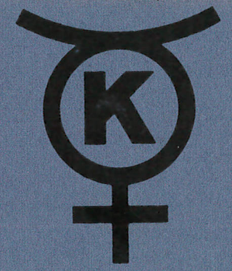
MINING PERMIT APPLICATION FOR MINING THE FLAMBEAU COPPER DEPOSIT RUSK COUNTY, WISCONSIN



Prepared by
Flambeau Mining Corporation
Ladysmith, Wisconsin
September 1976

MINING PERMIT APPLICATION

Submitted by

FLAMBEAU MINING CORPORATION

Ladysmith, Wisconsin

September 14, 1976

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WDNR PROPOSED CODE NR131.04(1)-(7)(9)-(13)

SECTION 1

1.1.0 NOTICE OF INTENT TO SUBMIT A MINING PERMIT APPLICATION FOR NEW OPERATION

Pursuant to the requirements of Wisconsin Statute 144.85 and the Wisconsin Department of Natural Resources (WDNR) proposed Code NR131.04 (1)-(7), (9)-(11), the following Notice of Intent to submit a mining permit application for new operation is submitted for WDNR approval by Flambeau Mining Corporation (FMC).

1.1.1 DESCRIPTION OF PROPOSED PROJECT

FMC, a wholly owned subsidiary of Kennecott Copper Corporation (KCC), proposes to establish an open pit copper mine one mile southwest of Ladysmith in Rusk County, Wisconsin. The copper sulfide ore would be concentrated at the project site and transported out of Wisconsin for smelting.

1.1.2 LAYOUT OF PROPOSED FACILITIES

See Exhibit A

1.1.3 PLANT CONSTRUCTION SCHEDULE

Construction on this project cannot commence until notification by the WDNR, other state and local bodies, and the Corps of Engineers that the necessary mining plans and permits have been approved and the KCC Board of Directors authorizes the expenditure of funds. The process plant and facilities construction period is expected to last 18 to 24 months after the beginning of mine prestripping (see Exhibit B for construction sequence).

1.1.4 ESTIMATED PROJECT COST

The total estimated cost of this project is approximately $27 million.

1.1.5 DESCRIPTION OF PROCESS

Ore from the mine would be upgraded in a concentrator plant located immediately adjacent to the mine. Because concentrate production from the mine would be much too small by itself to support a conventional smelter, the metal-bearing concentrates will be shipped by rail out of the state for smelting and refining. Processing of the mine ore entails crushing, grinding, flotation and dewatering. Briefly, the concentrating process is as follows (additional information is provided in Section 2):

1. Crushing: Ore from the mine is crushed to minus 3/4-inch size by a jaw crusher and a cone crusher working in series. This process will normally occur on one shift per day, seven days per week.

2. Grinding: The crushed ore is reduced to pulp by grinding in a rod mill and a ball mill working in series. This process will be operated three shifts per day, seven days per week.

3. Flotation: By aeration and the addition of chemical reagents, the copper sulfide mineral grains are physically separated from the ore pulp in a froth. The copper sulfide-rich froth, containing roughly 25% copper and a minor amount of precious metals, is continually removed from the top of the flotation cells and, when dewatered, is termed "concentrate" - the end product of the FMC operation. The remaining impoverished pulp, or tailing, is pumped from the cells to a prepared site for disposal as a waste product. This process will be operated three shifts per day, seven days per week.

4. Dewatering: The concentrate is dewatered by settling in a thickener tank and finally by vacuum filtering. This excess water along with tailings water from the waste containment area will be recycled with concentrator process makeup water coming primarily from mine drainage and at times possibly from wells.

5. Drying: After dewatering, the concentrate will be further dried in a rotary kiln for final shipment. Dryer temperatures will be less than 1600°F so that sulfur dioxide will not be produced.

1.1.6 PROCESS EQUIPMENT

It is the policy of KCC to procure all plant equipment on a competitive bid basis. Procurement specifications for equipment are presently being generated for this purpose. Bids, however, cannot be obtained until the necessary mining plans and permits are secured and funds are authorized by the KCC Board of Directors. Therefore, at this time it is impossible to designate the manufacturer of the many pieces of equipment which will be required for process purposes.

1.1.7 ANTICIPATED PRODUCTION RATE

Ore:	1,000 tpd removed from open pit
Wasterock:	4,120 tpd removed from open pit
Copper concentrate produced:	160 tpd (average)
Tailings:	840 dry tpd
Composition:	50% to 70% quartz, mica and clays, and 30% to 50% iron sulfide (iron pyrite)
Copper recovery from ore:	86% to 89% depending on ore type and grade

1.1.8 OPERATING SCHEDULE

Open pit mine:	5 days/week, 8 hours/day (normally)
Concentrator: Crushing	7 days/week, 8 hours/day (normally)
Concentrator: Grinding, Flotation, Dewatering, Drying	7 days/week, 24 hours/day (normally)
Truck shop:	5 days/week, 8 hours/day (normally)
Administrative offices:	5 days/week, 8 hours/day (normally)

1.1.9 LEGAL DESCRIPTION OF FLAMBEAU MINING CORPORATION PROPERTY (Figure 1)

Government Lot Seven (7) of Section Three (3); mineral rights only in Government Lot Two (2) of Section Four (4); all of Section Nine (9) excepting the NE¼NE¼, excepting Government Lots One (1) and Two (2), and excepting surface rights only on a two (2) acre tract in the NE corner of NW¼NE¼; all of Section Ten (10) lying east of State Highway 27 excepting three (3) tracts of land described as:

1. NE¼NE¼

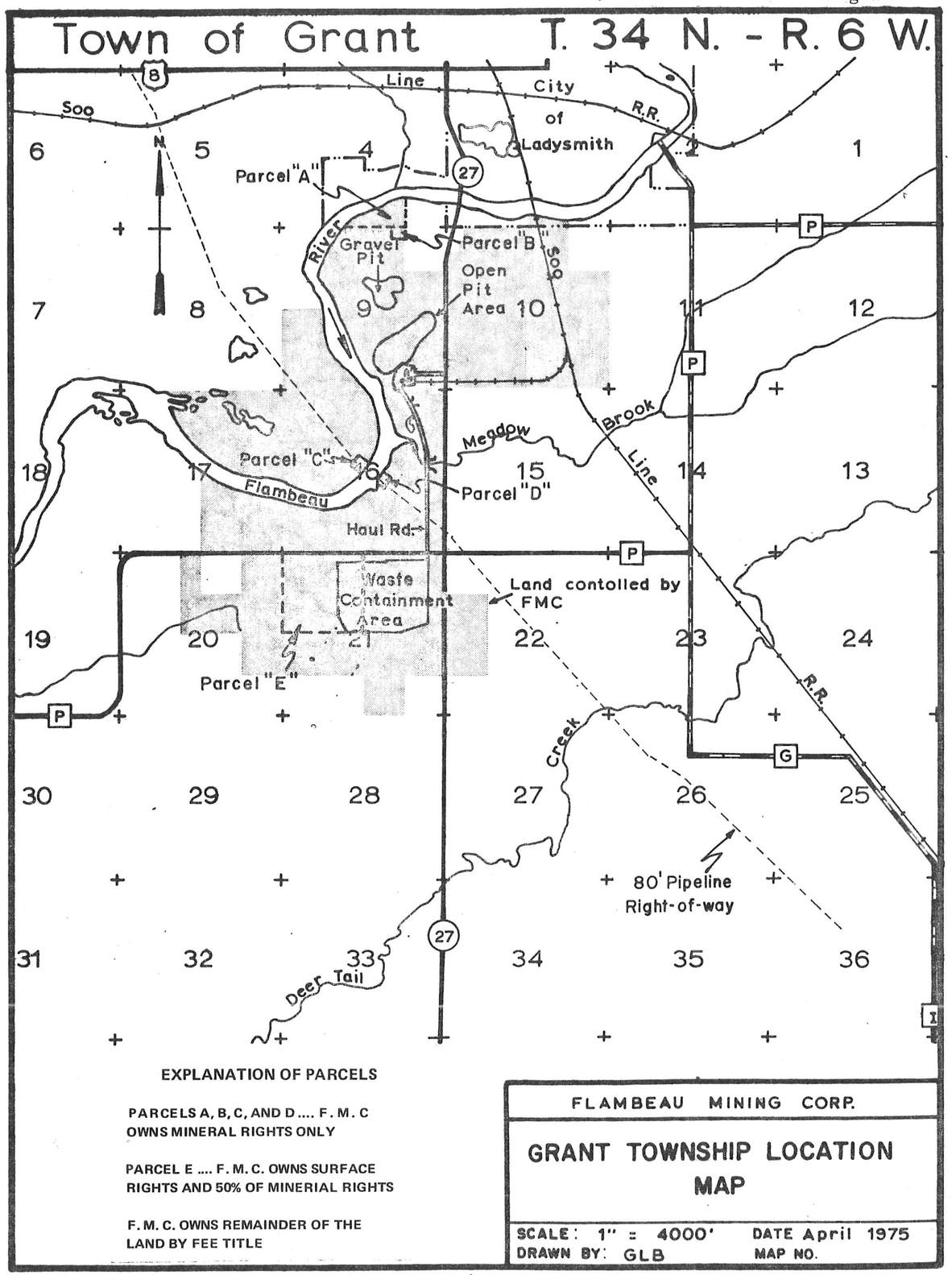
2. Commencing at the intersection of the South right-of-way line of Gokey Road with the East right-of-way line of State Highway 27, thence Southerly along said East right-of-way line, 175 feet, to the point of beginning of the land to be herein described; thence Southerly along the East line of highway 208.7 feet, thence Easterly at right angles, 208.7 feet, thence Northerly at right angles and parallel to said East right-of-way line, 208.7 feet; thence Westerly at right angles, 208.7 feet to the point of beginning; and

3. Commencing at the intersection of the South right-of-way line of Gokey Road with the East right-of-way line of State Highway 27; thence Southerly along said East right-of-way line 175 feet, thence Easterly at right angles, 150 feet, thence Northerly at right angles and parallel to said East right-of-way line, 215 feet to the South line of Town Road, thence Westerly along Town Road 156 feet, to the point of beginning;

all of Section Sixteen (16); the E½ and Government Lots Six (6) and Seven (7) of Section Seventeen (17); theE½E½NW¼, the NE¼SE¼, and the NE¼ excepting the NW¼NE¼ of Section Twenty (20); the N½, the N½S½, and the SW¼SE¼ of Section Twenty-one (21); and the SW¼NW¼ and the NW¼SW¼ of Section Twenty-two (22);

all in Township Thirty-four (34) North, Range Six (6) West, subject to State, County and Town rights-of-way, small tracts owned by Lakehead Pipe Line Company in Section Sixteen (16) and their easement in Sections Nine (9) and Sixteen (16), railroad right-of-way in Sections Three (3) and Ten (10), and reservation of 50% of the mineral rights by Cornell University in the NW¼ of Section Twenty-one (21).

Figure 1



1.2.0 SOILS

Soils (in the pedologic sense*) in the project area are predominantly silt loams derived from thin local loess overlying acidic sand and gravel outwash and stony sandy loam reddish-brown glacial till. These soils are productive of small grain and hay crops commonly planted on dairy farms of the area.

Natural drainage ranges from good over outwash where the water table is below four feet, to poor where the water table rises seasonally above the soil surface on both till and outwash plains. Some soils derived from outwash have a sandy loam surface texture, rather than silt loam. Also present are bodies of wet alluvial soils, mucks and peats.

