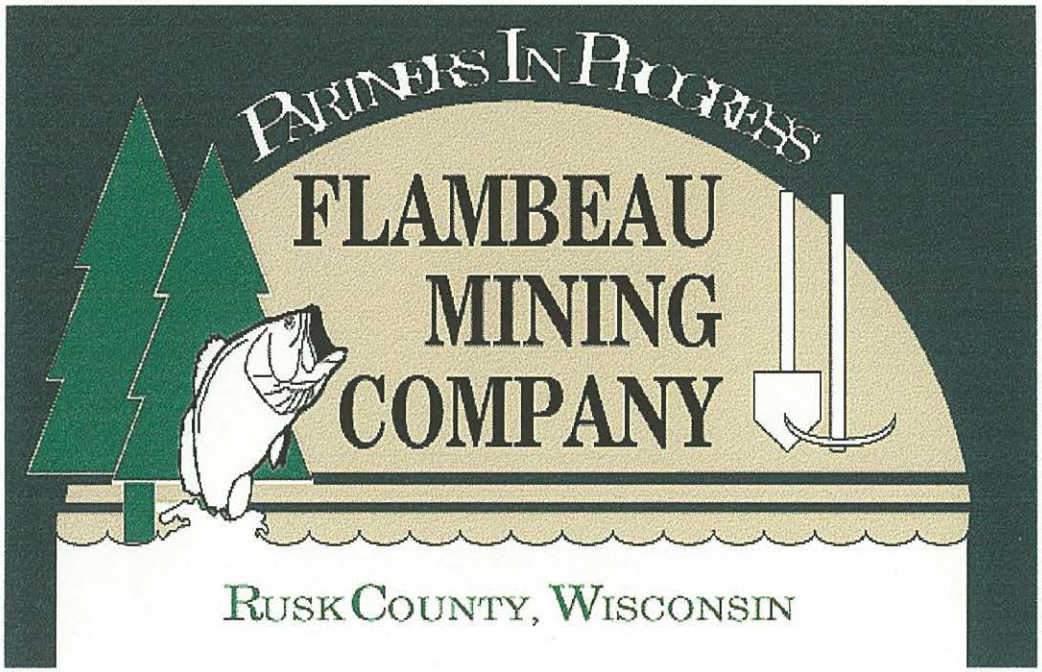
1998 Annual Report



January 1999

Flambeau Mining Company
N4100 Highway 27
Ladysmith, WI 54848
(715) 532-6690
FAX (715) 532-6885

Kennecott Minerals

January 29, 1999

Mr. Lawrence J. Lynch
Mine Reclamation Unit
Bureau of Solid and Hazardous Waste Management
101 South Webster Street, GEF II
Madison, WI 53707

Dear Mr. Lynch:

The Flambeau Mining Company (Flambeau) is submitting 12 copies of the attached 1998 Annual Report pursuant to Part 1-8 of the conditions of the Flambeau Mine Permit (Docket No. IH-89-14). This submittal also addresses other requirements of the Mining Permit and associated approvals.

If you have any comments or questions regarding this submittal, please contact me at (715) 532-6690 Ext. 105.

Sincerely,

Jana E. Murphy

Jana E. Murphy
Environmental & Reclamation Manager

Distribution

No. of Copies	Sent to
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FLAMBEAU MINING COMPANY
1998 ANNUAL REPORT

CONTENTS

TABLES

FIGURES

APPENDICES

1.0 PURPOSE AND NEED

This report serves to document the work that was done at the Flambeau Mine site in 1998 and to satisfy the requirements of the Mining Permit (MP).

Mining Permit, Part 1, Condition 8:

> *In accordance with sec. 144.89, Stats., Flambeau shall submit a report annually to the Department summarizing the activities which took place on the mining site during the year and shall include other additional information specified in this permit and associated plan approvals.*

Mining Permit, Part 2, Condition 4:

> *The annual report required under sec. 144.89, Stats., shall include discussion of all modifications received during the previous year and shall include an inventory of all modifications received subsequent to permit issuance. The annual report shall also discuss deviations from the approved Mining Plan as a result of final engineering refinements of subsequent plan approvals if these deviations do not require modifications, under Part 2, Conditions 2 and 3.*

Mining Permit, Part 2, Condition 6:

> *Flambeau shall keep a log of all incidents, such as spills, pond overflows and embankment failure or leakage, reported to its environmental compliance staff. This log shall, at all reasonable times, be available for inspection by any duly authorized Department employee. A summary of incidents subject to various Department reporting requirements shall be included in the annual report required under sec. 144.89, Stats.*

Mining Permit, Part 2, Condition 7 (Excerpt):

> *The annual report required under sec. 144.89, Stats, shall include a summary of all exploration drilling activities conducted on the mining site during the previous year.*

Mining Permit, Part 4, Condition 9:

> *Monitoring data and results shall be submitted to the Department within 30 days after completion of the required analyses. The annual report required in this permit shall summarize the year's monitoring activities and any observed trends in the monitoring data.*

Water Withdrawal Approval, Condition 1 (Excerpt):

> *Flambeau Mining Company shall maintain records which document the withdrawal. At a minimum, such information shall include the dates and duration of withdrawal, approximate pumping rate and approximate volume of water withdrawn. Monthly summaries shall be submitted to the department for those months in which a withdrawal occurs. This information shall be available for department review in a separate file at the Flambeau Mining Company office and shall also be summarized in the annual report submitted as a condition of the mining permit.*

The location of the information which fulfills the requirements of the above conditions are referenced in Table 1-1.

TABLE 1-1

Location Information Key

Condition No.	Location of Information
MP, Part 1-8	Section 2.0
WWA, Condition 1	Section 2.2.2 and Section 4.2.6
MP, Part 2-4	Section 2.5 and Appendix A
MP, Part 2-6	Section 2.7
MP, Part 2-7	Section 2.8
MP, Part 4-9	Section 4 and Appendix B through H

2.0 1998 Summary

During 1998, Flambeau Mining Company (Flambeau) accomplished many milestones associated with the reclamation of the Flambeau Mine site. Most importantly Flambeau completed the year without any lost time accidents experienced by contractors or Flambeau employees. In fact, Flambeau was again honored by the Wisconsin Safety Council by receiving the Wisconsin Corporate Safety Award for Flambeau's exemplary safety record and practices during 1997.

Flambeau's goal to complete surface stabilization was achieved despite delays associated with the process of modification of its Reclamation Plan. Through communication with concerned citizens and agreement to address their concerns, Flambeau was able to receive approval of modifications from the Wisconsin Department of Natural Resources (WDNR).

Additionally, Flambeau continued to partner with the community. The Flambeau School Greenhouse participated in revegetating the site by providing and planting over 2000 native wildflowers and grasses. Flambeau will be working with the community to develop trails across the reclaimed mine site providing opportunity for environmental education and passive recreation.

2.1 Material Redistribution

During 1997 the open pit was substantially backfilled and the majority of the mine site was brought to rough grade. The material which remained to be placed in the area of the former pit was till and a small quantity of sandstone. On January 8, 1998 Flambeau submitted to the WDNR a request for modification of Flambeau's Mining Permit and Reclamation Plan. The WDNR issued the approval of the modifications to Flambeau's Mining Permit and Reclamation Plan in a letter dated July 30, 1998. As a result of the modification process, which is discussed in greater detail in the 1998 Annual Reclamation Report, material redistribution in 1998 was performed in two phases.

2.1.1 Till

During the first phase, relocation of till initiated on March 16, 1998 and continued through June 8, 1998. Flambeau brought as much of the mine site to final grade as was possible during this first phase and still remain within the jurisdiction of the approved Reclamation Plan. As a result, Flambeau temporarily stockpiled approximately 107,000 yd^3 of till across a portion of the pit. The temporary stockpiling of till allowed for a substantial portion of the site to receive topsoil and undergo stabilization. The second phase of till relocation initiated on July 29, 1998 and was within the scope of the approved Reclamation Plan. Relocation of till during 1998 was performed in substantial accordance with the Updated Resident Project Representative Manual and documented in a technical memorandum provided to the WDNR in the 1998 Annual Reclamation Report submitted on November 13, 1998.

2.1.2 Topsoil

Topsoil relocation took place concurrently with till movement. Topsoil movement initiated April 27, 1998 and continued through early June 1998. The second phase of topsoil placement was completed in August 1998. Topsoil was placed by scrapers at a minimum depth of four inches and rough graded with a low pressure dozer. In accordance with Section 5.7.2.6 of the Mine Permit Application (December 1989), the final reclaimed pit surface was surveyed following topsoil placement. A copy of this survey is provided as Figure 2-1.

A topsoil stockpile containing approximately 12,000 yd^3 was established along the western perimeter of the future industrial outlot. This stockpile contains a sufficient quantity of topsoil to be used to reclaim the industrial outlot area in a manner consistent with the approved Reclamation Plan in the event that a user for the industrial outlot is not found by December 31, 2004. Additionally, an excess quantity of topsoil allowed approximately 3500 yd^3 to be stockpiled in the northeast corner of the inactive gravel pit south of Blackberry Lane and adjacent to the mine site. This topsoil will be utilized in the gravel pit during Spring 1999 as part of a restoration project in the gravel pit.

2.1.3 Hydric Soils

Hydric soil relocation from the hydric soil stockpile to the 8.5 acre wetland was not initiated until August 30, 1998 following receipt of the WDNR's approval of modifications to Flambeau's Reclamation Plan. Hydric soils were maintained in a saturated condition and dewatered previous to relocation. Following relocation and placement, hydric soils were saturated with river water if precipitation events did not provide sufficient water cover.

2.2 Water Management

2.2.1 Water Treatment Plant

The water treatment plant (WTP) was operational until final grading was substantially complete and erosion control features installed. The WTP discharged an average 0.485 million gallons per discharge day through outfall 001 to the Flambeau River. No difficulties were experienced in achieving the required effluent standards.

The WTP discharged 22.80 million gallons of effluent to the Flambeau River during 1998 as compared to 76.94 million gallons during 1997. The WTP was permanently shutdown on August 13, 1998. From WTP start-up through shutdown, Flambeau's WTP had discharged over 600 million gallons of effluent to the Flambeau River.

In accordance with the Reclamation Plan, all underground piping associated with the WTP was left in place. Underground piping associated with the transportation of water to and from the surge and runoff ponds and the WTP, including the Outfall 001 discharge pipe, were plugged

38,800 E | 39,000 E | 39,200 E | 39,400 E | 39,600 E | 39,800 E | 40,000 E | 40,200 E | 41,000 E

41,400 N
41,200 N
41,000 N
40,800 N
40,600 N
40,400 N
40,200 N
40,000 N

APPROXIMATE PIT OUTLINE

N

SURVEY PERFORMED SEPT. 16, 1998
BY FLAMBEAU MINING COMPANY

40,400 E | 40,600 E | 40,800 E

FLAMBEAU MINING COMPANY

FIGURE 2-1

RECLAIMED MINE PIT SURFACE
RECORD SURVEY - 1998

Scale: 0 100' 200' | Date: DECEMBER, 1998

Prepared By: Foth & Van Dyke | By: JRB2 | 97F011

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using concrete. The pit pumping line was plugged with concrete at the perimeter of the pit. A small portion of piping located in conjunction with the Type I settling ponds was left in place. Figure 2-2 provides a diagram of the industrial outlot area showing underground piping associated with the WTP and the concrete plugs installed by Flambeau as part of the WTP decommission. Figure 2-3 illustrates the major underground features left in place on the remainder of the project site.

In a letter dated September 8, 1998, the WDNR stated that with the shutdown of the WTP and construction of permanent stormwater facilities, stormwater management and discharges through Outfall 002 (south watershed drainage channel) would be regulated under the Mining Permit. The WDNR suggested that until the drainage area is fully vegetated and stabilized, Flambeau should maintain the capability to pump water from the 1.7 acre biofilter to the south gravel pit in the event of an extreme precipitation event. Two significant precipitation events occurred in 1998 following the shutdown of the WTP which resulted in runoff flowing through the south watershed drainage to the Flambeau River despite pumping runoff to the south gravel pit. Flambeau continues to maintain the capability to pump water from the 1.7 acre biofilter to the south gravel pit.

2.2.2 River Water Withdrawal

On May 5, 1998 the WDNR approved Flambeau's application to withdraw water from the Flambeau River for use on site for reclamation vegetation. The river water was used to irrigate woodland units, biofilters, constructed wetlands, the hydric soil stockpile and provide a source of dust suppression water. Following is a summary of river water withdrawal from the Flambeau River in 1998. The use of river water for wetland mitigation is discussed in detail in section 4.2.6 of this report..

1998	Reclamation Irrigation (Gallons)	Dust Suppression (Gallons)	Wetland Mitigation (Gallons)	Monthly Totals (Gallons)
May	42,000	118,000	0	160,000
June	131,000	0	483,000	614,000
July	256,000	442,000	523,000	1,221,000
August	1,214,000	0	186,000	1,400,000
September	271,000	0	0	271,000

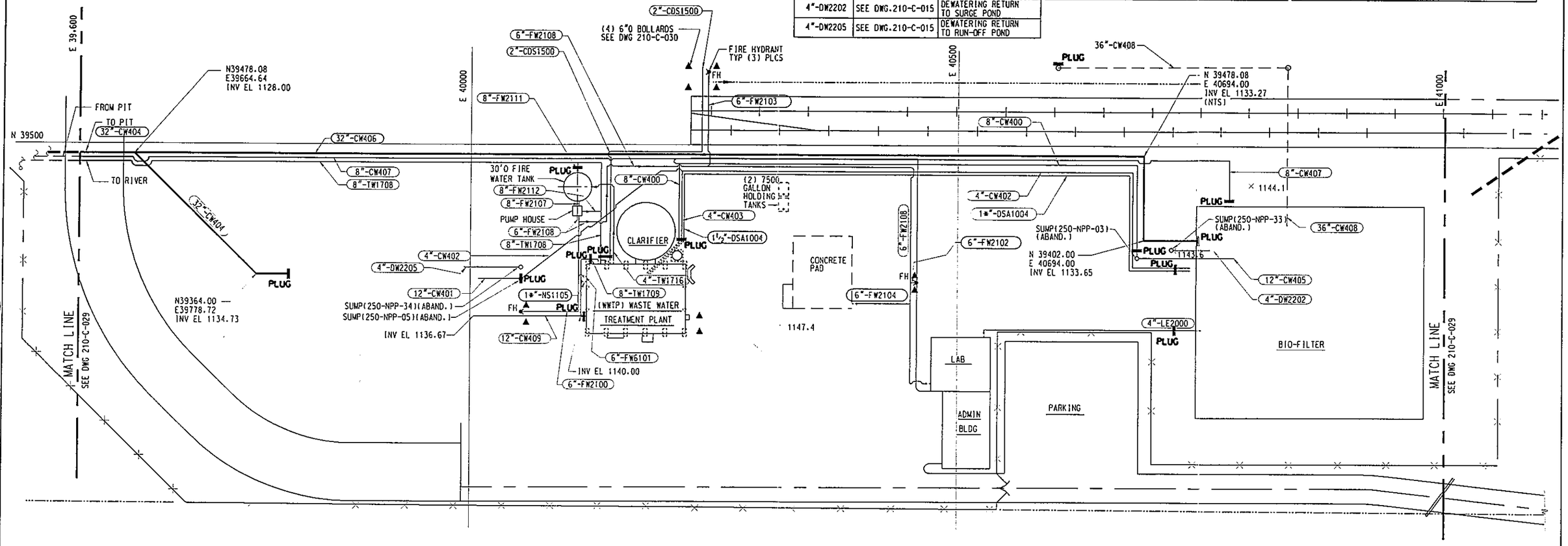
LINE #	INVERT ELEVATION	REMARKS
36"-CW408	SEE DWG 210-C-015	TYPE II STOCKPILE TO SURGE POND
12"-CW405	SEE PLAN	SURGE POND TO SUMP
12"-CW401	SEE PLAN	RUN-OFF POND TO SUMP

PIPING SCHEDULE

LINE #	INVERT ELEVATION	REMARKS
8"-FW2111	SEE NOTE #5	FIREWATER TANK O'FLOW TO 8"-TW1708
8"-FW2107	SEE NOTE #5	FIREWATER TANK TO PUMP HOUSE
8"-FW2112	SEE NOTE #5	PUMP HOUSE TO 8"-TW1708
6"-FW2100	SEE NOTE #5	6"-FW2108 TO RUN-OFF POND HYDRANT
6"-FW2104	SEE NOTE #5	6"-FW2108 TO MAINT. BLDG.
6"-FW2102	SEE NOTE #5	6"-FW2108 TO MAINT. BLDG. HYDRANT
6"-FW2103	SEE NOTE #5	6"-FW2108 TO R.R. TRACK HYDRANT
6"-FW2101	SEE NOTE #5	6"-FW2100 TO WWTP FIRE HOSE STATION
4"-DW2202	SEE DWG.210-C-015	DEWATERING RETURN TO SURGE POND
4"-DW2205	SEE DWG.210-C-015	DEWATERING RETURN TO RUN-OFF POND

LINE #	INVERT ELEVATION	REMARKS
8"-CW400	1136.00	SURGE POND TO WWTP
4"-CW402	1137.00	RUNOFF POND TO SURGE POND
4"-CW403	1137.00	FROM 4"-CW402 TO WWTP
32"-CW404 32"-CW406	VARIES SEE PLAN	POND OVERFLOW TO PIT
8"-CW407	1136.00	FROM PIT
12"-CW409	VARIES SEE PLAN	WWTP TO RUN-OFF POND (SLOPE 0.5% MIN)
4"-TW1716	1140.00	WWTP TO FIREWATER TANK
2"-PW307	1140.00	2"-PW305 TO MAINT. BUILDING

LINE #	INVERT ELEVATION	REMARKS
2"-CDS1500	1137.00	SEE NOTE #9
8"-TW1708	1139.00	WWTP TO OUTFALL 001
8"-TW1709	1139.00	WWTP TO 12"-CW409
1#"-NS1105	1140.00	WWTP TO 8"-TW1709
3"-NG1600	1141.00	HEADER TO BRANCHES AS SHOWN
1#"-DSA1004	1137.00	WWTP TO SURGE POND
6"-FW2108	1135.00	PUMP HOUSE TO DISTRIBUTION
4"-LE2000	VARIES SEE PLAN	SLOPE 1.04% (MIN)



LEGEND:

DW	DENOTES	DEWATERING WATER
CW	do	CONTAMINATED WATER
TW	do	TREATED WATER
FW	do	FIRE WATER
CDS	do	CRUSHER DUST SUPRESSION
NS	do	SODIUM SULFIDE
DSA	do	DILUTE SULFURIC ACID
MH	do	SANITARY SEWER MANHOLE
MH-E1	do	ELECTRICAL MANHOLE (#1)
▲	do	BOLLARDS
⊀	do	FIRE HYDRANT
○	do	SUMP

NOTE:
DRAWING FROM FORD, BACON & DAVIS, DRAWING NO. 210-C-028, REV. 5.

0 50' 100'
BAR SCALE

FLAMBEAU PROJECT LADYSMITH, WISCONSIN		MICROFILM	SCOPE 98F002
		DRAWING NO. 1	REV.
FLAMBEAU MINING COMPANY LADYSMITH, WISCONSIN 54848	FLAMBEAU MINE UNDERGROUND PIPING ASSOCIATED WITH WWTP JANUARY, 1999	PREPARED BY: JRB2	CHECKED BY: JBH
Foth & Van Dyke consultants - engineers - scientists	FIGURE 2-2	SCALE	SEE BAR SCALE

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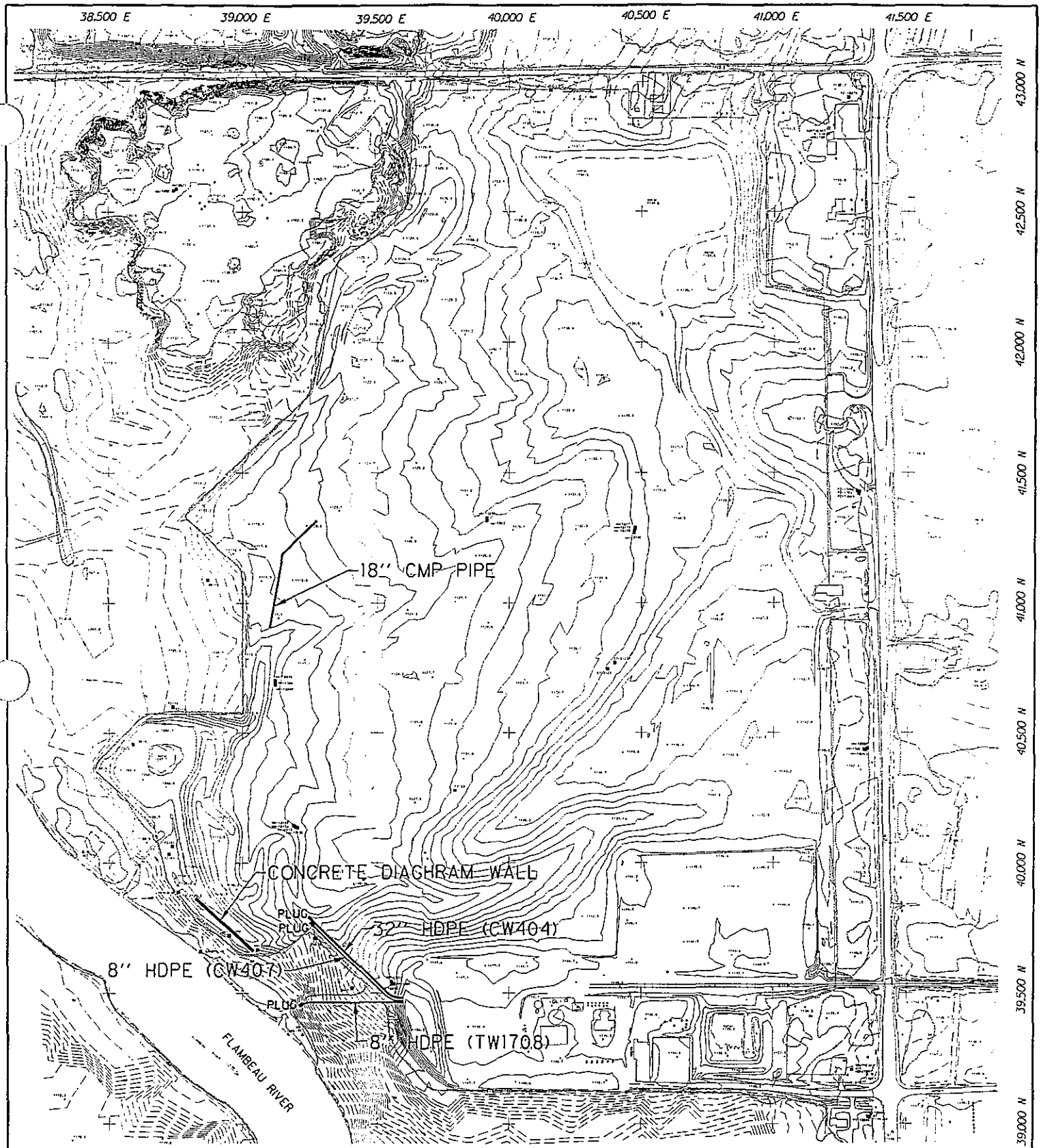


NOTE:
TOPOGRAPHY PROVIDED BY HORIZONS, INC.,
DATE OF PHOTOGRAPHY: SEPTEMBER, 1998.

N

0 250' 500'
BAR SCALE

Foth & Van Dyke
consultants • engineers • scientists

FLAMBEAU PROJECT
LADYSMITH, WISCONSIN

FLAMBEAU MINING COMPANY
LADYSMITH, WISCONSIN 54848

FLAMBEAU MINE
MAJOR UNDERGROUND STRUCTURES
OUTSIDE OF THE INDUSTRIAL OUTLOT
JANUARY, 1999
FIGURE 2-3

MICROFILM	SCOPE
	98F002
DRAWING NO.	REV.
2	
PREPARED BY:	CHECKED BY:
JRB2	JBH
SCALE	SEE BAR SCALE

I:\98f002\97f011\7111f47.dgn Jan. 26, 1999 15:46:20

2.3 Site Decommissioning

The following is a summary of the significant structures that were removed or decommissioned in 1998 as part of the mine site reclamation:

- Type I stockpile settling ponds
- Surge and runoff pond.
- Outfall 001
- Fuel storage area
- Contractor office building

2.4 Milestones

The following is a summary of significant milestones throughout the year:

Earthwork resumed	March 16, 1998
Topsoil application initiated	April 27, 1998
Informational meeting with petitioners	June 16, 1998
Modifications to Reclamation Plan/Mining Permit approved	July 30, 1998
Relocation of hydric soils initiated	July 30, 1998
Water Treatment Plant (WTP) permanent shutdown	August 13, 1998
Earthwork complete	August 29, 1998
Trail easement with Ladysmith developed	August 31, 1998
Backfill monitoring wells installed	September 23, 1998
Annual vegetation monitoring initiated	September 29, 1998
1998 seeding complete	October 15, 1998

2.5 DEVIATIONS AND MODIFICATIONS

Condition 2-4 in the Mine Permit requires an inventory of deviations and modifications to the Permit received subsequent to permit issuance.

On January 8, 1998 Flambeau submitted to the WDNR a request for modification of Flambeau's Mining Permit and Reclamation Plan. The proposed modifications included retaining the mining facilities (ie. Administration Building, WTP, railspur and an area totaling approximately 32 acres), relocating the 8.5 acre wetland, retaining Outfall 002 as the south watershed drainage channel, adjusting the onsite watersheds and drainage ways, retaining the Visitors Center parking lot as a trailhead, reclaiming the concrete diaphragm wall in place, and retaining the H&H Haulers building (H&H) for long-term site maintenance. The WDNR

issued the approval of modifications to Flambeau's Mining Permit and Reclamation Plan in a letter dated July 30, 1998. A copy of the WDNR's approval letter is provided in Appendix A. A detailed description of the modification process is provided in the Annual Reclamation Report submitted to the WDNR on November 13, 1998.

Minor deviations related to site decommission, topsoil relocation and site revegetation were reviewed and approved by WDNR prior to implementation on site .

A list of modifications and deviations for 1998 is also included in Appendix A.

2.6 CONSTRUCTION REPORTS

In September 1998, Flambeau installed two well nests each containing four monitoring wells screened at different vertical elevations into the backfilled pit area. Flambeau communicated the proposed installation and construction of the monitoring wells in letters dated July 29, 1998 and August 25, 1998. In a letter dated September 1, 1998, the WDNR conditionally approved the location and proposed construction plans and procedures for Well Nests 1013 and 1014 comprising four wells each into the backfilled pit. The wells were installed in substantial accordance with the approved construction plans and procedures. Well construction and well development documentation will be provided to the WDNR under a separate letter.

In accordance with Section 10.1.3.2 of the Mine Permit Application (December 1989) in situ permeability tests were conducted on the wells recently installed in the backfilled pit. On November 30, 1998 Scott Jansen of Foth & Van Dyke performed slug tests to evaluate the hydraulic conductivity of the formation surrounding the well screen of each well. For the wells screened below the saprolite layer, the hydraulic conductivity measurements ranged from 2.13E-6 cm/s to 1.19E-2 cm/s with a geometric mean of approximately 2E-4 cm/s. A memorandum summarizing the results of the slug tests is provided in Appendix B.

.006 Hd 33.73 Hd 0.567 Hd

2.7 INCIDENT LOG

Mine Permit Condition 2-6 requires a log of all incidents such as spills, pond overflow, embankment failure or leakage. This log is maintained on-site and is available for inspection. A summary of the incidents reported to the environmental staff during 1998 is included in Table 2-1. Spills are reported in accordance with Wis. Adm. Code ch. NR 706, CERCLA Reportable Quantities and SARA Section 302 Extremely Hazardous Substances Reportable Quantities.

Table 2-1
Flambeau Mining Company
1998 Incident Log

DATE	INCIDENT	ACTION
4/17/98	~20 gal. diesel fuel spill due to fuel pump malfunction on fuel truck.	Contaminated material contained and cleaned up. Spill prevention and control restressed with Ames Construction. WDNR notified on 4/17/98.
8/3/97	~10-12 gal. hydraulic fluid spill due to broken hydraulic line on backhoe.	Contaminated material contained and cleaned up. Continued inspection and replacement of parts as possible. WDNR notified 8/3/98.

2.8 DRILL HOLES

Mine Permit Condition 2-7 requires a summary of all exploration drilling activities conducted on the mine site during the previous year. No exploration drilling activities were conducted on the mine site during 1998.

3.0 RECLAMATION ACTIVITIES

As required by the Mine Permit Section 3, reports on progress of reclamation activities are prepared throughout the year. An annual report is required by Condition 3-26(d). The 1998 Annual Reclamation Report dated November 13, 1998 was submitted to the WDNR and is incorporated by reference. Other reclamation updates submitted on January 30 and November 6, 1998 are incorporated by reference. Reclamation activities reported in the November 1998 report included a summary of the modification of Flambeau's Mining Permit/Reclamation Plan, description of material redistribution in 1998, a summary of onsite vegetation activities including the seeding and planting of the site, water treatment plant decommission/shutdown and assessment and remediation of Wetland 1.

Wetland 1 is discussed in detail in Wetland Surface Flows, Section 4.2.6 of this report.

Reclamation activities during 1998 included the completion of material redistribution including topsoil and hydric soil. Seeding and planting of the site was conducted sequentially following the completion of earthmoving activities in specific areas. Erosion control measures continued to be consistent with the Surface Water Management Plan and the Surface Reclamation Implementation Plan. Inspection and maintenance of erosion control installations were routinely performed and control features were reinforced or added as needed.

In a January 8, 1998 letter, Flambeau had provided notice of several proposed modifications to the Reclamation Plan of which all were approved by the WDNR with the exception of modification to the Monitoring Plan. Since that time Flambeau has determined that the mine site status and vegetative performance can be assessed in accordance with the approved Monitoring Plan. In a letter dated December 7, 1998 Flambeau requested the withdrawal of proposed modifications to the Monitoring Plan. Additionally, Flambeau submitted with the December 7, 1998 letter a document titled Surface Reclamation Ecological Monitoring Program (SREMP). The SREMP provides detail regarding the implementation of the monitoring program. The procedures described in the SREMP are in accordance with Flambeau's approved Monitoring Plan (MPA, Section 5.11.4.8).

4.0 SITE MONITORING

4.1 GROUNDWATER QUALITY SAMPLING AND ANALYSIS

Quarterly groundwater monitoring was performed in accordance with descriptions provided in the Updated Monitoring Plan (July 1991), the Revised Mining Permit Quality Assurance/Quality Control Document (August 1991) and the Local Agreement. Results of the monitoring were submitted to the WDNR Mine Reclamation Unit March 30, June 30 and September 30 and December 29, 1998. Those reports are incorporated by reference.

Monitoring data for each groundwater monitoring site is graphed and tabulated in Appendix C. A statistical trend test (Mann-Kendall test) was performed on the results for each compound within each well. Those results are also shown with the tabulated data. Only those water quality parameters which showed a statistically significant trend upward or downward are discussed in this section. More detailed information on trend analysis and other trends is contained in Appendix C.

In general, the groundwater quality trends are very similar to those identified in 1997 with the exception of MW1000PR. As a result of distinct changes in water quality in well MW1000PR during 1998, interpretation of trend graphs was used rather than the Mann-Kendall test to determine current trends for MW1000PR. Interpretation of MW1000PR trend graphs indicate significant increases in the conductivity, and in the concentrations of alkalinity, copper, hardness, manganese, sulfate and TDS took place during 1998. The results for MW1000PR is discussed in more detail later in this section. Sample results from the following wells appeared to show statistical trends:

MW1002G	Hardness	(Downward Trend)
MW1004P	Alkalinity	(Downward Trend)
	Hardness	(Downward Trend)
	Iron	(Downward Trend)
	Manganese	(Downward Trend)
	Sulfate	(Upward Trend)
MW1004S	pH Field	(Downward Trend)
	Copper	(Downward Trend)
MW1005	Conductivity	(Downward Trend)
	Alkalinity	(Downward Trend)
	Hardness	(Downward Trend)

MW1005P	Hardness	(Downward Trend)
	Iron	(Downward Trend)
	Manganese	(Downward Trend)
	Sulfate	(Upward Trend)
MW1005S	Alkalinity	(Downward Trend)
	Hardness	(Downward Trend)
	Sulfate	(Upward Trend)
MW1010P	Alkalinity	(Downward Trend)
	Iron	(Downward Trend)
	TDS	(Downward Trend)

Monitoring well MW1010P indicates a downward trend for alkalinity, iron and TDS. These downward trends do not represent substantial changes in alkalinity, iron or TDS concentrations.

A downward trend was observed for hardness in MW1002G. The downward trend is slight and the concentrations have remained relatively constant since the fourth quarter of 1993 through 1998.

A downward trend was observed for alkalinity, hardness, iron and manganese in MW1004P. The downward trends for alkalinity and hardness are very slight. The downward trends for iron and manganese are mostly associated with drop in concentrations during 1993. A slight upward trend was observed for sulfate in MW1004P.

A downward trend was observed for pH and copper in MW1004S. Field pH readings have been in a range of 5.84 s.u. to 6.90 s.u. between October 1994 and October 1998 with the exception of an apparent anamolous reading in the third quarter of 1998.. This pH range is not significantly different from data collected from other groundwater monitoring wells in the area. The decrease in copper values does not reflect a substantial change in concentrations.

Monitoring wells MW1005P and MW1005S indicate downward trends for hardness. These trends were slight with actual concentrations dropping only slightly from 1991 through 1998. A downward trend was also observed for alkalinity in MW1005S and MW1005. Downward trends for iron and manganese and a slight upward trend for sulfate were observed in MW1005P. A slight upward trend for sulfate was also observed for MW1005S. A downward trend in MW1005 was also observed for conductivity and hardness.

Downward trends in groundwater elevations in some of the wells located within close proximity of the pit were observed from 1993 through 1996 and to a less significant degree in 1997. The installation of eight monitoring wells placed in the pit backfill in the fall of 1998

provided infromation as to the groundwater elevations in and around the backfilled pit. Groundwater elevation measurements as well as a corresponding potentiometric surface map shows substantial groundwater recovery in and around the backfilled pit. In 1998, recharges of groundwater elevations occurred at MW1000PR, MW1003P, MW1004P, MW1004S, MW1010P, OW39, 0W42, PZR1, PZS1 and PZS3. Figure 4-1 presents the locations of monitoring wells. Graphs and further discussion on groundwater elevations are included in Appendix C.

The increasing trends identified earlier in this section for MW-1000P-R is directly related to the substantial groundwater recovery in and around the backfilled pit. The groundwater elevations in and around the pit indicate that groundwater is now moving, as expected, from the pit toward Flambeau River, the regional groundwater discharge point. A more detailed discussion of the groundwater recovery in and around the pit as well as its coorelation to trends observed for MW-1000P-R is provided in Appendix C.

4.2 SURFACE WATER

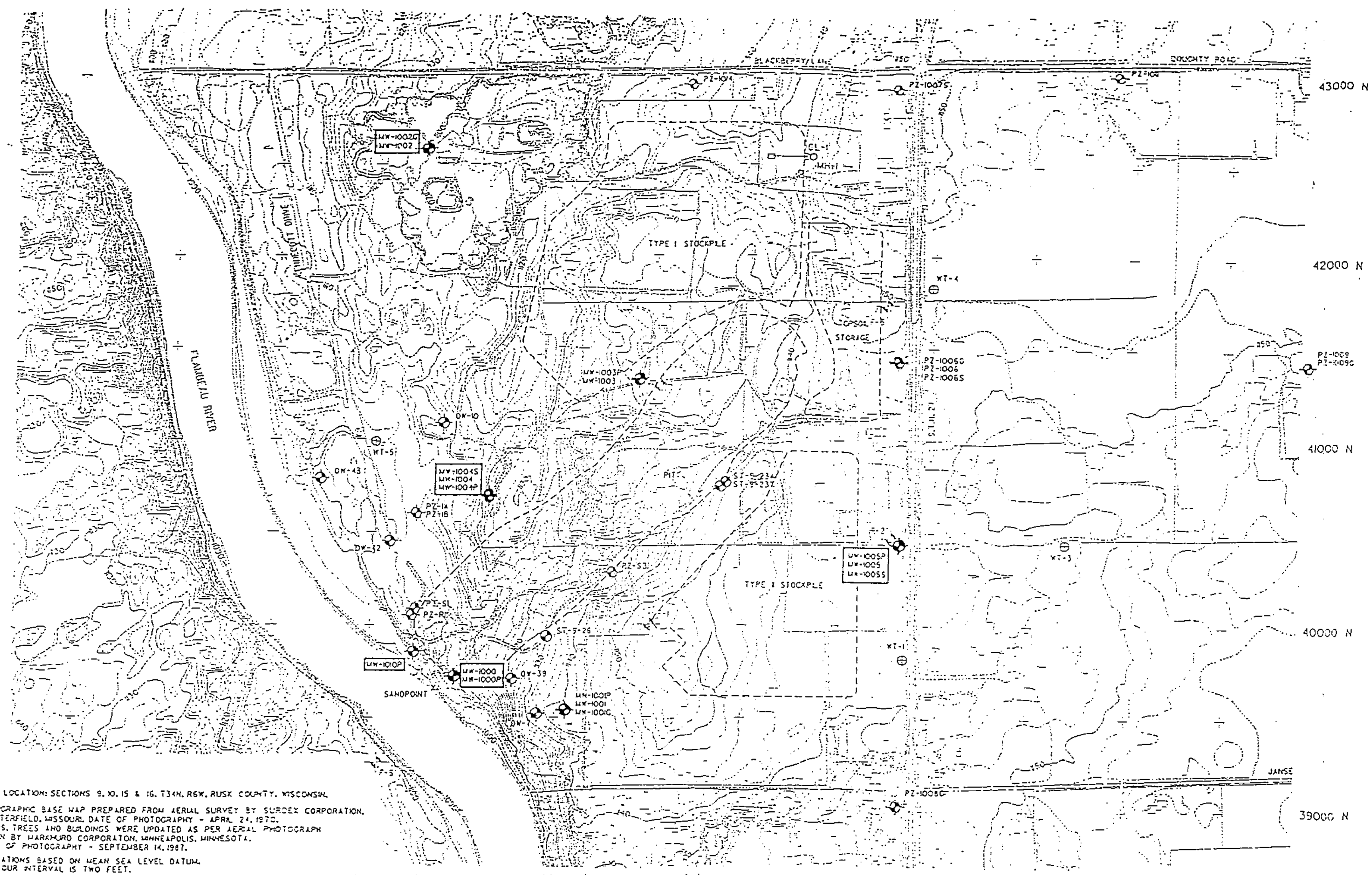
The surface water monitoring program includes sampling and analyses of the following elements: sediments, fish, macroinvertebrates, water quality, habitat characteristics and wetland surface flows. The Revised Mining Permit Quality Assurance/Quality Control Document (August 1991) specifies that an annual surface water monitoring report will be prepared and submitted to WDNR in March of each year. This portion of this report submitted in January, is the surface water monitoring report referenced in the Quality Assurance Document.

4.2.1 SEDIMENTS

Sediment samples are collected once per year at two locations in the Flambeau River. Sediment traps were installed upstream (Site S-1) and downstream (Site S-3) of the Flambeau discharge locations on June 4, 1998 and retrieved on August 4, 1998.

Figure 4-2 shows the sediment sampling locations. Results from the downstream sample site are noted on Table 4-1. Results from the Blackberry Lane sampling site upstream of the mine site are noted in Table 4-2. More detailed information about the sediment sampling is contained in Appendix D.

In general, jar samples from both sites appeared to contain quantities of sediment similar to previous years with little variability from jar to jar and from upstream sample to downstream sample. Comparison of 1998 analyses with all previous years' data indicates that no significant increase or decrease in parameter concentrations in river sediment is occurring. Downstream samples continue to compare favorably to upstream samples indicating that no observable impact on the Flambeau River sediments from mine activities has occurred.



COLLECTION LYSIMETER/ WELL/PIEZOMETER NUMBER	ELEVATION OF SCREENED INTERVAL (FT. MSL)	GEOLOGIC UNIT	PARAMETER*
MW-1000	1091-1081	PRECAMBRIAN, TILL	1, 2
MW-1000P	1049-1044	PRECAMBRIAN	1, 2
MW-1001	1118-1108	TILL	1
MW-1001G	1095-1090	TILL, SANDSTONE	1
MW-1001P	1051-1046	PRECAMBRIAN	1
MW-1002	1096-1086	SAND & GRAVEL	1, 2
MW-1002G	1055-1050	SAND & GRAVEL	1, 2
MW-1003	1113-1103	SANDSTONE	1
MW-1003P	1062-1057	PRECAMBRIAN	1
MW-1004	1112-1102	SAND & GRAVEL	1, 2
MW-1004S	1093-1088	SANDSTONE	1, 2
MW-1004P	1042-1037	PRECAMBRIAN	1, 2
MW-1005	1134-1124	TILL	1, 2
MW-1005S	1097-1092	SANDSTONE	1, 2
MW-1005P	1056-1051	PRECAMBRIAN	1, 2
PZ-1006	1143-1138	TILL	1
PZ-1006G	1119-1114	TILL	1
PZ-1006S	1101-1096	SANDSTONE	1
PZ-1007S	1110-1105	SANDSTONE	1
PZ-1008	1138-1128	TILL	1
PZ-1008G	1096-1091	SAND & GRAVEL	1
PZ-1009	1144-1134	TILL	1
PZ-1009G	1107-1102	TILL	1
MW-1010P	987- 982	PRECAMBRIAN	1, 2
PZ-1011	1108-1098	TILL	1
PZ-1012	1110-1100	TILL	1
PZ-R1	901- 881	PRECAMBRIAN	1
PZ-S1	1067-1062	PRECAMBRIAN	1
PZ-S3	1100-1095	SANDSTONE	1
SANDPOINT	1084-1082	SAND & GRAVEL	1
ST-9-23	1105-1101	SANDSTONE	1
ST-9-23A	1125-1120	SAND & GRAVEL	1
ST-9-26	1106-1101	TILL	1
PZ-1A	1099-1097	SAND & GRAVEL	1
PZ-1B	1103-1101	SAND & GRAVEL	1
OW-7	1088-1078	TILL	1
OW-10	1063-1059	TILL	1
OW-39	1107-1073	TILL	1
OW-42	1090-1058	SAND & GRAVEL	1
OW-43	1090-1022	SAND & GRAVEL	1
CL-1	N.A.	N.A.	3

GROUNDWATER AND COLLECTION LYSIMETER CONSTRUCTION AND OPERATION MONITORING PROGRAM

*1 GROUNDWATER ELEVATION (QUARTERLY).

*2 SPECIFIC CONDUCTIVITY (FIELD), PH (FIELD AND LAB), TDS, IRON, MANGANESE, SULFATE, COPPER, TOTAL ALKALINITY, TOTAL HARDNESS (ALL QUARTERLY).

*3 PH (FIELD AND LAB), SPECIFIC CONDUCTANCE (FIELD), TOTAL CHROMIUM, COPPER, IRON, MANGANESE, SULFATE, TOTAL DISSOLVED SOLIDS, TOTAL ALKALINITY, TOTAL HARDNESS, VOLUME OF LIQUID REMOVED (ALL QUARTERLY).

NOTES:

1. SITE LOCATION: SECTIONS 9, 10, 15 & 16, T34N, R6W, RUSK COUNTY, WISCONSIN.
2. TOPOGRAPHIC BASE MAP PREPARED FROM AERIAL SURVEY BY SURDEX CORPORATION, CHESTERFIELD, MISSOURI. DATE OF PHOTOGRAPHY - APRIL 24, 1970. ROADS, TREES AND BUILDINGS WERE UPDATED AS PER AERIAL PHOTOGRAPH TAKEN BY MARKHURD CORPORATION, MINNEAPOLIS, MINNESOTA. DATE OF PHOTOGRAPHY - SEPTEMBER 14, 1987.
3. ELEVATIONS BASED ON MEAN SEA LEVEL DATUM. CONTOUR INTERVAL IS TWO FEET.
4. HORIZONTAL DATUM BASED ON PROJECT SITE GRID SYSTEM. SITE GRID COORDINATES CORRELATION TO STATE PLANE COORDINATES DERIVED AS FOLLOWS:

SITE GRID COORDINATES CONTROL MONUMENT F-1	STATE PLANE COORDINATES
42000 N =	587,357.8087 N
42000 E =	1,713,516.1229 E

THE ANGULAR ROTATION FROM STATE PLANE BEARINGS TO SITE GRID BEARINGS IS 359°-13'-23" RIGHT WITH CONTROL POINT F-1 AS THE BASE POINT.

5. SEE FIGURE NO. 2-7 FOR THE LOCATION OF WETLAND STAFF GAUGE WT-2 AND FOR SURFACE WATER MONITORING LOCATIONS.

LEGEND

- 1100 EXISTING CONTOUR
- EXISTING PAVED ROADWAY
- EXISTING TRAIL/GRAVEL SURFACE
- TREES AND/OR BRUSH
- FENCE
- F-1 CONTROL MONUMENT
- MW-1005 MONITORING WELL
- PZ-R3 PIEZOMETER
- MW-1005 WELL ON THE WATER QUALITY MONITORING PROGRAM
- WT-5 WETLAND STAFF GAUGE

N

0 300' 600'
SCALE

FOTH & VAN DYKE
GEOSCIENCES & ENVIRONMENTAL MANAGEMENT DIVISION
GREEN BAY, WISCONSIN

FLAMBEAU PROJECT
LADYSMITH, WISCONSIN

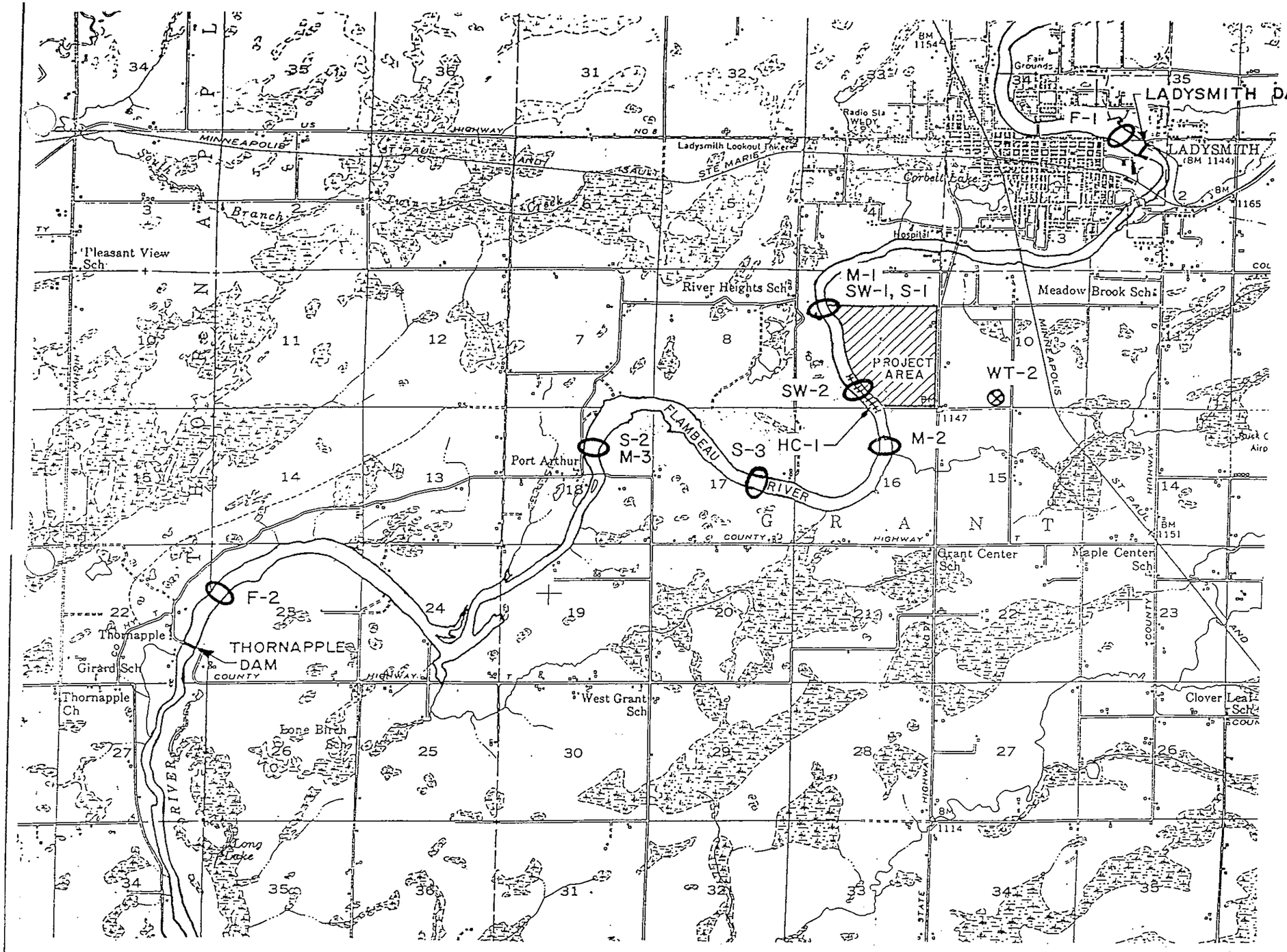
KENNECOTT MINERALS COMPANY
66 MINERAL SQUARE
SALT LAKE CITY, UTAH

FIGURE 4-1
CONSTRUCTION AND OPERATION GROUNDWATER AND COLLECTION LYSIMETER MONITORING PROGRAM

CHKD JBH 7-1-91

SCALE SEE BAR SCALE

REFERENCES — DWG. NO. — DESCRIPTION — 3
REVISIONS



NOTE: SEE FIGURE NO. 2-1 FOR THE LOCATION OF WETLAND STAFF GAUGES WT-1, WT-3, WT-4 AND WT-5.

N

0 4000' 8000'

SCALE

LEGEND

- SW-1 — SAMPLING LOCATIONS FOR SURFACE WATER SAMPLES
- S-1 — SAMPLING LOCATION FOR SEDIMENTS
- M-1 — SAMPLING LOCATION FOR MACRO-INVERTEBRATES
- F-1 — SAMPLING LOCATION FOR FISH
- HC-1 — LOCATION FOR HABITAT CHARACTERISTICS OBSERVATIONS
- WT-2 — WETLAND STAFF GAUGE

MAP SOURCE: U.S.G.S. LADYSMITH, WI. 15 MINUTE QUADRANGLE

DWG. NO.	DESCRIPTION

REFERENCES

DWG. NO.	DESCRIPTION
15	

NO.	DATE	REVISIONS	BY	CHK'D	DATE

NO.	DATE	REVISIONS	BY	CHK'D	DATE

	BY	DATE
PROJ. ENGR		
PROJ. SUPERVISOR		
DATE WORK		

	BY	DATE
DESIGN		
DRAWN	DHS	12/89
CHK'D		
QCL ENGR		
SCIT ENGR		

FOTH & VAN DYKE
GEOSCIENCES & ENVIRONMENTAL MANAGEMENT DIVISION
GREEN BAY, WISCONSIN

FLAMBEAU PROJECT
LADYSMITH, WISCONSIN

KENNECOTT MINERALS COMPANY
1515 MINERAL SQUARE
SALT LAKE CITY, UTAH 84112

FIGURE 4-2
CONSTRUCTION AND OPERATION
SURFACE WATER MONITORING
SITE LOCATIONS

RECEIPT NO.	JOB
DRAWING NO.	REV.
DIVISION DRAWING NO.	
SCALE 1	

TABLE 4-1

FLAMBEAU RIVER SEDIMENT SAMPLING RESULTS
DOWNSTREAM SAMPLING
(S-2 & S-3)

Metals (ppm)	1989 Baseline[1]	1991 (S-2)	1992 (S-2)	1993 (S-2)	1993 (S-3)	1994 (S-3)	1995 (S-3)	1996 (S-3)	1997 (S-3)	1998 (S-3)
aluminum	NA	4000.0	12000.0	1500	4400	4000	3600	2500	2400	2000
arsenic	1.1	1.5	4.1	<0.55	0.71	<1.6	1.5	<0.45	<0.71	0.94(1)
cadmium	<0.5	0.6	<1.4	<0.055	0.11	0.13	0.085	0.64	0.70	1.0
chromium	4.8	13.0	24.0	23.8	9.6	10	6.6	6.3	6.1	5.6
copper	2.6	7.2	24.0	2.1	6.7	7.1	7.0	8.2	6.7	6.1
iron	2200	16000	25000	3100	8200	7700	7300	6700	7900	6300
lead	<4.5	6.9	20	2.6	8.3	7.8	7.5	9.0	6.4	5.9
manganese	63	1600.0	570.0	610	830	860	780	840	910	910
mercury	<0.01	0.1	<0.3	<0.057	<0.07	<0.03	<0.06	<0.02	0.059	0.042(1)
nickel	NA	7.3	12.0	1.7	6.5	6.2	5.0	5.7	3.0	3.1
selenium	NA	0.4	<0.9	<0.28	<0.26	<1.6	<0.27	1.4	0.95	<0.37
silver	NA	<1.1	<2.6	0.086	0.58	<0.08	0.04	<0.56	<0.40	<0.044
zinc	28	45.0	79.0	9.6	33	46	26	28	24	21
Other										
Total Solids (%)	69	76.8	35.0	32	56	NA	44.8	49.8	30.6	24.5
Total Volatile Solids (%)	NA	2.5	12.0	5.8	6.24	NA	6.9	5.5	11	15

NA = Not Analyzed

[1] Environmental Impact Report, March 3, 1989, p. 3.7-1.1

(1) < LOQ

TABLE 4-2

FLAMBEAU RIVER SEDIMENT SAMPLING RESULTS
BLACKBERRY LANE (UPSTREAM)
(S-1)

Metals (ppm)	1989 Baseline[1]	1991	1992	1993	1994	1995	1996	1997	1998
aluminum	NA	3800.0	3300.0	4000.0	3900	2900	1900	2100	1900
arsenic	0.9	2.2	2.2	1.4	<4.2	<0.41	1.6	<0.87	<0.87
cadmium	<0.5	<0.7	<0.6	<0.06	<0.42	<0.03	0.72	1.2	1.2
chromium	5.5	11.0	10.0	11	10	4.4	4.1	5.6	5.3
copper	2.8	7.3	6.0	7.0	5.8	6.4	5.8	5.3	4.9
iron	3000	18000.0	16000.0	15000	11000	4800	6800	6500	7900
lead	<4.5	6.0	5.8	8.5	3.3	3.3	<2.2	5.1	5.1
manganese	130	1900.0	1000.0	1300	1500	600	510	700	1100
mercury	<0.01	0.1	<0.1	<0.045	<0.04	<0.02	<0.02	0.024	<0.013
nickel	NA	5.8	6.1	8.4	7.4	6.1	6.1	2.2	4.4
selenium	NA	0.4	<0.4	<0.32	4.2	<0.44	<0.28	<1.0	<0.37
silver	NA	<1.2	<1.1	0.057	<0.21	<0.05	<0.57	<0.70	<0.043
zinc	16	47	33.0	38.0	34	18	19	20	18
Other									
Total Solids (%)	85	73	78.6	79.2	NA	76.7	74.9	72.6	41.7
Total Volatile Solids (%)	NA	1.8	1.6	0.8	NA	<2.0	<2.0	<2.0	6.7

NA = Not Analyzed

[1] Environmental Impact Report, March 3, 1989, p. 3.7-1.1

4.2.2 FISH

Walleye are collected once per year during the annual low flow period. Samples are collected upstream and downstream of the mine site. Samples of fish tissue are analyzed for metals, while length, sex and stomach contents of each fish are noted. In 1998, fish were collected on August 4 and 5 using a boat mounted with an electroshocker. Procedures described in the Updated Monitoring Plan (July 1991) and Revised Mining Permit Quality Assurance/Quality Control Document (August 1991) were followed.

General observations showed that species observed during the collection were consistent with those collected in previous years. The stomach contents of the walleye were mostly digested and mostly undiscernible. There were no significant differences in metal content of fish tissue sampled downstream of the mine site compared to upstream of the mine site. As compared to previous years, fish liver analytical data is consistent with data obtained in previous years. Mercury concentrations in fish tissues continued to be similar to those seen in the past at both the upstream and downstream locations. Appendix E contains more detailed information about the fish sampling. Fish sampling locations are shown in Figure 4-2.

4.2.3 MACROINVERTEBRATES

Crayfish are collected at three sampling locations once per year for metal analyses. The sampling and analyses are conducted in accordance with the Updated Monitoring Plan and the Revised Mining Permit Quality Assurance/Quality Control Document (August 1991). Samples were collected on September 21, 1998. Whole bodies were used for analysis and the results represent a composite for all crayfish collected per site. The analytical data continues to indicate that there is no relative difference in parameter concentrations when comparing upstream to downstream locations.

Samples were collected on August 4, 1998 to identify macroinvertebrate fauna. Following collection, specimens were sent to EA Engineering, Deerbrook, Illinois for identification and enumeration. The results of the 1998 macroinvertebrate sampling continue to show general populations have remained relatively stable with slight variations in populations from site to site and year to year. Macroinvertebrate sampling locations are shown on Figure 4-2.

Results for macroinvertebrate sampling are included in Appendix F.

4.2.4 SURFACE WATER QUALITY

Water samples are taken once per quarter from the Flambeau River at two monitoring locations as long as the permitted discharge is occurring. In a letter dated September 23, 1998 the WDNR notified Flambeau that the WDNR had decided to close the wastewater permit for the discharge described in the Wisconsin Pollutant Discharge Elimination System permit No. WI-0047376-2. As a result of the cessation of permitted discharges from the site and the closing of the above mentioned permit, Flambeau was not required to collect fourth quarter surface

water quality samples. During 1998, samples were collected in accordance with procedures described in the Updated Monitoring Plan (July 1991) and the Revised Mine Permit Quality Assurance/Quality Control Document (August 1991).

The sample identified as SW-1 is upstream of the mine site; SW-2 is downstream of the mine site. Figure 4-2 shows the locations of the surface water sampling. Results of quarterly sampling have been submitted to WDNR on March 30, June 30 and September 30, 1998. Those submittals are incorporated by reference.

A summary of the 1998 surface water quality results are included on Table 4-3. The results from 1998 are generally consistent with data collected from the same locations in 1992-1997 and 1991 during baseline data collections. No significant difference in parameter concentrations is evident when comparing downstream water quality to upstream water quality; however, there is a slightly decreasing trend for aluminum and cadmium at sample location SW-1. A slight increasing trend for cadmium was observed at sample location SW-2. Trends of surface water quality results and statistical trend analysis are contained in Appendix C.

4.2.5 HABITAT CHARACTERISTICS

The annual habitat characterization along the eastern bank of the Flambeau River was conducted on August 4, 1998. The characterization followed procedures described in the Updated Monitoring Plan (July 1991) and the Revised Mining Quality Assurance/Quality Control Document (August 1991).

During the 1998 habitat characterization, substrate conditions of the Flambeau River were observed to have no appreciable differences that could be attributed to mining impacts as compared to 1992 observations which were previous to initiation of discharges from the mine's discharge channels. In accordance with Section 7.4.5 of the Mine Permit Application (December 1989), the 1998 habitat characterization is the final habitat characterization to be conducted.

Additional detail including photographs is provided in Appendix F of this report.

4.2.6 WETLAND SURFACE FLOWS

Water levels in wetlands 1, 5C, 6C, 7 and 10A are measured monthly between March and December. Staff gauges designated WT 1 (Wetland 5C), WT 2 (Wetland 7), WT 3 (Wetland 6C), WT 4 (Wetland 10A) and WT 5 (Wetland 1) are measured. Figure 4-1 and Figure 4-2 show the staff gauge locations.

Measurements were provided to WDNR Mine Reclamation Unit on March 30, June 30, September 30 and December 29, 1998; those reports are incorporated by reference. Tables 4-4 through 4-8 summarize the wetland elevations for the five wetlands. Wetlands 5C, 6C, 7 and 10A showed readings similar to previous years. Following the WDNR's May 5, 1998 approval to withdraw water from the Flambeau River, Wetland 1 was mitigated with water

from the Flambeau River in accordance with Flambeau's May 21, 1997 application. An assessment by a Foth & Van Dyke representative conducted on August 24, 1998, found that Wetland 1 continues to exhibit wetland characteristics and the hydrology is significantly improved due to mitigation water.

4.3 METEOROLOGY

As required in the Air Pollution Control Permit No. 89-DLJ-033, Condition 10, meteorological data is continuously collected from a meteorological station. Operation of the station is in accordance with the Updated Monitoring Plan (July 1991) and the Revised Quality Assurance/Quality Control Document (August 1991). The meteorological station is inspected routinely by Flambeau personnel to verify proper operation. Records of data at the meteorological station are maintained at the Flambeau Mine site and are available to WDNR as required by the Air Permit.

4.4 TOTAL SUSPENDED PARTICULATES (TSP)

As described in the Updated Monitoring Plan (July 1991), Flambeau's Mine Permit, Part 3, Condition 4(b) requires TSP sampling during the reclamation phase to be conducted once every three days during the first year. If after one year of monitoring there has been no exceedance of a TSP standard, the sampling schedule may be reduced to no less than once every 6 days. During the first 10 months of 1998, Flambeau conducted TSP sampling once every three days. In a letter dated October 5, 1998, Flambeau notified the WDNR of its intent to reduce the air monitoring frequency to no less than once every 6 days in accordance with the approved monitoring plan and conditions within the mining permit. The WDNR conveyed its concurrence with the reduced air monitoring frequency in a letter dated November 12, 1998. Flambeau initiated this reduction in the sampling frequency on November 19, 1998 and continued the reduced sampling frequency for the remainder of 1998.

On April 8, 1998, the TSP concentration at Flambeau's northeast air monitor was calculated to be 156 ug/m^3, exceeding the ambient air quality standard for particulate matter of 150 ug/m^3. On July 14, 1998 Flambeau provided an exceedance investigation report in accordance with Mining Permit, Part 4, Condition 4.e). The exceedance investigation report provided information regarding meteorological data, site conditions, site activities and site observations that clearly indicated that the exceedance recorded at the northeast air monitor station was cause by off-site conditions and air quality. Overall, Flambeau remained in compliance with permits and regulations since the remaining results in 1998 from all four air monitors were well below the ambient air quality standard for particulate matter.

The annual geometric mean of TSP measurements for air monitoring stations ranged from 15 ug/m^3 to 19 ug/m^3 which is very consistent with the 1994 and 1997 annual geometric means.

