# 2000 Annual Report

January 2001

Flambeau Mining Company
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Ladysmith, WI 54848

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**Kennecott**
Minerals

January 31, 2001

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 one copy of the attached 2000 Annual Report pursuant to Part 1-8 of the Flambeau Mine Permit (Docket No. IH-89-14). An additional eleven copies of the report will be submitted separately. 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. 2 or murphyj@kennecott.com.

Sincerely,

Jana E. Murphy

Jana E. Murphy
Environmental & Reclamation Manager

**Distribution**

| No. of Copies | Sent to |
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**FLAMBEAU MINING COMPANY**
**2000 ANNUAL REPORT**

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## APPENDICES

# 1 Purpose and Need

This report serves to document the work that was done at the Flambeau Mine site in 2000 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 and 3 |
| WWA, Condition 1 | Section 2.6.2 |
| MP, Part 2-4 | Section 2.8 |
| MP, Part 2-6 | Section 2.10 |
| MP, Part 2-7 | Section 2.11 |
| MP, Part 4-9 | Section 4 and Appendix A through E |

# 2 2000 Summary

## 2.1 Introduction

After an exhaustive permitting process including extensive opportunity for public input, the Flambeau Mining Company (Flambeau) on January 14, 1991 received from the Wisconsin Department of Natural Resources (Department) eleven permits to operate an open pit copper mine in Rusk County, Wisconsin. Over the life of the mine (1993 – 1997), 181,000 tons of copper, 3.3 million ounces of silver, and 334,000 ounces of gold were mined.

Backfilling of the open pit began in earnest in early 1997. Waste rock and soils were replaced to their approximate original location in the open pit. Over 30,000 tons of limestone was added to the sulfide-bearing waste rock to neutralize and buffer the groundwater as it resaturated the backfilled materials.

In 1998, the surface reclamation of the mine site began by returning the land surface to its approximate original contour. Stockpiled topsoil was spread across the site where grasslands and woodlands were created. Hydric (wetland) soils had been stockpiled as well and were used to create over ten acres of wetlands. Reclamation activities since 1998 have included seeding, plug planting, tree planting, erosion control, mowing, invasive species control, trail construction, and prescribed burning.

Continued protection of the Flambeau River, located 140 feet from the backfilled pit, has been documented by extensive monitoring. Throughout each phase of the project, samples have been collected from the Flambeau River and include water quality, sediments, fish, and macroinvertebrates. A habitat characterization was performed annually along the east bank of the river to document conditions of the river substrate. River monitoring has continued through reclamation and provides further documentation that the Flambeau River remains fully protected.

## 2.2 Groundwater Quality Assessments

Assessments of the backfill groundwater quality have been routinely performed with the most recent being completed in October 2000. The assessments show that the regional groundwater flow, including backfill water, is again flowing toward the Flambeau River as was predicted during permitting. The assessment found that all acidity in the backfill has been neutralized by the limestone. Concentrations of solutes in the backfill are stable and should not significantly vary in the future. The Flambeau River water quality is not affected by the pit backfill and monitoring data confirms this. Flambeau anticipates that a request for reduced sampling frequency for in-pit wells will be forthcoming during 2001 when additional data further confirms the findings in the October 2000 assessment.

During 2000, Flambeau and the Department began discussing the installation of an additional groundwater monitoring well nest. The well nest will be located closer to the compliance boundary since there are no monitoring wells at the compliance boundary. However, existing groundwater monitoring well nests located between the backfilled pit and the compliance boundary that show Flambeau to be in full compliance with permit standards. The monitoring wells closer to the compliance boundary would provide additional information regarding baseline groundwater quality near the compliance boundary and provide further documentation of Flambeau's continued compliance with groundwater permit standards. A location northwest of the project area down-gradient of the site and in the direction of groundwater flow was selected and installation of the new monitoring wells is scheduled for early 2001.

## 2.3 Notice of Completion

Monitoring of the reclaimed vegetation during 2000 has shown that Flambeau meets the vegetative performance standards for Notice of Completion (NOC). Flambeau has met the vegetative cover, target species diversity, minimum native species, and woody survival performance standards. Once Flambeau has removed the perimeter fence and west wall electrical, the NOC will be submitted to the Department. During August 2001, biomass samples will be collected for comparison to biomass samples collected at the time of the Certificate of Completion.

## 2.4 Industrial Outlot

A long-term lease agreement exists between Flambeau and the Ladysmith Community Industrial Development Corporation (LCIDC), where the LCIDC leases a 32-acre portion of the former mine site referred as the industrial outlot. The 32-acre area includes the former administration building now occupied by the Ladysmith Department of Natural Resources Service Center; the former Water Treatment Plant (WTP) building now occupied by Xcel Energy and the Department; the railspur for which the LCIDC is actively pursuing a user and has installed major improvements adjacent to the railspur outside of the mine project area; and an approximate eight-acre area north of the railspur in the former Type II stockpile area for which the LCIDC is pursuing a user.

During 2000, the LCIDC constructed a new vehicle storage building for the Department to house their fire-fighting equipment. Additionally, the LCIDC completed renovations of the WTP so that the Department and Xcel Energy could occupy their respective portion of the building for vehicle storage.

## 2.5 Community Involvement

Flambeau's involvement with the surrounding communities during 2000 included promotion of community activities, partnering with the communities, economic development, promoting tourism, enhancing communication, restoration projects, and maintaining an open door policy.

The major achievements for 2000 are set forth below:

- For the third year Flambeau High School students provided labor for planting native flowers and grasses raised in the Flambeau School Greenhouse. Approximately 2000 plants were raised from seed by the students and planted on the reclaimed mine site.

- Flambeau continued its open door policy and conducted numerous tours of the mine site. Presentations for schools, career fairs and assorted groups were provided in the communities.

- Bluebird nesting boxes were installed on the reclaimed mine site to provide nesting habitat and opportunities for future trail users to observe nesting bluebirds.

- An Open House at the Flambeau reclaimed mine site was held for the surrounding communities during August. About 100 visitors attended, viewed displays and had the opportunity to walk the four miles of trails. Guided ecological tours allowed the visitors to learn about site reclamation and identify birds and native plants. Cookies, ice cream, and T-shirts were appreciated by the visitors. Many visitors had positive comments as presented below:

    - "Very nice. Will enjoy the trail."
    - "Very well done. A great asset."
    - "What a beautiful walk. So much to see! Great job!"
    - "A great job and a great openhouse!! Throughout the project, Kennecott Minerals has done it RIGHT!"

- Kennecott Minerals Company committed to the State of Wisconsin property owned by Flambeau Mining Company located along the Flambeau River would be protected in its undeveloped state.

- Flambeau held a Birding Workshop at the Rusk County Community Library and a Bird Watch on the reclaimed mine site. A birding expert from the Hunt Hill Nature Center & Audubon Sanctuary in Sarona, Wisconsin assisted the birdwatchers in identifying birds.

- The four mile trail system on the reclaimed mine site was prepared for opening to the public by installing trail maps at each intersection and building a footbridge across a drainage swale. The Rusk County Wisconsin Conservation Corps provided the labor and Flambeau provided the materials for the footbridge.

## 2.6 Water Management

### 2.6.1 Precipitation Runoff

During the first two years of surface stabilization of the reclaimed mine site, Flambeau had approval to pump runoff from the 1.7-acre biofilter to the south gravel pit to minimize impacts to the Flambeau River. During 1999, the Department agreed that the site had become sufficiently stabilized to discontinue this practice. During 2000 the reclaimed mine site continued to be stabilized and pumping of water before it reached the river was not necessary.

Flambeau River water quality samples were collected upstream (SW-1) and downstream (SW-2) from the reclaimed mine site on June 1 and November 16, 2000 following a rain event and while runoff was leaving the site. Comparing analytical results, there was no significant difference between downstream and upstream samples and this further confirms that the reclaimed site is stable and functioning as designed. A summary of Flambeau river water quality results is found in Section 4.2.

### 2.6.2 River Water Withdrawal

On May 5, 1998 the Department approved Flambeau's application to withdraw water from the Flambeau River for use on site. During 2000, monthly reports on river water withdrawal were submitted to the Department on June 7, July 13, August 9, September 9, and October 6, 2000. All river water withdrawals were performed in accordance with the Department's May 1998 approval. During 2000 river water was used to irrigate woodland units and provide supplemental water to Wetland 1. Table 2-1 contains a summary of water withdrawal from the Flambeau River during 2000.

**Table 2-1. 2000 River Water Withdrawal**

| 2000 | Reclamation Irrigation (Gallons) | Wetland Mitigation (Gallons) | Monthly Totals (Gallons) |
|---|---|---|---|
| April | 0 | 0 | 0 |
| May | 388,000 | 0 | 388,000 |
| June | 0 | 0 | 0 |
| July | 3,000 | 295,000 | 298,000 |
| August | 89,000 | 206,000 | 295,000 |
| September | 0 | 0 | 0 |
| Totals | 480,000 | 501,000 | 981,000 |

### 2.7 Milestones

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

| Table 2-2. 2000 Milestones | Date |
|---|---|
| Department Suspends Air Permit Based Upon Minimal Site Activity and Reclaimed Mine Site Stability | April |
| Prescribed Burning of Grasslands Initiated and Will Continue on an Annual Basis for Ten Years | April |
| Kennecott Minerals Company Makes Commitment to the State of Wisconsin to Protect Property Owned by Flambeau Adjacent to the Flambeau River From Further Development | August |
| Reclaimed Mine Site Open House Attended by 100 Members of the Local Communities | August |
| Former WTP building occupied by Ladysmith Department of Natural Resources Service Center and Xcel Energy | Summer |
| Backfilled Pit Water Quality Assessment Provides Further Documentation that Flambeau Remains in Compliance With Permits and the Flambeau River Remains Protected | October |
| 2000 Annual Reclamation Report documents the reclaimed Flambeau Mine has met vegetative performance standards for NOC | November |

### 2.8 Modifications & Deviations

Condition 2-4 in the Mine Permit requires an inventory of deviations and modifications to the Permit received subsequent to permit issuance. Reclamation activities during 2000 were consistent with permits, approved plans, and modifications received subsequent to permit issuance. During 2000 there were no modifications or deviations to the Permit.

### 2.9 Construction Reports

During 2000, there were no construction activities that required reporting.

## 2.10 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. Spills are reported in accordance with Wis. Adm. Code ch. NR 706, CERCLA Reportable Quantities and SARA Section 302 Extremely Hazardous Substances Reportable Quantities.

During 2000 there were no reportable or recordable incidents that occurred on the Flambeau Mine site.

## 2.11 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 2000.

## 3 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 2000 Annual Reclamation Report dated November 15, 2000 was submitted to the Department and is incorporated by reference. Other reclamation updates submitted on January 31 and November 13, 2000 are incorporated by reference. Reclamation activities reported in the November 2000 Annual Reclamation Report included a summary of onsite vegetation activities that included tree planting, wetland planting, and plug planting. Revegetation of the site was substantially complete in 2000. A very limited number of plants were unavailable for 2000 planting activities and are to be installed during Spring 2001.

In the 2000 Annual Reclamation Report, Flambeau identified the Target Species Planting List for each of the three communities that are grassland, woodland, and wetland. Tables 3-1, 3-2, and 3-3 summarize the Target Species that were selected based upon the following criteria:

- Seeding rate greater than one ounce per acre;
- Planting rate greater than 100 plants per acre;
- Seed commercially procured and, therefore, tested for viability (ie, not locally harvested);
- Species ecologically appropriate for reclaimed mine site; and
- Species native to Wisconsin.

**Table 3-1. Target Species Planting List for the Grassland Community**

| Scientific Name | Common Name |
|---|---|
| **Herbaceous** | |
| Andropogon gerardii | Big bluestem |
| Aster laevis | Smooth blue aster |
| Aster novae-angliae | New England aster |
| Bouteloua curtipendula | Side-oats gramma |
| Desmodium canadense | Canada tick trefoil |
| Elymus canadensis | Canada Wild Rye |
| Elymus hystrix | Bottlebrush grass |
| Heliopsis helianthoides | False sunflower |
| Monarda fistulosa | Bergamot (wild) |
| Oenothera biennis | Evening primrose |
| Panicum virgatum | Switch grass |
| Ratibida pinnata | Yellow coneflower |
| Rudbeckia hirta | Black-eyed Susan |
| Schizachyrium scoparium | Little bluestem |
| Solidago nemoralis | Old field goldenrod |
| Solidago rigida | Stiff goldenrod |
| Sorghastrum nutans | Indiangrass |
| **Total Grassland Target Species** | **17** |

**Table 3-2. Target Species Planting List for the Woodland Community**

| Scientific Name | Common Name |
|---|---|
| **Herbaceous** | |
| Aster macrophyllus | Big-leaved aster |
| Carex pensylvanica | Pennsylvania sedge |
| Glyceria striata | Fowl manna grass |
| Smilacina racemosa | False solomon's seal (feathery) |
| **Shrubs** | |
| Amelanchier arborea | Serviceberry |
| Cornus racemosa | Gray dogwood |
| Corylus americanna | Hazelnut |
| Viburnum lentago | Viburnum (nannyberry) |
| **Trees** | |
| Abies balsamea | Balsam fir |
| Acer rubrum | Red maple |
| Acer saccharinum | Silver maple |
| Acer saccharum | Sugar maple |
| Betula alleghaniensis | Yellow birch |
| Betula papyrifera | Paper birch |
| Carya cordiformis | Bitternut hickory |
| Cornus alternifolia | Pagoda dogwood |
| Fraxinus americana | White ash |
| Picea alba (P. glauca) | White spruce |
| Pinus resinosa | Red pine |
| Pinus strobus | White pine |
| Populus tremuloides | Quaking aspen |
| Quercus alba | White oak |
| Quercus macrocarpa | Bur oak |
| Quercus ruba | Red oak |
| Tilia americana | Basswood |
| **Total Woodland Target Species** | **25** |

**Table 3-3. Target Species Planting List for the Wetland Community**

| Scientific Name | Common Name |
|---|---|
| **Herbaceous** | |
| Andropogon gerardii | Big bluestem |
| Panicum virgatum | Switch grass |
| Alisma subcordatum | Water plantain |
| Aster novae-angliae | New England aster |
| Aster lanceolatus | Panicled aster |
| Bidens cernua | Nodding bur marigold |
| Calamagrostis canadensis | Bluejoint grass |
| Carex comosa | Bristly sedge |
| Carex crinita | Fringed sedge |
| Carex rostrata | Retrorsa sedge |
| Carex scoparia | Pointed broom sedge |
| Carex tuckermanii | Bent-seed hop sedge |
| Carex vulpinoidea | Fox sedge |
| Eupatorium maculatum | Joe-pye weed |
| Eupatorium perfoliatum | Boneset |
| Euthamia graminifolia | Grass-leaved goldenrod |
| Helianthus grosseserratus | Sawtooth sunflower |
| Helianthus laetiflorus (pauciflorus) | Prairie sunflower |
| Polygonum pensylvanicum | Smartweed (Pennsylvania) |
| Polygonum spp | Smartweed |
| Pycnanthemum virginianum | Mountainmint |
| Scirpus acutus | Hard stemmed bulrush |
| Scirpus atrovirens | Bullrush (dark green) |
| Sirpus cyperinus | Woolgrass |
| Scirpus validus creber | Soft-stemmed bulrush |
| Sparganiumeurycarpum | Burreed |
| Spartina pectinata | Cordgrass |
| Typha latifolia | Cattail |
| Verbena hastata | Blue vervain |
| Veronicastrum virginicum | Culver's root |
| Zizania aquatica | Wild rice |
| **Shrubs** | |
| Alnus incana | Speckled alder |
| Cornus stolonifera | Redtwig dogwood |
| Corylus americana | Hazelnut |
| Ilex verticillata | Winter berry |
| Salix discolor | Pussy willow |
| Salix interior | Sandbar willow |
| Spiraea alba | Meadowsweet |
| Viburnum lentago | Viburnum (nannyberry) |
| **Total Wetland Target Species** | **39** |

Monitoring of the site was performed by Applied Ecological Services, Brodhead, WI during Spring and late Summer. Vegetation monitoring was performed in 300 sample quadrats along 30 transects. Bird and butterfly monitoring was performed to document use of the site by wildlife. Following are highlights of the 2000 monitoring program results:

- 96 percent plant cover across reclaimed site excluding wetlands and industrial outlot;
- 334 plant species found on site of which 70 percent are native;
- woody survival within the defined woodlands is at 81 percent;
- 36 bird species identified as breeding on site or immediate peripheral property; and
- 7 butterfly species recorded as using site.

The most significant finding of the monitoring data shows that Flambeau has met the vegetative performance standards for Notice of Completion (NOC). Table 3-4 summarizes the performance standards and the results of monitoring during 2000.

**Table 3-4. Performance Standards and Reclaimed Flambeau Site Status as of 2000.**

| | Total Cover (%) | Planted Native Species (#) | Diversity[1] (%) | Woody Survival (%) |
|---|---|---|---|---|
| **Performance Standard →** | **70** | **15/15/12[2]** | **80** | **80** |
| <u>Community</u> | | | | |
| Grassland | 95.9 | 15/6[3] | 88.2 | NA[4] |
| Woodland | 97.6 | 25/10 | 100.0 | 80.9 |
| Wetland | 100.0 | 32/35 | 82.1 | NA |
| Industrial Outlot | 95.7 | NA | NA | NA |

[1]As compared to Target Planted Species.
[2]Min. 15 planted native species each in grassland and woodland; and min. 12 planted native species in wetland.
[3]# Target Planted Species Found/# Enhancement Planted Species Found
[4]NA = Not Applicable

Management of the reclaimed mine site included reinforcement of erosion control along the gravel trails, herbicide treatment of invasive species, mowing firebreaks and grass trails, and the initiation of the 10-year prescribed burn period.

In summary, the results of 2000 surface reclamation monitoring show that the reclaimed mine has met the vegetative standard requirements for NOC. The site continues to track with the desired trajectory for plant community development, diversity, cover, plant frequency, productivity, and wildlife use.

# 4 Site Monitoring

Environmental monitoring at the reclaimed Flambeau Mine included assessing the quality of groundwater, backfill pore water, wetland water, wetland water levels, and Flambeau River water, sediments, crayfish, and fish. All environmental monitoring continues to show that Flambeau remains in compliance with all permit standards and the Flambeau River remains fully protected.

## 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 Department Mine Reclamation Unit March 22, April 22, June 30, September 29 and December 29, 2000. Those reports are incorporated by reference.

### 4.1.1 Backfilled Pit Water Quality Assessment

In a document dated August 27, 1999, Flambeau provided to the Department an evaluation of water quality data with respect to compliance with groundwater quality permit standards and the protection of water quality in the Flambeau River.

The August 1999 evaluation confirmed that Flambeau remains in full compliance with groundwater quality permit conditions, that in the future, groundwater quality will not be affected at the permitted compliance boundary, and that water quality in the Flambeau River will be protected.

In a document dated October 17, 2000, Flambeau submitted to the Department another assessment of the backfilled pit water quality that was prepared by SRK Consulting and Foth & Van Dyke. The memorandum evaluates data obtained since the pit was backfilled to assess the current and future performance of the reclaimed mine site with respect to compliance with groundwater quality permit standards and the protection of water quality in the Flambeau River.

As part of the permitting effort for the Flambeau project, assessments were completed to determine if the reclaimed site would comply with the permitted groundwater quality standards at the compliance boundary and protect surface water quality in the Flambeau River. The original assessment relied on predicted post-mining hydrologic conditions to conclude that the Flambeau River would act as a hydrologic boundary for the pore water migrating from the pit backfill and that backfill pore water would not migrate to the downgradient compliance boundary. In addition, the original analysis showed that the flux of backfill pore water into the river would be so small relative to the flow in the river that surface water quality would not experience a measurable change.

Environmental monitoring data from the reclaimed site supports the original analysis. This conclusion is based on the following:

- Groundwater elevation measurements show that regional groundwater, including backfill pore water, is again flowing toward the Flambeau River as predicted.

- Backfill pore water is in equilibrium with calcite and gypsum, indicating complete neutralization of the acidity.

- Consistent results in samples collected from 1998 through 2000 demonstrate that the concentrations of solutes in the backfill pore water are stable.

- Groundwater quality from the western end of the backfilled pit has, as expected, a signature that is consistent with the backfilled pit pore water, while all other monitoring wells show no change in water quality relative to historical trends.

- Surface water quality data show that the pit backfill is not affecting water quality in the Flambeau River.

- Calculations also show that after the hydrogeologic system is completely recovered, the flux of pore water from the backfill will be negligible with respect to its potential impact on water quality in the Flambeau River.

Given the hydrologic conditions at the site, the environmental monitoring data show that the Flambeau Mine is in compliance with groundwater quality permit conditions and that the water quality in the Flambeau River is protected.

Based on the above assessment and conclusions, SRK and Foth & Van Dyke recommended that:

- Flambeau continue to monitor Flambeau River water quality for iron, manganese, and sulfate to provide current data on concentrations of these parameters.

- With the exception of the two items listed below, monitoring of groundwater within and around the backfilled pit should continue to be performed in accordance with the program contained in the project's approved monitoring plan (Foth & Van Dyke, 1991). An annual review of the data should be included in the project's annual report to determine if conditions affecting the conclusions reached in the memorandum remain consistent. As additional data are collected and the continuation of stable conditions is documented, consideration can be given to reducing the frequency of monitoring within the backfilled pit.

- CO2 sampling be performed according to the April 2000 method for one more sampling period. If CO2 and alkalinity continue to be correlated, CO2 sampling and analysis should be discontinued, with alkalinity data used to assess any future changes in the effects of CO2 pore water quality in the backfilled pit.

- Eh measurements should be taken each quarterly sampling event until trends, or lack thereof, become evident.

The October 17, 2000 memorandum, Backfilled Pit Water Quality Assessment, is found in Appendix A.

### 4.1.2 Trend Analysis

The non-parametric Mann-Kendall test for trend was used to statistically determine whether any trends in groundwater or Flambeau River water were present in the data between July 1991 and November 2000. This test indicates whether any general increasing or decreasing trends have 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. The Type I error for each test was set to 0.01. Monitoring data for each groundwater and surface water monitoring site are graphed and tabulated in Appendix B. More detailed information on trend analysis and other trends is also contained in Appendix B.

Only those water quality parameters which showed a statistically significant trend upward or downward are discussed in this section. In many cases, the observed groundwater quality trends remained similar to those given in the 1999 Annual Report. The results of the Mann-Kendall tests are as follows:

**Table 4-1. Results of Trend Analysis**

| Well | Parameter | Trend |
|---|---|---|
| MW-1000PR | Sulfate | Increasing |
| | TDS | Increasing |
| MW-1002 | Copper | Decreasing |
| MW-1004P | Hardness | Decreasing |
| | Iron | Decreasing |
| | Manganese | Decreasing |
| | Sulfate | Increasing |
| MW-1004S | pH | Decreasing |
| | Copper | Decreasing |
| | Sulfate | Increasing |

| Well | Parameter | Trend |
|---|---|---|
| MW-1005 | Conductivity | Decreasing |
| | Alkalinity | Decreasing |
| | Hardness | Decreasing |
| | TDS | Decreasing |
| MW-1005P | Alkalinity | Decreasing |
| | Copper | Decreasing |
| | Hardness | Decreasing |
| | Iron | Decreasing |
| | Manganese | Decreasing |
| | Sulfate | Increasing |
| MW-1005S | Hardness | Decreasing |
| MW-1010P | Conductivity | Decreasing |
| | Alkalinity | Decreasing |
| MW-1013B | Manganese | Increasing |
| MW-1013C | Iron | Increasing |
| MW-1014C | Conductivity | Decreasing |
| SW-1 | Aluminum | Decreasing |
| | Copper | Decreasing |
| | Selenium | Decreasing |
| SW-2 | Copper | Decreasing |

The trend graphs found in Attachment B should be reviewed carefully in addition to the Mann-Kendall results to interpret current trends in MW-1000PR, due to the rebound of water elevation that began during the second half of 1997. MW-1000PR is found in the former west wall located between the backfilled pit and the Flambeau River. As stated in Section 4.1.1, "groundwater quality from the western end of the backfilled pit has, as expected, a signature that is consistent with the backfilled pit pore water" and increases in parameter concentrations are expected. In addition, MW-1000PR was constructed in sulfide-bearing bedrock that would also contribute to the increased parameter concentrations. With that in mind, significant increases in the conductivity, and in the concentrations of alkalinity, hardness, manganese, sulfate and TDS took place during 1998. Iron concentrations began increasing in this well during 1999. Hardness, manganese, sulfate and TDS concentrations have since stabilized and even decreased somewhat. Copper concentrations in MW-1000PR increased to a high in July 1999, but have since decreased to non-detectable levels.

Note that with the exception of the trends observed in MW-1000PR, and the trend of sulfate in MW-1004P, MW-1004S, and MW-1005P, all trends detected by the Mann-Kendall test are decreasing. In addition, the increasing trend of sulfate in MW-1004P and MW-1005P has reversed over the last two years, and is now at non-detectable levels. Even though sulfate in MW-1004S has continued to increase over the last year, actual increases in concentration are very small. The concentrations of iron and manganese in MW-1004P remain generally consistent after sharply decreasing in 1993. Iron concentrations in MW-1005P also decreased during 1993 and remained historically low, however, with a single elevated occurrence during October 1999.

The decreasing trend of pH in MW-1004S as indicated by the Mann-Kendall test is influenced by the higher pH values that occurred prior to July 1994. Since then, the trend of pH in this well has been relatively consistent.

Few trends are evident in the results collected to date of the in-pit wells. Those indicated by the Mann-Kendall test include increasing trends of manganese in MW-1013B and iron in MW-1013C, and a decreasing trend of conductivity in MW-1014C. Although not indicated by the Mann-Kendall test, a decreasing trend of iron in MW-1014C is also evident.

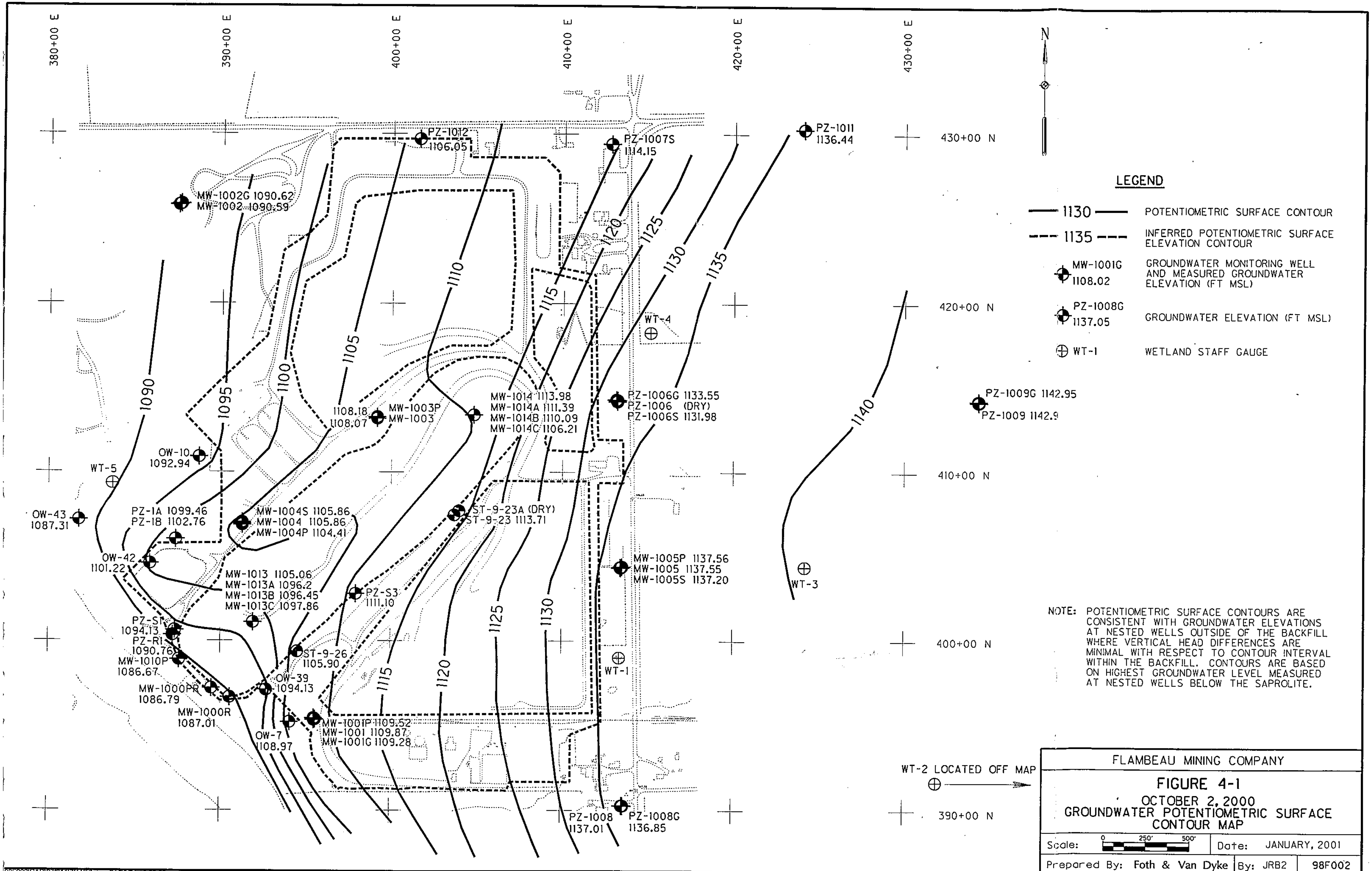
Very few trends were noted for the surface water samples. Slightly decreasing trends of aluminum and selenium were noted by the Mann-Kendall tests for SW-1 (upstream) and SW-2 (downstream). Note that surface water sampling on a quarterly basis ceased when permitted discharges from the mine site discontinued. This is consistent with Flambeau's approved monitoring plan.