1.2.1 PROJECT SITE - NORTHERN END

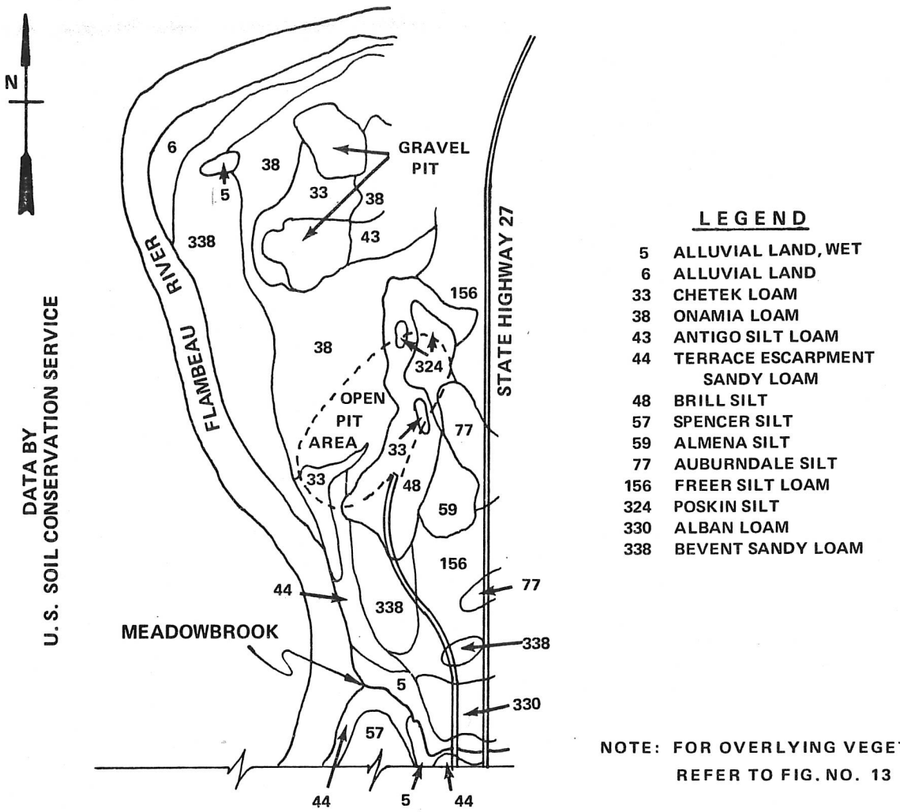
The U. S. Soil Conservation Service has mapped soils to a depth of five feet over the northern end of the project site (Figure 2). The Onamia (#38) soil is a well drained loamy soil over sand and gravel outwash. The Brill series (#48) is a moderately well drained silty soil underlain by sand and gravel at 20 to 40 inches. At the southwestern end of the proposed pit are Chetek (#33) series soils. These are loamy soils on a small set of stream terraces. The major soil series over the northeast end of the proposed pit is Poskin (#324). This soil type is a somewhat poorly drained silt over acidic sand and gravel.

Soils have been tested to a greater depth in the proposed plant area to determine their suitability for construction. These deeper soils consist of an upper layer of silty sand to eight or more inches below the surface and are underlain by cleaner gravelly fine to coarse-grained sands. Clay deposits were found beneath the sands approximately 20 to 35 feet below the surface. The clays are quite firm, with low water contents and unconfined strengths in excess of 4.5 tsf (tons per square foot). Below the clay is a dense silty and clayey sand or silty sand with varying amounts of gravel to either the sandstone or bedrock.

Soils along the proposed haul road route are primarily the Freer (#156) and Alban (#330) series. Although no particular problems would be expected with the Alban series, the Freer soils are poorly drained with a water table at less than three feet. This soil is highly susceptible to frost action.

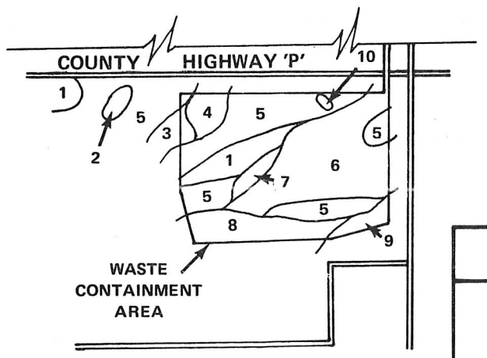
*Soil in the pedologic or green plant productivity sense extends to the depth of four to five feet, the depth of rooting of common perennial plants. Elsewhere in section, use of the word soil with respect to material below a depth of five feet is in the geologic sense, i.e., of unconsolidated geologic material below the common rooting zone of perennial plants.

Figure 2



	LEGEND
5	ALLUVIAL LAND, WET
6	ALLUVIAL LAND
33	CHETEK LOAM
38	ONAMIA LOAM
43	ANTIGO SILT LOAM
44	TERRACE ESCARPMENT SANDY LOAM
48	BRILL SILT
57	SPENCER SILT
59	ALMENA SILT
77	AUBURNDALE SILT
156	FREER SILT LOAM
324	POSKIN SILT
330	ALBAN LOAM
338	BEVENT SANDY LOAM

NOTE: FOR OVERLYING VEGETATION REFER TO FIG. NO. 13



1	CLAYEY SILT OVER SILT
2	SILTY SAND
3	CLAYEY SILT OVER SILTY SAND OR SILT
4	SILT OVER CLAYEY SILT
5	SILT OVER SILTY SAND
6	SILTY CALY OVER SILT OR SILTY SAND
7	SILT OVER CLEAN SAND
8	SILT OVER SILT CLAY OR CLAYEY SAND
9	SILTY CLAY OVER CLAYEY SAND
10	ORGANIC CLAY

FLAMBEAU MINING CORP.

SOIL SURVEY

SCALE: NO SCALE DATE: June 8, 1976
DRAWN BY: N.L.B. MAP NO.:

In general, the soils in the waste containment area consist of two associations: Almena-Auburndale and Peat. Almena-Auburndale association occupies a broad, nearly level to gently undulating glacial till plain. The Almena soils are somewhat poorly drained silt loam found on low broad interstream ridges. Auburndale soils are poorly drained and found at the foot slopes of the Almena. These silt loams have a well developed but thin silt-rich cap. Because of the above average silt content and the topographical position of the Auburndale soil in broad depressional areas, perched water tables or surface water areas are commonly found.

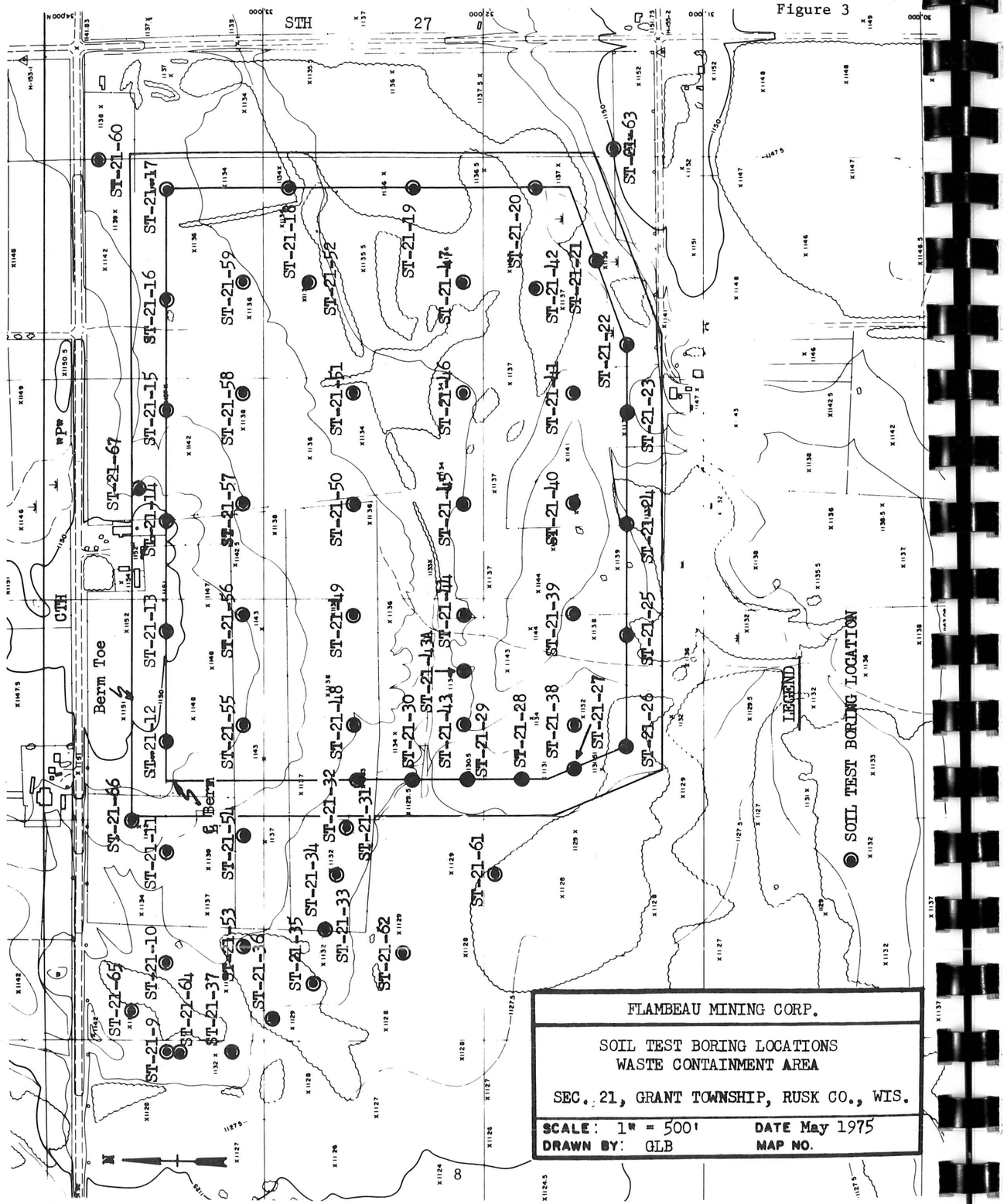
1.2.2 PROJECT SITE - WASTE CONTAINMENT AREA

Extensive soil testing has been conducted by Soil Testing Services of Wisconsin, Inc. of Green Bay in the proposed waste containment area (Figure 3). The borings generally revealed at least 3.5 to 4 feet of tight silts or clayey silts (Auburndale), however, two interior borings, ST21-44 and ST21-45, had 2.5 and 2 feet respectively.

The soil profile in this area is characterized by a mantle of a silt, clayey silt, or fine sandy silt that underlies the topsoil. The depth of this layer varied from about 3 to 4.5 feet, although there were several areas where the layer was slightly thicker to about 5 feet. This was at ST21-15 where an organic clay was found to 10 feet and in ST21-52 and ST21-59 where the very fine sandy silts or silts extended to depths of about 8 to 12 feet. A soils map showing a general distribution of the soils in the upper 6 feet is shown on Figure 2.

The silts were generally softer in the upper 2 feet as indicated by the higher water contents in excess of 20%. The samples from 2 to 4 feet were firmer as indicated by lower water contents and a higher dry density. In most of the borings, these finer grained soils were underlain by fine-to-medium or fine-to-coarse sands with varying amounts of silt and gravel. Generally the amount of silt as indicated on the grain-size analysis curves exceeded 20%. This deposit was considered a dense glacial till that extended to the end of the borings. In a few of the borings, the soil actually graded into a silty and sandy clay or clayey sand till, but was still in a dense condition. These soils extended to the end of the borings at either 15 or 30 feet. In general, the glacial till deposits were quite dense in nature. The exception to this was ST21-18 where silty very fine sands in a medium dense condition were found to the end of this boring at 17 feet. This condition extended to ST21-19, but access to this boring could not be gained and therefore it was advanced only to 10 feet by hand augers. However, the sandy silts were found underlying the silty and clayey sands in ST21-63 which was advanced by a truck-mounted drill rig.

Figure 3



FLAMBEAU MINING CORP.

SOIL TEST BORING LOCATIONS
WASTE CONTAINMENT AREA

SEC. 21, GRANT TOWNSHIP, RUSK CO., WIS.

SCALE: 1" = 500' DATE May 1975
DRAWN BY: GLB MAP NO.

Within these silty sand till deposits were found sands with considerably less silt (less than 10%) and therefore would greatly affect the permeability. Such a sand deposit was found in an occasional boring, but was continuously found starting at boring ST21-36, proceeding to the north to ST21-9, and then to the east to ST21-14. These sands consisted of a fine-to-medium sand with varying amounts of gravel and only traces of silt. This condition was confirmed in additional borings ST21-65 and ST21-66, but in ST21-67 a clean sand deposit was not encountered.

Zones of this cleaner sand were found at about the 4 to 9 or 12-foot level from ST21-44 to ST21-50 and on to ST21-58. However, borings adjacent to this zone did not encounter any of these cleaner sand deposits. This clean sand was also found at the 6 to 9-foot level at ST21-28 and ST21-29, and also at deeper depths in ST21-22. There appear to be isolated areas of this cleaner, more permeable sand deposit, but such sands were generally not found at the surface, and in all cases were overlain by a more impervious silt or clayey silt. In borings ST21-62 and ST21-61 and in the open swampy area to the southwest, the soil conditions were similar except for a 4-foot layer of peat over a clayey sand.

