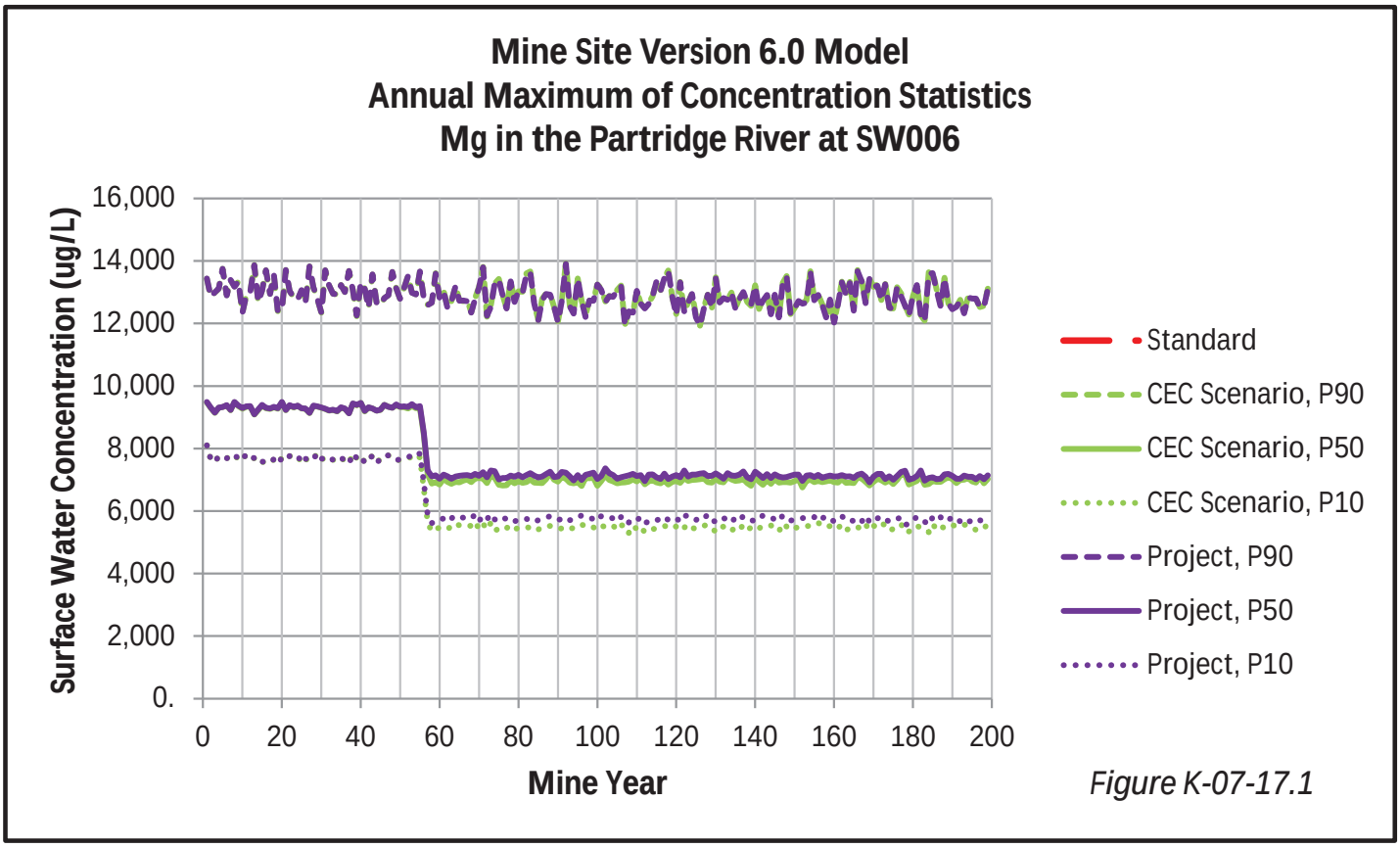

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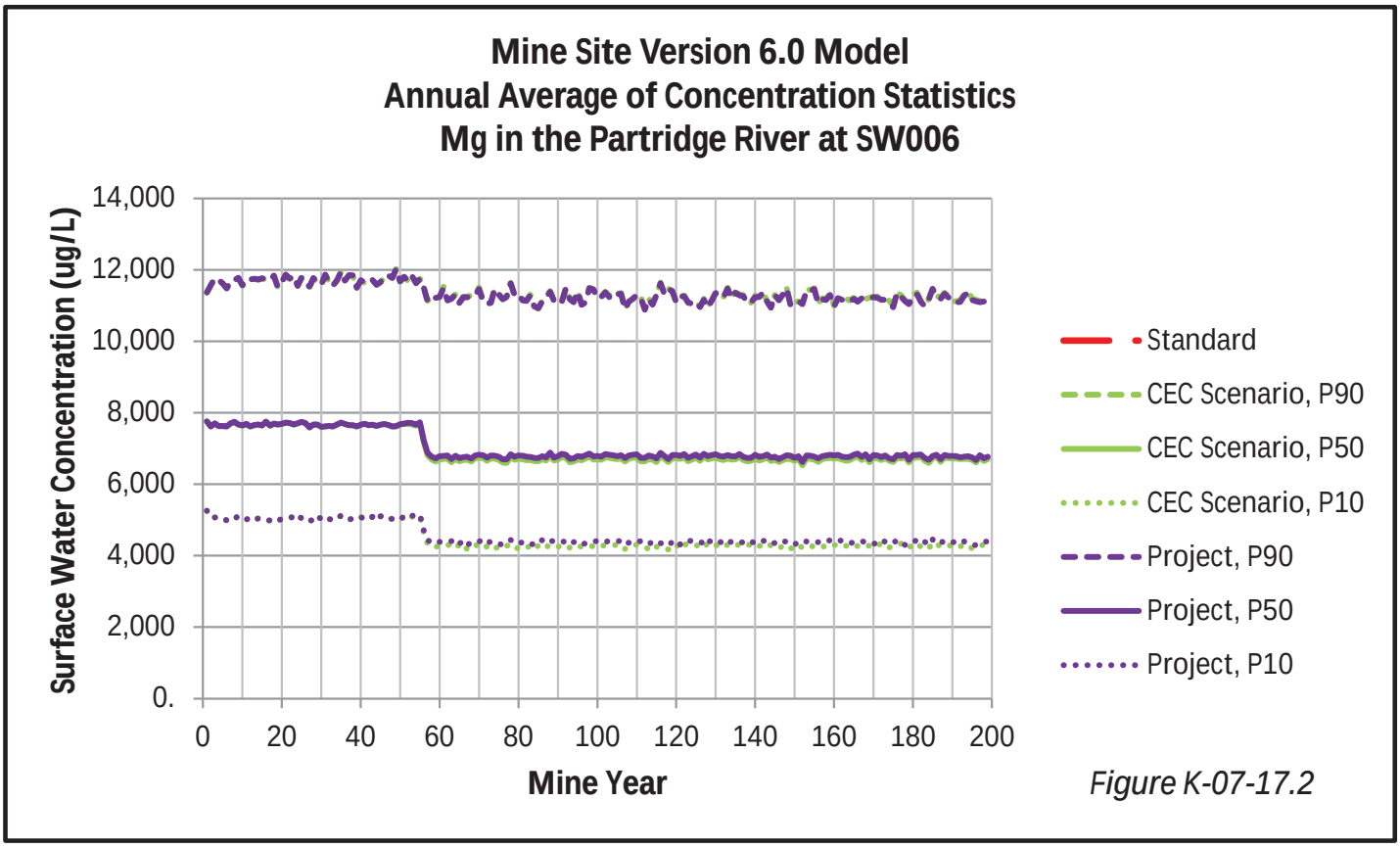

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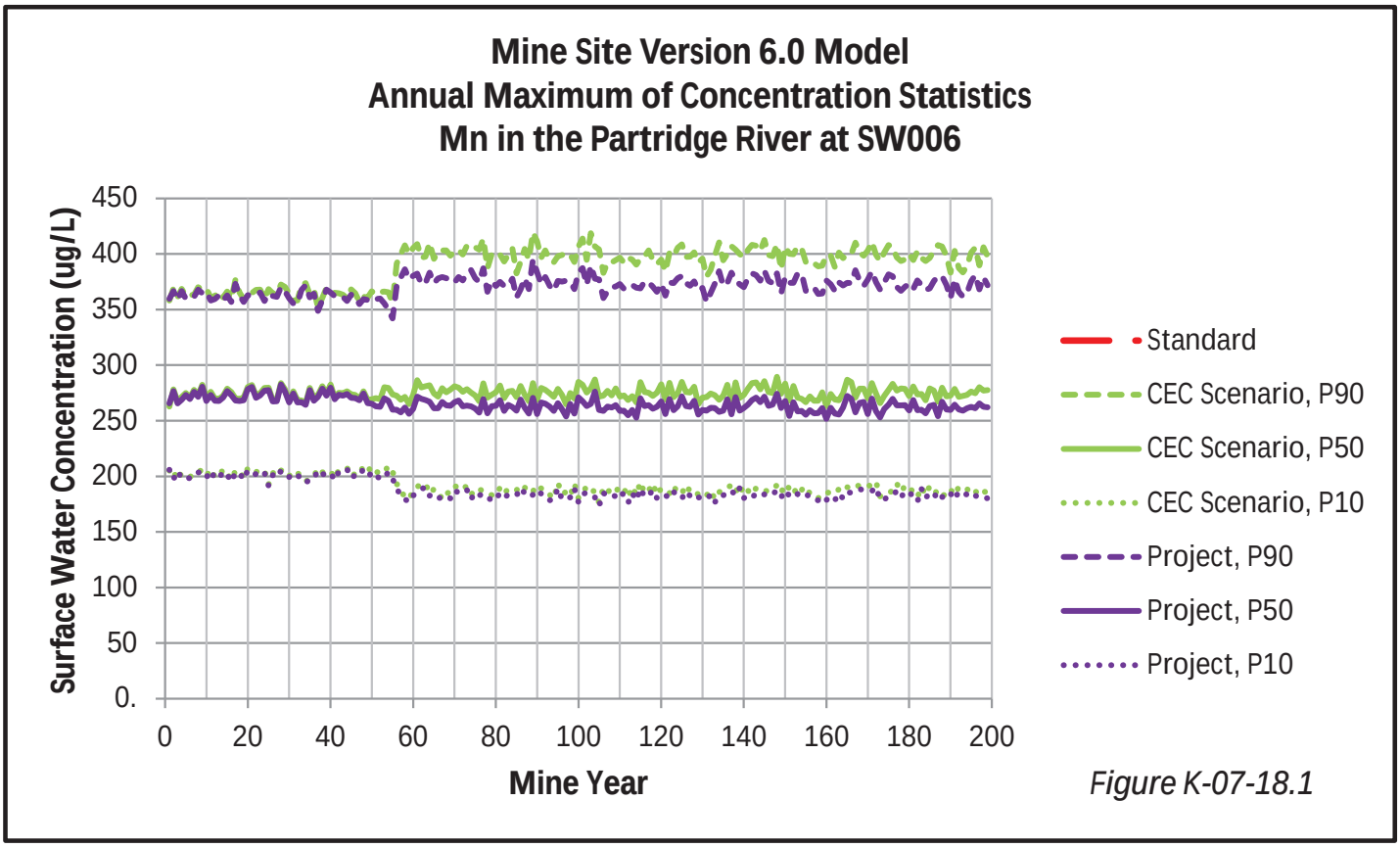

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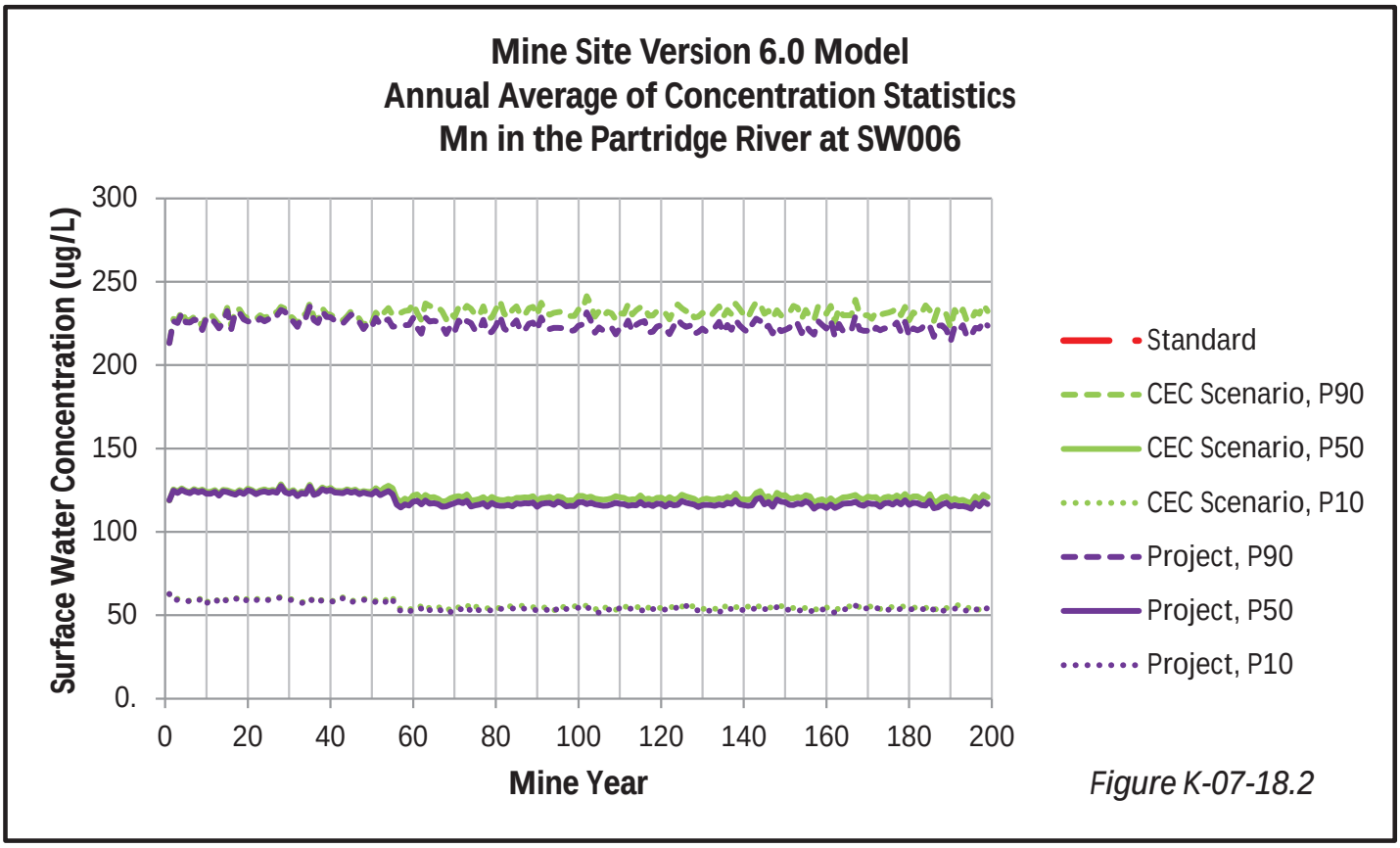

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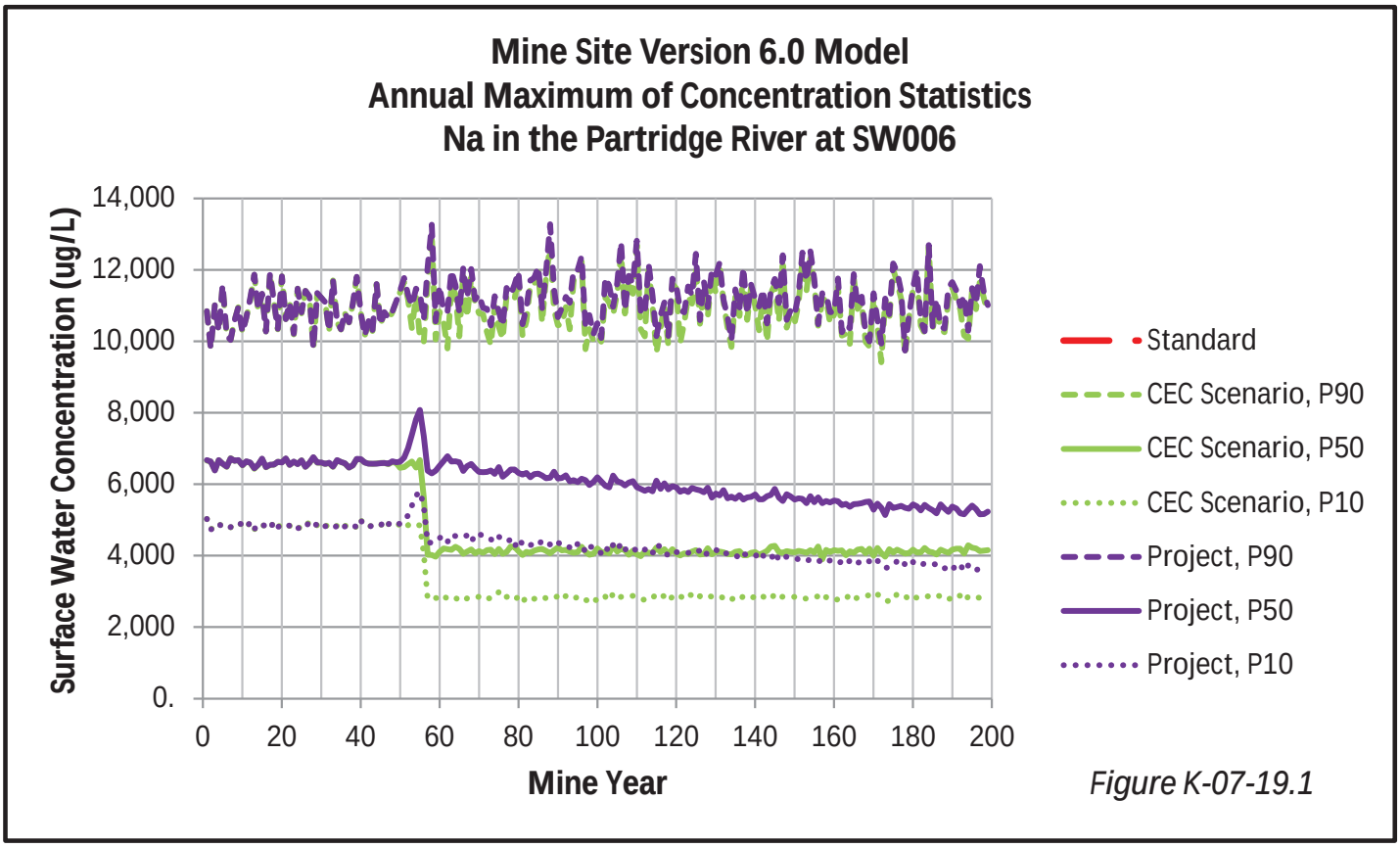

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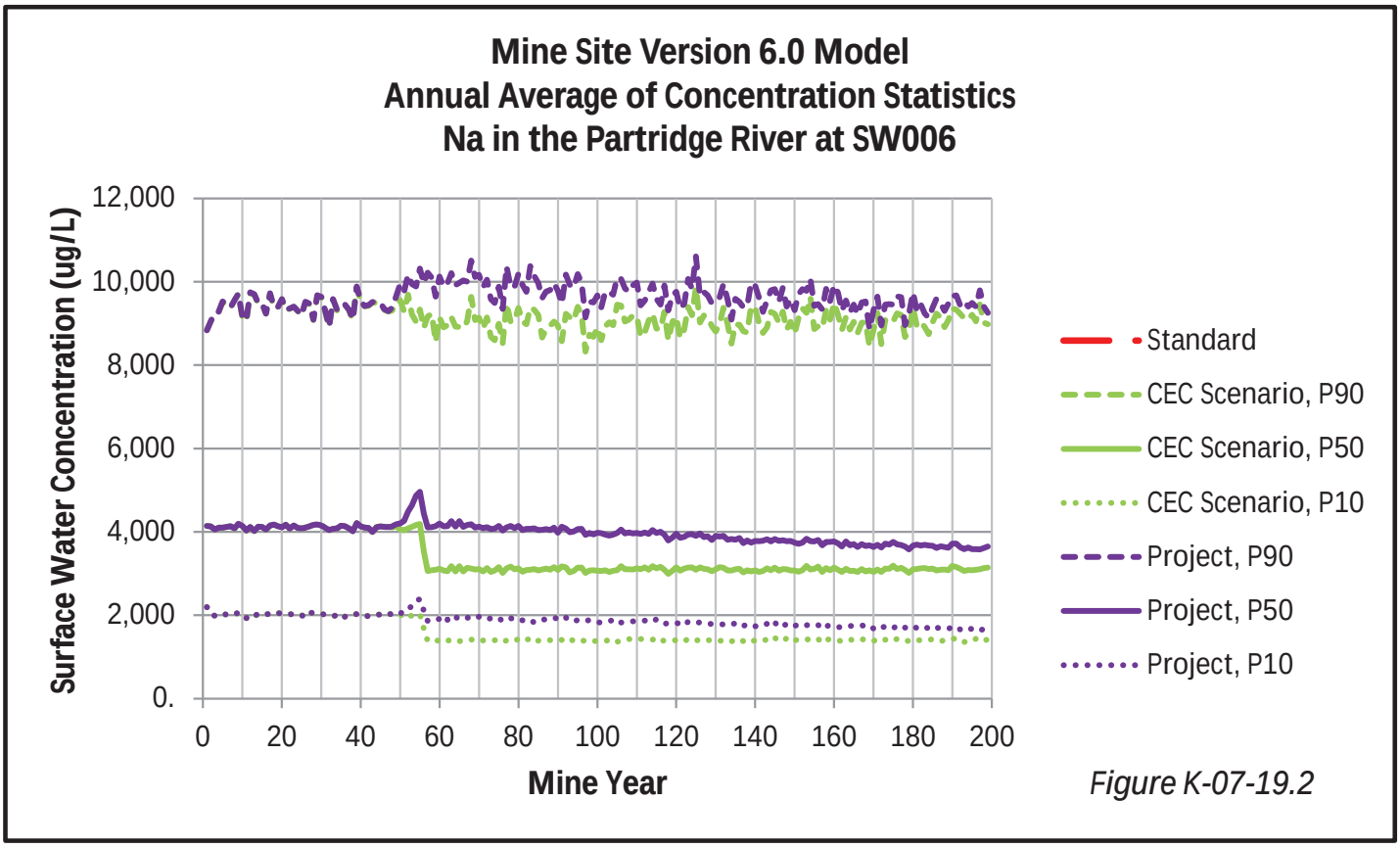

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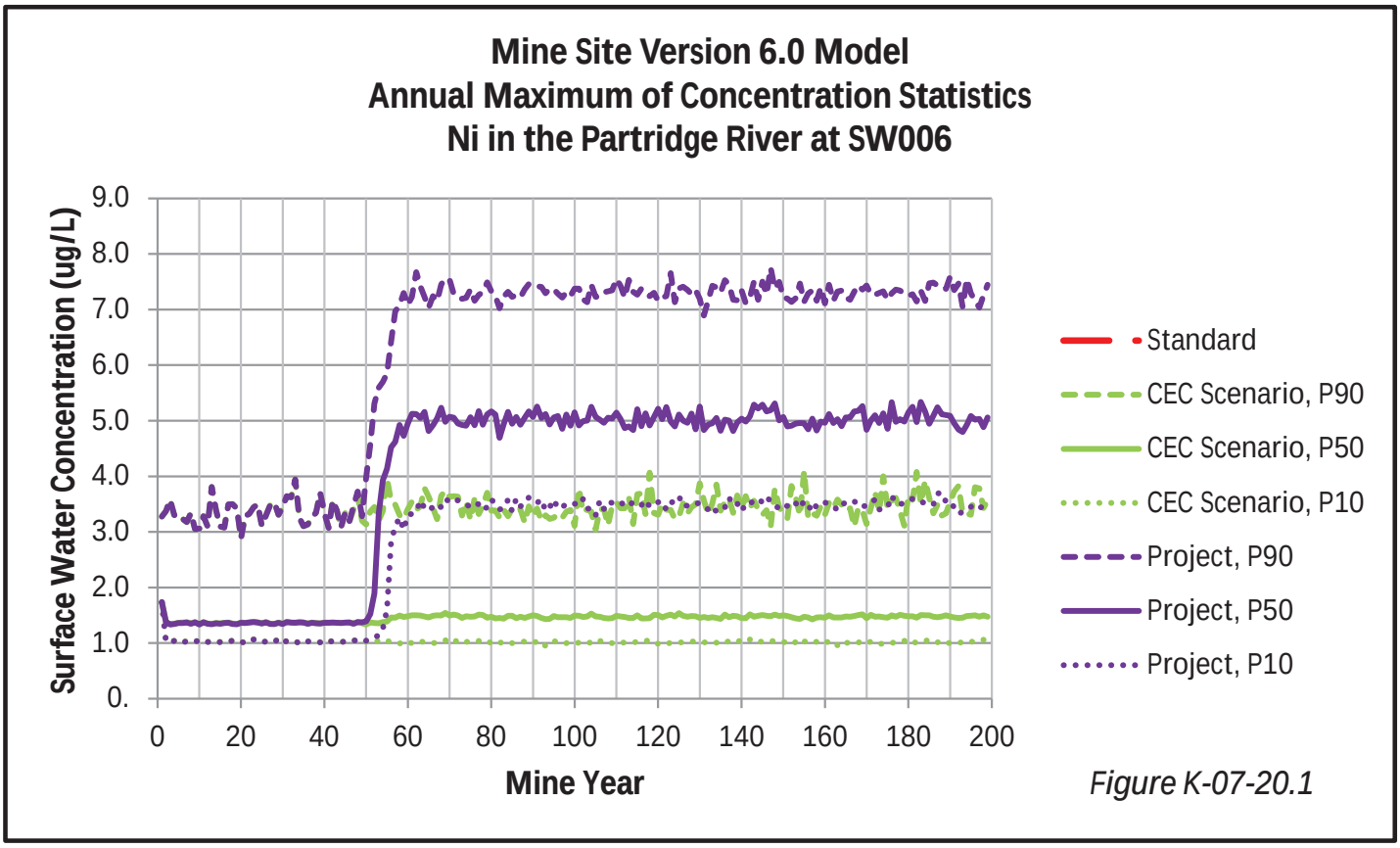

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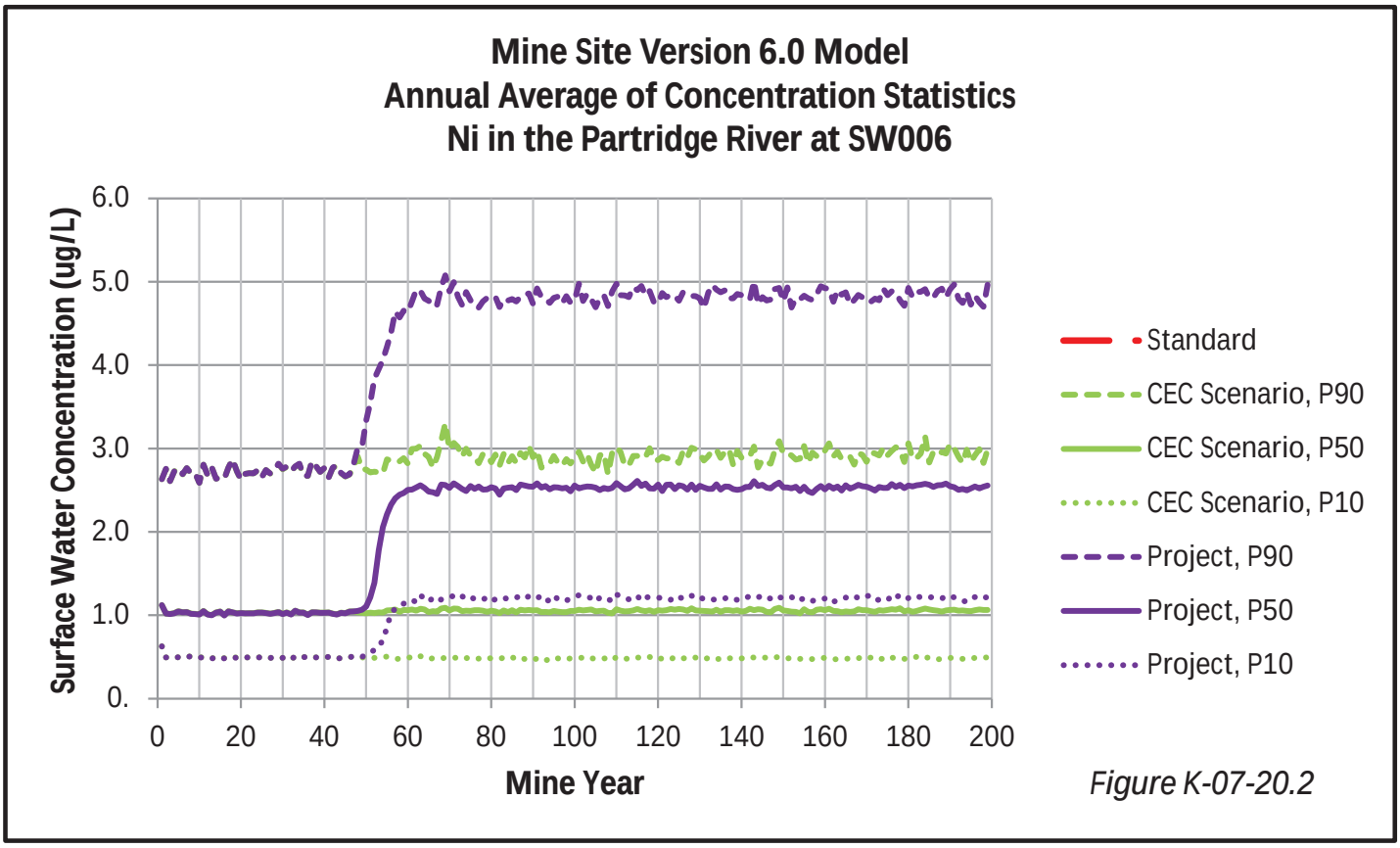

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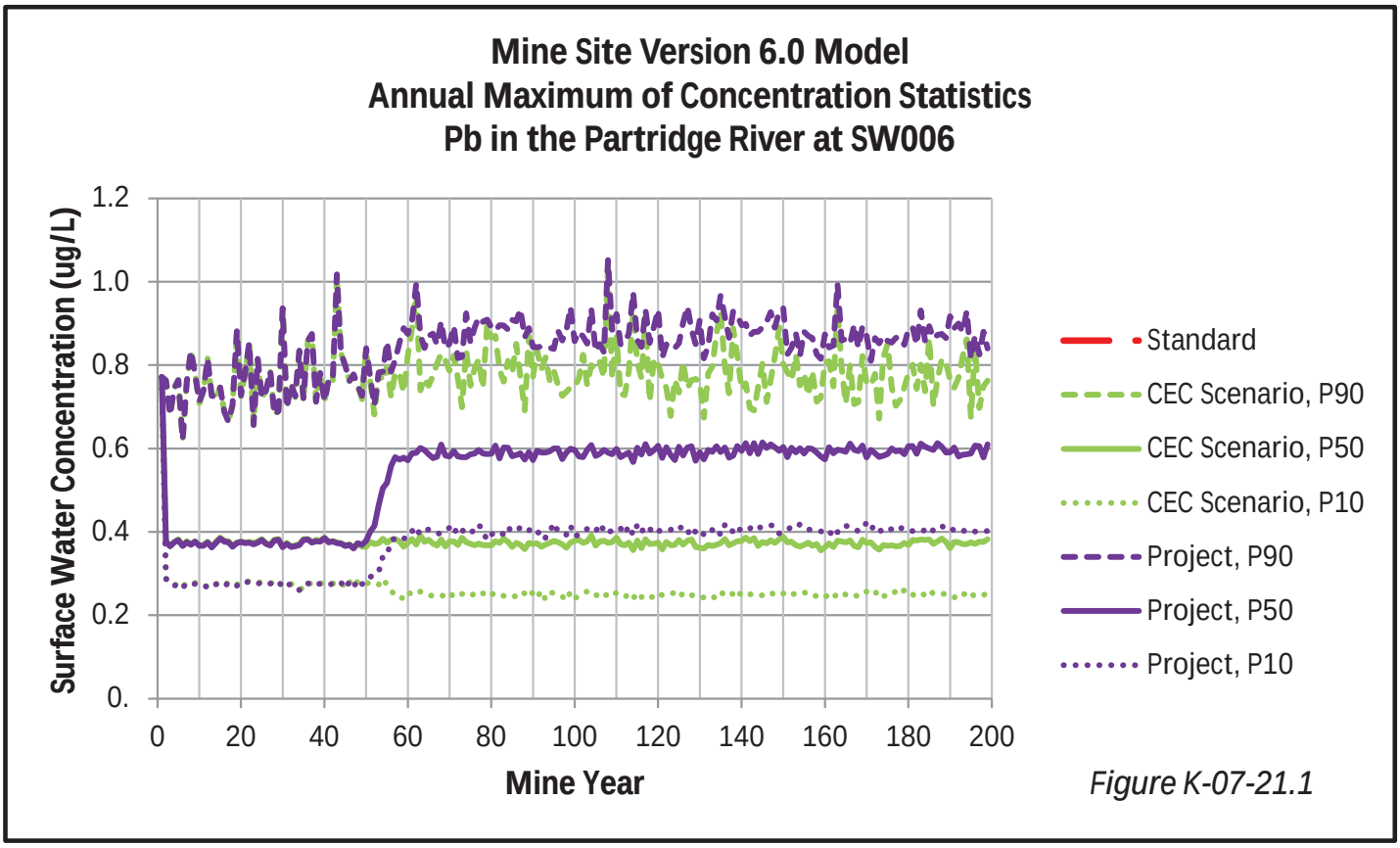

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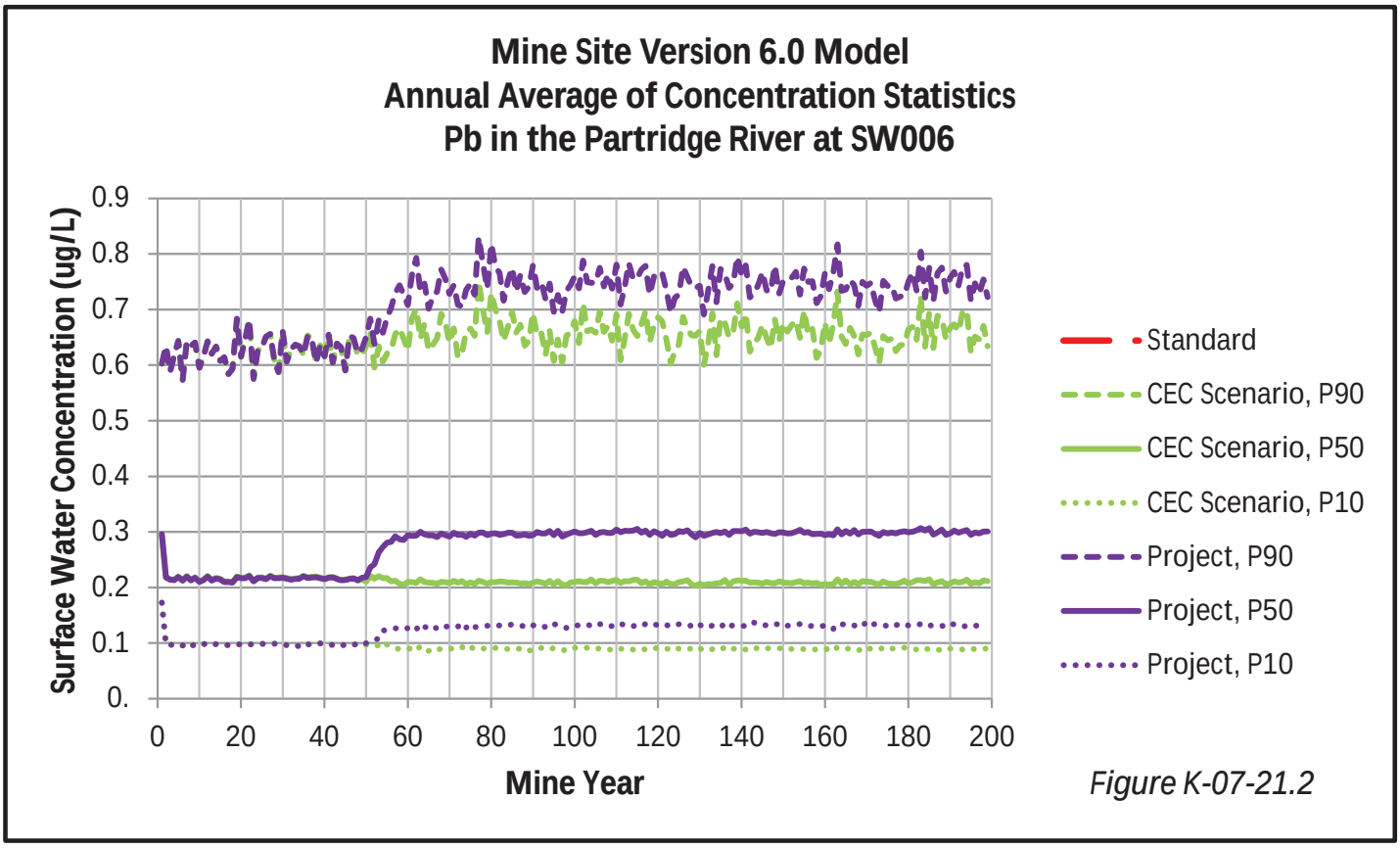

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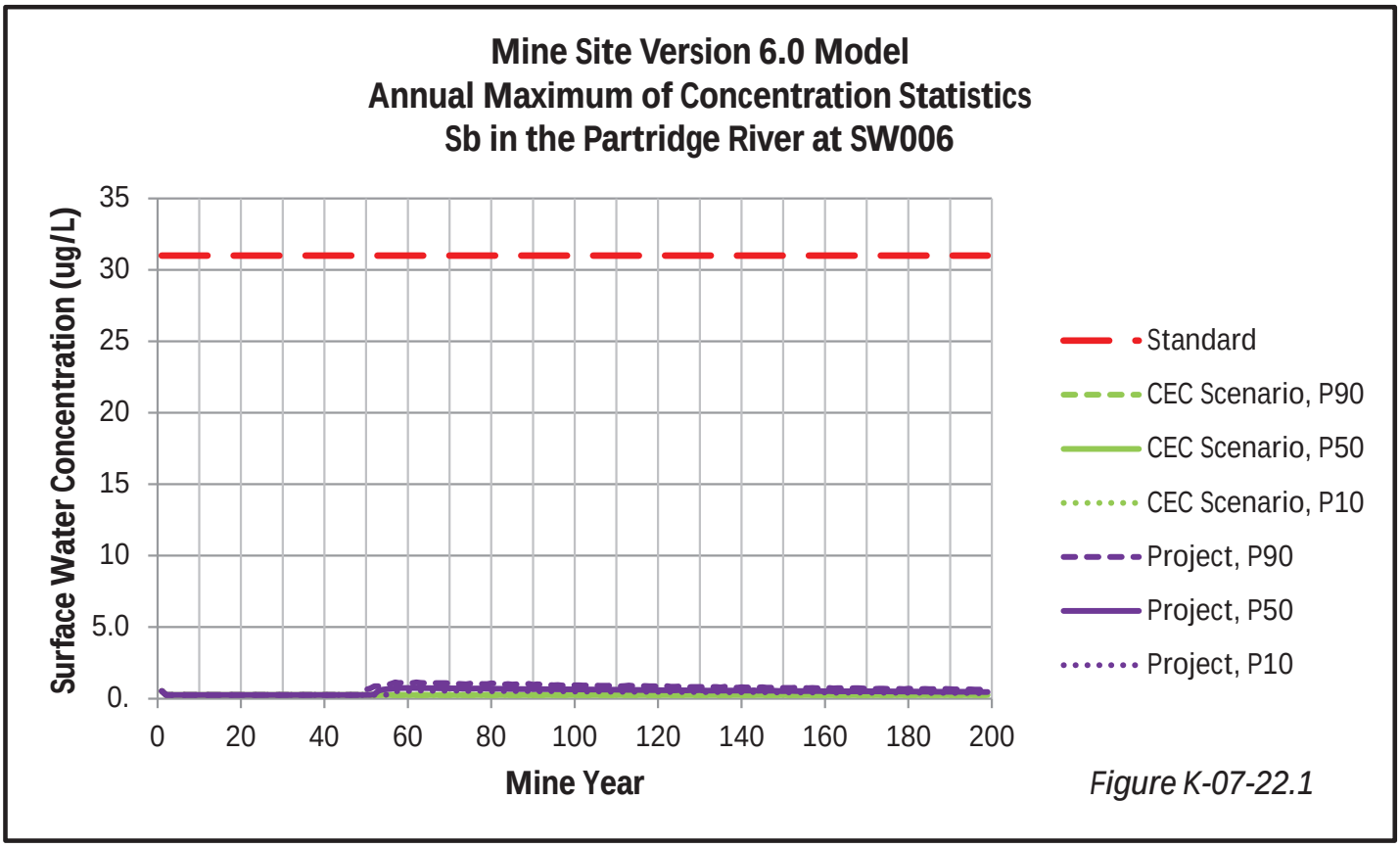

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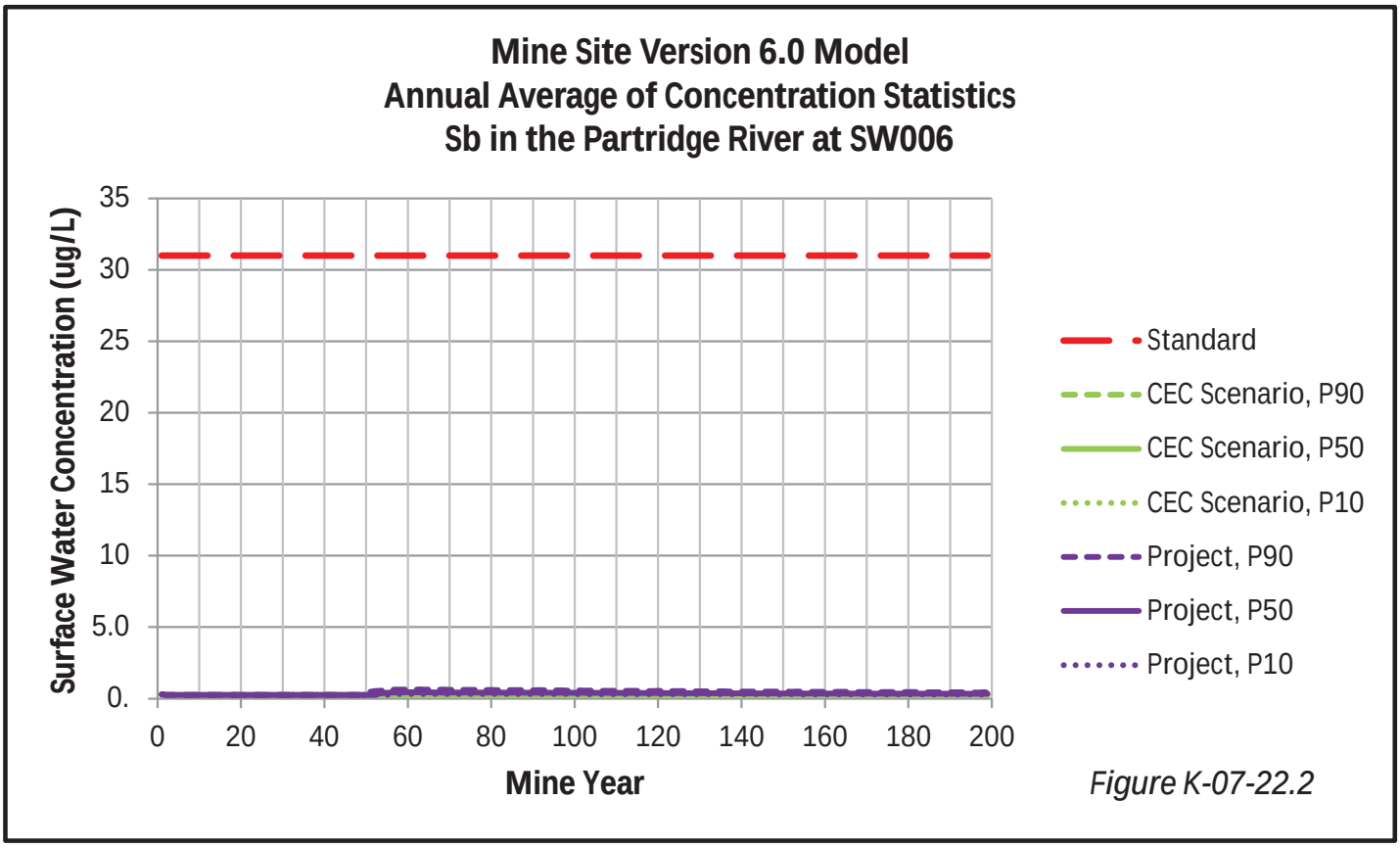

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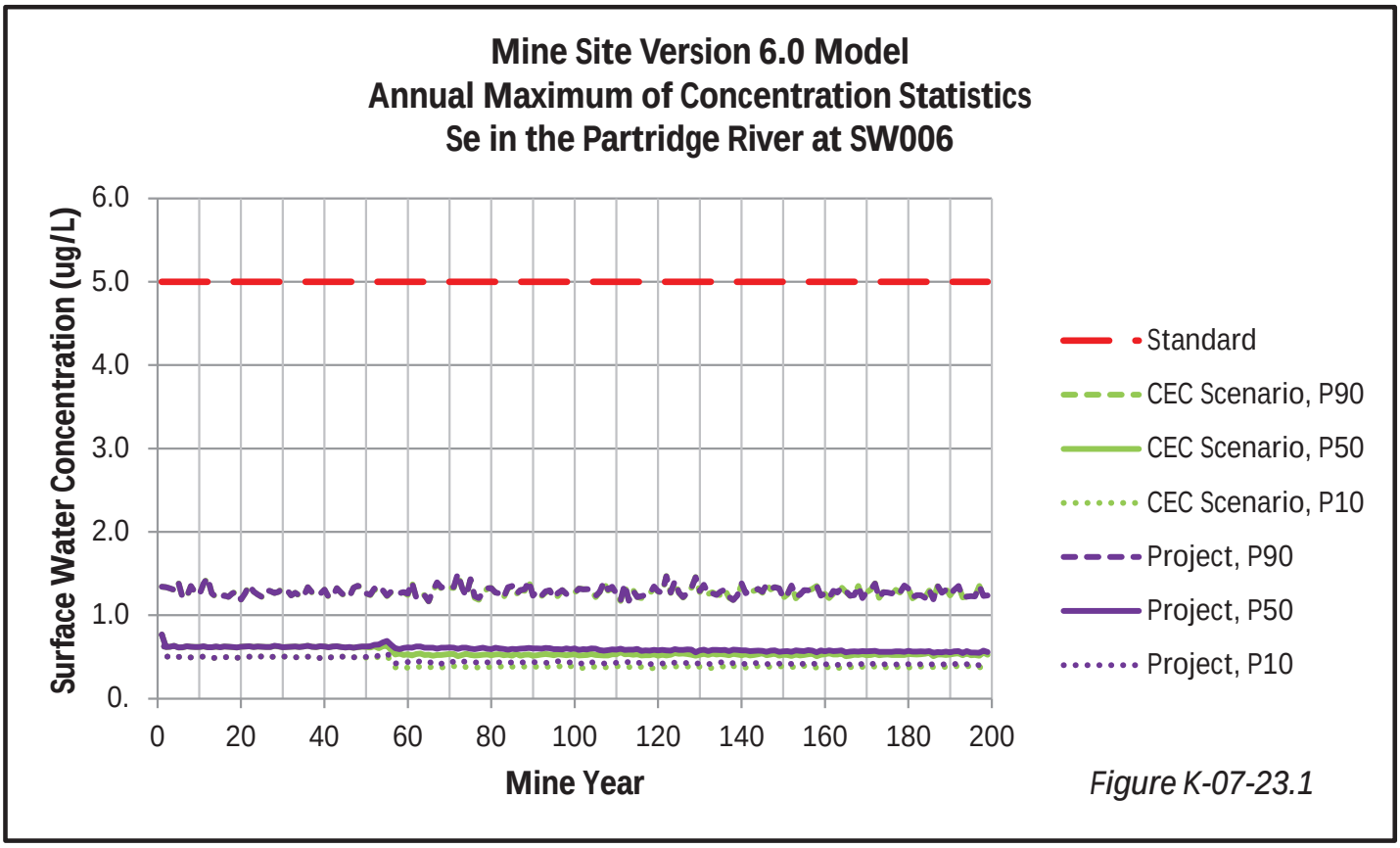

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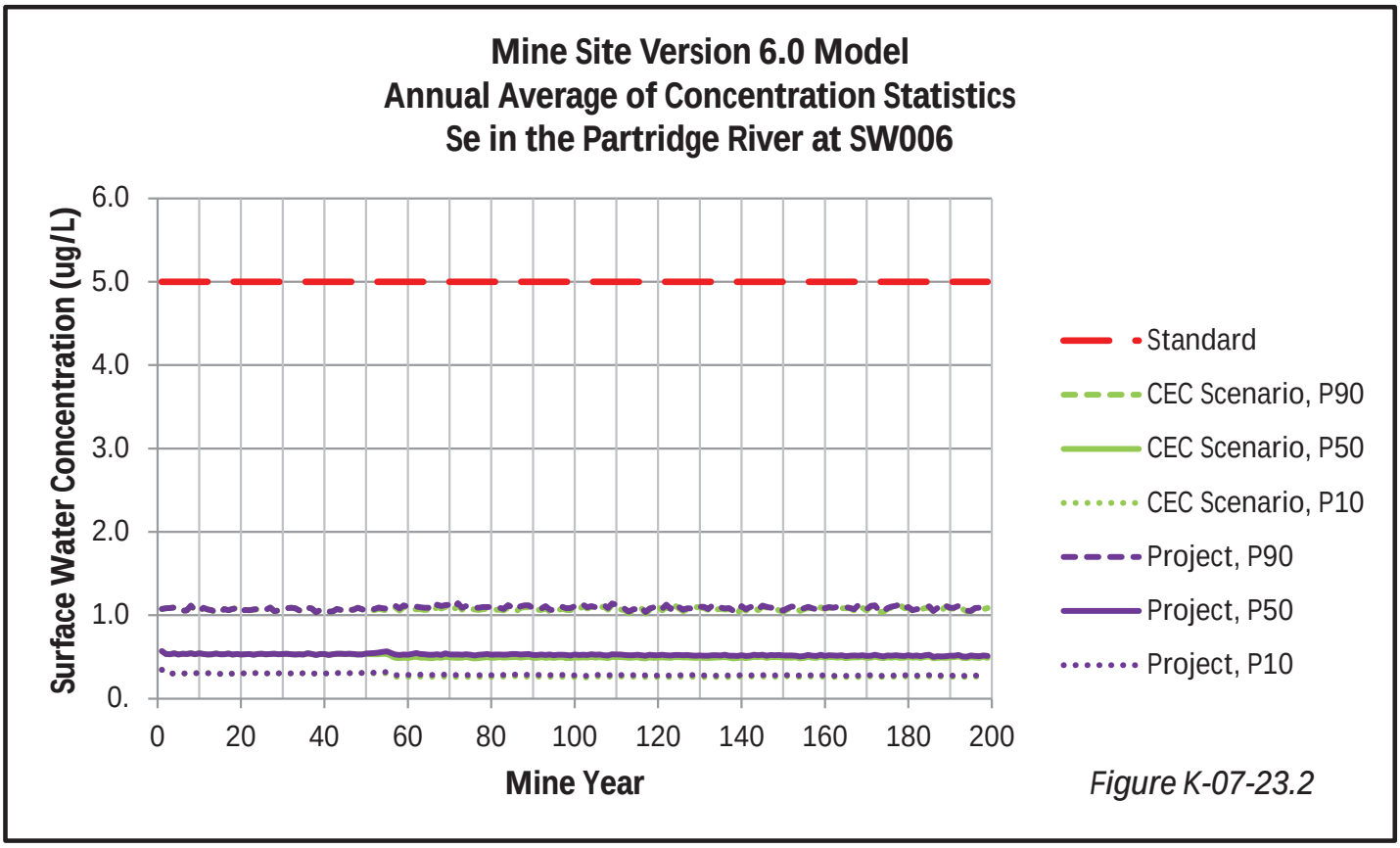

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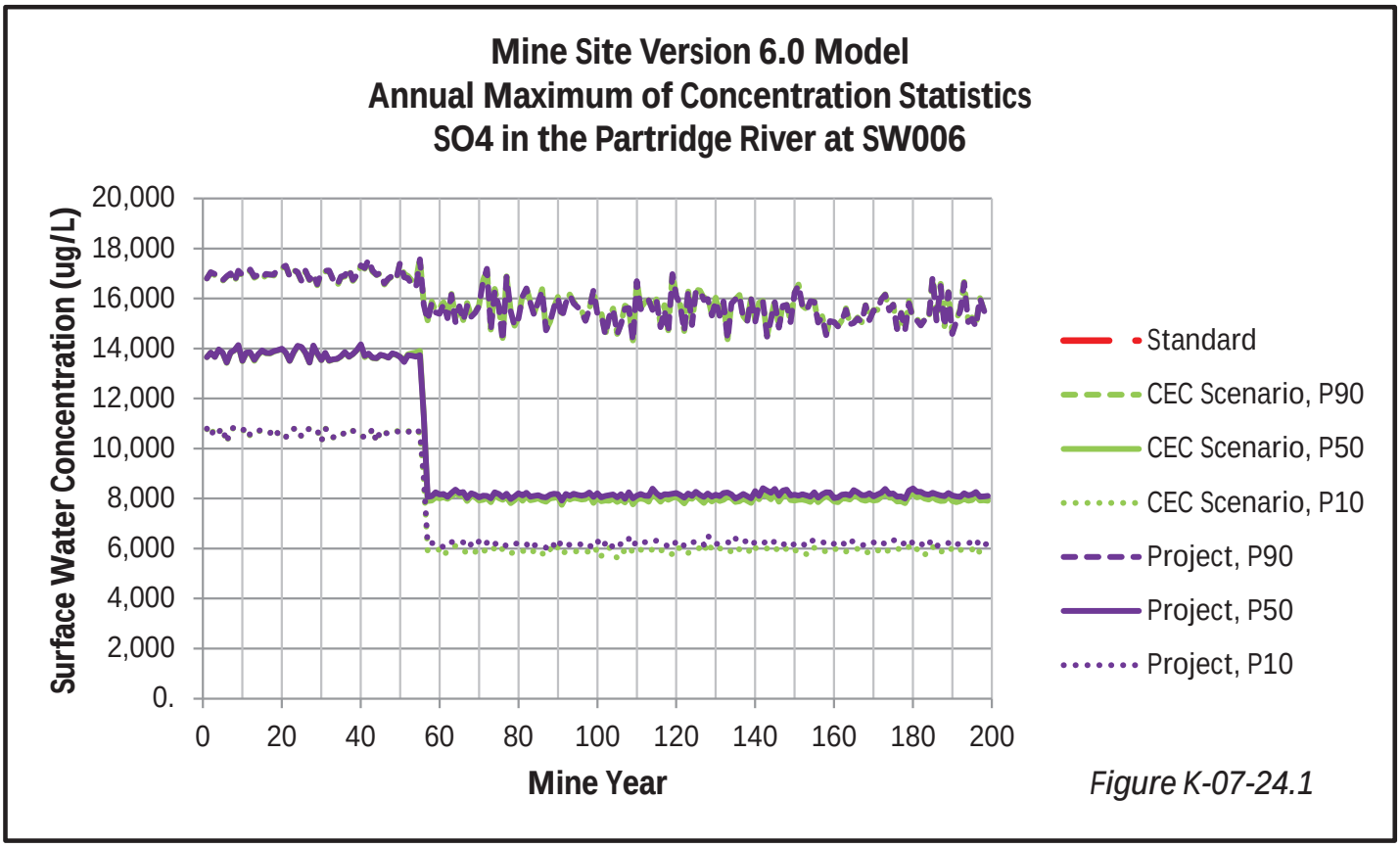

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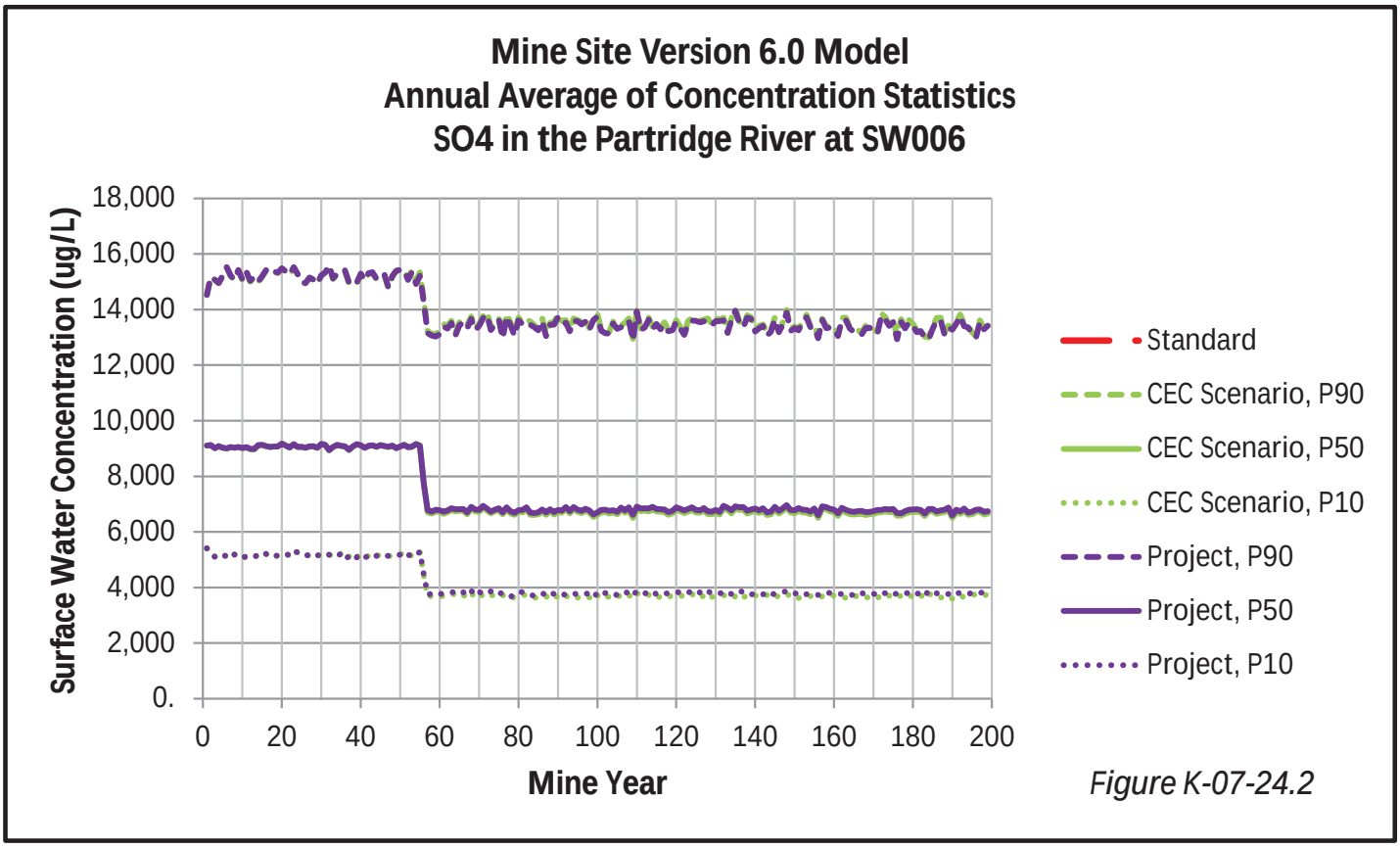

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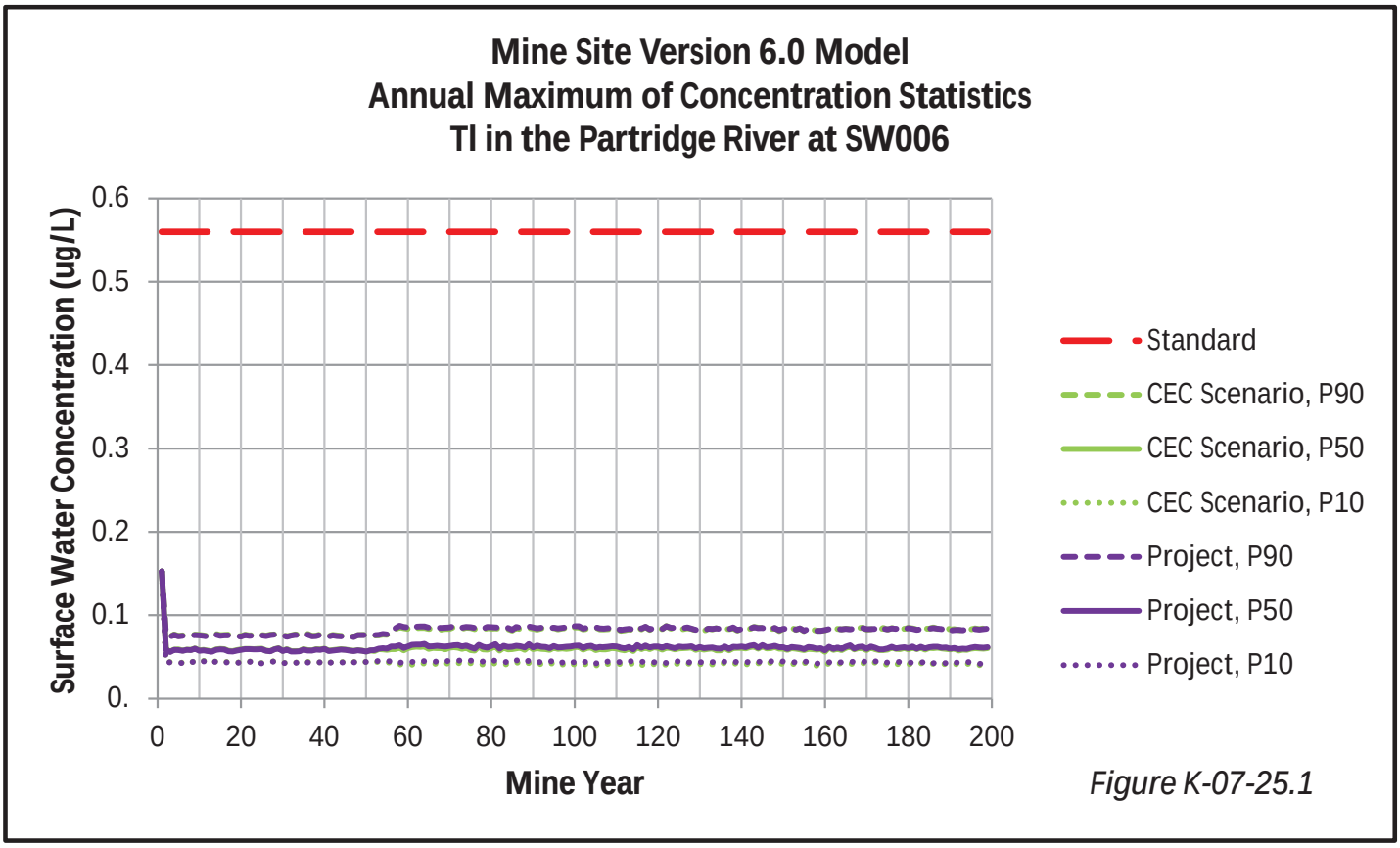

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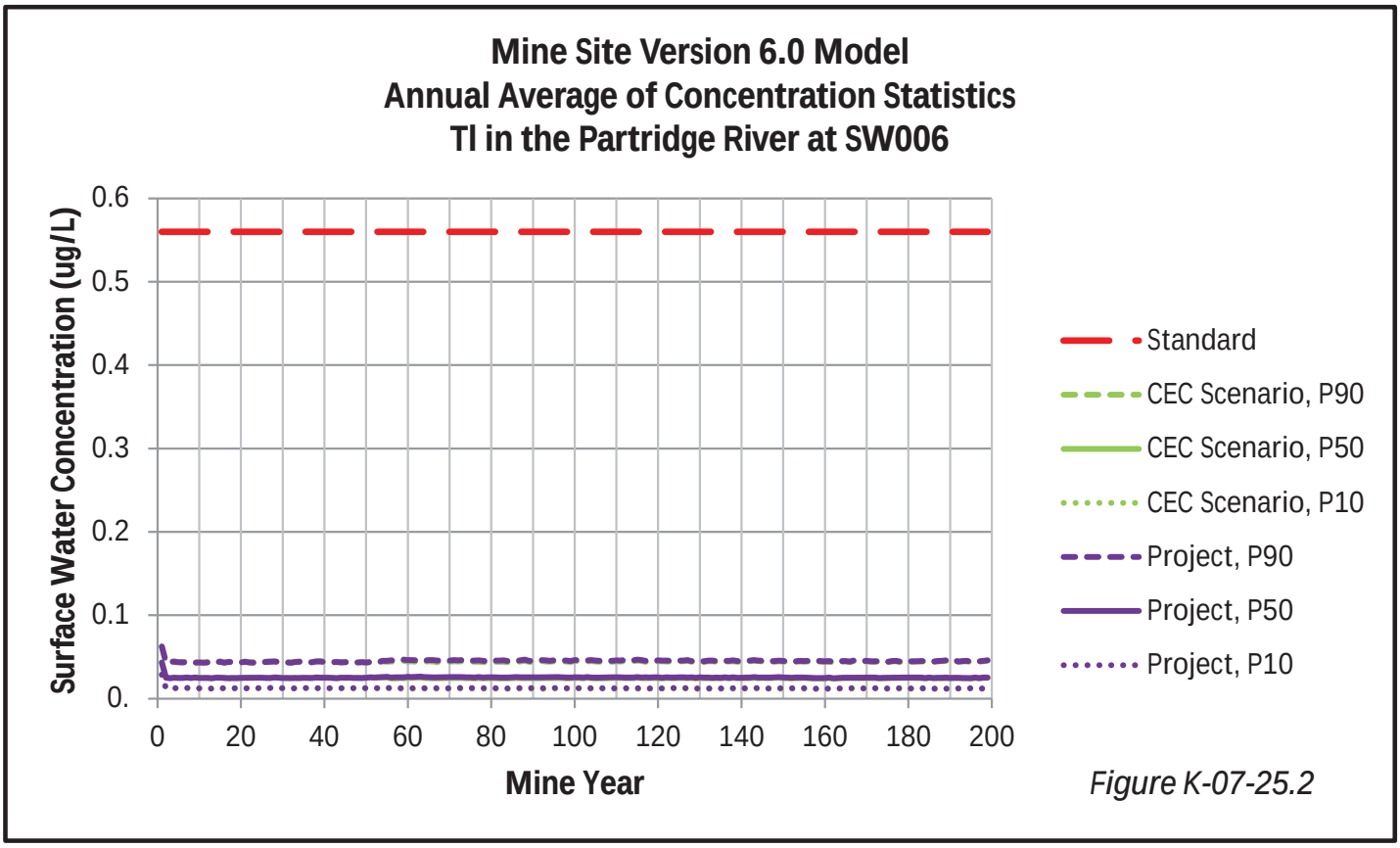

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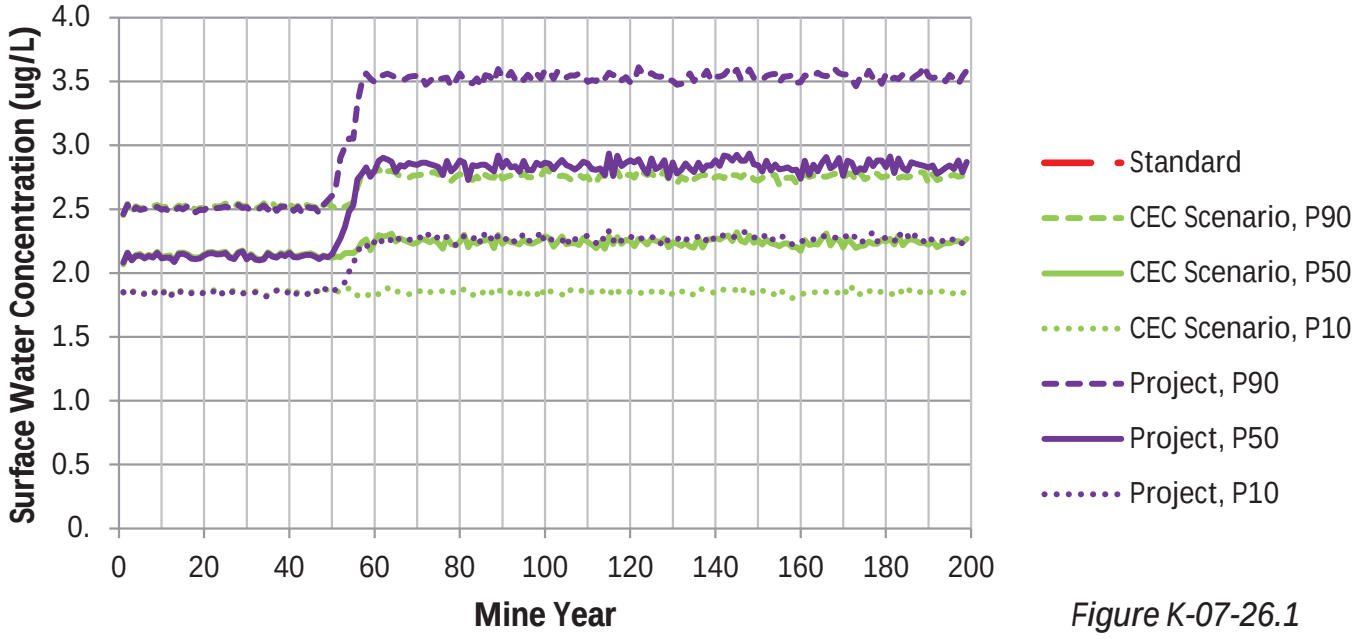

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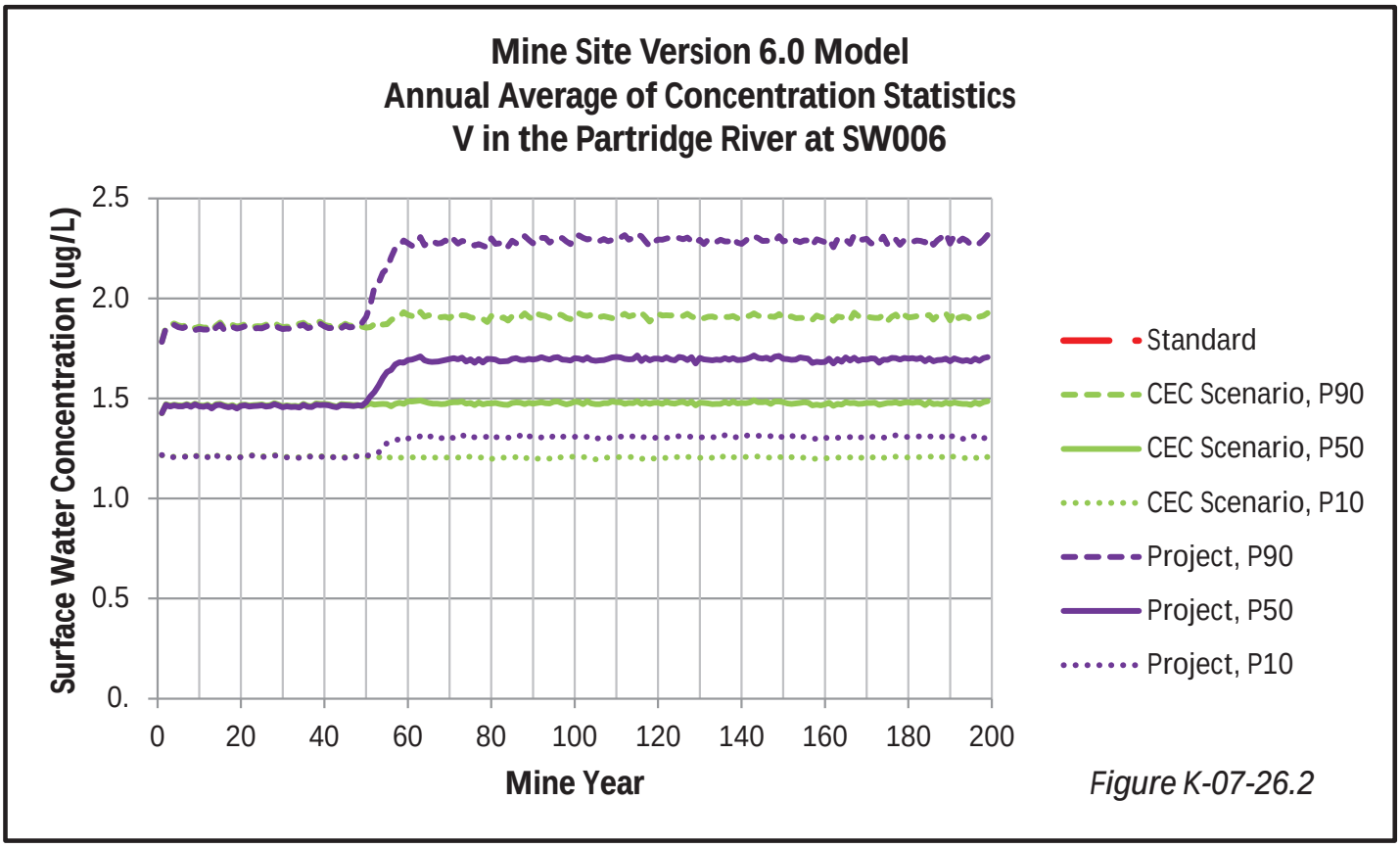

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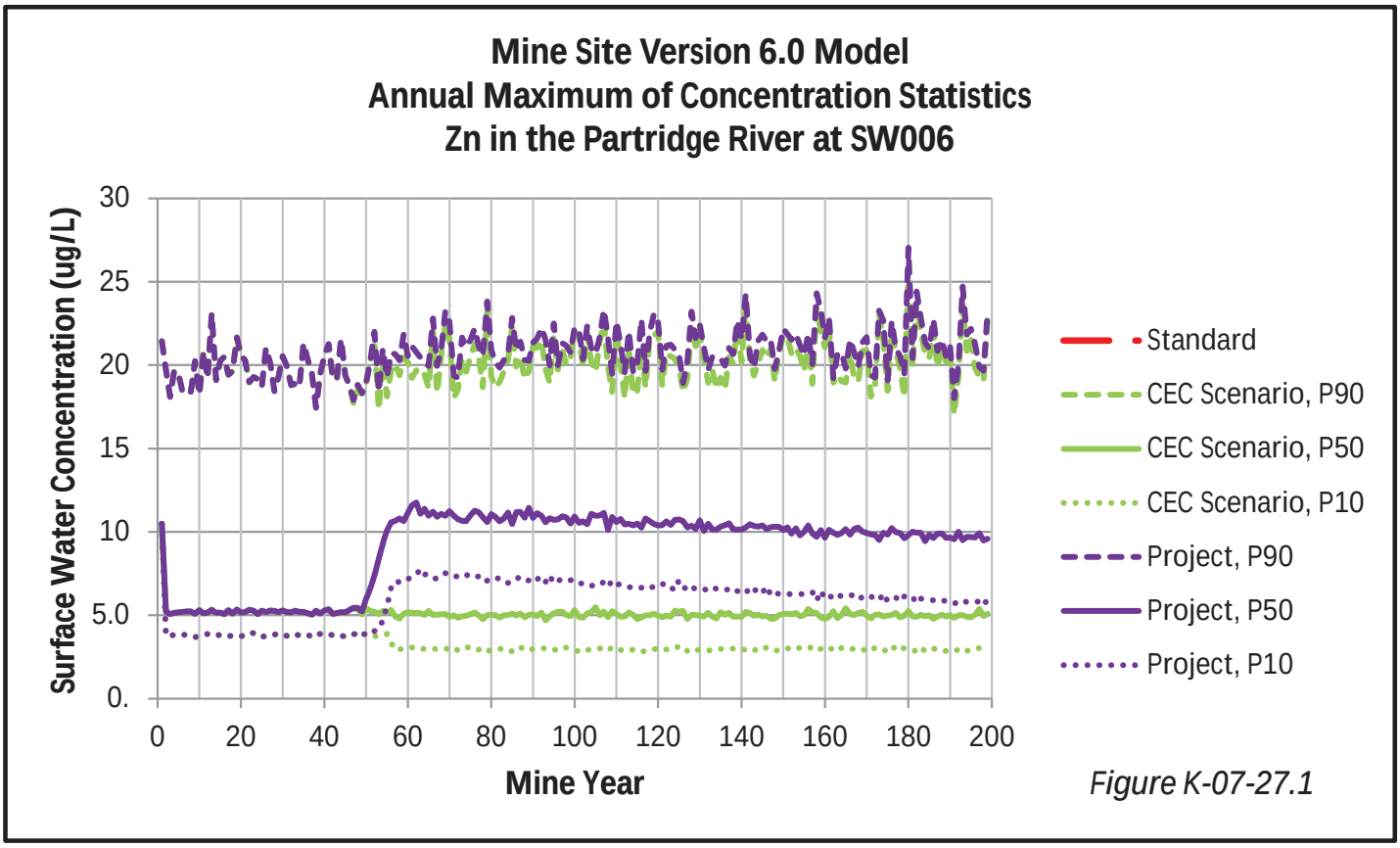

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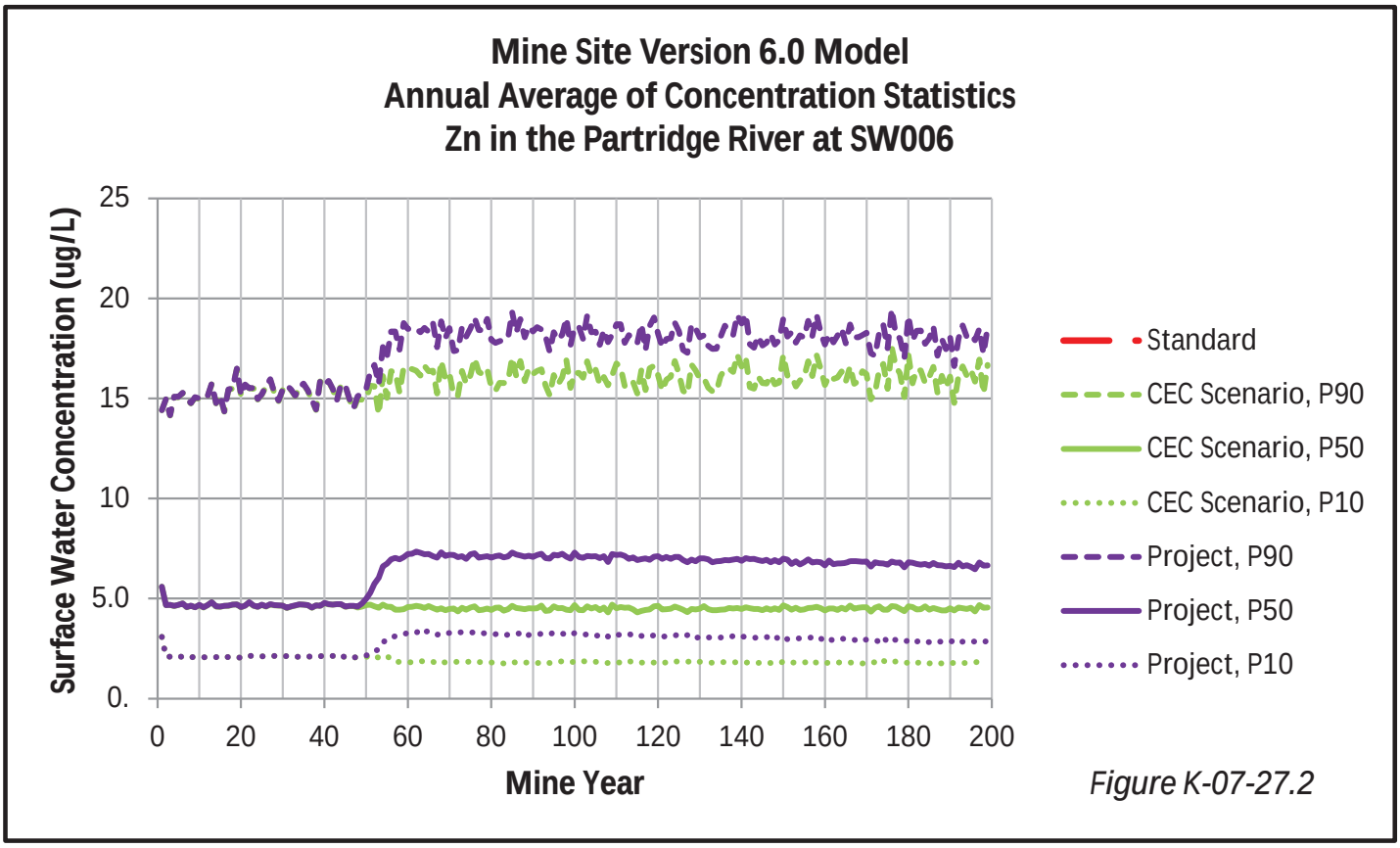

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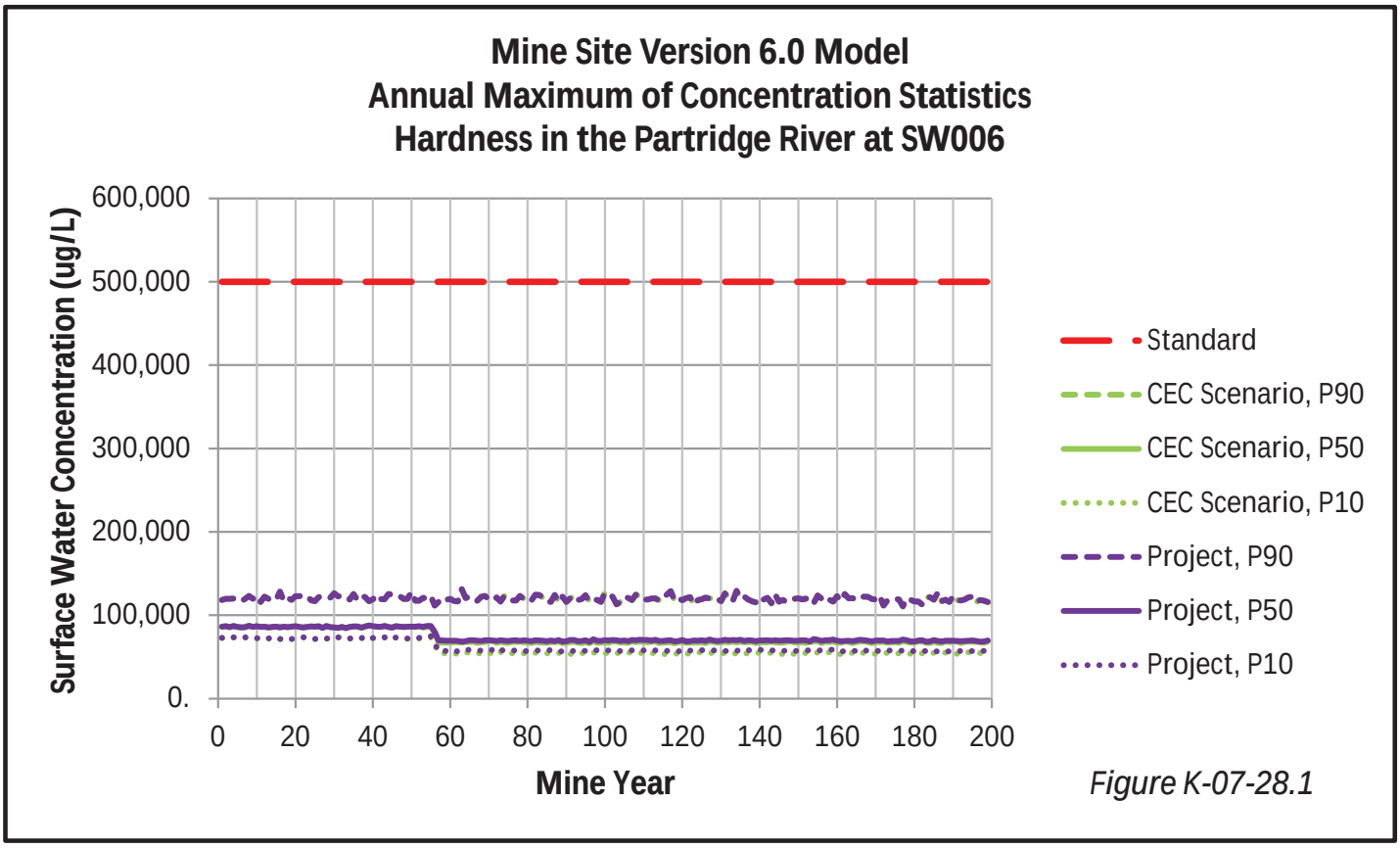

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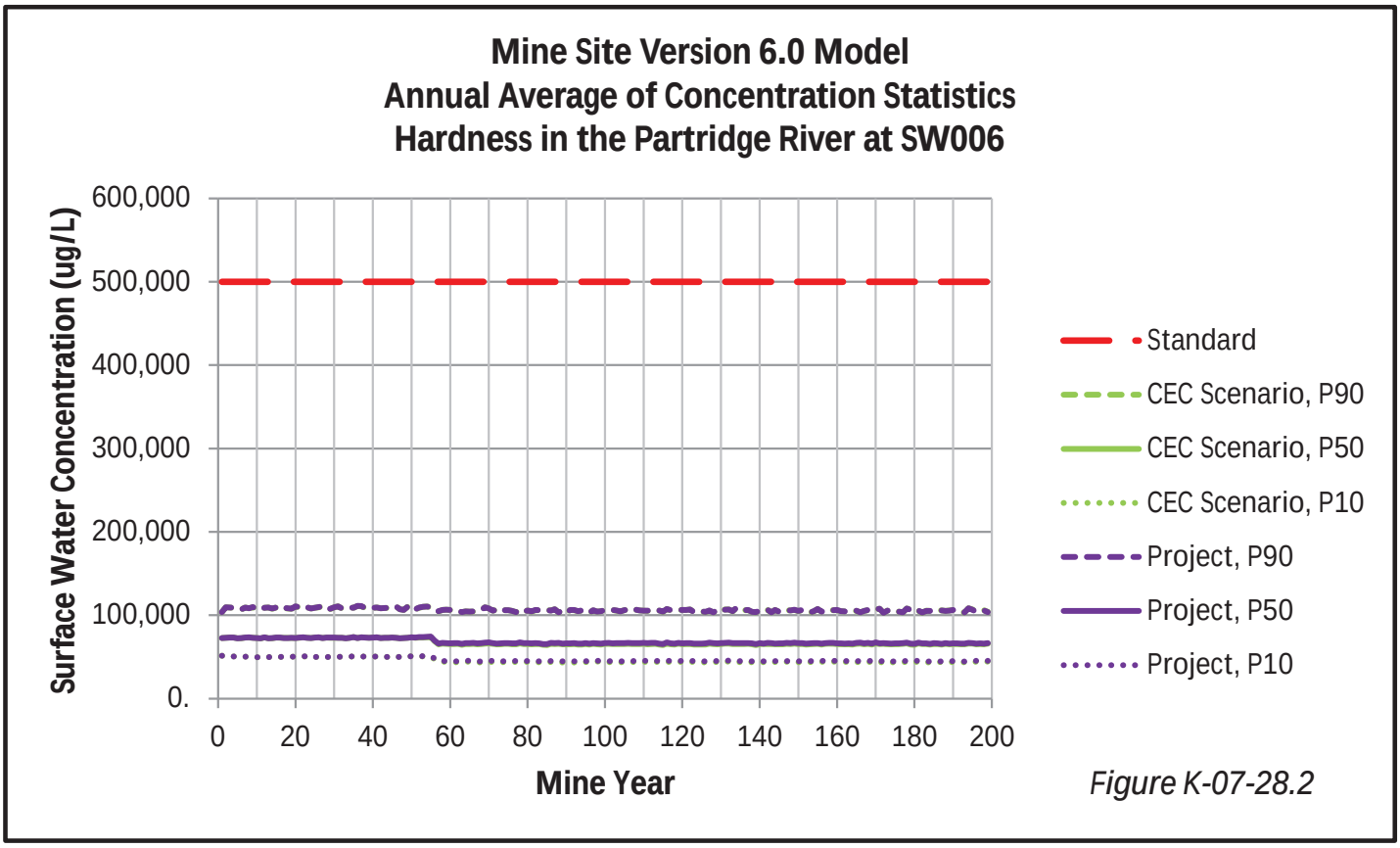

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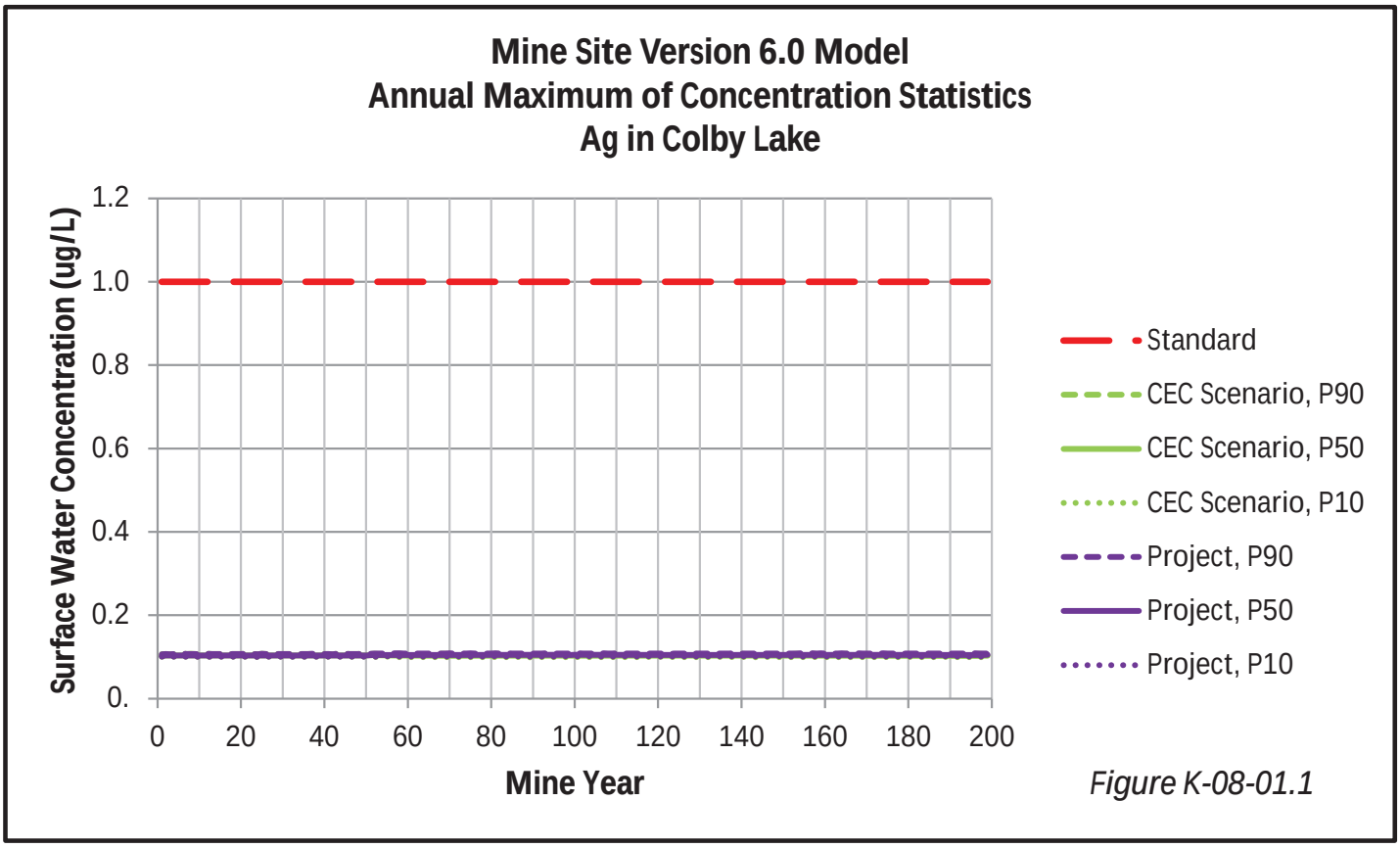

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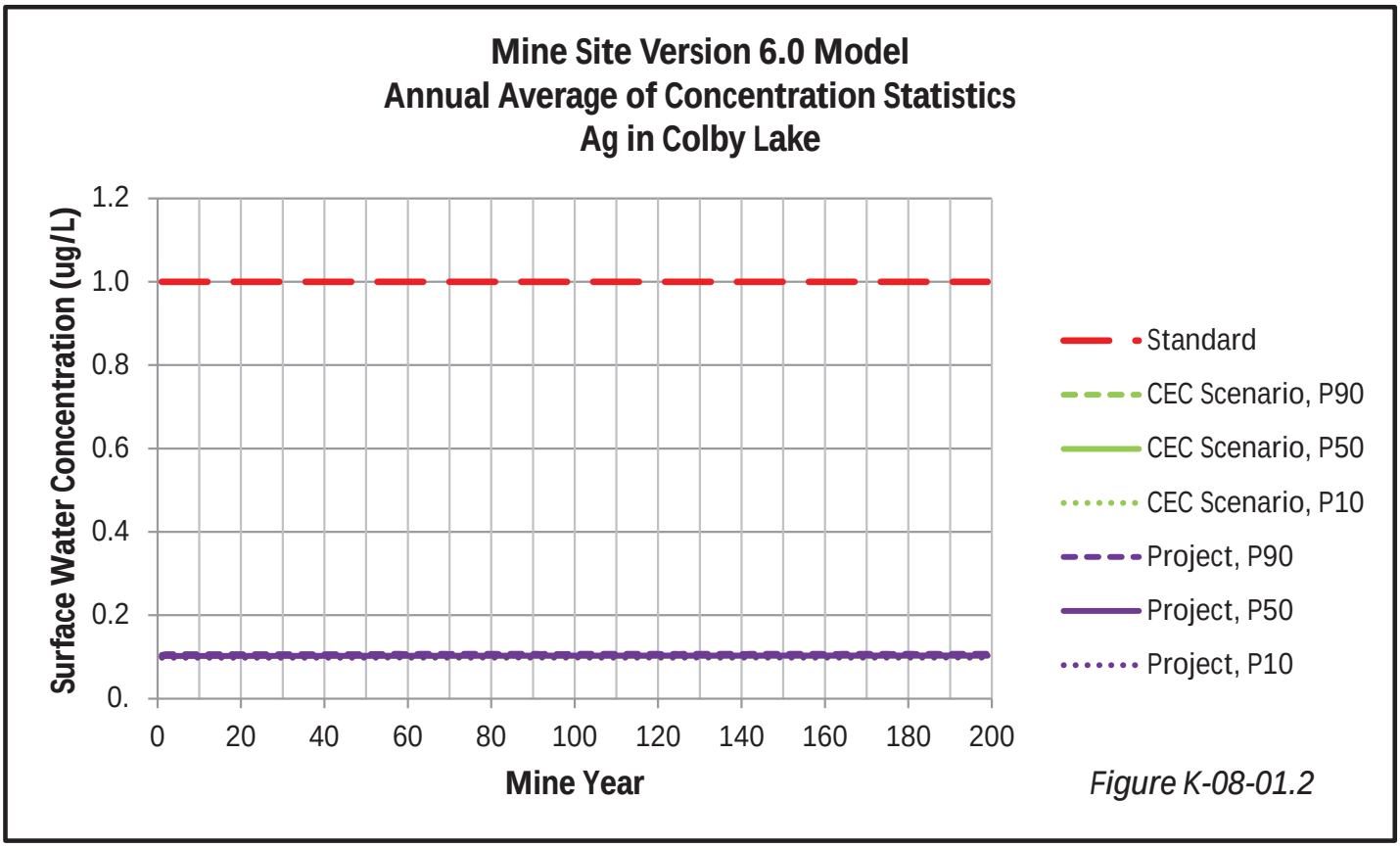

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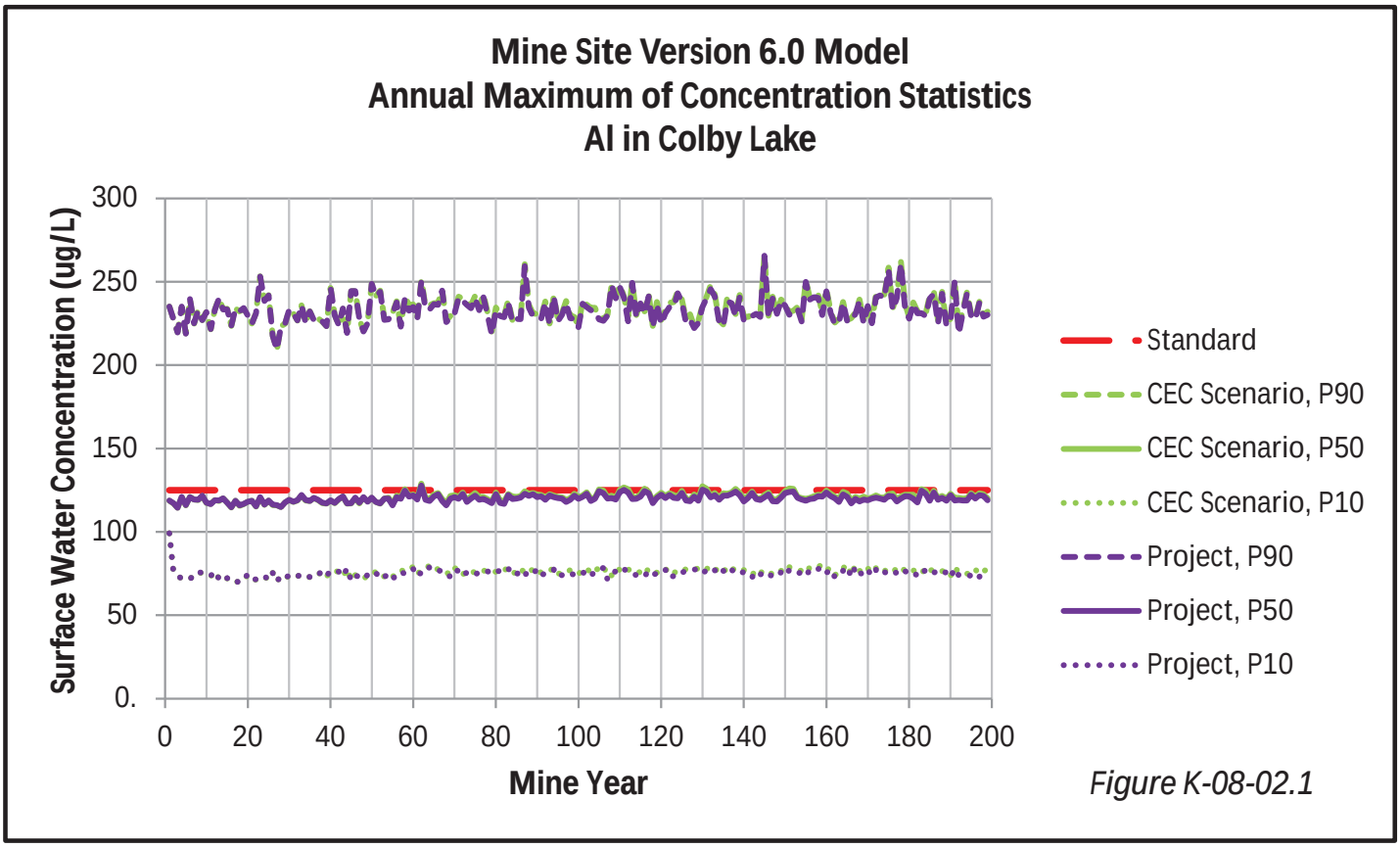

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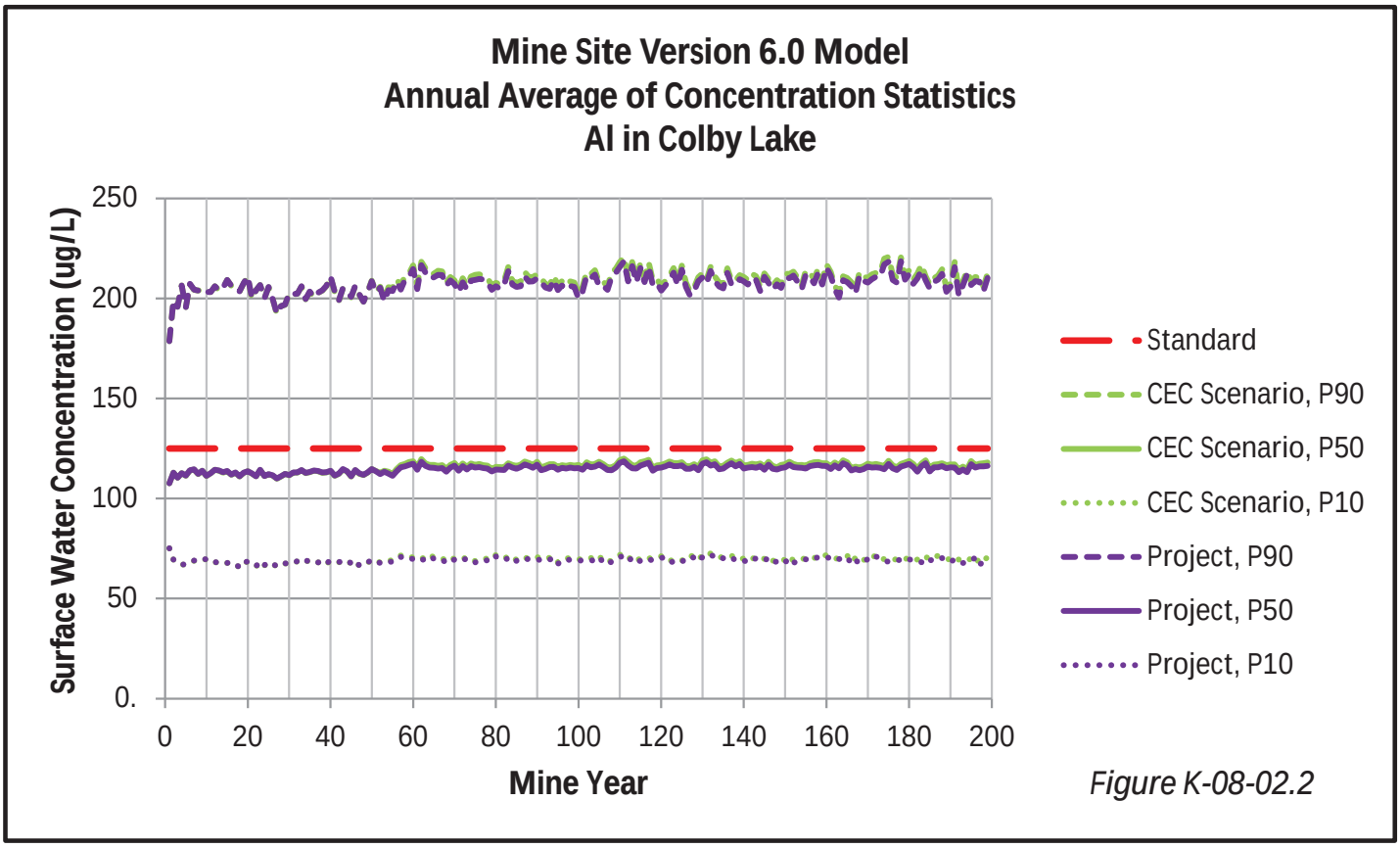

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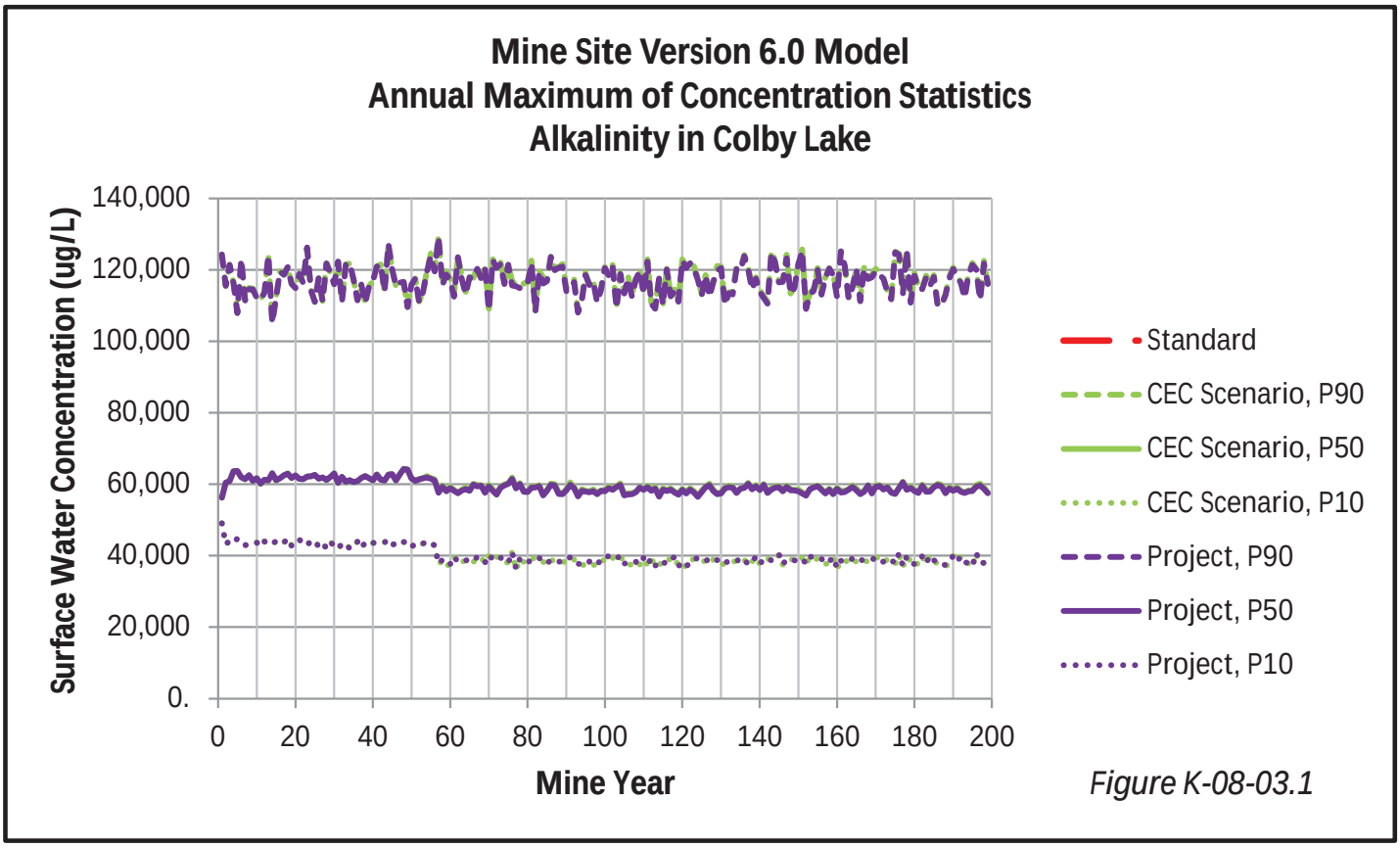

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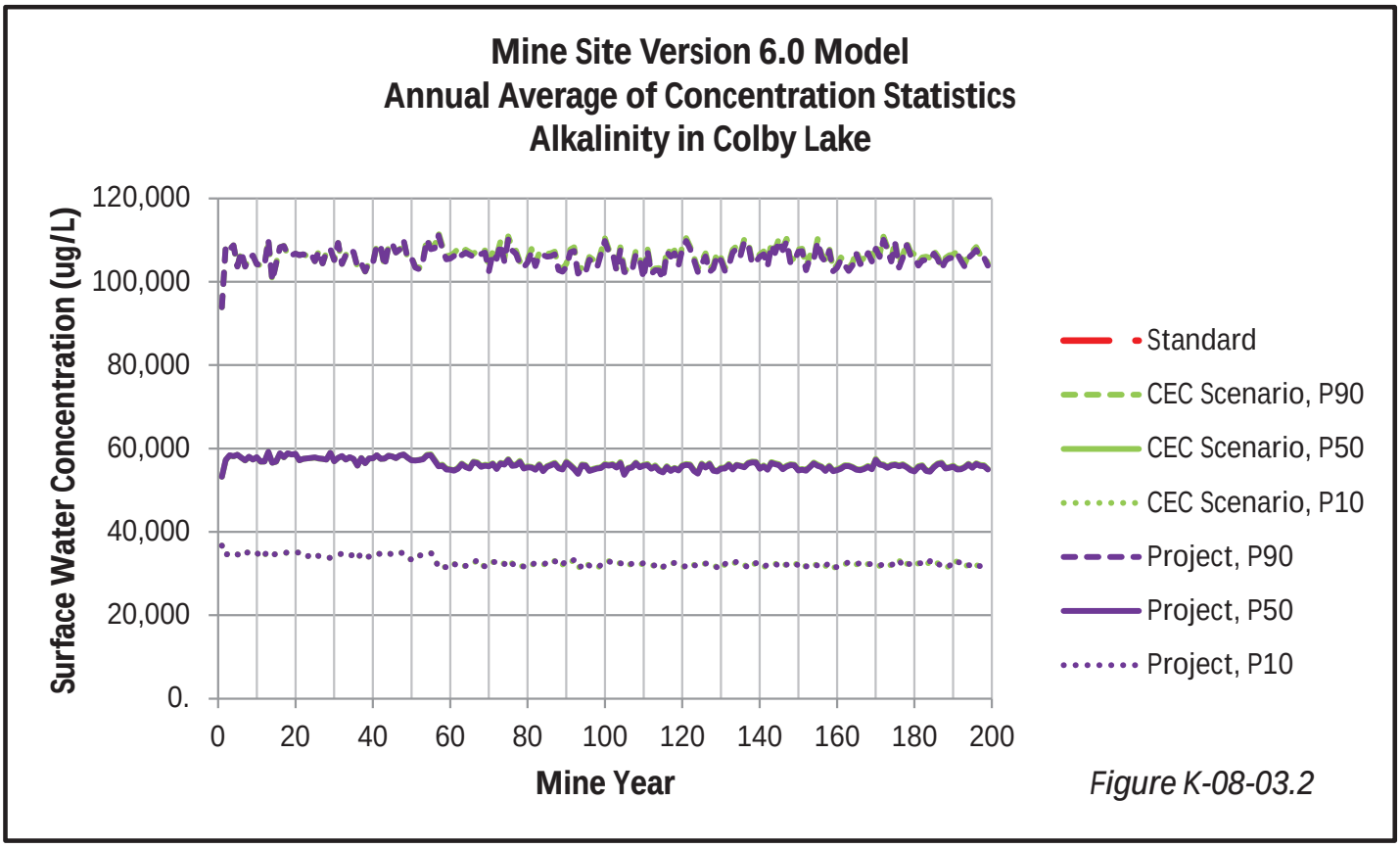

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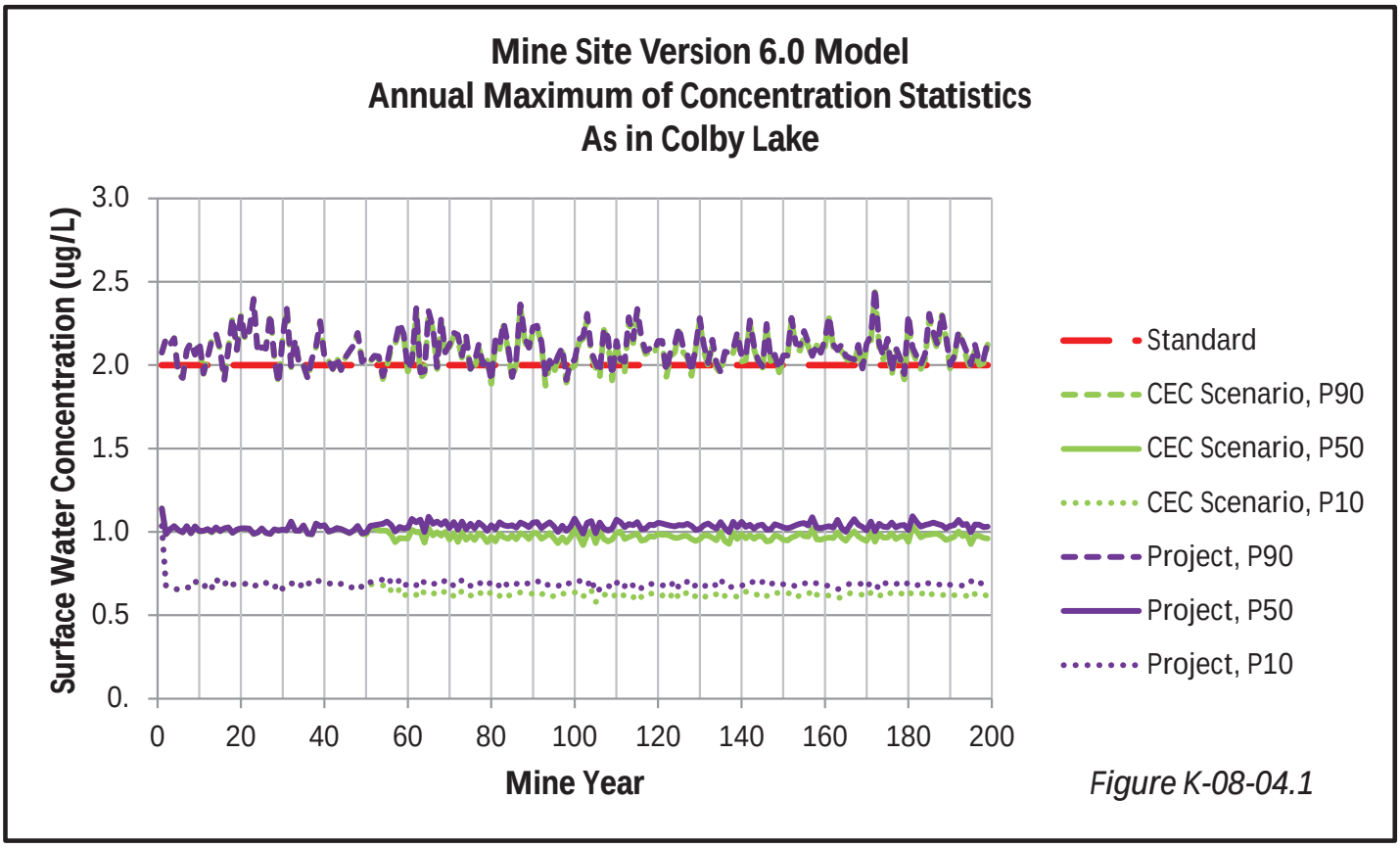

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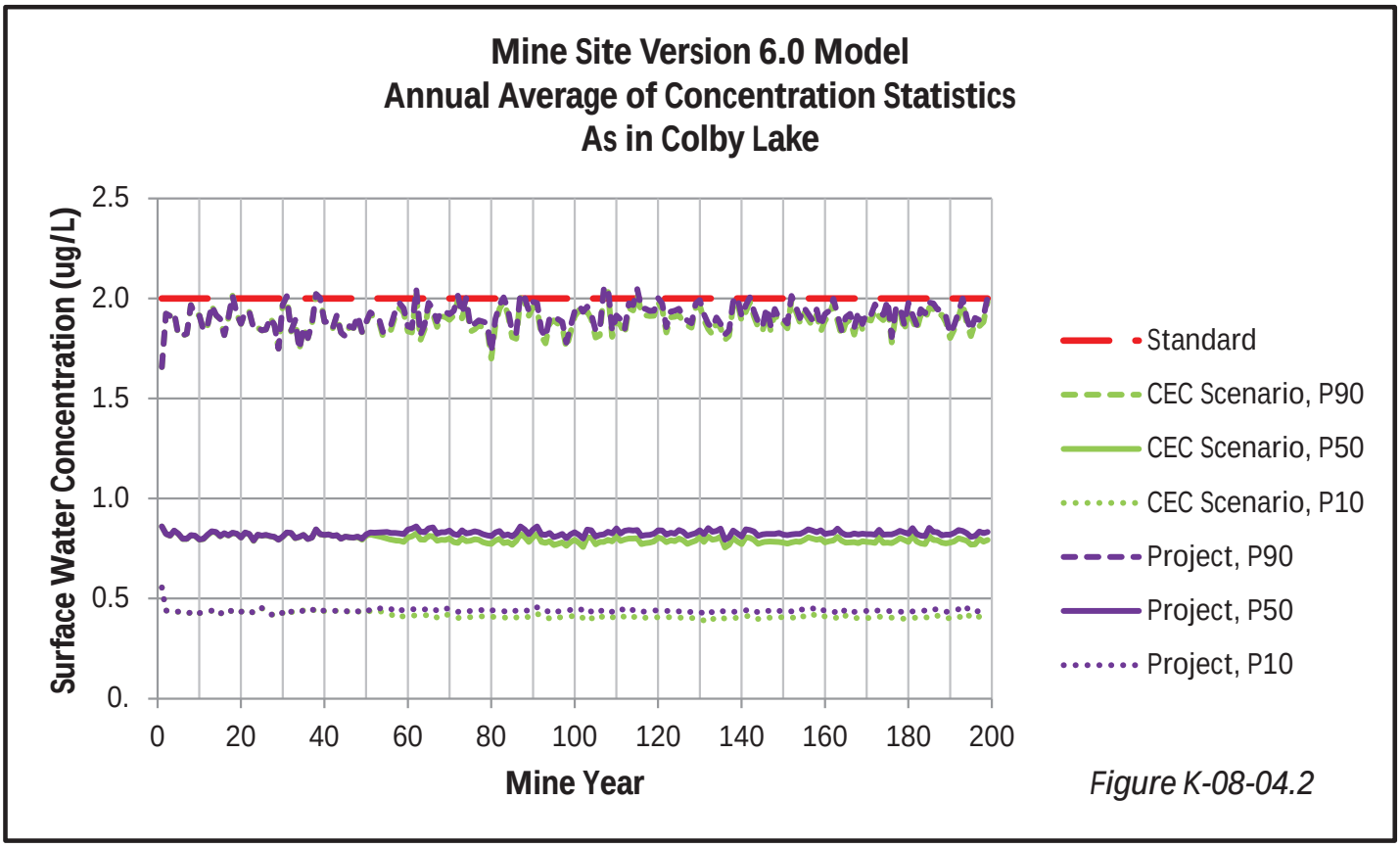

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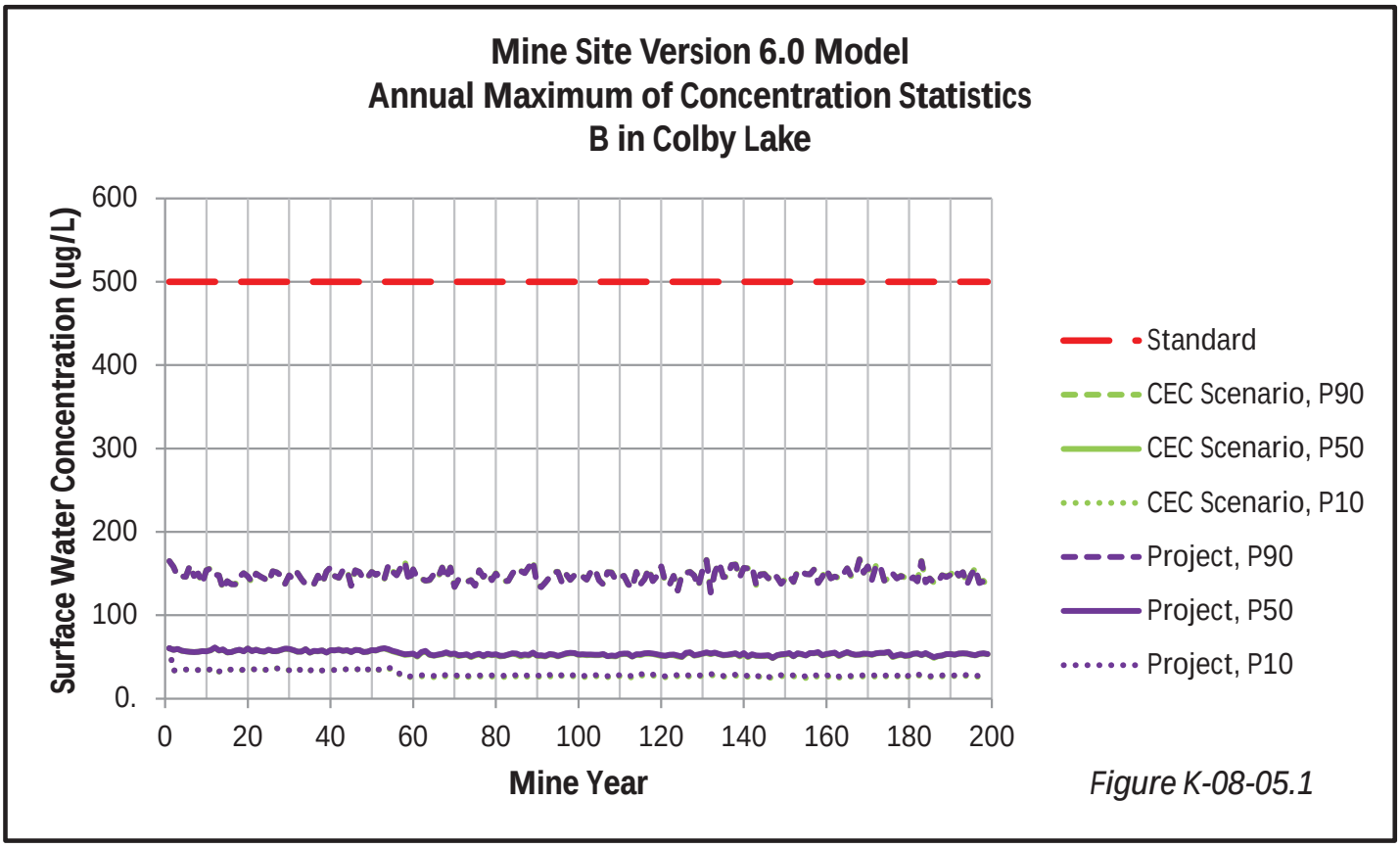

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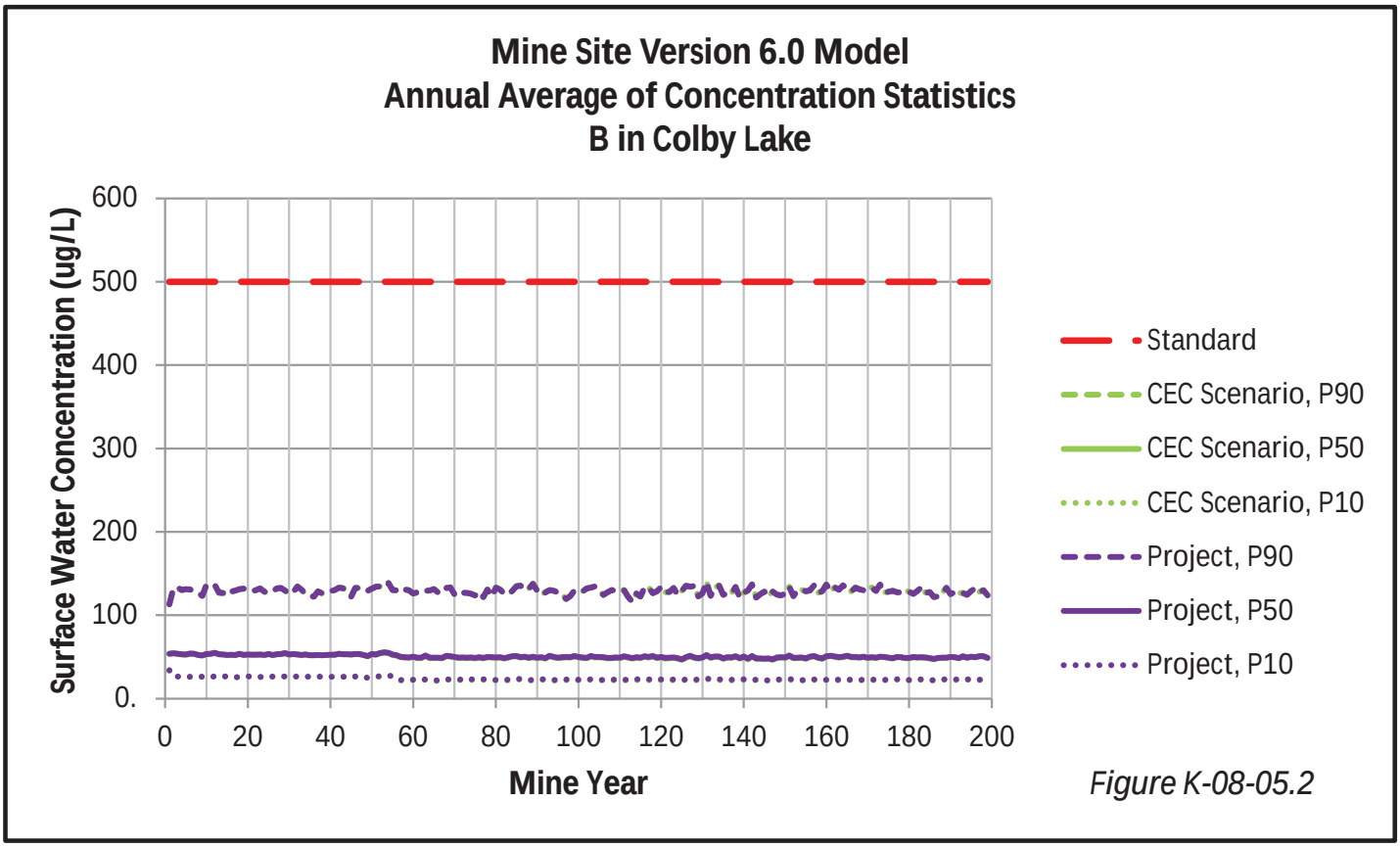

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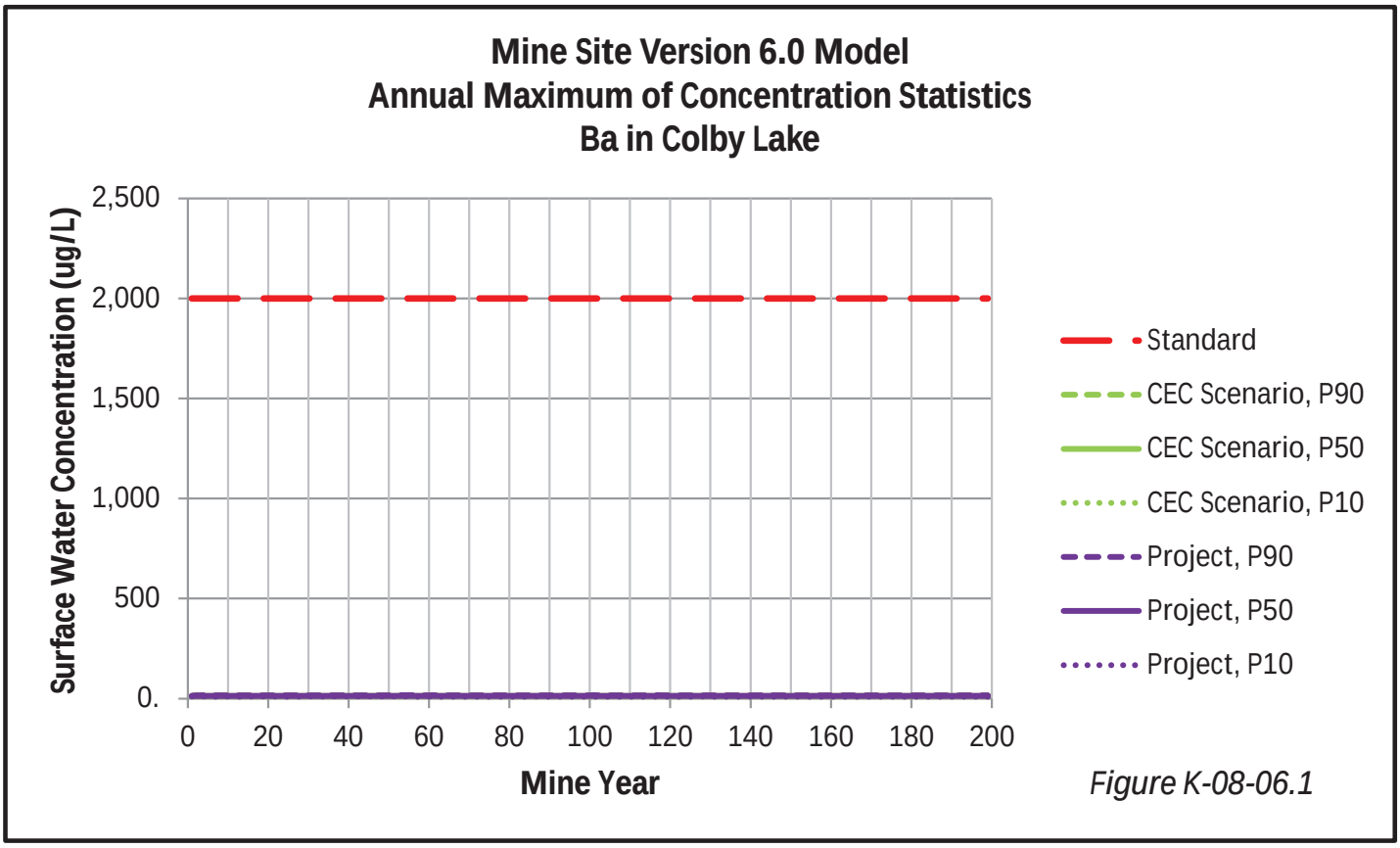

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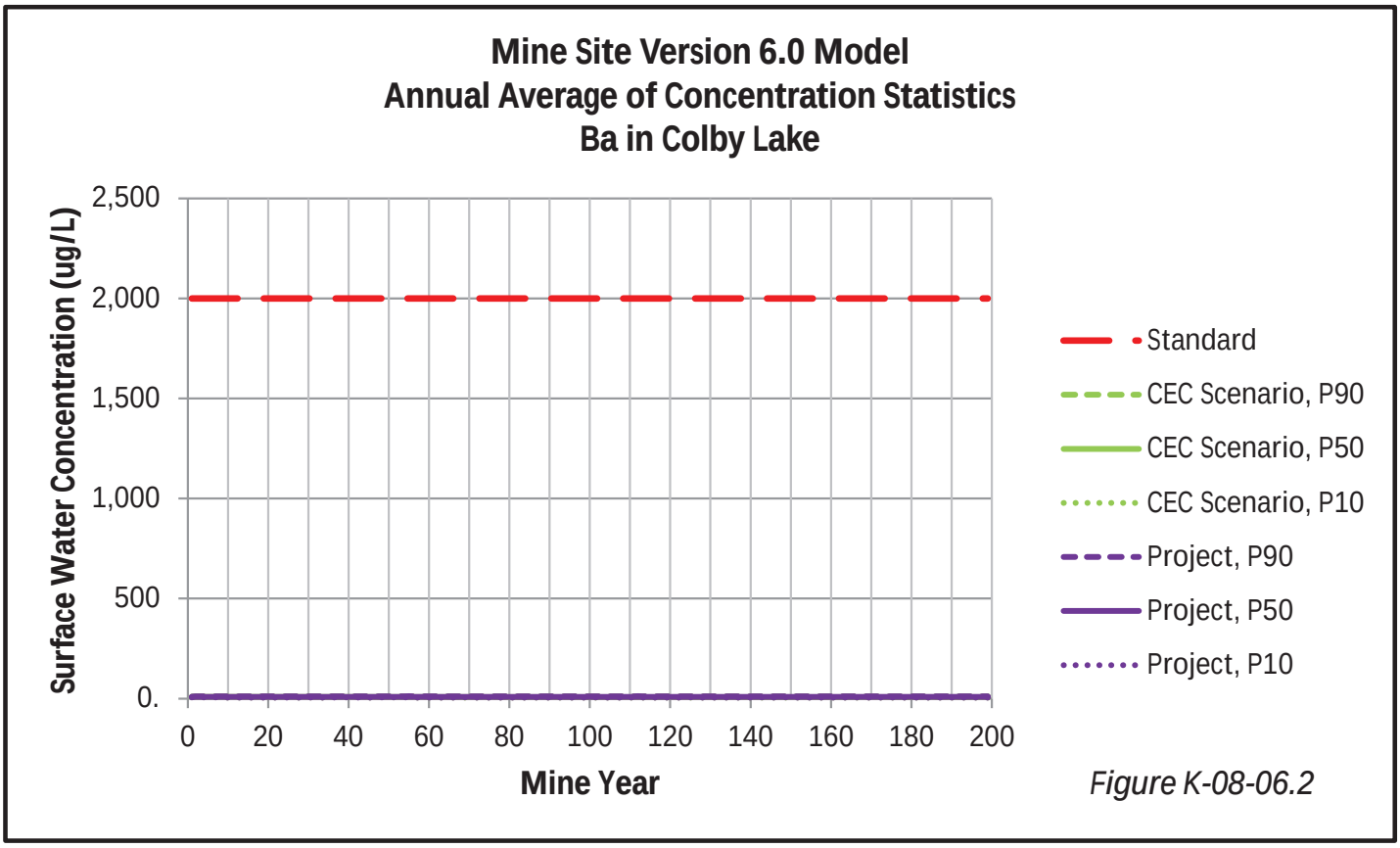

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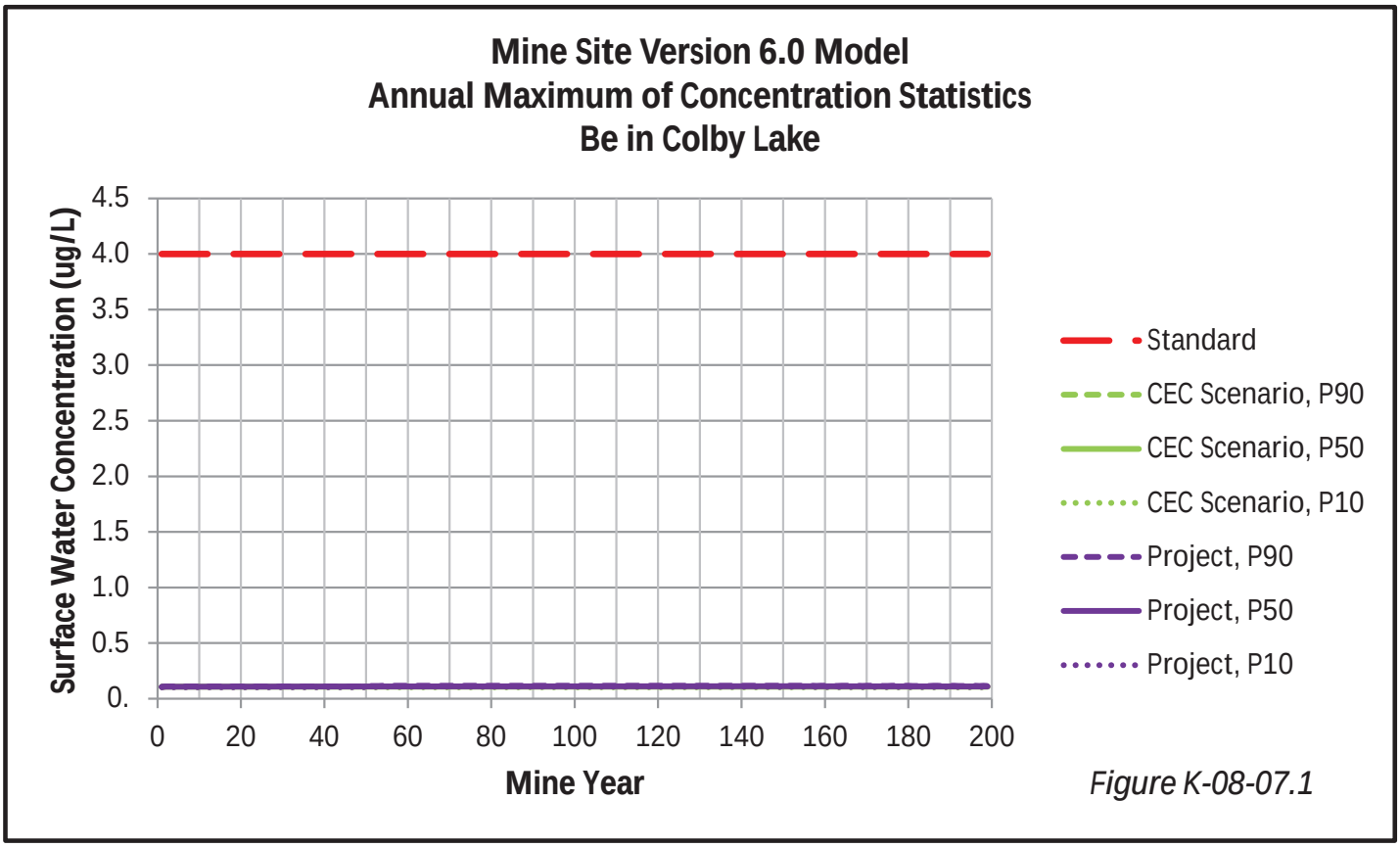

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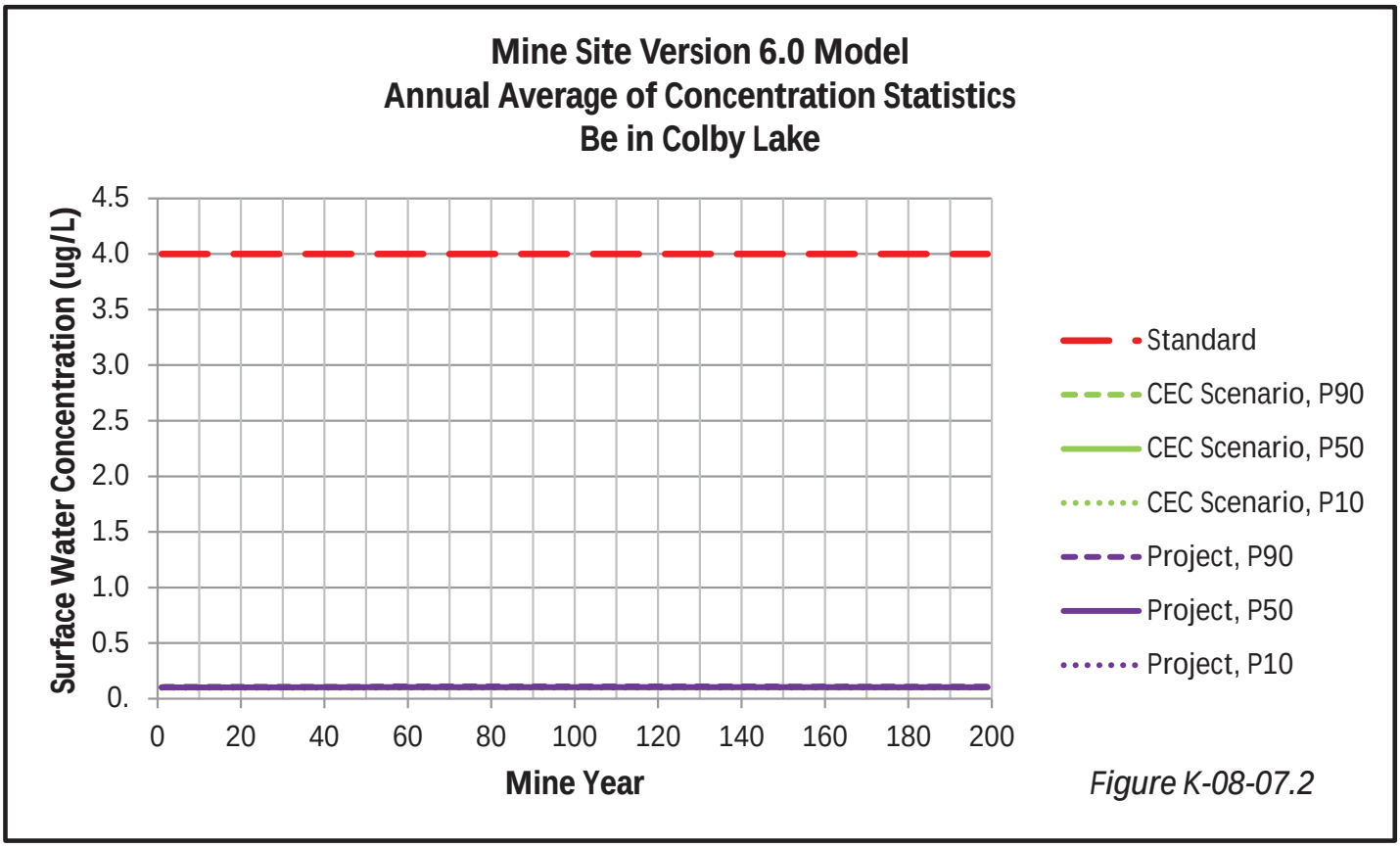

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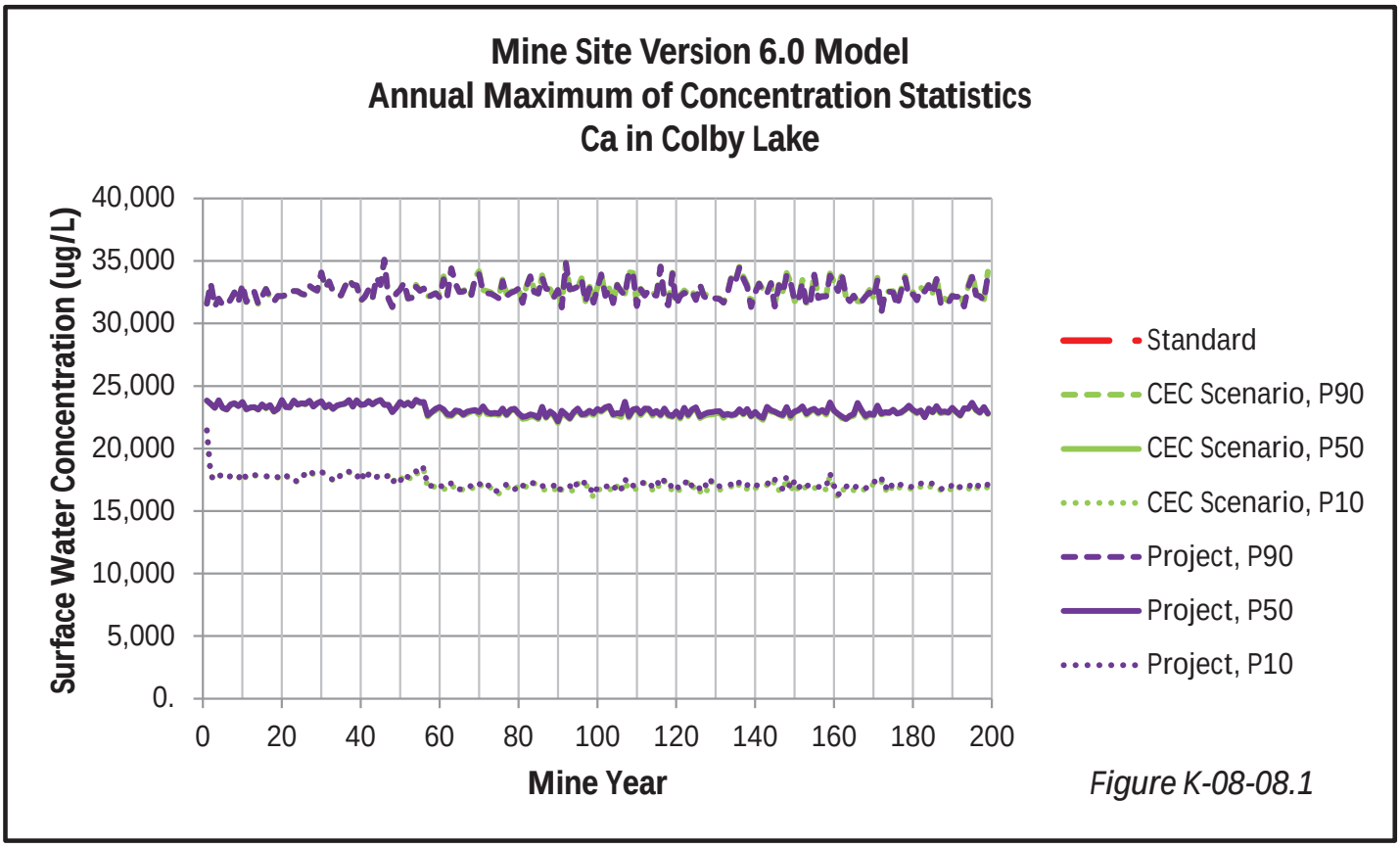

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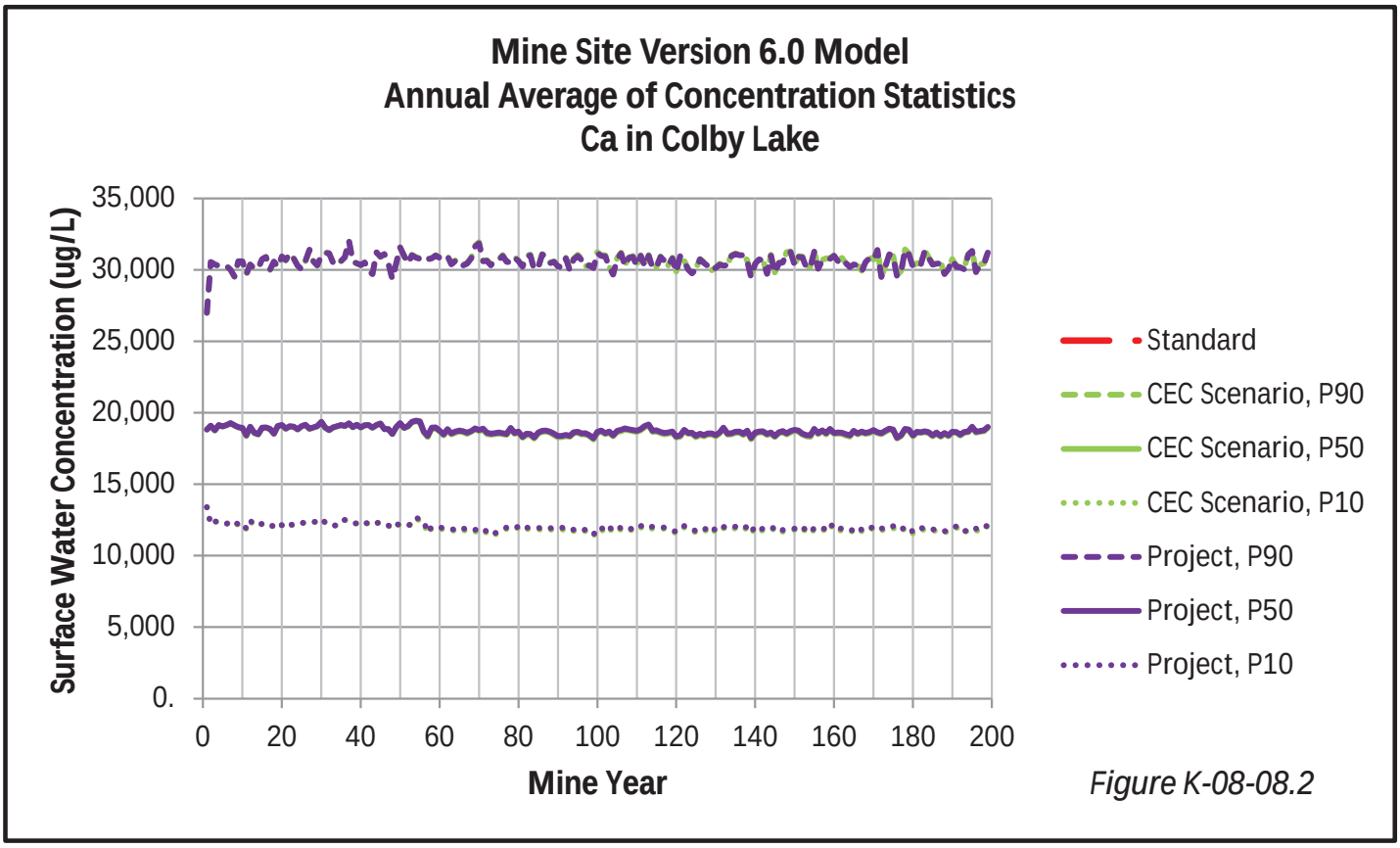

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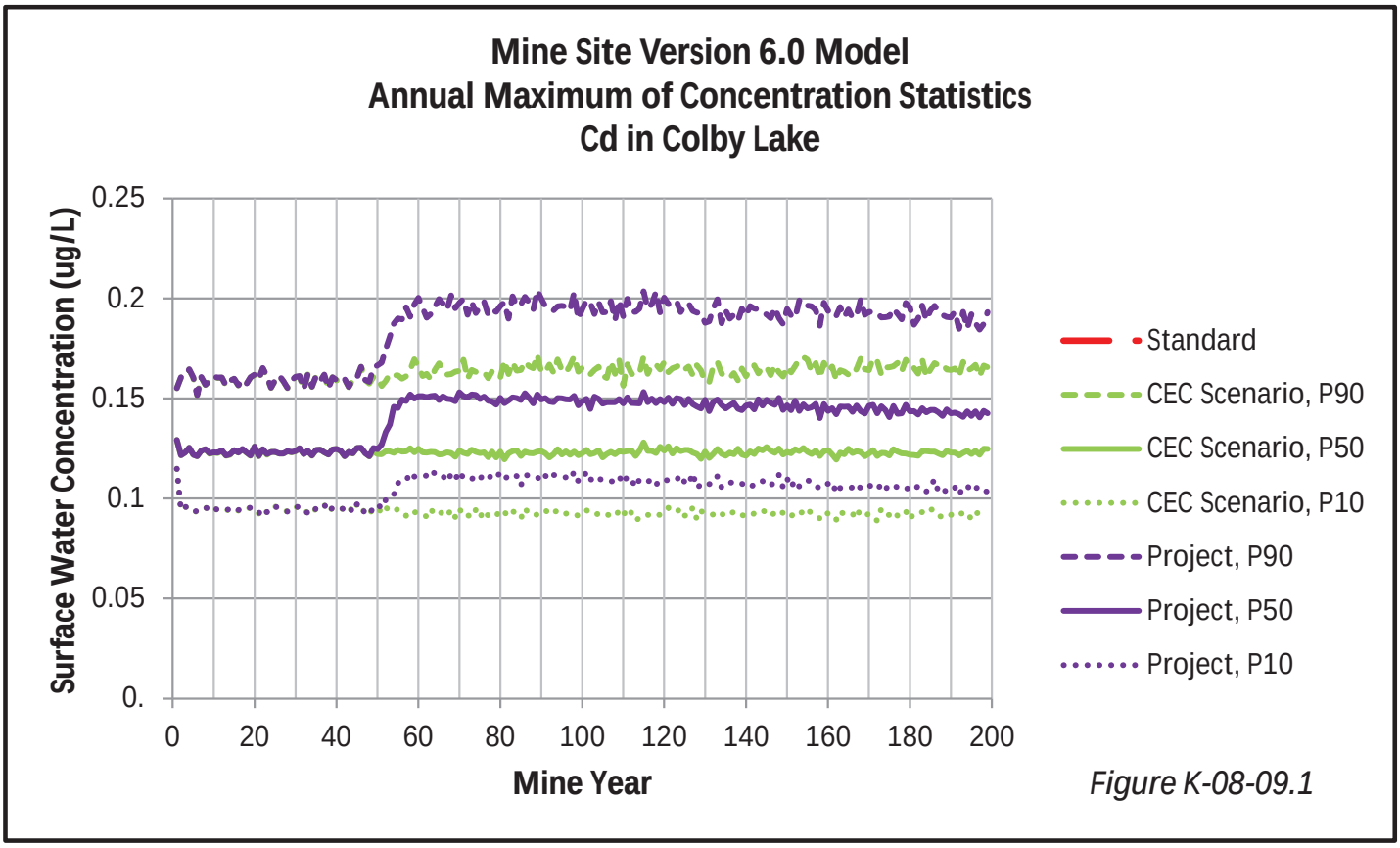

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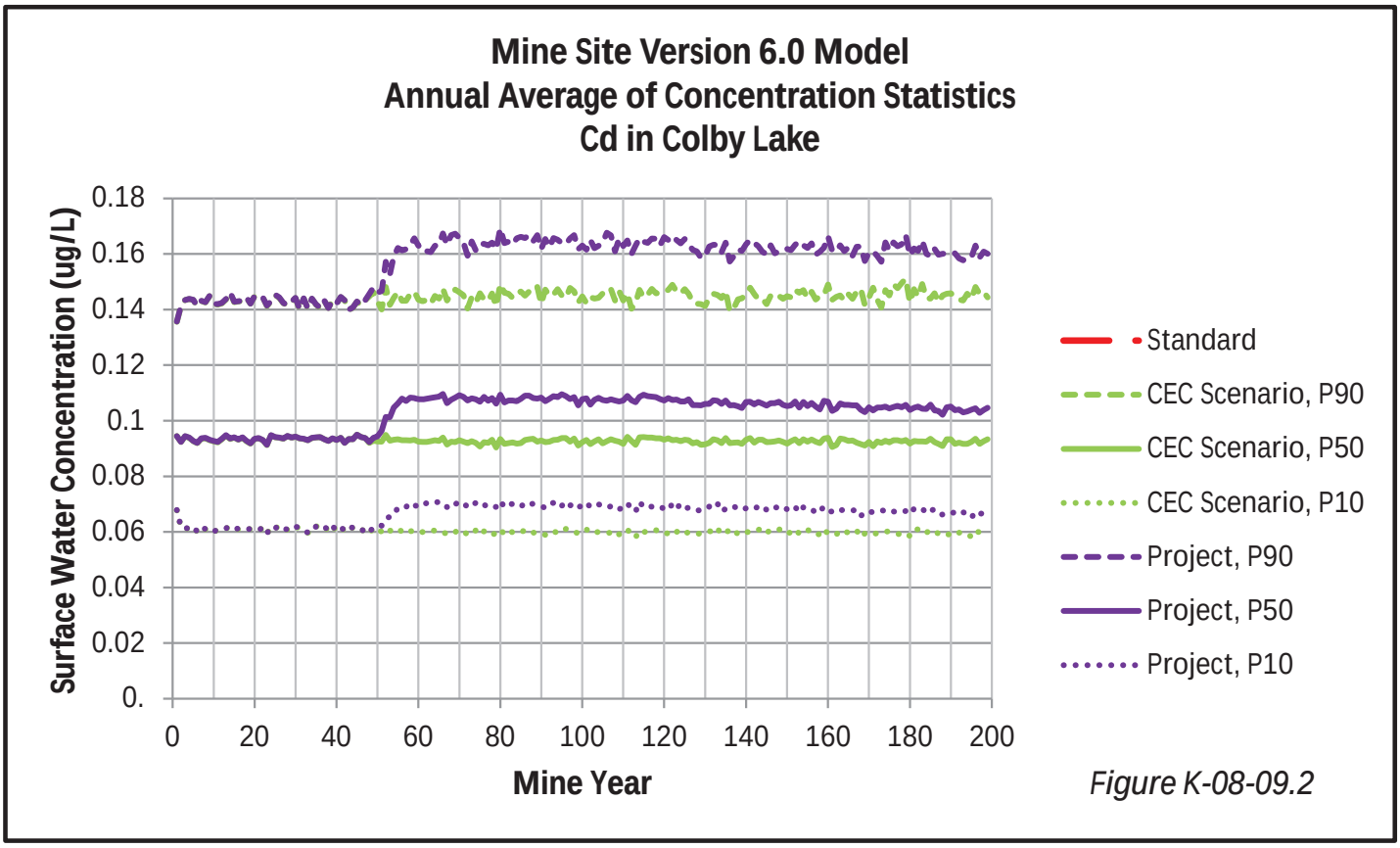

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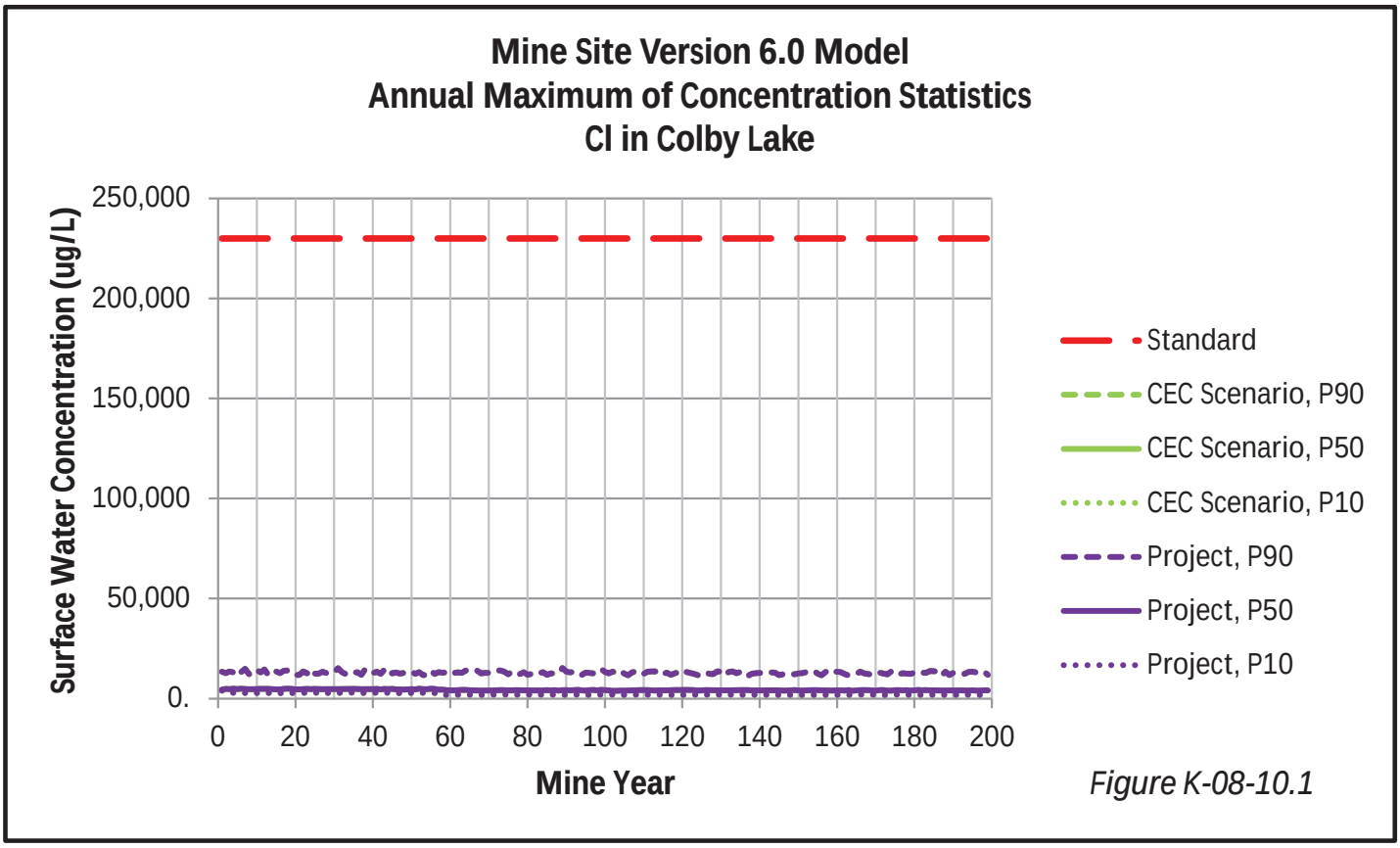

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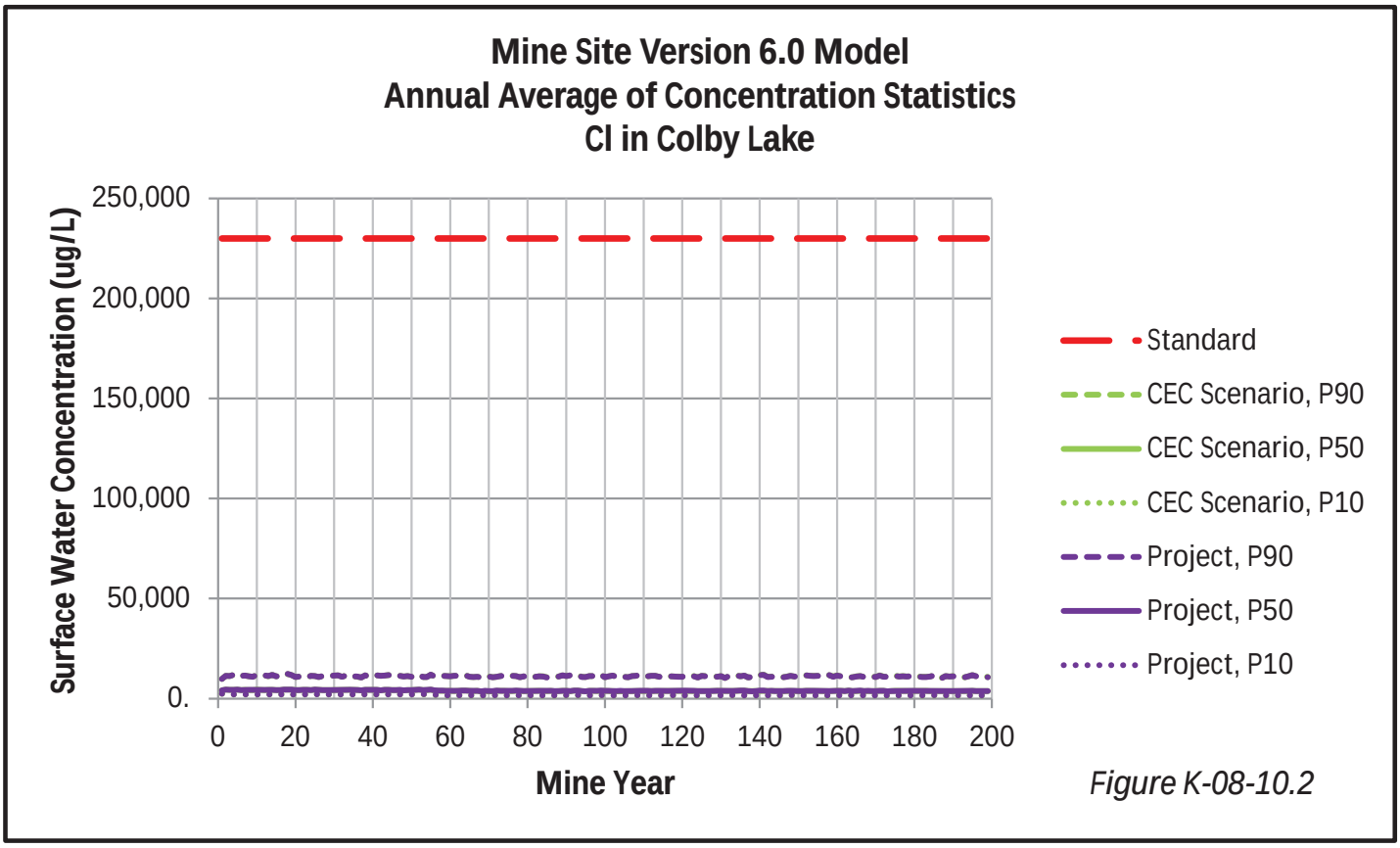

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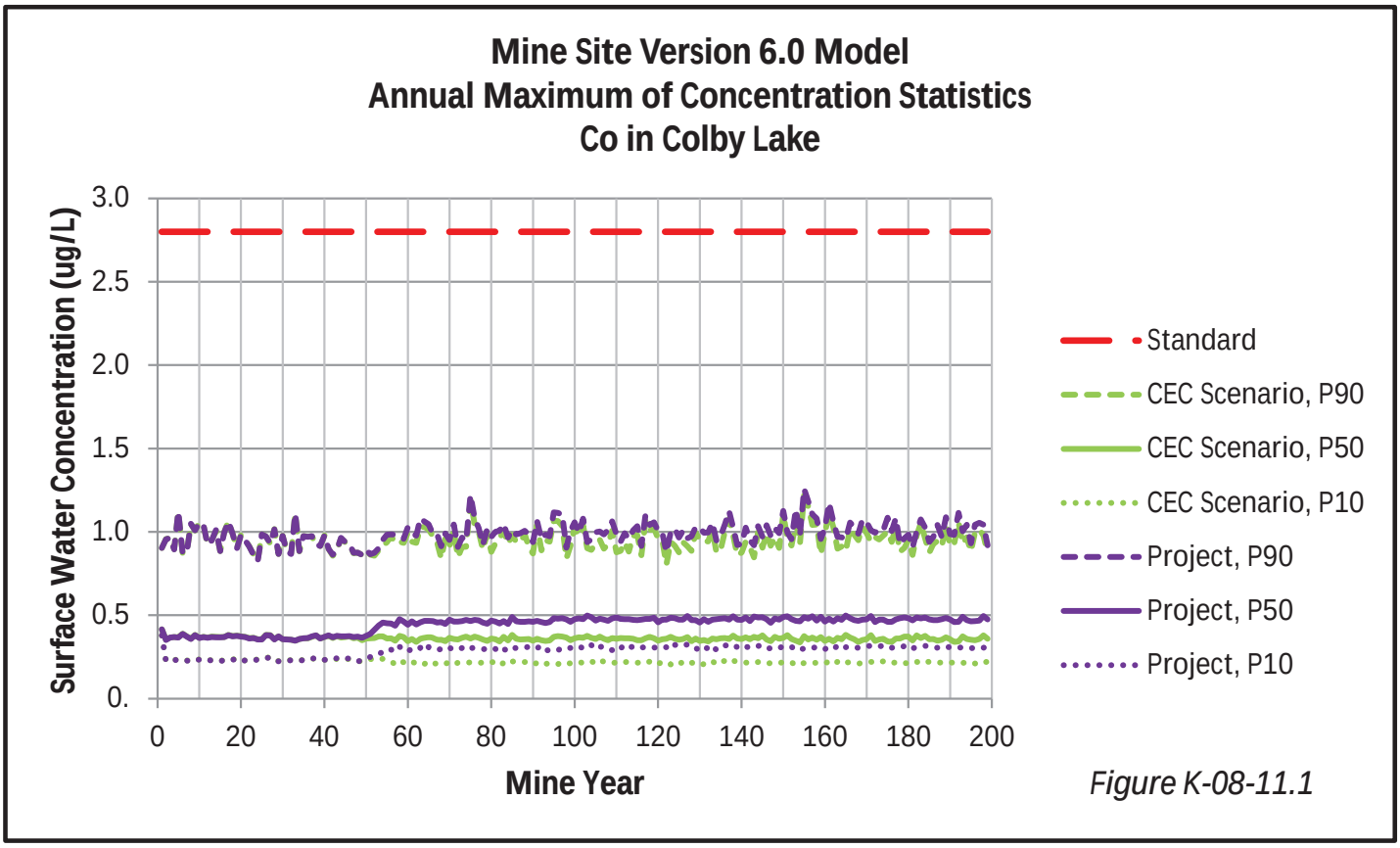

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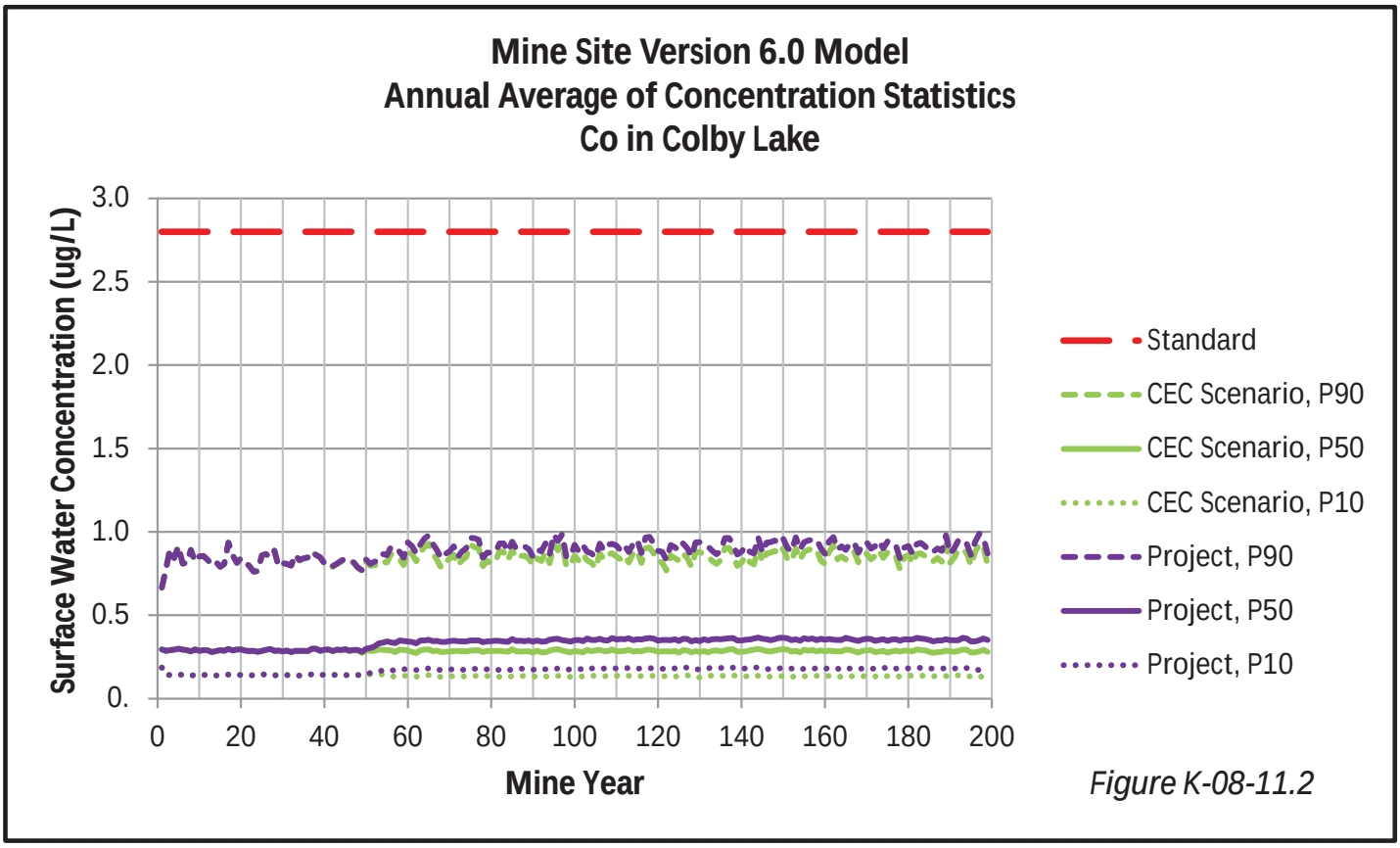

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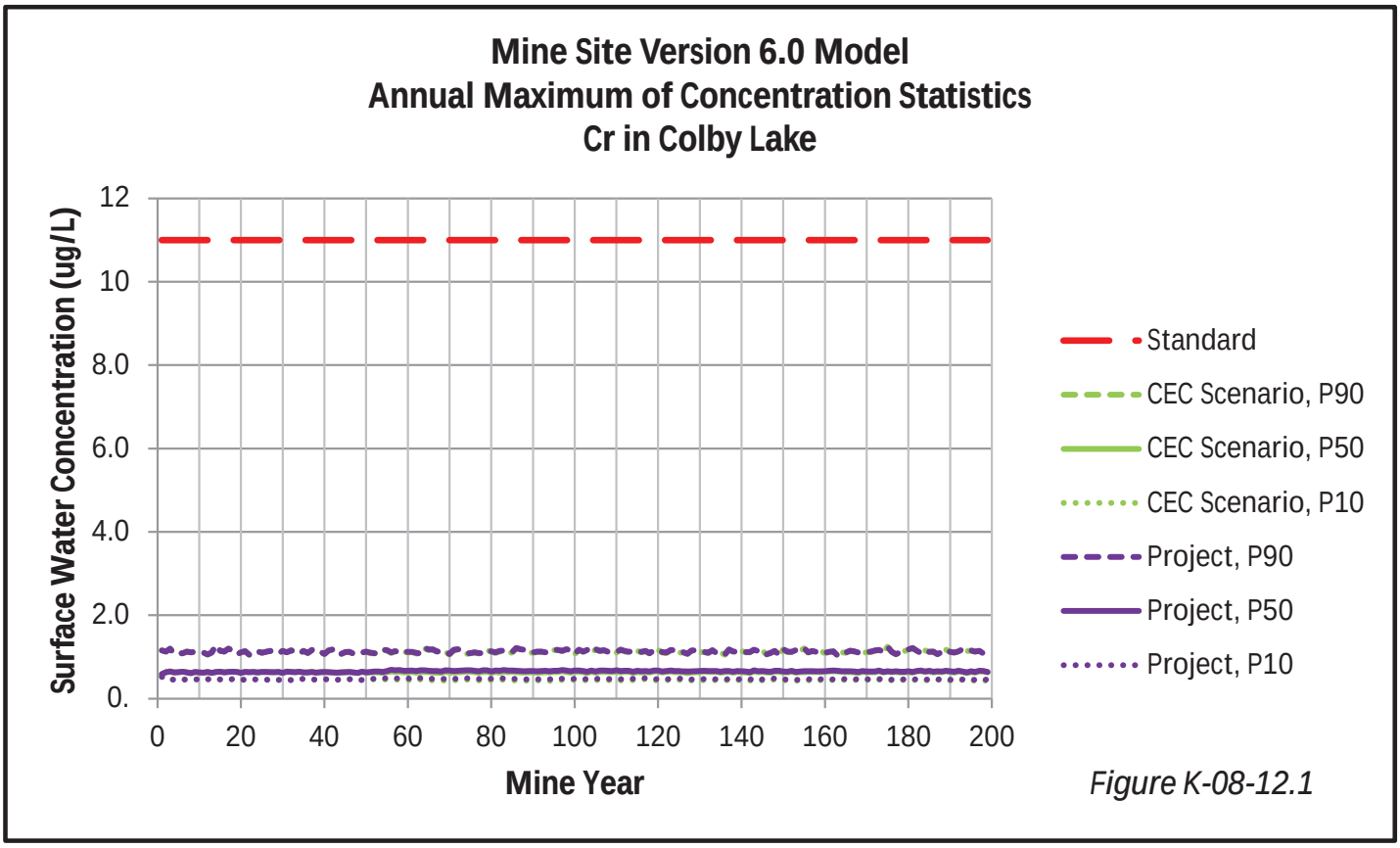

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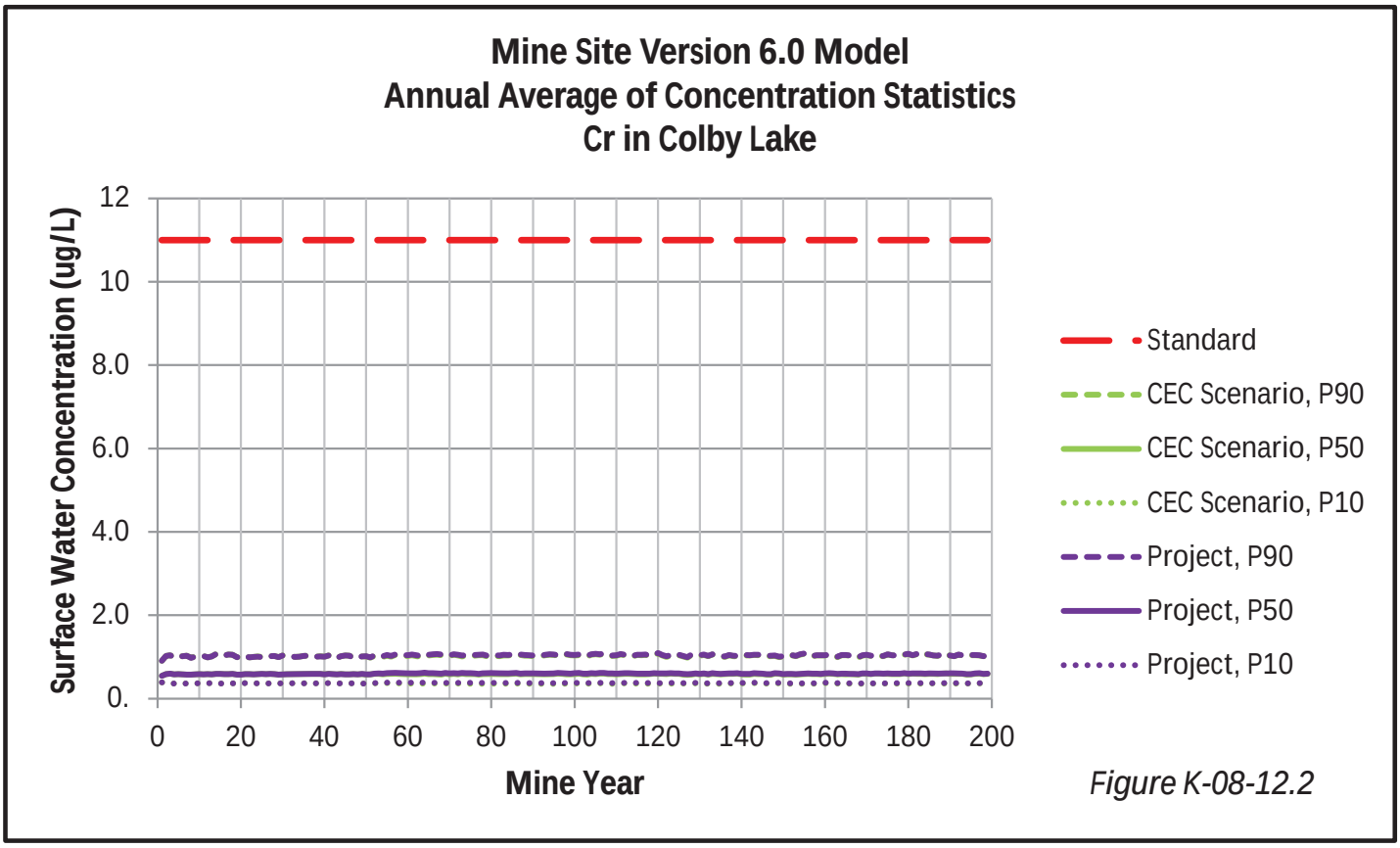

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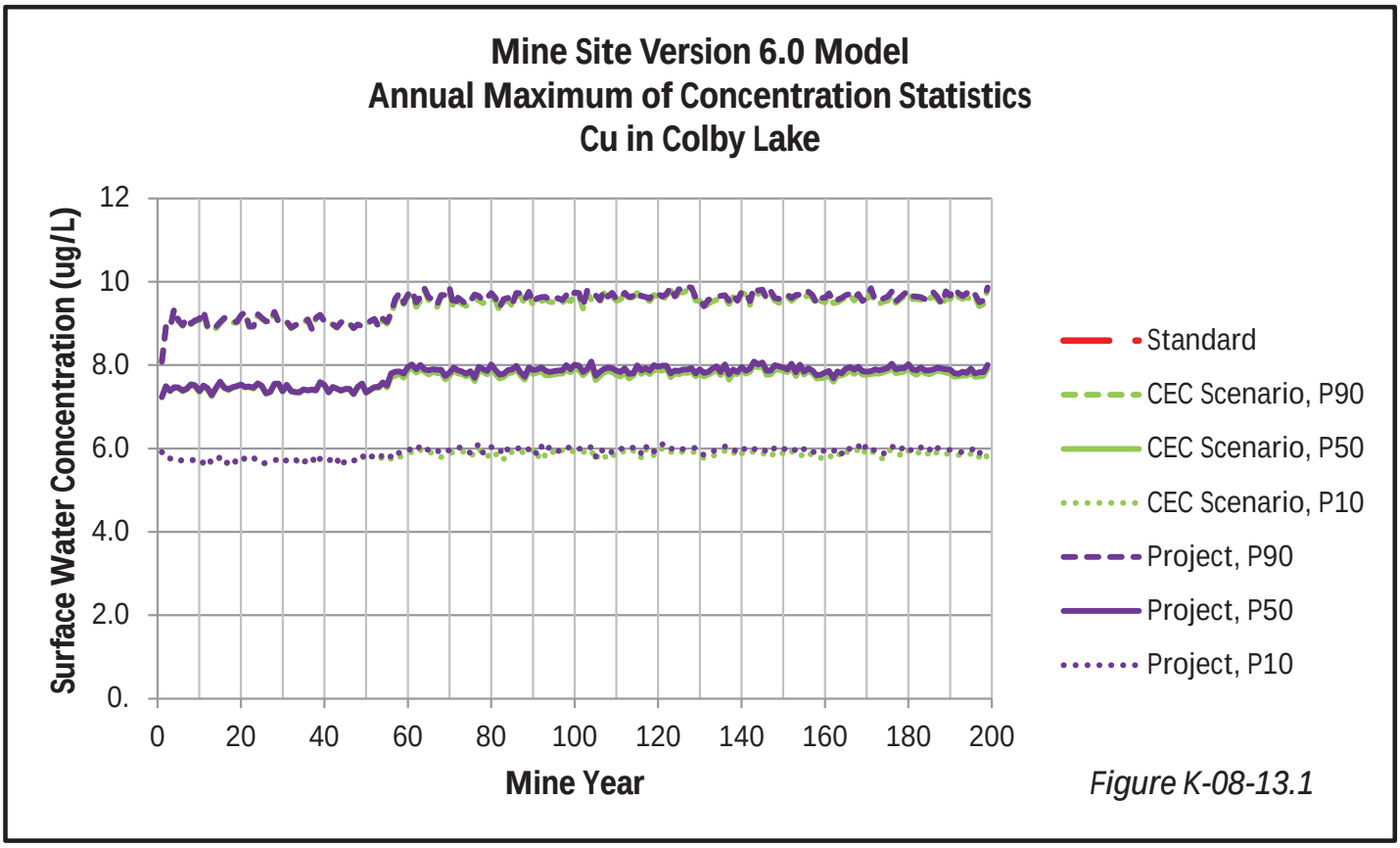

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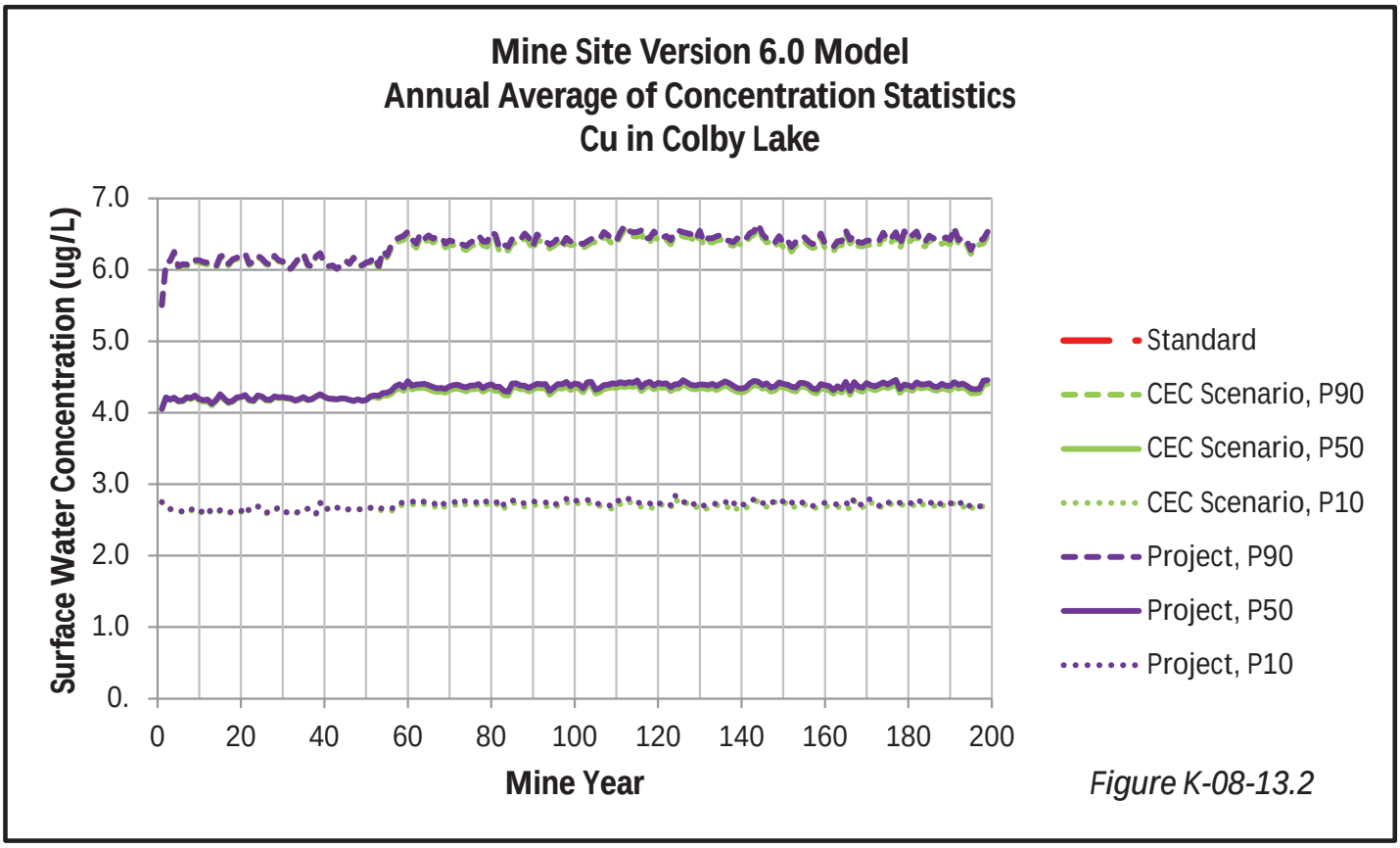

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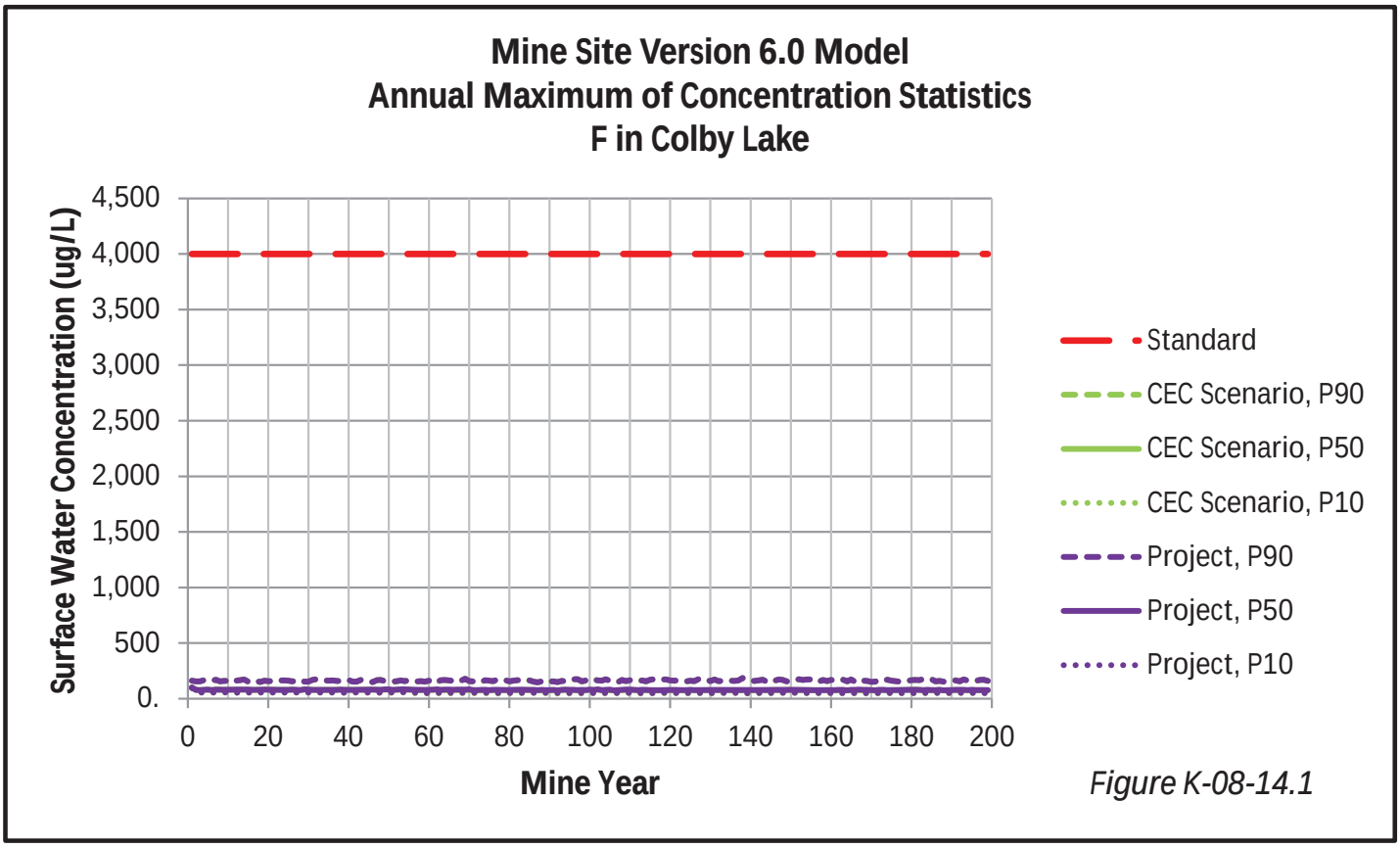

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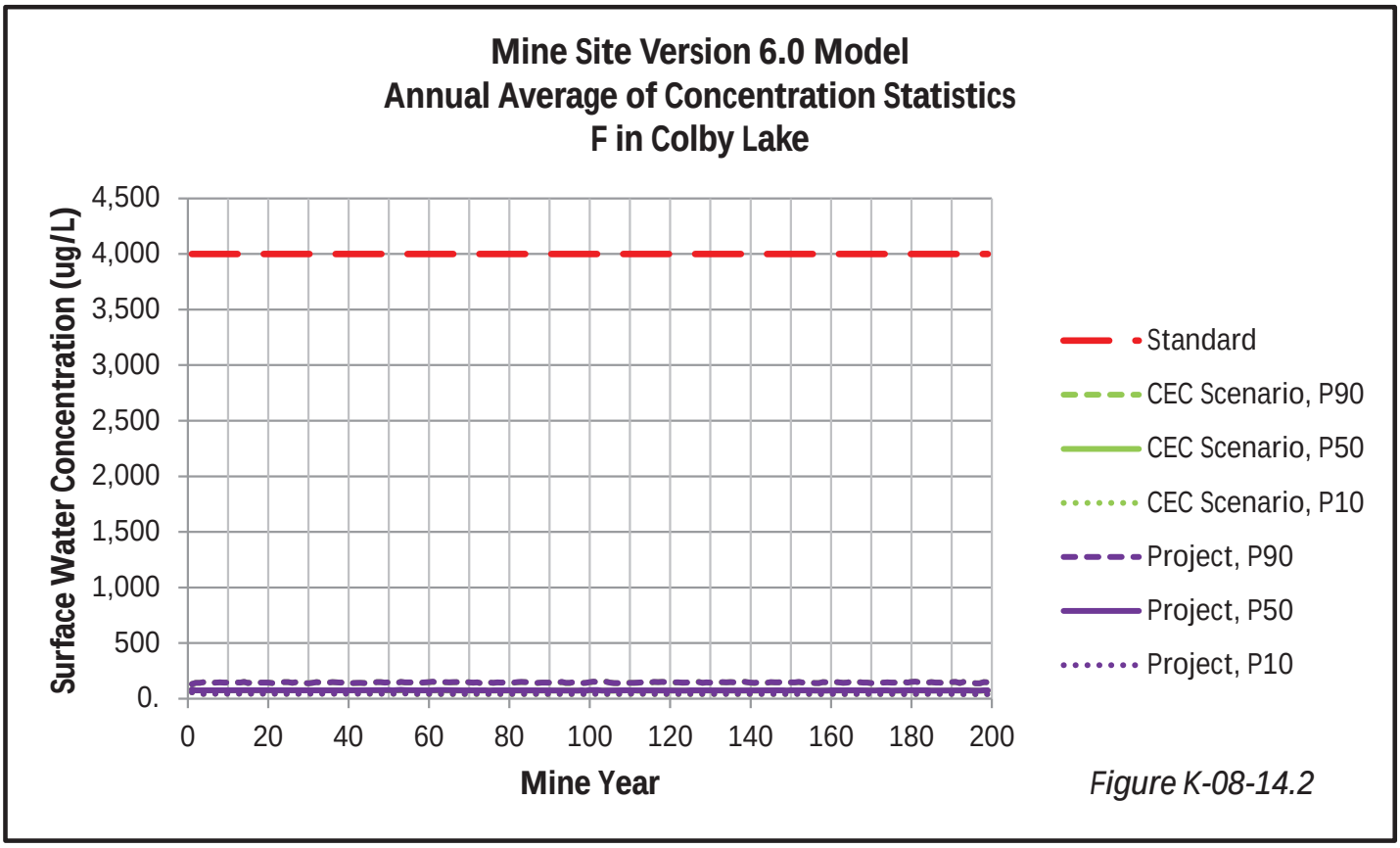

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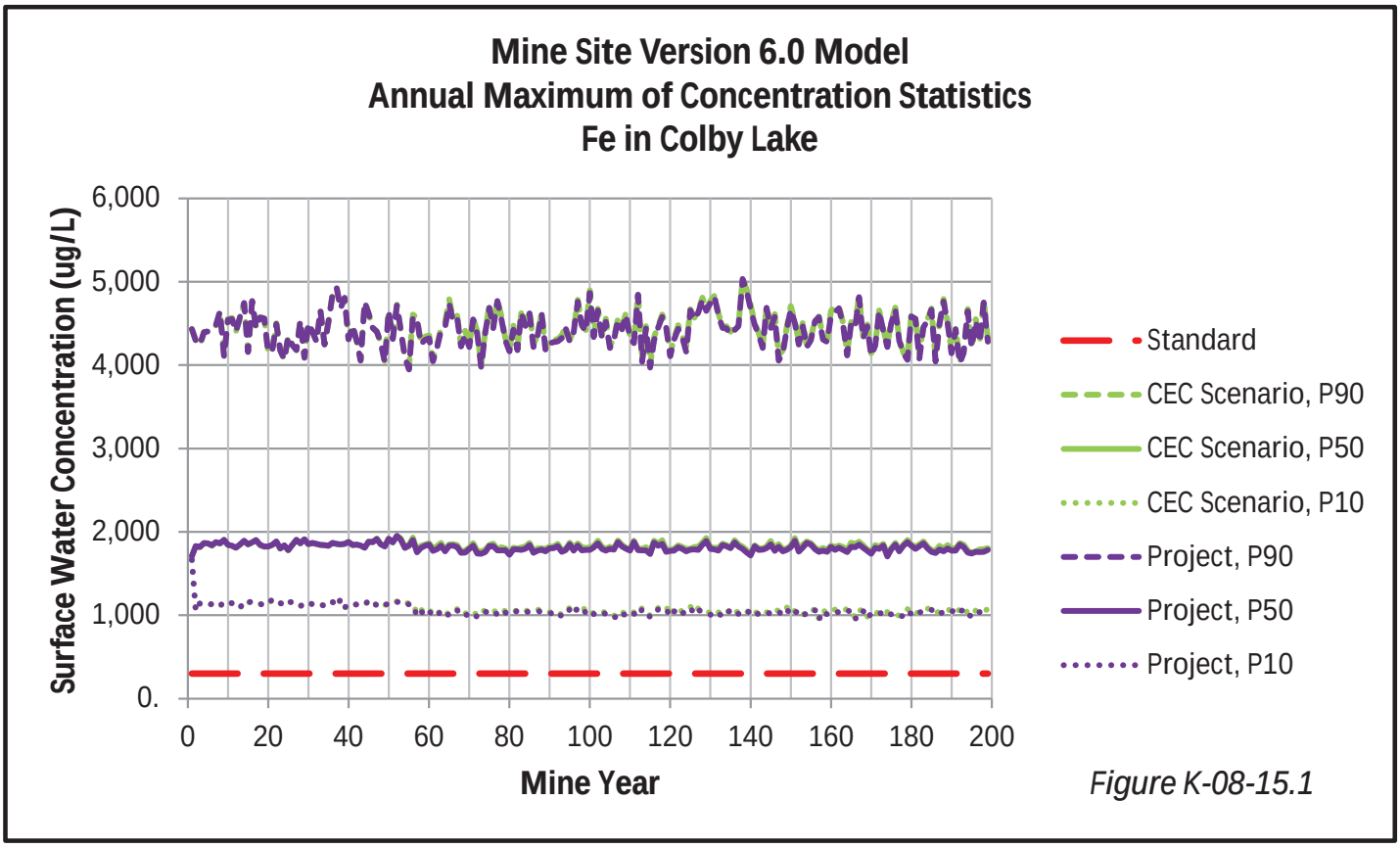

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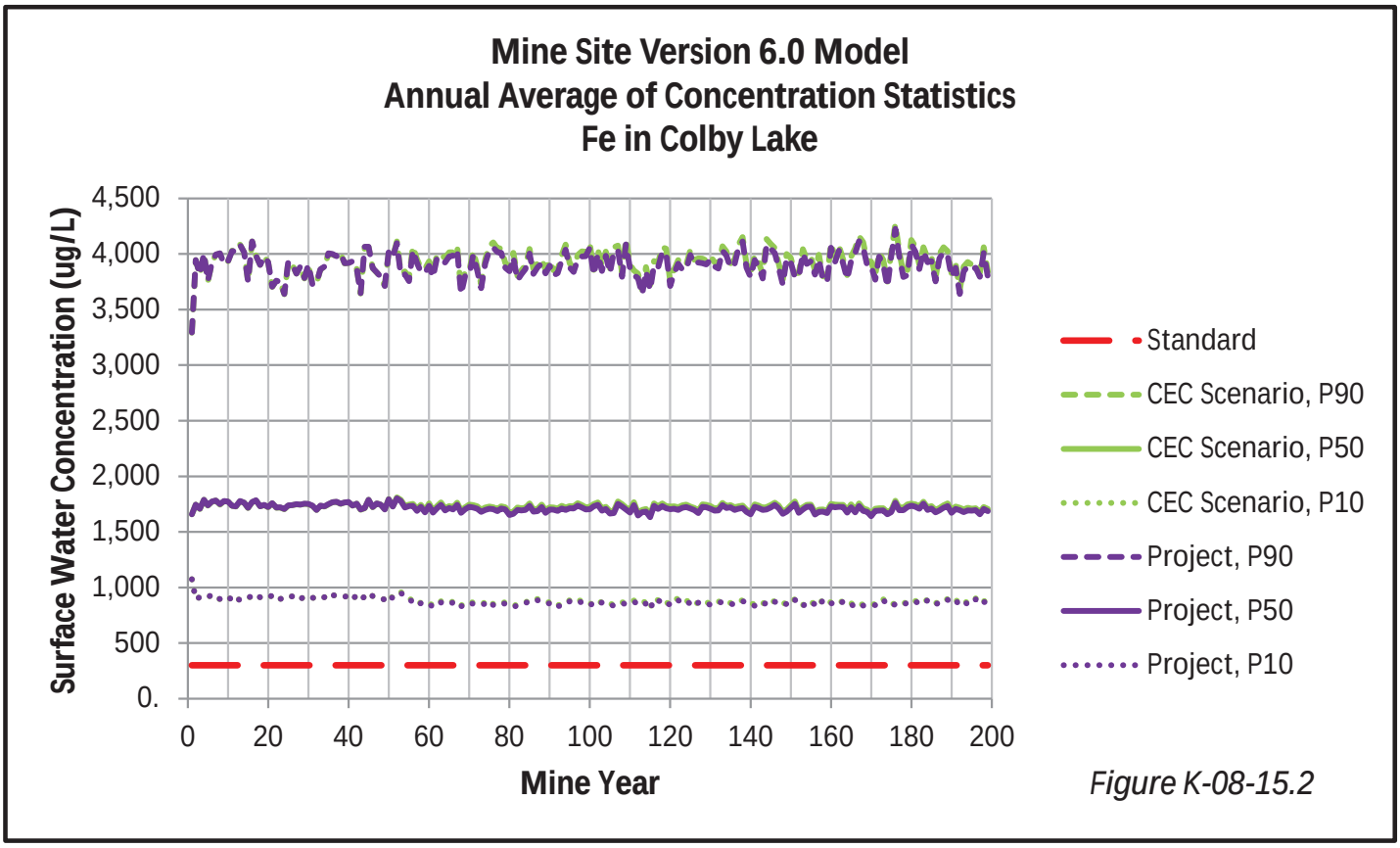

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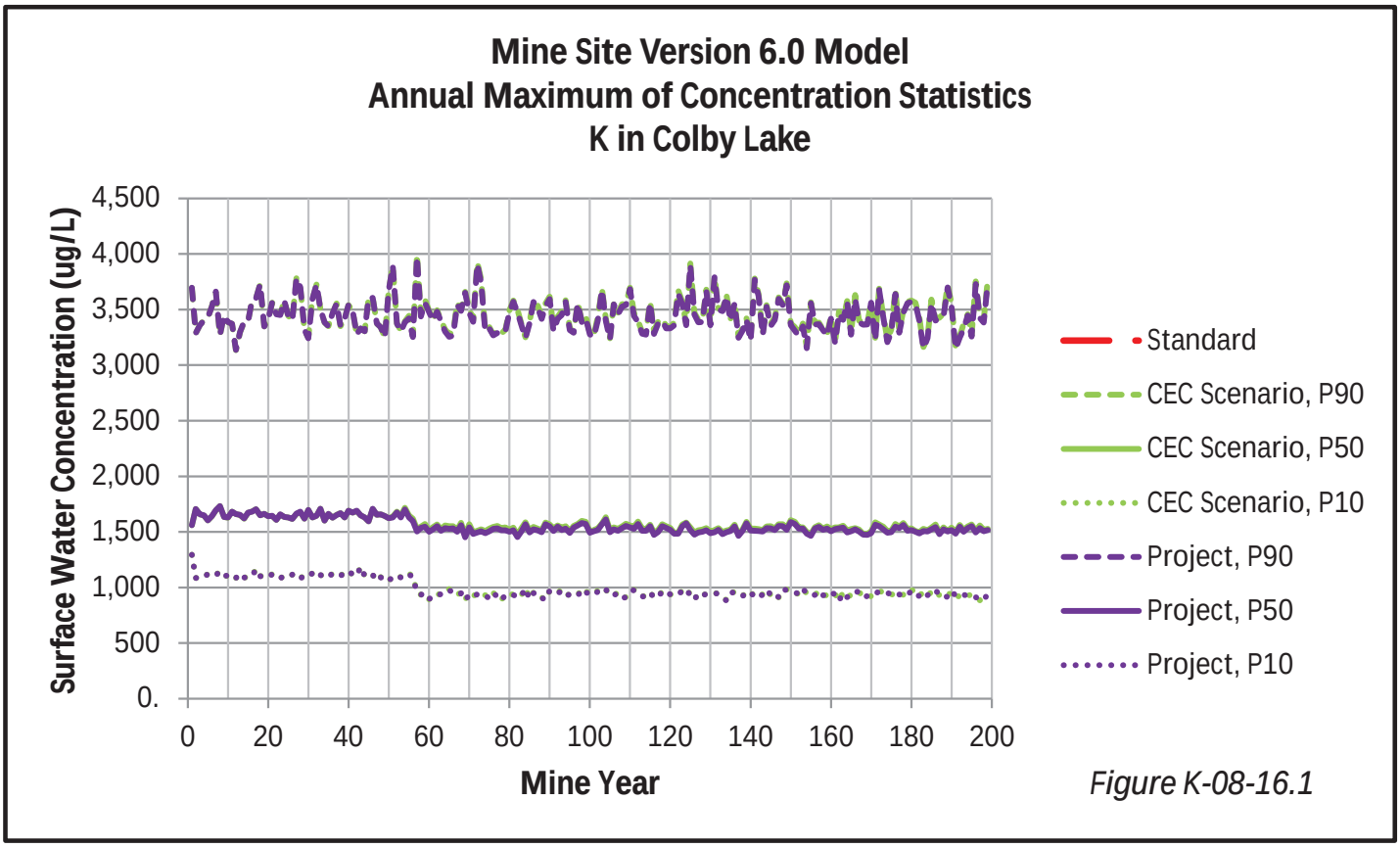

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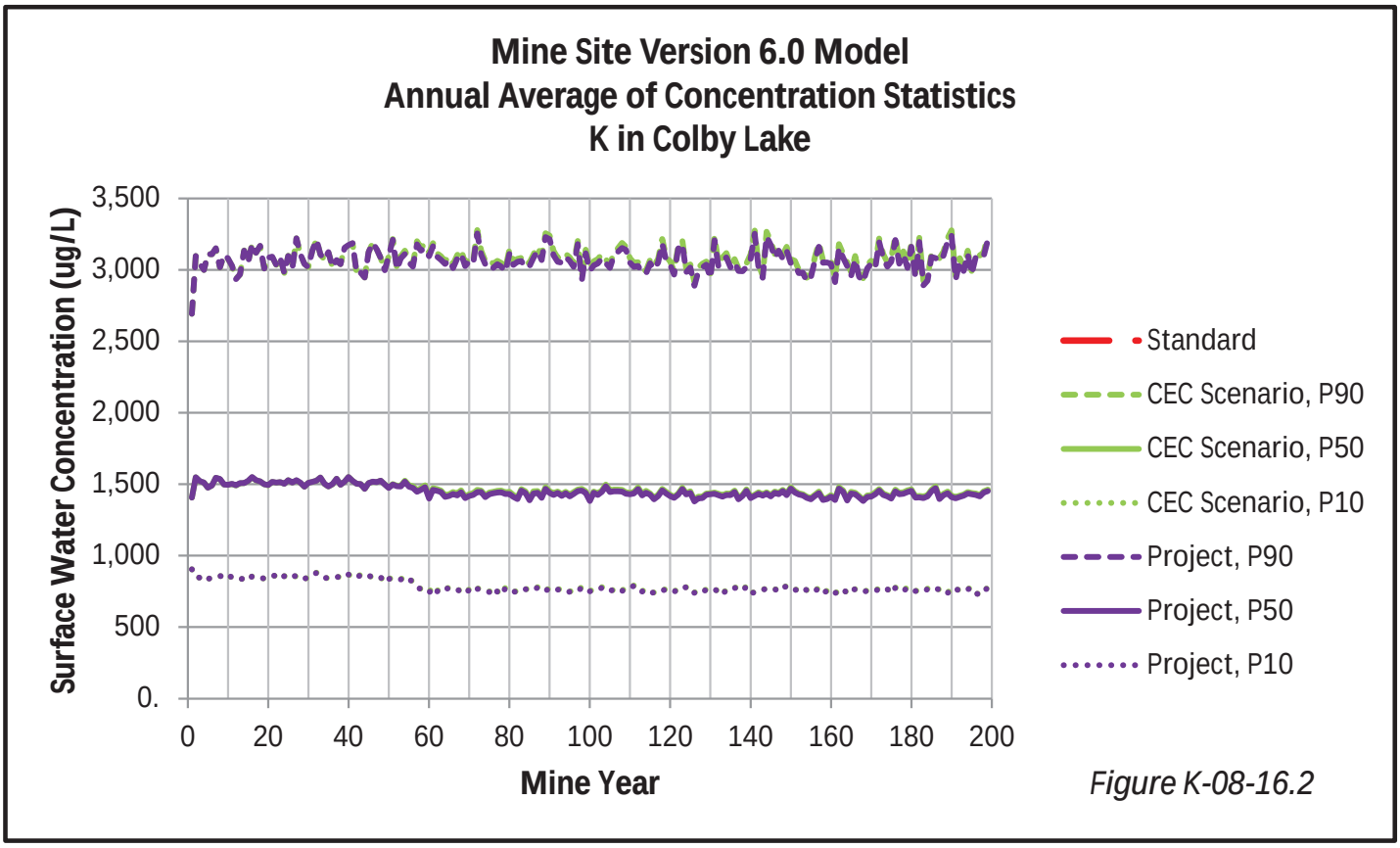

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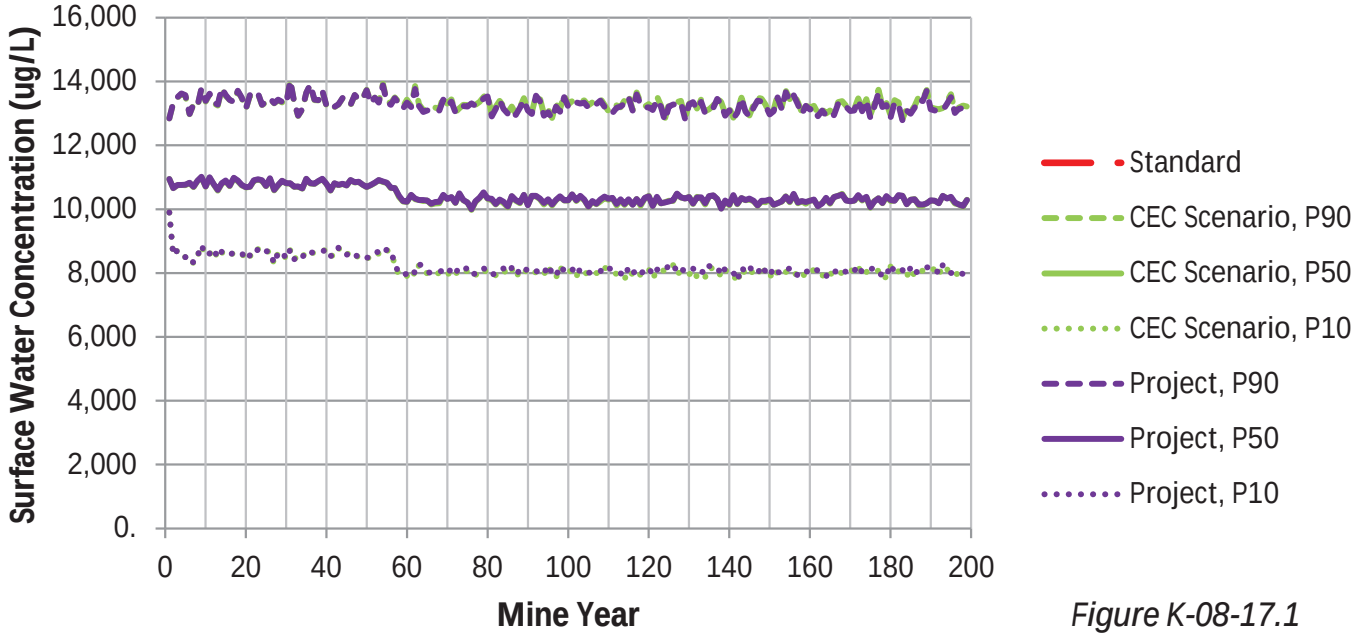

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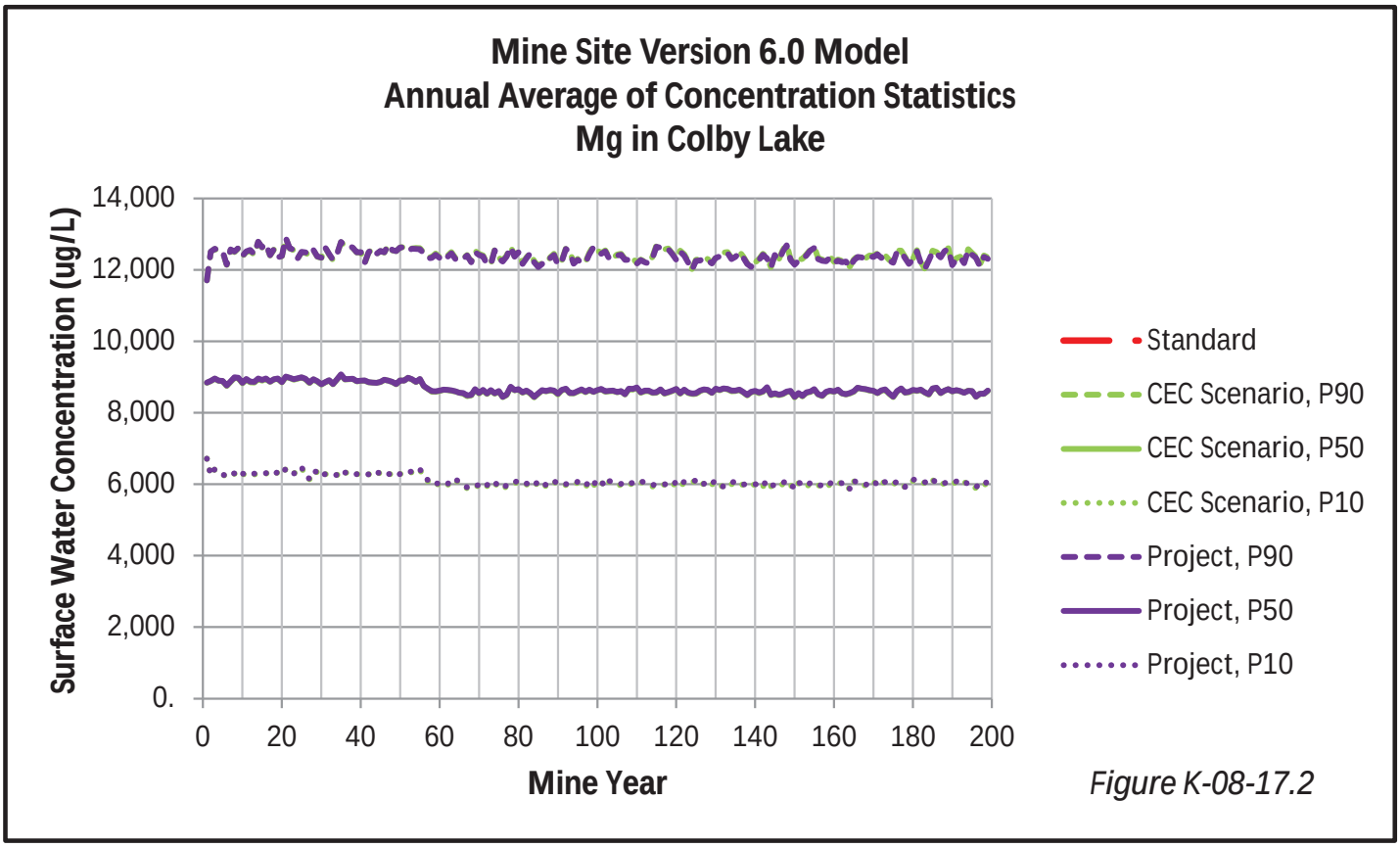

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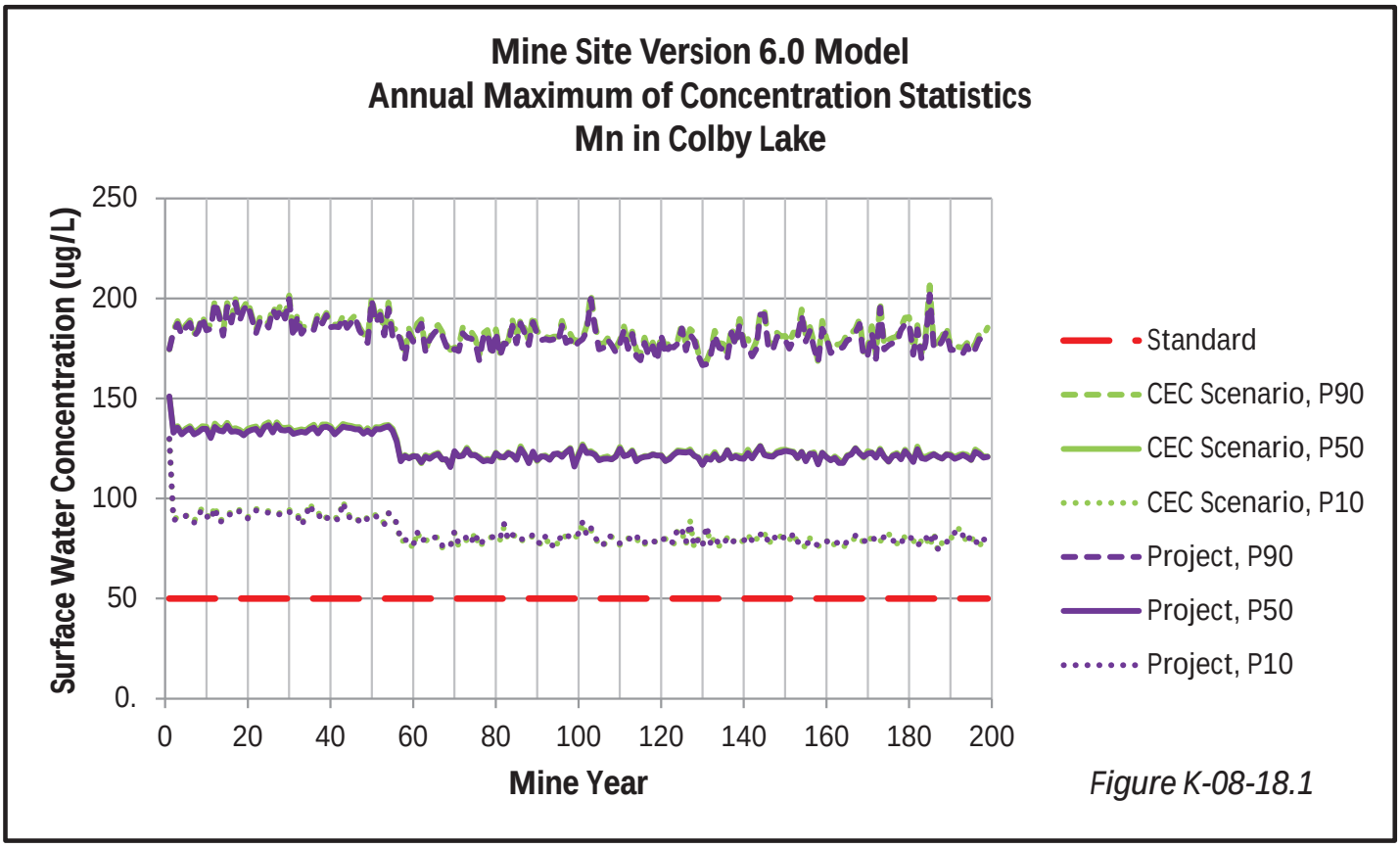

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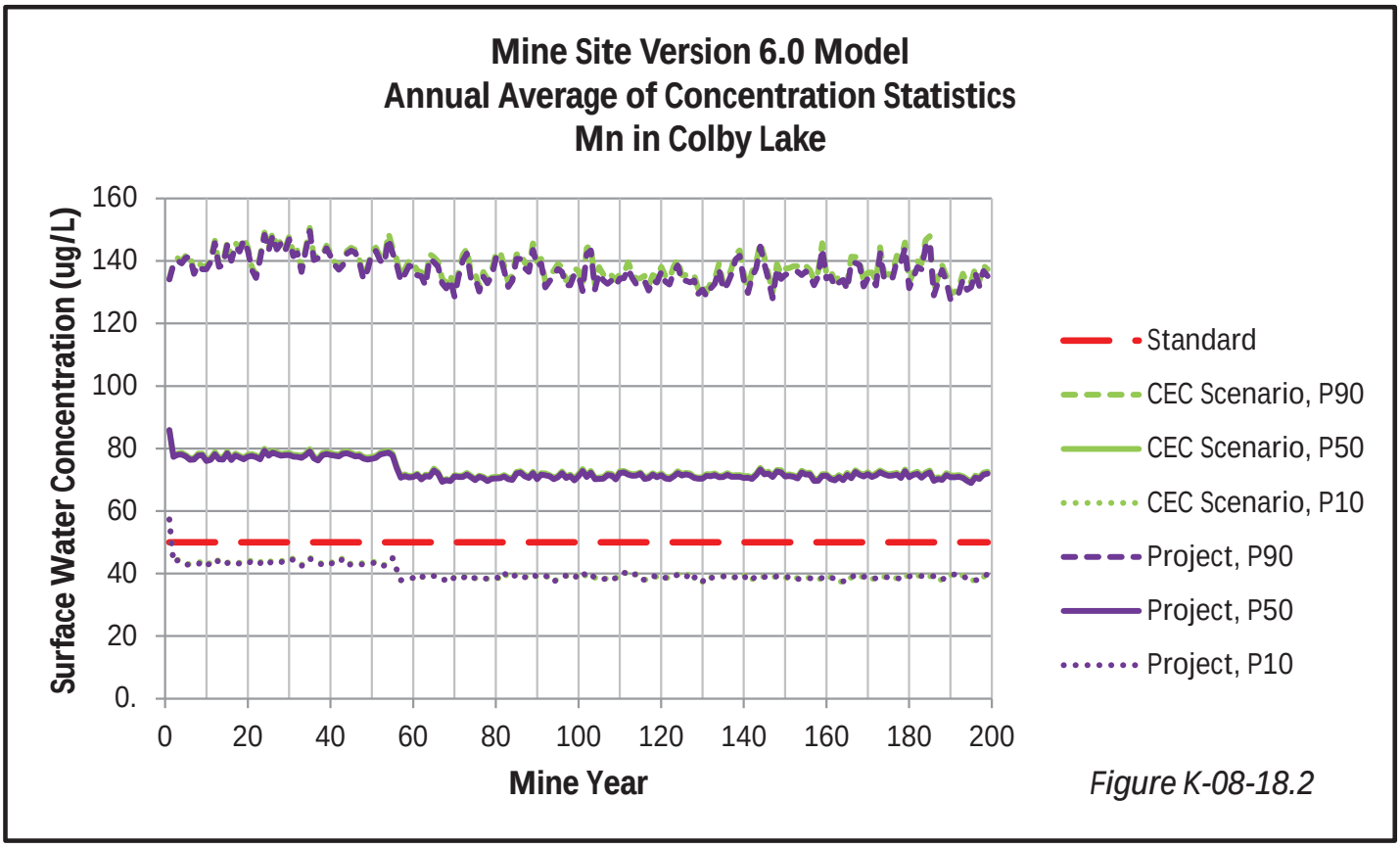

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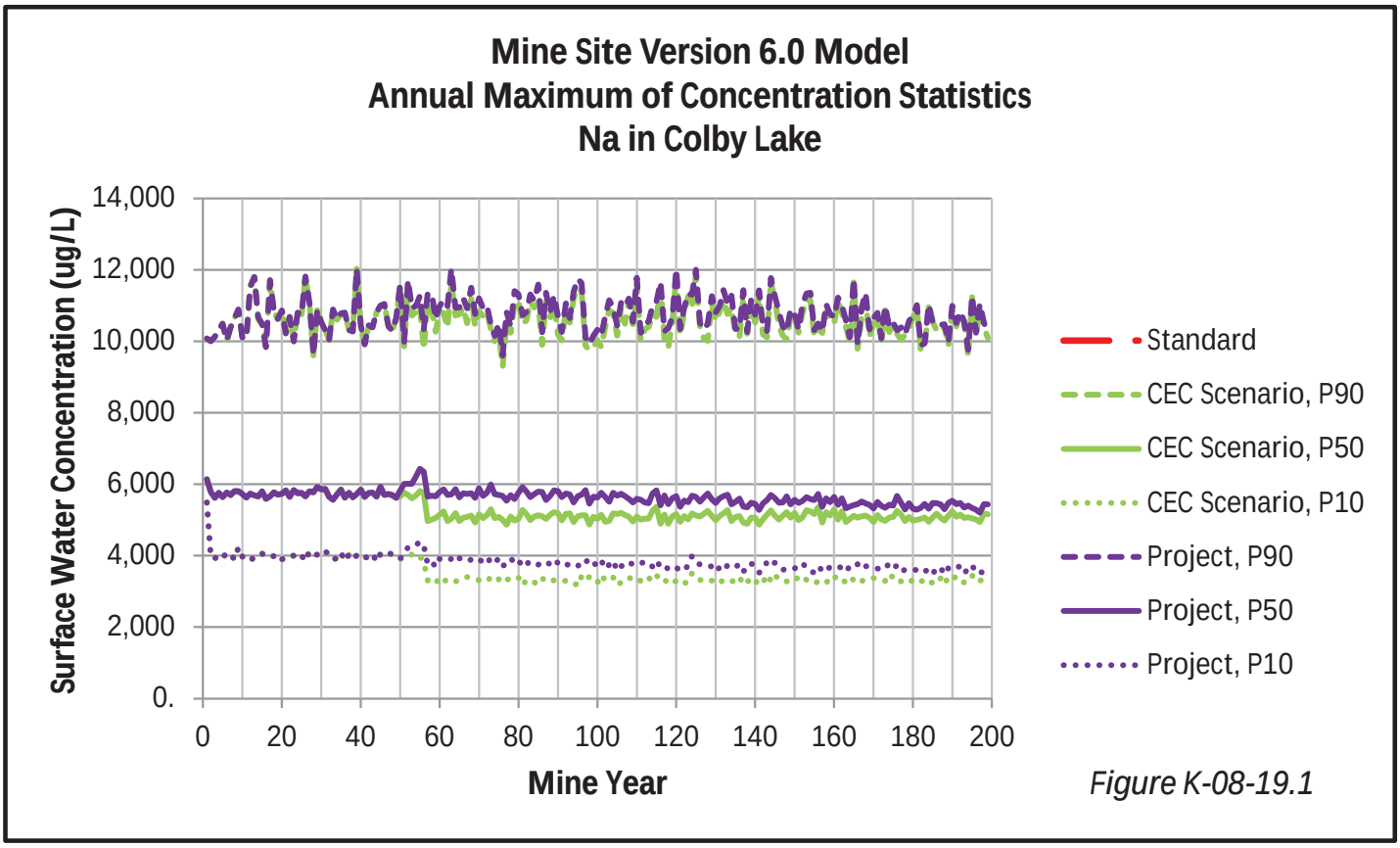

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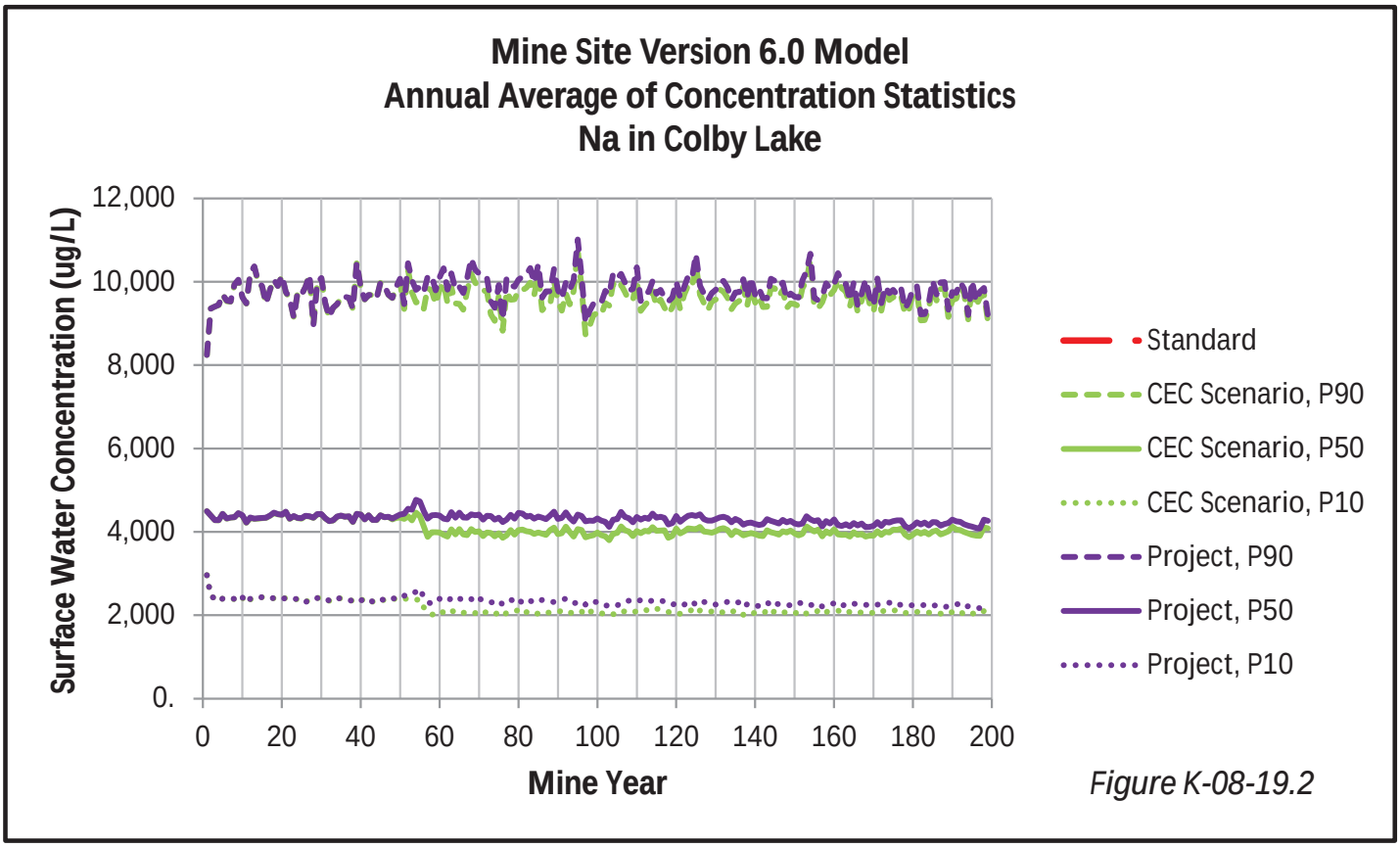

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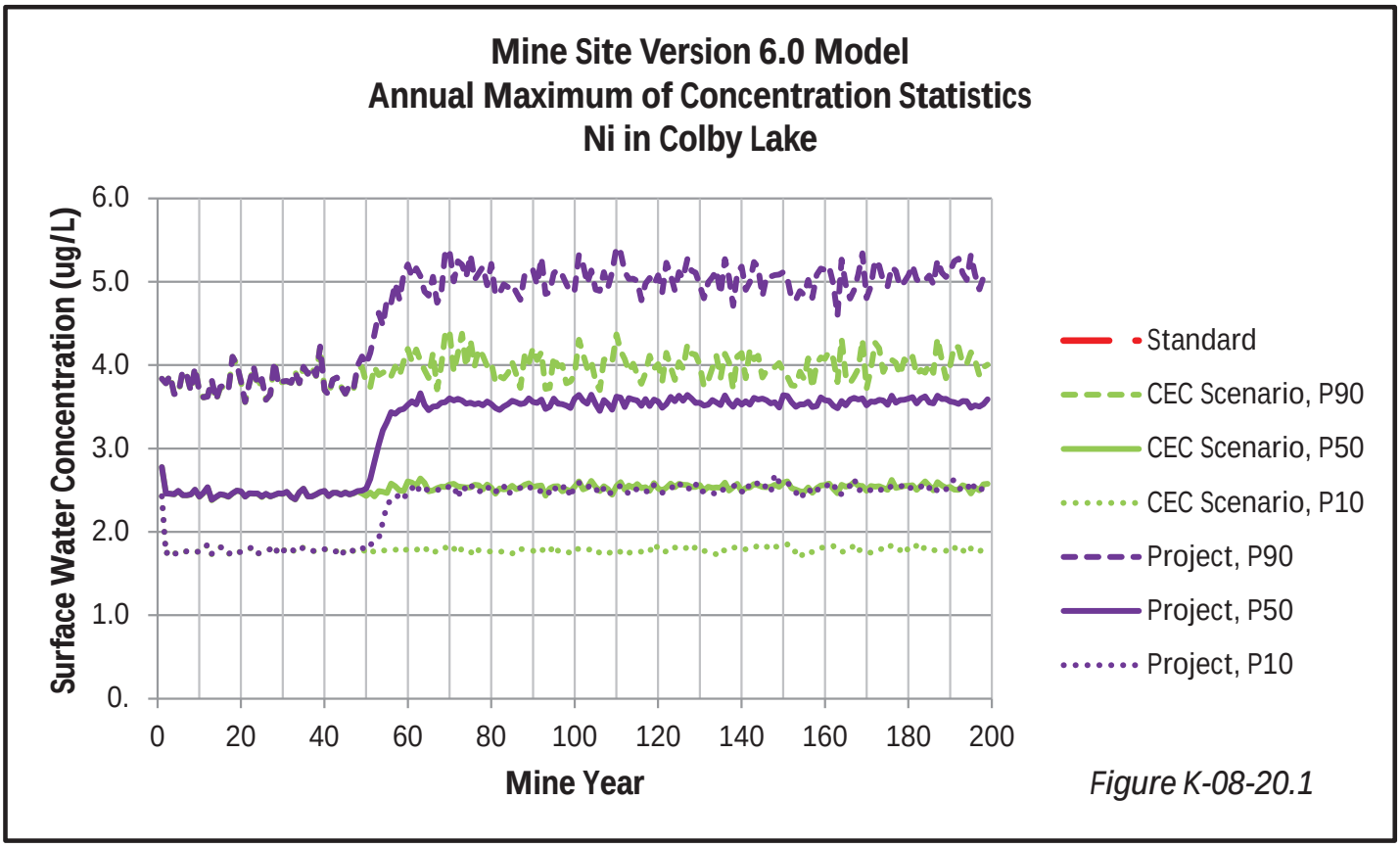

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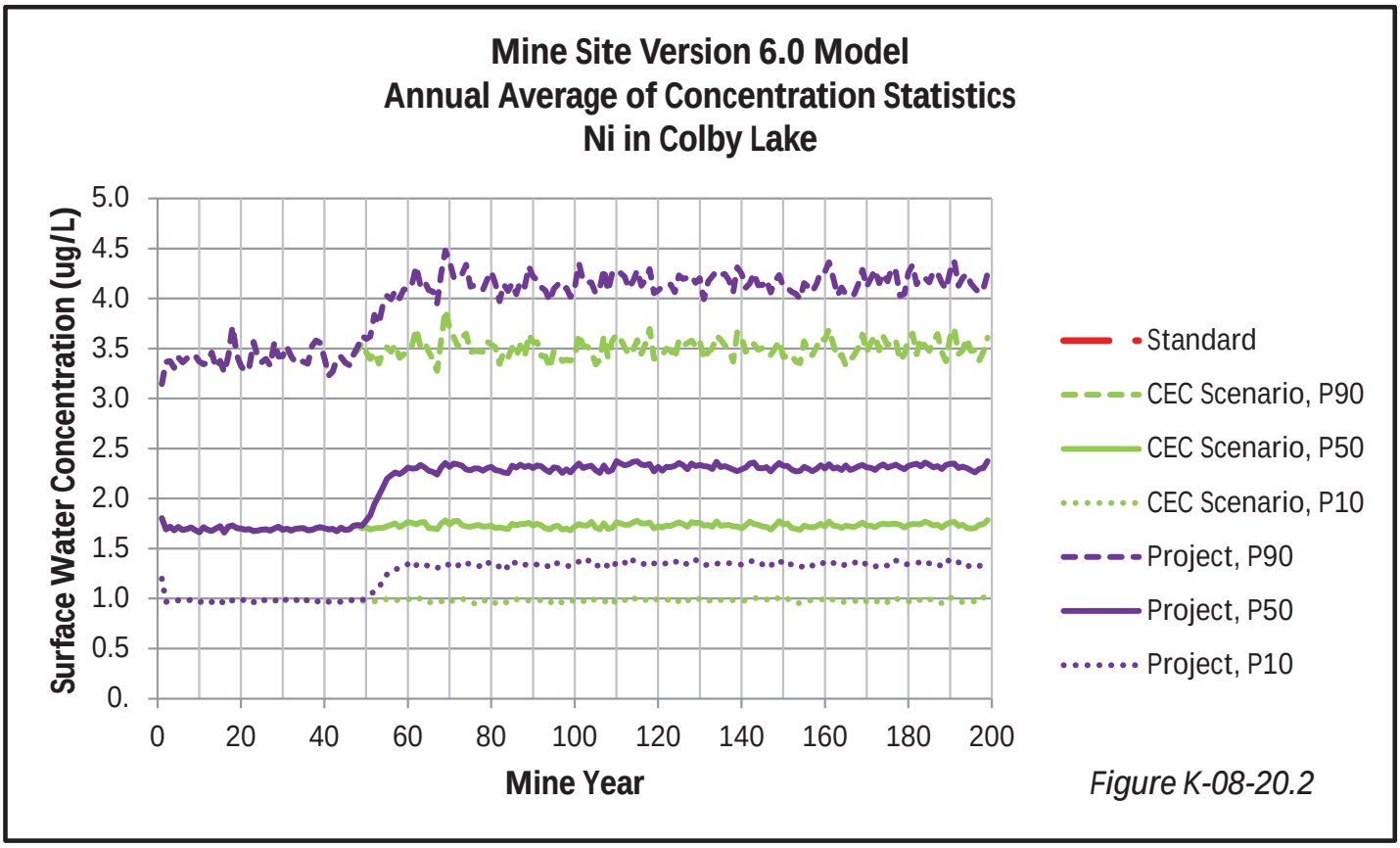

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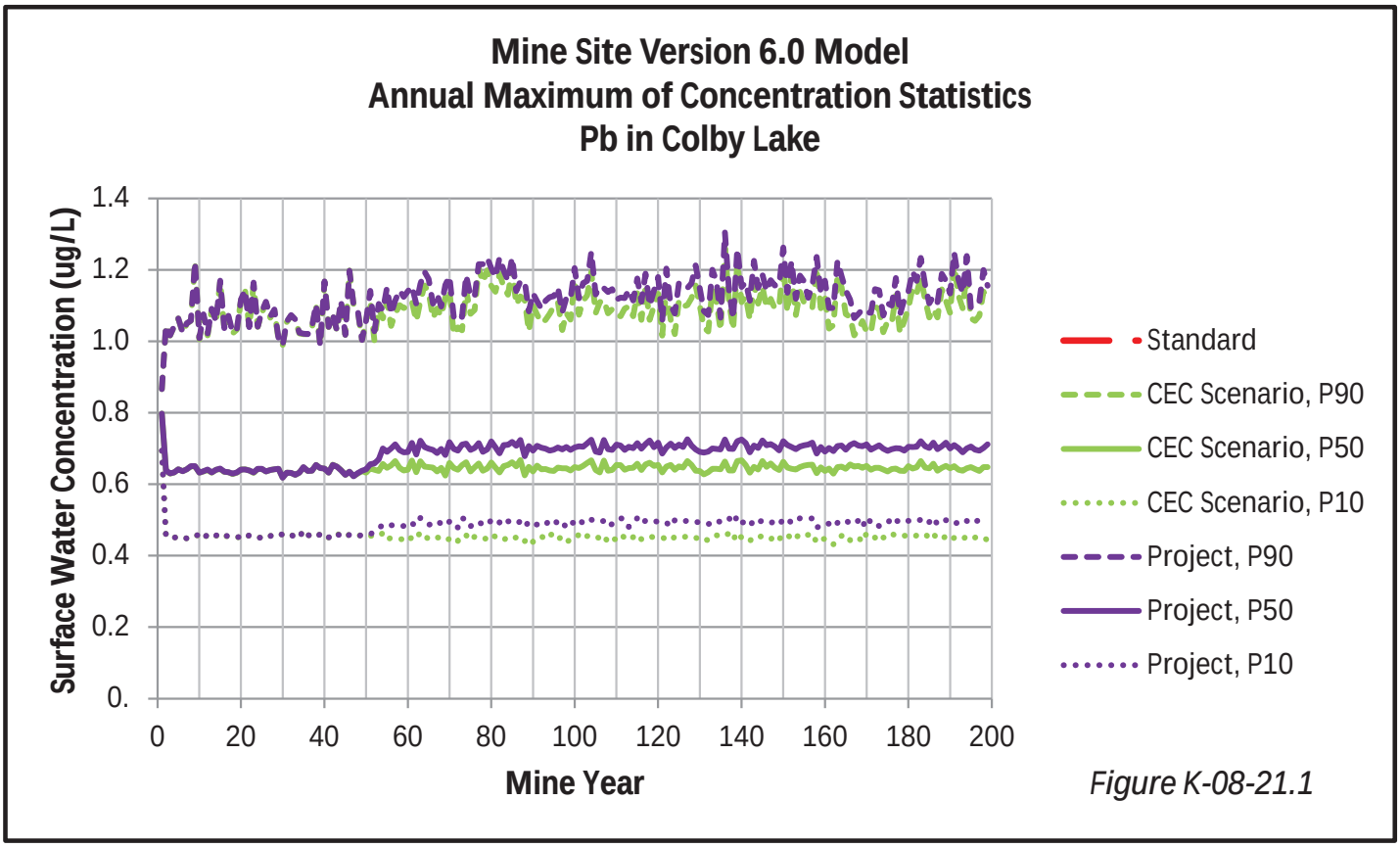

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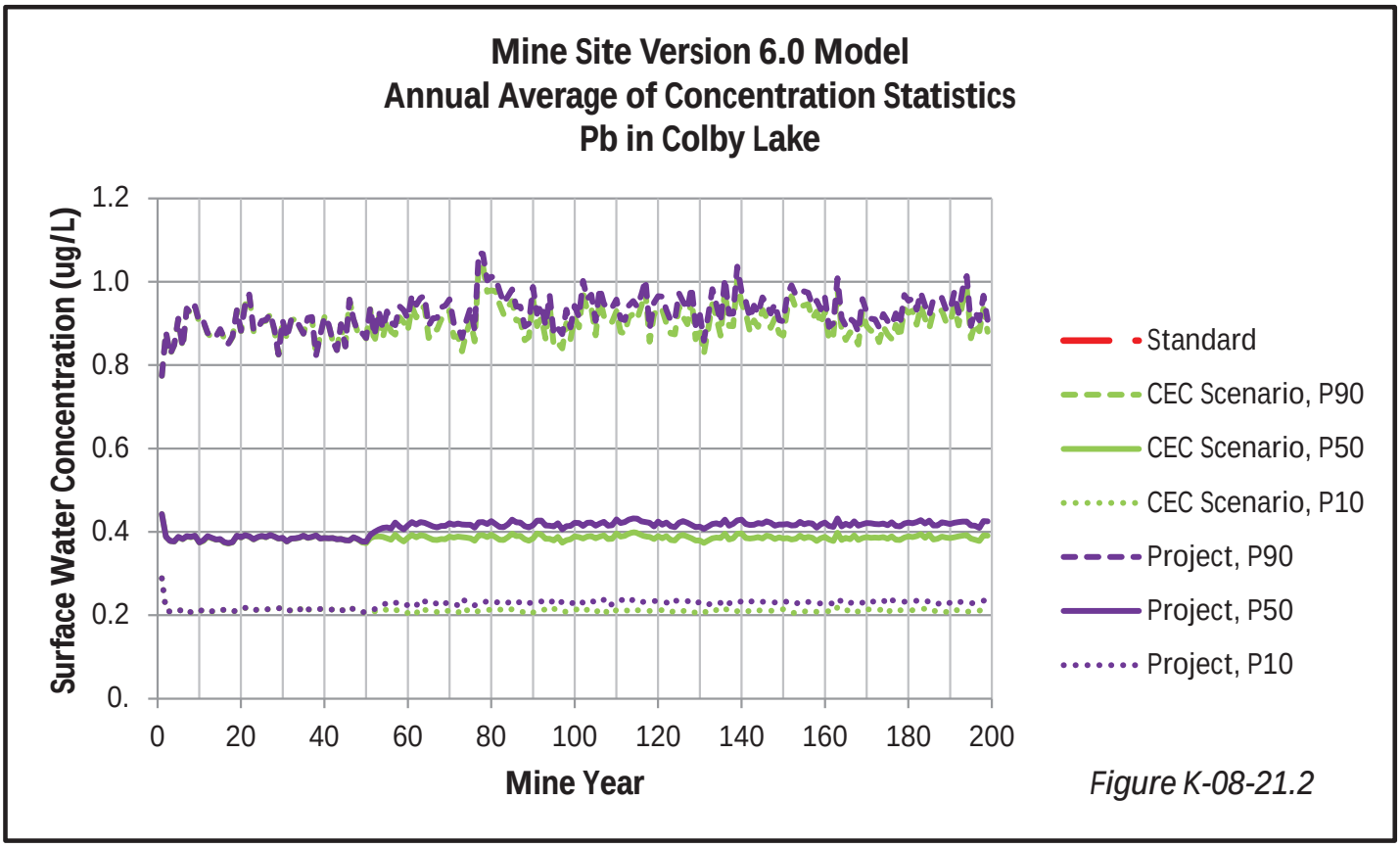

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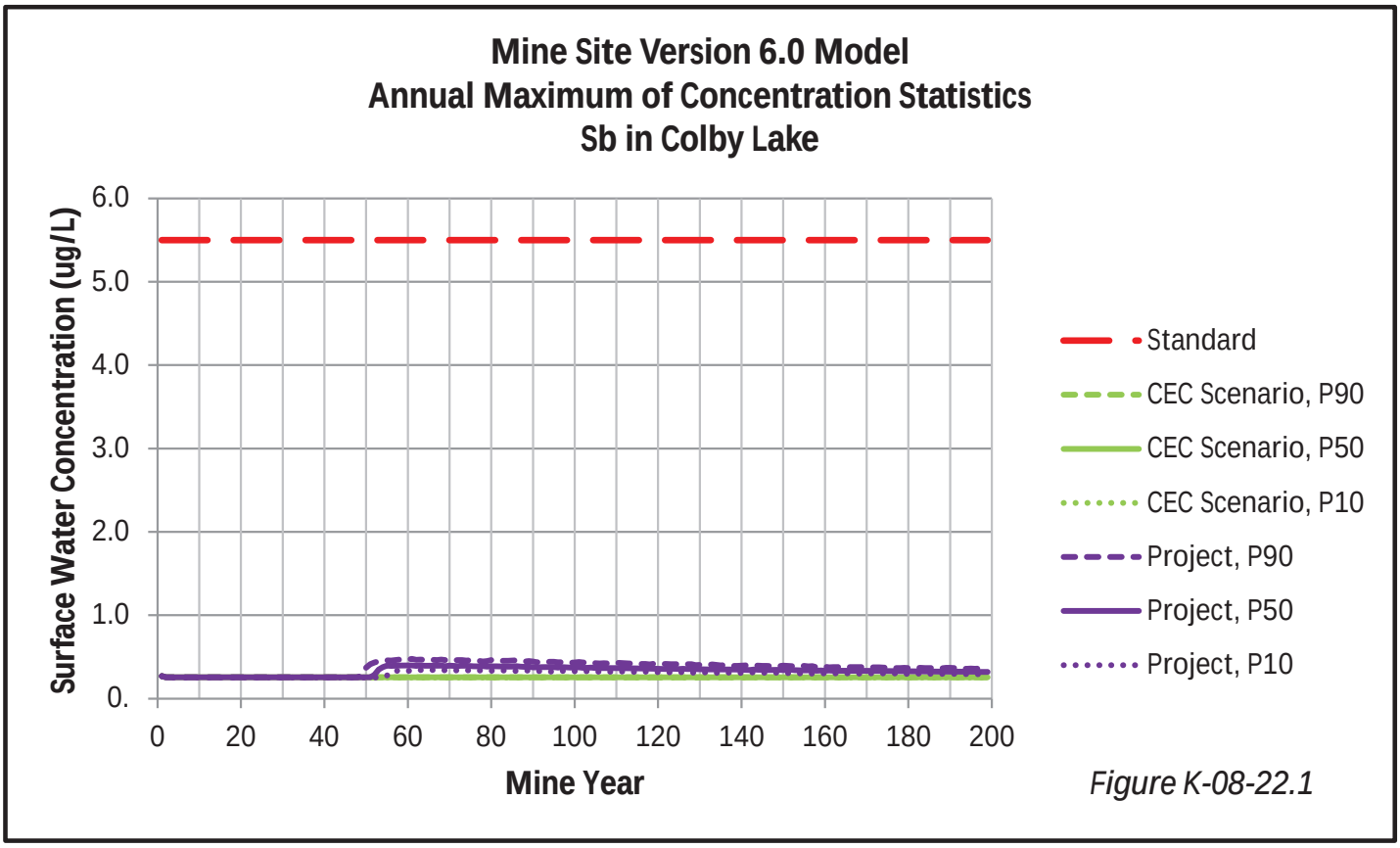

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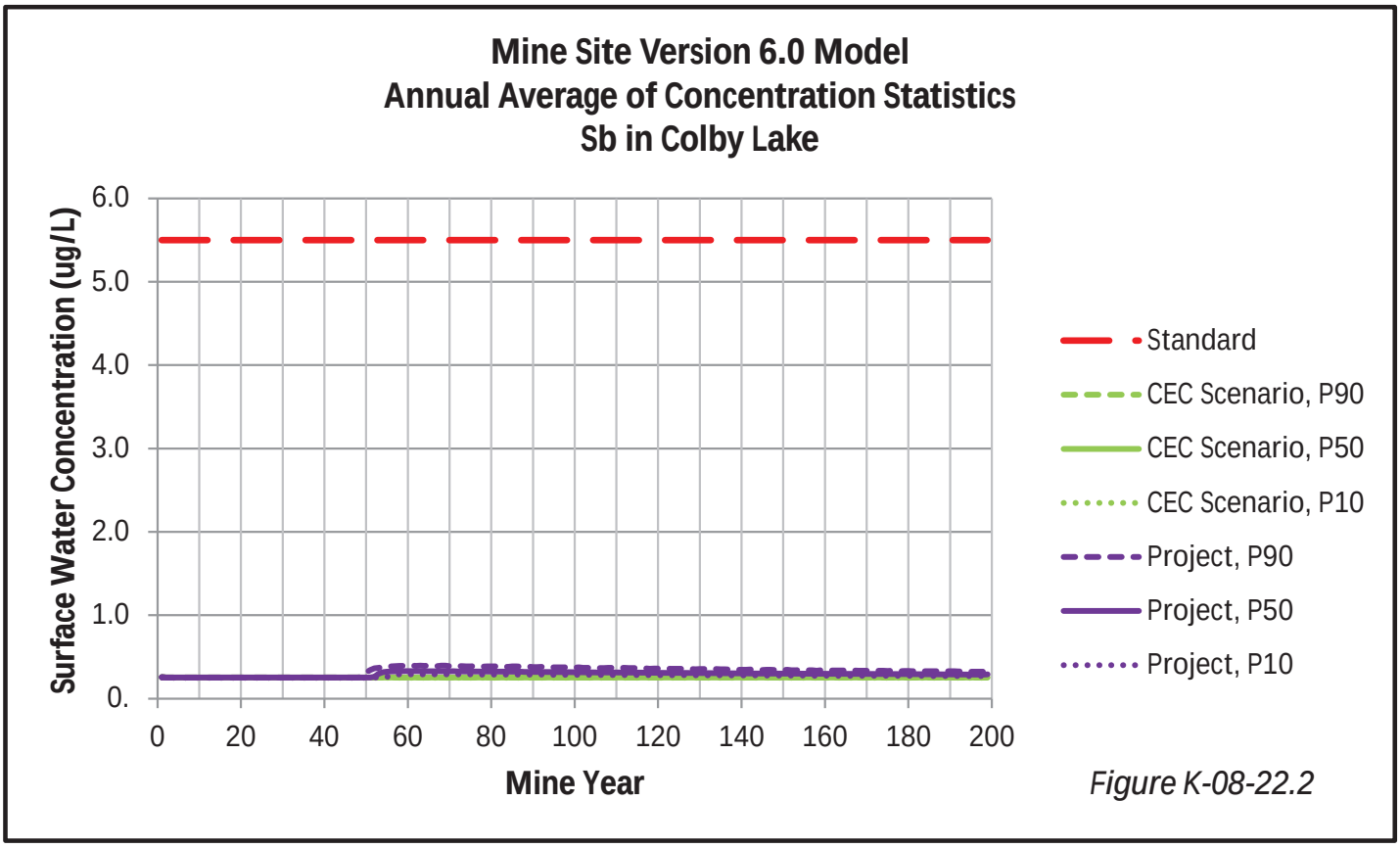

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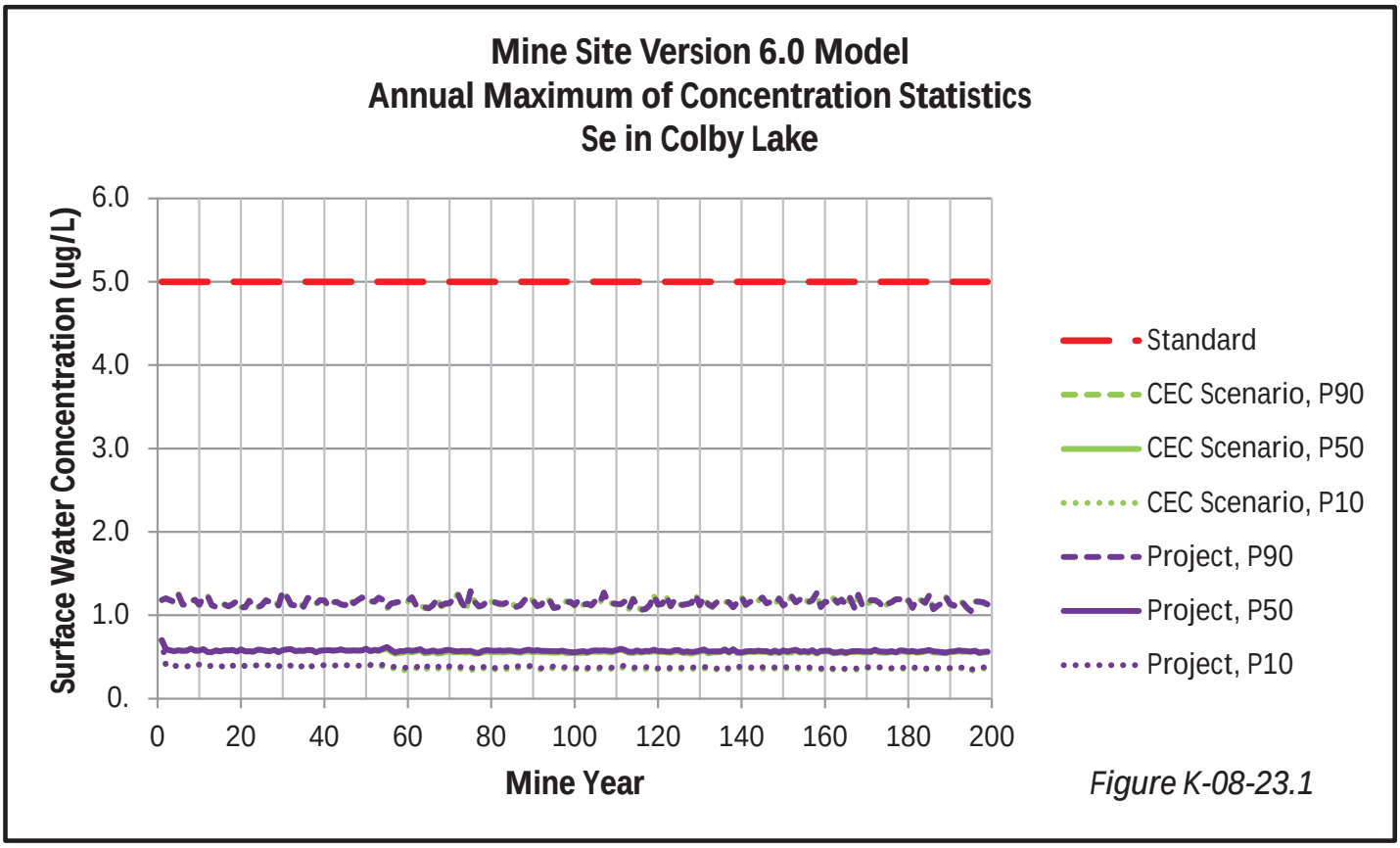

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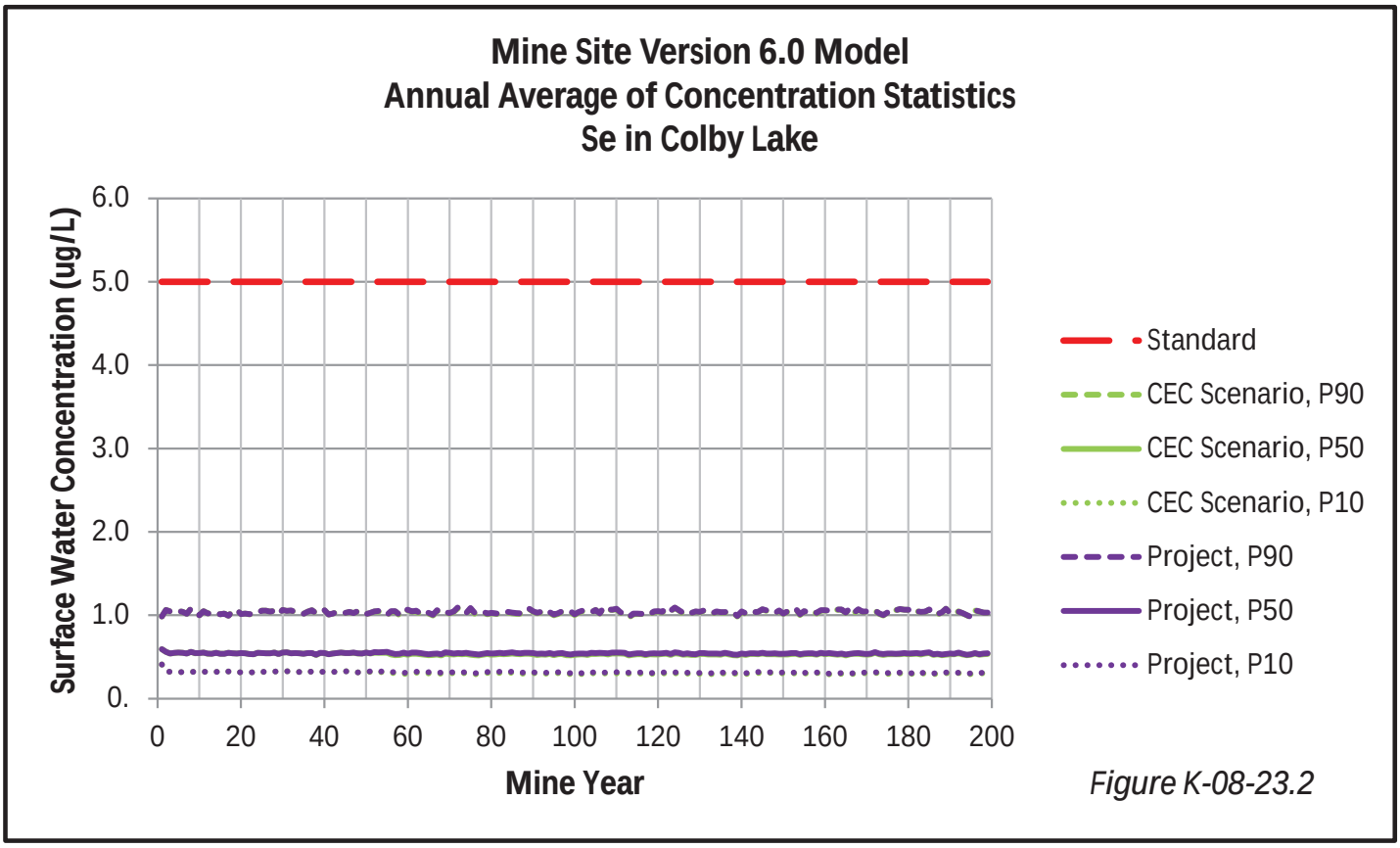

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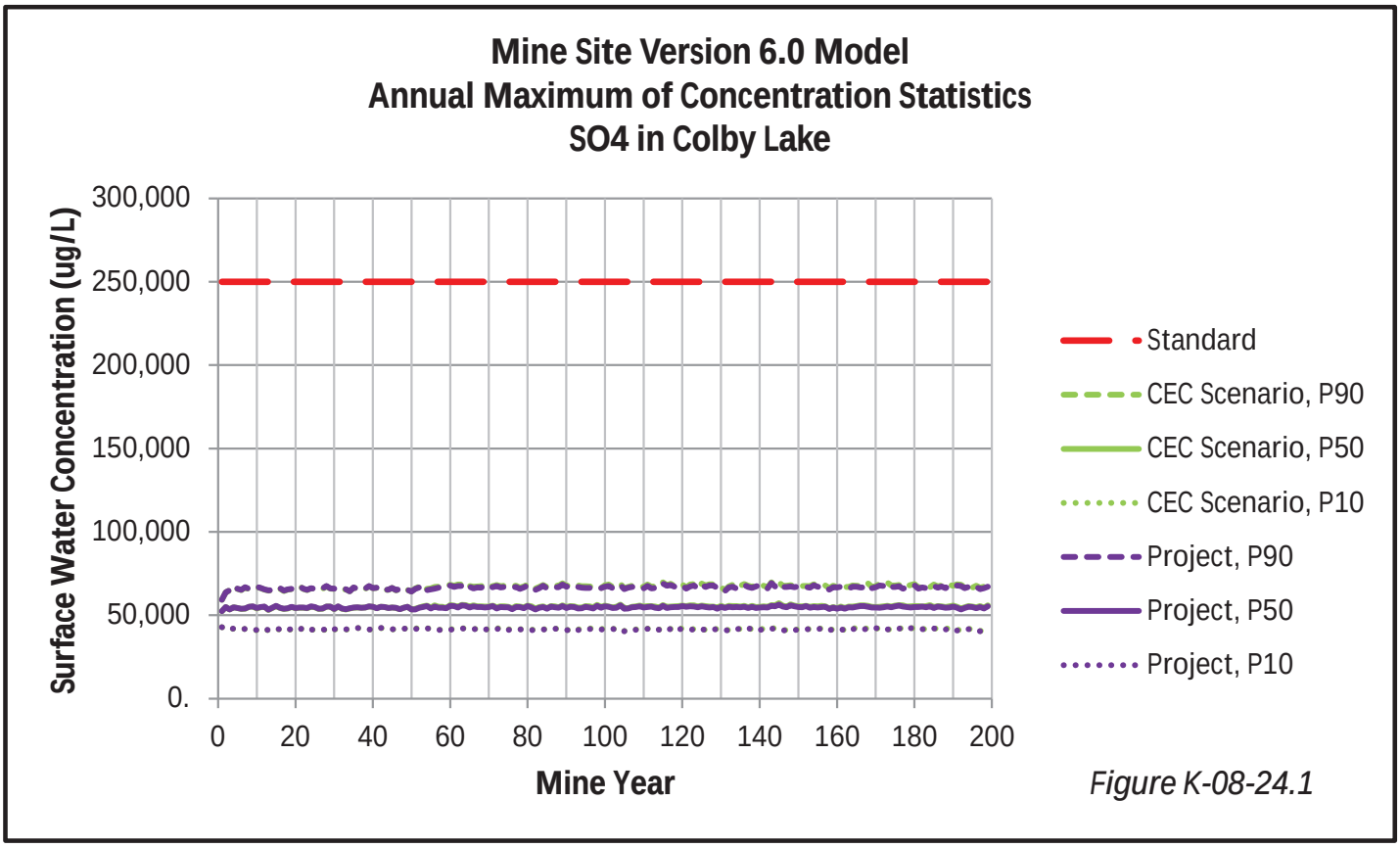

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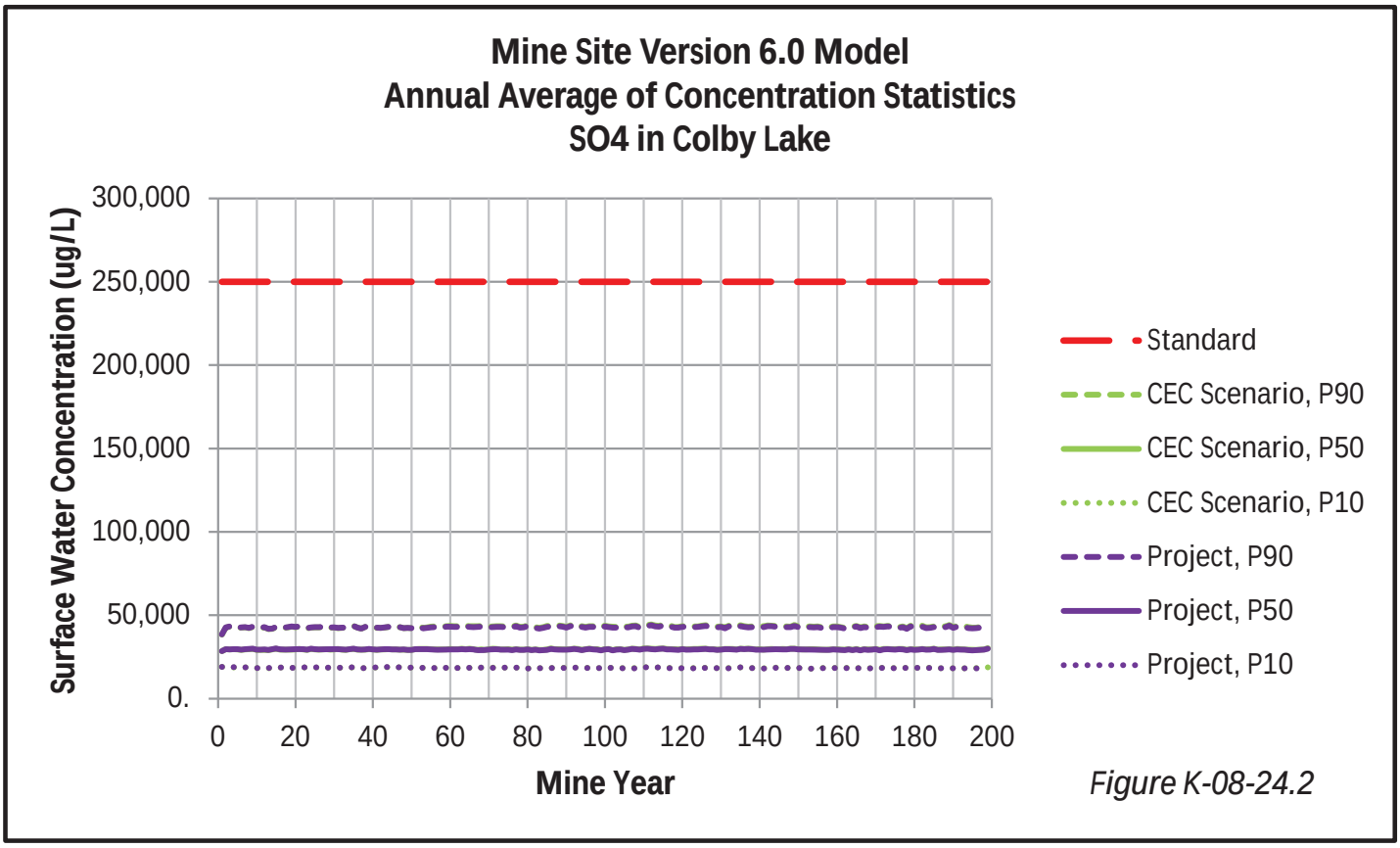

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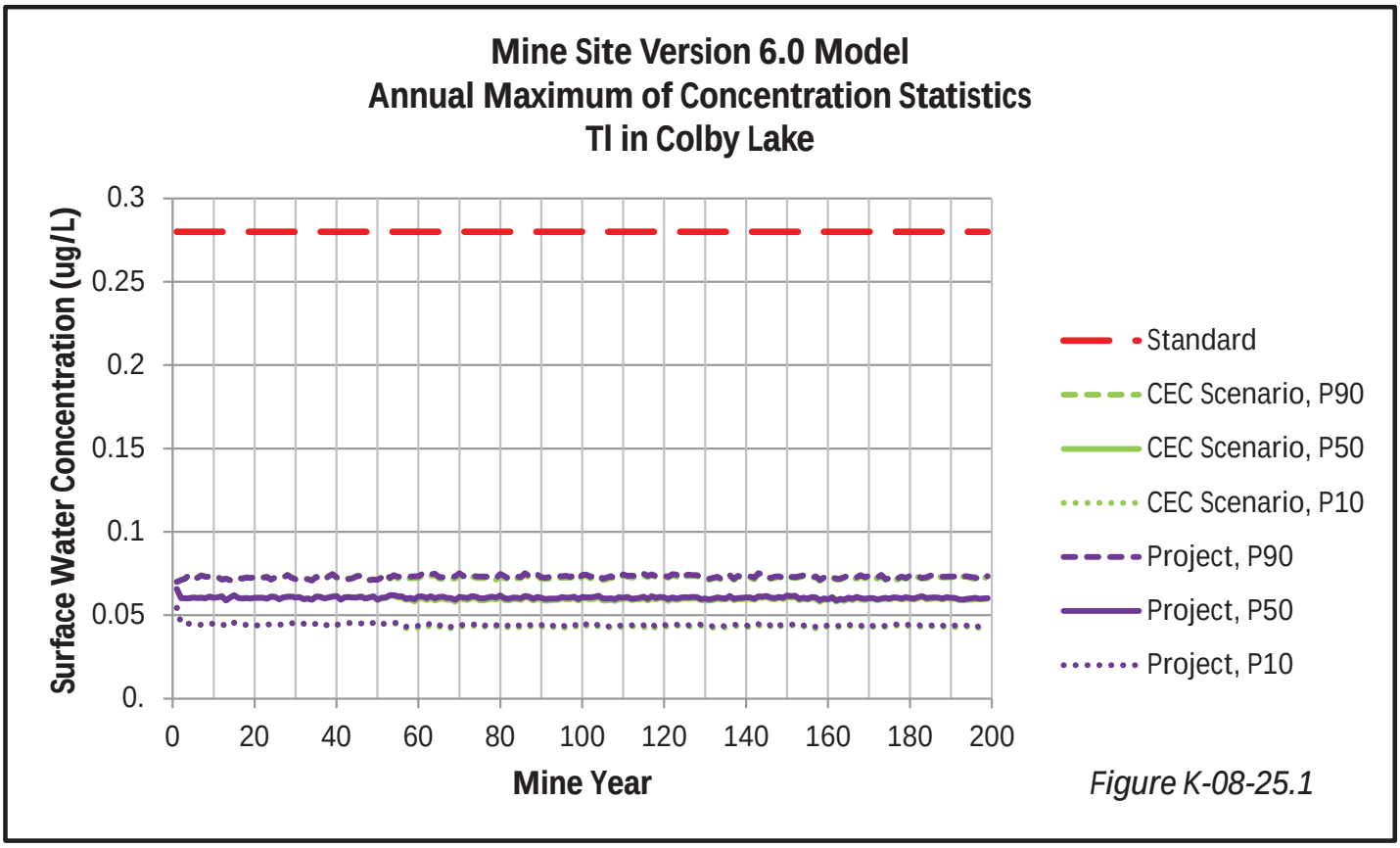

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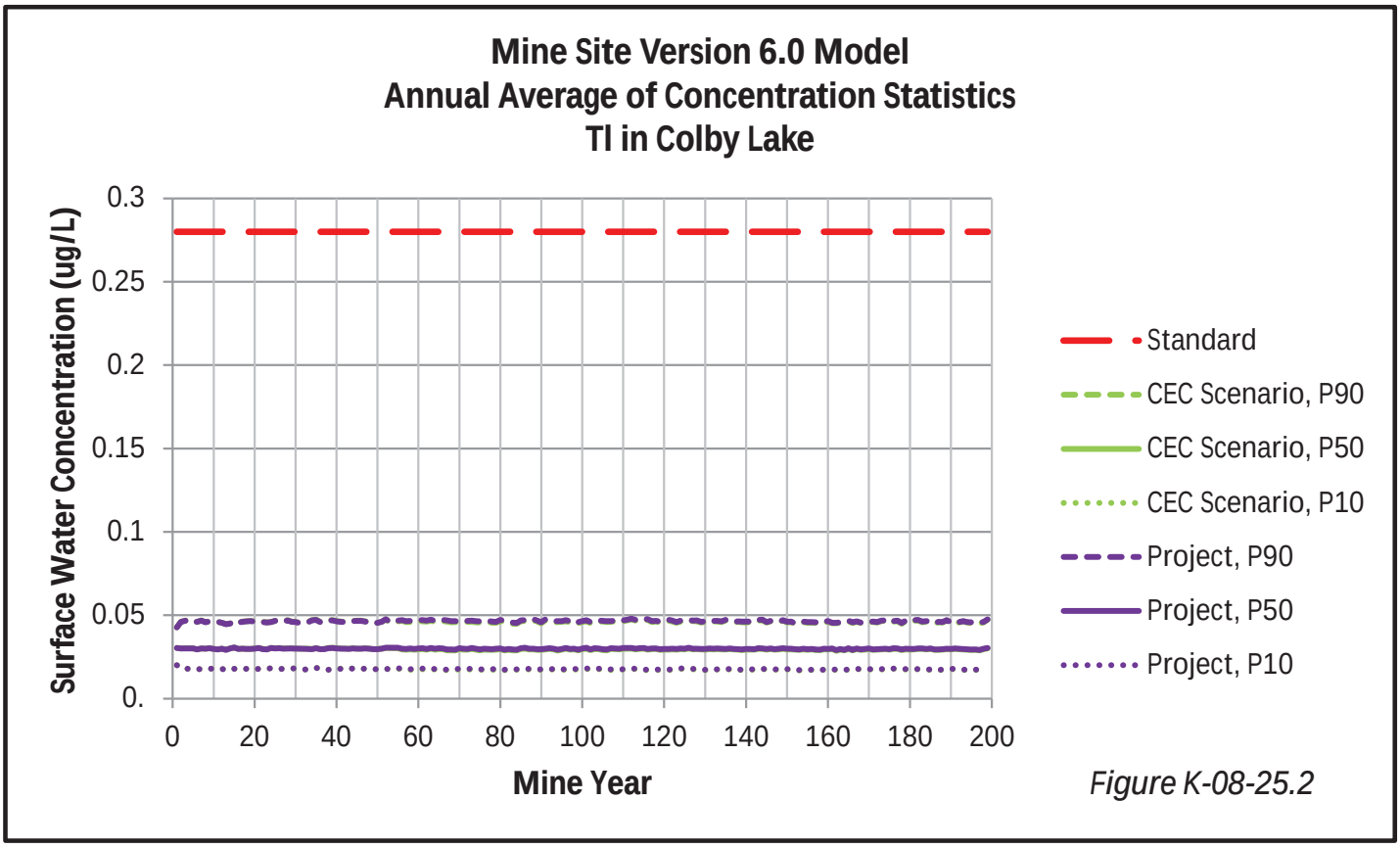

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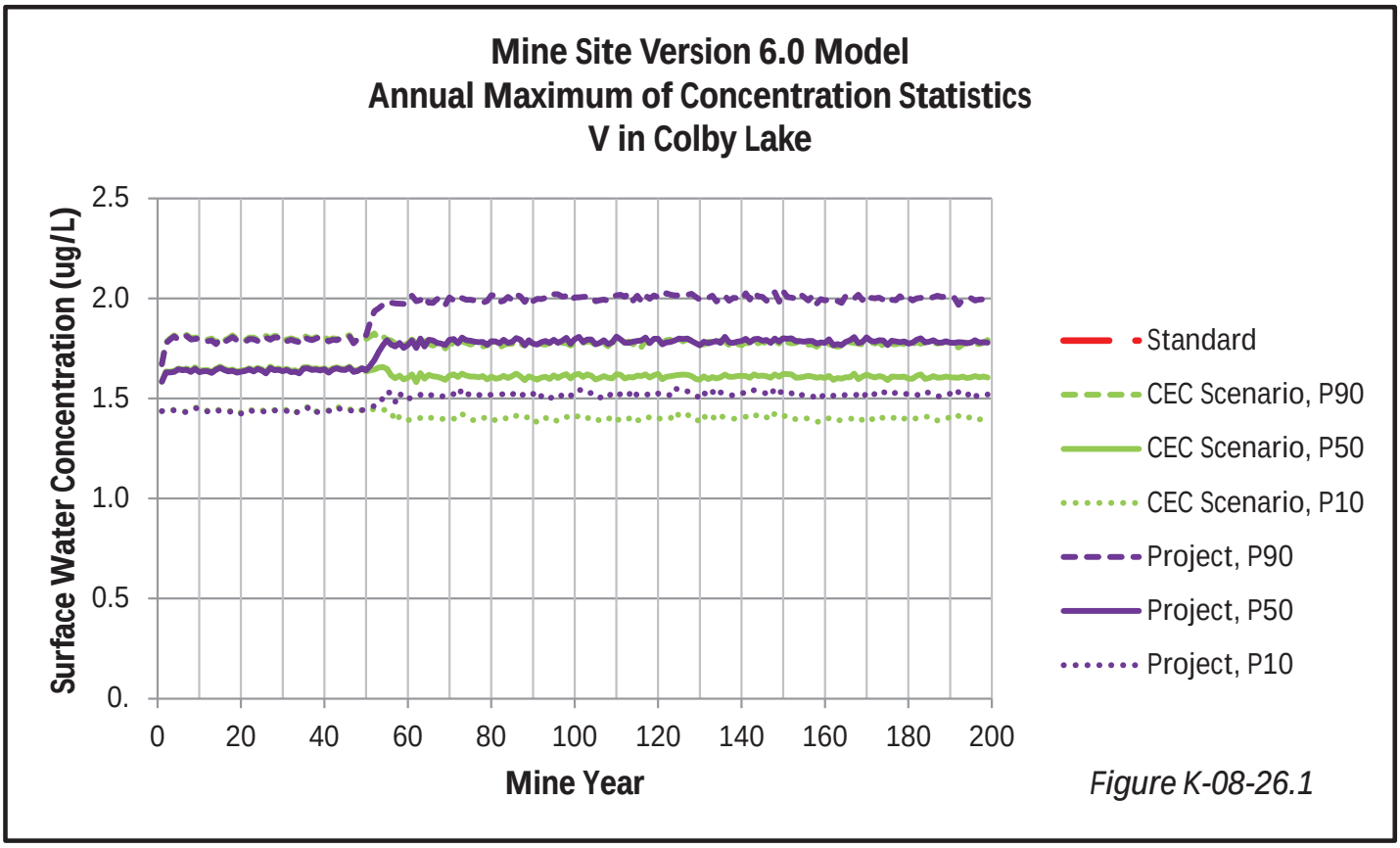

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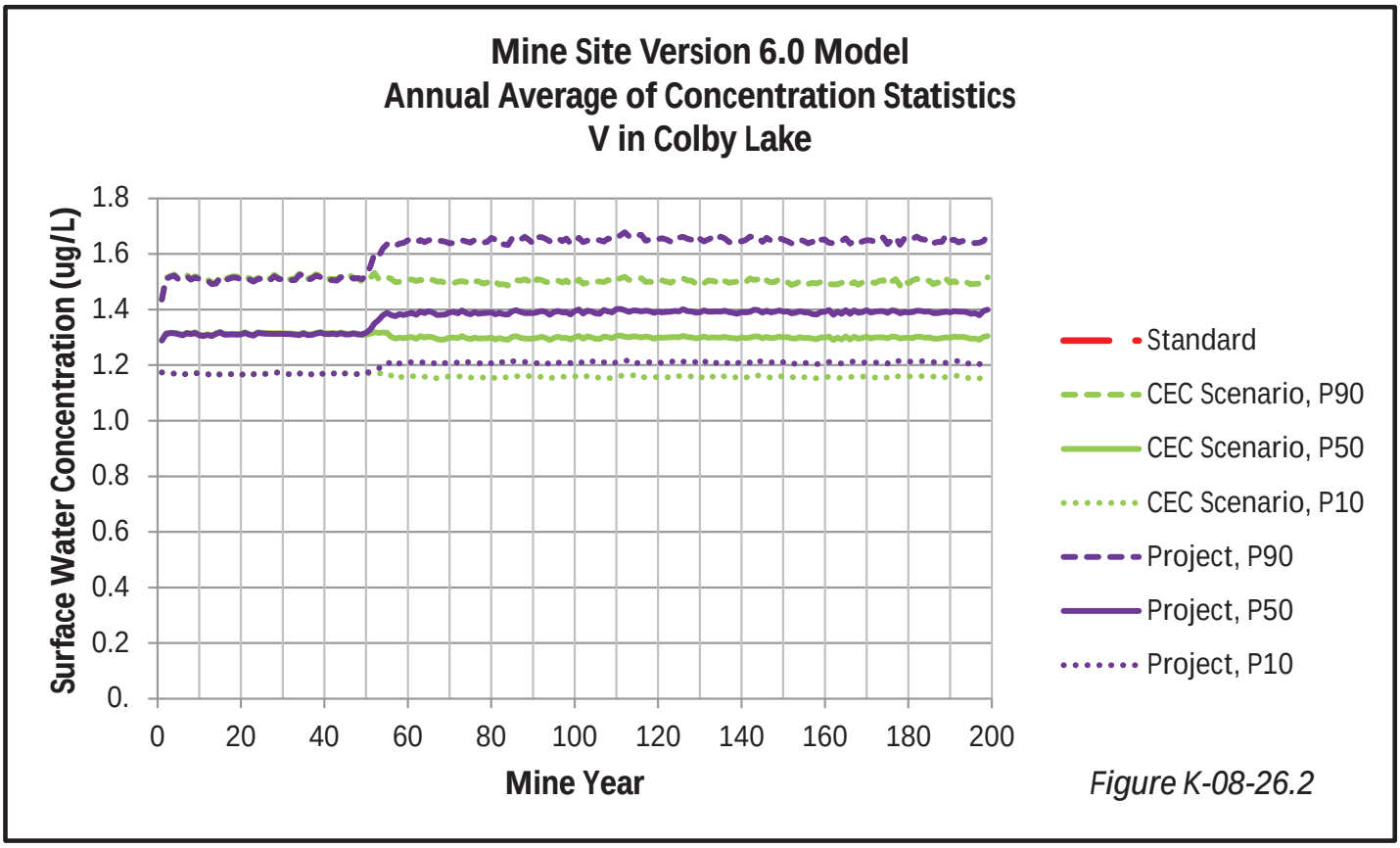

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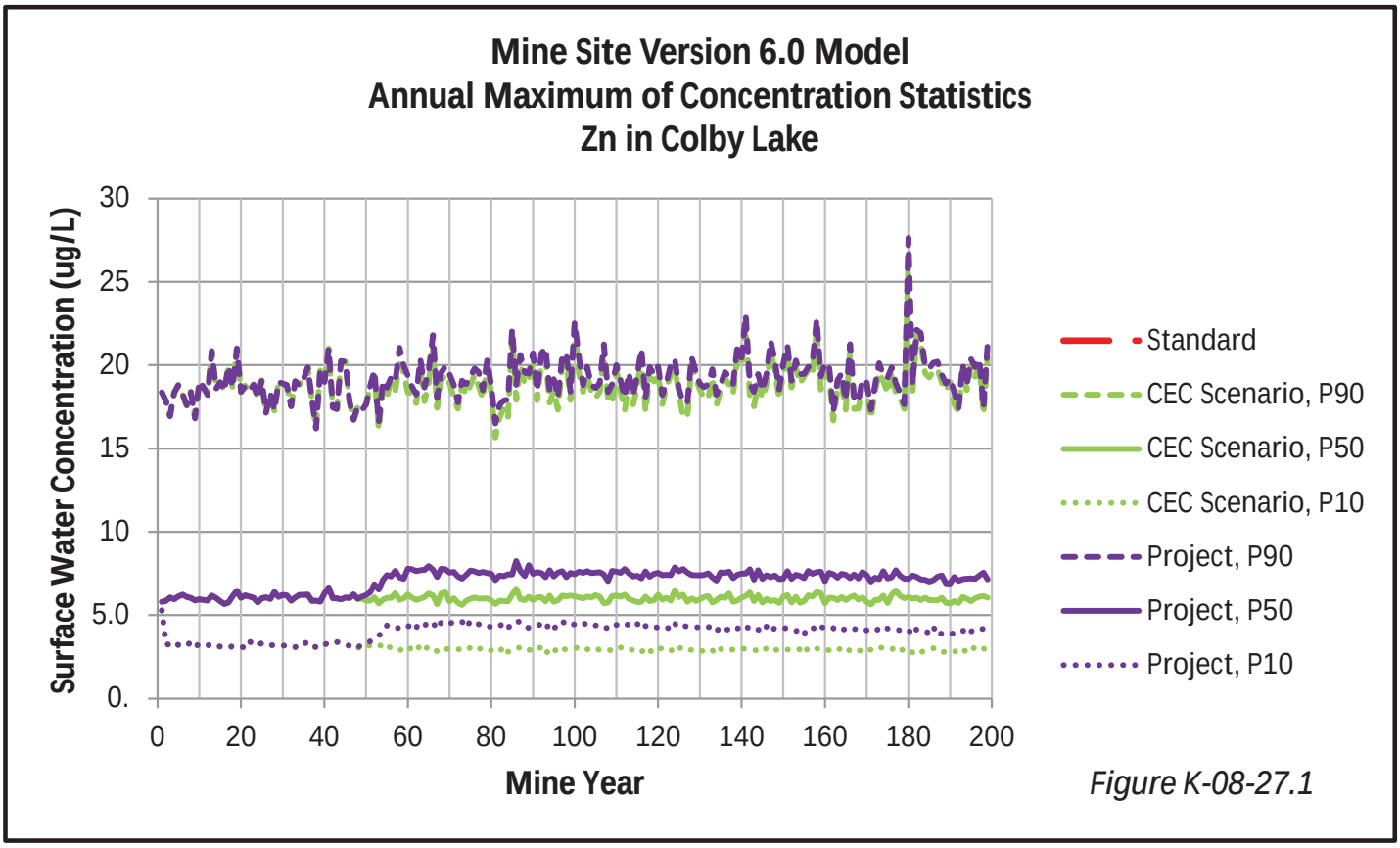

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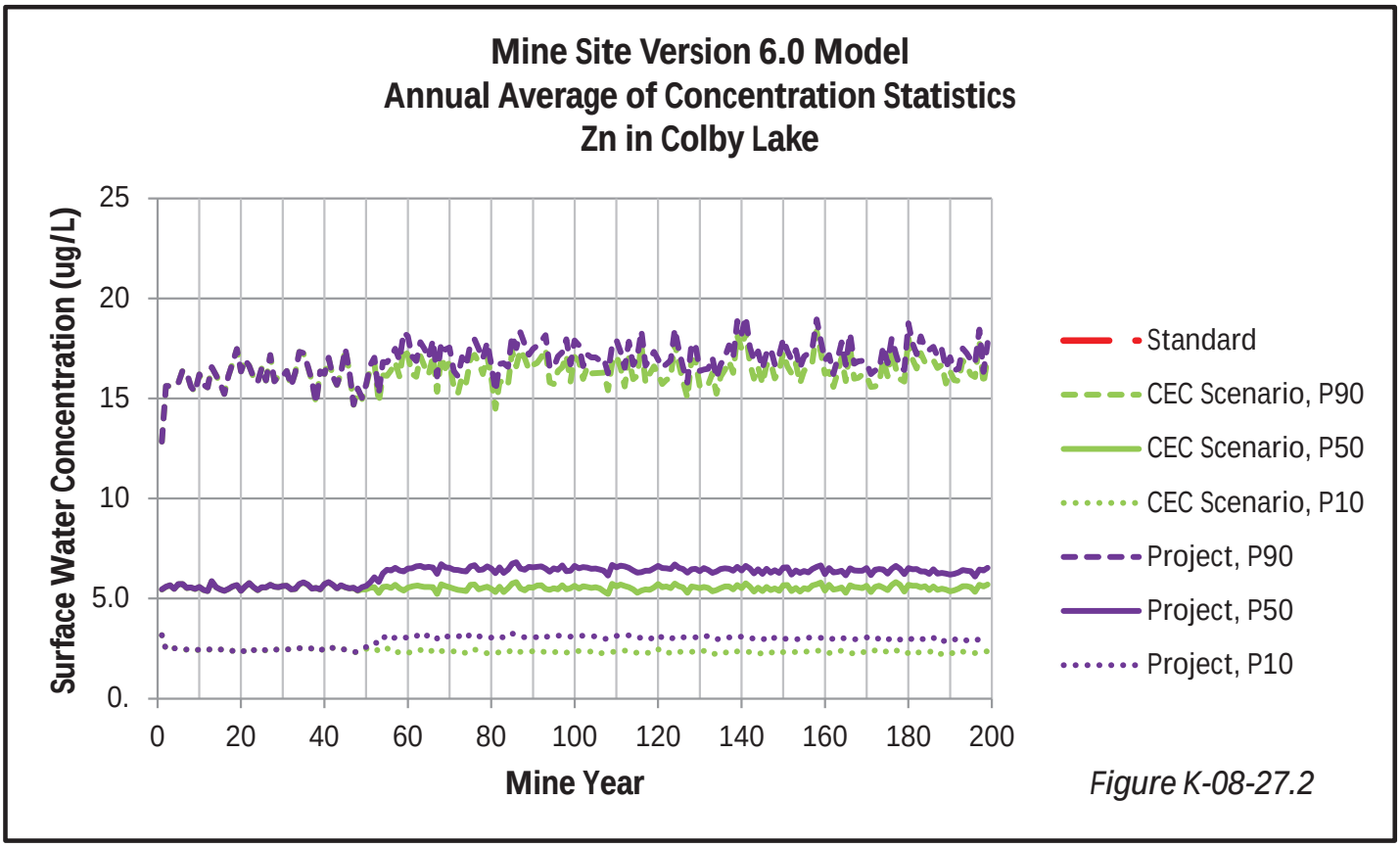

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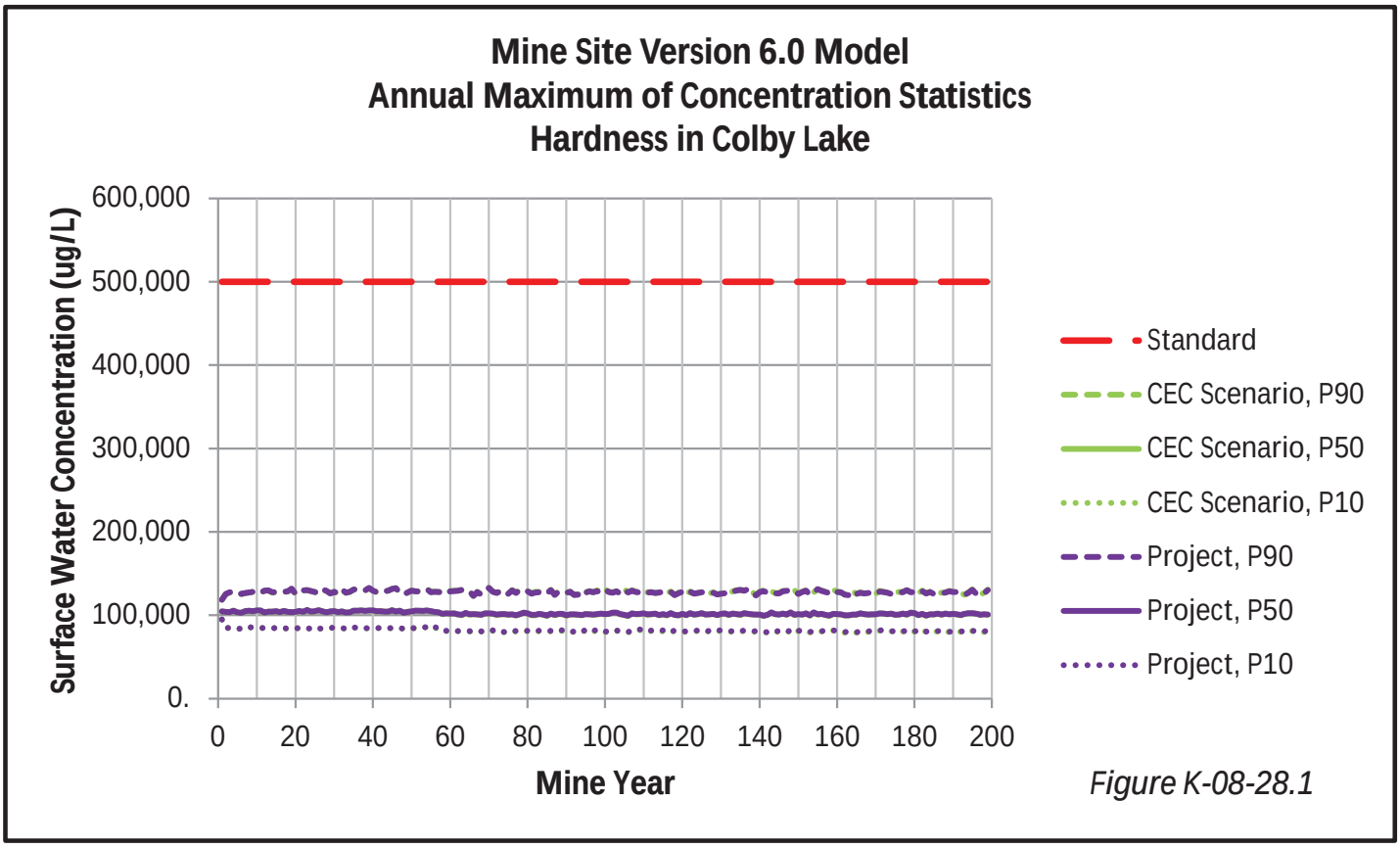

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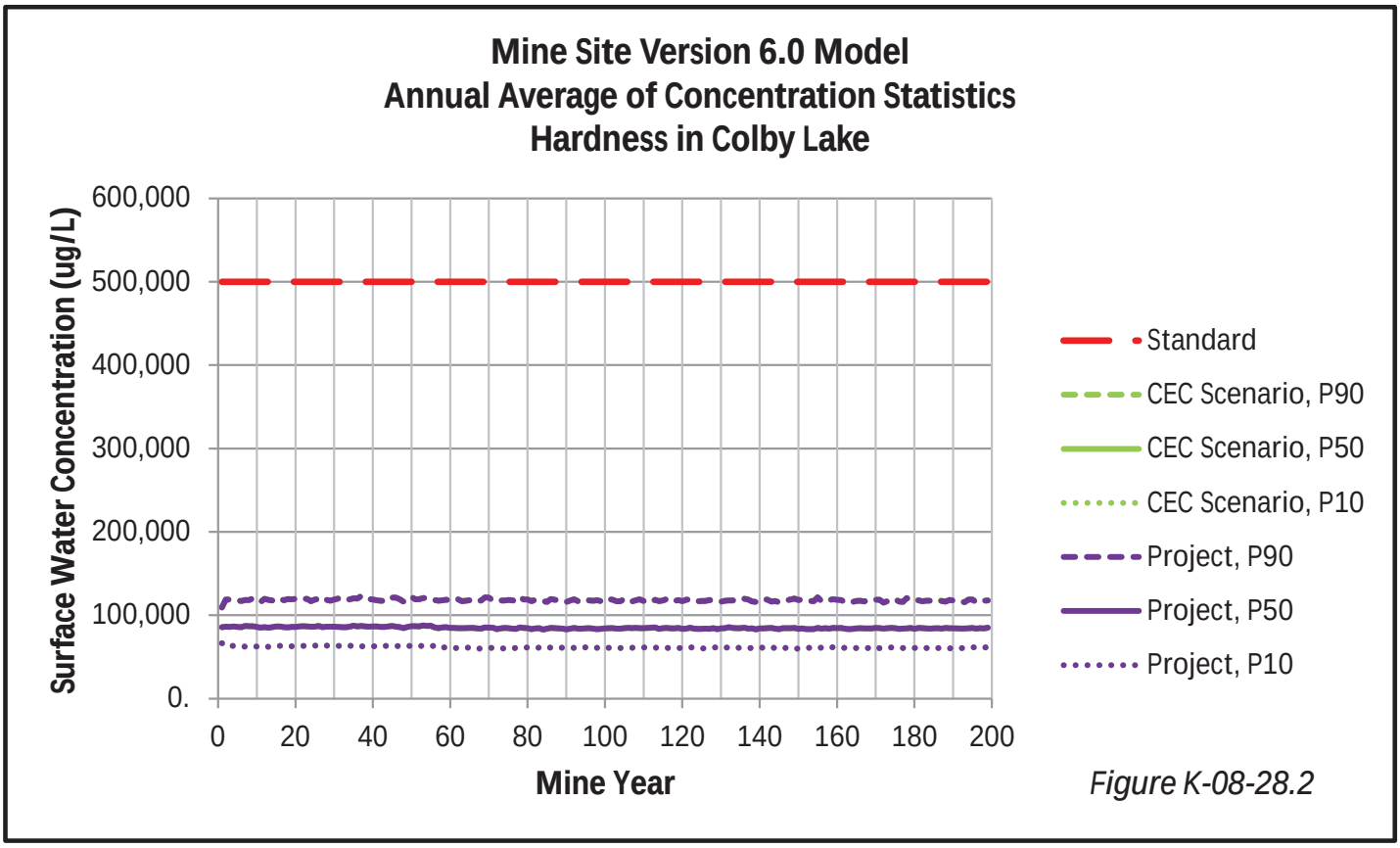


Figure K-08-28.2

Attachment L

Probability of Exceedance Time Series Results at Selected Surface Water Evaluation Locations

Attachment L Probability of Exceedance Time Series Results at Selected Surface Water Evaluation Locations

The plots in this section were created by taking the following steps:

- At any given time step, all constituents were individually evaluated (true/false) against the applicable surface water standard at all surface water evaluation locations. If the estimated concentration was greater than the standard, the result for that constituent, at that time, and at that location, is true; if it is not over the standard, the result is false.

- The evaluation was performed at every time step during a realization, resulting in a 200-year time series (2401 time steps/results) of true or false values.

- The process was repeated during each of the additional realizations until all 500 realizations were run. The result is a set of 500 true or false results at every time step for each constituent at each location.

- At any time step (24.33 years for example), the number of realizations showing a result of true was divided by 500, resulting in the probability of estimating an exceedance. Zero exceedances results in 0%, 50 exceedances results in 10%, etc.

- The probability of exceedance was determined for all time steps, resulting in a time series of the probability of exceeding the applicable surface water standard.

- Just as for the concentration statistics plots, the probability of exceedance plots are summarized annually by selecting either the maximum annual probability of exceedance for each year, or by the annual average probability of exceedance for each year.

The red line in the each figure shows the probability of exceedance through time. The blue-dashed line shows the probability of the Project Model simulating an exceedance when the Continuation of Existing Conditions Scenario Model would not show an exceedance. This represents the increase in the probability of an exceedance at each time step due to the Project. In each figure, the vertical black-dashed lines separate the time period operations (OPS) from reclamation (REC), and the time period reclamation from long-term closure (LONG-TERM).

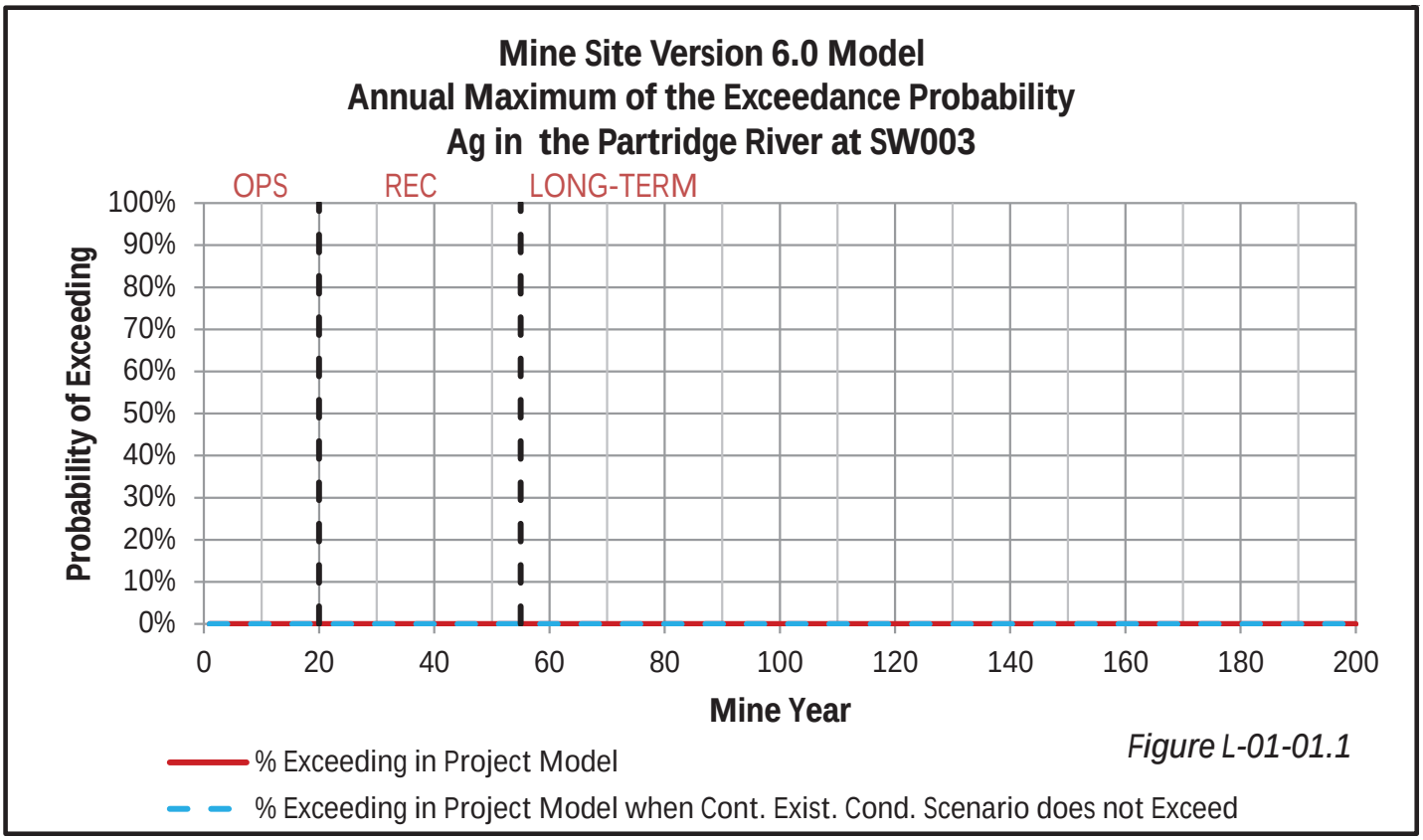
The figure numbering convention is "**Figure W-XX-YY.Z**" where:

- **W** indicates the Attachment.

- **XX** is a counter indicating the location; in this attachment it will count from "01" to "05" to account for the following surface water evaluation locations: SW003, SW004, SW004a, SW005 and Colby Lake.

- **YY** is a counter indicating the constituent; in this attachment it will count from "01" to "28" to show the 27 independently modeled constituents and the calculated hardness.

- **Z** is a numerical value, 1 or 2. A value of 1 indicates that the annual maximum has been plotted and a value of 2 indicates that the annual average has been plotted.