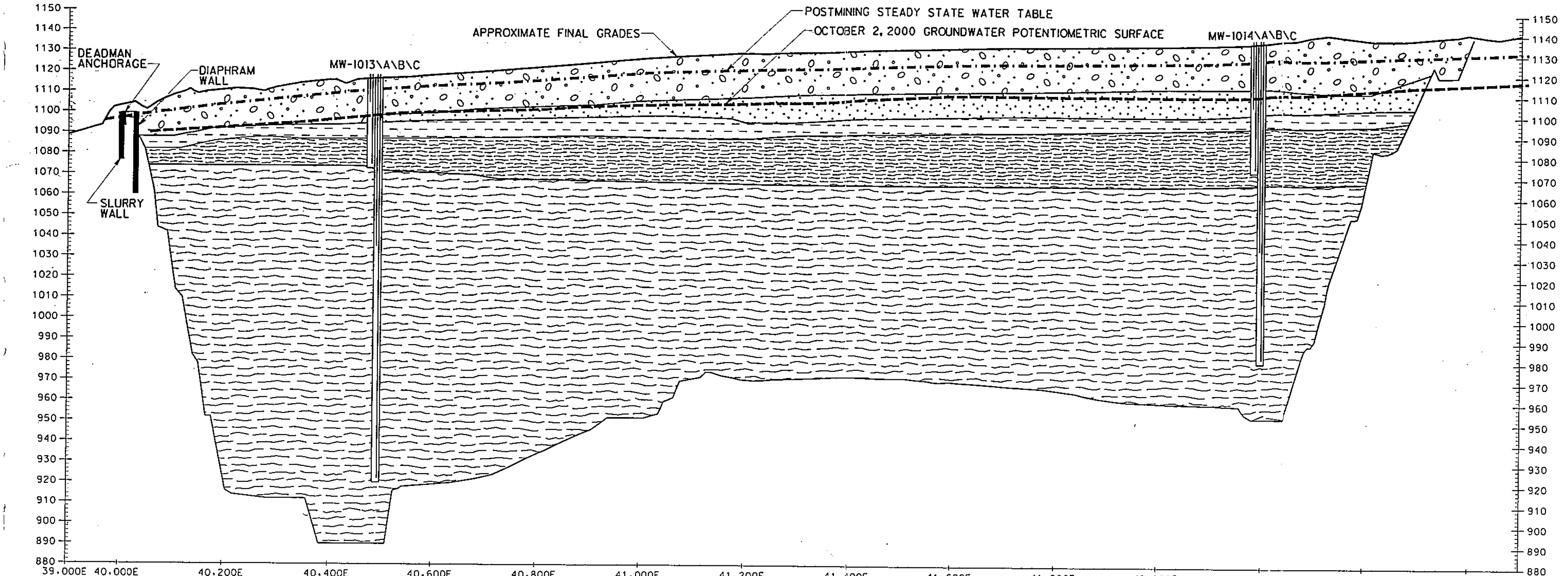
Recovery of groundwater elevations in MW-1000PR seems to have stabilized during the end of 1998 and remain so throughout 2000. Recovery of groundwater elevations continues in MW-1001, MW-1001G, MW-1001P, MW-1003, PZ-3 and ST-9-23. Additional wells in which groundwater elevations seem to have stabilized after rebounding during 1997 include MW-1010P, MW-1003P, MW-1004, MW-1004P, MW-1004S, OW-42, PZ-S1, and PZ-R1.

Figure 4-1 shows the groundwater potentiometric surface for October 2000 and presents the locations of monitoring wells. Figure 4-2 shows a cross section of the backfilled pit with in-pit monitoring wells, October 2000 groundwater potentiometric surface in relation to backfill materials, and the projected post-mining steady state groundwater elevation. Graphs and further discussion on groundwater elevations are included in Appendix B.

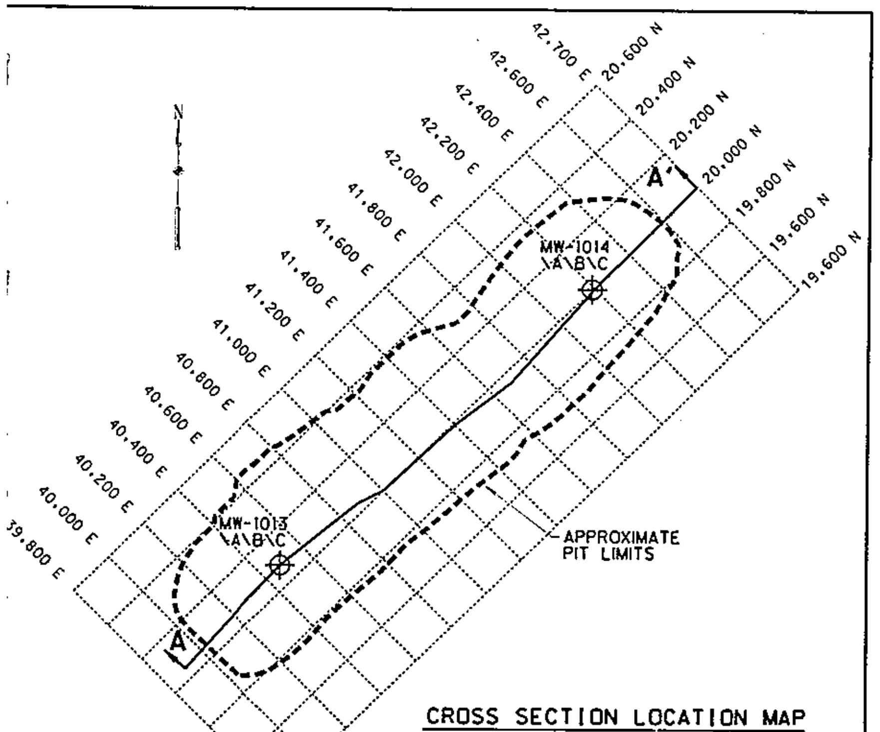
## 4.2 Surface Water

The 2000 surface water monitoring program included sampling and analyses of the following elements: sediments, crayfish, fish, water quality, 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 the Department in March of each year. This portion of the 2000 Annual Report meets this requirement.


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
1106.05
PZ-1007S
1114.15
PZ-1011
1136.44
MW-1002G 1090.62
MW-1002 1090.59
LEGEND
1130
POTENTIOMETRIC SURFACE CONTOUR
1135
INFERRED POTENTIOMETRIC SURFACE ELEVATION CONTOUR
MW-1001G
1108.02
GROUNDWATER MONITORING WELL AND MEASURED GROUNDWATER ELEVATION (FT MSL)
PZ-1008G
1137.05
GROUNDWATER ELEVATION (FT MSL)
WT-1
WETLAND STAFF GAUGE
1090
1095
1100
1105
1110
1115
1120
1125
1130
1135
1140
WT-4
PZ-1009G 1142.95
PZ-1009 1142.9
MW-1014 1113.98
MW-1014A 1111.39
MW-1014B 1110.09
MW-1014C 1106.21
PZ-1006G 1133.55
PZ-1006 (DRY)
PZ-1006S 1131.98
1108.18
1108.07
MW-1003P
MW-1003
OW-10
1092.94
WT-5
OW-43
1087.31
PZ-1A 1099.46
PZ-1B 1102.76
MW-1004S 1105.86
MW-1004 1105.86
MW-1004P 1104.41
ST-9-23A (DRY)
ST-9-23 1113.71
OW-42
1101.22
MW-1013 1105.06
MW-1013A 1096.2
MW-1013B 1096.45
MW-1013C 1097.86
PZ-S3
1111.10
MW-1005P 1137.56
MW-1005 1137.55
MW-1005S 1137.20
WT-3
PZ-S1
1094.13
PZ-R1
1090.76
MW-1010P
1086.67
ST-9-26
1105.90
WT-1
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.
MW-1000PR
1086.79
OW-39
1094.13
MW-1000R
1087.01
MW-1001P 1109.52
MW-1001 1109.87
MW-1001G 1109.28
OW-7
1108.97
WT-2 LOCATED OFF MAP
PZ-1008
1137.01
PZ-1008G
1136.85
FLAMBEAU MINING COMPANY
FIGURE 4-1
OCTOBER 2, 2000
GROUNDWATER POTENTIOMETRIC SURFACE CONTOUR MAP
Scale: 0 250' 500'
Date: JANUARY, 2001
Prepared By: Foth & Van Dyke
By: JRB2
98F002
98F002\CAD\97I011\7I11f53.dgn 01/29/01 10:08:20



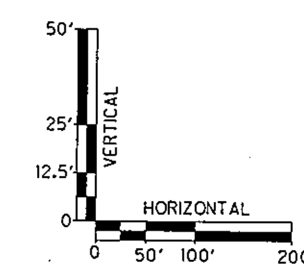

MINE PIT COORDINATES
SECTION A – A'




CROSS SECTION LOCATION MAP
SCALE: 1" = 600'

LEGEND

- TILL
- SANDSTONE
- SAPROLITE
- TYPE I MATERIAL
- TYPE II MATERIAL




SCALE

| FLAMBEAU MINING COMPANY | | | |
|---|---|---|---|
| FIGURE 4-2<br>MINE PIT CROSS SECTION A - A'<br>WITH IN-PIT GROUNDWATER<br>MONITORING WELLS | | | |
| Scale: SEE BAR SCALE | | Date: JANUARY, 2001 | |
| Prepared By: Foth & Van Dyke | | By: JRB2 | 98F009 |

\7f011\7f11xs.3d 01/29/01 09:56:59

In accordance with the Updated Monitoring Plan, after discharges from the wastewater treatment facilities have ceased, which they did in 1998, sediments, crayfish and fish will be collected once each year for two years. With the collection of sediments, crayfish and fish in 1999 and 2000, Flambeau has met this requirement. The Updated Monitoring Plan prescribes that during the third year after cessation of wastewater discharges and for each year thereafter, until notice of completion of reclamation is issued by Flambeau, crayfish will be sampled and analyzed. Given Flambeau's intent to issue the notice of completion during 2001, it is anticipated that 2001 will be the last year that crayfish are sampled. In accordance with the Updated Monitoring Plan, fish will be sampled during the year that the certificate of completion is issued.

The Updated Monitoring Plan requires that during the two years following the cessation of wastewater discharge, three surface water samplings will be made. Two of these samplings are to occur at the time of spring runoff during each of these years. One additional sample is to be taken during a stormwater runoff event so that the downstream sample taken in the Flambeau River includes runoff from the reclaimed mine site. Flambeau collected surface water samples on March 23, 1999, April 8, 1999, November 1, 1999, June 1, 2000 and November 16, 2000. Flambeau has met the requirement for collecting surface water samples in accordance with the approved monitoring plan. On its own initiative, Flambeau's intends to continue sampling the Flambeau River at SW-1 and SW-2 twice each year for copper, conductivity, iron, manganese, pH, sulfate and zinc to document the continued protection of the Flambeau River.

### 4.2.1 Sediments

Sediment samples were collected at two locations in the Flambeau River. Blue Iris Environmental, Inc., Black Creek, Wisconsin and Flambeau personnel installed sediment traps upstream (Site S-1) and downstream (Site S-3) of the former Flambeau discharge locations on June 12, 2000 and retrieved on August 29, 2000.

Figure 4-3 shows the sediment sampling locations. Results from the downstream sample site are summarized on Table 4-2. Results from the Blackberry Lane sampling site upstream of the mine site are summarized in Table 4-3. More detailed information about the sediment sampling is contained in Appendix C.

The data from the sieve analysis is consistent with the observations made of the riverbed during sample collection. That is, there was a higher amount of pebble and sand in the upstream sample while there was a higher amount of silt in the downstream sample. The downstream sample had more than three times the amount of volatile matter on a percentage basis as the upstream sample, which again was predictable, based on the observations at the time of collection.

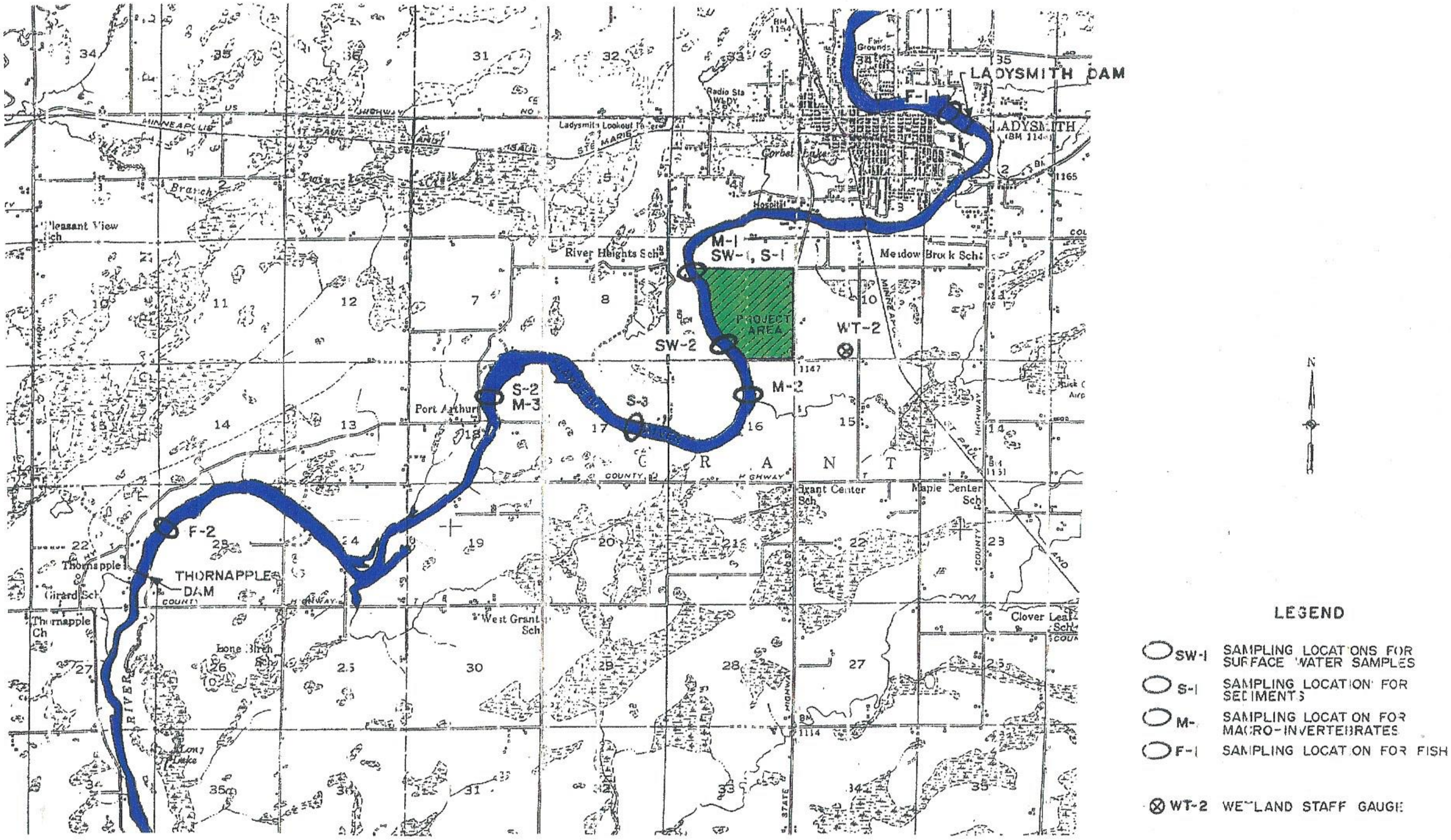



Figure 4-3. Surface Water Monitoring Site Locations
Flambeau Mining Company

# TABLE 4-2

## 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) | 1999 (S-3) | 2000 (S-3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| aluminum | NA | 4000 | 12000 | 1500 | 4400 | 4000 | 3600 | 2500 | 2400 | 2000 | 3000 | 3200 |
| arsenic | 1.1 | 1.5 | 4.1 | <0.55 | 0.71 | <1.6 | 1.5 | <0.45 | <0.71 | 0.94 | 0.90 | <0.67 |
| cadmium | <0.5 | 0.6 | <1.4 | <0.055 | 0.11 | 0.13 | 0.085 | 0.64 | 0.70 | 1.0 | 1.1 | 1.1 |
| chromium | 4.8 | 13.0 | 24.0 | 23.8 | 9.6 | 10 | 6.6 | 6.3 | 6.1 | 5.6 | 8.0 | 7.8 |
| copper | 2.6 | 7.2 | 24.0 | 2.1 | 6.7 | 7.1 | 7.0 | 8.2 | 6.7 | 6.1 | 7.7 | 6.4 |
| iron | 2200 | 16000 | 25000 | 3100 | 8200 | 7700 | 7300 | 6700 | 7900 | 6300 | 9300 | 18000 |
| lead | <4.5 | 6.9 | 20 | 2.6 | 8.3 | 7.8 | 7.5 | 9.0 | 6.4 | 5.9 | 11 | 8.9 |
| manganese | 63 | 1600 | 570 | 610 | 830 | 860 | 780 | 840 | 910 | 910 | 830 | 680 |
| mercury | <.01 | 0.1 | <0.3 | <0.057 | <0.07 | <0.03 | <0.06 | <0.02 | 0.059 | 0.042 | 0.029 | 0.060 |
| nickel | NA | 7.3 | 12.0 | 1.7 | 6.5 | 6.2 | 5.0 | 5.7 | 3.0 | 3.1 | 5.7 | 5.7 |
| selenium | NA | 0.4 | <0.9 | <0.28 | <0.26 | <1.6 | <0.27 | 1.4 | 0.95 | <0.37 | <0.54 | <0.54 |
| silver | NA | <1.1 | <2.6 | 0.086 | 0.58 | <0.08 | 0.04 | <0.56 | <0.40 | <0.044 | <0.058 | <0.17 |
| zinc | 28 | 45.0 | 79.0 | 9.6 | 33 | 46 | 26 | 28 | 24 | 21 | 34 | 30 |
| Other | | | | | | | | | | | | |
| Total Solids (%) | 69 | 76.8 | 35.0 | 32 | 56 | NA | 44.8 | 49.8 | 30.6 | 24.5 | 45.9 | 52.6 |
| Total Volatile Solids (%) | NA | 2.5 | 12.0 | 5.8 | 6.24 | NA | 6.9 | 5.5 | 11 | 15 | 6.0 | 6.0 |

NA = Not Analyzed
[1]Environmental Impact Report, March 3, 1989, p. 3.7-1.1

# TABLE 4-3

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

| Metals (ppm) | 1989 Baseline[1] | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| aluminum | NA | 3800 | 3300 | 4000 | 3900 | 2900 | 1900 | 2100 | 1900 | 2700 | 2900 |
| arsenic | 0.9 | 2.2 | 2.2 | 1.4 | <4.2 | <0.41 | 1.6 | <0.87 | 1.1 | 0.71 | <0.73 |
| cadmium | <0.5 | <0.7 | <0.6 | <0.06 | <0.42 | <0.03 | 0.72 | 1.2 | 1.2 | 1.4 | 1.7 |
| chromium | 5.5 | 11.0 | 10.0 | 11 | 10 | 4.4 | 4.1 | 5.6 | 5.3 | 7.7 | 7.3 |
| copper | 2.8 | 7.3 | 6.0 | 7.0 | 5.8 | 6.4 | 5.8 | 5.3 | 4.9 | 7.0 | 6.0 |
| iron | 3000 | 18000 | 16000 | 15000 | 11000 | 4800 | 6800 | 6500 | 7900 | 12000 | 13000 |
| lead | <4.5 | 6.0 | 5.8 | 8.5 | 3.3 | 3.3 | <2.2 | 5.1 | 5.1 | 7.8 | 6.9 |
| manganese | 130 | 1900 | 1000 | 1300 | 1500 | 600 | 510 | 700 | 1100 | 1500 | 1100 |
| mercury | <.01 | 0.1 | <0.1 | <0.045 | <0.04 | <0.02 | <0.02 | 0.024 | <0.013 | 0.0070 | <0.078 |
| nickel | NA | 5.8 | 6.1 | 8.4 | 7.4 | 6.1 | 6.1 | 2.2 | 4.4 | 6.7 | 6.6 |
| selenium | NA | 0.4 | <0.4 | <0.32 | 4.2 | <0.44 | <0.28 | <1.0 | <0.37 | <0.54 | <0.59 |
| silver | NA | <1.2 | <1.1 | 0.057 | <0.21 | <0.05 | <0.57 | <0.70 | <0.043 | <0.068 | <0.16 |
| zinc | 16 | 47 | 33.0 | 38.0 | 34 | 18 | 19 | 20 | 18 | 28 | 23 |
| Other | | | | | | | | | | | |
| Total Solids (%) | 85 | 73 | 78.6 | 79.2 | NA | 76.7 | 74.9 | 72.6 | 41.7 | 74.9 | 78.7 |
| Total Volatile Solids (%) | NA | 1.8 | 1.6 | 0.8 | NA | <2.0 | <2.0 | <2.0 | 6.7 | <2 | <2 |

NA = Not Analyzed
[1]Environmental Impact Report, March 3, 1989, p. 3.7-1.1

Data from the ten years of sediment analysis indicate that, in general, no increases or decreases in parameter concentrations in sediments are occurring. Data from 2000 compare favorably with data collected in 1999. Moreover, downstream samples continue to compare favorably with upstream sediment samples indicating no impacts due to mine activities.

### 4.2.2 Fish

Walleye were collected upstream and downstream of the reclaimed mine site. Samples of fish tissue are analyzed for metals, while length, sex and stomach contents of each fish are documented. In 2000, fish were collected on August 29 and 30 by EA Associates, Deerfield, Illinois and Blue Iris Environmental, Inc. 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 primarily minnows and crayfish. There were no significant differences in metal content of fish tissue sampled downstream of the mine site compared to upstream of the mine site. 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 D contains more detailed information about the fish sampling. Fish sampling locations are shown in Figure 4-3.

### 4.2.3 Macroinvertebrates (Crayfish)

Crayfish were collected in the Flambeau River at three sampling locations 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). Blue Iris Environmental, Inc. collected crayfish samples on August 29, 2000. 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. Data for the three sites are similar when compared to each other and are also comparable to previous years' results.

Results for collection and analyses of crayfish are included in Appendix E. Crayfish sampling locations are shown in Figure 4-3.

### 4.2.4 Surface Water Quality

Water samples were collected from the Flambeau River at two monitoring locations. In a letter dated September 23, 1998 the Department notified Flambeau that the Department was closing 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 is not required to collect surface water quality samples on a quarterly basis. During 2000, 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 reclaimed mine site; SW-2 is downstream of the reclaimed mine site. Figure 4-3 shows the locations of the surface water sampling. Results of sampling were submitted to the Department on August 11, 2000 and January 30, 2001. Those submittals are incorporated by reference.

While collecting the June 2000 samples, Flambeau noted that pH results were inconsistent with past results and between sampling points. Lab results confirm that the pH of the upstream and downstream samples were actually comparable. Additional pH sampling indicated that the pH meter was producing inconsistent results and not maintaining its calibration. As a result, this pH test meter was removed from service and replaced.

A summary of the 2000 surface water quality results is included in Table 4-4. The results from 2000 are generally consistent with data collected from the same locations in 1992-1999 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 are slightly decreasing trends for aluminum, copper and selenium at sample location SW-1 and a slightly decreasing trend for copper at SW-2. Trends of surface water quality results and statistical trend analysis are contained in Appendix B.

### 4.2.5 Wetland Surface Flows

Water levels in wetlands 1, 5C, 6C, 7 and 10A were 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 4-3 show the staff gauge locations.

Measurements were provided to the Department on March 22, June 30, September 29 and December 29, 2000; the reports are incorporated by reference. Tables 4-5 through 4-9 summarize the wetland elevations for the five wetlands. Wetlands 5C, 6C, 7 and 10A showed readings similar to previous years.