TABLE 4-3
1998 QUARTERLY SURFACE WATER QUALITY DATA SUMMARY

	SW-1 (Upstream)			SW-2 (Downstream)		
	Jan-98	Apr-98	Jul-98	Jan-98	Apr-98	Jul-98
aluminum (ug/l)	36 (1)	65 (1)	<25	74 (1)	57 (1)	120
arsenic (ug/l)	<1.8	<1.8	<1.8	<1.8	4.3 (1)	<1.8
beryllium (ug/l)	<0.083	<0.083	<0.083	<0.083	<0.083	0.21 (1)
cadmium (ug/l)	0.20 (1)	<0.16	<0.16	0.23 (1)	<0.16	<0.16
chromium VI (ug/l)	6.0	<3.6	<3.6	5.0	<3.6	<3.6
chromium (ug/l)	<0.61	<0.61	1.1	3.2	<0.61	1.6 (1)
copper (ug/l)	7.6	<1.7	<1.7	12	<1.7	<1.7
conductivity (field)	136	110	130	168	97	160
DO (mg/l)	7.3	9.0	8.2	7.2	8.7	7.6
hardness (mg/l)	46	29	41	49	28	52
lead (ug/l)	<2.0	<2.0	<2.0	2.1 (1)	<2.0	2.0 (1)
mercury (ug/l)	<0.050	0.33	<0.050	0.060	0.13	<0.050
nickel (ug/l)	1.9 (1)	1.0 (1)	<0.75	3.7	1.3	<0.75
pH (lab)	7.5	7.1	9.2	7.7	7.0	8.7
pH (field)	7.6	7.0	8.7	7.3	7.0	8.3
selenium (ug/l)	<1.6	<1.6	<1.6	2.6 (1)	4.0 (1)	<1.6
silver (ug/l)	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1
sulfide (mg/l)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
TDS (mg/l)	84	71	71	92	88	70
TSS (mg/l)	<1.0	6.0	6.0	3.0	5.0	12
zinc (ug/l)	43	<12	<12	89	<12	<12

(1) < LOQ

TABLE 4-4

MONTHLY WETLAND STAFF GAUGE READING SUMMARY

Staff Gauge Location/
Water Level (MSL)

WETLAND 5C

(WT-1)

	1991	1992	1993	1994	1995	1996	1997	1998
JAN	--	NRT	NRT	NRT	NRT	NRT	NRT	NRT
FEB	--	NRT	NRT	NRT	NRT	NRT	NRT	NRT
MAR	--	1140.62	NRT	NRT	NRT	NRT	NRT	1140.26
APR	--	1140.47	1140.60	1140.73	1140.34	1140.24	1140.28	NSW
MAY	1140.84	1140.21	1140.47	1140.22	1140.11	NSW	NSW	1141.00
JUN	1140.78	NSW	1140.34	1140.06	NSW	1140.14	NSW	NSW
JUL	1140.05	NSW	NSW	NSW	NSW	NSW	1140.10	NSW
AUG	NSW	NSW	1140.48	NSW	1140.65	NSW	1140.40	NSW
SEP	1140.21	1140.09	1140.51	1140.34	NSW	NSW	NSW	NSW
OCT	NSW	1140.68	1140.46	1140.28	1140.18	1140.29	1140.14	NSW
NOV	NRT	NRT	NRT	NRT	NRT	NRT	NRT	NSW
DEC	NRT	NRT	NRT	NRT	NRT	NRT	NRT	NRT

NRT = No reading taken due to frozen conditions
NSW = No standing water

TABLE 4-5

MONTHLY WETLAND STAFF GAUGE READING SUMMARY

Staff Gauge Location/
Water Level (MSL)

WETLAND 6C

(WT-3)

	1991	1992	1993	1994	1995	1996	1997	1998
JAN	--	NRT	NRT	NRT	NRT	NRT	NRT	NRT
FEB	--	NRT	NRT	NRT	NRT	NRT	NRT	NRT
MAR	--	1146.9	NRT	NRT	NRT	NRT	NRT	1146.58
APR	--	1146.72	NRT	1146.89	1146.67	1146.51	1146.51	NSW
MAY	1147.05	NSW	1146.78	NSW	1146.52	NSW	NSW	NSW
JUN	NSW	NSW	1146.66	NSW	NSW	NSW	NSW	NSW
JUL	NSW	NSW	NSW	NSW	NSW	NSW	NSW	NSW
AUG	NSW	NSW	NSW	NSW	NSW	NSW	NSW	NSW
SEP	NSW	NSW	NSW	NSW	NSW	NSW	NSW	NSW
OCT	NSW	NSW	NSW	NSW	1146.49	NSW	NSW	NSW
NOV	NRT	NRT	NRT	NRT	NRT	NRT	NRT	NSW
DEC	NRT	NRT	NRT	NRT	NRT	NRT	NRT	NRT

NRT = No reading taken due to frozen conditions
NSW = No standing water

TABLE 4-6

MONTHLY WETLAND STAFF GAUGE READING SUMMARY

Staff Gauge Location/
Water Level (MSL)

WETLAND 7

(WT-2)

	1991	1992	1993	1994	1995	1996	1997	1998
JAN	--	NRT	NRT	NRT	NRT	NRT	NRT	NRT
FEB	--	NRT	NRT	NRT	NRT	NRT	NRT	NRT
MAR	--	1153.85	NRT	NRT	NRT	NRT	NRT	1153.59
APR	--	1153.74	1153.82	1153.89	1153.59	1153.64	1153.62	1153.31
MAY	1154.00	1153.62	1153.57	1153.49	1153.50	1153.45	1153.39	1153.27
JUN	1153.58	1153.37	1153.64	1153.37	1152.99	1153.50	1153.10	1153.02
JUL	1153.51	1153.16	1153.46	1153.13	NSW	1153.27	1153.42	NSW
AUG	1153.15	1153.15	1153.56	NSW	1153.03	NSW	1153.52	NSW
SEP	1153.52	1153.06	1153.57	1153.48	1153.24	1152.90	1153.34	NSW
OCT	1153.44	1153.16	1153.51	1153.49	1153.58	1153.50	1153.48	NSW
NOV	NRT	NRT	NRT	NRT	NRT	NRT	NRT	1152.96
DEC	NRT	NRT	NRT	NRT	NRT	NRT	NRT	NRT

NRT = No reading taken due to frozen conditions
NSW = No standing water

TABLE 4-7

MONTHLY WETLAND STAFF GAUGE READING SUMMARY

Staff Gauge Location/
Water Level (MSL)

WETLAND 10A

(WT-4)

	1991	1992	1993	1994	1995	1996	1997	1998
JAN	--	NRT	NRT	NRT	NRT	NRT	NRT	NRT
FEB	--	NRT	NRT	NRT	NRT	NRT	NRT	NRT
MAR	--	1146.76	NRT	NRT	NRT	NRT	NRT	1146.63
APR	--	1146.58	1146.74	1146.86	1146.64	1146.58	1146.43	1146.30
MAY	1146.81	1146.46	1146.57	1146.48	1146.55	1146.38	1146.23	1146.39
JUN	NSW	1146.16	1146.55	1146.39	1146.13	1146.49	1145.97	1146.16
JUL	1146.11	1145.91	1146.41	1146.18	1145.83	1146.24	1146.38	NSW
AUG	NSW	1146.00	1146.55	1145.80	1146.52	NSW	1146.49	1145.56
SEP	1146.26	1146.12	1146.57	1146.45	1146.14	1145.85	1146.23	1145.87
OCT	1146.10	1146.34	1146.53	1146.43	1146.53	1146.51	1146.37	1145.65
NOV	NRT	NRT	NRT	NRT	NRT	NRT	NRT	1145.87
DEC	NRT	NRT	NRT	NRT	NRT	NRT	NRT	NRT

NRT = No reading taken due to frozen conditions
NSW = No standing water

TABLE 4-8

MONTHLY WETLAND STAFF GAUGE READING SUMMARY

Staff Gauge Location/
Water Level (MSL)

WETLAND 1

(WT-5)

	1991	1992	1993	1994	1995	1996	1997	1998
JAN	--	NRT	NRT	NRT	NRT	NRT	NRT	NRT
FEB	--	NRT	NRT	NRT	NRT	NRT	NRT	NRT
MAR	--	1102.32	NRT	NRT	NRT	NRT	NRT	1101.92
APR	--	1102.29	1102.49	1102.18	1101.93	1102.06	1101.91	NSW
MAY	1102.35	1102.25	1102.03	NSW	NSW	NSW	NSW	1101.84
JUN	1102.28	1102.26	NSW	NSW	NSW	NSW	NSW	NSW
JUL	1102.23	1101.90	NSW	NSW	NSW	NSW	NSW	NSW
AUG	NSW	1102.21	NSW	NSW	NSW	NSW	NSW	NSW
SEP	1102.33	1102.46	1101.92	NSW	NSW	NSW	NSW	NSW
OCT	1102.32	1102.37	NSW	NSW	1101.97	NSW	NSW	NSW
NOV	NRT	NRT	NRT	NRT	NRT	NRT	NRT	NSW
DEC	NRT	NRT	NRT	NRT	NRT	NRT	NRT	NRT

NRT = No reading taken due to frozen conditions
NSW = No standing water

TSP monitoring results were submitted to the WDNR Air Monitoring Section each month during 1998 as required in the Mine Permit Condition 4-9. The reports were submitted on the following dates: February 19, March 11, April 21, June 8, June 12, July 20, August 24, September 22, October 14 and December 22, 1998 and January 20, 1999. Copies of the reports are incorporated by reference.

Table 4-9 is a summary of the TSP monitoring results for 1998. Figures 4-3 to 4-6 illustrate 1997 trends for TSP at the Flambeau air monitoring stations. Air monitoring station locations are shown on Figure 4-7.

In addition to monitoring TSP, ambient air quality is monitored with respect to arsenic, beryllium, cadmium, chromium, mercury and nickel. Composites of the TSP filters collected over three month periods have been submitted for analyses as specified in Condition 4-4 of the Mine Permit.

Reports of the three month composites submitted to the WDNR Air Monitoring Section during 1998 are incorporated by reference and are summarized in Table 4-10. Analyses resulted in very low or non-detectable concentrations of these metals.

4.5 AERIAL AND COLOR INFRARED PHOTOGRAPHS

Aerial and color infrared photographs were taken of the mine project area and surrounding areas during the late summer on September 16, 1998. The aerial photography followed procedures described in the Mine Permit Application (December 1989) and the Updated Monitoring Plan (July 1991). When comparing the 1998 color infrared photographs to July 19, 1991 and September 1, 1995 photographs, there is no notable difference in terrestrial ecology surrounding the mine site. Aerial photographs were submitted to the Department on December 7, 1998 and are incorporated by reference. A topographic map of the reclaimed mine site is provided in Appendix H.

TABLE 4-9

FLAMBEAU MINING COMPANY
TSP Data Summary (ug/m3)

Date	0001 North Site	0003 Southeast Site	0004 Northeast Site	0005 Northwest Site
1/2/98	18	18	17	15
1/5/98	8	9	11	7
1/8/98	5	6	11	3
1/11/98	12	12	11	11
1/14/98	10	4	9	10
1/17/98	27	27	25	24
1/20/98	9	21	3	8
1/23/98	13	1	4	1
1/26/98	12	15	1	11
1/29/98	11	10	10	10
2/1/98	12	17	12	11
2/4/98	20	25	19	8
2/7/98	38	44	38	32
2/10/98	61	64	58	57
2/13/98	15	19	18	11
2/16/98	31	32	30	25
2/19/98	13	18	18	8
2/22/98	18	21	17	16
2/25/98	21	29	17	15
2/28/98	7	7	7	6
3/3/98	5	6	12	2
3/6/98	11	11	9	7
3/9/98	22	15	23	13
3/12/98	16	15	10	14
3/15/98	6	8	9	5
3/18/98	14	16	13	13
3/21/98	8	8	10	6
3/24/98	22	24	23	16
3/27/98	29	31	28	29
3/30/98	13	13	18	12

TABLE 4-9 (CONT.)

Date	0001 North Site	0003 Southeast Site	0004 Northeast Site	0005 Northwest Site
4/2/98	5	4	NS	4
4/5/98	21	20	22	18
4/8/98	18	24	156	20
4/11/98	22	25	24	22
4/14/98	15	14	10	9
4/17/98	22	21	21	18
4/20/98	16	18	46	12
4/23/98	44	54	NS	36
4/26/98	29	31	57	36
4/29/98	75	62	NS	66
5/2/98	46	58	56	40
5/5/98	57	64	65	58
5/8/98	36	41	54	38
5/11/98	50	57	64	40
5/14/98	91	4	91	95
5/17/98	43	46	43	41
5/20/98	27	27	23	20
5/23/98	35	38	34	29
5/26/98	44	46	66	44
5/29/98	40	42	77	32
6/1/98	36	26	59	36
6/4/98	16	19	16	11
6/7/98	16	12	11	13
6/10/98	28	36	27	21
6/13/98	19	21	22	17
6/16/98	31	32	31	26
6/19/98	19	22	19	16
6/22/98	18	26	20	21
6/25/98	19	25	19	18
6/28/98	19	21	18	18
7/1/98	29	26	30	21
7/4/98	14	15	15	12

TABLE 4-9 (CONT.)

Date	0001 North Site	0003 Southeast Site	0004 Northeast Site	0005 Northwest Site
7/7/98	17	21	17	14
7/10/98	32	34	31	23
7/13/98	38	34	35	35
7/16/98	23	17	19	17
7/19/98	21	20	20	20
7/22/98	23	21	17	18
7/25/98	19	16	24	14
7/28/98	23	27	21	20
7/31/98	28	20	23	17
8/3/98	30	29	25	32
8/6/98	36	38	37	33
8/9/98	26	25	25	24
8/12/98	46	47	43	39
8/15/98	26	28	27	22
8/18/98	12	17	12	NS
8/21/98	22	30	23	18
8/24/98	19	34	20	18
8/27/98	34	42	30	29
8/30/98	19	18	19	19
9/2/98	37	31	29	26
9/5/98	54	55	49	39
9/8/98	15	13	19	7
9/11/98	61	58	58	47
9/14/98	25	28	22	19
9/17/98	39	41	33	28
9/20/98	21	25	21	19
9/23/98	20	21	19	16
9/26/98	15	14	14	12
9/29/98	23	20	26	16
10/2/98	17	22	18	11
10/5/98	16	13	13	11
10/8/98	16	17	15	8

TABLE 4-9 (CONT.)

Date	0001 North Site	0003 Southeast Site	0004 Northeast Site	0005 Northwest Site
10/11/98	39	35	35	29
10/14/98	12	13	11	8
10/17/98	19	18	17	16
10/20/98	8	8	6	7
10/23/98	40	42	38	27
10/26/98	28	27	27	19
10/29/98	15	14	13	11
11/1/98	6	5	6	5
11/4/98	11	7	14	11
11/7/98	16	13	14	2
11/10/98	2	4	3	17
11/13/98	22	22	19	7
11/16/98	13	8	11	3
11/19/98	NS	NS	NS	NS
11/20/98	4	3	4	17
11/25/98	19	20	18	14
12/1/98	21	22	17	9
12/7/98	11	13	11	12
12/13/98	17	14	18	3
12/19/98	4	3	3	12
12/25/98	15	14	14	12
12/31/98	8	9	7	3

NS: No Sample

Figure 4-3

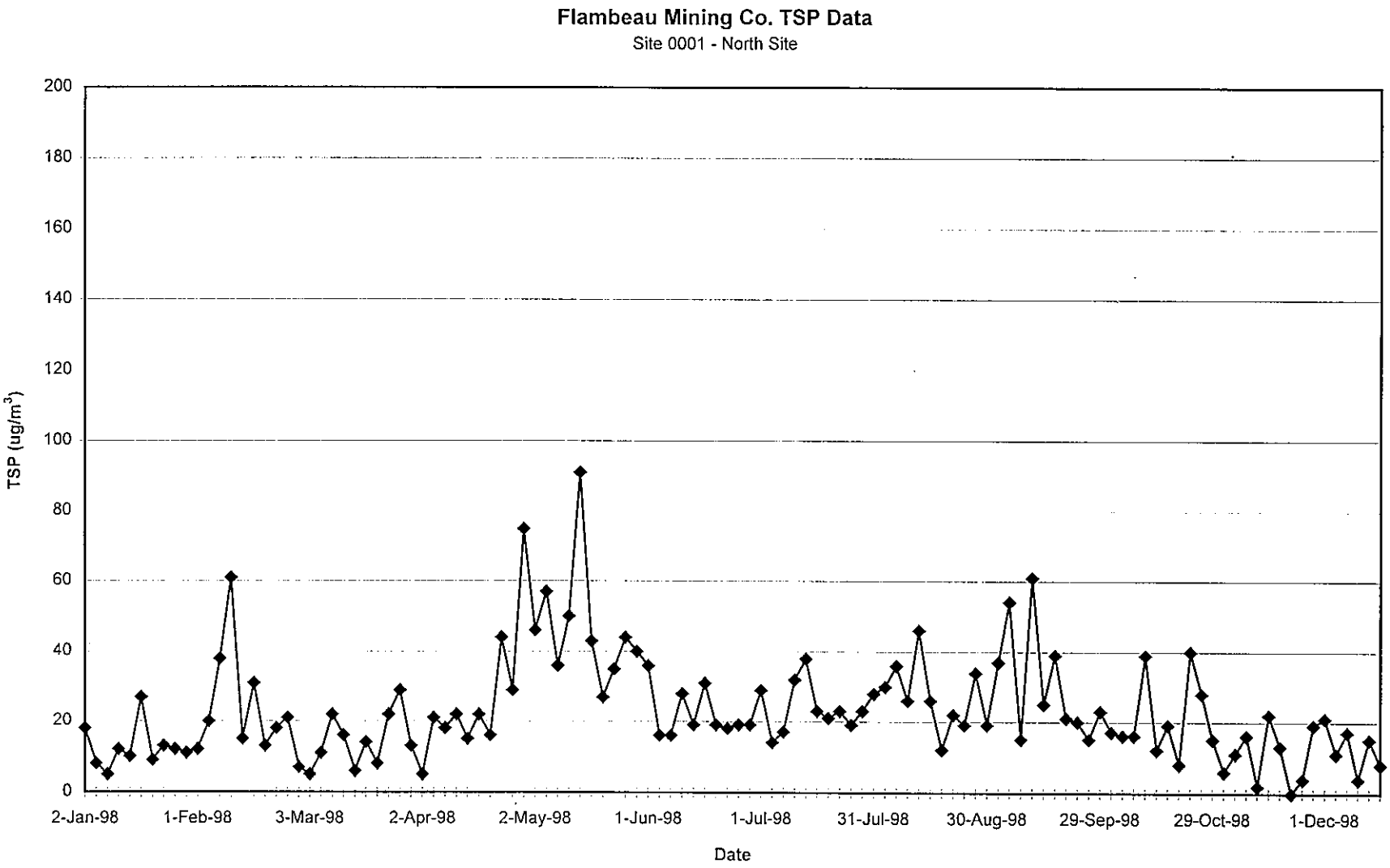

Flambeau Mining Co. TSP Data
Site 0001 - North Site
TSP (ug/m3)
200
180
160
140
120
100
80
60
40
20
0
2-Jan-98
1-Feb-98
3-Mar-98
2-Apr-98
2-May-98
1-Jun-98
1-Jul-98
31-Jul-98
30-Aug-98
29-Sep-98
29-Oct-98
1-Dec-98
Date

Figure 4-4

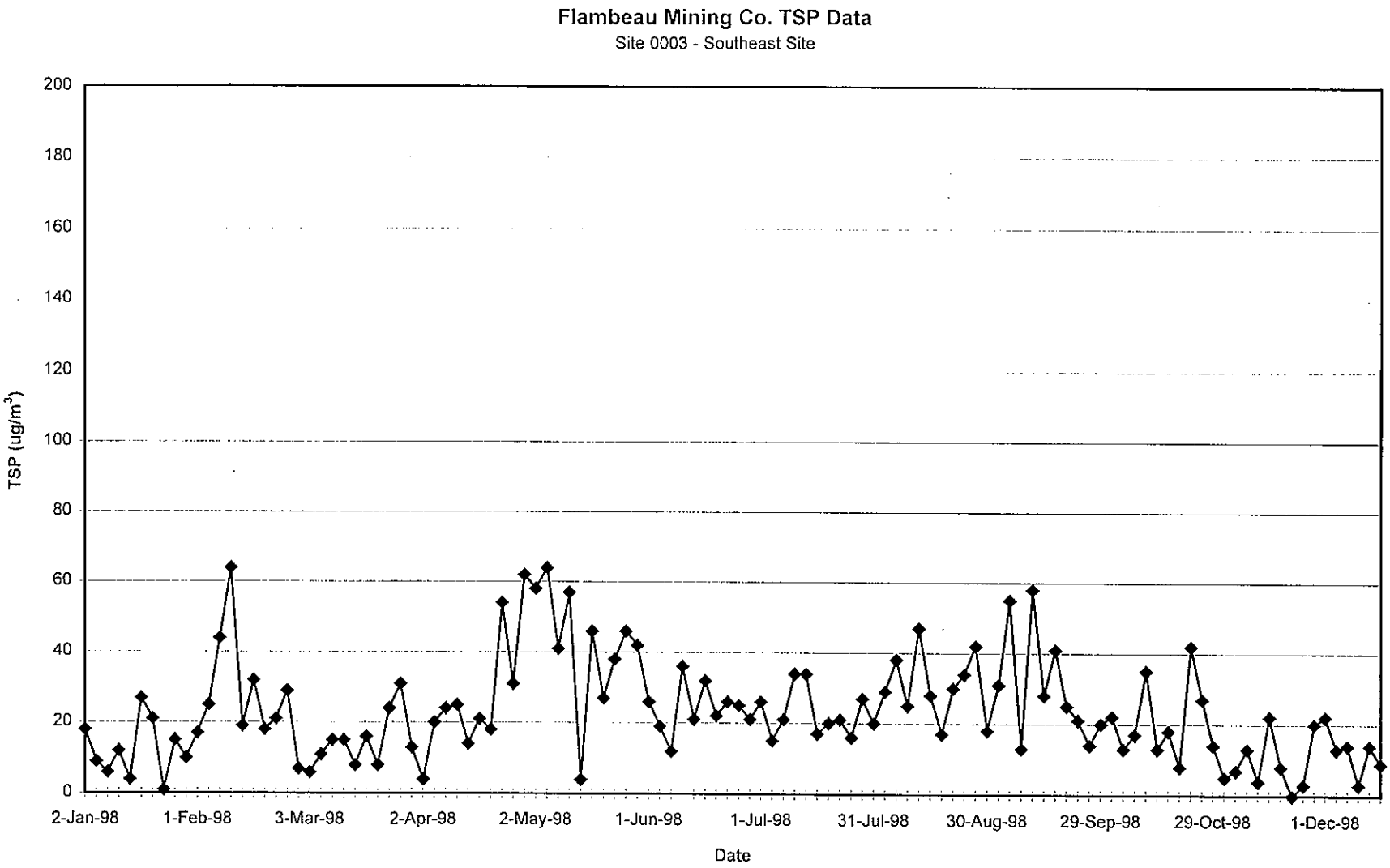

Flambeau Mining Co. TSP Data
Site 0003 - Southeast Site
TSP (ug/m3)
200
180
160
140
120
100
80
60
40
20
0
2-Jan-98
1-Feb-98
3-Mar-98
2-Apr-98
2-May-98
1-Jun-98
1-Jul-98
31-Jul-98
30-Aug-98
29-Sep-98
29-Oct-98
1-Dec-98
Date

Figure 4-5

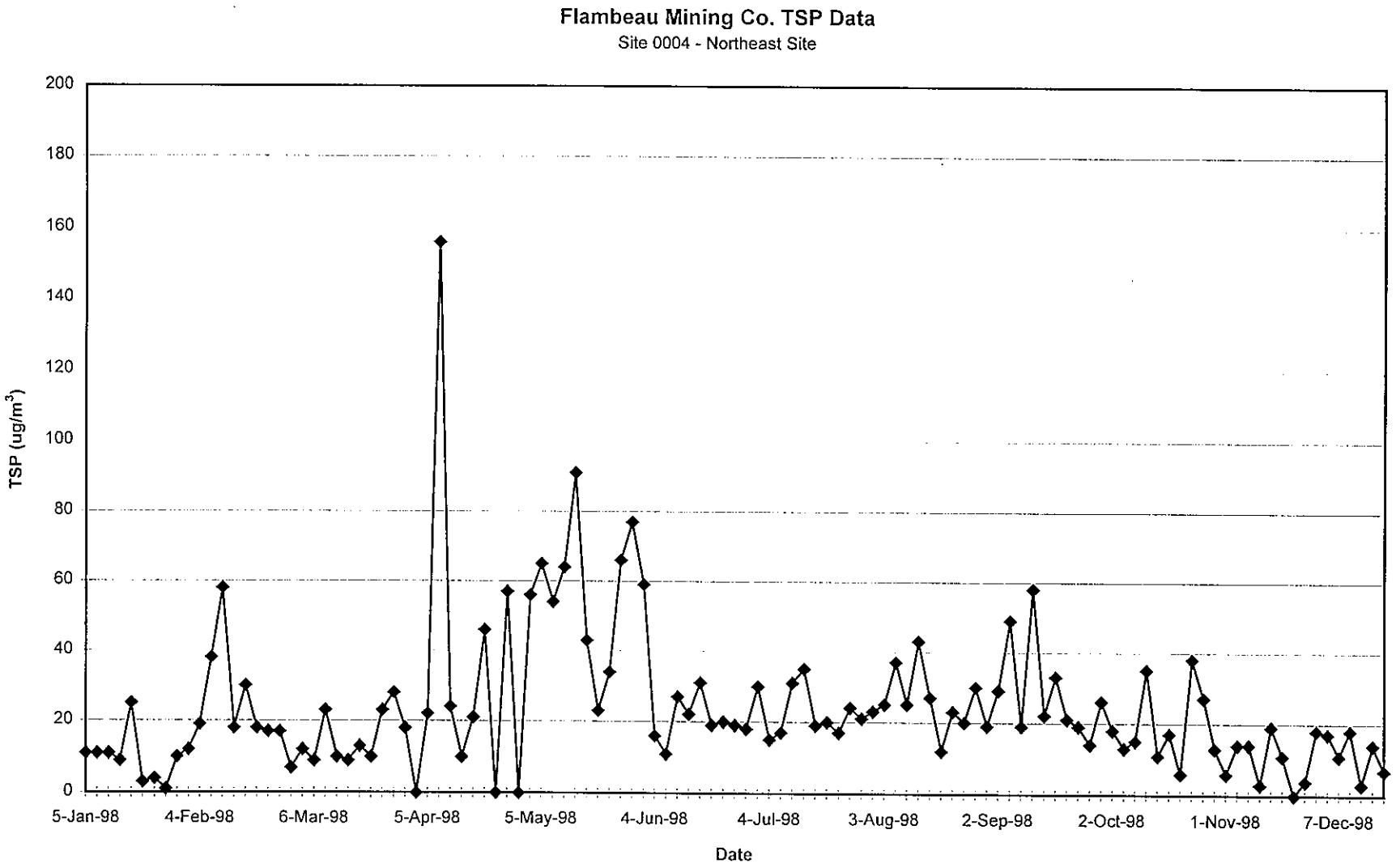
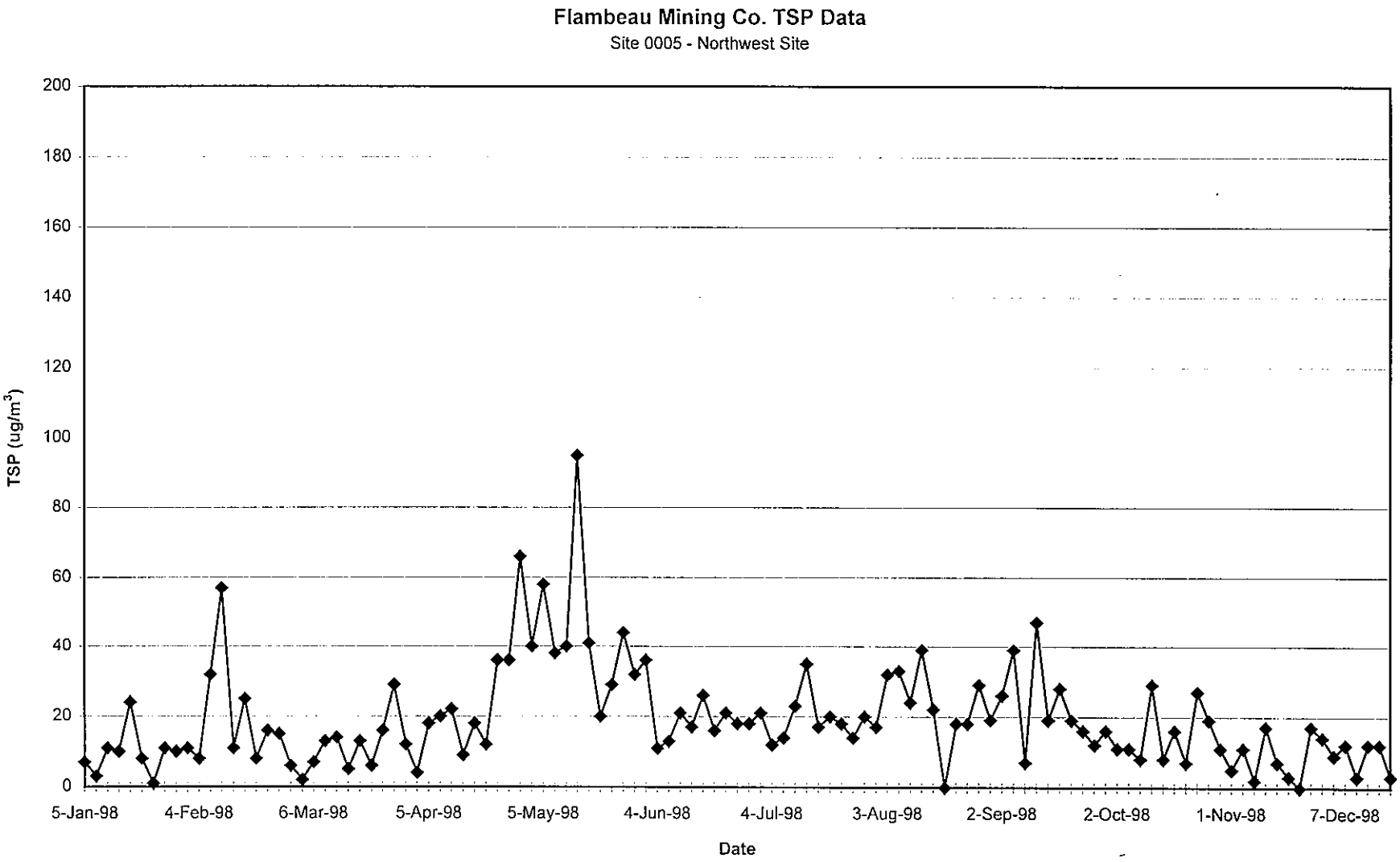
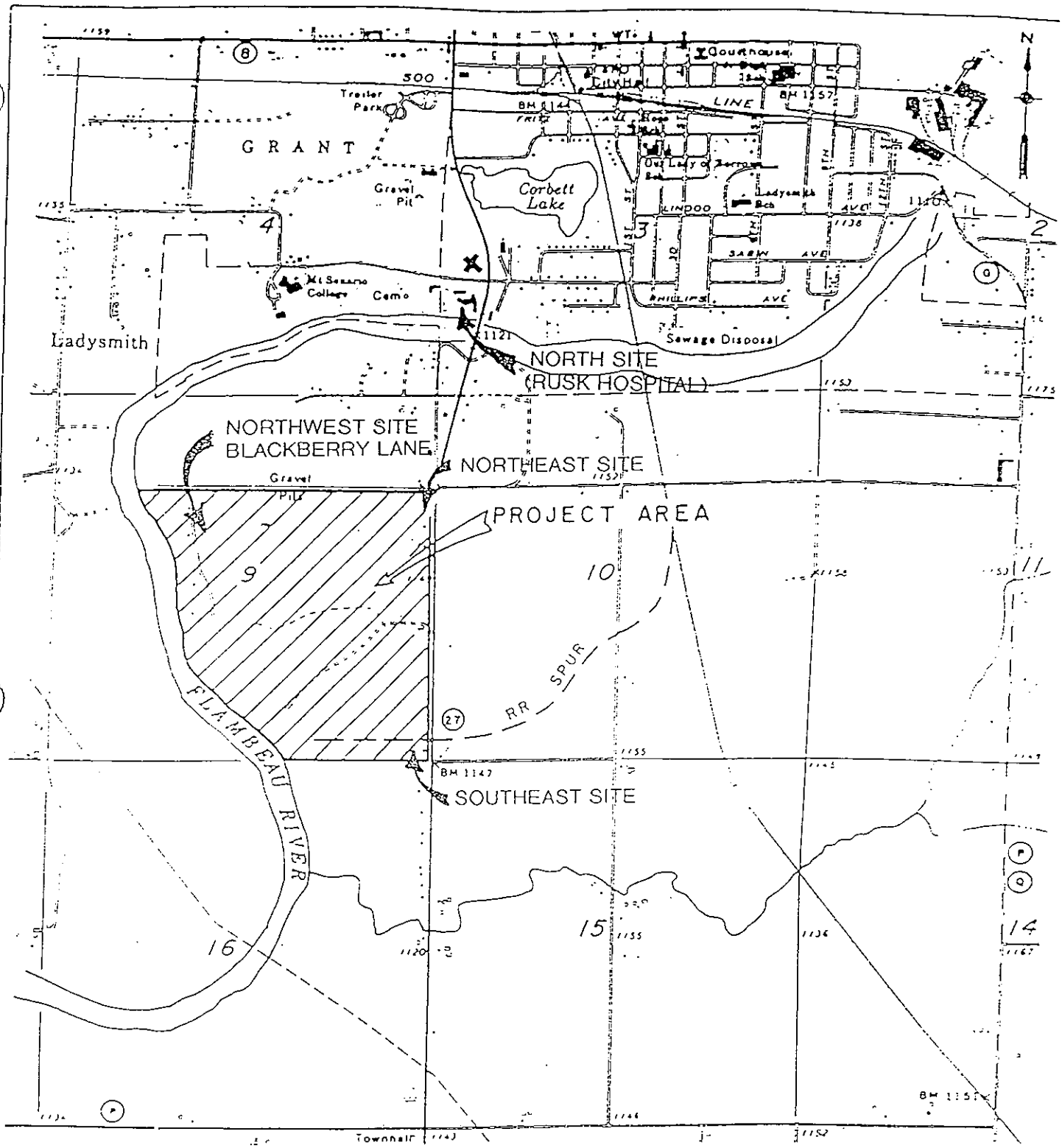

Flambeau Mining Co. TSP Data
Site 0004 - Northeast Site
TSP (ug/m3)
200
180
160
140
120
100
80
60
40
20
0
5-Jan-98
4-Feb-98
6-Mar-98
5-Apr-98
5-May-98
4-Jun-98
4-Jul-98
3-Aug-98
2-Sep-98
2-Oct-98
1-Nov-98
7-Dec-98
Date

Figure 4-6


Flambeau Mining Co. TSP Data
Site 0005 - Northwest Site
TSP (ug/m3)
200
180
160
140
120
100
80
60
40
20
0
5-Jan-98
4-Feb-98
6-Mar-98
5-Apr-98
5-May-98
4-Jun-98
4-Jul-98
3-Aug-98
2-Sep-98
2-Oct-98
1-Nov-98
7-Dec-98
Date



NOTES:

PROJECT AREA INCLUDES A 36 FOOT WIDE CORRIDOR ALONG RAILROAD SPURLINE EAST OF STH 27.

BASE MAP PREPARED FROM U.S.G.S. MAPS 7.5 MINUTE SERIES, LADYSMITH AND THORNAPPLE WI. QUADRANGLES

FOTH & VAN DYKE
GEOSCIENCES & ENVIRONMENTAL MANAGEMENT DIVISION
GREEN BAY, WISCONSIN

KENNECOTT MINERALS COMPANY
FLAMBEAU PROJECT
LADYSMITH, WISCONSIN

FIGURE NO. 4-7
AIR MONITORING SITES

NOTES	APPROVAL		DATE
	DESIGNED BY		
	DRAWN BY	SJL	2/89
	CHECKED BY	GWS	3/89
	APPROVED BY		
	CAD No.	SCALE 1" = 2000'	

Job No | Dwg No | REV

TABLE 4-10

TSP FILTER METAL RESULTS SUMMARY (ug/m3)

	Arsenic	Beryllium	Cadmium	Chromium	Mercury	Nickel
North Site						
12/3/97-2/28/98	0.00069	<0.000192	0.000229	0.000838	0.0000095	0.000927
3/3/98-5/29/98	0.000450	<0.000188	<0.00151	0.00177	0.0000074	0.000767
6/1/98-8/30/98	0.000687	<0.000555	0.000113	0.00448	0.000010	0.00249
9/2/98-11/28/98	0.000613	<0.000544	0.000164	0.00723	<0.000203	0.00441
Southeast Site						
12/3/97-2/28/98	0.000307	<0.000192	0.0000772	0.00148	<0.000156	0.000581
3/3/98-5/29/98	0.000528	<0.000188	<0.00151	0.00240	0.0000098	0.00107
6/1/98-8/30/98	0.000564	<0.000555	0.000133	0.00454	0.000012	0.00227
9/2/98-11/28/98	0.000602	<0.000544	0.000195	0.00337	<0.000203	0.00096

TABLE 4-10 (cont.)

TSP FILTER METAL RESULTS SUMMARY (ug/m3)

	Arsenic	Beryllium	Cadmium	Chromium	Mercury	Nickel
Northwest Site						
12/3/97-2/28/98	0.000553	<0.000192	0.000215	0.00159	<0.000156	0.000875
3/3/98-5/29/98	0.000453	<0.000188	<0.00151	0.00224	0.0000076	0.00101
6/1/98-8/30/98	0.000560	<0.000555	0.000247	0.00379	0.000010	0.00181
9/2/98-11/28/98	0.000522	<0.000544	0.00022	0.00733	<0.000203	0.00440
Northeast Site						
12/3/97-2/28/98	0.000639	<0.000192	0.000187	0.000617	<0.000156	0.001190
3/3/98-5/29/98	0.000405	<0.000188	<0.00151	0.00172	0.0000084	0.00140
6/1/98-8/30/98	0.000539	<0.000555	0.0000751	0.00310	0.000017	0.00152
9/2/98-11/28/98	0.000551	<0.000544	0.000212	0.0113	<0.000203	0.00707

REFERENCES

1998 Annual Reclamation Report	November 1998
Air Pollution Control Permit	January 1991
Enivronmental Impact Report	March 1989
Local Agreement	August 1988
Mining Permit	January 1991
Water Regulatory Permit	January 1991
Revised Mining Permit Quality Assurance/Quality Control Plan	August 1991
Topsoil and Hydric Soils Management Plan	May 1991
Updated Monitoring Plan	July 1991
Vegetative Aquascape Plan	May 1991
Mine Permit Application	December 1989

SUBMITTALS

DOCUMENT	DATE	WDNR SUBMITTEE
Section 2.0 Operating Activities		
1997 Annual Report	January 1998	Larry Lynch[1]
Contaminated Soil Disposal	January 1998	Norm Dunbar[6]
Whole Effluent Toxicity Report	Apr, May, Aug 1998	Paul Luebke[2]
Discharge Monitor Report	Monthly (Jan-Sept) 1998	Janet LaRose[3]
Signatory Authority on DMR's	April 1998	Jim Hansen[9]
State of Wisconsin Substance Release Form	April 1998	Jerry Carow[4]
State of Wisconsin Substance Release Form	August 1998	Jerry Carow[4]
Amendment to Release Notification dated August 5, 1998	August 1998	Jerry Carow[4]
Temporary Basin Water Characterization	August 1997	Larry Lynch[1]
Notice of Water Treatment Plant Shutdown	August 1998	Jim Hansen[9]
WI Stat. 166.20 Reporting	June 1998	Wes Taylor[5]
Clarifier Underflow Analyses (CUF)	April 1998	Larry Lynch[1]
Surface Water Withdrawal Permit	May 1998	Larry Lynch[1]
May 1998 Surface Water Withdrawal	June 1998	Larry Lynch[1]
June 1998 Surface Water Withdrawal	July 1998	Larry Lynch[1]
July 1998 Surface Water Withdrawal	August 1998	Larry Lynch[1]
August 1998 Surface Water Withdrawal	September 1998	Larry Lynch[1]

SUBMITTALS (CONT'D)

DOCUMENT	DATE	WDNR SUBMITTEE
September 1998 Surface Water Withdrawal	October 1998	Larry Lynch[1]
Addendum to Flambeau Mine Ground Water Model	May 1998	Larry Lynch[1]
Extension Request for Submittal of 1997 Emission Inventory	Febuary 1998	Paul Cahoon[7]
1997 Emission Inventory	March 1998	WDNR[14]
1997 Emission Inventory Certificate	July 1998	Ralph Patterson[15]
1997 Hazardous Waste Annual Reporting Exemption	March 1998	Susie Sutton[8]
1997 Environmental Fees Review	March 1998	Environmental Fees[17]
1997 Environmental Fees (Check)	June 1998	Environmental Fees[17]
1997 Environmental Fees (Check)	July 1998	Environmental Fees[17]
Request to use PVC glue on Monitoring Well MW-1000PR	July 1998	Ken Markart[1]
Well Variance Request	October 1998	Ken Markart[1]
Well Variance Request Addendum	November 1998	Ken Markart[1]
Change in Operator-In-Charge	July 1998	Jim Hansen[9]
Licensed Waste Facility Activity	April 1998	Larry Lynch[1]
Hazardous Waste Manifest Submittal	Nov, Dec 1998	WDNR[16]
Section 3.0 Reclamation Activities		
Request for Modifications to Reclamation Plan	January 1998	Larry Lynch[1]
List of 1998 Reclamation Activities	January 1998	Larry Lynch[1]

SUBMITTALS (CONT'D)

DOCUMENT	DATE	WDNR SUBMITTEE
Surface Reclamation Implementation Plan	March 1998	Larry Lynch[1]
Soil Amendment Plan	April 1998	Tom Portle[10]
Permanent One Acre Wetland	May 1998	Larry Lynch[1]
Permanent One Acre Wetland	May 1998	Larry Lynch[1]
Mid Summer Progress Report, 1998	November 1998	Larry Lynch[1]
1998 Annual Reclamation Report	November 1998	Larry Lynch[1]
Pit Backfill QA/QC 1997 Summary	March 1998	Larry Lynch[1]
Issues Raised By Petitioners Regarding Flambeau's Reclamation Plan	July 1998	Larry Lynch[1]
Grading Plan for Final Topography	July 1998	Ken Markart[1]
Surface Reclamation Ecological Monitoring Program	December 1998	Larry Lynch[1]
Section 4.0 Site Monitoring		
Environmental Monitoring Ground Water Quality Results	Quarterly 1998	Larry Lynch[1]
Air Monitoring Results (TSP)	Monthly 1998	Steve Schuenemann[11]
Air Monitoring TSP Exceedance Investigation Report	July 1998	Paul Cahoon[7]
Microscopic Analysis - Northeast Air Monitoring Station	February 1998	Paul Cahoon[7]
Air Monitoring Project-TSP Filer Metal Analytical Results	Feb, Apr, Jul, Nov 1998	Steve Schuenemann[11]

SUBMITTALS (CONT'D)

DOCUMENT	DATE	WDNR SUBMITTEE
Air Monitoring Calibration Data Sheets	Mar, Jun, July, Sept, Oct, Nov, Dec 1998	Steve Schuenemann[11]
Notice of Reduction in Air Monitoring Frequency	October 1998	Larry Lynch[1]
Reduced Air Monitoring Frequency	November 1998	Neil Baudhuin[13]
Potable Water Analysis Results	Mar, May, Sept, Dec 1998	Park Roush[12]
Groundwater Monitoring Well Nests Installation in Backfilled Pit	July 1998	Larry Lynch[1]
Revised Proposal for Constructing Proposed Wells for Backfilled Pit	August 1998	Larry Lynch[1]
1998 Aerial & Color Infrared Photography	December 1998	Larry Lynch[1]

1 Mine Reclamation Unit
Larry Lynch
Ken Markart

2 Bureau of Wastewater Management
Paul Luebke

3 Wisconsin Dept. Of Natural Resources
Janet LaRose

4 Wisconsin Dept. Of Natural Resources
Jerry Carow

SUBMITTALS (CONT'D)

5 Wisconsin Dept. Of Natural Resources
Wes Taylor - Toxics Coordinator

6 Wisconsin Dept. Of Natural Resources
Norm Dunbar

7 Wisconsin Dept. Of Natural Resources
Paul Cahoon

8 Wisconsin Dept. Of Natural Resources
Susie Sutton

9 Wisconsin Dept. Of Natural Resources
Jim Hansen

10 Wisconsin Dept. Of Natural Resources
Tom Portle

11 Air Monitor Section
Steve Schuenemann

12 Wisconsin Dept. Of Natural Resources
Park Roush

13 Wisconsin Dept. Of Natural Resources
Neil Baudhuin

14 Wisconsin Dept. Of Natural Resources
Consolidated Reporting System - AM/7

SUBMITTALS (CONT'D)

15 Wisconsin Dept. Of Natural Resources - AM/7
Ralph Patterson

16 Wisconsin Dept. Of Natural Resources
Bureau of Waste Management

17 Wisconsin Dept. Of Natural Resources
Environmental Fees

APPENDIX A

LIST OF MODIFICATIONS & DEVIATIONS

LIST OF MODIFICATIONS & DEVIATIONS
FROM APPROVED MINING PERMIT PLAN
(PER CONDITION 2-4)

Permit/Application	Section	Modification or Deviation	Authorization		
			Method	Person	Date
Modifications					
Mine Permit Application (Dec. 1989)	5.2 5.6 5.9.1-.4 Figure 5-4	Modification in final land use for 32 acres of the mining site to allow for alternative use of the on-site buildings and related ancillary facilities, railroad spur and a portion of the former Type II waste rock stockpile by the Ladysmith Community Industrial Development Corporation.	Written Approval	Suzanne Bangert	07/30/98
Mine Permit Application (Dec. 1989)	5.2 Figure 5-4	Retention of the existing "H&H Building" and the nearby visitor parking lot for future use.	Written Approval	Suzanne Bangert	07/30/98
Mine Permit Application (Dec. 1989)	5.11.2 5.11.2.1 Figure 5-3	Consolidation of the two restored wetland areas into one 8.5 acre wetland to be located near the northeast corner of the mining site.	Written Approval	Suzanne Bangert	07/30/98
Mine Permit Application (Dec. 1989)	5.11.2.2 Figure 5-3	Modification of the drainage basin for intermittent stream "B" so that the upper portion would become part of the drainage basin for intermittent stream "A" and flow into the reclaimed wetland area. Additionally, the lower part of stream "B" would discharge to the Flambeau River through the existing rip-rapped channel (Outfall 002).	Written Approval	Suzanne Bangert	07/30/98

Permit/Application	Section	Modification or Deviation	Authorization		
			Method	Person	Date
Modifications					
Mine Permit Application (Dec. 1989)		Retention of the concrete diaphragm wall and reclamation of the diaphragm wall in place.	Written Approval	Suzanne Bangert	07/30/98
Mine Permit Application (Dec. 1989)	5.9.5	Perimeter fence shall be removed prior to completion of reclmation activities.	Written Approval	Suzanne Bangert	07/30/98
Mine Permit Application (Dec. 1989)	5.9.6	Temporary retention of the power supply to the mine site including a line to the area adjacent to the west pit wall.	Written Approval	Suzanne Bangert	07/30/98
Mine Permit Application (Dec. 1989)	5.11.4.9	Changes to the maintenance methods applied to the grassland portions of the reclaimed mining site to include secondary methods not to replace burning as the primary method.	Written Approval	Suzanne Bangert	07/30/98
Deviations					
Mine Permit Application (Dec. 1989)		Deposit and/or spread Wastewater Treatment Plant precipitate on the mine site as a soil amendment.	Verbal/Written Approval	Larry lynch	03/19/98 03/20/98
Surface Water Management Plan (May 1991)	3.1.3	Surface water runoff was diverted to adjacent gravel pit.	Verbal/Written Approval	Larry Lynch	03/19/98 03/20/98

Permit/Application	Section	Modification or Deviation	Authorization		
			Method	Person	Date
Deviations					
Mine Permit (Jan. 1991) Mine Permit Application (Dec. 1989)	Part 4 Condition 1 10.1.3.2	Installation of two well nests in the backfilled pit each including four monitoring wells instead of the approved two monitoring wells at each well nest.	Written Approval	Ken Markart	09/01/98
Mine Permit Application (Dec. 1989)		Relocated excess topsoil from the site to the gravel pit adjacent to the mine site.	Verbal Approval	Larry Lynch/ Tom Portle	08/13/98
Mine Permit Application (Dec. 1989)	4.7.4.5 Figure 4-1	Relocation of security fence along west wall to facilitate surface reclamation activities.	Verbal Approval	Larry Lynch	07/14/98

APPENDIX B

SLUG TESTS ON GROUNDWATER MONITORING WELLS IN PIT BACKFILL

Foth & Van Dyke
Memorandum

January 11, 1999

TO: Jana Murphy, Flambeau Mining Company

CC: Jerry Sevick, Foth & Van Dyke
Jim Hutchison, Foth & Van Dyke

FR: Steve Donohue, Foth & Van Dyke SJD

RE: Flambeau Project - Slug Tests on Groundwater Monitoring Wells in Pit Backfill

On November 30, 1998, Scott Janssen of Foth & Van Dyke performed slug tests on groundwater monitoring wells recently installed in the pit-backfill. For groundwater monitoring wells screened below the water table, a slug-in and slug-out test was performed. For the water table well (MW-1013), only a slug-out test was performed. Note that a slug test was not performed at MW-1014 since the standing level of water in the well was less than two feet. During a slug-in test, the static water level in the well is instantaneously increased and the rate of water level decline is recorded. In a slug-out test, the static water level in the well is instantaneously lowered and the rate of water level increase is recorded. The rate of water level increase/decrease is related to the hydraulic conductivity of the formation surrounding the well screen. Slug tests were analyzed in accordance with the methodology described by Bouwer and Rice (1976) and Bouwer (1989). The results of the slug tests are summarized in Table 1 and provided in Attachment 1. For the wells screened below the saprolite layer, the hydraulic conductivity measurements ranged from 2.13E-6 cm/s to 1.19E-2 cm/s. This variability in measured hydraulic conductivity is consistent with the nature of the backfill material, a relatively heterogenous material. The geometric mean (average) of the hydraulic conductivity measurements for wells screened below the saprolite is approximately 2E-4 cm/s. — 0.567 ft/d

Also provided in Figure 1 is a potentiometric surface map based on groundwater elevation measurements from December 1998. The potentiometric surface map shows a substantial amount of groundwater recovery around the backfilled pit, with moderately convergent flow towards the backfilled pit. The reason for the more rapid rate of groundwater recovery than predicted with the project's groundwater flow model (ETA, 1998) is likely attributed to the method of representing the Precambrian bedrock in the regional groundwater flow model. The groundwater flow model represented the Precambrian bedrock, a fractured system, as an equivalent porous medium. During the recovery phase, the groundwater flow model simulates groundwater going back into storage in the Precambrian rock and other hydrostratigraphic units around the backfilled pit. The rate of recovery is related to the assumed porosity of the various bedrock model layers and the extent to which they are dewatered. The model accounts for water going back into storage in the Precambrian rock. In reality, the Precambrian rock is likely to

function as a porous medium only on a localized scale around the mine. This would require less water going back into storage than simulated in the model and accounts for the more rapid rate of groundwater recovery. With respect to future groundwater recovery rates, it is likely that the rate of recovery will be reduced as water goes back into storage in the more porous sandstone and glacial deposits around the site.

References

Bouwer, H. and R. C. Rice, 1976. A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells. Water Resources Research. Vol. 12, No.3.

Bouwer, H, 1989. The Bouwer and Rice Slug Test - An Update. Ground Water. Vol. 27, No. 3.

Engineering Technologies Associates, Inc., 1998. Addendum to Flambeau Mine Groundwater Model.

Table 1

Slug Test Summary for Pit Backfill Wells

Well	Test Method	Formation	Hydraulic Conductivity (cm/s)
MW-1013	Slug-out	Till/Sandstone	2.19×10^{-2}
MW-1013A	Slug-out	Type I Waste Rock	9.64×10^{-6}
	Slug-in		3.44×10^{-6}
MW-1013B	Slug-out	Type II Waste Rock	4.67×10^{-5}
	Slug-in		3.85×10^{-5}
MW-1013C	Slug-out	Type II Waste Rock	1.46×10^{-4}
	Slug-in		1.67×10^{-4}
MW-1014A	Slug-out	Type I Waste Rock	5.20×10^{-6}
	Slug-in		2.13×10^{-6}
MW-1014B	Slug-out	Type II Waste Rock	1.19×10^{-2}
	Slug-in		1.56×10^{-2}
MW-1014C	Slug-out	Type II Waste Rock	4.00×10^{-4}
	Slug-in		6.94×10^{-4}

Prepared by: SVD1
Checked by: JBH1

380+00 E
390+00 E
400+00 E
410+00 E
420+00 E
430+00 E

430+00 N
420+00 N
410+00 N
400+00 N
390+00 N

N

PZ-1012
1105.00

PZ-1007S
1113.97

PZ-1011
1136.23

MW-1002G 1089.77
MW-1002 1089.73

1100
1105
1110
1115
1120
1125
1130
1135
1095
1090
1085

1106.67
1106.67
MW-1003P
MW-1003

MW-1014 1108.41
MW-1014A 1099.88
MW-1014B 1105.34
MW-1014C 1102.04

PZ-1006G 1131.87
PZ-1006 (DRY)
PZ-1006S 1130.40

PZ-1009G 1141.38
PZ-1009 1141.33

OW-10
1085.68

OW-43
1083.12

PZ-1A 1097.89
PZ-1B 1102.94

MW-1004S 1104.35
MW-1004 1104.28
MW-1004P 1102.35

ST-9-23A (DRY)
ST-9-23 1107.13

OW-42
1088.16

MW-1005P 1135.99
MW-1005 1136.77
MW-1005S 1135.77

MW-1013 1106.17
MW-1013A 1095.32
MW-1013B 1094.33
MW-1013C 1094.97

PZ-S3
1104.53

PZ-S1
1092.25
PZ-R1
1089.49

ST-9-26
1101.80

MW-1010P
1086.46

OW-39
1108.48

MW-1000PR
1086.32

MW-1000R
1086.47

OW-7
1102.57

MW-1001P 1106.04
MW-1001 (DRY)
MW-1001G 1105.47

PZ-1008
1134.95

PZ-1008G
1135.13

LEGEND

1130 — POTENTIOMETRIC SURFACE CONTOUR

1135 — INFERRED POTENTIOMETRIC SURFACE ELEVATION CONTOUR

MW-1001G 1105.47 — GROUNDWATER MONITORING WELL AND MEASURED GROUNDWATER ELEVATION (FT MSL)

PZ-1008G 1135.13 — GROUNDWATER ELEVATION (FT MSL)

NOTE: POTENTIOMETRIC SURFACE CONTOURS ARE CONSISTENT WITH GROUNDWATER ELEVATIONS AT NESTED WELLS OUTSIDE OF THE BACKFILL WHERE VERTICAL HEAD DIFFERENCES ARE MINIMAL WITH RESPECT TO CONTOUR INTERVAL WITHIN THE BACKFILL. CONTOURS ARE BASED ON HIGHEST GROUNDWATER LEVEL MEASURED AT NESTED WELLS BELOW THE SAPROLITE.

FLAMBEAU MINING COMPANY

FIGURE 1

DECEMBER 1, 1998
GROUNDWATER POTENTIOMETRIC SURFACE CONTOUR MAP

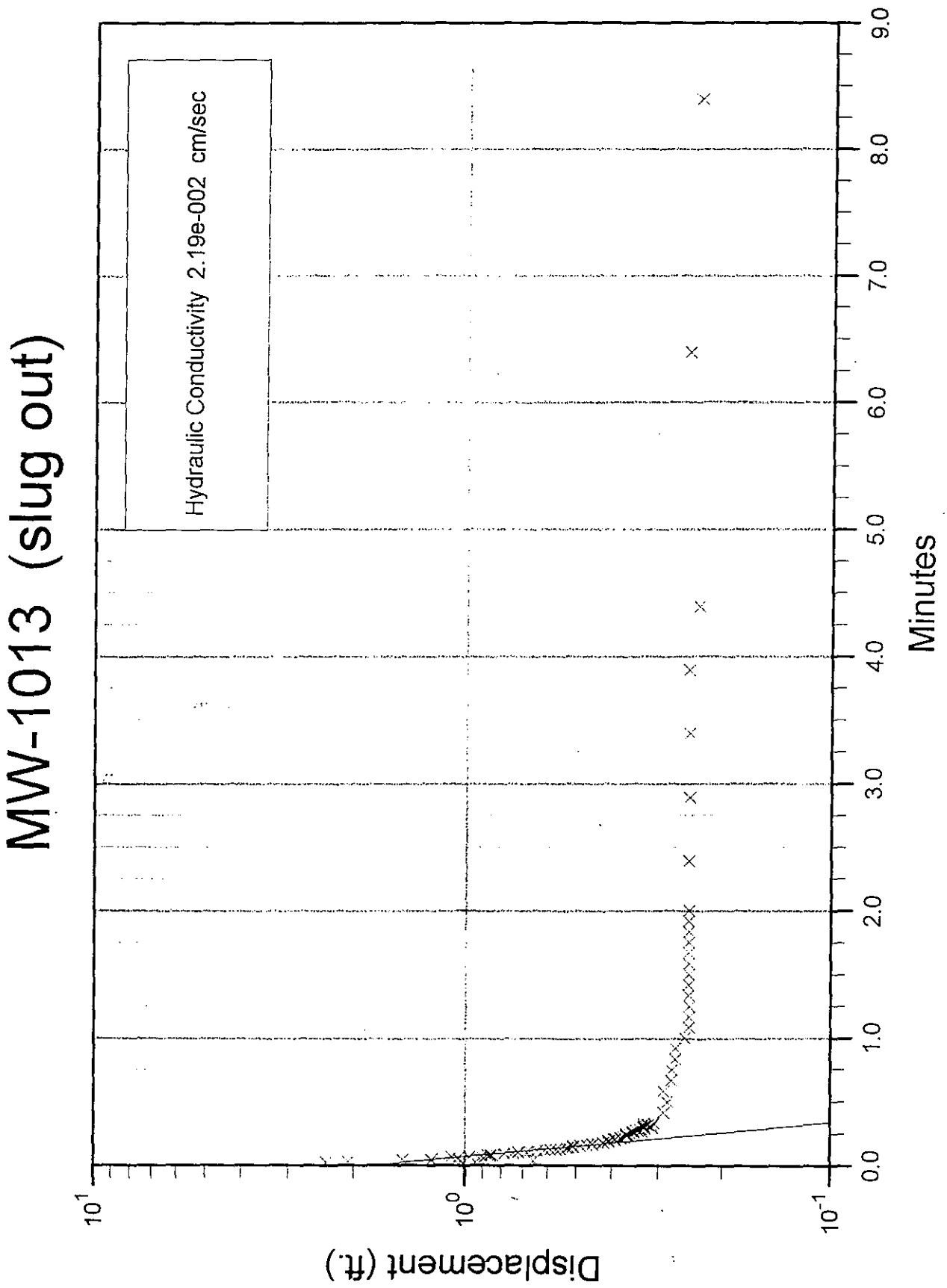
Scale: 0 250' 500'	Date: DECEMBER, 1998	
Prepared By: Foth & Van Dyke	By: DAT	98F002

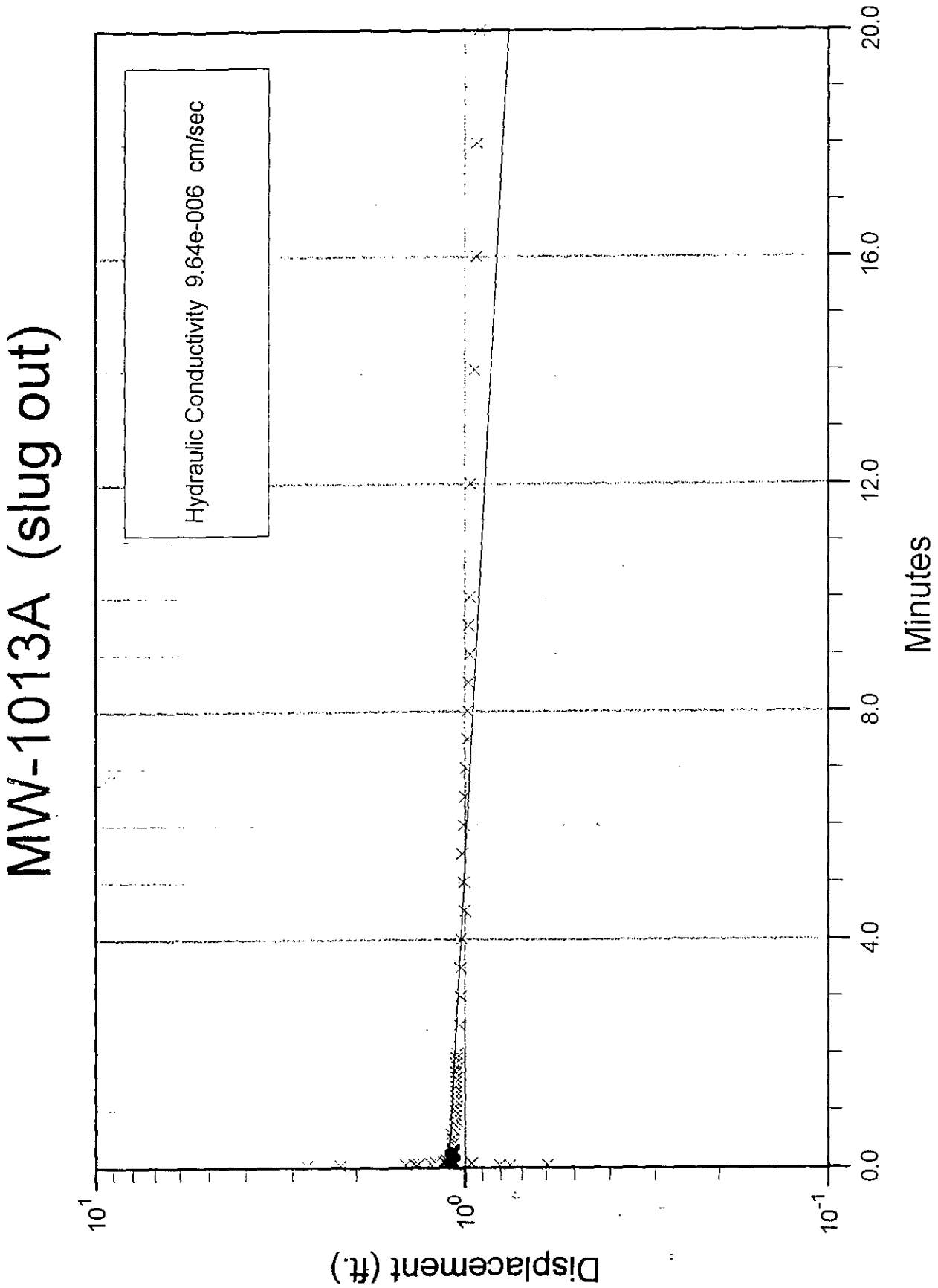
\\97f011\7f1143.dgn Dec. 10, 1998 15:03:43

Attachment 1

Slug Tests for Wells

- MW-1013, -1013A, -1013B, -1013C
- MW-1014A, 1014B, 1014C


MW-1013 (slug out)
Hydraulic Conductivity 2.19e-002 cm/sec
Displacement (ft.)
Minutes
10^{1}
10^{0}
10^{-1}
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0


MW-1013A (slug out)
Hydraulic Conductivity 9.64e-006 cm/sec
Displacement (ft.)
Minutes
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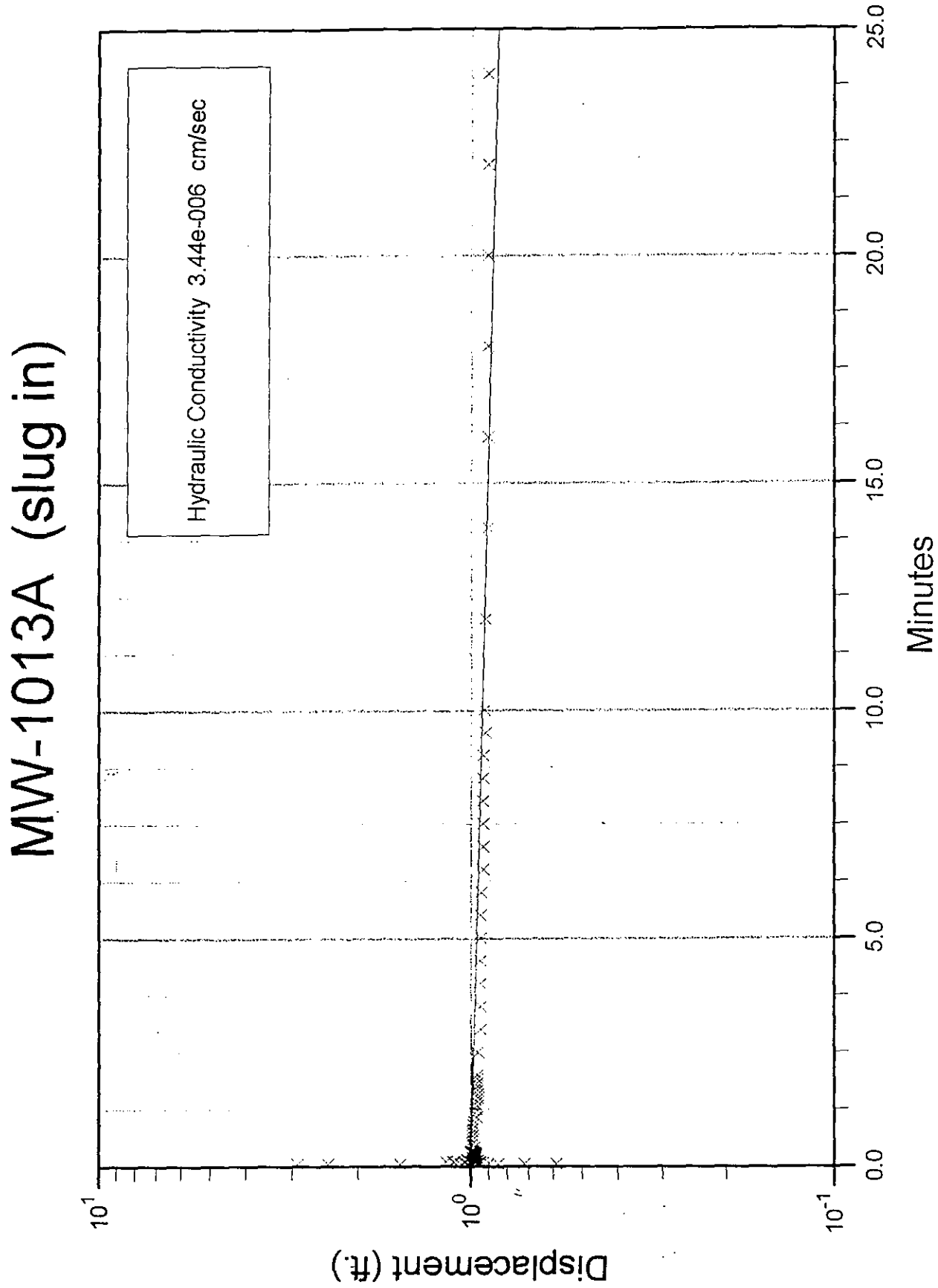
10^0
10^-1
0.0
4.0
8.0
12.0
16.0
20.0