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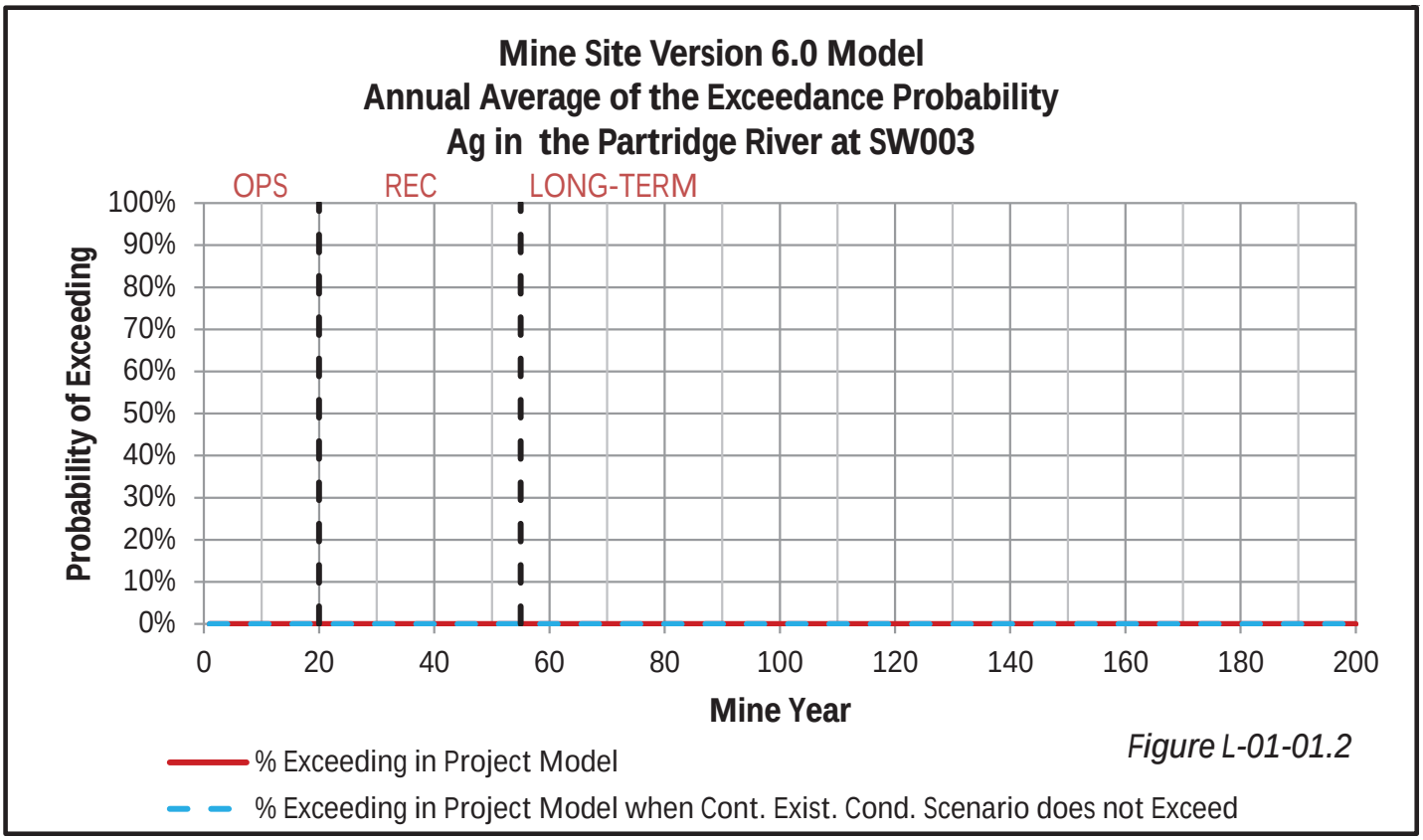

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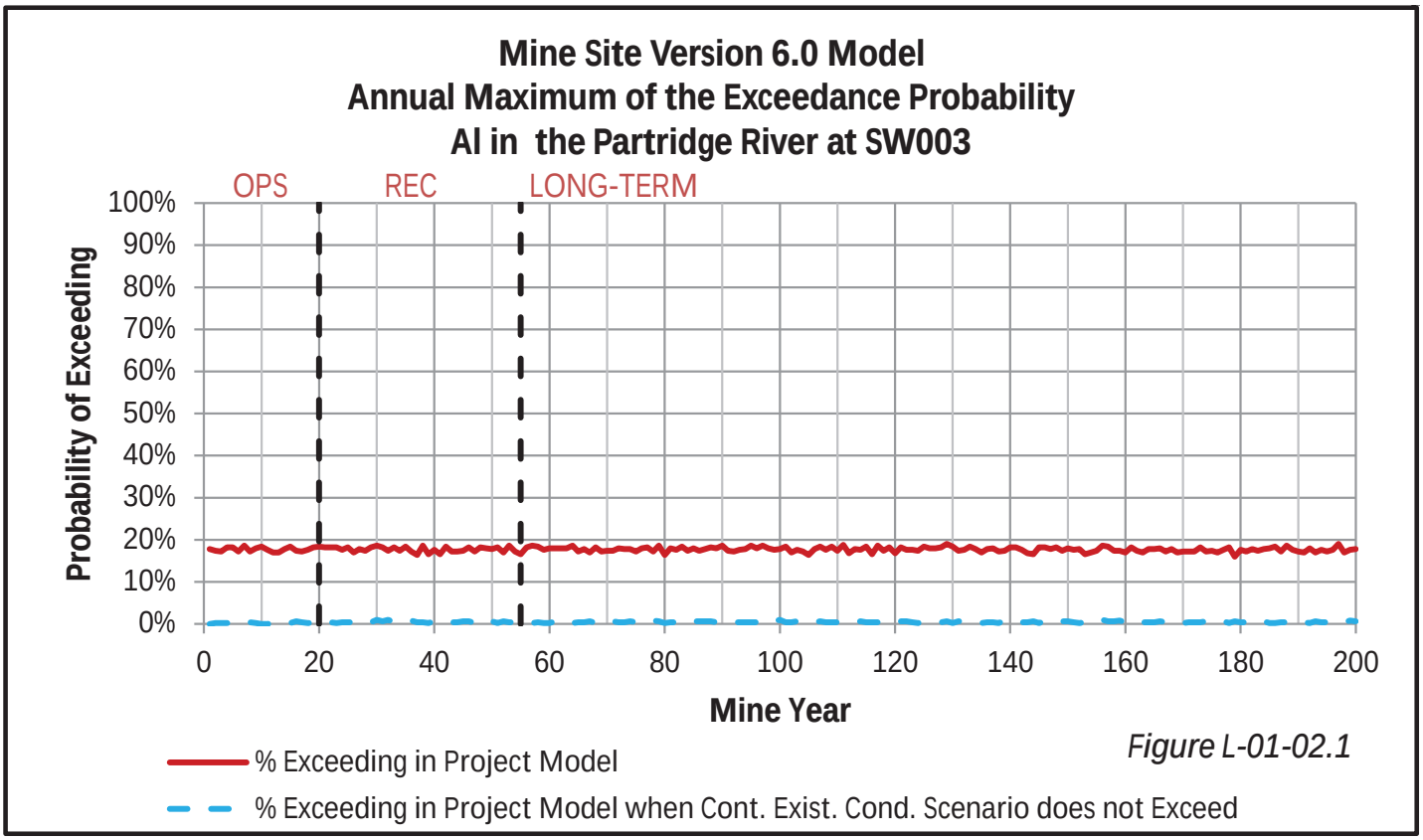

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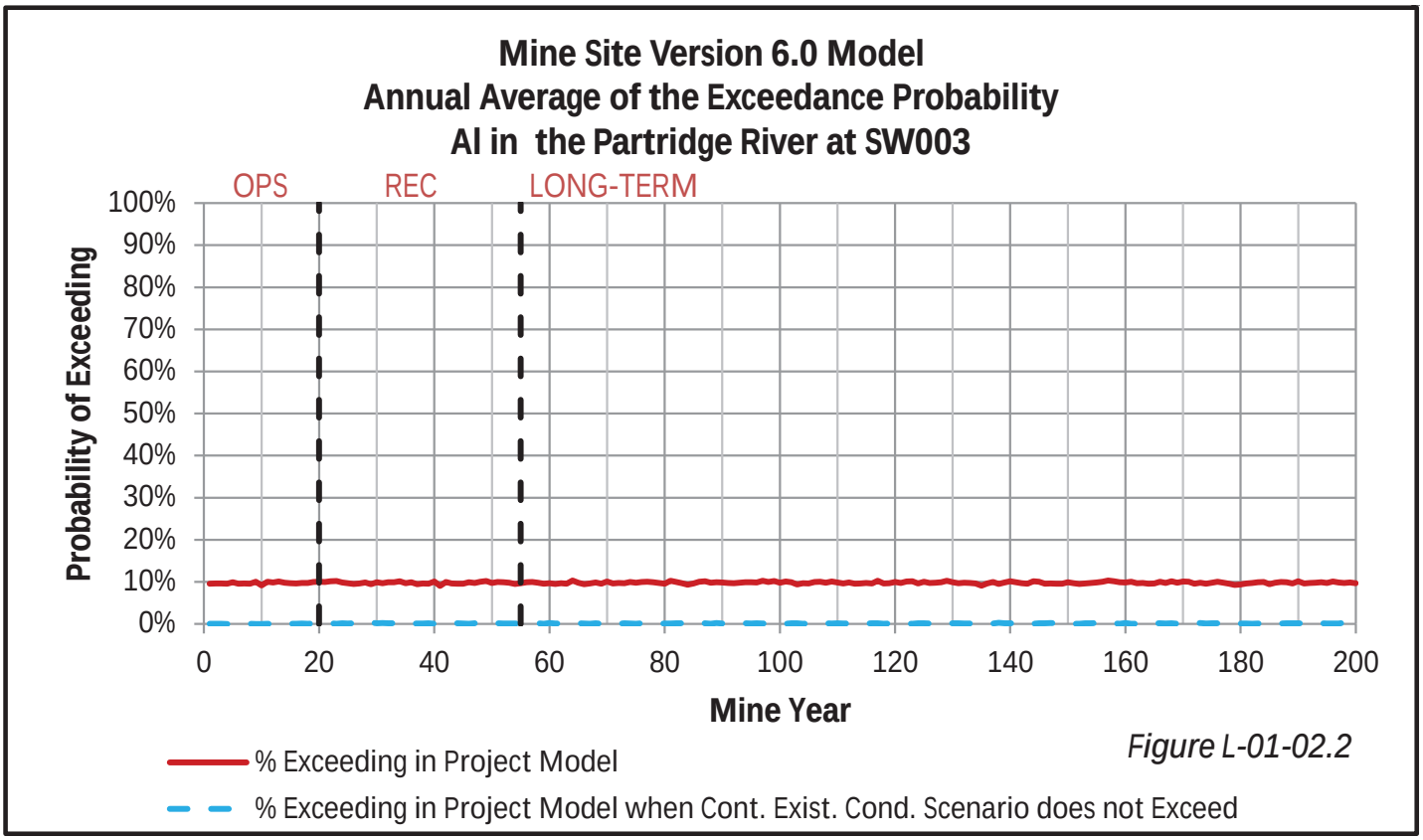

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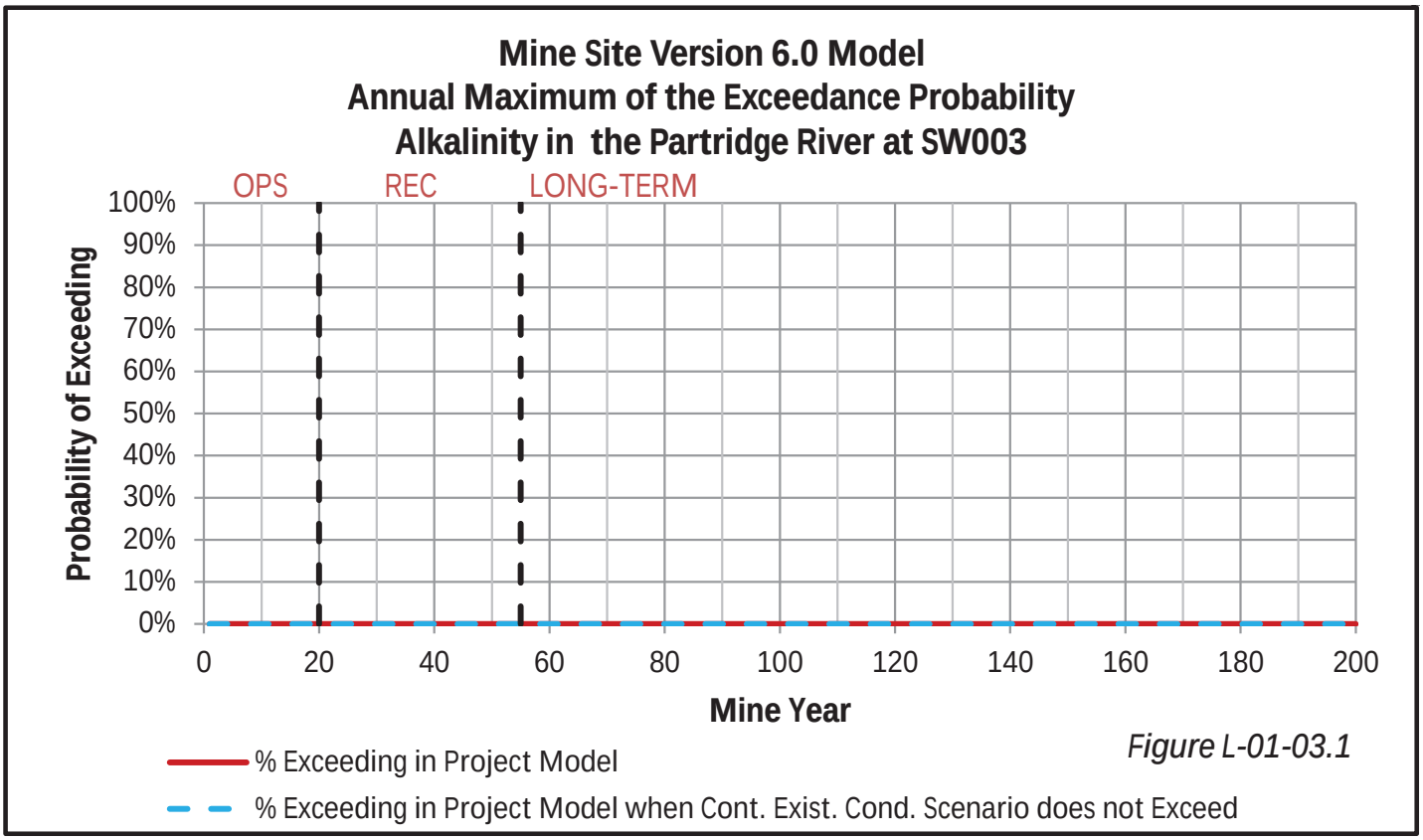

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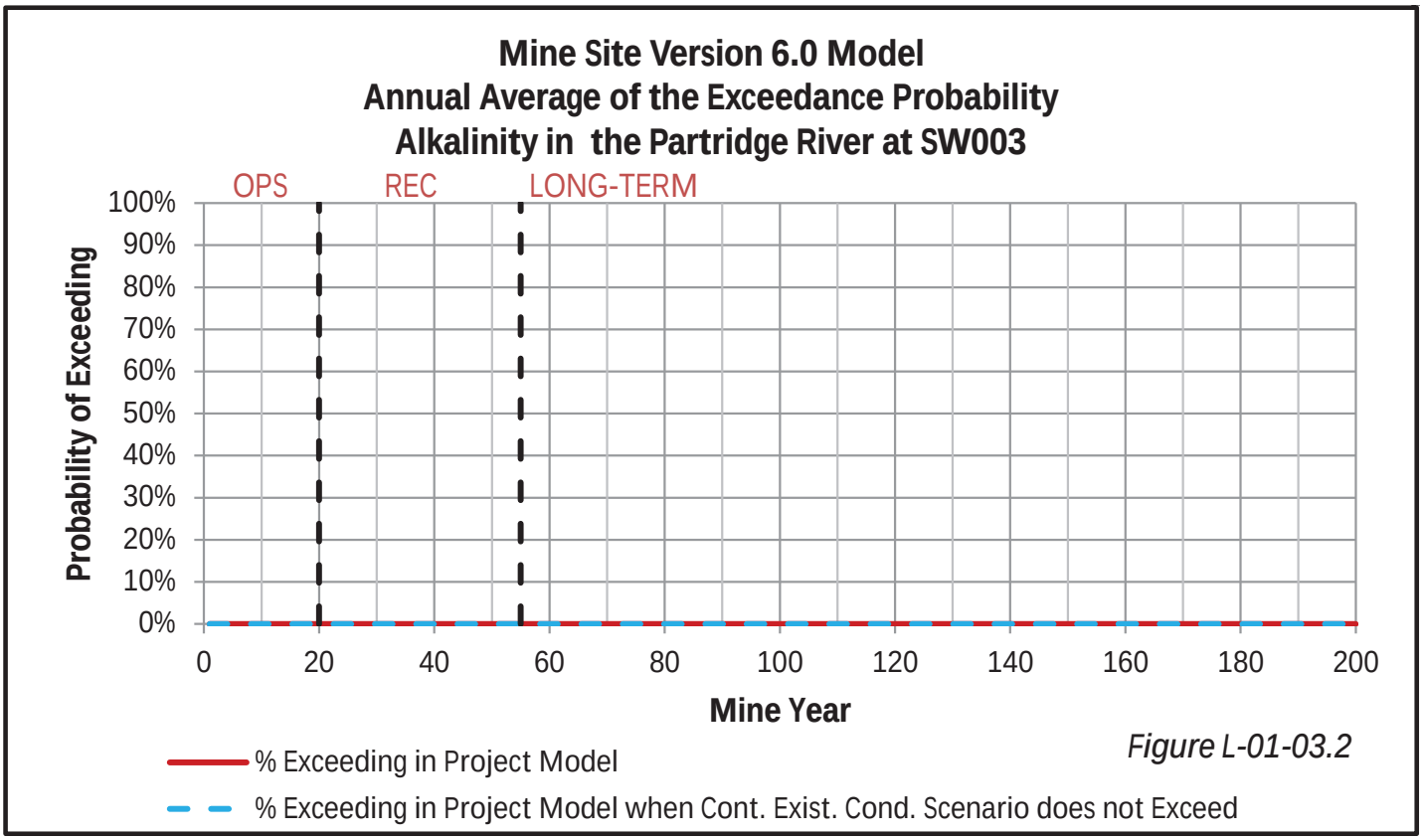

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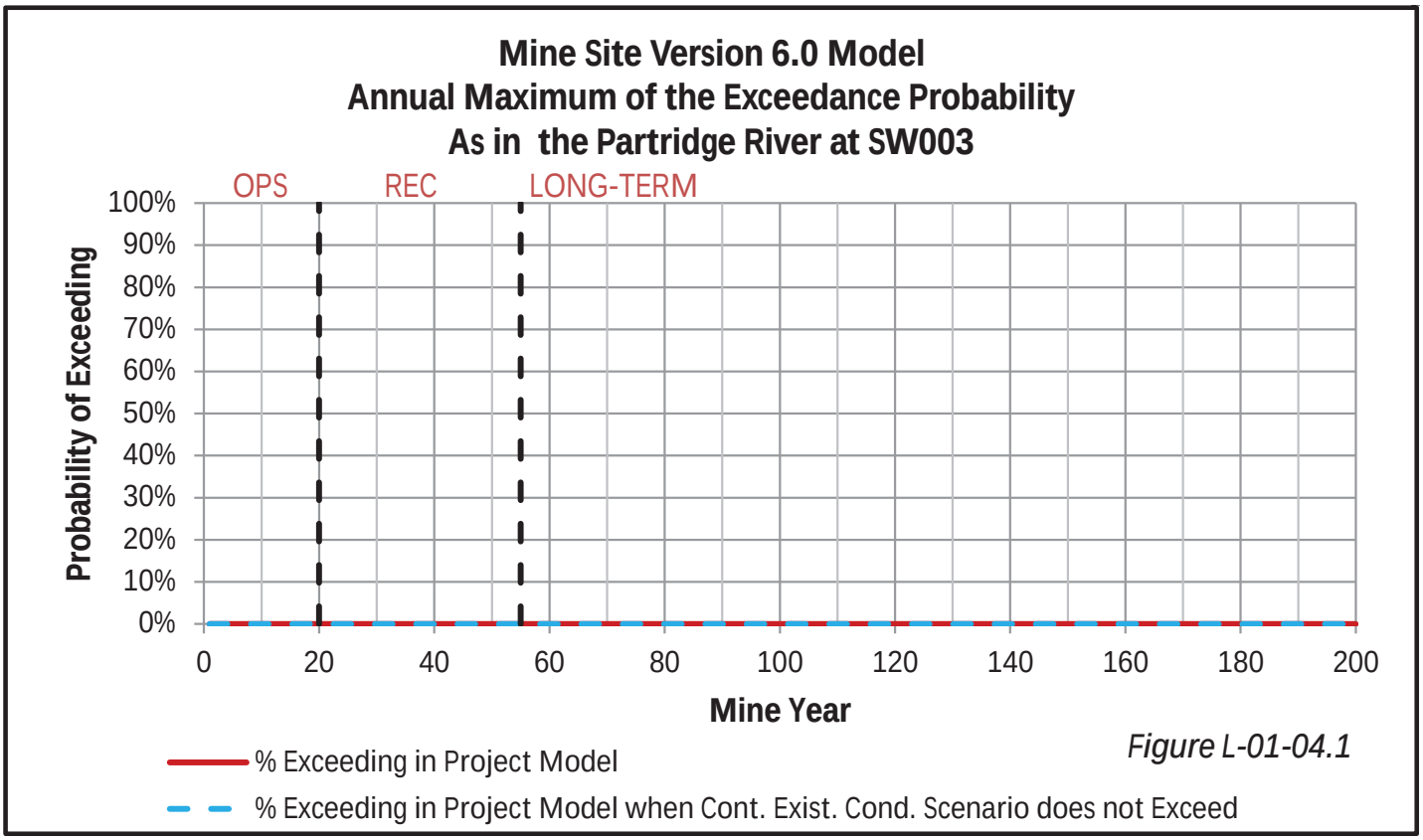

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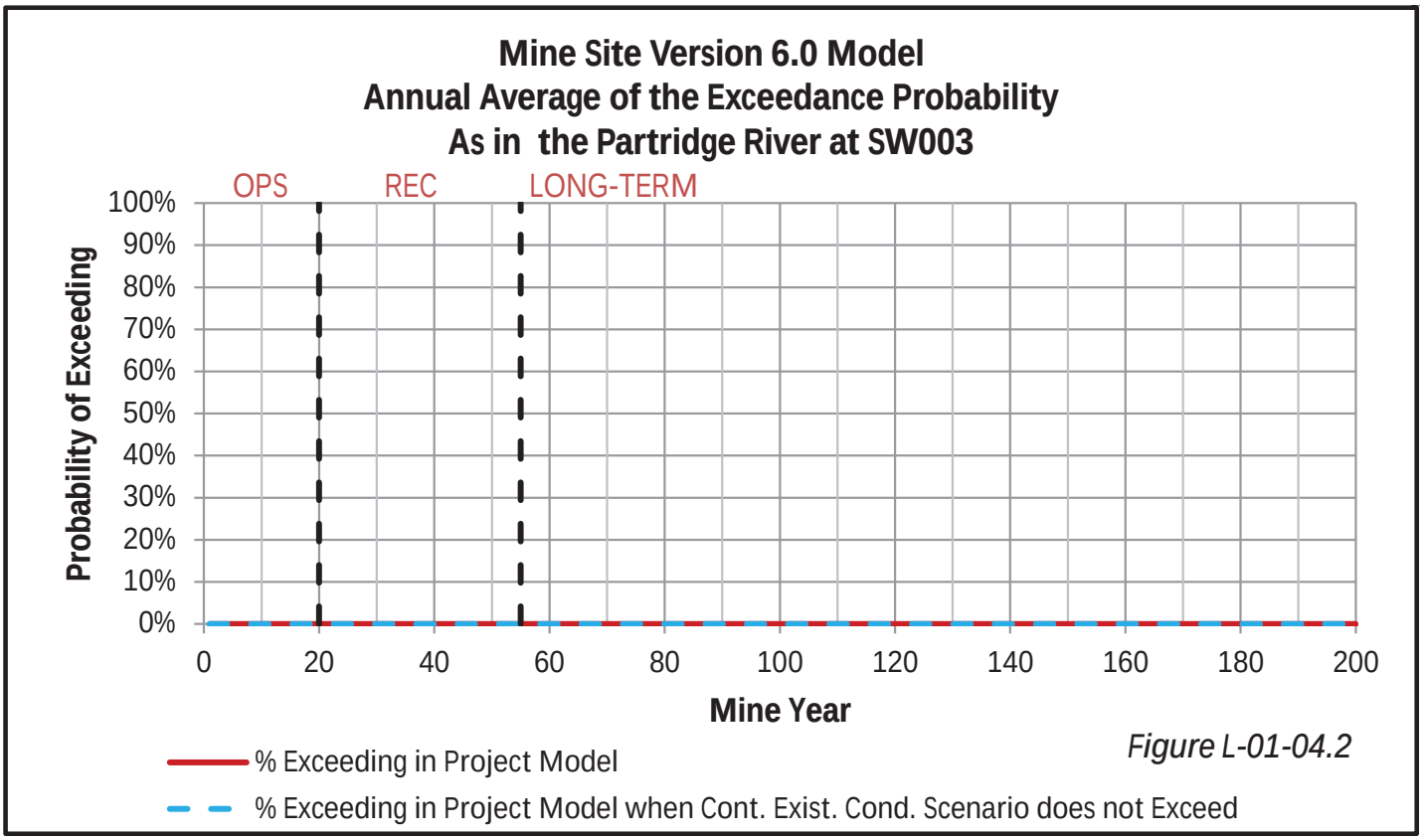

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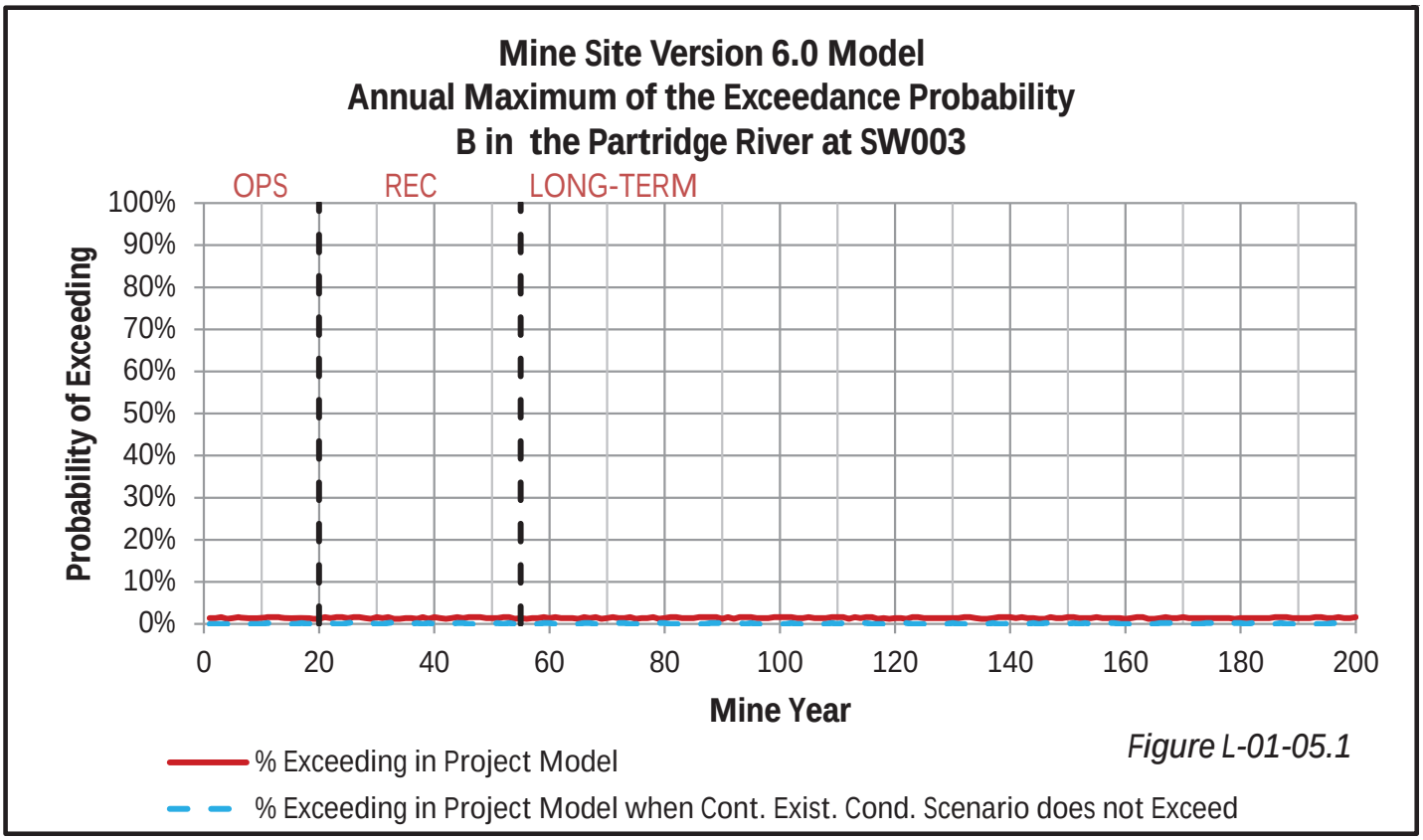

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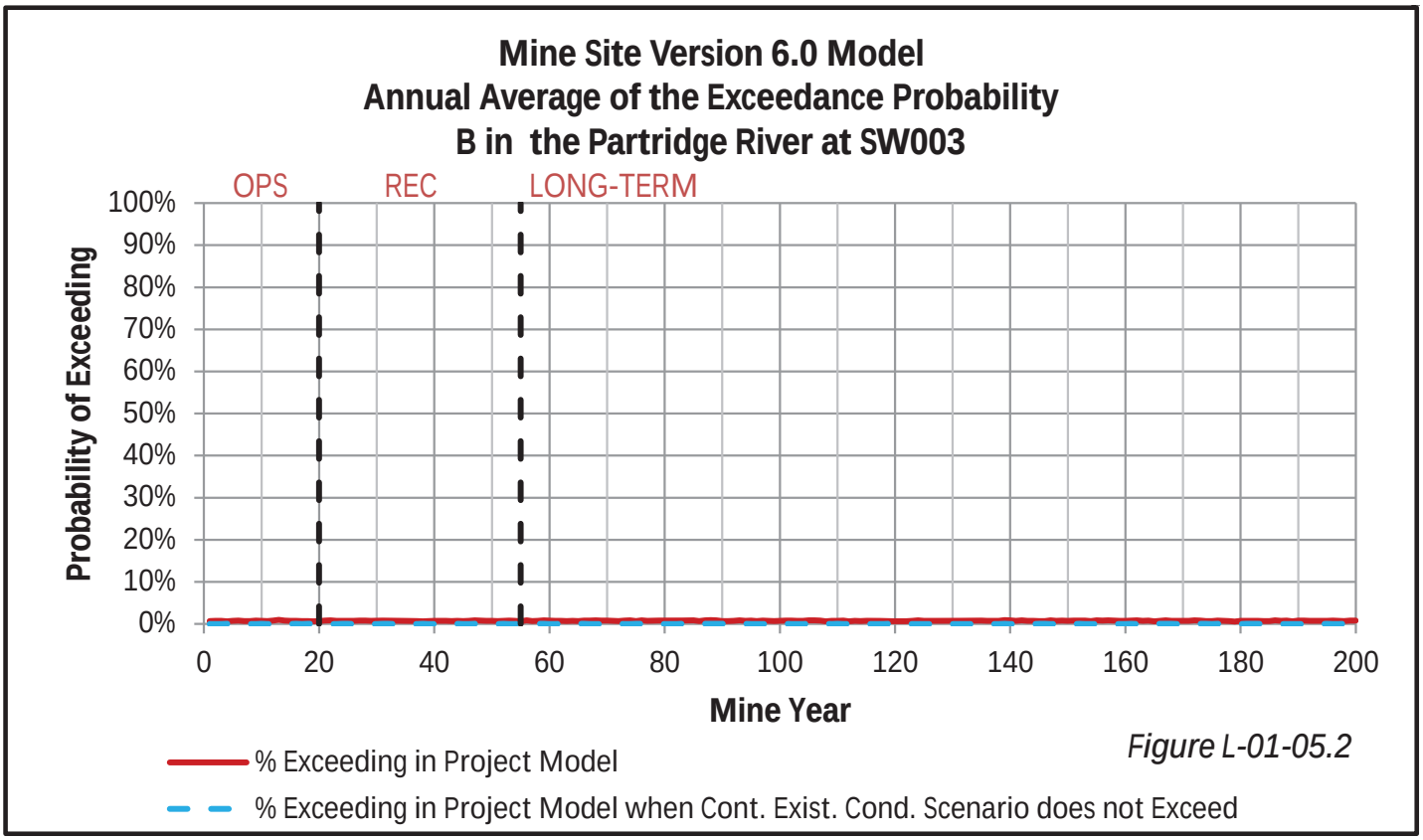

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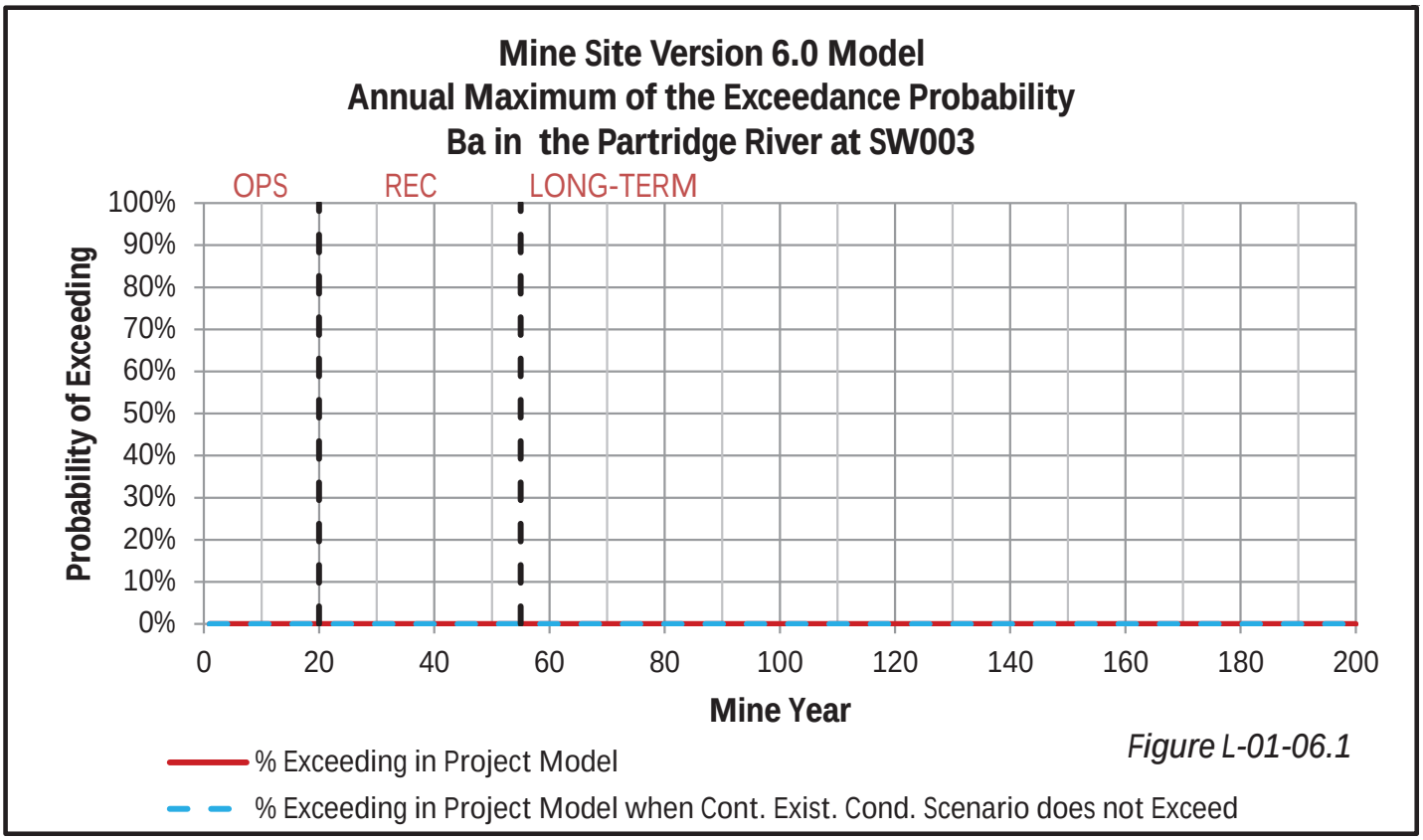

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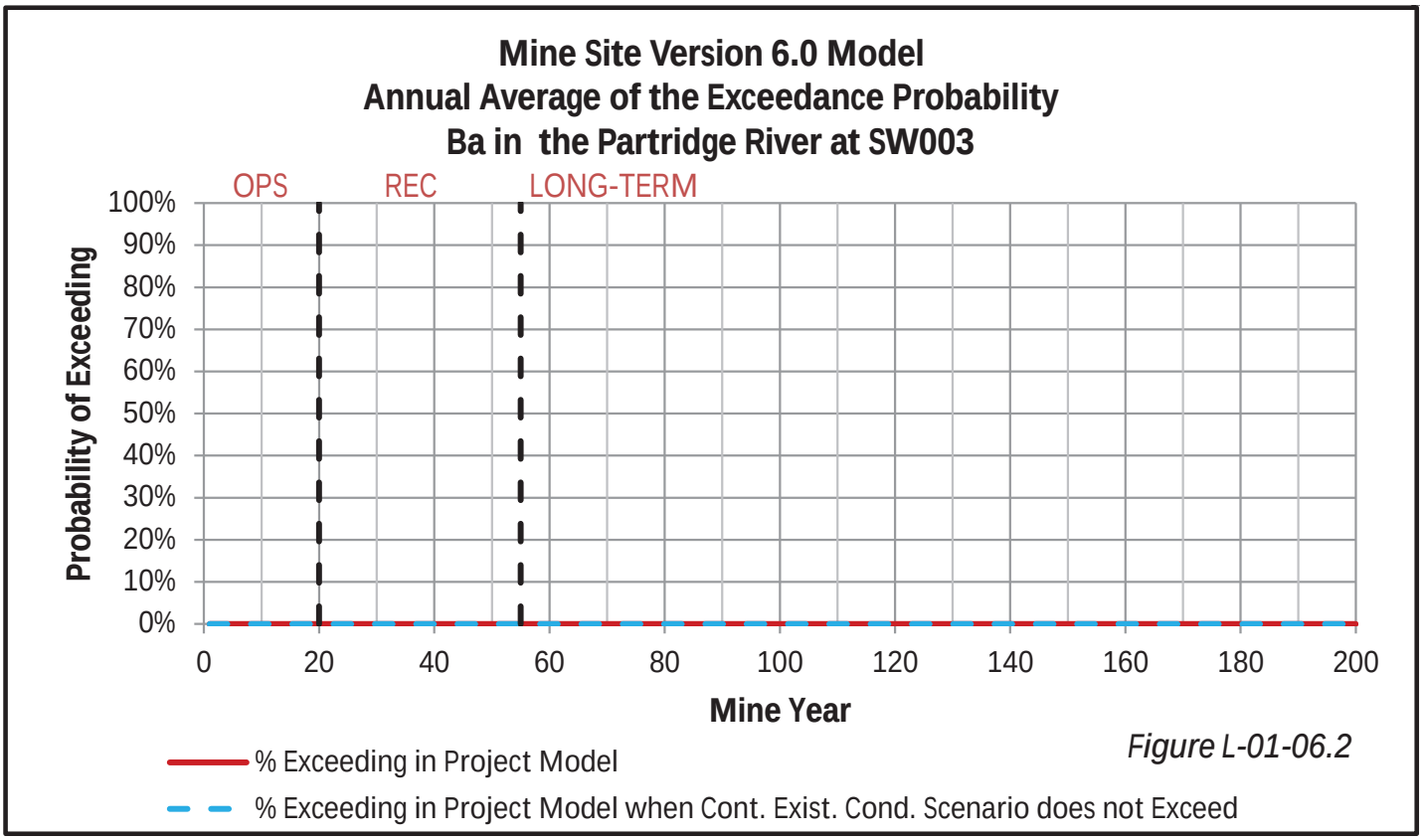

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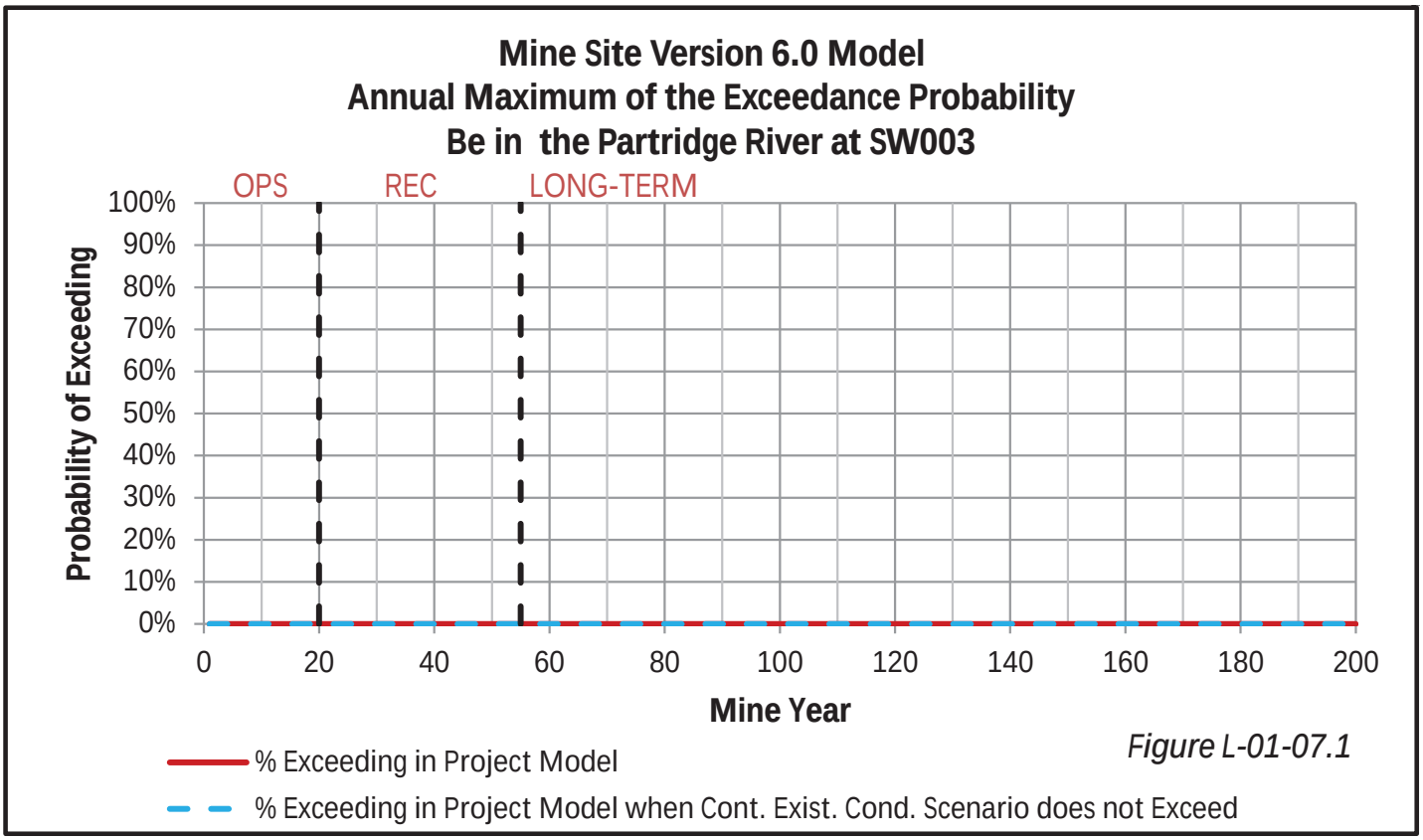

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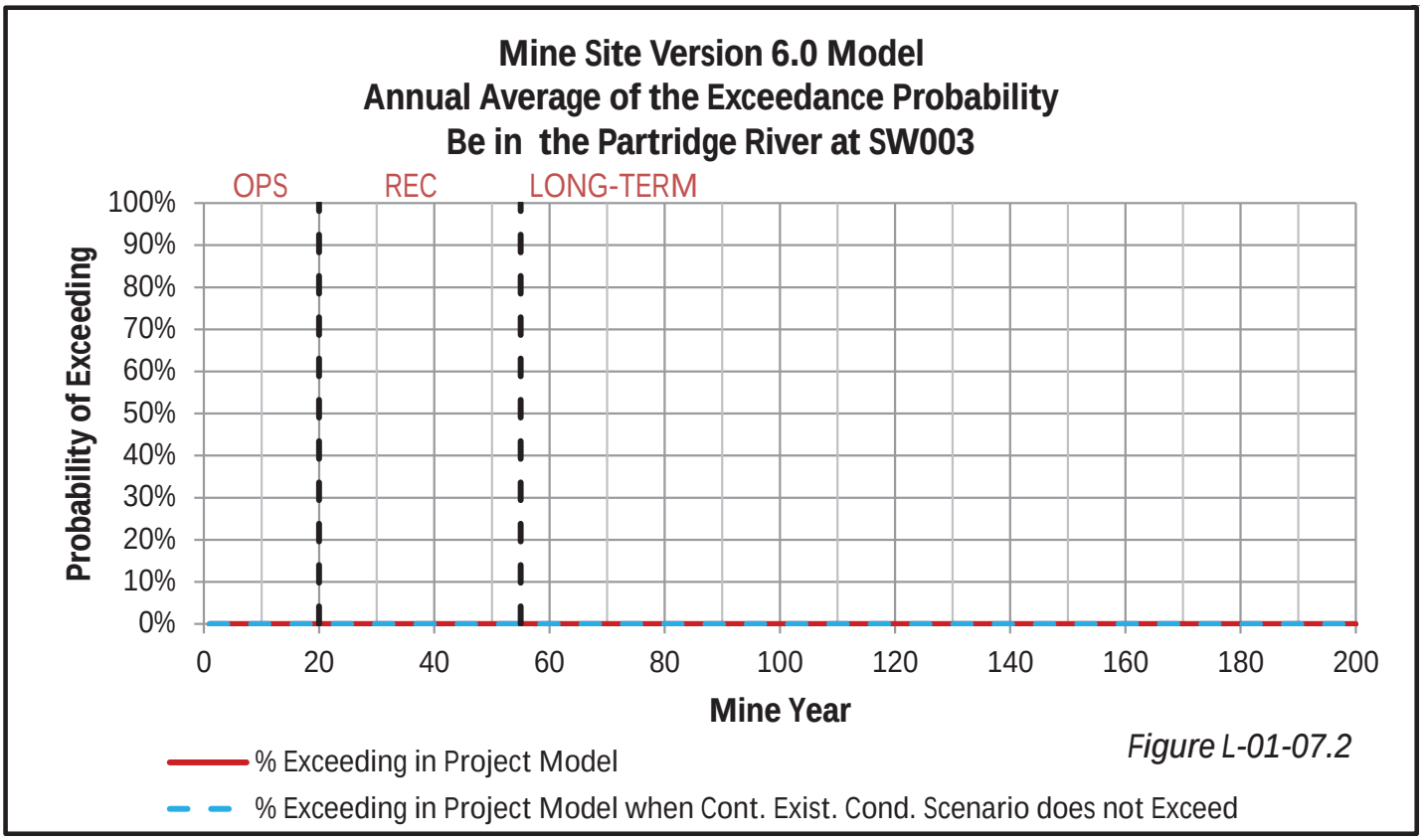

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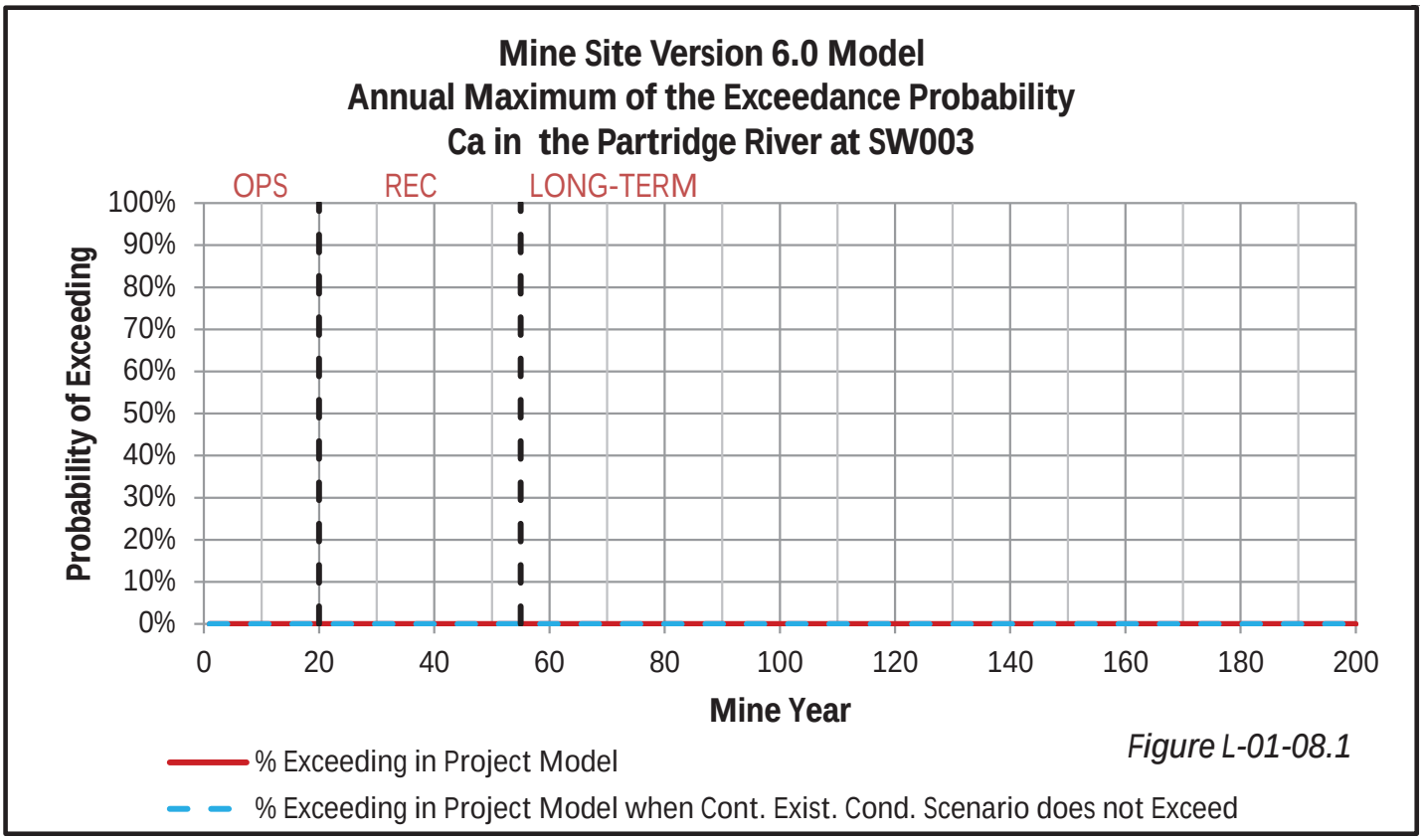

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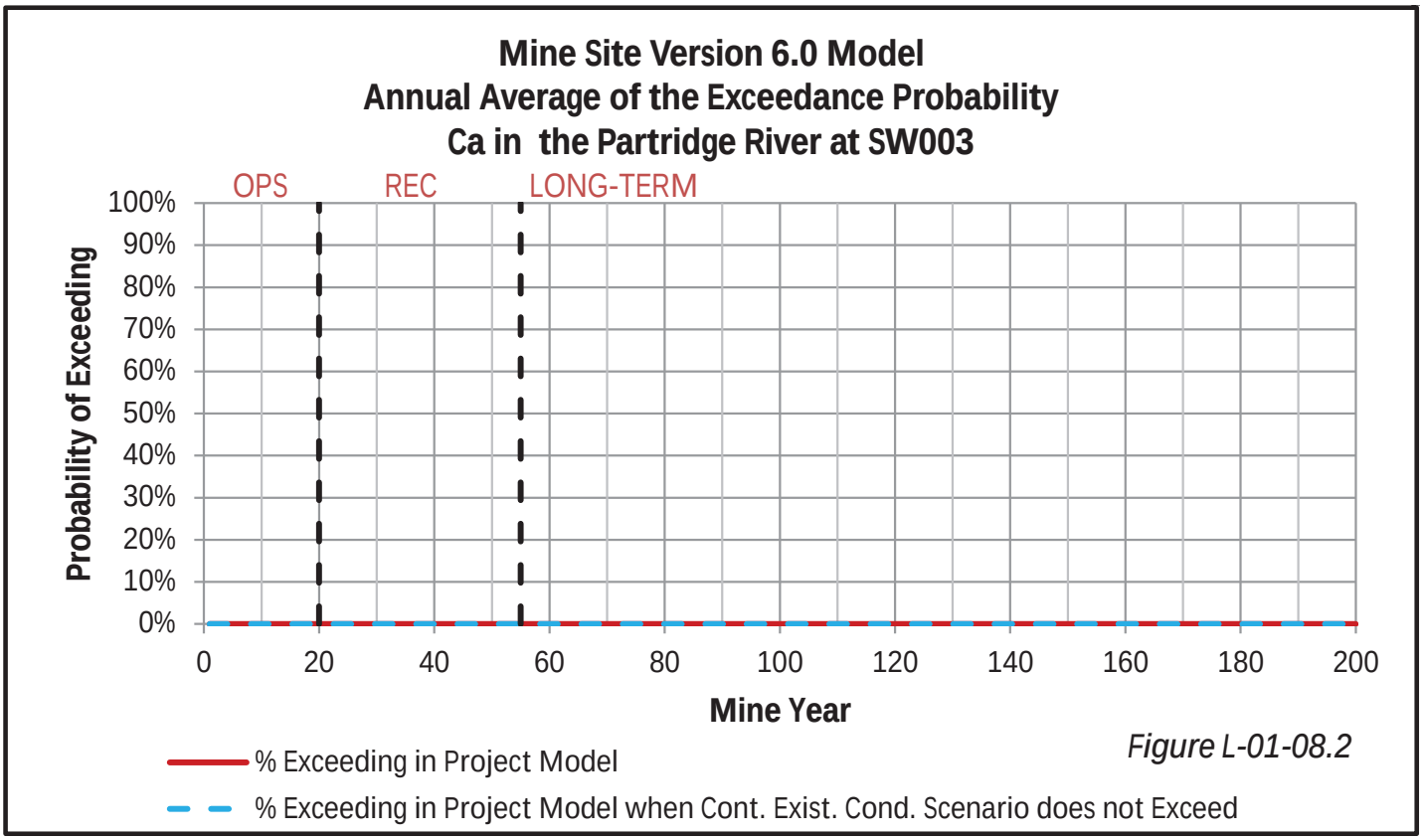

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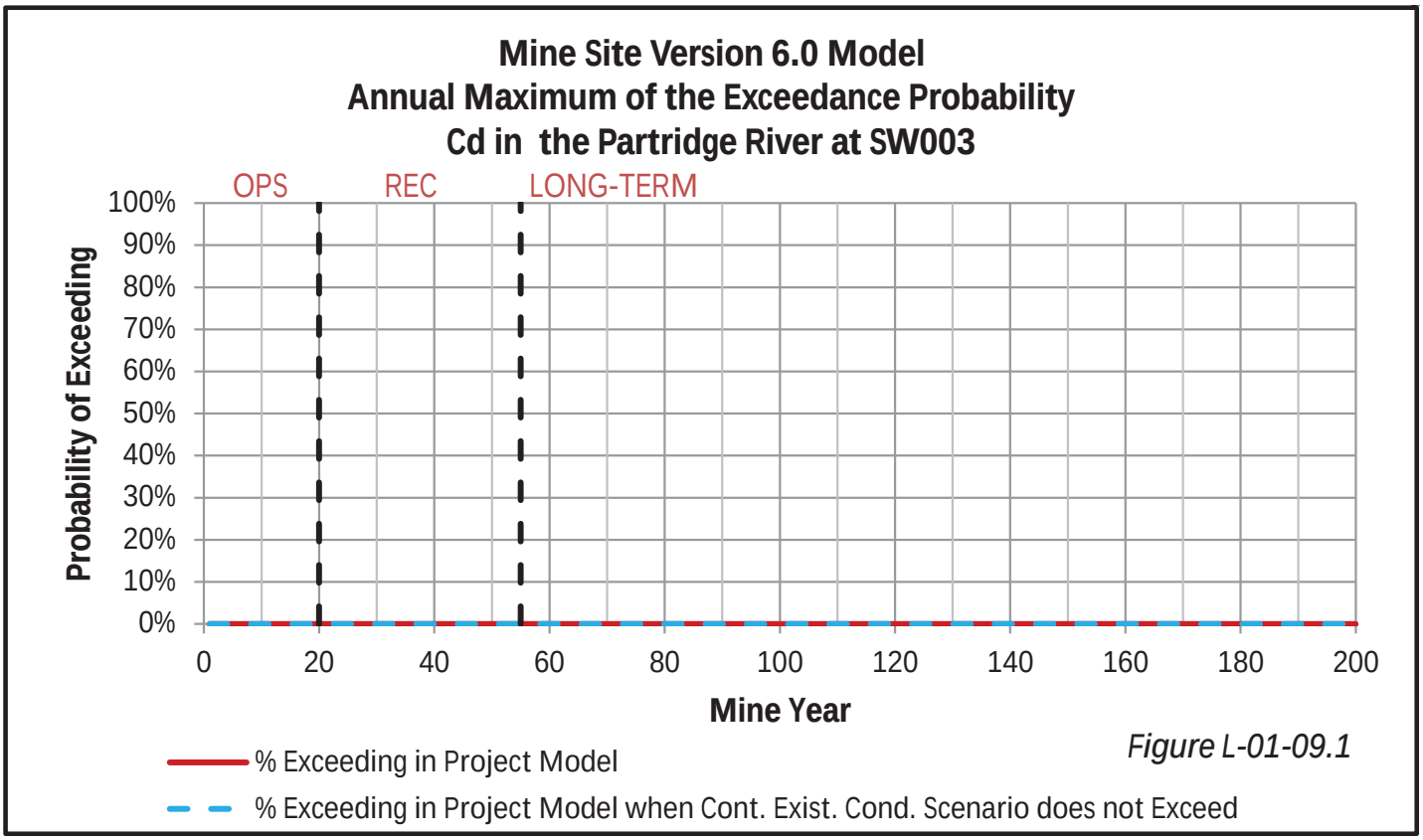

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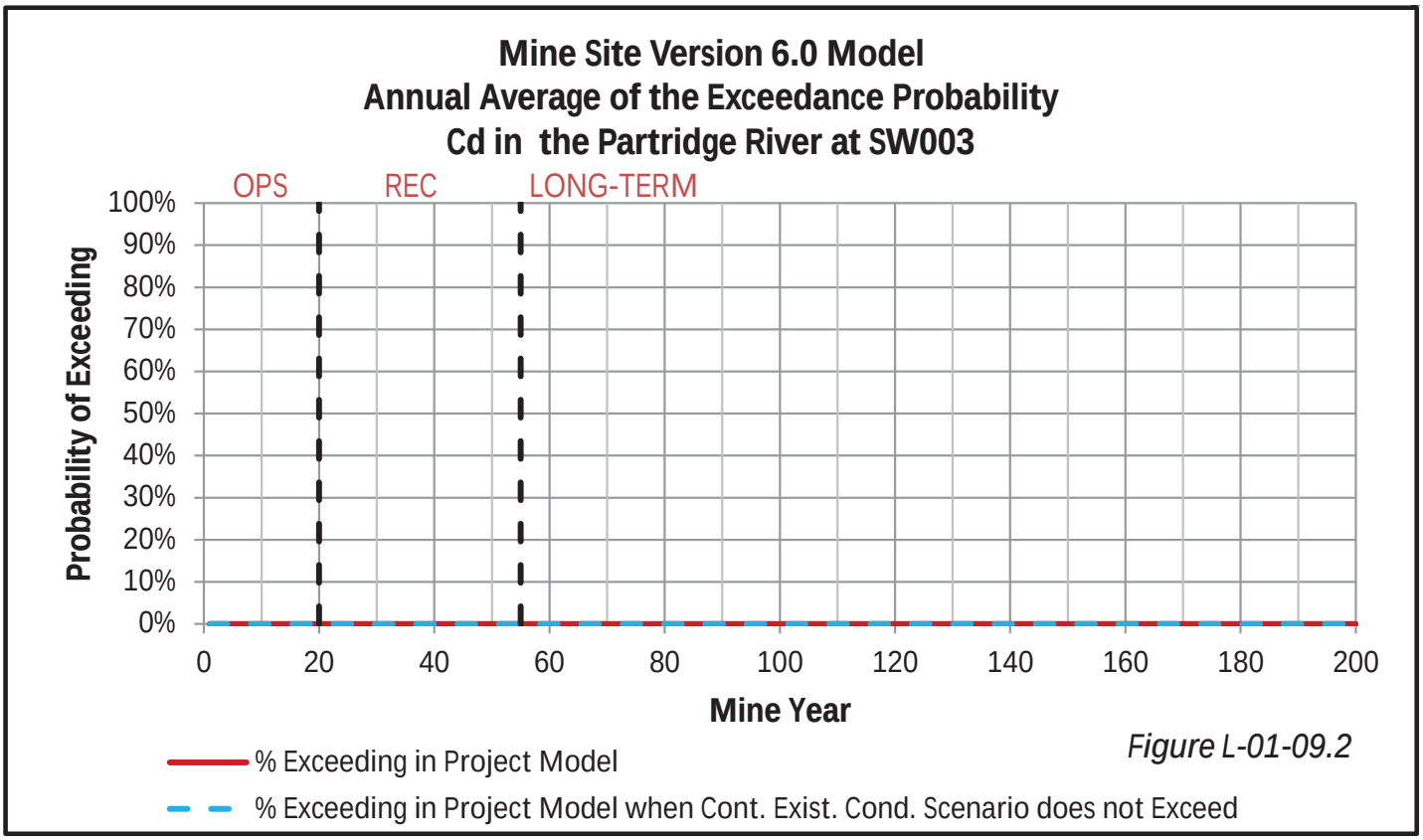

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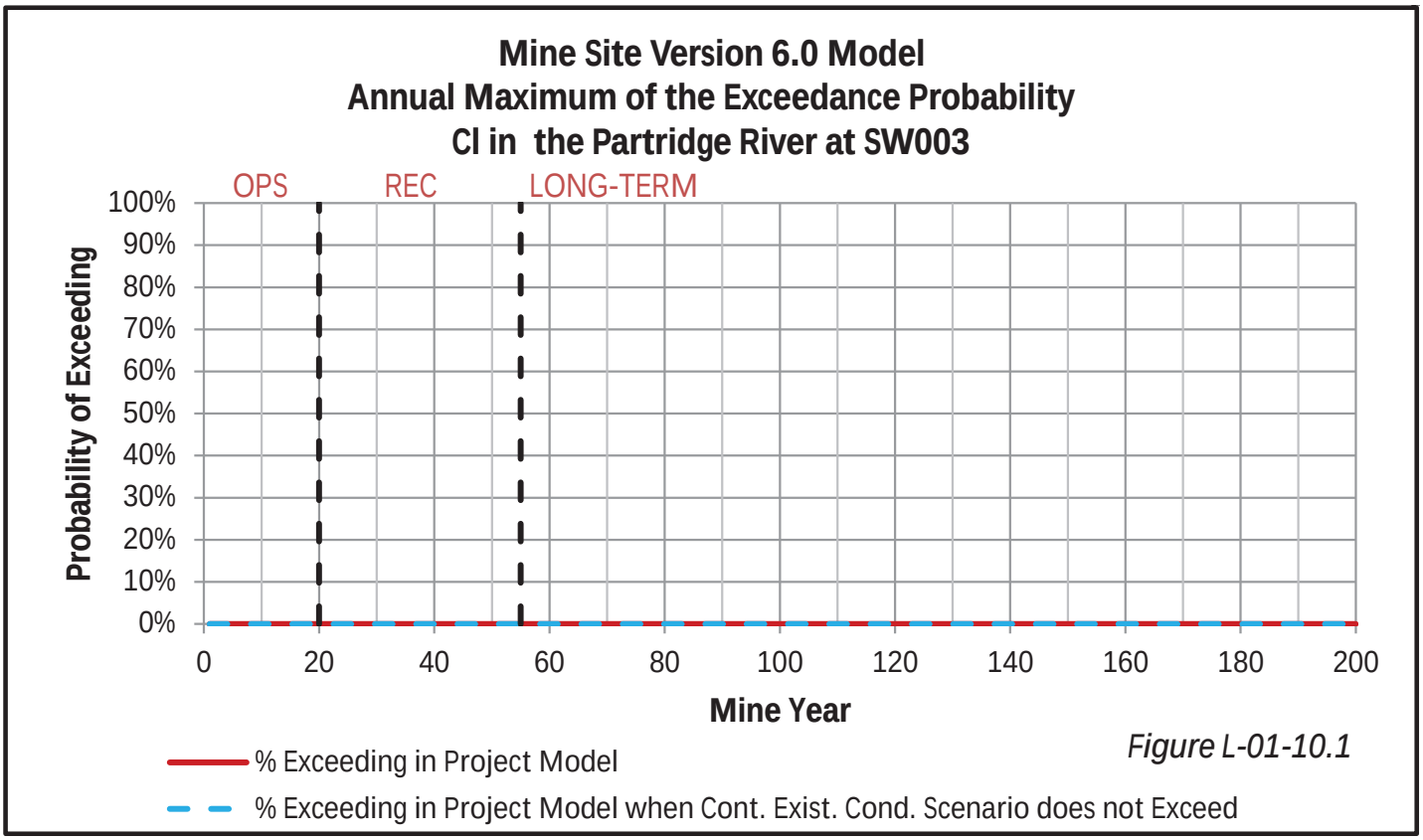

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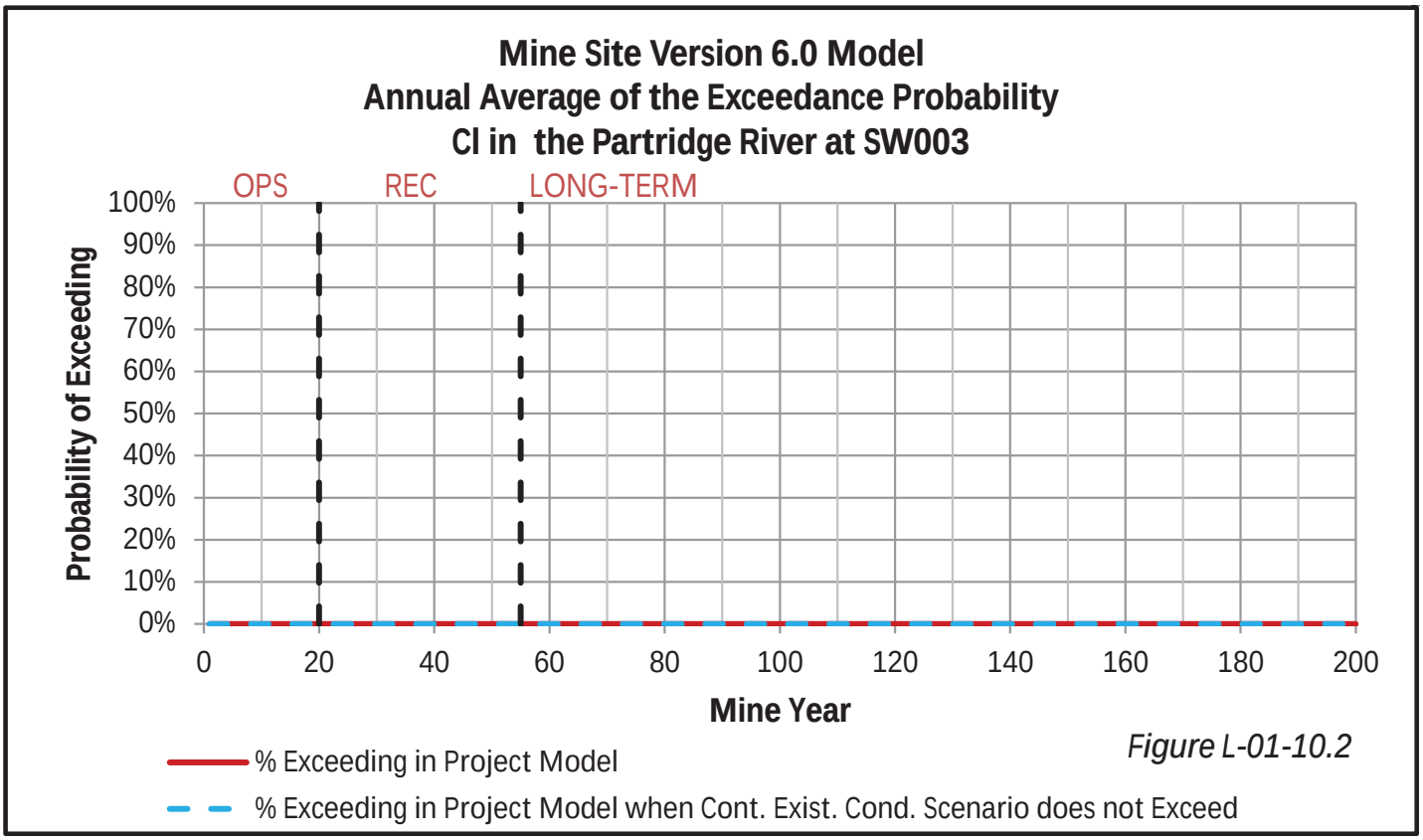

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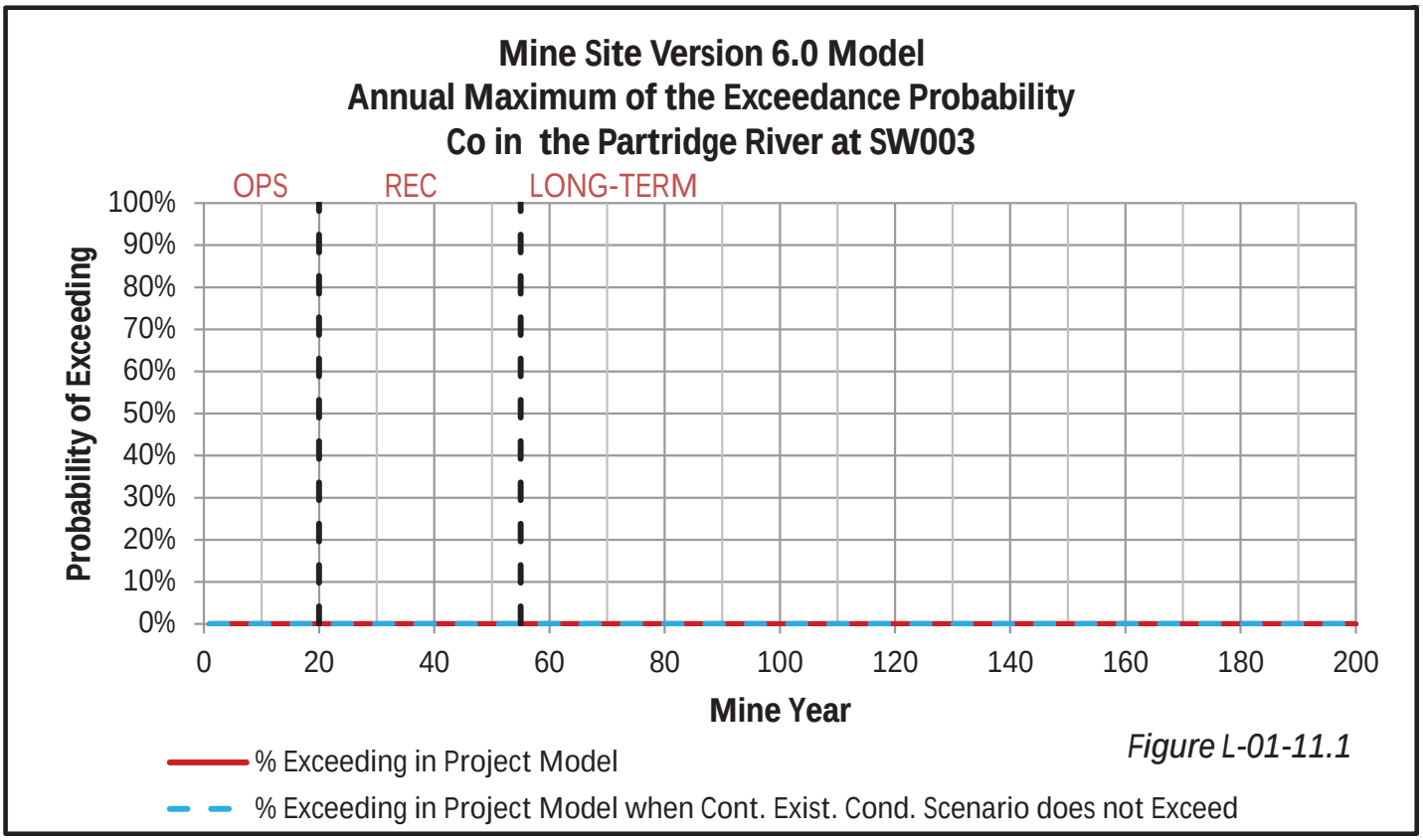

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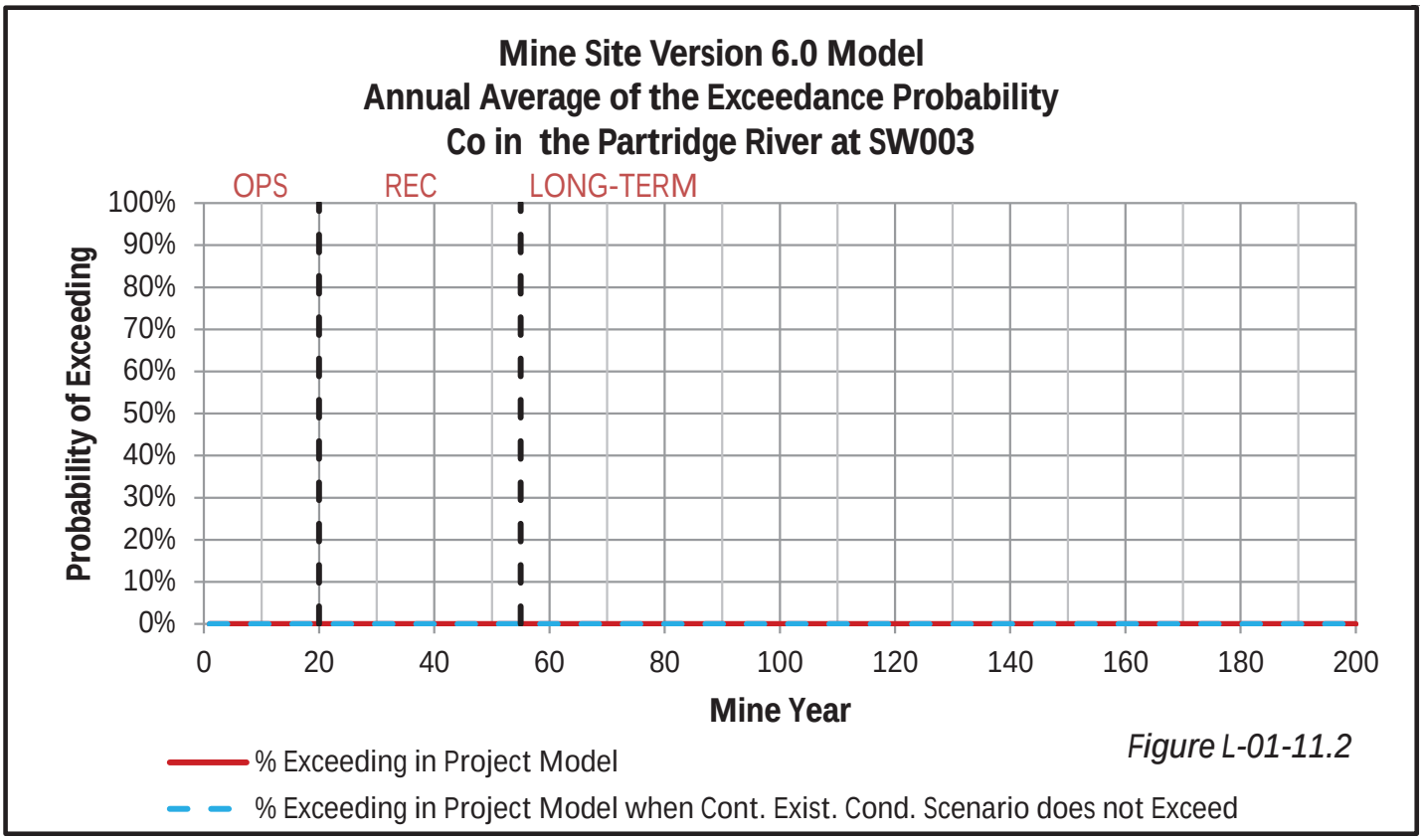

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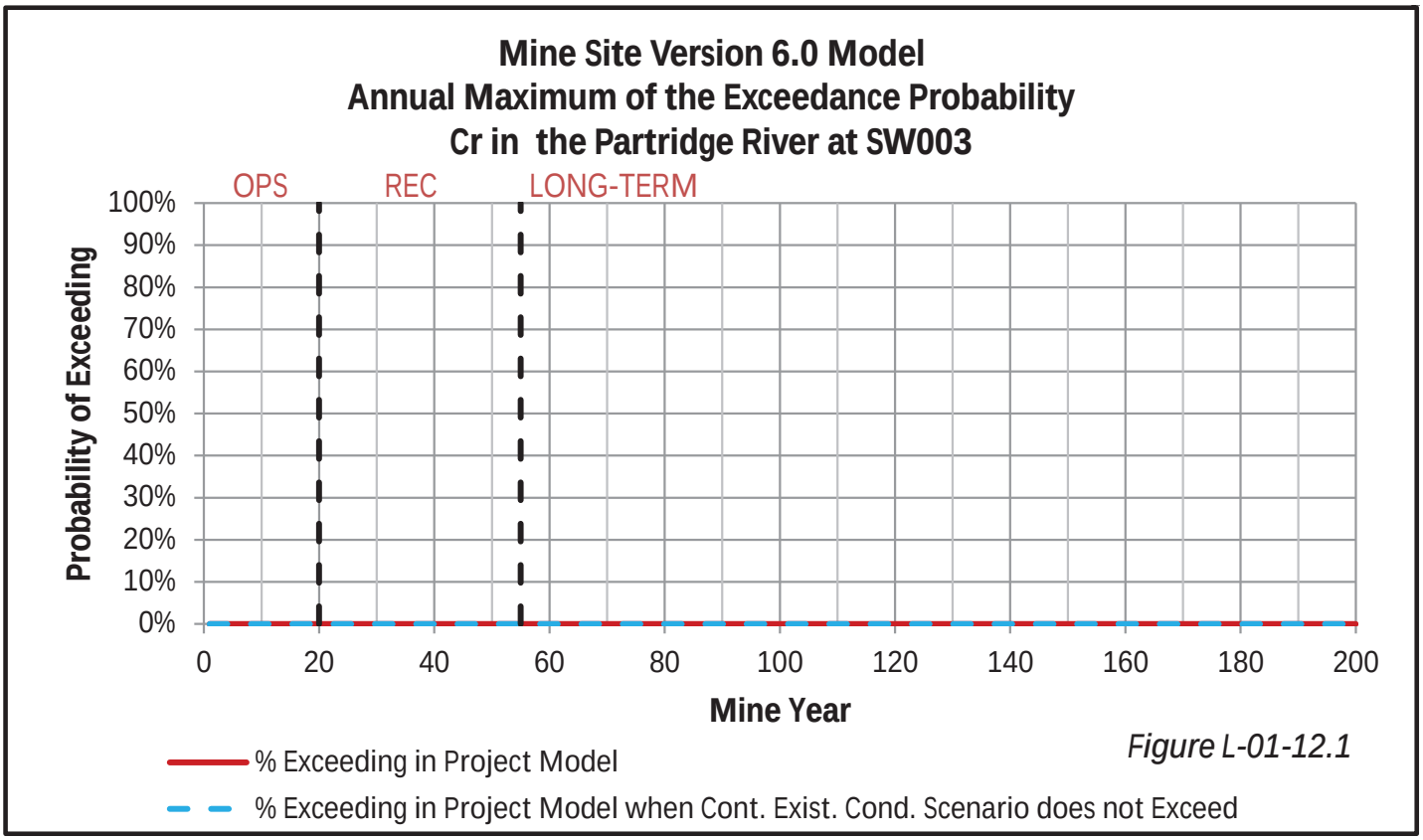

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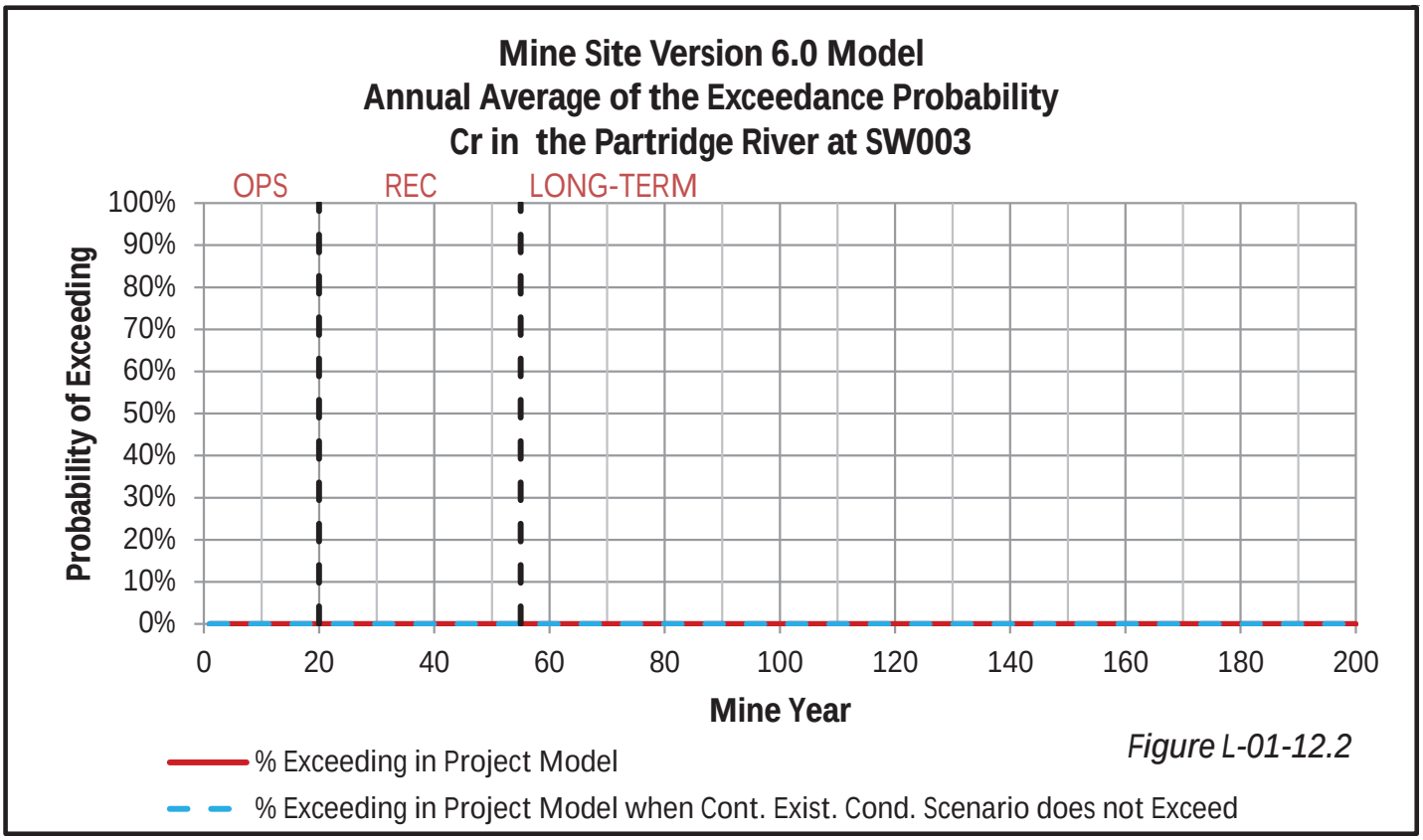

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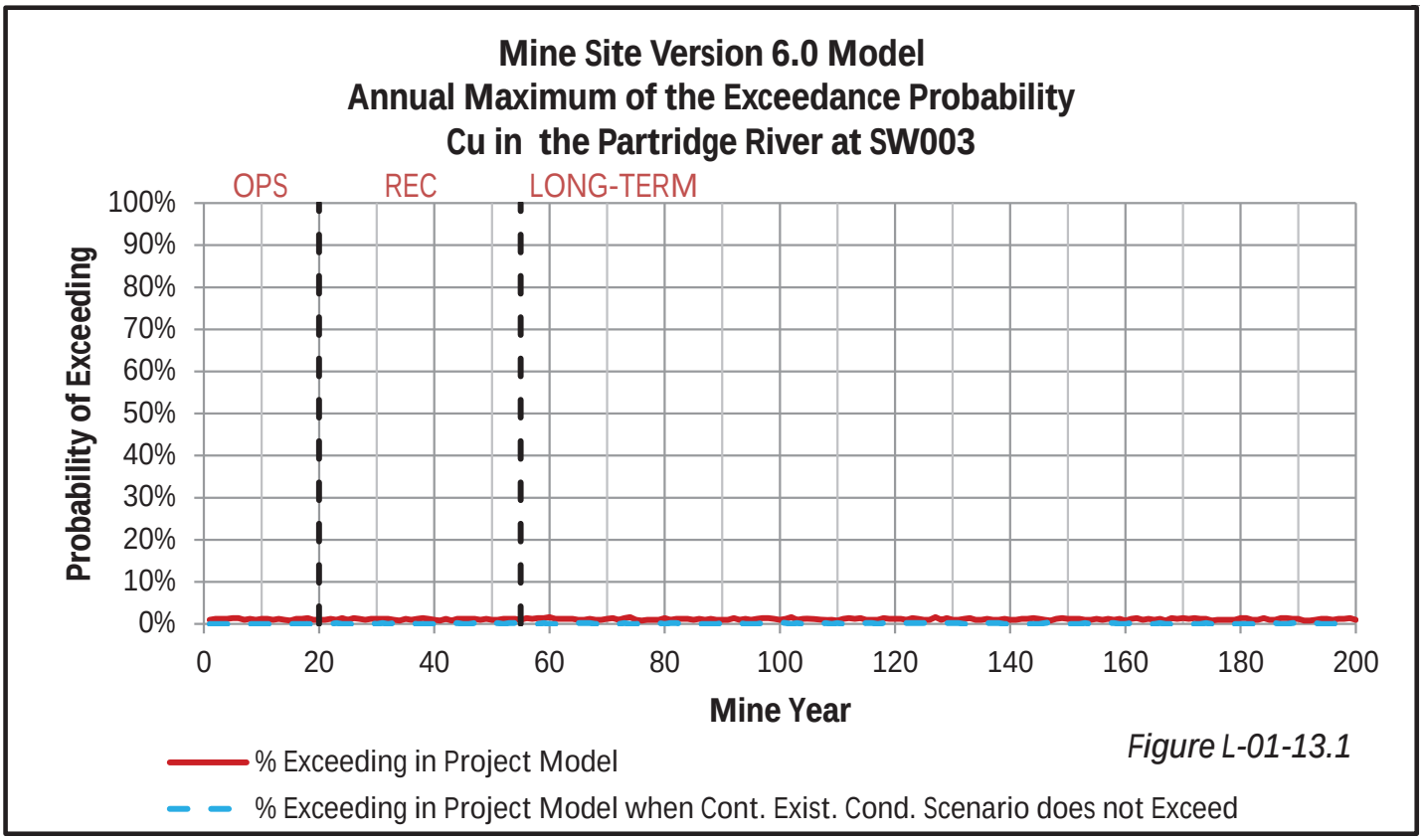

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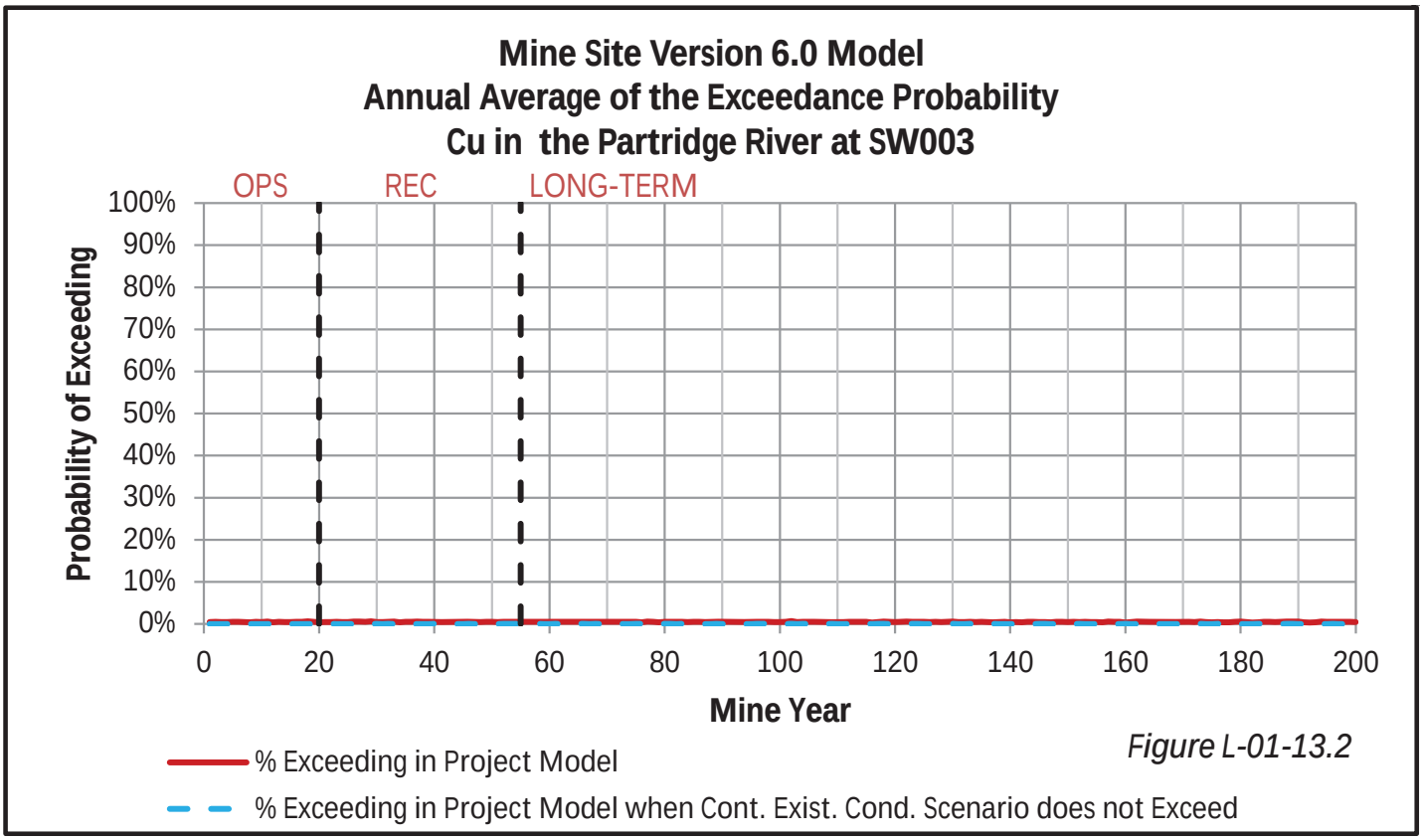

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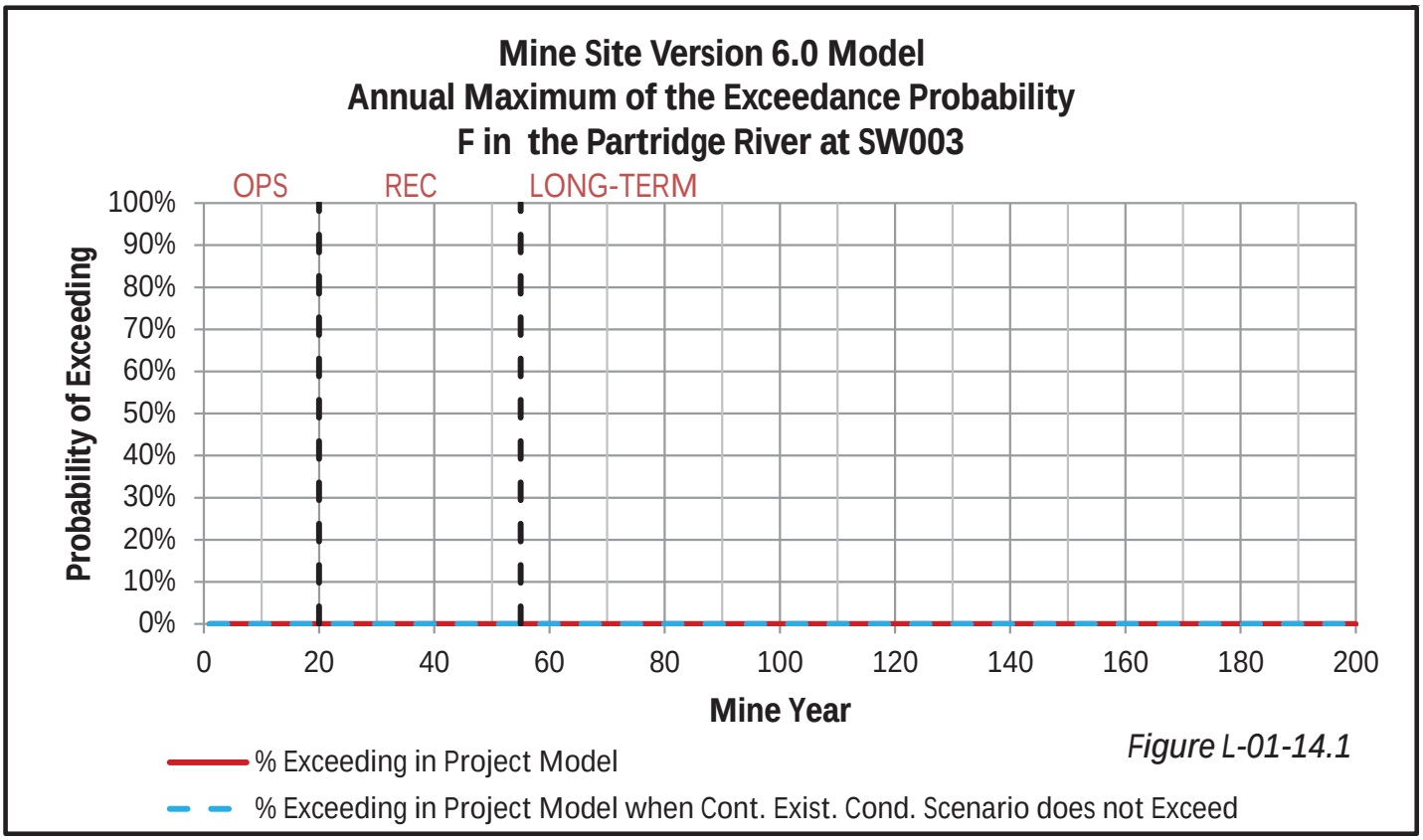

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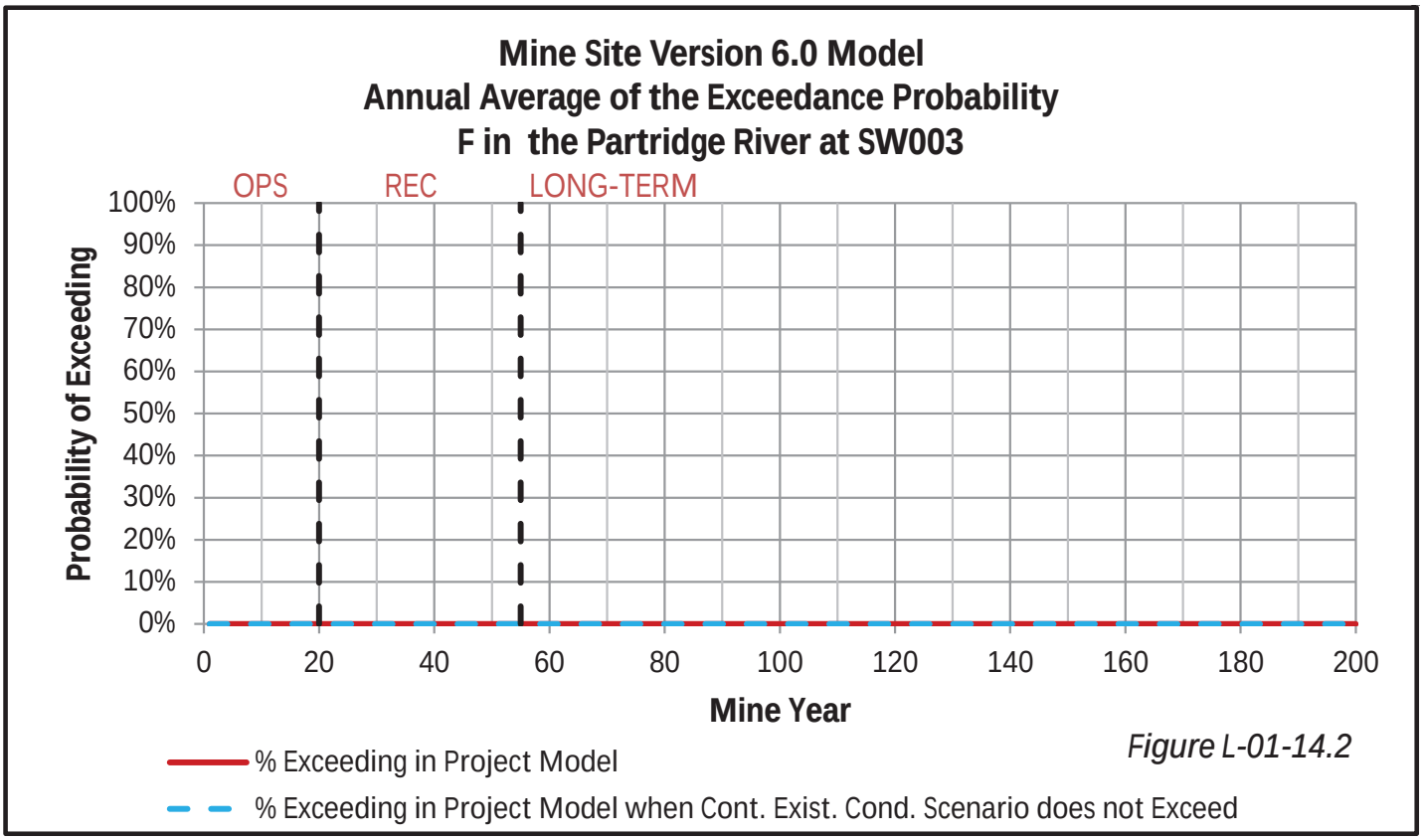

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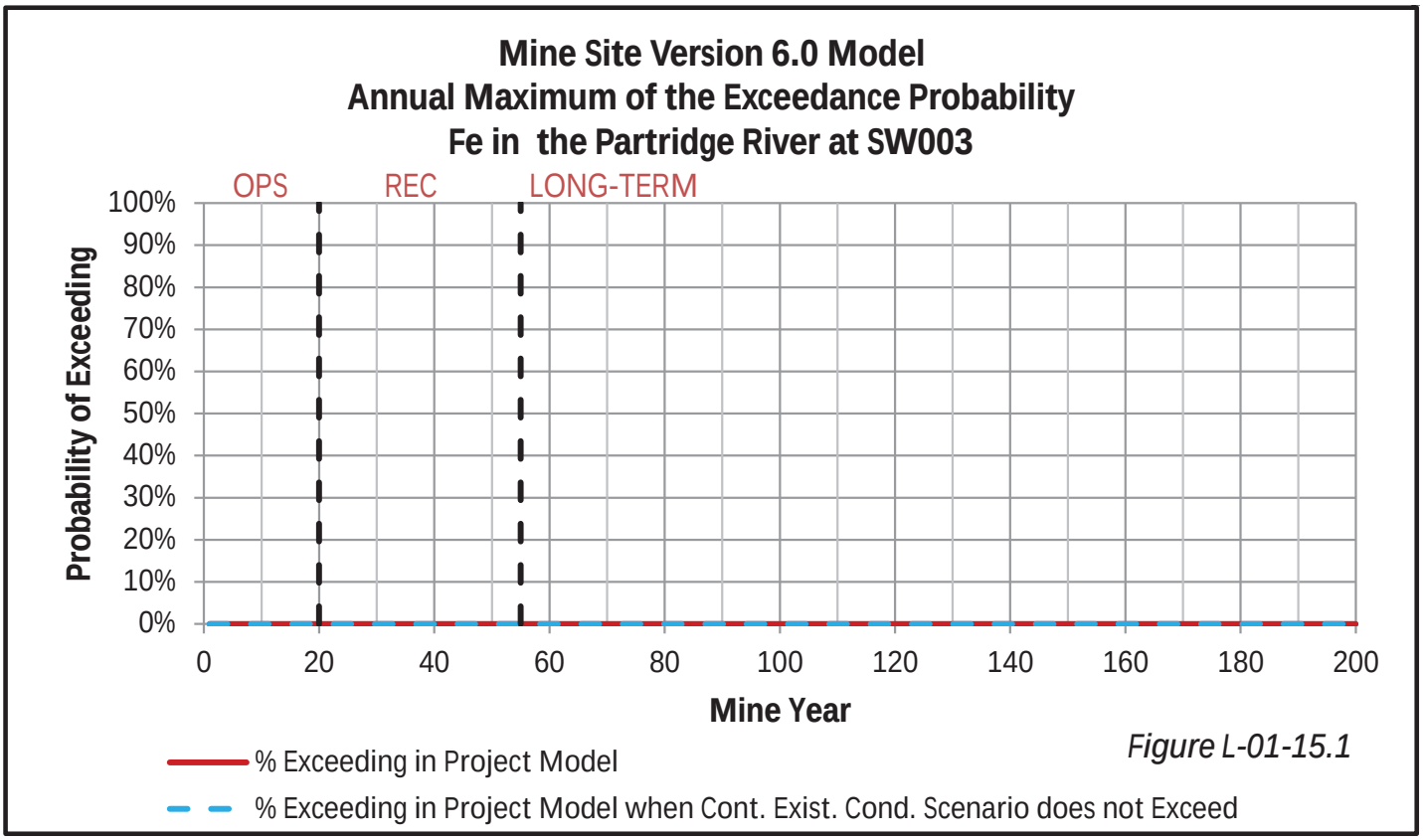

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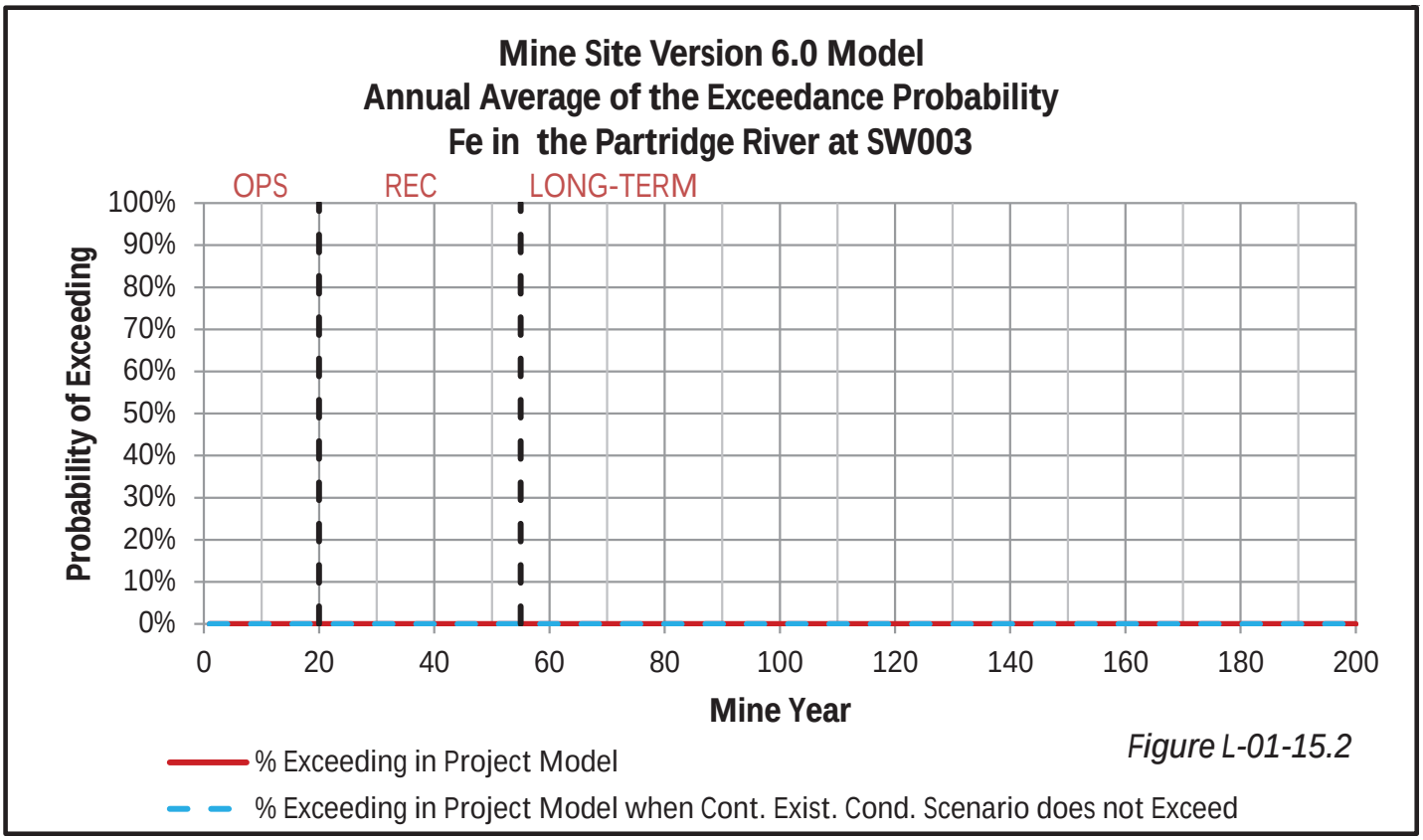

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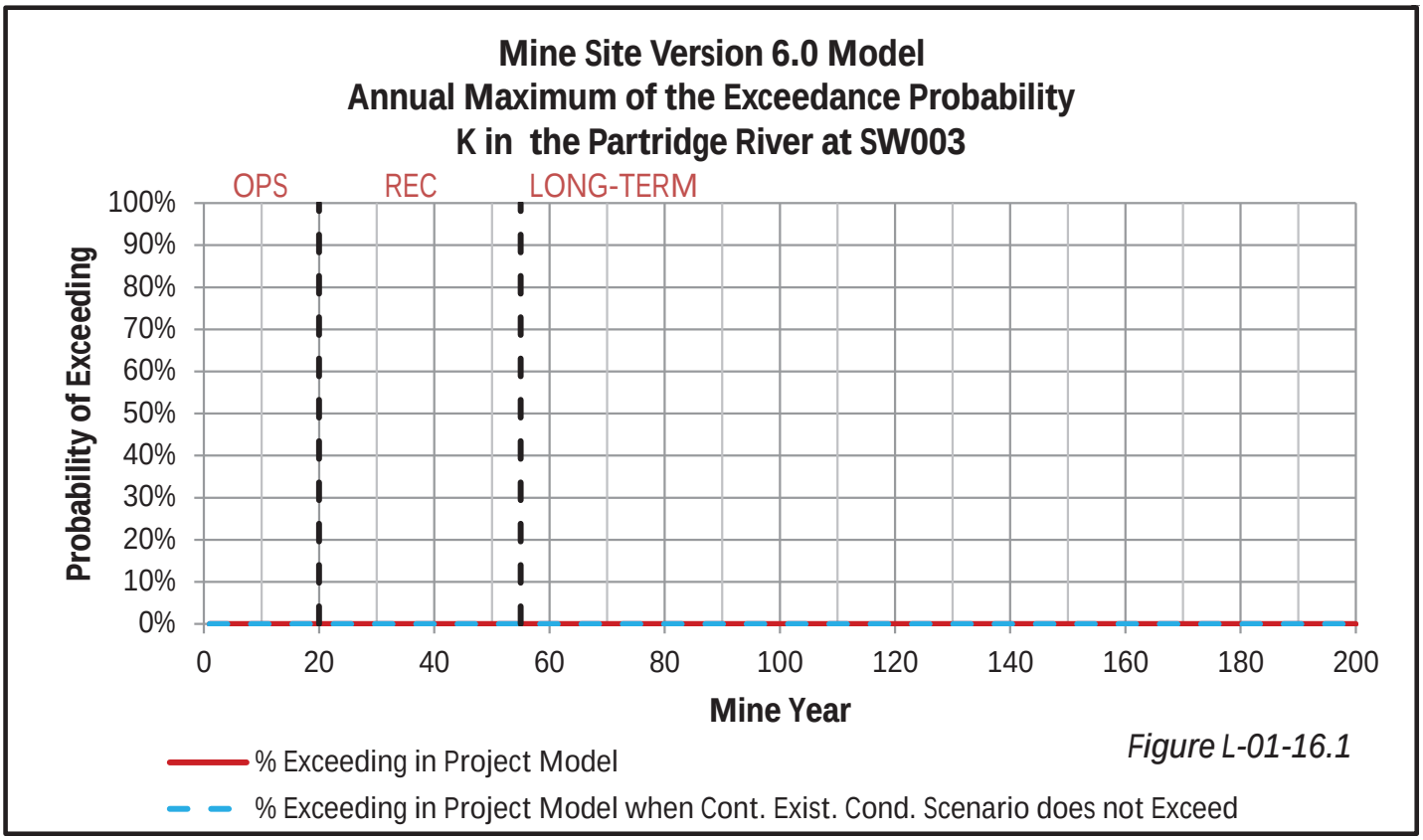

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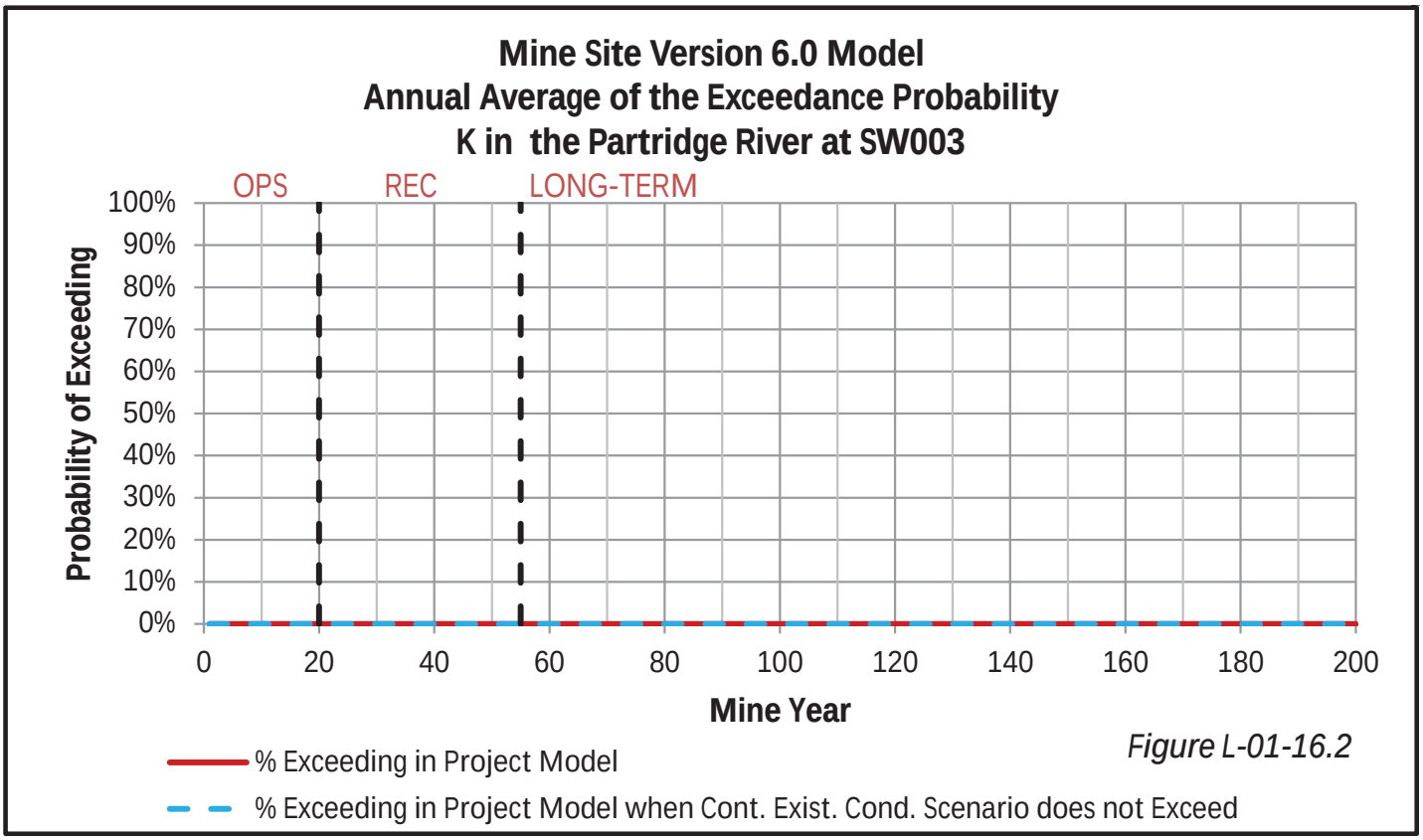

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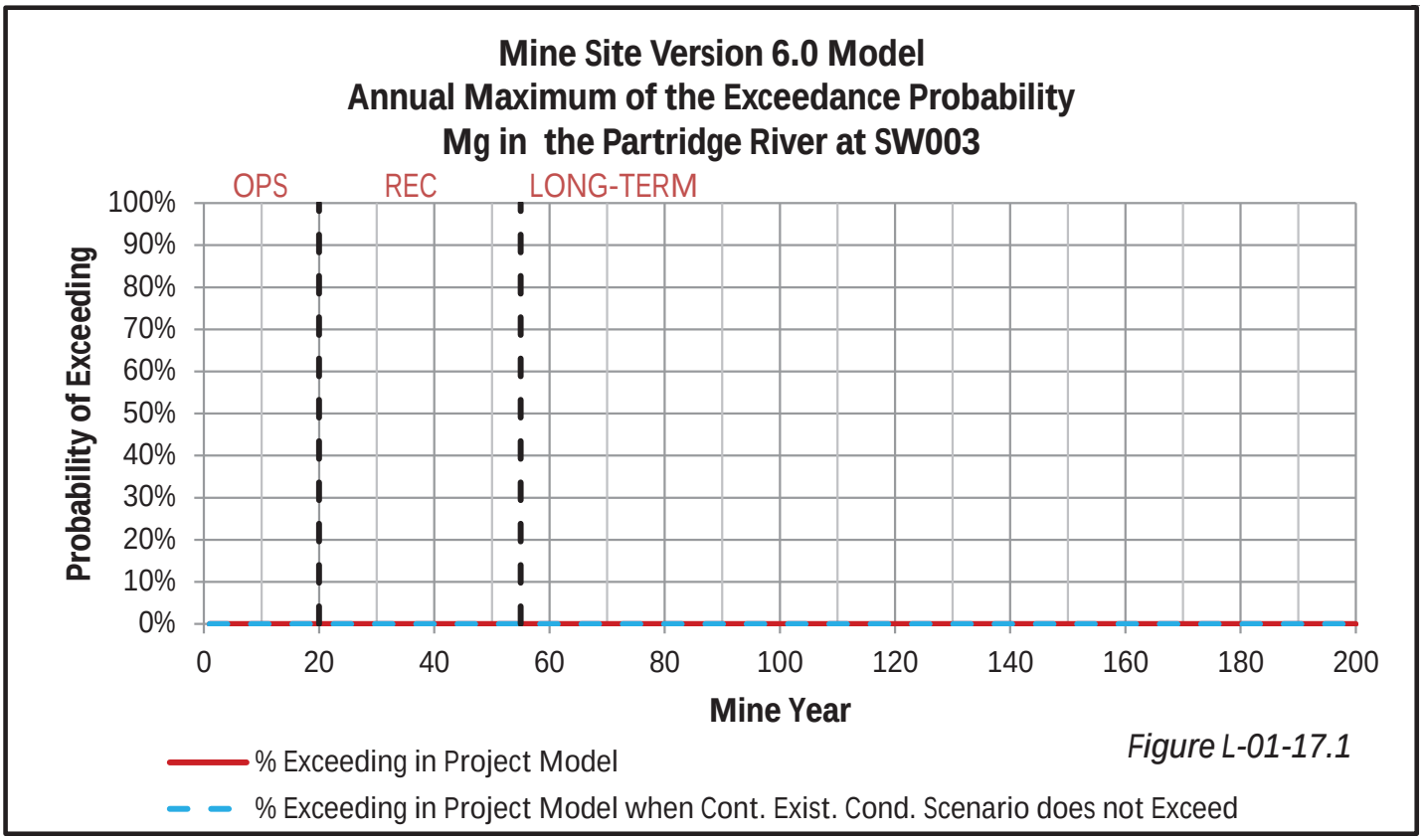

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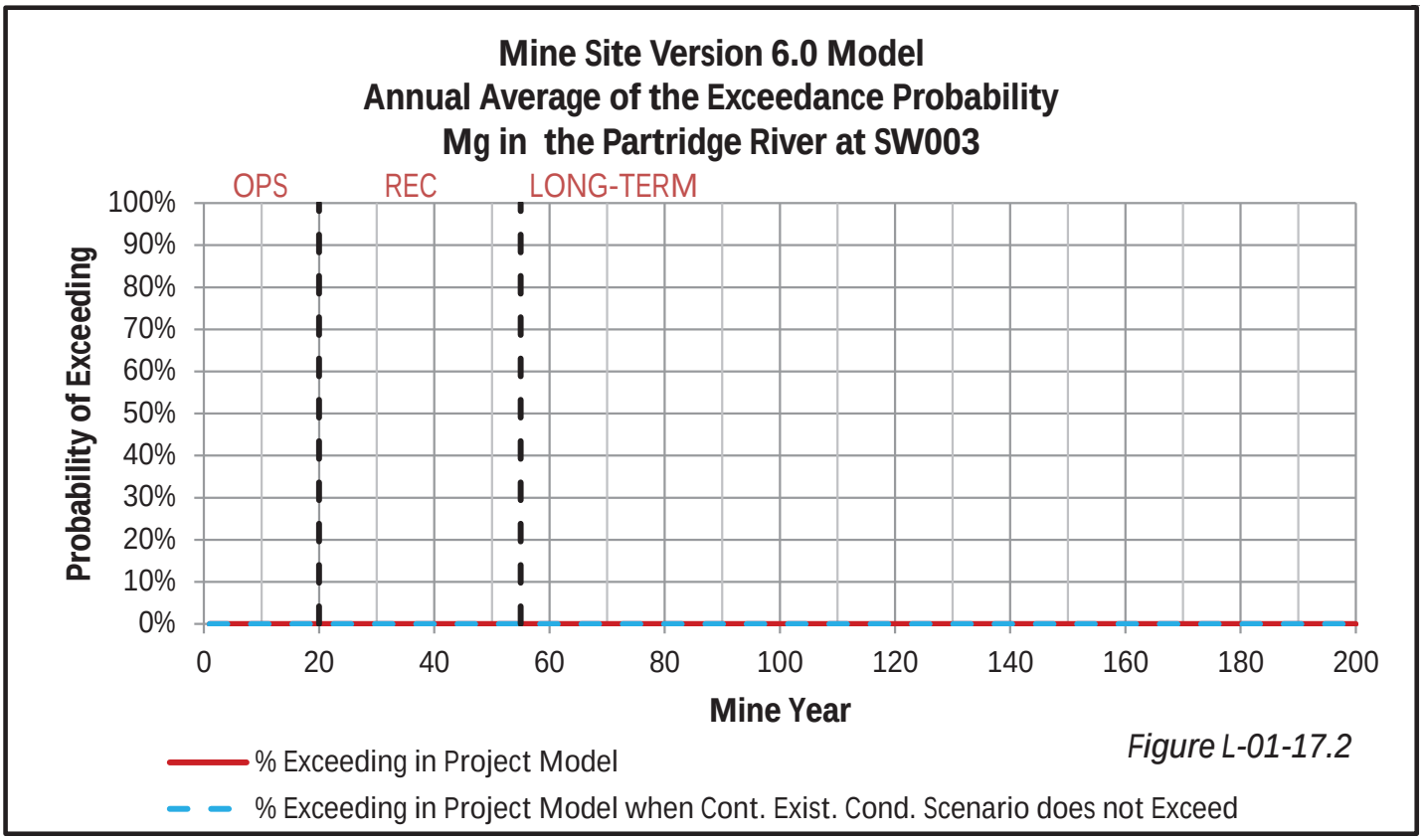

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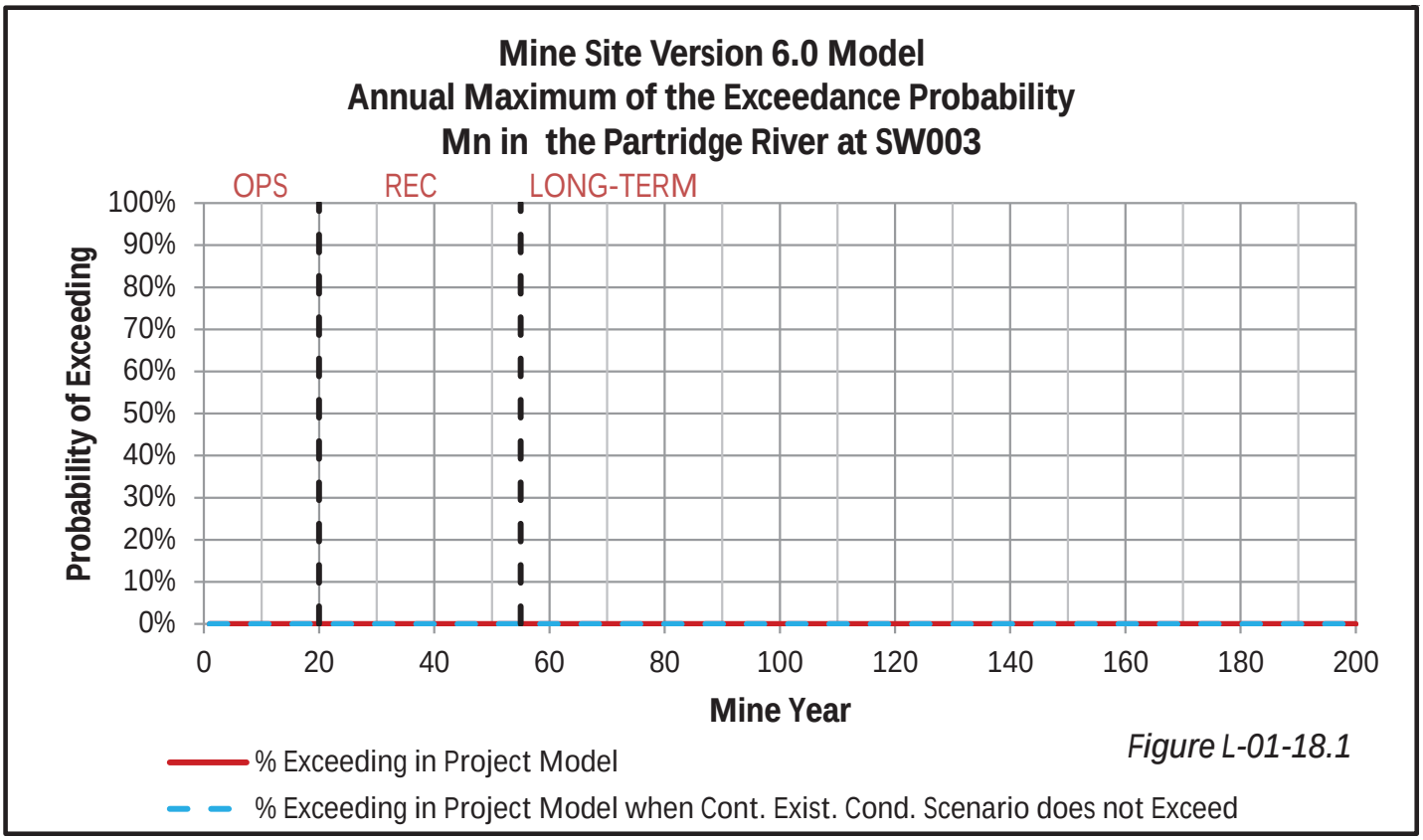

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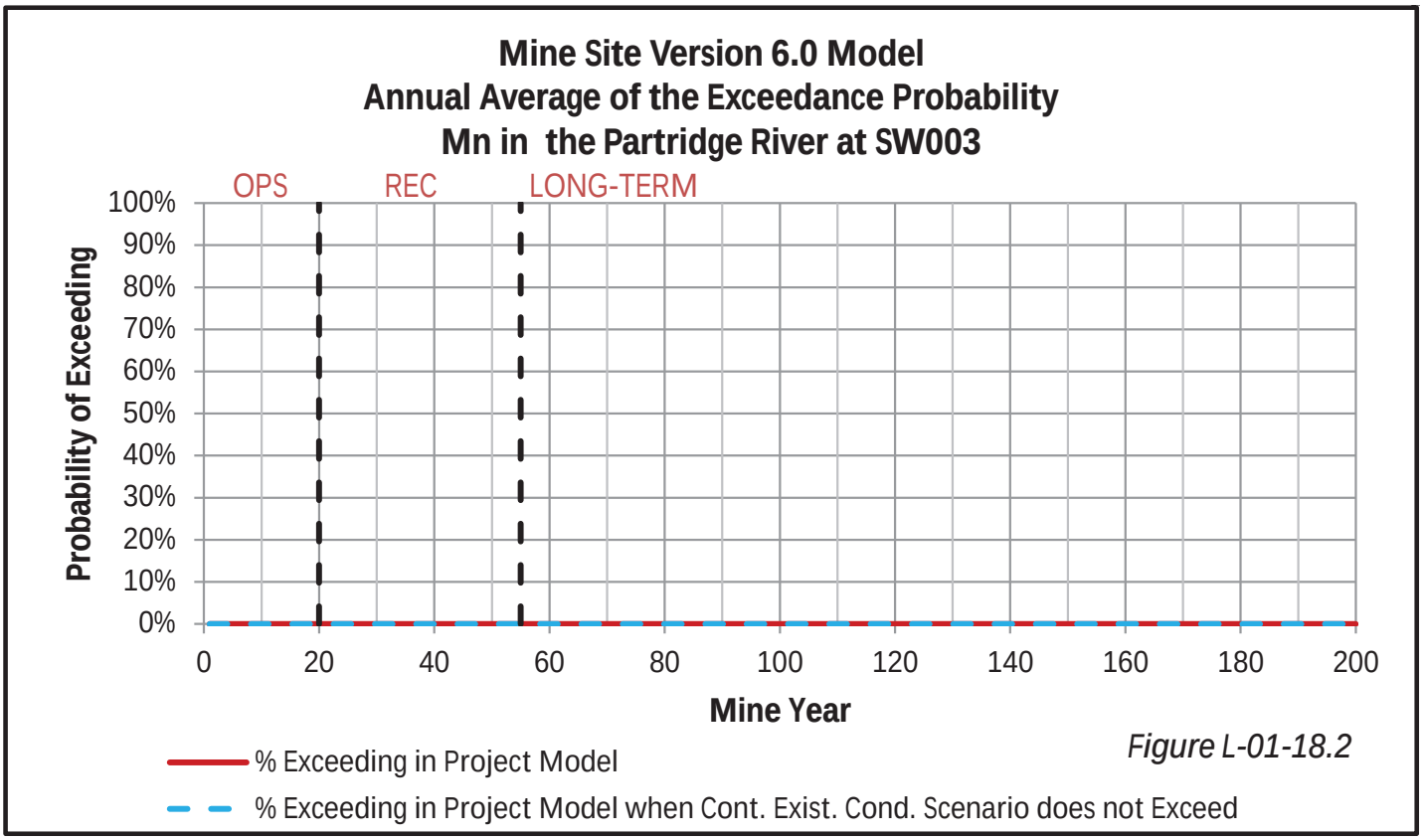

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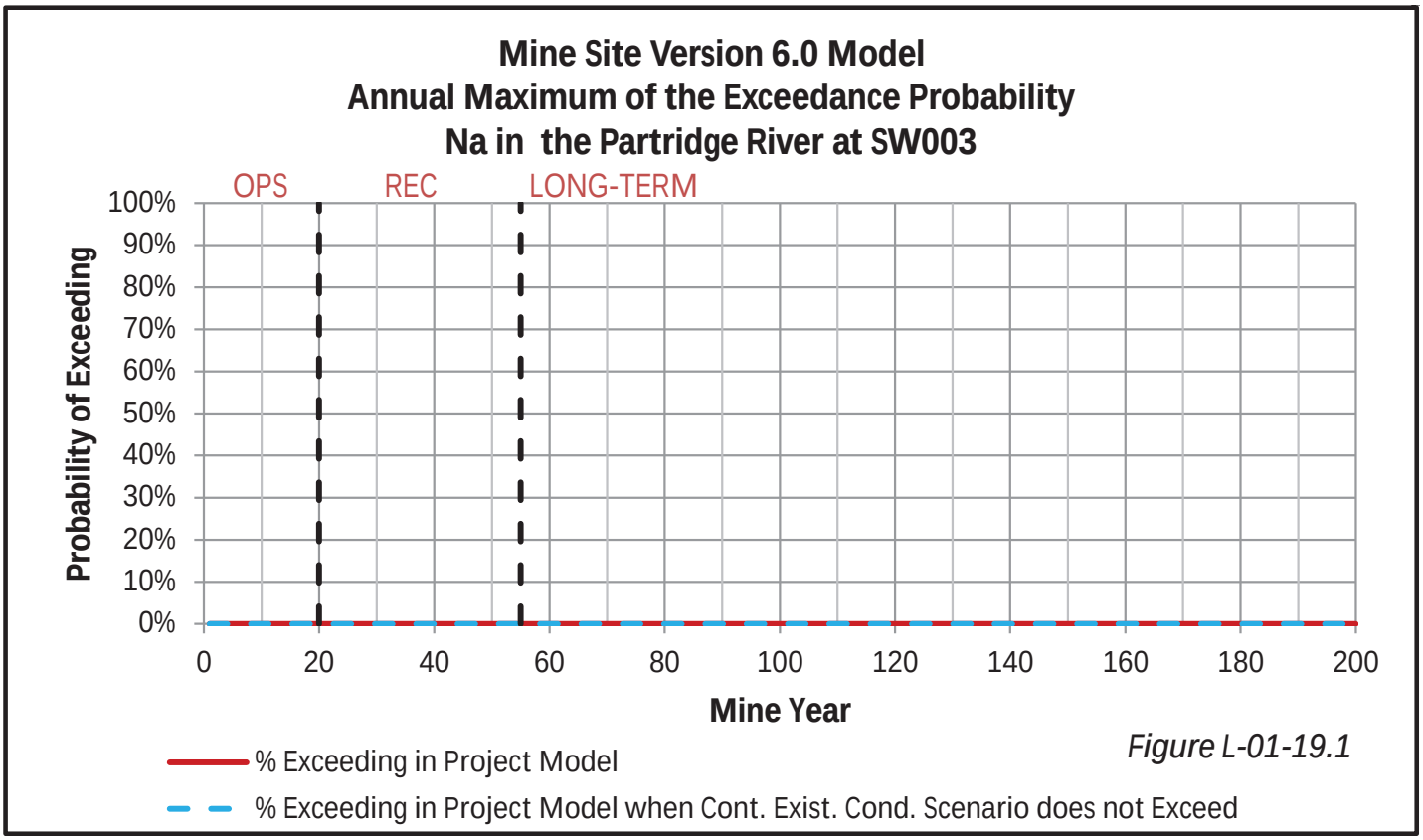

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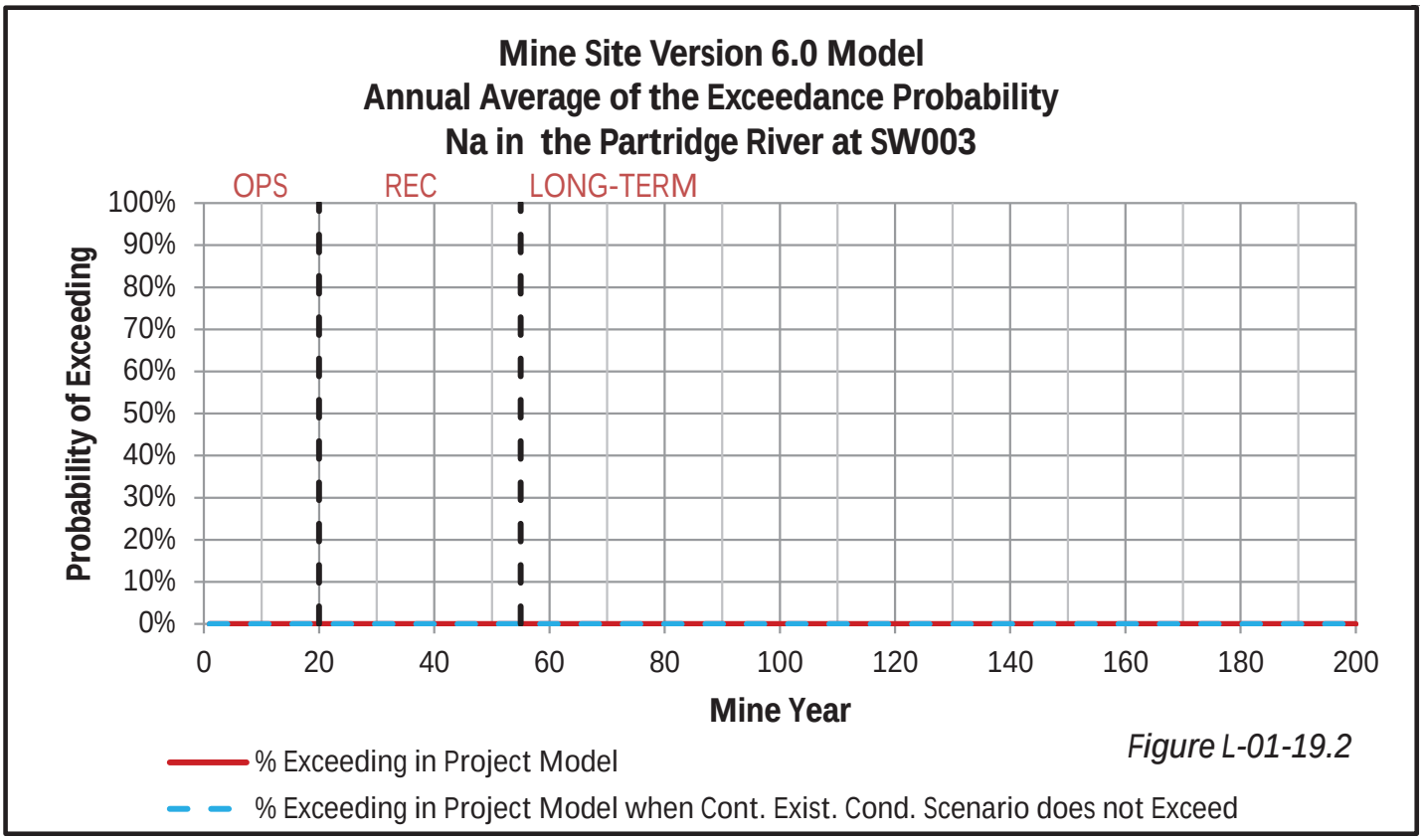

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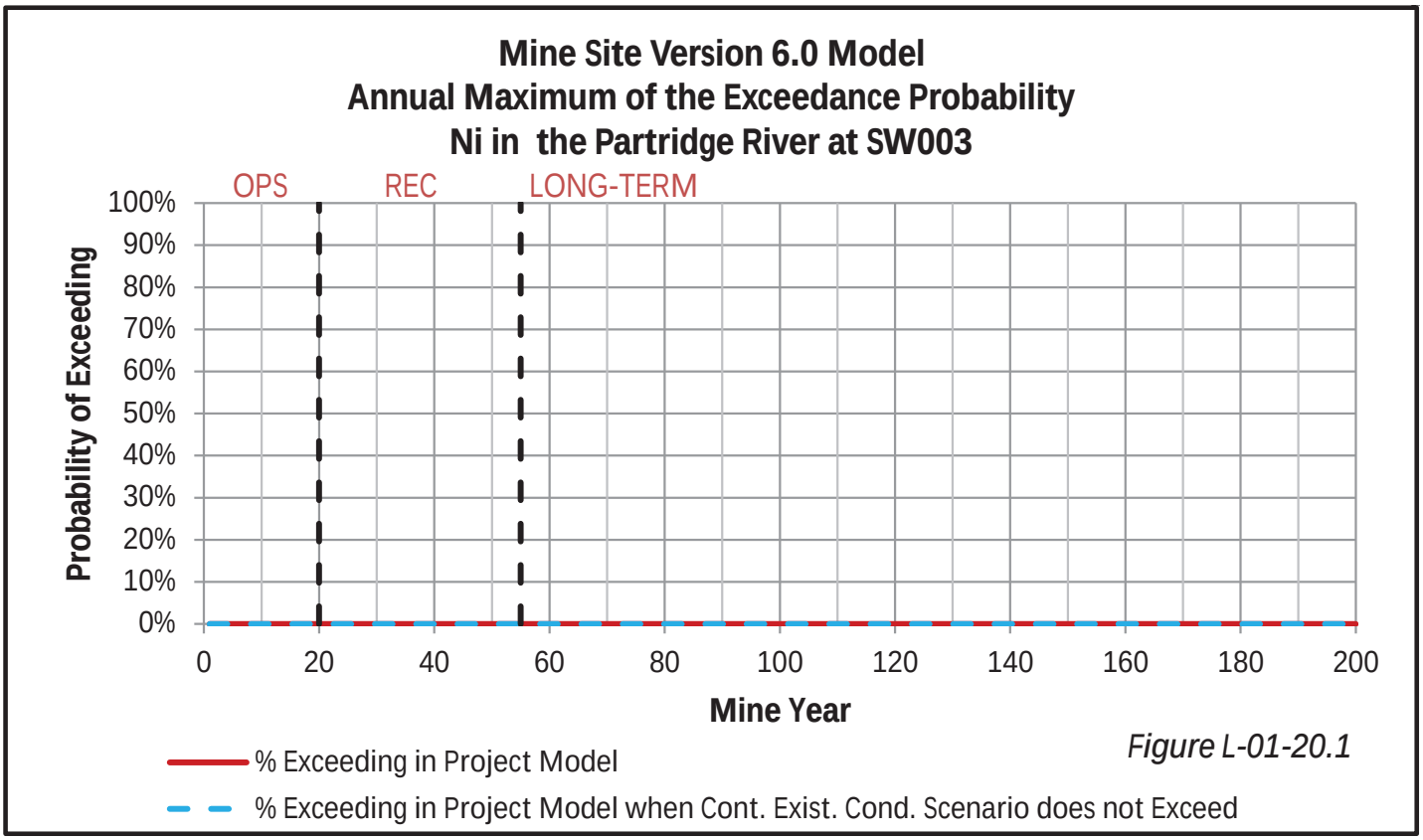

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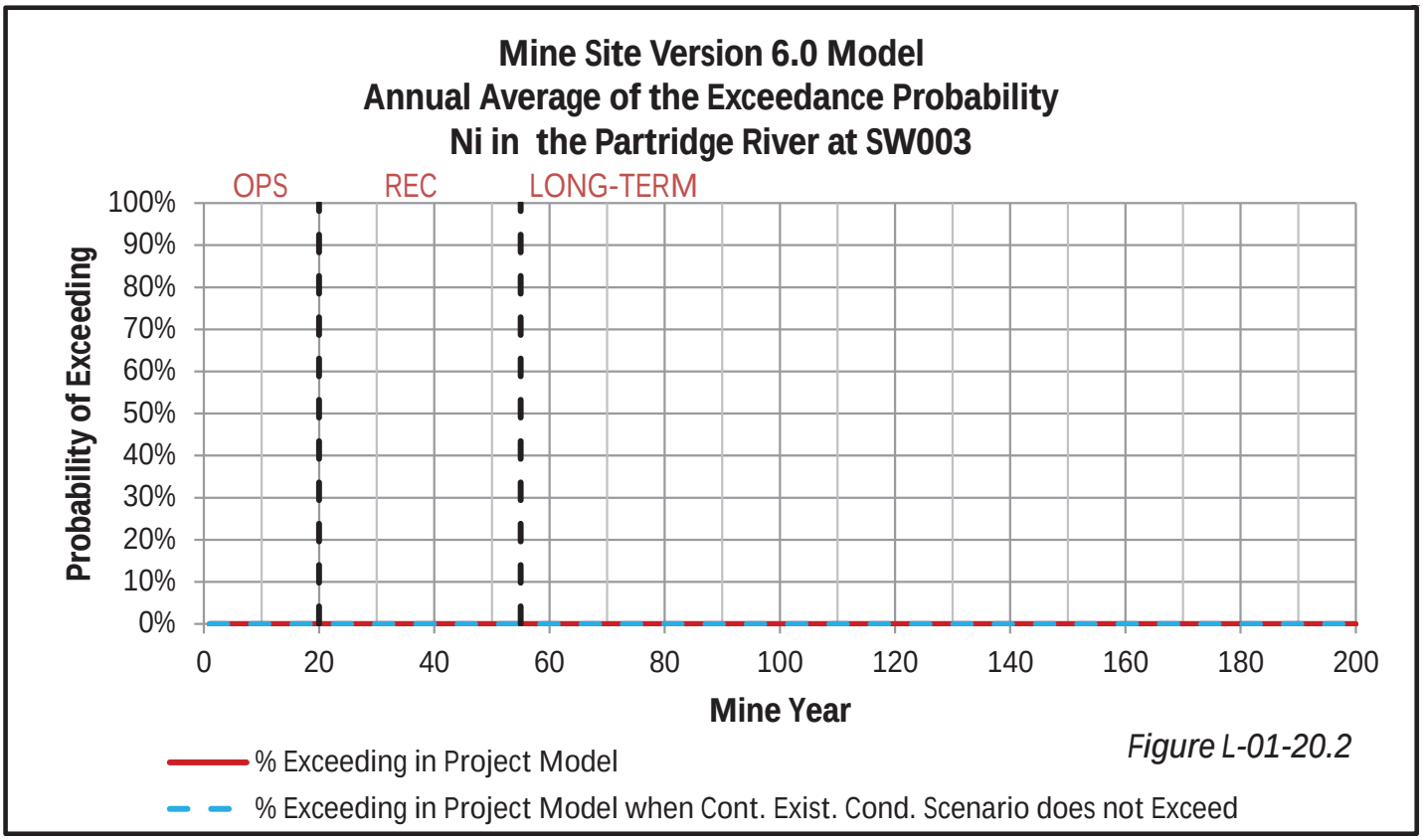

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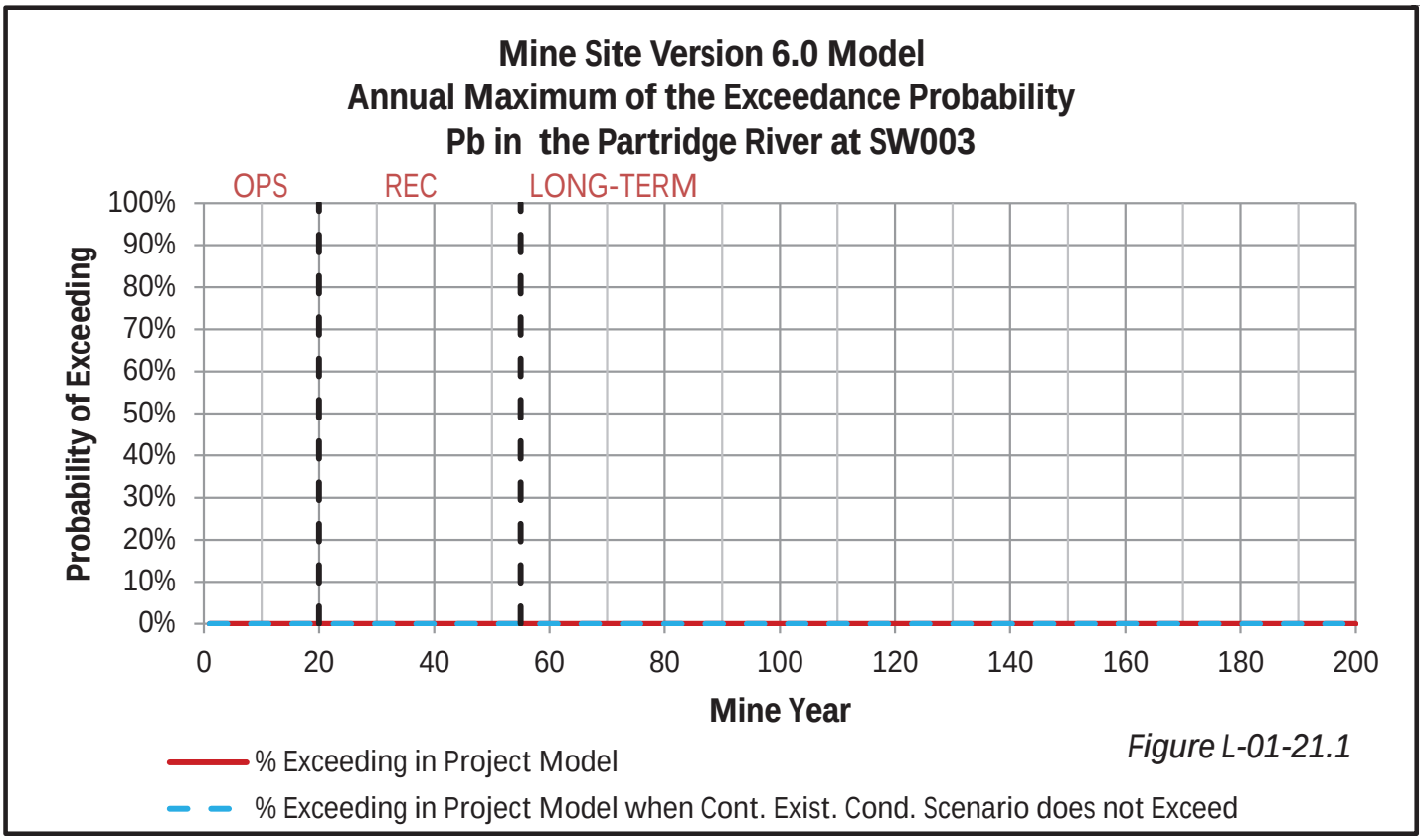

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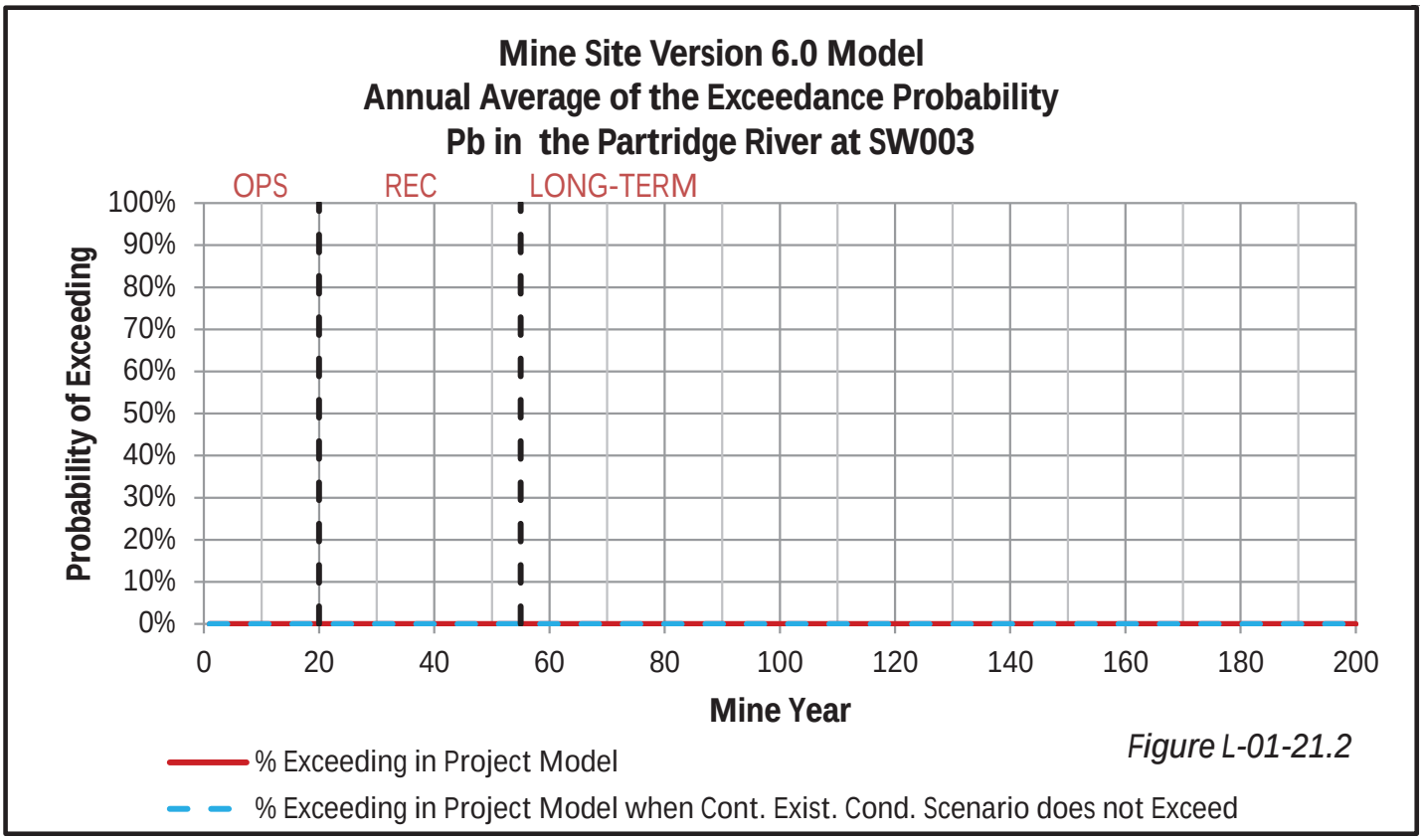

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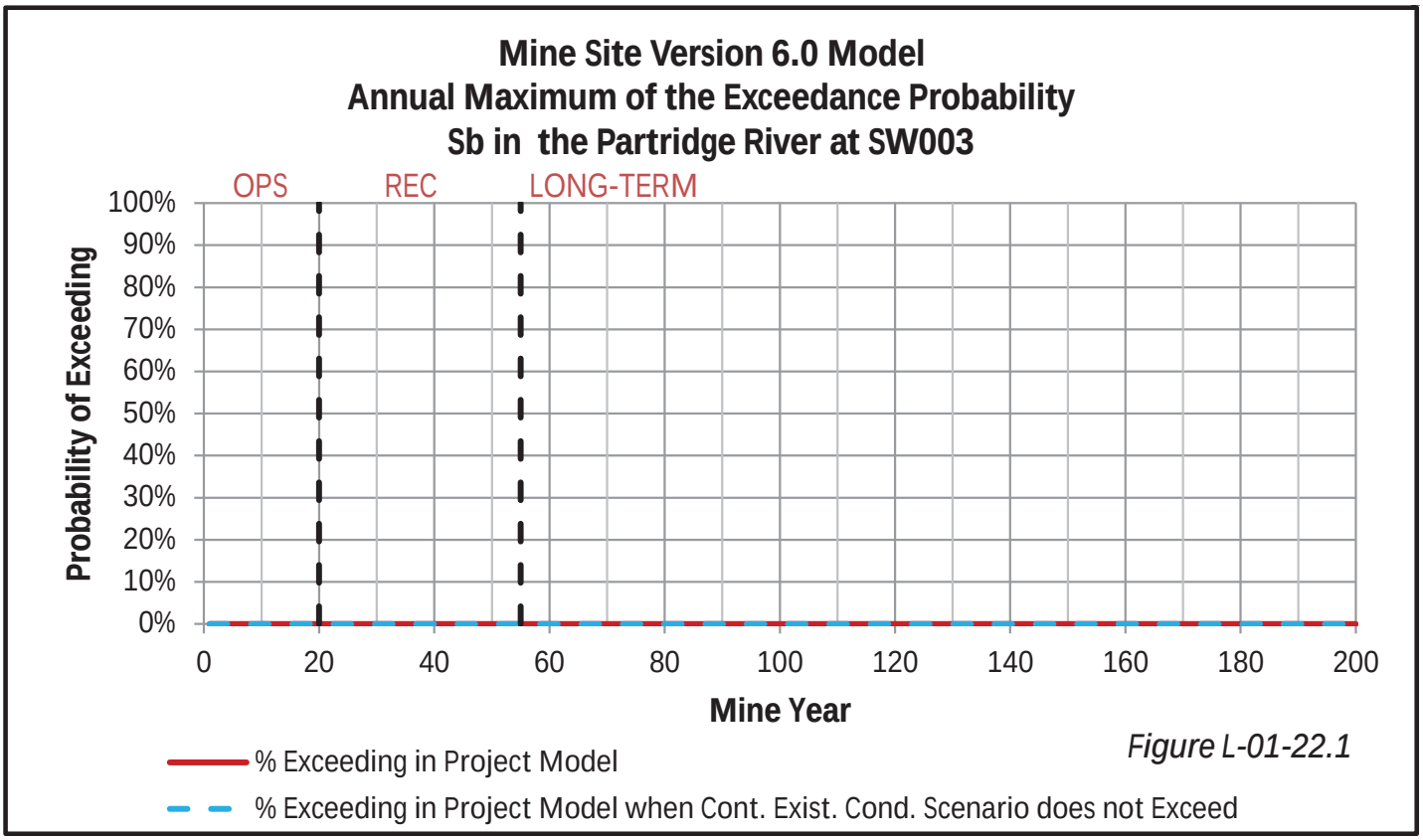

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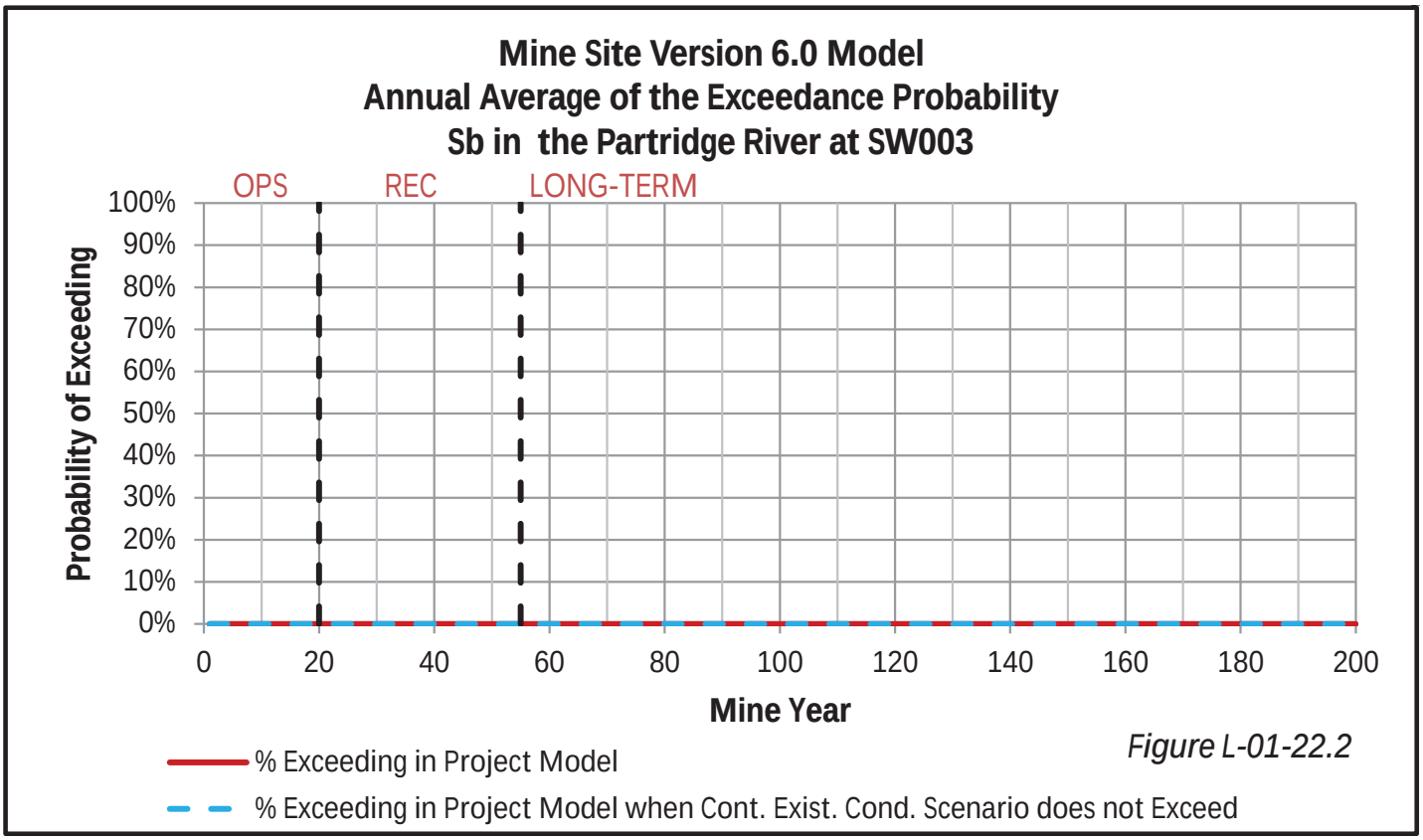

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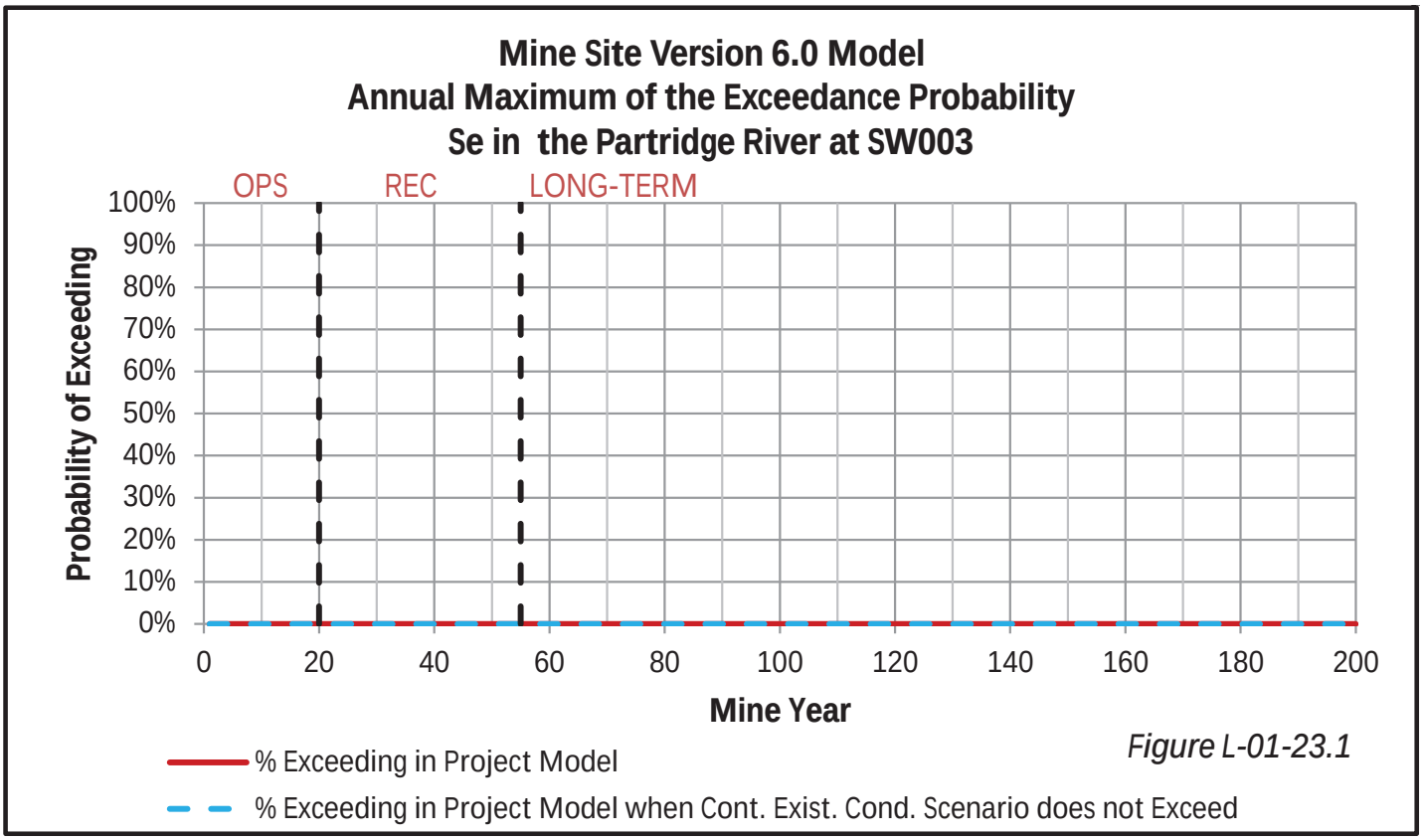

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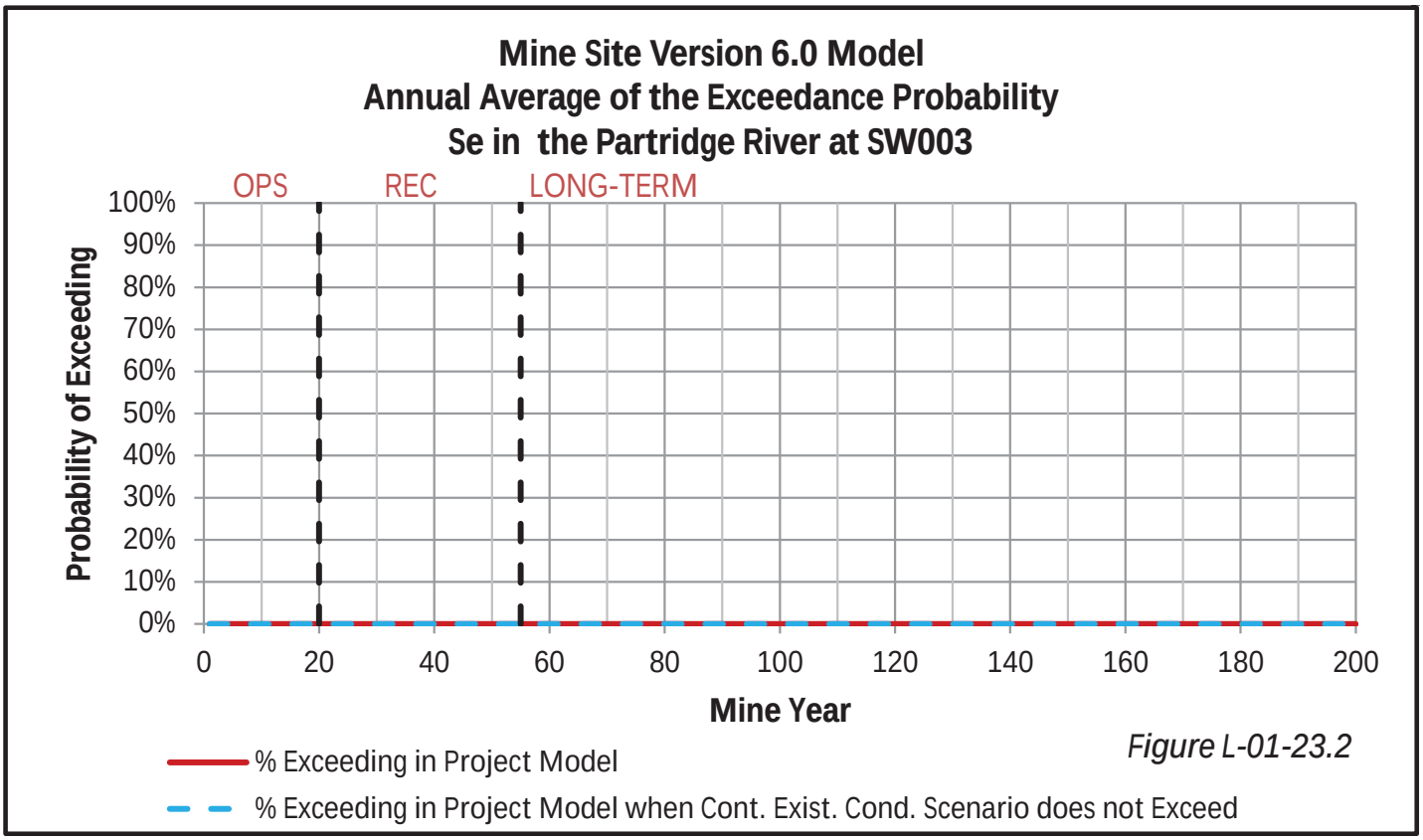

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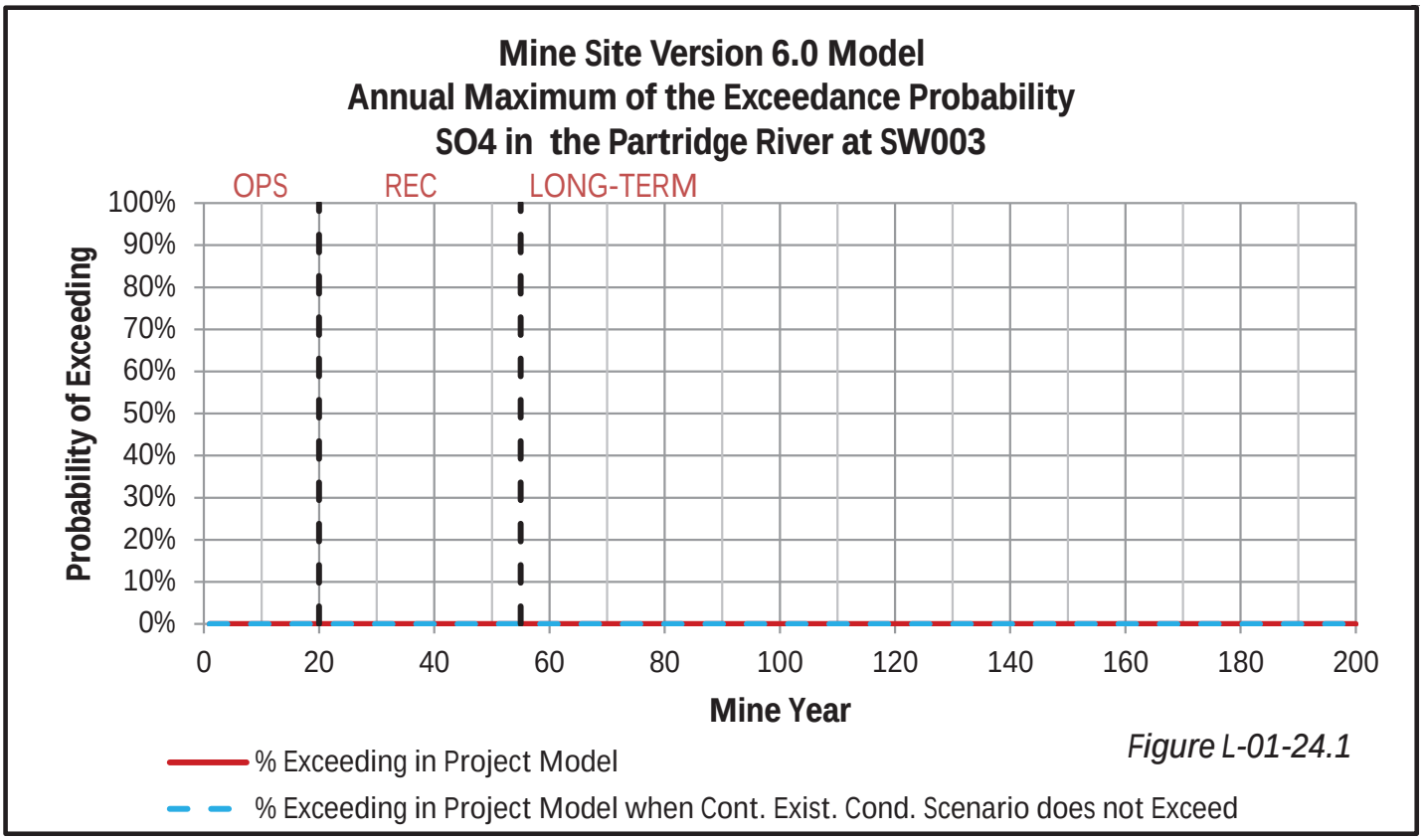

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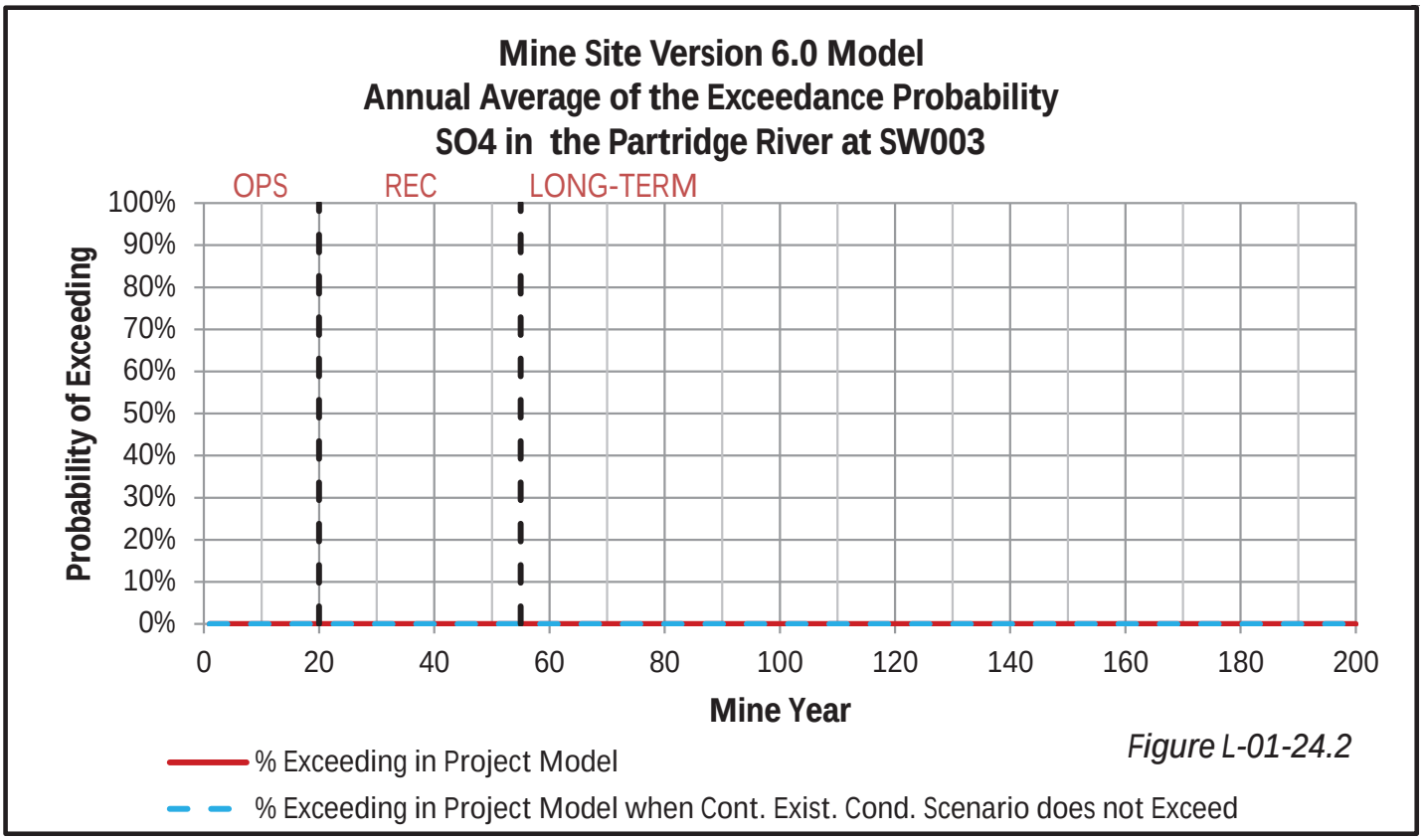

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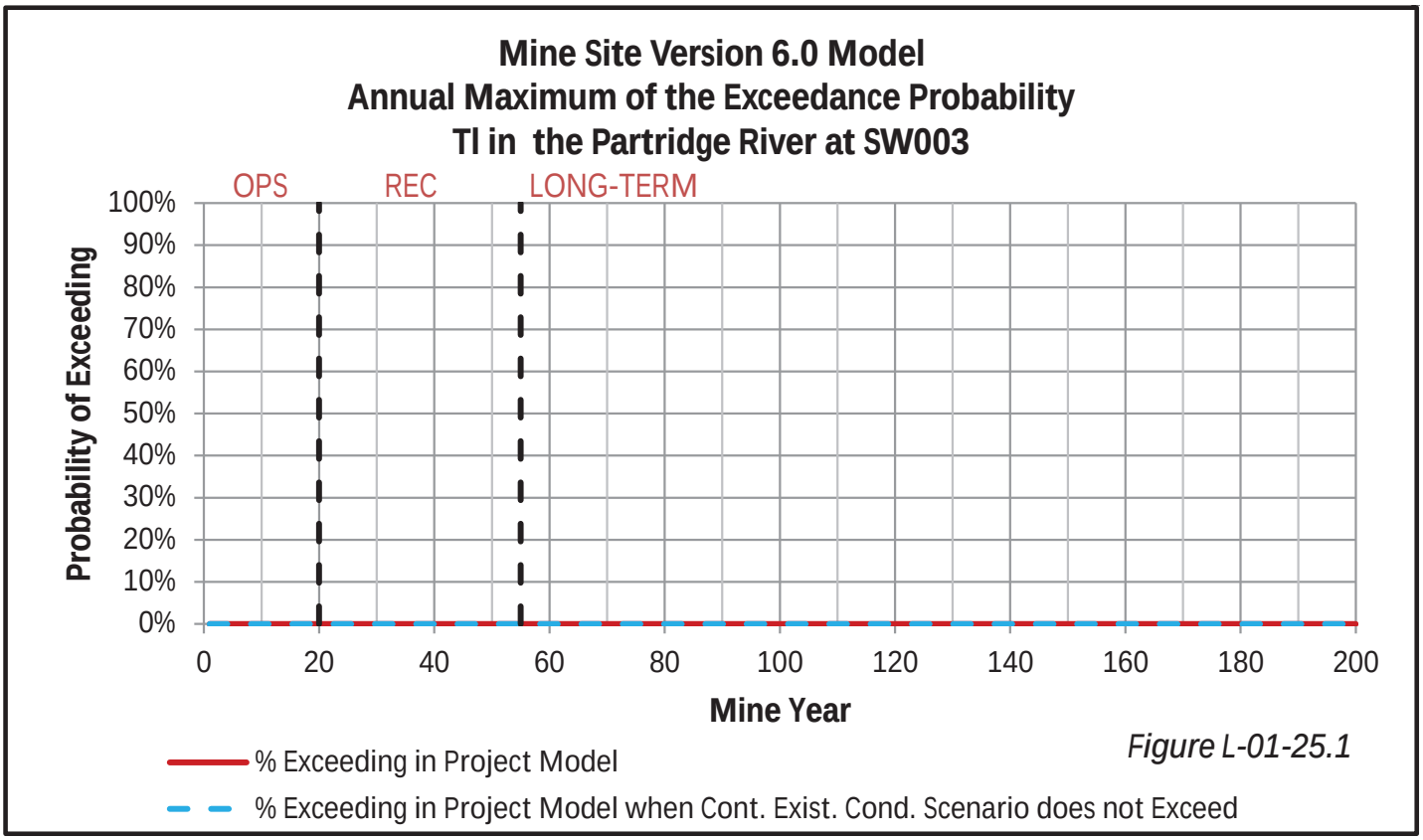

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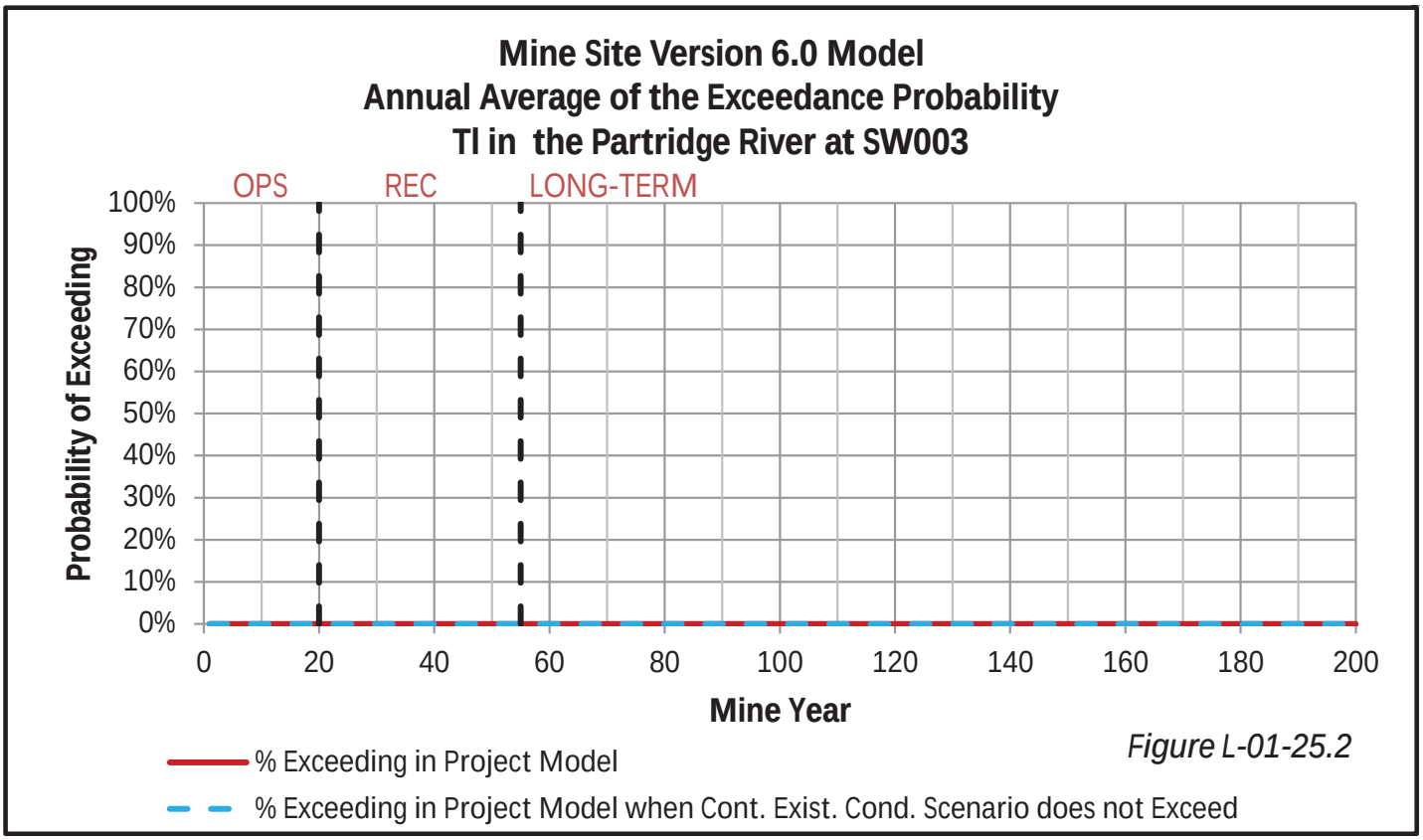

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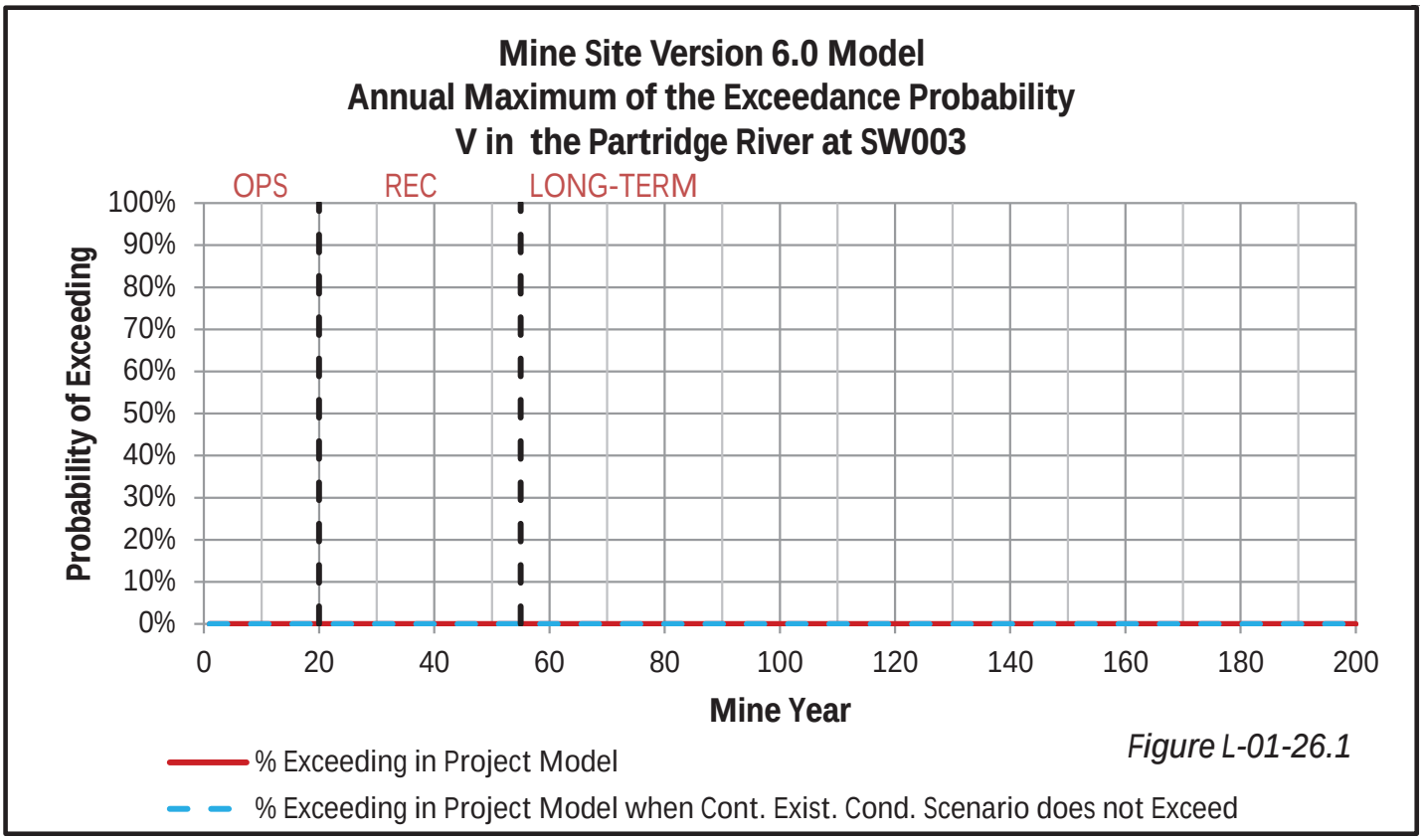

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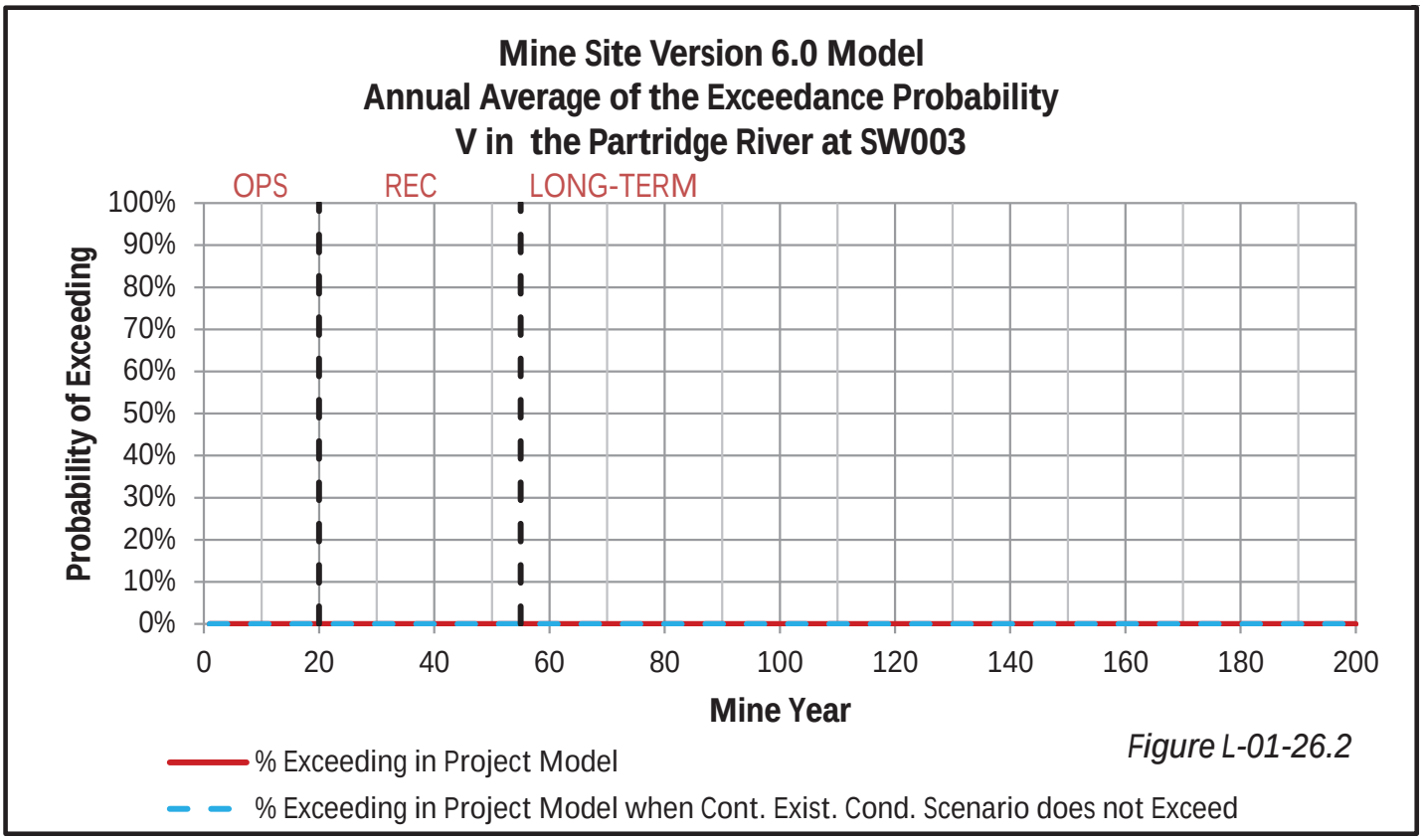

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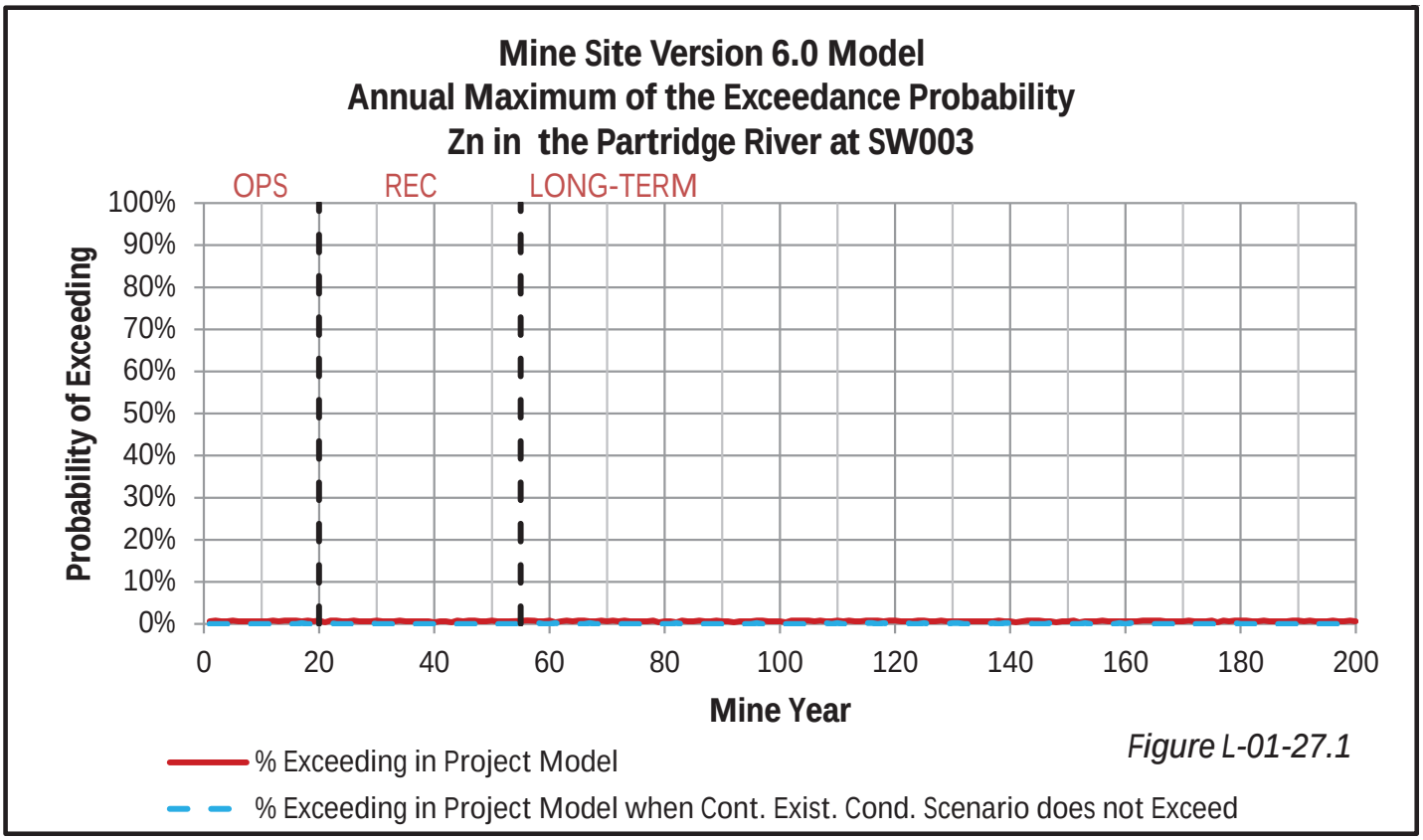

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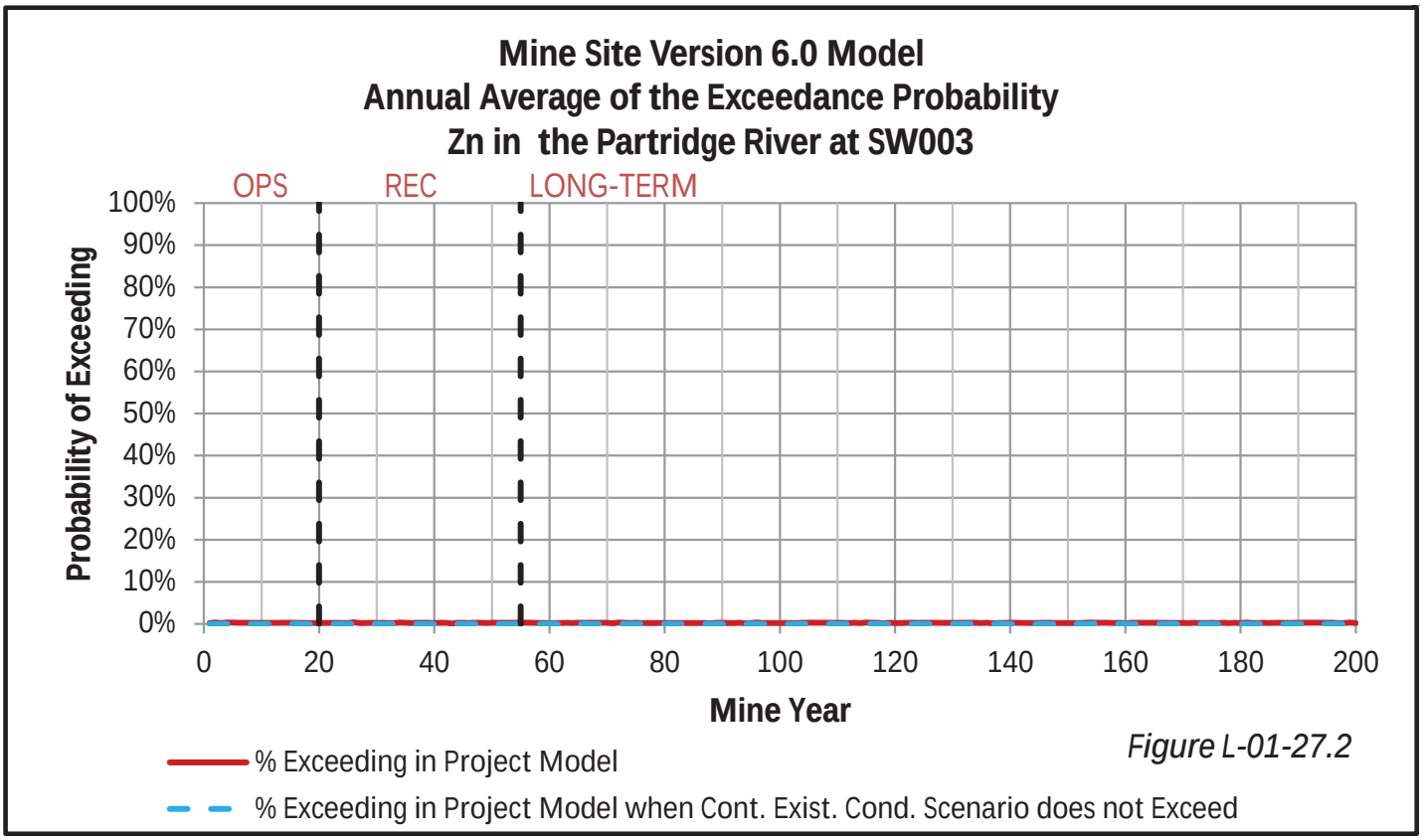

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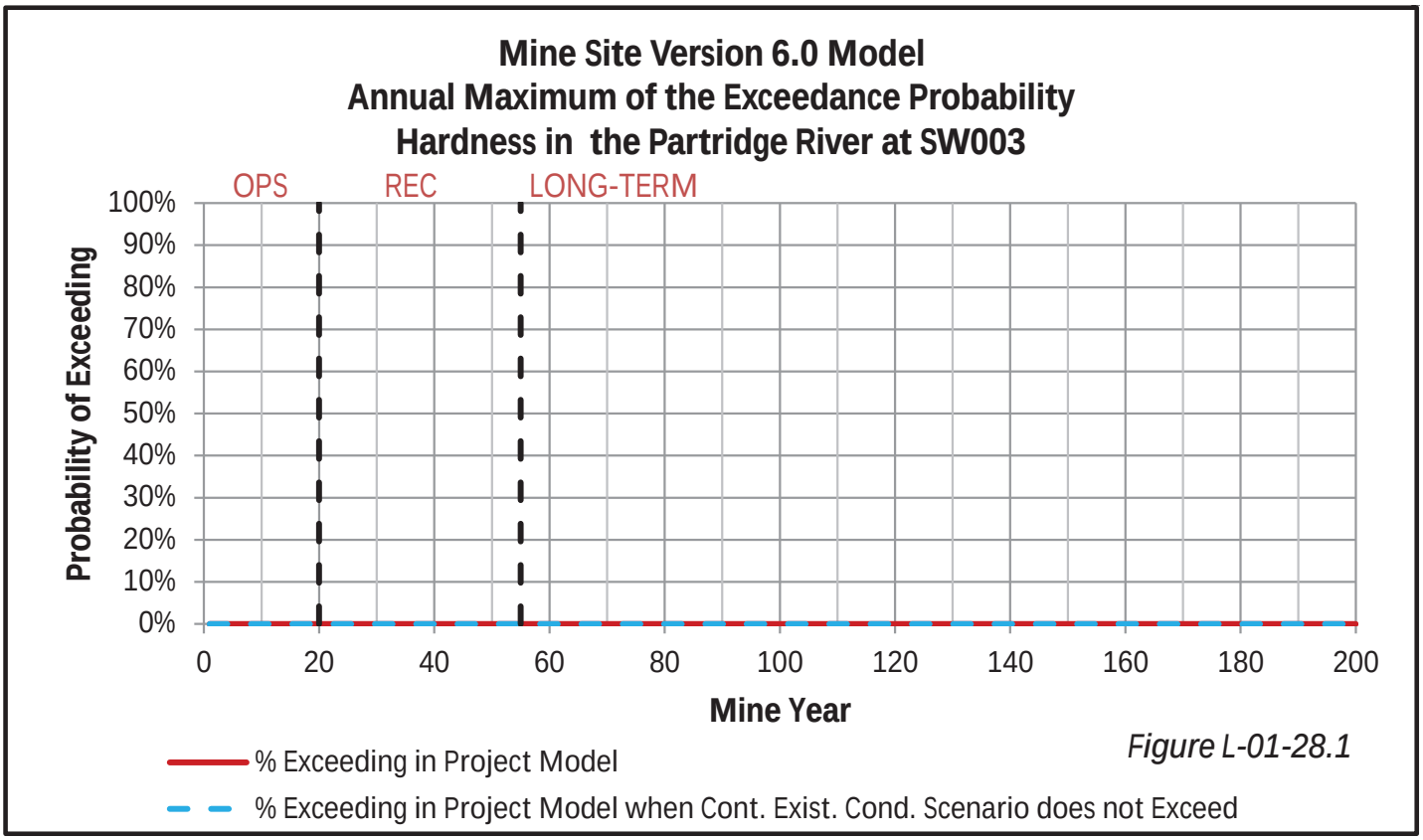

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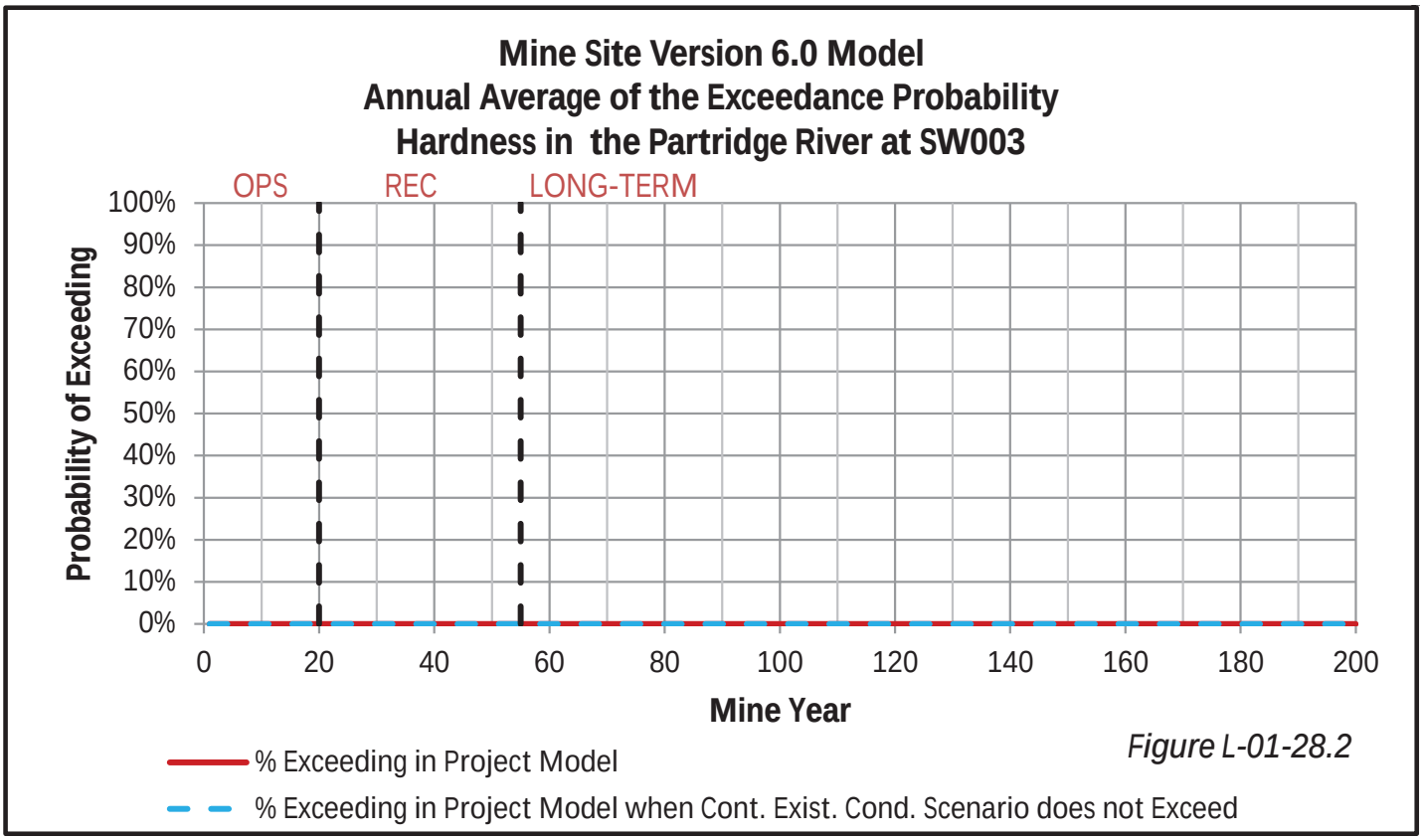

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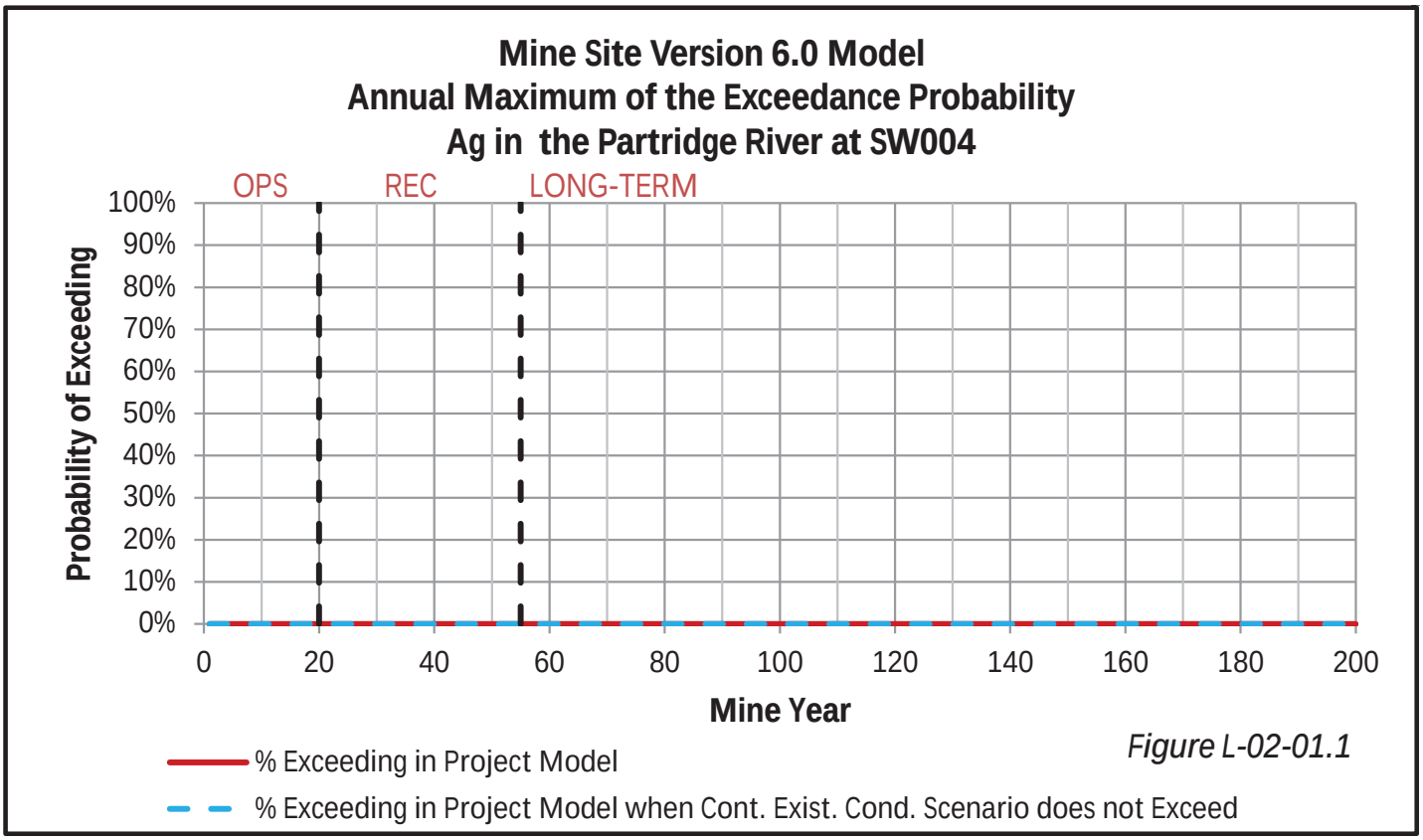

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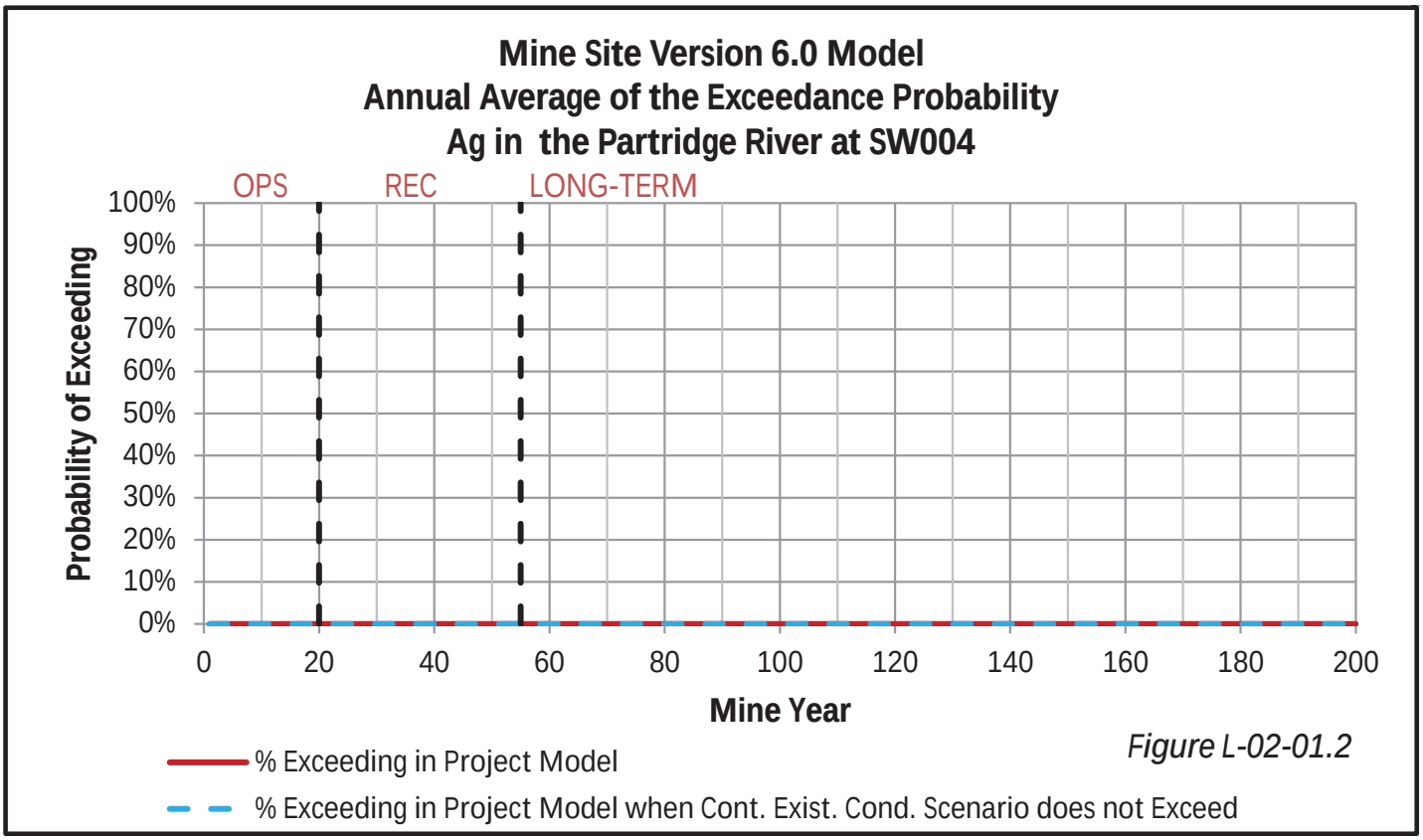

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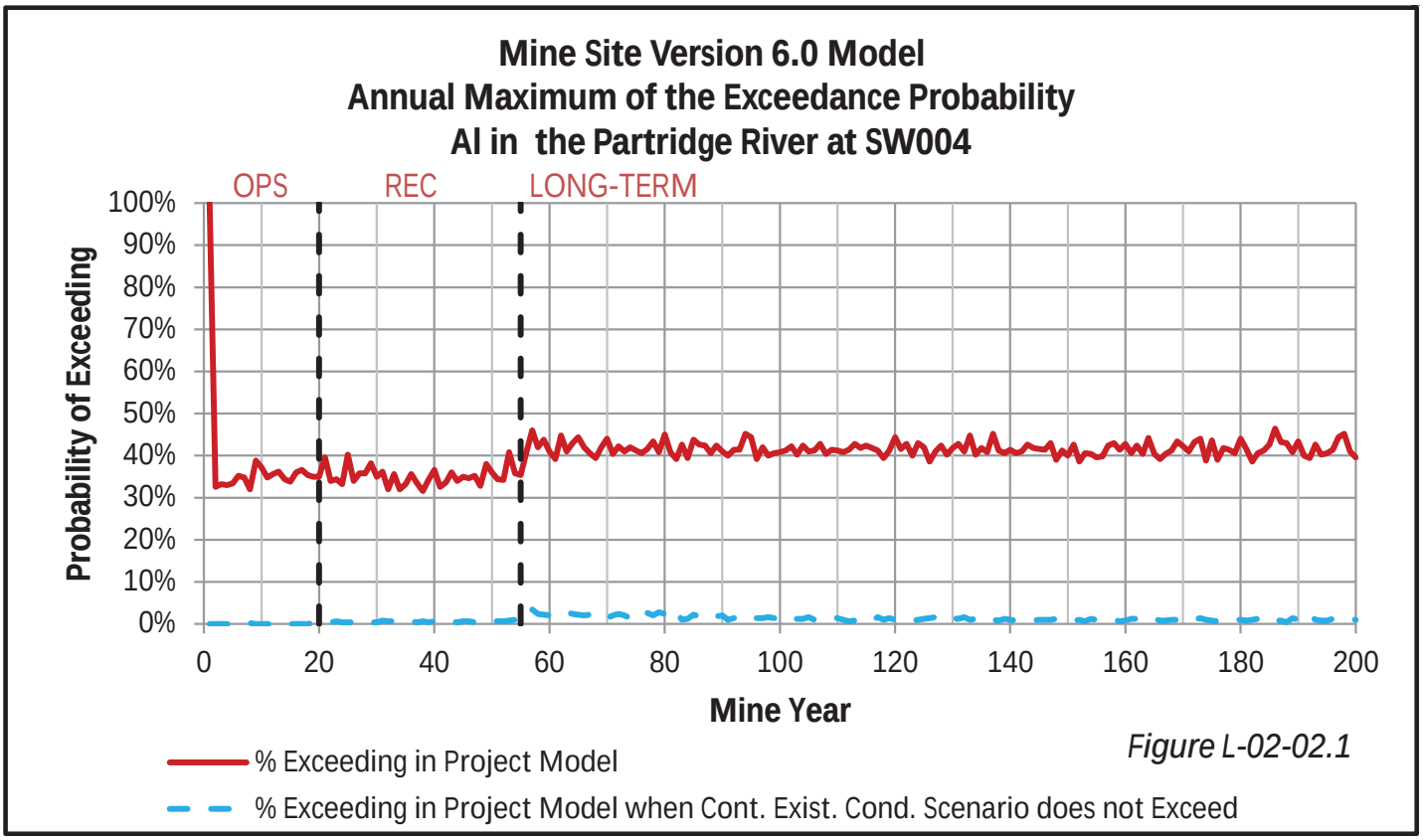

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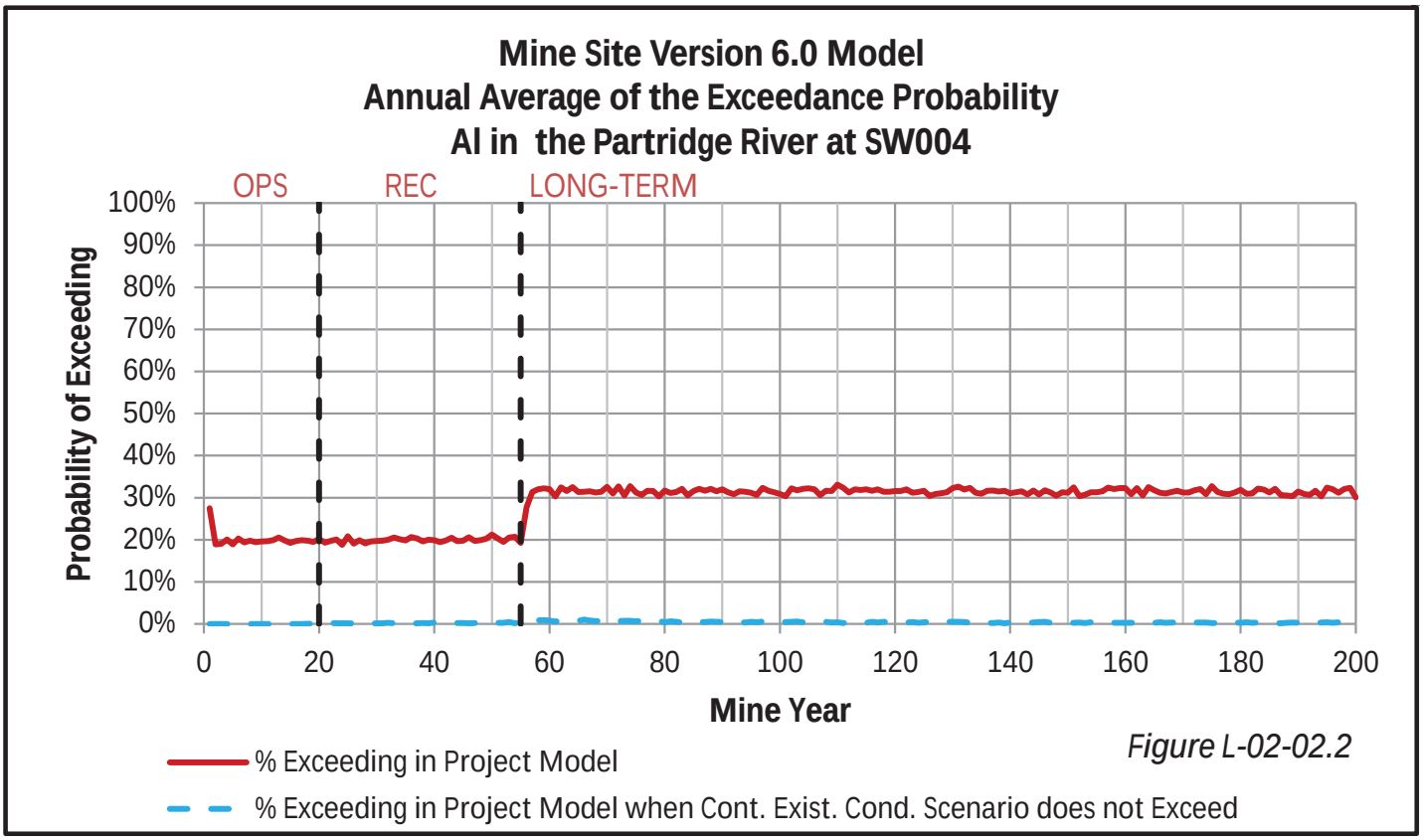

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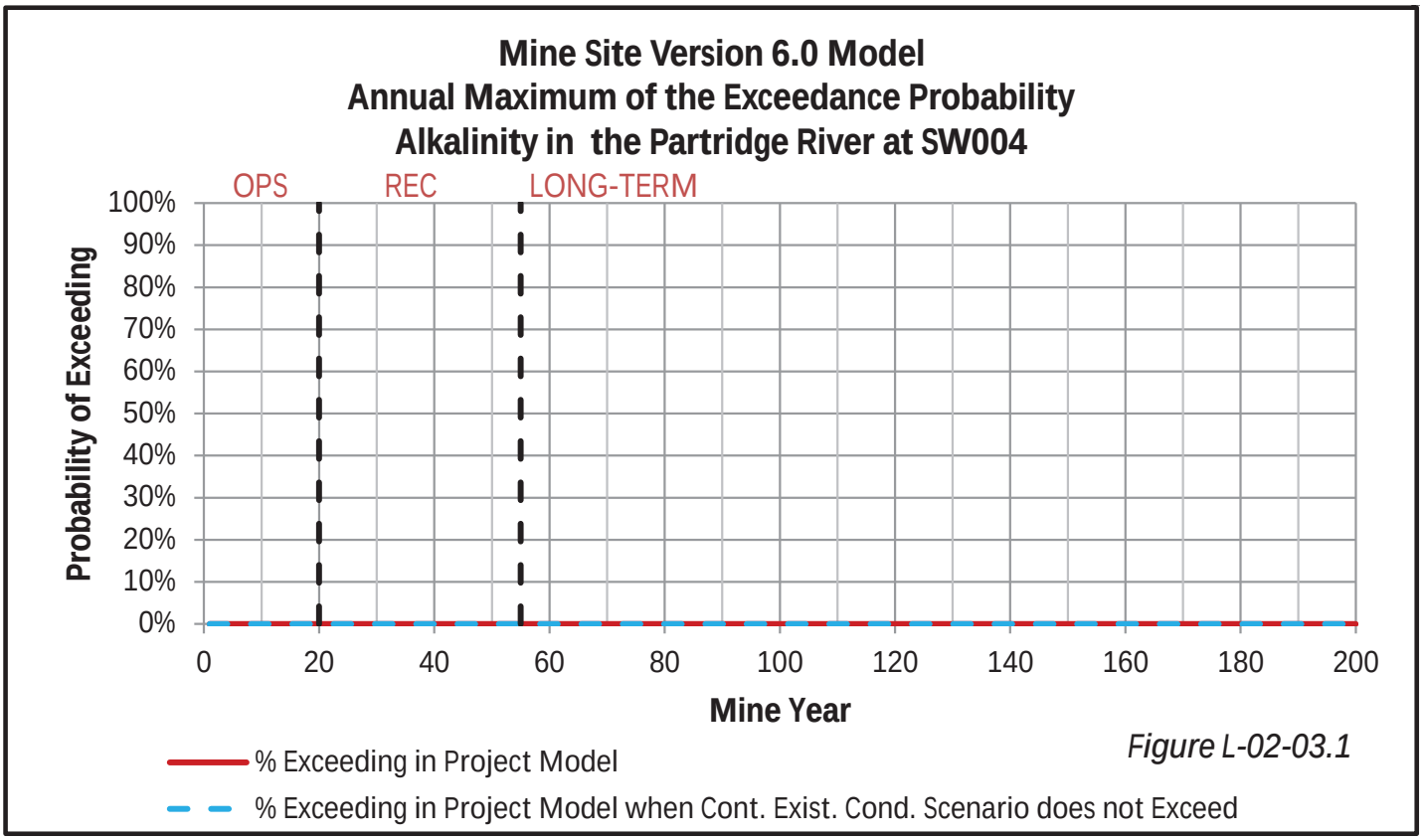

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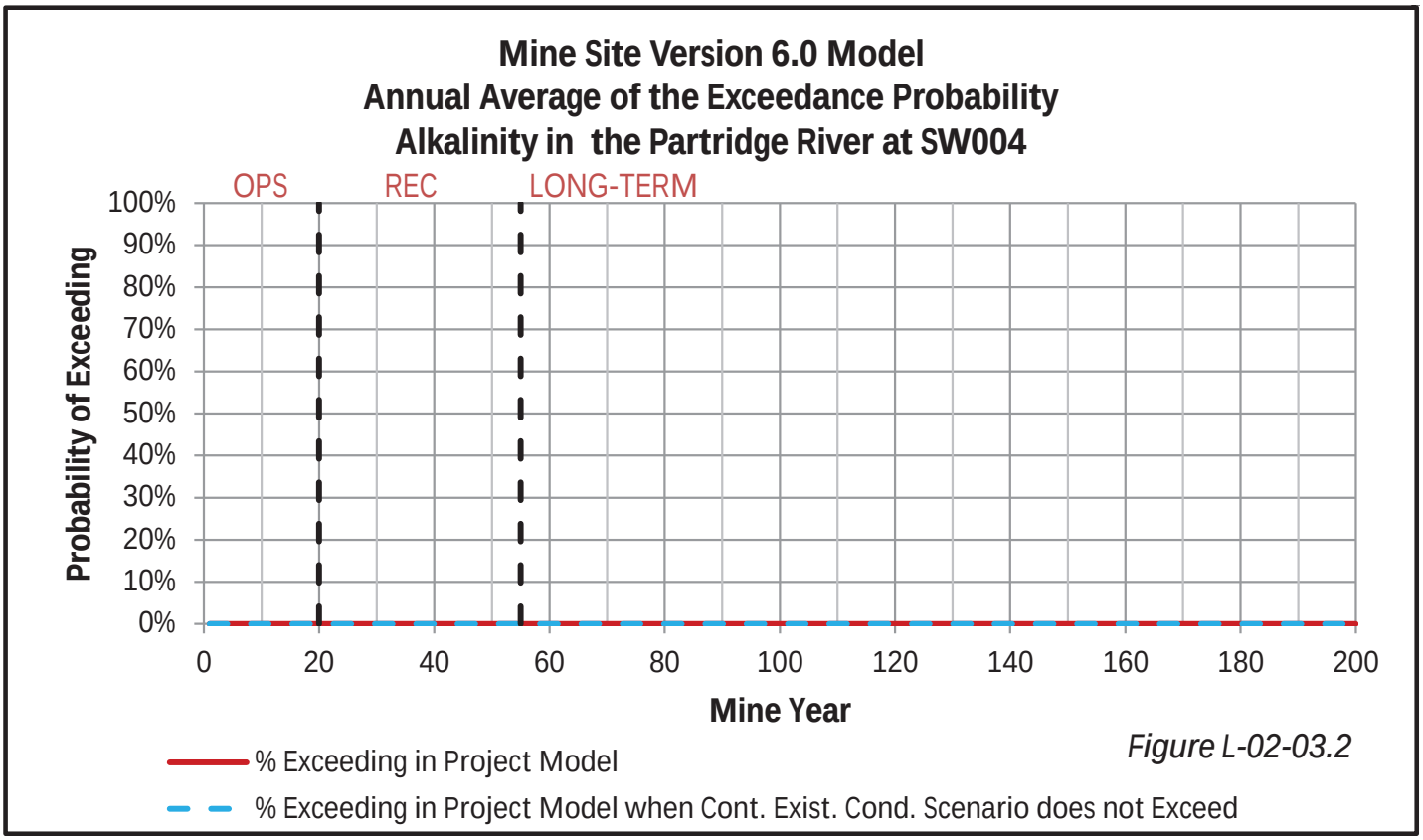

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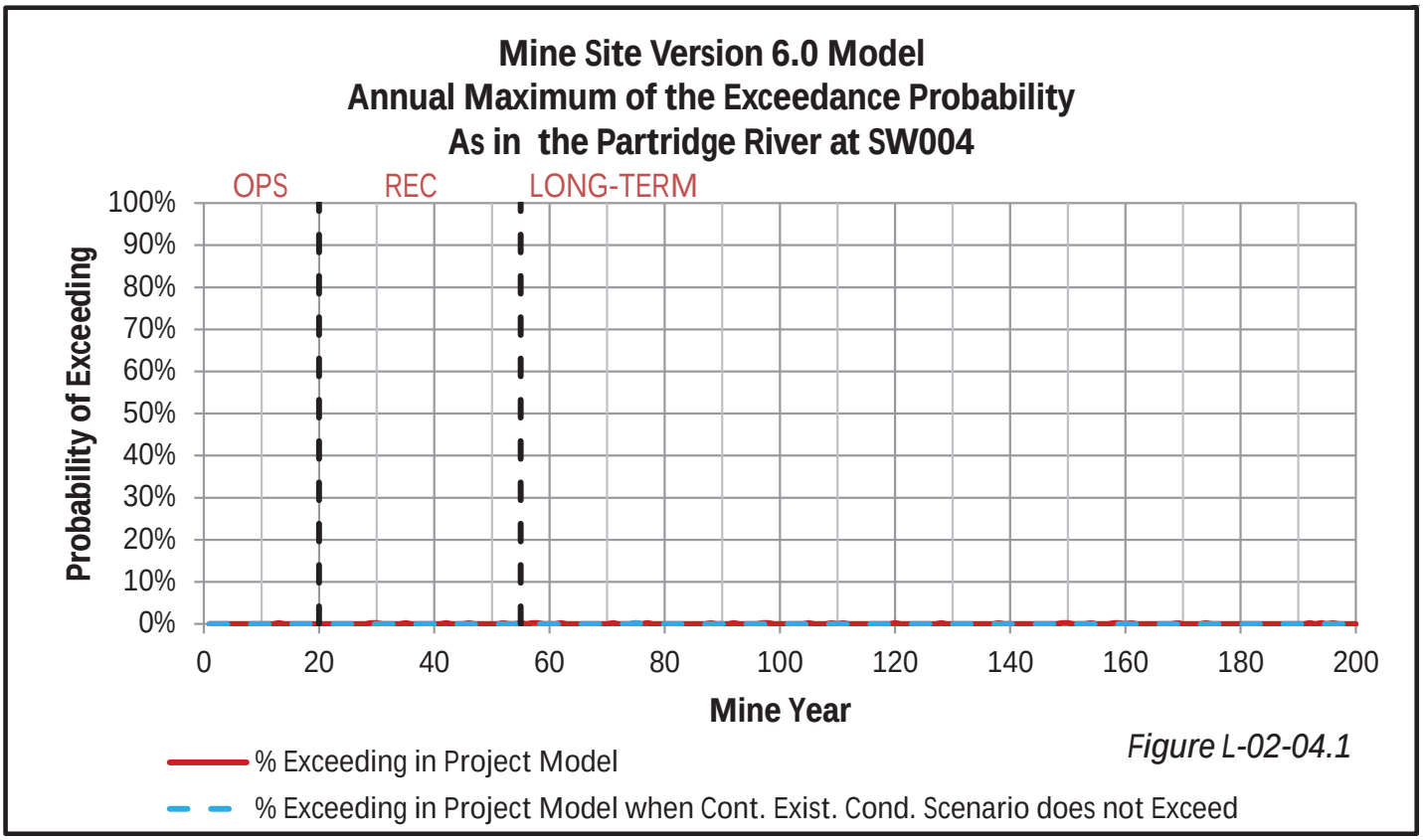

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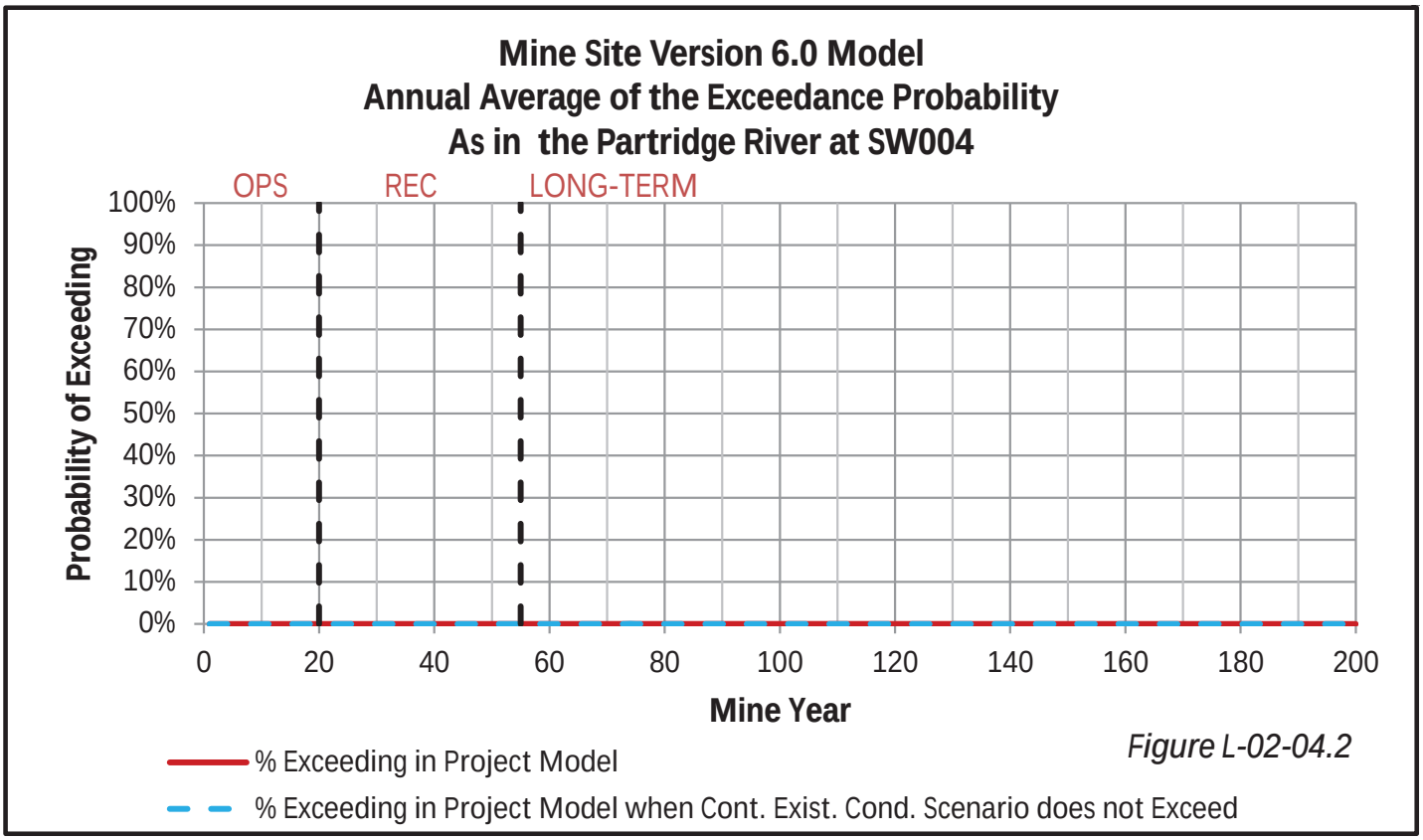

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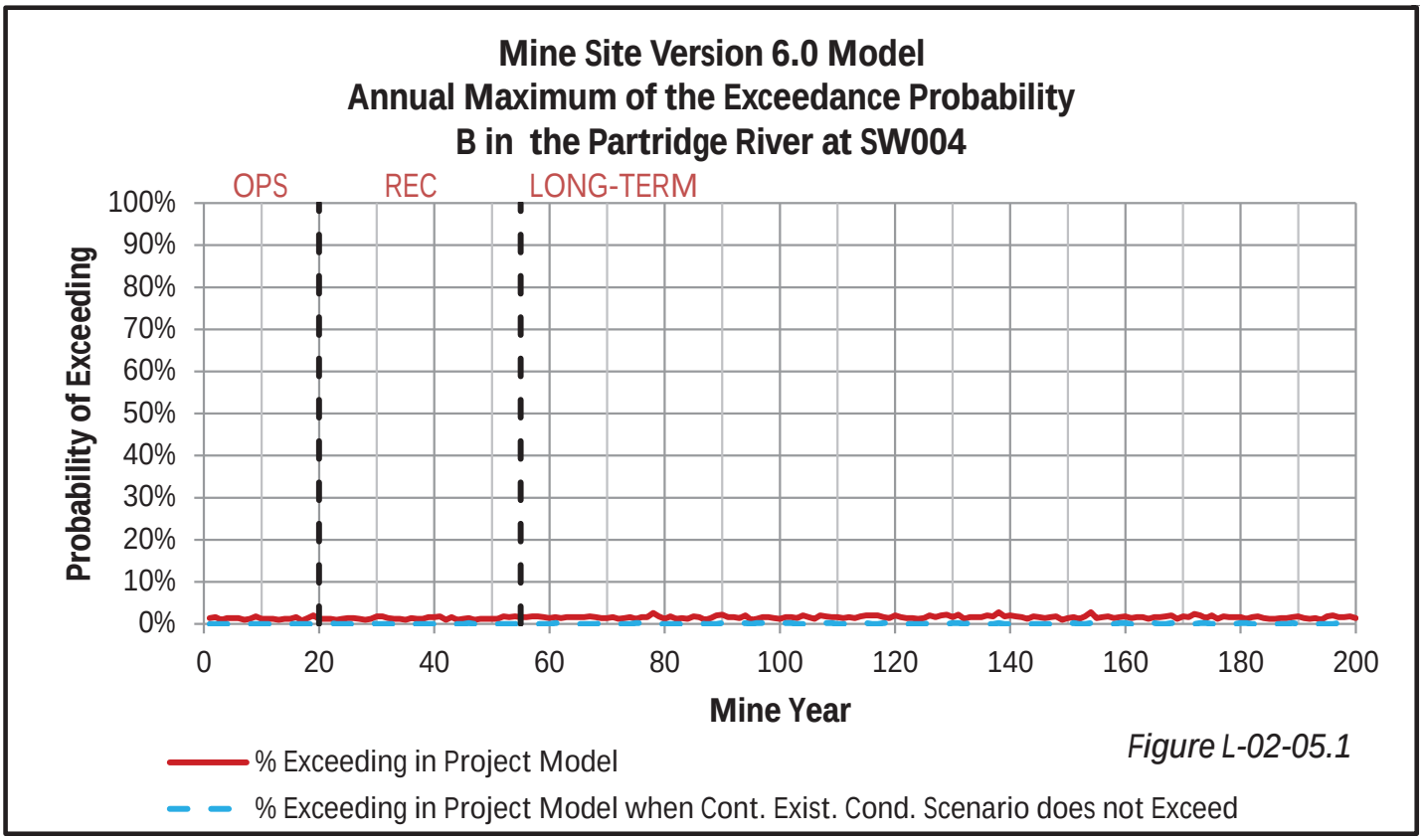

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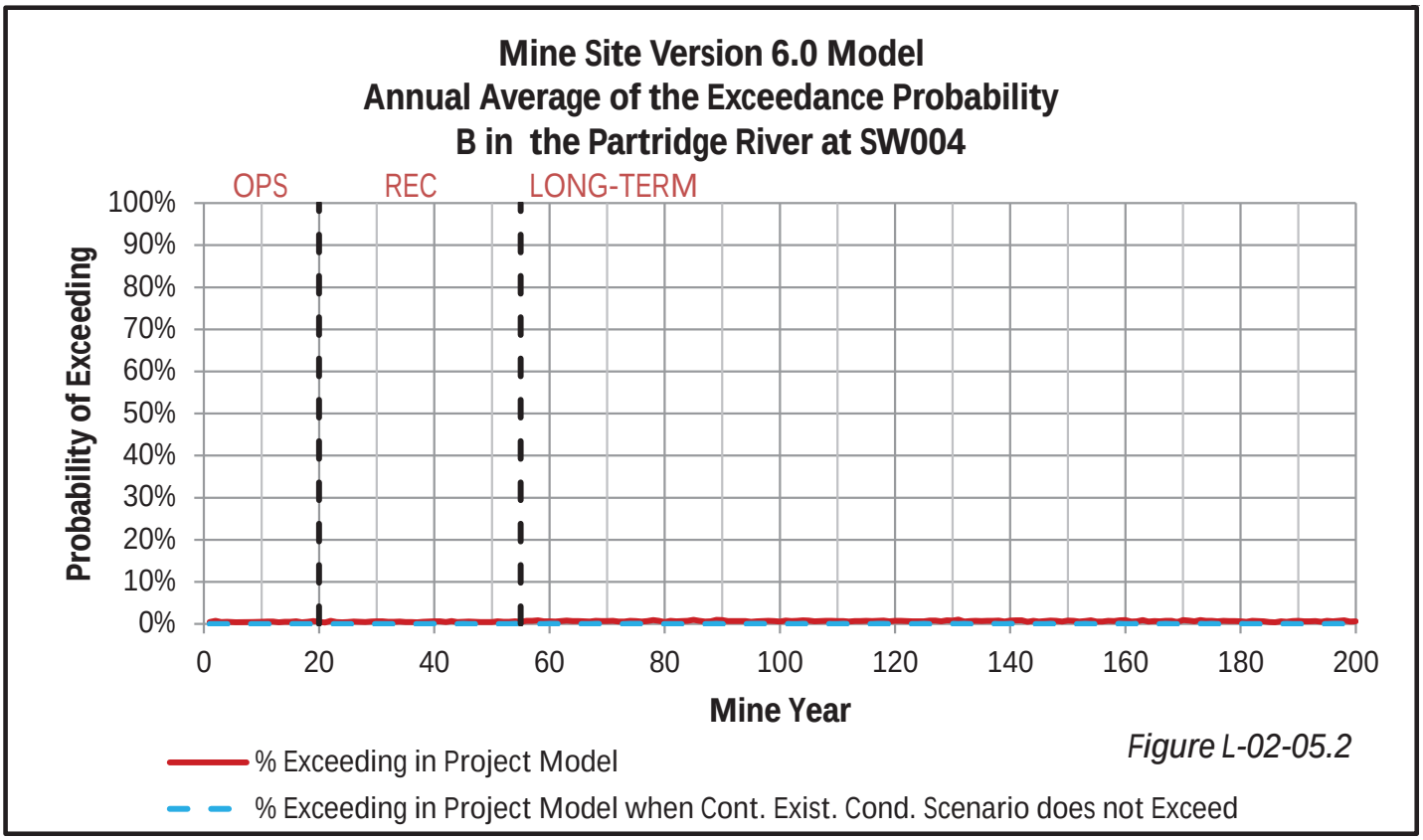

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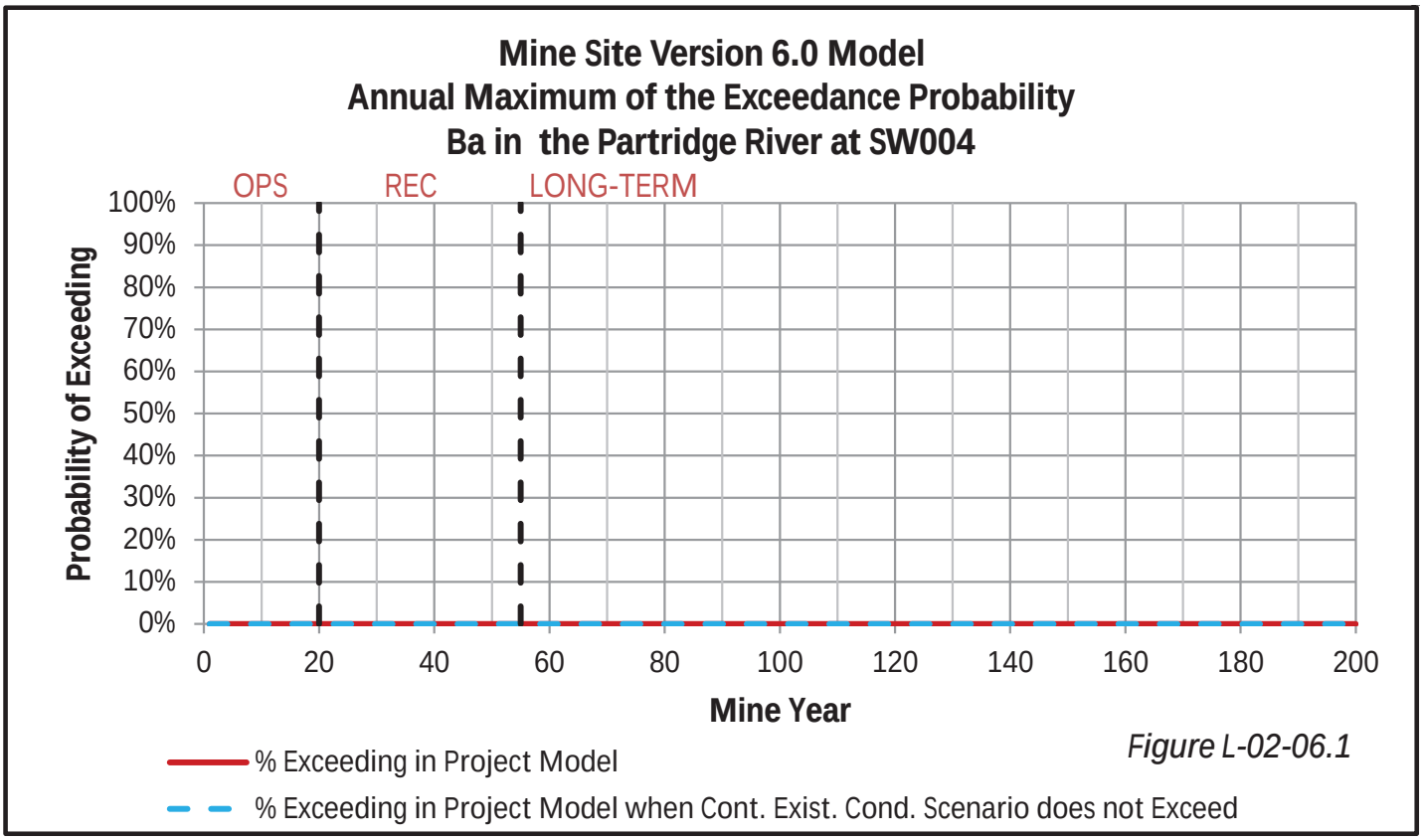

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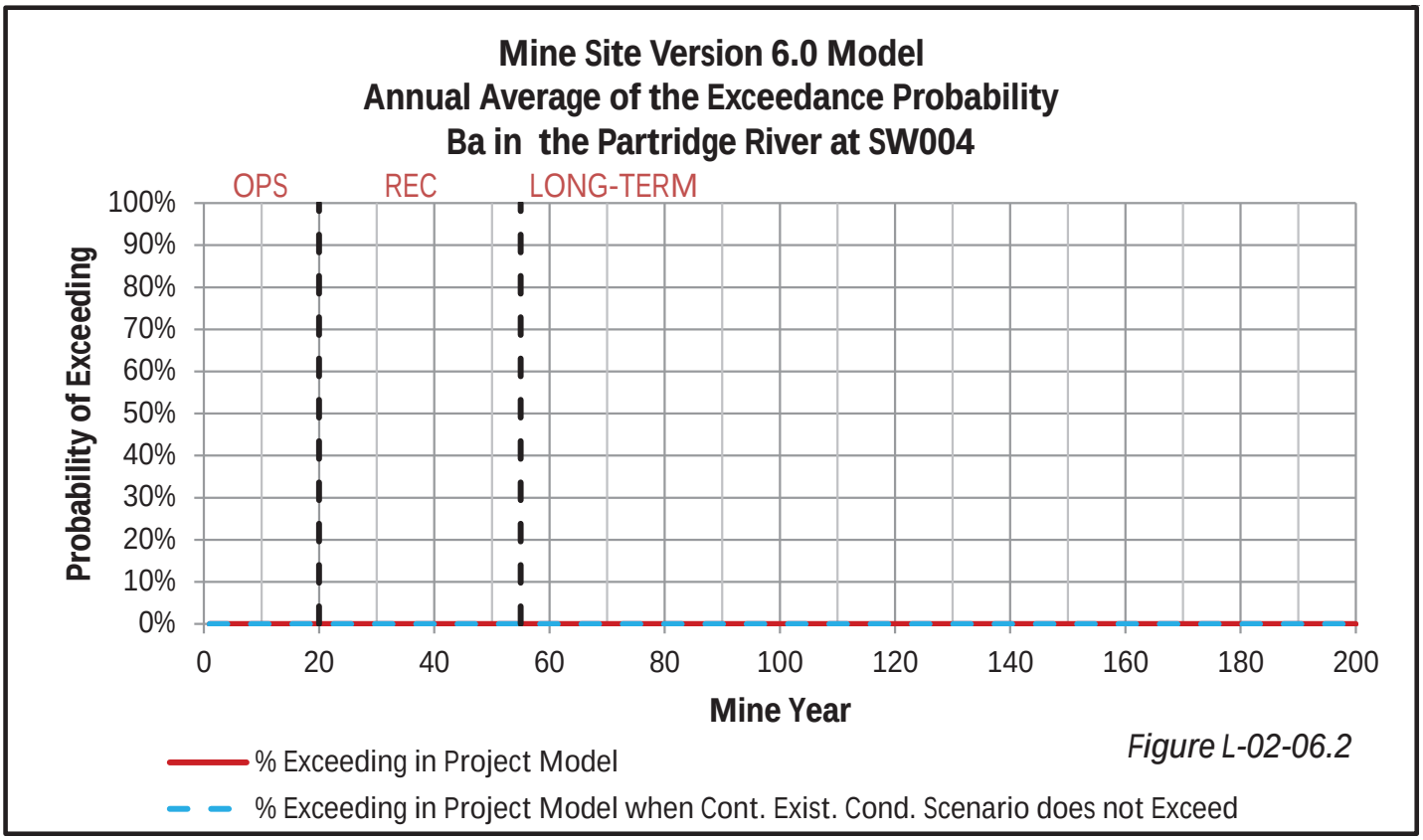

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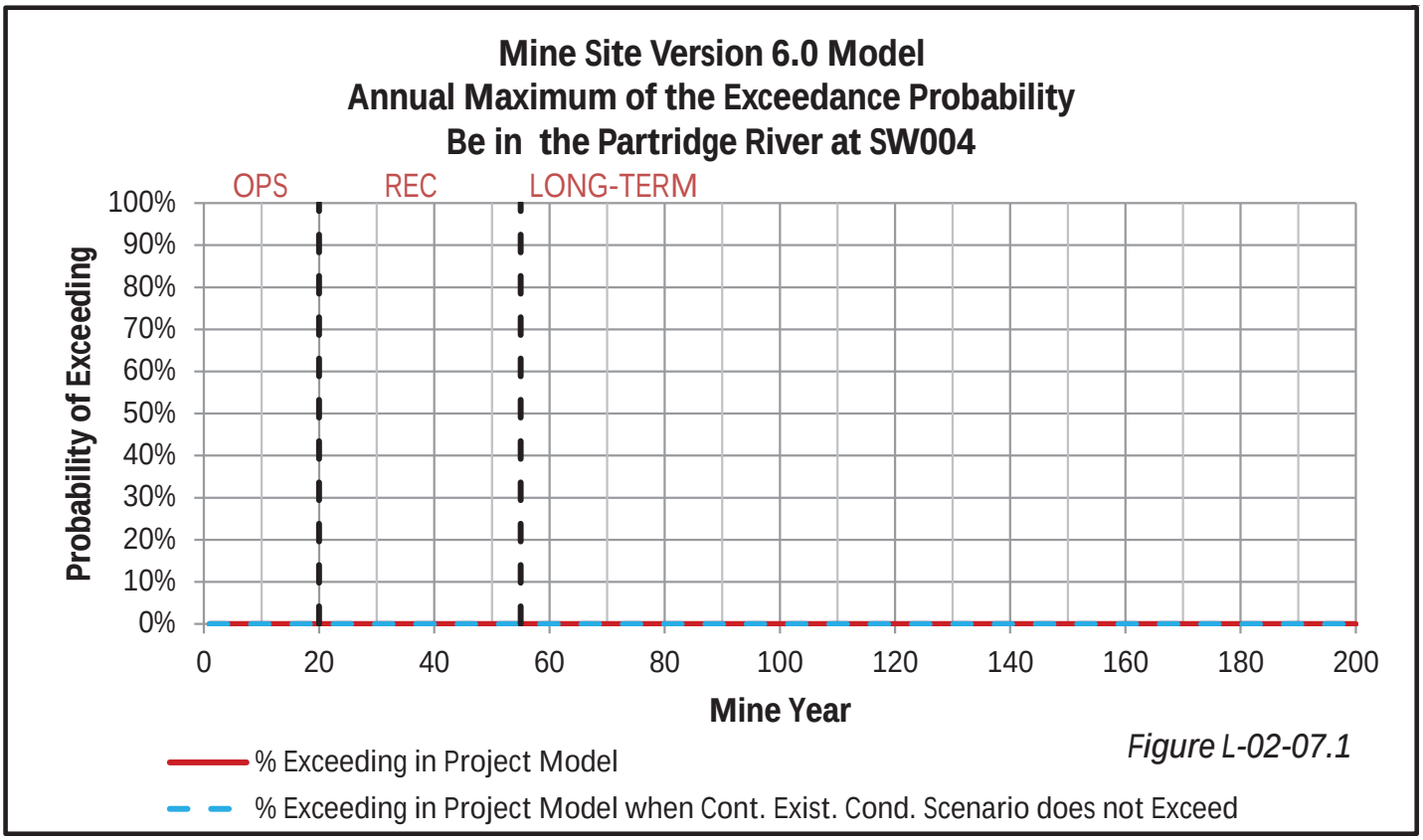

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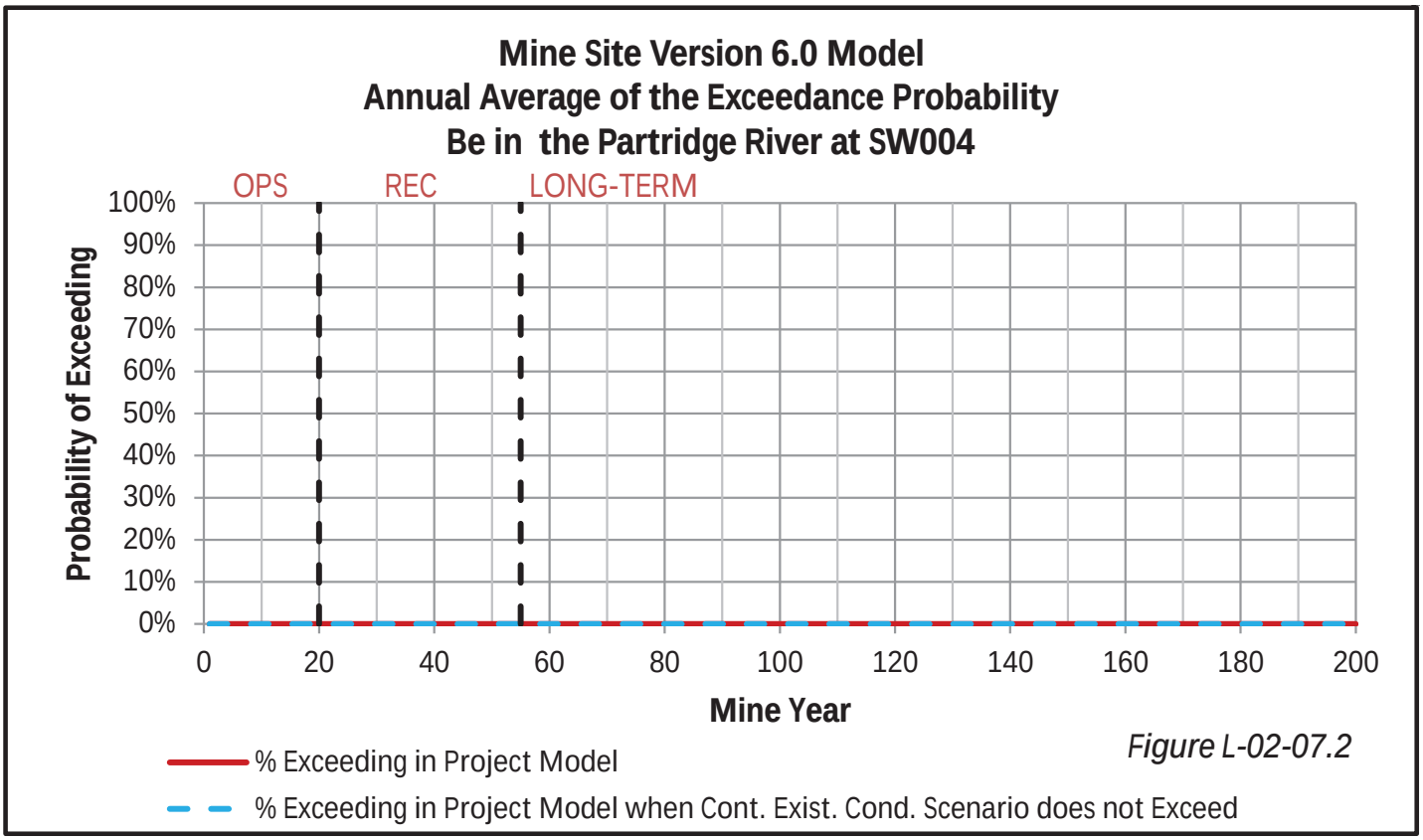

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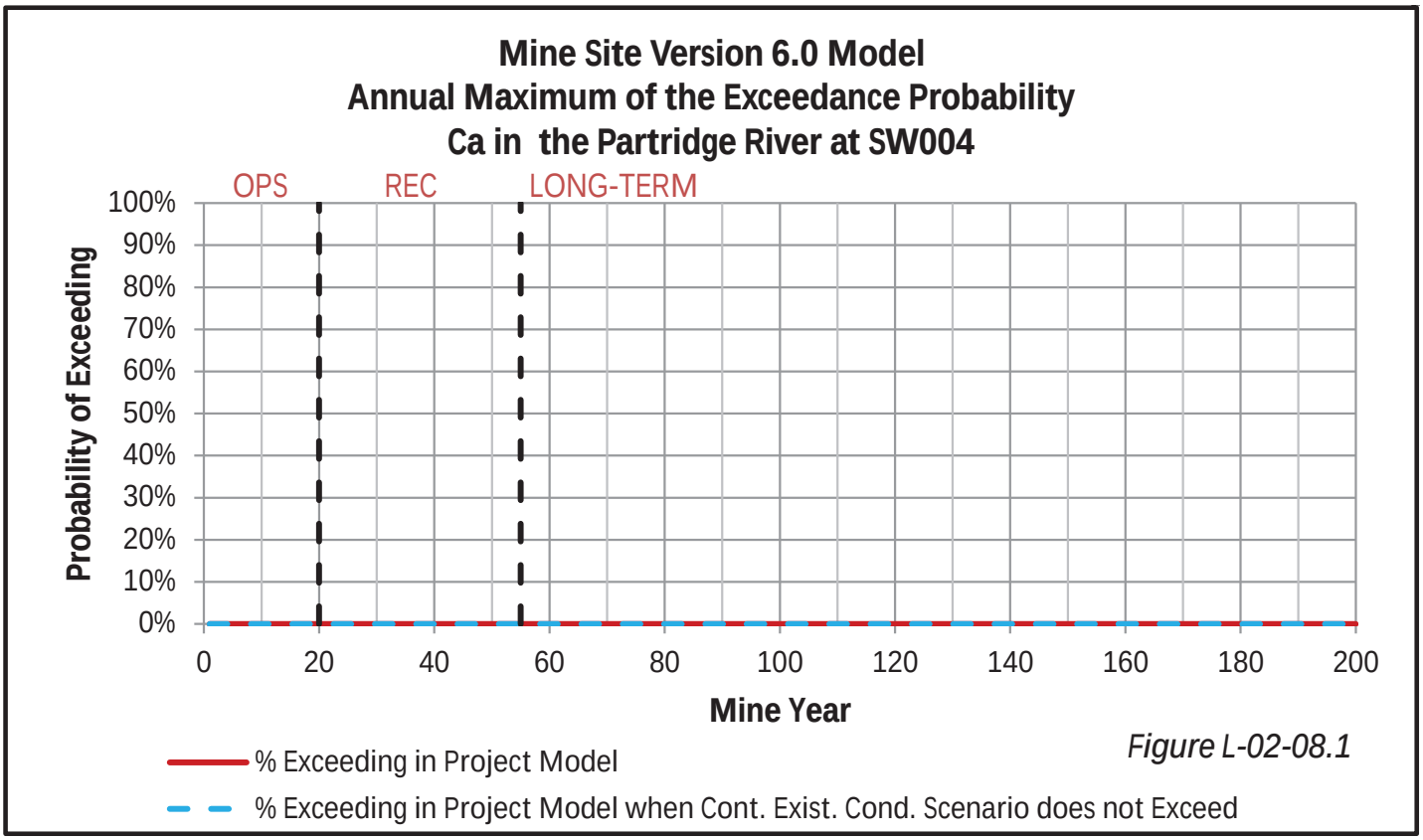

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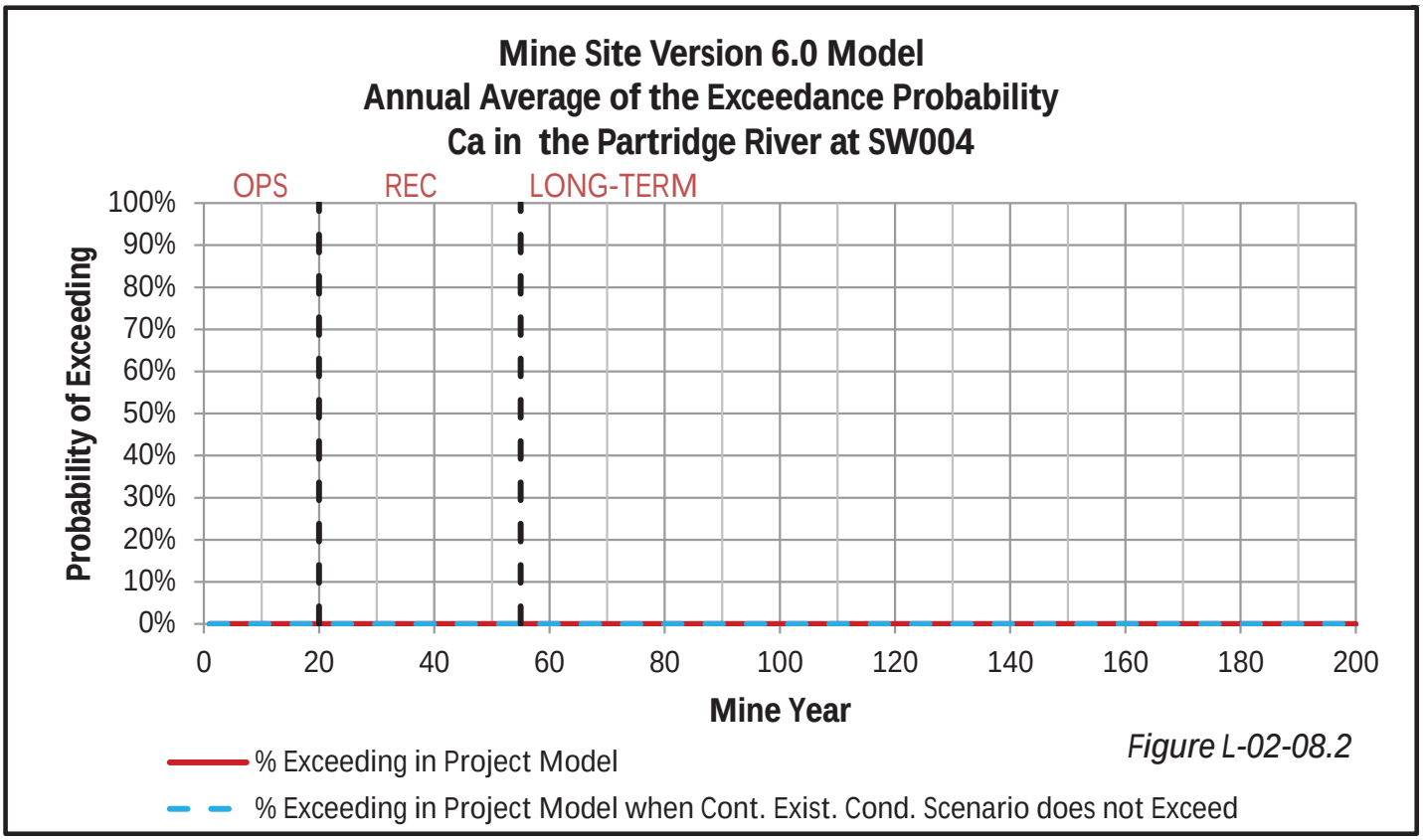

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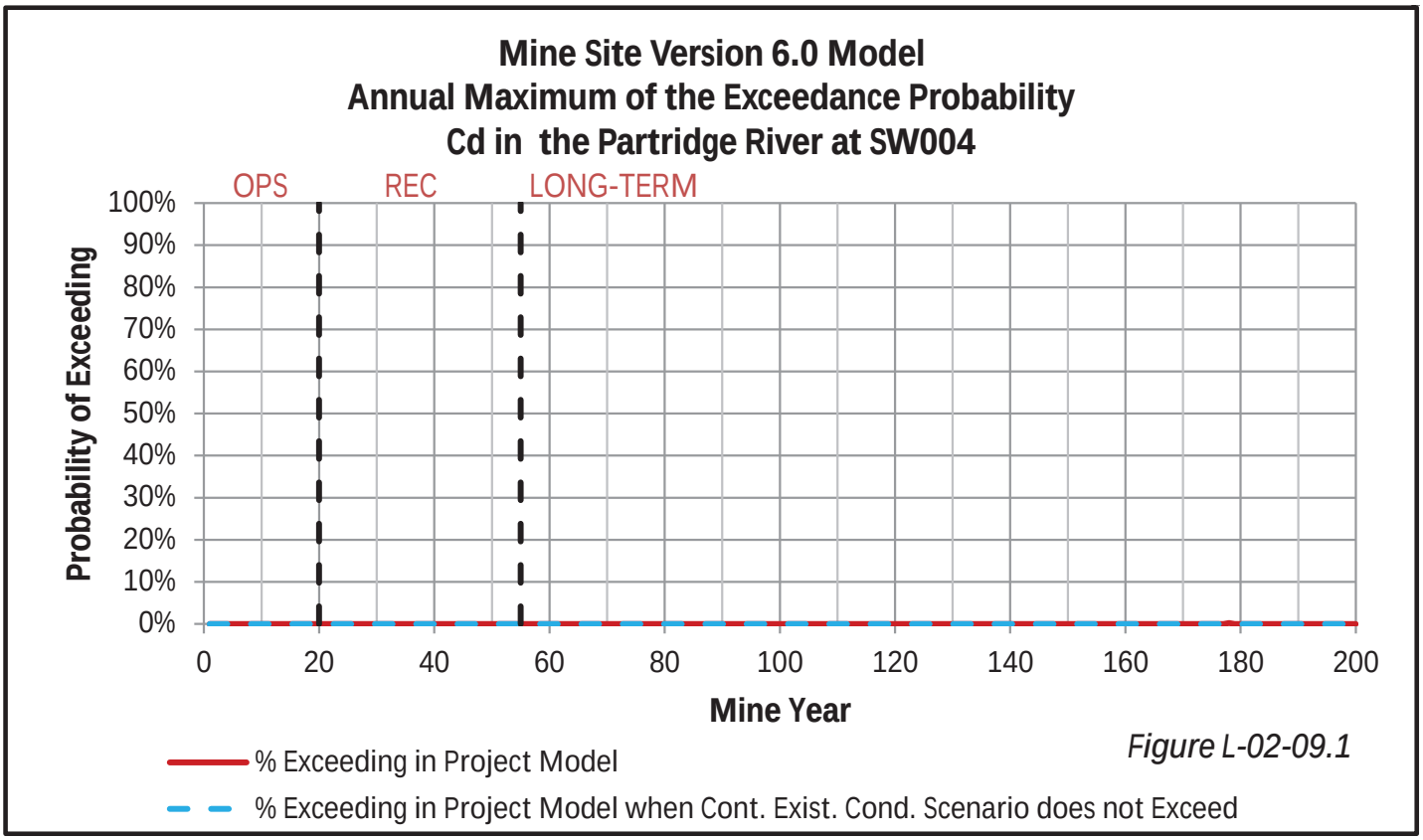

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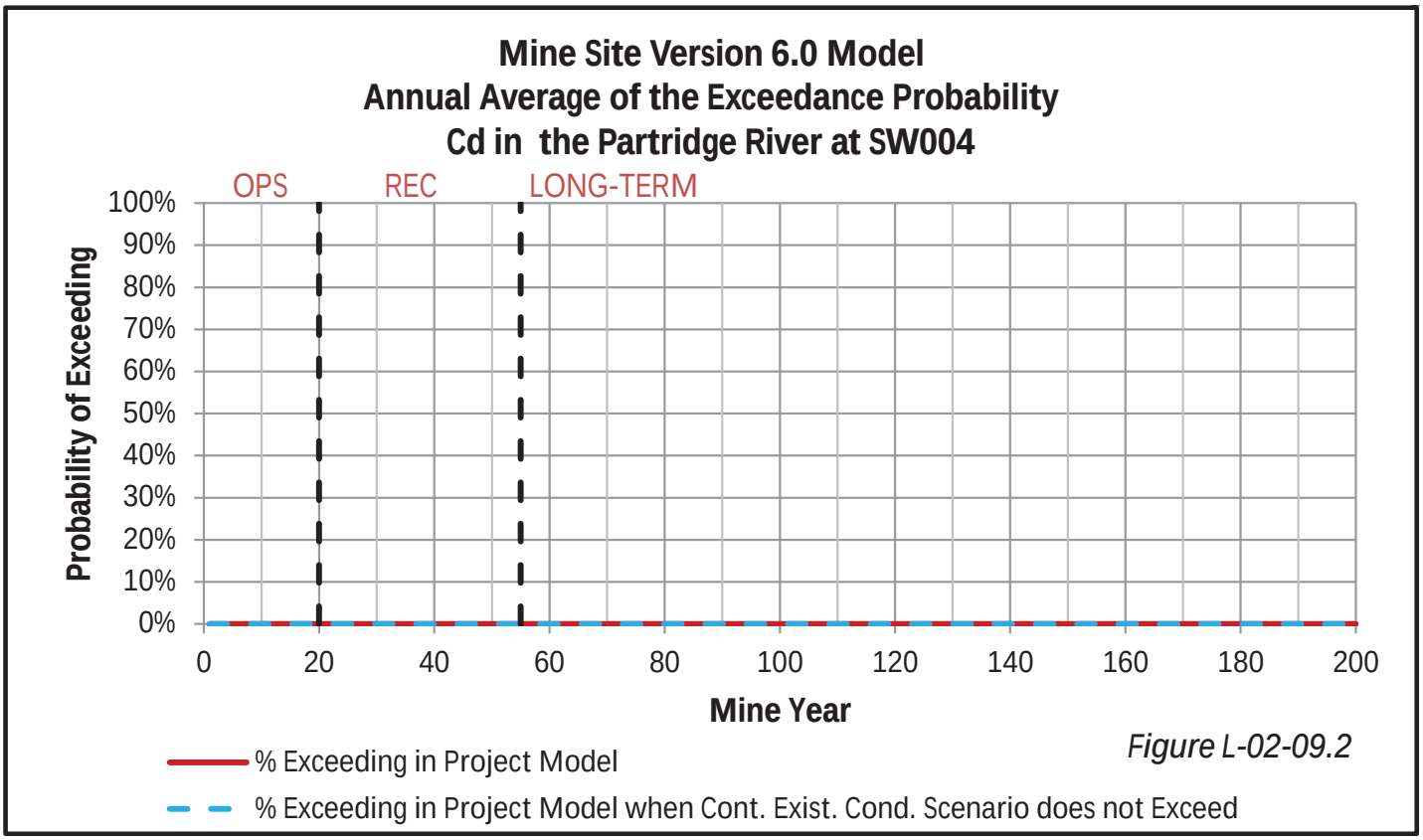

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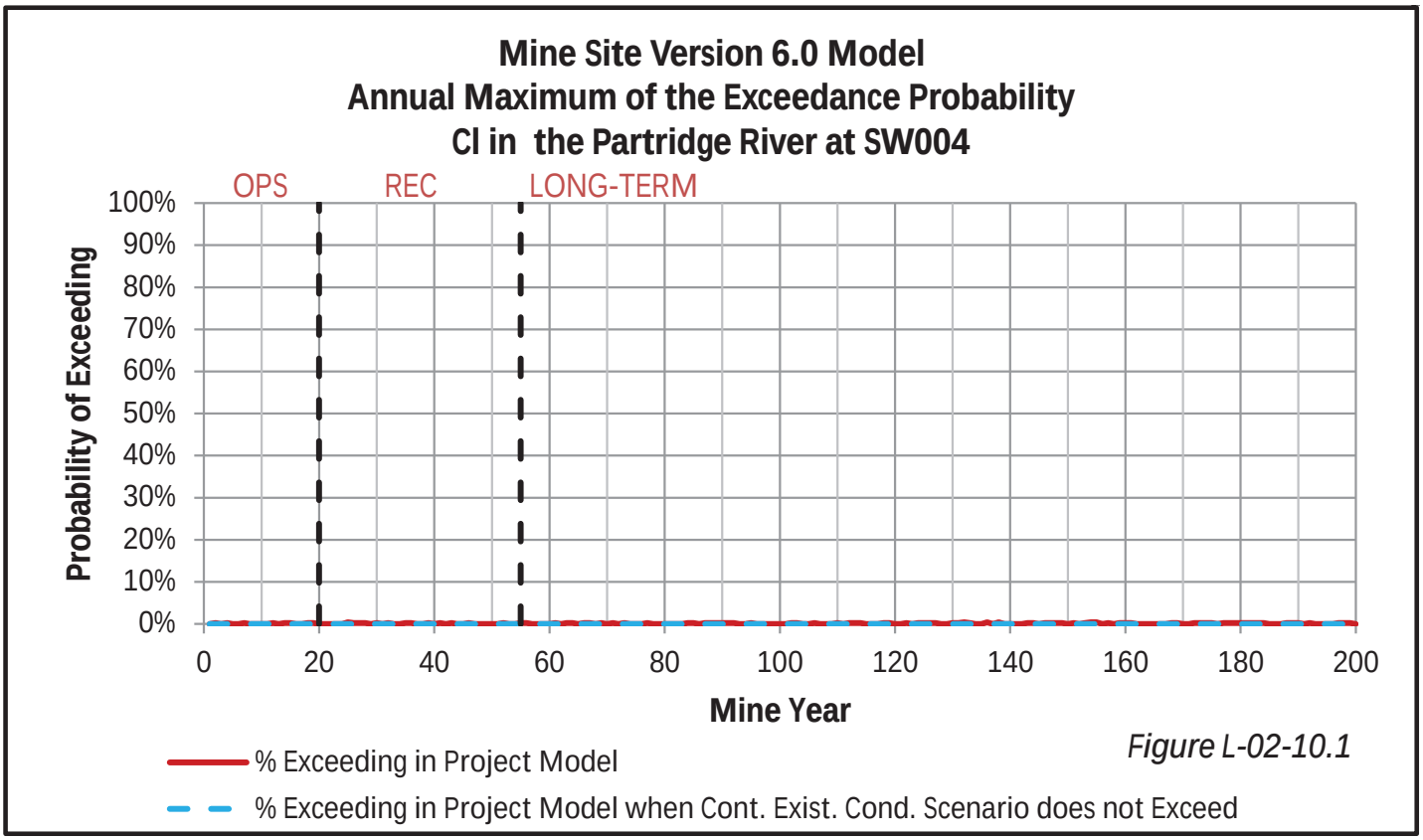

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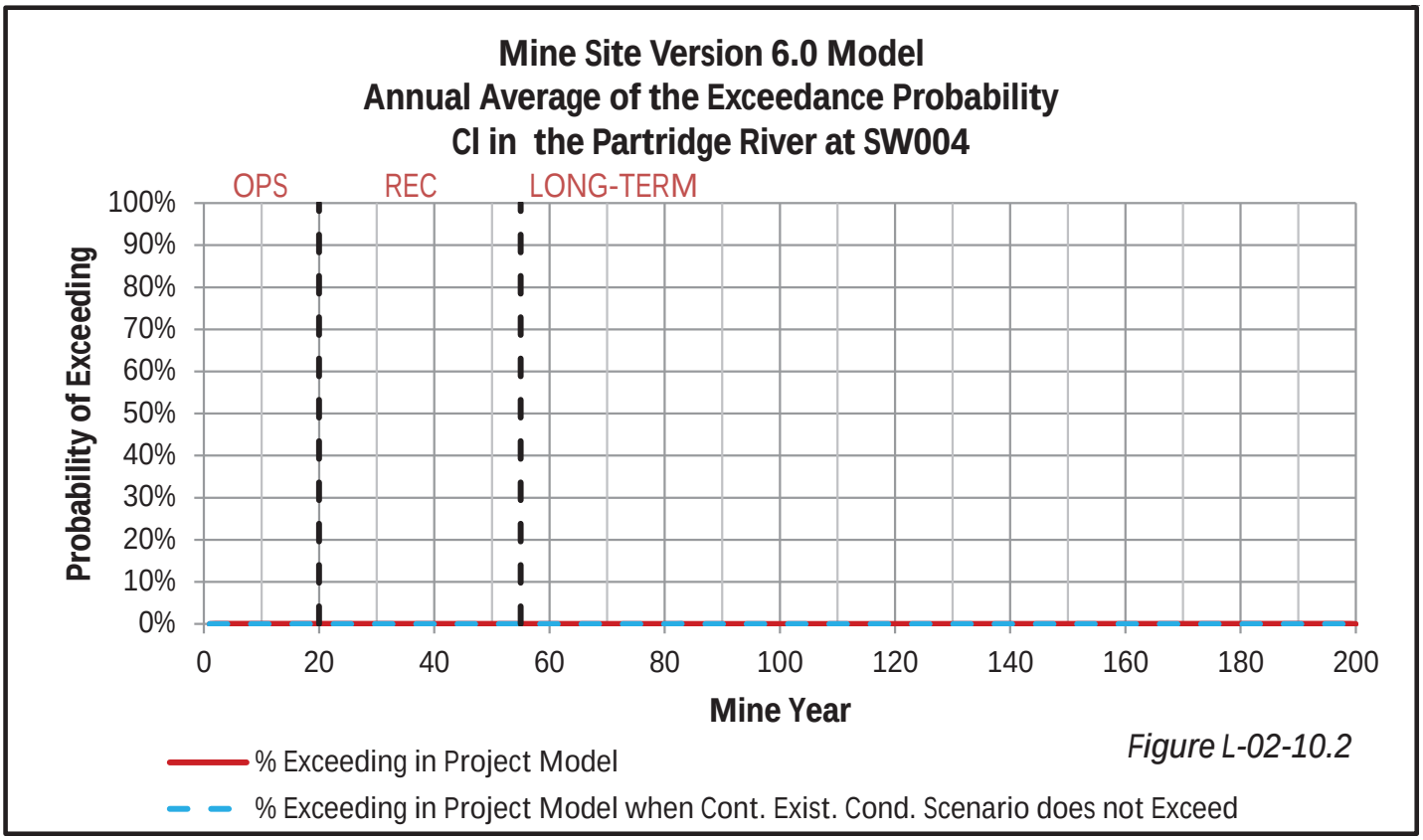

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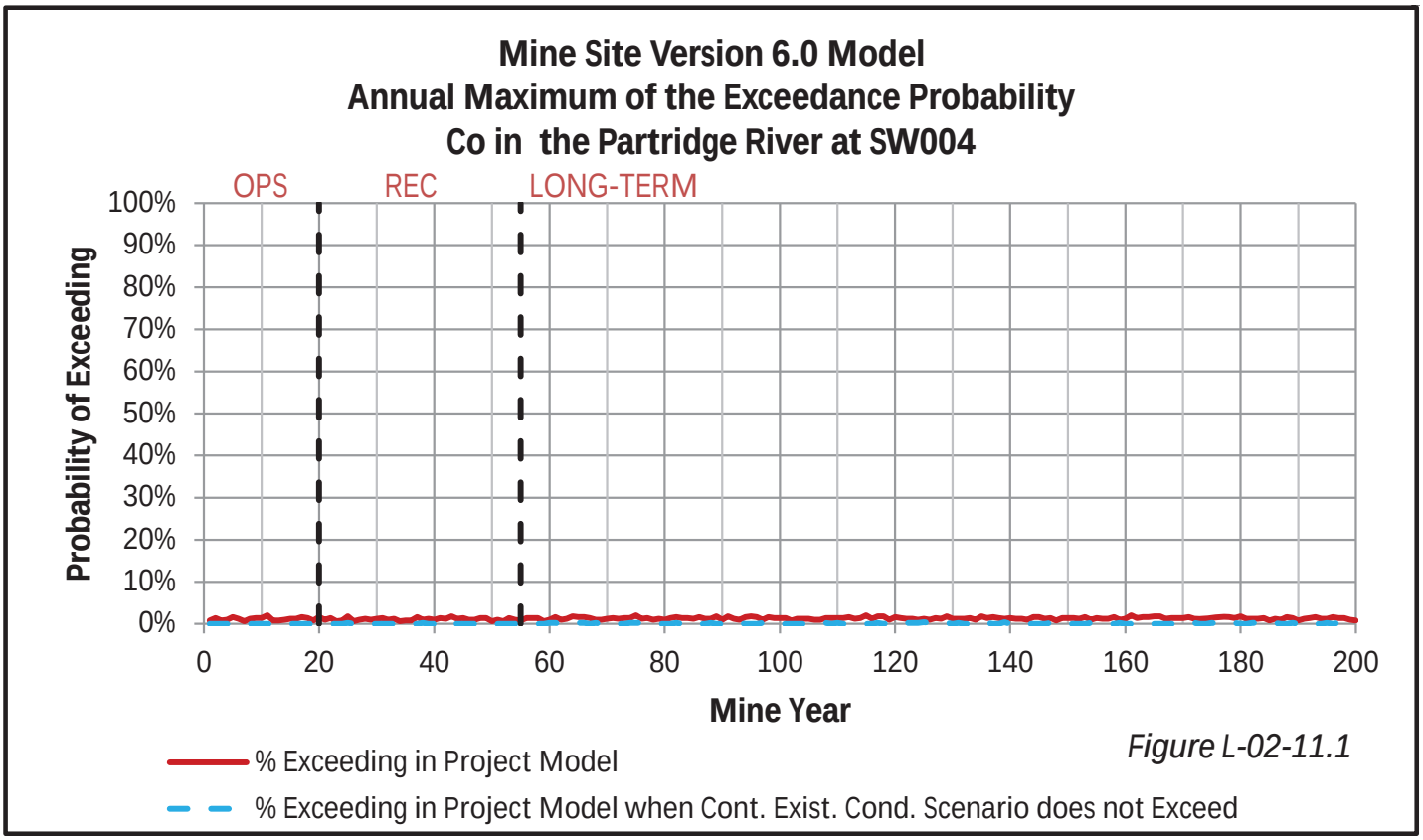

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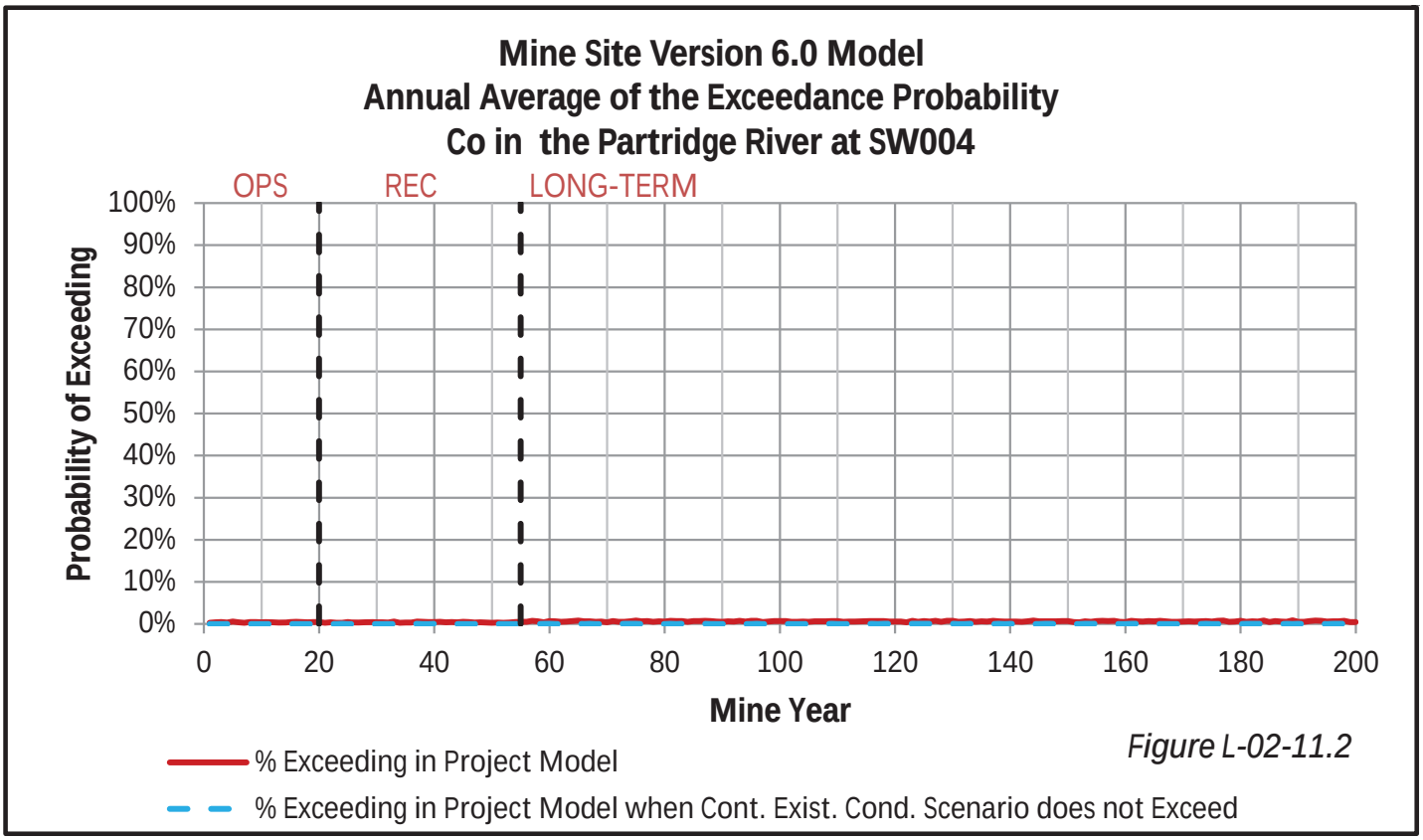

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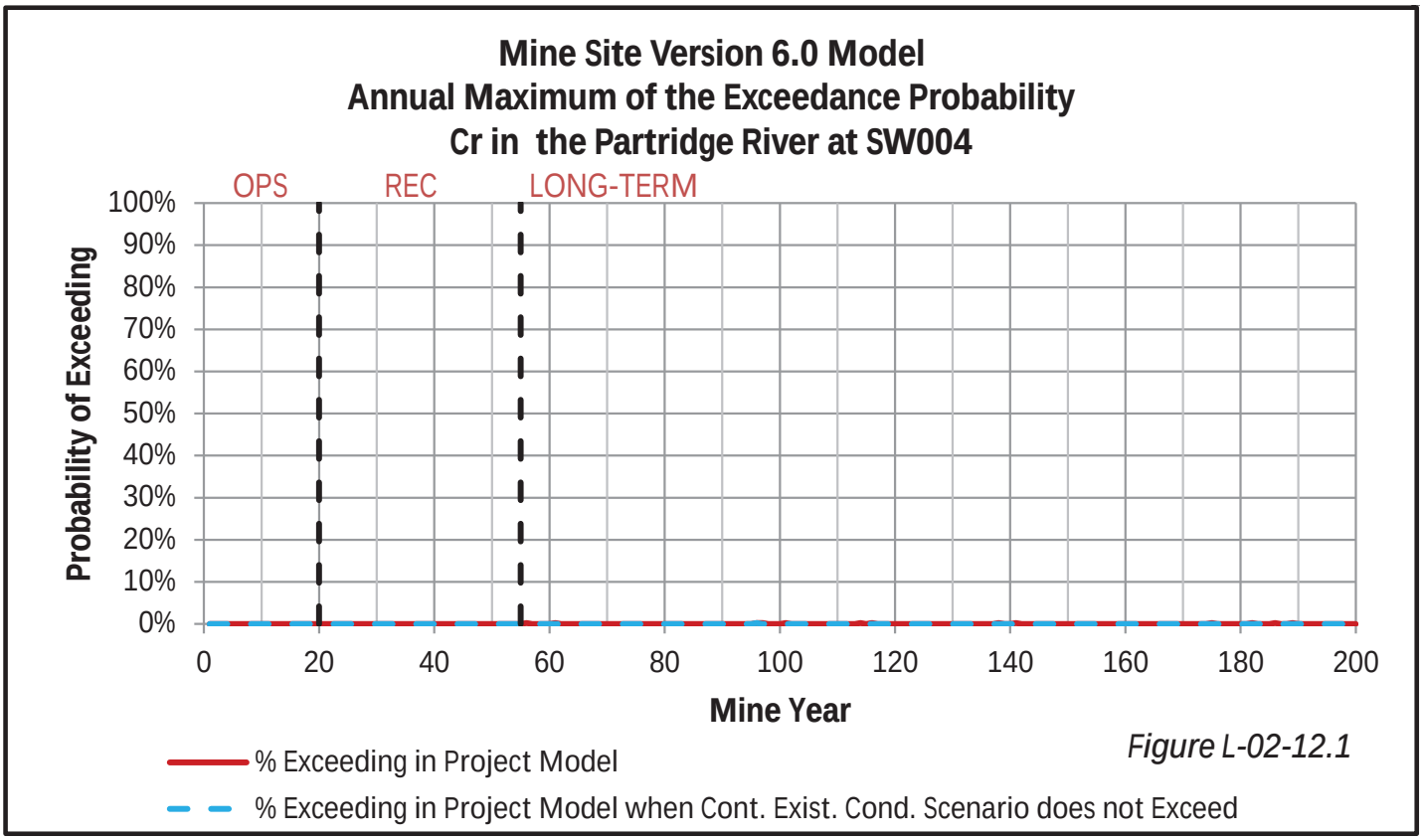

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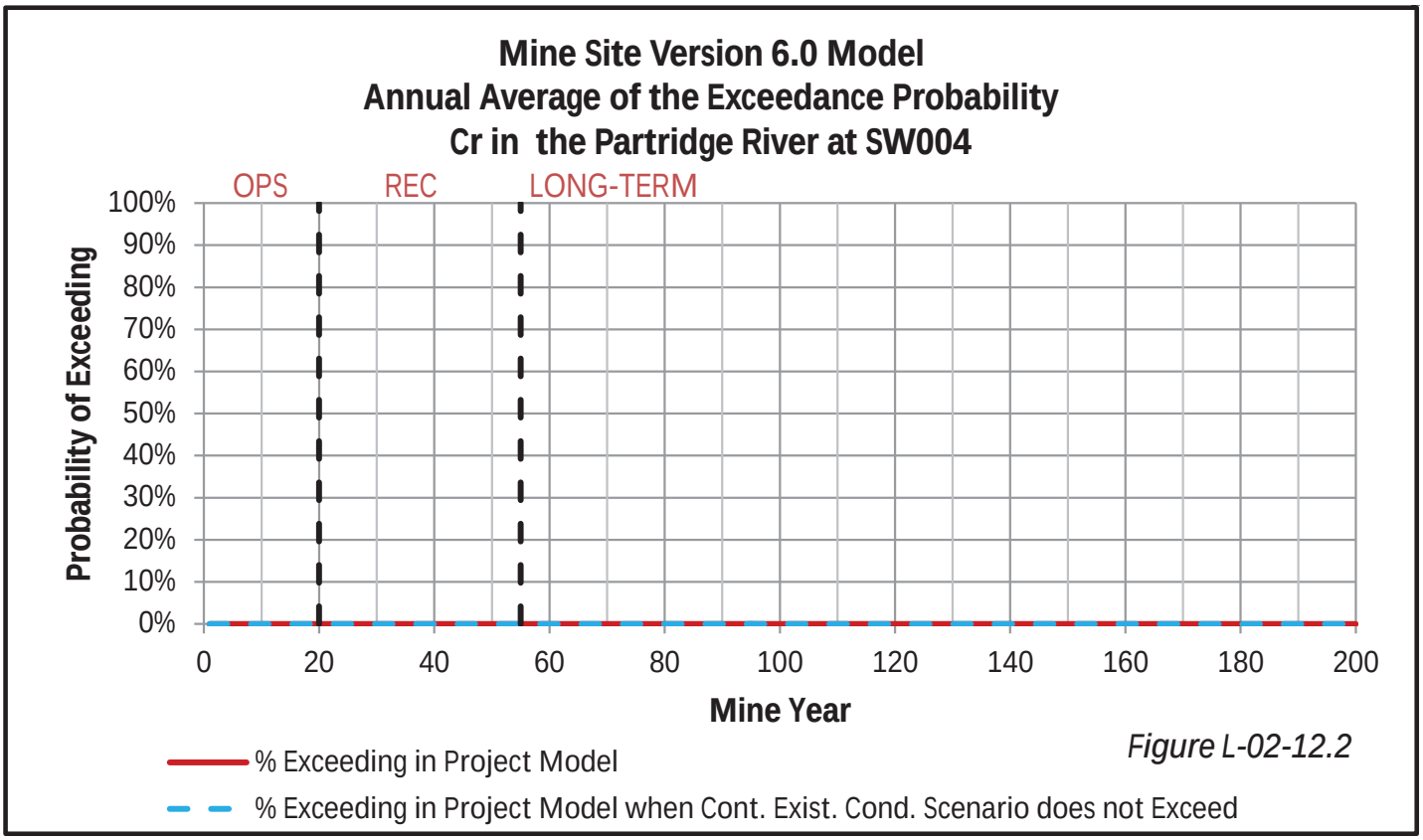

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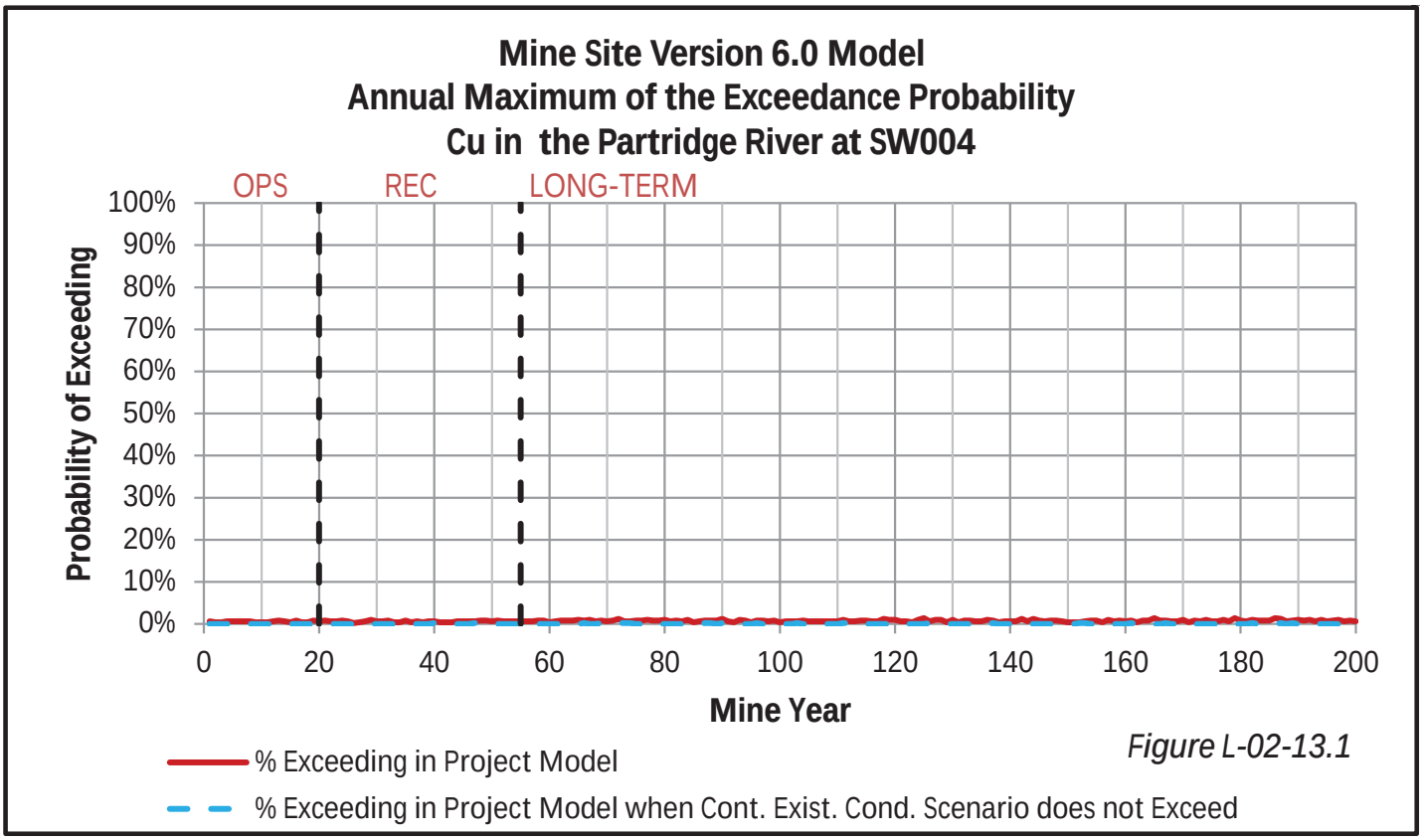

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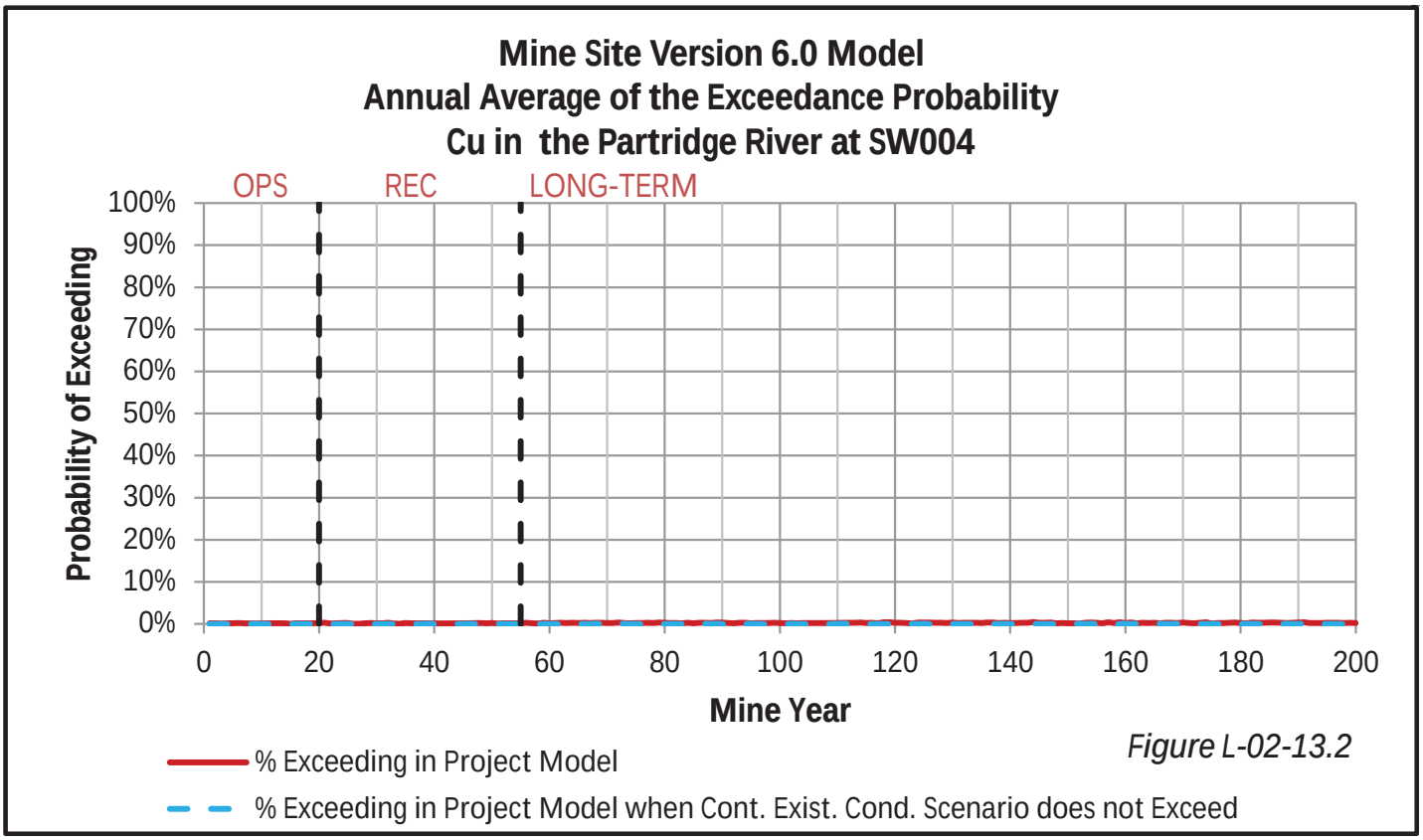

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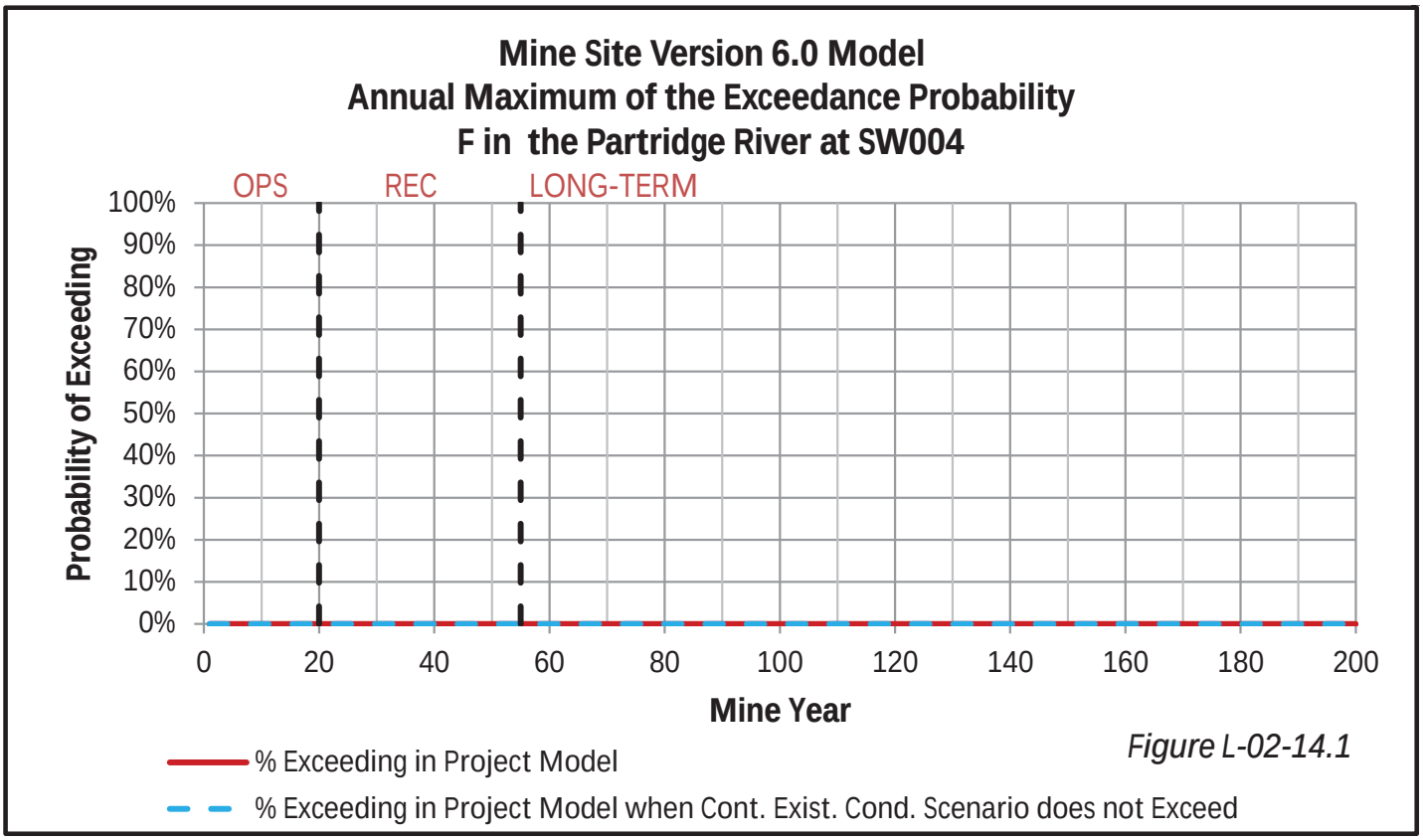

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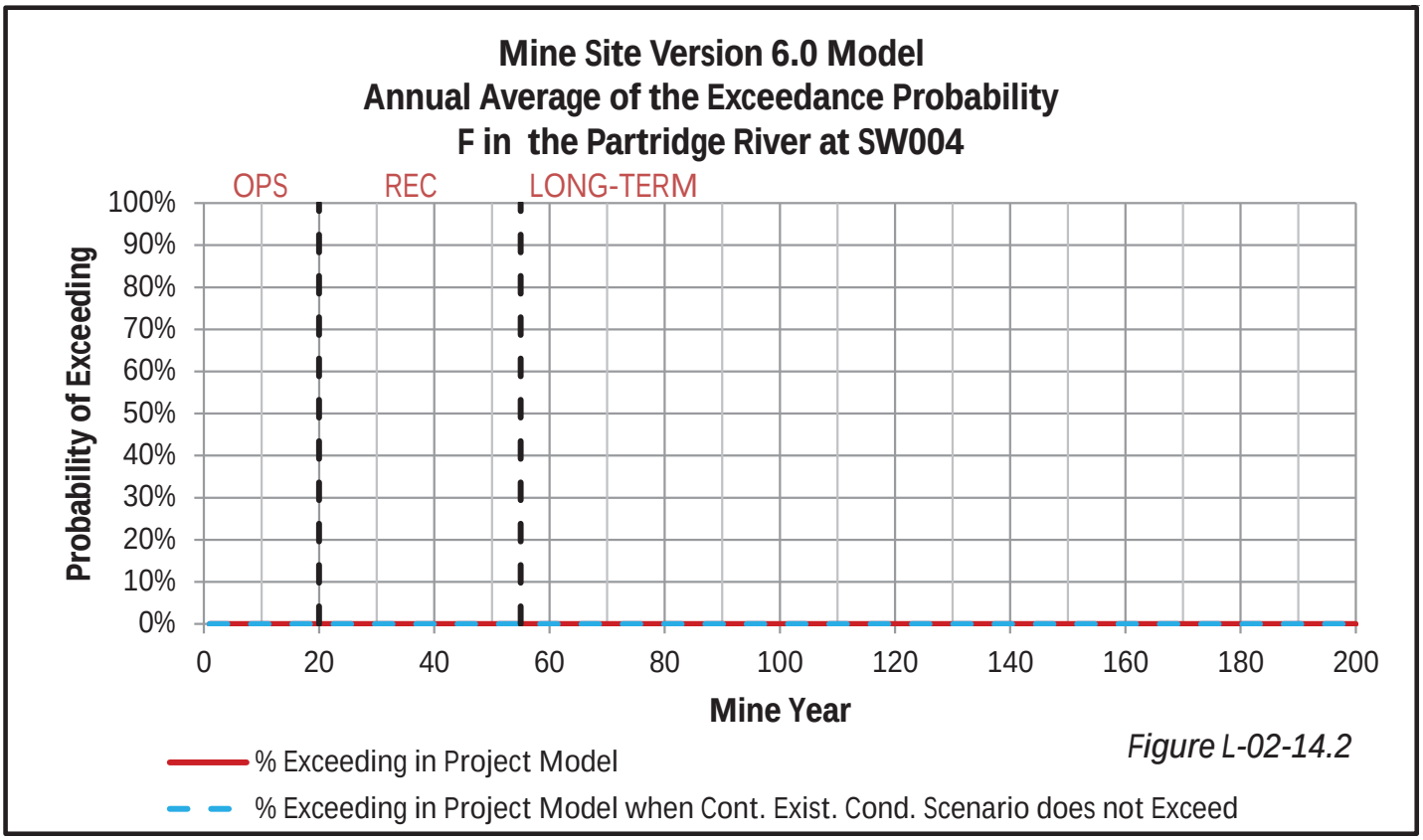

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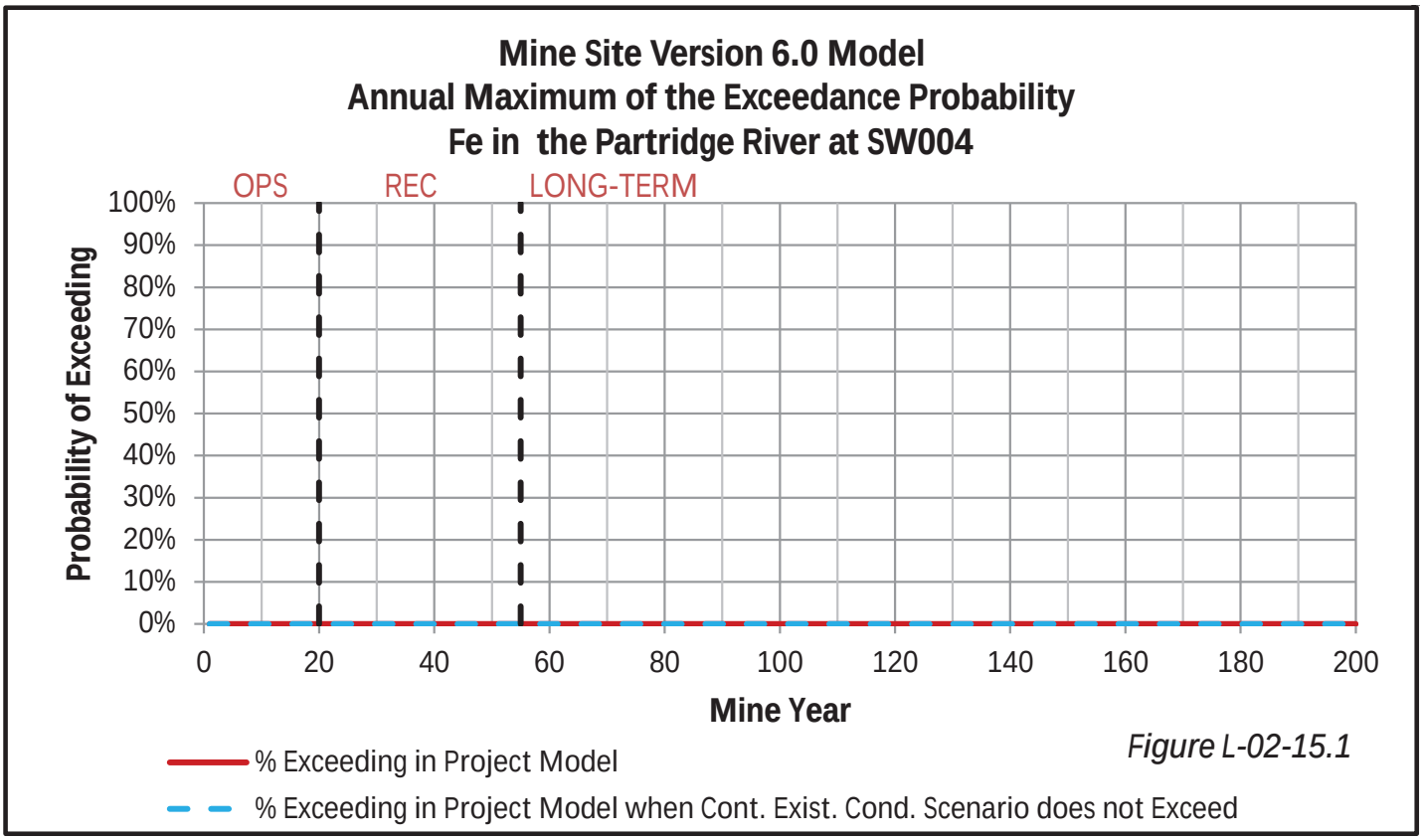

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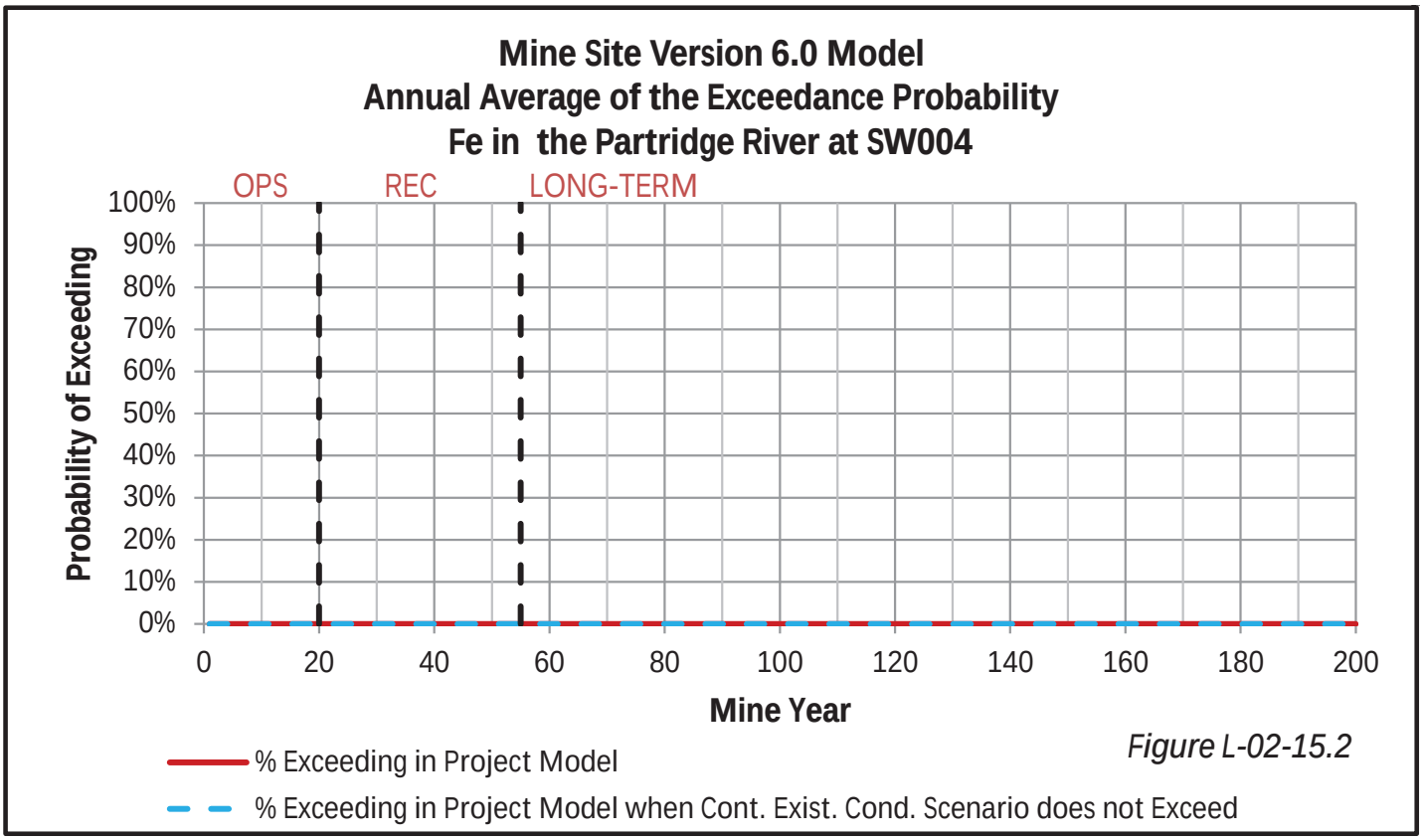

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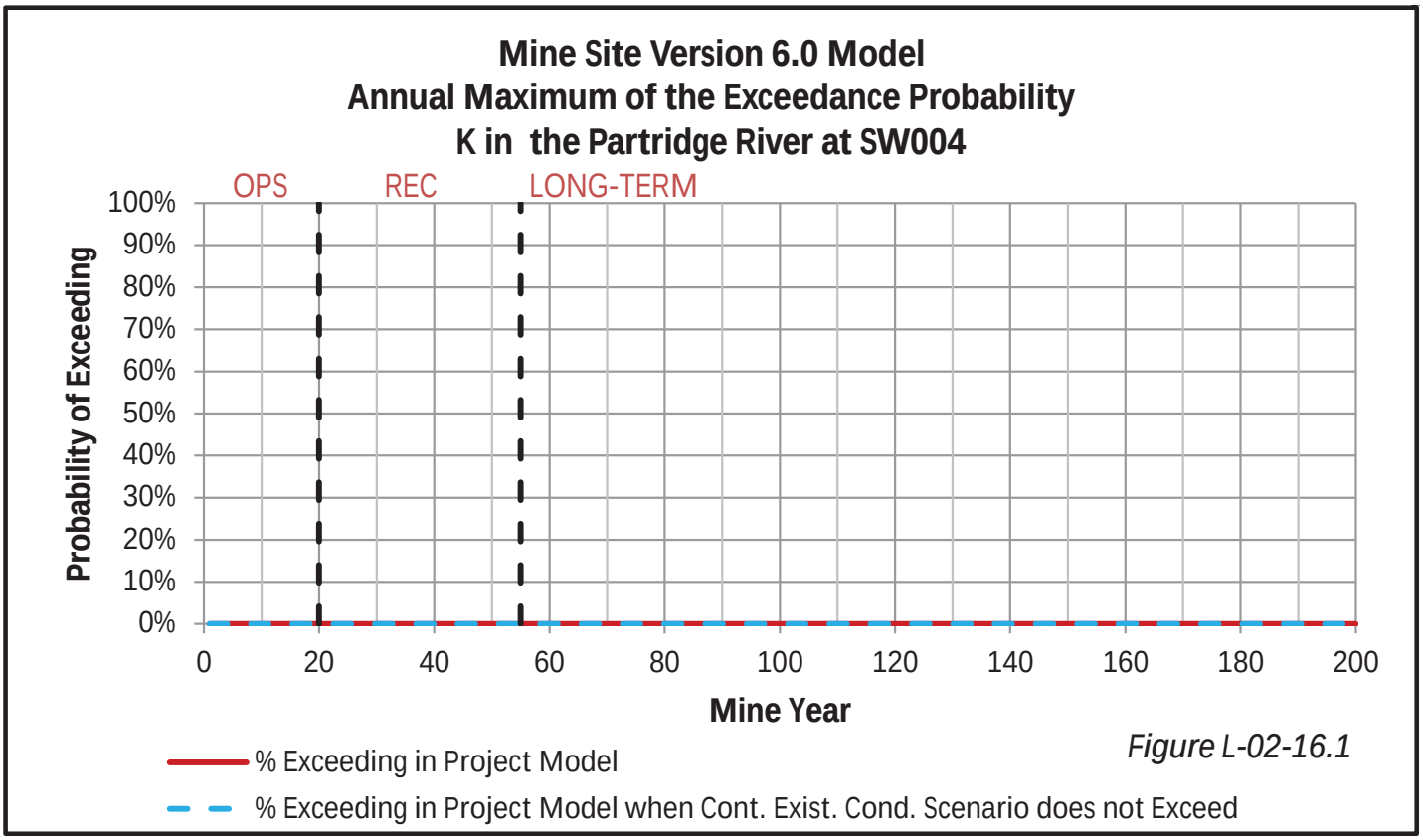

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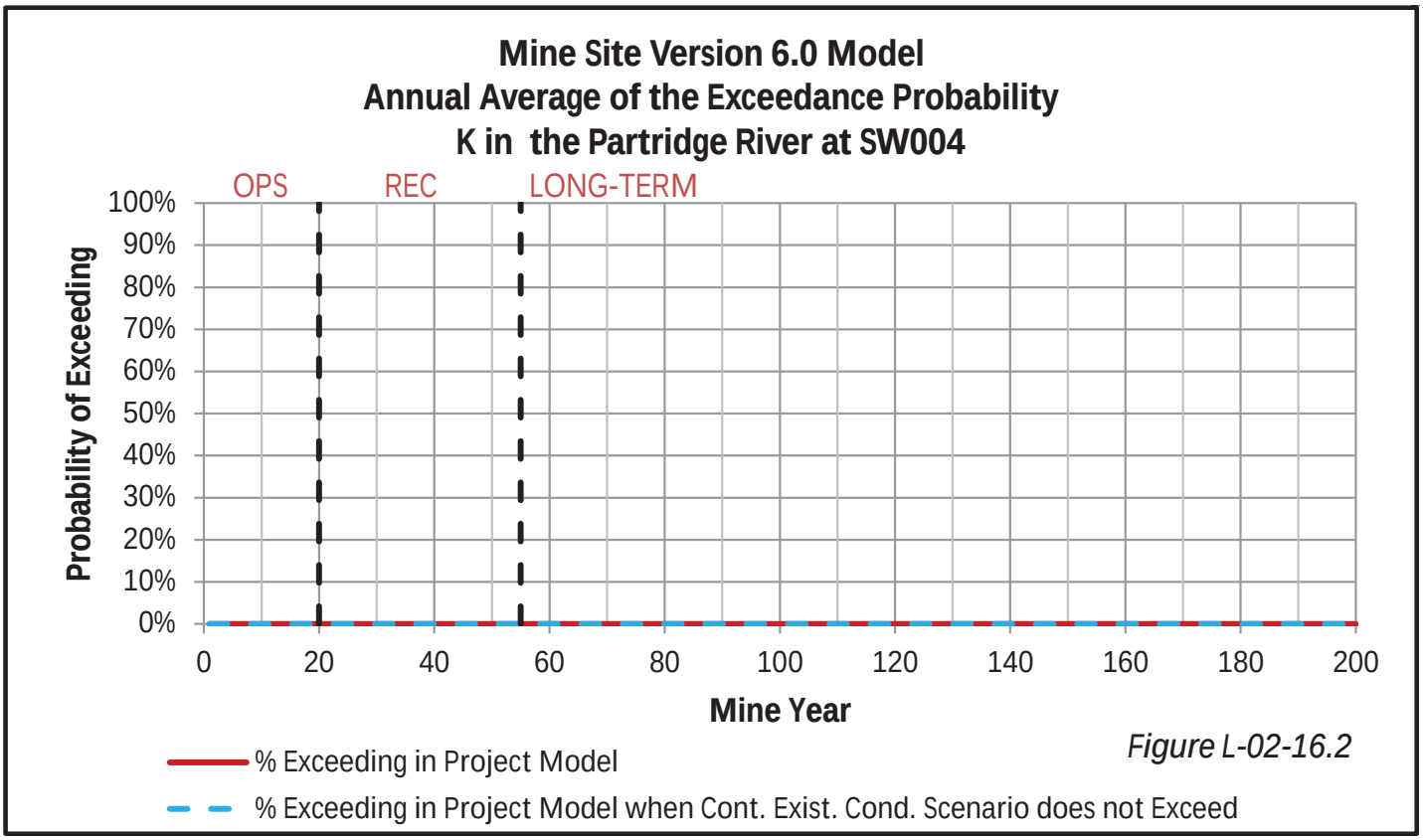

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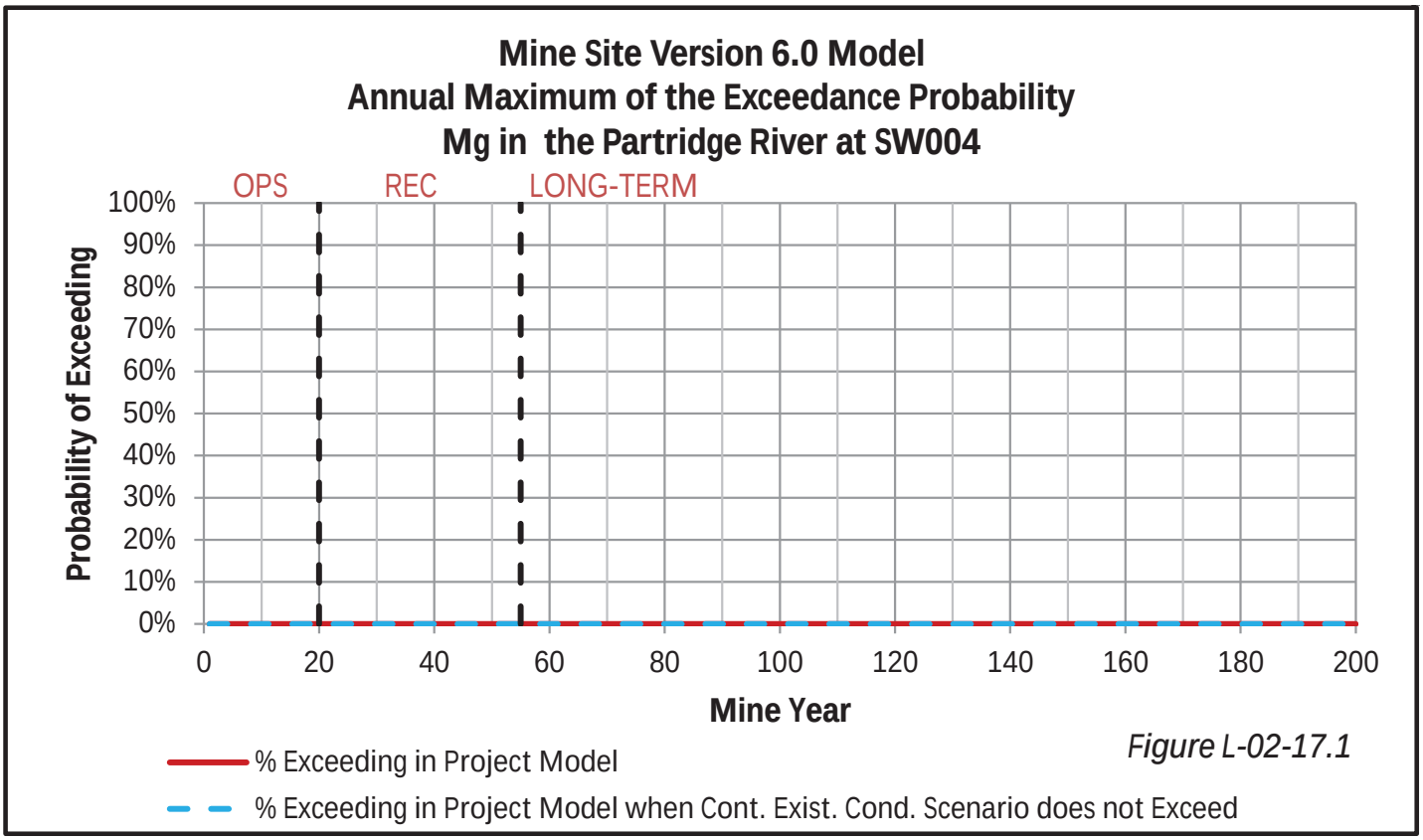

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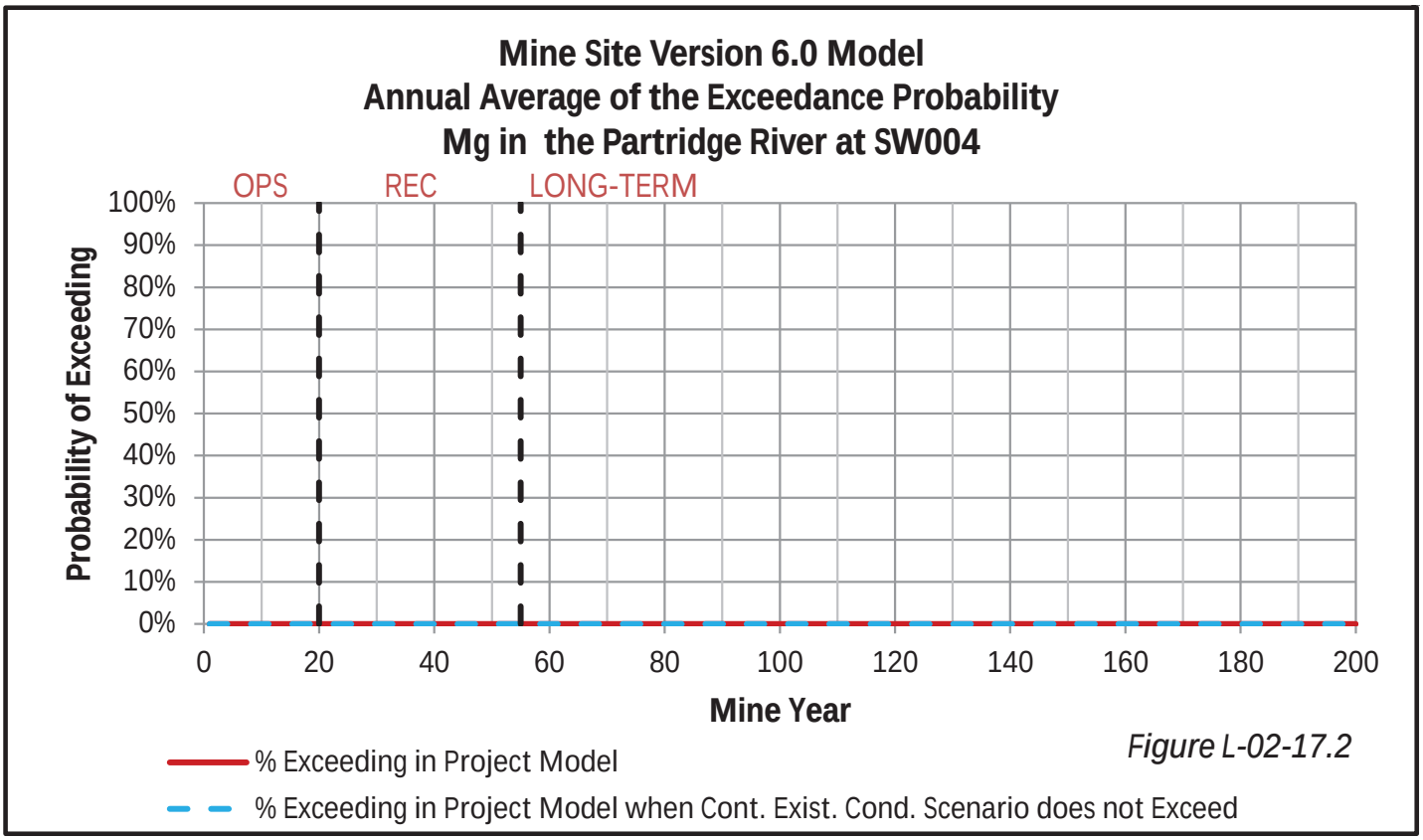

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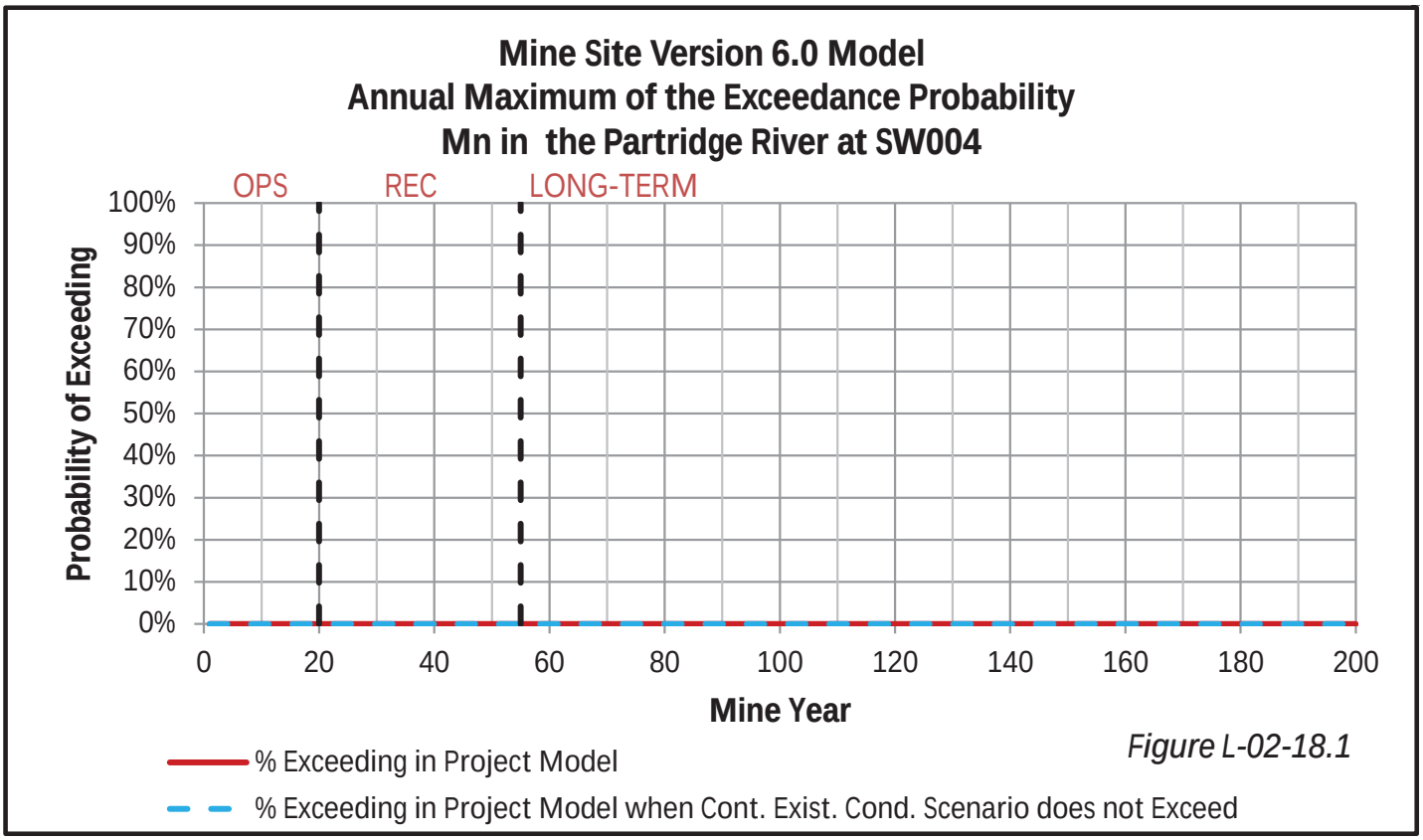

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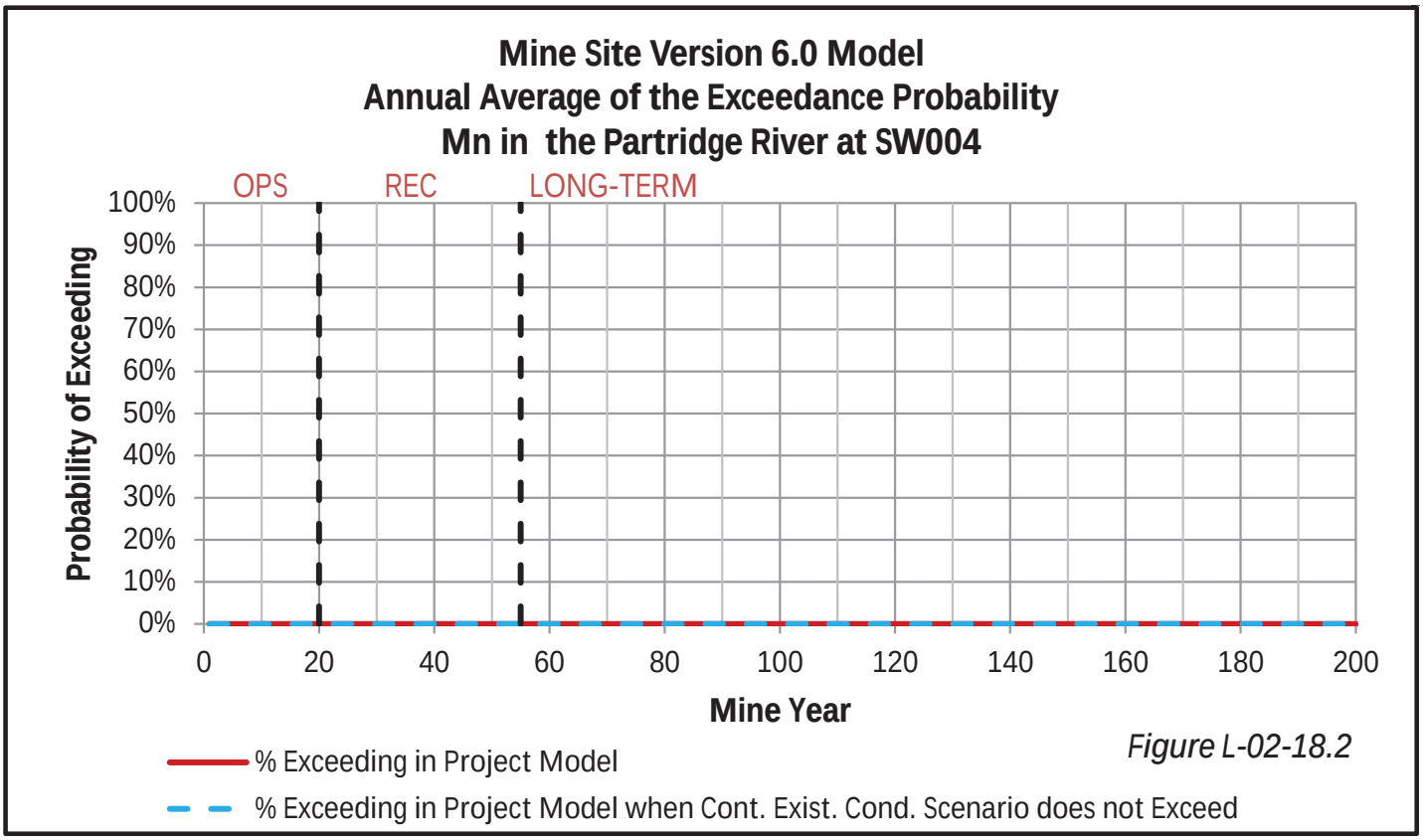

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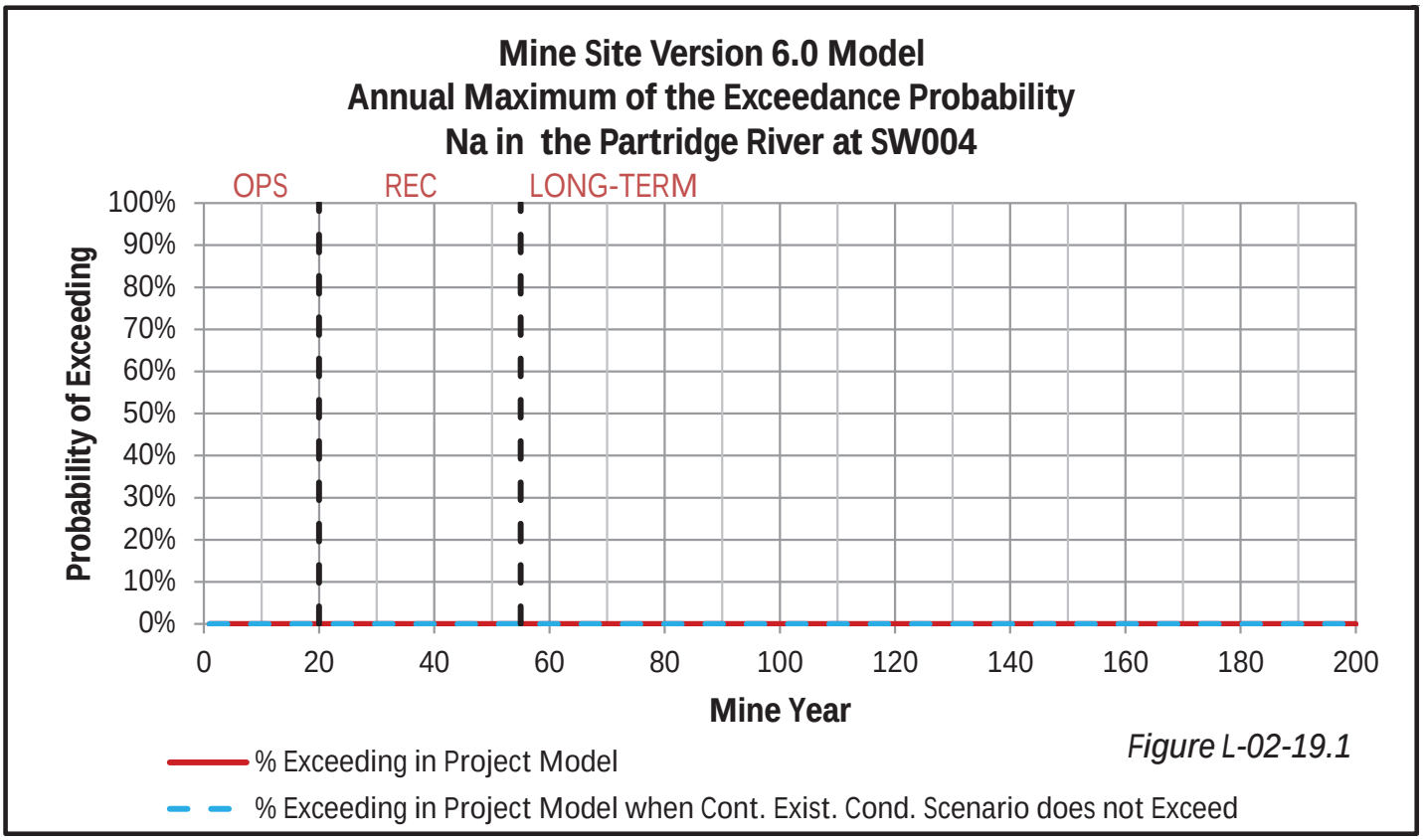

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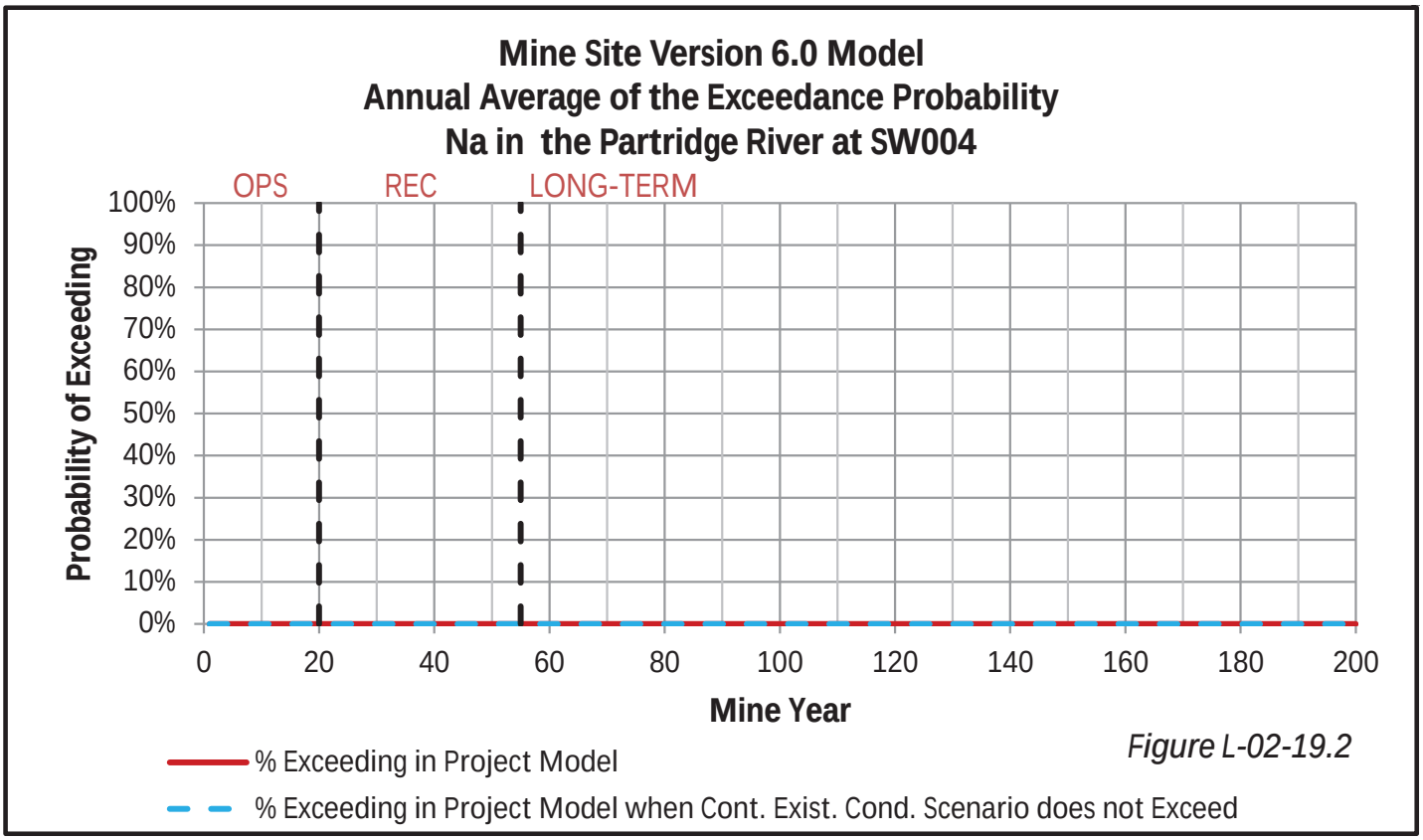

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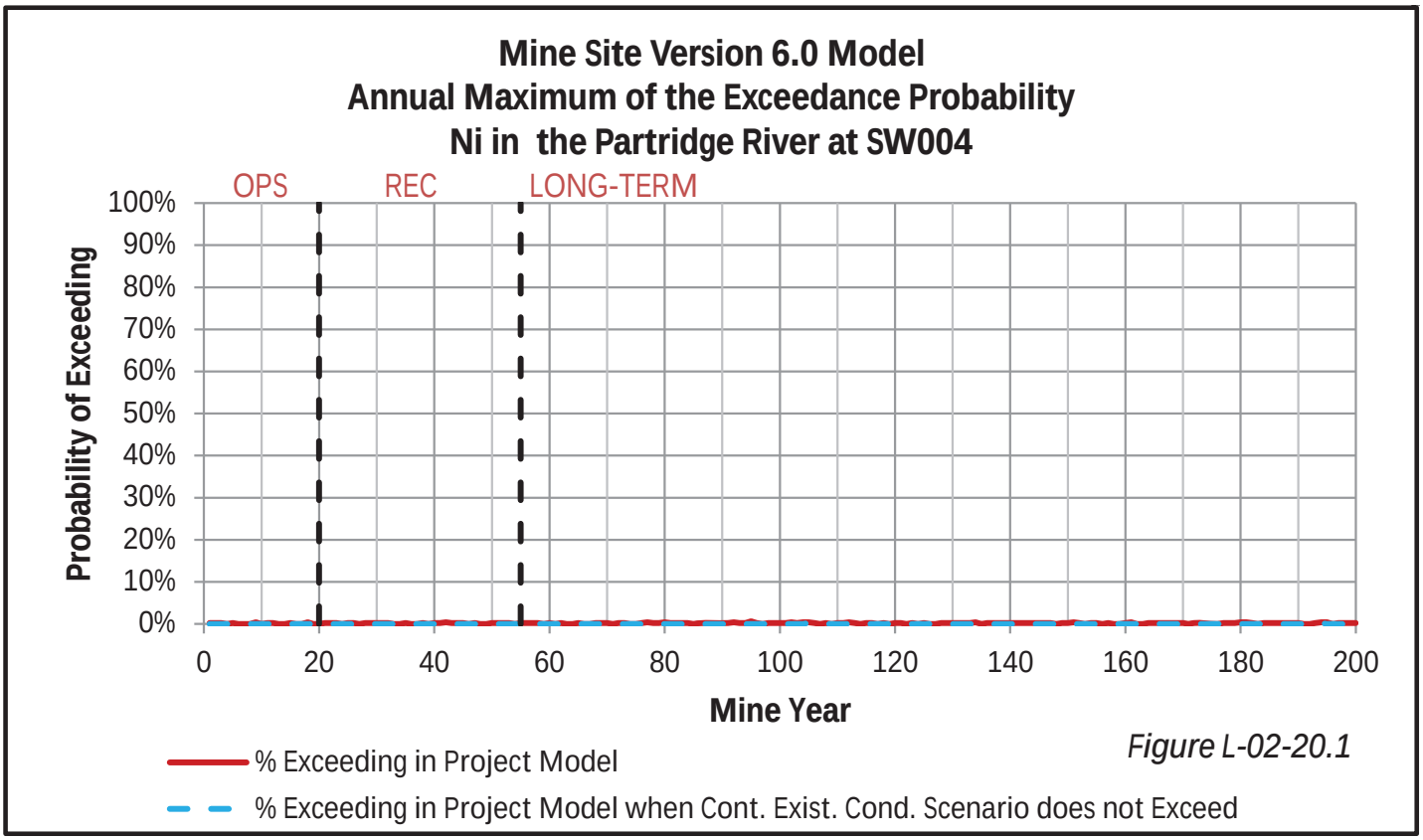