## Table 4-4. 2000 SURFACE WATER QUALITY DATA

| | SW-1 (Upstream) | | SW-2 (Downstream) | |
|---|---|---|---|---|
| | Jun-00 | Nov-00 | Jun-00 | Nov-00 |
| alkalinity (mg/l) | 39 | NA | 39 | NA |
| aluminum (ug/l) | 42 | NA | 160 | NA |
| arsenic (ug/l) | <3.0 | NA | <3.0 | NA |
| beryllium (ug/l) | <0.15 | NA | <0.15 | NA |
| cadmium (ug/l) | <0.31 | NA | <0.31 | NA |
| chromium VI (ug/l) | <18 | NA | <18 | NA |
| chromium (ug/l) | 0.92 | NA | 1.3 | NA |
| copper (ug/l) | 0. 94 | <1.2 | 1.3 | <1.2 |
| conductivity (field) | 120 | 126 | 120 | 125 |
| DO (mg/l) (field) | 6.3 | 11.5 | 7.5 | 11.5 |
| hardness (mg/l) | 38 | 50 | 40 | 49 |
| iron (mg/l) | 0.36 | 0.48 | 0.54 | 0.46 |
| lead (ug/l) | <2.4 | NA | <2.4 | NA |
| manganese (ug/l) | 60 | 56 | 89 | 53 |
| mercury (ug/l) | <0.050 | NA | <0.050 | NA |
| nickel (ug/l) | <1.0 | NA | 1.6 | NA |
| pH (lab) | 7.6 | 7.9 | 7.6 | 7.6 |
| pH (field) | 6.5* | 8.0 | 5.5* | 7.6 |
| selenium (ug/l) | <1.7 | NA | <1.7 | NA |
| silver (ug/l) | <0.47 | NA | <0.47 | NA |
| sulfate (mg/l) | 5.2 | 8.6 | 5.2 | 8.4 |
| TDS (mg/l) | 180 | NA | 85 | NA |
| TSS (mg/l) | <1.0 | NA | 10 | NA |
| zinc (ug/l) | <12 | <12 | <12 | <12 |

NA = Not Analyzed

* pH meter not operating correctly

TABLE 4-5

MONTHLY WETLAND STAFF GAUGE READING SUMMARY

Staff Gauge Location/
Water Level (MSL)

WETLAND 5C

(WT-1)

| | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| JAN | -- | NRT | NRT | NRT | NRT | NRT | NRT | NRT | NRT | NRT |
| FEB | -- | NRT | NRT | NRT | NRT | NRT | NRT | NRT | NRT | NRT |
| MAR | -- | 1140.62 | NRT | NRT | NRT | NRT | NRT | 1140.26 | NRT | NRT |
| APR | -- | 1140.47 | 1140.60 | 1140.73 | 1140.34 | 1140.24 | 1140.28 | NSW | 1140.07 | 1140.06 |
| MAY | 1140.84 | 1140.21 | 1140.47 | 1140.22 | 1140.11 | NSW | NSW | 1141.00 | NSW | 1140.04 |
| JUN | 1140.78 | NSW | 1140.34 | 1140.06 | NSW | 1140.14 | NSW | NSW | NSW | 1140.04 |
| JUL | 1140.05 | NSW | NSW | NSW | NSW | NSW | 1140.10 | NSW | NSW | NSW |
| AUG | NSW | NSW | 1140.48 | NSW | 1140.65 | NSW | 1140.40 | NSW | 1140.23 | NSW |
| SEP | 1140.21 | 1140.09 | 1140.51 | 1140.34 | NSW | NSW | NSW | NSW | NSW | NSW |
| OCT | NSW | 1140.68 | 1140.46 | 1140.28 | 1140.18 | 1140.29 | 1140.14 | NSW | NSW | NSW |
| NOV | NRT | NRT | NRT | NRT | NRT | NRT | NRT | NSW | NSW | NSW |
| DEC | NRT | NRT | 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 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| JAN | -- | NRT | NRT | NRT | NRT | NRT | NRT | NRT | NRT | NRT |
| FEB | -- | NRT | NRT | NRT | NRT | NRT | NRT | NRT | NRT | NRT |
| MAR | -- | 1153.85 | NRT | NRT | NRT | NRT | NRT | 1153.59 | NRT | NRT |
| APR | -- | 1153.74 | 1153.82 | 1153.89 | 1153.59 | 1153.64 | 1153.62 | 1153.31 | 1153.34 | 1153.58 |
| MAY | 1154.00 | 1153.62 | 1153.57 | 1153.49 | 1153.50 | 1153.45 | 1153.39 | 1153.27 | 1153.39 | 1153.57 |
| JUN | 1153.58 | 1153.37 | 1153.64 | 1153.37 | 1152.99 | 1153.50 | 1153.10 | 1153.02 | 1153.59 | 1153.50 |
| JUL | 1153.51 | 1153.16 | 1153.46 | 1153.13 | NSW | 1153.27 | 1153.42 | NSW | 1153.27 | 1153.47 |
| AUG | 1153.15 | 1153.15 | 1153.56 | NSW | 1153.03 | NSW | 1153.52 | NSW | 1153.64 | 1153.40 |
| SEP | 1153.52 | 1153.06 | 1153.57 | 1153.48 | 1153.24 | 1152.90 | 1153.34 | NSW | 1153.51 | 1153.50 |
| OCT | 1153.44 | 1153.16 | 1153.51 | 1153.49 | 1153.58 | 1153.50 | 1153.48 | NSW | 1153.31 | 1153.25 |
| NOV | NRT | NRT | NRT | NRT | NRT | NRT | NRT | 1152.96 | 1153.24 | 1153.25 |
| DEC | NRT | NRT | 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 6C

(WT-3)

| | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| JAN | -- | NRT | NRT | NRT | NRT | NRT | NRT | NRT | NRT | NRT |
| FEB | -- | NRT | NRT | NRT | NRT | NRT | NRT | NRT | NRT | NRT |
| MAR | -- | 1146.90 | NRT | NRT | NRT | NRT | NRT | 1146.58 | NRT | NRT |
| APR | -- | 1146.72 | NRT | 1146.89 | 1146.67 | 1146.51 | 1146.51 | NSW | 1146.59 | 1146.50 |
| MAY | 1147.05 | NSW | 1146.78 | NSW | 1146.52 | NSW | NSW | NSW | NSW | NSW |
| JUN | NSW | NSW | 1146.66 | NSW | NSW | NSW | NSW | NSW | NSW | NSW |
| JUL | NSW | NSW | NSW | NSW | NSW | NSW | NSW | NSW | NSW | NSW |
| AUG | NSW | NSW | NSW | NSW | NSW | NSW | NSW | NSW | NSW | NSW |
| SEP | NSW | NSW | NSW | NSW | NSW | NSW | NSW | NSW | NSW | NSW |
| OCT | NSW | NSW | NSW | NSW | 1146.49 | NSW | NSW | NSW | NSW | NSW |
| NOV | NRT | NRT | NRT | NRT | NRT | NRT | NRT | NSW | NSW | NSW |
| DEC | NRT | NRT | 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 10A

(WT-4)

| | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| JAN | -- | NRT | NRT | NRT | NRT | NRT | NRT | NRT | NRT | NRT |
| FEB | -- | NRT | NRT | NRT | NRT | NRT | NRT | NRT | NRT | NRT |
| MAR | -- | 1146.76 | NRT | NRT | NRT | NRT | NRT | 1146.63 | NRT | NRT |
| APR | -- | 1146.58 | 1146.74 | 1146.86 | 1146.64 | 1146.58 | 1146.43 | 1146.30 | 1146.57 | 1146.53 |
| MAY | 1146.81 | 1146.46 | 1146.57 | 1146.48 | 1146.55 | 1146.38 | 1146.23 | 1146.39 | 1146.31 | 1146.51 |
| JUN | NSW | 1146.16 | 1146.55 | 1146.39 | 1146.13 | 1146.49 | 1145.97 | 1146.16 | 1146.11 | 1146.41 |
| JUL | 1146.11 | 1145.91 | 1146.41 | 1146.18 | 1145.83 | 1146.24 | 1146.38 | NSW | 1146.02 | 1146.36 |
| AUG | NSW | 1146.00 | 1146.55 | 1145.80 | 1146.52 | NSW | 1146.49 | 1145.56 | 1146.59 | 1146.26 |
| SEP | 1146.26 | 1146.12 | 1146.57 | 1146.45 | 1146.14 | 1145.85 | 1146.23 | 1145.87 | 1146.48 | 1146.33 |
| OCT | 1146.10 | 1146.34 | 1146.53 | 1146.43 | 1146.53 | 1146.51 | 1146.37 | 1145.65 | 1146.12 | 1146.03 |
| NOV | NRT | NRT | NRT | NRT | NRT | NRT | NRT | 1145.87 | 1145.97 | 1146.07 |
| DEC | NRT | NRT | NRT | NRT | NRT | NRT | NRT | NRT | NRT | NRT |

NRT = No Reading Taken Due to Frozen Conditions
NSW = No Standing Water

TABLE 4-9

MONTHLY WETLAND STAFF GAUGE READING SUMMARY

Staff Gauge Location/
Water Level (MSL)

WETLAND 1

(WT-5)

| | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| JAN | -- | NRT | NRT | NRT | NRT | NRT | NRT | NRT | NRT | NRT |
| FEB | -- | NRT | NRT | NRT | NRT | NRT | NRT | NRT | NRT | NRT |
| MAR | -- | 1102.32 | NRT | NRT | NRT | NRT | NRT | 1101.92 | NRT | NRT |
| APR | -- | 1102.29 | 1102.49 | 1102.18 | 1101.93 | 1102.06 | 1101.91 | NSW | 1101.89 | 1101.92 |
| MAY | 1102.35 | 1102.25 | 1102.03 | NSW | NSW | NSW | NSW | 1101.84 | NSW | 1101.93 |
| JUN | 1102.28 | 1102.26 | NSW | NSW | NSW | NSW | NSW | NSW | NSW | 1102.01 |
| JUL | 1102.23 | 1101.90 | NSW | NSW | NSW | NSW | NSW | NSW | NSW | NSW |
| AUG | NSW | 1102.21 | NSW | NSW | NSW | NSW | NSW | NSW | 1102.09 | NSW |
| SEP | 1102.33 | 1102.46 | 1101.92 | NSW | NSW | NSW | NSW | NSW | NSW | NSW |
| OCT | 1102.32 | 1102.37 | NSW | NSW | 1101.97 | NSW | NSW | NSW | NSW | NSW |
| NOV | NRT | NRT | NRT | NRT | NRT | NRT | NRT | NSW | NSW | NSW |
| DEC | NRT | NRT | NRT | NRT | NRT | NRT | NRT | NRT | NRT | NRT |

NRT = No Reading Taken Due to Frozen Conditions
NSW = No Standing Water

Wetland 1 continues to have soil moisture that is higher than previous to the addition of river water to this wetland and since groundwater seeps have re-established. Springs within Wetland 1 were noted to be flowing. Wetland 1 will continue to be monitored at the staff gauge and the ability to add mitigation water will be retained until it is determined that the groundwater elevation in the area of Wetland 1 has stabilized.

During November 2000, wetland water quality samples were collected from onsite wetlands and a recovering groundwater seep in Wetland 1 to provide baseline data. The results of the analyses were submitted to the Department on January 30, 2001. Table 4-10 summarizes the analytical results from the 8.5-acre wetland, 1.7-acre biofilter, 0.9-acre biofilter, and Wetland 1. Results are comparable between the sample locations with the exception of copper and sulfate at the 0.9-acre biofilter that serves the industrial outlot. Some higher parameter values can be expected in the 0.9-acre biofilter since all runoff from the industrial outlot flows through this biofilter.

## 4.3 Meteorology

As required in the Air Pollution Control Permit No. 89-DLJ-033, Condition 10, meteorological data was continuously collected from a meteorological (met) station during the construction, operation, and active reclamation phases and while the high-volume TSP air monitors were in operation. With the termination of air monitoring at the end of June 1999, the meteorological station was also shutdown. The meteorological station was decommissioned during late Summer 2000. The Ladysmith Service Center collects meteorological data adjacent to the reclaimed mine site.

## 4.4 Air Quality

During June 1999 Flambeau requested authorization to terminate the air monitoring program. In a letter dated June 30, 1999 the Department determined that continued air monitoring was no longer necessary. Reclamation activities had progressed to the point of no major additional surface disturbance and adequate vegetation existed over most of the site. July 29, 1999 was the final date of air monitoring.

During 1999, Flambeau had requested that the Department revoke the air pollution control permit that had been issued January 14, 1991. This request was made since the facility and operations to which the permit applied had been permanently shutdown.

Following a 21-day notice period, the Department revoked Flambeau's air pollution control permit effective April 11, 2000.

## Table 4-10

## Wetland and Biofilter Baseline Monitoring
## November 2000

| Parameter | Units | Wetland 1 Seep | 8.5-Acre Wetland | 1.7-Acre Biofilter | 0.9-Acre Biofilter |
|---|---|---|---|---|---|
| Alkalinity | mg/l | 37 | 38 | 30 | 25 |
| Arsenic | ug/l | <1.7 | 3.0 | <1.7 | <1.7 |
| Barium | ug/l | 6.4 | 7.5 | 12 | 16 |
| Cadmium | ug/l | <0.21 | <0.21 | <0.21 | <0.21 |
| Chromium | ug/l | <0.74 | <0.74 | <0.74 | <0.74 |
| Copper | ug/l | 5.9 | 12 | 12 | 91 |
| Hardness | mg/l | 50 | 28 | 22 | 32 |
| Iron | mg/l | 0.024 | 0.050 | 0.17 | 0.076 |
| Lead | ug/l | <1.4 | <1.4 | <1.4 | <1.4 |
| Manganese | ug/l | 3.1 | 2.4 | 2.4 | 24 |
| Mercury | ug/l | <0.050 | <0.050 | <0.050 | <0.050 |
| Oil & Grease | mg/l | 2.4 | 9.7 | 5.6 | <1.4 |
| pH, Lab | s.u. | 6.6 | 7.3 | 6.8 | 6.8 |
| pH (Field) | s.u. | 6.3 | 7.4 | 7.2 | 7.0 |
| Selenium | ug/l | <1.6 | <1.6 | <1.2 | <1.6 |
| Silver | ug/l | <0.55 | <0.55 | <0.55 | <0.55 |
| Solids, tot. dis. | mg/l | 72 | 25 | 34 | 49 |
| Solids, tot. susp. | mg/l | 9.0 | 14 | 2.0 | 35 |
| Sulfate | mg/l | 8.8 | <5.0 | <5.0 | 18 |
| Zinc | ug/l | <12 | <12 | <12 | <12 |
| Conductivity (Field) | uS | 122 | 89 | 73 | 97 |
| Oxygen, diss. (Field) | mg/l | 7.8 | 10.1 | 11.1 | 13.4 |
| Temp. (Field) | C° | 8.4 | 1.6 | 2.2 | 3.6 |
| Water Elevation | Ft (msl) | NM | 1135.65 | 1100.71 | 1138.17 |

NM – Not Measured

**REFERENCES**

| | |
|---|---|
| 1999 Annual Report | January 2000 |
| 2000 Annual Reclamation Report | November 2000 |
| Air Pollution Control Permit | January 1991 |
| Environmental Impact Report | March 1989 |
| Local Agreement | August 1988 |
| Mining Permit | January 1991 |
| Revised Mining Permit Quality Assurance/Quality Control Plan | August 1991 |
| Updated Monitoring Plan | July 1991 |

## SUBMITTALS

| DOCUMENT | DATE | DEPARTMENT SUBMITTEE |
|---|---|---|
| **Section 2.0 Operating Activities** | | |
| 1999 Annual Report | January 2000 | Larry Lynch (1) |
| 1999 Emission Inventory | March 2000 | Department (2) |
| 1999 Hazardous Waste Annual Report | March 2000 | Department (4) |
| May 2000 Surface Water Withdrawal | June 2000 | Larry Lynch (1) |
| 1999 Air Emissions Certification | June 2000 | Ralph Patterson (2) |
| 2000 Environmental Fee Statement | July 2000 | Department (3) |
| June 2000 Surface Water Withdrawal | July 2000 | Larry Lynch (1) |
| July 2000 Surface Water Withdrawal | August 2000 | Larry Lynch (1) |
| August 2000 Surface Water Withdrawal | September 2000 | Larry Lynch (1) |
| **Section 3.0 Reclamation Activities** | | |
| List of Anticipated 1999 Reclamation Activities | January 2000 | Larry Lynch (1) |
| Prescribed Burning on Reclaimed Flambeau Mine | April 2000 | Larry Lynch (1) |
| Proposed HEP Species | August 2000 | Mark Schmidt (2) |
| MidSummer Progress Report, 2000 | November 2000 | Larry Lynch (1) |
| 2000 Annual Reclamation Report | November 2000 | Larry Lynch (1) |

## SUBMITTALS (CONT'D)

| DOCUMENT | DATE | DEPARTMENT SUBMITTEE |
|---|---|---|
| **Section 4.0 Site Monitoring** | | |
| Environmental Monitoring (First Quarter 2000) | March 2000 | Larry Lynch [1] |
| MW1005P Iron ACL | April 2000 | Larry Lynch [1] |
| Environmental Monitoring (Second Quarter 2000) | June 2000 | Larry Lynch [1] |
| Surface Water Quality Results – Spring 2000 | August 2000 | Larry Lynch [1] |
| Environmental Monitoring (Third Quarter 2000) | September 2000 | Larry Lynch [1] |
| Backfill Pore Water Quality Assessment | October 2000 | Larry Lynch [1] |
| Groundwater Monitoring Well Nest Installation at Compliance Boundary | December 2000 | Larry Lynch [1] |
| Environmental Monitoring (Fourth Quarter 2000) | December 2000 | Larry Lynch [1] |
| Surface Water Quality Results – Fall 2000 | January 2001 | Larry Lynch [1] |
| Wetland and Biofilter Baseline Monitoring – Fall 2000 | January 2001 | Larry Lynch [1] |

1 Wisconsin Department of Natural Resources
Bureau of Waste Management

2 Wisconsin Department of Natural Resources
Ladysmith Service Center

3 Wisconsin Dept. Of Natural Resources
Environmental Fees

4 Wisconsin Dept. Of Natural Resources
Bureau of Waste Management

# Appendix A

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

Kennecott Minerals

October 17, 2000

Mr. Lawrence J. Lynch
Mine Reclamation Unit
Bureau of Solid and Hazardous Waste Management
101 S. Webster Street, GEF II
PO Box 7921
Madison, WI 53707

Dear Mr. Lynch:

RE: Backfilled Pit Water Quality Assessment
Flambeau Mining Company

Flambeau Mining Company (Flambeau) is providing the attached memorandum prepared at Flambeau's request by SRK Consulting and Foth & Van Dyke evaluating data obtained since the pit was backfilled to assess the current and future performance of the reclaimed mine site with respect to compliance with groundwater quality permit standards and the protection of water quality in the Flambeau River.

As part of the permitting effort for the Flambeau Project, assessments were completed to determine if the reclaimed site would comply with permitted groundwater quality standards at the compliance boundary and protect surface water quality in the Flambeau River. The original assessment relied on predicted post-mining hydrologic conditions to conclude that the Flambeau River would act as a hydrologic boundary for pore water migrating from the pit backfill and that backfill pore water would not migrate to the downgradient compliance boundary. In addition, the original analysis showed that the flux of backfill pore water into the river would be so small relative to the flow in the river that surface water quality would not experience a measurable change.

Environmental monitoring data from the reclaimed site supports the original analysis. Given the hydrologic conditions at the site, the environmental monitoring data show that the Flambeau Mine is in compliance with groundwater quality permit conditions and that water quality in the Flambeau River is protected.

If you have any questions regarding this submittal, please contact me at 715-532-6690 Ext. 2.

Sincerely,

Jana E. Murphy
Environmental & Reclamation Manager

Attachment

Cc: Al Christianson, City of Ladysmith
Fred Fox, Kennecott Minerals Company
Jim Hutchison, Foth & Van Dyke
Ken Markart, WDNR
Thure Osuldsen, Rusk County
Tom Riegel, Town of Grant
Jerry Sevick, Foth & Van Dyke
CeCe Tesky, Rusk County Zoning

# Foth & Van Dyke/SRK Consulting
# Memorandum

October 12, 2000

TO: Jana Murphy, Flambeau Mining Company

CC: Jim Hutchison, Foth & Van Dyke
Master File

FR: Daryl Hockley, SRK Consulting
John Chapman, SRK Consulting
Jerry Sevick, Foth & Van Dyke JWS
Steve Donohue, Foth & Van Dyke

RE: Flambeau Project --Backfilled Pit Water Quality Assessment

## 1. Overview

Backfilling of the Flambeau pit was completed in the fall of 1997. Since that time, groundwater elevation and quality in and around the backfilled pit, and surface water quality data in the Flambeau River, have been collected. This memorandum consists of an evaluation of the data obtained since the pit was backfilled to assess the current and future performance of the reclaimed mine site with respect to compliance with groundwater quality permit standards and the protection of water quality in the Flambeau River.

As part of the permitting effort for the Flambeau Project, assessments were completed to determine if the reclaimed site would:

- comply with permitted groundwater quality standards at the compliance boundary; and
- protect surface water quality in the Flambeau River.

The original assessment, which was based on predicted post-mining hydrologic conditions, concluded that the Flambeau River would act as a hydrologic boundary for pore water migrating from the pit backfill and that backfill pore water would not migrate to the downgradient compliance boundary. In addition, the original analysis showed that the flux of backfill pore water into the river would be so small relative to the flow in the river that surface water quality would not experience a measurable change. This memorandum concludes that recent environmental monitoring data from the reclaimed site remain consistent with the original analysis.

Trends in the data collected through April 2000 for the backfill pore water indicate that the pH, alkalinity, and major element chemistry are stable, with possible slight increases in pH.

Calculations of dissipation times confirm that the carbon dioxide levels in the backfill are stable, and will change only over hundreds of years. Given the stable pH, alkalinity, and major ion chemistry, future increases in iron and manganese concentrations are unlikely. However, trends in redox potential cannot be discerned yet, because results from only one round of measurements are available. Increases in iron concentrations would be expected if redox potential decreases.

Data collected in April 2000 from monitoring of the pit backfill shows that carbon dioxide and alkalinity measurements are closely correlated, and that alkalinity measurements are more repeatable. Although measured $CO_2$ concentrations are well above atmospheric levels, they overlap the range of natural soil and groundwaters elsewhere.

Analysis of the data collected through April 2000 shows that backfill pore water is in equilibrium with calcite and gypsum, indicating that complete neutralization of the acidity originally present in the backfilled material has occurred. Iron and manganese concentrations in the backfill pore water are above those predicted by the 1997 geochemical modeling. The combination of higher than expected redox potential and higher than expected carbon dioxide may be responsible for the elevated iron concentrations. Slow equilibration of manganese, or formation of a carbonate solid-solution phase (rather than a pure manganese-carbonate like rhodochrosite), may be responsible for the elevated manganese concentrations.

Finally, the memorandum concludes that, with the exception of two minor items, monitoring of groundwater within and around the backfilled pit should continue to be performed in accordance with the program contained in the project's approved monitoring plan (Foth & Van Dyke, 1991). Also, an annual review of the data should be included in the project's annual report to determine if conditions affecting the conclusions reached in this memorandum remain consistent. As additional data are collected and the continuation of stable conditions is documented; per the approved monitoring plan, consideration can be given to reducing the frequency of monitoring within the backfilled pit.

## 2. Introduction

As part of the permitting process for the Flambeau Project, Flambeau Mining Company (Flambeau) evaluated post-mining groundwater flow and pit backfill geochemistry to demonstrate that the reclaimed mine would:

- comply with permitted groundwater quality standards; and
- protect water quality in the nearby Flambeau River.

Prior to the commencement of reclamation, a series of groundwater and geochemical studies (Engineering Technologies Associates, 1998; and Foth & Van Dyke, 1997) were completed to update the original assessment and to guide the reclamation process that was designed to maintain future compliance with permitted groundwater quality standards at the compliance boundary and to protect water quality in the Flambeau River.

Backfilling of the pit was completed in the fall of 1997. Since then, groundwater elevation, groundwater quality, and surface water quality data in the Flambeau River have been collected. In addition, nested monitoring wells were installed in September 1998 to monitor the quality of backfill pore water.

Flambeau requested Foth & Van Dyke and SRK Consulting (SRK) to evaluate the backfill pore water quality data obtained since 1999 from the backfilled pit monitoring well nests in order to assess the future performance of the facility with respect to compliance with groundwater quality permit standards and the protection of water quality in the Flambeau River. This memorandum describes that assessment and the conclusions reached.

The memorandum first presents a summary of the routine monitoring data that has been collected in the backfill monitoring well nests, including carbon dioxide and Eh data that have been collected periodically. The assessment of the data includes a comparison of actual monitoring results to predictions and a discussion of expected future changes in pore water quality. The next section of the memorandum addresses the protection of the Flambeau River and groundwater quality. Finally, the memorandum presents summary comments and recommendations.

# 3. Summary of Collected Data

## 3.1 Groundwater Monitoring Wells

Flambeau conducts a quarterly groundwater monitoring program to assess the elevation and characteristics of groundwater in and around the backfilled pit. The locations of the groundwater monitoring wells used in the program are shown in Figure 1. The wells have varied screen lengths. The mid-point depths below surface of the well screens for those wells used for groundwater quality sampling are listed in Table 1.

## 3.2 Analyses

Table 2 summarizes the parameters monitored for groundwater quality at the Flambeau site. Samples from all wells included in the groundwater quality monitoring program are analyzed for a routine suite of parameters during the January, April, and October quarterly monitoring events. In July of each year the parameter list is expanded to include additional metals. For the July and October 1999 and the April 2000 quarterly sampling events, samples from the wells in the saturated portion of the backfill (i.e., the MW-1013 and MW-1014 well nests) were analyzed for an expanded suite of parameters. A complete data base for the Flambeau groundwater monitoring program is included in Attachment 1. Note that data do not exist for all monitoring wells in the two backfilled pit well nests over the period of record, since the formations in which the well screens are located have progressively resaturated over time.

Samples taken from well nests MW-1013 and MW-1014 (in the backfilled pit), and well MW-1005P (upgradient of the backfilled pit) in October 1999 and April 2000 were also analyzed for dissolved carbon dioxide. Field Eh, or redox potential, was determined for these same wells in April 2000. Methods for these measurements are described in the following sections.

## 3.3 Carbon Dioxide Analysis

The dissolved carbon dioxide ($CO_2$) analyses were performed by Advanced Technology Laboratories Inc., using a modification of a method known as RFKSOP-175. In a previous report prepared by SRK Consulting (SRK, 1999), there had been some uncertainty about the meaning of the resulting $CO_2$ measurements. To resolve this uncertainty, SRK and Foth & Van Dyke contacted the laboratory directly, and obtained the method description, as well as raw data sheets and calculations from the April 2000 analyses.

The RFKSOP-175 method was developed for analysis of organic compounds such as methane, ethane and ethylene in water (Kampbell & Vandegrift, 1998). As initially developed, the method included sampling by carefully dribbling a stream of water down the side of a 60 ml serum bottle. That method of sampling is intended to minimize mixing with air and loss of volatile material. The sample is then acidified and the bottle sealed with a septa cap. The samples are kept in an ice chest during transport. In the laboratory, approximately 10% of the sample is removed by syringe, and replaced with helium gas. The bottle, now containing about 54 ml of sample and 6 ml of head space, is then shaken at room temperature for 24 hours. A sample of the head space gas is then removed and analyzed by gas chromatography. The direct result of the analysis is a concentration of the target compound in the helium-filled head space. That value is converted to the original concentration of the target compound in the water by a series of calculations. The calculations are based on Henry's Law, which states that the concentration of a volatile compound above an aqueous solution of that compound is related to the concentration in the solution by a simple linear relationship, i.e.,

$$P = K_H C$$

where P is the concentration of the compound in the gas (commonly expressed as a partial pressure with units of atm), C is the concentration of the compound in the solution (commonly expressed in units of M), and $K_H$ is the Henry's Law constant for the compound (commonly with units of $M^{-1}$ atm) at the appropriate (room) temperature.

When applying the procedure to $CO_2$, three changes to the standard procedure or data interpretation are necessary:

- The method of sampling by dribbling the water down the side of the bottle may lead to loss of $CO_2$. The analytical results need to be interpreted recognizing some loss of $CO_2$ likely occurred during sample collection.

- Acidification of the sample would tend to promote $CO_2$ volatilization. Samples taken in both October 1999 and April 2000 were not acidified.

- The use of a Henry's Law constant for $CO_2$ is complicated by the fact that $CO_2$ dissolved in water forms many species, including $CO_2$(aq), $H_2CO_3$, $HCO_3^-$ and $CO_3^{2-}$. In strong ionic solutions, dissolved $CO_2$ can also form complexes such as $FeHCO_3^+$ and $MnHCO_3^+$. A review of the methods used and data obtained shows that the Henry's Law constants used in the laboratory calculations refer to the sum of the dissolved species $CO_2$(aq) and $H_2CO_3$. That sum is commonly referred to as $H_2CO_3^*$ in the geochemical literature. Hence the Henry's Law constant used by the laboratory relates the measured partial pressure of $CO_2$ in the helium to the concentration of $H_2CO_3^*$ in the solution. The reported values should therefore be interpreted as concentrations of $H_2CO_3^*$.

## 3.4 Field Eh Analysis

A hydrolab minisonde, in combination with a surveyor 4, was used to measure redox potential at specified monitoring well locations during the April 2000 monitoring event. Two methods were used, depending on various field conditions. The first involved inserting a probe downhole to the well screen and then taking a reading without purging. The second method involved connecting the meter to the tubing from the dedicated pumps located in the well, and then taking a reading. The downhole method was used on monitoring wells MW-1000PR, MW-1005P, MW-1004P, MW-1010P, and MW-1014. The inline method was used for MW-1013A, MW-1013B, MW-1013C, MW-1014A, MW-1014B, and MW-1014C.

## 4. Data Assessment

### 4.1 Carbon Dioxide, Alkalinity, and Total Inorganic Carbon

Concentrations of carbon dioxide ($H_2CO_3^* = CO_2$ (aq) + $H_2CO_3$) and alkalinity (0.5 $HCO_3^-$ + $CO_3^{=}$ + 0.5 $OH^-$) are inter-related. If the pH of a solution is known, both quantities can be related to total inorganic carbon ($H_2CO_3^*$ + $HCO_3^-$ + $CO_3^{=}$). In reviewing the reported $CO_2$ measurements, it was helpful to compare them to measured alkalinities, and to convert both to units of total inorganic carbon.

Table 3 presents the carbon dioxide and alkalinity concentrations measured in the April 2000 and October 1999 samples. A series of simple equilibrium calculations were completed to relate each measured value to an equivalent total inorganic carbon. The equilibrium calculations neglected metal carbonate complexes for simplicity, but that simplification introduces only a small inaccuracy (i.e., less than a few percent).

The table shows that the April 2000 measurements of carbon dioxide and alkalinity lead to similar calculated values of total inorganic carbon. The total inorganic carbon values calculated from the carbon dioxide measurements from April 2000 samples are generally in good agreement with or slightly greater than those calculated from the alkalinity measurements. There is more disagreement between the total inorganic carbon values calculated from the October 1999 measurements of carbon dioxide and alkalinity. In the October 1999 data, total inorganic carbon values calculated from the carbon dioxide measurements are consistently much lower than those calculated from the alkalinity measurements.

Table 3 also shows that there are significant inconsistencies between the October 1999 and April 2000 measurements of carbon dioxide from each well in the backfilled pit. In contrast, the October 1999 and April 2000 measurements of alkalinity from each well are consistent.

The indication is that the alkalinity measurements are more reliable than the measurements of carbon dioxide. The difficulty in preventing carbon dioxide loss during sample collection and analysis is a likely reason.

It is noteworthy that the conclusions drawn from the comparison of calculated total inorganic carbon are supported by other methods of comparison. For example, it is also possible to calculate an estimate of alkalinity from a measurement of carbon dioxide, and vice versa. Several possible calculations of that type were made but not reported here for the sake of brevity. Complete equilibrium models of representative solutions were also run. The conclusion that the alkalinity data are consistent, and the carbon dioxide data are not, was supported in all cases.

A consequence of this conclusion is that it is inappropriate to use the October 1999 and April 2000 carbon dioxide measurements to discern temporal trends. The higher carbon dioxide values reported in April 2000, when compared to the October 1999 sampling, appear to be an artifact of the sampling method or analytical method. Comparison of the alkalinity measurements is more informative, and indicates no significant change between October 1999 and April 2000.

## 4.2 Estimation of Carbon Dioxide Partial Pressure

The Henry's Law method calculation discussed in Section 3.3 can also be used to estimate the concentration of $CO_2$ in a gas in equilibrium with the samples. Table 4 shows the results of the following calculations, applied to the April 2000 samples:

- $H_2CO_3$* concentrations estimated from the (more reliable) alkalinity data.
- Use of Henry's Law to estimate the equilibrium partial pressure of $CO_2$ gas. The Henry's Law constant was corrected for *in situ* temperature.
- Use of the hydrostatic head on the sample to estimate the total gas pressure at the sample depth.
- The use of partial pressure of the $CO_2$ gas divided by the total gas pressure to estimate the mole fraction of $CO_2$ in the gas.