MW-1013A (slug in)
Hydraulic Conductivity 3.44e-006 cm/sec
Displacement (ft.)
Minutes
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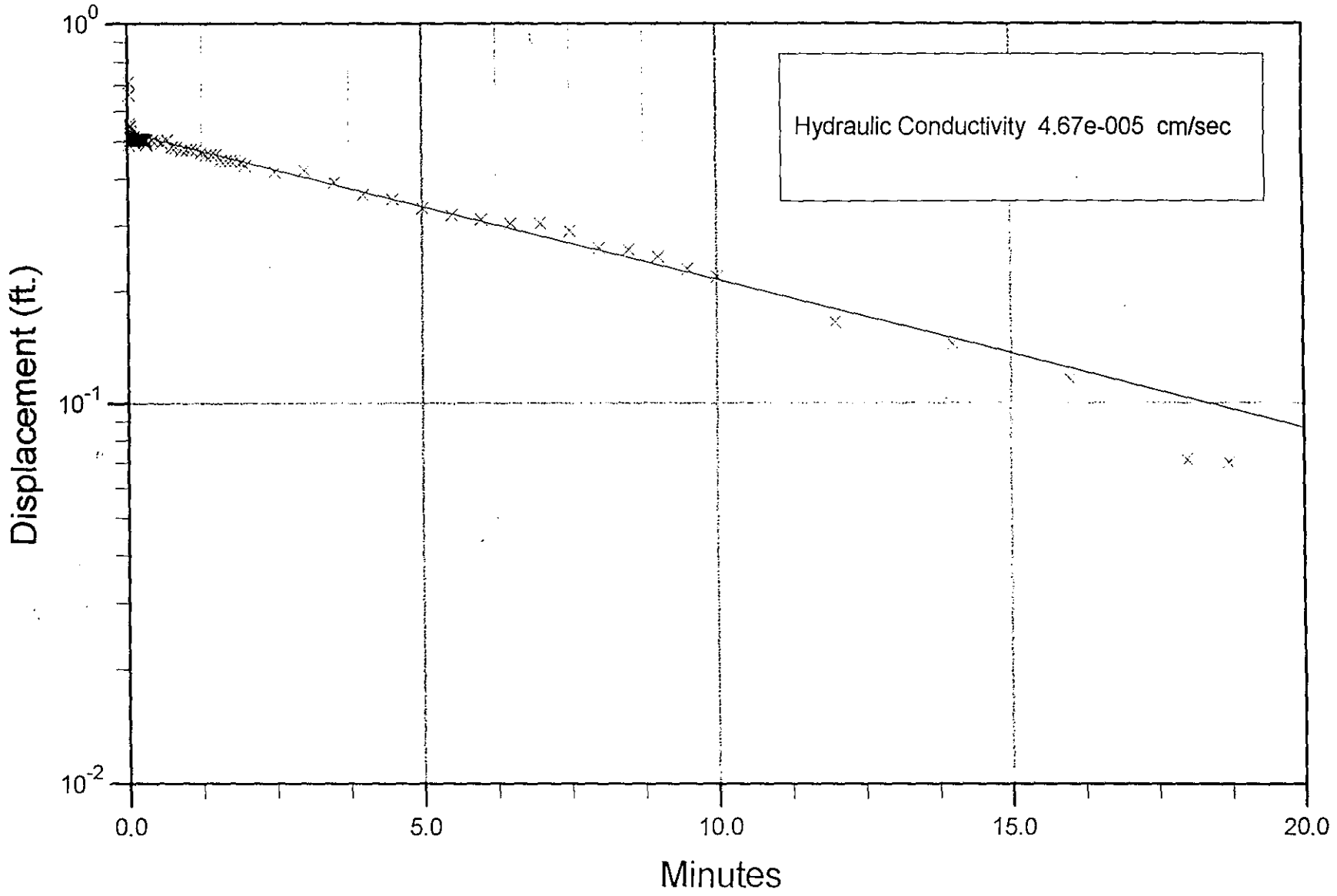
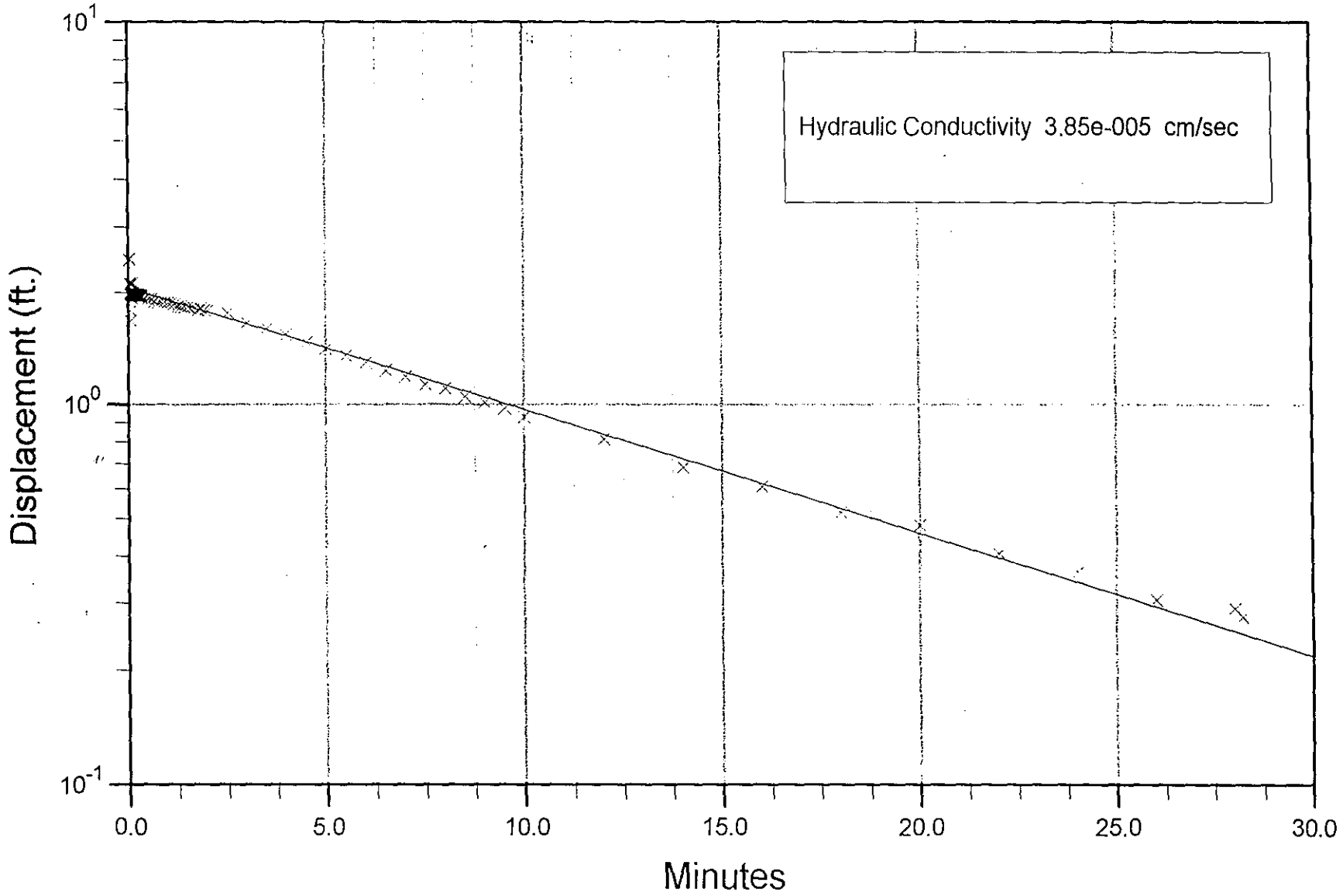
10^0
10^-1
0.0
5.0
10.0
15.0
20.0
25.0

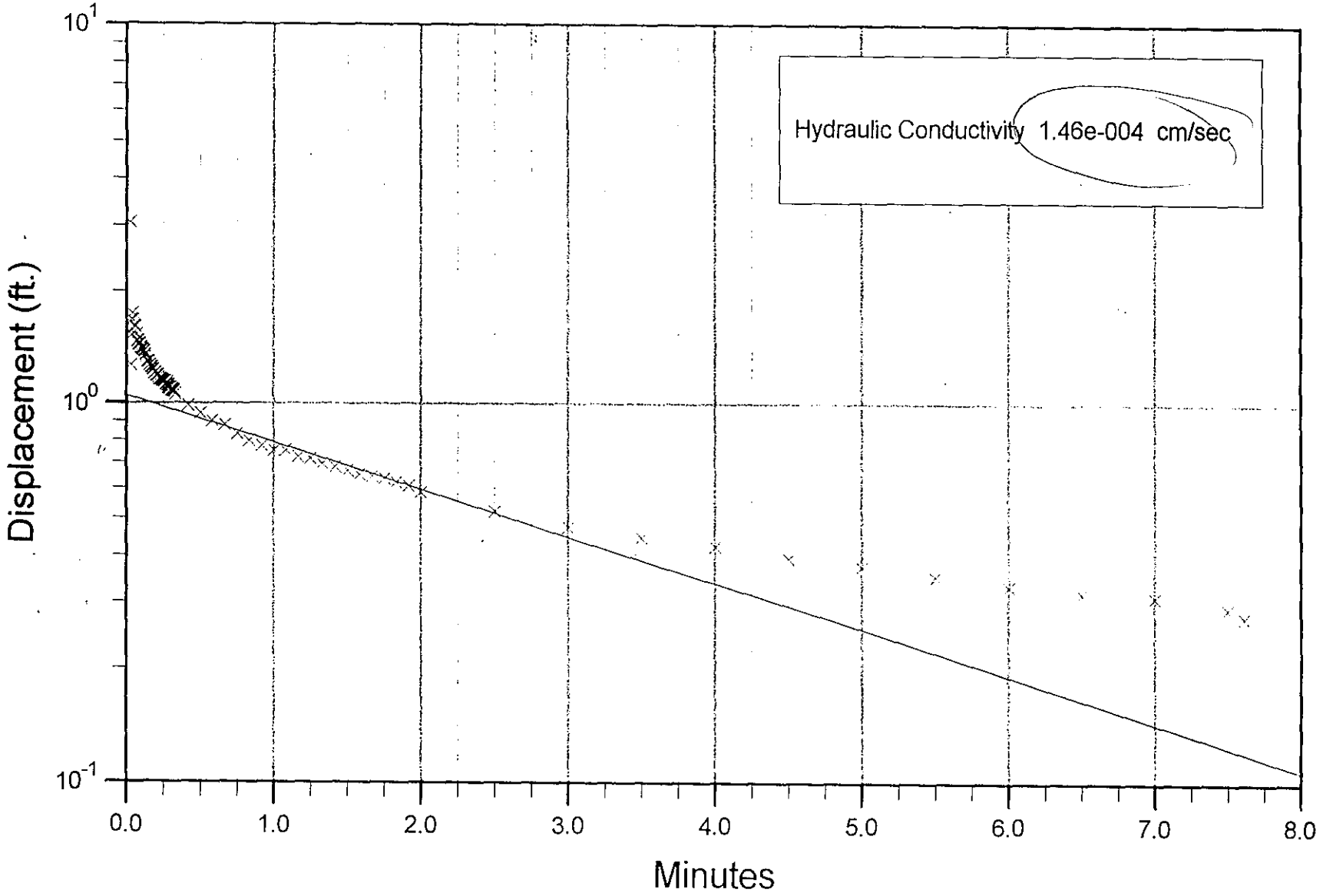
MW-1013B (slug out)



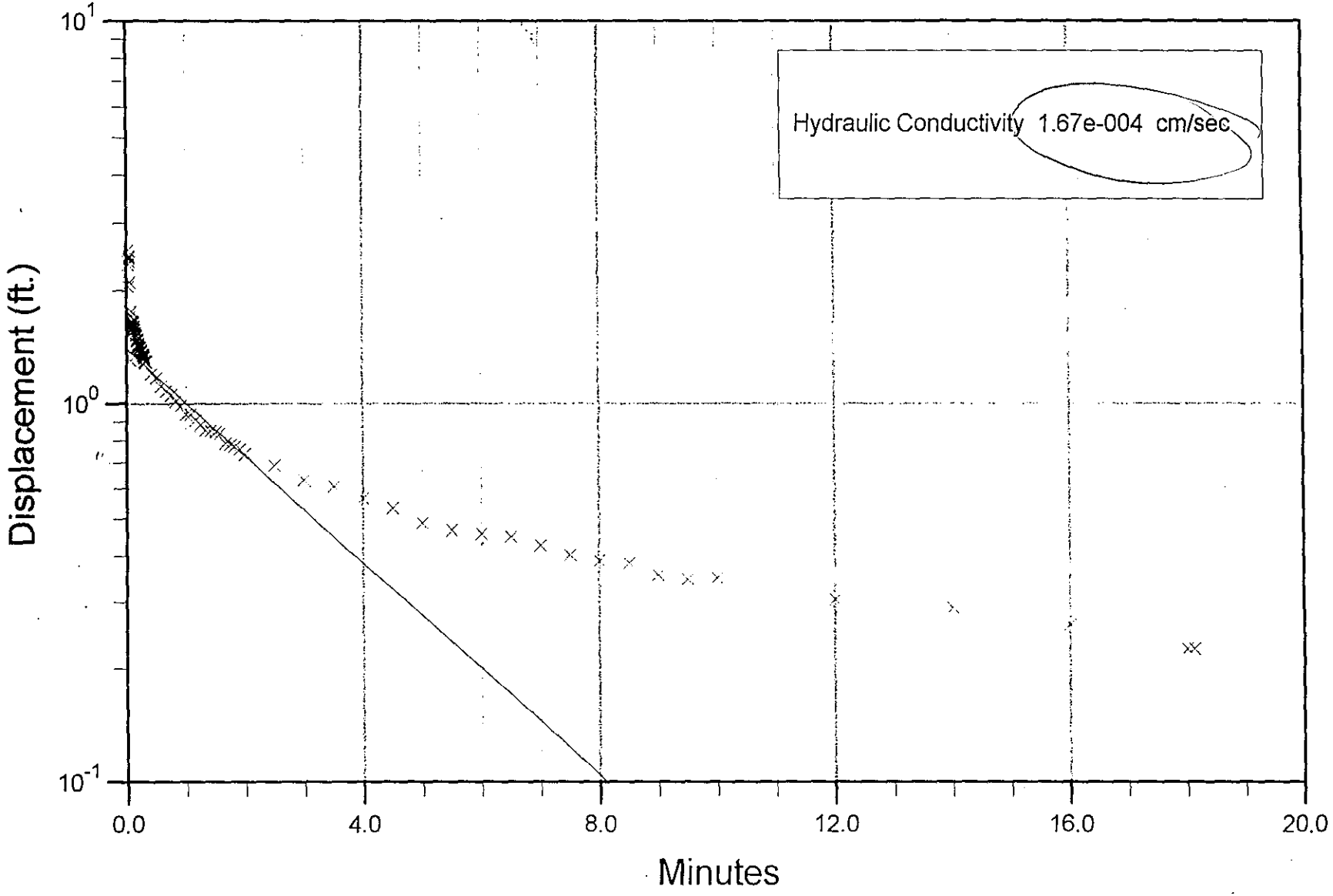
MW-1013B (slug in)

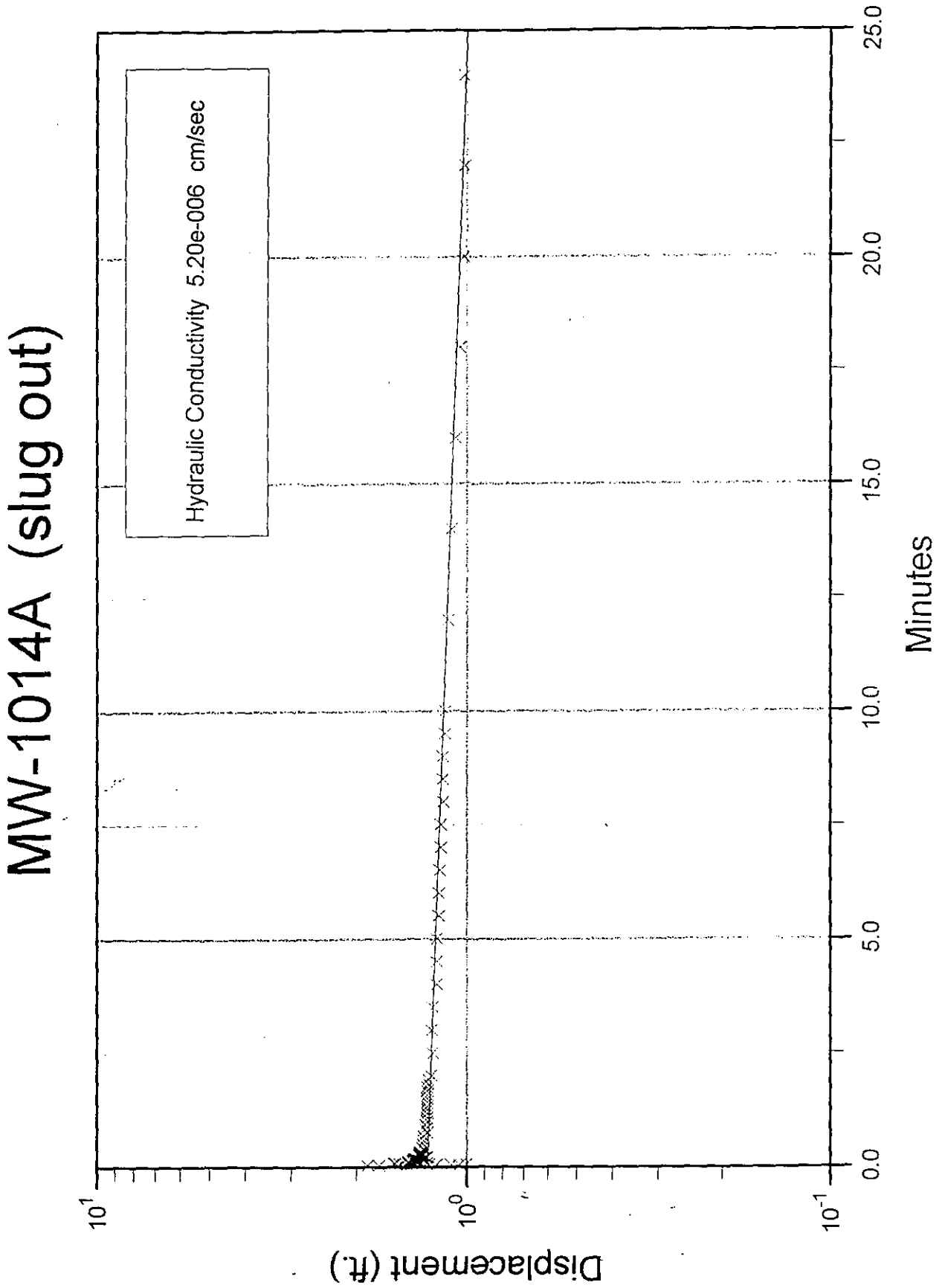


MW-1013C (slug out)



MW-1013C (slug in)




MW-1014A (slug out)
Hydraulic Conductivity 5.20e-006 cm/sec
Displacement (ft.)
Minutes
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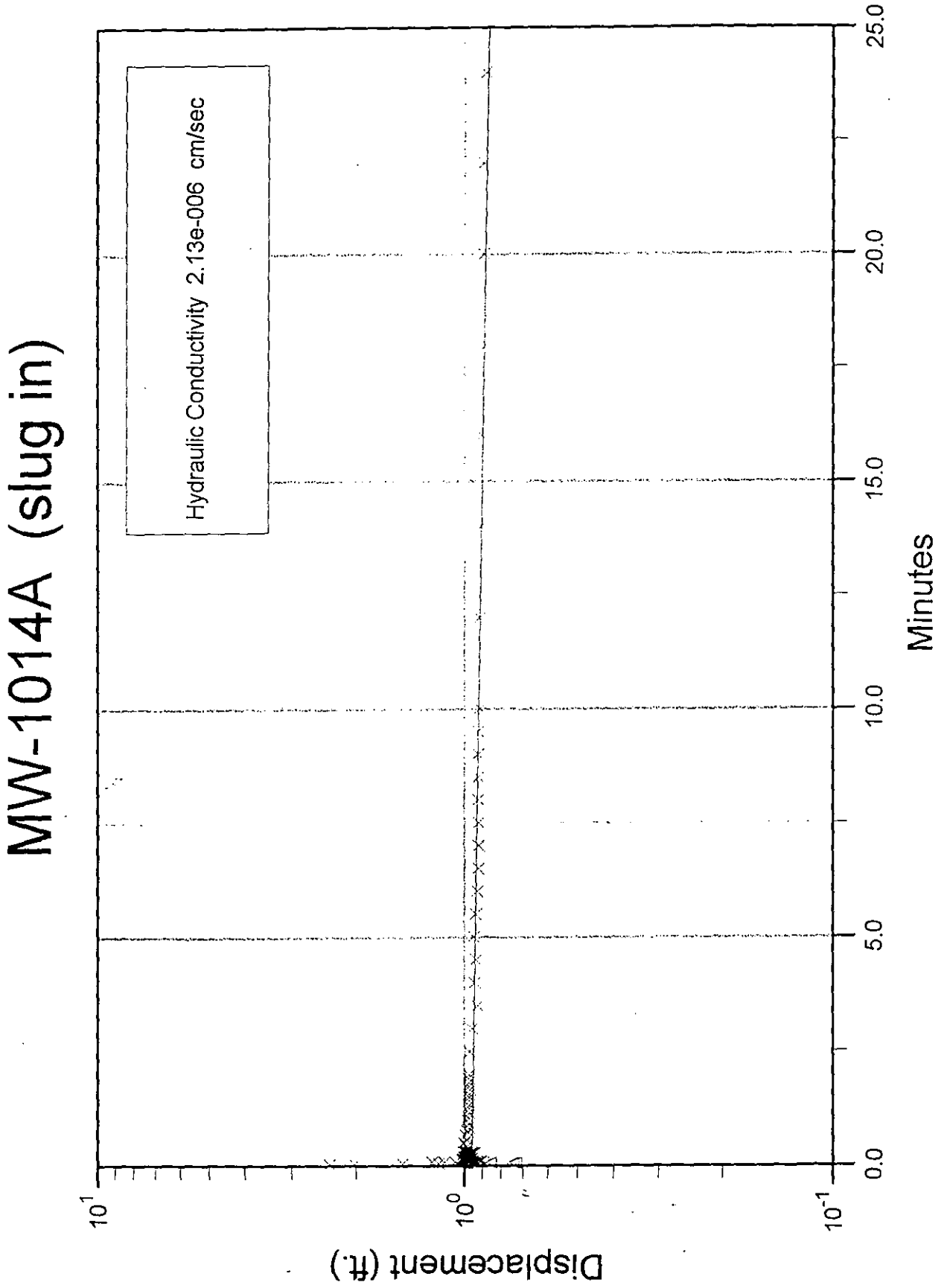
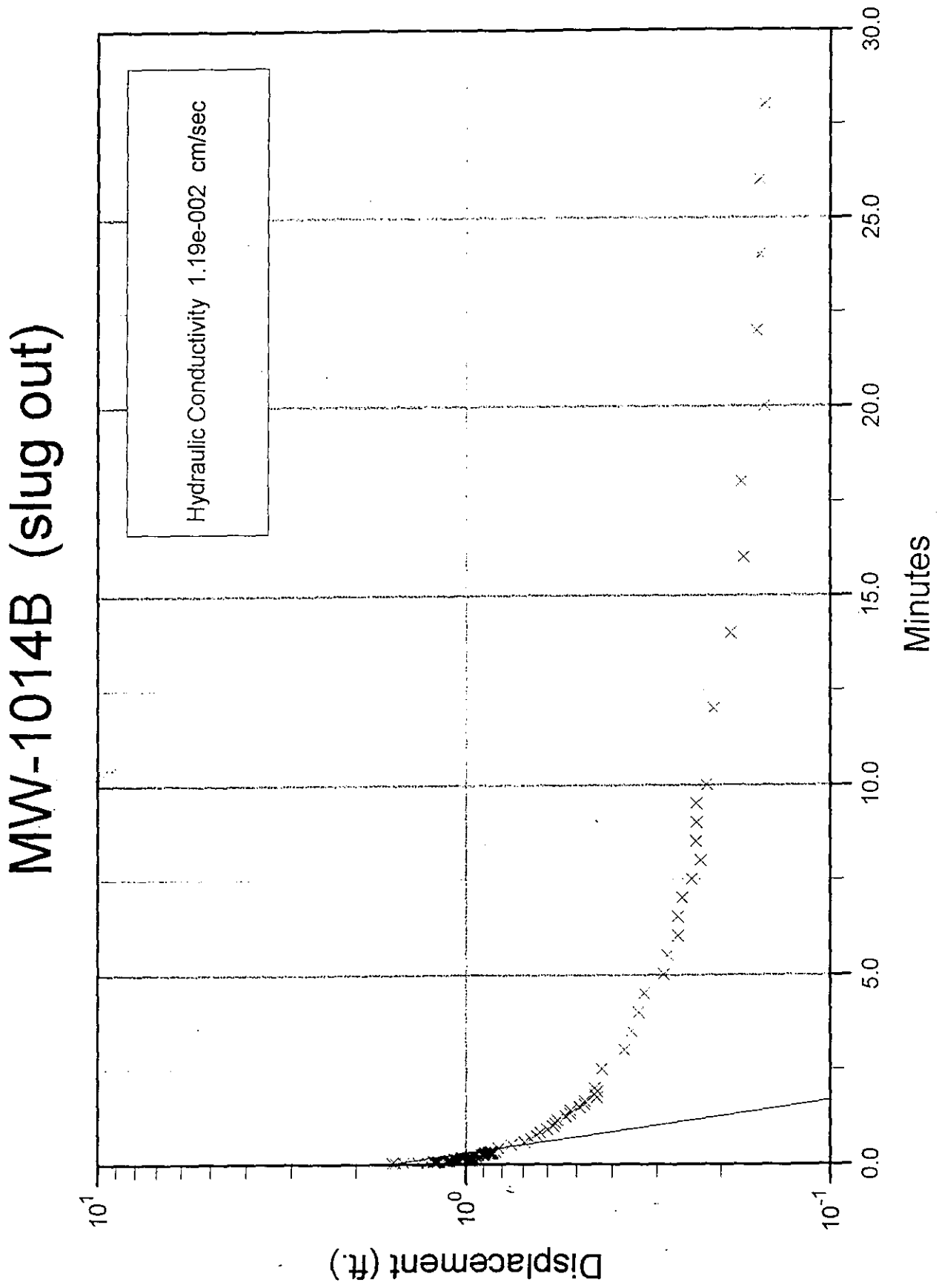
10^0
10^-1
0.0
5.0
10.0
15.0
20.0
25.0


MW-1014A (slug in)
Hydraulic Conductivity 2.13e-006 cm/sec
Displacement (ft.)
Minutes
10^{1}
10^{0}
10^{-1}
0.0
5.0
10.0
15.0
20.0
25.0


MW-1014B (slug out)
Hydraulic Conductivity 1.19e-002 cm/sec
Displacement (ft.)
Minutes
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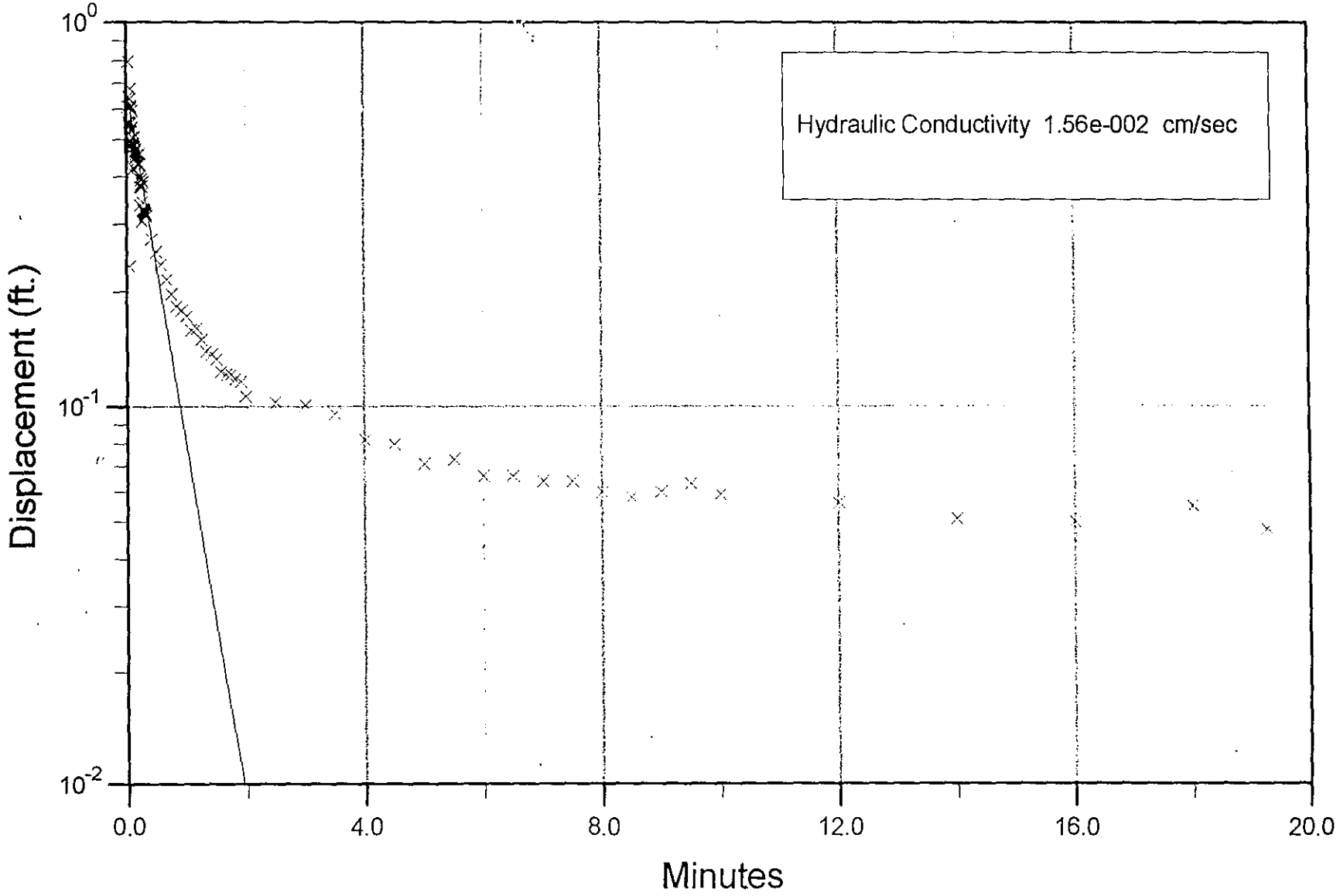
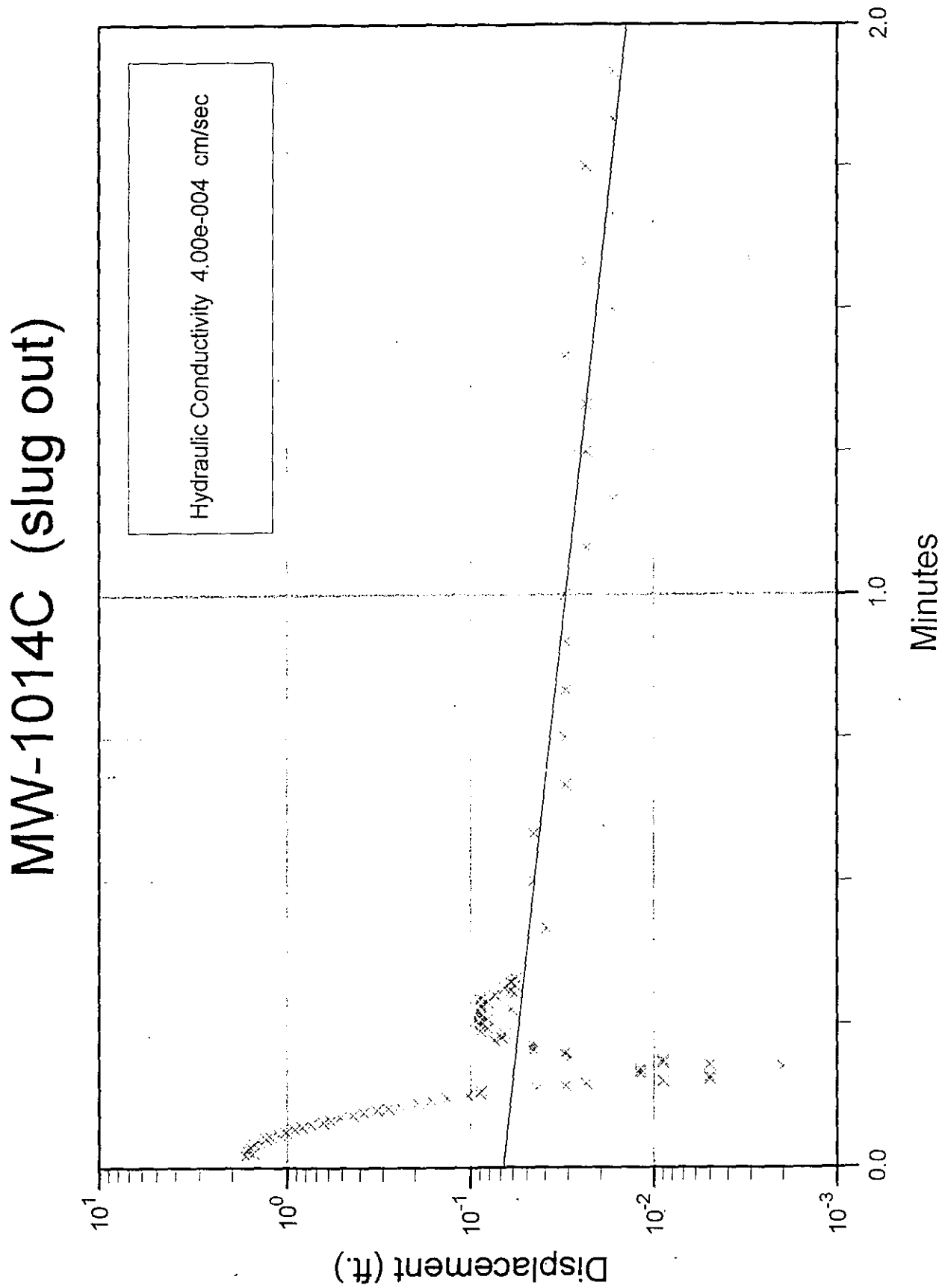
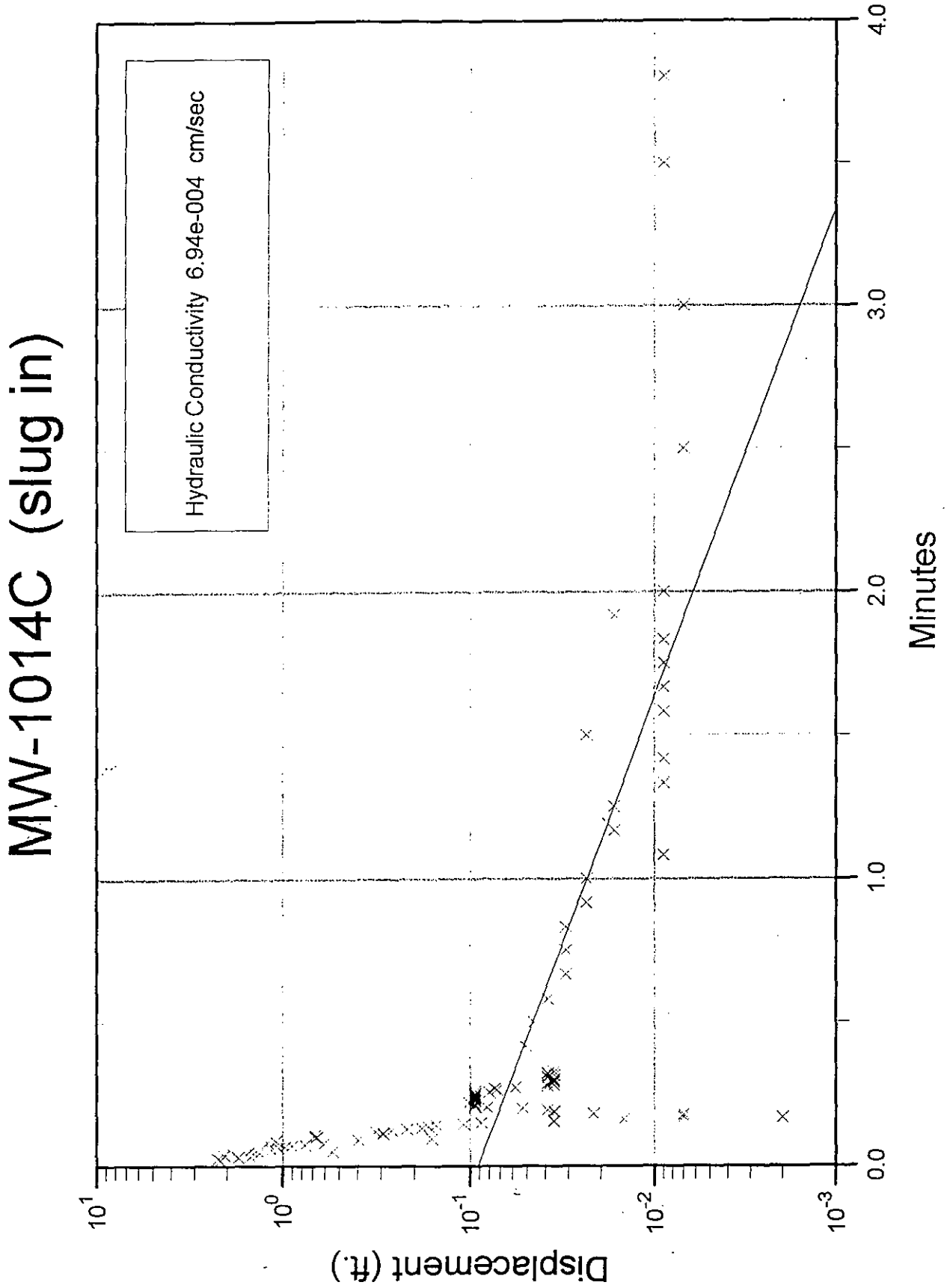
10^0
10^-1
0.0
5.0
10.0
15.0
20.0
25.0
30.0

MW-1014B (slug in)




MW-1014C (slug out)
Hydraulic Conductivity 4.00e-004 cm/sec
Displacement (ft.)
Minutes
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{-3}
0.0
1.0
2.0


MW-1014C (slug in)
Hydraulic Conductivity 6.94e-004 cm/sec
Displacement (ft.)
Minutes
10^1
10^0
10^-1
10^-2
10^-3
0.0
1.0
2.0
3.0
4.0

APPENDIX C

GROUNDWATER QUALITY & ELEVATION/SURFACE WATER QUALITY/TRENDS

Foth & Van Dyke
Memorandum

January 26, 1999

TO: Jana Murphy, Flambeau Mining Co

CC: Jim Hutchison, Foth & Van Dyke
Jerry Sevick, Foth & Van Dyke

FR: Steve Lehrke, Foth & Van Dyke SSL
Steve Donohue, Foth & Van Dyke SVD

RE: Flambeau Mining Company - 1998 Annual Report Groundwater and Surface Water Trends

Background

The groundwater and surface water sample results collected between July of 1991 and October of 1998 for the quarterly monitoring program have been graphically displayed and tested statistically to determine whether any significant increasing or decreasing trends are occurring in groundwater or surface water chemistry. July of 1991 was selected as the start date for the trend tests since this is when construction began on-site. Groundwater quality results during this time period are listed in Table 1A, and surface water quality results during this time period are listed in Table 2A. Trend graphs of the groundwater and surface water quality results are presented in Attachments 1 and 2, respectively. Trend graphs of groundwater elevations are presented in Attachment 3.

It should be noted that MW-1000P was damaged in the first quarter in 1996 and was replaced with MW-1000P-R at the exact same location and the same specifications. This monitoring point will be referred to as MW-1000P-R in this report.

Statistical Methods

The non-parametric Mann-Kendall test for trend was used to statistically determine whether any trends were present in the data between July 1991 and October 1998. This test used on the 1991 to 1998 data will indicate whether any general increasing or decreasing trends occurred during this time frame. Note that since only general trends are tested, the Mann-Kendall test will not identify short-term reversals in the data, and must be used in conjunction with the trend graphs of Attachments 1 and 2 to properly evaluate trend conditions.

The Mann-Kendall test was used rather than a parametric test such as regression analysis due to the non-normal distribution of many of the data sets which is typical for groundwater and surface water quality results In addition, the Mann-Kendall test determines whether any general trends

are present, regardless if they are linear or curvilinear. The Type I error for each test was set to 0.01. The procedure for the Mann-Kendall test is given in Gilbert (1987)[1].

As can be seen in the groundwater and surface water trend graphs (Attachments 1 and 2), several parameters had initially high detection limits which were later reduced. This resulted in detections at lower levels than the initial detection limits. Since the non-detected values with high detection limits cause increased uncertainty in the trend tests, all non-detects which were greater than two times the minimum detected value were omitted from the trend analysis.

Summary statistics for each parameter and well, along with the trend analysis results are given in Table 1B for groundwater and Table 2B for surface water. In the trend test results, a "+" indicates a statistically increasing trend and a "-" indicates a statistically decreasing trend. If neither a "+" or "-" is given, no significant trend is present. Again, it should be noted that this indicates a general trend between July 1991 and October 1998, and does not recognize changes in established trends occurring over a relatively smaller time interval. Also, it should be noted that a statistically increasing or decreasing trend does not necessarily indicate a substantial increase or decrease in parameter concentrations.

Trend Results

In many cases the observed groundwater quality trends remained similar to those given in the 1997 annual report. However, a few changes occurred in 1998, the most notable in MW-1000P-R. Due to the distinct changes in this well over only the last four monitoring events, the trend graphs given in Attachment 1 should be used instead of the Mann-Kendall results to interpret current trends. Significant increases in the conductivity, and in the concentrations of alkalinity, copper, hardness, manganese, sulfate and TDS took place during the last year. As given in Attachment 3, the groundwater elevation also increased to the higher levels observed from 1991 to 1993.

The remaining trends indicated by the Mann-Kendall tests are more reflective of those discussed in past annual reports. The remaining trends for groundwater are:

Well	Parameter	Trend
MW-1002G	Hardness	Decreasing
MW-1004P	Alkalinity	Decreasing
	Hardness	Decreasing
	Iron	Decreasing
	Manganese	Decreasing
	Sulfate	Increasing
MW-1004S	pH	Decreasing
	Copper	Decreasing

[1]Gilbert, Richard O. (1987) *Statistical Methods for Environmental Pollution Monitoring.* Van Nostrand Reinhold. New York, NY.

Well	Parameter	Trend
MW-1005	Conductivity	Decreasing
	Alkalinity	Decreasing
	Hardness	Decreasing
MW-1005P	Hardness	Decreasing
	Iron	Decreasing
	Manganese	Decreasing
	Sulfate	Increasing
MW-1005S	Alkalinity	Decreasing
	Hardness	Decreasing
	Sulfate	Increasing
MW-1010P	Alkalinity	Decreasing
	Iron	Decreasing
	TDS	Decreasing

Note that with the exception of sulfate, all trends detected by the Mann-Kendall test in wells MW-1002G, MW-1004P, MW-1004S, MW-1005, MW-1005P, MW-1005S and MW-1010P are decreasing. While sulfate shows a statistically increasing trend, the sulfate concentrations have not increased substantially. The concentrations of iron and manganese in MW-1004P, and iron in MW-1005P remain generally consistent after sharply decreasing in 1993. Based on both the Mann-Kendall tests and the trend graphs, sulfate continues a somewhat increasing trend in MW-1004P, MW-1004S, MW-1005P, and MW-1005S.

Very few trends were noted for the surface water samples. A slightly decreasing trend of aluminum and cadmium was noted for SW-1 (upstream) while a slightly increasing trend of cadmium was noted for SW-2 (downstream). The increasing trend of cadmium in SW-2 given by the Mann-Kendall test was due to four very low level detects observed in the data since 1995. Note that no surface water samples were available for October 1998. Surface water sampling on a quarterly basis ceased when permitted discharges from the mine site discontinued. This is consistent with Flambeau's approved monitoring plan.

Discussion

With the installation of eight monitoring wells within the pit backfill in September 1998, it is possible to assess the recovery of the groundwater table in and around the backfilled pit. Provided in Figure 1 is a potentiometric surface map based on groundwater elevation measurements from December 1998. The potentiometric surface map shows a substantial amount of groundwater recovery around the backfilled pit, with moderately convergent flow towards the backfilled pit. The reason for the more rapid rate of groundwater recovery than predicted with the project's groundwater flow model (ETA, 1998)[2] is likely attributed to the method of representing the Precambrian bedrock in the regional groundwater flow model. The

[2]Engineering Technologies Associates, Inc., 1998. Addendum to Flambeau Mine Groundwater Model.

groundwater flow model represented the Precambrian bedrock, a fractured system, as an equivalent porous medium. During the recovery phase, the groundwater flow model simulates groundwater going back into storage in the Precambrian rock and other hydrostratigraphic units around the backfilled pit. The rate of recovery is related to the assumed porosity of the various bedrock model layers and the extent to which they are dewatered. The model accounts for water going back into storage in the Precambrian rock. In reality, the Precambrian rock is likely to function as a porous medium only on a localized scale around the mine. This would require less water going back into storage than simulated in the model and accounts for the more rapid rate of groundwater recovery in the vicinity of the backfilled pit. With respect to future groundwater recovery rates, it is likely that the rate of recovery within the pit will be reduced as water goes back into storage in the more porous sandstone and glacial deposits around the site.

Observed drawdown and recovery at well monitoring locations where the Pre-Cambrian bedrock was not dewatered support this interpretation. At these location (see hydrographs for well nest MW-1001 and PZ-1006 and well OW-10), little recovery has been observed. This is due in part to the higher storage capacity in the sandstone and glacial materials as well as the continued flow of water toward the backfill pit.

The recent trends in groundwater quality are related to the changes in the groundwater flow system at the site. During operations, groundwater flow was directed inward toward the pit. Based on the data in Figure 1, groundwater flow is now converging on the pit and then flowing towards the Flambeau River, the regional groundwater discharge point. The groundwater quality data from MW-1000PR correlate well with this observation as the well is likely intercepting groundwater that is migrating from the pit backfill toward the river. This pattern in flow and resulting water chemistry is consistent with what was predicted to occur based on prior groundwater modeling studies.

Conclusions

The most notable change in trends during 1998 was the recent increase of several parameters in MW-1000P-R. Recovery of groundwater elevations also occurred in this well, along with MW-1003P, MW-1004P, MW-1004S, MW-1010P, OW-39, OW-42, PZ-R1, PZ-S1 and PZ-S3. General decreases continued to be observed for several parameters, including alkalinity, hardness, iron and manganese. General decreases continued to be observed for several parameters, including alkalinity, hardness, iron and manganese. A slight increase of sulfate continued to be observed for MW-1004P, MW-1004S, MW-1005P and MW-1005S.

Overall, the groundwater elevation, groundwater quality and surface water quality data indicate that groundwater levels in the pit have recovered sufficiently, that groundwater is now moving, as expected, from the pit toward the Flambeau River, the regional groundwater discharge point. As expected, and supported by the surface water quality data, the discharge of this water into the river is not affecting the water quality in the river.

SGL:lmc

Attachments

Table 1A

Groundwater Quality Results, Summary Statistics and Trend Analysis
July 1991 Through October 1998

Well/Parameter	Units	Jul-91	Oct-91	Jan-92	Apr-92	Jul-92	Oct-92	Jan-93	Apr-93
MW-1000P-R									
Conductivity(Field)	umhos	225	327	190	183.2	194	201	203	198
pH(Field)	S.U.	8.39	7.41	5.75	6.91	6.64	6.9	6.22	6.24
Alkalinity	mg/l	65	90	88	84	81	95	84	82
Copper	mg/l	< 0.014	< 0.014	< 0.014	< 0.014	0.014	< 0.014	< 0.014	0.02
Hardness	mg/l	84	110	110	88	120	100	88	90
Iron	mg/l	0.65	0.84	1.7	1.3	0.47	0.8	0.15	0.27
Manganese	mg/l	0.85	0.88	0.82	0.83	0.73	0.78	0.71	0.94
Sulfate	mg/l	< 10	< 10	11	14	12	12	< 10	12
TDS	mg/l	190	160	120	120	140	160	100	130
MW-1002									
Conductivity(Field)	umhos	157	189	138	145	118	181	127	136
pH(Field)	S.U.	8.33	6.78	6.88	6.05	5.61	6.94	6.96	6.33
Alkalinity	mg/l	50	49	47	49	41	53	53	66
Copper	mg/l	< 0.014	< 0.014	< 0.014	< 0.014	< 0.014	< 0.014	< 0.014	< 0.01
Hardness	mg/l	60	60	67	48	120	82	66	90
Iron	mg/l	0.99	< 0.055	< 0.055	< 0.055	< 0.055	< 0.055	0.059	< 0.01
Manganese	mg/l	0.0051	< 0.004	< 0.004	< 0.004	< 0.004	0.015	0.0047	< 0.004
Sulfate	mg/l	< 10	< 10	< 10	11	< 10	11	< 10	9
TDS	mg/l	160	170	100	85	87	130	90	120
MW-1002G									
Conductivity(Field)	umhos	277	272	221	199	198	254	197	239
pH(Field)	S.U.	7.56	6.98	6.93	6.25	6.02	6.94	7.14	6.13
Alkalinity	mg/l	86	88	80	84	79	85	75	44
Copper	mg/l	< 0.014	< 0.014	< 0.014	< 0.014	< 0.014	< 0.014	< 0.014	< 0.01
Hardness	mg/l	100	120	110	110	160	130	94	76
Iron	mg/l	< 0.055	< 0.055	< 0.055	< 0.055	< 0.055	< 0.055	< 0.055	< 0.01
Manganese	mg/l	0.0054	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Sulfate	mg/l	< 10	10	11	14	11	11	12	8
TDS	mg/l	240	280	140	150	150	180	98	74
MW-1004P									
Conductivity(Field)	umhos	175	352	302	282	295	342	291	329
pH(Field)	S.U.	8.15	7.15	6.8	6.88	6.74	7.46	6.24	7.74
Alkalinity	mg/l	160	170	160	170	160	190	170	170
Copper	mg/l	< 0.014	< 0.014	< 0.014	< 0.014	< 0.014	< 0.014	< 0.014	< 0.01
Hardness	mg/l	150	170	150	160	170	180	160	160
Iron	mg/l	0.33	0.22	0.32	0.37	0.38	0.32	0.39	< 0.01
Manganese	mg/l	0.13	0.13	0.12	0.14	0.13	0.13	0.14	< 0.004
Sulfate	mg/l	< 10	< 10	< 10	< 10	< 10	< 10	< 10	3
TDS	mg/l	210	310	160	180	180	260	160	160
MW-1004S									
Conductivity(Field)	umhos	161	135	146	153	175	258	174	168
pH(Field)	S.U.	8.64	7.25	7.03	6.7	6.5	6.96	6.37	7.77
Alkalinity	mg/l	50	49	27	60	74	100	73	51
Copper	mg/l	< 0.014	< 0.014	< 0.014	< 0.014	< 0.014	< 0.014	< 0.014	< 0.01
Hardness	mg/l	60	60	62	72	150	110	92	70
Iron	mg/l	< 0.055	< 0.055	< 0.055	< 0.055	< 0.055	< 0.055	< 0.055	< 0.01
Manganese	mg/l	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Sulfate	mg/l	< 10	10	11	12	< 10	< 10	< 10	11
TDS	mg/l	160	170	95	100	110	220	95	120

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Table 1A

Groundwater Quality Results, Summary Statistics and Trend Analysis
July 1991 Through October 1998

Well/Parameter	Units	Jul-93	Oct-93	Jan-94	Apr-94	Jul-94	Oct-94	Jan-95	Apr-95
MW-1000P-R									
Conductivity (Field)	umhos	217	233	135	124	133	116	116	106
pH (Field)	S.U.	6.6	7.03	6.9	7.7	7.5	7.2	7.1	7.4
Alkalinity	mg/l	82	62	43	44	39	34	30	38
Copper	mg/l	0.016	0.013	0.022	0.023	0.017	0.058	0.052	0.058
Hardness	mg/l	86	120	54	54	49	36	36	35
Iron	mg/l	0.061	0.032	< 0.015	0.021	0.026	0.047	0.12	0.026
Manganese	mg/l	0.73	0.91	0.34	0.5	0.42	0.36	0.29	0.32
Sulfate	mg/l	15	12	12	12	11	17	9.0	14.0
TDS	mg/l	140	110	70	95	90	120	88	90
MW-1002									
Conductivity (Field)	umhos	273	138	151	105	109.4	122	143.2	106
pH (Field)	S.U.	6.83	7.52	7.5	7.5	7	7	6.7	7.4
Alkalinity	mg/l	42	42	39	35	31	38	38	42
Copper	mg/l	< 0.012	< 0.012	< 0.012	< 0.012	< 0.012	< 0.0016	< 0.00047	0.002
Hardness	mg/l	52	52	50	45	44	46	47	42
Iron	mg/l	0.034	< 0.015	< 0.015	< 0.015	< 0.015	0.0056	0.0073	0.0039
Manganese	mg/l	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.00047	0.0027	0.00027
Sulfate	mg/l	10	6	7	7	6.6	6.1	6.2	7.3
TDS	mg/l	100	78	82	86	94	87	120	170
MW-1002G									
Conductivity (Field)	umhos	480	262	278	267	238	269	301	255
pH (Field)	S.U.	6.72	7.38	7	7.4	6.7	6.8	6.7	6.9
Alkalinity	mg/l	64	82	94	92	92	88	90	93
Copper	mg/l	< 0.012	< 0.012	< 0.012	< 0.012	< 0.012	< 0.0016	< 0.00047	0.0014
Hardness	mg/l	80	110	120	120	120	110	110	100
Iron	mg/l	< 0.015	< 0.015	< 0.015	< 0.015	< 0.015	0.0054	0.0072	0.0044
Manganese	mg/l	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.00047	0.0021	< 8.6E-05
Sulfate	mg/l	11	11	14	12	12	14	12	15
TDS	mg/l	140	190	180	170	170	200	240	170
MW-1004P									
Conductivity (Field)	umhos	347	329	371	287	317	303	315	292
pH (Field)	S.U.	7.4	7.61	7.3	7.4	7.1	7.1	6.7	7.4
Alkalinity	mg/l	170	170	140	160	160	170	170	170
Copper	mg/l	< 0.012	< 0.012	< 0.012	0.015	< 0.012	< 0.0016	0.0033	0.011
Hardness	mg/l	150	160	150	150	150	160	150	130
Iron	mg/l	0.042	0.048	< 0.015	0.033	0.024	0.035	0.014	0.025
Manganese	mg/l	0.022	0.04	0.02	0.045	0.028	0.029	0.029	0.031
Sulfate	mg/l	5	3	2	3	2.5	3.9	1.7	4.7
TDS	mg/l	180	230	160	180	190	200	190	250
MW-1004S									
Conductivity (Field)	umhos	178	186	123	109	200	124	142.4	131
pH (Field)	S.U.	7	7.41	7	7.8	6.8	6.7	6.2	6.7
Alkalinity	mg/l	24	32	42	38	140	44	100	55
Copper	mg/l	< 0.012	< 0.012	0.016	< 0.012	< 0.012	< 0.0016	0.0011	0.007
Hardness	mg/l	56	46	44	51	52	54	57	45
Iron	mg/l	< 0.015	< 0.015	< 0.015	< 0.015	< 0.015	0.0064	0.0049	0.0087
Manganese	mg/l	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.00047	0.0034	0.00087
Sulfate	mg/l	11	9	10	8	8	8.6	7.1	7.8
TDS	mg/l	110	98	74	100	100	150	140	150

Prepared By: SGL Checked By: JBH1

Table 1A

Groundwater Quality Results, Summary Statistics and Trend Analysis
July 1991 Through October 1998

Well/Parameter	Units	Jul-95	Oct-95	Jan-96	Apr-96	Jul-96	Oct-96	Jan-97	Apr-97
MW-1000P-R									
Conductivity(Field)	umhos	116	119	112.4	149.4	113.5	109	112.4	132.9
pH(Field)	S.U.	8.1	7.3	6.86	7.07	7.26	7.4	7.22	7.46
Alkalinity	mg/l	34	36	27	53	35	38	27	36
Copper	mg/l	0.043	0.061	0.049	0.031	0.033	0.057	0.033	0.032
Hardness	mg/l	36	39	33	40	38	36	33	43
Iron	mg/l	0.0096	0.027	0.011	0.018	0.0066	0.01	0.0093	0.043
Manganese	mg/l	0.24	0.11	0.054	0.064	0.12	0.14	0.15	0.19
Sulfate	mg/l	10	11	8.5	16	9.3	7.1	9.8	9.9
TDS	mg/l	99	75	87	130	140	76	160	160
MW-1002									
Conductivity(Field)	umhos	99	120	153.7	142.2	119.6	155.1	123.8	140
pH(Field)	S.U.	7.2	6.6	6.98	6.75	6.78	6.9	7.47	7.4
Alkalinity	mg/l	33	30	35	32	34	41	42	41
Copper	mg/l	0.00097	0.0016	< 0.00068	0.0017	0.0016	0.0035	0.00099	0.00079
Hardness	mg/l	35	38	41	36	97	42	46	46
Iron	mg/l	< 0.0017	0.0040	0.0031	0.017	0.021	0.0063	0.011	0.007
Manganese	mg/l	0.00042	0.0014	0.00012	0.00098	0.0005	0.0002	0.00018	0.00087
Sulfate	mg/l	5.3	7.9	5.4	5.9	5.9	6.9	6.3	7
TDS	mg/l	76	86	65	120	94	85	110	110
MW-1002G									
Conductivity(Field)	umhos	275	239	232	264	221	226	245	260
pH(Field)	S.U.	6.9	6.9	6.79	6.55	6.71	6.8	7.15	7
Alkalinity	mg/l	90	100	85	110	79	86	80	81
Copper	mg/l	< 0.00068	< 0.00068	< 0.00068	< 0.00068	< 0.00054	< 0.00054	0.0019	0.00054
Hardness	mg/l	100	110	100	100	93	93	96	100
Iron	mg/l	0.0019	< 0.0017	< 0.0017	0.0039	0.0038	0.0039	0.0024	0.0029
Manganese	mg/l	< 8.6E-05	< 8.6E-05	< 8.6E-05	0.00014	< 0.00018	< 0.00018	0.00018	0.00018
Sulfate	mg/l	11	14	11	11	11	11	9.6	10
TDS	mg/l	190	160	150	220	200	120	180	200
MW-1004P									
Conductivity(Field)	umhos	317	308	295	258	287	340	238	311
pH(Field)	S.U.	7.2	7.0	7.3	6.93	7.21	7.2	7.42	7.25
Alkalinity	mg/l	170	170	150	150	150	160	160	140
Copper	mg/l	0.02	0.0043	0.0033	0.0073	0.0033	0.0059	0.0062	0.016
Hardness	mg/l	130	150	130	130	130	120	120	130
Iron	mg/l	0.044	0.0086	0.0094	0.011	0.0047	0.0042	0.015	0.008
Manganese	mg/l	0.077	0.028	0.027	0.022	0.017	0.014	0.034	0.017
Sulfate	mg/l	1.8	8.1	2.3	4.2	4.3	4.2	5.5	6.9
TDS	mg/l	190	170	150	210	200	160	220	210
MW-1004S									
Conductivity(Field)	umhos	126.3	144.9	144.9	168.2	153.5	159.5	163.7	165.8
pH(Field)	S.U.	6.9	6.3	6.61	5.84	6.31	6.3	7.03	6.51
Alkalinity	mg/l	50	79	50	61	55	66	61	60
Copper	mg/l	0.0066	0.0076	0.0034	0.0026	0.0039	0.0018	0.0051	0.0018
Hardness	mg/l	50	59	54	52	46	59	62	59
Iron	mg/l	0.0031	0.0040	0.0038	0.0048	0.0023	0.0049	0.0061	0.0049
Manganese	mg/l	0.0005	0.0013	0.0011	0.00032	0.00072	0.00029	0.00025	0.00072
Sulfate	mg/l	6.2	9.4	5.8	6.2	6.9	6.5	6.6	8.2
TDS	mg/l	110	110	120	130	130	100	150	110

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Table 1A

Groundwater Quality Results, Summary Statistics and Trend Analysis
July 1991 Through October 1998

Well/Parameter	Units	Jul-97	Oct-97	Jan-98	Apr-98	Jul-98	Oct-98
MW-1000P-R							
Conductivity (Field)	umhos	107.1	132	576	888	1097	1338
pH (Field)	S.U.	6.72	6.55	6.47	6.69	6.28	6.24
Alkalinity	mg/l	33	40	54	93	71	100
Copper	mg/l	0.029	0.034	0.04	0.098	0.066	0.053
Hardness	mg/l	39	45	110	470	480	570
Iron	mg/l	0.0079	0.0044	0.0061	0.044	0.076	0.012
Manganese	mg/l	0.061	0.11	0.49	3	1.8	2
Sulfate	mg/l	7.8	5.9	180	310	350	480
TDS	mg/l	110	82	96	770	250	960
MW-1002							
Conductivity (Field)	umhos	118.4	114	109.8	131.7	124.8	158
pH (Field)	S.U.	6.38	6.02	7.15	7.32	6.55	7.13
Alkalinity	mg/l	30	40	40	30	44	52
Copper	mg/l	0.0013	0.00086	0.0014	0.00086	0.0009	0.00056
Hardness	mg/l	45	46	47	37	50	57
Iron	mg/l	0.0087	0.003	0.034	0.05	0.0077	0.0096
Manganese	mg/l	0.0008	0.00052	0.00026	0.0017	0.00092	0.0004
Sulfate	mg/l	6.6	6	7.6	< 5	8.2	6.9
TDS	mg/l	88	76	82	89	100	120
MW-1002G							
Conductivity (Field)	umhos	271	228	218	245	215	194
pH (Field)	S.U.	6.51	6.35	6.85	6.97	6.81	7
Alkalinity	mg/l	78	88	82	75	82	76
Copper	mg/l	0.00054	0.00054 <	0.00054 <	0.00054	0.00069 <	0.00054
Hardness	mg/l	100	98	100	98	93	97
Iron	mg/l	0.0051	0.001	0.0034	0.0047	0.0038 <	0.001
Manganese	mg/l	0.00018	0.00018 <	0.00018	0.00021 <	0.00018 <	0.00018
Sulfate	mg/l	9.3	7.8	12	11	13	13
TDS	mg/l	200	160	150	180	180	120
MW-1004P							
Conductivity (Field)	umhos	277	349	271	303	292	327
pH (Field)	S.U.	6.94	6.91	7.13	7.41	7.08	7.06
Alkalinity	mg/l	140	150	150	96	160	140
Copper	mg/l	0.014	0.04	0.027	0.02	0.01	0.005
Hardness	mg/l	140	140	140	130	130	140
Iron	mg/l	0.0035	0.0047	0.012	0.0064	0.0077	0.0094
Manganese	mg/l	0.012	0.01	0.012	0.0099	0.032	0.012
Sulfate	mg/l	6.5	5.3	8.8	8.5	9.2	8.6
TDS	mg/l	200	120	140	170	220	150
MW-1004S							
Conductivity (Field)	umhos	202	201	140.1	164.6	162.3	324
pH (Field)	S.U.	6.36	6.13	6.6	7.97	6.5	6.29
Alkalinity	mg/l	55	58	48	47	40	48
Copper	mg/l	0.002	0.0016	0.0016	0.00092	0.0014	0.0011
Hardness	mg/l	64	75	58	60	60	60
Iron	mg/l	0.0091	0.0057	0.0027	0.0049	0.0054	0.0029
Manganese	mg/l	0.00038	0.00093	0.0003	0.00052	0.00029	0.00045
Sulfate	mg/l	8	15	11	10	13	14
TDS	mg/l	130	100	120	140	140	98

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Table 1A

Groundwater Quality Results, Summary Statistics and Trend Analysis
July 1991 Through October 1998

Well/Parameter	Units	Jul-91	Oct-91	Jan-92	Apr-92	Jul-92	Oct-92	Jan-93	Apr-93
MW-1005									
Conductivity(Field)	umhos	1028	981	870	905	912	1013	945	971
pH(Field)	S.U.	7.73	7.34	6.12	6.32	6.01	6.13	6.21	6.11
Alkalinity	mg/l	84	92	86	90	90	110	94	78
Copper	mg/l	< 0.014	< 0.014	< 0.014	< 0.014	< 0.014	< 0.014	< 0.014	< 0.01
Hardness	mg/l	380	360	1000	520	440	420	400	500
Iron	mg/l	17	20	18	17	19	22	24	24
Manganese	mg/l	0.51	0.49	0.46	0.38	0.44	0.47	0.52	0.54
Sulfate	mg/l	15	12	14	16	15	15	23	15
TDS	mg/l	570	770	530	680	640	600	140	630
MW-1005P									
Conductivity(Field)	umhos	512	479	391	417	426	501	440	458
pH(Field)	S.U.	8.49	7.66	6.85	6.97	6.81	7.26	6.39	6.52
Alkalinity	mg/l	260	260	260	260	270	270	260	250
Copper	mg/l	< 0.014	< 0.014	< 0.014	< 0.014	< 0.014	< 0.014	< 0.014	< 0.01
Hardness	mg/l	230	230	240	240	260	260	240	250
Iron	mg/l	1.2	1	0.75	1	0.95	1.2	1.1	0.46
Manganese	mg/l	0.22	0.15	0.16	0.13	0.15	0.1	0.11	0.15
Sulfate	mg/l	< 10	< 10	< 10	< 10	< 10	< 10	< 10	2
TDS	mg/l	290	440	280	350	270	320	220	240
MW-1005S									
Conductivity(Field)	umhos	377	351	303	324	331	391	418	360
pH(Field)	S.U.	7.68	7.37	6.88	7.48	6.68	7.38	6.99	6.38
Alkalinity	mg/l	170	170	170	180	170	190	180	81
Copper	mg/l	< 0.014	< 0.014	< 0.014	< 0.014	< 0.014	< 0.014	< 0.014	< 0.01
Hardness	mg/l	170	170	250	290	220	270	180	210
Iron	mg/l	3	3.8	3.6	3.7	4.1	3.9	4.1	4.4
Manganese	mg/l	0.21	0.22	0.21	0.2	0.21	0.2	0.21	0.23
Sulfate	mg/l	< 10	< 10	< 10	< 10	< 10	< 10	10	8
TDS	mg/l	220	370	< 20	210	220	260	160	200
MW-1010P									
Conductivity(Field)	umhos	337	326	292	314	285	389	357	357
pH(Field)	S.U.	8.47	8.26	6.87	7.62	6.86	7.49	7.21	6.62
Alkalinity	mg/l	140	160	150	160	160	180	190	170
Copper	mg/l	< 0.014	< 0.014	< 0.014	< 0.014	< 0.014	< 0.014	< 0.014	< 0.014
Hardness	mg/l	140	130	130	140	180	160	130	130
Iron	mg/l	< 0.055	< 0.055	0.15	< 0.055	< 0.055	< 0.055	< 0.055	0.055
Manganese	mg/l	0.26	0.28	0.25	0.2	0.086	0.14	0.031	0.14
Sulfate	mg/l	< 10	10	16	14	< 10	< 10	32	28
TDS	mg/l	180	250	200	340	180	280	210	270