1.3.0 HYDROLOGY

1.3.1 SURFACE WATER

The project site includes an unimpeded 4.2-mile segment of the Flambeau River. The river drains a total area of approximately 1,993 square miles, and has a low gradient of about three feet per mile. There are nine dams and impoundments on the river, four of which are in Rusk County. The nearest dams are the Thornapple Dam (13-foot head) located about nine river miles southwest of the project site and the Peavey Paper Mill Dam (17-foot head) located approximately 3.8 miles above the site. The other dams on the Flambeau in Rusk County are the Dairyland REA Cooperative Dam (68-foot head) and the Big Falls Dam (50-foot head), both of which are located upstream from the project site.

Through the project site, the Flambeau River is a broad, meandering, entrenched stream with very little floodplain (Exhibit A). The average width of the river is 350 feet and the average gradient in this area is approximately two feet per mile. The course of the river at the project site has apparently changed very little in postglacial time. The disproportionately large meanders were probably formed while the Flambeau River was receiving large quantities of glacial meltwater.

River flow data are kept at a U. S. Geological Survey gaging station located 2.5 miles downstream from the Thornapple Dam. Average (mean) discharge at the station is 1,844 cubic feet per second (cfs). Normal or median discharge is 1,500 cfs. The recorded maximum discharge was 17,400 cfs on May 1, 1954, and the recorded minimum was 100 cfs in August of 1957. The discharge rate which is equaled or exceeded 95%

of the time has been established as 734 cfs at Ladysmith. River flows in the Ladysmith area are influenced by rainfall, snow melt and runoff, and the operations of several power plants, especially the Dairyland Dam.

Observations by the WDNR since 1969 indicate an average water level of the Flambeau River west of the ore deposit of 1,085 feet above mean sea level (msl), and a normal highwater mark of 1,086 msl. Prior to 1969, the average water level at this site was 1,094 msl, but removal of the Port Arthur Dam, six miles below the mine site, has lowered the average level by nine feet. Flood elevation and flows for a 100-year reoccurrence flood have been estimated from data provided by the Big Falls gage station. A 22,500 cfs 100-year flow has been predicted which would crest at an elevation of 1,098 msl, or 13 feet above the average water level (Figure 4). These flood elevation calculations were based on a velocity of 4.5 feet per second using the Conger method.

There are seven small streams which drain into the Flambeau River from the project site (Figure 5). Stream D (Meadowbrook Creek) and Stream G have continuous flows. Streams E, F and G have been channelized over parts of their lengths and generally exhibit sluggish or intermittent flows. Maximum discharge rates of these streams in 1973 were measured or estimated by company personnel.

Stream	Maximum Discharge - 1973 cfs
A	1.0
B	1.4
C	6.2
D (Meadowbrook Creek)	No measurement
E	3.1
F	1.1
G	3.1

Discharge rates for Streams A, B, C, F and G were measured using the V-notch weir technique. The discharge of Stream E was estimated from data on Stream G. The Meadowbrook Creek discharge rate was not measured in 1973; however, the 100-year reoccurrence flood discharge was estimated to be 1,800 cfs using the Conger technique.

There are two very small man-made ponds located northwest of the proposed pit. Other small wetland areas and ponds of much less than one acre are present in depressional areas throughout the project site.

Much of the eastern portion of Section 20 and the western part of Section 21 consists of wetlands. These wetlands extend into the west half of Section 20 beyond the project area. This area is drained by Stream G which flows some 2.6 miles to its mouth at the Flambeau River in the SE¼, Section 24, T34N, R7W. Water usually stands over this area to a depth of one foot or more. The area is underlain by a few inches to several feet of peat.

Figure 4

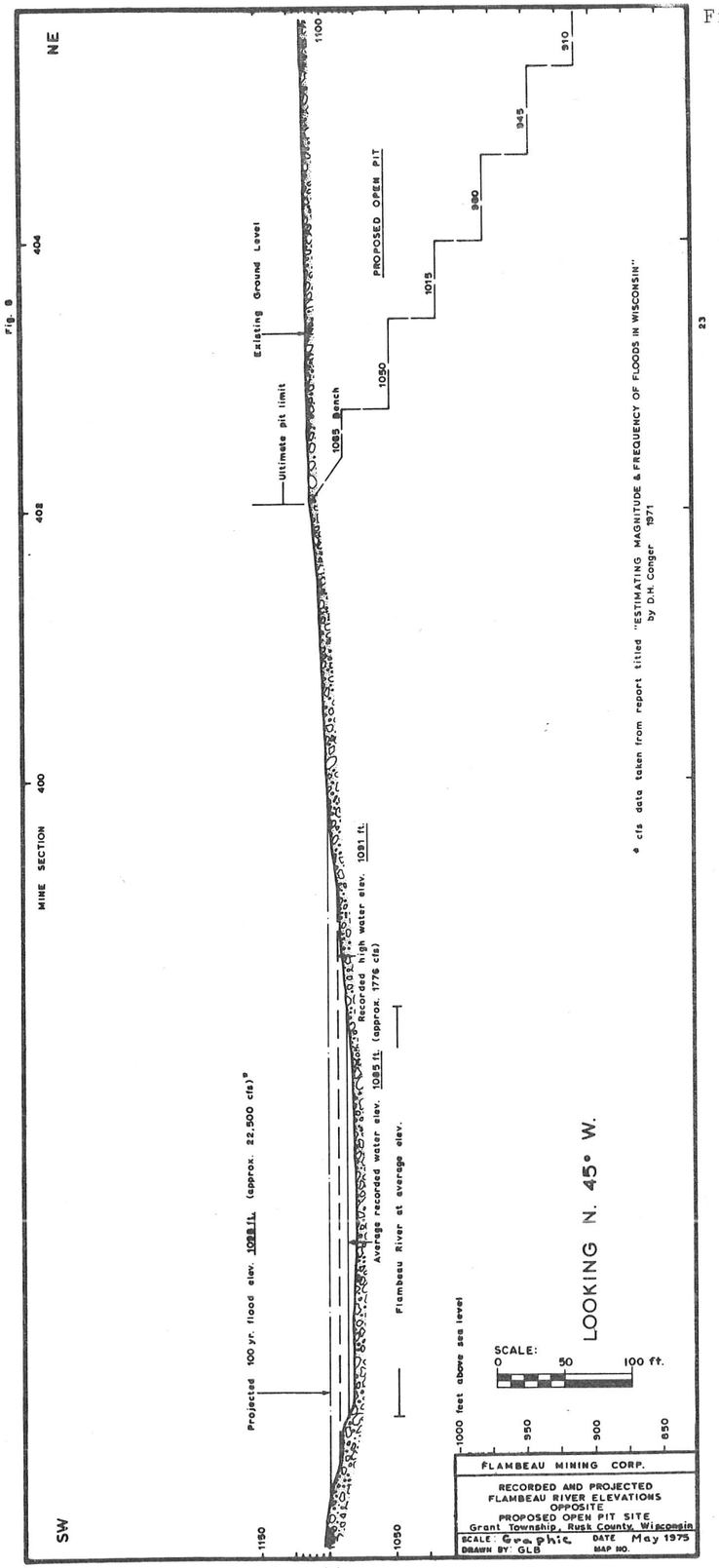
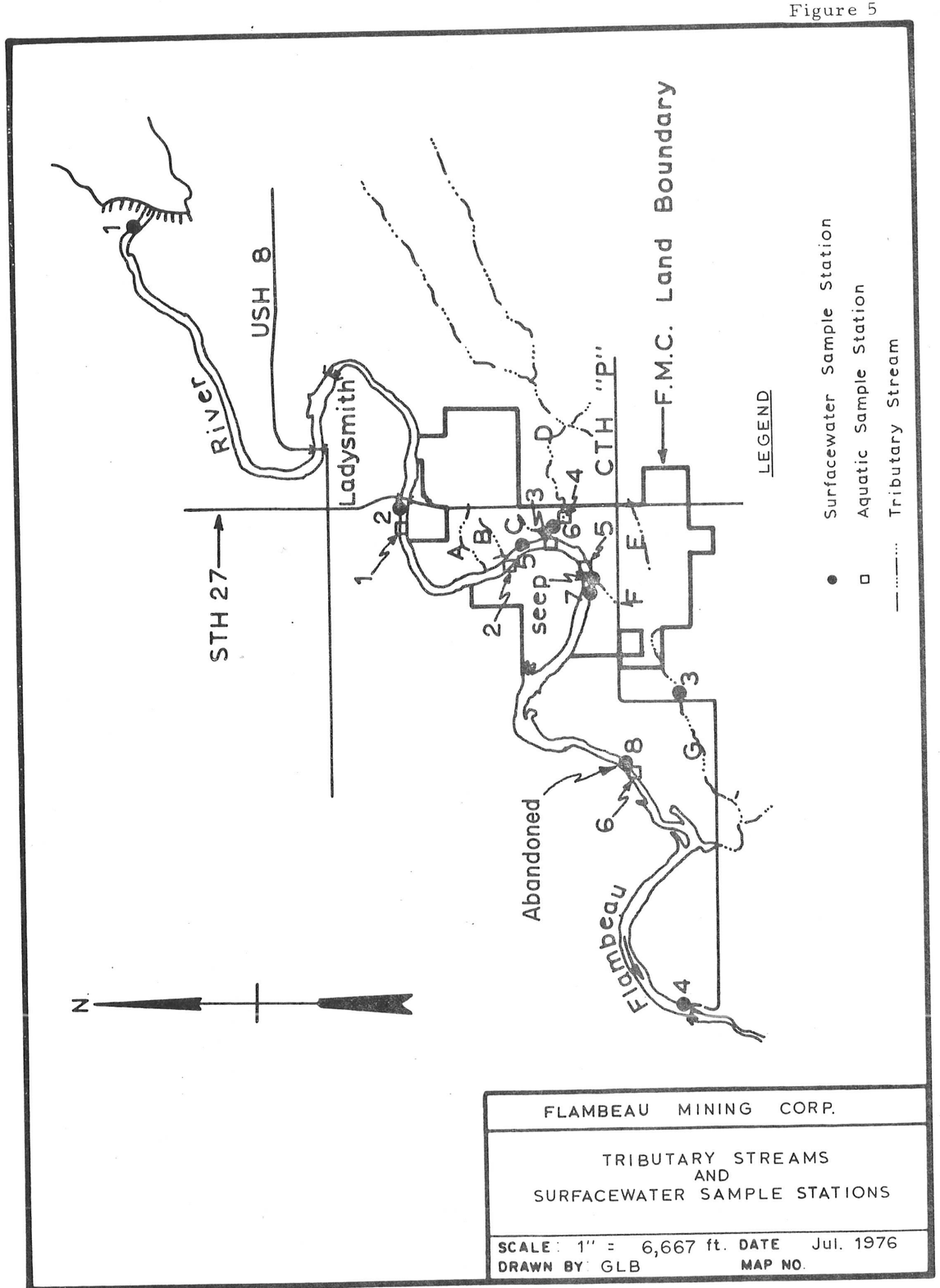


Figure 5



The principal uses of the Flambeau River are for power generation, disposal of treated sewage and paper mill effluent, recreation, wildlife habitat and livestock watering. In Rusk County the river is not used for domestic water supplies or commercial navigation.

The tributary streams which flow through the project site and the ponds and wetlands are used for agricultural purposes and by wildlife.