The resulting estimates of $CO_2$ gas concentration in the backfilled pit wells are generally in the range of 2% to 7%. The relatively high $CO_2$ concentrations are consistent with carbonate neutralization of acidic water. As expected, the $CO_2$ concentration estimate of 0.4% for sample MW-1005P from outside the backfill was significantly lower than the in-pit wells, though still significantly above atmospheric $CO_2$ concentrations of 0.032%.

For comparison, Table 5 presents measurements of $CO_2$ gas concentrations from other studies. Although the $CO_2$ concentrations in the Flambeau backfill are well above atmospheric levels, they overlap the range of natural soil and groundwaters elsewhere.

## 4.3 Major Ions

The major ion concentrations measured in the April 2000 sample results were reviewed through a series of calculations. Ion balance and total dissolved solids calculations were completed to check the internal consistency of each data set. In order to complete the ion balances, it was necessary to take the dominant carbonate species, $HCO_3^-$, into account. The $CO_2$ analyses (and the measured pH) were used to estimate the $HCO_3^-$ concentrations. With the $HCO_3^-$ estimates included, the calculations showed:

- The April 2000 samples from MW-1013C, MW-1014A, and MW-1014B had ion balances within 5%, and measured and calculated TDS values agreed within 10%.
- The April 2000 sample from MW-1013B was deficient in anions. To improve the ion balance, the sulfate concentration would need to be 1500 mg/L versus the reported value of 1200 mg/L. The 1500 mg/L value is, in fact, more consistent with earlier samples, suggesting that the reported sulfate value is likely erroneous.

- The April 2000 sample from MW-1014C was slightly deficient in cations. The ion balance would be improved if the measured calcium value was 290 mg/L versus the 260 mg/L reported value.

- Even after making the above adjustments to the data set for MW-1013B and MW-1014C, measured and calculated TDS values were different by more than 10%.

- The April 2000 sample from MW-1005P (upgradient of the backfilled pit) was not analyzed for cations. When results of the July 1999 expanded analysis are combined with the April 2000 alkalinity and Eh analysis, the ion balance is improved, but still 20% deficient in cations. Although the data from MW-1005P are considered reliable, they were not used in geochemical modeling since sufficient cation data was not available.

Water type calculations were completed on all of the samples. All of the April 2000 backfill samples classify as Ca-Mg-$SO_4$-$CO_3$ waters, which is consistent with neutralization of sulfate acidity by limestone. The July 1999 sample from MW-1005P upgradient of the backfill classifies as a Ca-Mg-$CO_3$ water.

The geochemical equilibrium model PHREEQ-C was used to compare the (corrected) solution compositions from the April 2000 samples to solubility limits for expected mineral phases. All runs were completed using the alkalinity data (rather than the $CO_2$ data) and measured temperature redox conditions. Complete results are included in Attachment 2. Table 6 summarizes the results in terms of saturation indices of calcite and gypsum. A saturation index of greater than zero indicates supersaturation of a mineral phase, and an index less than zero indicates under-saturation. A saturation index of near zero indicates that the mineral phase is probably present, and in equilibrium with the solution.

The table indicates that most of the samples are likely to be in equilibrium with calcite (or aragonite, a similar calcium carbonate phase) and gypsum. The samples with the best ion balance and TDS measurements, MW-1013C and MW-1014B, are clearly in equilibrium with these phases. These results show the acid that was present in the waste rock has been consumed by limestone dissolution and that the sulfate concentrations are now controlled by gypsum precipitation. The control of sulfate by gypsum precipitation was predicted in the 1997 study (Foth & Van Dyke, 1997). (Observed sulfate concentrations are slightly higher than predicted due to the presence of additional cations, particularly magnesium released from limestone dissolution.) The fact that the resulting solution is in equilibrium with calcite indicates that acid neutralization is complete. These results demonstrate that the acidity present in the backfill has been effectively neutralized.

## 4.4 Iron, Manganese, and Redox Potential

Iron and manganese concentrations are higher than predicted by the 1997 geochemical modeling (Foth & Van Dyke, 1997) in some of the backfilled pit monitoring wells. The 1997 modeling considered a range of $CO_2$ gas concentration from 1% to 10% (at atmospheric pressure), and equilibration of iron and manganese with the carbonate phases siderite and rhodocrosite.

The values of the $Fe(OH)_3$ saturation index calculated by the PHREEQ model, and shown in Table 6, indicate the backfill samples are near equilibrium with amorphous iron hydroxide. Amorphous iron hydroxide commonly forms when acidic mine drainage is neutralized. The slight undersaturation suggests that iron hydroxides may be dissolving and/or converting to more stable phases such as goethite or hematite. However, it is not unusual to see some disequilibrium in model runs that use a measured redox potential as input. The reason is that the Fe(II)/FE(III) redox couple is often out of equilibrium with the measured redox potential.

The PHREEQ-C results presented in Table 6 show that the backfill samples are undersaturated with respect to siderite and supersaturated with respect to rhodocrosite. The undersaturation with respect to siderite is apparently due to the complexation of ferrous iron with $HCO_3^-$. The supersaturation with respect to rhodocrosite was also noted in the column test data presented with the 1997 predictions (Foth & Van Dyke, 1997). At that time, the explanation was that formation of the rhodocrosite was expected to be very slow. That explanation may also hold for the field data. Another possibility is that manganese concentrations may be controlled by equilibration with a mixed carbonate phase.

## 4.5 Other Metals

Concentrations of other metals in the backfill pit monitoring wells are generally within the ranges measured or predicted in the 1997 study (Foth & Van Dyke, 1997). For example, copper concentrations were predicted to be less than 0.56 mg/L at 10% $CO_2$. The monitoring data show copper concentrations to be at or below that value in all but the February 1999 sample from monitoring well MW-1014B. The February 1999 outlier was 0.81 mg/L, only slightly above the prediction.

Zinc concentrations were not modeled in 1997, but show an interesting pattern in the monitoring data. Concentrations range from 5 mg/L in MW-1014B to <0.12 mg/L in MW-1013B. The variability in zinc concentrations likely reflects differences in the extent of oxidation that took place while the waste rock was stored on the surface. The fact that both MW-1013B and MW-1014B exhibit consistently neutral pH indicates that despite this variability, the limestone addition has been effective.

## 4.6 Future Pore Water Quality in Backfill

### 4.6.1 pH

As Figure 3 shows, pH measurements in the backfill are constant or increasing slightly with time. Results of the PHREEQ-C modeling confirmed that the pH of the samples taken from the backfill is controlled by equilibrium with the carbon dioxide and the solid carbonate mineral phases (calcite in the limestone). The calcite is present in excess, and the calculation shown in the next section indicate that the $CO_2$ would only dissipate over hundreds of years. Therefore, the pH in the backfill can be expected to remain near current levels for a similarly long time.

As the $CO_2$ concentrations drop, the pH will rise. Attachment 3 shows results of a PHREEQ-C run simulating the removal of carbon dioxide from the April 2000 sample from MW-1013C, in equilibrium with calcite. The pH rises from 6.6 to 7.6 as the $CO_2$ drops by a factor of ten. However, it would be incorrect to attribute the observed slight increases in pH, as shown in Figure 3, entirely to this effect, given the lack of evidence for a change in $CO_2$.

### 4.6.2 $CO_2$ Degassing

The rate of diffusion of carbon dioxide out of the backfill was estimated using Fick's Law. Diffusion through both the saturated backfill and an unsaturated soil layer were considered. The following assumptions were made:

- Dissolved $H_2CO_3$* is present in the pore water at the average for the April 2000 measurements.
- $CO_2$ (g) is present at equilibrium with the average $H_2CO_3$*.
- The unsaturated soil layer is 20 ft thick and has an effective diffusion coefficient of $1 \times 10^{-7}$ m²/s.
- The saturated backfill has an effective diffusion coefficient of $1 \times 10^{-9}\ m^2 s^{-1}$. Only the upper 10 ft of the saturated backfill was considered.
- Steady state diffusion, i.e. $flux = nD_eC_o/L$.

The results are summarized in Table 7, and indicate that the overall rate of $CO_2$ release will be limited by the rate of diffusion out of the saturated backfill, which is roughly two orders of magnitude lower than the rate of diffusion through the unsaturated soil. At these low rates, complete diffusion of the $CO_2$ out of the upper 10 feet of saturated backfill would take several hundred years.

### 4.6.3 Iron, Manganese, and Redox Potential

Figures 4 and 5, respectively, show that iron and manganese concentrations have been relatively constant. The implication is that the mechanisms controlling iron and manganese concentrations are stable. Any future changes in iron and manganese concentrations in the backfill would need to be driven by changes in pH or redox potential.

As discussed in Section 4.5.1, pH is expected to remain at current values until the carbon dioxide dissipates. Once the carbon dioxide dissipates and the pH rises, new solid phases may form. Results of the PHREEQ-C run in Attachment 3 show that the increased pH will favor the precipitation of ferihydrite ($Fe(OH)_3$). The saturation indices for siderite and rhodocrosite do not change significantly as the pH increases. Therefore, a future decrease in iron concentrations can be expected, but only over the long time frame required to dissipate the $CO_2$.

Redox potential in the backfill is likely controlled by the amorphous ferric hydroxide formed during the acid neutralization. There is a possibility that redox could change slowly over time, for example if the ferric hydroxide is reduced by contact with sulfide phases. However, it is not possible to draw conclusions about trends in redox potential, because only one set of Eh measurements is available.

It is possible to theorize about the effects of possible redox changes on iron and manganese solubility. A lowering of the redox potential would lead to increased solubility of (ferrous) iron, at least to the point of saturation with siderite. An increase in the redox potential would lead to precipitation of (ferric) iron. Manganese concentrations could be affected by an increase in redox potential. A significant increase in redox potential, say to the level associated with surface waters, would cause precipitation of the manganese as an oxide. A decrease in redox potential would not affect manganese concentrations.

In summary, given the stable pH, alkalinity, and major ion chemistry, future increases in iron and manganese concentrations are unlikely. Increases in iron concentrations would be expected if redox potential decreases.

### 4.6.4 Other Metals

The concentrations of other metals, such as copper and zinc, have also been relatively constant over the monitoring period. Copper concentrations are sensitive to pH. Any future increases in pH are likely to lead to lower copper concentrations. Neither zinc nor copper are strongly sensitive to redox potential within the expected range. Therefore, future increases in their concentrations are not expected. The spatial variability mentioned in Section 4.5 is likely to continue to be evident in future monitoring.

## 5. River and Groundwater Protection

To address the issue of Flambeau River and groundwater protection, it is important that an understanding of the conceptual model of hydrologic conditions relevant to facility compliance be understood. With this as background, a review of current hydrologic conditions and a comparison of the conceptual model to actual measured conditions can be completed.

### 5.1 Conceptual Model of Hydrologic Conditions Relevant to Facility Compliance

At the Flambeau site, regional groundwater generally flows from east/northeast to west/southwest. The Flambeau River to the west of the pit acts as a regional boundary for the discharge of groundwater flowing in the vicinity of the pit. During operations, pit dewatering depressed the water table locally around the open pit, thereby altering the local pattern of groundwater flow. During operations, localized groundwater in the immediate vicinity of the pit flowed into the pit, where it was pumped out and treated. In addition, water from the Flambeau River was drawn into the dewatered pit through fractured Precambrian bedrock that formed the western wall.

The original analysis of post-reclamation groundwater flow and compliance with groundwater quality standards predicted that after reclamation was completed, the groundwater system would recover and groundwater flow would be similar to pre-mining conditions (Prickett & Associates, 1989; and Foth & Van Dyke, 1989). Under this scenario, groundwater flowing through the pit would once again discharge at the regional groundwater discharge point formed by the Flambeau River. As such, it was concluded that dissolved constituents migrating out of the backfilled pit would also discharge to the regional groundwater discharge point (i.e., the Flambeau River). Furthermore, it was demonstrated that the small rate of pore water discharge to the Flambeau River, relative to the flow in the river, would not have a measurable impact on water quality in the Flambeau River.

### 5.2 Current Hydrologic Conditions/Verification of Conceptual Model

Since completion of the backfill program, the groundwater levels in the vicinity of the pit have been increasing. Figure 1 shows the regional groundwater potentiometric surface based on April 2000 data depicting the pattern of groundwater flow in the vicinity of the backfilled pit. The data displays an overall pattern of groundwater flow toward the Flambeau River. The contour map also shows a substantial amount of groundwater recovery around the backfilled pit, with locally convergent flow toward the backfilled pit. Lastly, the figure shows that higher heads exist within the backfill relative to downgradient groundwater monitoring points. The positive hydraulic gradient toward the river indicates that under current conditions pore water in the pit backfill is migrating, as was predicted to occur (Prickett & Associates, 1989; Foth & Van Dyke, 1989; and Engineering Technologies Associates, 1998), in a general direction toward the Flambeau River.

Overall, the water level trends indicate that the groundwater system is recovering and that the groundwater flow system is equilibrating to a condition that is similar to the pre-mining condition. The data collected to date also indicate that, as predicted at the time of permitting, pore water from the pit backfill is migrating toward the river. This conclusion is supported by the groundwater quality data collected from monitoring wells that surround the pit (Flambeau, 2000).

Groundwater elevation and quality data will continue to be collected in and around the backfilled pit in accordance with the project's monitoring plan. As the groundwater system recovers, the groundwater elevation and quality data will be evaluated to assess long term patterns of migration from the pit backfill.

Trend graphs of groundwater quality provided in Flambeau (2000) were also reviewed for this assessment. With the exception of well MW-1000PR, none of the wells show a noticeable increase in constituent concentrations relative to historical trends. MW-1000PR does show an increase in conductivity, alkalinity, hardness, iron, manganese, sulfate, and total dissolved solids. This increase is consistent with the original conceptual model developed at the time of permitting. Well MW-1000PR is screened within a weathered and highly fractured schist with disseminated pyrite that forms a strong hydraulic connection to the backfill. As the system has recovered, pore water has begun migrating through this fracture zone from the backfill toward the Flambeau River and well MW-1000PR. As such, this well is expected to yield water quality data and trends that are in fact similar to the backfill pore water quality discussed in Sections 3 and 4 above.

Surface water quality trends for the Flambeau River presented in Flambeau (2000) for sampling points SW-1 and SW-2, which are located upstream and downstream, respectively, of the backfilled pit, were also reviewed. The surface water quality trends show no change in water quality relative to historical trends. This data supports the original conceptual model (Foth & Van Dyke, 1989) that the small amount of pore water predicted to discharge into the Flambeau River will not affect water quality in the river.

As the groundwater system fully recovers, the gradient between the backfilled pit and river will increase, leading to a greater flux of pore water to the river. To assess this future condition, the volumetric flux from the backfill under completely recovered conditions has been calculated using Darcy's law. Using post-mining steady-state predictive results from the regional groundwater flow model (Engineering Technologies Associates, 1998), the following parameters were used in the Darcy calculation:

- the permeability (K) of the backfill is 0.028 ft/d;
- the hydraulic gradient (I) between the western end of the pit and the Flambeau River is 0.03 ft/ft; and
- the cross-sectional area (A) is equal to the approximate pit width (w) of 650 ft and thickness of the upper Precambrian aquifer (b) of 100 ft.

0.28gpm

Based on these parameter values, the flux of pore water (Q = K*I*A) to the river was calculated to be 54.6 cubic feet per day (cfd), or 6.3e-4 cubic feet per second (cfs). The average flow in the Flambeau River is 1,749 cfs. The 10-year, 7-day low flow in the Flambeau River is 412 cfs. Given these flow values, the concentration reduction factor for mixing the pore water with the flow in the river is arrived at by dividing the pore water flux by the flow in the river, and ranges from 0.0000015 under low flow conditions to 0.00000037 under average flow conditions. The incremental increases in solute concentrations in the river due to the pore water flux can then be estimated by multiplying the concentration reduction factor by the pore water concentration.

Using the April 2000 highest measured pore water concentrations at well nests MW-1013 and MW-1014, or monitoring well MW-1000PR, the range of the incremental increase in the river under fully recovered groundwater conditions are as shown in Table 8.

Based on the surface water quality trends presented in Flambeau, 2000, the background copper concentration in the Flambeau River is on the order of 0.004 mg/L. The potential increase in copper concentration is orders of magnitude below existing conditions, and would be immeasurable. Background concentrations for iron, manganese, and sulfate are provided in the project's *Environmental Impact Report* (Foth & Van Dyke, 1989a). The background concentration of iron in the Flambeau River ranged between 0.16 mg/L and 0.54 mg/L. The potential increase in iron concentration is orders of magnitude below this range, and would be immeasurable. Likewise for manganese, the background concentration ranged from <0.05 mg/L to 0.08 mg/L. The potential increase in manganese is several orders of magnitude below background, and would be immeasurable. Finally, with respect to sulfate, the background concentrations ranged between <5 mg/L and 15 mg/L. Again, the potential increase in sulfate is orders of magnitude below background and would be immeasurable.

In summary, the potential for backfill pore water to impact water quality in the Flambeau River is virtually non-existent because the potential incremental increases are orders of magnitude below background. Finally, note that the above analysis is conservative, since attenuating reactions such as adsorption are not considered.

229944 f³/d = 2.66 f³/s     2.66 / 412 = 0.00646

Cu max = .43 mg/L x .00646 = .00278

Sulfate max = 16000 x .00646 = 10.33

## 6. Summary

As part of the permitting effort for the Flambeau Project, assessments were completed to determine if the reclaimed site would comply with permitted groundwater quality standards at the compliance boundary and protect surface water quality in the Flambeau River. The original assessment relied on predicted post-mining hydrologic conditions to conclude that the Flambeau River would act as a hydrologic boundary for pore water migrating from the pit backfill and that backfill pore water would not migrate to the downgradient compliance boundary. In addition, the original analysis showed that the flux of backfill pore water into the river would be so small relative to the flow in the river that surface water quality would not experience a measurable change.

Environmental monitoring data from the reclaimed site supports the original analysis. This conclusion is based on the following:

- Groundwater elevation measurements show that regional groundwater, including backfill pore water, is again flowing toward the Flambeau River as predicted.
- Backfill pore water is in equilibrium with calcite and gypsum, indicating complete neutralization of the acidity.
- Consistent results in samples collected from 1998 through 2000 demonstrate that the concentrations of solutes in the backfill pore water are stable.
- Groundwater quality from the western end of the backfilled pit has, as expected, a signature that is consistent with the backfilled pit pore water, while all other monitoring wells show no change in water quality relative to historical trends.
- Surface water quality data show that the pit backfill is not affecting water quality in the Flambeau River.
- Calculations also show that after the hydrogeologic system is completely recovered, the flux of pore water from the backfill will be negligible with respect to its potential impact on water quality in the Flambeau River.

Given the hydrologic conditions at the site, the environmental monitoring data show that the Flambeau Mine is in compliance with groundwater quality permit conditions and that water quality in the Flambeau River is protected.

## 7. Recommendations

Based on the above assessment and conclusions, SRK and Foth & Van Dyke recommend that:

- Flambeau continue to monitor Flambeau River water quality for iron, manganese, and sulfate to provide current data on concentrations of these parameters.

- With the exception of the two items listed below, monitoring of groundwater within and around the backfilled pit should continue to be performed in accordance with the program contained in the project's approved monitoring plan (Foth & Van Dyke, 1991). An annual review of the data should be included in the project's annual report to determine if conditions affecting the conclusions reached in this memorandum remain consistent. As additional data are collected and the continuation of stable conditions is documented, consideration can be given to reducing the frequency of monitoring within the backfilled pit.

- $CO_2$ sampling be performed according to the April 2000 method for one more sampling period. If $CO_2$ and alkalinity data continue to be correlated, $CO_2$ sampling and analysis should be discontinued, with alkalinity data used to assess any future changes in the effects of $CO_2$ pore water quality in the backfilled pit.

- Eh measurements should be taken each quarterly sampling event until trends, or lack thereof, become evident.

## 8. References

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## Table 1

## Monitoring Wells and Screen Gravel Pack Mid-Point Elevations

| Well | Mid-Point Elevation (ft)[1] |
|---|---|
| MW-1000R | 1089.75 |
| MW-1000PR | 1049.00 |
| MW-1002 | 1092.13 |
| MW-1002G | 1053.71 |
| MW-1004 | 1109.55 |
| MW-1004S | 1091.25 |
| MW-1004P | 1040.81 |
| MW-1005 | 1129.95 |
| MW-1005S | 1095.59 |
| MW-1005P | 1054.17 |
| MW-1010P | 988.68 |
| MW-1013 | 1102.9 |
| MW-1013A | 1080.7 |
| MW-1013B | 1040.8 |
| MW-1013C | 926.1 |
| MW-1014 | 1111.8 |
| MW-1014A | 1081.6 |
| MW-1014B | 1040.6 |
| MW-1014C | 988.8 |

[1] Elevation of the mid-point of the gravel pack around the well screen.

# Table 2

## Summary of Monitored Parameters

| Parameter | Units | Quarterly[1] | Annual[2] | Expanded[3] |
|---|---|---|---|---|
| Alk, T | (mg/L) | x | x | x |
| As | (ug/L) | | x | x |
| Ba | (ug/L) | | x | x |
| Cd | (ug/L) | | x | x |
| Ca | (mg/L) | | | x |
| Cl | (mg/L) | | | x |
| Cr, T | (ug/L) | | x | x |
| Cu | (ug/L) | x | x | x |
| Hardness, T | (mg/L) | x | x | x |
| Fe | (mg/L) | x | x | x |
| Pb | (ug/L) | | x | x |
| Mg | (mg/L) | | | x |
| Mn | (ug/L) | x | x | x |
| Hg | (ug/L) | | x | x |
| Field pH | (s.u.) | x | x | x |
| Lab pH | (s.u.) | x | x | x |
| K | (mg/L) | | | x |
| Se | (ug/L) | | x | x |
| Ag | (ug/L) | | x | x |
| Na | (mg/L) | | | x |
| TDS | (mg/L) | x | x | x |
| Sulfate | (mg/L) | x | x | x |
| Zn | (ug/L) | | x | x |
| Color | (After Filter) | x | x | x |

Table 2 *(Continued)*

| Parameter | Units | Quarterly[1] | Annual[2] | Expanded[3] |
|---|---|---|---|---|
| Field Cond | (µmho) | x | x | x |
| Odor | | x | x | x |
| Turbidity | (Purging) | x | x | x |
| $CO_2$ | (ug/L) | | | See Note 4 |
| Redox | (mv) | | | See Note 4 |

[1] Quarterly parameter list for all wells for January, April, and October sampling events.

[2] Annual parameter list for all wells for July sampling event.

[3] Expanded parameter list was performed in July and October 1999 and April 2000 for monitoring well MW-1005P and for those wells included in the MW-1013 and MW-1014 well nests that contained water to assist in the assessment described in this memorandum.

[4] $CO_2$ tests were conducted in October 1999 and April 2000, and field redox potential tests were performed in April 2000 for monitoring well MW-1005P and for those wells included in the MW-1013 and MW-1014 well nests that contained water to assist in the assessment described in this memorandum.

# Table 3

## Comparison of Carbon Dioxide and Alkalinity Measurements

| Well | Sample Date | Temperature °C | Measured $H_2CO_3$* (mmol/L) | Measured Alkalinity (meq/L) | Total Inorganic Carbon (mmol/L) Calculated from $CO_2$ | Total Inorganic Carbon (mmol/L) Calculated from Alkalinity |
|---|---|---|---|---|---|---|
| MW-1013B | Apr-00 | 8.7 | 10.7 | 10.4 | 24 | 18 |
| MW-1013C | Apr-00 | 8.7 | 6.1 | 9.2 | 16 | 15 |
| MW-1014A | Apr-00 | 11.2 | 3.4 | 7.8 | 13 | 11 |
| MW-1014B | Apr-00 | 14.2 | 12.6 | 9.6 | 24 | 20 |
| MW-1014C | Apr-00 | 11.9 | 5.8 | 6.4 | 16 | 10 |
| MW-1005P | Apr-00 | 6.4 | 0.7 | 5.0 | 5.4 | 5.8 |
| MW-1013B | Oct-99 | 14.2 | 4.1 | 10.8 | 10 | 18 |
| MW-1013C | Oct-99 | 9.6 | 3.2 | 8.0 | 10 | 12 |
| MW-1014B | Oct-99 | 12.1 | 6.8 | 11.4 | 13 | 24 |
| MW-1014C | Oct-99 | 9.9 | 3.6 | 7.6 | 8.6 | 13 |
| MW-1005P | Oct-99 | 9.8 | 0.6 | 4.8 | 4.6 | 5.5 |

Note: Data for monitoring wells MW-1013, MW-1013A, MW-1014, and MW-1014A are not available in October 1999 since the wells were dry at the time of sample collection. Similarly, monitoring data for monitoring wells MW-1013, MW-1013A, and MW-1014 are not available for the April 2000 sampling event.

Note: $H_2CO_3^* = CO_2(aq) + H_2CO_3$

## Table 4

## Estimates of Carbon Dioxide Gas in Equilibrium with April 2000 Samples

| Well | Sample Date | $H_2CO_3$* (mmol/L) | $K_H$[1] (mol atm$^{-1}$) | $pCO_2$ (atm) | Head on Sample (feet) | P[2] (atm) | Mole Fraction $CO_2$ in gas |
|---|---|---|---|---|---|---|---|
| MW-1013B | Apr-00 | 7.7 | 17.8 | 0.138 | 55 | 2.62 | 5.2% |
| MW-1013C | Apr-00 | 5.6 | 17.8 | 0.100 | 171 | 6.04 | 1.7% |
| MW-1014A | Apr-00 | 2.9 | 19.2 | 0.055 | 28 | 1.83 | 3.0% |
| MW-1014B | Apr-00 | 10.3 | 20.5 | 0.211 | 68 | 3.01 | 7.0% |
| MW-1014C | Apr-00 | 3.6 | 19.7 | 0.071 | 116 | 4.42 | 1.6% |
| MW-1005P | Apr-00 | 0.8 | 16.2 | 0.013 | 83 | 3.45 | 0.4% |

1 Corrected for sample temperature
2 Absolute pressure at sample depth.

## Table 5

## Comparison of Carbon Dioxide Gas Concentrations to Measurements Elsewhere

| Measurements In | Source | Range of $CO_2$ (g) |
|---|---|---|
| Flambeau Backfill (MW-1013 & MW-1014) | Table 4 | 1.6% - 7.0% |
| Flambeau Background (MW-1005P) | Table 4 | 0.4% |
| Survey of data from world soils | Brook et al. (1983) | 0.2% to 3.2% |
| Survey of data from calcareous springs | Harmon et al. (1975) | $\log pCO_2 = -3.3 + 0.08$ T<br>$CO_2 = 0.13\%$ at 5°C<br>$CO_2 = 0.79\%$ at 15°C |

# Table 6

## Summary of PHREEQ-C Runs to Check Saturation of Calcite and Gypsum

| Sample Data Set | Conditions | | | Saturation Index | | | | |
|---|---|---|---|---|---|---|---|---|
| | T (°C) | pH | pe[5] | Calcite/ Aragonite | Gypsum | $Fe(OH)_3$ (am) | Siderite | Rhodocrosite |
| MW-1013B[1] | 8.7 | 6.63 | 4.11 | 0.24 / 0.08 | -0.03 | -0.23 | -1.01 | 1.36 |
| MW-1013C[2] | 8.5 | 6.73 | 3.17 | 0.15 / 0.00 | -0.01 | -0.08 | -0.25 | 0.73 |
| MW-1014A | 11.2 | 6.87 | 2.93 | 0.13 / -0.02 | -0.36 | -0.23 | -0.49 | 0.91 |
| MW-1014B[3] | 14.2 | 6.43 | 5.09 | -0.02 / -0.17 | -0.07 | -0.34 | -1.16 | 0.99 |
| MW-1014C | 11.9 | 6.65 | 1.56 | -0.02 / 0.17 | -0.64 | -0.82 | 0.76 | 0.49 |
| MW-1005P[4] | 15.9 | 6.91 | 1.08 | -0.37 / -0.52 | -2.83 | -2.66 | -1.24 | -1.00 |

[1] April 2000 data with sulfate adjusted upward to 1500 mg/L to improve ion balance.
[2] April 2000 data with calcium adjusted upward to 290 mg/L to improve ion balance.
[3] In the April 2000 data, the iron detection limit was anomalously high (0.15 mg/L). In the PHREEQ runs, the iron concentration was set to 0.06 mg/L, as measured in other samples from this well.
[4] Combination of analytical data from the July 1999 sample with Eh and alkalinity data from the April 2000 sample.
[5] The PHREEQ model uses "pe" as a measure of redox potential. The "pe" values were obtained by converting measured Eh values (at the measured temperature).