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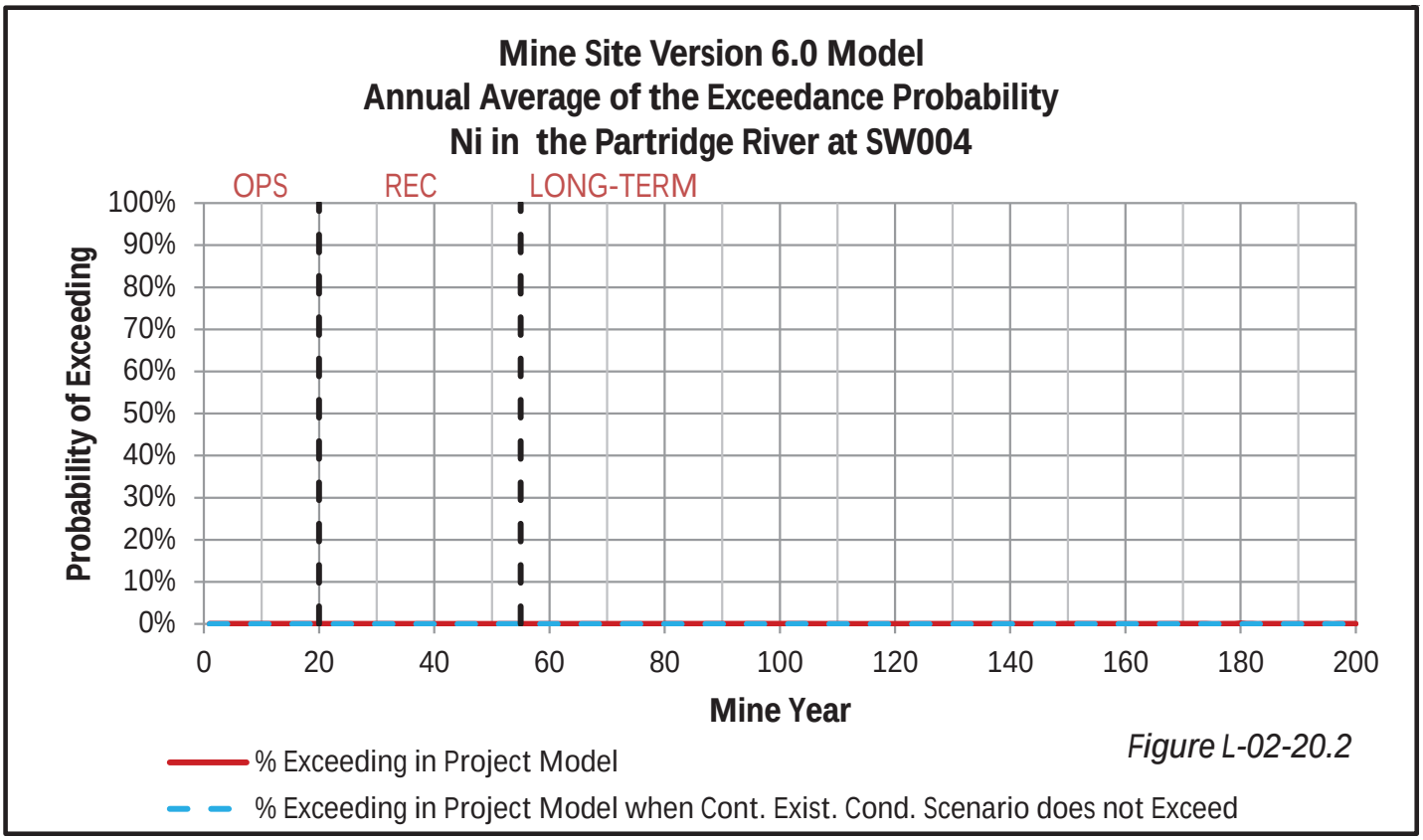

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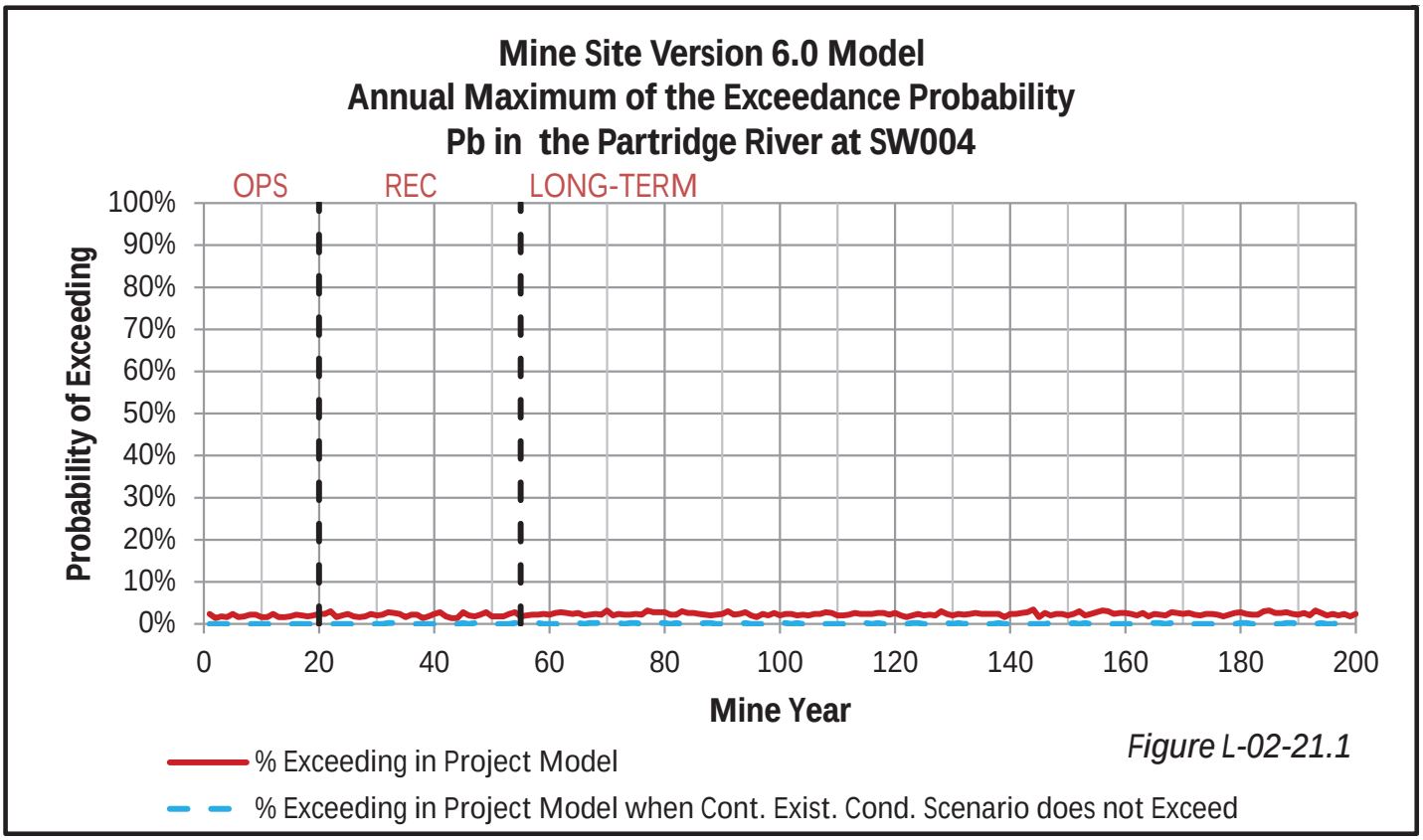

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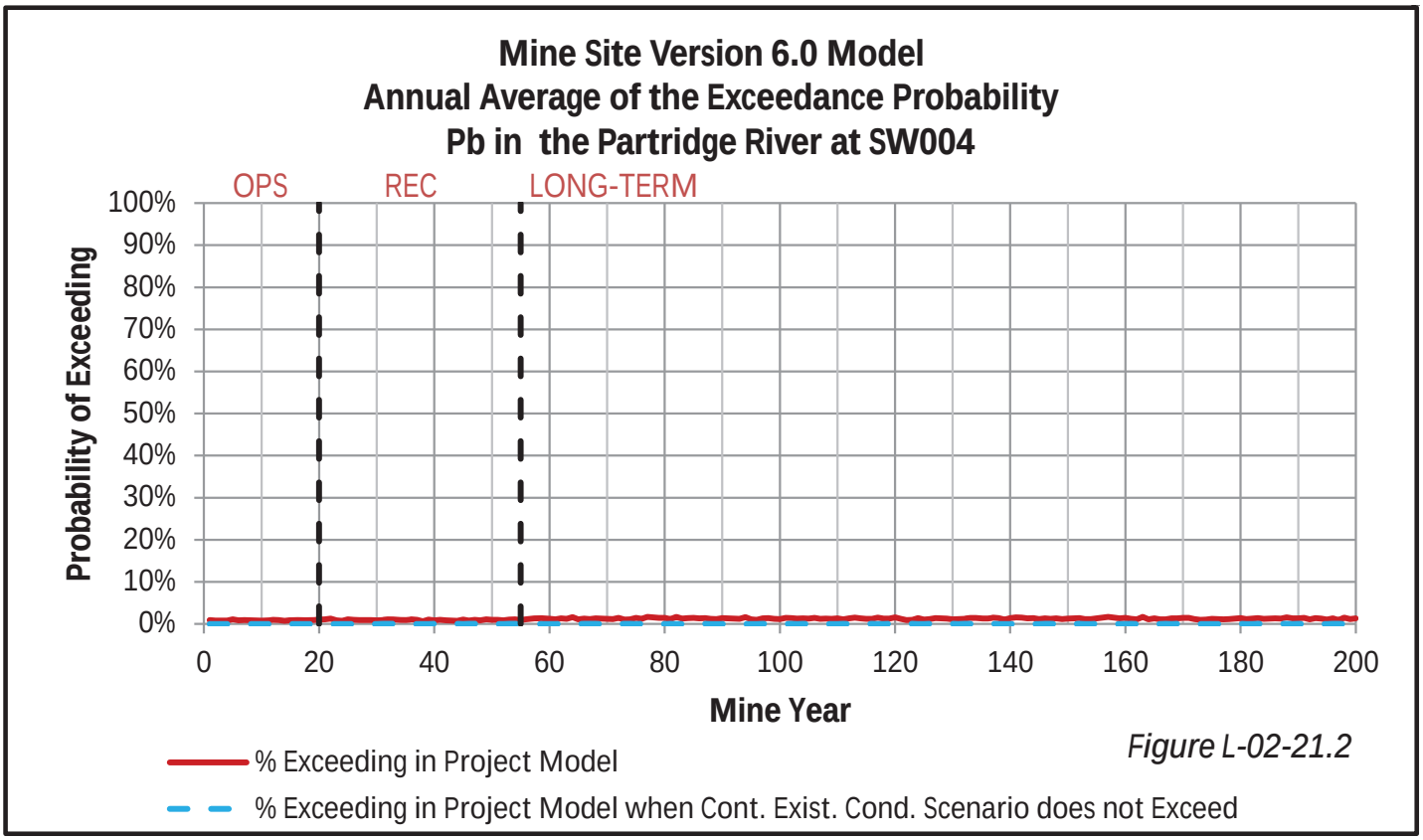

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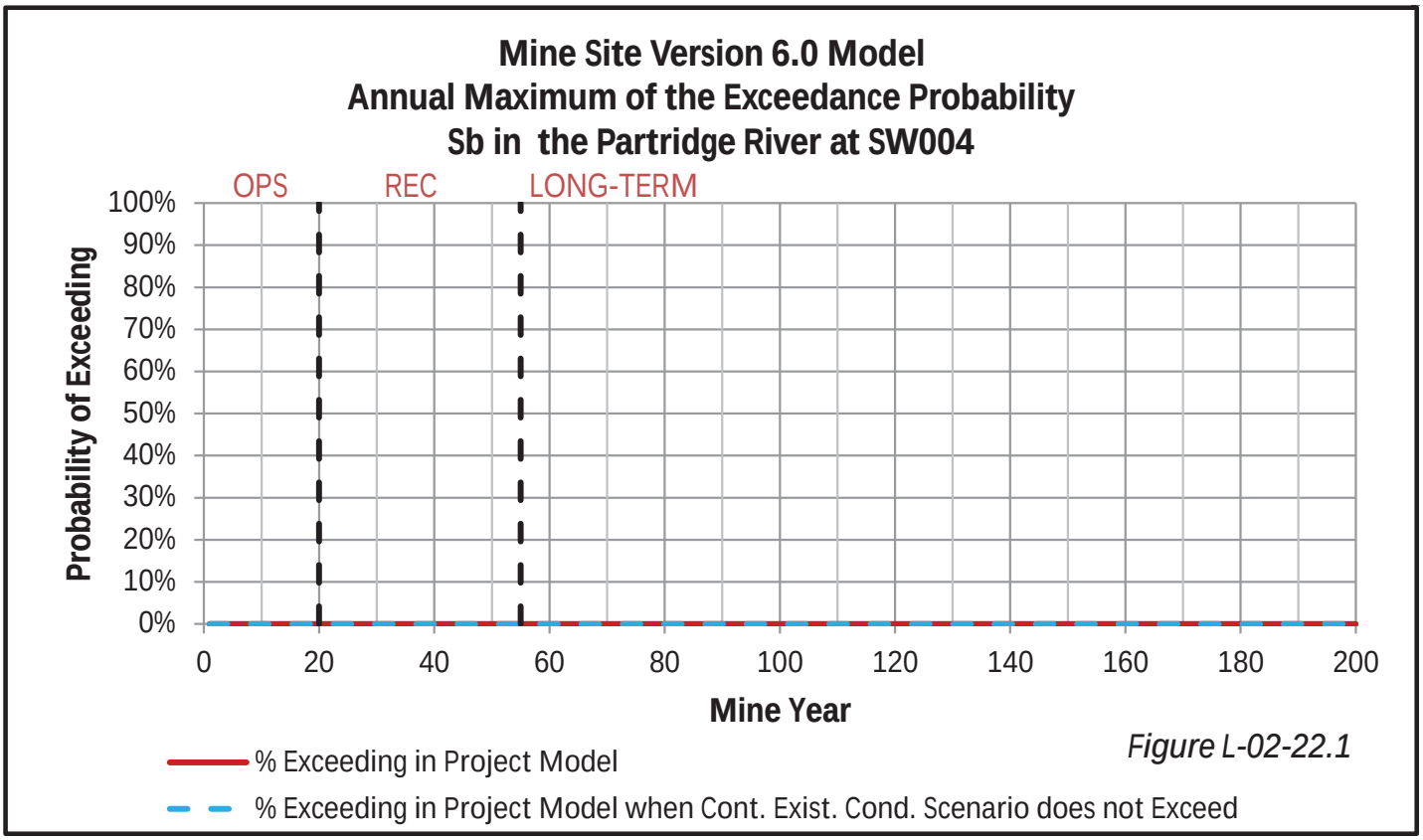

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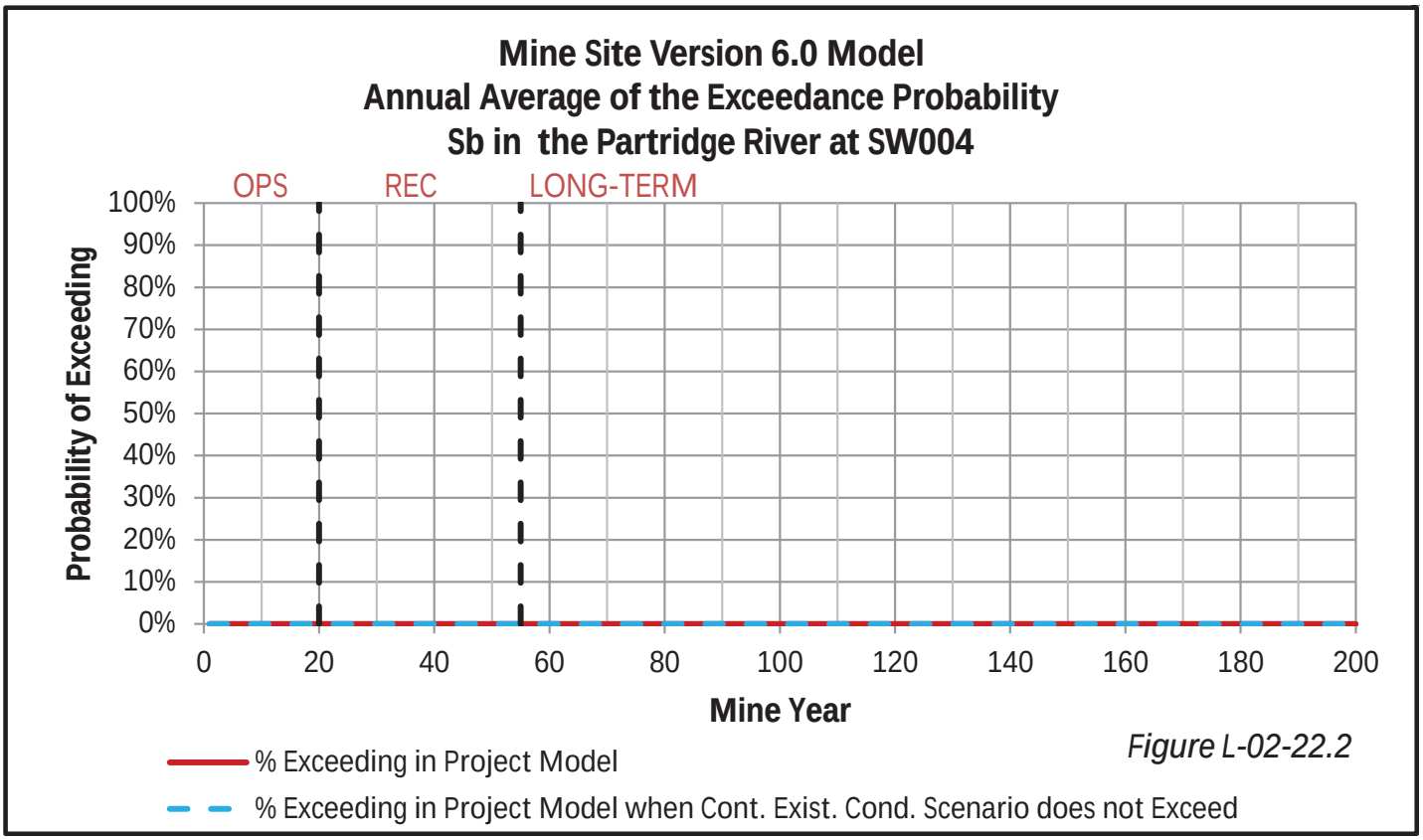

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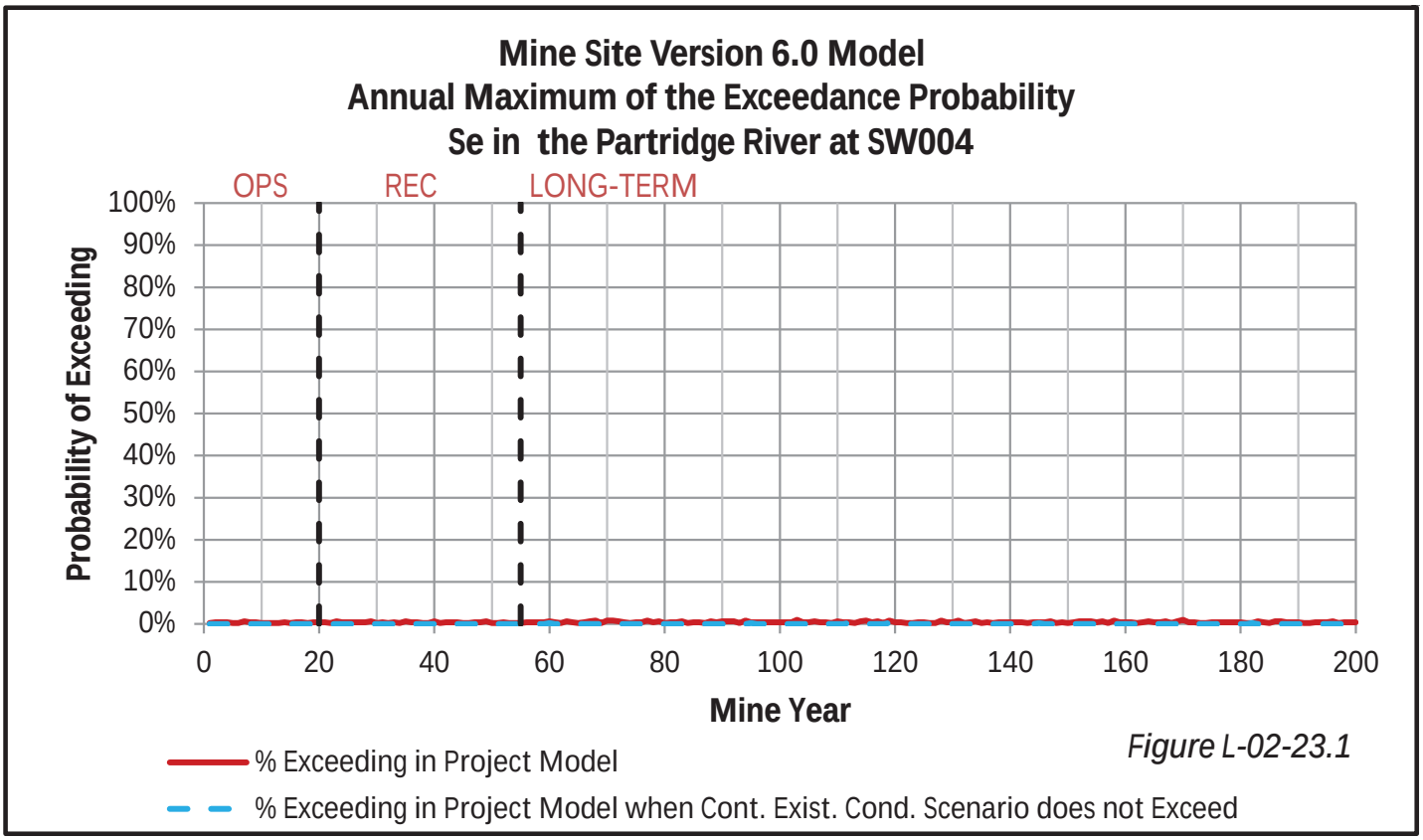

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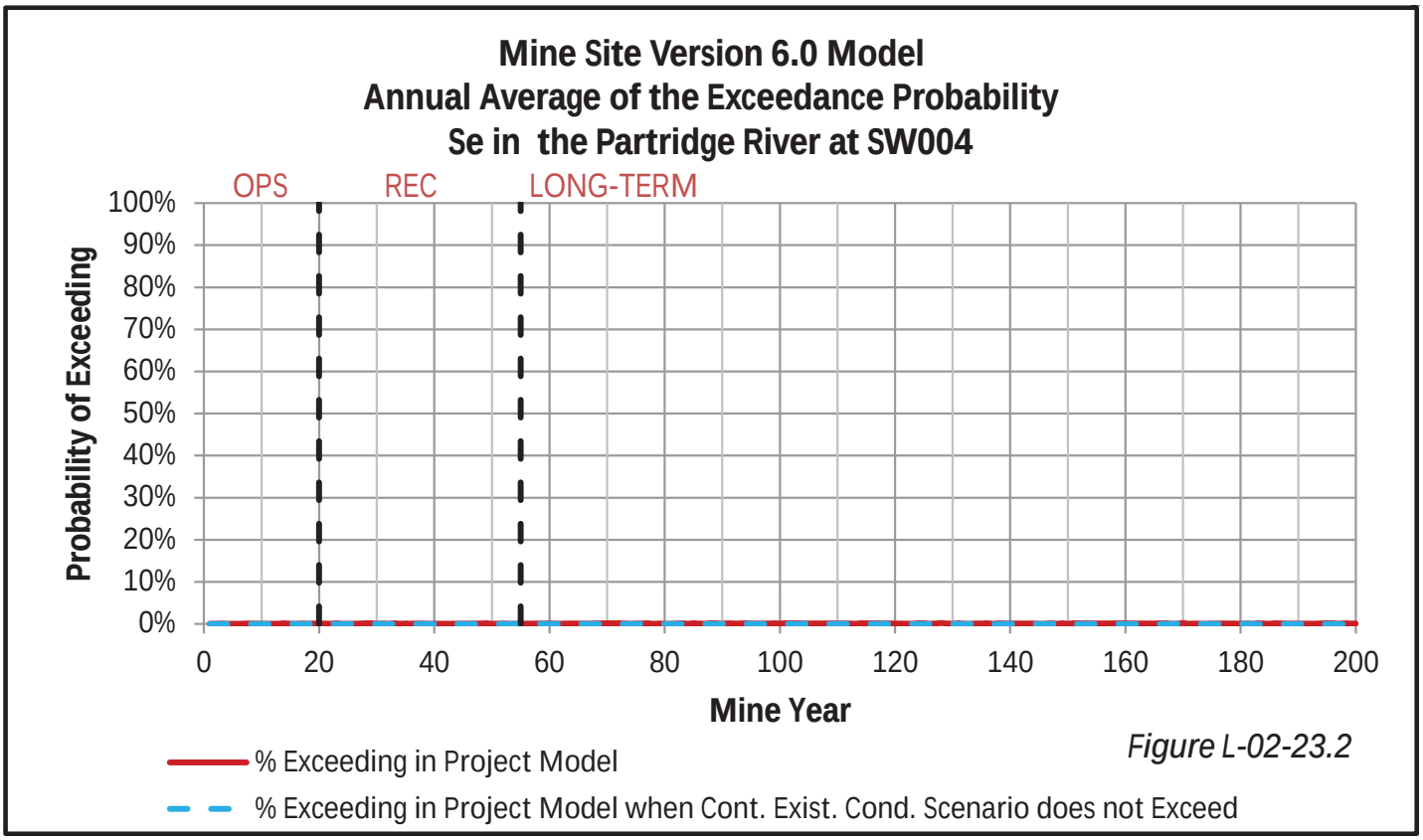

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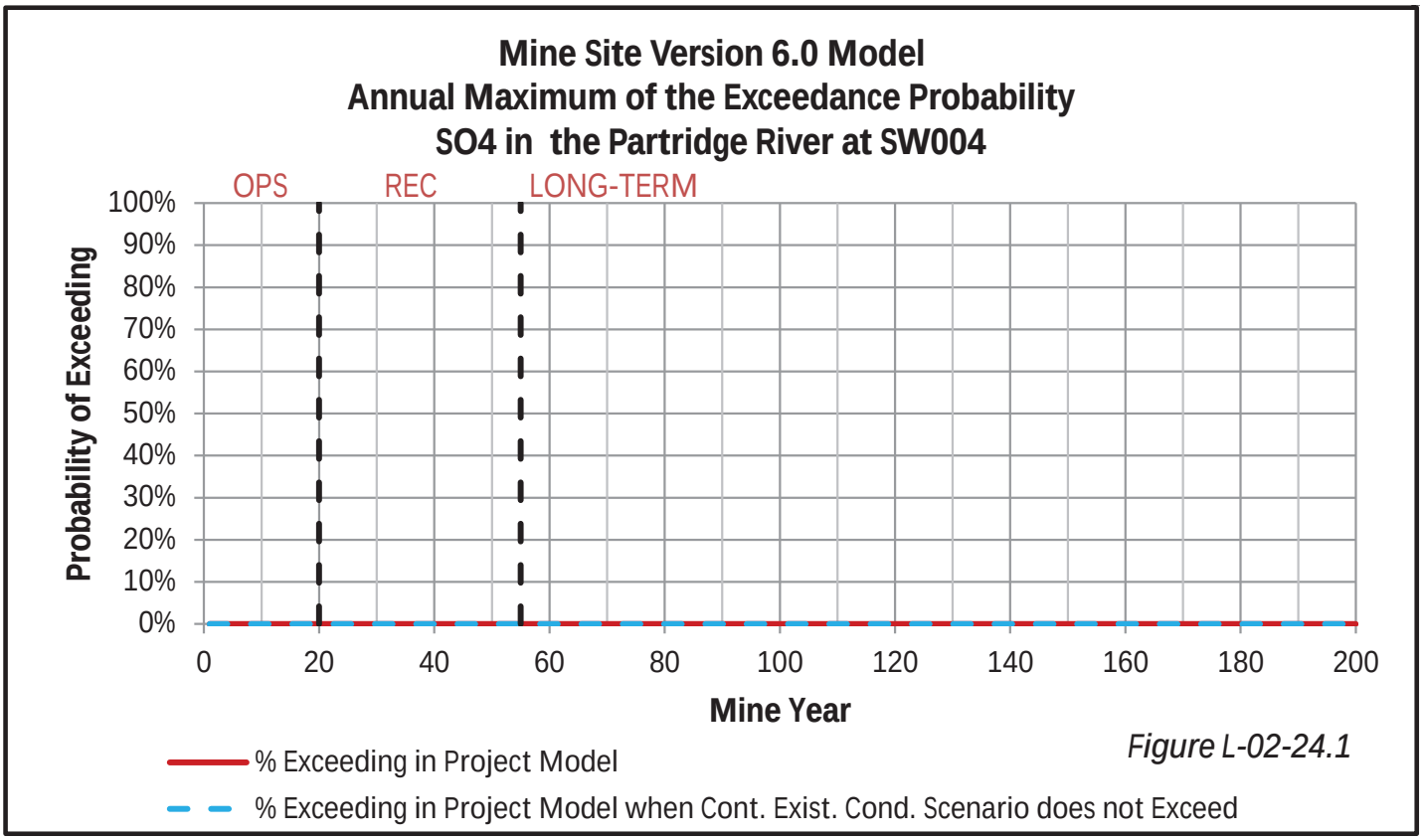

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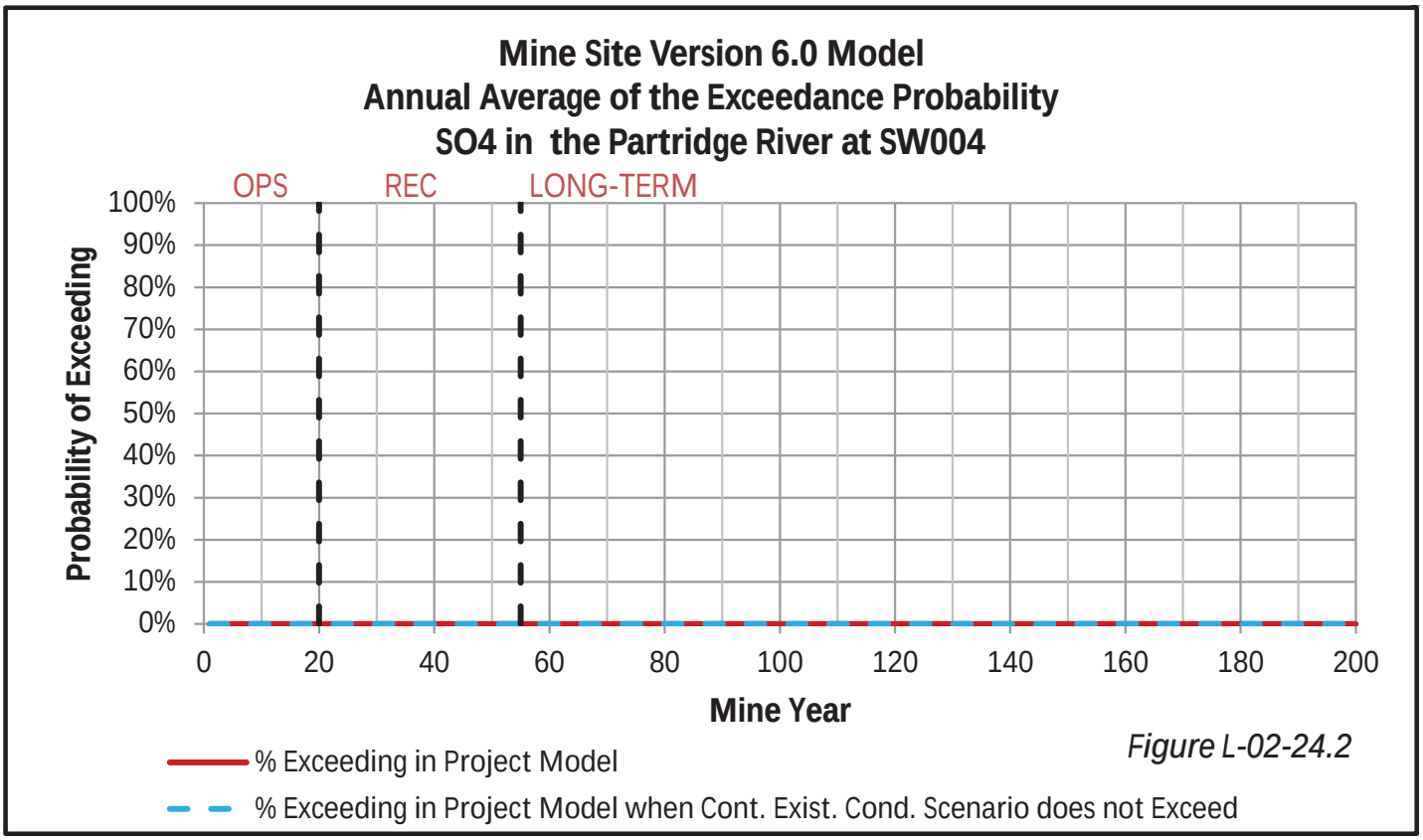

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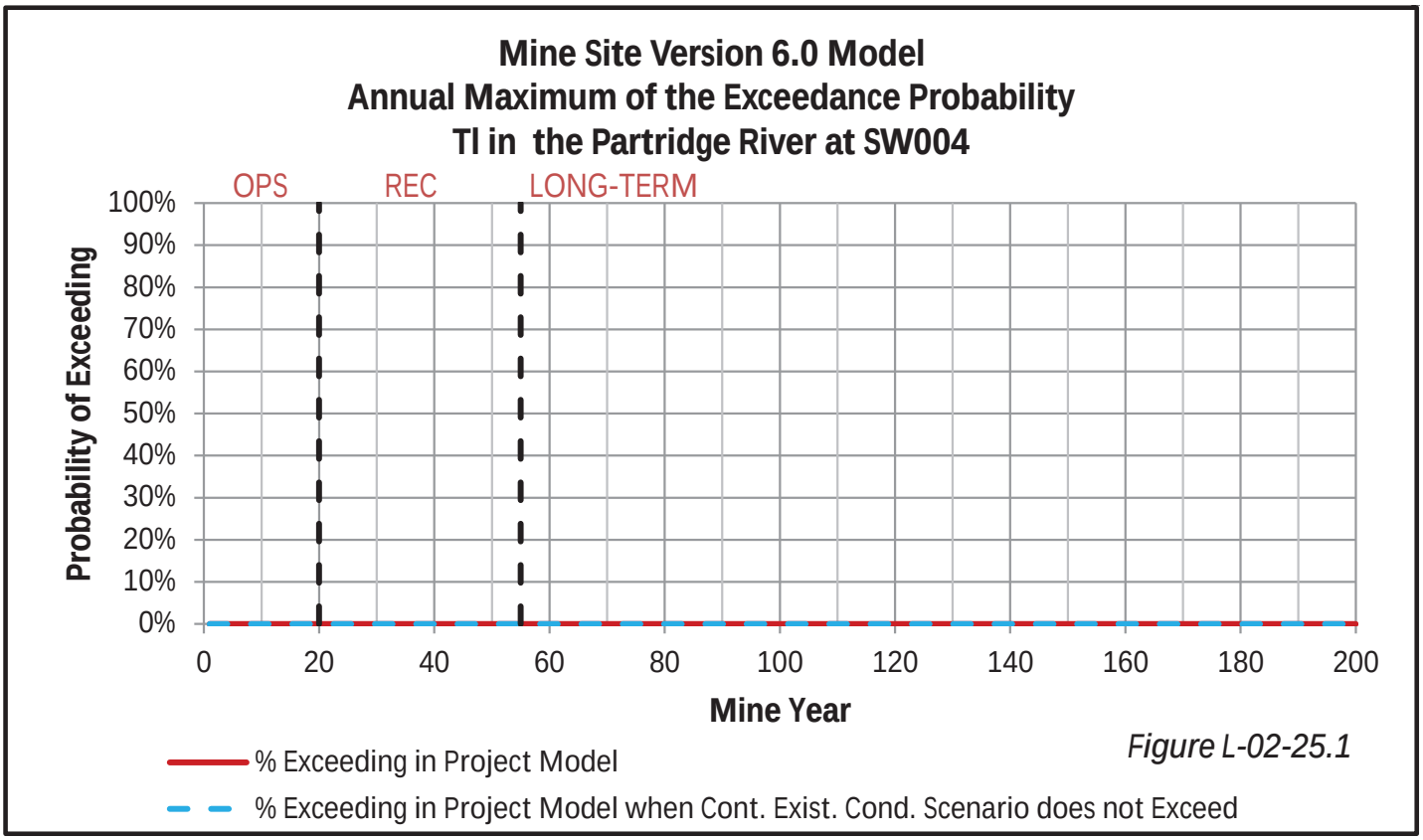

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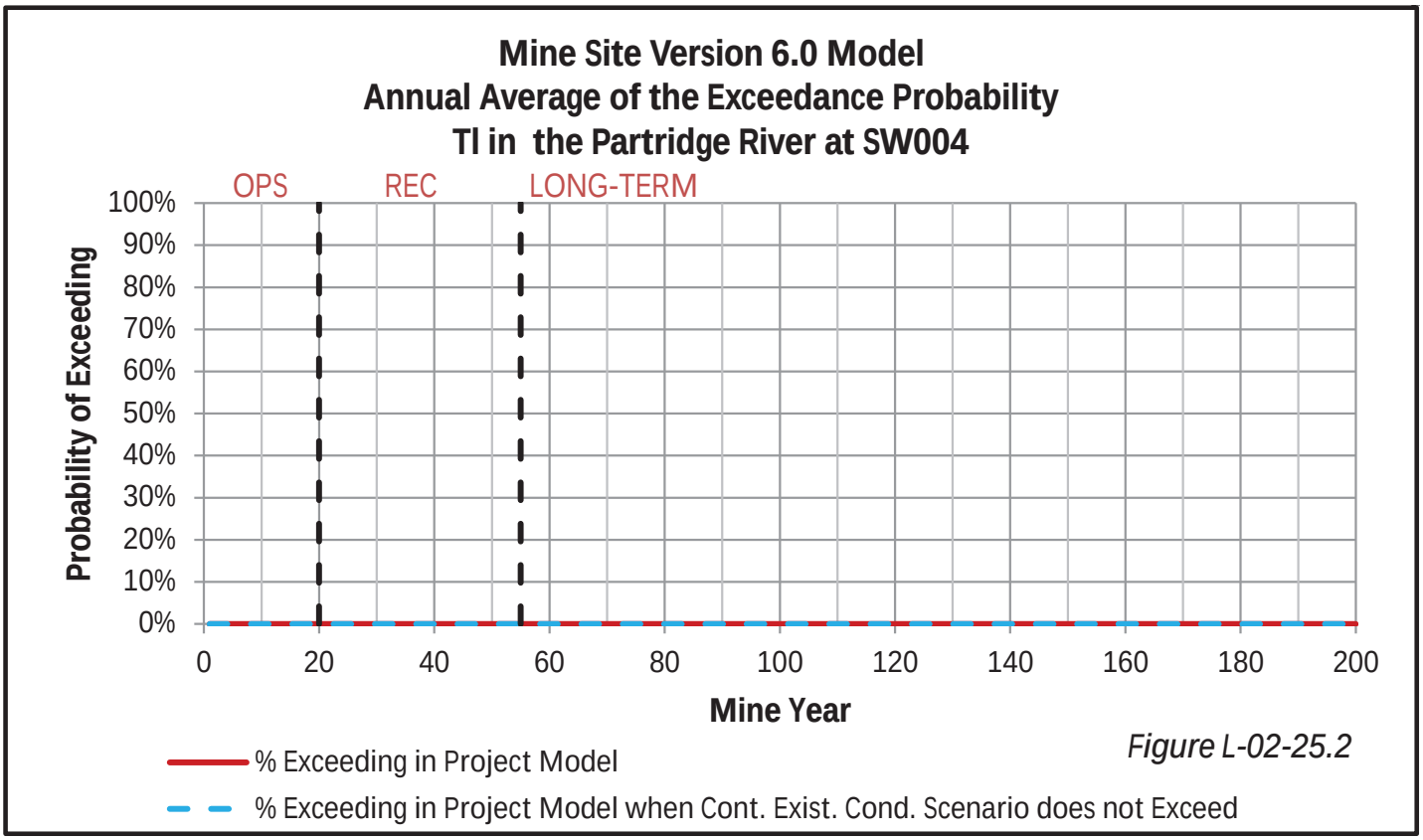

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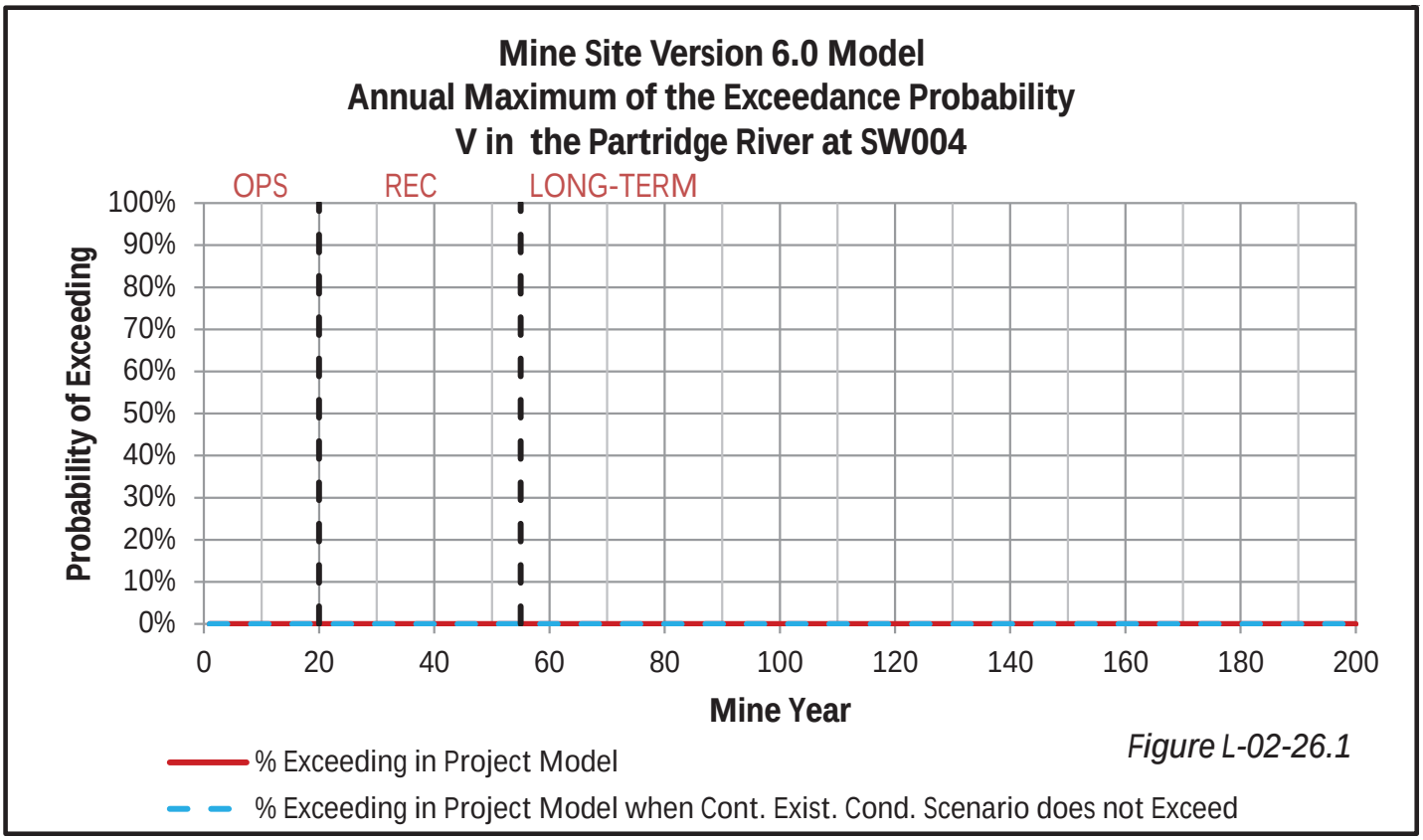

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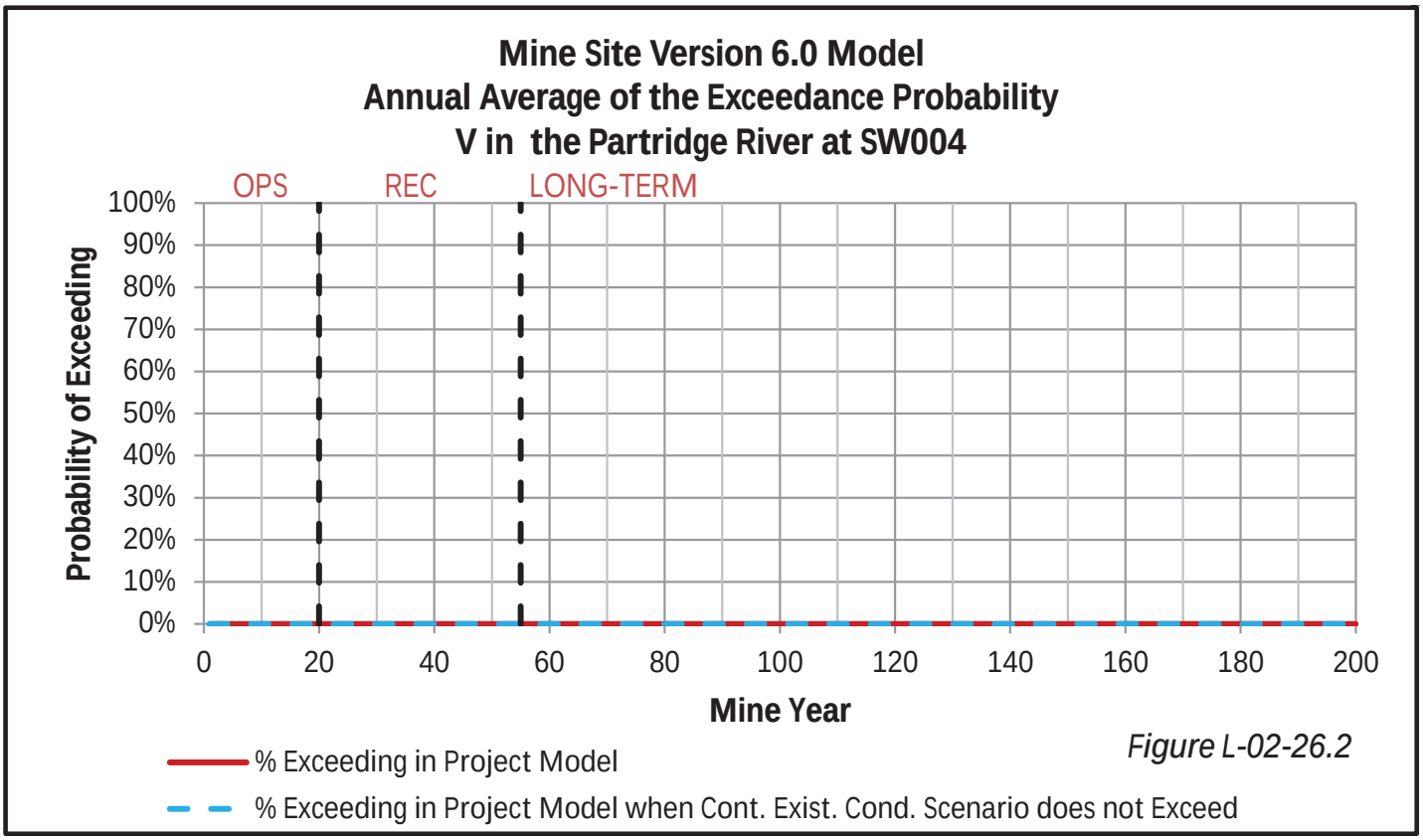

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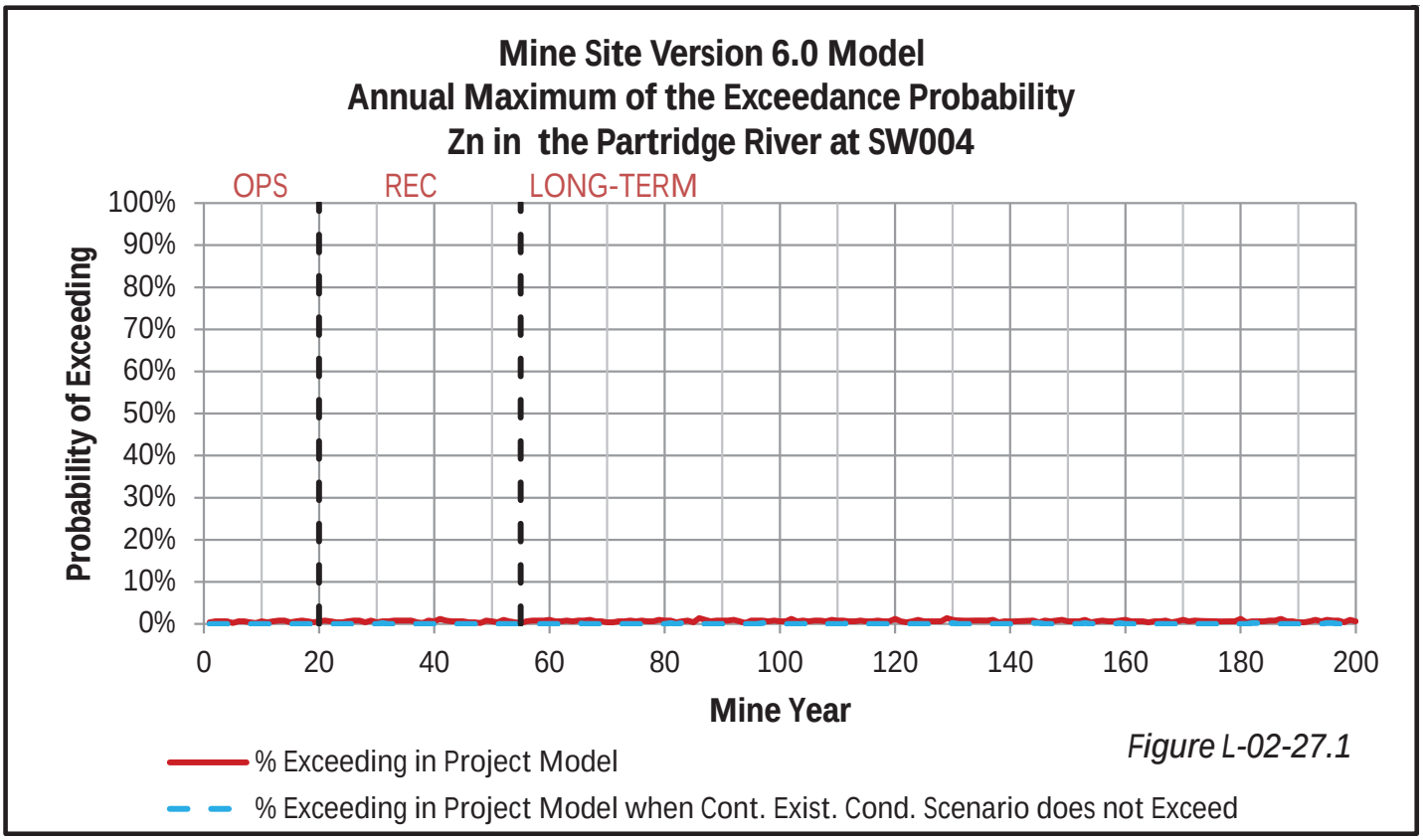

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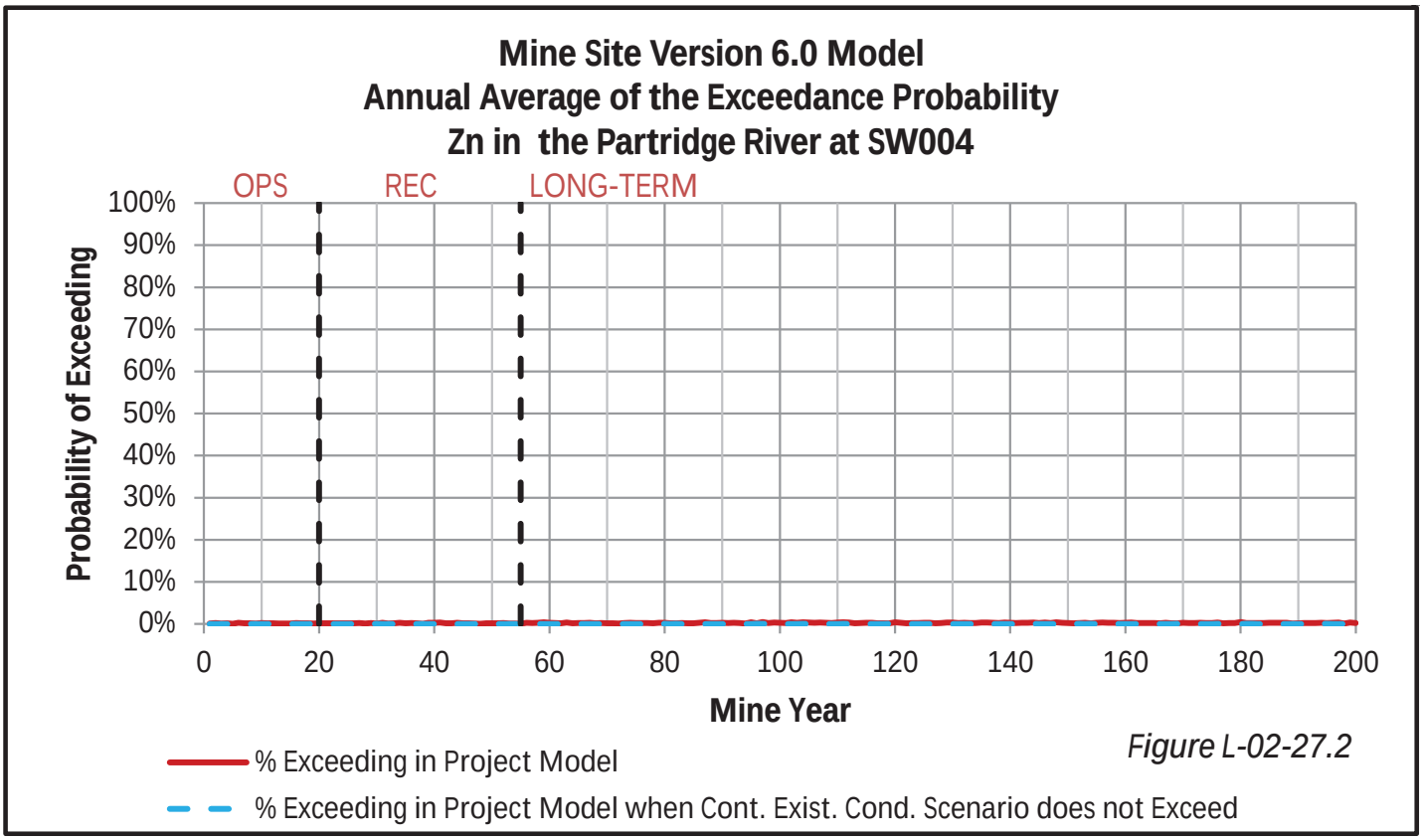

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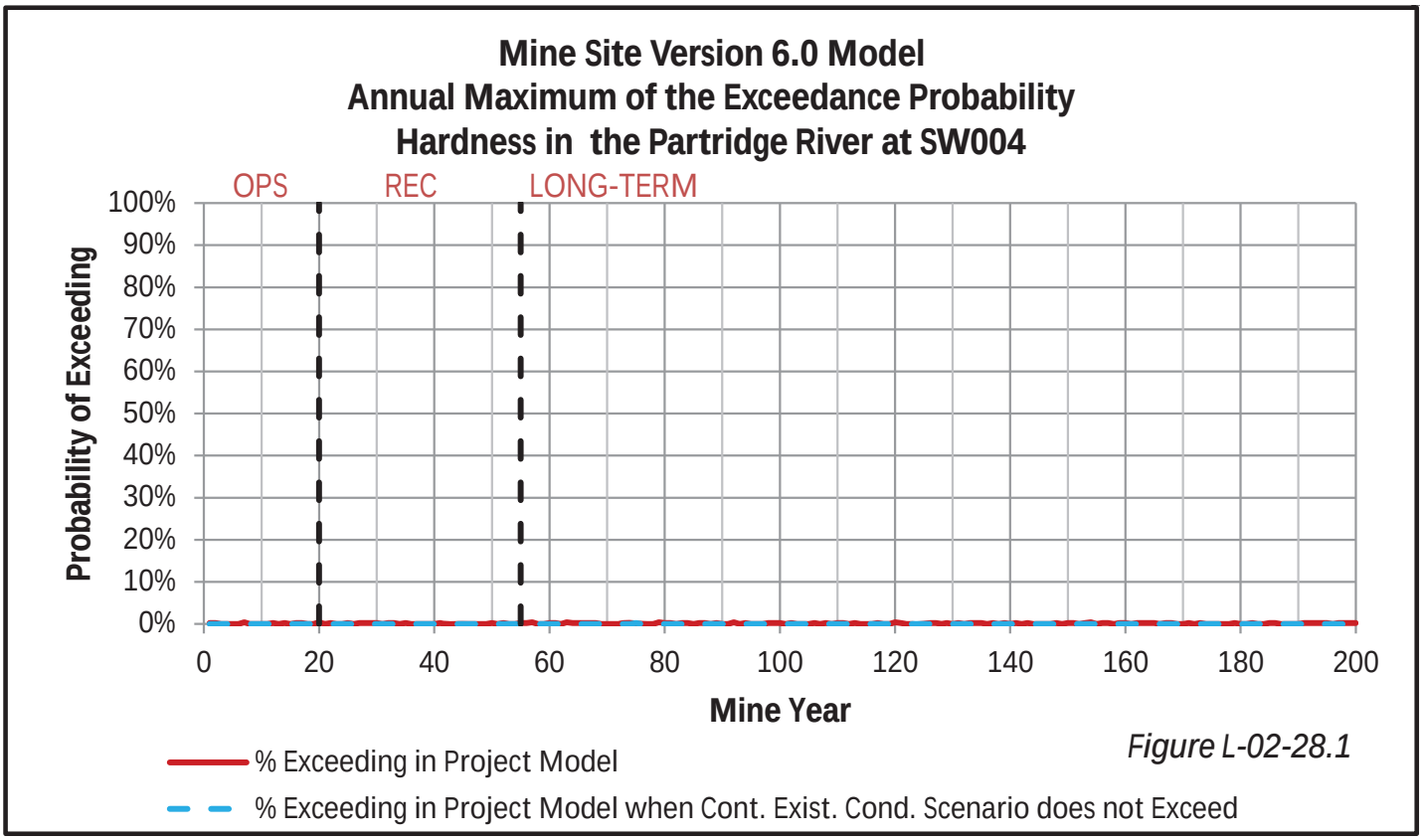

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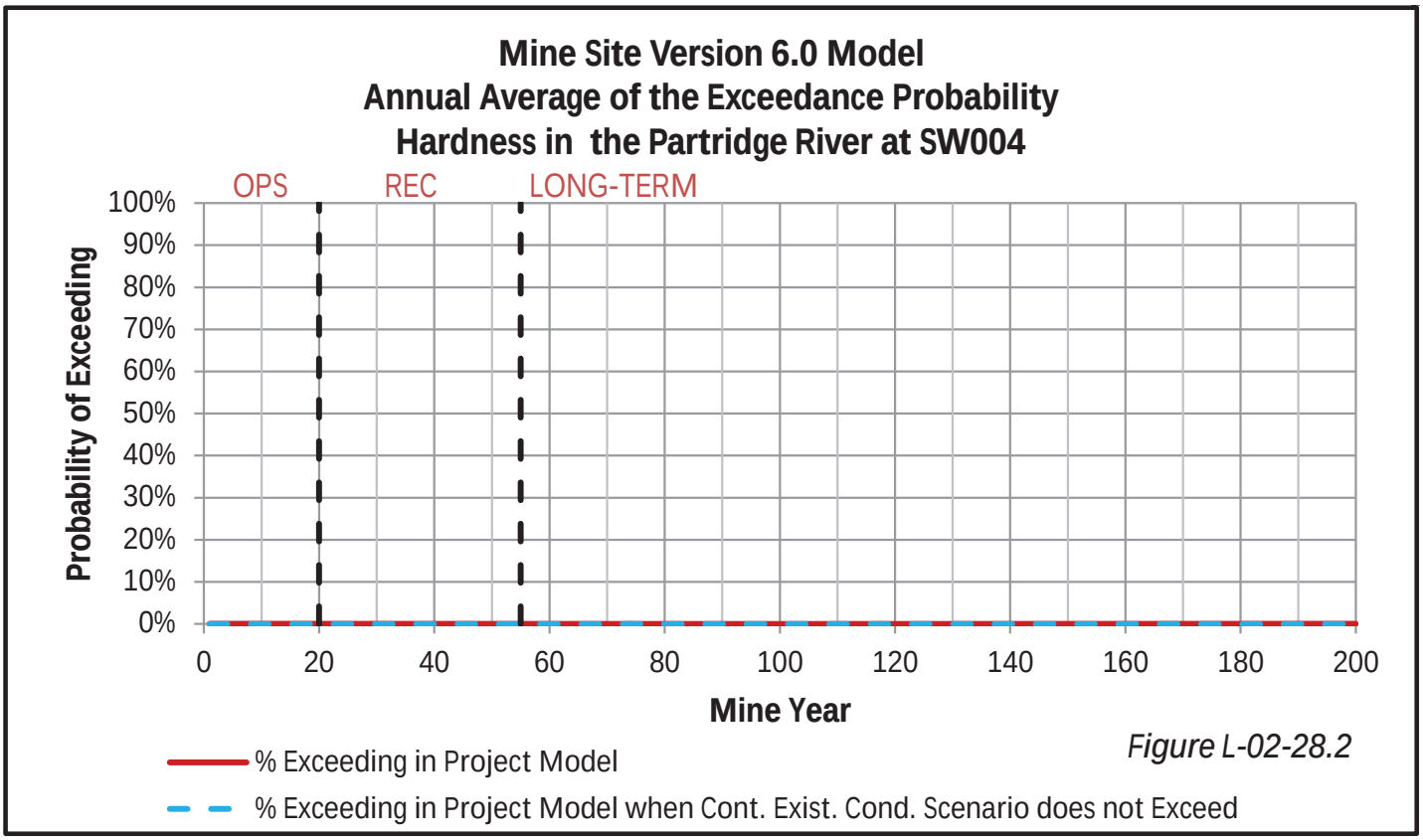

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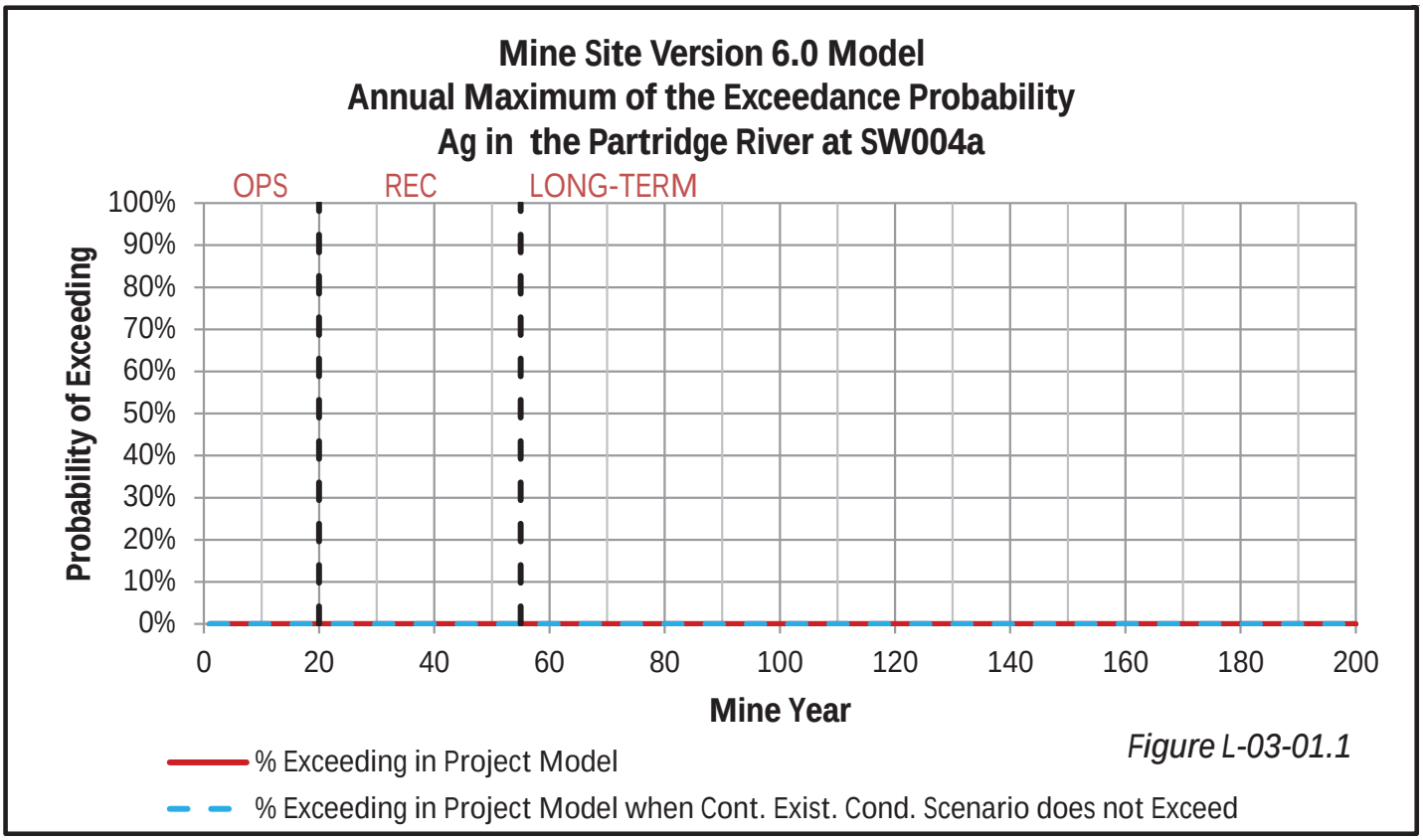

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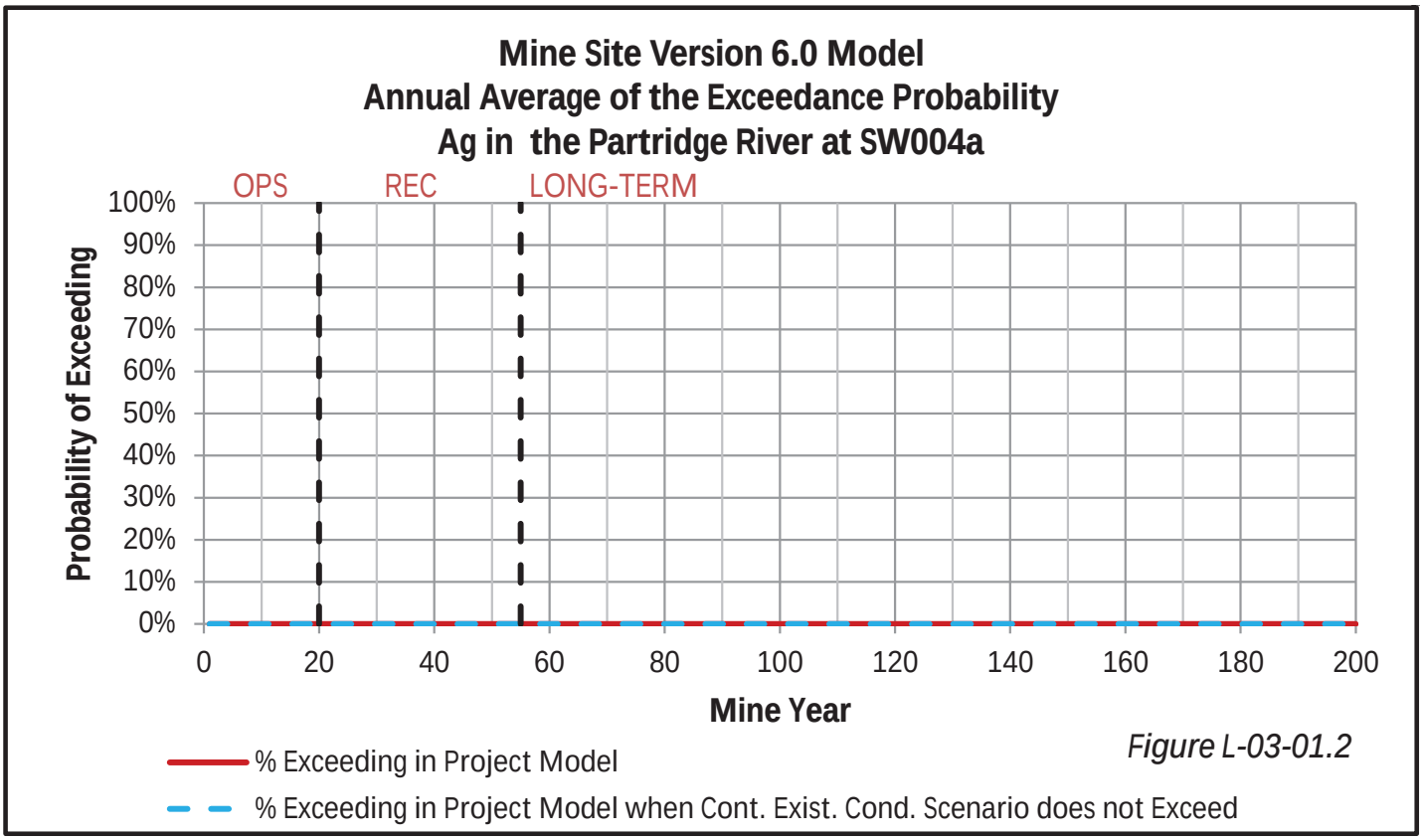

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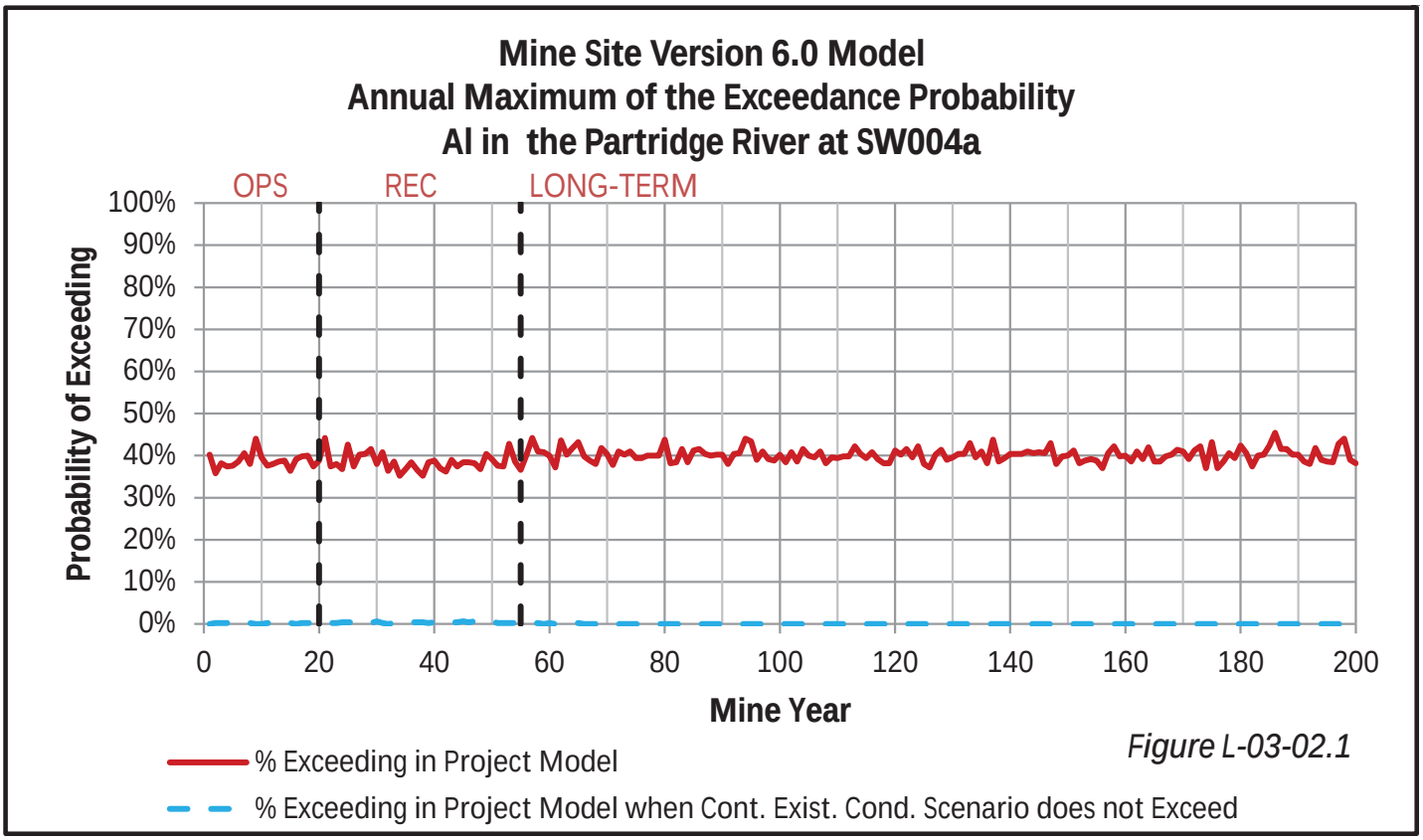

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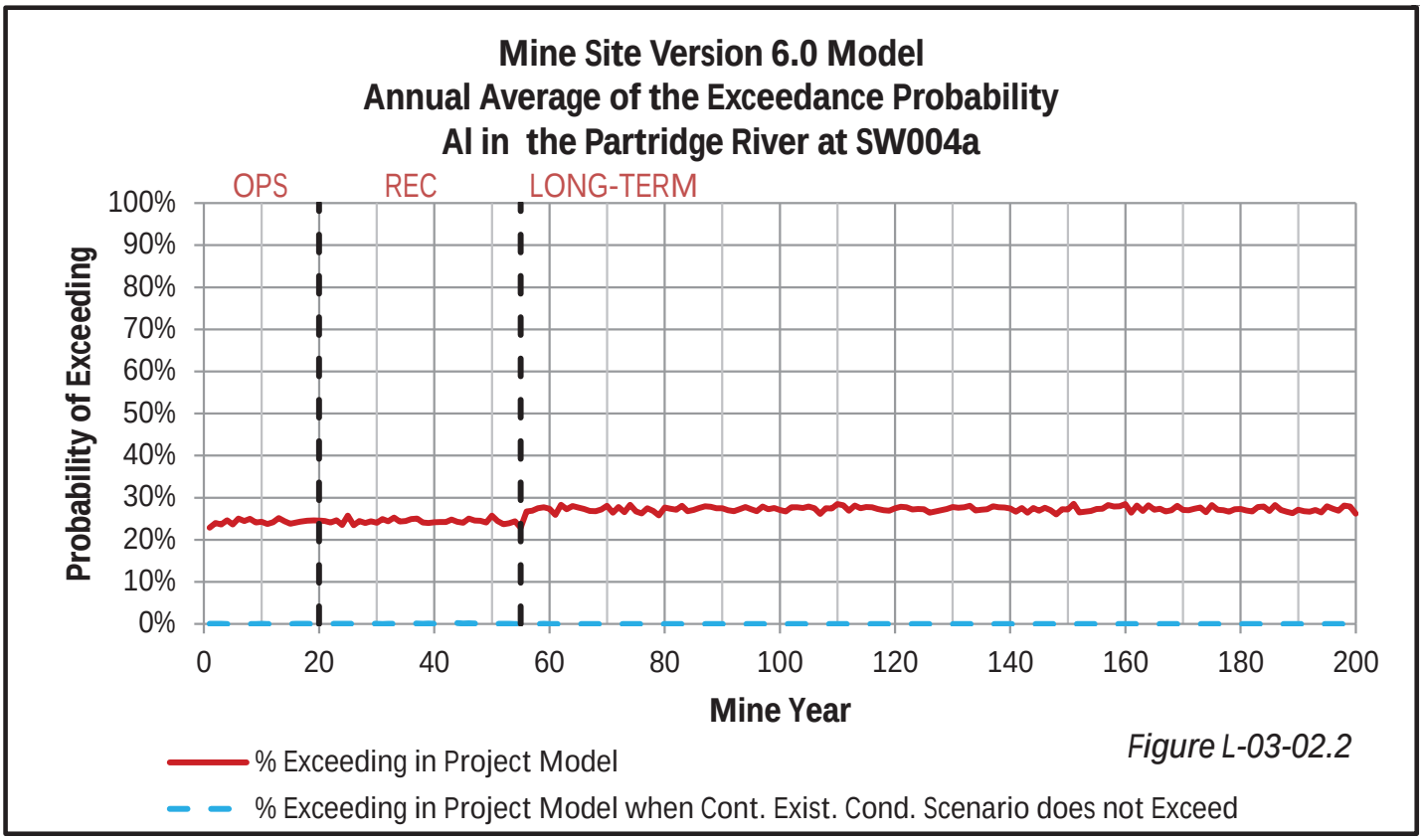

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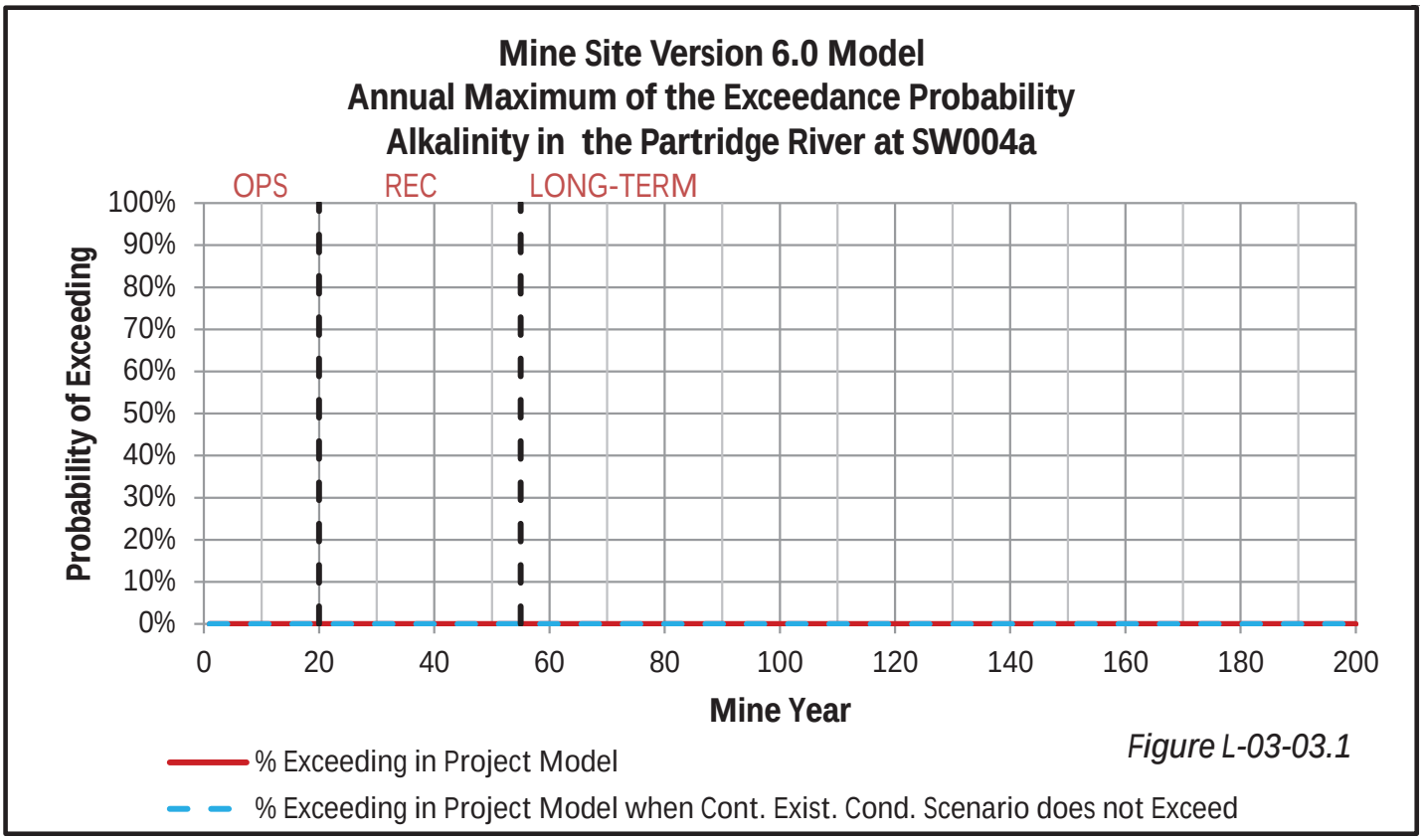

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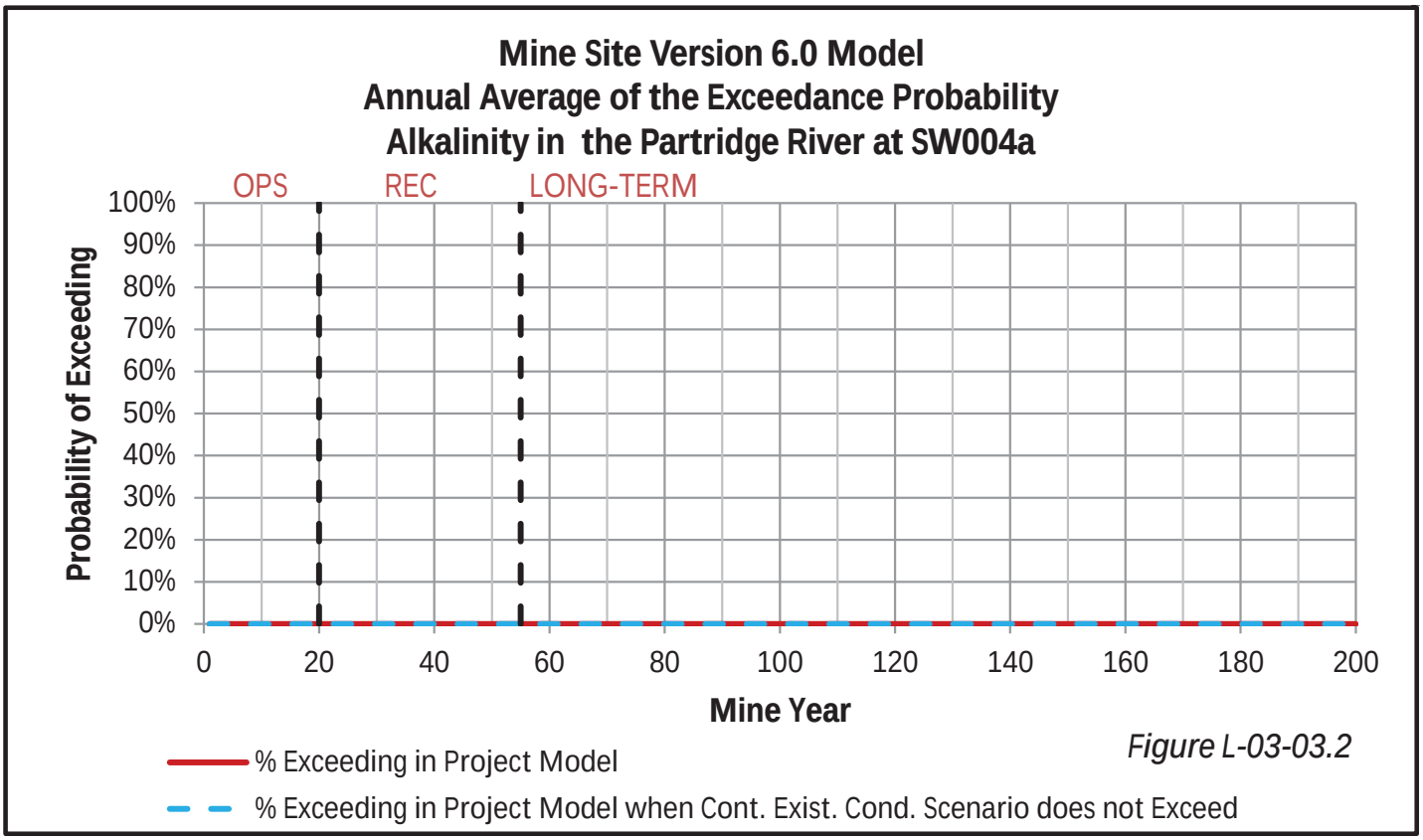

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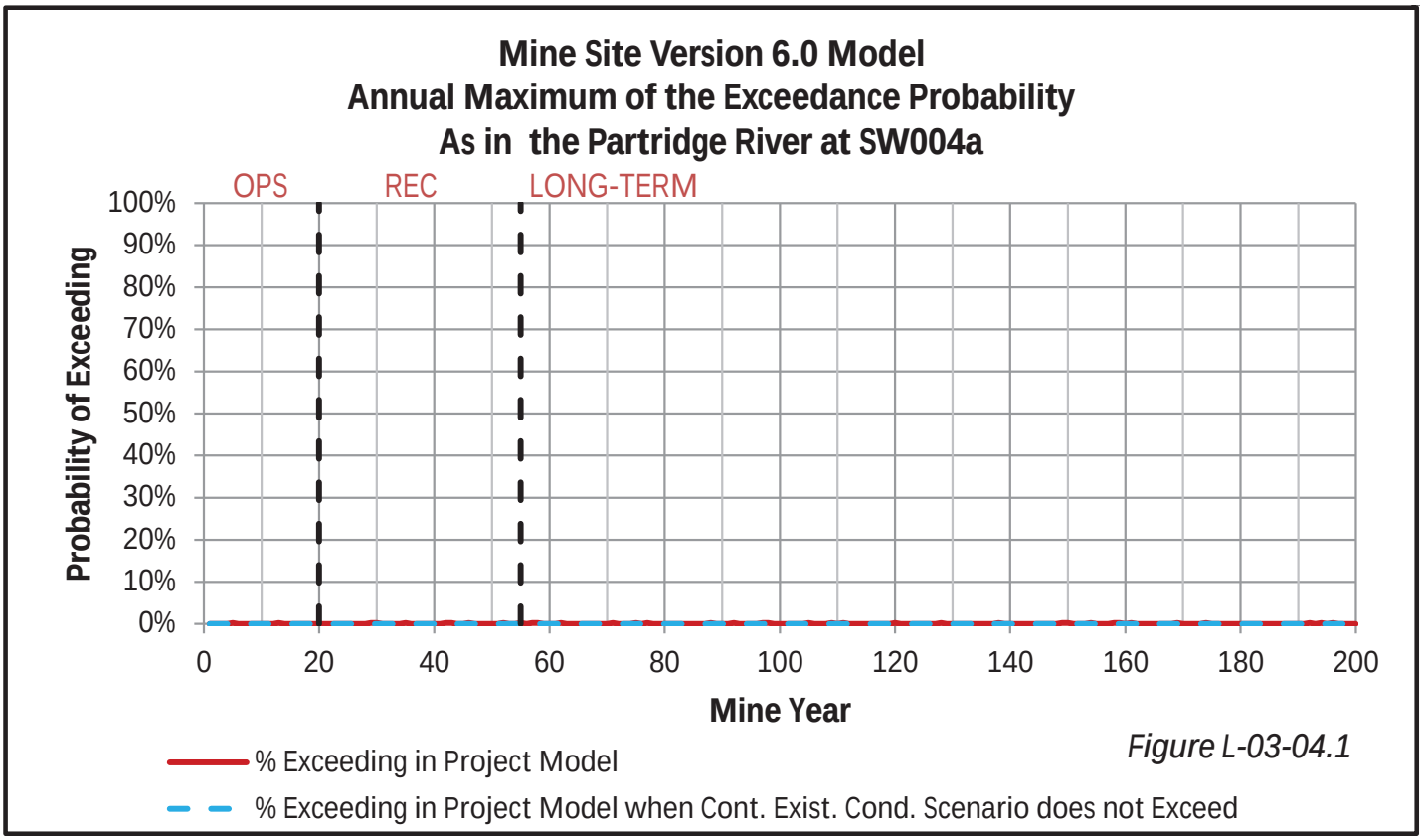

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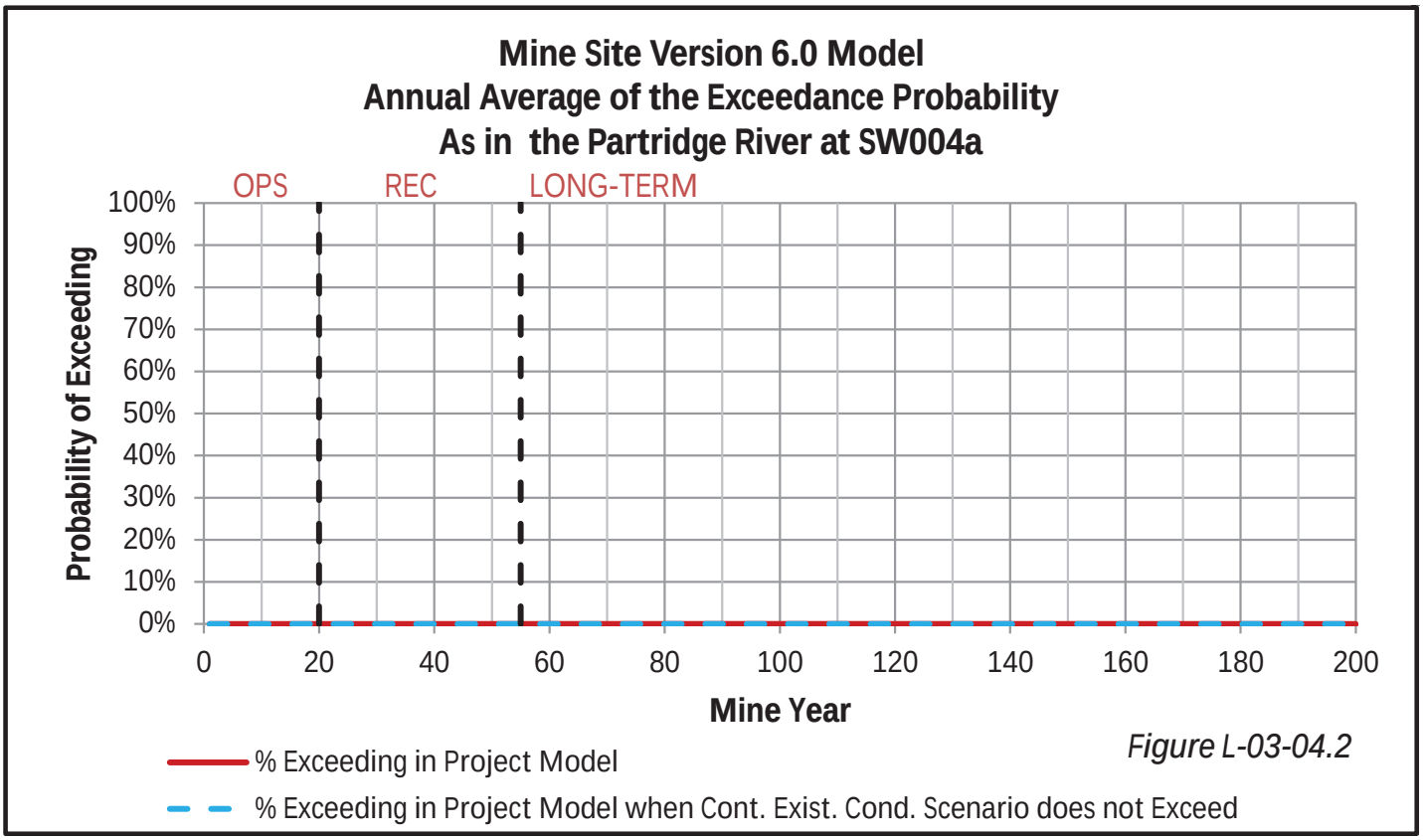

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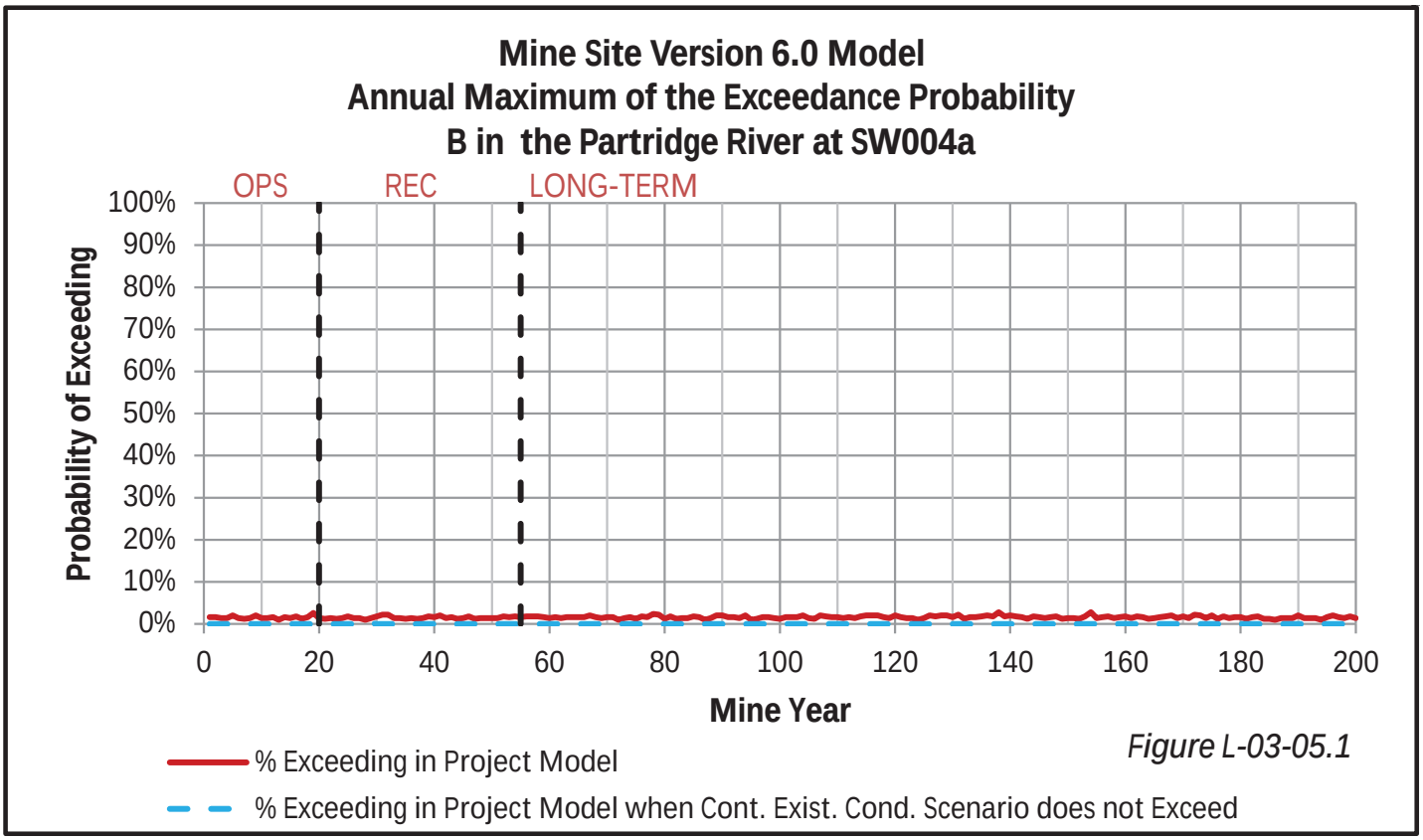

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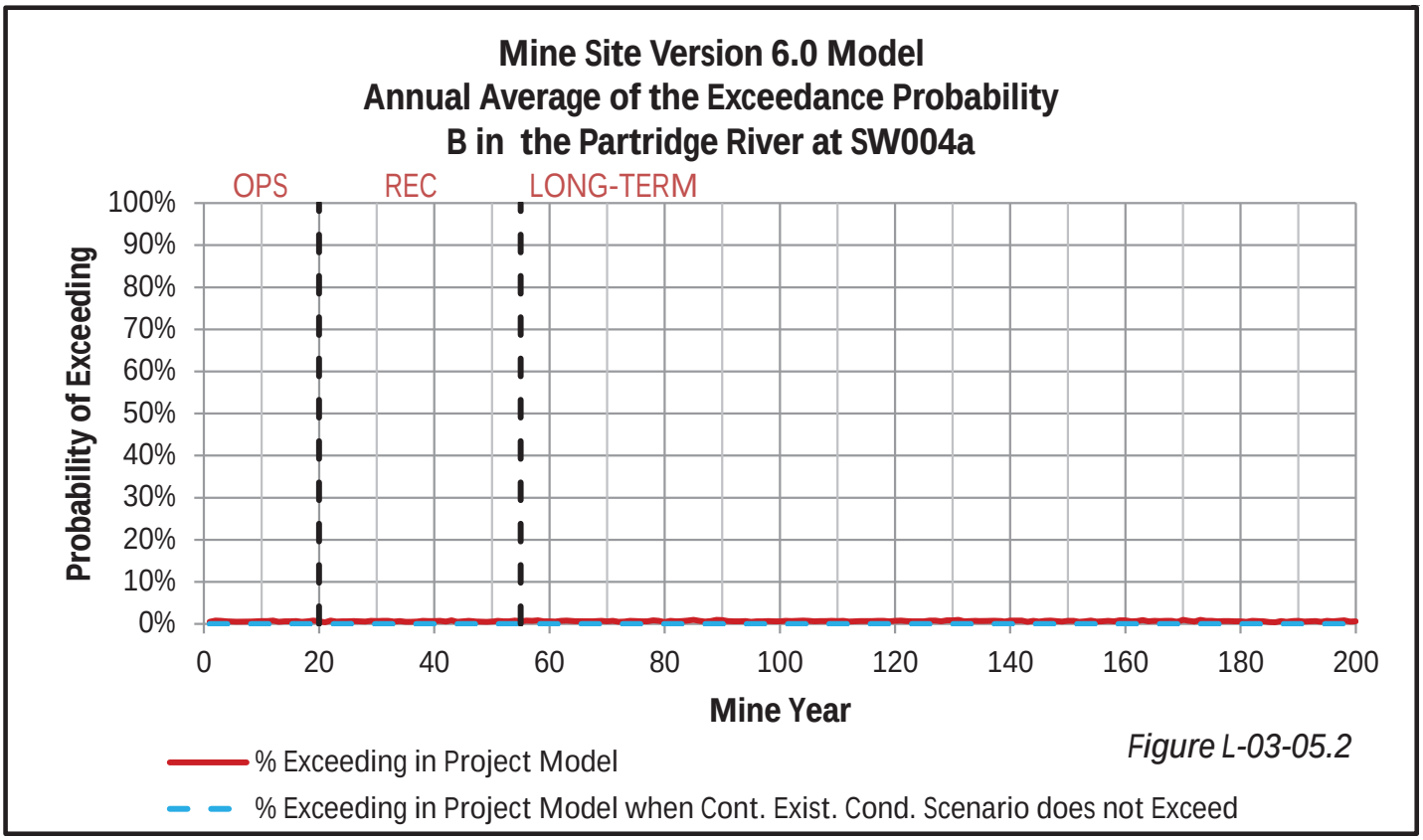

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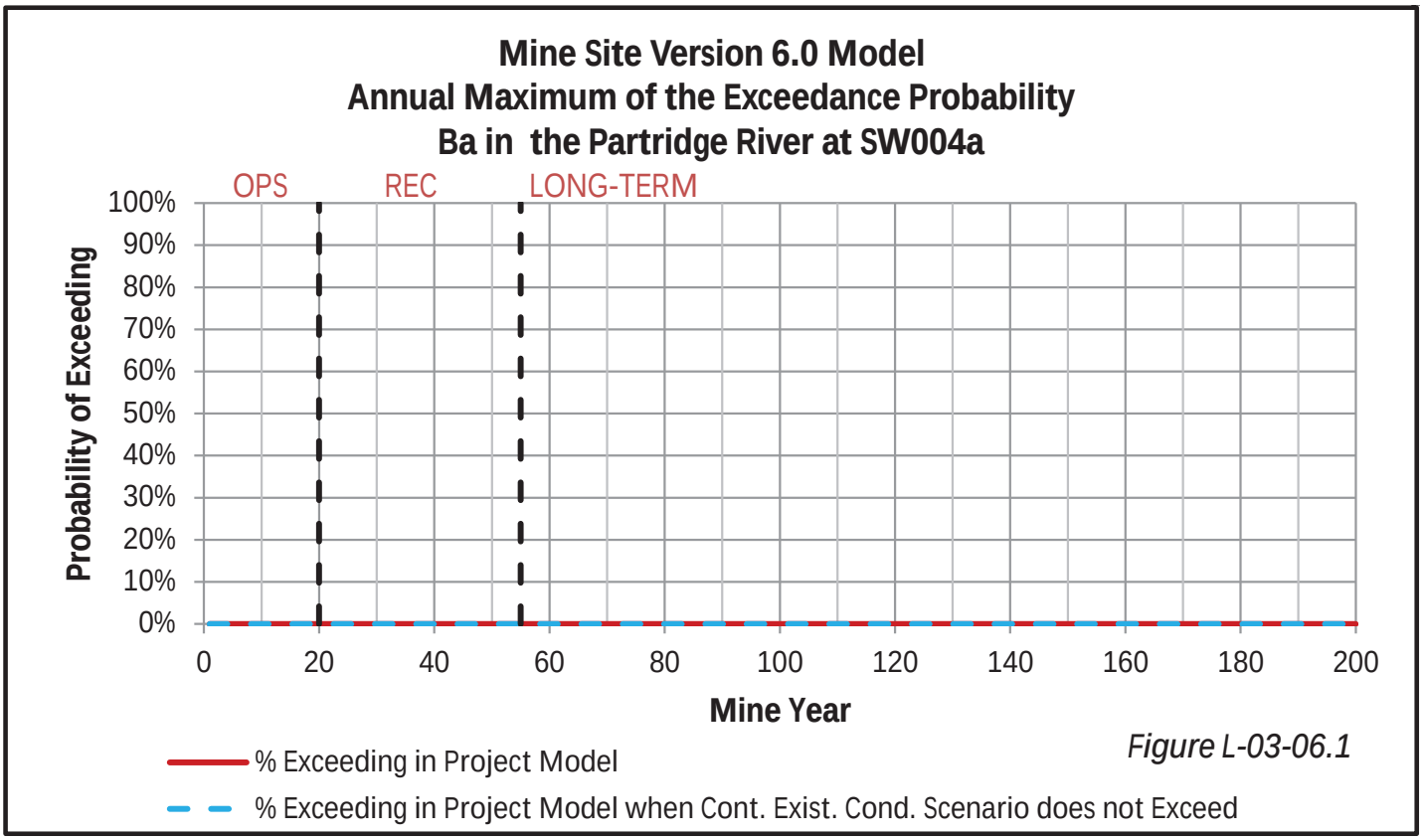

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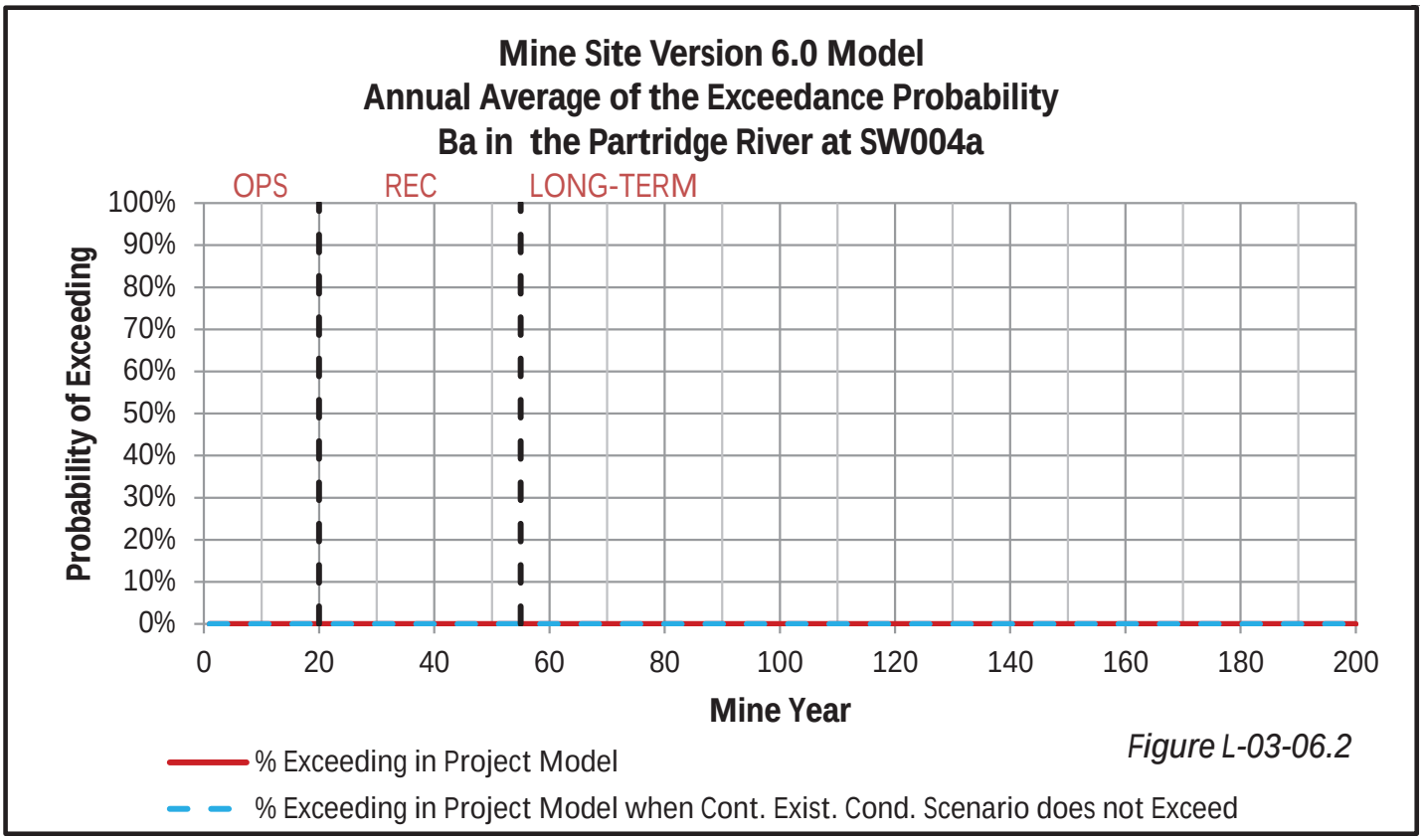

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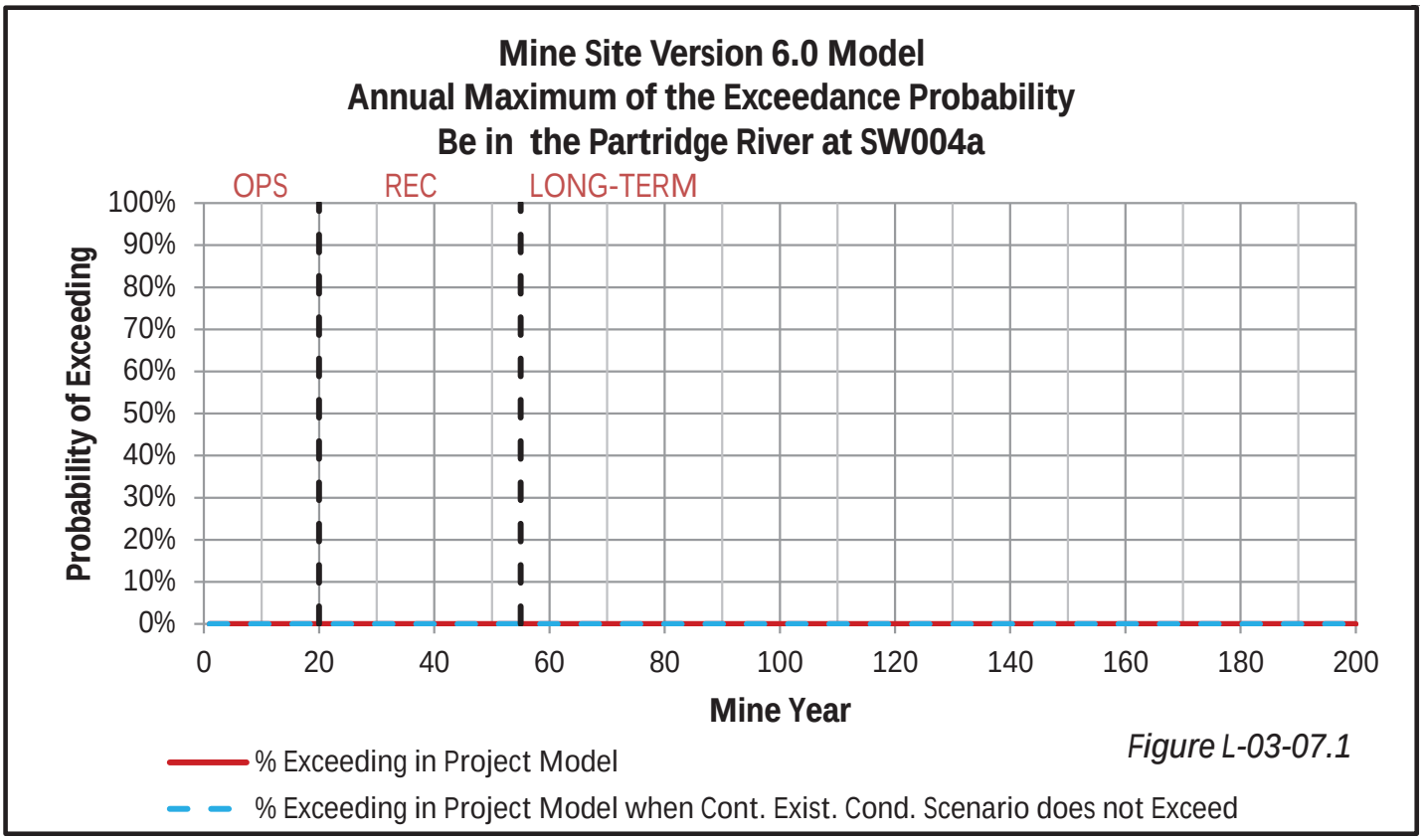

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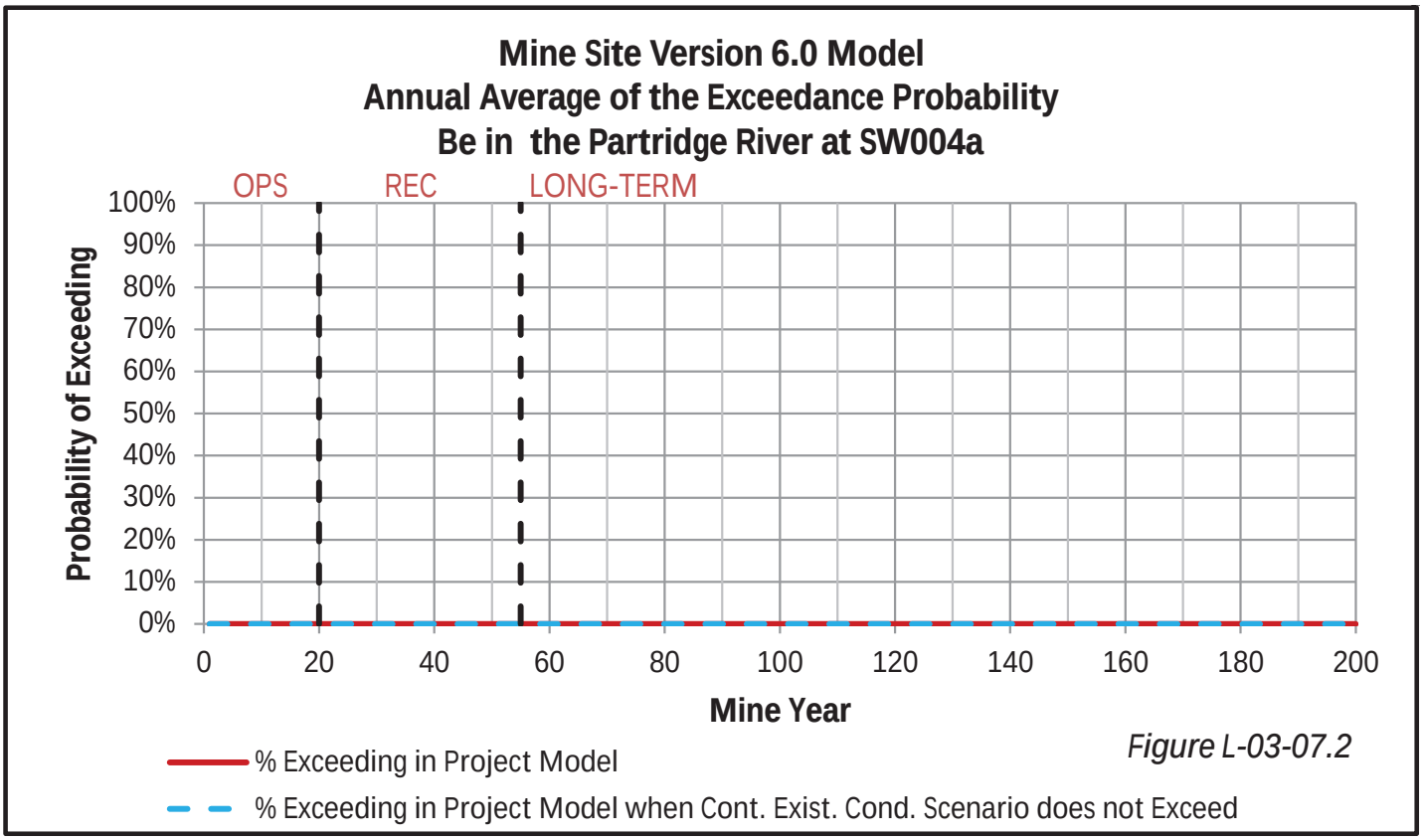

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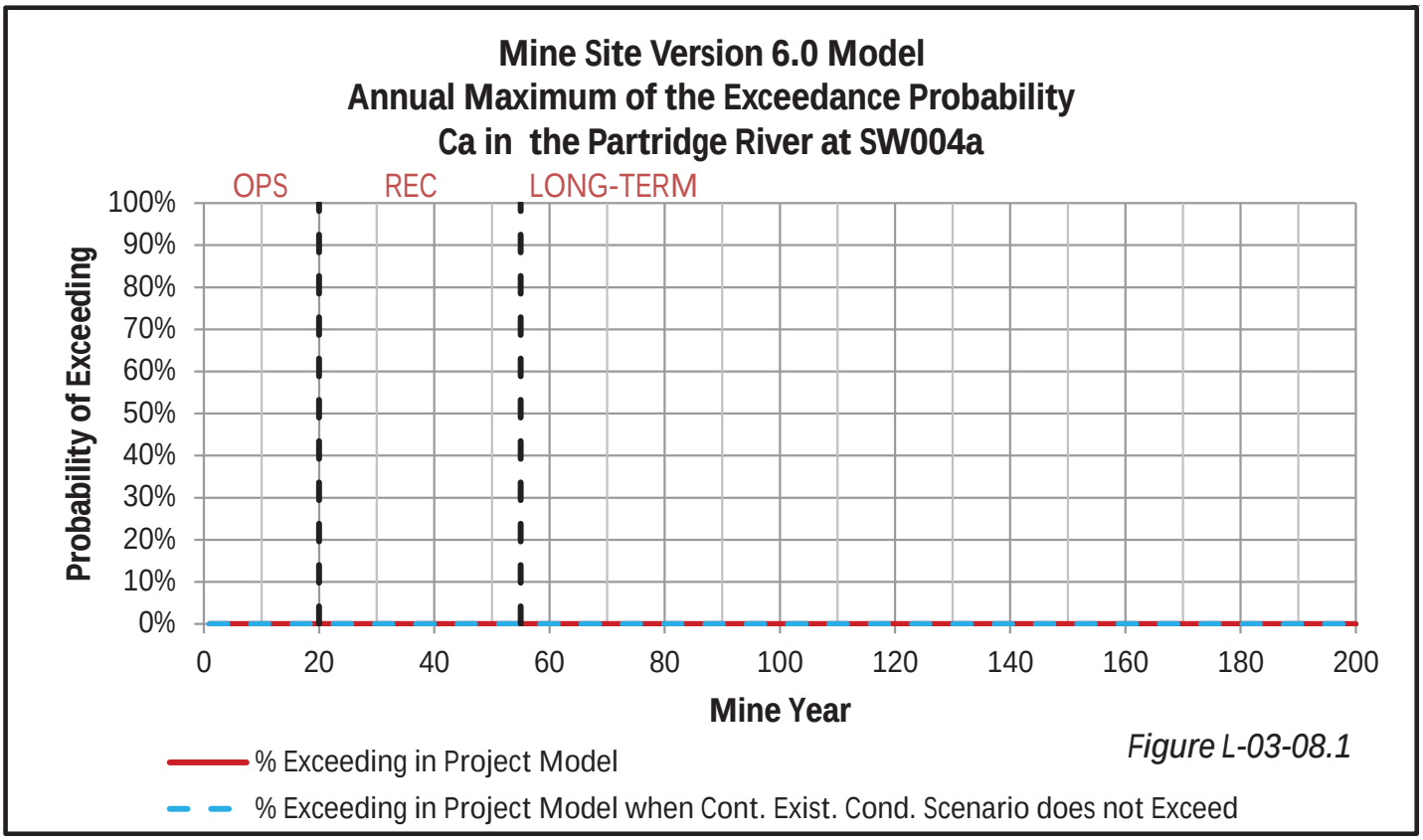

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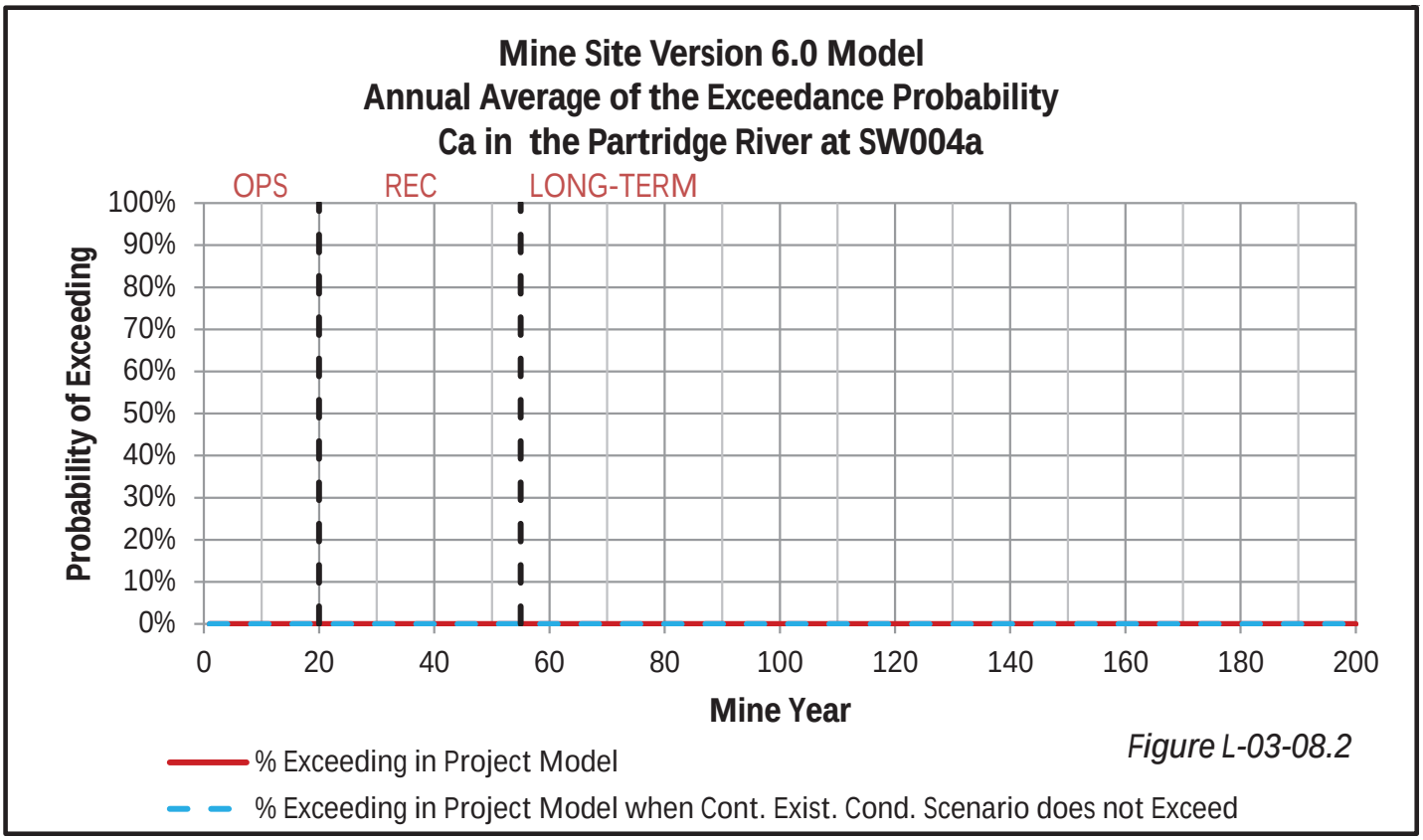

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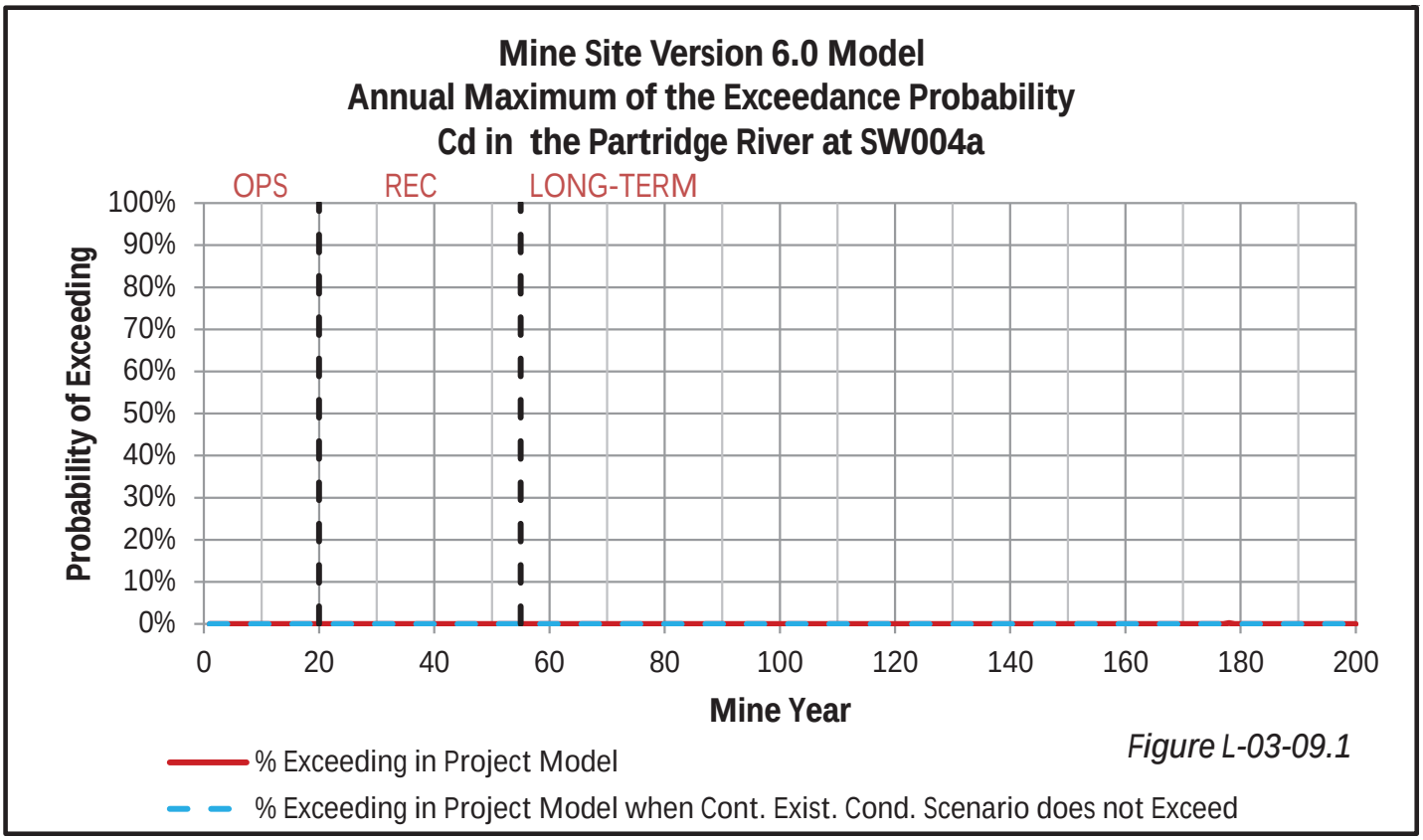

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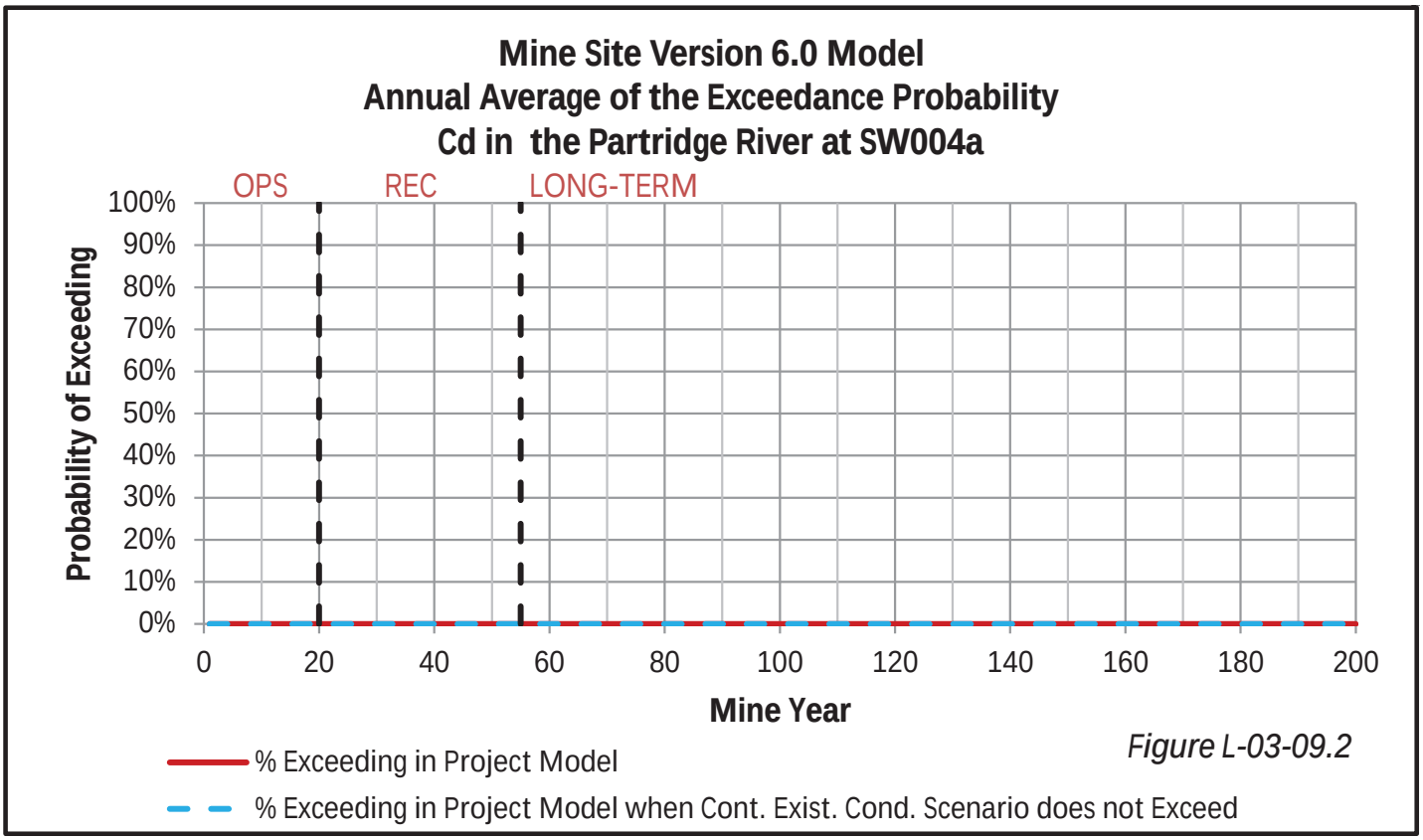

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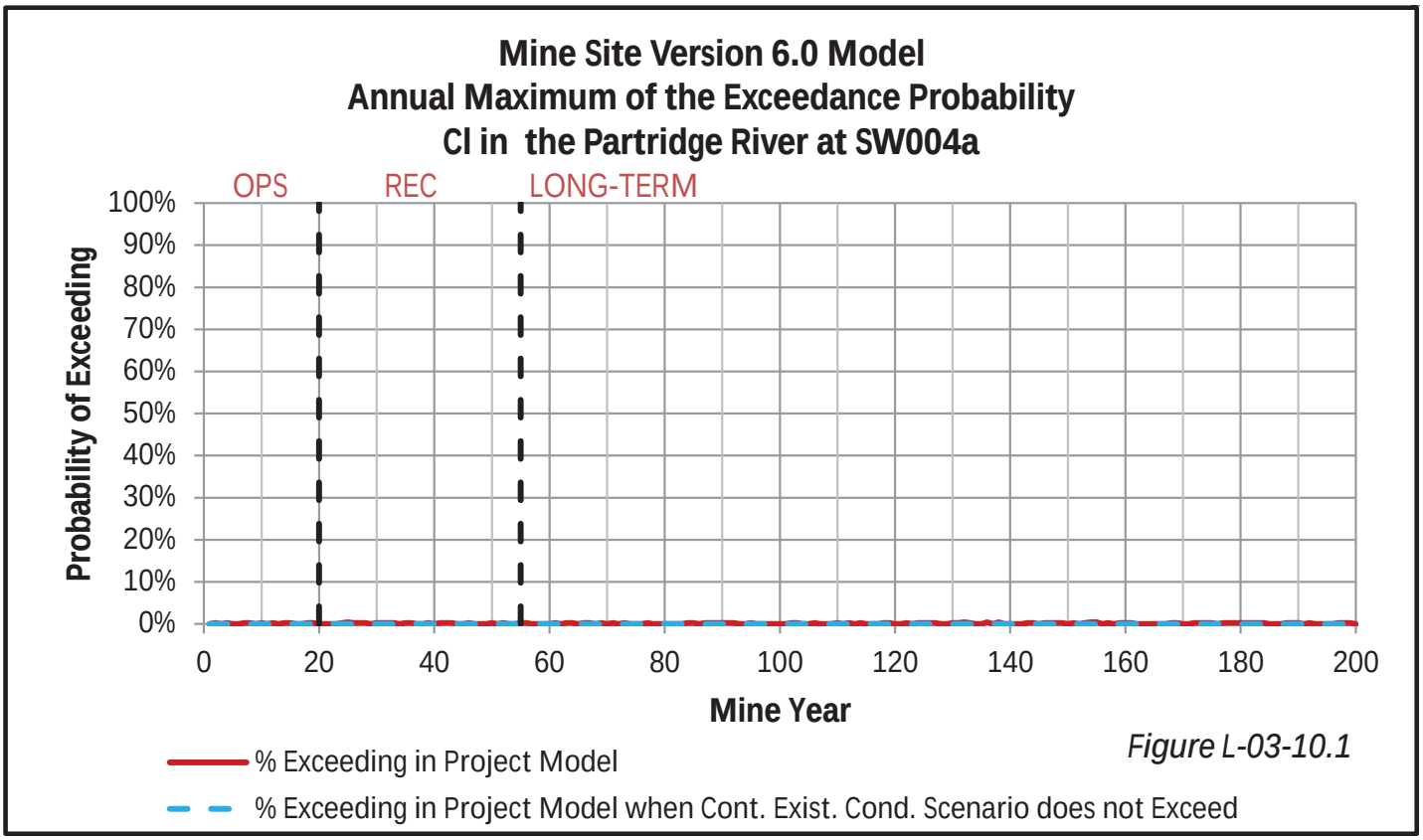

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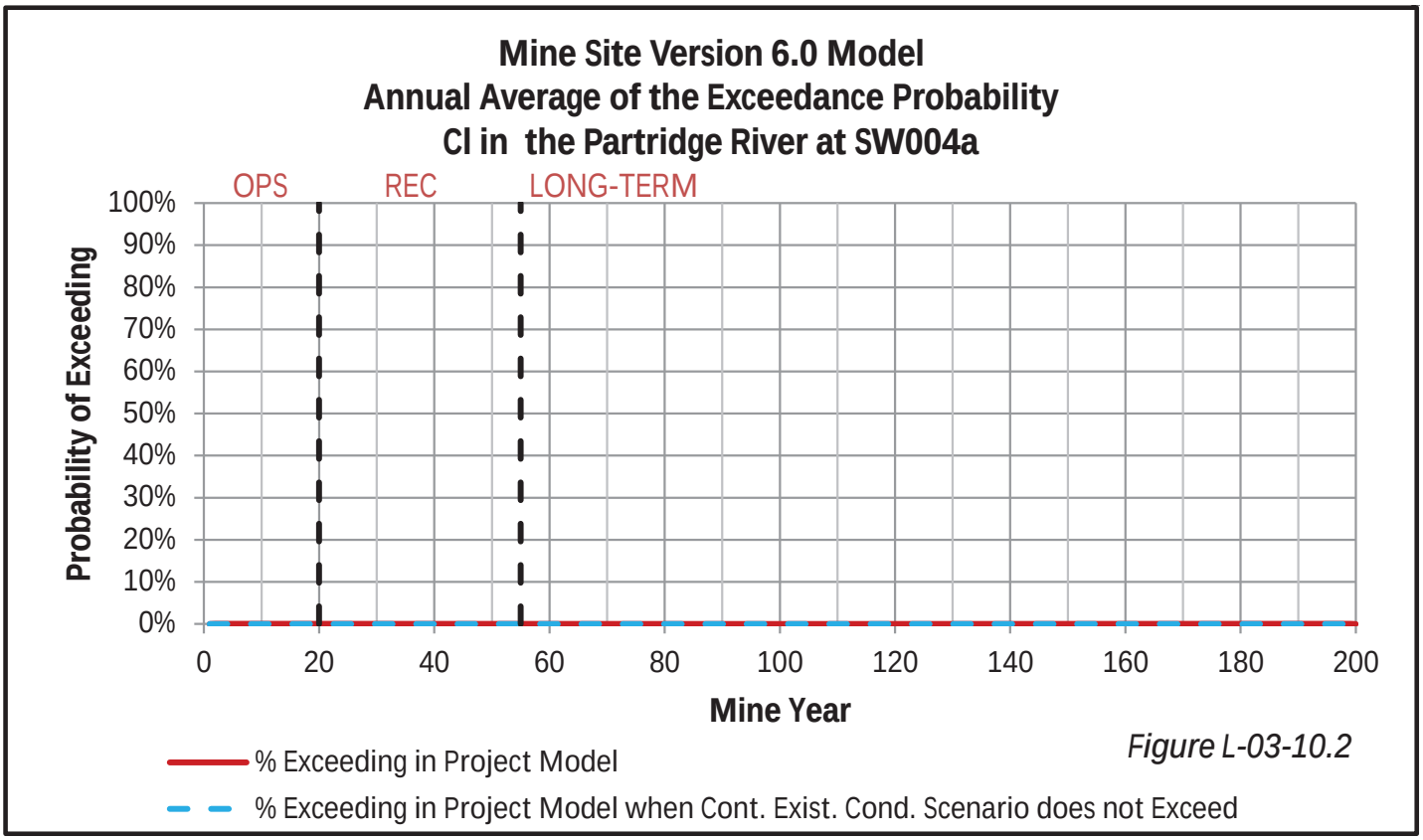

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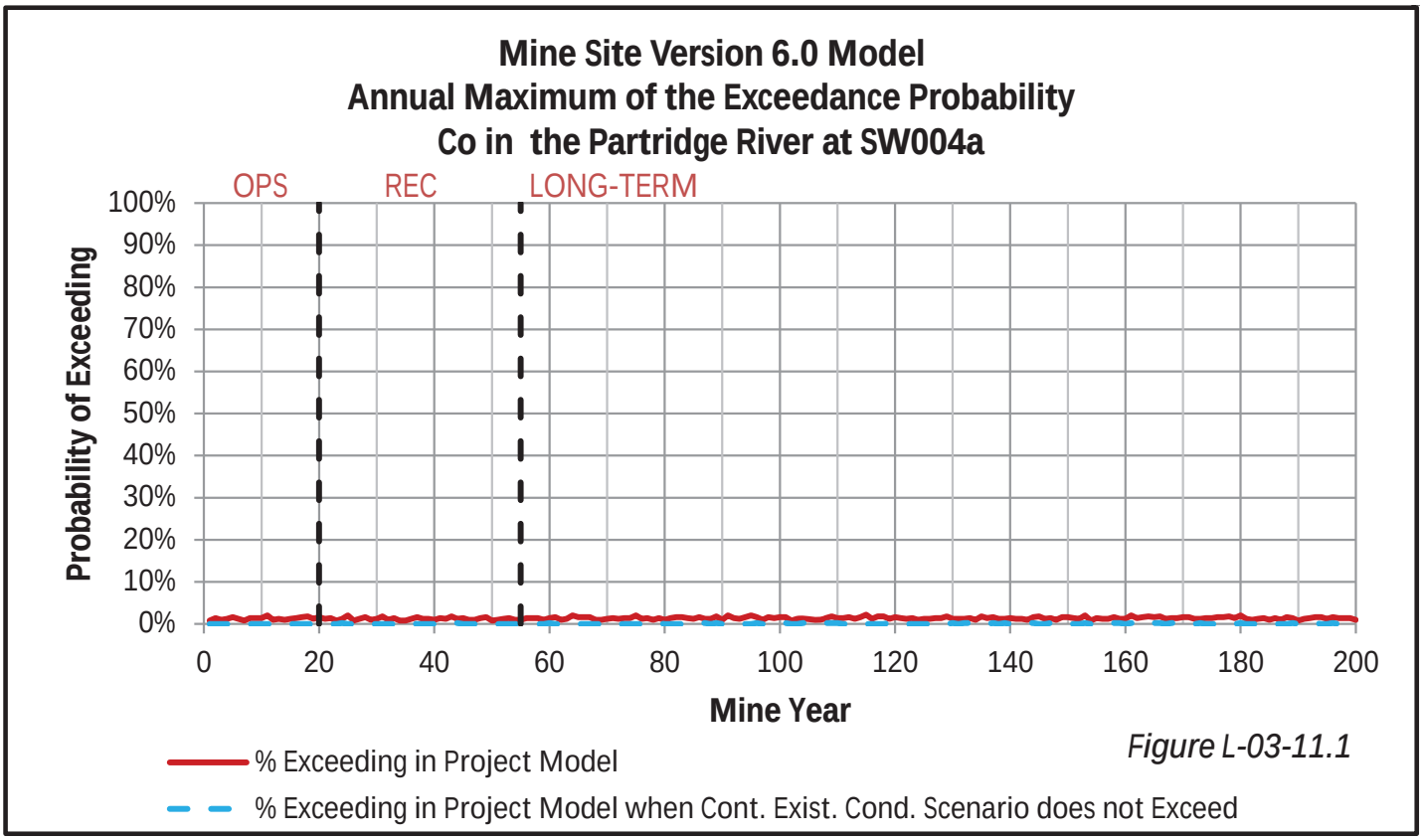

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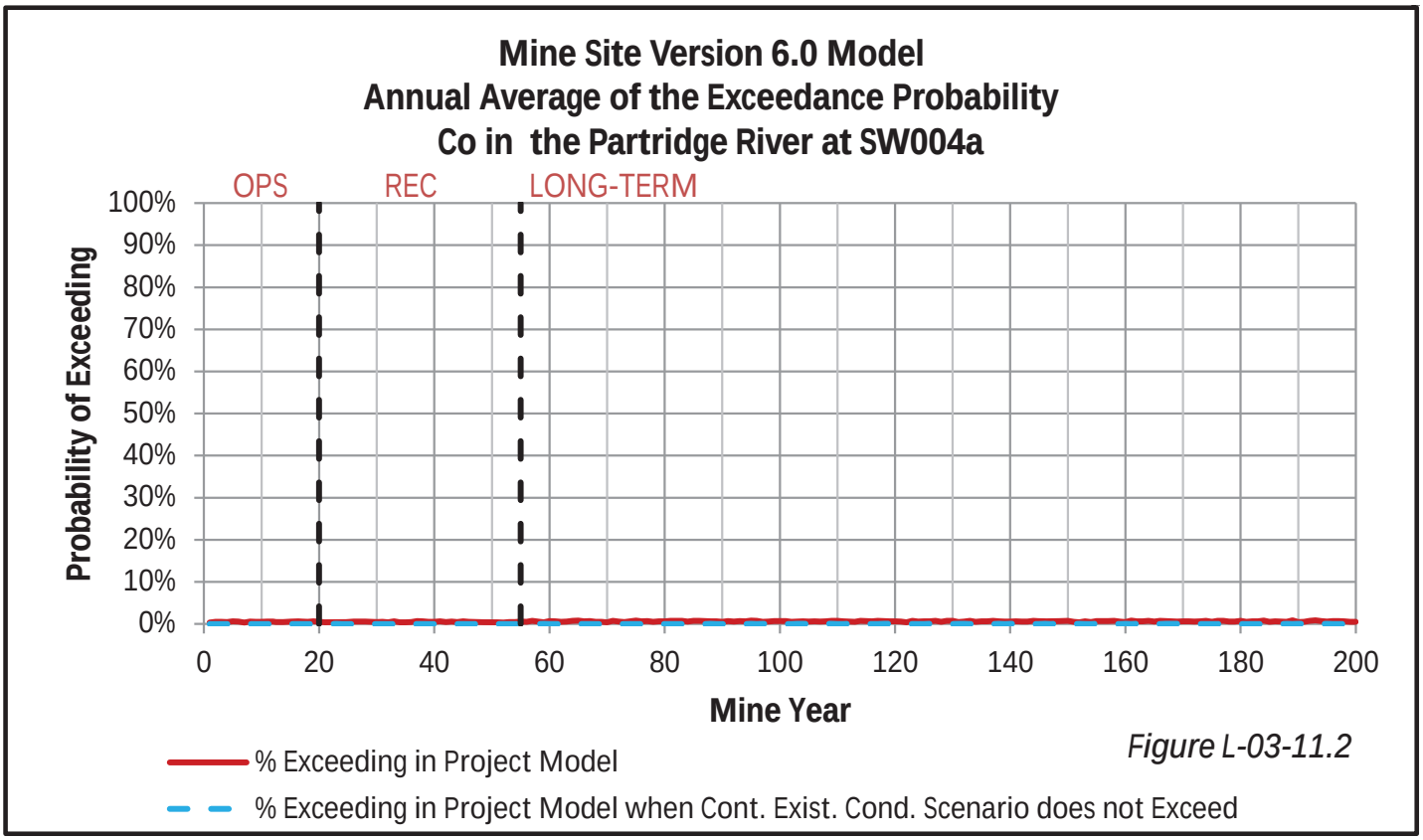

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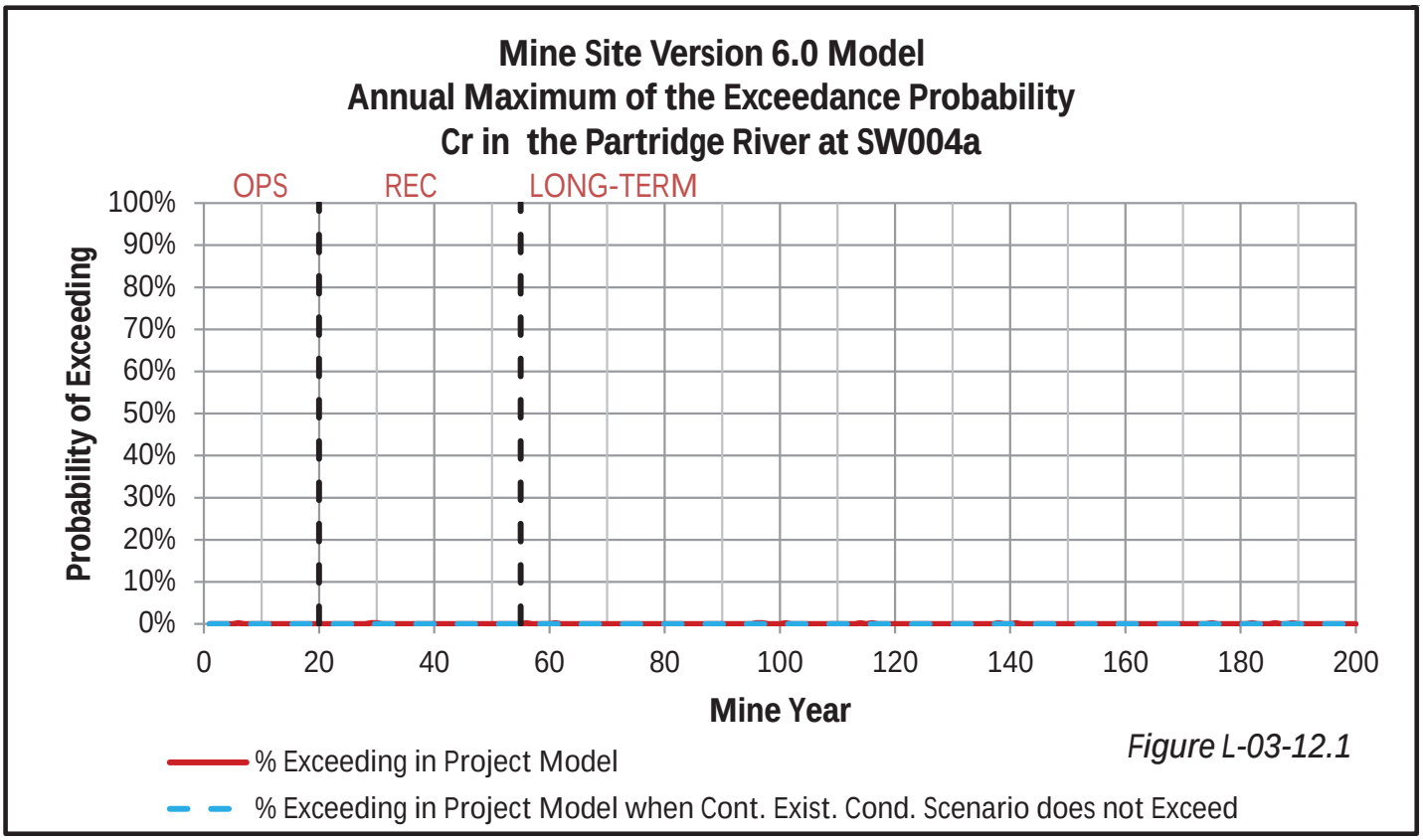

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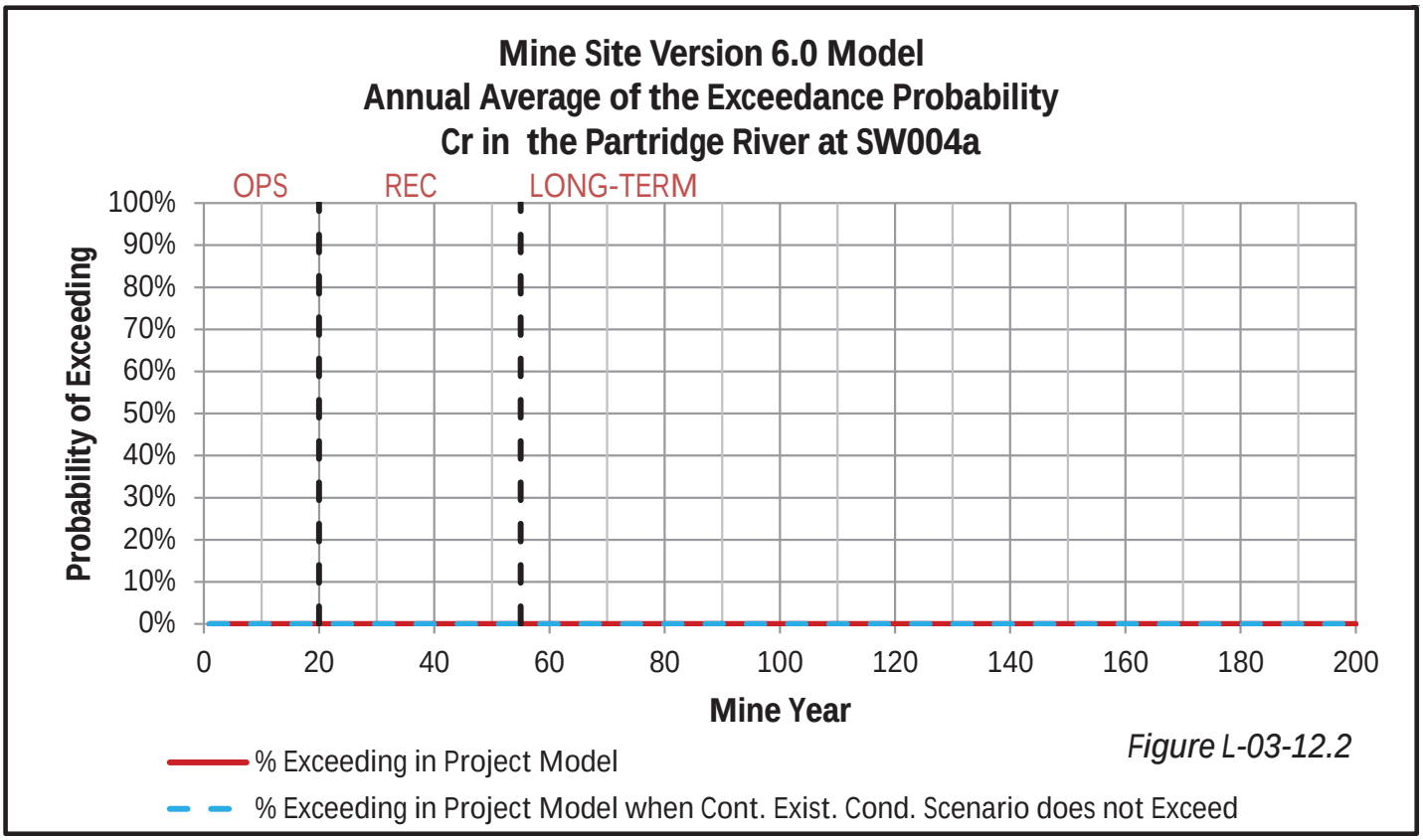

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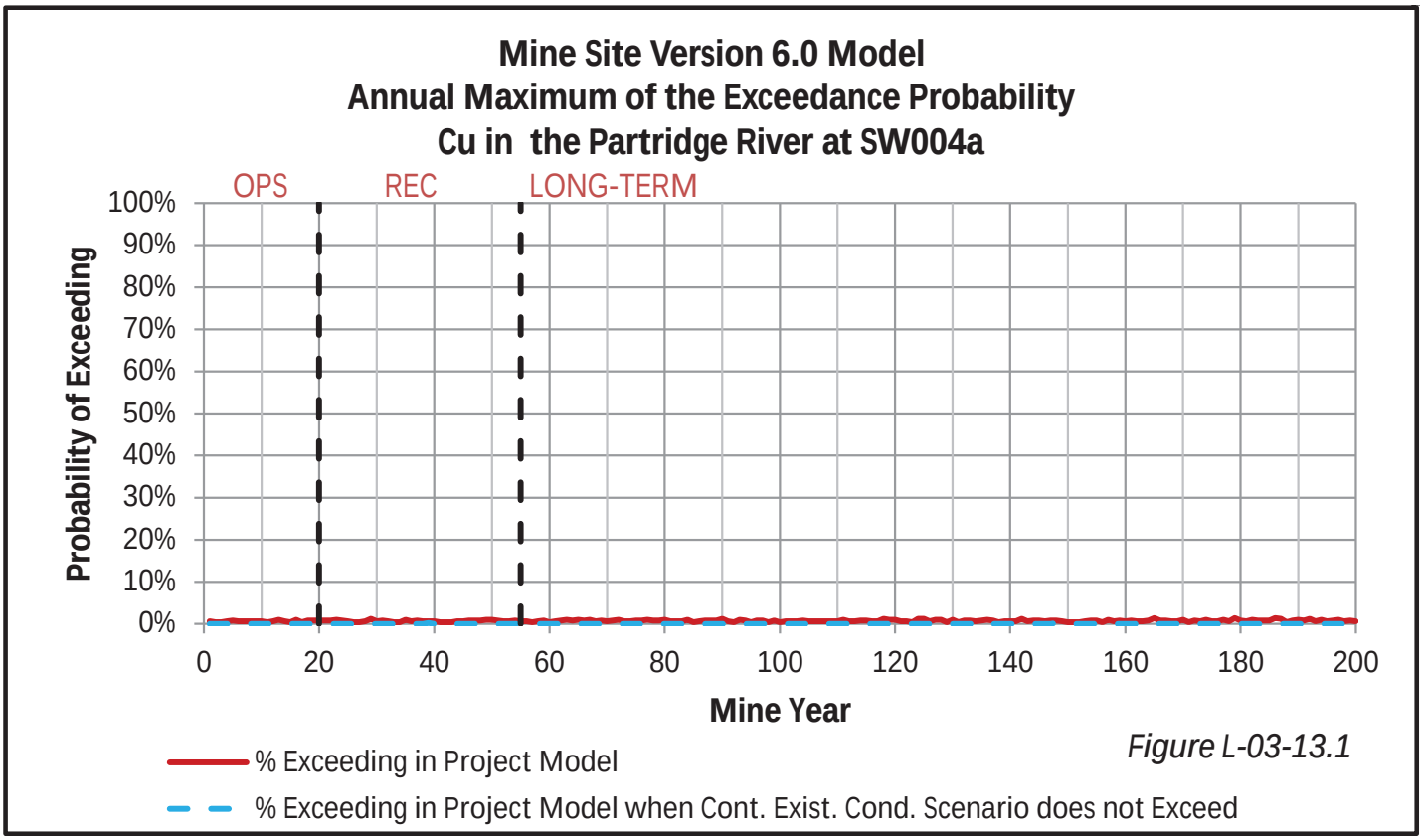

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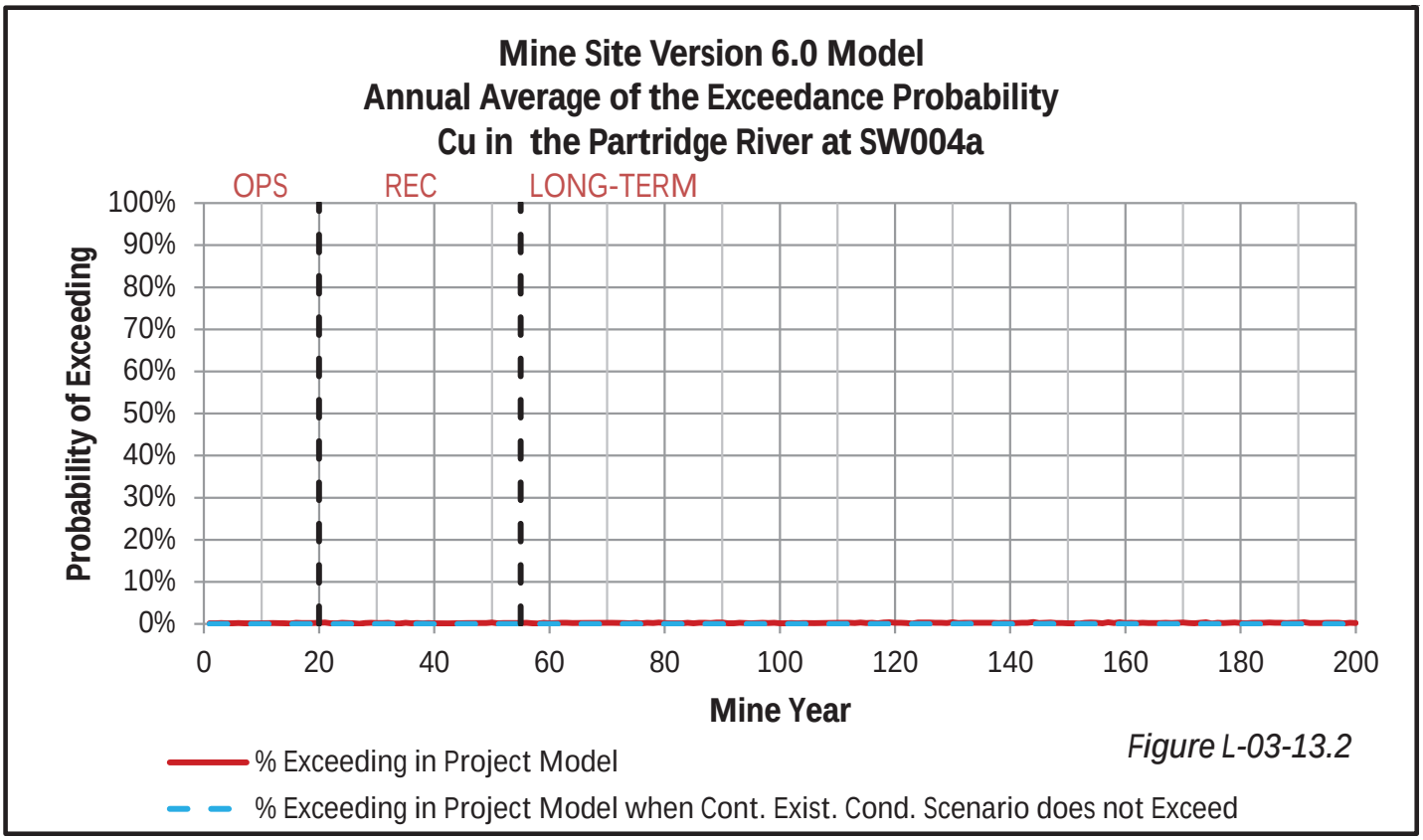

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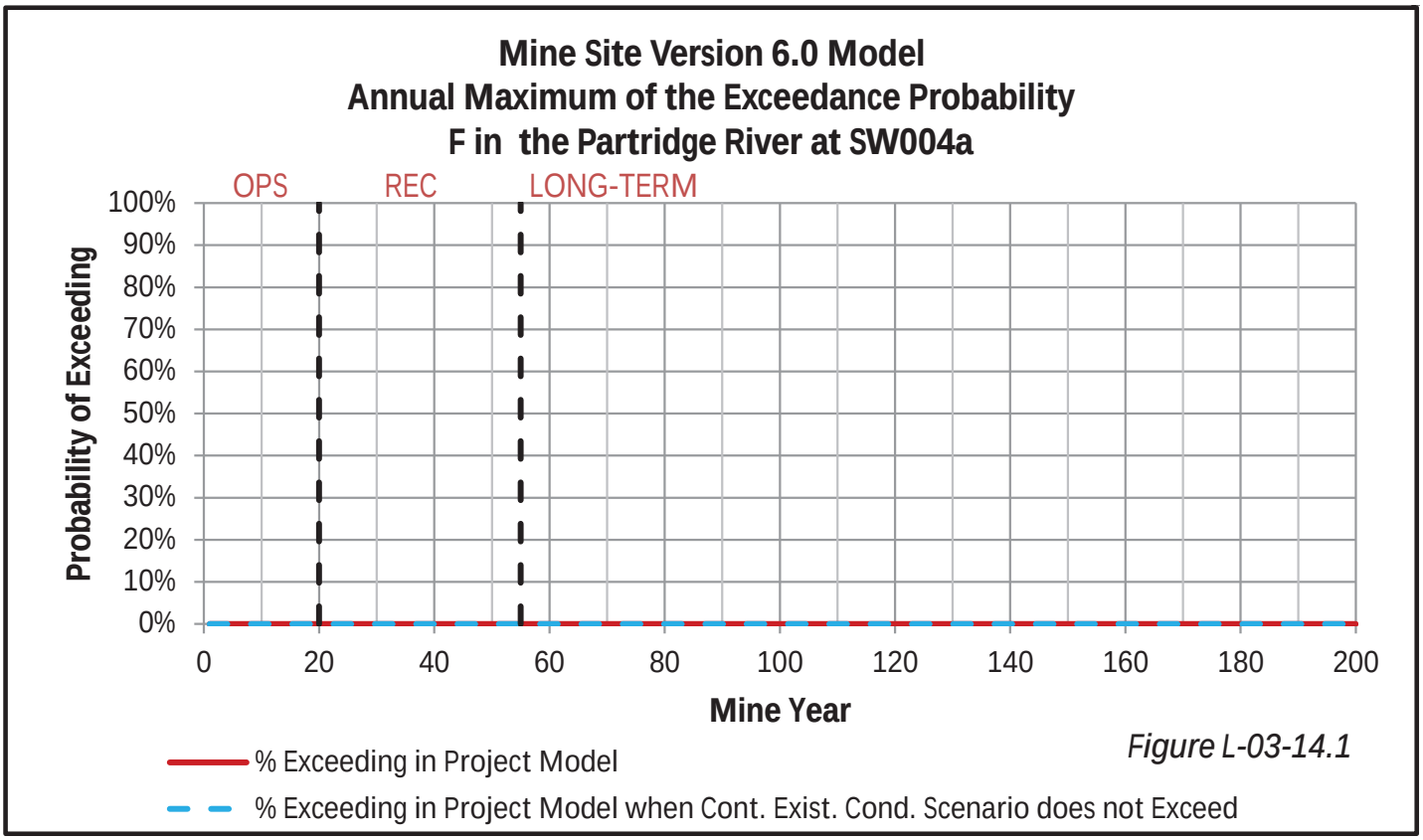

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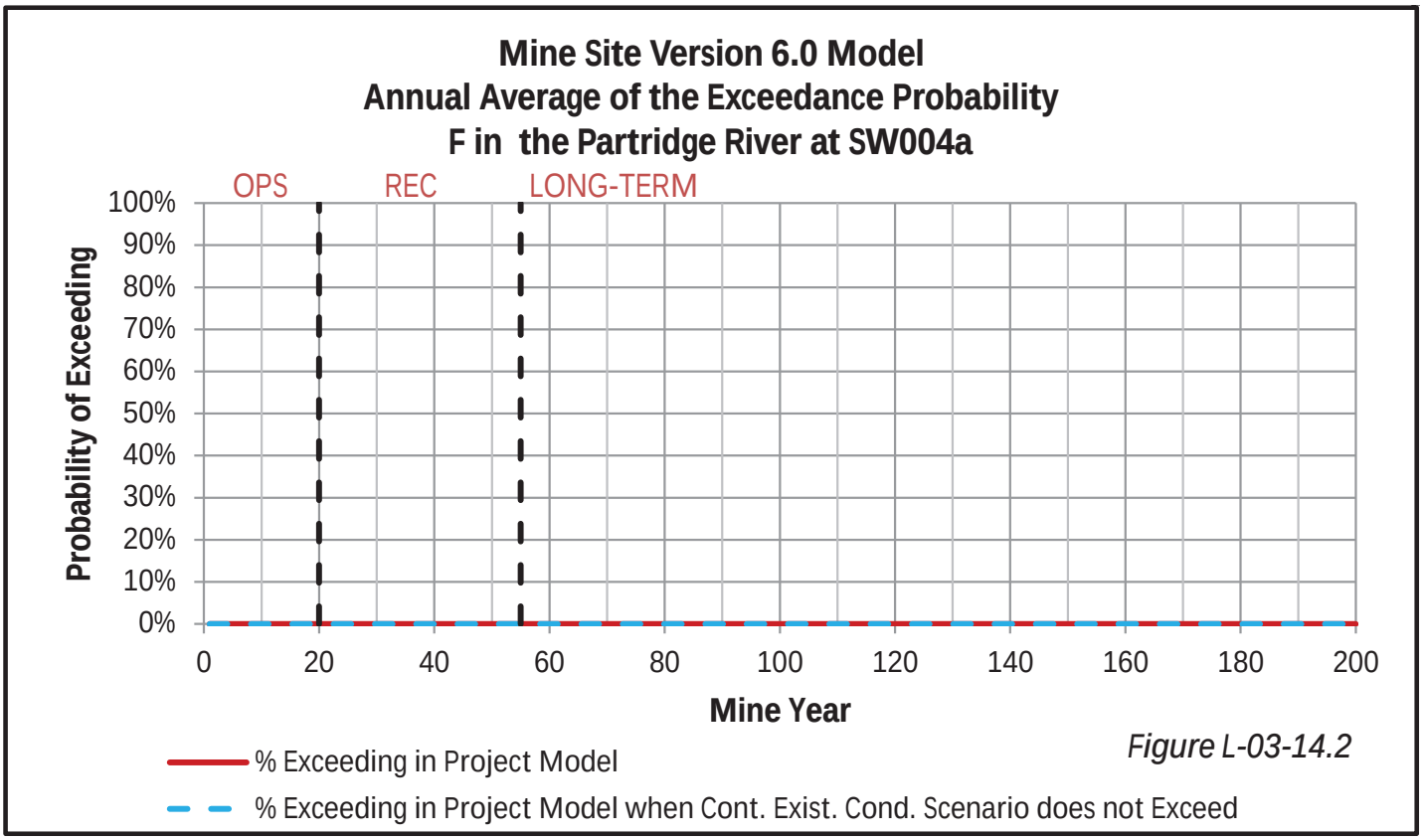

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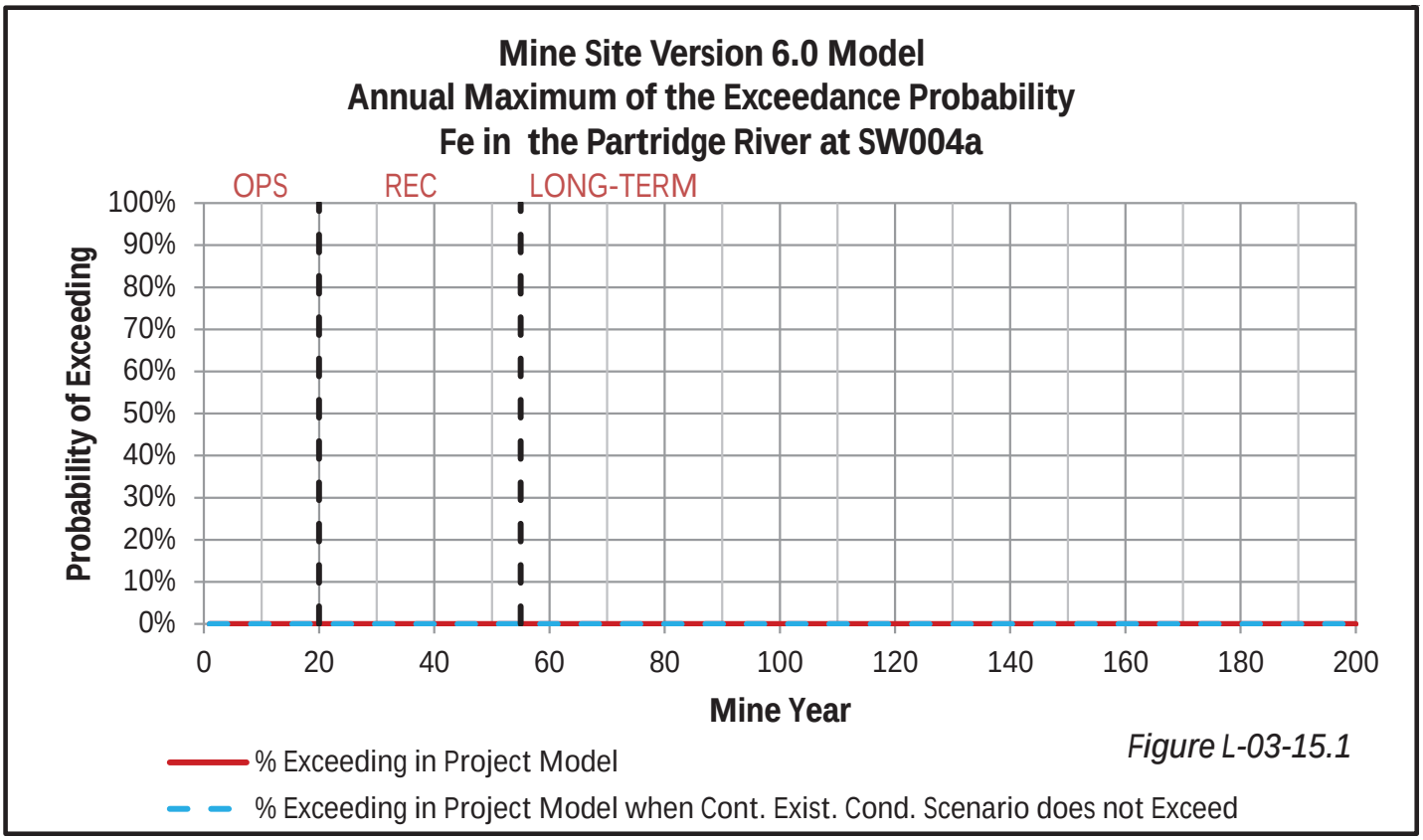

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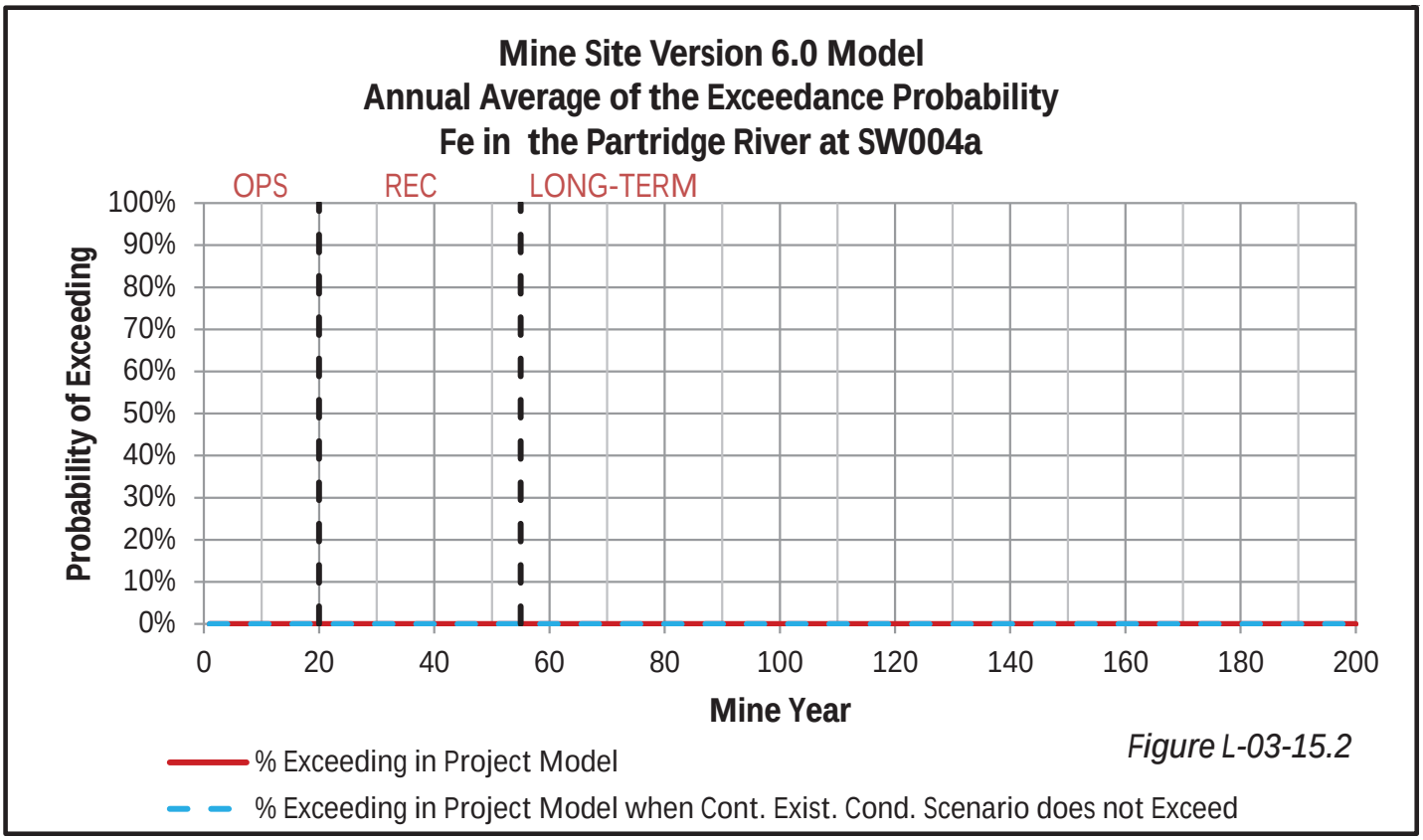

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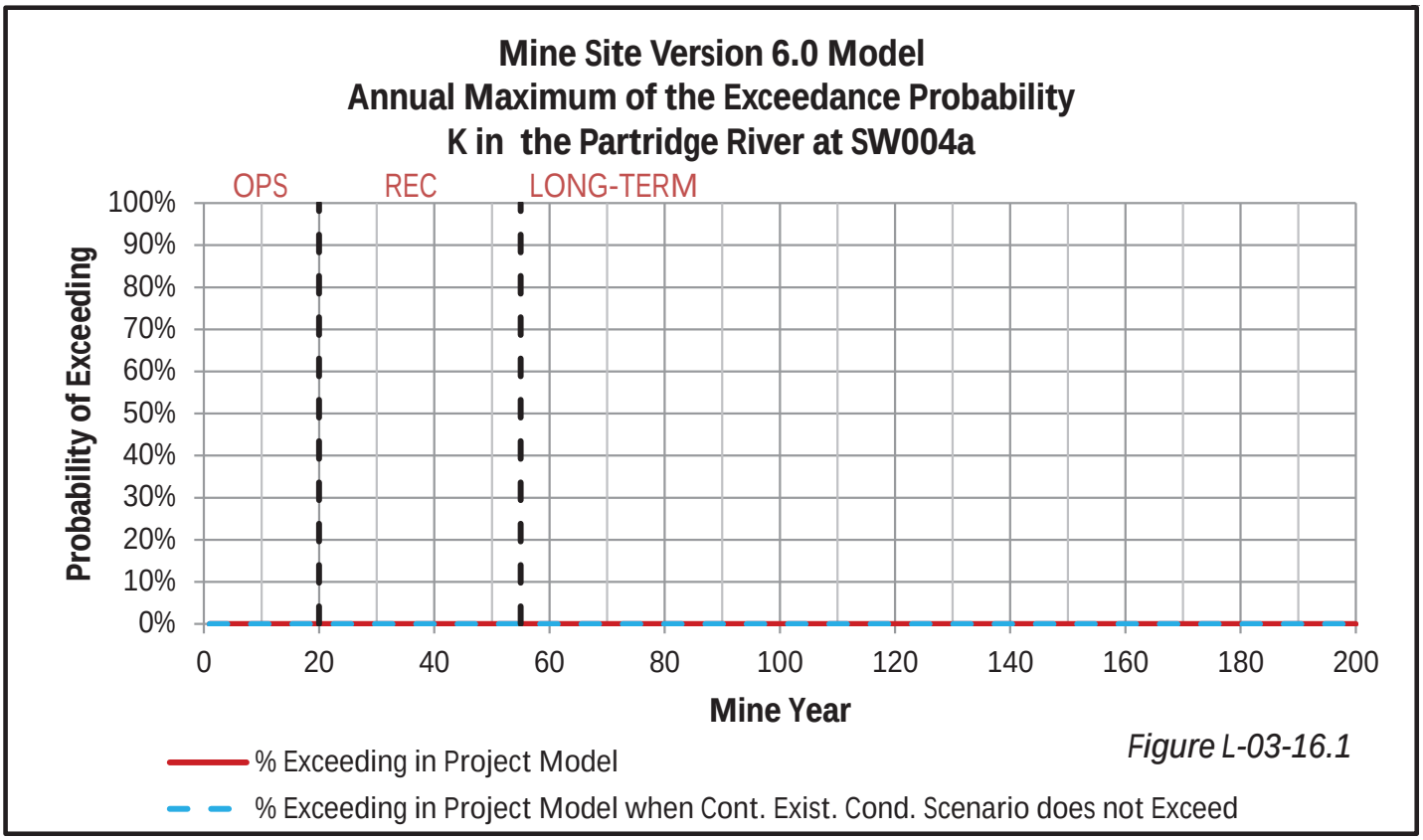

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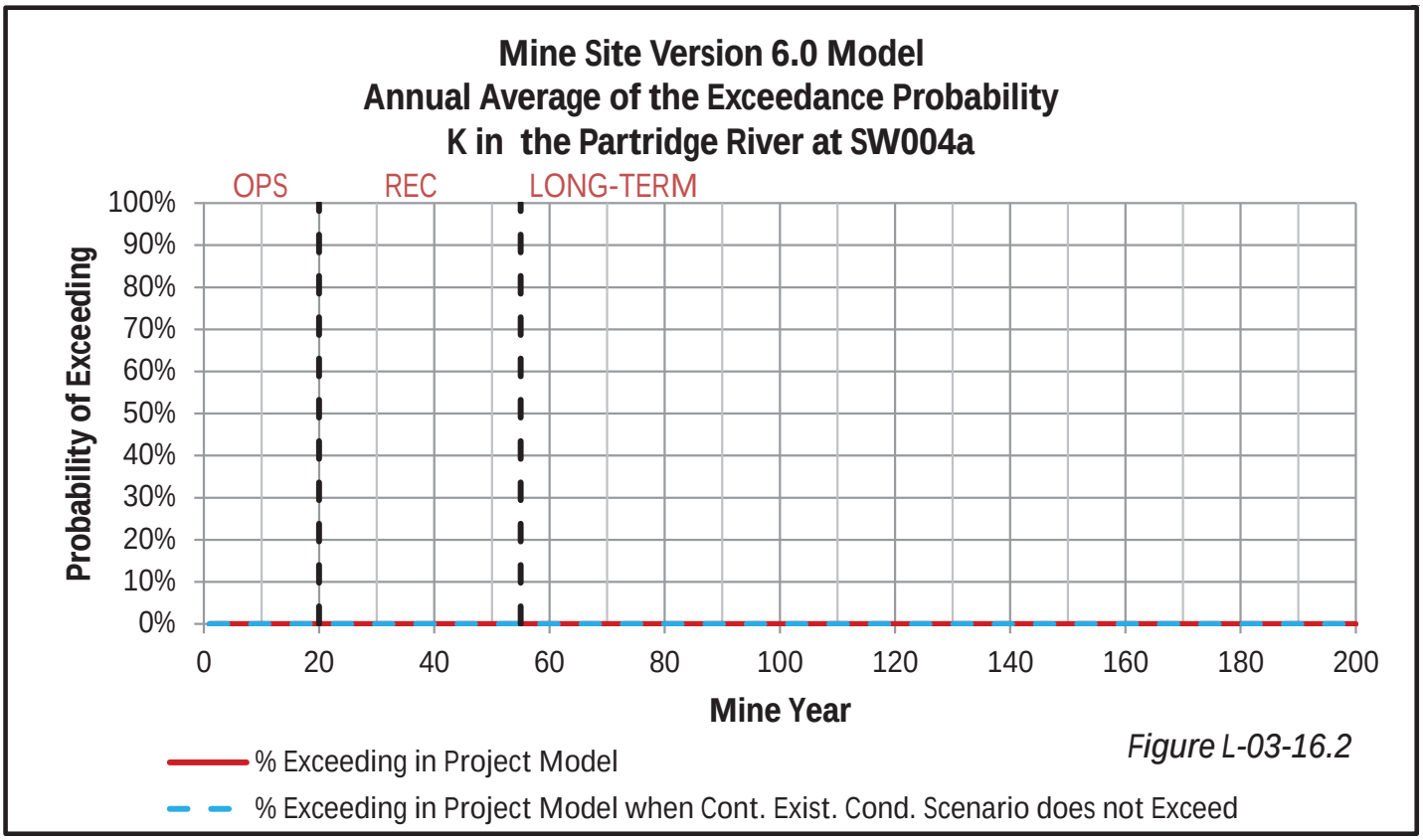

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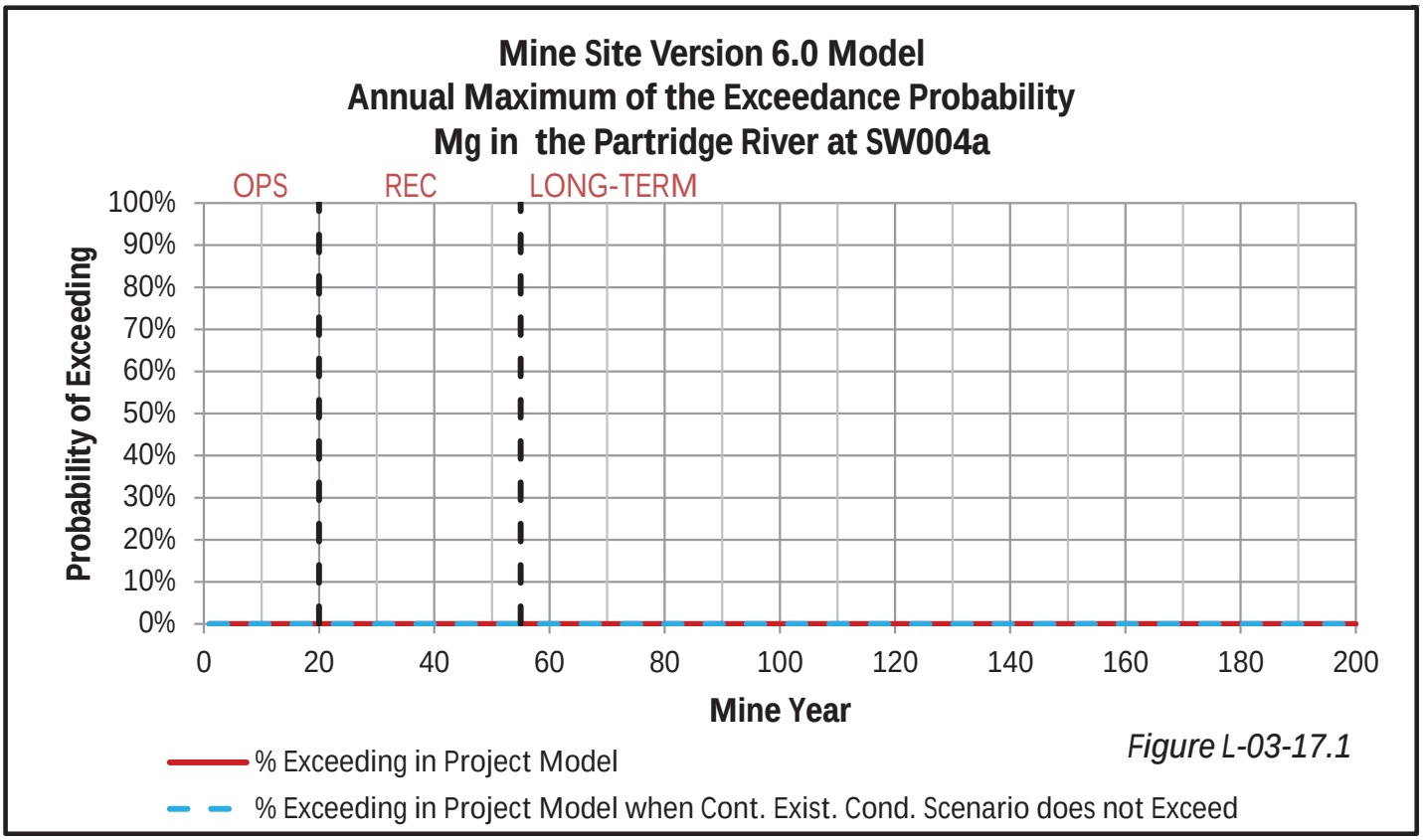

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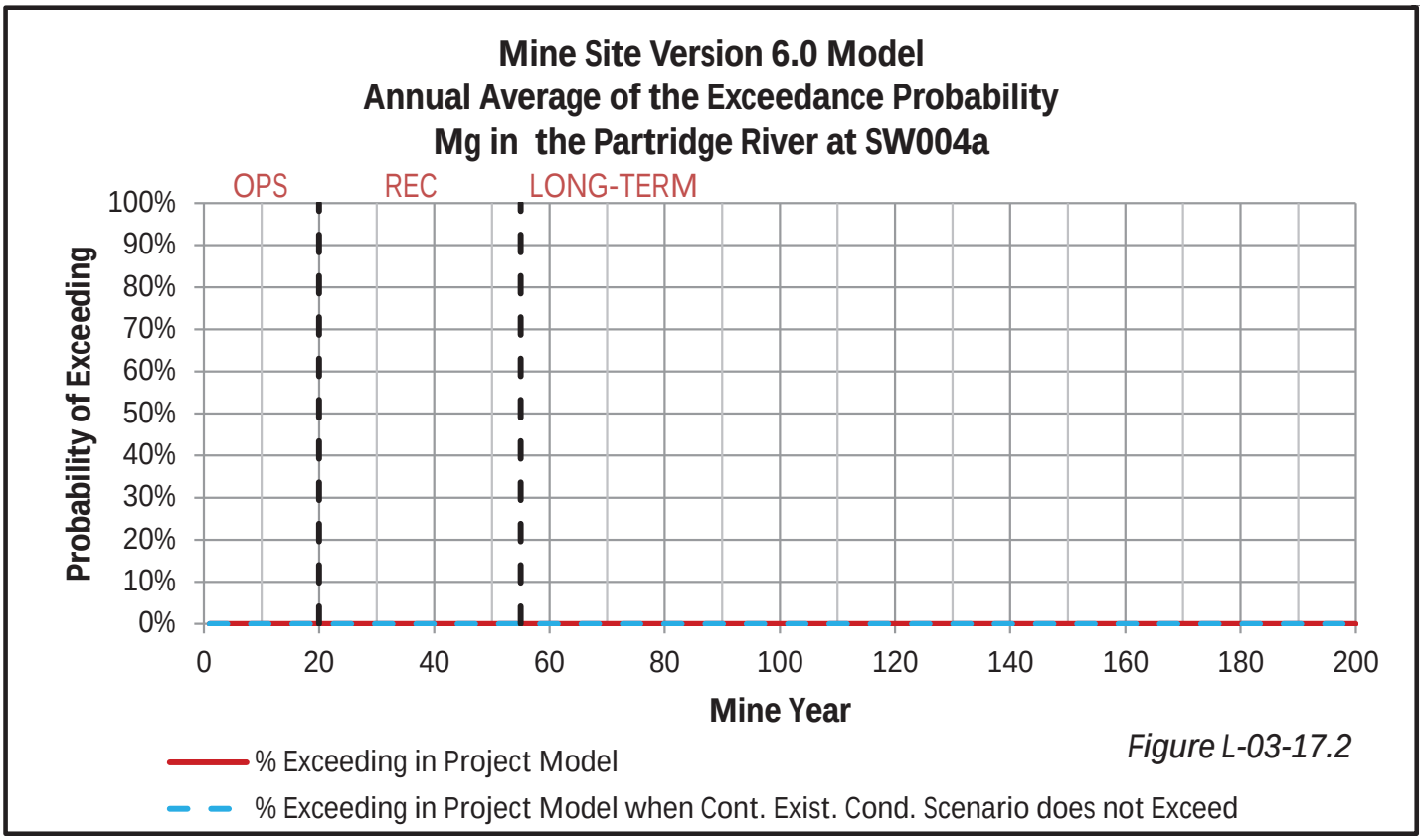

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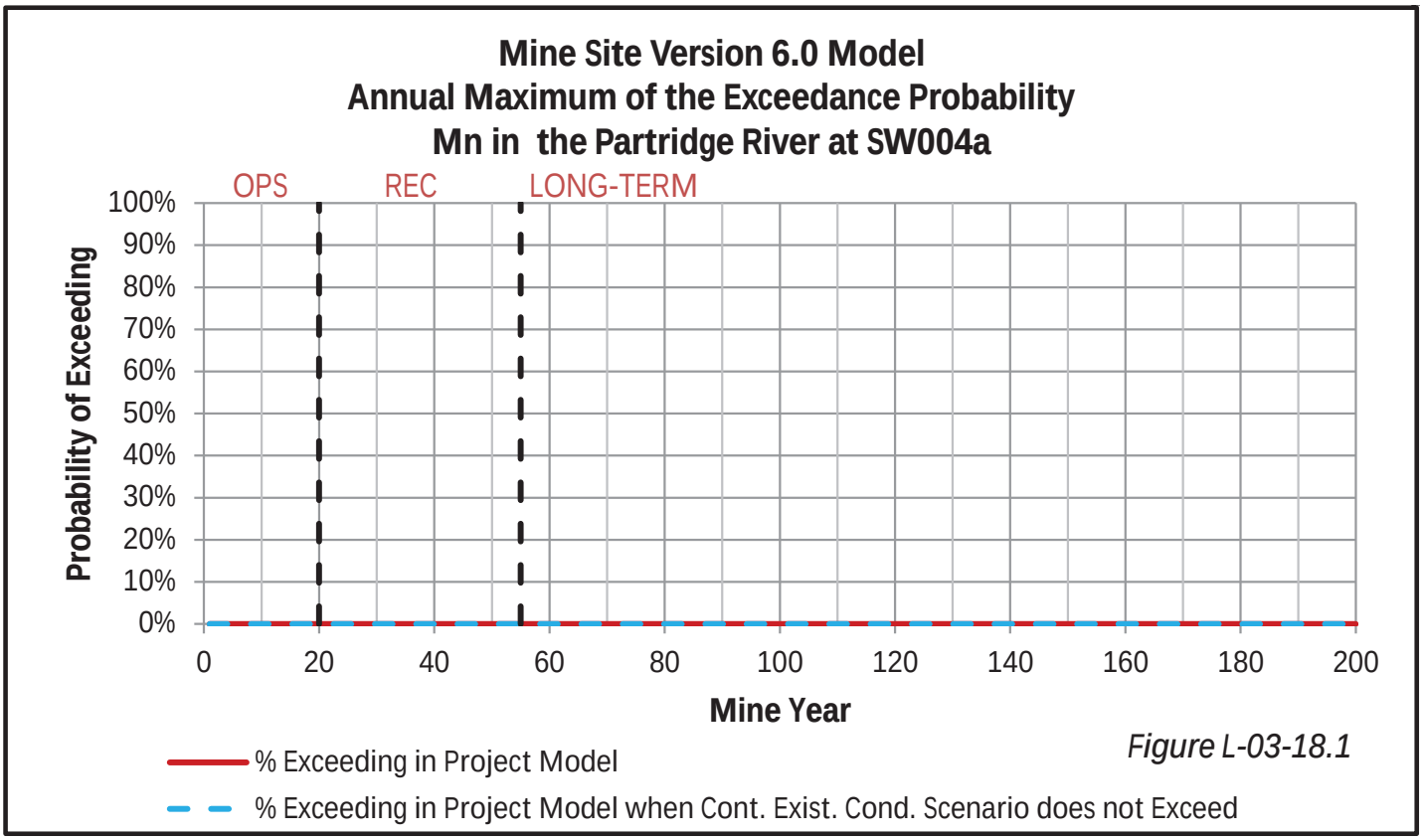

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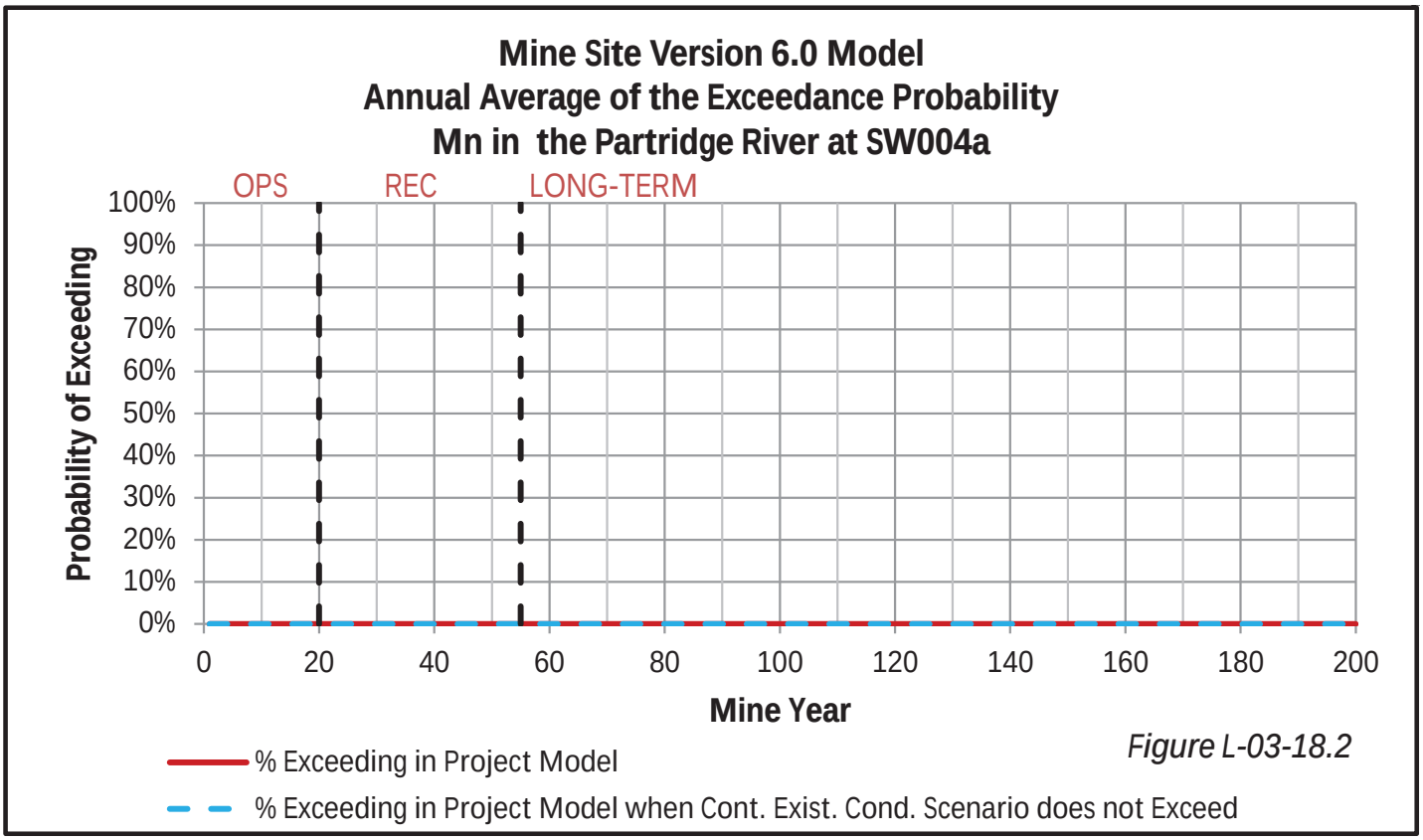

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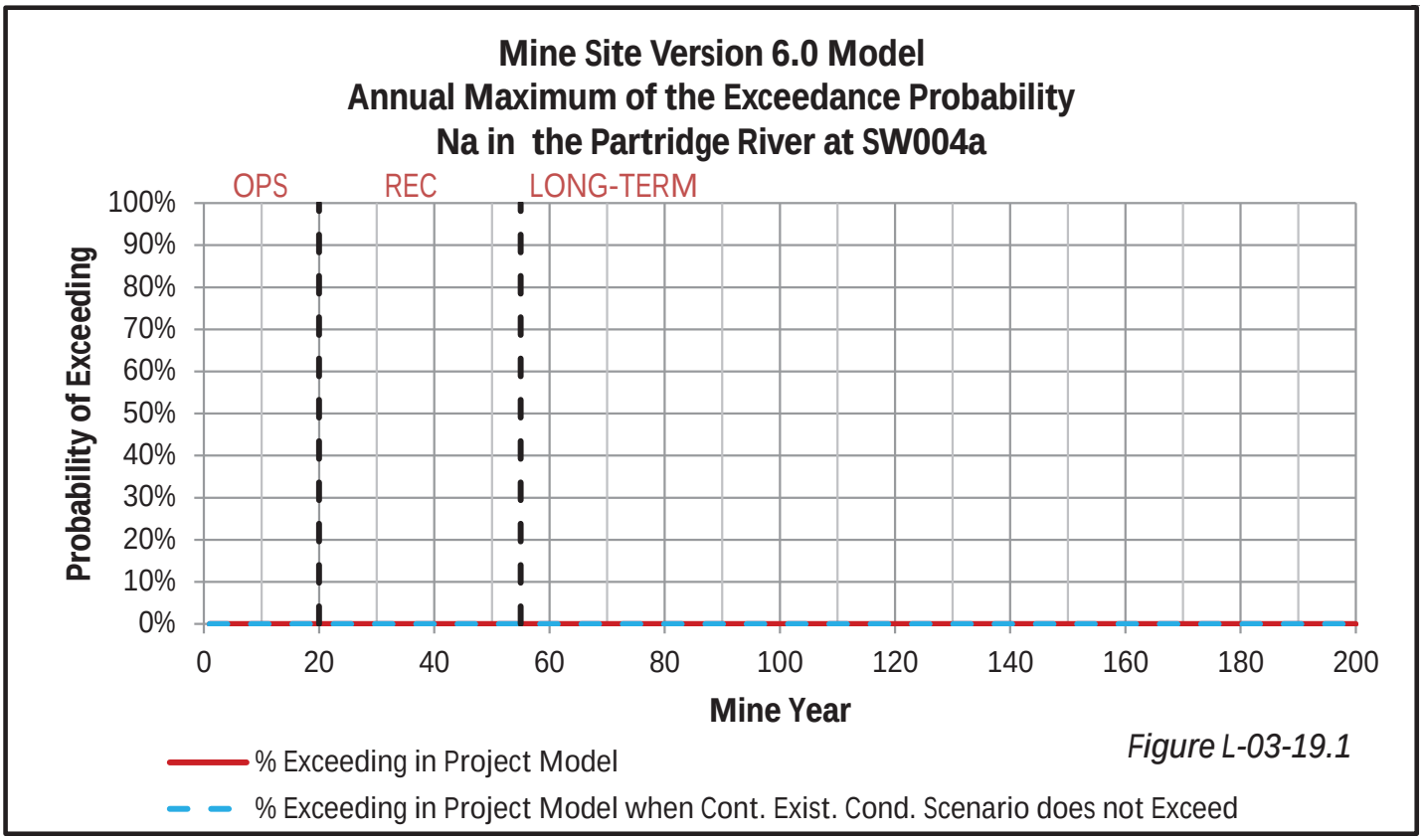

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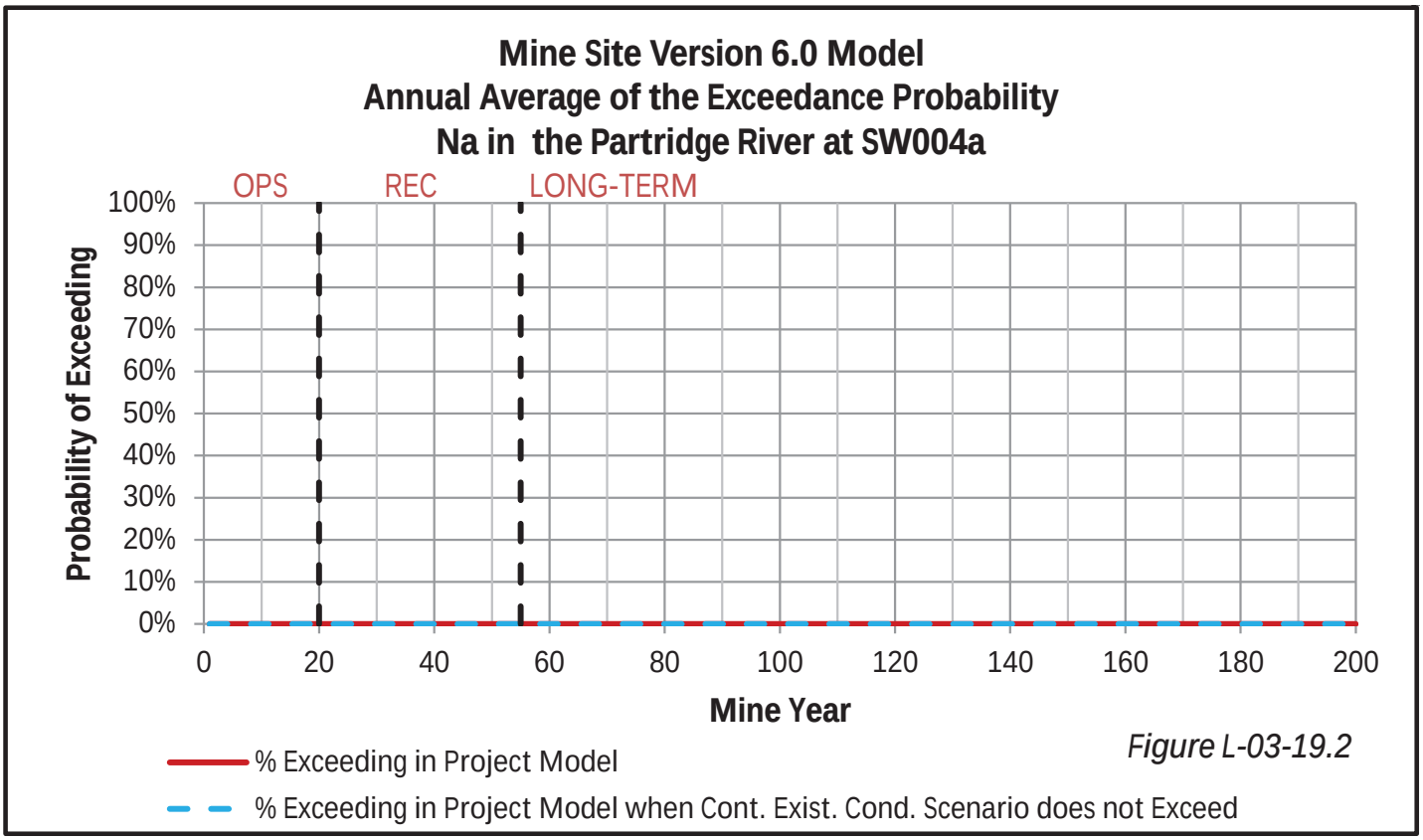

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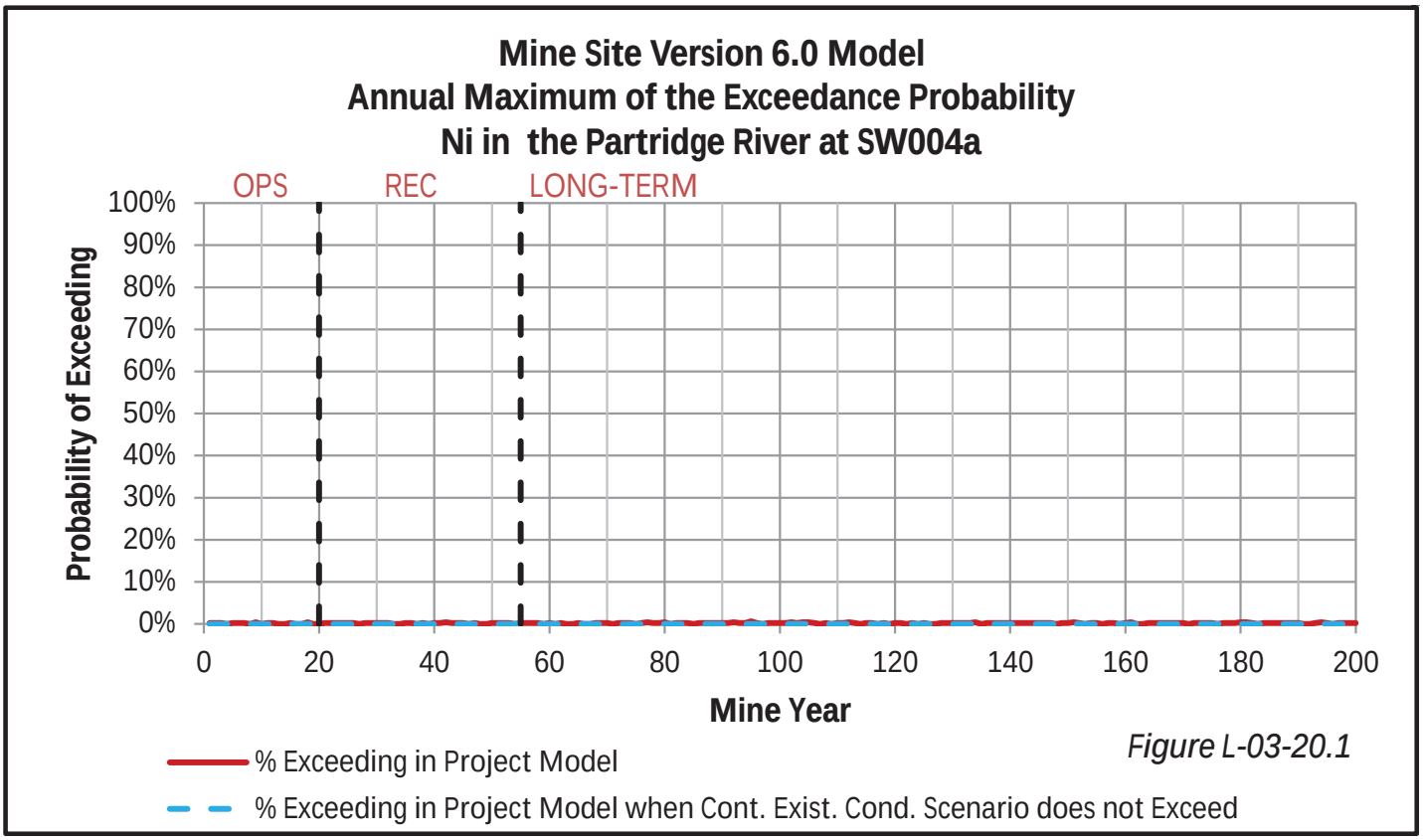

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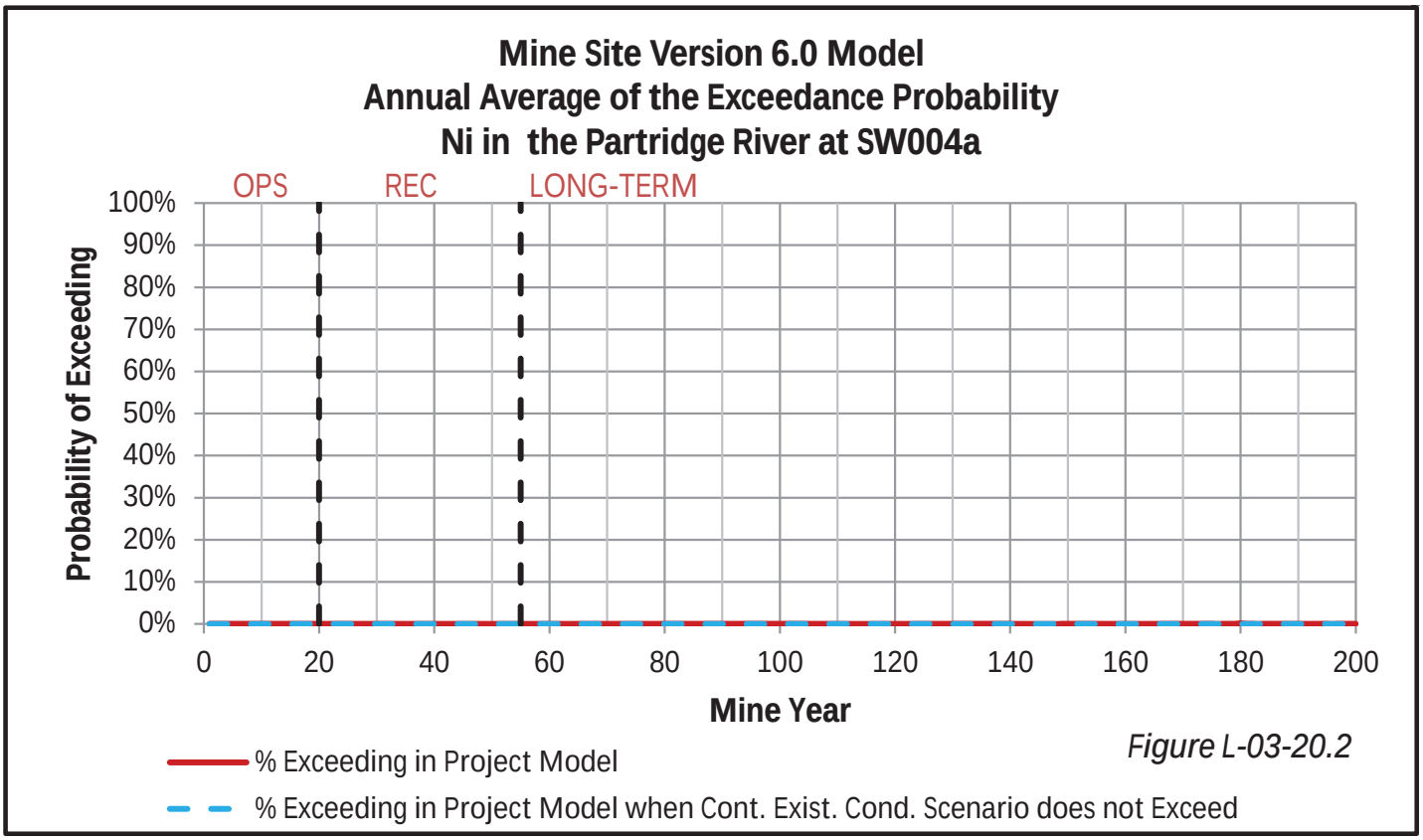

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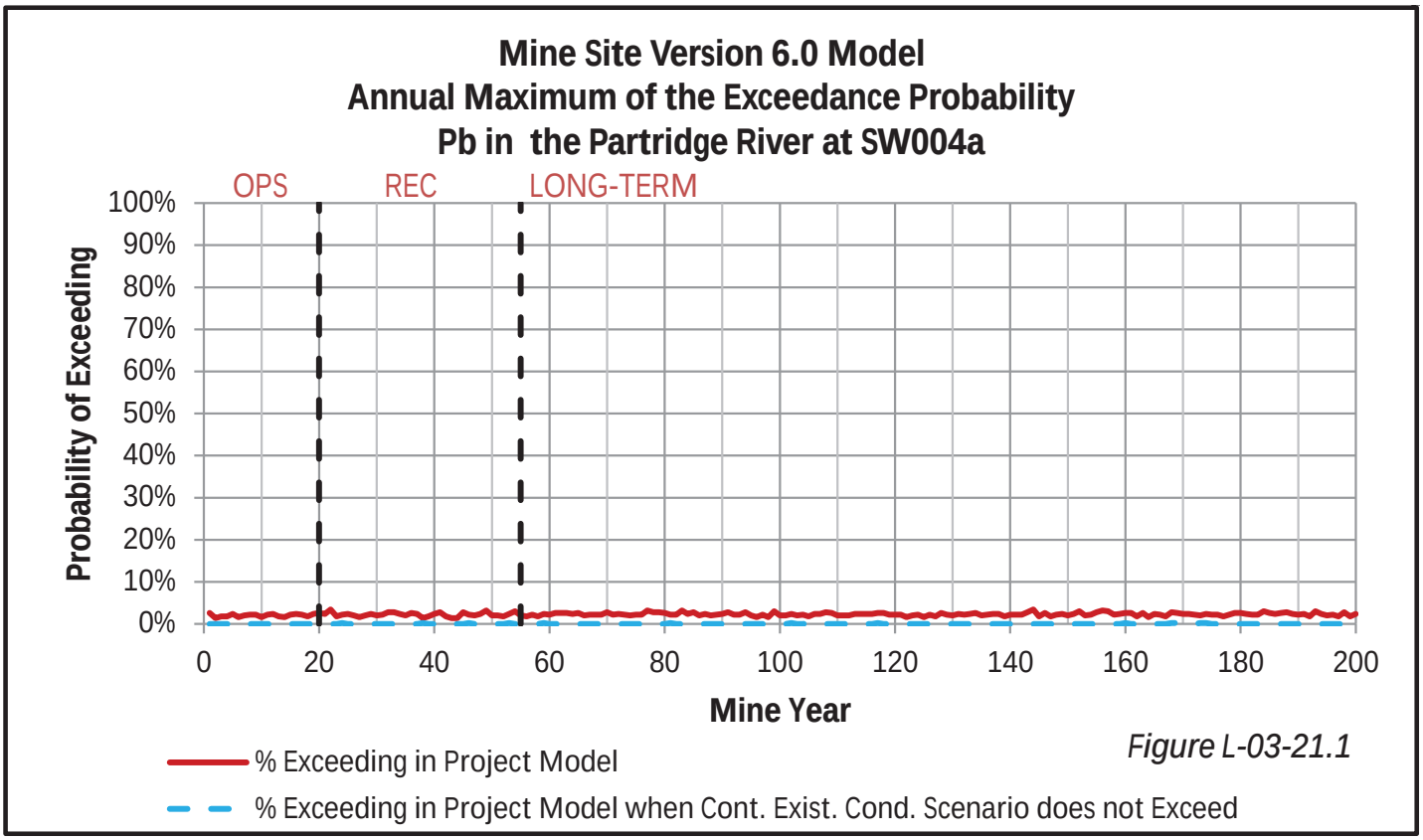

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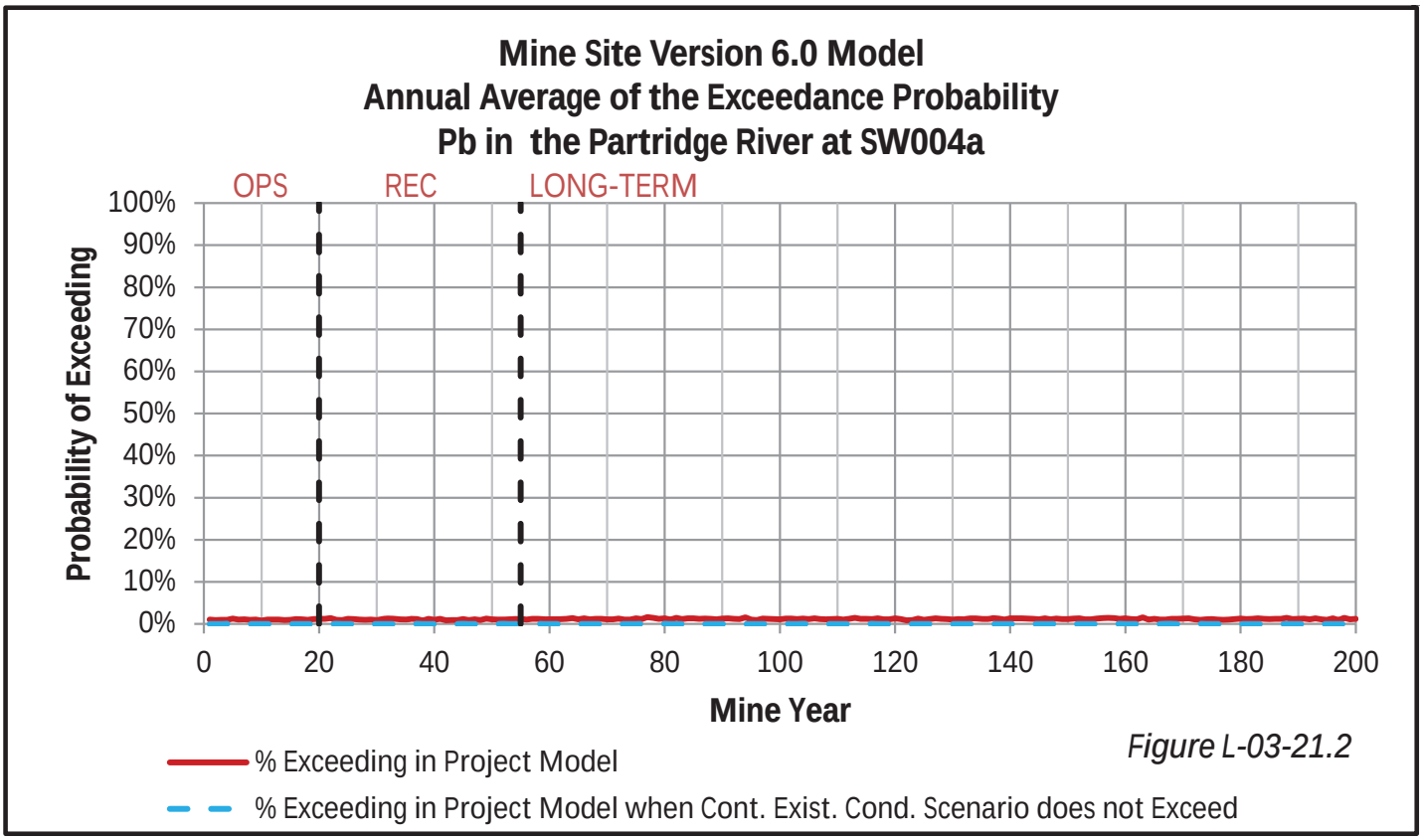

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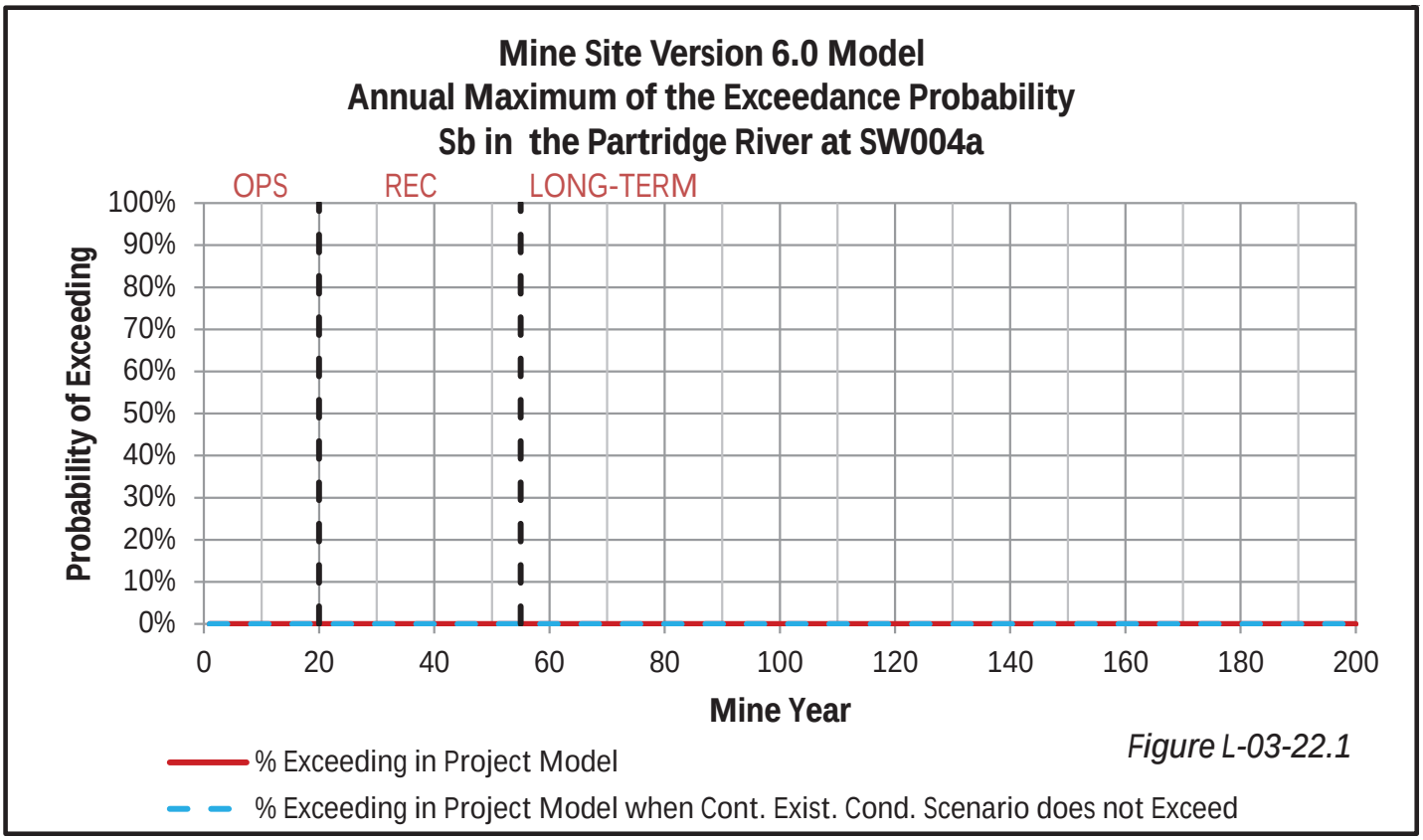

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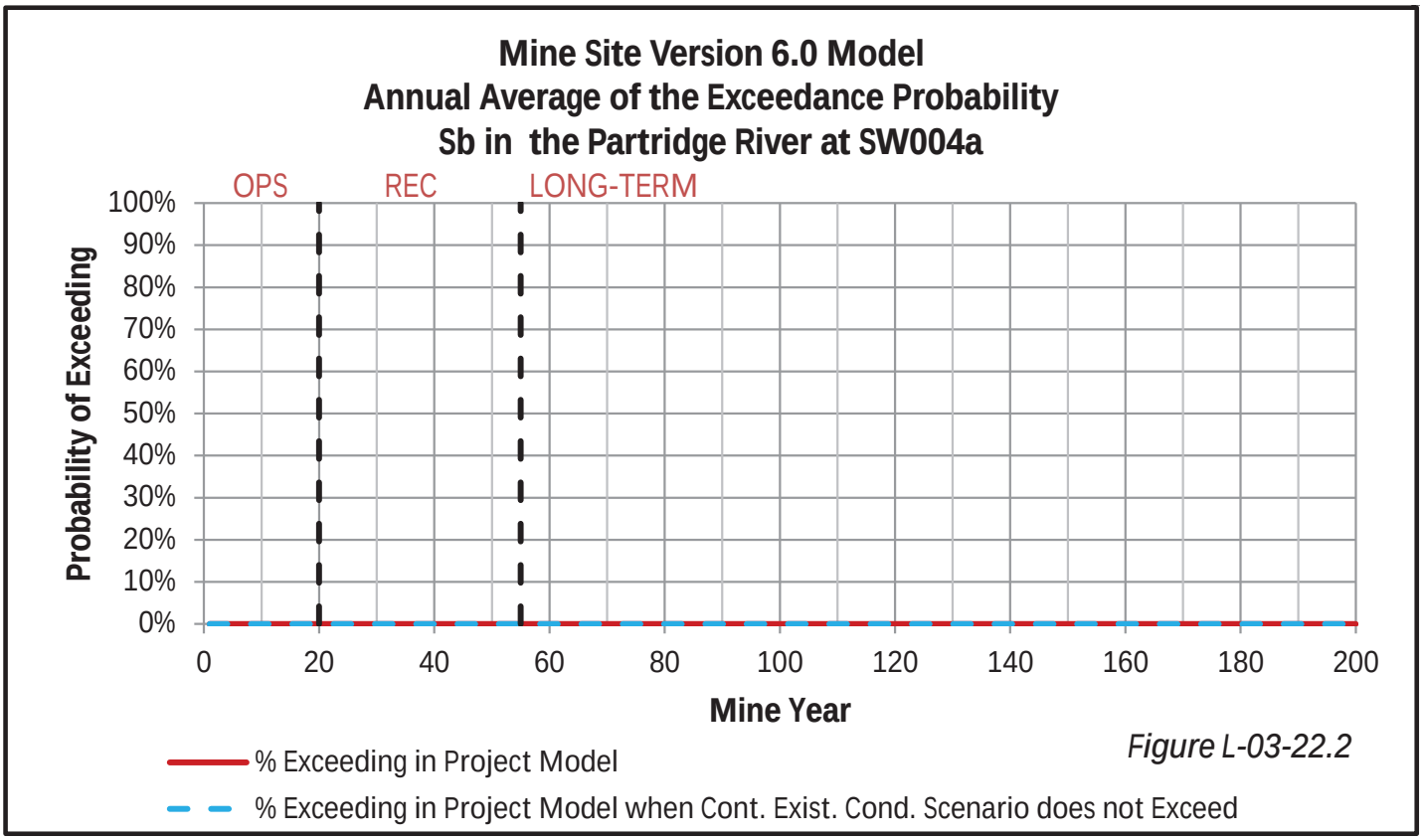

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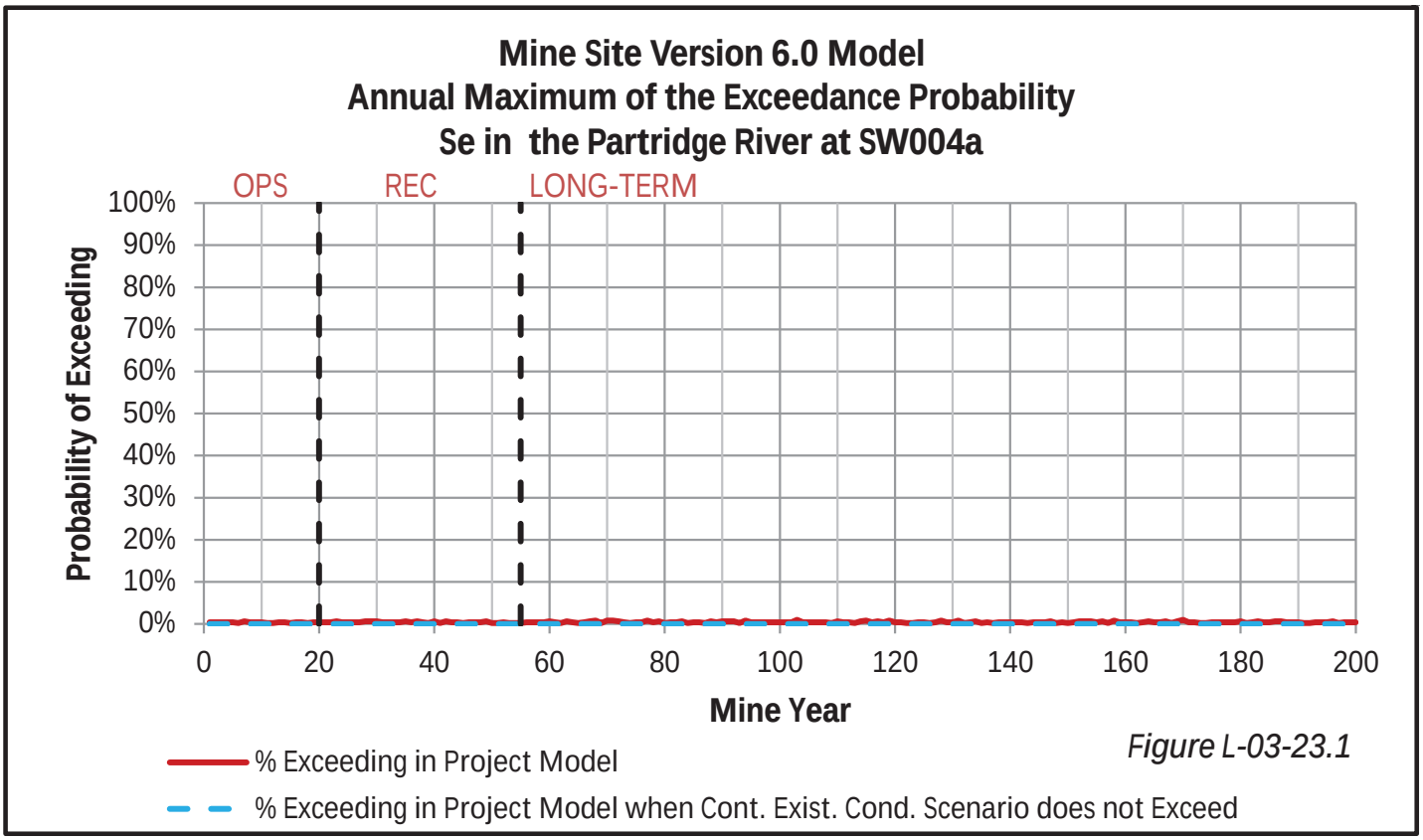

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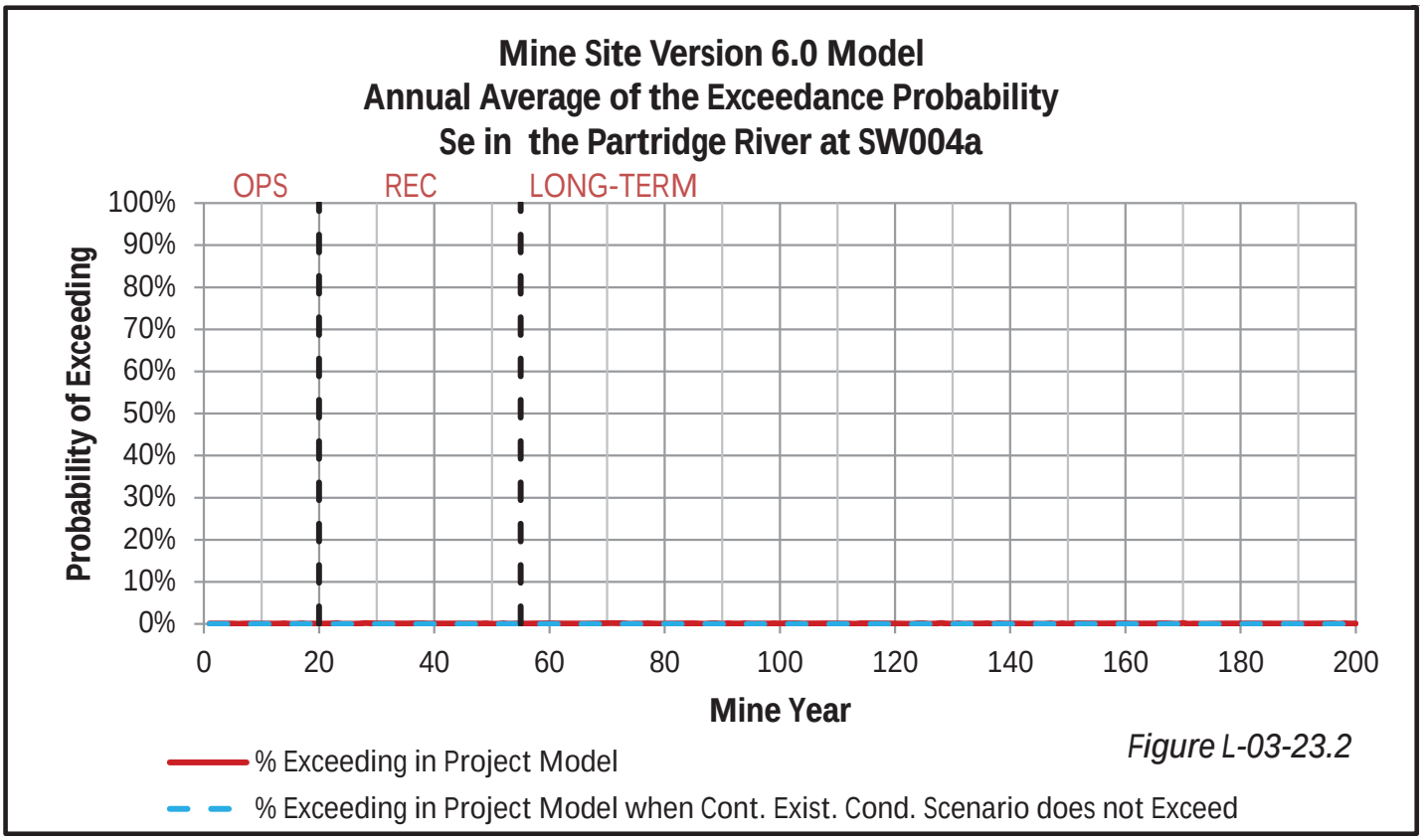

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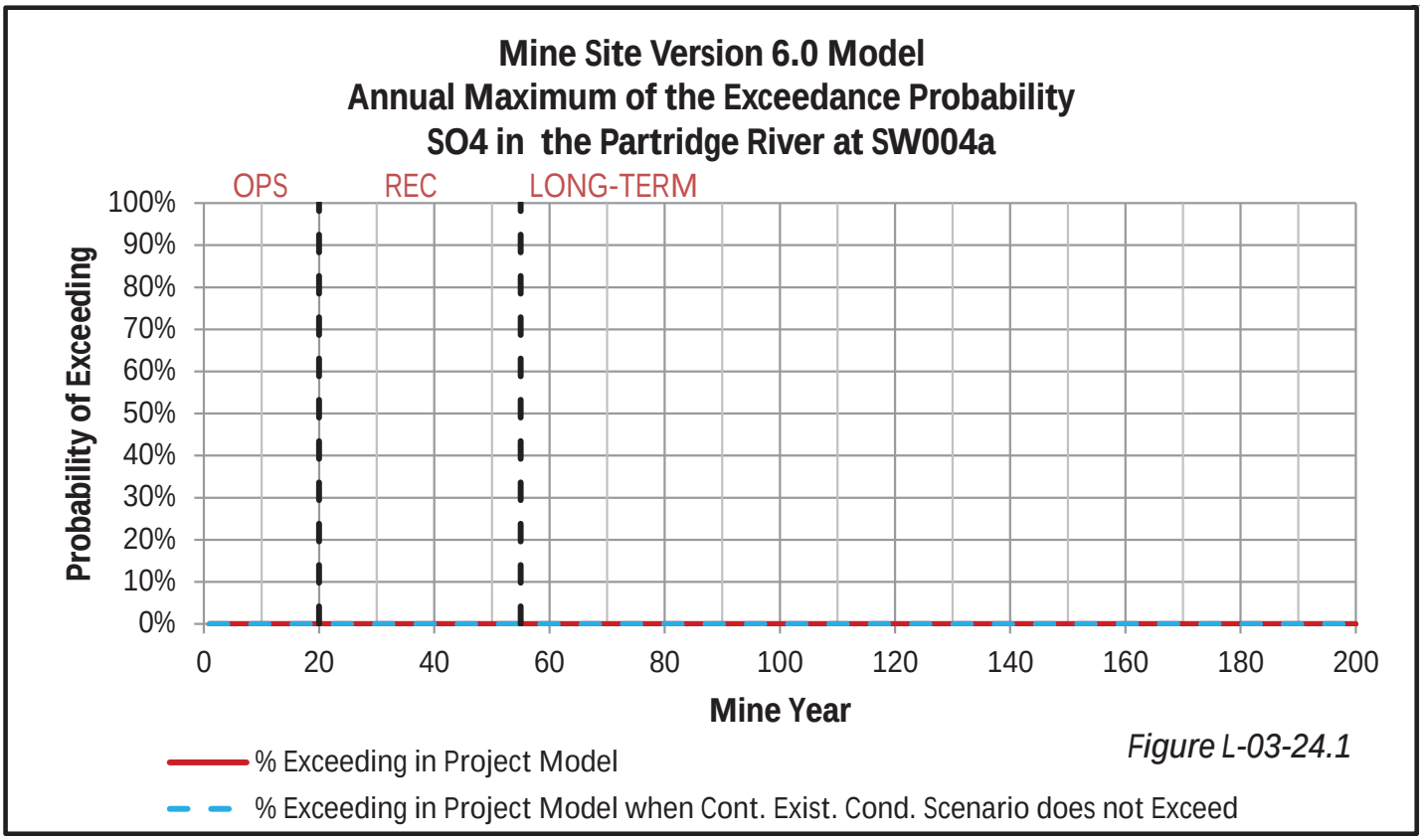

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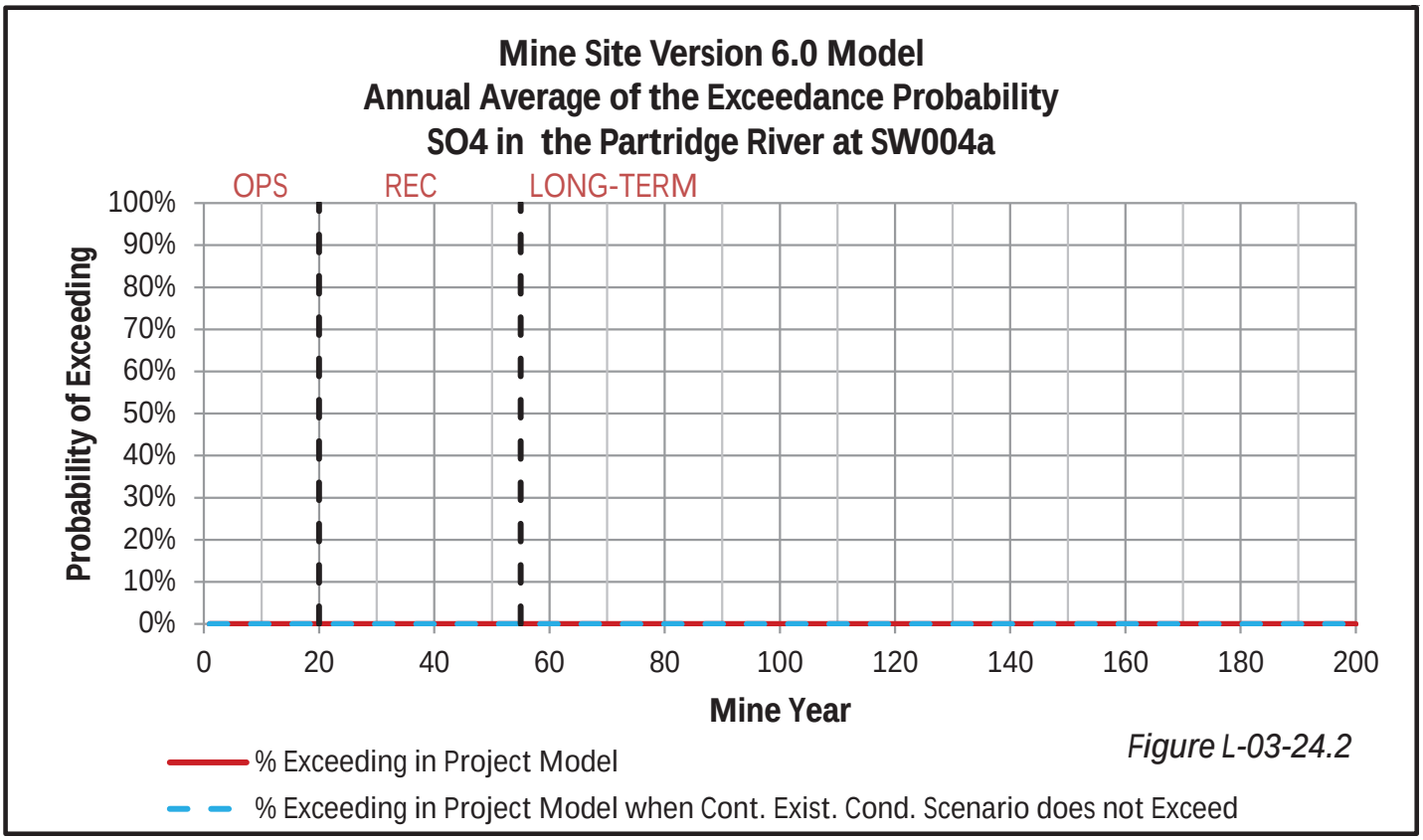

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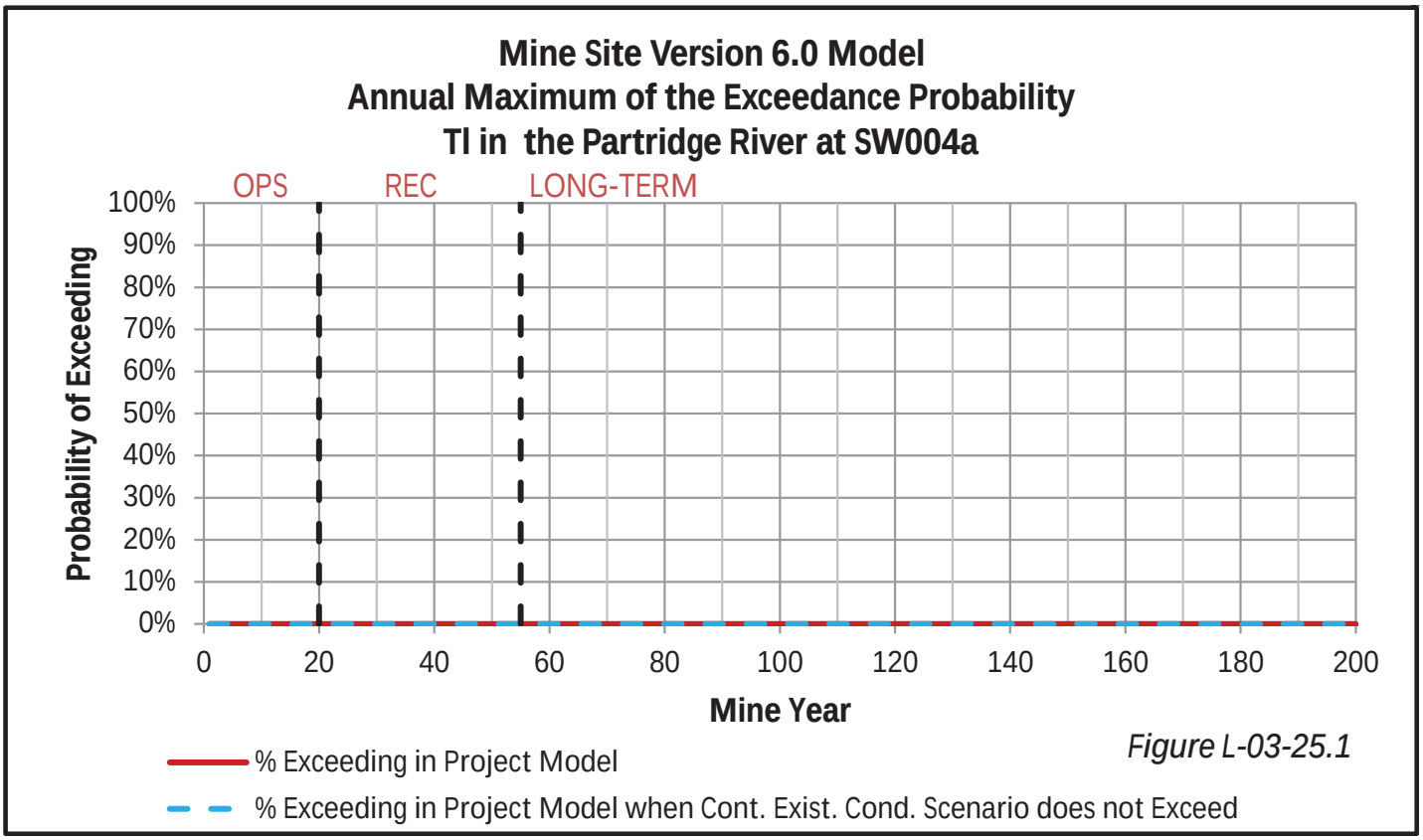

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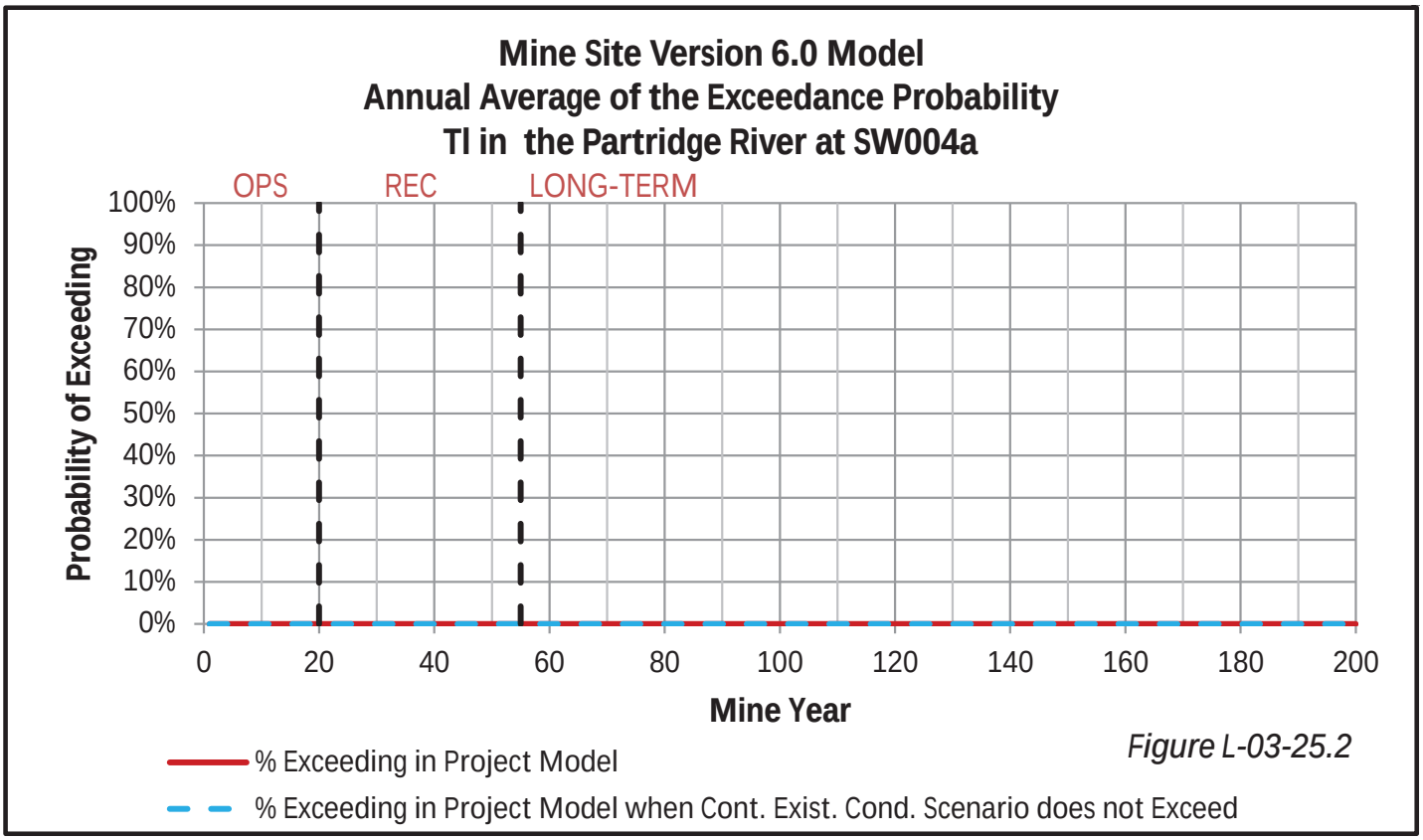

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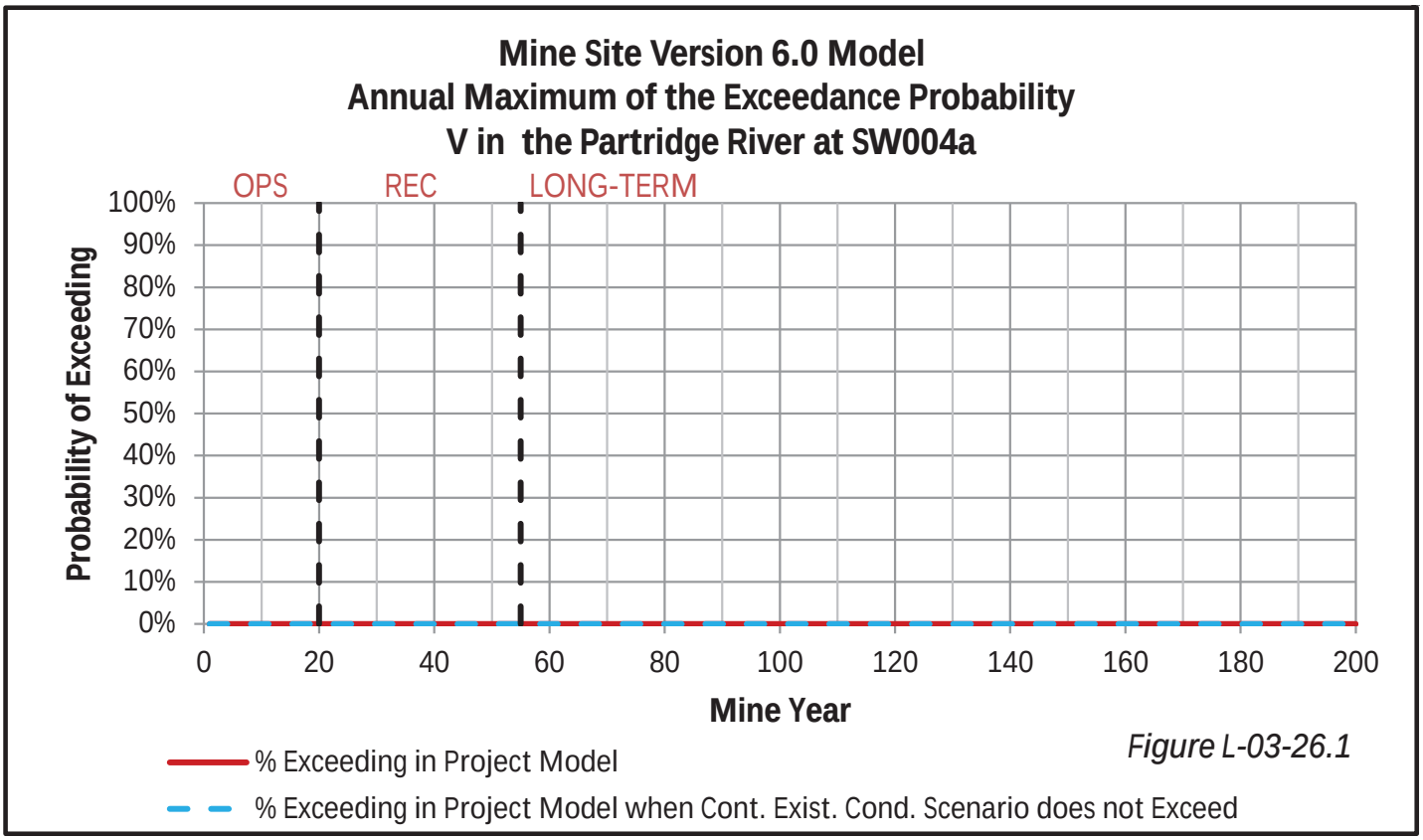

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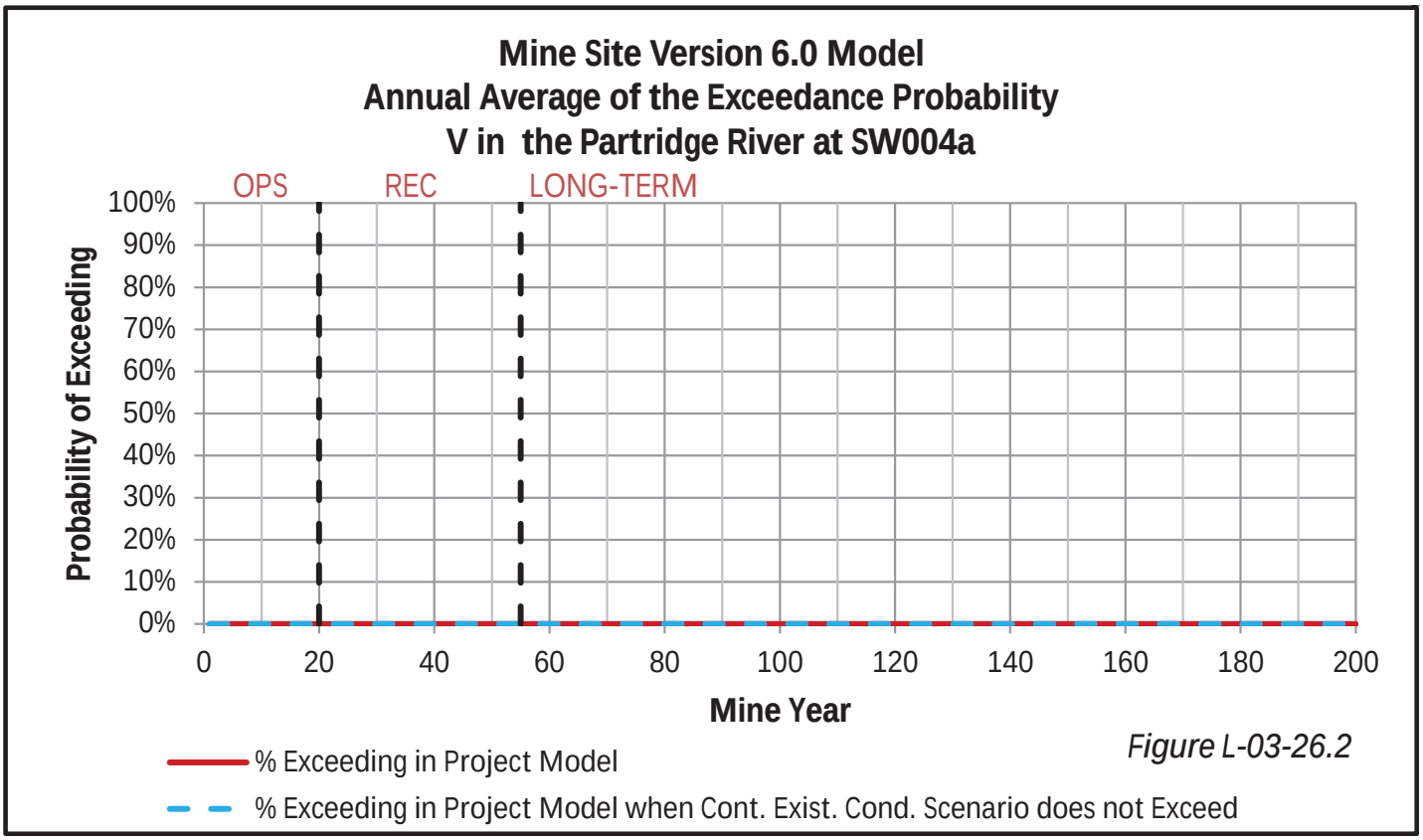

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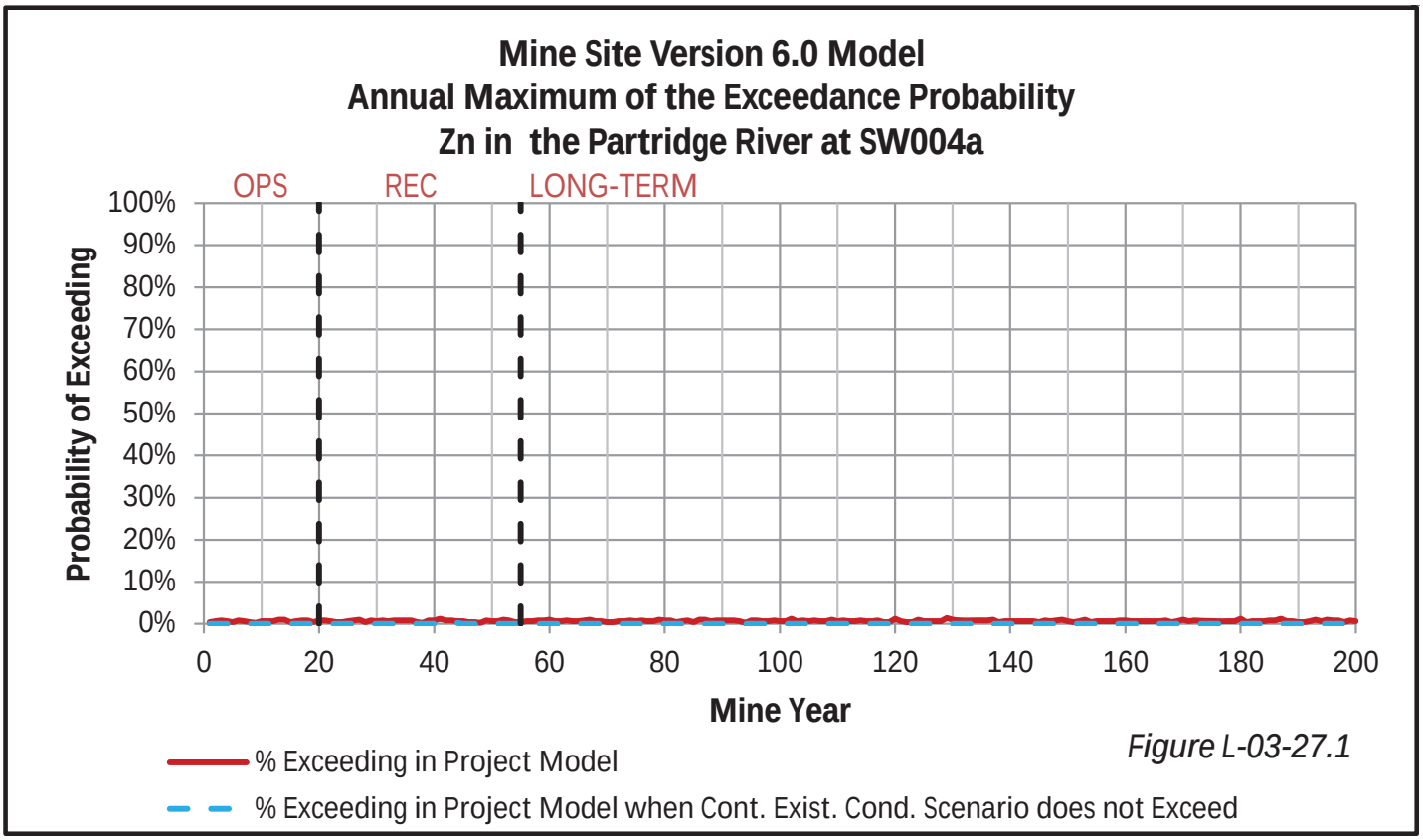

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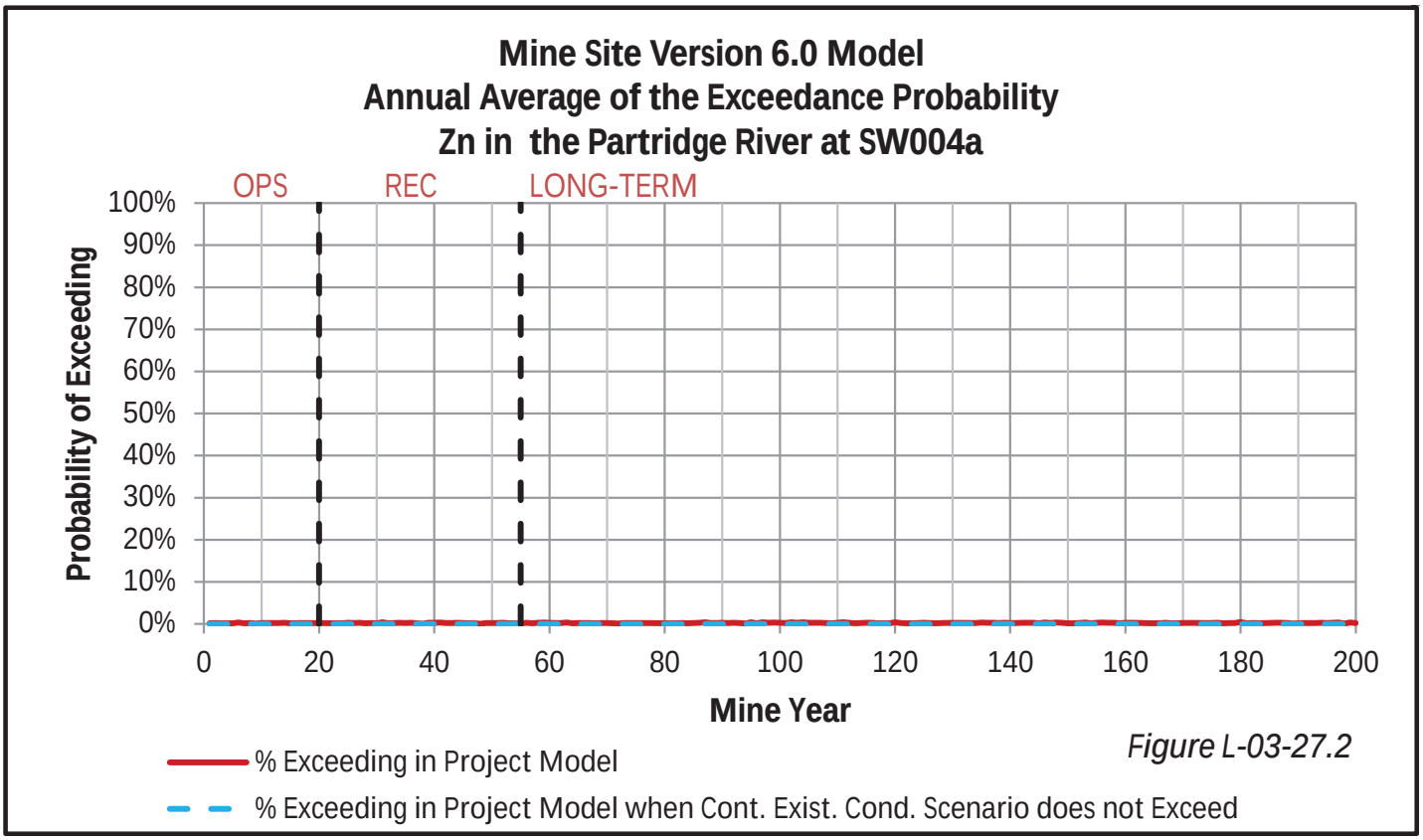

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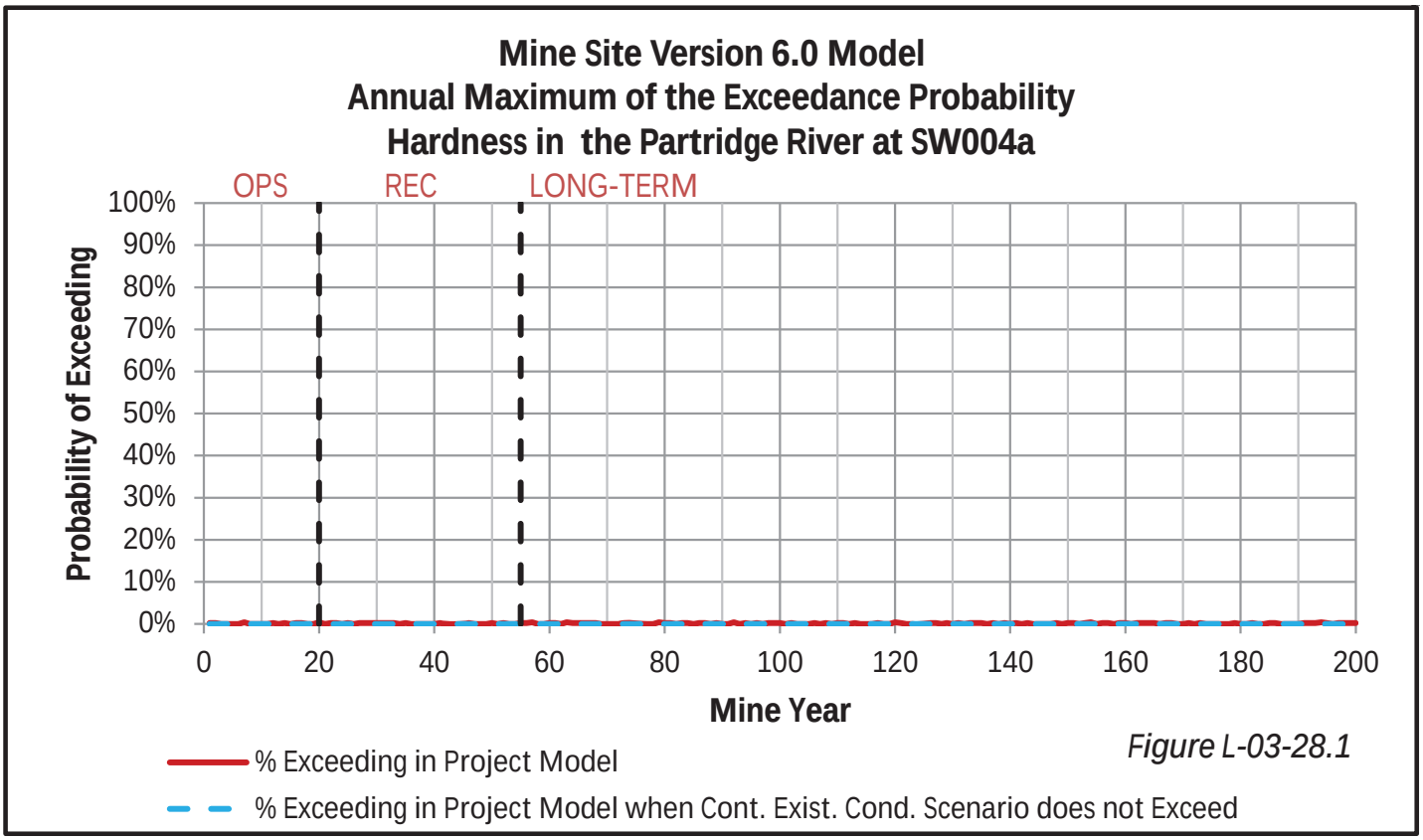

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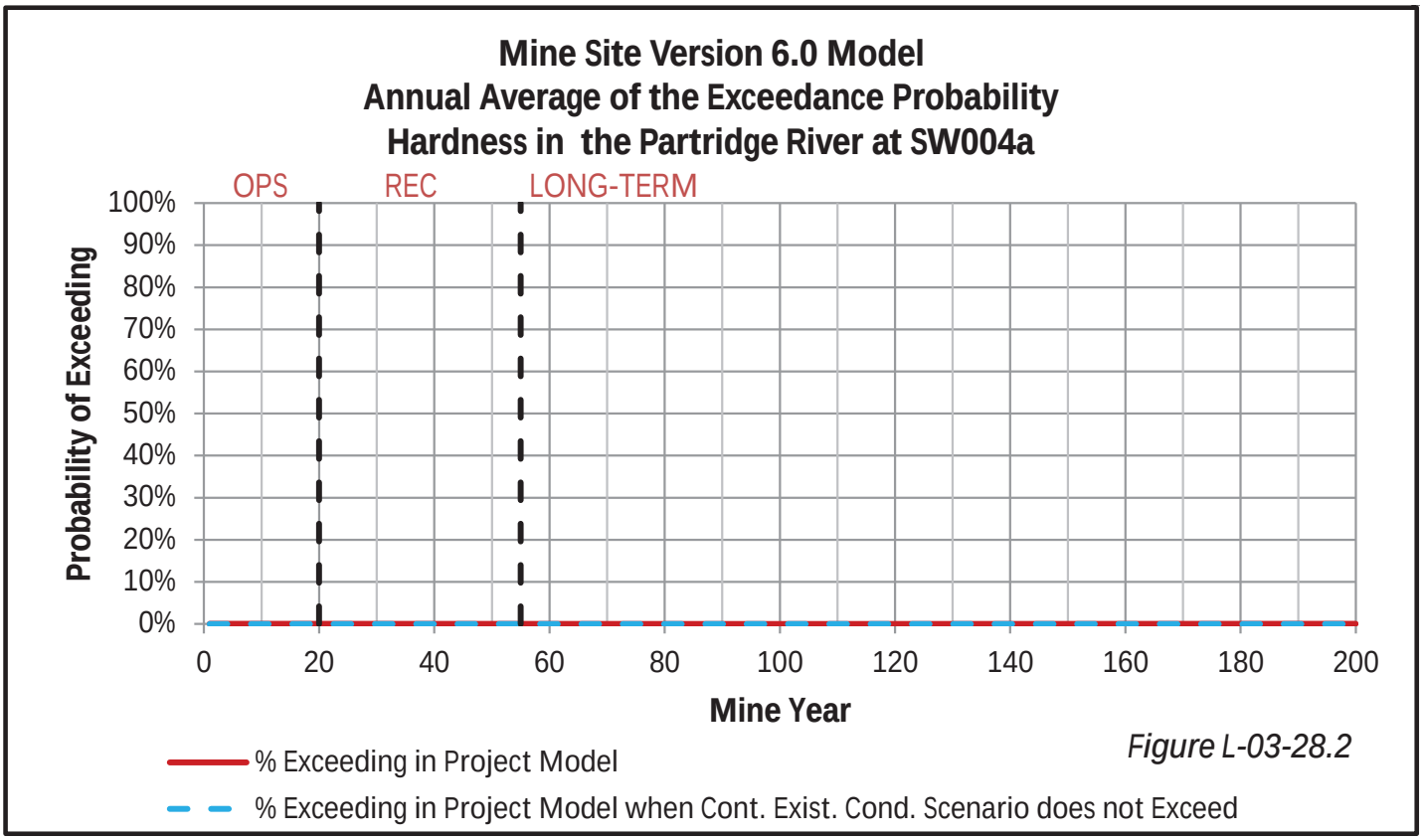

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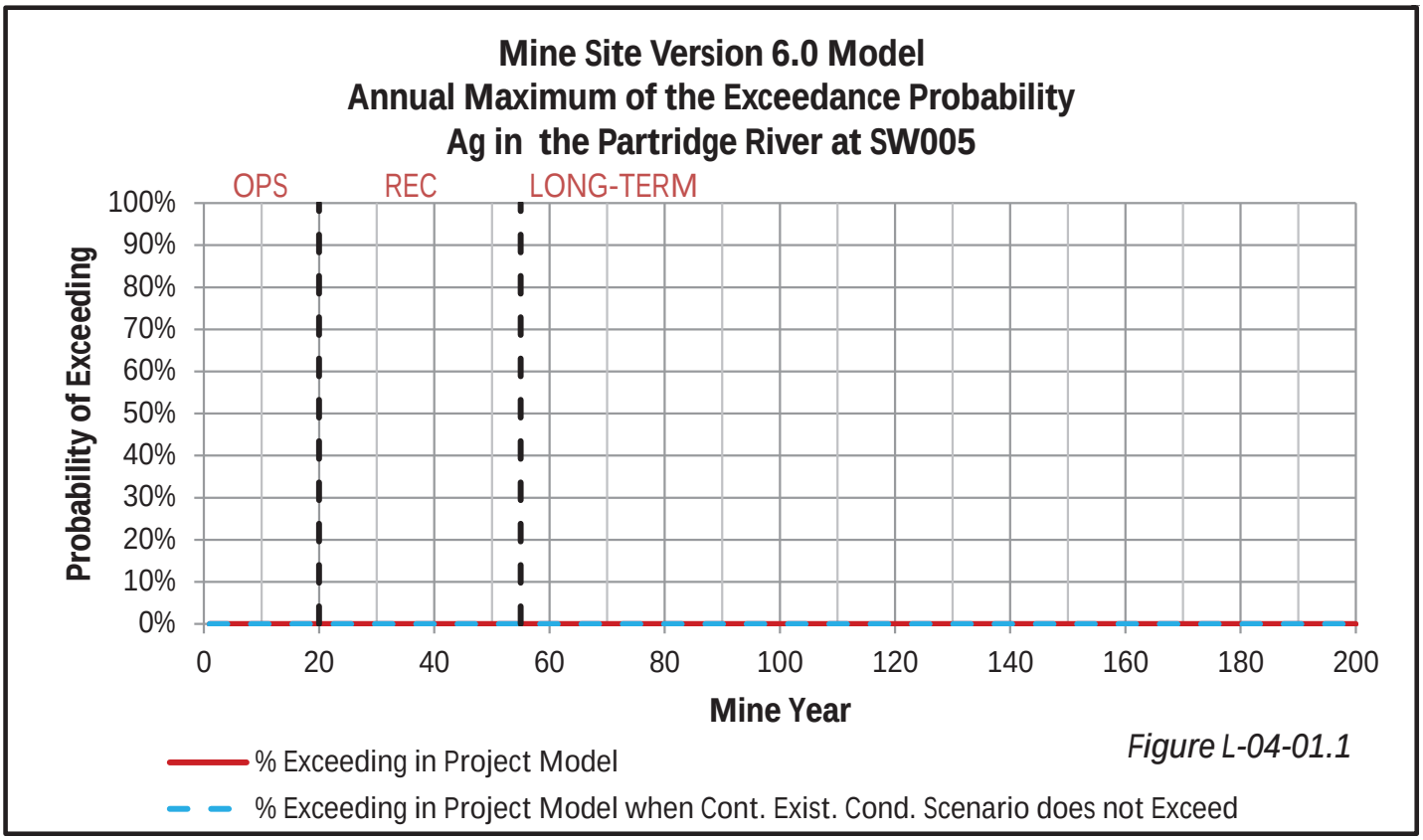

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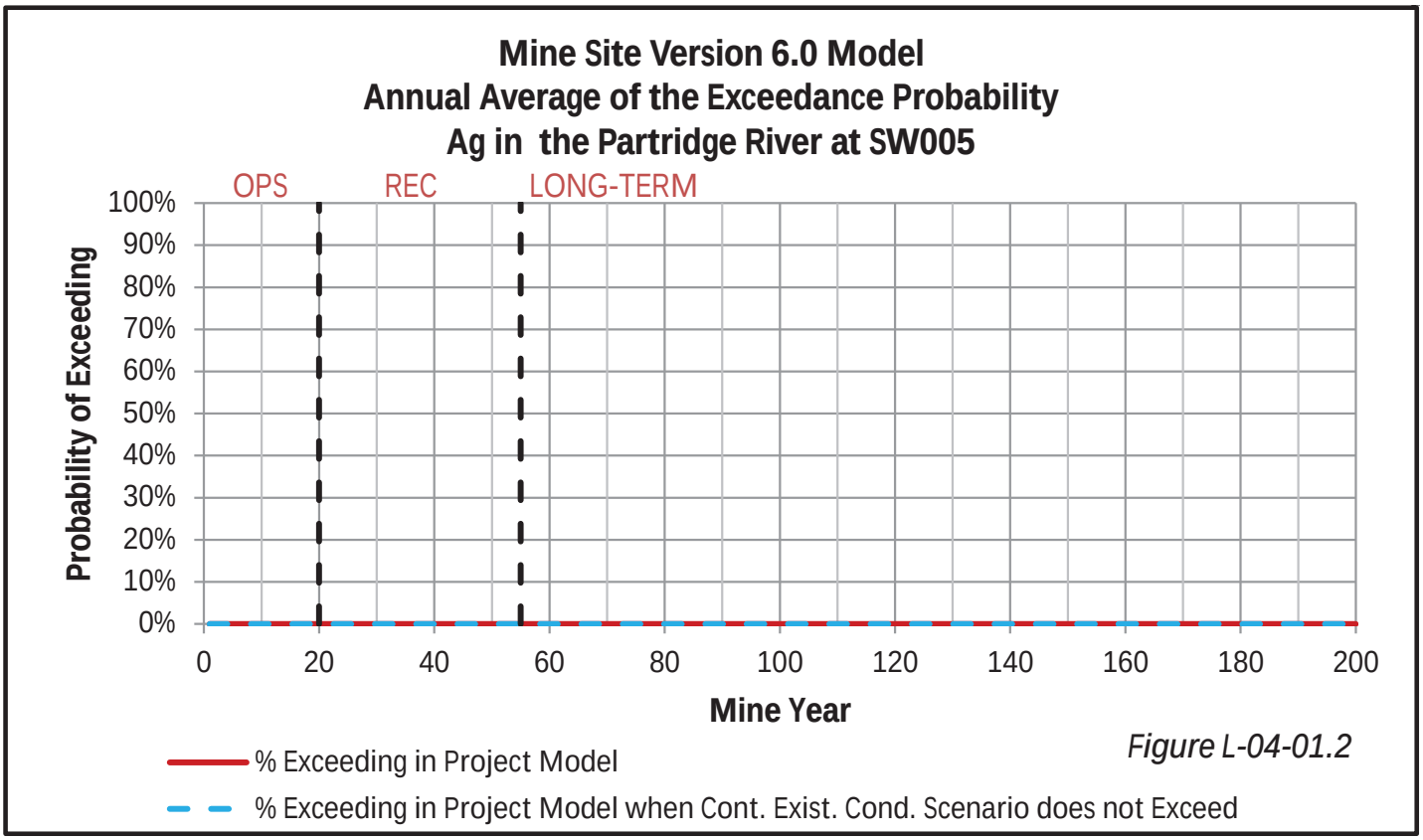

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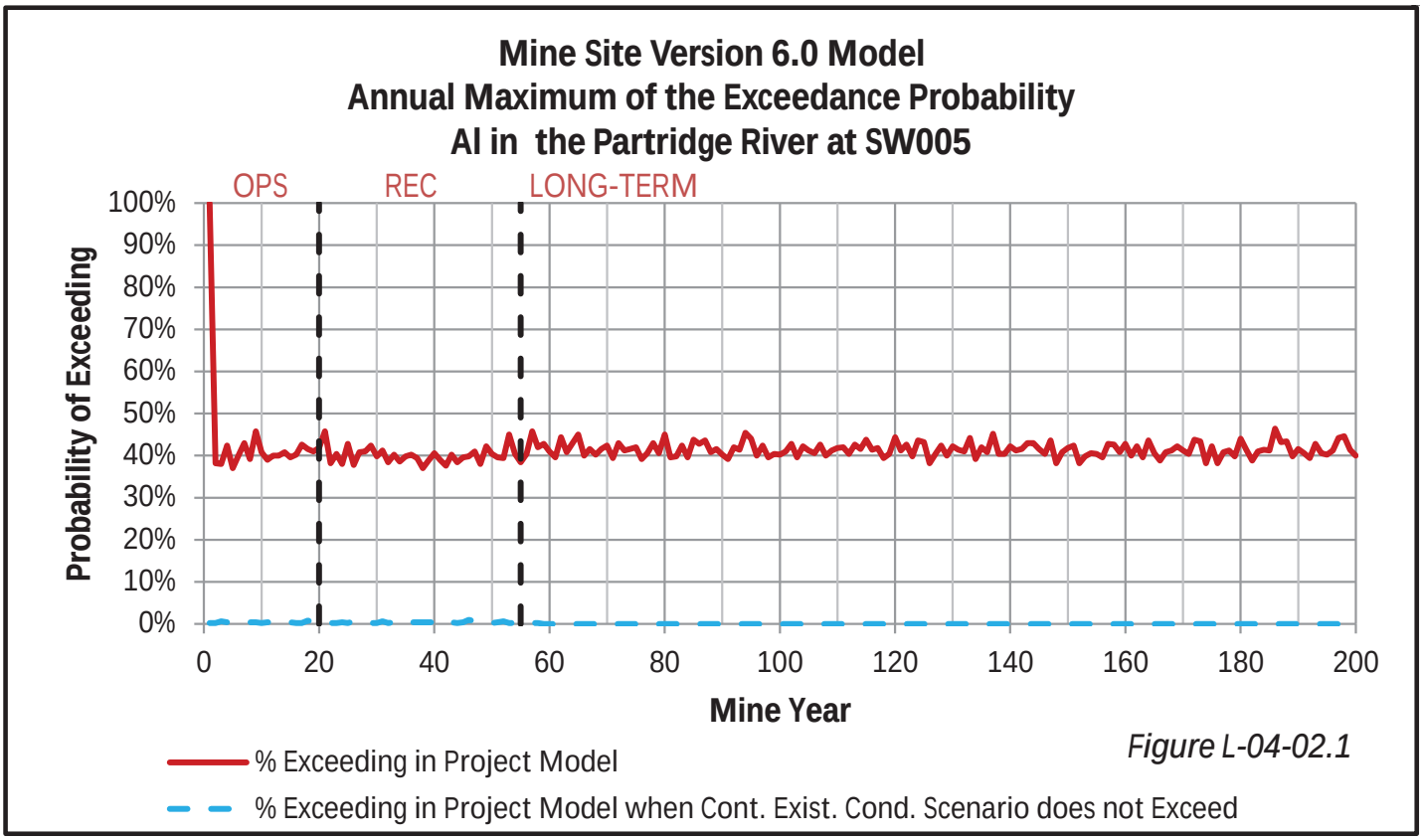

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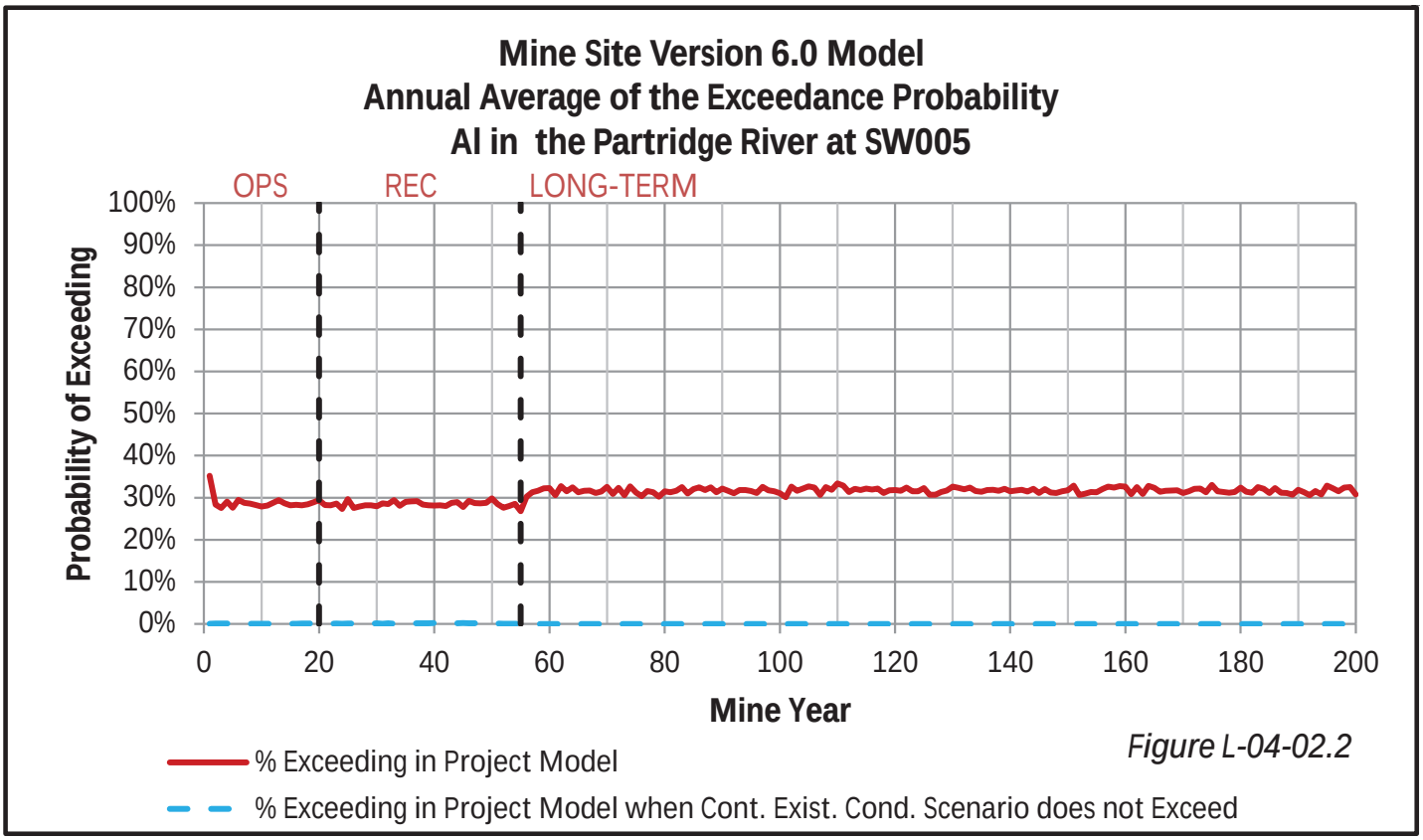

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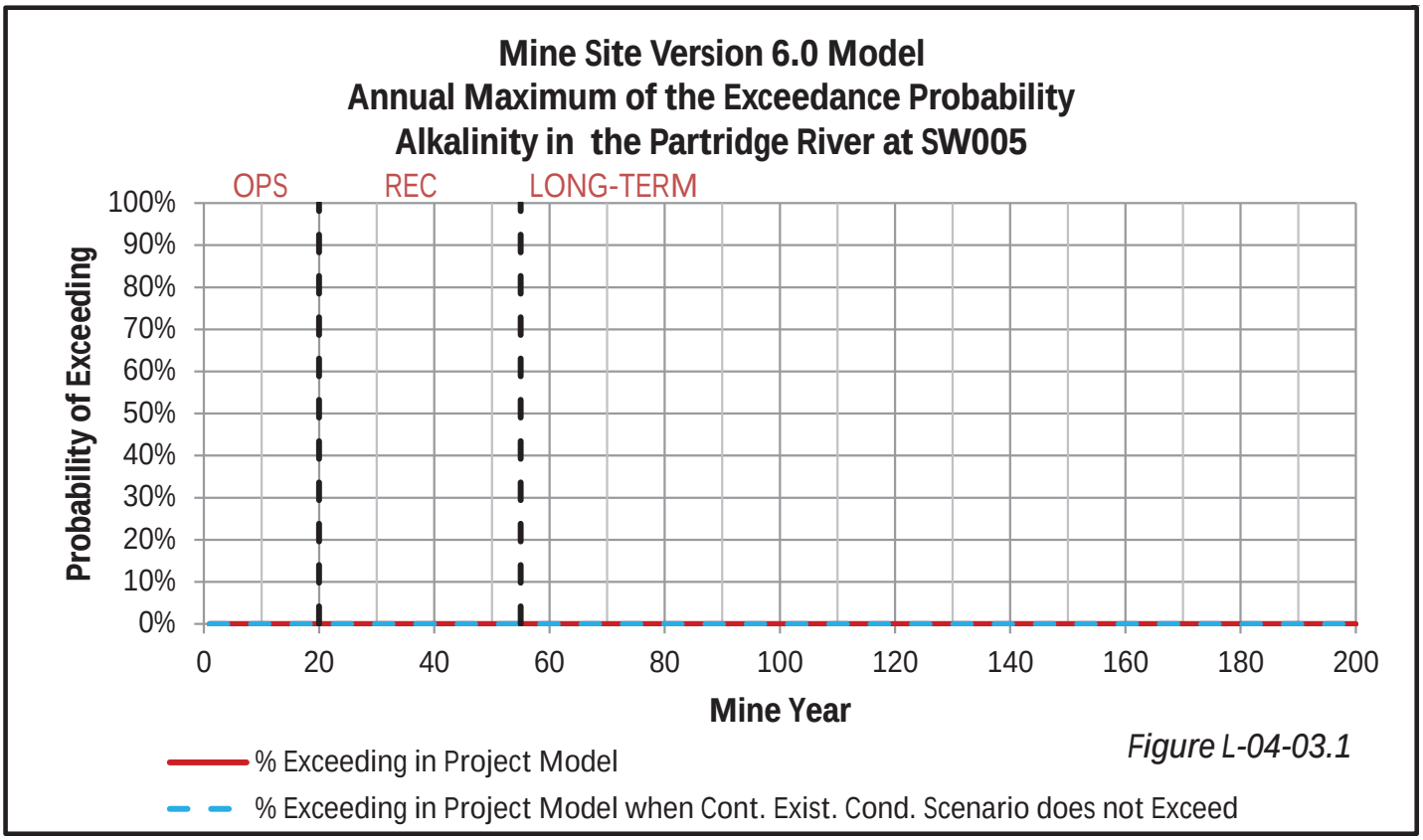

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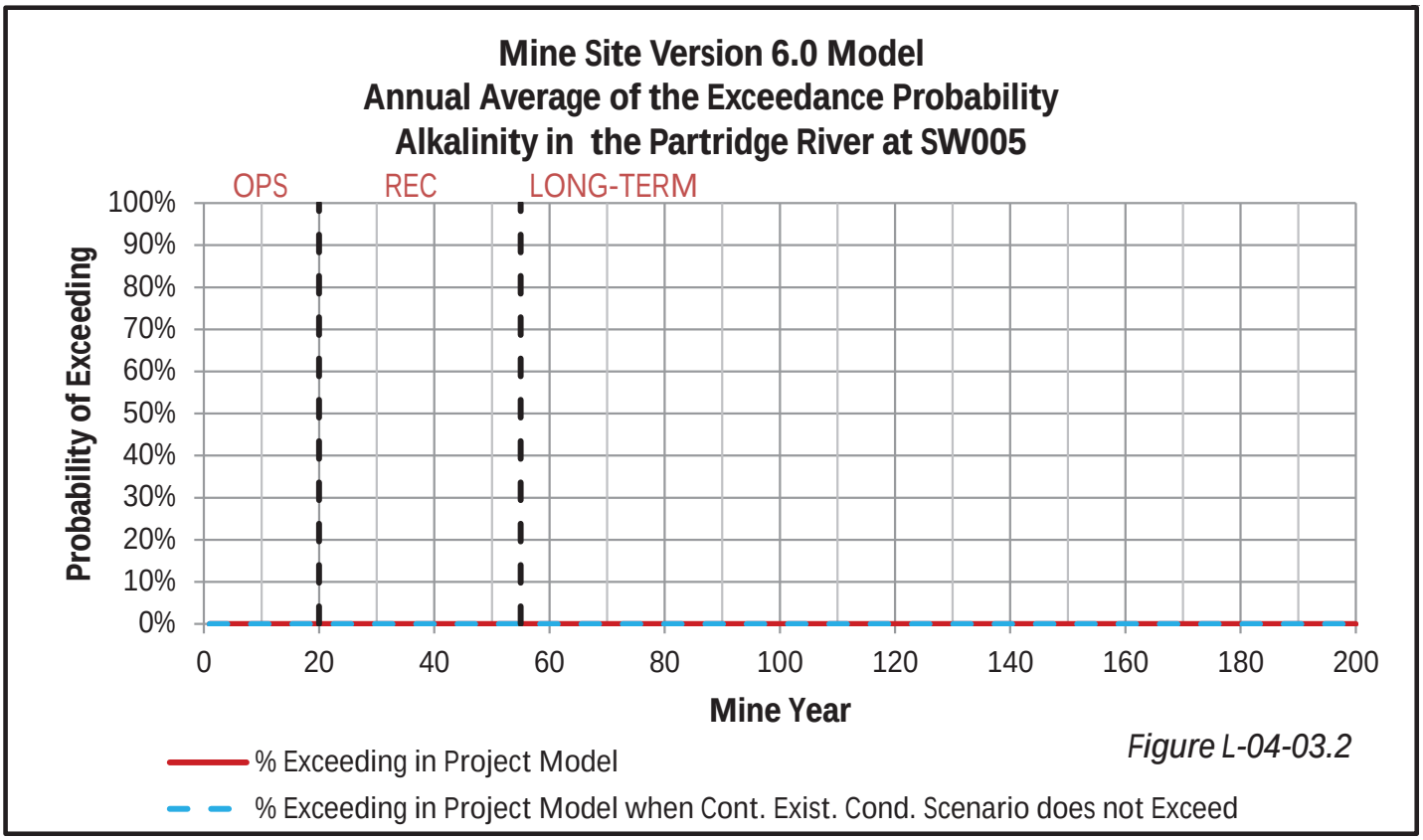

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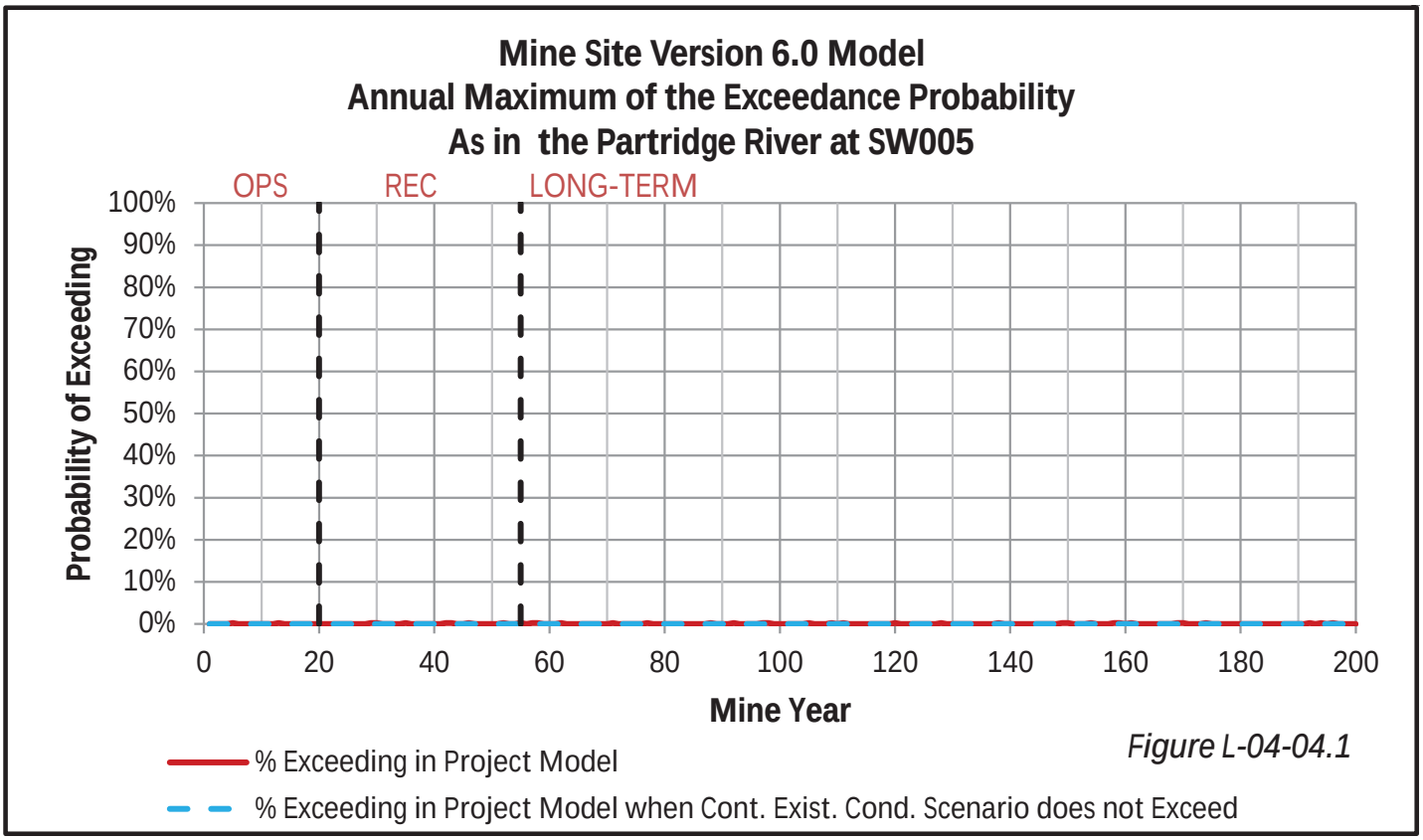

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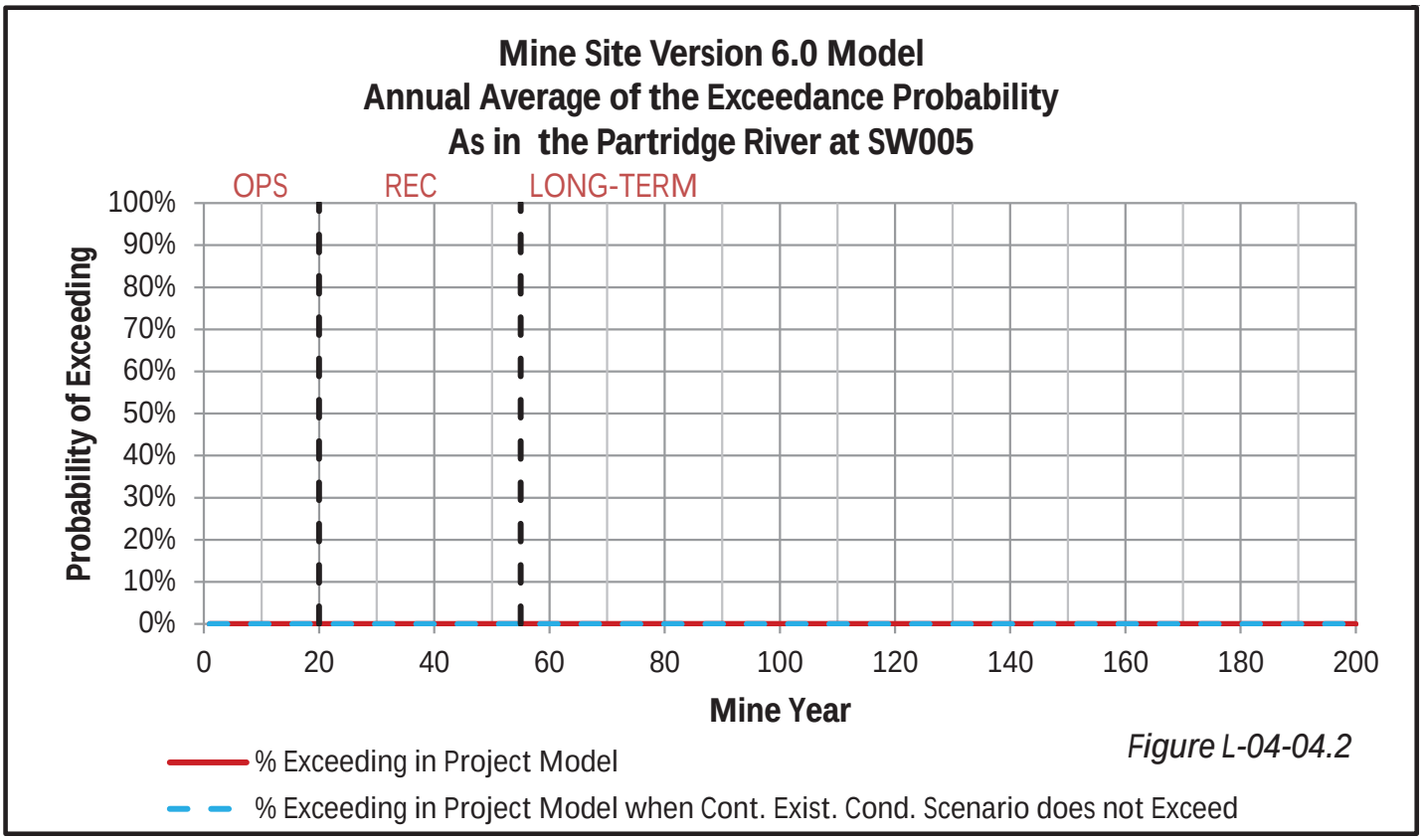

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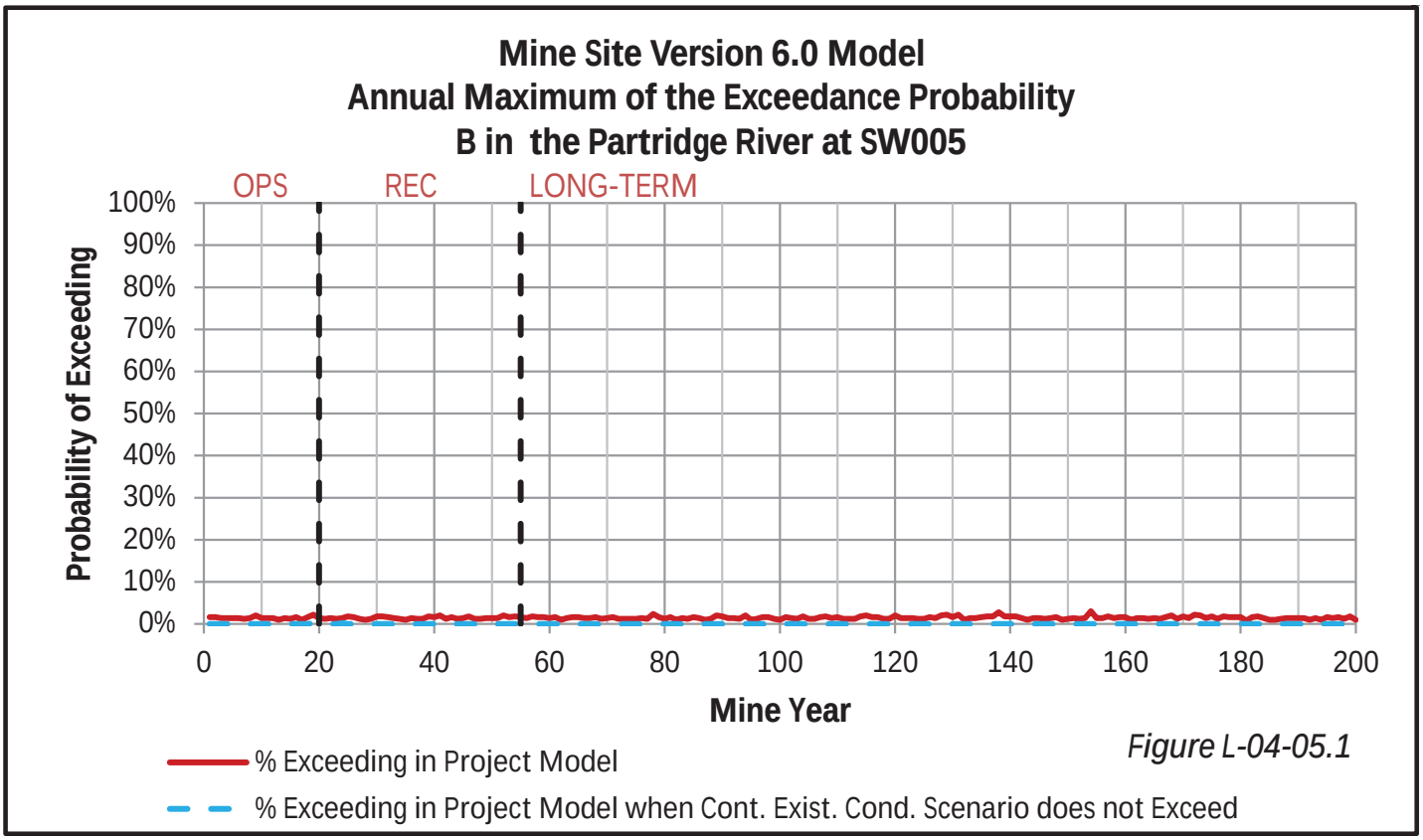

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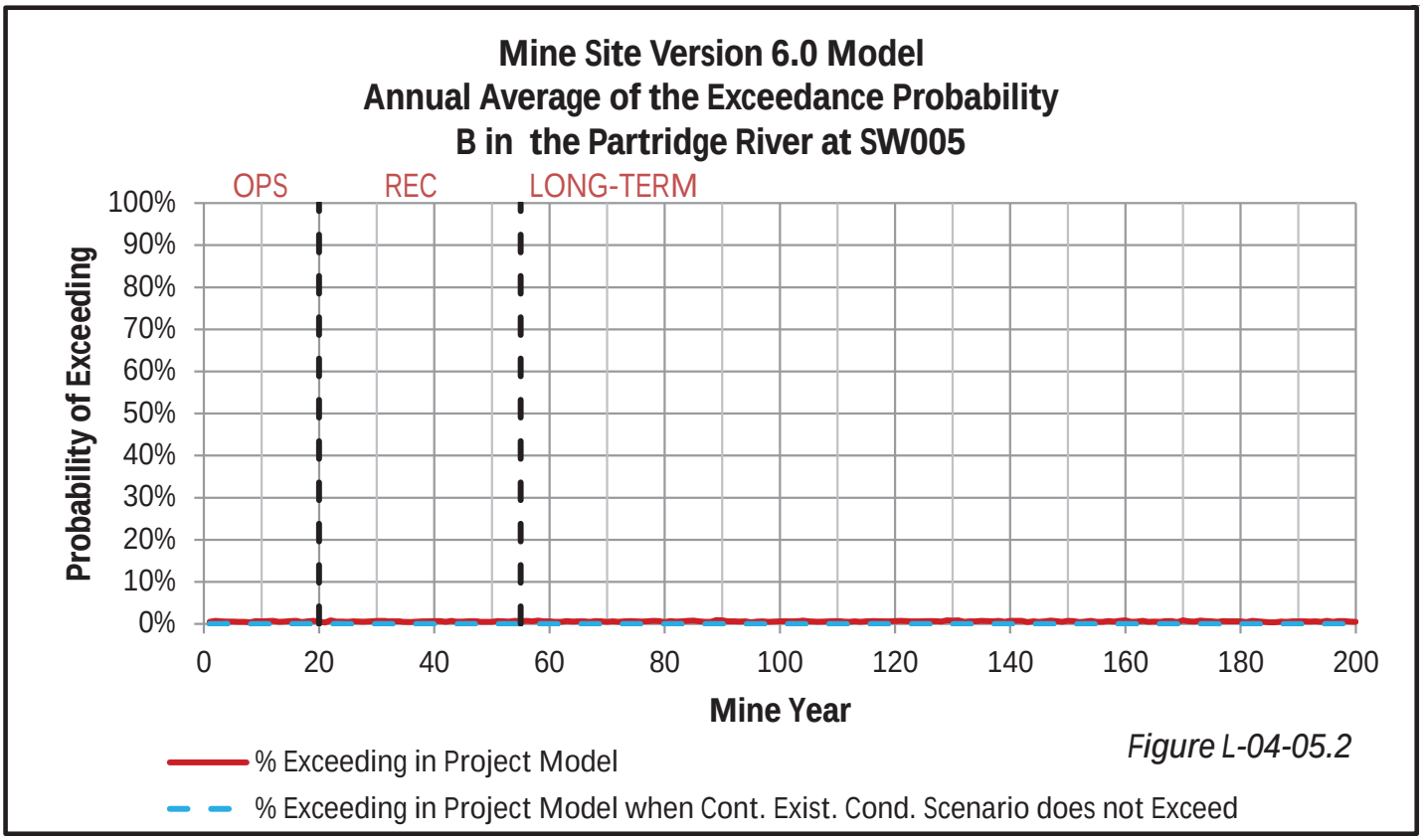

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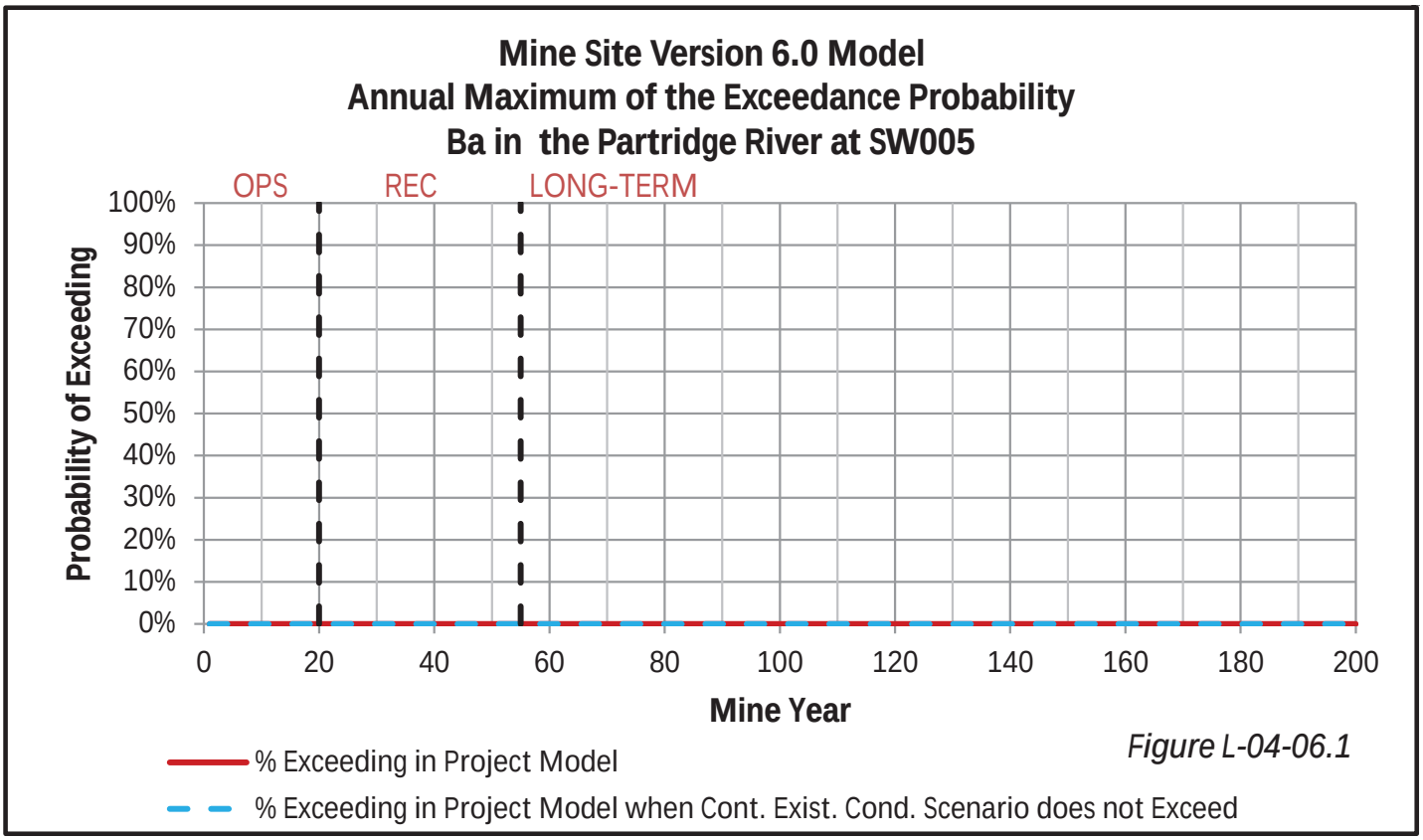

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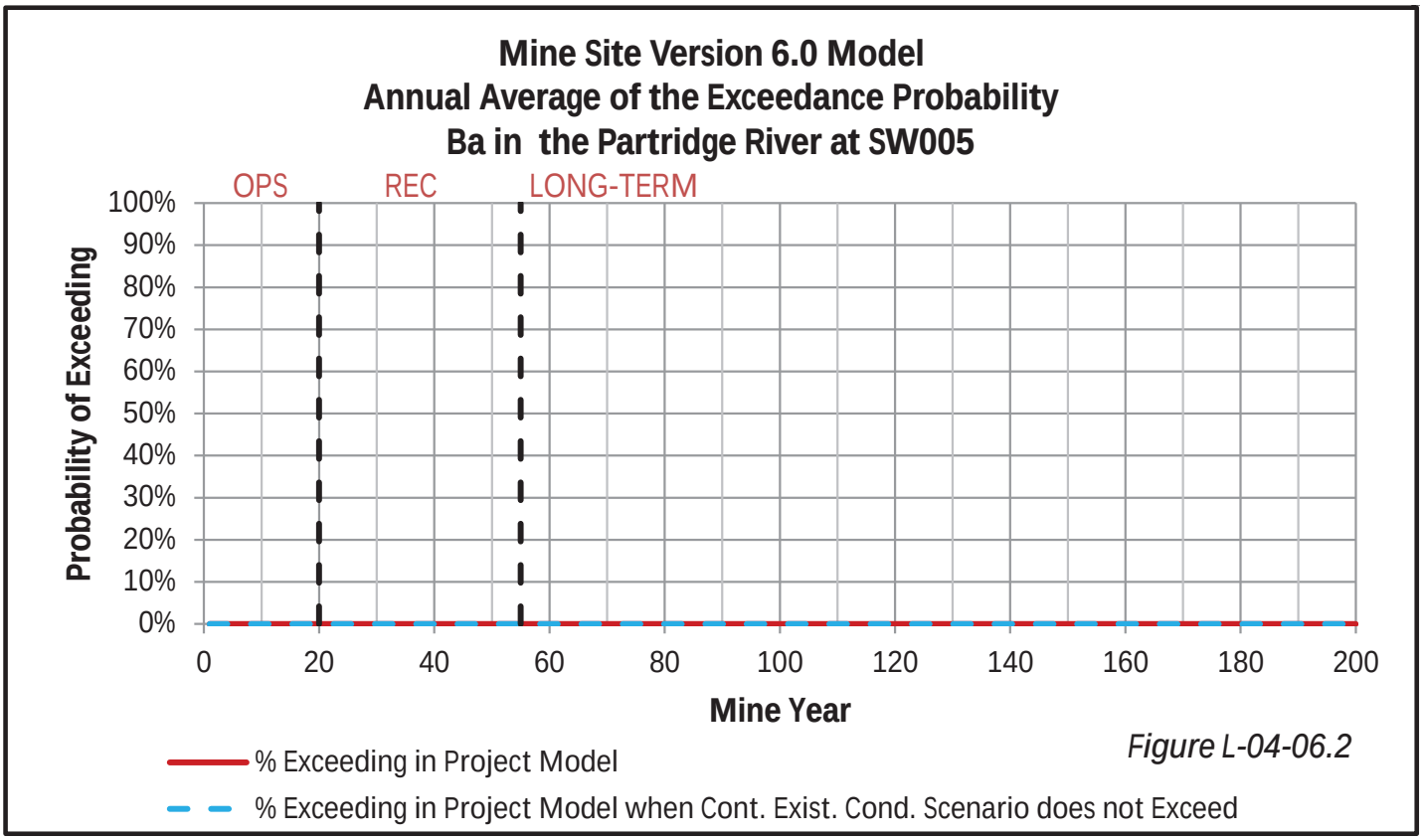

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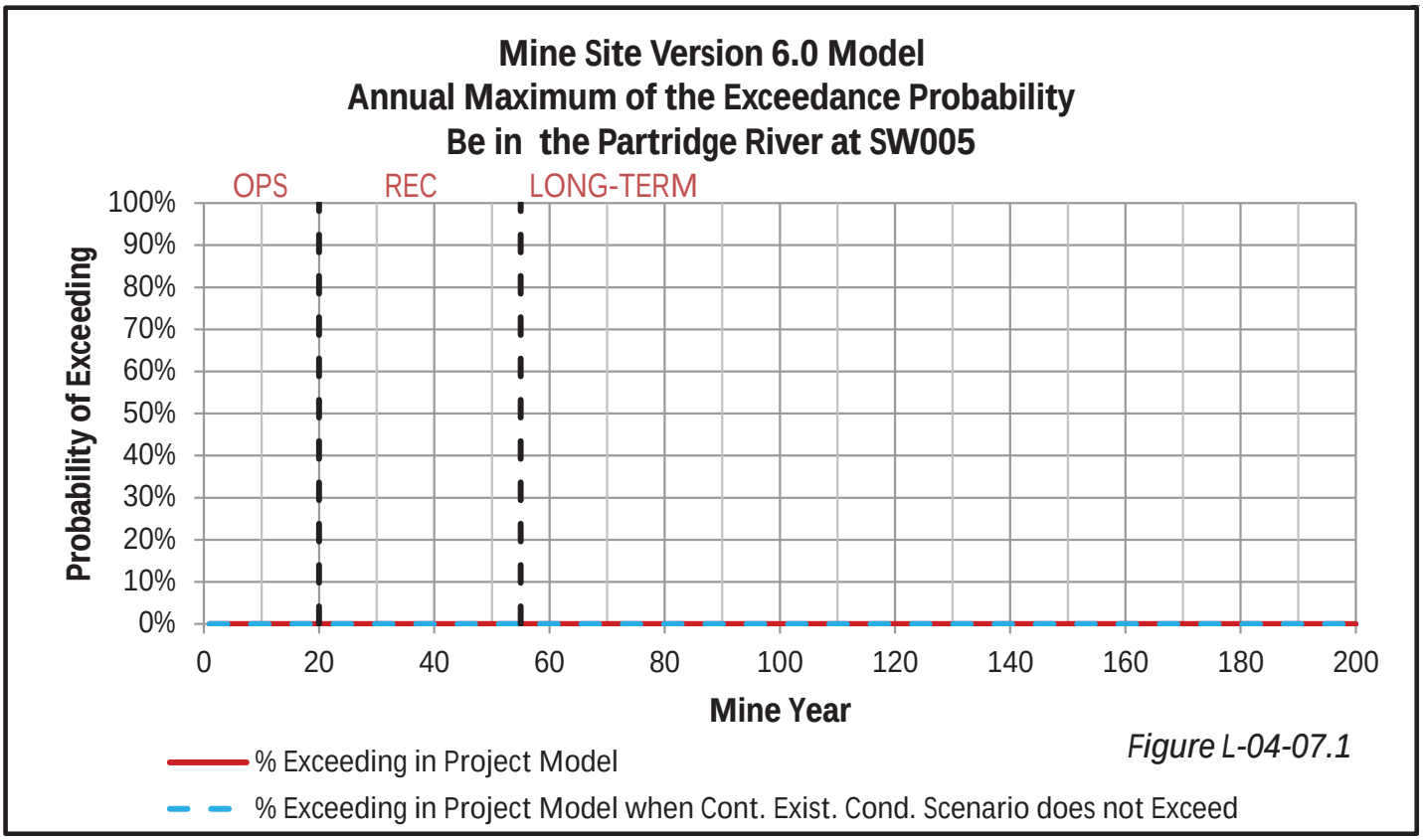

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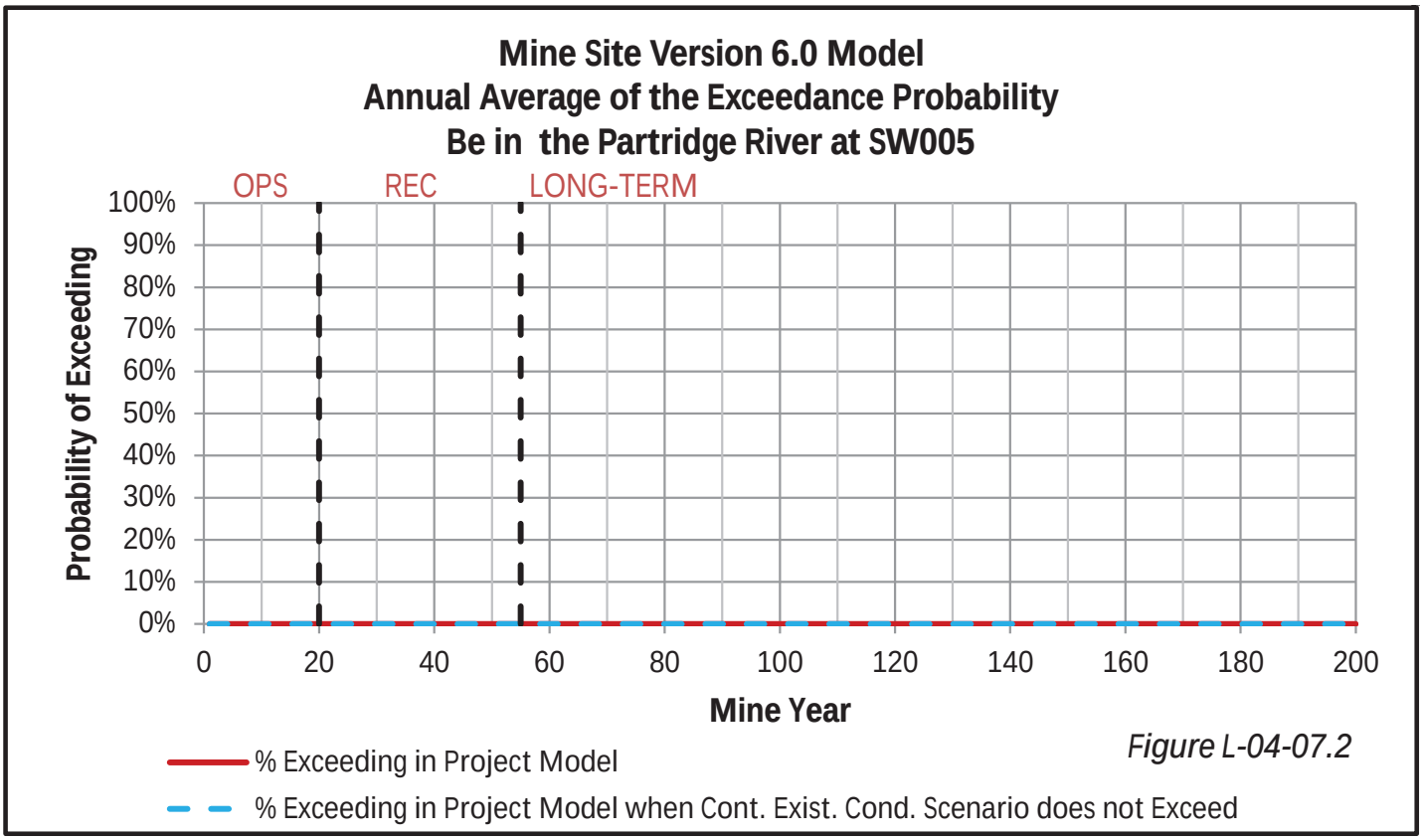

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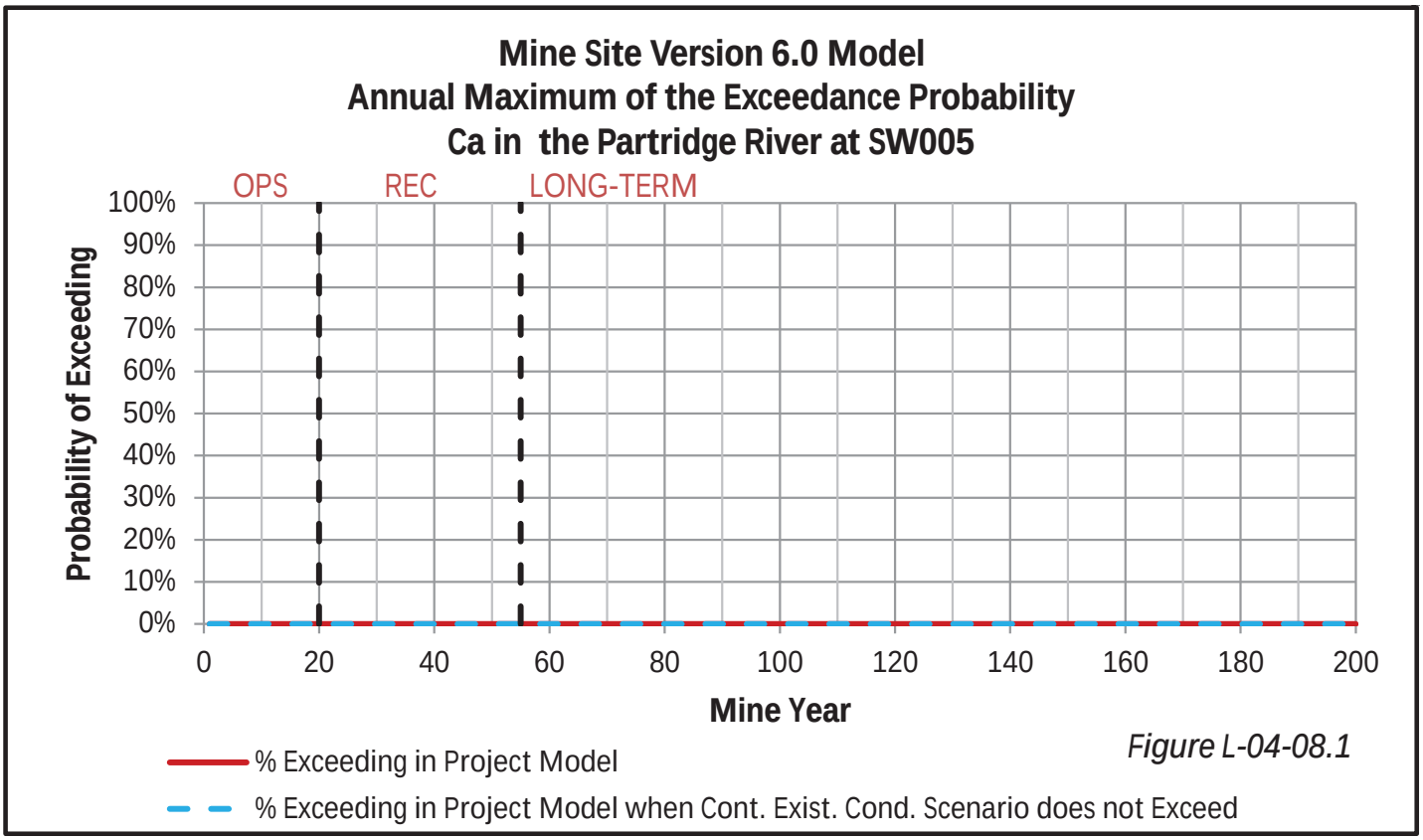