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Table 1A

Groundwater Quality Results, Summary Statistics and Trend Analysis
July 1991 Through October 1998

Well/Parameter	Units	Jul-93	Oct-93	Jan-94	Apr-94	Jul-94	Oct-94	Jan-95	Apr-95
MW-1005									
Conductivity (Field)	umhos	110	1005	1072	1082	1093	1028	1035	1014
pH (Field)	S.U.	6.12	6.68	6.3	7.6	6.2	6.1	6.2	6.2
Alkalinity	mg/l	74	84	81	88	75	78	84	79
Copper	mg/l	< 0.012	< 0.012	< 0.012	< 0.012	< 0.012	< 0.0016	< 0.00047	0.0013
Hardness	mg/l	410	390	440	450	450	420	370	320
Iron	mg/l	18	25	24	24	31	28	29	28
Manganese	mg/l	0.42	0.61	0.53	0.54	0.69	0.63	0.65	0.6
Sulfate	mg/l	18	17	18	13	14	20	14	18
TDS	mg/l	590	680	560	620	600	820	660	770
MW-1005P									
Conductivity (Field)	umhos	519	462	487	487	456	452	511	420
pH (Field)	S.U.	7.59	7.53	7.3	7.2	6.9	7.2	7.1	7.5
Alkalinity	mg/l	250	250	250	250	240	250	270	270
Copper	mg/l	< 0.012	< 0.012	< 0.012	< 0.012	< 0.012	< 0.0016	0.0044	0.0037
Hardness	mg/l	230	220	230	230	230	250	230	200
Iron	mg/l	0.61	0.17	0.19	0.2	0.22	0.24	0.04	0.08
Manganese	mg/l	0.14	0.069	0.035	0.16	0.1	0.062	0.041	0.041
Sulfate	mg/l	3	< 2	< 2	< 2	< 2	2.5	< 0.56	< 0.56
TDS	mg/l	260	300	260	270	270	280	340	300
MW-1005S									
Conductivity (Field)	umhos	372	321	357	344	322	320	425	315
pH (Field)	S.U.	7.28	7.28	7.2	7.5	6.9	7.3	6.7	7.0
Alkalinity	mg/l	170	170	160	160	160	160	160	160
Copper	mg/l	< 0.012	< 0.012	< 0.012	< 0.012	< 0.012	< 0.0016	< 0.00047	< 0.00068
Hardness	mg/l	160	160	160	160	160	160	150	130
Iron	mg/l	4.2	4.2	4	4.1	4.1	3.7	4.2	4.0
Manganese	mg/l	0.22	0.24	0.2	0.2	0.2	0.19	0.22	0.2
Sulfate	mg/l	9	6	9	8	7.2	13	8.9	9.3
TDS	mg/l	200	220	190	200	210	240	240	190
MW-1010P									
Conductivity (Field)	umhos	313	294	283	276	322	309	337	311
pH (Field)	S.U.	7.21	7.51	7.3	7.4	7.2	7.5	7.6	7.4
Alkalinity	mg/l	150	160	160	160	160	160	160	170
Copper	mg/l	< 0.012	< 0.012	< 0.012	< 0.012	< 0.012	0.0032	0.0067	0.0097
Hardness	mg/l	130	130	150	150	150	150	160	130
Iron	mg/l	< 0.015	< 0.015	< 0.015	< 0.015	< 0.015	0.0046	0.0040	0.0050
Manganese	mg/l	0.035	0.018	0.17	0.014	0.01	0.014	0.06	0.051
Sulfate	mg/l	11	5	3	3	3.4	4.5	3.3	5.0
TDS	mg/l	180	230	170	180	190	200	250	240

Prepared By: SGL Checked By: JBH1

Table 1A

Groundwater Quality Results, Summary Statistics and Trend Analysis
July 1991 Through October 1998

Well/Parameter	Units	Jul-95	Oct-95	Jan-96	Apr-96	Jul-96	Oct-96	Jan-97	Apr-97
MW-1005									
Conductivity(Field)	umhos	1049	976	963	967	858	948	921	812
pH(Field)	S.U.	6.3	6.2	6.17	5.97	6.07	6.2	5.91	6.34
Alkalinity	mg/l	75	55	78	73	68	64	79	66
Copper	mg/l	< 0.00068	< 0.00068	< 0.00068	< 0.00068	< 0.00054	0.005	0.015	0.0045
Hardness	mg/l	320	360	330	300	300	320	300	280
Iron	mg/l	28	32	28	23	19	17	23	21
Manganese	mg/l	0.64	0.7	0.6	0.55	0.47	0.43	0.54	0.51
Sulfate	mg/l	14	21	14	14	14	14	13	12
TDS	mg/l	730	740	560	530	650	550	600	620
MW-1005P									
Conductivity(Field)	umhos	454	470	464	486	441	471	462	480
pH(Field)	S.U.	7.2	7.2	7.31	6.85	6.9	7.2	7.04	7
Alkalinity	mg/l	280	260	240	250	240	260	260	250
Copper	mg/l	0.0018	0.0021	< 0.00068	< 0.00068	0.0039	0.0082	0.0027	0.0016
Hardness	mg/l	200	230	210	210	210	200	210	220
Iron	mg/l	0.07	0.17	0.28	0.049	0.064	0.37	0.073	0.41
Manganese	mg/l	0.09	0.072	0.097	0.035	0.14	0.067	0.024	0.077
Sulfate	mg/l	< 0.56	5.3	0.93	2.2	2.6	3.6	5.4	5.8
TDS	mg/l	290	260	270	300	300	280	280	320
MW-1005S									
Conductivity(Field)	umhos	358	354	360	329	323	329	321	344
pH(Field)	S.U.	6.9	7.1	7.27	6.8	6.8	7.1	6.8	6.8
Alkalinity	mg/l	170	170	160	160	150	160	160	160
Copper	mg/l	< 0.00068	< 0.00068	< 0.00068	< 0.00068	< 0.00054	0.00063	0.004	0.0016
Hardness	mg/l	140	160	140	140	140	130	140	150
Iron	mg/l	3.8	4.3	3.7	3.9	3.6	3.6	3.8	4.1
Manganese	mg/l	0.2	0.22	0.2	0.2	0.19	0.2	0.2	0.21
Sulfate	mg/l	6.9	14	7	7.6	8.8	8	7.4	9.5
TDS	mg/l	220	220	190	240	230	220	250	250
MW-1010P									
Conductivity(Field)	umhos	315	291	313	309	285	302	282	346
pH(Field)	S.U.	7.6	7.4	7.01	7.16	7.42	7.6	7.23	7.43
Alkalinity	mg/l	160	140	140	160	140	150	140	150
Copper	mg/l	0.021	0.063	0.045	0.016	0.074	0.039	0.056	0.015
Hardness	mg/l	130	140	130	140	130	130	130	150
Iron	mg/l	0.0017	0.037	0.0023	0.0036	< 0.001	0.0026	0.0018	0.008
Manganese	mg/l	0.011	0.021	0.013	0.1	0.12	0.021	0.028	0.12
Sulfate	mg/l	2.4	9.6	3.4	3.8	5.9	5.8	5.8	6.7
TDS	mg/l	200	200	180	200	200	170	180	170

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Table 1A

Groundwater Quality Results, Summary Statistics and Trend Analysis
July 1991 Through October 1998

Well/Parameter	Units	Jul-97	Oct-97	Jan-98	Apr-98	Jul-98	Oct-98
MW-1005							
Conductivity(Field)	umhos	755	804	782	725	644	724
pH(Field)	S.U.	6.22	6	6.1	6.06	6.16	6.12
Alkalinity	mg/l	63	77	71	69	130	65
Copper	mg/l	0.0059	0.00054 <	0.00054 <	0.00054 <	0.00054 <	0.00054
Hardness	mg/l	300	280	260	250	240	250
Iron	mg/l	29	23	21	21	17	19
Manganese	mg/l	0.8	0.59	0.49	0.5	0.4	0.46
Sulfate	mg/l	12	10	14	13	16	17
TDS	mg/l	220	510	490	440	440	430
MW-1005P							
Conductivity(Field)	umhos	448	505	456	461	458	477
pH(Field)	S.U.	7.03	6.9	7.06	7.36	7.01	6.96
Alkalinity	mg/l	240	240	250	240	260	230
Copper	mg/l	0.002	0.00054	0.00073	0.0011 <	0.00054	0.0019
Hardness	mg/l	230	230	220	210	220	220
Iron	mg/l	0.087	0.17	0.41	0.077	0.34	0.17
Manganese	mg/l	0.066	0.062	0.072	0.029	0.1	0.063
Sulfate	mg/l	6.7	5	11	9.6	12	9.4
TDS	mg/l	280	260	270	280	270	250
MW-1005S							
Conductivity(Field)	umhos	689	351	313	332	305	327
pH(Field)	S.U.	6.83	6.77	7.09	7.19	6.7	6.82
Alkalinity	mg/l	140	150	170	140	160	150
Copper	mg/l	0.00071	0.00054 <	0.00054 <	0.00054	0.011 <	0.00054
Hardness	mg/l	150	150	120	140	150	150
Iron	mg/l	4	4.2	3.3	4.2	3.9	3.9
Manganese	mg/l	0.2	0.21	0.17	0.2	0.2	0.21
Sulfate	mg/l	9.8	6.2	11	11	15	13
TDS	mg/l	260	190	200	250	230	180
MW-1010P							
Conductivity(Field)	umhos	295	303	284	294	284	309
pH(Field)	S.U.	7.25	7.03	7.4	7.64	7.24	7.53
Alkalinity	mg/l	130	140	140	130	150	130
Copper	mg/l	0.048	0.03	0.026	0.019	0.027	0.02
Hardness	mg/l	140	140	130	130	130	130
Iron	mg/l	0.001	0.001 <	0.001	0.0034	0.0034 <	0.001
Manganese	mg/l	0.026	0.029	0.029	0.043	0.029	0.022
Sulfate	mg/l	7	5.1	9.2	5.6	11	8.6
TDS	mg/l	170	170	190	170	160	190

Prepared By: SGL Checked By: JBH1

Table 1B

Groundwater Quality Results, Summary Statistics and Trend Analysis
July 1991 Through October 1998

Well/Parameter	Units	Total Samples	# Of Samples Included In Trend Test(*)	Total Detections	Mann-Kendall S	p-Level	
MW-1000P-R							
Conductivity (Field)	umhos	30	30	30	-70	0.221	
pH(Field)	S.U.	30	30	30	-43	0.456	
Alkalinity	mg/l	30	30	30	-125	0.026	
Copper	mg/l	30	30	24	258	0	+
Hardness	mg/l	30	30	30	-69	0.228	
Iron	mg/l	30	29	29	-241	0	-
Manganese	mg/l	30	30	30	-147	0.008	-
Sulfate	mg/l	30	30	27	59	0.304	
TDS	mg/l	30	30	30	-12	0.846	
MW-1002							
Conductivity (Field)	umhos	30	30	30	-82	0.149	
pH(Field)	S.U.	30	30	30	1	1	
Alkalinity	mg/l	30	30	30	-136	0.015	
Copper	mg/l	30	16	14	-21	0.374	
Hardness	mg/l	30	30	30	-145	0.01	
Iron	mg/l	30	20	19	-5	0.898	
Manganese	mg/l	30	19	18	-53	0.068	
Sulfate	mg/l	30	30	24	42	0.467	
TDS	mg/l	30	30	30	-58	0.312	
MW-1002G							
Conductivity (Field)	umhos	30	30	30	-82	0.149	
pH(Field)	S.U.	30	30	30	-22	0.711	
Alkalinity	mg/l	30	30	30	-28	0.633	
Copper	mg/l	30	16	3	0	1	
Hardness	mg/l	30	30	30	-158	0.004	-
Iron	mg/l	30	17	13	-26	0.308	
Manganese	mg/l	30	17	4	-26	0.308	
Sulfate	mg/l	30	30	29	12	0.846	
TDS	mg/l	30	30	30	5	0.944	
MW-1004P							
Conductivity (Field)	umhos	30	30	30	-45	0.436	
pH(Field)	S.U.	30	30	30	-38	0.513	
Alkalinity	mg/l	30	30	30	-178	0.002	-
Copper	mg/l	30	18	17	43	0.112	
Hardness	mg/l	30	30	30	-229	0	-
Iron	mg/l	30	28	28	-247	0	-
Manganese	mg/l	30	30	29	-235	0	-
Sulfate	mg/l	30	23	23	139	0	+
TDS	mg/l	30	30	30	-45	0.436	
MW-1004S							
Conductivity (Field)	umhos	30	30	30	64	0.264	
pH(Field)	S.U.	30	30	30	-157	0.004	-
Alkalinity	mg/l	30	30	30	-9	0.888	
Copper	mg/l	30	18	17	-68	0.009	-
Hardness	mg/l	30	30	30	-14	0.818	
Iron	mg/l	30	17	17	-6	0.84	
Manganese	mg/l	30	17	16	-30	0.236	
Sulfate	mg/l	30	30	26	64	0.264	
TDS	mg/l	30	30	30	25	0.672	

Prepared By: SGL Checked By: JBH1

Table 1B

Groundwater Quality Results, Summary Statistics and Trend Analysis
July 1991 Through October 1998

Well/Parameter	Units	Total Samples	# Of Samples Included In Trend Test(*)	Total Detections	Mann-Kendall S	p-Level	
MW-1005							
Conductivity (Field)	umhos	30	30	30	-190	0	-
pH(Field)	S.U.	30	30	30	-123	0.028	
Alkalinity	mg/l	30	30	30	-208	0	-
Copper	mg/l	30	17	5	4	0.904	
Hardness	mg/l	30	30	30	-308	0	-
Iron	mg/l	30	30	30	30	0.608	
Manganese	mg/l	30	30	30	36	0.536	
Sulfate	mg/l	30	30	30	-92	0.105	
TDS	mg/l	30	30	30	-136	0.015	
MW-1005P							
Conductivity (Field)	umhos	30	30	30	19	0.75	
pH(Field)	S.U.	30	30	30	-58	0.312	
Alkalinity	mg/l	30	30	30	-140	0.012	
Copper	mg/l	30	16	12	-38	0.096	
Hardness	mg/l	30	30	30	-170	0.002	-
Iron	mg/l	30	30	30	-174	0.002	-
Manganese	mg/l	30	30	30	-197	0	-
Sulfate	mg/l	30	18	15	102	0	+
TDS	mg/l	30	30	30	-53	0.356	
MW-1005S							
Conductivity (Field)	umhos	30	30	30	-80	0.16	
pH(Field)	S.U.	30	30	30	-137	0.014	
Alkalinity	mg/l	30	30	30	-188	0	-
Copper	mg/l	30	16	5	25	0.286	
Hardness	mg/l	30	30	30	-248	0	-
Iron	mg/l	30	30	30	5	0.944	
Manganese	mg/l	30	30	30	-100	0.077	
Sulfate	mg/l	30	30	24	206	0	+
TDS	mg/l	30	30	29	51	0.376	
MW-1010P							
Conductivity (Field)	umhos	30	30	30	-126	0.025	
pH(Field)	S.U.	30	30	30	2	0.986	
Alkalinity	mg/l	30	30	30	-183	0	-
Copper	mg/l	30	17	17	20	0.44	
Hardness	mg/l	30	30	30	-67	0.242	
Iron	mg/l	30	19	15	-84	0.003	-
Manganese	mg/l	30	30	30	-136	0.015	
Sulfate	mg/l	30	27	27	-6	0.918	
TDS	mg/l	30	30	30	-172	0.002	-

+ : Implies Statistically Increasing Trend
- : Implies Statistically Decreasing Trend

(*) If the value of a sample is below the detection limit, three situations apply:
1) If the detection limit is equal to or less than the minimum detected value, the result is replaced with zero.
2) If the detection limit is greater than the minimum detected value, but less than or equal to two times the minimum detected value, the minimum detected value, the result is replaced with the minimum detected value.
3) If the detection limit is greater than two times the minimum detected value the result is omitted from the trend analysis.

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Table 2A

Surface Water Quality Results, Summary Statistics and Trend Analysis
July 1991 Through October 1998

Station/Parameter	Units	Jul-91	Oct-91	Jan-92	Apr-92	Jul-92	Oct-92	Jan-93	Apr-93
SW-1									
Conductivity(Field)	umhos	112	102	84	74	86	134	136	84
pH(Field)	S.U.	7.43	7.92	6.95	6.71	6.75	7.23	6.71	7.07
Aluminum	mg/l	< 0.4	0.08	0.7	0.75	0.14	0.42	0.11	0.13
Arsenic	mg/l	< 0.001	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Beryllium	mg/l	< 0.2	< 0.2	< 0.2	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Cadmium	mg/l	< 0.0002	0.001	< 0.0002	< 0.0002	0.0006	< 0.0002	0.0007	< 0.0002
Chromium	mg/l	0.0027	< 0.002	0.002	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Chromium IV	mg/l	0.01	< 0.02	0.009	< 0.02	< 0.018	< 0.02	< 0.005	< 0.005
Copper	mg/l	< 0.003	0.004	0.003	0.005	0.002	0.004	< 0.002	< 0.002
Diss O2	mg/l	6.2	11	12	11.2	7.4	9.9	11	6.8
Hardness	mg/l	100	46	50	34	23	52	52	40
Lead	mg/l	0.0012	< 0.003	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.001
Mercury	mg/l	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/l	< 0.05	< 0.016	< 0.05	< 0.02	< 0.018	< 0.02	< 0.02	< 0.02
Selenium	mg/l	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Silver	mg/l	< 0.0005	< 0.002	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Sulfide	mg/l								
TDS	mg/l	140	98	90	86	90	90	100	66
TSS	mg/l	< 1	14	4	< 1	9	4	< 1	2
Zinc	mg/l	0.02	24	0.008	0.011	0.006	< 0.003	0.007	< 0.003
SW-2									
Conductivity(Field)	umhos	120	104	144	69	85	117	158	85
pH(Field)	S.U.	7.92	8.01	7.09	6.19	7.1	7.11	7.05	7.25
Aluminum	mg/l	< 0.4	0.06	0.42	0.72	0.14	0.54	0.07	0.11
Arsenic	mg/l	< 0.001	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Beryllium	mg/l	< 0.2	< 0.2	< 0.2	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Cadmium	mg/l	< 0.0002	0.0005	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	mg/l	0.0012	< 0.002	0.002	< 0.001	0.001	< 0.001	< 0.001	< 0.001
Chromium IV	mg/l	0.009	< 0.02	0.007	< 0.02	< 0.013	< 0.02	< 0.005	< 0.005
Copper	mg/l	0.0042	< 0.002	0.004	< 0.002	< 0.002	0.004	0.004	0.002
Diss O2	mg/l	6.5	10	12	11.5	7.6	10	12	11
Hardness	mg/l	48	47	50	34	28	68	52	40
Lead	mg/l	0.0012	< 0.003	0.001	< 0.001	0.003	< 0.001	< 0.001	< 0.001
Mercury	mg/l	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/l	< 0.05	< 0.016	< 0.05	< 0.02	< 0.018	< 0.02	< 0.02	< 0.02
Selenium	mg/l	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Silver	mg/l	< 0.0005	< 0.002	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Sulfide	mg/l								
TDS	mg/l	140	85	87	120	120	96	110	74
TSS	mg/l	< 1	4	< 1	< 1	7	5	< 1	1
Zinc	mg/l	0.02	< 3	0.004	0.009	0.008	< 0.003	0.008	< 0.003

Prepared By: SGL Checked By: JBH1

Table 2A

Surface Water Quality Results, Summary Statistics and Trend Analysis
July 1991 Through October 1998

Station/Parameter	Units	Jul-93	Nov-93	Jan-94	Apr-94	Jul-94	Oct-94	Jan-95	Apr-95
SW-1									
Conductivity(Field)	umhos	87	118.9	203	118	117	78	128.5	78.1
pH(Field)	S.U.	7.29	8.59	7.8	8	7.4	7.2	8.14	7.7
Aluminum	mg/l	0.18	0.047	0.12	0.29	0.07	0.2	0.059	0.093
Arsenic	mg/l	0.0028	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.0014	< 0.0014
Beryllium	mg/l	< 0.0004	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.00028	< 0.00028
Cadmium	mg/l	< 0.0008	< 0.0006	< 0.0002	0.00038	< 0.0002	< 0.0008	< 0.00052	0.00022
Chromium	mg/l	< 0.002	0.004	< 0.001	0.0018	0.0018	0.0025	< 0.00055	0.0043
Chromium IV	mg/l	< 0.005		< 0.005	< 0.005	< 0.005	< 0.0015	< 0.0015	< 0.0015
Copper	mg/l	< 0.012	< 0.002	0.0044	< 0.002	0.0027	0.002	0.0078	< 0.0038
Diss O2	mg/l	10	9	11.9	5.8	8.5	10.1	9	9.3
Hardness	mg/l	44	56	64	43	48	36	48	36
Lead	mg/l	< 0.005	< 0.001	< 0.001	0.01	0.0025	0.0011	< 0.00078	0.0045
Mercury	mg/l	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 9.5E-05	< 9.5E-05
Nickel	mg/l	< 0.016	< 0.016	< 0.016	< 0.016	< 0.016	< 0.016	< 0.0059	< 0.0059
Selenium	mg/l	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.0015	< 0.0015
Silver	mg/l	< 0.002	< 0.0015	< 0.0005	< 0.0005	< 0.0005	< 0.0025	0.0016	0.0013
Sulfide	mg/l		< 2			< 2	< 2	< 2	< 2
TDS	mg/l	66	91	93	84	96	100	120	100
TSS	mg/l	5	< 1	1	3	< 1	8	8	10
Zinc	mg/l	< 0.003	< 0.003	0.007	0.009	0.011	0.017	0.016	< 0.012
SW-2									
Conductivity(Field)	umhos	100	132.6	151	124	119	82	158	86
pH(Field)	S.U.	7.14	7.93	8.1	8	7.6	7.1	8.19	7.7
Aluminum	mg/l	0.36	0.072	0.036	0.31	0.14	0.22	0.26	0.12
Arsenic	mg/l	0.0027	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.0014	< 0.0014
Beryllium	mg/l	< 0.0004	< 0.001	< 0.001	< 0.001	0.0012	0.0012	0.0012	0.0006
Cadmium	mg/l	< 0.0008	< 0.0006	< 0.0002	< 0.0002	0.00022	< 0.0008	< 0.00052	< 0.0016
Chromium	mg/l	0.0021	0.004	< 0.001	0.0019	0.0023	0.0037	< 0.00055	0.0044
Chromium IV	mg/l	< 0.005		< 0.005	< 0.005	< 0.005	< 0.0015	< 0.0015	< 0.0015
Copper	mg/l	< 0.012	0.0032	< 0.002	0.0051	0.0036	0.0057	0.011	< 0.0038
Diss O2	mg/l	9.7	8.5	11.6	6.6	8.8	9.3	8.6	10.8
Hardness	mg/l	76	60	60	40	48	38	55	36
Lead	mg/l	< 0.005	< 0.001	< 0.001	< 0.001	0.0014	0.0015	0.0097	0.0061
Mercury	mg/l	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 9.5E-05	< 9.5E-05
Nickel	mg/l	< 0.016	< 0.016	< 0.016	< 0.016	< 0.016	< 0.016	< 0.0059	< 0.0059
Selenium	mg/l	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.0015	< 0.0015
Silver	mg/l	< 0.002	< 0.0015	< 0.0005	< 0.0005	< 0.0005	< 0.0025	< 0.00085	0.0018
Sulfide	mg/l		< 2			< 2	< 2	< 2	< 2
TDS	mg/l	100	88	83	82	100	92	150	81
TSS	mg/l	11	< 1	< 1	13	10	8	6	< 1
Zinc	mg/l	0.009	0.04	0.05	0.007	0.009	0.023	0.021	< 0.012

Prepared By: SGL Checked By: JBH1

Table 2A

Surface Water Quality Results, Summary Statistics and Trend Analysis
July 1991 Through October 1998

Station/Parameter	Units	Jul-95	Oct-95	Jan-96	Apr-96	Jul-96	Oct-96	Jan-97	Apr-97
SW-1									
Conductivity(Field)	umhos	105.5	112.5	150.5	124	94.5	153.5	113.3	58.9
pH(Field)	S.U.	7.18	7.74	7.15	6.5	7.53	7.95	7.57	6.82
Aluminum	mg/l	0.06	0.096	< 0.025	0.037	0.14	0.046	0.064	0.26
Arsenic	mg/l	< 0.0018	< 0.0018	< 0.0018	< 0.0018	< 0.0018	< 0.0018	< 0.0018	< 0.0018
Beryllium	mg/l	< 8.3E-05	0.00011	< 8.3E-05	< 8.3E-05	0.00022	< 8.3E-05	< 8.3E-05	< 8.3E-05
Cadmium	mg/l	< 0.00016	0.00019	0.00035	< 0.00016	0.00017	0.00031	< 0.00016	< 0.00016
Chromium	mg/l	< 0.00061	0.0014	0.0013	< 9.3E-06	0.0014	< 0.00061	0.0025	0.00082
Chromium IV	mg/l	< 0.0015	< 0.006	0.003	< 0.0015	< 0.029	0.004	< 0.0036	< 0.018
Copper	mg/l	< 0.0017	0.0037	< 0.0017	0.0033	0.0021	0.0019	< 0.0017	0.0018
Diss O2	mg/l	9.1	8.2	10.7	9.1	5.3	8.5	9.6	12.1
Hardness	mg/l	43	40	46	44	34	40	44	20
Lead	mg/l	< 0.002	0.0082	0.01	< 0.002	0.0027	< 0.002	0.0023	< 0.002
Mercury	mg/l	< 9.5E-05	< 9.5E-05	< 9.5E-05	< 9.5E-05	0.00066	< 6.7E-05	< 6.7E-05	< 6.7E-05
Nickel	mg/l	< 0.00075	0.0026	< 0.00075	< 0.00075	0.00081	< 0.00075	< 0.00075	0.00076
Selenium	mg/l	< 0.0015	< 0.0015	< 0.0015	< 0.0015	0.0017	0.0025	0.0018	< 0.0015
Silver	mg/l	< 0.0011	< 0.0011	< 0.0011	< 0.0011	< 0.0011	0.0015	< 0.0011	< 0.0011
Sulfide	mg/l	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
TDS	mg/l	80	120	86	120	120	16	100	98
TSS	mg/l	7	< 1	4	< 1	< 1	< 1	< 1	8
Zinc	mg/l	< 0.012	< 0.012	< 0.012	< 0.012	< 0.012	< 0.012	0.021	0.013
SW-2									
Conductivity(Field)	umhos	170	126	120.2	153.1	106.8	274	132	89.6
pH(Field)	S.U.	7.38	7.95	7.01	6.76	7.41	7.86	7.61	6.51
Aluminum	mg/l	0.043	0.12	< 0.025	0.071	0.091	0.047	0.058	0.24
Arsenic	mg/l	< 0.0018	< 0.0018	< 0.0018	< 0.0018	< 0.0018	0.002	< 0.0018	< 0.0018
Beryllium	mg/l	< 8.3E-05	0.00012	< 8.3E-05	< 8.3E-05	0.00011	< 8.3E-05	< 8.3E-05	< 8.3E-05
Cadmium	mg/l	< 0.00016	0.00027	< 0.00016	< 0.00016	< 0.00016	0.00028	< 0.00016	0.00016
Chromium	mg/l	< 0.00061	0.002	0.0014	< 9.3E-06	0.0012	< 0.00061	0.0021	0.0012
Chromium IV	mg/l	< 0.0015	< 0.006	0.003	< 0.0015	< 0.029	< 0.0036	< 0.0036	< 0.018
Copper	mg/l	< 0.0017	0.0043	< 0.0017	< 0.0017	< 0.0017	0.0043	< 0.0017	0.0026
Diss O2	mg/l	10.2	8.5	10.7	11.7	7.5	8.7	11.1	12.9
Hardness	mg/l	46	46	45	53	36	69	52	21
Lead	mg/l	< 0.002	0.0083	0.0096	< 0.002	0.0026	0.0022	0.0021	< 0.002
Mercury	mg/l	< 9.5E-05	< 9.5E-05	< 9.5E-05	< 9.5E-05	< 9.5E-05	< 6.7E-05	< 6.7E-05	< 6.7E-05
Nickel	mg/l	< 0.00075	0.0008	< 0.00075	< 0.00075	< 0.00075	< 0.00075	< 0.00075	< 0.00075
Selenium	mg/l	< 0.0015	< 0.0015	< 0.0015	< 0.0015	< 0.0015	< 0.0015	< 0.0015	< 0.0015
Silver	mg/l	< 0.0011	< 0.0011	< 0.0011	< 0.0011	< 0.0011	0.0013	< 0.0011	0.0016
Sulfide	mg/l	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
TDS	mg/l	63	110	95	110	120	98	84	100
TSS	mg/l	6	3	< 1	< 1	< 1	1	3	4
Zinc	mg/l	< 0.012	0.013	< 0.012	< 0.012	< 0.012	0.023	< 0.012	0.017

Prepared By: SGL Checked By: JBH1

Table 2A

Surface Water Quality Results, Summary Statistics and Trend Analysis
July 1991 Through October 1998

Station/Parameter	Units	Jul-97	Oct-97	Jan-98	Apr-98	Jul-98	Oct-98
SW-1							
Conductivity (Field)	umhos	96.1	107.6	136.3	110	130	
pH(Field)	S.U.	7.25	7.27	7.63	7	8.7	
Aluminum	mg/l	0.085	0.11	0.036	0.065	< 0.025	
Arsenic	mg/l	< 0.0014	< 0.0014	< 0.0018	< 0.0018	< 0.0018	
Beryllium	mg/l	0.00011	< 8.3E-05	< 8.3E-05	< 8.3E-05	< 8.3E-05	
Cadmium	mg/l	< 0.00016	< 0.00016	0.0002	< 0.00016	< 0.00016	
Chromium	mg/l	0.0011	< 0.00061	< 0.00061	< 0.00061	0.0011	
Chromium IV	mg/l	< 0.0036	< 0.0036	0.006	< 0.0036	< 0.0036	
Copper	mg/l	< 0.0017	0.0022	0.0076	< 0.0017	< 0.0017	
Diss O2	mg/l	6	6.9	8.7	8.5	8.2	
Hardness	mg/l	35	39	46	29	41	
Lead	mg/l	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	
Mercury	mg/l	< 5E-05	< 5E-05	< 5E-05	0.00033	< 5E-05	
Nickel	mg/l	< 0.00075	< 0.00075	0.0019	0.001	< 0.00075	
Selenium	mg/l	< 0.0016	< 0.0016	< 0.0016	< 0.0016	< 0.0016	
Silver	mg/l	< 0.0011	0.0011	< 0.0011	< 0.0011	< 0.0011	
Sulfide	mg/l	< 2	< 2	< 2	< 2	< 2	
TDS	mg/l	94	72	84	71	70	
TSS	mg/l	4	5	< 1	6	6	
Zinc	mg/l	< 0.012	< 0.012	0.043	< 0.012	< 0.012	
SW-2							
Conductivity (Field)	umhos	106.8	113.8	167.9	97	160	
pH(Field)	S.U.	7.25	7.44	7.32	7	8.3	
Aluminum	mg/l	0.08	0.072	0.074	0.057	0.12	
Arsenic	mg/l	< 0.0014	< 0.0014	< 0.0018	0.0043	< 0.0018	
Beryllium	mg/l	0.00023	< 8.3E-05	< 8.3E-05	< 8.3E-05	0.00021	
Cadmium	mg/l	< 0.00016	< 0.00016	0.00023	< 0.00016	< 0.00016	
Chromium	mg/l	0.0012	0.0014	0.0032	< 0.00061	0.0016	
Chromium IV	mg/l	< 0.0036	< 0.0036	0.005	< 0.0036	< 0.0036	
Copper	mg/l	< 0.0017	< 0.0017	0.012	< 0.0017	< 0.0017	
Diss O2	mg/l	6.1	8.1	8.5	8.7	8.6	
Hardness	mg/l	37	40	49	28	52	
Lead	mg/l	< 0.002	< 0.002	0.0021	< 0.002	0.002	
Mercury	mg/l	< 5E-05	< 5E-05	6E-05	0.00013	< 5E-05	
Nickel	mg/l	0.0011	< 0.00075	0.0037	0.0013	< 0.00075	
Selenium	mg/l	< 0.0016	< 0.0016	0.0026	0.004	< 0.0016	
Silver	mg/l	< 0.0011	< 0.0011	< 0.0011	< 0.0011	< 0.0011	
Sulfide	mg/l	< 2	< 2	< 2	< 2	< 2	
TDS	mg/l	99	80	92	88	70	
TSS	mg/l	3	< 1	3	5	12	
Zinc	mg/l	< 0.012	< 0.012	0.089	< 0.012	< 0.012	

Prepared By: SGL Checked By: JBH1

Table 2B

Surface Water Quality Results, Summary Statistics and Trend Analysis
July 1991 Through October 1998

Station/Parameter	Units	Total Samples	# Of Samples Included In Trend Test(*)	Total Detections	Mann-Kendall S	p-Level	
SW-1							
Conductivity(Field)	umhos	29	29	29	55	0.315	
pH(Field)	S.U.	29	29	29	41	0.457	
Aluminum	mg/l	29	28	26	-147	0.004	-
Arsenic	mg/l	29	29	1	-12	0.838	
Beryllium	mg/l	29	13	3	-10	0.59	
Cadmium	mg/l	29	25	10	-43	0	-
Chromium	mg/l	29	27	14	-33	0.508	
Chromium IV	mg/l	28	22	5	-13	0.738	
Copper	mg/l	29	27	16	-48	0.33	
Diss O2	mg/l	29	29	29	-83	0.125	
Hardness	mg/l	29	29	29	-124	0.02	
Lead	mg/l	29	27	10	-14	0.788	
Mercury	mg/l	29	29	2	37	0.503	
Nickel	mg/l	29	13	5	4	0.858	
Selenium	mg/l	29	29	3	43	0.435	
Silver	mg/l	29	28	4	30	0.57	
Sulfide	mg/l	18	18	0	0	1	
TDS	mg/l	29	29	29	-43	0.435	
TSS	mg/l	29	29	18	0	1	
Zinc	mg/l	29	29	14	-75	0.166	
SW-2							
Conductivity(Field)	umhos	29	29	29	70	0.198	
pH(Field)	S.U.	29	29	29	8	0.896	
Aluminum	mg/l	29	28	27	-103	0.044	
Arsenic	mg/l	29	29	3	29	0.603	
Beryllium	mg/l	29	17	8	-51	0.038	
Cadmium	mg/l	29	24	6	13	0	+
Chromium	mg/l	29	29	18	45	0.413	
Chromium IV	mg/l	28	22	4	-22	0.559	
Copper	mg/l	29	28	14	-43	0.411	
Diss O2	mg/l	29	29	29	-51	0.352	
Hardness	mg/l	29	29	29	-49	0.372	
Lead	mg/l	29	27	14	22	0.665	
Mercury	mg/l	29	15	2	23	0.282	
Nickel	mg/l	29	13	4	16	0.368	
Selenium	mg/l	29	29	2	51	0.352	
Silver	mg/l	29	29	3	33	0.552	
Sulfide	mg/l	18	18	0	0	1	
TDS	mg/l	29	29	29	-73	0.178	
TSS	mg/l	29	29	17	21	0.71	
Zinc	mg/l	29	18	16	59	0.026	

+ : Implies Statistically Increasing Trend
- : Implies Statistically Decreasing Trend

(*) If the value of a sample is below the detection limit, three situations apply:
1) If the detection limit is equal to or less than the minimum detected value, the result is replaced with zero.
2) If the detection limit is greater than the minimum detected value, but less than or equal to two times the minimum detected value, the minimum detected value, the result is replaced with the minimum detected value.
3) If the detection limit is greater than two times the minimum detected value the result is omitted from the trend analysis.

Prepared By: SGL Checked By: JBH1

380+00 E
390+00 E
400+00 E
410+00 E
420+00 E
430+00 E

N

430+00 N
420+00 N
410+00 N
400+00 N
390+00 N

PZ-1012
1105.00
PZ-1007S
1113.97
PZ-1011
1136.23
MW-1002G 1089.77
MW-1002 1089.73
1100
1105
1110
1115
1120
1125
1130
1135
1095
1106.67
1106.67
MW-1003P
MW-1003
MW-1014 1108.41
MW-1014A 1099.88
MW-1014B 1105.34
MW-1014C 1102.04
PZ-1006G 1131.87
PZ-1006 (DRY)
PZ-1006S 1130.40
PZ-1009G 1141.38
PZ-1009 1141.33
OW-10
1085.68
1090
1085
OW-43
1083.12
PZ-1A 1097.89
PZ-1B 1102.94
MW-1004S 1104.35
MW-1004 1104.28
MW-1004P 1102.35
ST-9-23A (DRY)
ST-9-23 1107.13
MW-1005P 1135.99
MW-1005 1136.77
MW-1005S 1135.77
OW-42
1088.16
MW-1013 1106.17
MW-1013A 1095.32
MW-1013B 1094.33
MW-1013C 1094.97
PZ-S3
1104.53
PZ-S1
1092.25
PZ-R1
1089.49
MW-1010P
1086.46
ST-9-26
1101.80
OW-39
1108.48
MW-1000PR
1086.32
MW-1000R
1086.47
OW-7
1102.57
MW-1001P 1106.04
MW-1001 (DRY)
MW-1001G 1105.47
PZ-1008
1134.95
PZ-1008G
1135.13

LEGEND

1130 — POTENTIOMETRIC SURFACE CONTOUR

1135 — INFERRED POTENTIOMETRIC SURFACE ELEVATION CONTOUR

MW-1001G 1105.47 — GROUNDWATER MONITORING WELL AND MEASURED GROUNDWATER ELEVATION (FT MSL)

PZ-1008G 1135.13 — GROUNDWATER ELEVATION (FT MSL)

NOTE: POTENTIOMETRIC SURFACE CONTOURS ARE CONSISTENT WITH GROUNDWATER ELEVATIONS AT NESTED WELLS OUTSIDE OF THE BACKFILL WHERE VERTICAL HEAD DIFFERENCES ARE MINIMAL WITH RESPECT TO CONTOUR INTERVAL WITHIN THE BACKFILL. CONTOURS ARE BASED ON HIGHEST GROUNDWATER LEVEL MEASURED AT NESTED WELLS BELOW THE SAPROLITE.

FLAMBEAU MINING COMPANY

FIGURE 1

DECEMBER 1, 1998
GROUNDWATER POTENTIOMETRIC SURFACE CONTOUR MAP

Scale: 0 250' 500'		Date: DECEMBER, 1998	
Prepared By: Foth & Van Dyke	By: DAT	98F002	

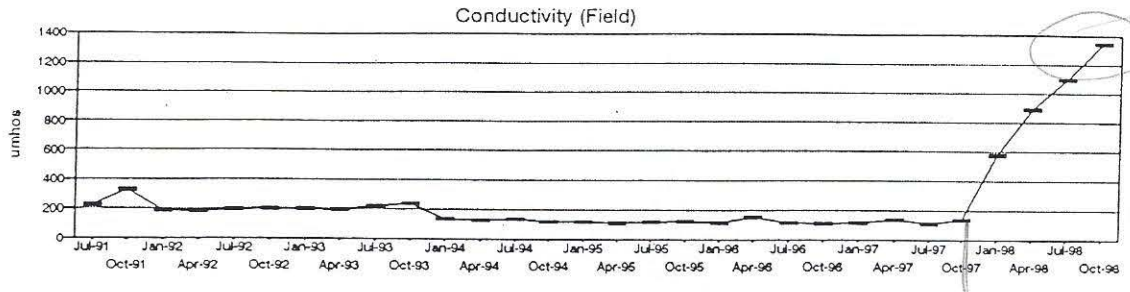
G:\761\11\7111143.dgn Dec 10, 1998 15:03:43

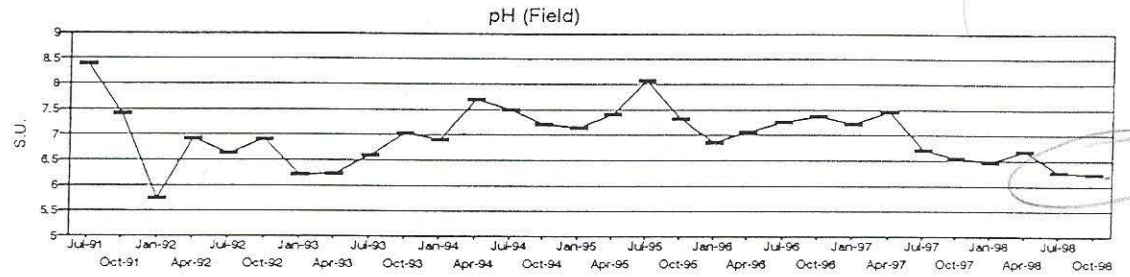
Attachment 1

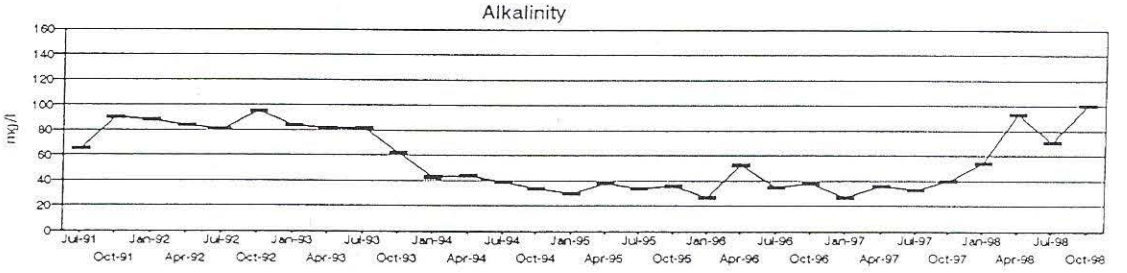
Trend Graphs
(Groundwater)

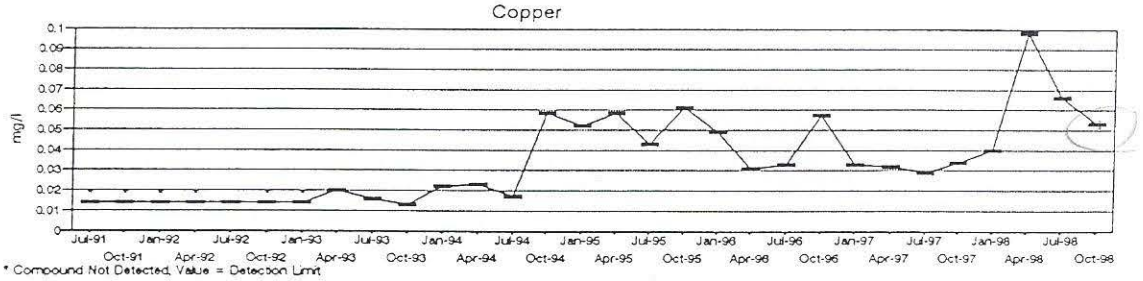
Flambeau Mining Company
Groundwater Quality Results

MW-1000P-R

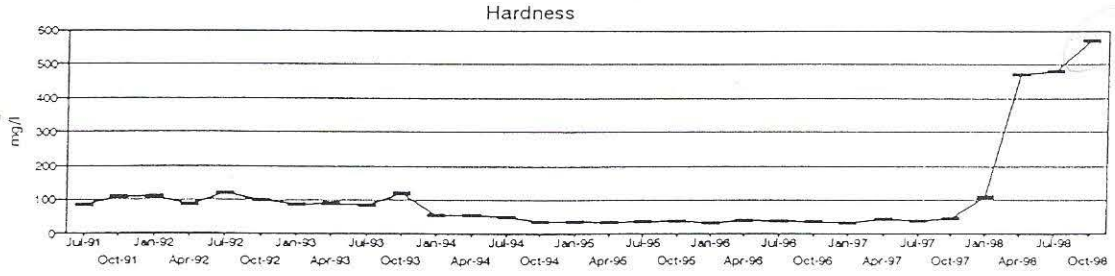








* Compound Not Detected, Value = Detection Limit

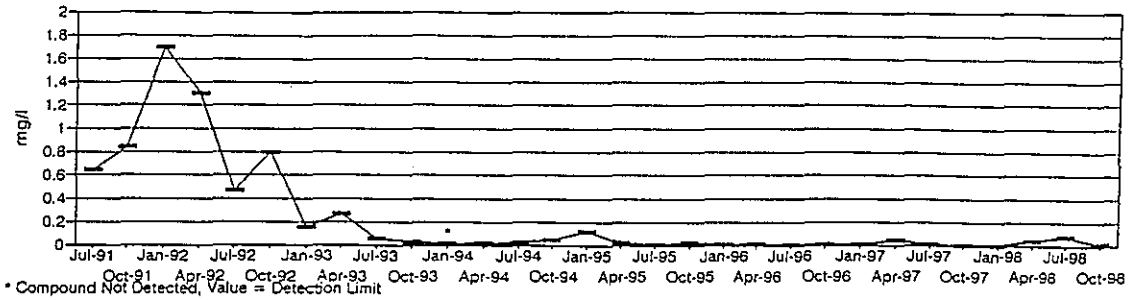


Prepared By: SGL Checked By: JBH1

Flambeau Mining Company
Groundwater Quality Results

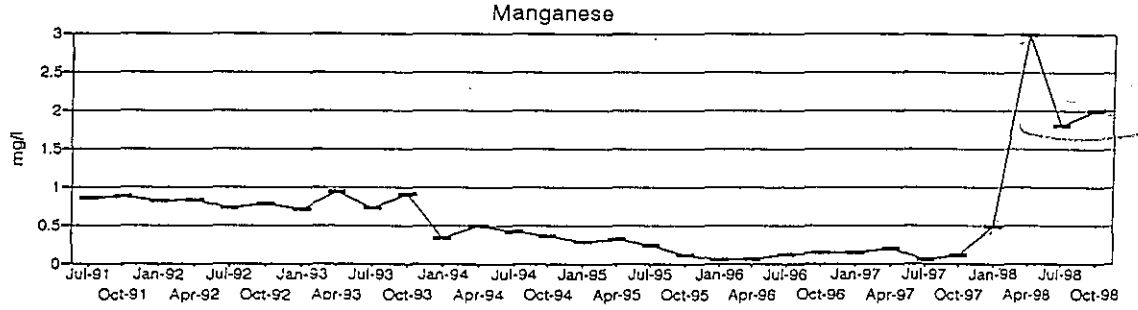
MW-1000P-R

Iron

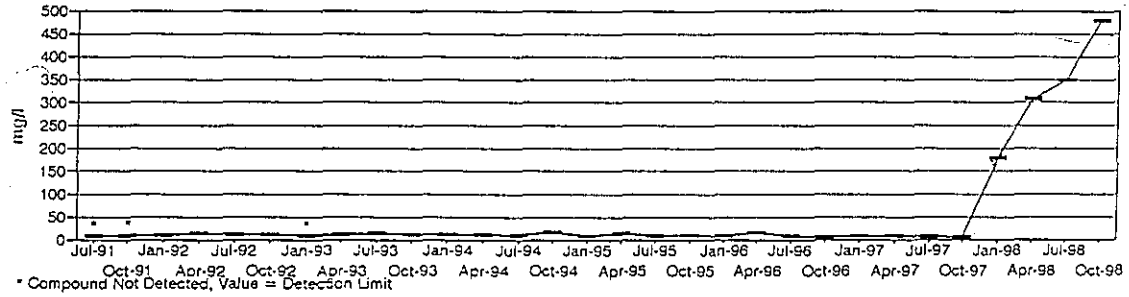


* Compound Not Detected, Value = Detection Limit

Manganese

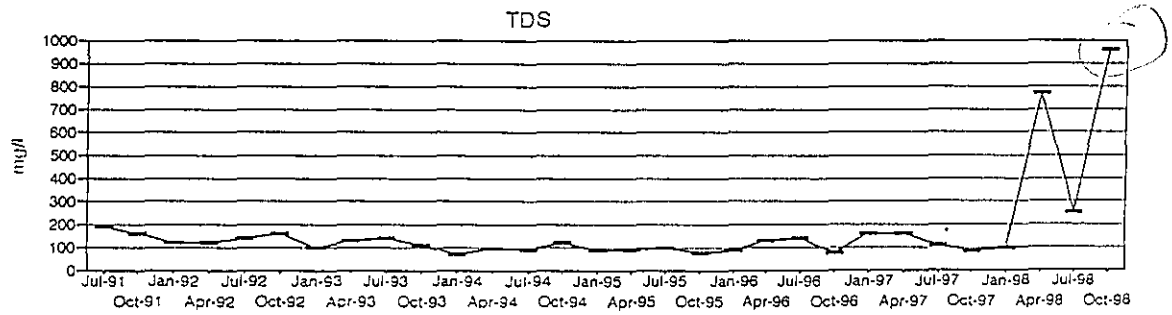


Sulfate



* Compound Not Detected, Value = Detection Limit

TDS

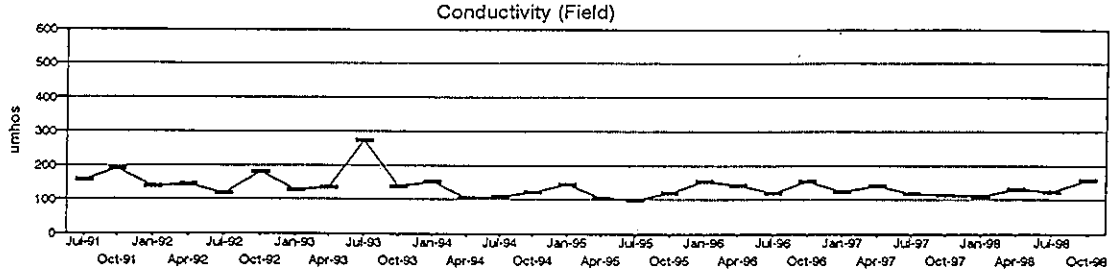


Prepared By: SGL Checked By: JBH1

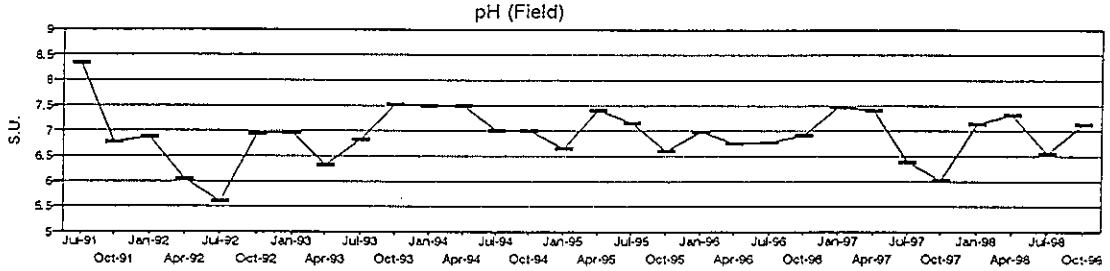
Flambeau Mining Company
Groundwater Quality Results

MW-1002

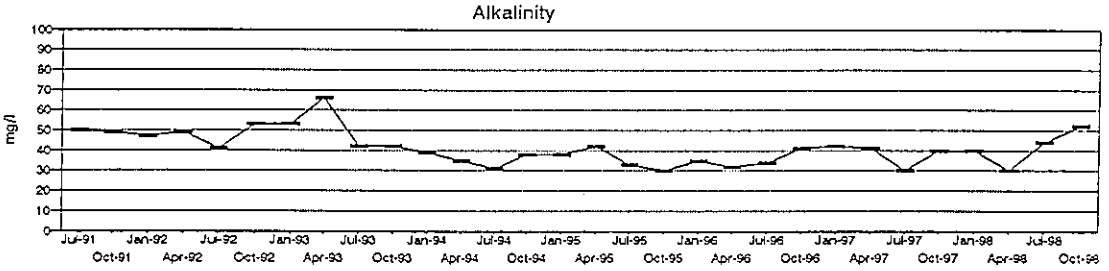
Conductivity (Field)



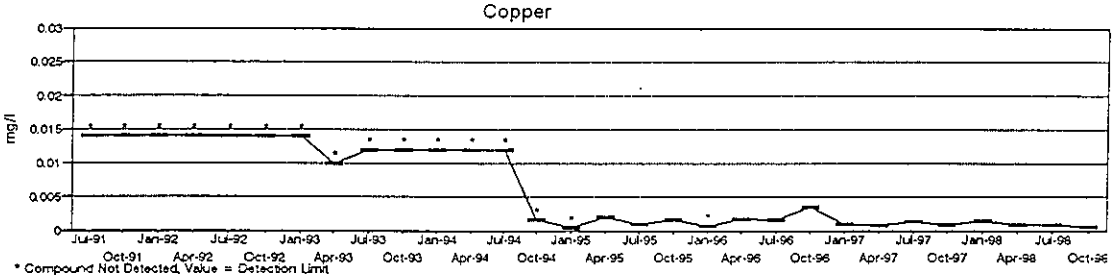
pH (Field)



Alkalinity

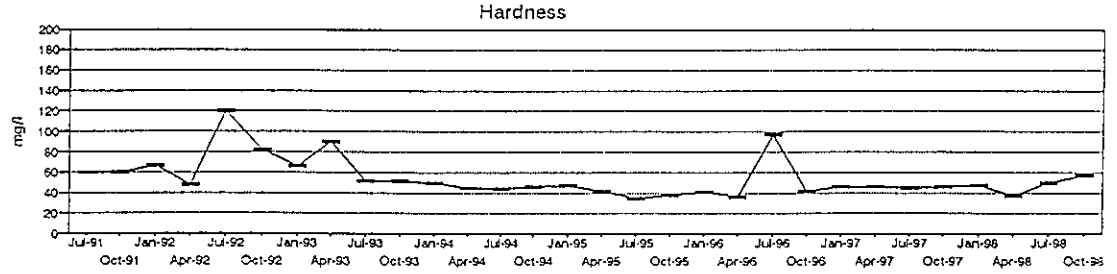


Copper



* Compound Not Detected, Value = Detection Limit

Hardness

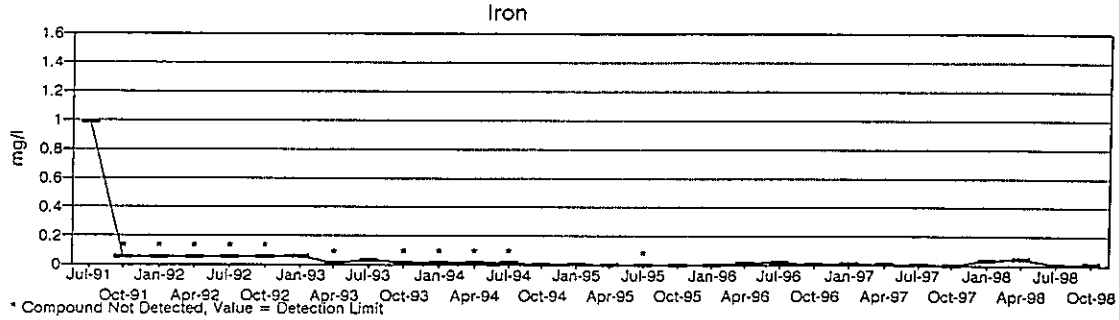


Prepared By: SGL Checked By: JBH1

Flambeau Mining Company
Groundwater Quality Results

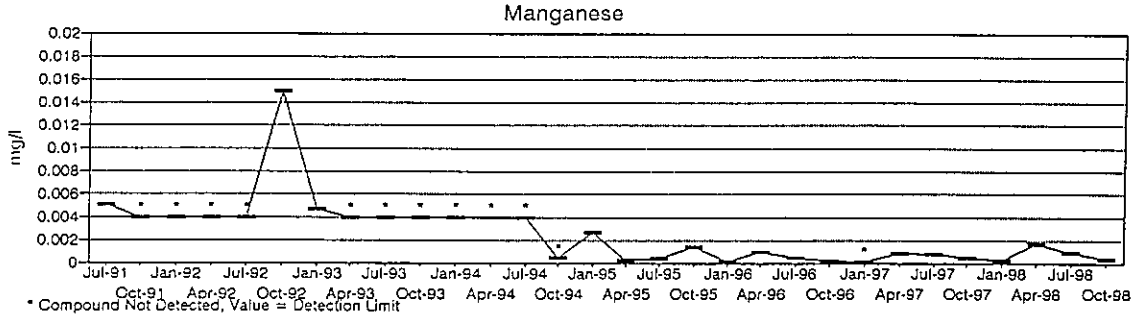
MW-1002

Iron



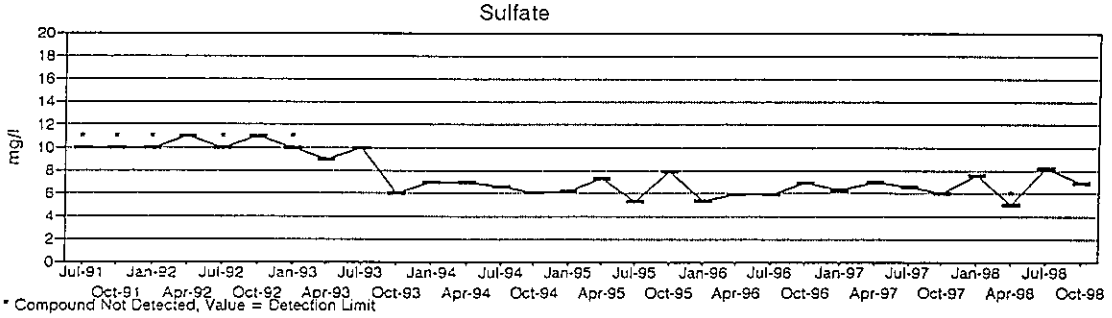
* Compound Not Detected, Value = Detection Limit

Manganese



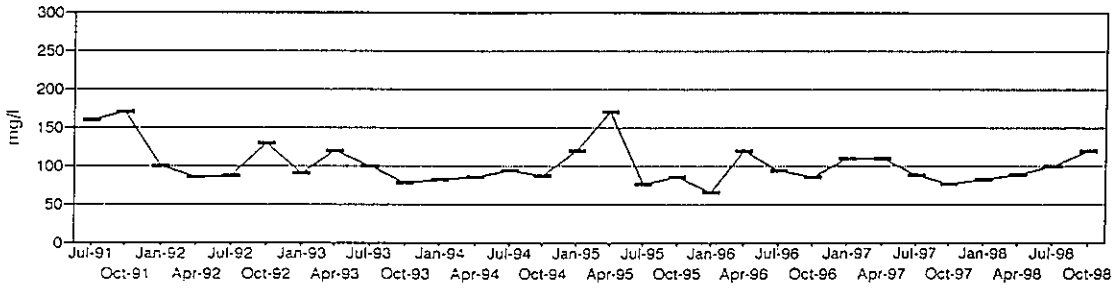
* Compound Not Detected, Value = Detection Limit

Sulfate



* Compound Not Detected, Value = Detection Limit

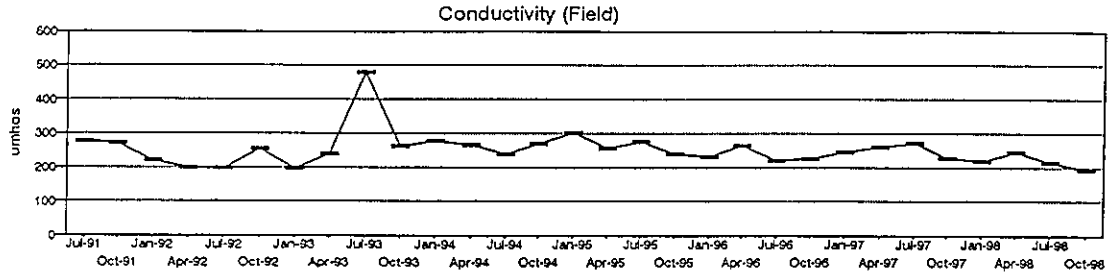
TDS

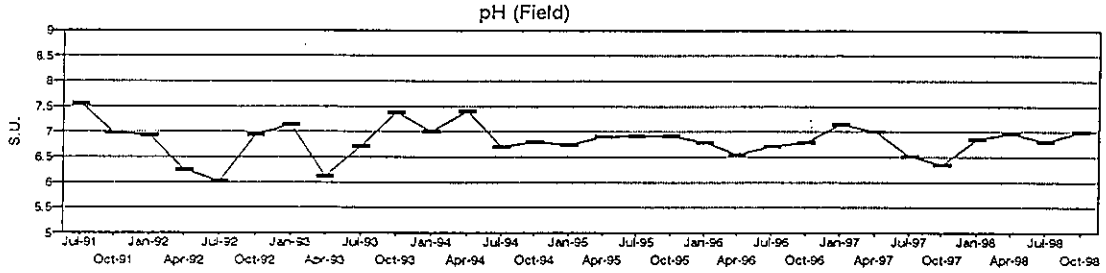


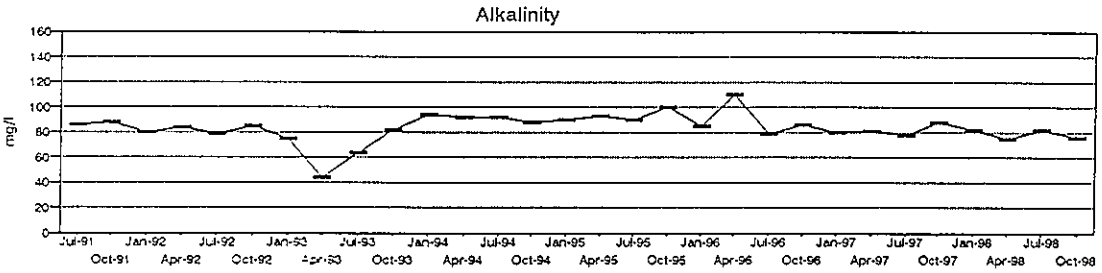
Prepared By: SGL Checked By: JBH1

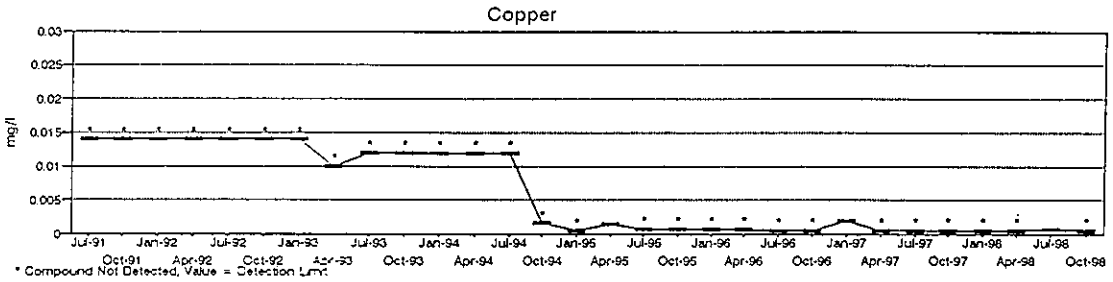
Flambeau Mining Company
Groundwater Quality Results