# Table 7

## Estimated $CO_2$ Fluxes through Unsaturated Soil and Saturated Waste Rock

| Component | $C_o$ (mol/m³) | $D_e$ (m²/s) | Porosity $n$ | $L$ (ft) | $CO_2$ Flux (mol m⁻² s⁻¹) |
|---|---|---|---|---|---|
| Unsaturated Soil (Gas) | 1.3 | $1.0 \times 10^{-6}$ | 0.3 | 20 | $6.5 \times 10^{-8}$ |
| Saturated Backfill (Water) | 6.56 | $1.0 \times 10^{-9}$ | 0.3 | 10 | $6.5 \times 10^{-10}$ |

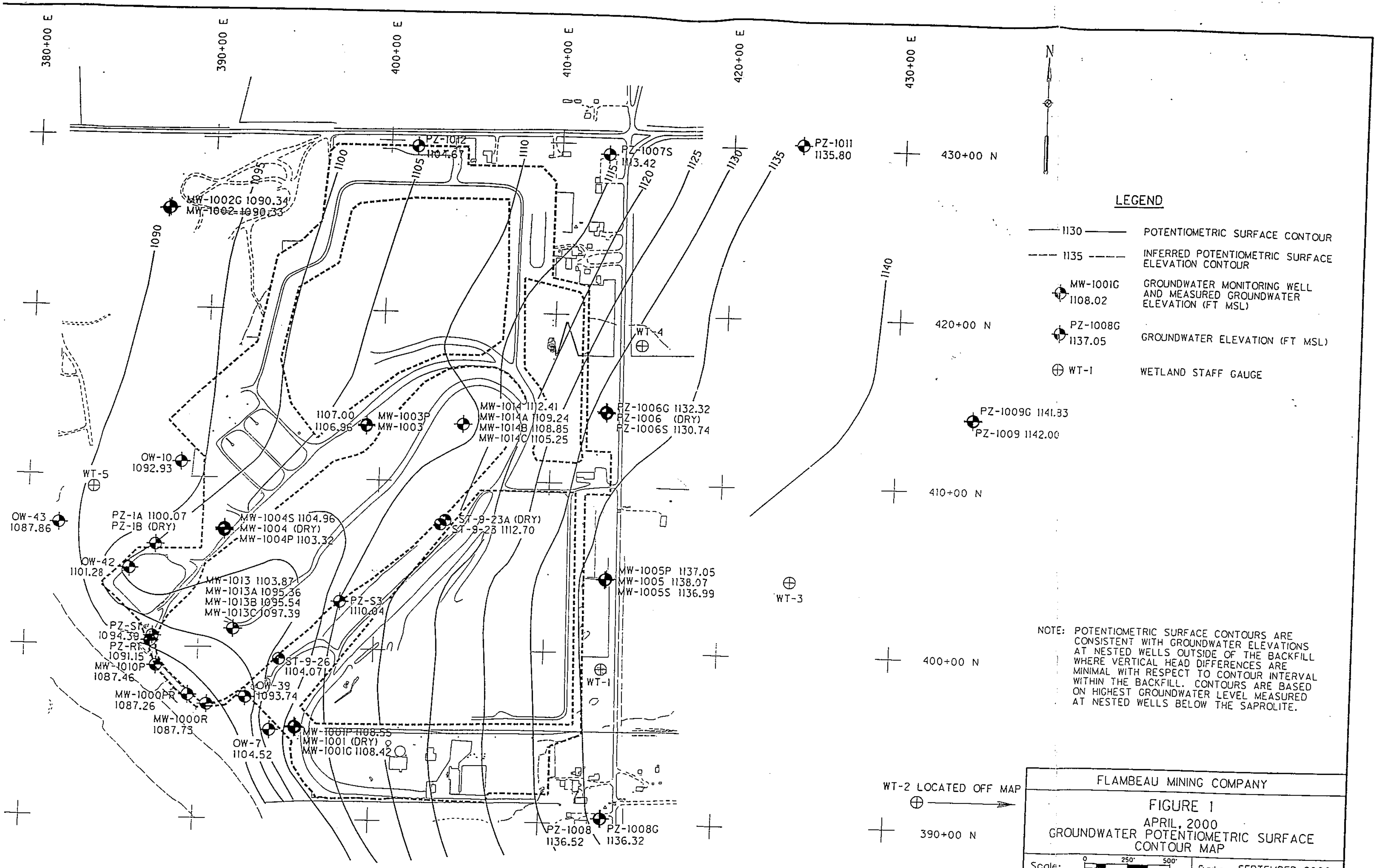
$C_o$ = Initial Concentration
$D_e$ = Effective Diffusion Coefficient
L = Diffusion Distance

# Table 8

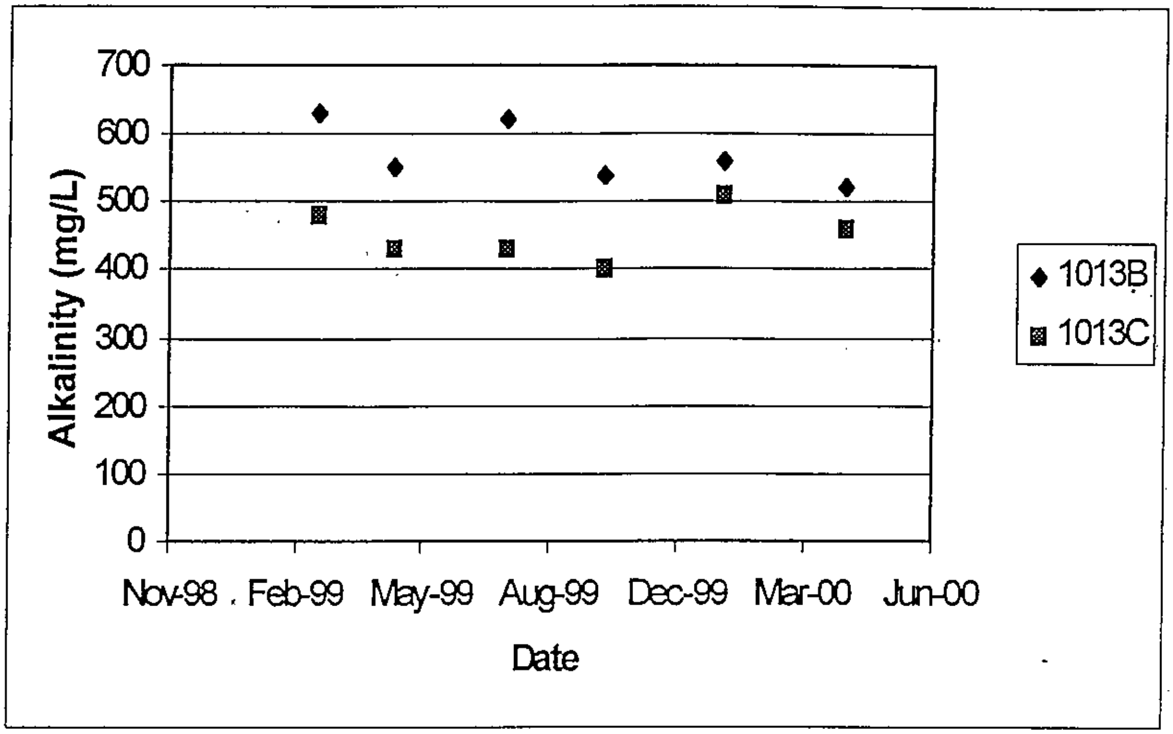
## Range of Estimated Incremental Increases in the Flambeau River

| | Incremental Increase | |
|---|---|---|
| | Average Flow (mg/L) | Low Flow (mg/L) |
| Copper | 0.00000029 | 0.0000012 |
| Iron | 0.0000054 | 0.000022 |
| Manganese | 0.000012 | 0.000048 |
| Sulfate | 0.00072 | 0.003 |

# FIGURES




3411.dgn 09/15/2000 11:13:32 AM



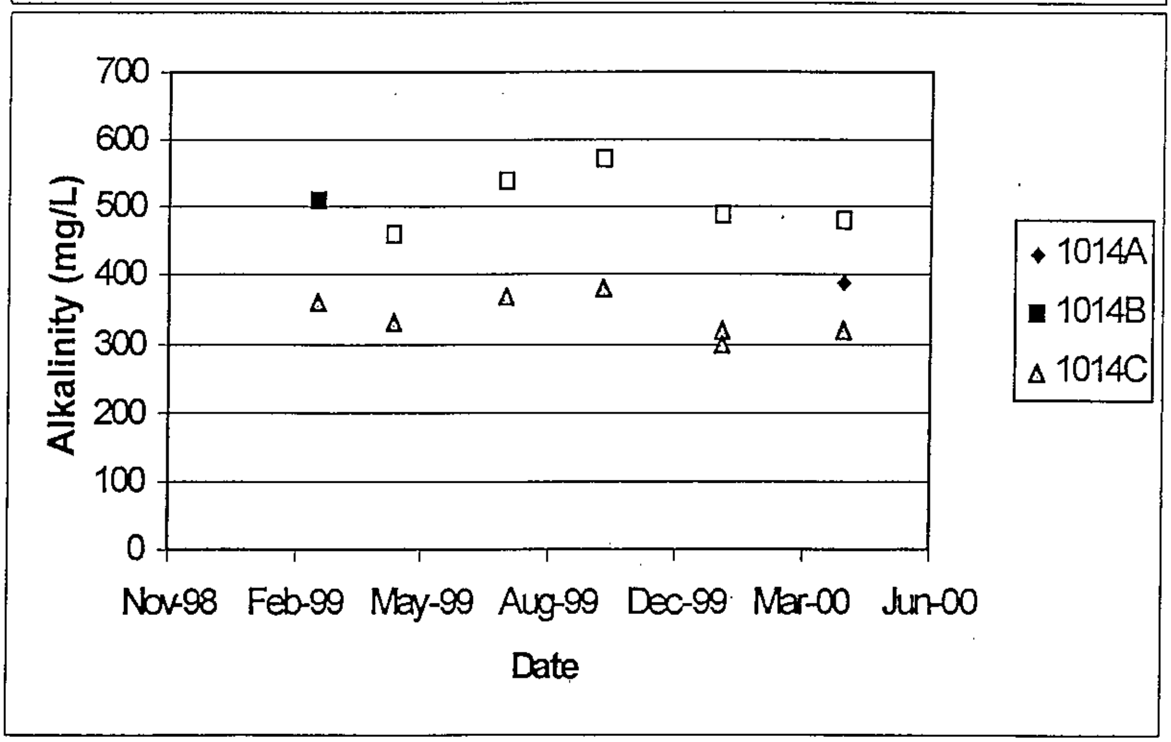




**Figure 2. Dissolved Alkalinity Measured in the Backfill Pore Water**

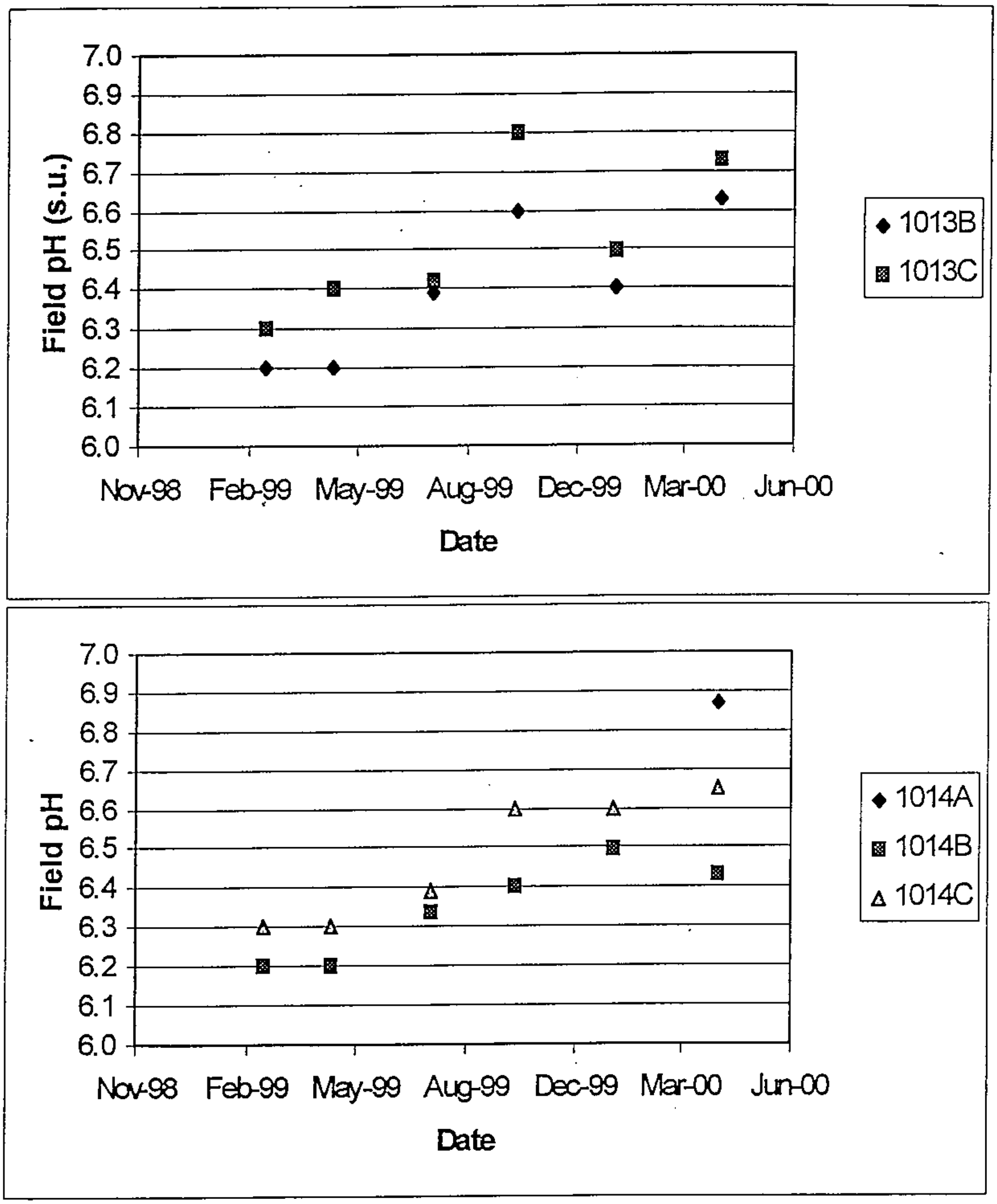



**Figure 3. Field pH Measurements in the Backfill Pore Water**

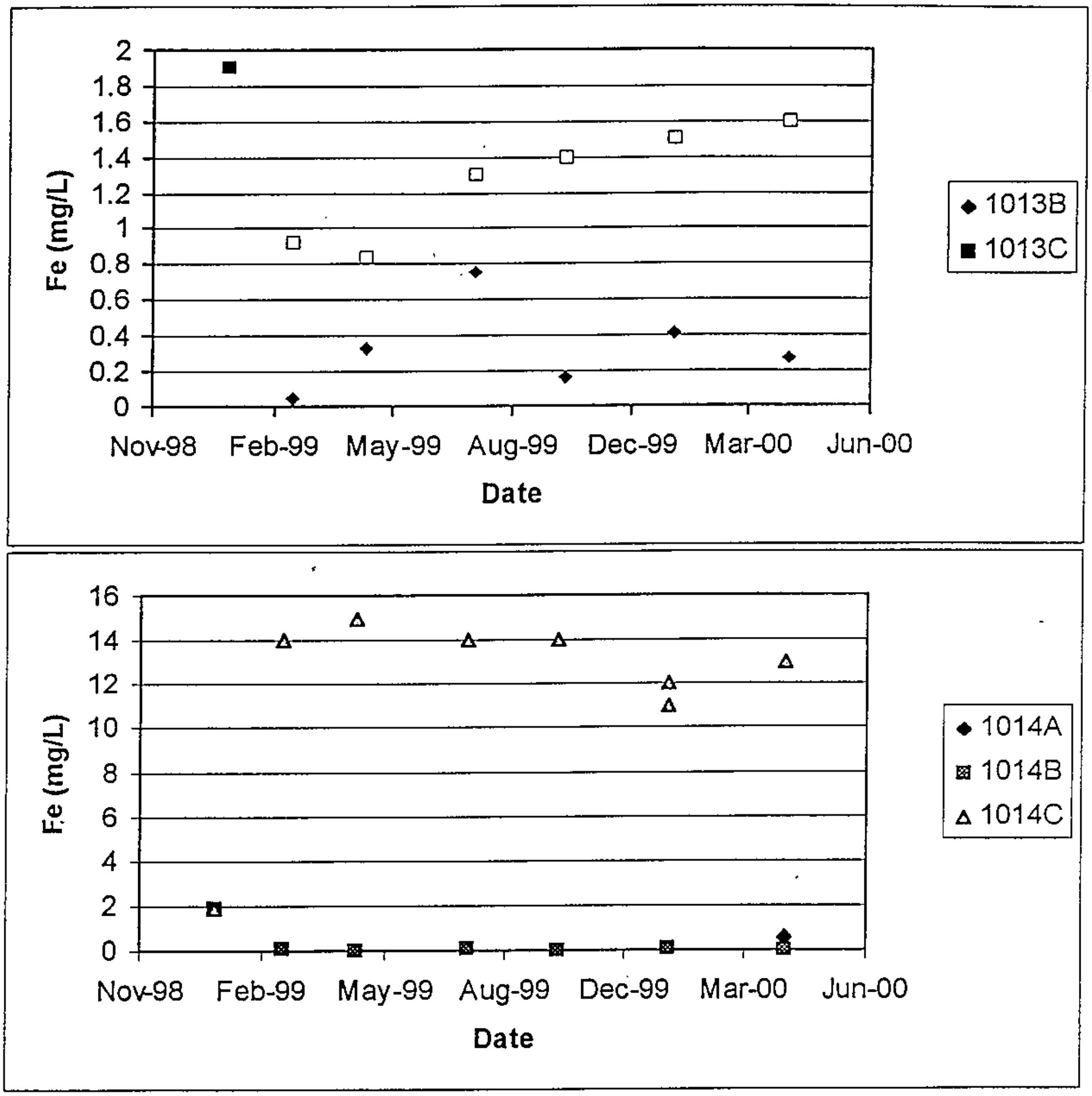



**Figure 4. Dissolved Iron Measured in the Backfill Pore Water**

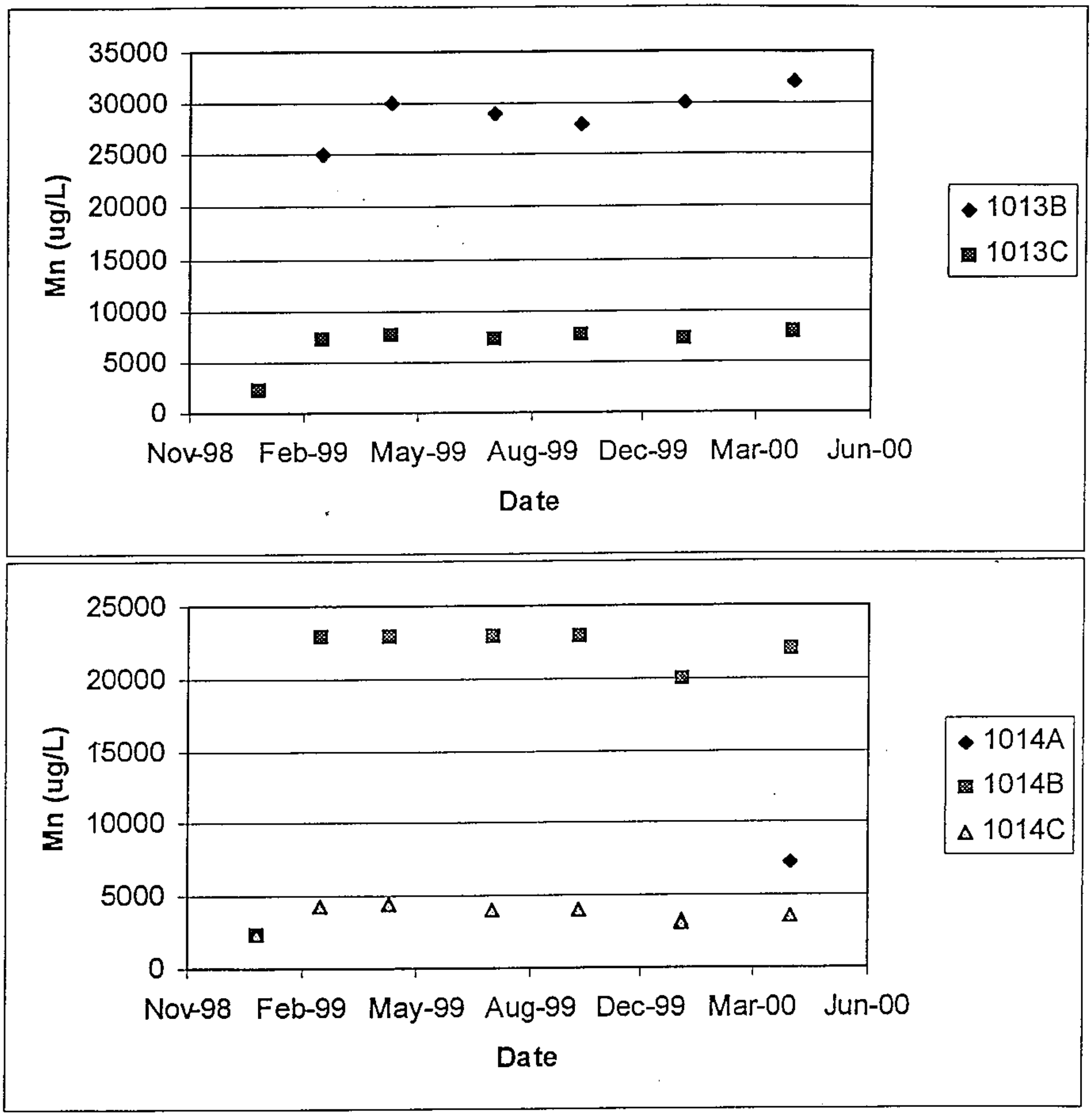



**Figure 5. Dissolved Manganese Measured in the Backfill Pore Water**

# Attachment 1

# Flambeau Groundwater Monitoring System Data Base

Well MW-1000PR Original Well Depth: 57.37' Reestablished as MW-1000P-R in 3/96 1998 Adj. Depth: 57.8'

| | | Alk (mg/l) | As (ug/l) | Ba (ug/l) | Cd (ug/l) | Ca (mg/l) | Cl (mg/l) | Cr (ug/l) | Cu (ug/l) | Hard (mg/l) | Fe (mg/l) | Pb (ug/l) | Mg (mg/l) | Mn (ug/l) | Hg (ug/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Standard | | | | | | | | | | | | | | | |
| L or Model | | | | | 9 | | | | 560 | | 1.9 | | | 2300 | |
| Jul-91 | | 65 | | | | | | | <14 | 84 | 0.65 | | | 850 | |
| Oct-91 | | 90 | | | | | | | <14 | 110 | 0.84 | | | 880 | |
| Jan-92 | | 88 | | | | | | | <14 | 110 | 1.7 | | | 820 | |
| Apr-92 | | 84 | | | | | | | <14 | 88 | 1.3 | | | 830 | |
| Jul-92 | | 81 | | | | | | | 14 | 120 | 0.47 | | | 730 | |
| Oct-92 | | 95 | | | | | | | <14 | 100 | 0.8 | | | 780 | |
| Jan-93 | | 84 | | | | | | | <14 | 88 | 0.15 | | | 710 | |
| Apr-93 | | 82 | | | | | | | 20 | 90 | 0.27 | | | 940 | |
| Jul-93 | | 82 | | | | | | | 16 | 86 | 0.061 | | | 730 | |
| Oct-93 | | 62 | | | | | | | 13 | 120 | 0.032 | | | 910 | |
| Jan-94 | | 43 | | | | | | | 22 | 54 | <0.015 | | | 340 | |
| Apr-94 | | 44 | | | | | | | 23 | 54 | 0.021 | | | 500 | |
| Jul-94 | | 39 | | | | | | | 17 | 49 | 0.026 | | | 420 | |
| Oct-94 | | 34 | | | | | | | 58 | 36 | 0.047 | | | 360 | |
| Jan-95 | | 30 | | | | | | | 52 | 36 | 0.12 | | | 290 | |
| Apr-95 | | 38 | | | | | | | 58 | 35 | 0.026 | | | 320 | |
| Jul-95 | | 34 | | | | | | | 43 | 36 | 0.0096 | | | 240 | |
| Oct-95 | | 36 | | | | | | | 61 | 39 | 0.027 | | | 110 | |
| Jan-96 | | 27 | | | | | | | 49 | 33 | 0.011 | | | 54 | |
| Apr-96 | | 53 | | | | | | | 31 | 40 | 0.018 | | | 64 | |
| Jul-96 | | 35 | | | | | | | 33 | 38 | 0.0066 | | | 120 | |
| Oct-96 | | 38 | | | | | | | 57 | 36 | 0.010 | | | 140 | |
| Jan-97 | | 27 | | | | | | | 33 | 33 | 0.0093 | | | 150 | |
| Apr-97 | | 36 | | | | | | | 32 | 43 | 0.043 | | | 190 | |
| Jul-97 | | 33 | | | | | | | 29 | 39 | 0.0079 | | | 61 | |
| Oct-97 | | 40 | | | | | | | 34 | 45 | 0.0044 | | | 110 | |
| Jan-98 | | 54 | | | | | | | 40 | 110 | 0.0061 | | | 490 | |
| Apr-98 | | 93 | | | | | | | 98 | 470 | 0.0440 | | | 3000 | |
| Jul-98 | | 71 | | | | | | | 66 | 480 | 0.076 | | | 1800 | |
| Oct-98 | | 100 | | | | | | | 53 | 570 | 0.012 | | | 2000 | |
| Feb-99 | | 120 | | | | | | | 37 | 760 | 1.2 | | | 4800 | |
| Apr-99 | | 120 | | | | | | | 54 | 740 | 1.2 | | | 5300 | |
| Apr-99 | D | 120 | | | | | | | 55 | 770 | 1.3 | | | 5300 | |
| Jul-99 | | 130 | <42 | <50 | 28 | 220 | 10 | <4.2 | 130 | 770 | 3.3 | <14 | 61 | 5400 | <0.050 |
| Jul-99 | D | 120 | <42 | <50 | <21 | 220 | 10 | <4.2 | 97 | 770 | 3.2 | <14 | 62 | 5600 | <0.050 |
| Oct-99 | | 130 | <8.4 | 43 | <2.1 | 210 | 11 | 2.6 | 17 | 760 | 3.6 | <2.9 | 56 | 5200 | <0.050 |
| Jan-00 | | 140 | | | | | | | 1.9 | 670 | 4.4 | | | 4100 | |
| Apr-00 | | 140 | | | | | | | 19 | 720 | 3.4 | | | 3800 | |
| Apr-00 | D | 150 | | | | | | | 18 | 700 | 4.3 | | | 4000 | |

| | | Field pH (s.u.) | Lab pH (s.u.) | K | Se (ug/l) | Ag (ug/l) | Na (mg/l) | TDS (mg/l) | Sulf (mg/l) | Zn (ug/l) | Color (After Filter) | Field Cond (umho) | Odor | Turbidity (Purging) | Temp (°C) | Grd Water El (Feet) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Standard | | | | | | | | | | | | | | | | |
| L or Model | | | | | | | | | 1043 | | | | | | | |
| Jul-91 | | | 6.8 | | | | | 190 | <10 | | | | | | | |
| Oct-91 | | | 6.9 | | | | | 160 | <10 | | | | | | | |
| Jan-92 | | | 6.4 | | | | | 120 | 11 | | | | | | | |
| Apr-92 | | | 6.7 | | | | | 120 | 14 | | | | | | | |
| Jul-92 | | | 7.1 | | | | | 140 | 12 | | | | | | | |
| Oct-92 | | | 7.1 | | | | | 160 | 12 | | | | | | | |
| Jan-93 | | | 6.5 | | | | | 100 | <10 | | | | | | | |
| Apr-93 | | | 6.4 | | | | | 130 | 12 | | | | | | | |
| Jul-93 | | | 6.3 | | | | | 140 | 15 | | | | | | | |
| Oct-93 | | 7.0 | 6.5 | | | | | 110 | 12 | | | 233 | | | | 1074.86 |
| Jan-94 | | 6.9 | 6.5 | | | | | 70 | 12 | | | 135 | | | | 1073.75 |
| Apr-94 | | 7.7 | 6.6 | | | | | 95 | 12 | | | 124 | | | | 1071.98 |
| Jul-94 | | 7.5 | 6.5 | | | | | 90 | 11 | | | 133 | | | | 1071.01 |
| Oct-94 | | 7.2 | 6.6 | | | | | 120 | 17 | | None | 116 | None | V. Sl. | | 1071.03 |
| Jan-95 | | 7.1 | 7.1 | | | | | 88 | 9.0 | | None | 116 | None | None | | 1068.79 |
| Apr-95 | | 7.4 | 6.8 | | | | | 90 | 14.0 | | None | 106 | None | Slight | | 1070.00 |
| Jul-95 | | 8.1 | 6.4 | | | | | 99 | 10 | | None | 116 | None | None | | 1070.99 |
| Oct-95 | | 7.3 | 6.7 | | | | | 75 | 11 | | None | 119 | None | None | | 1071.39 |
| Jan-96 | | 6.9 | 5.9 | | | | | 87 | 8.5 | | None | 112 | None | None | | 1069.64 |
| Apr-96 | | 7.1 | 7.2 | | | | | 130 | 16 | | None | 149 | None | None | | 1066.98 |
| Jul-96 | | 7.3 | 7.1 | | | | | 140 | 9.3 | | None | 114 | None | None | | 1070.33 |
| Oct-96 | | 7.4 | 7.2 | | | | | 76 | 7.1 | | None | 109 | None | None | | 1068.99 |
| Jan-97 | | 7.2 | 6.6 | | | | | 160 | 9.8 | | None | 112 | None | None | | 1070.35 |
| Apr-97 | | 7.5 | 7.1 | | | | | 160 | 9.9 | | None | 133 | None | None | | 1072.62 |
| Jul-97 | | 6.7 | 6.6 | | | | | 110 | 7.8 | | None | 107 | None | None | | 1073.70 |
| Oct-97 | | 6.6 | 6.7 | | | | | 82 | 5.9 | | None | 132 | None | None | | 1087.37 |
| Jan-98 | | 6.5 | 6.4 | | | | | 96 | 180 | | None | 576 | None | None | | 1087.51 |
| Apr-98 | | 6.7 | 6.5 | | | | | 770 | 310 | | None | 888 | None | None | | 1089.61 |
| Jul-98 | | 6.3 | 6.6 | | | | | 250 | 350 | | None | 1097 | None | None | | 1086.30 |
| Oct-98 | | 6.2 | 6.7 | | | | | 960 | 480 | | None | 1338 | None | None | | 1086.24 |
| Feb-99 | | 6.2 | 6.5 | | | | | 1200 | 560 | | None | 1293 | None | None | 9.7 | 1086.21 |
| Apr-99 | | 6.2 | 6.7 | | | | | 1300 | 440 | | None | 1319 | None | None | 14.3 | 1086.61 |
| Apr-99 | D | --- | 8.0 | | | | | 1200 | 340 | | --- | --- | --- | --- | --- | --- |
| Jul-99 | | 6.1 | 6.2 | 2.6 | <1.3 | <4.5 | 10 | 1300 | 380 | 890 | None | 1310 | None | None | 16.3 | 1087.96 |
| Jul-99 | D | --- | 6.2 | 2.8 | 1.6 | <4.5 | 10 | 1300 | 350 | 880 | --- | --- | --- | --- | --- | --- |
| Oct-99 | | 6.7 | 6.3 | 2.9 | <1.3 | <0.90 | 7.9 | 1100 | 680 | 730 | None | 1400 | None | None | 12.7 | 1086.75 |
| Jan-00 | | 6.3 | 6.2 | | | | | 1000 | 610 | | None | 1300 | None | None | 12.0 | 1086.61 |
| Apr-00 | | 6.9 | 6.0 | | | | | 920 | 560 | | None | 1274 | None | None | 8.4 | 1087.26 |
| Apr-00 | D | --- | 6.0 | | | | | 1000 | 550 | | --- | --- | --- | --- | --- | --- |