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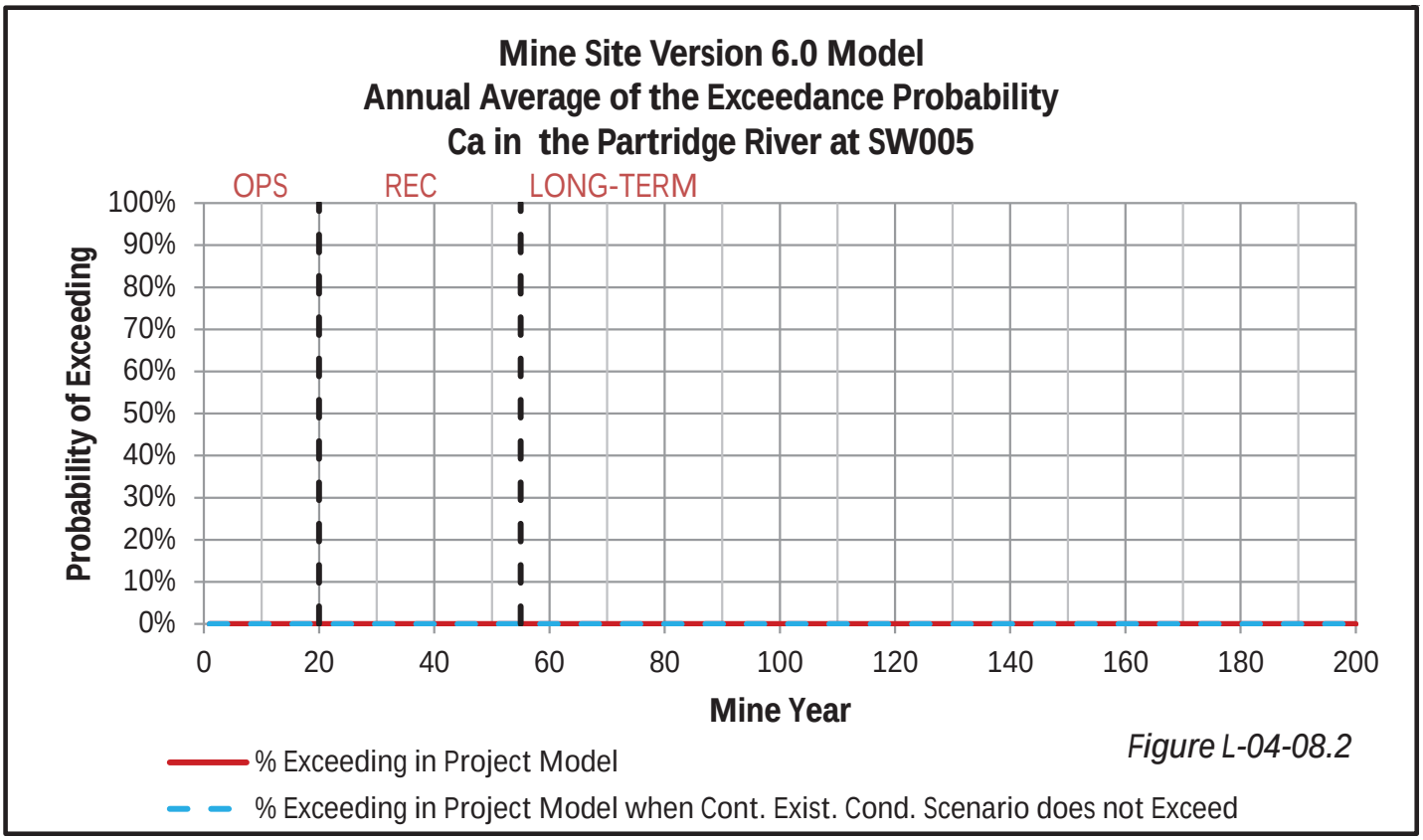

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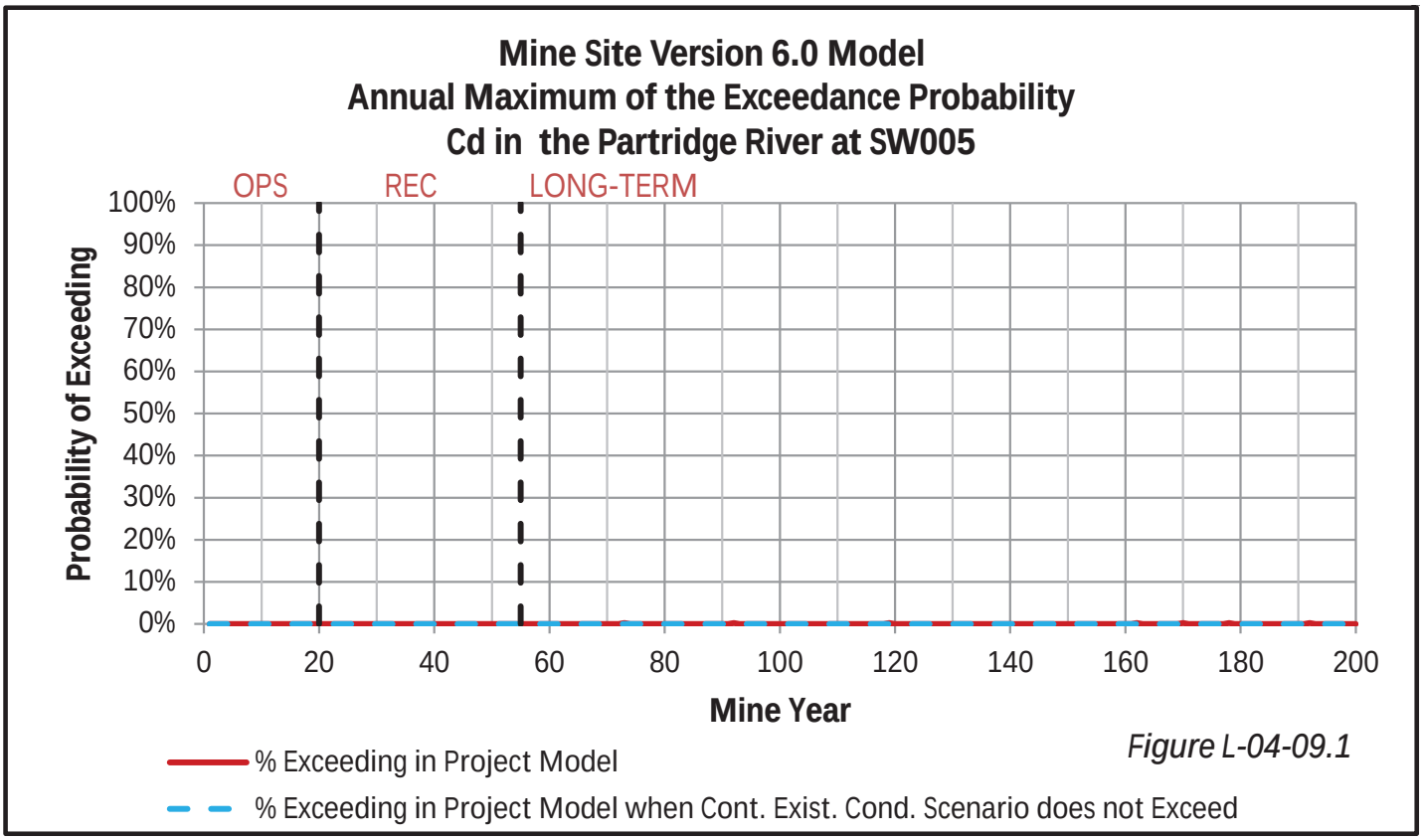

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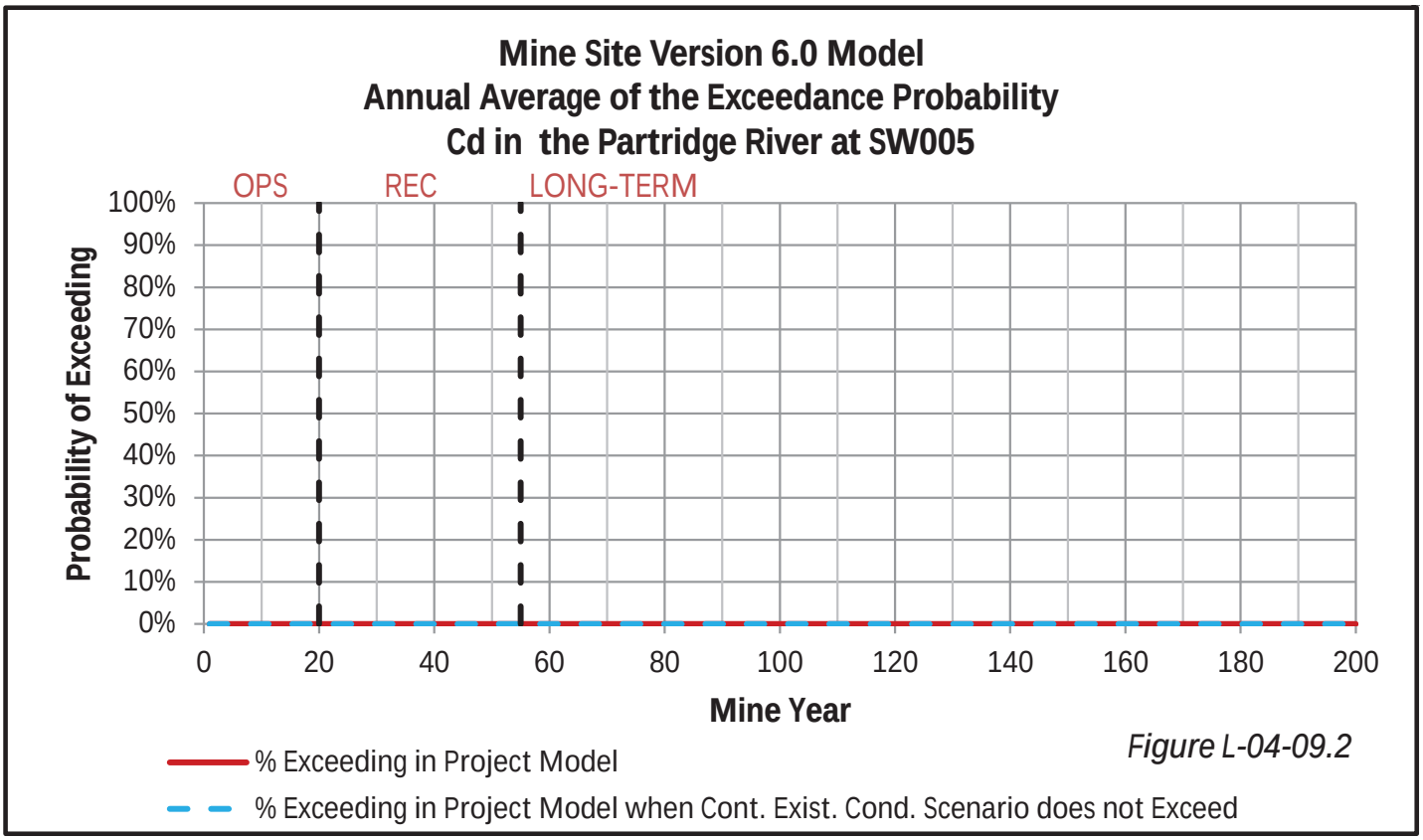

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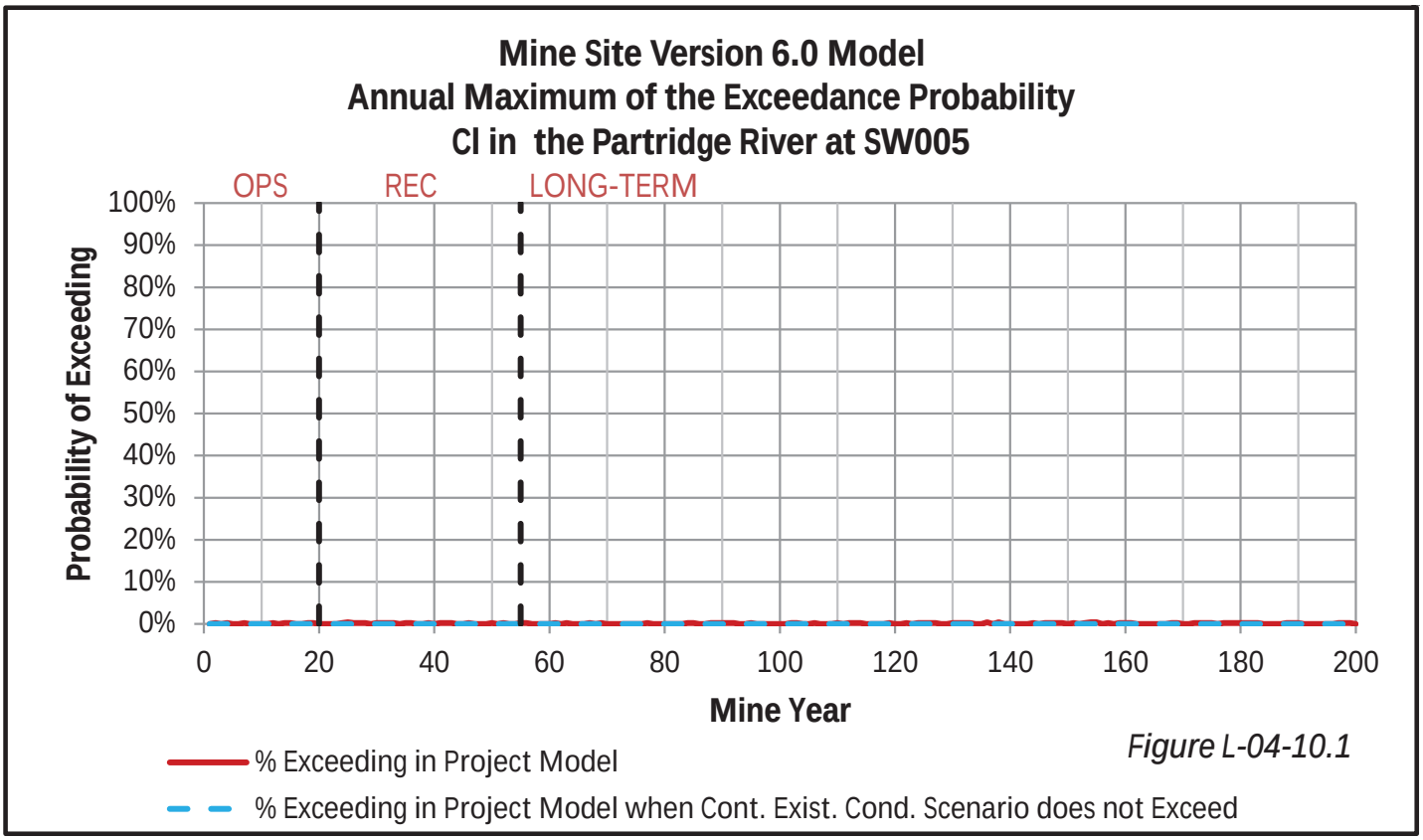

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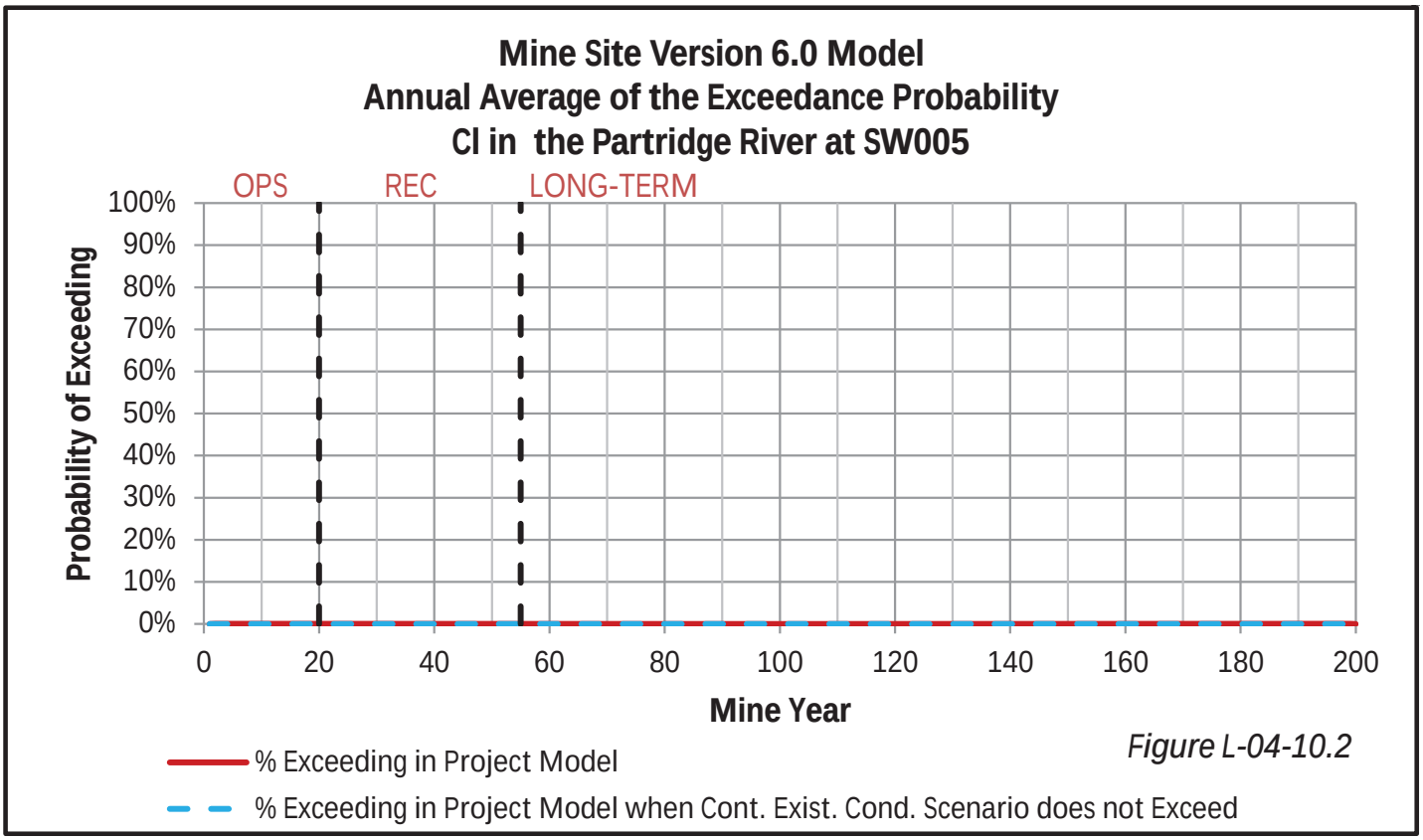

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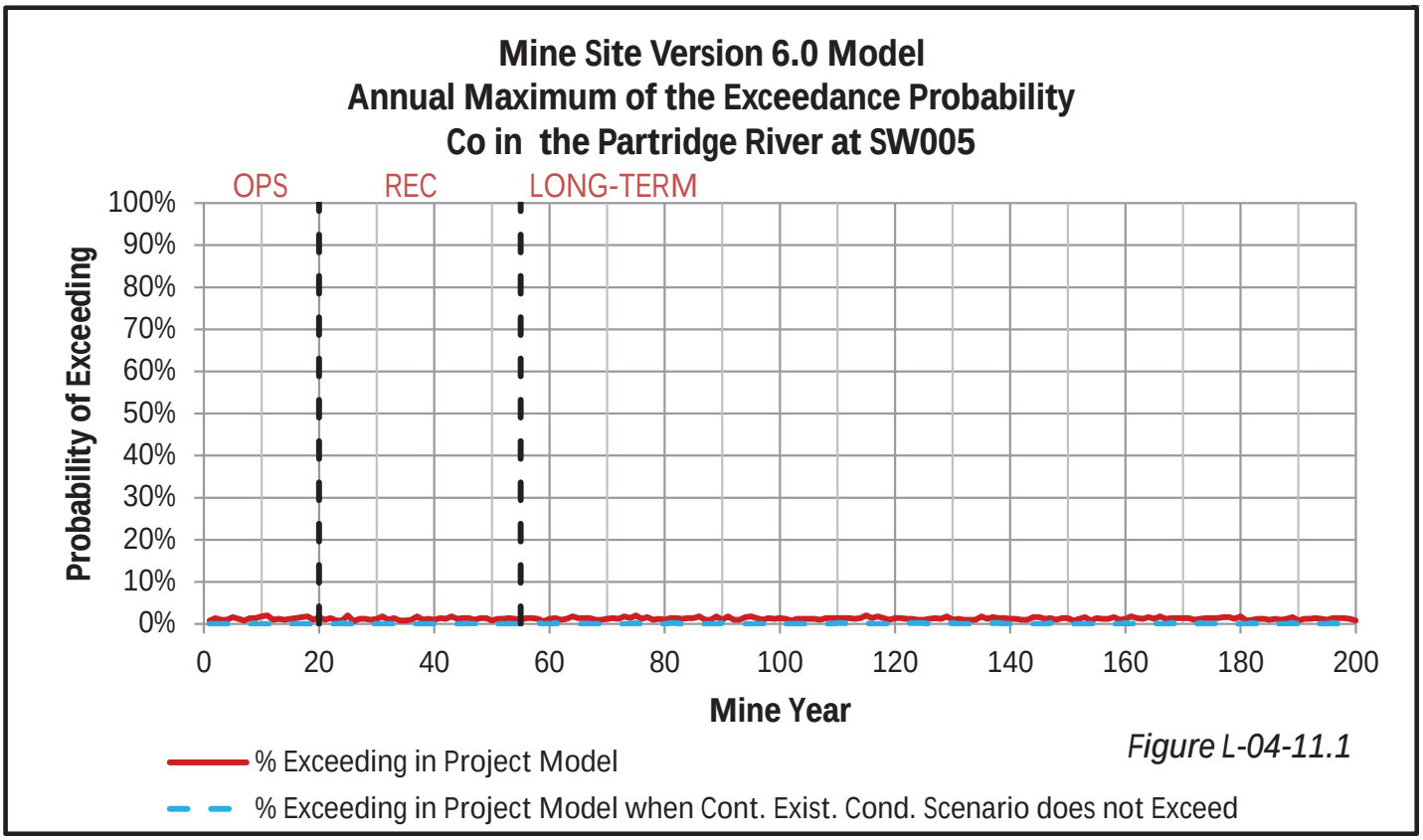

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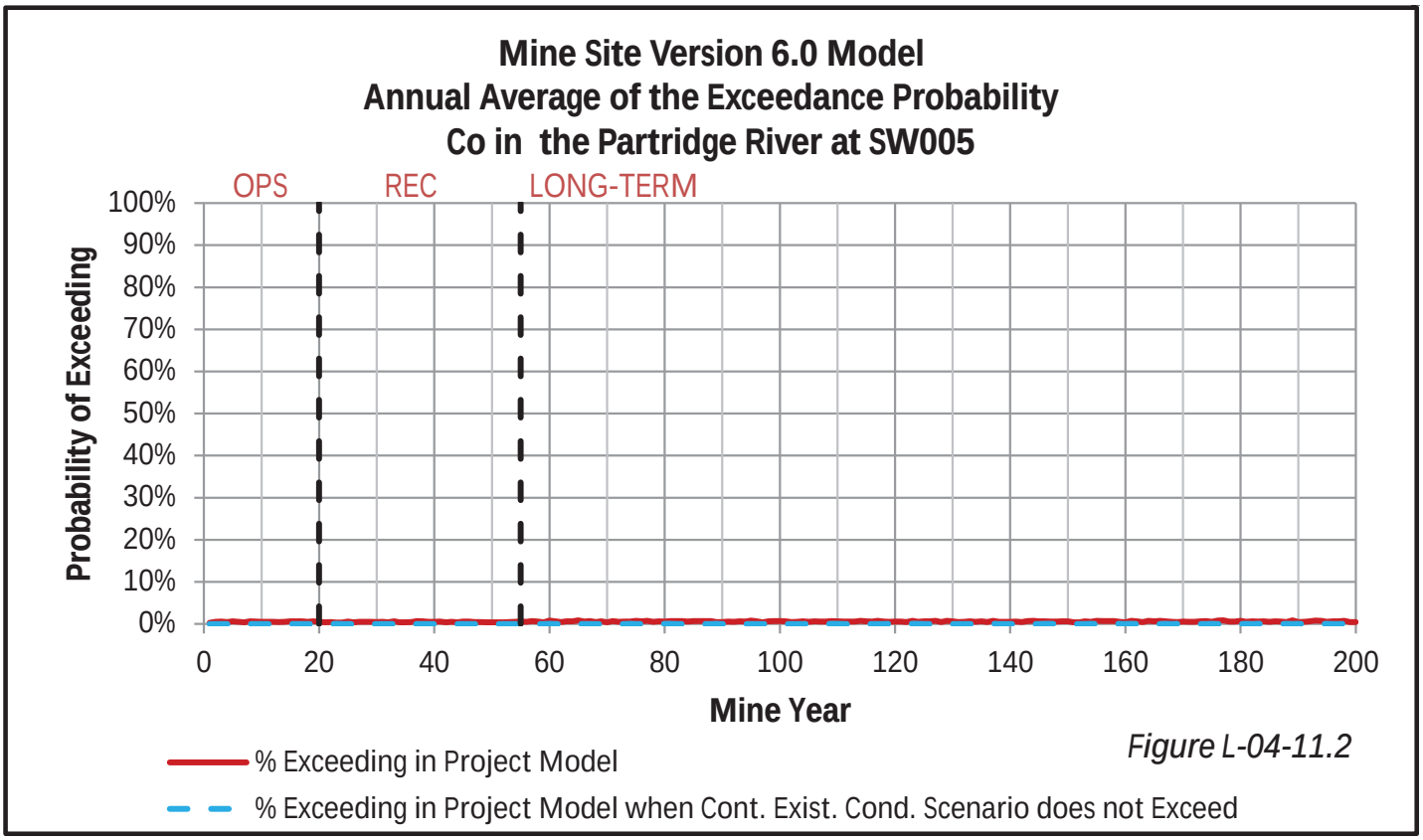

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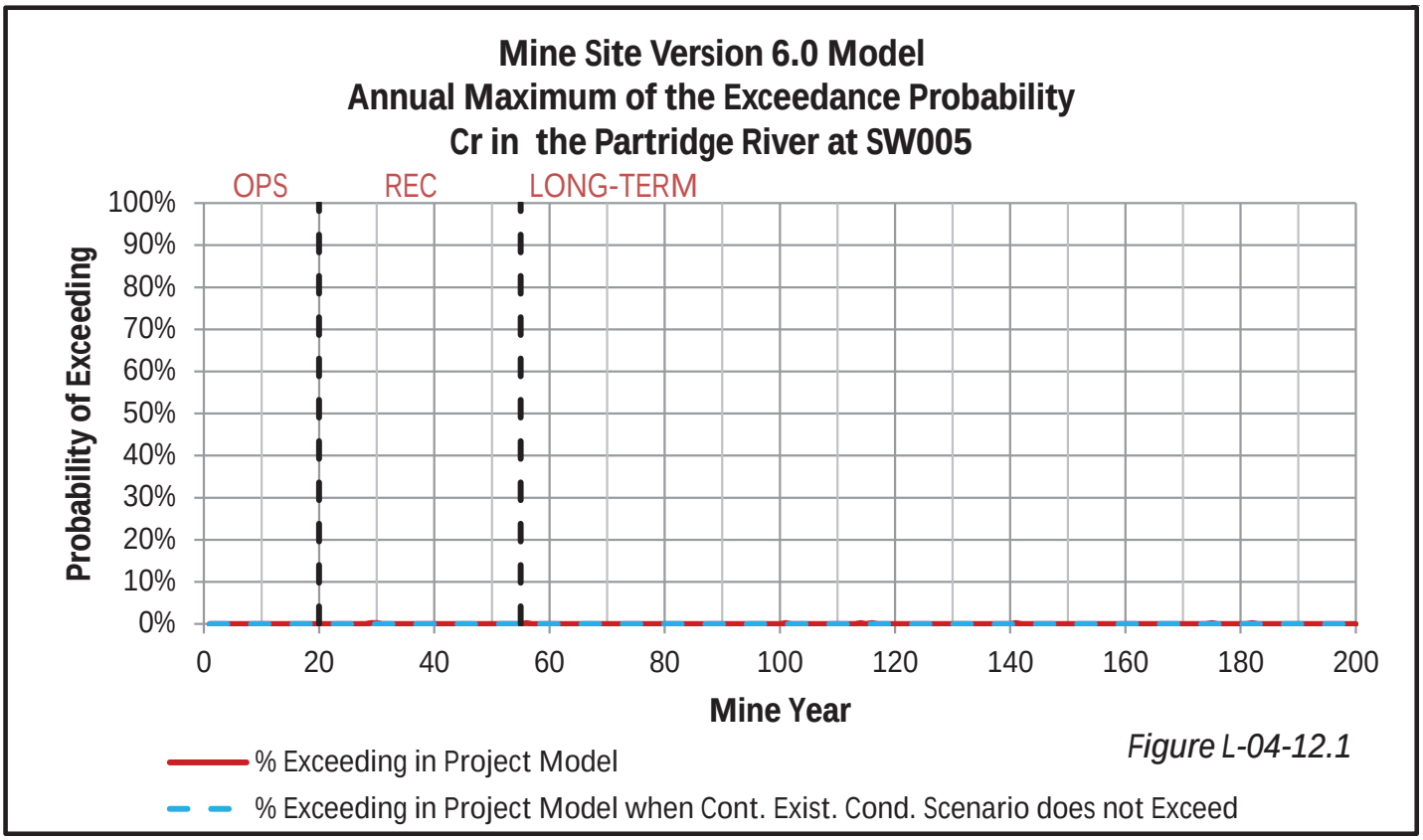

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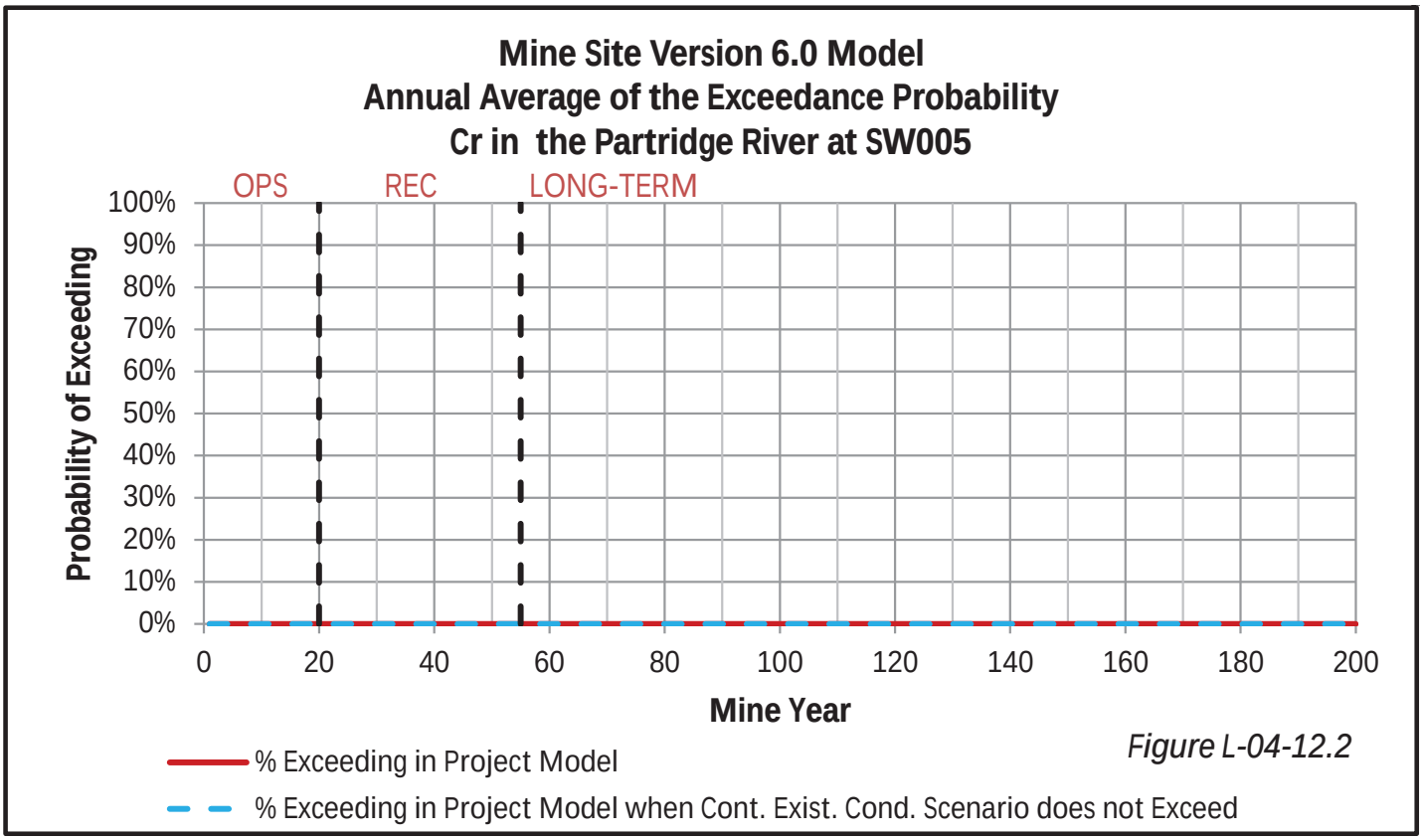

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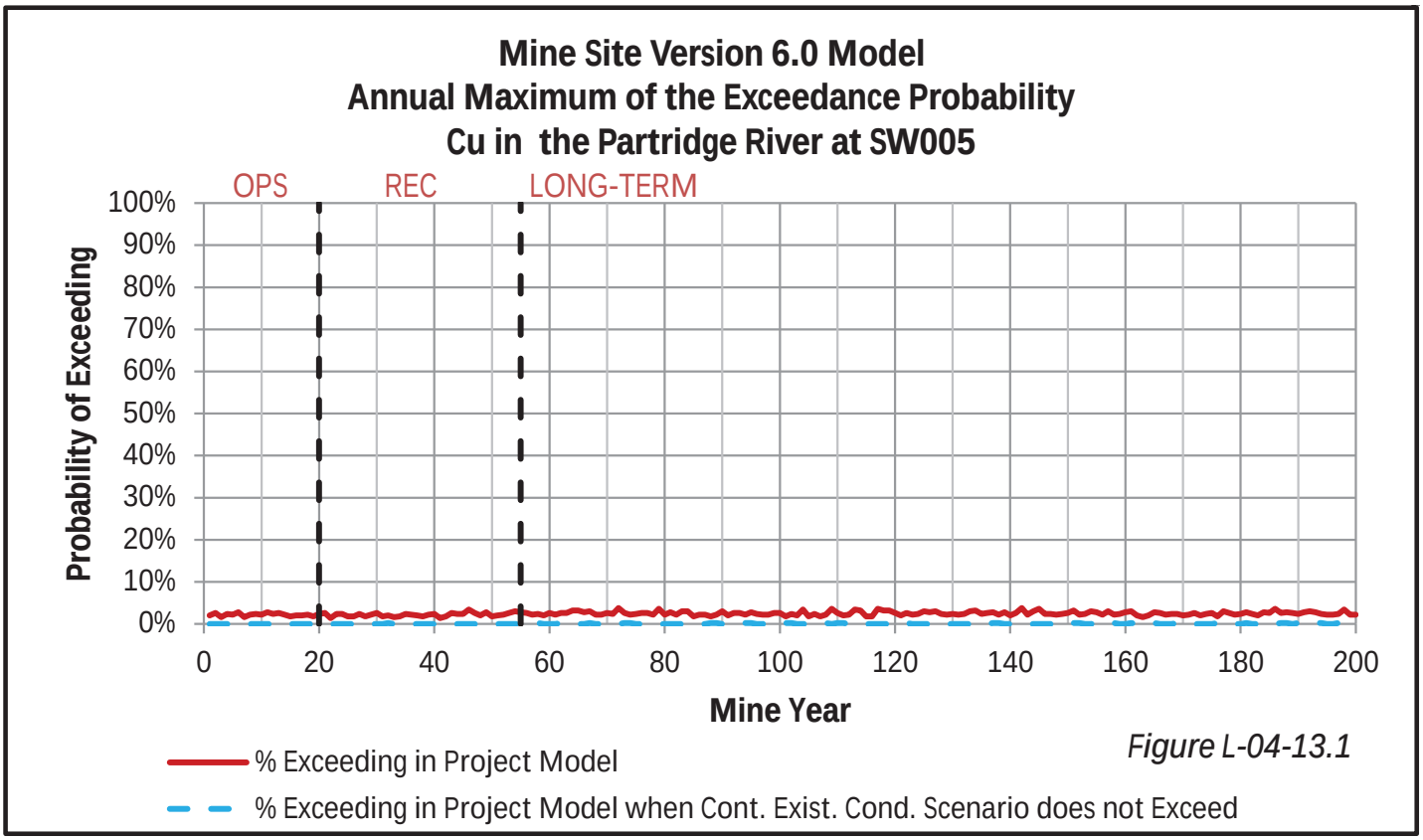

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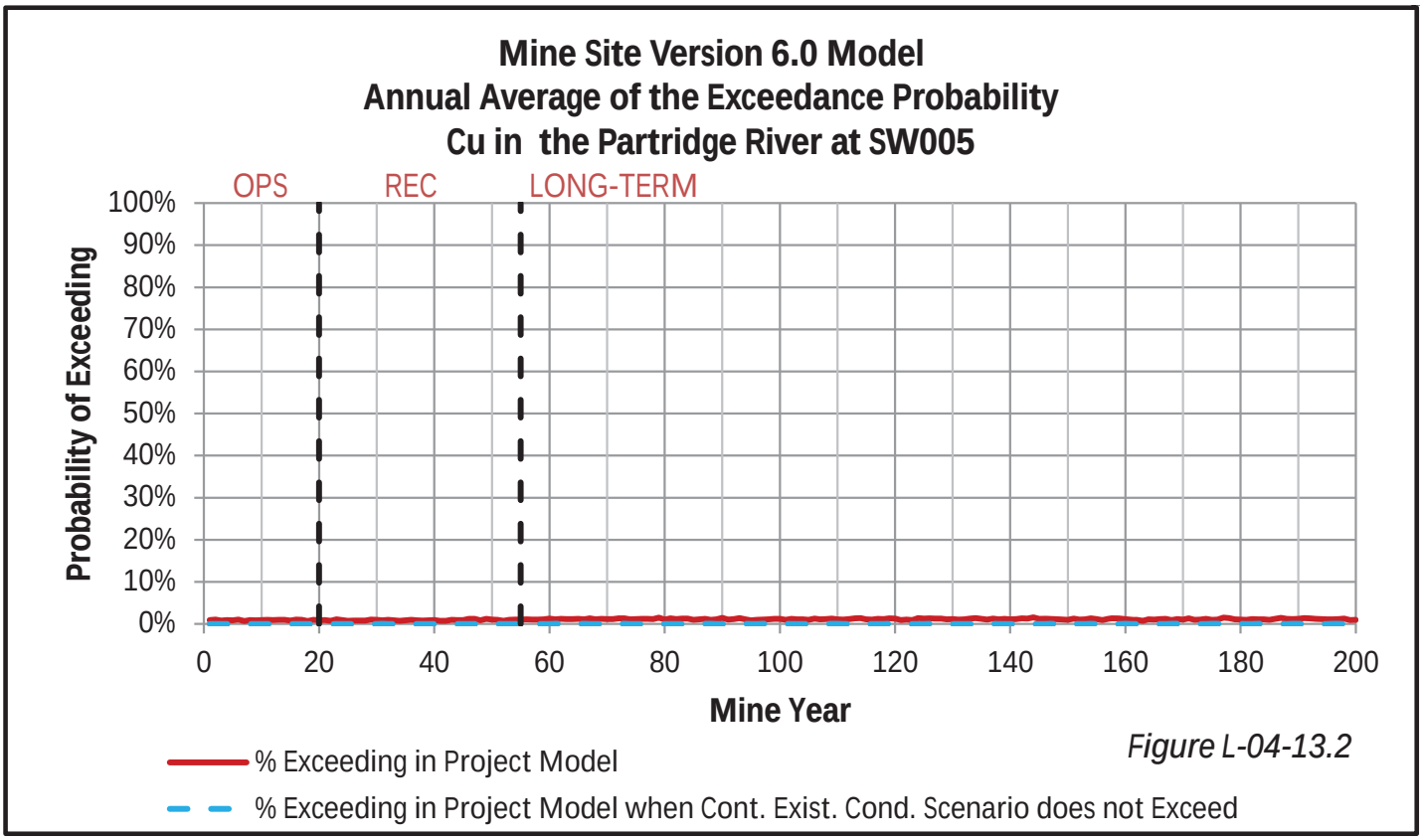

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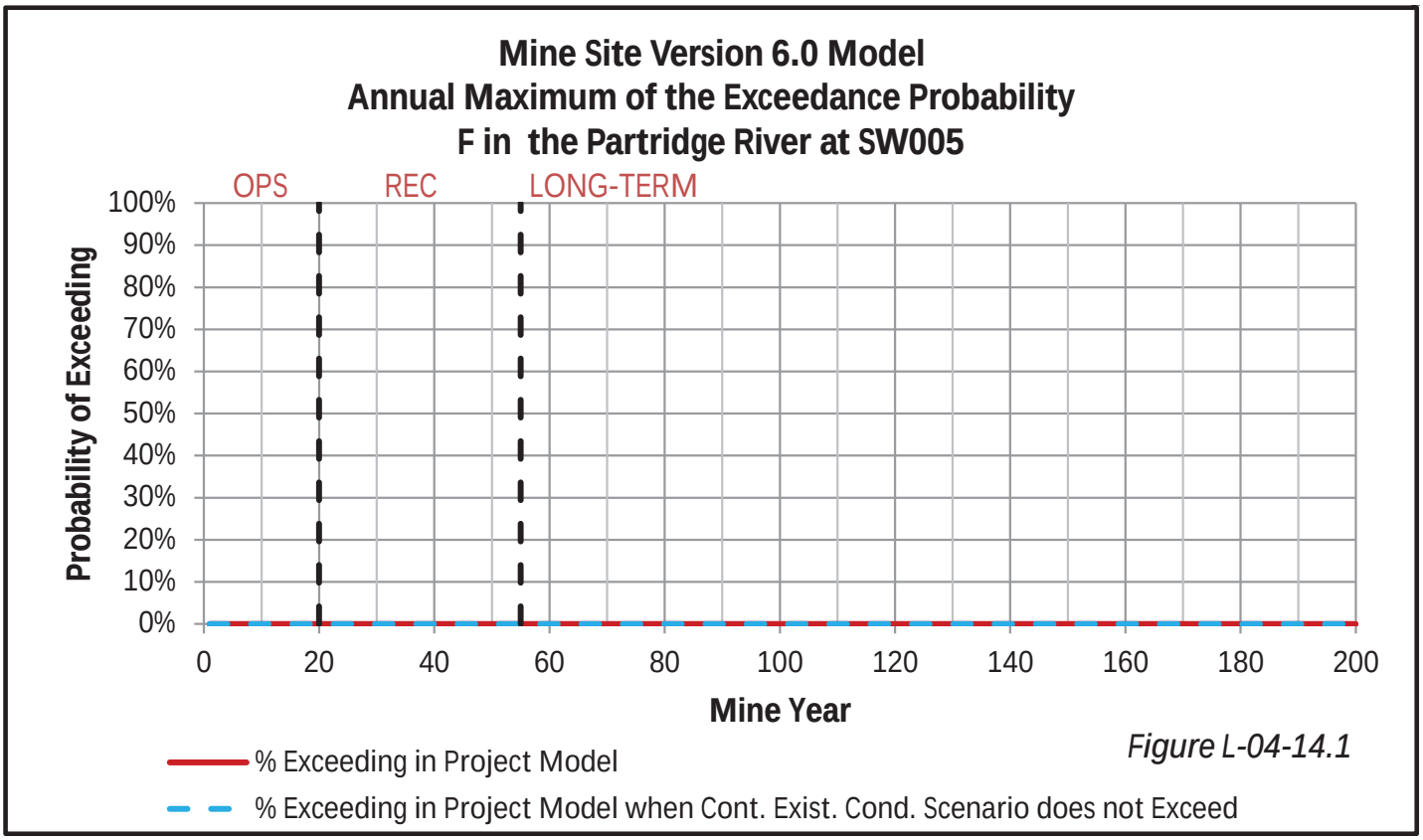

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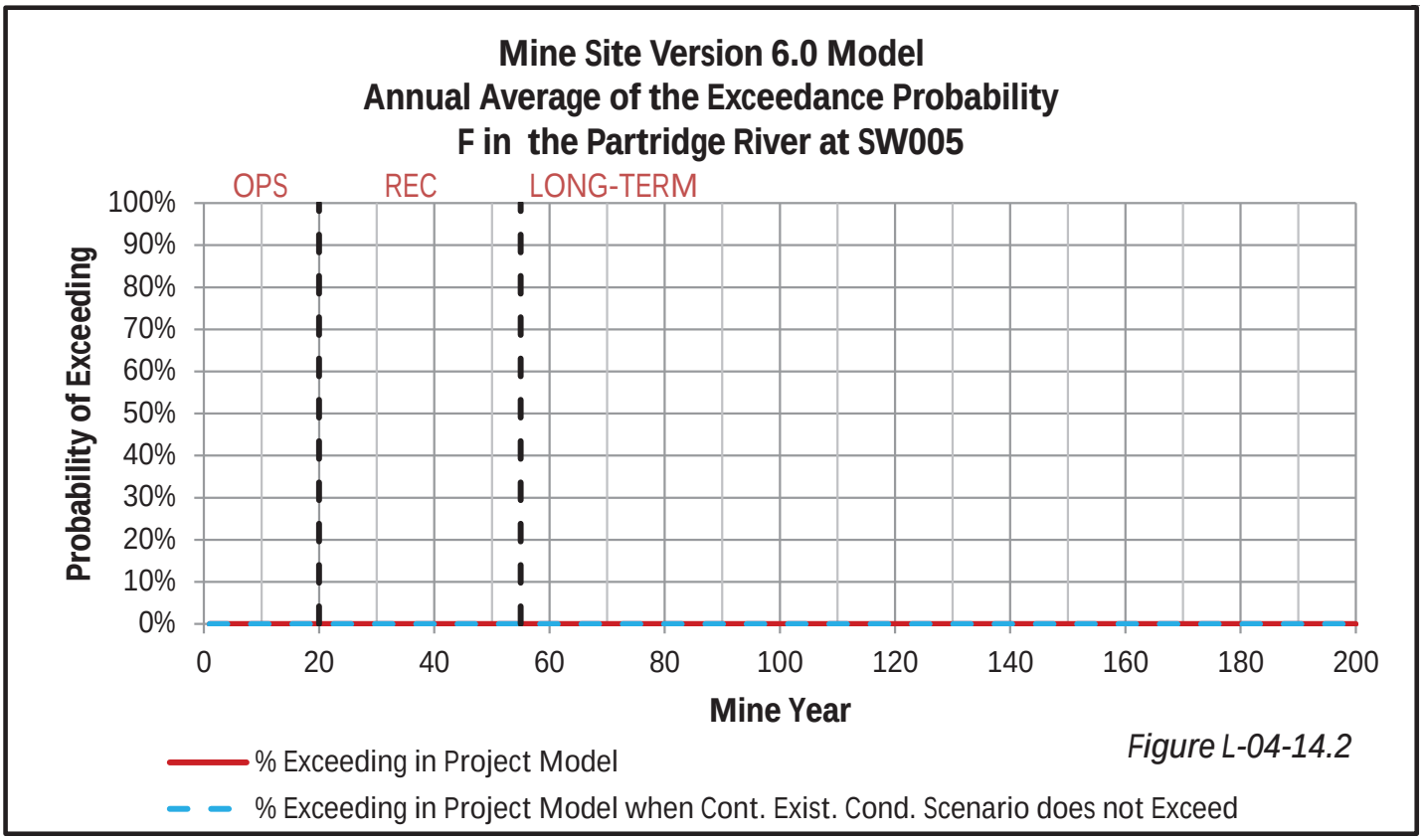

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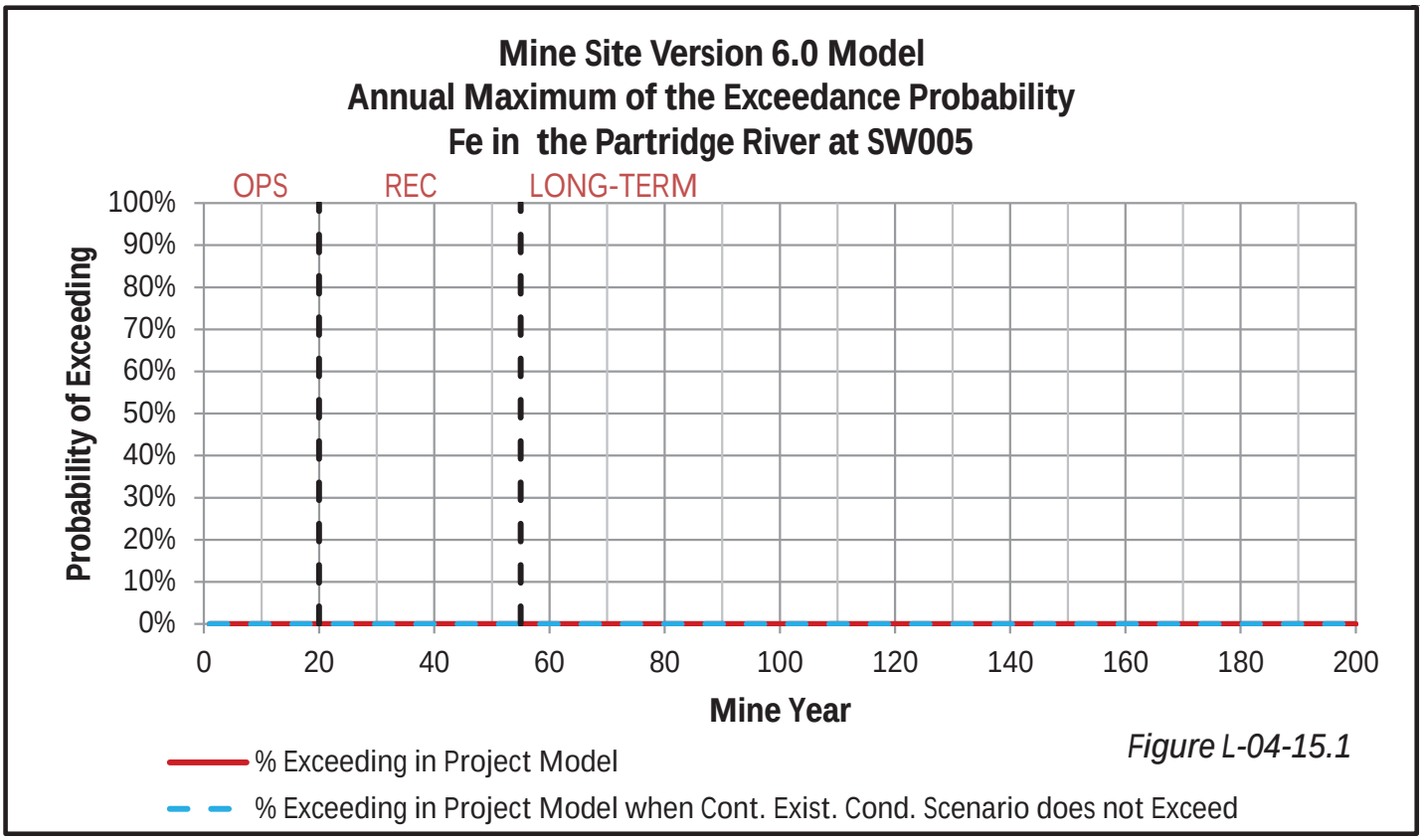

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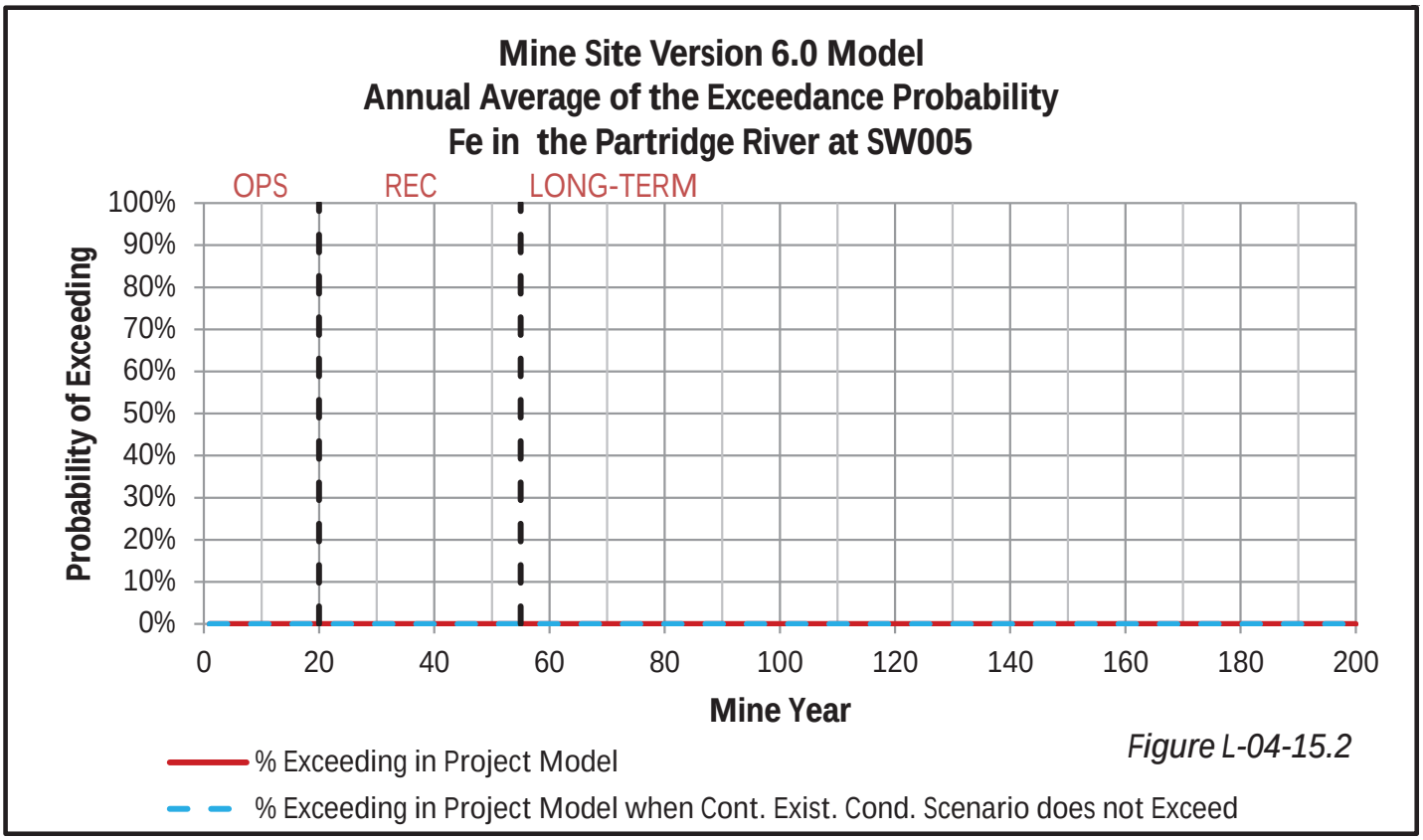

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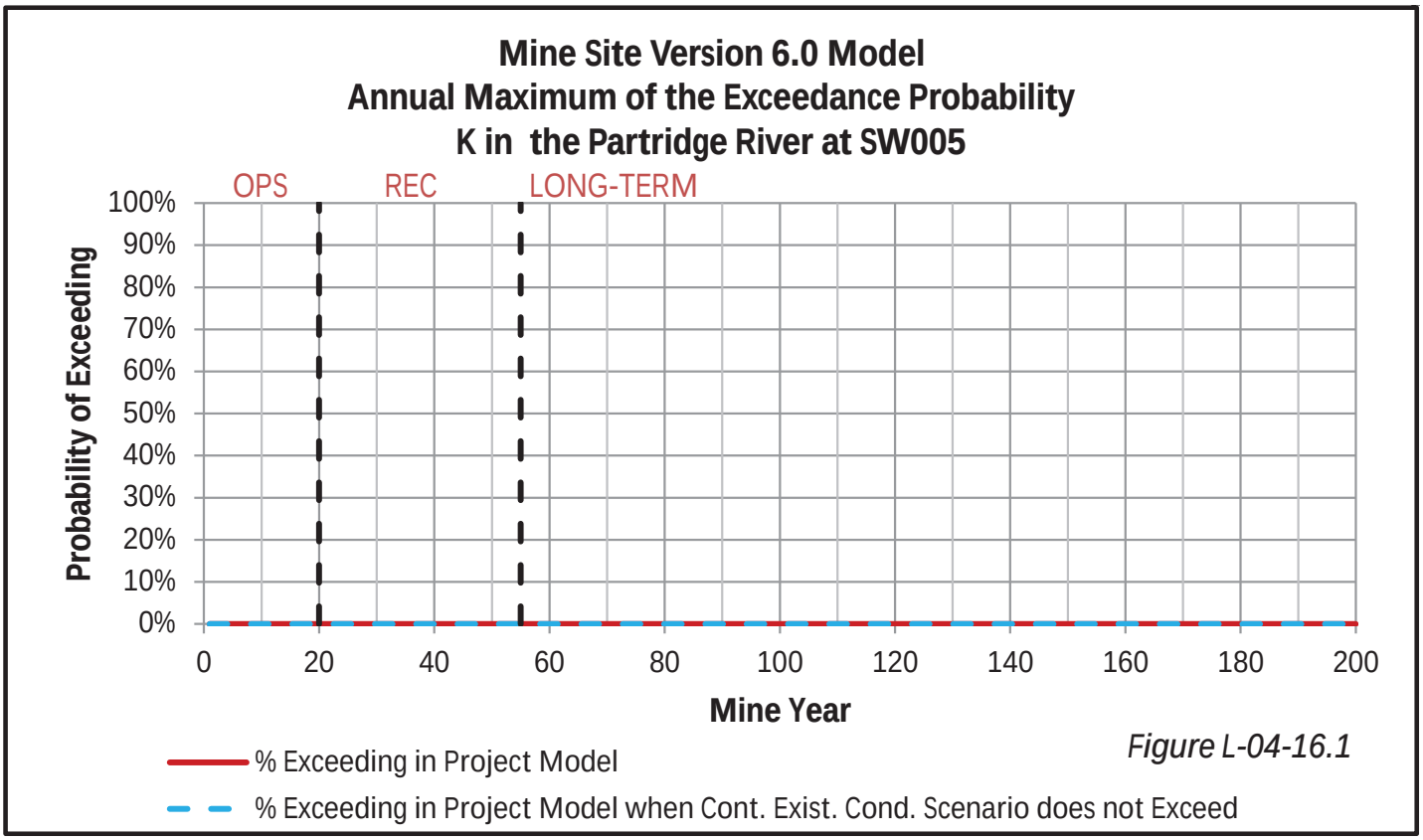

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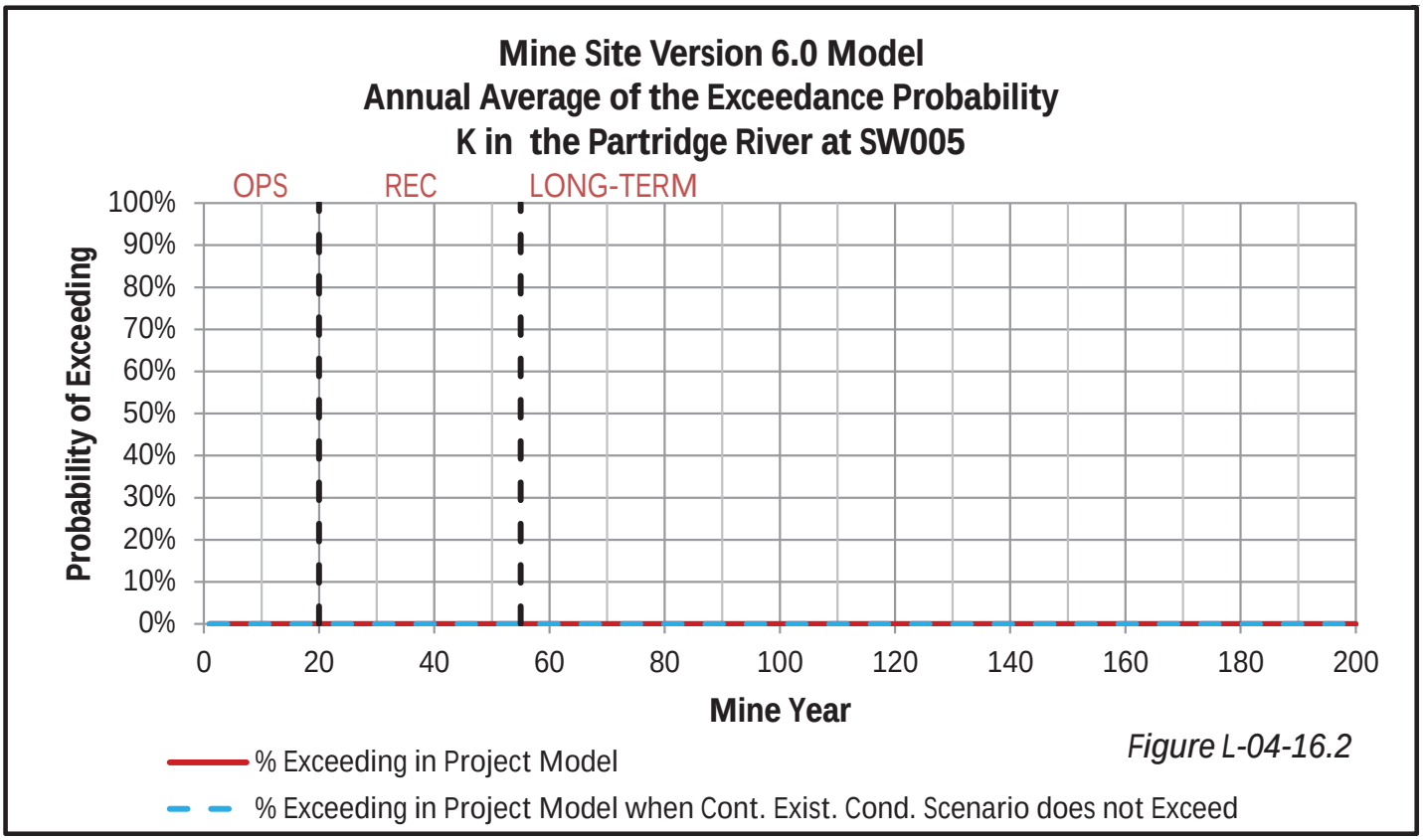

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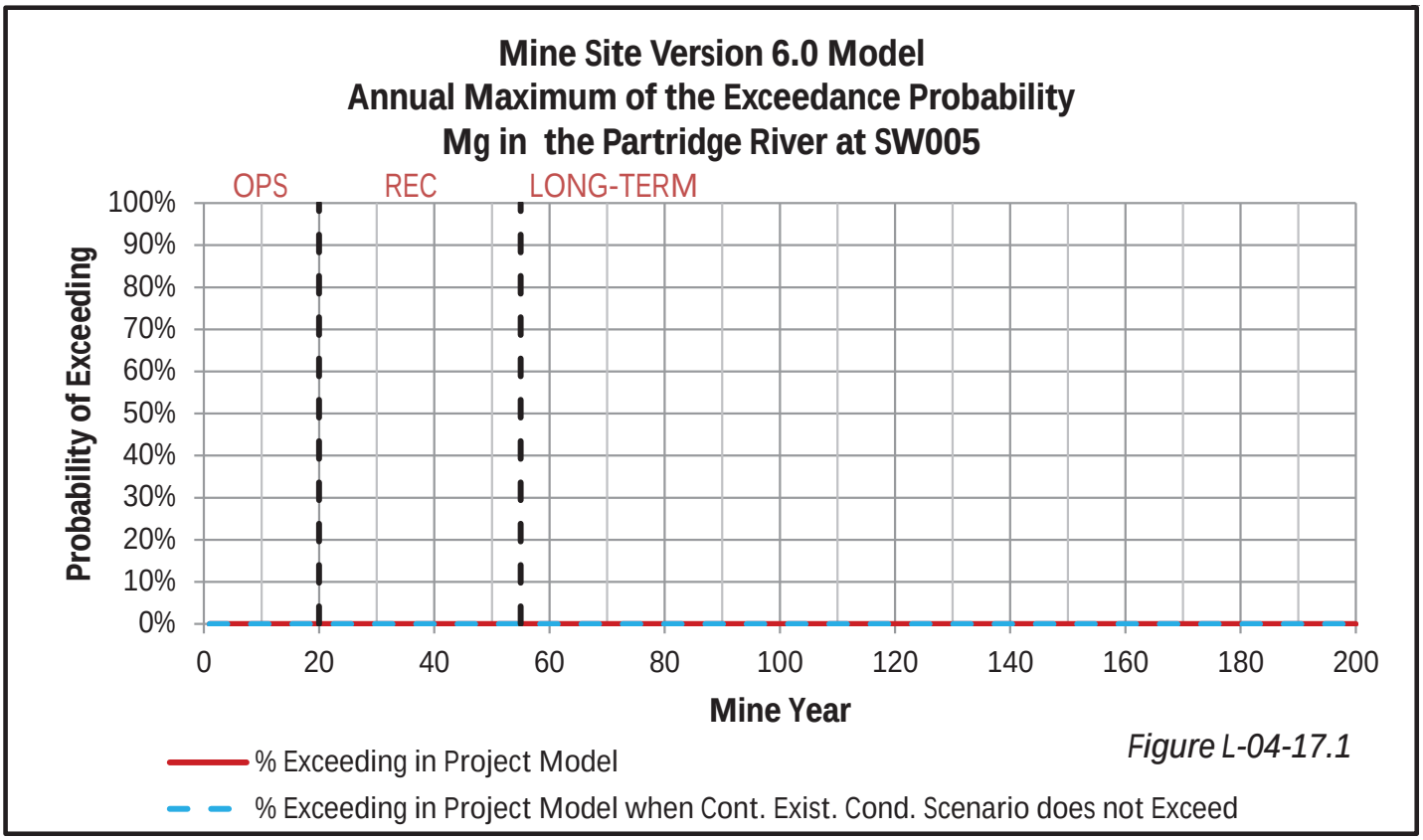

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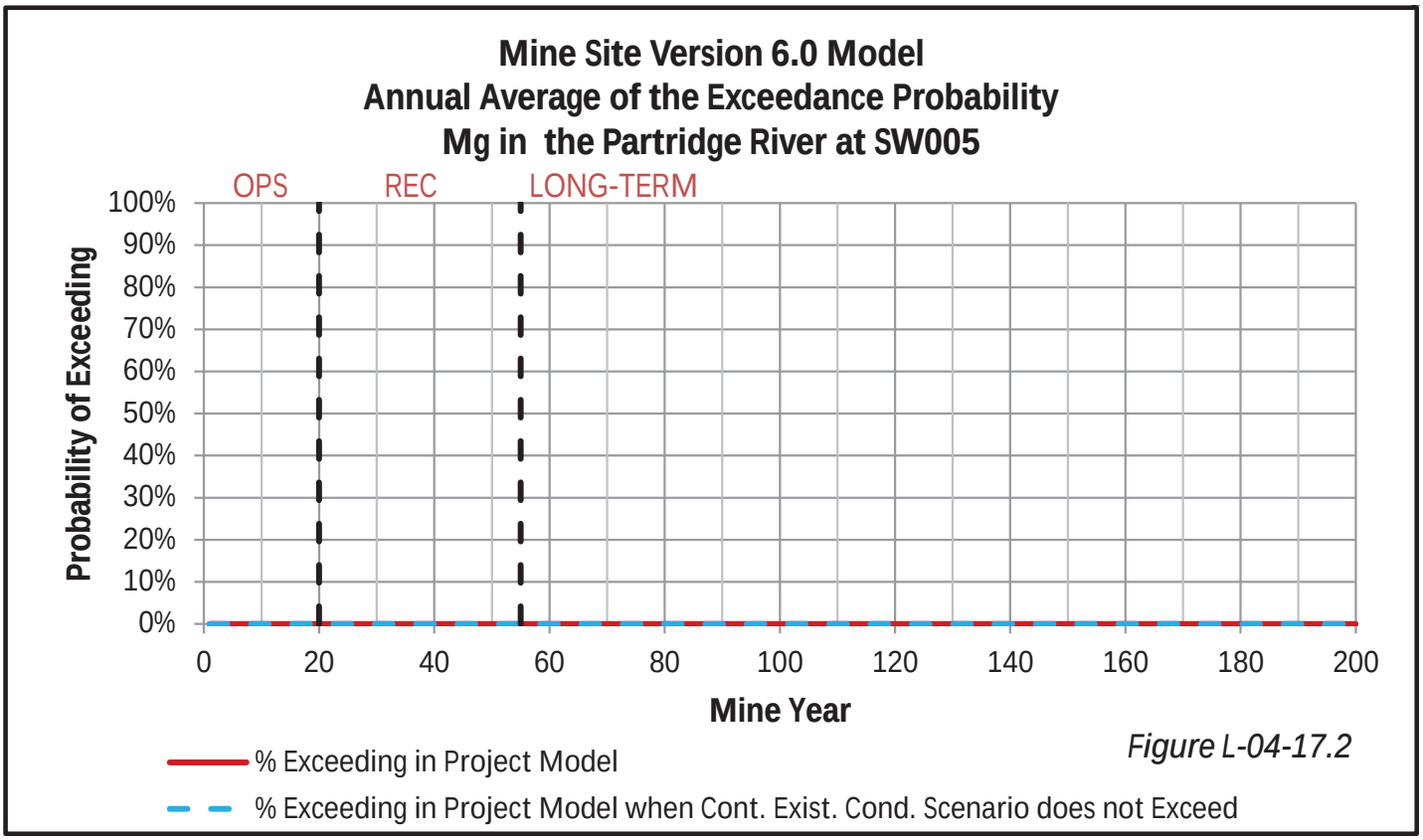

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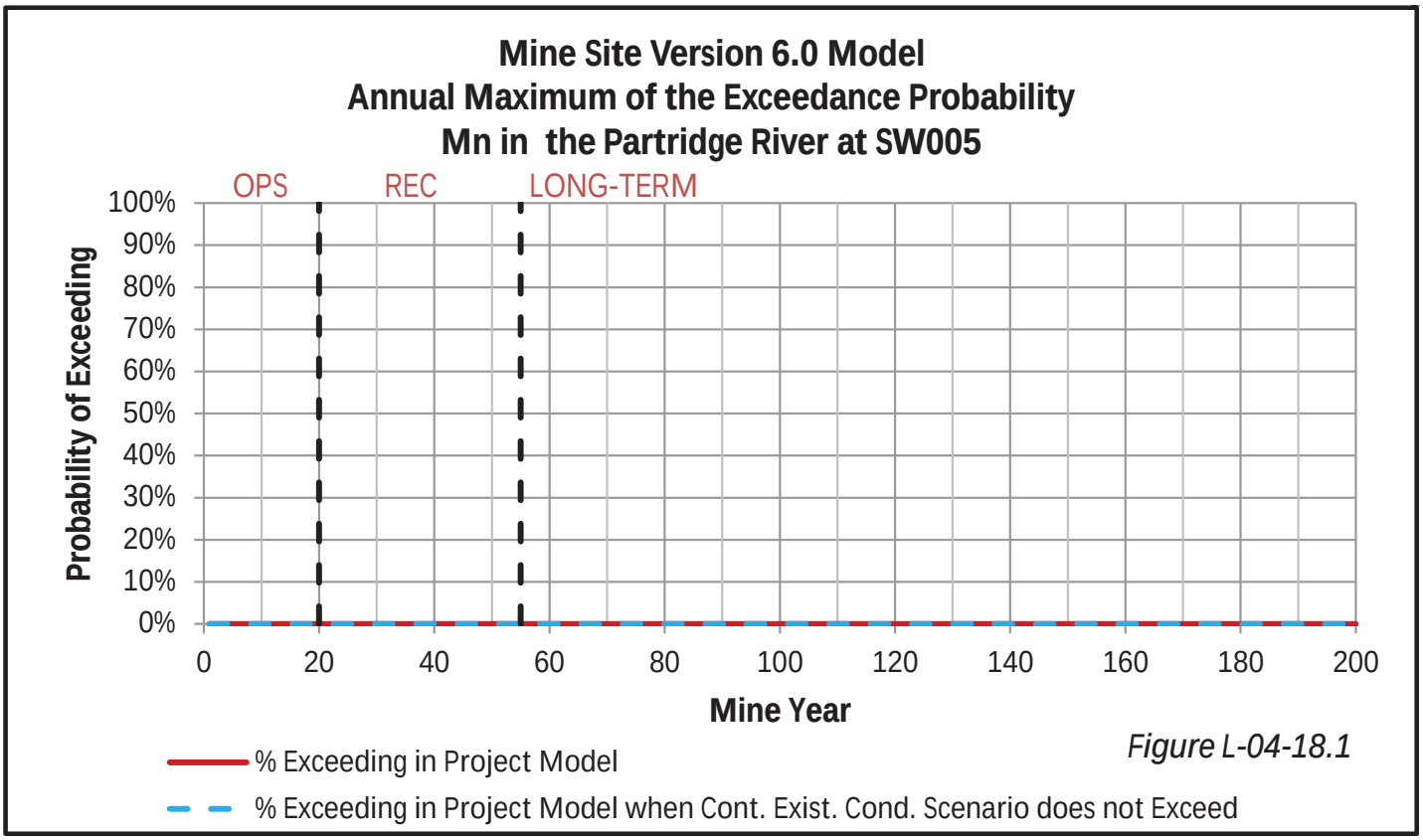

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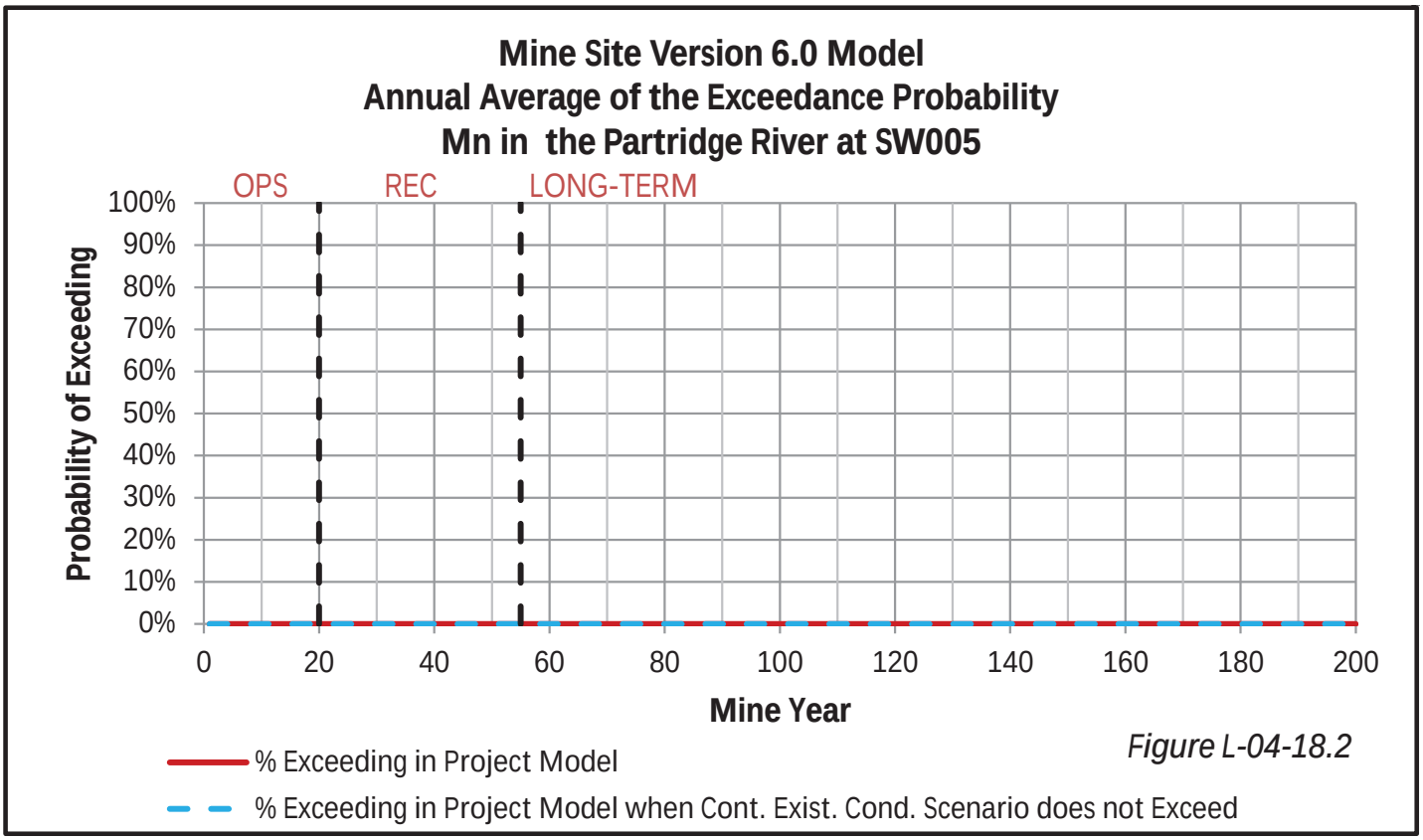

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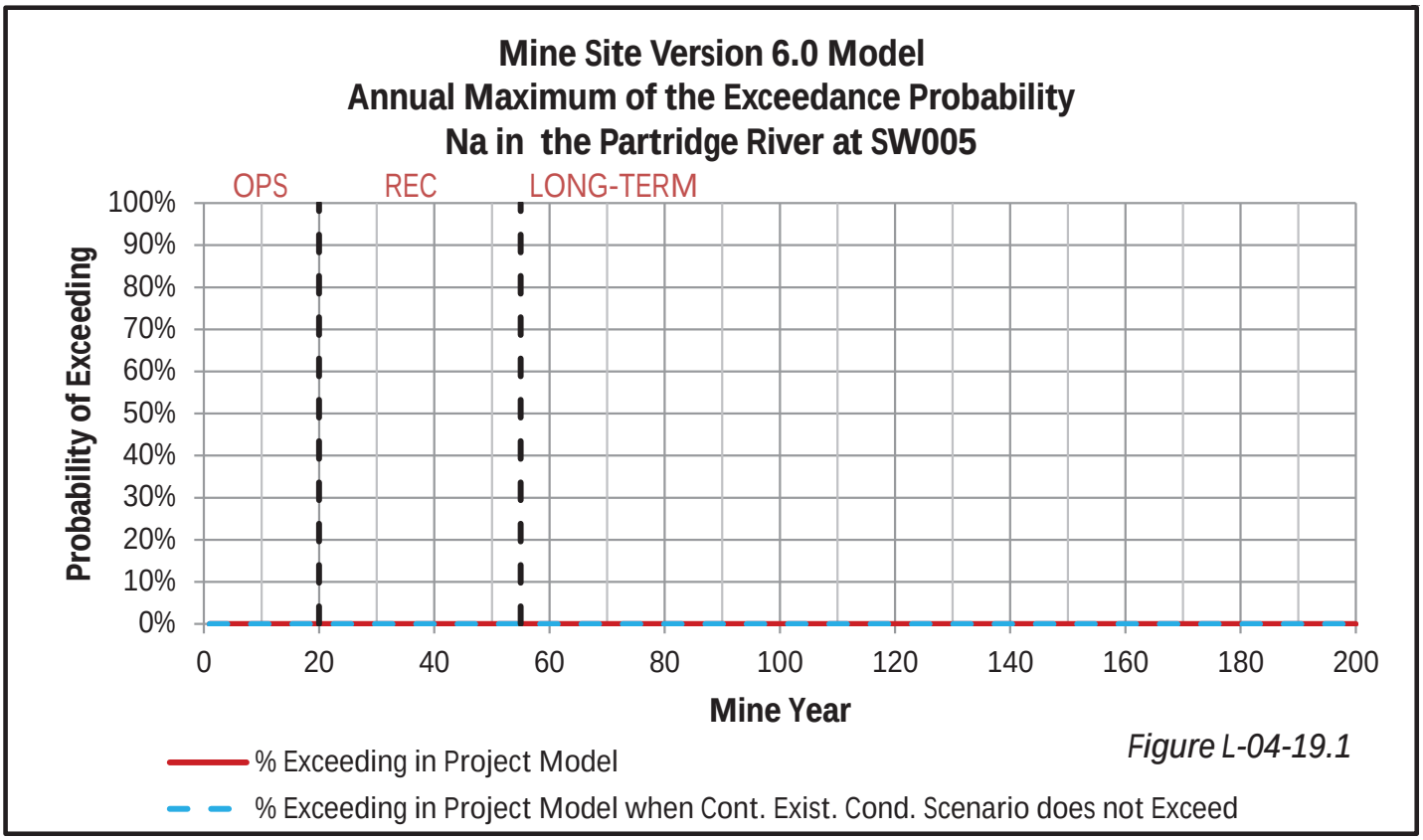

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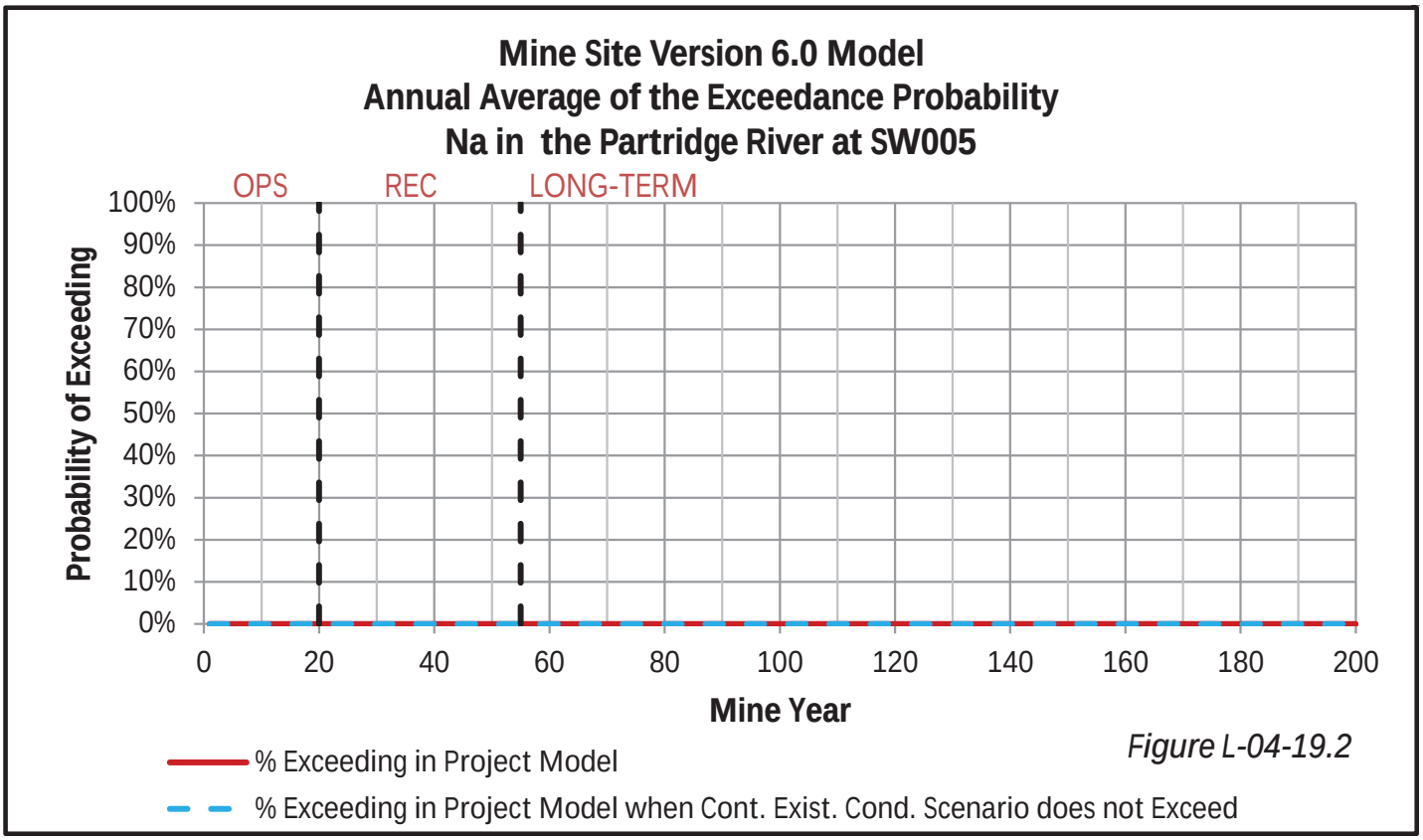

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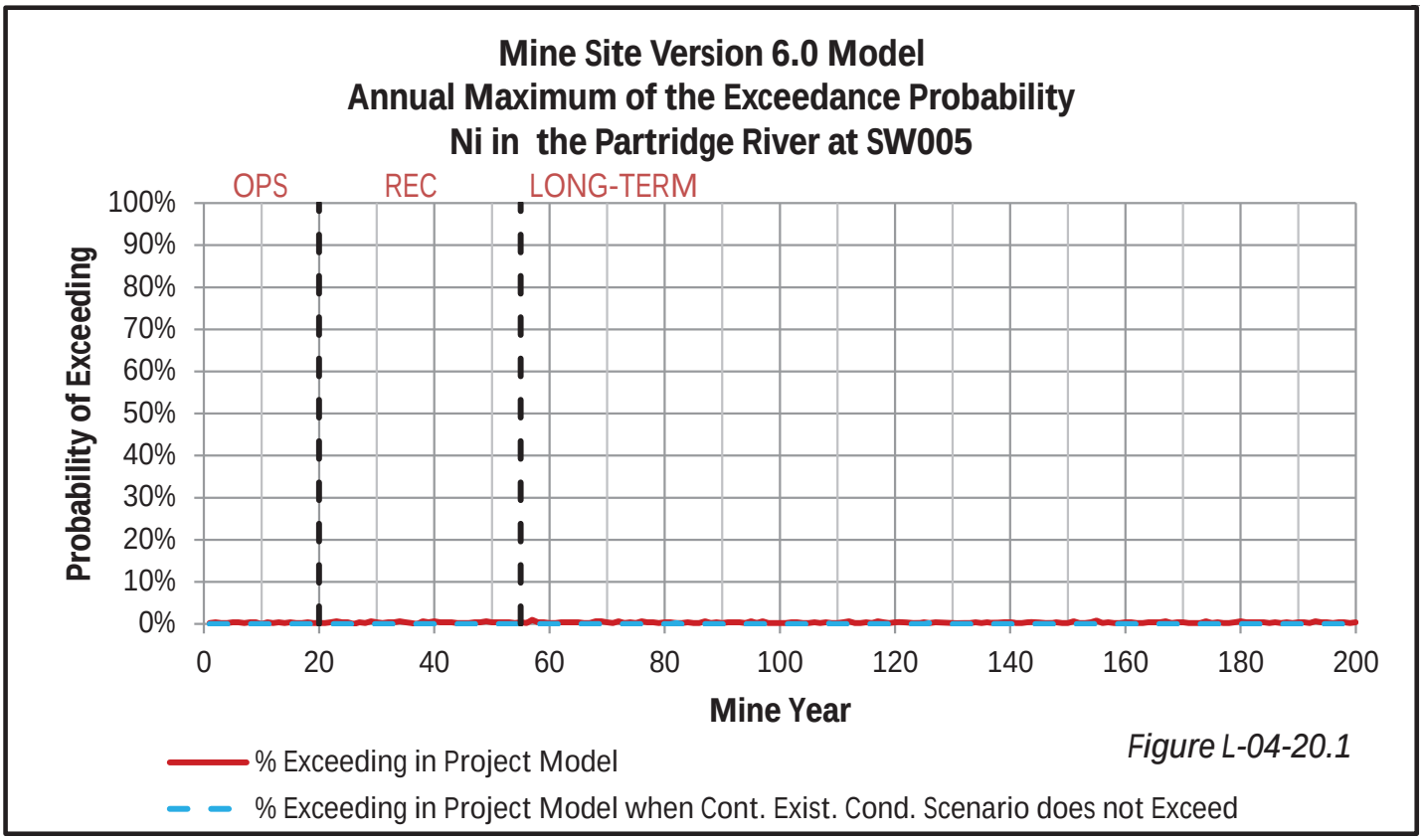

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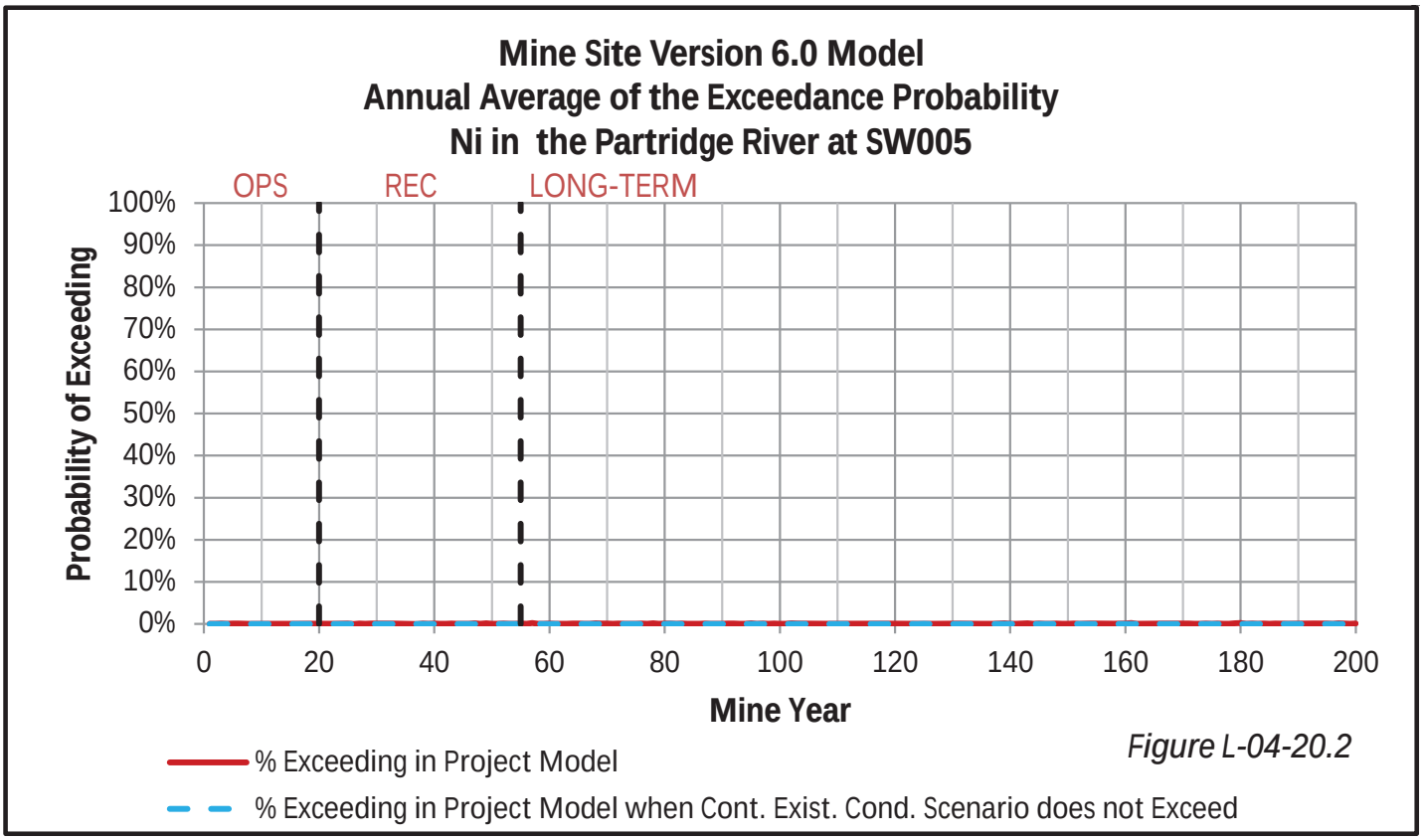

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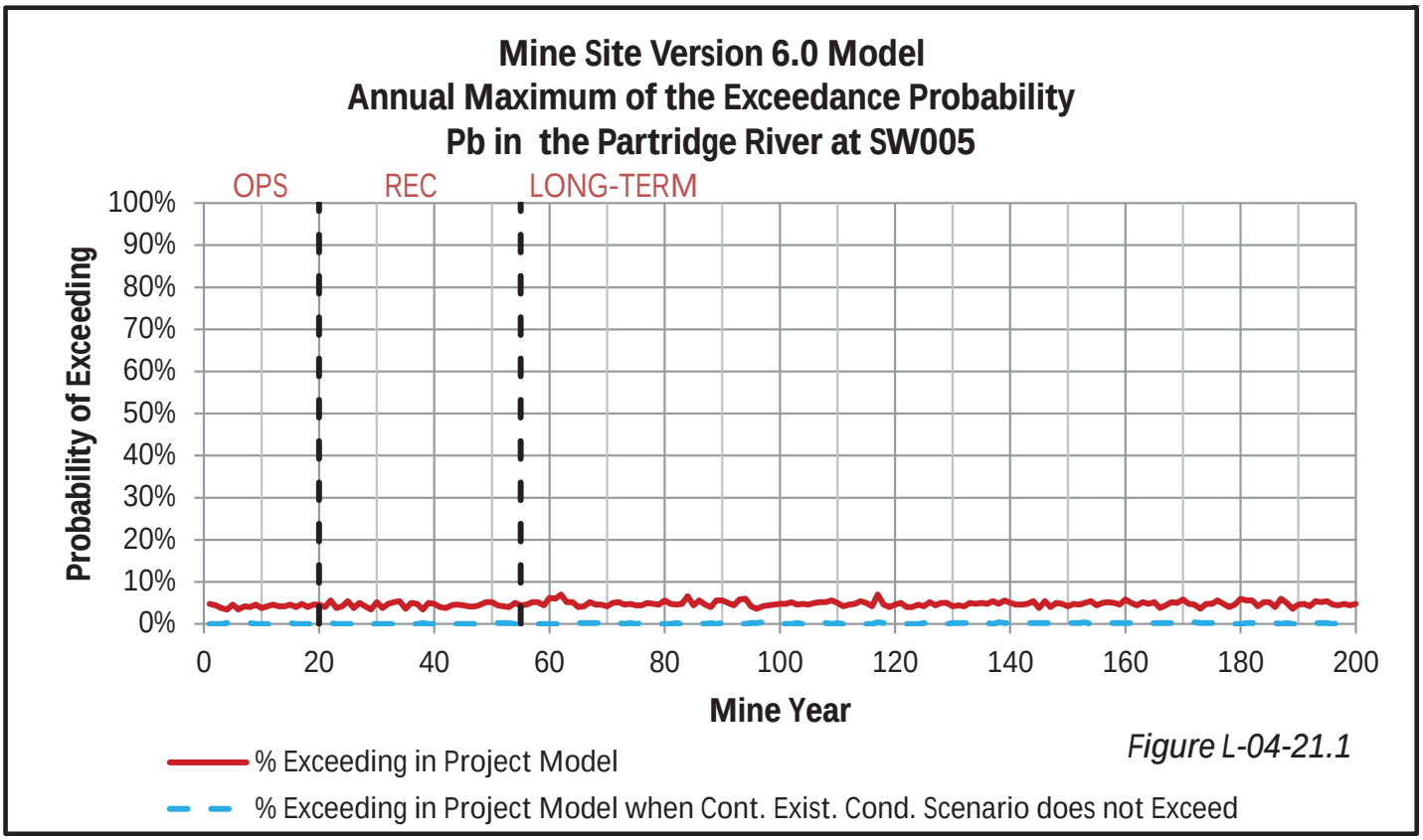

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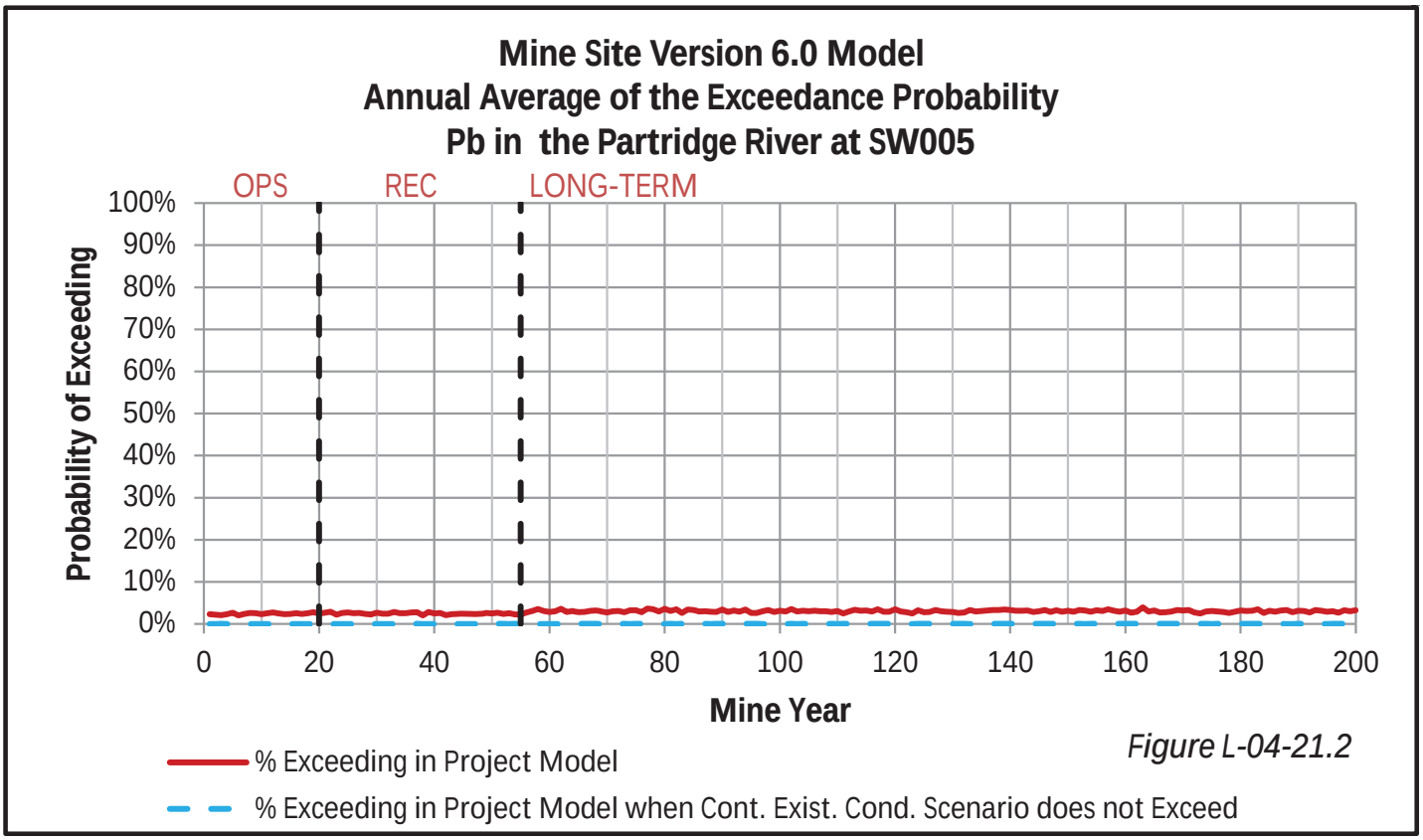

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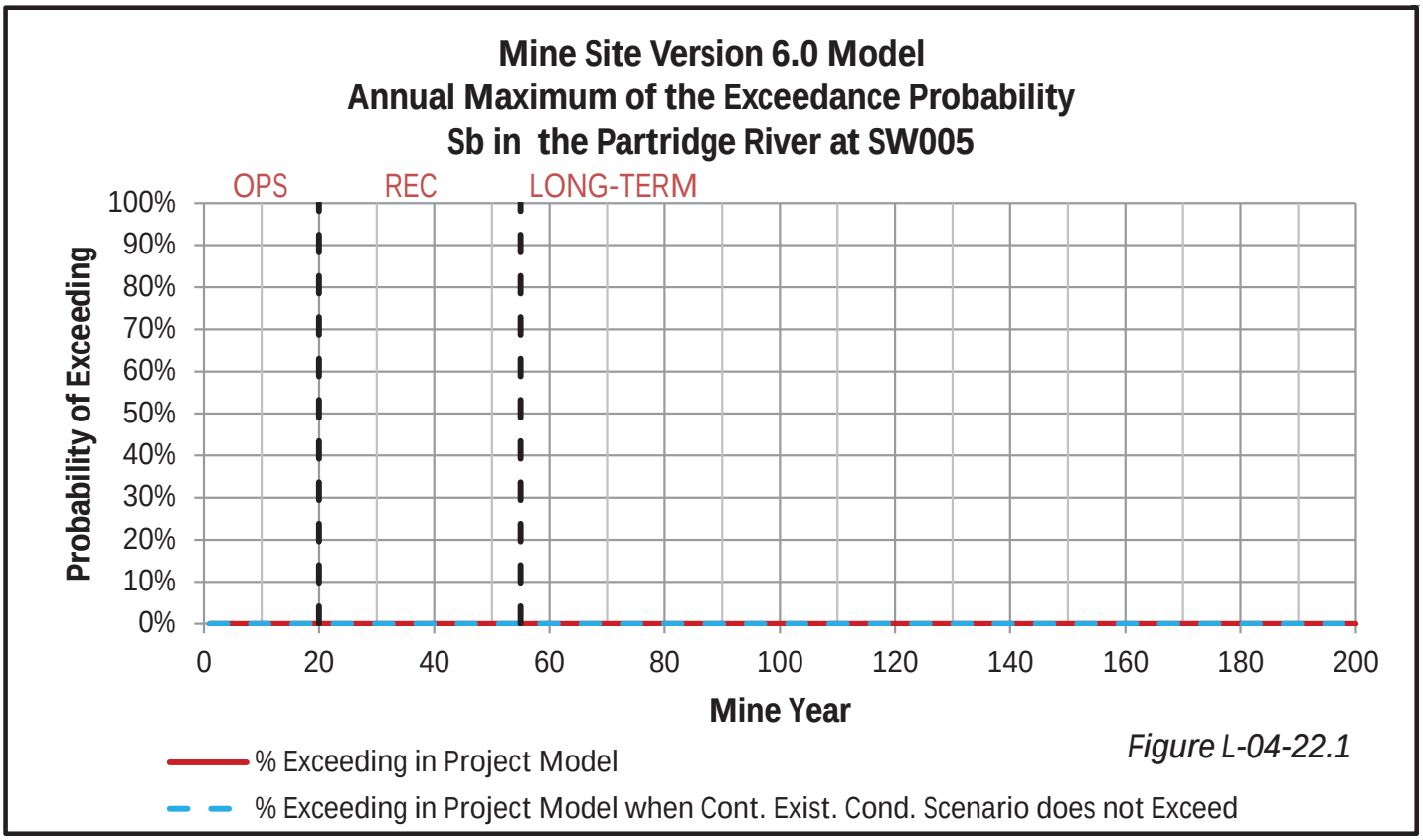

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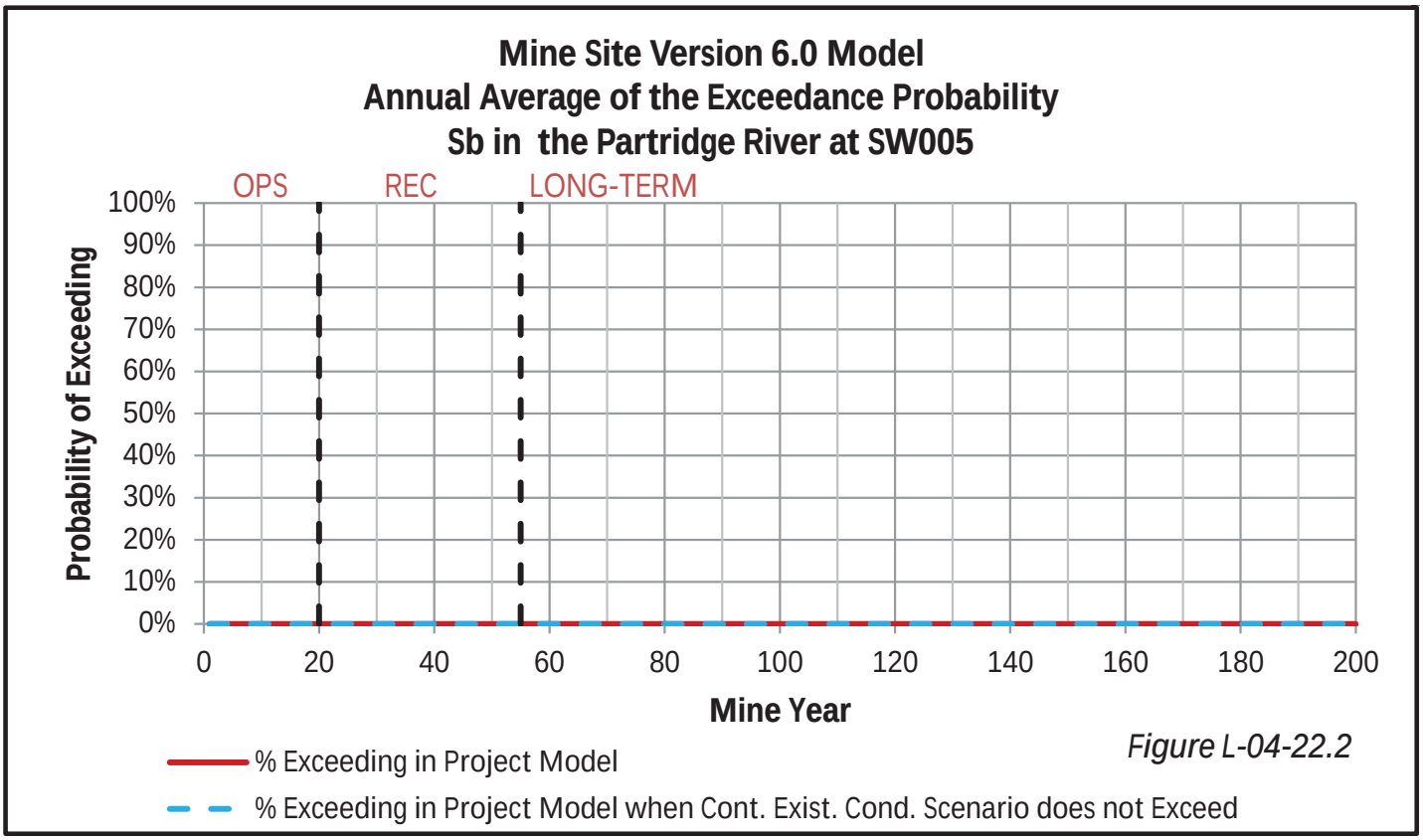

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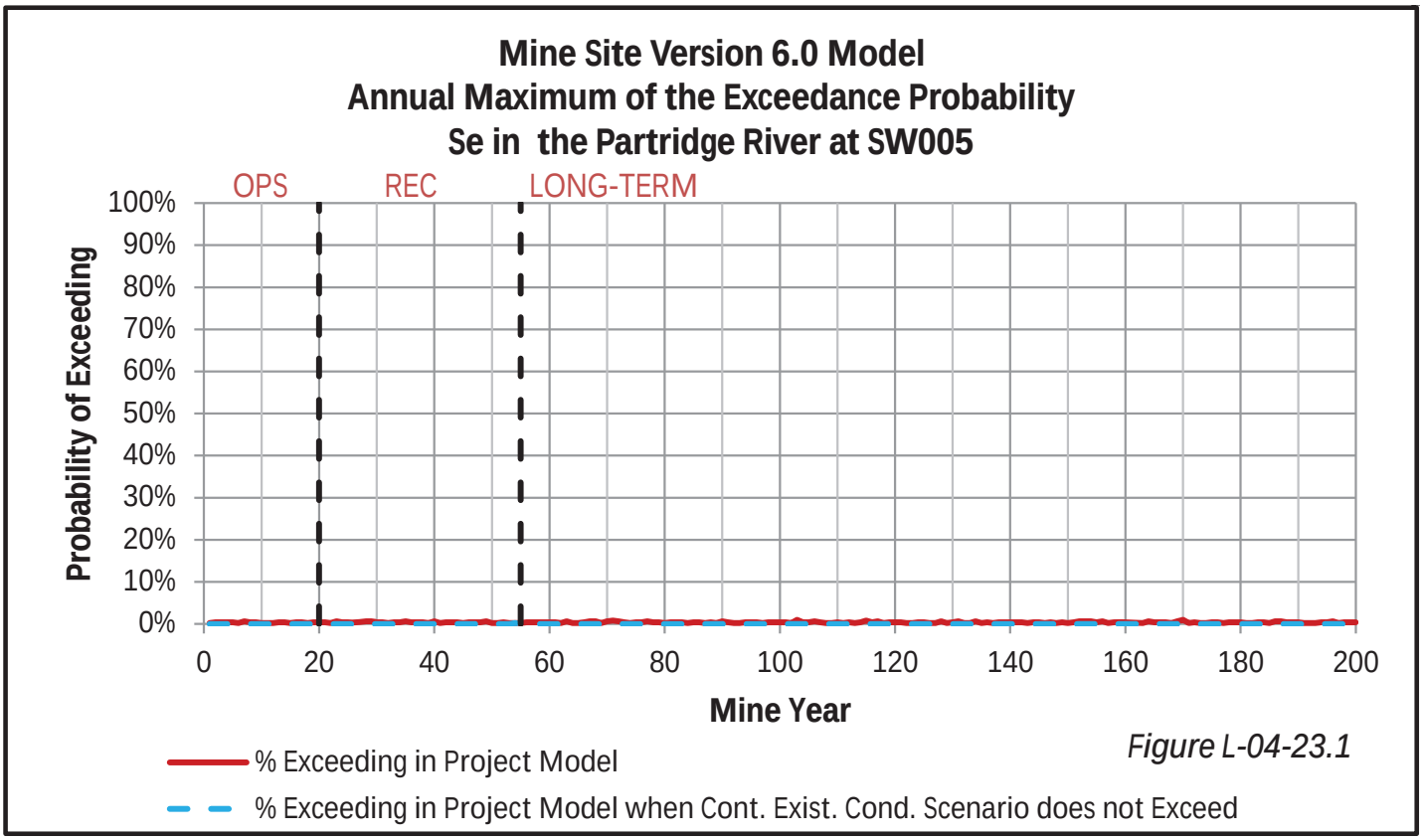

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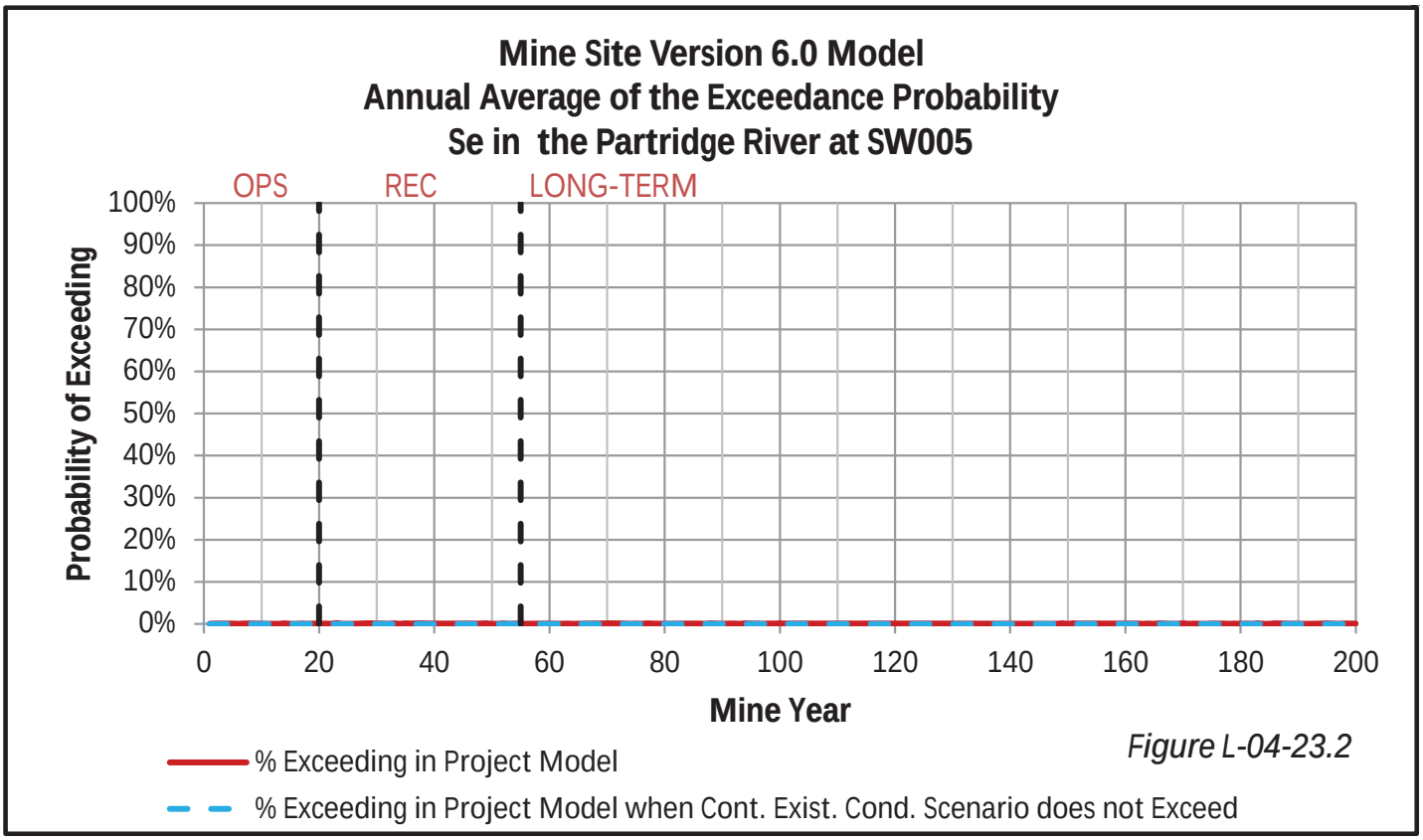

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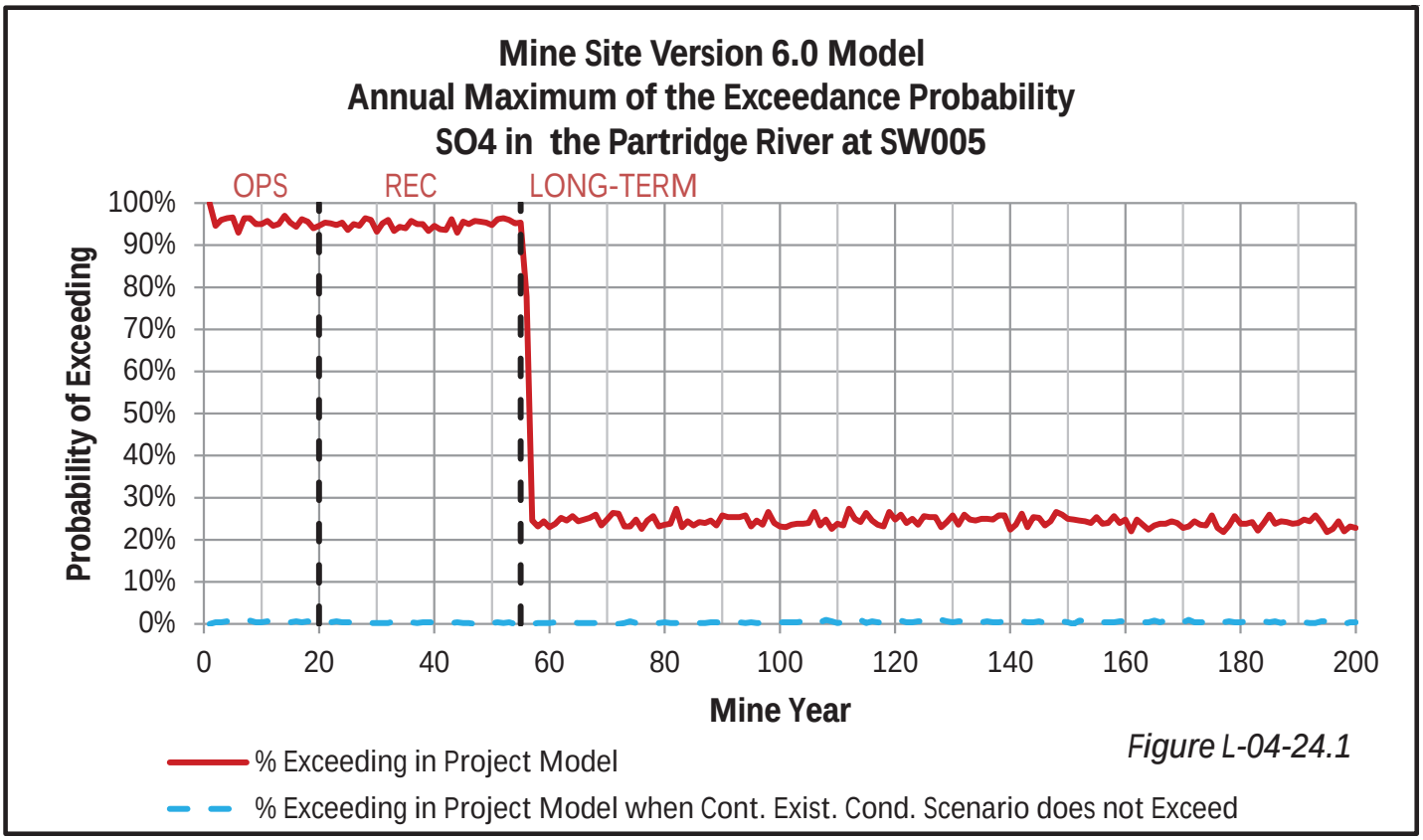

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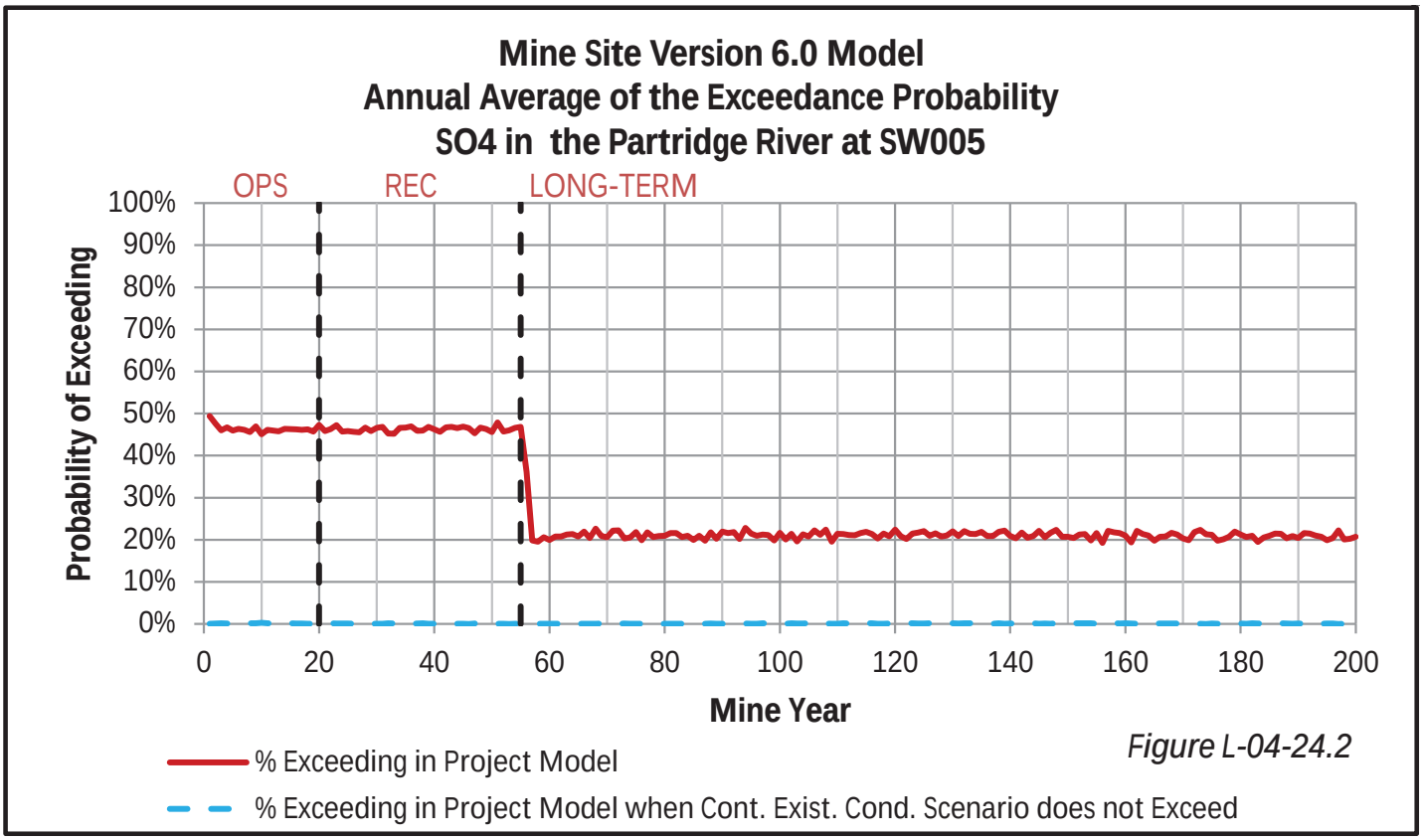

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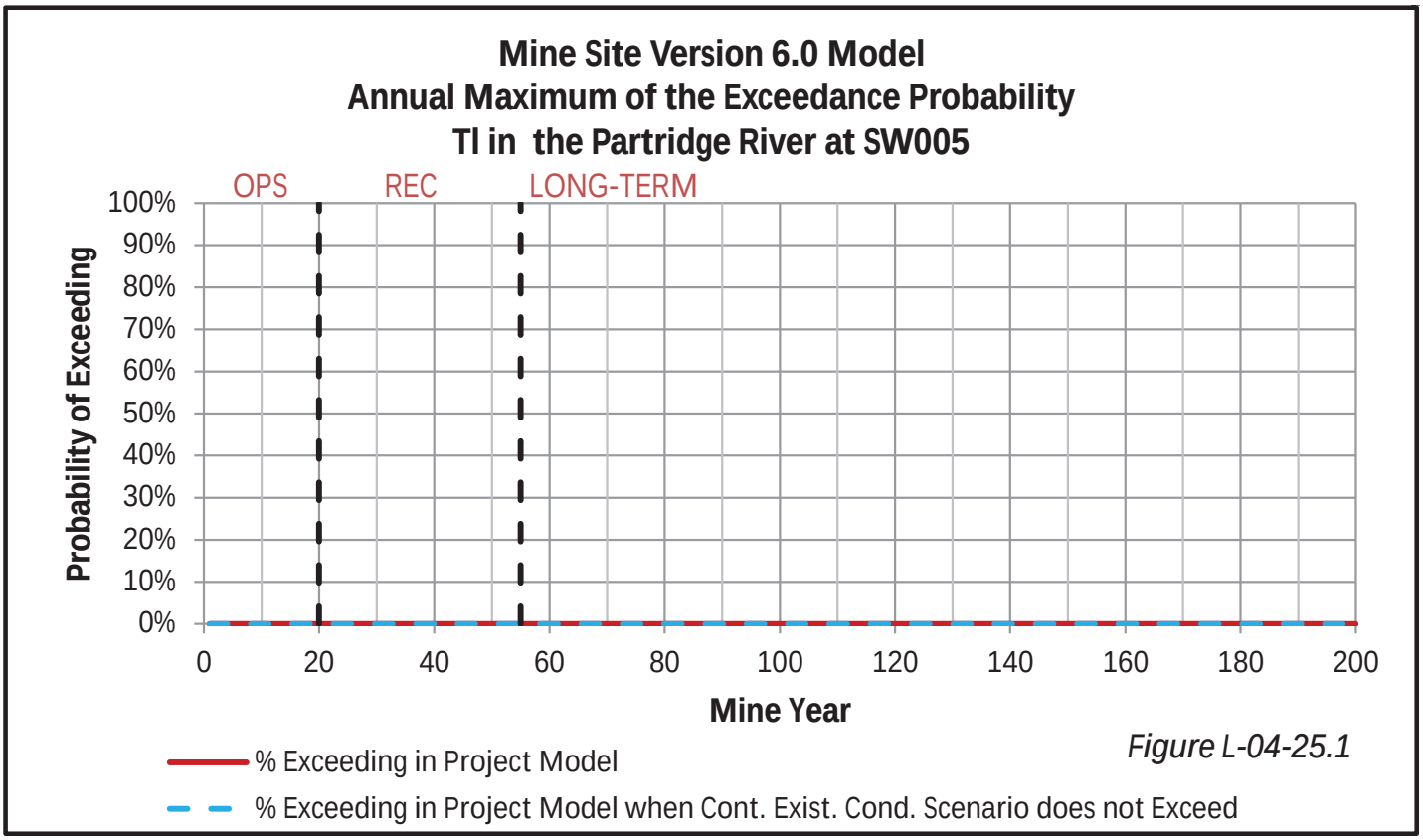

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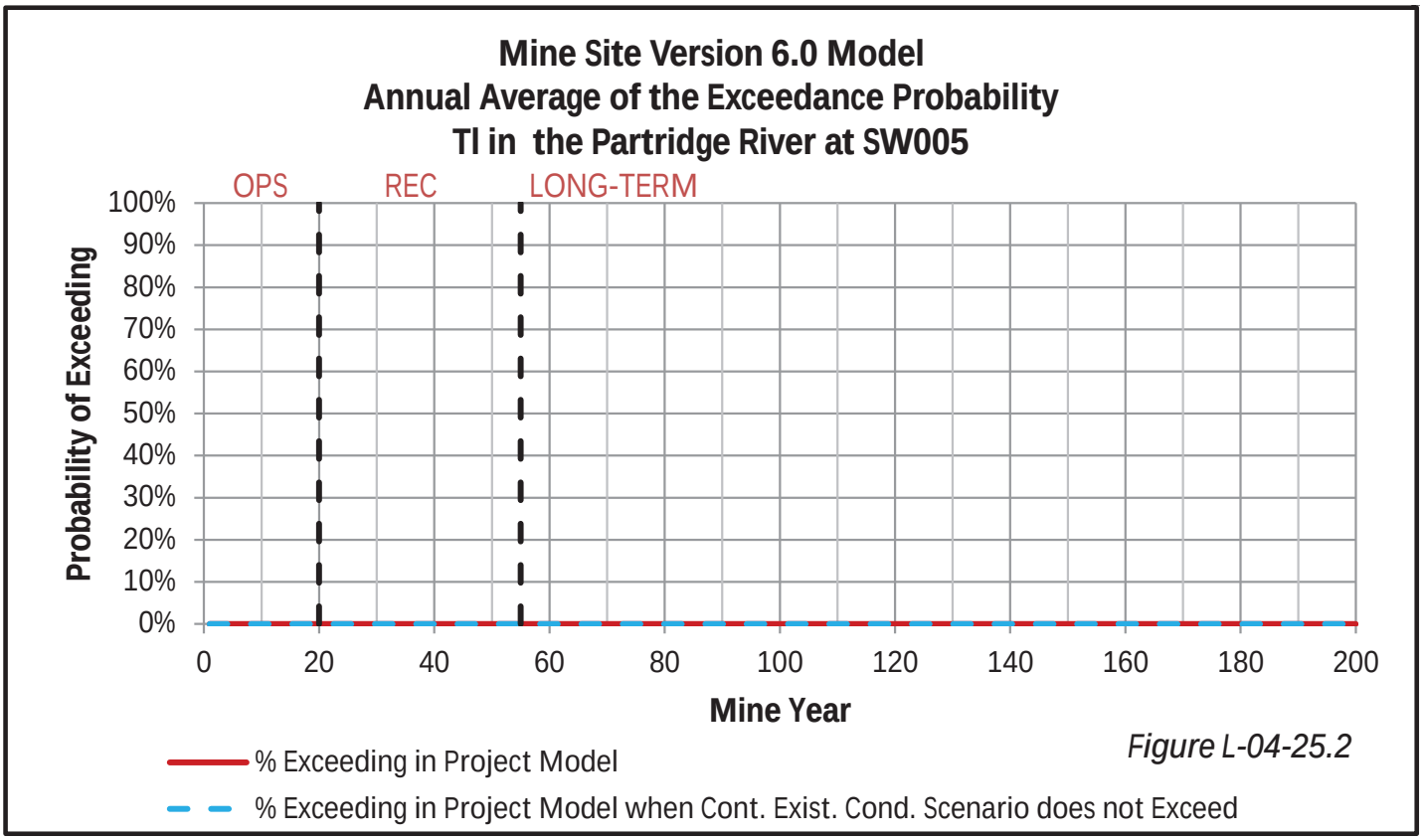

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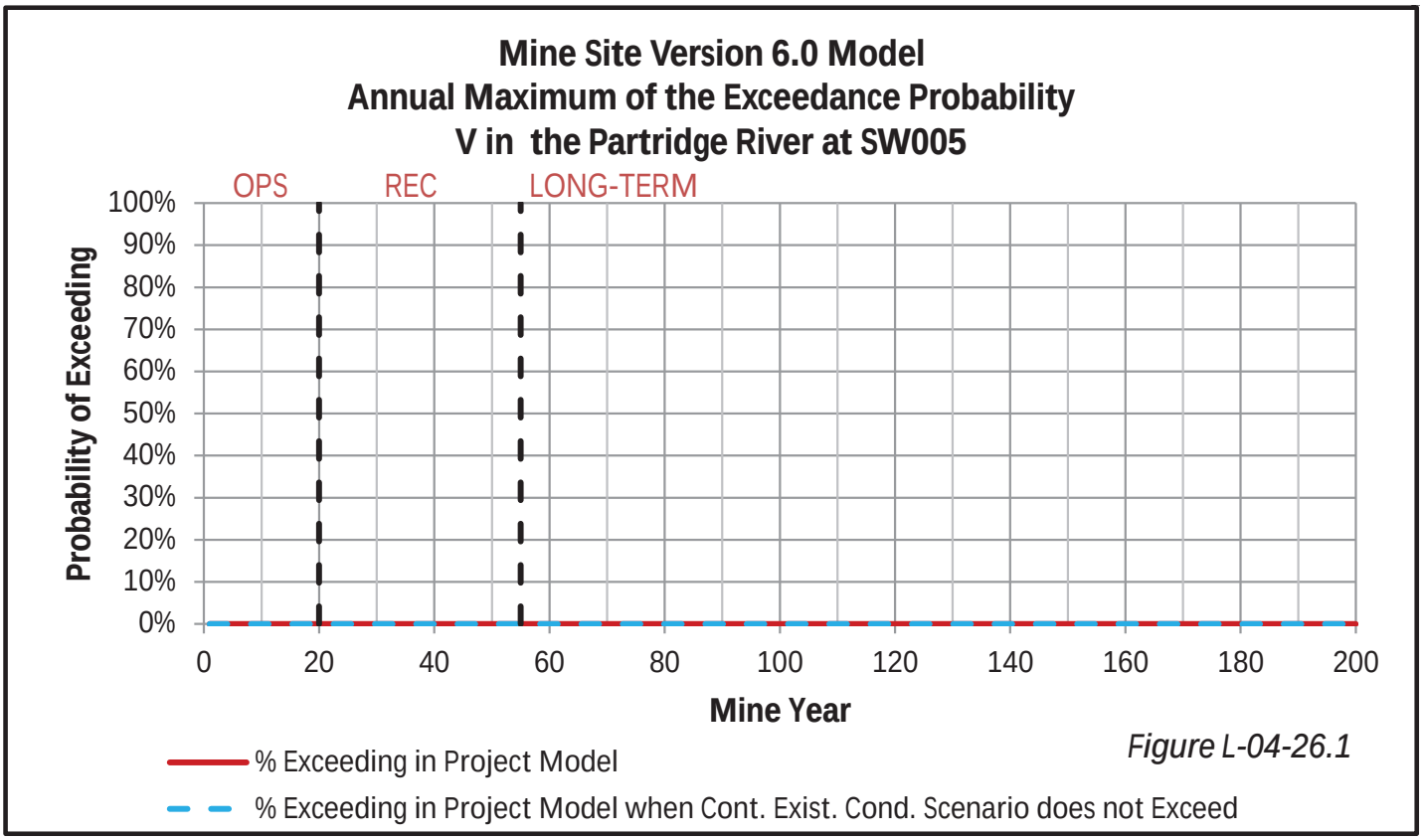

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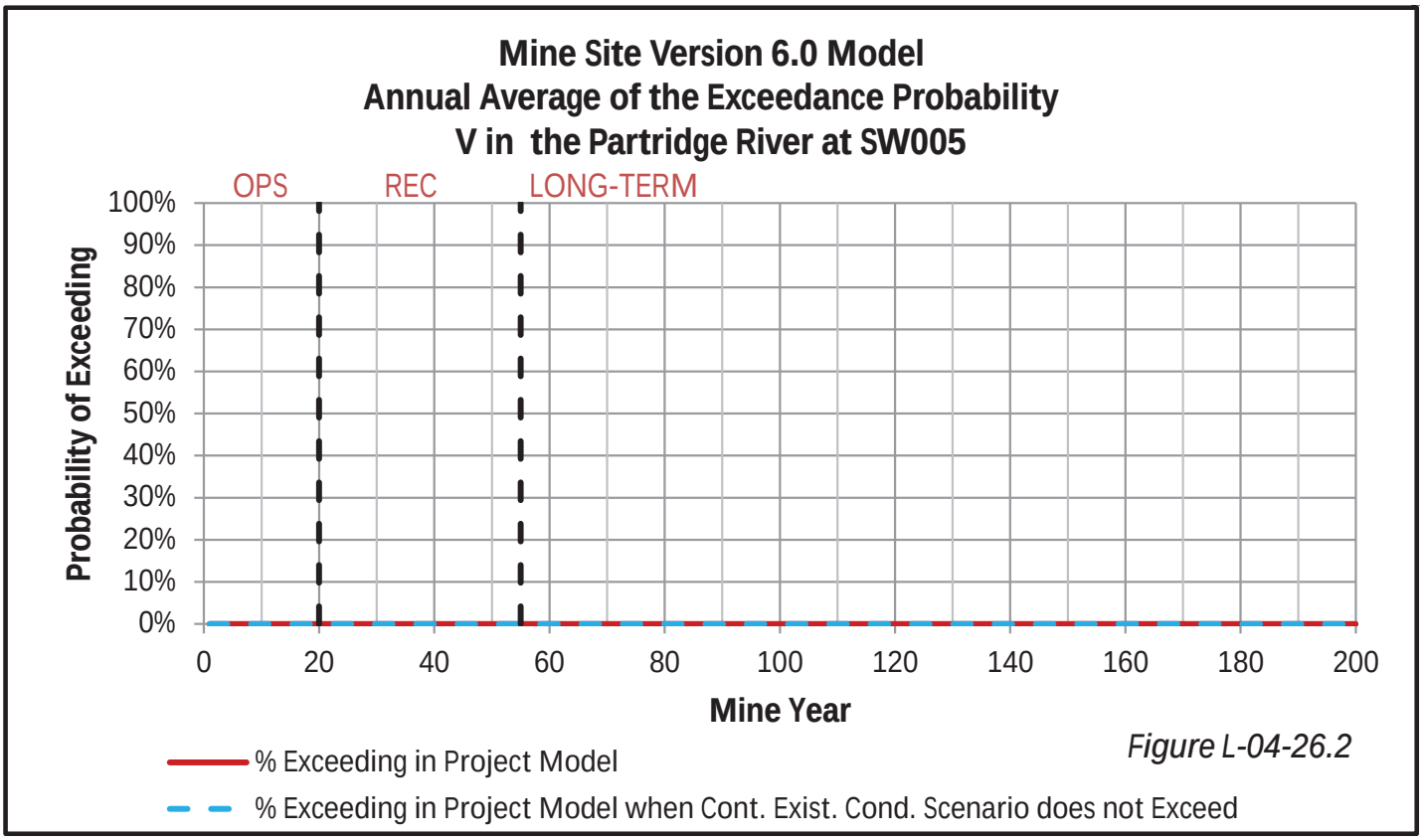

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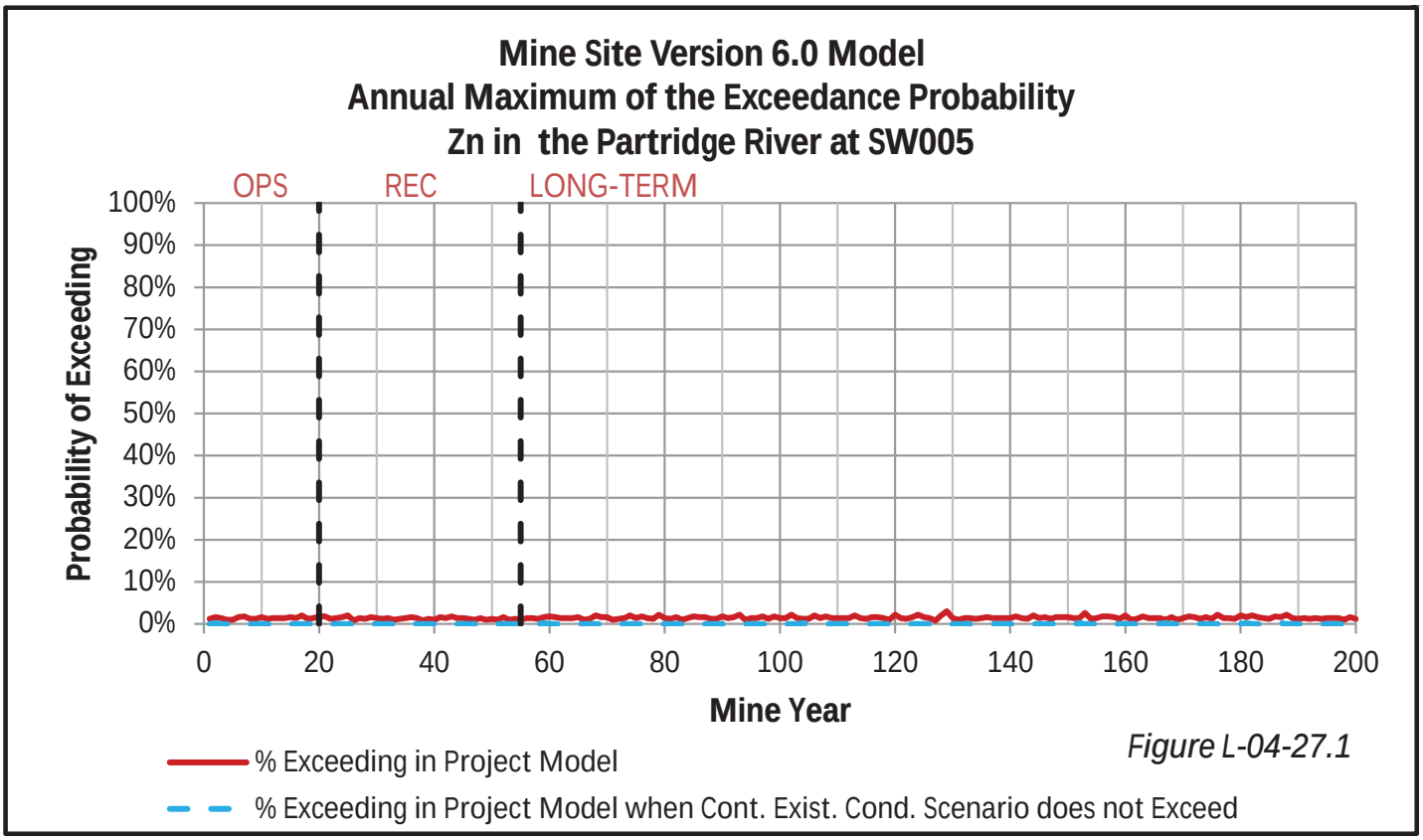
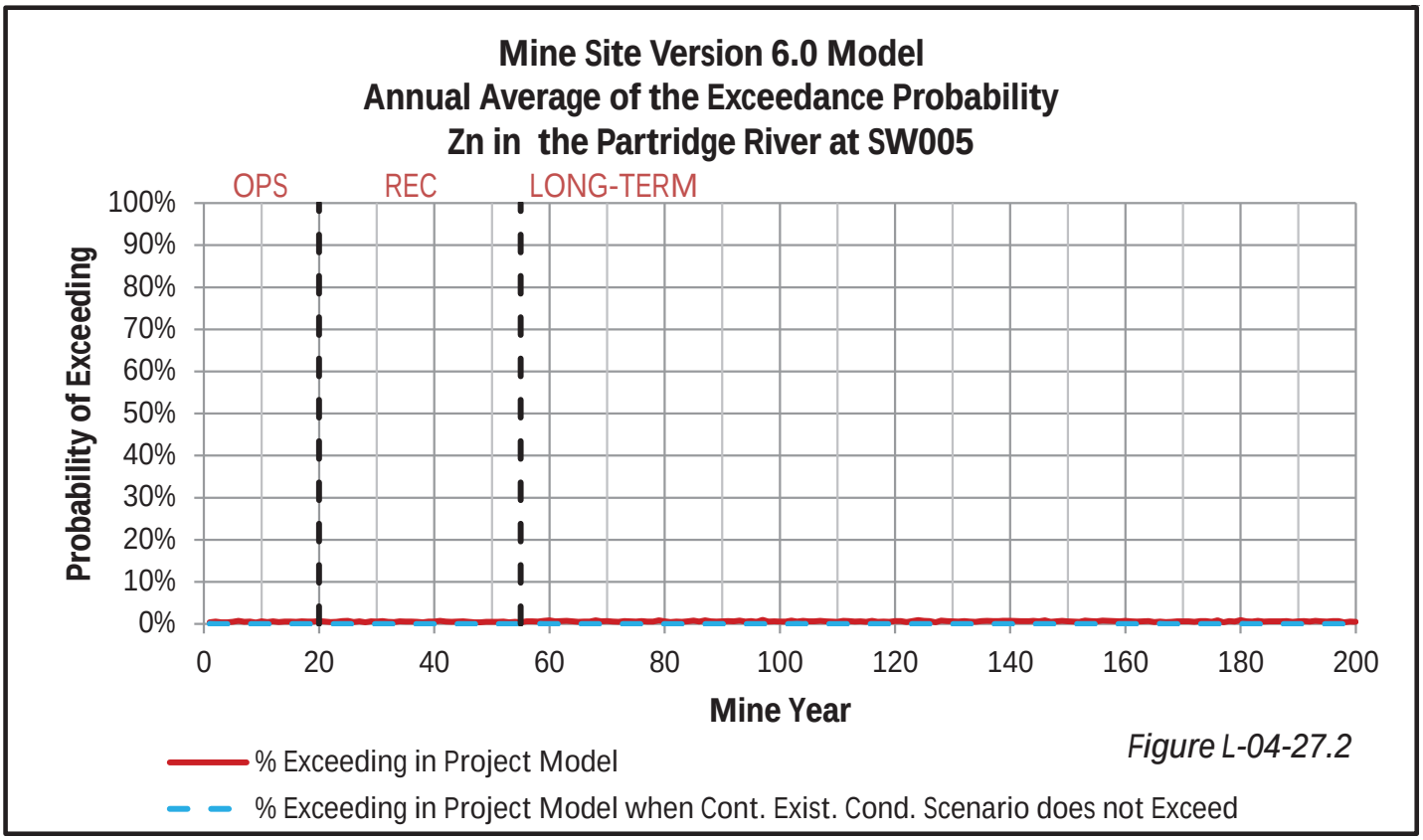


Figure L-04-27.1



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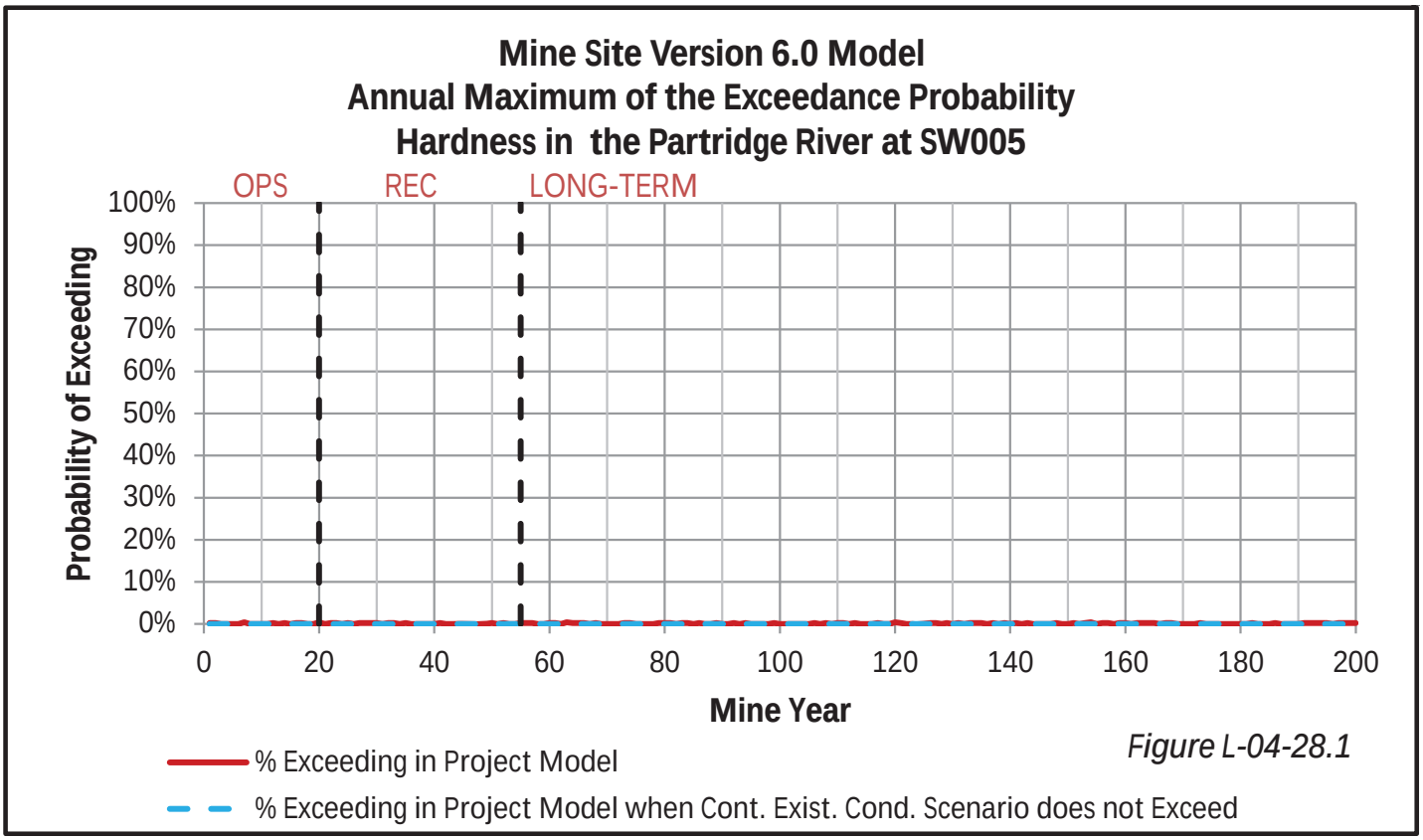

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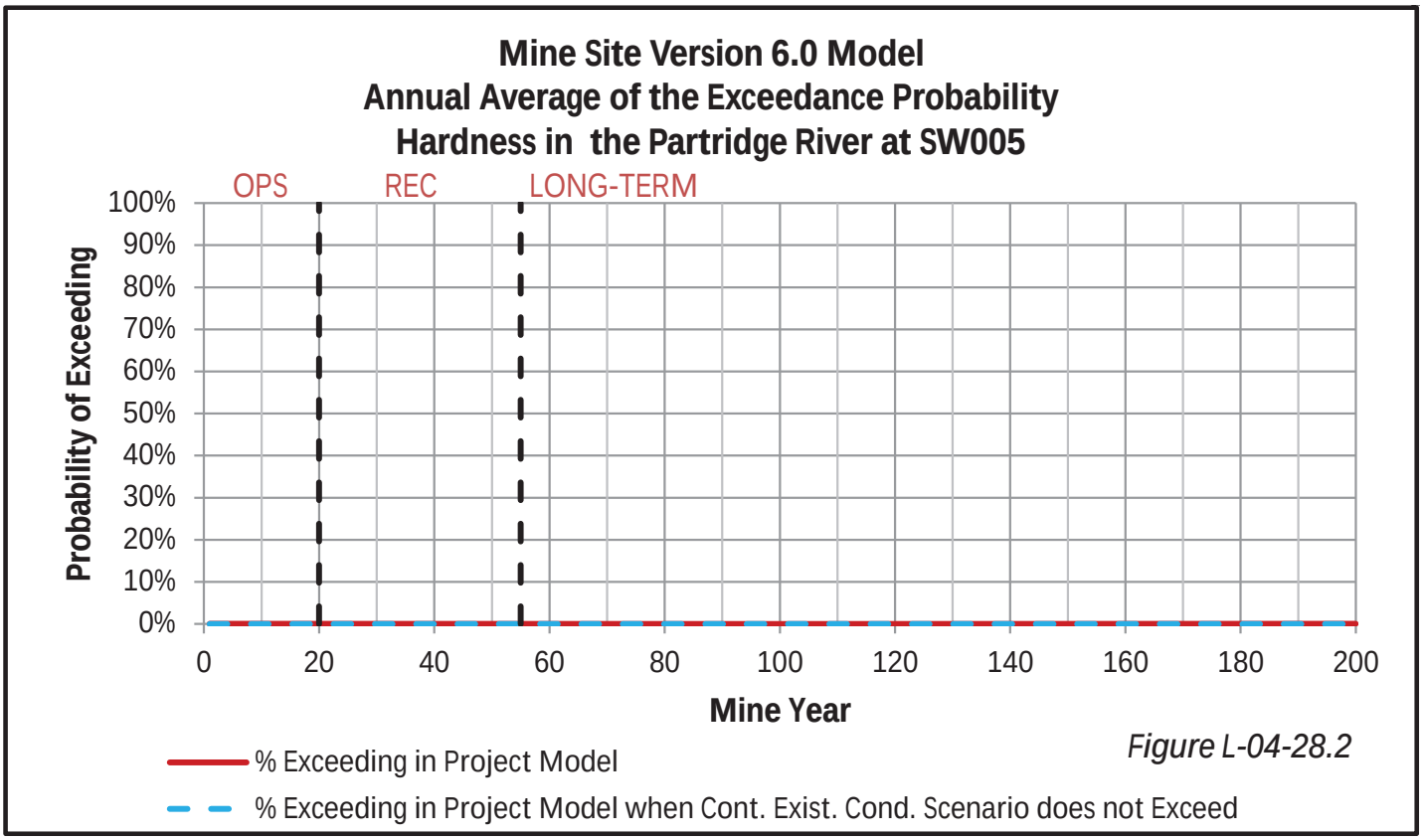

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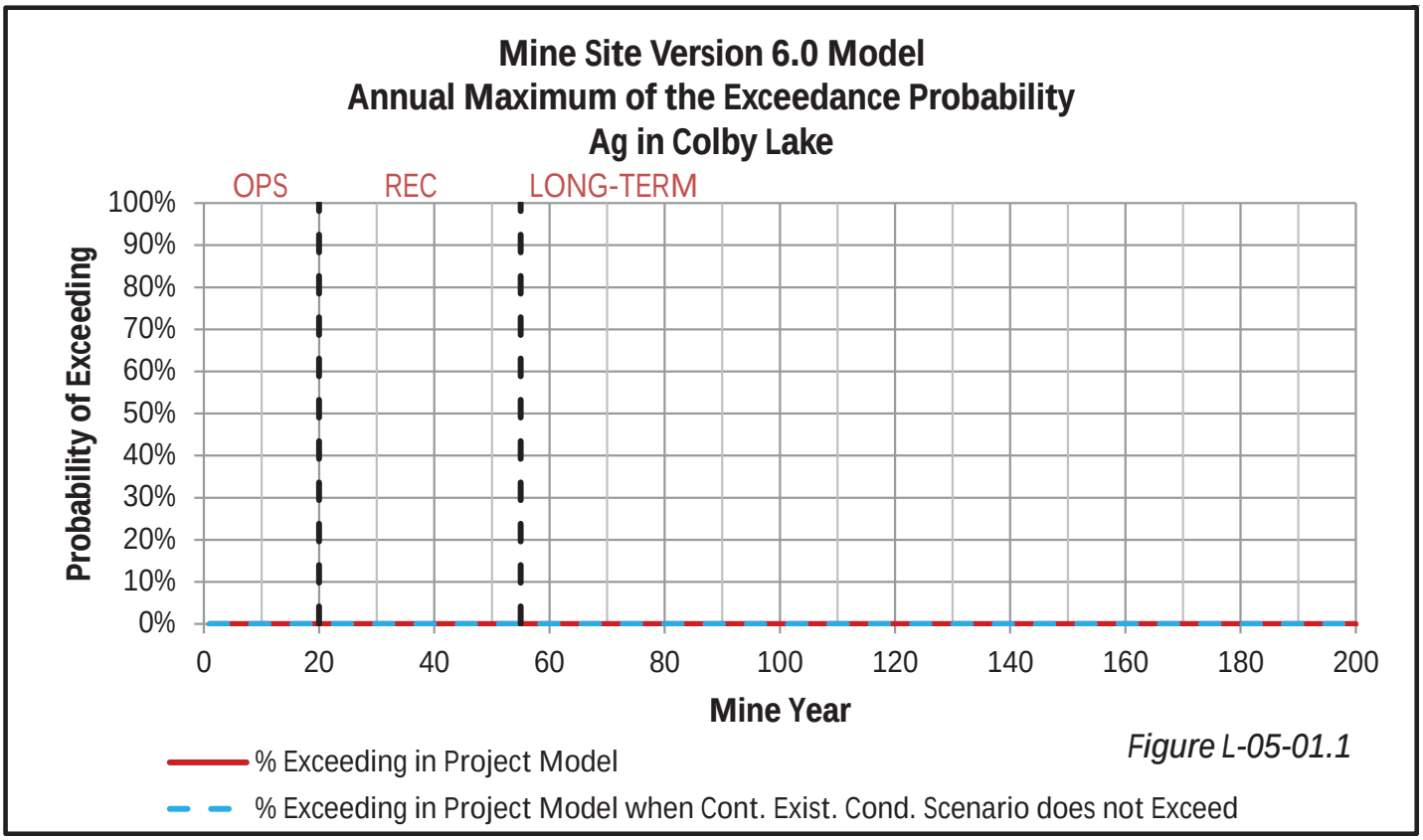

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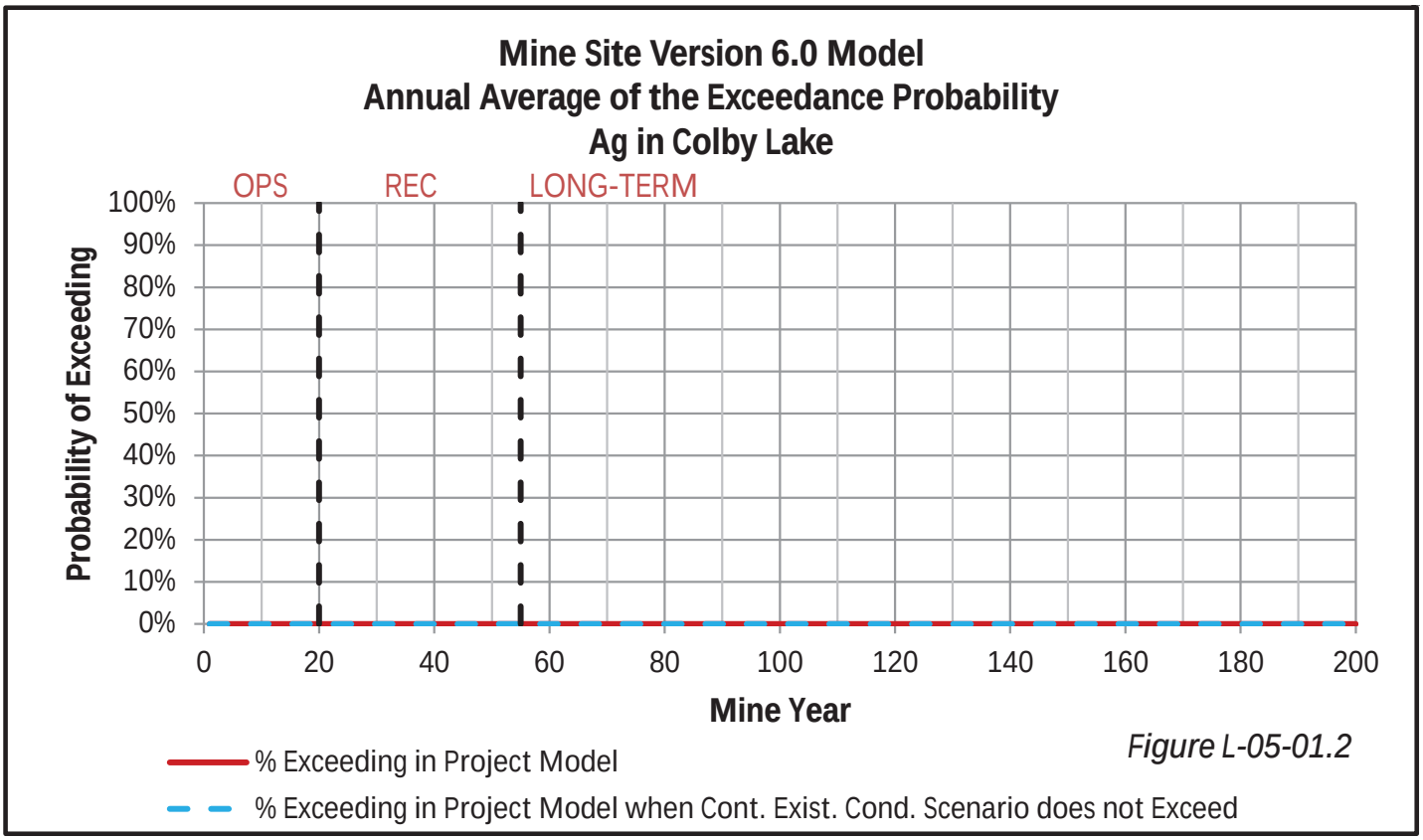

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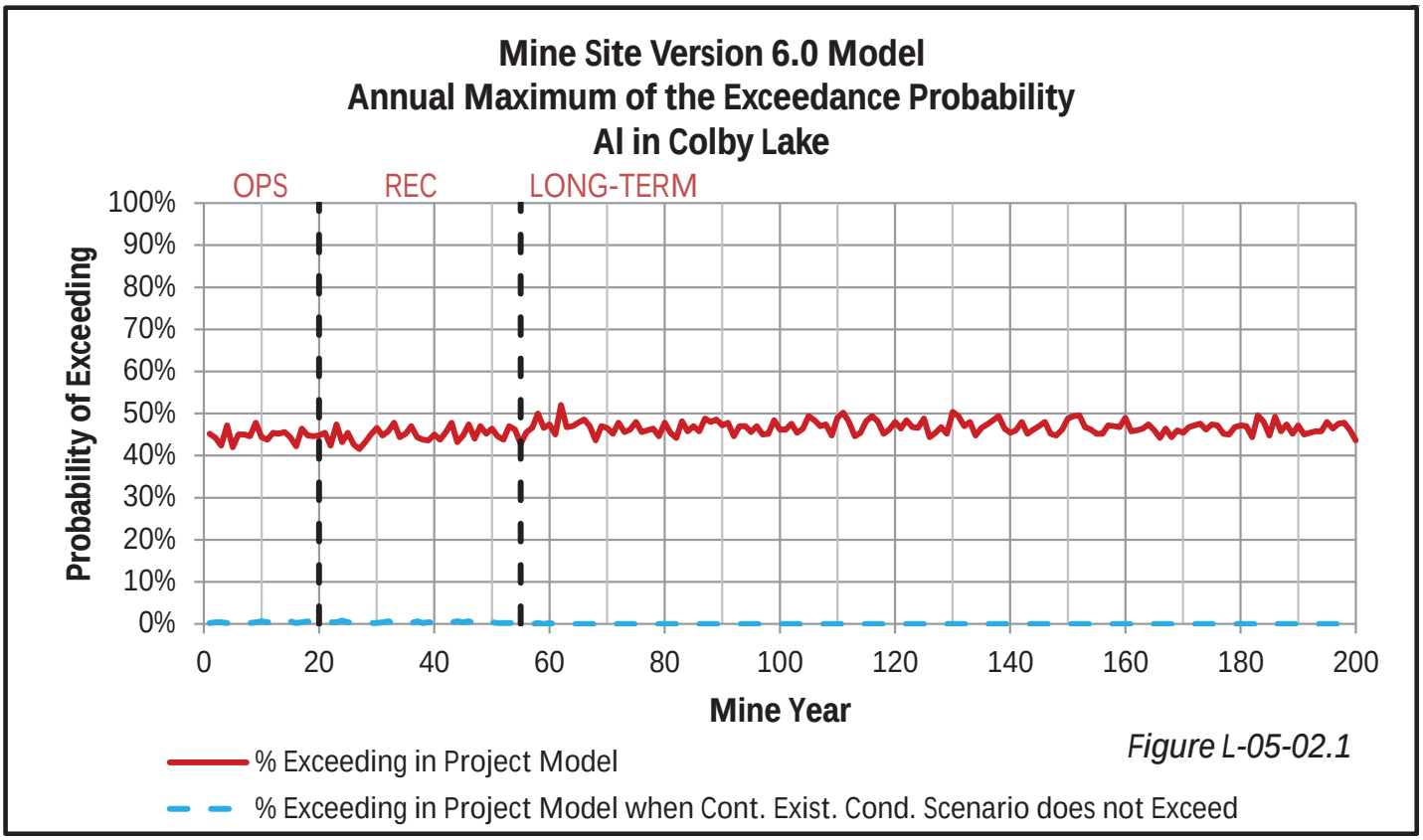

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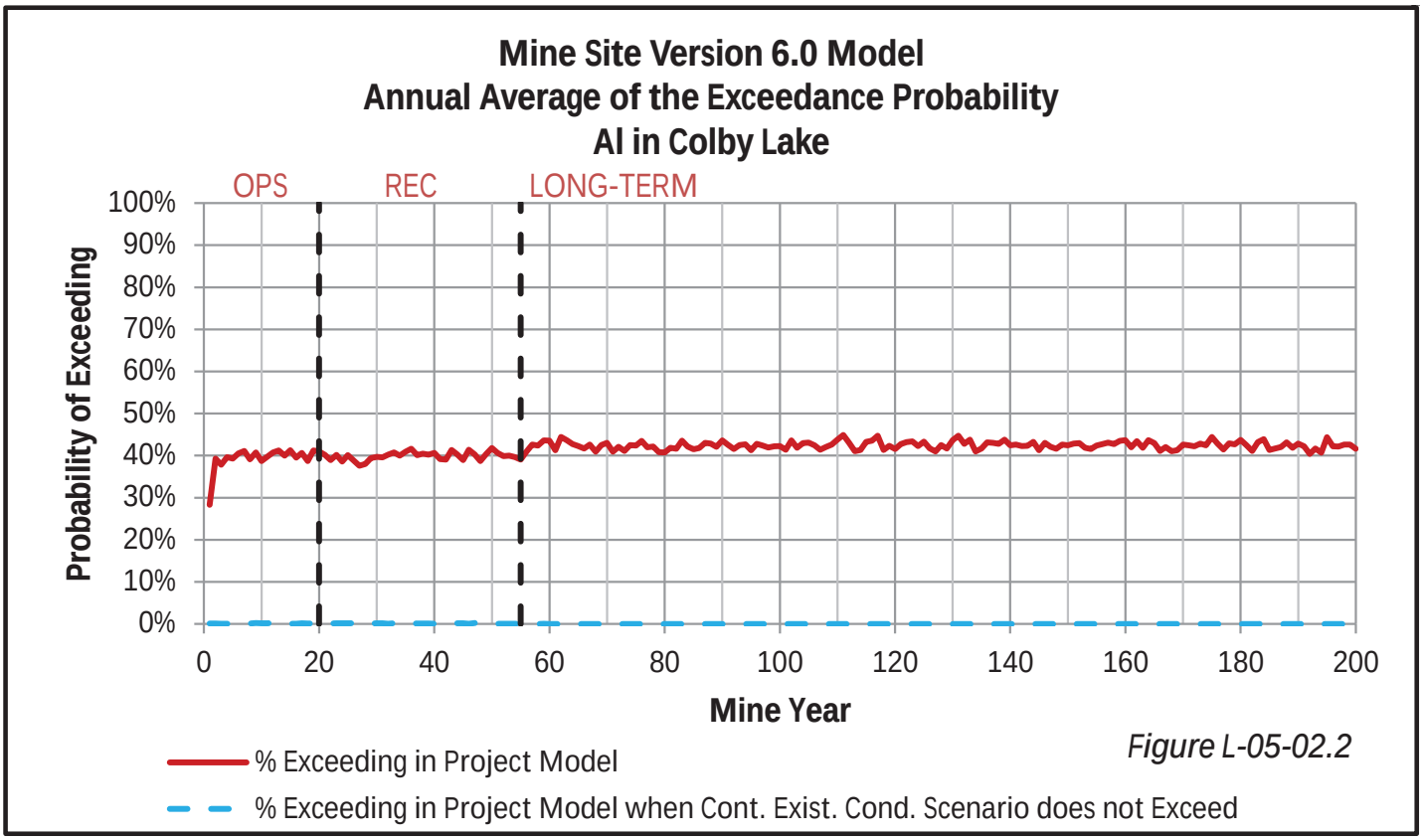

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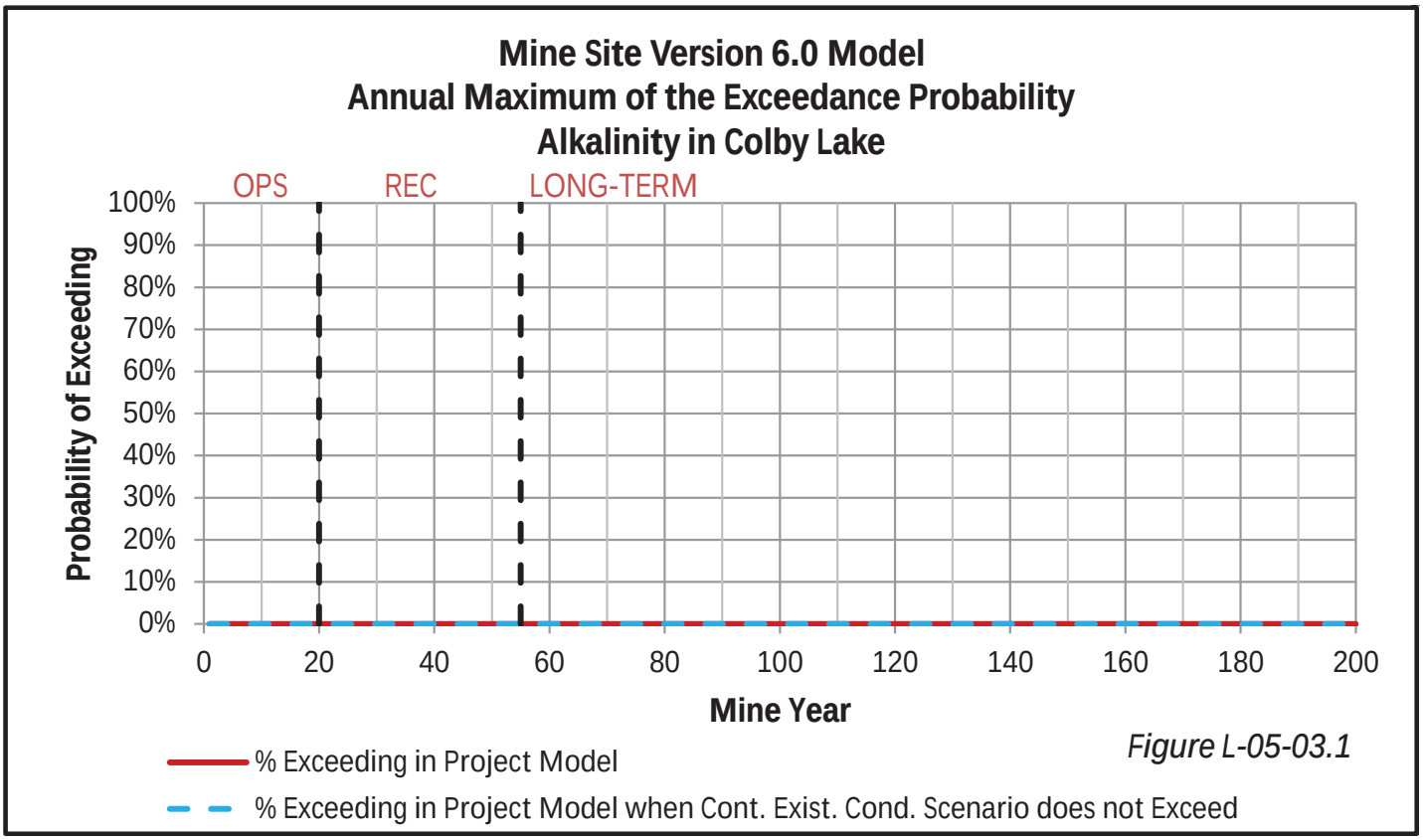

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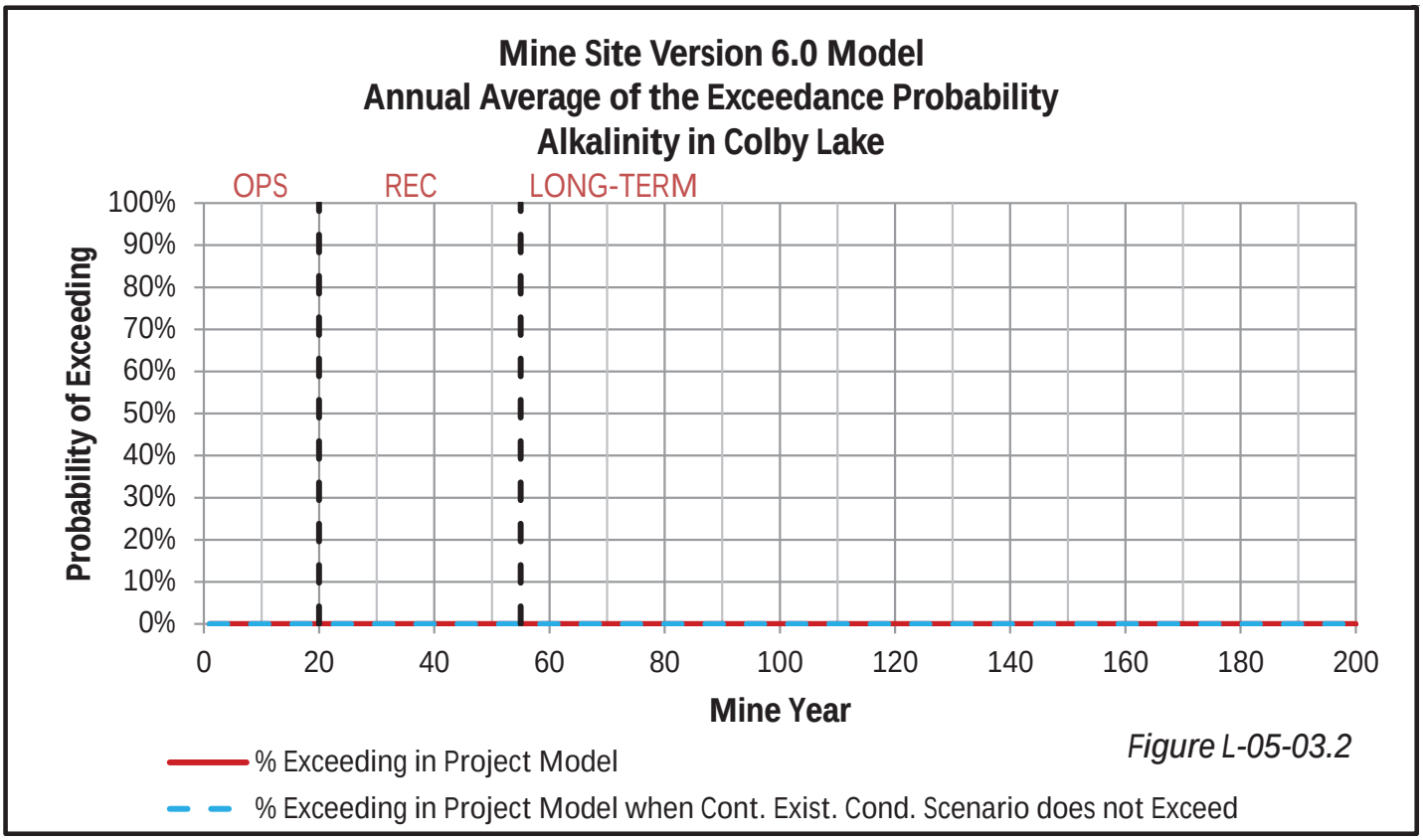

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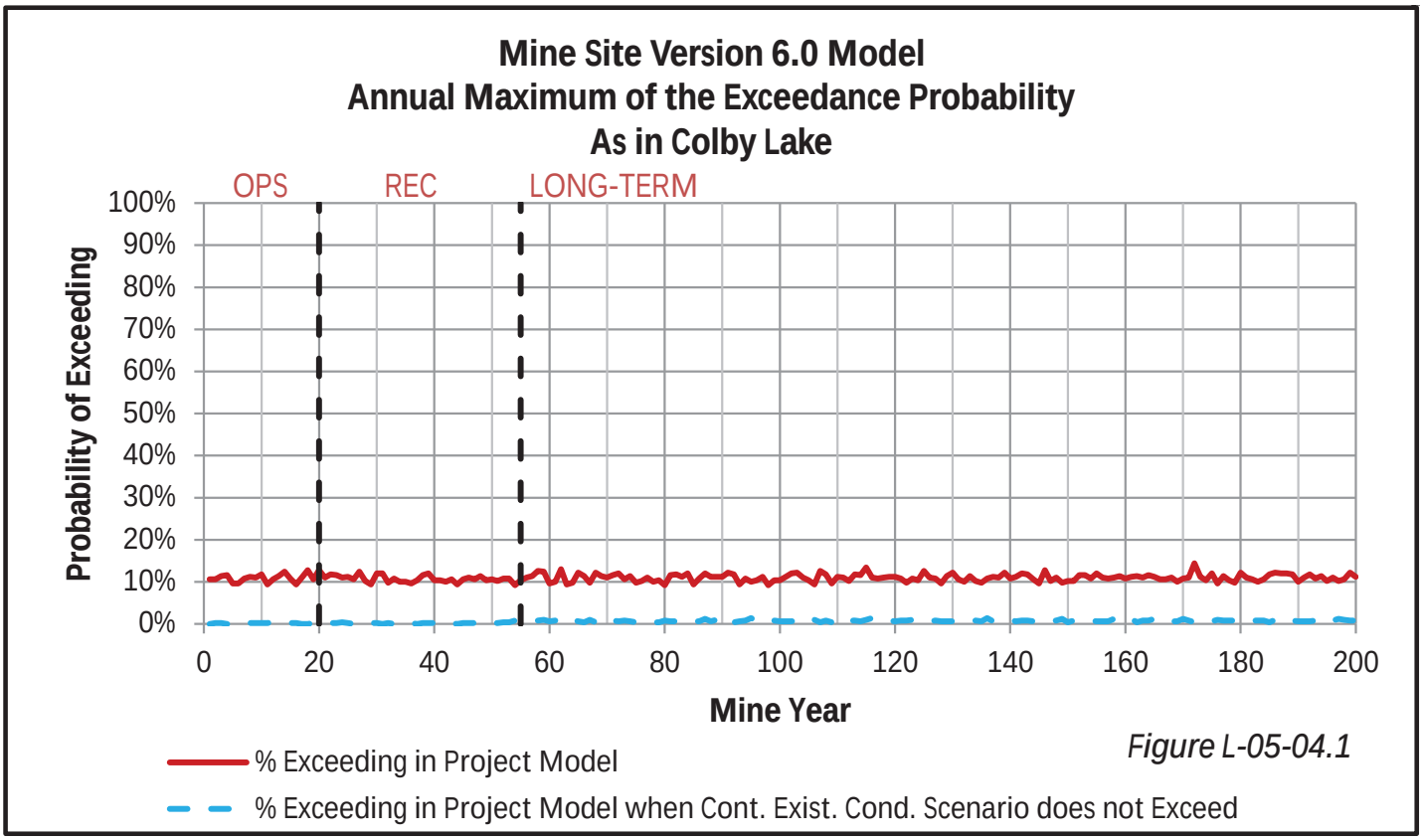

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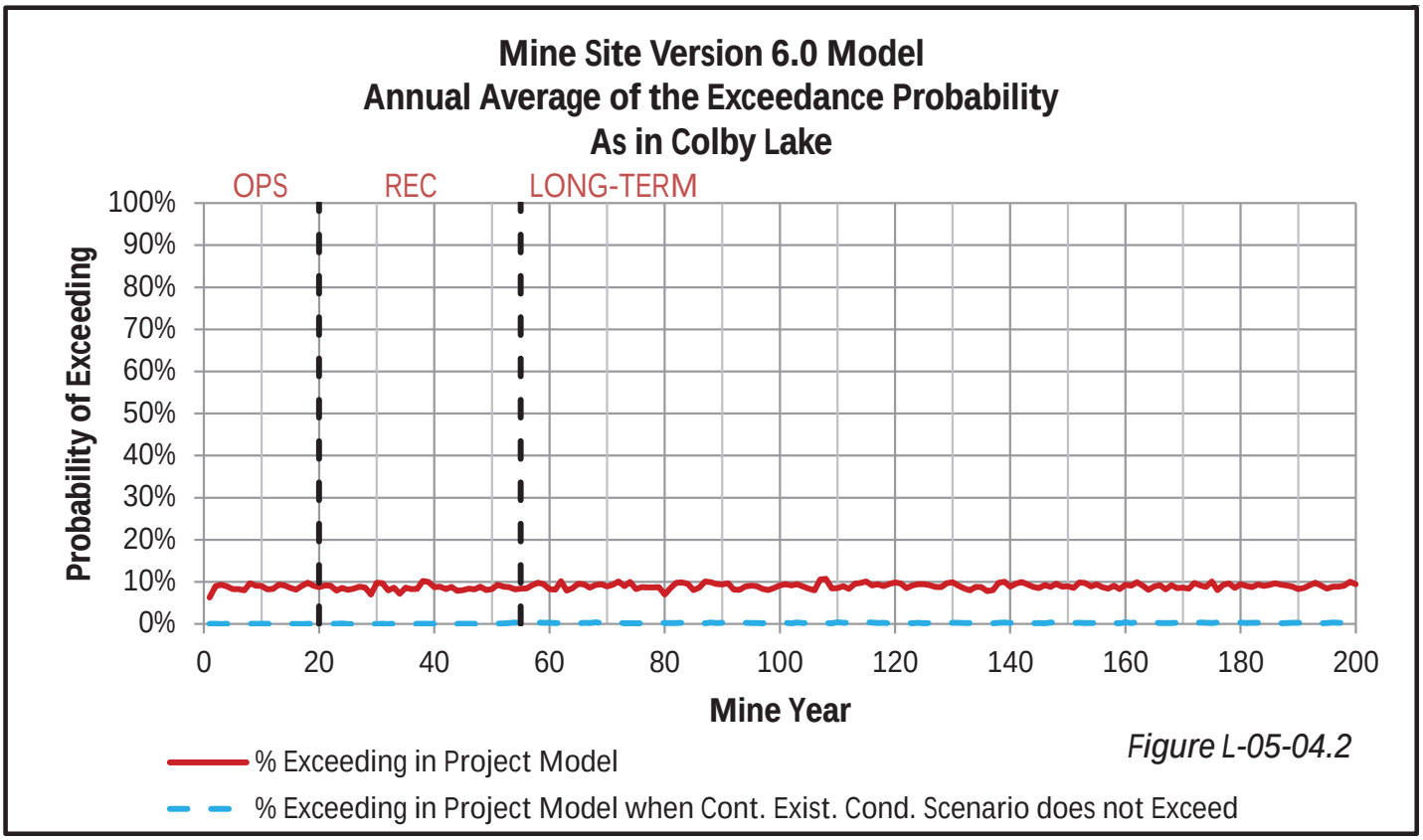

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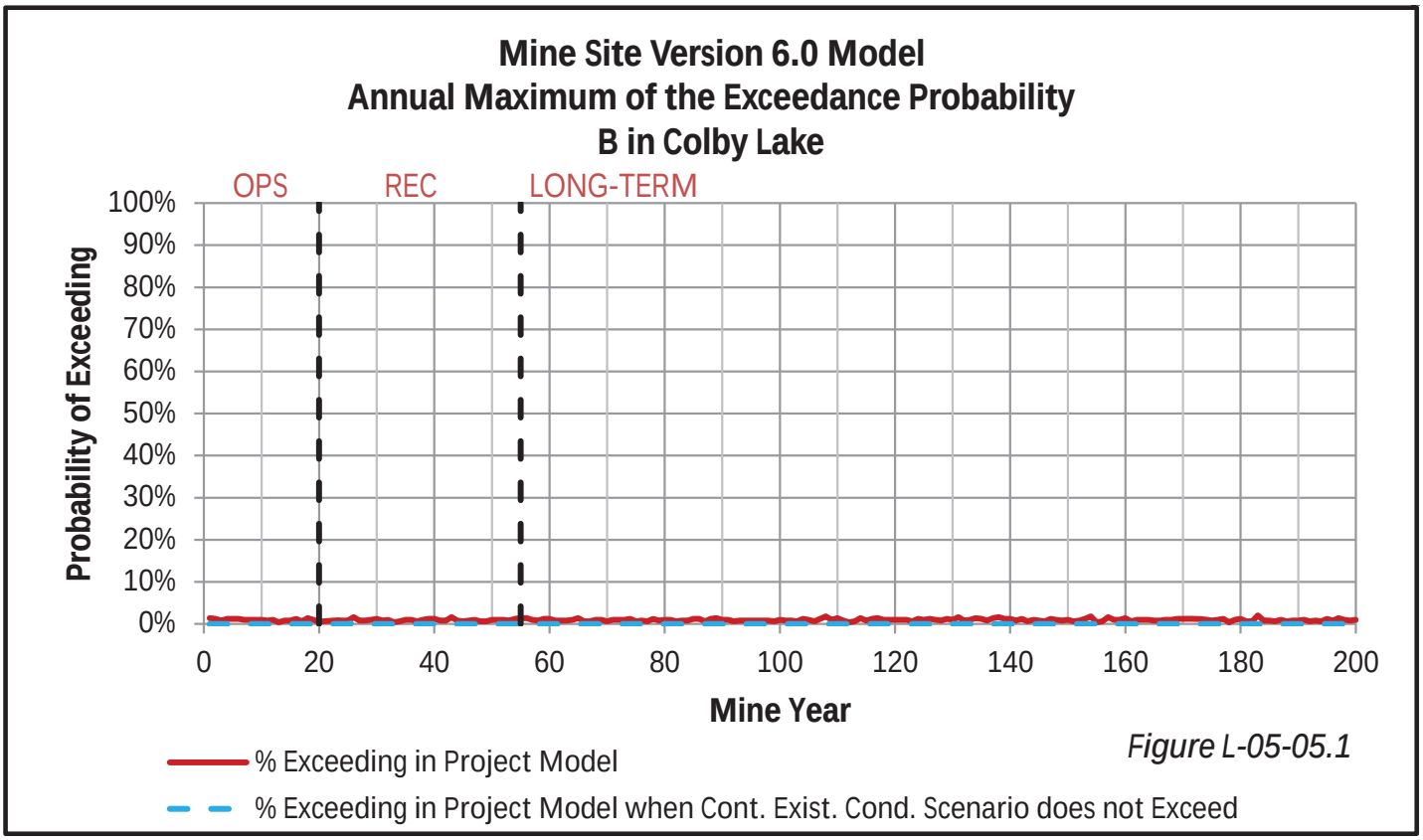

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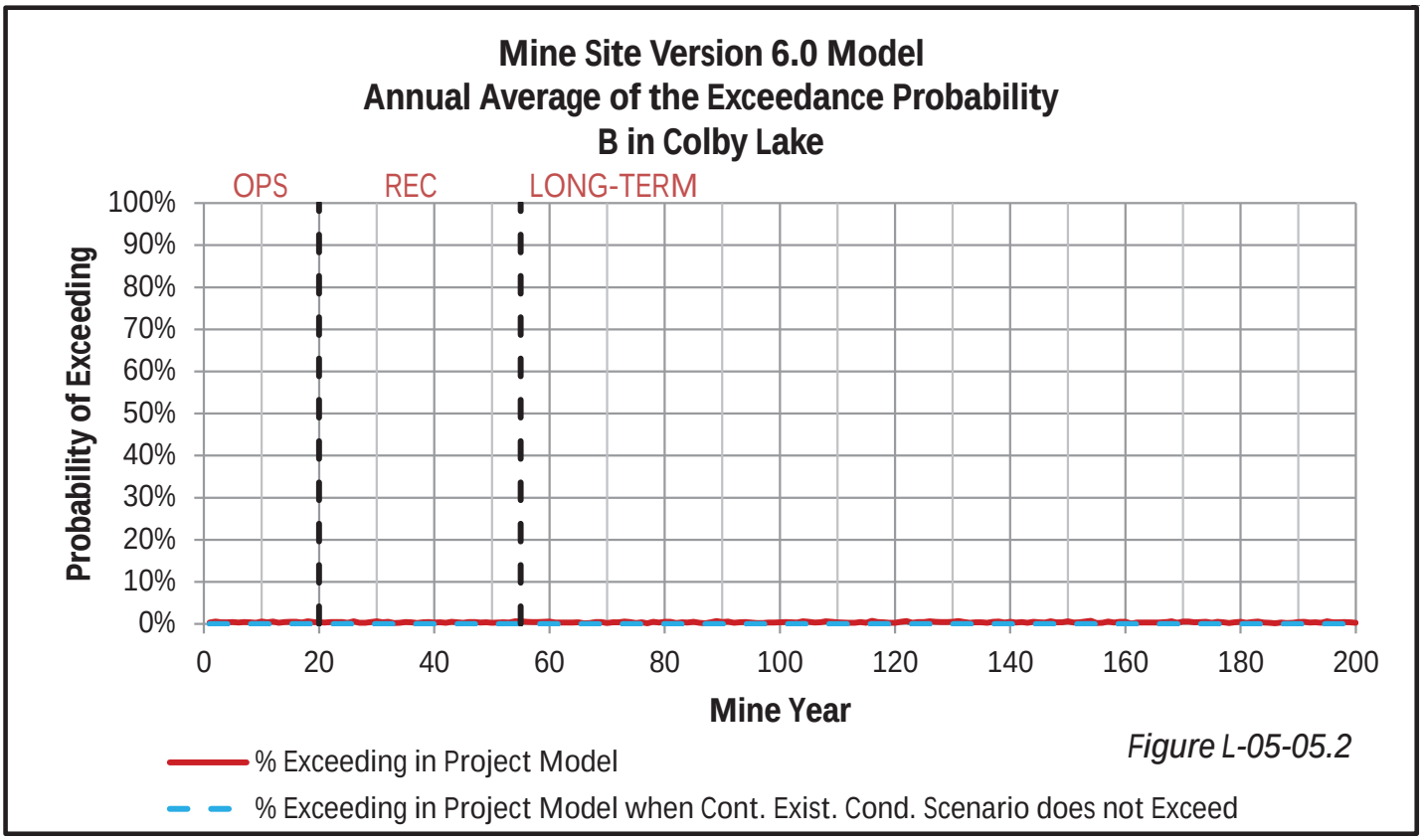

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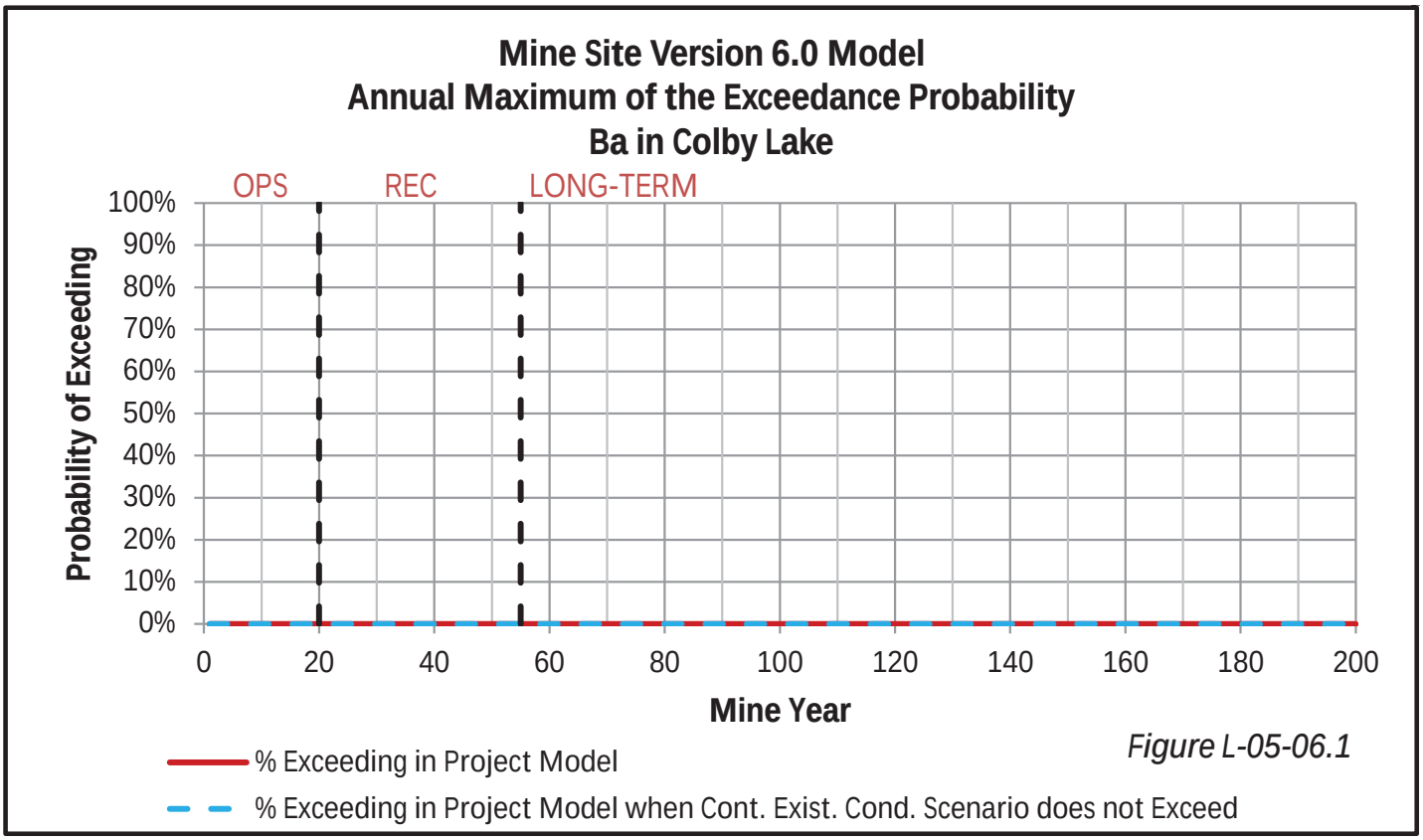

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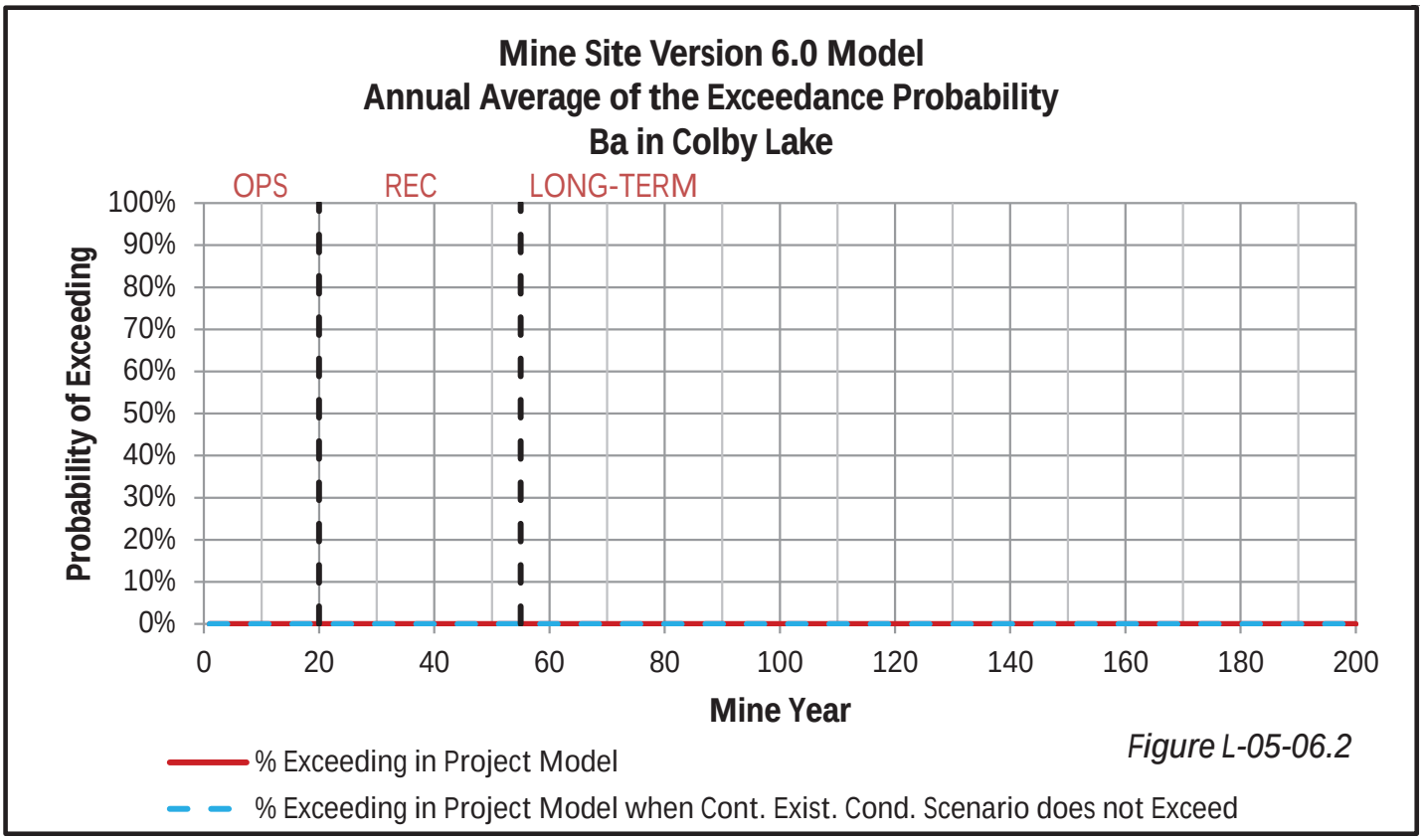

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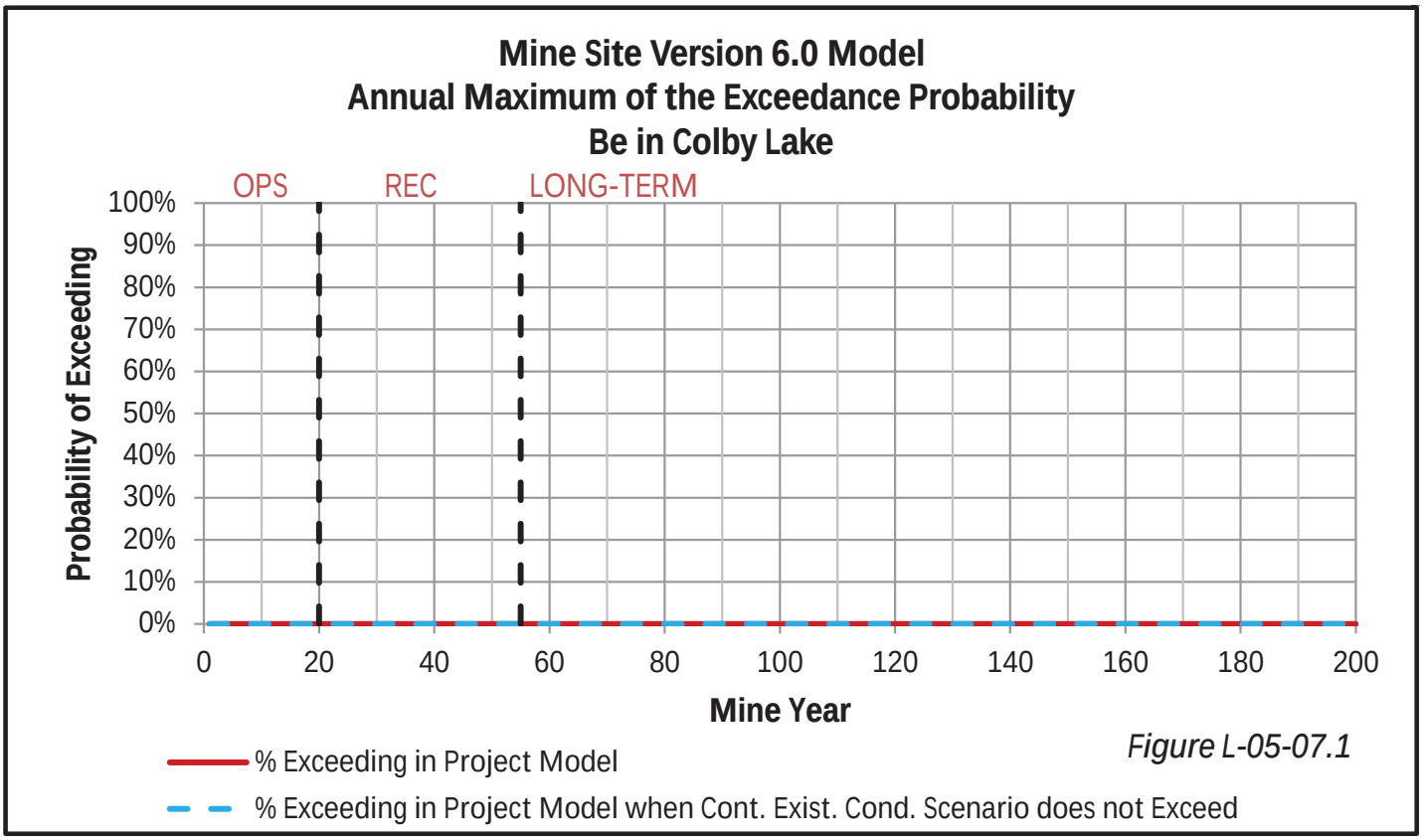

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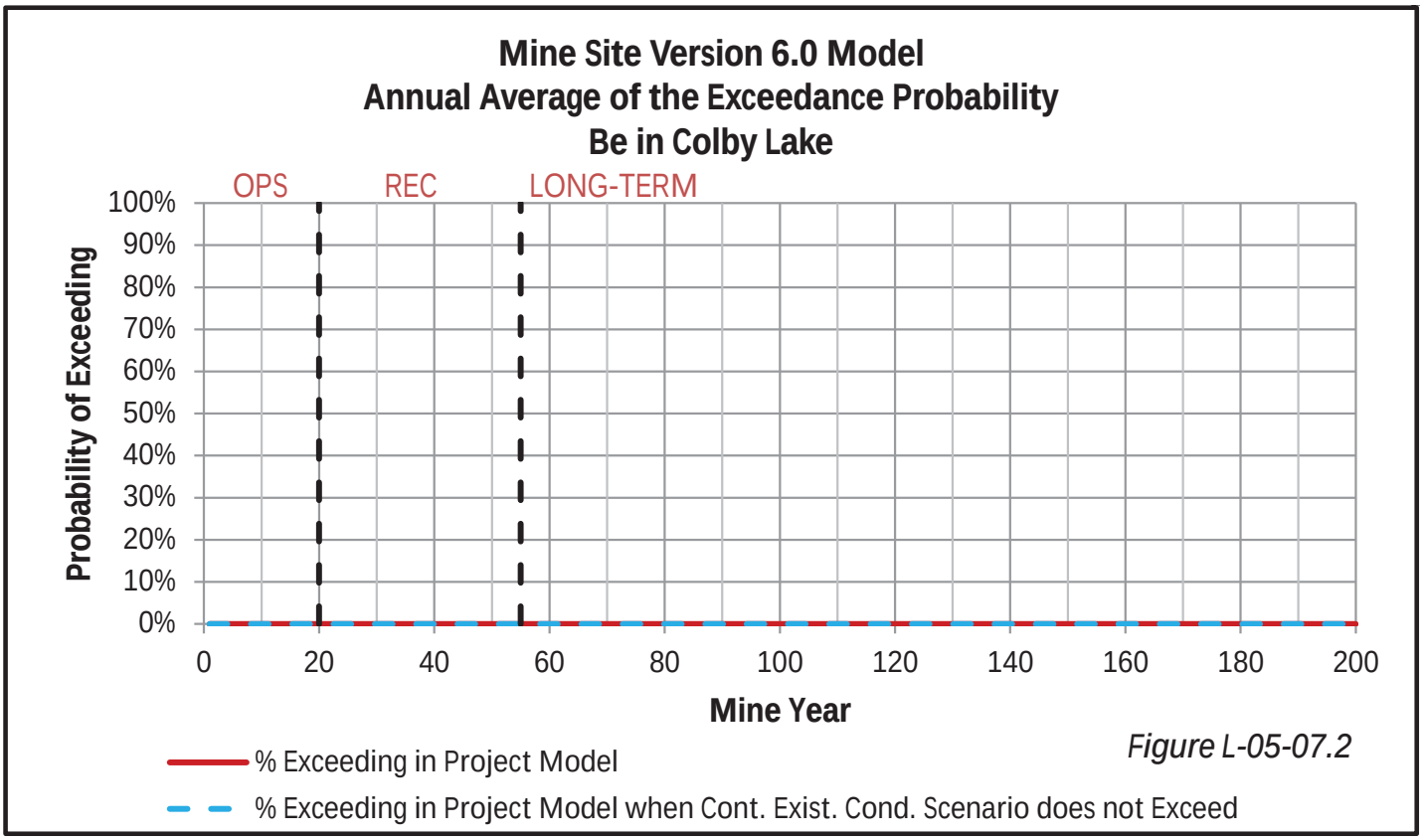

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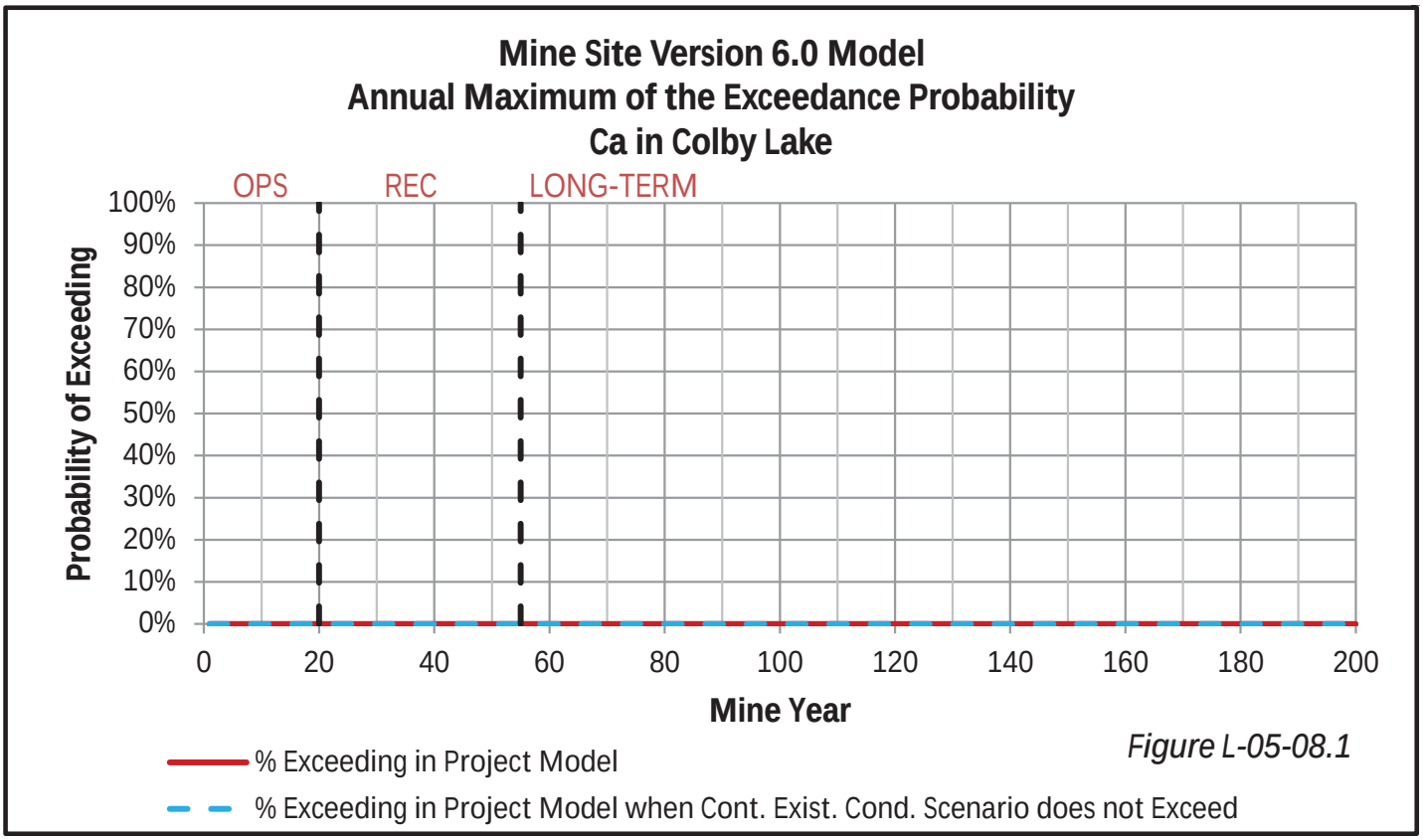

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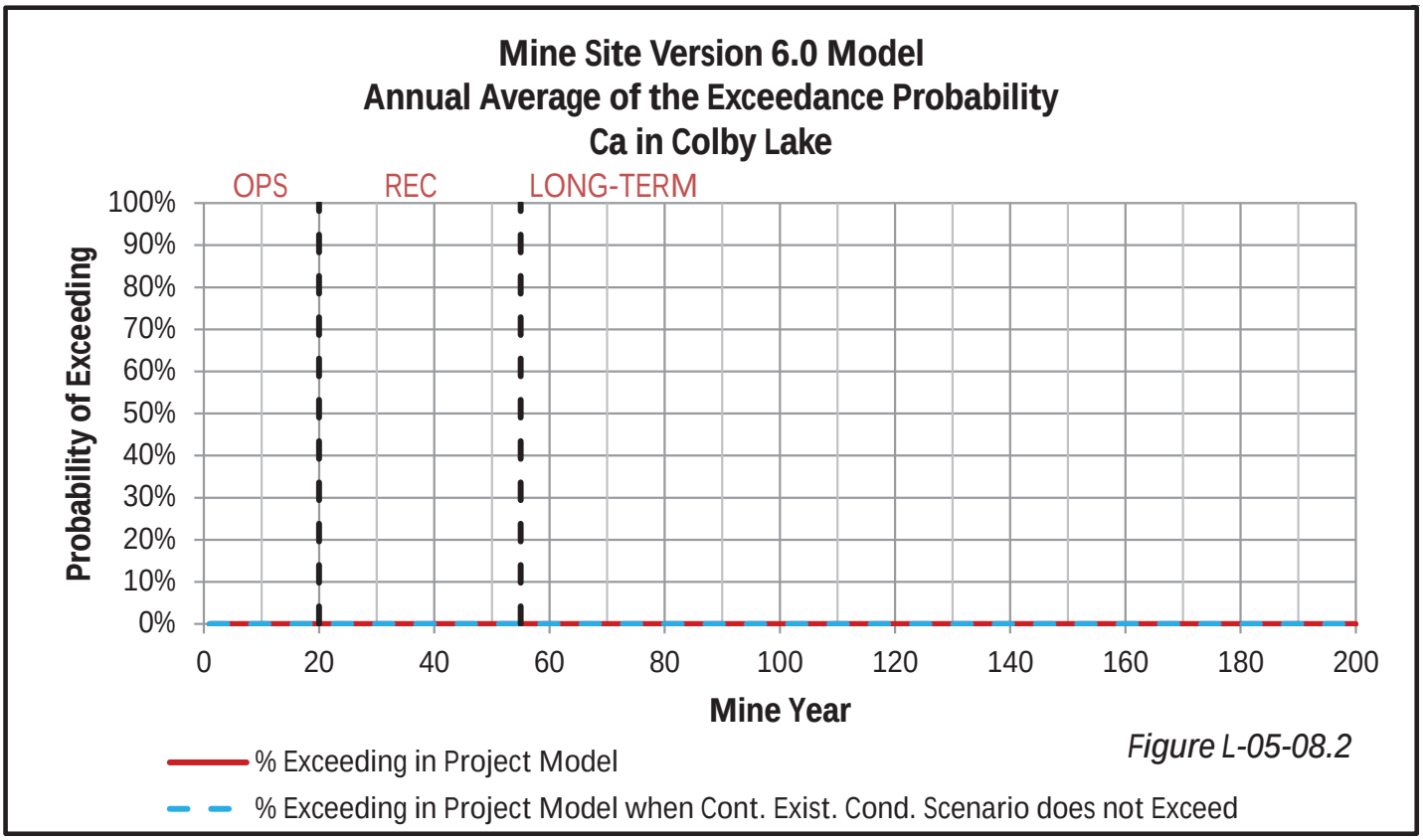

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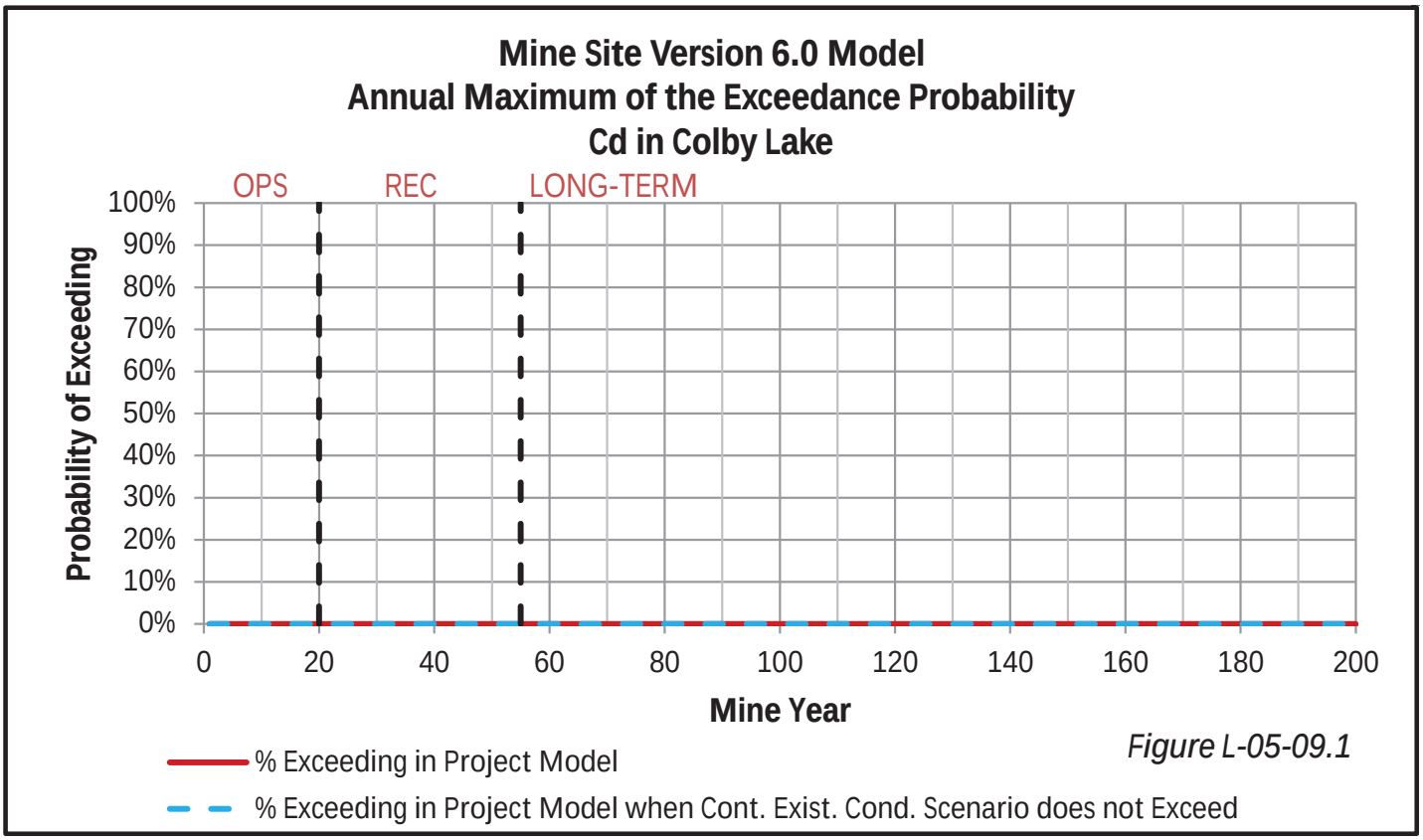

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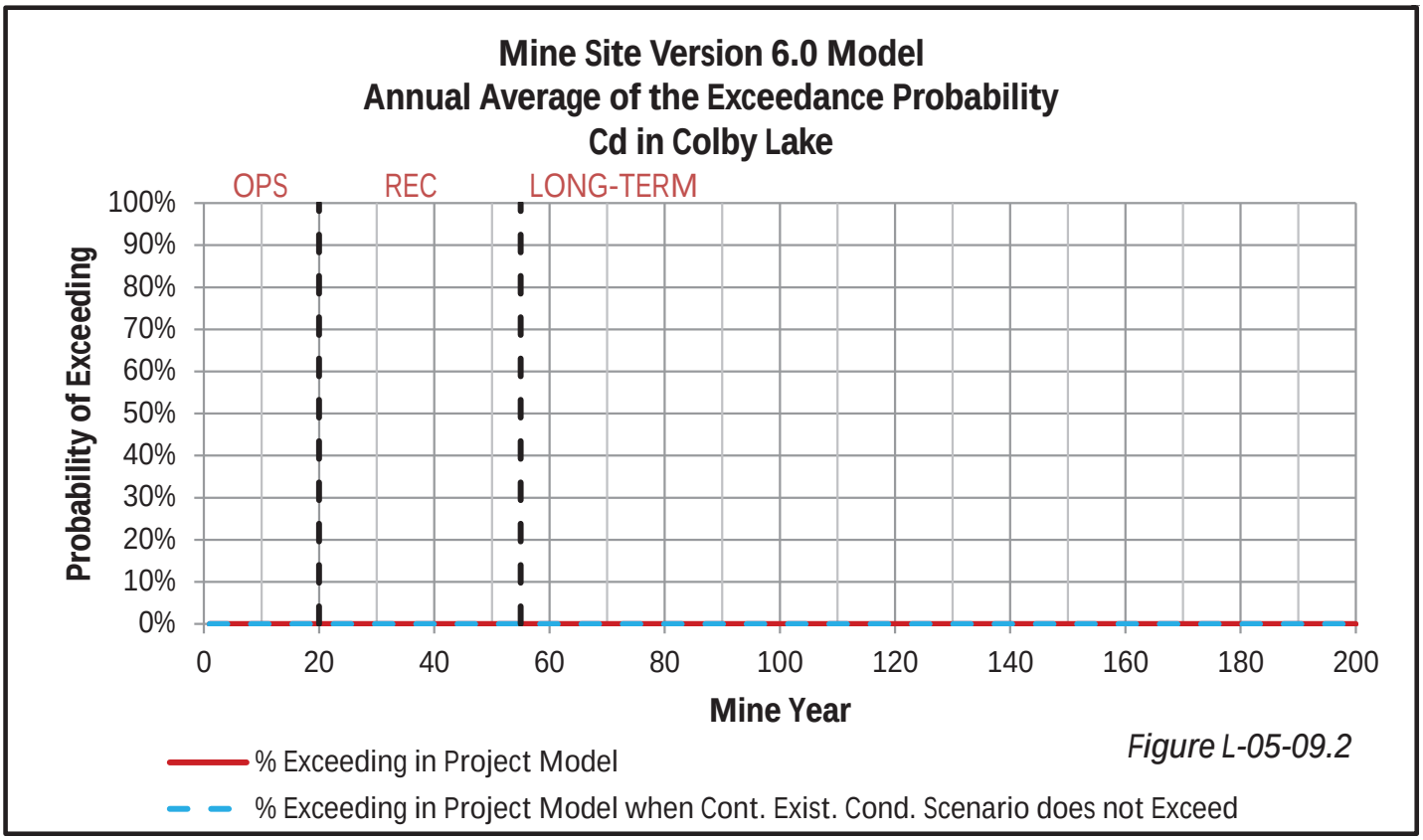

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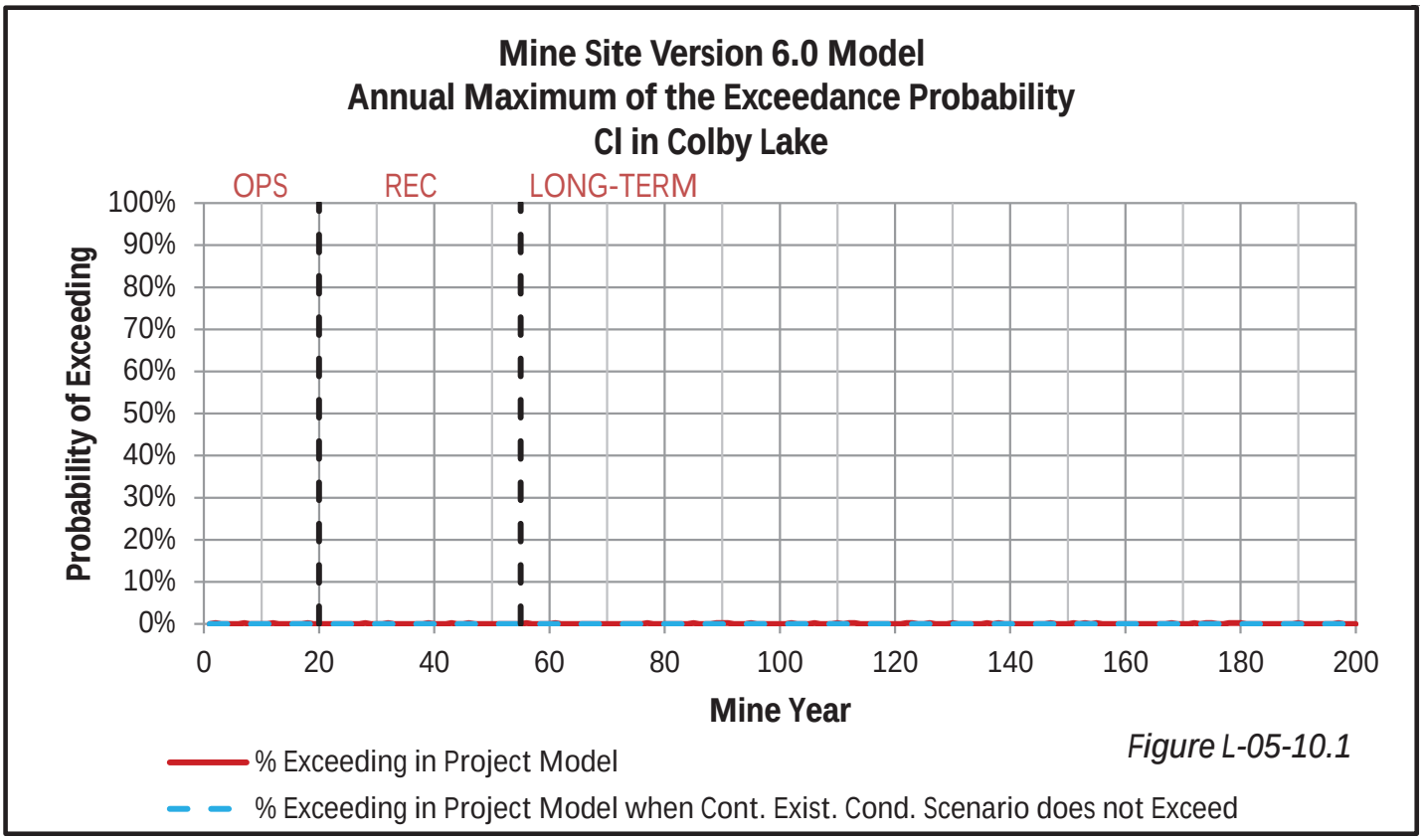

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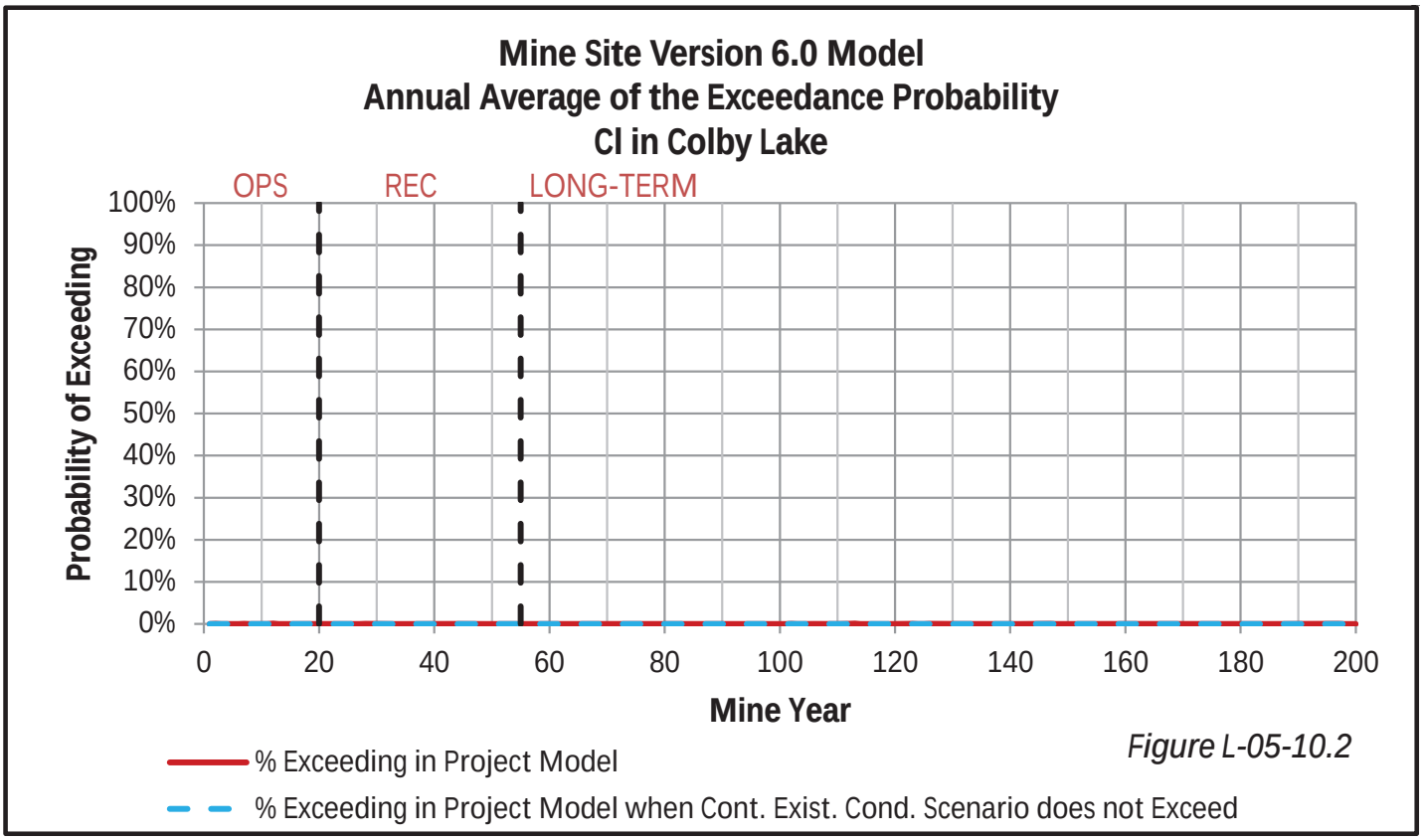

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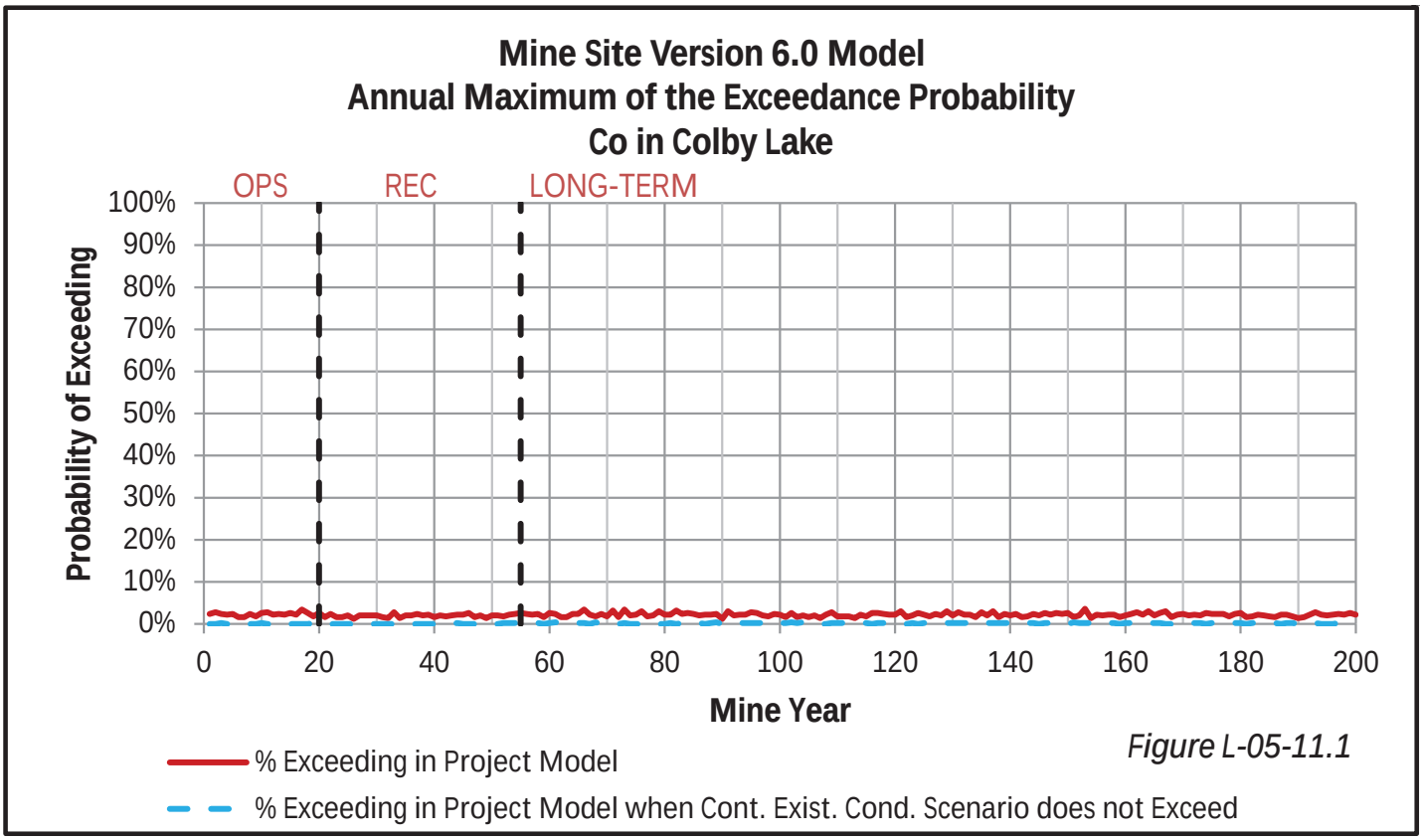

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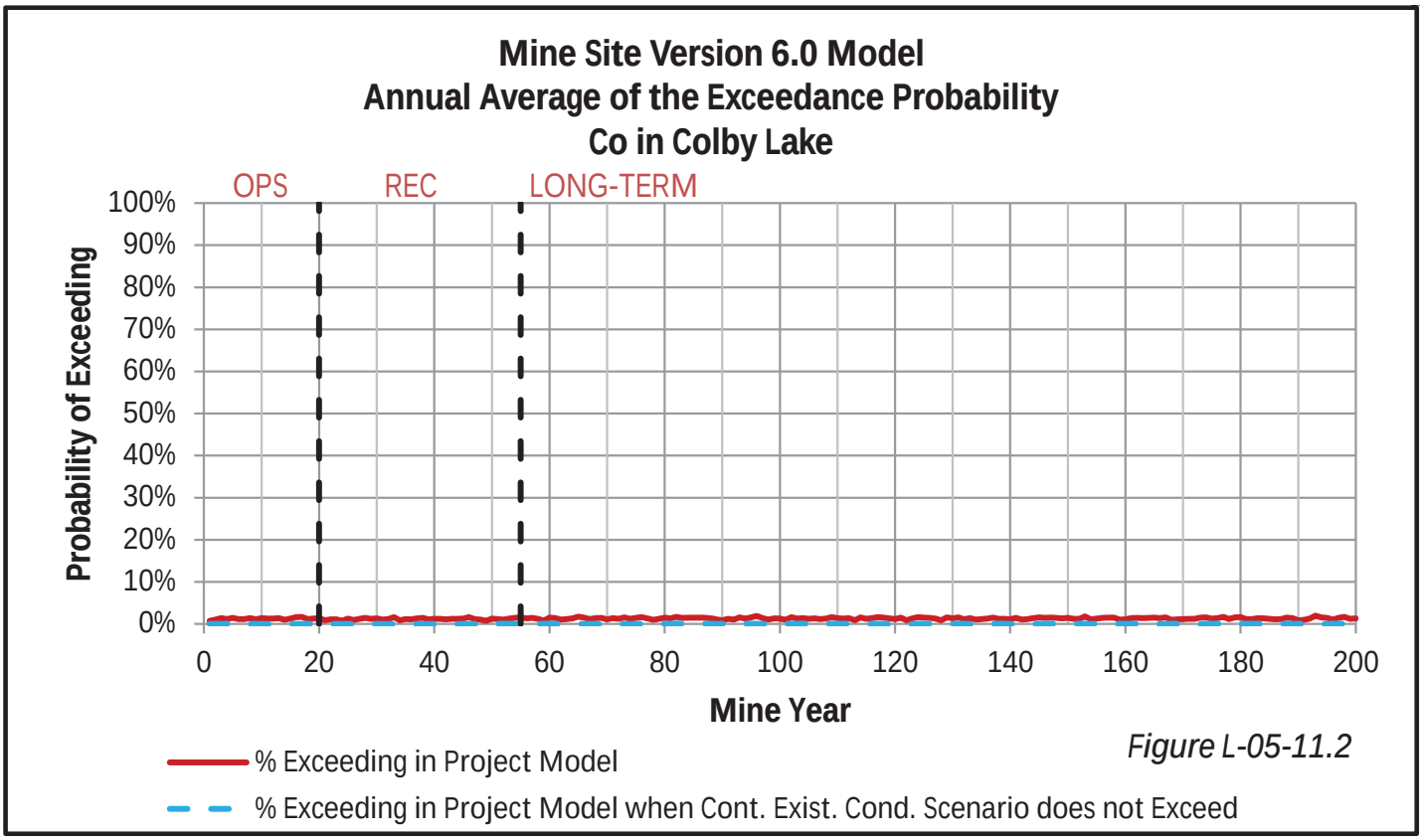

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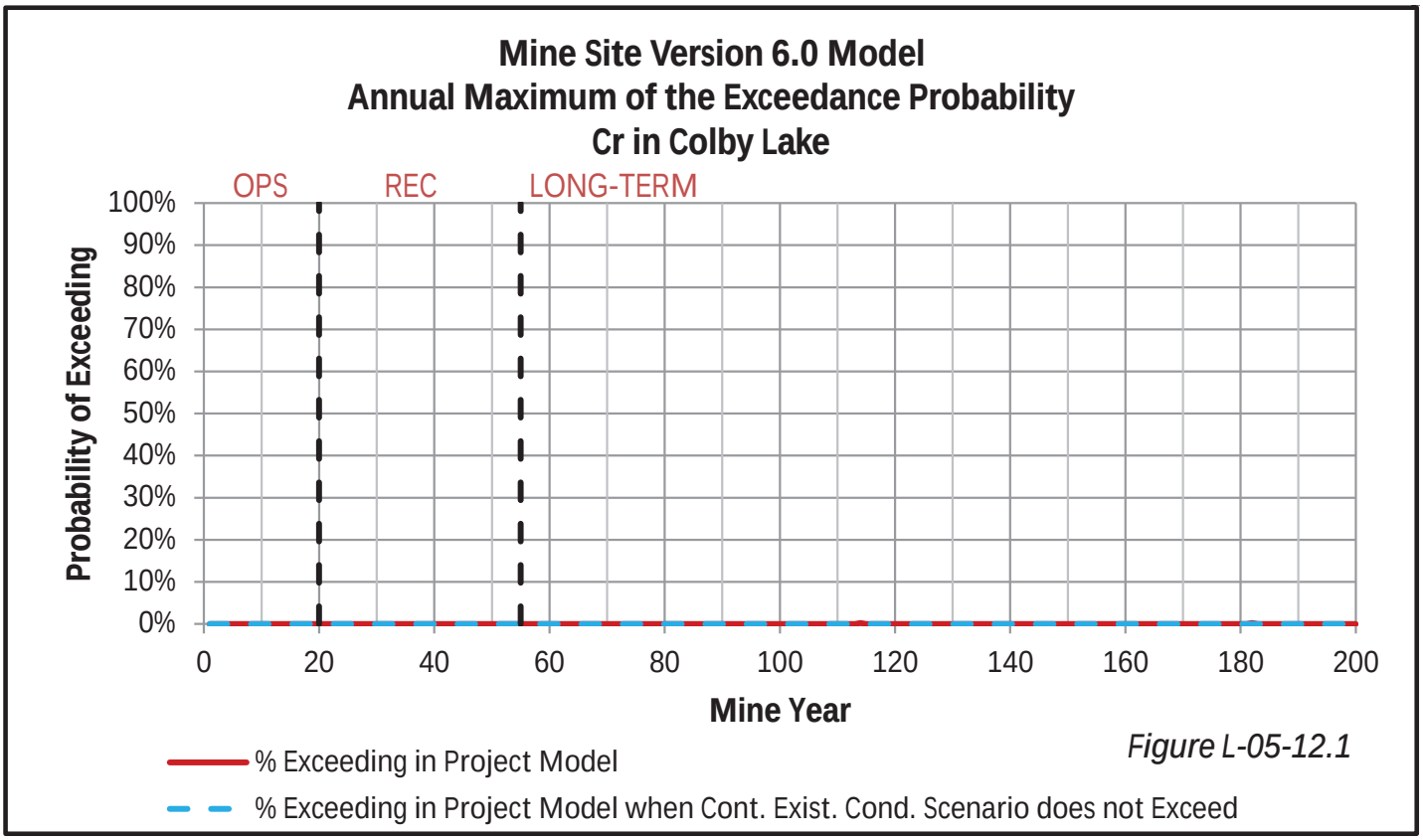

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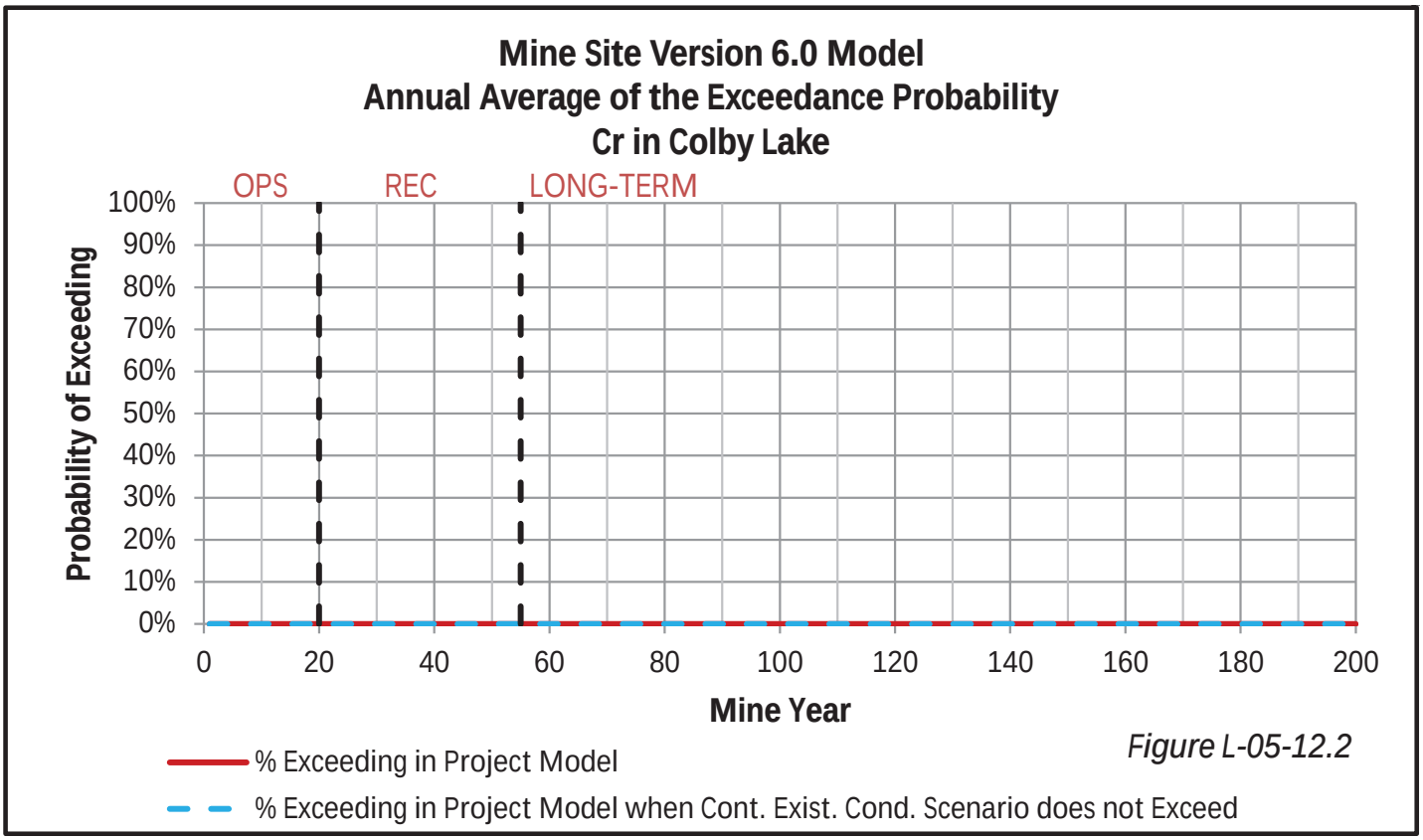

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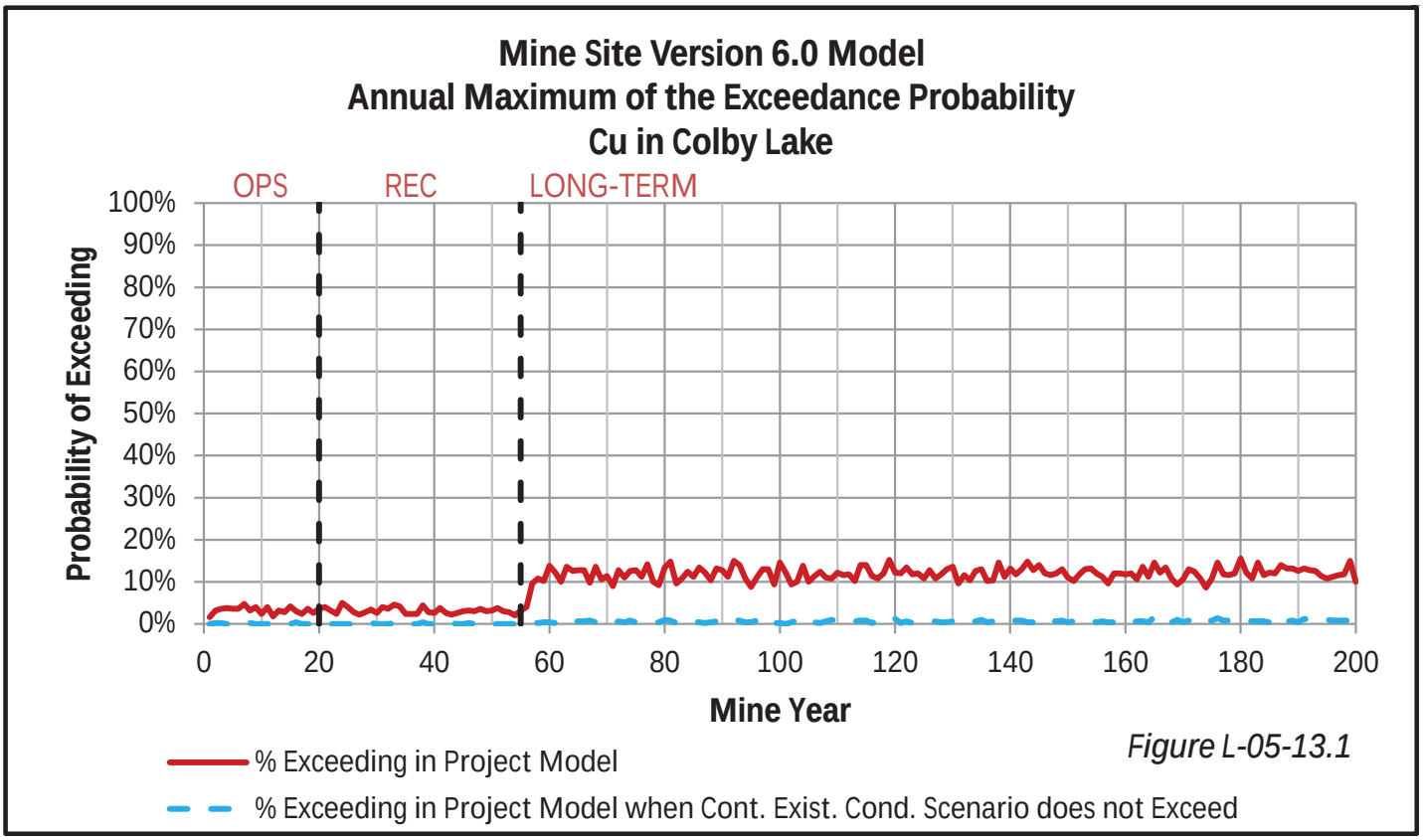

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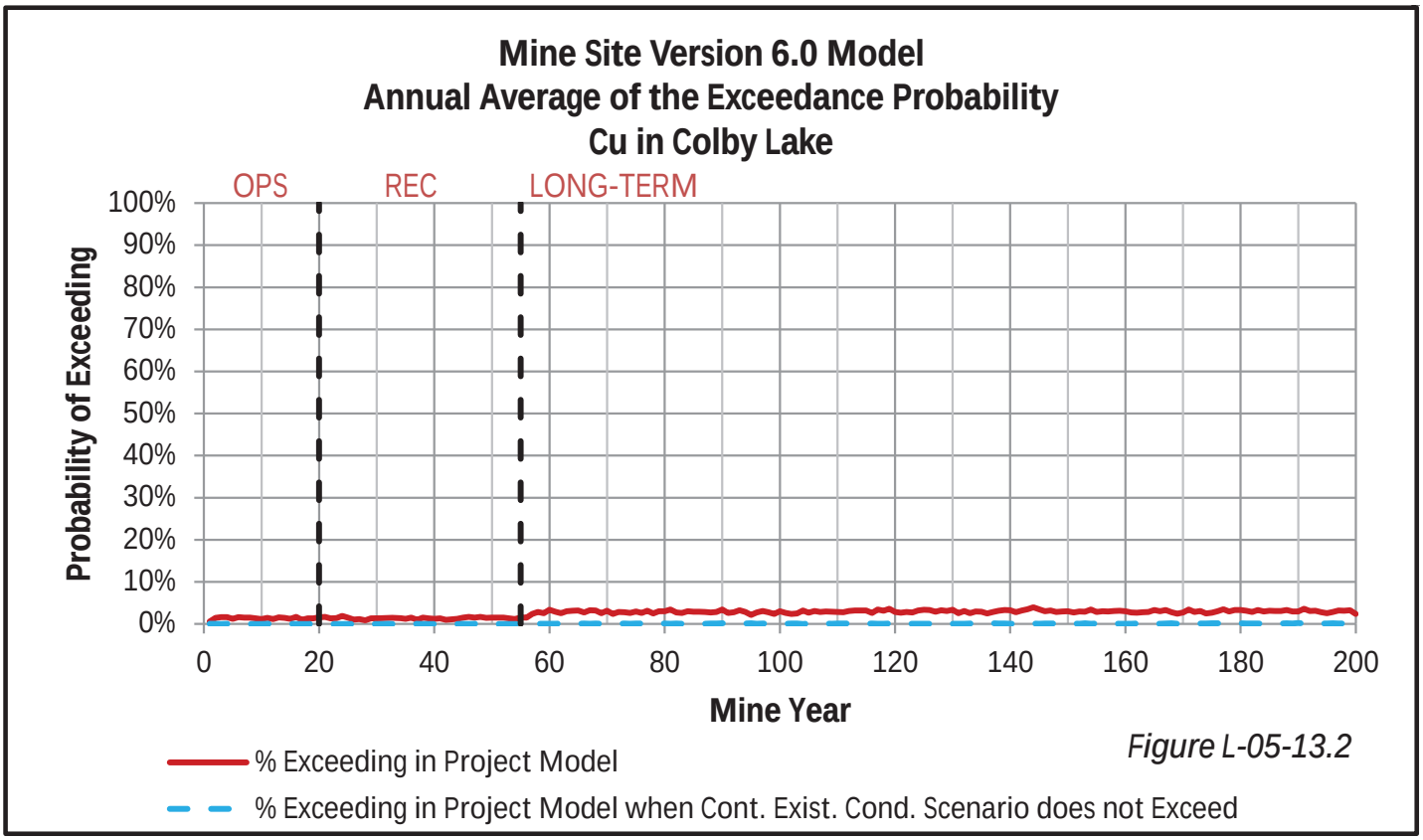

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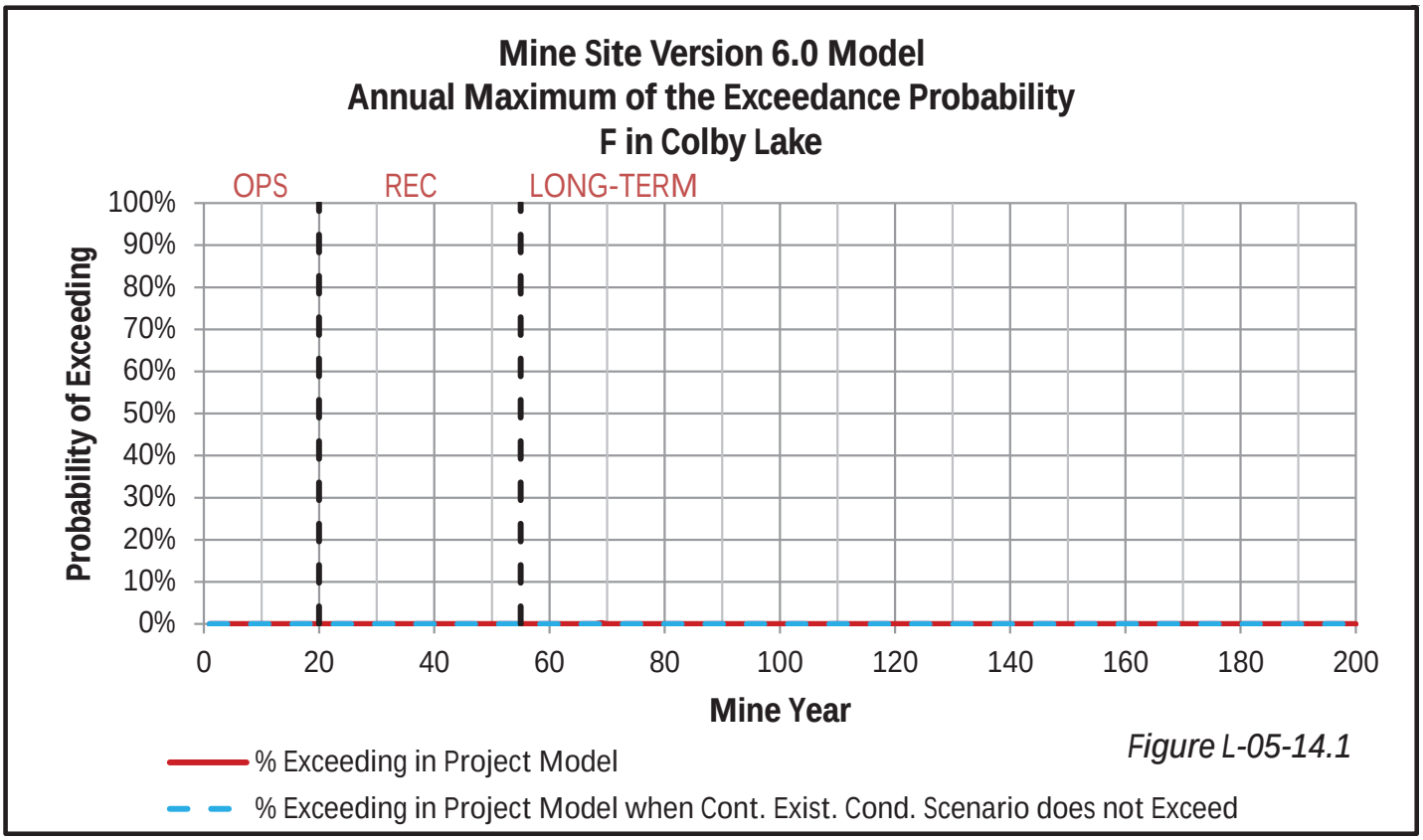

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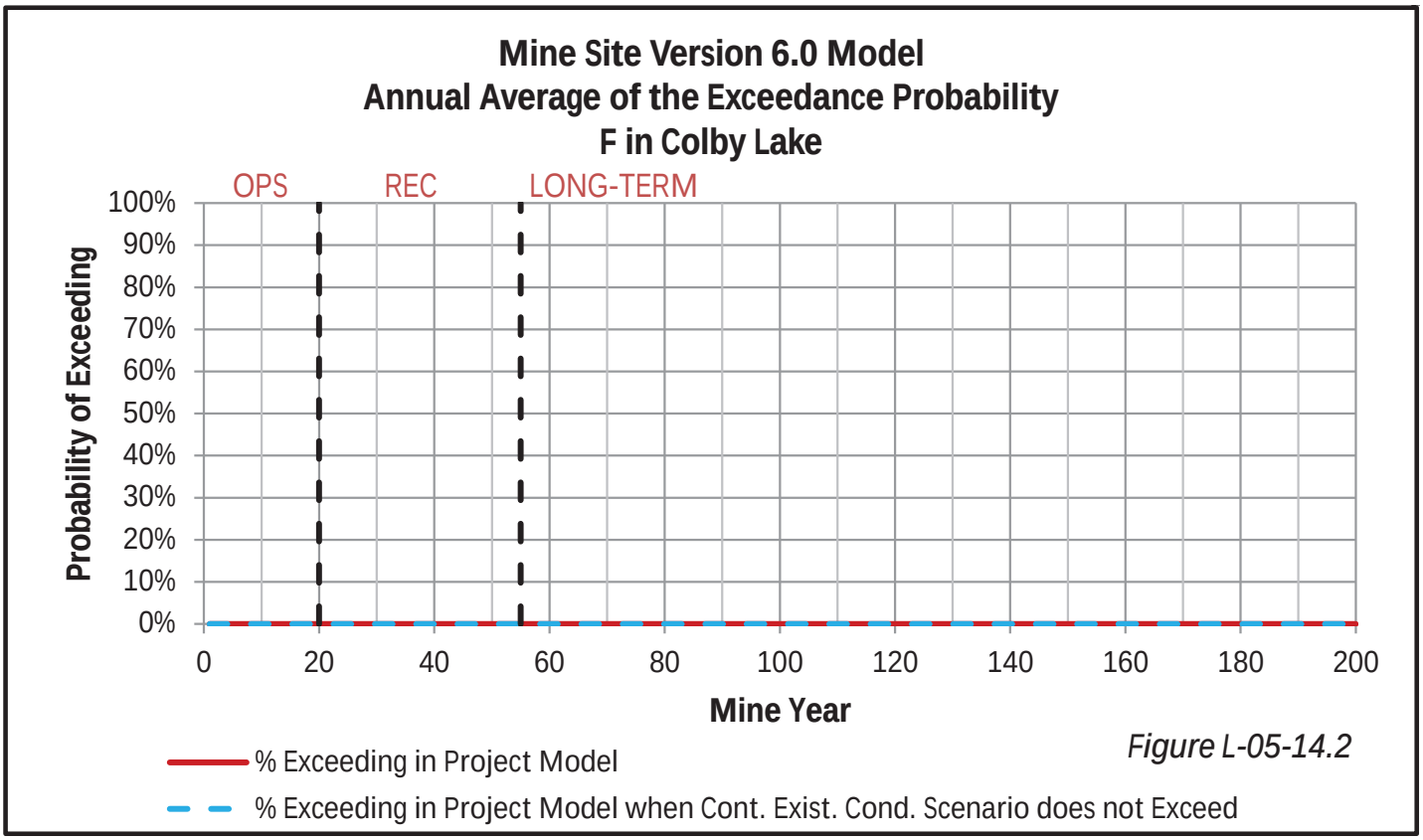

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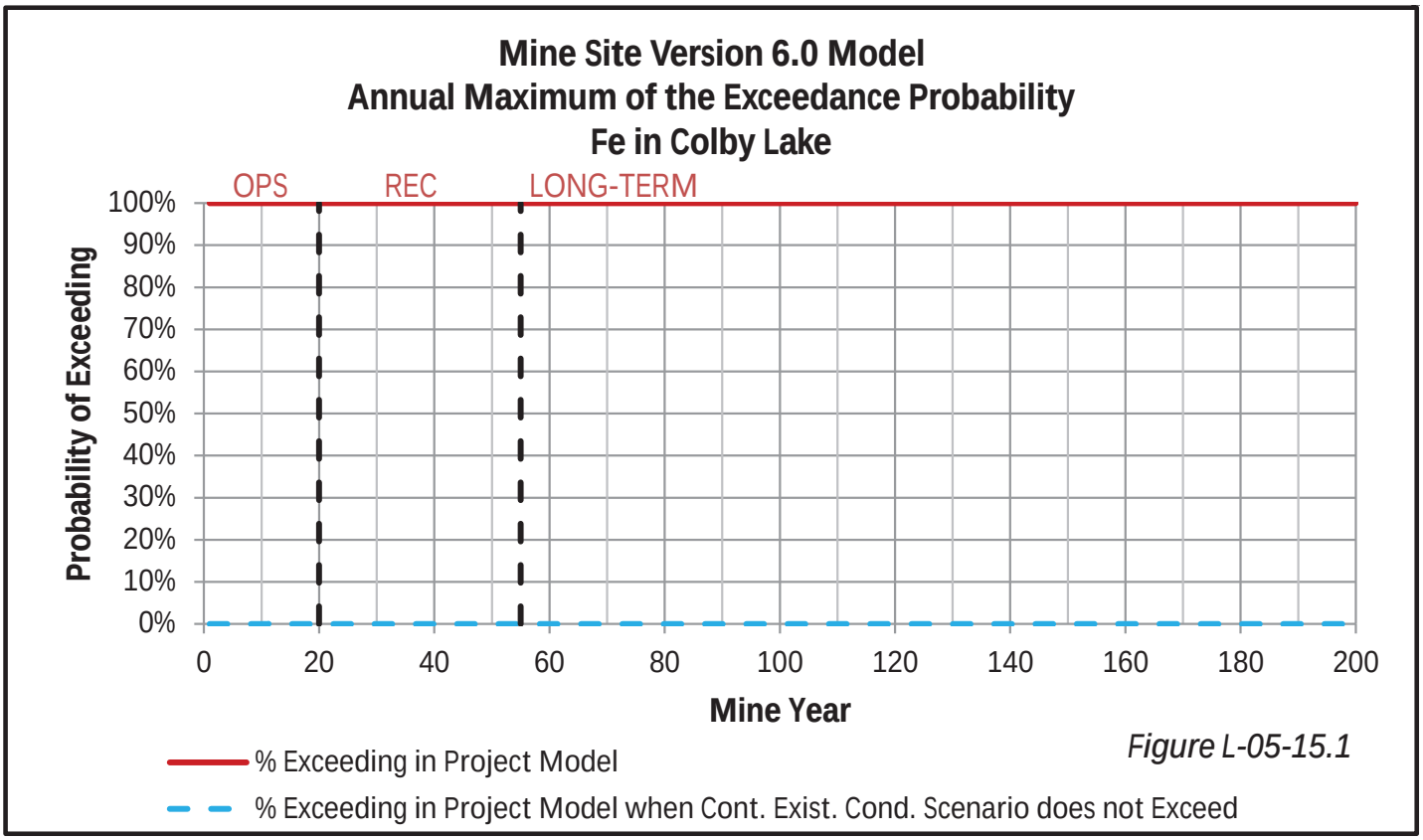

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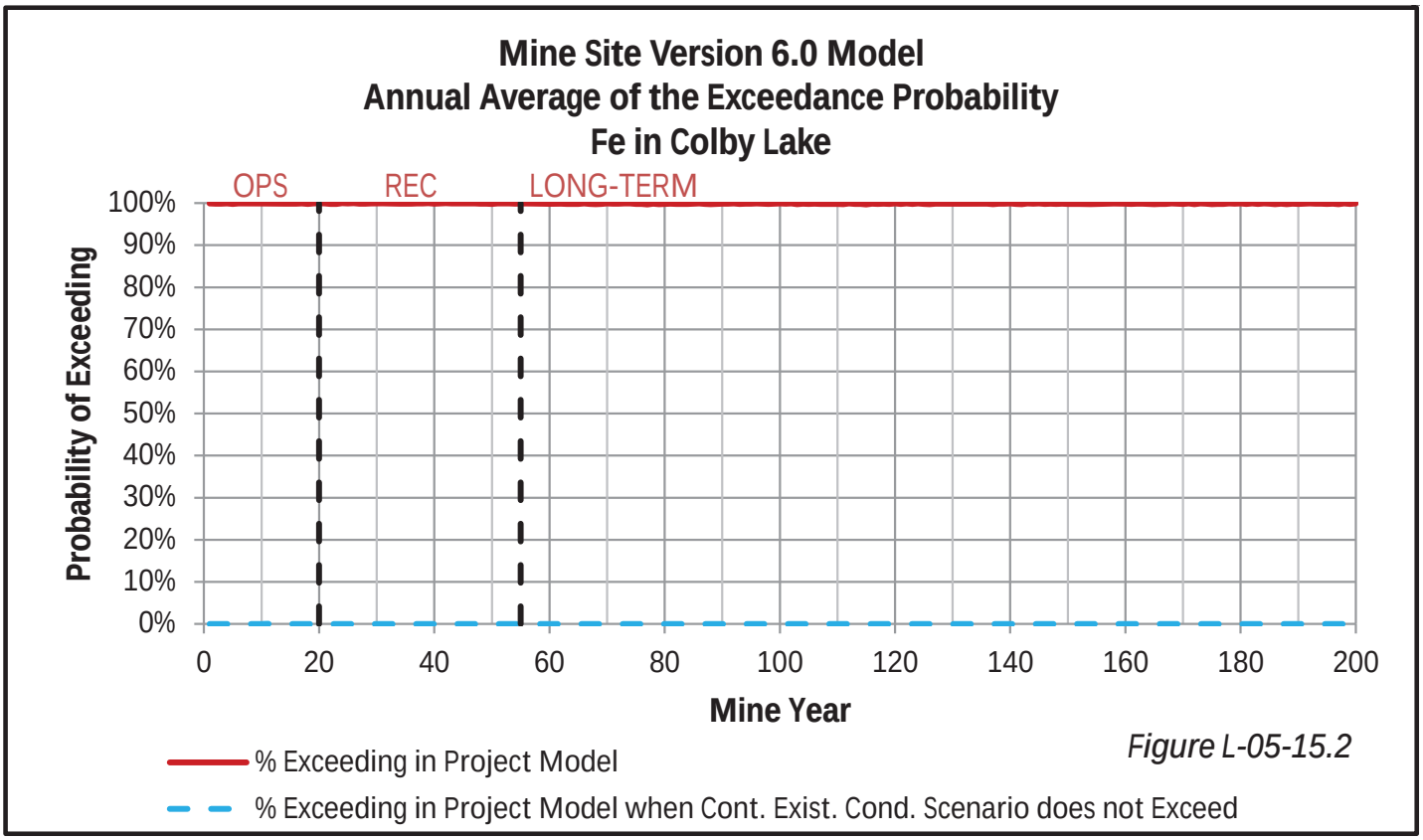

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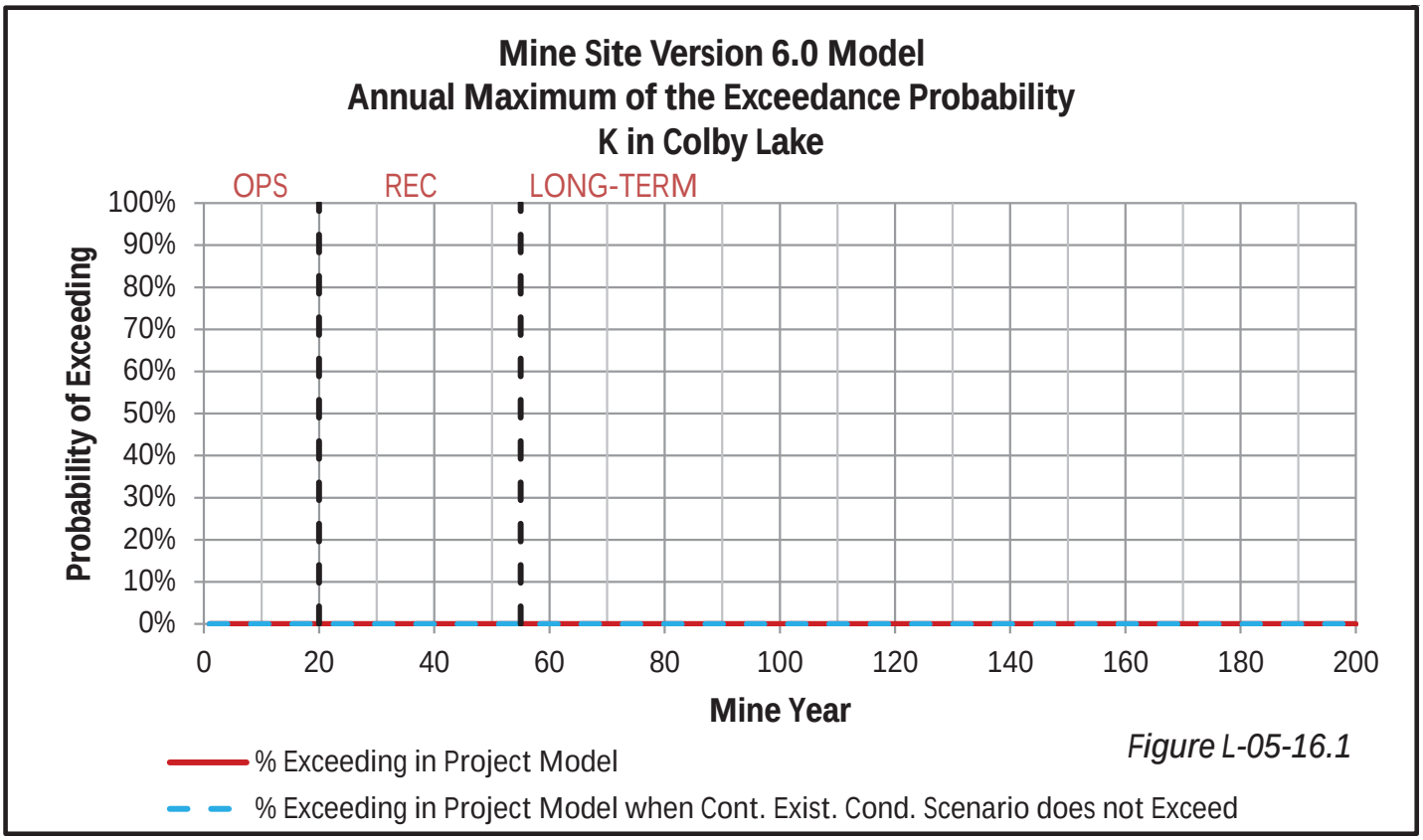

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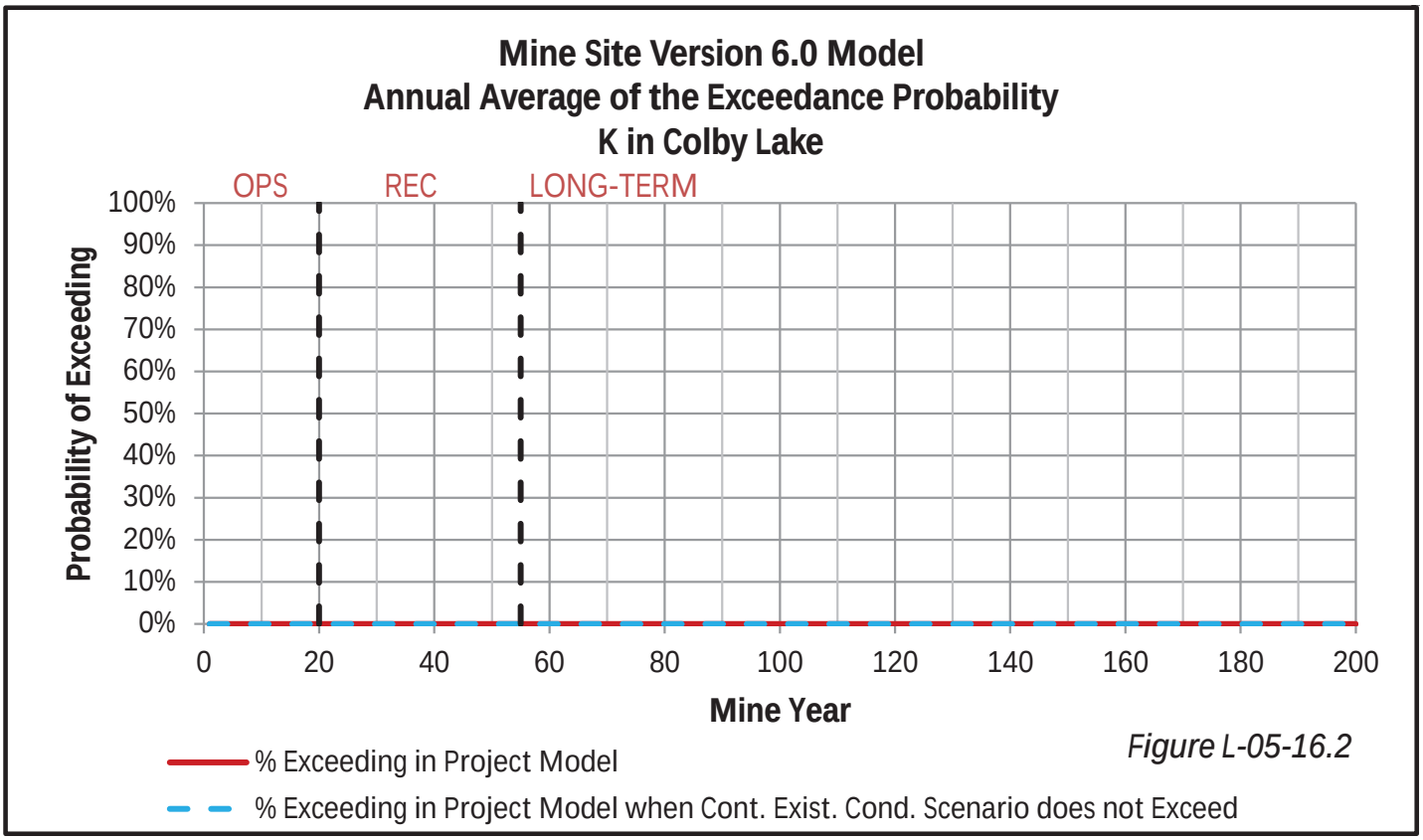

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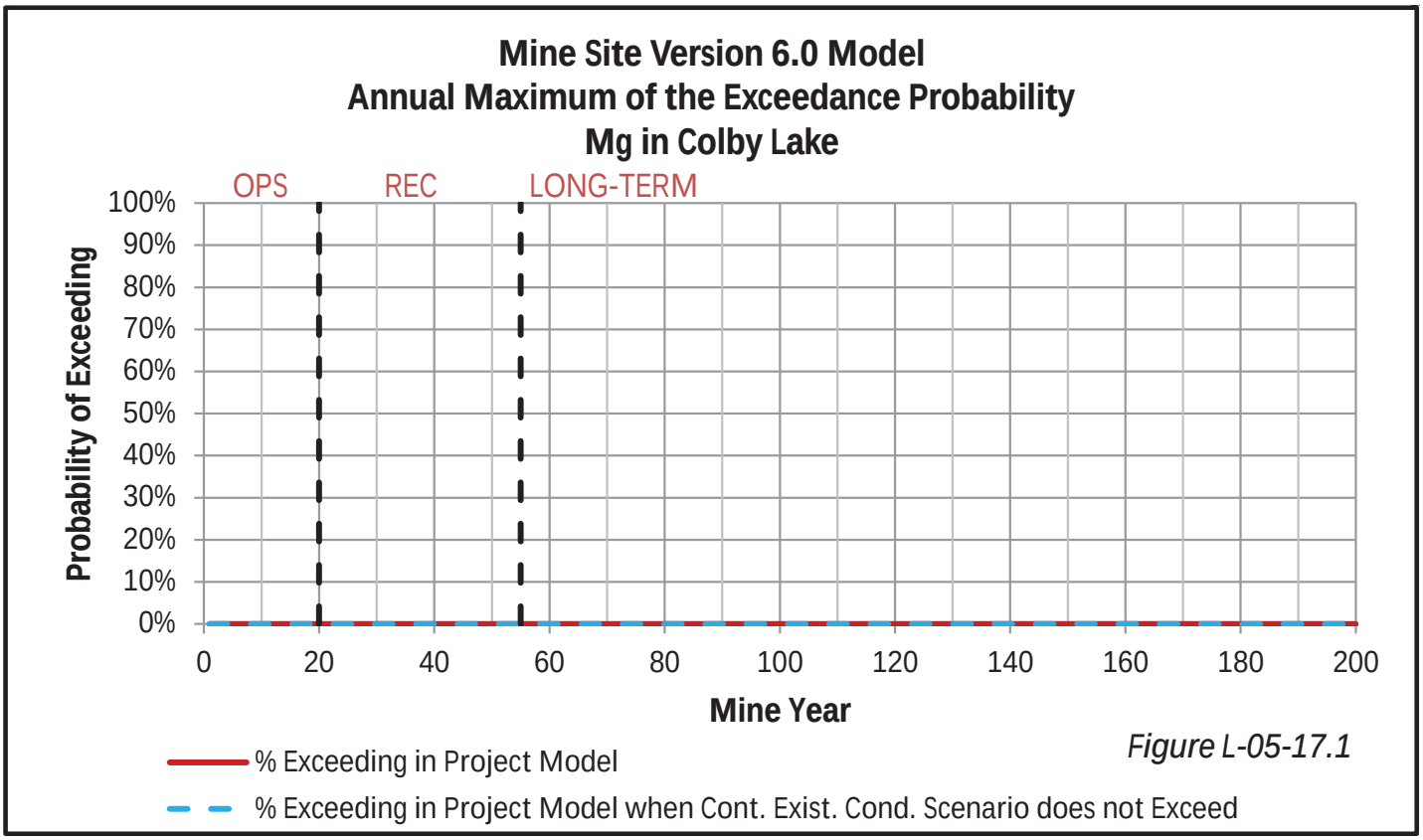

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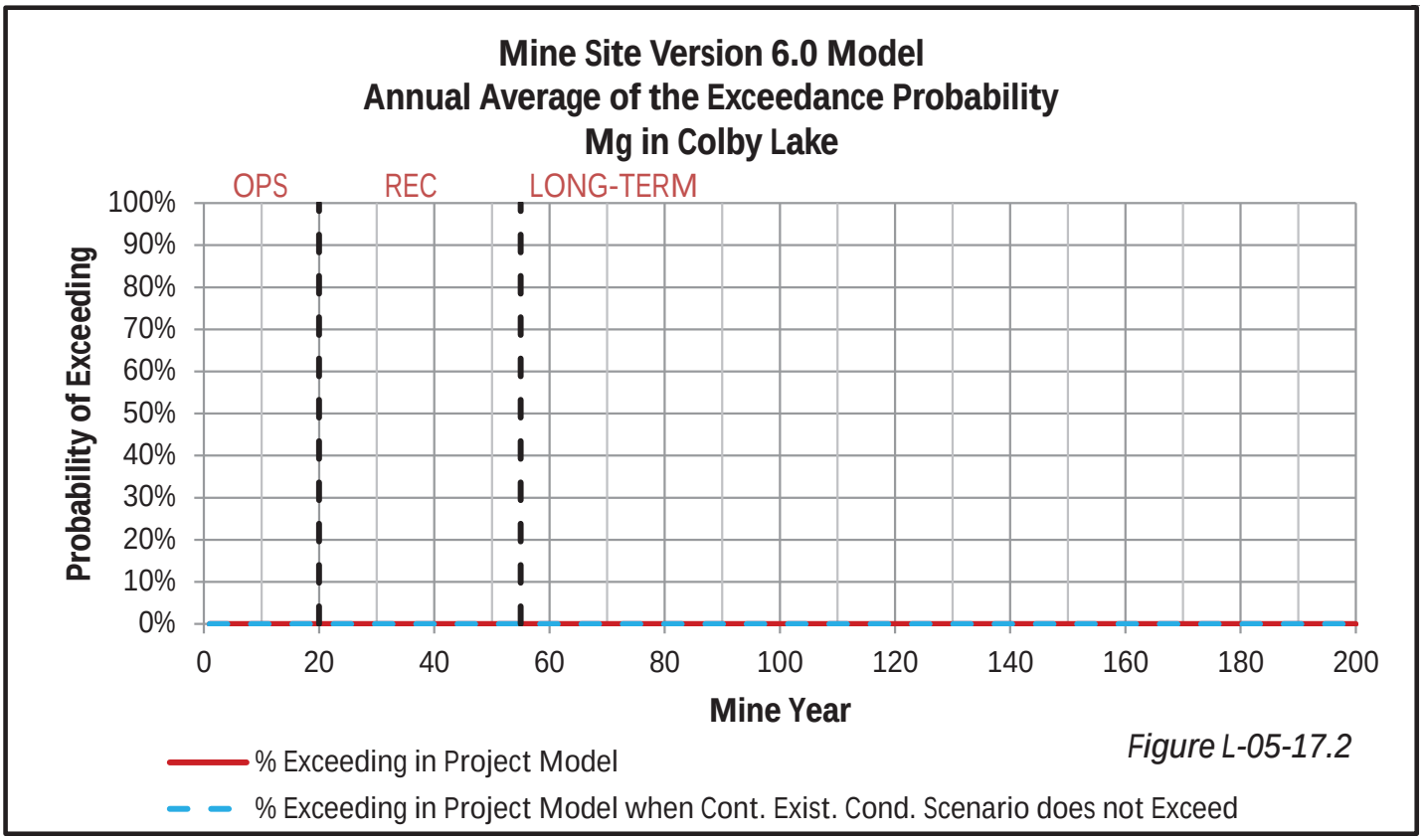

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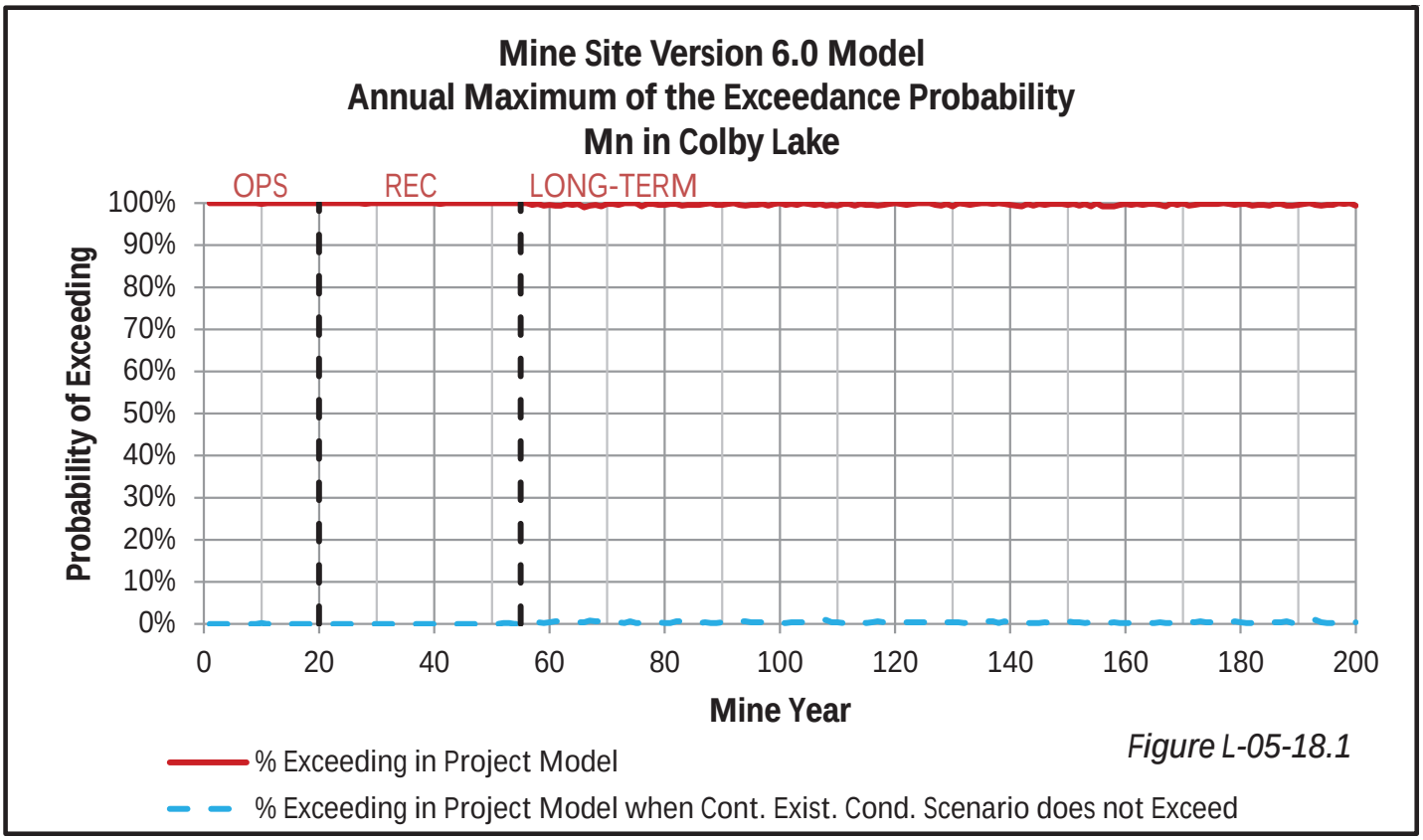

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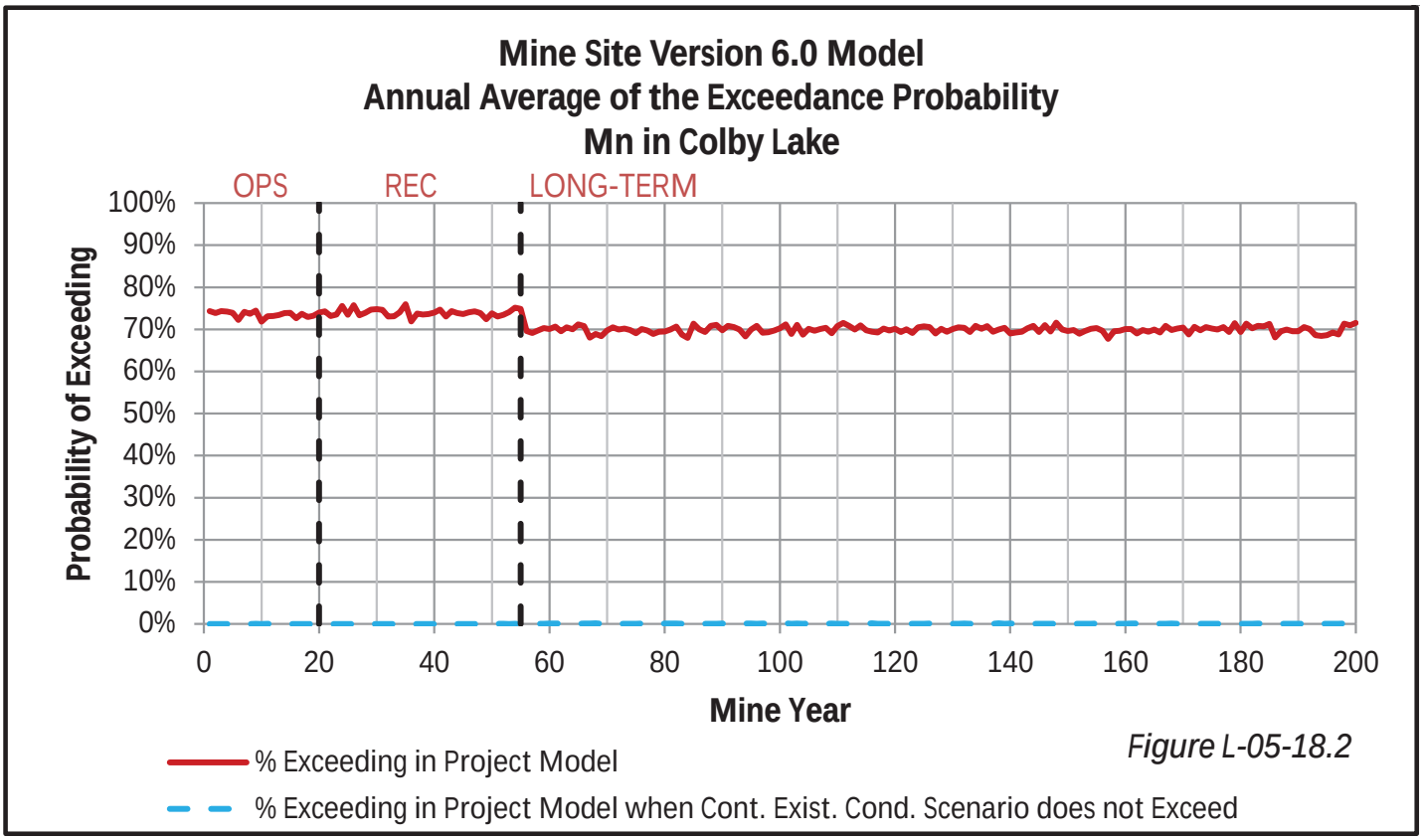

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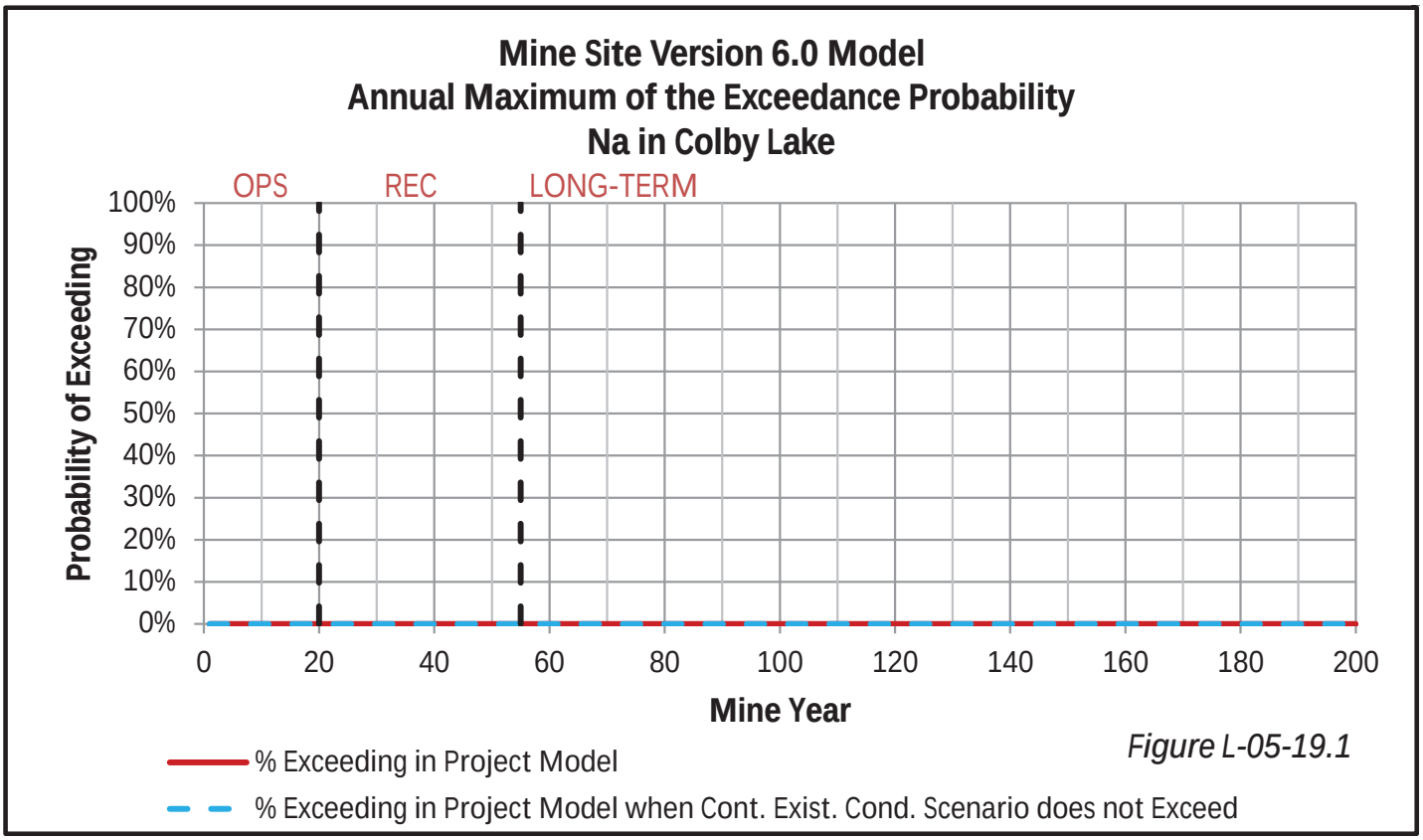

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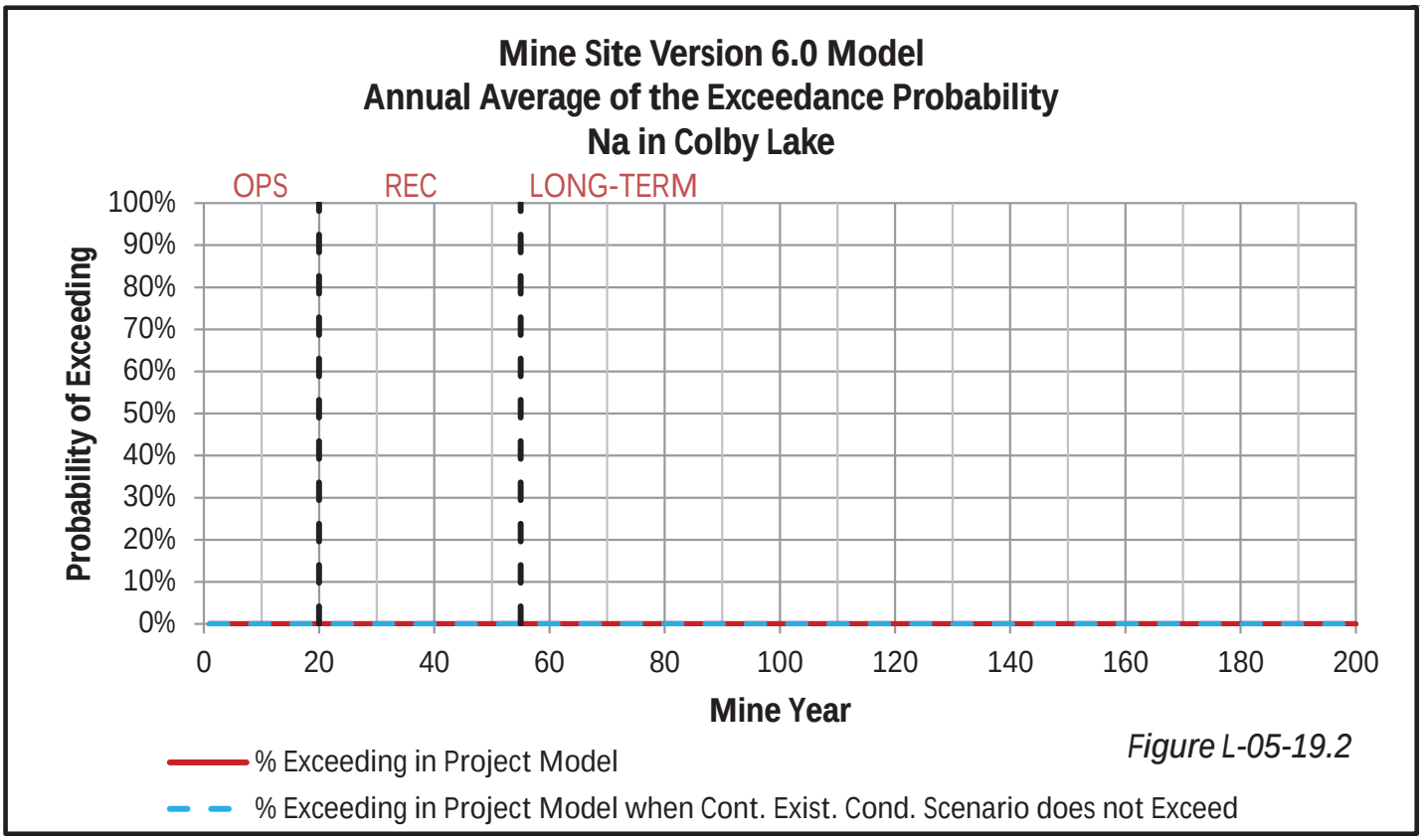

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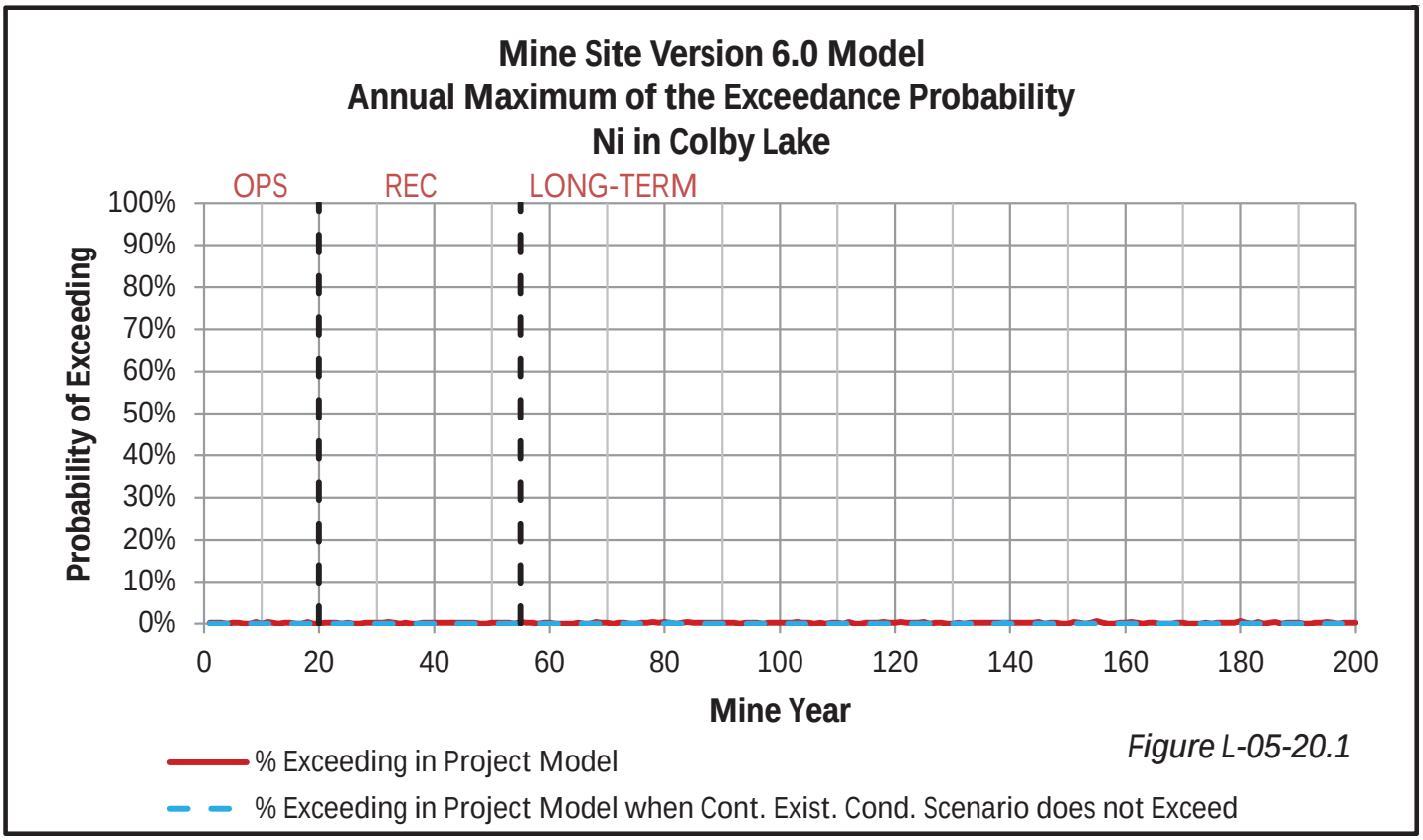

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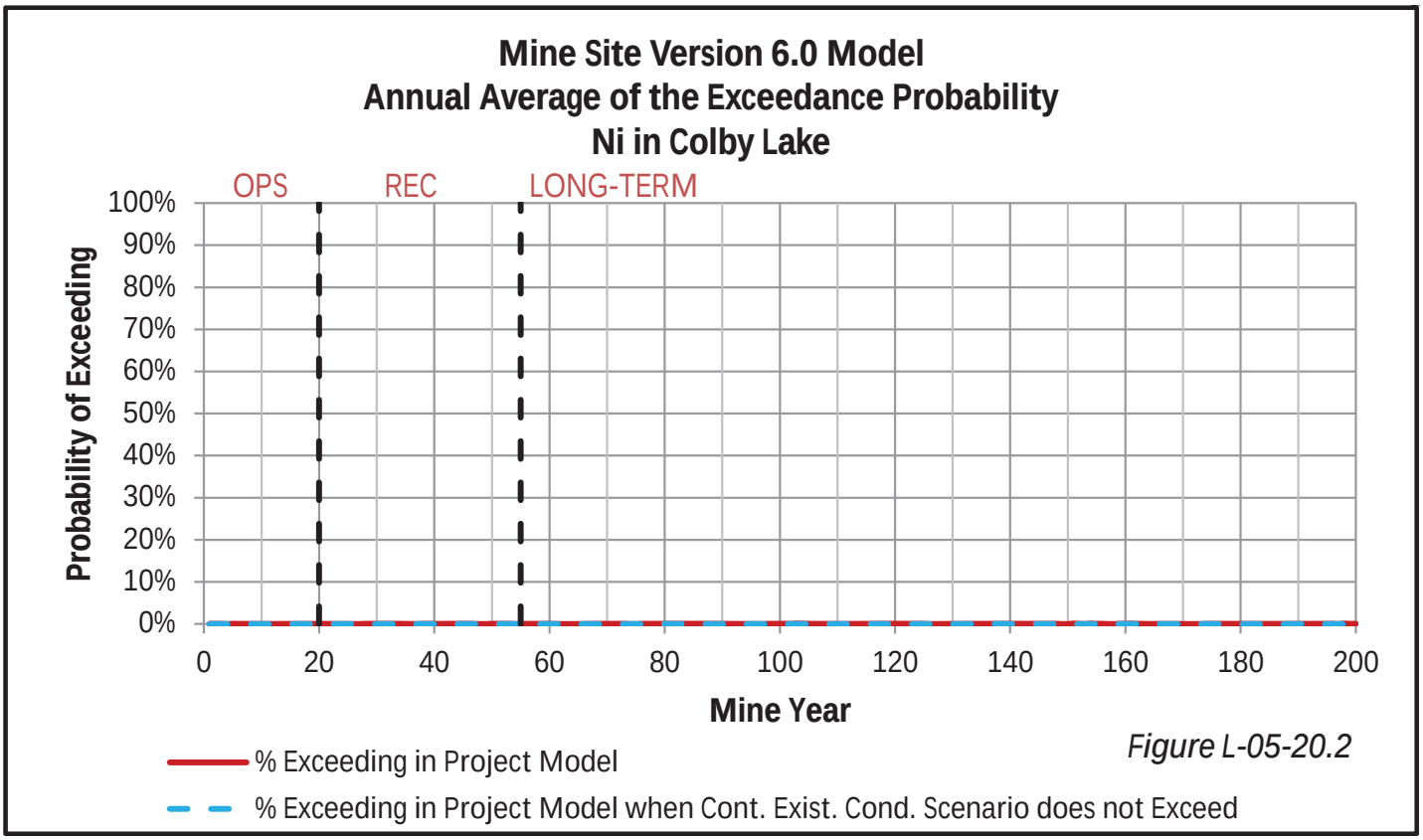

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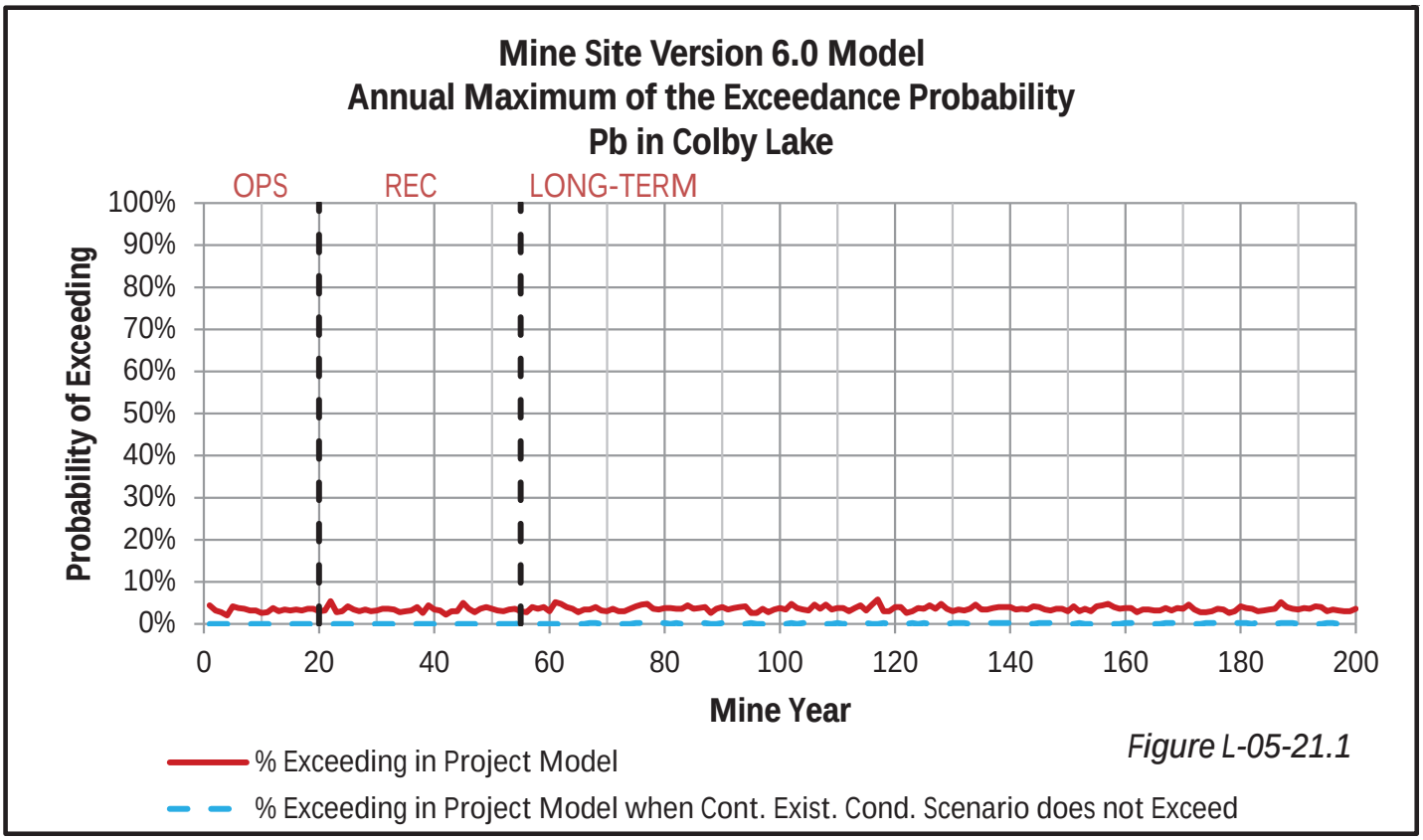

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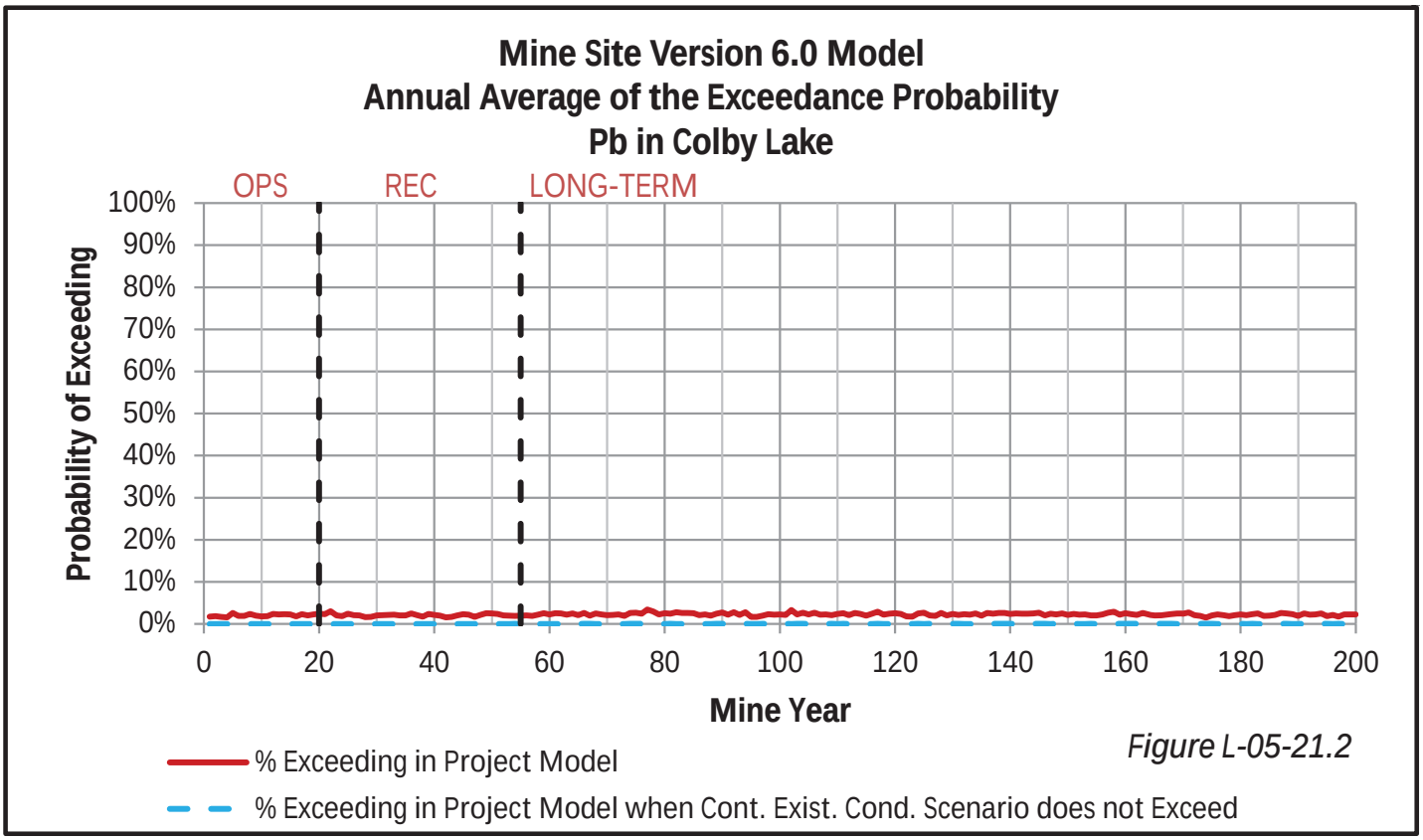

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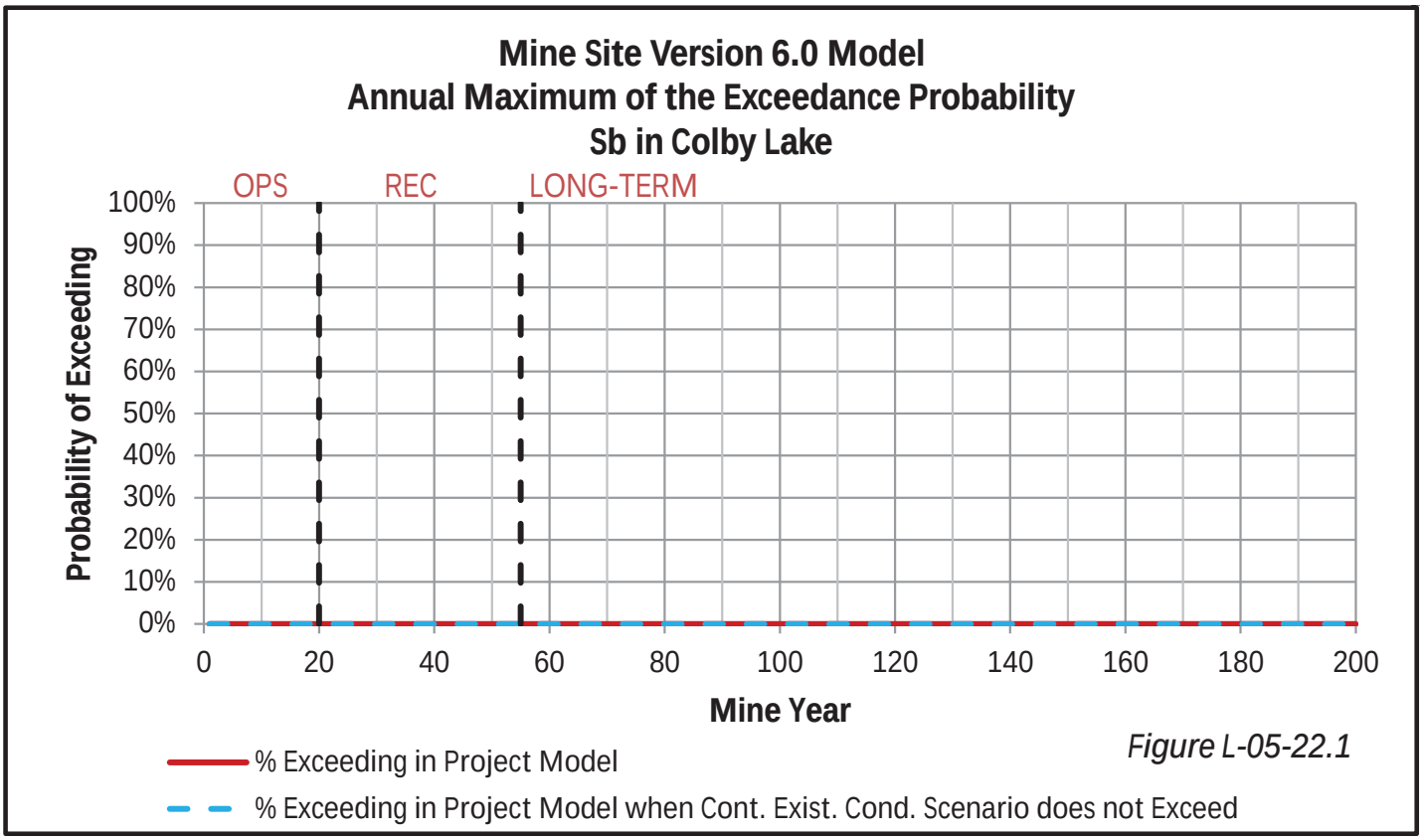

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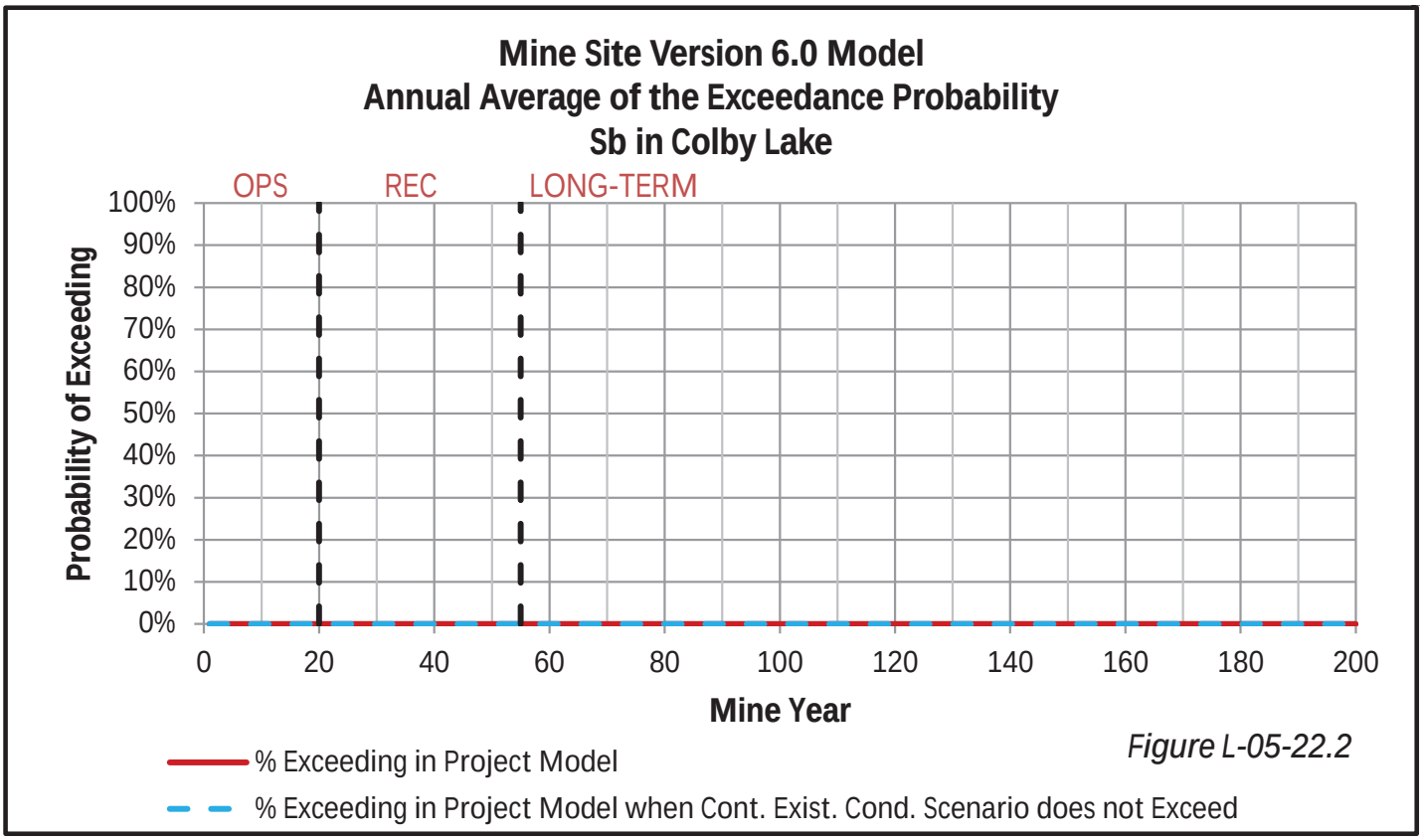

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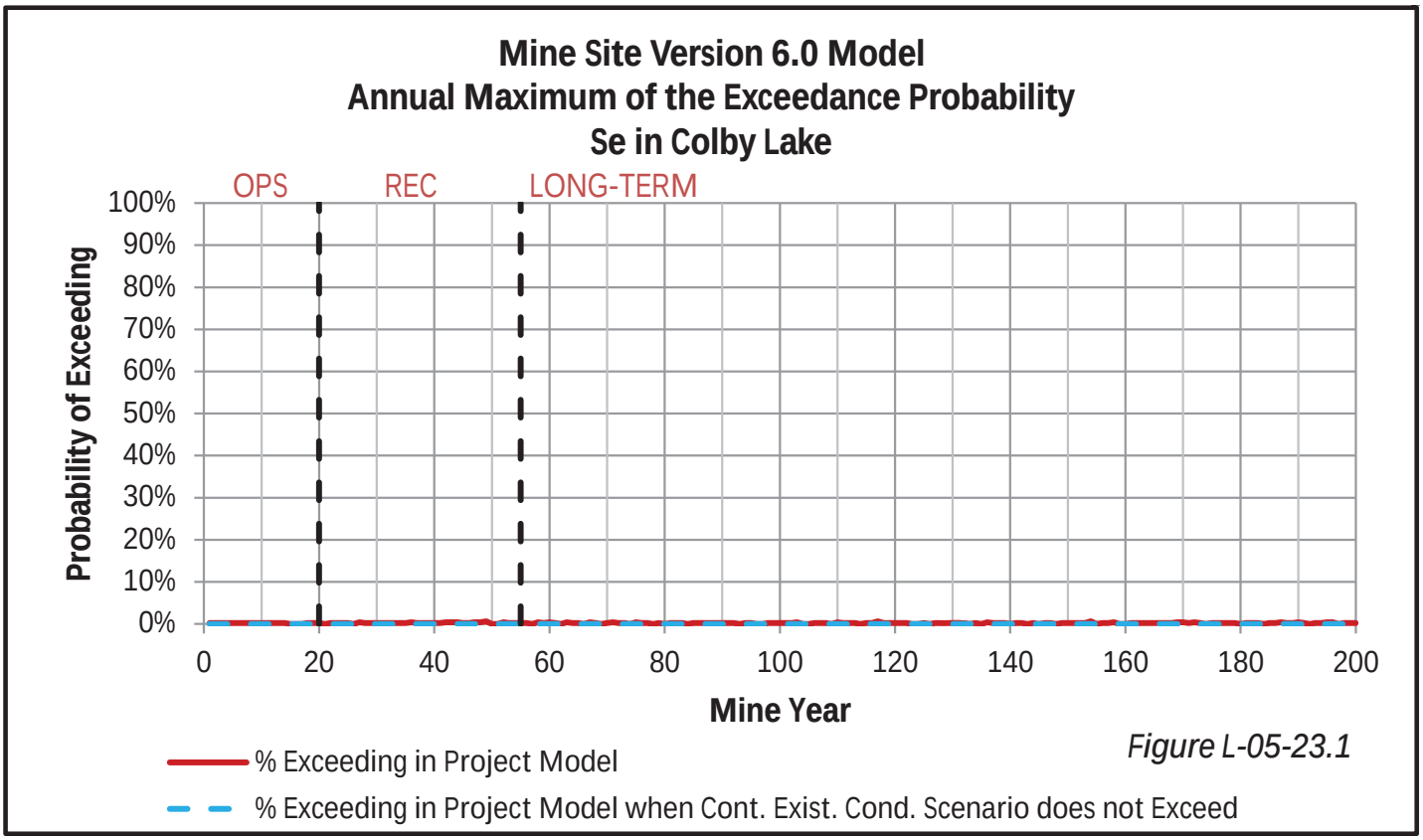

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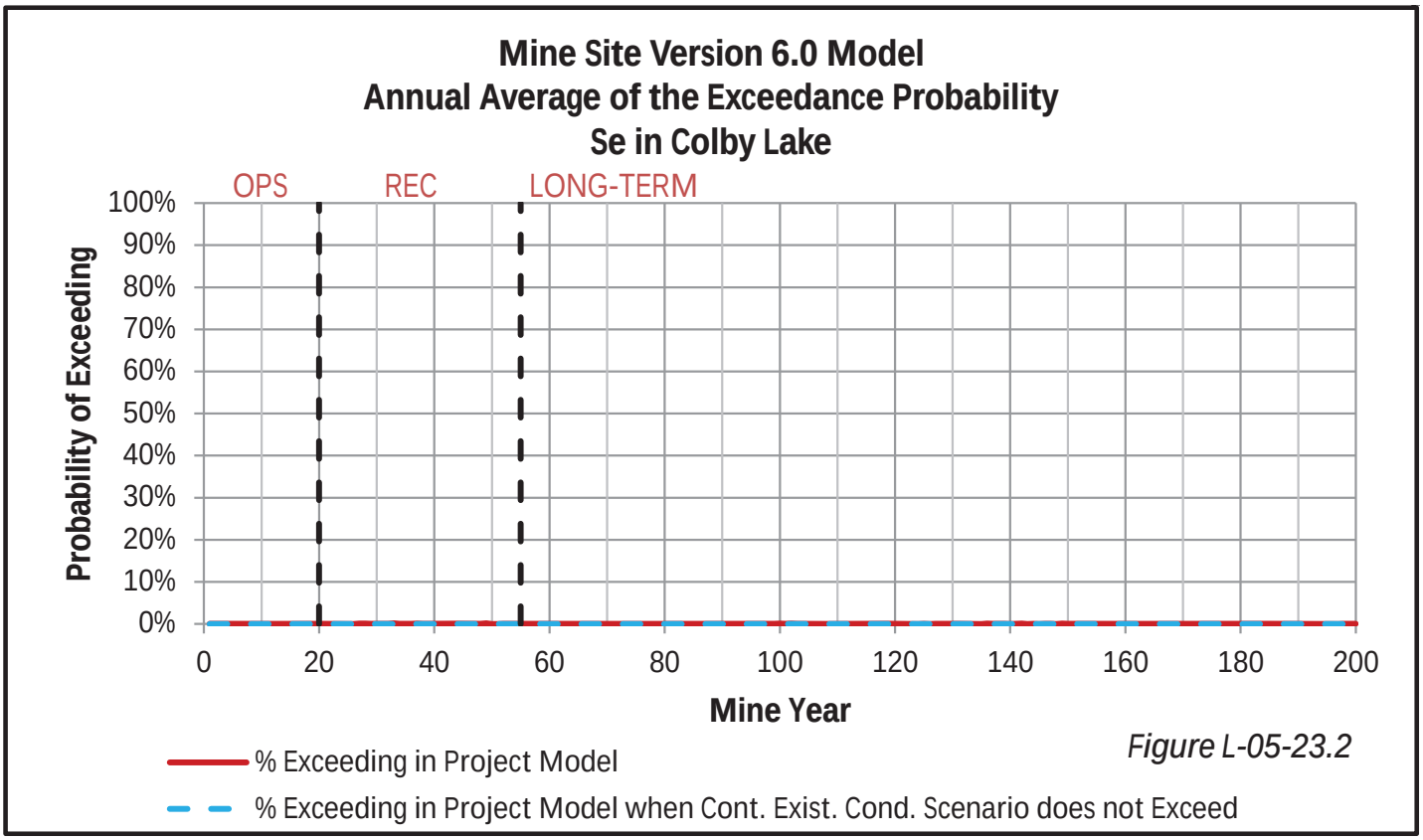

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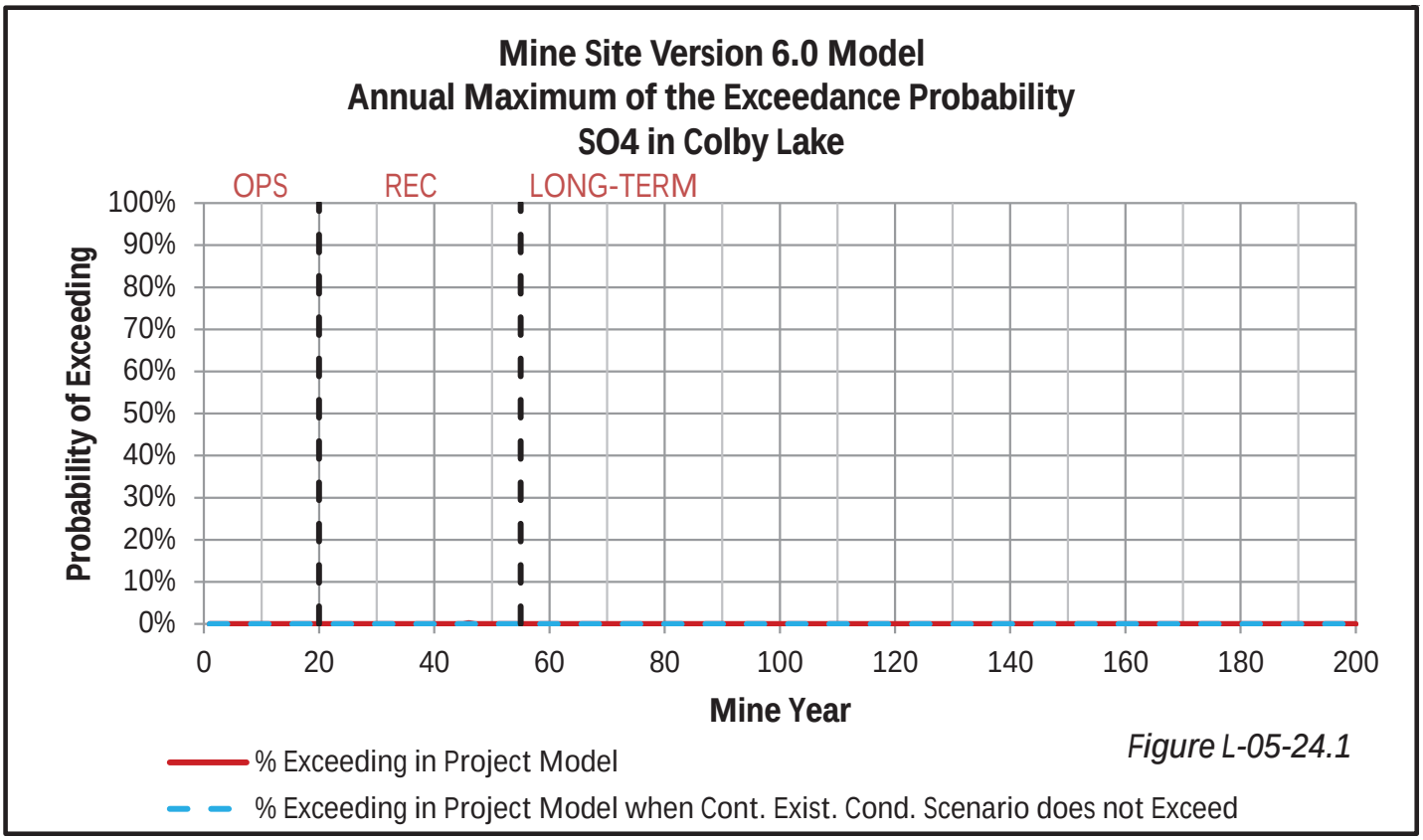

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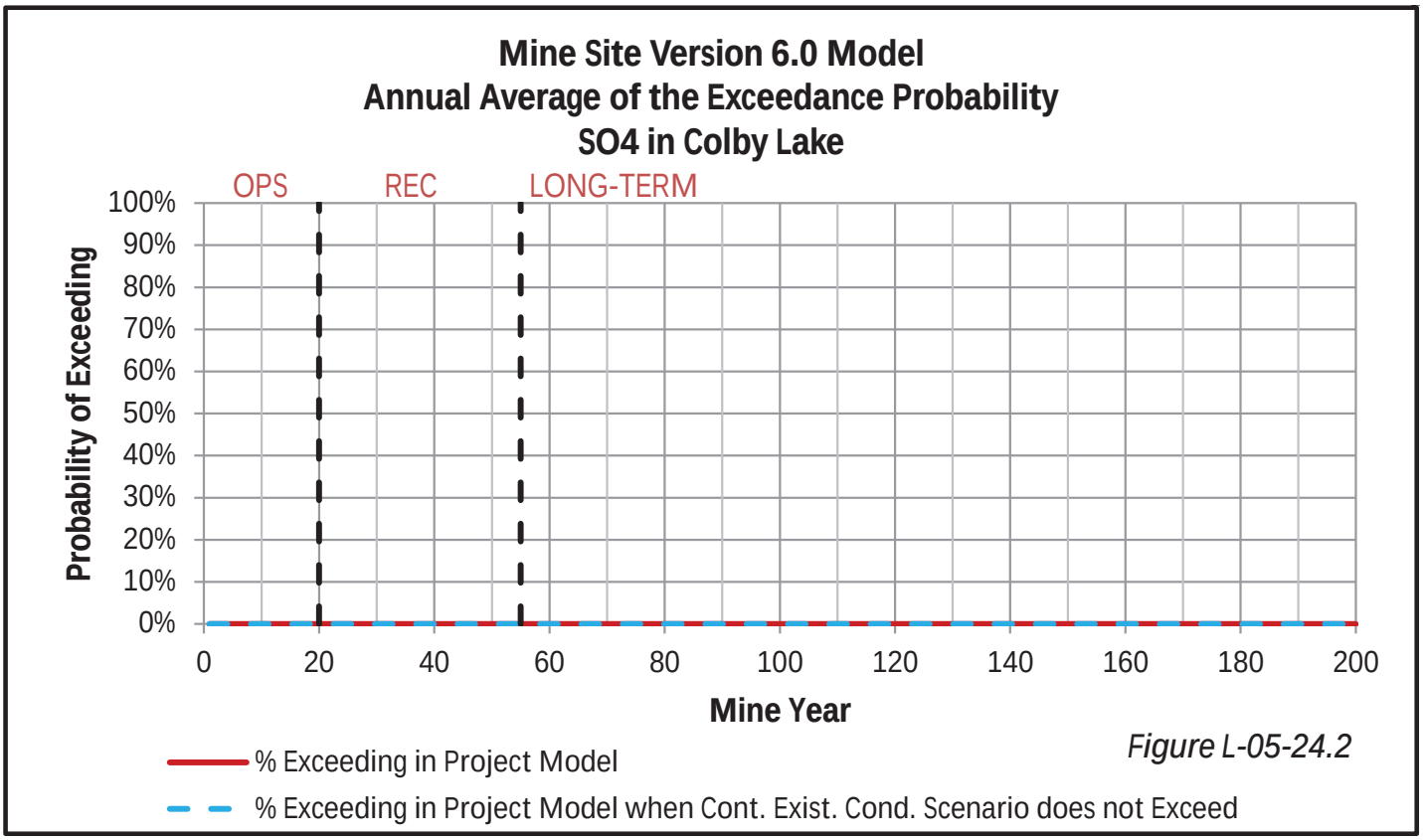

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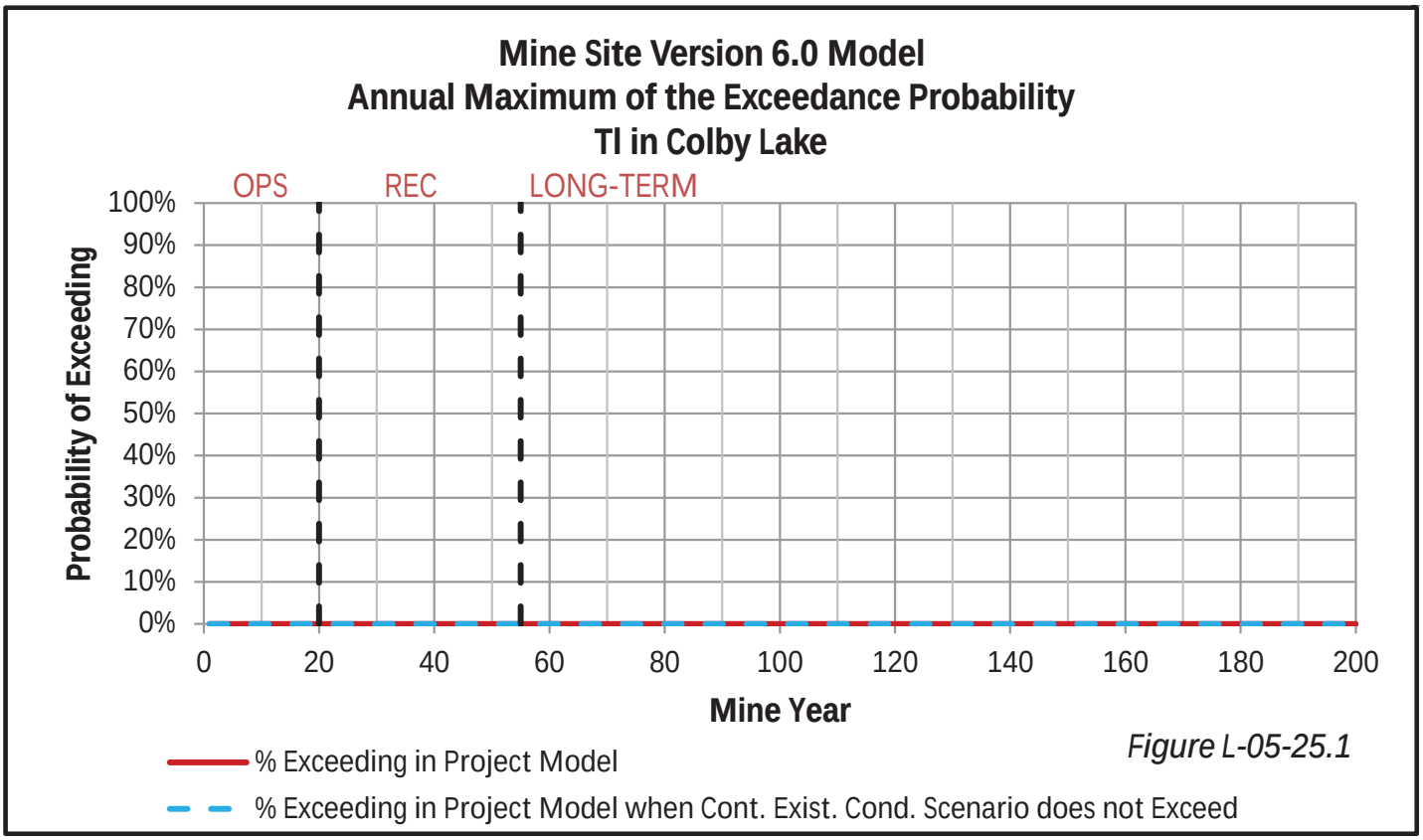

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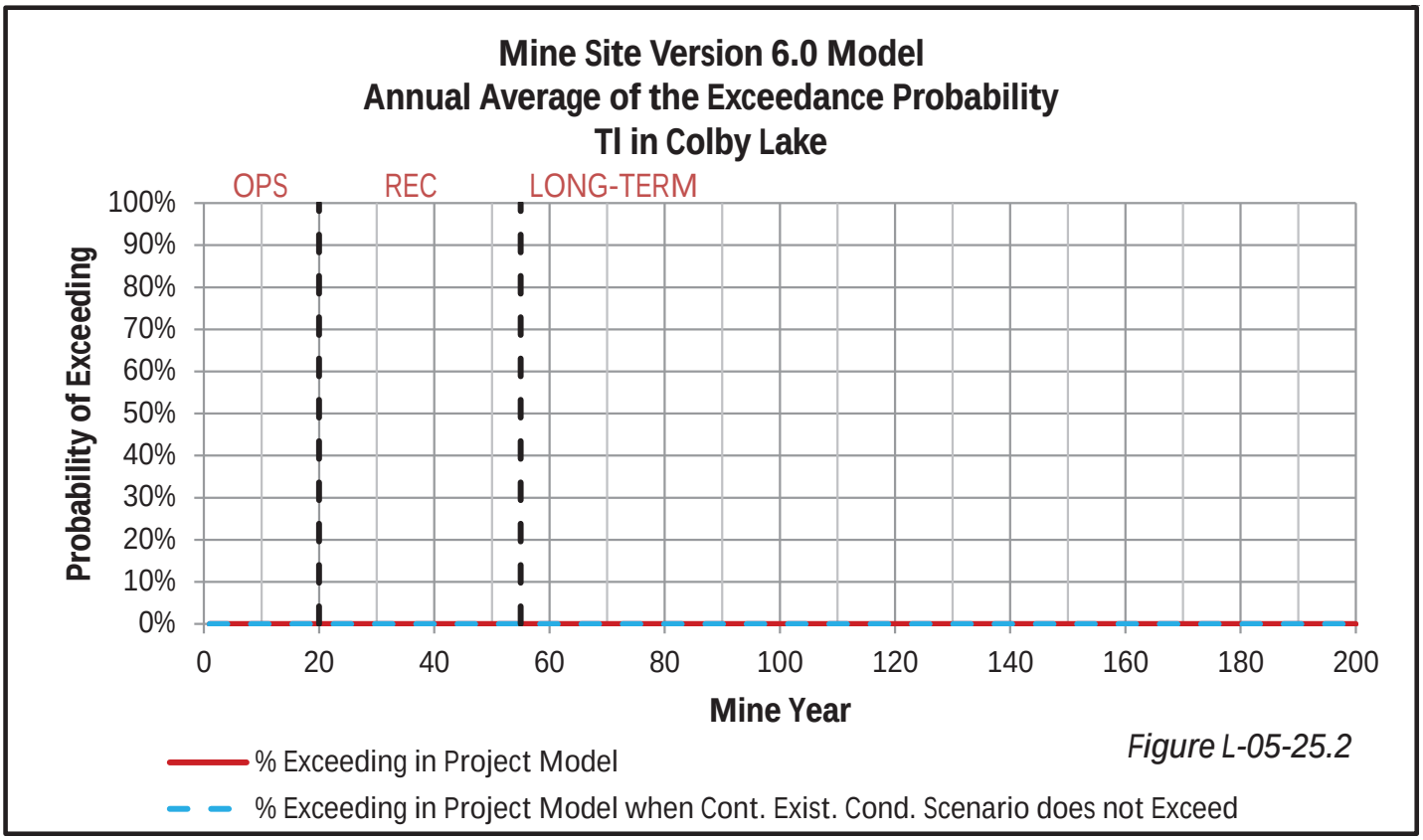

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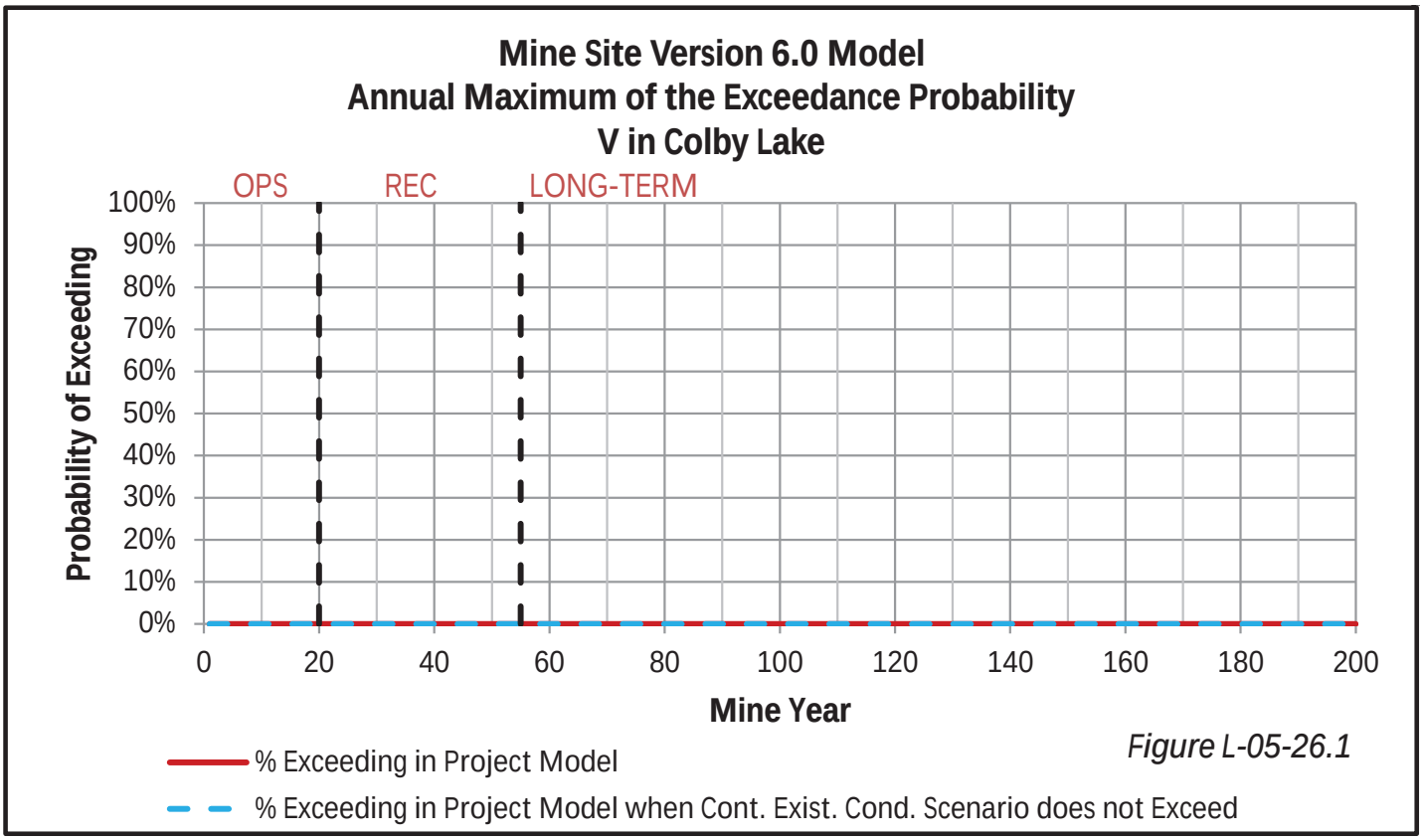

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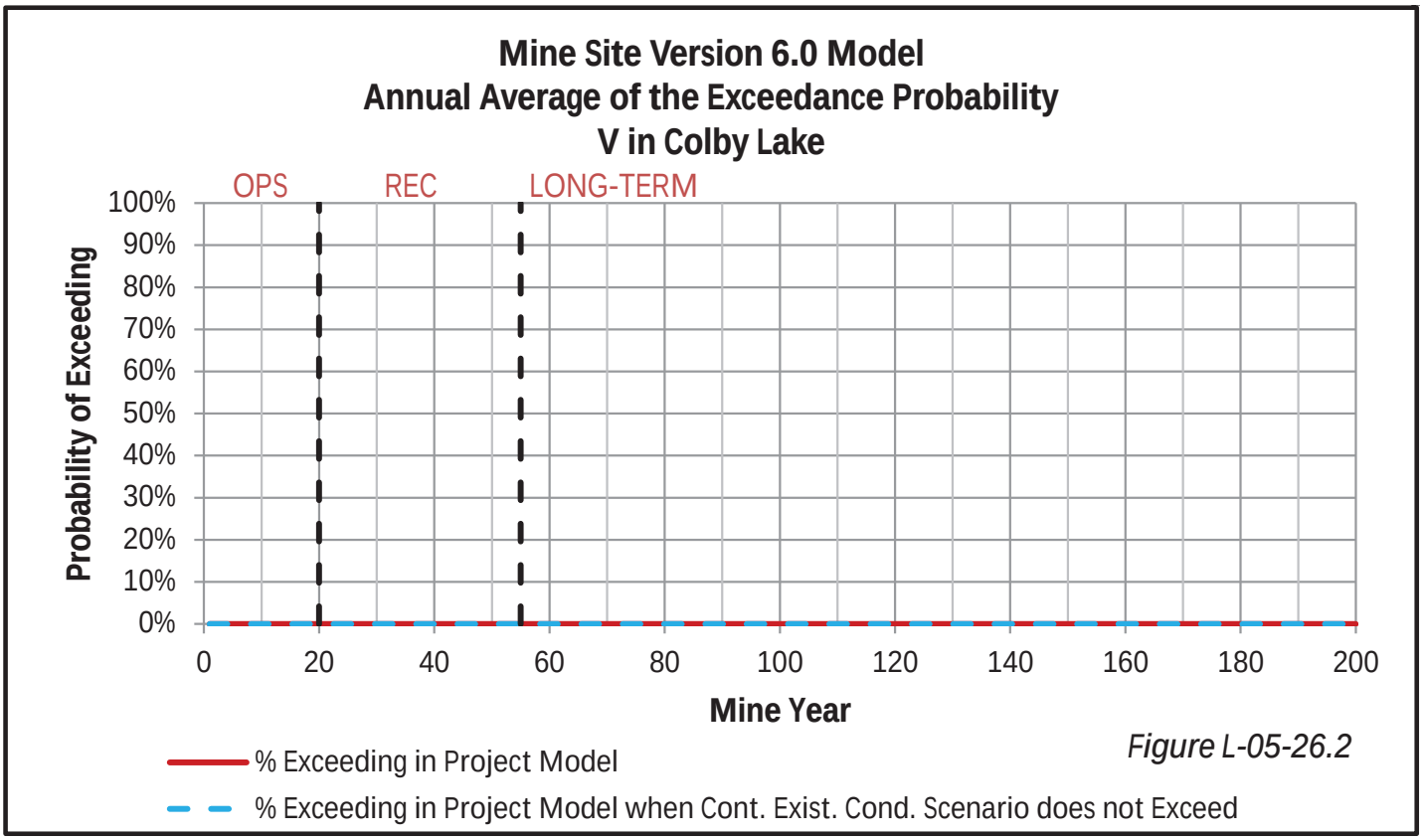

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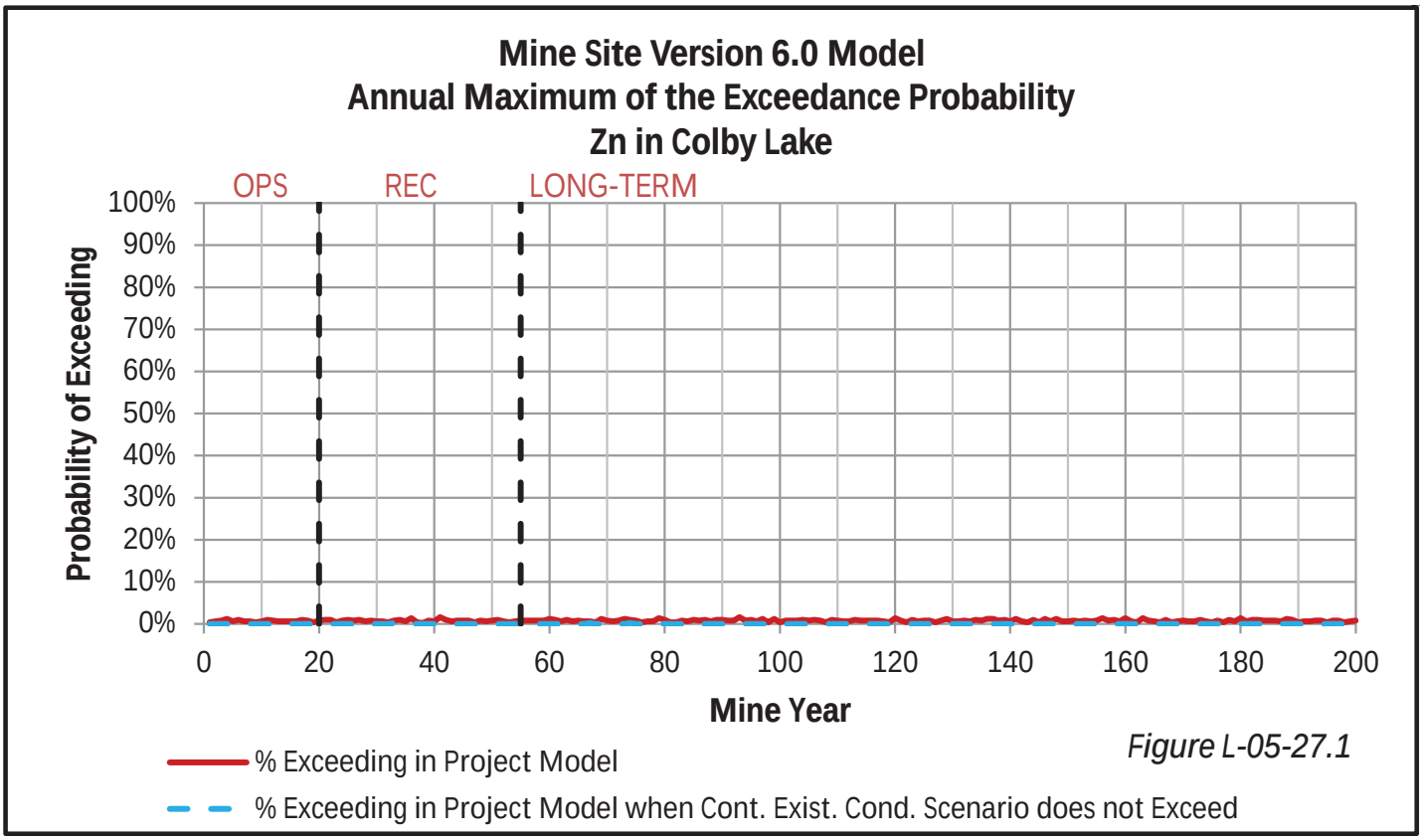

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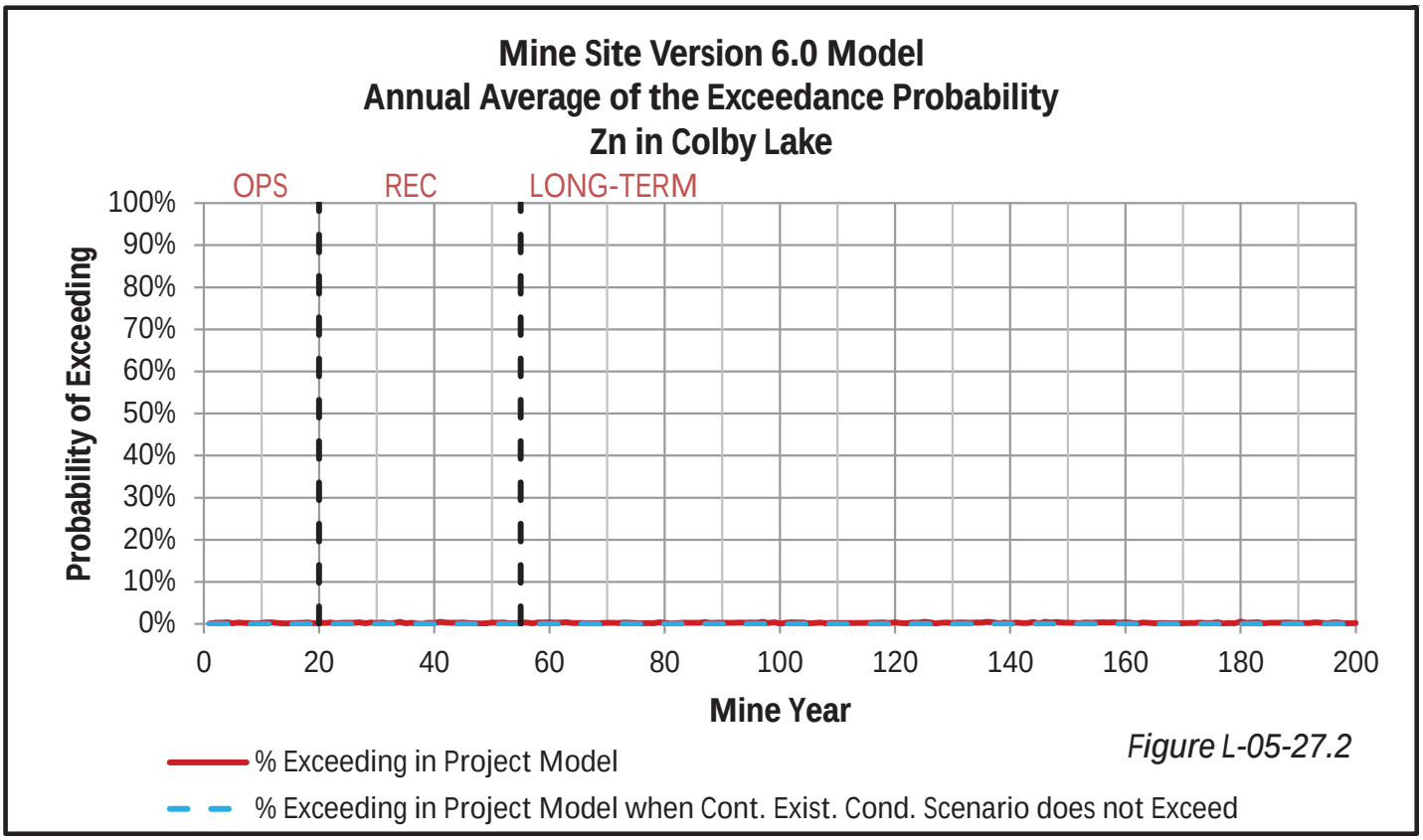

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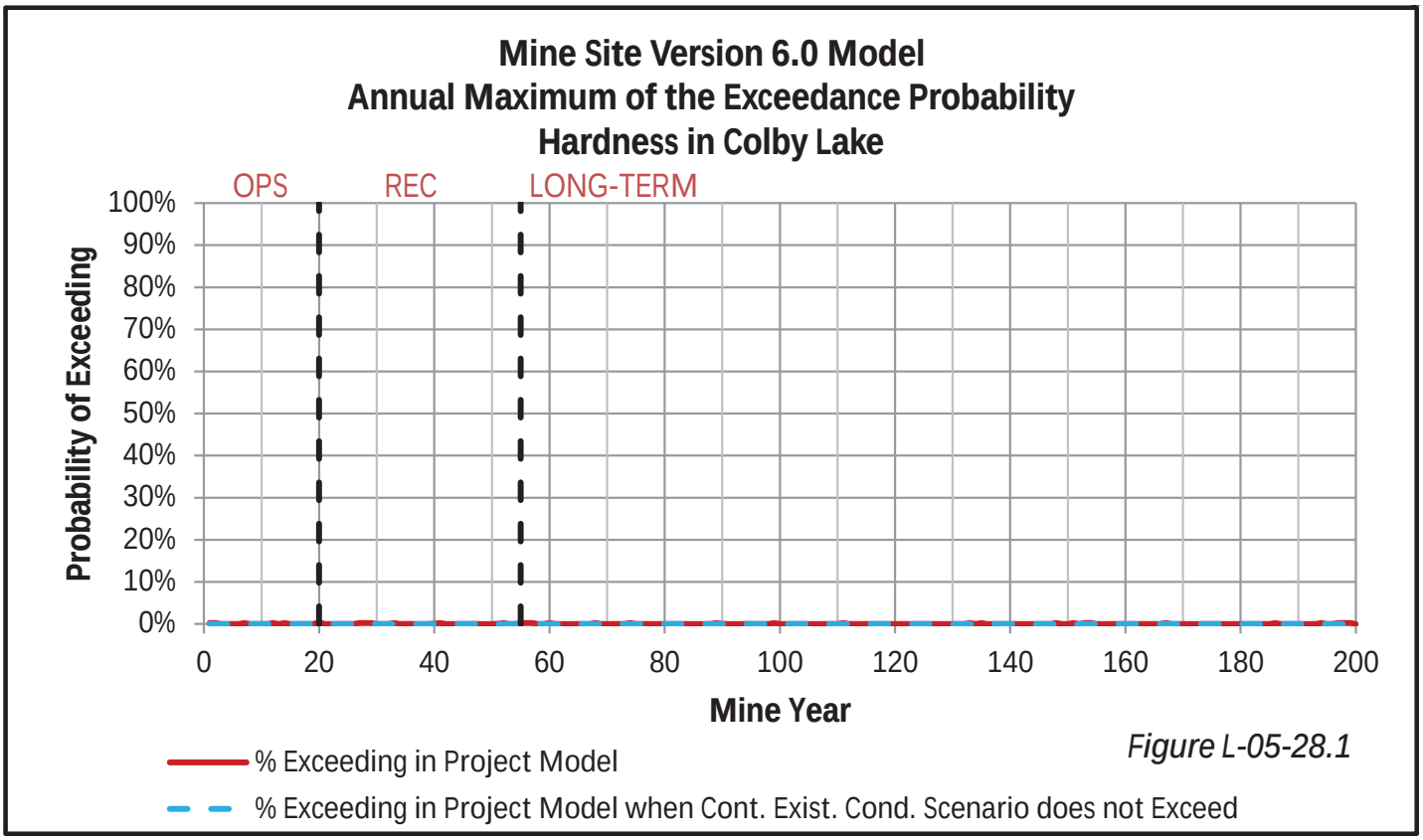

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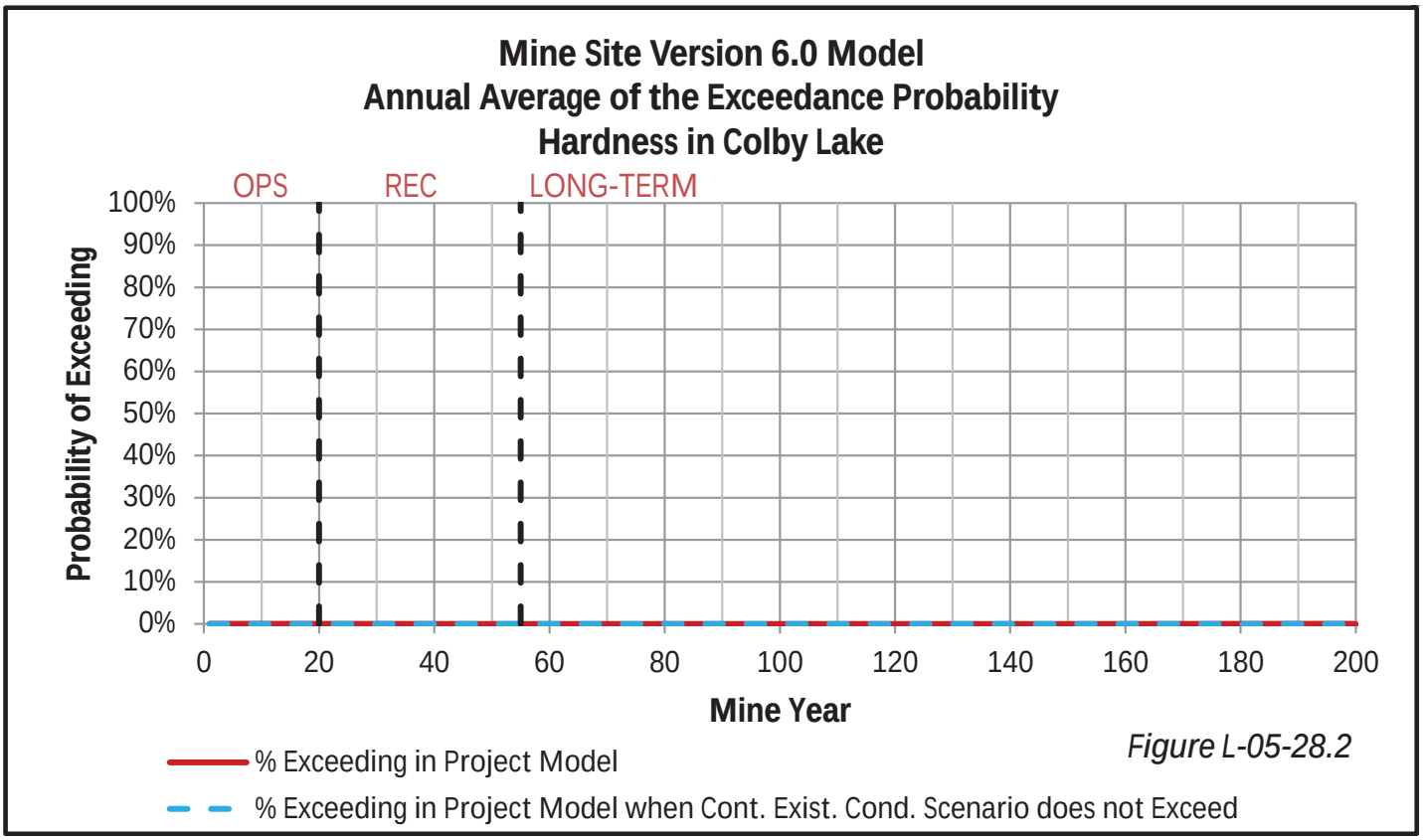


Figure L-05-28.2

Attachment M

Median Loading Rates to the Surface Water Evaluation Locations (Culpability Analysis)

Attachment M Median Loading Rates to the Surface Water Evaluation Locations (Culpability Analysis)

The plots in this attachment were created by taking the following steps:

- At any given time step, the mass loading rate (tonnes/yr) from every source contributing mass load to each of the surface water evaluation locations is calculated and stored. These sources are itemized in the legend of each figure.