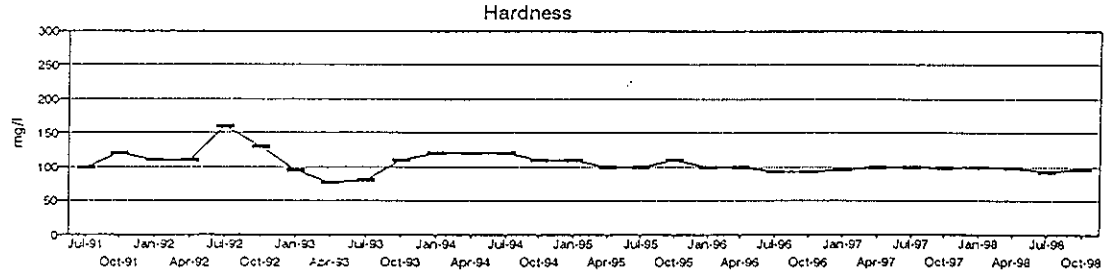
MW-1002G









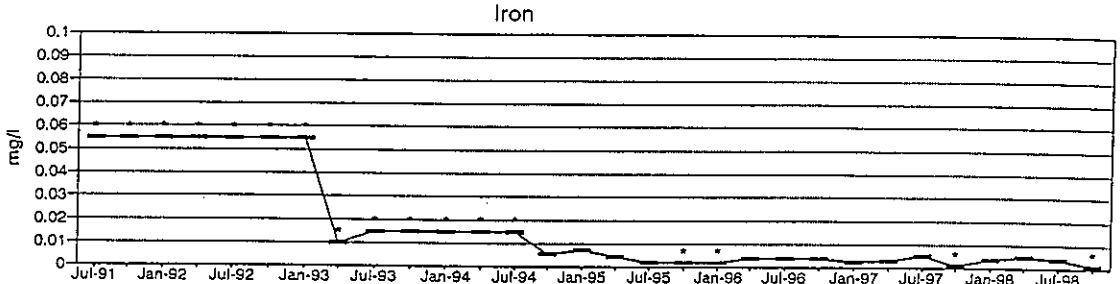


Prepared By: SGL Checked By: JBH1

Flambeau Mining Company
Groundwater Quality Results

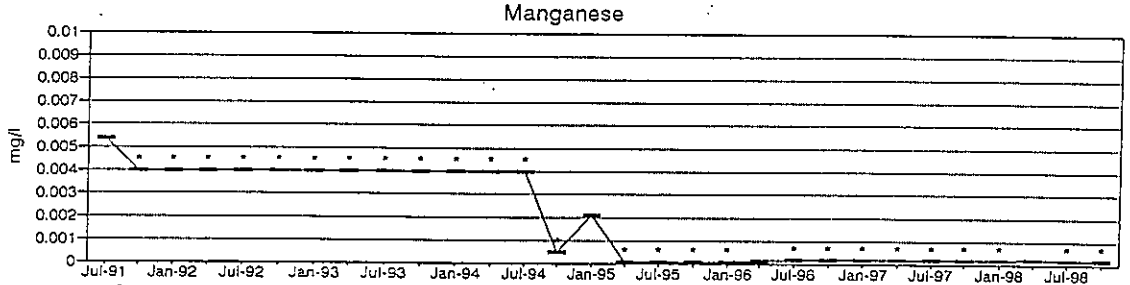
MW-1002G

Iron



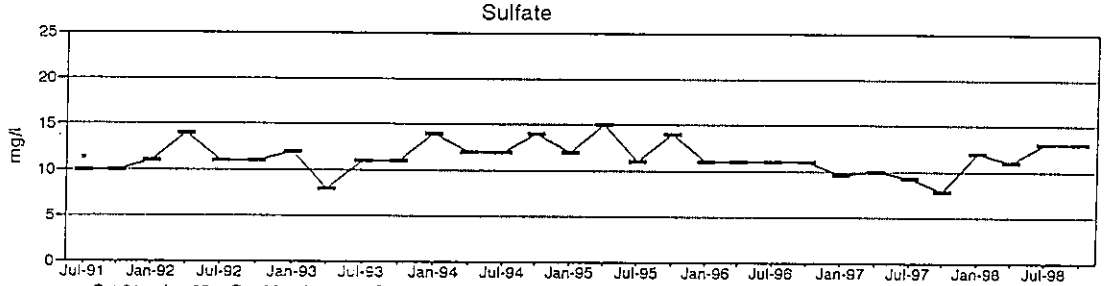
* Compound Not Detected, Value = Detection Limit

Manganese



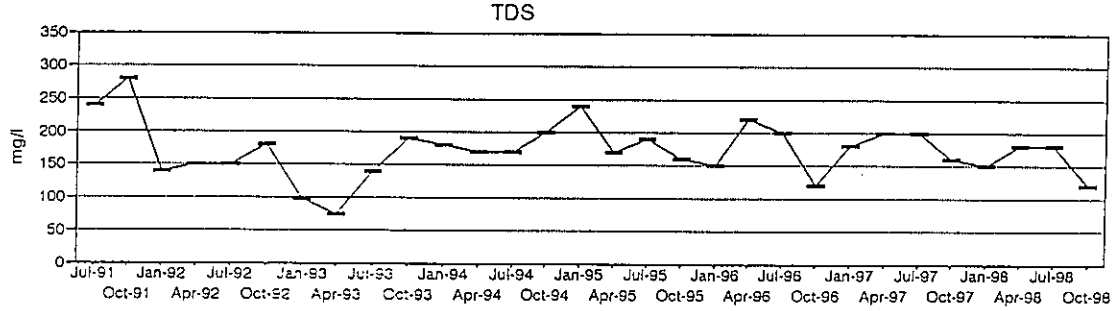
* Compound Not Detected, Value = Detection Limit

Sulfate



* Compound Not Detected, Value = Detection Limit

TDS

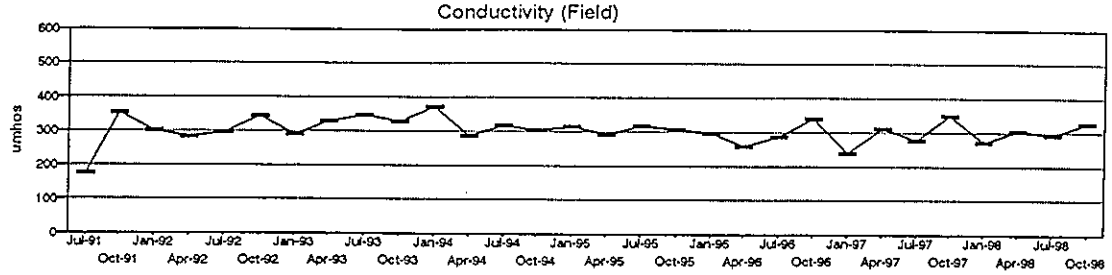


Prepared By: SGL Checked By: JBH1

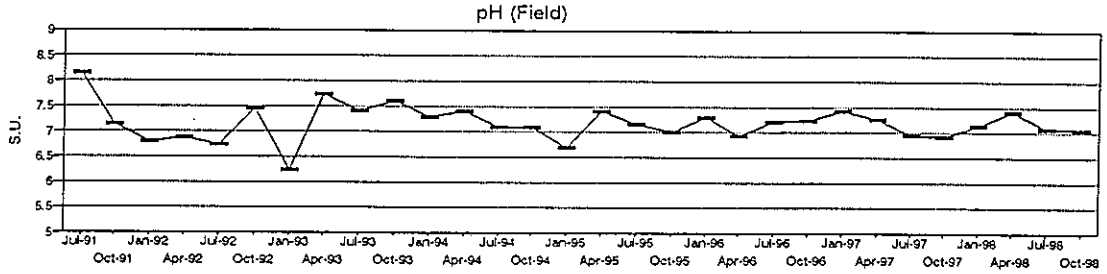
Flambeau Mining Company
Groundwater Quality Results

MW-1004P

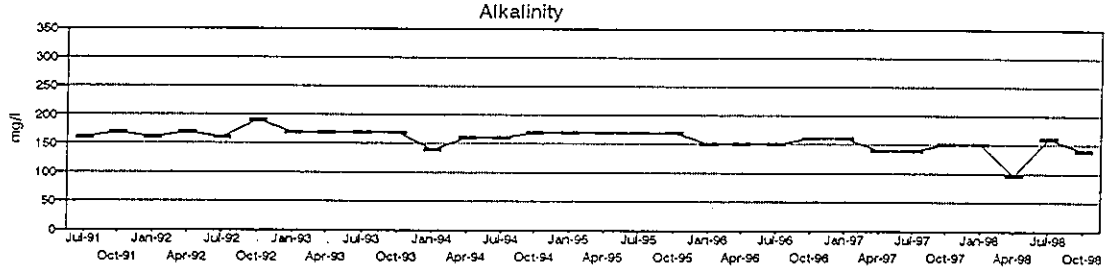
Conductivity (Field)



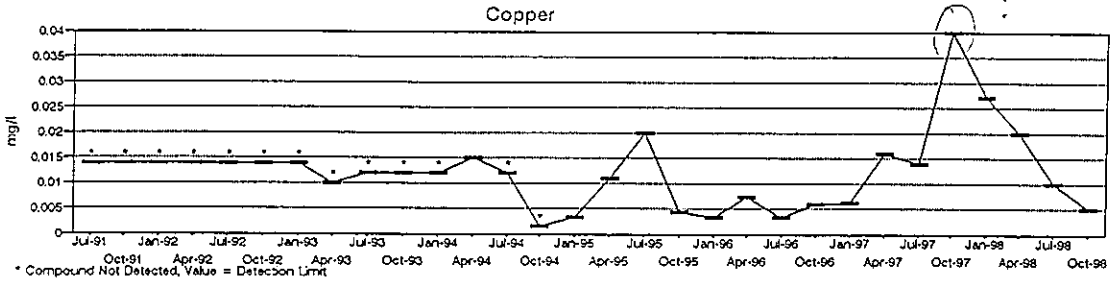
pH (Field)



Alkalinity

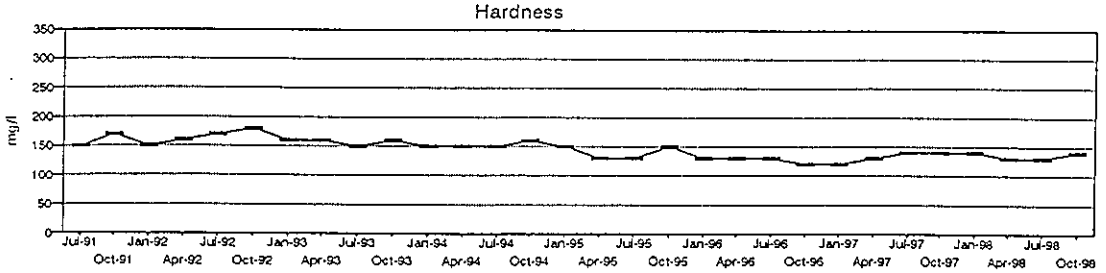


Copper



* Compound Not Detected, Value = Detection Limit

Hardness

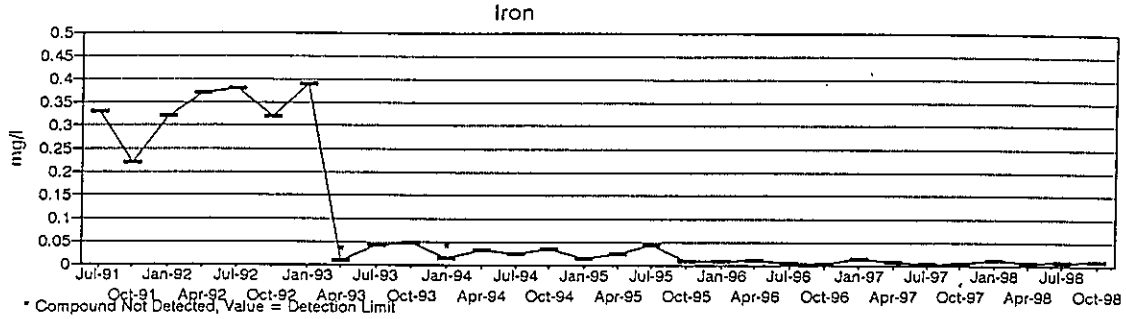


Prepared By: SGL Checked By: JBH1

Flambeau Mining Company
Groundwater Quality Results

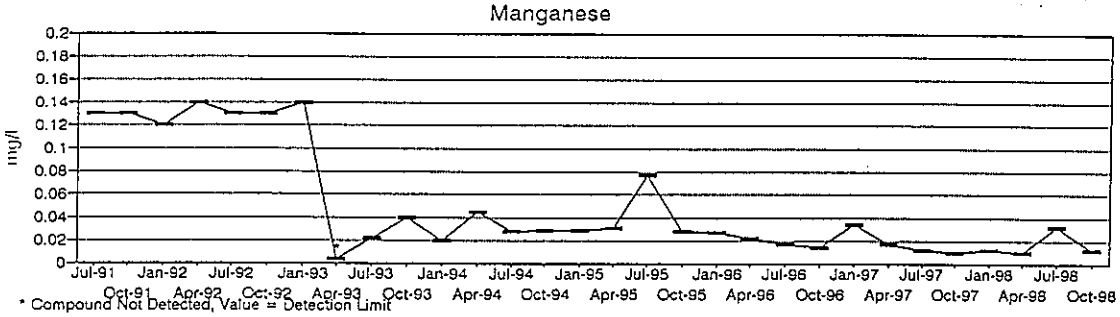
MW-1004P

Iron



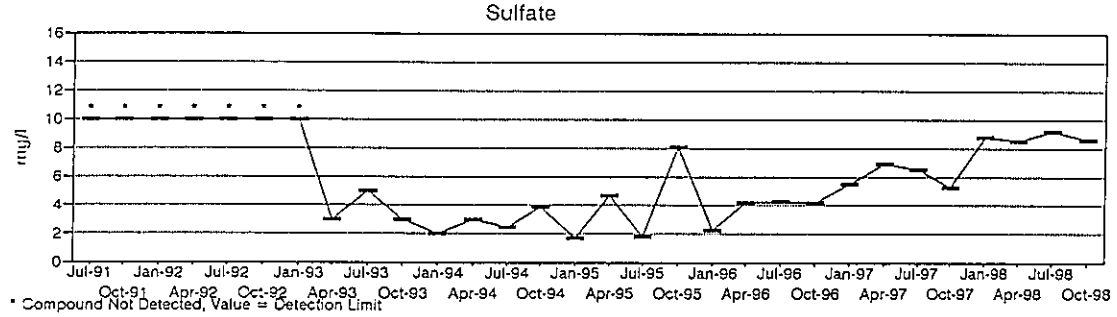
* Compound Not Detected, Value = Detection Limit

Manganese



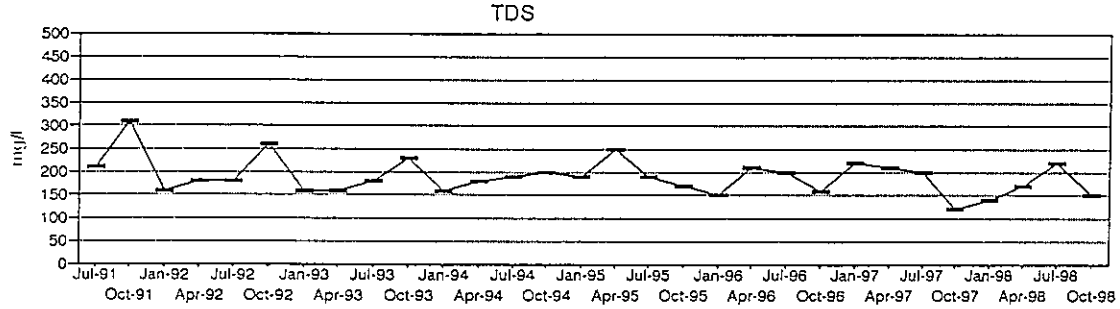
* Compound Not Detected, Value = Detection Limit

Sulfate



* Compound Not Detected, Value = Detection Limit

TDS

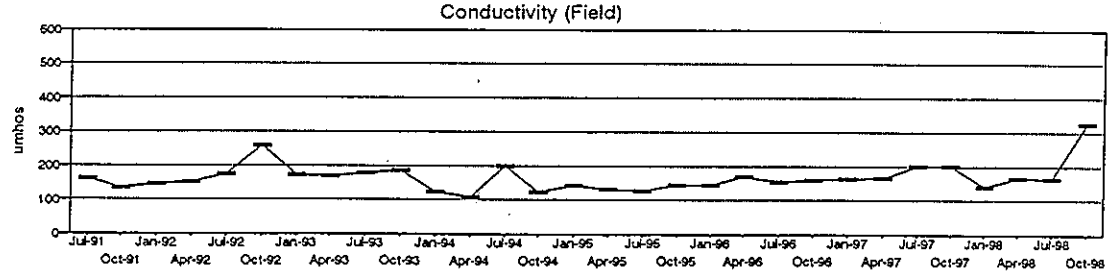


Prepared By: SGL Checked By: JBH1

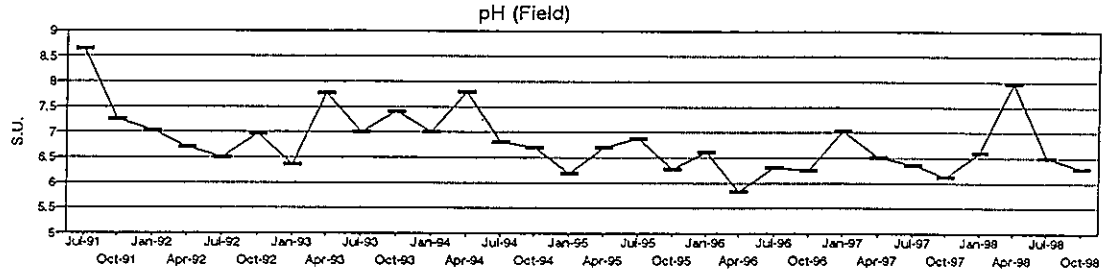
Flambeau Mining Company
Groundwater Quality Results

MW-1004S

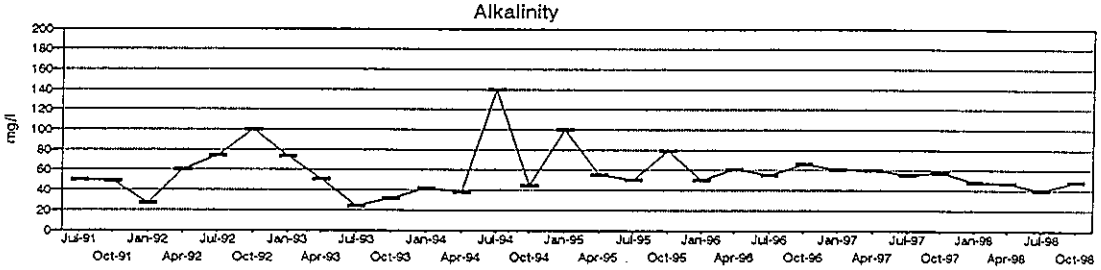
Conductivity (Field)



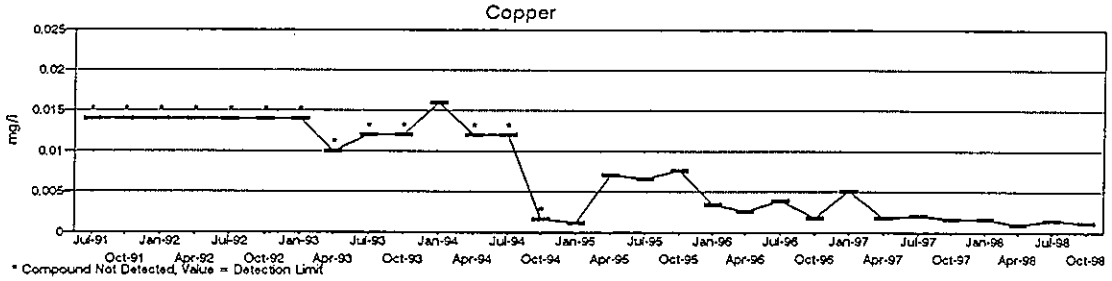
pH (Field)



Alkalinity

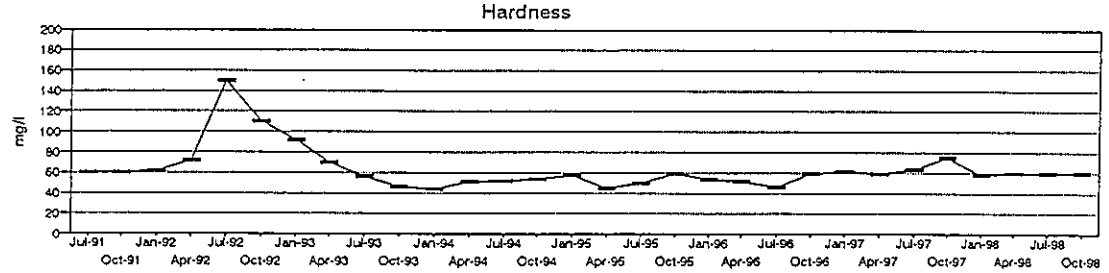


Copper



* Compound Not Detected, Value = Detection Limit

Hardness

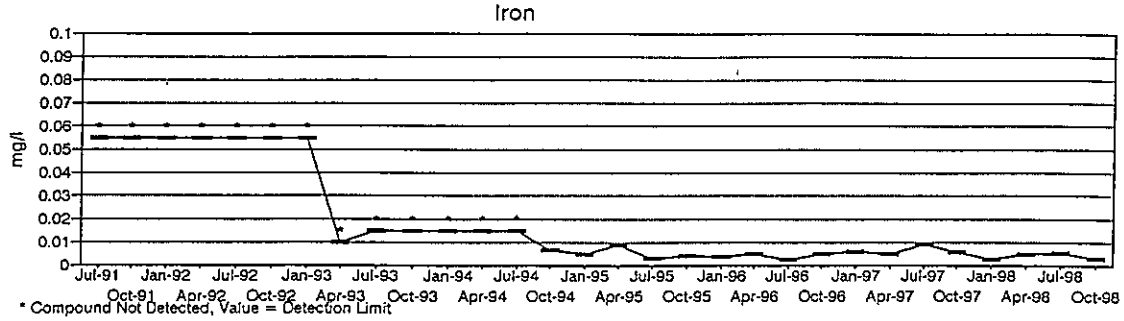


Prepared By: SGL Checked By: JBH1

Flambeau Mining Company
Groundwater Quality Results

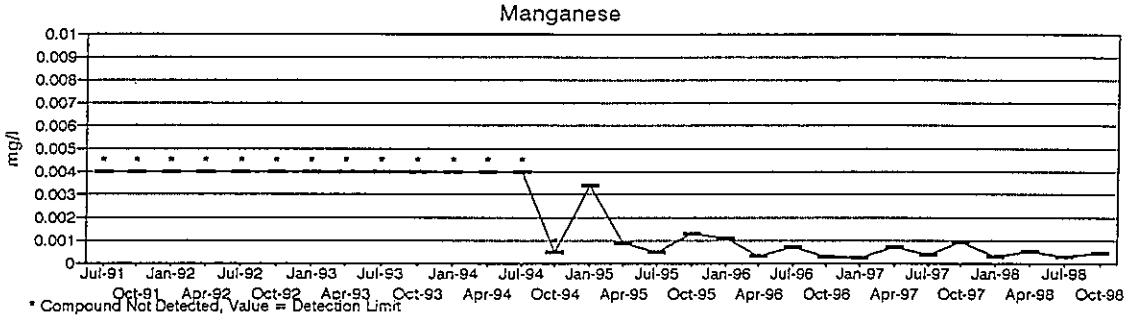
MW-1004S

Iron



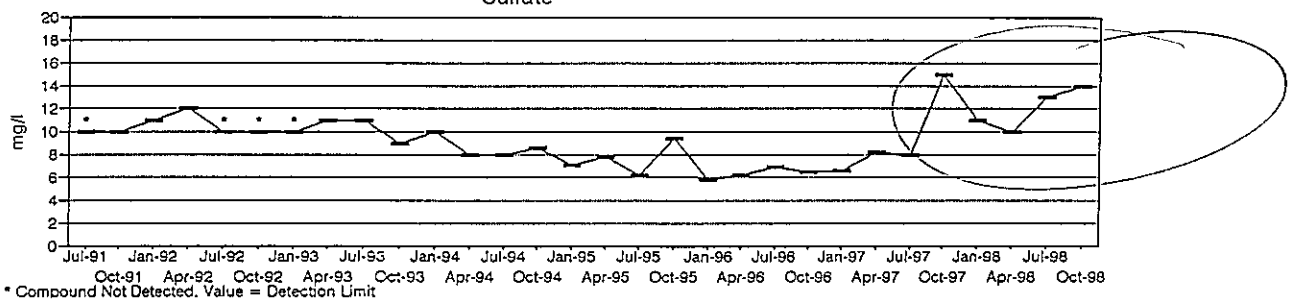
* Compound Not Detected, Value = Detection Limit

Manganese



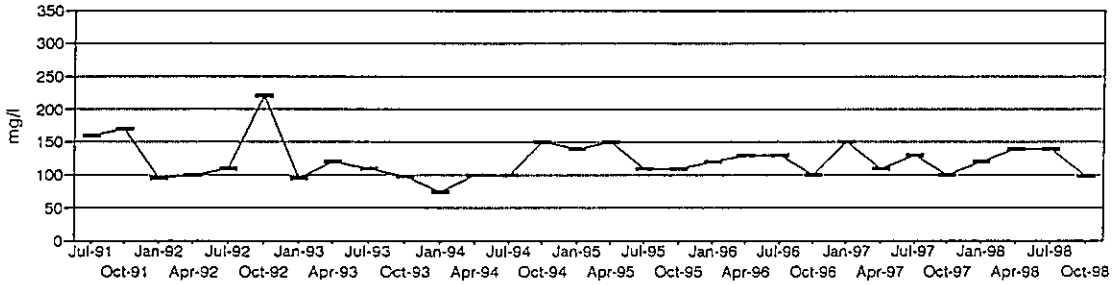
* Compound Not Detected, Value = Detection Limit

Sulfate



* Compound Not Detected, Value = Detection Limit

TDS

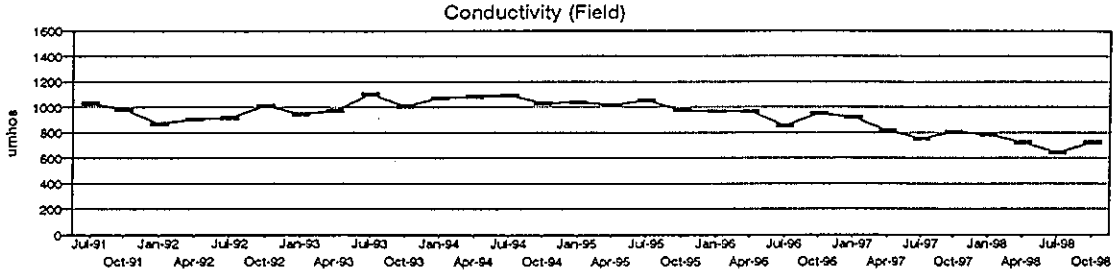


Prepared By: SGL Checked By: JBH1

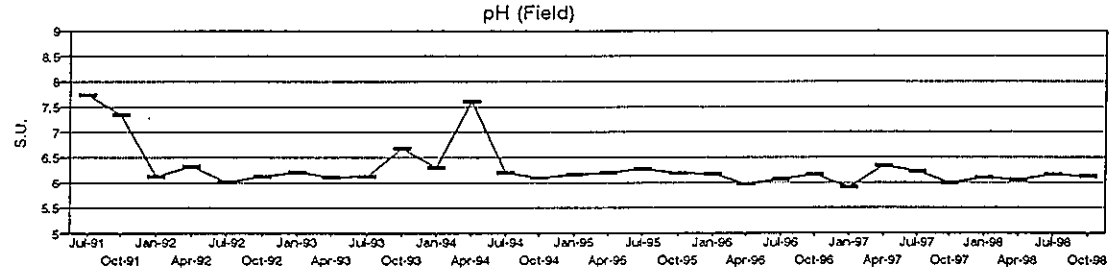
Flambeau Mining Company
Groundwater Quality Results

MW-1005

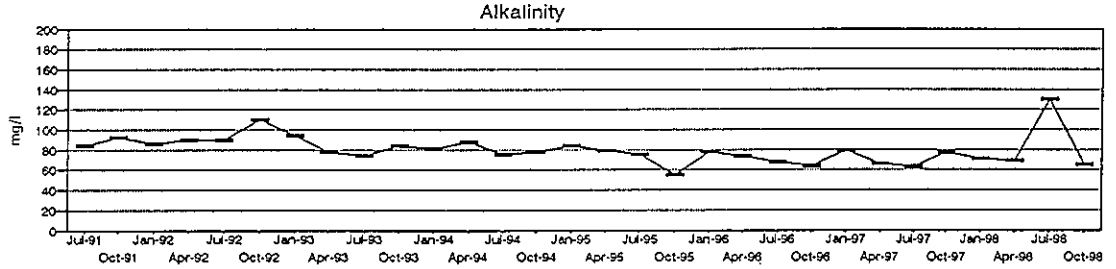
Conductivity (Field)



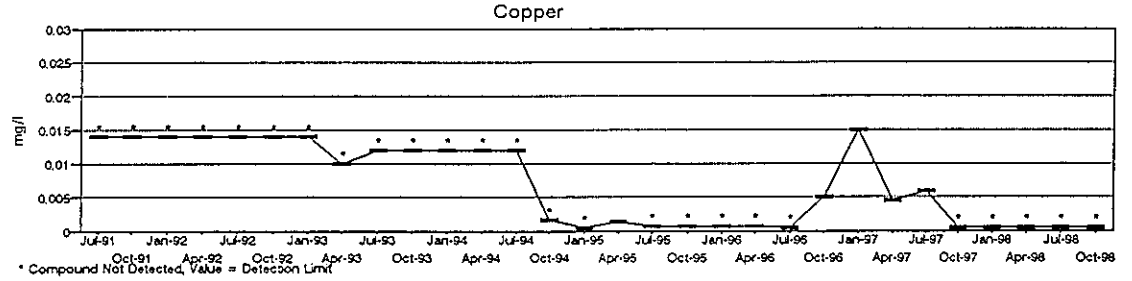
pH (Field)



Alkalinity

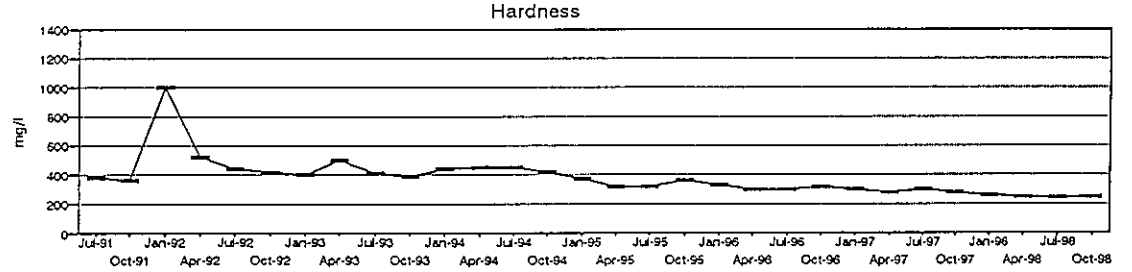


Copper



* Compound Not Detected, Value = Detection Limit

Hardness

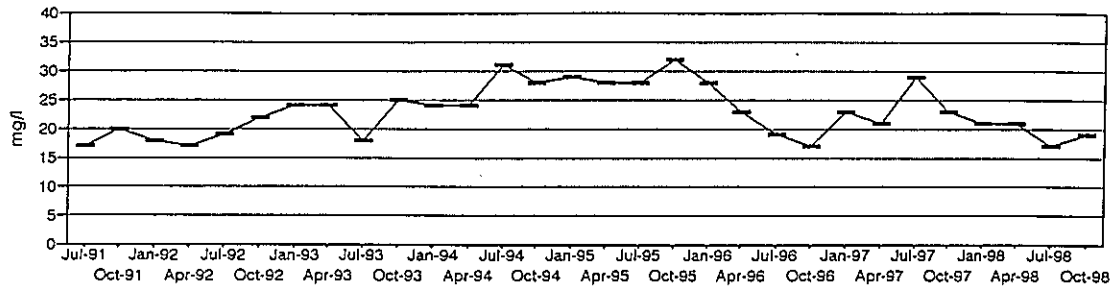


Prepared By: SGL Checked By: JBH1

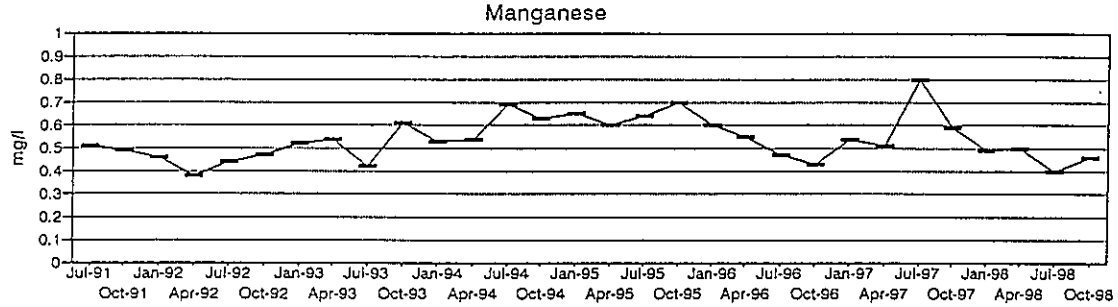
Flambeau Mining Company
Groundwater Quality Results

MW-1005

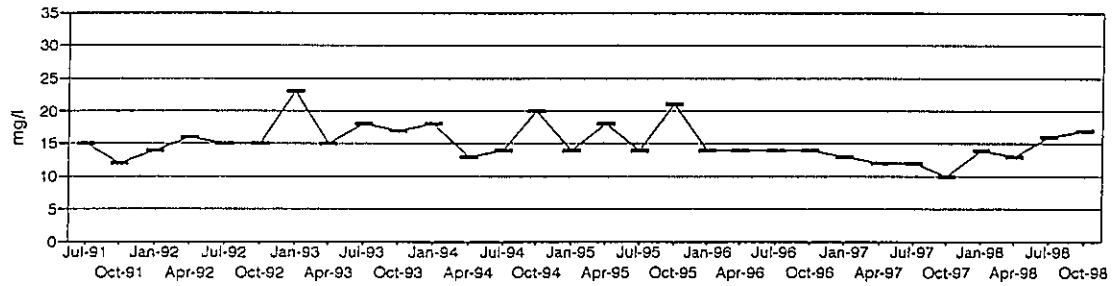
Iron



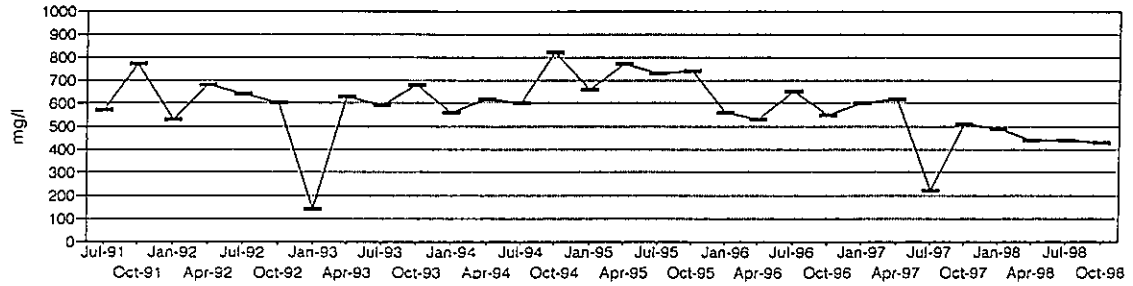
Manganese



Sulfate



TDS

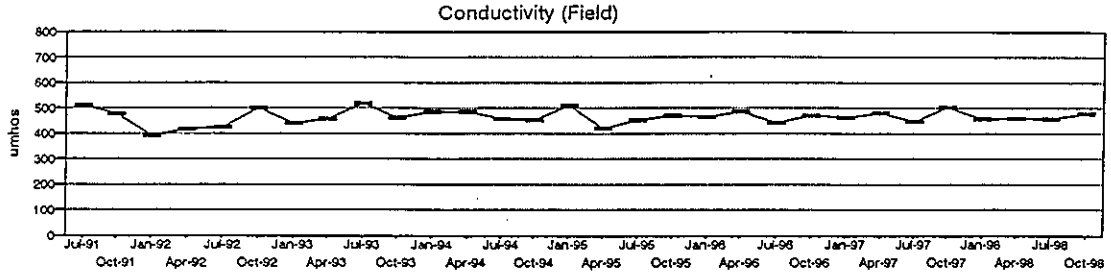


Prepared By: SGL Checked By: JBH1

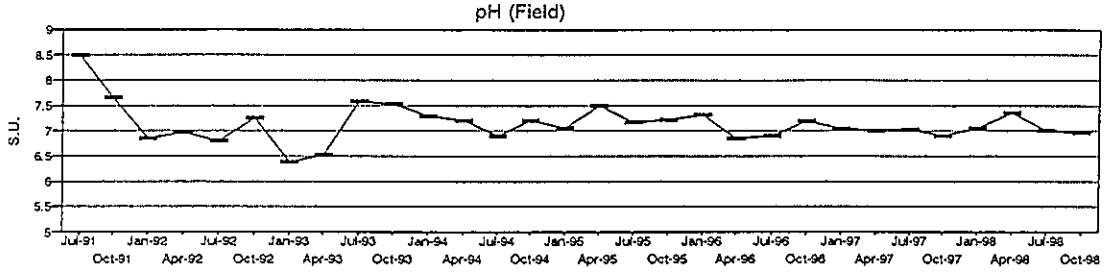
Flambeau Mining Company
Groundwater Quality Results

MW-1005P

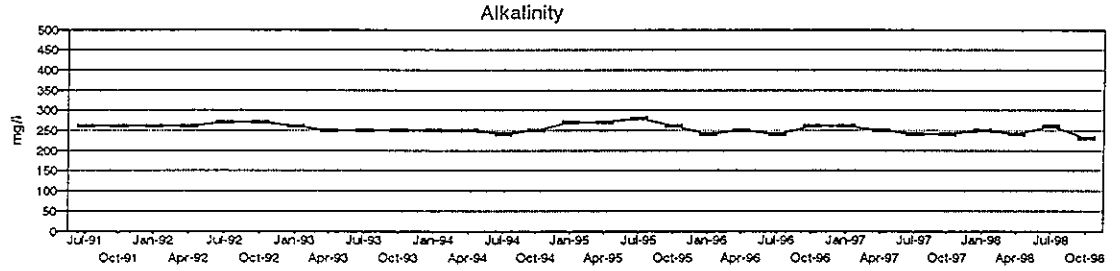
Conductivity (Field)



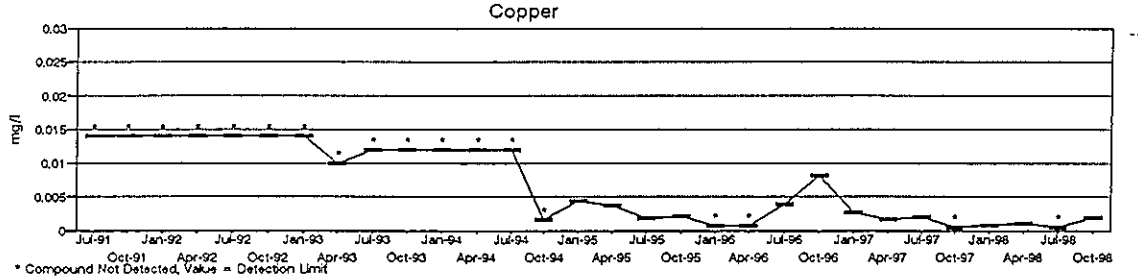
pH (Field)



Alkalinity

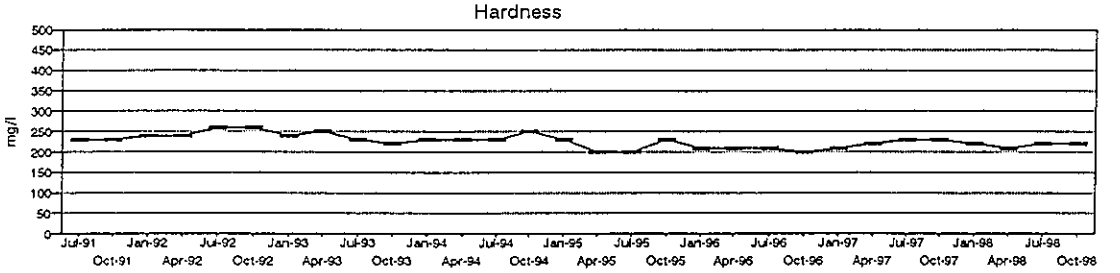


Copper



* Compound Not Detected, Value = Detection Limit

Hardness

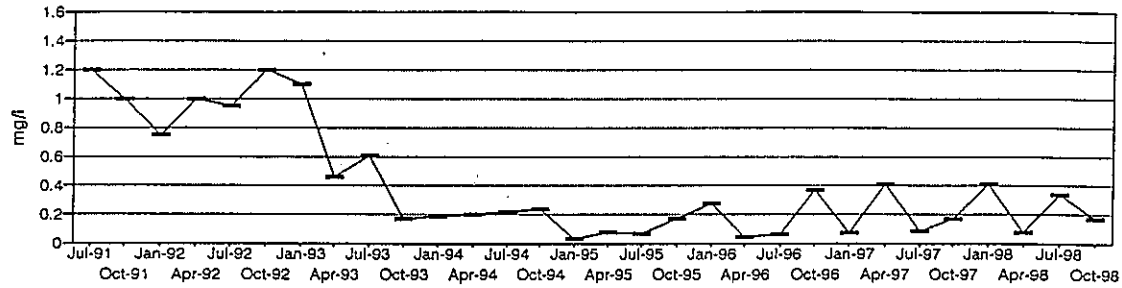


Prepared By: SGL Checked By: JBH1

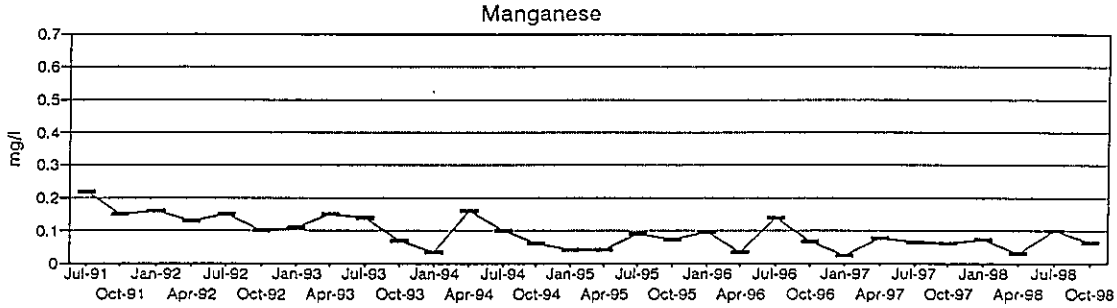
Flambeau Mining Company
Groundwater Quality Results

MW-1005P

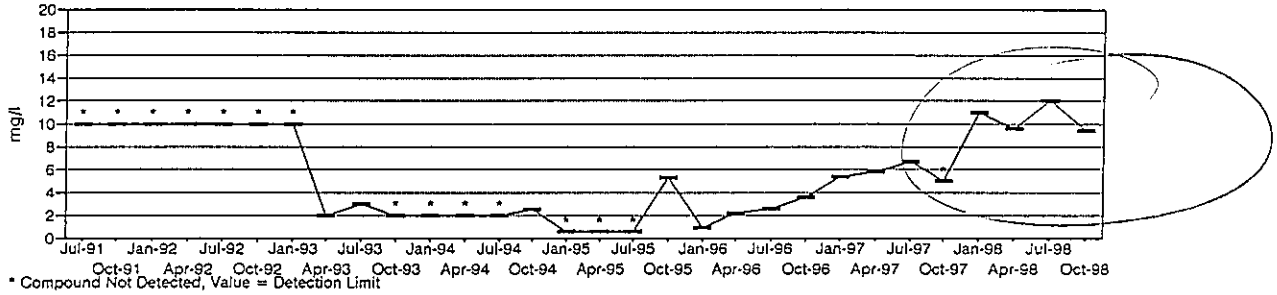
Iron



Manganese

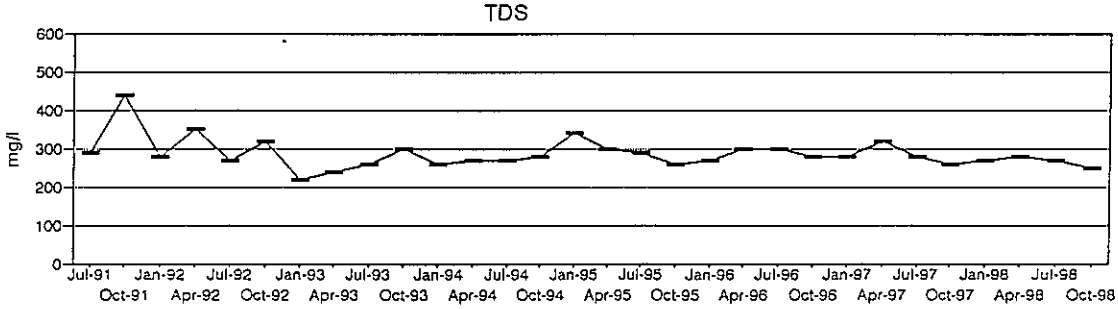


Sulfate



* Compound Not Detected, Value = Detection Limit

TDS

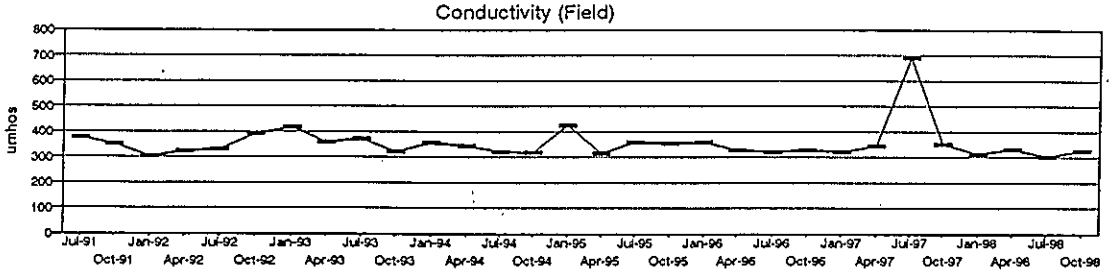


Prepared By: SGL Checked By: JBH1

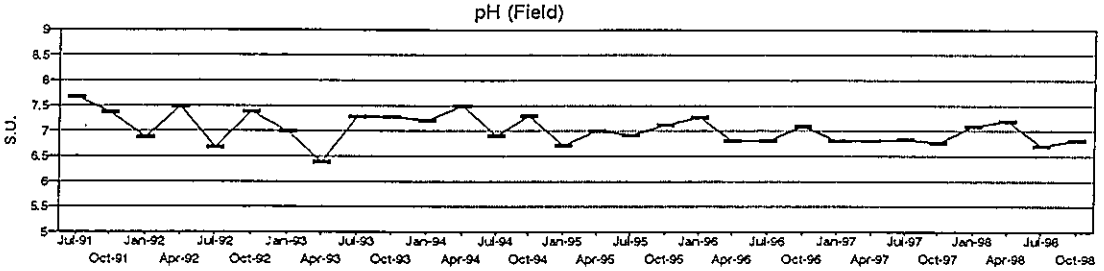
Flambeau Mining Company
Groundwater Quality Results

MW-1005S

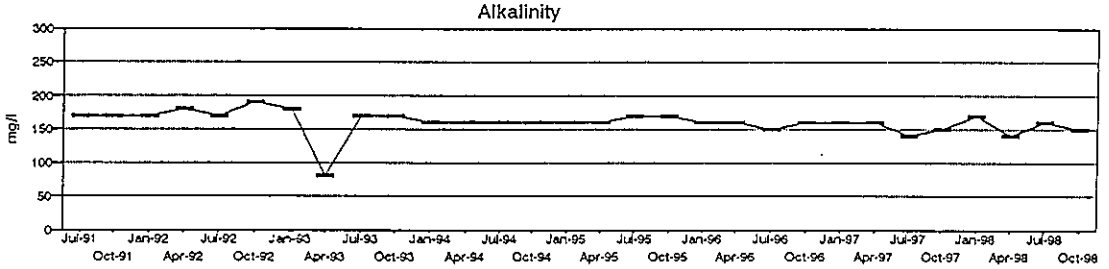
Conductivity (Field)



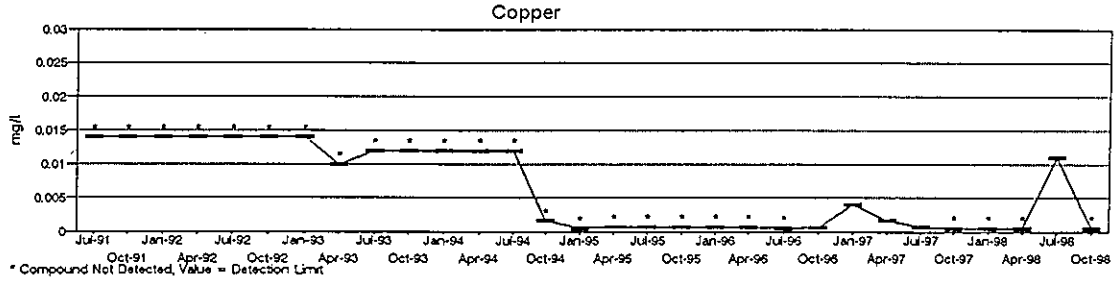
pH (Field)



Alkalinity

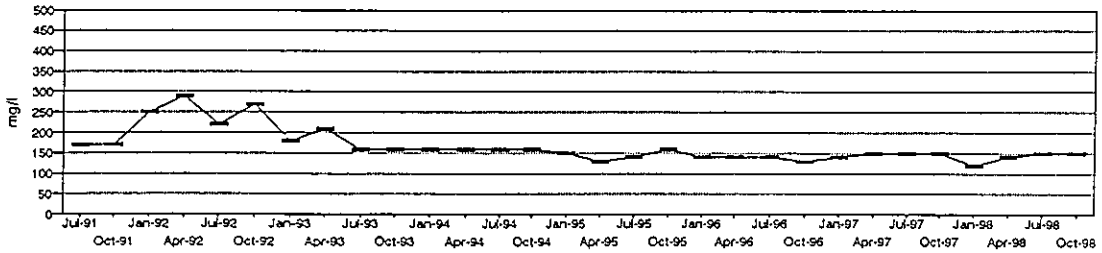


Copper



* Compound Not Detected, Value = Detection Limit

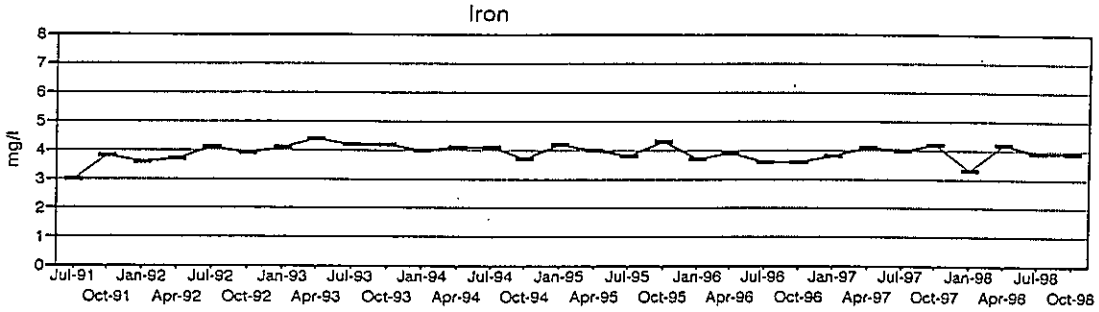
Hardness

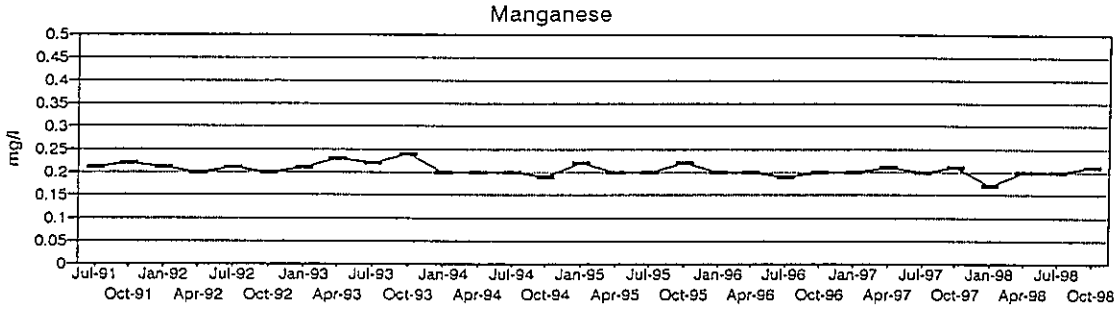


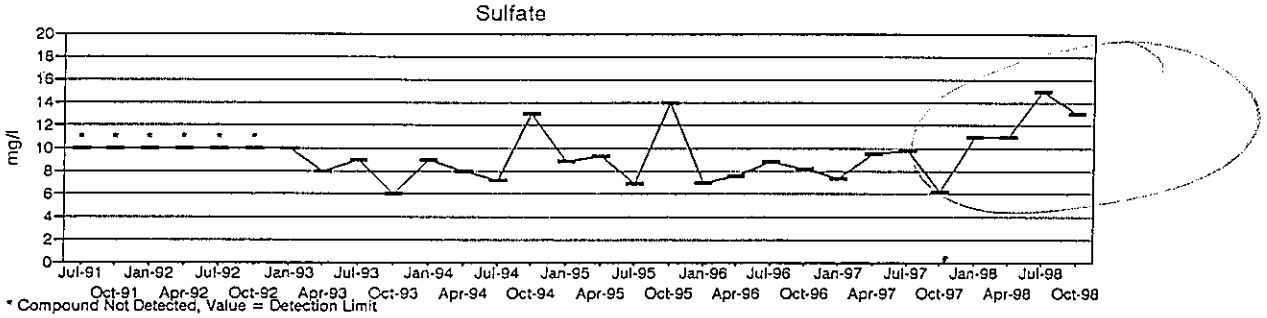
Prepared By: SGL Checked By: JBH1

Flambeau Mining Company
Groundwater Quality Results

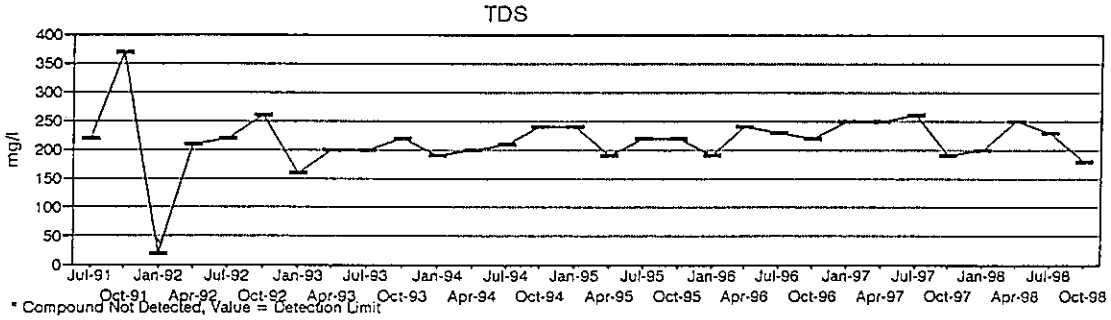
MW-1005S







* Compound Not Detected, Value = Detection Limit



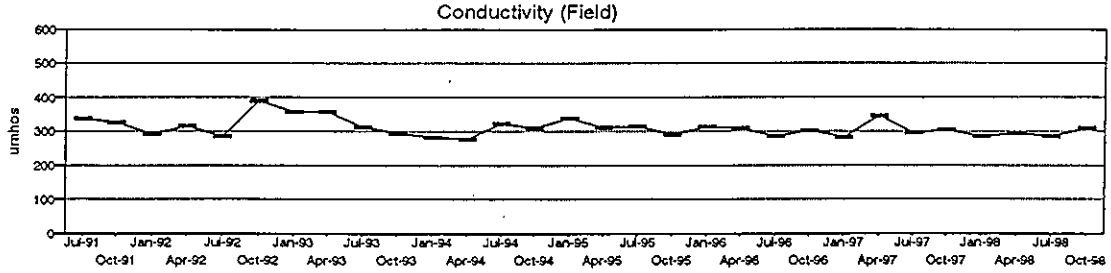
* Compound Not Detected, Value = Detection Limit

Prepared By: SGL Checked By: JBH1

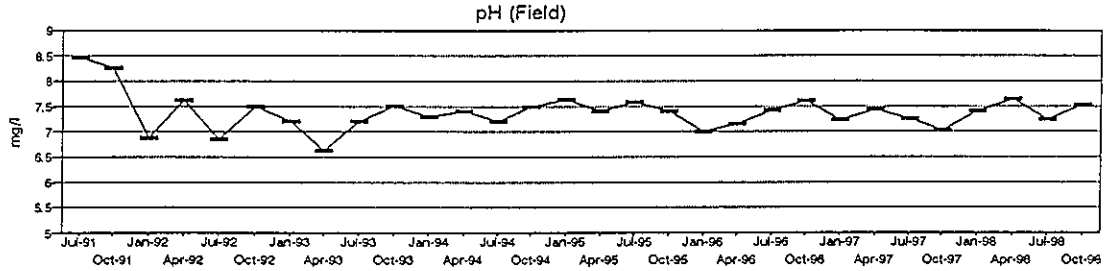
Flambeau Mining Company
Groundwater Quality Results

MW-1010P

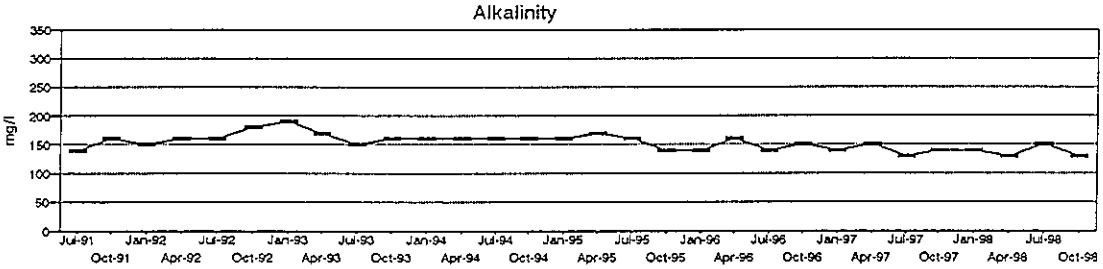
Conductivity (Field)



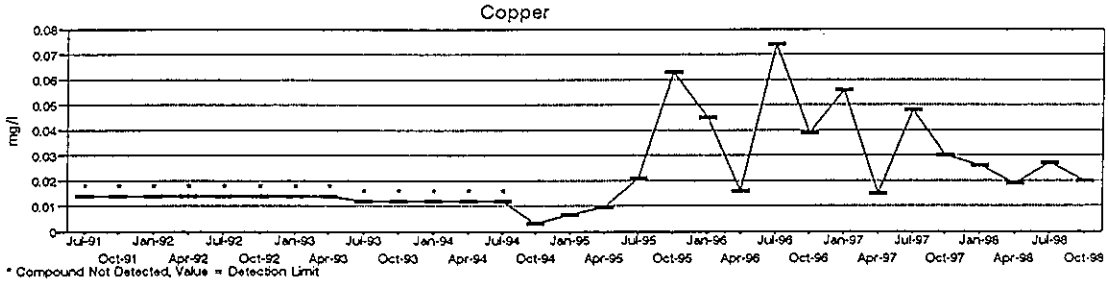
pH (Field)



Alkalinity

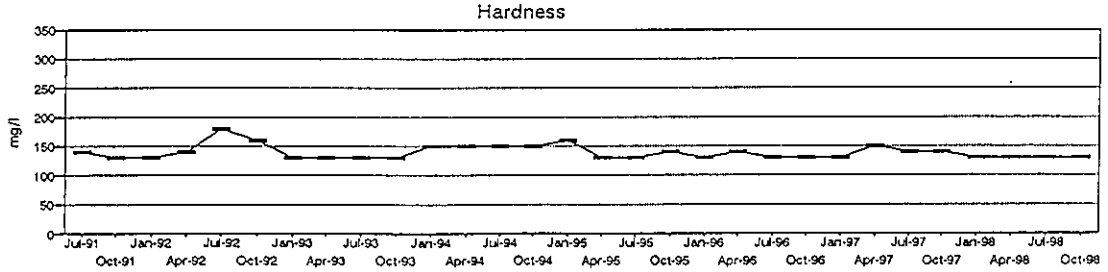


Copper



* Compound Not Detected, Value = Detection Limit

Hardness

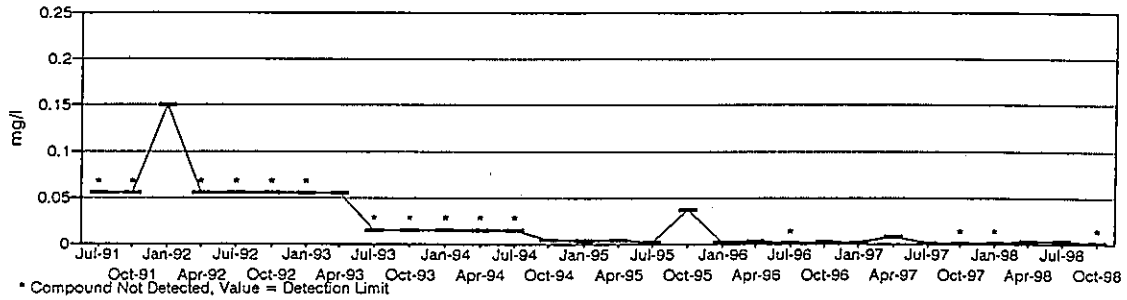


Prepared By: SGL Checked By: JBH1

Flambeau Mining Company
Groundwater Quality Results

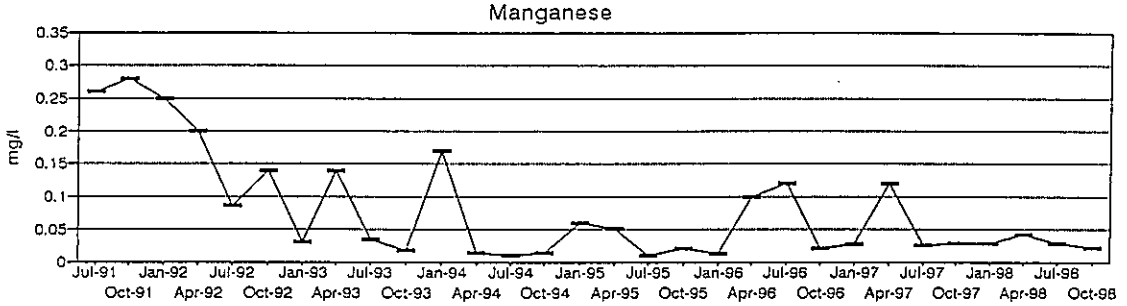
MW-1010P

Iron

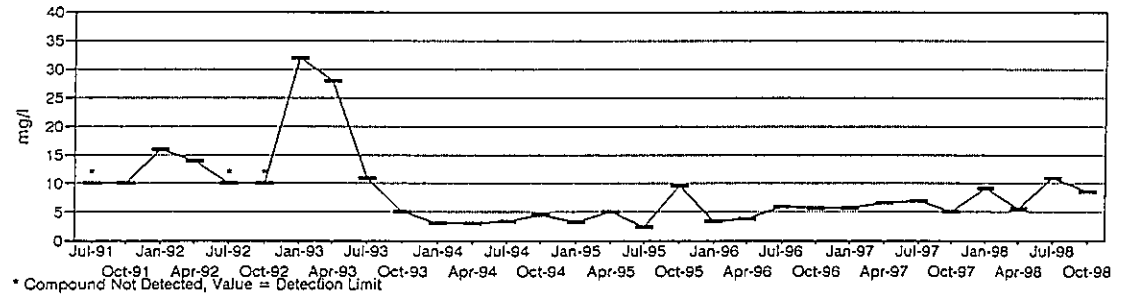


* Compound Not Detected, Value = Detection Limit

Manganese

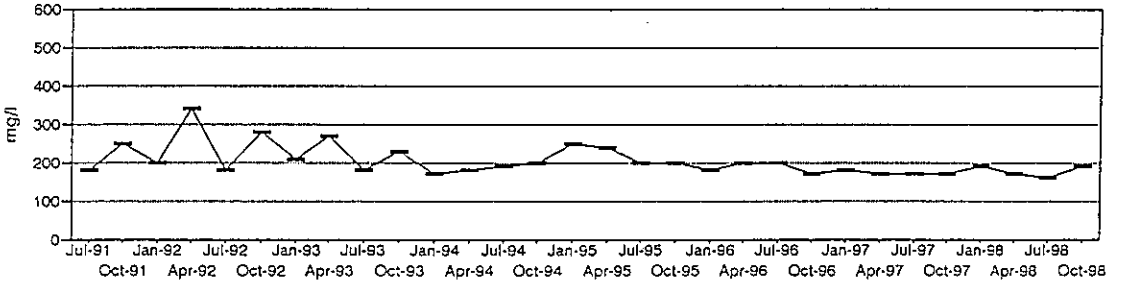


Sulfate



* Compound Not Detected, Value = Detection Limit

TDS



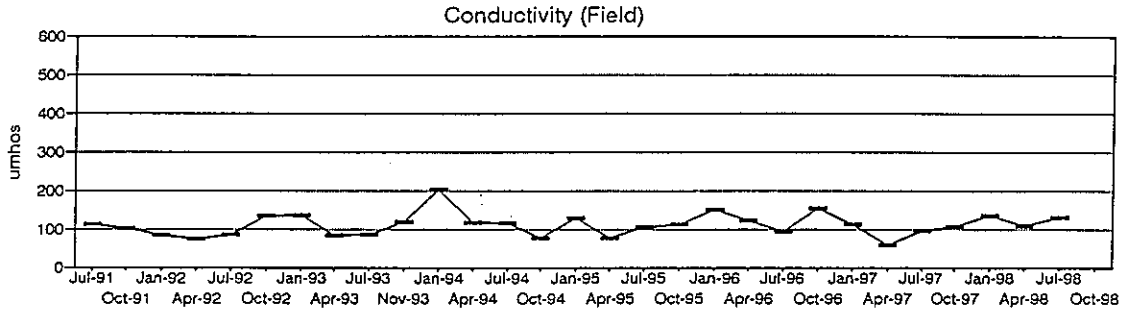
Prepared By: SGL Checked By: JBH1

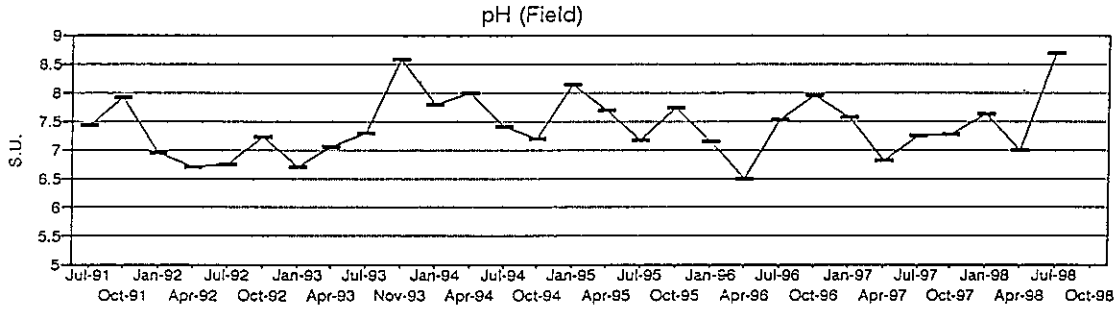
Attachment 2

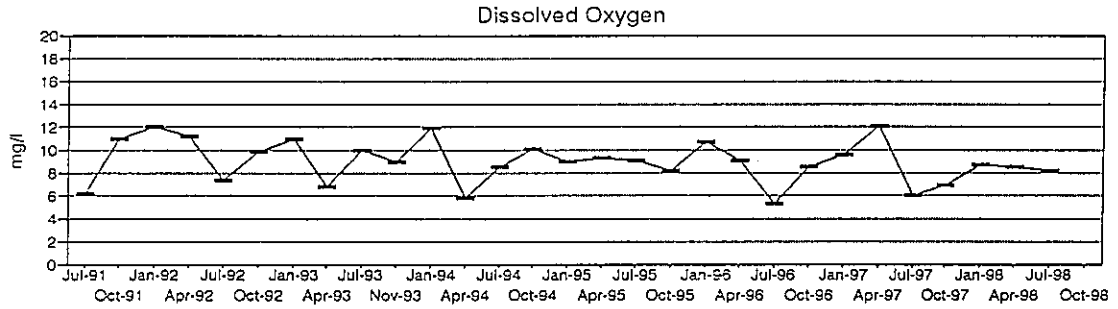
Trend Graphs
(Surface Water)