Well MW-1004S Original Well Depth: 38.02' 1998 Adj. Depth: 27.0'

| Date | Alk (mg/l) | As (ug/l) | Ba (ug/l) | Cd (ug/l) | Ca (mg/l) | Cl (mg/l) | Cr (ug/l) | Cu (ug/l) | Hard (mg/l) | Fe (mg/l) | Pb (ug/l) | Mg (mg/l) | Mn (ug/l) | Hg (ug/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| il-91 | 50 | | | | | | | <14 | 60 | <0.055 | | | <4.0 | |
| :t-91 | 49 | | | | | | | <14 | 60 | <0.055 | | | <4.0 | |
| n-92 | 27 | | | | | | | <14 | 62 | <0.055 | | | <4.0 | |
| ır-92 | 60 | | | | | | | <14 | 72 | <0.055 | | | <4.0 | |
| il-92 | 74 | | | | | | | <14 | 150 | <0.055 | | | <4.0 | |
| :t-92 | 100 | | | | | | | <14 | 110 | <0.055 | | | <4.0 | |
| n-93 | 73 | | | | | | | <14 | 92 | <0.055 | | | <4.0 | |
| ır-93 | 51 | | | | | | | <10 | 70 | <0.010 | | | <4.0 | |
| l-93 | 24 | | | | | | | <12 | 56 | <0.015 | | | <4.0 | |
| t-93 | 32 | | | | | | | <12 | 46 | <0.015 | | | <4.0 | |
| -94 | 42 | | | | | | | 16 | 44 | <0.015 | | | <4 | |
| r-94 | 38 | | | | | | | <12 | 51 | <0.015 | | | <4 | |
| l-94 | 140 | | | | | | | <12 | 52 | <0.015 | | | <4 | |
| t-94 | 44 | | | | | | | <1.6 | 54 | 0.0064 | | | <0.47 | |
| -95 | 100 | | | | | | | 1.1 | 57 | 0.0049 | | | 3.4 | |
| r-95 | 55 | | | | | | | 7.0 | 45 | 0.0087 | | | 0.87 | |
| l-95 | 50 | | | | | | | 6.6 | 50 | 0.0031 | | | 0.5 | |
| t-95 | 79 | | | | | | | 7.6 | 59 | 0.0040 | | | 1.3 | |
| -96 | 50 | | | | | | | 3.4 | 54 | 0.0038 | | | 1.1 | |
| r-96 | 61 | | | | | | | 2.6 | 52 | 0.0048 | | | 0.32 | |
| -96 | 55 | | | | | | | 3.9 | 46 | 0.0023 | | | 0.72 | |
| t-96 | 66 | | | | | | | 1.8 | 59 | 0.0049 | | | 0.29 | |
| -97 | 61 | | | | | | | 5.1 | 62 | 0.0061 | | | 0.25 | |
| -97 | 60 | | | | | | | 1.8 | 59 | 0.0049 | | | 0.72 | |
| -97 | 55 | | | | | | | 2.0 | 64 | 0.0091 | | | 0.38 | |
| :-97 | 58 | | | | | | | 1.6 | 75 | 0.0057 | | | 0.93 | |
| -98 | 48 | | | | | | | 1.6 | 58 | 0.0027 | | | 0.30 | |
| -98 | 47 | | | | | | | 0.9 | 60 | 0.0049 | | | 0.52 | |
| -98 | 40 | | | | | | | 1.4 | 60 | 0.0054 | | | 0.29 | |
| :-98 | 48 | | | | | | | 1.1 | 60 | 0.0029 | | | 0.45 | |
| -99 | 44 | | | | | | | 0.60 | 59 | 0.0050 | | | 0.62 | |
| -99 | 46 | | | | | | | 1.7 | 60 | 0.0037 | | | 0.87 | |
| -99 | 40 | <4.2 | <5.0 | <2.1 | 15 | 4.4 | <0.42 | <6.9 | 59 | 0.0068 | <1.4 | 5.6 | 2.3 | <0.050 |
| -99 | 41 | <4.2 | <5.0 | 0.38 | 15 | 4.4 | 0.88 | 0.83 | 57 | 0.0089 | <1.4 | 4.9 | 0.63 | <0.050 |
| -00 | 43 | | | | | | | <0.47 | 59 | 0.0051 | | | 0.65 | |
| -00 | 42 | | | | | | | 1.3 | 56 | 0.0027 | | | <0.41 | |
| -00 | | | | | | | | | | | | | | |

| Date | Field pH (s.u.) | Lab pH (s.u.) | K | Se (ug/l) | Ag (ug/l) | Na (mg/l) | TDS (mg/l) | Sulf (mg/l) | Zn (ug/l) | Color (After Filter) | Field Cond (umho) | Odor | Turbidity (Purging) | Temp (°C) | Grd Water El (Feet) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| il-91 | | 6.7 | | | | | 160 | <10 | | | | | | | |
| :t-91 | | 6.9 | | | | | 170 | 10 | | | | | | | |
| n-92 | | 6.5 | | | | | 95 | 11 | | | | | | | |
| ır-92 | | 7.2 | | | | | 100 | 12 | | | | | | | |
| il-92 | | 6.8 | | | | | 110 | <10 | | | | | | | |
| :t-92 | | 7.0 | | | | | 220 | <10 | | | | | | | |
| n-93 | | 6.5 | | | | | 95 | <10 | | | | | | | |
| ır-93 | | 6.0 | | | | | 120 | 11 | | | | | | | |
| l-93 | | 6.0 | | | | | 110 | 11 | | | | | | | |
| t-93 | 7.4 | 6.4 | | | | | 98 | 9 | | | 186 | | | | 1099.82 |
| -94 | 7.0 | 6.4 | | | | | 74 | 10 | | | 123 | | | | 1097.96 |
| r-94 | 7.8 | 6.4 | | | | | 100 | 8.0 | | | 109 | | | | 1097.72 |
| l-94 | 6.8 | 6.3 | | | | | 100 | 8.0 | | | 200 | | | | 1097.66 |
| t-94 | 6.7 | 6.4 | | | | | 150 | 8.6 | | None | 124 | None | None | | 1097.75 |
| -95 | 6.2 | 6.5 | | | | | 140 | 7.1 | | None | 142 | None | None | | 1096.59 |
| r-95 | 6.7 | 6.5 | | | | | 150 | 7.6 | | None | 131 | None | None | | 1096.68 |
| l-95 | 6.9 | 6.2 | | | | | 110 | 6.2 | | None | 126 | None | None | | 1096.28 |
| t-95 | 6.3 | 6.6 | | | | | 110 | 9.4 | | None | 145 | None | None | | 1097.49 |
| -96 | 6.6 | 5.9 | | | | | 120 | 5.8 | | None | 145 | None | None | | 1095.89 |
| r-96 | 5.8 | 6.8 | | | | | 130 | 6.2 | | None | 168 | None | None | | 1096.23 |
| -96 | 6.3 | 6.3 | | | | | 130 | 6.9 | | None | 154 | None | None | | 1096.12 |
| t-96 | 6.3 | 6.5 | | | | | 100 | 6.5 | | None | 160 | None | None | | 1095.43 |
| -97 | 7.0 | 6.4 | | | | | 150 | 6.6 | | None | 164 | None | None | | 1095.33 |
| -97 | 6.5 | 6.9 | | | | | 110 | 8.2 | | None | 166 | None | None | | 1096.67 |
| -97 | 6.4 | 5.9 | | | | | 130 | 8.0 | | None | 202 | None | None | | 1096.13 |
| :-97 | 6.1 | 6.0 | | | | | 100 | 15 | | None | 201 | None | None | | 1097.72 |
| -98 | 6.6 | 6.3 | | | | | 120 | 11 | | None | 140 | None | None | | 1099.89 |
| -98 | 8.0 | 6.5 | | | | | 140 | 10 | | None | 165 | None | None | | 1103.49 |
| -98 | 6.5 | 6.4 | | | | | 140 | 13 | | None | 162 | None | None | | 1104.89 |
| :-98 | 6.3 | 7.1 | | | | | 98 | 14 | | None | 324 | None | None | | 1104.57 |
| -99 | 6.6 | 6.6 | | | | | 120 | 11 | | None | 142 | None | None | 9.3 | 1103.70 |
| -99 | 6.1 | 6.8 | | | | | 82 | 10 | | None | 157 | None | None | 12.1 | 1105.50 |
| -99 | 5.9 | 6.5 | <1.1 | <1.3 | <0.45 | 3.6 | 100 | 10 | <12 | None | 158 | None | None | 11.8 | 1107.29 |
| -99 | 6.5 | 6.5 | 1.1 | <1.3 | <0.45 | 7.7 | 84 | 15 | <12 | None | 160 | None | None | 10.5 | 1106.69 |
| -00 | 6.7 | 6.4 | | | | | 110 | 16 | | None | 160 | None | None | 11.8 | 1104.64 |
| -00 | 6.9 | 6.1 | | | | | 98 | 15 | | None | 156 | None | None | 8.8 | 1104.96 |
| -00 | | | | | | | | | | | | | | | |

Well MW-1004P Original Well Depth: 89.34' 1998 Adj. Depth: 75.9'

| | | Alk | As | Ba | Cd | Ca | Cl | Cr | Cu | Hard | Fe | Pb | Mg | Mn | Hg | Field pH | Lab pH | K | Se | Ag | Na | TDS | Sulf | Zn | Color | Field Cond | Odor | Turbidity | Temp | Grd Water |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (mg/l) | (ug/l) | (ug/l) | (ug/l) | (mg/l) | (mg/l) | (ug/l) | (ug/l) | (mg/l) | (mg/l) | (ug/l) | (mg/l) | (ug/l) | (ug/l) | (s.u.) | (s.u.) | | (ug/l) | (ug/l) | (mg/l) | (mg/l) | (mg/l) | (ug/l) | (After Filter) | (umho) | | (Purging) | (°C) | El (Feet) |
| 91 | | 160 | | | | | | | <14 | 150 | 0.33 | | | 130 | | | 6.9 | | | | | 210 | <10 | | | | | | | |
| ·91 | | 170 | | | | | | | <14 | 170 | 0.22 | | | 130 | | | 7.4 | | | | | 310 | <10 | | | | | | | |
| ·92 | | 160 | | | | | | | <14 | 150 | 0.32 | | | 120 | | | 6.7 | | | | | 160 | <10 | | | | | | | |
| ·92 | | 170 | | | | | | | <14 | 160 | 0.37 | | | 140 | | | 7.0 | | | | | 180 | <10 | | | | | | | |
| 92 | | 160 | | | | | | | <14 | 170 | 0.38 | | | 130 | | | 7.0 | | | | | 180 | <10 | | | | | | | |
| ·92 | | 190 | | | | | | | <14 | 180 | 0.32 | | | 130 | | | 7.8 | | | | | 260 | <10 | | | | | | | |
| 93 | | 170 | | | | | | | <14 | 160 | 0.39 | | | 140 | | | 7.4 | | | | | 160 | <10 | | | | | | | |
| 93 | | 170 | | | | | | | <10 | 160 | <0.010 | | | <4 | | | 6.5 | | | | | 160 | 3 | | | | | | | |
| 93 | | 170 | | | | | | | <12 | 150 | 0.042 | | | 22 | | | 6.6 | | | | | 180 | 5 | | | | | | | |
| 93 | | 170 | | | | | | | <12 | 160 | 0.048 | | | 40 | | 7.6 | 7.3 | | | | | 230 | 3 | | | 329 | | | | 1090.27 |
| 94 | | 140 | | | | | | | <12 | 150 | <0.015 | | | 20 | | 7.3 | 7.3 | | | | | 160 | 2 | | | 371 | | | | 1088.40 |
| 94 | | 160 | | | | | | | 15 | 150 | 0.033 | | | 45 | | 7.4 | 7.3 | | | | | 180 | 3.0 | | | 287 | | | | 1087.03 |
| 94 | | 160 | | | | | | | <12 | 150 | 0.024 | | | 28 | | 7.1 | 7.2 | | | | | 190 | 2.5 | | | 317 | | | | 1086.74 |
| 94 | | 170 | | | | | | | <1.6 | 160 | 0.035 | | | 29 | | 7.1 | 7.3 | | | | | 200 | 3.9 | | None | 303 | None | Mod. | | 1086.36 |
| 95 | | 170 | | | | | | | 3.3 | 150 | 0.014 | | | 29 | | 6.7 | 7.4 | | | | | 190 | 1.7 | | None | 315 | None | None | | 1085.81 |
| 95 | | 170 | | | | | | | 11 | 130 | 0.025 | | | 31 | | 7.4 | 7.3 | | | | | 250 | 4.7 | | None | 292 | None | None | | 1086.80 |
| 95 | | 170 | | | | | | | 20 | 130 | 0.044 | | | 77 | | 7.2 | 7.1 | | | | | 190 | 1.8 | | None | 317 | None | None | | 1086.38 |
| 95 | | 170 | | | | | | | 4.3 | 150 | 0.0086 | | | 28 | | 7.0 | 7.2 | | | | | 170 | 8.1 | | None | 308 | None | None | | 1079.81 |
| 96 | | 150 | | | | | | | 3.3 | 130 | 0.0094 | | | 27 | | 7.3 | 6.3 | | | | | 150 | 2.3 | | None | 295 | None | None | | 1078.22 |
| 96 | | 150 | | | | | | | 7.3 | 130 | 0.011 | | | 22 | | 6.9 | 7.0 | | | | | 210 | 4.2 | | None | 258 | None | None | | 1077.65 |
| 96 | | 150 | | | | | | | 3.3 | 130 | 0.0047 | | | 17 | | 7.2 | 7.2 | | | | | 200 | 4.3 | | None | 287 | None | None | | 1076.74 |
| 96 | | 160 | | | | | | | 5.9 | 120 | 0.0042 | | | 14 | | 7.2 | 7.3 | | | | | 160 | 4.2 | | None | 340 | None | None | | 1076.74 |
| 97 | | 160 | | | | | | | 6.2 | 120 | 0.015 | | | 34 | | 7.4 | 7.0 | | | | | 220 | 5.5 | | None | 238 | None | None | | 1077.50 |
| 97 | | 140 | | | | | | | 16 | 130 | 0.0080 | | | 17 | | 7.3 | 6.9 | | | | | 210 | 6.9 | | None | 311 | None | None | | 1078.42 |
| 97 | | 140 | | | | | | | 14 | 140 | 0.0035 | | | 12 | | 6.9 | 7.0 | | | | | 200 | 6.5 | | None | 277 | None | None | | 1083.61 |
| 97 | | 150 | | | | | | | 40 | 140 | 0.0047 | | | 10 | | 6.9 | 7.2 | | | | | 120 | 5.3 | | None | 349 | None | None | | 1096.14 |
| 98 | | 150 | | | | | | | 27 | 140 | 0.012 | | | 12 | | 7.1 | 7.3 | | | | | 140 | 8.8 | | None | 271 | None | None | | 1097.86 |
| 98 | | 96 | | | | | | | 20 | 130 | 0.0064 | | | 9.9 | | 7.4 | 7.4 | | | | | 170 | 8.5 | | None | 303 | None | None | | 1099.54 |
| 8 | | 160 | | | | | | | 10 | 130 | 0.0077 | | | 32 | | 7.1 | 7.5 | | | | | 220 | 9.2 | | None | 292 | None | None | | 1103.73 |
| 98 | | 140 | | | | | | | 5.0 | 140 | 0.0094 | | | 12 | | 7.1 | 7.1 | | | | | 150 | 8.6 | | None | 327 | None | None | | 1102.49 |
| 99 | | 160 | | | | | | | 2.6 | 140 | 0.0070 | | | 12 | | 7.5 | 7.0 | | | | | 140 | 7.6 | | None | 267 | None | None | 7.7 | 1101.91 |
| 99 | D | 160 | | | | | | | 2.8 | 140 | 0.0059 | | | 12 | | — | 7.3 | | | | | 170 | 7.6 | | — | — | — | — | — | — |
| 99 | | 160 | | | | | | | 3.2 | 130 | 0.0066 | | | 9.0 | | 6.7 | 8.0 | | | | | 140 | 6.6 | | None | 294 | None | None | 14.3 | 1103.29 |
| 9 | | 160 | <4.2 | 40 | <2.1 | 34 | <1.7 | 0.58 | <6.9 | 140 | 0.014 | <1.4 | 14 | 10 | <0.050 | 7.1 | 7.2 | 3.60 | <1.3 | <0.45 | 6.0 | 180 | 3 | <12 | None | 308 | None | None | 16.1 | 1104.97 |
| 99 | | 160 | <4.2 | 41 | 0.22 | 33 | <1.7 | 0.53 | 1.9 | 140 | 0.014 | <1.4 | 13 | 8.1 | <0.050 | 7.4 | 7.7 | 5.9 | <1.3 | <0.45 | 5.8 | 180 | 2.8 | <12 | None | 320 | None | None | 9.8 | 1104.88 |
| 00 | | 160 | | | | | | | <0.47 | 130 | 0.065 | | | 56 | | 6.7 | 7.1 | | | | | 150 | <5.0 | | None | 310 | None | None | 10.7 | 1103.16 |
| 00 | | 160 | | | | | | | 1.7 | 140 | 0.012 | | | 7.9 | | 6.9 | 7.1 | | | | | 170 | <5.0 | | None | 293 | None | None | 9.6 | 1103.32 |

| Well MW-1002 Well Depth: 17.71' | Alk (mg/l) | As (ug/l) | Ba (ug/l) | Cd (ug/l) | Ca (mg/l) | Cl (mg/l) | Cr (ug/l) | Cu (ug/l) | Hard (mg/l) | Fe (mg/l) | Pb (ug/l) | Mg (mg/l) | Mn (ug/l) | Hg (ug/l) | Field pH (s.u.) | Lab pH su | K | Se (ug/l) | Ag (ug/l) | Na (mg/l) | TDS (mg/l) | Sulf (mg/l) | Zn (ug/l) | Color (After Filter) | Field Cond (umho) | Odor | Turbidity (Purging) | Temp (°C) | Grd Water El (Feet) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| l-91 | 50 | | | | | | | < 14 | 60 | 0.99 | | | 5.1 | | | 6.8 | | | | | 160 | < 10 | | | | | | | |
| t-91 | 49 | | | | | | | < 14 | 60 | <0.055 | | | <4.0 | | | 6.9 | | | | | 170 | < 10 | | | | | | | |
| n-92 | 47 | | | | | | | < 14 | 67 | <0.055 | | | <4.0 | | | 6.5 | | | | | 100 | < 10 | | | | | | | |
| r-92 | 49 | | | | | | | < 14 | 48 | <0.055 | | | <4.0 | | | 7.0 | | | | | 85 | 11 | | | | | | | |
| l-92 | 41 | | | | | | | < 14 | 120 | <0.055 | | | <4.0 | | | 7.0 | | | | | 87 | < 10 | | | | | | | |
| t-92 | 53 | | | | | | | < 14 | 82 | <0.055 | | | 15 | | | 7.5 | | | | | 130 | 11 | | | | | | | |
| n-93 | 53 | | | | | | | < 14 | 66 | 0.059 | | | 4.7 | | | 6.7 | | | | | 90 | < 10 | | | | | | | |
| r-93 | 66 | | | | | | | < 10 | 90 | <0.010 | | | <4.0 | | | 6.5 | | | | | 120 | 9 | | | | | | | |
| l-93 | 42 | | | | | | | < 12 | 52 | 0.034 | | | <4.0 | | | 5.8 | | | | | 100 | 10 | | | | | | | |
| t-93 | 42 | | | | | | | < 12 | 52 | <0.015 | | | <4.0 | | 7.5 | 6.5 | | | | | 78 | 6 | | | 138 | | | | 1091.71 |
| n-94 | 39 | | | | | | | < 12 | 50 | <0.015 | | | <4 | | 7.5 | 6.6 | | | | | 82 | 7 | | | 151 | | | | 1091.21 |
| r-94 | 35 | | | | | | | < 12 | 45 | <0.015 | | | <4 | | 7.5 | 6.7 | | | | | 86 | 7.0 | | | 105 | | | | 1091.21 |
| l-94 | 31 | | | | | | | < 12 | 44 | <0.015 | | | <4 | | 7.0 | 6.5 | | | | | 94 | 6.6 | | | 109 | | | | 1091.02 |
| t-94 | 38 | | | | | | | < 1.6 | 46 | 0.0056 | | | <0.47 | | 7.0 | 6.6 | | | | | 87 | 6.1 | | None | 122 | None | None | | 1092.12 |
| n-95 | 38 | | | | | | | <0.47 | 47 | 0.0073 | | | 2.7 | | 6.7 | 6.8 | | | | | 120 | 6.2 | | None | 143 | None | None | | 1090.71 |
| r-95 | 42 | | | | | | | 2.0 | 42 | 0.0039 | | | 0.27 | | 7.4 | 6.7 | | | | | 170 | 7.3 | | None | 106 | None | None | | 1091.70 |
| -95 | 33 | | | | | | | 0.97 | 35 | <0.0017 | | | 0.42 | | 7.2 | 6.3 | | | | | 76 | 5.3 | | None | 99 | None | None | | 1090.41 |
| t-95 | 30 | | | | | | | 1.6 | 38 | 0.0040 | | | 1.4 | | 6.6 | 6.7 | | | | | 86 | 7.9 | | None | 120 | None | None | | 1091.61 |
| n-96 | 35 | | | | | | | <0.68 | 41 | 0.0031 | | | 0.12 | | 7.0 | 6.2 | | | | | 65 | 5.4 | | None | 154 | None | None | | 1091.25 |
| -96 | 32 | | | | | | | 1.7 | 36 | 0.017 | | | 0.98 | | 6.8 | 6.7 | | | | | 120 | 5.9 | | None | 142 | None | None | | 1091.57 |
| -96 | 34 | | | | | | | 1.6 | 97 | 0.021 | | | 0.50 | | 6.8 | 6.5 | | | | | 94 | 5.9 | | None | 120 | None | None | | 1092.26 |
| :-96 | 41 | | | | | | | 3.5 | 42 | 0.0063 | | | 0.20 | | 6.9 | 7.1 | | | | | 85 | 6.9 | | None | 155 | None | None | | 1090.73 |
| -97 | 42 | | | | | | | 0.99 | 46 | 0.011 | | | <0.16 | | 7.5 | 7.1 | | | | | 110 | 6.3 | | None | 124 | None | None | | 1092.32 |
| -97 | 41 | | | | | | | 0.79 | 46 | 0.0070 | | | 0.87 | | 7.4 | 6.8 | | | | | 110 | 7.0 | | None | 140 | None | None | | 1094.09 |
| -97 | 30 | | | | | | | 1.3 | 45 | 0.0087 | | | 0.80 | | 6.4 | 6.3 | | | | | 88 | 6.6 | | None | 118 | None | None | | 1091.83 |
| :-97 | 40 | | | | | | | 0.86 | 46 | 0.0030 | | | 0.52 | | 6.0 | 6.7 | | | | | 76 | 6.0 | | None | 114 | None | None | | 1090.89 |
| -98 | 40 | | | | | | | 1.4 | 47 | 0.034 | | | 0.26 | | 7.2 | 6.6 | | | | | 82 | 7.6 | | None | 110 | None | None | | 1090.00 |
| -98 | 30 | | | | | | | 0.86 | 37 | 0.050 | | | 1.7 | | 7.3 | 6.8 | | | | | 89 | <5.0 | | None | 132 | None | None | | 1095.91 |
| -98 | 44 | | | | | | | 0.90 | 50 | 0.0077 | | | 0.92 | | 6.6 | 7.0 | | | | | 100 | 8.2 | | None | 125 | None | None | | 1090.67 |
| -98 | 52 | | | | | | | 0.56 | 57 | 0.0096 | | | 0.40 | | 7.1 | 6.7 | | | | | 120 | 6.9 | | None | 158 | None | None | | 1090.03 |
| -99 | 54 | | | | | | | <0.54 | 60 | 0.012 | | | 0.71 | | 7.3 | 6.7 | | | | | 92 | 8.3 | | None | 143 | None | None | 8.4 | 1089.33 |
| -99 | 52 | | | | | | | 0.51 | 59 | 0.0018 | | | <0.41 | | 6.6 | 7.2 | | | | | 72 | 7.3 | | None | 160 | None | None | 12.8 | 1091.06 |
| -99 | 50 | <4.2 | 6.6 | 2.6 | 15 | 2.0 | 1.0 | <4.7 | 58 | 0.0027 | < 1.4 | 4.9 | <0.41 | <0.050 | 6.7 | 6.7 | < 1.1 | < 1.3 | <0.45 | 2.8 | 110 | 5.9 | < 12 | None | 149 | None | None | 16.0 | 1092.31 |
| -99 | 46 | | | | | | | <0.47 | 51 | 0.029 | | | <0.41 | | 7.0 | 6.9 | | | | | 91 | 6.9 | | None | 140 | None | None | 12.3 | 1090.59 |
| -00 | 57 | | | | | | | <0.47 | 65 | <0.0010 | | | <0.41 | | 6.9 | 6.9 | | | | | 110 | 5.6 | | None | 170 | None | None | 10.7 | 1089.42 |
| -00 | 55 | | | | | | | 0.91 | 67 | 0.0039 | | | <0.41 | | 6.8 | 6.5 | | | | | 98 | 5.2 | | None | 166 | None | None | 9.4 | 1090.33 |