- Once the 500 realizations are complete, at every monthly time step the loading rates of a particular constituent from a particular source were sorted minimum to maximum and the median value (250th) was chosen. This step was performed for all sources and all constituents.

- The monthly median loading rates of each constituent from each source were annualized by taking the average of the twelve monthly median loading rates each year. This results in one representative average annual median loading rate of each constituent from each source.

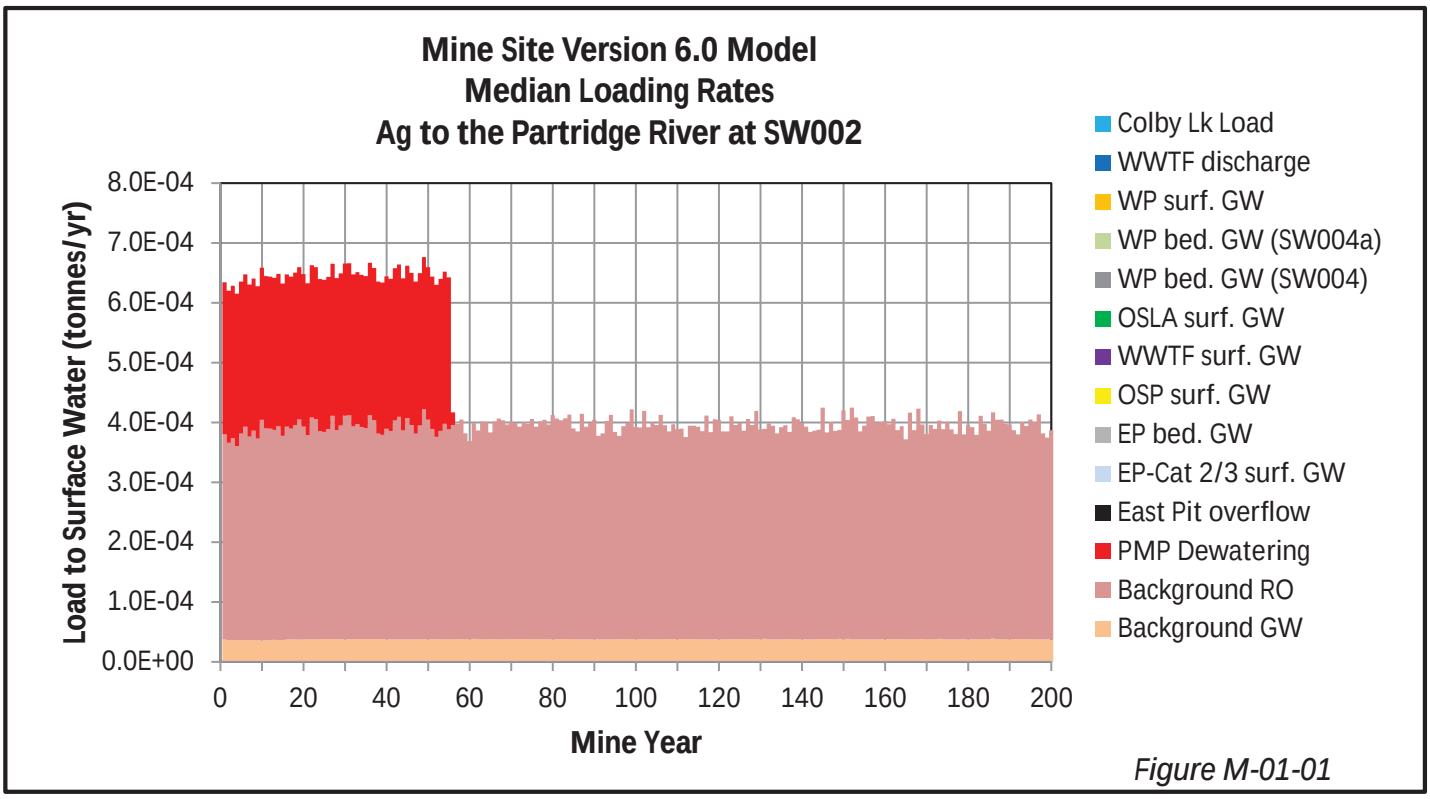
- A stacked bar graph is used to directly compare the average annual median loading rates from each source for any constituent to each of the surface water evaluation locations. The source (uniquely colored in each figure) which covers the most area of the graph at any given time is therefore the most culpable source. Showing a time series graph of loading rates also helps show how the culpable source may change through time.

The figure numbering convention is "**Figure W-XX-YY**" where:

- **W** indicates the Attachment.

- **XX** is a counter indicating the location; in this attachment it will count from "01" to "08" to account for the surface water evaluation locations in order from upstream (SW002) to downstream (Colby Lake).

- **YY** is a counter indicating the constituent; in this attachment it will count from "01" to "27" to show the 27 independently modeled constituents.



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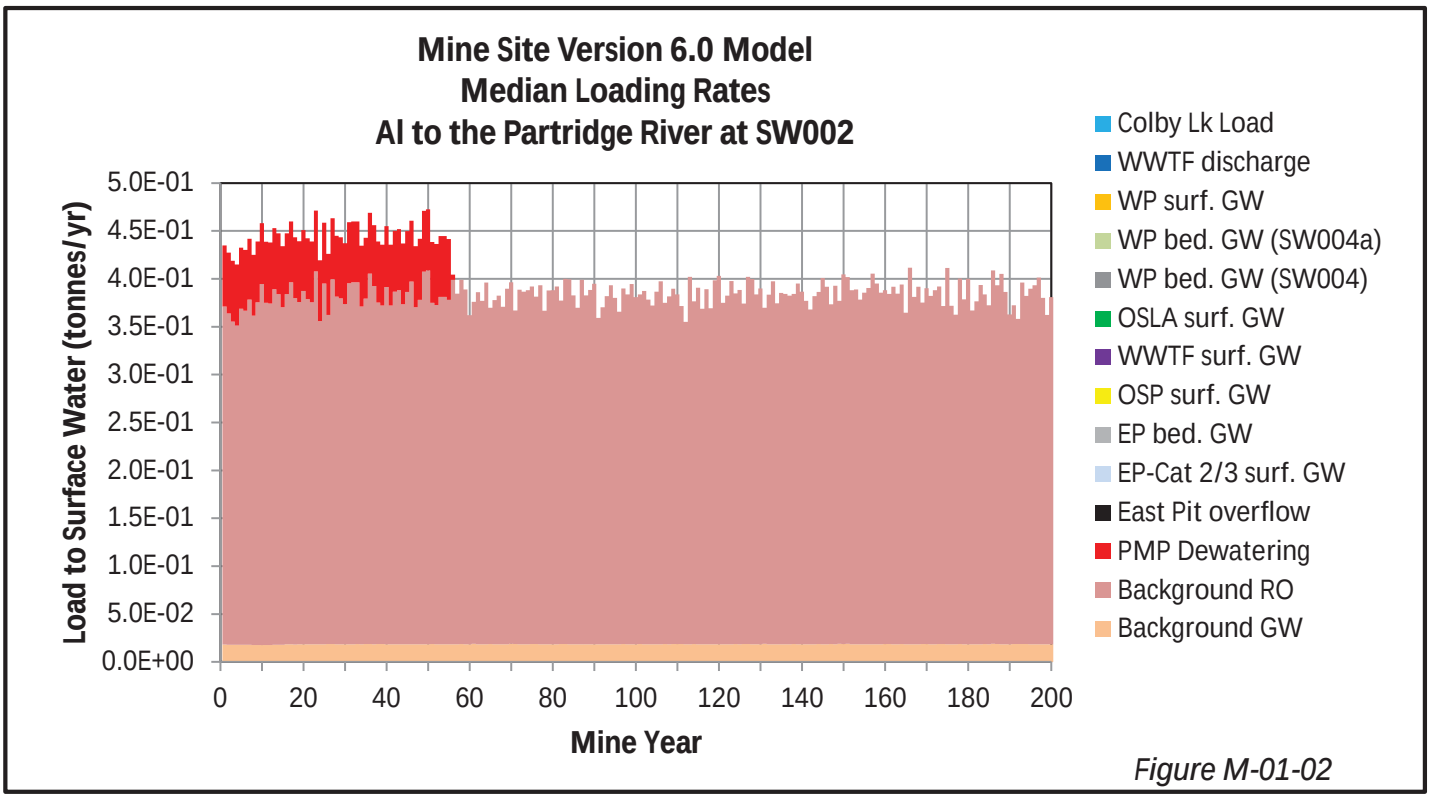

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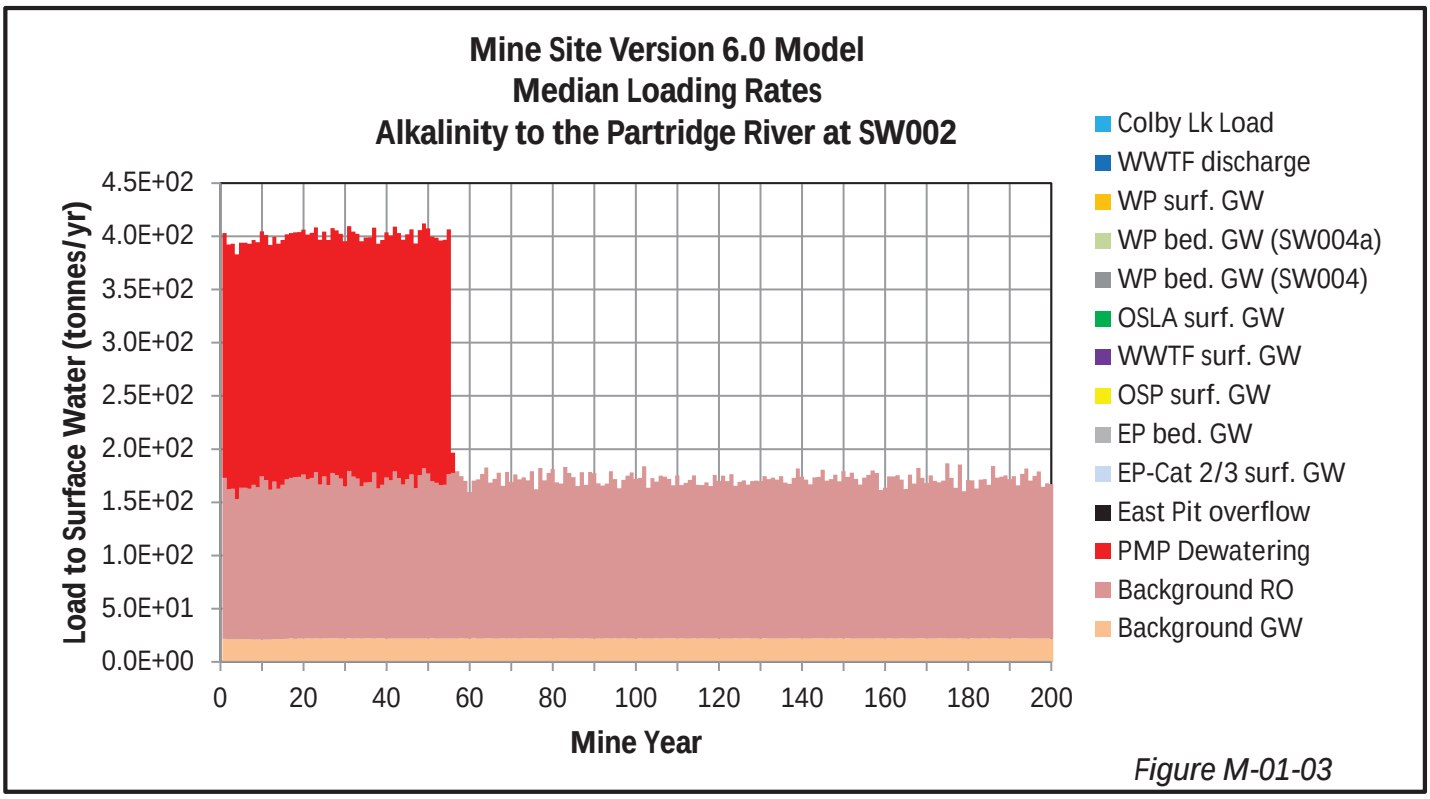

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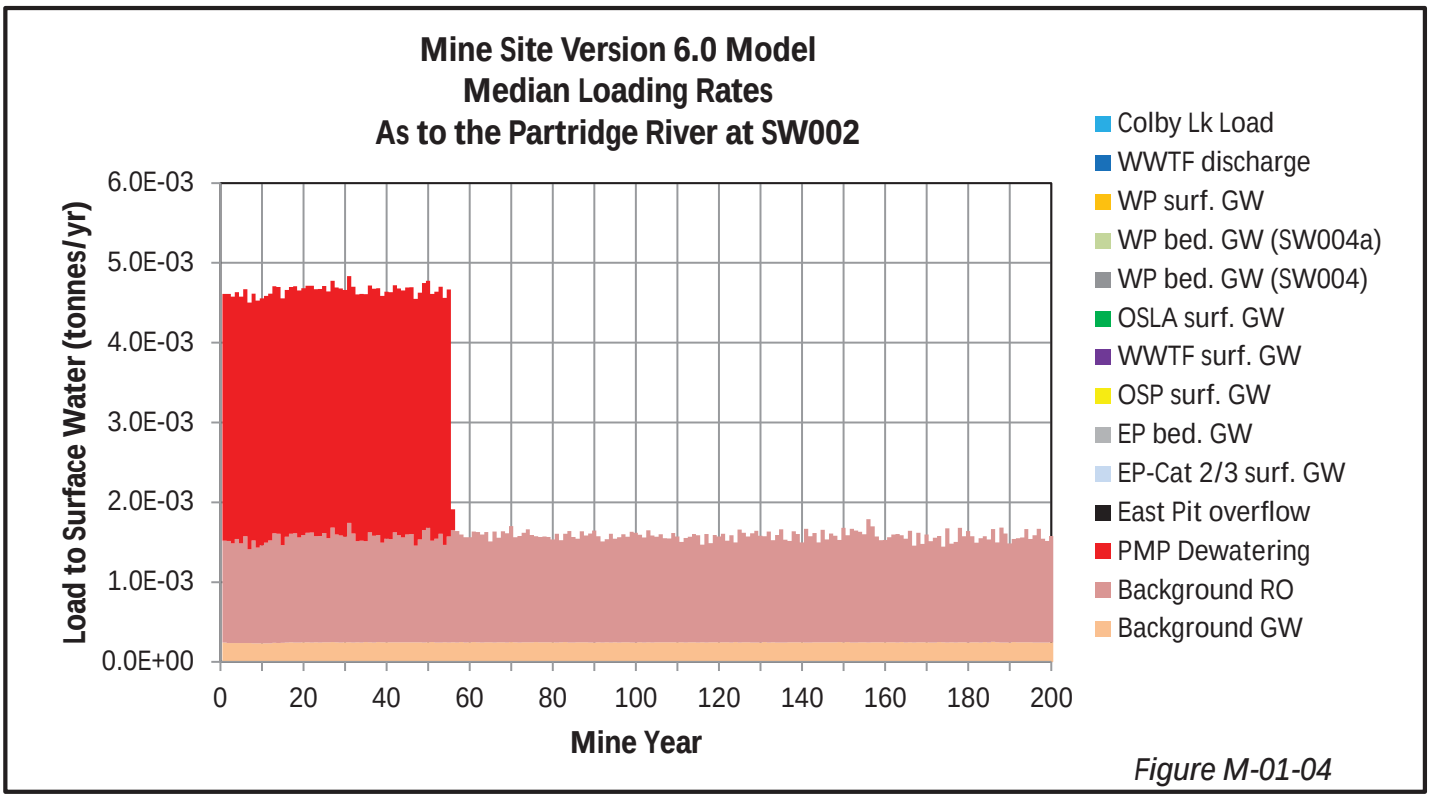
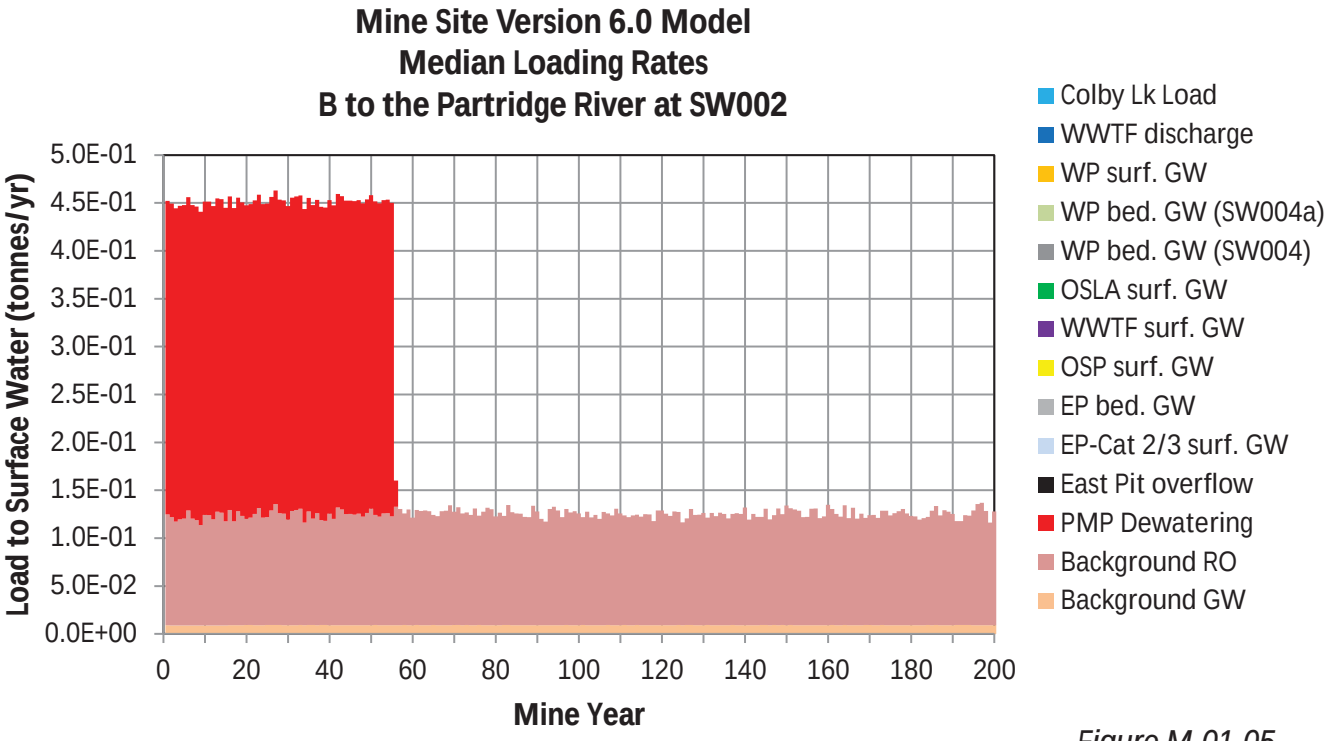


Figure M-01-04



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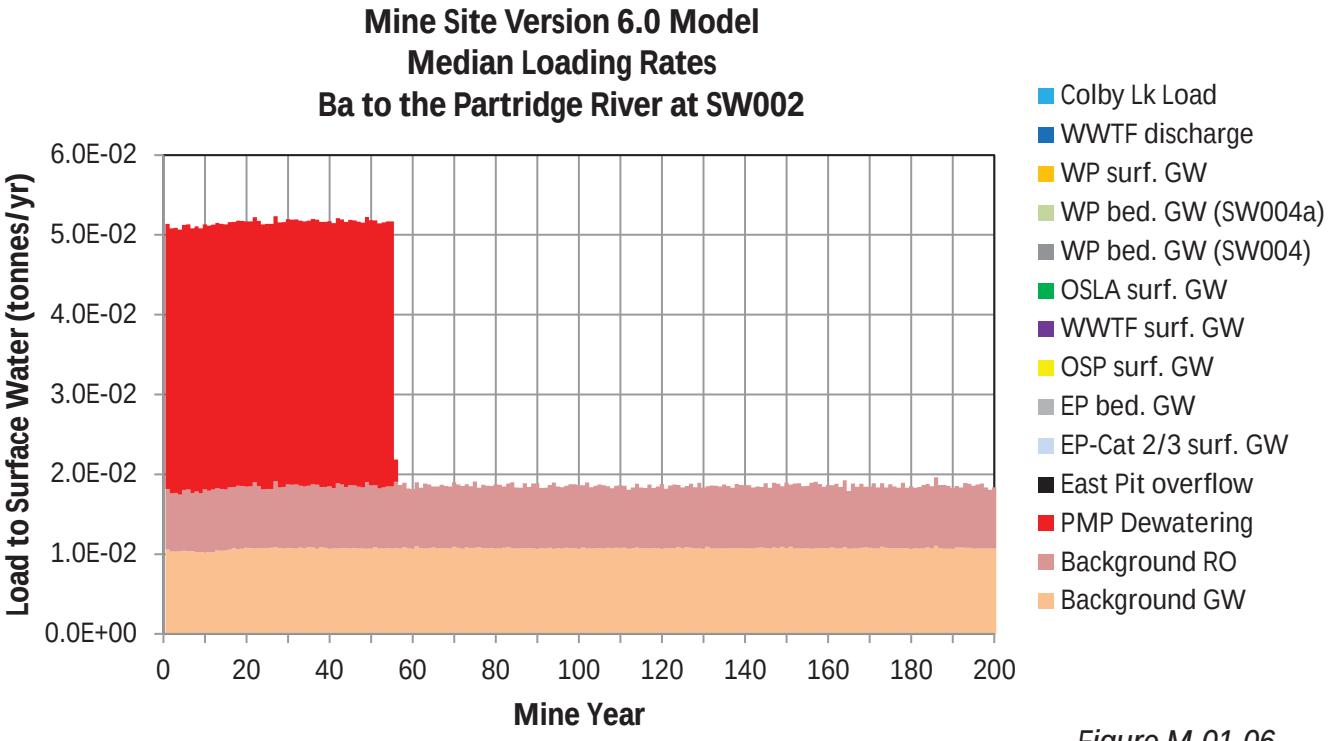

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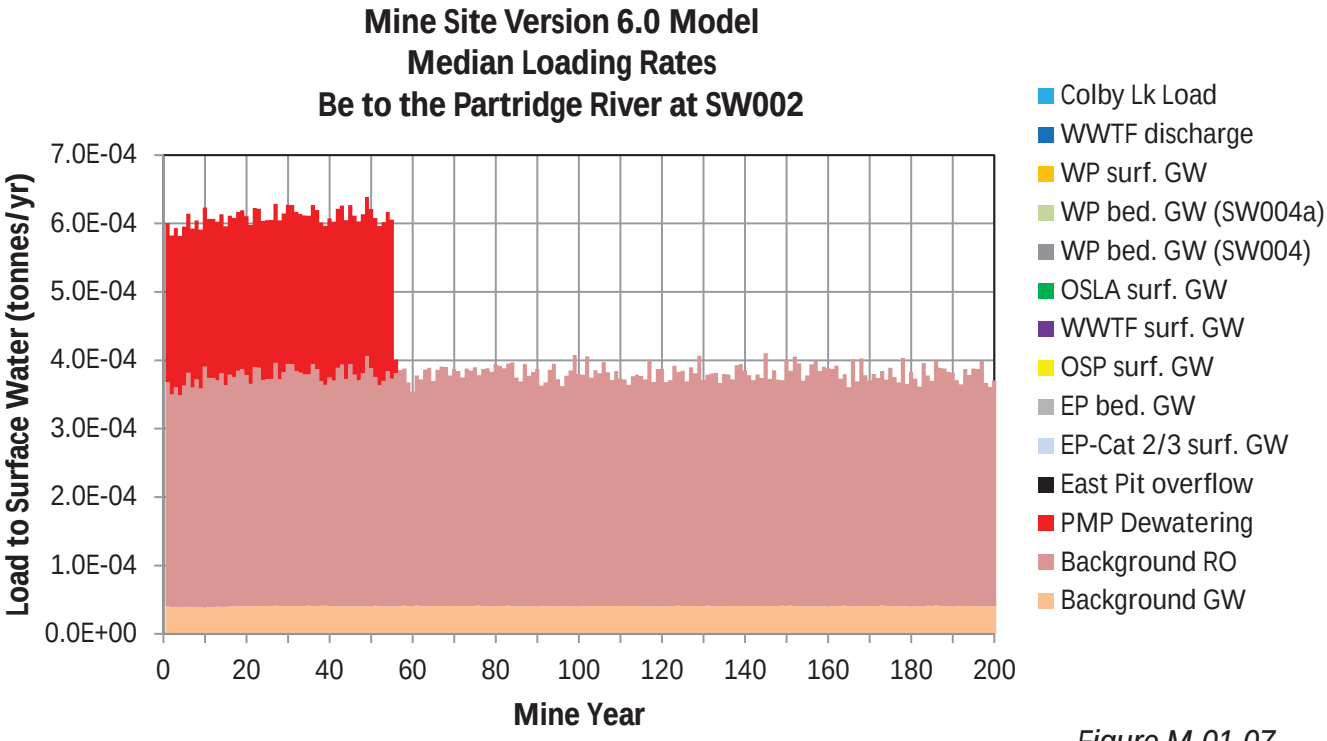

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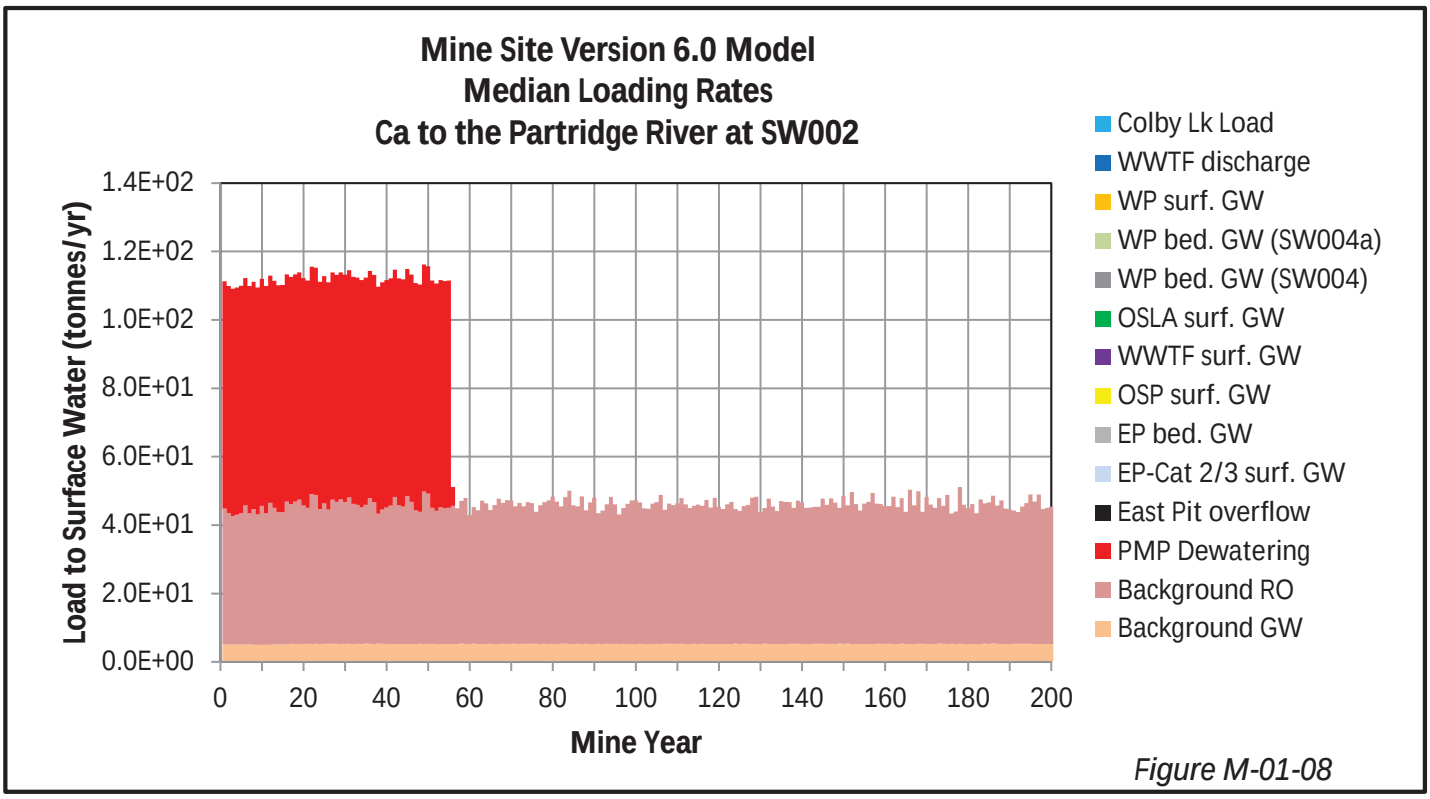

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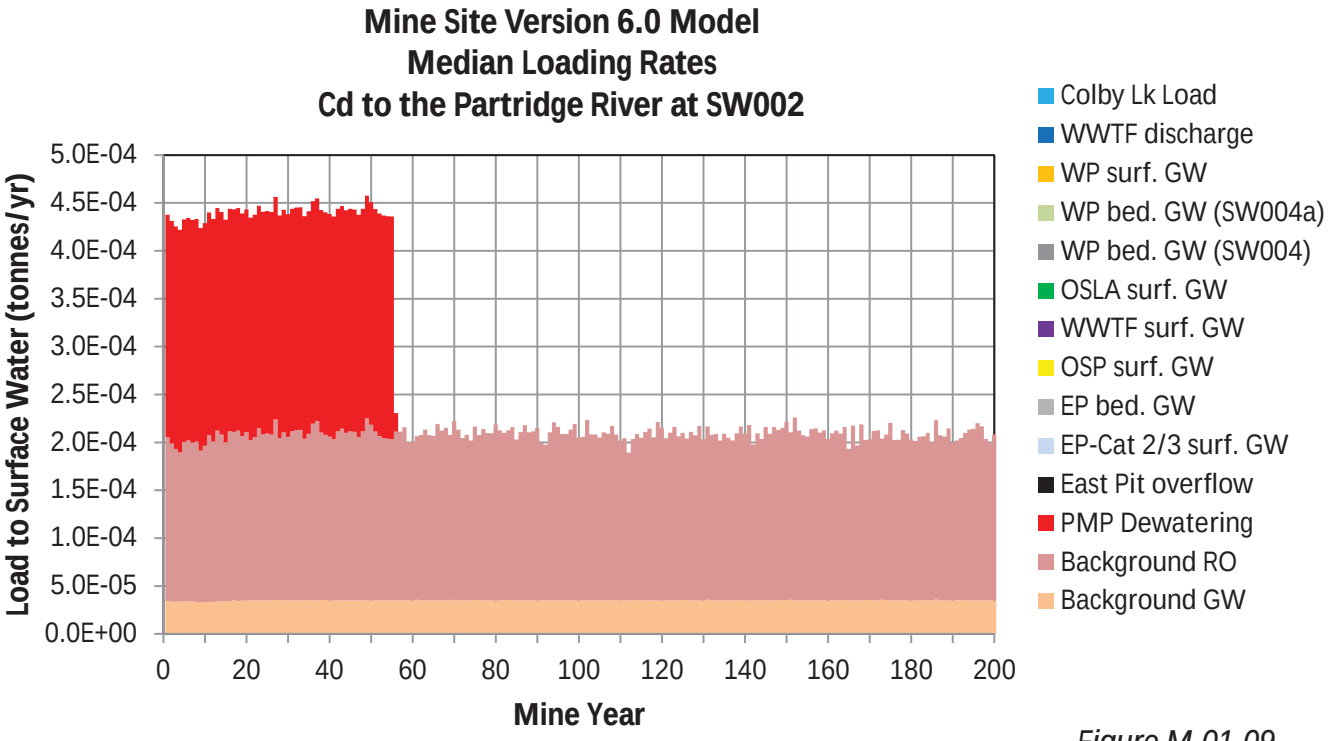

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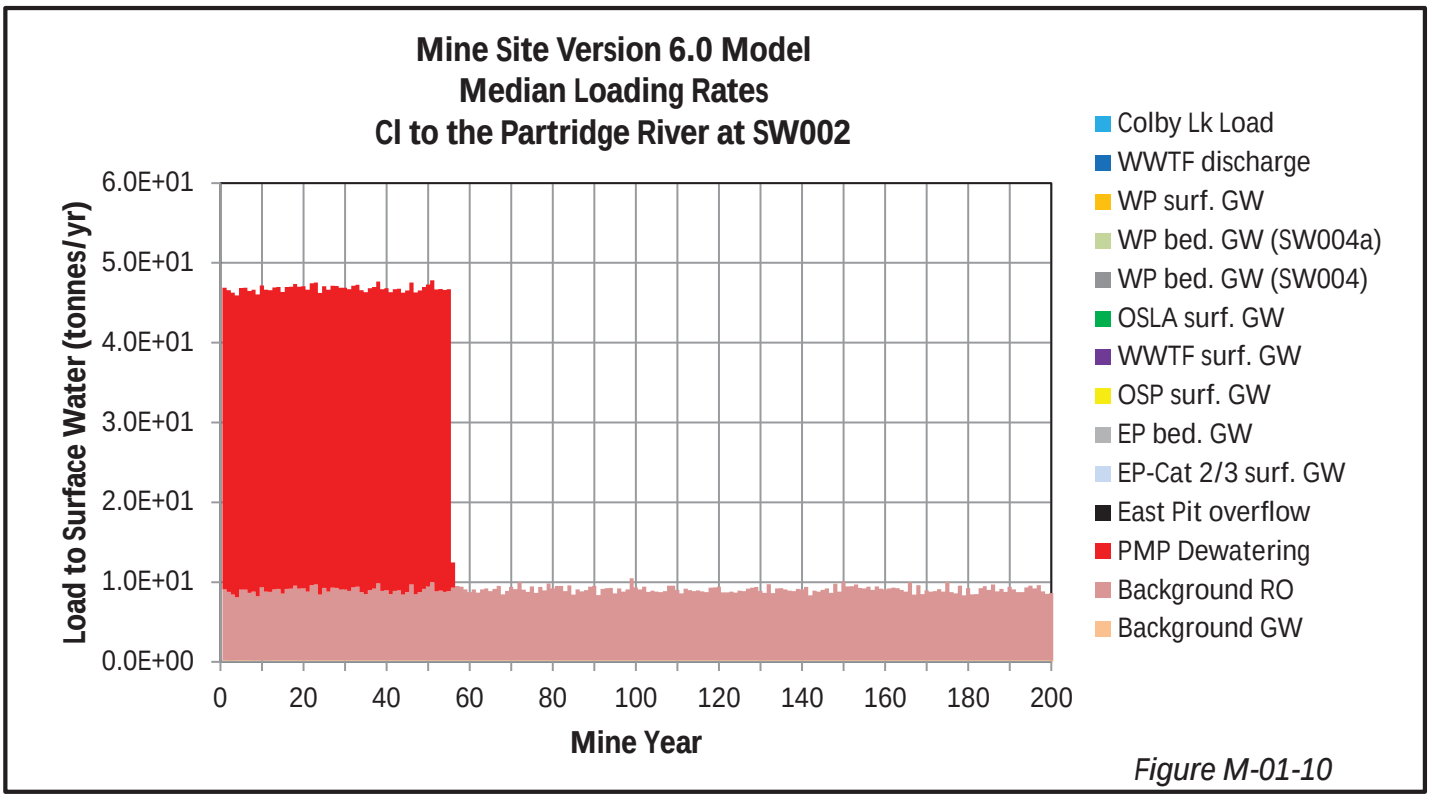

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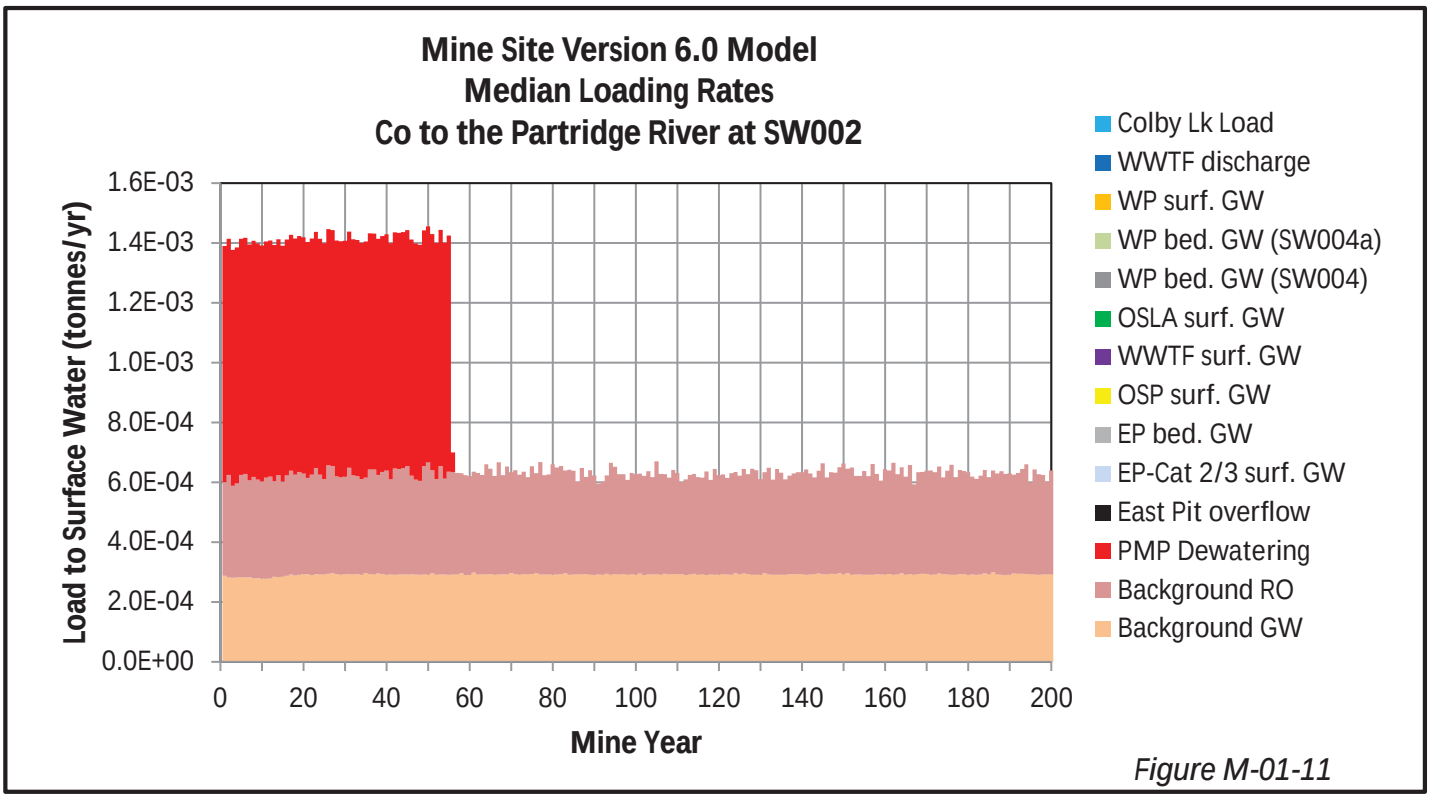

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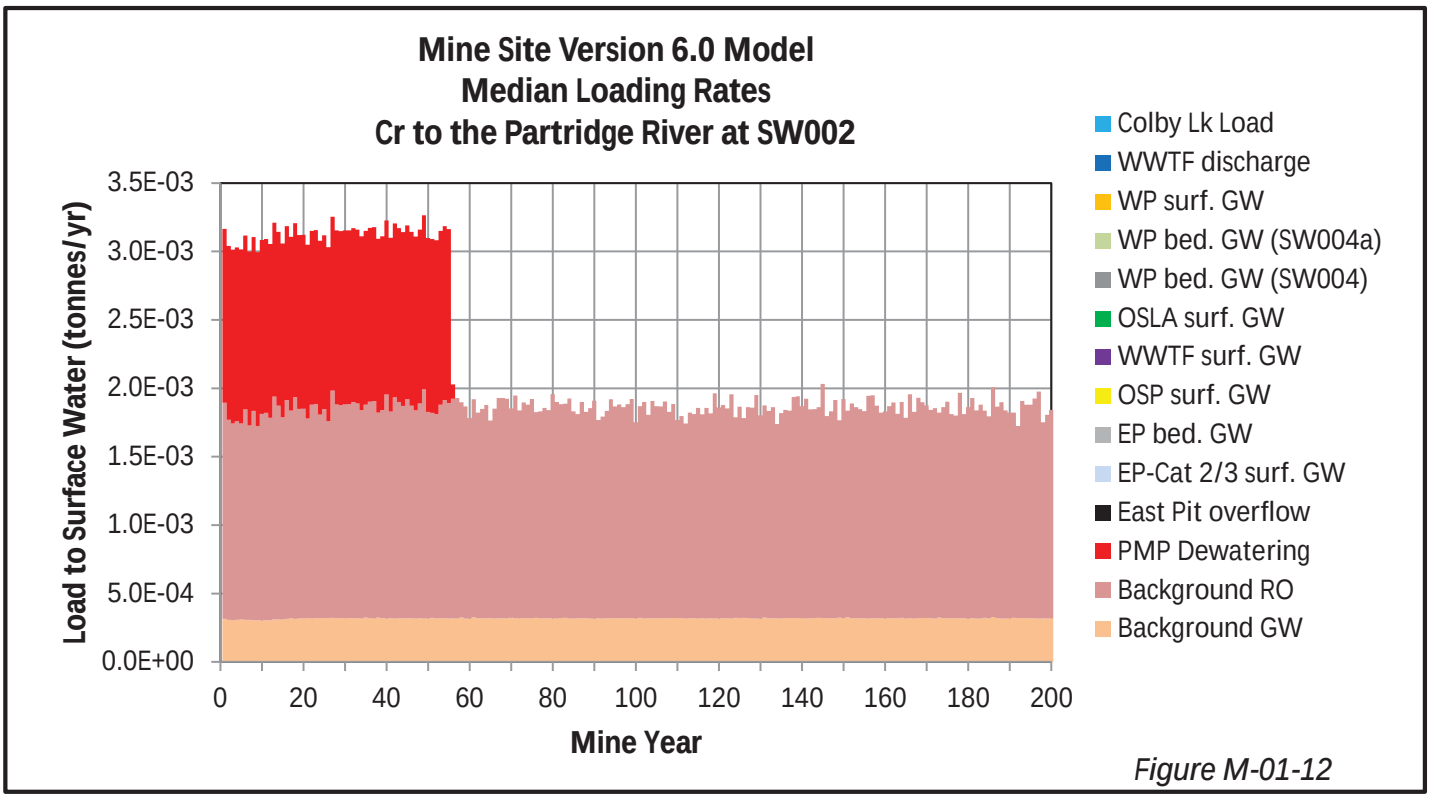

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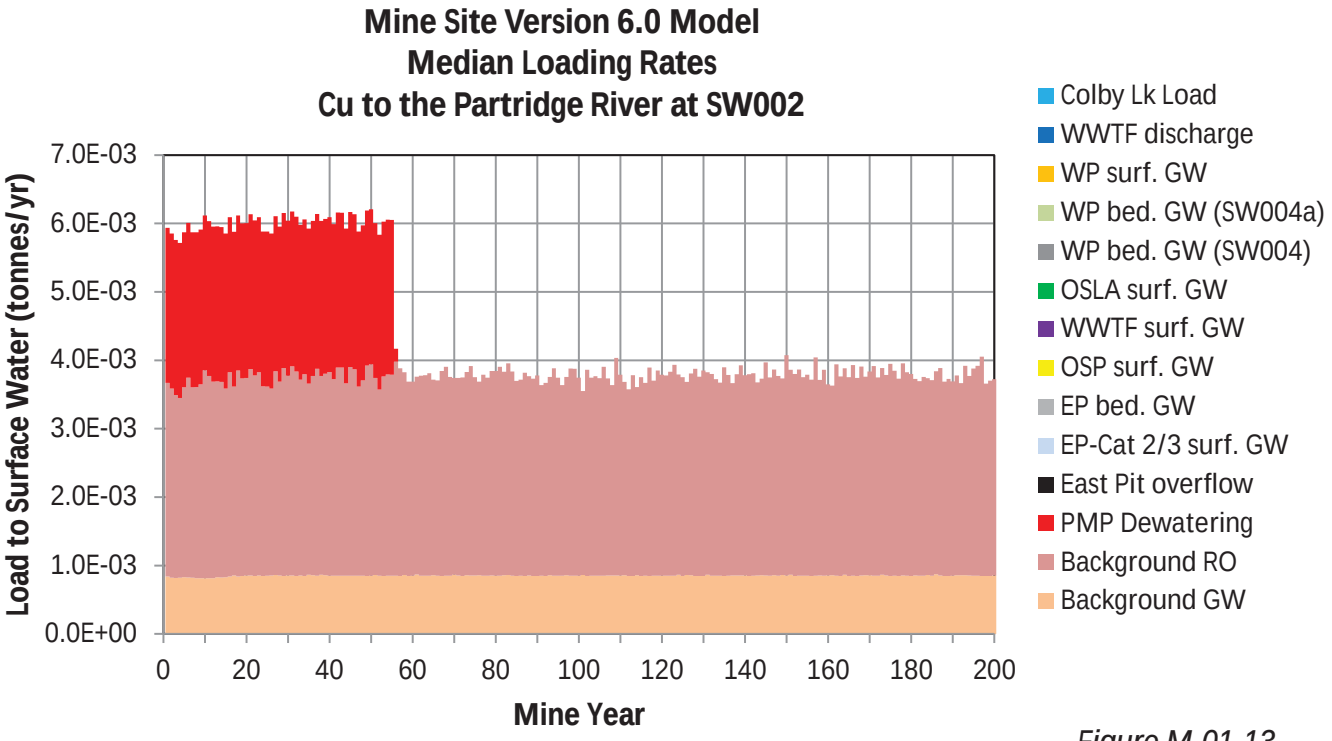

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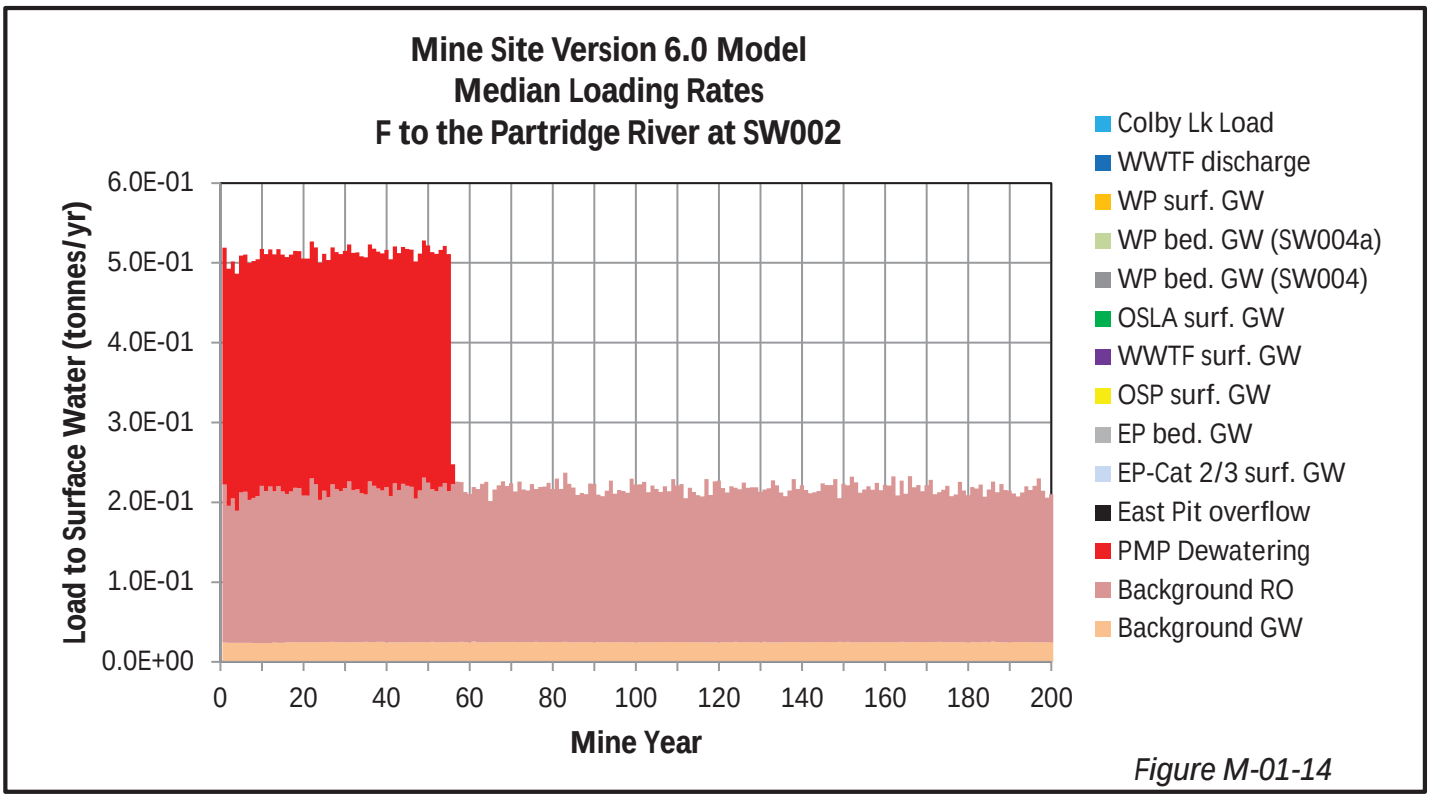

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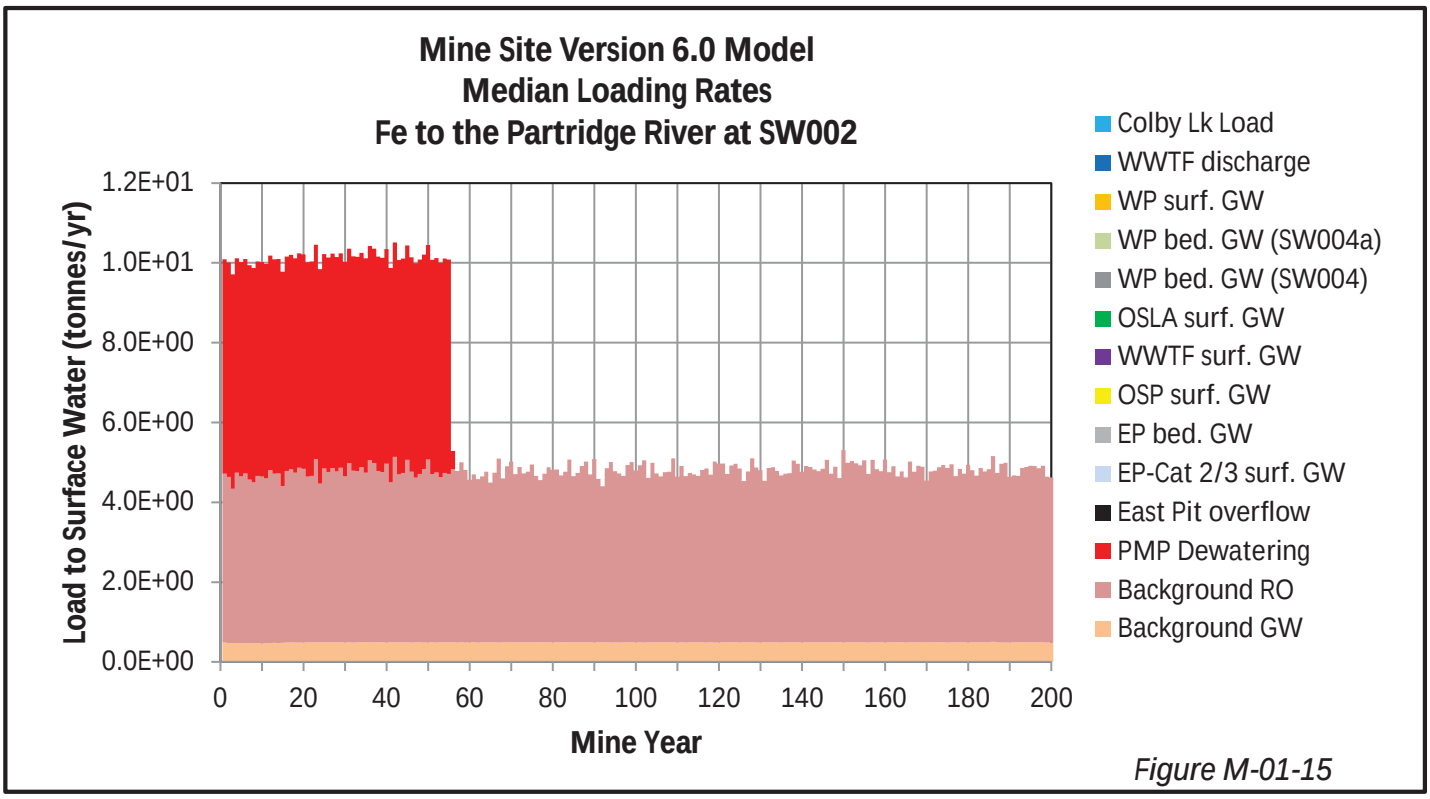

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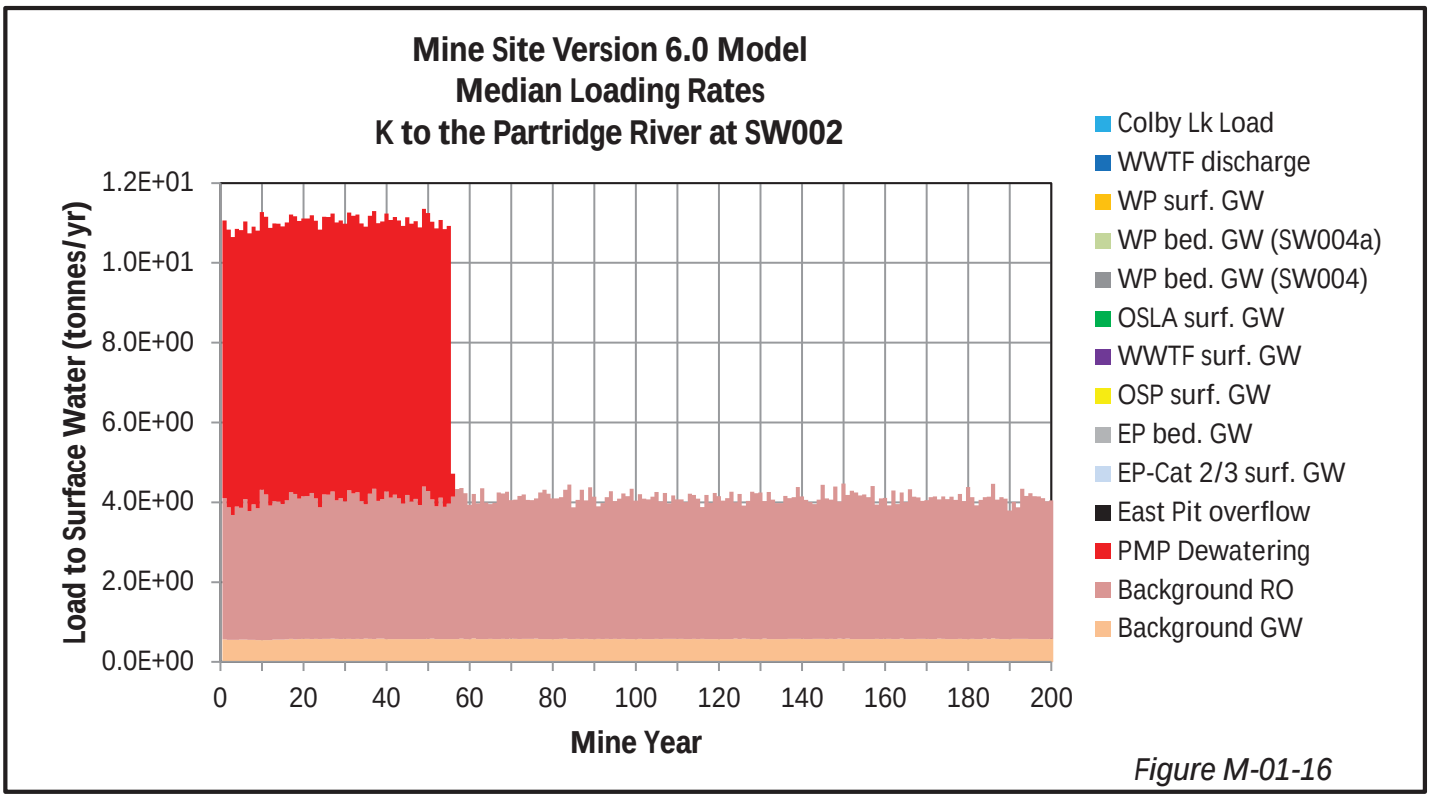

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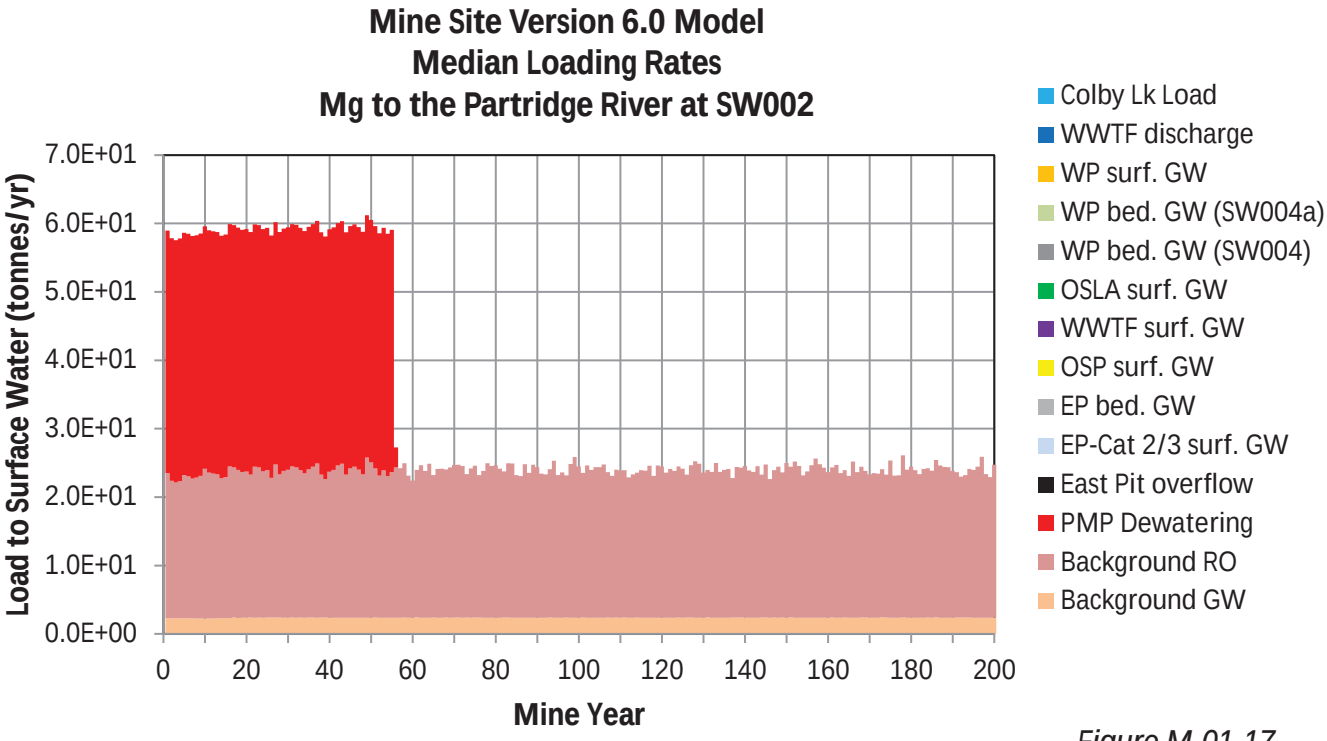

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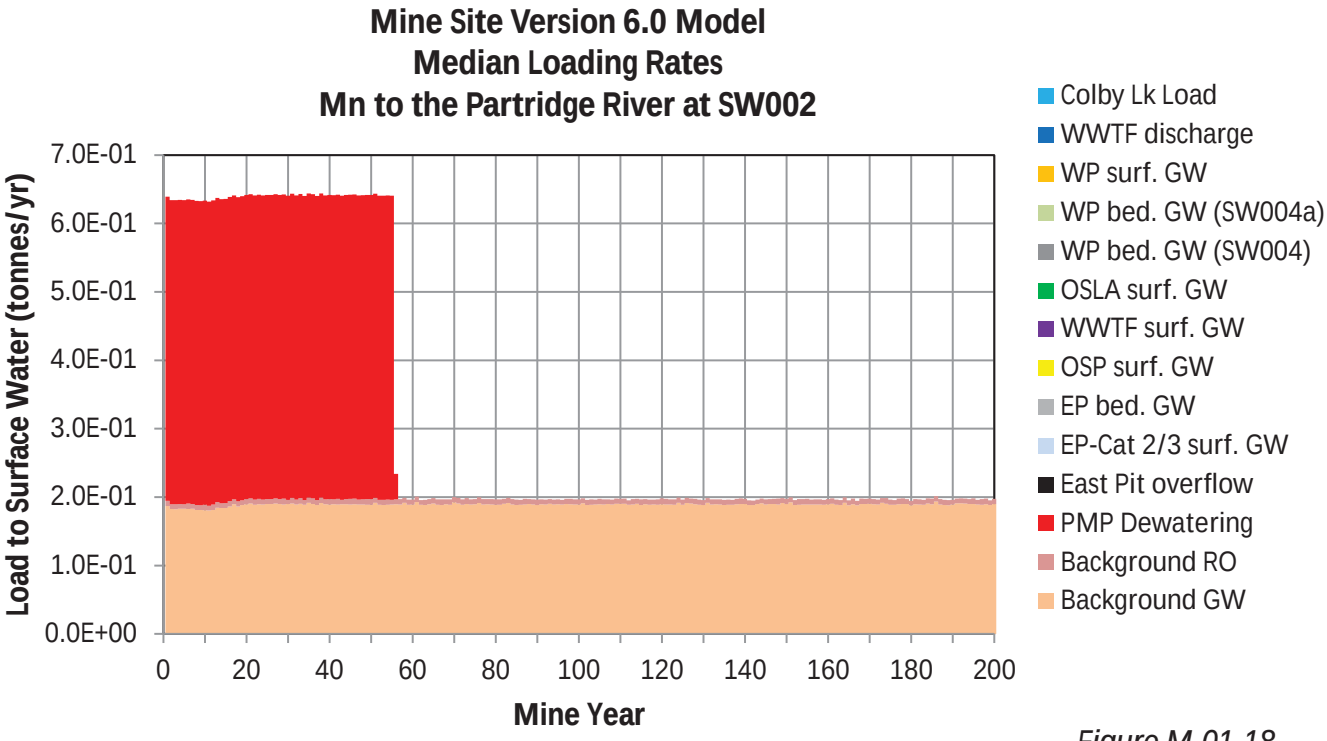

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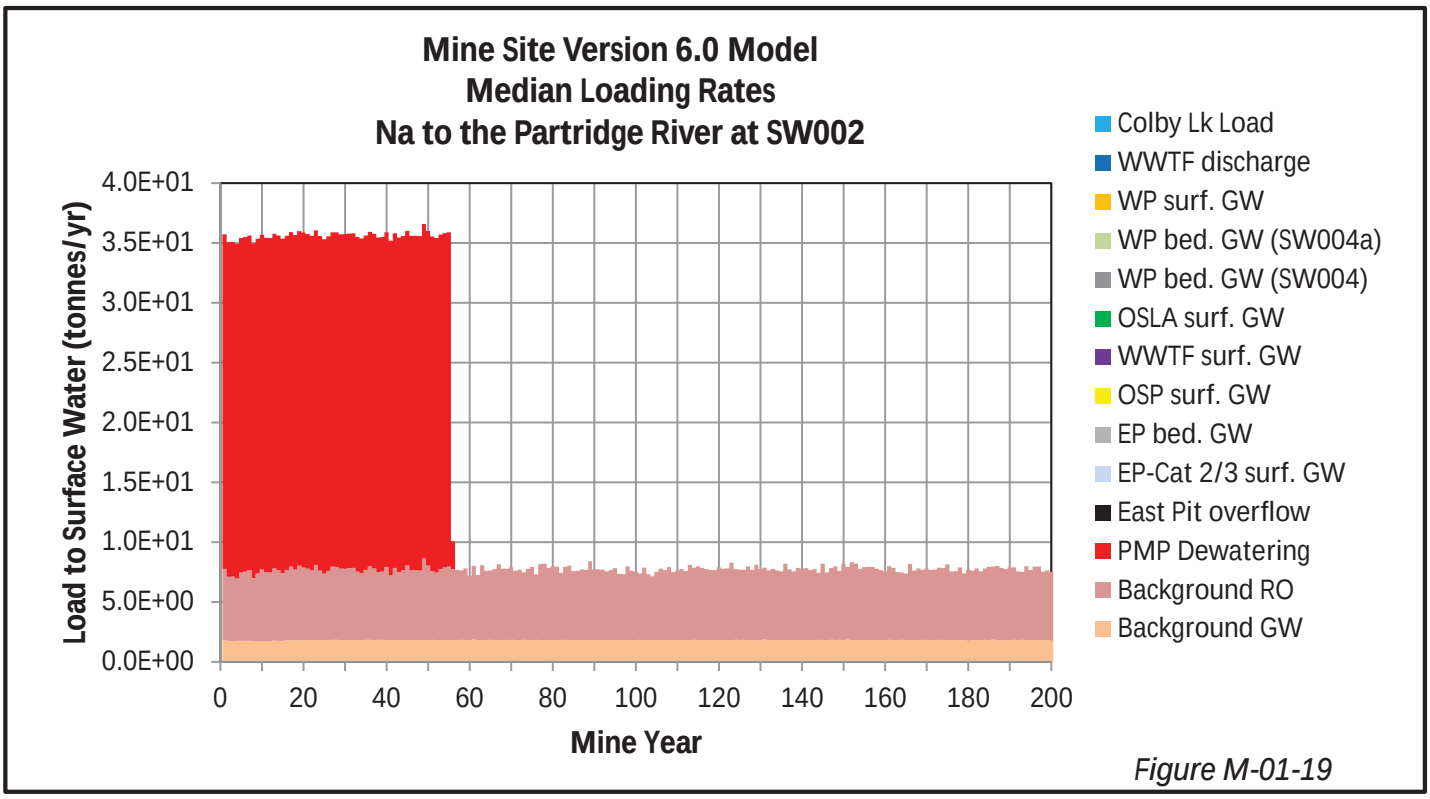

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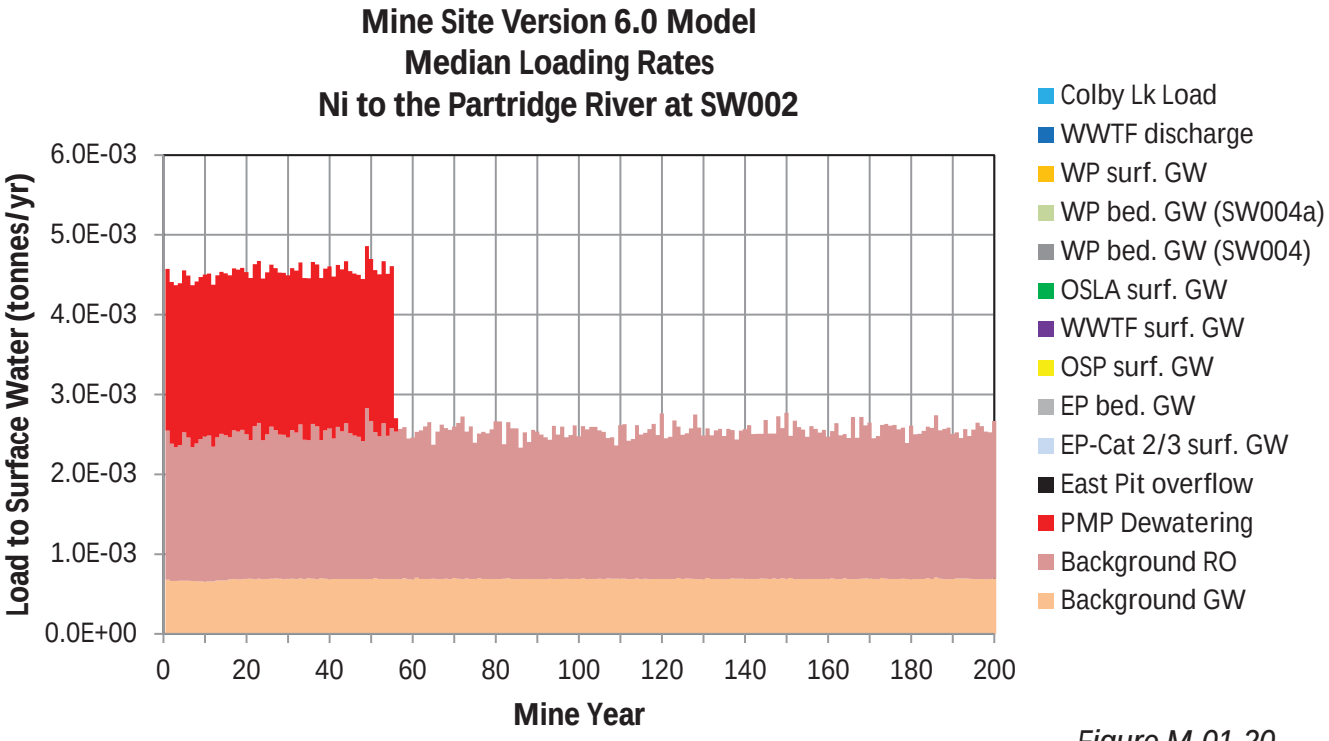

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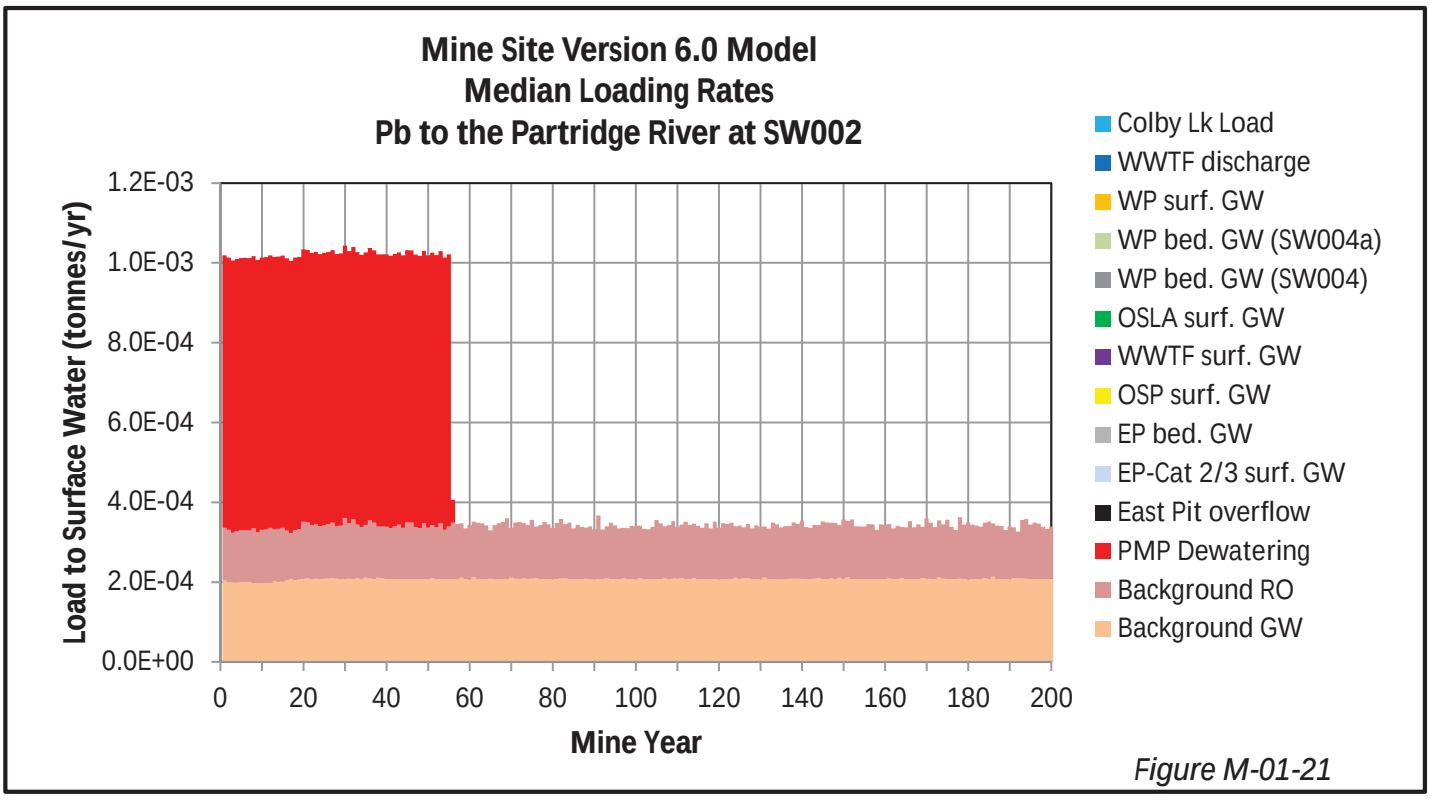

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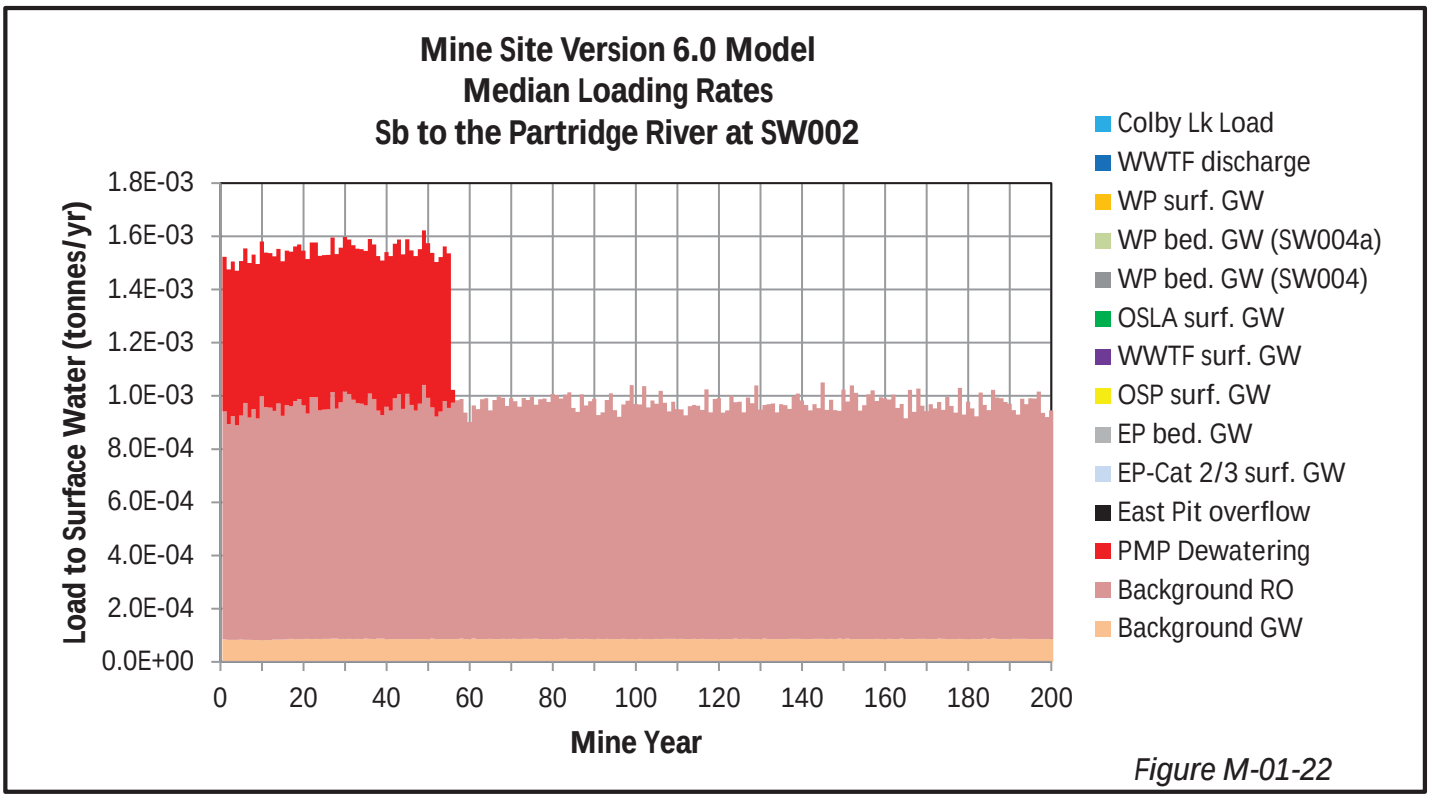

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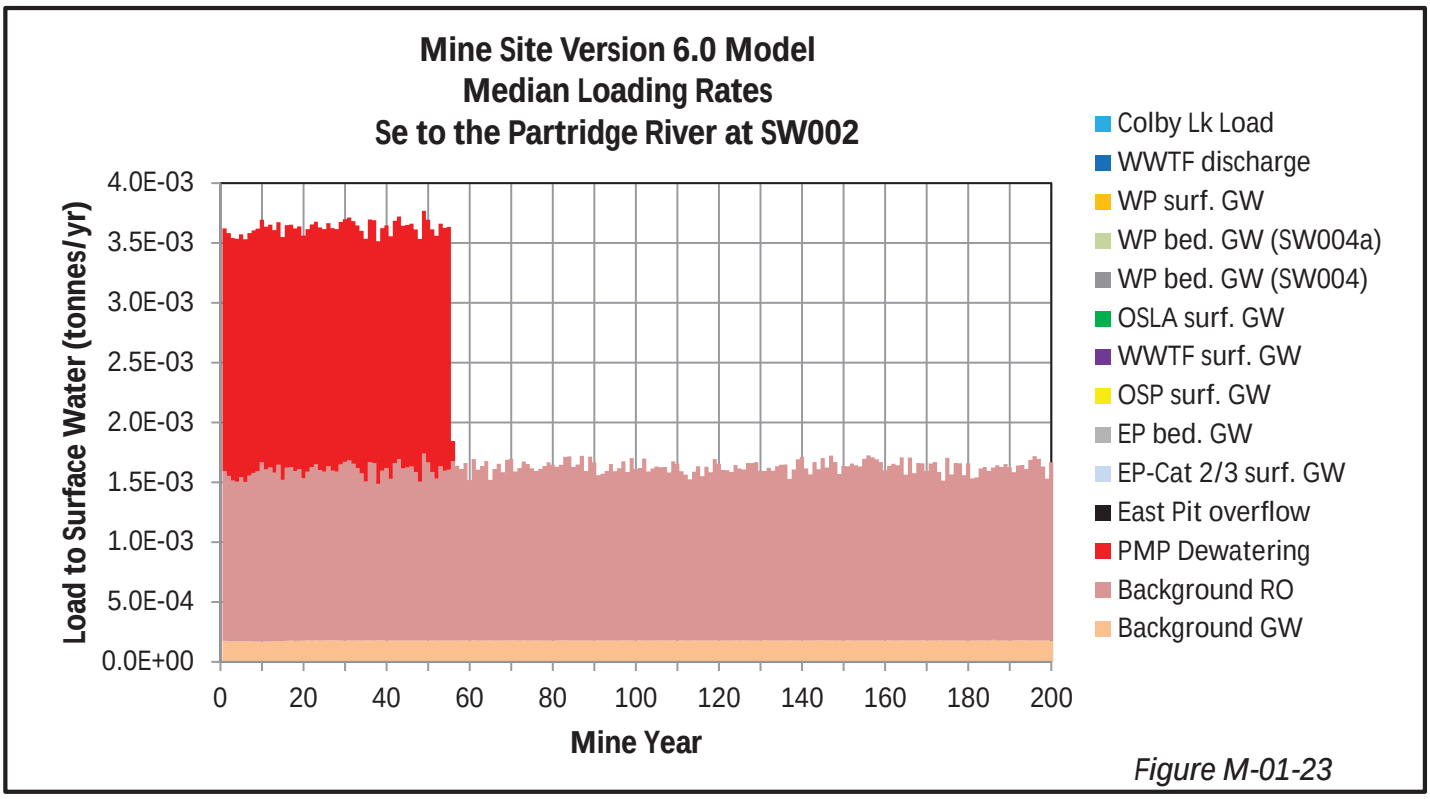

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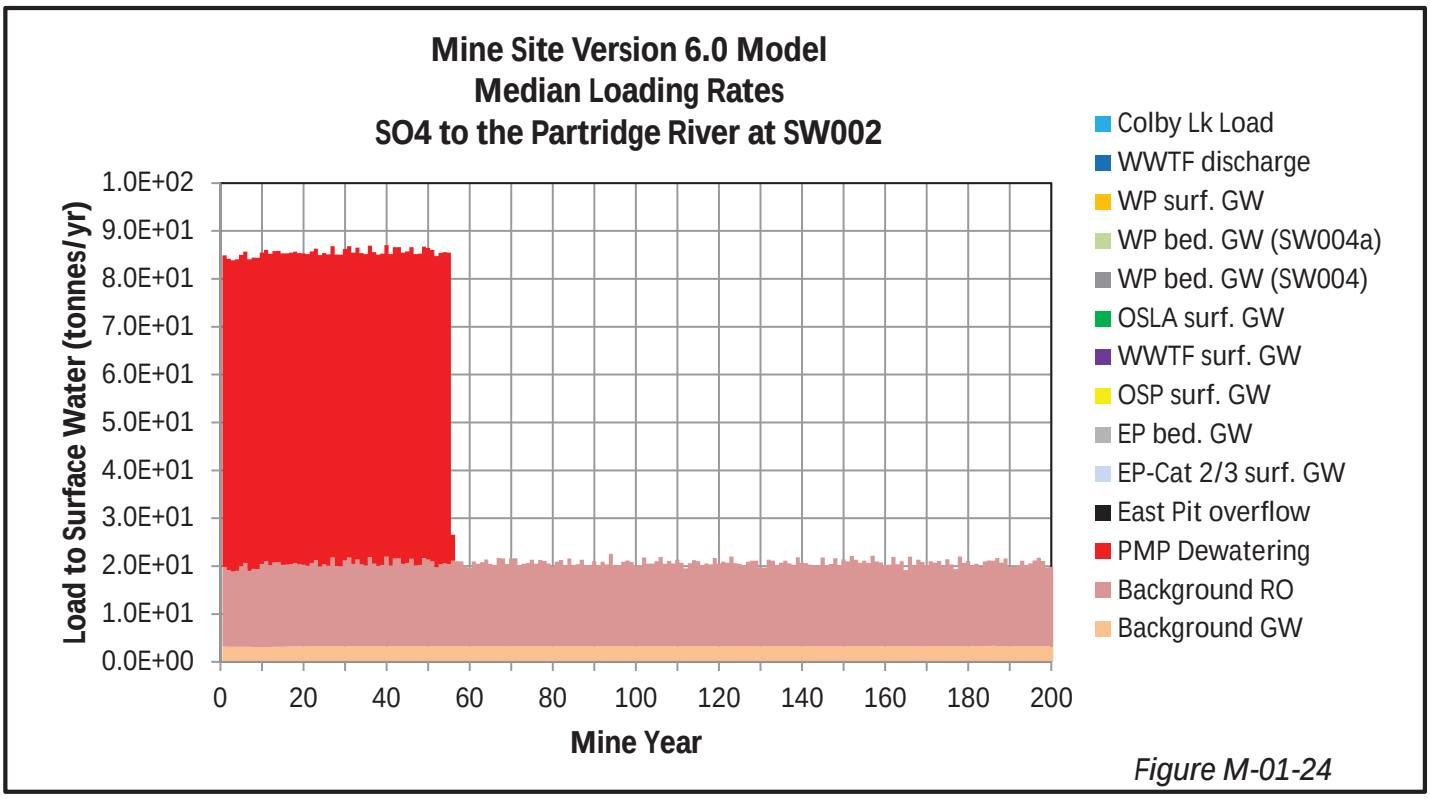

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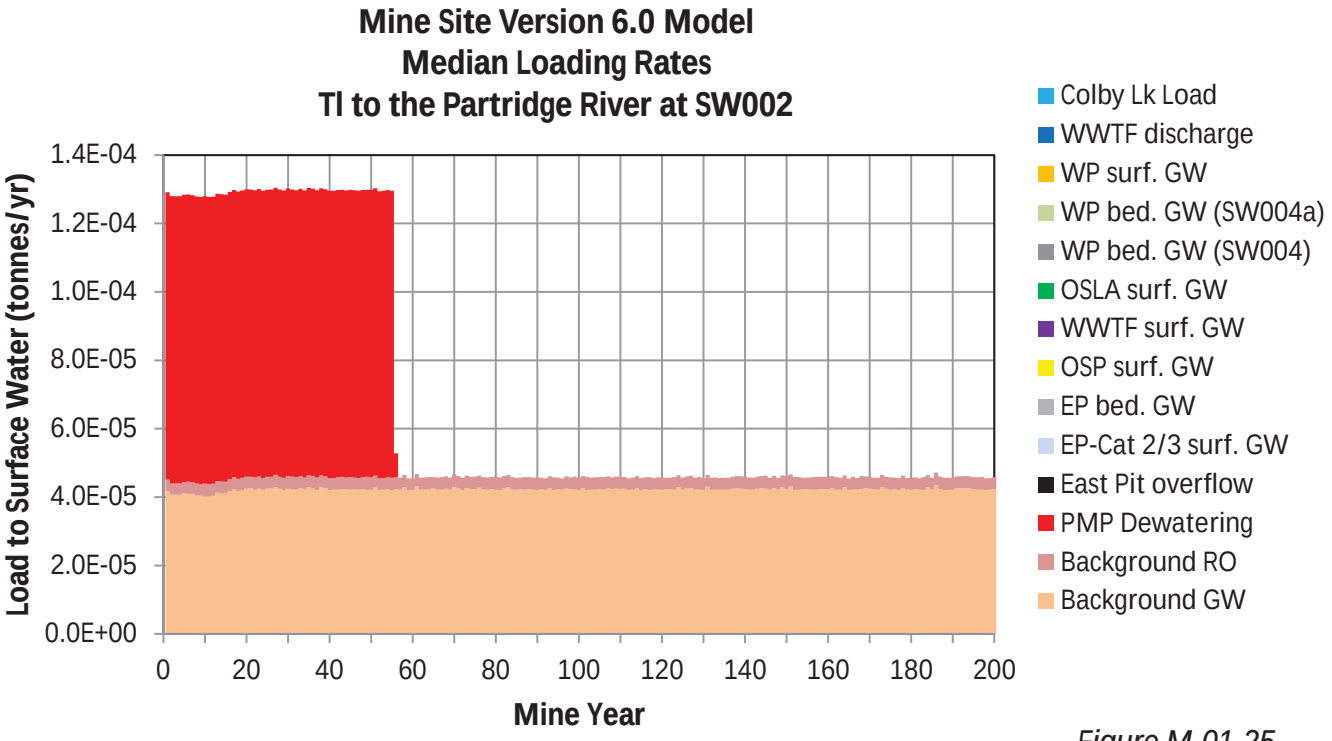

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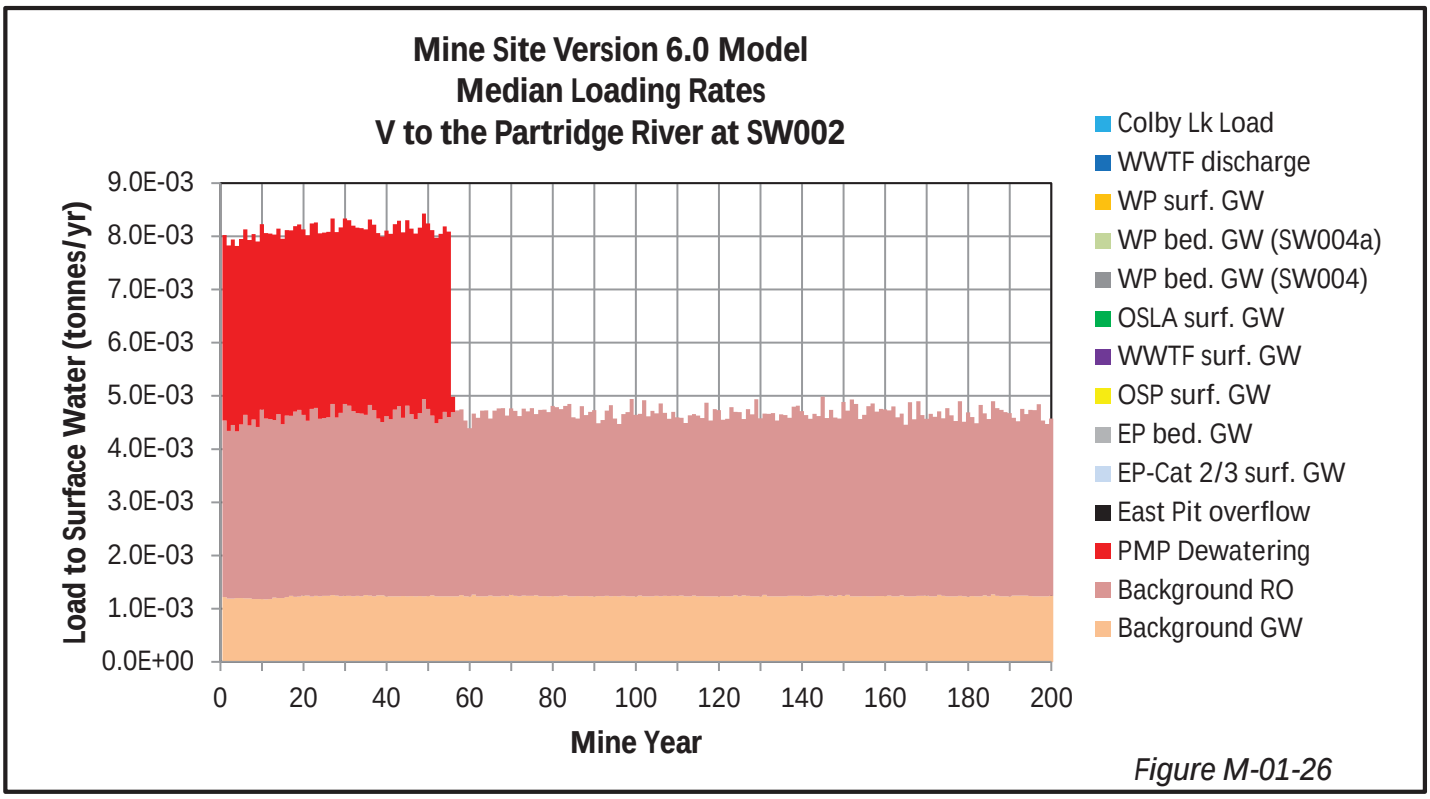

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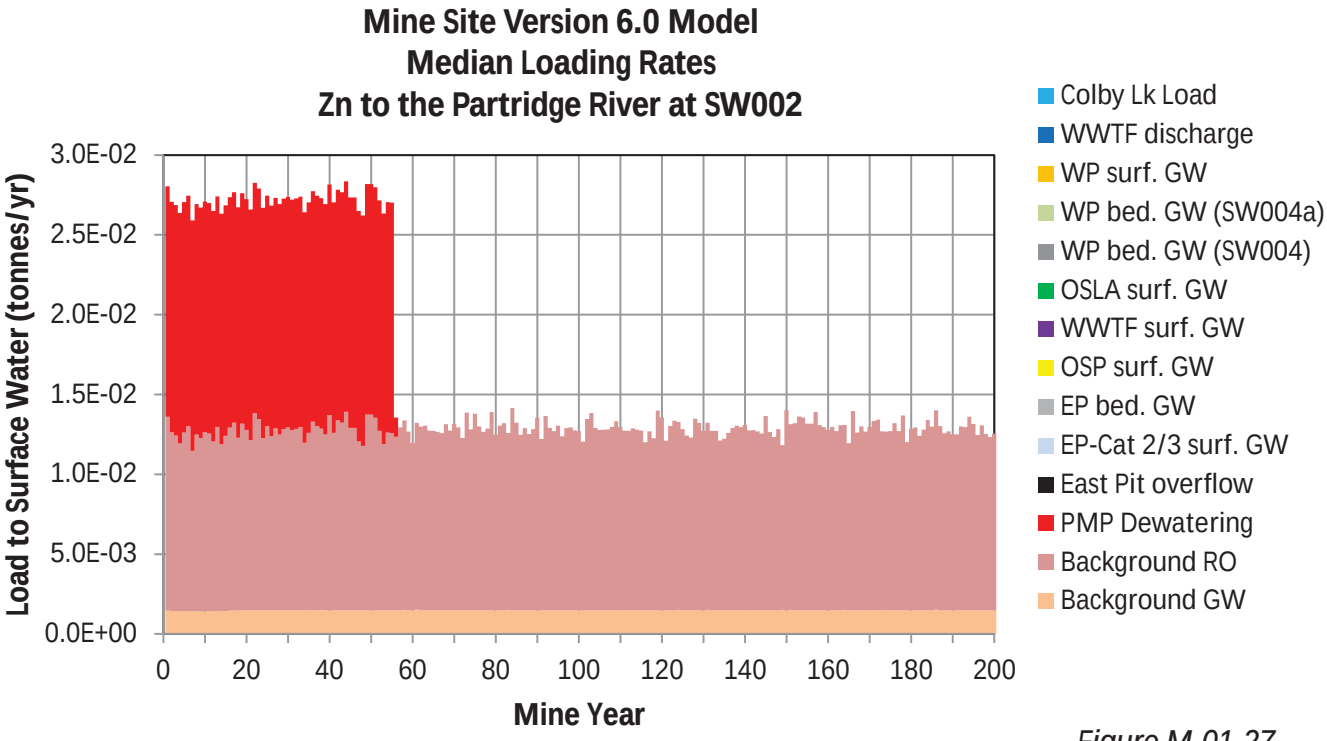

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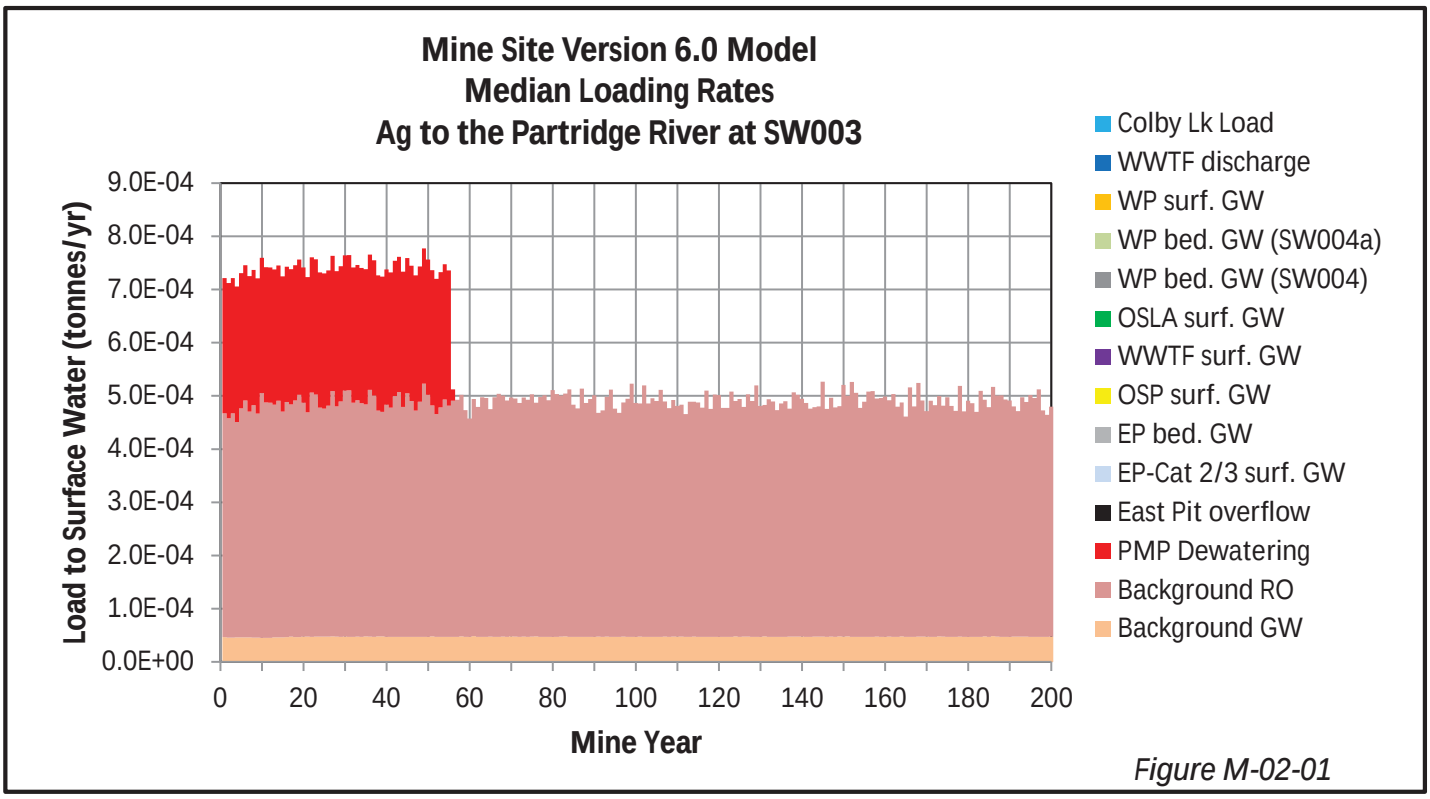

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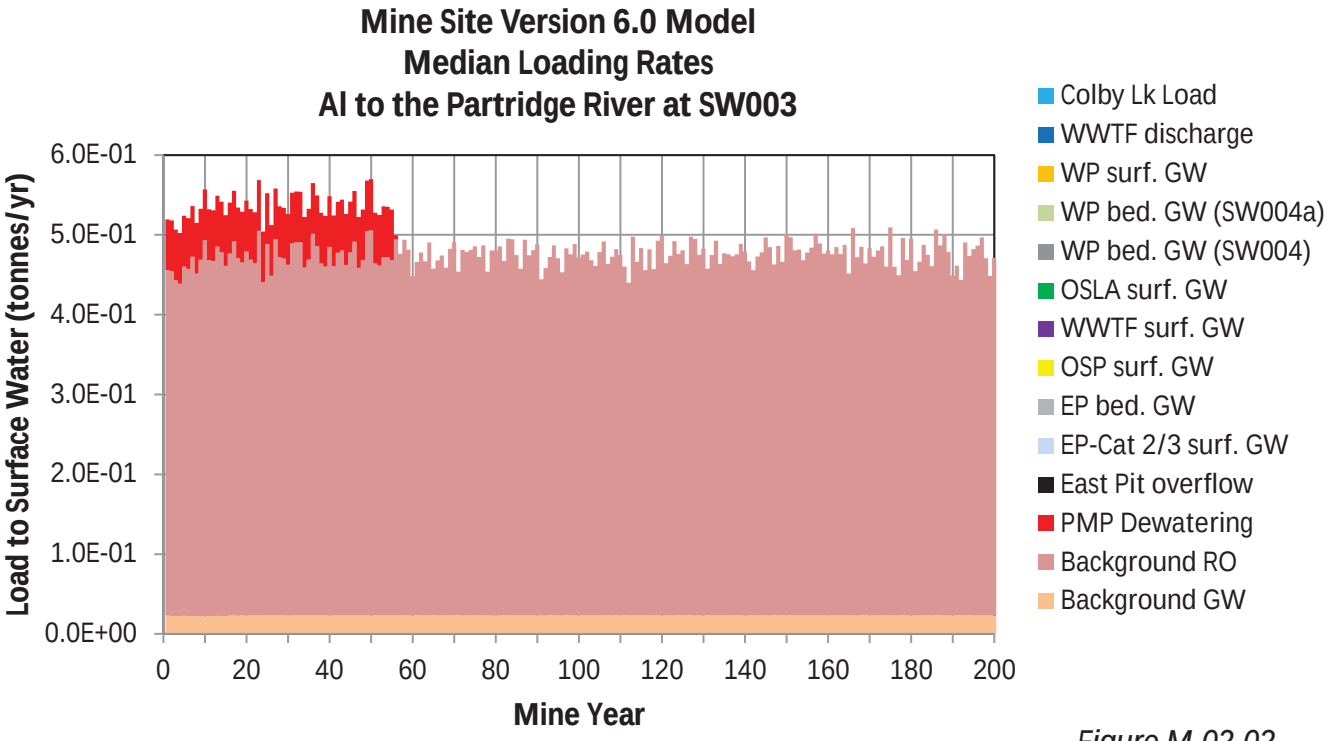

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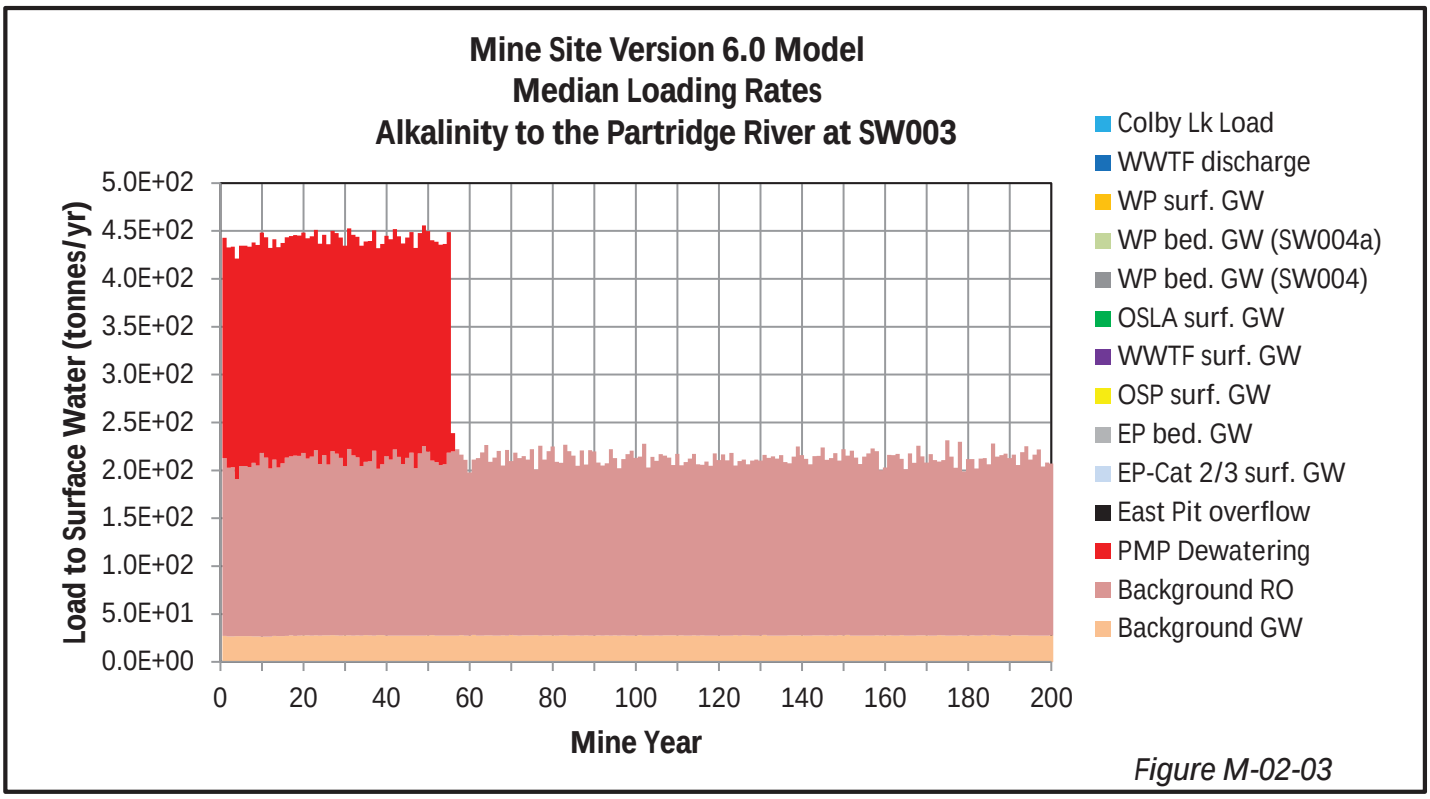

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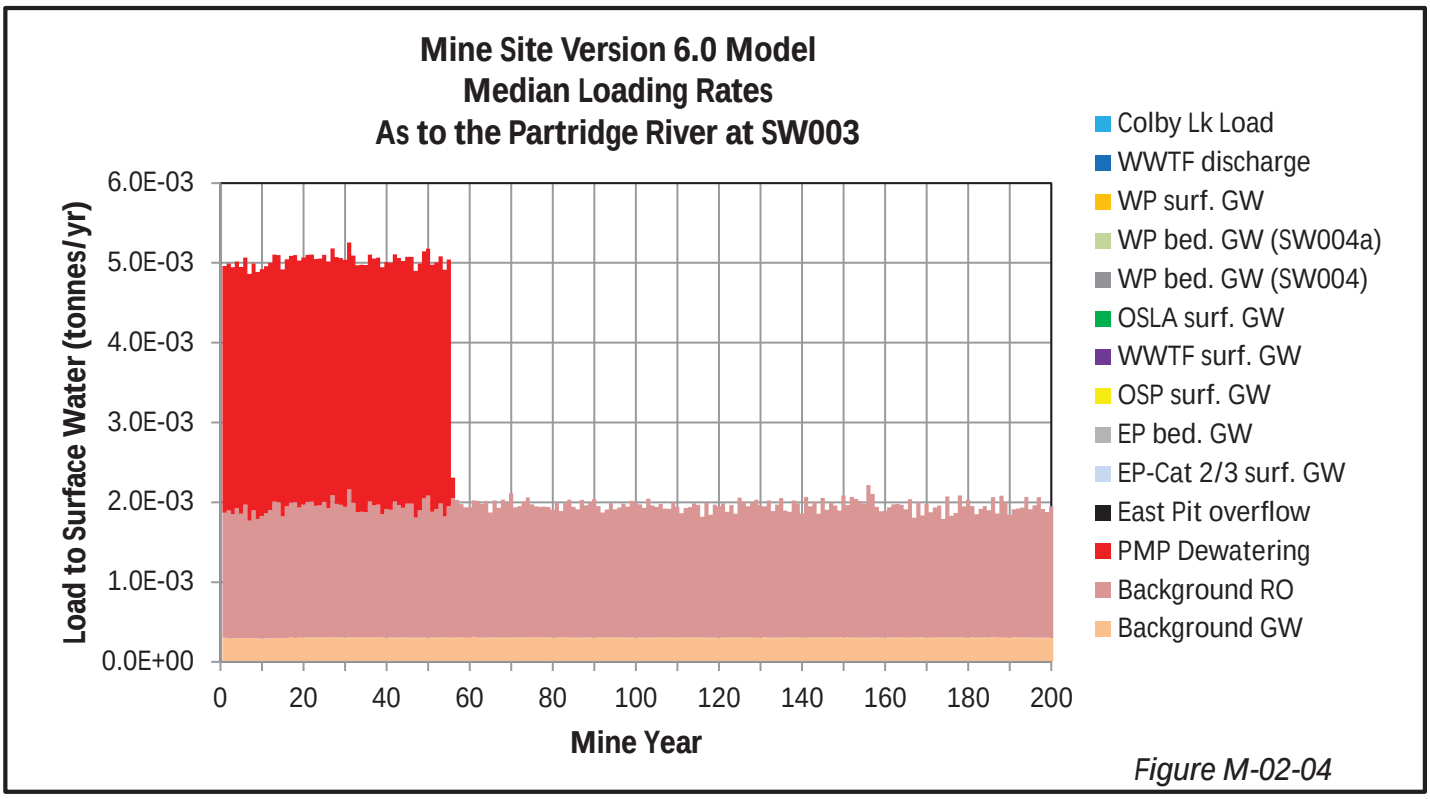

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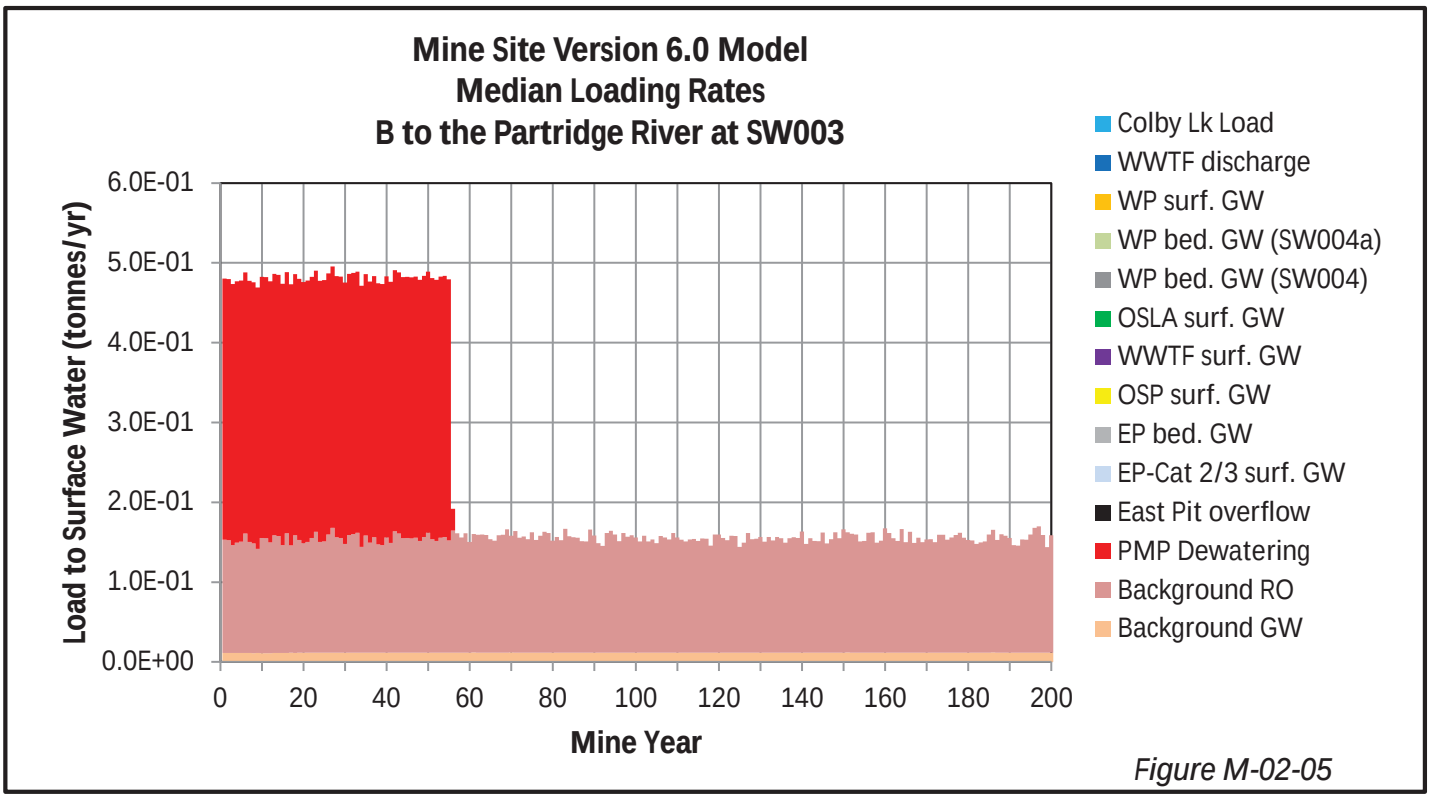

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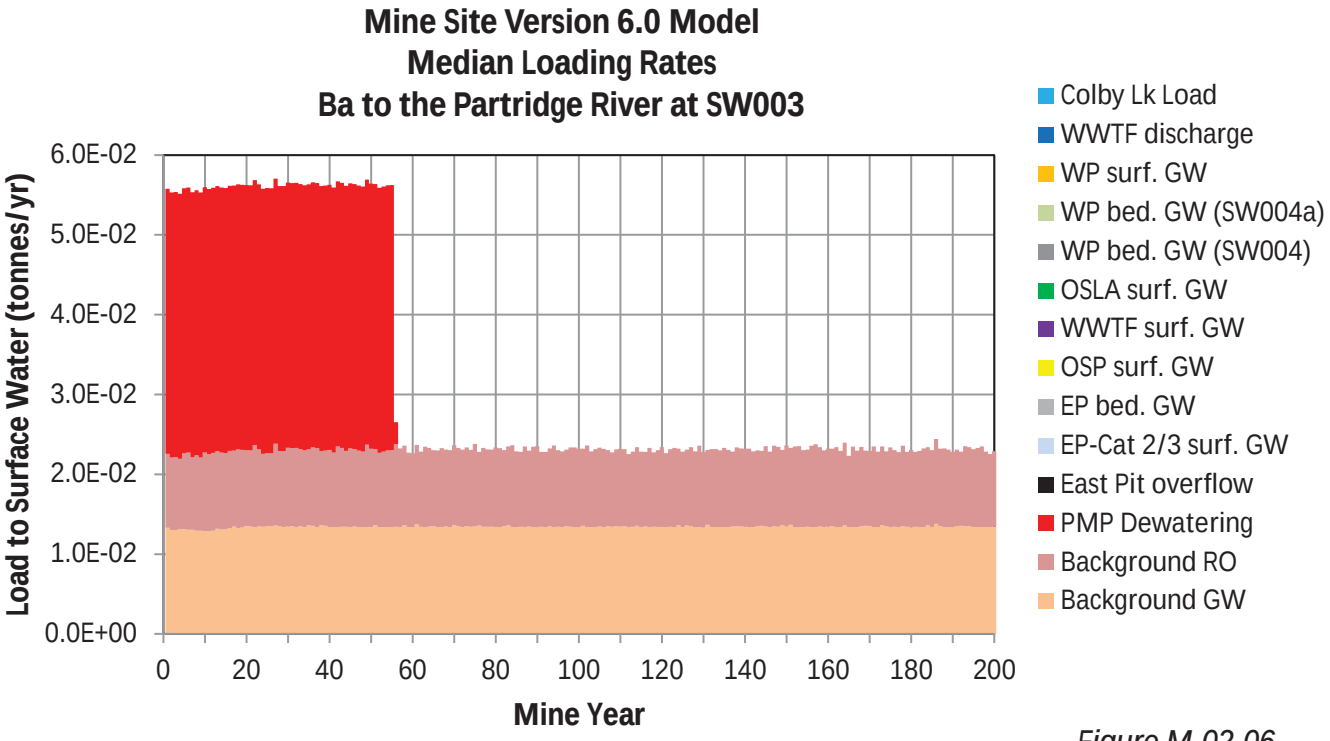

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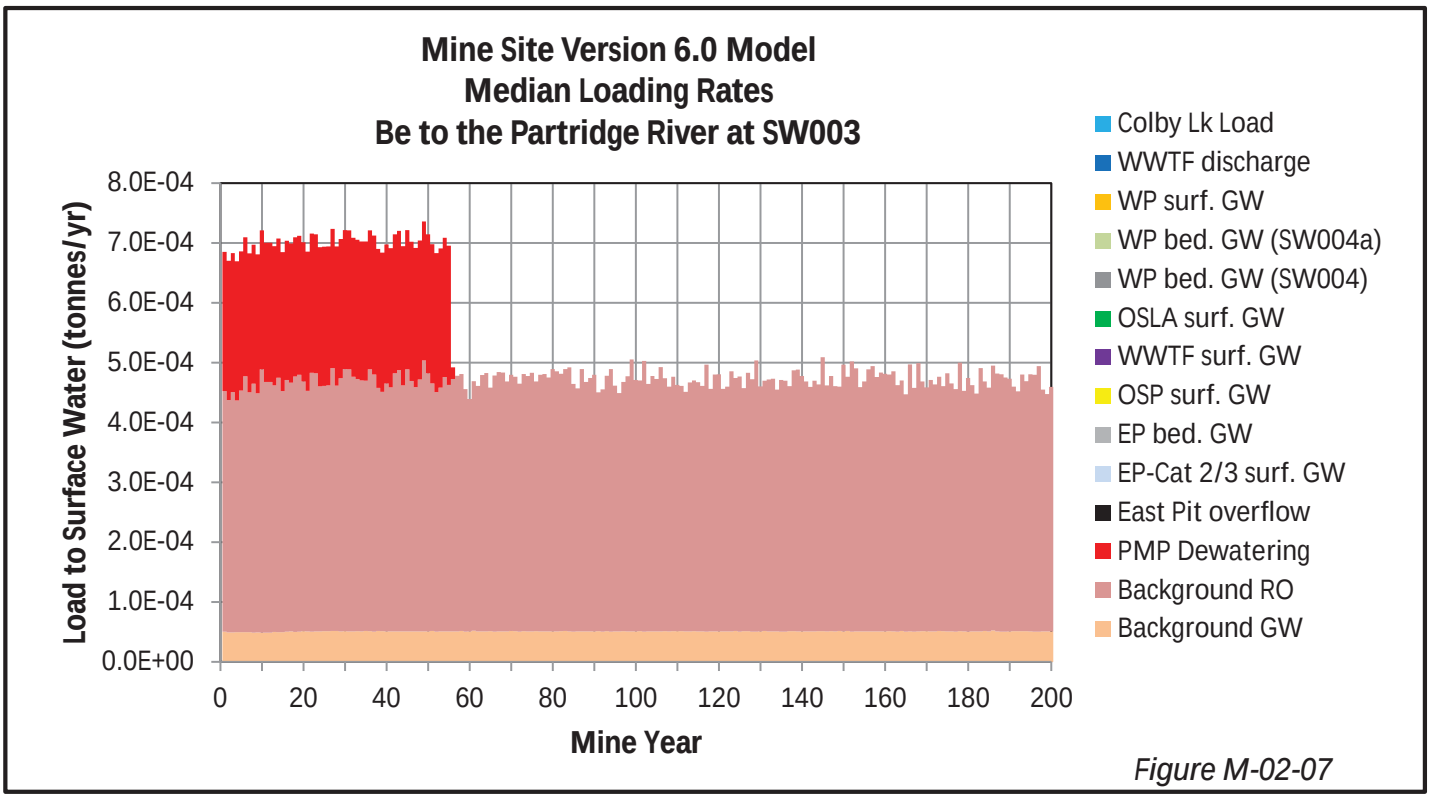

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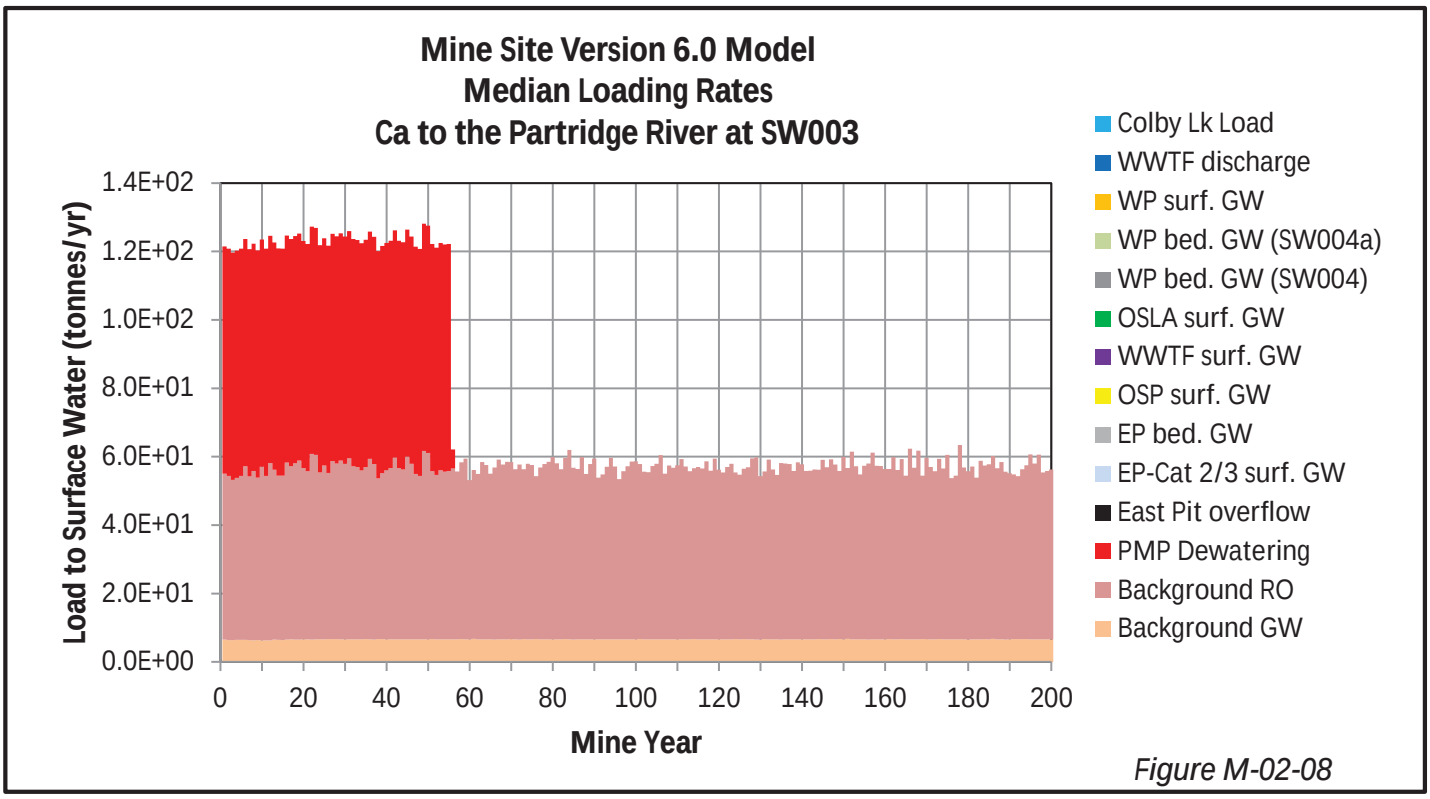

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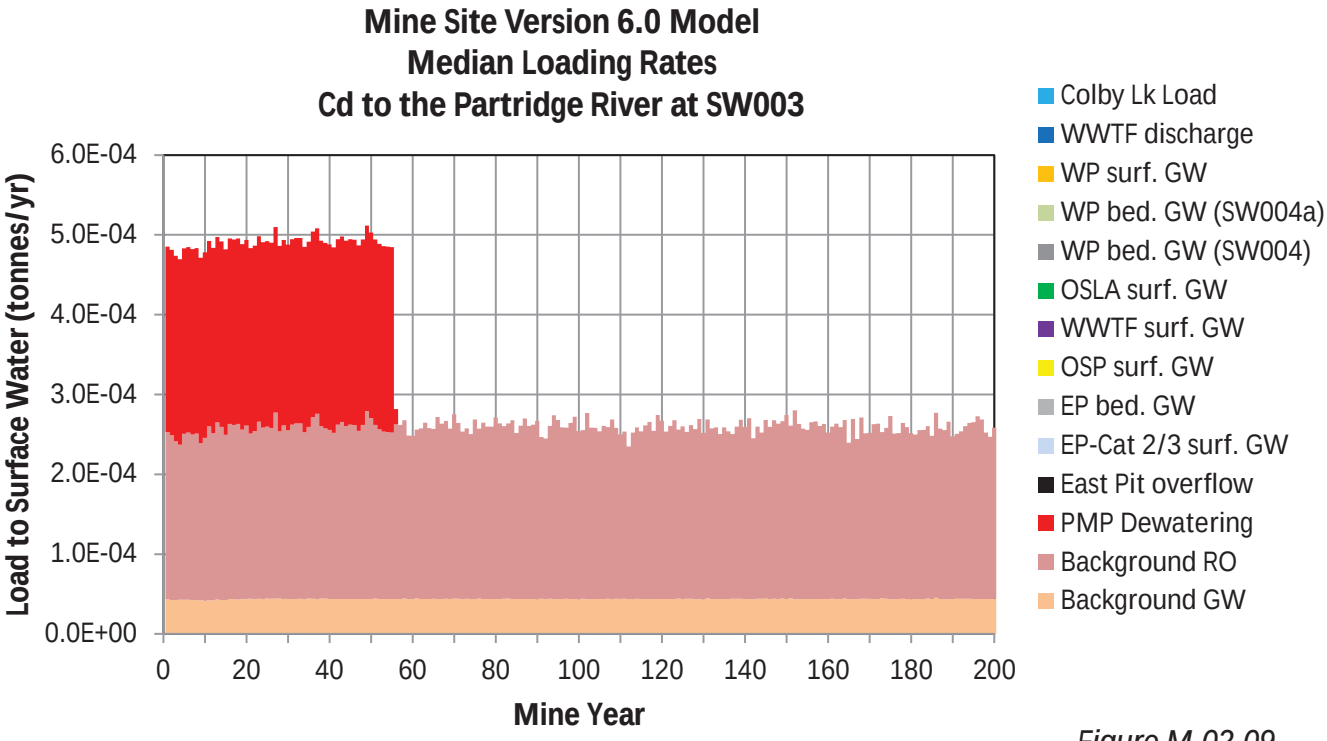

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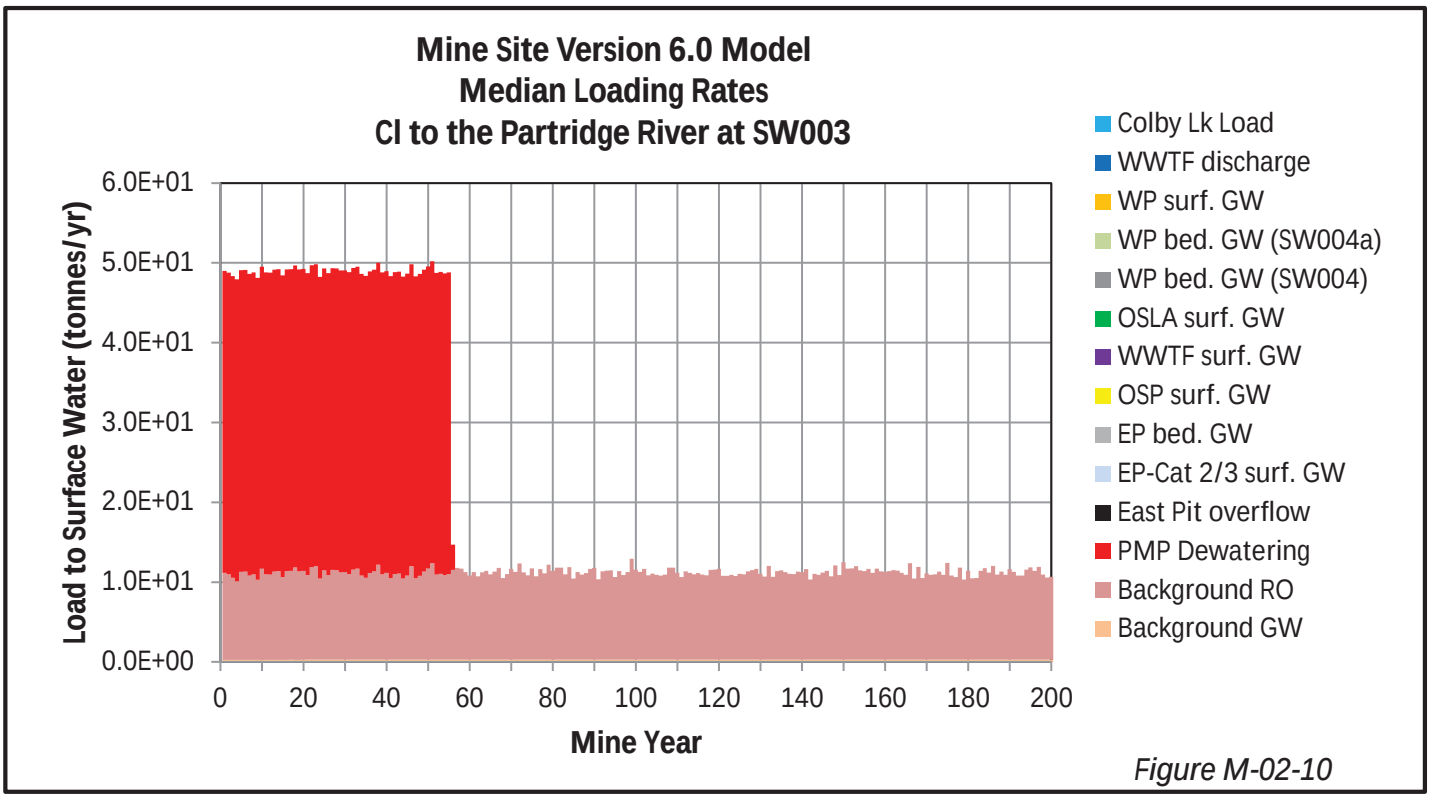

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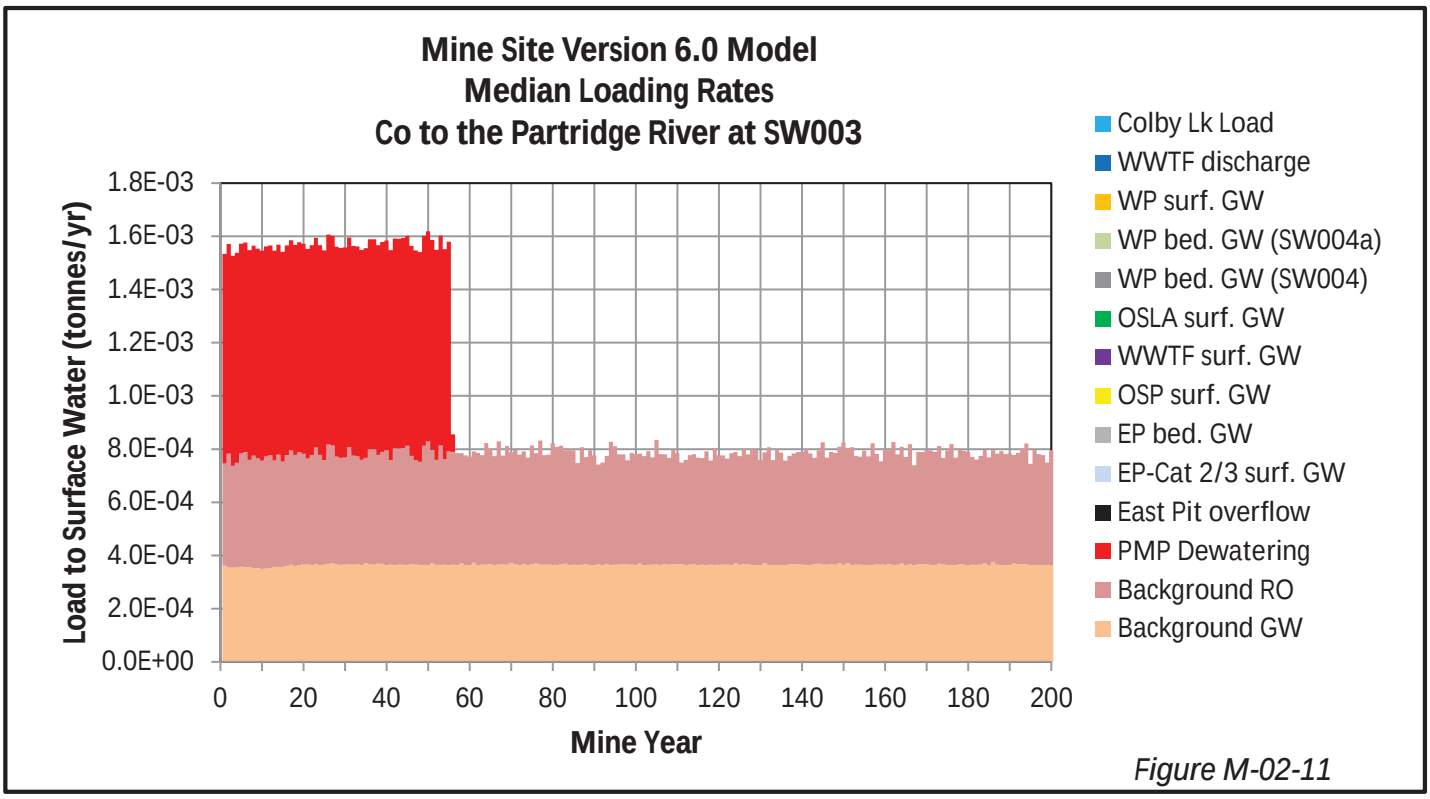

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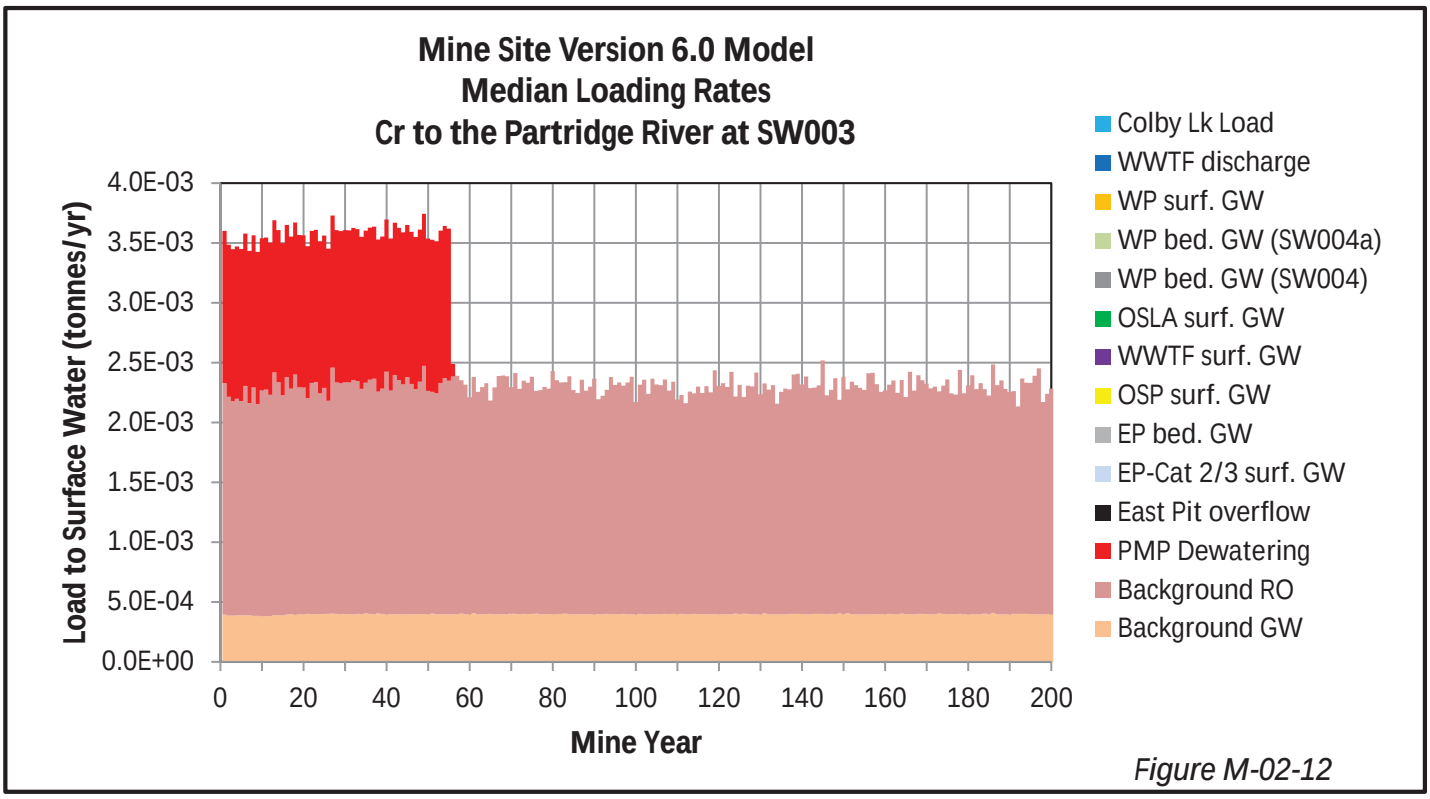

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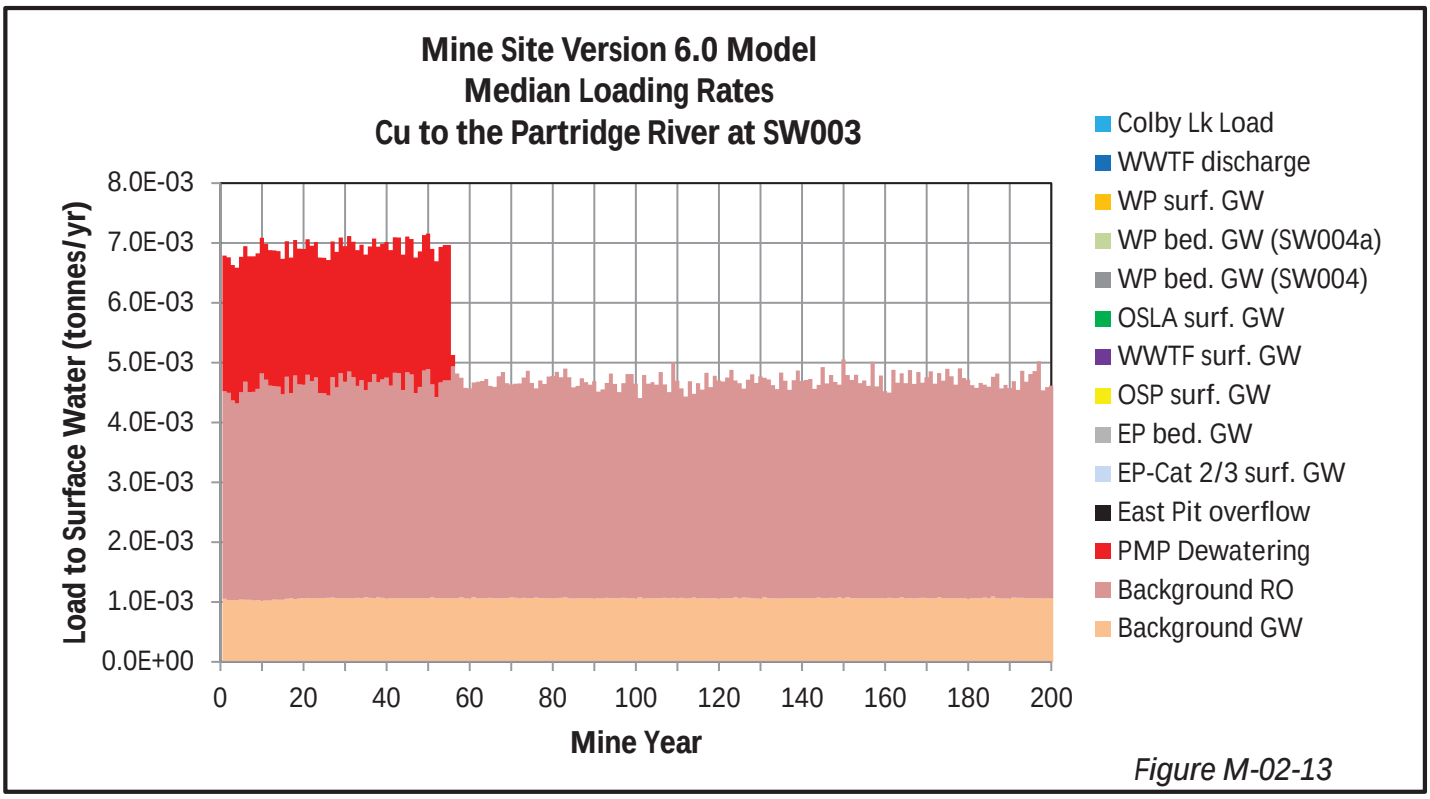

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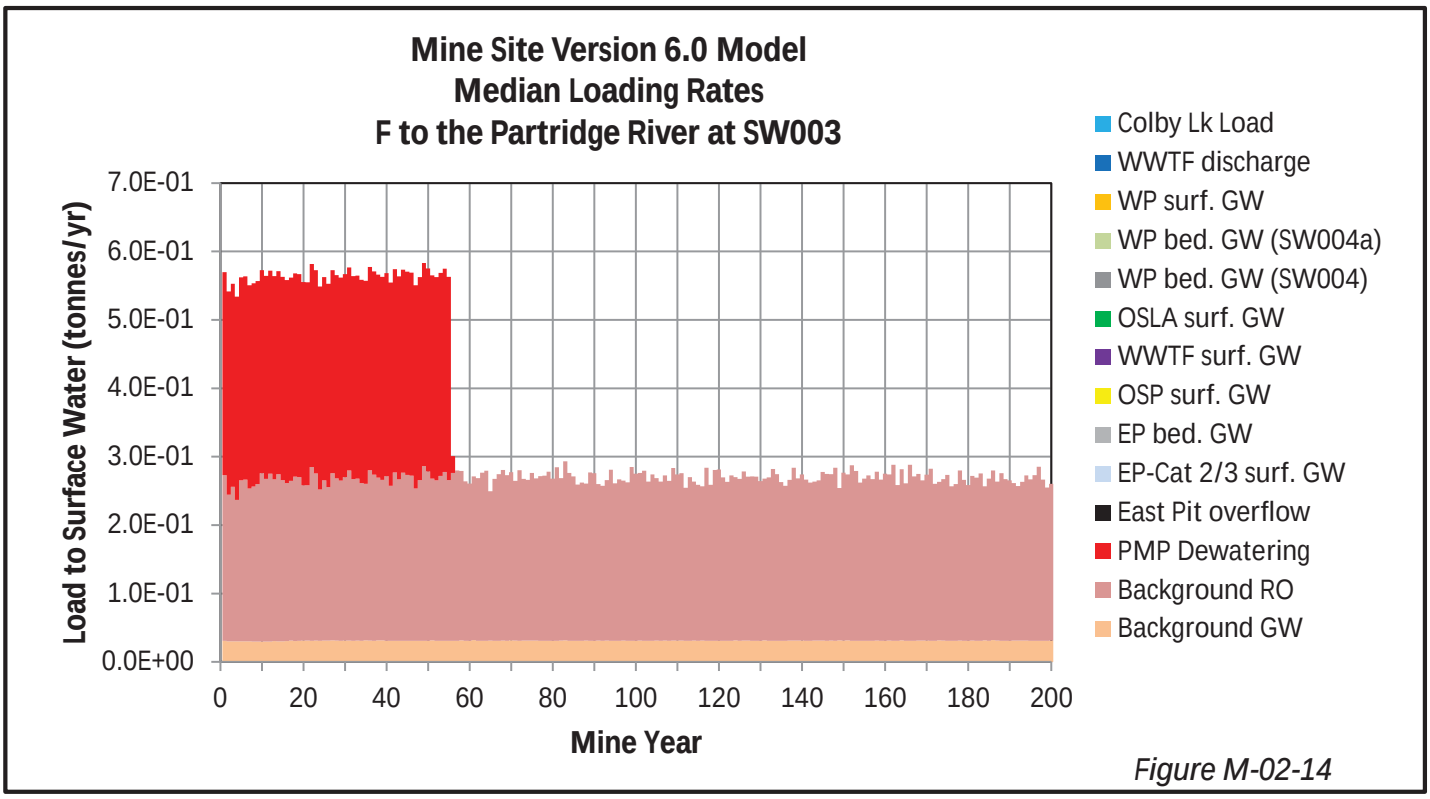

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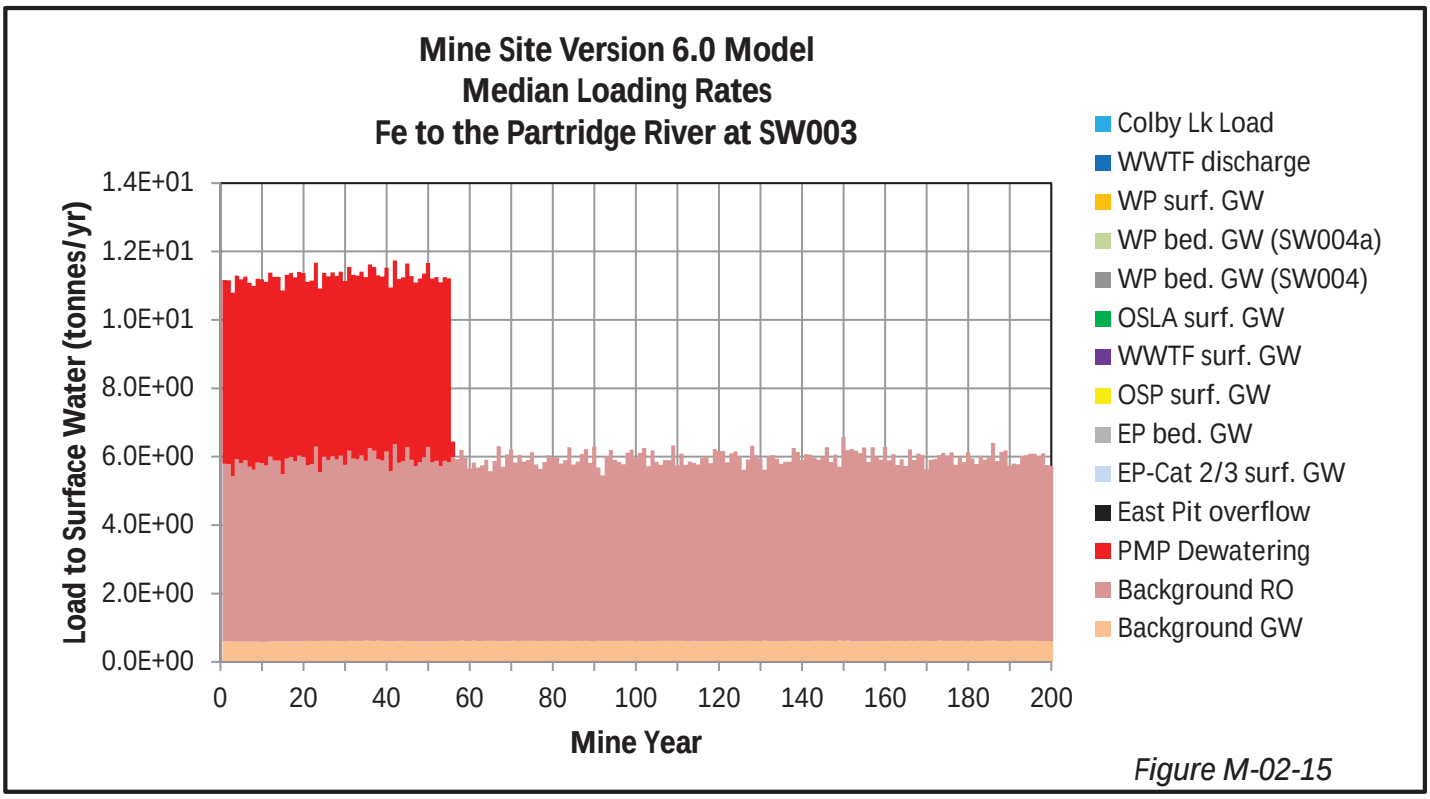

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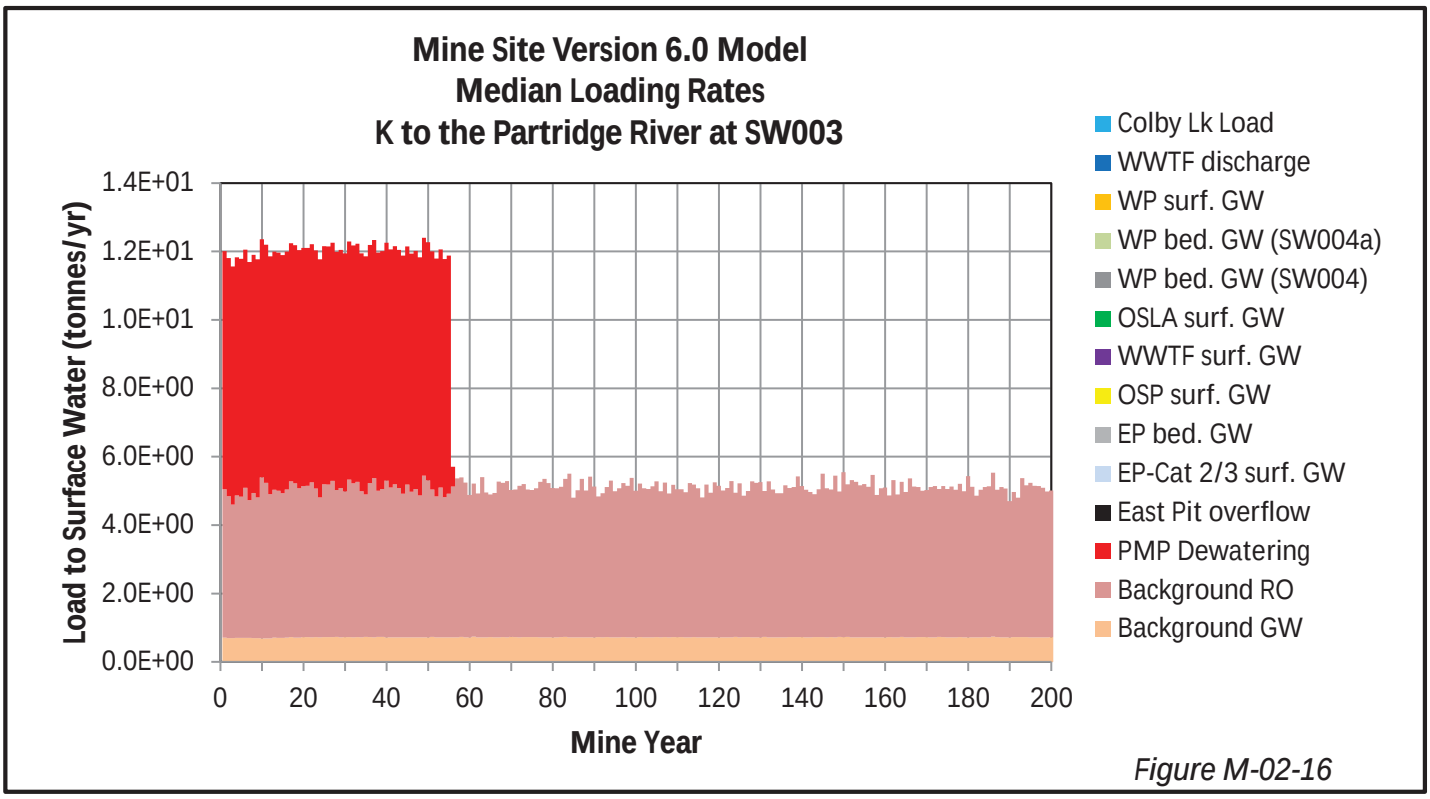

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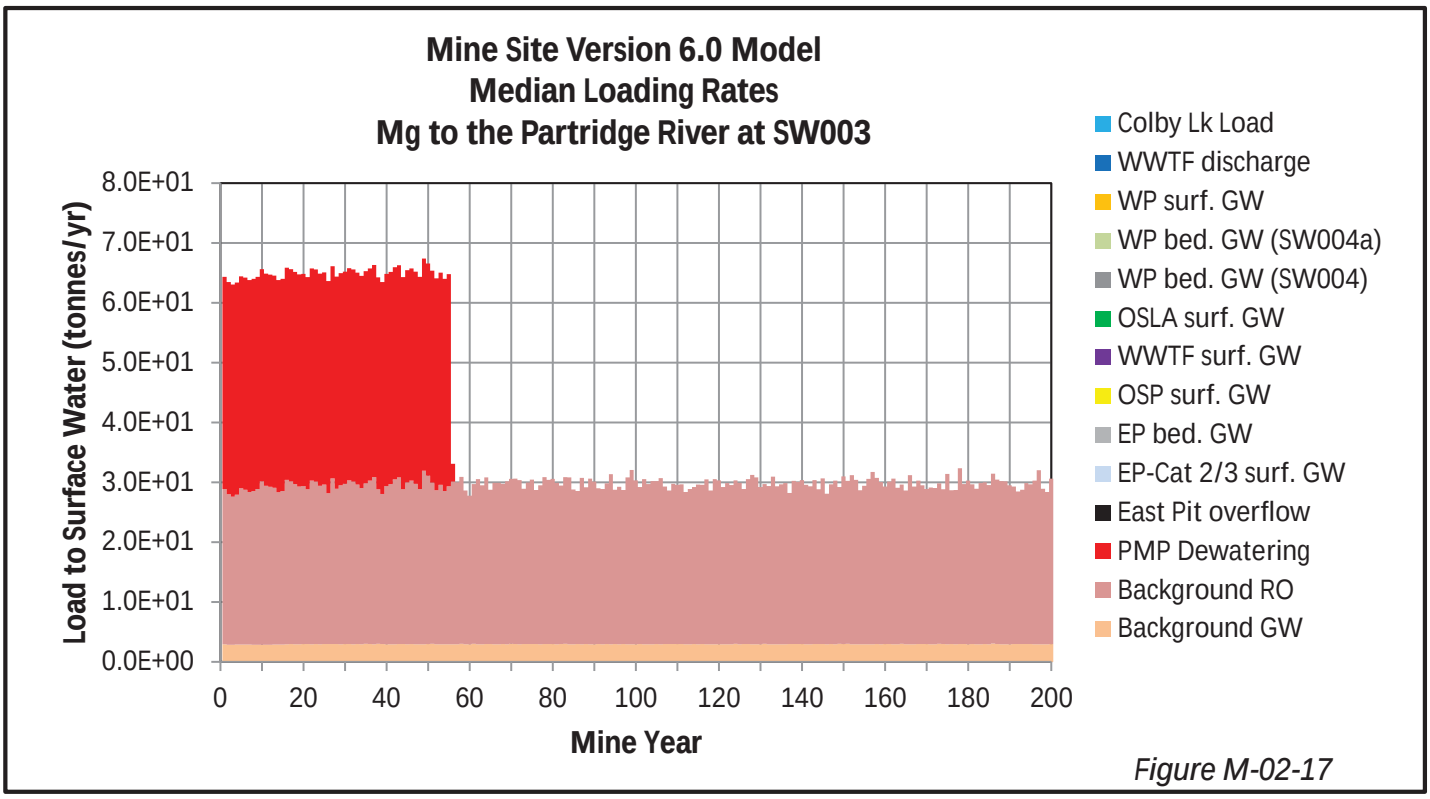

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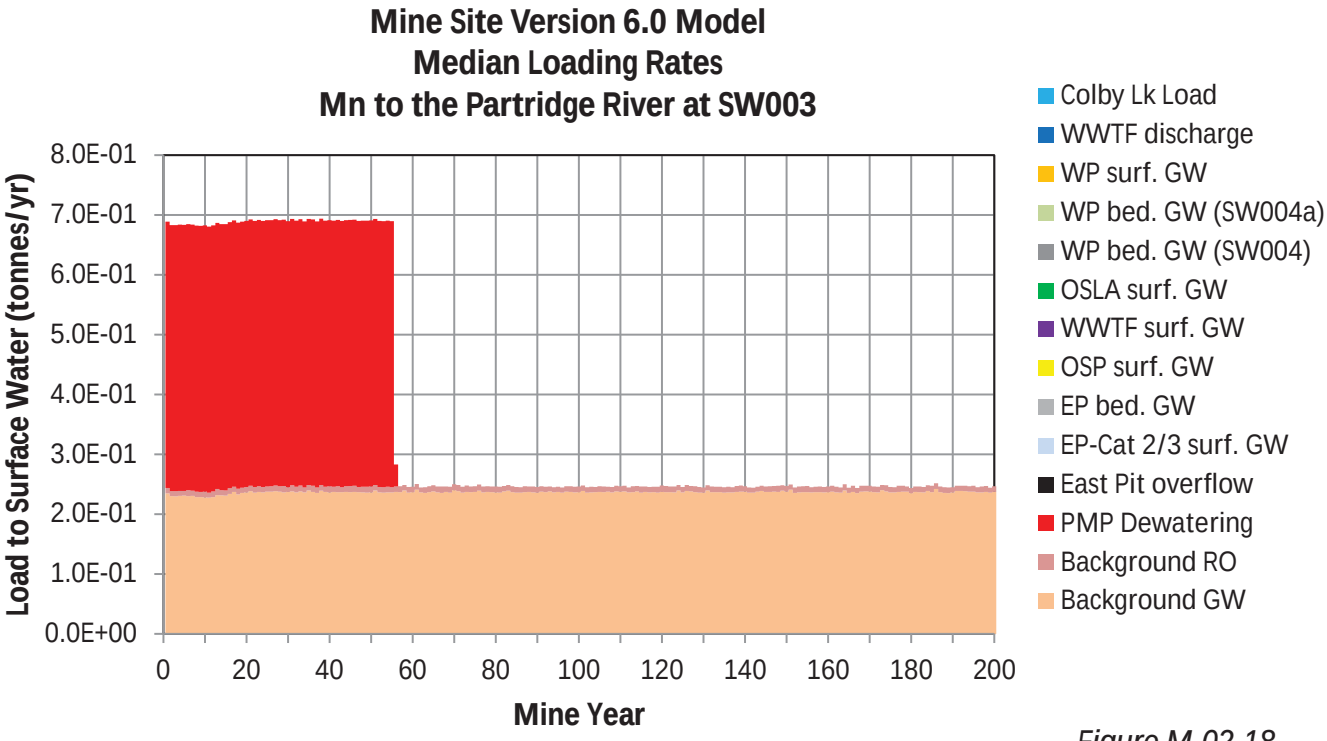

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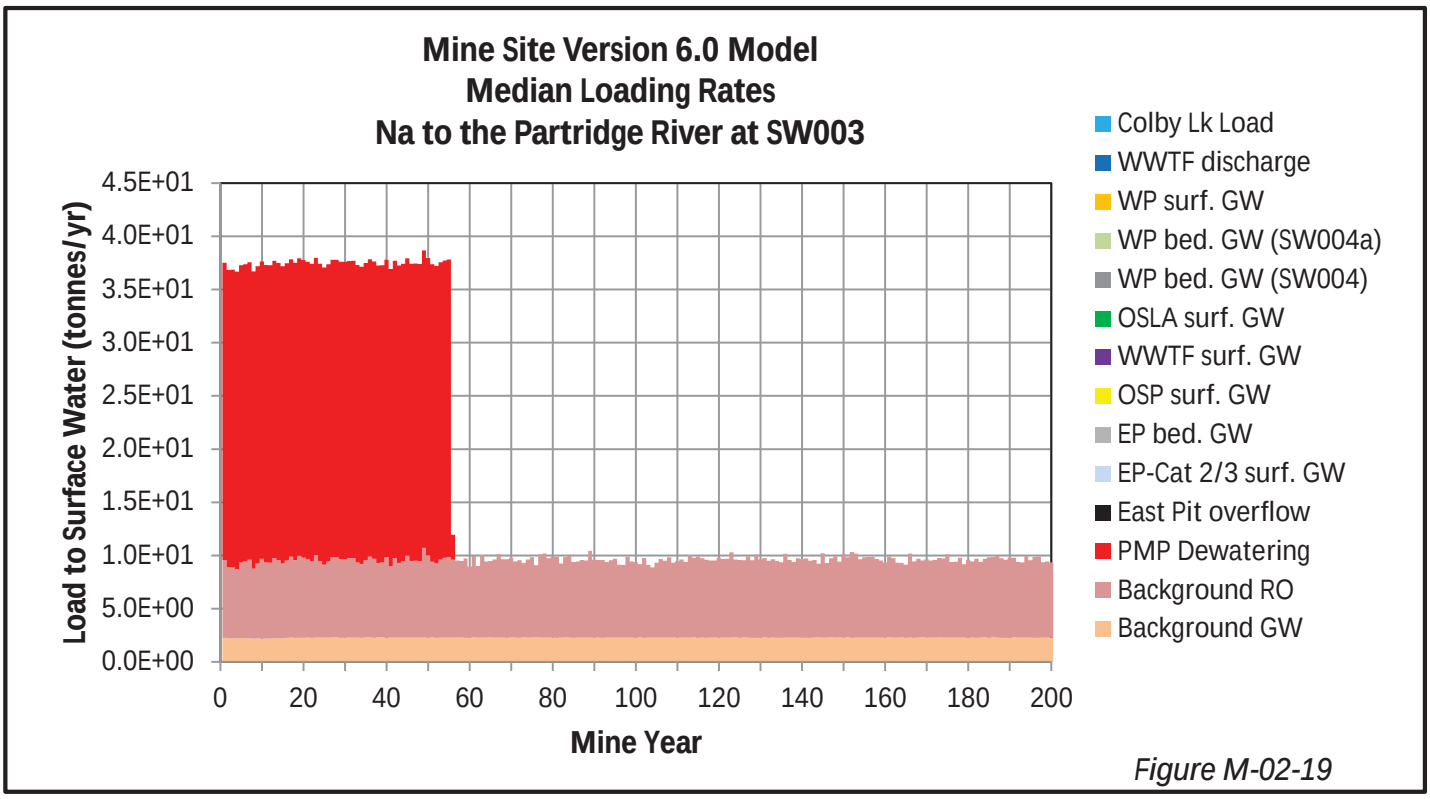

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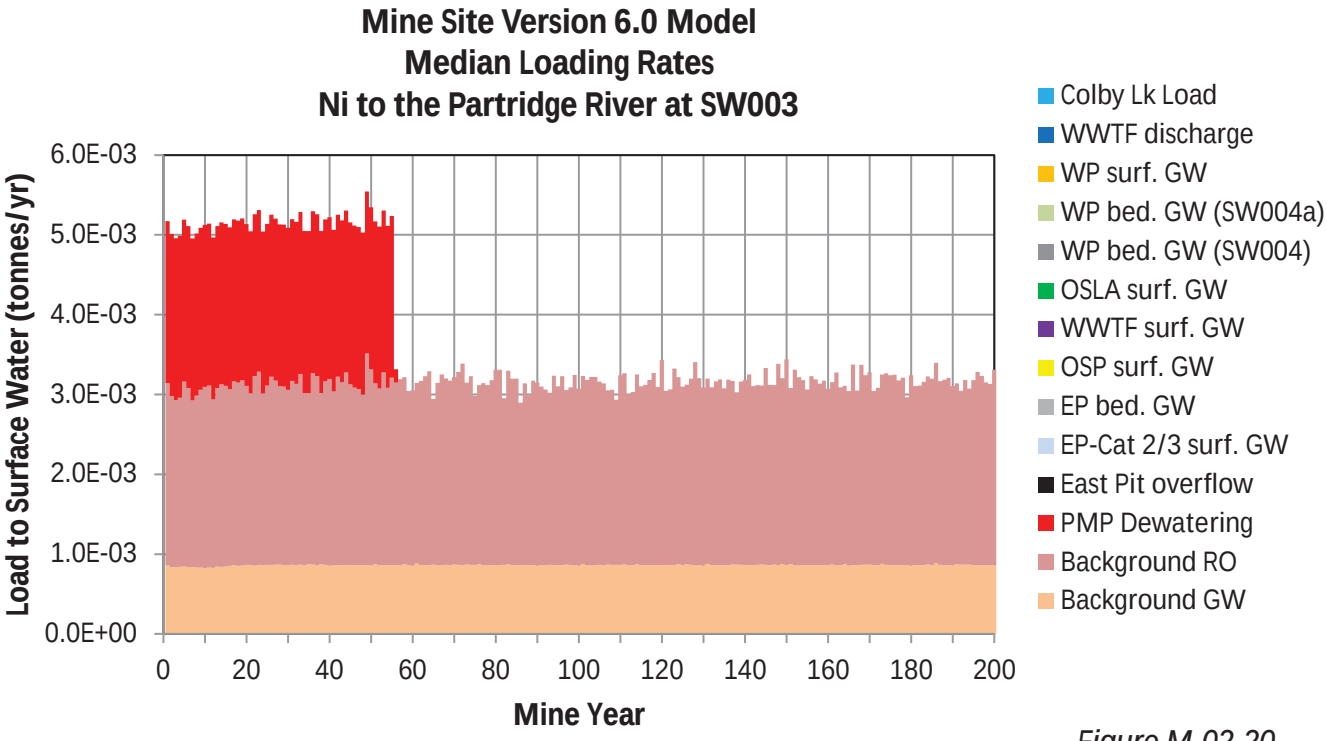

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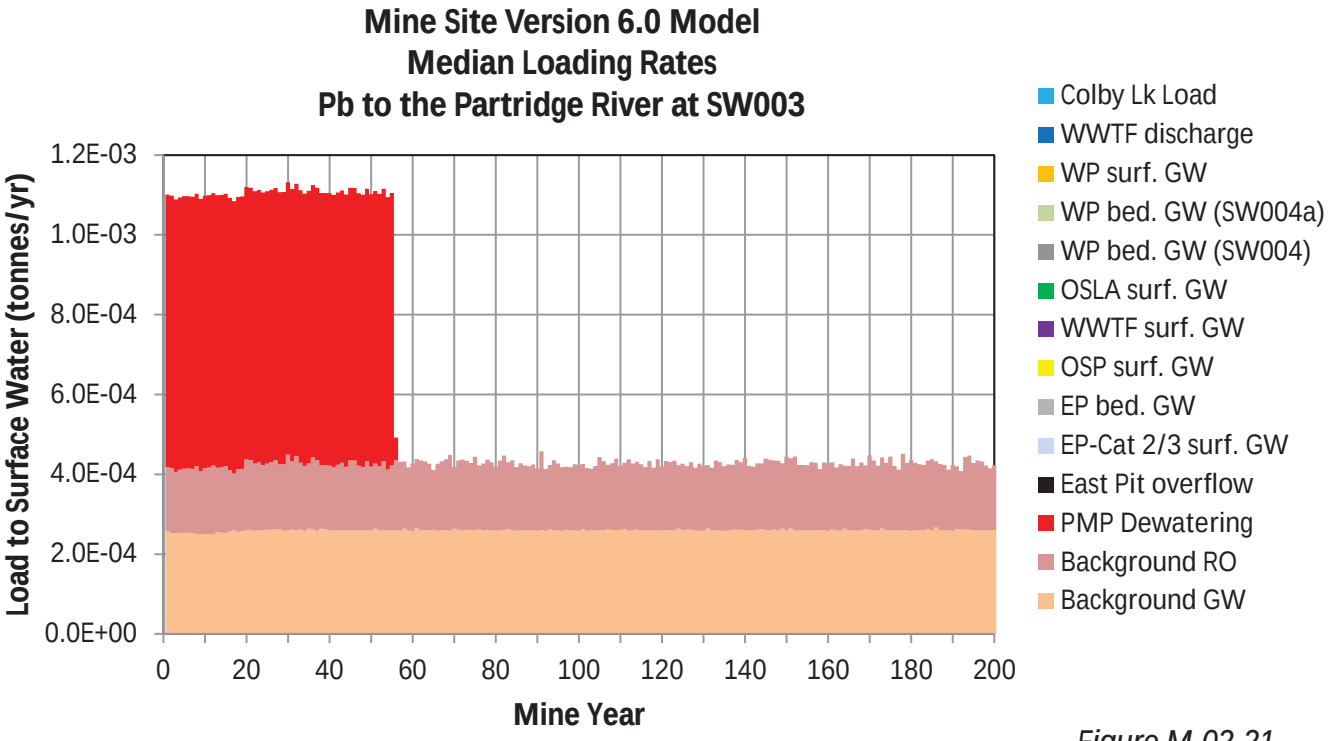

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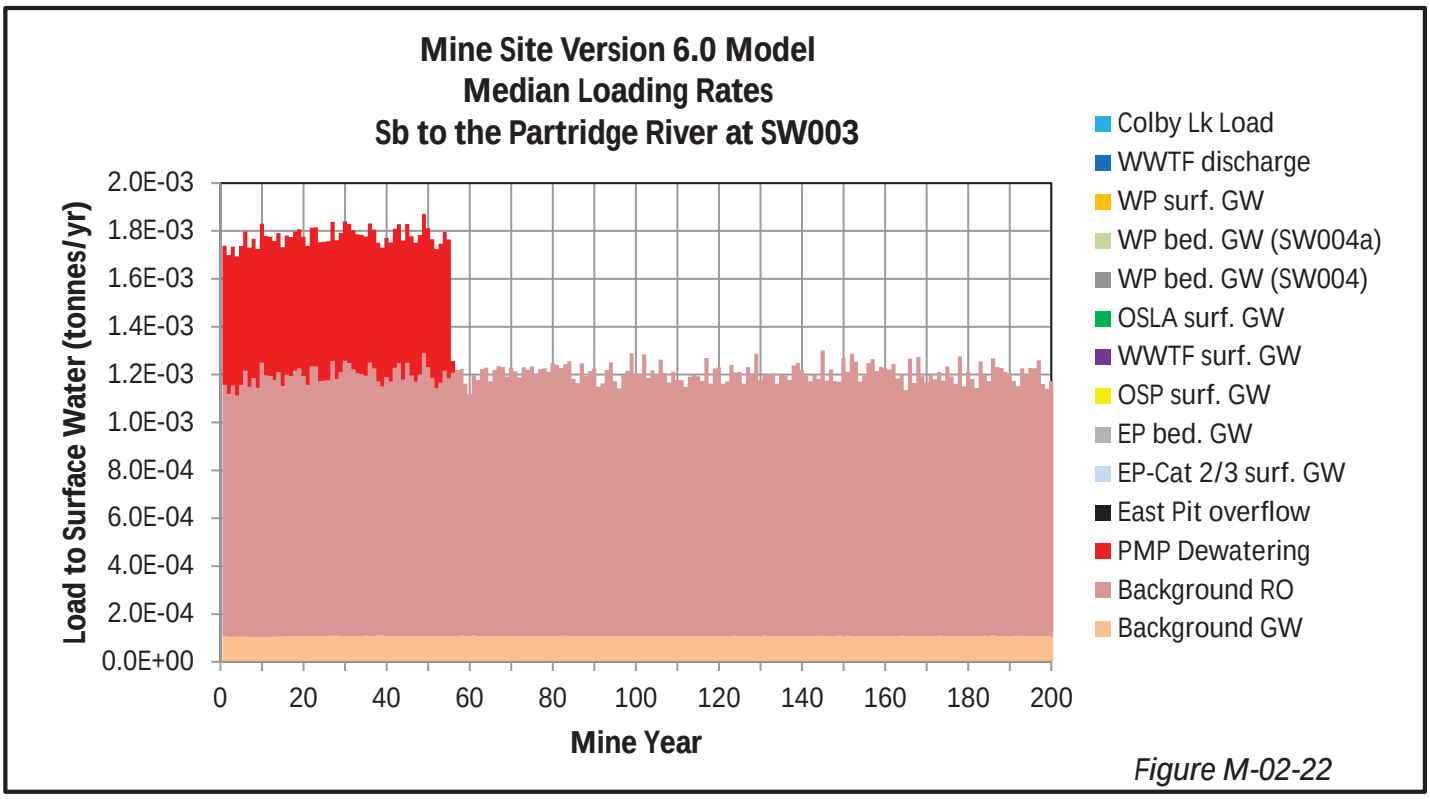

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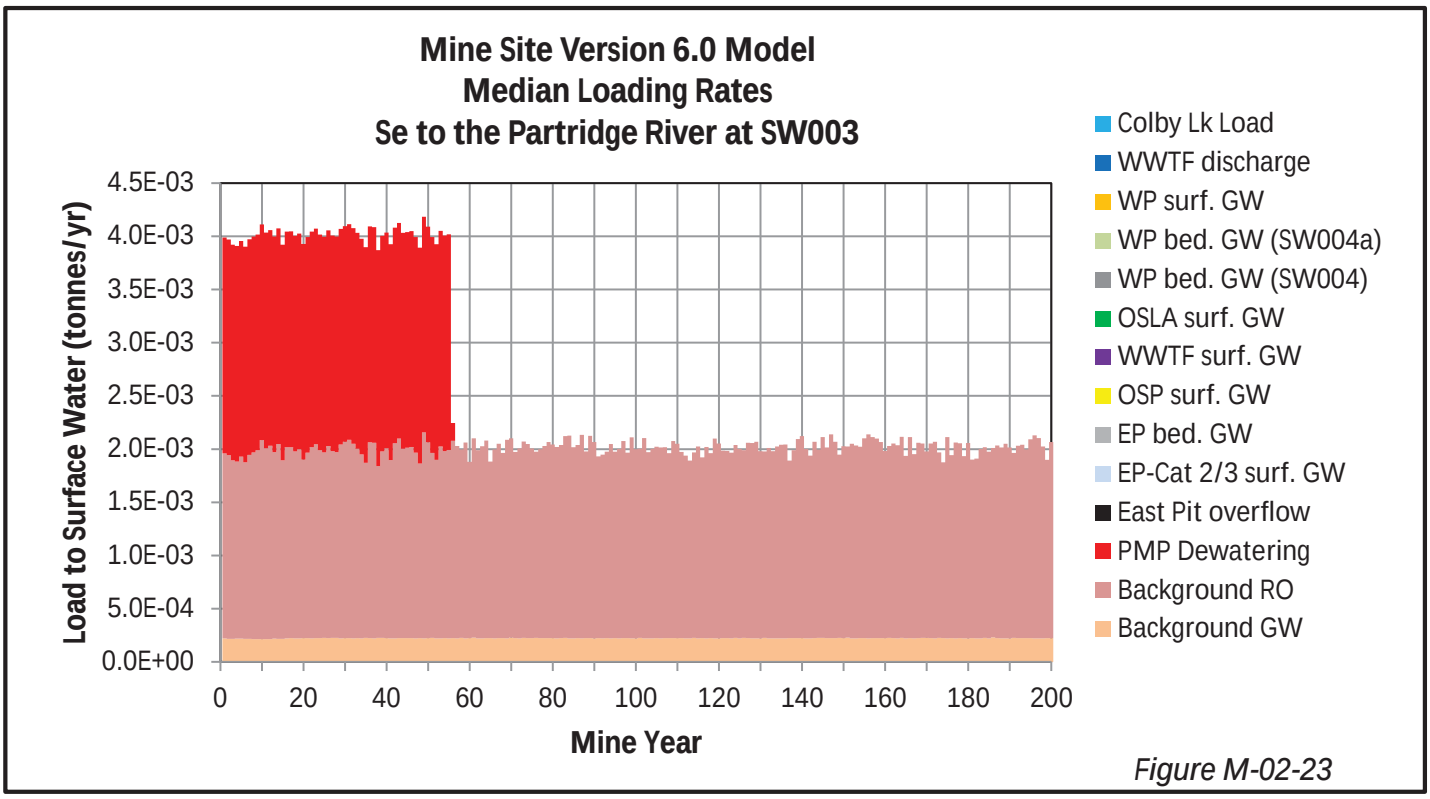

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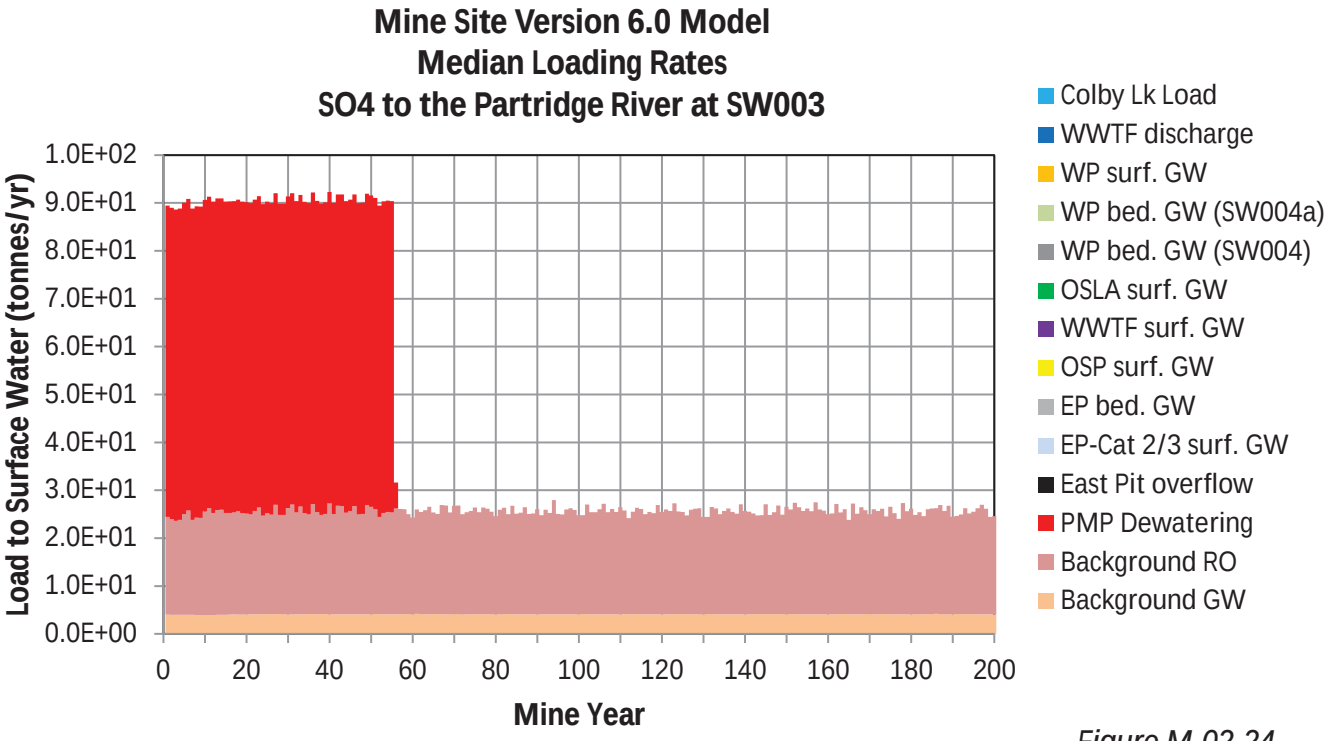

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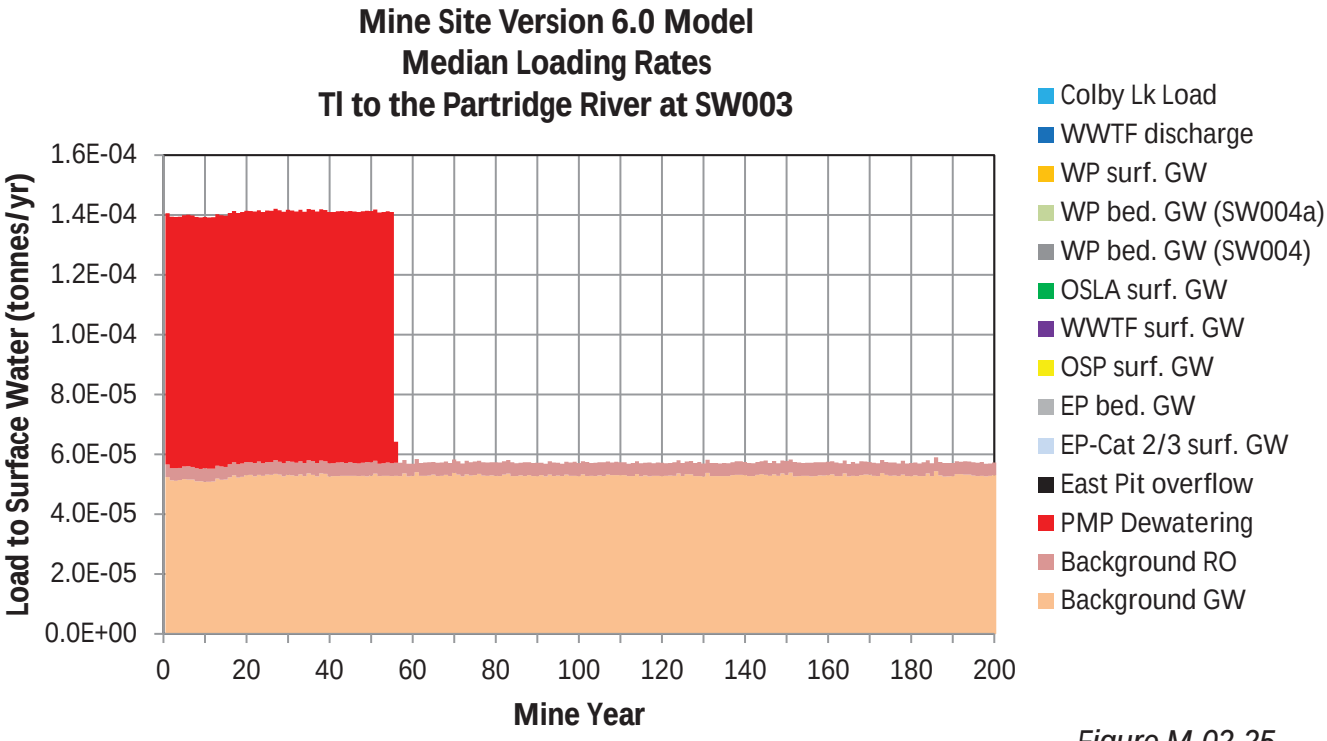

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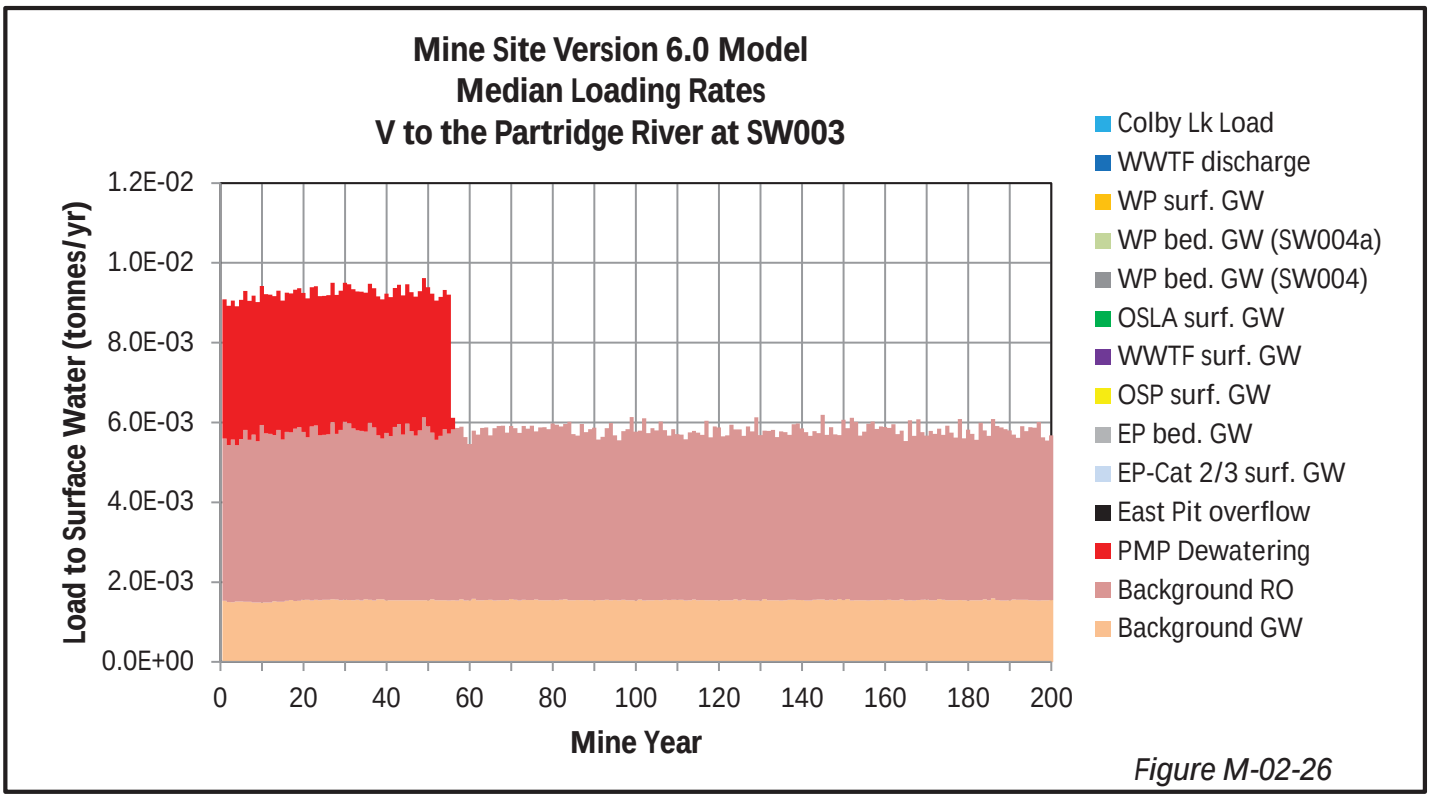

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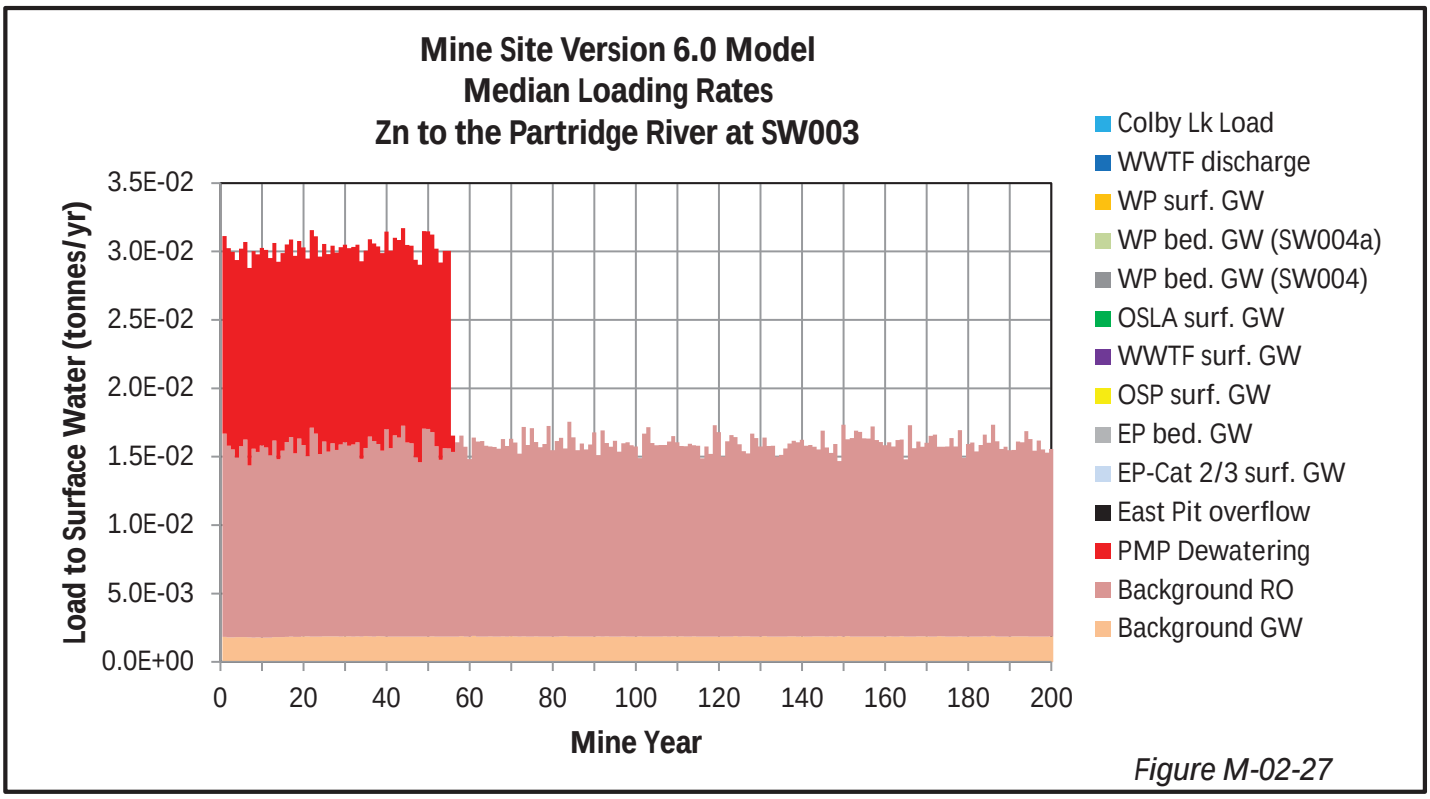

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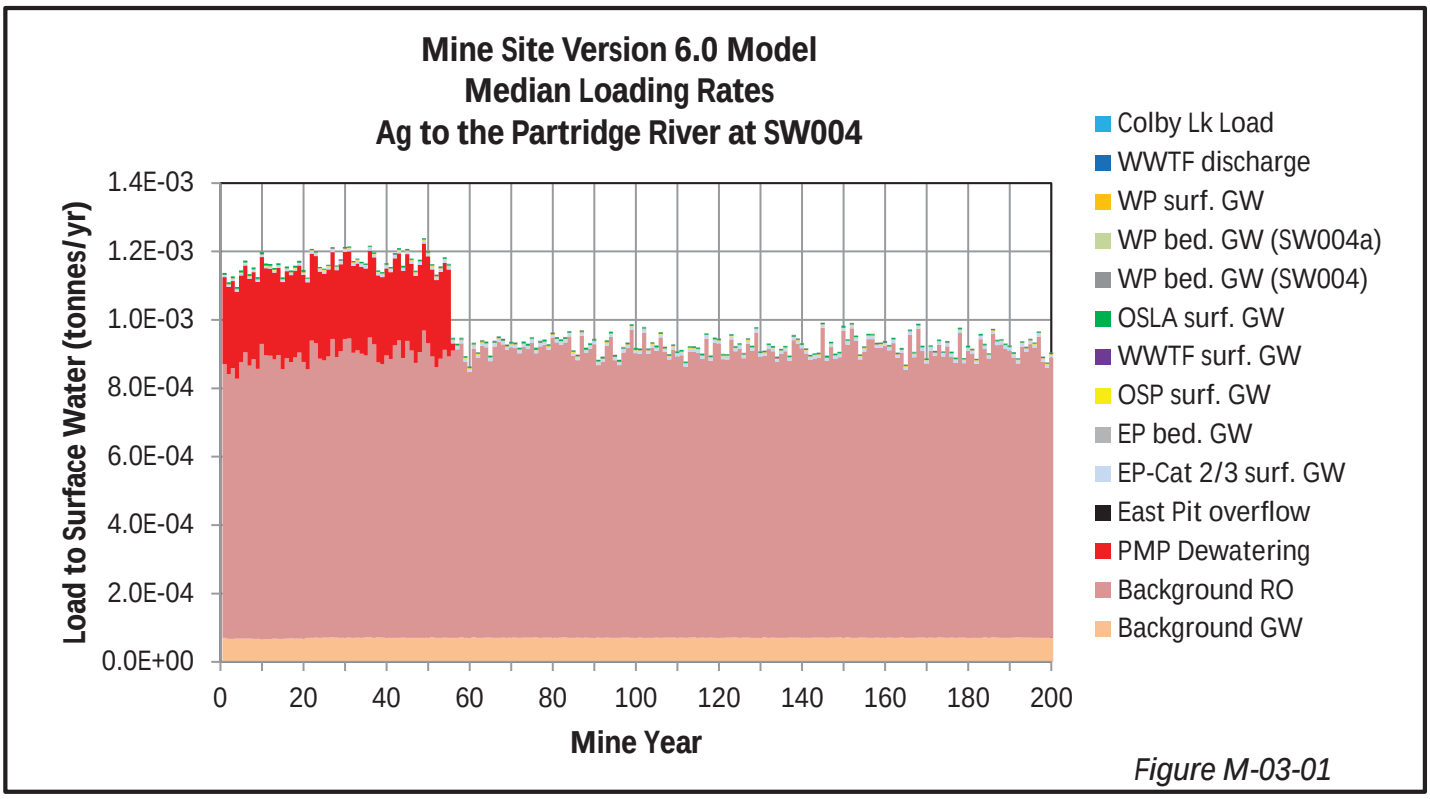

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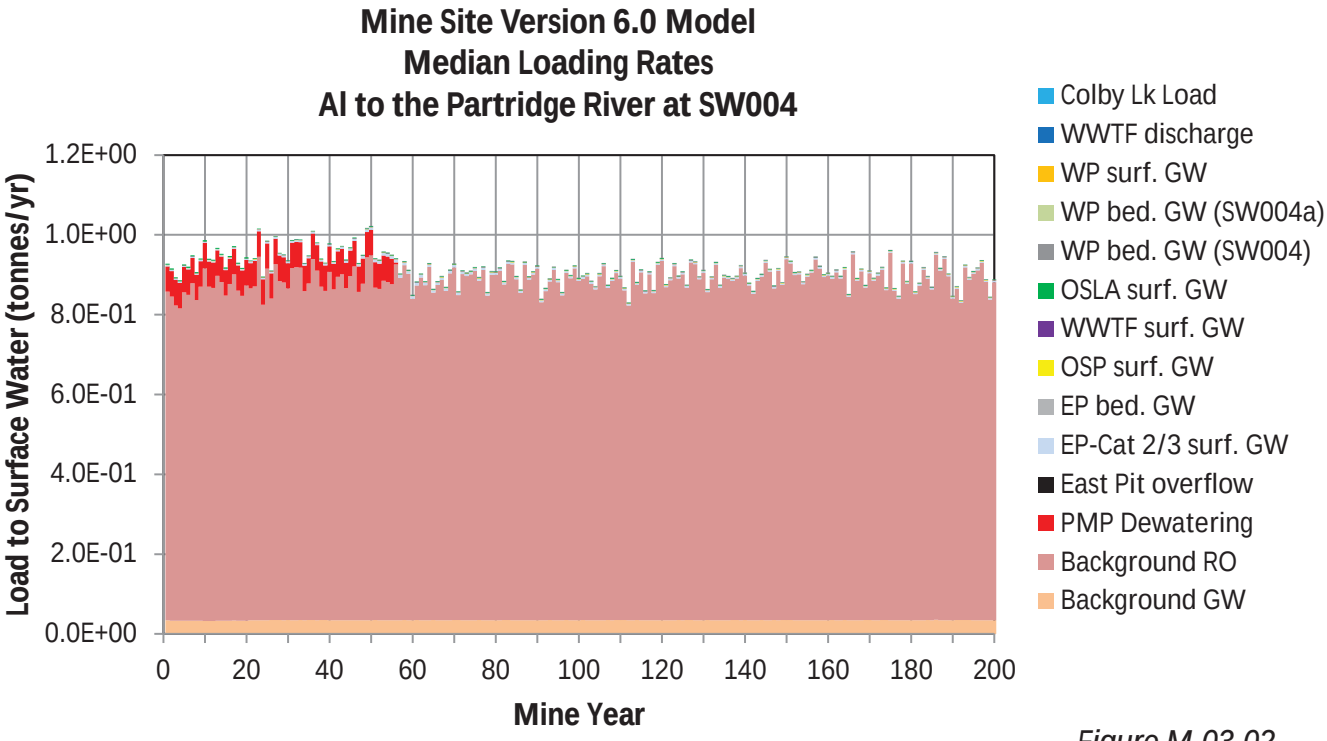

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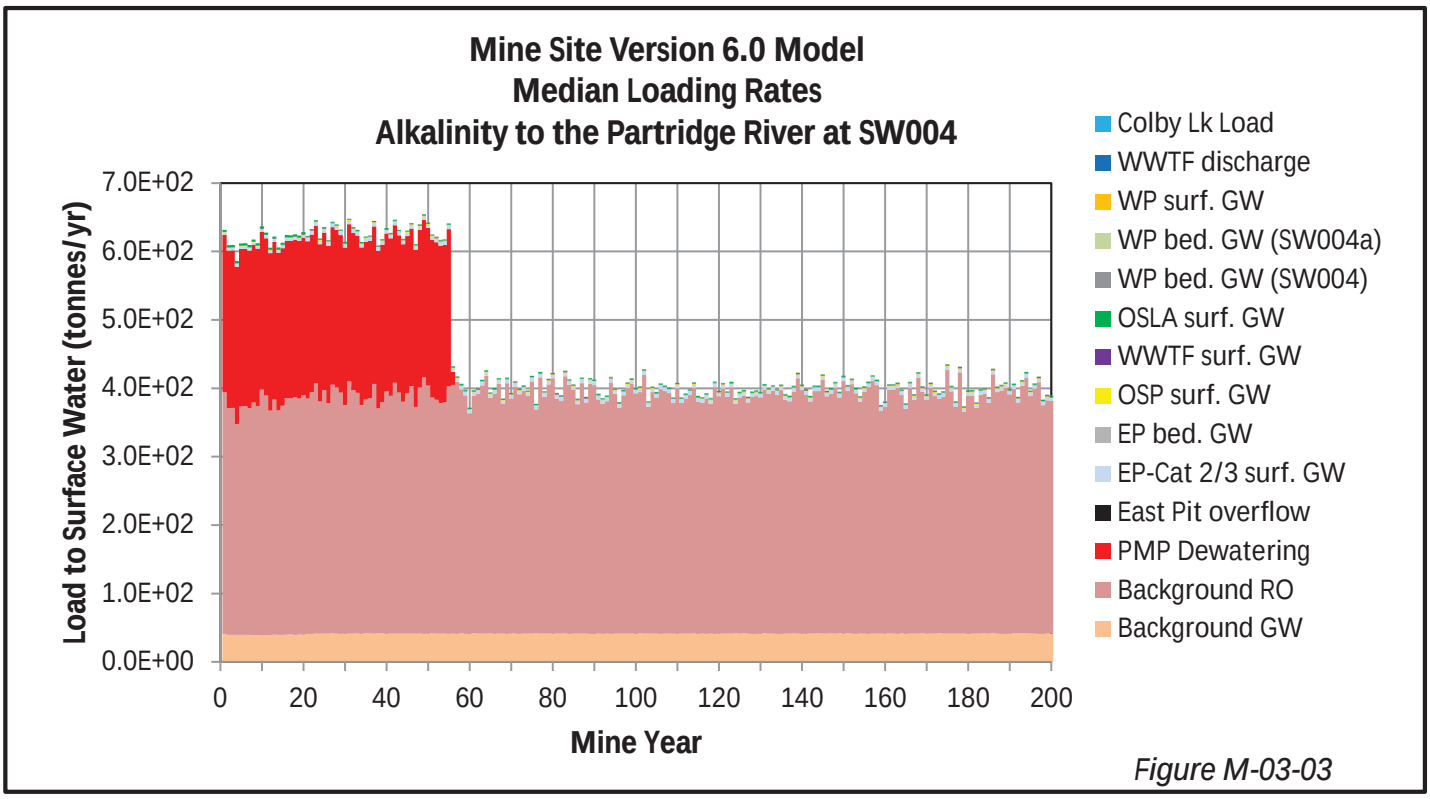

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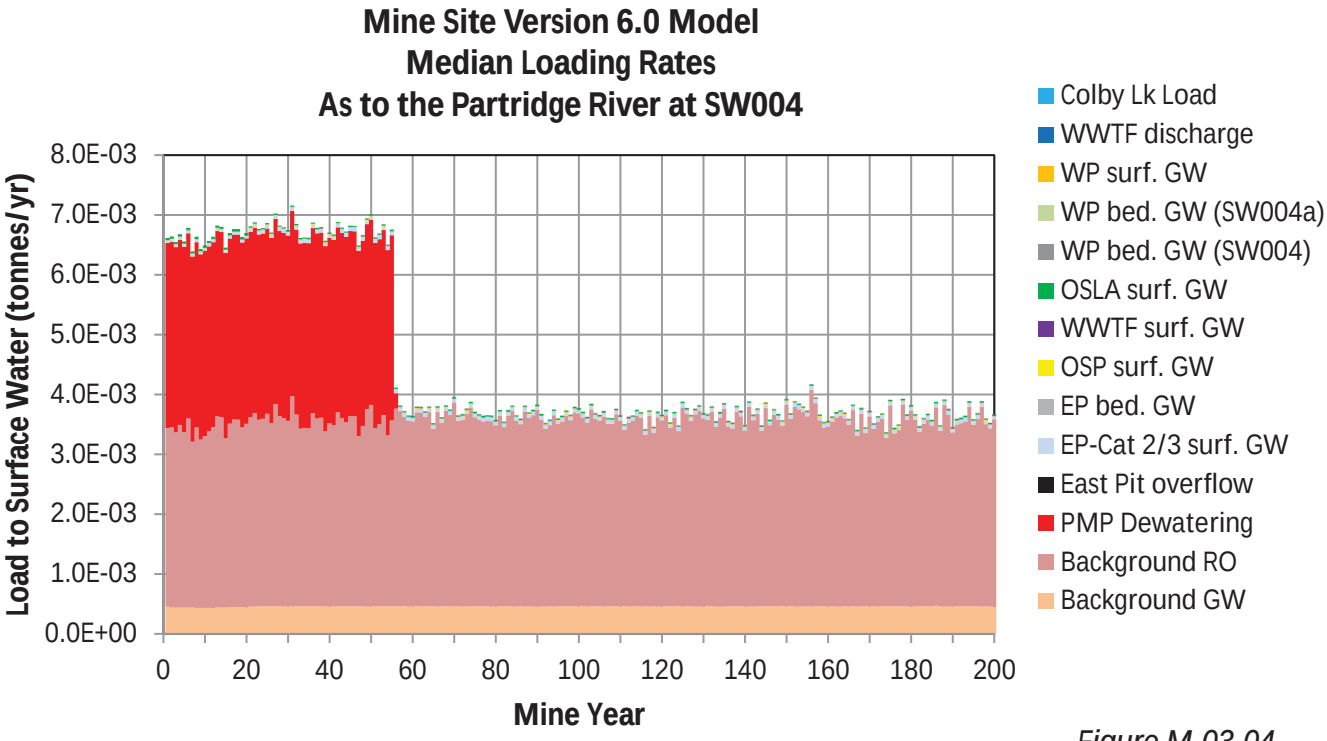

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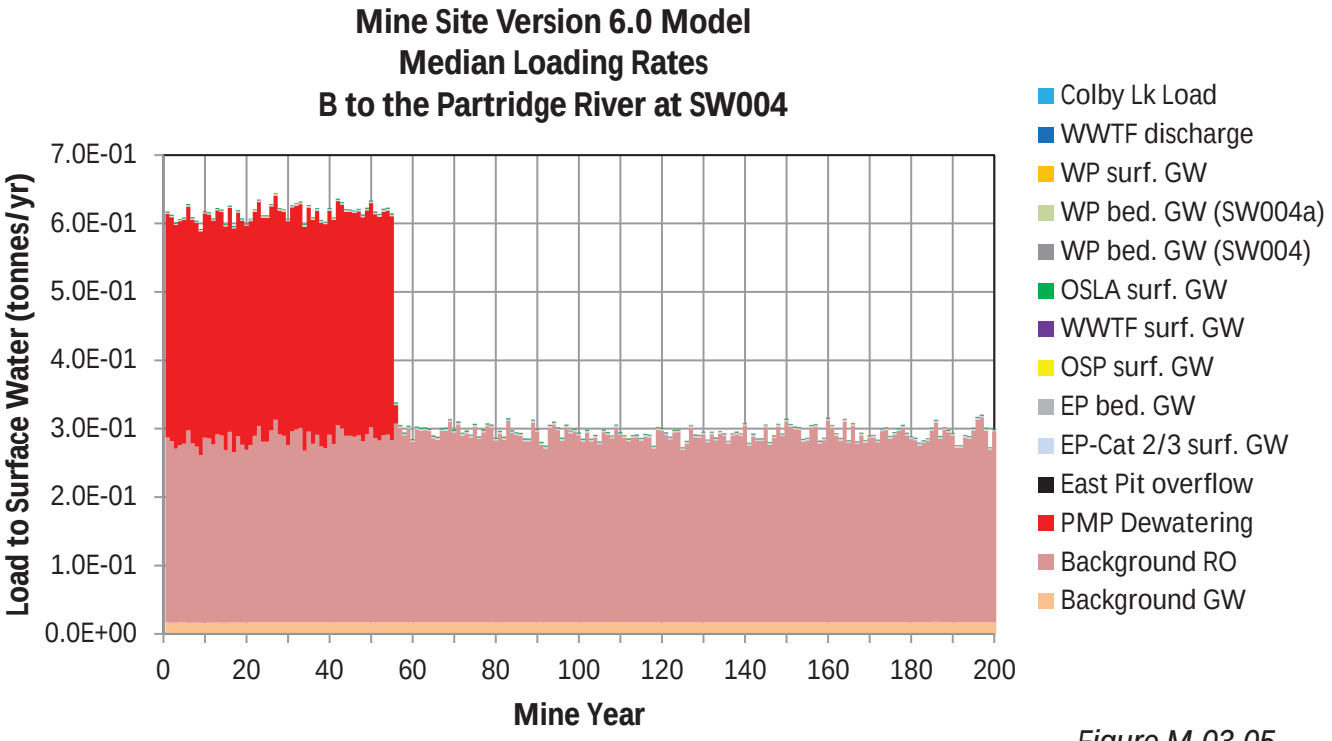

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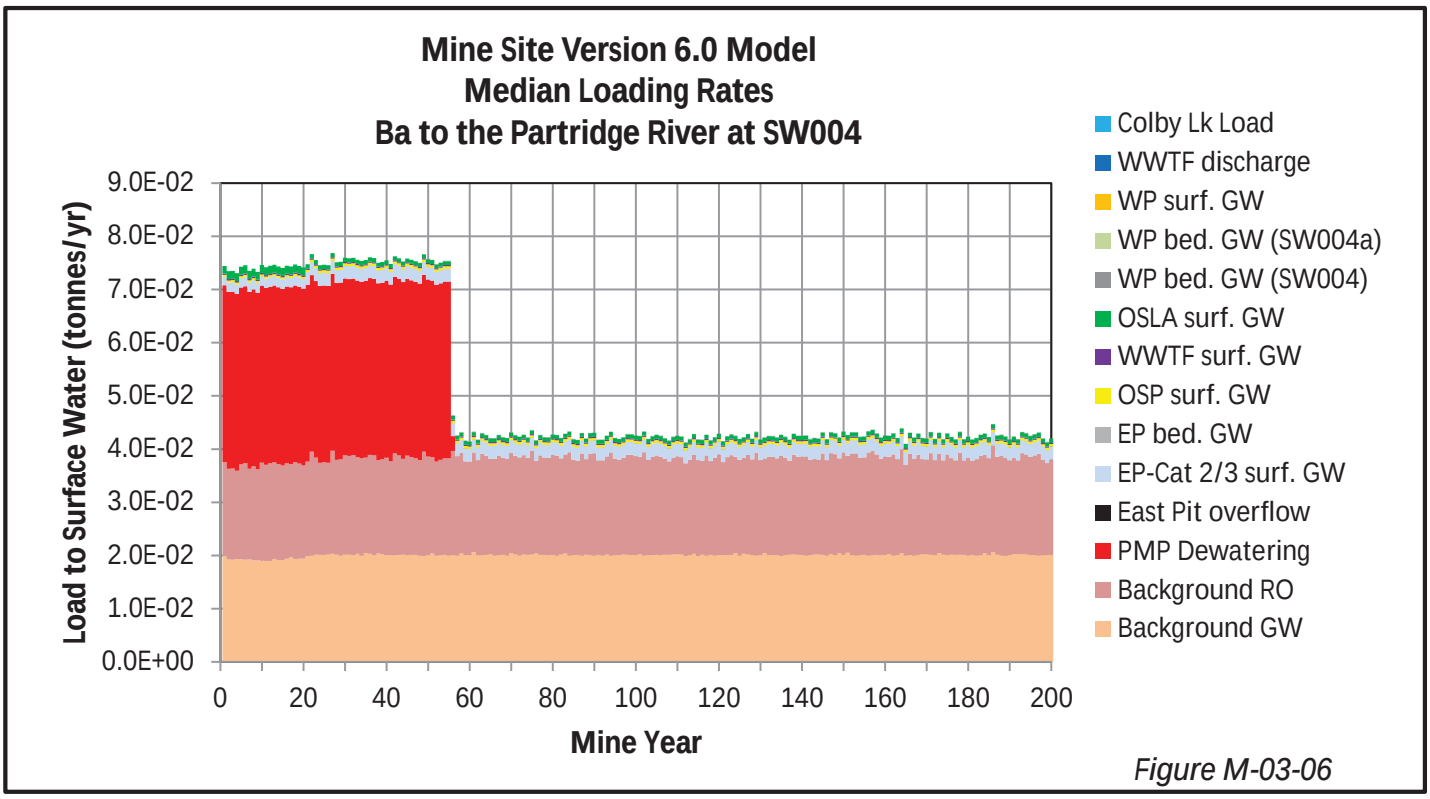

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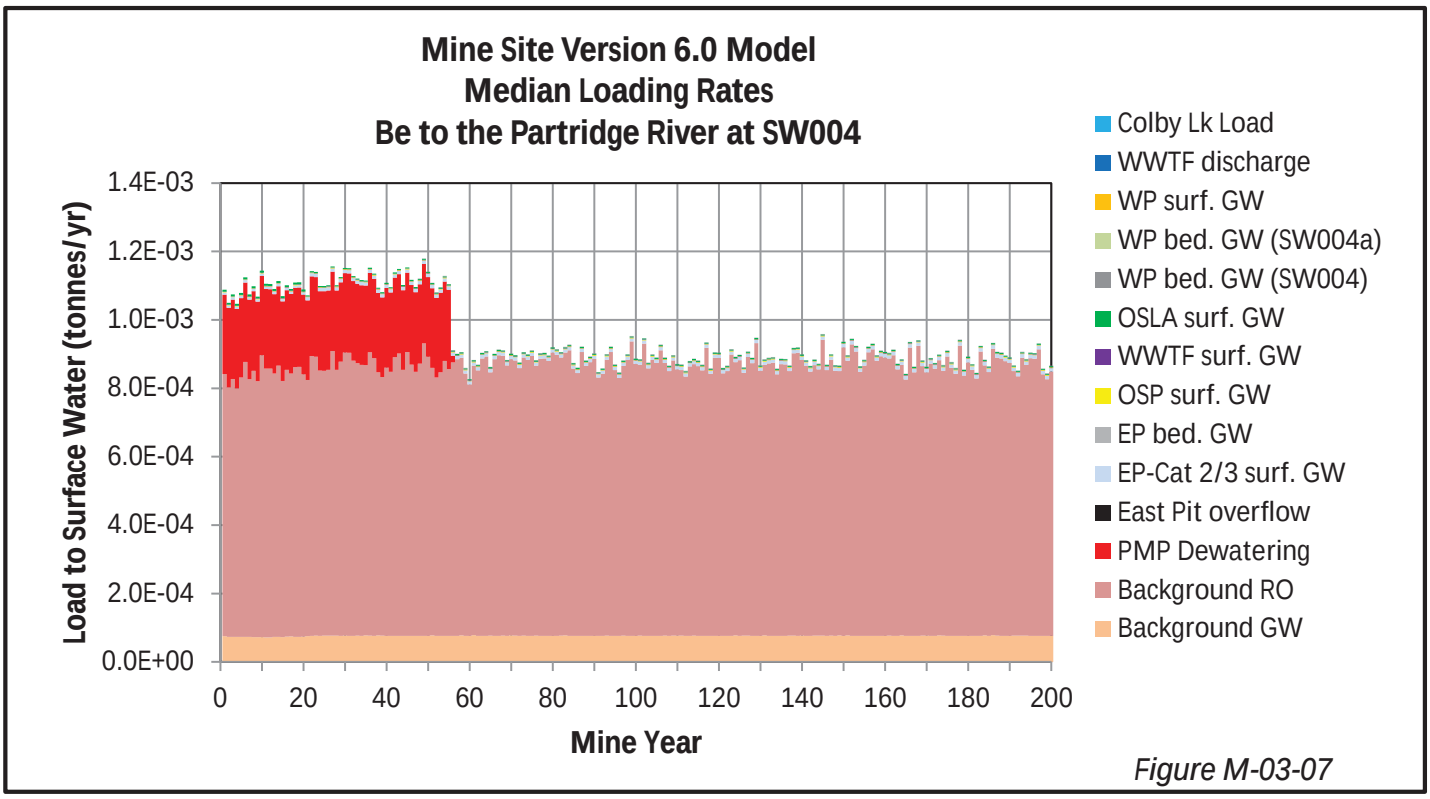

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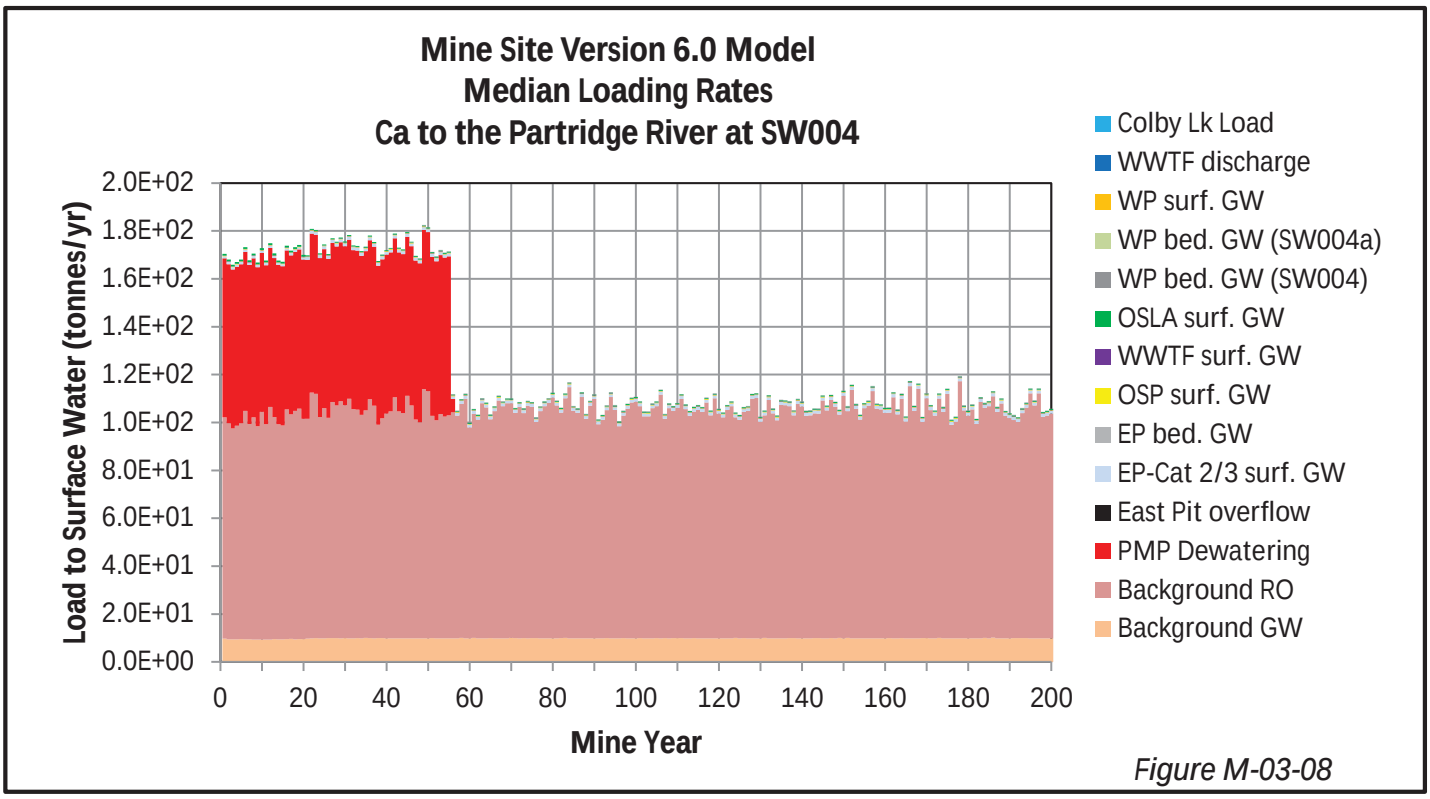

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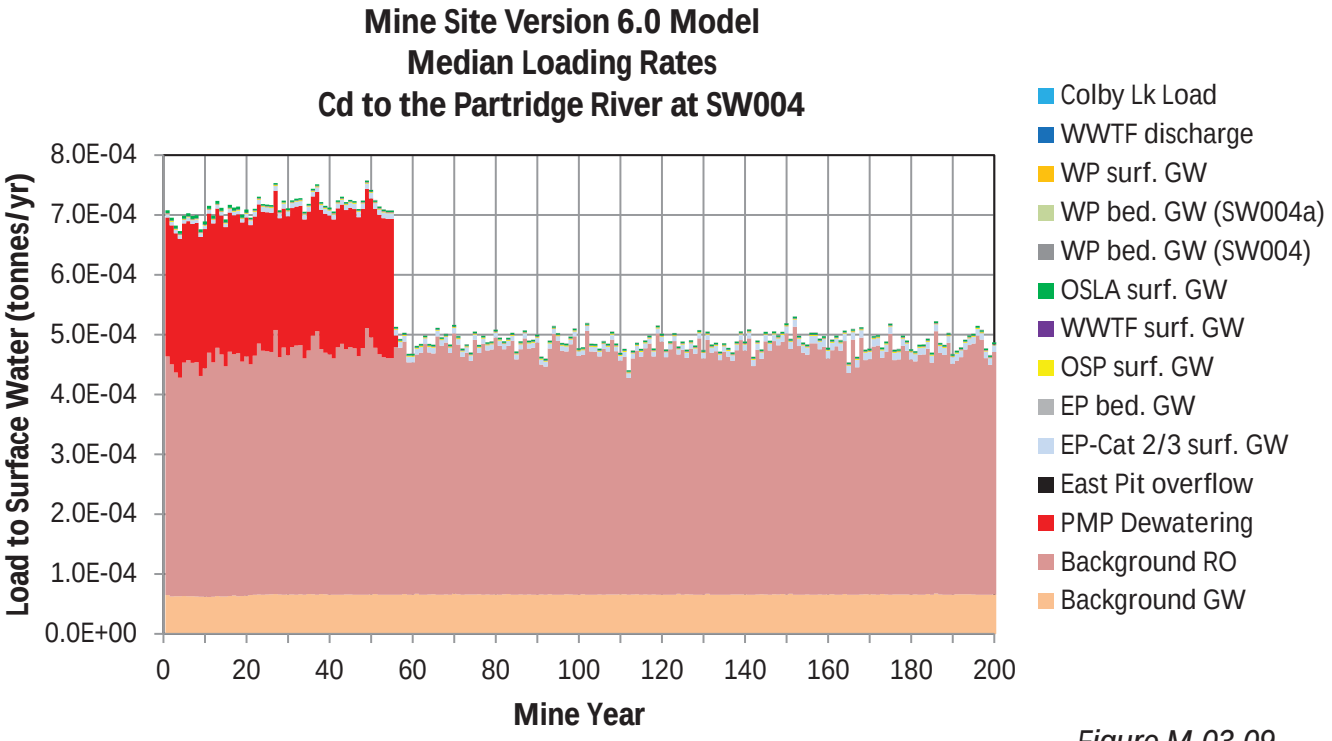

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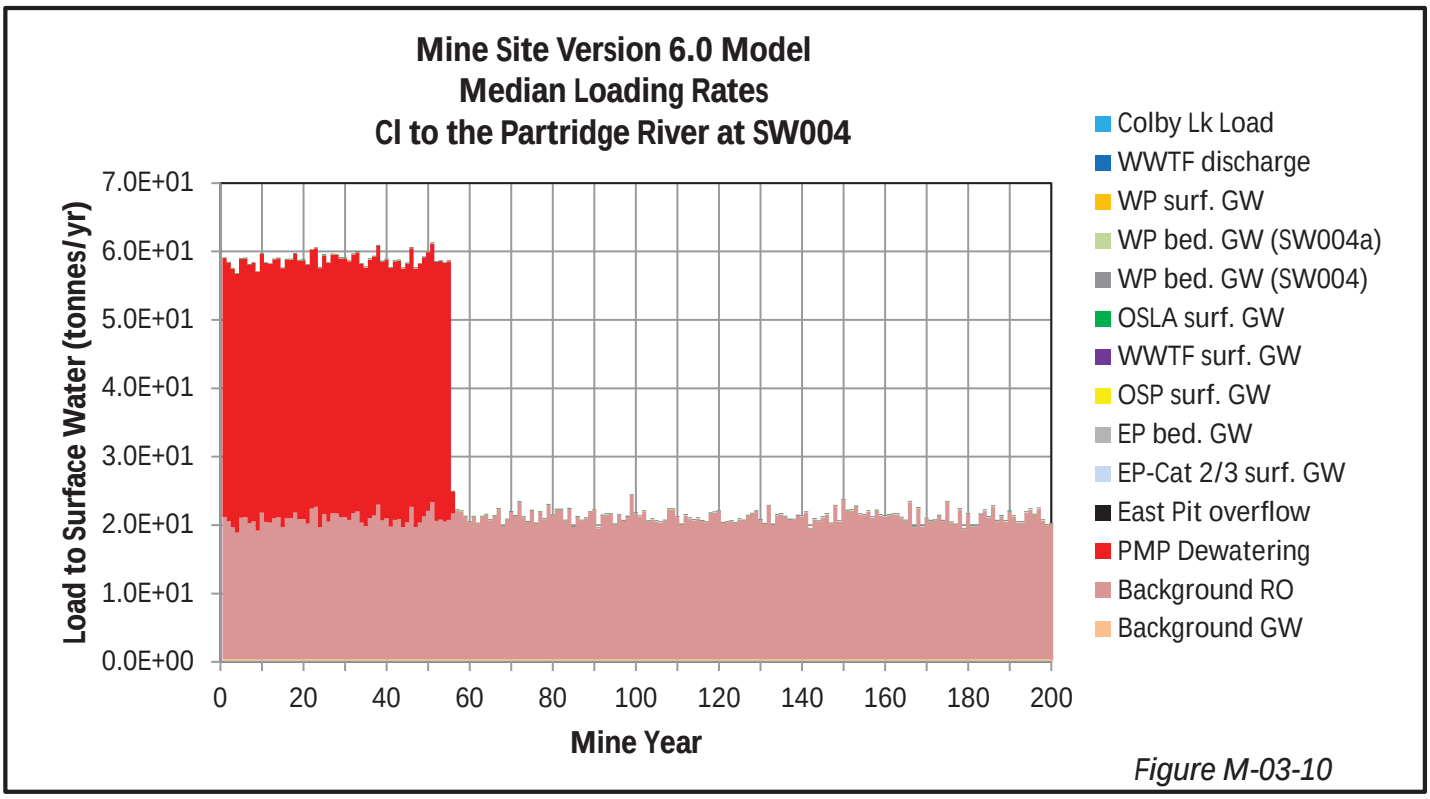

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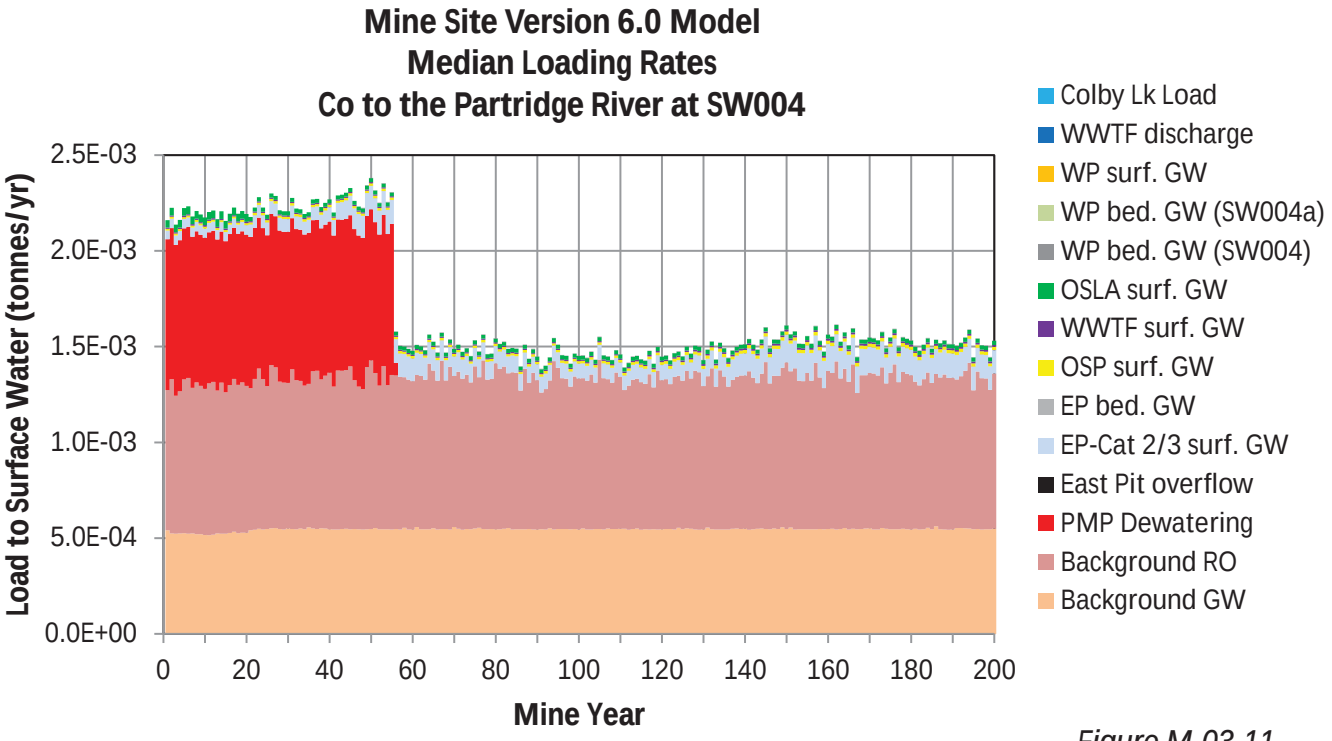

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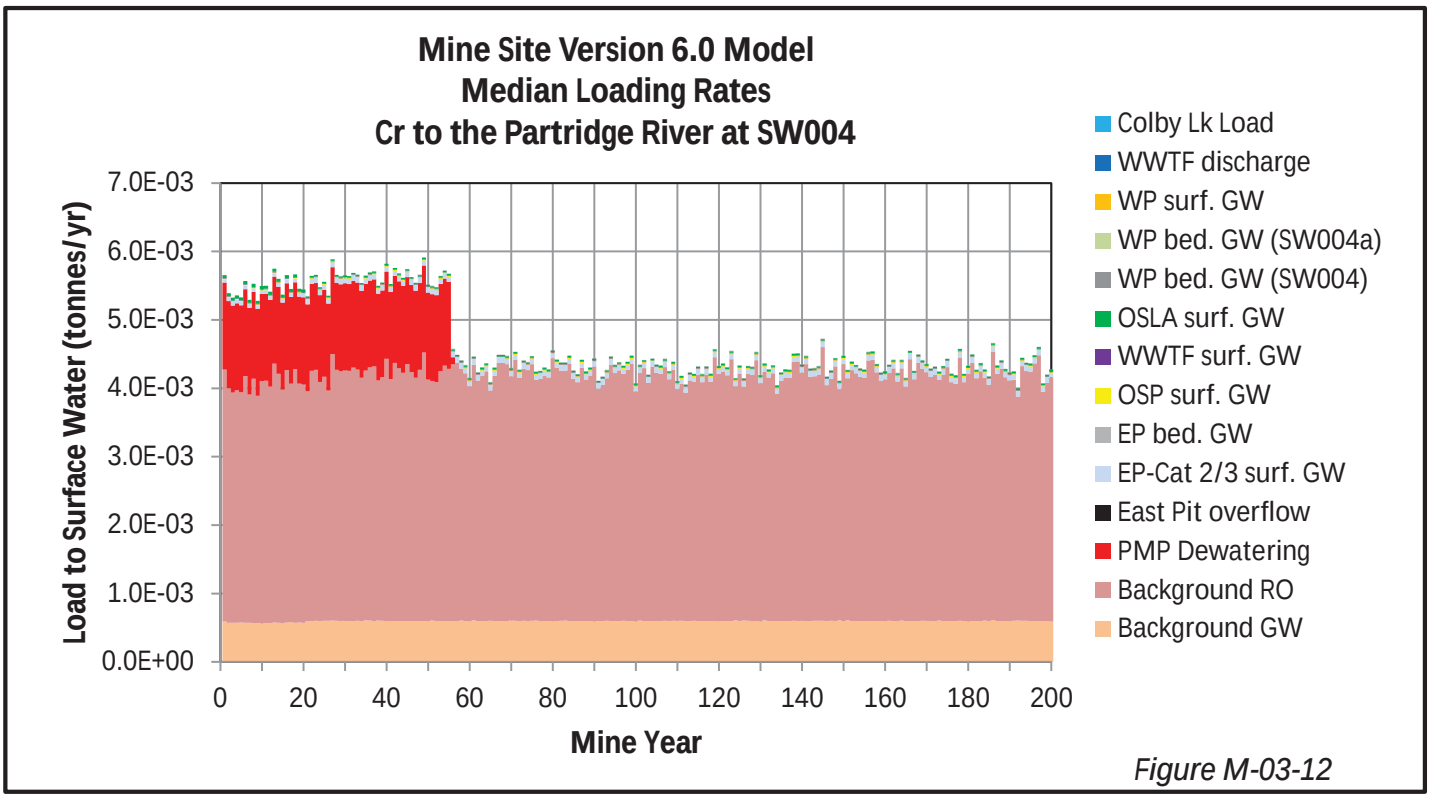

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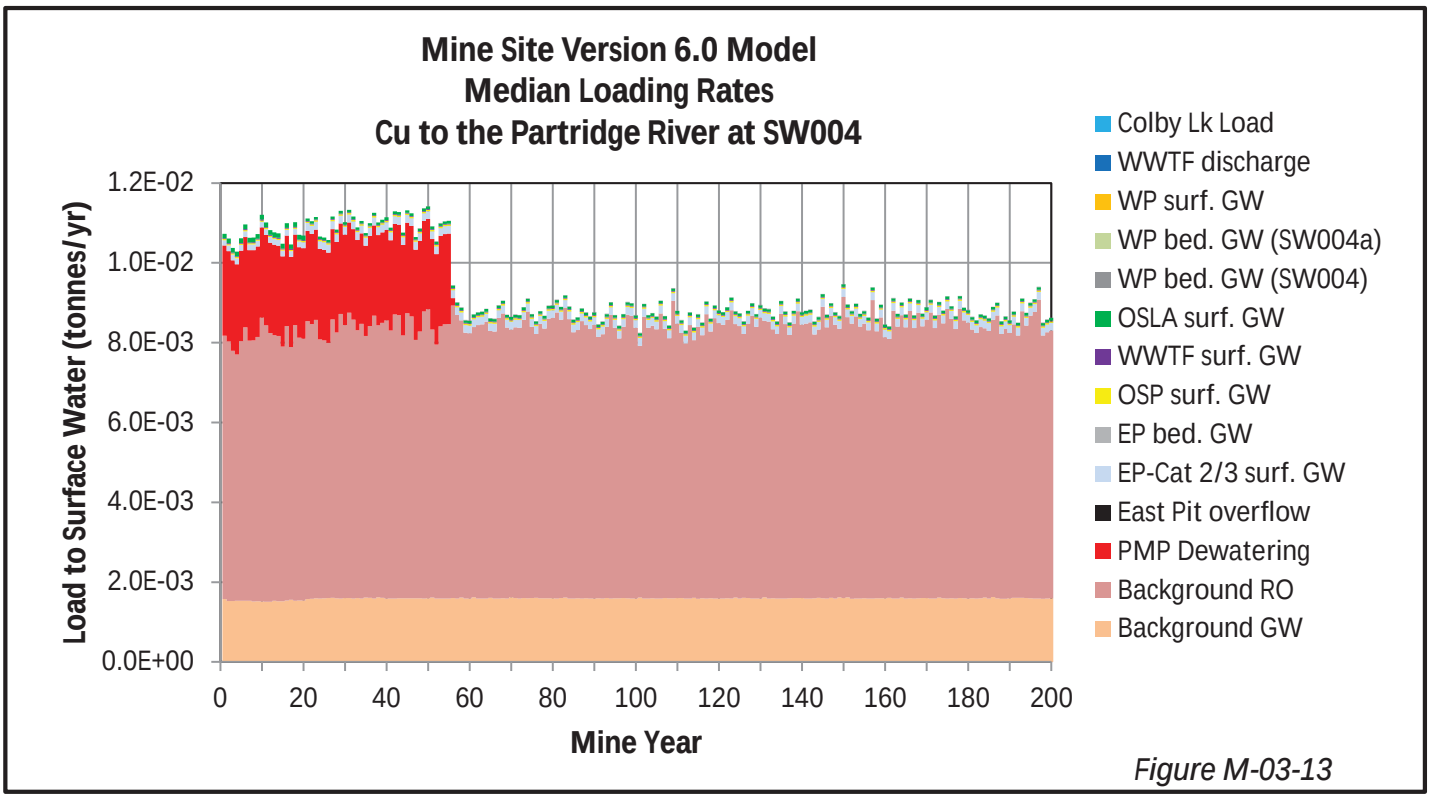

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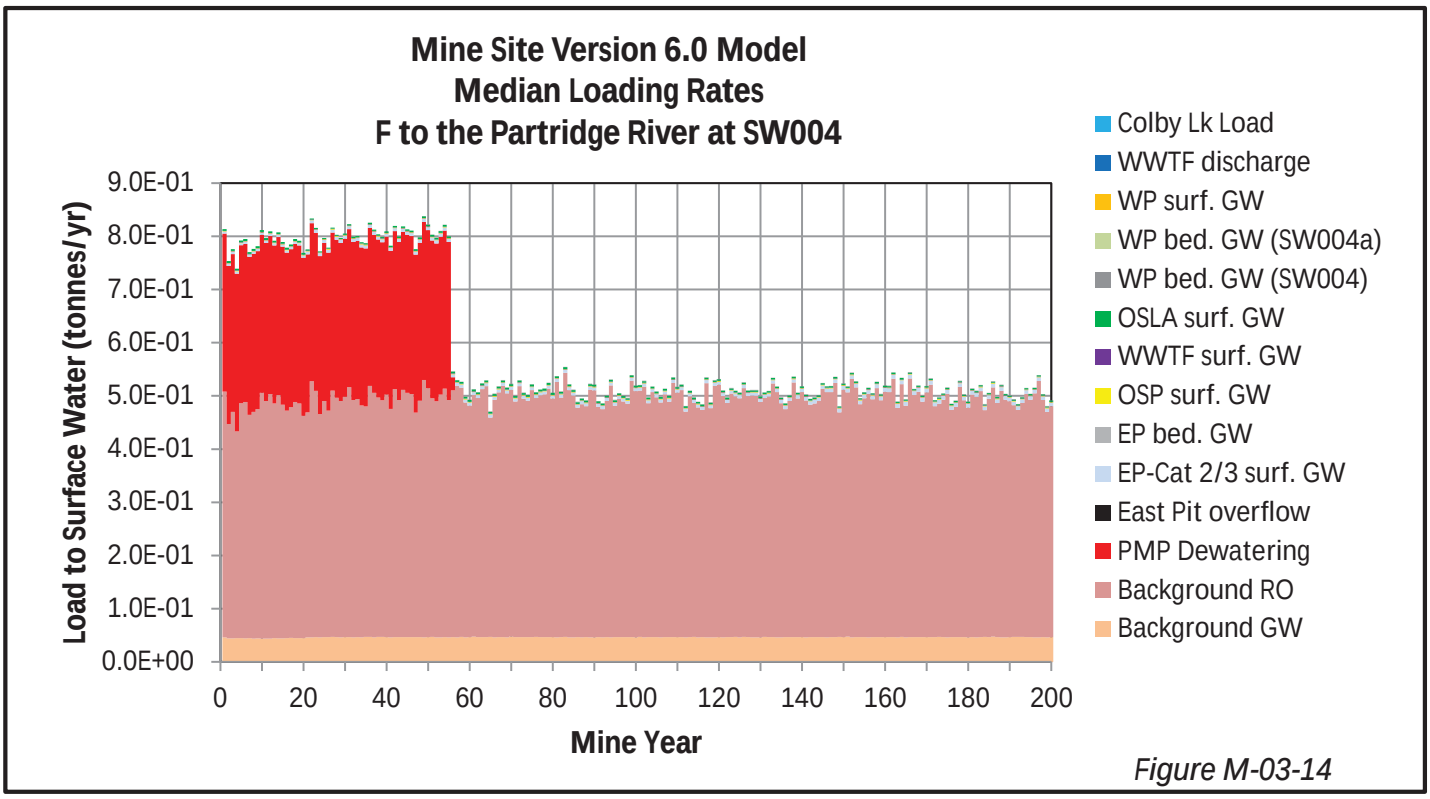

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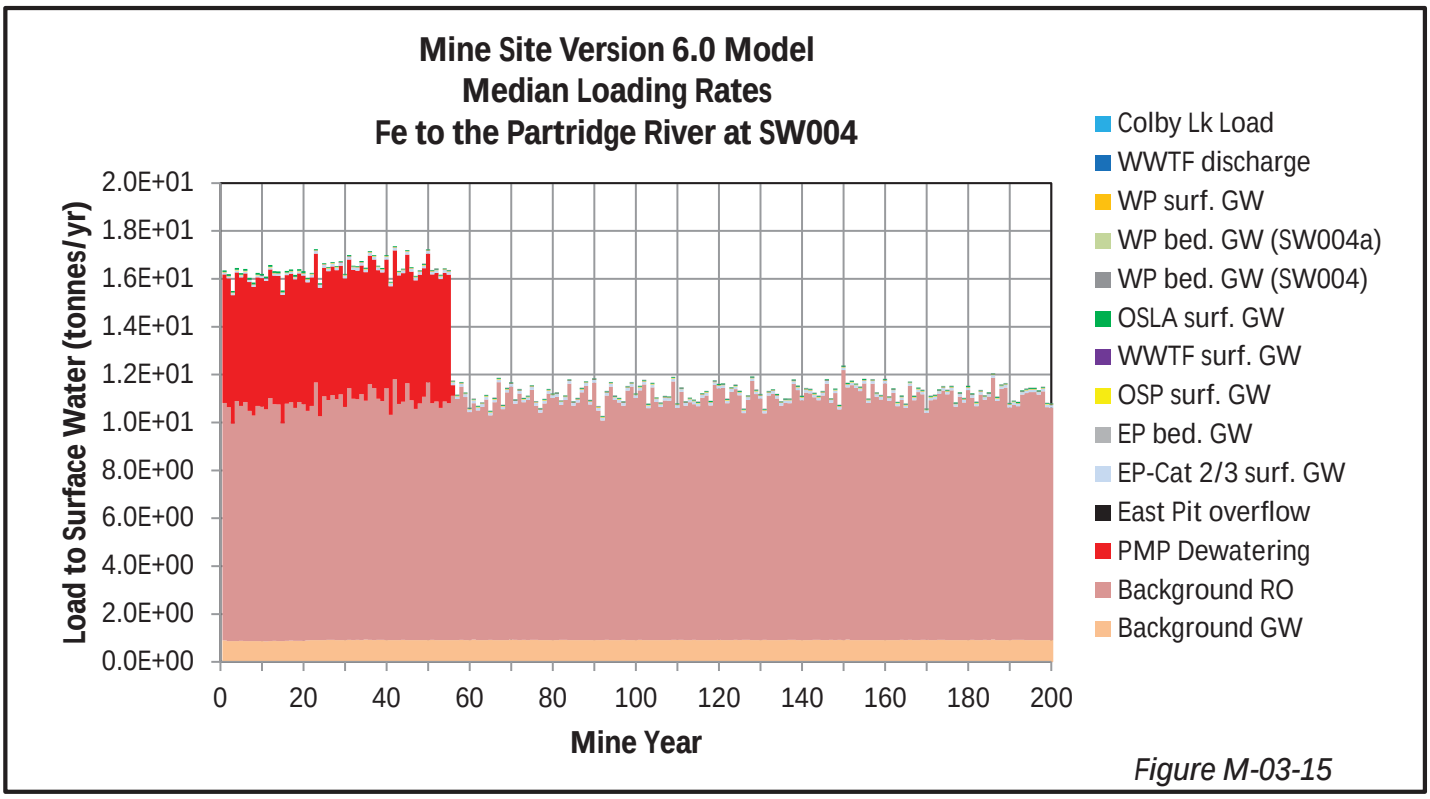

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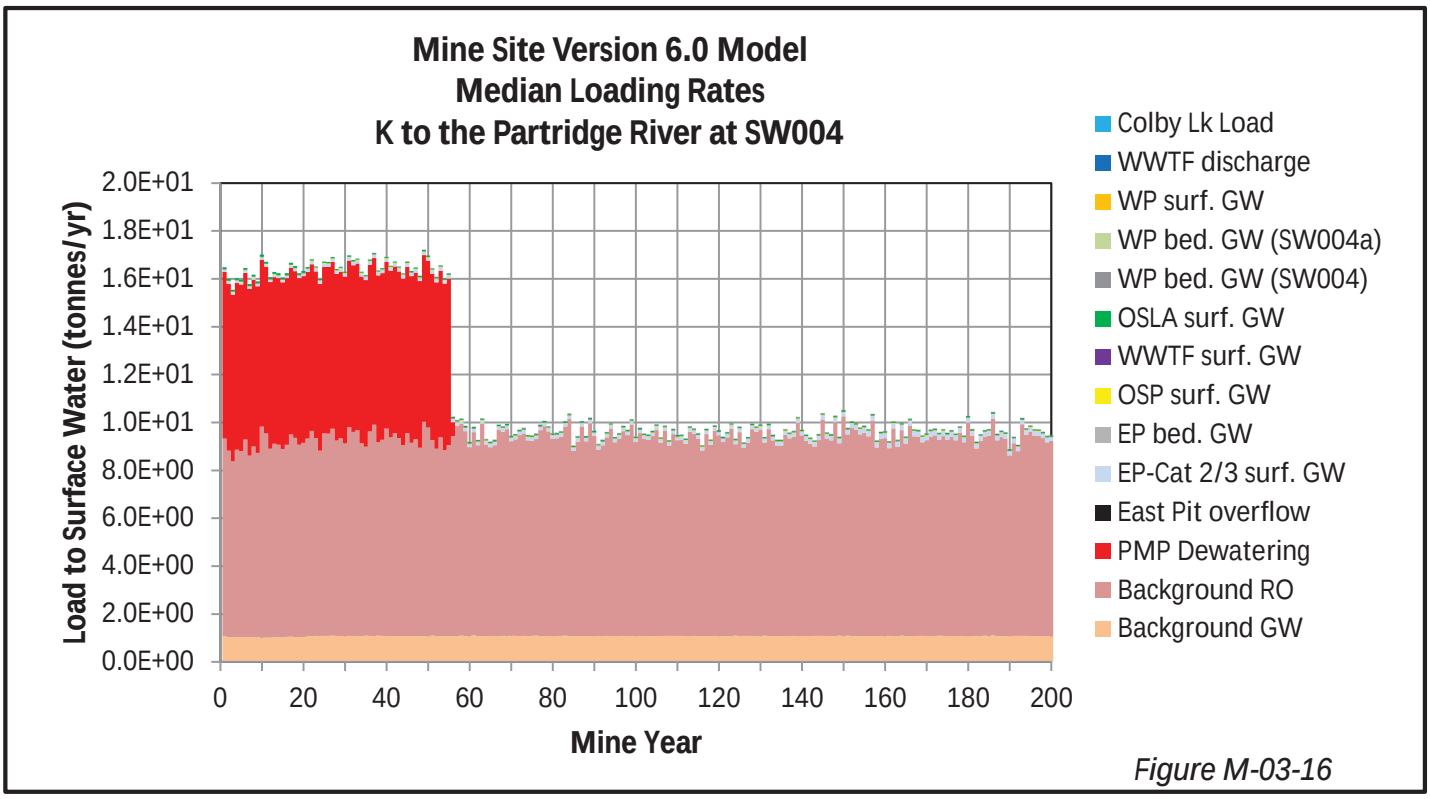

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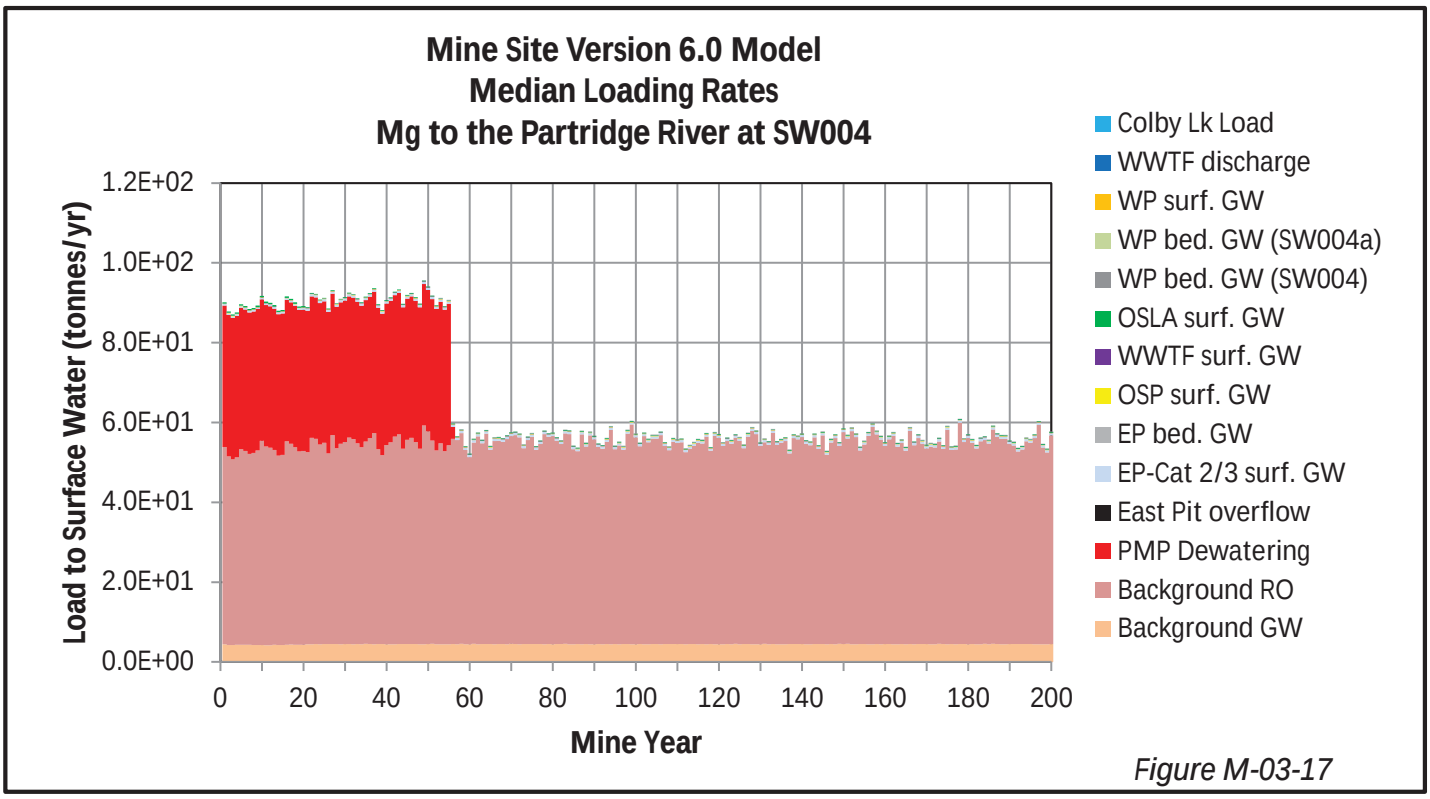

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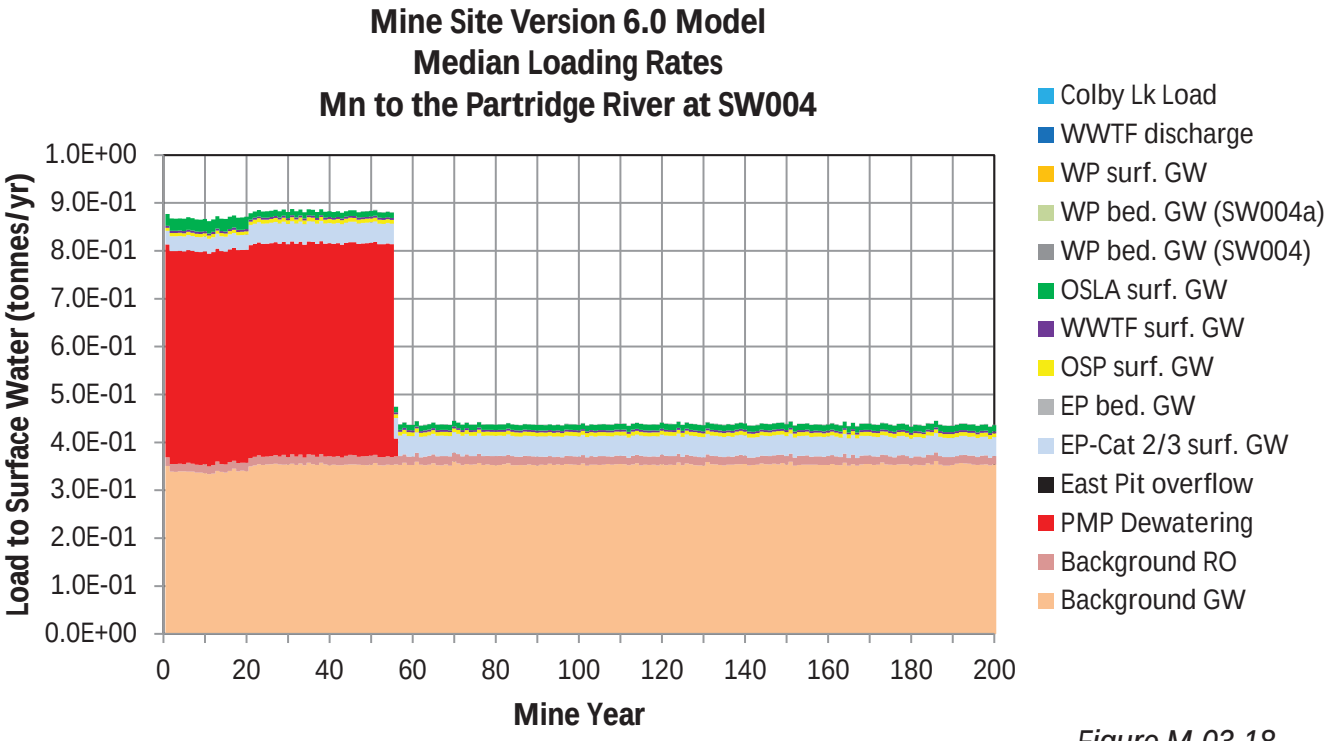

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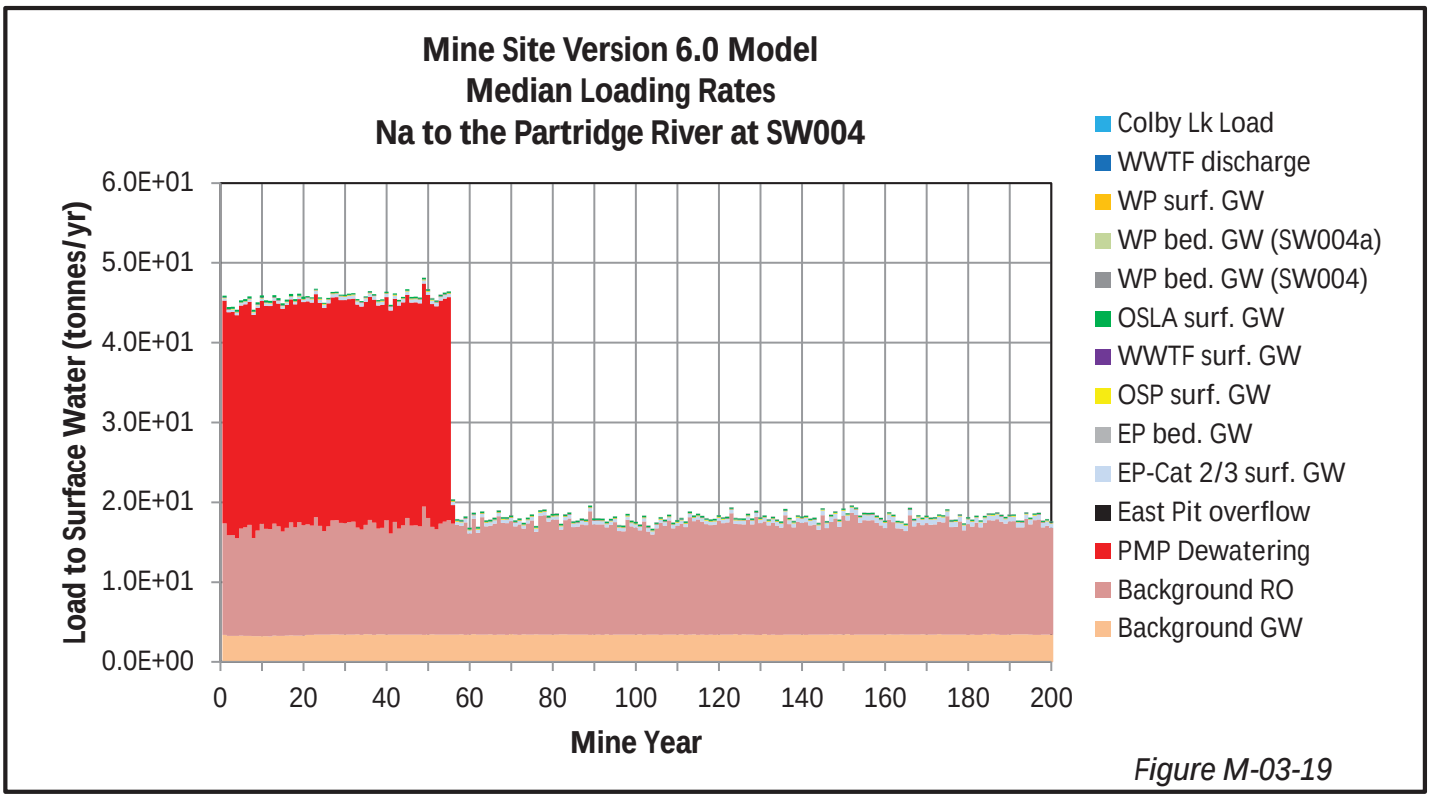

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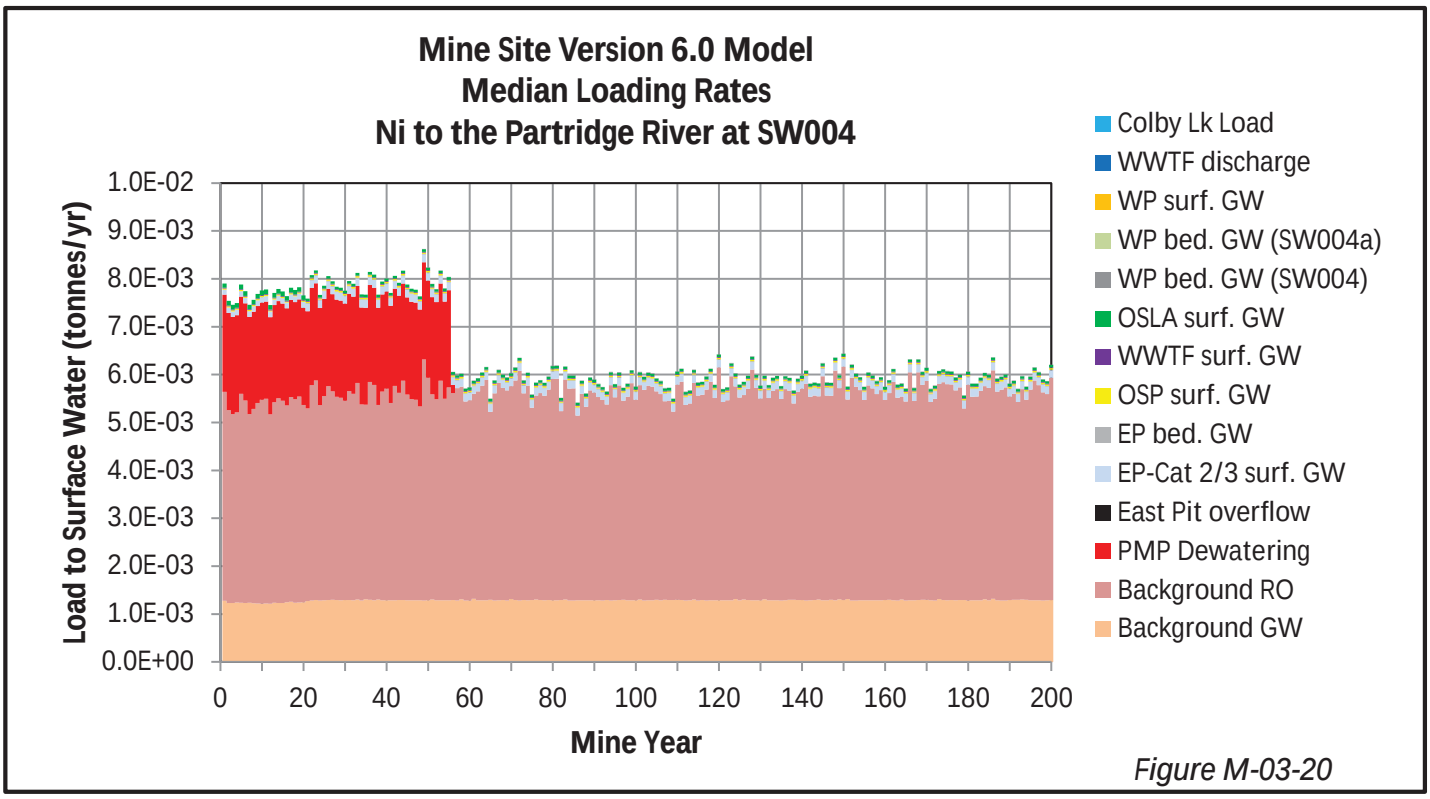

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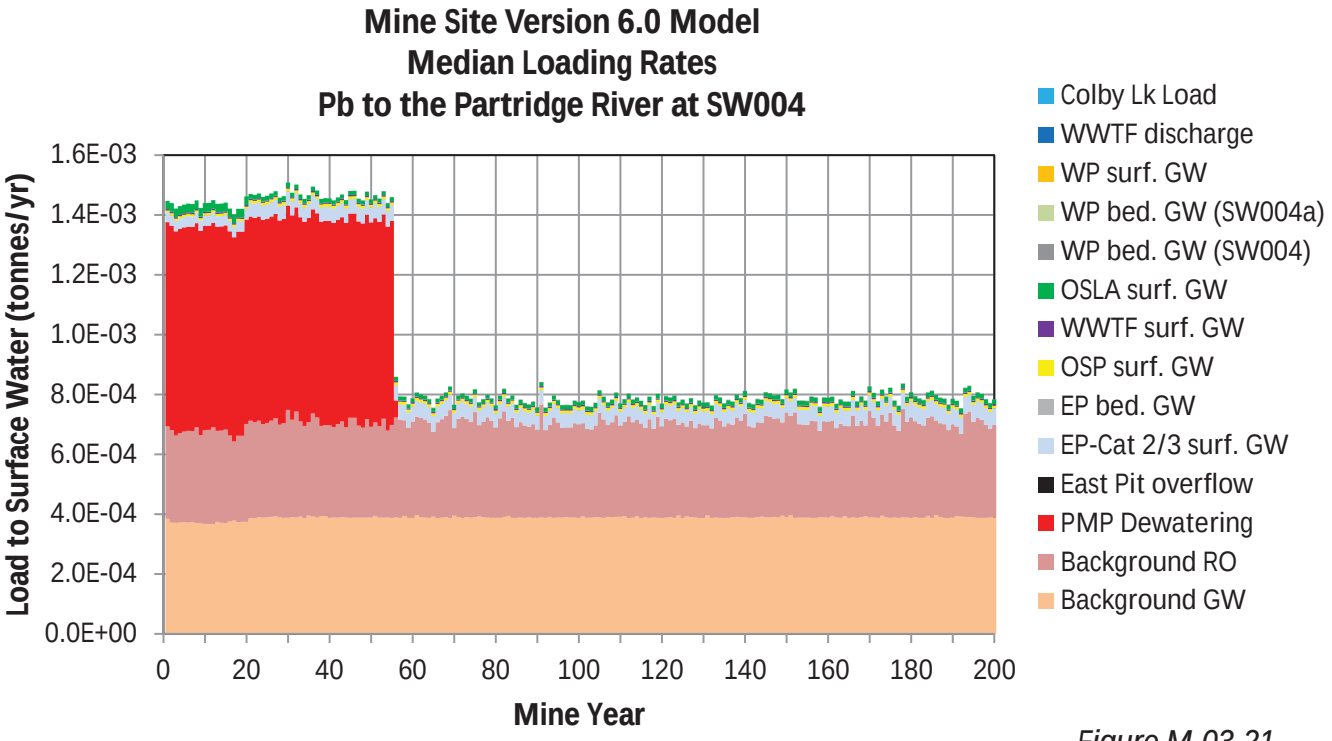

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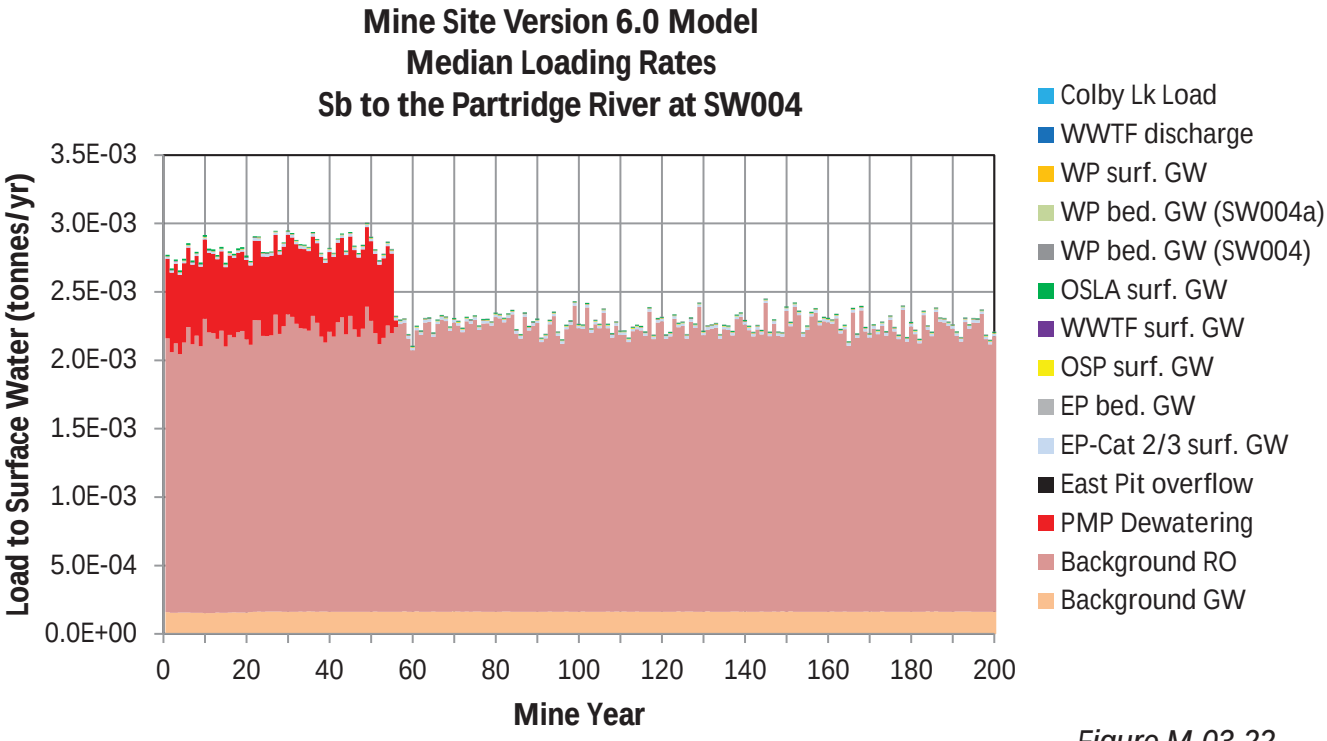

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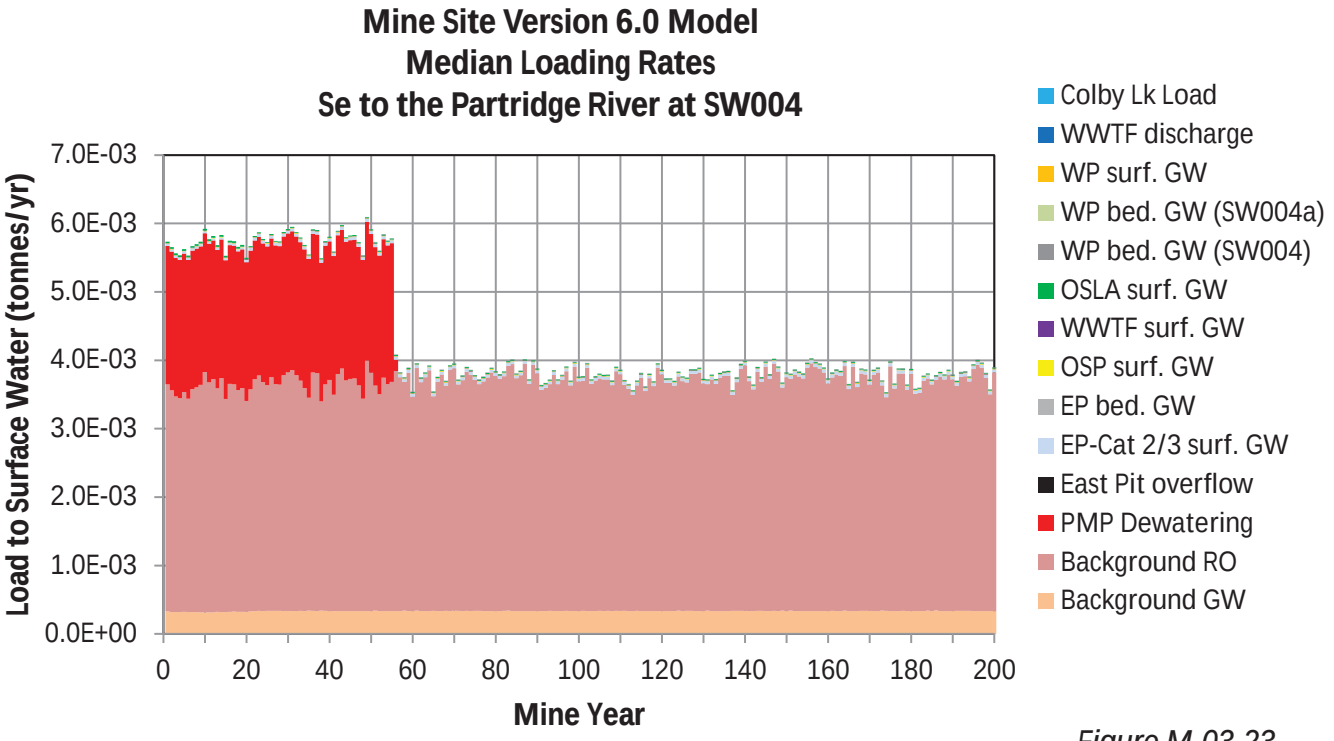

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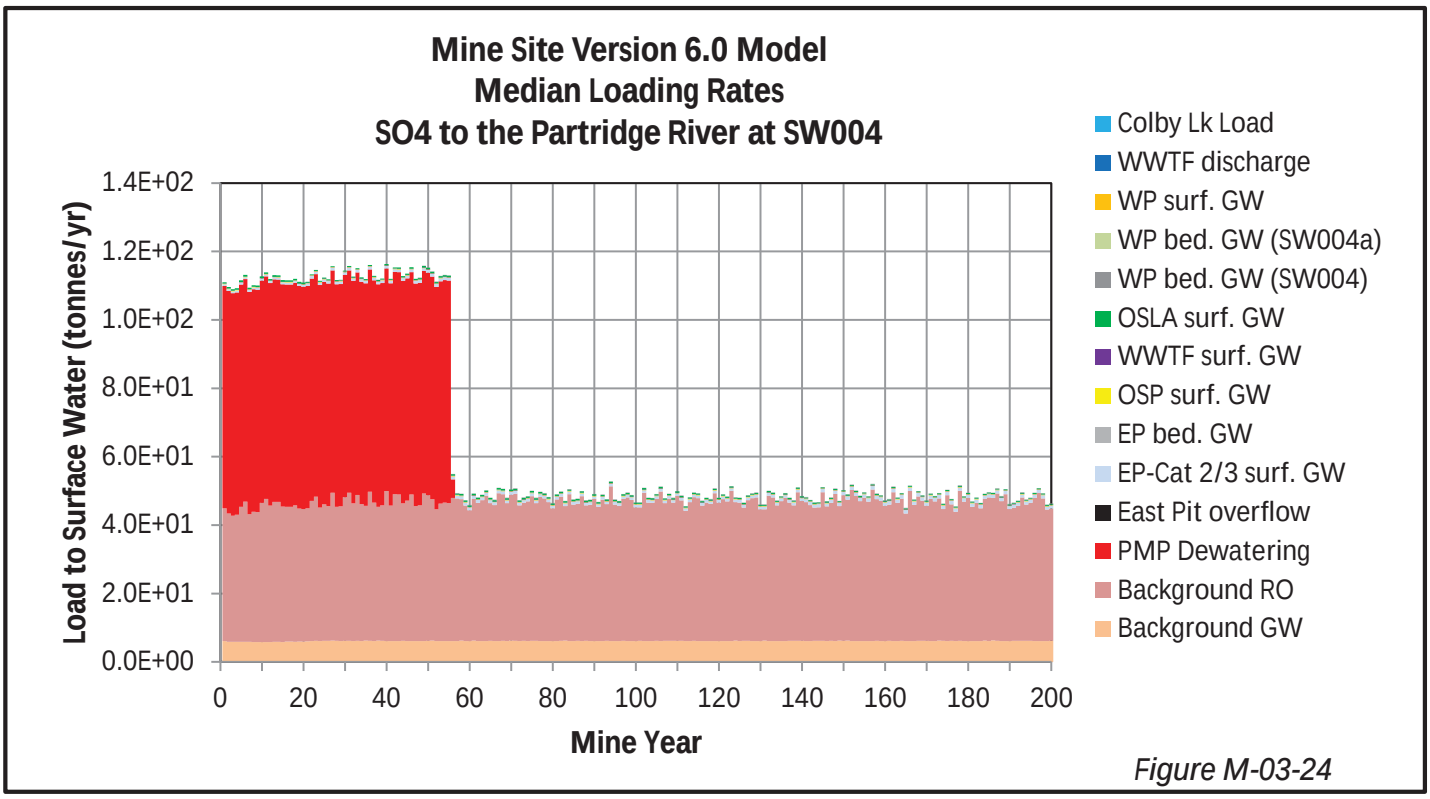

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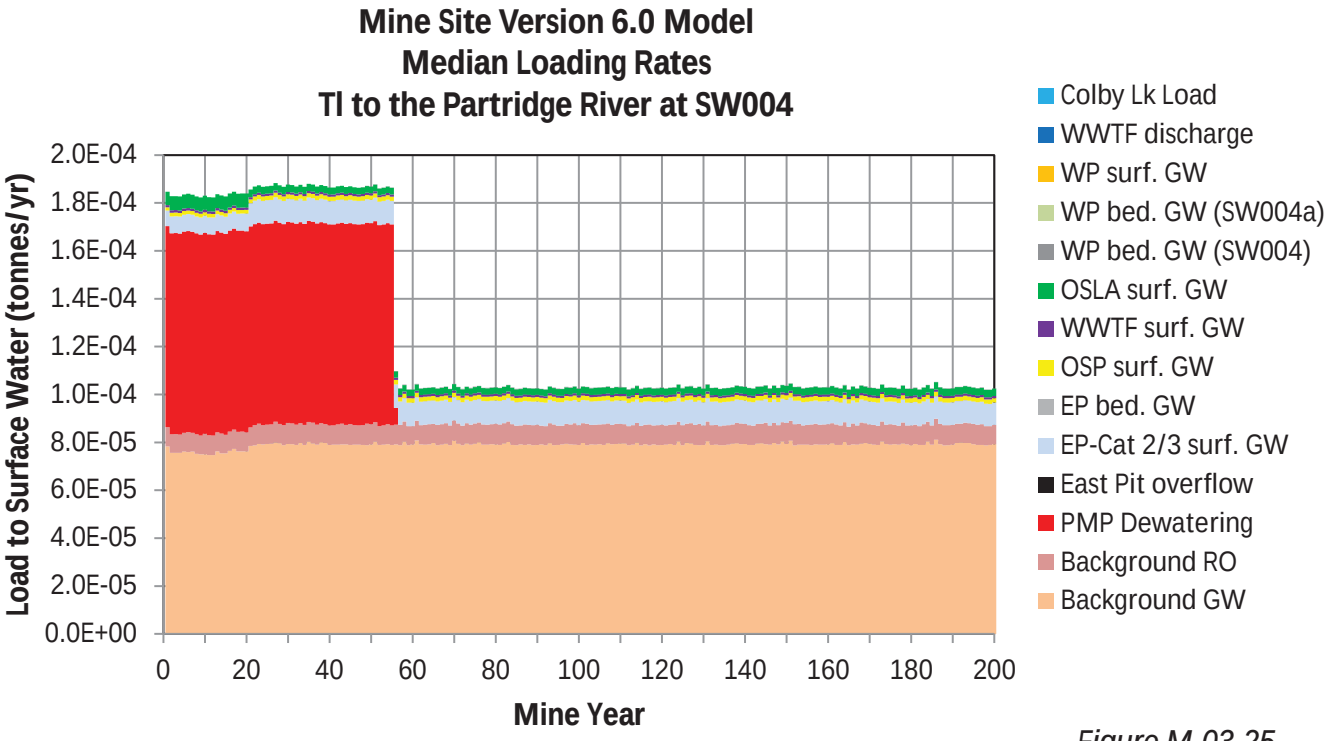

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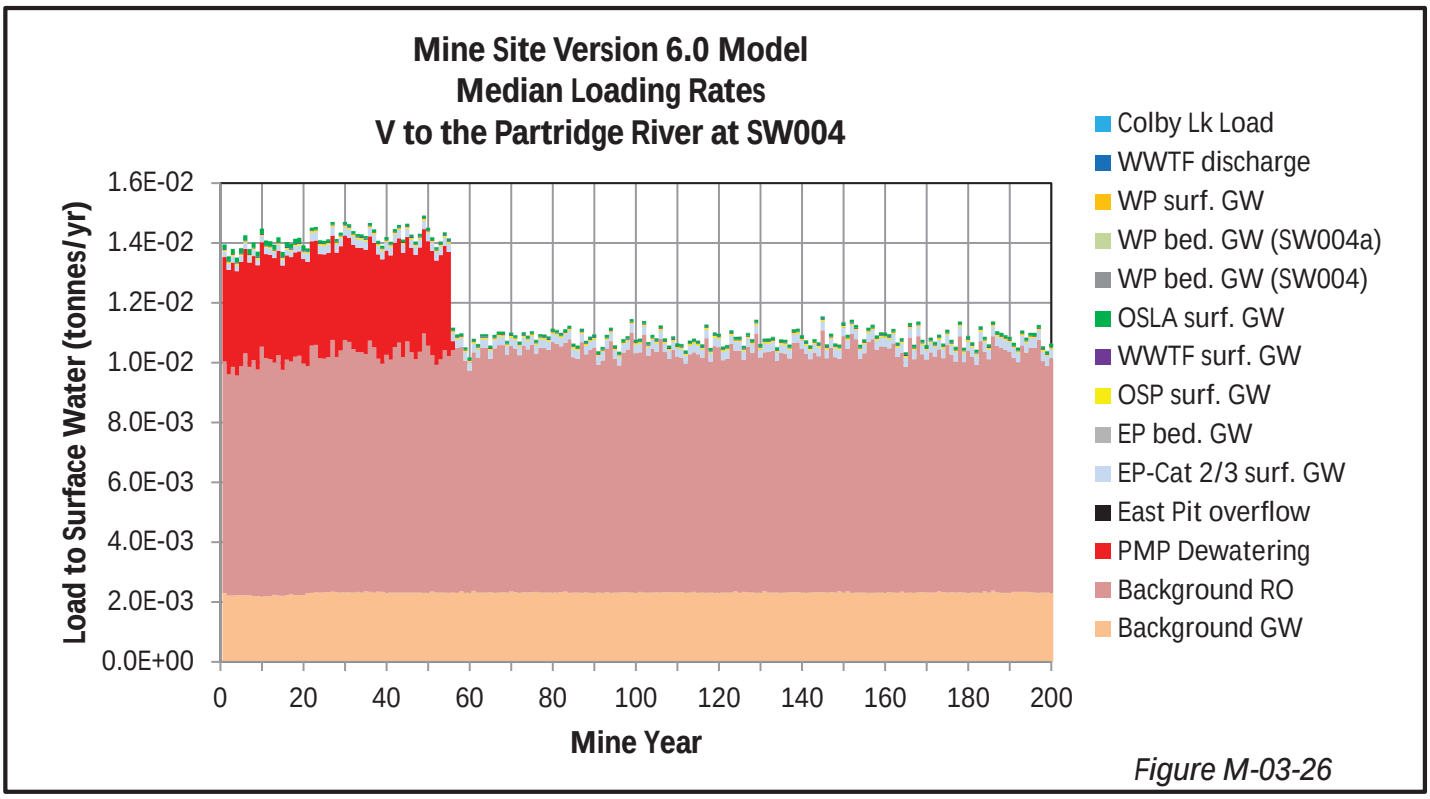

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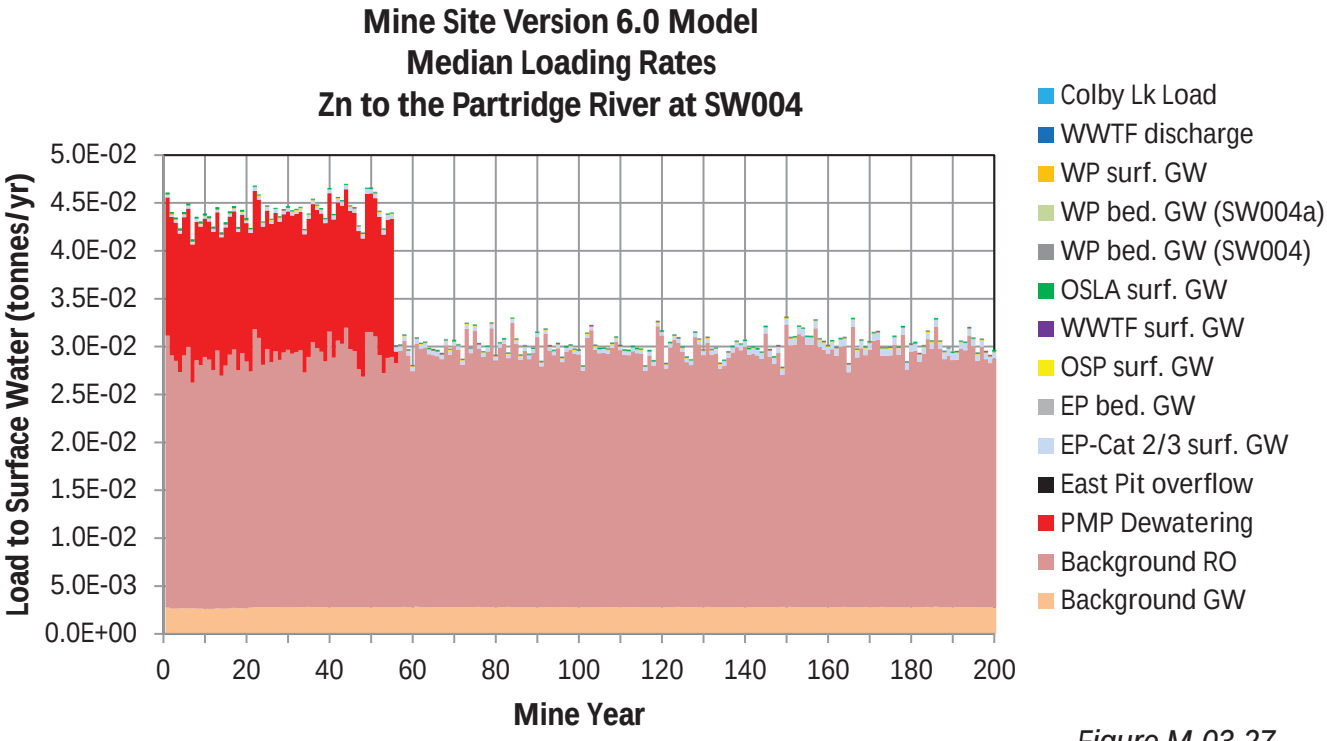

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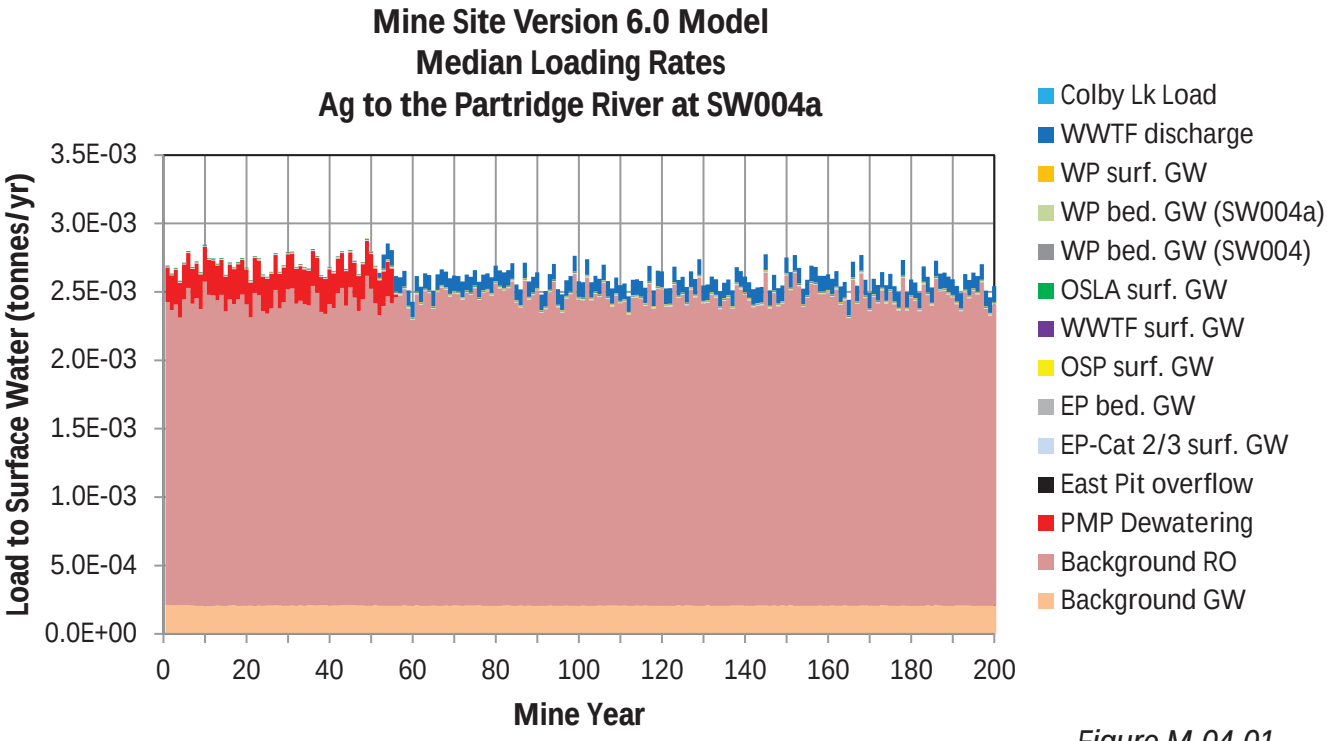

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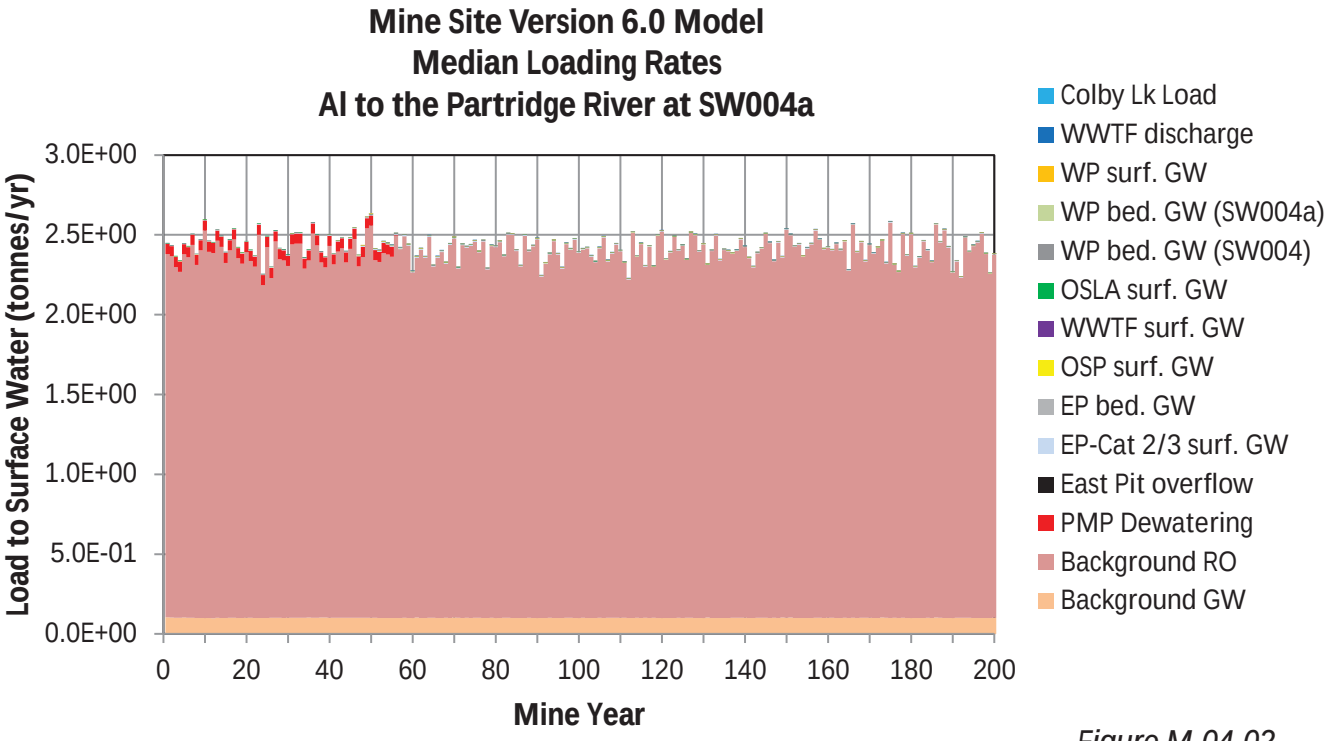

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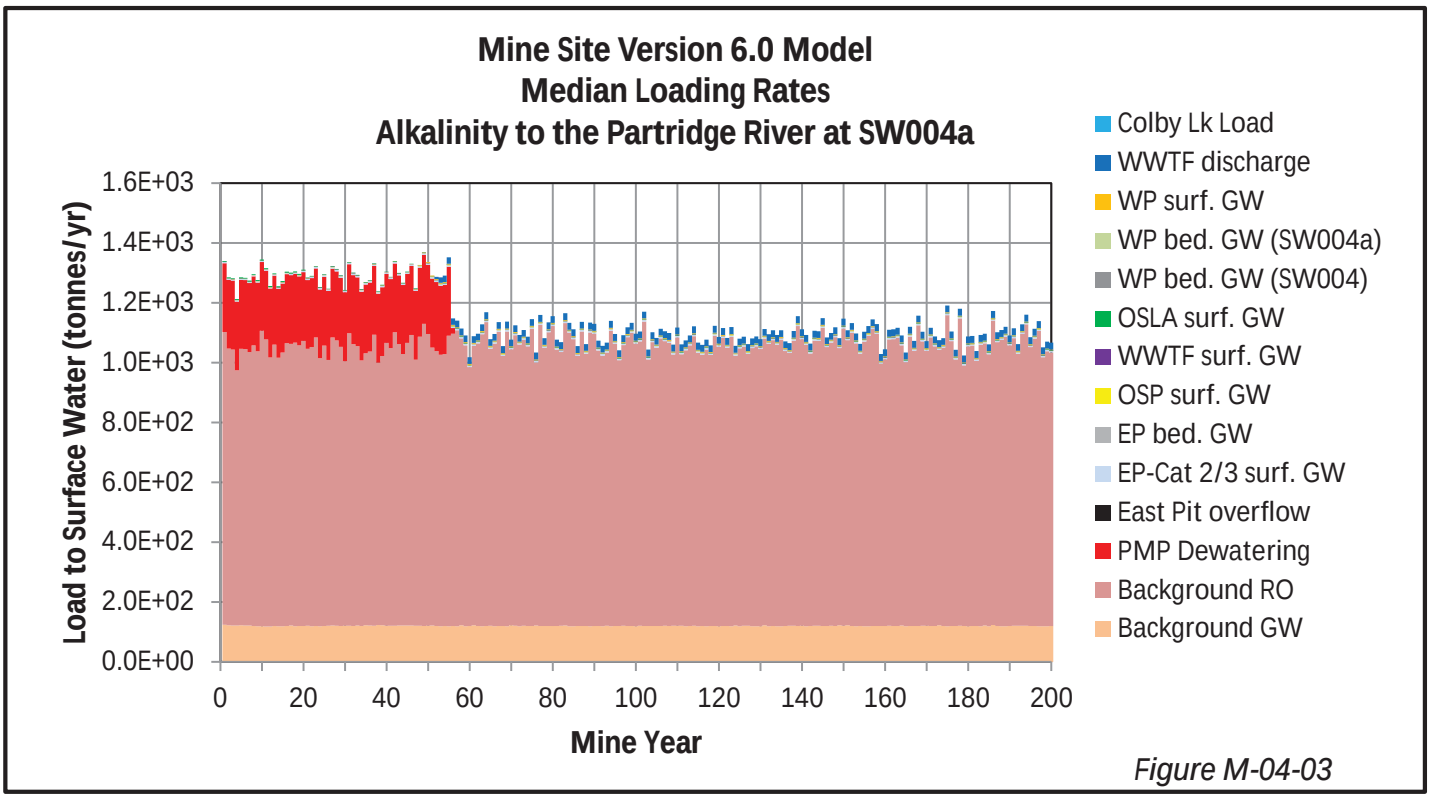