1.3.2 GROUNDWATER

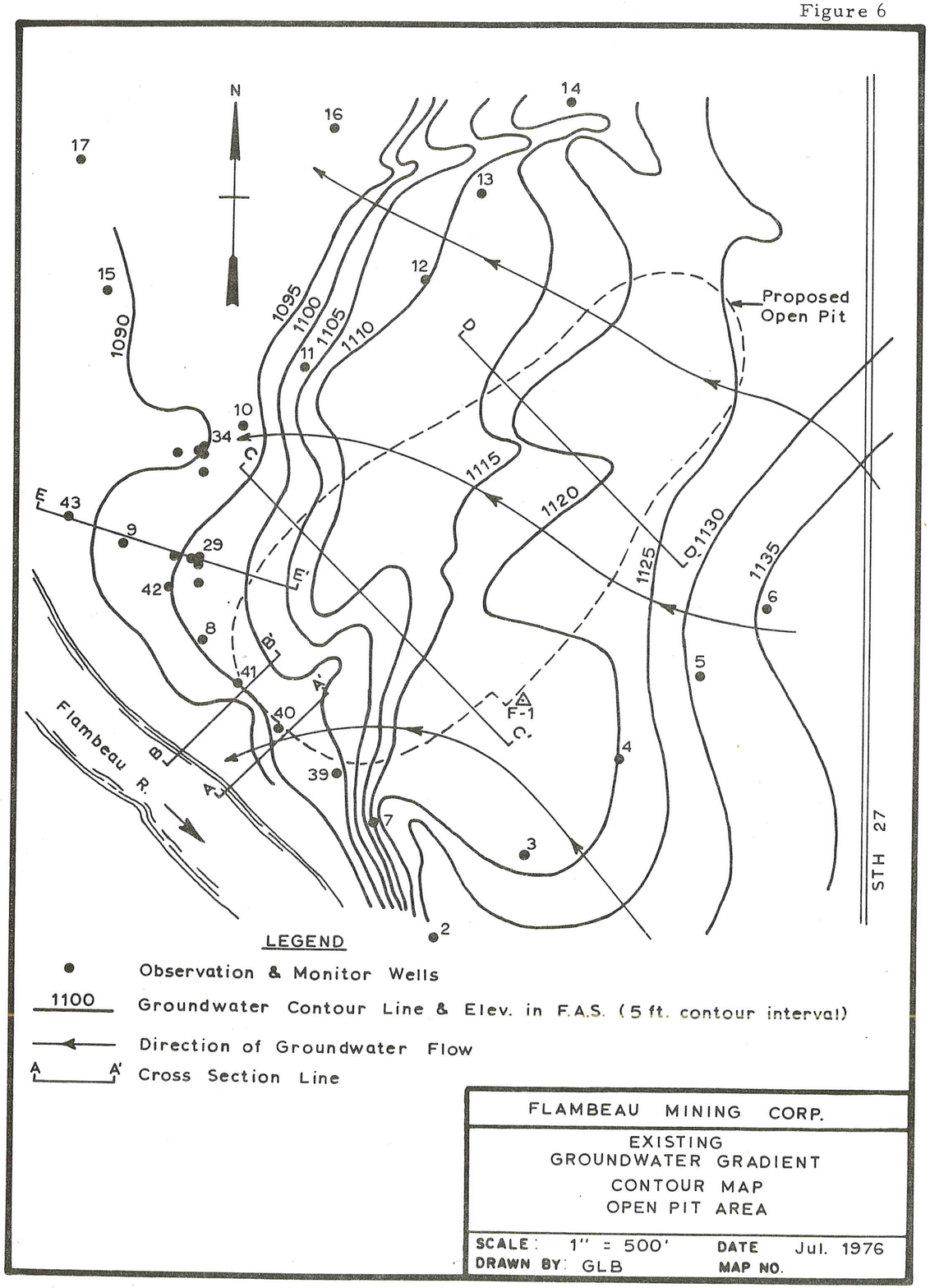
At the project site, free groundwater is contained, with minor exceptions, in the unconsolidated glacial materials, in the Cambrian sandstone which lies above the Precambrian bedrock in the area of the orebody, and to a slight extent within the fractured Precambrian bedrock itself. The highly impermeable clay saprolite developed during ancient weathering of the Precambrian rocks serves as a barrier to downward movement of groundwater. As a result of this controlling factor, the slope of the present water table roughly parallels the nearly horizontal ancient bedrock surface. The thickness of the zone of saturation above this surface ranges from 18 to 80 feet. Perched water tables, or zones of differential permeability, of limited areal extent occur in isolated areas above shallow layers of impermeable glacial material. Movement of groundwater in the saturated zone above bedrock takes place through horizontally discontinuous but vertically interconnected aquifers. Seasonal fluctuations in the depth to the main water table are on the order of four to five feet.

Two basic types of glacial materials are present. The areas inside the large meanders of the Flambeau River are occupied by glacial outwash deposits consisting of moderately well sorted sands and gravels. Elsewhere, the project site is largely underlain by glacial till consisting of unsorted silt-rich materials. Aquifers are more abundant, extensive and better interconnected in the outwash deposits than in the till. Confined aquifers, perched groundwater tables, or zones of differential permeability, are more abundant in the areas underlain by till than in the outwash area.

To determine groundwater conditions in the proposed mine area, the company drilled 20 wells during June 1970 at the locations shown in Figure 6. Low-capacity and short-duration pumping tests were conducted in eight of these wells. A total of 16 field permeameter tests from wells drilled in July 1973 were also conducted at selected locations around the planned pit perimeter. Thirty-one of these wells are within the area shown in Figure 6. Additional information was obtained from nearby domestic wells, from the mineral exploration core holes, from soil test borings and from three shallow pits excavated to bedrock along the proposed southwest perimeter of the mine.

The average depth and configuration of the water table in the proposed mine area is shown on Figure 6. The water table, which reflects the hydraulic gradient, slopes approximately 1.5% to the northwest across the orebody, steepens to 6% in the NNE-trending transition zone between glacial till and glacial outwash deposits, then flattens to 2% in the

Figure 6



outwash material inside the large meander of the Flambeau River northwest of the orebody. The water table roughly parallels the slope of the Precambrian bedrock surface which appears to slope 2% to the northwest into the ancestral Flambeau valley, except along the southwest end of the proposed pit where the water table slopes to the southwest to the Flambeau River.

Fluctuations of the water table, measured in wells 6 and 12 (Figure 7) in the area underlain by till and wells 8 and 15 in outwash, indicate that water table levels are controlled by precipitation and runoff rather than by river levels.

The transition zone between glacial till and glacial outwash, as determined by drill hole data, soil test borings, and geomorphological studies, is from 250 to 400 feet wide and follows the line defined by test wells 20, 12 and 40, as shown in Figure 7. Hydrogeologic cross sections related to Figure 7 are presented in Figures 7A, B and C. Table 1 summarizes the field test data and aquifer characteristics for wells 8, 9, 29, 34, 39, 42 and 43, and for the 16 field permeater tests in the vicinity of the orebody. (The apparent low soil permeability at ST9-18 may be explained by a small sample quantity obtained for this test. The low permeability at ST9-22 may be due to silt and clay seams which were found in the sandstone.) The wells were located between the proposed pit and the Flambeau River in the outwash zone to test the area of greatest permeability, where aquifer yields were expected to be greatest. The highest permeability values were found in wells 8, 29 and 43. Well 43, located in outwash materials 300 feet from the river and 800 feet from the proposed pit, had the highest values. Drawdown tests performed on wells 29 and 34 (each surrounded by four monitor wells) supplied data that indicated very low values and yields for the outwash deposits. These data suggest that interaction of the Flambeau River with groundwater in the mine area is slight.

Groundwater conditions in the waste containment area were determined from data developed in eight monitor wells and sixty soil test holes as shown on Figure 8. Hydrogeologic cross sections of the area are presented in Figures 8A and 8B. The Precambrian bedrock surface slopes toward the northwest into the ancestral Flambeau valley in this area as it does in the area of the orebody. A layer of clay saprolite of variable thickness is also present at the bedrock surface. A thin remnant of Cambrian sandstone overlies bedrock west of the area. Glacial deposits overlying bedrock range in thickness from 55 to at least 124 feet and, except northwest of the area, consist of till overlain by a continuous mantle of silty materials ranging from 3.5 to 11.5 feet in thickness. Northwest of the area, topsoils are underlain by coarser grained sandy materials which were deposited along the edges of the large stagnant-ice mass which formerly occupied the present wetland area to the west. The wetlands occupy the site of a basin in the original ground moraine surface, which after the stagnant-ice mass melted, filled with lacustrine silts and a thick accumulation of peat.