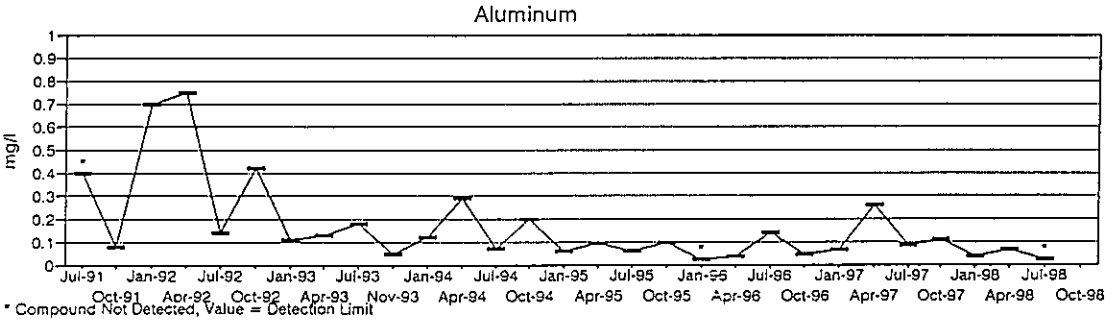
Flambeau Mining Company
Surface Water Quality Results

SW-1 (Upstream)









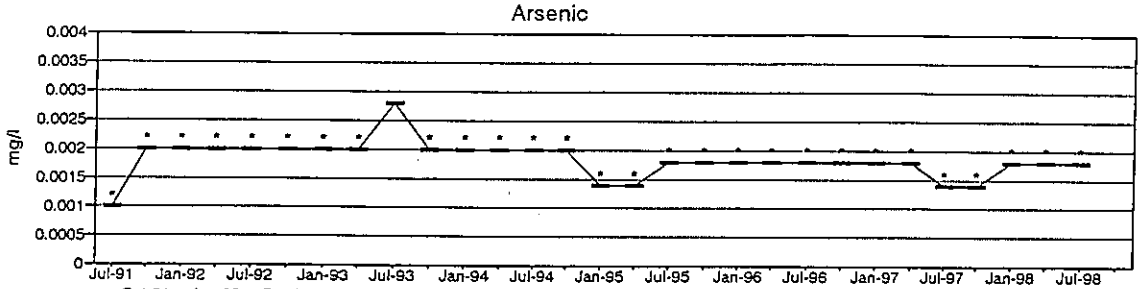
* Compound Not Detected, Value = Detection Limit

Prepared By: SGL Checked By: JBH1

Flambeau Mining Company
Surface Water Quality Results

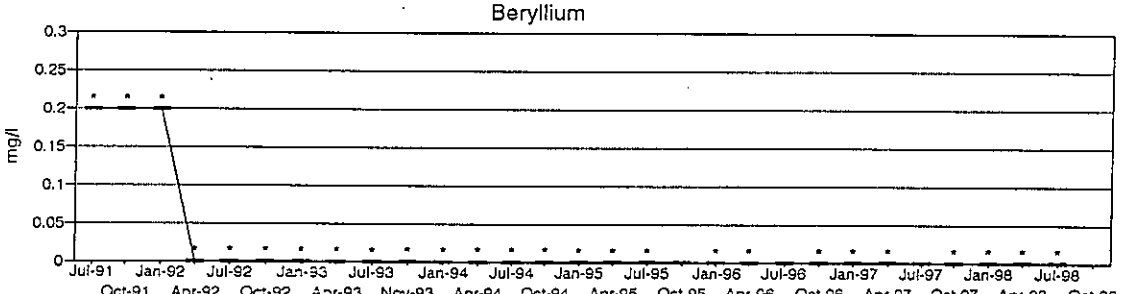
SW-1 (Upstream)

Arsenic



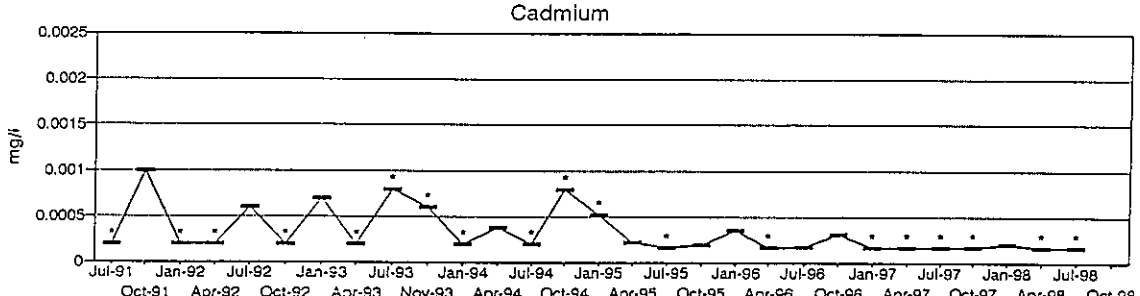
* Compound Not Detected, Value = Detection Limit

Beryllium



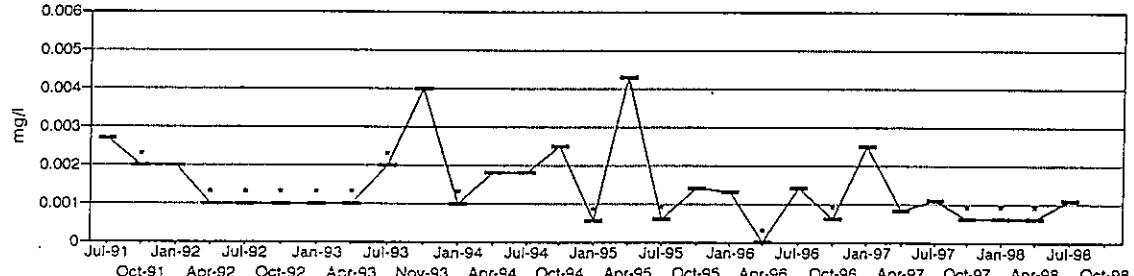
* Compound Not Detected, Value = Detection Limit

Cadmium



* Compound Not Detected, Value = Detection Limit

Chromium



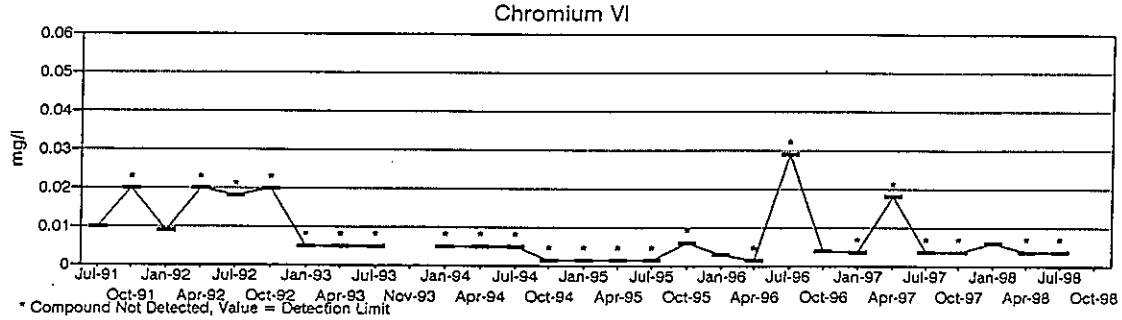
* Compound Not Detected, Value = Detection Limit

Prepared By: SGL Checked By: JBH1

Flambeau Mining Company
Surface Water Quality Results

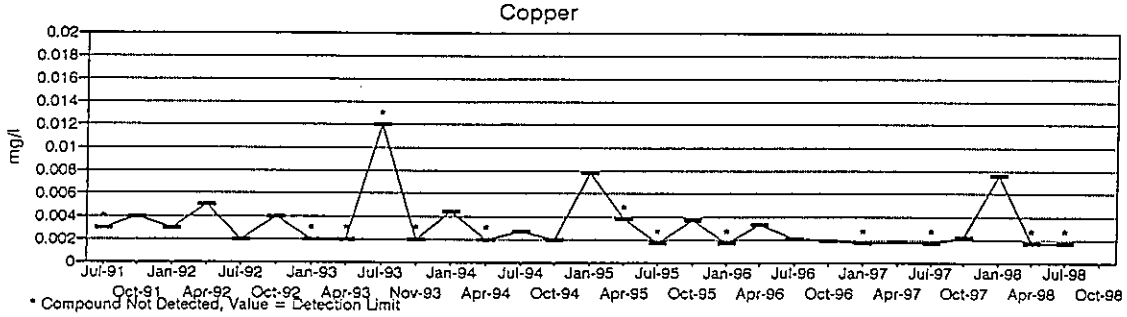
SW-1 (Upstream)

Chromium VI



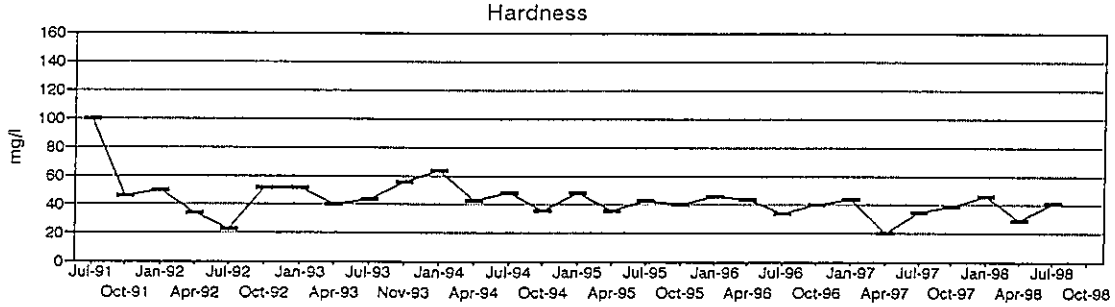
* Compound Not Detected, Value = Detection Limit

Copper

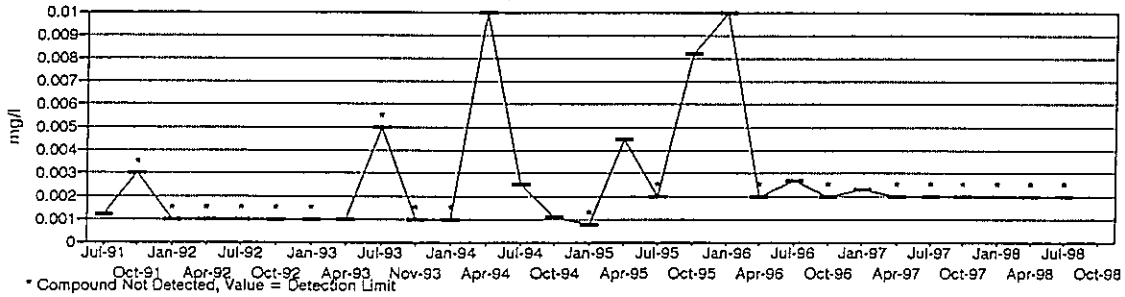


* Compound Not Detected, Value = Detection Limit

Hardness



Lead



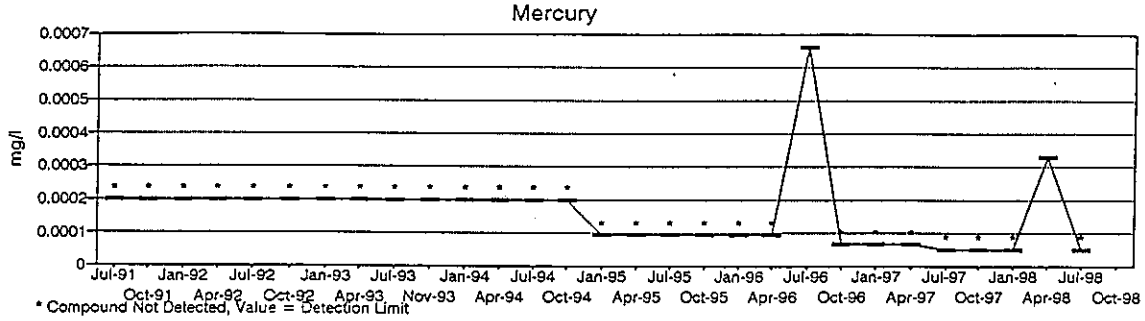
* Compound Not Detected, Value = Detection Limit

Prepared By: SGL Checked By: JBH1

Flambeau Mining Company
Surface Water Quality Results

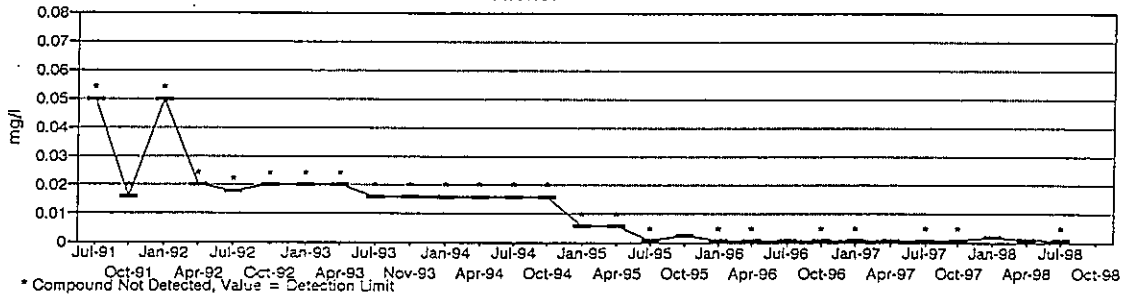
SW-1 (Upstream)

Mercury



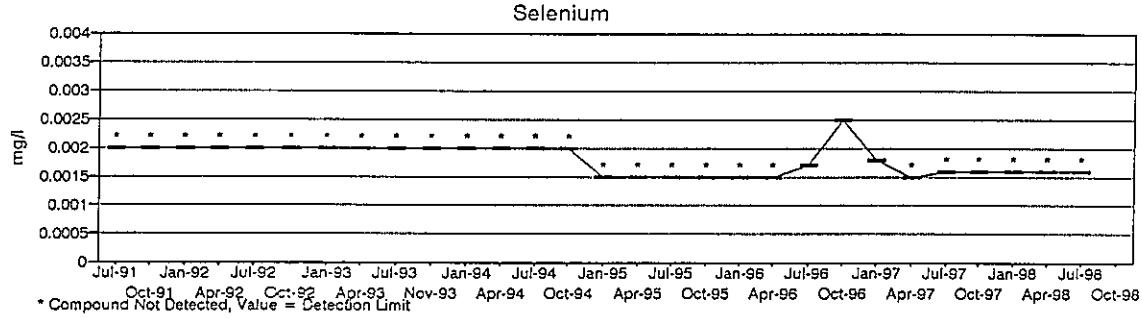
* Compound Not Detected, Value = Detection Limit

Nickel



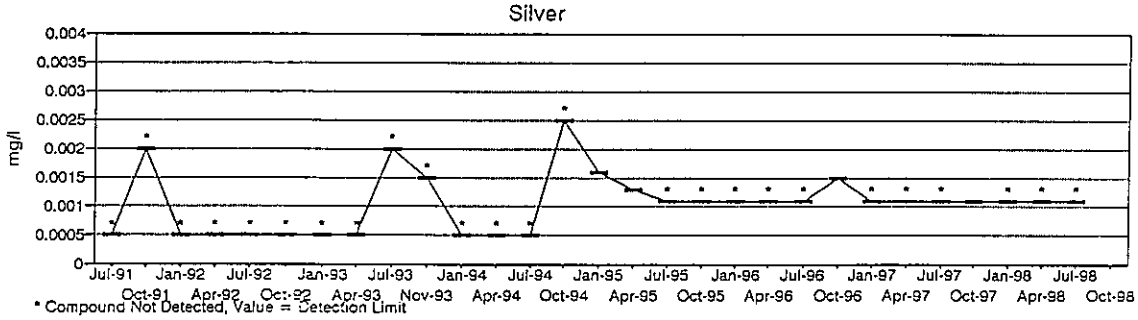
* Compound Not Detected, Value = Detection Limit

Selenium



* Compound Not Detected, Value = Detection Limit

Silver



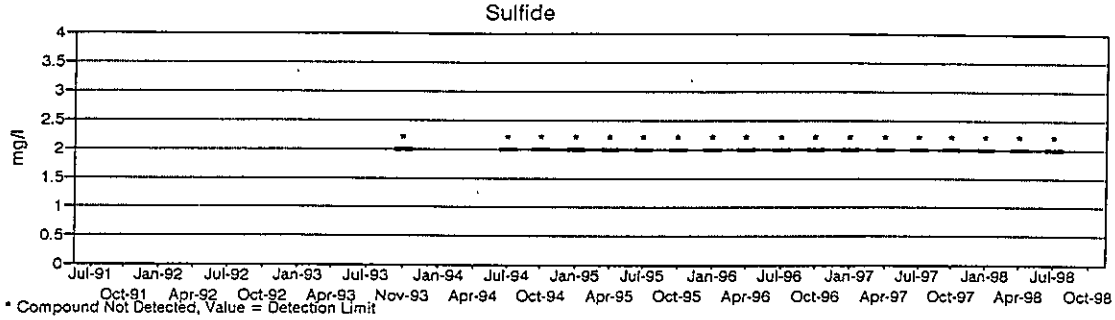
* Compound Not Detected, Value = Detection Limit

Prepared By: SGL Checked By: JBH1

Flambeau Mining Company
Surface Water Quality Results

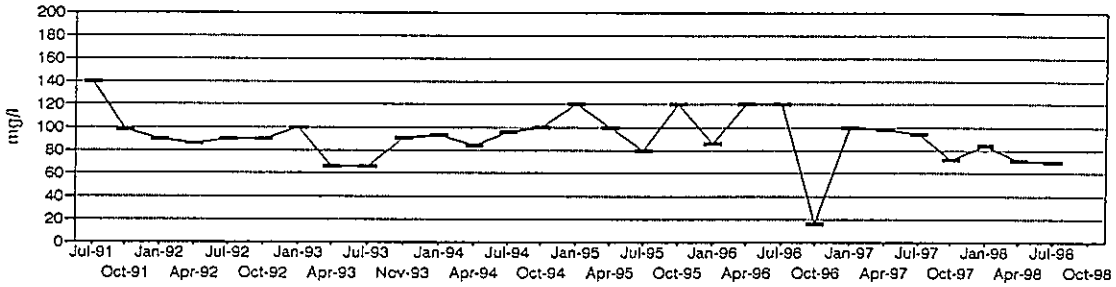
SW-1 (Upstream)

Sulfide

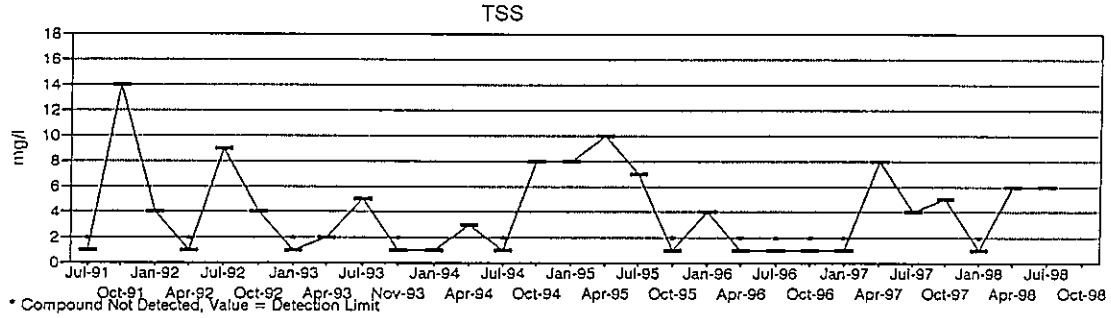


* Compound Not Detected, Value = Detection Limit

TDS

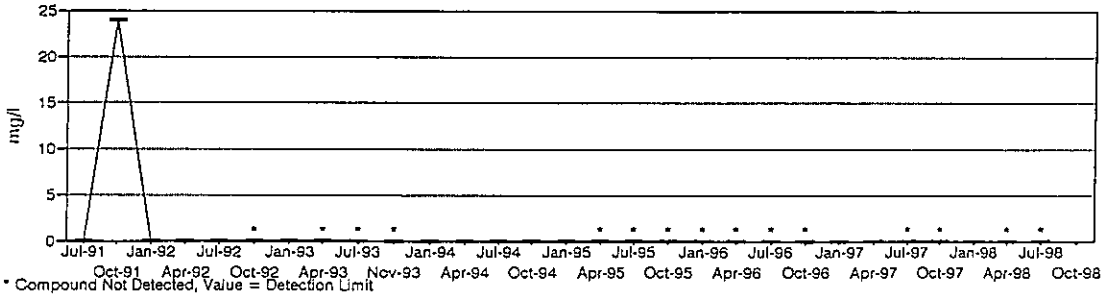


TSS



* Compound Not Detected, Value = Detection Limit

Zinc

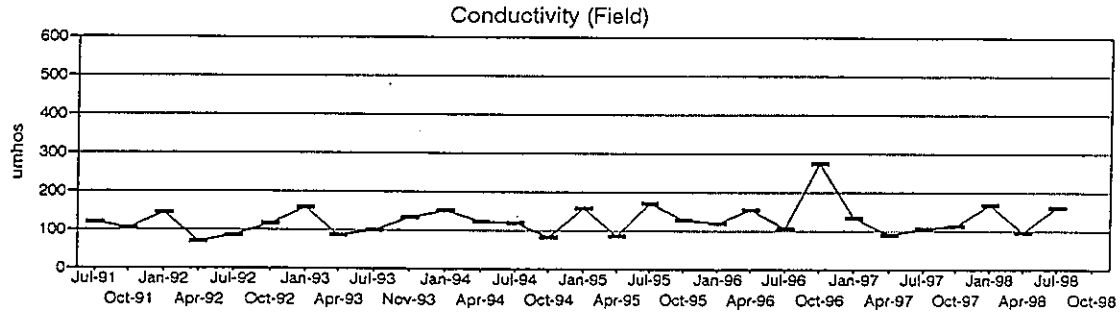


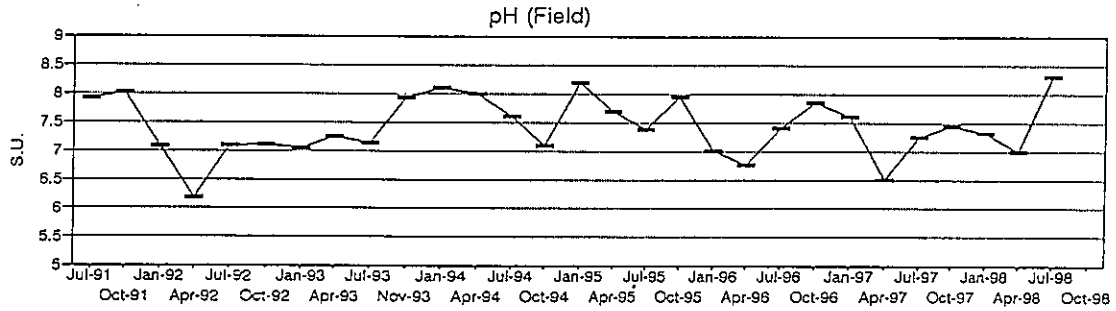
* Compound Not Detected, Value = Detection Limit

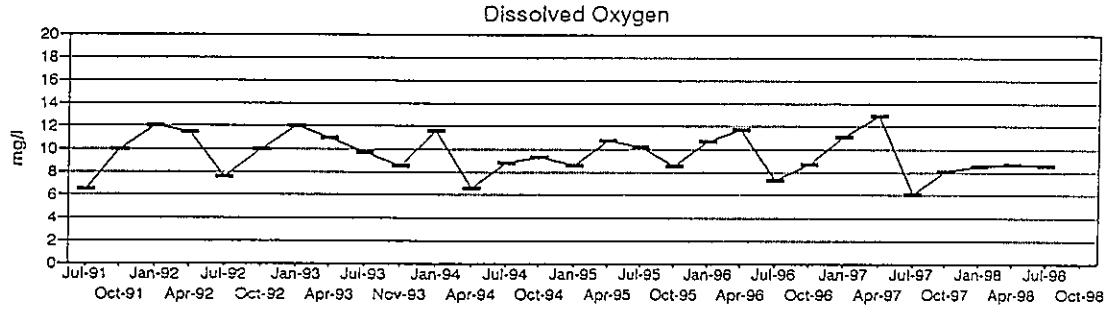
Prepared By: SGL Checked By: JBH1

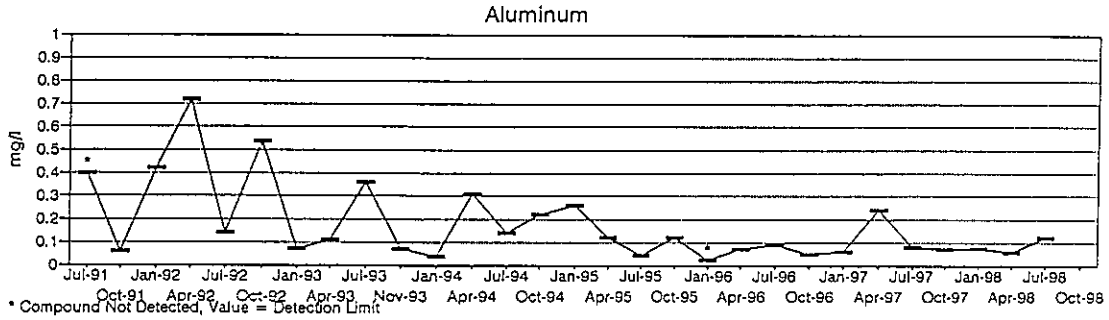
Flambeau Mining Company
Surface Water Quality Results

SW-2 (Downstream)









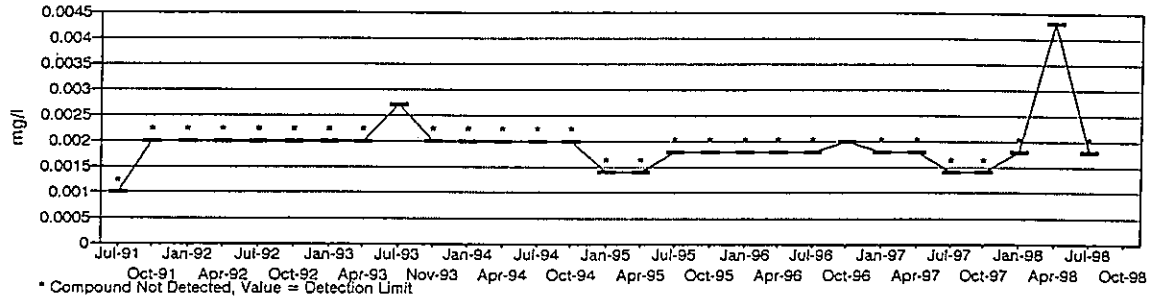
* Compound Not Detected, Value = Detection Limit

Prepared By: SGL Checked By: JBH1

Flambeau Mining Company
Surface Water Quality Results

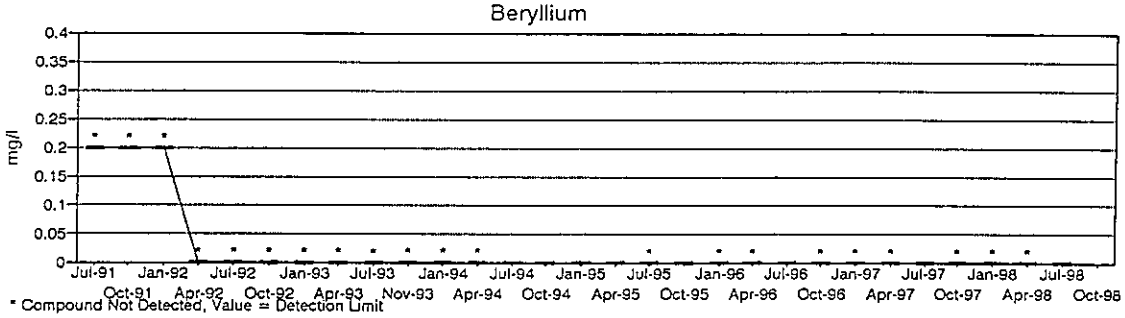
SW-2 (Downstream)

Arsenic



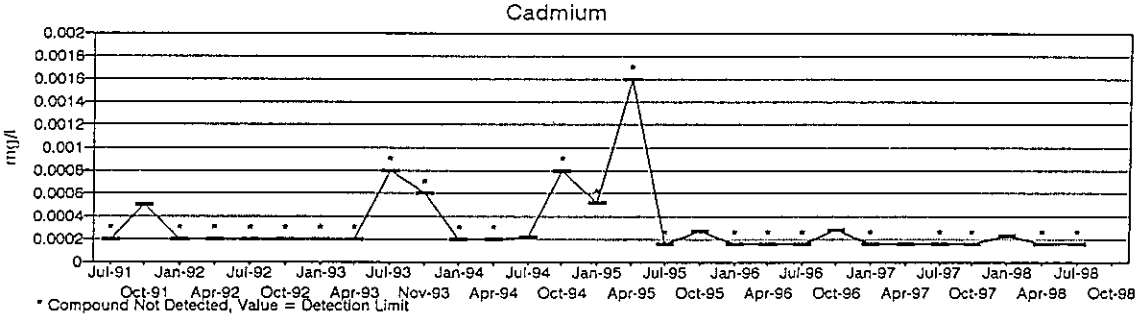
* Compound Not Detected, Value = Detection Limit

Beryllium



* Compound Not Detected, Value = Detection Limit

Cadmium



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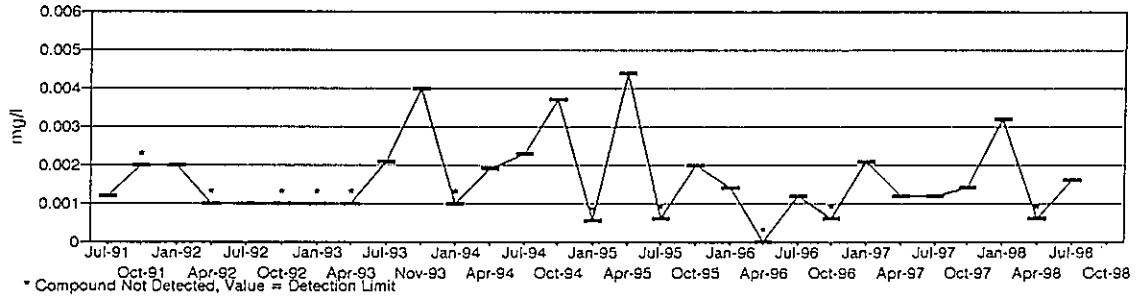
Chromium



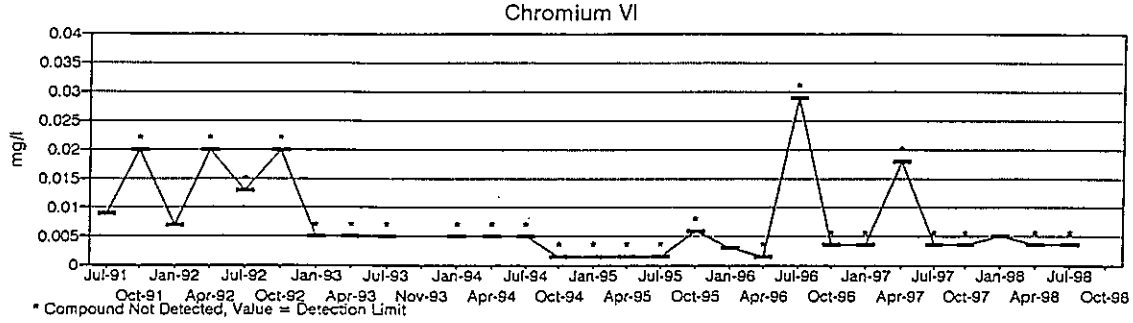
* Compound Not Detected, Value = Detection Limit

Prepared By: SGL Checked By: JBH1

Flambeau Mining Company
Surface Water Quality Results

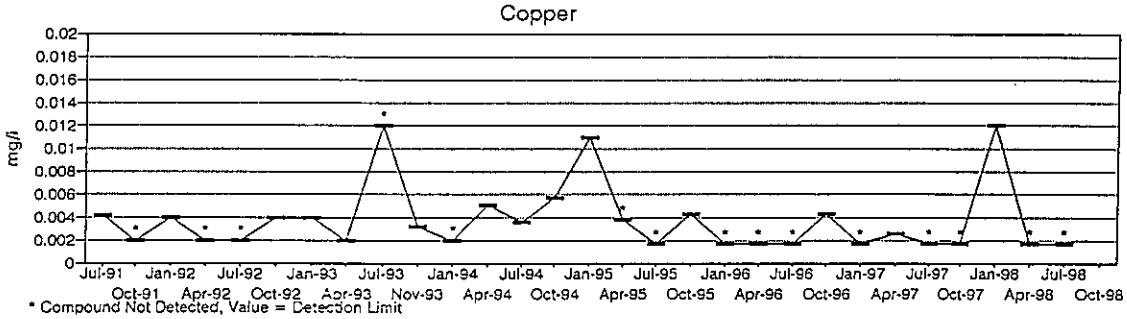
SW-2 (Downstream)

Chromium VI



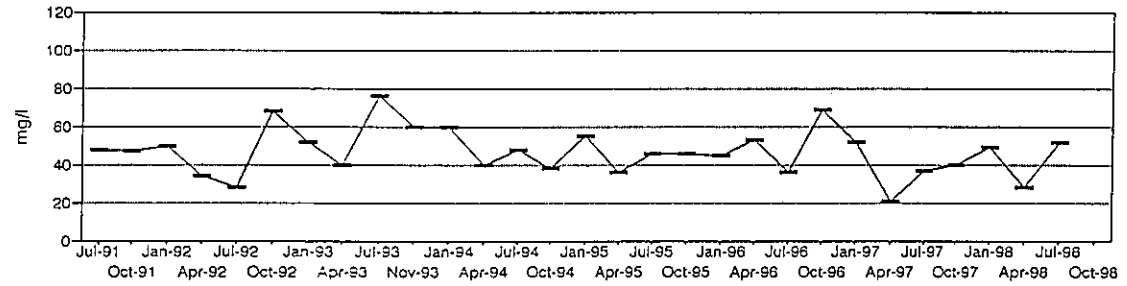
* Compound Not Detected, Value = Detection Limit

Copper

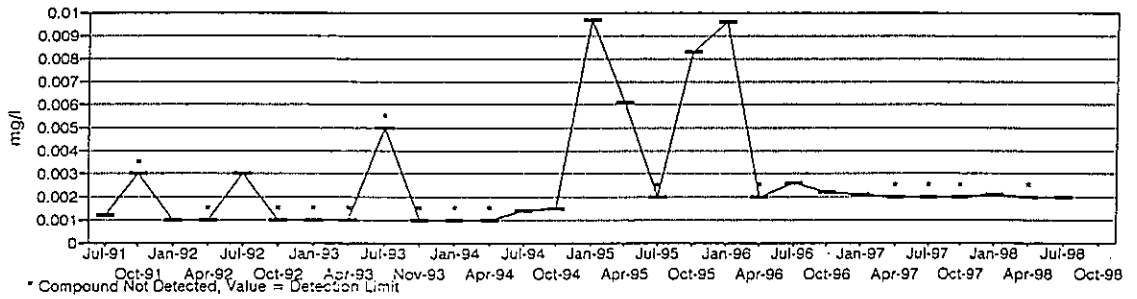


* Compound Not Detected, Value = Detection Limit

Hardness



Lead



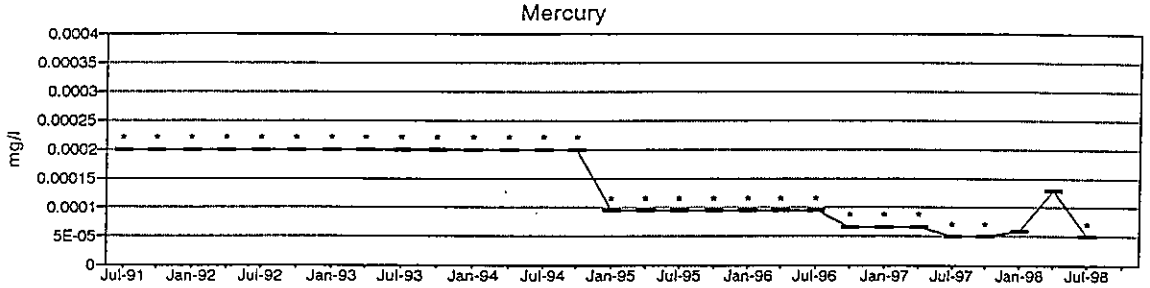
* Compound Not Detected, Value = Detection Limit

Prepared By: SGL Checked By: JBH1

Flambeau Mining Company
Surface Water Quality Results

SW-2 (Downstream)

Mercury



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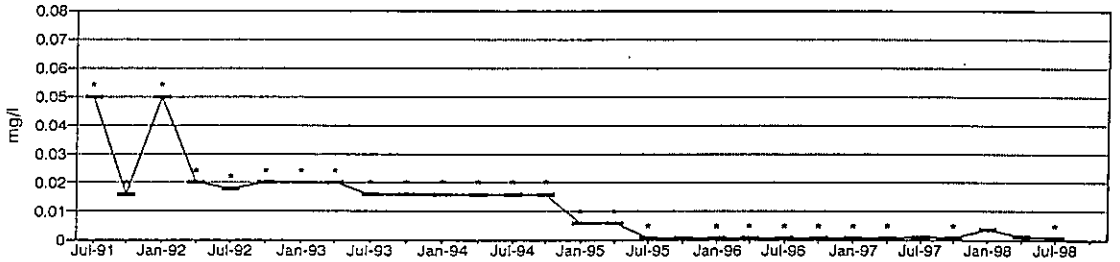
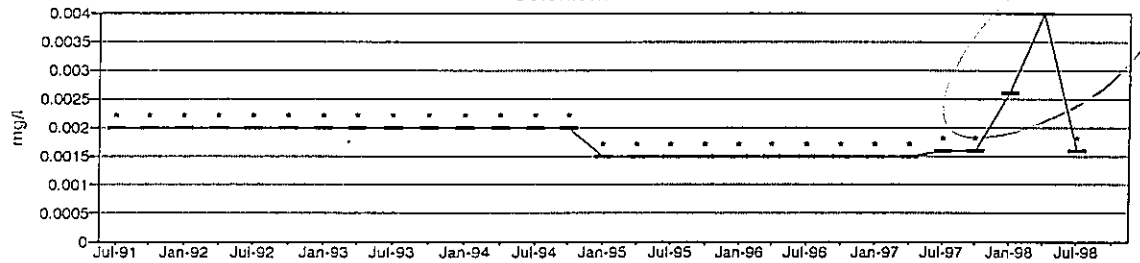
Nickel



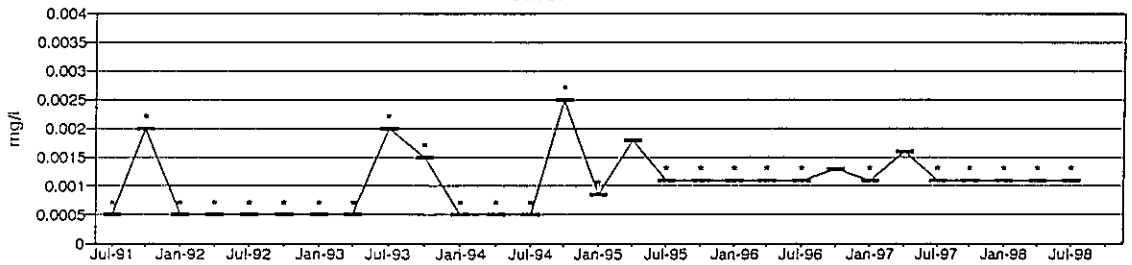
* Compound Not Detected, Value = Detection Limit

Selenium



* Compound Not Detected, Value = Detection Limit

Silver



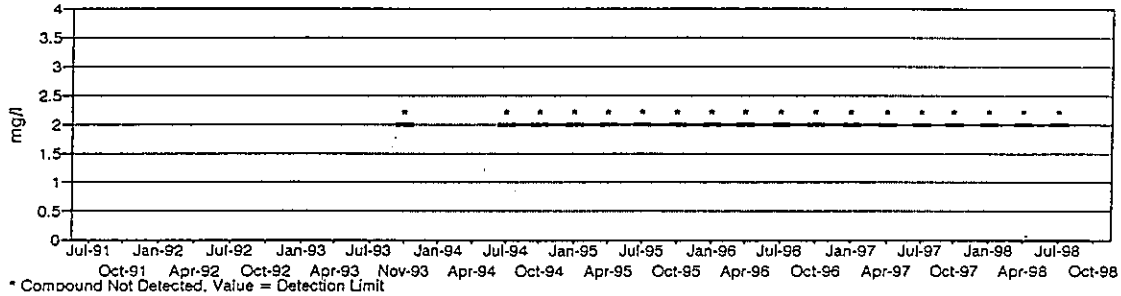
* Compound Not Detected, Value = Detection Limit

Prepared By: SGL Checked By: JBH1

Flambeau Mining Company
Surface Water Quality Results

SW-2 (Downstream)

Sulfide



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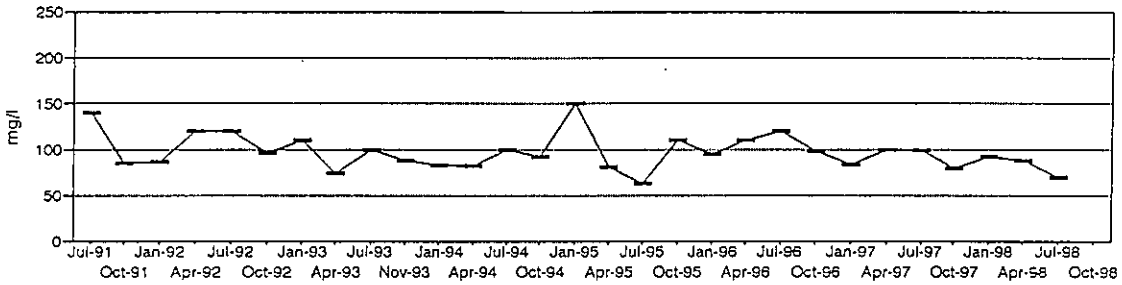
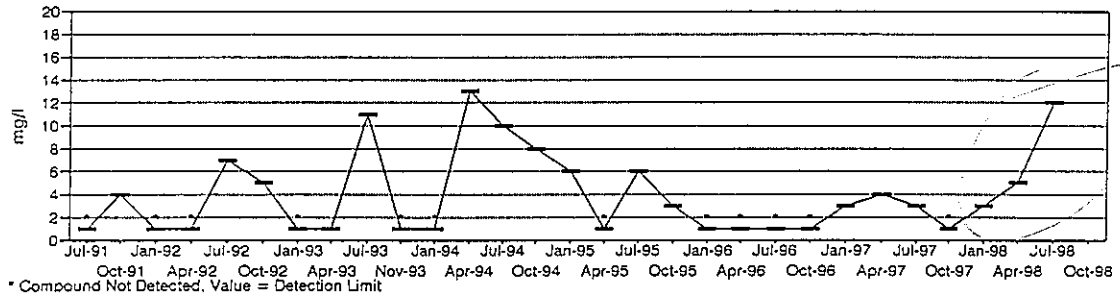
TDS

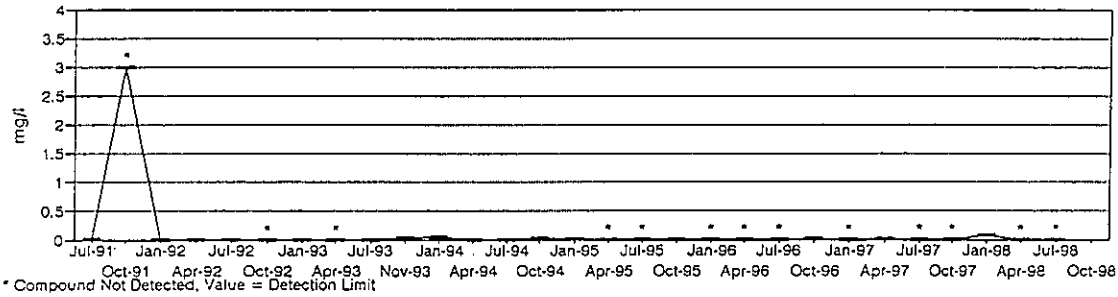


TSS



* Compound Not Detected, Value = Detection Limit

Zinc



* Compound Not Detected, Value = Detection Limit

Prepared By: SGL Checked By: JBH1

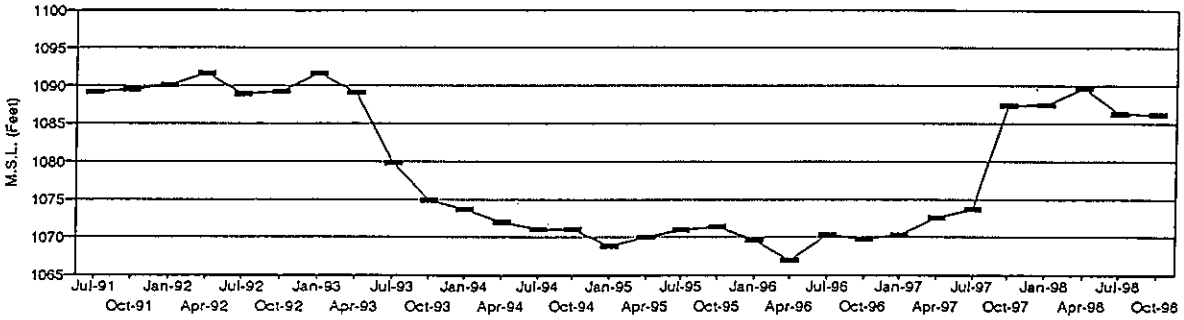
Attachment 3

Groundwater Elevation Trends

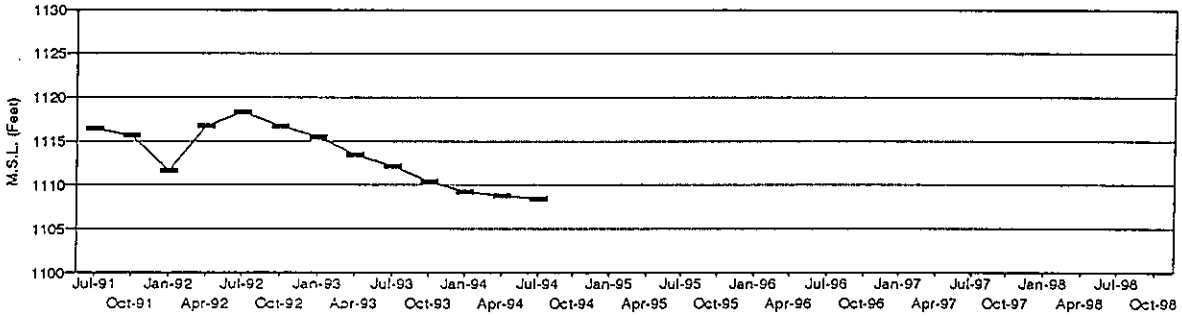
Flambeau Mining Company

Groundwater Elevation Results

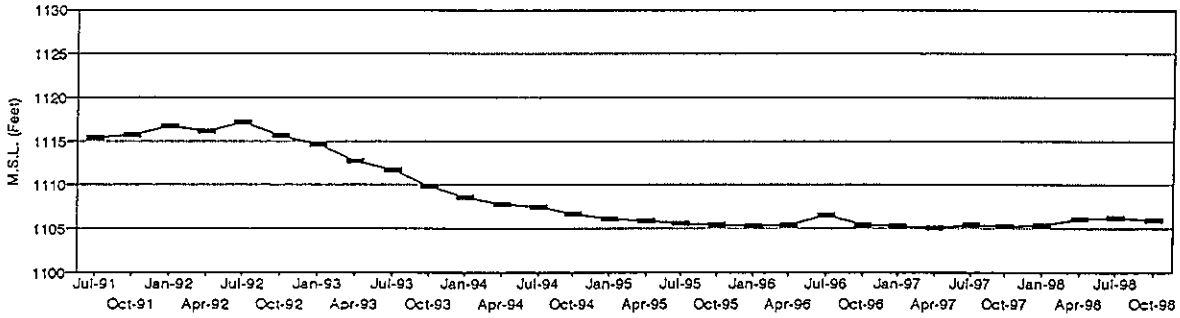
MW-1000P-R



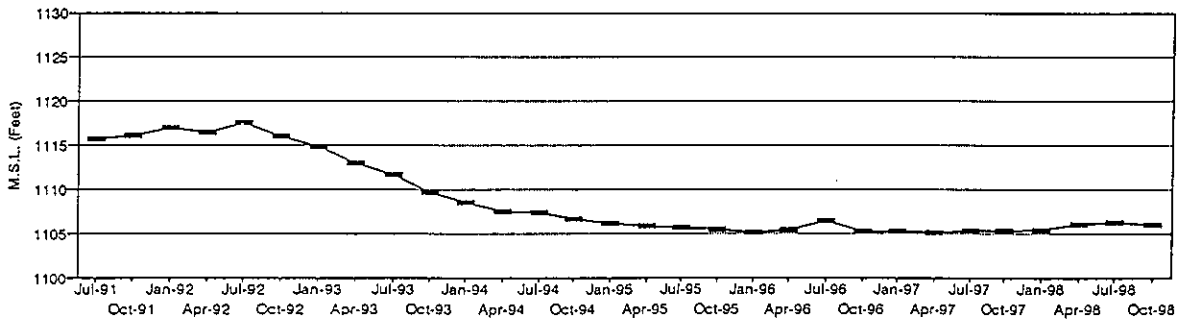
MW-1001



MW-1001G



MW-1001P

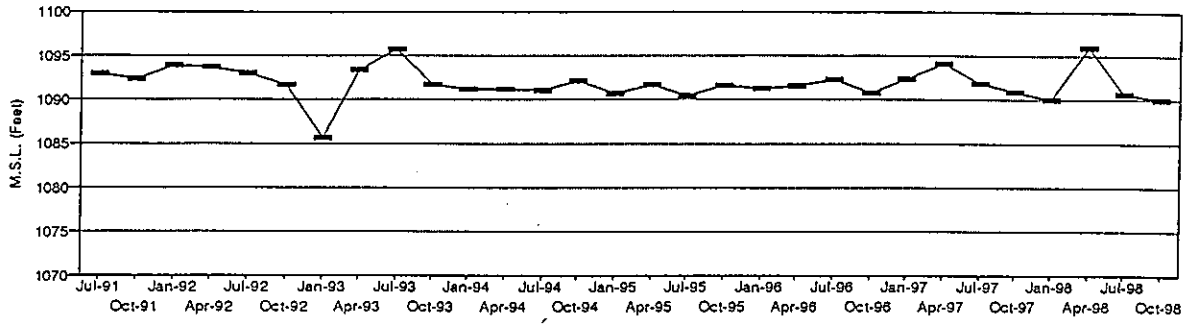


Prepared By: SGL Checked By: JBH1

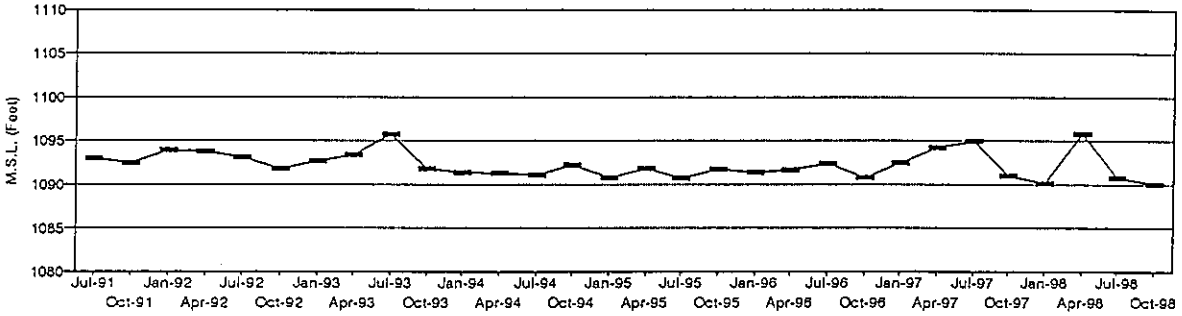
Flambeau Mining Company

Groundwater Elevation Results

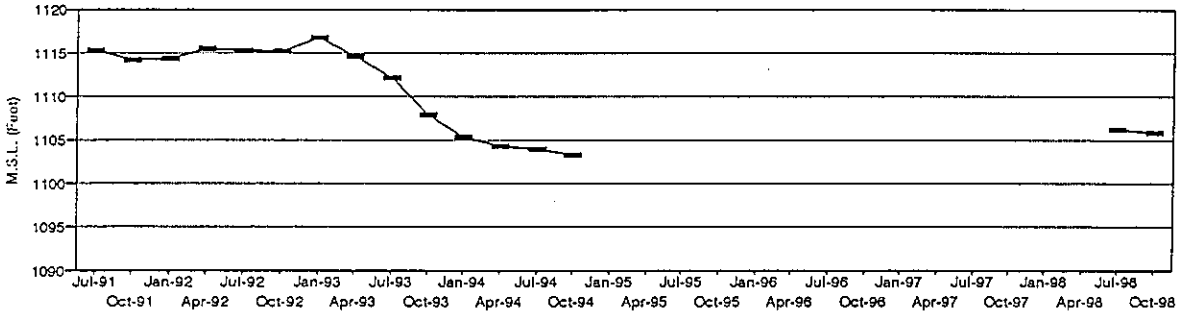
MW-1002



MW-1002G



MW-1003



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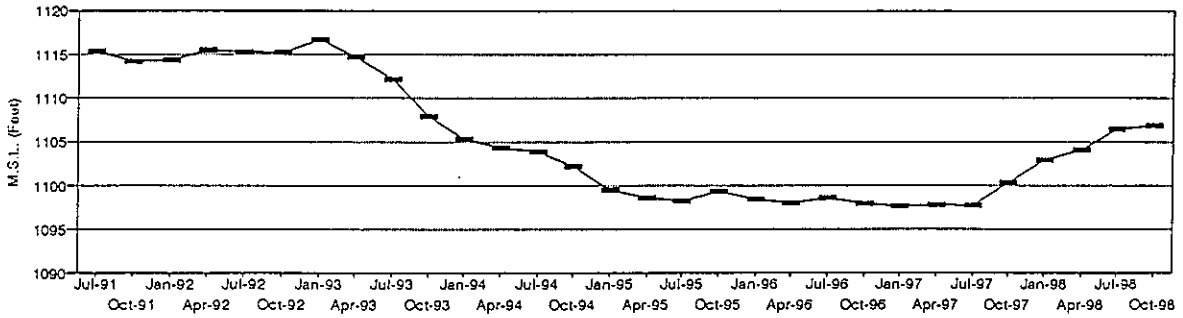
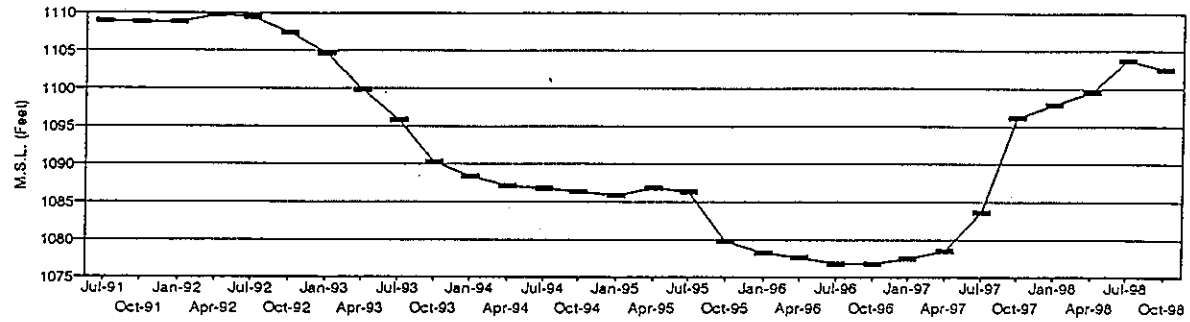


Prepared By: SGL Checked By: JBH1

Flambeau Mining Company

Groundwater Elevation Results

MW-1004P



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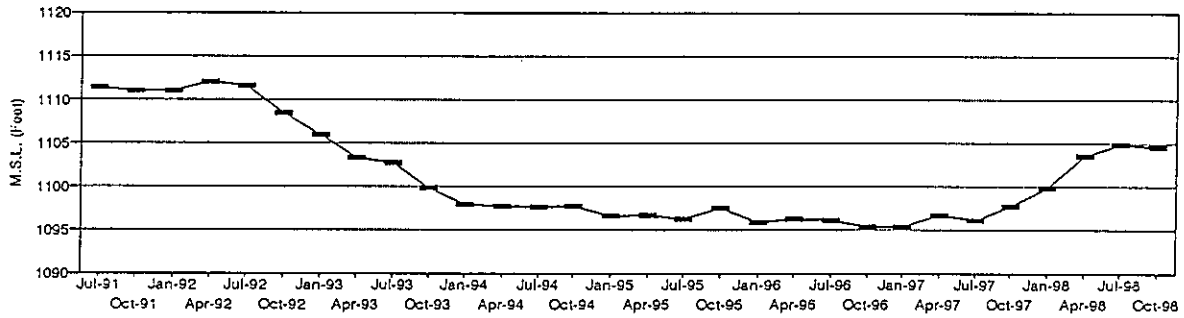

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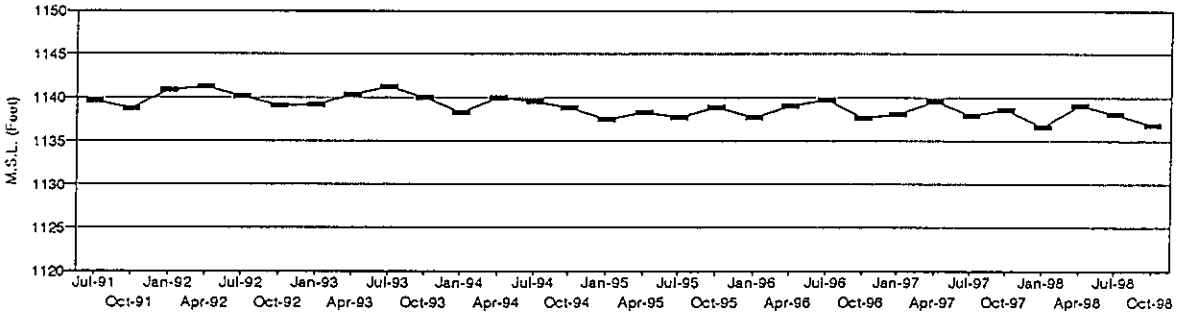

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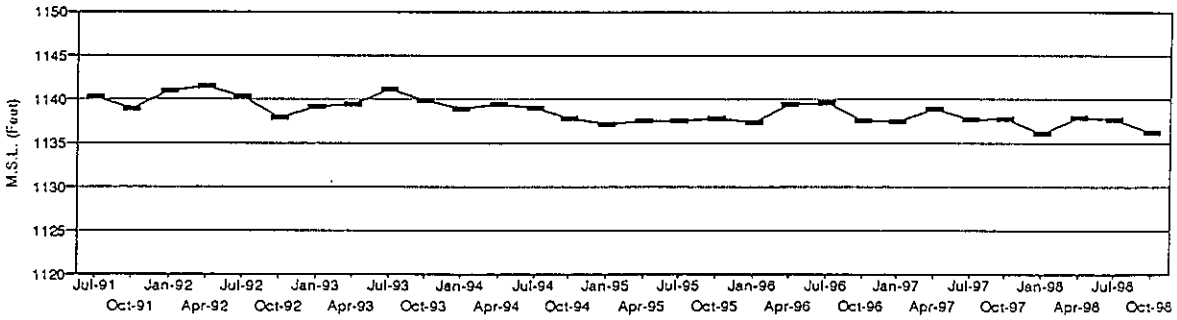
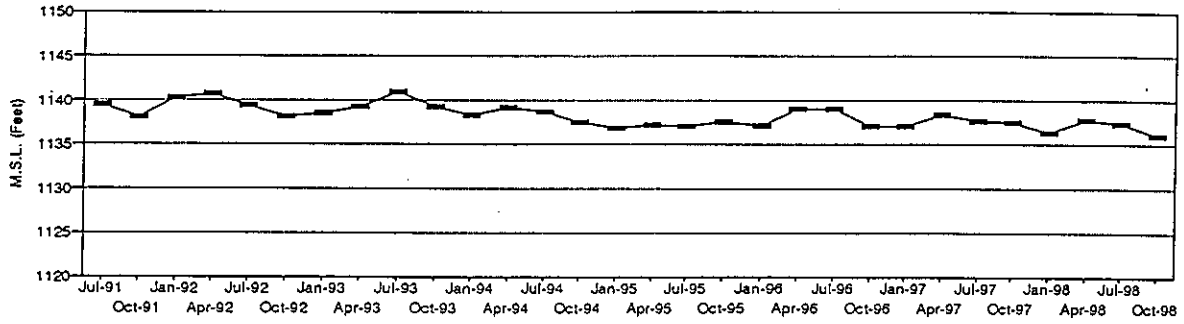


Prepared By: SGL Checked By: JBH1

Flambeau Mining Company

Groundwater Elevation Results

MW-1005S



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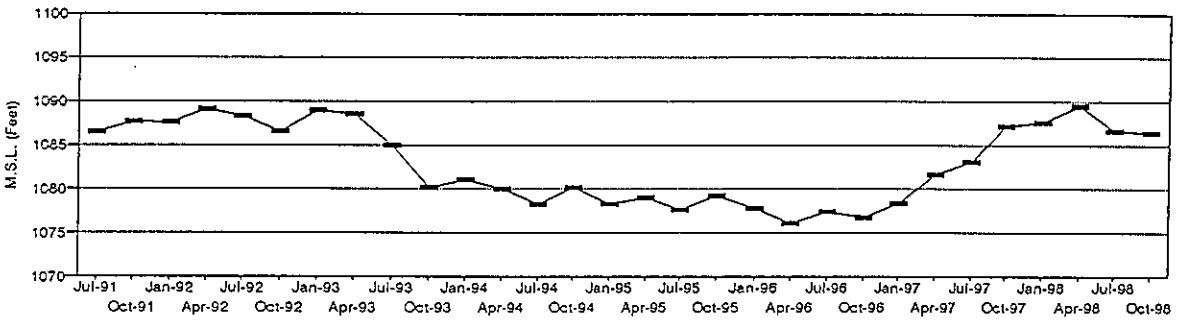

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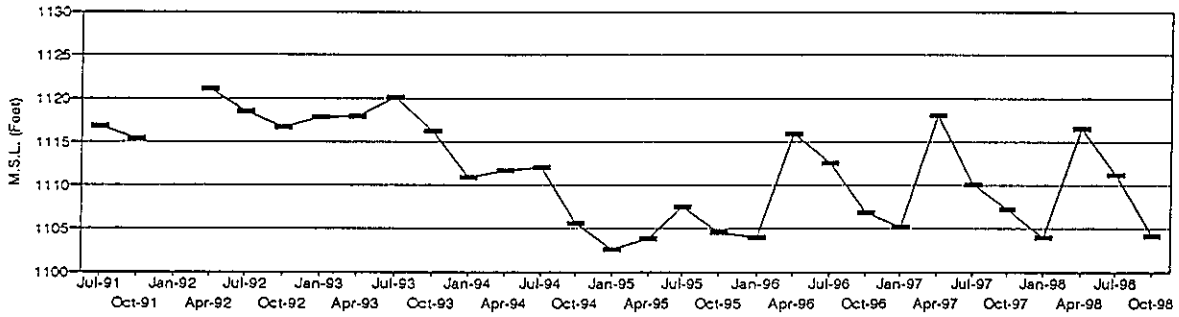