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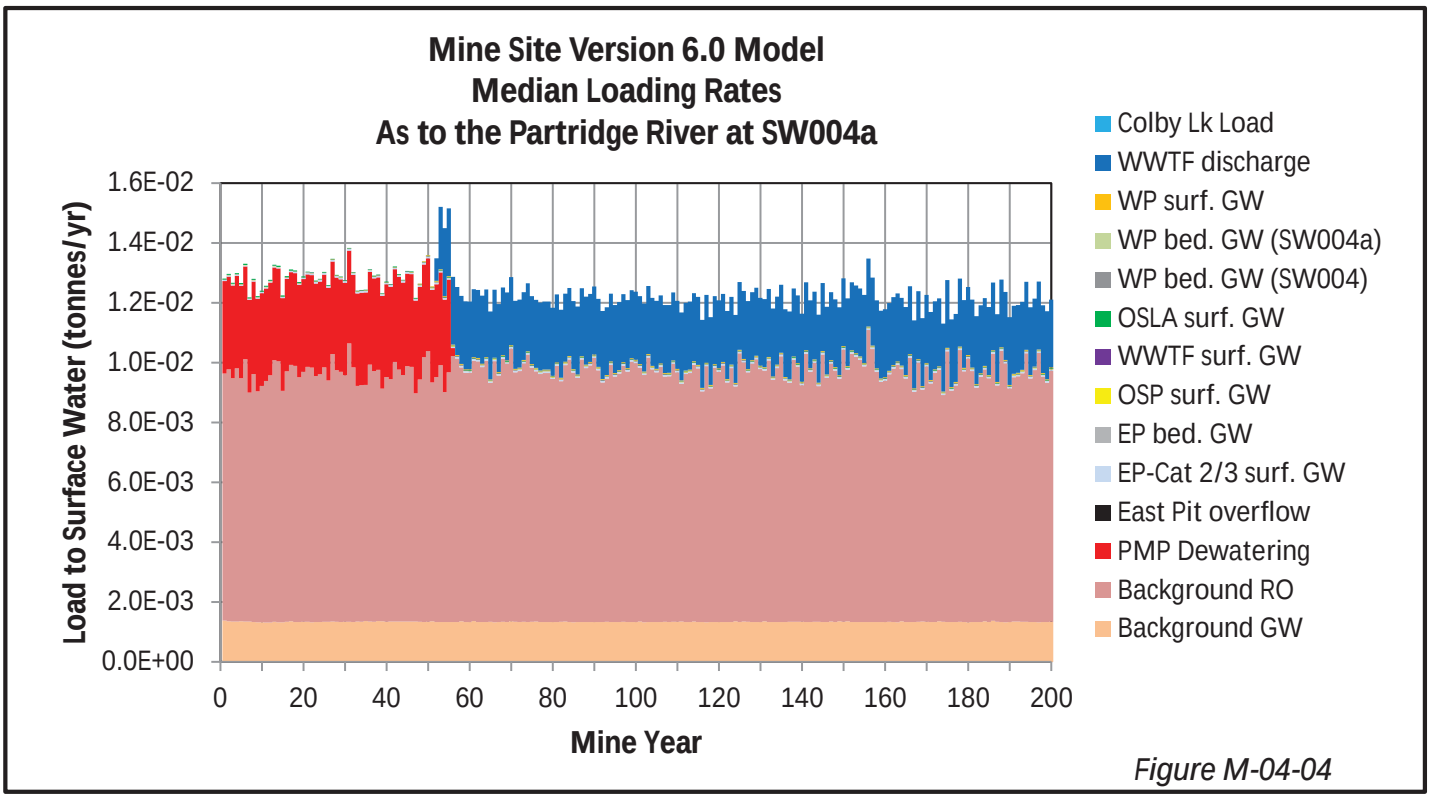

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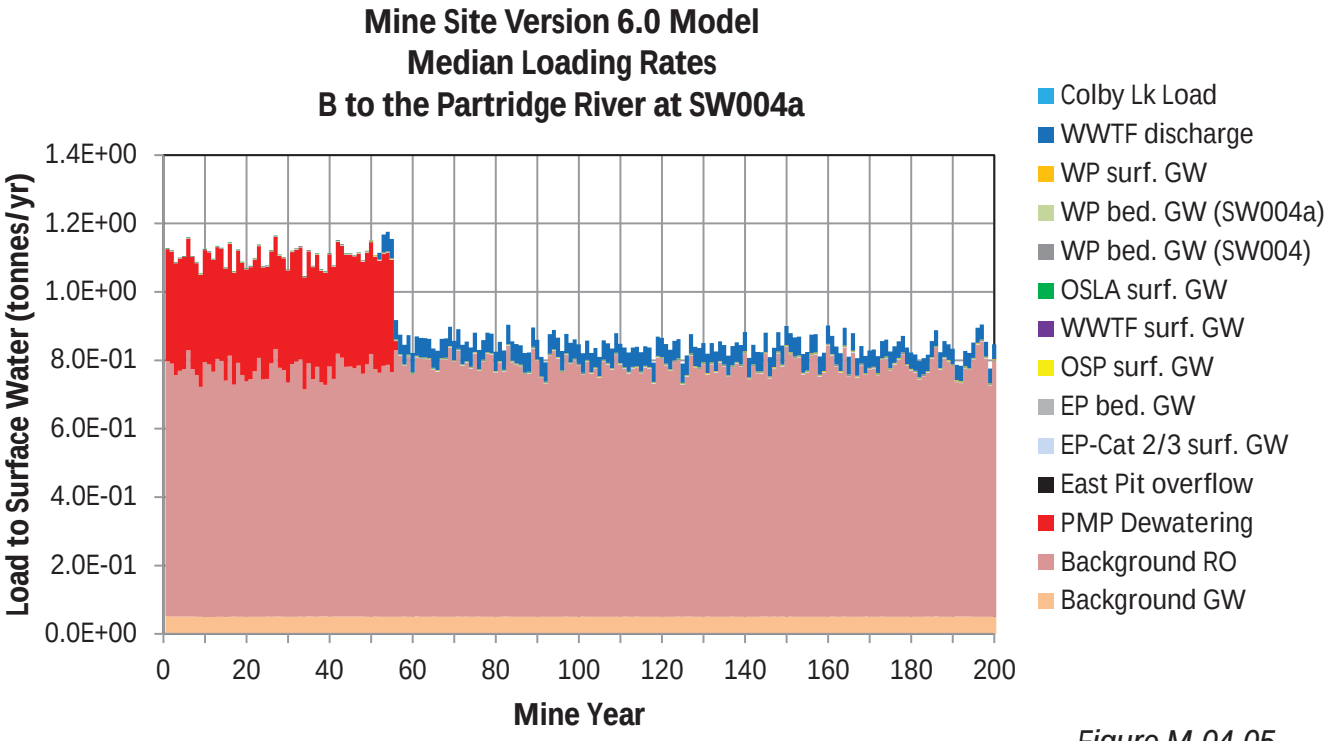

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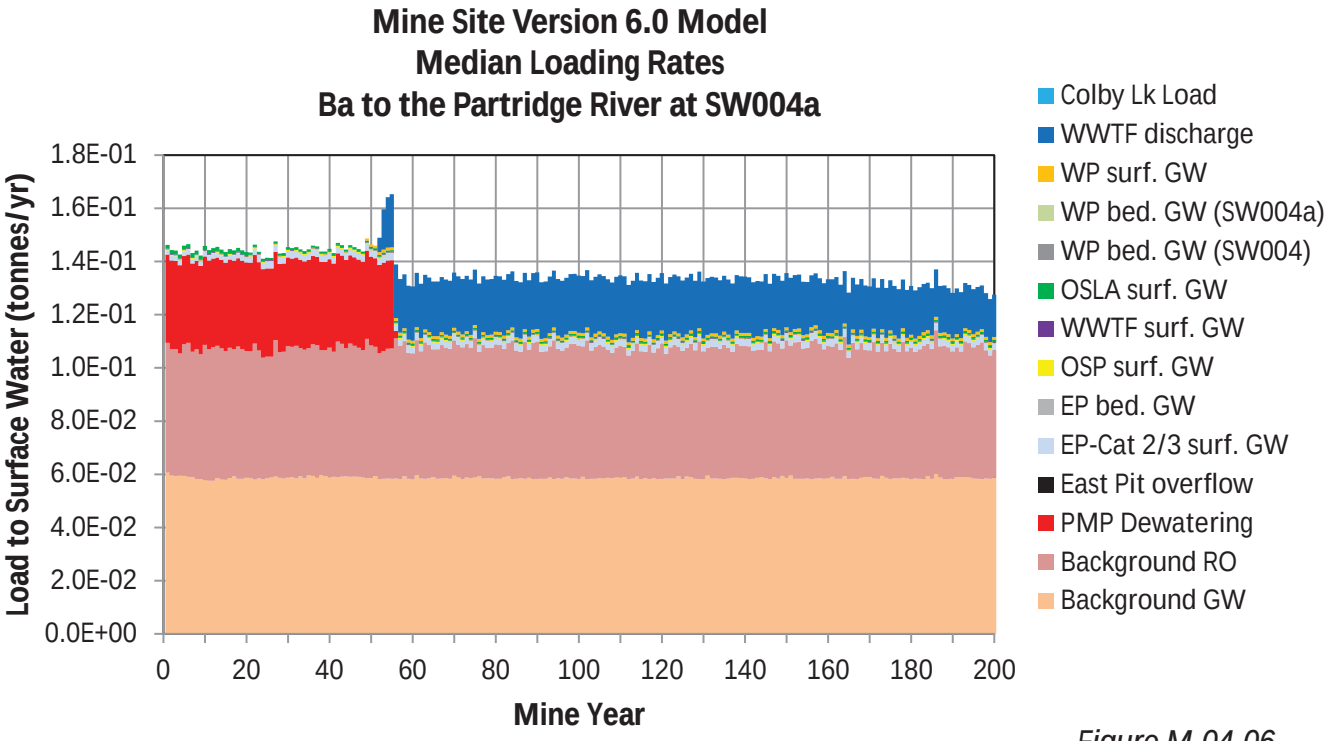

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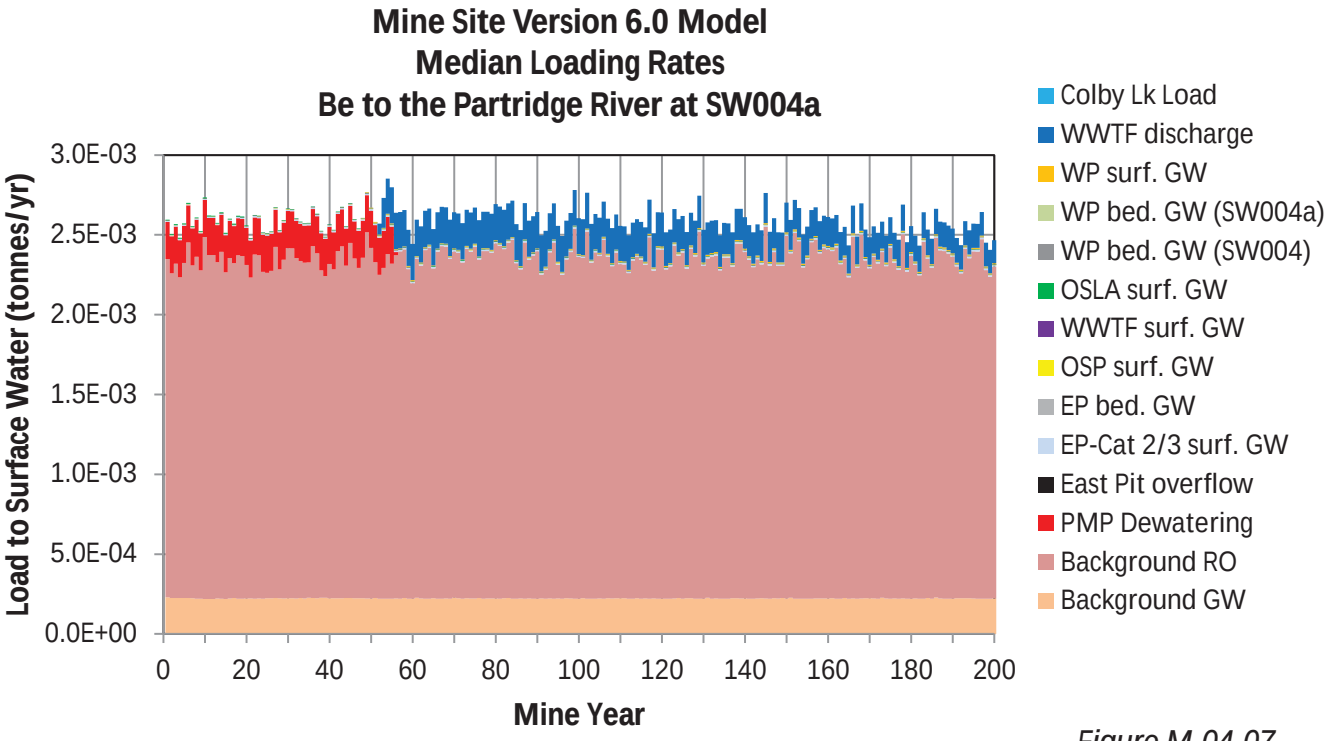

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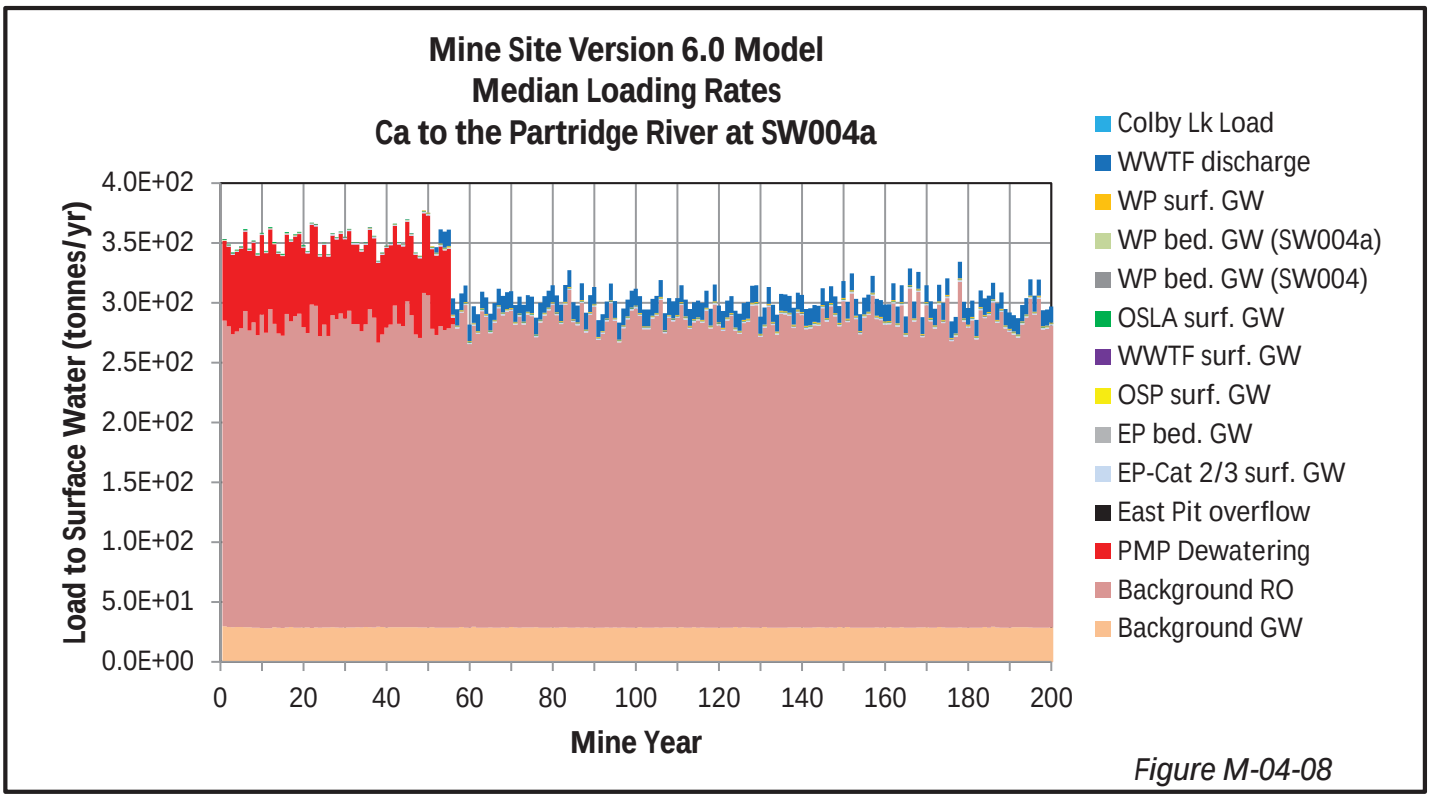

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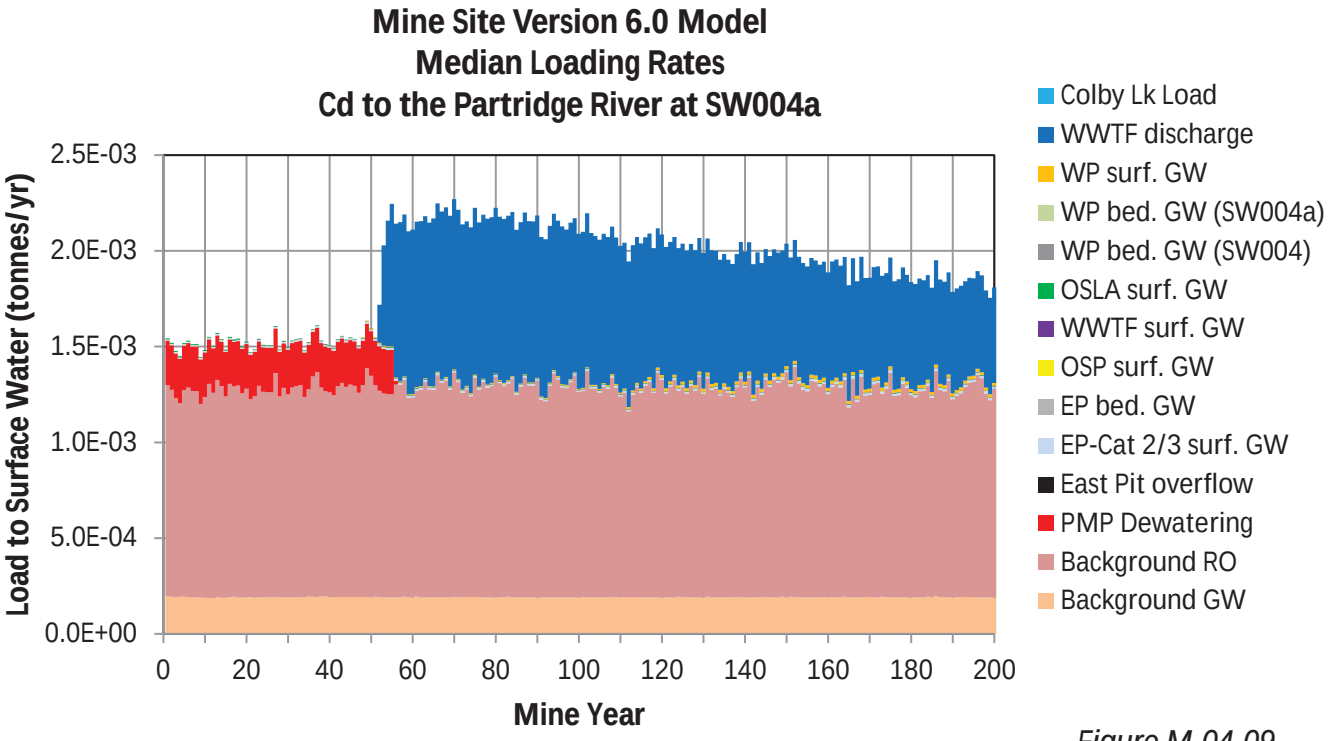

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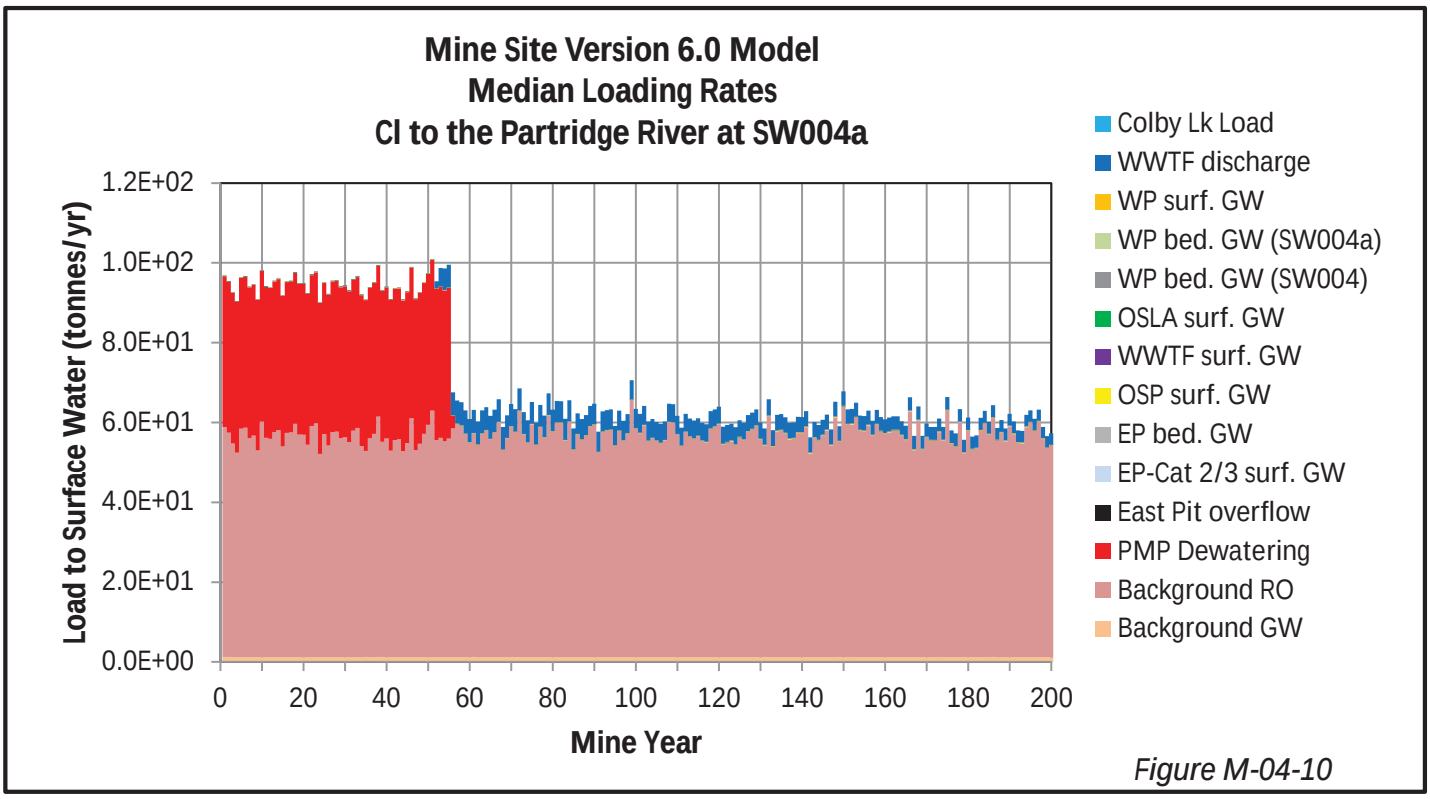

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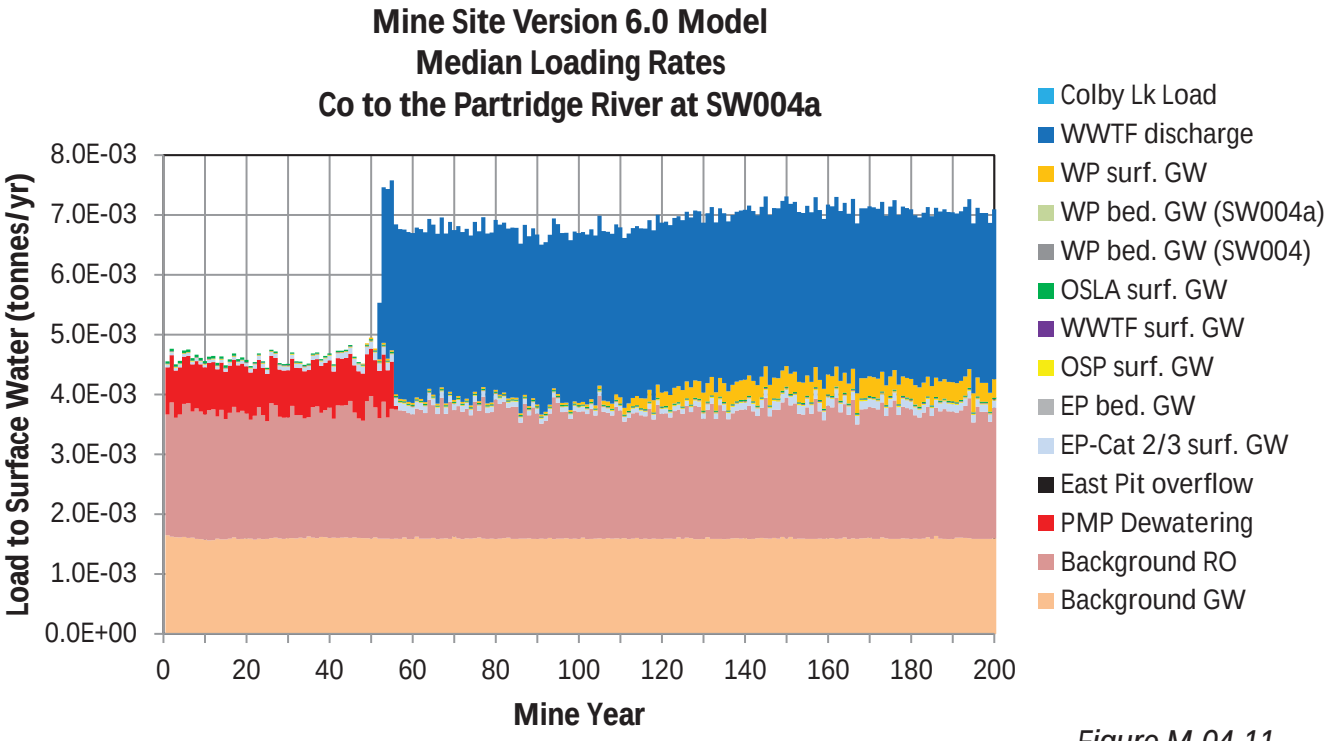

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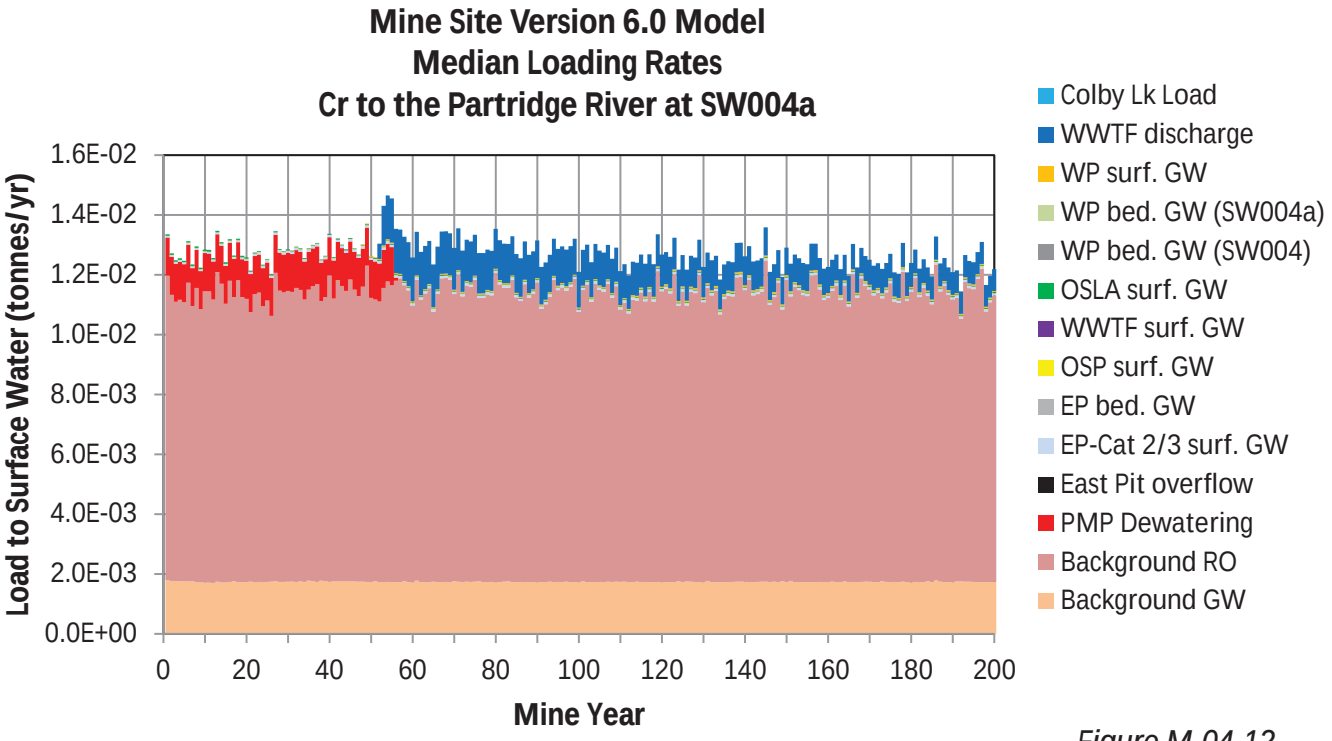

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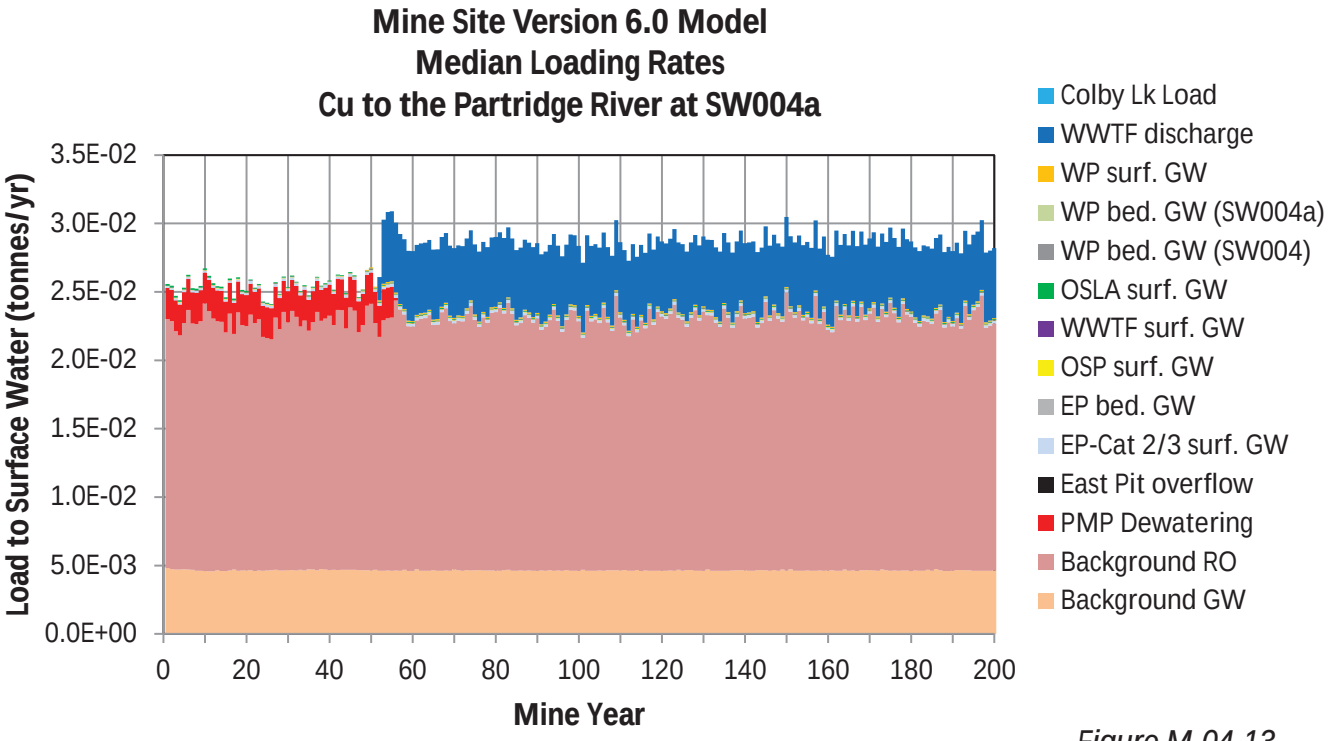

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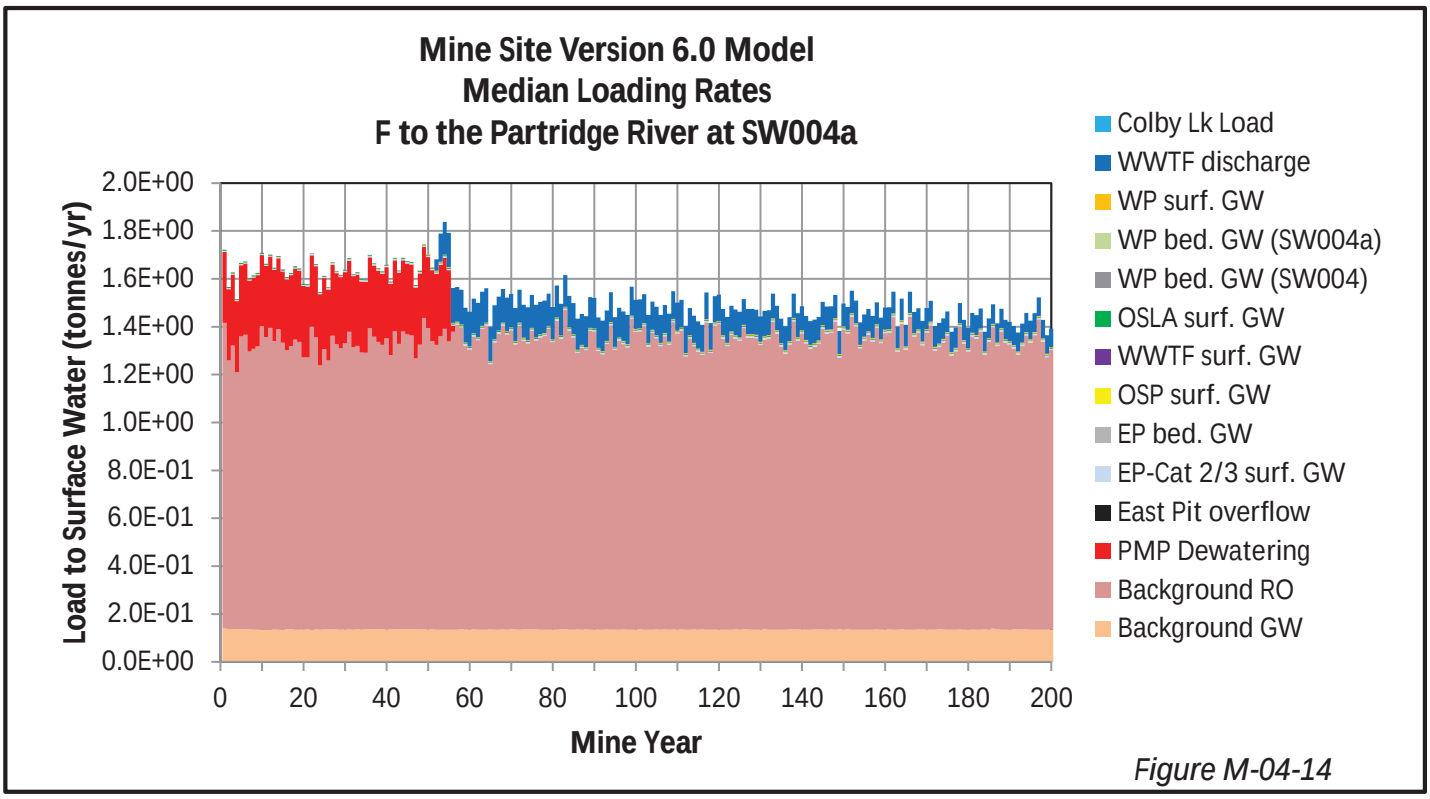

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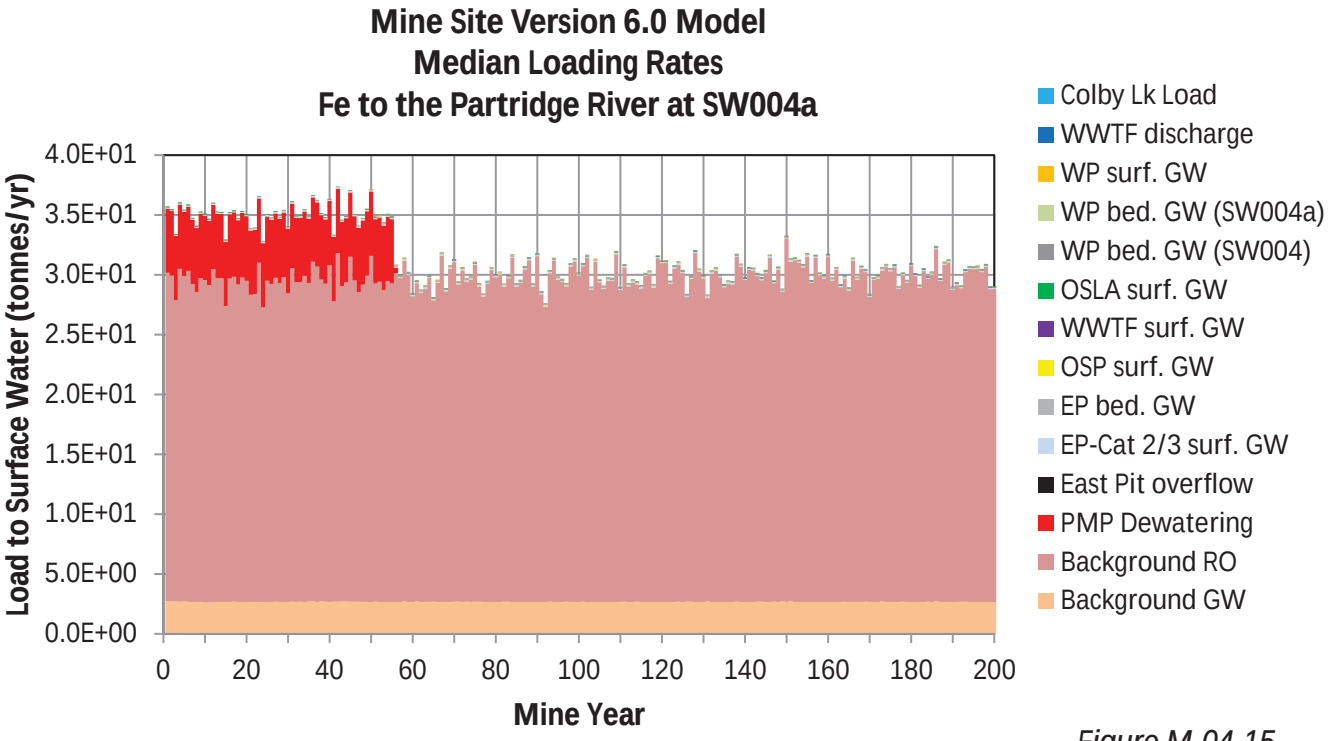

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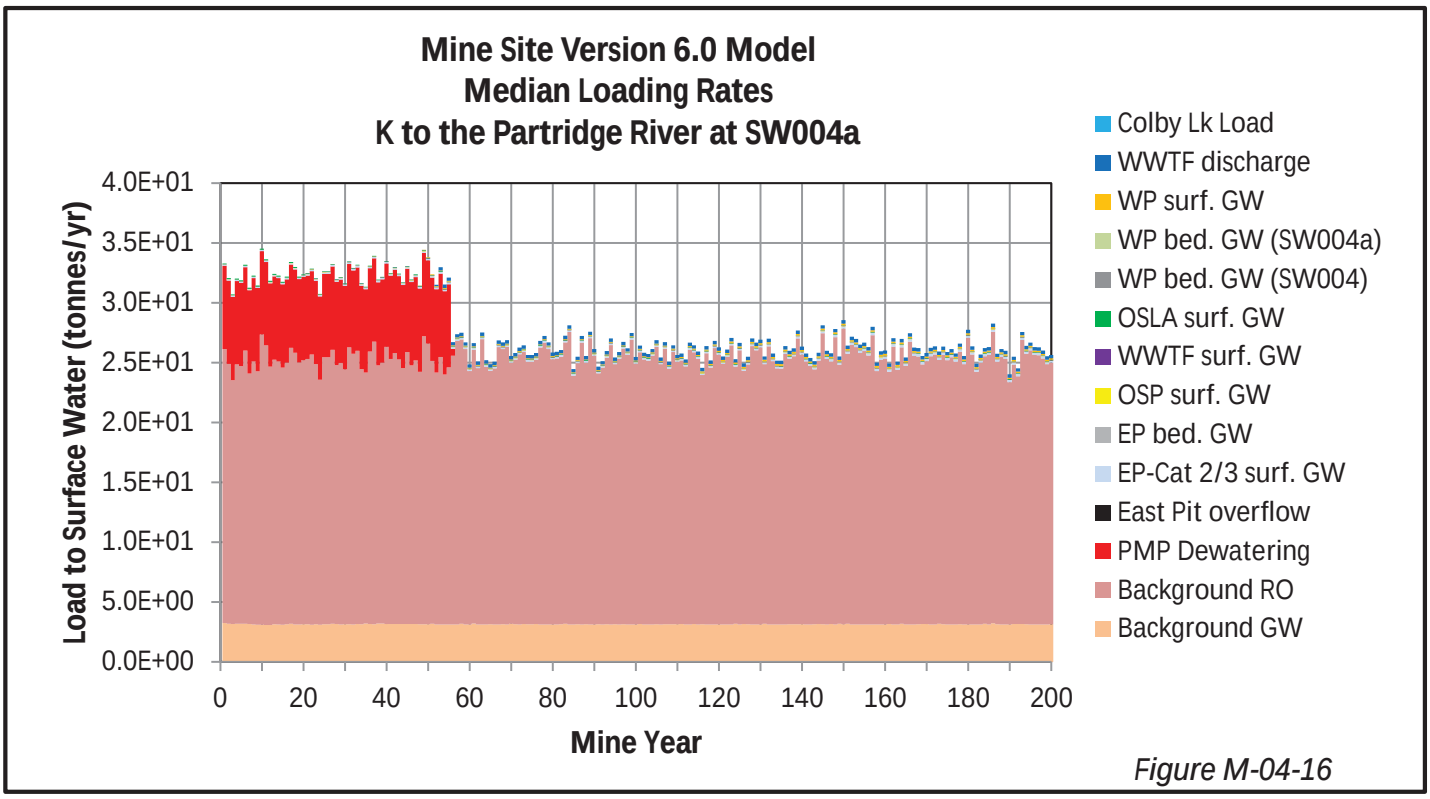

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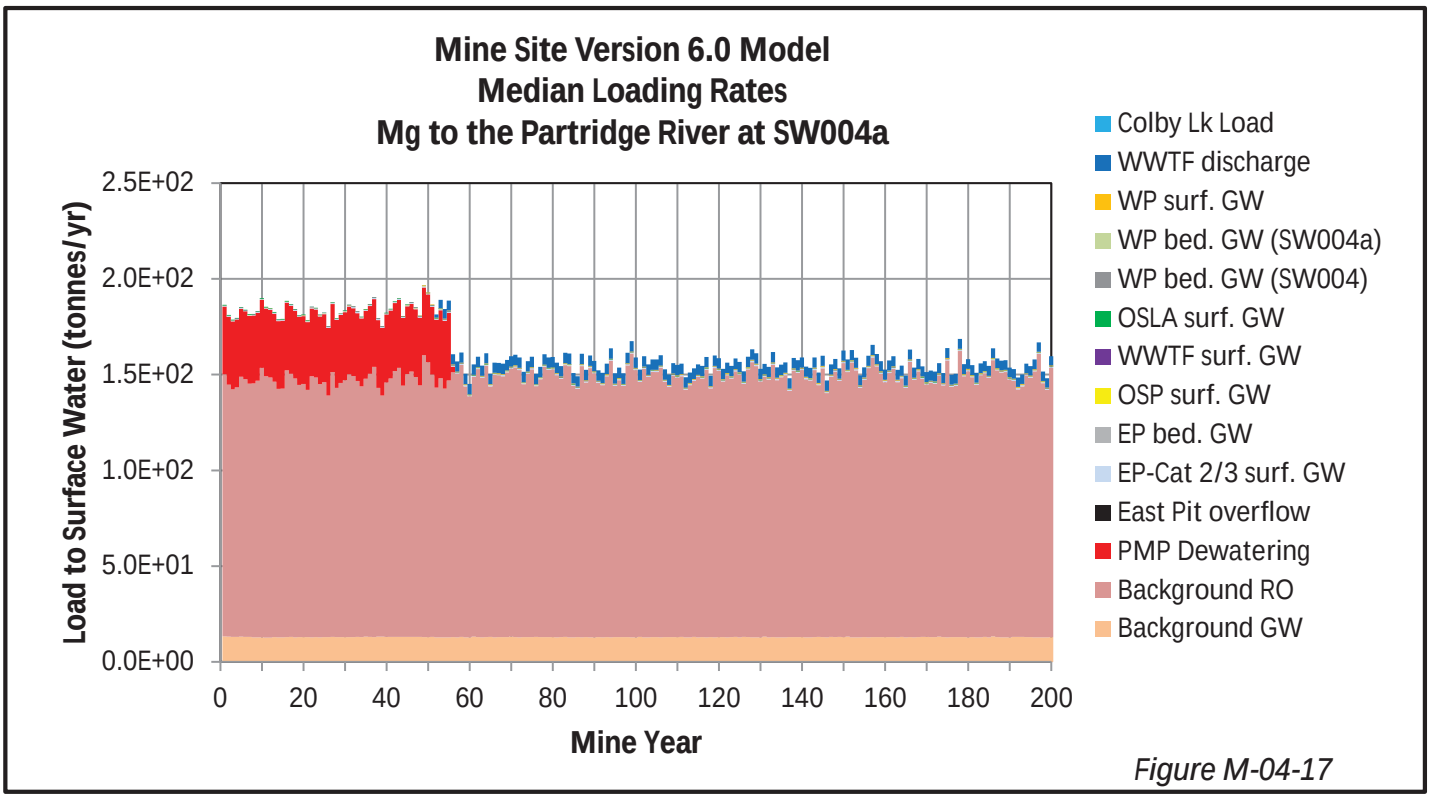

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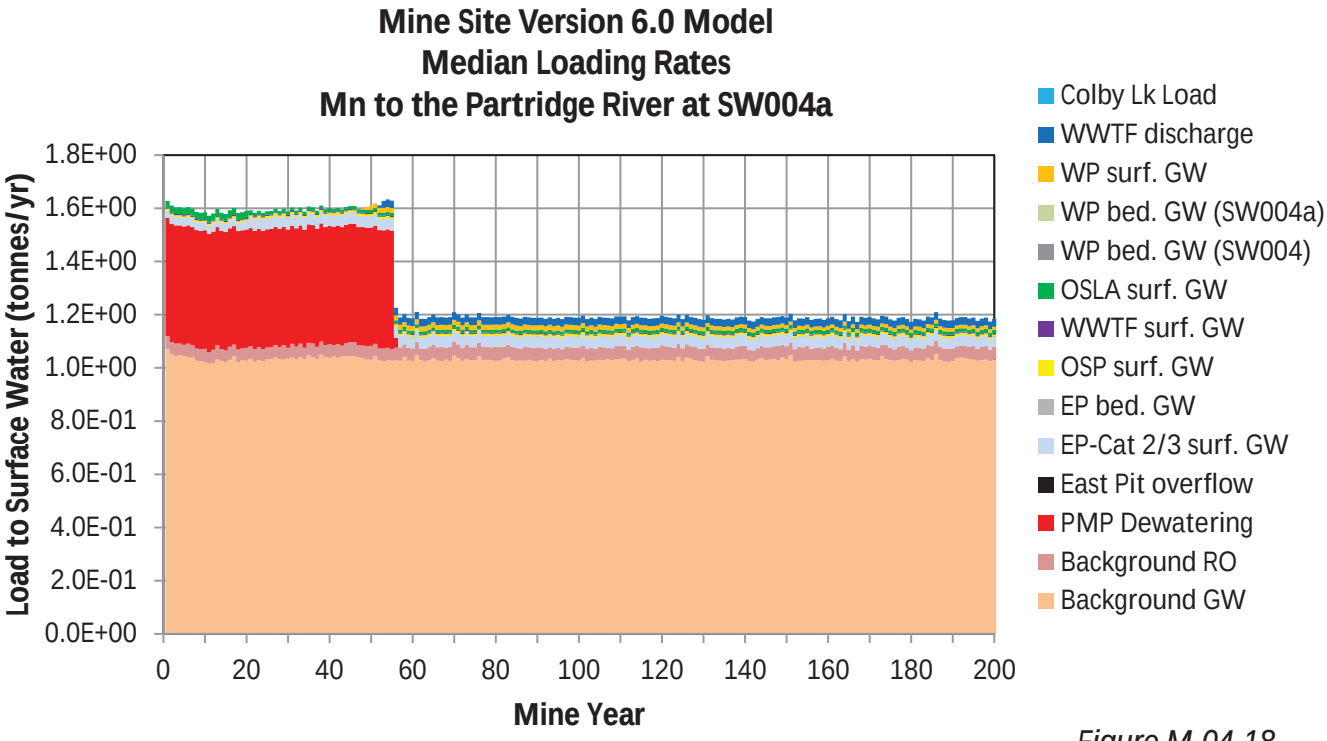

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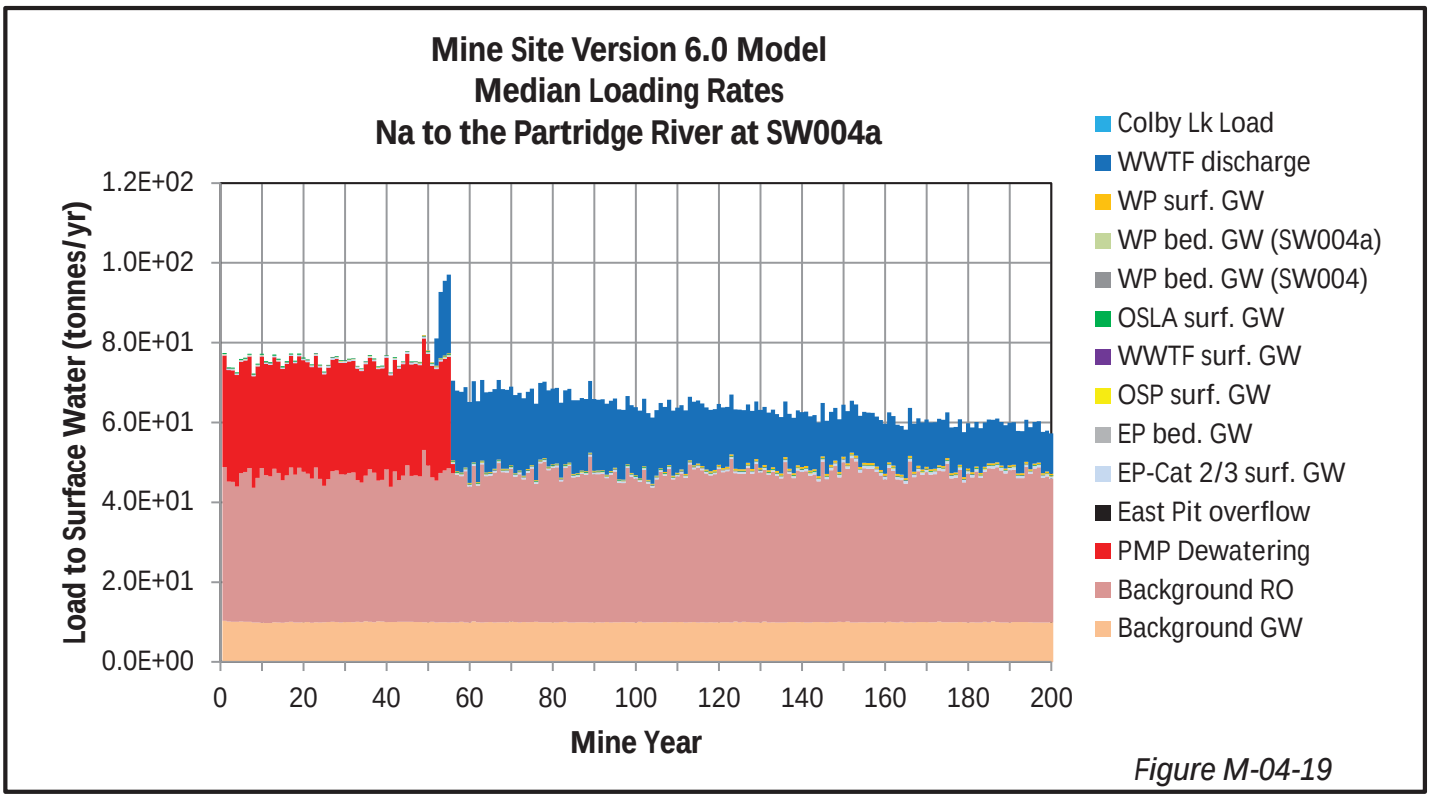

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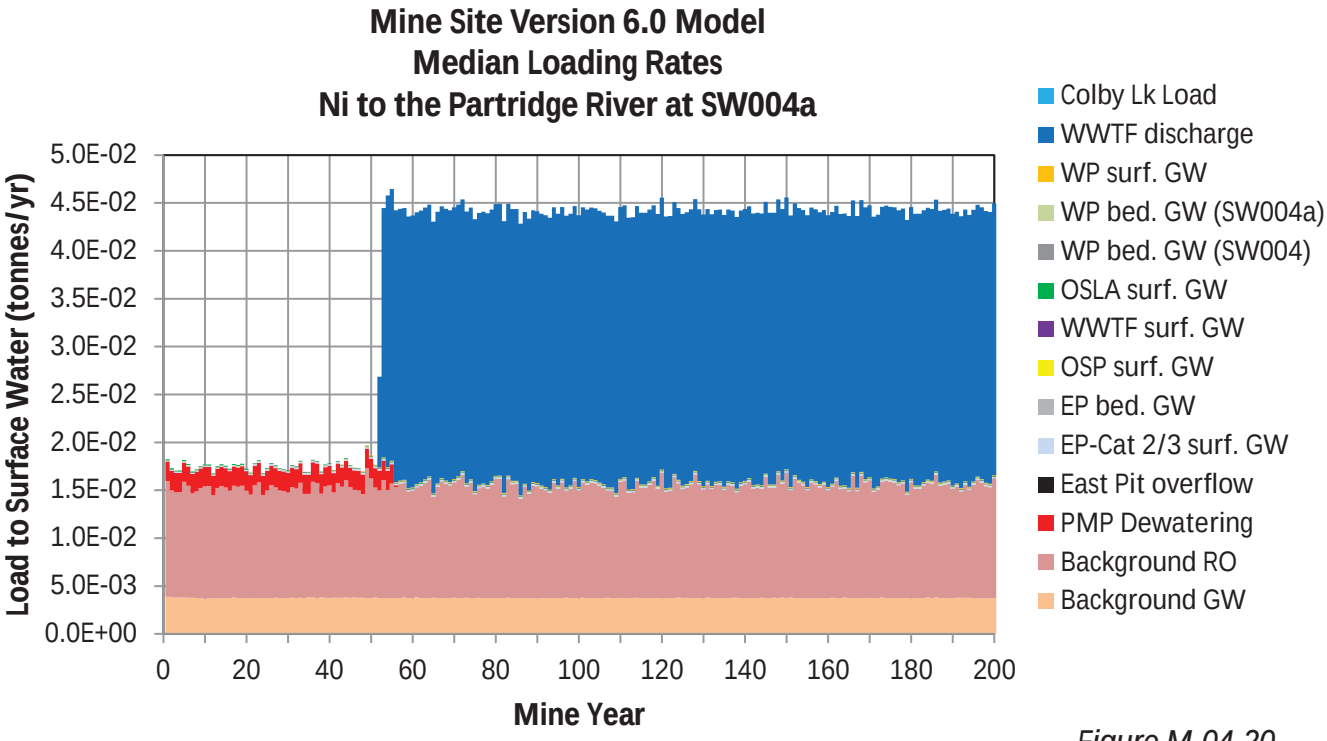

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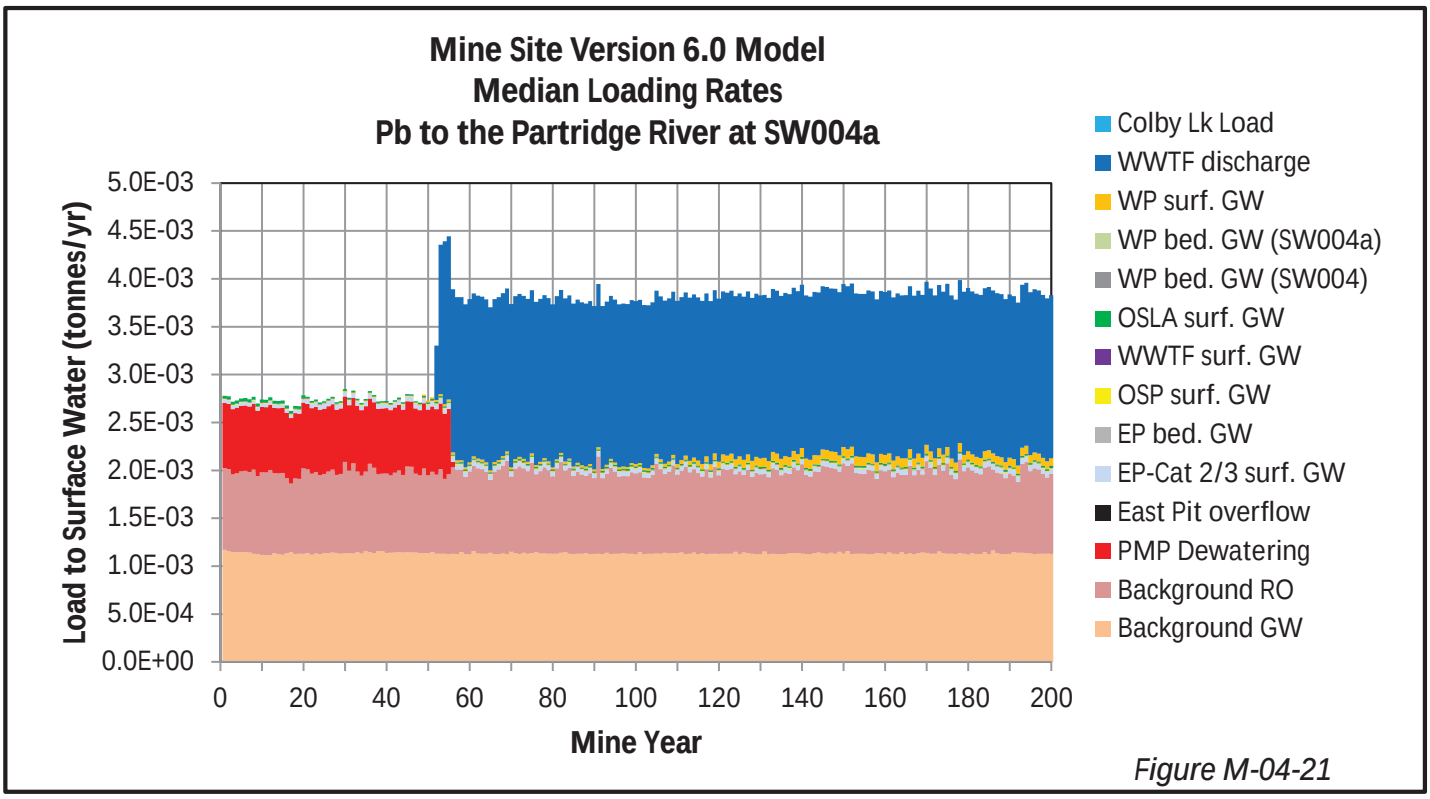

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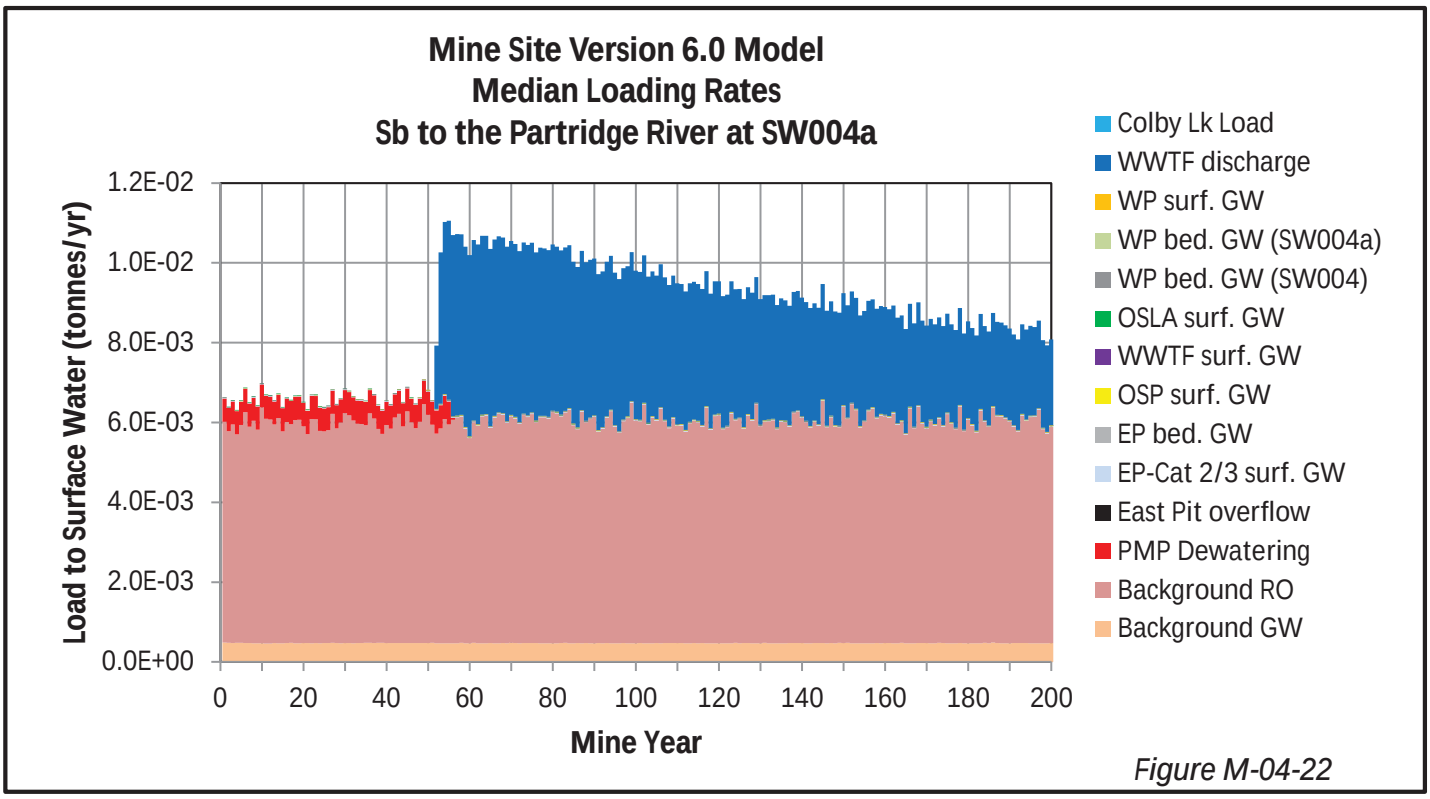

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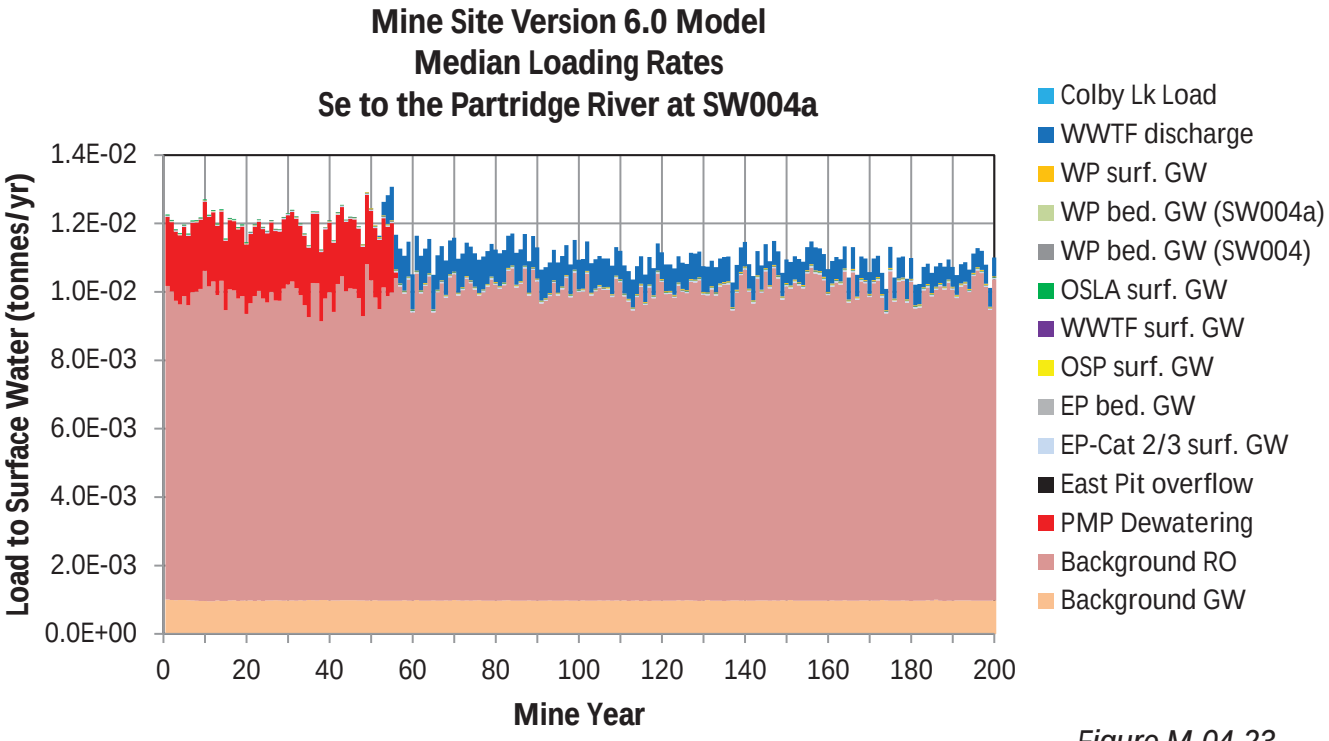

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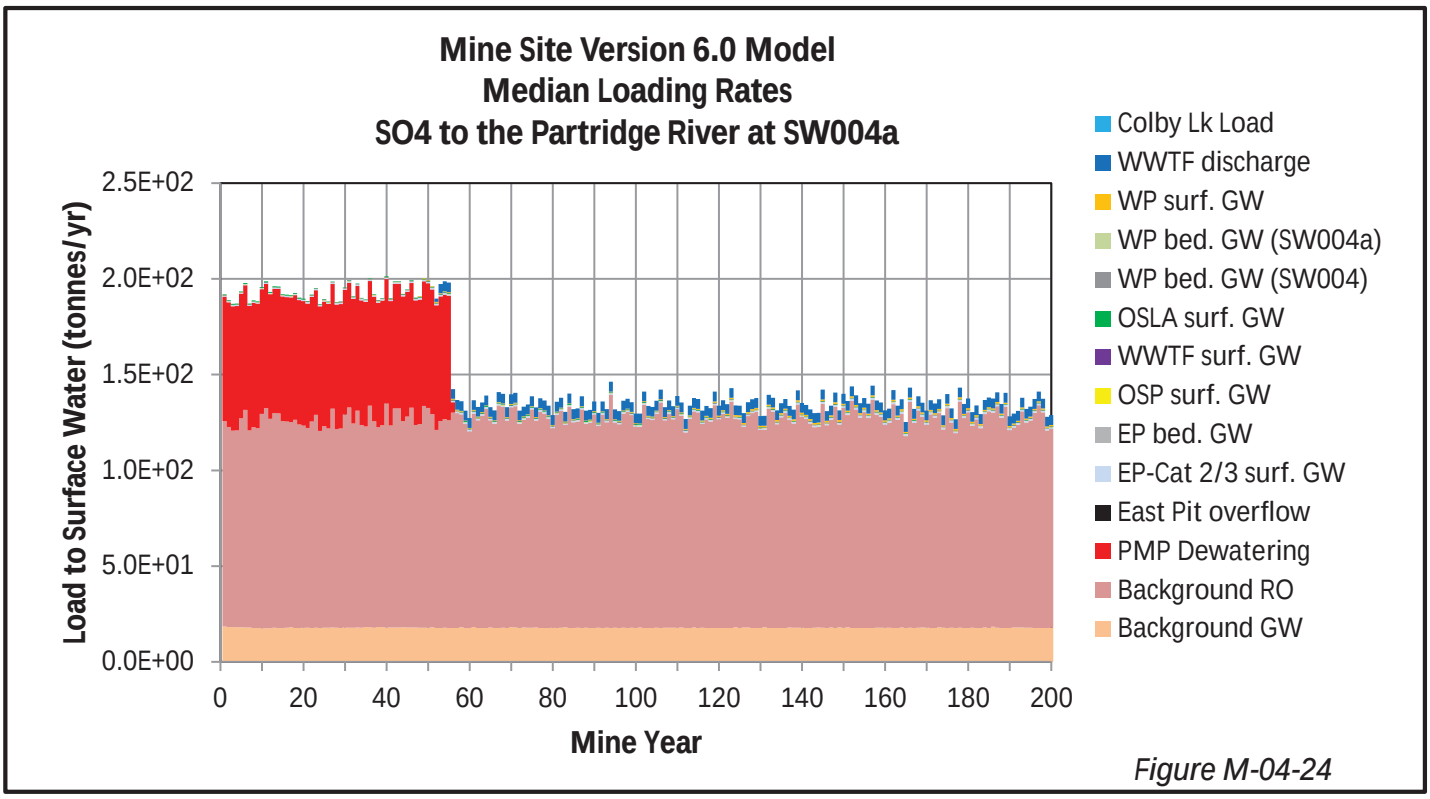

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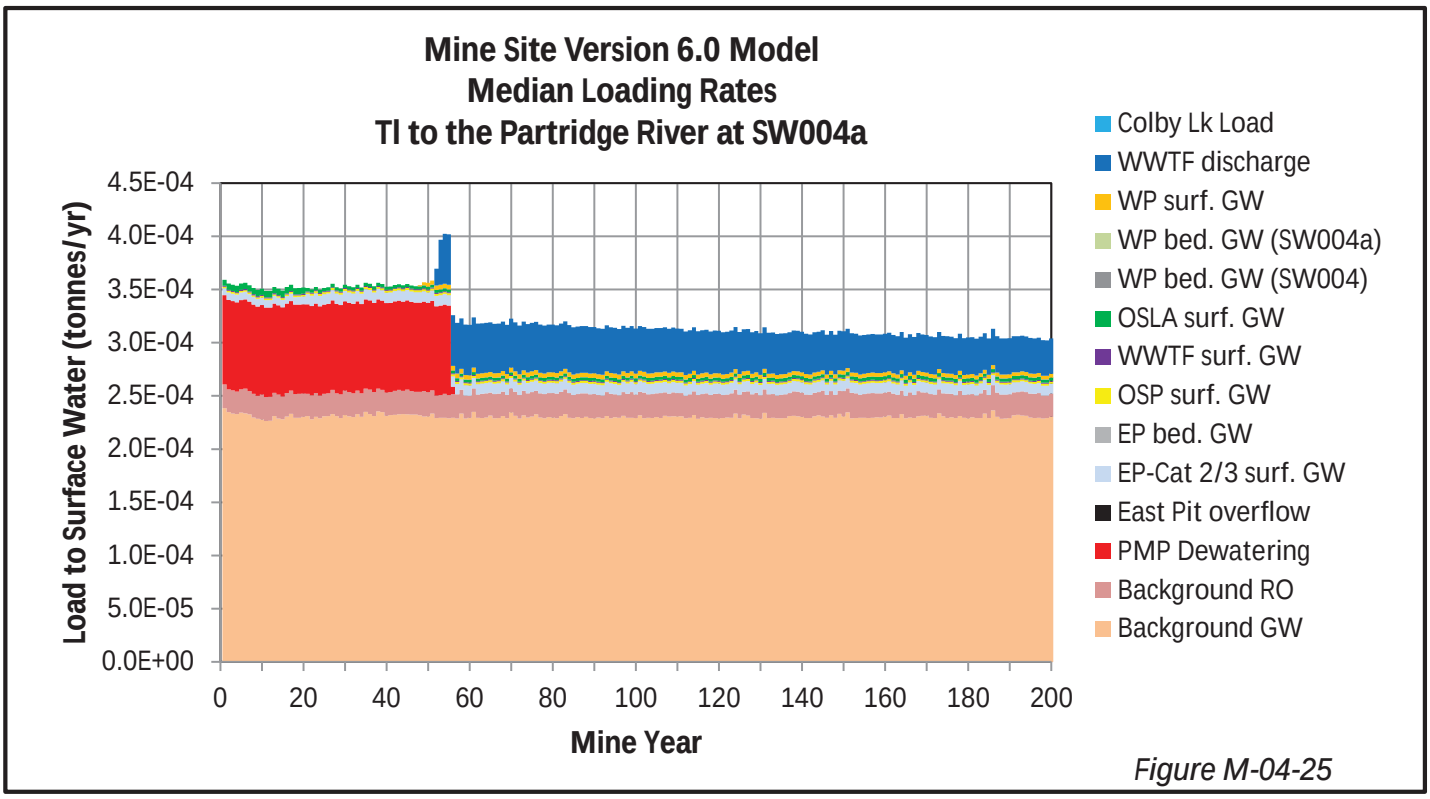

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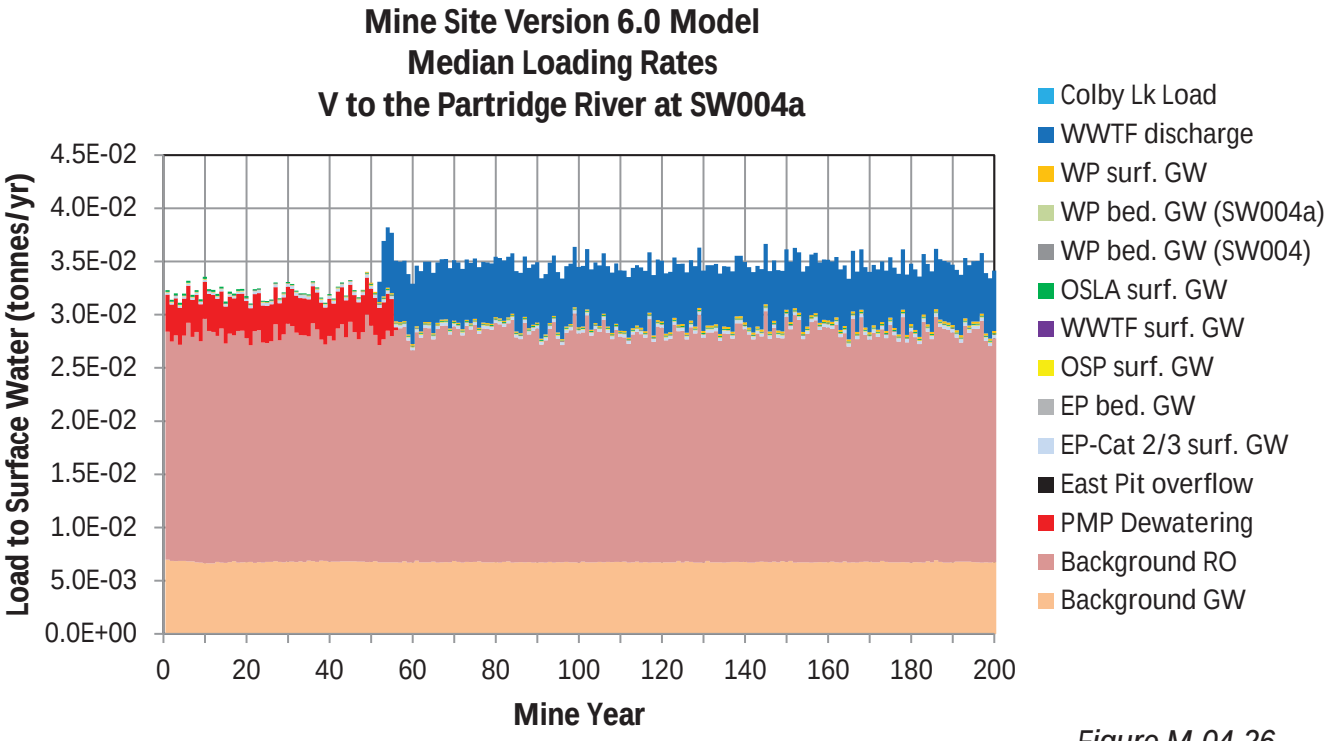

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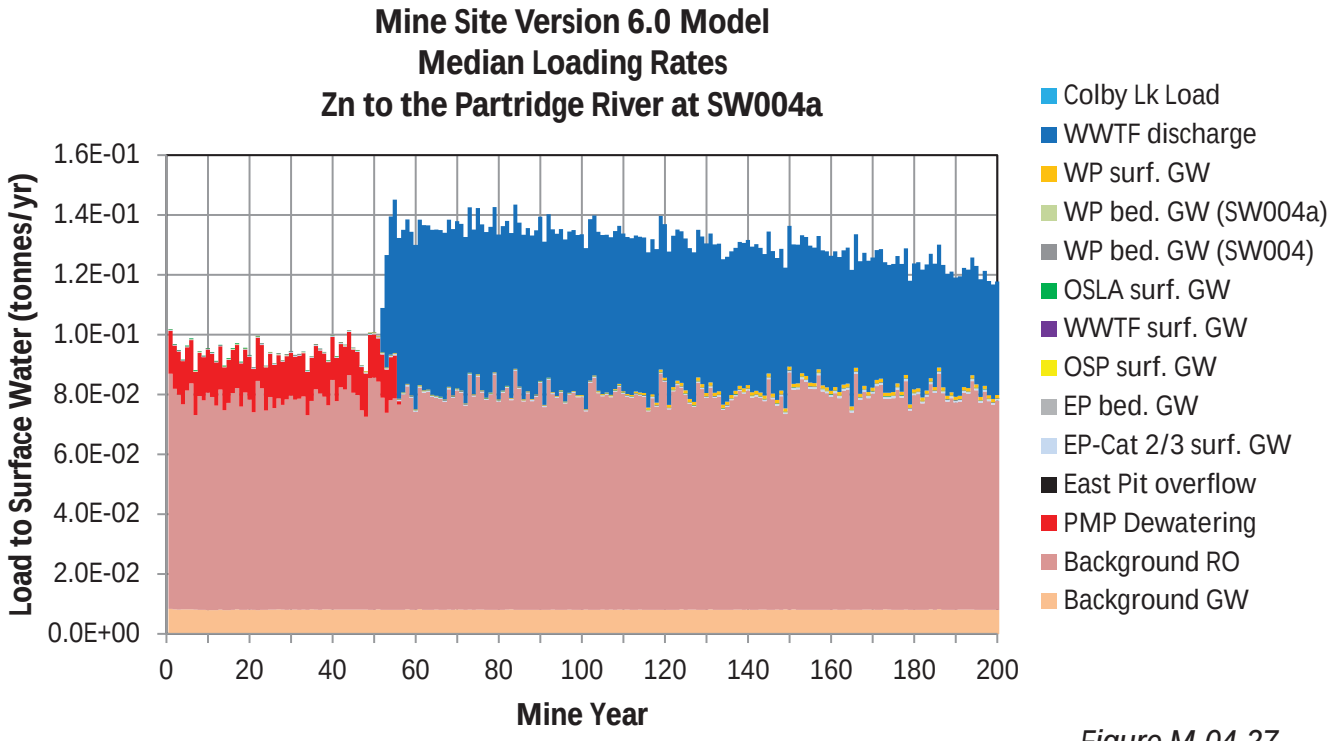

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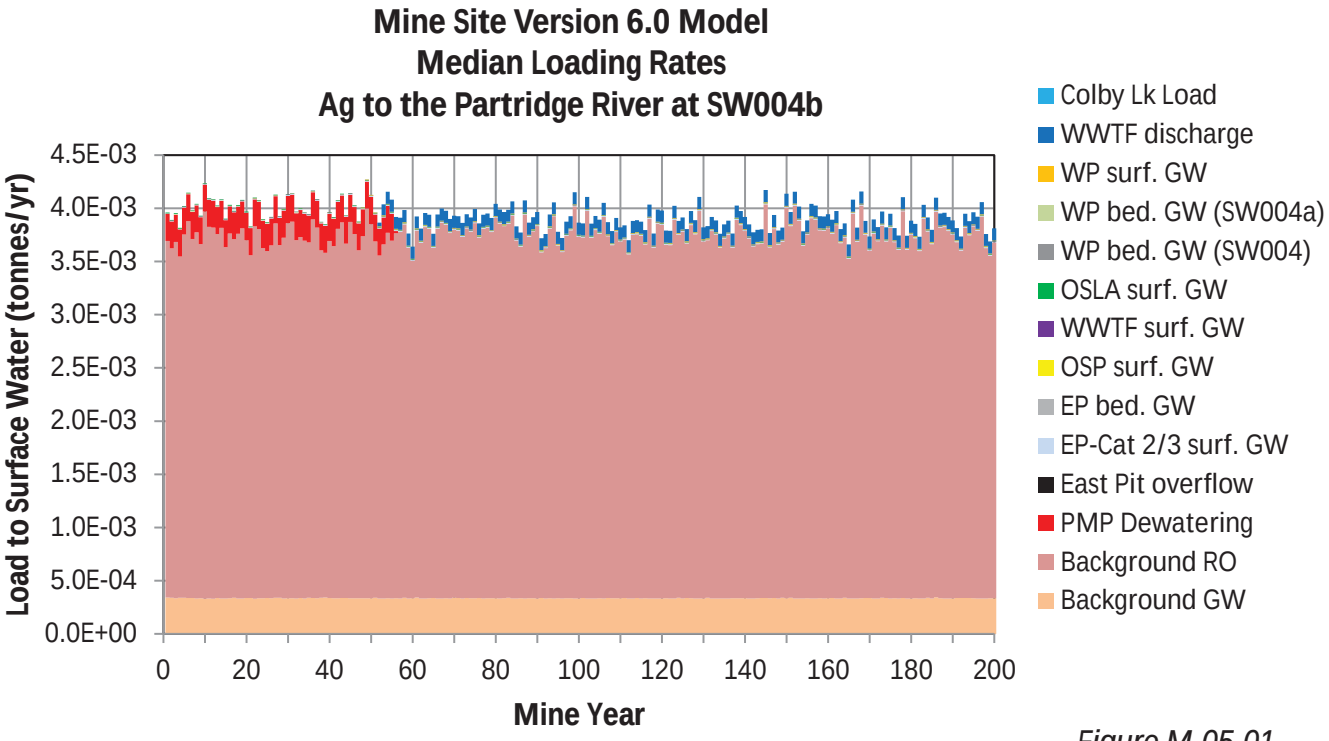

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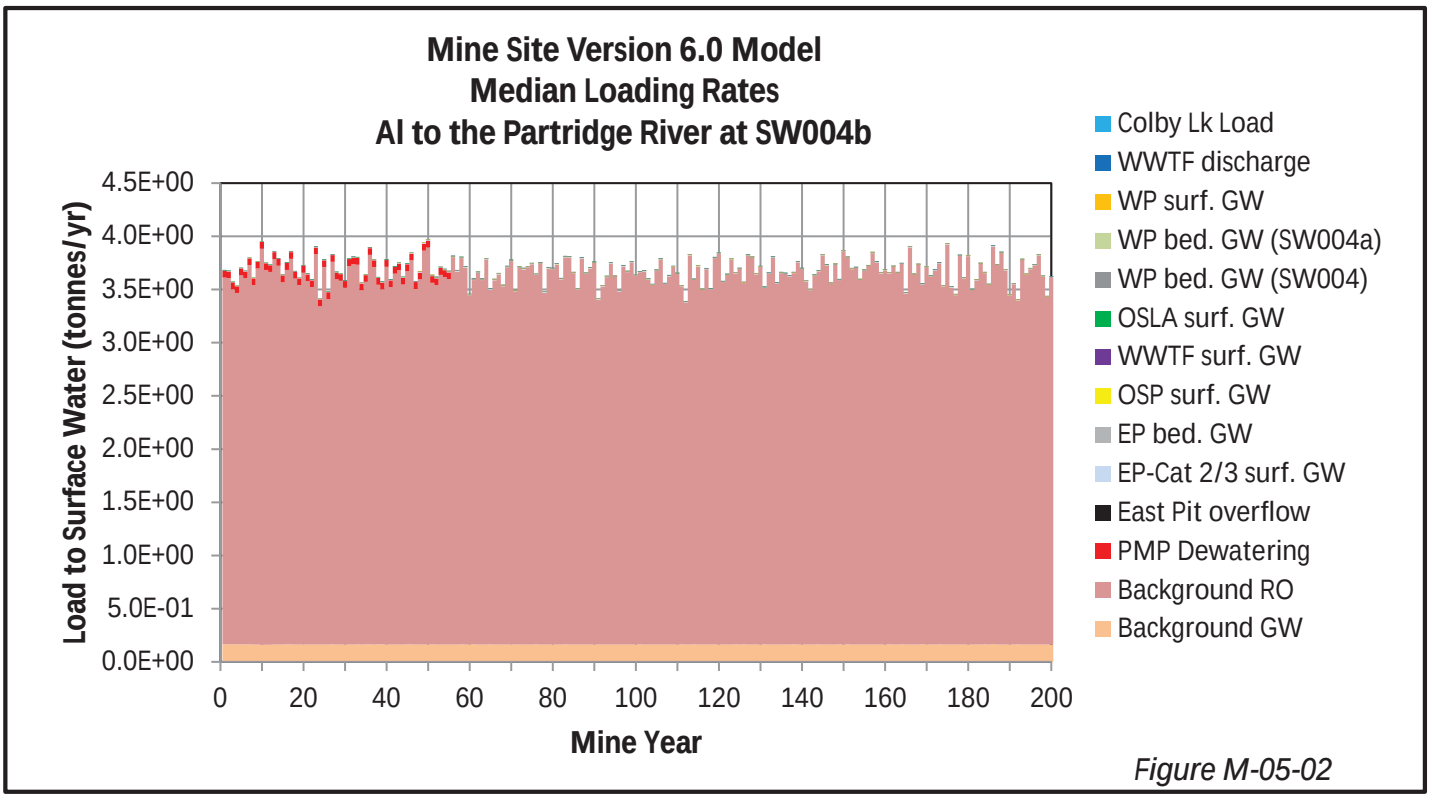

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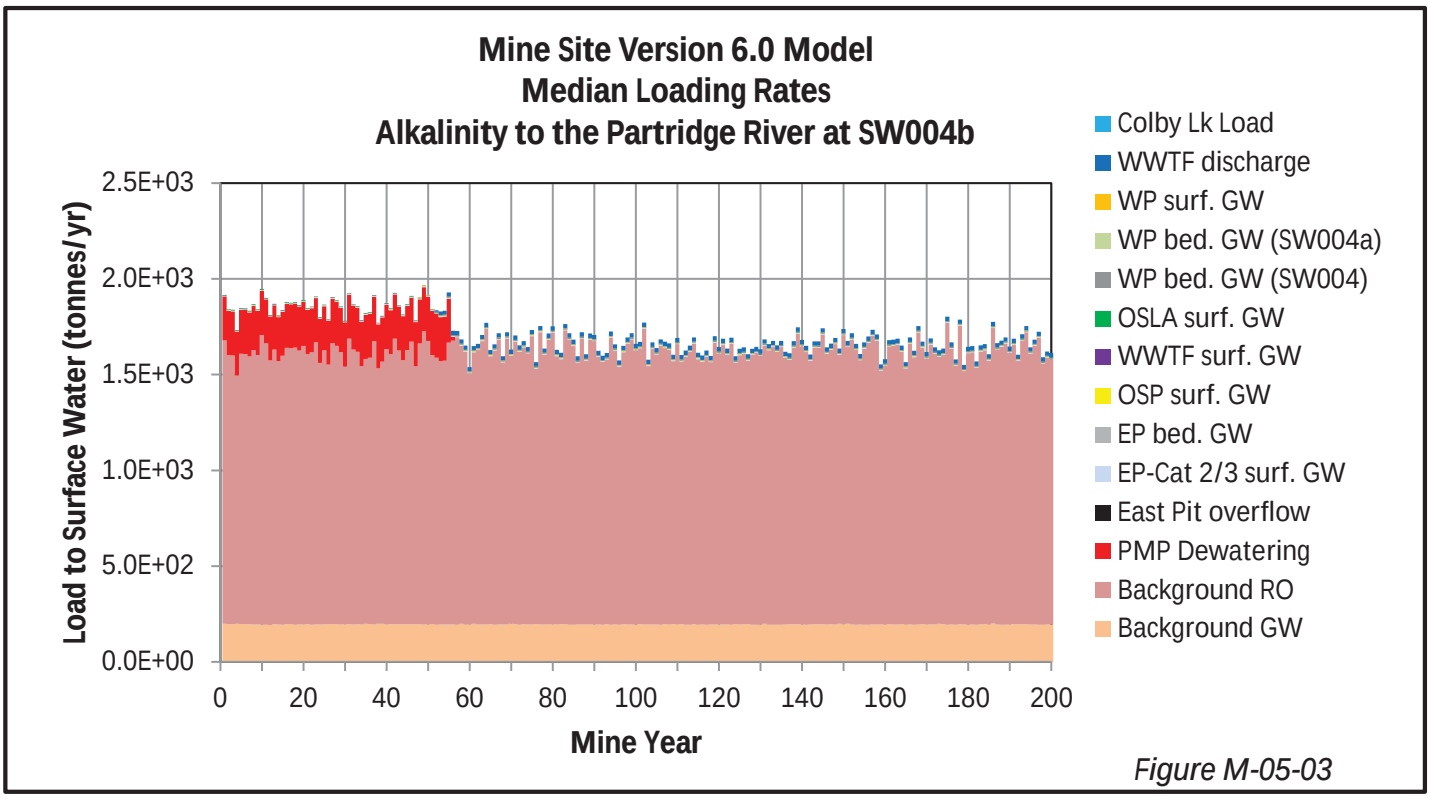

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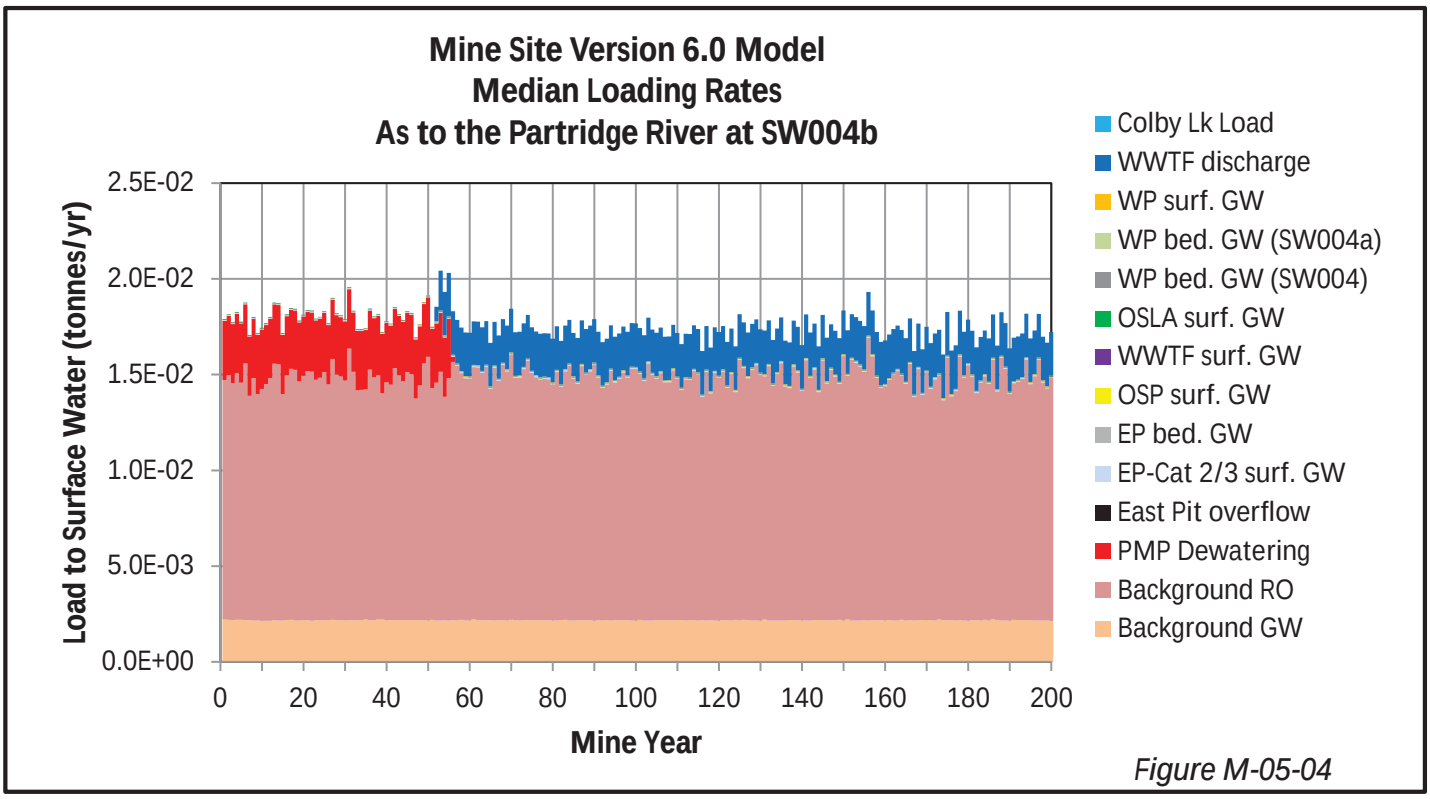

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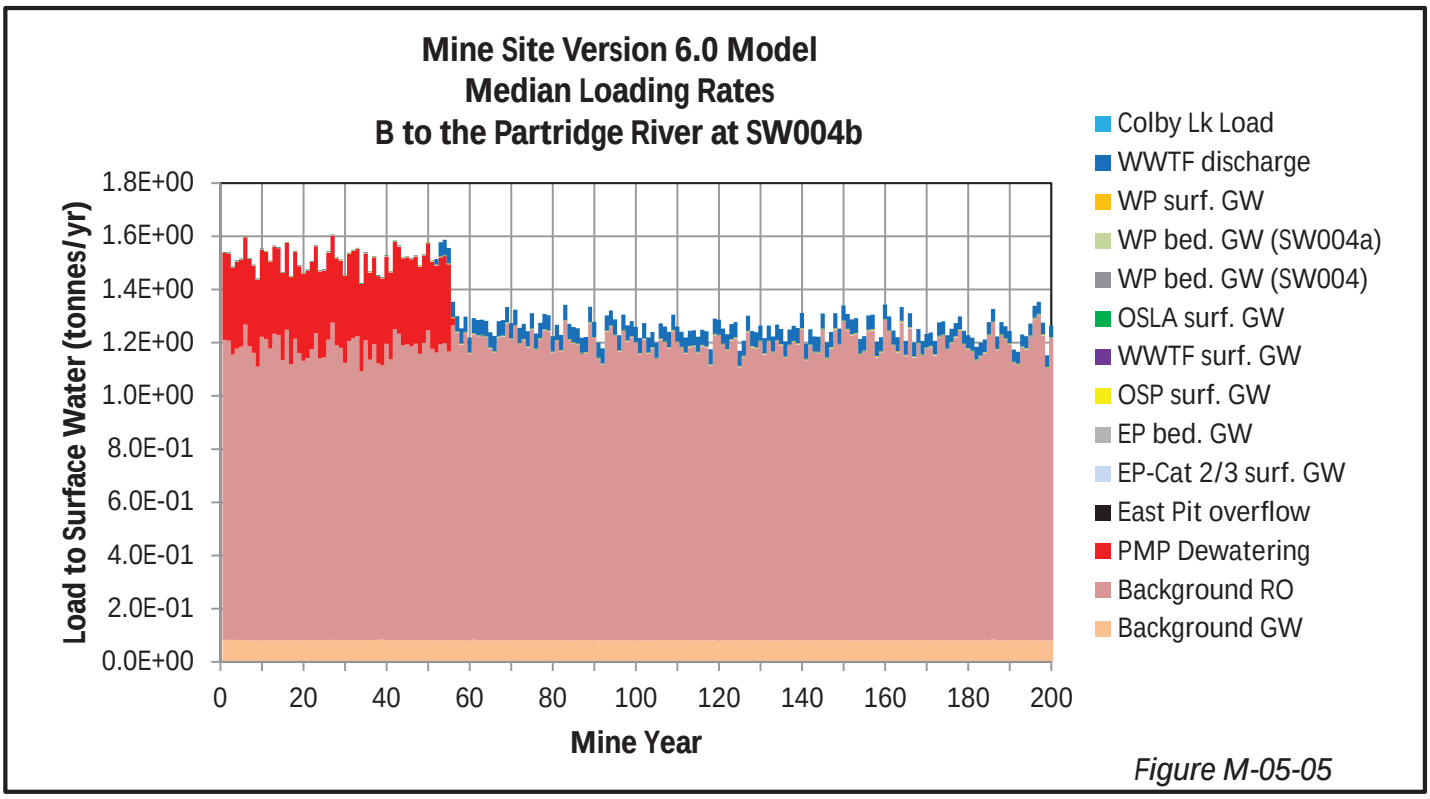

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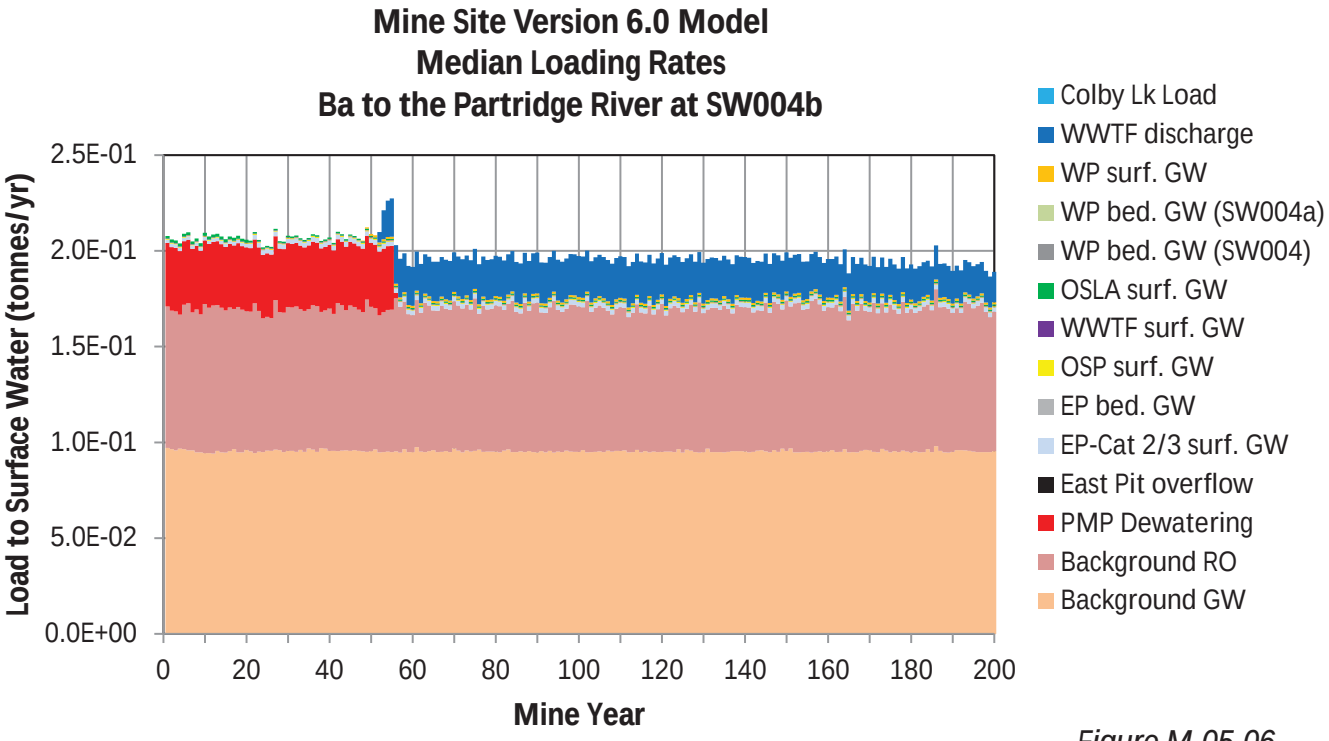

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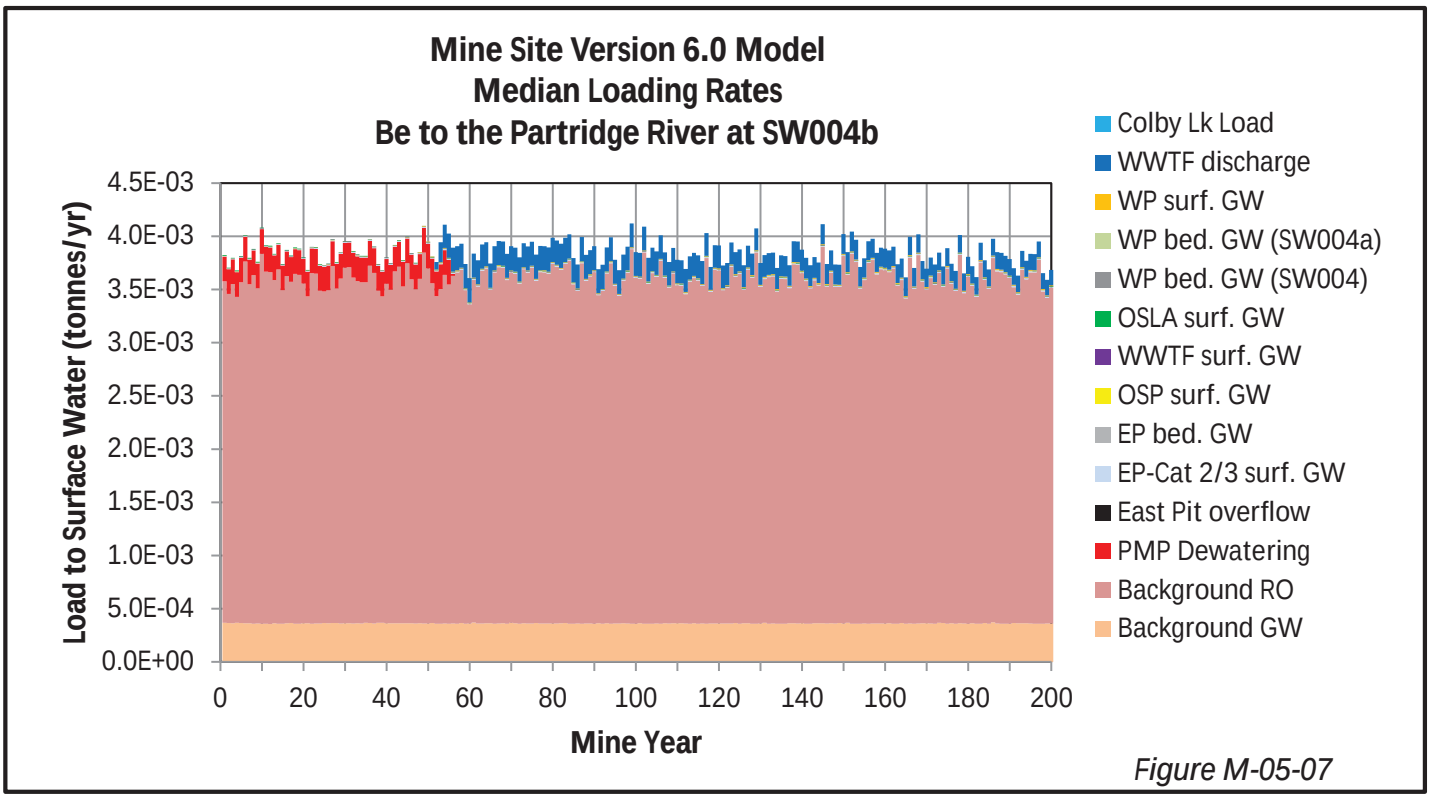

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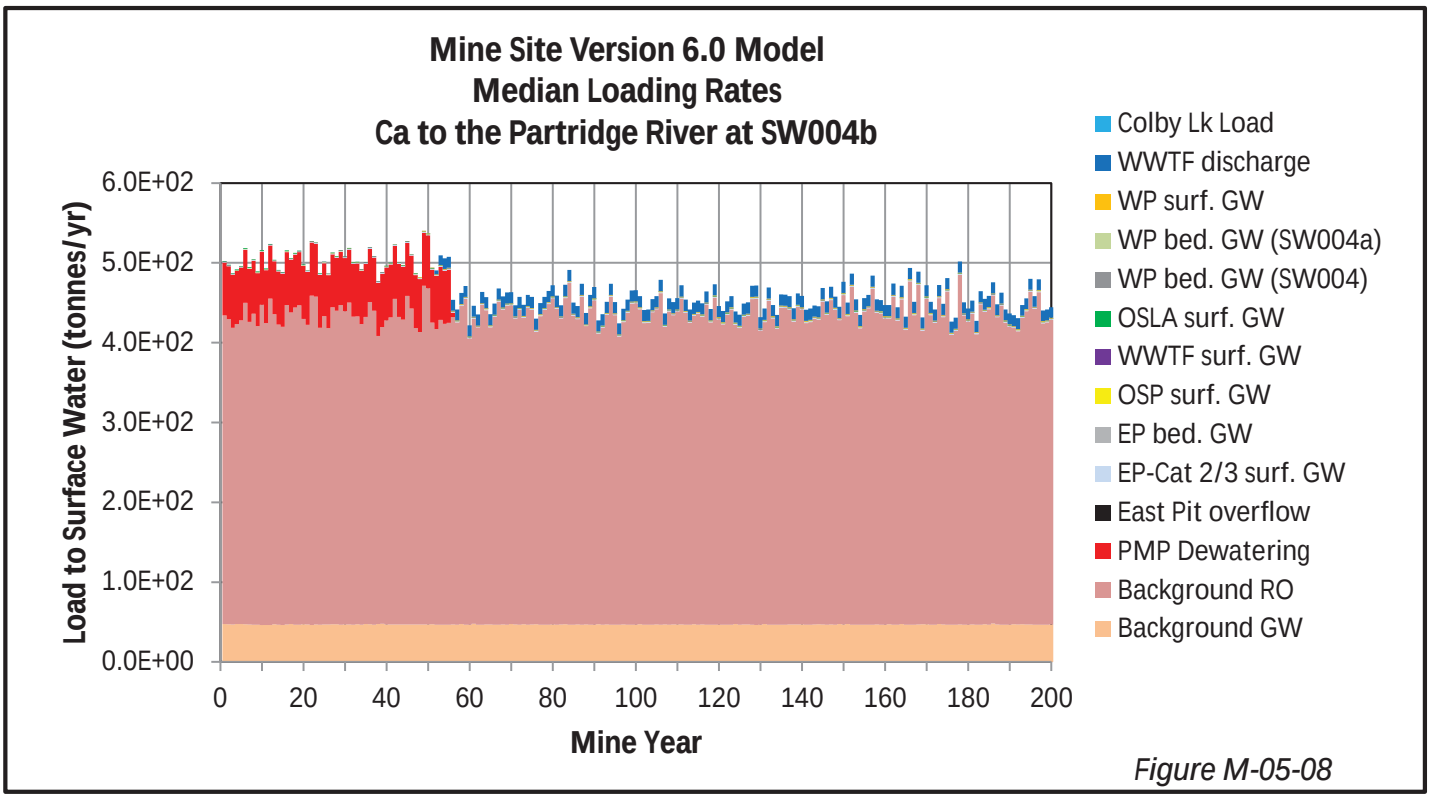

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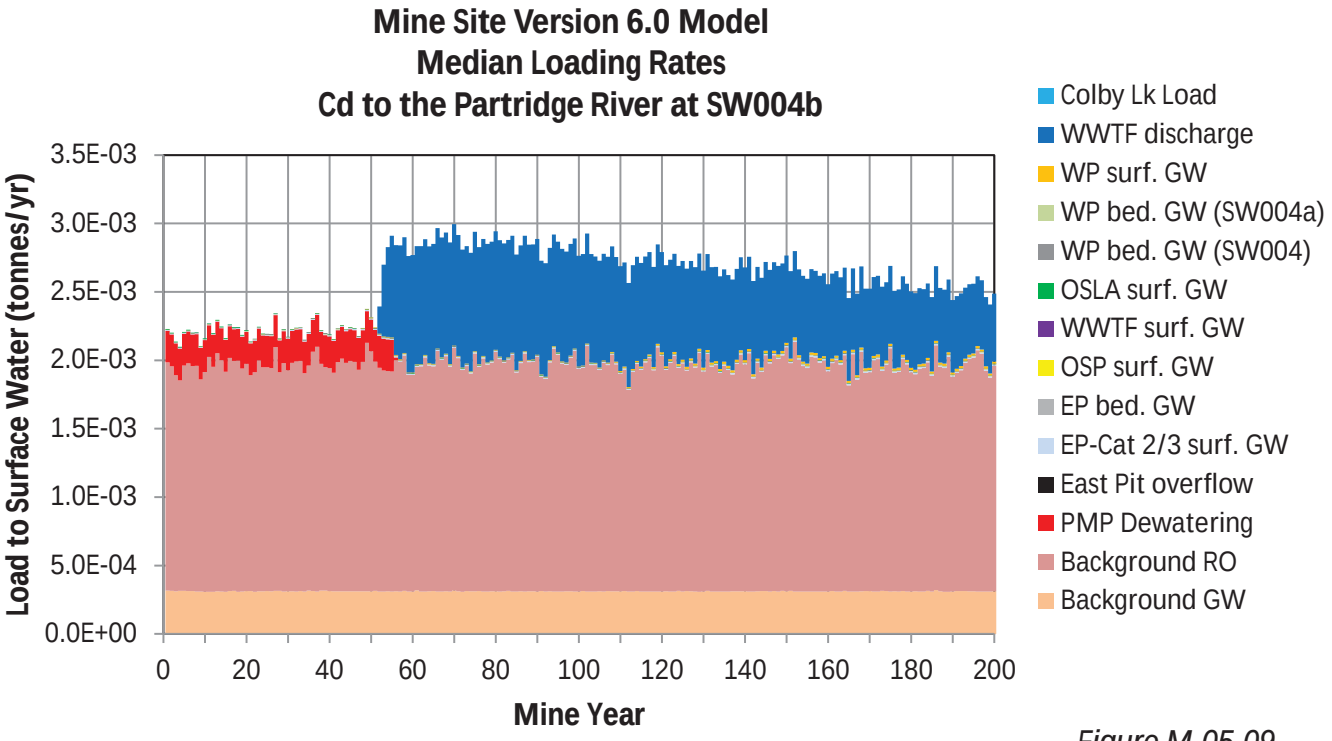

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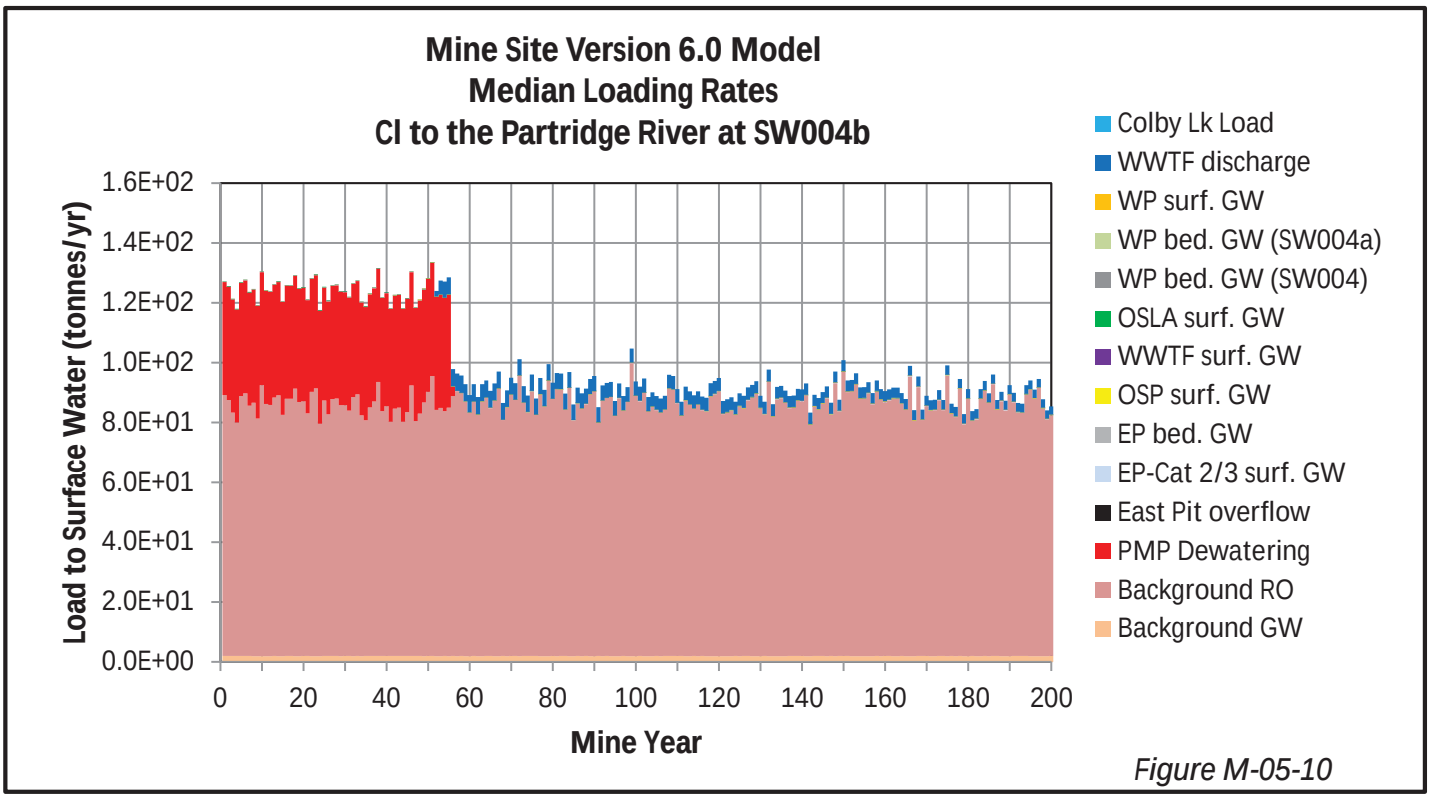

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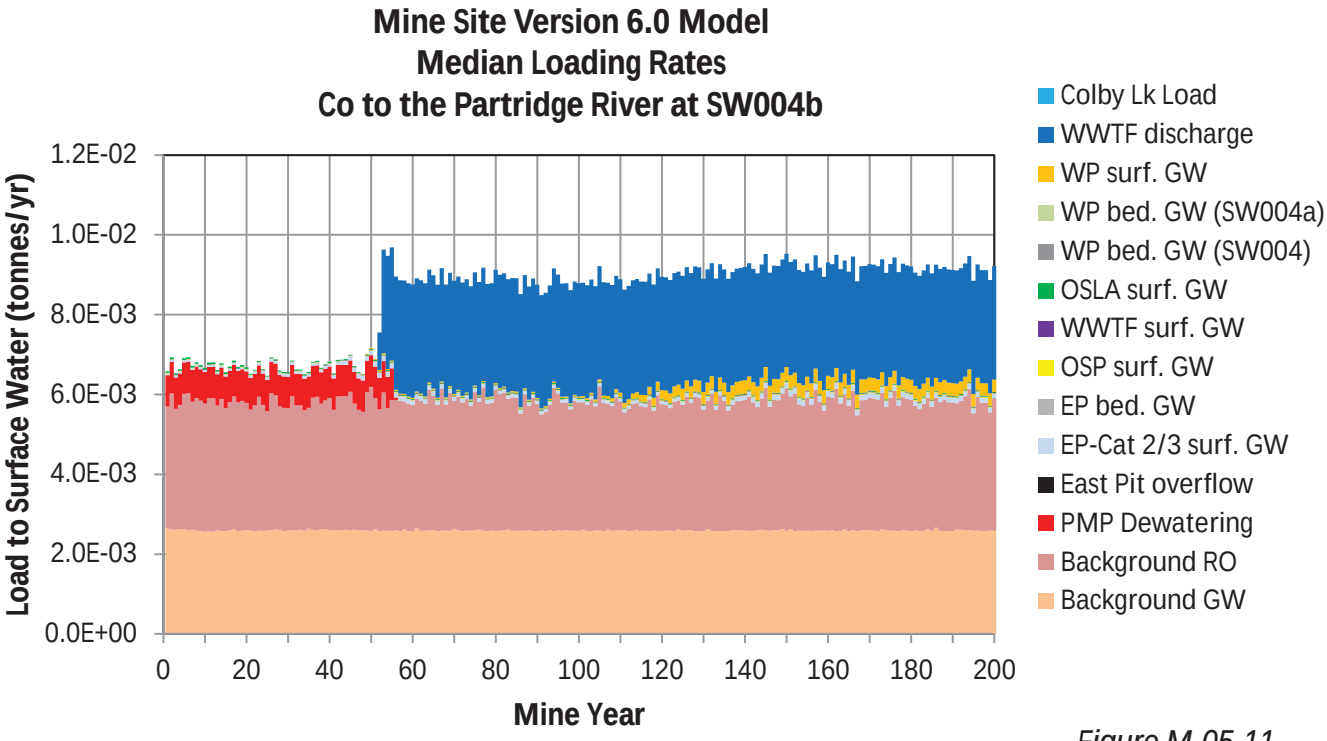

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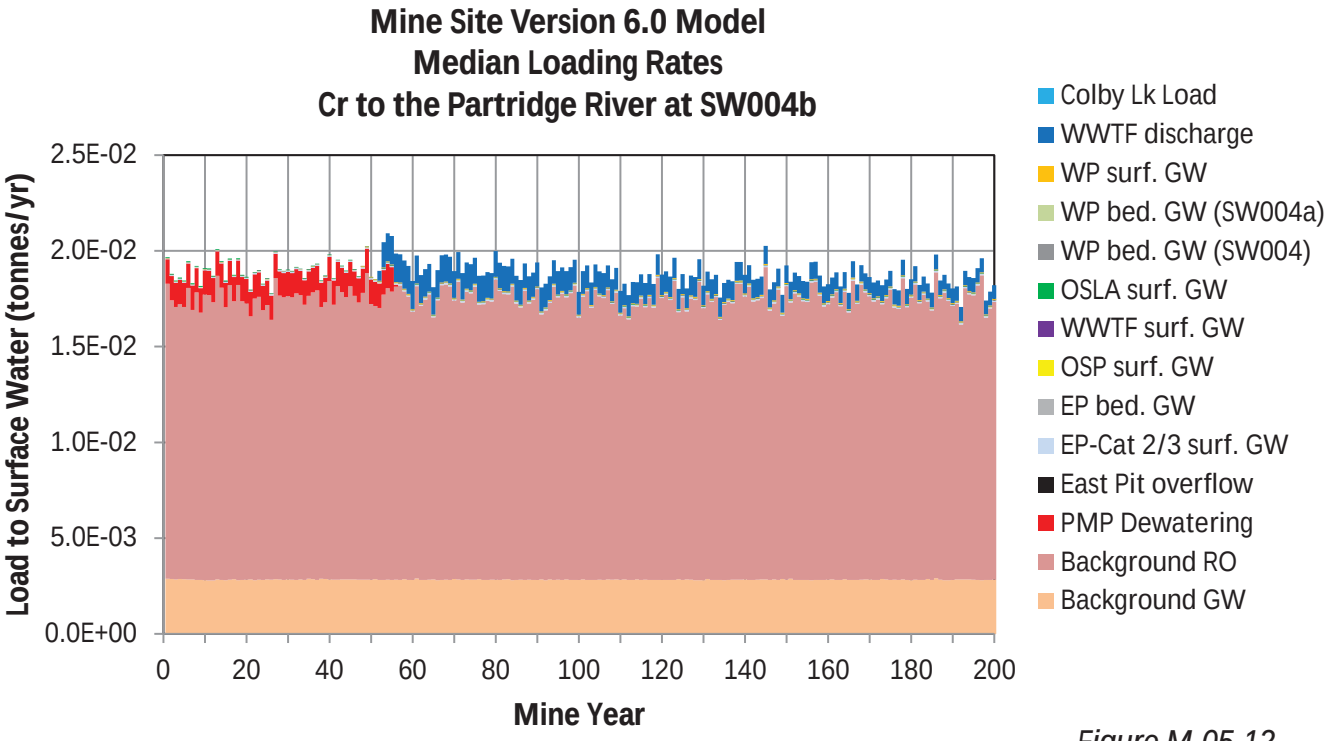

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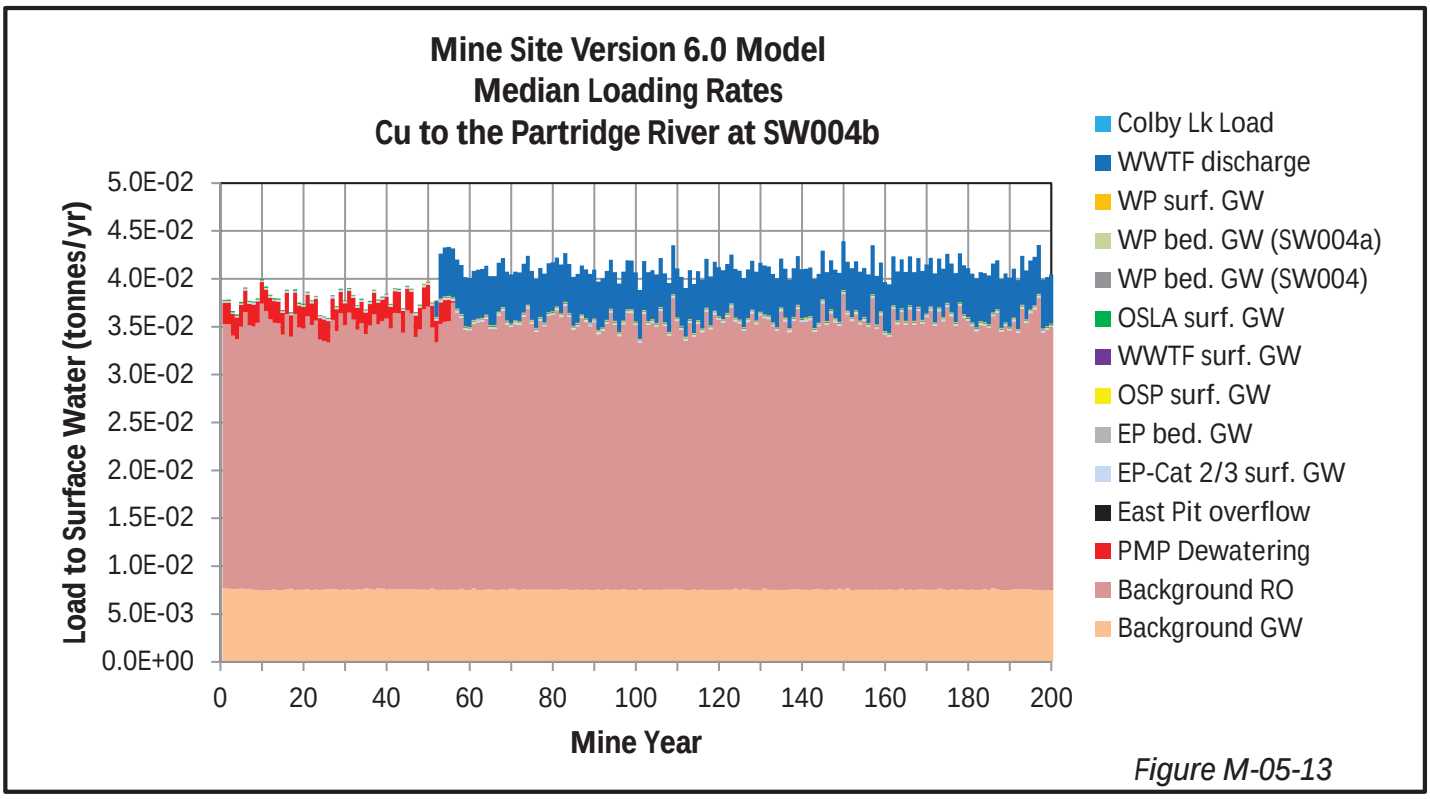

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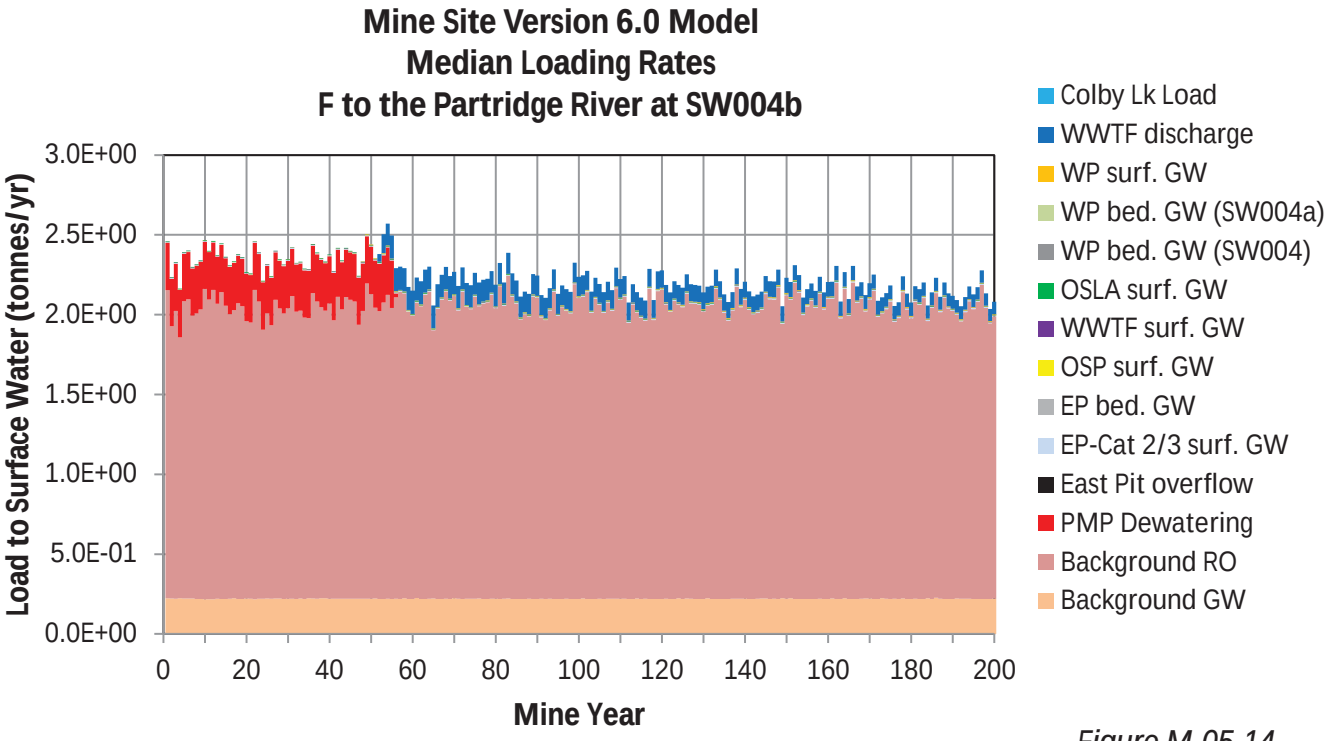

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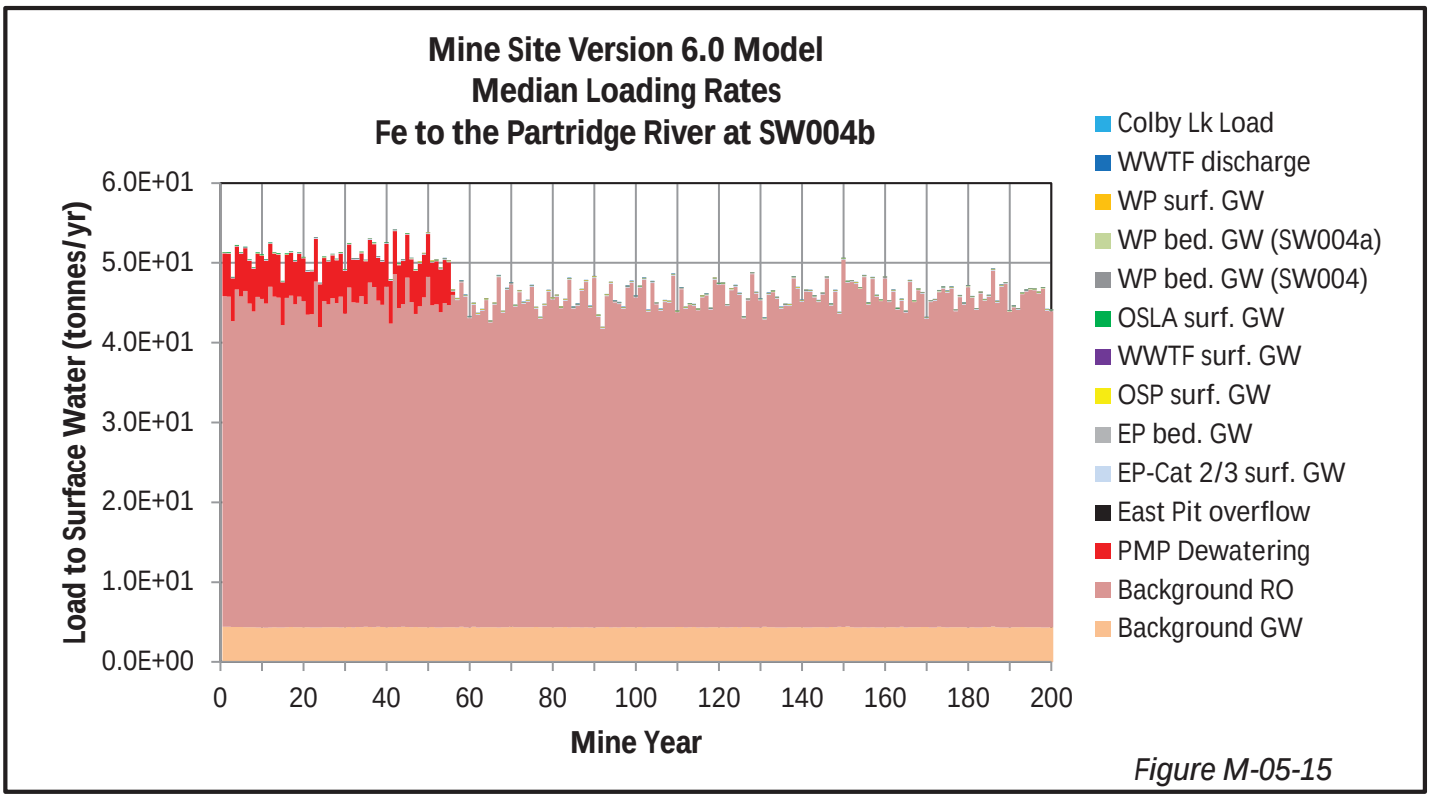

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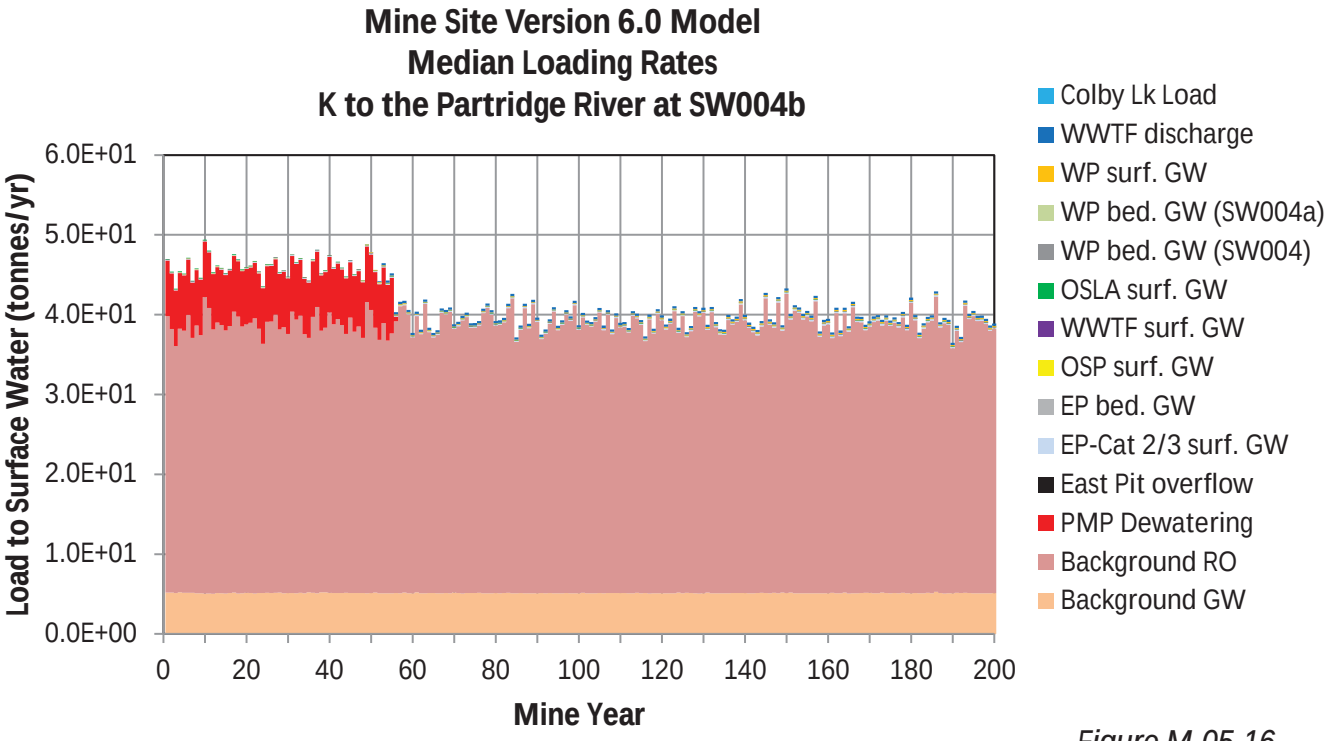

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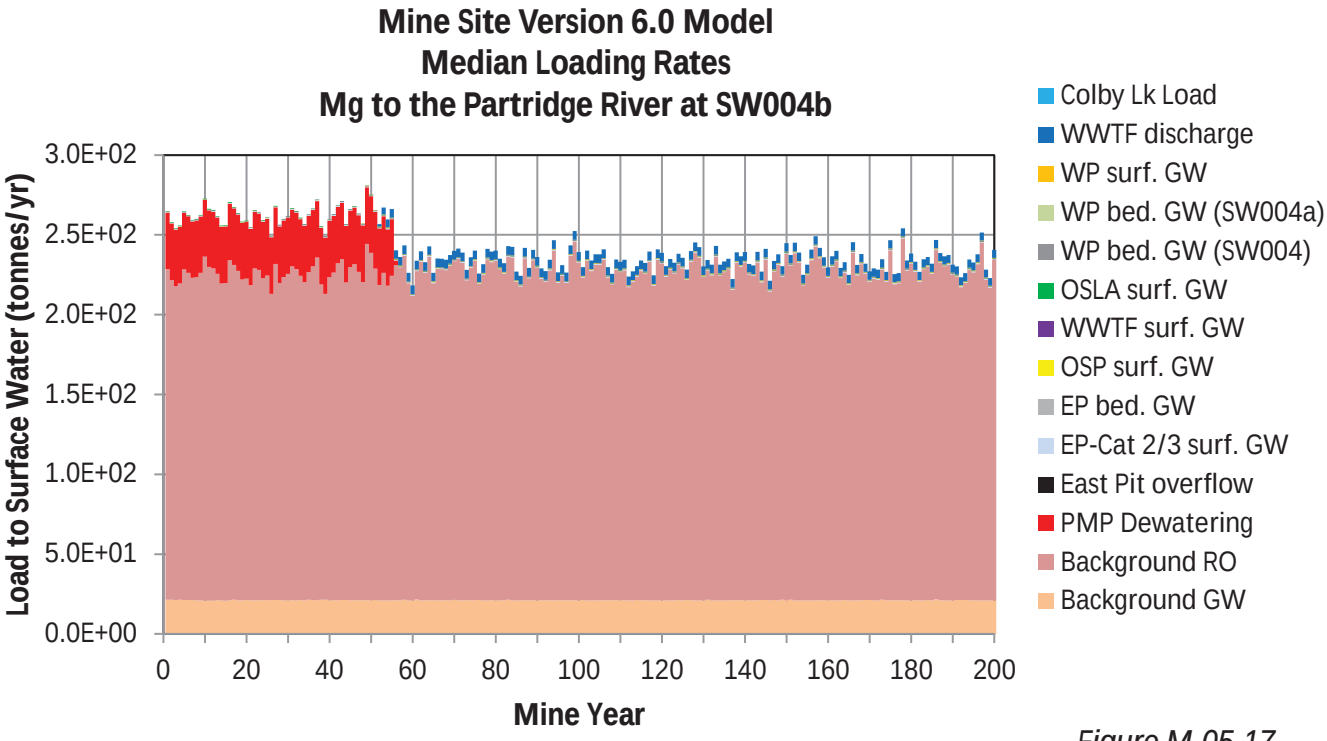

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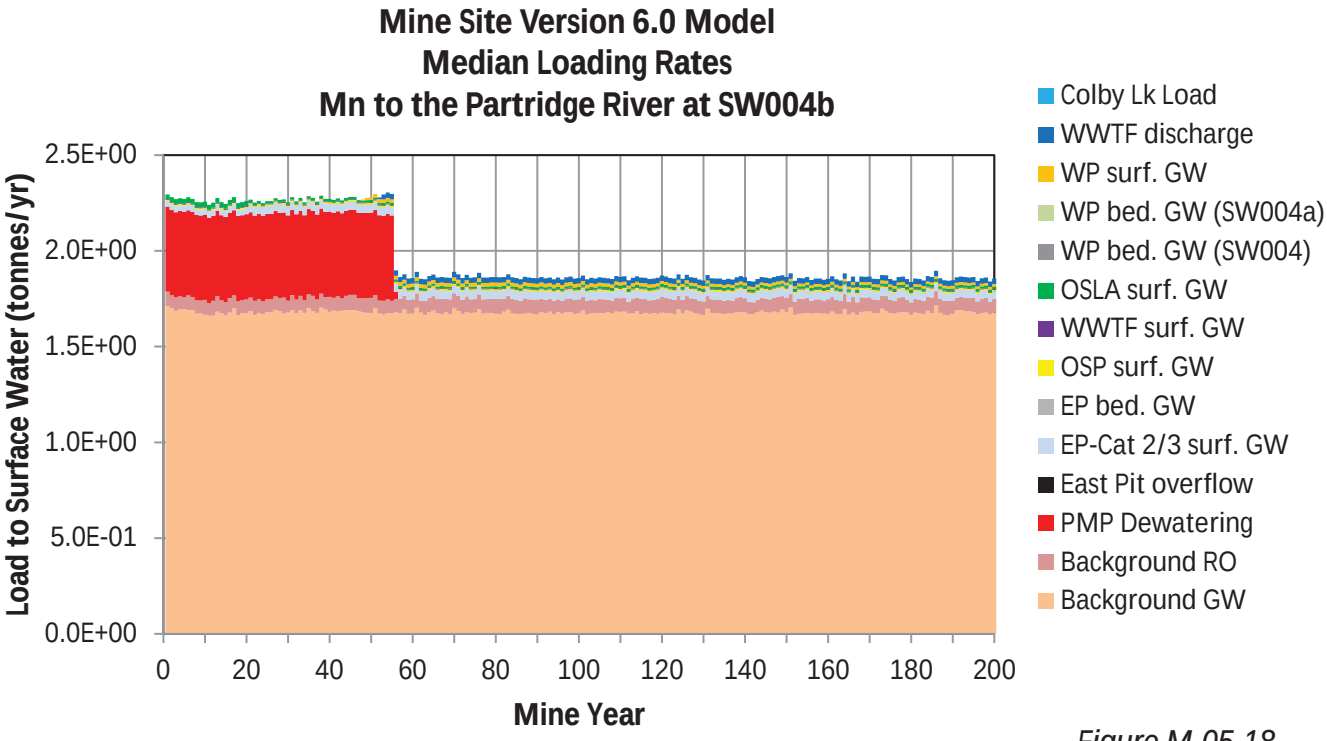

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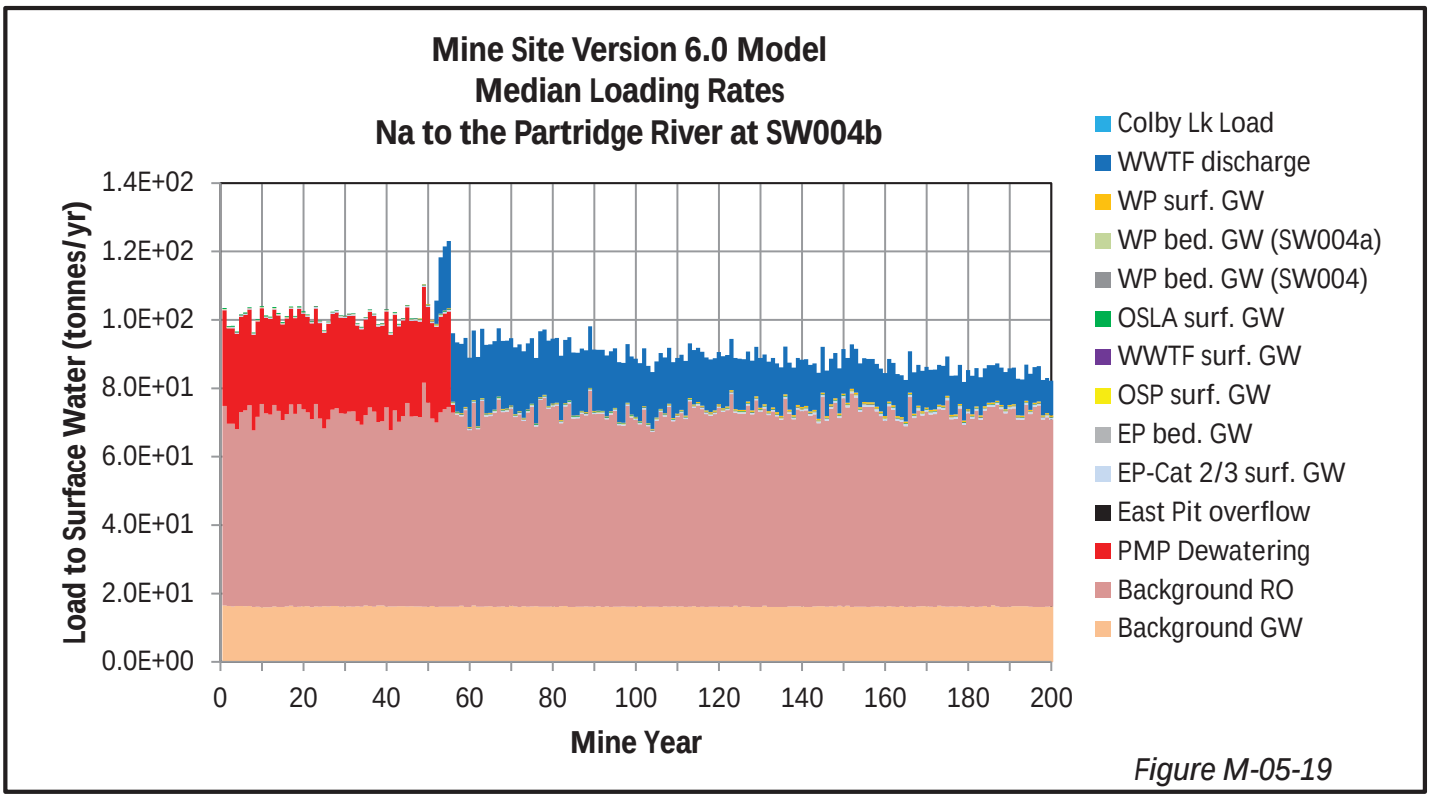

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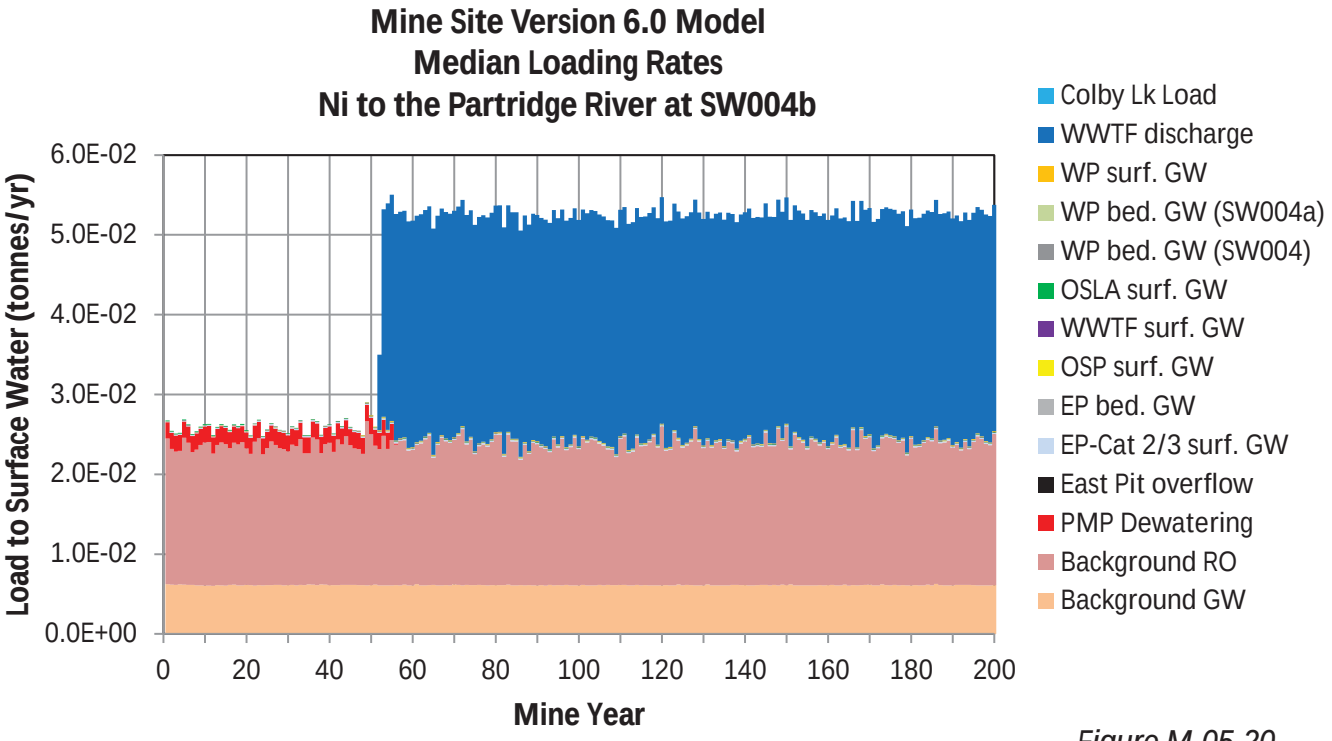

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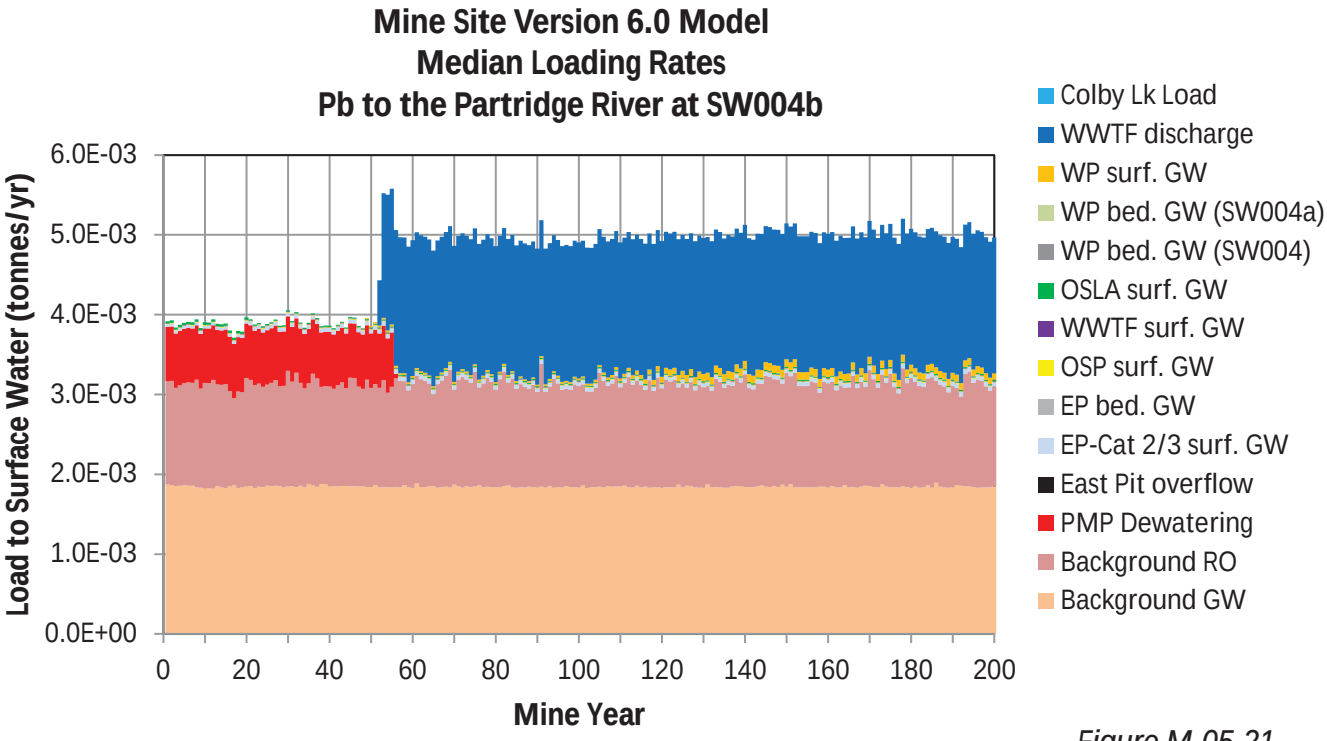

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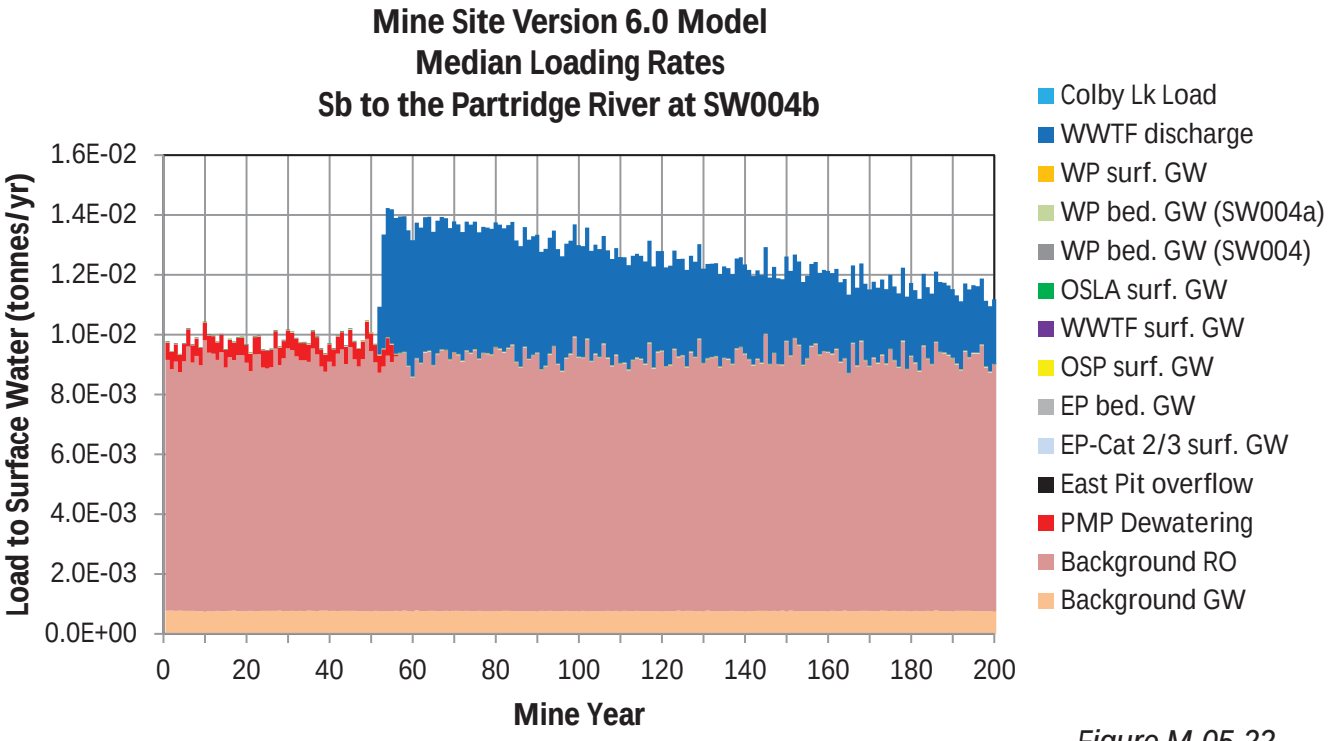

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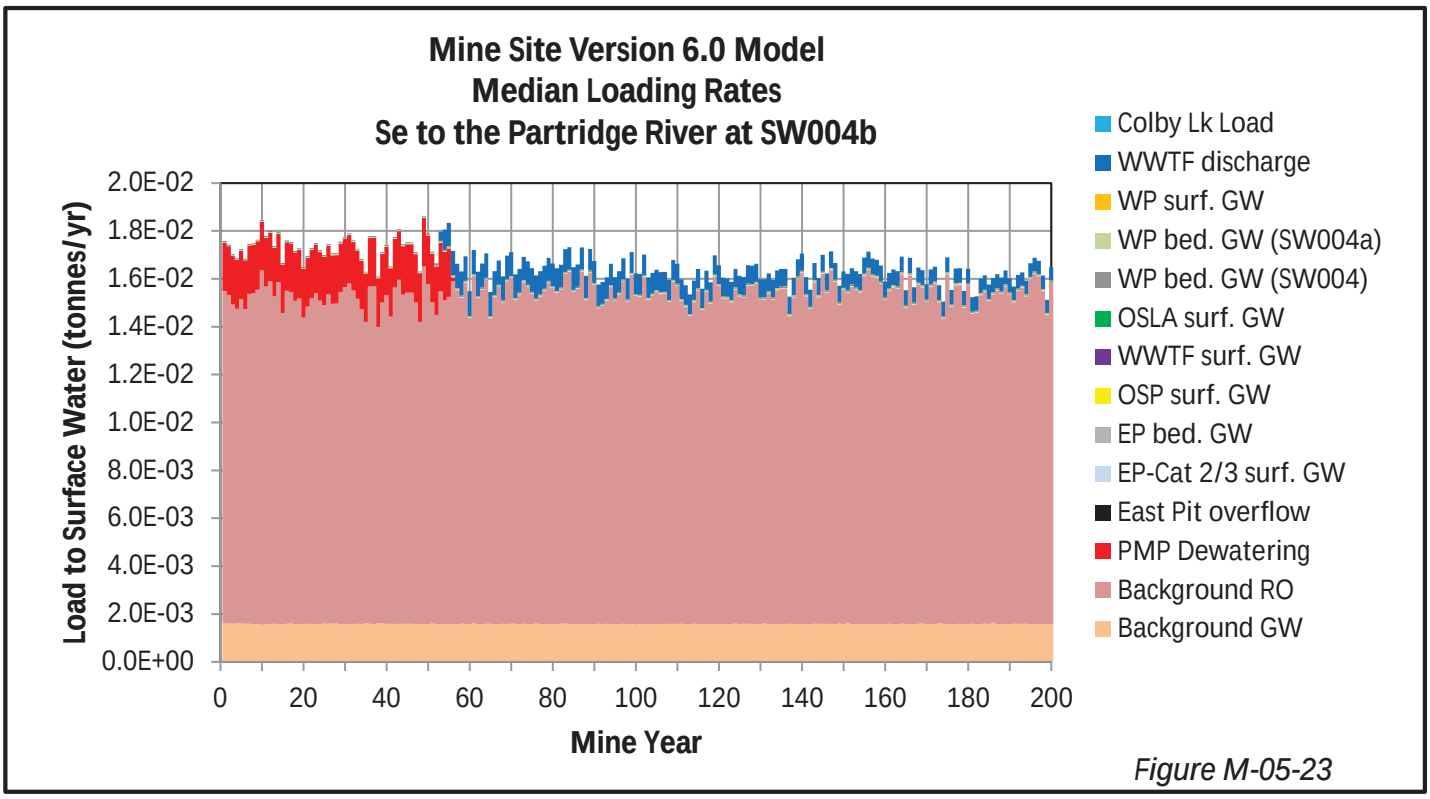

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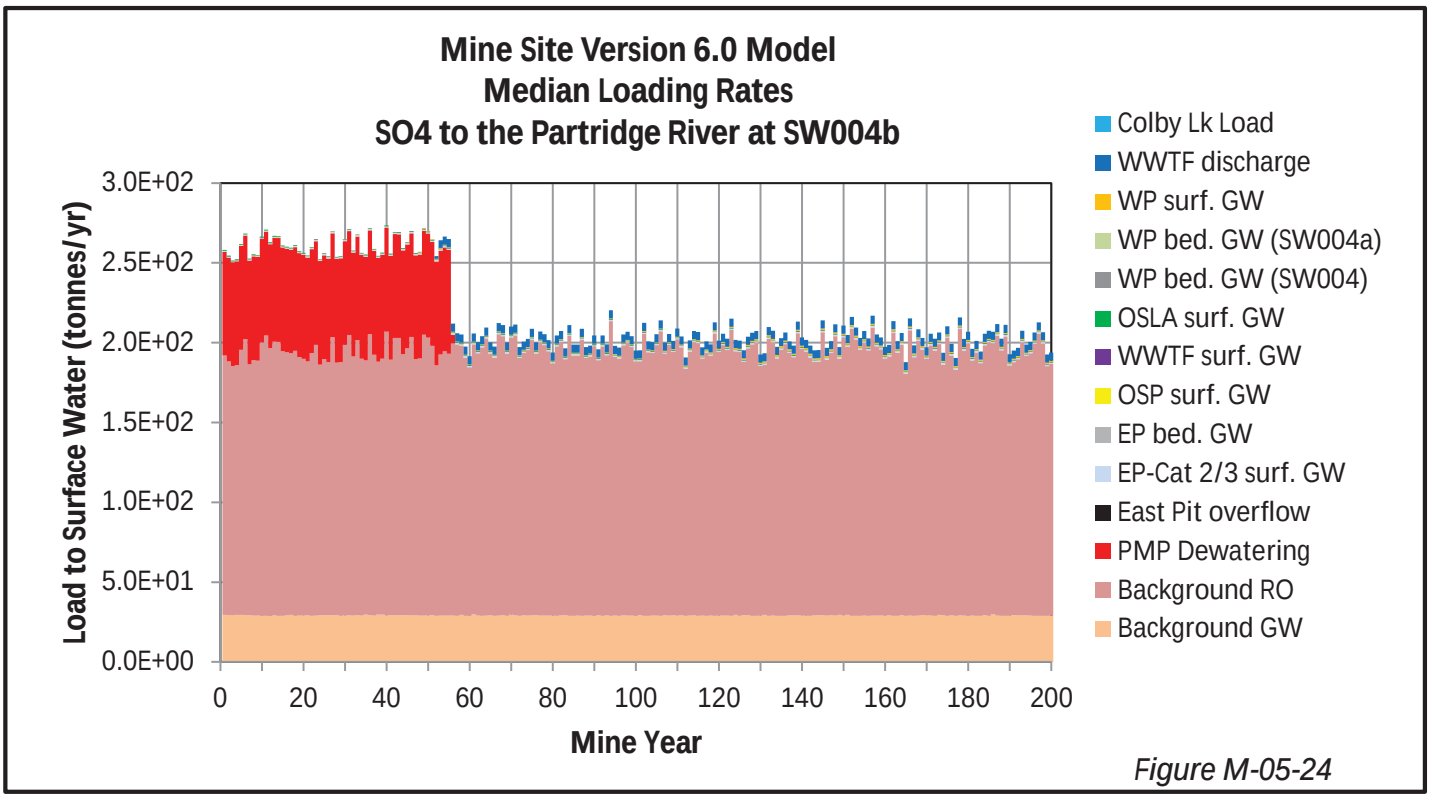

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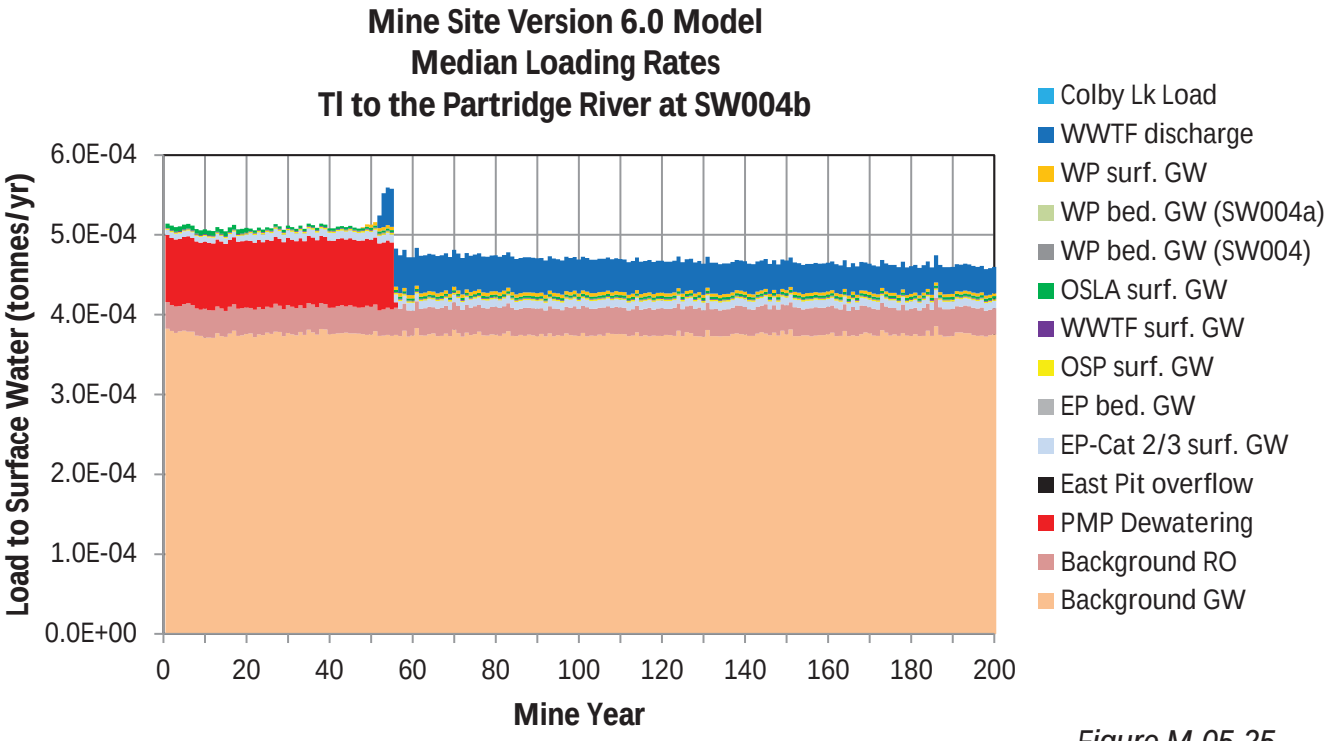

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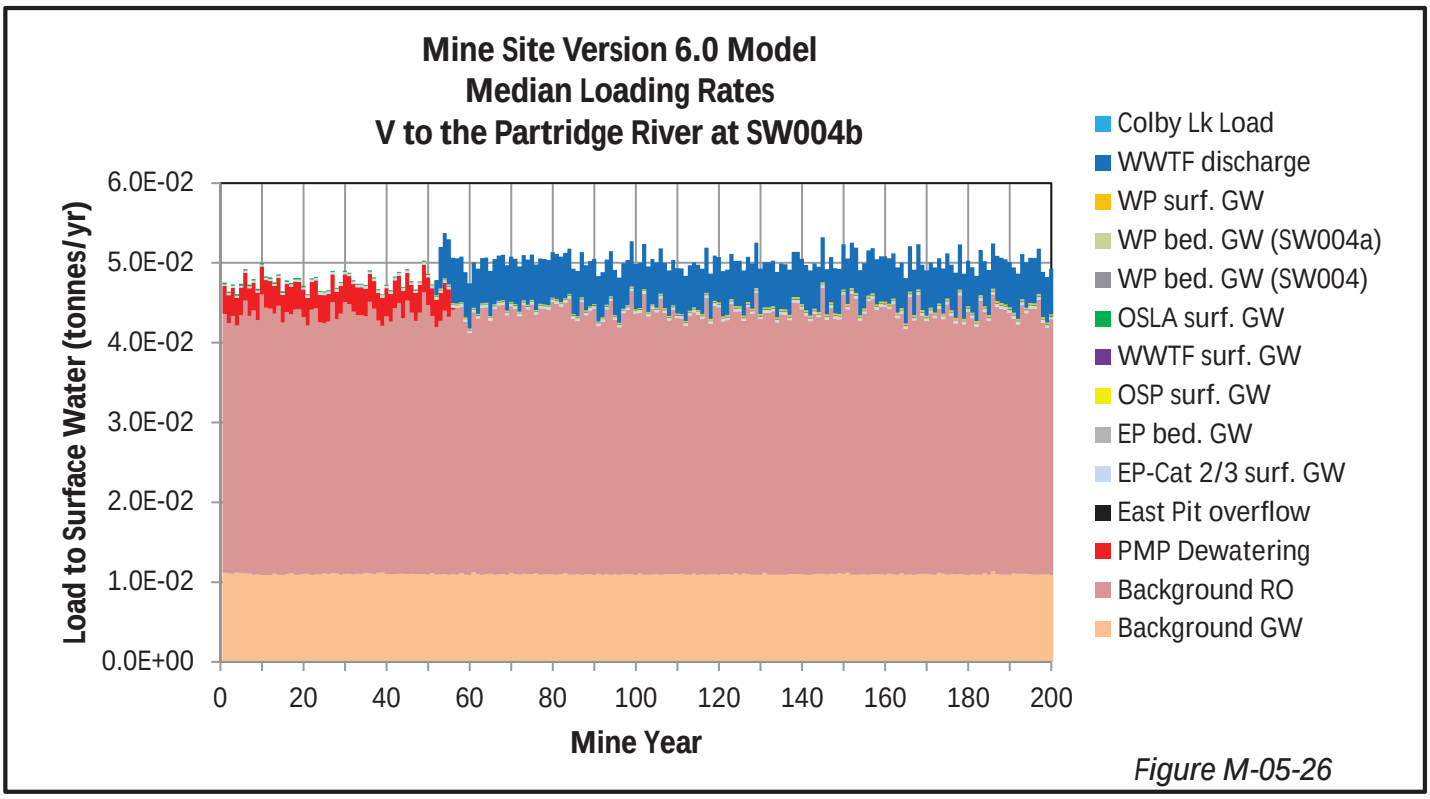

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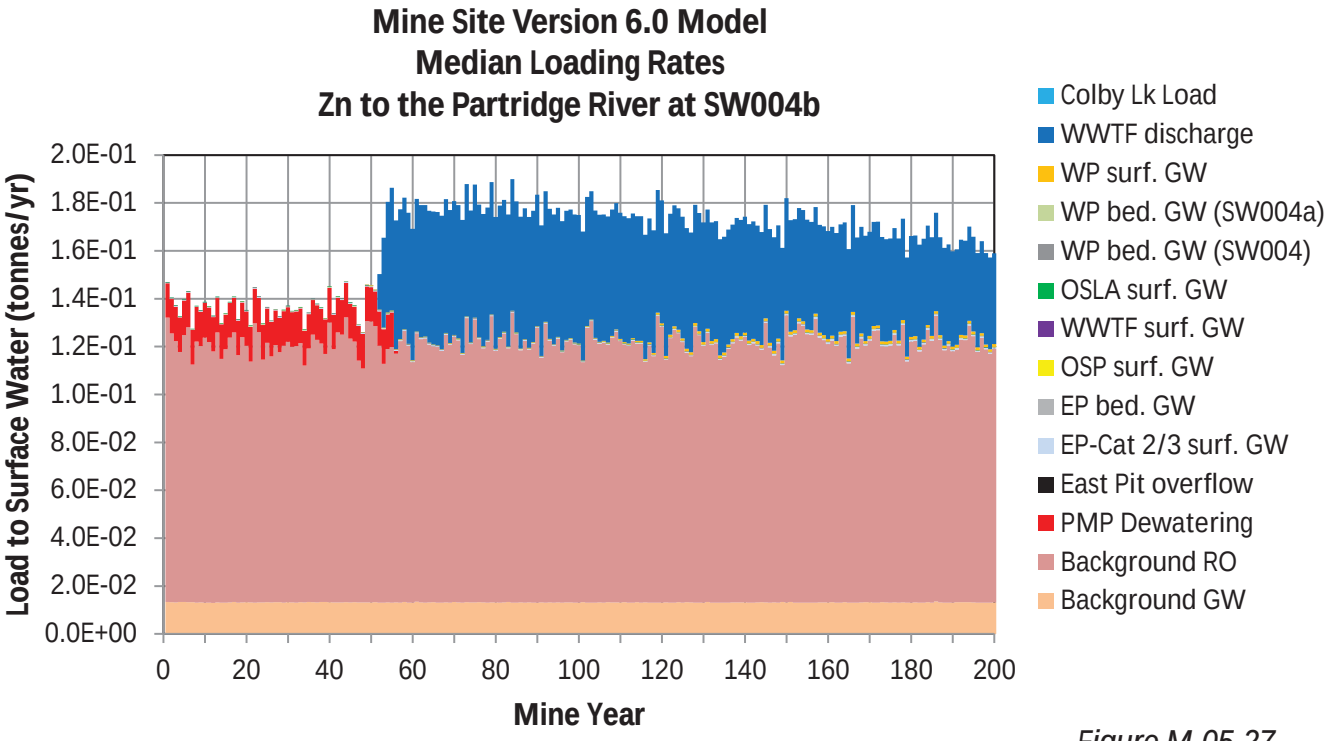

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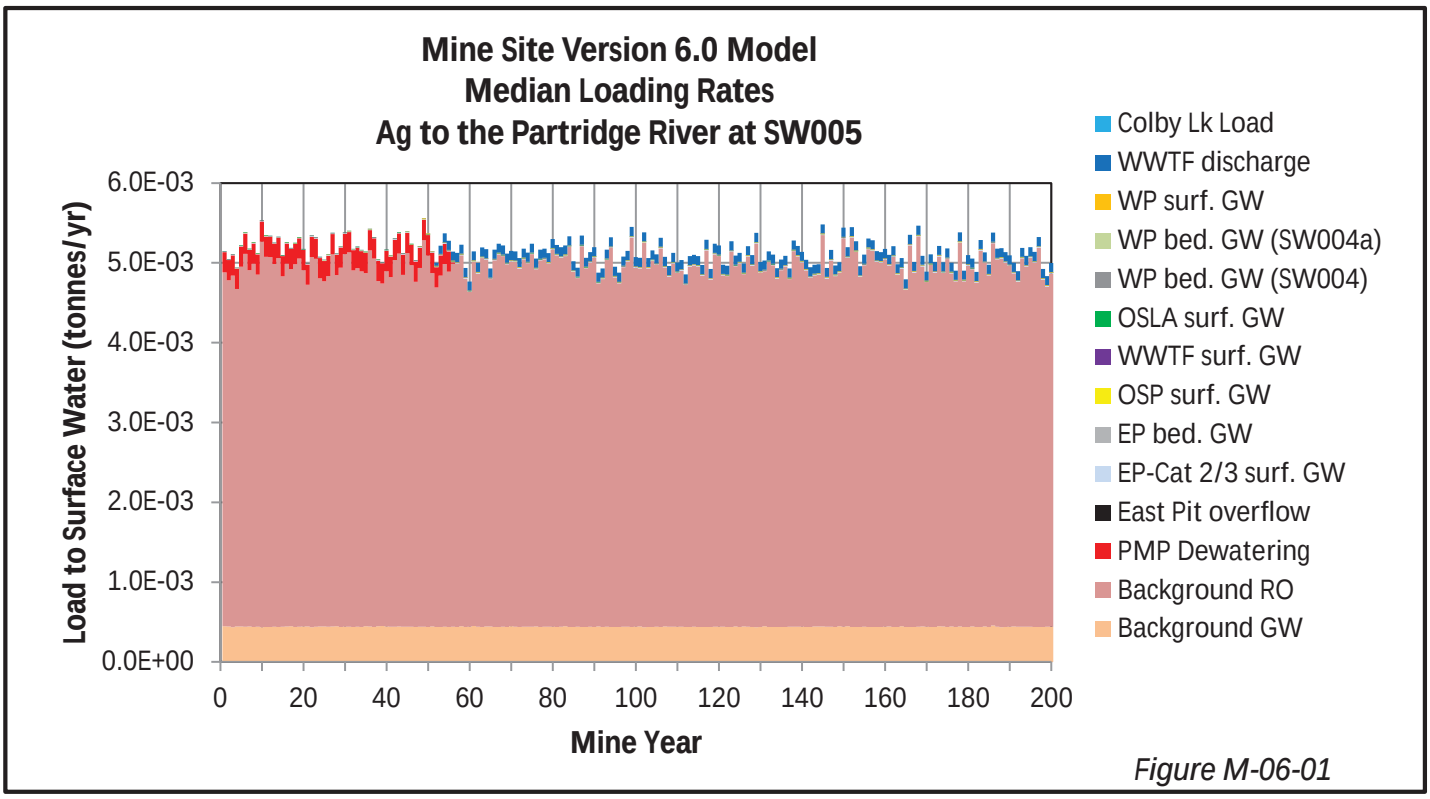

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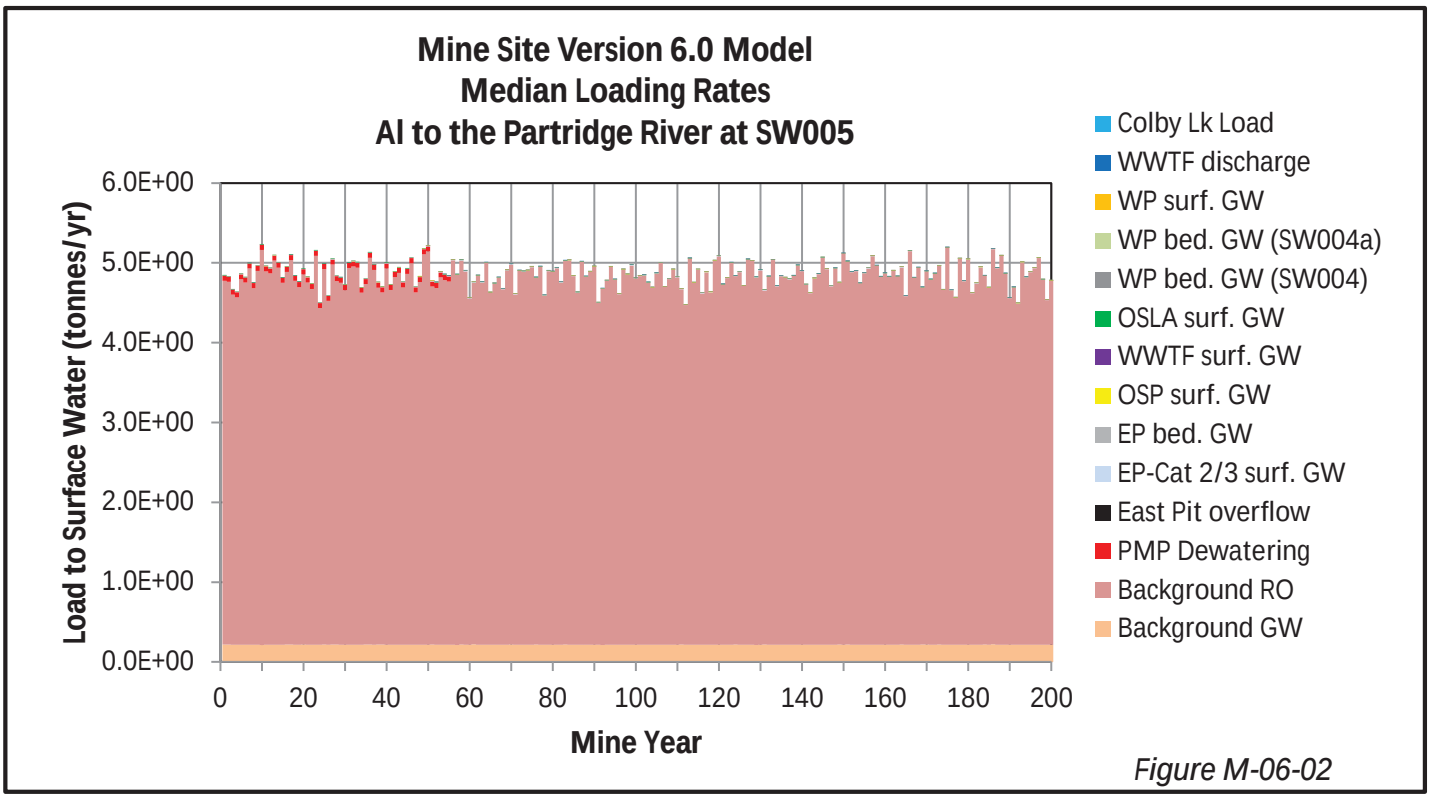

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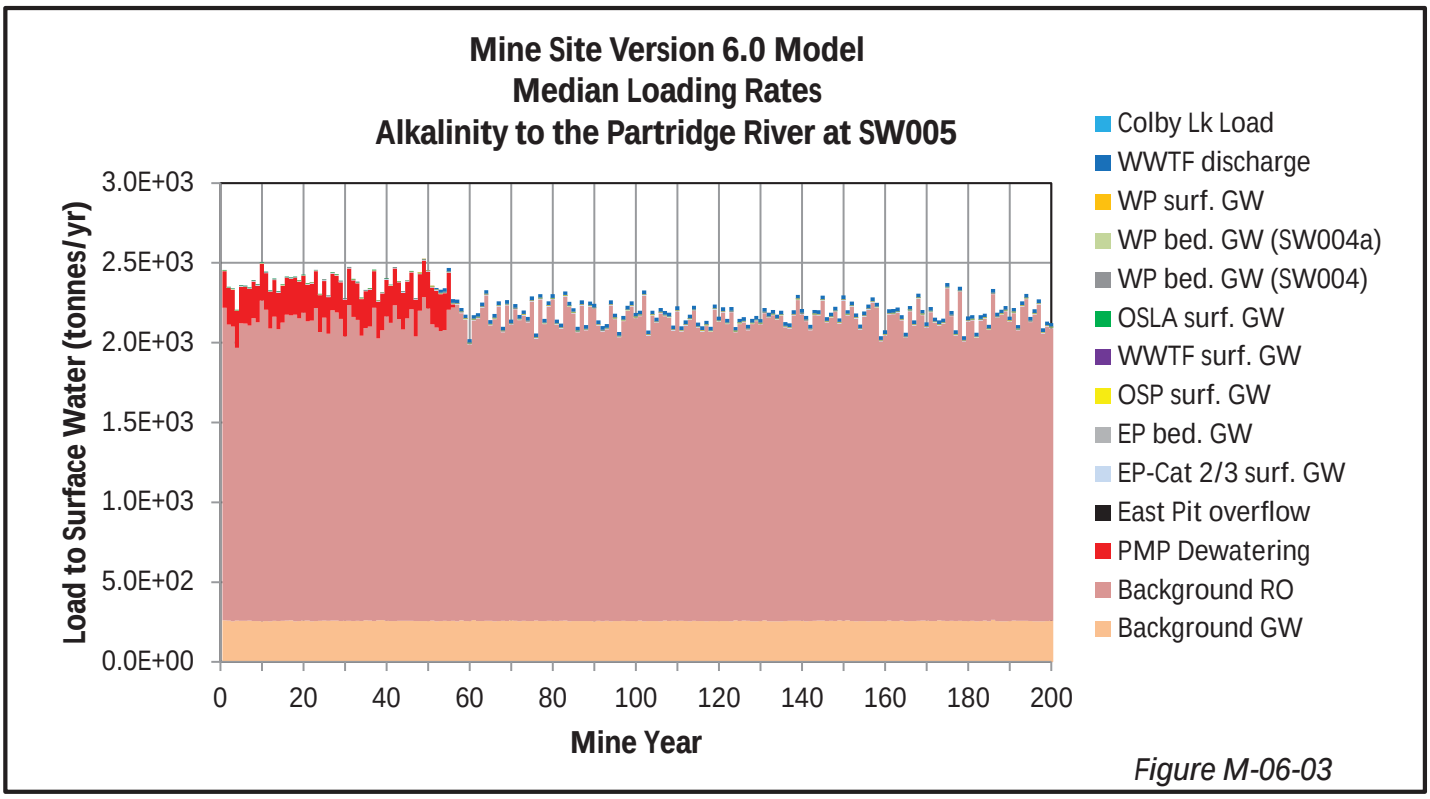

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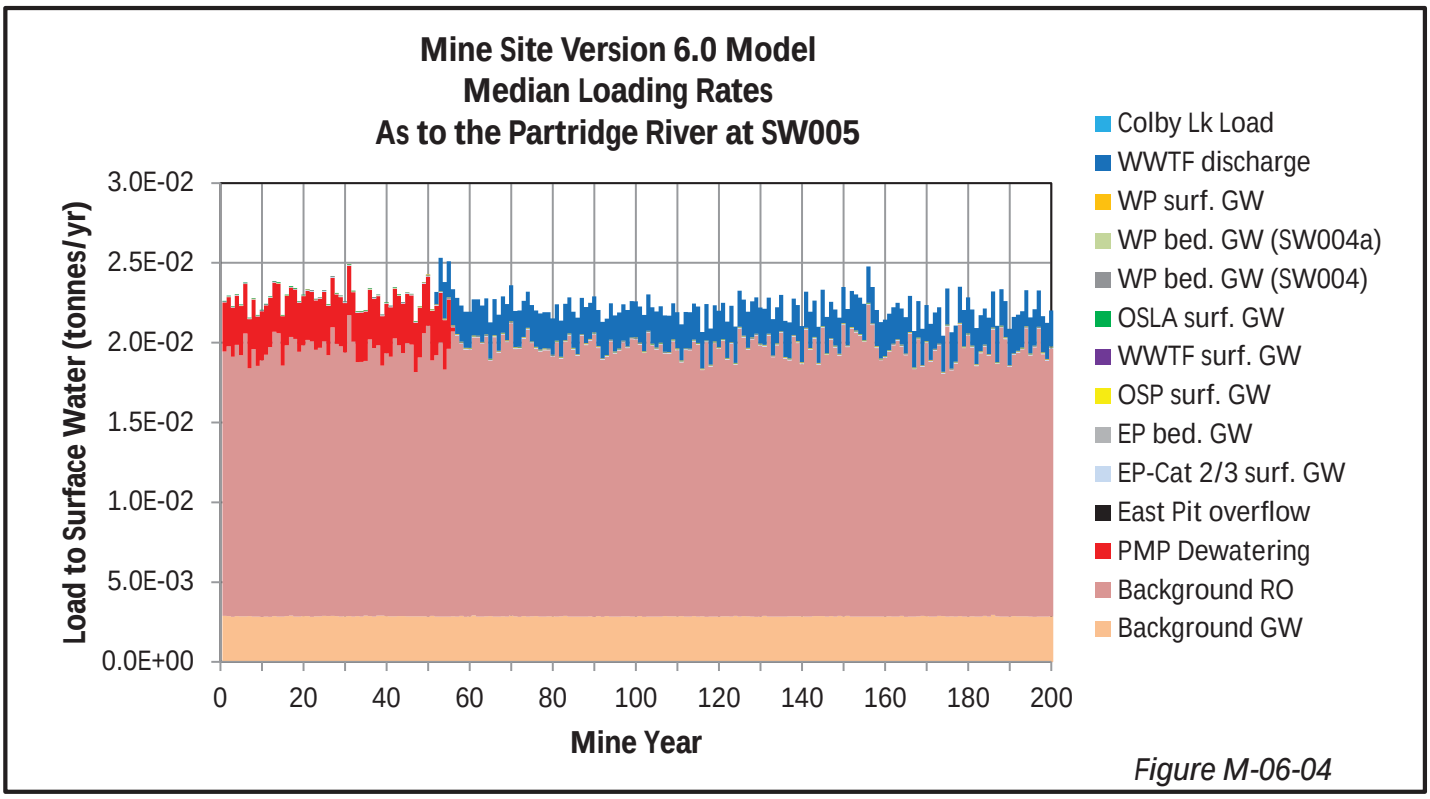

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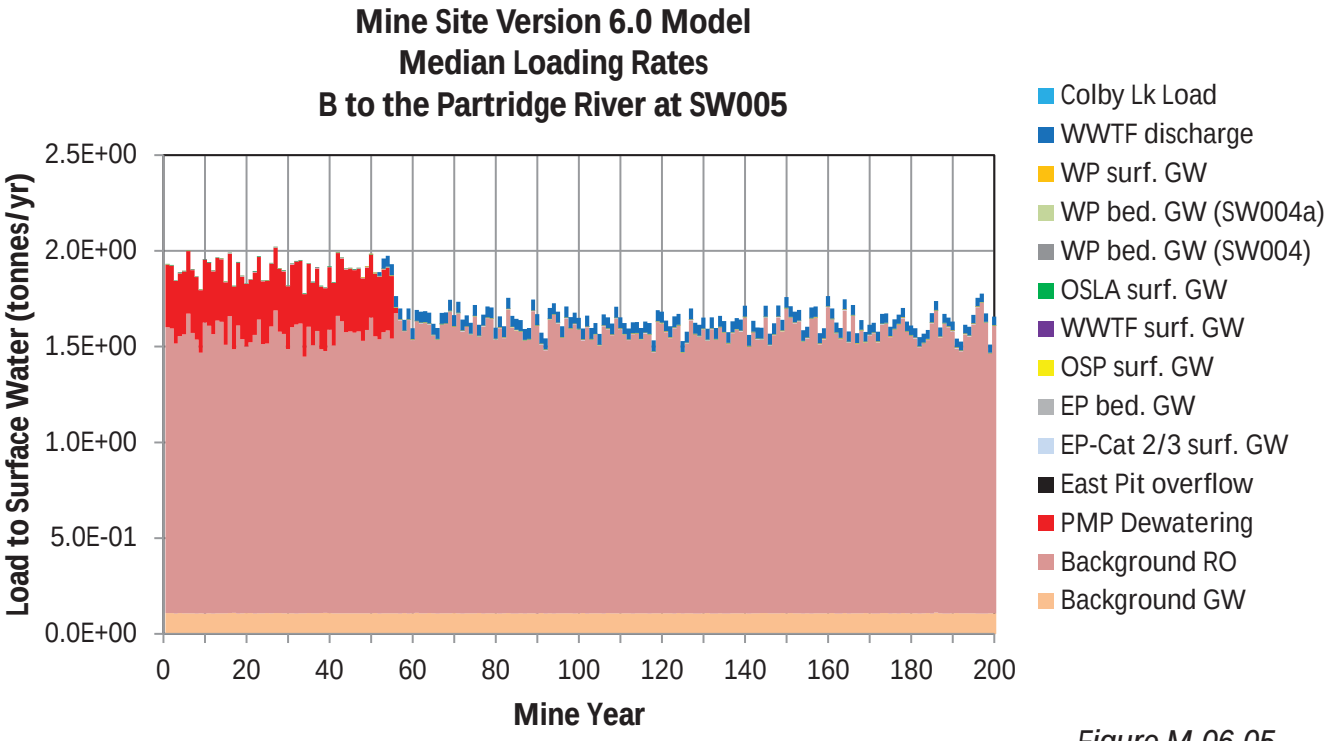

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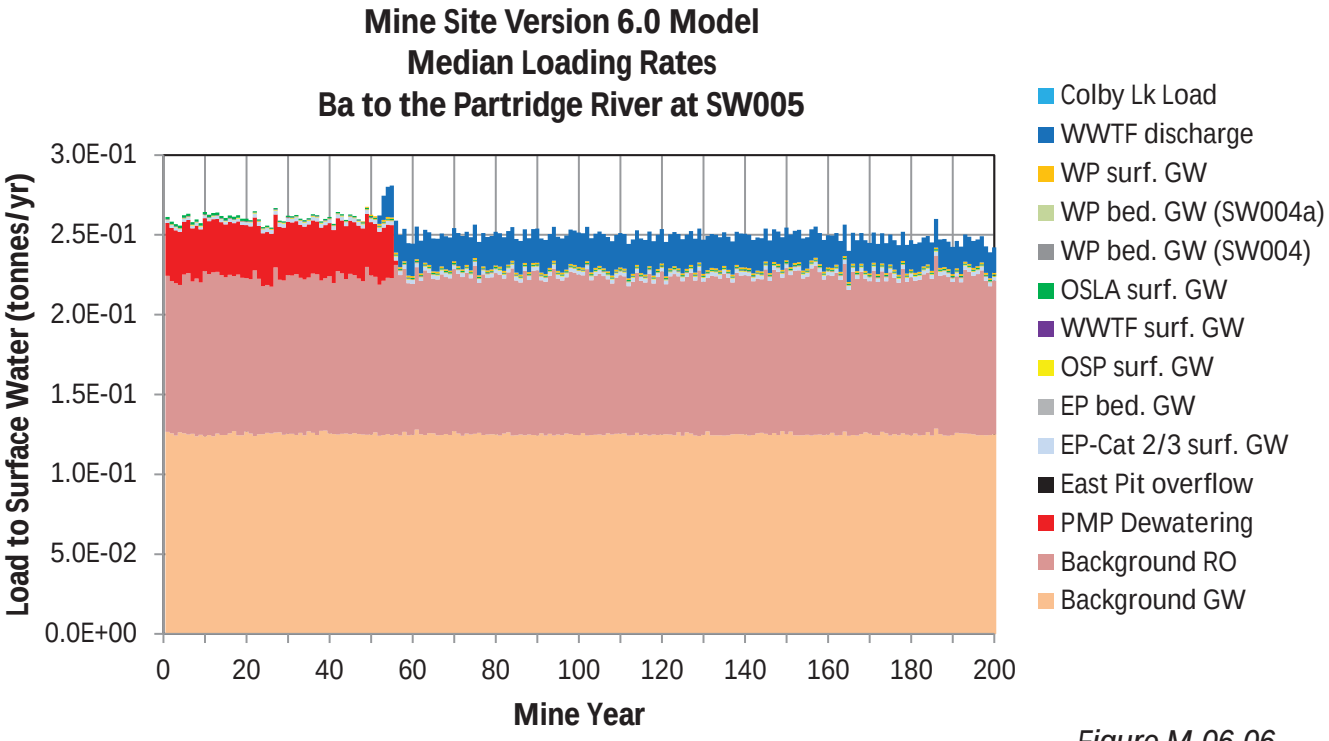

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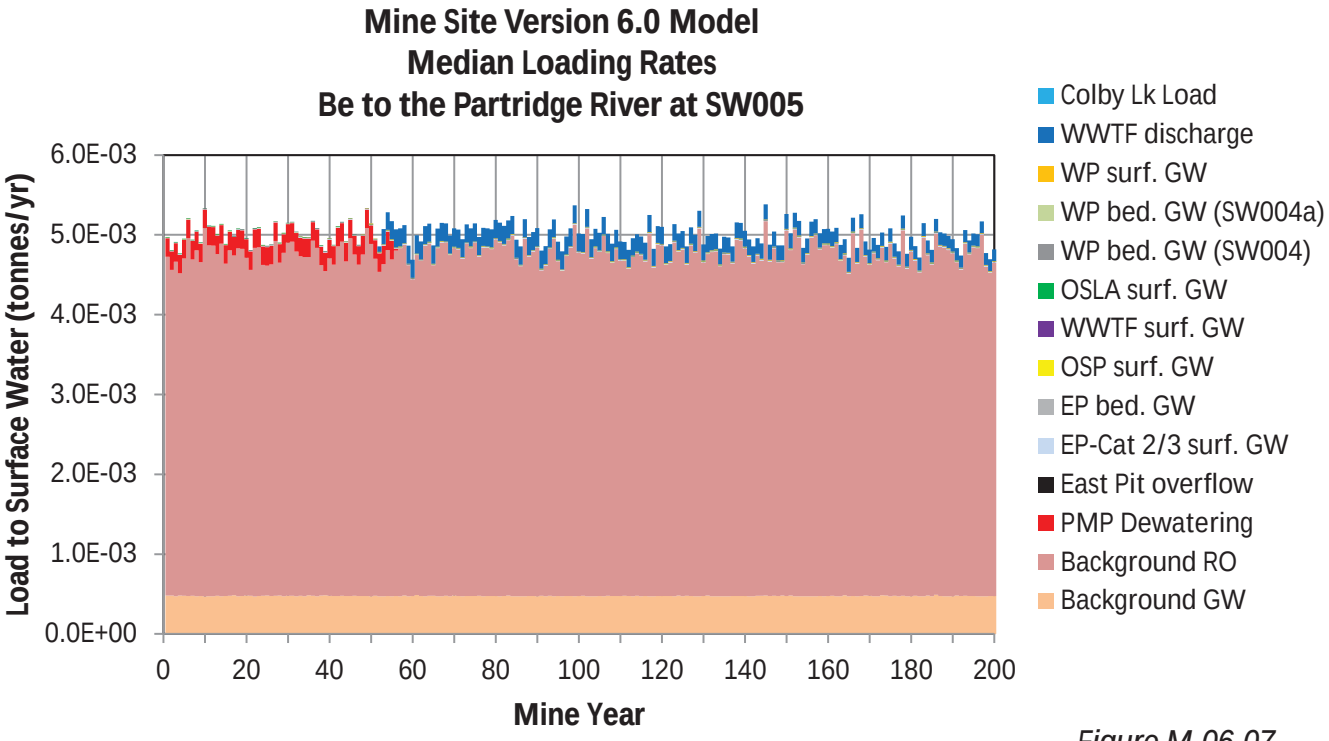

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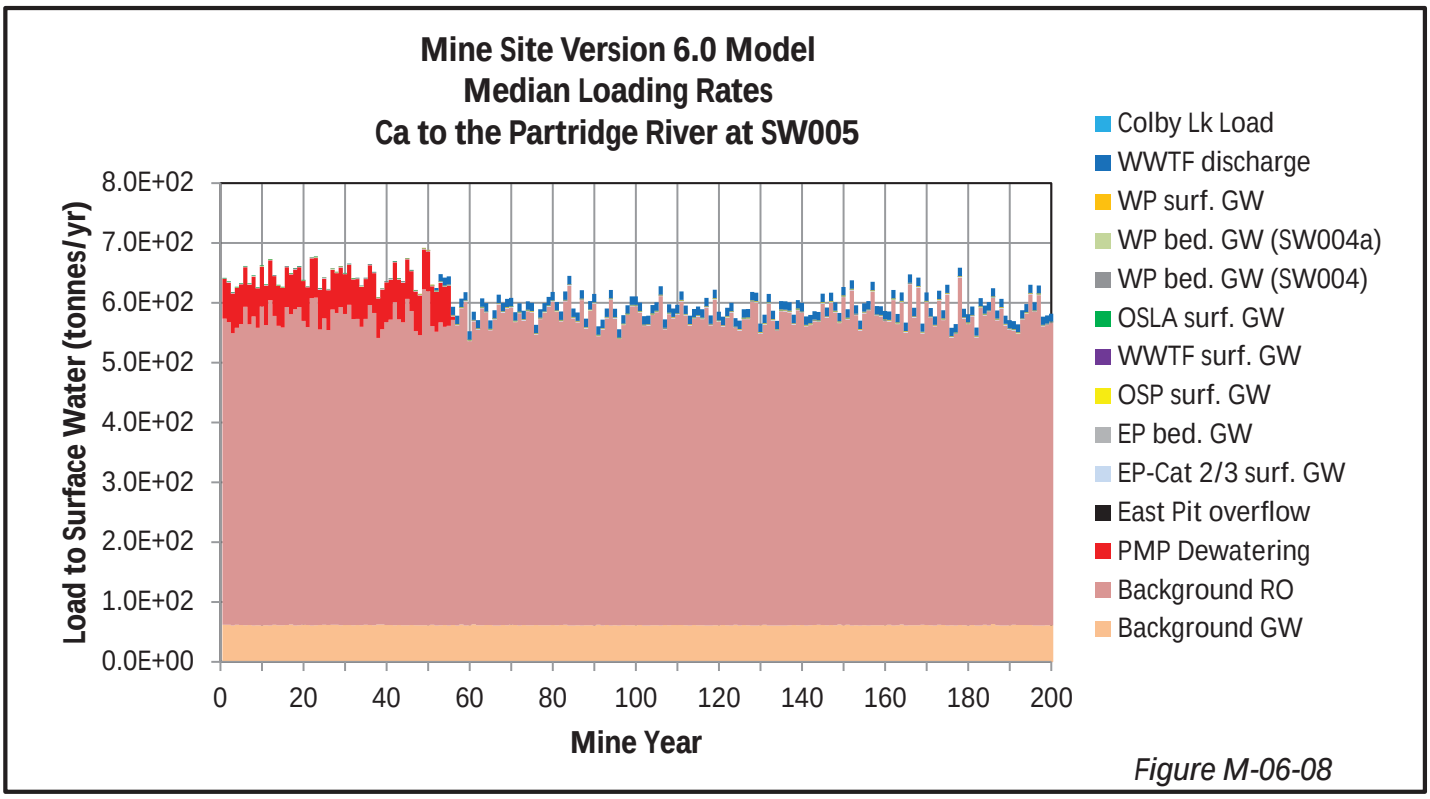

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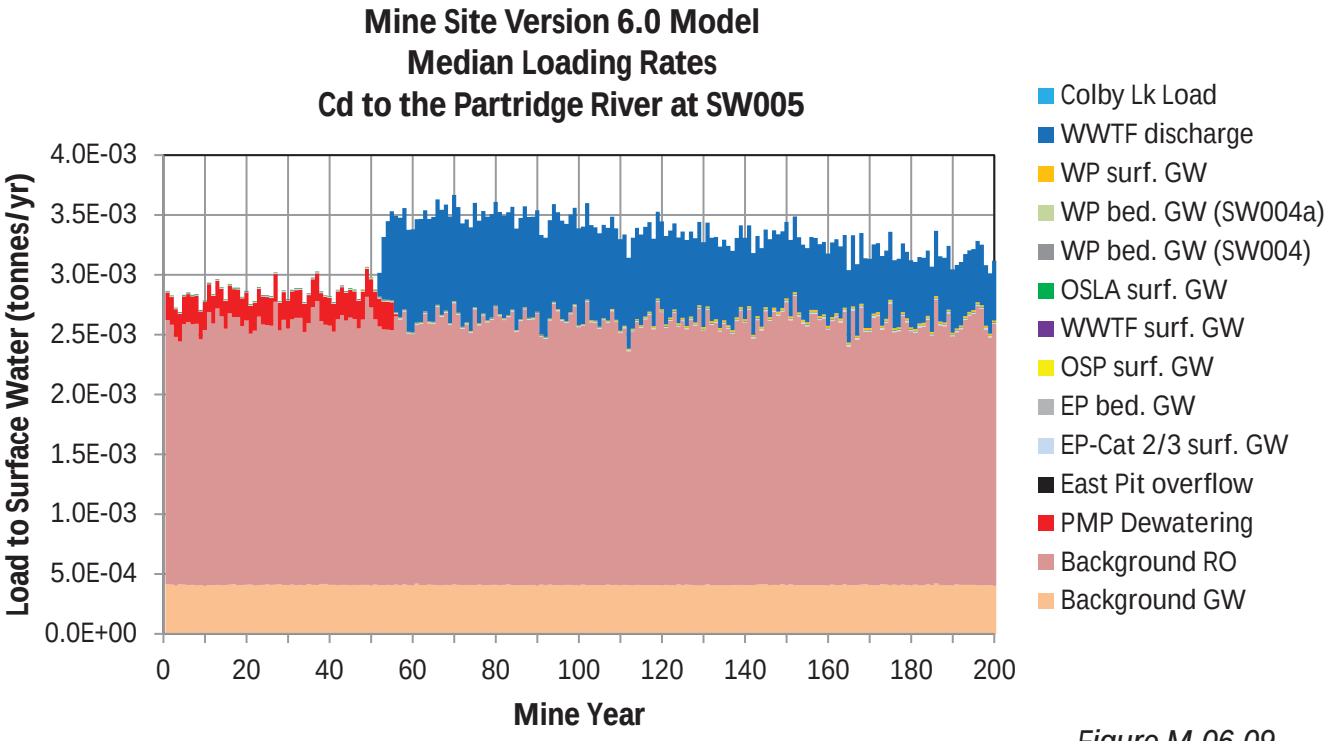

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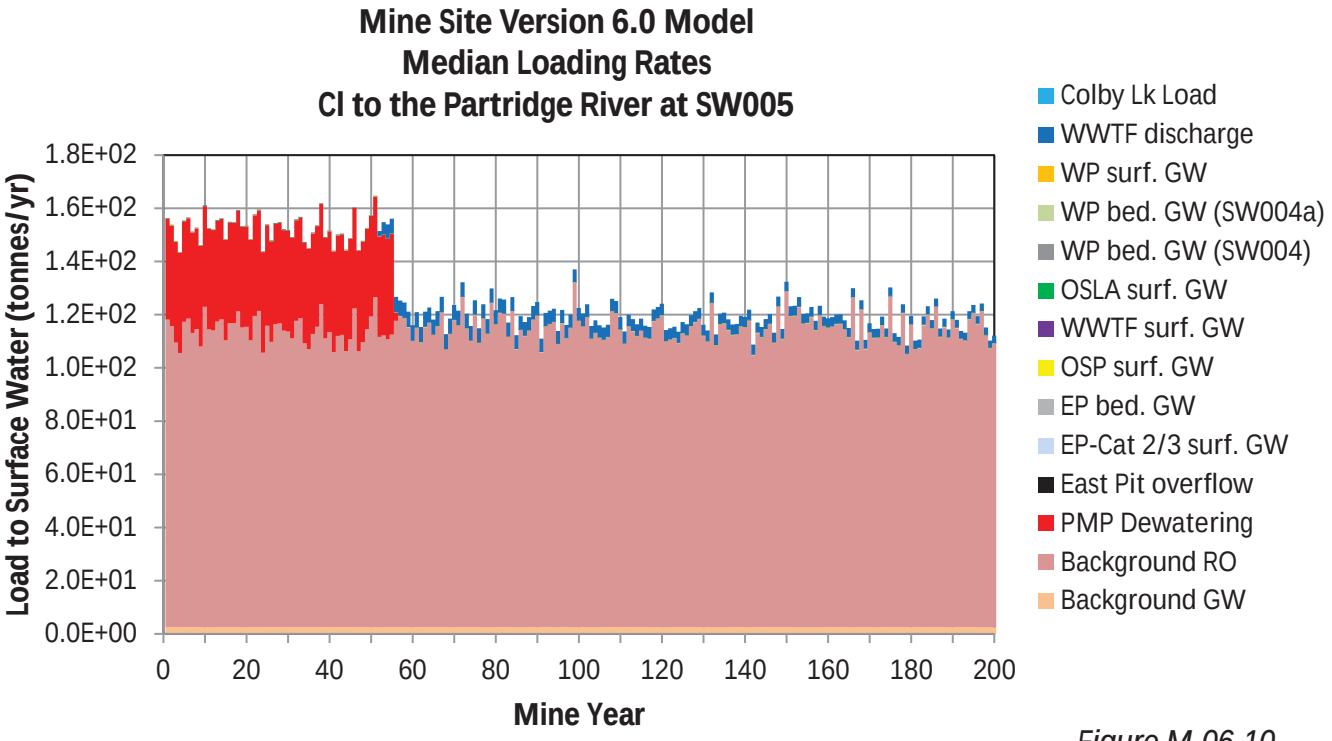

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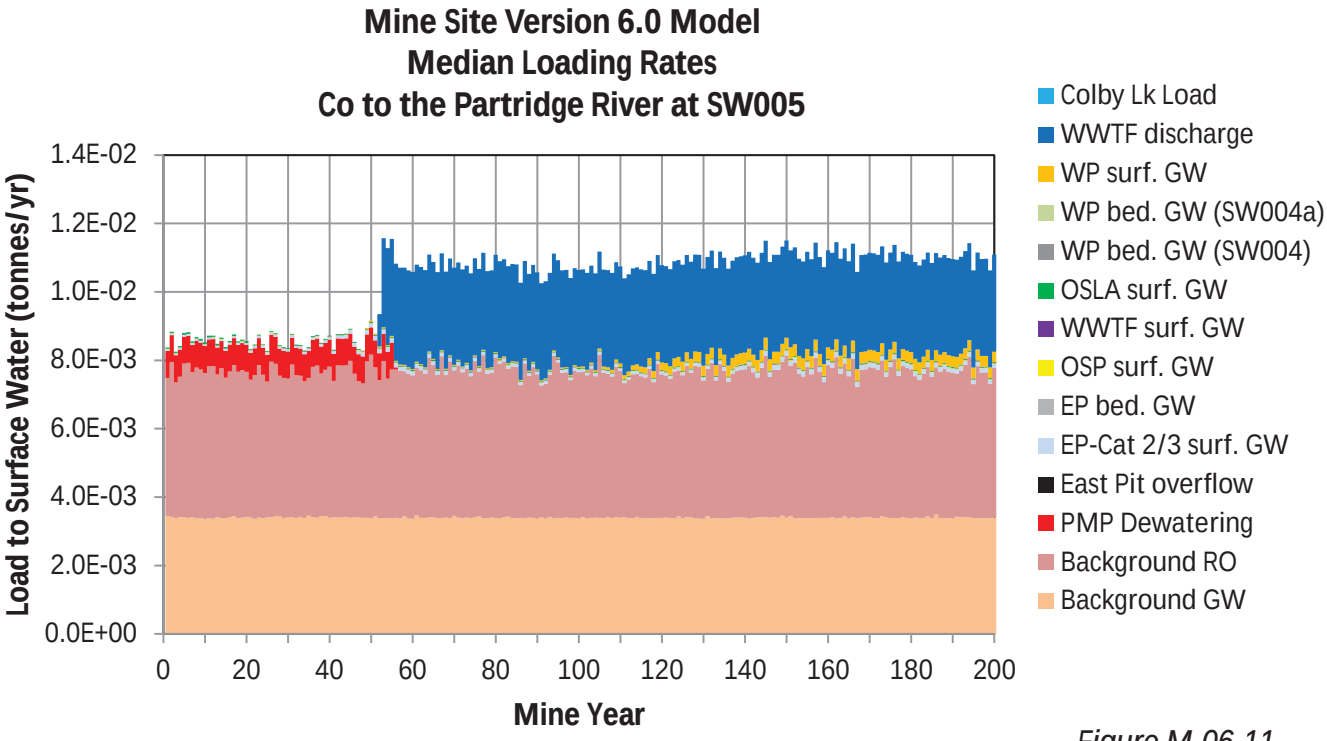

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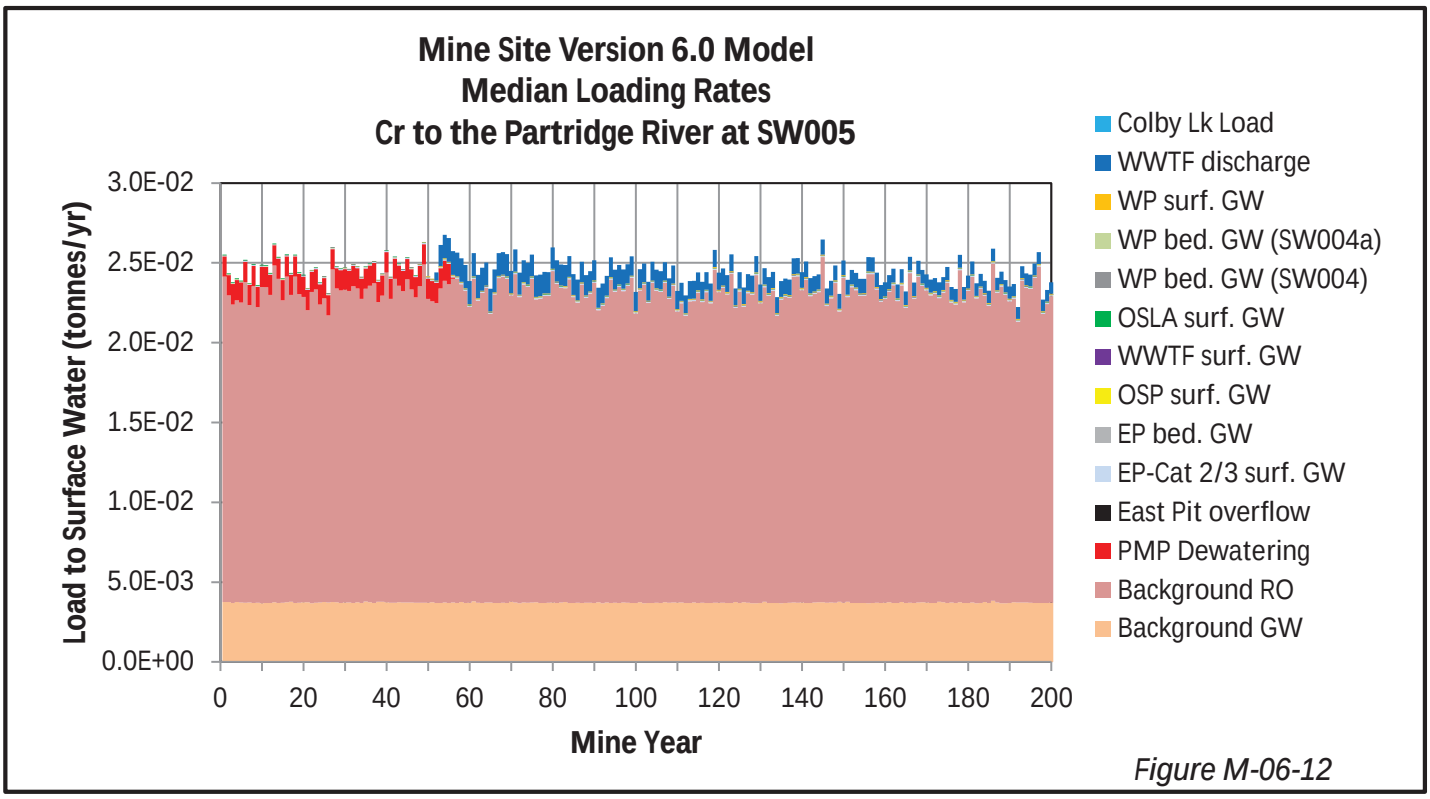

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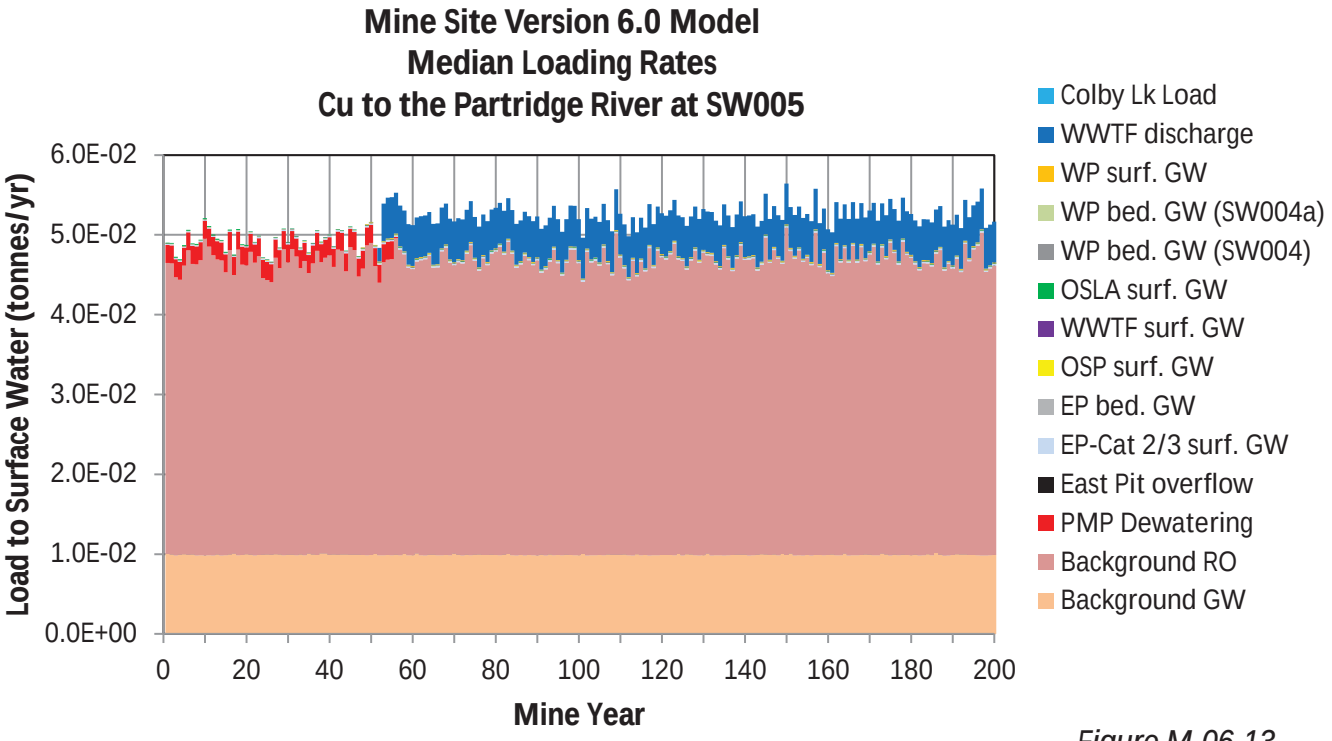

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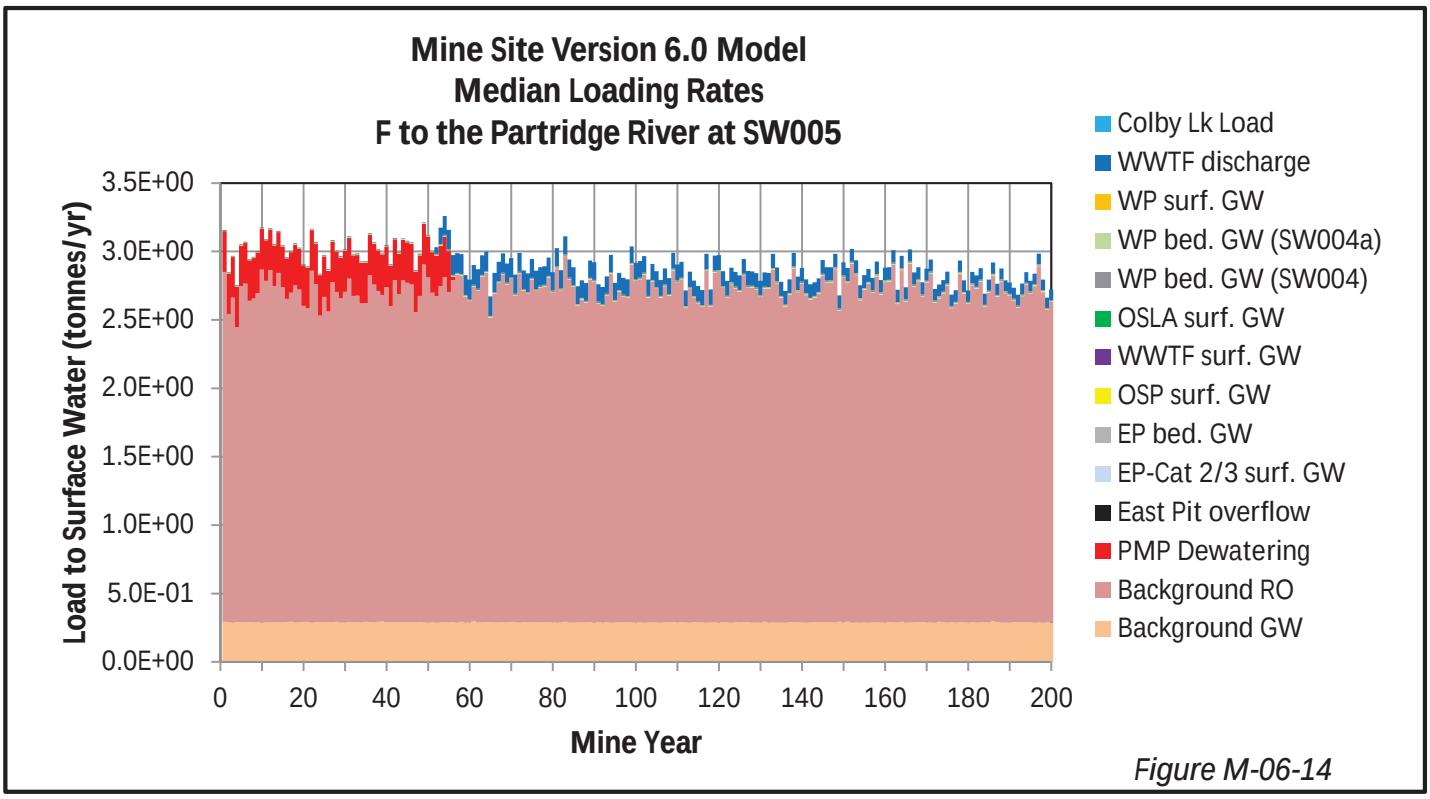

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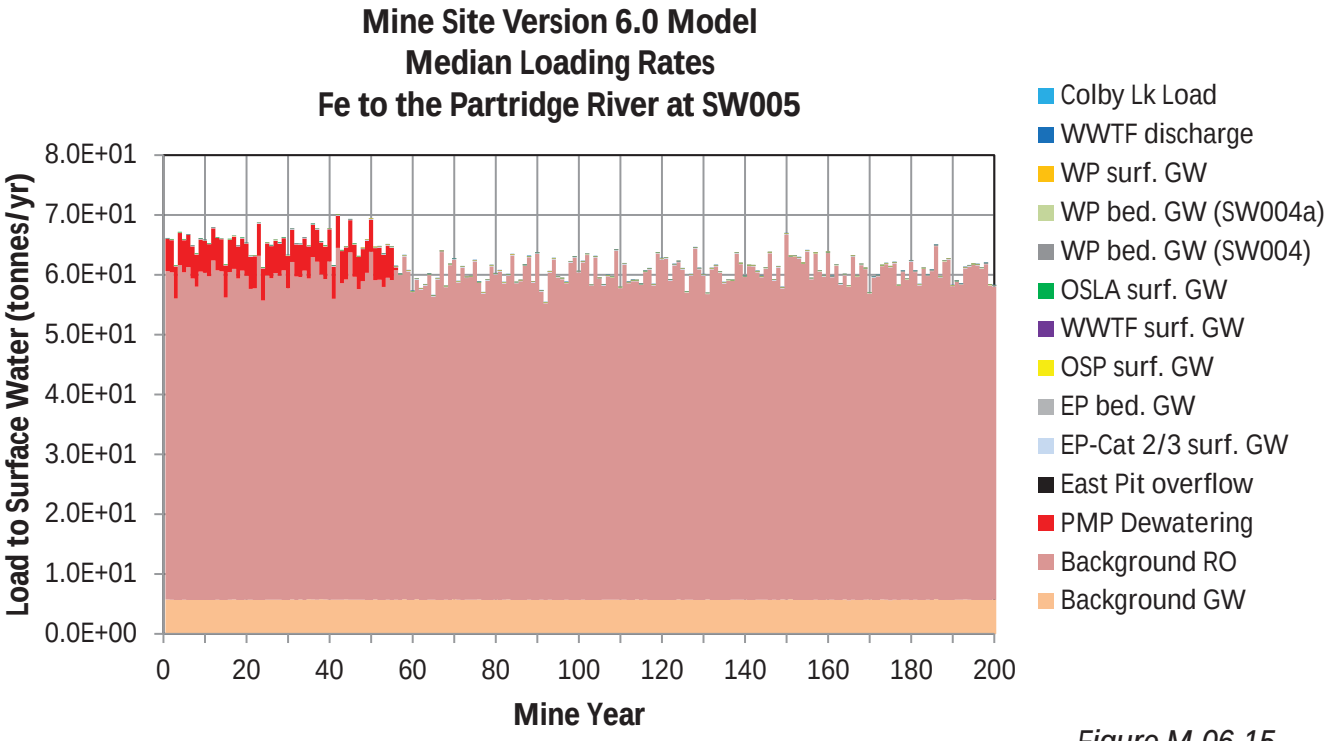

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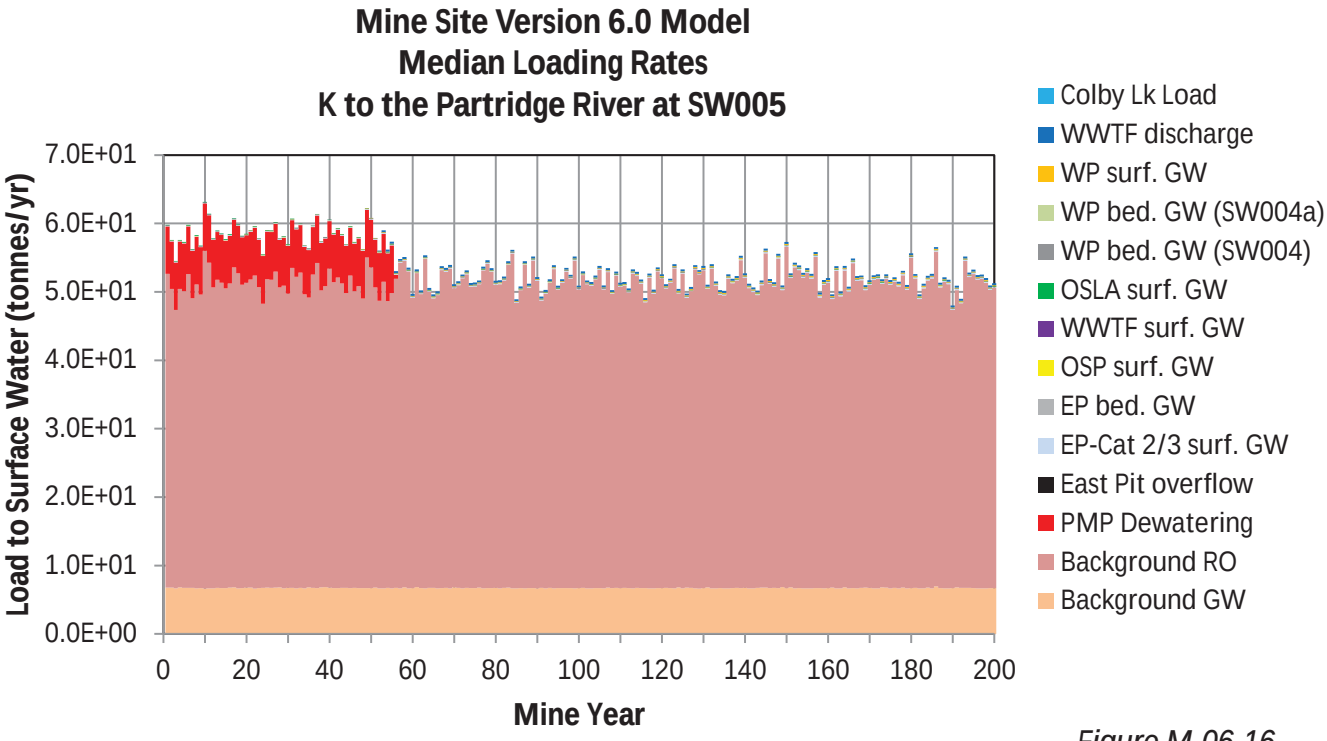

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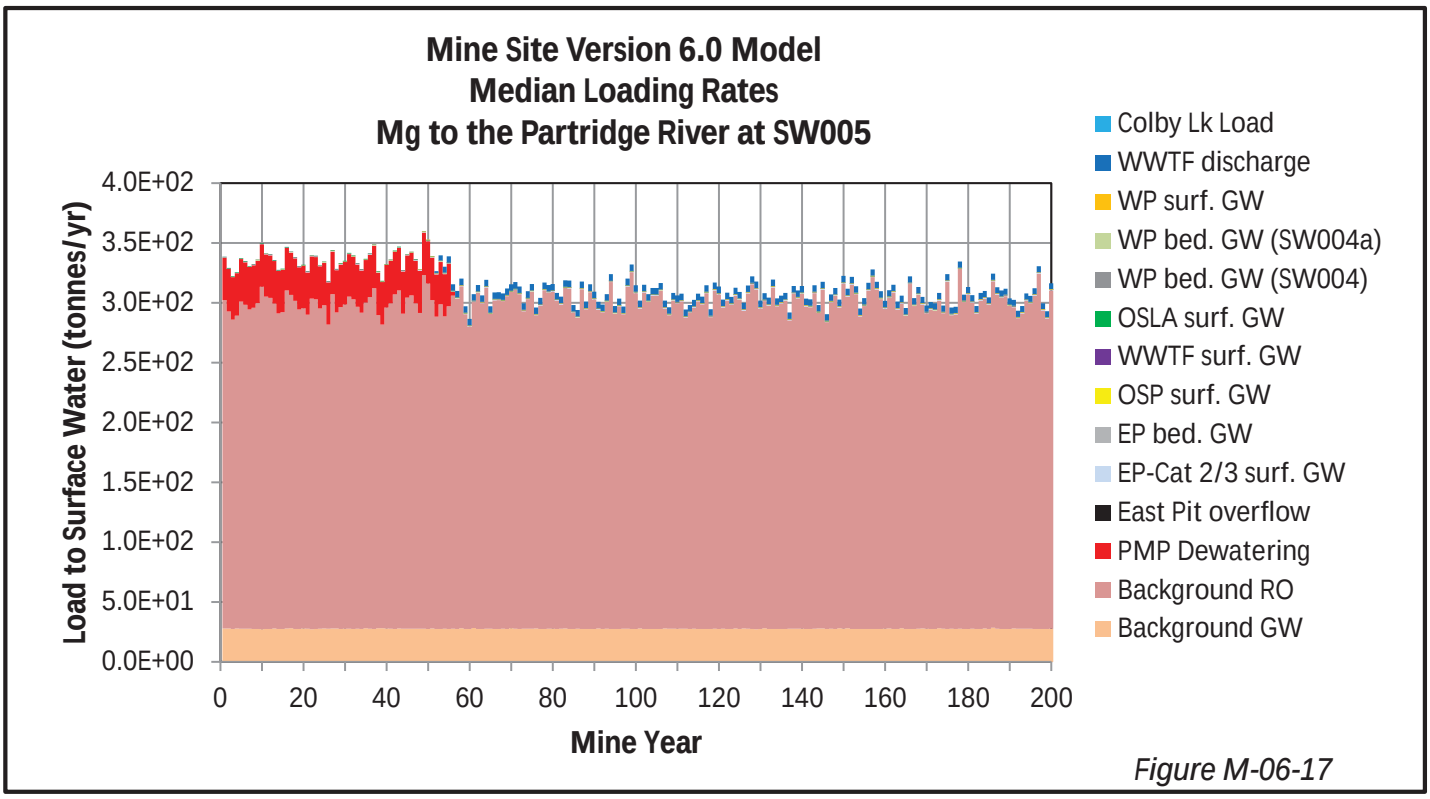

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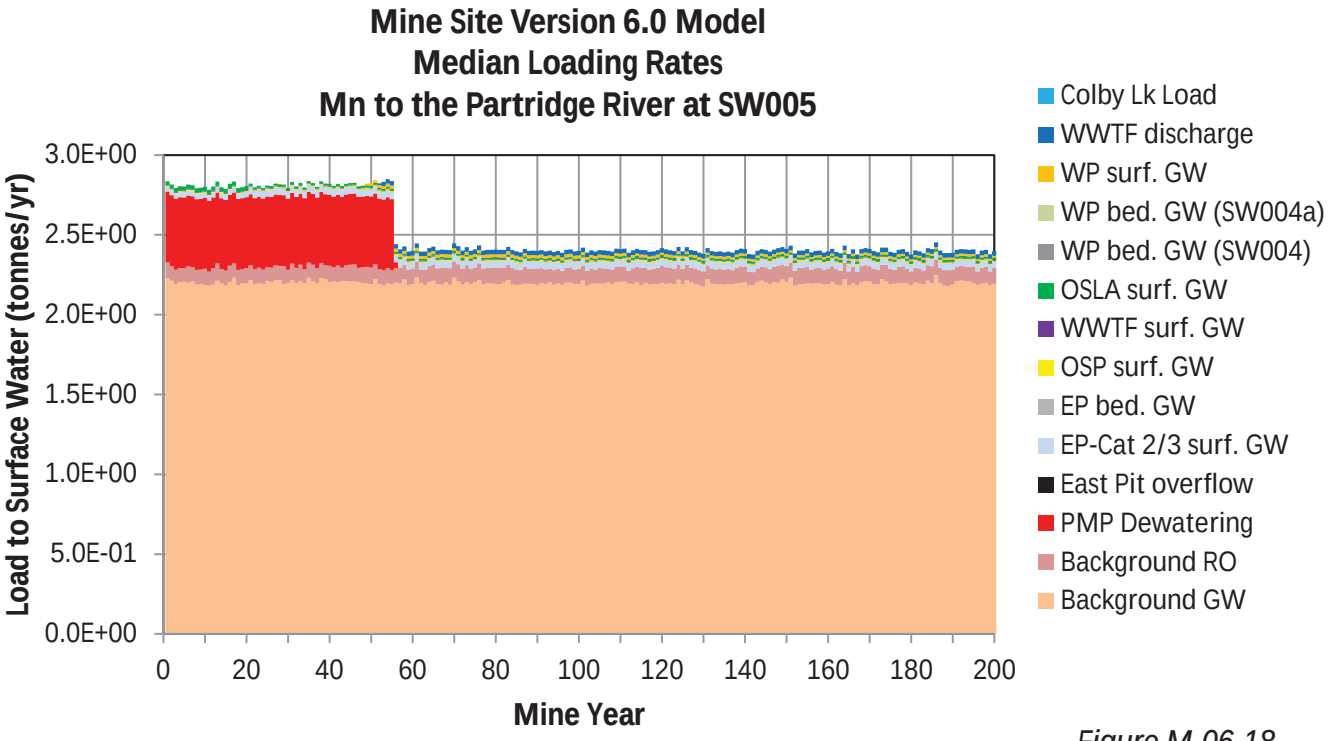

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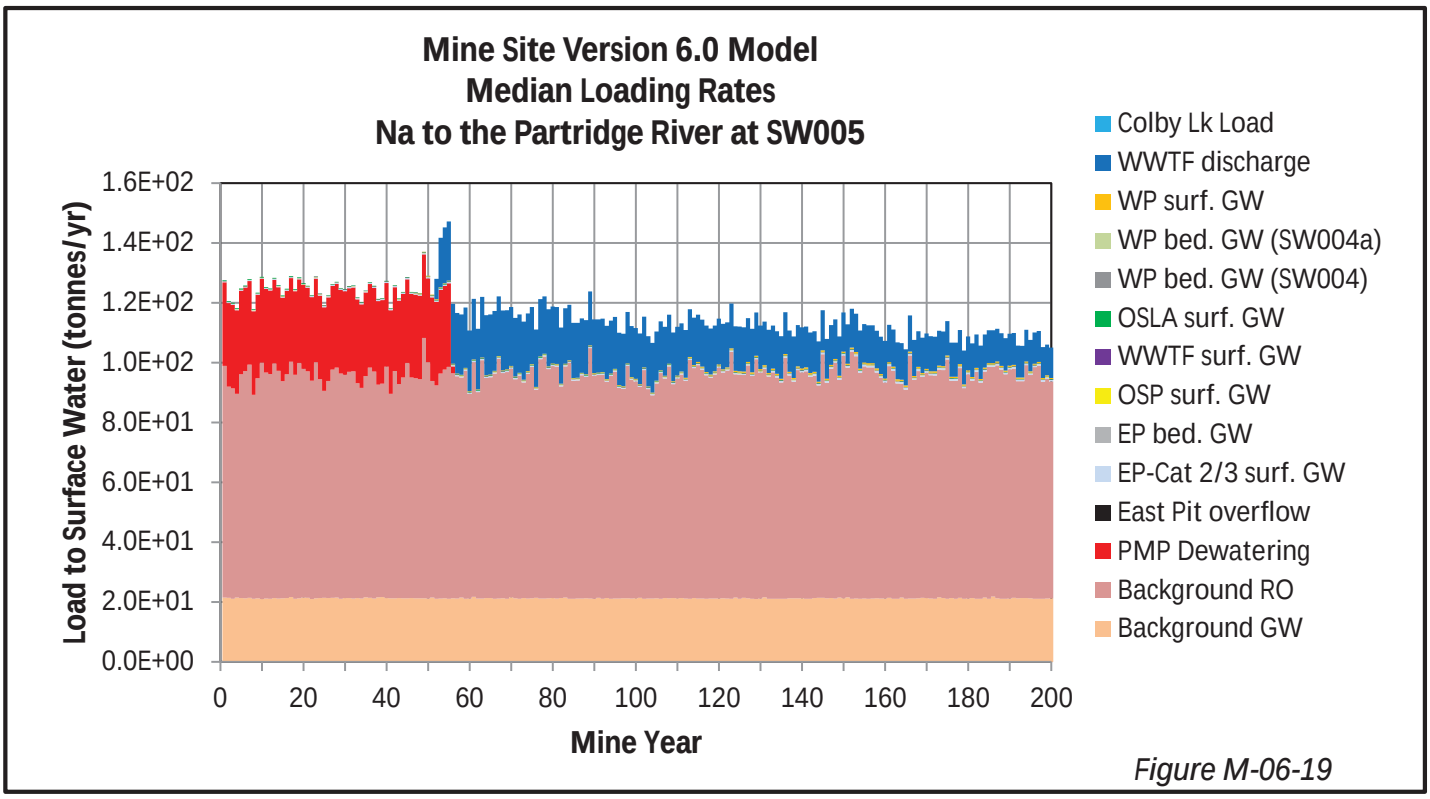

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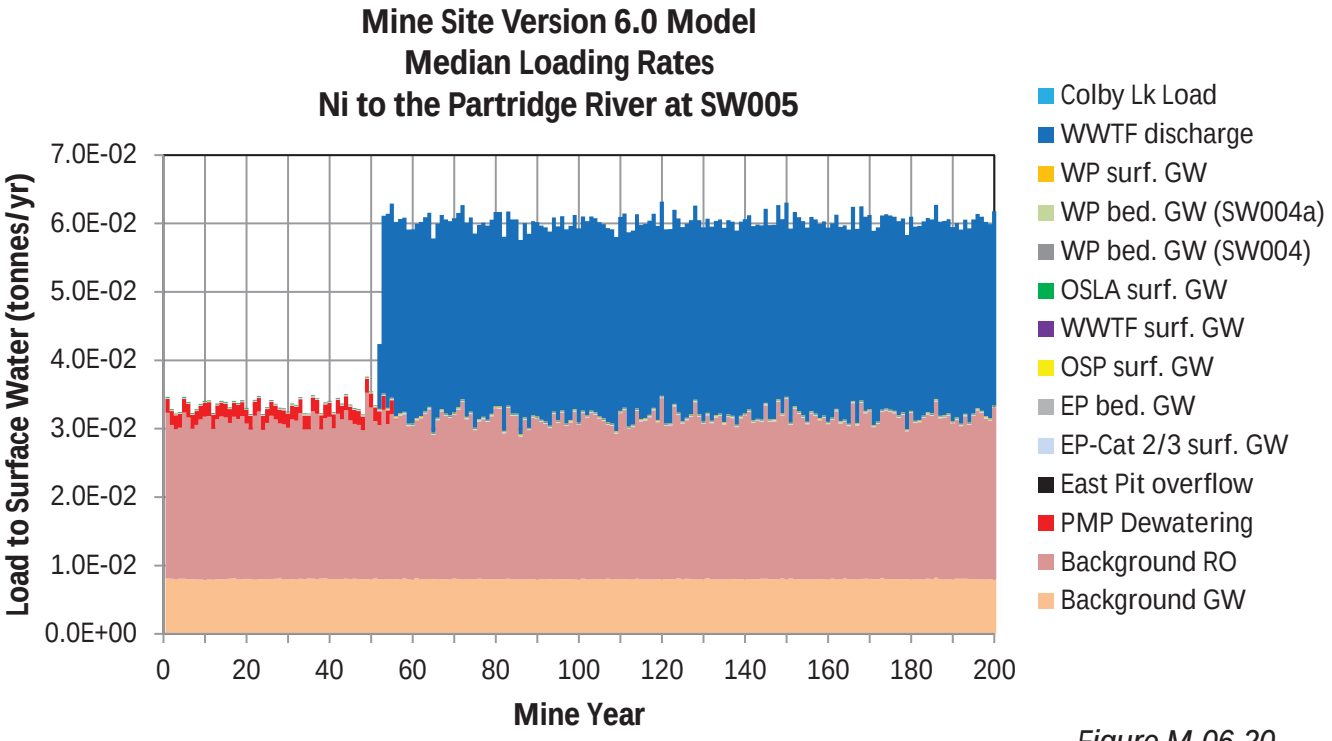

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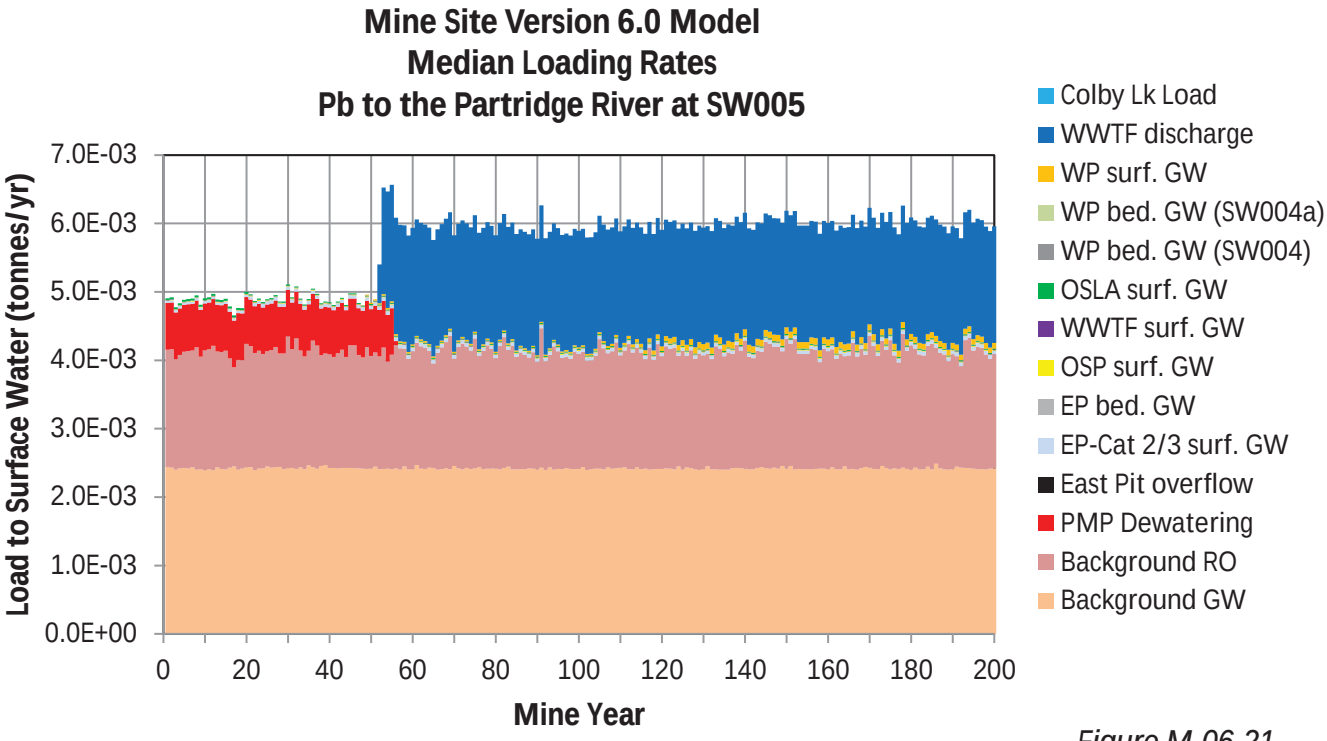

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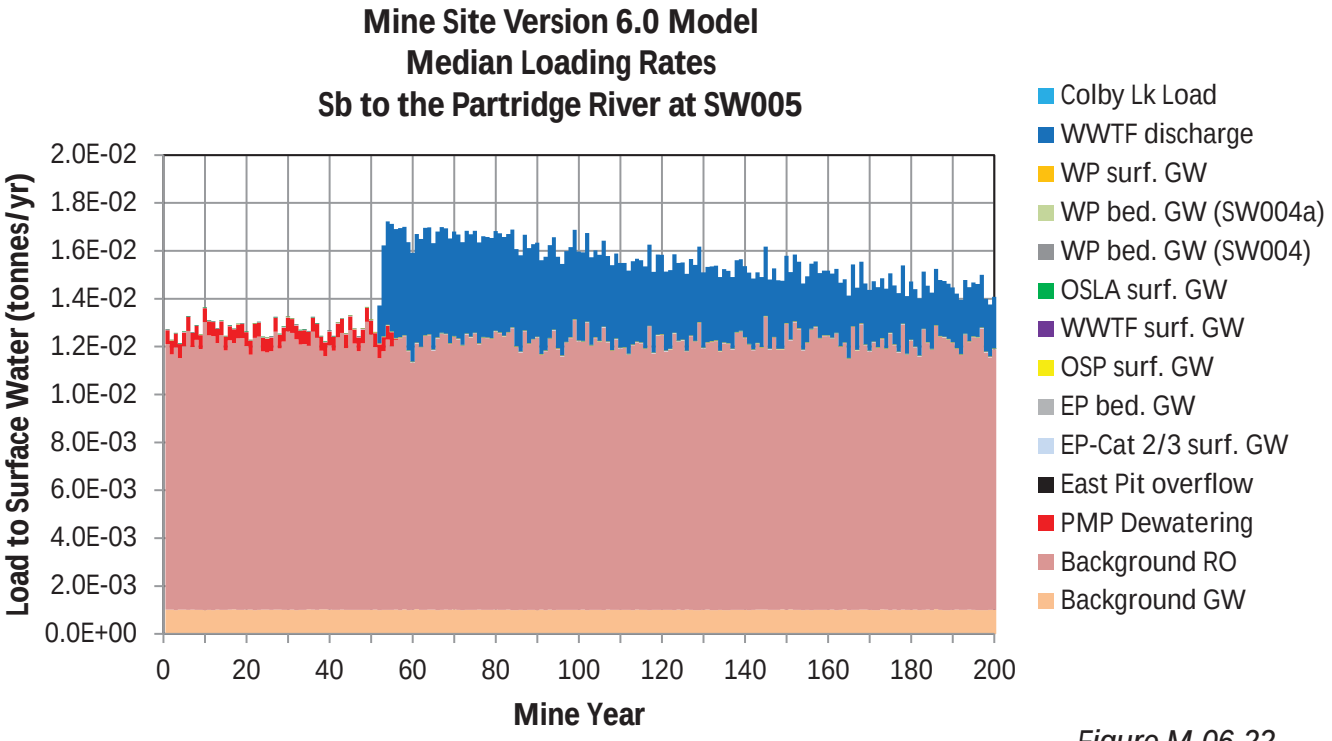

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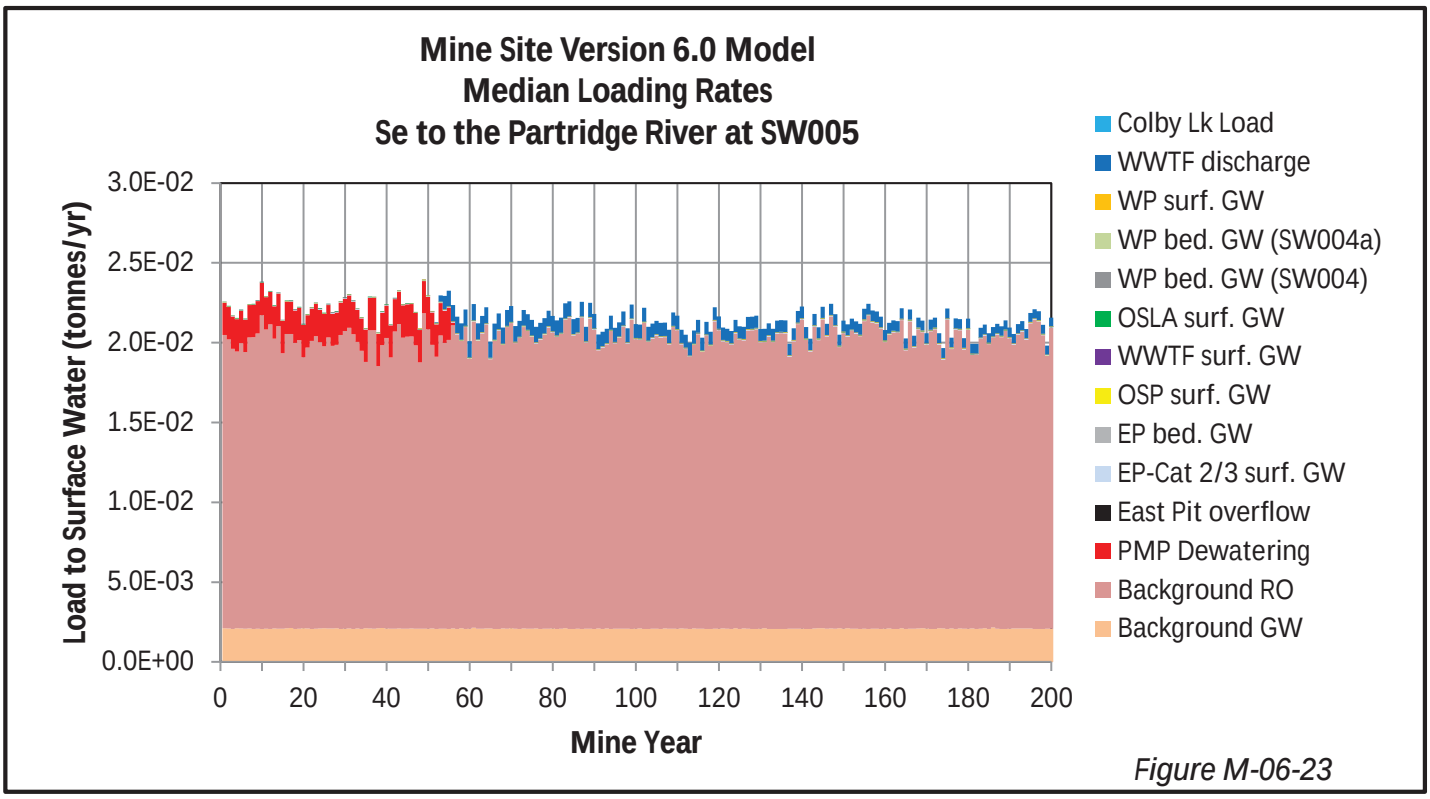

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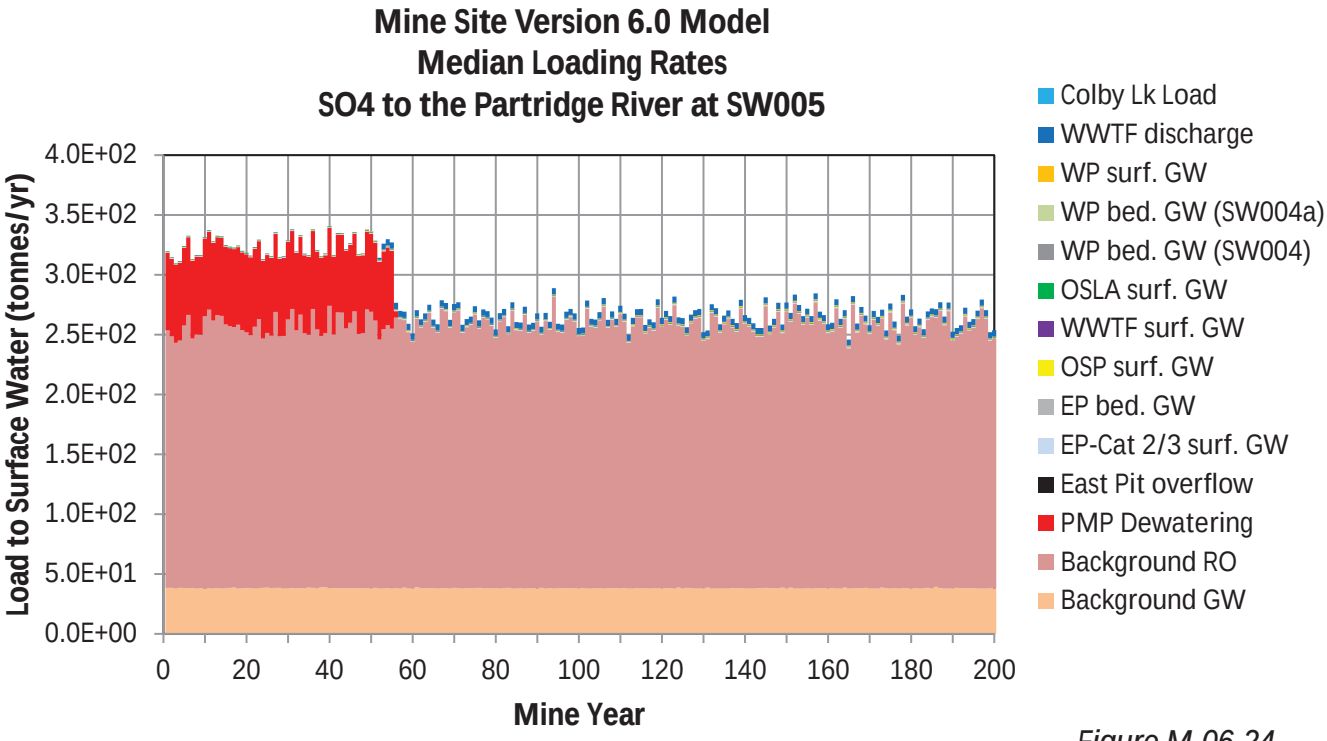

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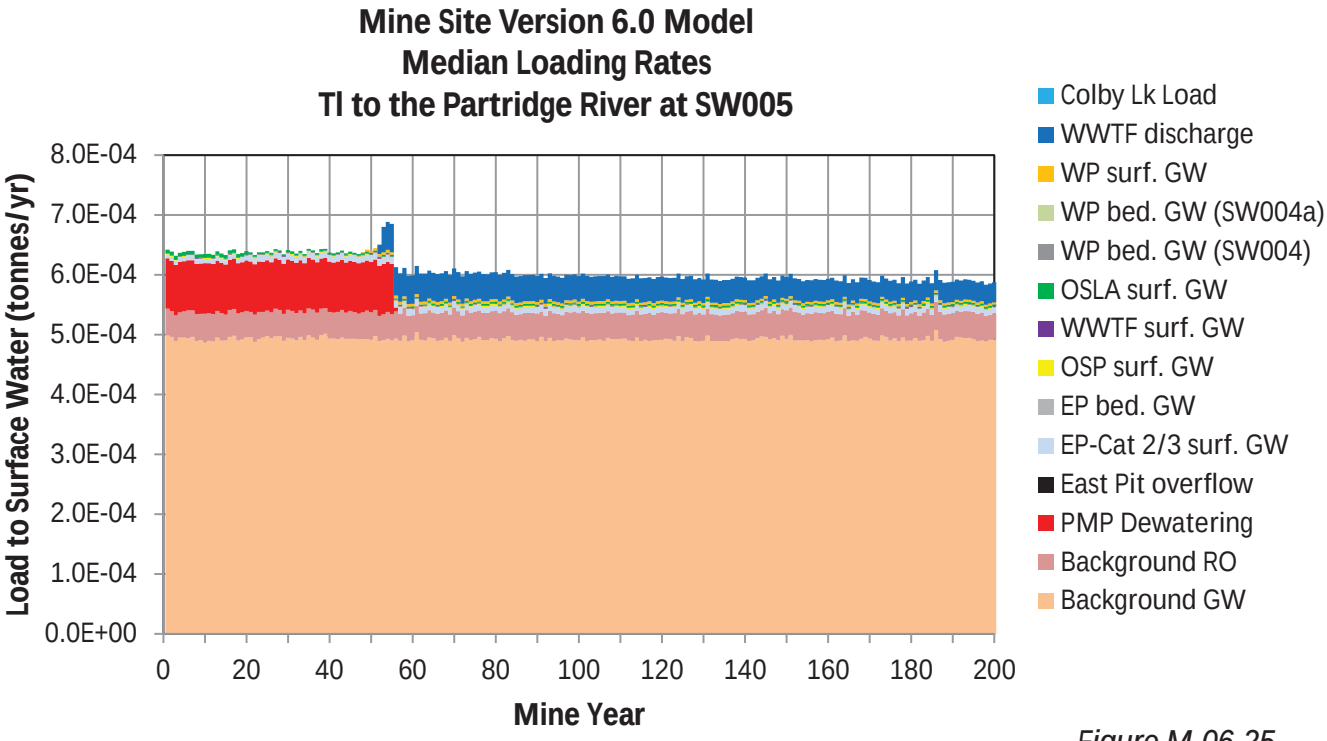

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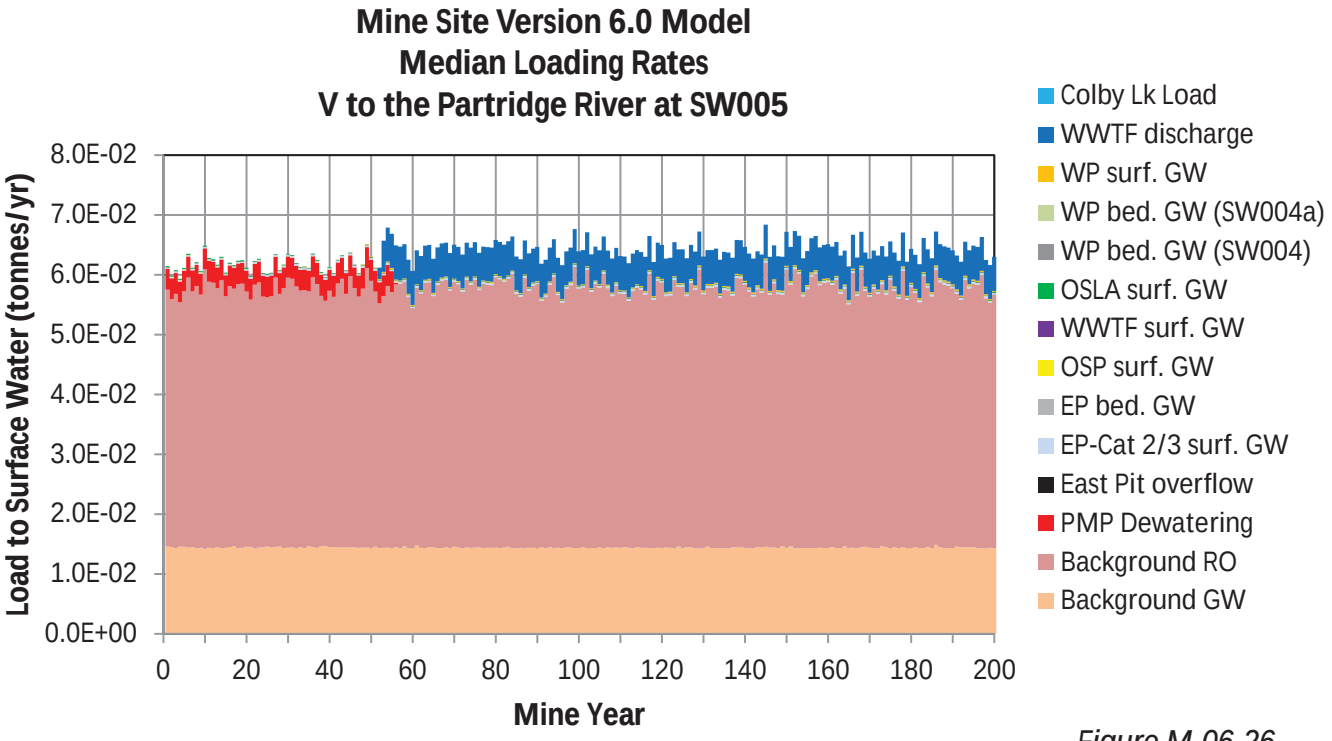

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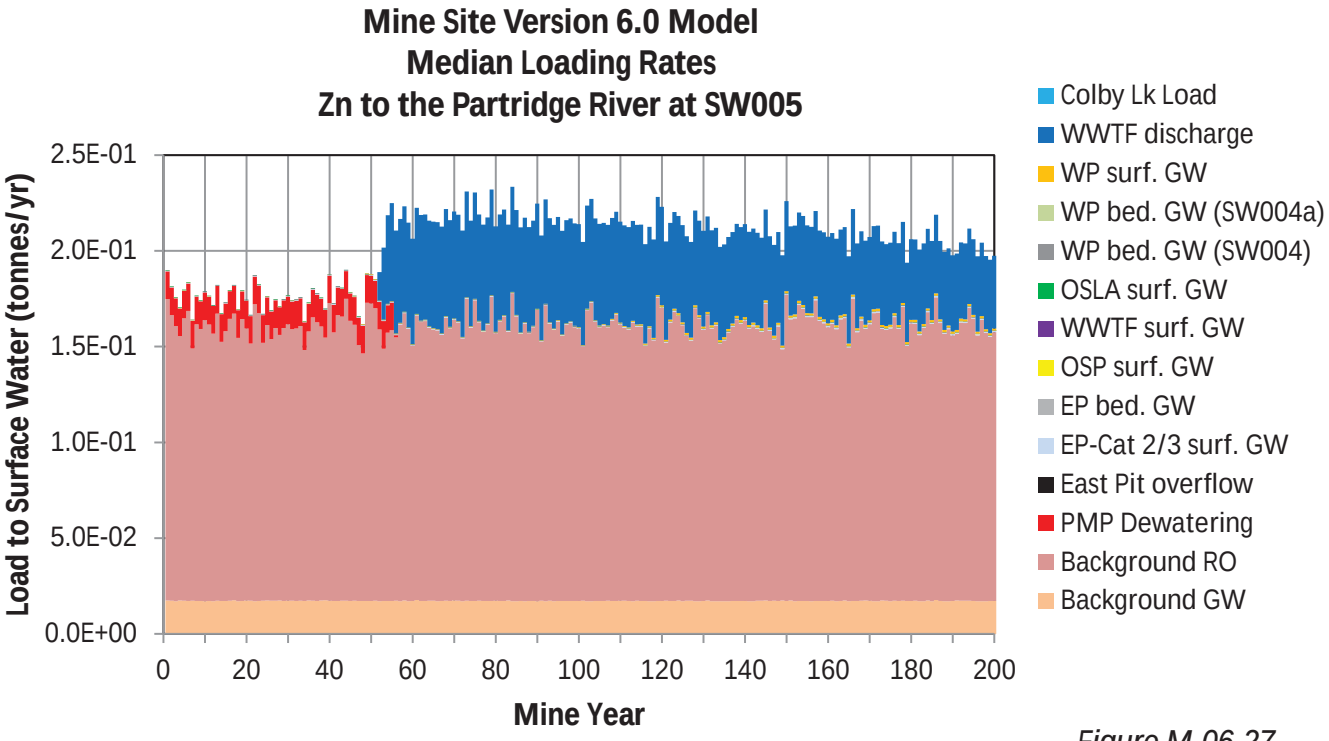

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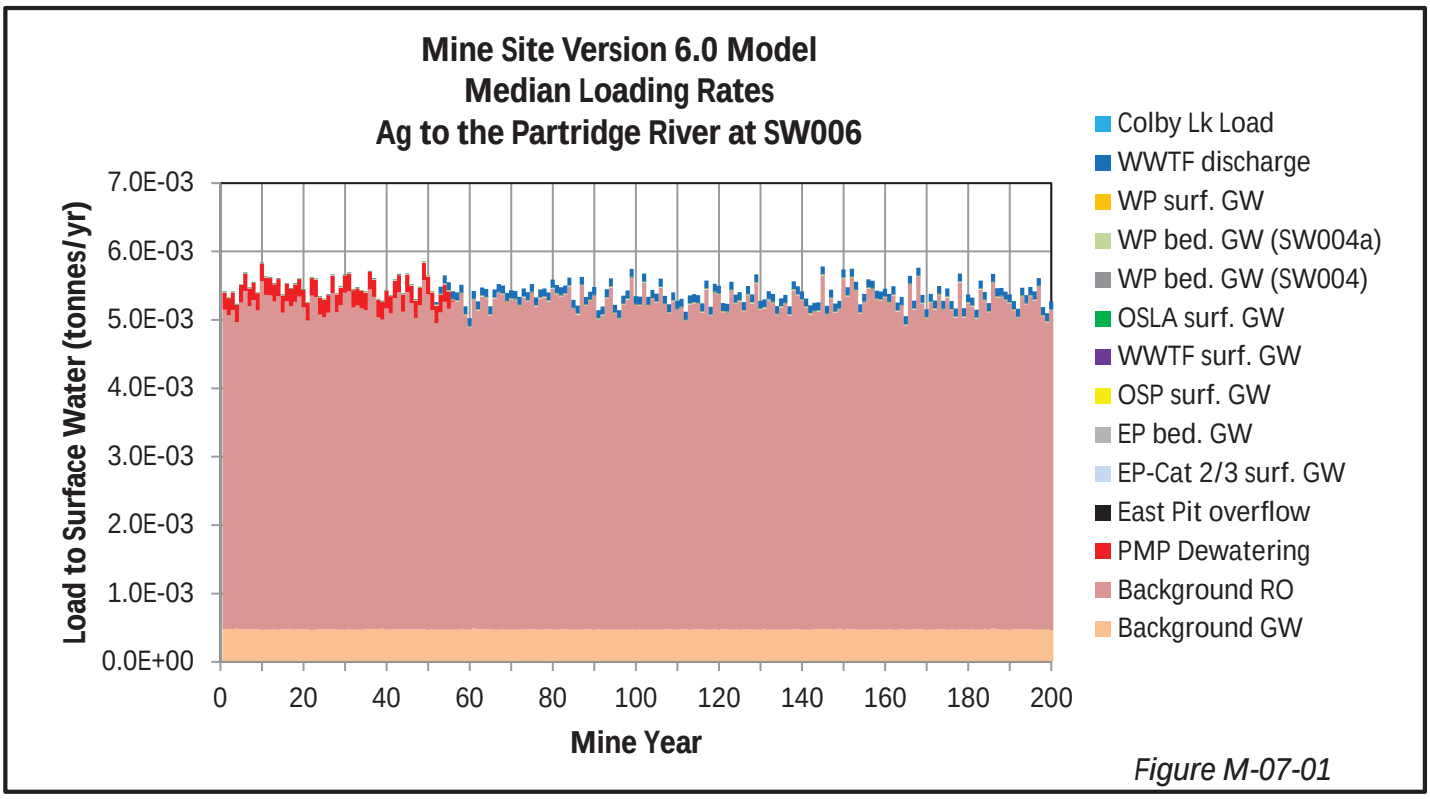

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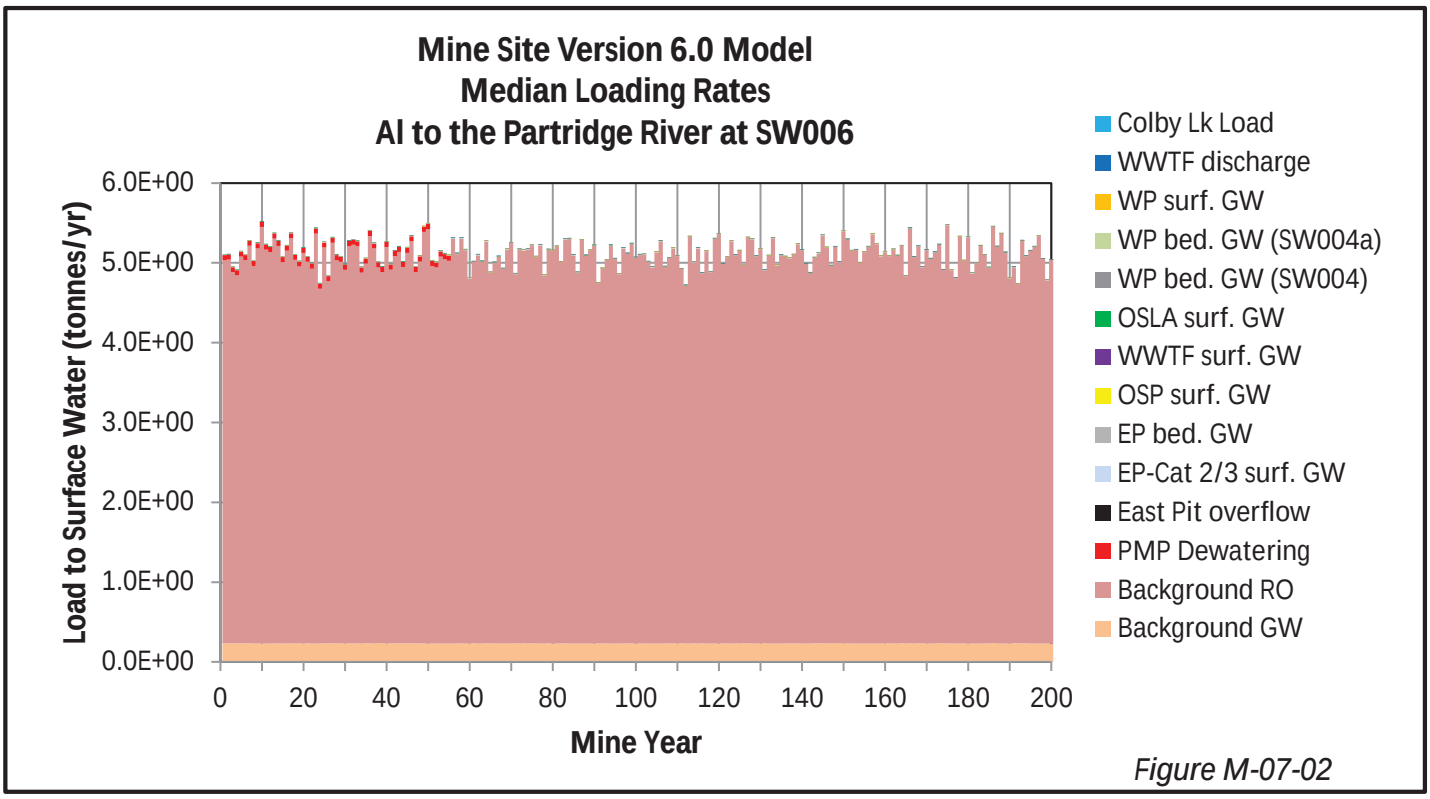

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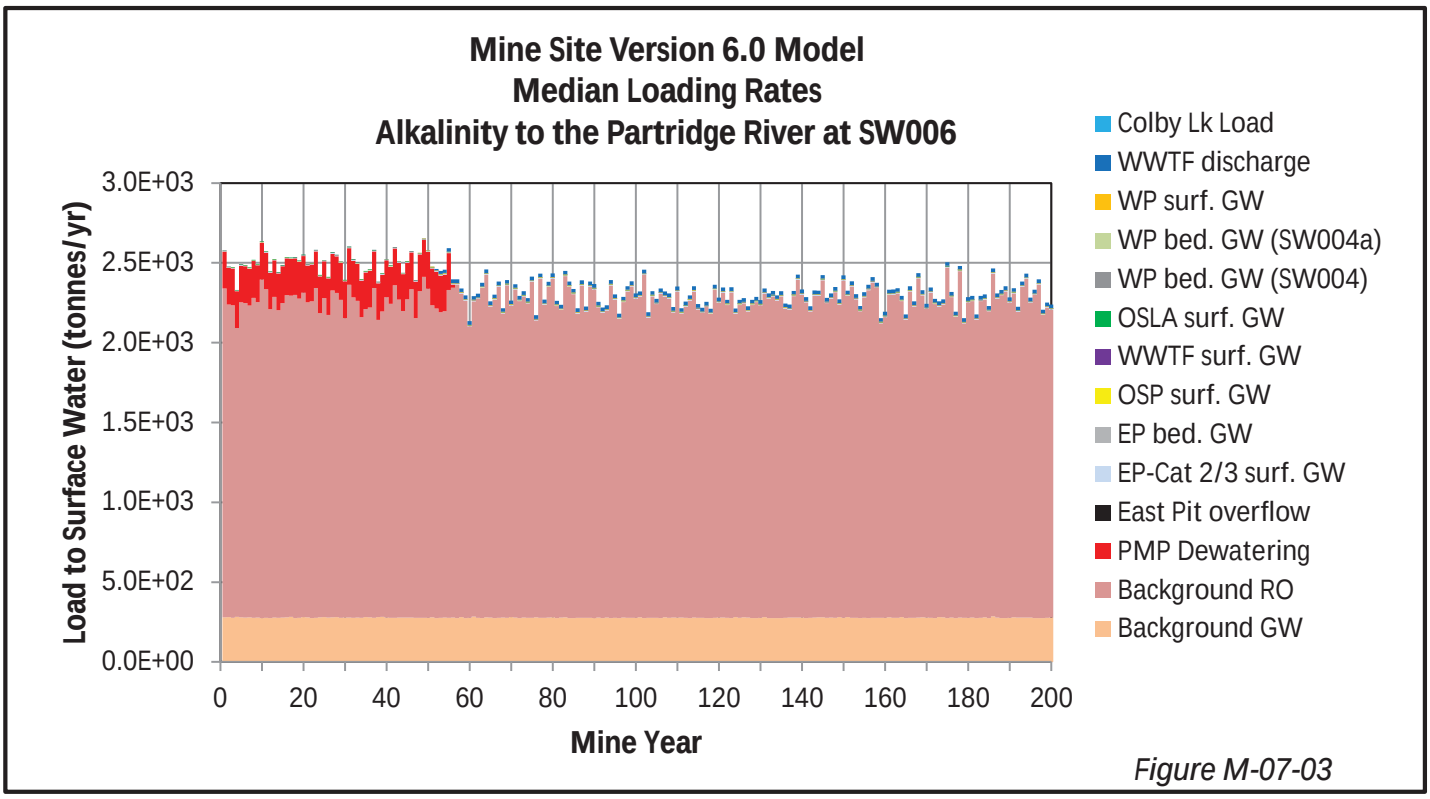

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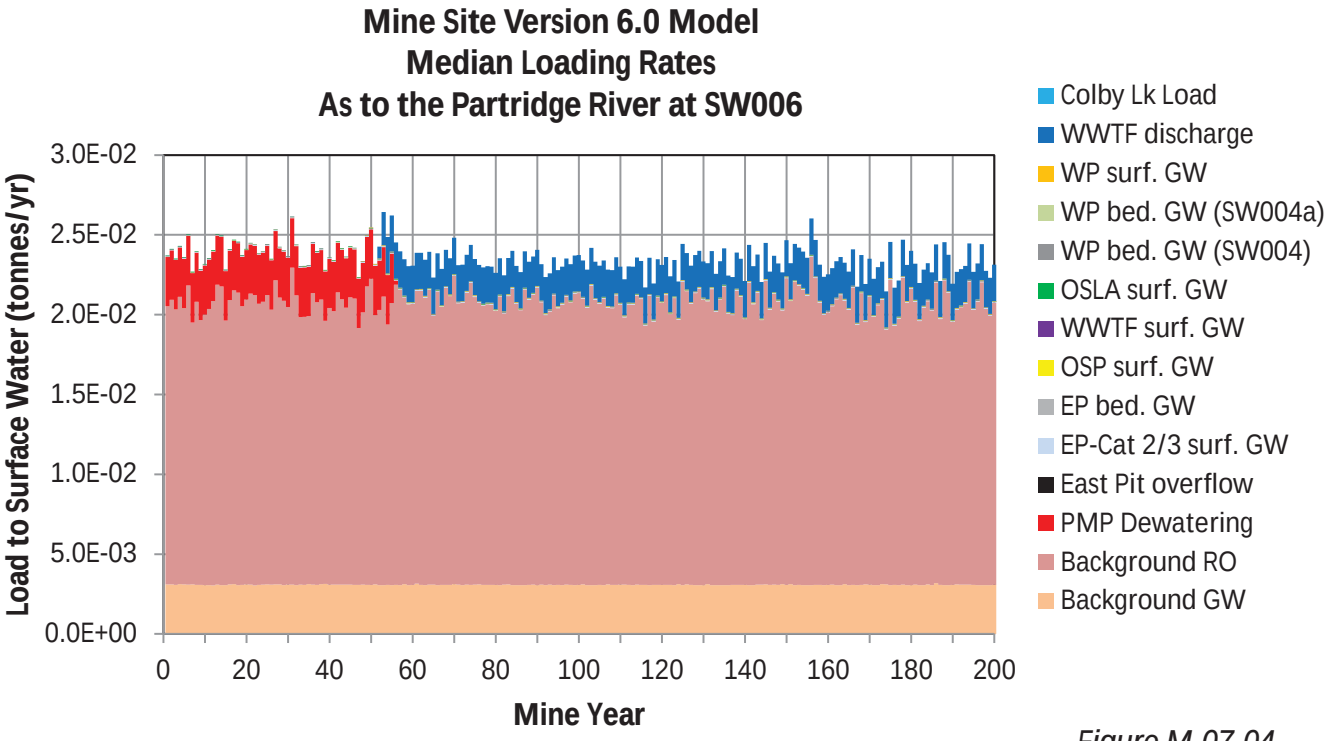

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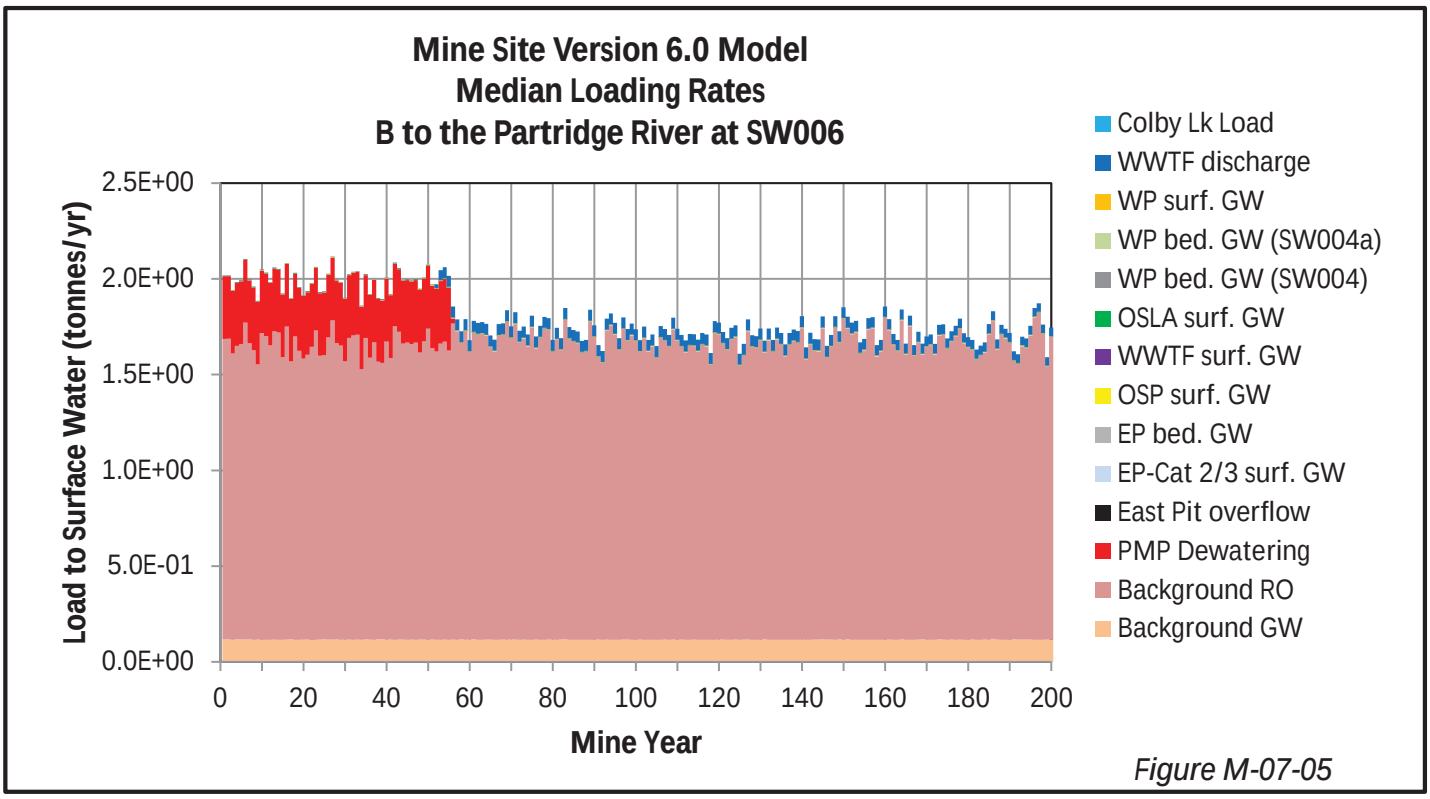

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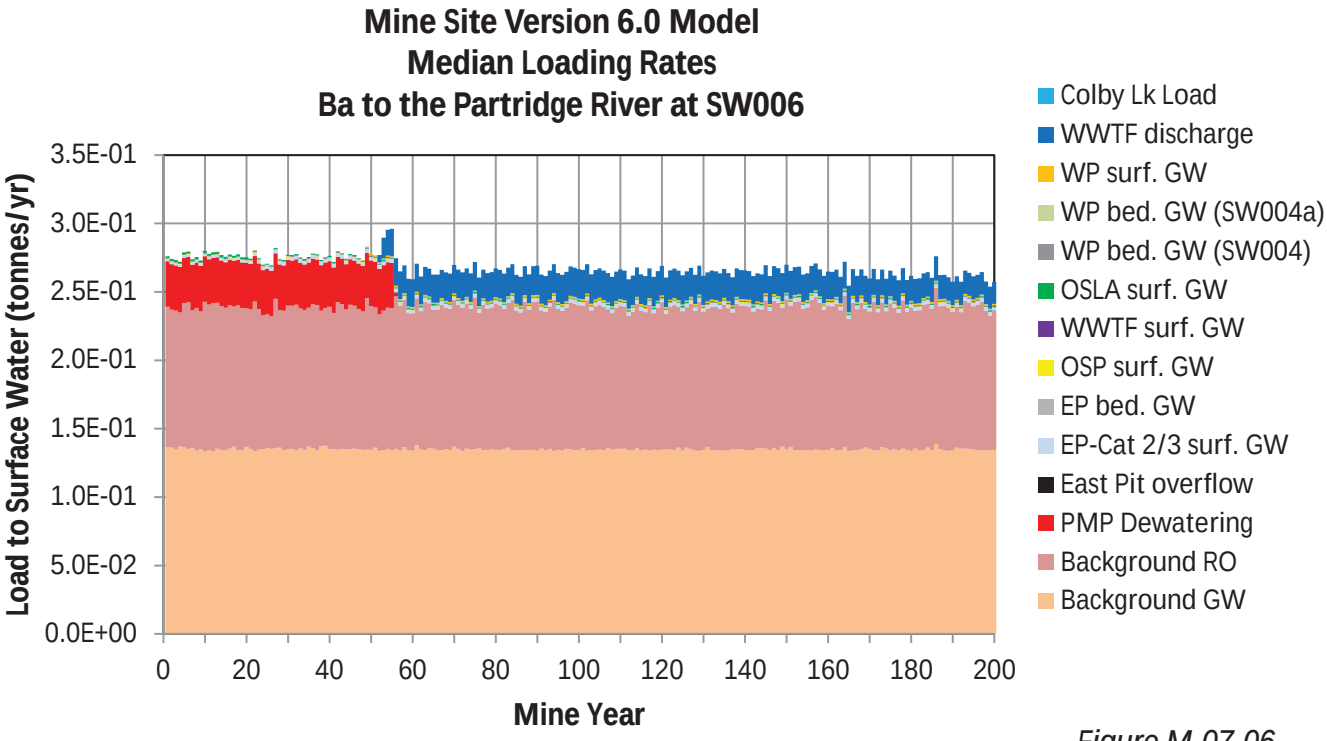

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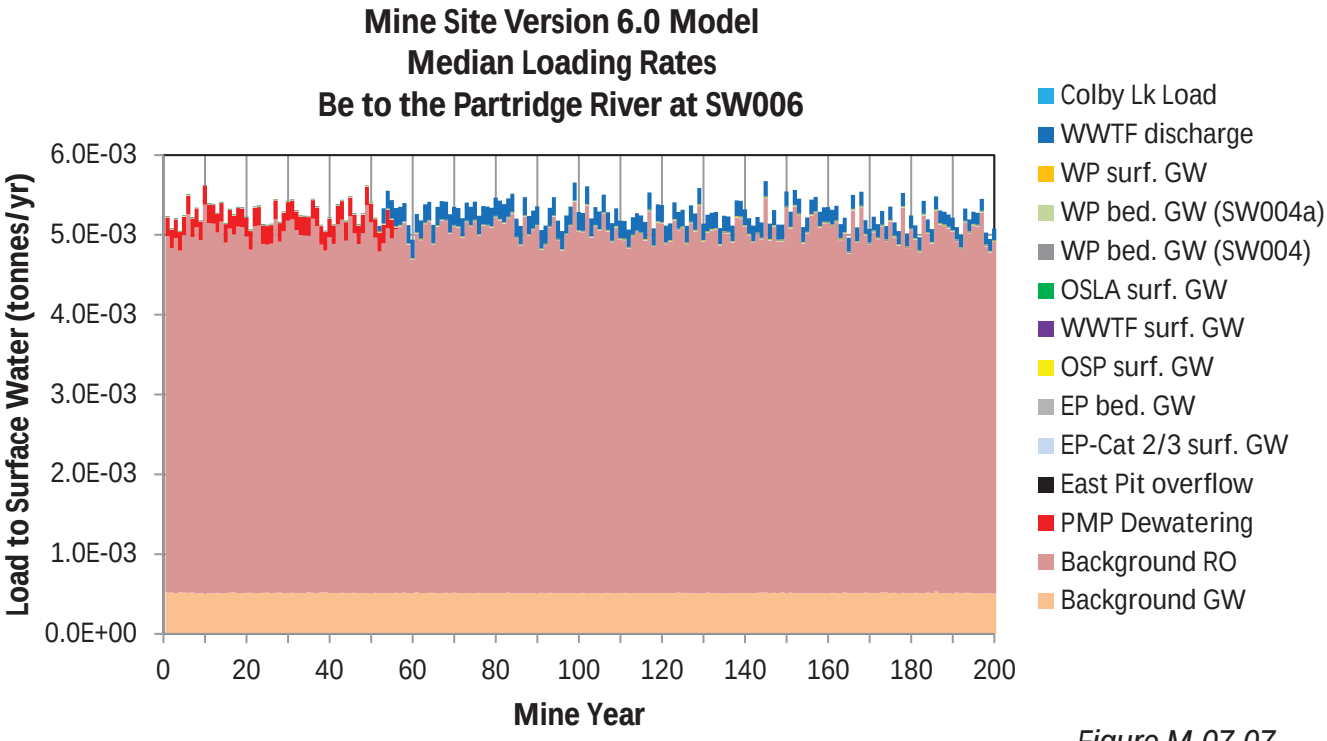

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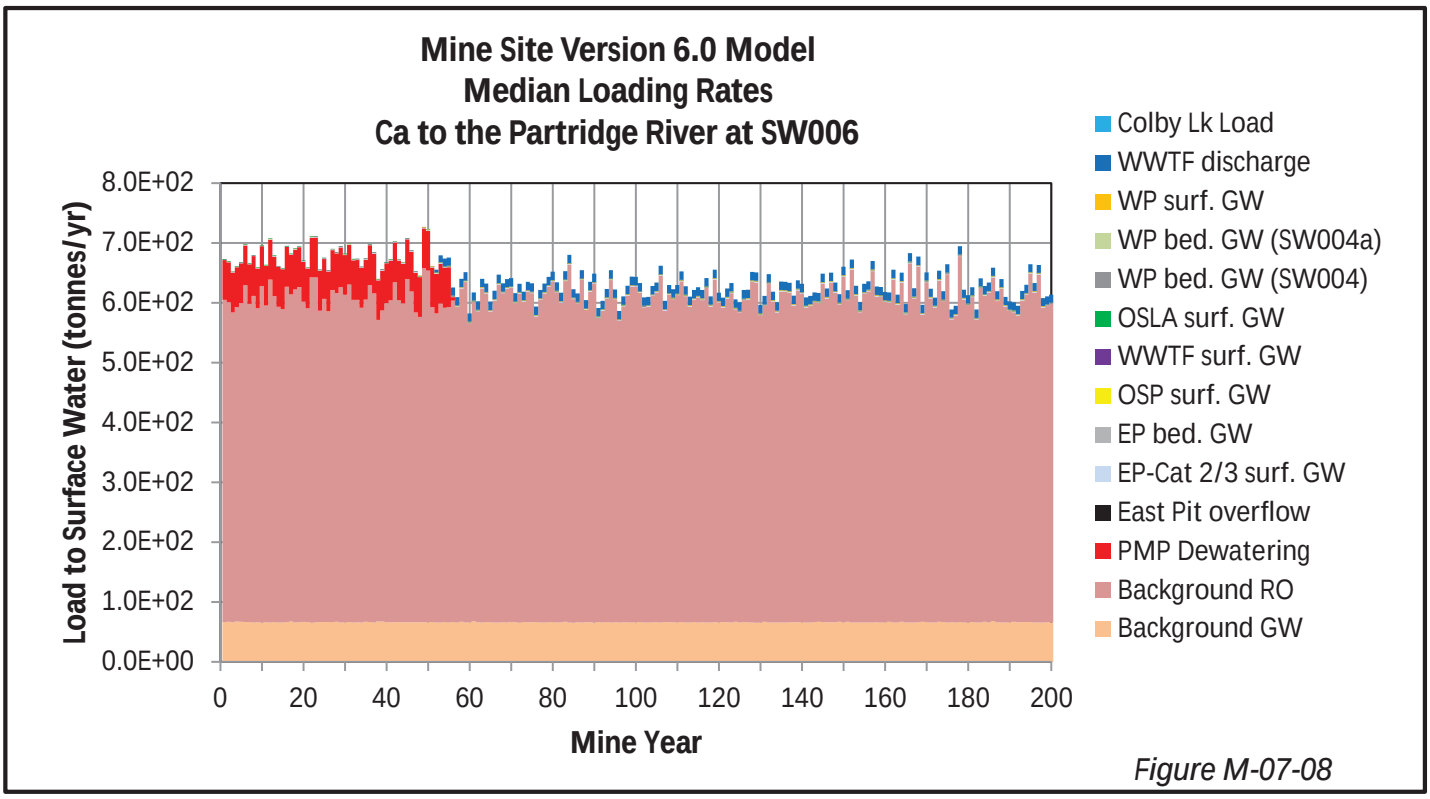

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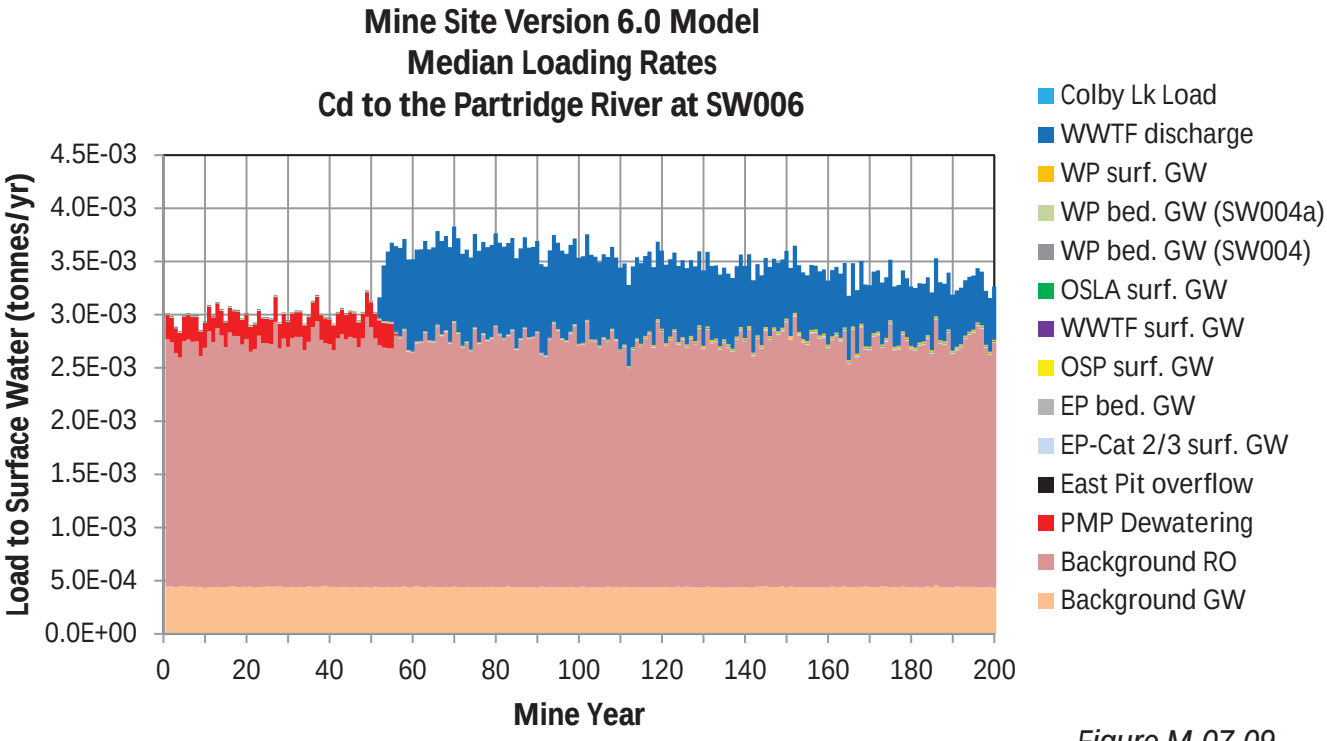

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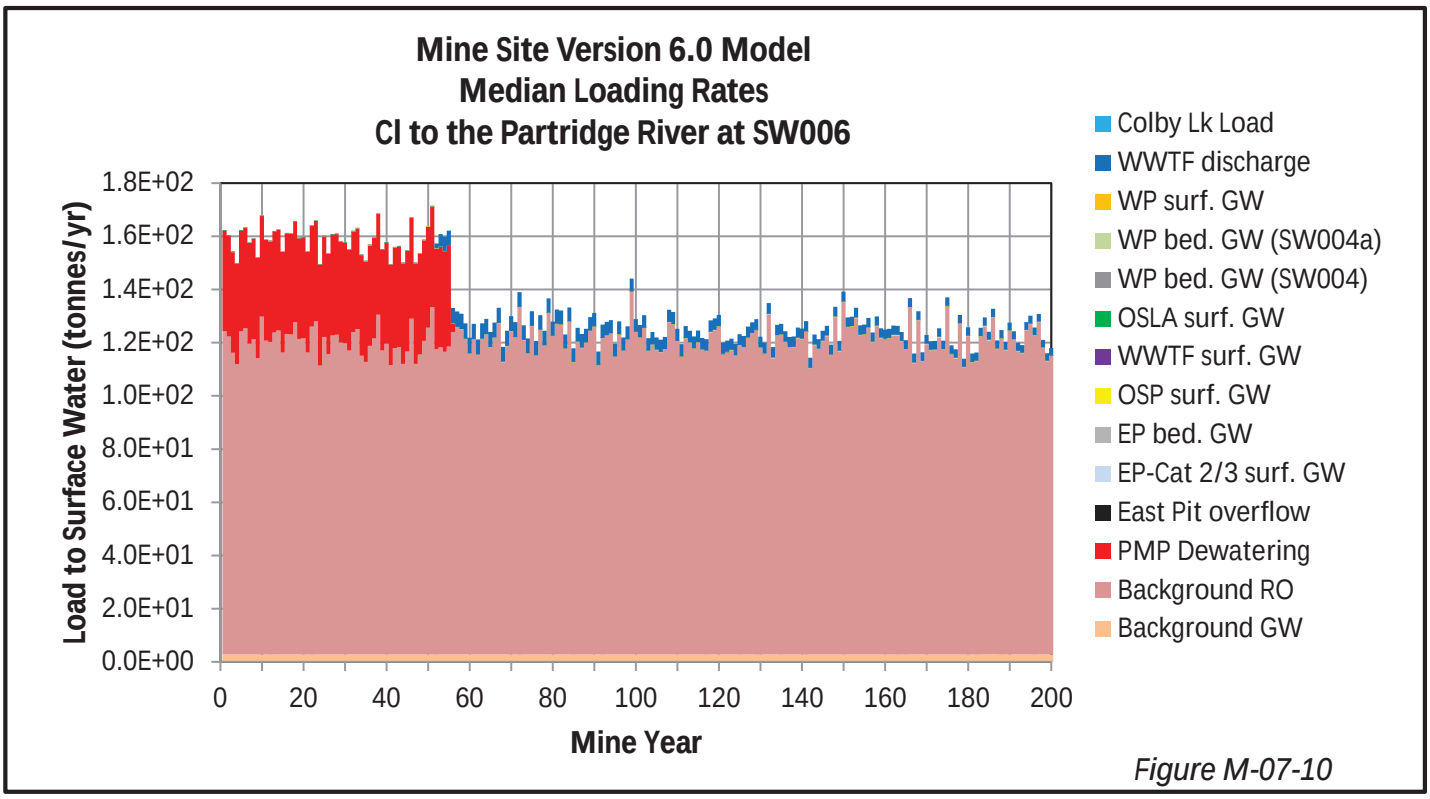

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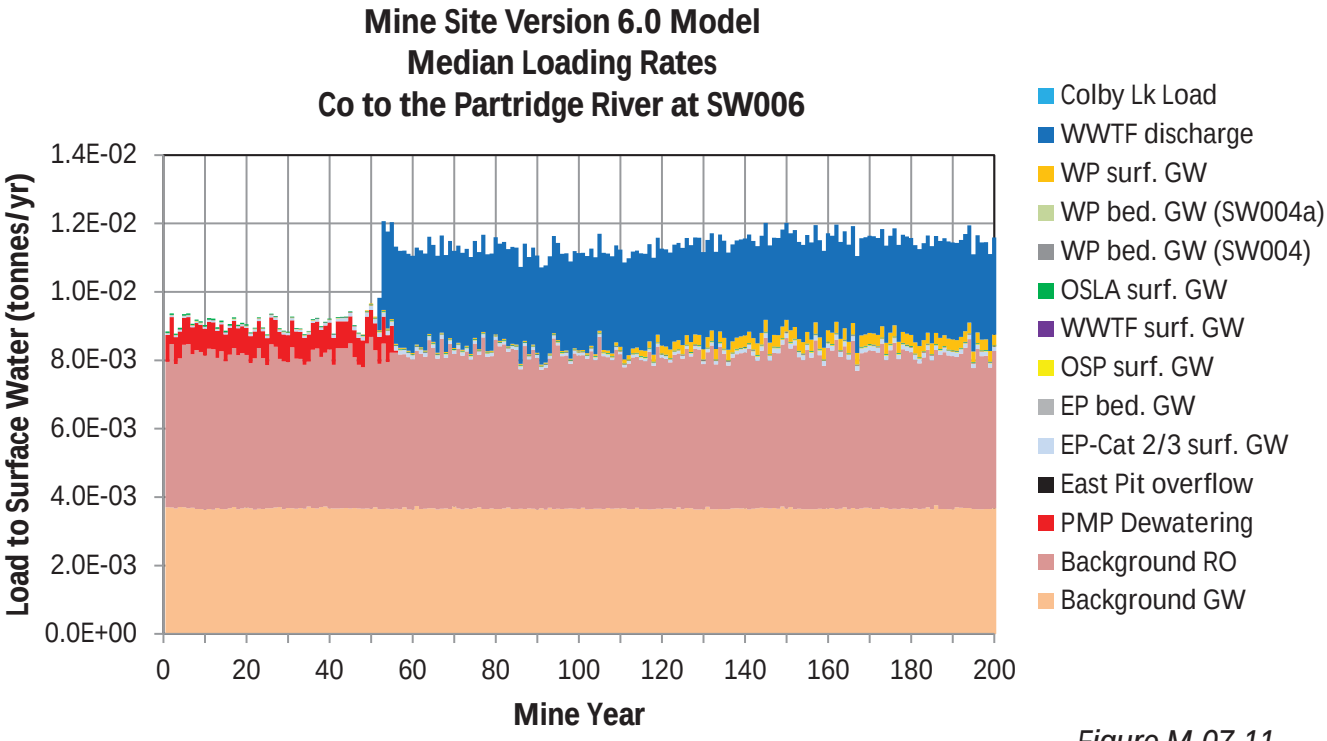

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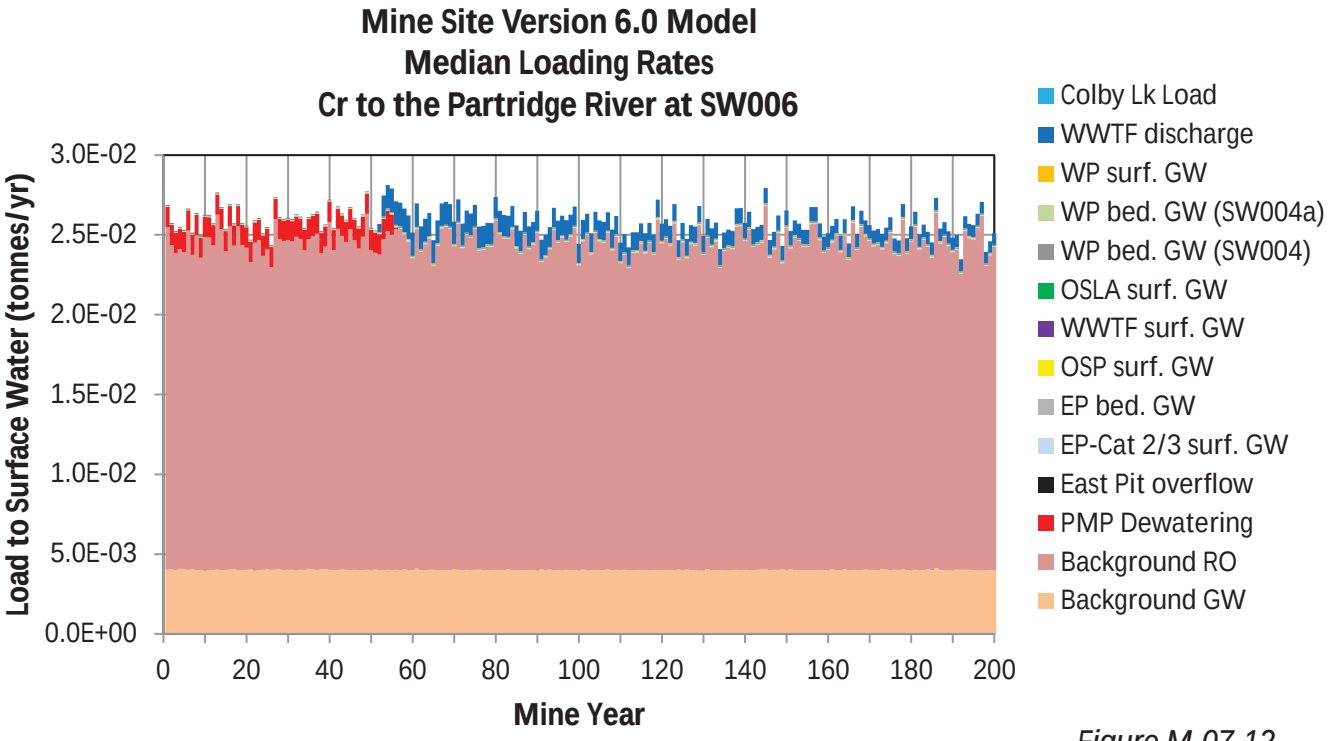

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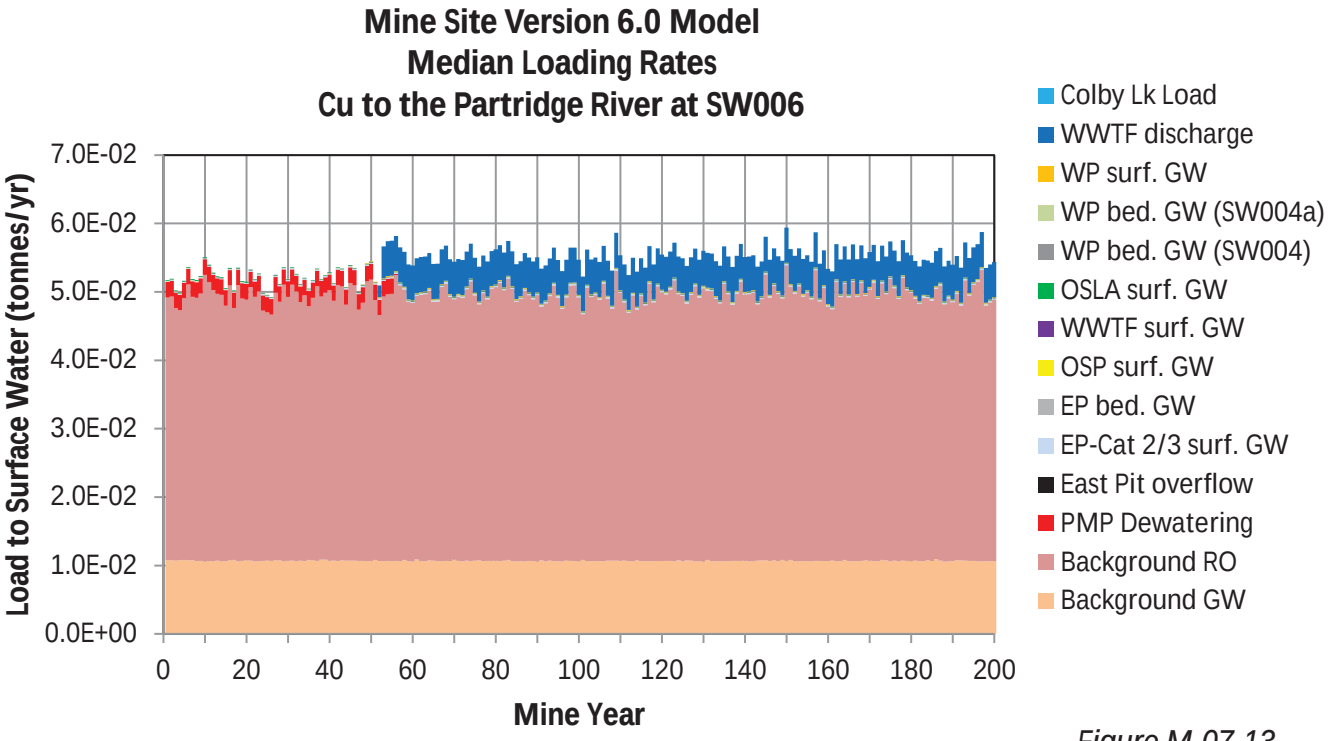

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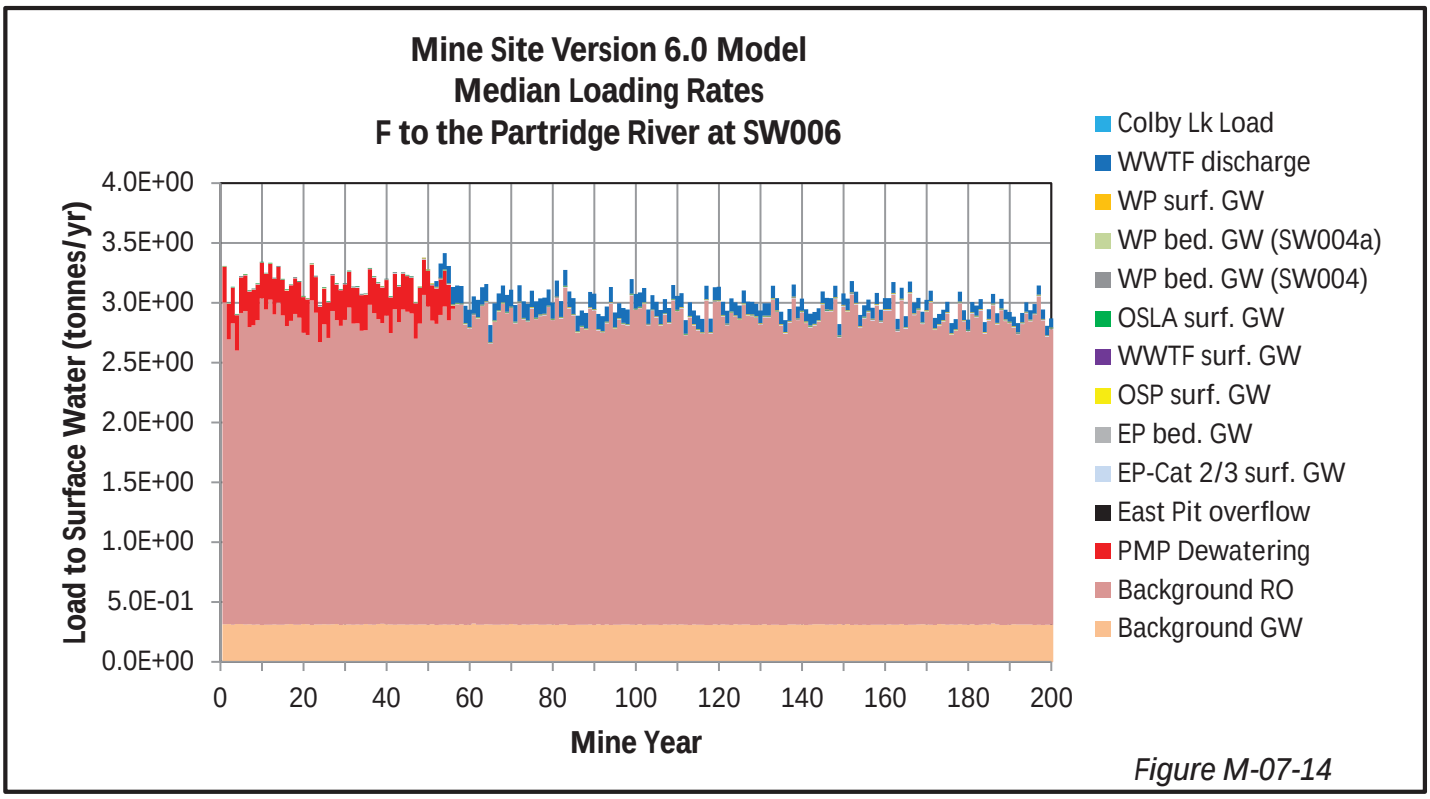

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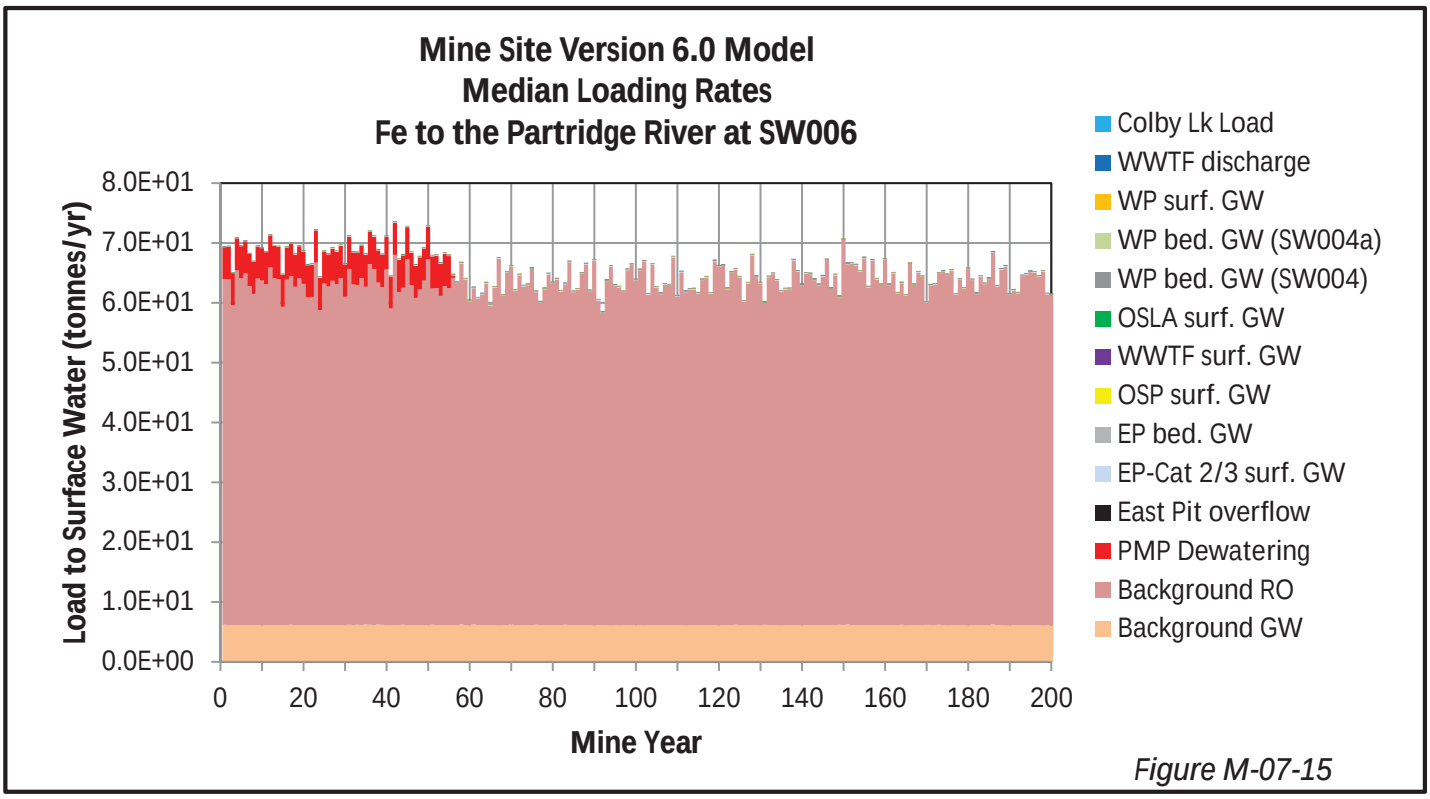

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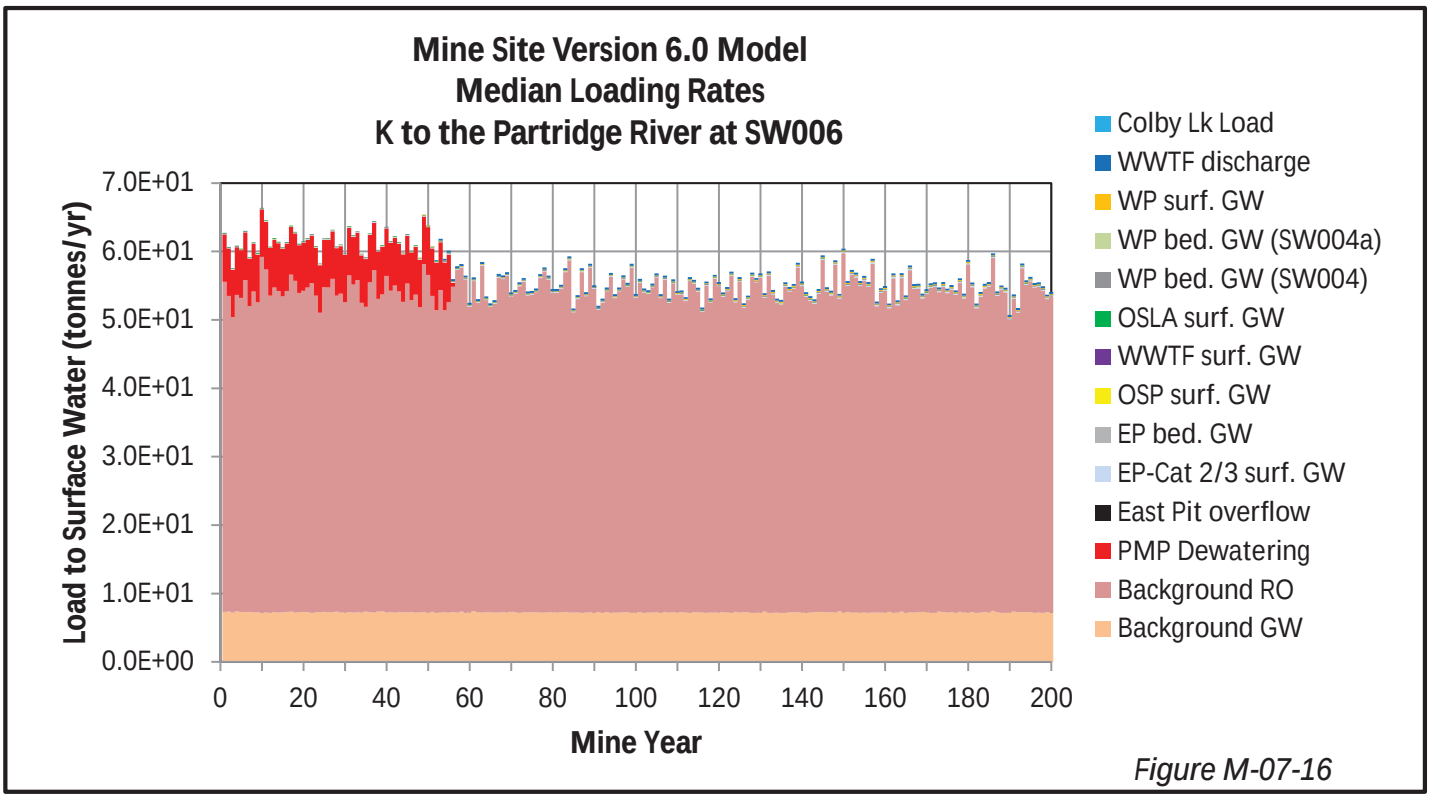

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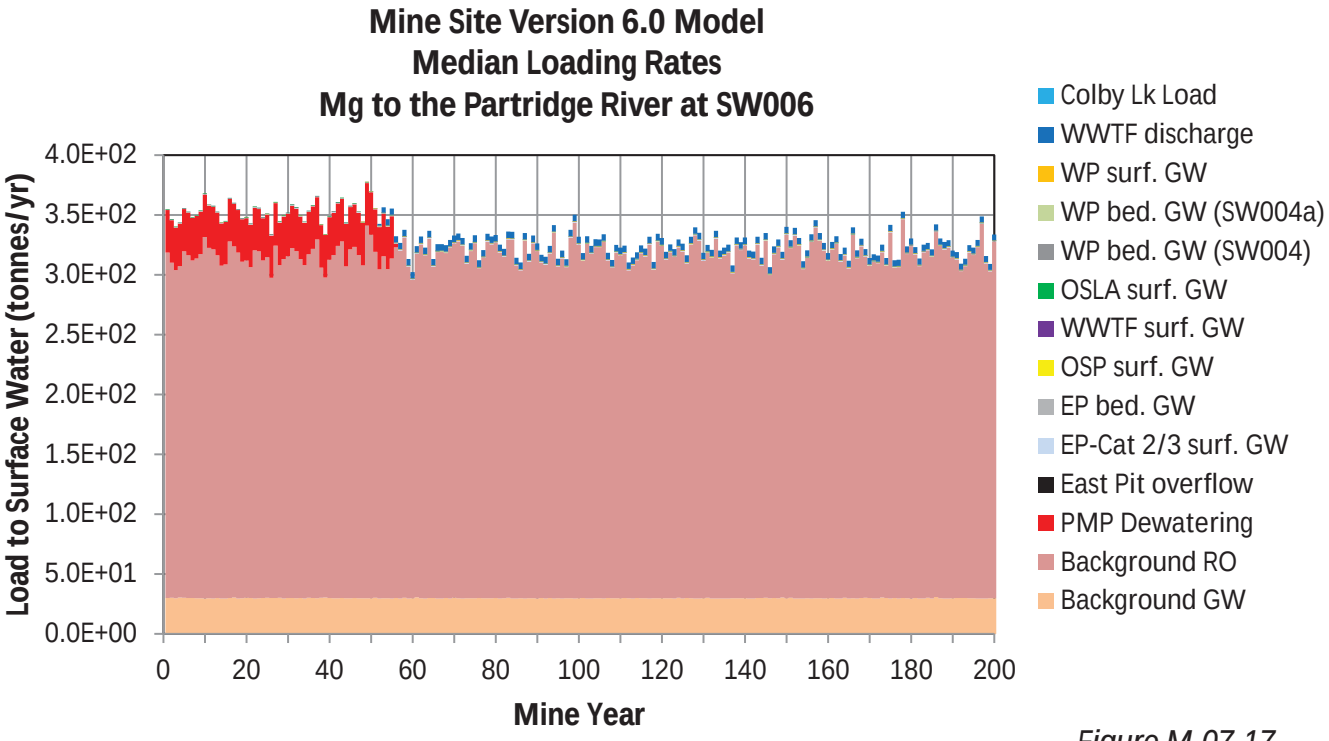

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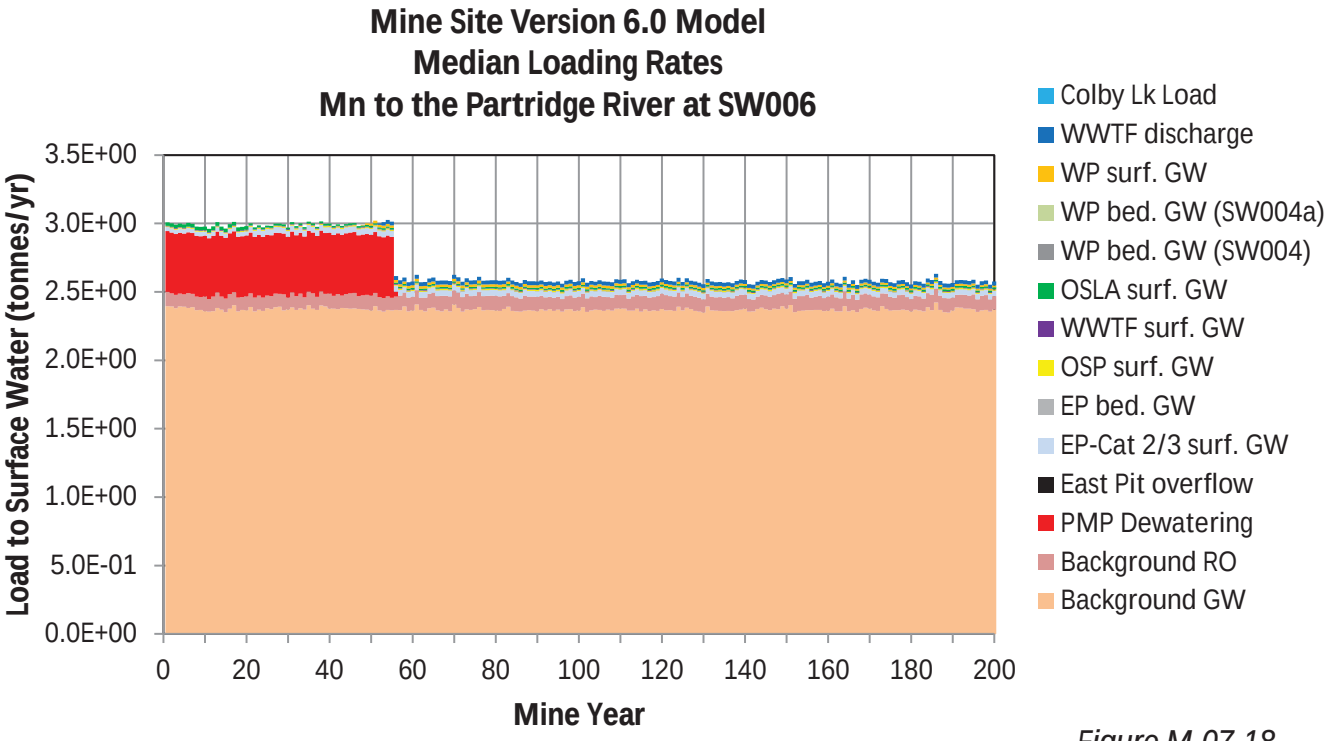

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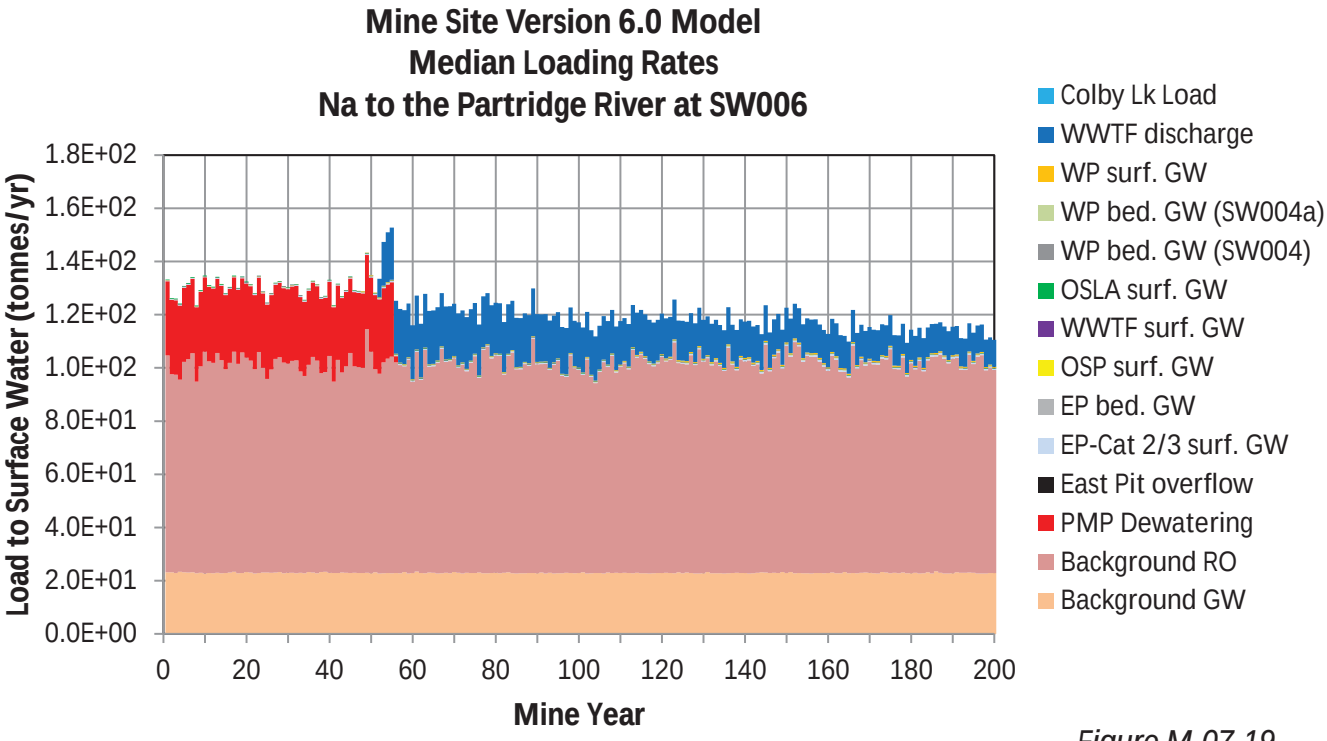