Figure 7

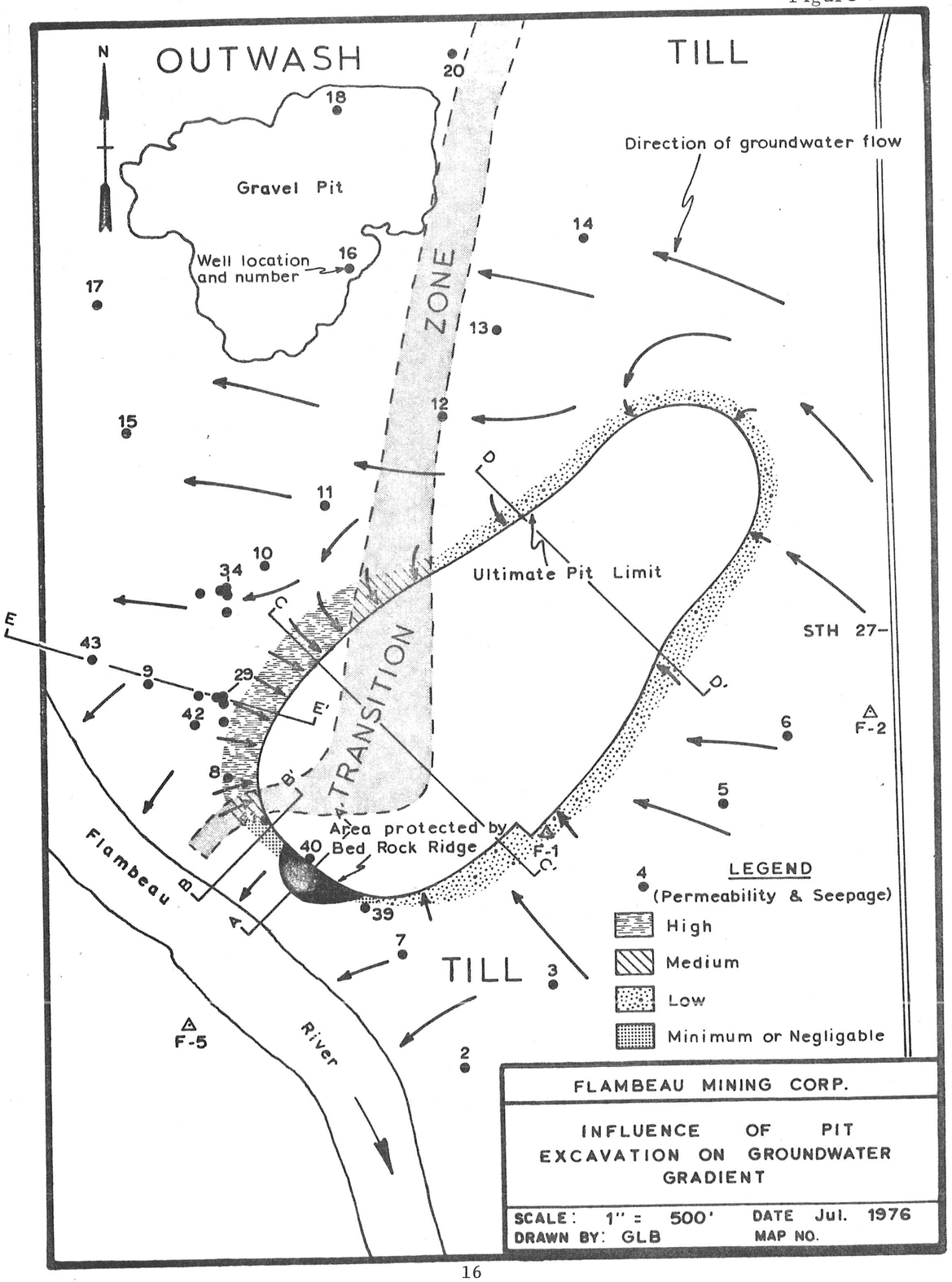
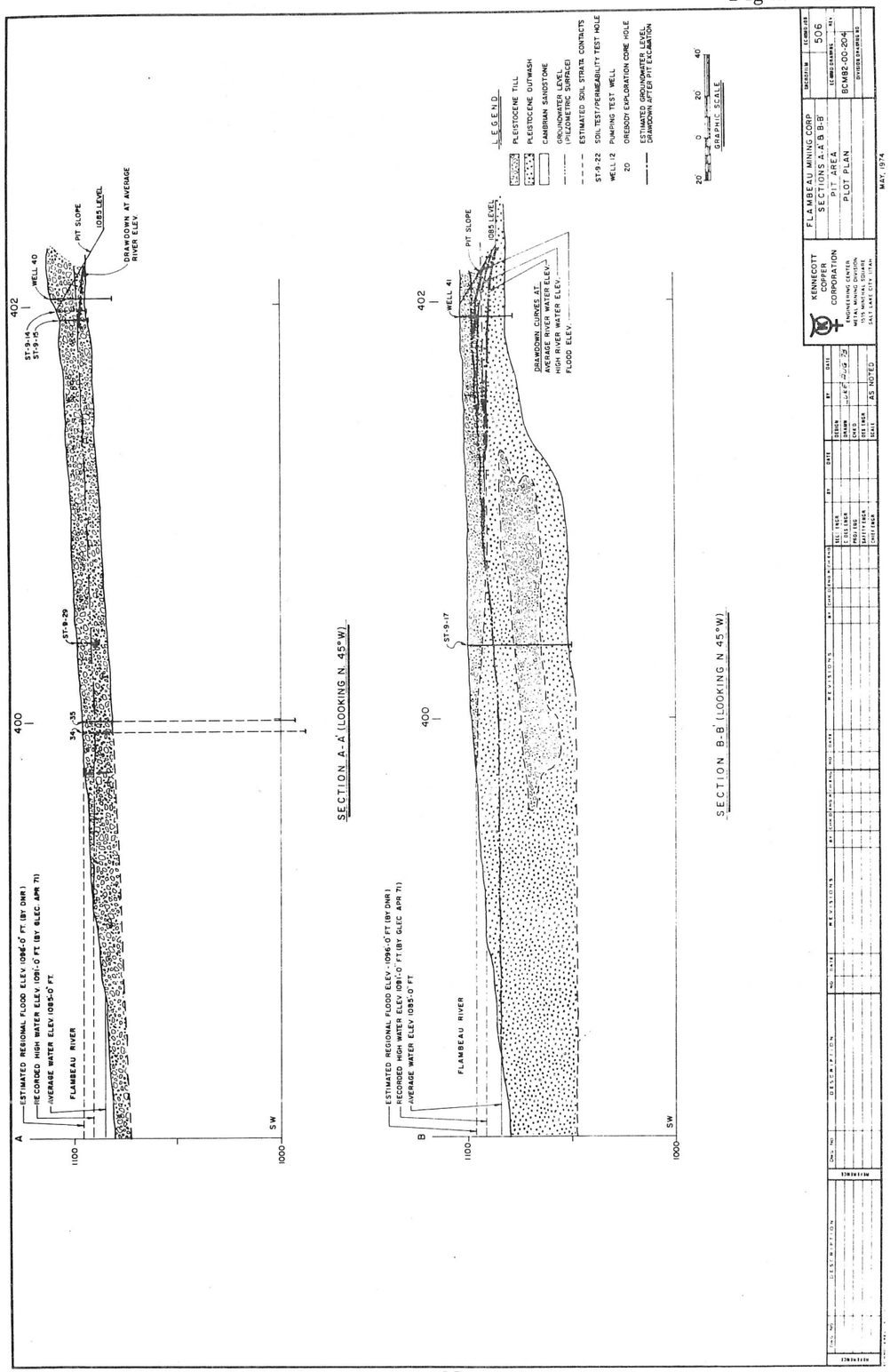
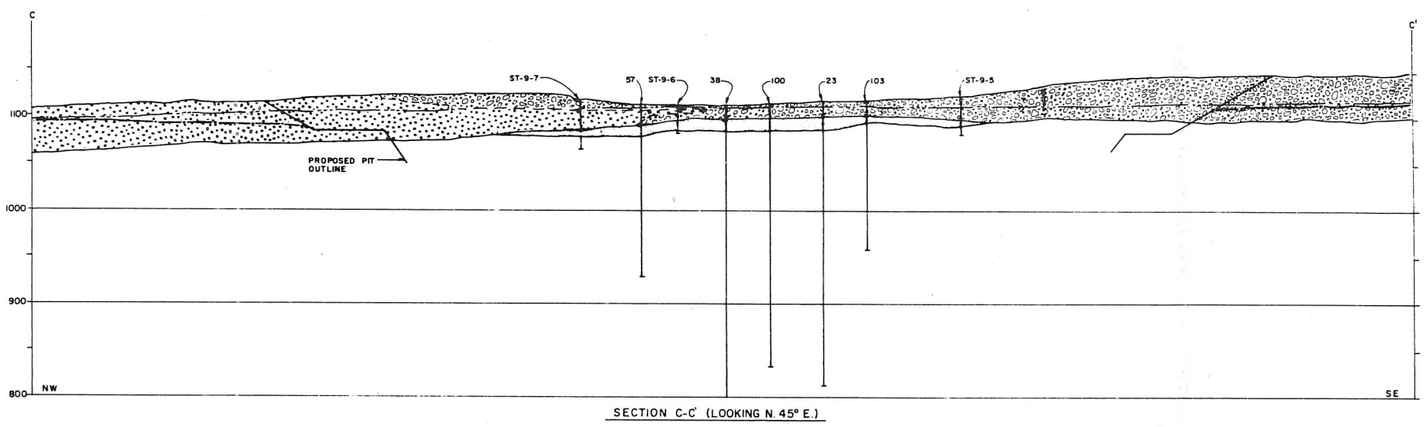
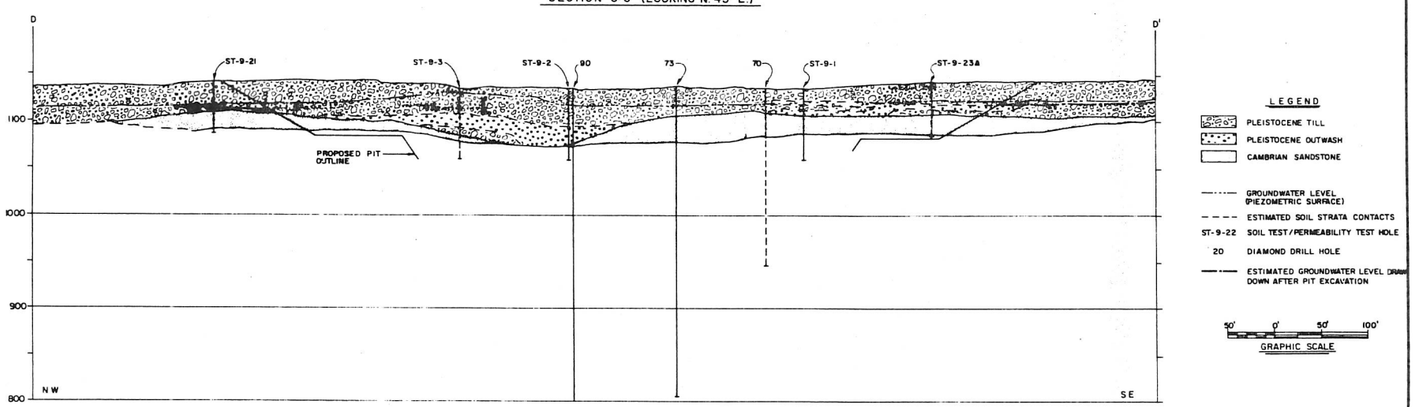


Figure 7a





SECTION C-C' (LOOKING N. 45° E.)



SECTION D-D' (LOOKING N. 45° E.)

DWG. NO.	DESCRIPTION

REFERENCE

DWG. NO.	DESCRIPTION

REFERENCE

NO.	DATE	REVISIONS	BY	CHK'D	ENG'R	CHIEF ENG'R

NO.	DATE	REVISIONS	BY	CHK'D	ENG'R	CHIEF ENG'R

	BY	DATE
SECT. ENGR.		
C. DES. ENGR.		
PROJ. ENG.		
SAFETY ENGR.		
CHIEF ENGR.		

	BY	DATE
DESIGN		
DRAWN		
CHK'D		
DES. ENGR.		
SCALE	AS NOTED	

KENNECOTT COPPER CORPORATION
ENGINEERING CENTER
METAL MINING DIVISION
1515 MINERAL SQUARE
SALT LAKE CITY, UTAH

FLAMBEAU MINING CORP
SECTIONS C-C' / D-D'
PIT AREA
PLOT PLAN

MICROFILM | EC&MD JOB
506
EC&MD DRAWING | REV.
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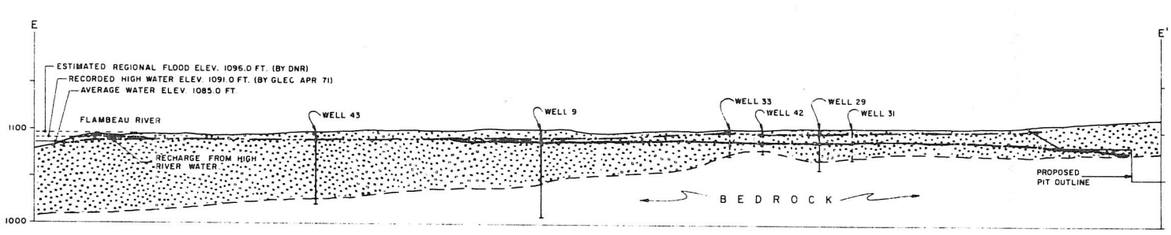
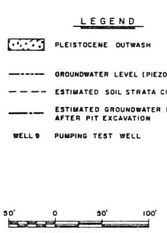
MAY, 1974

Figure 7b

18



SECTION E-E' (LOOKING N. 17° E.)



DWG. NO.	DESCRIPTION

REFERENCE

DWG. NO.	DESCRIPTION

REFERENCE

NO.	DATE	REVISIONS	BY	CHK'D	ENG'R	CHIEF ENG'R

NO.	DATE	REVISIONS	BY	CHK'D	ENG'R	CHIEF ENG'R

	BY	DATE
SECT. ENGR.		
C. DES. ENGR.		
PROJ. ENG.		
SAFETY ENGR.		
CHIEF ENGR.		

	BY	DATE
DESIGN	MJ	Aug 73
DRAWN		
CHK'D		
DES. ENGR.		
SCALE	AS NOTED	

KENNECOTT COPPER CORPORATION
ENGINEERING CENTER
METAL MINING DIVISION
1515 MINERAL SQUARE
SALT LAKE CITY, UTAH

FLAMBEAU MINING CORP
SECTION E-E'
PIT AREA
PLOT PLAN

MICROFILM | EC&MD JOB
506
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8CM82-00-213
DIVISION DRAWING NO.

MAY, 1974

Figure 7c

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TABLE 1

SUMMARY OF FIELD PERMEABILITY TESTS
ORE BODY AREA

Test No. (Figure 7)	Permeability Ft/Day	Permeability GPD/Ft^2	Material Tested
T.W. 8	7.15	53.48	Outwash (SW)
9	5.07	37.92	Outwash (SW)
29	7.06	52.80	Outwash (SW)
34	0.53	3.96	Outwash (SW) (?)
39	1.47	11.00	Till (SM)
42	3.51	26.25	Outwash (SW)
43	136.2	1018.8	Outwash (SW)
ST-9-17 A	3.96	29.4	Outwash (SW)
18	5.57×10^{-6}	4.17×10^{-5}	Till (SM)
19	5.66	42.34	Bedrock - Sandstone
19A	10.63	79.51	Outwash (SW)
20A	4.42×10^{-3}	3.31×10^{-2}	Bedrock - Sandstone
21	1.32	9.87	Bedrock - Sandstone
22	7.94×10^{-5}	5.94×10^{-4}	Bedrock - Sandstone
22A	2.66	19.90	Till (SM)
23	2.85	21.32	Bedrock - Sandstone
23A	4.25	31.79	Till (SM)
24	3.19	23.86	Bedrock - Sandstone
25	2.06	15.41	Till (SM)
26	1.46×10^{-2}	0.11	Till (SM)
27B	4.83×10^{-2}	0.36	Till (SM)
28B	1.13	8.45	Till (SM)
29	1.16×10^{-1}	0.87	Till (SM)