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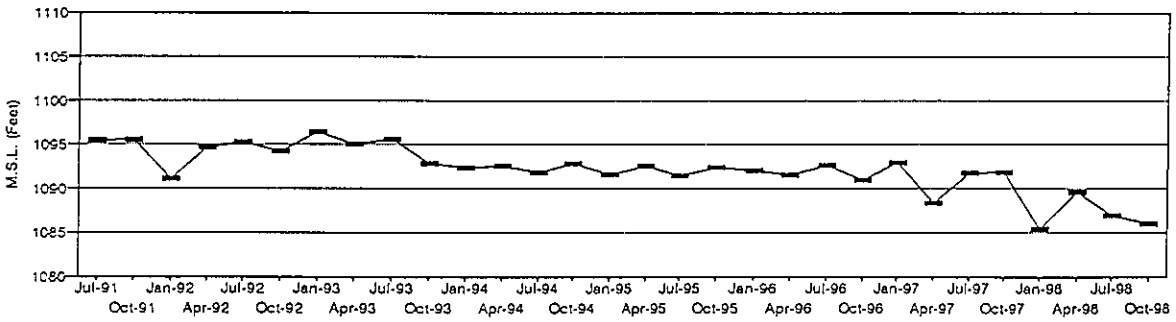
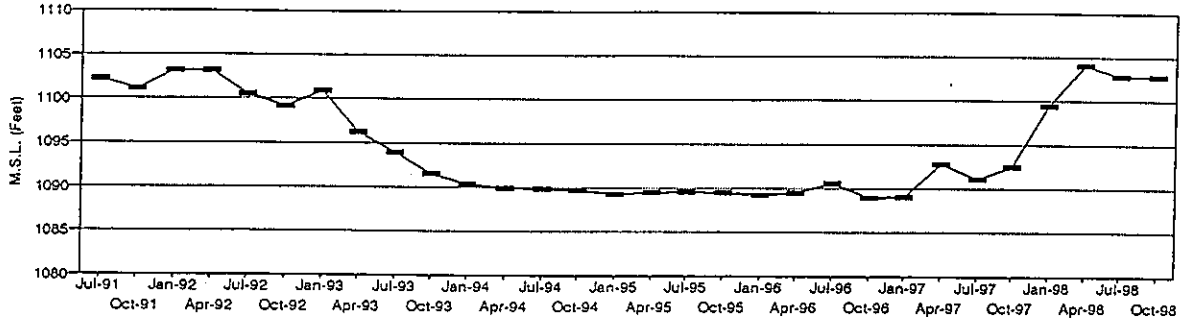


Prepared By: SGL Checked By: JBH1

Flambeau Mining Company

Groundwater Elevation Results

OW-39



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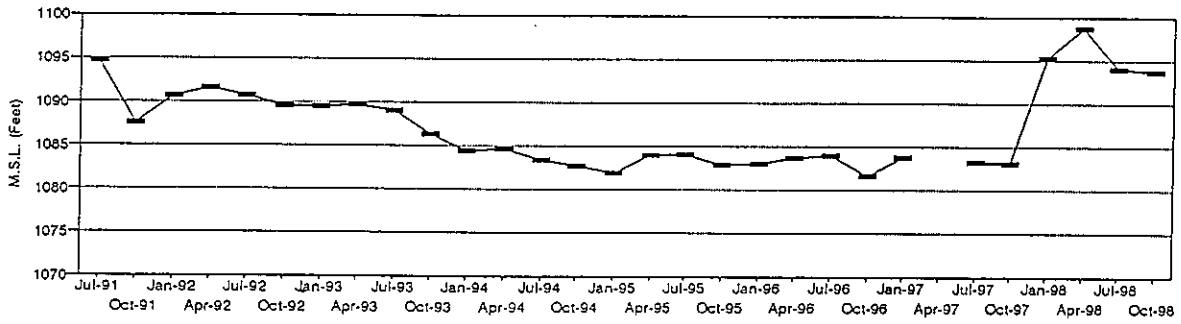

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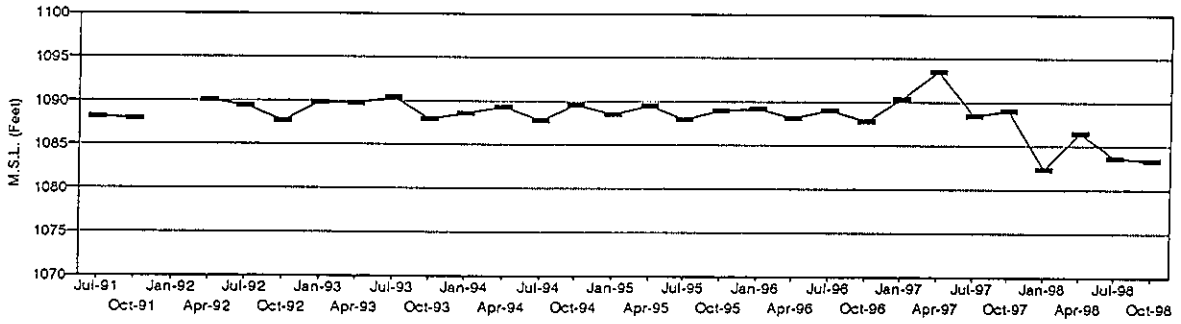

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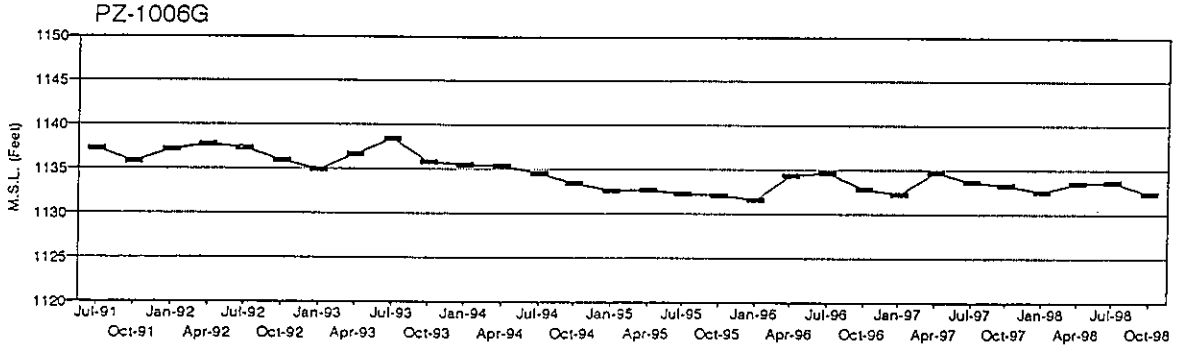
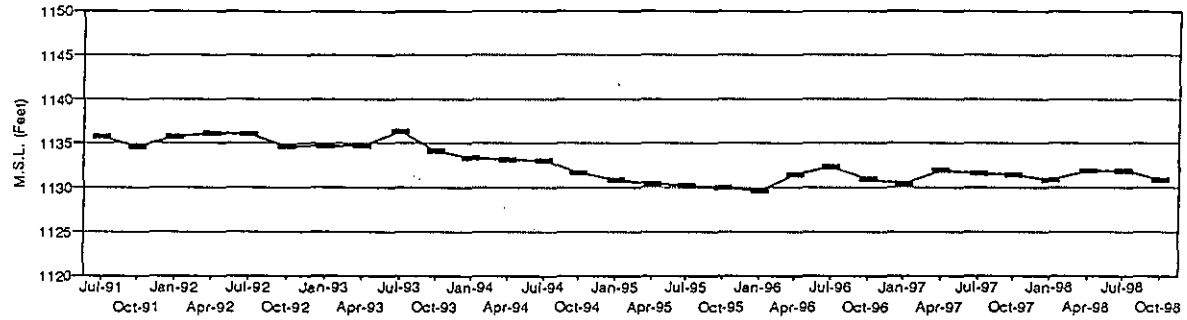


Prepared By: SGL Checked By: JBH1

Flambeau Mining Company

Groundwater Elevation Results

PZ-1006S



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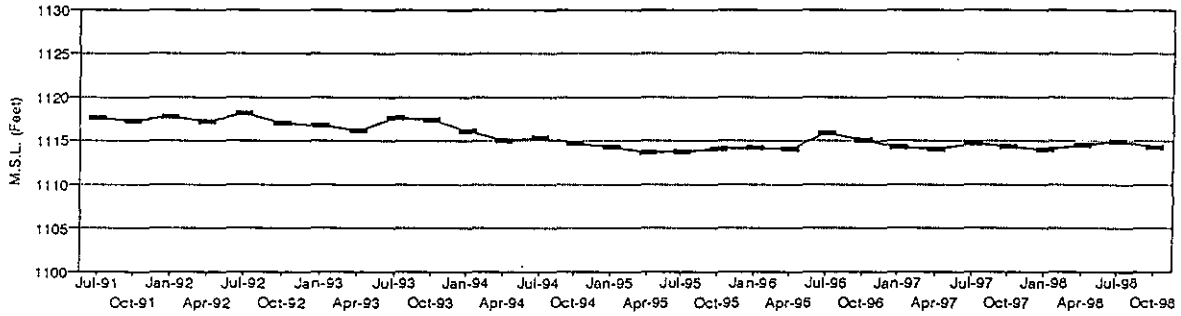

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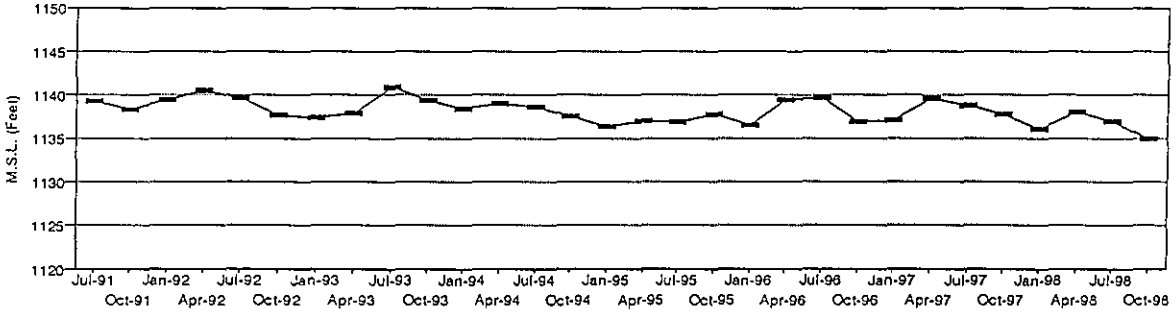

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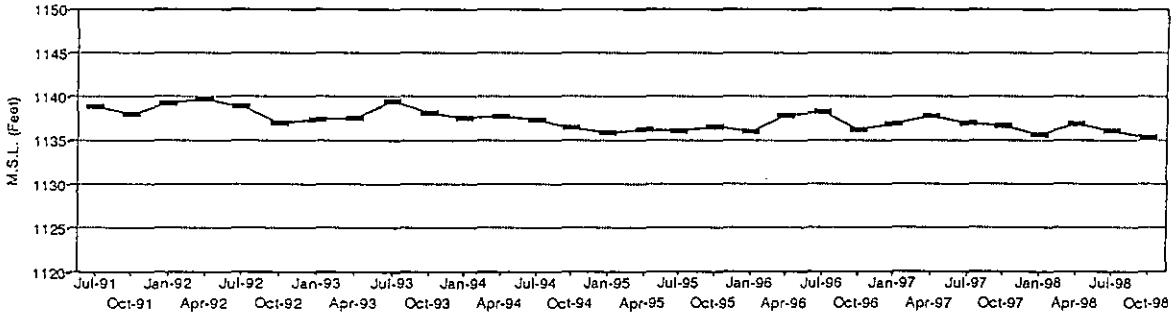
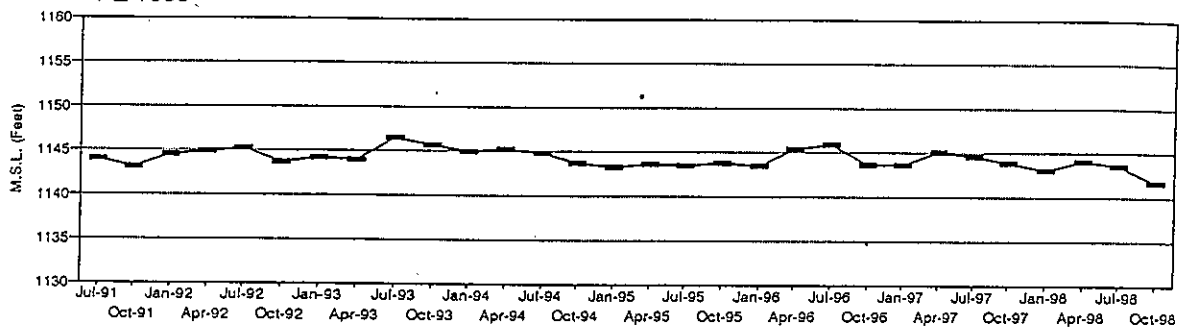


Prepared By: SGL Checked By: JBH1

Flambeau Mining Company

Groundwater Elevation Results

PZ-1009



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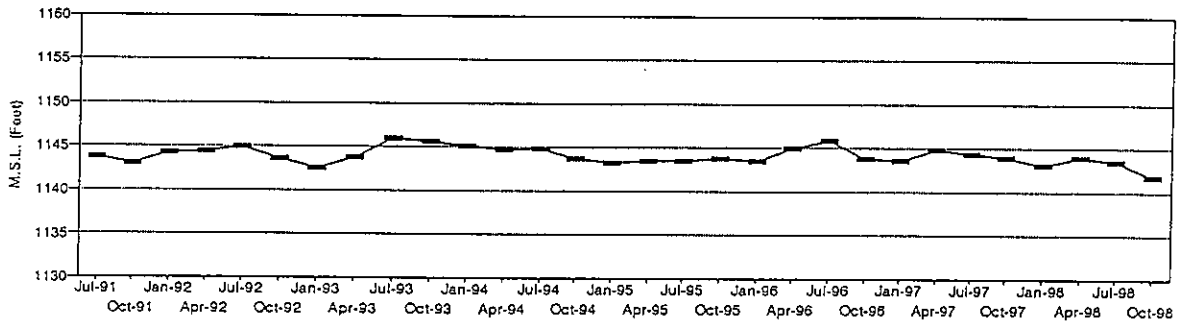

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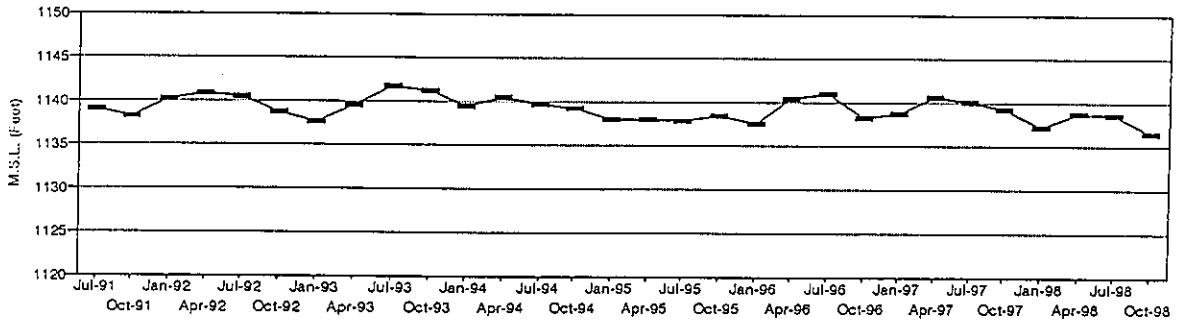

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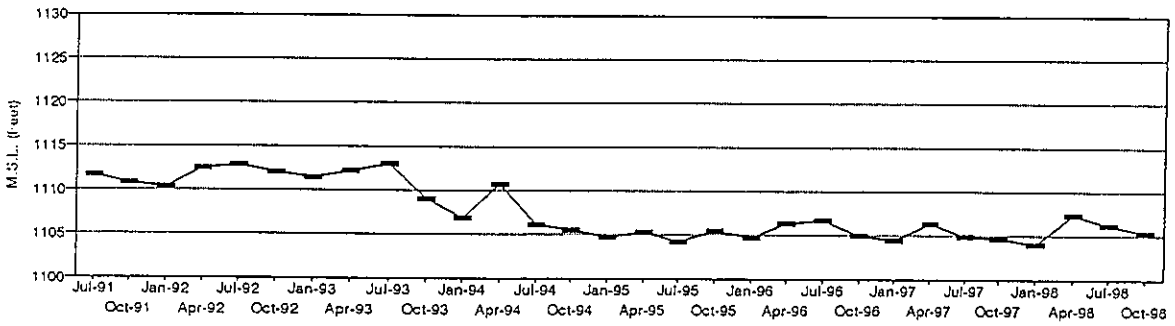
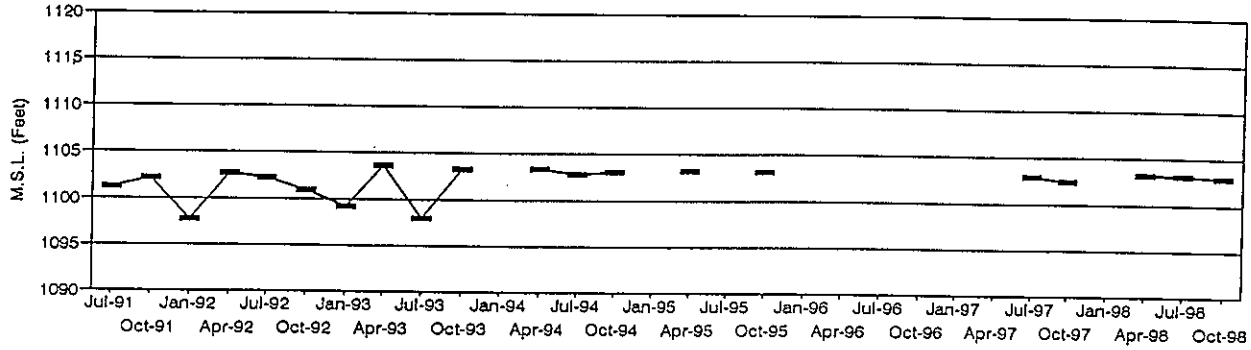


Prepared By: SGL Checked By: JBH1

Flambeau Mining Company

Groundwater Elevation Results

PZ-1B



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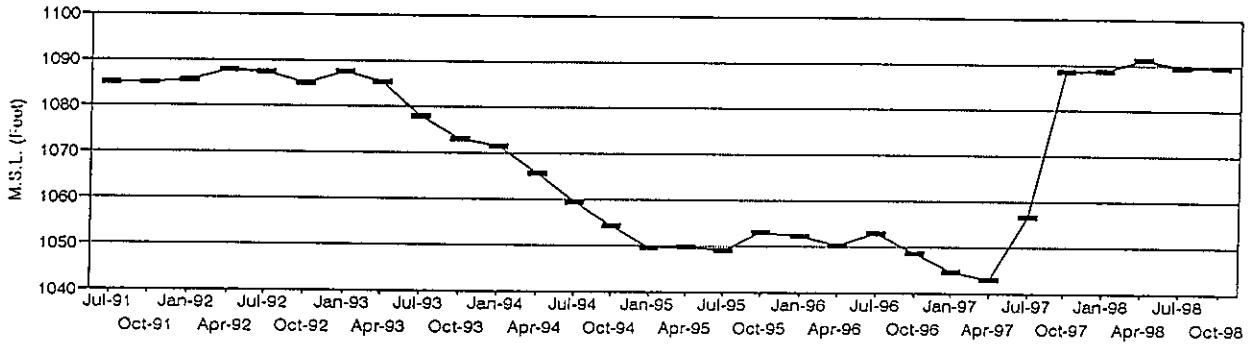

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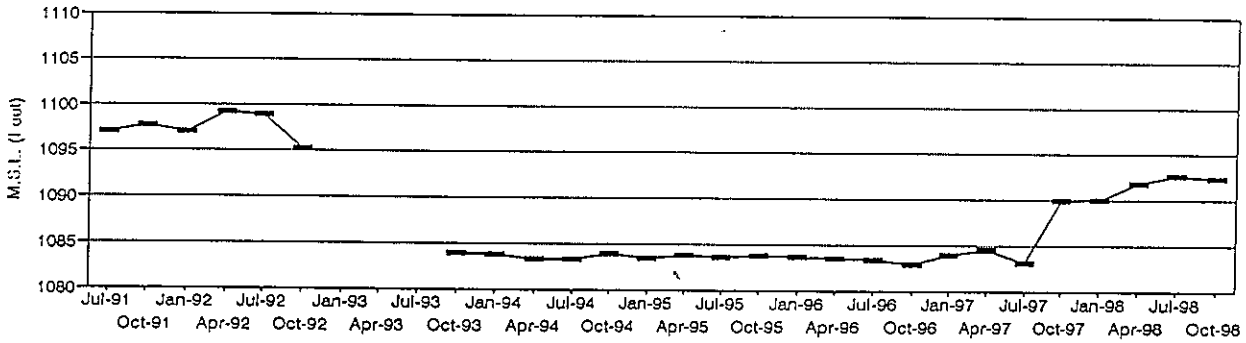

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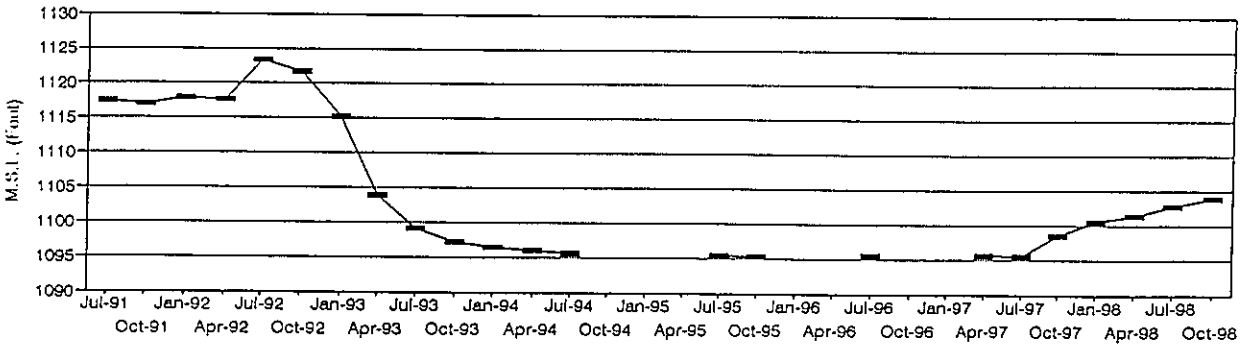
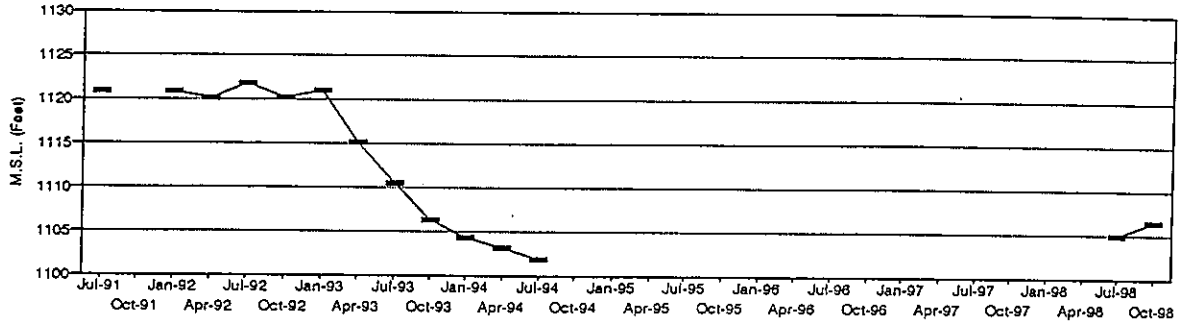


Prepared By: SGL Checked By: JBH1

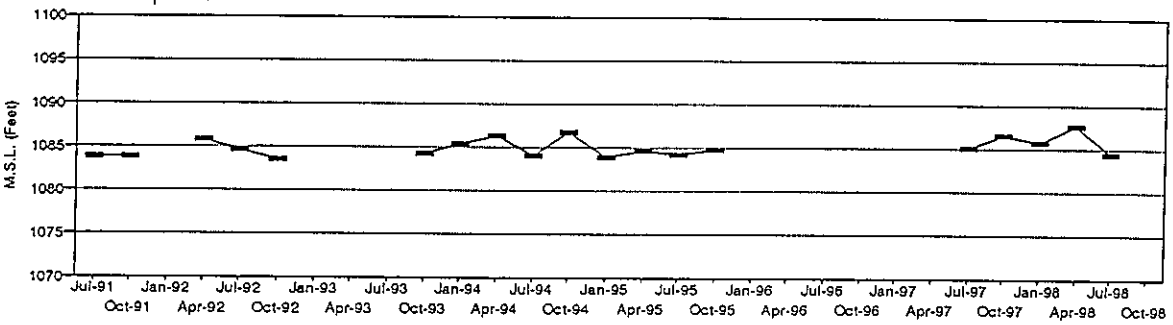
Flambeau Mining Company

Groundwater Elevation Results

ST-9-23



Sandpoint



Prepared By: SGL Checked By: JBH1

APPENDIX D

SEDEIMENT SAMPLING

ENVIRONMENTAL COMPLIANCE CONSULTANTS, INC.
P.O. BOX 11417 • GREEN BAY, WI 54307-1417 • 920-434-6380 (VOICE) • 920-434-6381 (FAX)

Environmental Compliance Consultants, Inc.
Memorandum

September 29, 1998

TO: Jana Murphy, Flambeau Mining Company

CC: Jeff Earnshaw, Flambeau Mining Company

FR: Bill West, ECCI

RE: Report on Activities Associated with 1998 Sediment Sampling , Flambeau River, Ladysmith, Wisconsin

Introduction

On June 4, 1998, Bill West of Environmental Compliance Consultants, Inc., was accompanied by Jack Christman of Flambeau Mining Company (Flambeau) for the purpose of installing sediment traps in the Flambeau River. This activity is part of routine site monitoring required of the Flambeau Mining Permit.

Four individual sampling containers were positioned in two locations in the Flambeau River. One location was above the Flambeau discharge Outfall 001 (Site S-1) at the Blackberry Lane access. The second location was downstream of mining site Outfall 001 near the Sister's Farm (Site S-3). Sample Site S-2 was replaced by Site S-3 in 1993 and succeeding years. The sampling locations for 1998 were the same locations sampled in 1993 through 1997.

Sediment sample jars were retrieved from the Flambeau River on August 4, 1998 after a two month exposure window.

Methodology

Sediment traps were installed upstream and downstream of the Flambeau discharge locations as illustrated in Figure 1. Sample containers consisted of one-quart wide mouth mason jars which were acid washed prior to installation.

At each sampling location, a set of four sample jars were placed in the river, each surrounded by a concrete half block secured by rebar. Rebar was driven into the substrate to the point of being flush with the top of the block. Sinking the rebar flush with the block discourages the collection of debris which may cover the jar opening. Observations of sediment traps at the time of trap removal from the river in previous years indicated that this technique was successful in keeping debris from accumulating on and around the traps.

Quart jars inserted into the submerged half block opening were positioned so that the top of the jar was either flush with the top of the block or slightly below the top of the block. This positioning was designed to reduce the potential for breakage due to an encounter with water-borne debris.

With every four jar set, the outer most jar (most distal to the shore) was positioned approximately ten feet and 45 degrees upstream of the second jar. The second, third, and fourth jars were similarly placed at 45 degrees and downstream of the previously placed jar. When placing jars in the block, the upstream jar was positioned first followed by the second, third and fourth descending downstream. In this manner, the chance of impacting downstream jars while placing the upstream jars was eliminated.

As in previous years, a nitex screen with ½-inch mesh was fitted over each of the jars and secured with plastic ties. This technique was used to prevent the colonization of the traps by crayfish and/or fish.

Sample containers were retrieved on August 4, 1998. At each site, the container furthest downstream of the four sample set was collected first followed by the next upstream sample and so on until each of the four was collected. Collecting samples in this manner prevented the downstream samples from being contaminated by activity from upstream sample collection, had the upstream sample been collected first.

During sample collection, the plastic tie and mesh screen were removed prior to removing the sample from the water. After screen removal, a sheet of parafilm was placed over the jar opening. After placement of the parafilm, the jars were fitted with a lid and ring seal. Samples were placed on ice and taken to Northern Lake Service in Crandon, Wisconsin for analysis. At the laboratory, samples collected at each site were composited into a single sample, S-1 for the upstream sample and S-3 for the downstream sample. As in previous years, these samples were analyzed for metals and a sieve analysis was conducted on these samples.

Observations

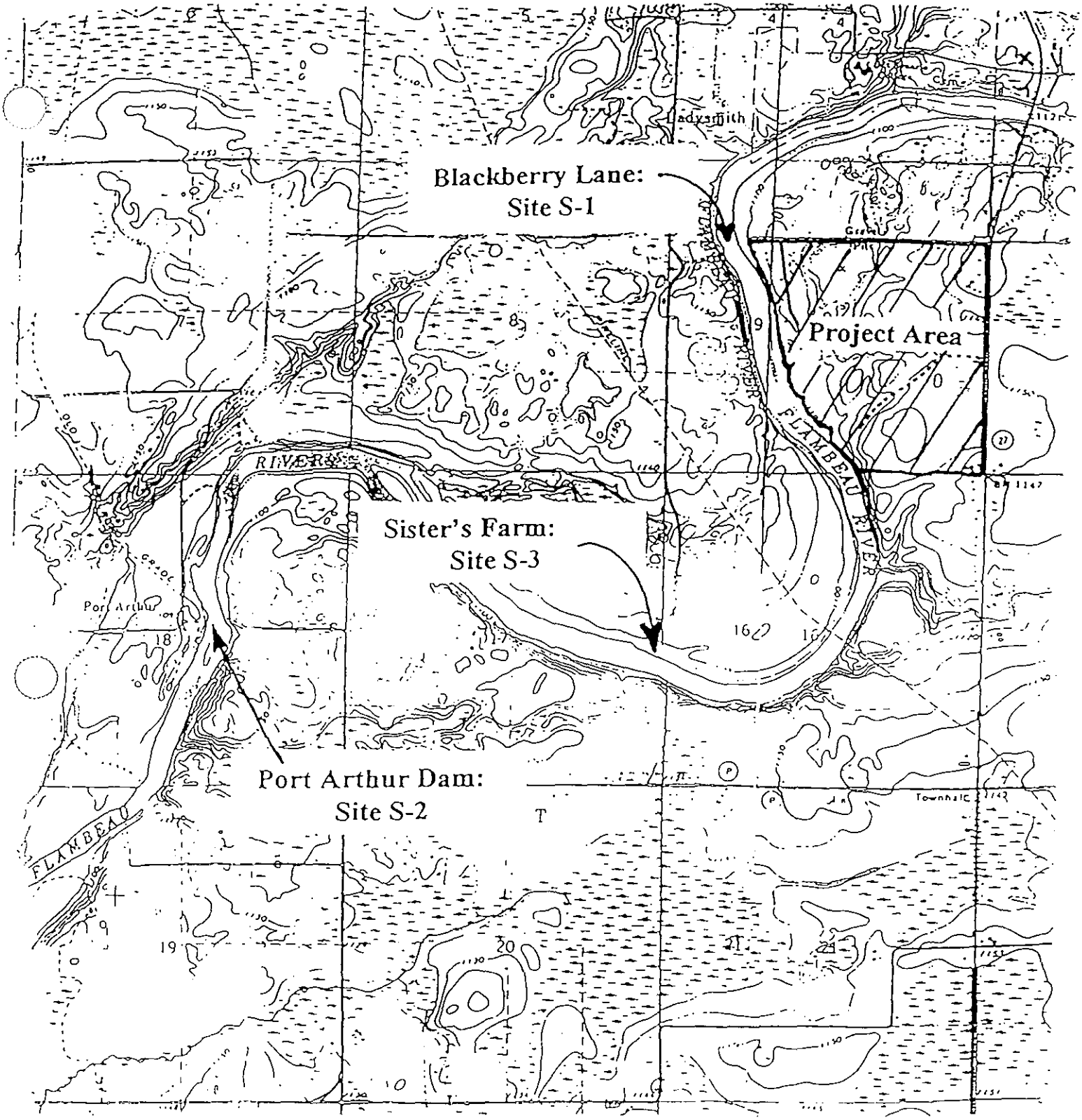
Jar samples from both sites appeared to contain amounts of sediments which were typical of previous years. There appeared to be less variability from jar to jar and from upstream sample to downstream sample with respect to the amount of sediment collected. Both sets of jars were colonized by the immature forms of caddisfly. Because of the lower flow witnessed in 1998, one might expect less substrate in each of the jars but a higher percent volatile suspended solids. The higher volatile fraction would be expected based on a higher percentage of biological matter versus inorganic matter collected over the two month collection period. The data appears to bear this out.

Results

A summary of results of the laboratory analysis of the sediment samples from the two sampling sites is shown in Table 1. Individual sample analytical data and sieve analysis are provided in Appendix 1.

Discussion

Data from the eight years of sediment analysis indicate that, in general, no increase or decrease in parameter concentration in sediments is occurring. Moreover, downstream samples continue to compare favorably with upstream sediment samples indicating no impacts due to mine activities.



Flambeau Mining Company	
Figure 1 Flambeau River Sediment Sample Collection Locations	
Scale: None	Date: 10/96

Table 1
Flambeau River Sediment Sampling Results
1991 - 1998

	Sample Location/Number																
	Blackberry Lane (S-1)								Port Arthur Dam (S-2) Sister's Farm(S-3)								
Parameter (mg/kg)	S-1-01 (1991)	S-1-02 (1992)	S-1-03 (1993)	S-1-04 (1994)	S-1-05 (1995)	S-1-06 (1996)	S-1-07 (1997)	S-1-08 (1998)	S-2-01 (1991)	S-2-02 (1992)	S-2-03 (1993)	S-3-03 (1993)	S-3-04 (1994)	S-3-05 (1995)	S-3-06 (1996)	S-3-07 (1997)	S-3-08 (1998)
Silver	<1.2	<1.1	0.057	<0.21	<0.05	<0.57	<0.70	<0.043	<1.1	<2.6	0.086	0.58	<0.08	0.04	<0.56	<0.40	<0.044
Aluminum	3800	3300	4000	3900	2900	1900	2100	1900	4000	12000	1500.0	4400	4000	3600	2500	2400	2000
Arsenic	2.2	2.2	1.4	<4.2	<0.41	1.6	<0.87	1.1	1.5	4.1	<0.55	0.71	<1.6	1.5	<0.45	<0.71	<0.94>
Cadmium	<0.7	<0.6	<0.06	<0.42	<0.03	0.72	1.2	1.2	0.6	<1.4	<0.055	0.11	0.13	0.085	0.64	0.70	1.0
Chromium	11.0	10.0	11	10	4.4	4.1	5.6	5.3	13.0	24.0	23.8	9.6	10	6.6	6.3	6.1	5.6
Copper	7.3	6.0	7.0	5.8	6.4	5.8	5.3	4.9	7.2	24.0	2.1	6.7	7.1	7.0	8.2	6.7	6.1
Iron	18000	16000	15000	11000	4800	6800	6500	7900	16000	25000	3100	8200	7700	7300	6700	7900	6300
Mercury	0.1	<0.1	<0.045	<0.04	<0.02	<0.02	<0.024>	<0.013	0.1	<0.3	<0.057	<0.07	<0.03	<0.06	<0.02	<0.059>	<0.042>
Manganese	1900	1000	1300	1500	600	510	700	1100	1600	570	610	830	860	780	840	910	910
Nickel	5.8	6.1	8.4	7.4	6.1	6.1	2.2	4.4	7.3	12.0	1.7	6.5	6.2	5.0	5.7	3.0	3.1
Lead	6.0	5.8	8.5	3.3	3.3	<2.2	<5.1>	5.1	6.9	20.0	2.6	8.3	7.8	7.5	9.0	6.4	5.9
Selenium	0.4	<0.4	<0.32	4.2	<0.44	<0.28	<1.0	<0.37	0.4	<0.9	<0.28	<0.26	<1.6	<0.27	1.4	<0.95>	<0.37
Zinc	47.0	33.0	38	34	18	19	20	18	45.0	79.0	9.6	33	46	26	28	24	21
Total Solids%	73.0	78.6	79.2	NA	76.7	74.9	72.6	41.7	76.8	35.0	32	56	NA	44.8	49.8	30.6	24.5
Total Vol. Solids %	1.8	1.6	0.77	NA	<2	<2	<2	6.7	2.5	12.0	5.8	6.24	NA	6.9	5.5	11	15
Field Temp. C	25.0	16.2	15.0	NA	25.0	27.0	18.9	22.8	25.0	15.8	15.5	15.5	NA	25.0	27.0	19.4	22.8

NA = Data Not Available
Data from Site S-1 is referenced by Sample ID#175835, Site S-3 is represented by Sample ID#175839
Data appearing in brackets (< >) was reported as observed between the level of detection (LOD) and level of quantitation (LOQ)

Prepared by: RDK
Checked by: WMW

Appendix 1

Laboratory Data for Sediment Analysis
Flambeau Mining Project, 1998

NORTHERN LAKE SERVICE, INC.
Analytical Laboratory and Environmental Services
400 North Lake Avenue - Crandon, WI 54520
Tel:(715)478-2777 Fax:(715)478-3060

WIS. LAB CERT. NO. 721026460

ANALYTICAL REPORT

PAGE: 1 NLS PROJECT# 42872
NLS CUST# 10513

Client: E.C.C.I. (GB)
Attn: Bill West
PO Box 11417
2637 Tulip Ln
Green Bay, WI 54307

Project Description: Flambeau Mining Company - Sediment

Sample ID: FMC-A-1/A-4 NLS#: 175835
Ref. Line 1 of COC 32589 Description: FMC-A-1/A-4
Collected: 08/04/98 Received: 08/07/98 Reported: 09/02/98

Parameter	Result	Units	LOD	LOQ	Method	Analyzed	Lab
Aluminum, tot. as Al	1900	mg/Kg WWB	0.26	0.89	SW846 6010	08/19/98	721026460
Arsenic, tot. as As by furnace	1.1	mg/Kg WWB	0.32	1.1	SW846 7060	08/18/98	721026460
Cadmium, tot. as Cd	1.2	mg/Kg WWB	0.044	0.16	SW846 6010	08/18/98	721026460
Chromium, tot. as Cr	5.3	mg/Kg WWB	0.092	0.33	SW846 6010	08/18/98	721026460
Copper, tot. as Cu	4.9	mg/Kg WWB	0.025	0.085	SW846 6010	08/18/98	721026460
Iron, tot. as Fe	7900	mg/Kg WWB	7.8	27	SW846 6010	08/18/98	721026460
Lead, tot. as Pb	5.1	mg/Kg WWB	0.86	3.1	SW846 6010	08/17/98	721026460
Manganese, tot. as Mn	1100	mg/Kg WWB	0.20	0.71	SW846 6010	08/18/98	721026460
Mercury, total as Hg	ND	mg/Kg WWB	0.013	0.048	SW846 7470A	08/12/98	721026460
Nickel, tot. as Ni	4.4	mg/Kg WWB	0.17	0.60	SW846 6010	08/18/98	721026460
Selenium, tot. as Se by furnace	ND	mg/Kg WWB	0.37	1.3	SW846 7740	08/16/98	721026460
Silver, tot. as Ag	ND	mg/Kg WWB	0.043	0.15	SW846 6010	08/18/98	721026460
Solids, total on solids	41.7	%	0.10		ASTM D2216	08/12/98	721026460
Solids, tot. volatile	6.7	% DWB	2.0		EPA 160.4	08/11/98	721026460
Zinc, tot. as Zn	18	mg/Kg WWB	0.13	0.13	SW846 6010	08/18/98	721026460
Metals digestion - total (soil/sludge) ICP	yes				SW846 3050	08/13/98	721026460
Metals digestion - total (soil/sludge) furnace	yes				SW846 3050	08/13/98	721026460
Particle Size	see attached					09/02/98	NA

NORTHERN LAKE SERVICE, INC.
Analytical Laboratory and Environmental Services
400 North Avenue - Crandon, WI 54520
Tel:(715)478-2777 Fax:(715)478-3060

WIS. LAB CERT. NO. 721026460

ANALYTICAL REPORT

 NLS PROJECT# 42872
NLS CUST# 10513

Client: E.C.C.I. (GB)
Attn: Bill West
PO Box 11417
2637 Tulip Ln
Green Bay, WI 54307

Project Description: Flambeau Mining Company - Sediment

Sample ID: FMC-B-1/B-4 NLS#: 175839
Ref. Line 5 of COC 32589 Description: FMC-B-1/B-4
Collected: 08/04/98 Received: 08/07/98 Reported: 09/02/98

Parameter	Result	Units	LOD	LOQ	Method	Analyzed	Lab
Aluminum, tot. as Al	2000	mg/Kg WWB	0.27	0.91	SW846 6010	08/19/98	721026460
Arsenic, tot. as As by furnace	< 0.94 >	mg/Kg WWB	0.32	1.1	SW846 7060	08/18/98	721026460
Cadmium, tot. as Cd	1.0	mg/Kg WWB	0.045	0.16	SW846 6010	08/18/98	721026460
Chromium, tot. as Cr	5.6	mg/Kg WWB	0.093	0.33	SW846 6010	08/18/98	721026460
Copper, tot. as Cu	6.0	mg/Kg WWB	0.026	0.087	SW846 6010	08/18/98	721026460
Iron, tot. as Fe	6300	mg/Kg WWB	7.9	28	SW846 6010	08/18/98	721026460
Lead, tot. as Pb	5.9	mg/Kg WWB	0.88	3.1	SW846 6010	08/17/98	721026460
Manganese, tot. as Mn	910	mg/Kg WWB	0.20	0.72	SW846 6010	08/18/98	721026460
Mercury, total as Hg	< 0.042 >	mg/Kg WWB	0.013	0.048	SW846 7470A	08/12/98	721026460
Nickel, tot. as Ni	3.1	mg/Kg WWB	0.17	0.61	SW846 6010	08/18/98	721026460
Selenium, tot. as Se by furnace	ND	mg/Kg WWB	0.37	1.3	SW846 7740	08/16/98	721026460
Silver, tot. as Ag	ND	mg/Kg WWB	0.044	0.15	SW846 6010	08/18/98	721026460
Solids, total on solids	24.5	%	0.10		ASTM D2216	08/12/98	721026460
Solids, tot. volatile	15	% DWB	2.0		EPA 160.4	08/11/98	721026460
Zinc, tot. as Zn	21	mg/Kg WWB	0.13	0.13	SW846 6010	08/18/98	721026460
Metals digestion - total (soil/sludge) ICP	yes				SW846 3050	08/13/98	721026460
Metals digestion - total (soil/sludge) furnace	yes				SW846 3050	08/13/98	721026460
Particle Size	see attached					09/02/98	NA

Values in brackets represent results greater than the LOD but less than the LOQ and are within a region of "Less-Certain Quantitation". Results greater than the LOQ are considered to be in the region of "Certain Quantitation".

LOD = Limit of Detection LOQ = Limit of Quantitation ND = Not Detected
DWB = Dry Weight Basis NA = Not Applicable %DWB = (mg/kg DWB)/10000

Thomas R Krueger

Reviewed by:

Authorized by:
R. T. Krueger
Laboratory Manager

GRADATION ANALYSIS

CLIENT: Northern Lakes Service
PROJECT: NLS Project #42872

JOB NO.: 14172M120

SPECIFICATION:
SOURCE: FMC-A1/A4
SAMPLED BY: NLS
SAMPLE NO: 175835

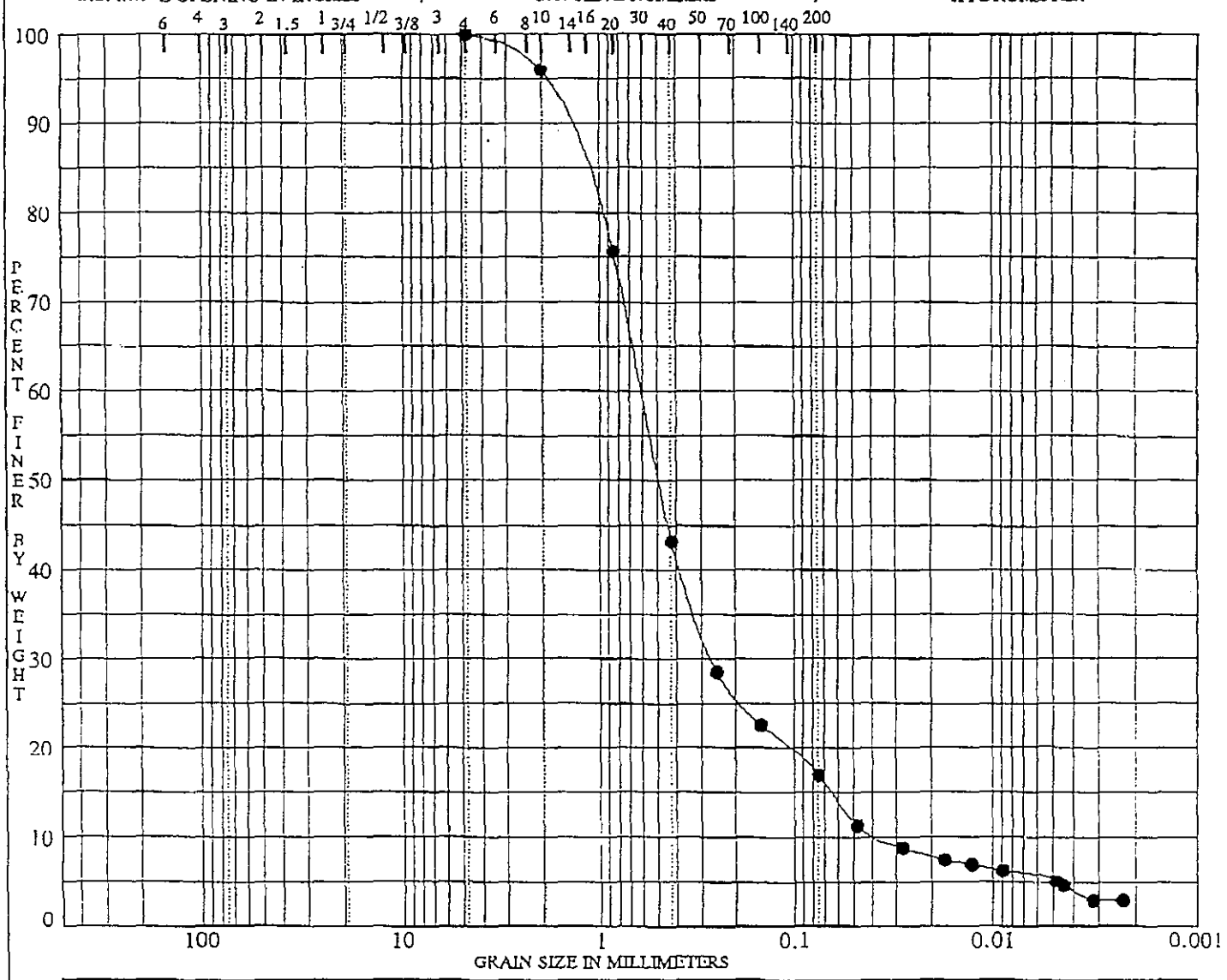
TEST DATE: 09/02/98
TESTED BY: TMO
REVIEWED BY: MRZ
DEPTH OF SAMPLE: 0.0

TOTAL WEIGHT OF SAMPLE (g): 84.83

SIEVE TEST ANALYSIS (ASTM D422)

SIEVE # (in)	%FINER	REQUIRED SPECS	
		MIN	MAX
3	100.0		
1 1/2	100.0		
1	100.0		
3/4	100.0		
1/2	100.0		
3/8	100.0		
1/4	100.0		
SIEVE #			
4	100.0		
8			
10	95.9		
16			
20	75.6		
30			
40	43.2		
50			
60	28.5		
100	22.5		
200	16.9		

MILLER
ENGINEERS
SCIENTISTS



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	175835	0.0							

* = Visual Classification (ASTM D2488)

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	175835	0.0	4.75	0.61	0.264	0.0366	0.0	83.1	11.8	5.1

CLIENT : Northern Lakes Service
PROJECT: NLS Project #42872

JOB NO.: 14172M120
TEST DATE: 09/02/98
SOURCE: FMC-A1/A4
SAMPLED BY: NLS
TESTED BY: TMO
REVIEWED BY: MRZ

MILLER
ENGINEERS
SCIENTISTS

INDEX TEST RESULTS
ASTM D422

GRADATION ANALYSIS

CLIENT: Northern Lakes Service
PROJECT: NLS Project #42872

JOB NO.: 14172M120

SPECIFICATION:
SOURCE: FMC-B1/B4
SAMPLED BY: NLS
SAMPLE NO: 175839

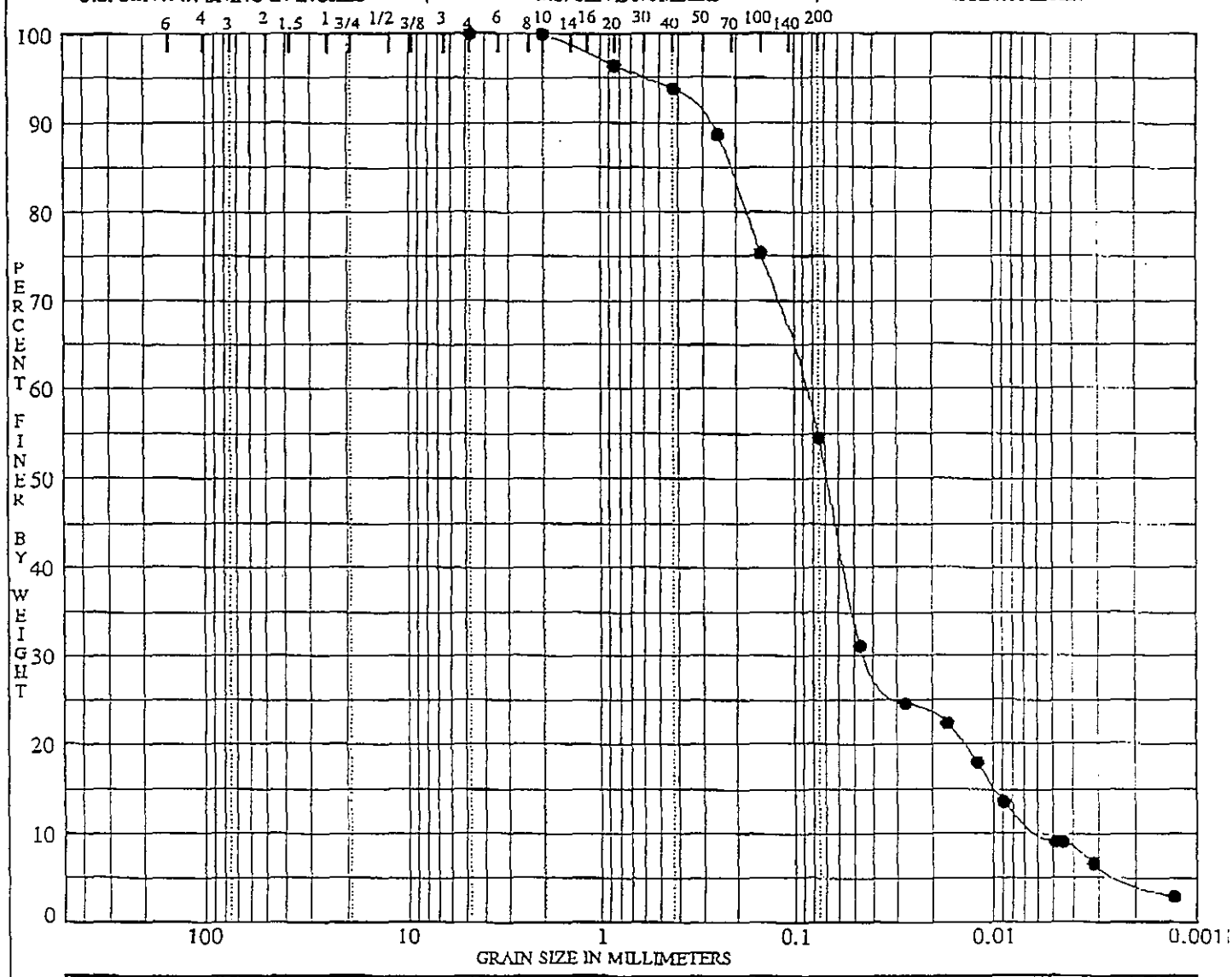
TEST DATE: 09/02/98
TESTED BY: TMO
REVIEWED BY: MRZ
DEPTH OF SAMPLE: 0.0

TOTAL WEIGHT OF SAMPLE (g): 35.95

SIEVE TEST ANALYSIS (ASTM D422)

SIEVE # (in)	%FINER	REQUIRED SPECS	
		MIN	MAX
3	100.0		
1 1/2	100.0		
1	100.0		
3/4	100.0		
1/2	100.0		
3/8	100.0		
1/4	100.0		
SIEVE #			
4	100.0		
8			
10	99.9		
16			
20	96.3		
30			
40	93.7		
50			
60	88.6		
100	75.3		
200	54.5		

MILLER
ENGINEERS
SCIENTISTS



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	175839	0.0							

* = Visual Classification (ASTM D2488)

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	175839	0.0	4.75	0.09	0.043	0.0055	0.0	45.5	45.3	9.2

CLIENT : Northern Lakes Service
PROJECT: NLS Project #42872

JOB NO.: 14172M120
TEST DATE: 09/02/98

MILLER ENGINEERS SCIENTISTS

INDEX TEST RESULTS
ASTM D422

SOURCE: FMC-B1/B4
SAMPLED BY: NLS
TESTED BY: TMO
REVIEWED BY: MRZ

APPENDIX E

FISH SAMPLING

ENVIRONMENTAL COMPLIANCE CONSULTANTS, INC.

P.O. BOX 11417 • GREEN BAY, WI 54307-1417 • 920-434-6380 (VOICE) • 920-434-6381 (FAX)

Environmental Compliance Consultants, Inc.
Memorandum

November 4, 1998

TO: Jana Murphy, Flambeau Mining Company

CC: Jeff Earnshaw, Flambeau Mining Company

FR: Bill West, ECCI

RE: Report on Activities Associated with 1998 Fish Sampling
Flambeau River, Ladysmith, Wisconsin

Introduction

On August 4 and 5, 1998, representatives of EA Associates, Deerfield, Illinois and Environmental Compliance Consultants, Inc., (ECCI) electroshocked two impoundments on the Flambeau River located above and below the Flambeau Mining Site. These impoundments included the flowage above the Ladysmith Dam, Ladysmith, Wisconsin (upstream sample location) and above the Thornapple Dam (downstream location). The purpose of this activity was to fulfill requirements of the Flambeau Mining Permit which requires Flambeau Mining Company (Flambeau) to conduct metals analysis of fish (walleye) tissue at specified sites above and below the mining outfalls. In addition to tissue analysis, captured fish are required to be aged, sexed, lengths recorded, and stomach contents evaluated. Relative abundance of all fish encountered was also to be recorded for each flowage.

Methods

Acceptable sampling methods for fish collection include hook and line, electrofishing, and fyke netting. As in previous years, electrofishing was used for the collection of walleye. Per the Mining Permit, walleye in the following size ranges were targeted for collection:

- 10 to 12 inches - one fish
- 12 to 15 inches - two fish
- 15 to 18 inches - three fish
- 18 to 22 inches - two fish
- > 22 inches - one fish

Electrofishing was conducted on the Thornapple Flowage on August 4, 1998 and on the Ladysmith Flowage on August 5, 1998. Approximately 35-40% of the workable shoreline of the Thornapple Flowage was sampled (4.6 hours of energized time); however, several shoreline areas were sampled with multiple passes with the boat electrofisher. Weather conditions at the initiation of the collection period included an overcast sky with a temperature in the mid to upper 60s (F). Initial water conditions included a temperature of 23.2 °C, dissolved oxygen of 6.5 mg/L, and conductivity of 130 umhs/cm (all measurements taken near the boat ramp prior to sampling).

Approximately 45-50% of the workable shoreline of the Ladysmith Flowage was sampled (5.5 hours of energized time). Weather conditions at the initiation of the collection period included a cloudy sky with scattered showers, air temperature in the low 60s (F) and a slight breeze. Initial water conditions included a temperature of 23.2°C, dissolved oxygen of 7.7 mg/L, and conductivity of 125 umhs/cm (all measurements taken at the boat ramp prior to sampling).

During each of the collection efforts, observed fish species were recorded. As in previous years, fish in the largest walleye size class were not obtained. Therefore, fish collected in the next lower size class were substituted for the largest size. Walleyes which met the criteria for length were set aside in tubs of ice water for further processing. Walleyes were measured for length, filleted, and certain organs were extracted for analysis. Scales of each walleye were extracted for aging and on the largest walleye, dorsal spines were also taken. Paired walleye fillets were bagged separately for analysis. The livers from each of the nine walleyes from a single flowage were composited into a single sample for analysis. Individual walleye stomachs were extracted and preserved in formalin, the contents of which to be analyzed on an individual basis. Walleye fillets and livers once processed were placed on ice for transport to Northern Lake Service, Crandon, Wisconsin, for analysis. Walleye stomachs were retained by ECCI for analysis.

Results and Discussion

The physical data of the walleye collected for analysis is provided in Table 1. Total species of fish observed and their relative abundance are provided in Table 2. An analysis of the stomach contents of the walleye is provided in Table 3. Analytical results of fish tissue and liver are provided in Tables 4 and 5 respectively. A copy of the analytical results relative to this report is provided in Appendix 1.

Data which is provided in Tables 1 through 5 is consistent with the data which was obtained in previous years.

A review of the historical information (data from 1991 to 1998) suggests that relative values for copper in walleye liver from the Thornapple Flowage and from the Ladysmith Flowage are

consistent. Moreover, it is observed that year-to-year increases and decreases in concentrations of copper in the liver of walleye are comparable from the upstream flowage to the downstream flowage.

ECCI has reviewed other data for the Flambeau River for this time period including crayfish tissue analysis, surface water data and sediment deposition data. None of these data sets show other than consistent copper or other metals concentrations in the ecosystem for the time period of 1991 to 1998. It is concluded that the operation of the mine, including the time window when reclamation and habitat restoration activities are being conducted, has had no impact on the concentrations of metals which are observed in the liver of walleye.

Table 1

Physical Data of Walleye
Flambeau River, Ladysmith, Wisconsin
August 1998

ID No.	Length (mm)	Weight (g)	Sex	Age
		Thornapple Flowage		
WE-TA-01	273	190	M	2+
WE-TA-02	335	380	F	3+
WE-TA-03	364	460	F	3+
WE-TA-04	384	545	M	3+
WE-TA-05	386	580	F	3+
WE-TA-06	445	910	M	4+
WE-TA-07	464	1030	F	4+
WE-TA-08	473	1020	F	4+
WE-TA-09	484	1090	F	5+
		Ladysmith Flowage		
WE-LS-01	300	240	F	2+
WE-LS-02	315	290	F	2+
WE-LS-03	317	290	M	2+
WE-LS-04	354	430	F	3+
WE-LS-05	358	460	M	3+
WE-LS-06	359	440	M	3+
WE-LS-07	394	560	F	3+
WE-LS-08	398	565	F	3+
WE-LS-09	444	780	F	4+

Prepared by: WMW
Checked by: RDK

Table 2

Fish Species Observed
Flambeau River, Ladysmith, Wisconsin
August 1998

Fish Species	Thornapple* Flowage	Ladysmith* Flowage
Northern pike	P	C
Muskellunge	C	P
Silver redhorse	C	P
Golden redhorse	C	---
Walleye	A	A
Burbot	P	P
White sucker	P	P
Rock bass	C	C
Smallmouth bass	C	C
Yellow perch	A	A
Shorthead redhorse	---	P
Pumpkinseed sunfish	A	C
Bluegill	P	---
Northern hog sucker	P	---
Logperch	P	P
Golden shiner	A	C
Lake sturgeon	P	---

* A=Abundant
C=Common
P=Present

Prepared by: WMW
Checked by: RDK

Table 3

Stomach Analaysis of Walleye
Flambeau River, Ladysmith, Wisconsin
August 1998

Sample ID	Percent Full	Type of Content	General Comment
		Thornapple Flowage	
WE-TA-01	10%	Undiscernible matter	Mostly digested
WE-TA-02	70%	1 minnow, 2.7 cm	Partially digested
WE-TA-03	70%	Undiscernible matter, some crayfish	Mostly digested
WE-TA-04	20%	Undiscernible matter, possible crayfish	Mostly digested
WE-TA-05	70%	Undiscernible matter, some crayfish	Mostly digested
WE-TA-06	20%	1 crayfish	Mostly digested
WE-TA-07	10%	Undiscernible matter, possible crayfish	Mostly digested
WE-TA-08	40%	Undiscernible matter, possible crayfish	Mostly digested
WE-TA-09	100%	1 minnow	Mostly digested
		Ladysmith Flowage	
WE-LS-01	Empty	None	None
WE-LS-02	80%	Undiscernible matter, some minnow	Mostly digested
WE-LS-03	20%	Undiscernible matter, some plant material	Mostly digested
WE-LS-04	50%	Undiscernible matter, some crayfish	Mostly digested
WE-LS-05	5%	Undiscernible matter	Mostly digested
WE-LS-06	10%	Undiscernible matter, possible crayfish	Mostly digested
WE-LS-07	Empty	None	None
WE-LS-08	70%	Undiscernible matter, some plant material	Mostly digested
WE-LS-09	20%	Undiscernible matter, some plant material	Mostly digested

Table 4

Fish Tissue Analysis
Flambeau River, Ladysmith, Wisconsin
Mercury 1991 - 1998 (mg/kg)

Fish ID No.	Year							
	1991	1992	1993	1994	1995	1996	1997	1998
				Thornapple Flowage				
WE-TA-01	0.09	0.78	0.40	0.10	0.08	0.12	0.16	<0.24>
WE-TA-02	1.00	0.55	0.40	0.18	0.10	0.09	0.13	<0.13>
WE-TA-03	0.60	0.59	0.20	0.19	0.09	0.19	0.15	<0.24>
WE-TA-04	0.80	0.52	0.48	0.21	0.13	0.13	0.66	<0.24>
WE-TA-05	0.40	0.68	0.39	0.37	0.12	0.16	<0.072>	<0.20>
WE-TA-06	0.70	0.76	0.33	0.88	0.12	0.19	0.14	0.29
WE-TA-07	0.60	0.44	1.10	0.59	0.14	0.35	0.14	<0.19>
WE-TA-08	0.80	0.47	0.63	0.29	0.13	0.23	0.14	<0.20>
WE-TA-09	0.60	0.38	0.91	0.32	0.13	0.19	0.52	<0.22>
Average Concentration	0.71	0.57	0.54	0.35	0.12	0.17	0.20	0.22
				Ladysmith Flowage				
WE-LS-01	0.90	0.99	0.68	0.35	0.19	0.17	<0.079>	<0.20>
WE-LS-02	0.80	0.94	0.67	0.45	0.12	0.23	0.25	0.27
WE-LS-03	0.80	0.79	0.55	0.31	0.18	0.44	0.34	<0.19>
WE-LS-04	0.70	0.85	0.44	0.25	0.16	0.27	0.16	0.27
WE-LS-05	0.90	0.81	0.81	0.53	0.15	0.30	0.12	0.29
WE-LS-06	0.60	0.91	0.66	0.35	0.15	0.50	0.34	0.34
WE-LS-07	0.80	0.82	0.71	0.25	0.29	0.40	0.32	0.33
WE-LS-08	0.60	0.96	0.76	0.18	0.25	0.38	0.22	0.31
WE-LS-09	0.60	0.55	0.77	0.31	0.29	0.38	0.26	0.50
Average Concentration	0.67	0.84	0.67	0.33	0.20	0.34	0.20	0.30

Data appearing in brackets (< >) were observed in concentrations between the level of detection (LOD) and the level of quantitation (LOQ)

Prepared by: RDK
Checked by: WMW

Table 5

Metals Analysis of Walleye Liver
Flambeau River, Ladysmith, Wisconsin
1991 - 1998 (mg/kg)

Sample ID	Cd	Cr	Cu	Ni	Pb	Zn	Al	Hg	As	Se	Ag	Fe	Mn
Thornapple Flowage													
WE-TA-1-9 1991	0.1	0.2	1.5	0.4	1.3	17	1.1	0.3	0.02	0.51	0.2	73	1.5
WE-TA-1-9 1992	<0.1	<0.1	1.6	<0.2	<0.1	33	15	0.2	<0.04	0.6	<0.1	96	1.6
WE-TA-1-9 1993	0.10	<0.10	4.3	<0.2	<0.05	21	1.6	0.45	<0.09	0.70	0.03	110	1.6
WE-TA-1-9 1994	<0.27	<0.63	1.2	<0.72	<3.9	16	7.9	0.12	<1.3	<1.3	<0.45	140	1.4
WE-TA-1-9 1995	<0.9	<1.2	3.6	0.34	<1.1	14	1.8	0.07	<0.60	<0.65	<0.30	99	1.6
WE-TA-1-9 1996	0.10	0.31	45(40*)	0.64	<1.1	29	2.3	<0.01	<0.26	0.97	<0.29	72	1.1
WE-TA-1-9 1997	<0.21>	<0.45>	45(43*)	<0.77	<1.3	30	1.9	0.13	<0.86	<1.2>	<0.48>	110	1.3
WE-TA-1-9 1998	<0.15>	<0.20>	33	<0.27>	<0.80	21	1.3	<0.15>	<0.27	<0.40>	<0.040	75	1.1
Ladysmith Flowage													
WE-LS-1-9 1991	0.1	0.3	6.0	0.5	1.2	18	2.9	0.3	0.02	0.48	0.2	67	1.4
WE-LS-1-9 1992	0.2	0.2	9.6	<0.2	<0.1	37	14	0.4	<0.05	0.6	<0.1	59	2.0
WE-LS-1-9 1993	0.19	<0.08	17	0.17	<0.04	22	1.6	0.28	<0.09	0.64	0.07	63	1.3
WE-LS-1-9 1994	0.32	<0.58	3.1	<0.67	<3.7	19	4.0	0.19	<1.4	<1.4	<0.42	76	1.6
WE-LS-1-9 1995	<0.10	<0.13	13	0.47	<1.2	18	1.5	0.26	<0.54	1.2	<0.33	56	1.3
WE-LS-1-9 1996	0.18	0.30	26(45*)	0.96	<1.3	22	2.2	0.22	<0.27	0.76	<0.34	68	1.3
WE-LS-1-9 1997	0.48	<0.46>	33(33*)	<0.33>	<1.1	27	5.2	0.22	<0.90	<1.0	<0.41	90	1.8
WE-LS-1-9 1998	0.37	<0.14>	29	<0.42>	<0.92>	18	2.4	<0.24>	<0.23	<0.38>	<0.034	54	1.8

Data for the Thornapple Flowage have sample ID#175855,Data for the Ladysmith Flowage have sample ID#175865 Prepared by: RDK
Data in appearing brackets (< >) were observed in concentrations between the level of detection (LOD) and level of quantitation (LOQ) Checked by: WMW

*Values in parentheses were derived from re-digestion and re-run of laboratory analytical process and which are believed to be representative of the copper concentrations present in the walleye liver.