Well MW-1002G Well Depth: 53.88'

| | Alk (mg/l) | As (ug/l) | Ba (ug/l) | Cd (ug/l) | Ca (mg/l) | Cl (mg/l) | Cr (ug/l) | Cu (ug/l) | Hard (mg/l) | Fe (mg/l) | Pb (ug/l) | Mg (mg/l) | Mn (ug/l) | Hg (ug/l) | Field pH (s.u.) | Lab pH (s.u.) | K | Se (ug/l) | Ag (ug/l) | Na (mg/l) | TDS (mg/l) | Sulf (mg/l) | Zn (ug/l) | Color (After Filter) | Field Cond (umho) | Odor | Turbidity (Purging) | Temp (°C) | Grd Water El (Feet) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| il-91 | 86 | | | | | | | <14 | 100 | <0.055 | | | 5.4 | | | 6.8 | | | | | 240 | <10 | | | | | | | |
| :t-91 | 88 | | | | | | | <14 | 120 | <0.055 | | | <4.0 | | | 6.8 | | | | | 280 | 10 | | | | | | | |
| n-92 | 80 | | | | | | | <14 | 110 | <0.055 | | | <4.0 | | | 6.4 | | | | | 140 | 11 | | | | | | | |
| x-92 | 84 | | | | | | | <14 | 110 | <0.055 | | | <4.0 | | | 6.9 | | | | | 150 | 14 | | | | | | | |
| il-92 | 79 | | | | | | | <14 | 160 | <0.055 | | | <4.0 | | | 6.8 | | | | | 150 | 11 | | | | | | | |
| :t-92 | 85 | | | | | | | <14 | 130 | <0.055 | | | <4.0 | | | 7.2 | | | | | 180 | 11 | | | | | | | |
| n-93 | 75 | | | | | | | <14 | 94 | <0.055 | | | <4.0 | | | 6.6 | | | | | 98 | 12 | | | | | | | |
| x-93 | 44 | | | | | | | <10 | 76 | <0.010 | | | <4.0 | | | 6.4 | | | | | 74 | 8 | | | | | | | |
| l-93 | 64 | | | | | | | <12 | 80 | <0.015 | | | <4.0 | | | 6.2 | | | | | 140 | 11 | | | | | | | |
| :t-93 | 82 | | | | | | | <12 | 110 | <0.015 | | | <4.0 | | 7.4 | 6.6 | | | | | 190 | 11 | | | 262 | | | | 1091.77 |
| n-94 | 94 | | | | | | | <12 | 120 | <0.015 | | | <4 | | 7.0 | 6.6 | | | | | 180 | 14 | | | 278 | | | | 1091.31 |
| r-94 | 92 | | | | | | | <12 | 120 | <0.015 | | | <4 | | 7.4 | 6.6 | | | | | 170 | 12 | | | 267 | | | | 1091.27 |
| l-94 | 92 | | | | | | | <12 | 120 | <0.015 | | | <4 | | 6.7 | 6.5 | | | | | 170 | 12 | | | 238 | | | | 1091.07 |
| t-94 | 88 | | | | | | | <1.6 | 110 | 0.0054 | | | <0.47 | | 6.8 | 6.6 | | | | | 200 | 14 | | None | 269 | None | None | | 1092.18 |
| n-95 | 90 | | | | | | | <0.47 | 110 | 0.0072 | | | 2.1 | | 6.7 | 6.7 | | | | | 240 | 12 | | None | 301 | None | None | | 1090.77 |
| r-95 | 93 | | | | | | | 1.4 | 100 | 0.0044 | | | <0.086 | | 6.9 | 6.6 | | | | | 170 | 15 | | None | 255 | None | None | | 1091.77 |
| l-95 | 90 | | | | | | | <0.68 | 100 | 0.0019 | | | <0.086 | | 6.9 | 6.5 | | | | | 190 | 11 | | None | 275 | None | None | | 1090.65 |
| t-95 | 100 | | | | | | | <0.68 | 110 | <0.0017 | | | <0.086 | | 6.9 | 6.8 | | | | | 160 | 14 | | None | 239 | None | None | | 1091.68 |
| n-96 | 85 | | | | | | | <0.68 | 100 | <0.0017 | | | <0.086 | | 6.8 | 6.4 | | | | | 150 | 11 | | None | 232 | None | None | | 1091.31 |
| r-96 | 110 | | | | | | | <0.68 | 100 | 0.0039 | | | 0.14 | | 6.6 | 6.7 | | | | | 220 | 11 | | None | 264 | None | None | | 1091.63 |
| l-96 | 79 | | | | | | | <0.54 | 93 | 0.0038 | | | <0.18 | | 6.7 | 6.6 | | | | | 200 | 11 | | None | 221 | None | None | | 1092.33 |
| t-96 | 86 | | | | | | | <0.54 | 93 | 0.0039 | | | <0.18 | | 6.8 | 6.8 | | | | | 120 | 11 | | None | 226 | None | None | | 1090.78 |
| n-97 | 80 | | | | | | | 1.9 | 96 | 0.0024 | | | <0.18 | | 7.2 | 6.7 | | | | | 180 | 9.6 | | None | 245 | None | None | | 1092.43 |
| r-97 | 81 | | | | | | | <0.54 | 100 | 0.0029 | | | <0.18 | | 7.0 | 6.6 | | | | | 200 | 10 | | None | 260 | None | None | | 1094.21 |
| -97 | 78 | | | | | | | <0.54 | 100 | 0.0051 | | | <0.18 | | 6.5 | 6.3 | | | | | 200 | 9.3 | | None | 271 | None | None | | 1094.93 |
| t-97 | 88 | | | | | | | <0.54 | 98 | <0.0010 | | | <0.18 | | 6.4 | 6.5 | | | | | 160 | 7.8 | | None | 228 | None | None | | 1090.97 |
| n-98 | 82 | | | | | | | <0.54 | 100 | 0.0034 | | | <0.18 | | 6.9 | 6.6 | | | | | 150 | 12 | | None | 218 | None | None | | 1090.06 |
| -98 | 75 | | | | | | | <0.54 | 98 | 0.0047 | | | 0.21 | | 7.0 | 6.8 | | | | | 180 | 11 | | None | 245 | None | None | | 1095.83 |
| -98 | 82 | | | | | | | 0.69 | 93 | 0.0038 | | | <0.18 | | 6.8 | 6.9 | | | | | 180 | 13 | | None | 215 | None | None | | 1090.72 |
| :-98 | 76 | | | | | | | <0.54 | 97 | <0.0010 | | | <0.18 | | 7.0 | 6.7 | | | | | 120 | 13 | | None | 194 | None | None | | 1090.04 |
| n-99 | 85 | | | | | | | <0.54 | 97 | 0.0035 | | | 0.24 | | 6.5 | 6.7 | | | | | 160 | 11 | | None | 215 | None | None | 9.1 | 1089.39 |
| -99 | 85 | | | | | | | <0.47 | 95 | <.0010 | | | <0.41 | | 6.5 | 7.2 | | | | | 100 | 9.8 | | None | 248 | None | None | 14.4 | 1091.10 |
| -99 | 84 | 5.0 | 24 | 3.4 | 25 | 9.7 | <0.42 | <4.7 | 100 | 0.0022 | <1.4 | 9.5 | <0.41 | <0.050 | 7.0 | 6.5 | <1.1 | <1.3 | <0.45 | 4.7‹ | 180 | 11 | <12 | None | 227 | None | None | 17.8 | 1092.30 |
| :-99 | 87 | | | | | | | <0.47 | 100 | 0.0061 | | | <0.41 | | 7.2 | 6.9 | | | | | 150 | 12 | | None | 240 | None | None | 8.9 | 1090.62 |
| n-00 | 87 | | | | | | | <0.47 | 98 | 0.0031 | | | <0.41 | | 7.1 | 6.8 | | | | | 120 | 12 | | None | 240 | None | None | 8.7 | 1089.43 |
| -00 | 89 | | | | | | | <0.60 | 100 | 0.0027 | | | <0.41 | | 6.8 | 6.5 | | | | | 140 | 11 | | None | 239 | None | None | 8.1 | 1090.34 |

| Well MW-1005 Well Depth: 20.16' | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Alk (mg/l) | As (ug/l) | Ba (ug/l) | Cd (ug/l) | Ca (mg/l) | Cl (mg/l) | Cr (ug/l) | Cu (ug/l) | Hard (mg/l) | Fe (mg/l) | Pb (ug/l) | Mg (mg/l) | Mn (ug/l) | Hg (ug/l) | Field pH (s.u.) | Lab pH (s.u.) | K | Se (ug/l) | Ag (ug/l) | Na (mg/l) | TDS (mg/l) | Sulf (mg/l) | Zn (uc/l) | Color (After Filter) | Field Cond (umho) | Odor | Turbidity (Purging) | Temp (°C) | Grd Water El (Feet) |
| 91 | 84 | | | | | | | <14 | 380 | 17 | | | 510 | | 7.7 | 6.3 | | | | | 570 | 15 | | None | 1028 | None | Moderate | | |
| -91 | 92 | | | | | | | <14 | 360 | 20 | | | 490 | | 7.3 | 6.4 | | | | | 770 | 12 | | None | 981 | None | High | | |
| -92 | 86 | | | | | | | <14 | 1000 | 18 | | | 460 | | 6.1 | 6.2 | | | | | 530 | 14 | | None | 870 | None | Moderate | | |
| -92 | 90 | | | | | | | <14 | 520 | 17 | | | 380 | | 6.3 | 6.3 | | | | | 680 | 16 | | None | 905 | Slight | High | | |
| 92 | 90 | | | | | | | <14 | 440 | 19 | | | 440 | | 6.0 | 6.3 | | | | | 640 | 15 | | None | 912 | Slight | Slight | | |
| -92 | 110 | | | | | | | <14 | 420 | 22 | | | 470 | | 6.1 | 6.5 | | | | | 600 | 15 | | None | 1013 | Moderate | VSlight | | |
| -93 | 94 | | | | | | | <14 | 400 | 24 | | | 520 | | | 6.2 | | | | | 140 | 23 | | | | | | | |
| -93 | 78 | | | | | | | <10 | 500 | 24 | | | 540 | | 6.1 | 5.8 | | | | | 630 | 15 | | None | 971 | None | Slight | | |
| 93 | 74 | | | | | | | <12 | 410 | 18 | | | 420 | | 6.1 | 5.6 | | | | | 590 | 18 | | None | | None | Slight | | |
| -93 | 84 | | | | | | | <12 | 390 | 25 | | | 610 | | 6.7 | 5.9 | | | | | 680 | 17 | | None | 1005 | Slight | Slight | | 1140.03 |
| -94 | 81 | | | | | | | <12 | 440 | 24 | | | 530 | | 6.3 | 6.0 | | | | | 560 | 18 | | None | 1072 | Slight | None | | 1138.39 |
| -94 | 88 | | | | | | | <12 | 450 | 24 | | | 540 | | 7.6 | 5.9 | | | | | 620 | 13 | | None | 1082 | None | None | | 1140.00 |
| 94 | 75 | | | | | | | <12 | 450 | 31 | | | 690 | | 6.2 | 5.9 | | | | | 600 | 14 | | None | 1093 | None | Moderate | | 1139.53 |
| -94 | 78 | | | | | | | <1.6 | 420 | 28 | | | 630 | | 6.1 | 5.9 | | | | | 820 | 20 | | None | 1028 | None | None | | 1138.79 |
| 95 | 84 | | | | | | | <0.47 | 370 | 29 | | | 650 | | 6.2 | 6.1 | | | | | 660 | 14 | | None | 1035 | Slight | None | | 1137.52 |
| 95 | 79 | | | | | | | 1.3 | 320 | 28 | | | 600 | | 6.2 | 5.8 | | | | | 770 | 18 | | None | 1014 | None | None | | 1138.27 |
| 95 | 75 | | | | | | | <0.68 | 320 | 28 | | | 640 | | 6.3 | 5.9 | | | | | 730 | 14 | | None | 1049 | Slight | Slight | | 1137.69 |
| 95 | 55 | | | | | | | <0.68 | 360 | 32 | | | 700 | | 6.2 | 6.0 | | | | | 740 | 21 | | None | 976 | Slight | None | | 1138.86 |
| 96 | 78 | | | | | | | <0.68 | 330 | 28 | | | 600 | | 6.2 | 5.8 | | | | | 560 | 14 | | None | 963 | None | None | | 1137.72 |
| 96 | 73 | | | | | | | <0.68 | 300 | 23 | | | 550 | | 6.0 | 6.1 | | | | | 530 | 14 | | V. Slight | 967 | Slight | None | | 1139.05 |
| 96 | 68 | | | | | | | <0.54 | 300 | 19 | | | 470 | | 6.1 | 6.0 | | | | | 650 | 14 | | None | 858 | None | None | | 1139.74 |
| 96 | 64 | | | | | | | 5.0 | 320 | 17 | | | 430 | | 6.2 | 6.1 | | | | | 550 | 14 | | None | 948 | None | None | | 1137.60 |
| 97 | 79 | | | | | | | 15 | 300 | 23 | | | 540 | | 5.9 | 5.9 | | | | | 600 | 13 | | None | 921 | None | None | | 1138.10 |
| 97 | 66 | | | | | | | 4.5 | 280 | 21 | | | 510 | | 6.3 | 6.2 | | | | | 620 | 12 | | None | 812 | None | None | | 1139.51 |
| 97 | 63 | | | | | | | 5.9 | 300 | 29 | | | 800 | | 6.2 | 5.7 | | | | | 220 | 12 | | None | 755 | None | None | | 1137.92 |
| 97 | 77 | | | | | | | <0.54 | 280 | 23 | | | 590 | | 6.0 | 6.0 | | | | | 510 | 10 | | None | 804 | None | None | | 1138.61 |
| 98 | 71 | | | | | | | <0.54 | 260 | 21 | | | 490 | | 6.1 | 6.1 | | | | | 490 | 14 | | None | 782 | Slight | None | | 1136.65 |
| 98 | 69 | | | | | | | <0.54 | 250 | 21 | | | 500 | | 6.1 | 6.3 | | | | | 440 | 13 | | None | 725 | Slight | None | | 1139.07 |
| 98 | 130 | | | | | | | <0.54 | 240 | 17 | | | 400 | | 6.2 | 6.2 | | | | | 440 | 16 | | None | 644 | Slight | None | | 1138.11 |
| 98 | 65 | | | | | | | <0.54 | 250 | 19 | | | 460 | | 6.1 | 6.1 | | | | | 430 | 17 | | None | 724 | None | None | | 1136.87 |
| 99 | 74 | | | | | | | <0.54 | 230 | 20 | | | 470 | | 6.2 | 6.1 | | | | | 370 | 12 | | None | 598 | None | None | 6.9 | 1135.69 |
| 99 | 69 | | | | | | | <0.47 | 200 | 20 | | | 480 | | 6.3 | 6.4 | | | | | 430 | 11 | | None | 596 | Slight | None | 16.7 | 1137.97 |
| 99 | 65 | 5.0 | 92 | <2.1 | 44 | 240 | 1.5 | <4.7 | 200 | 19 | <1.4 | 22 | 460 | <0.050 | 6.2 | 6.0 | <1.1 | <1.3 | <0.45 | 13 | 530 | 12 | <12 | None | 603 | None | None | 14.6 | 1139.21 |
| 99 | 65 | | | | | | | <0.47 | 190 | 18 | | | 410 | | 6.5 | 6.5 | | | | | 400 | 17 | | None | 570 | Slight | None | 10.7 | 1137.86 |
| 00 | 85 | | | | | | | <0.47 | 200 | 16 | | | 530 | | 6.8 | 6.1 | | | | | 300 | 16 | | None | 600 | None | None | — | 1137.18 |
| 00 | 66 | | | | | | | <0.67 | 190 | 18 | | | 410 | | 6.8 | 6.0 | | | | | 400 | 13 | | None | 598 | Slight | None | 5.4 | 1138.07 |



Flambeau Mining Company
10/12/2000
Flambeau Groundwater Data - Updated 6-28-00 - Sent to Foth and Van Dyke 9-1-00.xls

| | Well MW-1005S Well Depth: 52.43 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Alk (mg/l) | As (ug/l) | Ba (ug/l) | Cd (ug/l) | Ca (mg/l) | Cl (mg/l) | Cr (ug/l) | Cu (ug/l) | Hard (mg/l) | Fe (mg/l) | Pb (ug/l) | Mg (mg/l) | Mn (ug/l) | Hg (ug/l) | Field pH (s.u.) | Lab pH (s.u.) | K | Se (ug/l) | Ag (ug/l) | Na (mg/l) | TDS (mg/l) | Sulf (mg/l) | Zn (ug/l) | Color (After Filter) | Field Cond (umho) | Odor | Turbidity (Purging) | Temp (°C) | Grd Water El (Feet) |
| il-91 | 170 | | | | | | | <14 | 170 | 0.3 | | | 210 | | | 6.4 | | | | | 220 | <10 | | | | | | | |
| :t-91 | 170 | | | | | | | <14 | 170 | 3.8 | | | 220 | | | 7.0 | | | | | 370 | <10 | | | | | | | |
| n-92 | 170 | | | | | | | <14 | 250 | 3.6 | | | 210 | | | 6.7 | | | | | | <10 | | | | | | | |
| r-92 | 180 | | | | | | | <14 | 290 | 3.7 | | | 200 | | | 7.1 | | | | | 210 | <10 | | | | | | | |
| il-92 | 170 | | | | | | | <14 | 220 | 4.1 | | | 210 | | | 6.8 | | | | | 220 | <10 | | | | | | | |
| :t-92 | 190 | | | | | | | <14 | 270 | 3.9 | | | 200 | | | 7.3 | | | | | 260 | <10 | | | | | | | |
| n-93 | 180 | | | | | | | <14 | 180 | 4.1 | | | 210 | | | 7.3 | | | | | 160 | 10 | | | | | | | |
| r-93 | 81 | | | | | | | <10 | 210 | 4.4 | | | 230 | | | 6.6 | | | | | 200 | 8 | | | | | | | |
| l-93 | 170 | | | | | | | <12 | 160 | 4.2 | | | 220 | | | 6.4 | | | | | 200 | 9 | | | | | | | |
| :t-93 | 170 | | | | | | | <12 | 160 | 4.2 | | | 240 | | 7.3 | 6.9 | | | | | 220 | 6 | | | 321 | | | | 1139.29 |
| n-94 | 160 | | | | | | | <12 | 160 | 4.0 | | | 200 | | 7.2 | 7.0 | | | | | 190 | 9 | | | 357 | | | | 1138.29 |
| r-94 | 160 | | | | | | | <12 | 160 | 4.1 | | | 200 | | 7.5 | 7.0 | | | | | 200 | 8.0 | | | 344 | | | | 1139.14 |
| l-94 | 160 | | | | | | | <12 | 160 | 4.1 | | | 200 | | 6.9 | 6.9 | | | | | 210 | 7.2 | | | 322 | | | | 1138.65 |
| t-94 | 160 | | | | | | | <1.6 | 160 | 3.7 | | | 190 | | 7.3 | 7.0 | | | | | 240 | 13.0 | | None | 320 | Slight | None | | 1137.49 |
| n-95 | 160 | | | | | | | <0.47 | 150 | 4.2 | | | 220 | | 6.7 | 7.1 | | | | | 240 | 8.9 | | None | 425 | Slight | None | | 1136.86 |
| r-95 | 160 | | | | | | | <0.68 | 130 | 4.0 | | | 200 | | 7.0 | 7.1 | | | | | 190 | 9.3 | | None | 315 | Slight | None | | 1137.20 |
| l-95 | 170 | | | | | | | <0.68 | 140 | 3.8 | | | 200 | | 6.9 | 6.8 | | | | | 220 | 6.9 | | None | 358 | Slight | None | | 1137.06 |
| t-95 | 170 | | | | | | | <0.68 | 160 | 4.3 | | | 220 | | 7.1 | 7.0 | | | | | 220 | 14 | | None | 354 | Slight | None | | 1137.60 |
| n-96 | 160 | | | | | | | <0.68 | 140 | 3.7 | | | 200 | | 7.3 | 6.7 | | | | | 190 | 7.0 | | None | 360 | None | None | | 1137.09 |
| r-96 | 160 | | | | | | | <0.68 | 140 | 3.9 | | | 200 | | 6.8 | 6.9 | | | | | 240 | 7.6 | | None | 329 | None | None | | 1139.04 |
| l-96 | 150 | | | | | | | <0.54 | 140 | 3.6 | | | 190 | | 6.8 | 6.6 | | | | | 230 | 8.8 | | None | 323 | Slight | None | | 1139.05 |
| t-96 | 160 | | | | | | | 0.63 | 130 | 3.6 | | | 200 | | 7.1 | 7.0 | | | | | 220 | 8.2 | | None | 329 | None | None | | 1137.07 |
| n-97 | 160 | | | | | | | 4.0 | 140 | 3.8 | | | 200 | | 6.8 | 6.7 | | | | | 250 | 7.4 | | None | 321 | None | None | | 1137.05 |
| r-97 | 160 | | | | | | | 1.6 | 150 | 4.1 | | | 210 | | 6.8 | 6.5 | | | | | 250 | 9.5 | | None | 344 | None | None | | 1138.40 |
| l-97 | 140 | | | | | | | 0.71 | 150 | 4.0 | | | 200 | | 6.8 | 6.7 | | | | | 260 | 9.8 | | None | 689 | None | None | | 1137.65 |
| t-97 | 150 | | | | | | | <0.54 | 150 | 4.2 | | | 210 | | 6.8 | 7.0 | | | | | 190 | 6.2 | | Slight | 351 | None | None | | 1137.49 |
| n-98 | 170 | | | | | | | <0.54 | 120 | 3.3 | | | 170 | | 7.1 | 6.8 | | | | | 200 | 11 | | None | 313 | Strong | None | | 1136.35 |
| r-98 | 140 | | | | | | | <0.54 | 140 | 4.2 | | | 200 | | 7.2 | 7.1 | | | | | 250 | 11 | | None | 332 | Slight | None | | 1137.81 |
| :-98 | 160 | | | | | | | 11 | 150 | 3.9 | | | 200 | | 6.7 | 7.2 | | | | | 230 | 15 | | None | 305 | None | None | | 1137.32 |
| t-98 | 150 | | | | | | | <0.54 | 150 | 3.9 | | | 210 | | 6.8 | 6.8 | | | | | 180 | 13 | | None | 327 | None | None | | 1136.02 |
| n-99 | 170 | | | | | | | <0.54 | 150 | 4.0 | | | 200 | | 6.9 | 6.9 | | | | | 180 | 8.9 | | None | 319 | None | None | 5.7 | 1135.21 |
| ;-99 | 160 | | | | | | | <0.47 | 140 | 4.1 | | | 210 | | 7.0 | 7.4 | | | | | 210 | 8.6 | | None | 297 | None | None | 16.6 | 1136.65 |
| -99 | 160 | <4.2 | 39 | <2.1 | 38 | <1.7 | 0.57 | <4.7 | 150 | 4.3 | <1.4 | 13 | 220 | <0.050 | 6.7 | 6.8 | 2.1 | <1.3 | <0.45 | 5.6 | 240 | 9.5 | <12 | None | 331 | Slight | None | 17.2 | 1138.05 |
| t-99 | 160 | | | | | | | <0.47 | 150 | 4.1 | | | 210 | | 7.0 | 7.3 | | | | | 210 | 5.6 | | None | 320 | Slight | None | 8.3 | 1137.32 |
| n-00 | 170 | | | | | | | <0.47 | 150 | 3.9 | | | 210 | | 6.7 | 6.8 | | | | | 210 | <5.0 | | None | 380 | Moderate | None | — | 1136.76 |
| -00 | 170 | | | | | | | <0.60 | 150 | 4.2 | | | 220 | | 7.0 | 6.9 | | | | | 230 | <5.0 | | None | 354 | Moderate | None | 6.6 | 1136.99 |



Flambeau Mining Company
10/12/2000
Flambeau Groundwater Data - Updated 6-28-00 - Sent to Foth and Van Dyke 9-1-00.xls

Well MW-1005P Well Depth: 93.46'

| | Alk (mg/l) | As (ug/l) | Ba (ug/l) | Cd (ug/l) | Ca (mg/l) | Cl (mg/l) | Cr (ug/l) | Cu (ug/l) | Hard (mg/l) | Fe (mg/l) | Pb (ug/l) | Mg (mg/l) | Mn (ug/l) | CO2 (ug/l) | Hg (ug/l) | Field pH (s.u.) | Lab pH (s.u.) | K | Se (ug/l) | Ag (ug/l) | Na (mg/l) | TDS (mg/l) | Sulf (mg/l) | Zn (ug/l) | Color (After Filter) | Field Cond (umho) | Redox (mV) | Odor | Turbidity (Purging) | Temp (°C) | Grd Water El (Feet) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| l-91 | 260 | | | | | | | <14 | 230 | 1.2 | | | 220 | | | | 7.2 | | | | | 290 | <10 | | | | | | | | |
| t-91 | 260 | | | | | | | <14 | 230 | 1.0 | | | 150 | | | | 7.1 | | | | | 440 | <10 | | | | | | | | |
| n-92 | 260 | | | | | | | <14 | 240 | 0.75 | | | 160 | | | | 6.8 | | | | | 280 | <10 | | | | | | | | |
| r-92 | 260 | | | | | | | <14 | 240 | 1.0 | | | 130 | | | | 7.0 | | | | | 350 | <10 | | | | | | | | |
| l-92 | 270 | | | | | | | <14 | 260 | 0.95 | | | 150 | | | | 6.9 | | | | | 270 | <10 | | | | | | | | |
| t-92 | 270 | | | | | | | <14 | 260 | 12 | | | 100 | | | | 7.6 | | | | | 320 | <10 | | | | | | | | |
| n-93 | 260 | | | | | | | <14 | 240 | 1.1 | | | 110 | | | | 7.4 | | | | | 220 | <10 | | | | | | | | |
| r-93 | 250 | | | | | | | <10 | 250 | 0.46 | | | 150 | | | | 6.9 | | | | | 240 | 2 | | | | | | | | |
| l-93 | 250 | | | | | | | <12 | 230 | 0.61 | | | 140 | | | | 6.6 | | | | | 260 | 3 | | | | | | | | |
| t-93 | 250 | | | | | | | <12 | 220 | 0.17 | | | 69 | | | 7.5 | 7.3 | | | | | 300 | <2 | | | 462 | | | | | 1139.85 |
| n-94 | 250 | | | | | | | <12 | 230 | 0.19 | | | 35 | | | 7.3 | 7.4 | | | | | 260 | <2 | | | 487 | | | | | 1138.88 |
| r-94 | 250 | | | | | | | <12 | 230 | 0.20 | | | 160 | | | 7.2 | 7.1 | | | | | 270 | <2 | | | 487 | | | | | 1139.44 |
| l-94 | 240 | | | | | | | <12 | 230 | 0.22 | | | 100 | | | 6.9 | 7.0 | | | | | 270 | <2 | | | 456 | | | | | 1138.96 |
| t-94 | 250 | | | | | | | <1.6 | 250 | 0.24 | | | 62 | | | 7.2 | 7.2 | | | | | 280 | 2.5 | | None | 452 | | V. Sl. | V. Sl. | | 1137.79 |
| n-95 | 270 | | | | | | | 4.4 | 230 | 0.04 | | | 41 | | | 7.1 | 7.4 | | | | | 340 | <0.56 | | None | 511 | | None | None | | 1137.14 |
| r-95 | 270 | | | | | | | 3.7 | 200 | 0.08 | | | 41 | | | 7.5 | 7.3 | | | | | 300 | <0.56 | | None | 420 | | None | None | | 1137.45 |
| l-95 | 280 | | | | | | | 1.8 | 200 | 0.07 | | | 90 | | | 7.2 | 7.0 | | | | | 290 | <0.56 | | None | 454 | | Slight | None | | 1137.47 |
| t-95 | 260 | | | | | | | 2.1 | 230 | 0.17 | | | 72 | | | 7.2 | 7.1 | | | | | 260 | 5.3 | | None | 470 | | None | None | | 1137.79 |
| n-96 | 240 | | | | | | | <0.68 | 210 | 0.28 | | | 97 | | | 7.3 | 6.9 | | | | | 270 | 0.93 | | None | 464 | | None | None | | 1137.39 |
| r-96 | 250 | | | | | | | <0.68 | 210 | 0.049 | | | 35 | | | 6.9 | 7.2 | | | | | 300 | 2.2 | | None | 486 | | None | None | | 1139.37 |
| l-96 | 240 | | | | | | | 3.9 | 210 | 0.064 | | | 140 | | | 6.9 | 7.1 | | | | | 300 | 2.6 | | None | 441 | | None | None | | 1139.57 |
| t-96 | 260 | | | | | | | 8.2 | 200 | 0.37 | | | 67 | | | 7.2 | 7.1 | | | | | 280 | 3.6 | | None | 471 | | None | None | | 1137.46 |
| n-97 | 260 | | | | | | | 2.7 | 210 | 0.073 | | | 24 | | | 7.0 | 7.4 | | | | | 280 | 5.4 | | None | 462 | | None | None | | 1137.41 |
| r-97 | 250 | | | | | | | 1.6 | 220 | 0.41 | | | 77 | | | 7.0 | 6.7 | | | | | 320 | 6.8 | | None | 480 | | None | None | | 1138.85 |
| l-97 | 240 | | | | | | | 2.0 | 230 | 0.087 | | | 66 | | | 7.0 | 6.8 | | | | | 280 | 6.7 | | None | 448 | | None | None | | 1137.66 |
| t-97 | 240 | | | | | | | <0.54 | 230 | 0.17 | | | 62 | | | 6.9 | 7.1 | | | | | 260 | <5.0 | | None | 505 | | None | None | | 1137.77 |
| n-98 | 250 | | | | | | | 0.7 | 220 | 0.41 | | | 72 | | | 7.1 | 7.1 | | | | | 270 | 11 | | None | 456 | | None | None | | 1136.00 |
| r-98 | 240 | | | | | | | 1.1 | 210 | 0.077 | | | 29 | | | 7.4 | 7.4 | | | | | 280 | 9.6 | | None | 461 | | None | None | | 1137.92 |
| l-98 | 260 | | | | | | | <0.54 | 220 | 0.34 | | | 100 | | | 7.0 | 7.3 | | | | | 270 | 12 | | None | 458 | | None | None | | 1137.63 |
| t-98 | 230 | | | | | | | 1.9 | 220 | 0.17 | | | 63 | | | 7.0 | 6.6 | | | | | 250 | 9.4 | | None | 477 | | None | None | | 1136.19 |
| n-99 | 250 | | | | | | | <0.54 | 220 | 0.066 | | | 27 | | | 7.6 | 7.3 | | | | | 250 | 7.8 | | None | 449 | | None | None | 6.7 | 1135.35 |
| r-99 | 250 | | | | | | | 1.1 | 210 | 0.049 | | | 23 | | | 7.0 | 7.7 | | | | | 230 | 7.8 | | None | 464 | | None | None | 11.0 | 1136.65 |
| l-99 | 240 | <4.2 | 64 | <2.1 | 52 | 3.5 | <0.42 | <4.7 | 220 | 0.054 | <1.4 | 21 | 51 | | <0.050 | 6.9 | 7.0 | 8.1 | <1.3 | <0.45 | 9.0 | 250 | 7.3 | <12 | None | 501 | | None | None | 15.9 | 1138.09 |
| t-99 | 240 | | | | | | | <0.47 | 220 | 0.97 | | | 88 | 26000 | | 7.3 | 7.4 | | | | | 260 | <1.5 | | None | 460 | | Slight | None | 9.8 | 1137.64 |
| n-00 | 250 | | | | | | | <0.47 | 200 | 0.14 | | | 47 | | | 6.7 | 7.1 | | | | | 280 | <5.0 | | None | 480 | | Moderate | None | ---- | 1136.65 |
| r-00 | 250 | | | | | | | <0.60 | 220 | 0.37 | | | 80 | 32000 | | 7.3 | 7.0 | | | | | 220 | <5.0 | | None | 483 | 64 | None | None | 6.4 | 1137.05 |