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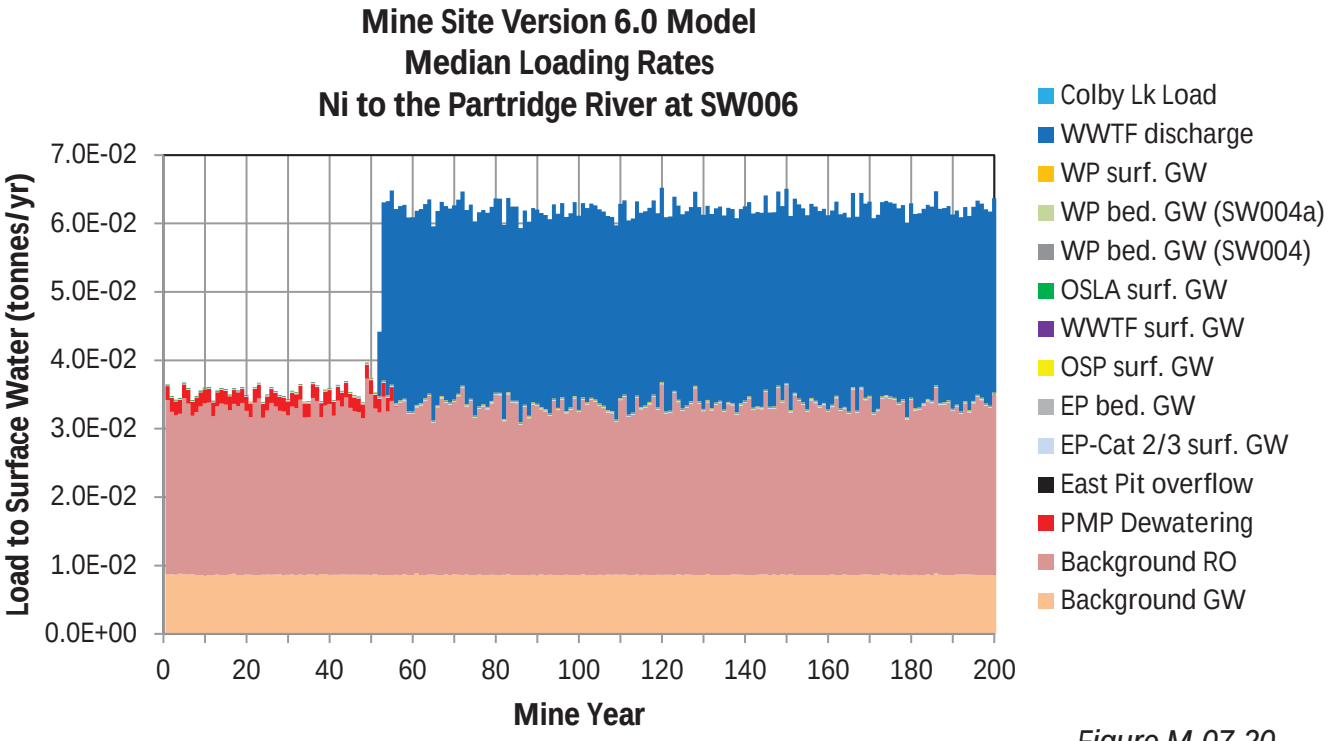

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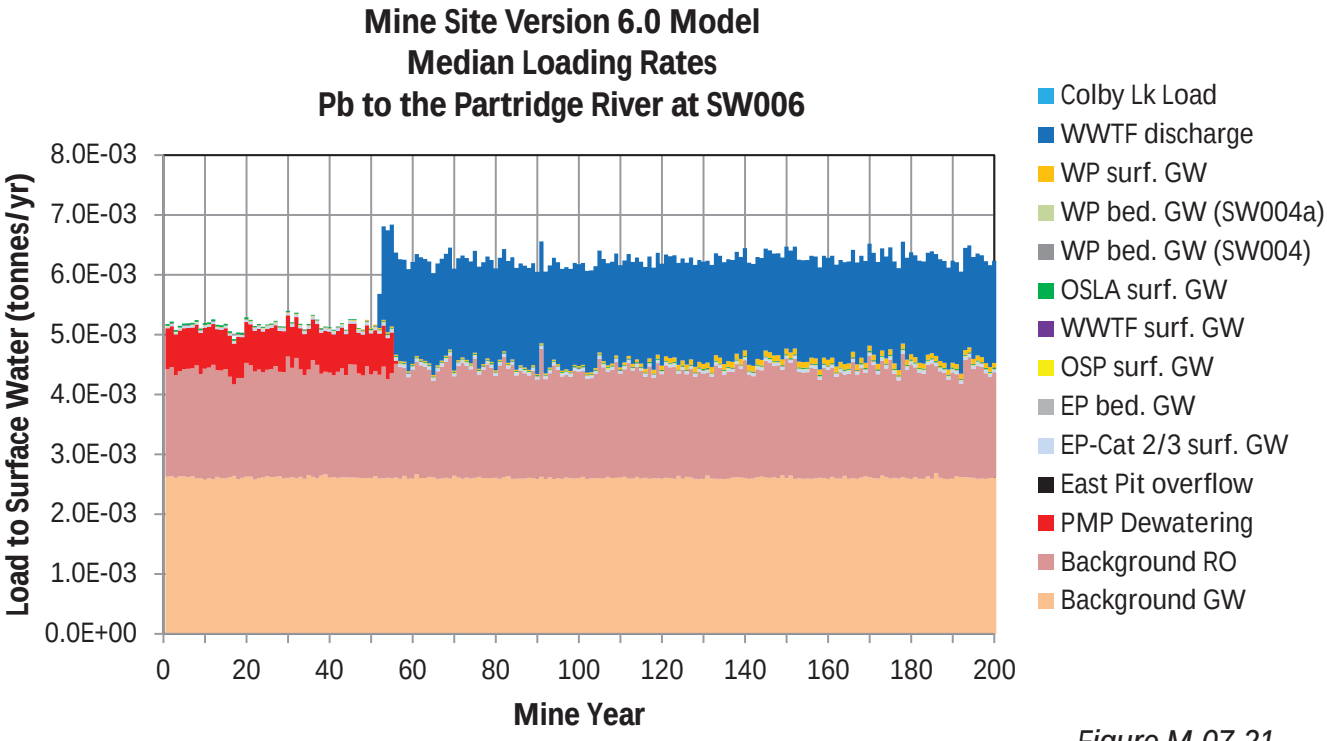

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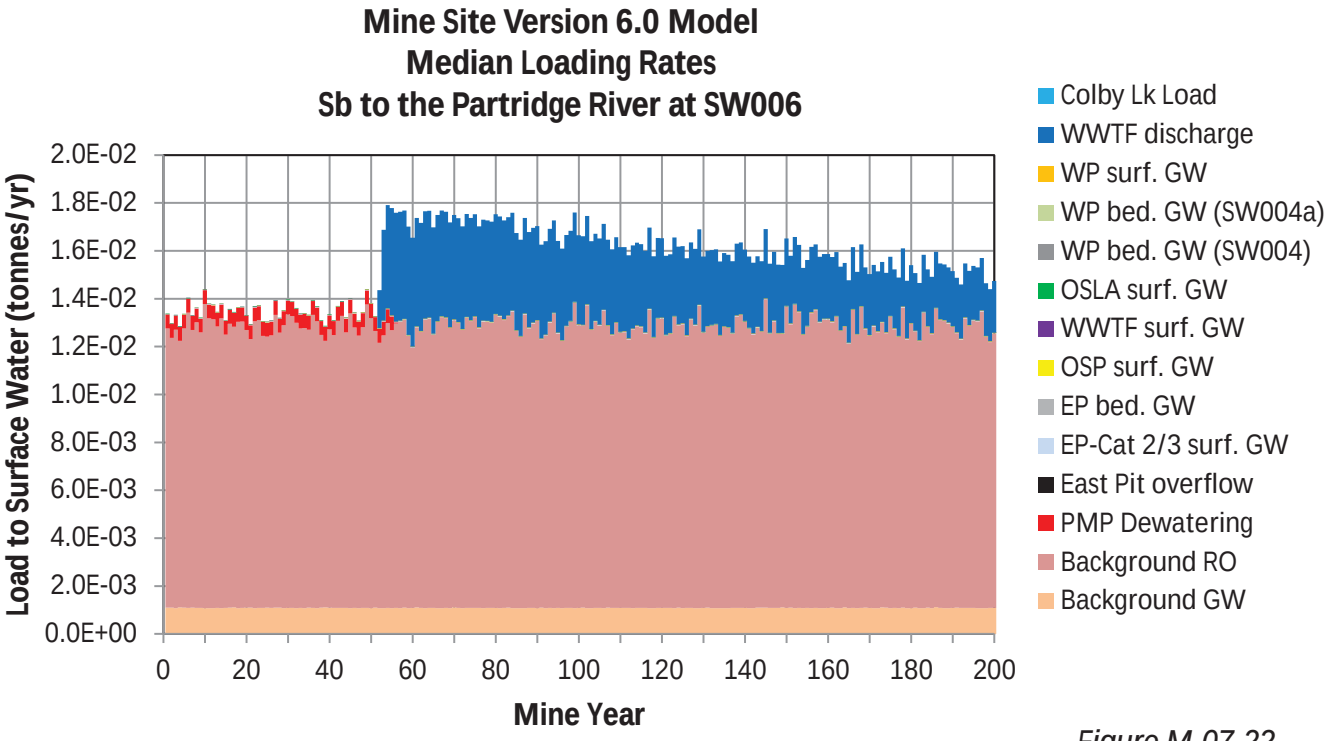

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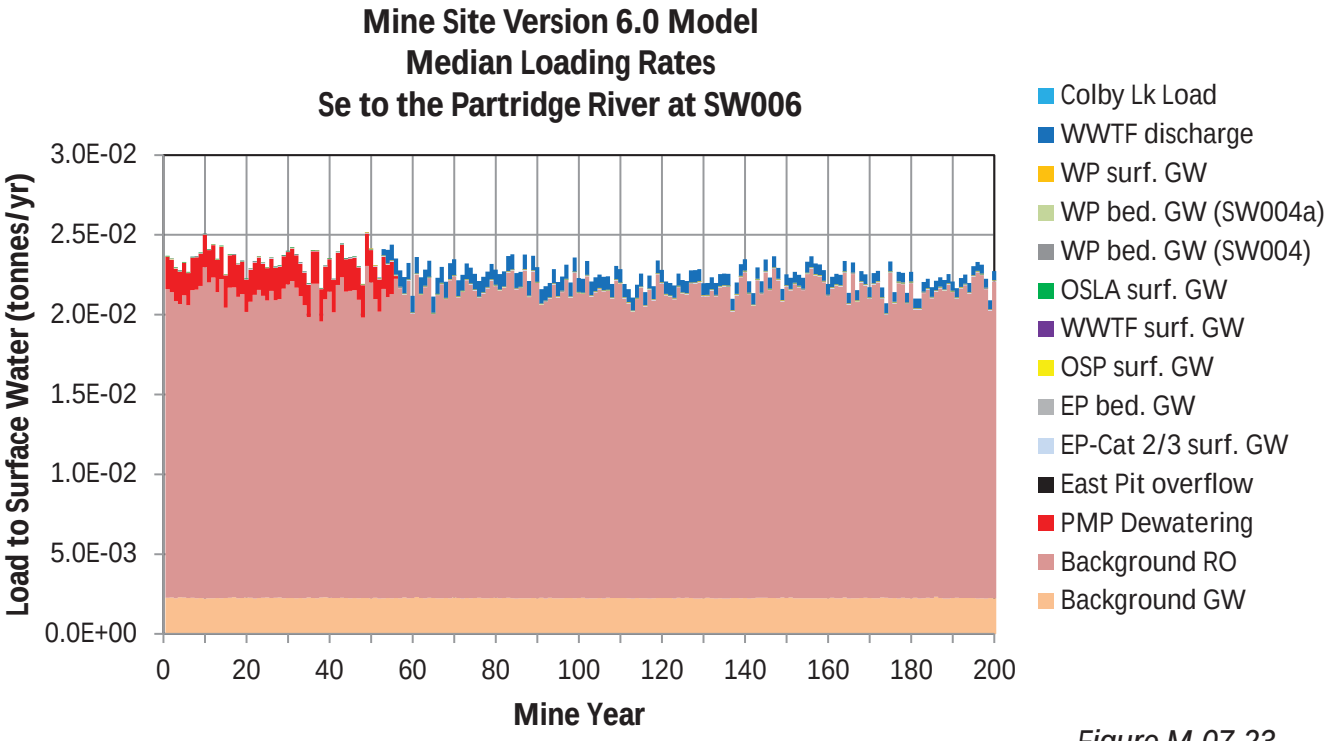

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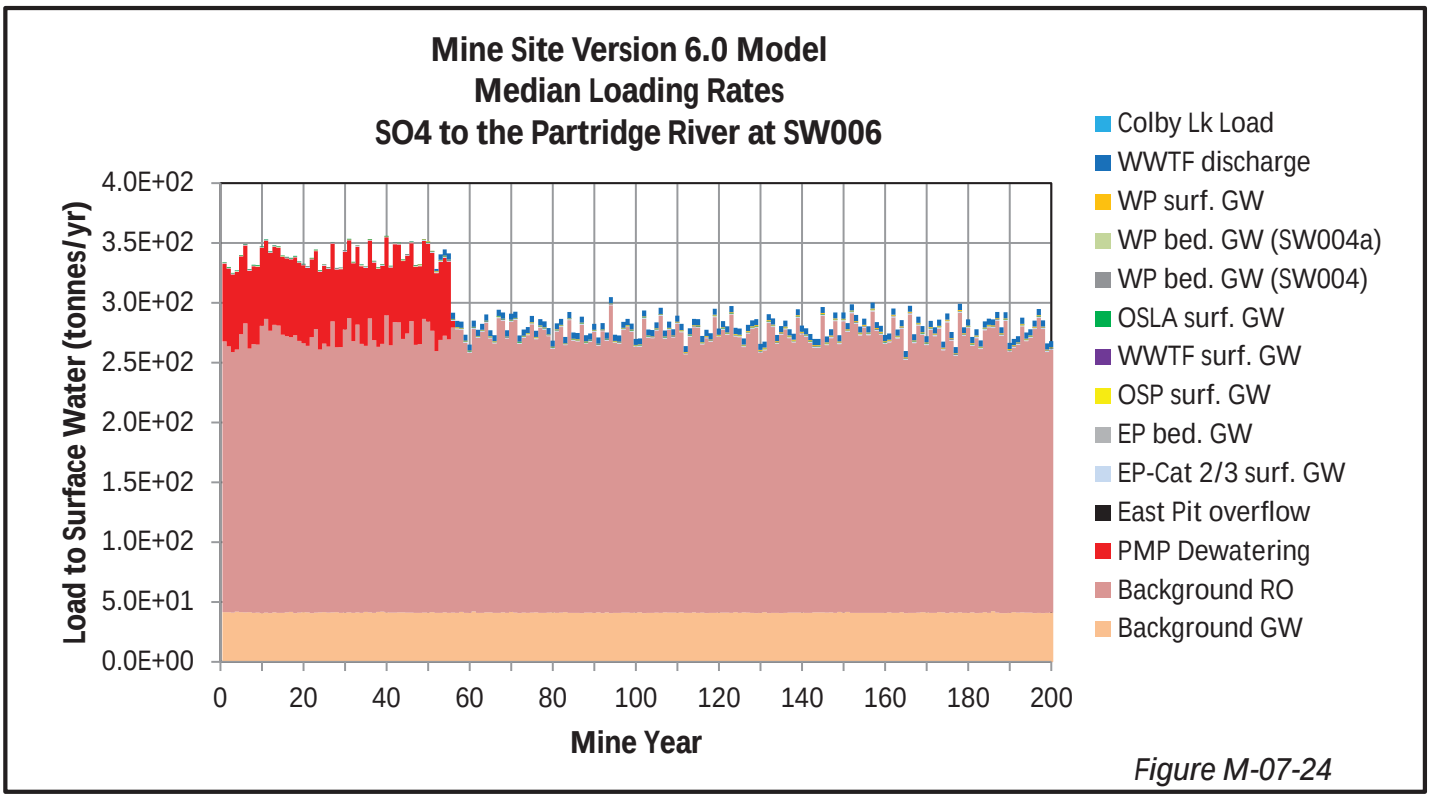

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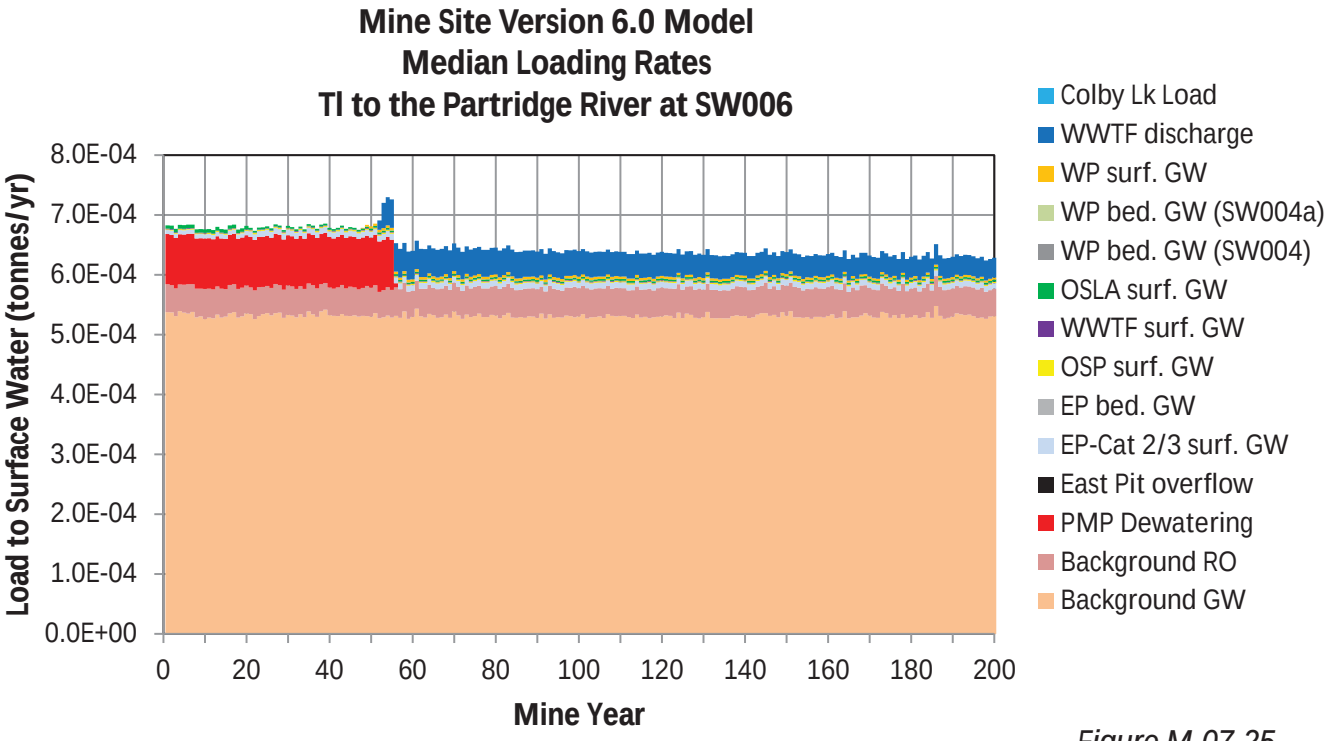

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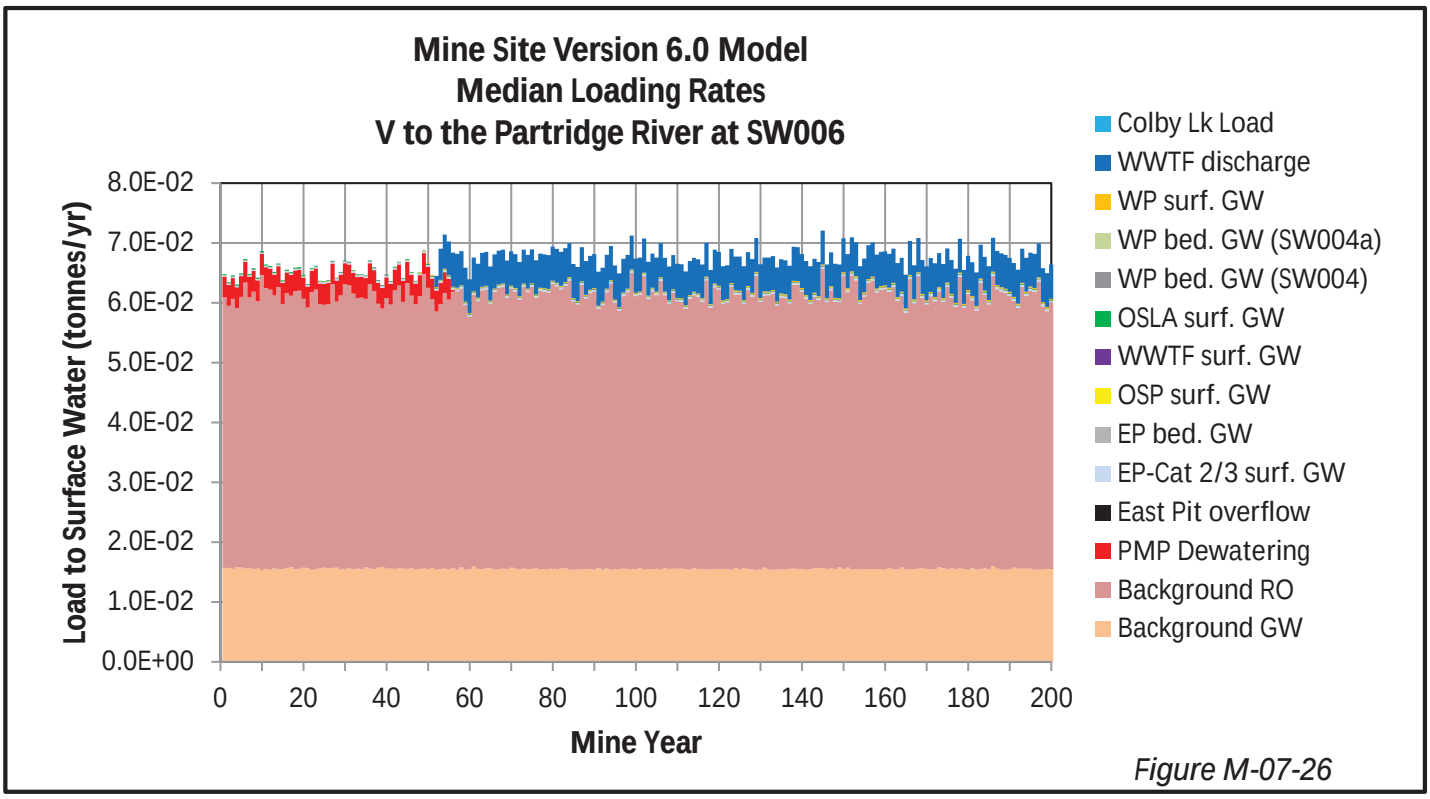

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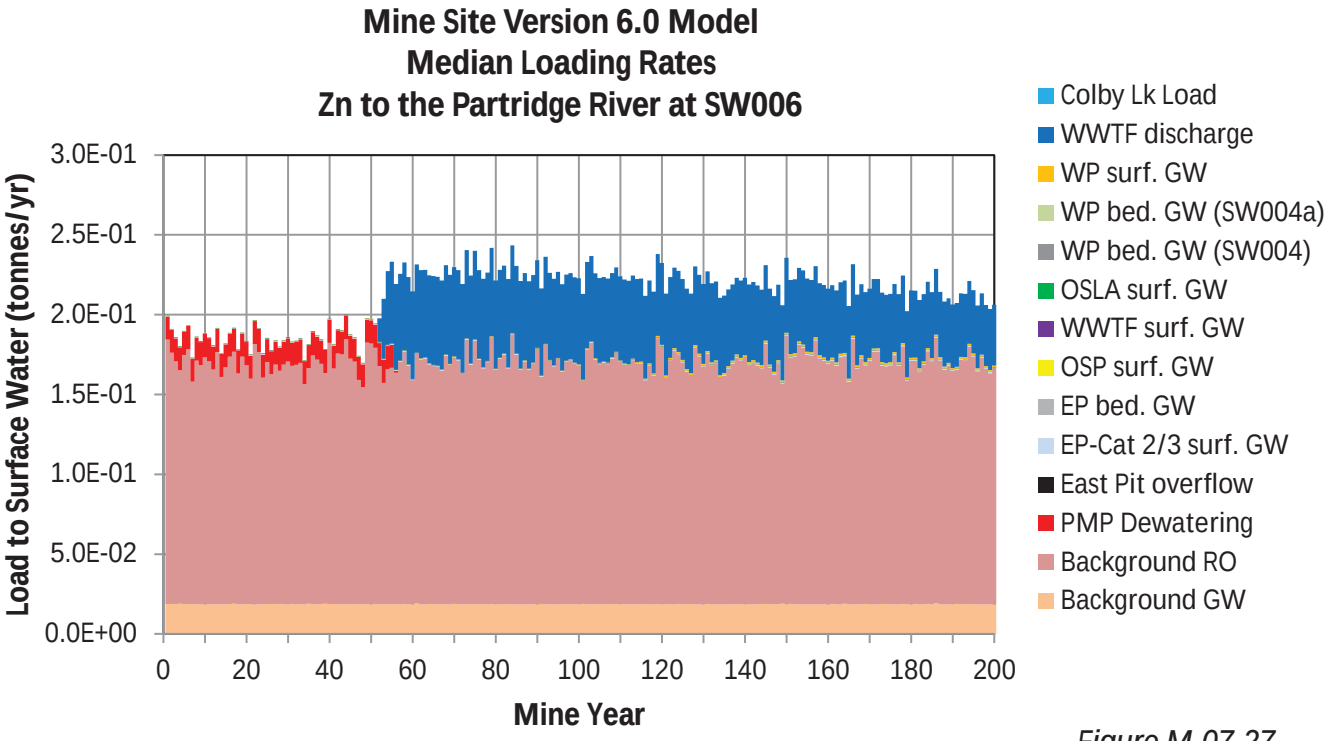

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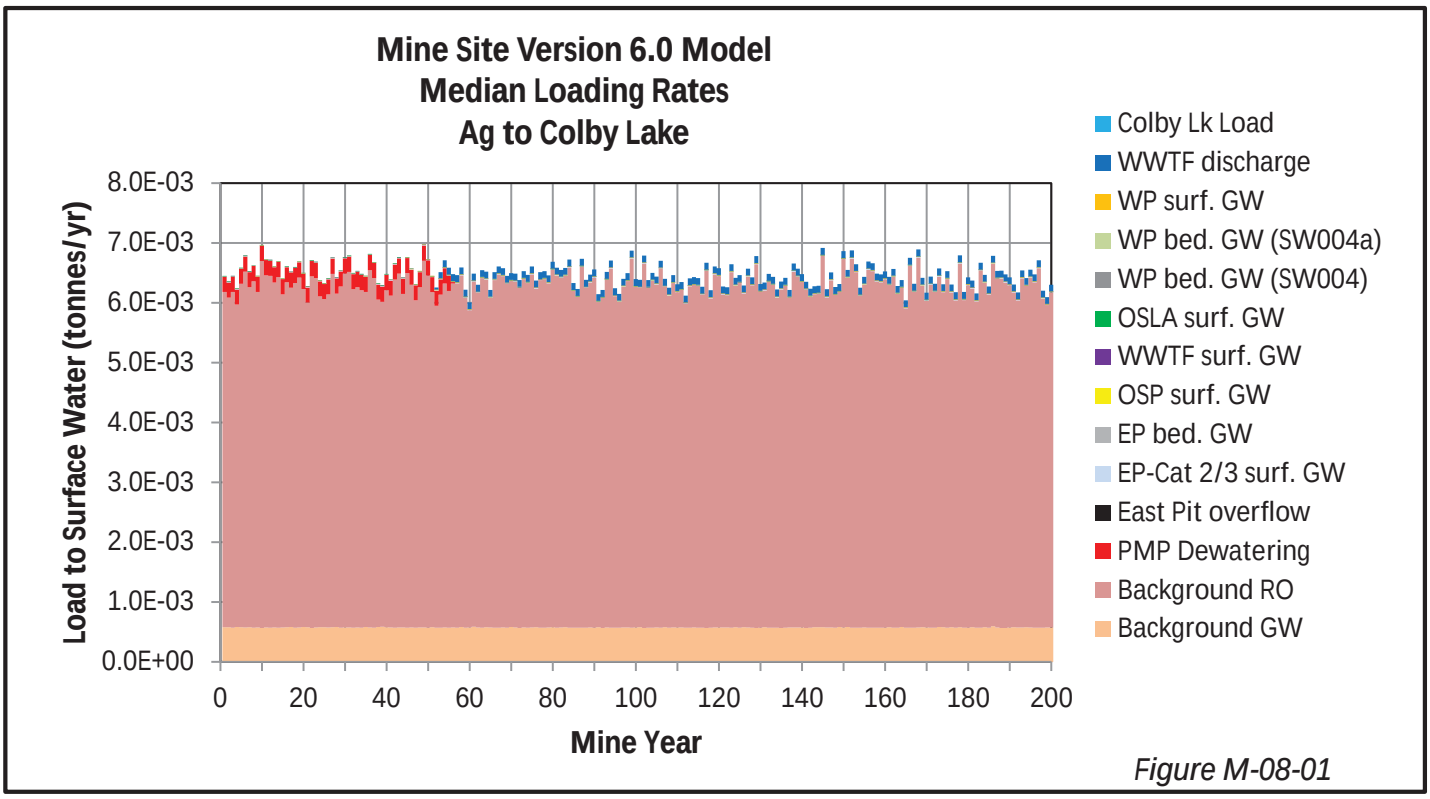

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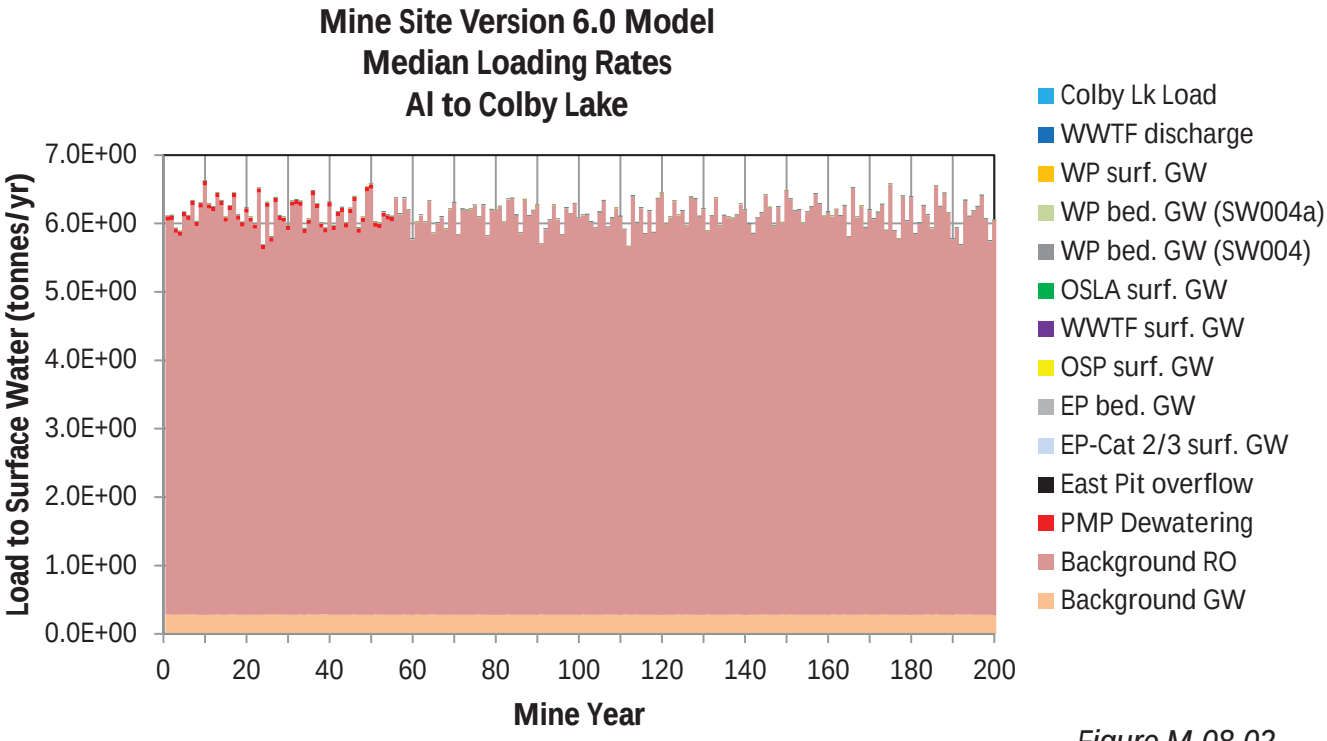

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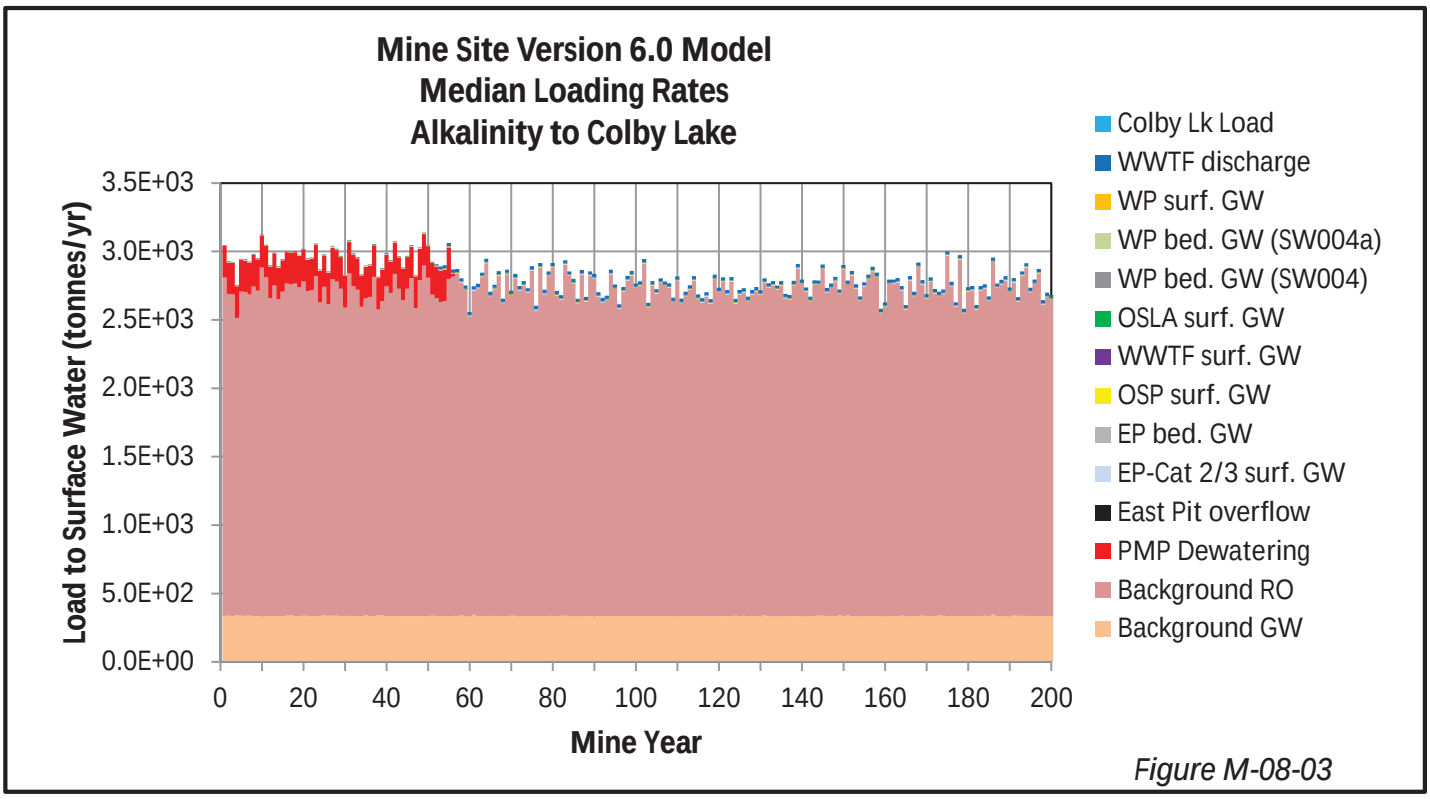

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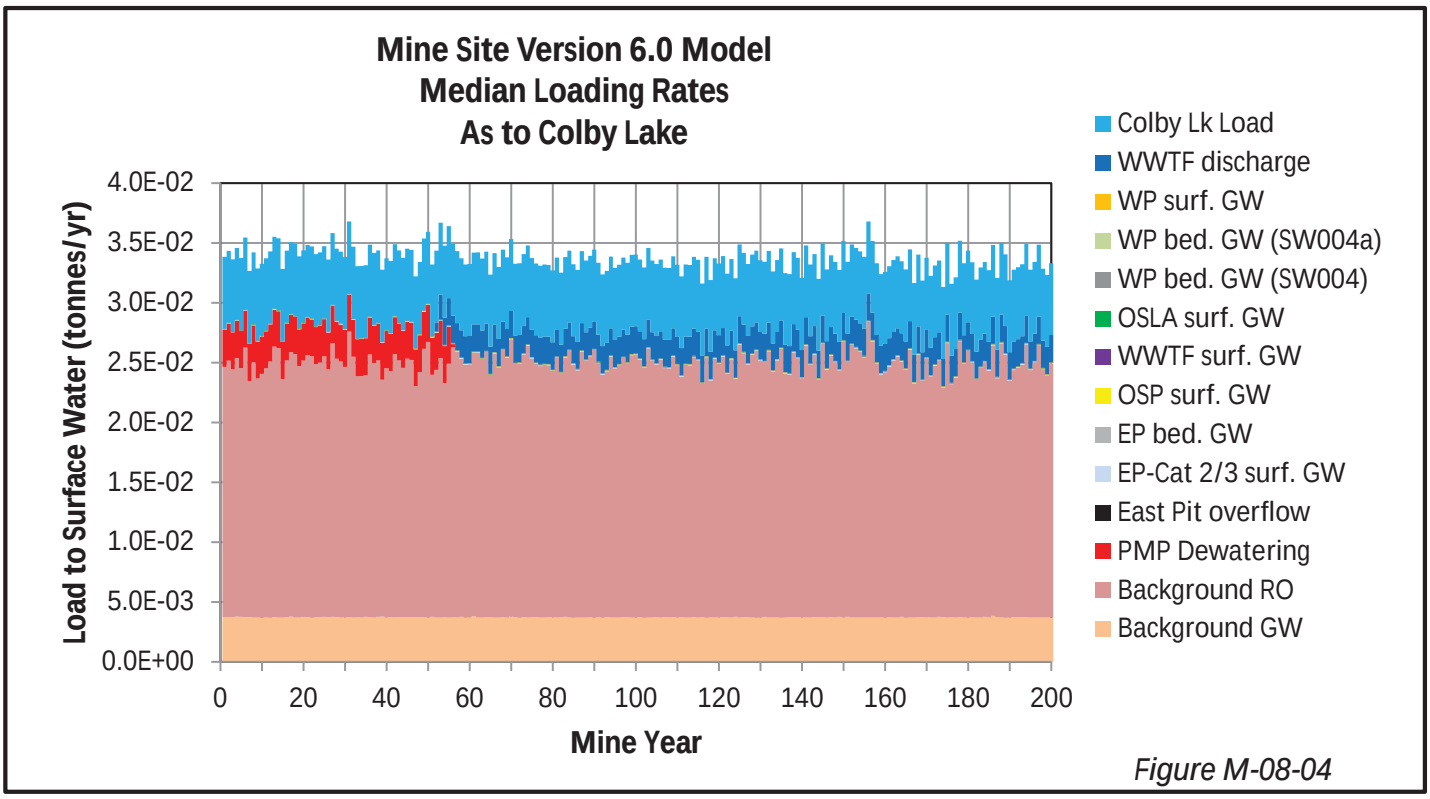

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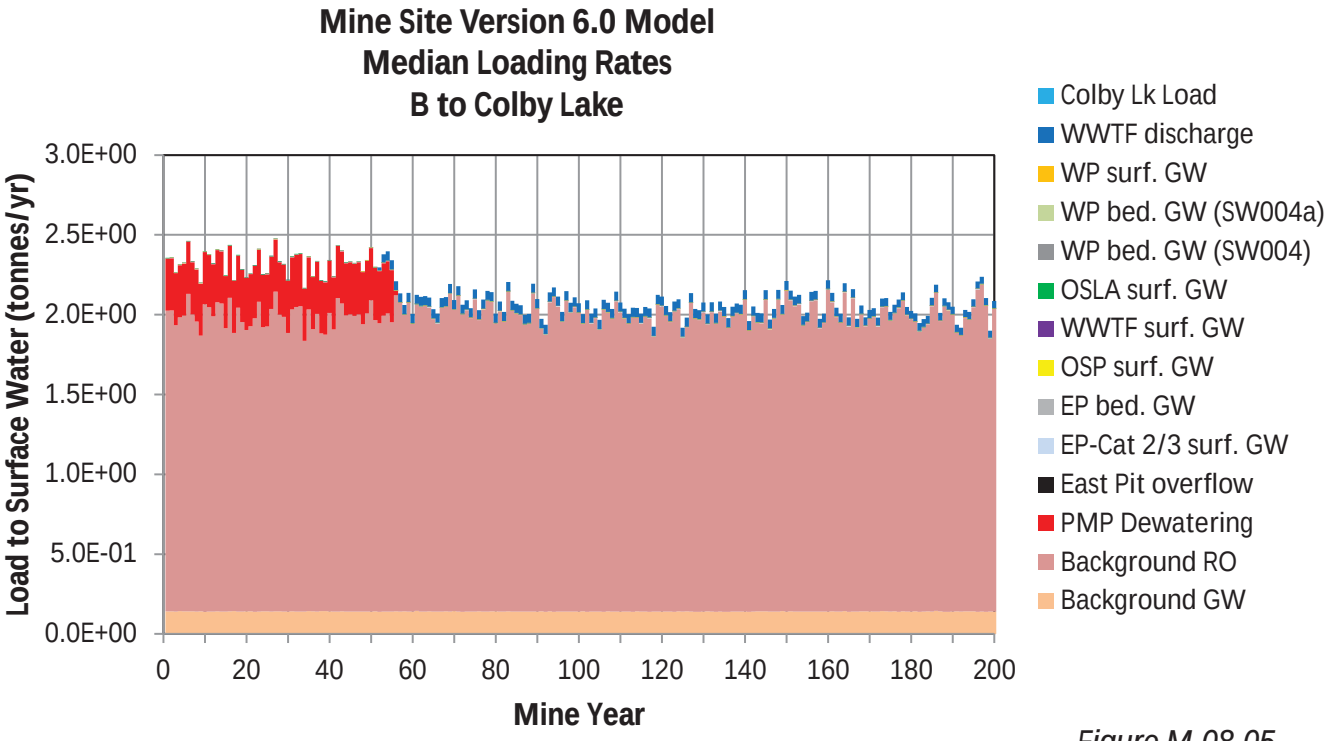

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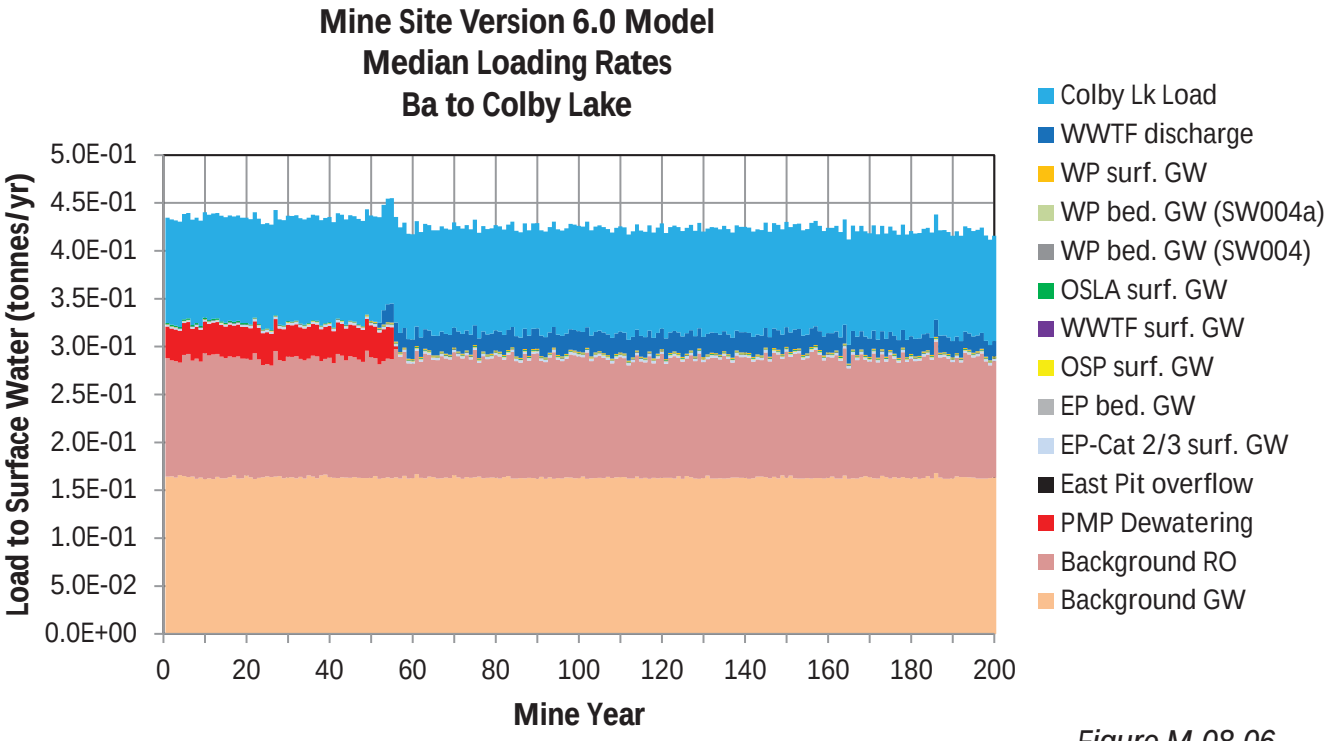

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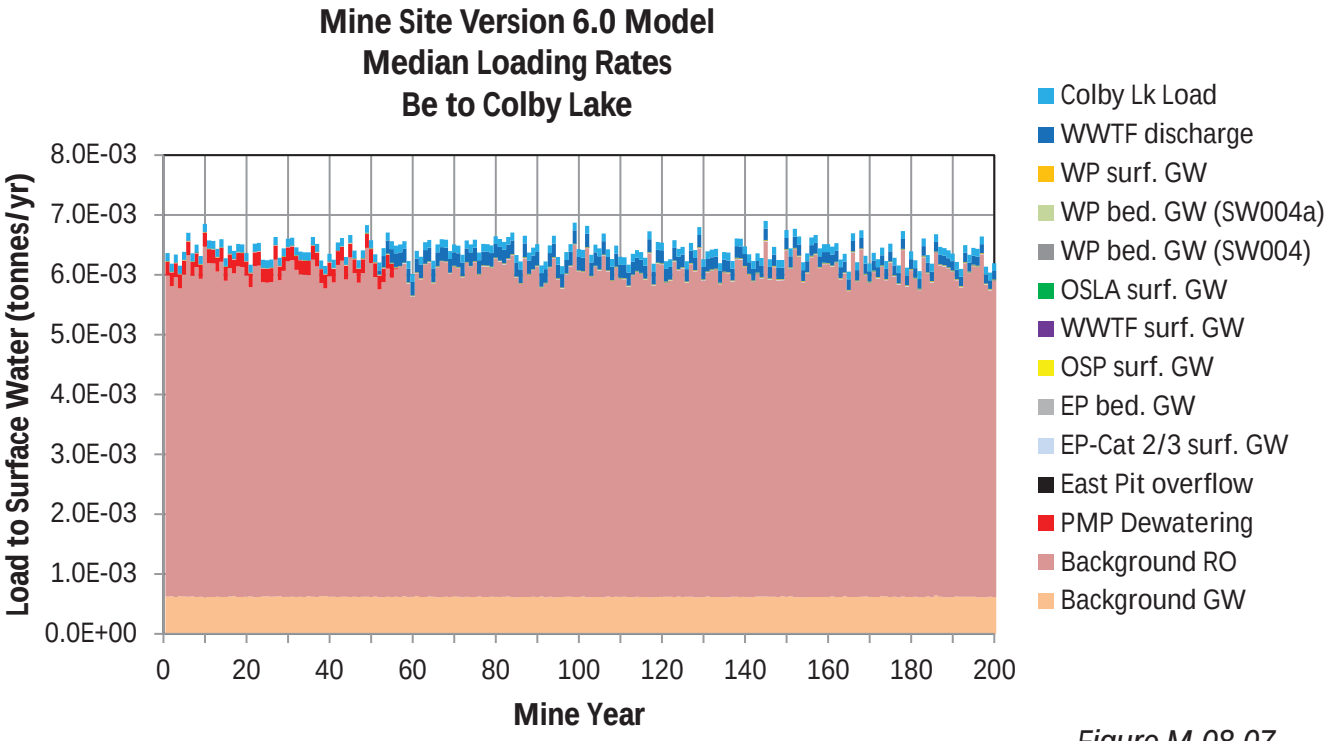

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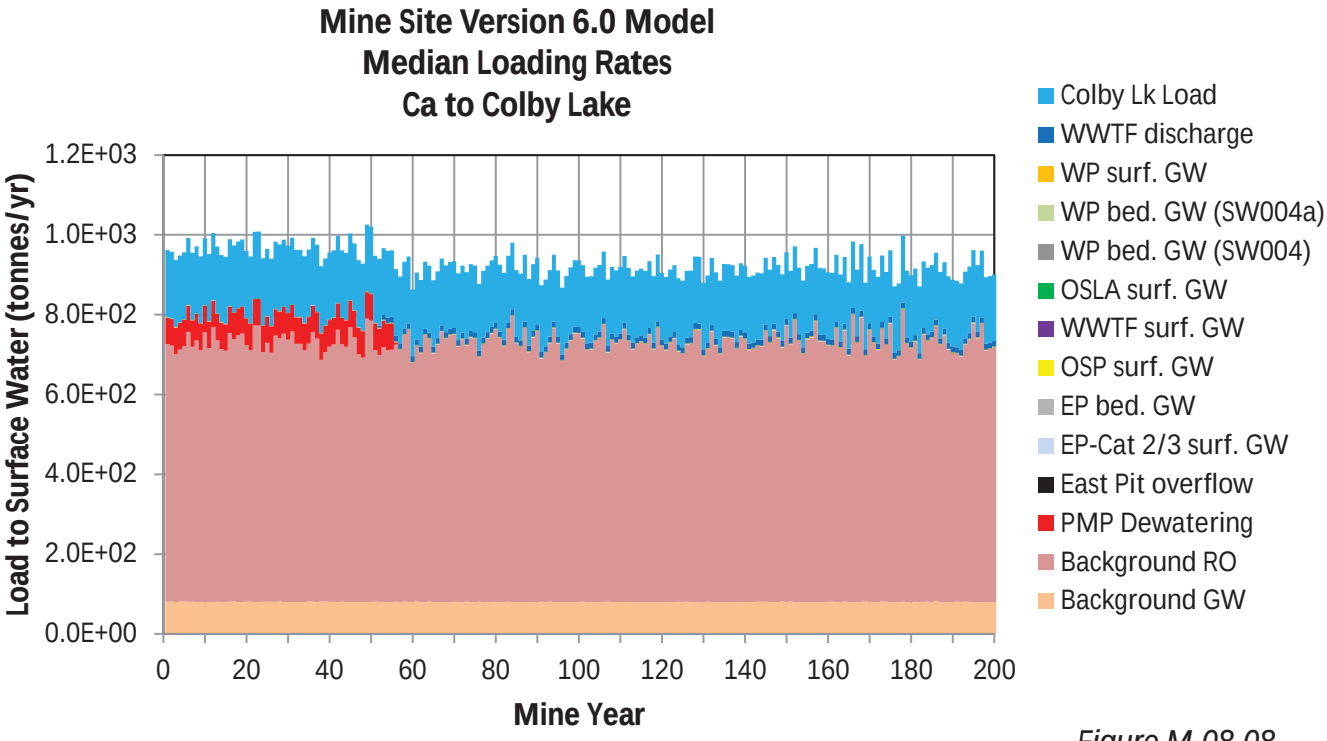

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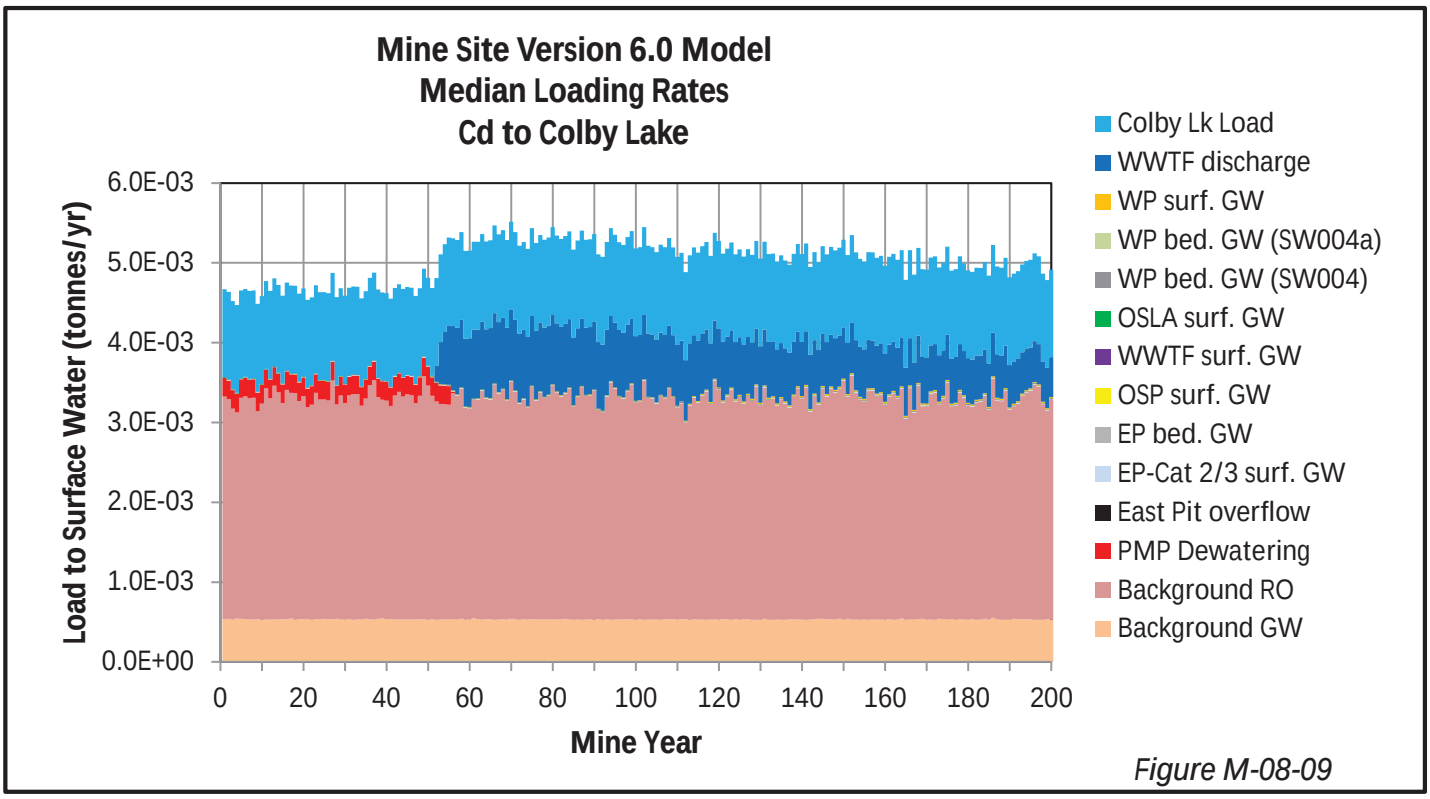

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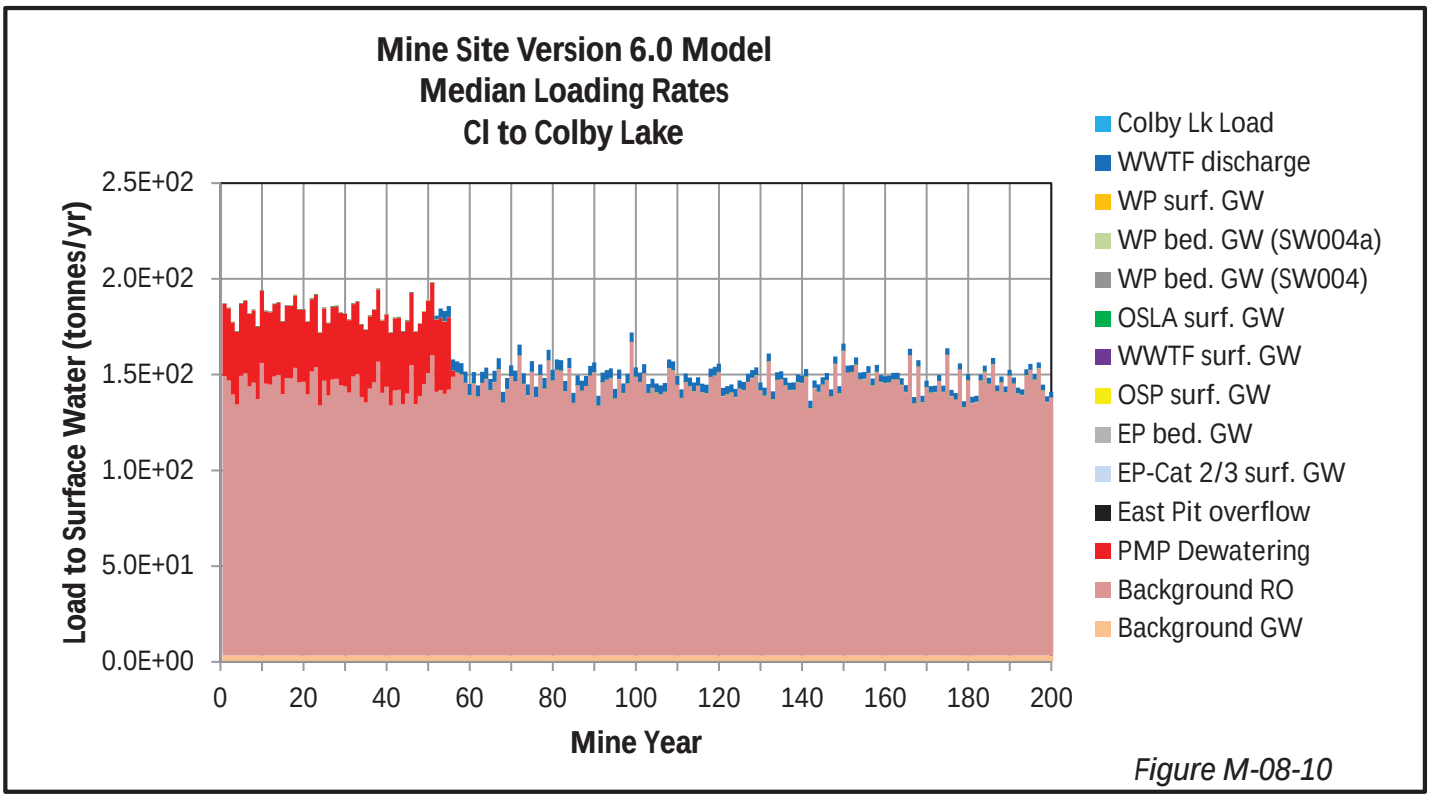

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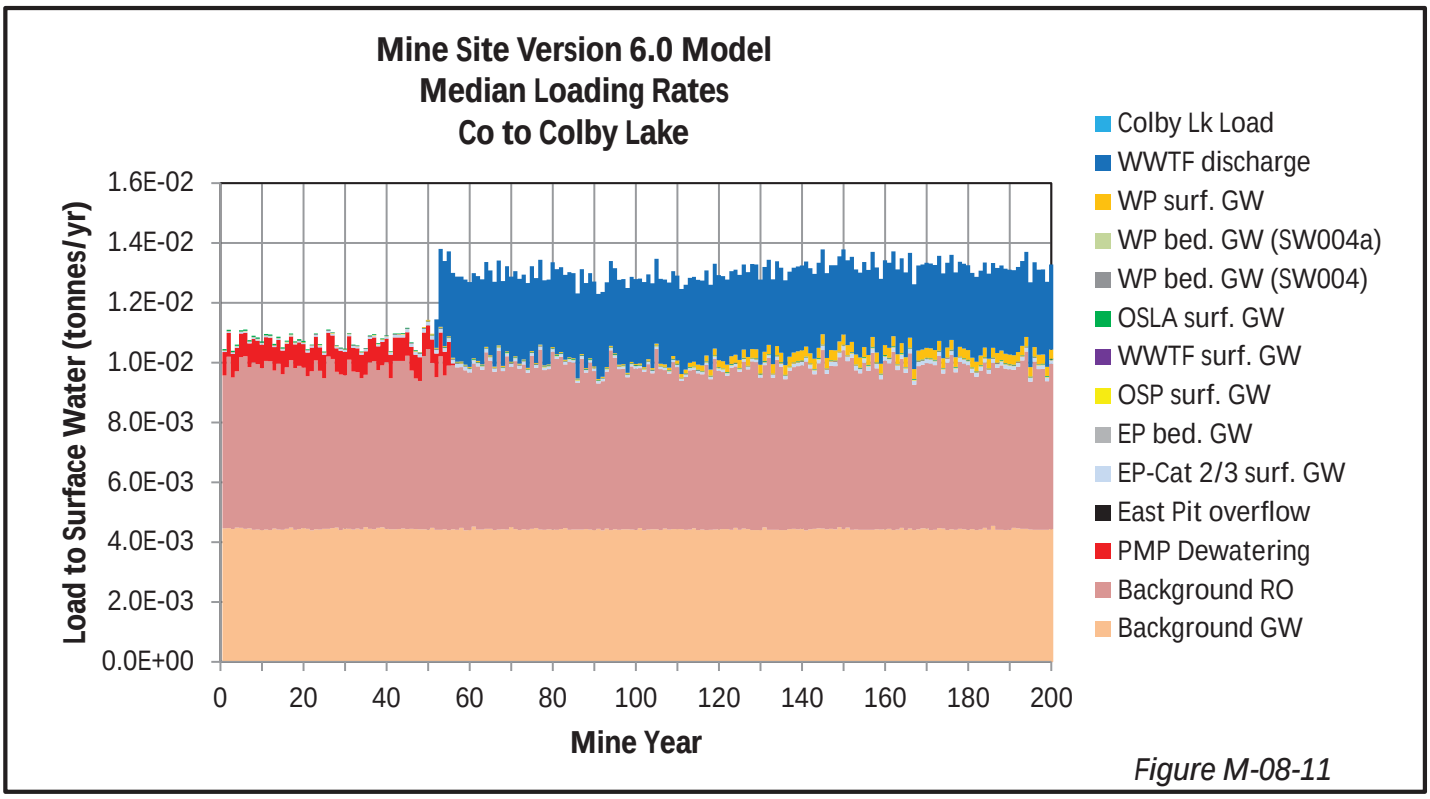

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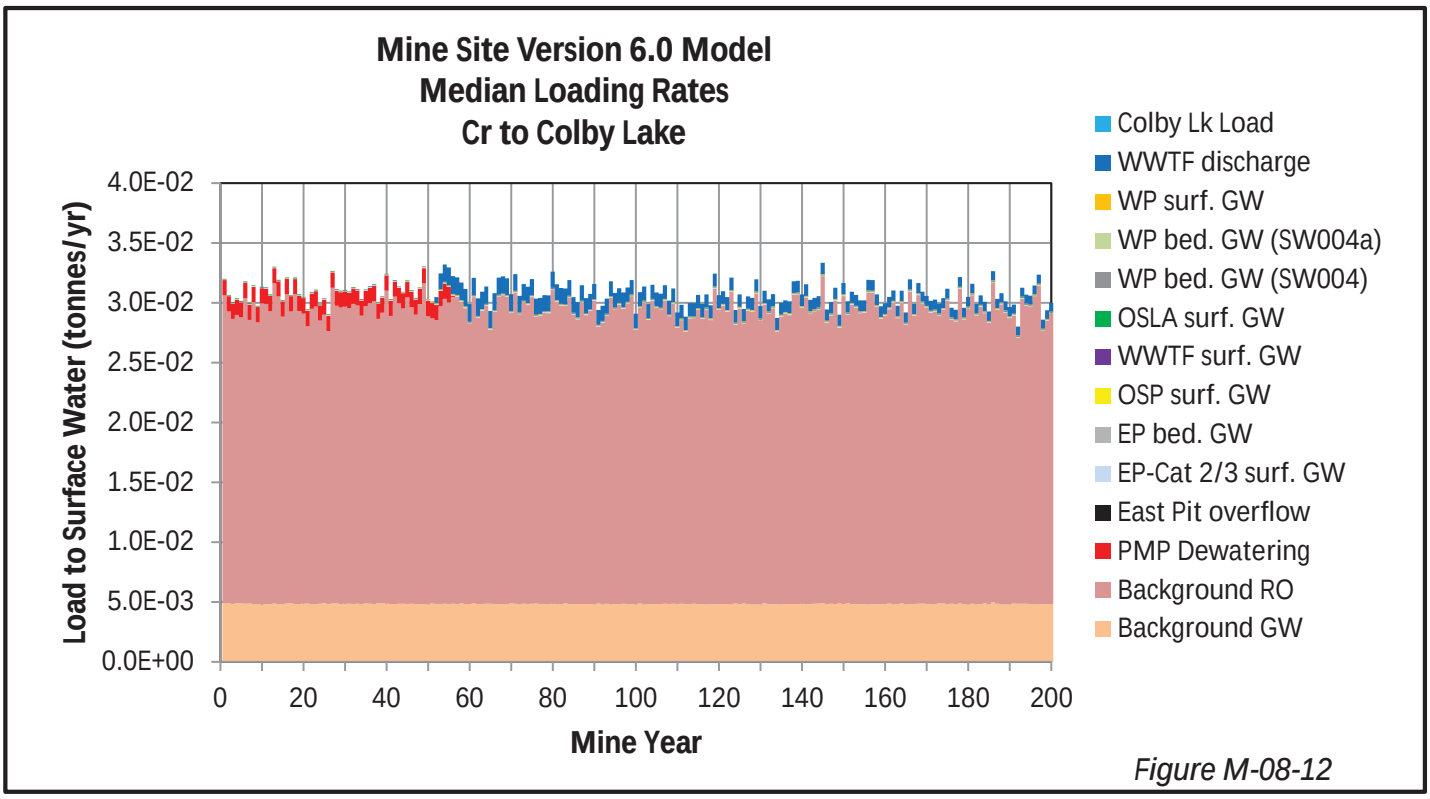

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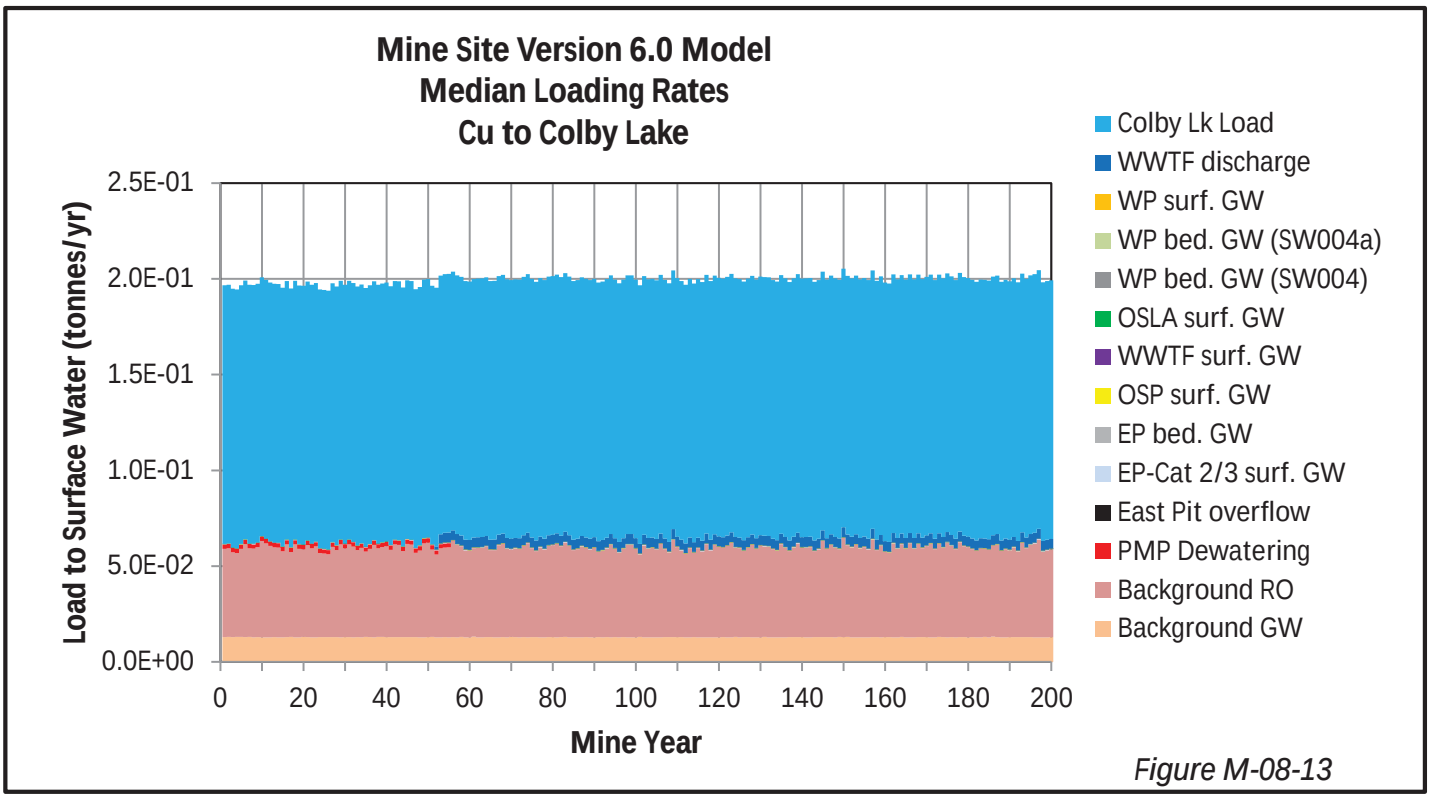

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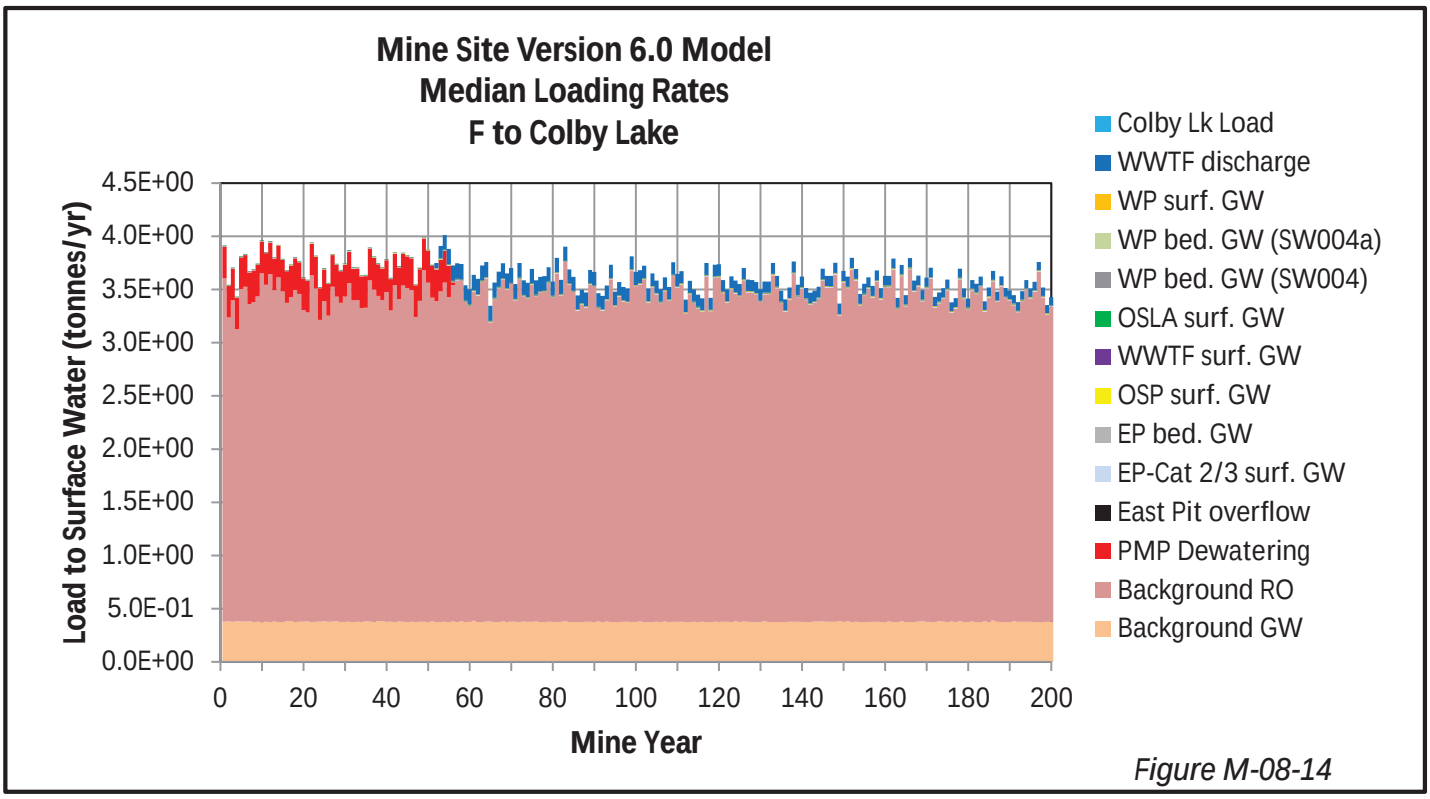

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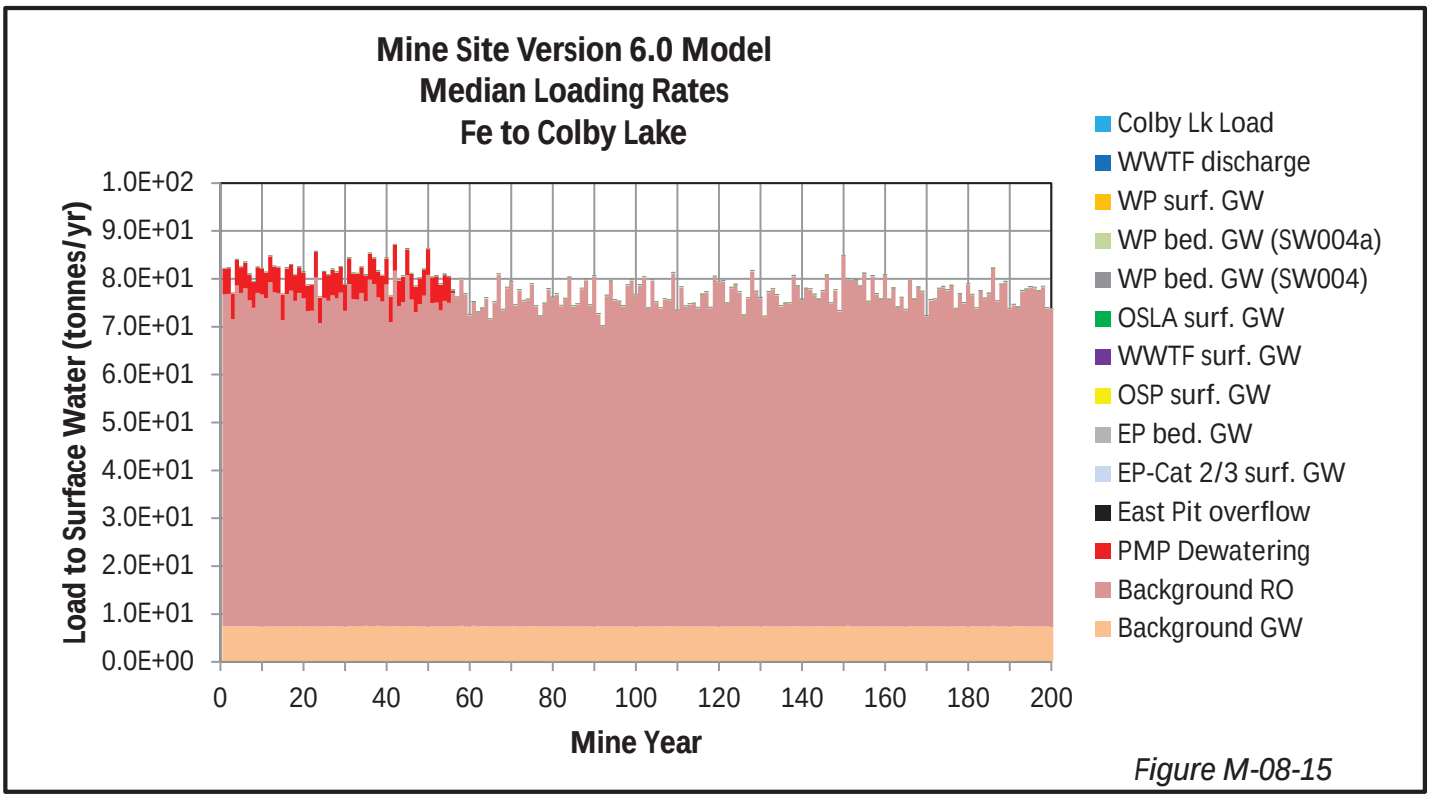

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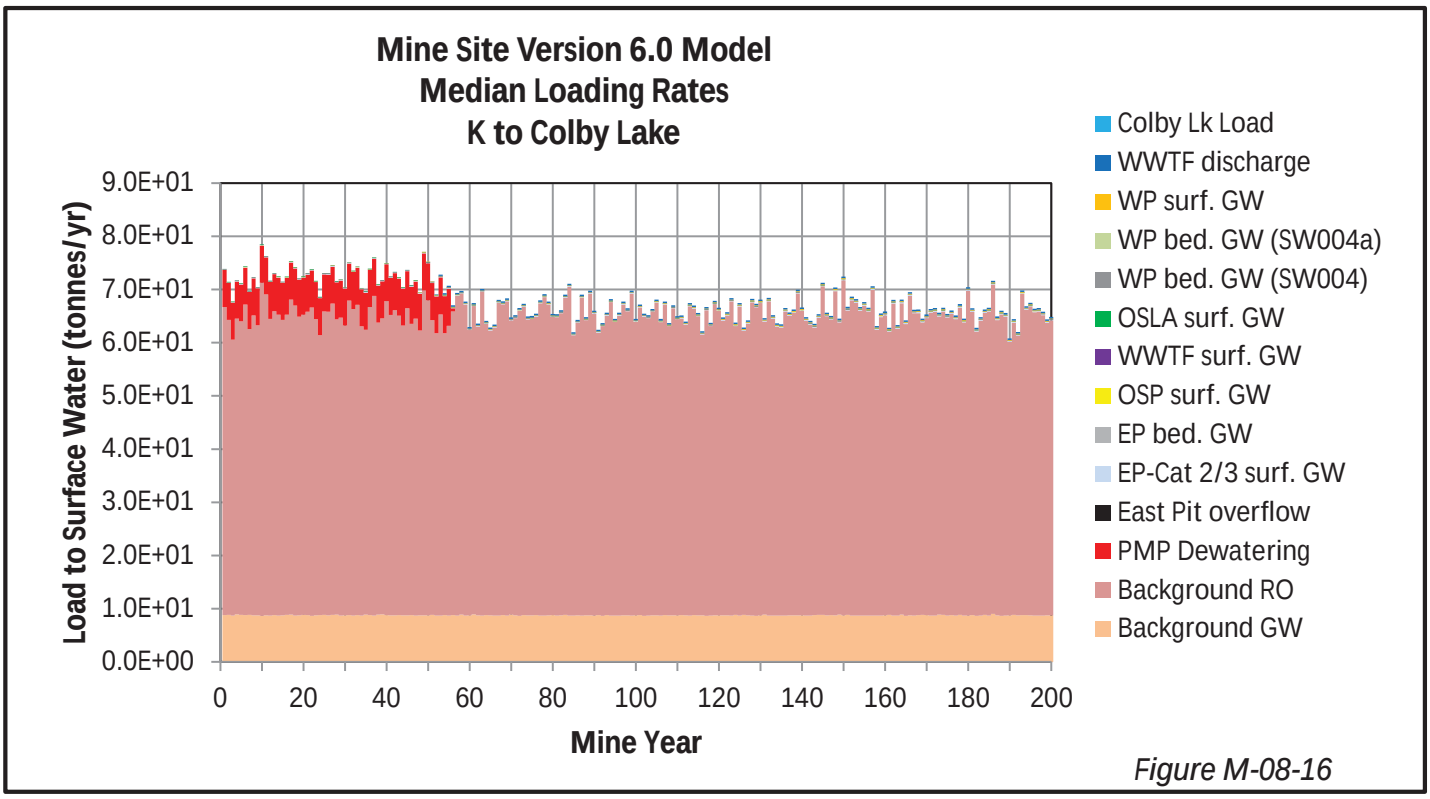

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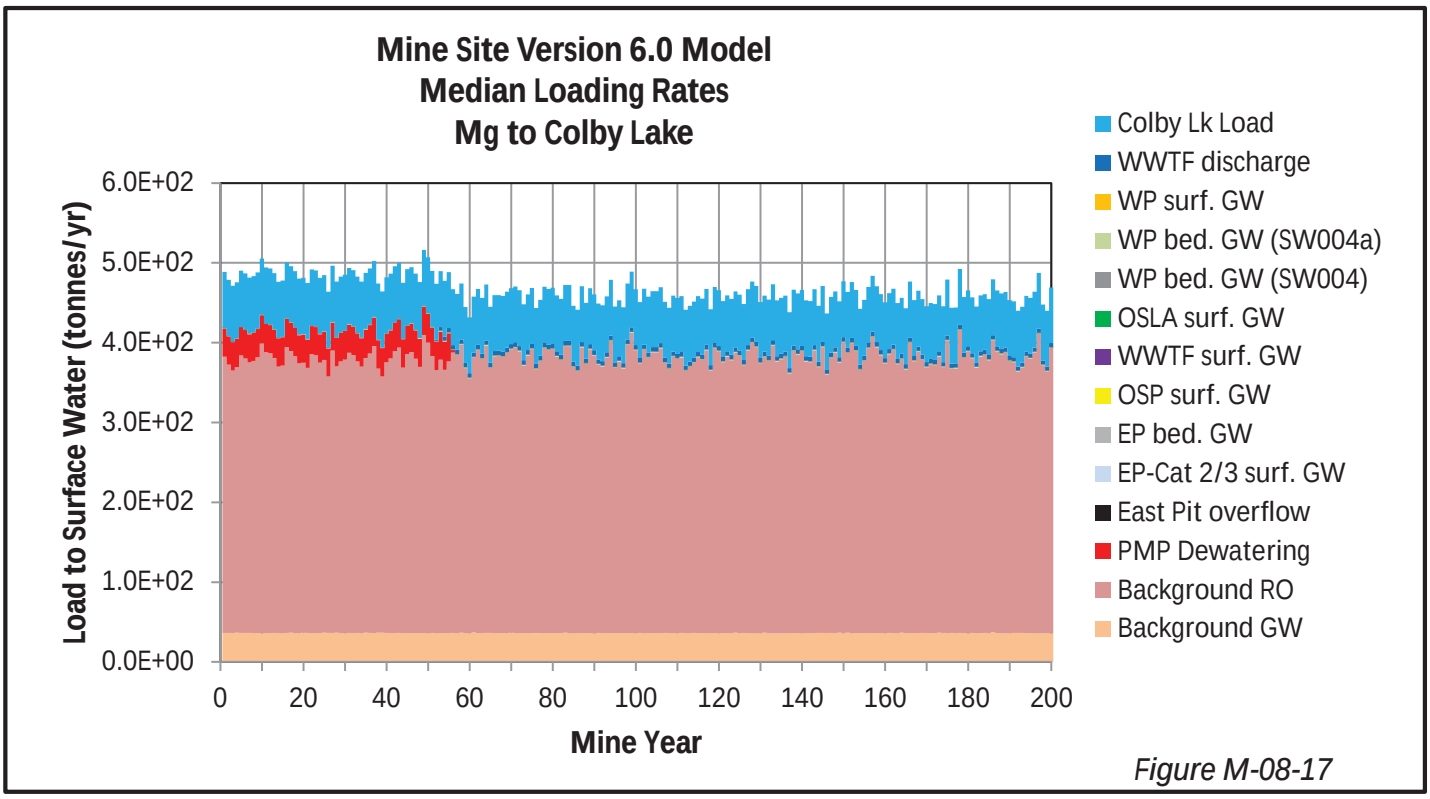

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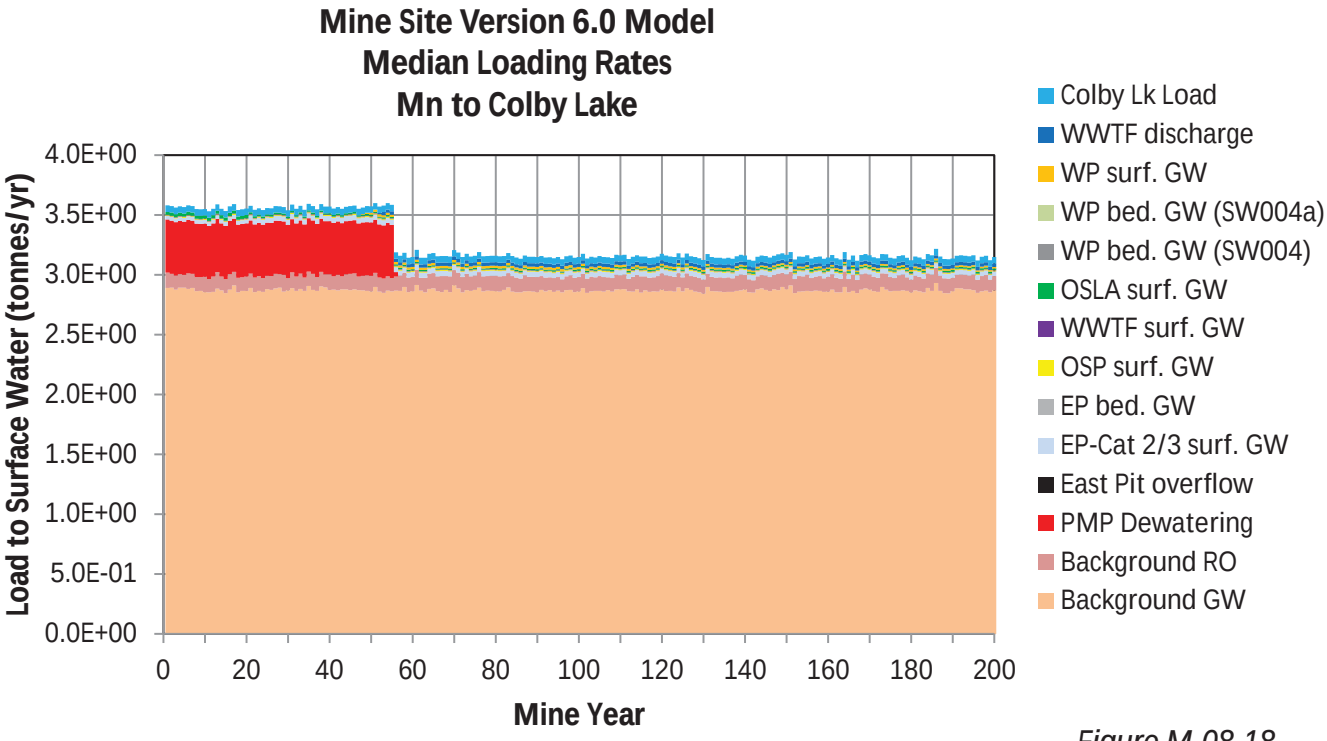

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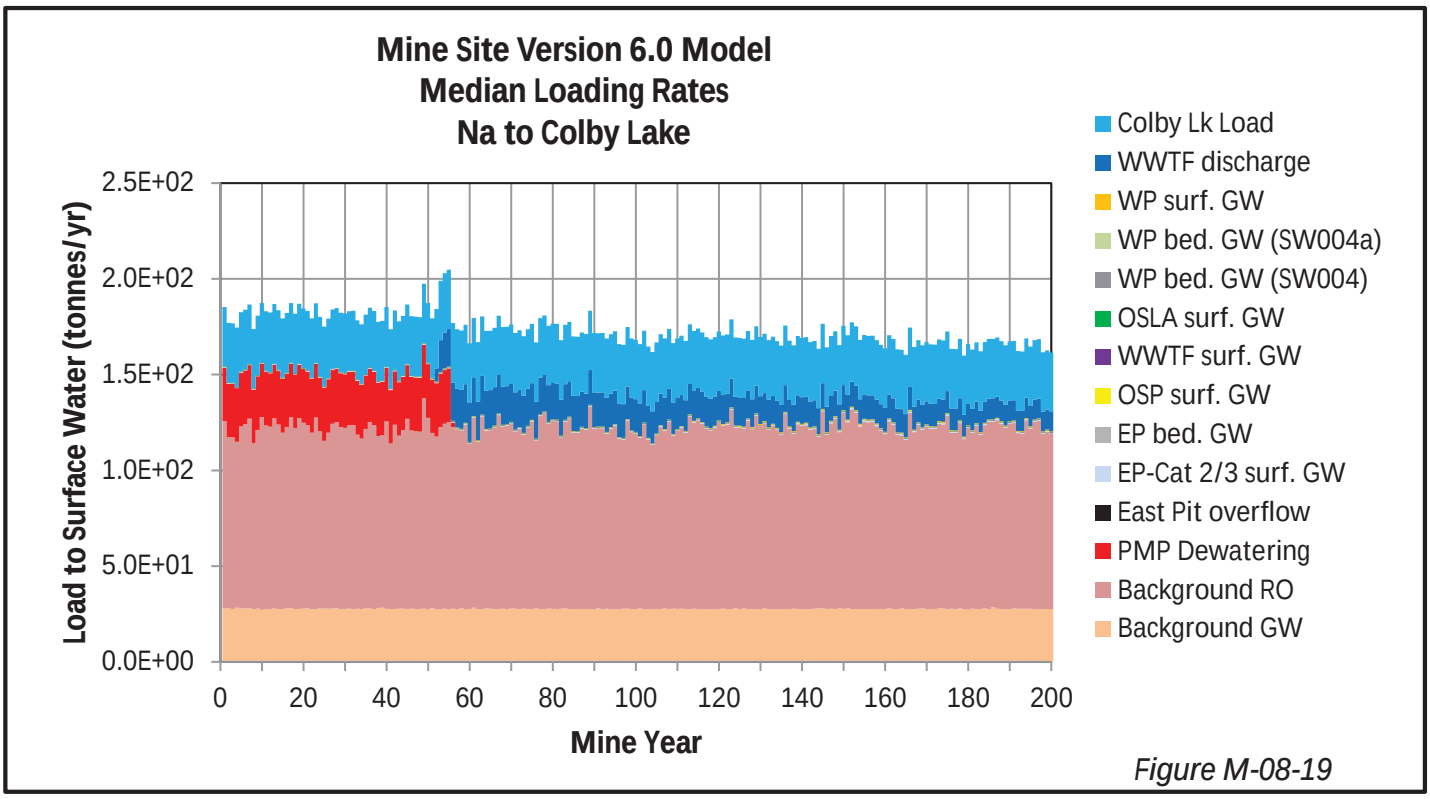

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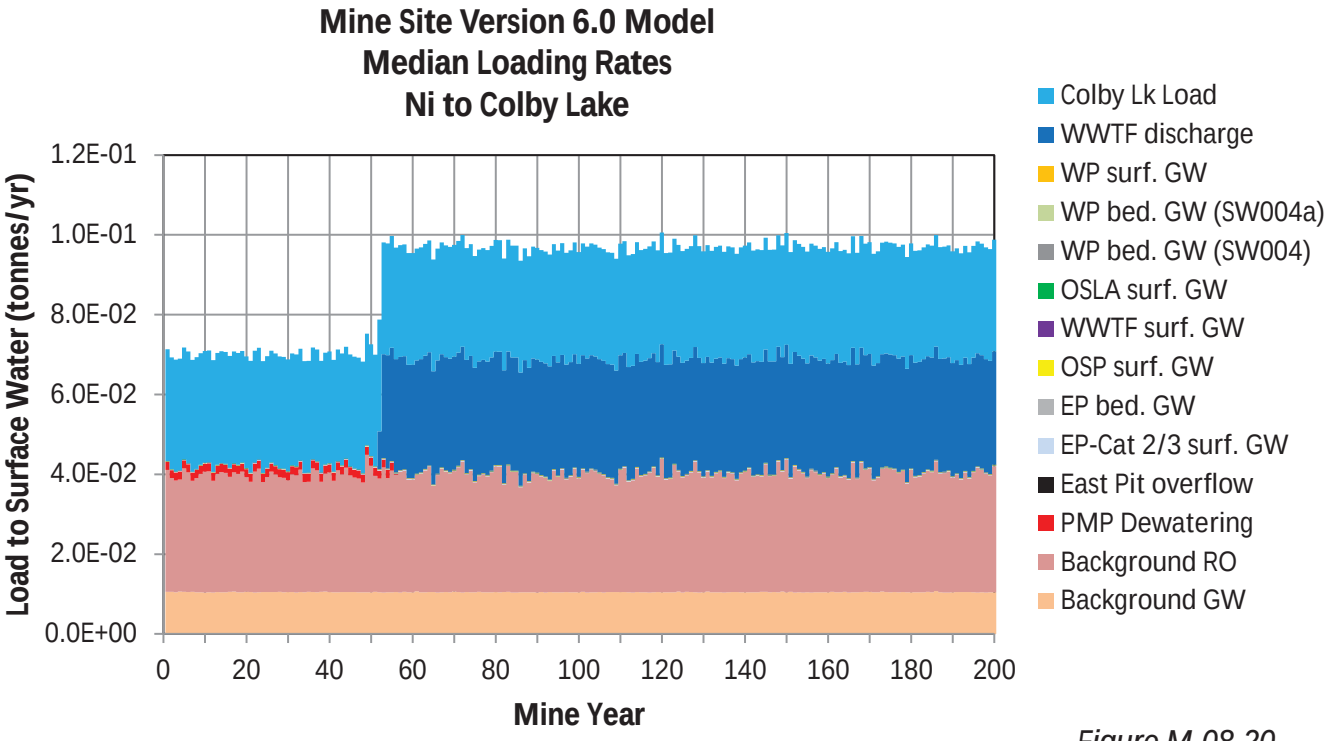

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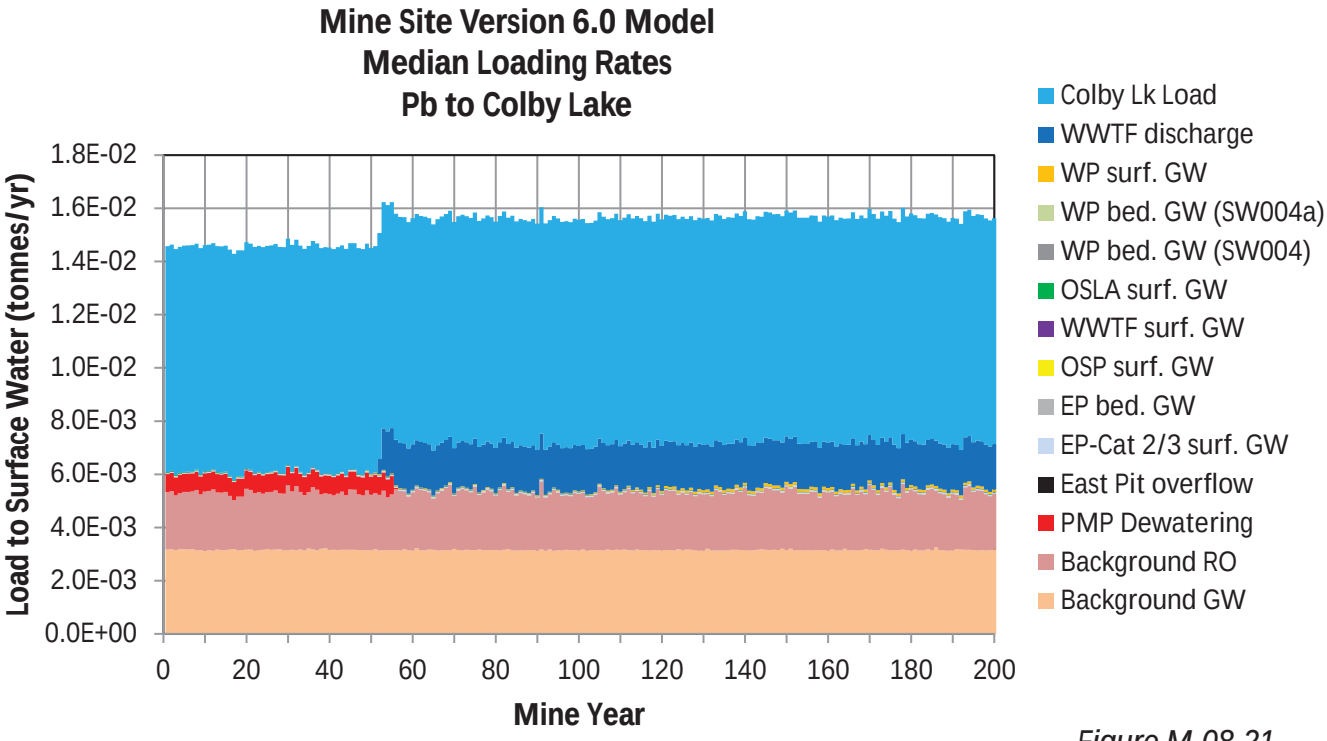

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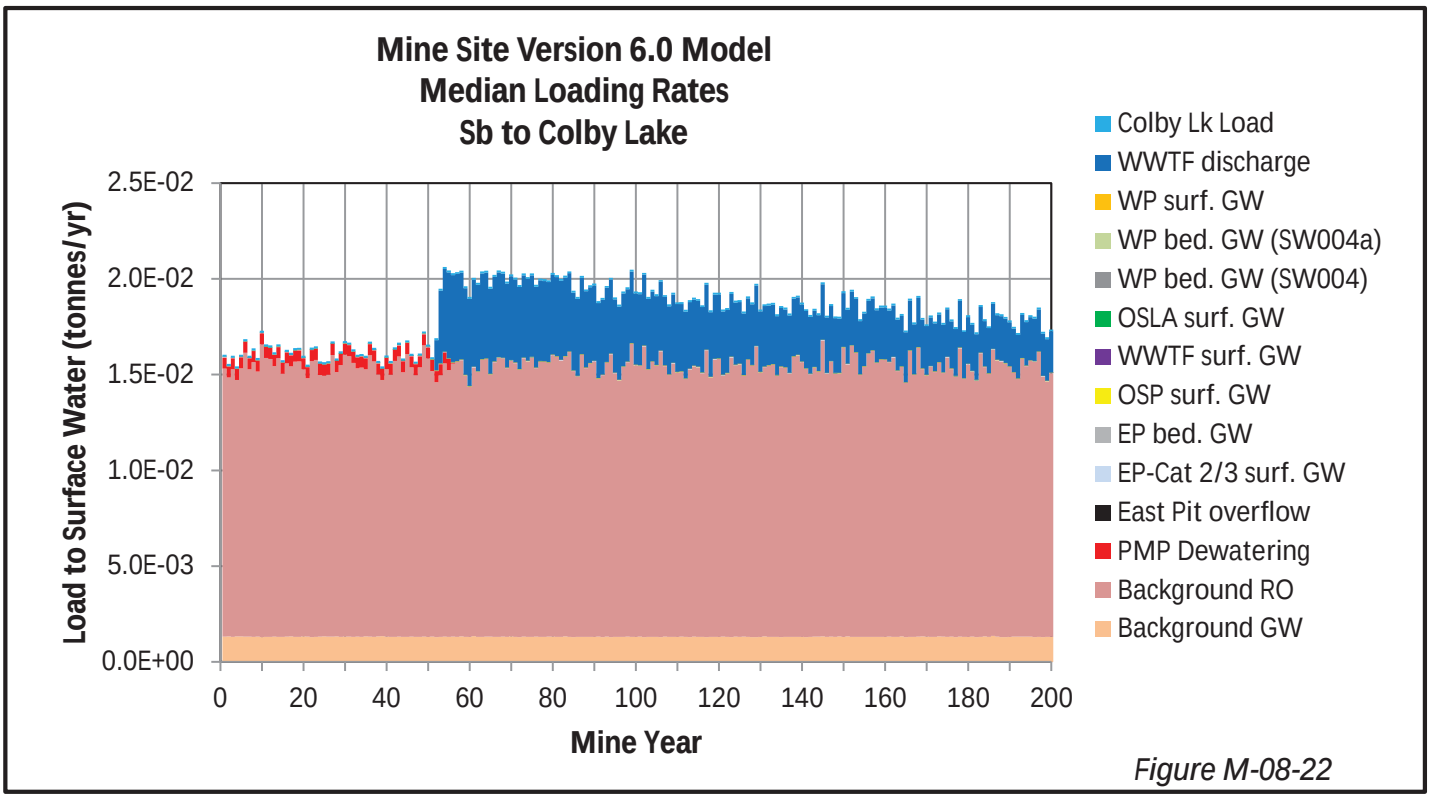

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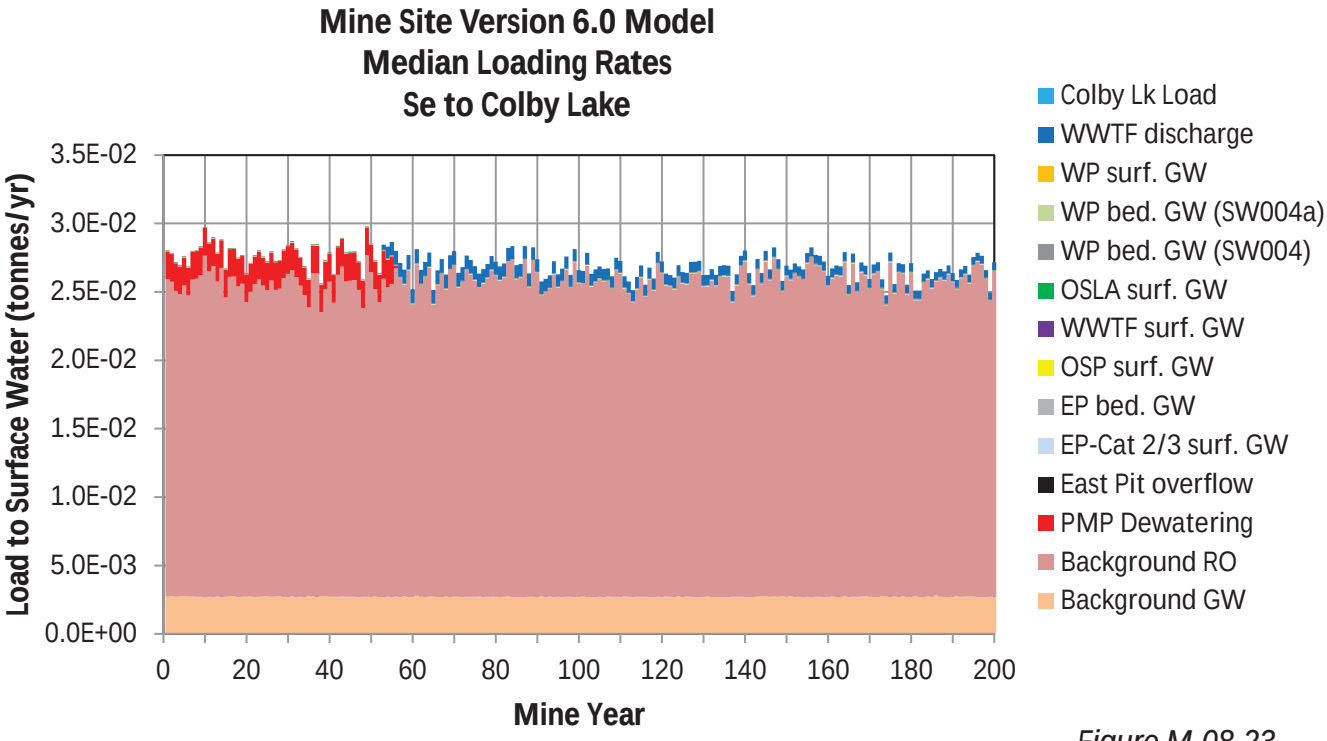

Figure M-08-23

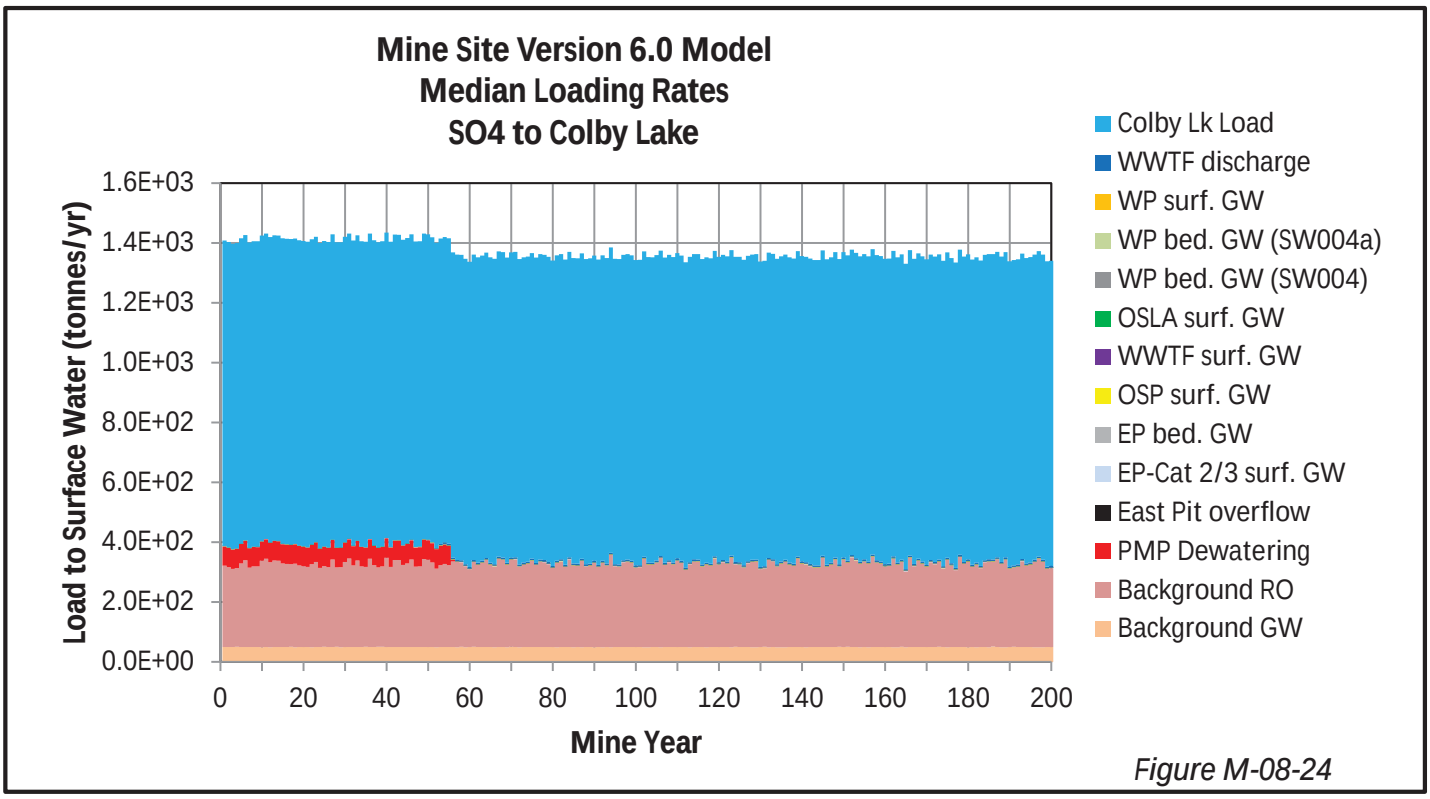

Figure M-08-24

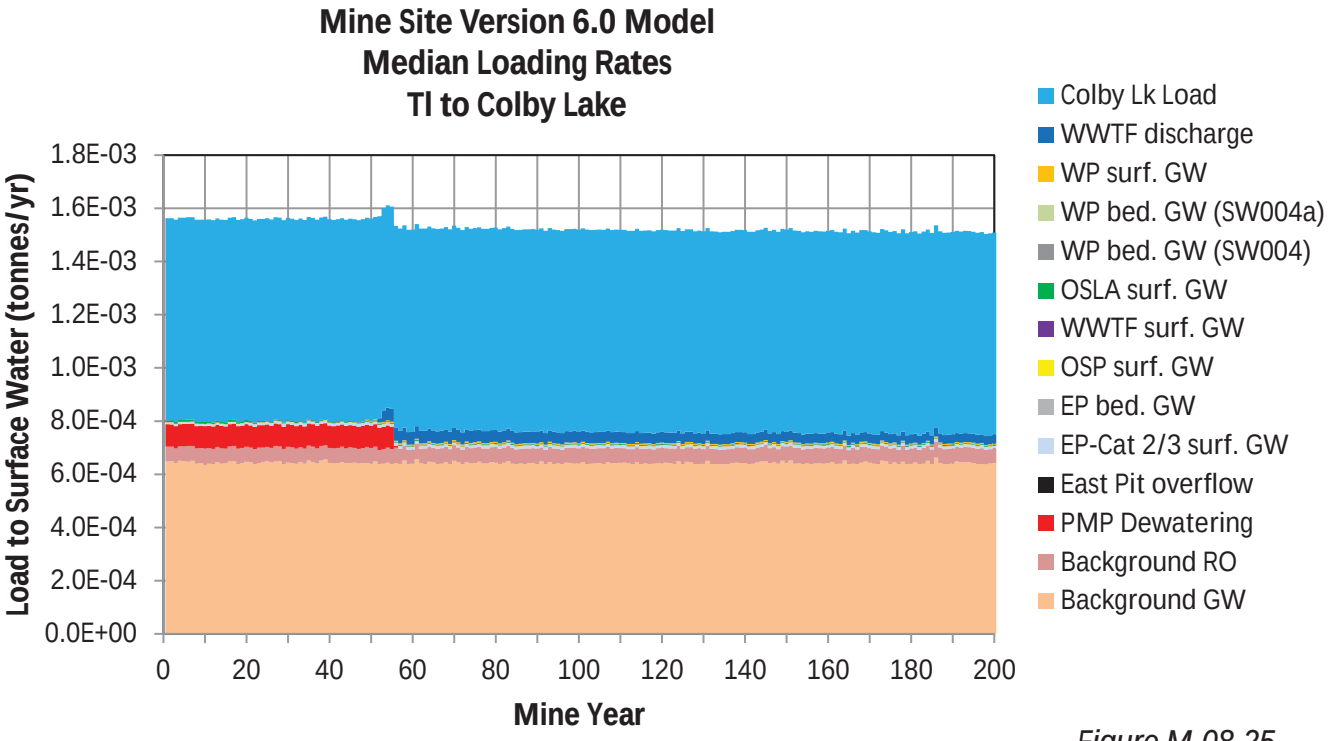

Figure M-08-25

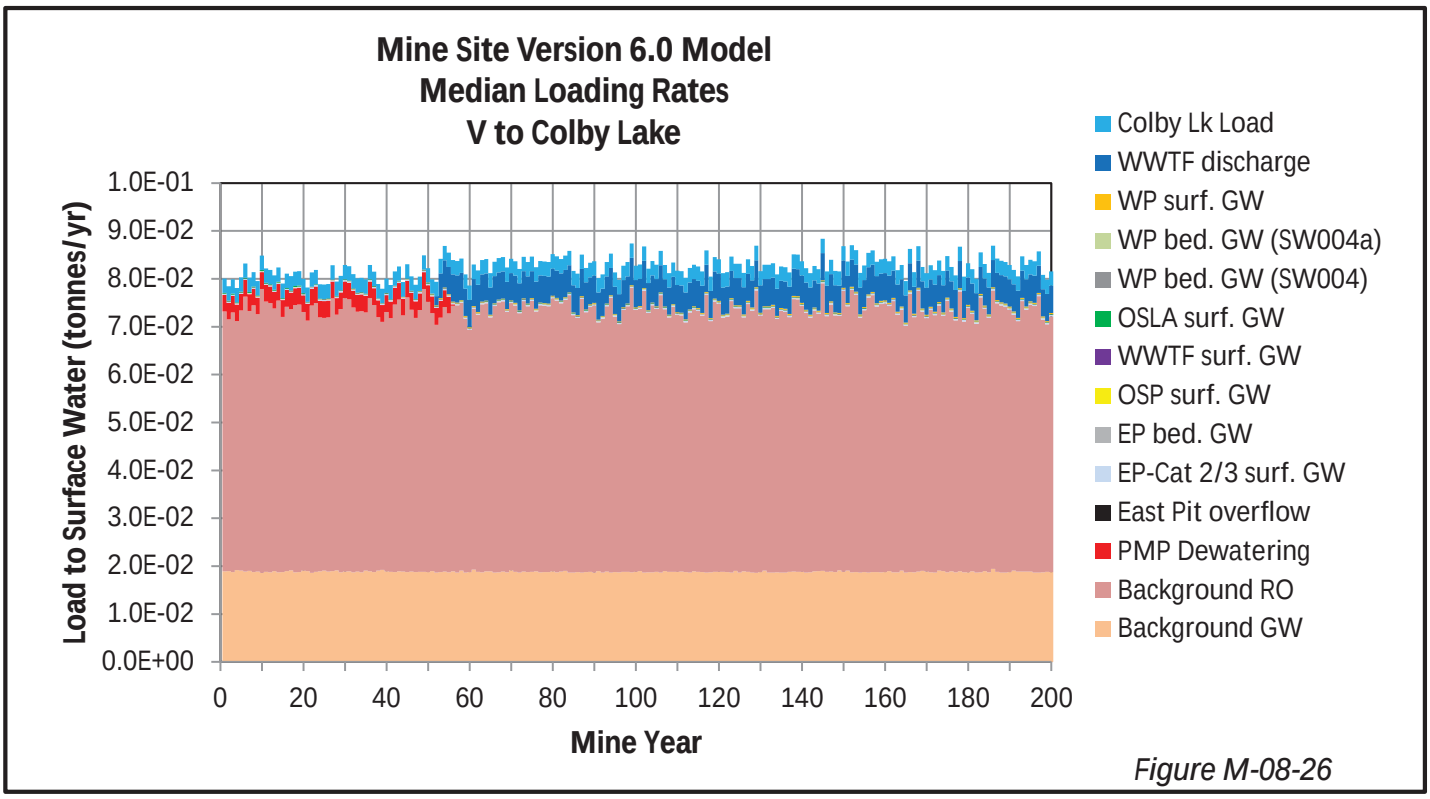

Figure M-08-26

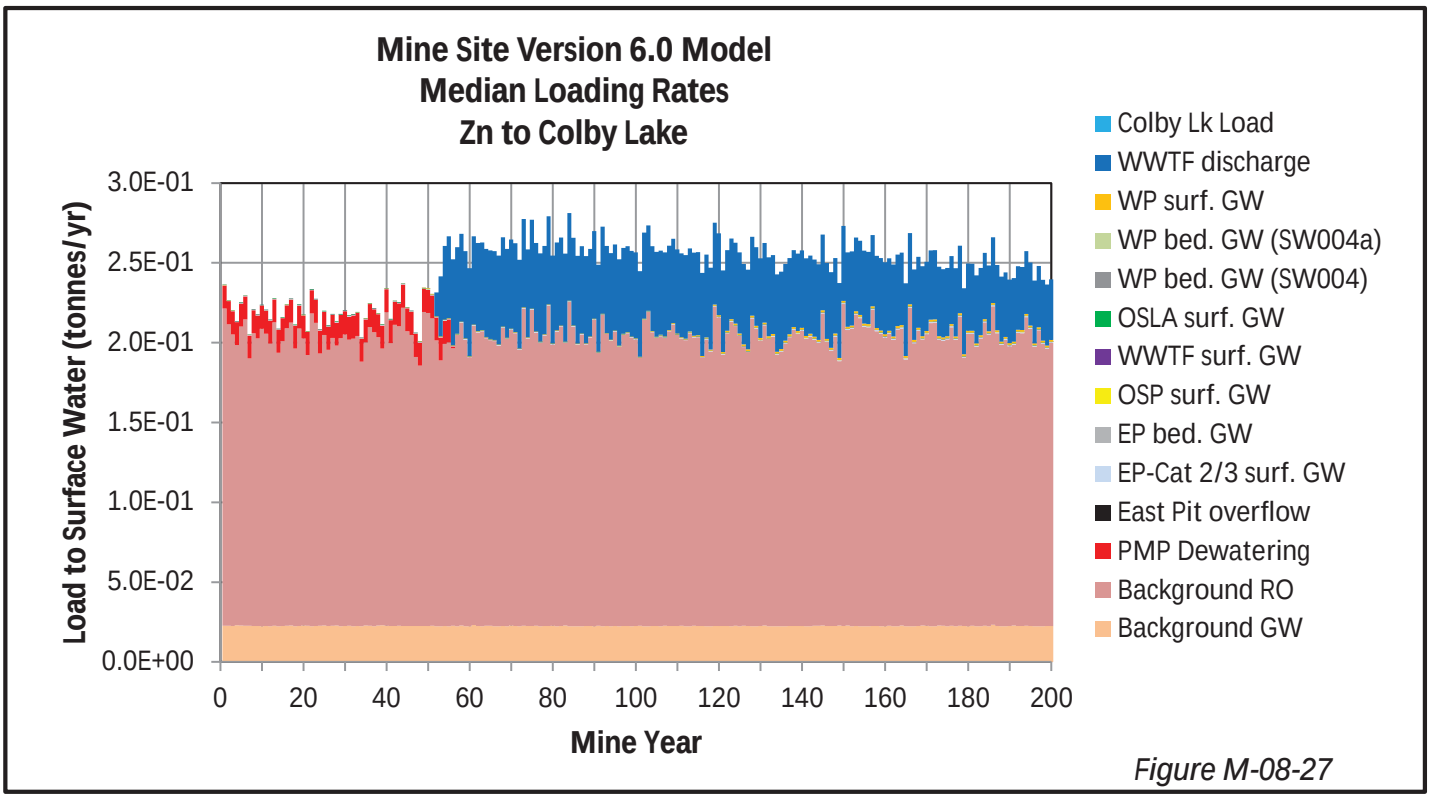

Figure M-08-27

Attachment N

Mine Site Water Quality Model Quality Assurance Project Plan (QAPP)

NorthMet Project

Mine Site Water Quality Model Quality Assurance Project Plan

Prepared by
Barr Engineering Company
On behalf of
PolyMet Mining, Inc.

Version 2

Issue Date: April 24, 2012

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1.0 Introduction

This document presents the Mine Site Water Quality Model Quality Assurance Project Plan (MSWQ-QAPP, or simply QAPP) for the water quality modeling presented in the Water Modeling Data Package Volume 1 – Mine Site (Reference (1)) and the NorthMet Mine Site Water Modeling Work Plan (Section 5.7 of Reference (2)). This QAPP follows the general guidance provided by EPA's Guidance for Quality Assurance Project Plans for Modeling (EPA QA/G-5M) as well as Barr Engineering Company's (Barr) Quality Management Plan, which was prepared in accordance to EPA QA/R-2.

1.1 Project Definition and Objectives

The primary objective of the probabilistic water quality model is to compare potential water quality impacts between project alternatives for the NorthMet Project (Project), in this case the No Action alternative and the Proposed Project alternative (also referred to as the Mine Site – Draft Alternative). This work is being conducted in support of the SDEIS for the Project. Details on the Project description are provided in Reference (3), and the model scenarios are documented in Section 3.4 of Reference (1). Water quality impacts are to be evaluated at specified locations within the surficial deposits and bedrock (Mine Site only), and in area streams. Locations for evaluation are presented in Reference (1) Section 5.5 (surface water) and Section 5.4.2 (groundwater).

The probabilistic water quality modeling for the Mine Site will be conducted using GoldSim Version 10.5, SP1 (GoldSim Technology Group, 2011). The selection of this modeling platform, including a discussion of modeling needs and other platforms considered, is included in Section 3.2 of Reference (1).

1.2 Background

The development of the of work plans for the water quality modeling covered by this QAPP has been a rigorous process lead by the Co-lead Agencies for the SDEIS. This process, referred to as the Impact Assessment Planning (IAP) process, involved the Co-lead Agencies and Cooperating Agencies, and included the formation of small technical teams to discuss details of the water quality modeling and associated impact criteria. These discussions, and the water modeling work plans and data packages that document the decisions made in these discussions, addressed the following topics:

- Identification of the problem, including types of model output and locations for evaluation;
- Peer review of theory and equations used in the modeling;
- Selection of modeling platform;
- Identification of input parameters needed for modeling
- Assessment of accuracy and appropriateness of input data for use in the modeling; and

- Definition of output data that should be provided from the model.

The work plans and associated data packages, which provide the documentation of assumptions, theory, parameterization and input data discussed during the IAP process, are subject to Co-lead Agency review and approval. These topics will not be discussed in detail in this QAPP. Instead, this QAPP focus on how the model will be reviewed and verified in order to help ensure that the model is constructed consistent with the approved work plans and performs as expected.

1.3 Project/Task Organization

Barr will be performing the modeling work covered in this QAPP under contract to PolyMet Mining, Inc. (PolyMet). SRK Consultants, also under contract to PolyMet, are providing technical oversight of geochemistry aspects of the modeling which is described in Reference (4). The modeling is being conducted under the direction of the SDEIS Co-lead Agencies: the US Army Corps of Engineers (USACE), the US Forest Service (USFS), and the Minnesota Department of Natural Resources (MDNR). The Co-lead Agencies may choose to include Cooperating Agencies, such as the U.S. Environmental Protection Agency (USEPA), the Fond du Lac Band of Lake Superior Chippewa, the Bois Forte Band of Chippewa, and the Grand Portage Band of Lake Superior Chippewa, as well as the EIS contractor, ERM. The Co-lead Agencies have developed a technical review team for the Mine Site Water Quality Model, consisting of representatives from the Co-lead Agencies, a Regulating Agency (Minnesota Pollution Control Agency (MPCA)) and select Cooperating Agencies.

1.4 Special Training Requirements

The work covered by this QAPP requires the modeling team to have training or experience in several specific areas, including:

- Groundwater flow and contaminant transport modeling;
- Surface water hydrology modeling;
- Aqueous geochemistry; and
- Probabilistic modeling.

All lead modelers executing this work have taken formal training on the use of the modeling platform being used (GoldSim) for probabilistic modeling (training provided by GoldSim Technology Group on September 28-30, 2010).

Model reviewers need to have a basic understanding of the above areas, and must have a working familiarity with GoldSim. GoldSim Technology Group and Barr Engineering have held two “Introduction to GoldSim Probabilistic Simulation Environment” training sessions for the Co-lead and Cooperating Agencies (September 28, 2010 and June 2, 2011).

2.0 Quality Assurance Procedures

2.1 Data Quality Objectives

Because the data needs for the model and sources of data used for model inputs were addressed as part of the IAP and work plan review processes, review of model performance is more appropriate than data quality objectives. This QAPP addresses model performance by focusing on model corroboration and evaluation of model outputs. Section 2.3 documents the peer reviews that will be conducted on the GoldSim model and other associated models. Section 2.4 documents model performance evaluation tests that will be conducted.

Input data used in the model do have limitations due to incompleteness, measurement error, representativeness, etc. These issues are addressed by using a probabilistic modeling approach, which uses explicit representations of uncertainty and variability in defining the distribution parameters for the model inputs. The distributions parameters were subjected to technical review during the IAP and work plan review processes.

2.2 Model Calibration

Portions of the GoldSim model will be calibrated; the MODFLOW model and XP-SWMM models, which provide data for use as input into the GoldSim model, will also be calibrated. Calibration of these models is discussed in the following locations:

- SP-SWMM – A detailed discussion of the calibration of the XP-SWMM Model is presented in the *Streamflow and Lake Level Changes, Model Calibration Report for the PolyMet NorthMet Mine Site, RS73A Draft-03* report. This calibration is summarized in 5.6.2 of Reference (1).
- MODFLOW – The calibration of the current conditions MODFLOW model is presented in Attachment B of Reference (1). This documentation includes a discussion of the calibration data set, the calibration objective, and calibration results, which include plots of simulated and observed heads.

Calibration of the GoldSim model consists of the adjustment of runoff chemistry and baseline groundwater concentrations for the surficial aquifer in the No Action model, so that there is an acceptable match between simulated and observed concentrations in the Partridge River (Section 5.3.2 of Reference (1)).

2.3 Model Peer Review

The GoldSim model will undergo internal peer review using the GoldSim Model Technical Review Checklist provided in Appendix A. This review will focus on a review of model inputs relative to proposed values provided in the approved work plans, consistency of model construction relative to Reference (3), and verification that model equations are consistent with documentation provided in Reference (2) and Reference (1).

The MODFLOW models of the Mine Site will undergo peer review using the MODFLOW Model Technical Review Checklist provided in Appendix A. The Mine Site MODFLOW model is used to estimate groundwater inflow rates to the mine pits during operation and closure.

The XP-SWMM model of the Partridge River watershed will undergo peer review using the XP-SWMM Model Technical Review Checklist provided in Appendix A. The XP-SWMM model is used to estimate hydrologic impacts to the Partridge River and provides estimates of streamflow at various locations along the Partridge River where no stream gage exists for use in the GoldSim model.

Each peer review will be conducted by Barr technical staff familiar with the model being reviewed (GoldSim, MODFLOW or XP-SWMM) and the Project, but not directly responsible for the construction of the models. Model review will be documented with the Model Technical Review Checklists, which will be provided with final model documentation.

2.4 Model Performance Evaluations

Model performance evaluation includes the quantitative and qualitative methods for evaluating the degree to which the model corresponds to reality. Several types of evaluations will be performed:

- Test cases – basic model runs where an analytical solution is available or an empirical solution is known to ensure that algorithms and computational processes are implemented correctly;
- Model check – either simple desktop calculation checks of model results or model mass balance checks;
- Sensitivity analysis; and
- Corroboration of model results with observations.

Several model performance evaluations have already been conducted or scoped through the IAP process. These evaluations are summarized below. Additional evaluations may be identified during the modeling process either as a result of the internal peer reviews of the model, or as a result of the Co-lead Agencies formal review of the model. All model performance evaluations that are performed will be documented with the submittal of the modeling results in Reference (1).

2.4.1 Test Case – Groundwater Transport

A test case will be developed to compare the simulation of contaminant flow and transport in groundwater using GoldSim relative to the industry standard groundwater modeling codes MODFLOW (Reference (5)) and MT3DMS (Reference (6)). This evaluation will be conducted using the Category 2/3 – East Pit surficial aquifer flow path. It should be noted

that the GoldSim flow path model used for this comparison will be "stand alone" and modified slightly from the full GoldSim model. Due to the way source loading is defined using MT3D (concentration is constant within a stress period), it would not be feasible to recreate the complex stockpile loading from the full GoldSim model, which can vary on a monthly basis. Therefore, a GoldSim model with simplified loading terms will be developed for comparison with the MDFLOW/MT3D model. For this test case, a MODFLOW/MT3DMS model will be constructed using the same assumptions as are being used in the GoldSim model, in terms of both aquifer characteristics (dimensions, hydraulic conductivity, etc.) and source loading (rate and concentration of stockpile liner leakage, East Pit outflow, and recharge). A comparison will be made between estimated concentrations at the groundwater evaluation locations between the GoldSim model and the MODFLOW/MT3DMS model. This test case will not test the appropriateness of the assumptions being made, but it will test whether the computational processes related to groundwater flow and contaminant transport are implemented correctly in the GoldSim model.

2.4.2 Model Check – Stream Hydrology

Results from the XP-SWMM model are used in conjunction with USGS gage data to define flow distributions for each month of the year for each location where a surface water quality parameter is modeled. For the most down-stream evaluation location on the Partridge River (SW-006) the resulting flow statistics from the GoldSim model will be compared to the flow statistics from the XP-SWMM model and USGS gage data. The flow statistics that will be included in this check include the median and average flows from each calendar month, and the median and average annual flows. The maximum and minimum flows from each model run will also be assessed to ensure they fall within the possible range as determined from the XP-SWMM/USGS gage input data. This model check will help to ensure that there have not been data entry errors for the associated model inputs, and that the stream flow calculations are being performed as expected in the GoldSim model. The GoldSim model results may not be checked against all hydrologic statistics (i.e., the Richter statistics) due to the incompatibility of the GoldSim model time step with several time-duration flow statistics. Several flow statistics will be checked by hand calculation to verify the accuracy of the Excel macro used to calculate the Richter statistics.

2.4.3 Model Check – Stockpile Mass Balance

The contaminant transport functions within the GoldSim software are designed to maintain a consistent mass balance throughout the calculation procedure. Constituent mass is not allowed to enter or leave the system unless a transport pathway is defined by the user. A mass balance check will be implemented for each of the waste rock stockpiles and the mine pits to verify this functionality. This model check will help to ensure that all inflows and outflows of constituent mass from each feature are properly accounted for and documented.

2.4.4 Model Check – Stockpile Hydrology

The stockpile hydrology calculations included in GoldSim maintain a water balance on each

stockpile. In this water balance, all precipitation over a stockpile is accounted for as evaporation/evapotranspiration, surface runoff, infiltration collected by the liner (or collection system in the case of the Category 1 Waste Rock Stockpile) and routed elsewhere, or leakage through the liner. No storage is assumed within the stockpile, consistent with the water quality modeling assumptions for the DEIS (and as described in Reference (1) Section 6.1.1.1). At randomly selected time-steps, the terms listed above will be summed for each stockpile and compared to the precipitation for that time-step to verify equivalence. The GoldSim model will also track the cumulative volume of water attributable to each of the above terms over each model run and compare that against the total precipitation volume.

2.4.5 Sensitivity Analysis – Baseline Groundwater Quality Surficial Aquifer

The Co-lead Agencies have requested that an evaluation be performed testing the sensitivity of the GoldSim model results to the surficial aquifer baseline groundwater quality input term. The scope of work for this sensitivity analysis in under review by the Co-lead Agencies, but is outlined below. The purpose of this sensitivity analysis is to address the question: what happens if average groundwater concentrations in the surficial aquifer at the Mine Site are higher than existing data suggests?

The probabilistic modeling results will be evaluated to determine the solute-evaluation location (groundwater or surface water) combinations where a standard has the highest probability of being exceeded for the Proposed Action. For each combination identified, the baseline surficial aquifer groundwater quality input parameter, referred to here as the *baseline gw input (solute n)*, will be set at a deterministic value, which will be incrementally increased until the probability that the standard in question will not be exceeded is equal to 90% (consistent with the impact criteria as defined by the Co-lead Agencies). The resulting concentration, referred to as the *maximum acceptable baseline gw input (solute n)*, represents the highest possible average baseline groundwater quality which would not result in an exceedance of a standard in more than 10% of model runs (and thus violate the impact criteria as defined by the Co-lead Agencies). This concentration can then be compared to existing data, both from the Mine Site and regionally.

2.4.6 Model Corroboration – Geochemistry Model of the AMAX Piles

The proposed modeling methodologies for the simulation of sulfate release from waste rock will be corroborated by simulating the AMAX stockpiles, and comparing model sulfate release to observed sulfate release in collected pile drainage. This evaluation will help corroborate the appropriateness of specific assumptions, including the assumed scaling factors (Section 8.3 Reference (4) and effects of acidification (Section 8.2 Reference (4)).

The AMAX field study was performed between 1978 and 1993 on Duluth Complex rock that is similar to the NorthMet Category 2/3 and Category 4 waste rock. The AMAX piles are characterized in terms of their size, sulfur content, particle size distribution, and continuously-monitored drainage quantity and chemistry. In addition, long term laboratory studies on the AMAX rock are ongoing. This combined field/laboratory data set provides an

ideal opportunity for verifying the proposed modeling methodology, which is based on NorthMet laboratory data and the expected characteristics of the NorthMet stockpiles.

3.0 Documentation

Reference (1) will document the data, model formulation and details, and assumptions used in the model. This document will also present the methods and results of the Model Peer Review and Model Corroboration steps from Section 2.3 and 2.4 above. Any deviations in the model design, construction, calibration, or input values will be documented. Results of the calibration of the GoldSim model (see Section 2.2) will be presented to the technical review team established by the Co-lead Agencies prior to proceeding with the modeling.

An annotated version of the GoldSim model will be provided to the Co-lead Agencies for their review. All reports will be internally peer reviewed for data accuracy prior to release. Reference (1), Reference (4) and the GoldSim model files will be posted to the project website. In addition, the model files from the MODFLOW model and the XP-SWMM model will be made available for review by the Co-lead Agencies.

Revision History

Date	Version	Description
11/7/2011	1	Initial release
4/24/2012	2	Updated based on agency comments on Version 1.

References

1. **PolyMet Mining, Inc.** NorthMet Project - Water Modeling Data Package, Volume 1 - Mine Site (v9). December 2011.

2. —. *NorthMet Mine Site Water Modeling Work Plan (v3).* 2011.

3. —. *NorthMet Project - Project Description (v3).* 2011.

4. —. NorthMet Project - Waste Characterization Data Package (v8). February 2012.

5. *User's Documentation for MODFLOW-96, an updated to the U.S. Geological Survey Modular Finite-Difference Ground-Water Flow Model.* **McDonald, M.G. and Harbaugh, A.W.** 1996, U.S. Geological Survey Open-File Report 96-485.

6. *MT3DMS: A Modular Three-Dimensional Multispecies Transport Model for Simulation of Advection, Dispersion, and Chemical Reactions of Contaminants in Groundwater Systems; Documentation and User's Guide.* **Zheng, C. and Wang, P.P.** 1999, U.S. Army Corps of Engineers Contract Report SERDP-99-1.

List of Appendices

Appendix A Model Technical Review Checklist

Appendix A

Model Technical Review Checklist

MODEL TECHNICAL REVIEW CHECKLIST

General - GoldSim

1. MODEL NAME:	**2. MODEL DATE:**
3. MODEL LOCATION:	
4. PROJECT NUMBER:	**5. PROJECT PIC:**
6. PRIMARY MODELER:	**7. REVIEWER:**
8. REVIEWER (<u>After</u> review is completed and all comments were resolved):	

printed name _____ concurrent signature _____ date _____

No.	Criteria	Comments/Notes
1	Do model input values match documented input values?	

Model Technical Review Checklist
General - GoldSim

No.	Criteria	Comments/Notes
2	Are model equations consistent with equations or conceptual model document in the Work Plan?	

MODEL TECHNICAL REVIEW CHECKLIST
MODFLOW

1. MODEL NAME:	**2. MODEL DATE:**
3. MODEL LOCATION:	
4. PROJECT NUMBER:	**5. PROJECT PIC:**
6. PRIMARY MODELER:	**7. REVIEWER:**
8. REVIEWER (<u>After</u> review is completed and all comments were resolved):	

printed name _____ concurrent signature _____ date _____

No.	Criteria	Comments/Notes
1	Is the choice of mathematical model appropriate (analytical/numerical)?	
2	Is the purpose of the model (i.e. the problem(s) the model is intended to evaluate) clearly defined?	
3	Is the spatial extent of the model appropriate?	

Model Technical Review Checklist
MODFLOW

4	In the number of model layers justified?	
5	Is the model discretization (planer) appropriate?	
6	Is steady state simulated?	
7	Is the stress period reasonable?	
8	Is the number of time steps per stress period justified?	
9	Are the applied boundary conditions plausible and unrestrictive?	
10	Are boundary condition locations consistent with the model grid configuration?	

Model Technical Review Checklist
MODFLOW

11	Are the initial conditions defensible?	
12	Do model input values match documented input values?	
13	Are the calibrated parameter distributions and ranges plausible?	
14	Is model mass balance error between -1% and 1%?	
15	Does the calibration statistic satisfy agreed performance criteria if specified, or industry standards if not specified?	
16	Are model predictions made at scales consistent with model space and time scales?	
17	Are model predictions plausible?	

Model Technical Review Checklist
MODFLOW

18	Are model predictions likely to be impacted by constraining boundary conditions?	
19	If boundary conditions affect the predictions, are the predictions defensible?	

MODEL TECHNICAL REVIEW CHECKLIST

XP-SWMM

1. MODEL NAME:	**2. MODEL DATE:**
3. MODEL LOCATION:	
4. PROJECT NUMBER:	**5. PROJECT PIC:**
6. PRIMARY MODELER:	**7. REVIEWER:**
8. REVIEWER (<u>After</u> review is completed and all comments were resolved):	

printed name _____ concurrent signature _____ date _____

No.	Criteria	Comments/Notes
1	Is runoff continuity error between -1% to 1%. If not correct or determine why & impacts? (Table R5)	
2	Does the Number of watersheds listed in the output file match Arc View?	
3	Does the Total watershed area listed in the output file match the total study area?	

Model Technical Review Checklist
XP-SWMM

4	Does the total rainfall amount listed in the output file match the rainfall amount for the storm frequency and duration that is being modeled?	
5	Are the rainfall dates contained within the Runoff simulation dates?	
6	Is the same rainfall global database being used for all the watersheds? (Table R2)	
7	Is the same runoff methodology being used for all the watersheds? (Table R2)	
8	Is the correct rainfall distribution being used for the simulated storm frequency & duration?	
9	Do the Infiltration inputs (global databases) seem reasonable including overland flow roughness and Horton/Green Ampt parameters (Table R2)	
10	Do the infiltration assumptions include water areas when appropriate (Zero % Detention)?	

Model Technical Review Checklist
XP-SWMM

11	Are there any flow redirections in the Runoff layer? Does redirected flow get added appropriately?	
12	Were correct units assumed during watershed data entry? (Table R1) (Area = ac, Percent Impervious = % (directly connected only), Width = ft, Slope = ft/ft	
13	Do peak watershed runoff rates seems reasonable when compared to "Rules of Thumb", Rational Method, Barr Method, etc? (Table R9)	
14	Does runoff volumes seems reasonable when compared to Barr Method, SCS method, etc? (Table R9)	
15	Have all warnings & errors been corrected prior to final simulation? (Error log prior to simulating the Hydraulics layer)	
16	Does the Hydraulics layer simulation dates span the Runoff simulation dates? If no correct.	
17	Is Hydraulics continuity error between -2% to 2% (Table E22). May be allowable as high as 5% but must be checked and explained.	

Model Technical Review Checklist
XP-SWMM

18	Are "Special Conduits" (Arches, Ellipses, etc) being modeled correctly by XP-SWMM? Check pipe cross sectional area against manufacturer information to make sure correct area is used. (Table E1)	
19	Have conduit minor losses (entrance/exit, other, expansion/contraction) been entered throughout the model? (Table E2)	
20	Has storage information been entered correctly (Depth = El - Node Inv El & area in acres)?	
21	Was Ponding Allowed used? Where & Why?	
22	Check weir parameters to make sure crown El results in weir surcharging only when appropriate.	
23	Check Orifice parameters.	
24	Check Pump curves	

25	Check User Inflow Hydrographs @ all node they are used	
26	Check user defined rating curves and weirs	
27	Are pipe flow & velocities reasonable? (Table E15)	
28	Is there any water being "Lost from the System"? Check for flooding/surcharge (Table E3B & E20). Lost water must be corrected	
29	Are the correct number of weirs, orifices, and pumps being used? (after Table E20)	
30	Is model simulation stable? (i.e., Are there any flow/elevation oscillations in any nodes/links that impact results?) If unstable the model must be corrected.	
31	Are most nodes converging? (Table E18 or E22) If not some model adjustments may be necessary	

Model Technical Review Checklist
XP-SWMM

32	Are there any open channels (Trapezoidal or Natural Sections) that overtop during the simulation that most be corrected? (Look for * in Table E10)	
33	Is storage being double counted by using channels and a storage node? If so this must be corrected?	
34	Does Hydraulic simulation extended long enough to capture all the peak flows/elevations?	
35	Have initial depths been entered to account for tailwater conditions and pond normal water levels?	
36	Are the correct boundary conditions being used? (Tailwater Elevations)	

Quality Assurance Procedure Implementation Records

Summary of Quality Assurance Procedure Tasks

Summary of Quality Assurance Procedure Tasks

QAPP Section	Description	Location
2.2	Documentation of XP-SWMM model calibration	*Streamflow and Lake Level Changes, Model Calibration Report for the PolyMet NorthMet Mine Site, RS73A Draft-03* , summarized in Mine Site Water Modeling Data Package Section 5.4.2.3
2.2	Documentation of MODFLOW model calibration	Mine Site Water Modeling Data Package, Attachment B
2.2	Documentation of GoldSim model calibration	Summarized in Mine Site Water Modeling Data Package Section 5.2.3.8 (Background Groundwater Quality) and 5.2.4.7 (Background Surface Runoff Quality)
2.3	GoldSim Model Technical Review Checklist	Following this table
2.3	MODFLOW Model Technical Review Checklist	Following this table
2.3	XP-SWMM Model Technical Review Checklist	Following this table
2.4.1	Test Case - Groundwater Transport	Included in "MODFLOW/GoldSim Results Comparison", Technical Memo from Jere Mohr and Cory Anderson (Barr Engineering), March 6, 2013
2.4.2	Model Check - Stream Hydrology	Included in "Verification of Mine Site QAPP Section 2.4.2 - Stream Hydrology", Technical Memo from Greg Williams to Peter Hinck and Tina Pint (Barr Engineering), March 5, 2013
2.4.3	Model Check - Stockpile Mass Balance	Included in "QAPP Sections 2.4.3 and 2.4.4 Verification", Technical Memo from Josiah Hawley to Peter Hinck and Tina Pint (Barr Engineering), December 29, 2014
2.4.4	Model Check - Stockpile Hydrology	
2.4.5	Sensitivity Analysis - Baseline Groundwater Quality Surficial Aquifer	Included in *Sensitivity Analysis of the NorthMet Water Quality Models* , Version 2 (separate submittal, pending January 2015)
2.4.6	Model Corroboration - AMAX Piles Geochemistry	Included in "Verification of NorthMet Project Model for the AMAX Piles," Technical Memo from Peter Hinck (Barr Engineering) and Stephen Day (SRK) to Jim Scott (PolyMet), October 13, 2011

Mine Site GoldSim Model Revision Tracking Log

MINE SITE GOLDSIM MODEL
REVISION TRACKING LOG
v5.0 - v6.0

Item	Date	Model / Version	Problem / Issue	Change (changes affecting input tables in BOLD)	Updated Model Version
41	9/30/2014	MS V5.0	Updates needed based on updated background water quality data	Background groundwater quality distributions (**Table 1-12**) updated. Hardness for evaluating standards at SW004 and SW004a (**Table 1-17**) updated. Partridge River initial concentrations (**Table 1-14**) updated.	MS V6.0
42	10/6/2014	MS V5.0	Long-term WWTF arsenic target changed during SDEIS model results review process.	Arsenic target in **Table 1-34** updated	MS V6.0
43	10/17/2014	MS V5.0	Release rate updates needed for constituents with detailed non-detects analysis.	Release rates for Cat1, Cat 2/3, and Cat 4DC updated for several constituents (**Tables 1-24 through 1-26**).	MS V6.0
44	10/22/2014	MS V5.0	West Pit surficial flowpath calculations incorrectly limiting the range of K values allowed	Changed equations in WP_K_min and WP_K_max to reference WP_Ops_Grad rather than WP_Clos_Grad	MS V6.0
45	10/22/2014	MS V5.0	Discharge from Peter Mitchell Pit (Northshore Mine) recalibrated based on updated data and methodology. Discharge to end at approximately year 2070.	Flow_PMP changed to 2.6 cfs (from 1 cfs) based on Co-Lead recommendation, updated in surface water calibration model as well. Flow_PMP_end added to model, set to Mine Year 55. Beyond this elapsed time, flow from Peter Mitchell Pit not allowed. Selectors added to Project and NoAction Partridge River models to turn off PMP flow.	MS V6.0
46	10/22/2014	MS V5.0	Partridge River model is not correctly holding back groundwater flow and load duing below-baseflow periods in the river. Flow from flow paths is reduced, but spike in concentration in mixing cells results in no decrease in load (as intended).	Routines added to Project and NoAction models to calculate volume of groundwater flow that is "held back" from each river node and store the flow in a reservoir element. When flow next exceeds baseflow, the stored water is released to the river as much as possible, displacing what would otherwise be surface runoff above the baseflow level. For Project model, held back water is divided between unimpacted groundwater (modeled the same as for the NoAction model) and flow path groundwater (modeled with Contaminant Transport elements). Volume of mixing cells just upstream of the river is adjusted dynamically to represent the volume of "held back" water and maintain a more-constant concentration, thereby reducing loading during low-flow periods as intended.	MS V6.0
47	11/17/2014	MS V5.0	Updates based on recalibrated Mine Site MODFLOW model	Flow path gradient and conductivity distributions (**Table 1-15**) updated. Mine pit inflows (**Table 1-22a and 1-22b**) updated.	MS V6.0

MINE SITE GOLDSIM MODEL
REVISION TRACKING LOG
v5.0 - v6.0

Item	Date	Model / Version	Problem / Issue	Change (changes affecting input tables in BOLD)	Updated Model Version
48	12/1/2014	MS V5.0	Updated MODFLOW modeling of Category 1 Waste Rock Stockpile Containment System shows small amount of leakage to East Pit and to deep bedrock.	Value of Cat1SP_Leak_WP updated based on modeling. New inputs C**at1SP_Leak_EP and Cat1SP_Leak_Bed added to Table 1-5**. New outflows added to Cat 1 water balance (\Stockpile_Models\Cat1SP_Model\Cat1SP_WaterBal\Cat1SP_Infilt_Split) and mass balance (\Stockpile_Models\Cat1SP_Model\Cat1SP_MassBal\Cat1SP_water_mixed) to send flow and load to East Pit sump and West Pit bedrock flowpaths. Stockpile mass balance check (\Stockpile_Models\Cat1SP_Model\Cat1SP_BalCheck) updated accordingly. New seepage term to East PIt added to \Pit_Models\EastPit_Model\EP_WaterBal\EP_Other_Inflows\Stockpile_Seep_to_EP, East Pit mass balance check updated.	MS V6.0
49	12/4/2014	MS V5.0	Calibration requested by Co-leads to average Colby Lake water quality.	New model input **SW_Conc.Load_Colby added to Table 1-13**. Load term added to Project and No-Action models: \Partridge_River_Models\Partridge_NoAction_Model\Partridge_Flows_Loads\Partridge_Loads\Nat_River_Load_NoAct and \Partridge_River_Models\Partridge_NorthMet_Model\Partridge_Flows_Loads\Partridge_Loads\Nat_River_Load	MS V6.0
50	12/6/2014	MS V5.0	Surface runoff concentrations are incorrectly only re-sampling values once per realization	All stochastic elements in \Input_Data\Background_Chem\SW_RO_Random set to resample every timestep (On Changed "Etime").	MS V6.0
51	12/6/2014	MS V5.0	Co-lead Agency direction to model bedrock flowpaths as 15 meter thickness	\Input_Data\Flowpaths\Thick vectore updated for corresponding flowpaths.	MS V6.0
52	12/6/2014	MS V5.0	Reduced volume of flow from Plant Site in closure extends West Pit flooding time and requires model logic changes to minimize time to flood pit.	\Input_Data\Pit_Hydrology\TP_Stop_Vol set to 50,000 acre-ft (reduced from 60,000 acre-ft). Logic in \Pit_Models\WestPit_Model\WP_WaterBal\WP_Treat_Flows\TP_toWP_Active changed to continue flow from Plant Site beyond TP_Stop_Elev as long as East Pit treatment ("WWTF_Reclamation")is not active. Input values from Plant Site model updated with current Plant Site results (**Tables 1-35 through 1-40**). Stream flow parameters adjusted to account for approximate West Pit discharge beginning in Mine Year 50 (**Tables 1-18, 1-20 and 1-21**).	MS V6.0

MINE SITE GOLDSIM MODEL
REVISION TRACKING LOG
v5.0 - v6.0

Item	Date	Model / Version	Problem / Issue	Change (changes affecting input tables in BOLD)	Updated Model Version
53	12/11/2014	MS V5.0	Surface runoff calibration target and Peter Mitchell concetration data source changed based on Agency review of preliminary results.	Peter Mitchell Pit concentrations, calibrated surface runoff distributions, and Colby Lake loading terms updated (**Table 1-13**)	MS V6.0
54	12/15/2014	MS V5.0	East Pit sump mixing cell experiences a spike in concentration between beginning of backfilling and development of the Central Pit.	Loading logic edited so that all load to the sump from this period (Mine Years 10.5-10.75) is transferred to the EPCP_PoreLower mixing cell. Model elements Backfill_Begins and EPCP_Sump_to_EPCPPoreLower added.	MS V6.0

Model Technical Review Checklist – GoldSim

MODEL TECHNICAL REVIEW CHECKLIST

General - GoldSim

1. MODEL NAME:	**NorthMet_MineSite_Base_v06.0_GOLDSIM_10.5.gsm**	**2. MODEL DATE:**	22-Dec-14
3. MODEL LOCATION:	**P:\Mpls\23 MN\69\2369862\WorkFiles\APA\Support Docs\Surface WQ\Workfiles\Models\GoldSim\Mine Site\2014 FEIS MODEL\Base Model**		
4. PROJECT NUMBER:	**23/69-0862.00 042 008**	**5. PROJECT PIC:**	**CDP**
6. PRIMARY MODELER:	**PJH2**	**7. REVIEWER:**	**CDA**

8. REVIEWER (<u>After</u> review is completed and all comments were resolved):

Cory Anderson	Cory Anderson	12/29/2014
printed name	concurrent signature	date

No.	Criteria	Comments/Notes
1	Do model input values match documented input values?	See attached memo from Cory Anderson, dated December 23, 2014, and attached annotated Table 1-1 and other input tables with edits. PJH2 reviewed the memo and input tables and made the necessary documentation corrections in input tables and the model file. All but one comment was resolved without a change to the model inputs. Upon review of the memo and input tables PJH2 identifed that the release rates for Tl, V, and Zn were incorrect on Table 1-24. The input table was corrected by PJH2 on 12/26/14 and the GoldSim model re-run. This correction required re-running the Plant Site model and Mine Site model several times in series until the transferred concentrations stabilized, which was performed 12/26/14 and the Plant Site input tables (1-35 through 1-40) were updated.
2	Are model equations consistent with equations or conceptual model document in the Work Plan?	See attached memo from Cory Anderson, dated December 23, 2014.

resourceful. naturally.
engineering and environmental consultants

BARR

Internal
Memorandum

To: Project File
From: Cory Anderson
Subject: Mine Site GoldSim Water Quality Model QA/QC
Date: December 23, 2014
Project: 23690862.00

Cory Anderson was asked to perform a QA/QC check of the inputs to the Mine Site GoldSim model. He was given the model (file name "NorthMet_MineSite_Base_v06.0_GOLDSIM_10.5.gsm", dated 12/22/2014 at 6:51 pm) from the folder "P:\Mpls\23 MN\69\2369862\WorkFiles\APA\Support Docs\Surface WQ\Workfiles\Models\GoldSim\Mine Site\2014 FEIS MODEL\Base Model". The model has been previously reviewed extensively. For this round of review only the inputs that had changed since the previous model review were reviewed, assuming that all other inputs were left alone and had been previously checked and discrepancies had been previously addressed. The issues found during the model review were primarily related to descriptions of the input variables. After discussions about the model, we found that the inputs in the model were correct and that the tables describing the inputs were not fully updated. I believe there are no issues with the model inputs variables.

Cory's review comments in the primary input table (Table 1-1), checks of the other necessary tables, and responses or corrections from Peter Hinck are documented in the attached annotated Table 1-1.

An additional external peer review of the GoldSim model, including all inputs and multiple calculations within the model file itself, was performed by ERM and submitted to the Co-lead Agencies in several phases. The final comprehensive review document ("NorthMet Mining Project GoldSim Water Quality Model – Phase 3 Quality Assurance", February 25, 2013) is attached. The model that was reviewed by ERM in 2013 was the model modified to create the model reviewed and discussed here. Therefore, this same extensive review of the model itself was not redone. The model will be reviewed again, however, by ERM to ensure that the few and minor changes to the model construction are understood and were complete and accurate.

Table 1-1 Input Variables for the Mine Site Model

Reviewed by CDA, 12/23/14

Variable Name	Units	Deterministic/ Uncertain	Sampling/ Calculation Frequency	Distribution	Mean or Mode	Standard Deviation	Minimum	Maximum	Description	Source of Input Data	Modeling Package Section
Grey cells indicate changes from the previously published version											
Water Quality Standards											
Ground_Standards	[mg/L]	Deterministic	N/A	Constant	Vector by Constituent. Reference Table 1-2				Primary and secondary groundwater quality standards applicable to the project	MN Rules 7050 and 4717	Water Section 2.1 MN GW Standards
Surface_Standards	[mg/L]	Deterministic	N/A	Constant	Vector by Constituent. Reference Table 1-3				Constant surface water quality standards applicable to the project	MN Rules 7050 and 7052	Water Section 2.2 MN SW Standards
Hardness_Coefficients	[-]	Deterministic	N/A	Constant	Vector by Constituent. Reference Table 1-4				Hardness-dependent surface water quality standards applicable to the project	MN Rules 7050 and 7052	Water Section 2.2 MN SW Standards
Wild_Rice_Sulfate	[mg/L]	Deterministic	N/A	Constant	10	N/A	N/A	N/A	Seasonal sulfate standard in wild rice waters	MN Rules 7050	Water Section 2.3 WW Rice Standard
Wild_Rice_Locs	[-]	Deterministic	N/A	Constant	Vector by location. Reference Table 1-17				Locations where the wild rice standard applies	MPCA staff guidance	Water Section 2.3 Wild Rice Standard
Hardness_RefStandard	[mg/L]	Deterministic	N/A	Constant	Vector by location. Reference Table 1-17				Hardness used to evaluate hardness-dependent standards, if other than modeled	MPCA staff guidance	Water Section 2.2 MN SW Standards
"--" used in table, "-1" used in Goldsim to represent no standard.											
General Engineering Variables											
Closure_Year	[yr]	Deterministic	N/A	Constant	20	N/A	N/A	N/A	Year after mining when operations cease and closure begins	Project Description	Water Section 5.1 Conceptual Model
Ore_Processing_Rate	[tons/day]	Deterministic	N/A	Constant	30,800	N/A	N/A	N/A	Mine rate of ore production and transfer to Plant Site	Project Description	Water Section 5.1 Conceptual Model
Ore_Storage_Time	[years]	Uncertain	Realization	Uniform	N/A	N/A	1	6	Length of time that any unit of ore is stored in in-pit stockpiles	Assumed	Waste Section 10.6.3.1 Ore Leaching Load
Category 3 Waste Rock Stockpile Characteristics											
Cat3SP_Mass	[ton]	Deterministic	Timestep	Time Series	Imported from worksheet. Reference Table 1-5				Mass of waste rock in stockpile from Mine Plan	Rock/OB Management Plan	Water Section 5.1 Conceptual Model
Cat3SP_Bare_Geomem	[acre]	Deterministic	Timestep	Time Series	Imported from worksheet. Reference Table 1-5				Bare area of stockpile if geomembrane installed	AWMP Section 3 (pending)	AWMP Section 3 (pending)
Cat3SP_Reclaim_Geomem	[acre]	Deterministic	Timestep	Time Series	Imported from worksheet. Reference Table 1-5				Reclaimed area of stockpile if geomembrane installed, begins at end of mining	AWMP Section 3 (pending)	AWMP Section 3 (pending)
Cat3SP_RO_EP	[acre]	Deterministic	N/A	Constant	0	N/A	N/A	N/A	Area with runoff directed to the East Pit during pit flooding	AP3WRM Model GIS analysis	Water Section 5.1 Conceptual Model
Cat3SP_RO_WP	[acre]	Deterministic	N/A	Constant	279	N/A	N/A	N/A	Area with runoff directed to the West Pit during pit flooding	AP3WRM Model GIS analysis	Water Section 5.1 Conceptual Model
Cat3SP_Contain_EP	[acre]	Deterministic	N/A	Time Series	Imported from worksheet. Reference Table 1-5				Area with contained seepage that is directed to the East Pit	Rock/OB Management Plan	Water Section 4.1.2.1 Active Waste Rock and Ore Stockpiles
Cat3SP_Contain_WP_Extend	[acre]	Deterministic	N/A	Time Series	Imported from worksheet. Reference Table 1-5b				Area with contained seepage that is directed to the West Pit, extended to include entire footprint	AWMP Section 3 (pending)	AWMP Section 3 (pending)
Cat3SP_Sulfur	[%S]	Deterministic	N/A	Constant	0.063	N/A	N/A	N/A	Mass-weighted average sulfur content of stockpile	Block Model	Waste Section 4.3.2 Sulfur Content

Table 1-1 **Input Variables for the Mine Site Model**

Variable Name	Units	Deterministic/ Uncertain	Sampling/ Calculation Frequency	Distribution	Mean or Mode	Standard Deviation	Minimum	Maximum	Description	Source of Input Data	Modeling Package Section
Grey cells indicate changes from the previously published version											
Category 2/3 Waste Rock Stockpile Characteristics											
Cat23SP_Mass	[ton]	Deterministic	Timestep	Time Series	Imported from worksheet: Reference Table 1-6				Mass of waste rock in stockpile from Mine Plan	Rock/OB Management Plan	Water Section 5.1 *Conceptual Model*
Cat23SP_SatOB	[yd³]	Deterministic	Timestep	Time Series	Imported from worksheet: Reference Table 1-6				Volume of saturated overburden in stockpile from Mine Plan	Rock/OB Management Plan	Water Section 5.1 *Conceptual Model*
Cat23SP_Bare	[acre]	Deterministic	Timestep	Time Series	Imported from worksheet: Reference Table 1-6				Bare area of stockpile from Mine Plan	Rock/OB Management Plan	Water Section 5.1 *Conceptual Model*
Cat23SP_Sulfur	[%S]	Deterministic	N/A	Constant	0.21	N/A	N/A	N/A	Mass-weighted average sulfur content of stockpile	Block Model	Waste Section 4.3.2 *Sulfur Content*
Category 4 Waste Rock Stockpile Characteristics											
Cat4SP_MassDC	[ton]	Deterministic	Timestep	Time Series	Imported from worksheet: Reference Table 1-7				Mass of Duluth Complex waste rock in stockpile from Mine Plan	Rock/OB Management Plan	Water Section 5.1 *Conceptual Model*
Cat4SP_MassVF	[ton]	Deterministic	Timestep	Time Series	Imported from worksheet: Reference Table 1-7				Mass of Virginia Formation waste rock in stockpile from Mine Plan	Rock/OB Management Plan	Water Section 5.1 *Conceptual Model*
Cat4SP_SatOB	[yd³]	Deterministic	Timestep	Time Series	Imported from worksheet: Reference Table 1-7				Volume of saturated overburden in stockpile from Mine Plan	Rock/OB Management Plan	Water Section 5.1 *Conceptual Model*
Cat4SP_Bare	[acre]	Deterministic	Timestep	Time Series	Imported from worksheet: Reference Table 1-7				Bare area of stockpile from Mine Plan	Rock/OB Management Plan	Water Section 5.1 *Conceptual Model*
Ore Surge Pile											
OSP_Mass	[ton]	Deterministic	Timestep	Time Series	Imported from worksheet: Reference Table 1-8				Mass in the OSP from Mine Plan	Rock/OB Management Plan	Water Section 5.1 *Conceptual Model*
OSP_Bare	[acre]	Deterministic	Timestep	Time Series	Imported from worksheet: Reference Table 1-8				Bare area of the OSP from Mine Plan	Rock/OB Management Plan	Water Section 5.1 *Conceptual Model*
OSP_Sulfur	[%S]	Deterministic	N/A	Constant	0.408	N/A	N/A	N/A	Mass-weighted average sulfur content of stockpile	Block Model	Waste Section 4.3.2 *Sulfur Content*
Overburden Storage and Laydown Area Characteristics											
UnsatOB_Bare	[acre]	Deterministic	Timestep	Constant	22.4	N/A	N/A	N/A	Area of unsaturated overburden in the OSLA, assumed to be half of the total area	Rock/OB Management Plan	Water Section 5.1 *Conceptual Model*
Peat_Bare	[acre]	Deterministic	Timestep	Constant	22.4	N/A	N/A	N/A	Area of peat in the OSLA, assumed to be half of the total area	Rock/OB Management Plan	Water Section 5.1 *Conceptual Model*

Table 1-1 **Input Variables for the Mine Site Model**

Variable Name	*Units*	*Deterministic/ Uncertain*	*Sampling/ Calculation Frequency*	*Distribution*	*Mean or Mode*	*Standard Deviation*	*Minimum*	*Maximum*	*Description*	*Source of Input Data*	*Modeling Package Section*
Grey cells indicate changes from the previously published version											
East Pit Characteristics											
EP_Elev_to_Volume	[ft^3]	Deterministic	N/A	Lookup	Imported from worksheet. Reference Figure 1-1				Volume of final pit shell as a function of elevation	Mine Plan	Water Section 5.1 *Conceptual Model*
EP_Volume_to_Elev	[ft]	Deterministic	N/A	Lookup	Imported from worksheet. Reference Figure 1-1				Water surface elevation as a function of volume of final pit shell (inverse of Elev_to_Volume)	Mine Plan	Water Section 5.1 *Conceptual Model*
EP_Elev_to_PlanArea	[ft^2]	Deterministic	N/A	Lookup	Imported from worksheet. Reference Figure 1-2				Plan view area of final pit shell as a function of elevation	Mine Plan	Water Section 5.1 *Conceptual Model*
EP_Footprint_Area	[acre]	Deterministic	N/A	Constant	154.7	N/A	N/A	N/A	Area contributing runoff during operations	Mine Plan	Water Section 5.1 *Conceptual Model*
EP_Min_Elev	[ft]	Deterministic	N/A	Constant	920	N/A	N/A	N/A	Minimum elevation in the East Pit	Mine Plan	Water Section 5.1 *Conceptual Model*
EP_Water_Limit_Elev	[ft]	Deterministic	N/A	Constant	1260	N/A	N/A	N/A	Limiting elevation for backfill flooding in the EP during CP mining	Mine Plan	Water Section 5.1 *Conceptual Model*
EP_BlastOre_Mass	[ton]	Deterministic	Timestep	Time Series	Imported from worksheet. Reference Table 1-9				Blasted inventory of ore in pit awaiting removal	Mine Plan	Water Section 5.1 *Conceptual Model*
Central Pit Characteristics											
CP_Elev_to_Volume	[ft^3]	Deterministic	N/A	Lookup	Imported from worksheet. Reference Figure 1-1				Volume of final pit shell as a function of elevation	Mine Plan	Water Section 5.1 *Conceptual Model*
CP_Volume_to_Elev	[ft]	Deterministic	N/A	Lookup	Imported from worksheet. Reference Figure 1-1				Water surface elevation as a function of volume of final pit shell (inverse of Elev_to_Volume)	Mine Plan	Water Section 5.1 *Conceptual Model*
CP_Elev_to_PlanArea	[ft^2]	Deterministic	N/A	Lookup	Imported from worksheet. Reference Figure 1-2				Plan view area of final pit shell as a function of elevation	Mine Plan	Water Section 5.1 *Conceptual Model*
CP_Footprint_Area	[acre]	Deterministic	N/A	Constant	51.9	N/A	N/A	N/A	Area contributing runoff during operations, only applies after CP_Mine_Start	Mine Plan	Water Section 5.1 *Conceptual Model*
CP_Min_Elev	[ft]	Deterministic	N/A	Constant	1260	N/A	N/A	N/A	Minimum elevation in the Central Pit	Mine Plan	Water Section 5.1 *Conceptual Model*
CP_Max_Elev	[ft]	Deterministic	N/A	Constant	1420	N/A	N/A	N/A	Maximum elevation of the pit, point where EP/CP combine	Mine Plan	Water Section 5.1 *Conceptual Model*
CP_Mine_Start	[yr]	Deterministic	N/A	Constant	10.75	N/A	N/A	N/A	Mine year that mining in the Central Pit begins	Mine Plan	Water Section 5.1 *Conceptual Model*
CP_Mine_End	[yr]	Deterministic	N/A	Constant	15.25	N/A	N/A	N/A	Mine year that mining in the Central Pit is complete	Mine Plan	Water Section 5.1 *Conceptual Model*

Table 1-1 **Input Variables for the Mine Site Model**

Variable Name	Units	Deterministic/ Uncertain	Sampling/ Calculation Frequency	Distribution	Mean or Mode	Standard Deviation	Minimum	Maximum	Description	Source of Input Data	Modeling Package Section
Grey cells indicate changes from the previously published version											
Combined East/Central Pit Characteristics											
EPCP_Elev_to_Volume	[ft³]	Deterministic	N/A	Lookup	Imported from worksheet. Reference Figure 1-1				Volume of final pit shell as a function of elevation	Mine Plan	Water Section 5.1 *Conceptual Model*
EPCP_Volume_to_Elev	[ft]	Deterministic	N/A	Lookup	Imported from worksheet. Reference Figure 1-1				Water surface elevation as a function of volume of final pit shell (inverse of Elev_to_Volume)	Mine Plan	Water Section 5.1 *Conceptual Model*
EPCP_Elev_to_PlanArea	[ft²]	Deterministic	N/A	Lookup	Imported from worksheet. Reference Figure 1-2				Plan view area of final pit shell as a function of elevation	Mine Plan	Water Section 5.1 *Conceptual Model*
EPCP_Sump_Area	[ft²]	Deterministic	N/A	Constant	1,000	N/A	N/A	N/A	Water surface area in the sump	Assumed value	Water Section 6.1.3.3 *Water Balance, Mine Pits*
EPCP_Sump_Volume	[ft³]	Deterministic	N/A	Constant	10,000	N/A	N/A	N/A	Volume of the sump, assumed to be always full	Assumed value	Water Section 6.1.3.3 *Water Balance, Mine Pits*
EPCP_Elev_to_WallFrac	[%]	Deterministic	N/A	Lookup	Vector by category, imported from worksheet. Reference Figure 1-3a				Fraction of each rock category in wall rock in final pit shell as a function of elevation	Mine Plan	Water Section 5.1 *Conceptual Model*; Waste Section 4.3.2 *Sulfur Content*
EPCP_Elev_to_WallArea	[ft²]	Deterministic	N/A	Lookup	Imported from worksheet. Reference Figure 1-4				Plan view area of wall rock in final pit shell as a function of elevation	Mine Plan	Water Section 5.1 *Conceptual Model*; Waste Section 4.3.2 *Sulfur Content*
EPCP_Elev_to_SetBackArea	[ft²]	Deterministic	N/A	Lookup	Imported from worksheet. Reference Figure 1-4				Plan view area of pit rim set back above final pit shell as a function of elevation	Mine Plan	Water Section 5.1 *Conceptual Model*; Waste Section 4.3.2 *Sulfur Content*
EPCP_SetBack_Elev	[ft]	Deterministic	N/A	Constant	1174	N/A	N/A	N/A	Lowest elevation of the pit rim set back	Mine Plan	Water Section 5.1 *Conceptual Model*; Waste Section 4.3.2 *Sulfur Content*
EPCP_Elev_to_Sulfur	[%]	Deterministic	N/A	Lookup	Vector by category, imported from worksheet. Reference Figures 1-5, 1-6 and 1-7				Area-weighted average wall rock sulfur content in final pit shell as a function of elevation	Mine Plan	Waste Section 4.3.2 *Sulfur Content*
EPCP_Direct_Mass	[ton]	Deterministic	Timestep	Time Series	Vector by category, imported from worksheet. Reference Table 1-11				Mass of waste rock direct from West Pit to East Pit in Mine Plan	Rock/OB Management Plan	Water Section 5.1 *Conceptual Model*
EPCP_Max_Mass	[ton]	Deterministic	N/A	Constant	140,191,500	N/A	N/A	N/A	Maximum tonnage of backfill rock in the East Pit	Rock/OB Management Plan	Water Section 5.1 *Conceptual Model*
EPCP_Total_Mass	[ton]	Deterministic	N/A	Time Series	Imported from worksheet. Reference Table 1-11b				Mass of total backfill to East Pit in Mine Plan (all rock types together, no overburden)	Rock/OB Management Plan	Water Section 5.1 *Conceptual Model*
EPCP_Max_OBVol	[yd³]	Deterministic	N/A	Constant	4,498,100	N/A	N/A	N/A	Maximum volume of backfill saturated OB in the East Pit	Rock/OB Management Plan	Water Section 5.1 *Conceptual Model*
EPCP_Total_OBVol	[yd³]	Deterministic	N/A	Time Series	Imported from worksheet. Reference Table 1-10b				Volume of total saturated OB backfill to East Pit in Mine Plan	Rock/OB Management Plan	Water Section 5.1 *Conceptual Model*
EPCP_Backfill_Margin	[ft]	Deterministic	N/A	Constant	1	N/A	N/A	N/A	Required minimum distance between the top of the waste rock and the water	Mine Plan	Waste Section 9.6.1 *Backfill Modeling Parameters*
EPCP_RO_Flooding	[acre]	Deterministic	N/A	Constant	83	N/A	N/A	N/A	Area contributing to runoff to the East Pit during West Pit flooding	WPSWMM Model GIS analysis	Water Section 6.1.3.3 *Water Balance, Mine Pits*
EPCP_RO_PostClos	[acre]	Deterministic	N/A	Constant	83	N/A	N/A	N/A	Area contributing to runoff to the East Pit in post-closure	WPSWMM Model GIS analysis	Water Section 6.1.3.3 *Water Balance, Mine Pits*
EPCP_Outlet_Elev	[ft]	Deterministic	N/A	Constant	1552	N/A	N/A	N/A	Elevation at the constructed outlet structure	Mine Plan	Water Section 5.1 *Conceptual Model*
EPCP_Outlet_Length	[ft]	Deterministic	N/A	Constant	10	N/A	N/A	N/A	Length of the constructed outlet structure weir	Mine Plan	Water Section 5.1 *Conceptual Model*
EPCP_Spill_Elev	[ft]	Deterministic	N/A	Constant	1594	N/A	N/A	N/A	Elevation at the pit rim low point	Mine Plan	Water Section 5.1 *Conceptual Model*

Table 1-1 **Input Variables for the Mine Site Model**

Variable Name	*Units*	*Deterministic/ Uncertain*	*Sampling/ Calculation Frequency*	*Distribution*	*Mean or Mode*	*Standard Deviation*	*Minimum*	*Maximum*	*Description*	*Source of Input Data*	*Modeling Package Section*
Grey cells indicate changes from the previously published version											
West Pit Characteristics											
WP_Elev_to_Volume	[ft^3]	Deterministic	N/A	Lookup	Imported from worksheet. Reference Figure 1-1				Volume of final pit shell as a function of elevation	Mine Plan	Water Section 5.1 *Conceptual Model*
WP_Volume_to_Elev	[ft]	Deterministic	N/A	Lookup	Imported from worksheet. Reference Figure 1-1				Water surface elevation as a function of volume of final pit shell (inverse of Elev_to_Volume)	Mine Plan	Water Section 5.1 *Conceptual Model*
WP_Elev_to_PlanArea	[ft^2]	Deterministic	N/A	Lookup	Imported from worksheet. Reference Figure 1-2				Plan view area of final pit shell as a function of elevation	Mine Plan	Water Section 5.1 *Conceptual Model*
WP_Footprint_Area	[acre]	Deterministic	N/A	Time Series	Imported from worksheet. Reference Table 1-9b				Area contributing runoff during operations	Mine Plan	Water Section 5.1 *Conceptual Model*
WP_Min_Elev	[ft]	Deterministic	N/A	Constant	940	N/A	N/A	N/A	Minimum elevation in the West Pit	Mine Plan	Water Section 5.1 *Conceptual Model*
WP_Outlet_Elev	[ft]	Deterministic	N/A	Constant	1573	N/A	N/A	N/A	Elevation at the constructed outlet structure	Design variable	Water Section 5.5.2 *West Pit Overflow*
WP_Spill_Elev	[ft]	Deterministic	N/A	Constant	1579	N/A	N/A	N/A	Elevation at the pit rim low point	Mine Plan	Water Section 5.1 *Conceptual Model*
WP_Sump_Area	[ft^2]	Deterministic	N/A	Constant	1,000	N/A	N/A	N/A	Water surface area in the sump	Assumed value	Water Section 6.1.3.3 *Water Balance, Mine Pits*
WP_Sump_Volume	[ft^3]	Deterministic	N/A	Constant	10,000	N/A	N/A	N/A	Volume of the sump, assumed to be always full	Assumed value	Water Section 6.1.3.3 *Water Balance, Mine Pits*
WP_Elev_to_WallFrac	[%]	Deterministic	N/A	Lookup	Vector by category, imported from worksheet. Reference Figure 1-3b				Fraction of each rock category in wall rock in final pit shell as a function of elevation	Mine Plan	Water Section 5.1 *Conceptual Model*, Waste Section 4.3.2 *Sulfur Content*
WP_Elev_to_WallArea	[ft^2]	Deterministic	N/A	Lookup	Imported from worksheet. Reference Figure 1-4				Plan view area of wall rock in final pit shell as a function of elevation	Mine Plan	Water Section 5.1 *Conceptual Model*, Waste Section 4.3.2 *Sulfur Content*
WP_Elev_to_SetBackArea	[ft^2]	Deterministic	N/A	Lookup	Imported from worksheet. Reference Figure 1-4				Plan view area of pit rim set back above final pit shell as a function of elevation	Mine Plan	Water Section 5.1 *Conceptual Model*, Waste Section 4.3.2 *Sulfur Content*
WP_SetBack_Elev	[ft]	Deterministic	N/A	Constant	1544	N/A	N/A	N/A	Lowest elevation of the pit rim set back	Mine Plan	Water Section 5.1 *Conceptual Model*, Waste Section 4.3.2 *Sulfur Content*
WP_Elev_to_Sulfur	[%]	Deterministic	N/A	Lookup	Vector by category, imported from worksheet. Reference Figures 1-5, 1-6 and 1-7				Area-weighted average wall rock sulfur content in final pit shell as a function of elevation	Mine Plan	Waste Section 4.3.2 *Sulfur Content*
WP_BlastOre_Mass	[ton]	Deterministic	Timestep	Time Series	Imported from worksheet. Reference Table 1-9				Blasted inventory of ore in pit awaiting removal	Mine Plan	Water Section 5.1 *Conceptual Model*
WP_RO_Flooding	[acre]	Deterministic	N/A	Constant	291	N/A	N/A	N/A	Area contributing to runoff to the West Pit during pit flooding	XPSWMM Model GIS analysis	Water Section 6.1.3.3 *Water Balance, Mine Pits*
WP_RO_PostClos	[acre]	Deterministic	N/A	Constant	0	N/A	N/A	N/A	Area contributing to runoff to the West Pit in post-closure	XPSWMM Model GIS analysis	Water Section 6.1.3.3 *Water Balance, Mine Pits*

Table 1-1 **Input Variables for the Mine Site Model**

Variable Name	Units	Deterministic/ Uncertain	Sampling/ Calculation Frequency	Distribution	Mean or Mode	Standard Deviation	Minimum	Maximum	Description	Source of Input Data	Modeling Package Section
Grey cells indicate changes from the previously published version											
Waste Water Treatment Facility Characteristics											
WestPond_Area	[acre]	Deterministic	N/A	Constant	4.9	N/A	N/A	N/A	Liner area of the equalization pond receiving water from the Cat 1 stockpile, pit dewatering, and haul roads	Water Management Plan	Water Section 6.1.3.4 Water Balance, Other Facilities
EastPond_Area	[acre]	Deterministic	N/A	Constant	2.4	N/A	N/A	N/A	Liner area of the equalization pond receiving water from the other process water features	Water Management Plan	Water Section 6.1.3.4 Water Balance, Other Facilities
CPS_Pond_Area	[acre]	Deterministic	N/A	Constant	1.3	N/A	N/A	N/A	Liner area of the CPS pond	Water Management Plan	Water Section 6.1.3.4 Water Balance, Other Facilities
Pond_Leakage	[gal/ac/day]	Deterministic	N/A	Constant	5	N/A	N/A	N/A	Leakage from lined WWTF and CPS ponds when full (summer months)	Water Management Plan	Water Section 6.1.3.4 Water Balance, Other Facilities
Pump_Limit_EP	[gpm]	Deterministic	N/A	Constant	3,000	N/A	N/A	N/A	Highest pumping rate between the WWTF and East Pit allowed	Design variable, model results will determine appropriate design value (lower than shown)	Water Section 6.1.3.3 Water Balance, Mine Pits
Pump_Limit_CP	[gpm]	Deterministic	N/A	Constant	3,000	N/A	N/A	N/A	Highest pumping rate between the WWTF and Central Pit allowed	Design variable, model results will determine appropriate design value (lower than shown)	Water Section 6.1.3.3 Water Balance, Mine Pits
Pump_Limit_WP	[gpm]	Deterministic	N/A	Constant	3,000	N/A	N/A	N/A	Highest pumping rate between the WWTF and West Pit allowed	Design variable, model results will determine appropriate design value (lower than shown)	Water Section 6.1.3.3 Water Balance, Mine Pits
Reclam_Pump_Total	[gpm]	Deterministic	N/A	Constant	2,400	N/A	N/A	N/A	Total rate of treatment from East Pit and other higher-strength sources in reclamation	Design variable, may change due to model results	Water Section 6.1.3.3 Water Balance, Mine Pits
LongTerm_Pump_WP	[gpm]	Deterministic	N/A	Constant	600	N/A	N/A	N/A	Total rate of treatment and discharge from the West Pit	Design variable, may change due to model results	Water Section 6.1.3.3 Water Balance, Mine Pits
WWTF_Targets	[mg/L]	Deterministic	N/A	Constant	Vector by Constituent. Reference Table 1-34				Treatment effluent target concentrations	Water Management Plan	Water Section 6.1.3.4 Water Balance, Other Facilities
WWTF_Targets_Reclam	[mg/L]	Deterministic	N/A	Constant	Vector by Constituent. Reference Table 1-34				Treatment effluent target concentrations during pit treatment during reclamation	Water Management Plan	Water Section 6.1.3.4 Water Balance, Other Facilities
WWTF_Targets_LongTerm	[mg/L]	Deterministic	N/A	Constant	Vector by Constituent. Reference Table 1-34				Treatment effluent target concentrations during long-term treatment and discharge	Water Management Plan	Water Section 6.1.3.4 Water Balance, Other Facilities
RTH_Trib_Area	[acre]	Deterministic	N/A	Constant	1.55	N/A	N/A	N/A	Contributing area to the RTH pond for runoff calculation	Water Management Plan	Water Section 6.1.3.4 Water Balance, Other Facilities
RTH_Ore_Depth	[ft]	Deterministic	N/A	Constant	1.0	N/A	N/A	N/A	Depth of spilled fine ore material on RTH	Water Management Plan	Water Section 6.1.3.4 Water Balance, Other Facilities
HR_Trib_Area	[acre]	Deterministic	N/A	Constant	72.4	N/A	N/A	N/A	Contributing area to the Haul Road ponds for runoff calculation	Water Management Plan	Water Section 6.1.3.4 Water Balance, Other Facilities
HR_Cat1_Depth	[ft]	Deterministic	N/A	Constant	1.0	N/A	N/A	N/A	Depth of crushed fine Category 1 waste rock material on haul roads	Water Management Plan	Water Section 6.1.3.4 Water Balance, Other Facilities
Concentrate_toWWTF_Flow_Dist	[gpm]	Uncertain	Month	Normal	Vector by Constituent. Reference Table 1-48		0	1.00E+03	Brine returned from the Plant Site to the chemical precipitation plant (autocorrelation = 0.8)	Water Management Plan	Water Section 6.1.3.4 Water Balance, Other Facilities
Concentrate_toWWTF_Conc_Dist	[mg/L]	Uncertain	Month	Normal	Vector by Constituent. Reference Table 1-39 & 1-40		0	1.00E+03	Water quality of brine returned from the Plant Site to the chemical precipitation plant	Water Management Plan	Water Section 6.1.3.4 Water Balance, Other Facilities
Sludge_Water_Out	[gpm]	Deterministic	N/A	Constant	5	N/A	0	0	Water lost from the WWTF system in the dewatered sludge	Water Management Plan	Water Section 6.1.3.4 Water Balance, Other Facilities
EP_Return_Deficit	[gpm]	Deterministic	N/A	Constant	100	N/A	0	0	Flow not returned to East Pit in order to maintain an inward GW gradient	Water Management Plan	Water Section 6.1.3.4 Water Balance, Other Facilities
Retentate_Reclam	[%]	Deterministic	N/A	Constant	20%	N/A	0	0	Portion of inflows to the higher-concentration UF/NF line that is further treated in the chemical precipitation	Water Management Plan	Water Section 6.1.3.4 Water Balance, Other Facilities
Concentrate_LongTerm	[%]	Deterministic	N/A	Constant	5%	N/A	0	0	Portion of inflows to the RO line that is lost to evaporation or removal from site	Water Management Plan	Water Section 6.1.3.4 Water Balance, Other Facilities

Table 1-1 Input Variables for the Mine Site Model

Variable Name	Units	Deterministic/ Uncertain	Sampling/ Calculation Frequency	Distribution	Mean or Mode	Standard Deviation	Minimum	Maximum	Description	Source of Input Data	Modeling Package Section
Grey cells indicate changes from the previously published version											
Climatic Variables											
Annual_Precip_Cuberoot	$(in^{1/3})$	Uncertain	Annual	Trunc Normal	3.05	0.16	0	N/A	Cube root of the annual precipitation	HiDen Climate network for Mine Site (1980-2010 climate normal)	Water Section 5.2.1 *Climate Inputs*
Monthly_Precip_Factors	[%]	Deterministic	N/A	Constant	Vector by month. Reference Table 1-11				Factors for partitioning annual precipitation to monthly	HiDen Climate network for Mine Site (1980-2010 climate normal)	Water Section 5.2.1 *Climate Inputs*
Annual_Evap	[in/yr]	Uncertain	Annual	Normal	20.8	1.13	N/A	N/A	Annual evaporation from open water	HiDen Climate network for Mine Site (1980-2010 climate normal), Baker (1979)	Water Section 5.2.1 *Climate Inputs*
Monthly_Evap_Factors	[%]	Deterministic	N/A	Constant	Vector by month. Reference Table 1-11				Factors for partitioning annual open water evaporation to monthly	Baker (1979) for partitioning ratios	Water Section 5.2.1 *Climate Inputs*
Snowmelt	[-]	Deterministic	N/A	Constant	4	N/A	N/A	N/A	Month when snowmelt occurs	USGS Gage Data	Water Section 6.1.3.3 *Water Balance, Mine Pits*
Freeseup	[-]	Deterministic	N/A	Constant	11	N/A	N/A	N/A	Month when freeseup occurs, consistent with WWTF design team definition	USGS Gage Data	Water Section 6.1.3.3 *Water Balance, Mine Pits*
Background Chemistry											
SW_Conc_Surf	[mg/L]	Uncertain	Realization	Lognormal	Vector by Constituent. Reference Table 1-12				Surficial groundwater concentrations in the Partridge River watershed	Analysis of PolyMet background water quality data	Water Section 5.3.1 *Background Groundwater*
SW_Conc_Bed	[mg/L]	Uncertain	Realization	Lognormal	Vector by Constituent. Reference Table 1-12				Bedrock groundwater concentrations in the Partridge River watershed	Analysis of PolyMet background water quality data	Water Section 5.3.1 *Background Groundwater*
SW_Conc_RO	[mg/L]	Uncertain	Realization	Lognormal	Vector by Constituent. Reference Table 1-13				Calibrated surface runoff concentrations in the Partridge River watershed	Calibration of model to baseline conditions	Water Section 5.3.1 *Background Surface Runoff*
SW_Conc_PMP	[mg/L]	Deterministic	N/A	Constant	Vector by Constituent. Reference Table 1-13				Concentration leaving the Peter Mitchell Pits	2004-2007 WQ modeling at SW-001	Water Section 5.5.3.1 *Other (Non-Project) Loads*
Flow_PMP	[cfs]	Deterministic	N/A	Constant	2.6	N/A	N/A	N/A	Flow from Peter Mitchell Pit dewatering to SW-001	Calibration of model to baseline conditions	Water Section 5.5.3.1 *Other (Non-Project) Loads*
Flow_PMP_wtd	[gr]	Deterministic	N/A	Constant	63	N/A	N/A	N/A	Mine Year when flow from Peter Mitchell Pit ends, equivalent to year 2070	Northshore Mine Plan	Water Section 5.5.3.1 *Other (Non-Project) Loads*
SW_Conc_Partridge	[mg/L]	Deterministic	N/A	Constant	Matrix by Constituent and location. Reference Table 1-14				Baseline existing chemistry in Partridge River used to evaluate model	2004-2010 Monitoring Data of Partridge River	Water Section 4.4.4.1 *Water Quality, Partridge River*
Load_Colby	[kg/yr]	Deterministic	N/A	Constant	Vector by Constituent. Reference Table 1-13				Calibrated additional loading to Colby Lake	Calibration of model to baseline conditions	Water Section 5.5.3.1 *Other (Non-Project) Loads*

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Table 1-1 **Input Variables for the Mine Site Model**

Variable Name	Units	Deterministic/ Uncertain	Sampling/ Calculation Frequency	Distribution	Mean or Mode	Standard Deviation	Minimum	Maximum	Description	Source of Input Data	Modeling Package Section
Grey cells indicate changes from the previously published version											
Groundwater Flowpath Characteristics											
i_opn	[-]	Uncertain	Realization	Uniform	Vector by flowpath. Reference Table 1-15				Average hydraulic gradient along aquifer	Mine Site MODFLOW model	Water Section 5.4.1 Groundwater Flowpath Modeling
i_close	[-]	Uncertain	Realization	Uniform	Vector by flowpath. Reference Table 1-13				Average hydraulic gradient along aquifer in closure	Mine Site MODFLOW model	Water Section 5.4.1 Groundwater Flowpath Modeling
thick	[m]	Deterministic	N/A	Constant	Vector by flowpath. Reference Table 1-11				Aquifer thickness	Assumed value	Water Section 5.4.1 Groundwater Flowpath Modeling
El_Pit	[ft]	Deterministic	N/A	Constant	Vector by flowpath. Reference Table 1-13				Pit surficial outflow elevation	GIS data/calculations	Water Section 5.4.1 Groundwater Flowpath Modeling
Width	[m]	Deterministic	N/A	Constant	Vector by flowpath. Reference Table 1-13				Flowpath width	GIS data/calculations	Water Section 5.4.1 Groundwater Flowpath Modeling
L_Upstream	[m]	Deterministic	N/A	Constant	Vector by flowpath. Reference Table 1-13				Length upstream of stockpile	GIS data/calculations	Water Section 5.4.1 Groundwater Flowpath Modeling
L_Stock	[m]	Deterministic	N/A	Constant	Vector by flowpath. Reference Table 1-13				Source (stockpile) length	GIS data/calculations	Water Section 5.4.1 Groundwater Flowpath Modeling
L_Eval_1	[m]	Deterministic	N/A	Constant	Vector by flowpath. Reference Table 1-13				Length to Evaluation Point #1	GIS data/calculations	Water Section 5.4.1 Groundwater Flowpath Modeling
L_Eval_2	[m]	Deterministic	N/A	Constant	Vector by flowpath. Reference Table 1-13				Length to Evaluation Point #2	GIS data/calculations	Water Section 5.4.1 Groundwater Flowpath Modeling
L_Eval_3	[m]	Deterministic	N/A	Constant	Vector by flowpath. Reference Table 1-13				Length to Evaluation Point #3	GIS data/calculations	Water Section 5.4.1 Groundwater Flowpath Modeling
L_Total	[m]	Deterministic	N/A	Constant	Vector by flowpath. Reference Table 1-15				Total flowpath length	GIS data/calculations	Water Section 5.4.1 Groundwater Flowpath Modeling
Groundwater Flow Variables											
Bedrock_Porosity	[-]	Deterministic	N/A	Constant	0.05	N/A	N/A	N/A	Porosity of the bedrock flowpaths	Mine Site MODFLOW model (Bedrock units)	Water Section 5.4.1 Groundwater Flowpath Modeling
Surficial_Porosity	[-]	Deterministic	N/A	Constant	0.3	N/A	N/A	N/A	Porosity of the surficial flowpaths	Assumed value, e.g. Fetter, 2001	Water Section 5.4.1 Groundwater Flowpath Modeling
K_Flowpath	[m/d]	Uncertain	Realization	Triangular	Vector by flowpath. Reference Table 1-15				Hydraulic conductivity of the surficial and bedrock material	Mine Site MODFLOW model (Duluth Complex), constraints discussed in Water Section 5.4.1	Water Section 5.4.4 Groundwater Transport in GoldSim
Recharge_min	[in/yr]	Deterministic	N/A	Constant	0.26	N/A	N/A	N/A	Minimum allowed recharge in surficial aquifer (for checking calculated value)	Mine Site MODFLOW model	Water Section 5.4.1 Groundwater Flowpath Modeling
Recharge_max	[in/yr]	Deterministic	N/A	Constant	1.8	N/A	N/A	N/A	Maximum allowed recharge in surficial aquifer (for checking calculated value)	Mine Site MODFLOW model	Water Section 5.4.1 Groundwater Flowpath Modeling
Surficial_Density	[kg/m3]	Deterministic	N/A	Constant	1,500	N/A	N/A	N/A	Dry (bulk) Density of the surficial deposits	USDA St. Louis County Soil Survey Database	Water Section 5.4.1 Groundwater Flowpath Modeling
Kd_Surficial	[L/kg]	Deterministic	N/A	Constant	Vector by Constituent. Reference Table 1-16				Sorption coefficients for the surficial aquifer (As, Sb, Cu, Ni)	EPA screening-level values	Water Section 5.4.3 Sorption
Stream Reach Characteristics											
Segment_Area	[in^2]	Deterministic	N/A	Constant	Vector by location. Reference Table 1-17				Cross sectional area of each segment upstream of each node	RS3G geomorphic surveys	Water Section 5.5 Surface Water Modeling
Segment_Length	[in]	Deterministic	N/A	Constant	Vector by location. Reference Table 1-17				Length of river upstream of each node	GIS data	Water Section 5.5 Surface Water Modeling
Colby_Volume	[acre-ft]	Deterministic	N/A	Constant	3,300	N/A	N/A	N/A	Colby Lake storage volume from RS7DE	1968 bathymetric maps (summarized in RS7DE)	Water Section 6.1.3 Water Balance, Colby Lake
Contributing_Area	[acre]	Deterministic	N/A	Time Series	Matrix by location and year. Reference Table 1-18				Contributing watershed area to each river node (incremental), used to calculate recharge	XP-SWMM Model GIS analysis	Water Section 5.6.4 Modeling Future Conditions

Table 1-1 **Input Variables for the Mine Site Model**

Variable Name	Units	Deterministic/ Uncertain	Sampling/ Calculation Frequency	Distribution	Mean or Mode	Standard Deviation	Minimum	Maximum	Description	Source of Input Data	Modelling Package Section
Grey cells indicate changes from the previously published version											
Stream Flow Variables											
StreamFlow_SW006_(Month)	(cfs)	Uncertain	Timestep	User-defined	Imported from worksheet. Reference Table 1-19				Randomly sampled daily streamflow at SW-006 for each month	LSGS gage data (corrected for PMP developing)	Water Section 5.6.3. *Developing Probabilistic Model Inputs*
Inc_Flow_Factor_(Month)	[-]	Deterministic	N/A	Time Series	Imported from worksheet. Reference Table 1-20a through 1-20l				Factor to multiply Q at SW006 to get the incremental inflow between nodes for each month	KP-SWMM model results (relative differences)	Water Section 5.6.5. *Developing Probabilistic Model Inputs*
SDA_Inc_Baseflow	(cfs)	Deterministic	N/A	Time Series	Imported from worksheet. Reference Table 1-21				Baseflow adding to evaluation points via natural groundwater	KP-SWMM model results scaled to observed baseflow at SW-006	Water Section 5.6.5. *Developing Probabilistic Model Inputs*
Stockpile Hydrology											
Bare_ET	[--]	Uncertain	Realization	Normal	0.524	0.026	N/A	N/A	ET from bare waste rock as a fraction of precipitation	Analysis of Amax test pile data (Eger and Lapakko, 1985)	Water Section 6.1.1 *Stockpile Hydrology Modeling*
Bare_RO	[--]	Deterministic	N/A	Constant	0	N/A	N/A	N/A	Runoff from bare portion of the stockpile as a fraction of precipitation	Assumed value	Water Section 6.1.1 *Stockpile Hydrology Modeling*
Reclaim_ET	[--]	Uncertain	Realization	Normal	0.704	0.021	N/A	N/A	ET from reclaimed waste rock as a fraction of precipitation	Analysis of Amax test pile data (Eger and Lapakko, 1985)	Water Section 6.1.1 *Stockpile Hydrology Modeling*
Reclaim_RO	[--]	Uncertain	Realization	Trunc. Normal	0.082	0.0027	0	N/A	Runoff from reclaimed waste rock as a fraction of precipitation	Analysis of Amax test pile data (Eger and Lapakko, 1985)	Water Section 6.1.1 *Stockpile Hydrology Modeling*
Cat1SP_Geomem_Perc	[--]	Uncertain	Realization	Lognormal	0.00527	0.00535	N/A	N/A	Percolation through membrane covered stockpile as a fraction of precipitation	Range used in membrane cover modeling for DEIS	AMAP Section 2 (pending)
Cat1SP_Leak_WP	[%]	Deterministic	N/A	Constant	6%	N/A	N/A	N/A	Fraction of Cat 1 stockpile seepage water that bypasses the containment system to the West Pit	MODFLOW modeling of the stockpile	Water Section 6.1.3.1 *Active Waste Rock and Ore Stockpiles*
Cat1SP_Leak_EP	[%]	Deterministic	N/A	Time Series	Imported from worksheet. Reference Table 1-3				Fraction of Cat 1 stockpile seepage water that bypasses the containment system to the East Pit	MODFLOW modeling of the stockpile	Water Section 6.1.3.1 *Active Waste Rock and Ore Stockpiles*
Cat1SP_Leak_Bed	[%]	Deterministic	N/A	Time Series	Imported from worksheet. Reference Table 1-4				Fraction of Cat 1 stockpile seepage water that bypasses the containment system to bedrock	MODFLOW modeling of the stockpile	Water Section 6.1.3.1 *Active Waste Rock and Ore Stockpiles*
Mean_Bare_Infil	[in/yr]	Deterministic	N/A	Constant	13.5	N/A	N/A	N/A	Infiltration for mean stockpile conditions (precip., ET, RO) for use as flowpath initial condition	Calculated from mean of other model parameters	Water Section 6.1.1 *Stockpile Hydrology Modeling*
Mean_Reclaim_Infil	[in/yr]	Deterministic	N/A	Constant	6.1	N/A	N/A	N/A	Infiltration for mean stockpile conditions (precip., ET, RO) for use as flowpath initial condition	Calculated from mean of other model parameters	Water Section 6.1.1 *Stockpile Hydrology Modeling*
Liner_Leak_13	[--]	Uncertain	Realization	Lognormal	0.000302	0.000174	N/A	N/A	Fraction of water from the top of the liner that leaks (Cat 1/3 stockpile)	HSSM Analysis on HELP model results	Water Section 6.1.3 *Water Balance, Active Stockpiles*
Liner_Leak_4_OSP	[--]	Uncertain	Realization	Lognormal	0.000081	0.000073	N/A	N/A	Fraction of water from the top of the liner that leaks (Cat 4 and OSP)	HSSM Analysis on HELP model results	Water Section 6.1.3 *Water Balance, Active Stockpiles*

Table 1-1 **Input Variables for the Mine Site Model**

Variable Name	Units	Deterministic/ Uncertain	Sampling/ Calculation Frequency	Distribution	Mean or Mode	Standard Deviation	Minimum	Maximum	Description	Source of Input Data	Modeling Package Section
Grey cells indicate changes from the previously published version											
Pit Hydrology											
Wall_RO	[-]	Uncertain	Realization	Uniform	N/A	N/A	0.4	0.6	Runoff from bare pit walls as a fraction of precipitation	Best professional judgment (watershed avg ~42%)	Water Section 6.1.1.3 *Water Balance, Mine Pits*
Natural_RO_Winter	[-]	Uncertain	Annual	Trunc. Normal	0.63	0.275	0	N/A	Runoff (freeze period) from non-stockpile areas as a fraction of precipitation	Calculated from annual fraction and open-water seasonal fraction	Water Section 6.1.1.3 *Water Balance, Mine Pits*
Natural_RO_Summer	[-]	Uncertain	Annual	Trunc. Normal	0.30	0.092	0	N/A	Runoff (open-water period) from non-stockpile areas as a fraction of precipitation	Average watershed yield from Partridge River (USGS gage)	Water Section 6.1.1.3 *Water Balance, Mine Pits*
Pit_GW_Uncertainty_unshift	[-]	Uncertain	Realization	Log-Normal	0.1	0.11	N/A	N/A	Uncertainty multiplier for the groundwater flow into the pits (un-shifted)	Best professional judgment	Water Section 6.1.1.3 *Water Balance, Mine Pits*
Pit_GW_Uncertainty_shift	[-]	Deterministic	N/A	Constant	0.7	N/A	N/A	N/A	Upward shift for uncertainty multiplier for the groundwater flow into the pits (shifted mean = 1.0)	Best professional judgment	Water Section 6.1.1.3 *Water Balance, Mine Pits*
WP_GW_Inflow	[gpm]	Deterministic	Timestep	Time Series/ Lookup	Imported from worksheet. Reference Table 1-21a and 1-22b				Groundwater inflow to the pit as a function of time or elevation	MODFLOW modeling	Water Section 5.4.5 *Groundwater Modeling, MODFLOW*
WP_GW_Surf	[%]	Deterministic	Timestep	Time Series/ Lookup	Imported from worksheet. Reference Table 1-21a and 1-22b				Surficial fraction of inflow to the pit as a function of elevation	MODFLOW modeling	Water Section 5.4.5 *Groundwater Modeling, MODFLOW*
EP_GW_Inflow	[gpm]	Deterministic	Timestep	Time Series/ Lookup	Imported from worksheet. Reference Table 1-21a and 1-22b				Groundwater inflow to the pit as a function of time or elevation	MODFLOW modeling	Water Section 5.4.5 *Groundwater Modeling, MODFLOW*
EP_GW_Surf	[%]	Deterministic	Timestep	Time Series/ Lookup	Imported from worksheet. Reference Table 1-21a and 1-22b				Surficial fraction of inflow to the pit as a function of elevation	MODFLOW modeling	Water Section 5.4.5 *Groundwater Modeling, MODFLOW*
CP_GW_Inflow	[gpm]	Deterministic	Timestep	Time Series/ Lookup	Imported from worksheet. Reference Table 1-21a and 1-22b				Groundwater inflow to the pit as a function of time or elevation	MODFLOW modeling	Water Section 5.4.5 *Groundwater Modeling, MODFLOW*
CP_GW_Surf	[%]	Deterministic	Timestep	Time Series/ Lookup	Imported from worksheet. Reference Table 1-21a and 1-22b				Surficial fraction of inflow to the pit as a function of elevation	MODFLOW modeling	Water Section 5.4.5 *Groundwater Modeling, MODFLOW*
CP_to_WP	[gpm]	Deterministic	N/A	Constant	0.1	N/A	N/A	N/A	Flow through bedrock from East Pit porewater to West Pit during pit filling (0 after West Pit is full)	MODFLOW modeling	Water Section 5.4.5 *Groundwater Modeling, MODFLOW*

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Table 1-1 **Input Variables for the Mine Site Model**

Variable Name	Units	Deterministic/ Uncertain	Sampling/ Calculation Frequency	Distribution	Mean or Mode	Standard Deviation	Minimum	Maximum	Description	Source of Input Data	Modeling Package Section
Grey cells indicate changes from the previously published version											
Geochemical Parameters for Pollutant Release											
OB_Conc_Unsat	(mg/L)	Uncertain	Realization	Uniform	Vector by Constituent. Reference Table 1-23				Seepage concentrations from unsaturated OB storage areas	Analysis of overburden leach test data	Waste Section 7.1 Leachate Water Quality, Unsaturated Overburden
OB_Conc_Peat	(mg/L)	Uncertain	Realization	Uniform	Vector by Constituent. Reference Table 1-23				Seepage concentrations from peat storage areas	Analysis of overburden leach test data	Waste Section 7.1 Leachate Water Quality, Peat
Cat1_Release	(varies)	Uncertain	Realization	Varies	Vector by Constituent. Reference Table 1-24				Release rates and ratios for Category 1 waste rock	Analysis of HCT, Aqua Regia, and Microprobe data	Waste Section 6.1 Laboratory Release Rates
Cat23_Release	(varies)	Uncertain	Realization	Varies	Vector by Constituent. Reference Table 1-25				Release rates and ratios for Category 2/3 waste rock	Analysis of HCT, Aqua Regia, and Microprobe data	Waste Section 6.1 Laboratory Release Rates
Cat4DC_Release	(varies)	Uncertain	Realization	Varies	Vector by Constituent. Reference Table 1-26				Release rates and ratios for Duluth Complex Category 4 waste rock	Analysis of HCT, Aqua Regia, and Microprobe data	Waste Section 6.1 Laboratory Release Rates
Ore_Release	(varies)	Uncertain	Realization	Varies	Vector by Constituent. Reference Table 1-27				Release rates and ratios for ore in the OSP	Analysis of HCT, Aqua Regia, and Microprobe data	Waste Section 6.1 Laboratory Release Rates
Cat4VF_Release	(varies)	Uncertain	Realization	Varies	Vector by Constituent. Reference Table 1-28				Release rates and ratios for Virginia Formation Category 4 waste rock	Analysis of HCT, Aqua Regia, and Microprobe data	Waste Section 6.1 Laboratory Release Rates
Rock_Content_All	(mg/kg)	Deterministic	N/A	Constant	Matrix by Constituent and Rock Type. Reference Table 1-29				Content of constituents of concern in waste rock	Analysis of Aqua Regia data	Waste Section 6.4.1 Depletion
Cat1_ConcCaps	(mg/L)	Uncertain	Realization	Varies	Vector by Constituent. Reference Table 1-30				Concentration caps for Category 1 waste rock	Analysis of laboratory and analog site data	Waste Section 6.3 Concentration caps
Cat1_pH	(s.u.)	Uncertain	Realization	Uniform	N/A	N/A	7.0	7.5	Assumed distribution of porewater pH in the Category 1 stockpile	Geochemical modeling of Category 1 waste rock	Waste Section 6.3 Concentration caps
Cat234_pH	(s.u.)	Uncertain	Realization	Uniform	N/A	N/A	6.0	7.5	Assumed distribution of porewater pH in the nonacidic Category 2/3 and Category 4 rock	Assumed pH prior to onset of acidic conditions	Waste Section 6.3 Concentration caps
Cat234_nonacid_ConcCaps	(mg/L)	Uncertain	Realization	Varies	Vector by Constituent. Reference Table 1-31				Concentration caps for nonacidic Duluth Complex Category 2/3/4 waste rock and ore	Analysis of laboratory and analog site data	Waste Section 6.3 Concentration caps
Cat234_acid_ConcCaps	(mg/L)	Uncertain	Realization	Varies	Vector by Constituent. Reference Table 1-32				Concentration caps for acidic Duluth Complex Category 2/3/4 waste rock and ore	Analysis of laboratory and analog site data	Waste Section 6.3 Concentration caps
Cat4VF_ConcCaps	(mg/L)	Uncertain	Realization	Varies	Vector by Constituent. Reference Table 1-33				Concentration caps for acidic Virginia Formation Category 4 waste rock	Analysis of laboratory and analog site data	Waste Section 6.3 Concentration caps
Geochemical Parameters for Scaling											
Scale_Factor_MDNR	(--)	Uncertain	Year	Beta	0.118	0.081	0.019	0.687	Scaling factor for Category 1 stockpile	MDNR analysis of Dunka Mine data.	Waste Section 6.2.9 Lab to Field Scale Up, Category 1 Waste Rock Stockpile
Contact_Factor	(--)	Uncertain	Realization	Triangular	0.1	N/A	0.1	0.9	Fraction of waste rock contacted by water	Professional judgement	Waste Section 6.2 Lab to Field Scale Up
Size_Factor	(--)	Uncertain	Realization	Triangular	0.14	N/A	0.08	0.35	Scaling factor to adjust to field scale waste rock	Analysis of NorthMet and ANAX data	Waste Section 6.2 Lab to Field Scale Up
Field_Temp	(C)	Uncertain	Year	Normal	2.00E	1.38E	N/A	N/A	Stockpile or wall internal temperature, same as air temperature	HiGen Climate data for 1961-2010	Waste Section 6.2 Lab to Field Scale Up
Field_Temp_Mean	(C)	Uncertain	Realization	Normal	2.00E	0.253E	N/A	N/A	Average annual temperature, used for acid onset timing	HiGen Climate data for 1961-2010	Waste Section 6.2 Lab to Field Scale Up
Lab_Temp	(C)	Deterministic	N/A	Constant	20	N/A	N/A	N/A	Laboratory temperature (known)	KS 11/42	Waste Section 6.2 Lab to Field Scale Up
Activation_Energy	(kJ/mol)	Uncertain	Realization	Uniform	N/A	N/A	47	63	Activation energy of pyrrhotite for the Arrhenius equation	Literature-reported range	Waste Section 6.2 Lab to Field Scale Up
Wall_Temp_Solar	(C)	Deterministic	N/A	Constant	1.3	N/A	N/A	N/A	Average temp. increase for portion of pit wall that has solar heating	Energy balance for pit wall face	Waste Section 9.3 Lab to Field Scale Up
Size_factor_walls	(--)	Uncertain	Realization	Uniform	N/A	N/A	0.05	0.15	Scaling factor to adjust to field scale wall rock	Professional judgement	Waste Section 9.3 Lab to Field Scale Up

Table 1-1 **Input Variables for the Mine Site Model**

Variable Name	Units	Deterministic/ Uncertain	Sampling/ Calculation Frequency	Distribution	Mean or Mode	Standard Deviation	Minimum	Maximum	Description	Source of Input Data	Modeling Package Section
Grey cells indicate changes from the previously published version											
Geochemical Parameters for Acidic Conditions and Decay											
Acid_Onset_Time_Cl	[yr]	Uncertain	Realization	Triangular	6.81	N/A	5.15	7.79	Time for Category 1/3 rock to go acidic in the laboratory	Analysis of DNR long-term reactor data	Waste Section 8.2 *Lab to Field Scale Up*
Acid_Onset_Time_4DC	[yr]	Uncertain	Realization	Triangular	5.41	N/A	4.97	6.81	Time for Duluth Complex Category 4 rock to go acidic in the laboratory	Analysis of DNR long-term reactor data	Waste Section 8.2 *Lab to Field Scale Up*
Acid_Factor_DC	[-]	Uncertain	Realization	Beta	8.22	7.48	1.01	32.36	Increase in sulfate release when Duluth Complex rock goes acidic **(correlation to a1 = -0.831)**	Analysis of DNR long-term reactor data and NorthMet humidity cells	Waste Section 8.2 *Lab to Field Scale Up*
Decay_a1	[-]	Uncertain	Realization	Uniform	N/A	N/A	1.088	-0.087	Parameter to define shape of decay of sulfate release in wall rock **(correlated to acid factor and a0)**	Analysis of DNR long-term reactor data and NorthMet humidity cells	Waste Section 9.4 *Acidification and Long-Term Decay*
Decay_a0	[-]	Uncertain	Realization	Uniform	N/A	N/A	1.60	1.48	Parameter to define shape of decay of sulfate release in wall rock **(correlation to a1 = -0.989)**	Analysis of DNR long-term reactor data and NorthMet humidity cells	Waste Section 9.4 *Acidification and Long-Term Decay*
Geochemical Parameters for Pit Wall and Backfill											
Begin_Oxidizing_EP	[yr]	Deterministic	Realization	Constant	0	N/A	N/A	N/A	Average point in the mine life when rock walls begin oxidizing	Assumed	Waste Section 9.6.1 *Age of Pit Walls*
Begin_Oxidizing_WP	[yr]	Deterministic	Realization	Constant	0	N/A	N/A	N/A	Average point in the mine life when rock walls begin oxidizing	Assumed	Waste Section 9.6.1 *Age of Pit Walls*
SetBack_Depth_Fraction	[-]	Deterministic	N/A	Constant	0.1	N/A	N/A	N/A	Average depth of oxidizing bedrock in the upper unblasted bench, relative to the pit wall depths	Professional judgement	Waste Section 9.2 *Mass of Reactive Wall Rock*
Wall_Depth_DC	[m]	Uncertain	Realization	Triangular	2	N/A	1	5	Average depth of oxidizing Duluth Complex wall rock	Professional judgement	Waste Section 9.2 *Mass of Reactive Wall Rock*
Wall_Depth_VF	[m]	Uncertain	Realization	Triangular	4	N/A	2	6	Average depth of oxidizing Virginia Formation wall rock	Professional judgement	Waste Section 9.2 *Mass of Reactive Wall Rock*
South_Face_EP	[-]	Deterministic	N/A	Constant	0.5	N/A	N/A	N/A	Portion of pit wall that is south facing and subject to solar heating	Assumed	Waste Section 9.3 *Lab to Field Scale Up*
South_Face_WP	[-]	Deterministic	N/A	Constant	0.5	N/A	N/A	N/A	Portion of pit wall that is south facing and subject to solar heating	Assumed	Waste Section 9.3 *Lab to Field Scale Up*
WR_Swell	[-]	Deterministic	N/A	Constant	0.3	N/A	N/A	N/A	Swelling of the rock due to void spaces	Rock/OB Management Plan	Waste Section 9.6.2 *Backfill Modeling Parameters*
WR_Sp_Gravity	[-]	Deterministic	N/A	Constant	2.83	N/A	N/A	N/A	Specific gravity of the waste rock	Rock/OB Management Plan	Waste Section 9.6.2 *Backfill Modeling Parameters*
SatOB_Porosity	[-]	Deterministic	N/A	Constant	0.2	N/A	N/A	N/A	Porosity of the saturated overburden backfill	Rock/OB Management Plan	Waste Section 9.6.2 *Backfill Modeling Parameters*
SatOB_BulkDens	[ton/cy]	Deterministic	N/A	Constant	1.472	N/A	N/A	N/A	Compacted bulk density of the saturated overburden	Rock/OB Management Plan	Waste Section 9.6.1 *Backfill Modeling Parameters*
Parameters for Plant Site Water											
TR_toWP_Flow_____	[gpm]	Uncertain	Month	Normal	Vector by Constituent, Reference Table 1-33		0	1.00E+10	Flow returned from the Plant Site to the West Pit in closure **(autocorrelation = 0.9)**	AWMP Section 7 (pending)	AWMP Section 7 (pending)
TR_toWP_Conc_____	[g/L, mg/L]	Uncertain	Month	Normal	Vector by Constituent, Reference Table 1-36 & 1-37		0	1.00E+10	Water quality returned from the Plant Site to the West Pit in closure	AWMP Section 7 (pending)	AWMP Section 7 (pending)
TR_Stop_Elev	[ft]	Deterministic	N/A	Constant	1550	N/A	0	0	West Pit elevation that stops water transfer from the Plant Site to the West Pit	AWMP Section 7 (pending)	AWMP Section 7 (pending)
TR_Stop_Vol	[acre-ft]	Deterministic	N/A	Constant	50,000	N/A	0	0	Transferred water volume that stops water transfer from the Plant Site to the West Pit	AWMP Section 7 (pending)	AWMP Section 7 (pending)

Table 1-1 **Input Variables for the Mine Site Model**

Variable Name	*Units*	*Deterministic/ Uncertain*	*Sampling/ Calculation Frequency*	*Distribution*	*Mean or Mode*	*Standard Deviation*	*Minimum*	*Maximum*	*Description*	*Source of Input Data*	*Modeling Package Section*
Grey cells indicate changes from the previously published version											
Parameters for Model Stability											
Water_Depth	[in]	Deterministic	N/A	Constant	0.1	N/A	N/A	N/A	Average depth of water at the bottom of stockpile (for volume calculation)	Assumed, small value leads to less "memory" of previous timestep	
Tiny_Area	[acre]	Deterministic	N/A	Constant	0.001	N/A	N/A	N/A	Tiny area to prevent dividing by zero	Assumed	
Tiny_Mass	[kg]	Deterministic	N/A	Constant	0.001	N/A	N/A	N/A	Tiny mass to prevent dividing by zero	Assumed	
Tiny_Volume	[m^3]	Deterministic	N/A	Constant	0.001	N/A	N/A	N/A	Tiny volume to prevent dividing by zero	Assumed	

Table 1-5 Mine Plan Summary for the Category 1 Waste Rock Stockpile

Time (years)	*[Cat1SP_Mass] Stockpile Mass (short tons)*	*[Cat1SP_Bare_Geomem] Bare Area (acres)*	*[Cat1SP_Reclaim_Geomem] Reclaimed Area (acres)*	*[Cat1SP_Contain_EP] Containment Area to East Pit (acres)**	*[Cat1SP_Contain_WP_Extend] Containment Area to West Pit (acres)**	*[Cat1SP_Leak_EP] Containment Leakage to East Pit (%)*	*[Cat1SP_Leak_Bed] Containment Leakage to Bedrock (%)*
0	0	212.7	0	132.3	80.4	0.0	0.0
1	18,707,500	212.7	0	132.3	80.4	0.2	0.2
2	33,724,200	212.7	0	132.3	80.4	0.4	0.4
3	49,863,200	294.9	0	150.7	144.2	0.6	0.6
4	62,659,900	377.1	0	155.8	221.3	0.8	0.8
5	74,401,200	459.3	0	168.9	290.4	1.0	1.0
6	91,243,400	515.4	0	185.6	329.8	1.2	1.2
7	101,648,400	515.4	0	185.6	329.8	1.4	1.4
8	118,588,200	515.4	0	185.6	329.8	1.6	1.6
9	131,144,400	515.4	0	185.6	329.8	1.8	1.8
10	144,118,600	515.4	0	185.6	329.8	2.0	2.0
11	154,299,000	515.4	0	185.6	329.8	1.8	1.8
12	165,072,100	515.4	0	0	515.4	1.6	1.6
13	167,922,100	515.4	0	0	515.4	1.4	1.4
21	167,922,100	0	525.9	0	525.9	0	0
2000	167,922,100	0	525.9	0	526	0	0

Notes

Based on PolyMet block model, GIS shapefile data, and Containment System modeling

* Area with seepage reporting toward the pits via the seepage containment system; may be pumped directly to WWTF or treated in PRB prior to entering pits

Cells highlighted grey indicate a change from previously published values

Table 1-15 Groundwater Flowpath Characteristics

Variable Name	Units	Description	Groundwater Flowpath							
			East Pit (Bedrock)	East Pit & Cat 2/3 Stockpile (Surficial Aquifer)	Ore Surge Pile	Waste Water Treatment Facility	Overburden Storage Area	West Pit (Surficial Aquifer)	West Pit (Bedrock to SW-004)	West Pit (Bedrock to SW-004a)
I_ops	[--]	Minimum flowpath gradient (uniform distribution)	0	3.87E-03	9.47E-03	8.38E-03	8.88E-03	3.99E-03	0	0
		Maximum flowpath gradient (uniform distribution)	0	4.34E-03	1.02E-02	8.96E-03	9.50E-03	4.65E-03	0	0
I_close	[--]	Minimum flowpath gradient (uniform distribution)	8.05E-03	5.99E-03	0	0	0	8.97E-03	8.70E-03	9.07E-03
		Maximum flowpath gradient (uniform distribution)	8.59E-03	6.46E-03	0	0	0	9.63E-03	9.37E-03	9.73E-03
Thick	[m]	Aquifer thickness	15	5	5	5	5	5	15	15
EL_Pit	[ft]	Pit surficial outflow elevation	0	1577	0	0	0	1550	0	0
Width	[m]	Flowpath width	1735	1440	430	240	550	665	535	810
L_Upstream	[m]	Length upstream of stockpile	0	775	0	0	0	0	0	0
L_Stock	[m]	Source (stockpile) length	0	395	230	420	375	0	0	0
L_Eval_1	[m]	Length to Evaluation Point #1 (Dunka Rd.)	0	30	40	60	5	175	0	0
L_Eval_2	[m]	Length to Evaluation Point #2 (Prop. or river)	1435	140	1085	910	235	680	505	340
L_Eval_3	[m]	Length to Evaluation Point #3 (Average river)	440	780	60	340	985	650	1115	1160
L_Total	[m]	Total flowpath length	1875	2120	1415	1730	1600	1505	1620	1500
K_Flowpaths	[m/d]	Minimum hydraulic conductivity	0.001	0.82	0.24	0.41	2.06	0.39	0.001	0.001
		Most likely hydraulic conductivity (mode)	0.003	1.94	0.52	0.88	3.55	1.31	0.003	0.003
		Maximum hydraulic conductivity	0.010	5.49	1.31	2.20	6.17	4.73	0.010	0.010

Grey indicates a change in value since the previous publication

Table 1-17 Partridge River Reach Characteristics

Partridge River Evaluation Point	*[Segment_Length] Upstream Reach Length (m)*	*[Segment_Area] Cross Sectional Area (m^2)*	*[Wild_Rice_Locs] Wild Rice Location?*	*[Hardness_forStandard] Hardness used for Evaluating Standards (mg/L)**
SW-001	400	0.3	No	--
SW-002	4,800	2.0	No	--
SW-003	4,200	2.5	No	--
SW-004	6,600	4.8	No	102.5
SW-004a	1,300	13.8	No	105.5
SW-004b	5,200	20.6	No	--
SW-005	15,300	26.7	Yes	--
SW-006	5,200	28.0	No	--
Colby Lake	1,200	28.0	No	--

Notes

Dimensions shown are for the reach upstream of each evaluation point, wild rice location applies to the point itself

Based on GIS public waters shapefile data and PolyMet stream surveys

Wild rice locations based on MPCA staff guidance

* For non-discharge locations, the hardness used for evaluating hardness-based standards will be the modeled instantaneous hardness at that location. For locations receiving loading from project features, the hardness used will be the existing median measured hardness (values shown).

Cells highlighted grey indicate a change from previously published values

Table 1-18 Partridge River Tributary Areas

Year	[Contributing_Area] Incremental Tributary Area (acres)								
	SW-001	SW-002	SW-003	SW-004	SW-004a	SW-004b	SW-005	SW-006	Colby Lake
0	670	3,838	1,042	5,016	19,991	15,108	13,400	2,991	12,580
1	670	3,637	1,042	4,669	19,834	15,108	13,400	2,991	12,580
2	670	3,636	1,042	4,669	19,736	15,108	13,400	2,991	12,580
11	670	3,594	1,037	4,606	19,134	15,108	13,400	2,991	12,580
20	670	3,814	1,037	4,605	19,378	15,108	13,400	2,991	12,580
21	670	3,792	1,042	4,893	18,936	15,108	13,400	2,991	12,580
50	670	3,792	1,042	4,893	19,506	15,108	13,400	2,991	12,580
2000	670	3,792	1,042	4,893	19,506	15,108	13,400	2,991	12,580

Notes

Based on updated GIS shapefile data

* Area tributary to the West Pit during and after filling is not included (modeled seperately)

Cells highlighted grey indicate a change from previously published values

Table 1-20a Incremental Percent of Predicted Flow at SW-006 Entering Each Evaluation Point - January*

Year	SW001	SW-002	SW-003	SW-004	SW-004a	SW-004b	SW-005	SW-006	CL
0	1.06%	5.93%	2.04%	7.84%	31.82%	24.98%	21.66%	4.66%	20.00%
1	1.06%	5.64%	2.22%	7.40%	31.61%	25.20%	21.72%	4.81%	20.00%
2	1.06%	5.64%	2.23%	7.40%	31.46%	25.20%	21.06%	5.48%	20.00%
11	1.06%	5.58%	2.22%	7.30%	30.41%	25.19%	21.74%	4.82%	20.00%
20	1.06%	5.96%	2.24%	7.29%	30.86%	25.20%	21.73%	4.81%	20.00%
21	1.06%	5.93%	2.25%	7.77%	30.12%	25.19%	21.73%	4.82%	20.00%
50	1.06%	5.93%	2.25%	7.77%	31.12%	25.21%	21.73%	4.81%	20.00%
2000	1.06%	5.93%	2.25%	7.77%	31.12%	25.21%	21.73%	4.81%	20.00%

Table 1-20b Incremental Percent of Predicted Flow at SW-006 Entering Each Evaluation Point - February*

Year	SW001	SW-002	SW-003	SW-004	SW-004a	SW-004b	SW-005	SW-006	CL
0	1.24%	6.66%	1.56%	8.46%	31.20%	24.47%	21.24%	5.17%	20.00%
1	1.24%	6.33%	1.77%	7.99%	31.03%	24.70%	21.30%	5.32%	20.00%
2	1.24%	6.33%	1.77%	7.99%	30.87%	24.70%	20.64%	5.98%	20.00%
11	1.24%	6.27%	1.77%	7.88%	29.82%	24.70%	21.32%	5.32%	20.00%
20	1.24%	6.69%	1.76%	7.87%	30.26%	24.70%	21.31%	5.32%	20.00%
21	1.24%	6.66%	1.77%	8.39%	29.48%	24.70%	21.31%	5.32%	20.00%
50	1.24%	6.66%	1.77%	8.38%	30.49%	24.70%	21.30%	5.32%	20.00%
2000	1.24%	6.66%	1.77%	8.38%	30.49%	24.70%	21.30%	5.32%	20.00%

Table 1-20c Incremental Percent of Predicted Flow at SW-006 Entering Each Evaluation Point - March*

Year	SW001	SW-002	SW-003	SW-004	SW-004a	SW-004b	SW-005	SW-006	CL
0	1.52%	7.39%	1.65%	8.64%	33.54%	24.80%	16.51%	5.94%	20.00%
1	1.52%	7.02%	1.90%	8.14%	33.35%	25.06%	16.61%	6.09%	20.00%
2	1.52%	7.03%	1.90%	8.14%	33.18%	25.06%	15.97%	6.74%	20.00%
11	1.52%	6.95%	1.89%	8.02%	32.05%	25.09%	16.72%	6.08%	20.00%
20	1.52%	7.43%	1.88%	8.00%	32.52%	25.07%	16.65%	6.08%	20.00%
21	1.52%	7.39%	1.89%	8.55%	31.69%	25.07%	16.68%	6.08%	20.00%
50	1.52%	7.39%	1.89%	8.54%	32.77%	25.05%	16.60%	6.09%	20.00%
2000	1.52%	7.39%	1.89%	8.54%	32.77%	25.05%	16.60%	6.09%	20.00%

Table 1-20d Incremental Percent of Predicted Flow at SW-006 Entering Each Evaluation Point - April*

Year	SW001	SW-002	SW-003	SW-004	SW-004a	SW-004b	SW-005	SW-006	CL
0	1.13%	6.31%	1.54%	8.41%	31.47%	24.34%	21.91%	4.89%	20.00%
1	1.13%	6.01%	1.74%	7.95%	31.28%	24.57%	21.97%	5.04%	20.00%
2	1.13%	6.01%	1.74%	7.95%	31.12%	24.57%	21.31%	5.70%	20.00%
11	1.13%	5.95%	1.73%	7.84%	30.08%	24.57%	21.98%	5.04%	20.00%
20	1.13%	6.35%	1.73%	7.84%	30.52%	24.57%	21.97%	5.04%	20.00%
21	1.13%	6.32%	1.74%	8.34%	29.76%	24.57%	21.97%	5.04%	20.00%
50	1.13%	6.32%	1.74%	8.33%	30.76%	24.57%	21.97%	5.04%	20.00%
2000	1.13%	6.32%	1.74%	8.33%	30.76%	24.57%	21.97%	5.04%	20.00%

Percentages are incremental flow relative to SW-006 (i.e. total flow into Colby Lake is 120% of flow into SW-006)

Cells highlighted grey indicate a change from previously published values

Table 1-20e Incremental Percent of Predicted Flow at SW-006 Entering Each Evaluation Point - May*

Year	SW001	SW-002	SW-003	SW-004	SW-004a	SW-004b	SW-005	SW-006	CL
0	1.25%	5.57%	1.56%	7.84%	29.15%	24.49%	25.36%	4.78%	20.00%
1	1.25%	5.28%	1.74%	7.41%	28.98%	24.69%	25.40%	4.93%	20.00%
2	1.25%	5.29%	1.74%	7.41%	28.83%	24.68%	24.73%	5.59%	20.00%
11	1.25%	5.23%	1.73%	7.31%	27.86%	24.65%	25.35%	4.93%	20.00%
20	1.25%	5.60%	1.74%	7.32%	28.27%	24.67%	25.38%	4.93%	20.00%
21	1.25%	5.57%	1.75%	7.78%	27.56%	24.66%	25.37%	4.93%	20.00%
50	1.25%	5.57%	1.75%	7.78%	28.49%	24.69%	25.41%	4.93%	20.00%
2000	1.25%	5.57%	1.75%	7.78%	28.49%	24.69%	25.41%	4.93%	20.00%

Table 1-20f Incremental Percent of Predicted Flow at SW-006 Entering Each Evaluation Point - June*

Year	SW001	SW-002	SW-003	SW-004	SW-004a	SW-004b	SW-005	SW-006	CL
0	1.51%	7.03%	1.47%	8.89%	31.21%	24.69%	19.82%	5.36%	20.00%
1	1.51%	6.68%	1.70%	8.39%	31.05%	24.92%	19.90%	5.51%	20.00%
2	1.51%	6.69%	1.71%	8.39%	30.89%	24.93%	19.25%	6.17%	20.00%
11	1.51%	6.61%	1.70%	8.28%	29.83%	24.93%	19.95%	5.51%	20.00%
20	1.51%	7.07%	1.69%	8.27%	30.26%	24.93%	19.92%	5.51%	20.00%
21	1.51%	7.04%	1.70%	8.81%	29.45%	24.93%	19.93%	5.51%	20.00%
50	1.51%	7.04%	1.70%	8.81%	30.48%	24.92%	19.90%	5.51%	20.00%
2000	1.51%	7.04%	1.70%	8.81%	30.48%	24.92%	19.90%	5.51%	20.00%

Table 1-20g Incremental Percent of Predicted Flow at SW-006 Entering Each Evaluation Point - July*

Year	SW001	SW-002	SW-003	SW-004	SW-004a	SW-004b	SW-005	SW-006	CL
0	1.51%	5.91%	1.40%	8.01%	27.39%	23.62%	26.58%	5.58%	20.00%
1	1.51%	5.60%	1.60%	7.57%	27.25%	23.81%	26.61%	5.73%	20.00%
2	1.51%	5.61%	1.60%	7.57%	27.11%	23.81%	25.94%	6.38%	20.00%
11	1.51%	5.54%	1.60%	7.46%	26.17%	23.78%	26.53%	5.72%	20.00%
20	1.51%	5.94%	1.59%	7.46%	26.55%	23.80%	26.57%	5.73%	20.00%
21	1.51%	5.91%	1.60%	7.94%	25.83%	23.79%	26.56%	5.72%	20.00%
50	1.51%	5.91%	1.60%	7.94%	26.74%	23.81%	26.62%	5.73%	20.00%
2000	1.51%	5.91%	1.60%	7.94%	26.74%	23.81%	26.62%	5.73%	20.00%

Table 1-20h Incremental Percent of Predicted Flow at SW-006 Entering Each Evaluation Point - August*

Year	SW001	SW-002	SW-003	SW-004	SW-004a	SW-004b	SW-005	SW-006	CL
0	1.79%	7.04%	1.67%	8.35%	30.33%	23.78%	20.89%	6.15%	20.00%
1	1.79%	6.68%	1.90%	7.86%	30.18%	24.02%	20.96%	6.30%	20.00%
2	1.79%	6.68%	1.91%	7.85%	30.02%	24.02%	20.31%	6.95%	20.00%
11	1.79%	6.61%	1.90%	7.74%	28.98%	24.03%	20.98%	6.28%	20.00%
20	1.79%	7.08%	1.89%	7.71%	29.40%	24.02%	20.97%	6.29%	20.00%
21	1.79%	7.04%	1.90%	8.25%	28.60%	24.02%	20.97%	6.29%	20.00%
50	1.79%	7.05%	1.90%	8.25%	29.61%	24.01%	20.96%	6.30%	20.00%
2000	1.79%	7.05%	1.90%	8.25%	29.61%	24.01%	20.96%	6.30%	20.00%

Percentages are incremental flow relative to SW-006 (i.e. total flow into Colby Lake is 120% of flow into SW-006)
Cells highlighted grey indicate a change from previously published values

Table 1-20i Incremental Percent of Predicted Flow at SW-006 Entering Each Evaluation Point - September*

Year	SW001	SW-002	SW-003	SW-004	SW-004a	SW-004b	SW-005	SW-006	CL
0	1.52%	6.60%	1.73%	8.45%	29.81%	23.97%	22.11%	5.79%	20.00%
1	1.52%	6.26%	1.95%	7.97%	29.67%	24.19%	22.17%	5.94%	20.00%
2	1.52%	6.26%	1.95%	7.97%	29.51%	24.19%	21.51%	6.59%	20.00%
11	1.52%	6.19%	1.95%	7.86%	28.49%	24.20%	22.17%	5.93%	20.00%
20	1.52%	6.63%	1.95%	7.85%	28.90%	24.19%	22.17%	5.93%	20.00%
21	1.52%	6.60%	1.96%	8.37%	28.12%	24.19%	22.17%	5.93%	20.00%
50	1.52%	6.60%	1.96%	8.37%	29.11%	24.19%	22.17%	5.94%	20.00%
2000	1.52%	6.60%	1.96%	8.37%	29.11%	24.19%	22.17%	5.94%	20.00%

Table 1-20j Incremental Percent of Predicted Flow at SW-006 Entering Each Evaluation Point - October*

Year	SW001	SW-002	SW-003	SW-004	SW-004a	SW-004b	SW-005	SW-006	CL
0	1.25%	6.49%	1.64%	8.45%	31.15%	24.51%	21.26%	5.24%	20.00%
1	1.25%	6.16%	1.85%	7.98%	30.98%	24.73%	21.33%	5.39%	20.00%
2	1.25%	6.17%	1.85%	7.98%	30.82%	24.73%	20.67%	6.05%	20.00%
11	1.25%	6.10%	1.84%	7.87%	29.78%	24.73%	21.35%	5.39%	20.00%
20	1.25%	6.52%	1.84%	7.87%	30.21%	24.73%	21.34%	5.39%	20.00%
21	1.25%	6.49%	1.85%	8.38%	29.44%	24.73%	21.34%	5.39%	20.00%
50	1.25%	6.49%	1.85%	8.37%	30.44%	24.73%	21.33%	5.39%	20.00%
2000	1.25%	6.49%	1.85%	8.37%	30.44%	24.73%	21.33%	5.39%	20.00%

Table 1-20k Incremental Percent of Predicted Flow at SW-006 Entering Each Evaluation Point - November*

Year	SW001	SW-002	SW-003	SW-004	SW-004a	SW-004b	SW-005	SW-006	CL
0	0.87%	5.79%	1.76%	8.53%	28.92%	25.51%	24.50%	4.13%	20.00%
1	0.87%	5.51%	1.94%	8.08%	28.76%	25.70%	24.54%	4.28%	20.00%
2	0.87%	5.51%	1.94%	8.08%	28.61%	25.69%	23.87%	4.95%	20.00%
11	0.87%	5.46%	1.93%	7.97%	27.64%	25.65%	24.51%	4.30%	20.00%
20	0.87%	5.82%	1.95%	7.99%	28.04%	25.68%	24.53%	4.29%	20.00%
21	0.87%	5.79%	1.95%	8.47%	27.31%	25.67%	24.52%	4.29%	20.00%
50	0.87%	5.79%	1.95%	8.47%	28.25%	25.71%	24.55%	4.28%	20.00%
2000	0.87%	5.79%	1.95%	8.47%	28.25%	25.71%	24.55%	4.28%	20.00%

Table 1-20l Incremental Percent of Predicted Flow at SW-006 Entering Each Evaluation Point - December*

Year	SW001	SW-002	SW-003	SW-004	SW-004a	SW-004b	SW-005	SW-006	CL
0	0.92%	5.22%	2.14%	7.71%	30.39%	24.74%	24.90%	3.98%	20.00%
1	0.92%	4.96%	2.29%	7.29%	30.19%	24.95%	24.94%	4.13%	20.00%
2	0.92%	4.97%	2.30%	7.29%	30.04%	24.94%	24.27%	4.80%	20.00%
11	0.92%	4.92%	2.28%	7.19%	29.04%	24.92%	24.90%	4.15%	20.00%
20	0.92%	5.25%	2.32%	7.19%	29.47%	24.93%	24.92%	4.14%	20.00%
21	0.92%	5.22%	2.32%	7.65%	28.77%	24.93%	24.91%	4.14%	20.00%
50	0.92%	5.22%	2.32%	7.65%	29.72%	24.95%	24.95%	4.13%	20.00%
2000	0.92%	5.22%	2.32%	7.65%	29.72%	24.95%	24.95%	4.13%	20.00%

Percentages are incremental flow relative to SW-006 (i.e. total flow into Colby Lake is 120% of flow into SW-006)
Cells highlighted grey indicate a change from previously published values

Table 1-22a Groundwater Inflows to the Pits During Operations

	East Pit		Central Pit		West Pit	
Year	*[EP_GW_Inflow_Ops] Flow Rate (gpm)*	*[EP_GW_Surf_Ops] Surficial Percent*	*[CP_GW_Inflow_Ops] Flow Rate (gpm)*	*[CP_GW_Surf_Ops] Surficial Percent*	*[WP_GW_Inflow_Ops] Flow Rate (gpm)*	*[WP_GW_Surf_Ops] Surficial Percent*
0	0	100	0	100	0	100
1	220	19.0	0	100	0	100
2	190	13.5	0	100	60	98.3
3	210	8.5	0	100	40	96.3
4	250	5.5	0	100	30	93.9
5	450	2.4	0	100	30	91.4
6	430	2.2	0	100	50	95.6
7	420	2.1	0	100	40	90.9
8	460	1.9	0	100	40	85.4
9	690	1.2	0	100	30	81.3
10	710	1.2	0	100	30	74.4
10.75	760	0.8	30	99.6	80	91.0
11	760	0.8	30	99.6	80	91
12	760	0.8	20	96.5	50	86.8
13	700	0.8	10	92.6	50	83.8
14	710	0.7	10	87.1	40	81.6
15	710	0.7	10	75.8	40	77.9
16	*570*	*0.8*	*10*	*75.2*	40	75.3
17	*380*	*1.2*	*10*	*80.4*	40	72.3
18	*270*	*1.7*	*10*	*81.9*	40	70.4
19	*170*	*2.6*	*10*	*84.6*	40	67.1
20	*40*	*9.5*	*10*	*98.6*	40	63.7
2000	*90*	*4.8*	*10*	*100*	*40*	*64.4*

Note: Time series not used beyond year 15 for East/Central pit and year 20 for West Pit, values shown are necessary for input but not used in model. See Table 1-22b for inflow lookup in closure.

Cells highlighted grey indicate a change from previously published values

Table 1-22b Groundwater Inflows to the Pits During Backfilling and Closure

West Pit		
WS Elevation (ft)	*Flow Rate (gpm)*	*Surficial Percent*
940	50	80.1
1000	50	80.1
1100	50	80.6
1200	50	81.5
1320	50	83.7
1450	50	89.1
1579	30	98.4
1585	30	98.8

East Pit		
WS Elevation (ft)	*Flow Rate (gpm)*	*Surficial Percent*
1260	730	0.8
1360	710	0.7
1435	710	0.7
1485	570	0.8
1530	320	1.5
1565	190	2.4
1592	30	29.2
1595	20	53.2

Central Pit		
WS Elevation (ft)	*Flow Rate (gpm)*	*Surficial Percent*
1260	10	75.8
1360	10	75.3
1435	8	82.3
1485	7	85.5
1530	6	93.8
1565	6	98.6
1592	1	98.6
1595	6	100.0

Cells highlighted grey indicate a change from previously published values

Table 1-34 Waste Water Treatment Facility Effluent Targets

Constituent	*[WWTF_Effluent. WWTF_Targets] Operations Target Concentration (mg/L)*	*[WWTF_Effluent. WWTF_Targets_Reclam] Reclamation Target Concentration (mg/L)*	*[WWTF_Effluent. WWTF_Targets_LongTerm] Long-Term Target Concentration (mg/L)*
Ag	0.001	0.001	0.001
Al	0.125	0.125	0.125
Alk	-1	-1	-1
As	0.01	0.01	0.004
B	0.5	0.5	0.5
Ba	2	2	2
Be	0.004	0.004	0.004
Ca*	-1	-1	-1
Cd	0.004	0.004	0.002
Cl	230	230	230
Co	0.005	0.005	0.005
Cr	0.011	0.011	0.011
Cu	0.03	0.016	0.009
F	2	2	2
Fe	0.3	0.3	0.3
K	-1	-1	0.5
Mg*	-1	-1	-1
Mn	0.05	0.05	0.05
Na	-1	-1	-1
Ni	0.100	0.090	0.050
Pb	0.019	0.007	0.003
Sb	0.031	0.031	0.031
Se	0.005	0.005	0.005
SO_4	250	150	9
Tl	0.00056	0.00056	0.00056
V	0.05	0.05	0.05
Zn	0.388	0.200	0.100
Hardness	250	200	100

Notes

Source: RS29T and RS29T Appendix C

* Calcium and magnesium concentrations are limited by the target hardness concentration

Constituents without defined limits are assumed to not be removed by the WWTF

Change from previously published value

Table 1-24 Category 1 Release Distributions

Constituent	Method	Source	Units	Distribution	Mean/Mode	St. Dev.	Minimum	Maximum
Ag	Rate	HCT (1+2)*	mg Ag/kg/week	Lognormal	6.46E-06	2.11E-02	0	0
Al	Ca ratio	Anorthite Formula	mg Al / mg Ca	Constant	1.35E+00	0	0	0
Alkalinity	Rate	HCT (1+2)	mg Alk/kg/week	Beta	4.92E+00	2.21E+00	2.63E+00	1.15E+01
As	Rate	HCT (1+2)*	mg As/kg/week	Lognormal	1.85E-04	1.84E-04	0	0
B	Rate	HCT (1+2)*	mg B/kg/week	Lognormal	4.33E-03	1.27E-02	0	0
Ba	K ratio	Aqua Regia	mg Ba / mg K	Normal	2.90E-02	1.98E-04	0	0
Be	Rate	HCT (1+2)*	mg Be/kg/week	Lognormal	6.37E-06	4.61E-05	0	0
Ca	Rate	HCT (1+2)	mg Ca/kg/week	Beta	1.15E+00	3.48E-01	5.78E-01	2.34E+00
Cd	Zn rate ratio	HCT (2)	mg Cd / mg Zn	Beta	2.03E-02	5.10E-03	1.44E-02	4.44E-02
Cl	Flush	HCT (all)	mg Cl/kg	Beta	9.78E+00	1.17E+01	1.38E+00	7.30E+01
Co	Ni rate ratio	HCT (2)	mg Co / mg Ni	Beta	1.55E-01	5.11E-02	7.28E-02	3.11E-01
Cr	Rate	HCT (1+2)*	mg Cr/kg/week	Lognormal	5.90E-05	2.80E-05	0	0
Cu	S ratio	Aqua Regia	mg Cu / mg S	Normal	5.87E-01	2.51E-02	0	0
F	Rate	HCT (1+2)	mg F/kg/week	Beta	2.33E-02	1.08E-03	1.99E-02	2.52E-02
Fe	S ratio	Pyrrhotite microprobe	mg Fe / mg S	Beta	1.62E+00	8.72E-02	1.49E+00	1.92E+00
K	Rate	HCT (1+2)	mg K/kg/week	Beta	2.14E-01	9.17E-02	1.02E-01	4.98E-01
Mg	Rate	HCT (1+2)	mg Mg/kg/week	Beta	3.14E-01	2.04E-01	1.31E-01	1.10E+00
Mn	SO_4 rate ratio	HCT (2)	mg Mn / mg SO_4	Beta	1.96E-03	9.73E-04	1.15E-03	5.95E-03
Na	Rate	HCT (1+2)	mg Na/kg/week	Beta	4.13E-01	4.02E-01	1.28E-01	2.50E+00
Ni	S ratio	Cat 4 Aqua Regia	mg Ni / mg S	Normal	3.06E-02	1.86E-03	0	0
Pb	Rate	HCT (1+2)*	mg Pb/kg/week	Lognormal	6.56E-06	6.44E-06	0	0
Sb	Rate	Reactor*	mg Sb/kg/week	Lognormal	4.36E-04	4.81E-04	0	0
Se	SO_4 rate ratio	HCT (2)*	mg Se / mg SO_4	Lognormal	1.90E-05	2.32E-04	0	0
SO_4	Rate Regression	HCT (1+2)	mg SO_4/kg/week/%S	Normal	13.92	0.581	0	0
Tl	Rate	HCT (1+2)*	mg Tl/kg/week	Lognormal	7.00E-07	1.24E-05	0	0
V	Rate	HCT (1+2)*	mg V/kg/week	Lognormal	9.23E-07	1.77E-05	0	0
Zn	Mg ratio	Aqua Regia	mg Zn / mg Mg	Normal	1.52E-04	1.68E-04	0	0

TRUNCATED

1e10 mg/kg

Additional Distributions for Selected Constituents

Constituent	Method	Source	Units	Distribution	Mean/Mode	St. Dev.	Minimum	Maximum
Al	Na ratio	Albite Formula	mg Al / mg Na	Constant	1.17E+00	0	0	0
Fe	Mg ratio	Olivine microprobe	mg Fe / mg Mg	Beta	1.87E+00	6.75E-01	1.19E+00	4.51E+00
Ni	Mg ratio	Olivine microprobe	mg Ni / mg Mg	Beta	4.59E-03	1.95E-03	1.10E-04	7.43E-03

0 = not used

Notes

- Humidity cell data used through February 2011 unless noted otherwise
- HCT (1+2) indicates average rates from humidity cells over Condition 1 and Condition 2.
- HCT (2) indicates average rates from humidity cells over Condition 2.
- * indicates average rates from humidity cells over conditions noted with refined modeling of non-detects (see Section 8.1.2.1). Data used though December 2013.
- For Sb only the smaller MDNR-style reactors were used to estimate a release rate, including refined modeling of non-detects. Data used through February 2007
- Except for SO_4, all distributions from humidity cell data represent the full range of the observed values, with no weighting.
- Distributions from aqua regia data represent the uncertainty in the average ratios, weighted by geologic unit.
- Distributions from microprobe data represent the full range of the observed ratios for each mineral, with no weighting.
- For nickel, S ratio from Category 4 aqua regia data represents the effect of all sulfide minerals combined.
- For chloride, release is a one-time flush from newly-exposed waste rock with a distribution determined from all humidity cells combined.

Table 1-25 Category 2/3 Release Distributions

Constituent	Method	Source	Units	Distribution	Mean/Mode	St. Dev.	Minimum	Maximum
Ag	S ratio	Aqua Regia	mg Ag / mg S	Normal	1.32E-04	4.54E-06	0	0
Al	Ca ratio	Anorthite Formula	mg Al / mg Ca	Constant	1.35E+00	0	0	0
Alkalinity	Nonacidic rate	HCT (1+2)	mg Alk/kg/week	Beta	4.50E+00	2.59E+00	1.45E+00	1.10E+01
As	S ratio	Aqua Regia	mg As / mg S	Normal	1.67E-03	1.28E-04	0	0
B	Nonacidic rate	HCT (1+2)*	mg B/kg/week	Lognormal	5.84E-03	1.10E-03	0	0
Ba	K ratio	Aqua Regia	mg Ba / mg K	Normal	2.93E-02	5.69E-04	0	0
Be	K ratio	Aqua Regia	mg Be / mg K	Normal	1.87E-04	3.77E-06	0	0
Ca	SO_4 rate ratio	HCT (1+2)	mg Ca / mg SO_4	Beta	6.81E-01	4.29E-01	2.61E-01	2.59E+00
Cd	Zn rate ratio	HCT (2)	mg Cd / mg Zn	Beta	1.65E-02	1.20E-02	1.01E-03	5.84E-02
Cl	Flush	HCT (all)	mg Cl/kg	Beta	9.78E+00	1.17E+01	1.38E+00	7.30E+01
Co	Ni rate ratio	HCT (2)	mg Co / mg Ni	Beta	8.29E-02	3.91E-02	2.24E-02	2.06E-01
Cr	Nonacidic rate	HCT (1+2)*	mg Cr/kg/week	Lognormal	5.49E-05	2.19E-05	0	0
Cu	S ratio	Aqua Regia	mg Cu / mg S	Normal	3.59E-01	8.84E-03	0	0
F	Nonacidic rate	HCT (1+2)	mg F/kg/week	Beta	2.36E-02	1.45E-03	2.04E-02	2.74E-02
Fe	S ratio	Pyrrhotite microprobe	mg Fe / mg S	Beta	1.62E+00	8.72E-02	1.49E+00	1.92E+00
K	SO_4 rate ratio	HCT (1+2)	mg K / mg SO_4	Beta	1.29E-01	8.54E-02	5.39E-02	4.00E-01
Mg	SO_4 rate ratio	HCT (1+2)	mg Mg / mg SO_4	Beta	1.39E-01	1.06E-01	3.37E-02	4.96E-01
Mn	SO_4 rate ratio	HCT (2)	mg Mn / mg SO_4	Beta	2.81E-03	2.56E-03	4.36E-04	1.10E-02
Na	SO_4 rate ratio	HCT (1+2)	mg Na / mg SO_4	Beta	1.33E-01	9.29E-02	3.54E-02	4.51E-01
Ni	S ratio	Cat 4 Aqua Regia	mg Ni / mg S	Normal	3.06E-02	1.86E-03	0	0
Pb	S ratio	Aqua Regia	mg Pb / mg S	Normal	1.24E-03	5.95E-05	0	0
Sb	S ratio	Aqua Regia	mg Sb / mg S	Normal	6.53E-04	2.81E-05	0	0
Se	SO_4 rate ratio	HCT (2)	mg Se / mg SO_4	Beta	3.54E-05	1.67E-05	1.30E-05	9.16E-05
SO_4	Rate Regression	HCT (1+2)	mg SO_4/kg/week/%S	Normal	13.92	0.581	0	0
Tl	Nonacidic rate	HCT (1+2)*	mg Tl/kg/week	Lognormal	2.73E-06	8.15E-06	0	0
V	K ratio	Aqua Regia	mg V / mg K	Normal	2.32E-02	7.29E-04	0	0
Zn	Ni rate ratio	HCT (2)	mg Zn / mg Ni	Beta	3.35E-01	3.71E-01	3.31E-02	1.60E+00

Additional Distributions for Selected Constituents

Constituent	Method	Source	Units	Distribution	Mean/Mode	St. Dev.	Minimum	Maximum
Al	Na ratio	Albite Formula	mg Al / mg Na	Constant	1.17E+00	0	0	0
Fe	Mg ratio	Olivine microprobe	mg Fe / mg Mg	Beta	1.87E+00	6.75E-01	1.19E+00	4.51E+00
Ni	Mg ratio	Olivine microprobe	mg Ni / mg Mg	Beta	4.59E-03	1.95E-03	1.10E-04	7.43E-03

Acidic-Conditions Distributions for Selected Constituents

Constituent	Method	Source	Units	Distribution	Mean/Mode	St. Dev.	Minimum	Maximum
Alkalinity	Acidic rate	No release	mg Alk/kg/week	Constant	0	0	0	0
B	Acidic rate	HCT (3)	mg B/kg/week	Triangular	4.58E-04	0	4.58E-04	1.61E-02
Cr	Acidic rate	HCT (3)	mg Cr/kg/week	Triangular	9.17E-05	0	9.17E-05	1.06E-04
F	Acidic rate	HCT (3)	mg F/kg/week	Triangular	2.29E-02	0	2.27E-03	2.29E-02
Tl	Acidic rate	HCT (3)	mg Tl/kg/week	Triangular	9.17E-06	0	9.17E-06	2.29E-05

0 = not used

Notes

- Humidity cell data used through February 2011 unless noted otherwise.
- HCT (1+2) indicates average rates from humidity cells over Condition 1 and Condition 2.
- HCT (2) indicates average rates from humidity cells over Condition 2.
- HCT (3) indicates average rates from humidity cells over Condition 3.
- * indicates average rates from humidity cells over conditions noted with refined modeling of non-detects (see Section 8.1.2.1). Data used though December 2013.
- Except for SO4, all distributions from humidity cell data represent the full range of the observed values, with no weighting.
- Acidic release rate for SO_4 to be determined from nonacidic rate times an acidic increase factor, as discussed in Section 8.2.
- Distributions from aqua regia data represent the uncertainty in the average ratios, weighted by geologic unit.
- Distributions from microprobe data represent the full range of the observed ratios for each mineral, with no weighting.
- For nickel, S ratio from Category 4 aqua regia data represents the effect of all sulfide minerals combined.
- For chloride, release is a one-time flush from newly-exposed waste rock with a distribution determined from all humidity cells combined.

Table 1-26 Duluth Complex Category 4 Release Distributions

Constituent	Method	Source	Units	Distribution	Mean/Mode	St. Dev.	Minimum	Maximum
Ag	S ratio	Aqua Regia	mg Ag / mg S	Normal	3.30E-05	3.21E-06	0	0
Al	Ca ratio	Anorthite Formula	mg Al / mg Ca	Constant	1.35E+00	0	0	0
Alkalinity	Nonacidic rate	HCT (1+2)	mg Alk/kg/week	Beta	4.43E+00	2.60E+00	1.47E+00	1.10E+01
As	S ratio	Aqua Regia	mg As / mg S	Normal	1.40E-03	1.13E-04	0	0
B	Nonacidic rate	HCT (1+2)*	mg B/kg/week	Lognormal	9.99E-03	6.37E-03	0	0
Ba	K ratio	Aqua Regia	mg Ba / mg K	Normal	2.46E-02	1.17E-03	0	0
Be	K ratio	Aqua Regia	mg Be / mg K	Normal	3.30E-04	3.04E-05	0	0
Ca	SO_4 rate ratio	HCT (1+2)	mg Ca / mg SO_4	Beta	3.56E-01	1.26E-01	1.80E-01	7.91E-01
Cd	Zn rate ratio	HCT (2)	mg Cd / mg Zn	Beta	9.16E-03	5.39E-03	2.70E-03	3.15E-02
Cl	Flush	HCT (all)	mg Cl/kg	Beta	9.78E+00	1.17E+01	1.38E+00	7.30E+01
Co	Ni rate ratio	HCT (2)	mg Co / mg Ni	Beta	1.56E-01	7.51E-02	7.79E-02	4.64E-01
Cr	Nonacidic rate	HCT (1+2)*	mg Cr/kg/week	Lognormal	4.34E-05	7.03E-05	0	0
Cu	S ratio	Aqua Regia	mg Cu / mg S	Normal	6.81E-02	4.76E-03	0	0
F	Nonacidic rate	HCT (1+2)	mg F/kg/week	Beta	4.68E-02	4.78E-02	2.16E-02	3.37E-01
Fe	S ratio	Pyrrhotite microprobe	mg Fe / mg S	Beta	1.62E+00	8.72E-02	1.49E+00	1.92E+00
K	SO_4 rate ratio	HCT (1+2)	mg K / mg SO_4	Beta	1.00E-01	5.61E-02	2.61E-04	2.45E-01
Mg	SO_4 rate ratio	HCT (1+2)	mg Mg / mg SO_4	Beta	6.61E-02	4.17E-02	2.92E-02	2.00E-01
Mn	SO_4 rate ratio	HCT (2)	mg Mn / mg SO_4	Beta	2.94E-03	2.15E-03	5.94E-04	9.00E-03
Na	SO_4 rate ratio	HCT (1+2)	mg Na / mg SO_4	Beta	1.06E-01	1.02E-01	1.43E-02	4.51E-01
Ni	S ratio	Cat 4 Aqua Regia	mg Ni / mg S	Normal	3.06E-02	1.86E-03	0	0
Pb	S ratio	Aqua Regia	mg Pb / mg S	Normal	3.97E-04	4.33E-05	0	0
Sb	S ratio	Aqua Regia	mg Sb / mg S	Normal	1.30E-04	9.01E-06	0	0
Se	SO_4 rate ratio	HCT (2)	mg Se / mg SO_4	Beta	1.87E-05	9.12E-06	9.15E-06	4.91E-05
SO_4	Nonacidic rate	HCT (1+2)	mg SO_4/kg/week	Beta	1.27E+01	8.37E+00	3.74E+00	5.50E+01
Tl	Nonacidic rate	HCT (1+2)*	mg Tl/kg/week	Lognormal	7.36E-06	6.40E-06	0	0
V	K ratio	Aqua Regia	mg V / mg K	Normal	4.33E-02	3.24E-03	0	0
Zn	Ni rate ratio	HCT (2)	mg Zn / mg Ni	Beta	4.42E-01	6.69E-01	3.47E-02	3.50E+00

Additional Distributions for Selected Constituents

Constituent	Method	Source	Units	Distribution	Mean/Mode	St. Dev.	Minimum	Maximum
Al	Na ratio	Albite Formula	mg Al / mg Na	Constant	1.17E+00	0	0	0
Fe	Mg ratio	Olivine microprobe	mg Fe / mg Mg	Beta	1.87E+00	6.75E-01	1.19E+00	4.51E+00
Ni	Mg ratio	Olivine microprobe	mg Ni / mg Mg	Beta	4.59E-03	1.95E-03	1.10E-04	7.43E-03

Acidic-Conditions Distributions for Selected Constituents

Constituent	Method	Source	Units	Distribution	Mean/Mode	St. Dev.	Minimum	Maximum
Alkalinity	Acidic rate	No release	mg Alk/kg/week	Constant	0	0	0	0
B	Acidic rate	HCT (3)	mg B/kg/week	Beta	2.52E-03	2.33E-03	5.06E-04	1.00E-02
Cr	Acidic rate	HCT (3)	mg Cr/kg/week	Beta	1.07E-04	1.20E-05	9.34E-05	1.47E-04
F	Acidic rate	HCT (3)	mg F/kg/week	Beta	2.57E-02	4.30E-03	2.25E-02	4.19E-02
Tl	Acidic rate	HCT (3)	mg Tl/kg/week	Beta	1.54E-05	7.45E-06	9.73E-06	4.26E-05

0 = not used

Notes

- Humidity cell data used through February 2011 unless noted otherwise.
- HCT (1+2) indicates average rates from humidity cells over Condition 1 and Condition 2.
- HCT (2) indicates average rates from humidity cells over Condition 2.
- HCT (3) indicates average rates from humidity cells over Condition 3.
- * indicates average rates from humidity cells over conditions noted with refined modeling of non-detects (see Section 8.1.2.1). Data used though December 2013.
- All distributions from humidity cell data represent the full range of the observed values, with no weighting.
- Acidic release rate for SO4 to be determined from nonacidic rate times an acidic increase factor, as discussed in Section 8.2.
- Distributions from aqua regia data represent the uncertainty in the average ratios, weighted by geologic unit.
- Distributions from microprobe data represent the full range of the observed ratios for each mineral, with no weighting.
- For nickel, S ratio from Category 4 aqua regia data represents the effect of all sulfide minerals combined.
- For chloride, release is a one-time flush from newly-exposed waste rock with a distribution determined from all humidity cells combined.

NorthMet Mining Project GoldSim Water Quality Model
Phase 3 Quality Assurance

(independent review for Co-Lead Agencies by ERM)

Environmental Resources Management

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Date: February 25, 2013

Subject: NorthMet Mining Project GoldSim Water Quality Model - Phase 3 Quality Assurance

INTRODUCTION

This technical memorandum summarizes a series of Quality Assurance (QA) evaluations that were performed on two water quality models used to estimate environmental impacts associated with the proposed NorthMet Mining Project. The two models, one for the Mine Site and one for the Plant Site, were programmed using GoldSim®, a commercially available "systems" model. The models were developed by Barr Engineering Company (Barr) to estimate potential effects from the proposed mine on the quality and quantity of water resources. The QA audits were conducted by members of the ERM Project Team to provide technical support to the State of Minnesota in preparation of the NorthMet Mining Project and Land Exchange Supplemental Draft Environmental Impact Statement (SDEIS).

SUMMARY OF WORK AND CONCLUSIONS REGARDING THE GOLDSIM MINE SITE MODEL

The Phase 3 QA audit was performed on the version 4 (v4) NorthMet Project Mine Site GoldSim water-quality model that was run during January 2013. The current (v5) version of the model is not substantially different from the v4 version that was evaluated. Previously, the ERM Team conducted an audit of the version 3 (v3) GoldSim model that was run during September 2012. Results of the v3 audit are summarized in an ERM memorandum dated October 30, 2012 (Appendix A of this memorandum). The October 2012 audit was not a 100-percent verification of model calculations, but instead focused on select model components that are critical in the estimates of solute release/transport. A QA update conducted during January 2013 (Appendix B of this memorandum) provided a supplementary audit of additional model components at the Plant Site that were not evaluated previously or had changed due to modified inputs or GoldSim programming.

The January 2013 audit confirmed that model changes were appropriately incorporated into the v4 GoldSim model and the changes did not raise any QA concerns. The following evaluations were performed using a deterministic run of the v4 GoldSim model with P50 inputs:

- Re-evaluation of water quality in the West and East Pits.
- Evaluation of chemical migration in surficial groundwater flowpaths.
- Evaluation of chemical loading to the Partridge River caused by groundwater discharge from the surficial groundwater flowpaths.

Each of these evaluations is described in Appendix B.

Overall, the results of this audit provide good evidence that the v5 Mine Site GoldSim model has appropriate and mathematically correct algorithms for (1) estimating flows and chemical concentrations of impacted water leaving the Mine Site facilities, (2) simulating chemical migration in the surficial groundwater flowpaths, and (3) estimating Partridge River chemical concentrations caused by mixing of background and human-affected water sources to the river.

SUMMARY OF WORK AND CONCLUSIONS REGARDING THE GOLDSIM PLANT SITE MODEL

The Phase 3 QA audit was performed on the version 5 (v5) NorthMet Project Plant Site GoldSim water-quality model that was run during February 2013. Previously, the ERM Team conducted an audit of the version 3 (v3) GoldSim model that was run during September 2012. Results of the v3 audit are summarized in an ERM memorandum dated October 30, 2012 (Appendix A of this memorandum). The October 2012 audit was not a 100-percent verification of model calculations, but instead focused on select model components that are critical in the estimates of solute release/transport. A QA update conducted during February 2013 (Appendix C of this memorandum) provided a supplementary audit of additional model components at the Plant Site that were not evaluated previously or had changed due to modified inputs or GoldSim programming. The most important model changes that were made in going from v3 to v5 are the following:

- Revised chemical concentrations in the WWTP effluent based on pilot testing.
- Revised calibration factors for release of sulfate from fine and coarse LTVSMC tailings to provide consistency with previously agreed upon vanGenuchten parameters (CDF055).
- New GoldSim programming that effectively increased the flow rate of tailings-impacted groundwater that by-passes the containment system and enters surficial groundwater flowpaths (CDF061)
- Use of water from Colby Lake to augment streamflow in tributaries to the Embarrass River (CDF069 and CDF062).
- Modified watershed areas (CDF051).

The February 2013 audit confirmed that these model changes were appropriately incorporated into the v5 GoldSim model and the changes did not raise any QA concerns. The following evaluations were performed using a deterministic run of the v5 GoldSim model with P50 inputs:

- Re-evaluation of chemical release from subareas of the Flotation Tailings Basin (FTB).

- Evaluation of containment system bypass and associated chemical migration in surficial groundwater flowpaths.
- Evaluation of chemical loading to the Embarrass River caused by discharge of WWTP effluent, Colby Lake augmentation water, and discharge from the surficial groundwater flowpaths.

Each of these evaluations is described in Appendix C.

Overall, the results of this audit provide good evidence that the v5 Plant Site GoldSim model has appropriate and mathematically correct algorithms for (1) estimating flows and chemical concentrations of impacted water leaving the FTB, (2) simulating chemical migration in the surficial groundwater flowpaths, and (3) estimating Embarrass River chemical concentrations caused by mixing of background and human-affected water sources to the river.

OVERALL CONCLUSIONS

The Mine Site and Plant Site GoldSim models are very complex and contain thousands of lines of custom programming. It was not feasible to validate and check every line of code contain in the models. The approach taken by the ERM Team in the QA evaluations was to use a combination of independent calculations and profession judgment to identify potential problems with the codes and work with Barr to correct these issues.

There is good evidence that the v5 GoldSim models are functionally accurate and have addressed all issues identified by the ERM Team. The Team concludes that the v5 GoldSim models have acceptable reliability and can be used as a basis for assessing environmental impacts in the SDEIS.

Appendix A
NorthMet Quality Assurance
Memo October 29, 2012

Memorandum

Environmental Resources Management

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Date: October 30, 2012

Subject: Quality Assurance

INTRODUCTION

This memorandum summarizes the Quality Assurance (QA) evaluation of two models developed by Barr Engineering Company (Barr) for the proposed NorthMet Mining Project (Project), located in northern Minnesota. One model performs calculations for the Mine Site and the other for the Plant Site. The models are connected in that excess water from the Mine Site will be pumped to the Plant Site during operations (for use as process water), and chemically affected water from the Plant Site tailings collection system will be pumped to the West Pit component of the Mine Site during the first twenty years of closure. The models are designed to estimate chemical mass release rates from the various mine facilities and track water constituent migration from the facilities to evaluation locations in the groundwater flow system and at surface water features. The models are programmed using the commercially available GoldSim® software, which provides a platform for performing Monte Carlo simulations. The primary model output is the probabilistic prediction of chemical concentrations in surface water and groundwater.

Previous QA efforts were performed to verify that the models used the input values specified in the Mine Site and Plant Site Water Modeling Workplans. The objective of the subsequent QA evaluation was to provide independent verification that the models are correctly using formulas and algorithms presented in the Mine Site and Plant Site Water Modeling Data Packages. The inputs and equations presented in the Work Plans and Data Packages were previously agreed upon by Barr and the Minnesota Department of Natural Resources (MDNR). This QA evaluation did not assess their scientific validity or reliability.

This QA audit does not represent a complete verification of all model calculations. Instead, emphasis was placed on model components having the potential to generate the greatest amounts of chemical mass. At the Plant Site, the major components are the subareas of the Flotation Tailings Basin (FTB). At the Mine Site, the major components are the Cat 1 Stockpile, East Pit, Plant Site water pumped to the West Pit, and ore wall rock in the West Pit. Of these, water pumped from the Plant Site to the West Pit is the greatest source of chemical loading to the Mine

Site. If one considers the Plant and Mine Sites collectively, the FTB is the primary chemical source for the Project.

This model QA effort placed more emphasis on the closure period than the operations period. This is because mechanical Waste Water Treatment Plants (WWTPs) will be in operation during mining and for at least 20 years after mining. If unanticipated site conditions occur during this 40 year period (e.g., chemical concentrations higher than expected), the mine permit will likely require that the site operator upgrade the WWTPs as necessary to mitigate the situation. However, it is during longer-term closure that decisions will be made to scale-down operation of mechanical WWTPs or to replace them with non-mechanical treatment systems.

The primary method applied in this audit was to develop independent calculations that generally reproduce the GoldSim® model estimates for the load and/or concentration of chemicals released from selected NorthMet facilities. Examples include calculations to reproduce model-predicted water flows from various facilities, release rates for chemical mass generated through oxygen diffusion into tailings material, and kinetically-limited reaction rates of the pit wall rock.

There was minimal assessment of chemical release from facilities that are highly engineered to reduce mass loads and/or meet water quality criteria in discharge, such as wastewater treatment facilities or the temporary lined facilities for reactive rock. These do not contain significant uncertainty, and the designs could, if necessary, be modified to meet future unanticipated site conditions.

This evaluation focused on the release and transport of sulfate, which is the primary product of sulfide mineral oxidation and is the basis for estimating the release of most other chemicals. Other chemicals evaluated included 5 of the 28 water-quality constituents tracked in the GoldSim® models: arsenic, cobalt, copper, nickel, and zinc. These six constituents were selected because preliminary assessments indicated a possibility that they could be released from mine rock at rates high enough to exceed surface water and/or groundwater regulatory standards.

This evaluation did not focus on pathways that connect the chemical-generating components to the groundwater and surface water compliance points. As currently proposed, the Project will use mechanical water treatment and discharge for as long as necessary to meet water-quality objectives. If necessary, the mechanical treatment plants will be modified during operations and closure to ensure that applicable discharge requirements are met. Because site-wide mine water treatment will not rely on hydrologic or geochemical processes occurring in groundwater or surface water pathways, the modeling of these pathways is not of critical importance to regulatory decision making.

PRINCIPAL FINDINGS

The Review Team identified a number of calculation issues early in the QA process and these were resolved with Barr. With one exception, the Review Team did not identify any new issues that would potentially require a major model modification and new model output. The excepted issue pertains to sulfate generation below bentonite-amended subareas of the FTB. This issue is discussed in a subsequent section of this memorandum. A complete log of all model issues identified by either the model development team or the Review Team is included as Attachment 3.

In the Review Team's opinion, the current models are a reasonable platform for assessing design concepts and closure strategies. However, the Review Team has concerns regarding use of the models to make regulatory decisions that need to be based on the models' absolute predictive accuracy. The Review Team questions whether these models (or any other model) could provide accurate predictions of what will happen at a very complicated site 50 or 100 years in to the future.

The above issue becomes more apparent when one recognizes the numerous assumptions and calibration/correction factors contained in the models. For example, a suite of factors are applied to the LTVSMC humidity test results that reduce the model-simulated leach rates to a fraction of what was observed during the tests. For sulfate, the reduction ranges from 94 to 97 percent, but for some metals, the reduction is many orders of magnitude. Many of these factors were determined by calibrating the existing-conditions model to measured chemical concentrations in groundwater and surface water, but it is uncertain how well these factors will apply to future conditions. In addition, each calibration factor is treated as deterministic input, so its scientific uncertainty is not incorporated into the Monte Carlo (probabilistic) analyses. Conversely, no calibration factors are applied to the humidity cell results for NorthMet tailings, although it would be consistent to reduce the model-simulated leaching rates for these materials as well.

With regard to the model components that have been checked, the Review Team did not identify any components that appear to be producing sulfur or other chemical constituents at rates significantly different than what the Review Team computed independently (using equations and inputs mutually agreed upon by Barr and MDNR) or in conflict with the Review Team's professional judgment. While this is a favorable outcome, it does not constitute a complete certification of the GoldSim® models.

SPECIFIC MODEL ISSUES

Cat 1 Stockpile Concentration Caps

Independent calculations show that seepage from the Cat 1 Stockpile will have chemical concentrations at maximum values mutually agreed upon by Barr and MDNR (referred to as concentration caps). Table 1 presents a MathCad® calculation worksheet showing concentration caps for five chemical constituents. The blue entries in the table are the 50% probability (P50) values extracted from the GoldSim® Mine Site model. As shown, there is good agreement between the GoldSim® model values and concentrations independently calculated using mutually agreed upon inputs.

Chemical Generation from FTB Tailings

For the FTB, independent calculations were performed by the Review Team to check chemical generation rates for both LTVSMC tailings and NorthMet tailings during closure. Each independent calculation was programmed into a MathCad® calculation worksheet that automatically performed unit conversions and provided a printed record. Based on P50 input values, examples of the independent chemical release calculations are provided in Attachment 2. On these worksheets, blue entries are values extracted from a deterministic GoldSim® model run using P50 inputs. As shown, there is generally very good agreement between the GoldSim® model values and the independent calculations made outside the model.

To assess the sulfate load to the Plant Site WWTP during closure, the independent calculations for each subarea of the Tailings Basin are summarized in Table 2. The blue entries in this table are values extracted from the deterministic GoldSim® Plant Site model using P50 inputs. As shown there is generally good agreement between the independent calculations and the GoldSim® model results. The independently estimated flow rate to the WWTP is 1795 gpm, which is very close to the GoldSim® model estimate of 1783 gpm. The independently estimated sulfate mass flux of 2511 kg/day to the WWTP is reasonably close to the GoldSim® model value of 2656 kg/day. The independently estimated sulfate concentration to the WWTP is 257 mg/L, which compares favorably to the GoldSim® model estimate of 273 mg/L.

Table 3 shows a similar comparison for copper. For input to the WWTP, the independent calculations give a mass flux of 1.34 kg/day and a copper concentration of 0.137 mg/L. These values are very close to the GoldSim® model estimates of 1.29 kg/day and 0.133 mg/L.

The relatively good agreement between the GoldSim® model results and independent calculations performed outside the model suggests that the FTB inputs and algorithms mutually agreed upon by Barr and MDNR have been properly incorporated into the GoldSim® model.

Table 1 Cat 1 Concentration Caps

Cat 1 seepage concentration from deterministic GoldSim model with P50 inputs at t = 500 years

Sulfate (solubility equation)

$Mg := \frac{0.235127}{24.305}$ — P50 magnesium release rate in mmole/kg/week (Table 1-24 and GoldSim to compute P50 value) — $Mg = 9.674 \times 10^{-3}$

$Ca := \frac{1.10426}{40.078}$ — P50 calcium release rate in mmole/kg/week (Table 1-24 and GoldSim to compute P50 value) — $Ca = 0.028$

$K := \frac{0.191692}{39.0983}$ — P50 potassium release rate in mmole/kg/week (Table 1-24 and GoldSim to compute P50 value) — $K = 4.903 \times 10^{-3}$

$Na := \frac{0.227726}{22.989}$ — P50 sodium release rate in mmole/kg/week (Table 1-24 and GoldSim to compute P50 value) — $Na = 9.906 \times 10^{-3}$

$CAP_{SO4} := \left[1294 \cdot \frac{(Mg + 0.5 \cdot Na + 0.5 \cdot K)}{Ca} + 1760\right] \cdot \frac{mg}{L}$ — SO4 concentration cap computed from P50 values (equation in Table 1-30) — $CAP_{SO4} = 2562 \cdot \frac{mg}{L}$ — 2562

Copper (based on pH and AMAX data)

$pH := 7.25$ — Assumed Cat 1 pH with geomembrane cover — $pH = 7.25$

$CAP_{Cu} := \frac{(0.200 + 0.178 + 0.260 + 0.340)}{4} \cdot \frac{mg}{L}$ — P50 copper concentration cap from pH based values (Table 1-30) — $CAP_{Cu} = 0.244 \cdot \frac{mg}{L}$ — 0.237

Zinc (based on pH and AMAX data)

$pH := 7.25$ — Assumed Cat 1 pH with geomembrane cover — $pH = 7.25$

$CAP_{Zn} := \frac{(0.133 + 0.170 + 0.230 + 0.230)}{4} \cdot \frac{mg}{L}$ — P50 zinc concentration cap from pH based values (Table 1-30) — $CAP_{Zn} = 0.191 \cdot \frac{mg}{L}$ — 0.186

Nickel (based on pH and AMAX data)

$pH := 7.25$ — Assumed Cat 1 pH with geomembrane cover — $pH = 7.25$

$CAP_{Ni} := \frac{(1.62 + 2.08 + 2.29 + 3.42)}{4} \cdot \frac{mg}{L}$ — P50 nickel concentration cap from pH based values (Table 1-30) — $CAP_{Ni} = 2.353 \cdot \frac{mg}{L}$ — 2.267

Cobalt (based on pH and AMAX data)

$pH := 7.25$ — Assumed Cat 1 pH with geomembrane cover — $pH = 7.25$

$CAP_{Co} := \frac{(0.093 + 0.1368 + 0.120 + 0.150)}{4} \cdot \frac{mg}{L}$ — P50 cobalt concentration cap from pH based values (Table 1-30) — $CAP_{Co} = 0.125 \cdot \frac{mg}{L}$ — 0.123

Cat 1 seepage concentrations are at concentration caps at the end of simulation (t = 500 yrs)

Table 2. Sulfate - Plant Site During Closure

P50 rainfall = 27.818

Tailings Basin Sub-Area	Tailings Material	Bentonite Amended	Area	Perc	Flow	Sulfur MRA	Sulfate MR	Check GoldSim t=100 yrs	Flow Distribution N	NW	W	S	Flow Rate (Q) N	NW	W	S	Mass Rate (MR) N	NW	W	S
			acre	in/yr	gpm	mg/m2/week	kg/day	kg/day	%	%	%	%	gpm	gpm	gpm	gpm	kg/day	kg/day	kg/day	kg/day
North Dam banks (outer slopes)	LTV bulk (other)	Operations and closure	249.00	6.07	78.08	24.22	10.44	10.10	100	0	0	0	78.08	0.00	0.00	0.00	10.44	0.00	0.00	0.00
East Dam banks (outer slopes)	LTV bulk (other)	Operations and closure	40.00	6.07	12.54	24.22	1.68	1.68	100	0	0	0	12.54	0.00	0.00	0.00	1.68	0.00	0.00	0.00
South Dam banks (outer slopes)	LTV bulk (other)	Operations and closure	91.00	6.07	28.54	24.22	3.82	3.81	0	0	0	100	0.00	0.00	0.00	28.54	0.00	0.00	0.00	3.82
North Beach	35% NM fine, 65% NM coarse	Closure only	75.67	6.07	23.73	233.99	30.66	30.53	100	0	0	0	23.73	0.00	0.00	0.00	30.66	0.00	0.00	0.00
East Beach	35% NM fine, 65% NM coarse	Closure only	45.61	6.07	14.30	233.99	18.48	15.41	100	0	0	0	14.30	0.00	0.00	0.00	18.48	0.00	0.00	0.00
South Beach	35% NM fine, 65% NM coarse	Closure only	103.08	6.07	32.32	233.99	41.77	34.79	3.8	0	0	96.2	1.23	0.00	0.00	31.10	1.59	0.00	0.00	40.18
Closure Beach	35% NM fine, 65% NM coarse	Closure only	188.64	6.07	59.15	233.99	76.44	64.79	84.8	0	0	15.2	50.16	0.00	0.00	8.99	64.82	0.00	0.00	11.62
Pond	n/a	Closure (after 30 years)	972.60	6.50	326.59		58.43		81	0	0	19	264.54	0.00	0.00	62.05	47.33	0.00	0.00	11.10
1E coarse	LTV coarse	none	3.38	2.68	0.47	1167.29	6.83	4.59	0	0	0	100	0.00	0.00	0.00	0.47	0.00	0.00	0.00	6.83
1E fine	LTV fine	none	0.00	2.19					1.5	31.7	7	59.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2E coarse	LTV coarse	none	0.00	5.04					1.5	98.5	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2E fine	LTV fine	none	0.00	3.92					100	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2E other	LTV coarse	none	75.29	5.50	21.40	518.25	67.57	67.25	98.6	1.4	0	0	21.10	0.30	0.00	0.00	66.63	0.95	0.00	0.00
2W coarse	LTV coarse	none	220.08	13.27	150.86	1539.87	586.91	575.76	14.6	31.1	35.2	19.1	22.03	46.92	53.10	28.81	85.69	182.53	206.59	112.10
2W fine	LTV fine	none	748.07	15.93	615.75	727.95	943.09	940.79	8.9	55.5	35.4	0.2	54.80	341.74	217.97	1.23	83.94	523.42	333.85	1.89
2W banks	LTV coarse	none	339.18	7.82	136.97	1073.15	630.38	619.96	11.1	36.1	41.6	11.2	15.20	49.45	56.98	15.34	69.97	227.57	262.24	70.60
South Buttress banks	Assumed Cat 1 waste rock	none	15.00	13.24	10.26		7.53		0.0	0.0	0.0	100.0	0.00	0.00	0.00	10.26	0.00	0.00	0.00	7.53
North Buttress banks	Assumed Cat 1 waste rock	none	45.00	13.24	30.78		26.51		100.0	0.0	0.0	0.0	30.78	0.00	0.00	0.00	26.51	0.00	0.00	0.00
													GW to Individual Collection Systems				507.74	934.46	802.68	265.67
																	637.80	927.10	804.00	286.80
Total GW to Collection System													GW to Combined Collection			Total -->	1541.73			Total -->	2510.55
SW Runoff to Collection Systems													SW Runoff to Combined Collection				253.47				0.00
Total Average to WWTP													Total Average to WWTP				**1795.20**				**2510.55**
																Check	1783.40			Check	2655.70
																			Concentration to WWTP (mg/L)		**256.55**
																				Check	273.18

Blue entries are values extracted from the GoldSim model
Red entries from Mathcad worksheets
All values are independently calculated using inputs and equations mutually agreed upon by the Agencies and Barr.
Values in this table compare favorably to GoldSim output.

MRA Mass rate of chemical release per unit map area
MR Mass rate of chemical release

N North Toe
NW Northwest Toe
W West Toe
S South Toe

Table 3. Copper - Plant Site During Closure

Tailings Basin Sub-Area	Tailings Material	Bentonite Amended	Flow gpm	From Table 2 Sulfate MR kg/day	Sulfur MR kg/day	Ratio to Sulfur R mg/mg	Calib Factor C	Conc Cap if used Cap mg/L	Copper MR kg/day	Check GoldSim t=100 yrs kg/day	Flow Distribution N %	NW %	W %	S %	Flow Rate (Q) N gpm	NW gpm	W gpm	S gpm	Mass Rate (MR) N kg/day	NW kg/day	W kg/day	S kg/day
North Dam banks (outer slopes)	LTV bulk (other)	Operations and closure	78.08	10.44	3.49	3.10E-02	0.0005		5.40E-05	5.34E-05	100	0	0	0	78.08	0.00	0.00	0.00	5.40E-05	0.00E+00	0.00E+00	0.00E+00
East Dam banks (outer slopes)	LTV bulk (other)	Operations and closure	12.54	1.68	0.56	3.10E-02	0.0005		8.68E-06	8.57E-06	100	0	0	0	12.54	0.00	0.00	0.00	8.68E-06	0.00E+00	0.00E+00	0.00E+00
South Dam banks (outer slopes)	LTV bulk (other)	Operations and closure	28.54	3.82	1.27	3.10E-02	0.0005		1.97E-05	1.95E-05	0	0	0	100	0.00	0.00	0.00	28.54	0.00E+00	0.00E+00	0.00E+00	1.97E-05
North Beach	35% NM fine, 65% NM coarse	Closure only	23.73					0.5157	6.67E-02		100	0	0	0	23.73	0.00	0.00	0.00	6.67E-02	0.00E+00	0.00E+00	0.00E+00
East Beach	35% NM fine, 65% NM coarse	Closure only	14.30					0.5157	4.02E-02		100	0	0	0	14.30	0.00	0.00	0.00	4.02E-02	0.00E+00	0.00E+00	0.00E+00
South Beach	35% NM fine, 65% NM coarse	Closure only	32.32					0.5157	9.09E-02		3.8	0	0	96.2	1.23	0.00	0.00	31.10	3.45E-03	0.00E+00	0.00E+00	8.74E-02
Closure Beach	35% NM fine, 65% NM coarse	Closure only	59.15					0.5157	1.66E-01		84.8	0	0	15.2	50.16	0.00	0.00	8.99	1.41E-01	0.00E+00	0.00E+00	2.53E-02
Pond	LTV	Closure (after 30 years)	326.59					0.5157	9.18E-01		81	0	0	19	264.54	0.00	0.00	62.05	7.44E-01	0.00E+00	0.00E+00	1.74E-01
1E coarse	LTV coarse	none	0.47	6.83	2.28	3.10E-02	0.0005		3.53E-05	3.49E-05	0	0	0	100	0.00	0.00	0.00	0.47	0.00E+00	0.00E+00	0.00E+00	3.53E-05
1E fine	LTV fine	none									1.5	31.7	7	59.8	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2E coarse	LTV coarse	none									1.5	98.5	0	0	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2E fine	LTV fine	none									100	0	0	0	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2E other	LTV coarse	none	21.40	67.57	22.56	3.10E-02	0.0005		3.49E-04	3.45E-04	98.6	1.4	0	0	21.10	0.30	0.00	0.00	3.44E-04	4.89E-06	0.00E+00	0.00E+00
2W coarse	LTV coarse	none	150.86	586.91	195.91	3.10E-02	0.0005		3.03E-03	3.00E-03	14.6	31.1	35.2	19.1	22.03	46.92	53.10	28.81	4.43E-04	9.43E-04	1.07E-03	5.79E-04
2W fine	LTV fine	none	615.75	943.09	314.80	3.10E-02	0.0005		4.87E-03	4.82E-03	8.9	55.5	35.4	0.2	54.80	341.74	217.97	1.23	4.34E-04	2.70E-03	1.72E-03	9.75E-06
2W banks	LTV coarse	none	136.97	630.38	210.42	3.10E-02	0.0005		3.26E-03	3.22E-03	11.1	36.1	41.6	11.2	15.20	49.45	56.98	15.34	3.62E-04	1.18E-03	1.35E-03	3.65E-04
South Buttress banks	Assumed Cat 1 waste rock	none	10.26						1.33E-02	1.33E-02	0.0	0.0	0.0	100.0	0.00	0.00	0.00	10.26	0.00E+00	0.00E+00	0.00E+00	1.33E-02
North Buttress banks	Assumed Cat 1 waste rock	none	30.78						3.44E-02	3.44E-02	100.0	0.0	0.0	0.0	30.78	0.00	0.00	0.00	3.44E-02	0.00E+00	0.00E+00	0.00E+00

Theoretical result over-ridden by concentration cap

GW to Individual Collection Systems	588.49	438.40	328.06	186.79	1.0309 0.0048 0.0041 0.3014
					0.9996 0.0050 0.0044 0.2850
GW to Combined Collection			Total -->	1541.73	Total --> 1.3413
SW Runoff to Combined Collection				253.47	0.0000
Total Average to WWTP				**1795.20**	**1.3413**
			Check	1783.40	1.2939

Total GW to Collection System
SW Runoff to Collection Systems
Total Average to WWTP

Blue entries are values extracted from the GoldSim model

All values are independently calculated using inputs and equations mutually agreed upon by the Agencies and Barr.
Values in this table compare favorably to GoldSim output.

Concentration to WWTP (mg/L) **0.1371**
Check 0.1330

R Ratio of copper mass to sulfur mass
MR Mass rate of chemical release

N North Toe
NW Northwest Toe
W West Toe
S South Toe

Sulfate Generation in Bentonite-Amended Subareas of the FTB

The Review Team questioned the method used by the model to compute sulfur generation below bentonite-amended subareas of the FTB and proposed a different mathematical approach when the availability of oxygen is limited by diffusion through the bentonite-amended layer. In comparing the two methods, it was found that the Review Team's approach computed sulfur production rates similar to those computed by the model (within a factor of 2). The Review Team concluded that the current model could be improved with regard to sulfur generation below bentonite-amended subareas, but the potential errors are not large compared to the higher sulfur generation rates in other subareas of the FTB. Given these considerations, the Review Team did not recommend modifying the current model for this QA audit. However, the issue should be revisited at a later time when the model is modified for other reasons.

Chemical Generation from Wall Rock in the West Pit

The audit of West Pit water quality predictions used independent calculations to check the predicted chemical loads from wall-rock to the West Pit Lake and evaluated whether the concentration caps that impart limits on maximum solute concentrations in the lake were applied correctly.

Results indicate that the GoldSim® model successfully applied concentration caps to all of the evaluated constituents that were predicted to reach their caps (nickel, copper, cobalt, and arsenic). Concentrations reported by the GoldSim® model when these solutes were at their caps were slightly different from the 50th percentile cap values (e.g., relative percent differences <30%), but this may reflect the difference between median model results and results run using median values for all parameters. This discrepancy is small relative to the reported uncertainty in GoldSim predictions.

The audit matched well with the GoldSim® model estimates for cumulative solutes loads to the West Pit from the two wall rock units evaluated: the Cat 4 Duluth Complex (a reactive rock, but a minor source of metals due to its small surface area), and Ore (a dominant source of nickel, cobalt, and copper to the West Pit Lake due to its high reactivity, metal content, and pit-wall area). The audit analyzed the period during active mining (years 1 to 20) when solutes leached from wall rock will be captured in a sump, and the 25 years after mining (years 20 to 45) when the West Pit Lake is filling and wall-rock loading includes continued leaching by runoff plus the release of stored solutes in the wall rock that will be leached out when the rock is inundated. The audit provided a good match to cumulative loading predicted by the GoldSim® model for all evaluated solutes except copper, which indicated higher loading than predicted by the GoldSim® model. This difference is consistent with the prediction that modeled copper loading to the West Pit will be limited continuously by the copper solubility cap. The audit did not account for the reduction in wall-rock loading caused by solubility caps, and thus overestimated copper loading relative to the GoldSim® model. The audit of the West Pit is described in more detail in Attachment 1.

Chemical Generation in the East Pit

The East Pit is essentially an engineered system with runoff and inflow pumped and treated from a sump during operations. Eventually the pit is backfilled with acid-generating waste rock, flooded, and actively pumped and treated to reduce water solute concentrations to water-quality

thresholds. In addition, mine plans retain an option to treat the rock backfilled to the East Pit to neutralize acidity which will reduce initial pore-water concentrations to the concentration caps for Category 1 rock, thereby further reducing the need for water treatment. As a result, the loading from wall rock and backfill was not replicated in detail as part of this audit. The audit instead evaluated whether the GoldSim ® model predictions effectively limited pore-water concentrations to the values for neutral Cat 1 rock.

Results indicated that the GoldSim® model correctly applied the pore water concentration caps to all evaluated solutes when the backfilled rock is first flooded (year 11). The concentrations predicted in the GoldSim® model match the Cat 1 caps for sulfate, arsenic, and antimony. The caps applied in the GoldSim ® model to cobalt, copper, and nickel exceed the neutral Cat 1 concentration caps, reflecting the use of intermediate caps for these metals (e.g., caps applicable to Cat 2/3/4 Duluth Complex rock under non-acidic conditions). More detailed information on the audit of the East Pit is provided in Attachment 1.

ATTACHMENT 1: AUDIT OF GOLDSIM® WATER QUALITY MODEL FOR WEST PIT AND EAST PIT, POLYMET NORTHMET PROJECT

Houston Kempton, Knight Piesold

Prepared in coordination with Interralogic, Inc.

29 October 2012

SCOPE OF THE GOLDSIM WATER QUALITY MODEL AUDIT FOR THE NORTHMET WEST AND EAST PITS

This audit is intended to confirm that the calculations used in the GoldSim model to estimate water quality in the West and East Pits of the NorthMet project have used the assumptions and parameter values presented in the supporting work plans and data packages and have been performed accurately. The audit is not a 100-percent verification of model calculations, but does focus on evaluating the model components that are most critical for estimating water management costs so that discharges meet regulatory thresholds during and after the NorthMet project. This audit is based on model parameter values and model results presented in the 26 September 2012 version of the NorthMet GoldSim water quality model provided by Barr Engineering.

This audit of the pit water quality included 6 of the 28 water-quality constituents included in the full GoldSim modeling: arsenic, antimony, copper, cobalt, nickel, and sulfate. These six were selected because preliminary assessments have indicated a reasonable possibility that they could be released from mine rock at rates high enough to exceed surface or groundwater thresholds at the NorthMet Mine. (Magnesium was not a primary target of this audit, but is included in some audit results because it is a required component in calculating the release of nickel from some mine rock).

The audit calculations are deterministic, using the 50th percentile (i.e., P50) value for model parameters. Audit results are then compared results to either deterministic GoldSim results that also used median parameter values, or to median results from probabilistic GoldSim runs. Uncertainty in model predictions is based on the probability distributions for specific model parameter, and the accuracy of these distributions was demonstrated in Task 1 of this audit, completed in February 2012.

West Pit

The audit of West Pit water quality predictions conducted independent calculations to check the predicted pollutant loads from wall-rock to the West Pit Lake, and evaluate whether the "concentration caps" that impart limits on maximum solute concentrations in the lake were applied correctly. The estimates of solute loads from the various sources were "Control Volume" file produced by running GoldSim in deterministic model using P50 values for model parameters. GoldSim considered loads from 11 different sources to the West Pit: Runoff, Groundwater, East Pit Wetland, East Pit Porewater, WWTF Return Water, In-pit Blast Ore, Cat

1 Stockpile, Cat 1 Wallrock, Cat 2/3 Wallrock, Cat 4 Wallrock, Ore Wallrock, Tailings Basin Water.

In keeping with the project's emphasis on using an adaptive management approach to meet water quality thresholds, the audit focused on the major uncontrolled sources of pollutants. Thus the external loads (i.e., sources delivered from other facilities to the West Pit, such as WWTF Return Water or Cat 1 Stockpile), were omitted from the West Pit Lake audit. The predicted external load to the West Pit is dominated by two facilities: Discharge from the Tailings Basin, which is evaluated separately in the main body of this audit report; and Waste Water Treatment Facility discharge, which will be engineered to meet discharge thresholds.

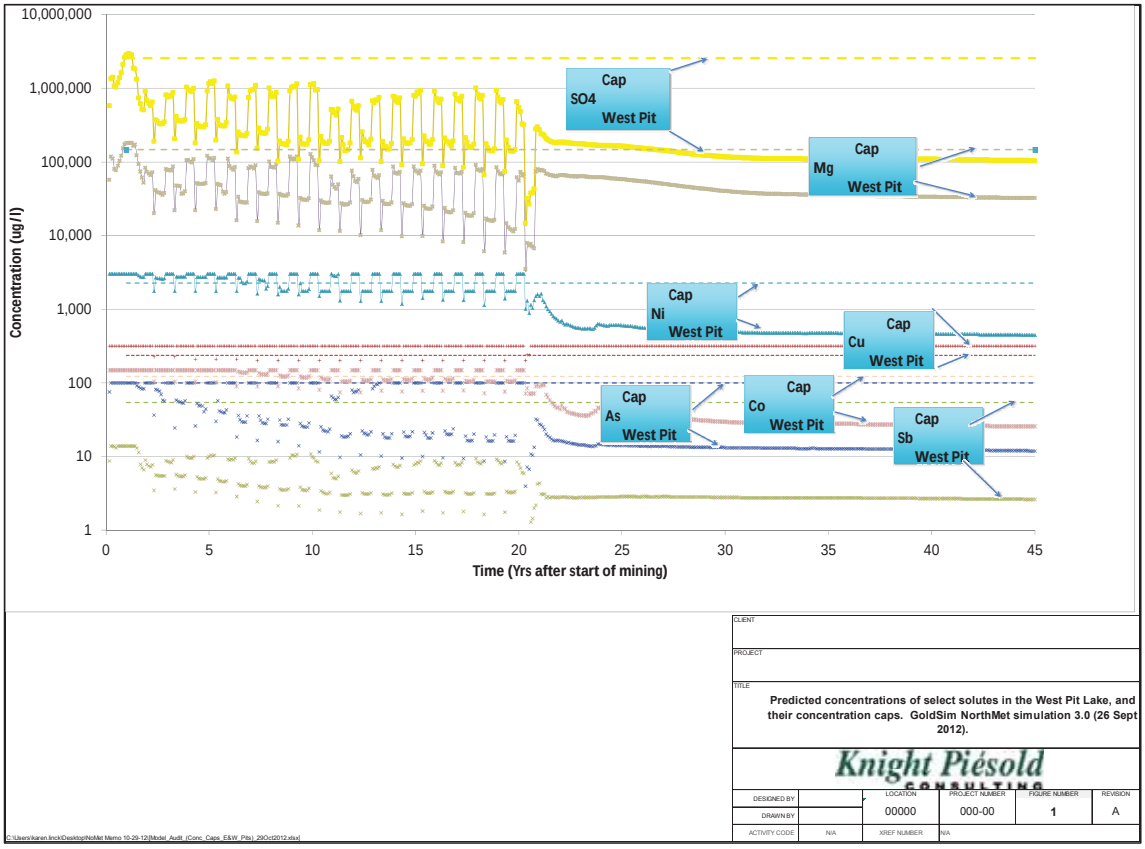
The West Pit Lake audit consisted of reproducing calculated loads for two in-pit sources: The Cat 4 Duluth Complex Wall rock, which is predicted to be a minor source of metals (included in the audit to confirm that it was in fact a minor contributor of pollutants), and the ore wall rock, which is predicted to be the dominant source of nickel, cobalt, and copper to the West Pit Lake. The Cat 4 Duluth Complex wall rock is a reactive acid-generating material, but is predicted to have a minor load due to the small area of this material in the pit walls. The Ore wall rock is a similarly reactive acid-generating material, but is a large contributor because of its large surface area in the pit walls and greater concentrations of metals. The estimates for wall rock loads to the West Pit were tracked in GoldSim as "Mine Site Control Volume 2," and were reported in spreadsheet files "MineSite_CV2.xlsx."

Application of Concentration Caps to West Pit Water

The predicted concentrations of the 6 evaluated solutes in the West Pit Lake indicate that GoldSim applied correctly the concentration caps for the evaluated solutes (Figure 1). Median solute concentrations in the West Pit Lake predicted by GoldSim between year 1 and 45 were drawn from reported output for the median concentrations (file provided by Barr Engineering = "WP_Concs_Output.txt"). Concentration caps were extracted from the Base Mine Site version 3.0 version of the NorthMet GoldSim model provided by Barr Engineering (Barr, 26 September 2012), and checked for consistency with the concentration cap values reported with model input (File = "Concentration_Caps.xlsx").

The GoldSim model of the West Pit Lake applies Cat 1 concentration caps to leachate from wall rock and to the pit lake itself. This application of concentration caps follows from the assumption that the West Pit Lake will have a near-neutral pH, either by natural buffering by rock and groundwater, or by active maintenance. The GoldSim algorithm for solutes loaded to the West Pit Lake is based on a conceptual model that assumes reversible precipitation of minerals, so that loads that would produce concentrations above the concentration cap are removed from solution, but are then allowed to precipitate back into solution later as soon as the lake concentration drops below the concentration cap. During active mining, GoldSim reflects the plan to capture groundwater inflow and wall-rock runoff in a small sump at the base of the West Pit that will be pumped out as necessary. As a result, predicted water quality during mining (year 1 to 20) has a strong seasonal signal (Figures 1), reflecting a large ratio in load: volume. Beyond year 20, the West Pit will be allowed to form a lake, so the seasonal effect is dampened as solutes leached from wall rock are added to an increasingly volume of water until the lake reaches its final elevation mine year 45.

Figure 1 ***Predicted concentrations of select solutes in the West Pit Lake, and their concentration caps. GoldSim NorthMet simulation 3.0 (26 Sept 2012).***



Specific results for application of GoldSim concentration caps to the West Pit Lake (Figure 1) for evaluated analytes include:

- Sulfate (P50 cap = 2,562 mg/l) is never limited by its concentration cap.
- Nickel (P50 cap = 2.266 mg/l) exceeds its concentration cap for part of each season during mining, but is always below its cap once the lake begins to fill after year 20.
- Copper (P50 cap = 0.237 mg/l) exceeds its concentration cap for part of each season during mining, and remains at the concentration cap between end of mining and filling of the West Pit Lake at year 45.
- Cobalt (P50 cap = 0.123 mg/l) exceeds its concentration cap for part of each season during mining, but is always below its cap after the lake begins to fill at year 20.
- Magnesium (P50 cap = 142 mg/l) essentially never exceeds its concentration cap.
- Arsenic (P50 cap = 0.1 mg/l) exceeds its concentration cap for part of each season during mining, but is always below its cap after the lake begins to fill at year 20.
- Antimony (P50 cap = 0.54 mg/l) remains always below its concentration cap during and after filling of the West Pit.

These results indicate that wall-rock loading from copper should be limited by concentration caps during and after mining, but that most or all of the loads of the other 5 solutes evaluated in this audit should be transferred to the West Pit Lake.

Discrepancies in Model Audit Results

The concentration caps applied to several of the evaluated solutes in the GoldSim model (median values from model results) were slightly higher than the P50 value for the caps, including:

- Mg: 180 mg/l applied cap vs. 147 mg/l P50 cap value.
- Ni: 3.02 mg/l applied cap vs. 2.266 mg/l P50 cap value.
- Cu: 0.316 mg/l applied cap vs. 0.237 mg/l P50 cap value.
- Co: 0.15 mg/l applied cap vs. 0.12 mg/l P50 cap value.

These discrepancies in concentration-cap values may be explained by differences between P50 cap values and median model results, but they are, in any event, very small (<30% relative percent difference) relative to the total range in prediction uncertainty between the 10th and 90th percentile concentrations for these solutes.

Oxidation and Solute Release from West Pit Wall Rock

The audit of the West Pit Lake GoldSim model included independent calculation of cumulative loads of seven evaluated solutes from two wall rock units (Cat 4 Duluth Complex, and Ore) over the period between mine year 1 (start of mining) and year 45 (West Pit Lake reaches final elevation). The calculation of wall rock loads followed the algorithm presented in the Waste Characterization Data Package, v9 (Jul 2012).

Parameters and effects included in these calculations, and thus evaluated by this audit, include:

- Area of wall rock exposed in pit wall;
- Thickness of reactive wall rock zone;
- Density of wall rock;
- Duration of exposure before wall rock is inundated with water given the predicted lake fill rate;
- Oxidation rate in the rock and associated rate of sulfate release;
- Rates of metal release from wall rock based on relation to sulfate release rates;
- Temperature factor (slows rate of field oxidation relative to laboratory rate based on field temperature and activation energy in oxidation);
- Size factor (on average, only 10% of the wall rock is small enough to appreciably oxidize);
- Contact Factor (on average, 50% of solutes in wall rock are assumed to be flushed to the pit each year by rain and snow);
- Latent release of solutes from flooded wall rock (the fraction of solutes in wall rock that are not released immediately by rain and snow melt but that are leached out when the rock is inundated by the lake);
- Duration of oxidation in sulfide-bearing wall rock before pore water becomes acidic;
- Spike in oxidation rate when pore water becomes acidic (occurs at ~mine-year 20 under field conditions), subsequent decay in rate as sulfide S is depleted in the wall rock; and.
- The effect of concentration caps, which in the GoldSim model will restrict the leaching of solutes from wall rock if the concentrations in the lake are above the concentration cap.

The audit of GoldSim's load rate for Cat 4 Duluth Complex and Ore wall rock (Figures 2 through 8) to the West Pit show a similar trend for all 7 evaluated solutes. The audit calculation matches well to the load rates between start of mining and year 20, which is the period when solutes leached from wall rock are captured in a sump for active treatment. These results suggest that GoldSim is applying correctly the wall-rock-loading-model parameters agreed upon by PolyMet and the Co-Lead Agencies in preparation of the Model Work Plans. Also, the consistency indicates that the relative sources have been analyzed and reported by GoldSim in accordance with work plans, i.e., that the Cat 4 Duluth Complex wall rock is a minor source of solutes, and the that ore wall rock is predicted to be the major source of cobalt, copper, and nickel to the West Pit Lake. Finally, as expected, the load of copper to the West Pit Lake calculated by the audit (which did not explicitly include the effect of concentration caps) is greater than the values indicated by GoldSim (which did reduce solutes load rates that would have caused lake concentrations to exceed the cap threshold). Copper concentrations in the West Pit Lake are continuously limited by the application of the Cat 1 concentration caps, and this has reduced predicted load of copper in GoldSim relative to the Audit. In longer-term GoldSim simulations, the copper withheld from the West Pit to meet the concentration cap during the lake filling period will be available to re-dissolve at later times.

Figure 2 *Comparison of Sulfate Load to West Pit from Wall Rock (Cat4 Duluth Complex and Ore): GoldSim Model vs. Audit Calculation.*

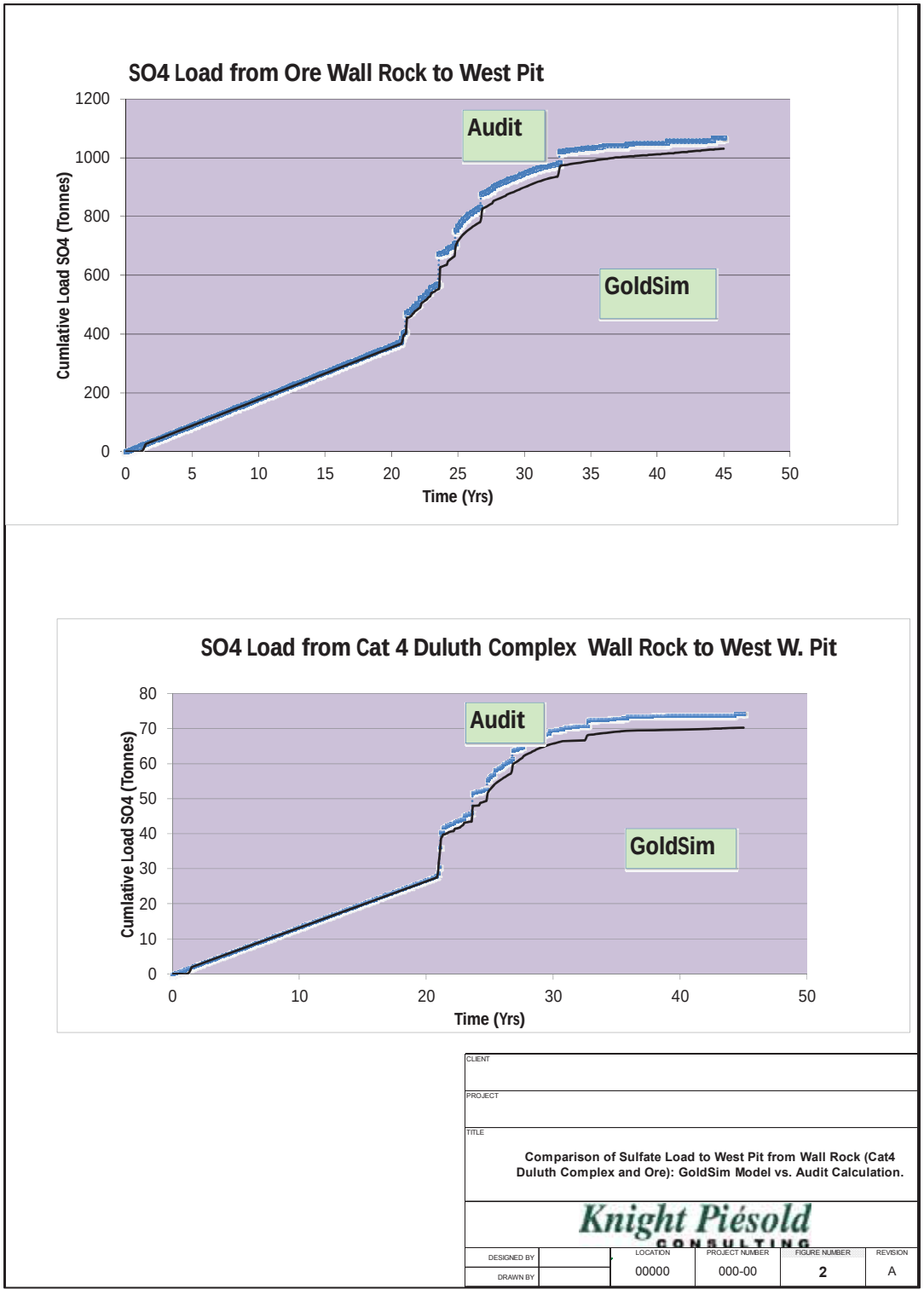


Figure 3 *Comparison of Arsenic Load to West Pit from Wall Rock (Cat4 Duluth Complex and Ore): GoldSim Model vs. Audit Calculation*

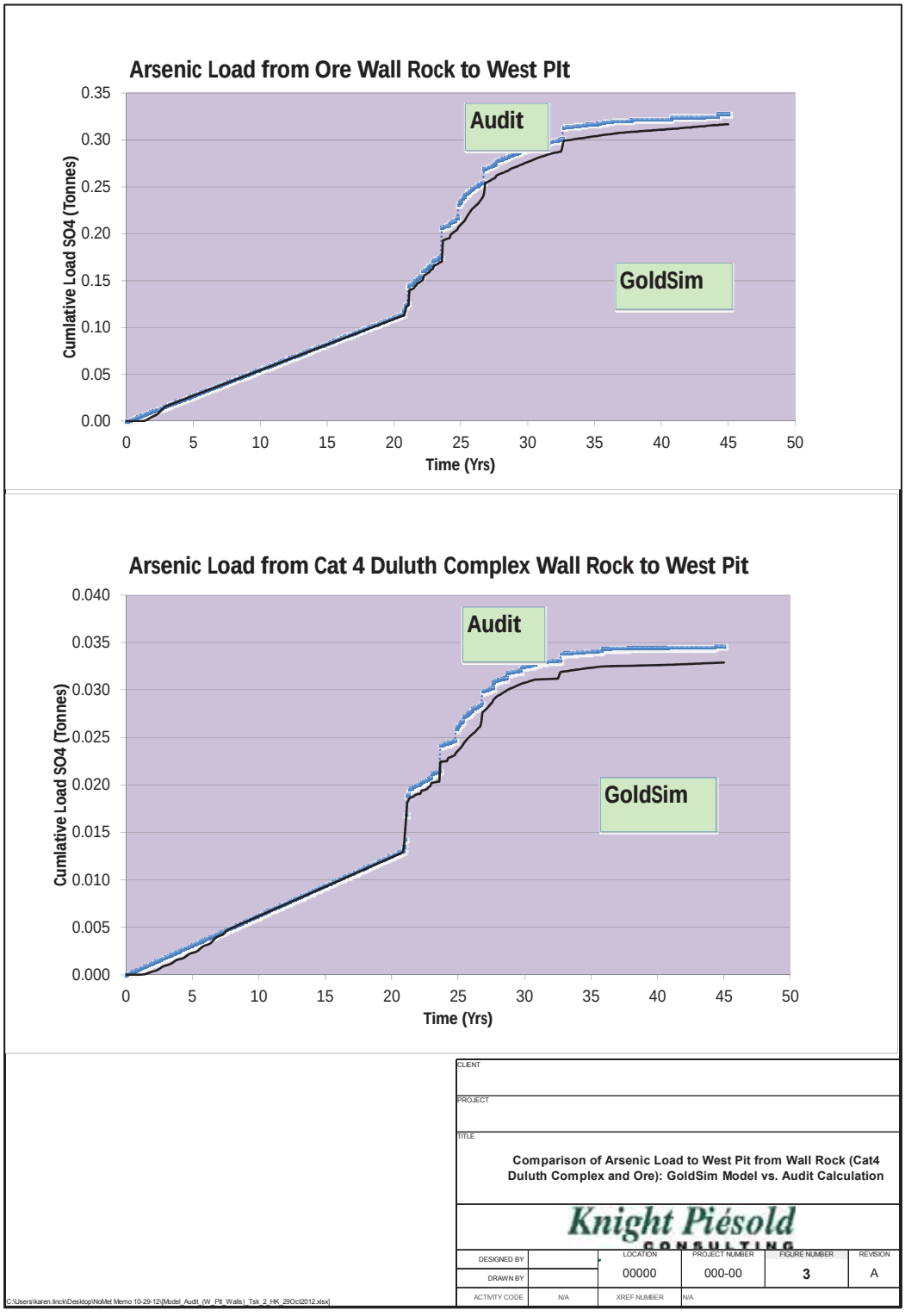


Figure 4 *Comparison of Copper Load to West Pit from Wall Rock (Cat4 Duluth Complex and Ore): GoldSim Model vs. Audit Calculation*

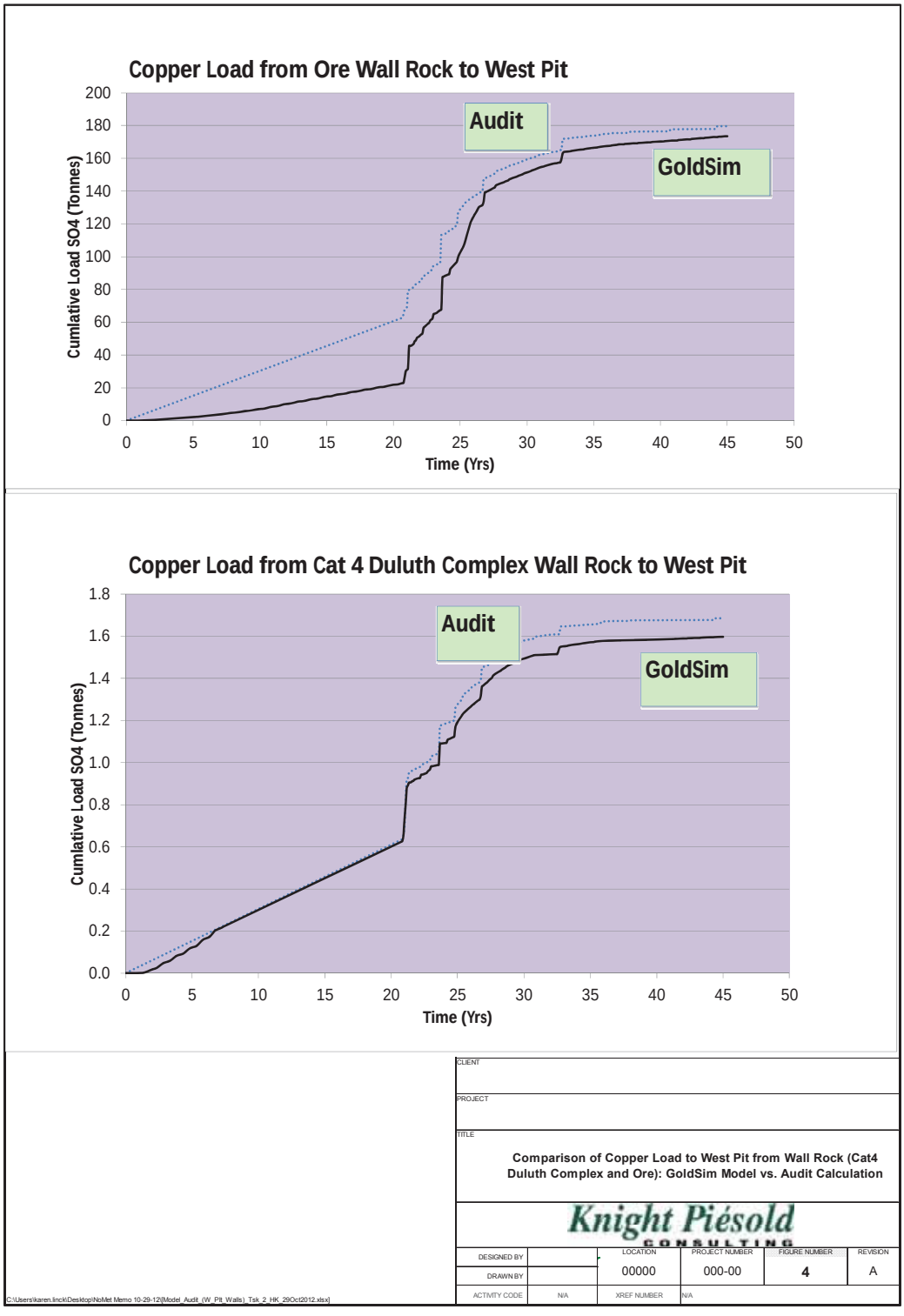


Figure 5 *Comparison of Antimony Load to West Pit from Wall Rock (Cat4 Duluth Complex and Ore): GoldSim Model vs. Audit Calculation*

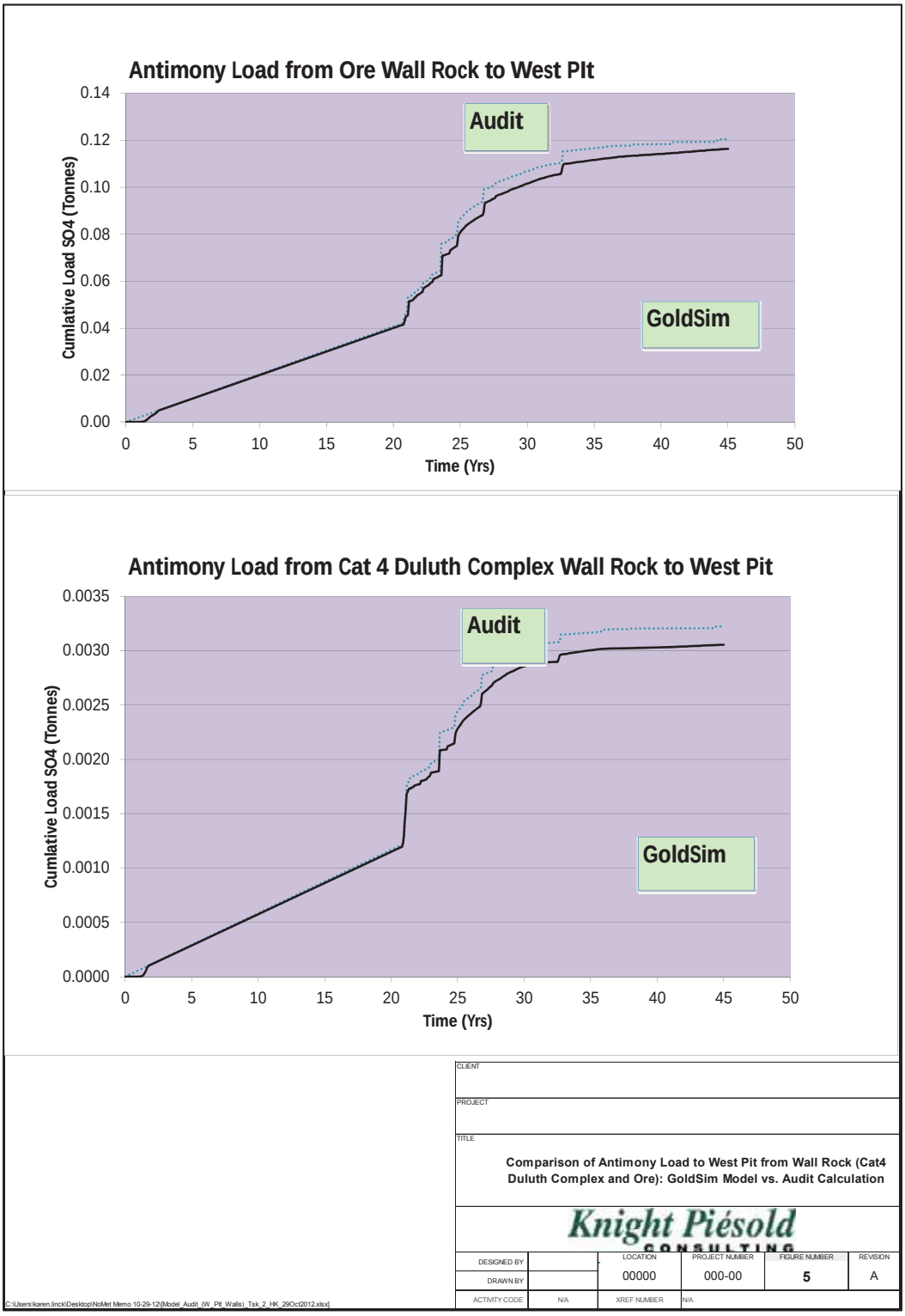


Figure 6 *Comparison of Nickel Load to West Pit from Wall Rock (Cat4 Duluth Complex and Ore): GoldSim Model vs. Audit Calculation*

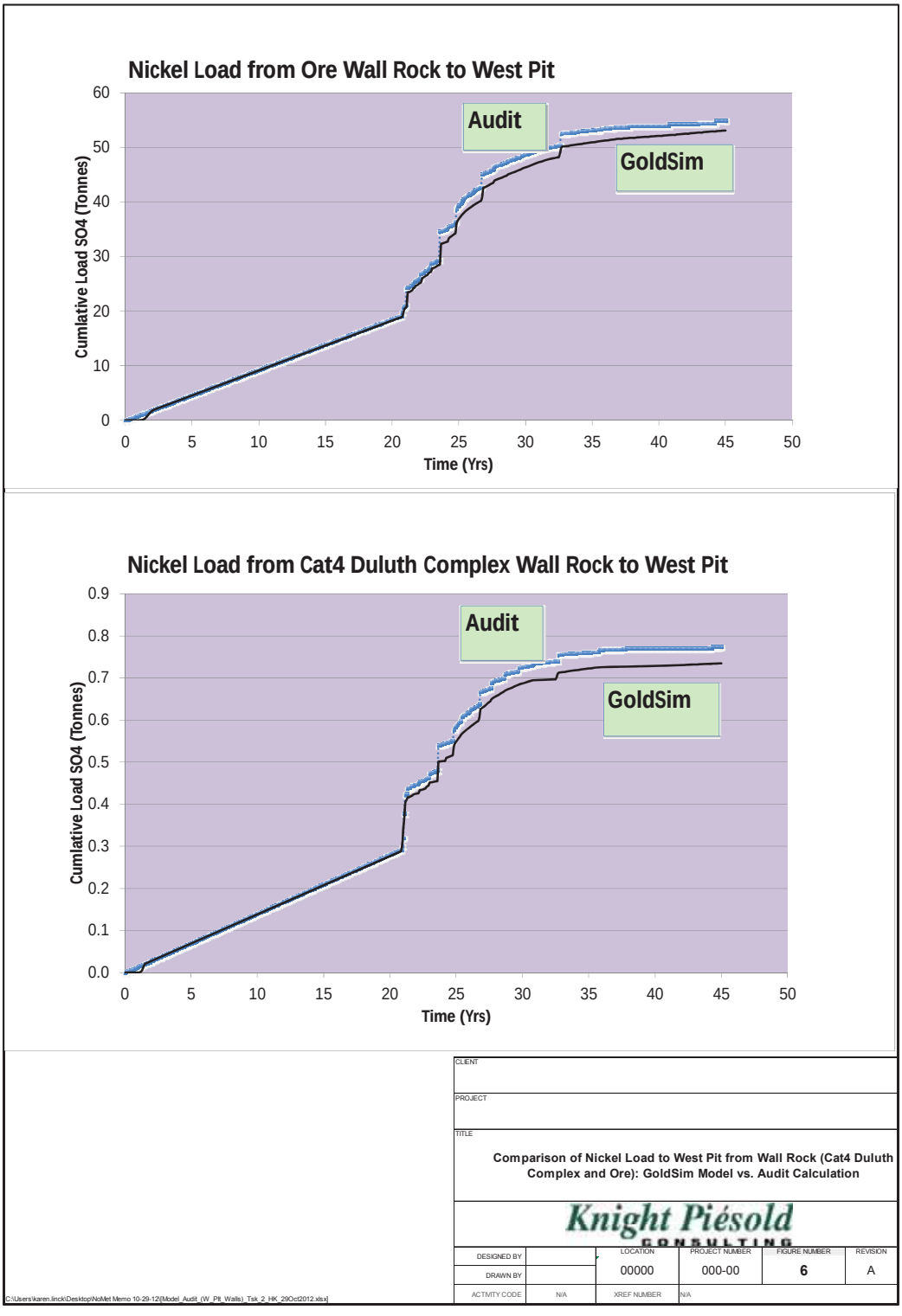


Figure 7 *Comparison of Cobalt Load to West Pit from Wall Rock (Cat4 Duluth Complex and Ore): GoldSim Model vs. Audit Calculation*

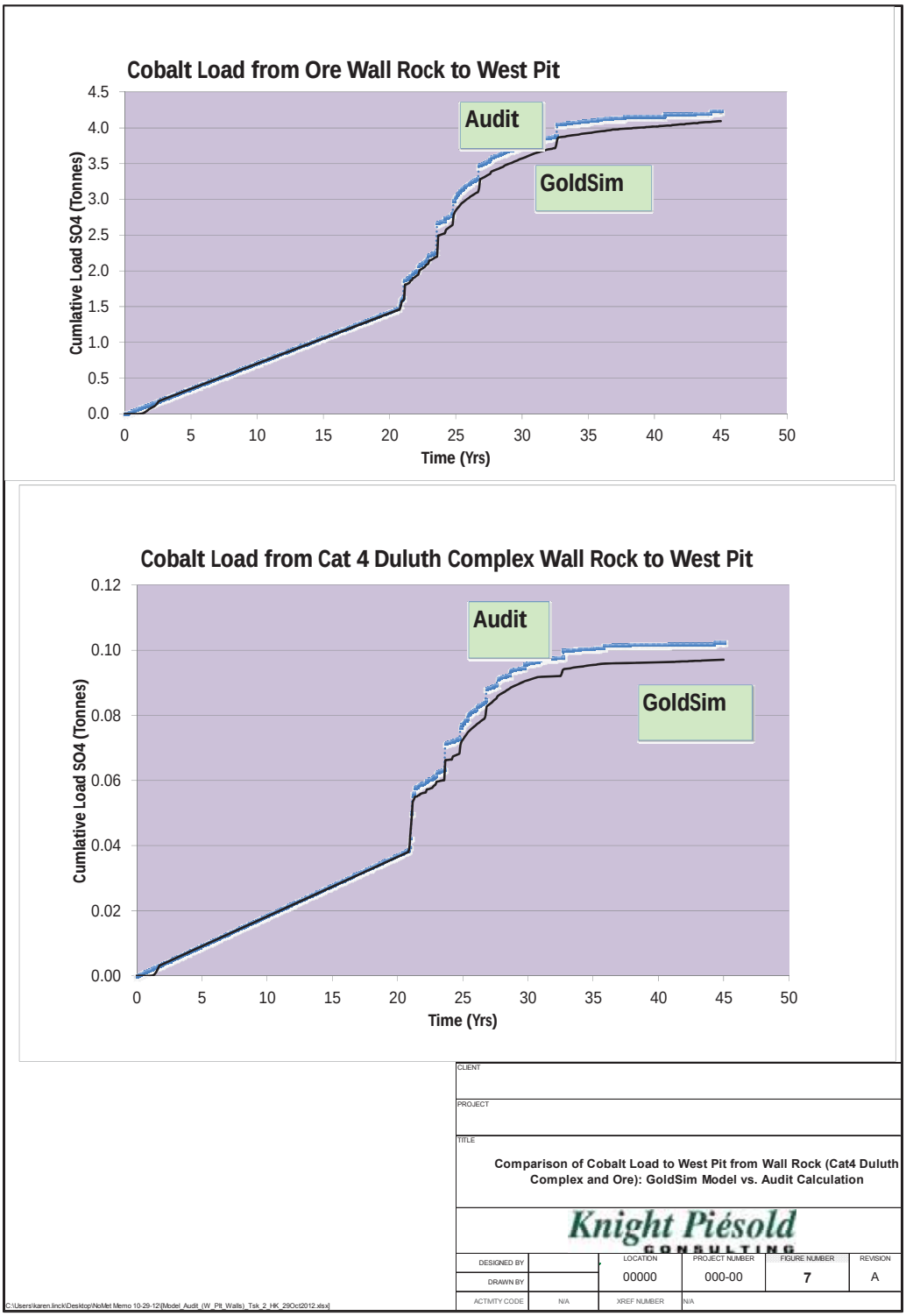
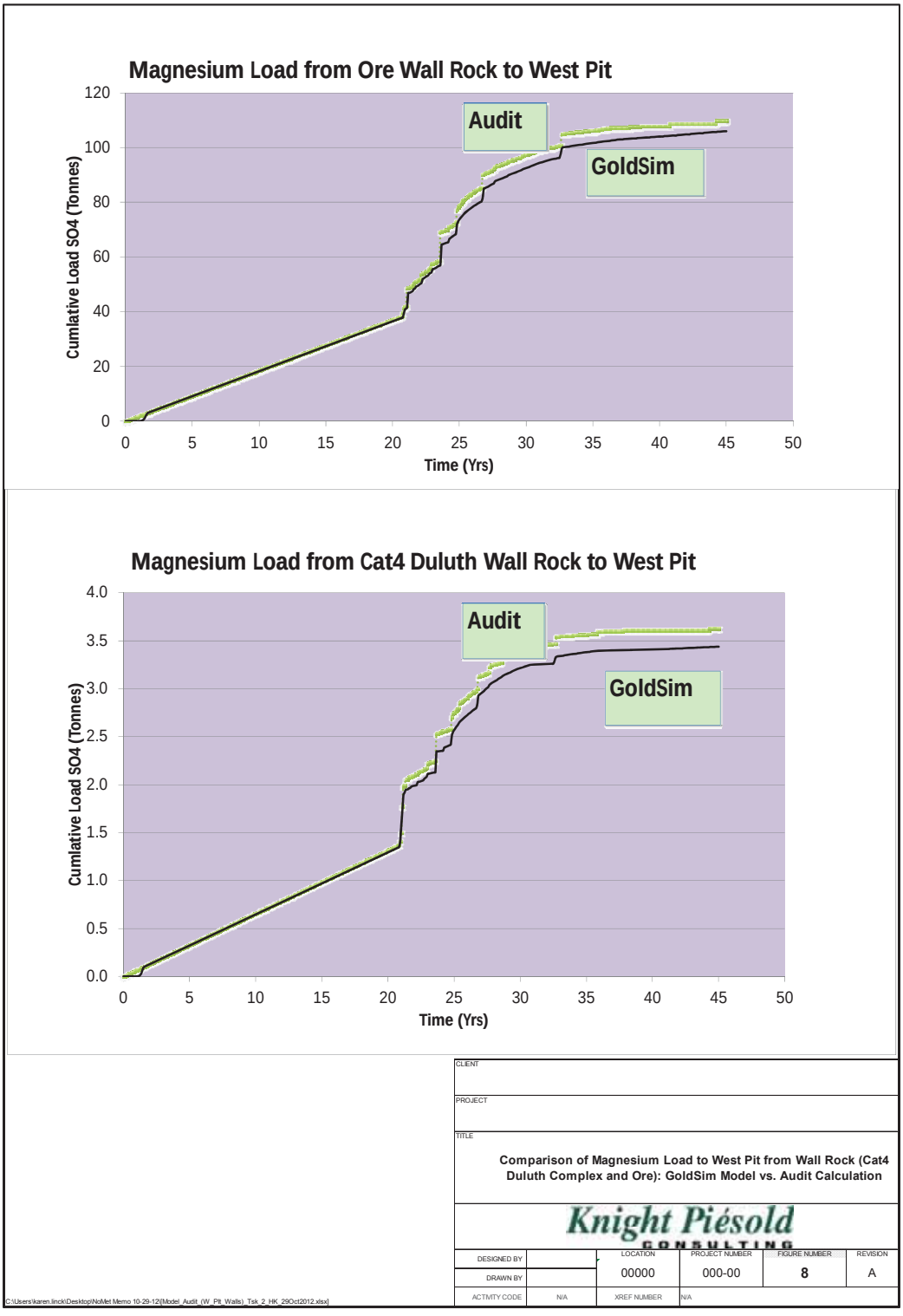


Figure 8 *Comparison of Magnesium Load to West Pit from Wall Rock (Cat4 Duluth Complex and Ore): GoldSim Model vs. Audit Calculation*



Discrepancies in Model Audit Results:

The "Culpability" files produced by GoldSim to indicate solute loading from West Pit wall rock may not contain all sources of loading.