Appendix 1

Analytical Data - Fish Tissue Analysis
1998

NORTHE LAKE SERVICE, INC.
Analytical L tory and Environmental Services
400 North Lake Avenue - Crandon, WI 54520
Tel:(715)478-2777 Fax:(715)478-3060

WIS. LAB CERT. NO. 721026460

ANALYTICAL REPORT

PAGE: 1 NLS PROJECT# 42874
NLS CUST# 10513

Client: E.C.C.I. (GB)
Attn: Bill West
PO Box 11417
2637 Tulip Ln
Green Bay, WI 54307

Project Description: Flambeau Mining - Fish

Sample ID: WE-TA-01 NLS#: 175846
Ref. Line 1 of COC 32590 Description: WE-TA-01
Collected: 08/04/98 Received: 08/07/98 Reported: 08/27/98

Parameter	Result	Units	LOD	LOQ	Method	Analyzed	Lab
Mercury (Tissue) by CVAA	< 0.24 >	mg/Kg WWB	0.067	0.24	EPA 245.1	08/22/98	721026460

Sample ID: WE-TA-02 NLS#: 175847
Ref. Line 2 of COC 32590 Description: WE-TA-02
Collected: 08/04/98 Received: 08/07/98 Reported: 08/27/98

Parameter	Result	Units	LOD	LOQ	Method	Analyzed	Lab
Mercury (Tissue) by CVAA	< 0.13 >	mg/Kg WWB	0.067	0.24	EPA 245.1	08/22/98	721026460

Sample ID: WE-TA-03 NLS#: 175848
Ref. Line 3 of COC 32590 Description: WE-TA-03
Collected: 08/04/98 Received: 08/07/98 Reported: 08/27/98

Parameter	Result	Units	LOD	LOQ	Method	Analyzed	Lab
Mercury (Tissue) by CVAA	< 0.24 >	mg/Kg WWB	0.067	0.24	EPA 245.1	08/22/98	721026460

NORTHERN LAKE SERVICE, INC.
Analytical Laboratory and Environmental Services
400 North Lake Avenue - Crandon, WI 54520
Tel:(715)478-2777 Fax:(715)478-3060

WIS. LAB CERT. NO. 721026460

ANALYTICAL REPORT

 NLS PROJECT# 42874
NLS CUST# 10513

Client: E.C.C.I. (GB)
Attn: Bill West
PO Box 11417
2637 Tulip Ln
Green Bay, WI 54307

Project Description: Flambeau Mining - Fish

Sample ID: WE-TA-04 NLS#: 175849
Ref. Line 4 of COC 32590 Description: WE-TA-04
Collected: 08/04/98 Received: 08/07/98 Reported: 08/27/98

Parameter	Result	Units	LOD	LOQ	Method	Analyzed	Lab
Mercury (Tissue) by CVAA	< 0.24 >	mg/Kg WWB	0.067	0.24	EPA 245.1	08/22/98	721026460

Sample ID: WE-TA-05 NLS#: 175850
Ref. Line 5 of COC 32590 Description: WE-TA-05
Collected: 08/04/98 Received: 08/07/98 Reported: 08/27/98

Parameter	Result	Units	LOD	LOQ	Method	Analyzed	Lab
Mercury (Tissue) by CVAA	< 0.20 >	mg/Kg WWB	0.067	0.24	EPA 245.1	08/22/98	721026460

Sample ID: WE-TA-06 NLS#: 175851
Ref. Line 6 of COC 32590 Description: WE-TA-06
Collected: 08/04/98 Received: 08/07/98 Reported: 08/27/98

Parameter	Result	Units	LOD	LOQ	Method	Analyzed	Lab
Mercury (Tissue) by CVAA	0.29	mg/Kg WWB	0.067	0.24	EPA 245.1	08/22/98	721026460

NORTHE[illegible]AKE SERVICE, INC.
Analytical La[illegible]atory and Environmental Services
400 North Lake Avenue - Crandon, WI 54520
Tel:(715)478-2777 Fax:(715)478-3060

WIS. LAB CERT. NO. 721026460

ANALYTICAL REPORT

 NLS PROJECT# 42874
NLS CUST# 10513

Client: E.C.C.I. (GB)
Attn: Bill West
PO Box 11417
2637 Tulip Ln
Green Bay, WI 54307

Project Description: Flambeau Mining - Fish

Sample ID: WE-TA-07 NLS#: 175852
Ref. Line 7 of COC 32590 Description: WE-TA-07
Collected: 08/04/98 Received: 08/07/98 Reported: 08/27/98

Parameter	Result	Units	LOD	LOQ	Method	Analyzed	Lab
Mercury (Tissue) by CVAA	< 0.19 >	mg/Kg WWB	0.067	0.24	EPA 245.1	08/22/98	721026460

Sample ID: WE-TA-08 NLS#: 175853
Ref. Line 8 of COC 32590 Description: WE-TA-08
Collected: 08/04/98 Received: 08/07/98 Reported: 08/27/98

Parameter	Result	Units	LOD	LOQ	Method	Analyzed	Lab
Mercury (Tissue) by CVAA	< 0.20 >	mg/Kg WWB	0.067	0.24	EPA 245.1	08/22/98	721026460

Sample ID: WE-TA-09 NLS#: 175854
Ref. Line 9 of COC 32590 Description: WE-TA-09
Collected: 08/04/98 Received: 08/07/98 Reported: 08/27/98

Parameter	Result	Units	LOD	LOQ	Method	Analyzed	Lab
Mercury (Tissue) by CVAA	< 0.22 >	mg/Kg WWB	0.067	0.24	EPA 245.1	08/22/98	721026460

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Analytical La tory and Environmental Services
400 North Lake Avenue - Crandon, WI 54520
Tel:(715)478-2777 Fax:(715)478-3060

WIS. LAB CERT. NO. 721026460

ANALYTICAL REPORT

 NLS PROJECT# 42874
NLS CUST# 10513

Client: E.C.C.I. (GB)
Attn: Bill West
PO Box 11417
2637 Tulip Ln
Green Bay, WI 54307

Project Description: Flambeau Mining - Fish

Sample ID: WE-TA (1-9) Livers NLS#: 175855
Ref. Line 10 of COC 32590 Description: WE-TA (1-9) Livers
Collected: 08/04/98 Received: 08/07/98 Reported: 08/27/98

Parameter	Result	Units	LOD	LOQ	Method	Analyzed	Lab
Aluminum, tot. as Al	1.3	mg/Kg WWB	0.24	0.83	EPA 200.7	08/19/98	721026460
Arsenic, tot. as As by furnace	ND	mg/Kg WWB	0.27	0.93	EPA 206.2	08/18/98	721026460
Cadmium, tot. as Cd	< 0.15 >	mg/Kg WWB	0.041	0.15	EPA 200.7	08/18/98	721026460
Chromium, tot. as Cr	< 0.20 >	mg/Kg WWB	0.085	0.30	EPA 200.7	08/18/98	721026460
Copper, tot. as Cu	33	mg/Kg WWB	0.023	0.079	EPA 200.7	08/18/98	721026460
Iron, tot. as Fe	75	mg/Kg WWB	0.72	2.5	EPA 200.7	08/18/98	721026460
Lead, tot. as Pb	ND	mg/Kg WWB	0.80	2.8	EPA 200.7	08/17/98	721026460
Manganese, tot. as Mn	1.1	mg/Kg WWB	0.019	0.066	EPA 200.7	08/18/98	721026460
Mercury (Tissue) by CVAA	< 0.15 >	mg/Kg WWB	0.067	0.24	EPA 245.1	08/22/98	721026460
Nickel, tot. as Ni	< 0.27 >	mg/Kg WWB	0.16	0.56	EPA 200.7	08/18/98	721026460
Selenium, tot. as Se by furnace	< 0.40 >	mg/Kg WWB	0.32	1.1	EPA 270.2	08/16/98	721026460
Silver, tot. as Ag	ND	mg/Kg WWB	0.040	0.14	EPA 200.7	08/27/98	721026460
Zinc, tot. as Zn	21	mg/Kg WWB	0.12	0.12	EPA 200.7	08/18/98	721026460
Metals digestion - total (soil/sludge) ICP	yes				EPA 200.0	08/13/98	721026460
Metals digestion - total (soil/sludge) furnace	yes				EPA 200.0	08/13/98	721026460

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WIS. LAB CERT. NO. 721026460

ANALYTICAL REPORT

 NLS PROJECT# 42874
NLS CUST# 10513

Client: E.C.C.I. (GB)
Attn: Bill West
PO Box 11417
2637 Tulip Ln
Green Bay, WI 54307

Project Description: Flambeau Mining - Fish

Sample ID: WE-LS-01 NLS#: 175856
Ref. Line 1 of COC 32591 Description: WE-LS-01
Collected: 08/05/98 Received: 08/07/98 Reported: 08/27/98

Parameter	Result	Units	LOD	LOQ	Method	Analyzed	Lab
Mercury (Tissue) by CVAA	< 0.20 >	mg/Kg WWB	0.067	0.24	EPA 245.1	08/22/98	721026460

Sample ID: WE-LS-02 NLS#: 175857
Ref. Line 2 of COC 32591 Description: WE-LS-02
Collected: 08/05/98 Received: 08/07/98 Reported: 08/27/98

Parameter	Result	Units	LOD	LOQ	Method	Analyzed	Lab
Mercury (Tissue) by CVAA	0.27	mg/Kg WWB	0.067	0.24	EPA 245.1	08/22/98	721026460

Sample ID: WE-LS-03 NLS#: 175858
Ref. Line 3 of COC 32591 Description: WE-LS-03
Collected: 08/05/98 Received: 08/07/98 Reported: 08/27/98

Parameter	Result	Units	LOD	LOQ	Method	Analyzed	Lab
Mercury (Tissue) by CVAA	< 0.19 >	mg/Kg WWB	0.067	0.24	EPA 245.1	08/22/98	721026460

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WIS. LAB CERT. NO. 721026460

ANALYTICAL REPORT

 NLS PROJECT# 42874
NLS CUST# 10513

Client: E.C.C.I. (GB)
Attn: Bill West
PO Box 11417
2637 Tulip Ln
Green Bay, WI 54307

Project Description: Flambeau Mining - Fish

Sample ID: WE-LS-04 NLS#: 175859
Ref. Line 4 of COC 32591 Description: WE-LS-04
Collected: 08/05/98 Received: 08/07/98 Reported: 08/27/98

Parameter	Result	Units	LOD	LOQ	Method	Analyzed	Lab
Mercury (Tissue) by CVAA	0.27	mg/Kg WWB	0.067	0.24	EPA 245.1	08/22/98	721026460

Sample ID: WE-LS-05 NLS#: 175860
Ref. Line 5 of COC 32591 Description: WE-LS-05
Collected: 08/05/98 Received: 08/07/98 Reported: 08/27/98

Parameter	Result	Units	LOD	LOQ	Method	Analyzed	Lab
Mercury (Tissue) by CVAA	0.29	mg/Kg WWB	0.067	0.24	EPA 245.1	08/22/98	721026460

Sample ID: WE-LS-06 NLS#: 175861
Ref. Line 6 of COC 32591 Description: WE-LS-06
Collected: 08/05/98 Received: 08/07/98 Reported: 08/27/98

Parameter	Result	Units	LOD	LOQ	Method	Analyzed	Lab
Mercury (Tissue) by CVAA	0.34	mg/Kg WWB	0.067	0.24	EPA 245.1	08/22/98	721026460

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WIS. LAB CERT. NO. 721026460

ANALYTICAL REPORT

 NLS PROJECT# 42874
NLS CUST# 10513

Client: E.C.C.I. (GB)
Attn: Bill West
PO Box 11417
2637 Tulip Ln
Green Bay, WI 54307

Project Description: Flambeau Mining - Fish

Sample ID: WE-LS-07 NLS#: 175862
Ref. Line 7 of COC 32591 Description: WE-LS-07
Collected: 08/05/98 Received: 08/07/98 Reported: 08/27/98

Parameter	Result	Units	LOD	LOQ	Method	Analyzed	Lab
Mercury (Tissue) by CVAA	0.33	mg/Kg WWB	0.067	0.24	EPA 245.1	08/22/98	721026460

Sample ID: WE-LS-08 NLS#: 175863
Ref. Line 8 of COC 32591 Description: WE-LS-08
Collected: 08/05/98 Received: 08/07/98 Reported: 08/27/98

Parameter	Result	Units	LOD	LOQ	Method	Analyzed	Lab
Mercury (Tissue) by CVAA	0.31	mg/Kg WWB	0.067	0.24	EPA 245.1	08/22/98	721026460

Sample ID: WE-LS-09 NLS#: 175864
Ref. Line 9 of COC 32591 Description: WE-LS-09
Collected: 08/05/98 Received: 08/07/98 Reported: 08/27/98

Parameter	Result	Units	LOD	LOQ	Method	Analyzed	Lab
Mercury (Tissue) by CVAA	0.50	mg/Kg WWB	0.067	0.24	EPA 245.1	08/22/98	721026460

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ANALYTICAL REPORT

 NLS PROJECT# 42874
NLS CUST# 10513

Client: E.C.C.I. (GB)
Attn: Bill West
PO Box 11417
2637 Tulip Ln
Green Bay, WI 54307

Project Description: Flambeau Mining - Fish

Sample ID: WE-LS (1-9) Livers NLS#: 175865
Ref. Line 10 of COC 32591 Description: WE-LS (1-9) Livers
Collected: 08/05/98 Received: 08/07/98 Reported: 08/27/98

Parameter	Result	Units	LOD	LOQ	Method	Analyzed	Lab
Aluminum, tot. as Al	2.4	mg/Kg WWB	0.21	0.71	EPA 200.7	08/19/98	721026460
Arsenic, tot. as As by furnace	ND	mg/Kg WWB	0.23	0.80	EPA 206.2	08/18/98	721026460
Cadmium, tot. as Cd	0.37	mg/Kg WWB	0.035	0.13	EPA 200.7	08/18/98	721026460
Chromium, tot. as Cr	< 0.14 >	mg/Kg WWB	0.073	0.26	EPA 200.7	08/18/98	721026460
Copper, tot. as Cu	29	mg/Kg WWB	0.020	0.068	EPA 200.7	08/18/98	721026460
Iron, tot. as Fe	54	mg/Kg WWB	0.62	2.2	EPA 200.7	08/18/98	721026460
Lead, tot. as Pb	< 0.92 >	mg/Kg WWB	0.69	2.4	EPA 200.7	08/17/98	721026460
Manganese, tot. as Mn	1.8	mg/Kg WWB	0.016	0.056	EPA 200.7	08/18/98	721026460
Mercury (Tissue) by CVAA	< 0.24 >	mg/Kg WWB	0.067	0.24	EPA 245.1	08/22/98	721026460
Nickel, tot. as Ni	< 0.42 >	mg/Kg WWB	0.13	0.48	EPA 200.7	08/18/98	721026460
Selenium, tot. as Se by furnace	< 0.38 >	mg/Kg WWB	0.27	0.96	EPA 270.2	08/16/98	721026460
Silver, tot. as Ag	ND	mg/Kg WWB	0.034	0.12	EPA 200.7	08/27/98	721026460
Zinc, tot. as Zn	18	mg/Kg WWB	0.10	0.10	EPA 200.7	08/18/98	721026460
Metals digestion - total (soil/sludge) ICP	yes				EPA 200.0	08/13/98	721026460
Metals digestion - total (soil/sludge) furnace	yes				EPA 200.0	08/13/98	721026460

Values in brackets represent results greater than the LOD but less than the LOQ and are within a region of "Less-Certain Quantitation". Results greater than the LOQ are considered to be in the region of "Certain Quantitation".

LOD = Limit of Detection
LOQ = Limit of Quantitation
ND = Not Detected
DWB = Dry Weight Basis
NA = Not Applicable
%DWB = (mg/kg DWB)/10000

Thomas R Krueger

Reviewed by:

Authorized by:

R. T. Krueger
Laboratory Manager

APPENDIX F

MACROINVERTEBRATE SAMPLING

ENVIRONMENTAL COMPLIANCE CONSULTANTS, INC.
P.O. BOX 11417 • GREEN BAY, WI 54307-1417 • 920-434-6380 (VOICE) • 920-434-6381 (FAX)

Environmental Compliance Consultants, Inc.
Memorandum

October 28, 1998

TO: Jana Murphy

CC: Jeff Earnshaw, Flambeau Mining Company

FR: Bill West, ECCI

RE: Report of Activities Conducted in 1998 Associated with Collection and Analysis of Crayfish from the Flambeau River, Ladysmith, Wisconsin

Introduction

On August 4, 1997, Bill West of Environmental Compliance Consultants, Inc. (ECCI), completed crayfish collection activities at three sites on the Flambeau River downstream of Ladysmith, Wisconsin. The purpose of this activity was to fulfill requirements of the Flambeau Mining Permit which requires Flambeau Mining Company (Flambeau) to conduct metals analysis of crayfish at selected sites upstream and downstream of the mining discharge point (Outfall 001). The permit requires that a minimum of 25 crayfish be collected at the following sites:

- The Flambeau River at the Blackberry Lane access (upstream site)
- The Flambeau River at Meadowbrook Creek (downstream site)
- The Flambeau River at the site of the former Port Arthur Dam (downstream site)

The time of year of collection is not defined, however, from past experience, the best time to collect appears to be mid to late summer when crayfish are active and easily obtained. This is also the time to obtain larger size crayfish which would provide better information on metals uptake in macroinvertebrates over time.

Methodology

All samples were collected using an 8 by 18-inch rectangular net with 800 to 900 micron mesh size. Crayfish were collected by using a kick seine method.

Crayfish were collected during the following time windows:

Site Location	Time of Collection	Number of Crayfish
Blackberry Lane	11:00 a.m. - 1:00 p.m.	30
Port Arthur Dam	7:00 - 9:00 a.m.	30
Meadowbrook Creek	9:00 - 11:00 a.m.	30

Specimens were composited for each site in a Ziploc bag and placed on ice. Specimens were transported to Northern Lake Service, Crandon, Wisconsin for metals analysis.

Results and Discussion

The results of the analysis of the crayfish appear in Table 1. Raw laboratory results are provided in Appendix 1. The results represent a composite from all crayfish collected per site. Whole bodies were used for analysis. A review of the data indicates that no relative difference in parameter concentrations from upstream locations to downstream locations is evident. Data for the three sites are similar when compared to each other and are also comparable to previous year's results.

Table 1
Metals Analysis of Crayfish
Flambeau River, Ladysmith, Wisconsin
Results in mg/kg
1991 - 1998

Sample ID	Cadmium	Chromium	Copper	Nickel	Lead	Zinc	Aluminum	Mercury	Arsenic	Selenium	Silver
Blackberry Lane											
1991	0.1	1.0	17	0.4	1.2	23	36	0.1	0.24	0.14	0.2
1992	<0.1	0.4	16	<0.2	0.1	43	46	0.1	0.30	0.13	<0.1
1993	0.03	<0.09	15	0.2	<0.05	16	28	<0.2	<0.09	<0.19	0.06
1994	0.02	0.92	9.9	<0.22	<0.05	12	17	<0.02	<0.75	<1.93	<0.09
1995	<0.04	0.96	21	<0.19	<0.23	21	48	<0.05	<0.41	<0.44	<0.05
1996	<0.06	<0.16	20	0.40	<0.97	16	24	<0.02	0.33	<0.13	<0.25
1997	<0.070	0.67	18	<0.41>	<1.2	20	17	<0.025>	<0.82	<0.95	<0.44
1998	<0.038>	<0.17>	15	<0.47>	<0.71	14	15	<0.067	<0.45>	<0.28	<0.035
Meadowbrook Creek											
1991	0.1	1.6	20	0.5	1.3	27	36	0.1	0.29	0.15	0.2
1992	<0.1	0.5	19	<0.2	0.2	39	82	0.11	0.4	0.12	<001
1993	0.04	<0.09	15	0.2	<0.04	15	18	<0.20	<0.08	<0.35	0.08
1994	0.02	0.74	22	<0.29	<0.09	17	31	<0.03	<0.66	<1.64	<0.08
1995	<0.05	0.71	27	<0.23	<0.33	19	69	<0.06	<0.60	<0.64	<0.07
1996	<0.08	<0.22	28	0.74	<1.3	16	30	<0.02	<0.26	<0.14	<0.35
1997	<0.066	<0.49>	24	<0.55>	<1.1	17	42	<0.029	<0.78	<0.91	<0.41
1998	<0.037	<0.19>	24	<0.34>	<0.72	14	32	<0.067	<0.50>	<0.28	<0.036

Crayfish Metals Analysis (cont)

Sample ID	Cadmium	Chromium	Copper	Nickel	Lead	Zinc	Aluminum	Mercury	Arsenic	Selenium	Silver
Port Arthur											
1991	0.1	1.6	20	0.5	1.2	21	27	0.3	0.28	0.15	0.2
1992	<0.1	0.4	14	1.5	0.2	33	430	0.1	0.34	0.14	<0.1
1993	0.03	<0.09	12	<0.15	<0.04	11	22	<0.2	<0.1	<0.36	0.09
1994	0.04	0.92	18	<1.4	<0.10	15	28	<0.02	<0.76	<1.88	<0.09
1995	<0.04	4.5	24	0.05	<0.25	16	130	<0.06	<0.45	<0.48	<0.05
1996	<0.07	0.17	28	0.44	<1.1	16	68	<0.02	<0.28	<0.42	<0.28
1997	<0.049	<0.26>	22	<0.53>	<0.81	16	11	0.065	<0.74	<0.86	<0.30
1998	<0.037	<0.27>	24	<0.20>	<0.72	15	29	<0.067	<0.46>	<0.29	<0.036

Data for Blackberry Lane is represented by Sample ID#175843, Meadowbrook Creek by ID#175844, and Port Arthur Dam by ID#175845
Data appearing in brackets (< >) fall between the level of detection (LOD) and level of quantitation (LOQ)

Prepared by: RDK
Checked by: WMW

Appendix 1

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Analytical Laboratory and Environmental Services
400 North Lake Avenue - Crandon, WI 54520
Tel:(715)478-2777 Fax:(715)478-3060

WIS. LAB CERT. NO. 721026460

ANALYTICAL REPORT

NLS PROJECT# 42873

NLS CUST# 10513

Client: E.C.C.I. (GB)
Attn: Bill West
PO Box 11417
2637 Tulip Ln
Green Bay, WI 54307

Project Description: Flambeau Mining Company - Crayfish

Sample ID: FMC-CR-BBL NLS#: 175843
Ref. Line 10 of COC 32589 Description: FMC-CR-BBL
Collected: 08/04/98 Received: 08/07/98 Reported: 08/27/98

Parameter	Result	Units	LOD	LOQ	Method	Analyzed	Lab
Aluminum, tot. as Al	15	mg/Kg WWB	0.22	0.73	EPA 200.7	08/19/98	721026460
Arsenic, tot. as As by furnace	< 0.45 >	mg/Kg WWB	0.24	0.81	EPA 206.2	08/18/98	721026460
Cadmium, tot. as Cd	< 0.038 >	mg/Kg WWB	0.036	0.13	EPA 200.7	08/18/98	721026460
Chromium, tot. as Cr	< 0.17 >	mg/Kg WWB	0.075	0.27	EPA 200.7	08/18/98	721026460
Copper, tot. as Cu	15	mg/Kg WWB	0.021	0.070	EPA 200.7	08/18/98	721026460
Lead, tot. as Pb	ND	mg/Kg WWB	0.71	2.5	EPA 200.7	08/17/98	721026460
Mercury (Tissue) by CVAA	ND	mg/Kg WWB	0.067	0.24	EPA 245.1	08/22/98	721026460
Nickel, tot. as Ni	< 0.47 >	mg/Kg WWB	0.14	0.49	EPA 200.7	08/18/98	721026460
Selenium, tot. as Se by furnace	ND	mg/Kg WWB	0.28	0.98	EPA 270.2	08/16/98	721026460
Silver, tot. as Ag	ND	mg/Kg WWB	0.035	0.12	EPA 200.7	08/18/98	721026460
Zinc, tot. as Zn	14	mg/Kg WWB	0.10	0.10	EPA 200.7	08/18/98	721026460
Metals digestion - total (soil/sludge) ICP	yes				EPA 200.0	08/13/98	721026460
Metals digestion - total (soil/sludge) furnace	yes				EPA 200.0	08/13/98	721026460

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Analytical Laboratory and Environmental Services
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WIS. LAB CERT. NO. 721026460

ANALYTICAL REPORT

 NLS PROJECT# 42873
NLS CUST# 10513

Client: E.C.C.I. (GB)
Attn: Bill West
PO Box 11417
2637 Tulip Ln
Green Bay, WI 54307

Project Description: Flambeau Mining Company - Crayfish

Sample ID: FMC-CR-MBC NLS#: 175844
Ref. Line 11 of COC 32589 Description: FMC-CR-MBC
Collected: 08/04/98 Received: 08/07/98 Reported: 08/27/98

Parameter	Result	Units	LOD	LOQ	Method	Analyzed	Lab
Aluminum, tot. as Al	32	mg/Kg WWB	0.22	0.75	EPA 200.7	08/19/98	721026460
Arsenic, tot. as As by furnace	< 0.50 >	mg/Kg WWB	0.24	0.81	EPA 206.2	08/18/98	721026460
Cadmium, tot. as Cd	ND	mg/Kg WWB	0.037	0.13	EPA 200.7	08/18/98	721026460
Chromium, tot. as Cr	< 0.19 >	mg/Kg WWB	0.076	0.27	EPA 200.7	08/18/98	721026460
Copper, tot. as Cu	24	mg/Kg WWB	0.021	0.071	EPA 200.7	08/18/98	721026460
Lead, tot. as Pb	ND	mg/Kg WWB	0.72	2.6	EPA 200.7	08/17/98	721026460
Mercury (Tissue) by CVAA	ND	mg/Kg WWB	0.067	0.24	EPA 245.1	08/22/98	721026460
Nickel, tot. as Ni	< 0.34 >	mg/Kg WWB	0.14	0.50	EPA 200.7	08/18/98	721026460
Selenium, tot. as Se by furnace	ND	mg/Kg WWB	0.28	0.98	EPA 270.2	08/16/98	721026460
Silver, tot. as Ag	ND	mg/Kg WWB	0.036	0.12	EPA 200.7	08/18/98	721026460
Zinc, tot. as Zn	14	mg/Kg WWB	0.11	0.11	EPA 200.7	08/18/98	721026460
Metals digestion - total (soil/sludge) ICP	yes				EPA 200.0	08/13/98	721026460
Metals digestion - total (soil/sludge) furnace	yes				EPA 200.0	08/13/98	721026460

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ANALYTICAL REPORT

 NLS PROJECT# 42873
NLS CUST# 10513

Client: E.C.C.I. (GB)
Attn: Bill West
PO Box 11417
2637 Tulip Ln
Green Bay, WI 54307

Project Description: Flambeau Mining Company - Crayfish

Sample ID: FMC-CR-PAD NLS#: 175845
Ref. Line 12 of COC 32589 Description: FMC-CR-PAD
Collected: 08/04/98 Received: 08/07/98 Reported: 08/27/98

Parameter	Result	Units	LOD	LOQ	Method	Analyzed	Lab
Aluminum, tot. as Al	29	mg/Kg WWB	0.22	0.75	EPA 200.7	08/19/98	721026460
Arsenic, tot. as As by furnace	< 0.46 >	mg/Kg WWB	0.25	0.85	EPA 206.2	08/18/98	721026460
Cadmium, tot. as Cd	ND	mg/Kg WWB	0.037	0.13	EPA 200.7	08/18/98	721026460
Chromium, tot. as Cr	< 0.27 >	mg/Kg WWB	0.077	0.27	EPA 200.7	08/18/98	721026460
Copper, tot. as Cu	24	mg/Kg WWB	0.021	0.071	EPA 200.7	08/18/98	721026460
Lead, tot. as Pb	ND	mg/Kg WWB	0.72	2.6	EPA 200.7	08/17/98	721026460
Mercury (Tissue) by CVAA	ND	mg/Kg WWB	0.067	0.24	EPA 245.1	08/22/98	721026460
Nickel, tot. as Ni	< 0.20 >	mg/Kg WWB	0.14	0.50	EPA 200.7	08/18/98	721026460
Selenium, tot. as Se by furnace	ND	mg/Kg WWB	0.29	1.0	EPA 270.2	08/16/98	721026460
Silver, tot. as Ag	ND	mg/Kg WWB	0.036	0.12	EPA 200.7	08/27/98	721026460
Zinc, tot. as Zn	15	mg/Kg WWB	0.11	0.11	EPA 200.7	08/18/98	721026460
Metals digestion - total (soil/sludge) ICP	yes				EPA 200.0	08/13/98	721026460
Metals digestion - total (soil/sludge) furnace	yes				EPA 200.0	08/13/98	721026460

Values in brackets represent results greater than the LOD but less than the LOQ and are within a region of "Less-Certain Quantitation". Results greater than the LOQ are considered to be in the region of "Certain Quantitation".

LOD = Limit of Detection
DWB = Dry Weight Basis
LOQ = Limit of Quantitation
NA = Not Applicable
ND = Not Detected
%DWB = (mg/kg DWB)/10000

Steven R. Cupi
Reviewed by:

Authorized by:
R. T. Krueger
Laboratory Manager

ENVIRONMENTAL COMPLIANCE CONSULTANTS, INC.
P.O. BOX 11417 • GREEN BAY, WI 54307-1417 • 920-434-6380 (VOICE) • 920-434-6381 (FAX)

Environmental Compliance Consultants, Inc.
Memorandum

November 27, 1998

TO: Jana Murphy, Flambeau Mining Company

CC: Jeff Earnshaw, Flambeau Mining Company

FR: Bill West, Environmental Compliance Consultants, Inc. (ECCI)

RE: Summary of Activities, 1998, Macroinvertebrate Collection
Flambeau River, Ladysmith, Wisconsin

Introduction

On September 21, 1998, Bill West of ECCI completed the 1998 macroinvertebrate collection activities for the Flambeau Mine Project. These activities are a requirement of the project's Mining Permit. Three locations, one upstream of the mine discharge locations and two downstream of the discharges, are required to be sampled annually. Sampling locations include the end of Blackberry Lane (upstream), the Flambeau River at the confluence with Meadowbrook Creek and at the site of the former Port Arthur Dam - the latter two sites being downstream sites. Sample site locations are identified in Figure 1. This report describes the collection activities and records observations noted on the day of collection.

Site Conditions

Flows in the river for the period of collection were considered well below normal as the river height was between one and two feet below bank stage. The low water level means that exposed substrate varied from anywhere between two and thirty feet depending on the location on the river. Because of the lower water level, collections from Blackberry Lane were, at the time of collection, assumed to collect fewer species which inhabit shoreline vegetation. Blackberry Lane is the only site of the three sites which contains a significant amount of overhanging vegetation. Because of the lower water, this habitat could not be sampled in 1998 at Blackberry Lane. Kick seining was the predominant method for collecting specimens. Because of the low flow, kick seining may not have been as productive as in previous years.

Methods

Macroinvertebrate samples were collected using a net with an 8 by 18-inch opening and a 800 to 900 micron mesh size. In-stream sampling methods consisted of kick seining.

At each of the three sites, in-stream sampling was conducted for approximately two man-hours. This time window included sorting of collected specimens from debris. Specimens were preserved in 10% formalin.

Once collected and preserved, samples were sent to EA Engineering, Deerbrook, Illinois, for identification and enumeration.

Site-Specific Observations and Conditions

Blackberry Lane

Sampling was initiated at the end of Blackberry Lane at 12:00 noon and was terminated at 2:00 p.m. Water temperature at the time of collection was 66°F. Water stage was well below bank stage.

Bank vegetation downstream of the Blackberry Lane access is made up of grass/sedge with a significant amount of overhang at the water edge. Normally, this is an excellent habitat from which to collect macroinvertebrates particularly certain beetles, water scorpions, water striders, and damselflies. This habitat was not sampled in 1998 because of the lower water levels.

The substrate of Blackberry Lane is characterized as well washed rock and cobble with gravel filling the interstices.

Meadowbrook Creek

Sampling at Meadowbrook Creek was conducted between the hours of 10:00 a.m. and noon. Water temperature at the time of sample collection was 63°F. Water level was below bank stage during the time of collection.

The substrate of the Meadowbrook Creek sampling site is characterized as rock/cobble with some boulder. Collections were concentrated in a portion of the Flambeau River immediately above the confluence of the Flambeau River with Meadowbrook Creek.

Port Arthur Dam

Sampling at Port Arthur Dam was conducted from 7:10 a.m. to 9:30 a.m. Water temperature at the time of sampling was 64°F. Water level was below bank stage during the time of collection.

The substrate of the Flambeau River at this site is characterized as rock in the four to twelve inch size category.

Results and Discussion

Containers with all collected specimens were sent to EA Engineering for enumeration and identification. Table 1 contains a list of organisms collected during the 1998 sampling event.

Populations of aquatic macroinvertebrates can be seen to vary from site to site and from year to year. In general, populations have remained relatively stable. Individual reports for the years 1994 and 1995 noted the occurrence of natural phenomena, such as severe flooding immediately prior to the sample collection event, which may have caused a decline in relative numbers of organisms collected. Sampling efforts in 1997 and again in 1998 followed periods of low water levels, particularly true in 1998 when a significant portion of the summer experienced low flows. With the low flows, it is anticipated that there was a loss of habitat for a major part of the summer. Loss of habitat may equate to lower numbers of specimens collected and observed in 1998 and in particular fewer specimens of organisms which inhabit areas associated with the bank and streamside vegetation. In this respect, data from 1997 and 1998 are very consistent and similar.

There is no evidence at this time that discharges from the Flambeau Mine treatment facility are having any impact on the macroinvertebrate populations on the Flambeau River.

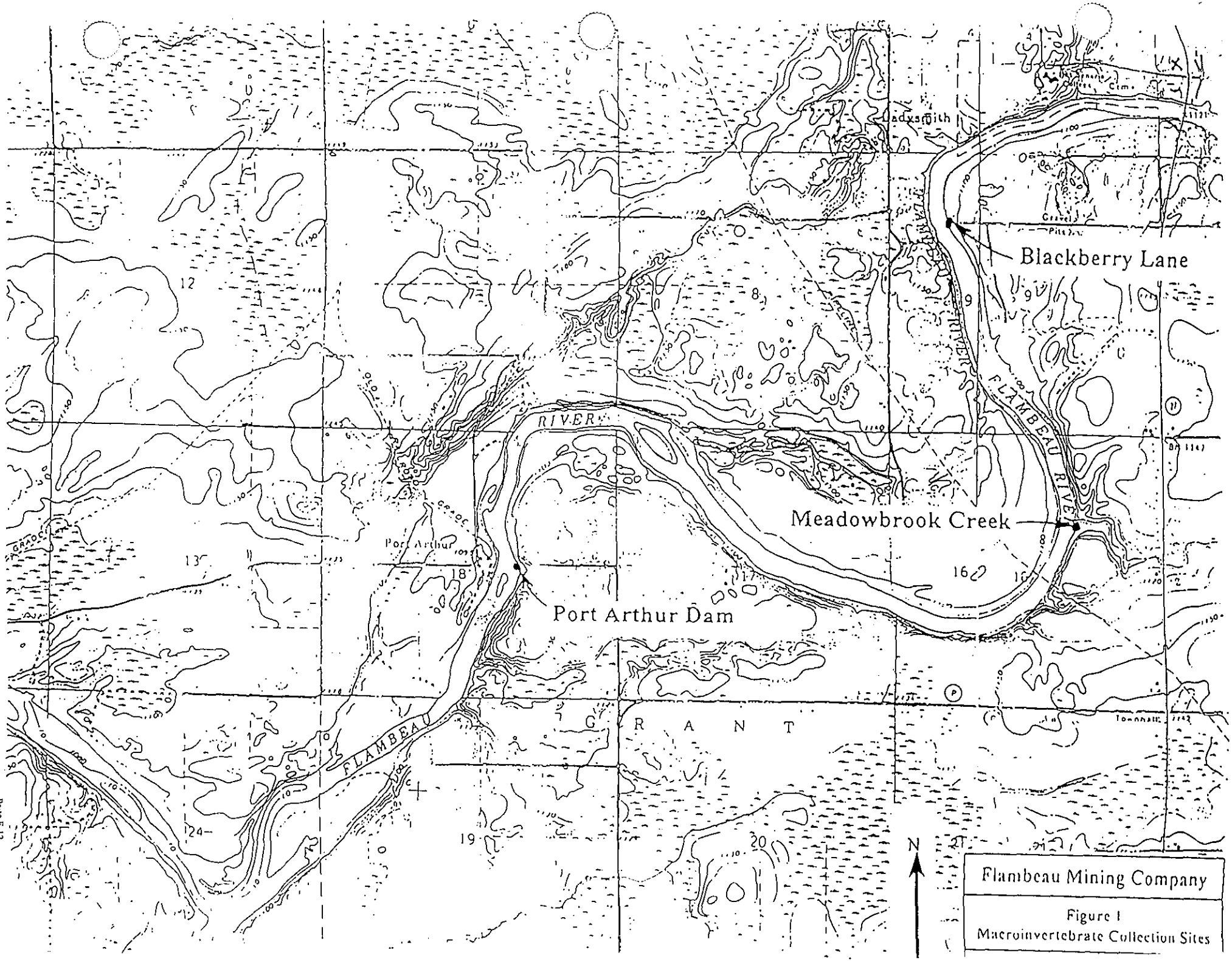

Blackberry Lane
Meadowbrook Creek
Port Arthur Dam
RIVER
FLAMBEAU RIVER
FLAMBEAU
GRANT
Ladysmith
Port Arthur
N
Flambeau Mining Company
Figure 1
Macroinvertebrate Collection Sites

Table 1

Macroinvertebrates Collected From Three Locations Near the Flambeau River Mine Site September 1998

Taxa	Blackberry Lane	Meadowbrook Creek	Port Arthur Dam
Turbellaria			
Dugesia sp.	1	-	-
Oligochaeta			
Tubificidae	1	14	6
Branchiobdellidae	3	6	3
Naididae	14	3	5
Decapoda			
Orconectes rusticus	4	5	3
Amphipoda			
Gammarus sp.	-	-	8
Gastropoda			
Ferrissia sp.	6	6	-
Pelecypoda			
Elliptio dilatata	-	1	-
Pisidium sp.	-	2	-
Ephemeroptera			
Isonychia (Isonychia) sp.	1	-	-
Anthopotamus verticis	74	115	147
Stenonema exiguum	-	-	1
Stenonema femoratum	-	7	2
Stenonema mediopunctatum	12	4	2
Stenonema terminatum	1	5	2
Stenonoma vicarium	7	42	44
Lecrocuta sp.	8	2	2
Baetis flavistriga	1	-	-

Taxa	Blackberry Lane	Meadowbrook Creek	Port Arthur Dam
Ephemeroptera (cont.)			
Acerpenna pygmaea	1	1	-
Centroptilum sp.	-	4	1
Ephemera simulans	-	51	40
Caenis sp.	3	3	-
Choroterpes sp.	-	1	1
Leptophlebia sp.	-	7	6
Odonata			
Ophiogomphus sp.	5	1	-
Ophiogomphus rupinsulensis	-	-	1
Plecoptera			
Agnetina capitata	2	-	-
Neoperla clymene	30	4	8
Acroneuria abnormis	2	1	-
Perlinella drymo	2	-	-
Megaloptera			
Nigronia serricornis	-	3	5
Hemiptera			
Belostoma flumineum	-	1	2
Ranatra sp.	-	-	2
Coleoptera			
Optioservus sp.	2	1	-
Stenelmis sp.	4	10	-
Tricoptera			
Chimarra obscura	19	-	-
Cheumatopsyche sp.	81	12	2
Ceratopsyche morosa	16	-	-
Macrostemum zebratum	8	-	-
Polycentropus sp.	-	3	-

Taxa	Blackberry Lane	Meadowbrook Creek	Port Arthur Dam
Tricoptera (cont.)			
Hydropsyche bidens	-	-	1
Diptera			
Ceratopogonidae	1	-	-
Ablabesmyia janta	-	-	1
Hexatoma sp.	5	10	-
Chironomus sp.	3	1	-
Nilothauma sp.	2	-	-
Cricotopus bicinctus grp.	5	-	-
Demicryptochironomus	-	-	1
Parakiefferiella sp.	1	-	-
Polypedilum sp.	-	1	-
Thienemannimyia sp. grp.	1	1	-
Tribelos jucundum	2	3	-
Stempellinella sp.	2	1	-
Djalmabatista sp.	1	1	-
Microtendipes pedellus grp.	4	7	5
Stictochironomus sp.	8	12	2
Total Taxa	38	37	27

Prepared by: RDK
Checked by: WMW

APPENDIX G

HABITAT CHARACTERIZATION

ENVIRONMENTAL COMPLIANCE CONSULTANTS, INC.

P.O. BOX 11417 • GREEN BAY, WI 54307-1417 • 920-434-6380 (VOICE) • 920-434-6381 (FAX)

Environmental Compliance Consultants, Inc.
Memorandum

September 11, 1998

TO: Jana Murphy, Flambeau Mining Company

CC: Jeff Earnshaw, Flambeau Mining Company

FR: Bill West, Environmental Compliance Consultants, Inc.

RE: Report on 1998 Habitat Characterization, Flambeau River, Ladysmith, Wisconsin

Introduction

On August 4, 1998, Bill West of Environmental Compliance Consultants, Inc.(ECCI), conducted a habitat characterization of the Flambeau River in an area adjacent to the Flambeau Mine site. The purpose of the characterization was to provide an assessment of the habitat in the Flambeau River above and below the mining site and to compare conditions in the river to those documented prior to the initiation of discharges from the mine wastewater treatment plant. Habitat characterization study requirements are described in the mining application (December 1989) and approved pursuant to Docket No. IH-89-14. This report describes the habitat/substrate along the east bank of the Flambeau River from a point 100 yards above Outfall 002 to a point 1000 yards downstream of discharge Outfall 001 (the approximate location of the pipeline crossing).

As the mining activities were completed in 1997 and site restoration was initiated in 1997 and carried over into 1998, the need to conduct additional habitat assessments in future years is not warranted or required. Specifically, the "Updated Monitoring Plan" for the Flambeau Mine states that the habitat analysis "will be completed annually during the low flow period until the permitted surface water discharges from the site cease." Therefore, as part of this report, a section providing a summary of habitat assessments over the life of the mine is included. This summary provides a broad overview of Flambeau River habitats and may be of value in establishing habitat assessment criteria for future similar projects.

Methodology

On August 4, 1998, substrates along the east bank of the Flambeau River were noted and characterized. The area of study is identified in Figure 1.

The study was initiated at 1:30 p.m. at Meadowbrook Creek. Stream observations were conducted from Meadowbrook Creek upstream to a point adjacent to the mining site and immediately upstream of Outfall 002. Upon concluding the documentation for the upstream segment, a similar observation was then conducted from Meadowbrook Creek downstream to the pipeline crossing.

The stream assessment from above Outfall 002 to the pipeline crossing was conducted to physically evaluate the condition of the substrate, amount of deposition, if any, and the type of deposition, e.g., particle size of silt or larger.

Summary of Findings

Substrate descriptions were previously documented in a report submitted in January 1993 titled Flambeau Mining Company 1992 Annual Report (Appendix K). Conditions observed in 1998 were similar to the conditions noted in 1992 (Figure 2) except where noted below.

As a general observation, the summer of 1998 was extremely dry, though not to the extent of the records observed in 1988 and 1989. As a result of the low flows observed in 1998, much of the summer witnessed significant periods of time when whole shorelines were exposed. Photos which are included herein demonstrate the low flow conditions, which resulted in the loss of habitat. It should also be noted that while the river has an opportunity to fluctuate daily because of releases for power production, the photos provided are considered to represent high flows for the day during times when power production was taking place.

Photograph #1 shows Outfall 002, which is located upstream of the Outfall 001. Over the duration of mine operation, little water actually flowed through this Outfall 002. Within the last three years, vegetation encroachment has been observed to the point where the outfall is nearly overgrown. This is further evidence that the outfall seldom if ever transports rainwater. In 1994 at the time of the flood, the outfall was inundated and deposition actually occurred from river sediments being transported across the outfall and riprap. These conditions were noted in reports submitted in previous years.

Photograph #2 is a picture of Outfall 001 which receives the treated discharge from the mine wastewater facility. No deposition was observed on the riprap nor at the point of confluence with the Flambeau River.

Photograph #3 was taken at a point approximately 50 to 80 meters upstream of Meadowbrook Creek looking upstream. The area of the river bank adjacent to the mine is identified in the middle of the picture where there appears to be a meadow along the shore. The river is well below bank stage and shoreline exposure may constitute an area between two and twenty feet horizontally depending on the immediate topography of the streambed.

Photograph #4 was taken at the same location as Photograph #3 except that the view is facing downstream. During normal midday high water flows, the two rocks are usually nearly submerged. This picture provides an indication of the loss of instream habitat which has been prevalent throughout most of the summer on the river.

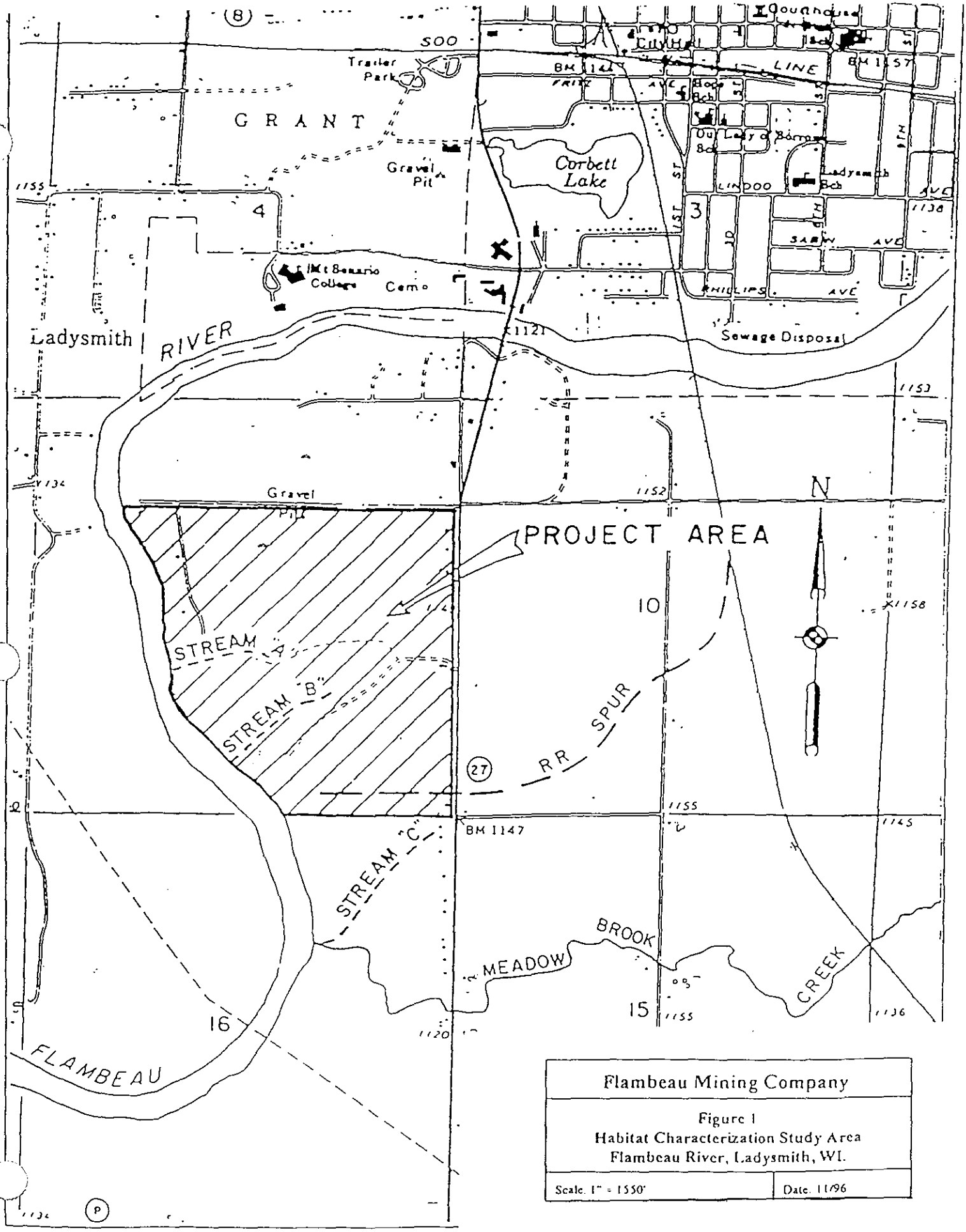
Photograph #5 shows intermittent Stream C. As in previous years, this stream is normally dry except during wet periods such as in the spring or after heavy rains. While this stream passes under the rail spur and the entry road to the mine, there has never been an observation of mine type deposition in the stream bed, i.e., sediments or debris.

Photograph #6 is a picture of the confluence of Meadowbrook Creek with the Flambeau River. Under normal wet conditions, this stream is navigable for approximately 50 yards upstream of the Flambeau River.

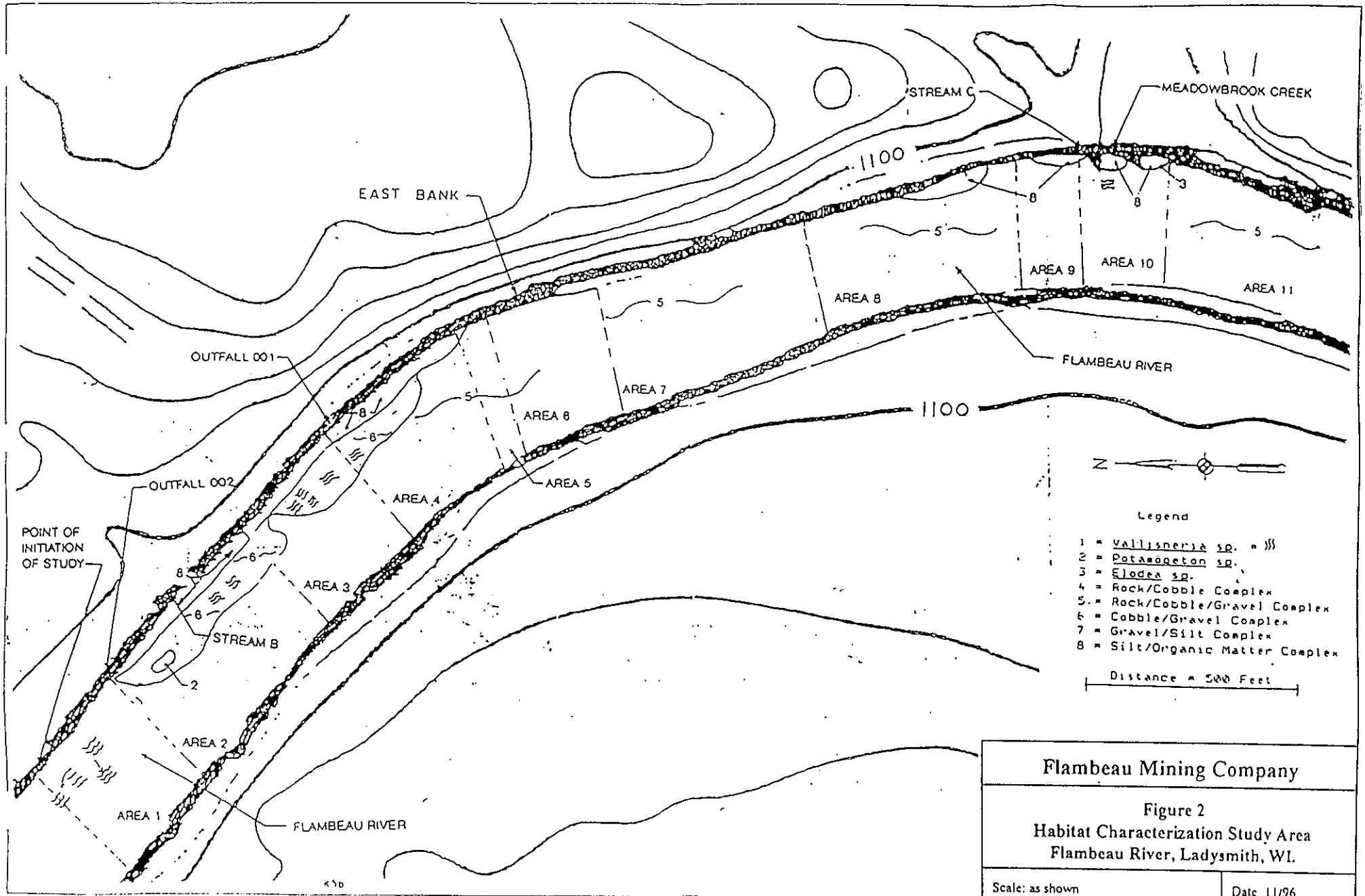
Photograph #7 was taken just downstream of Meadowbrook Creek. The gravel bar in the middle of the picture is normally under two feet of water. The pocket of water behind the gravel bar is the location where *Elodea sp.* was found prior to 1994. The population of *Elodea sp.* was eliminated during the flood of 1994 and has not returned.

Photograph #8 shows the location of the pipeline crossing. Even with the loss of head in the river, most of the habitat in this area associated with the rapids has remained submerged. The background (right side) shows the location of the area where a new pipeline was placed in late 1997, early 1998.

As a general observation, no debris or vegetation was observed on overhanging tree branches along the study area in either 1997 or 1998. This suggests that localized flooding which could impact the flora and fauna of this river had not occurred to the same extent as in the years prior to 1997. Beaver activity is common along this stretch of the river. In 1997, such activity was noted about 100 yards above Meadowbrook Creek. Remnants of a hut persist along the bank in 1998 but no new activity was observed.



Flambeau Mining Company	
Figure 1 Habitat Characterization Study Area Flambeau River, Ladysmith, WI.	
Scale. 1" = 1550'	Date. 11/96



Flambeau Mining Company

Figure 2
Habitat Characterization Study Area
Flambeau River, Ladysmith, WI.

Scale: as shown | Date 11/96

Habitat Assessment Overview, Flambeau Mining Project 1992 - 1998

Habitat assessments of the Flambeau River have been conducted since the beginning of the Flambeau Mining Project. The purpose of the assessments was to monitor habitats upstream and downstream of the Flambeau Mining Site. Based on the requirements of the Flambeau Mine Permit, it is concluded that the intent of the habitat assessment was mainly for the purpose of monitoring sediment deposition in the river. This conclusion is based on the fact that a mine effluent discharge could only have an impact on sedimentation and toxicology. In other situations, flow volume of discharge may have an impact on habitat, however, the flow of the mine discharge is considered insignificant compared to the flow of the Flambeau River and therefore was not considered to be a measurable assessment parameter. However, as noted below, river flow itself was a determinant of habitat gain or loss during the project life.

Observations which were recorded each year of the Project suggest that there are two potential types of impacts, one being the result of mining activities (unnatural) and the other the result of natural causes. The loss or gain of habitats can be classified as unnatural or natural and this report will address those observations which are attributable to each.

Throughout the Flambeau Mine Project, four specific areas were searched for signs of mining impacts which may result in habitat loss or gain. These areas included the area around and adjacent to Outfall 002, Outfall 001 (mine treated effluent discharge point), Stream C, and general points between the three points listed. Since Outfalls 001 and 002 were both riprapped, any deposition of sediment on or between the rocks could be a sign that sediments were being discharged as a result of mining activities. Since Stream C passes through the southeast corner of the mine site, deposition along the length of Stream C could indicate that loss of sediment might be occurring due to mining activities. Finally, if deposition was observed anywhere along the shoreline between the confluence of Stream C with the Flambeau River and Outfall 002, that deposition might also suggest that some losses of sediment might be occurring as a result of mining activities.

Prior to the mine start-up, a single episode of deposition was observed and noted. The deposition occurred during a period of heavy rainfall after preliminary site development had commenced. At the time of the rain event, Flambeau Mining Company (Flambeau) had received a temporary court-ordered injunction to cease activities at the mine. Activities had been discontinued, however; because of the injunction, Flambeau was unable to stabilize the site. Consequently some sediment was carried by rain to the river at a location several meters downstream of Outfall 001. The location and assessment of this event was noted in the first habitat assessment report. As a result of this event, Flambeau was requested to secure the site to prevent recurrence of similar events during the period of the injunction.

During mine start-up and mine operation, no sediment deposition was noted at any of the locations assessed with the exception of that which was observed to occur naturally.

During the Flambeau Mining Project several instances of habitat loss or gain were noted which were attributed to natural causes. Most notable, river dynamics resulted in severe flooding and erosion while beaver activity was responsible for isolated areas of deposition. The types of habitat losses or gains due to natural causes are as follows:

- **Erosion** — Highly erodible shoreline was generally affected annually. River-borne deposition occurred on the rocks of both outfalls in areas where the outfall protruded into the Flambeau River. Undercut banks were generally used by macroinvertebrates and fish at various times during the day and seasonally. Banks were also used by crayfish for burrows. Erosion and resultant deposition could have smothered some organisms while creating habitat for others. Erosion also contributed to deposition in and around location of beaver activity.

- **Flooding** — Flooding was typically responsible for displacement of organisms and habitats. Most notable was the flood of 1994 during which the dam in Ladysmith was partially lost. With the partial loss of the dam and along with the high flows, significant scouring occurred. Much of the plant life in the river was lost due to the aggressive flow and scouring. Therefore, loss of habitat for macroinvertebrates and fish occurred. Other areas of the river witnessed an increase in deposition, especially slack areas and backwaters.

- **Beaver** — At least two beaver huts were established in the Flambeau River during the Project. One hut was located in the vicinity of Outfall 002 while the second hut was located just upstream of Stream C. In addition, a significant amount of debris such as tree branches was observed along the river. While the introduction of additional substrate increased the potential habitat for many aquatic organisms, the obstructions also encouraged the deposition of sediment.

- **Flow** — The low flow conditions of the Flambeau River are probably the most critical parameter in habitat loss which can occur on a temporary basis. Throughout the Project life, various periods of low flow were observed and these periods occurred regardless of the operation of the upstream dams. The most recent observed low flow conditions occurred in 1998 when, even during daily periods of power production, exposed substrates included areas up to twenty feet in a horizontal plane. This suggests that major portions of the river bed were exposed for weeks on end during the summer of 1998, representing a significant habitat loss during that time window. Fauna which is mobile can likely adapt to these conditions, however, flora which is not mobile and which is already scarce in the Flambeau River will likely suffer setbacks during these conditions. Low flow conditions are considered natural events which may occur seasonably or may be a condition which is manifested over a several year window.

In summary, the habitat evaluation assessments which were conducted during the Flambeau Mine Project life suggest that the mining activities have had no impact on local habitats in the Flambeau River. Conversely, the habitat assessments have been able to identify several natural situations which have caused both gains and losses of habitat in the Flambeau River. Natural situations include flooding, low flow conditions, erosion, and animal activity. The effects of these natural phenomena were observable in each of the years that habitat assessments were conducted. Habitat losses and gains due to natural phenomena should be expected to continue to occur regardless of the presence or absence of a mine or mine discharge.

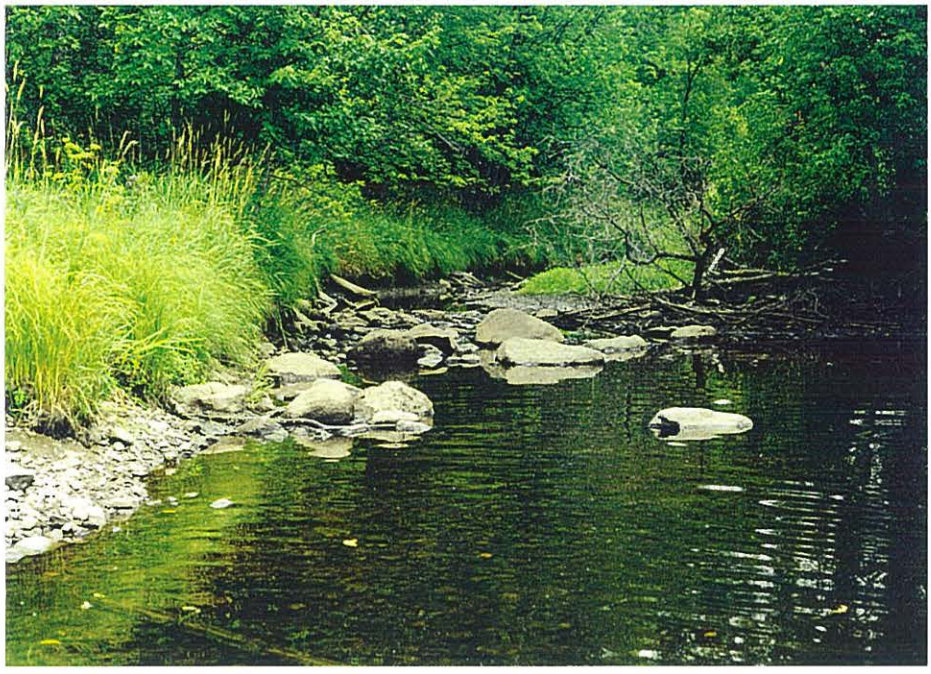
Photograph 1: View of Downstream Portion of Outfall 002

Photograph 2: View of Outfall 001 at Flambeau River

Photograph 3: View of Flambeau River Looking Upstream From a Point Just Upstream of Meadowbrook Creek

Photograph 4: View of Flambeau River Looking Downstream From a Point Just Upstream of Meadowbrook Creek

Photograph 5: View of Stream C at Confluence with Flambeau River



Photograph 6: View of Meadowbrook Creek at Confluence with Flambeau River

Photograph 7: View of Flambeau River below Meadowbrook Creek

Photograph 8: View of Flambeau River at Pipeline Crossing

APPENDIX H

RECLAIMED SITE TOPOGRAPHY

DOUGHTY ROAD

NORTHEAST AIR MONITOR

SOUTHEAST AIR MONITOR

HIGHWAY 27

JANSEN

SANDPRINT

FLAMBEAU RIVER

Water 1134.5

Water 1097.7

Water 1135.2

PZ-1012

PZ-1007S

MW1002G

MW-1002

MW-1003P

MW-1003

MW-1004S

MW-1004

MW-1004P

MW-1005P

MW-1005

MW-1005S

MW-1006P

MW-1006

MW-1006S

MW-1008

PZ-1008

MW-1013B

MW-1013A

MW-1013

MW-1013C

MW-1014

MW-1014A

MW-1014B

MW-1014C

PZ-1A

PZ-1B

PZ-S1

PZ-R1

PZ-S3

OW-10

OW-33

OW-42

ST-9-23

ST-9-23A

ST-9-26

55 1089.86

52 1144.74

53 1152.39

55 1093.14

52 1140.46

53 1145.04

39,500 N

40,000 N

40,500 N

41,000 N

41,500 N

42,000 N

42,500 N

43,000 N

39,000 E

39,500 E

40,000 E

40,500 E

41,000 E

41,500 E

LEGEND

- PAVED ROAD
- GRAVEL ROAD
- TRAIL
- PAVED PARKING
- DRIVEWAY
- RAILROAD
- PIPELINE
- FIRE BOX
- FENCE
- GATE
- WALL
- LAKE/POND
- DRAINAGE LINE
- STREAM
- CULVERT
- AIR MONITOR
- TREE
- TREE COVER
- SWAMP
- BUILDING
- LOCATED OBJECTS
- SIGNS
- POLE
- HORIZ. CONTROL
- HOLDING TANK BALLARD
- RAILROAD SWITCH
- INDEX CONTOUR
- INTERMEDIATE CONTOUR
- OBSCURED CONTOUR
- DEPRESSION CONTOUR
- SPOT ELEVATION
- HORIZ/VERT CONTROL
- MONITOR WELL

Elevations in obscured areas are approximate and may not meet National Map Accuracy Standards.

MAP SCALE

NORTH

Scale in Feet

100 0 100 200

Contour Interval 2'

REVISIONS	No	DATE	MADE BY	DESCRIPTION
	1			
	2			
	3			
	4			
	5			

DATE	DRAWN BY	CHECKED	APPROVED
SEPT-1998	LMS		

FLAMBEAU MINING COMPANY

Ladysmith, Wisconsin

MAP 1

MAP INDEX NUMBER	SCALE	DRAWING NUMBER
	1"=100'	HORIZON'S FILE # 9-8808 FLIGHT DATE: 9-16-98