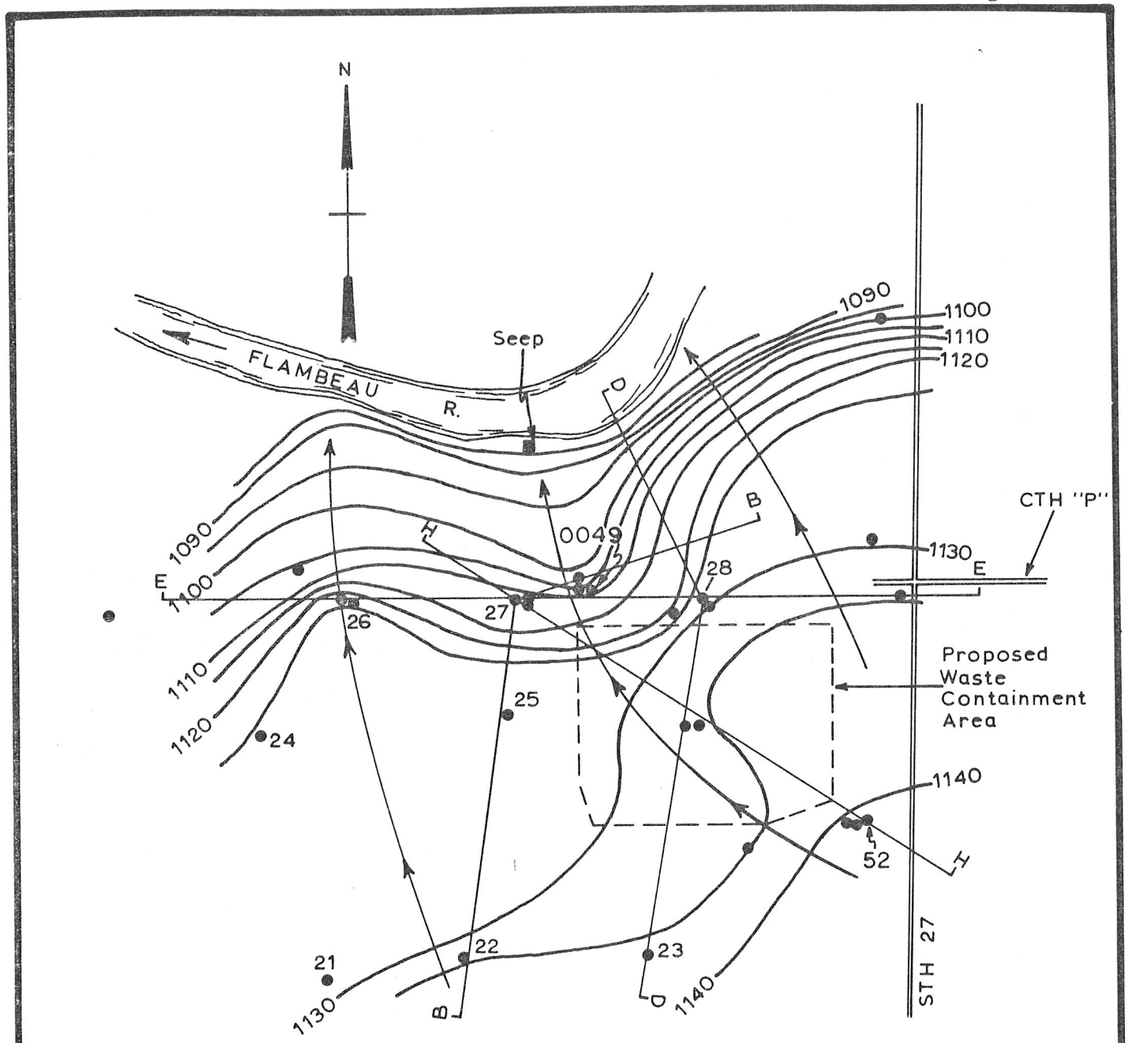
Permeabilities: By Lithology

Soils - SW	20 to 80 gpd/ft^2	50 Avg.
Soils - SM	0.1 to 20 gpd/ft^2	5 Avg.
Bedrock-Sandstone	10 to 50 gpd/ft^2	20 Avg.
Till Section		20 Avg.

By Pit Sector (in till - sandstone section)

West Side	50 gpd/ft^2 (approx. from ST-9-18 to 20)
Southwest Side	10 gpd/ft^2 (approx. from ST-9-26 to 18)
Remainder	20 gpd/ft^2

Figure 8



LEGEND

- ● Observation & Monitor Wells
- 1100 Groundwater Contour Line & Elev. in F.A.S. (5 ft. contour interval)
- ← Direction of Groundwater Flow
- E — E Cross Section Line

FLAMBEAU MINING CORP.

GROUNDWATER GRADIENT
CONTOUR MAP
WASTE CONTAINMENT AREA

SCALE: 1" = 1800 ft. DATE Jul. 1976
DRAWN BY: GLB MAP NO.

Figure 8a

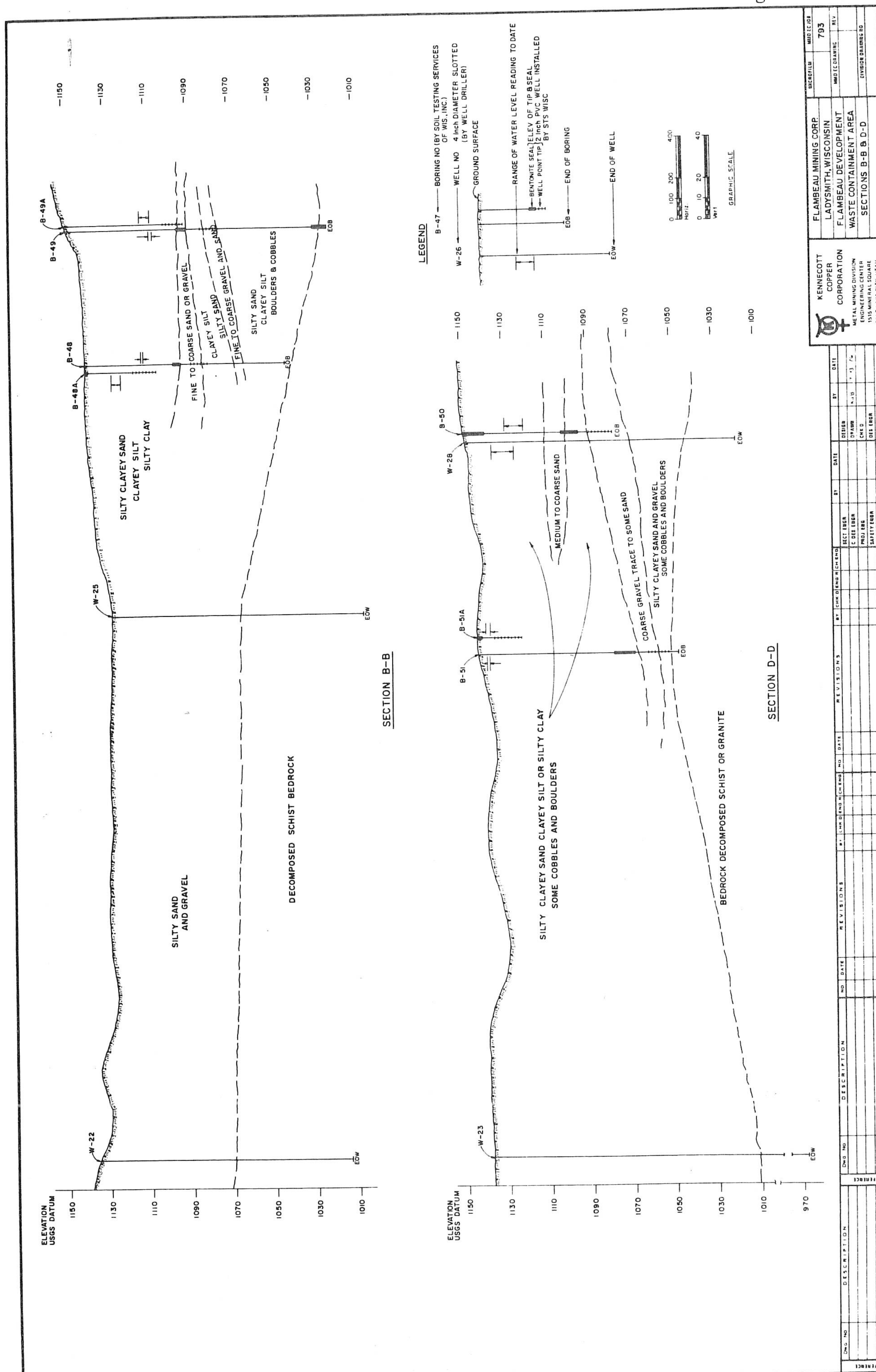
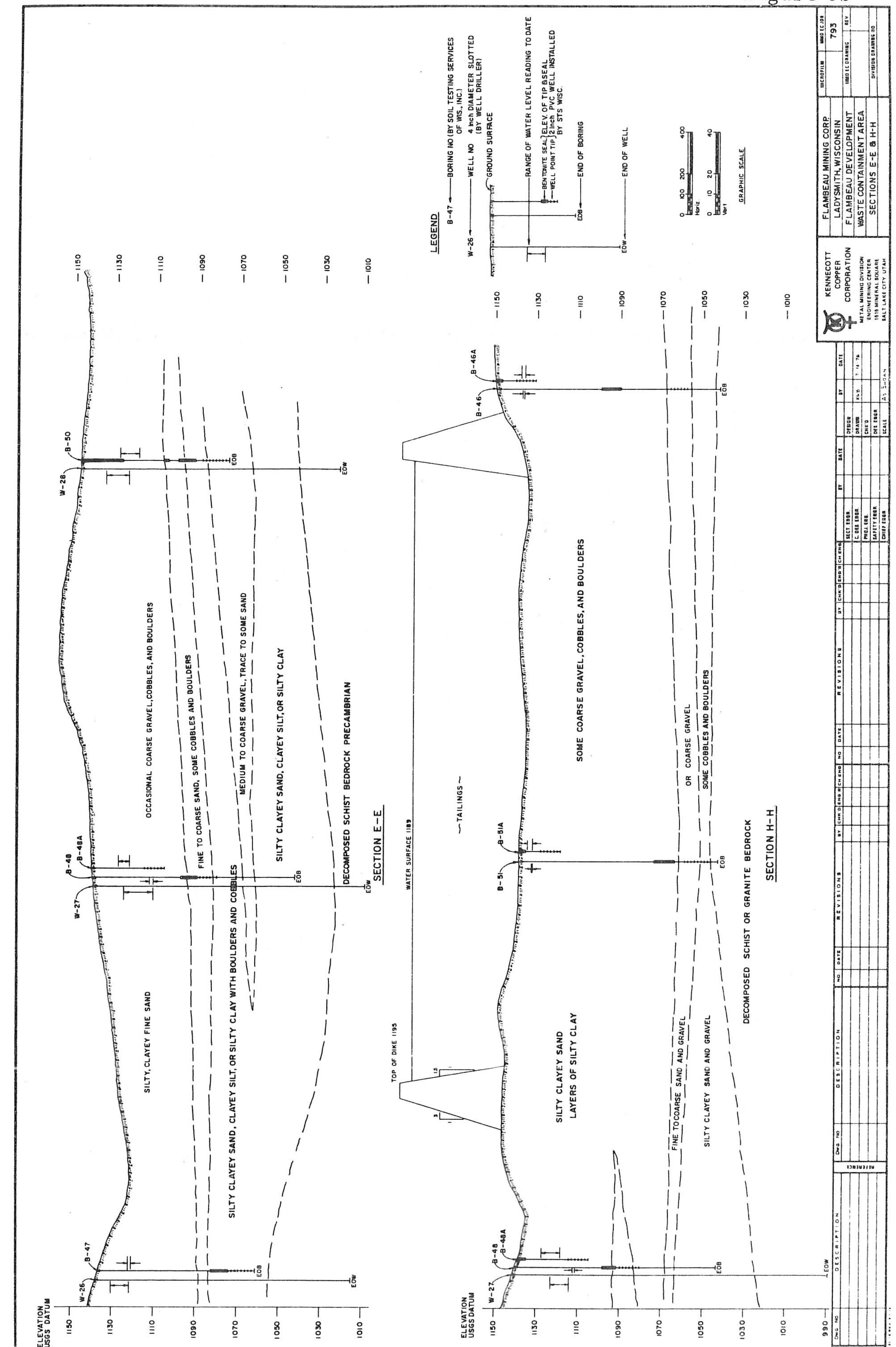


Figure 8b



Because of the presence of extensive layers of relatively permeable silty materials at shallow depths over most of the area, perched water tables or areas of differential permeability are common. The depth of the soil to the normal groundwater table varies from about 15 feet at the highest point along County Highway P to less than one foot in the lowland area just west of the proposed waste containment area. The existing groundwater flow pattern is to the north-northwest. Most of the flow is toward the Flambeau River and emerges as seeps and springs along the river bank. Some groundwater does flow into the wetlands west of the proposed waste containment area (Figure 8).