The independent-audit estimates of wall-rock solute loading to the West Pit suggested that the GoldSim results provided in the "Culpability" files (i.e., indicating loads of specific constituents to specific facilities) did not include the loading of solutes leached to the lake when the wall rock is inundated by the lake. Although the mass balance results from GoldSim produced in the "Control Volume" files do contain a complete account of solute release from wall rock, and the culpability files should be modified so that they also contain all sources of solutes released from mine rock.

GoldSim uses solute release parameters for Ca2/3 rock to estimate solute release of several constituents from ore in wall rock.

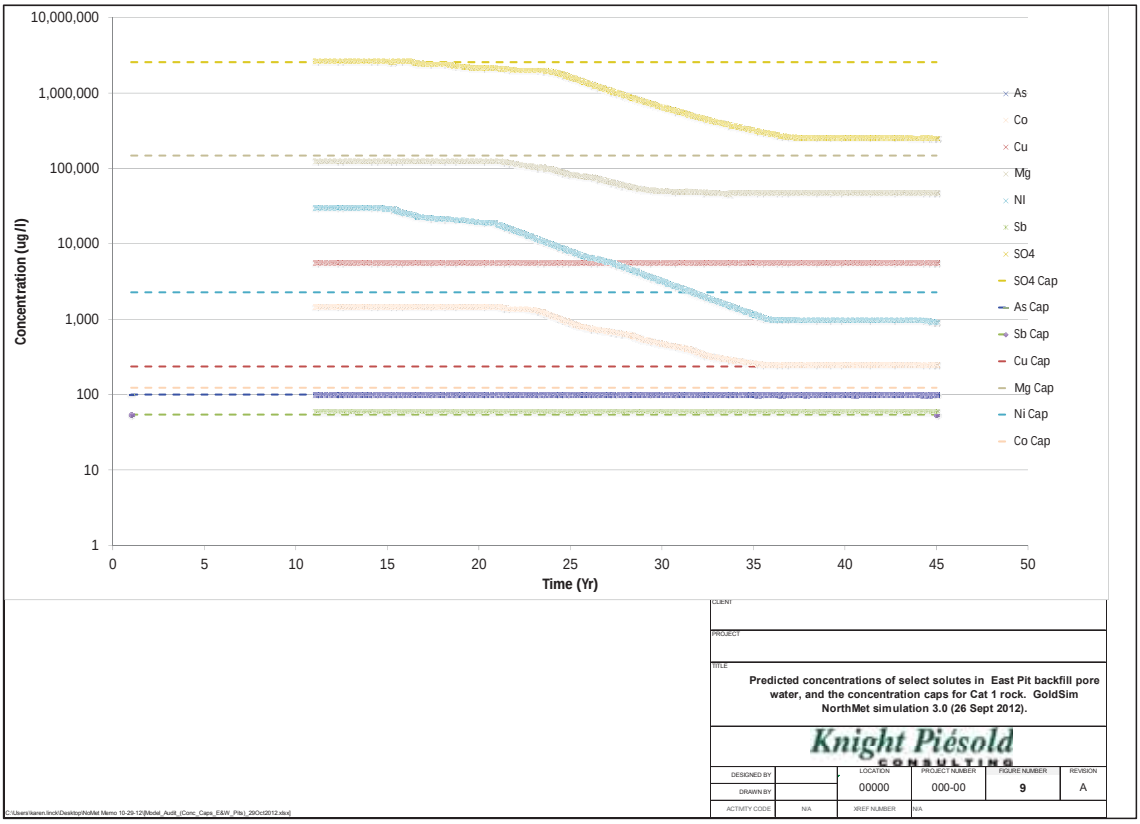
Parameters extracted from the GoldSim input files for ore wall rock indicate that the release of several solutes from ore wall rock were based on release rates for Cat 2/3 rock (i.e., in Barr 2012, Water Modeling Work Plan – Mine Site, ver. 7, July 2012, GoldSim applied values from Table 1-25 [Category 2/3 release distribution] instead of Table 1-27 [Ore Release Distributions]). This applies to ratios for Co/Ni, Mg/SO4, Co/SO4, Zn/SO4, Cd/SO4, Na/SO4, Zn/Ni, and Cd/Zn.

East Pit

The East Pit is critical to the overall NorthMet water management because it is the permanent repository for all of the high-sulfide, acid-generating waste rock (Category 2, 3, and 4). However, the backfilled East Pit is essentially an engineered system, and was thus not replicated in detail. Specifically, the rock backfilled to the East Pit will be flooded by natural inflow (groundwater and wall rock runoff), and inflow augmented with tailings pond water to inundate the reactive rock at the desired rate. Once flooded, the processes of oxidation, acid production, and solute-release essentially stop, and the water in the East Pit will be circulated and treated to achieve eventual restoration of the pore water composition to groundwater standards. Further, current mine plans retain an option to treat the rock backfilled to the East Pit to neutralize acidity, which will reduce initial pore-water concentrations to the concentration caps for Category 1 rock, thereby reducing further the need for water treatment.

In response, the audit of the East Pit was limited to confirming that pore-water concentrations in the backfilled were limited by solubility caps. Results from the NorthMet GoldSim Model ver. 3.0 (26 Sept 2012) were obtained from the file "EP_Pore_Cons_Output.txt." These indicated that predicted pore water concentrations of all evaluated solutes are at capped values when the backfill is first flooded (year 11; Figure 9). Sulfate, magnesium, arsenic, and antimony are essentially at the concentrations caps for neutral Cat 1 rock. But cobalt, copper, and nickel exceed the neutral Cat 1 concentration caps, reflecting the use of intermediate caps for these metals. If mine plans indicate that water would benefit from lower concentrations of additional metals, then the discharge concentrations of all solutes could be reduced to the Cat 1 rock concentration caps by implementing the plan to amend the waste rock backfill to the East Pit as it is emplaced.

Figure 9 ***Predicted concentrations of select solutes in East Pit backfill pore water, and the concentration caps for Cat 1 rock. GoldSim NorthMet simulation 3.0 (26 Sept 2012).***



ATTACHMENT 2: CALCULATION WORKSHEETS FOR INDEPENDENT VERIFICATION OF CHEMICAL MASS RELEASE FROM THE PLANT SITE TAILINGS BASIN

Interralogic, Inc.

This attachment contains a series of MathCad® calculation worksheets that estimate the release of sulfate and other constituents from different subareas of the FTB. The MathCad® calculations were developed independently of the GoldSim® model and therefore provide a check of the GoldSim® model results. In each worksheet blue entries represent values obtained from the GoldSim® model, and these are compared with the corresponding MathCad® value. In nearly all cases, there is relatively close agreement between the GoldSim® model values and the independently-computed values.

Cell 1E Coarse - Sulfate - Closure

LTVSMC coarse tailings

Blue values generated by GoldSim model

$K_s := 2.40 \cdot 10^{-3} \cdot \frac{cm}{sec}$ Saturated hydraulic conductivity (Table 1-12a)

$\beta := 2$ vanGenuchten parameter (Table 1-12a)

$\theta_r := 0.041$ Residual volumetric water content (Table 1-12a)

$\phi := 0.412$ Porosity (Table 1-12a)

$G := 2.80$ Specfic gravity (Table 1-12a)

$\mu g := 10^{-6} \cdot gm$

$\rho_w := 1 \cdot \frac{gm}{cm^3}$ Water density (standard value)

$A := 3.3784 acre$ Map area (Table 1-33)

$q := 2.6812 \cdot \frac{in}{yr}$ Percolation flux (from seepage spreadsheet with Barr edits)

$\tau := 0.273$ Tortuosity (Table 1-1, sheet 5)

$D_a := 1.8 \cdot 10^{-5} \cdot \frac{m^2}{sec}$ Free diffusion coefficient of oxygen in air (Table 1-1, sheet 5)

$c := 3.28$ Empirical constant (Table 1-1, sheet 5)

$D_w := 2.2 \cdot 10^{-9} \cdot \frac{m^2}{sec}$ Free difussion coeff of oxygen in water (Table 1-1, sheet 5)

$K_H := 33.9$ Henry's constant for oxygen (Table 1-1, sheet 5)

$C_o := 8.89 \cdot \frac{mol}{m^3}$ O2 concentration in air (Table 1-1, sheet 5)

$W_{SO4} := 96.07 \cdot \frac{gm}{mole}$ Molecular weight of sulfate (standard value)

$W_S := 32.066 \cdot \frac{gm}{mole}$ Molecular weight of sulfur (standard value)

$R_{SO4} := 1.95186 \cdot \frac{mg}{kg \cdot 7 \cdot day}$ P50 SO4 distribution paramater for tailings (Table 1-19)

$CF := 0.185$ Calibration factor for tailings (Table 1-1, sheet 5)

$TF := 0.228589$ Temperature factor (computed in GS using numerous inputs)

$FF := \frac{3.4}{12}$ Freeze factor (from Table 1-1, sheet 3) $FF = 0.28333$

$moleratio := \frac{4}{9}$ mole SO4 / mole O2 = mole S / mole O2 (Table 1-1, sheet 6) $moleratio = 0.444$

$DTW := 117.8 \cdot ft$ Depth to water table in cell 2E during closure (value in Table 1-34 is 51.0 ft; GS value used in calcs is 52.3 ft)

$Cont_S := 329 \cdot \frac{mg}{kg}$ Sulfur content. Mass of S per unit mass of tailings. (Table 1-22)

$\rho_b := G \cdot \rho_w \cdot (1 - \phi)$ Tailings dry bulk density. Mass of solids per unit bulk volume. $\rho_b = 1.646 \cdot \frac{gm}{cm^3}$

$\gamma := 1 - \frac{1}{\beta}$ Computed vanGenuchten parameter $\gamma = 0.5$

$K(ss) := K_s \left(\frac{ss \cdot \phi - \theta_r}{\phi - \theta_r} \right)^{0.5} \cdot \left[1 - \left[1 - \left(\frac{ss \cdot \phi - \theta_r}{\phi - \theta_r} \right)^{\frac{1}{\gamma}} \right]^{\gamma} \right]^2$

Unsaturated hydraulic conductivity as a function of saturation (ss) based on vanGenuchten relationship

$f(ss) := q - K(ss)$ $ss := 0.4$ Root equation and saturation guess

$SAT := root(f(ss), ss)$ Computed saturation associated with flux (q) $SAT = 0.2536$ 0.2816

$q - K(SAT) = -9.282 \times 10^{-10} \cdot \frac{in}{yr}$ Confirm root calculation (result should be approx zero) 1.661 x 10^{-6}

$D := \tau \cdot D_a \cdot (1 - SAT)^c + \tau \cdot SAT \cdot \frac{D_w}{K_H}$ Effective O2 diffusion coeff referenced to void volume $D = 1.883 \times 10^{-6} \frac{m^2}{s}$

$MRM_{SO4} := R_{SO4} \cdot CF \cdot TF \cdot (1 - FF)$ Mass rate of released SO4 per unit mass of tailings solids $MRM_{SO4} = 0.0592 \cdot \frac{mg}{kg \cdot 7 \cdot day}$

Effect of three factors $CF \cdot TF \cdot (1 - FF) = 0.030$

$R_{O2} := \frac{MRM_{SO4}}{W_{SO4} \cdot moleratio} \cdot \frac{\rho_b}{\phi}$ Molar consumption rate of O2 per unit void volume. 0.005542 $R_{O2} = 0.005536 \cdot \frac{mol}{m^3 \cdot 7 \cdot day}$

$d := \sqrt{\frac{2 \cdot D \cdot C_o}{R_{O2}}}$ Thickness of sulfate reaction zone if controlled by diffusion 56.77 $d = 60.475\,m$

$b := \min(d, DTW)$ Actual thickness of sulfate reaction zone. Minimum of diffusion controlled reaction zone or depth-to-water. $b = 35.905\,m$

$MR_{SO4} := MRM_{SO4} \cdot b \cdot A \cdot \rho_b$ Mass rate of released sulfate $MR_{SO4} = 6.83 \cdot \frac{kg}{day}$

$MRV_S := R_{O2} \cdot W_S \cdot moleratio \cdot \phi$ Mass rate of released S per unit bulk volume $MRV_S = 4.644 \cdot \frac{mg}{m^3 \cdot day}$

$MRA_S := MRV_S \cdot b$ Mass rate of released S per unit map area (m^2) 1167.3 $MRA_S = 1167.2 \cdot \frac{mg}{m^2 \cdot 7 \cdot day}$

$MR_S := MRA_S \cdot A$ Mass rate of released S $MR_S = 2.28 \cdot \frac{kg}{day}$

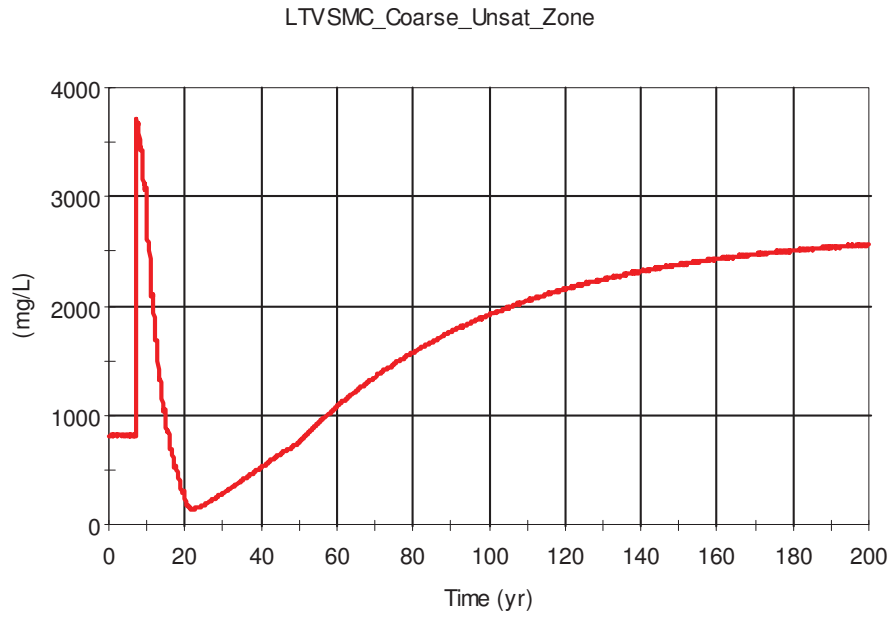
$Q := q \cdot A$ Seepage flow rate $Q = 0.468 \cdot gpm$

$C_{SO4} := \frac{MR_{SO4}}{Q}$ Sulfate concentration in seepage 2559 at t= 200 yrs $C_{SO4} = 2679.2 \cdot \frac{mg}{liter}$

$t_{end} := \frac{Cont_S \cdot \rho_b \cdot A \cdot DTW}{MR_S}$ Time to deplete all sulfur in the reaction zone. $t_{end} = 319 \cdot yr$

GoldSim Output

MR_{SO4} at 100 years is 4.882 kg/day



Other Chemicals

Arsenic

$RR_{As} := 0.09995$ Release ratio of As to S

$CF_{As} := 0.0001$ As calibration factor

$MR_{As} := MR_S \cdot RR_{As} \cdot CF_{As}$ Mass rate of released As 8.322 x 10^{-6} $MR_{As} = 8.322 \times 10^{-6} \cdot \frac{tonne}{yr}$

$C_{As} := \frac{MR_{As}}{Q}$ As concentration in seepage $C_{As} = 8.938 \cdot \frac{\mu g}{L}$

Cobalt

$RR_{Co} := 0.03076$ Release ratio of Co to S

$CF_{Co} := 0.0006$ Co calibration factor

$MR_{Co} := MR_S \cdot RR_{Co} \cdot CF_{Co}$ Mass rate of released Co 1.536 x 10^{-5} $MR_{Co} = 1.537 \times 10^{-5} \cdot \frac{tonne}{yr}$

$C_{Co} := \frac{MR_{Co}}{Q}$ Co concentration in seepage $C_{Co} = 16.505 \cdot \frac{\mu g}{L}$

Copper

$RR_{Cu} := 0.030598$ Release ratio of Cu to S

$CF_{Cu} := 0.0005$ Cu calibration factor

$MR_{Cu} := MR_S \cdot RR_{Cu} \cdot CF_{Cu}$ Mass rate of released Cu 1.274 x 10^{-5} $MR_{Cu} = 1.274 \times 10^{-5} \cdot \frac{tonne}{yr}$

$C_{Cu} := \frac{MR_{Cu}}{Q}$ Cu concentration in seepage $C_{Cu} = 13.681 \cdot \frac{\mu g}{L}$

Nickel

$RR_{Ni} := 0.014307$ Release ratio of Ni to S

$CF_{Ni} := 0.0027$ Ni calibration factor

$MR_{Ni} := MR_S \cdot RR_{Ni} \cdot CF_{Ni}$ Mass rate of released Ni 3.216 x 10^{-5} $MR_{Ni} = 3.216 \times 10^{-5} \cdot \frac{tonne}{yr}$

$C_{Ni} := \frac{MR_{Ni}}{Q}$ Ni concentration in seepage $C_{Ni} = 34.544 \cdot \frac{\mu g}{L}$

Zinc

$RR_{Zn} := 5.0629 \cdot 10^{-5}$ Release ratio of Zn to SO4

$CF_{Zn} := 0.2596$ Zn calibration factor

$MR_{Zn} := MR_{SO4} \cdot RR_{Zn} \cdot CF_{Zn}$ Mass rate of released Zn 3.278 x 10^{-5} $MR_{Zn} = 3.279 \times 10^{-5} \cdot \frac{tonne}{yr}$

$C_{Zn} := \frac{MR_{Zn}}{Q}$ Zn concentration in seepage $C_{Zn} = 35.214 \cdot \frac{\mu g}{L}$

Cell 2E Other - Sulfate - Closure

LTVSMC coarse tailings

Blue values generated by GoldSim model

$K_s := 2.24 \cdot 10^{-3} \cdot \frac{cm}{sec}$ Saturated hydraulic conductivity (Table 1-12a)

$\beta := 2$ vanGenuchten parameter (Table 1-12a)

$\theta_r := 0.041$ Residual volumetric water content (Table 1-12a)

$\phi := 0.412$ Porosity (Table 1-12a)

$G := 2.80$ Specfic gravity (Table 1-12a)

$\mu g := 10^{-6} \cdot gm$

$\rho_w := 1 \cdot \frac{gm}{cm^3}$ Water density (standard value)

$A := 304688 \cdot m^2$ Map area (Table 1-33)

$A = 75.29 \cdot acre$

$q := 5.50 \cdot \frac{in}{yr}$ Percolation flux (from seepage spreadsheet with Barr edits)

$\tau := 0.273$ Tortuosity (Table 1-1, sheet 5)

$D_a := 1.8 \cdot 10^{-5} \cdot \frac{m^2}{sec}$ Free diffusion coefficient of oxygen in air (Table 1-1, sheet 5)

$c := 3.28$ Empirical constant (Table 1-1, sheet 5)

$D_w := 2.2 \cdot 10^{-9} \cdot \frac{m^2}{sec}$ Free difussion coeff of oxygen in water (Table 1-1, sheet 5)

$K_H := 33.9$ Henry's constant for oxygen (Table 1-1, sheet 5)

$C_o := 8.89 \cdot \frac{mol}{m^3}$ O2 concentration in air (Table 1-1, sheet 5)

$W_{SO4} := 96.07 \cdot \frac{gm}{mole}$ Molecular weight of sulfate (standard value)

$W_S := 32.066 \cdot \frac{gm}{mole}$ Molecular weight of sulfur (standard value)

$R_{SO4} := 1.95186 \cdot \frac{mg}{kg \cdot 7 \cdot day}$ P50 SO4 distribution paramater for tailings (Table 1-19)

$CF := 0.185$ Calibration factor for tailings (Table 1-1, sheet 5)

$TF := 0.228589$ Temperature factor (computed in GS using numerous inputs)

$FF := \frac{3.4}{12}$ Freeze factor (from Table 1-1, sheet 3)

$FF = 0.28333$

$moleratio := \frac{4}{9}$ mole SO4 / mole O2 = mole S / mole O2
(Table 1-1, sheet 6)

$moleratio = 0.444$

$DTW := 52.3 \cdot ft$ Depth to water table in cell 2E during closure
(value in Table 1-34 is 51.0 ft; GS value used in calcs is 52.3 ft)

$Cont_S := 329 \cdot \frac{mg}{kg}$ Sulfur content. Mass of S per unit mass of tailings.
(Table 1-22)

$\rho_b := G \cdot \rho_w \cdot (1 - \phi)$ Tailings dry bulk density. Mass of solids per unit bulk volume.

$\rho_b = 1.646 \cdot \frac{gm}{cm^3}$

$\gamma := 1 - \frac{1}{\beta}$ Computed vanGenuchten parameter $\gamma = 0.5$

$K(ss) := K_s \left(\frac{ss \cdot \phi - \theta_r}{\phi - \theta_r} \right)^{0.5} \cdot \left[1 - \left[1 - \left(\frac{ss \cdot \phi - \theta_r}{\phi - \theta_r} \right)^{\frac{1}{\gamma}} \right]^{\gamma} \right]^2$

Unsaturated hydraulic conductivity as a function of saturation (ss) based on vanGenuchten relationship

$f(ss) := q - K(ss)$ $ss := 0.6$ Root equation and saturation guess

$SAT := root(f(ss), ss)$ Computed saturation associated with flux (q) $SAT = 0.2828$ 0.2816

$q - K(SAT) = -1.216 \times 10^{-8} \cdot \frac{in}{yr}$ Confirm root calculation (result should be approx zero) 1.661 x 10^{-6}

$D := \tau \cdot D_a \cdot (1 - SAT)^c + \tau \cdot SAT \cdot \frac{D_w}{K_H}$ Effective O2 diffusion coeff referenced to void volume $D = 1.652 \times 10^{-6} \frac{m^2}{s}$

$MRM_{SO4} := R_{SO4} \cdot CF \cdot TF \cdot (1 - FF)$ Mass rate of released SO4 per unit mass of tailings solids $MRM_{SO4} = 0.0592 \cdot \frac{mg}{kg \cdot 7 \cdot day}$

Effect of three factors $CF \cdot TF \cdot (1 - FF) = 0.030$

$R_{O2} := \frac{MRM_{SO4}}{W_{SO4} \cdot moleratio} \cdot \frac{\rho_b}{\phi}$ Molar consumption rate of O2 per unit void volume. 0.005542 $R_{O2} = 0.005536 \cdot \frac{mol}{m^3 \cdot 7 \cdot day}$

$d := \sqrt{\frac{2 \cdot D \cdot C_o}{R_{O2}}}$ Thickness of sulfate reaction zone if controlled by diffusion 56.77 $d = 56.642\,m$

$b := \min(d, DTW)$ Actual thickness of sulfate reaction zone. Minimum of diffusion controlled reaction zone or depth-to-water. $b = 15.941\,m$

$MR_{SO4} := MRM_{SO4} \cdot b \cdot A \cdot \rho_b$ Mass rate of released sulfate $MR_{SO4} = 67.578 \cdot \frac{kg}{day}$

$MRV_S := R_{O2} \cdot W_S \cdot moleratio \cdot \phi$ Mass rate of released S per unit bulk volume $MRV_S = 4.644 \cdot \frac{mg}{m^3 \cdot day}$

$MRA_S := MRV_S \cdot b$ Mass rate of released S per unit map area (m^2) 518.245 $MRA_S = 518.205 \cdot \frac{mg}{m^2 \cdot 7 \cdot day}$

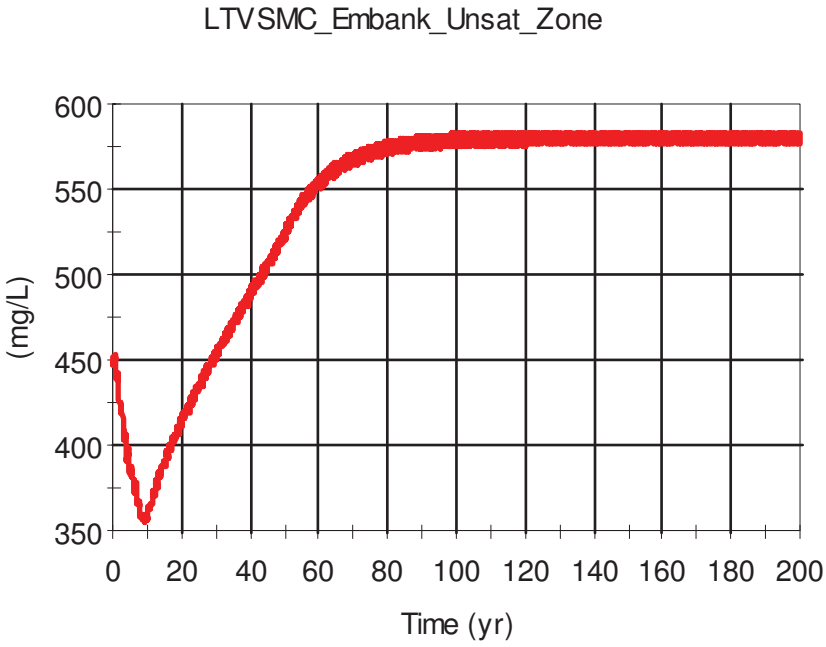
$MR_S := MRA_S \cdot A$ Mass rate of released S $MR_S = 22.556 \cdot \frac{kg}{day}$

$Q := q \cdot A$ Seepage flow rate $Q = 21.379 \cdot gpm$

$C_{SO4} := \frac{MR_{SO4}}{Q}$ Sulfate concentration in seepage 579.9 $C_{SO4} = 579.9 \cdot \frac{mg}{liter}$

$t_{end} := \frac{Cont_S \cdot \rho_b \cdot A \cdot DTW}{MR_S}$ Time to deplete all sulfur in the reaction zone. $t_{end} = 319 \cdot yr$

GoldSim Output



Other Chemicals

Arsenic

$RR_{As} := 0.09995$ Release ratio of As to S

$CF_{As} := 0.0001$ As calibration factor

$MR_{As} := MR_S \cdot RR_{As} \cdot CF_{As}$ Mass rate of released As 8.234 x 10^{-5} $MR_{As} = 8.234 \times 10^{-5} \cdot \frac{tonne}{yr}$

$C_{As} := \frac{MR_{As}}{Q}$ As concentration in seepage $C_{As} = 1.935 \cdot \frac{\mu g}{L}$

Cobalt

$RR_{Co} := 0.03076$ Release ratio of Co to S

$CF_{Co} := 0.0006$ Co calibration factor

$MR_{Co} := MR_S \cdot RR_{Co} \cdot CF_{Co}$ Mass rate of released Co 1.521 x 10^{-4} $MR_{Co} = 1.52 \times 10^{-4} \cdot \frac{tonne}{yr}$

$C_{Co} := \frac{MR_{Co}}{Q}$ Co concentration in seepage $C_{Co} = 3.572 \cdot \frac{\mu g}{L}$

Copper

$RR_{Cu} := 0.030598$ Release ratio of Cu to S

$CF_{Cu} := 0.0005$ Cu calibration factor

$MR_{Cu} := MR_S \cdot RR_{Cu} \cdot CF_{Cu}$ Mass rate of released Cu 1.261 x 10^{-4} $MR_{Cu} = 1.260 \times 10^{-4} \cdot \frac{tonne}{yr}$

$C_{Cu} := \frac{MR_{Cu}}{Q}$ Cu concentration in seepage $C_{Cu} = 2.961 \cdot \frac{\mu g}{L}$

Nickel

$RR_{Ni} := 0.014307$ Release ratio of Ni to S

$CF_{Ni} := 0.0027$ Ni calibration factor

$MR_{Ni} := MR_S \cdot RR_{Ni} \cdot CF_{Ni}$ Mass rate of released Ni 3.183 x 10^{-4} $MR_{Ni} = 3.182 \times 10^{-4} \cdot \frac{tonne}{yr}$

$C_{Ni} := \frac{MR_{Ni}}{Q}$ Ni concentration in seepage $C_{Ni} = 7.477 \cdot \frac{\mu g}{L}$

Zinc

$RR_{Zn} := 5.0629 \cdot 10^{-5}$ Release ratio of Zn to SO4

$CF_{Zn} := 0.2596$ Zn calibration factor

$MR_{Zn} := MR_{SO4} \cdot RR_{Zn} \cdot CF_{Zn}$ Mass rate of released Zn 3.244 x 10^{-4} $MR_{Zn} = 3.244 \times 10^{-4} \cdot \frac{tonne}{yr}$

$C_{Zn} := \frac{MR_{Zn}}{Q}$ Zn concentration in seepage $C_{Zn} = 7.621 \cdot \frac{\mu g}{L}$

Cell 2W Banks - Sulfur - Transient

LTVSMC coarse tailings

$A := 1372626 \cdot m^2$ Map area (Table 1-33) $A = 339.183 \cdot acre$

$q := 7.82 \cdot \frac{in}{yr}$ Percolation flux (from seepage spreadsheet with Barr edits)

$K_s := 1.17 \cdot 10^{-3} \cdot \frac{cm}{sec}$ Saturated hydraulic conductivity of tailings (Table 1-12a)

$\beta := 2$ vanGenuchten parameter of tailings (Table 1-12a)

$\theta_r := 0.041$ Residual volumetric water content of tailings (Table 1-12a)

$\phi := 0.412$ Porosity of tailings (Table 1-12a)

$G := 2.8$ Specfic gravity of tailings solids (Table 1-12a)

$\rho_w := 1 \cdot \frac{gm}{cm^3}$ Water density (standard value)

$\tau := 0.273$ Tortuosity (Table 1-1, sheet 5)

$D_a := 1.8 \cdot 10^{-5} \cdot \frac{m^2}{sec}$ Free diffusion coefficient of oxygen in air (Table 1-1, sheet 5)

$c := 3.28$ Empirical constant (Table 1-1, sheet 5)

$D_w := 2.2 \cdot 10^{-9} \cdot \frac{m^2}{sec}$ Free difussion coeff of oxygen in water (Table 1-1, sheet 5)

$K_H := 33.9$ Henry's constant for oxygen (Table 1-1, sheet 5)

$C_o := 8.89 \cdot \frac{mol}{m^3}$ O2 concentration in air. Moles of O2 per unit volume of air (Table 1-1, sheet 5)

$W_{SO4} := 96.07 \cdot \frac{gm}{mole}$ Molecular weight of sulfate (standard value)

$W_S := 32.066 \cdot \frac{gm}{mole}$ Molecular weight of sulfur (standard value)

$R_{SO4} := 1.95186 \cdot \frac{mg}{kg \cdot 7 \cdot day}$ 1.95186 P50 SO4 distribution parameter for tailings (Table 1-19; P50 from GoldSim)

$CF := 0.185$ Calibration factor for tailings (Table 1-1, sheet 5)

$TF := 0.228589$ Temperature factor (computed in GS using numerous inputs)

$FF := \frac{3.4}{12}$ Freeze factor (from Table 1-1, sheet 3) $FF = 0.28333$

$moleratio := \frac{4}{9}$ mole SO4 / mole O2 = mole S / mole O2 (Table 1-1, sheet 6) $moleratio = 0.444$

$Cont_S := 329 \cdot \frac{mg}{kg}$ 329 Sulfur content. Mass of S per unit mass of tailings. (Table 1-22)

$Co_{SO4} := 728 \cdot \frac{mg}{L}$ Initial concentration in tailings pore water

$t_1 := 0 \cdot yr$ $D_1 := 96.4 \cdot ft$ Piecewise linear function to approximate DTW vs time

$t_2 := 2 \cdot yr$ $D_2 := 89.0 \cdot ft$

$t_3 := 7 \cdot yr$ $D_3 := 91.4 \cdot ft$

$t_4 := 10 \cdot yr \qquad D_4 := 90.6 \cdot ft$

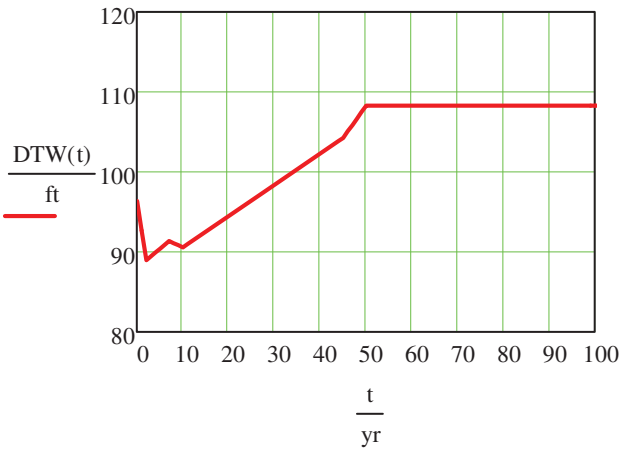
$t_5 := 45 \cdot yr \qquad D_5 := 104.3 \cdot ft$

$t_6 := 50 \cdot yr \qquad D_6 := 108.3 \cdot ft$

$t_7 := 200 \cdot yr \qquad D_7 := 108.3 \cdot ft$

$$DTW(t) := \begin{cases} D_1 + \frac{D_2 - D_1}{t_2 - t_1} \cdot (t - t_1) & \text{if } t_1 \le t \le t_2 \\ D_2 + \frac{D_3 - D_2}{t_3 - t_2} \cdot (t - t_2) & \text{if } t_2 < t \le t_3 \\ D_3 + \frac{D_4 - D_3}{t_4 - t_3} \cdot (t - t_3) & \text{if } t_3 < t \le t_4 \\ D_4 + \frac{D_5 - D_4}{t_5 - t_4} \cdot (t - t_4) & \text{if } t_4 < t \le t_5 \\ D_5 + \frac{D_6 - D_5}{t_6 - t_5} \cdot (t - t_5) & \text{if } t_5 < t \le t_6 \\ D_6 + \frac{D_7 - D_6}{t_7 - t_6} \cdot (t - t_6) & \text{if } t_6 < t \le t_7 \end{cases}$$

$t := 0 \cdot yr, 1 \cdot yr .. 200 \cdot yr$



$\rho_b := G \cdot \rho_w \cdot (1 - \phi)$ Tailings dry bulk density. Mass of solids per unit bulk volume. $\rho_b = 1.646 \cdot \frac{gm}{cm^3}$

$\gamma := 1 - \frac{1}{\beta}$ Computed vanGenuchten parameter $\gamma = 0.5$

$$K(ss) := K_s \left(\frac{ss \cdot \phi - \theta_r}{\phi - \theta_r} \right)^{0.5} \cdot \left[1 - \left[1 - \left(\frac{ss \cdot \phi - \theta_r}{\phi - \theta_r} \right)^{\frac{1}{\gamma}} \right]^{\gamma} \right]^2$$

Unsaturated hydraulic conductivity as a function of saturation (ss) based on vanGenuchten relationship

$f(ss) := q - K(ss) \qquad ss := .4$ Root equation and saturation guess

$SAT := root(f(ss), ss)$ Computed saturation associated with flux (q) 0.32784 $SAT = 0.32786$

$q - K(SAT) = -3.452 \times 10^{-7} \cdot \frac{in}{yr}$ Confirm root calculation (result should be approx zero)

$D := \tau \cdot D_a \cdot (1 - SAT)^c + \tau \cdot SAT \cdot \frac{D_w}{K_H}$ Effective O2 diffusion coeff used in GS. This diffusion coeff is referenced to void volume. 1.335 x 10-6 $D = 1.335 \times 10^{-6} \frac{m^2}{s}$

$MRM_{SO4} := R_{SO4} \cdot CF \cdot TF \cdot (1 - FF)$ Mass rate of released SO4 per unit mass of tailings solids $R_{SO4} = 1.952 \cdot \frac{mg}{kg \cdot 7 \cdot day}$

Effect of three factors $CF \cdot TF \cdot (1 - FF) = 0.030$

$R_{O2} := \frac{MRM_{SO4}}{W_{SO4} \cdot moleratio} \cdot \frac{\rho_b}{\phi}$ Molar consumption rate of O2 per unit void volume 0.00554 $R_{O2} = 0.00554 \cdot \frac{mol}{m^3 \cdot 7 \cdot day}$

$d := \sqrt{\frac{2 \cdot D \cdot C_o}{R_{O2}}}$

Thickness of sulfate reaction zone if controlled by diffusion. Note: both D and R_{O2} are referenced to void volume.

50.90 $d = 50.923\,m$

$d = 167.07 \cdot ft$

$b(t) := \min(d, DTW(t))$

Actual thickness of sulfate reaction zone. Minimum of diffusion controlled reaction zone or depth-to-water.

$MR_{SO4}(t) := MRM_{SO4} \cdot b(t) \cdot A \cdot \rho_b$

Mass rate of released sulfate

$MRV_S := R_{O2} \cdot W_S \cdot moleratio \cdot \phi$

Mass rate of released S per unit bulk volume

$MRV_S = 5.375 \times 10^{-11} \frac{kg}{m^3 \cdot s}$

$MRA_S(t) := MRV_S \cdot b(t)$

Mass rate of released S per unit map area (m^2)

$MR_S(t) := MRA_S(t) \cdot A$

Mass rate of released S

$M_S(t) := \int_0^t MR_S(t)\,dt$

$MT_S := Cont_S \cdot \rho_b \cdot A \cdot DTW(200 \cdot yr)$

Total mass of available sulfur

$MT_S = 2.454 \times 10^4 \cdot tonne$

$ff(tt) := M_S(tt) - MT_S \quad tt := 100 \cdot yr$

Root equation and time guess

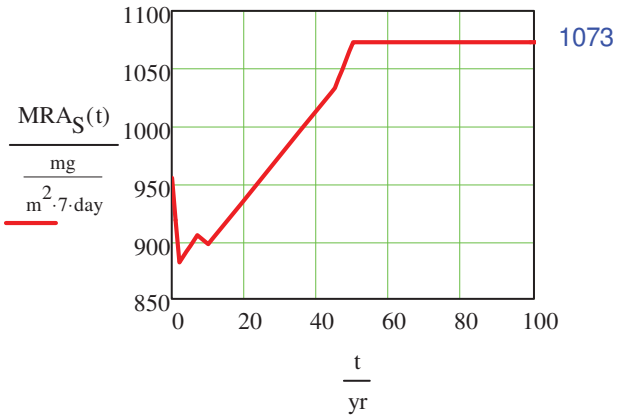
$t_{end} := root(ff(tt), tt)$

Sulfate depletion time > 200 yr

Set --> $t_{end} := 201 \cdot yr$

$$MRA_S(t) := \begin{cases} MRV_S \cdot b(t) & \text{if } 0 \le t < t_{end} \\ 0 & \text{if } t \ge t_{end} \end{cases}$$

$$MR_S(t) := \begin{cases} MRA_S(t) \cdot A & \text{if } 0 \le t < t_{end} \\ 0 & \text{if } t \ge t_{end} \end{cases}$$



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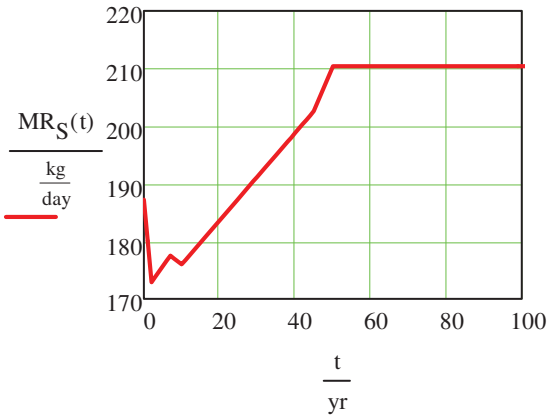


$Q_{seep} := q \cdot A$

Seepage flow rate

$Q_{seep} = 136.942 \cdot gpm$

$V_w := SAT \cdot \phi \cdot A \cdot DTW(200 \cdot yr)$

Water volume in unsat zone

$V_w = 6.12 \times 10^6 \cdot m^3$

Set up dimensionless equations using m-kg-day units

$tt_{end} := \frac{t_{end}}{day}$ End of sulfate generation in days $tt_{end} = 7.341 \times 10^{4}$

$MR(tt) := \frac{MR_{SO4}(tt \cdot day)}{kg \cdot day^{-1}}$ Mass rate of sulfate generation in kg/day

$M(tt) := \begin{cases} MR(tt) & \text{if } tt < tt_{end} \\ 0 & \text{otherwise} \end{cases}$ Sultate mass generation function

$V := \frac{V_w}{m^3}$ Water volume in m^3 $V = 6.12 \times 10^{6}$

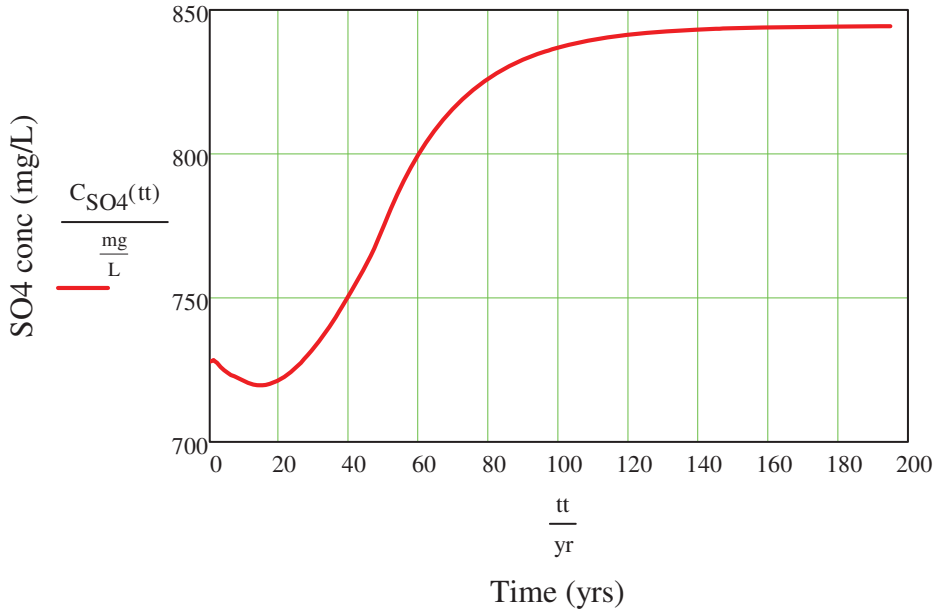
$Q := \frac{Q_{seep}}{m^3 \cdot day^{-1}}$ Seepage flow rate in m^3/day $Q = 746.469$

$Co := \frac{Co_{SO4}}{kg \cdot m^{-3}}$ Initial sulfate conc in kg/m^3 $Co = 0.728$

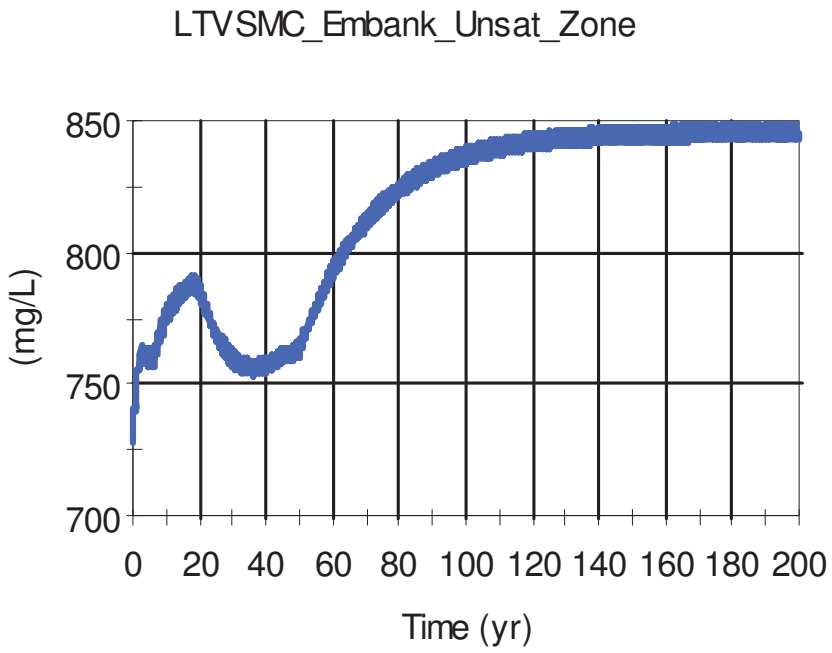
Given $\frac{d}{dt}C(t) = \frac{M(t) - Q \cdot C(t)}{V}$ $C(0) = Co$ $C := Odesolve(t, 196 \cdot 365)$ Governing ODE and IC

$C_{SO4}(tt) := C\left(\frac{tt}{day}\right) \cdot kg \cdot m^{-3}$ Seepage sulfate conc as a function of time $tt := 0, 1 \cdot yr .. 200 \cdot yr$

MathCad Output



GoldSim Output



Sulfate Generation - Cell 2W Coarse

LTVSMC coarse tailings

$A := 890625 \cdot m^2$ — Map area (Table 1-33) — $A = 220.078 \cdot acre$

$q := 13.27 \cdot \frac{in}{yr}$ — Percolation flux (from seepage spreadsheet with Barr edits)

$K_s := 1.17 \cdot 10^{-3} \cdot \frac{cm}{sec}$ — Saturated hydraulic conductivity of tailings (Table 1-12b)

$\beta := 2$ — vanGenuchten parameter of tailings (Table 1-12a)

$\theta_r := 0.041$ — Residual volumetric water content of tailings (Table 1-12a)

$\phi := 0.412$ — Porosity of tailings (Table 1-12a)

$G := 2.8$ — Specfic gravity of tailings (Table 1-12a)

$\rho_w := 1 \cdot \frac{gm}{cm^3}$ — Water density (standard value)

$\tau := 0.273$ — Tortuosity (Table 1-1, sheet 5)

$D_a := 1.8 \cdot 10^{-5} \cdot \frac{m^2}{sec}$ — Free diffusion coefficient of oxygen in air (Table 1-1, sheet 5)

$c := 3.28$ — Empirical constant (Table 1-1, sheet 5)

$D_w := 2.2 \cdot 10^{-9} \cdot \frac{m^2}{sec}$ — Free difussion coeff of oxygen in water (Table 1-1, sheet 5)

$K_H := 33.9$ — Henry's constant for oxygen (Table 1-1, sheet 5)

$C_o := 8.89 \cdot \frac{mol}{m^3}$ — O2 concentration in air. Moles of O2 per unit volume of air (Table 1-1, sheet 5)

$W_{SO4} := 96.07 \cdot \frac{gm}{mole}$ — Molecular weight of sulfate (standard value)

$W_S := 32.066 \cdot \frac{gm}{mole}$ — Molecular weight of sulfur (standard value)

$R_{SO4} := 1.95186 \cdot \frac{mg}{kg \cdot 7 \cdot day}$ 1.95186 — P50 SO4 distribution parameter of tailings (Table 1-19; P50 from GoldSim)

$CF := 0.185$ — Calibration factor for tailings (Table 1-1, sheet 5)

$TF := 0.228589$ — Temperature factor (computed in GS using numerous inputs)

$FF := \frac{3.4}{12}$ — Freeze factor (from Table 1-1, sheet 3) — $FF = 0.28333$

$moleratio := \frac{4}{9}$ — mole SO4 / mole O2 = mole S / mole O2 (Table 1-1, sheet 6) — $moleratio = 0.444$

$Cont_S := 329 \cdot \frac{mg}{kg}$ 329 — Sulfur content. Mass of S per unit mass of tailings. (Table 1-22)

$Co_{SO4} := 560 \cdot \frac{mg}{L}$ — Initial concentration in tailings pore water

Piecewise linear function to approximate DTW vs time

$t_1 := 0 \cdot yr$ $D_1 := 125.4 \cdot ft$

$t_2 := 18 \cdot yr$ $D_2 := 114.8 \cdot ft$

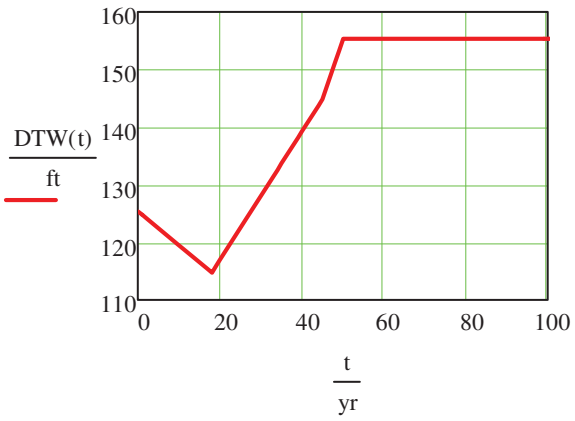
$t_3 := 45 \cdot yr$ $D_3 := 144.9 \cdot ft$

$t_4 := 50 \cdot yr \qquad D_4 := 155.4 \cdot ft$

$t_5 := 200 \cdot yr \qquad D_5 := 155.4 \cdot ft$

$$DTW(t) := \begin{cases} D_1 + \frac{D_2 - D_1}{t_2 - t_1} \cdot (t - t_1) & \text{if } t_1 \le t \le t_2 \\ D_2 + \frac{D_3 - D_2}{t_3 - t_2} \cdot (t - t_2) & \text{if } t_2 < t \le t_3 \\ D_3 + \frac{D_4 - D_3}{t_4 - t_3} \cdot (t - t_3) & \text{if } t_3 < t \le t_4 \\ D_4 + \frac{D_5 - D_4}{t_5 - t_4} \cdot (t - t_4) & \text{if } t_4 < t \le t_5 \end{cases}$$

$t := 0 \cdot yr, 1 \cdot yr .. 200 \cdot yr$



$\rho_b := G \cdot \rho_w \cdot (1 - \phi)$ Tailings dry bulk density. Mass of solids per unit bulk volume. $\rho_b = 1.646 \cdot \frac{gm}{cm^3}$

$\gamma := 1 - \frac{1}{\beta}$ Computed vanGenuchten parameter $\gamma = 0.5$

$$K(ss) := K_s \left(\frac{ss \cdot \phi - \theta_r}{\phi - \theta_r} \right)^{0.5} \cdot \left[1 - \left[1 - \left(\frac{ss \cdot \phi - \theta_r}{\phi - \theta_r} \right)^{\frac{1}{\gamma}} \right]^{\gamma} \right]^2$$

Unsaturated hydraulic conductivity as a function of saturation (ss) based on vanGenuchten relationship

$f(ss) := q - K(ss) \qquad ss := 0.5$ Root equation and saturation guess

$SAT := root(f(ss), ss)$ Computed saturation associated with flux (q) 0.35582 $SAT = 0.35583$

$q - K(SAT) = -3.36 \times 10^{-6} \cdot \frac{in}{yr}$ Confirm root calculation (result should be approx zero)

$D := \tau \cdot D_a \cdot (1 - SAT)^c + \tau \cdot SAT \cdot \frac{D_w}{K_H}$ Effective O2 diffusion coeff used in GS. This diffusion coeff is referenced to void volume. 1.161 x 10-6 $D = 1.161 \times 10^{-6} \frac{m^2}{s}$

$MRM_{SO4} := R_{SO4} \cdot CF \cdot TF \cdot (1 - FF)$ Mass rate of released SO4 per unit mass of tailings solids $R_{SO4} = 1.952 \cdot \frac{mg}{kg \cdot 7 \cdot day}$

Effect of three factors $CF \cdot TF \cdot (1 - FF) = 0.030$

$R_{O2} := \frac{MRM_{SO4}}{W_{SO4} \cdot moleratio} \cdot \frac{\rho_b}{\phi}$ Molar consumption rate of O2 per unit void volume 0.00554 $R_{O2} = 0.00554 \cdot \frac{mol}{m^3 \cdot 7 \cdot day}$

$d := \sqrt{\frac{2 \cdot D \cdot C_o}{R_{O2}}}$ Thickness of sulfate reaction zone if controlled by diffusion. Note: both D and R_{O2} are referenced to void volume. 47.47 $d = 47.494\,m$

$b(t) := \min(d, DTW(t))$ Actual thickness of sulfate reaction zone. Minimum of diffusion controlled reaction

zone or depth-to-water.

$MR_{SO4}(t) := MRM_{SO4} \cdot b(t) \cdot A \cdot \rho_b$ Mass rate of released sulfate

$MRV_S := R_{O2} \cdot W_S \cdot moleratio \cdot \phi$ Mass rate of released S per unit bulk volume $MRV_S = 5.375 \times 10^{-11} \frac{kg}{m^3 \cdot s}$

$MRA_S(t) := MRV_S \cdot b(t)$ Mass rate of released S per unit map area (m^2)

$MR_S(t) := MRA_S(t) \cdot A$ Mass rate of released S

$M_S(t) := \int_0^t MR_S(t)\, dt$

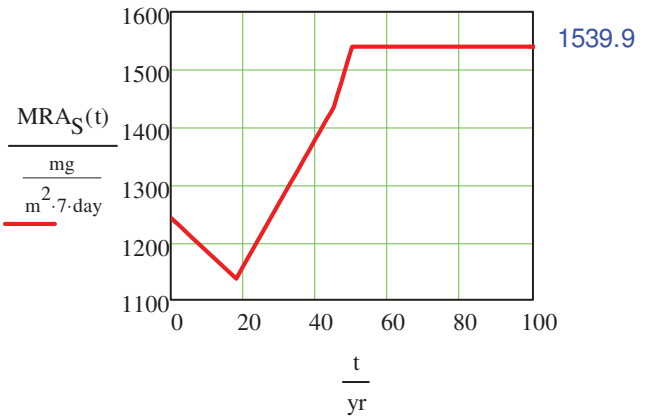
$MT_S := Cont_S \cdot \rho_b \cdot A \cdot DTW(200 \cdot yr)$ Total mass of available sulfur $MT_S = 2.285 \times 10^4 \cdot tonne$

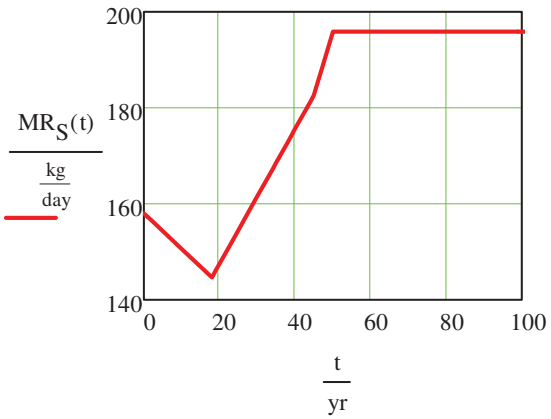
$ff(tt) := M_S(tt) - MT_S \quad tt := 100 \cdot yr$ Root equation and time guess

$t_{end} := root(ff(tt), tt)$ Sulfate depletion time > 200 yr Set --> $t_{end} := 201 \cdot yr$

$$MRA_S(t) := \begin{cases} MRV_S \cdot b(t) & \text{if } 0 \le t < t_{end} \\ 0 & \text{if } t \ge t_{end} \end{cases}$$

$$MR_S(t) := \begin{cases} MRA_S(t) \cdot A & \text{if } 0 \le t < t_{end} \\ 0 & \text{if } t \ge t_{end} \end{cases}$$





$Q_{seep} := q \cdot A$ Seepage flow rate $Q_{seep} = 150.78 \cdot gpm$

$V_w := SAT \cdot \phi \cdot A \cdot DTW(200 \cdot yr)$ Water volume in unsat zone $V_w = 6.184 \times 10^6 \cdot m^3$

Set up dimensionless equations using m-kg-day units

$tt_{end} := \frac{t_{end}}{day}$ End of sulfate generation in days $tt_{end} = 7.341 \times 10^{4}$

$MR(tt) := \frac{MR_{SO4}(tt \cdot day)}{kg \cdot day^{-1}}$ Mass rate of sulfate generation in kg/day

$M(tt) := \begin{cases} MR(tt) & \text{if } tt < tt_{end} \\ 0 & \text{otherwise} \end{cases}$ Sultate mass generation function

$V := \frac{V_w}{m^3}$ Water volume in m^3 $V = 6.184 \times 10^{6}$

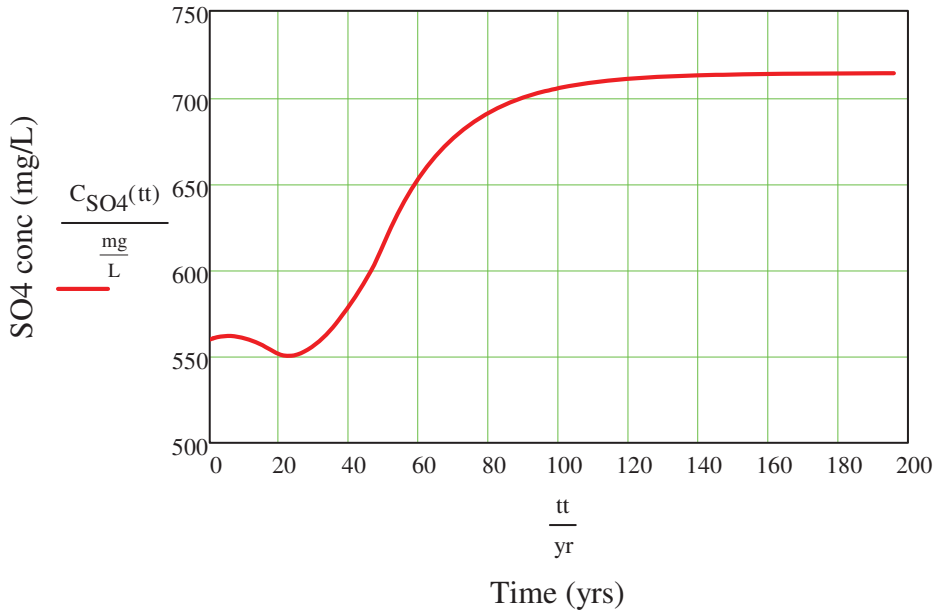
$Q := \frac{Q_{seep}}{m^3 \cdot day^{-1}}$ Seepage flow rate in m^3/day $Q = 821.899$

$Co := \frac{Co_{SO4}}{kg \cdot m^{-3}}$ Initial sulfate conc in kg/m^3 $Co = 0.56$

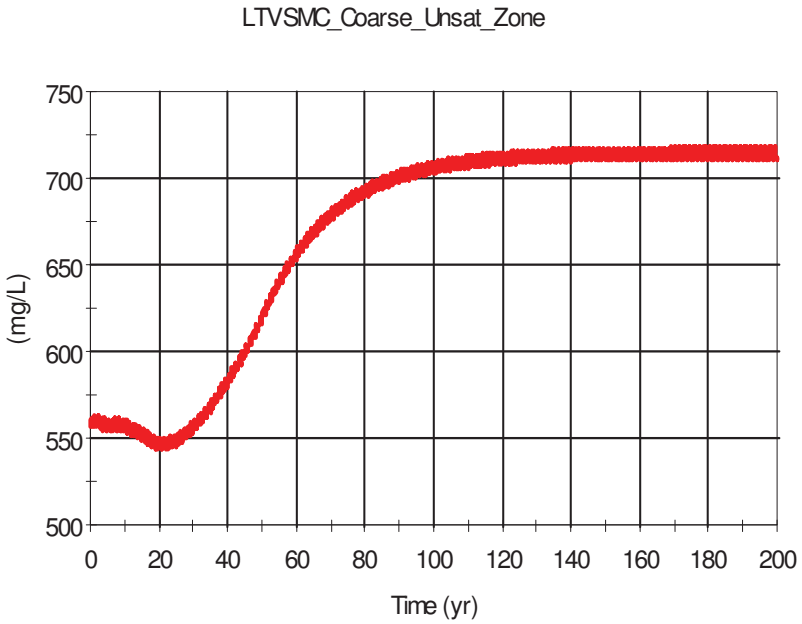
Given $\frac{d}{dt}C(t) = \frac{M(t) - Q \cdot C(t)}{V}$ $C(0) = Co$ $C := Odesolve(t, 197 \cdot 365)$ Governing ODE and IC

$C_{SO4}(tt) := C\left(\frac{tt}{day}\right) \cdot kg \cdot m^{-3}$ Seepage sulfate conc as a function of time $tt := 0, 1 \cdot yr .. 200 \cdot yr$

MathCad Output



GoldSim Output



Sulfate Generation - Cell 2W Fine

LTVSMC fine tailings

$A := 3027344 \cdot m^2$ Map area (Table 1-33) $A = 748.073 \cdot acre$

$q := 15.93 \cdot \frac{in}{yr}$ Percolation flux (from seepage spreadsheet with Barr edits)

$K_s := 1.1 \cdot 10^{-4} \cdot \frac{cm}{sec}$ Saturated hydraulic conductivity of tailings (Table 1-12b)

$\beta := 1.6$ vanGenuchten parameter of tailings (Table 1-12a)

$\theta_r := 0.059$ Residual volumetric water content of tailings (Table 1-12a)

$\phi := 0.493$ Porosity of tailings (Table 1-12a)

$G := 2.9$ Specfic gravity of tailings solids (Table 1-12a)

$\rho_w := 1 \cdot \frac{gm}{cm^3}$ Water density (standard value)

$\tau := 0.273$ Tortuosity (Table 1-1, sheet 5)

$D_a := 1.8 \cdot 10^{-5} \cdot \frac{m^2}{sec}$ Free diffusion coefficient of oxygen in air (Table 1-1, sheet 5)

$c := 3.28$ Empirical constant (Table 1-1, sheet 5)

$D_w := 2.2 \cdot 10^{-9} \cdot \frac{m^2}{sec}$ Free difussion coeff of oxygen in water (Table 1-1, sheet 5)

$K_H := 33.9$ Henry's constant for oxygen (Table 1-1, sheet 5)

$C_o := 8.89 \cdot \frac{mol}{m^3}$ O2 concentration in air. Moles of O2 per unit volume of air (Table 1-1, sheet 5)

$W_{SO4} := 96.07 \cdot \frac{gm}{mole}$ Molecular weight of sulfate (standard value)

$W_S := 32.066 \cdot \frac{gm}{mole}$ Molecular weight of sulfur (standard value)

$R_{SO4} := 1.95186 \cdot \frac{mg}{kg \cdot 7 \cdot day}$ 1.95186 P50 SO4 distribution parameter for tailings (Table 1-19; P50 from GoldSim)

$CF := 0.36$ Calibration factor for tailings (Table 1-1, sheet 5)

$TF := 0.228589$ Temperature factor (computed in GS using numerous inputs)

$FF := \frac{3.4}{12}$ Freeze factor (from Table 1-1, sheet 3) $FF = 0.28333$

$moleratio := \frac{4}{9}$ mole SO4 / mole O2 = mole S / mole O2 (Table 1-1, sheet 6) $moleratio = 0.444$

$Cont_S := 329 \cdot \frac{mg}{kg}$ 329 Sulfur content. Mass of S per unit mass of tailings. (Table 1-22)

$Co_{SO4} := 272.4 \cdot \frac{mg}{L}$ Initial concentration in tailings pore water

$t_1 := 0 \cdot yr$ $D_1 := 114.9 \cdot ft$ Piecewise linear function to approximate DTW vs time

$t_2 := 7 \cdot yr$ $D_2 := 70.9 \cdot ft$

$t_3 := 10 \cdot yr$ $D_3 := 70.6 \cdot ft$

$t_4 := 18 \cdot yr \qquad D_4 := 59.8 \cdot ft$

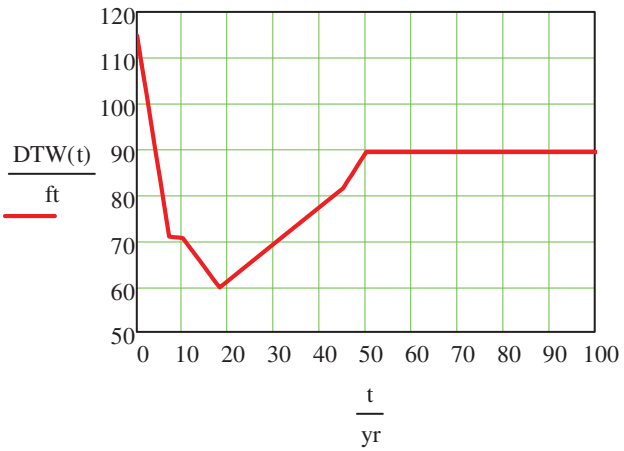
$t_5 := 45 \cdot yr \qquad D_5 := 81.5 \cdot ft$

$t_6 := 50 \cdot yr \qquad D_6 := 89.4 \cdot ft$

$t_7 := 200 \cdot yr \qquad D_7 := 89.4 \cdot ft$

$$DTW(t) := \begin{cases} D_1 + \frac{D_2 - D_1}{t_2 - t_1} \cdot (t - t_1) & \text{if } t_1 \le t \le t_2 \\ D_2 + \frac{D_3 - D_2}{t_3 - t_2} \cdot (t - t_2) & \text{if } t_2 < t \le t_3 \\ D_3 + \frac{D_4 - D_3}{t_4 - t_3} \cdot (t - t_3) & \text{if } t_3 < t \le t_4 \\ D_4 + \frac{D_5 - D_4}{t_5 - t_4} \cdot (t - t_4) & \text{if } t_4 < t \le t_5 \\ D_5 + \frac{D_6 - D_5}{t_6 - t_5} \cdot (t - t_5) & \text{if } t_5 < t \le t_6 \\ D_6 + \frac{D_7 - D_6}{t_7 - t_6} \cdot (t - t_6) & \text{if } t_6 < t \le t_7 \end{cases}$$

$t := 0 \cdot yr, 1 \cdot yr .. 200 \cdot yr$



$\rho_b := G \cdot \rho_w \cdot (1 - \phi)$ Tailings dry bulk density. Mass of solids per unit bulk volume. $\rho_b = 1.47 \cdot \frac{gm}{cm^3}$

$\gamma := 1 - \frac{1}{\beta}$ Computed vanGenuchten parameter $\gamma = 0.375$

$$K(ss) := K_s \left(\frac{ss \cdot \phi - \theta_r}{\phi - \theta_r} \right)^{0.5} \cdot \left[1 - \left[1 - \left(\frac{ss \cdot \phi - \theta_r}{\phi - \theta_r} \right)^{\frac{1}{\gamma}} \right]^{\gamma} \right]^2$$

Unsaturated hydraulic conductivity as a function of saturation (ss) based on vanGenuchten relationship

$f(ss) := q - K(ss) \qquad ss := 0.8$ Root equation and saturation guess

$SAT := root(f(ss), ss)$ Computed saturation associated with flux (q) 0.6741 $SAT = 0.6741$

$q - K(SAT) = -4.179 \times 10^{-9} \cdot \frac{in}{yr}$ Confirm root calculation (result should be approx zero)

$D := \tau \cdot D_a \cdot (1 - SAT)^c + \tau \cdot SAT \cdot \frac{D_w}{K_H}$ Effective O2 diffusion coeff used in GS. This diffusion coeff is referenced to void volume. 1.243 x 10-7 $D = 1.243 \times 10^{-7} \frac{m^2}{s}$

$MRM_{SO4} := R_{SO4} \cdot CF \cdot TF \cdot (1 - FF)$ Mass rate of released SO4 per unit mass of tailings solids $R_{SO4} = 1.952 \cdot \frac{mg}{kg \cdot 7 \cdot day}$

Effect of three factors $CF \cdot TF \cdot (1 - FF) = 0.059$

$R_{O2} := \frac{MRM_{SO4}}{W_{SO4} \cdot moleratio} \cdot \frac{\rho_b}{\phi}$ Molar consumption rate of O2 per unit void volume 0.00805 $R_{O2} = 0.00804 \cdot \frac{mol}{m^3 \cdot 7 \cdot day}$

$d := \sqrt{\frac{2 \cdot D \cdot C_o}{R_{O2}}}$

Thickness of sulfate reaction zone if controlled by diffusion. Note: both D and R_{O2} are referenced to void volume.

12.88 $d = 12.892\,m$

$d = 42.297 \cdot ft$

$b(t) := \min(d, DTW(t))$

Actual thickness of sulfate reaction zone. Minimum of diffusion controlled reaction zone or depth-to-water.

$MR_{SO4}(t) := MRM_{SO4} \cdot b(t) \cdot A \cdot \rho_b$

Mass rate of released sulfate

$MRV_S := R_{O2} \cdot W_S \cdot moleratio \cdot \phi$

Mass rate of released S per unit bulk volume

$MRV_S = 9.341 \times 10^{-11} \frac{kg}{m^3 \cdot s}$

$MRA_S(t) := MRV_S \cdot b(t)$

Mass rate of released S per unit map area (m^2)

$MR_S(t) := MRA_S(t) \cdot A$

Mass rate of released S

$M_S(t) := \int_0^t MR_S(t)\,dt$

$MT_S := Cont_S \cdot \rho_b \cdot A \cdot DTW(200 \cdot yr)$

Total mass of available sulfur

$MT_S = 3.99 \times 10^4 \cdot tonne$

$ff(tt) := M_S(tt) - MT_S \quad tt := 100 \cdot yr$

Root equation and time guess

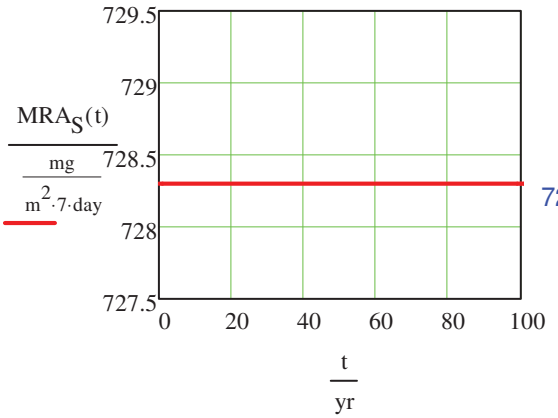
$t_{end} := root(ff(tt), tt)$

Sulfate depletion time > 200 yr

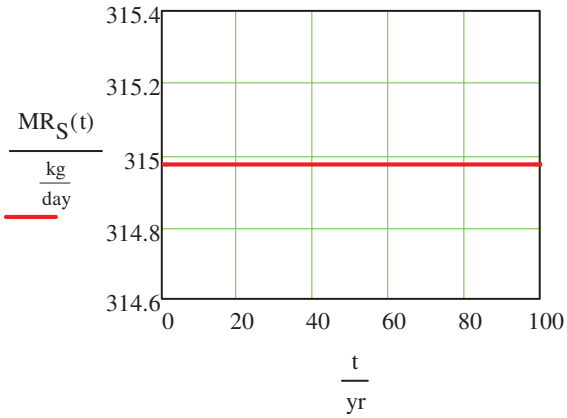
Set --> $t_{end} := 201 \cdot yr$

$$MRA_S(t) := \begin{cases} MRV_S \cdot b(t) & \text{if } 0 \le t < t_{end} \\ 0 & \text{if } t \ge t_{end} \end{cases}$$

$$MR_S(t) := \begin{cases} MRA_S(t) \cdot A & \text{if } 0 \le t < t_{end} \\ 0 & \text{if } t \ge t_{end} \end{cases}$$



728.0



$Q_{seep} := q \cdot A$

Seepage flow rate

$Q_{seep} = 615.254 \cdot gpm$

$V_w := SAT \cdot \phi \cdot A \cdot DTW(200 \cdot yr)$

Water volume in unsat zone

$V_w = 2.741 \times 10^7 \cdot m^3$

Set up dimensionless equations using m-kg-day units

$tt_{end} := \frac{t_{end}}{day}$ End of sulfate generation in days $tt_{end} = 7.341 \times 10^{4}$

$MR(tt) := \frac{MR_{SO4}(tt \cdot day)}{kg \cdot day^{-1}}$ Mass rate of sulfate generation in kg/day

$M(tt) := \begin{cases} MR(tt) & \text{if } tt < tt_{end} \\ 0 & \text{otherwise} \end{cases}$ Sultate mass generation function

$V := \frac{V_w}{m^3}$ Water volume in m^3 $V = 2.741 \times 10^{7}$

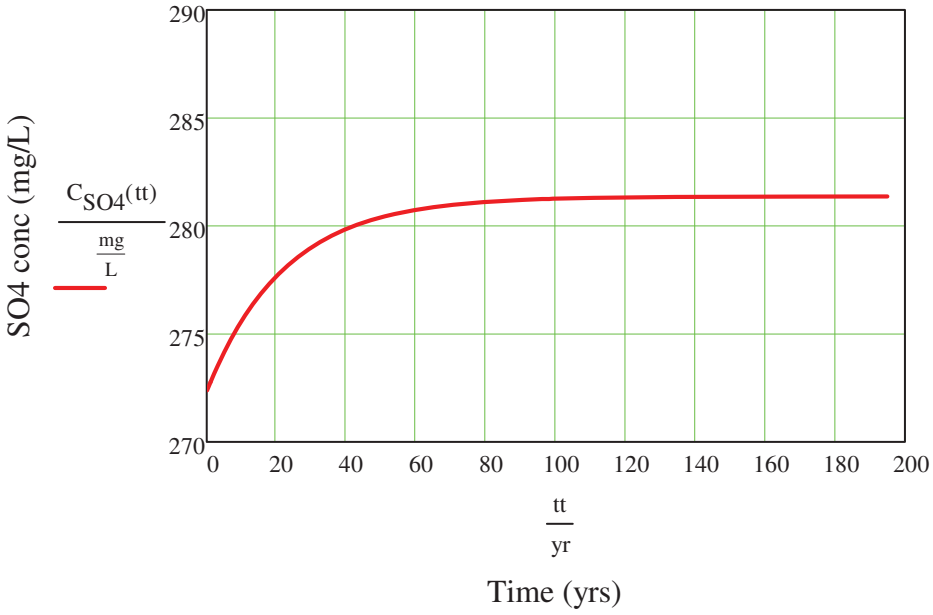
$Q := \frac{Q_{seep}}{m^3 \cdot day^{-1}}$ Seepage flow rate in m^3/day $Q = 3.354 \times 10^{3}$

$Co := \frac{Co_{SO4}}{kg \cdot m^{-3}}$ Initial sulfate conc in kg/m^3 $Co = 0.272$

Given $\frac{d}{dt}C(t) = \frac{M(t) - Q \cdot C(t)}{V}$ $C(0) = Co$ $C := Odesolve(t, 196 \cdot 365)$ Governing ODE and IC

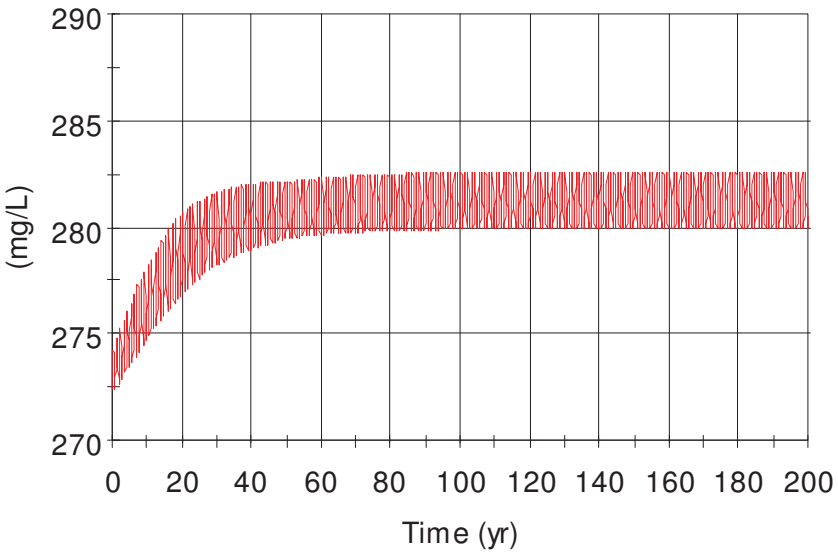
$C_{SO4}(tt) := C\left(\frac{tt}{day}\right) \cdot kg \cdot m^{-3}$ Seepage sulfate conc as a function of time $tt := 0, 1 \cdot yr .. 200 \cdot yr$

MathCad Output



GoldSim Output

LTVSMC_Fine_Unsat_Zone



North Beach - Misc Chemicals - Closure

Mixture of fine and coarse NM tailings with bentonite amendment

$\mu g := 10^{-6} \cdot gm$

Blue values are generated by GoldSim model

$q := 6.07 \cdot \frac{in}{yr}$ Percolation flux

$A := 75.67 \cdot acre$ Map area

Tailings

$F := 0.35$ Fraction of fine tailings

$R_{SO4coarse} := 11.83451 \cdot \frac{mg}{kg \cdot 7 \cdot day}$ P50 SO4 distribution parameter for coarse tailings (GS for P50 value)

$R_{SO4fine} := 19.32669 \cdot \frac{mg}{kg \cdot 7 \cdot day}$ P50 SO4 distribution parameter for fine tailings (GS for P50 value)

$CF := 1$ Calibration factor

$DTW := 137.3 \cdot ft$ Depth to water table during closure (Table 1-29)

$G := 3.0$ Specfic gravity (Table 1-12a)

$\phi := 0.41$ Porosity (Table 1-12a)

$K_s := 1.04961 \cdot 10^{-3} \cdot \frac{cm}{sec}$ Saturated hydraulic conductivity (Table 1-12a)

$\theta_r := 0.0113$ Residual water content (Table 1-12a)

$\alpha := 0.008775 \cdot cm^{-1}$ vanGenuchten parameter (Table 1-12a)

$\beta := 2.6944$ vanGenuchten parameter (Table 1-12a)

Bentonite-Amended Layer

$\phi_{bn} := 0.36$ Porosity of bentonite amended tailings (Table 1-1, sheet 4)

$K_{sbn} := 5.56 \cdot 10^{-6} \cdot \frac{cm}{sec}$ Saturated hydraulic conductivity of bentonite amended tailings (Table 1-1; sheet 4)

$\theta_{rbn} := 0.07$ Residual volumetric water content for bentonite amended tailings (Table 1-1, sheet 4)

$\beta_{bn} := 1.09$ vanGenuchten parameter for bentonite amended tailings (Table 1-1, sheet 4

$\alpha_{bn} := 0.005 \cdot cm^{-1}$ vanGenuchten parameter for bentonite amended tailings (Table 1-1,sheet4)

General Inputs

$\tau := 0.273$ Tortuosity (Table 1-1, sheet 5)

$D_a := 1.8 \cdot 10^{-5} \cdot \frac{m^2}{sec}$ Free diffusion coefficient of oxygen in air (Table 1-1, sheet 5)

$c := 3.28$ Empirical constant (Table 1-1, sheet 5)

$D_w := 2.2 \cdot 10^{-9} \cdot \frac{m^2}{sec}$ Free difussion coeff of oxygen in water (Table 1-1, sheet 5)

$K_H := 33.9$ Henry's constant for oxygen (Table 1-1, sheet 5)

$C_o := 8.89 \cdot \frac{mol}{m^3}$ O2 concentration in air (Table 1-1, sheet 5)

$W_{SO4} := 96.07 \cdot \frac{gm}{mole}$ Molecular weight of sulfate (standard value)

$W_S := 32.066 \cdot \frac{gm}{mole}$ Molecular weight of sulfur (standard value)

$TF := 0.228589$ Temperature factor (computed in GS using numerous inputs)

$FF := \frac{3.4}{12}$ Freeze factor (from Table 1-1, sheet 3) $FF = 0.28333$

$moleratio := \frac{4}{9}$ mole SO4 / mole O2 = mole S / mole O2 (Table 1-1, sheet 6) $moleratio = 0.444$

$W_{O2} := 32 \cdot \frac{gm}{mole}$ Molecular weight of O2

$\rho_w := 1 \cdot \frac{gm}{cm^3}$ Water density (standard value)

Calcs for LTV Bulk Tailings

$\rho := G \cdot \rho_w \cdot (1 - \phi)$ Bulk density $\rho = 1.77 \times 10^3 \frac{kg}{m^3}$

$\gamma := 1 - \frac{1}{\beta}$ Computed vanGenuchten parameter $\gamma = 0.629$

$Sat := 0.18228476$ 0.18450 Saturation

$$K := K_s \left(\frac{Sat \cdot \phi - \theta_r}{\phi - \theta_r} \right)^{0.5} \cdot \left[1 - \left[1 - \left(\frac{Sat \cdot \phi - \theta_r}{\phi - \theta_r} \right)^{\frac{1}{\gamma}} \right]^{\gamma} \right]^2$$

Unsaturated hydraulic conductivity as a function of saturation (Sat) based on vanGenuchten relationship and unit hydraulic gradient

For unit gradient conditions $q = 6.07000 \cdot \frac{in}{yr}$ $K = 6.070000 \cdot \frac{in}{yr}$

$$h := \frac{1}{\alpha} \cdot \left[\left(\frac{\phi - \theta_r}{Sat \cdot \phi - \theta_r} \right)^{\frac{1}{\gamma}} - 1 \right]^{\frac{1}{\beta}}$$

Suction head in tailings for unit gradient conditions 332.426 $h = 330.36 \cdot cm$

Calcs for Bentonite-Amended Tailings

$\gamma_{bn} := 1 - \frac{1}{\beta_{bn}}$ Computed vanGenuchten parameter

$$Sat_{bn} := \frac{1}{\phi_{bn}} \cdot \left[\theta_{rbn} + \frac{\phi_{bn} - \theta_{rbn}}{\left[1 + \left(\alpha_{bn} \cdot h \right)^{\beta_{bn}} \right]^{\gamma_{bn}}} \right]$$

Saturation at bottom of the bentonite layer. Assumed to apply to entire layer. $Sat_{bn} = 0.9359$ 0.93567

$D_{bn} := \tau \cdot D_a \cdot \left(1 - Sat_{bn} \right)^c + \tau \cdot Sat_{bn} \cdot \frac{D_w}{K_H}$ Effective O2 diffusion coeff used in GS. This parameter is referenced to the void volume. $D_{bn} = 6.151 \times 10^{-10} \frac{m^2}{s}$

6.2326 x 10^{-10}

Diffusion Related Calcs

$R_{SO4} := F \cdot R_{SO4fine} + (1 - F) \cdot R_{SO4coarse}$ $R_{SO4} = 14.457 \cdot \frac{mg}{kg \cdot 7 \cdot day}$

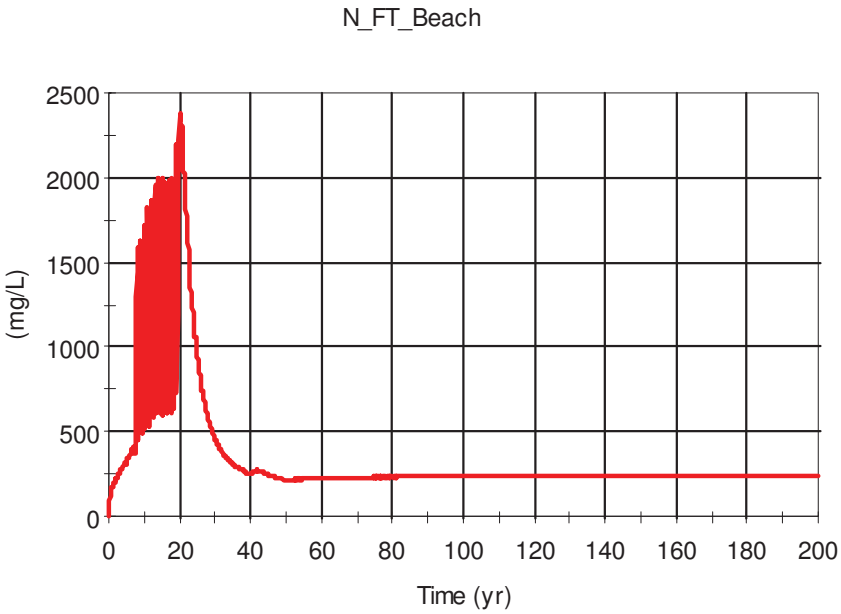
$MRM_{SO4} := R_{SO4} \cdot CF \cdot TF \cdot (1 - FF)$ Mass rate of released SO4 per unit mass of tailings solids $MRM_{SO4} = 2.368 \cdot \frac{mg}{kg \cdot 7 \cdot day}$

	Effect of three factors	$CF \cdot TF \cdot (1 - FF) = 0.164$
$r_{nm} := \frac{MRM_{SO4}}{W_{SO4} \cdot moleratio} \cdot \frac{\rho}{\phi}$	Molar consumption rate of O2 per unit volume of voids 0.23968	$r_{nm} = 0.23946 \cdot \frac{mol}{m^3 \cdot 7 \cdot day}$
$d := \sqrt{\frac{2 \cdot D_{bn} \cdot C_o}{r_{nm}}}$	Thickness of sulfate reaction zone if controlled by diffusion	$d = 0.166\,m$
$b := \min(d, DTW)$	Actual thickness of sulfate reaction zone. Minimum of diffusion controlled reaction zone or depth-to-water. 0.1672	$b = 0.166\,m$

Sulfate Calcs

$MRV_{SO4} := MRM_{SO4} \cdot \rho$	Mass rate of released sulfate per unit bulk volume	$MRV_{SO4} = 6.931 \times 10^{-9} \frac{kg}{m^3 \cdot s}$
$MR_{SO4} := MRV_{SO4} \cdot A \cdot b$	Mass rate of released SO4	$MR_{SO4} = 30.479 \cdot \frac{kg}{day}$
$Q := q \cdot A$	Seepage flow rate	$Q = 23.714 \cdot gpm$
$C_{SO4} := \frac{MR_{SO4}}{Q}$	Sulfate concentration in seepage 237.5	$C_{SO4} = 235.79 \cdot \frac{mg}{liter}$

GoldSim Output



Sulfur Calcs

$MRV_S := MRV_{SO4} \cdot \frac{W_S}{W_{SO4}}$	Mass rate per unit bulk volume of released sulfur	$MRV_S = 2.313 \times 10^{-9} \frac{kg}{m^3 \cdot s}$
$MRA_S := MRV_S \cdot b$	Mass rate per unit area of released sulfur 233.99	$MRA_S = 232.552 \cdot \frac{mg}{m^2 \cdot 7 \cdot day}$
$MR_S := MRA_S \cdot A$	Mass rate of sulfur generation	$MR_S = 10.173 \cdot \frac{kg}{day}$

Other Chemicals

Arsenic

$RR_{As} := F \cdot 0.00189041 + (1 - F) \cdot 0.00178929$ Release ratio of As to S

$CF_{As} := 1$ As calibration factor

$MR_{As} := MR_S \cdot RR_{As} \cdot CF_{As}$ Mass rate of released As 6.822 x 10^{-3} $MR_{As} = 6.780 \times 10^{-3} \cdot \frac{tonne}{yr}$

$C_{As} := \frac{MR_{As}}{Q}$ As concentration in seepage $C_{As} = 143.604 \cdot \frac{\mu g}{L}$

Copper

$RR_{Cu} := F \cdot 00.09250 + (1 - F) \cdot 0.208367$ Release ratio of Cu to S

$CF_{Cu} := 1$ Cu calibration factor

$MR_{Cu} := MR_S \cdot RR_{Cu} \cdot CF_{Cu}$ Mass rate of released Cu 6.274 x 10^{-1} $MR_{Cu} = 6.235 \times 10^{-1} \cdot \frac{tonne}{yr}$

$C_{Cu} := \frac{MR_{Cu}}{Q}$ Cu concentration in seepage $C_{Cu} = 13207.082 \cdot \frac{\mu g}{L}$

Nickel

$RR_{Ni} := 0.00272356$ Release ratio of Ni to S

$CF_{Ni} := 1$ Ni calibration factor

$MR_{Ni} := MR_S \cdot RR_{Ni} \cdot CF_{Ni}$ Mass rate of released Ni 1.018 x 10^{-2} $MR_{Ni} = 1.012 \times 10^{-2} \cdot \frac{tonne}{yr}$

$C_{Ni} := \frac{MR_{Ni}}{Q}$ Ni concentration in seepage $C_{Ni} = 214.347 \cdot \frac{\mu g}{L}$

Cobalt

$RR_{Co} := 0.0770998$ Release ratio of Co to Ni

$CF_{Co} := 1$ Co calibration factor

$MR_{Co} := MR_{Ni} \cdot RR_{Co} \cdot CF_{Co}$ Mass rate of released Co 7.851 x 10^{-4} $MR_{Co} = 7.803 \times 10^{-4} \cdot \frac{tonne}{yr}$

$C_{Co} := \frac{MR_{Co}}{Q}$ Co concentration in seepage $C_{Co} = 16.526 \cdot \frac{\mu g}{L}$

Zinc

$RR_{Zn} := 0.168192$ Release ratio of Zn to Ni

$CF_{Zn} := 1$ Zn calibration factor

$MR_{Zn} := MR_{Ni} \cdot RR_{Zn} \cdot CF_{Zn}$ Mass rate of released Zn 1.713 x 10^{-3} $MR_{Zn} = 1.702 \times 10^{-3} \cdot \frac{tonne}{yr}$

$C_{Zn} := \frac{MR_{Zn}}{Q}$ Zn concentration in seepage $C_{Zn} = 36.051 \cdot \frac{\mu g}{L}$

North Dam - Misc Chemicals - Closure

LTVSMC bulk tailings with bentonite amendment

$q := 6.07 \cdot \frac{in}{yr}$ Percolation flux

$\mu g := 10^{-6} \cdot gm$

$A := 249 \cdot acre$ Map area of North Dam

Blue values are generated by GoldSim model

LTV bulk tailings

$R_{SO4} := 1.95186 \cdot \frac{mg}{kg \cdot 7 \cdot day}$ P50 SO4 distribution parameter (GS for P50 value)

$CF_{coarse} := 0.185$ SO4 calibration factor for coarse tailings (Table 1-1, sheet 5)

$CF_{fine} := 0.360$ SO4 calibration factor for fine tailings (Table 1-1, sheet 5)

$DTW := 152 \cdot ft$ Depth to water table during closure (Table 1-29)

$G := 2.85$ Specfic gravity (Table 1-12a)

$\phi := 0.440$ Porosity (Table 1-12a)

$K_s := 8.02 \cdot 10^{-5} \cdot \frac{cm}{sec}$ Saturated hydraulic conductivity (Table 1-12a)

$\theta_r := 0.048$ Residual water content (Table 1-12a)

$\alpha := 0.011 \cdot cm^{-1}$ vanGenuchten parameter (Table 1-12a)

$\beta := 2.0$ vanGenuchten parameter (Table 1-12a)

Bentonite-Amended Layer

$\phi_{bn} := 0.36$ Porosity of bentonite amended tailings (Table 1-1, sheet 4)

$K_{sbn} := 5.56 \cdot 10^{-6} \cdot \frac{cm}{sec}$ Saturated hydraulic conductivity of bentonite amended tailings (Table 1-1; sheet 4)

$\theta_{rbn} := 0.07$ Residual volumetric water content for bentonite amended tailings (Table 1-1, sheet 4)

$\beta_{bn} := 1.09$ vanGenuchten parameter for bentonite amended tailings (Table 1-1, sheet 4

$\alpha_{bn} := 0.005 \cdot cm^{-1}$ vanGenuchten parameter for bentonite amended tailings (Table 1-1,sheet4)

General Inputs

$\tau := 0.273$ Tortuosity (Table 1-1, sheet 5)

$D_a := 1.8 \cdot 10^{-5} \cdot \frac{m^2}{sec}$ Free diffusion coefficient of oxygen in air (Table 1-1, sheet 5)

$c := 3.28$ Empirical constant (Table 1-1, sheet 5)

$D_w := 2.2 \cdot 10^{-9} \cdot \frac{m^2}{sec}$ Free difussion coeff of oxygen in water (Table 1-1, sheet 5)

$K_H := 33.9$ Henry's constant for oxygen (Table 1-1, sheet 5)

$C_o := 8.89 \cdot \frac{mol}{m^3}$ O2 concentration in air (Table 1-1, sheet 5)

$W_{SO4} := 96.07 \cdot \frac{gm}{mole}$ Molecular weight of sulfate (standard value)

$W_S := 32.066 \cdot \frac{gm}{mole}$ Molecular weight of sulfur (standard value)

$TF := 0.228589$ Temperature factor (computed in GS using numerous inputs)

$FF := \frac{3.4}{12}$ Freeze factor (from Table 1-1, sheet 3) $FF = 0.28333$

$moleratio := \frac{4}{9}$ mole SO4 / mole O2 = mole S / mole O2 (Table 1-1, sheet 6) $moleratio = 0.444$

$W_{O2} := 32 \cdot \frac{gm}{mole}$ Molecular weight of O2

$\rho_w := 1 \cdot \frac{gm}{cm^3}$ Water density (standard value)

Calcs for LTV Bulk Tailings

$\rho := G \cdot \rho_w \cdot (1 - \phi)$ Bulk density $\rho = 1.596 \times 10^3 \frac{kg}{m^3}$

$\gamma := 1 - \frac{1}{\beta}$ Computed vanGenuchten parameter $\gamma = 0.5$

$Sat := 0.490864$ Saturation

0.48785

$$K := K_s \left(\frac{Sat \cdot \phi - \theta_r}{\phi - \theta_r} \right)^{0.5} \cdot \left[1 - \left[1 - \left(\frac{Sat \cdot \phi - \theta_r}{\phi - \theta_r} \right)^{\frac{1}{\gamma}} \right]^{\gamma} \right]^2$$

Unsaturated hydraulic conductivity as a function of saturation (Sat) based on vanGenuchten relationship and unit hydraulic gradient

For unit gradient conditions $q = 6.07000 \cdot \frac{in}{yr}$ $K = 6.07000 \cdot \frac{in}{yr}$

$$h := \frac{1}{\alpha} \cdot \left[\left(\frac{\phi - \theta_r}{Sat \cdot \phi - \theta_r} \right)^{\frac{1}{\gamma}} - 1 \right]^{\frac{1}{\beta}}$$

Suction head in tailings for unit gradient conditions $h = 191.681 \cdot cm$

193.549

Calcs for Bentonite-Amended Tailings

$\gamma_{bn} := 1 - \frac{1}{\beta_{bn}}$ Computed vanGenuchten parameter

$$Sat_{bn} := \frac{1}{\phi_{bn}} \cdot \left[\theta_{rbn} + \frac{\phi_{bn} - \theta_{rbn}}{\left[1 + \left(\alpha_{bn} \cdot h \right)^{\beta_{bn}} \right]^{\gamma_{bn}}} \right]$$

Saturation at bottom of the bentonite layer. Assumed to apply to entire layer. $Sat_{bn} = 0.9566$

0.9563

$D_{bn} := \tau \cdot D_a \cdot \left(1 - Sat_{bn}\right)^c + \tau \cdot Sat_{bn} \cdot \frac{D_w}{K_H}$ Effective O2 diffusion coeff used in GS. This parameter is referenced to the void volume. $D_{bn} = 1.835 \times 10^{-10} \frac{m^2}{s}$

1.876×10^{-10}

Diffusion Related Calcs

$CF := \frac{CF_{fine} + CF_{coarse}}{2}$ Sulfate calibration factor

$MRM_{SO4} := R_{SO4} \cdot CF \cdot TF \cdot (1 - FF)$ Mass rate of released SO4 per unit mass of tailings solids $MRM_{SO4} = 0.087 \cdot \frac{mg}{kg \cdot 7 \cdot day}$

Effect of three factors

$CF \cdot TF \cdot (1 - FF) = 0.045$

$r_{nm} := \frac{MRM_{SO4}}{W_{SO4} \cdot moleratio} \cdot \frac{\rho}{\phi}$

Molar consumption rate of O2 per unit volume of voids

$r_{nm} = 0.00740 \cdot \frac{mol}{m^3 \cdot 7 \cdot day}$

0.00741

$d := \sqrt{\frac{2 \cdot D_{bn} \cdot C_o}{r_{nm}}}$

Thickness of sulfate reaction zone if controlled by diffusion

$d = 0.516\,m$

$b := \min(d, DTW)$

Actual thickness of sulfate reaction zone. Minimum of diffusion controlled reaction zone or depth-to-water.

$b = 0.516\,m$

0.522

Sulfate Calcs

$MRV_{SO4} := MRM_{SO4} \cdot \rho$

Mass rate of released sulfate per unit bulk volume

$MRV_{SO4} = 2.299 \times 10^{-10} \frac{kg}{m^3 \cdot s}$

$MR_{SO4} := MRV_{SO4} \cdot A \cdot b$

Mass rate of released SO4

$MR_{SO4} = 10.335 \cdot \frac{kg}{day}$

$Q := q \cdot A$

Seepage flow rate

$Q = 78.034 \cdot gpm$

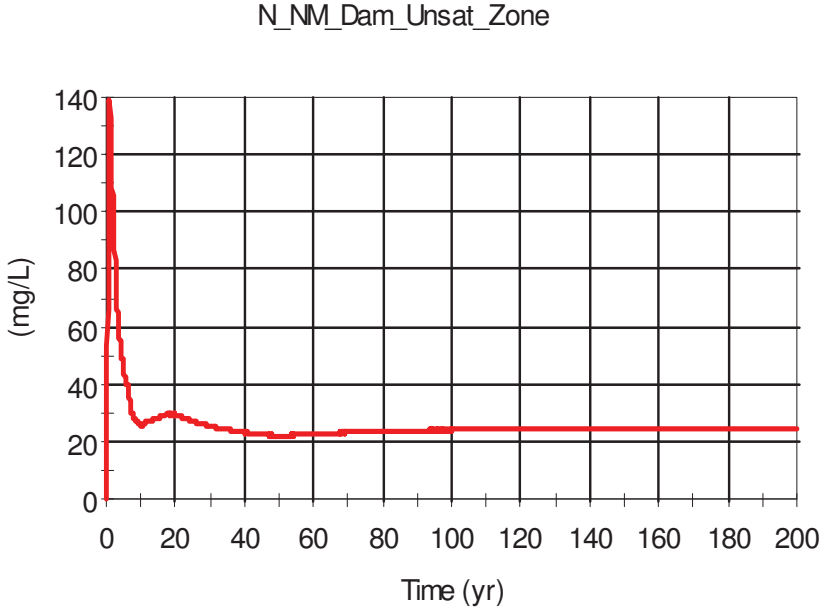
$C_{SO4} := \frac{MR_{SO4}}{Q}$

Sulfate concentration in seepage

24.5

$C_{SO4} = 24.3 \cdot \frac{mg}{liter}$

GoldSim Output



Sulfur Calcs

$MRV_S := MRV_{SO4} \cdot \frac{W_S}{W_{SO4}}$

Mass rate per unit bulk volume of released sulfur

$MRV_S = 7.675 \times 10^{-11} \frac{kg}{m^3 \cdot s}$

$MRA_S := MRV_S \cdot b$

Mass rate per unit area of released sulfur

$MRA_S = 23.962 \cdot \frac{mg}{m^2 \cdot 7 \cdot day}$

24.22

$MR_S := MRA_S \cdot A$

Mass rate of sulfur generation

$MR_S = 3.449 \cdot \frac{kg}{day}$

Other Chemicals

$RR_{As} := 0.09995$ Release ratio of As to S

$CF_{As} := 0.0001$ As calibration factor

$MR_{As} := MR_S \cdot RR_{As} \cdot CF_{As}$ Mass rate of released As 1.273 x 10^{-5} $MR_{As} = 1.259 \times 10^{-5} \cdot \frac{tonne}{yr}$

$C_{As} := \frac{MR_{As}}{Q}$ As concentration in seeapge $C_{As} = 0.081 \cdot \frac{\mu g}{L}$

$RR_{Co} := 0.03076$ Release ratio of Co to S

$CF_{Co} := 0.0006$ Co calibration factor

$MR_{Co} := MR_S \cdot RR_{Co} \cdot CF_{Co}$ Mass rate of released Co 2.350 x 10^{-5} $MR_{Co} = 2.325 \times 10^{-5} \cdot \frac{tonne}{yr}$

$C_{Co} := \frac{MR_{Co}}{Q}$ Co concentration in seeapge $C_{Co} = 0.150 \cdot \frac{\mu g}{L}$

$RR_{Cu} := 0.030598$ Release ratio of Cu to S

$CF_{Cu} := 0.0005$ Cu calibration factor

$MR_{Cu} := MR_S \cdot RR_{Cu} \cdot CF_{Cu}$ Mass rate of released Cu 1.948 x 10^{-5} $MR_{Cu} = 1.928 \times 10^{-5} \cdot \frac{tonne}{yr}$

$C_{Cu} := \frac{MR_{Cu}}{Q}$ Cu concentration in seeapge $C_{Cu} = 0.124 \cdot \frac{\mu g}{L}$

$RR_{Ni} := 0.014307$ Release ratio of Ni to S

$CF_{Ni} := 0.0027$ Ni calibration factor

$MR_{Ni} := MR_S \cdot RR_{Ni} \cdot CF_{Ni}$ Mass rate of released Ni 4.920 x 10^{-5} $MR_{Ni} = 4.867 \times 10^{-5} \cdot \frac{tonne}{yr}$

$C_{Ni} := \frac{MR_{Ni}}{Q}$ Ni concentration in seeapge $C_{Ni} = 0.313 \cdot \frac{\mu g}{L}$

$RR_{Zn} := 5.0629 \cdot 10^{-5}$ Release ratio of Zn to SO4

$CF_{Zn} := 0.2596$ Zn calibration factor

$MR_{Zn} := MR_{SO4} \cdot RR_{Zn} \cdot CF_{Zn}$ Mass rate of released Zn 5.014 x 10^{-5} $MR_{Zn} = 4.961 \times 10^{-5} \cdot \frac{tonne}{yr}$

$C_{Zn} := \frac{MR_{Zn}}{Q}$ Zn concentration in seeapge $C_{Zn} = 0.319 \cdot \frac{\mu g}{L}$

Pond Area - Sulfate - Bentonite Amended - Closure at t = 100 yrs

$A := 972.6 \cdot acre$ Pond area (GS output)

$q := 6.5 \cdot \frac{in}{yr}$ Seepage flux for bentonite amended pond bottom (Table 1-31)

$C_o := 12.48 \cdot \frac{mg}{L}$ Average annual pond DO concentration (Table 1-18)

$W_{O2} := 32 \cdot \frac{gm}{mole}$ O2 molecular weight

$W_{SO4} := 96.07 \cdot \frac{gm}{mole}$ SO4 molecular weight

$W_S := 32.07 \cdot \frac{gm}{mole}$ S molecular weight

$C_{SO4p} := 16.19 \cdot \frac{mg}{L}$ 16.19 Sulfate concentration in pond water (GS output table)

$moleratio := \frac{4}{9}$ moles of SO4 generated per mole of O2 consumed $moleratio = 0.444$

$Q := q \cdot A$ Seepage flow rate 326.4 $Q = 326.394 \cdot gpm$

$MR_{O2} := C_o \cdot Q$ Mass rate of O2 brought in with pond seeapge water 1.555 x 10^8 $MR_{O2} = 1.554 \times 10^8 \cdot \frac{mg}{7 \cdot day}$

$MR_S := MR_{O2} \cdot \left(\frac{W_S}{W_{O2}} \right) \cdot moleratio$ Mass rate of S produced by tailings oxidation 6.917 x 10^7 $MR_S = 6.923 \times 10^7 \cdot \frac{mg}{7 \cdot day}$

$MR_{SO4o} := MR_{O2} \cdot \left(\frac{W_{SO4}}{W_{O2}} \right) \cdot moleratio$ Mass rate of SO4 produced by tailings oxidation 29.622 $MR_{SO4o} = 29.627 \cdot \frac{kg}{day}$

$MR_{SO4o} = 29.627 \cdot \frac{kg}{day}$

$MR_{SO4p} := C_{SO4p} \cdot Q$ Mass rate of SO4 brought in with pond seepage $MR_{SO4p} = 28.805 \cdot \frac{kg}{day}$

$MR_{SO4} := MR_{SO4o} + MR_{SO4p}$ Mass rate of SO4 in pond area seepage. This value is transferred to Table 2. $MR_{SO4} = 58.432 \cdot \frac{kg}{day}$

$C_{SO4} := \frac{MR_{SO4}}{Q}$ Sulfate concentration in seepage water to toes $C_{SO4} = 32.842 \cdot \frac{mg}{L}$

Buttress North - Sulfate - Closure

Assume Cat 1 Waste Rock

$A := 45 \cdot acre$ Map area (Table 1-23)

$q := 13.241 \cdot \frac{in}{yr}$ Percolation rate

$V_{tail} := 1145900 \cdot yd^3$ Volume of tailings (Table 1-23)

$Cont_S := 0.063 \cdot \%$ Sulfur content (Table 1-1, sheet 7)

$\rho_b := 140 \cdot \frac{lbm}{ft^3}$ Dry bulk density (Table 1-1, sheet 7)

$MRMP_{SO4} := 13.92 \cdot \frac{mg}{kg \cdot 7 \cdot day \cdot \%}$ Cat 1 sulfate release rate as function of % sulfur. Mass rate per unit mass of tailings per % sulfur. (Table 1-1, sheet 10; also see Mine Site Worklan Table 1-27)

$SF := 0.107685$ P50 LAM scale factor (Table 1-1, sheet 6, P50 from GS)

$MRM_{SO4} := MRMP_{SO4} \cdot Cont_S \cdot SF$ Mass rate of produced sulfate per unit mass of tailings 0.094435 $MRM_{SO4} = 0.094435 \cdot \frac{mg}{kg \cdot 7 \cdot day}$

$M_{tail} := \rho_b \cdot V_{tail}$ Mass tailings 1.965 x 10^6 $M_{tail} = 1.965 \times 10^6 \cdot tonne$

$Q := A \cdot q$ Percolation rate 30.76 $Q = 30.763 \cdot gpm$

$MR_{SO4} := MRM_{SO4} \cdot M_{tail}$ Mass rate of sulfate generated by buttress 26.501 $MR_{SO4} = 26.506 \cdot \frac{kg}{day}$

$C_{SO4} := \frac{MR_{SO4}}{Q}$ Sulfate concentration in bottom drainage $C_{SO4} = 158.066 \cdot \frac{mg}{L}$

Buttress South - Sulfate - Closure

Assume Cat 1 Waste Rock

$A := 15 \cdot acre$ Map area (Table 1-23)

$q := 13.241 \cdot \frac{in}{yr}$ Percolation rate

$V_{tail} := 325500 \cdot yd^3$ Volume of tailings (Table 1-23)

$Cont_S := 0.063 \cdot \%$ Sulfur content (Table 1-1, sheet 7)

$\rho_b := 140 \cdot \frac{lbm}{ft^3}$ Dry bulk density (Table 1-1, sheet 7)

$MRMP_{SO4} := 13.92 \cdot \frac{mg}{kg \cdot 7 \cdot day \cdot \%}$ Cat 1 sulfate release rate as function of % sulfur. Mass rate per unit mass of tailings per % sulfur. (Table 1-1, sheet 10; also see Mine Site Worklan Table 1-27)

$SF := 0.107685$ P50 LAM scale factor (Table 1-1, sheet 6, P50 from GS)

$MRM_{SO4} := MRMP_{SO4} \cdot Cont_S \cdot SF$ Mass rate of produced sulfate per unit mass of tailings

$MRM_{SO4} = 0.094435 \cdot \frac{mg}{kg \cdot 7 \cdot day}$

$M_{tail} := \rho_b \cdot V_{tail}$ Mass tailings

$M_{tail} = 5.581 \times 10^5 \cdot tonne$

$Q := A \cdot q$ Percolation rate

$Q = 10.254 \cdot gpm$

$MR_{SO4} := MRM_{SO4} \cdot M_{tail}$ Mass rate of sulfate generated by buttress

$MR_{SO4} = 7.529 \cdot \frac{kg}{day}$

$C_{SO4} := \frac{MR_{SO4}}{Q}$ Sulfate concentration in bottom drainage

$C_{SO4} = 134.699 \cdot \frac{mg}{L}$

ATTACHMENT 3: QA/QC TRACKING LOG FOR PLANT AND MINE SITE MODELS

Barr Engineering Company

This attachment contains the ongoing model QA/QC tracking log maintained by Barr Engineering Company. The tracking log documents all model-related issues identified by either model developers or model reviewers and details how each issues was resolved. The Review Team verifies that the log is accurate with regard to communications that have taken place between the Review Team and Barr.

	Mine and Plant Site Model QA/QC Tracking Log (Maintained by Barr)					
Item	**Date**	**Model / AWMP Version**	**Problem / Issue**	**Change (changes affecting input tables in BOLD)**	**Updated Model Version**	**Previous change, status in AWMP V3.0 Model**
1	8/2/2012	MS V1.0 / AWMPV2.0	ERM found that the pH used in the model did not match that proposed in Version 2 of the AWMP	The Mine Site model was updated (email from Peter Hinck to Fred Marinelli on 7/19/12) to match AWMP V2. However, subsequent discussion of the AWMP modeling parameters has led to this change being dropped from the proposed model. **Cat1SP_pH_Geomem no longer used in modeling**	MS AWMPV2.1	Unchanged from V2.1
2	8/2/2012	MS V1.0 / AWMPV2.0	ERM identified a greater-than-expected mass removal in the Cat 1 PRB	This issue is associated with the percolation through the Category 1 geomembrane, which was updated in the 7/19/12 email submittal to match the distribution proposed in the AWMP V2. The design flow of the PRB was not updated at the same time, resulting in longer-than-intended retention times in the PRB, and therefore greater-than-intended mass removal. **Cat1SP_PRB_Design_Flow value changed to 2.5 gpm**	MS AWMPV2.1	Cat 1 PRB no longer modeled
3	8/2/2012	MS V1.0 / AWMPV2.0	Additional model outputs are necessary to facilitate the impacts analysis	Barr added additional results reporting and standards checking functionality in the surface water portion of the model.	MS AWMPV2.1	Additional outputs added
4	8/2/2012	MS V1.0 / AWMPV2.0	Barr found during internal QA/QC that the flow lines carrying wall rock mass to the West Pit in the flow chart were combined into one defined function in the model. Task 2 QA/QC needed those flow lines separated into water flows and direct mass transfers.	The functions, which were the addition of all wall rock flow lines for a rock category, were changed into 2 functions which separated mass flux in flowing water and direct transfers via wall rock inundation. These are now two distinct elements to facilitate the Task 2 QA/QC.	MS AWMPV2.1	Unchanged from V2.1
5	8/2/2012	MS V1.0 / AWMPV2.0	Barr found during internal QA/QC that the groundwater inflow to the West Pit was not properly accounted for in the water balance, although the mass balance was correct.	Barr corrected the West Pit water balance equations.	MS AWMPV2.1	Unchanged from V2.1
6	8/2/2012	MS V1.0 / AWMPV2.0	Barr found during internal QA/QC that the calculation of added alkalinity and calcium to the pit outflow as a result of pH adjustment in the limestone channel was not correct.	Barr updated the calculations relating to limestone dissolution.	MS AWMPV2.1	West Pit limestone / wetland treatment no longer modeled
7	8/2/2012	MS V1.0 / PS V1.0 / AWMPV2.0	Internal QA/QC has identified several small inconsistencies in the model flowcharts (not the models themselves).	Barr marked up the flowcharts used for the Task 2 QA/QC control volume identification.	MS AWMPV2.1 / PS AWMPV2.1	Updated for V3.0
8	8/2/2012	PS V1.0 / AWMPV2.0	Plant Site mass balance: first Plant Site control volume mass balance did not appear to close when using the initially provided flows and concentrations to calculate mass loading rates	Barr has shown (and discussed with Fred Marinelli on 8/1/12) that the model output flows and concentrations cannot be used to replicate GoldSim's mass loading results due to the complex differential equation solutions performed in GoldSim. An alternative means of performing the control volume calculations is to use GoldSim-reported water flow rates and GoldSim-reported constituent mass flux rates along with stored water volumes and constituent masses.	PS AWMPV2.1	
9	8/2/2012	PS V1.0 / AWMPV2.0	Barr could not do a direct comparison of Existing Conditions and Project Conditions without the two models being in one model. Critical for the impact analysis.	Barr incorporated the Existing Conditions Model INTO the Project (Base) model so that there is only 1 model to transfer now rather than 2 separate models.	PS AWMPV2.1	

	Mine and Plant Site Model QA/QC Tracking Log (Maintained by Barr)					
Item	**Date**	**Model / AWMP Version**	**Problem / Issue**	**Change (changes affecting input tables in BOLD)**	**Updated Model Version**	**Previous change, status in AWMP V3.0 Model**
10	8/2/2012	PS V1.0 / AWMPV2.0	Barr found during internal QA/QC that the defined volume in river nodes MLC-3 and MLC-2 were incorrect (MLC-3 referenced the MLC-2 volume and vice-versa).	Barr changed the volume definition of river nodes MLC-3 and MLC-2 in both the Project portion of the model and the Existing portion of the model.	PS AWMPV2.1	
11	8/2/2012	PS V1.0 / AWMPV2.0	Barr found during internal QA/QC that 2 of the flow lines in the flow chart (surface runoff and tailings basin runoff to MLC-3) were combined into one defined function in the model. Task 2 QA/QC needed those two flow lines separate.	The function, which was the addition of two separate flow lines, was changed into 2 functions which separated runoff from natural areas and the tailings basin. These are now two distinct flow lines to facilitate the Task 2 QA/QC.	PS AWMPV2.1	
12	8/2/2012	PS V1.0 / AWMPV2.0	Barr found that the MODFLOW model of the FTB in closure did not match the AWMPV2.0 (reduced infiltration from the pond in Cell 1E/2E).	Barr updated the predictive MODFLOW simulation of the closure period and updated several tables of the work plan related to directions of flow and depths to the water table. **Updated Plant Site tables 1-25, 1-27, 1-29, 1-31, 1-34, 1-35, 1-37, and 1-39.**	PS AWMPV2.1	
13	8/8/2012	MS AWMPV2.1	Barr found during internal QA/QC that the West Pit outflow mass balance model combines the controlled outflow and any pit overtopping.	Barr changed the mass balance of the West Pit so that overtopping flows (unlikely) bypass the passive treatment and contribute directly to SW-004a.	MS AWMPV2.2	Unchanged from V2.2
14	8/8/2012	MS AWMPV2.1	Barr found during internal QA/QC that the West Pit surficial aquifer flow calculations contained an error in the flows for Section 2 (between Dunka Road and the Property Boundary).	Barr edited the cell flows vector calculation in the West Pit surficial aquifer (\Flowpath_Models\WP_Surf\Cell_Flows\Flows)	MS AWMPV2.2	Unchanged from V2.2
15	8/9/2012	MS AWMPV2.1	Based on comments from reviewers and Barr staff, PRB modeling was determined to be overly complicated.	Barr edited the modeling of the Category 1 stockpile PRB to be a constant removal efficiency (ex. 50% removal for SO4) irrespective of flow rates or retention time.	MS AWMPV2.2	Cat 1 PRB no longer modeled
16	8/10/2012	MS AWMPV2.1	During detailed West Pit treatment wetland design it was determined that the West Pit water elevation needs to be increased slightly.	Barr added a new variable representing the elevation that the West Pit water returns to after annual discharge. **WP_Outlet_Elev_New value set to 1575'** Barr also edited the equation for WP_Seasonal_Discharge to account for the current timestep inflows in calculating the desired outflow	MS AWMPV2.2	West Pit limestone / wetland treatment no longer modeled; elevation returned to previous value
17	8/15/2012	MS AWMPV2.2	Barr found during internal QA/QC that the East Pit wetland outflow to the surficial aquifer was defined differently in the flowpath and pit water balances	Barr edited the water balance calculation (EPCP_GW_Outflow) and aquifer (EP_at_Aquifer) to both initiate seepage when water levels reach the aquifer, without respect to pit pump-and-treat.	MS AWMPV2.3	Unchanged from V2.3
18	8/15/2012	PS AWMPV2.1	Mitigation measure at Tailings Basin	Barr has made significant edits to the features at the toes of the Tailings Basin, namely converting from a PRB system to a Wetland treatment system	PS AWMPV2.2	Unchanged from V2.2

	Mine and Plant Site Model QA/QC Tracking Log (Maintained by Barr)					
Item	**Date**	**Model / AWMP Version**	**Problem / Issue**	**Change (changes affecting input tables in BOLD)**	**Updated Model Version**	**Previous change, status in AWMP V3.0 Model**
19	8/15/2012	PS AWMPV2.1	Barr found during internal QA/QC that the inputs of Table 1-49 did not differentiate runoff area of the embankments of the existing Tailings Basin between Cell 2W and Cell 2E.	The areas which were under Cell 2W were divided into Cell 2W and Cell 2E. **See Table 1-49.**	PS AWMPV2.2	Unchanged from V2.2
20	8/15/2012	PS AWMPV2.1	During review of the tailings humidity cells, it was determined that the rates currently being used were not appropriate.	SRK suggested a new method and new distributions were created. These have not yet been checked by the agencies so the distributions are in the "proposal" stage; current distributions are as discussed with LAM on 9/28/12. **See tables 1-13 and 1-14**	PS AWMPV2.2	Updated for V3.0
21	8/15/2012	PS AWMPV2.1	ERM found that the sulfate concentration cap for the tailings was not checking correctly. The calcium release rate was changed from a ratio to Na to a ratio to SO4 using CDF056. This change was captured in the release of Ca, but was not changed in the calculation of the sulfate cap.	The error in the model was fixed.	PS AWMPV2.2	Unchanged from V2.2
22	8/16/2012	MS AWMPV2.2	Barr found during internal QA/QC that the East Pit wetland overflow to the West Pit did not appropriately calculate flows during low-inflow periods.	Barr changed the calculation for EPCP_Wetland_Outflow so that outflow equals inflow if the starting water level for the month is equal to the outlet elevation.	MS AWMPV2.3	Unchanged from V2.3
23	8/16/2012	MS AWMPV2.2	Barr found during internal QA/QC that the flow lines carrying wall rock mass to the East Pit in the flow chart were combined into one defined function in the model. Task 2 QA/QC needed those flow lines separated into water flows and direct mass transfers.	The functions, which were the addition of all wall rock flow lines for a rock category, were changed into 5 functions which separated mass flux in flowing water and direct transfers via wall rock inundation to the 3 East Pit mass storage nodes. These are now 5 distinct elements to facilitate the Task 2 QA/QC.	MS AWMPV2.3	Unchanged from V2.3
24	8/16/2012	MS AWMPV2.2	Barr found during internal QA/QC that there was an inconsistency between the stockpile liner leakage flows used for the stockpile and GW flowpath water balances.	Barr changed the calculations for the source zone recharge ("S") terms for the following flowpaths: EPCat23_Surf, OSP_Surf, OSLA_Surf. Flow into the flowpath now equals the stockpile outflow rate.	MS AWMPV2.3	Unchanged from V2.3
25	8/21/2012	PS AWMPV2.3	Foth found an inconsistency between the plant site input tables and the model. The release rates for several constituents were defined using log-normal or discrete distributions rather than beta distributions as defined in the work plan (Tables 1-13 and 1-14).	The work plan tables are correct. The model was modified in anticipation of CDF056, which was later rejected. The values in the input tables were changed back, but the input distributions themselves were not changed back from log-normal and discrete distributions to beta distributions. The model has since been updated so that the release rates match the work plan input tables.	PS AWMPV3.0	
26	8/22/2012	MS AWMPV2.3	Based on recommendation from Agency staff it was determined that the sulfate wild rice standard has been applied at incorrect locations in the Partridge River.	Barr changed the locations where the wild rice standard applies in the model variable Wild_Rice_Locs to be only at SW-005. **Updated Mine Site Tables 2-2 and 1-17.**	MS AWMPV3.0	

	Mine and Plant Site Model QA/QC Tracking Log (Maintained by Barr)					
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27	8/31/2012	MS AWMPV2.3	Based on decision to switch to mechanical treatment and constant discharge in post-closure, the model needs to be updated to remove non-mechanical treatment systems and alter the treatment system modeling.	Barr made major changes to the modeling of the WWTF and previous passive treatment systems to reflect the shift to long-term active treatment, including: * Category 1 stockpile PRB deactivated, inputs removed * West Pit controlled (seasonal) discharge deactivated * West Pit limestone/wetland treatment deactivated, inputs removed * Category 1 stockpile containment water balance revised; water routed to WWTF in operations/reclamation/long-term closure * Added detail to the WWTF water balance calculations * Added new triggers to define "reclamation" and "long-term" conditions, updated pit and Category 1 stockpile water balances to use new triggers * Added new mixing cells to represent reclamation and long-term WWTFs, updated pit and stockpile contaminant transport elements to direct flow to new cells * Updated pit, Category 1 stockpile, and WWTF mass balance checks *** Updated Mine Site Tables 1-35, 1-36, and 1-37 (Plant Site flow and quality to West Pit).** *** Reclam_Pump_Total set at 2400 gpm** *** LongTerm_Pump_WP set at 600 gpm** *** EP_Return_Deficit set at 100 gpm** *** Retentate_Reclam set at 20%, Retentate_LongTerm set at 15%** *** Updated Mine Site Table 1-34 (WWTF targets)**	MS AWMPV3.0	
28	9/17/2012	MS AWMPV2.3	Based on MODFLOW modeling of the Category 1 stockpile, some uncaptured seepage is expected to enter the West Pit even under 100% containment.	Barr changed the Category 1 stockpile water balance modeling to direct seepage "leaking" past the containment system to the West Pit. **Cat1_Contain_Leak defined as 7% of total infiltration**	MS AWMPV3.0	
29	9/21/2012	MS AWMPV2.1	Barr identified in response to agency questions that not all WWTF interactions between the Mine Site and Plant Site were accounted for in the WWTF water and mass balance.	Barr added an inflow of Plant Site brine (flow and chemistry) to the West EQ Pond and reclamation WWTF. Barr added an outflow of sludge water (flow) from the operations WWTF and (chemistry) from the CPS pond; and an outflow of sludge water (flow and chemistry) from the reclamation WWTF. **New Mine Site Tables 1-38, 1-39, and 1-40 (Brine flow and quality).** **New input variable Sludge_Water_Out defined as 5 gpm.**	MS AWMPV3.0	
30	9/21/2012	MS AWMPV2.3	The time of the West Pit overflow has changed to approximately year 40.	Barr changed the overflow year from 65 to 40 in the Partridge River flow tables. **Updated Mine Site Tables 1-18, 1-20a through 1-20l and 1-21.**	MS AWMPV3.0	
31	9/24/2012	MS AWMPV2.3	Agency staff requested that the background groundwater distributions be updated	Barr updated the distributions for the surficial groundwater quality (data through June 2012); subsequently Barr updated the surface water quality calibration. **Updated Mine Site Tables 1-12 and 1-13**	MS AWMPV3.0	
32	9/24/2012	MS AWMPV2.3	Partridge River concentration outputs were overly complicated	Barr changed the concentration summary calculations for the NoAction and NorthMet models	MS AWMPV3.0	
33	9/24/2012	MS AWMPV2.3	Internal QA/QC identified an unnecessary timestep in one of the input tables	Barr edited the West Pit footprint input table to remove the unnecessary timestep. **Updated Mine Site Table 1-9b**	MS AWMPV3.0	

	Mine and Plant Site Model QA/QC Tracking Log (Maintained by Barr)					
Item	**Date**	**Model / AWMP Version**	**Problem / Issue**	**Change (changes affecting input tables in BOLD)**	**Updated Model Version**	**Previous change, status in AWMP V3.0 Model**
34	9/24/2012	MS AWMPV2.3	Updated Plant Site modeling has changed the water quality available to flood the West Pit	Barr edited the West Pit water balance to identify the desired flow quantity and duration **Updated Mine Site Tables 1-35, 1-36, and 1-37 (Plant Site flow and quality to West Pit) TB_Stop_Vol defined as 50,000 acre-ft**	MS AWMPV3.0	
35	9/24/2012	MS AWMPV2.3	Based on MODFLOW modeling of the Category 1 stockpile, reclamation needs to begin earlier to avoid water table mounding beneath the stockpile	Barr changed the beginning of the 8-year reclamation period to the start of mine year 14 (t = 13 years). **Updated Mine Site Table 1-5b**	MS AWMPV3.0	
36	9/28/2012	PS AWMPV2.3	No longer considering trees in Cell 2W to improve evaporation and reduce percolation	Changed the Current_2W_Evap element, moved the Use_Mitigation_Evap_in_2W element to the Inactive_Container, and modified the Precip_Budget elements of the coarse and fine tailings in Cell 2W of the project.	PS AWMPV3.0	
37	9/28/2012	PS AWMPV2.3		Changed the triggers of multiple switches in the Globals container to match the control of water flow.	PS AWMPV3.0	
38	9/28/2012	PS AWMPV2.3	No input that controls the drainage time of the Hydrometallurgical Residue Facility	**HRF_Drainage_Period** element added to control the draining and treating of the HRF. This input is added to the Work Plan Table 1-1. Also had to add functionality to the drainage from the HRF in closure to properly send the total volume to the WWTP over the drainage period.	PS AWMPV3.0	
39	9/28/2012	PS AWMPV2.3	Barr found that the magnesium concentration cap for the tailings was not checking correctly. The calcium release rate was changed from a ratio to Na to a ratio to SO4 using CDF056. This change was captured in the release of Ca, but was not changed in the calculation of the sulfate cap.	The Mg_Cap was corrected for both the Atmospheric and CO2 Enriched conditions. This is similar to the fix for the sulfate release cap error of Item 22.	PS AWMPV3.0	
40	9/28/2012	PS AWMPV2.3	Barr found errors in the constituent content of the LTVSMC tailings for multiple constituents.	The Work Plan table has been updated and highlighted. The element LTVSMC_Content was updated in the model.	PS AWMPV3.0	
41	9/28/2012	PS AWMPV2.3	Cleaning up the QA/QC folders	Multiple changes were made to the Inputs_Checking container to facilitate the Task 1 QA/QC that is coming up.	PS AWMPV3.0	
42	9/28/2012	PS AWMPV2.3	Missing a control for the total volume of water than can be sent to the Mine Site	Added element **Max_Vol_To_Mine** to the container \Project\MINE_SITE. Also added to the Work Plan Table 1-1 and highlighted.	PS AWMPV3.0	
43	9/28/2012	PS AWMPV2.3	Changes to the Project Description	Major changes were made to the containers Interception_System, FTB_WWTP, and Tailings_Basin_Toes to account for the updates to the collection plan, the treatment plan, and the distribution of treated/blended water.	PS AWMPV3.0	
44	9/28/2012	PS AWMPV2.0	Could not directly export flow and stored water values to spreadsheets during the Task 2 QA/QC review.	Added flow related elements to the unsaturated tailings portions of the model. Changed flow controls (outflow rates) of the mixing cells in the unsaturated tailings portions of the model. All of this was for the purpose of aiding the Task 2 QA/QC.	PS AWMPV3.0	
45	9/28/2012	PS AWMPV2.3	The model was applying inappropriate solubility limits to the unsaturated tailings portions of the Tailings Basin	Solubility controls were added to each of the unsaturated tailings portions of the models so that each mixing cell was referencing the correct solubility limit.	PS AWMPV3.0	
46	9/28/2012	PS AWMPV2.3	Elements that show up in the Existing and Project models that should be identical were both in the model independently as inputs.	Those few elements in \Project\Tailings_Basin\NorthMet_Basin\CELL_1E\Basin_Characteristics were cloned to prevent possible differences in the future.	PS AWMPV3.0	

	Mine and Plant Site Model QA/QC Tracking Log (Maintained by Barr)					
Item	**Date**	**Model / AWMP Version**	**Problem / Issue**	**Change (changes affecting input tables in BOLD)**	**Updated Model Version**	**Previous change, status in AWMP V3.0 Model**
47	9/28/2012	MS AWMPV2.3	Barr found during internal QA/QC that there was an over-release of consituents in the first timestep from all stockpiles, due to an attempt to prevent divide-by-zero errors.	Barr changed the calculations for the release rate terms throughout the model (stockpiles, pit walls, pit backfill) to release zero mass in the initial timestep when the previous "InRock" mass is zero. See model element \Stockpile_Models\Cat4SP_Model\Cat4SP_MassBal\Cat4SP_VFCat4SP_ReleaseVF_frac for an example.	MS AWMPV3.0 / PS AWMPV3.0	
48	9/28/2012	PS AWMPV2.3	During Task 2 QA/QC review, Barr found that the initial conditions of the existing basin did not seem correct.	Barr found that the initial conditions of the basin were not updated when CDF 055 was approved which changed the initial saturation conditions and necessarily changed the initial mass and loading rates. Initial values were modified.	PS AWMPV3.0	
49	9/28/2012	PS AWMPV2.3	Barr found during internal QA/QC that the pH-based concentration caps used in the Plant Site model were not the same as the Cat1 concentration caps in the Mine Site model.	Both the lookup tables in the model and in the work plan were updated so that the two models are using the same inputs as they should be.	PS AWMPV3.0	
50	9/28/2012	PS AWMPV2.3	The Plant Site model was not accounting for the watershed area between the toes of the tailings basin and the containment system in the project condition.	Barr modified Input Table 1-49 to show both the existing condition and the project condition, accounting for the watershed area to the containment system, which is taken out of the Embarrass River Tributary watershed areas.	PS AWMPV3.0	

Appendix B
NorthMet Quality Assurance
Memo January 17, 2013

Memorandum

Environmental Resources Management

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To: Bill Johnson, MDNR

From: Fred Marinelli, InTerraLogic
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CC: Al Trippel, ERM
Melinda Todorov, ERM

Date: January 17, 2013

Subject: NorthMet Project Quality Assurance Update - Mine Site

This technical memorandum describes a screening-level audit of the NorthMet Project Mine Site GoldSim water-quality model version 4.1 (simulation run on December 11, 2012). This model for the Mine Site was developed by Barr Engineering Company (Barr) to estimate potential environmental effects from the proposed mine on the quality and quantity of water resources. This audit has been conducted by members of the ERM Project Team to provide technical support to the State of Minnesota in preparation of the NorthMet Project Supplemental Draft Environmental Impact Statement (SDEIS). Previously, the ERM team conducted an audit of version 3 of the GoldSim model (run on September 26, 2012), which included project components of the Mine Site and Plant Site. Results of the version 3 audit were summarized in an October 2012 memorandum. The 2012 audit was not a 100-percent verification of model calculations, but instead focused on evaluating select model components that are critical in the estimates of solute release/transport and associated water management costs. This update provides a supplementary audit of certain additional model components at the Mine Site that were not evaluated previously. It was confirmed during this audit that the few input assumptions that have changed since the prior review were incorporated into the current GoldSim model (version 4.1) and the changes did not raise any Quality Assurance (QA) concerns.

For this QA update, the following evaluations were performed, with each presented as a separate attachment:

- Attachment 1: GoldSim Estimates of Water Quality in the West Pit and East Pit
- Attachment 2: GoldSim Estimates of Groundwater Transport
- Attachment 3: GoldSim Estimates of Partridge River Water Quality

The results of this audit provide good evidence that the Mine Site GoldSim model (version 4.1) has appropriate and mathematically correct algorithms for (1) estimating chemical concentrations in the East and West pits, (2) simulating chemical migration in the surficial groundwater flowpaths, and (3) estimating Partridge River chemical concentrations by the mixing of background and impacted water sources to the river.

ATTACHMENT 1: MINE SITE AUDIT – GOLDSIM ESTIMATES OF WATER QUALITY IN THE WEST PIT AND EAST PIT

INTRODUCTION

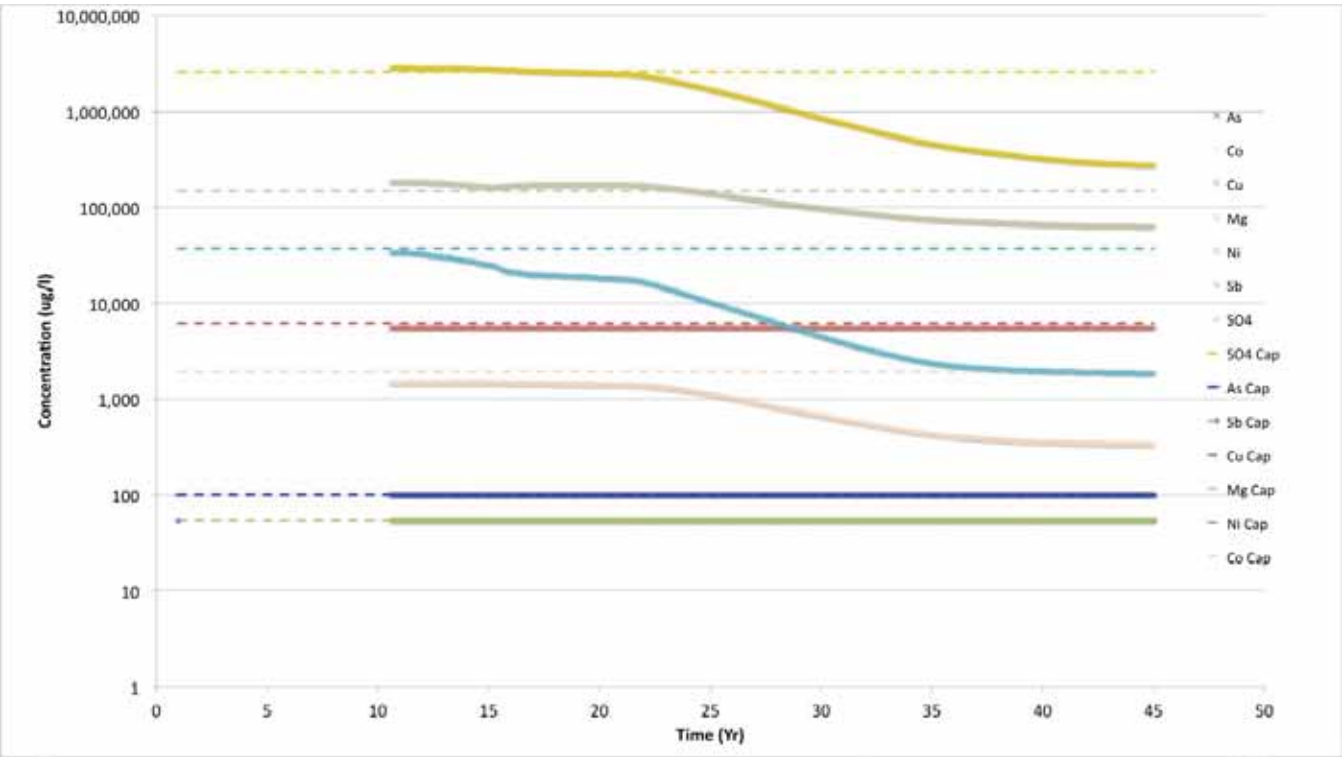
This audit of the GoldSim model version 4.1 re-visits the components in the audit of GoldSim model version 3 related to the East and West Pits, both of which are located in the Mine Site. As with the audit of model version 3, this audit checks the GoldSim estimates for pit water quality and load rates for the same 6 water-quality constituents included in the full GoldSim modeling (arsenic, antimony, copper, cobalt, nickel, and sulfate). A seventh constituent, manganese, was also included in the audit as it was tracked to determine nickel loads. The audit comparisons apply the 50th-percentile (P50) model input parameter values in deterministic calculations to provide an independent check on the GoldSim predictions. Specific components in this audit include solubility caps in the pit waters and the load of pollutants from the West Pit wall rock.

EAST PIT PORE WATER QUALITY - COMPARISON OF SOLUBILITY CAPS

The audit of the East Pit assessed whether the GoldSim model accurately limited pore-water concentrations to the concentration caps presented in NorthMet Project model work plans. The East Pit is a critical component in to the overall NorthMet water management because it is the permanent repository for all of the high-sulfide, acid-generating waste rock (Category 2, 3, and 4). However, the backfilled East Pit is essentially an engineered system and mine plans include an option to lime the pit backfill if necessary to maintain pore waters at near-neutral pH and thus ensure that dissolved pollutant concentrations remain at the concentration caps for neutral pH. This audit thus compared predicted pore water concentrations in the East Pit backfill to the applicable concentration caps (i.e., Category 2, 3, and 4 waste rock under non-acidic conditions) for the 7 evaluated solutes. The evaluation period was mine year 1 through 45, which covers the period when the East Pit is excavated, backfilled with reactive waste rock, and then completely flooded to stop oxidation. Simulated solute concentrations were obtained from the GoldSim model results provided by Barr.

As shown on Figure 1, GoldSim results indicate that the solute concentration caps simulated in the East Pit are consistent with the concentration-cap values specified in Waste Characterization Data Package, v9 (Large Table 13, PolyMet Mining, July 2012).

Figure 1 ***Predicted concentrations of selected solutes in East Pit backfill pore water, and the concentration caps for Cat 2,3,4 rock (non-acidic).***

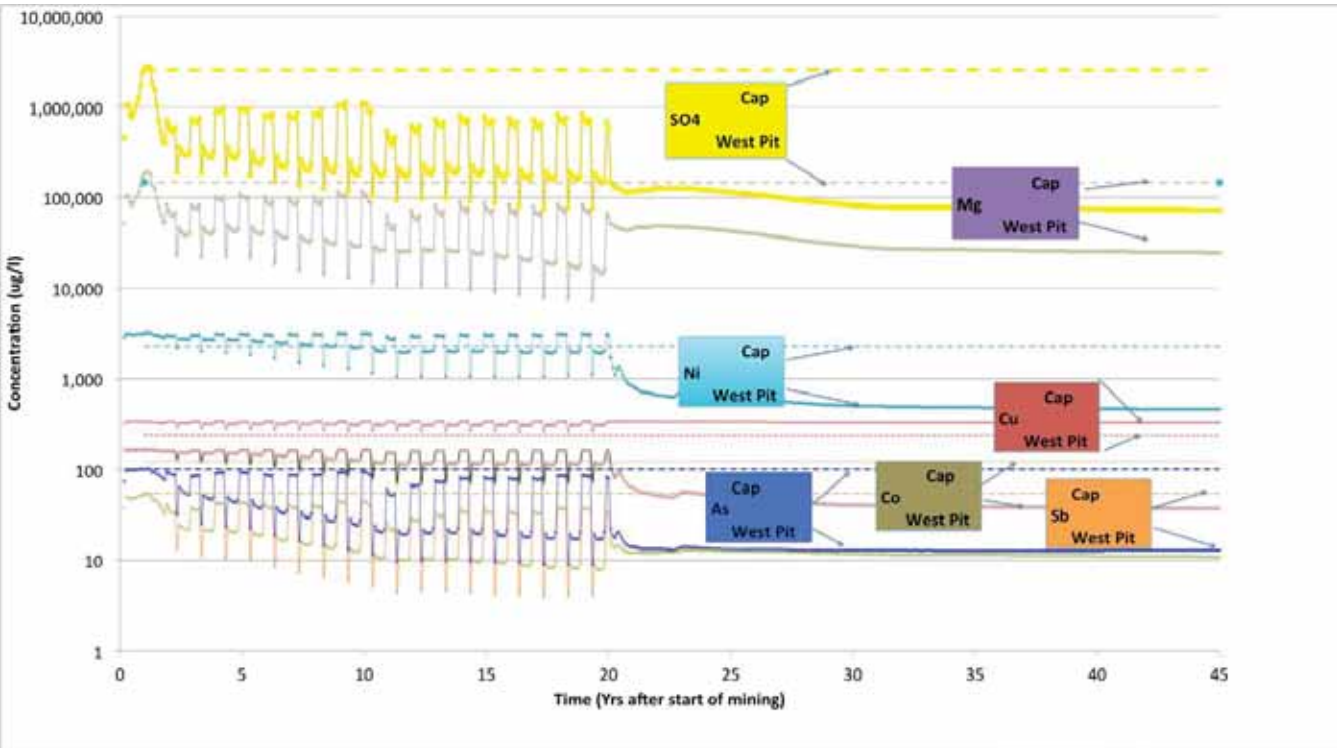


WEST PIT LAKE WATER QUALITY - COMPARISON TO SOLUBILITY CAPS

Water Management Plans for the NorthMet project include contingencies to maintain water in the West Pit at a near-neutral pH so that solute concentrations in the lake will be limited to concentration caps near the values applied for Category 1 rock. In response, this audit compared predicted water quality in the West Pit Lake water to determine whether the GoldSim model accurately limited solute concentrations to the Category 1 thresholds. Predicted solute concentrations in the West Pit (median values) were obtained from model outputs provided by Barr.

Results of this comparison (Figure 2) indicate that GoldSim does limit solute concentrations in the West Pit Lake to the concentration caps identified in Large Table 12 of the Waste Characterization Data Package version 9 (PolyMet, September 2012). The trend for all solutes (except copper) is that concentrations are initially limited by the concentration cap for some period, or at least for part of the year. The concentration cycles apparent between years 1 and 20 reflect seasonal changes in wall-rock runoff and pit volume over the period, when water is assumed to be sumped out to allow excavation. Beyond year 20, the lake begins to fill and concentrations stabilize as seasonal runoff becomes a smaller fraction relative to the increasing volume of the lake. In this period beyond year 20, the concentrations of all solutes tracked in this audit (except copper) drop below their concentration cap level.

Figure 2 ***Predicted concentrations of select solutes in the West Pit Lake, and their concentration caps.***



WEST PIT LAKE - SOLUTE LOADING FROM WALL ROCK

The GoldSim model of the West Pit water quality predicts that the oxidation in the wall rock will be a major source of solutes to the West Pit Lake. In response, the 2012 audit of the GoldSim Mine Site Model version 3 included an independent calculation of loading to the lake from two wall-rock zones: (1) Cat 4 Duluth Complex Wall rock, which is predicted to be a minor source of metals (included in the audit to confirm that it was in fact a minor contributor of pollutants) and (2) the ore wall rock, which is predicted to be the dominant source of nickel, cobalt, and copper to the West Pit Lake. The audit of wall-rock loading incorporated 13 parameters, with the most important for chemical solute release being intrinsic oxidation rate in wall rock, the effects of temperature and fragment size on oxidation rate, and the change in oxidation rate that occurs when the pore waters shift from neutral to acidic conditions. The independent calculations used to audit the version 3 GoldSim model reproduced the loading of the 6 audit solutes from the two wall-rock units during both the excavation phase (mine year 1 to 20), when the pit is assumed to be open and solutes leached from wall rock are capture in a sump, and the filling phase (mine years 20 to 45), when loads to the lake also includes dissolution of solutes previously stored in the wall rock (Table 1). The only discrepancy larger than ~5% was in copper loading, a discrepancy caused by the omission of concentration-cap effects in the audit. Note that copper is predicted to be at its concentration cap in the West Pit Lake over the entire 45-year filling period, which limits the load of copper from wall rock runoff (Figure 2).

Table 1 ***Cumulative Loads to West Pit from Ore in Wall Rock at Year 20, GoldSim Model v 3 and 4.1***

Constituent	Model v 3			Model v 4.1	Change in Model Result
	GoldSim	Audit	Discrepancy Rel. % Diff.	GoldSim	GoldSim v3 to v4.1 Rel. % Diff.
	[tonne]	[tonne]	[%]	[tonne]	[%]
Sulfate	355	361	1.69%	317	-11%
Cobalt	1.41	1.43	1.67%	1.02	-32%
Arsenic	0.109	0.111	1.67%	0.097	-12%
Magnesium	36.4	37.1	1.80%	31.6	-14%
Nickel	18.3	18.6	1.67%	14.3	-24%
Antimony	0.040	0.041	1.67%	0.034	-16%
Copper	21.8	60.7	94.30%	19.6	-11%

This review of the version 4.1 NorthMet model compared cumulative load from the ore wall rock (the main wall-rock source of metals and sulfate to the West Pit during excavation and filling) through year 20. The 1-20 year time interval was selected because it incorporates the important physical parameters: pit geometry and the areas of lithologic units in pit wall rock, plus the effects of temperature, fragment size, and pit-wall sulfide S concentration on chemical reaction rates. The loading during lake filling (years 20 to 45) was not considered in this screening audit to avoid the additional complexity that arises when the estimates of cumulative loads vary more in response to water balance changes that affect the fill rate of the West Pit.

The results of this comparison indicate that the estimates of cumulative wall-rock loading to the West Pit in GoldSim model version 4.1 is similar to the loads estimated in model version 3 (Table 1). The cumulative loads are systematically lower in version 4.1 than were predicted in version 3 (relative percent difference in cumulative loading from ore wall-rock between Mine Site model version 3 and version 4.1 ranged from -11 and -32 percent). The cause of this discrepancy is not clear, because the pit geometry should be unchanged and at the selected evaluation time (year 20), the effects of West Pit filling have not begun. However, these discrepancies are much lower than the uncertainty range indicated by the model (e.g., the cumulative loads at year 20 for the 7 solutes considered in this audit ranged by several hundred percent or more between the 10th and 90th percentile model result). Additional refinement of the audit of pollutant loads to the West Pit would involve updating the independent audit values will all GoldSim values for wall-rock geometry and chemistry, and extending the audit period through pit filling (year 45) under the revised water balance assumptions included in Model version 4.1.

ATTACHMENT 2: MINE SITE AUDIT – GOLDSIM ESTIMATES OF GROUNDWATER TRANSPORT

INTRODUCTION

This attachment documents a strategic audit of the Mine Site GoldSim model (version 4.1) with regard to chemical migration in groundwater flowpaths that transport solutes from project-related chemical sources to the Partridge River. Emphasis was placed on the West Pit Surficial Flowpath and the East Pit Cat 2/3 Surficial Flowpath, because these flowpaths within the surficial groundwater aquifer connect long-term chemical sources (West Pit and East Pit) to the Partridge River. Other surficial flowpaths (OSLA, WWTP, and OSP) were not analyzed because they are tied to temporary chemical sources and use the same model algorithms for chemical transport. Bedrock flowpaths were not considered because hand calculations show that chemical migration in these flowpaths has negligible impact on water quality in the Partridge River. GoldSim results were compared to independent calculations of chemical transport for sulfate, cobalt, and aluminum. These nonreactive solutes were chosen because their source concentrations are significantly different from background concentrations, their transport behavior should be similar to other nonreactive solutes in the model, and they serve as good tracers for evaluating chemical migration.

METHODS

The Mine Site GoldSim model has been programmed by Barr to generate extensive Excel spreadsheets of the model results on a time step by time step basis. Separate spreadsheets are generated for ten Control Volumes that divide the Mine Site into hydraulic subcomponents. Each time the model is run, the outputs are generated for one chemical solute specified by the user. For each Control Volume, a separate spreadsheet documents the water balance (inflows, outflows, and internal water storage) and chemical mass balance (inflow concentrations, outflow concentrations, and concentrations of stored water).

The GoldSim model has been programmed to develop a separate Control Volume (and output spreadsheet) for the West Pit Flowpath and East Pit Cat 2/3 Flowpath. To generate the output required for this evaluation, three deterministic (P50 input) model runs were performed by the ERM team, with outputs specified for sulfate, cobalt, and aluminum. This provided a total of six output spreadsheets; three spreadsheets (sulfate, cobalt, and aluminum) for the West Pit Flowpath and three similar spreadsheets for the East Pit Cat 2/3 Flowpath. With regard to flow, the general approach was to compile the GoldSim water balance for each flowpath and compare the numerical values with independent hand calculations. For chemical transport, the GoldSim estimates of chemical migration were compared to hand calculations of sharp-front chemical arrival times at the Partridge River and peak concentrations of groundwater discharge to the river.

RESULTS

Figures 1 and 2 show the GoldSim water balance for the West Pit Flowpath and East Pit Cat 2/3 Flowpath, respectively. T here is no temporal change in the internal water storage of each flowpath, so the water balance simplifies to:

> Inflow entering flowpath at upgradient boundary + recharge along flowpath = groundwater discharge to Partridge River

Figure 1

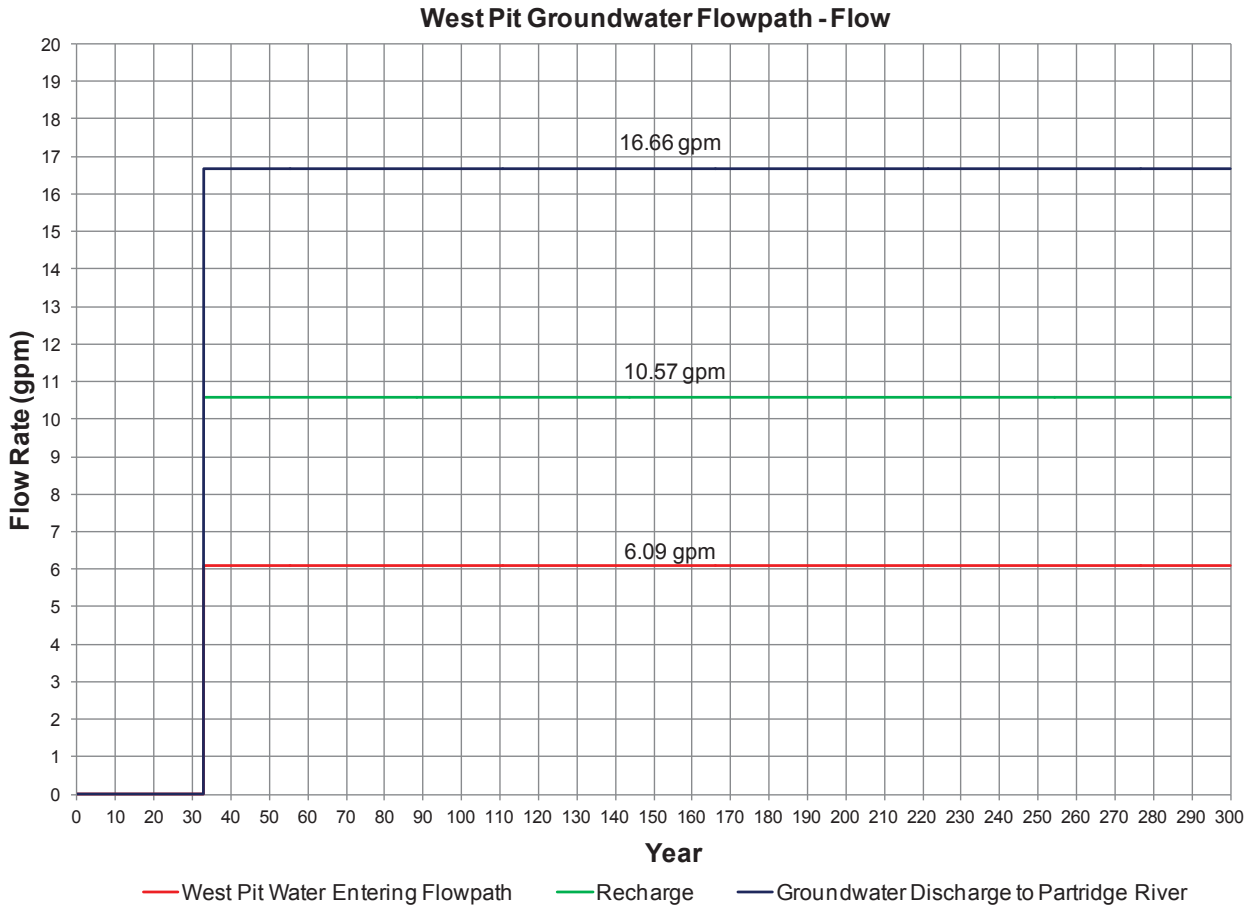
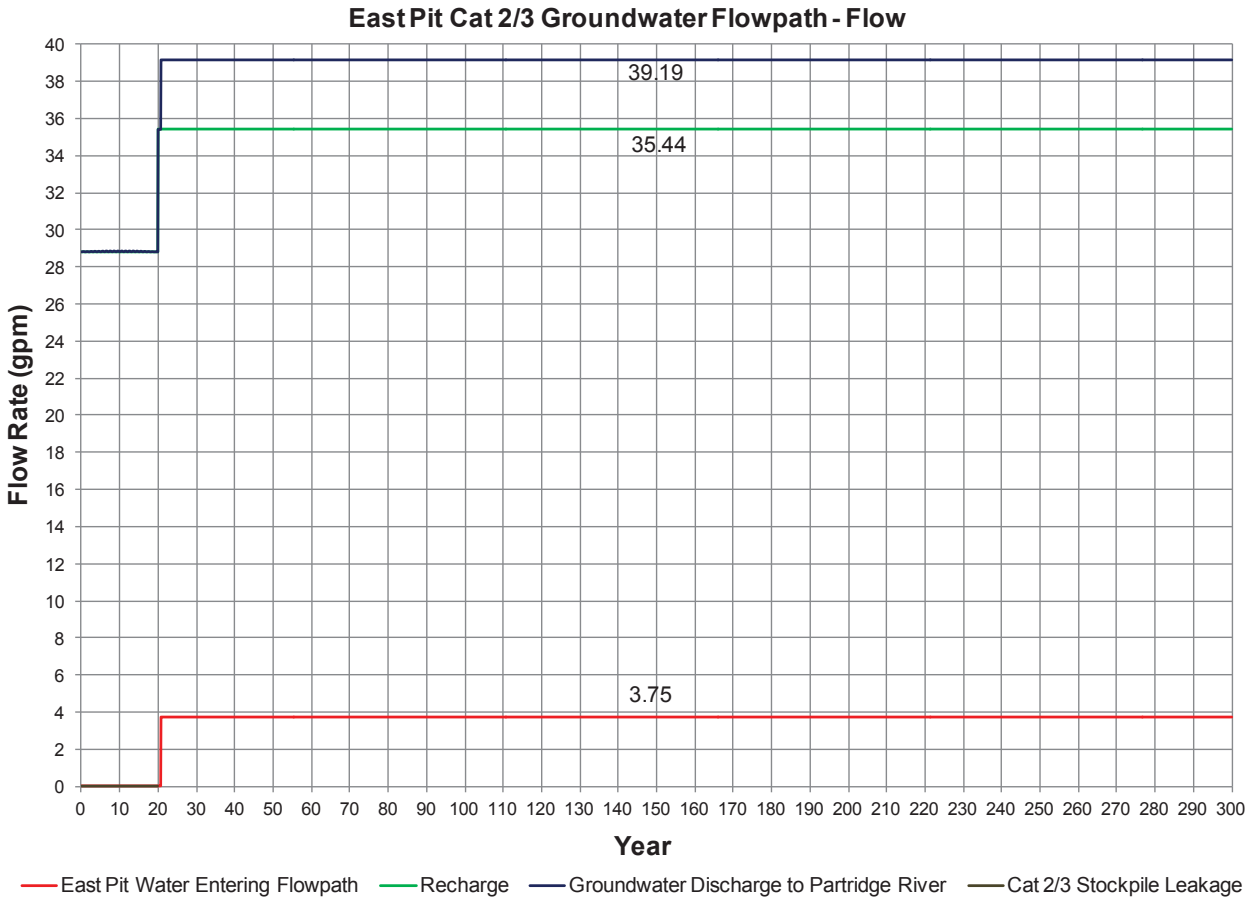


Figure 2



Figures 1 and 2 show that the GoldSim model conserves the flow balance for each flowpath. For the two selected flowpaths, Table 1 shows very good agreement between the GoldSim water balance results and independent hand calculations.

Table 1 Mine Site Flowpath Water Balance

Description	Units	Flowpath				
		West Pit	OSLA	WWTP	OSP	East Pit - Cat 2/3
Flow rate entering flowpath	gpm	6.09	2.62	0.83	1.14	3.75
Net meteoric recharge rate	in/yr	0.828	0.993	0.647	0.902	0.910
Flowpath width	m	665	550	240	430	1440
Flowpath total length	m	1505	1600	1730	1415	2120
Recharge	gpm	10.58	11.16	3.43	7.01	35.47
Computed groundwater discharge to surface water	gpm	16.67	13.78	4.26	8.15	39.22
GoldSim groundwater discharge to surface water	gpm	16.66				39.19

Figures 3, 4, and 5 pertain to the West Pit Flowpath and show GoldSim inflow (chemical source) concentrations and outflow (groundwater discharge) concentrations for sulfate, cobalt, and aluminum, respectively. On each plot, the groundwater discharge concentration shows the GoldSim-predicted arrival of a chemical plume at the Partridge River. For sulfate and cobalt, the plume arrival is shown as an increase in discharge concentration because the source (West Pit) concentration is higher than the background groundwater concentration. For aluminum, the plume arrival is indicated by a decrease in discharge concentration because the source concentration is lower than background. Due to longitudinal dispersion, the GoldSim plume arrival is gradual over a period of about thirty years and the effective arrival time of 105 years is taken as the midpoint of the initial change in discharge concentration. Table 2 shows a comparison between the GoldSim-predicted arrival time and an independent (sharp-front) hand calculation based on the following equation that accounts for the effect of recharge on groundwater seepage velocity:

$$t_a(x) = t_s + \frac{b\,n}{R} \ln\left(1 + \frac{R\,w\,x}{Q_o}\right)$$

where:

t_a	=	chemical (sharp-front) arrival time
x	=	distance from chemical source to location of interest (Partridge River)
t_s	=	chemical source start-up time
b	=	flowpath saturated thickness
w	=	flowpath width
n	=	effective porosity
R	=	recharge flux
Q_o	=	groundwater flow rate at the chemical source

Figure 3

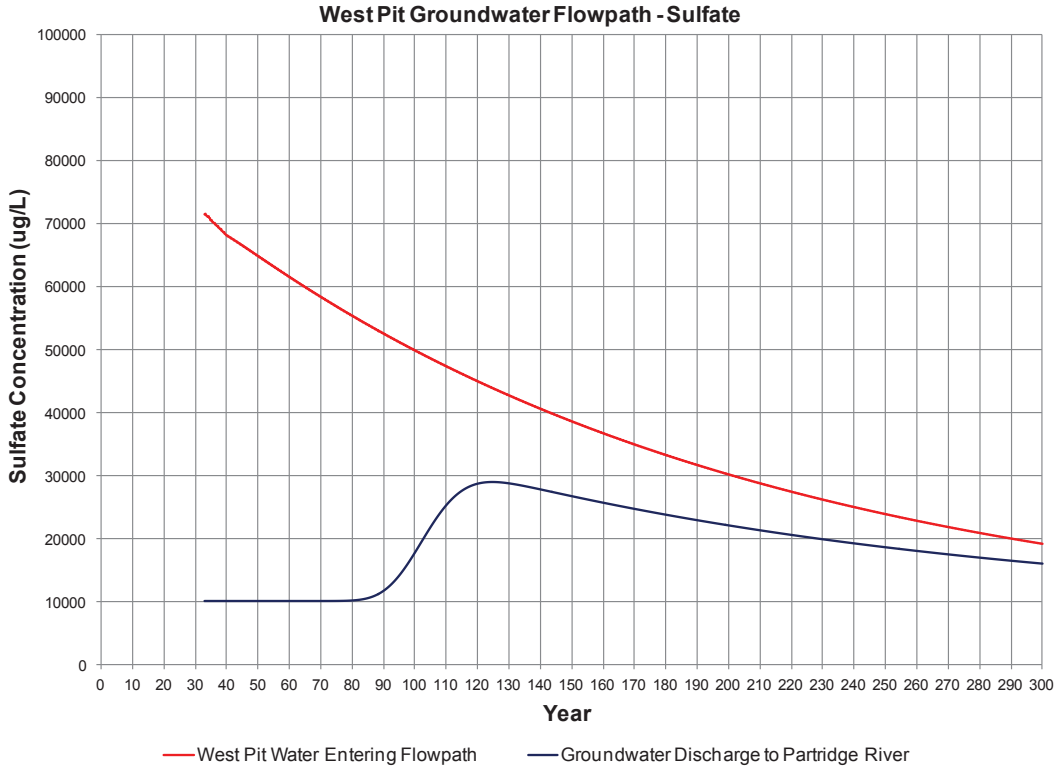


Figure 4

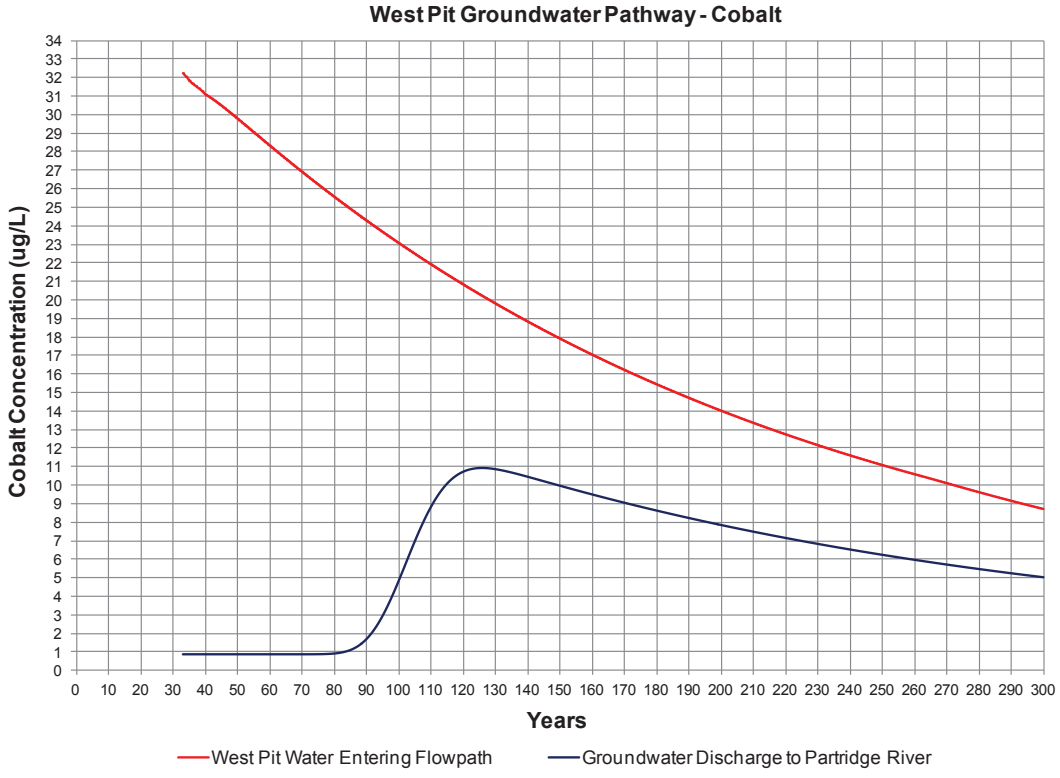
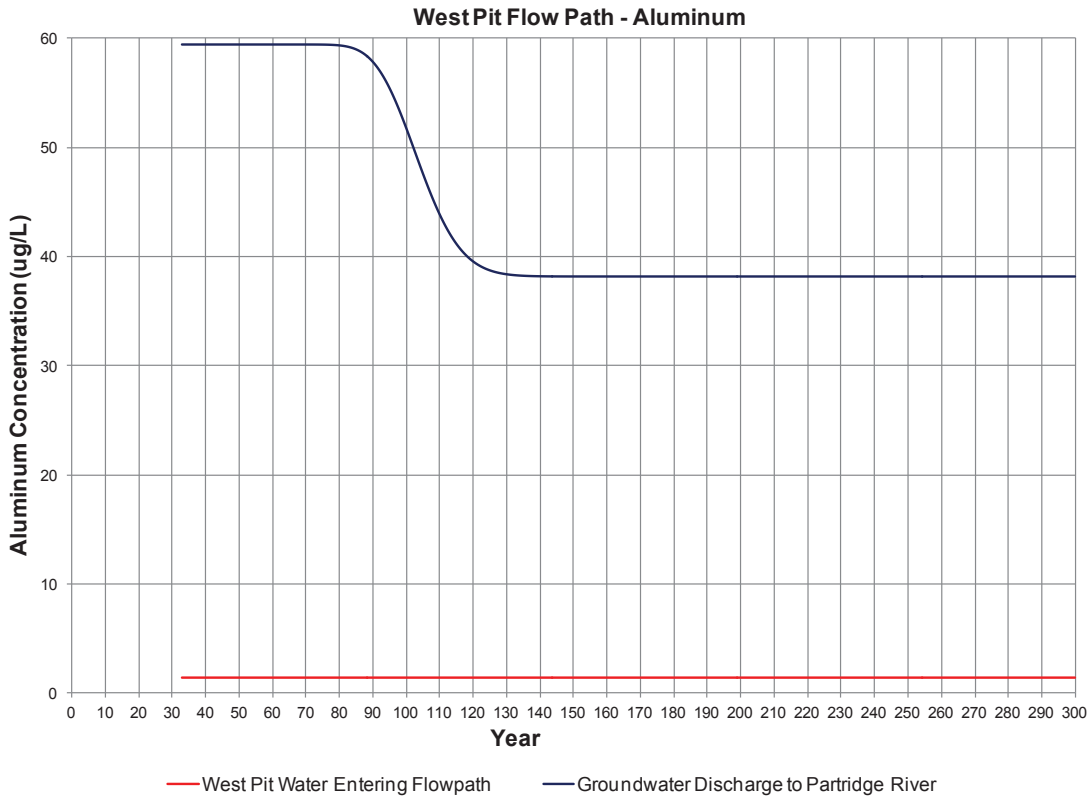


Figure 5



As shown in Table 2, there is very good agreement between the GoldSim arrival time and the independent calculation for the West Pit Flowpath (105 years).

Table 2 Chemical Arrival Time

Description	Units	Flowpath					
		West Pit	OSLA	WWTP	OSP	Cat 2/3	East Pit
Groundwater flow rate at chemical source	gpm	6.09	2.62	0.83	1.14	23.31	3.75
Net meteoric recharge rate	in/yr	0.828	0.993	0.647	0.902	0.910	0.910
Flowpath width	m	665	550	240	430	1440	1440
Flowpath thickness	m	5	5	5	5	5	5
Aquifer porosity	(--)	0.30	0.30	0.30	0.30	0.30	0.30
Distance from chemical source to mine property boundary (groundwater compliance point)	m	860	235	910	1085	140	1345
Distance from chemical source to Partridge River (surface water discharge)	m	1505	1225	1310	1185	955	2120
Groundwater travel time from chemical source to mine property boundary	yr	49	29	105	114	6	126
Groundwater travel time from chemical source to Partridge River	yr	72	86	129	119	34	152
Chemical source begin time	yr	33	0	0	0	0	21
Chemical source end time	yr	Contin-uous	20	35	21	20	Contin-uous
Sharp front chemical arrival time at property boundary (based on chemical source begin time)	yr	82	29	105	114	6	147
Computed sharp front chemical arrival time at the Partridge River (based on chemical source begin time)	yr	105	86	129	119	34	173
GoldSim sharp front chemical arrival time at the Partridge River (based on chemical source begin time)	yr	105				48	148

Figures 6 through 11 pertain to the East Pit Cat 2/3 Flowpath and show GoldSim inflow and discharge concentrations for the three solutes on interest. Due to concentration contrasts, separate plots are shown for source concentrations and discharge concentrations. Note that the flowpath is affected by two chemical sources that are at different locations and operate at different times; Cat 2/3 leakage from zero to 20 years followed by East Pit inflow after 20 years. As a consequence, GoldSim predicts the arrival of two chemical plumes at the Partridge River. The first arrival at 48 years results from Cat 2/3 stockpile leakage, and the second at 148 years is associated with East Pit inflow to the flowpath. Table 2 provides a comparison between these GoldSim arrival times and independent hand calculations based on the above equation. The values are similar, but in general the GoldSim arrival times are 16 to 34 percent longer than the

hand-calculated arrival times. Given the excellent agreement for the West Pit Flowpath, it would be valuable to understand the discrepancy between the GoldSim and hand-calculated arrival times. However, the discrepancy for the East Pit Cat 2/3 Flowpath is not considered large enough to question the GoldSim results.

Figure 6

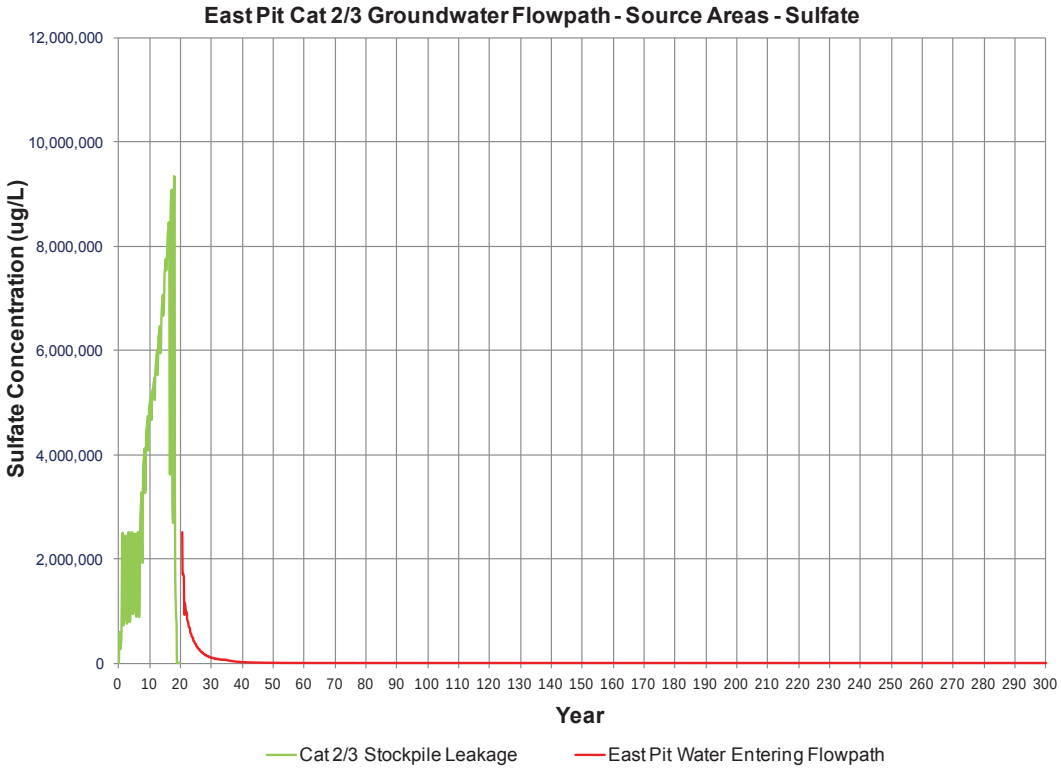


Figure 7

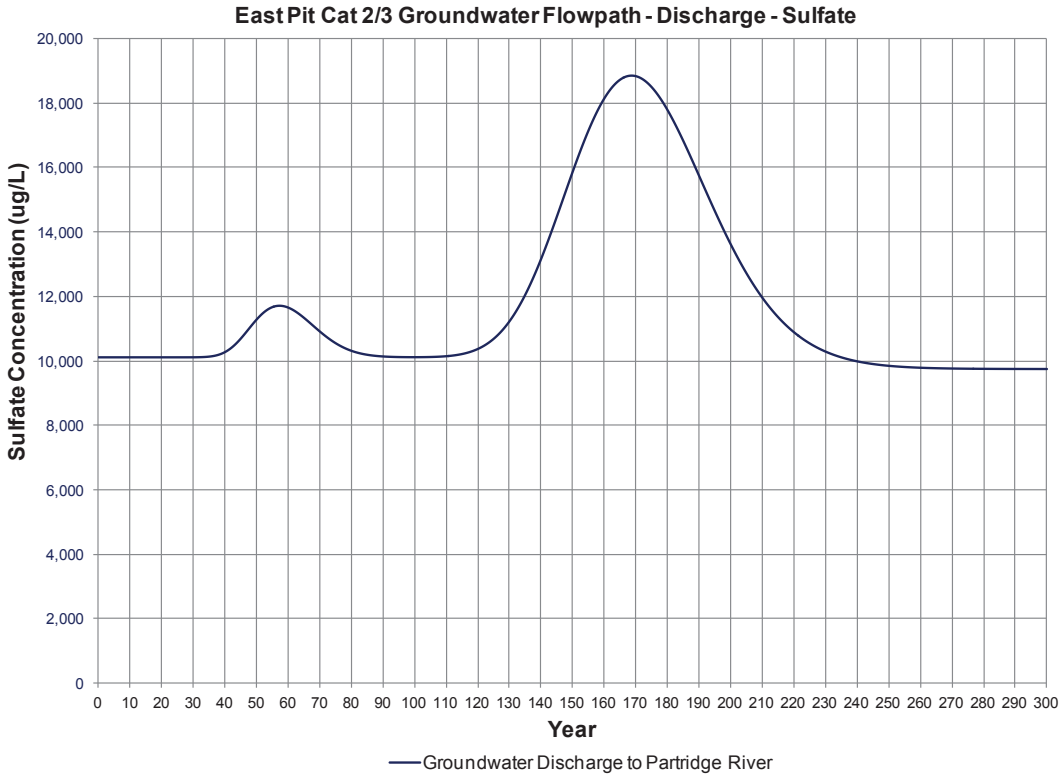


Figure 8

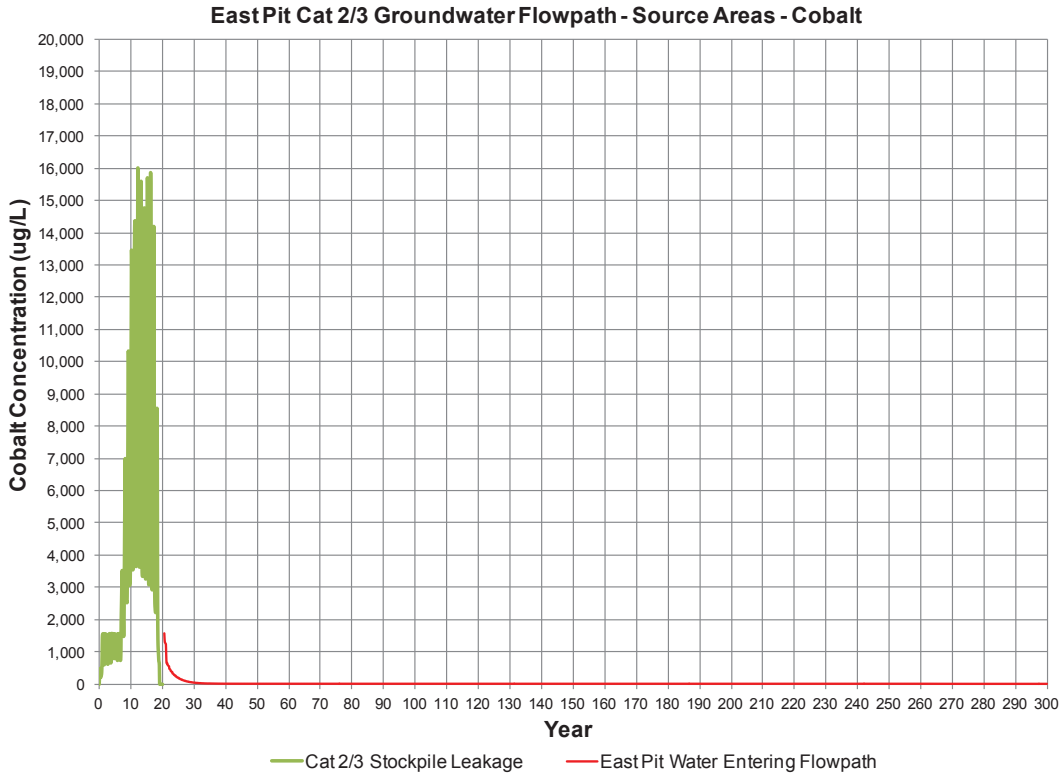


Figure 9

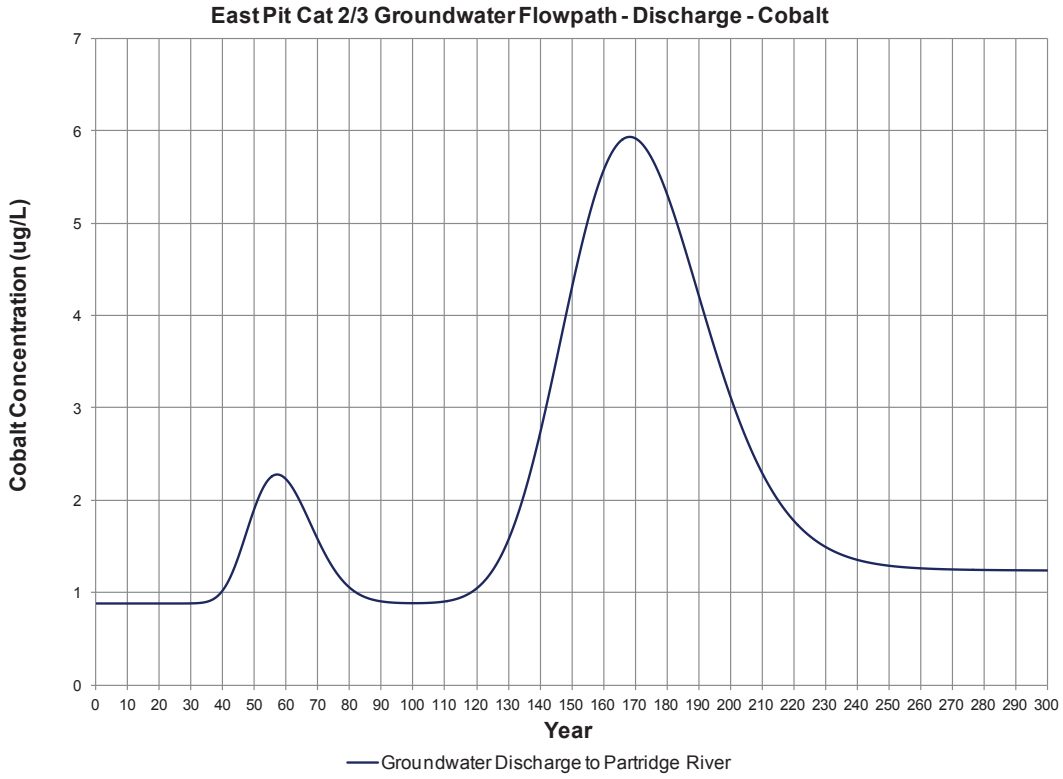


Figure 10

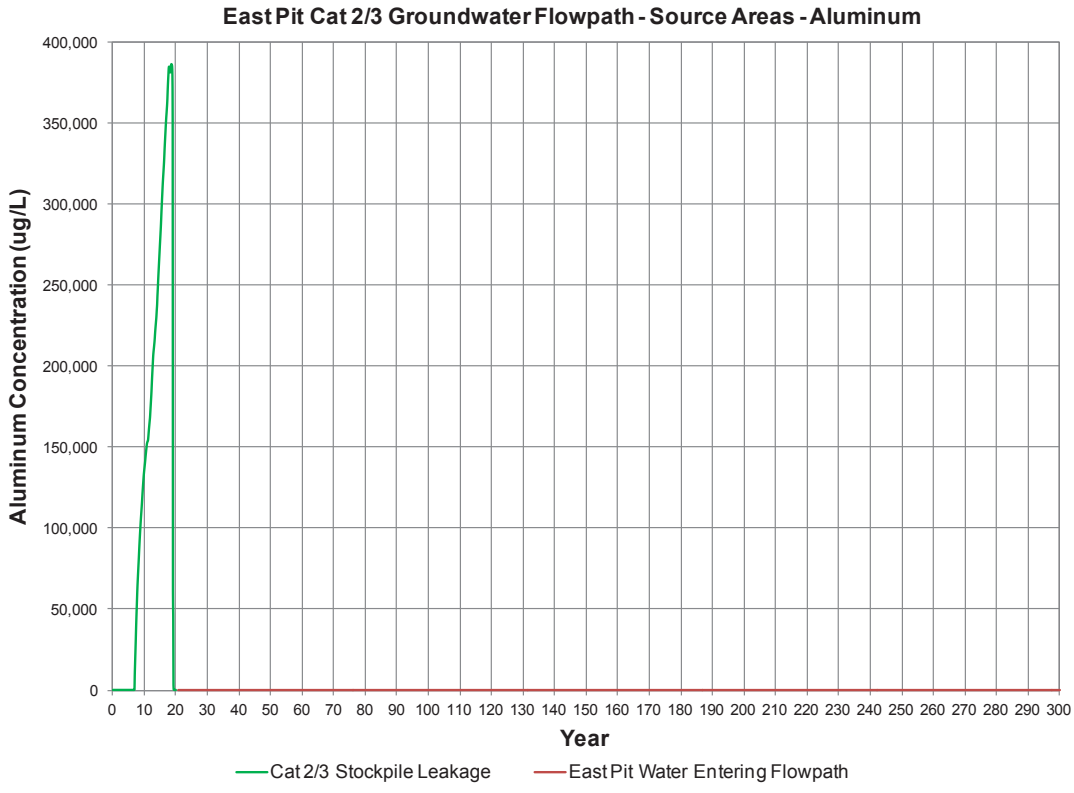
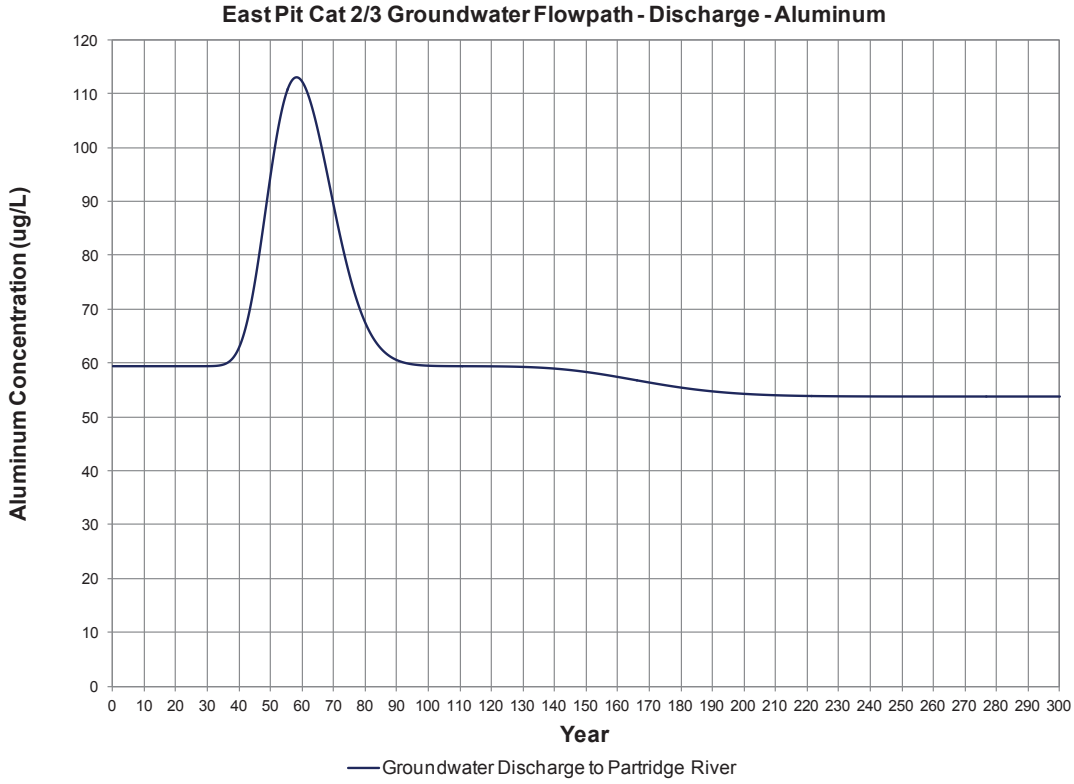


Figure 11



As shown in Table 3, an additional check was performed using independent mixing calculations to estimate the peak concentrations of groundwater discharging into the Partridge River. These calculations consider the arrival of plumes from three chemical sources; West Pit (via the West Pit Flowpath), and Cat 2/3 and East Pit (via the East Pit Cat 2/3 Flowpath). The calculated peak concentration is considered approximate because it assumes a constant source concentration that generally differs from the time-varying source concentrations simulated in the GoldSim model. To perform the hand calculations, it was generally assumed that the source concentration was equal to the average GoldSim source concentration over the first twenty years that the source is active. As shown, there is good agreement between the independently computed peak concentrations and peak or long-term concentrations observed on plots of the GoldSim results (Figures 2, 3, and 4 for the West Pit Flowpath and Figures 7, 9, and 11 for the East Pit Cat 2/3 Flowpath). The only significant discrepancy is the cobalt plume associated with the East Pit chemical source, for which the GoldSim concentration of 5.95 ug/L is less than the calculated value of 15.15 ug/L. As shown on Figure 8, the GoldSim East Pit cobalt concentration decreases dramatically during its initial period as an active source (20 to 40 years), and this likely limits the accuracy of the hand calculation. Overall, the independent mixing calculations support the GoldSim results.

Table 3 Peak Concentration in Groundwater Discharge to the Partridge River

Source Area	Constituent	Source Flowrate gpm	Source Conc ug/L	Recharge Flowrate gpm	Recharge Conc ug/L	Discharge Flowrate gpm	Computed Peak Discharge Conc ug/L	GoldSim Peak Discharge Conc ug/L
West Pit	Sulfate	6.09	65,000	10.58	10,125	16.67	30,172	29,500
	Cobalt	6.09	30.0	10.58	0.882	16.67	11.5	11.0
	Aluminum	6.09	1.5	10.58	59.4	16.67	38.2	38.5
Cat 2/3	Sulfate	0.0193	3,800,000	39.17	10,125	39.19	11,991	11,725
	Cobalt	0.0193	4,200	39.17	0.882	39.19	2.9	2.2
	Aluminum	0.0193	133,000	39.17	59.4	39.19	125	112
East Pit	Sulfate	3.75	1,100,000	35.44	10,125	39.19	114,413	118,800
	Cobalt	3.75	150	35.44	0.882	39.19	15.15	5.95
	Aluminum	3.75	0.5	35.44	59.4	39.19	53.8	54.0

CONCLUSIONS

This audit of groundwater transport simulations performed by the Mine Site GoldSim model is "strategic" in that only two flowpaths and three chemical constituents are considered. However, the selected flowpaths (West Pit and East Pit Cat 2/3) are the most important with regard to long-term impacts to the Partridge River and the selected solutes are reasonable surrogates for other chemical constituents in groundwater and surface water. T his evaluation does not raise any major concerns regarding algorithms in the Mine Site GoldSim model that are used to simulate chemical migration in the surficial groundwater aquifer.

ATTACHMENT 3: MINE SITE AUDIT - GOLDSIM ESTIMATES OF PARTRIDGE RIVER WATER QUALITY

INTRODUCTION

This attachment performs independent calculations of sulfate, aluminum, and cobalt river concentrations for a selected time and location in the Partridge River, and compares these values with analogous results from the Mine Site GoldSim model. The location selected for analysis was SW-004a. The selected approach was not expected to produce results exactly equivalent to the GoldSim outputs, but rather to determine if a simplified, alternative process of estimating Project impacts would produce estimates of Partridge River Project water quality that are reasonably similar to the GoldSim outputs.

METHODS

With regard to the Project, there are six groundwater-related chemical inputs to the Partridge River at SW-004a: (1) East Pit, (2) Cat 2/3 Stockpile, (3) OSP, (4) WWTP pond, (5) OSLA, and (6) West Pit. Via migration in five groundwater surficial flowpaths, the chemical effects from each of these sources reaches the river at different times, ranging from about 30 years for the Cat 2/3 Stockpile to about 170 years for the East Pit. In addition, effluent from the WWTP (meeting all water quality standards) is discharged to the Partridge River starting at about year 36. The target time for this evaluation (mine year 159.58) was arbitrarily selected with the intent of including some input from most of the mine-related chemical sources. This year, however, was not intended to represent a time when maximum Project impacts are expected.

Based on a deterministic run of the Mine Site GoldSim model (version 4.1) using P50 inputs, background streamflow at SW-004a was determined by reducing the river flow rate at year 159.58 by the sum of flowpath discharge rates for the same year. Background Partridge River water quality (concentration) was taken from Barr's No Action average P50 estimate for each constituent for year 159.58. Project flows and associated water quality for each of the groundwater sources and the WWTP effluent at year 159.58 were taken from output spreadsheets generated by Mine Site GoldSim model. The estimate of Partridge River Project water quality at SW004a for each constituent was estimated by a simple mixing calculation that considered background chemical load (upstream river flow multiplied by concentration) and each of the Project source loads (source flows multiplied by concentrations) and dividing by the sum of background and source-related flow rates. Note that in GoldSim, the flows and concentrations for the Cat 2/3 stockpile and East Pit are mathematically combined because they both enter the same groundwater flowpath.

RESULTS

The calculation of Project water quality at SW-004a includes some input from all six groundwater sources plus the WWTP effluent. As shown in Table 1, the independently calculated sulfate concentration at SW-004a (9,637 µg/L) is very close to the GoldSim estimate (9,531 ug/L) based on a deterministic model run using P50 inputs. Table 2 provides a similar comparison for aluminum, for which there is close agreement between the independently

computed value of 63.45 µg/L and the GoldSim estimate of 60.36 µg/L. For cobalt (Table 3), the comparison is also favorable, with a computed concentration of 0.66 µg/L versus the Goldsim estimate of 0.55 µg/L.

Table 1 Estimated Partridge River Project Sulfate Water Quality at SW-004a

	NON-PROJECT FLOW[1]				PROJECT FLOWS[2]			MIXED FLOWS[3]
	Q, cfs	**Conc, µg/L**	**Relative Load, Q x Conc**	**Source**	**Q, cfs**	**Conc, µg/L**	**Relative Load, Q x Conc**	**Total Load/Total Q vs Project ave P50, µg/L**
SO_4	25.23	9,598	242,158	WWTF, Eff	0.635	9000	5,715	
				W. Pit gw	0.0371	23,867	885.47	
				E. Pit/2/3	0.0873	18,661	1629.11	
				OSP	0.0156	10,309	160.82	
				WWTF,gw	0.0076	10,675	81.13	
				OSLA	0.0248	12,919	320.39	
					0.807		8,791.92	25,095/26.04 = 9,637 vs 9,531

[1]Source: SW_Flows and SW_Conc Timeseries Spreadsheets, Barr, Dec2012, No Action
[2]Source: MineSite_CV Spreadsheets, Barr 2012
[3]Source: SW_Concs_Timeseries_MineSite.xlsm, Barr, Dec2012

Table 2 Estimated Partridge River Project Aluminum Water Quality at SW-004a

	NON-PROJECT FLOW[1]				PROJECT FLOWS[2]			MIXED FLOWS[3]
	Q, cfs	**Conc, µg/L**	**Relative Load, Q x Conc**	**Source**	**Q, cfs**	**Conc, µg/L**	**Relative Load, Q x Conc**	**Total Load/Total Q vs Project ave P50, µg/L**
Al	25.23	65.07	1641.7	WWTF, Eff	0.635	1.41	0.895	
				W. Pit gw	0.0371	38.18	1.416	
				E. Pit/2/3	0.0873	57.35	5.007	
				OSP	0.0156	65.84	1.027	
				WWTF,gw	0.0076	76.19	0.581	
				OSLA	0.0248	65.84	1.633	
					0.807		10.56	1652.26/26.04 = 63.45 vs 60.36

[1]Source: SW_Flows and SW_Conc Timeseries Spreadsheets, Barr, Dec2012, No Action
[2]Source: MineSite_CV Spreadsheets, Barr 2012
[3]Source: SW_Concs_Timeseries_MineSite.xlsm, Barr, Dec2012

Table 3 Estimated Partridge River Project Cobalt Water Quality at SW-004a

	NON-PROJECT FLOW[1]			PROJECT FLOWS[2]				MIXED FLOWS[3]
	Q, cfs	Conc, µg/L	Relative Load, Q x Conc	Source	Q, cfs	Conc, µg/L	Relative Load, Q x Conc	Total Load/Total Q vs Project ave P50, µg/L
Co	25.23	0.395	9.966	WWTF, Eff	0.635	5.0	3.175	
				W. Pit gw	0.0371	8.64	0.321	
				E. Pit/2/3	0.0873	7.66	0.669	
				OSP	0.0156	1.43	0.022	
				WWTF,gw	0.0076	1.52	0.012	
				OSLA	0.0248	0.859	0.021	
					0.807		3.551	17.07/26.04 = 0.66 vs 0.55

[1]Source: SW_Flows and SW_Conc Timeseries Spreadsheets, Barr, Dec2012, No Action
[2]Source: MineSite_CV Spreadsheets, Barr 2012
[3]Source: SW_Concs_Timeseries_MineSite.xlsm, Barr, Dec2012

CONCLUSION

With regard to river concentrations for three solutes, the independent calculations reasonably reproduce the GoldSim model outputs at location SW-004a for the selected year. T his evaluation provides good evidence that the GoldSim model adequately accounts for Project-related chemical inputs to the Partridge River and correctly computes river concentrations using simple mixing.

Appendix C
Project Plant Site Audit (v5) -
Goldsim Water-Quality Model

APPENDIX C: PROJECT PLANT SITE AUDIT (V5) - GOLDSIM WATER-QUALITY MODEL

INTRODUCTION

This technical memorandum describes an audit of the version 5 (v5) NorthMet Project Plant Site GoldSim water-quality model that was run during February 2013. This model for the Plant Site was developed by Barr Engineering Company (Barr) to estimate potential environmental effects from the proposed mine on the quality and quantity of water resources. This audit has been conducted by members of the ERM Project Team to provide technical support to the State of Minnesota in preparation of the NorthMet Project Supplemental Draft Environmental Impact Statement (SDEIS).

Previously, the ERM Team conducted an audit of the version 3 (v3) GoldSim model that was run during September 2012. Results of the v3 audit were summarized in an ERM memorandum dated October 30, 2012 (Appendix A this report). The October 2012 audit was not a 100-percent verification of model calculations, but instead focused on evaluating select model components that are critical in the estimates of solute release/transport. This update provides a supplementary audit of additional model components at the Plant Site that were not evaluated previously or have changed due to modified inputs or GoldSim programming. The most important model changes that were made in going from v3 to v5 are the following:

- Revised chemical concentrations in the WWTP effluent based on pilot testing.
- Revised calibration factors for release of sulfate from fine and coarse LTVSMC tailings to provide consistency with previously agreed upon vanGenuchten parameters (CDF055).
- New GoldSim programming that effectively increases the flow rate of tailings-impacted groundwater that by-passes the containment system and enters surficial groundwater flow paths (CDF061)
- Using water from Colby Lake to augment streamflow in tributaries to the Embarrass River (CDF069 and CDF062).
- Modified watershed areas (CDF051).

It was confirmed during this audit that these model changes were appropriately incorporated into the v5 GoldSim model and the changes did not raise any QA concerns.

For this QA update, the following specific evaluations were performed using a deterministic run of the v5 GoldSim model with P50 inputs:

- Re-evaluation of chemical release from subareas of the Flotation Tailings Basin (FTB).
- Evaluation of containment system bypass and associated chemical migration in groundwater surficial pathways.
- Evaluation of chemical loading to the Embarrass River caused by discharge of WWTP effluent and Colby Lake augmentation water.

Each of these evaluations is described in subsequent sections of this memorandum.

Overall, the results of this audit provide good evidence that the v5 Plant Site GoldSim model has appropriate and mathematically correct algorithms for (1) estimating flows and chemical concentrations of impacted water leaving the TFB, (2) simulating chemical migration in the surficial groundwater flowpaths, and (3) estimating Embarrass River chemical concentrations by mixing of background and human-affected water sources to the river.

EVALUATION 1 – FTB CHEMICAL SOURCES

In the October 2012 memorandum, a comprehensive set of Mathcad worksheets and Excel spreadsheets were used to independently compute the flows and concentrations of sulfate and copper generated by subareas of the FTB. These calculations were based on v3 calibration factors for fine and course LTVSMC tailings, which were changed in v5 to be consistent with new vanGenuchten parameters presented in CDF055. The calibration factors, documented in Table 1-1 (sheet 5), of the current Plant Site Work Plan, are as follows:

- Input name: "Coarse_Calibration_Fact" v3 value = 0.181 v5 value = 0.151
- Input name: " Fine_Calibration_Fact" v3 value = 0.360 v5 value = 0.207

This evaluation performed essentially the same calculations, but incorporated the new v5 calibration values. In addition, the trace metal of interest was changed from copper to lead because previous runs of the model showed that the FTB will release lead concentrations that are significantly higher than groundwater background concentrations.

The results of this evaluation for lead are summarized in Table 1. Using flow distributions specified in the GoldSim inputs, mixing calculations were used to compute the post-closure lead concentration in FTB seepage reporting to each of the four FTB toes (see "Independently computed concentration"). For comparison, the analogous post-closure lead concentration at each toe was extracted from the GoldSim output files (see "GoldSim concentration"). Figure 1 is an example of the GoldSim output for lead concentration in seepage reporting to the North Toe, which for long-term post closure conditions has a concentration of about 17 µg/L. As shown in Table 1, there is very good agreement between the independently computed lead concentrations and the analogous concentrations generated by the GoldSim model.

Table 2 is a similar summary of independent calculations performed for sulfate. As shown, there is very good agreement between the independently computed values and the GoldSim estimates.

This evaluation provides good evidence that the GoldSim Plant Site model correctly computes flow rates and chemical concentrations in seepage water reaching the toes of the FTB.

EVALUATION 2 – CONTAINMENT SYSTEM BY-PASS AND GROUNDWATER TRANSPORT

In CDF061, a revised method was presented for estimating the groundwater flow rate approaching different segments of the FTB containment system and the associated bypass that would enter the upgradient end of each adjacent groundwater surficial flowpath. The upper portion of Table 3 summarizes independent calculations of the by-pass flow rate for each flowpath (north, northwest, and west) and compares these values with flow rates extracted from the GoldSim model. As shown, there is exact agreement between the two sets of by-pass flow rates.

Table 1. Lead Concentration in Groundwater at FTB Toes

Tailings Basin Sub-Area	Tailings Material	Bentonite Amended	From Sulfate Table Flow gpm	From Sulfate Table MR kg/day	Sulfur MR kg/day	Ratio Lead to Sulfur R mg/mg	Calib Factor C	Conc Cap if used Cap mg/L	Lead MR kg/day	Flow Distribution N %	NW %	W %	S %	Flow Rate (Q) N gpm	NW gpm	W gpm	S gpm	Mass Rate (MR) N kg/day	NW kg/day	W kg/day	S kg/day
North Dam banks (outer slopes)	LTV bulk (other)	Operations and closure	78.08	8.37	2.79	5.800E-03	0.0003		4.86E-06	100	0	0	0	78.08	0.00	0.00	0.00	4.86E-06	0.00E+00	0.00E+00	0.00E+00
East Dam banks (outer slopes)	LTV bulk (other)	Operations and closure	12.54	1.35	0.45	5.800E-03	0.0003		7.84E-07	100	0	0	0	12.54	0.00	0.00	0.00	7.84E-07	0.00E+00	0.00E+00	0.00E+00
South Dam banks (outer slopes)	LTV bulk (other)	Operations and closure	28.54	3.06	1.02	5.800E-03	0.0003		1.78E-06	0	0	0	100	0.00	0.00	0.00	28.54	0.00E+00	0.00E+00	0.00E+00	1.78E-06
North Beach	35% NM fine, 65% NM coarse	Closure only	23.73					0.100	1.29E-02	100	0	0	0	23.73	0.00	0.00	0.00	1.29E-02	0.00E+00	0.00E+00	0.00E+00
East Beach	35% NM fine, 65% NM coarse	Closure only	14.30					0.100	7.80E-03	100	0	0	0	14.30	0.00	0.00	0.00	7.80E-03	0.00E+00	0.00E+00	0.00E+00
South Beach	35% NM fine, 65% NM coarse	Closure only	32.32					0.100	1.76E-02	3.8	0	0	96.2	1.23	0.00	0.00	31.10	6.70E-04	0.00E+00	0.00E+00	1.69E-02
Closure Beach	35% NM fine, 65% NM coarse	Closure only	59.15					0.100	3.22E-02	84.8	0	0	15.2	50.16	0.00	0.00	8.99	2.73E-02	0.00E+00	0.00E+00	4.90E-03
Pond	LTV	Closure (after 30 years)	326.59		9.89	5.800E-03	0.0003		1.72E-05	81	0	0	19	264.54	0.00	0.00	62.05	1.39E-05	0.00E+00	0.00E+00	3.27E-06
1E coarse	LTV coarse	none	0.47	5.57	1.86	5.800E-03	0.0003		3.24E-06	0	0	0	100	0.00	0.00	0.00	0.47	0.00E+00	0.00E+00	0.00E+00	3.24E-06
1E fine	LTV fine	none								1.5	31.7	7	59.8	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2E coarse	LTV coarse	none								1.5	98.5	0	0	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2E fine	LTV fine	none								100	0	0	0	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2E other	LTV coarse	none	21.40	55.15	18.41	5.800E-03	0.0003		3.20E-05	98.6	1.4	0	0	21.10	0.30	0.00	0.00	3.16E-05	4.48E-07	0.00E+00	0.00E+00
2W coarse	LTV coarse	none	150.86	479.01	159.89	5.800E-03	0.0003		2.78E-04	14.6	31.1	35.2	19.1	22.03	46.92	53.10	28.81	4.06E-05	8.65E-05	9.79E-05	5.31E-05
2W fine	LTV fine	none	615.75	715.48	238.83	5.800E-03	0.0003		4.16E-04	8.9	55.5	35.4	0.2	54.80	341.74	217.97	1.23	3.70E-05	2.31E-04	1.47E-04	8.31E-07
2W banks	LTV coarse	none	136.97	514.49	171.74	5.800E-03	0.0003		2.99E-04	11.1	36.1	41.6	11.2	15.20	49.45	56.98	15.34	3.32E-05	1.08E-04	1.24E-04	3.35E-05
South Buttress banks	Assumed Cat 1 waste rock	none	10.26					0.1000	5.59E-03	0.0	0.0	0.0	100.0	0.00	0.00	0.00	10.26	0.00E+00	0.00E+00	0.00E+00	5.59E-03
North Buttress banks	Assumed Cat 1 waste rock	none	30.78					0.1000	1.68E-02	100.0	0.0	0.0	0.0	30.78	0.00	0.00	0.00	1.68E-02	0.00E+00	0.00E+00	0.00E+00
Total GW to Collection System										GW to Individual Collection Systems				588.49	438.40	328.06	186.79	6.568E-02	4.255E-04	3.693E-04	2.754E-02
SW Runoff to Collection Systems																					
Total Average to WWTP																					
																		Independently computed concentration (ug/L) ->			
																		20.476	0.178	0.207	27.048
																		GoldSim concentration (ug/L) ->			
																		17.280	0.178	0.207	23.504

All values are independently calculated using inputs and equations mutually agreed upon by the Agencies and Barr.

R Ratio of copper mass to sulfur mass
MR Mass rate of chemical release

N North Toe
NW Northwest Toe

Theoretical result over-ridden by concentration cap

Based on dissolved oxygen brought in with pond seepage

From Sulfate	From Sulfate	Ratio Lead	Calib	Conc Cap

Table 2. Sulfate Concentration in Groundwater at FTB Toes

P50 rainfall = 27.818

Tailings Basin Sub-Area	Tailings Material	Bentonite Amended	Area acre	Perc in/yr	Flow gpm	Sulfur MRA mg/m2/week	Sulfate MR kg/day	Flow Distribution N %	NW %	W %	S %	Flow Rate (Q) N gpm	NW gpm	W gpm	S gpm	Mass Rate (MR) N kg/day	NW kg/day	W kg/day	S kg/day
North Dam banks (outer slopes)	LTV bulk (other)	Operations and closure	249.00	6.07	78.08	19.421	8.37	100	0	0	0	78.08	0.00	0.00	0.00	8.37	0.00	0.00	0.00
East Dam banks (outer slopes)	LTV bulk (other)	Operations and closure	40.00	6.07	12.54	19.421	1.35	100	0	0	0	12.54	0.00	0.00	0.00	1.35	0.00	0.00	0.00
South Dam banks (outer slopes)	LTV bulk (other)	Operations and closure	91.00	6.07	28.54	19.421	3.06	0	0	0	100	0.00	0.00	0.00	28.54	0.00	0.00	0.00	3.06
North Beach	35% NM fine, 65% NM coarse	Closure only	75.67	6.07	23.73	233.990	30.66	100	0	0	0	23.73	0.00	0.00	0.00	30.66	0.00	0.00	0.00
East Beach	35% NM fine, 65% NM coarse	Closure only	45.61	6.07	14.30	233.990	18.48	100	0	0	0	14.30	0.00	0.00	0.00	18.48	0.00	0.00	0.00
South Beach	35% NM fine, 65% NM coarse	Closure only	103.08	6.07	32.32	233.990	41.77	3.8	0	0	96.2	1.23	0.00	0.00	31.10	1.59	0.00	0.00	40.18
Closure Beach	35% NM fine, 65% NM coarse	Closure only	188.64	6.07	59.15	233.990	76.44	84.8	0	0	15.2	50.16	0.00	0.00	8.99	64.82	0.00	0.00	11.62
Pond	n/a	Closure (after 30 years)	972.60	6.50	326.59		58.43	81	0	0	19	264.54	0.00	0.00	62.05	47.33	0.00	0.00	11.10
1E coarse	LTV coarse	none	3.38	2.68	0.47	952.688	5.57	0	0	0	100	0.00	0.00	0.00	0.47	0.00	0.00	0.00	5.57
1E fine	LTV fine	none	0.00	2.19				1.5	31.7	7	59.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2E coarse	LTV coarse	none	0.00	5.04				1.5	98.5	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2E fine	LTV fine	none	0.00	3.92				100	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2E other	LTV coarse	none	75.29	5.50	21.40	422.968	55.15	98.6	1.4	0	0	21.10	0.30	0.00	0.00	54.38	0.77	0.00	0.00
2W coarse	LTV coarse	none	220.08	13.27	150.86	1256.772	479.01	14.6	31.1	35.2	19.1	22.03	46.92	53.10	28.81	69.94	148.97	168.61	91.49
2W fine	LTV fine	none	748.07	15.93	615.75	552.262	715.48	8.9	55.5	35.4	0.2	54.80	341.74	217.97	1.23	63.68	397.09	253.28	1.43
2W banks	LTV coarse	none	339.18	7.82	136.97	875.858	514.49	11.1	36.1	41.6	11.2	15.20	49.45	56.98	15.34	57.11	185.73	214.03	57.62
South Buttress banks	Assumed Cat 1 waste rock	none	15.00	13.24	10.26		7.53	0.0	0.0	0.0	100.0	0.00	0.00	0.00	10.26	0.00	0.00	0.00	7.53
North Buttress banks	Assumed Cat 1 waste rock	none	45.00	13.24	30.78		26.51	100.0	0.0	0.0	0.0	30.78	0.00	0.00	0.00	26.51	0.00	0.00	0.00
Total GW to Collection System								GW to Individual Collection Systems				588.49	438.40	328.06	186.79	444.21	732.57	635.92	229.61
SW Runoff to Collection Systems																			
Total Average to WWTP																			
															Independently computed concentration (ug/L) ->	138,478	306,549	355,614	225,517
															GoldSim concentration (ug/L) ->	144,300	306,700	355,800	238,400

All values are independently calculated using inputs and equations mutually agreed upon by the Agencies and Barr.

MRA Mass rate of chemical release per unit map area
MR Mass rate of chemical release

N North Toe
NW Northwest Toe
W West Toe
S South Toe

Based on Mathcad worksheets for oxygen diffusion

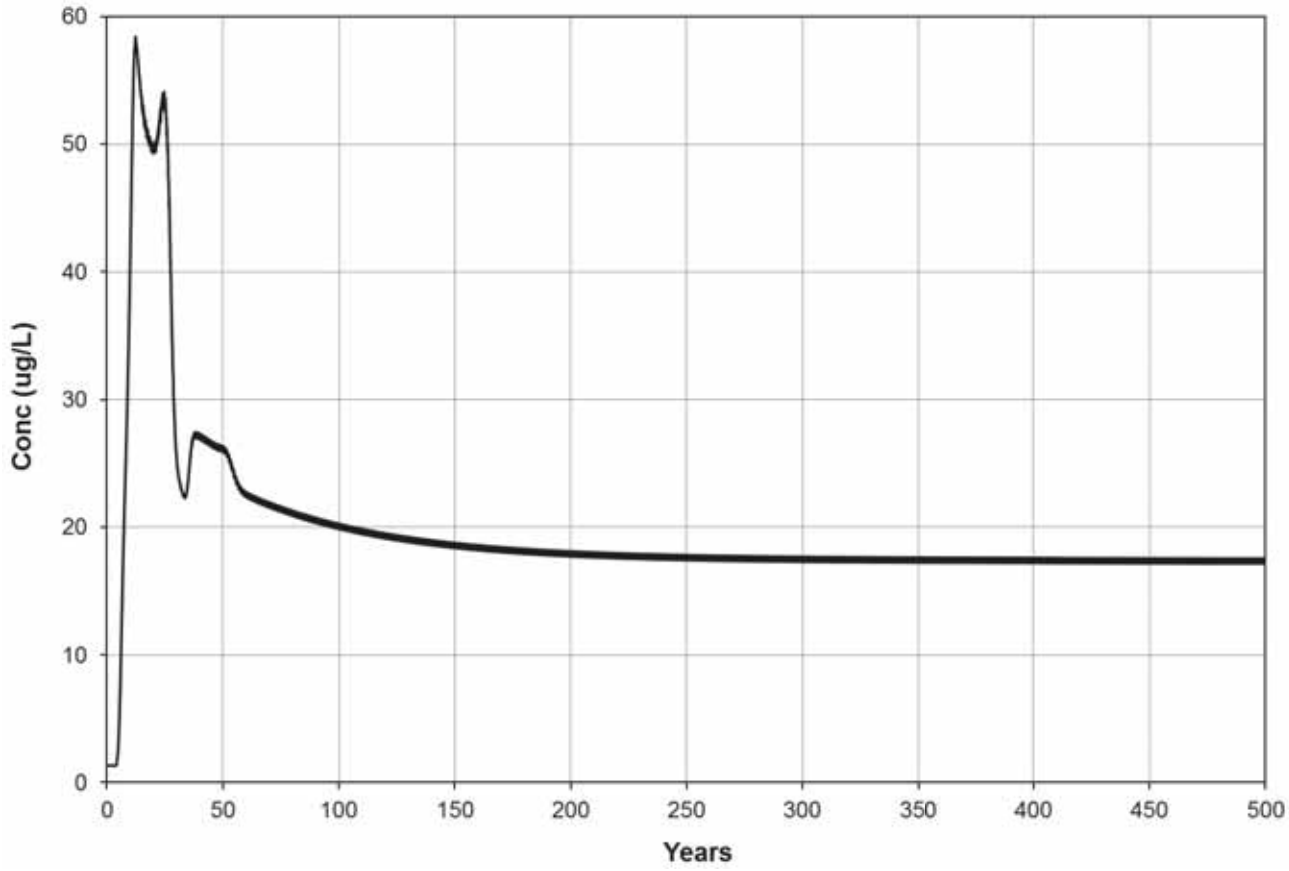
Based on pond sulfate and dissolved oxygen concentrations

Based on Category 1 sulfate oxidation and LAM scale factor

Table 3. Plant Site Surficial Flowpaths - Flow Rates and Travel Times

Description	Units	Surficial Aquifer Pathway		
		West	Northwest	North
Flowpath width	m	2920	2090	1920
Flowpath thickness	m	7	7	7
Hydraulic gradient	---	0.00736	0.00514	0.00444
Hydraulic conductivity	m/d	3.7139	3.7139	3.7139
Groundwater flow rate approaching containment system	gpm	102.50	51.23	40.66
Containment system capture efficiency	%	90	90	90
Indpendently computed groundwater flow rate by-passing containment system	gpm	10.25	5.12	4.07
GoldSim result based on deterministic run with P50 inputs		10.25	5.12	4.07
Net meteoric recharge	in/yr	0.765	0.765	0.765
Aquifer porosity	---	0.30	0.30	0.30
Distance from containment system to mine property boundary (groundwater compliance point)	m	3023	1250	1132
Distance from containment system to location of groundwater discharge to surface water	m	5331	3645	3191
Independently computed groundwater discharge rate to surface water	gpm	162.31	79.54	63.92
GoldSim result based on deterministic run with P50 inputs		162.18	79.45	63.87
Independently computed sharp-front chemical arrival time at the property boundary	yr	242.2	193.3	197.5
GoldSim result - apparent travel time for lead based on 50th percentile conc from Monte Carlo simulation		225	175	200
Independenly computed sharp-front chemical arrival time at the location of groundwater discharge to surface water	yr	298.5	296.3	297.7
GoldSim result - apparent travel time for lead based on deterministic run with P50 inputs		290	290	290

Figure 1. GoldSim Lead Concentration at Upgradient (containment) end of North Flowpath Based on Deterministic Run with P50 Inputs

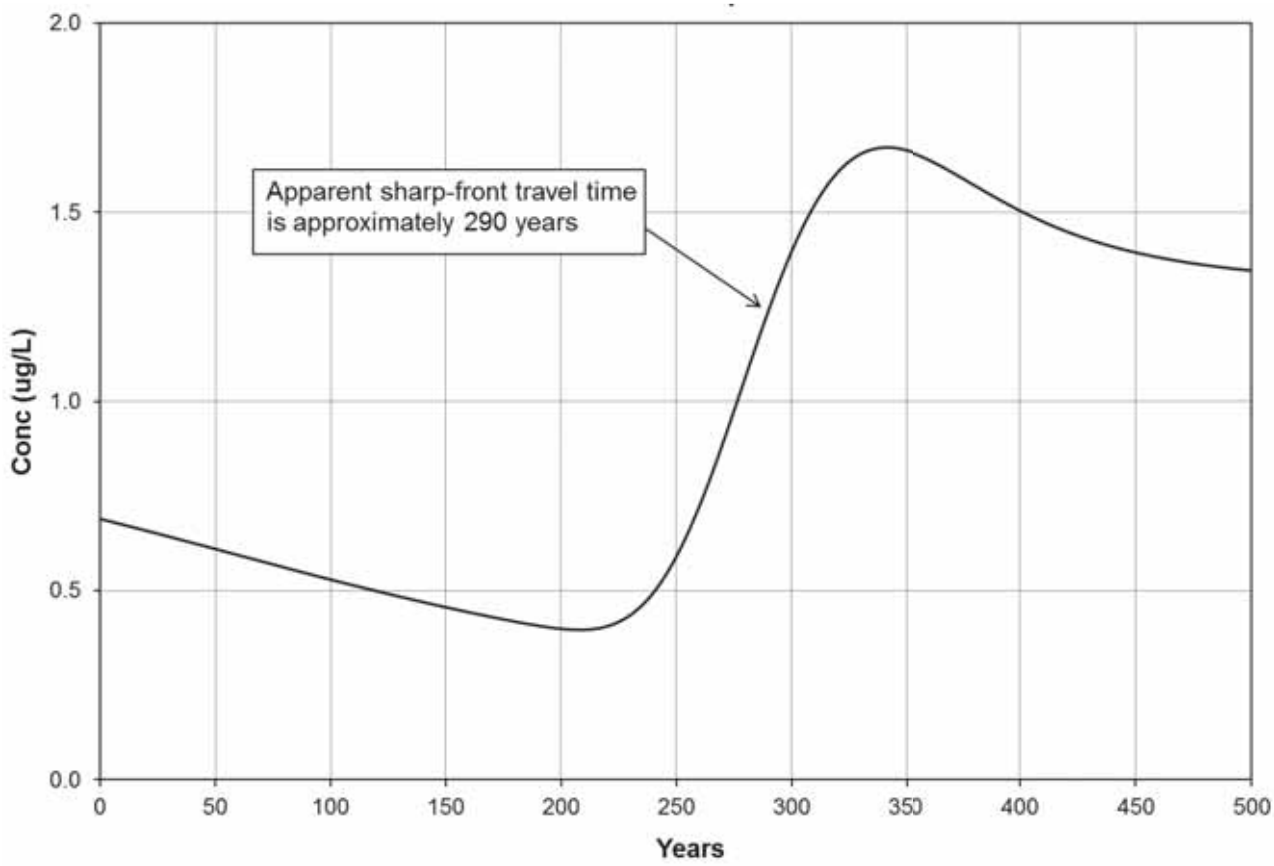


Between the upgradient (containment system) end and downgradient (discharge) end of each flowpath, there is a systematic increase in the groundwater flow rate due to net recharge of meteoric water into the groundwater system. In Table 1, the downgradient groundwater discharge flow rate is computed for each flowpath and is shown to be in excellent agreement with the analogous value extracted from the GoldSim model. These rates represent the discharge of groundwater to surface water at the end of the surficial flowpaths, which are constant in the GodlSim model. Groundwater discharges from the North and Northwest Flowpaths go to the Embarrass River via tributaries Mud Lake Creek and Trimble Creek, respectively. Discharge from the West Flowpath goes directly into the Embarrass River.

Figure 2 shows the GoldSim lead concentration at the discharge (downgradient) end of the North Flowpath over time. Lead is a good tracer in the GoldSim model because its concentration in the containment system by-pass water is much larger than the background concentration in groundwater. The increase in the discharge concentration on Figure 2 results from groundwater transport through the flowpath beginning at the containment system. As shown on Figure 2, the concentration begins to rise at about 225 years and reaches a peak at about 340 years. Due to longitudinal dispersion, the GoldSim plume arrival is gradual, but the shape of the curve indicates an effective "sharp-front" travel time of about 290 years. The sharp-front travel time is

the theoretical travel time that would occur if there was no dispersion in the system. For the physical system considered in the GoldSim model, an independent estimate of the sharp-front travel time can be made using the equation presented in the Mine Site QA Update (Appendix B this report). This equation accounts for effect of recharge on the groundwater seepage velocity, which increases in the downgradient direction. In the lower portion of Table 1, the equation is used to independently compute the sharp-front travel time to the property boundary and to the discharge point for each flowpath. As shown, there is good agreement between the apparent sharp-front travel times interpreted form the GoldSim outputs and the theoretical sharp-front travel times predicted from the analytical equation.

Figure 2. GoldSim lead concentration at downgradient (discharge) end of North Flowpath based on deterministic run with P50 inputs



As summarized in Table 4, a n additional check was performed using independent mixing calculations to estimate the long-term chemical concentrations in groundwater discharging to surface water. T hese calculations generally considered chemical concentrations in the upgradient end of the flowpath at 100 to 200 years, when concentrations tend to be steady or slowly changing. The calculation then mixed the flow/concentration at the upstream end of the flow path with the recharge flow/concentration along the flowpath to compute the concentration at the downstream end. This was considered the downgradient concentration that would occur at 400 to 500 years, because there is a 300-year travel time through the entire flowpath. T he computed value was then compared to the GoldSim concentration at the downstream end of the flowpath at 400 to 500 years.

As an example, Figure 1 shows that the upgradient lead concentration in the North Flowpath is about 17.6 µg/L at 200 years. The independent calculation gives a computed downgradient concentration of 1.35 µg/L. Figure 2 s hows that the GoldSim lead concentration at the downstream end of the North Flowpath is about 1.35 at 500 years, which compares favorably with the computed value. As shown in Table 4, there is generally good agreement between the independently computed sulfate and lead concentrations at the downgradient end of each flowpath and analogous values extracted from the GoldSim outputs.

This evaluation provides good evidence that the GoldSim Plant Site model correctly simulates chemical transport and meteoric dilution in the groundwater surficial flowpaths.

Table 4. Plant Site Flowpaths - Discharge Concentrations

Flowpath	Constituent	Containment System Bypass		Recharge		Compare Values: Flow Rate of GW Discharge to SW		Compare Values: Concentration in GW Discharge to SW	
		Flow Rate gpm	Conc ug/L	Flow Rate gpm	Conc ug/L	Computed gpm	GoldSim gpm	Computed ug/L	GoldSim ug/L
North	Sulfate	4.07	156400	59.85	7920	63.92	63.87	17374	17100
	Lead	4.07	17.6	59.85	0.250	63.92	63.87	1.35	1.35
Northwest	Sulfate	5.12	307000	74.42	7920	79.54	79.45	27172	26600
	Lead	5.12	0.179	74.42	0.250	79.54	79.45	0.245	0.246
West	Sulfate	10.25	355700	152.06	7920	162.31	162.18	29883	28200
	Lead	10.25	0.207	152.06	0.250	162.31	162.18	0.247	0.211

EVALUATION 3 – CONSERVATION OF FLOW AND CHEMICAL MASS IN THE EMBARRASS RIVER

Review of the GoldSim Plant Site model has indicated that when reduced to average annual values, the flow rates and chemical mass rates associated with natural components are generally uniform. In the GoldSim model, natural components affecting the Embarrass River include upstream river water entering the Plant Site area, groundwater baseflow, and storm runoff. Some tributary flows and mass rates are variable from the beginning of operations to about year 42 due to variations in WWTP discharge and water from Colby Lake used to augmentation. There is also a s ystematic variation of chemical concentrations in groundwater discharging from the surficial flowplaths to surface water during this period. In the Embarrass River, noticeable fluctuations in flow and mass rates occur at PM-13 between zero and 42 years due to these factors. An integrated check of how the model accounts for flow and chemical mass entering the river is to compare the system components with variable flow/concentration against GoldSim

computed variations at PM-13. The zero to 42 year time frame is chosen because it is during this period that WWTP effluent and Colby Lake augmentation have large annual variations.

The GoldSim flow chart indicates that WWTP effluent and Colby Lake augmentation water are discharged to three tributaries of the Embarrass River. These locations are designated in the model as Mudlake Creek (MLC3), Trimble Creek (TC1), and unnamed creek (PM-11). When water is discharged to these tributaries, the model assumes that the flow reaches the Embarrass River instantaneously. GoldSim output indicates that the discharge from each groundwater surficial flowpath exhibits a constant flow rate, but variable chemical concentrations.

For operations and initial closure, Figure 3 shows the sum of WWTP discharge, Colby Lake augmentation, and groundwater flowpath discharge (WWTP+CL+FP) as annual average flow rates, which are shown to vary between 3.4 and 5.1 cfs (left scale). Also shown is the Embarrass River (ER) annual average flow rate at PM-13, which varies from 53.4 to 55.4 cfs (right scale). If natural river inputs (other than WWTP+CL+FP) are uniform, there should be a 1-to-1 relationship between WWTP+CL+FP flow variations and PM-13 flow variations. To provide a comparison, the PM-13 scale on Figure 3 is shifted to bring the two curves into closer proximity. As shown, after year 8 there is an exact correspondence between the two curves. If the WWTP+CL+FP annual average flow rate changes by ΔQ, there is an exact corresponding change in flow at PM-13. This provides good evidence that the GoldSim model properly accounts for human-affected (WWTP+CL+FP) flows entering the Embarrass River and that all other river inputs are uniform after year 8.

Figure 3. Embarrass River annual average flow rates based on GoldSim deterministic run with P50 inputs

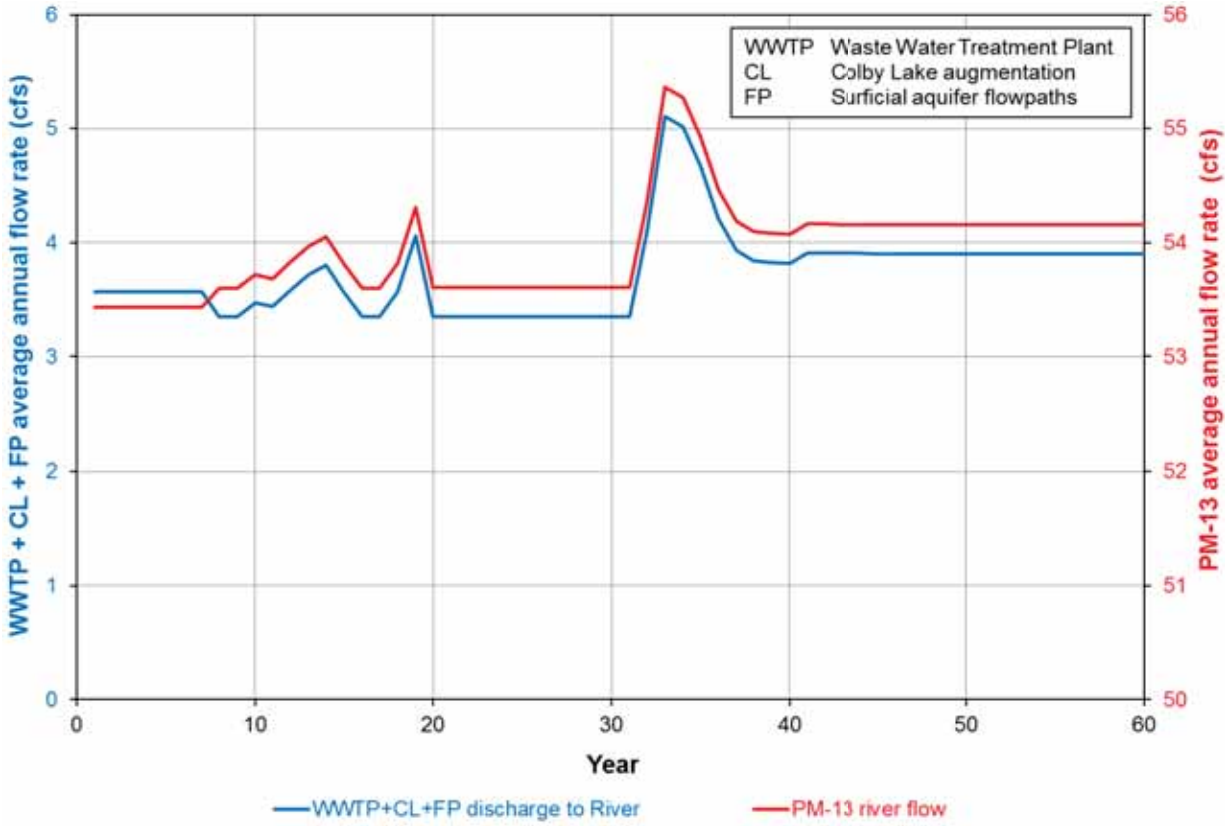
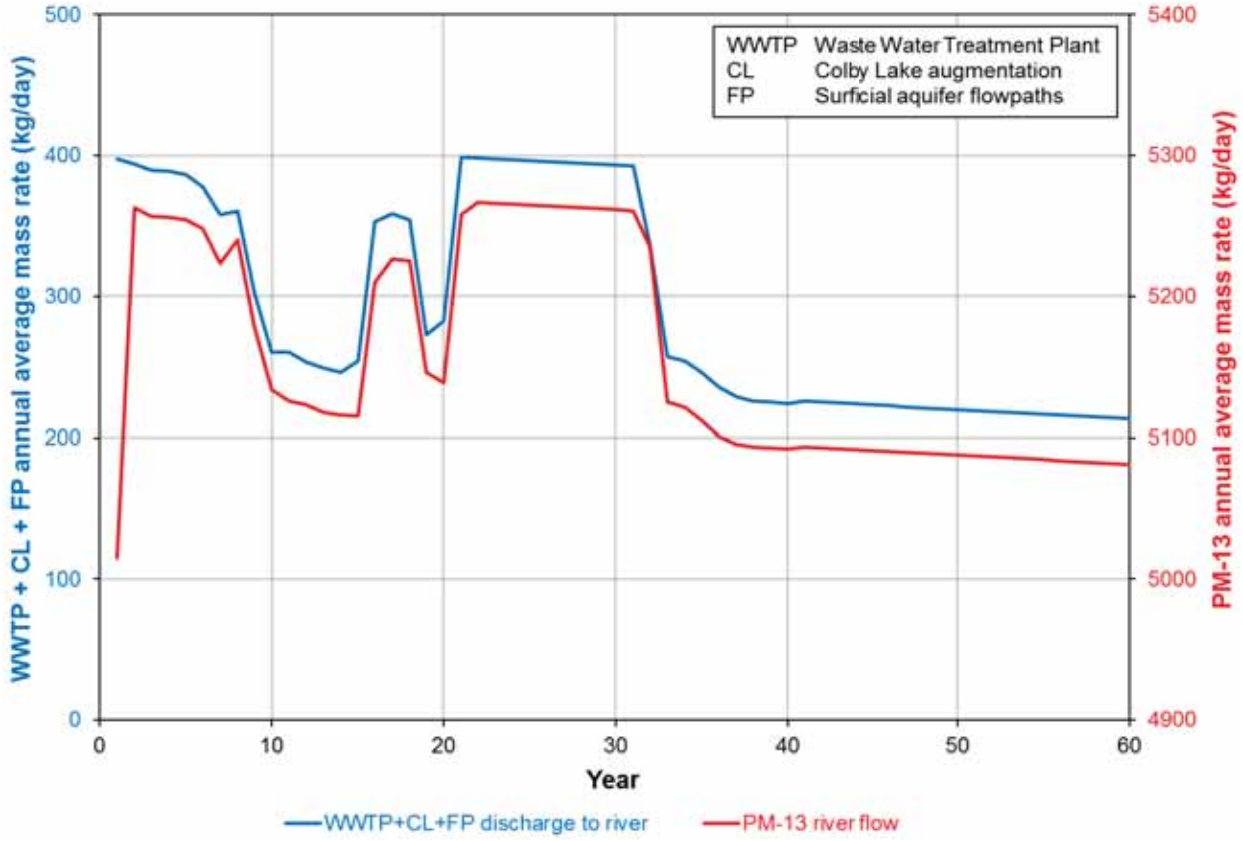


Figure 4 is a similar plot, except it is based on sulfate annual average mass rates. As shown, there is a very good correspondence between fluctuations in WWTP+CL+FP mass rates entering the river and PM-13 mass rate variations.

This evaluation provides good evidence that the GoldSim Plant Site model correctly accounts for human-affected flow and chemical loading to the Embarrass River.

Figure 4. ***Embarrass River annual average sulfate mass rates based on GoldSim deterministic run with P50 inputs***



Model Technical Review Checklist – MODFLOW

MODEL TECHNICAL REVIEW CHECKLIST
MODFLOW

1. MODEL NAME:	**Groundwater Model of the NorthMet Mine Site**	**2. MODEL DATE:**	Dec-14
3. MODEL LOCATION:	**Northeastern Minnesota**		
4. PROJECT NUMBER:	**2369862**	**5. PROJECT PIC:**	**CDP**
6. PRIMARY MODELER:	**JAM2**	**7. REVIEWER:**	**RWW**

8. REVIEWER (After review is completed and all comments were resolved):

Ray W. Wuolo		12/26/2014
printed name	concurrent signature	date

No.	Criteria	Comments/Notes
1	Is the choice of mathematical model appropriate (analytical/numerical)?	MODFLOW-NWT was used. This is appropriate, given the potential for instabilities that could result from unsaturated conditions during model runs. Rationale for model selection was described.
2	Is the purpose of the model (i.e. the problem(s) the model is intended to evaluate) clearly defined?	Yes. "The primary objective of this study was to estimate the amount of groundwater flow expected into the mine pits during operations and pit filling and to evaluate the groundwater flow conditions following pit closure. To meet these objectives, a series of numerical groundwater flow models were developed. These models were designed to simulate current conditions, conditions during mining, and conditions in closure."
3	Is the spatial extent of the model appropriate?	Yes. The TMR approach uses a local-scale model that is embedded in a regional model. The regional model is used to define the boundary conditions for the local-scale model. At the Mine Site, it was not possible to determine a priori what the aquifer boundaries were for the bedrock units. The TMR approach was used to account for uncertainty in the location of boundaries. The regional model is very large - 1,000 square miles. It does not appear that the regional model dynamically interacts with the boundaries of the TMR.
4	In the number of model layers justified?	The regional model is a single layer - which is appropriate for the purposes used. The local model is seven layers - designed primarily to capture both the bedrock/surficial deposits and to accommodate simulations of multi-level water-level measurements during pumping tests, as well as the hanging wall/footwall geometries as mining progressed.

Model Technical Review Checklist
MODFLOW

5	Is the model discretization (planer) appropriate?	The discretization of the TMR model was @ 50-660 feet, with increased resolution near the mine. For flow purposes, this is a sufficient level of discretization.
6	Is steady state simulated?	Calibration was steady state. In the forward (predictive) simulation section, it states that a transient simulation was used to simulate 20 years of mine pit operation. Following mine operations, a series of steady-state simulations were used to simulate inflow rates for the stages of mine pit filling.
7	Is the stress period reasonable?	Single-year stress periods were used during the transient simulation - these appear to be appropriate for the purposes fo the model.
8	Is the number of time steps per stress period justified?	This is not stated in the report. Model files indicate 5 time steps per stress period with a 1.2 multiplier. Provided that model convergence to head and mass flux are adequate, these time steps should be sufficient for the problem at hand.
9	Are the applied boundary conditions plausible and unrestrictive?	Boundaries were set from the regional model (but are not dynamic from the regional model). CHD boundaries were extracted from the hds file of the regional model for the perimeter of the TMR. A sensitivity analysis was performed to ensure that these TMR boundaries were not restrictive.
10	Are boundary condition locations consistent with the model grid configuration?	Yes.
11	Are the initial conditions defensible?	Yes.

Model Technical Review Checklist
MODFLOW

12	Do model input values match documented input values?	Yes.
13	Are the calibrated parameter distributions and ranges plausible?	Yes.
14	Is model mass balance error between -1% and 1%?	Mass flux error at the end of the simulations is -0.00096.
15	Does the calibration statistic satisfy agreed performance criteria if specified, or industry standards if not specified?	Yes.
16	Are model predictions made at scales consistent with model space and time scales?	Yes.
17	Are model predictions plausible?	Yes.
18	Are model predictions likely to be impacted by constraining boundary conditions?	No. A sensitivity analysis was performed that evaluated the effects of the boundary conditions and they were found to not be constraining to the problem's stresses and predictions

Model Technical Review Checklist
MODFLOW

19	If boundary conditions affect the predictions, are the predictions defensible?	Even with changes in boundary conditions (provided they are a few percent), the predictions should not be impacted.

Model Technical Review Checklist – XP-SWMM

MODEL TECHNICAL REVIEW CHECKLIST

XP-SWMM

1. MODEL NAME:	Partridge River - Existing Conditions Model	**2. MODEL DATE:**	
3. MODEL LOCATION:	P:\Mpls\23 MN\69\2369862\WorkFiles\APA\Support Docs\Hydrology\xpSWMM\2012 Modeling\November2012\Updated_Existing		
4. PROJECT NUMBER:	23/69-0862.00-042-001	**5. PROJECT PIC:**	JPB
6. PRIMARY MODELER:	SGW	**7. REVIEWER:**	RSM

8. REVIEWER (After review is completed and all comments were resolved):

Ross Mullen	Ross Mullen	4/9/2012
printed name	concurrent signature	date

No.	Criteria	Comments/Notes
1	Is runoff continuity error between -1% to 1%. If not correct or determine why & impacts? (Table R5)	Continuity error = 1.72. Desired continuity error of -1% to 1% is for event-based modeling. Higher error is acceptable for continuous modeling and is often linked to inclusion of snowmelt subroutine. Model error for May to October 1977, for example, is less than 0.5 percent.
2	Does the Number of watersheds listed in the output file match Arc View?	Yes. 75 subwatersheds are present in ArcMap base map and SWMM model.
3	Does the Total watershed area listed in the output file match the total study area?	Yes. ArcMap area = 66177 acres. XP-SWMM acres = 66202 (less 25 acres of watershed PM11RR that is turned off in the hydrology layer, versus removed from the model).

Model Technical Review Checklist
XP-SWMM

4	Does the total rainfall amount listed in the output file match the rainfall amount for the storm frequency and duration that is being modeled?	Precipitation data is organized into 9 groups (1003 to 1009). Group 3 (1003) is duplicated in the model. Group 9 (1009), listed as gage 10 in the output file, runs for an additional 4 hours (out of an 11 year simulation) and includes 0.01 inches more precip.
5	Are the rainfall dates contained within the Runoff simulation dates?	The 9 precipitation groups cover the 1977 to 1988 runoff simulation period. The 100-yr SCS type II, 100-yr 10 day Snowmelt, and 500-yr SCS Type 1 storms are also included in the model but are not run as part of the continuous model simulation (i.e., the hydrologic impacts assessment).
6	Is the same rainfall global database being used for all the watersheds? (Table R2)	No. Eight of 10 gages are used in the model, representing 8 of 9 different precip groups. Gage 4 (station 1003) is a duplicate of gage 3 (station 1003) and is not used. Gage 8 (station 1007) is applicable only to watersheds that are turned off in the model (the Peter Mitchell Pit watersheds).
7	Is the same runoff methodology being used for all the watersheds? (Table R2)	Yes, SWMM Method.
8	Is the correct rainfall distribution being used for the simulated storm frequency & duration?	See item 6. Note that this is a continuous model.
9	Do the Infiltration inputs (global databases) seem reasonable including overland flow roughness and Horton/Green Ampt parameters (Table R2)	Yes.
10	Do the infiltration assumptions include water areas when appropriate (Zero % Detention)?	Zero % Detention is applied to 100% of all watersheds. This is based on the modeling assumption that all impervious area is open water, and thus is not subject to detention.

Model Technical Review Checklist
XP-SWMM

11	Are there any flow redirections in the Runoff layer? Does redirected flow get added appropriately?	No flow redirections.
12	Were correct units assumed during watershed data entry? (Table R1) (Area = ac, Percent Impervious = % (directly connected only), Width = ft, Slope = ft/ft	Yes. Watershed widths determing using ArcGIS tool.
13	Do peak watershed runoff rates seems reasonable when compared to "Rules of Thumb", Rational Method, Barr Method, etc? (Table R9)	Runoff less than 1 cfs/acre, owing to low imperviousness and large watershed areas.
14	Does runoff volumes seems reasonable when compared to Barr Method, SCS method, etc? (Table R9)	Overall watershed yield is 8.4 inches per year. Similar magnitude to 10-11 inches per year observed from USGS record and data published in Baker's Climate of Minnesota (1979).
15	Have all warnings & errors been corrected prior to final simulation? (Error log prior to simulating the Hydraulics layer)	No errors remain. Warnings remain regarding minimum conduit length (negligable), slope override (acceptable), and area-elevation curves for storage nodes. Storage nodes are correctly input as elevation (MSL) vs. area, based on the "AE" configuration parameter.
16	Does the Hydraulics layer simulation dates span the Runoff simulation dates? If no correct.	Yes.
17	Is Hydraulics continuity error between -2% to 2% (Table E22). May be allowable as high as 5% but must be checked and explained.	Overall error = -0.51%

Model Technical Review Checklist
XP-SWMM

18	Are "Special Conduits" (Arches, Ellipses, etc) being modeled correctly by XP-SWMM? Check pipe cross sectional area against manufacturer information to make sure correct area is used. (Table E1)	No arches or ellipses present in model.
19	Have conduit minor losses (entrance/exit, other, expansion/contraction) been entered throughout the model? (Table E2)	Yes. Expansion/contraction are used for natural and trapezoidal channels. Entrance and exit coefficients used for circular conduits (i.e., culverts).
20	Has storage information been entered correctly (Depth = El - Node Inv El & area in acres)?	Storage nodes are input as elevation (MSL) vs. area. The use of elevation in place of depth relative to invert or spill crest is allowable based on the "AE" configuration parameter. Storage elevations were confirmed in the output file.
21	Was Ponding Allowed used? Where & Why?	No, it was not allowed.
22	Check weir parameters to make sure crown El results in weir surcharging only when appropriate.	Discharge Coeff for all weirs is 3.0.
23	Check Orifice parameters.	No Orifices in model.
24	Check Pump curves	No Pumps in model.

Model Technical Review Checklist
XP-SWMM

25	Check User Inflow Hydrographs @ all node they are used	
26	Check user defined rating curves and weirs	No User Inflow Hydrographs.
27	Are pipe flow & velocities reasonable? (Table E15)	Maximum velocities are less than 10 feet per second in all conduits.
28	Is there any water being "Lost from the System"? Check for flooding/surcharge (Table E3B & E20). Lost water must be corrected	No water is being lost.
29	Are the correct number of weirs, orifices, and pumps being used? (after Table E20)	Yes weirs are used for overflows only. No orifices or pumps used in this model.
30	Is model simulation stable? (i.e., Are there any flow/elevation oscillations in any nodes/links that impact results?) If unstable the model must be corrected.	Yes.
31	Are most nodes converging? (Table E18 or E22) If not some model adjustments may be necessary	Overall error is -0.51%. Continuity error as a percent of inflow to each junction is less than 1 percent for all junctions except for Big Lake, which has a continuity error of 3.2% of the inflow. Eleven junctions failed to converge more than 1 time. Mean node continuity is excellent; worst node continuity was good.

Model Technical Review Checklist
XP-SWMM

32	Are there any open channels (Trapezoidal or Natural Sections) that overtop during the simulation that most be corrected? (Look for * in Table E10)	L-40 "overtops" due to bank points set within the channel (i.e., the bank elevations are artificially low, unrealistically constricting the channel). The overtopping is minor and the WSEL exceeds the channel top by approximately 3 inches. The water is still contained within the real channel.
33	Is storage being double counted by using channels and a storage node? If so this must be corrected?	Storage nodes along channels are minimual relative to channel size, minimizing any double-counting of water. Any significant storage areas occur at upstream end of channels, preventing double-counting.
34	Does Hydraulic simulation extended long enough to capture all the peak flows/elevations?	Yes, the model runs for a continuous period greater than 10 years.
35	Have initial depths been entered to account for tailwater conditions and pond normal water levels?	Initial depths are not necessary as the model includes a one-year "initialization" period. The first year of simulation (Water Year 1977) is intended to initialize water levels to ambient conditions.
36	Are the correct boundary conditions being used? (Tailwater Elevations)	N93 shows an outfall with normal depth controlling.

MODFLOW/GoldSim Results Comparison
Technical Memorandum

Technical Memorandum

To: Project File
From: Jeré Mohr, Cory Anderson
Subject: MODFLOW/GoldSim Results Comparison
Date: March 6, 2013
Project: 23690862

The purpose of this memo is to document work completed in July 2011 to compare results from groundwater solute transport models developed using MODFLOW/MT3D and GoldSim. MODFLOW and MT3D are industry standard finite-difference codes for simulating groundwater flow and contaminant transport, respectively. The GoldSim Contaminant Transport module is being used to simulate potential water quality impacts associated with the NorthMet Project. A test case was developed to compare the simulation of groundwater flow and contaminant transport using GoldSim to MODFLOW and MT3D.

Location of Model Files

The GoldSim model is saved on the Barr Network at (P:\Mpls\23 MN\69\2369862\WorkFiles\APA\Support Docs\Groundwater\Standalone GoldSim Models\ 3_Zone_GW_Flow_Cells.gsm) and the MODFLOW/MT3D model is saved at V:\23\69\862\GWV\APA_misc\Cat23_confined_test\Cat23_confined_test.gwv.

Description of Test Case and Model Setup

The evaluation was conducted using the Category 2/3 – East Pit surficial aquifer flow path. The GoldSim flow path model used for this comparison was "stand alone" and modified slightly from the full GoldSim model. Due to the way source loading is defined using MT3D (concentration is constant within a model stress period), it was not feasible to recreate the complex stockpile loading from the full GoldSim model, which can vary on a monthly basis. Therefore, a GoldSim model with simplified loading terms was developed for comparison with the MDFLOW/MT3D model.

The flow path was simulated using a network of cells in the GoldSim model. In GoldSim, the groundwater flow paths were set up as a series of coupled, cell pathways. Cell pathways in GoldSim are

intended to represent discrete, well-mixed "compartments" of media through which contaminant mass flow and are stored. The setup is essentially a finite-difference or finite-volume analysis which is similar to the methods used in MODFLOW/MT3D. Each cell represents a discrete physical portion of the flow path. Flow rates through each cell, exterior mass loading rates (i.e. boundary conditions), and the cell connections are all defined to properly transport contaminant mass from sources to the evaluation locations and eventually the discharge points.

Flow Path Geometry and Characteristics

The simulated flow path had a total length of 2,120 meters and a thickness of 5 meters. In MODFLOW, the flow path was simulated using a single layer and a series of model cells with length and thickness of 5 meters. In GoldSim, the flow path was 1,440 meters wide. Because the sources of loading (pit, stockpile, and background recharge) do not vary perpendicular to the direction of groundwater flow, concentrations do not vary perpendicular to flow. Therefore, the MODFLOW model was set up as a one meter wide model and simulates a unit width of aquifer. The horizontal hydraulic conductivity of the aquifer was 2.96 m/day and porosity was 0.3.

Model Stress Periods

The total duration of the model simulation is 1000 years. The MODLOW model was divided into seven stress periods as shown on Table 1. As discussed below, concentrations for the sources of water entering the model were variable by stress period.

Table 1 – MODFLOW Model Stress Periods

Stress Period	Duration (yr)
1	5
2	5
3	5
4	2
5	3
6	10
7	970

The stress periods in the MODFLOW model were transient, but the storage coefficient for the aquifer was set at an extremely low value (10^{-12}) so that the storage terms were negligible and the model behaved as steady-state.

Boundary Conditions

Inflow from Pit

Flow from the pit into the aquifer at the upstream end of the flow path was simulated in the MODFLOW model using a specified flux (well) cell. The well cell discharge was set to zero until the pit becomes full, which occurs at year 30. Once the pit becomes full and flows into the aquifer, the discharge was set to 31.8532 m^3/day (0.022 m^3/day/m of aquifer width).

Recharge

Recharge in areas of the model outside the stockpile footprint was set at 7.0654E-5 m/day (1.02 in/year) for the entire simulation period.

Stockpile Leakage

The stockpile was simulated using a separate recharge zone in the MODFLOW model and is located between a distance of 775 meters to 1,170 meters from the upstream end of the flow path. The stockpile is present from the start of the simulation until year 20. During this period, the recharge rate in the stockpile footprint area is 4.5202E-6 m/day (0.065 in/year). Once the stockpile is removed, the leakage rate returns to the rate for background recharge (1.02 in/year).

Downgradient Head

The head at the downstream end of the flow path was set using a specified head cell with an assigned elevation of 5 meters.

Initial and Source Concentrations

The initial concentration in the aquifer was set to 16.13 mg/L.

Table 2 summarizes the concentrations assigned to the sources of water to the model at various times during the simulation.

Table 2 – Summary of Source Concentrations

Time (year)	Stockpile Leakage Concentration (mg/L)	Pit Concentration (mg/L)	Non-Stockpile Area Recharge Concentration (mg/L)
0 <= t < 5	200	No pit discharge to aquifer	16.13
5 <= t < 10	500	No pit discharge to aquifer	16.13
10 <= t < 15	900	No pit discharge to aquifer	16.13
15 <= t < 17	1000	No pit discharge to aquifer	16.13
17 <= t < 20	700	No pit discharge to aquifer	16.13
20 <= t < 1000	0	100	16.13
1000 <= t	0	100	16.13

Dispersivity

In the MODFLOW/MT3D, the longitudinal dispersivity was set at a uniform value of 15.1 meters. There is no transverse or vertical dispersion simulated for this test case. In GoldSim, dispersion is simulated by selecting the number of cells such that the numerical dispersion is equal to the desired amount of physical dispersion. In this test case, since the total length of the flow path is 2,120 meters, and the desired dispersion length is 15.1 meters, 71 well-mixed cell pathways coupled in series were used to simulate the flow path. This means that each cell pathway in GoldSim represented a portion of the flow path that was 5 meters thick, 1,440 meters wide, and 29.9 meters long.

Evaluation Locations

The concentrations in the flow path were compared to the results of the MODFLOW/MT3D results at five evaluation locations:

- Upstream of the stockpile (775 meters from the upstream end of the flow path)
- Downstream of the stockpile (1,170 meters from the upstream end of the flow path)

- At 1,200 meters from the upstream end of the flow path
- At 1,340 meters from the upstream end of the flow path
- At the downstream end of the flow path or the discharge location (2,120 meters from the upstream end of the flow path)

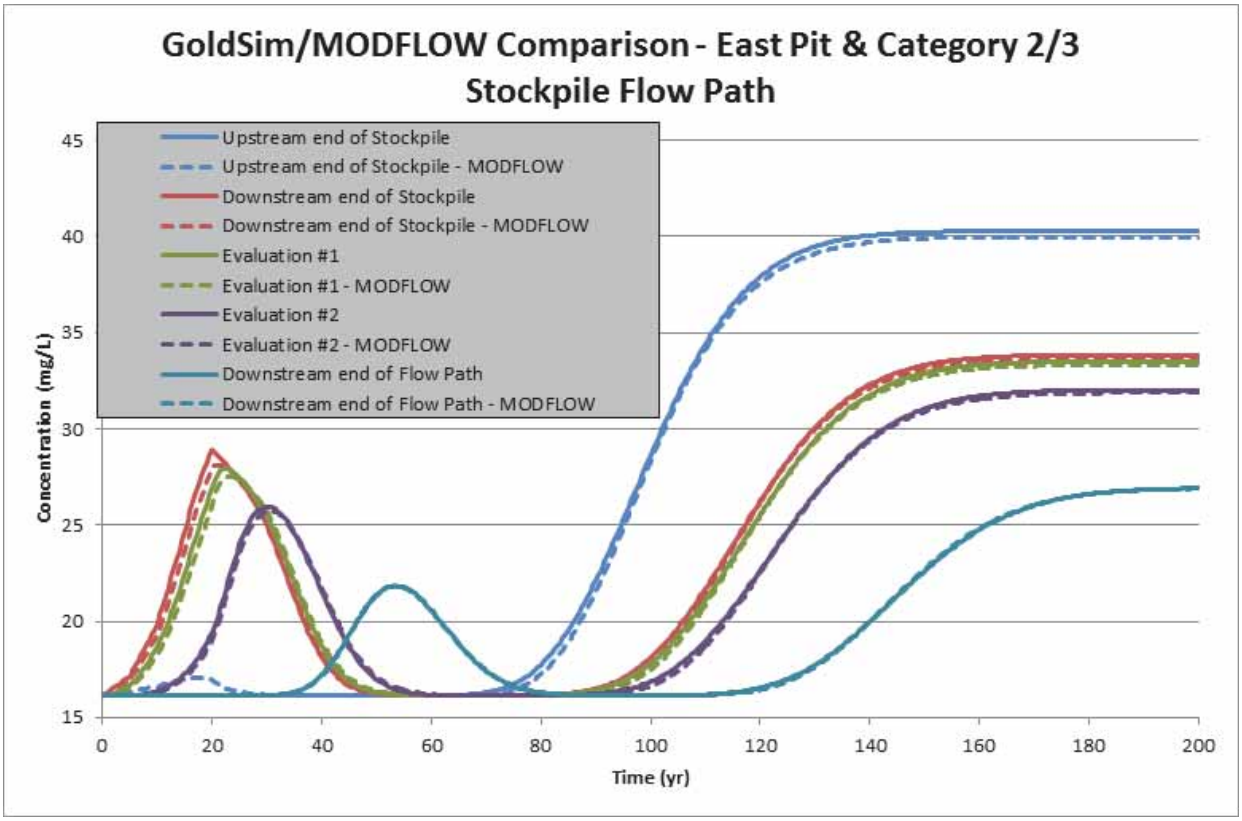
Comparison of Model Results

As an initial comparison, the long-term steady state mixed concentration of the pit outflow and the recharge to the flow path were checked at each evaluation location. Given the flow and concentration from each source to each evaluation location (i.e., always 31.8532 m^3/day from the pit and varying total recharge flow as a function of flow path length), the mixed concentration at each evaluation location in the long-term steady state should be (from upstream to downstream) 40.2 mg/L, 33.8 mg/L, 33.4 mg/L, 32.0 mg/L, and 26.9 mg/L. The results from the GoldSim and MODFLOW models match these long-term steady state results very well.

Figure 1 shows a comparison between the results from the MODFLOW/MT3D and GoldSim models at several evaluation points along the flow path. In general, there is very close agreement between the results produced by the two models. The GoldSim model tends to predict slightly higher concentrations than the MODFLOW/MT3D model. The MODFLOW/MT3D model produced a small concentration peak at the evaluation point located at the upstream end of the stockpile between years 0 and 20 that was not produced by the GoldSim model. This peak may be a result of error in the MODFLOW model associated with the numerical techniques used by MT3D to solve the transport equations. The third-order total-variation-diminishing (TVD) solver was used for the transport simulation, which acts to minimize (but may not completely eliminate) numerical dispersion and artificial oscillation. It is possible that using smaller cells in the MODFLOW/MT3D model would eliminate this peak. It is also possible that a small amount of "upstream" dispersion or diffusion could have occurred in the model. However, the diffusion coefficient was set to zero and, based on the cell-by-cell flow components from the model, there was no component of upstream flow in the cell at the upstream end of the stockpile (which should prevent any dispersion from occurring). Given the very close match between GoldSim and MODFLOW/MT3D at the

other evaluation points (including the evaluation points actually used in the GoldSim model), this peak was not evaluated further.

Figure 1 – Comparison of GoldSim and MODFLOW/MT3D Model Results



With recharge, upstream discharge, and downstream head specified, the head at the upstream end of the model can be calculated using the governing equations for groundwater flow. As an additional check, the calculated head at the upstream end of the model was compared to the head predicted by the MODFLOW model. The upstream head changes during the simulation, due to changes in the pit discharge to the flow path. Table 3 provides a comparison between the heads calculated using the governing equations and heads from MODFLOW.

Table 3 – Comparison Between Calculated Heads and MODFLOW Model Heads at Upstream End of Model

Time (year)	Calculated Head (m)	MODLFOW Head (m)
0 <= t < 20	13.7026	13.7234
20 <= t < 30	15.7280	15.7533
30 <= t <= 1000	18.8966	18.9217

Conclusions

A test case was run using the GoldSim contaminant transport module and the industry-standard finite-difference code MODFLOW/MT3D. The two models produced very similar results for concentrations versus time at various evaluation points and for heads at the upstream end of the model. This comparison indicates that GoldSim is accurately representing the transport processes being simulated by the model.

Verification of Mine Site QAPP Sections 2.4.2 – Stream Hydrology Technical Memorandum

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Technical Memorandum

To: Peter Hinck and Tina Pint
From: Greg Williams
Subject: Verification of Mine Site QAPP Sections 2.4.2 – Stream Hydrology
Date: March 5, 2013
Project: 23/69-0862.00-042-002

This memorandum compares output from the Partridge River XP-SWMM model to GoldSim model results to verify that the GoldSim model is accurately calculating Partridge River streamflow. This analysis is described in Section 2.4.2 of the NorthMet Project, Mine Site Water Quality Model Quality Assurance Project Plan (QAPP), version 2.

Stream Hydrology Model Inputs

Results from the XP-SWMM model are used in conjunction with USGS gage data to define flow distributions for each month of the year for each model evaluation location. The distributions of daily flow for each month at the most downstream location (SW-006, USGS gage 04015475) are presented in Table 5-13 of the NorthMet Project, Water Modeling Data Package Volume 1 – Mine Site. The distributions presented in Table 5-13 are based on the 1978-1988 USGS flow record adjusted to remove the discharge from the Peter Mitchell Pit. The relevant values from Table 5-13 are included in Table 1.

Table 1 – Distributions of Daily Flow at SW006 by Month (minimum, median, and maximum)

%tile	Daily flow by month (cfs)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Min	1.7	1.0	0.6	4.0	17.0	6.0	0.5	0.7	5.3	17.0	13.0	5.3
50%	8.0	2.0	6.6	168	172	74.9	46.3	37.0	61.9	62.2	37.4	14.0
Max	22.0	23.9	209	1940	874	566	866	480	367	760	459	86.5

Note: this table is a subset of Table 5-13 from the Water Modeling Data Package Volume 1 – Mine Site

It should be noted that the model input distributions in Table 5-13 and Table 1 represent a composite of distributions created using several methods to account for dewatering (see Section 4.4.1.2 of the Water Modeling Data Package Volume 1 – Mine Site), and are not directly developed from a single time-series of flow. Because these distributions are not directly developed from a single time-series of flow data, calculation and comparison of mean monthly and mean annual flows would represent a purely statistical exercise and is omitted from this analysis. Comparison of monthly and annual mean flows was referenced in Section 2.4.2 of the QAPP.

Stream Hydrology GoldSim Model Results

Streamflow at model evaluation location SW-006 was output from a 200 year, 10 realization GoldSim Mine Site model run representing the No Action condition, generating 2,000 values of monthly flow for each month. The resulting minimum, median, and maximum flows at SW-006 for each month are presented in Table 2, after subtracting the modeled inflow from the Peter Mitchell Pit (1 cfs).

Table 2 – GoldSim Model Results at SW-006 (less 1 cfs inflow from the Peter Mitchell Pit)

%tile	Daily flow by month (cfs)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Min	1.7	1.0	0.6	4.6	17.0	6.0	0.5	0.7	5.3	17.0	13.0	5.3
50%	8.0	2.0	6.8	164	175	74.7	45.7	43.6	64.3	65.0	37.7	14.3
Max	22.0	23.9	209	1915	872	565	866	480	367	754	452	86.2

Conclusion

Minimum, median, and maximum monthly flows returned from the GoldSim model (see Table 2) are similar to the input distributions developed from the USGS flow record (see Table 1). Minor differences occur due to the limited number of GoldSim model realizations evaluated. In all cases, the GoldSim model results are within the limits of the input distributions. Low flows, which generally correlate to higher constituent concentrations in GoldSim model (due to less dilution from natural sources), are accurately reflected in the GoldSim results.

QAPP Sections 2.4.3 and 2.4.4 Verification – Stockpile Water and Mass Balance
Technical Memorandum

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Technical Memorandum

To: Peter Hinck and Tina Pint
From: Josiah Hawley
Subject: QAPP Sections 2.4.3 and 2.4.4 Verification - Stockpile Water and Mass Balance
Date: 12/29/2014
Project: 23/69-0862.00

This memo summarizes the model results used to verify that the GoldSim model is accurately tracking mass and water flows from the Mine Site stockpiles according to the specifications given in sections 2.4.3 and 2.4.4 of the NorthMet Project, Mine Site Water Quality Model Quality Assurance Project Plan, version 2 (QAPP).

QAPP Section 2.4.3: Model Check – Stockpile Mass Balance

A 200 year, 500 realization GoldSim Mine Site simulation was performed to ensure that the constituent mass inflows, outflows, and stored mass in each of the stockpiles and mine pits are accounted for in the model. The stored mass and cumulative outflow mass were subtracted from the cumulative inflow mass at every monthly time step for each of the mine site features and the resulting values were rounded to the nearest kilogram. At no time step during the 200 year model run were any of the constituent mass flows of any of the stockpiles or mine pits out of balance by more than 0.5 kilograms (all values rounded to zero).

QAPP Section 2.4.4: Model Check – Stockpile Hydrology

A 50 year, 100 realization GoldSim Mine Site simulation was performed to ensure that the water inflows and outflows from each of the stockpiles are accounted for in the model. The outflows were subtracted from the inflows at every monthly time step for each of the stockpiles and the resulting difference was recorded. There is no stored water within the stockpiles in the modeled water balance. The largest and smallest balance values observed at any time step over the 50 year run are shown in Table 1. The time step balance values were also averaged over the lifespan of the stockpile and these average values are also given in Table 1.

In addition to these time step balances, the cumulative balance at the end of each of the realizations was also recorded to ensure that there was no net accumulation or loss of water from the stockpiles. The maximum, minimum and average cumulative values for the 100 realizations are shown below in Table 1.

Table 1 Incremental and cumulative water balance values for the Mine Site stockpiles.

	Incremental Balance after each Time Step			Cumulative Balance at the end of each Realization		
Stockpile	Maximum Value (gal)	Minimum Value (gal)	Average (gal)	Maximum (gal)	Minimum (gal)	Average (gal)
Category 1	0.07	-0.07	0.00	0.00	0.00	0.00
Category 2/3	0.01	-0.02	0.00	0.00	0.00	0.00
Category 4	0.00	0.00	0.00	0.00	0.00	0.00
OSLA	0.01	-0.01	0.00	0.00	0.00	0.00
OSP	0.00	0.00	0.00	0.00	0.00	0.00

Based on the values shown in Table 1 the model is correctly balancing the water inflows and outflows to and from the stockpiles. There are some slight imbalances at some of the time steps due to the probabilistic nature of the model as well as the time lag in the water infiltrating through the stockpiles, but the time step averages and cumulative balances are all zero.

Conclusion

Based on these results, the Mine Site GoldSim model does appear to be accurately tracking the flow of mass and water through the stockpiles in accordance with the specifications given in sections 2.4.3 and 2.4.4 of the NorthMet Project, Mine Site Water Quality Model Quality Assurace Project Plan, version 2 (QAPP).

Verification of NorthMet Project Model for the AMAX Piles Technical Memorandum

Technical Memorandum

To: Jim Scott, PolyMet
From: Peter Hinck, Barr, and Stephen Day, SRK
Subject: Verification of NorthMet Project Model for the AMAX Piles
Date: October 13, 2011
Project: 23690862-042-002
c: Mike Olson, MDNR

Executive Summary

This memorandum documents the verification of the modeling method proposed for the NorthMet Project (Project) by modeling the AMAX test piles and comparing modeled sulfate release to observed sulfate release in collected pile drainage.

For the AMAX piles during fully acidic periods (drainage pH < 5.5), the Project modeling method provides good estimates of the median annual observed sulfate release without any calibration (see acidic Drainage Condition in Summary Table). In all cases, the high end of the distribution of modeled sulfate release is well above the highest single-year observed sulfate release.

Summary Table – AMAX Modeled and Observed Sulfate Release

Pile	Avg S [%]	Drainage Condition	Observed Sulfate Release[1] [mol/yr] min	med	max	% assumed acid	Modeled Sulfate Release [mol/yr] P5	P50	P95
FL1	0.64	non-acidic	640	850	1200	35%	240	740	2500
FL2	0.64	non-acidic	220	460	950	10%	210	430	1000
FL3	0.64	non-acidic	510	1000	1600	50%	190	690	2800
FL3	0.64	acidic	1100	1200	1700	100%	200	1200	4300
FL4	0.64	non-acidic	360	590	880	5%	310	560	1100
FL4	0.64	acidic	740	1300	1500	100%	240	1400	6600
FL6	0.79	acidic	1200	2500	3900	100%	380	2200	9100
FL5	1.41	acidic	1100	1800	4200	100%	430	2300	6500

[1] From Lapakko et al. (2004), Tables A2.7.1 to A2.7.6

For the AMAX piles in transition to full acidification (drainage pH > 5.5), the model has been adjusted by assuming that a reasonable fraction of each pile had reached acidic conditions. This assumption is justified because it is consistent with the known mineralogy of the piles, the drainage from all piles became fully acidic by the end of the study period, and it is reasonable to assume that all rock in the piles does not reach this condition at the same time due to the variability of sulfur content of the piles. For the piles in transition to becoming acidic, the Project modeling method provides good estimates of the median annual observed sulfate release (see non-acidic Drainage Condition in Summary Table). In all cases, the high end of the distribution of modeled sulfate release is above the highest single-year observed sulfate release.

The Project modeling method has also been used to calculate the bulk scaling factor for each of the AMAX piles by dividing the modeled sulfate release in collected pile drainage by the non-acidic sulfate release in humidity cells. These values are consistent with bulk scaling factors calculated by MDNR for the AMAX piles, and also to those calculated for the Dunka stockpiles. The proposed modeling method generates bulk scaling factors in (or above) the MDNR calculated range when the effects of stockpile acidification are considered.

The work discussed above shows that (1) the proposed modeling method provides reasonable estimates of the observed field sulfate release from the AMAX piles, and (2) the modeled scale factors are consistent with the scaling effects observed by MDNR, thus verifying the modeling method.

Introduction

Recent discussions regarding the use of scaling factors in the geochemical modeling proposed for the NorthMet Project (Project) have revealed a difference in professional opinion between the PolyMet/SRK/Barr team and the Minnesota Department of Natural Resources, Division of Lands & Minerals (MDNR). PolyMet has agreed to use the recently updated comparisons between laboratory sulfate release rates and release rates observed at the Dunka stockpiles and AMAX test piles (MDNR 2011a and MDNR 2011b) to verify and, if necessary, adjust the modeling method for the Project.

The proposed modeling method is used to estimate the sulfate release from the AMAX test piles. The goal of this exercise is to show that the proposed modeling method provides reasonable estimates of the observed sulfate release (in collected pile drainage) thus verifying the modeling method.

The AMAX piles are the best choice for this exercise because the (1) humidity cells (used as the lab portion of MDNR's lab-to-field bulk scaling factor calculation and to define the sulfate release rate in the proposed modeling method) are the same rock that is in the AMAX piles, (2) the contents of the piles are well known and (3) all of the drainage from the piles was collected and analyzed. The Dunka stockpiles are not the best choice for this exercise because the (1) there are no humidity cells with the same rock that is in the Dunka stockpiles, (2) the geological and geochemical contents of the stockpiles are not well known and (3) the seeps collected and analyzed to represent stockpile sulfate release may contain water not coming from the stockpile and are not all of the drainage coming from the stockpile.

Once the model method is verified a range of bulk scaling factors for the AMAX piles will be calculated using the model and compared to the range of observed AMAX pile and Dunka stockpile bulk scaling factors.

The AMAX field study was performed between 1978 and 1993, and data were summarized in a comprehensive report in 2004 (Lapakko et al. 2004). Laboratory tests on Duluth Complex rock from the AMAX site were summarized in a MDNR report in 2006 (Lapakko and Antonson 2006), and additional laboratory data were provided via email on September 27, 2011 (email from Mike Olson, MDNR).

Review of Proposed Method

For clarity in discussion, a flowchart of the proposed modeling process is shown in Figure 1. Note that the usage of "scaling factor" is different between the SRK/Barr team and MDNR. In the proposed method for the NorthMet Project "composite scaling factor" (S_C) refers to the scaling of non-acidic sulfate release rates from the laboratory to the field scale ($S_C = R_{Field,non\text{-}acidic} / R_{Lab,non\text{-}acidic}$). Additional adjustments to account for acidic conditions or the effect of solubility limits (a.k.a. concentration caps) are applied in further modeling steps. The "bulk scaling factor" (S_B) calculated by MDNR, in contrast, is based on actual field data that necessarily includes all of these effects together ($S_B = L_{Actual} / (M * R_{Lab,non\text{-}acidic})$). The difference between these two usages of the term "scaling factor" has significantly added to the confusion over this aspect of the proposed modeling methodology.

Variable Definition

- $R_{Lab,non\text{-}acidic}$ – non-acidic SO_4 release rate from humidity cell data [mg/kg/week]
- k_T – temperature correction (if applicable)
- k_C – water contact correction
- k_S – particle size correction
- S_C – composite scaling factor (field/lab non-acidic release)
- $R_{Field,non\text{-}acidic}$ – non-acidic SO_4 release rate under field conditions [mg/kg/week]
- AF – acidic increase in SO_4 release, relative to non-acidic conditions (if applicable)
- $R_{Field,acidic}$ – acidic SO_4 release rate under field conditions [mg/kg/week]
- M – waste rock mass [kg]
- I – infiltration [L/yr]
- $C_{potential}$ – potential SO_4 concentration in infiltrating water [mg/L]
- C_{limit} – SO_4 solubility limit [mg/L]
- L_{actual} – resultant SO_4 load leaving the system [mg/yr or mol/yr]
- S_B – bulk scaling factor (field/lab total leaching)

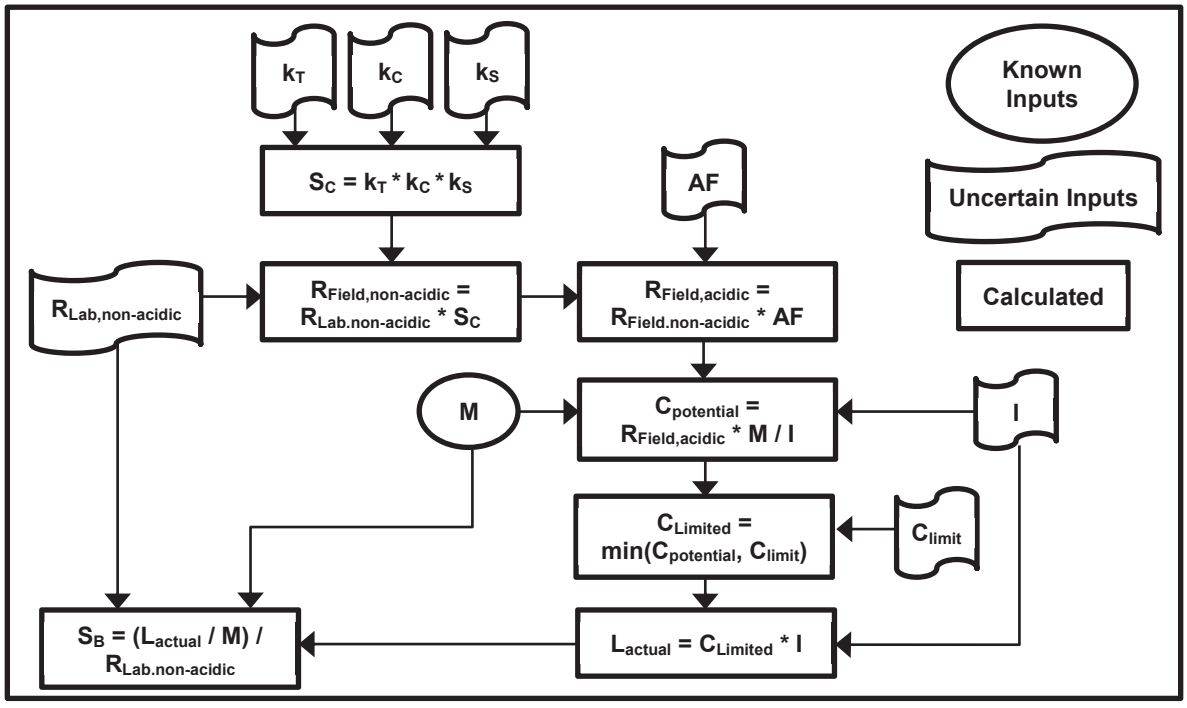

Figure 1 – NorthMet Project Proposed Modeling Method Flowchart

Modeling of the AMAX Piles

In general, the modeling of the AMAX piles discussed here is performed according to the proposed method defined in the NorthMet Waste Characterization Data Package (WCDP, PolyMet 2011). Section and figure references are to the most recently-submitted Version 5. All adjustments to the proposed method for application to the AMAX piles are identified.

The AMAX piles are modeled using a small Monte Carlo simulation model constructed with the GoldSim software, run for 1,000 realizations. The model is designed as a steady-state representation of the long-term sulfate release and leaching characteristics of the piles. As such, annual or intra-annual fluctuations in sulfate release due to precipitation variation are not represented in the model; the model output should therefore be compared to the typical long-term behavior of the piles (median or mean annual release as measured from collected pile drainage).

The AMAX model also does not attempt to capture the progression of a rock pile from an initial non-acidic state to a long-term acidic state. This is a departure from the modeling proposed in the WCDP, which simulates changing stockpile conditions through time. The general progression of a stockpile from an initial non-acidic state to a final fully acidic state is conceptually shown in Figure 2. For this exercise the AMAX piles have been divided into "acidic" and "non-acidic" based on the median drainage pH reported in each field season, using pH = 5.5 as the division. Several of the piles (FL3 and FL4) had significant periods of non-acidic conditions before becoming acidic, and two separate models are constructed to represent each time period.

The modeling of each variable shown in Figure 1 is discussed in the sections below.

AMAX Pile Characteristics

Physical and geochemical characteristics of the AMAX piles are taken from Table 1 of Lapakko et al. (2004). Time periods used for modeling acidic and non-acidic conditions are based on the median pH values from Tables 15-20. The relevant characteristics for this exercise are shown in Table 1.

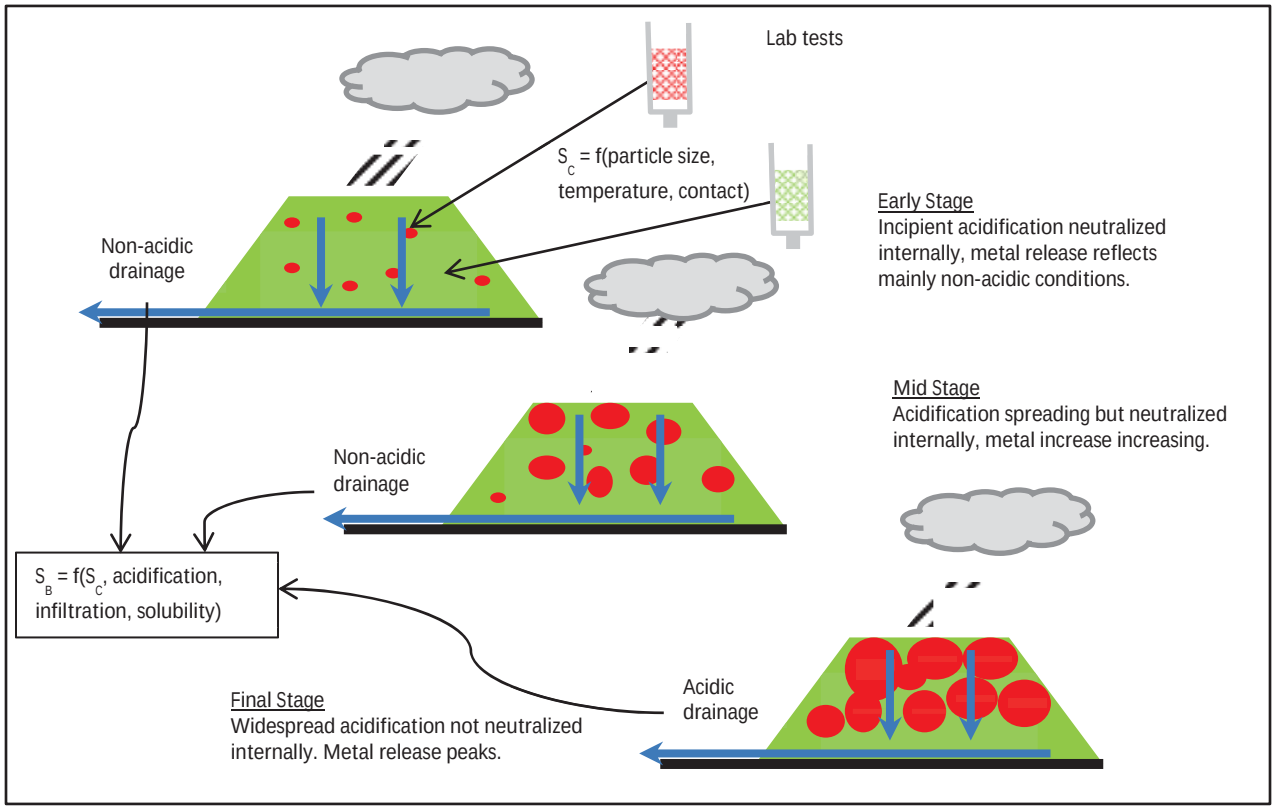

Figure 2 – Acidic Progression in Stockpiled Waste Rock (red = acidic rock; green = non-acidic rock)

Table 1 – AMAX Pile Characteristics (from Lapakko et al. 2004)

	FL1	FL2	FL3	FL4	FL6	FL5
Avg. S (%)	0.64	0.64	0.64	0.64	0.79	1.41
Mass (tonnes)	1100	1100	830	1700[1]	1300	815
Plan area (m^2)	290	340	300	330	320	340
Cover material	none	topsoil	coarse sand	none	none	sandy till over coarse sand
Non-acidic drainage period	1978-1990	1978-1987	1978-1983	1978-1982	1978-1979[2]	--
Acidic drainage period	1991-1993[2]	1988-1993[2]	1984-1989	1984-1989	1980-1993	1978-1993

[1] Approximately 40% of FL4 was removed in 1983. The reduced mass is assumed to be 1020 tonnes for 1984-1989, with no change in the plan area.
[2] Time periods not modeled in this analysis.

Non-acidic Laboratory Release Rate

Similar to the modeling proposed in the WCDP (see Section 8.1.1), humidity cell data are used to develop a relationship between non-acidic sulfate release and sulfur content. The data for this relationship are taken from MDNR data for weeks 6-52 of the Babbitt prospect test work (understood to be samples from the same source as the AMAX piles). During this period, all but two of the MDNR humidity cells had pH greater than 6.5. The highest-sulfur humidity cells (Cell 15, 1.03 %S and Cell 16, 1.36%S) had initial pH of greater than 7.0, with a rapid decline to 5.0 by approximately week 40. These cells are not included in the regression analysis, which includes data for test cells with sulfur content from 0.13% to 0.72%. The regression relationship developed here is assumed to apply to sulfur contents outside of this range (maximum AMAX pile S is 1.41%).

The linear regression (method of least squares) for the remaining humidity cells is shown in Figure 3. The intercept of the best-fit line is not significantly different from zero, so a zero-intercept model is used. The slope of the best-fit line is 14.48 [mg/kg/week/%S], with a standard error of 1.94 [mg/kg/week/%S]. These values define the uncertainty in the sulfate-sulfur relationship to be used in the probabilistic model (normal distribution assumed). For comparison, the average slope value derived from the more-extensive NorthMet humidity cell dataset is 13.92 [mg/kg/week/%S] with a standard error of 0.581 [mg/kg/week/%S] (see WCDP Figure 8-6).

The sulfur content of each of the AMAX piles is assumed to be known from Table 1. It should be noted that there was significant variability in the sulfur content of samples from the rock used to construct the AMAX piles (see Table 5 in Lapakko et al. 2004). For this exercise, each pile is assumed to be at the stated average sulfur content.

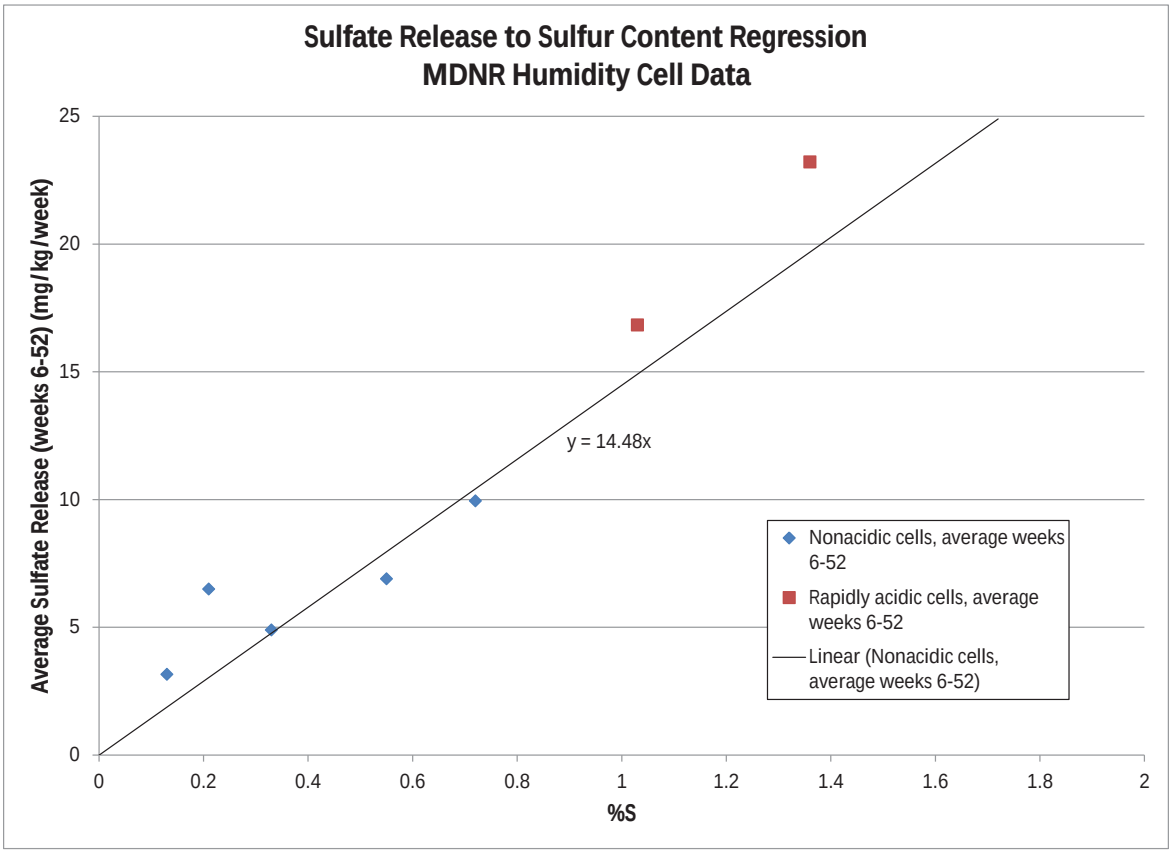

Figure 3 – Humidity Cell Sulfate Release Regression

Temperature Correction

The modeling method proposed for the Category 2/3/4 Duluth Complex rock in the Project assumes that the Category 2/3 and Category 4 Waste Rock Stockpiles (sulfur > 0.12%) are heated to laboratory temperature (20°C) by the sulfide oxidation reactions. In this case the temperature correction factor is 1. This is a conservative assumption because if the stockpiles do not heat up, the temperature correction factor would be less than 1 resulting in lower sulfate release from the stockpile.

For the AMAX piles, in contrast, it is the consensus of MDNR and SRK staff that the test piles are likely too small to retain significant heat in excess of ambient temperatures. The temperature correction method proposed for the low-sulfur Category 1 waste rock in the Project is therefore used for the AMAX model. The simulated temperature factor ranges from 0.15 to 0.35, as shown in Figure 4 (reproduction of WCDP Figure 8-13).

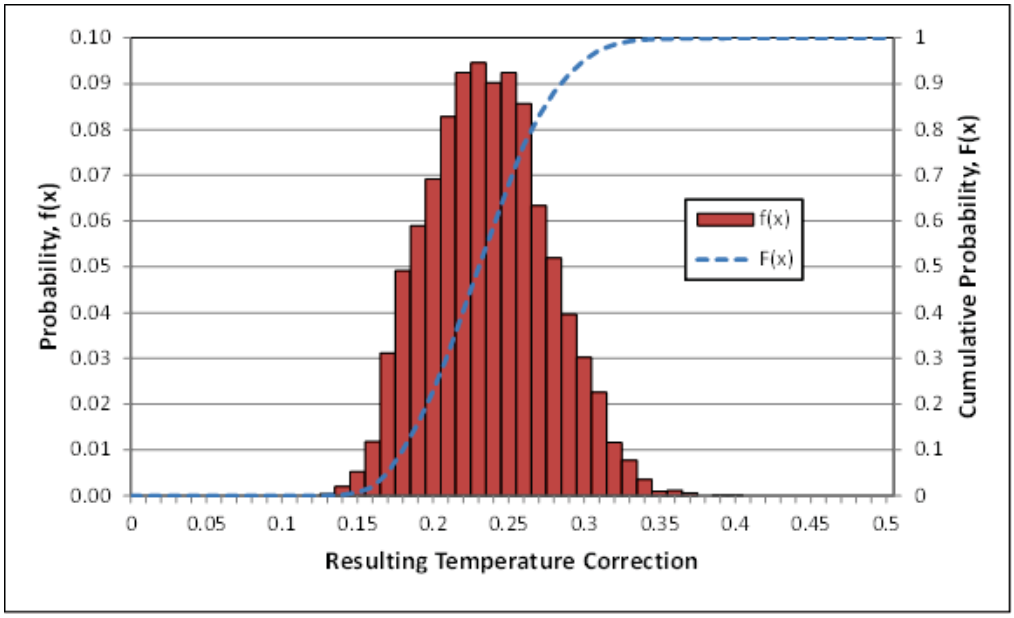

Figure 4 – Simulated Temperature Factor Distribution

Water Contact Correction

For the Project, the proposed distribution for the water contact factor ranges from 0.1 to 0.9, with the most likely value at 0.5 (triangular distribution, see WCDP Figure 8-9). Due to the small size of the AMAX piles relative to a full-scale waste rock stockpile, it is assumed that a greater fraction of the waste rock "sees" water. This is because the relatively short flow path from the top to the bottom of the piles provides little possibility for preferential flow paths to develop. The water contact factor used here ranges from 0.5 to 0.9, with the most likely value at 0.7 (triangular distribution).

A quantification of the difference in the Project stockpiles and the AMAX test piles that drive water contact correction is the ratio of stockpile volume to stockpile area (proportional to the rock to water ratio) which is the average height of the stockpile. For the Project stockpile this ratio is 30, 27, and 17 [m] for the full Category 1, Category 2/3 and Category 4 Waste Rock Stockpiles respectively and for the AMAX piles it ranges from 1.2 to 2.8 [m].

Particle Size Correction

For the Project, the proposed distribution for the particle size factor is based on a comparison of the NorthMet humidity cell particle size distribution to an assumed distribution for the blasted NorthMet waste rock. The resulting range is approximately between 0.08 and 0.28.

For the AMAX piles, particle size information exists from numerous bulk samples collected during the study (Table 24 of Lapakko et al. 2004). Assuming the particle break into cubes on average, the samples have a surface area to mass ratio of between 1.0 and 2.4 [m^2/kg]. For the MDNR humidity cells, particle size information is presented in the MDNR report (Table 2 of Lapakko and Antonson 2006), and yields a range of between 4.4 and 6.4 [m^2/kg]. The ratio between these two datasets (field/lab) defines the particle size scaling factor. The distribution used here ranges from 0.2 to 0.45, with the most likely value at 0.325 (triangular distribution). The difference between this distribution and that for the Project is primarily due to the difference in the humidity cell particle size distributions.

Acidic Increase Factor

For the Project, the increase in sulfate release relative to non-acidic conditions is modeled with an acidic factor (see WCDP Section 8.2) to reflect the expected increase in sulfide oxidation and sulfate release with acidic conditions. This factor accounts for the fact that the humidity cell release rates used in this calculation represent non-acidic conditions. For the AMAX piles the acidic increase factor is applied in the same manner as for the Project, using the distribution shown in Figure 5 (reproduction of WCDP Figure 8-8). This distribution is based on both MDNR long-term reactor data and NorthMet humidity cell data. The acidic increase factor is only applied to AMAX piles (or portions of piles) that are considered to be acidic.

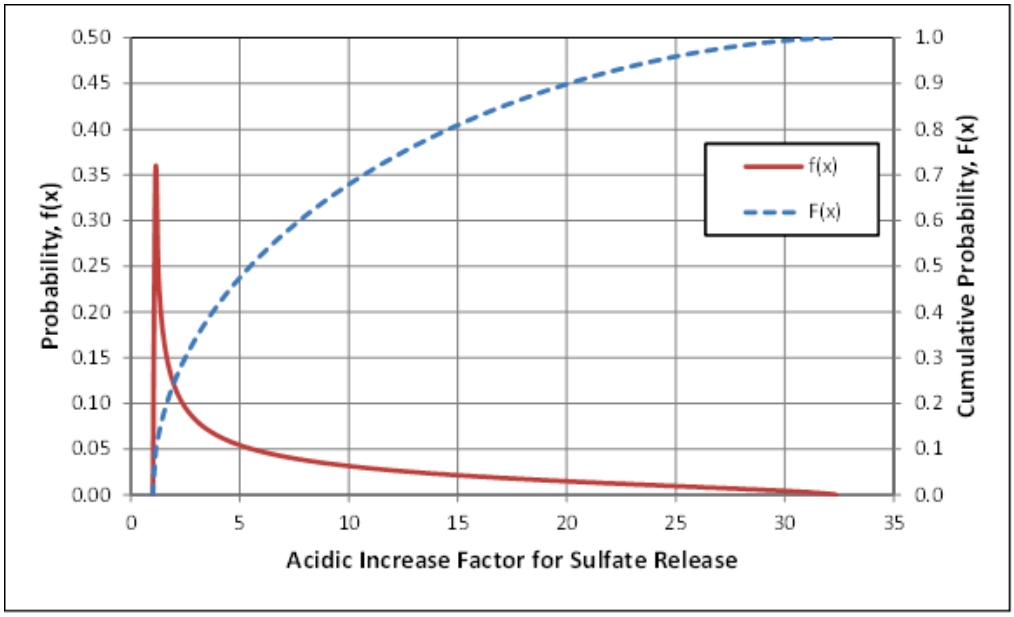

Figure 5 – Distribution for the Increase in Sulfate Release with Acidity

Stockpile Infiltration

Average infiltration for each AMAX pile is a function of the cover type and the pile footprint area. The method used to model infiltration for this exercise is identical to those proposed for bare and covered stockpiles for the Project (see PolyMet 2011b, Section 6.1.1). In order to be consistent with the Project modeling method, the actual flow data reported in Lapakko et al. (2004) are not used. The area of each pile is assumed to be known from Table 1.

Because the modeling presented here is concerned with the typical (median or mean) long-term behavior of the AMAX piles, year-to-year fluctuations in infiltration are not represented in the model. As shown in Figure 1, the infiltration quantity only becomes important in the model if the potential concentration exceeds the defined solubility limit. If the solubility limit is not reached, the model will calculate the same resultant sulfate loading leaving the system regardless of the quantity of infiltration (the contact factor is assumed to be independent of the infiltration through the pile).

Solubility Limit

The distribution for the acidic solubility limit for sulfate used in the AMAX model is identical to that proposed for the Project (see WCDP Section 8.4.3). This distribution was developed from leachate water quality data from the Whistle Mine analog site, and ranges from 3,300 [mg/L] to 18,100 [mg/L].

The method for calculating the non-acidic solubility limit for sulfate in the Project is dependent on the metal release characteristics of the particular waste rock stockpile. For the purposes of this modeling, a distribution ranging from 1,900 [mg/L] to 6,000 [mg/L] is used in place of the detailed method, which corresponds to the distribution resulting from the Project modeling method for Duluth Complex Category 4 waste rock (average sulfur content 0.95%).

It will be apparent from the results of this modeling that the solubility limits as defined are almost never reached during the simulation, indicating that the distributions used for this parameter and the pile infiltration do not significantly influence the results. This is not surprising given the relatively small rock to water ratio for these piles.

Results and Discussion

Observed and calculated sulfate loading from each test pile during the modeled time period is shown in Figure 9 through Figure 16 at the end of this document. The results for the AMAX piles are presented in order of decreasing sulfur content (FL5, FL6, FL4, FL3, FL2, FL1).

Acidic Piles

The model evaluates acidic conditions for AMAX piles FL5 (Figure 9) and FL6 (Figure 10) throughout the majority of the period of record, and FL4 (Figure 11) and FL3 (Figure 13) for the last five years of the study. In each of the result figures, the blue line shows the distribution of observed sulfate loading as reported in Lapakko et al. (2004), Tables A2.7.1-A2.7.6 [mol/yr]. Based on communication with MDNR staff, it is assumed for this analysis that the field season loading as reported by the MDNR represents the entire annual sulfate loading from each pile (i.e. zero flow during the winter). The red line in each figure shows the distribution of modeled sulfate loading, using the method described above (including the increase in sulfate release with acidic conditions).

In all cases, the modeled range of sulfate loading captures the observed loading and extends well above the observed range. The median (50th percentile) observed annual load plots between the 40th and 54th

percentile of the calculated annual load. Given that the objective of this analysis is to model "typical" loading conditions, the model of acidic conditions is successful without any adjustment. The very high modeled sulfate loading at the higher percentiles is driven primarily by the uncertainty in the acidic increase factor (see Figure 5). The median value for this factor is approximately 6, but the high end of the distribution extends to above 30. It is these high values that drive the high end of the modeled sulfate loading.

As discussed above, there is very little influence in the model of the defined solubility limit or infiltration parameters. As shown in Figure 6, the distributions for the potential and limited sulfate concentrations for pile FL6 are nearly identical. This is the typical case for the majority of the piles modeled, most piles have even less variation (only FL5 shows any significant effect of solubility limits). The assumed solubility limits, therefore, are not significant drivers of the observed sulfate loading or the bulk scaling factors, and will not be discussed further.

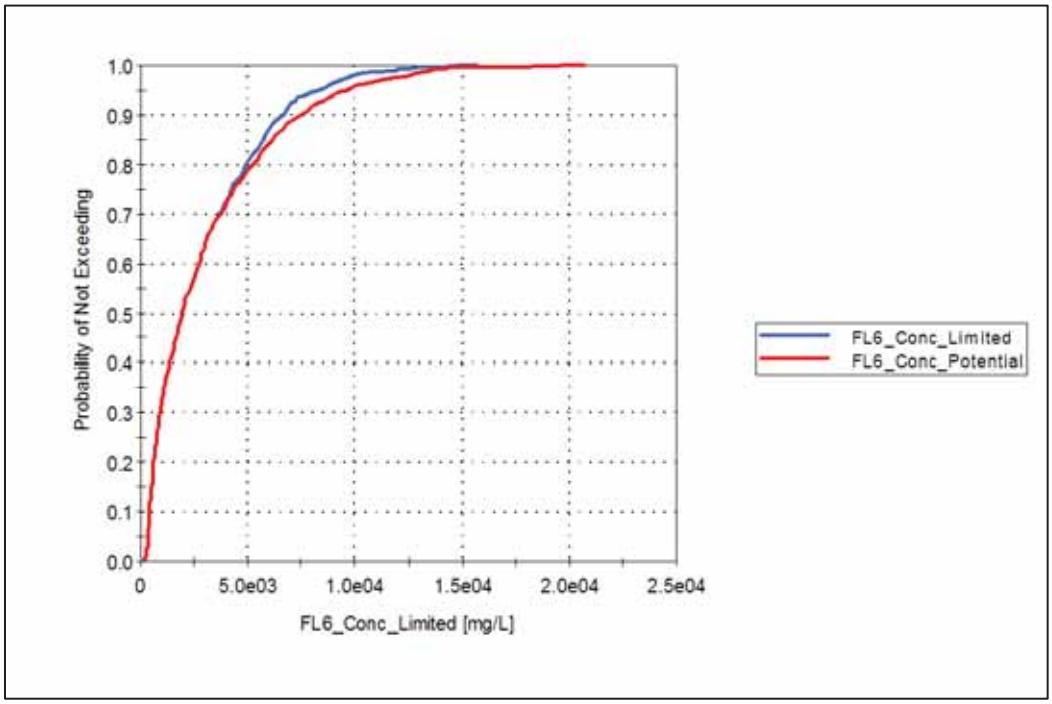

Figure 6 – Example Comparison between Limited and Potential Sulfate Concentrations

Non-acidic Piles

The model evaluates non-acidic conditions for AMAX piles FL1 (Figure 16) and FL2 (Figure 15) throughout the majority of the period of record, and FL3 (Figure 14) and FL4 (Figure 12) for the first four to five years of the study. In each of the result figures, the blue line shows the distribution of observed sulfate loading as reported in Lapakko et al. (2004), Tables A2.7.1-A2.7.6 [mol/yr]. Similar to the acidic piles, it is assumed for this analysis that the field season loading as reported by the MDNR represents the entire annual sulfate loading from each pile (i.e. zero flow during the winter).

The red line in each figure shows the distribution of calculated sulfate loading, using the method described above and assuming that the pile was fully non-acidic. It is clear from the figures that this method does not fit the observed sulfate loading as well as for the acidic conditions, especially for piles FL3 and FL1. In order to adjust the model to be closer to the observed data, a portion of each pile is assumed to be acidic and the pile is re-modeled, using the same method but including the increase in sulfate release due to acidity for the acidic portion of the pile. The results of this analysis are shown as the green line in each figure. A satisfactory visual fit to the observed data is obtained with the following assumptions: FL1 is 35% acidic, FL2 is 10% acidic, FL3 is 50% acidic, and FL4 is 5% acidic on average. While there is no observed data to support these specific percentages, SRK/Barr believes that they are reasonable given known variability of the sulfur in the piles and the fact that all piles eventually produced acidic drainage.

The assumption that parts of the pile are oxidizing under acidic conditions while overall drainage is non-acidic is supported by the range of sulfur content in the rock being tested. The increasing metal concentrations under non-acidic conditions also imply that accelerated metal release is occurring ahead of complete acidification. See Figure 2 for a conceptual explanation of the process of acidification within the rock pile.

The proposed modeling method for the Project accounts for partial acidification in the Category 2/3/4 Waste Rock Stockpiles by tracking when rock is placed in the stockpiles and triggering acidic conditions 5-8 years after placement for Category 2/3 and immediately for Virginia Formation Category 4 (see WCDP Section 8.2). This has the effect of increasing the percentage of the stockpile that is acidic over time as rock placed in various years becomes acidic. The Category 1 Waste Rock Stockpile is not assumed to generate acid.

AMAX Modeling Summary

The proposed modeling method has been used to model the sulfate release from the AMAX test piles and compare that to the observed sulfate release. Table 2 compares the modeled and observed sulfate loading leaving the piles in drainage.

Table 2 – AMAX Modeled and Observed Sulfate Release

Pile	Avg S [%]	Drainage Condition	Figure	Observed Sulfate Release[1] [mol/yr] min	med	max	% assumed acid	Modeled Sulfate Release [mol/yr] P5	P50	P95
FL1	0.64	non-acidic	15	640	850	1200	35%	240	740	2500
FL2	0.64	non-acidic	14	220	460	950	10%	210	430	1000
FL3	0.64	non-acidic	13	510	1000	1600	50%	190	690	2800
FL3	0.64	acidic	12	1100	1200	1700	100%	200	1200	4300
FL4	0.64	non-acidic	11	360	590	880	5%	310	560	1100
FL4	0.64	acidic	10	740	1300	1500	100%	240	1400	6600
FL6	0.79	acidic	9	1200	2500	3900	100%	380	2200	9100
FL5	1.41	acidic	8	1100	1800	4200	100%	430	2300	6500

[1] From Lapakko et al. (2004), Tables A2.7.1-6

This verifies the proposed modeling method by reasonably estimating the observed sulfate releases from the AMAX piles, especially for the median condition. In all cases the high end of the modeled sulfate release rate (95th percentile of the simulation) is larger than the maximum observed release rate, often significantly larger.

Comparison of Bulk Scale Factors

The proposed modeling method can also be used to calculate the a probability distribution of the bulk scaling factor for the modeled AMAX piles, which can then be compared to the observed range of bulk scaling factors for the AMAX piles and Dunka stockpiles.

The modeled S_B distributions (MDNR definition) for the acidic piles are shown in Figure 7. The median value of S_B for all of the acidic piles is approximately 0.27. The modeled S_B distributions (MDNR definition) for the partially-acidic piles are shown in Figure 8. The median values range from 0.07 for FL4 (5% acidic) to 0.16 for FL3 (50% acidic).

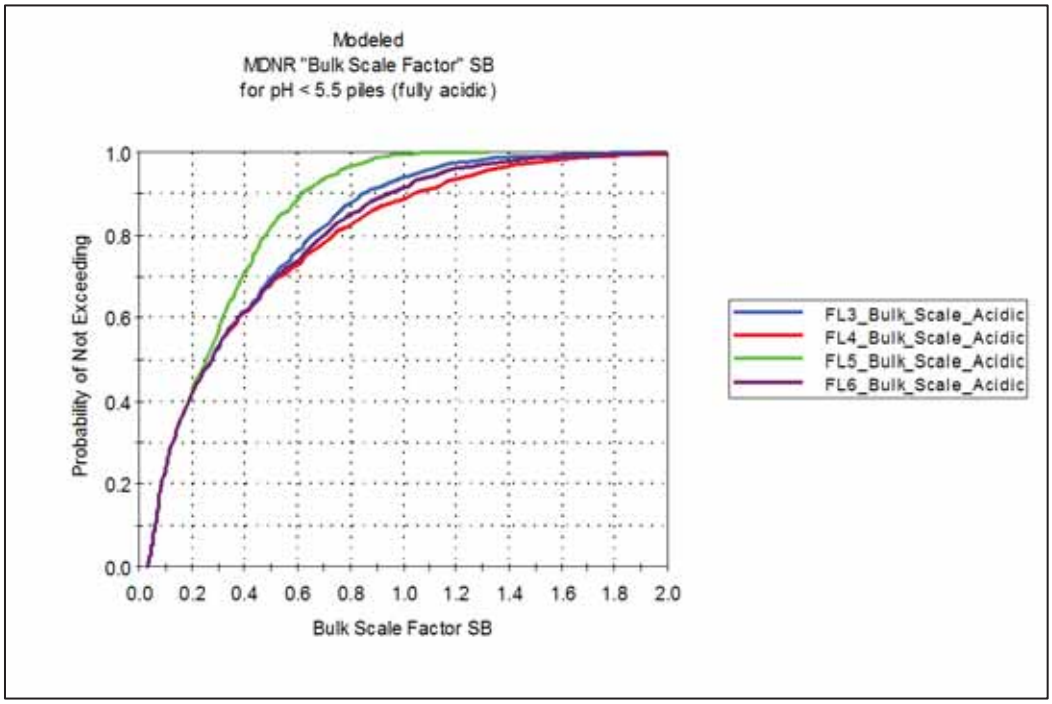

Figure 7 – Modeled S_B Distributions (MDNR Definition) for the Acidic AMAX Piles

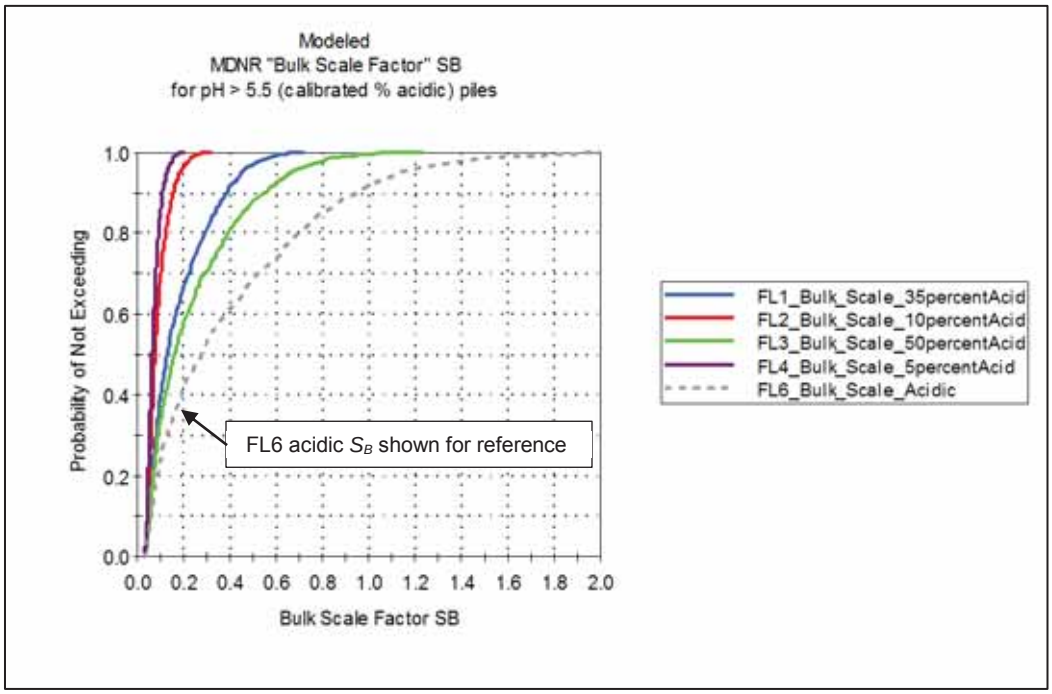

Figure 8 – Modeled S_B Distributions (MDNR Definition) for the Non-acidic AMAX Piles

The MDNR analysis of S_B (presented in MDNR 2011a and updated in MDNR 2011b) for the AMAX and Dunka test sites shows an absolute range from 0.02 to 0.61. For the ratio between the average annual field release and the early humidity cell release, equivalent to the analysis performed here, the range is from 0.05 to 0.35 with an average value of 0.14 for the Dunka site and 0.20 for the AMAX site (MDNR analysis expanded to all AMAX piles). The MDNR analysis (MDNR 2011b) also includes ratios to additional humidity cell time periods that result in slightly higher values of S_B; this larger range is shown in Table 3.

The proposed modeling method generates bulk scaling factors in (or above) the observed range when the effects of stockpile acidification are considered. Including the effects of acidification in this analysis is justified because the drainage from all piles became fully acidic by the end of the study period and it is reasonable to assume that all rock in the piles does not reach this condition at the same time.

Table 3 – AMAX Modeled and Observed Bulk Scale Factors (S_B)

Modeled Case	**P5**	**P50**	**P95**
Modeled AMAX – acidic drainage	0.05	0.27	0.75 - 1.0
Modeled AMAX – partially acidic drainage	0.05	0.07 – 0.16	0.13 – 0.67
Observed Ratio for Average Annual Loading	**Min**	**Mean**	**Max**
Observed – AMAX FL1 and FL6[1]	0.19	0.31	0.45
Observed – AMAX (all combined)[2]	0.11	0.24	0.45
Observed – Dunka (all combined)[1]	0.05	0.19	0.37

[1] MDNR analysis in MDNR (2011b) for "Field Data (ave)" case, including early, average, and late humidity cell release
[2] MDNR analysis methods extended to all AMAX piles for "Field Data (ave)" case, including acidic and partially-acidic periods

References

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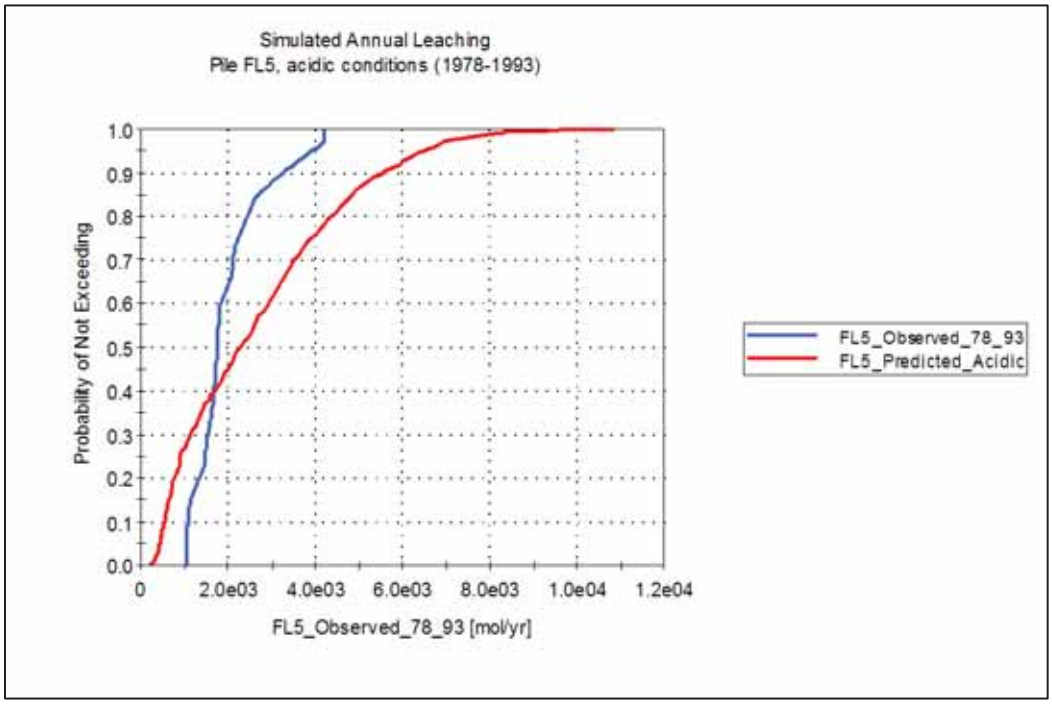

Figure 9 – Model Results for AMAX pile FL5 (1.41%S)

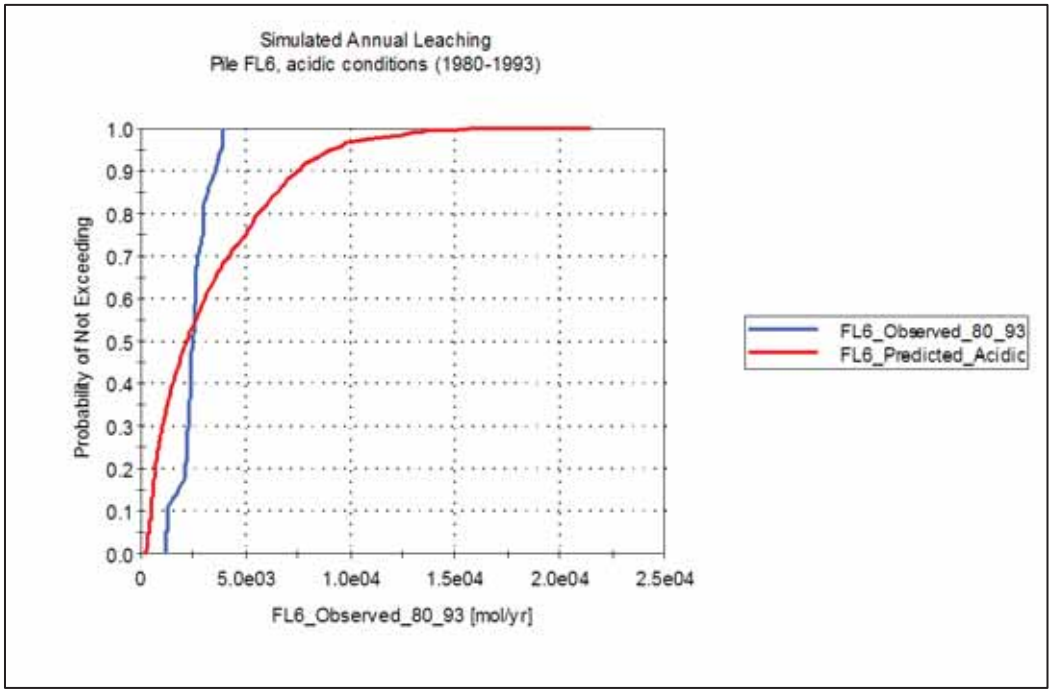

Figure 10 – Model Results for AMAX Pile FL6 (0.79%S)

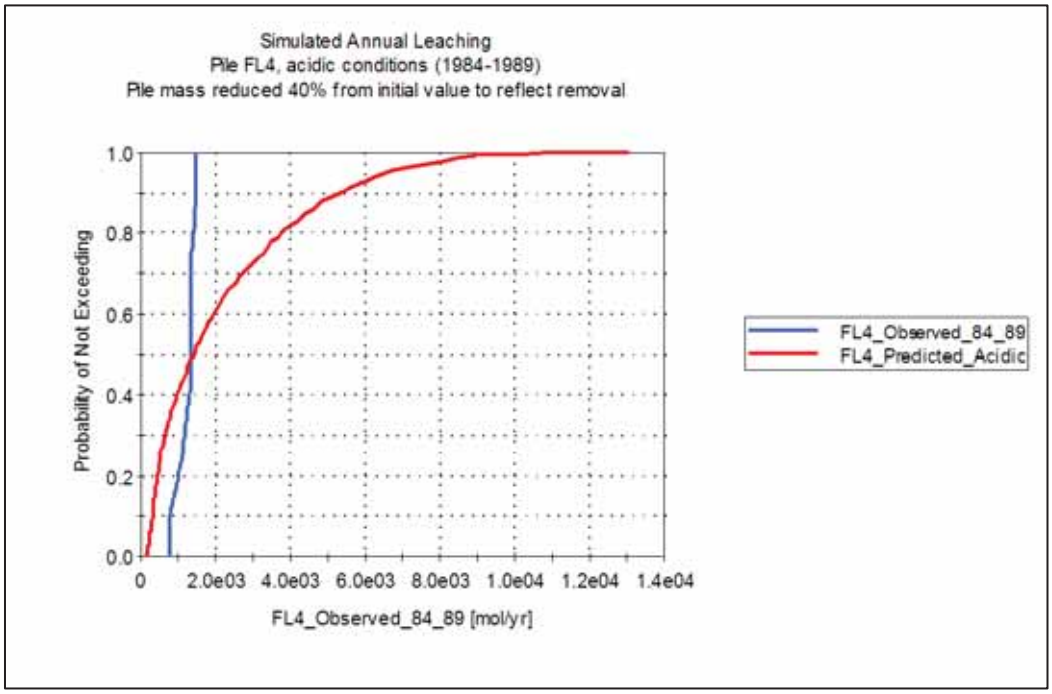

Figure 11 – Model Results for AMAX Pile FL4 (0.64%S), acidic conditions

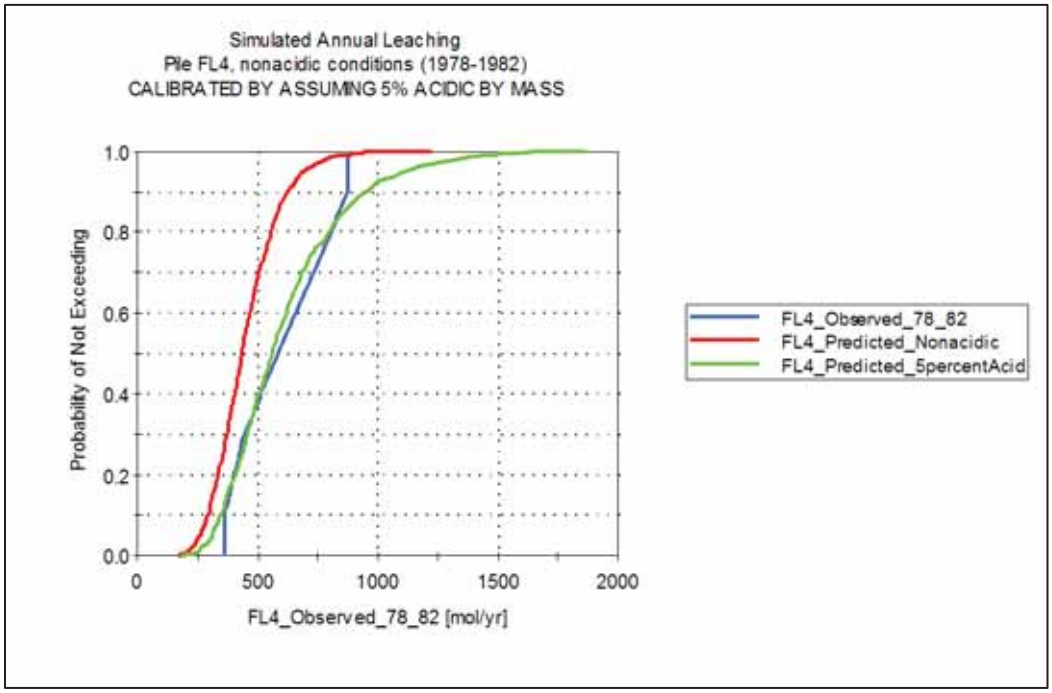

Figure 12 – Model Results for AMAX Pile FL4 (0.64%S), non-acidic conditions

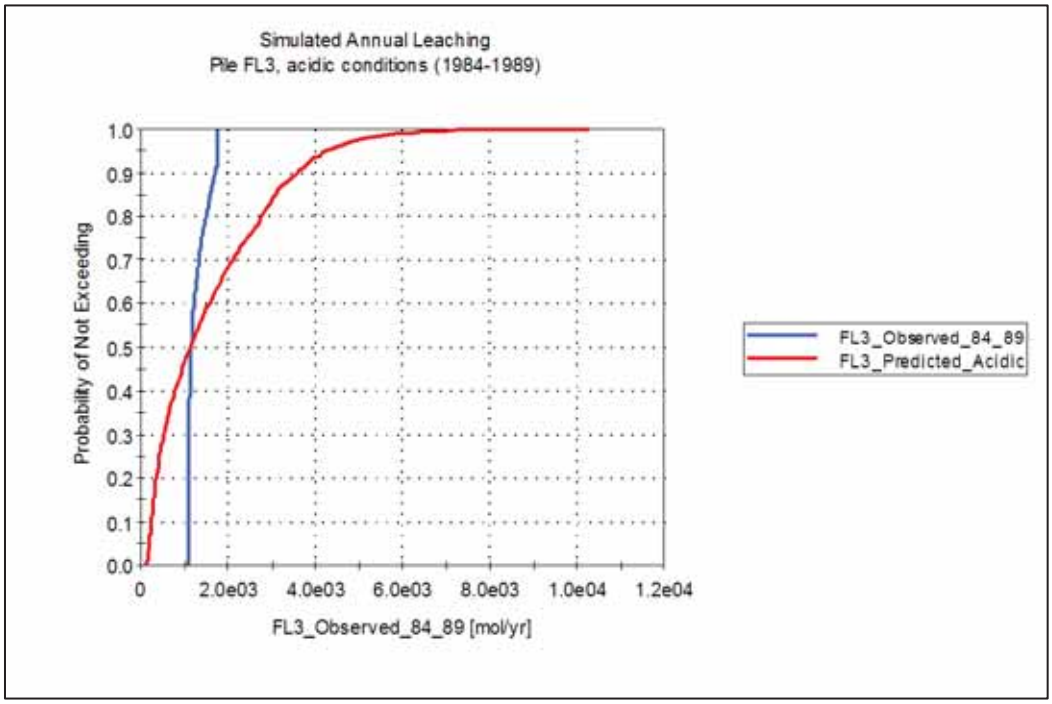

Figure 13 -- Model Results for AMAX Pile FL3 (0.64%S), acidic conditions

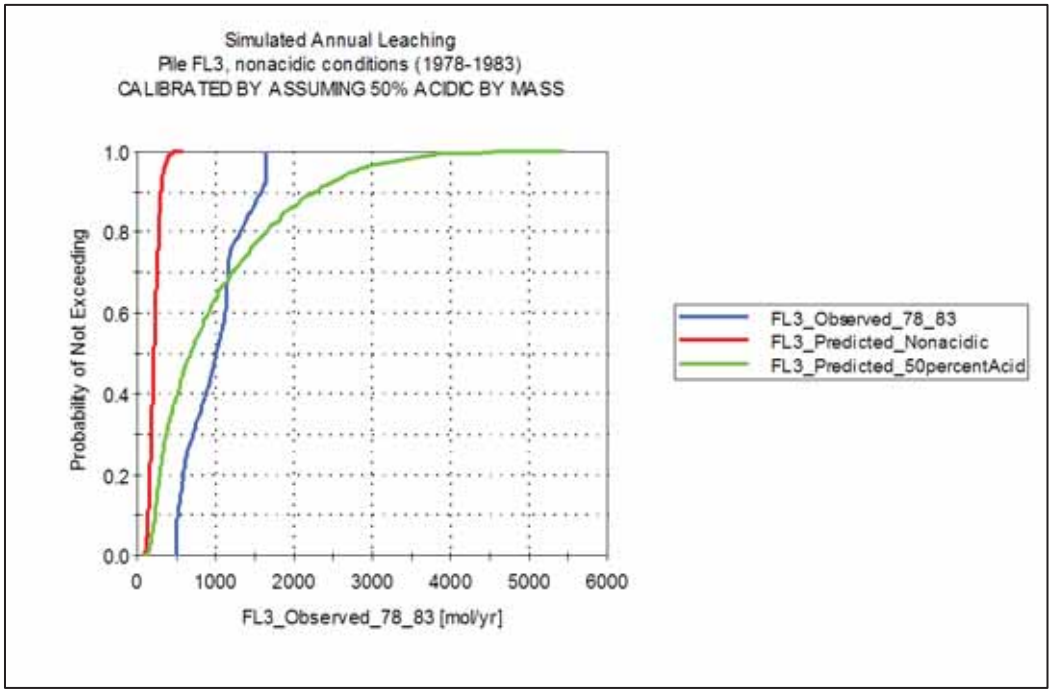

Figure 14 -- Model Results for AMAX Pile FL3 (0.64%S), non-acidic conditions

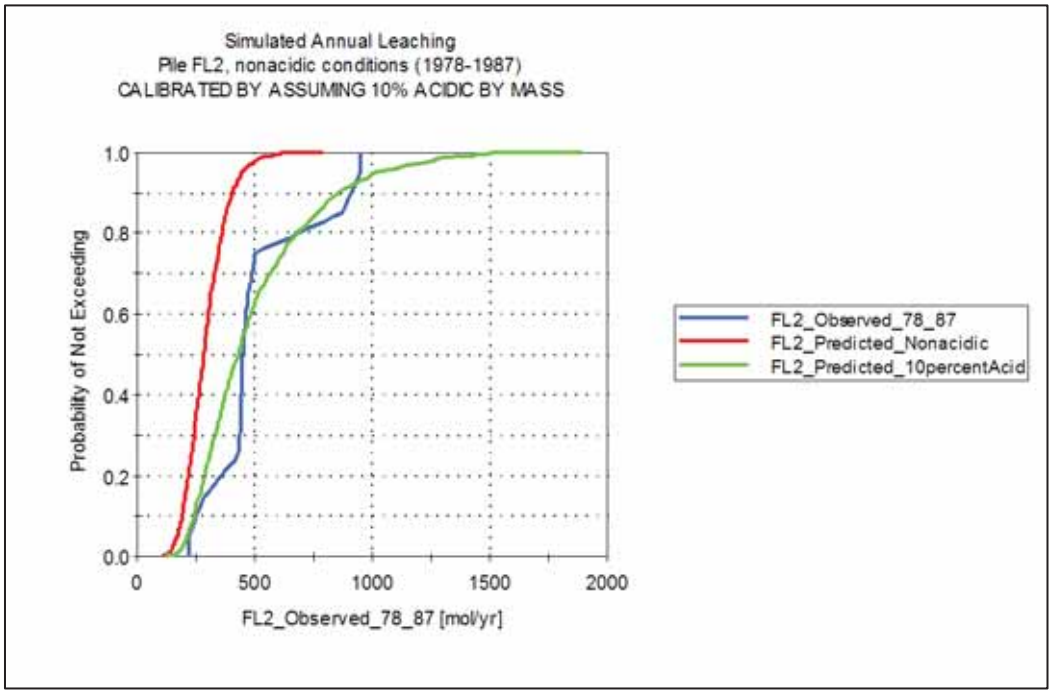

Figure 15 -- Model Results for AMAX Pile FL2 (0.64%S), non-acidic conditions

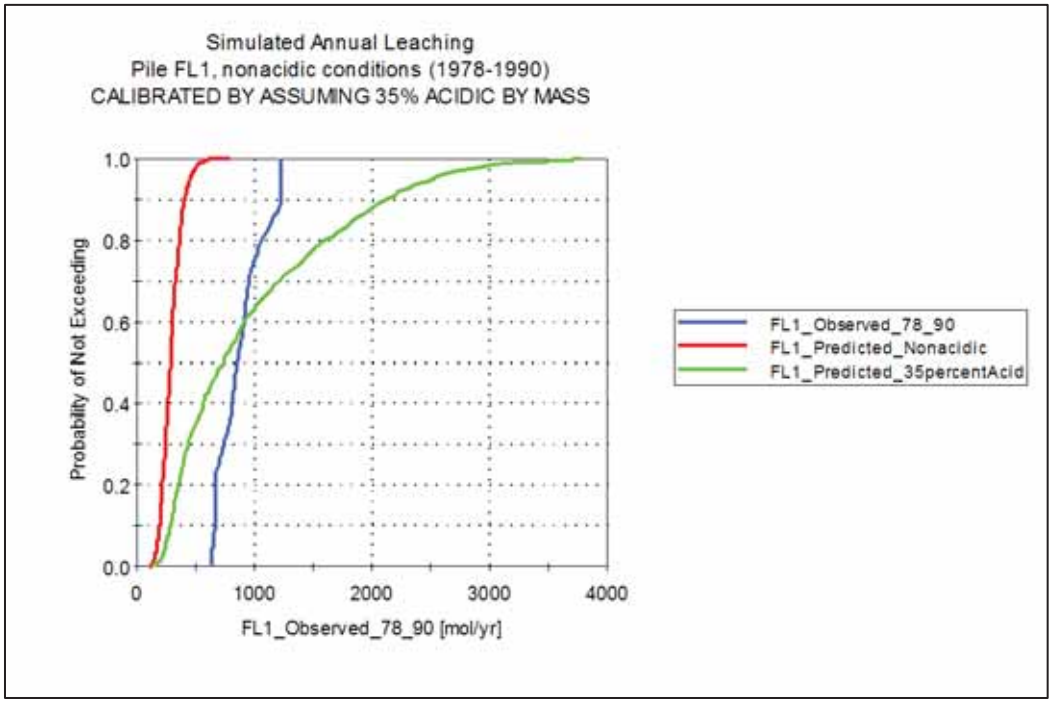

Figure 16 -- Model Results for AMAX Pile FL1 (0.64%S), non-acidic conditions