In general, soil permeabilities are low to very low and uniform under the waste containment area. Presently, most incident precipitation runs off this area into the adjacent wetlands because of the low capacity of the soils to transmit water. Table 2 lists the average permeabilities of the soils which underlie the area. Most of the soils tested had permeabilities near one ft/year (1×10^{-6} cm/sec), although some permeabilities were as low as 0.03 ft/year (2.8×10^{-8} cm/sec). The thickness of these relatively impermeable strata range from beneath the topsoil to more than 11 feet deep. Northwest of the proposed waste containment area the 3.5 feet of impermeable soil (Soil 4, one ft/yr) is underlain with a layer of more permeable sand (Soil 5, 1,000 ft/yr). All of the testing consistently showed that the permeability of the near-surface soils was quite low, and in fact the underlying soils also had quite low permeabilities. This is due to the high percentage of silt and the generally dense nature of the underlying till.

TABLE 2
PERMEABILITIES OF SELECTED BASE SOILS UNDER THE WASTE CONTAINMENT AREA

Sampling Station	Depth and Thickness of Soil Tested (ft)	Soil Type	Average Permeabilities (ft/yr)
21-27	6.0 - 7.0	Silt over silty sand	0.67
21-33	2.0 - 3.5	Clayey silt over silty sand	1.13
21-38	0.0 - 8.0	Silt over silty sand	1.74
21-53	2.0 - 5.0	Silt over silty sand	0.07
21-40	0.0 - 11.5	Silt over silty sand	0.93

Source: Soil Testing Services of Wisconsin, Inc. 1973

The major exception is a layer of the cleaner sands found beneath the north dike wall starting at boring ST21-11, and terminating eastward between ST21-14 and ST21-15. Similar sands were also encountered between borings ST21-28 and ST21-29 near the southwest corner of the proposed dike (Figure 3). Permeabilities in these areas are approximately 100 ft/yr. These cleaner, more permeable sandy subsoils are underlain by dense, less permeable silty sands which are located at a depth of 13 to 15 feet below the surface.

1.4.0 GEOLOGY

The Canadian Shield is an extensive region of Precambrian-age rock that forms the bedrock for a land area of about 1,800,000 square miles. Most of this area lies in Canada, but about 93,000 square miles lie in the northern parts of Minnesota, Wisconsin and Michigan (Figure 9). Major rock types of the Shield consist of gneisses, mixed volcanic suites and the so-called greenstone belts, and sediments including banded iron formations. Surrounding, intruding and replacing these rock types are igneous rocks of varying compositions. All of these rocks have been subjected to structural deformation (folding or faulting) during Precambrian time. However, they have been little disturbed since Cambrian time, and the Shield now forms one of the most geologically stable areas on the earth's crust. Present-day seismic activity in the region and in Rusk County is extremely low.

It is within the greenstone volcanic belts that a considerable portion of the massive sulfide deposits are found. The term greenstone is frequently used when no accurate rock determination is possible and includes rocks that have been so altered that they have assumed a distinctive green color because of the presence of the mineral chlorite. Greenstone belts consisting of volcanic and volcani-sedimentary rocks are found in northern Wisconsin and are generally covered by a thin mantle of Pleistocene glacial material or, farther to the south, by ever-increasing amounts of younger Paleozoic sediments.

One of many such covered greenstone belts lies south of Ladysmith in Rusk County. It is within this steeply dipping northeast-trending complex suite of volcanic rocks that the Flambeau deposit was identified in 1968. The volcanics are terminated west of the project site by a granite intrusion which is believed to be the southern extension of a large granite body underlying Ladysmith. There is no indication the sulfide mineralization extends beneath Ladysmith (Figure 10).

The Flambeau deposit is completely covered by Pleistocene glacial material. The glacial material varies in thickness from ten feet over the mineralization between the river and pit to 30 feet at the east end of the proposed pit. Rapid thickening of the glacial material to the northwest suggests the presence of an ancestral Flambeau valley now filled with at least 90 feet of gravel-rich outwash. These outwash deposits are currently being mined for gravel and are locally an important source of well water. East of the outwash is a SSW-trending transition zone. This zone, of variable width, composition and permeability, is a transition between the outwash material and the more silt-rich till deposits to the east (Figure 7). Glacial till, characterized by high silt content, variable composition and generally low permeabilities, overlies the southwest, south and east half of the open pit. Interbedded with and overlying the till is a silty sand probably derived from windblown material.

In late Precambrian time, intensive weathering and disintegration of the steeply tilted volcanic rocks formed a clay-rich layer, termed saprolite, at the Precambrian bedrock surface in the orebody area.

Figure 9

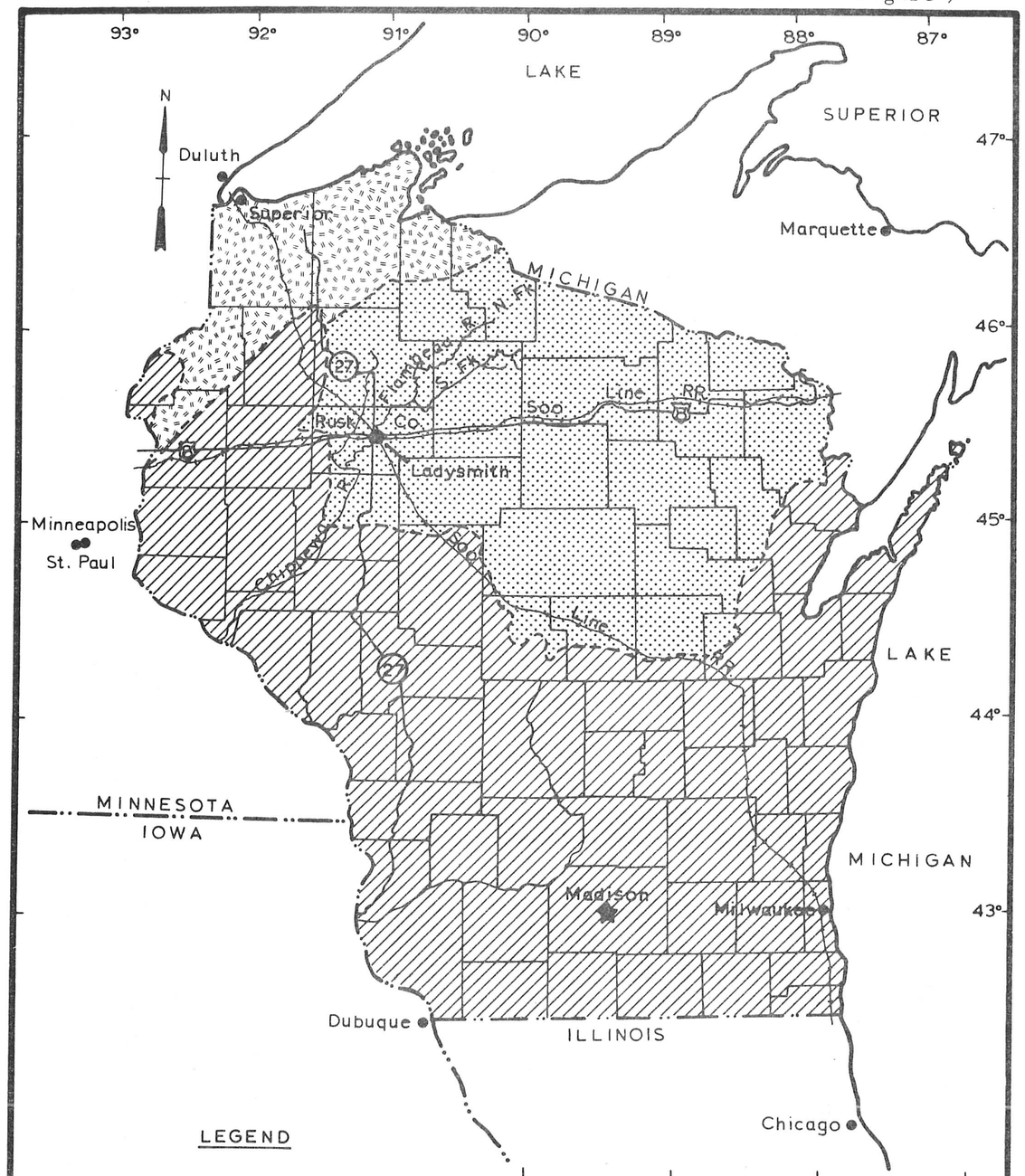
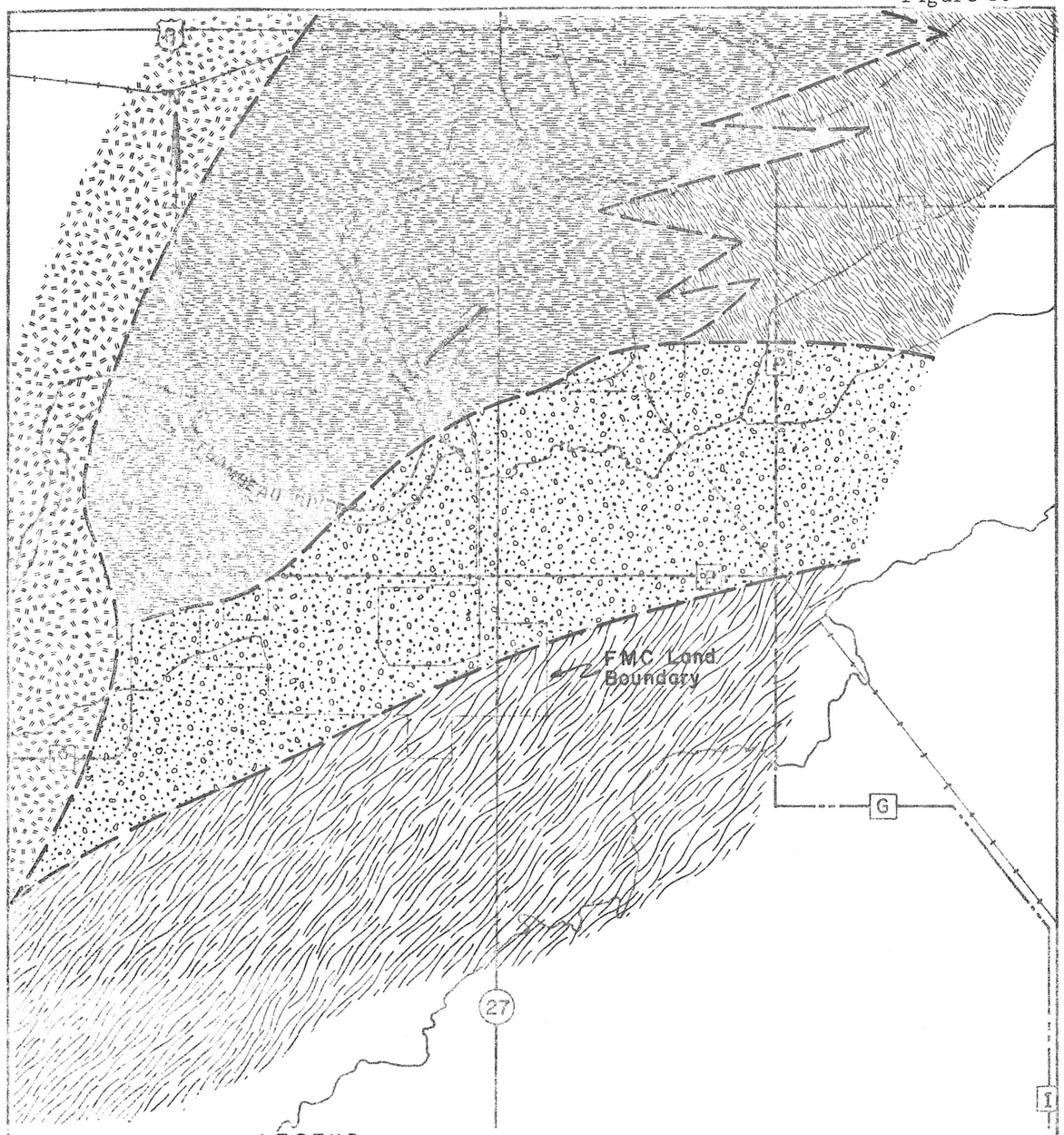


Figure 10



The saprolite layer is thickest adjacent to the orebody and beneath the Cambrian sandstone, and thins rapidly away from the mineralization under the glacial cover. Saprolite is particularly well developed in those rocks rich in plagioclase feldspar such as the actinolite schist. The presence of the saprolite layer limits groundwaters from reaching the Precambrian bedrock surface.

The Precambrian bedrock consists of a complex interfingering suite of volcanic and volcaniclastic rocks now metamorphosed and altered to schists and phyllites (Figure 11). These rocks were probably volcanic flows, ash beds, pumice deposits and volcanic-derived sediments of Middle Precambrian age. Within this complex volcanic pile is a distinctive rock type, a quartz-sericite schist, termed the ore horizon since it contains the copper orebody. The ore horizon pinches and swells along strike for 15,000 feet and varies in width from 25 to 200 feet. Only the one ore horizon containing a single known orebody 2,400 feet in length has been found on FMC land holdings in the Town of Grant (Figure 12). The upper enriched part of the orebody extends under but not across the Flambeau River.

The ore horizon, because it contains more quartz than the adjoining rocks, has resisted erosion to form a gentle broad northeast-trending ridge in the Precambrian bedrock surface. This bedrock ridge is of significance to the development and operation of the open pit mine, for it acts as a natural impermeable barrier between the river and the pit located some 300 feet to the east (Figure 7A). The buried ridge rises beneath the east bank of the river to reach a subsurface elevation of 1,095 feet under the west pit perimeter. This elevation is approximately ten feet higher than the average river level.

1.5.0 MINERAL DEPOSIT

The Flambeau orebody lies conformably within a quartz-sericite schist and is intimately associated with lenses of metachert. The orebody strikes north 45° east and dips approximately 70° to the northwest. Diamond drilling has outlined a tabular-shaped massive sulfide deposit 2,400 feet long, averaging 50 feet in width, and extending to 800 feet beneath the surface. Deeper drilling has not intersected economical mineralization. Massive sulfide mineralization, greater than 50% sulfide, grades at depth into semimassive sulfides which vary from 20% to 50% sulfide. An envelope of disseminated sulfides, predominantly pyrite with minor amounts of chalcopyrite, encloses the orebody and is found along strike within the ore horizon. The width of this pyrite halo averages 110 feet to the north of the orebody but only 55 feet to the south. Contacts between the massive-semimassive orebody and the enclosing rock vary from knife-edge sharp to gradational over 15 to 20 feet. Therefore any improvements in mining technology or higher copper prices would not have an appreciable effect in increasing ore reserves.

Pyrite is the predominant sulfide mineral. The chief copper mineral is chalcopyrite which is found scattered throughout the pyrite. In the upper or north wall of the orebody the sulfides are crudely banded;

Figure 11

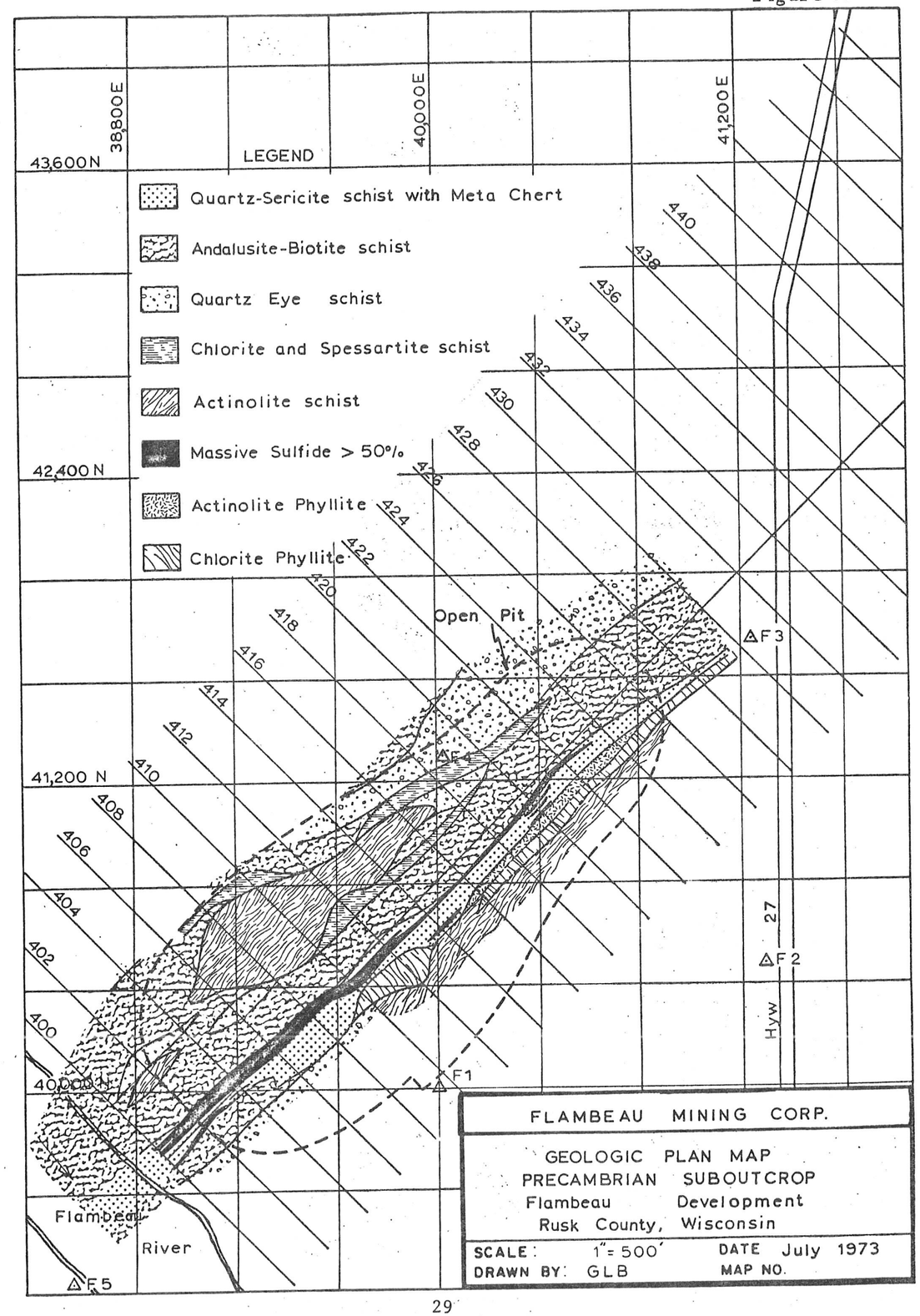
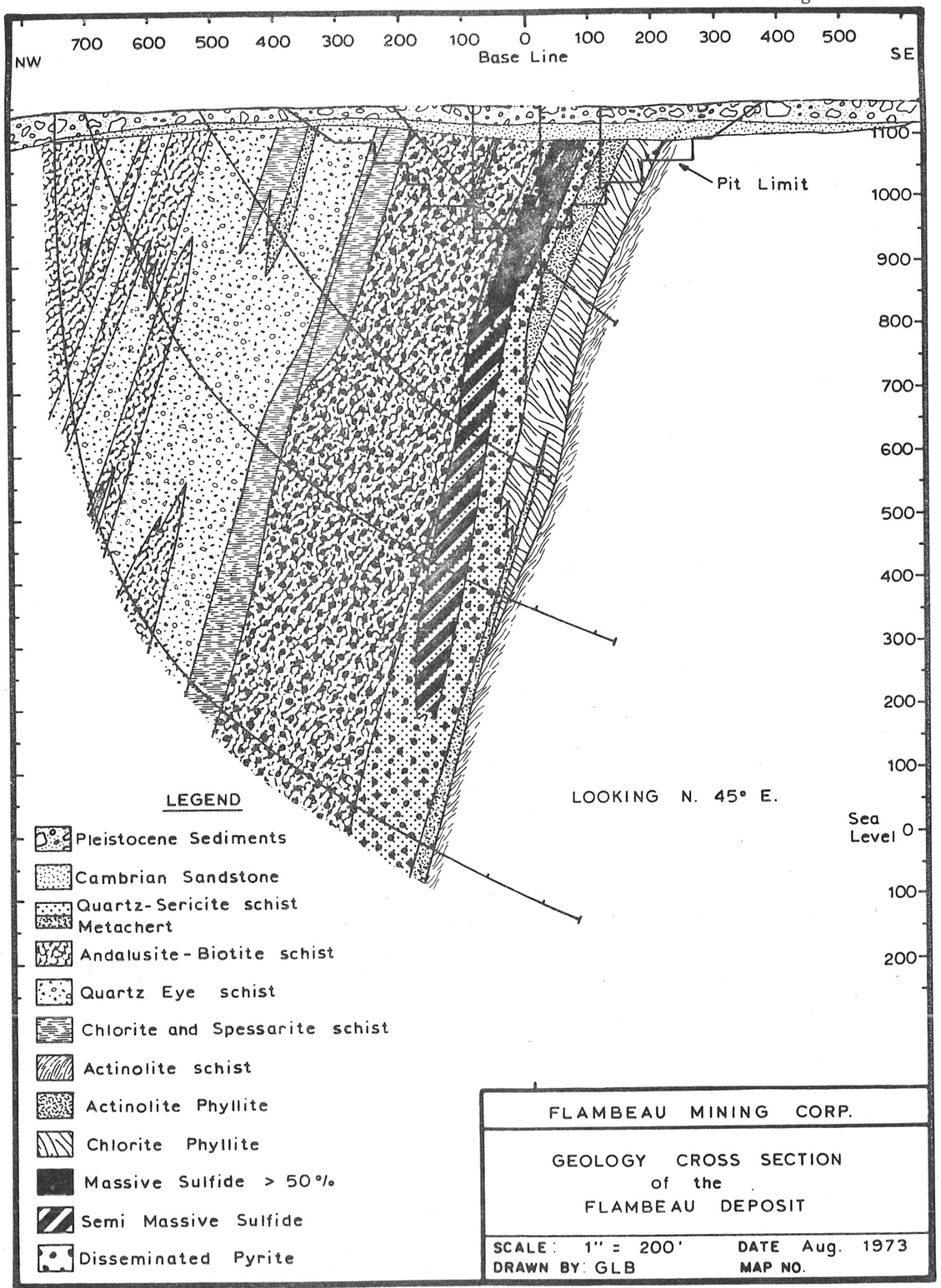


Figure 12



however, the character of the mineralogy changes across the orebody as well as with depth. Sphalerite, a zinc sulfide, increases noticeably toward the lower contact of the orebody, imparting a well banded appearance to the orebody when mixed with pyrite and chalcopyrite. At depth, pyrite decreases, sphalerite is reduced to minor amounts, and the chalcopyrite grains coalesce to form irregular masses. The uppermost 50 to 150 feet of the orebody has been supergene enriched. Chalcocite is the predominant copper mineral in the upper portion of the enriched zone, whereas bornite predominates in the lower half. The disseminated pyrite halo has been enriched on either side of the massive sulfide vein. Zinc minerals are virtually absent in the enriched zone.

Copper with trace amounts of gold and silver would be produced from the Flambeau orebody. Although small amounts of zinc are found in the lower wall and in satellitic lenses beneath the vein, there is insufficient tonnage to warrant recovery under present economic conditions.

The ore has been tested for asbestos and no cummingtonite or other problem fibrous silicate minerals are present in the Flambeau ore. Their absence is important from a public health standpoint since asbestos fibers are suspected to cause lung cancer when inhaled in small quantities over an extended period of time.

1.6.0 BIOTIC CHARACTERISTICS

1.6.1 TERRESTRIAL AND AQUATIC PLANT COMMUNITIES

The basic plant communities of the Flambeau project site are shown on Figure 13. The Point-Quarter Method was used for the analysis of the woody species in the communities of the study area, whereas the list and abundance estimates of the herbaceous flora relied on the expertise of the botanical investigator.

The mixed deciduous-coniferous lowland forest occupies the most acreage of any plant community in the study area (Table 3). Of the 1,000 acres in the study area, the mixed deciduous-coniferous lowland forest comprises approximately 280 acres, or 28%. The forest is classified as lowland because of the relative closeness of the groundwater table to the surface of the forest floor. This forest community borders the marshes and swamps.

The predominant species are the trembling aspen (Populus tremuloides), red maple (Acre rubrum), the elms (Ulmus sp.), black ash (Fraxinus nigra) and white birch (Betula papyrifera). The forest has been disturbed in recent times. Some of the more mature trembling aspen south of the waste containment area were cut for pulp in 1972 by former owners. There is evidence from the old stumps in the forest that this area had suffered a fire many years ago. Local residents claim that the present pulp cutting is the third crop from this land. Burned sites are the most favorable to the trembling aspen (a prolific seeder) which makes up 47% of the trees in this lowland forest.