Flambeau Mining Company
10/12/2000
Flambeau Groundwater Data - Updated 6-26-00 - Sent to Foth and Van Dyke 9-1-00.xls

D = Field Duplicate Sample

Well MW-1010P Well Depth: 115.4'

| | | Alk (mg/l) | As (ug/l) | Ba (ug/l) | Cd (ug/l) | Ca (mg/l) | Cl (mg/l) | Cr (ug/l) | Cu (ug/l) | Hard (mg/l) | Fe (mg/l) | Pb (ug/l) | Mg (mg/l) | Mn (ug/l) | Hg (ug/l) | Field pH (s.u.) | Lab pH (s.u.) | K | Se (ug/l) | Ag (ug/l) | Na (mg/l) | TDS (mg/l) | Sulf (mg/l) | Zn (ug/l) | Color (After Filter) | Field Cond (umho) | Redox (mV) | Odor | Turbidity (Purging) | Temp (°C) | Grd Water El (Feet) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ul-91 | | 140 | | | | | | | <14 | 140 | <0.055 | | | 260 | | | 7.1 | | | | | 180 | <10 | | | | | | | | |
| ct-91 | | 160 | | | | | | | <15 | 130 | <0.055 | | | 280 | | | 7.3 | | | | | 250 | 10 | | | | | | | | |
| an-92 | | 150 | | | | | | | <16 | 130 | 0.15 | | | 250 | | | 7.2 | | | | | 200 | 16 | | | | | | | | |
| pr-92 | | 160 | | | | | | | <17 | 140 | <0.055 | | | 200 | | | 7.7 | | | | | 340 | 14 | | | | | | | | |
| ul-92 | | 160 | | | | | | | <18 | 180 | <0.055 | | | 86 | | | 7.0 | | | | | 180 | <10 | | | | | | | | |
| ct-92 | | 180 | | | | | | | <19 | 160 | <0.055 | | | 140 | | | 7.8 | | | | | 280 | <10 | | | | | | | | |
| an-93 | | 190 | | | | | | | <20 | 130 | <0.055 | | | 31 | | | 8.4 | | | | | 210 | 32 | | | | | | | | |
| pr-93 | | 170 | | | | | | | <21 | 130 | 0.055 | | | 140 | | | 7.1 | | | | | 270 | 28 | | | | | | | | |
| ul-93 | | 150 | | | | | | | <22 | 130 | <0.015 | | | 35 | | | 6.7 | | | | | 180 | 11 | | | | | | | | |
| ct-93 | | 160 | | | | | | | <23 | 130 | <0.015 | | | 18 | | 7.5 | 7.4 | | | | | 230 | 5 | | | 294 | | | | | 1080.16 |
| an-94 | | 160 | | | | | | | <24 | 150 | <0.015 | | | 170 | | 7.3 | 7.6 | | | | | 170 | 3 | | | 283 | | | | | 1081.09 |
| pr-94 | | 160 | | | | | | | <25 | 150 | <0.015 | | | 14 | | 7.4 | 7.5 | | | | | 180 | 3.0 | | | 276 | | | | | 1080.00 |
| ul-94 | | 160 | | | | | | | <26 | 150 | <0.015 | | | 10 | | 7.2 | 7.3 | | | | | 190 | 3.4 | | | 322 | | | | | 1078.27 |
| ct-94 | | 160 | | | | | | | 3.2 | 150 | 0.0046 | | | 14 | | 7.5 | 7.4 | | | | | 200 | 4.5 | | None | 309 | | None | V. Sl. | | 1080.17 |
| n-95 | | 160 | | | | | | | 6.7 | 160 | 0.0040 | | | 60 | | 7.0 | 7.5 | | | | | 250 | 3.3 | | None | 337 | | None | None | | 1078.26 |
| r-95 | | 170 | | | | | | | 9.7 | 130 | 0.0050 | | | 51 | | 7.4 | 7.6 | | | | | 240 | 5.0 | | None | 311 | | None | None | | 1079.01 |
| l-95 | | 160 | | | | | | | 21 | 130 | 0.0017 | | | 11 | | 7.6 | 7.3 | | | | | 200 | 2.4 | | None | 315 | | None | None | | 1077.61 |
| t-95 | | 140 | | | | | | | 63 | 140 | 0.037 | | | 21 | | 7.4 | 7.4 | | | | | 200 | 9.6 | | None | 291 | | None | None | | 1079.23 |
| n-96 | | 140 | | | | | | | 45 | 130 | 0.0023 | | | 13 | | 7.0 | 6.5 | | | | | 180 | 3.4 | | None | 313 | | None | None | | 1077.28 |
| r-96 | | 160 | | | | | | | 16 | 140 | 0.0036 | | | 100 | | 7.2 | 7.2 | | | | | 200 | 3.8 | | None | 309 | | None | None | | 1076.11 |
| l-96 | | 140 | | | | | | | 74 | 130 | <0.0010 | | | 18 | | 7.4 | 7.5 | | | | | 200 | 5.9 | | None | 285 | | None | None | | 1077.43 |
| t-96 | | 150 | | | | | | | 39 | 130 | 0.0026 | | | 21 | | 7.6 | 7.5 | | | | | 170 | 5.8 | | None | 302 | | None | None | | 1076.75 |
| n-97 | | 140 | | | | | | | 56 | 130 | 0.0018 | | | 28 | | 7.2 | 7.1 | | | | | 180 | 5.8 | | None | 282 | | None | None | | 1078.40 |
| r-97 | | 150 | | | | | | | 15 | 150 | 0.0080 | | | 120 | | 7.4 | 6.9 | | | | | 170 | 6.7 | | None | 346 | | None | None | | 1081.61 |
| l-97 | | 130 | | | | | | | 48 | 140 | 0.0010 | | | 26 | | 7.3 | 7.3 | | | | | 170 | 7.0 | | None | 295 | | None | None | | 1083.07 |
| t-97 | | 140 | | | | | | | 30 | 140 | <0.0010 | | | 29 | | 7.0 | 7.5 | | | | | 170 | 5.1 | | None | 303 | | None | None | | 1087.13 |
| n-98 | | 140 | | | | | | | 26 | 130 | <0.0010 | | | 29 | | 7.4 | 7.6 | | | | | 190 | 9.2 | | None | 284 | | None | None | | 1087.61 |
| r-98 | | 130 | | | | | | | 19 | 130 | 0.0034 | | | 43 | | 7.6 | 7.5 | | | | | 170 | 5.6 | | None | 294 | | None | None | | 1089.49 |
| l-98 | | 150 | | | | | | | 27 | 130 | 0.0034 | | | 29 | | 7.2 | 7.7 | | | | | 160 | 11 | | None | 284 | | None | None | | 1086.64 |
| t-98 | | 130 | | | | | | | 20 | 130 | <0.0010 | | | 22 | | 7.5 | 7.1 | | | | | 190 | 8.6 | | None | 309 | | None | None | | 1086.42 |
| b-99 | | 140 | | | | | | | 24 | 130 | 0.0046 | | | 20 | | 7.0 | 7.3 | | | | | 170 | 8.3 | | None | 288 | | None | None | 9.7 | 1086.37 |
| r-99 | | 160 | | | | | | | 12 | 140 | 0.019 | | | 67 | | 7.1 | 8.0 | | | | | 140 | 7.6 | | None | 284 | | None | None | 15.2 | 1086.95 |
| l-99 | | 150 | 16 | 38 | <2.1 | 39 | 2.9 | <0.42 | 12 | 140 | 0.0074 | <1.4 | 11 | 59 | <0.050 | 7.2 | 7.3 | 1.80 | <1.3 | <0.45 | 5.1 | 200 | 5.5 | <12 | None | 269 | | None | None | 15.2 | 1088.46 |
| t-99 | | 150 | 6.8 | 40 | 0.29 | 38 | 3.1 | <0.42 | 3.5 | 140 | 0.0096 | <1.4 | 9.8 | 65 | <0.050 | 7.6 | 7.8 | 2.7 | <1.3 | <0.45 | 4.7 | 170 | 5.3 | <12 | None | 300 | | None | None | 9.0 | 1086.81 |
| t-99 | D | 140 | 13 | 41 | <0.21 | 40 | 2.6 | <0.42 | 0.84 | 140 | 0.011 | <1.4 | 10 | 130 | <0.050 | ---- | | 2.6 | <1.3 | <0.45 | 3.7 | 170 | 5.2 | <12 | ---- | ---- | | ---- | ---- | ---- | ---- |
| b-00 | | 140 | | | | | | | 2.2 | 130 | 0.017 | | | 39 | | 6.8 | 7.2 | | | | | 130 | <5.0 | | None | 280 | | None | None | 10.1 | 1086.65 |
| r-00 | | 140 | | | | | | | 9.9 | 150 | 0.0066 | | | 24 | | 7.1 | 7.3 | | | | | 140 | <5.0 | | None | 283 | 77 | None | None | 9.6 | 1087.46 |

Well MW-1013

| | Alk (mg/l) | As (ug/l) | Ba (ug/l) | Cd (ug/l) | Ca (mg/l) | Cl (mg/l) | Cr (ug/l) | Cu (ug/l) | Hard (mg/l) | Fe (mg/l) | Pb (ug/l) | Mg (mg/l) | Mn (ug/l) | CO2 (ug/l) | Hg (ug/l) | Field pH (s.u.) | Lab pH (s.u.) | K | Se (ug/l) | Ag (ug/l) | Na (ug/l) | TDS (mg/l) | Sulf (mg/l) | Zn (ug/l) | Color (After Filter) | Field Cond (umho) | Redox (mV) | Odor | Turbidity (Purging) | Temp (°C) | Grd Water El (Feet) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| r-99 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1105.11 |
| -99 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1106.07 |
| t-99 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1105.80 |
| r-00 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1104.64 |
| r-00 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1103.87 |

Well not recovered sufficiently to collect groundwater sample.

Well MW-1013A

| | Alk (mg/l) | As (ug/l) | Ba (ug/l) | Cd (ug/l) | Ca (mg/l) | Cl (mg/l) | Cr (ug/l) | Cu (ug/l) | Hard (mg/l) | Fe (mg/l) | Pb (ug/l) | Mg (mg/l) | Mn (ug/l) | CO2 (ug/l) | Hg (ug/l) | Field pH (s.u.) | Lab pH (s.u.) | K | Se (ug/l) | Ag (ug/l) | Na (ug/l) | TDS (mg/l) | Sulf (mg/l) | Zn (ug/l) | Color (After Filter) | Field Cond (umho) | Redox (mV) | Odor | Turbidity (Purging) | Temp (°C) | Grd Water El (Feet) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 99 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1094.73 |
| 39 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1095.38 |
| 99 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1095.51 |
| 00 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1095.62 |
| 00 | | | | | | | | | | | | | | | | | | | | | | | | | | | 97 | | | | 1095.36 |

Well not recovered sufficiently to collect groundwater sample.

Well MW-1013B Well Depth: 86.3'

| | Alk (mg/l) | As (ug/l) | Ba (ug/l) | Cd (ug/l) | Ca (mg/l) | Cl (mg/l) | Cr (ug/l) | Cu (ug/l) | Hard (mg/l) | Fe (mg/l) | Pb (ug/l) | Mg (mg/l) | Mn (ug/l) | CO2 [ug/l] | Hg (ug/l) | Field pH (s.u.) | Lab pH (s.u.) | K | Se (ug/l) | Ag (ug/l) | Na (ug/l) | TDS (mg/l) | Sulf (mg/l) | Zn (ug/l) | Color (After Filter) | Field Cond (umho) | Redox (mV) | Odor | Turbidity (Purging) | Temp (°C) | Grd Water El (Feet) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 99 | 630 | | | | | | | 36 | 2300 | 0.045 | | | 25000 | | | 6.2 | 6.5 | | | | | 3100 | 1400 | | None | 3540 | | None | None | | 1093.95 |
| 99 | 550 | | | | | | | 16 | 2300 | 0.33 | | | 30000 | | | 6.2 | 6.4 | | | | | 3700 | 770 | | Slight | 3130 | | None | Moderate | 16.0 | 1094.58 |
| 99 | 620 | <42 | <50 | <21 | 630 | 35 | 16 | 33 | 2200 | 0.76 | <14 | 150 | 29000 | | <0.050 | 6.4 | 6.5 | 8.2 | 1.7 | <4.5 | 35 | 3800 | 1600 | <120 | None | 3020 | | Slight | Slight | 18.3 | 1095.20 |
| 99 | 540 | <42 | <50 | <4.2 | 650 | 35 | 14 | <9.4 | 2200 | 0.17 | <14 | 150 | 28000 | 180000 | <0.050 | 6.6 | 6.8 | 5.9 | <1.3 | <4.5 | 26 | 3700 | 1900 | <120 | None | 3200 | | Slight | Slight | 14.2 | 1095.49 |
| 00 | 560 | 17 | <50 | <2.1 | 600 | 28 | 18 | <4.7 | 2100 | 0.41 | <14 | 150 | 30000 | | <0.050 | 6.4 | 6.4 | 6.4 | <1.3 | <4.5 | 33 | 3300 | 1700 | <120 | None | 3000 | | None | Slight | 12.6 | 1095.59 |
| 00 | 520 | 12 | <50 | <3.1 | 630 | 35 | <6.2 | 19 | 2200 | 0.27 | <24 | 150 | 32000 | 470000 | <0.050 | 6.6 | 6.3 | 8,5 | <7.8 | <4.7 | 27 | 3600 | 1200 | <120 | None | 3120 | 230 | None | Slight | 8.7 | 1095.54 |

<50ng/L

mg/L = ppm

mg = ppb
mg = ppm
mg = ppt

1 l = 1,000g

1 mg/L = .001/1000 = 1/1,000,000 = 1 ppm

.18/1000   .018/100

Flambeau Mining Co.
2000 Annual Report

Flambeau Mining Company
10/12/2000
Flambeau Groundwater Data - Updated 6-28-00 - Sent to Foth and Van Dyke 9-1-00.xls

MW-1013C

| Well MW-1013C Well Depth: 201.5' | Alk (mg/l) | As (ug/l) | Ba (ug/l) | Cd (ug/l) | Ca (mg/l) | Cl (mg/l) | Cr (ug/l) | Cu (ug/l) | Hard (mg/l) | Fe (mg/l) | Pb (ug/l) | Mg (mg/l) | Mn (ug/l) | CO2 (ug/l) | Hg (ug/l) | Field pH (s.u.) | Lab pH (s.u.) | K (ug/l) | Se (ug/l) | Ag (ug/l) | Na (mg/l) | TDS (mg/l) | Sulf (mg/l) | Zn (ug/l) | Color (After Filter) | Field Cond (umho) | Redox (mV) | Odor | Turbidity (Purging) | Temp (°C) | Grd Water El (Feet) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -99 | 480 | | | | | | | 100 | 2100 | 0.92 | | | 7200 | | | 6.3 | 6.6 | | | | | 3000 | 1300 | | None | 3170 | | None | None | | 1095.27 |
| -99 | 430 | | | | | | | 75 | 2200 | 0.84 | | | 7700 | | | 6.4 | 6.6 | | | | | 3300 | 920 | | None | 3030 | | None | None | 13.5 | 1095.73 |
| -99 | 430 | 83 | <50 | <21 | 570 | 50 | <4.2 | 50 | 2100 | 1.3 | <14 | 160 | 7300 | | <0.050 | 6.4 | 6.7 | 23 | 3.0 | <4.5 | 35 | 2700 | 870 | 660 | Slight | 3020 | | None | VSlight | ----- | 1096.67 |
| -99 | 400 | <42 | <50 | <4.2 | 610 | 50 | 7.2 | <9.4 | 2200 | 1.4 | <14 | 170 | 7600 | 140000 | <0.050 | 6.8 | 6.7 | 26 | <1.3 | <4.5 | 29 | 3000 | 2000 | 660 | None | 3300 | | None | Moderate | 9.6 | 1096.97 |
| -00 | 510 | <15 | <50 | 2.1 | 550 | 58 | <4.2 | <4.7 | 2100 | 1.5 | <14 | 170 | 7300 | | <0.050 | 6.5 | 6.4 | 23 | <1.3 | 5.2 | 39 | 2900 | 1700 | 630 | None | 2700 | | Vslight | Slight | 10.4 | 1097.10 |
| -00 | 460 | 14 | <50 | <3.1 | 590 | 50 | <6.2 | 11 | 2200 | 1.6 | <24 | 170 | 7800 | 270000 | <0.050 | 6.7 | 6.4 | 25 | <7.8 | <4.7 | 34 | 2900 | 1700 | 610 | None | 3370 | 177 | None | Moderate | 8.5 | 1097.39 |

| Well MW-1014 | Alk (mg/l) | As (ug/l) | Ba (ug/l) | Cd (ug/l) | Ca (mg/l) | Cl (mg/l) | Cr (ug/l) | Cu (ug/l) | Hard (mg/l) | Fe (mg/l) | Pb (ug/l) | Mg (mg/l) | Mn (ug/l) | CO2 (ug/l) | Hg (ug/l) | Field pH (s.u.) | Lab pH (s.u.) | K | Se (ug/l) | Ag (ug/l) | Na (ug/l) | TDS (mg/l) | Sulf (mg/l) | Zn (ug/l) | Color (After Filter) | Field Cond (umho) | Redox (mV) | Odor | Turbidity (Purging) | Temp (°C) | Grd Water El (Feet) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 99 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | DRY |
| 99 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | DRY |
| 99 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1111.60 |
| 00 | | | Well not recovered sufficiently to collect groundwater sample. | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1112.07 |
| 00 | | | | | | | | | | | | | | | | | | | | | | | | | | | 160 | | | | 1112.41 |

Well MW-1014A Well Depth: 63.9'

| | Alk (mg/l) | As (ug/l) | Ba (ug/l) | Cd (ug/l) | Ca (mg/l) | Cl (mg/l) | Cr (ug/l) | Cu (ug/l) | Hard (mg/l) | Fe (mg/l) | Pb (ug/l) | Mg (mg/l) | Mn (ug/l) | CO2 (ug/l) | Hg (ug/l) | Field pH (s.u.) | Lab pH (s.u.) | K (ug/l) | Se (ug/l) | Ag (ug/l) | Na (mg/l) | TDS (mg/l) | Sulf (mg/l) | Zn (ug/l) | Color (After Filter) | Field Cond (umho) | Redox (mV) | Odor | Turbidity (Purging) | Temp (°C) | Grd Water El (Feet) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -99 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1103.93 |
| 99 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1106.42 |
| -99 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1107.87 |
| -00 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1109.22 |
| -00 | 390 | 15 | 59 | <3.1 | 330 | <50 | <6.2 | <6.0 | 1300 | 0.55 | <24 | 120 | 7200 | 150000 | <0.050 | 6.9 | 6.6 | 12 | <7.8 | <4.7 | 34 | 1800 | 970 | <120 | None | 2220 | 165 | None | None | 11.2 | 1109.24 |

Previous to April 2000, well not recovered sufficiently to collect groundwater sample.

MW-1014B

Well MW-1014B Well Depth: 104.9'

| | Alk (mg/l) | As (ug/l) | Ba (ug/l) | Cd (ug/l) | Ca (mg/l) | Cl (mg/l) | Cr (ug/l) | Cu (ug/l) | Hard (mg/l) | Fe (mg/l) | Pb (ug/l) | Mg (mg/l) | Mn (ug/l) | CO2 (ug/l) | Hg (ug/l) | Field pH (s.u.) | Lab pH (s.u.) | K (ug/l) | Se (ug/l) | Ag (ug/l) | Na (mg/l) | TDS (mg/l) | Sulf (mg/l) | Zn (ug/l) | Color (After Filter) | Field Cond (umho) | Redox (mV) | Odor | Turbidity (Purging) | Temp (°C) | Grd Water El (Feet) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -99 | 510 | | | | | | | 810 | 2100 | 0.062 | | | 23000 | | | 6.2 | 6.3 | | | | | 2900 | 1200 | | None | 3280 | | None | Slight | | 1105.62 |
| -99 | 460 | | | | | | | 420 | 2100 | 0.033 | | | 23000 | | | 6.2 | 6.4 | | | | | 3300 | 770 | | None | 2890 | | None | None | 14.2 | 1106.23 |
| 99 | 540 | 70 | <50 | 31 | 580 | 49 | 13 | 520 | 2100 | 0.072 | <14 | 170 | 23000 | | <0.050 | 6.3 | 6.4 | 25 | 2.2 | <45 | 93 | 3100 | 580 | 2500 | None | 3540 | | None | Moderate | 17.4 | 1107.13 |
| -99 | 570 | <42 | <50 | 10 | 640 | 43 | 7.4 | 530 | 2200 | <0.010 | <14 | 150 | 23000 | 300000 | <0.050 | 6.4 | 6.5 | 17 | 1.4 | <4.5 | 24 | 3100 | 1600 | 5000 | None | 3200 | | None | Moderate | 12.1 | 1108.33 |
| :00 | 490 | <15 | <50 | 10 | 550 | <100 | <4.2 | 500 | 1900 | 0.055 | <14 | 140 | 20000 | | <0.050 | 6.5 | 6.2 | 18 | 2.6 | <4.5 | 27 | 3200 | 1400 | 4100 | None | 3000 | | None | Slight | 12.1 | 1108.88 |
| 00 | 480 | <7.5 | <50 | 10 | 600 | 42 | <6.2 | 520 | 2100 | <0.15 | <24 | 150 | 22000 | 560000 | <0.050 | 6.4 | 6.2 | 23 | <7.8 | <4.7 | 26 | 3200 | 1500 | 3700 | None | 2940 | 290 | None | Slight | 14.2 | 1108.85 |

D = Field Duplicate Sample

Well MW-1014C Well Depth: 156.6'

| | | Alk (mg/l) | As (ug/l) | Ba (ug/l) | Cd (ug/l) | Ca (mg/l) | Cl (mg/l) | Cr (ug/l) | Cu (ug/l) | Hard (mg/l) | Fe (mg/l) | Pb (ug/l) | Mg (mg/l) | Mn (ug/l) | CO2 (ug/l) | Hg (ug/l) | Field pH (s.u.) | Lab pH (s.u.) | K | Se (ug/l) | Ag (ug/l) | Na (mg/l) | TDS (mg/l) | Sulf (mg/l) | Zn (ug/l) | Color (After Filter) | Field Cond (umho) | Redox (mV) | Odor | Turbidity (Purging) | Temp (°C) | Grd Water El (Feet) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19 | | 360 | | | | | | | <4.7 | 980 | 14 | | | 4300 | | | 6.3 | 6.5 | | | | | 1200 | 520 | | None | 1900 | | None | None | | 1103.39 |
| 9 | | 330 | | | | | | | <4.7 | 1000 | 15 | | | 4500 | | | 6.3 | 6.5 | | | | | 1200 | 440 | | None | 1623 | | None | None | 13.5 | 1102.83 |
| 9 | | 370 | <42 | <50 | <21 | 280 | 32 | <4.2 | 16 | 930 | 14 | <14 | 56 | 4000 | | <0.050 | 6.4 | 6.5 | 4.8 | 1.8 | <45 | 11 | 1200 | 370 | 2200 | None | 1657 | | None | None | 13.2 | 1103.90 |
| 9 | | 380 | <42 | <50 | <4.2 | 290 | 33 | <4.2 | <9.4 | 960 | 14 | <14 | 56 | 4000 | 160000 | <0.050 | 6.8 | 6.7 | 4.0 | <1.3 | <4.5 | 9.6 | 1200 | 700 | 2100 | None | 1600 | | None | None | 9.9 | 1104.81 |
| 0 | | 320 | <15 | 25 | <0.21 | 250 | 31 | <0.42 | <0.47 | 810 | 12 | <1.4 | 48 | 3200 | | <0.050 | 6.8 | 6.5 | 6.3 | 1.9 | <0.45 | 12 | 1200 | 540 | 1700 | None | 1500 | | None | None | 10.5 | 1105.18 |
| 0 | D | 300 | <15 | 25 | <0.21 | 230 | 30 | 2.0 | <0.47 | 820 | 11 | 2.0 | 46 | 3100 | | <0.050 | — | 6.4 | 6.3 | 1.6 | <0.45 | 11 | 1300 | 560 | 1600 | — | — | | — | — | — | — |
| 0 | | 320 | 14 | <50 | <3.1 | 260 | 33 | <6.2 | <6.0 | 870 | 13 | <24 | 51 | 3600 | 260000 | <0.050 | 6.7 | 6.3 | 7.6 | <7.8 | <4.7 | 9.4 | 1000 | 440 | 1800 | None | 1470 | 88 | None | None | 11.9 | 1105.25 |

16

26%

260000/1000

.000260/1

# Attachment 2

## PHREEQ-C Runs with Current Conditions

```
------------------
Reading data base.
------------------

      SOLUTION_MASTER_SPECIES
      SOLUTION_SPECIES
      PHASES
      EXCHANGE_MASTER_SPECIES
      EXCHANGE_SPECIES
      SURFACE_MASTER_SPECIES
      SURFACE_SPECIES
      END
------------------------------------
Reading input data for simulation 1.
------------------------------------

      SOLUTION 18  13B-Apr-00  Ca-Mg-SO4-HCO3  0018
            units mmol/l
            pH    6.63
            pe    4.11
            density     1
            temp  8.7
            redox pe
            Ca    15.71856
            Mg    6.1703
            Na    1.174424E-03
            K     0.2173913
            Fe    4.835243E-03
            Mn    0.5824536
            Cl    0.9872225
            Alkalinity  12.93273  as HCO3
            S     15.61589
      SOLUTION 24  13C-Apr-00  Ca-Mg-SO4-HCO3  0024
            units mmol/l
            pH    6.73
            pe    3.17
            density     1
            temp  8.5
            redox pe
            Ca    14.72056
            Mg    6.993007
            Na    1.478904E-03
            K     0.6393862
            Fe    2.865329E-02
            Mn    0.1419731
            Cl    1.410318
            Alkalinity  9.310254  as HCO3
            S     17.69801
            Zn    9.331497E-03
      SOLUTION 54  14A-Apr-00  Ca-Mg-SO4-HCO3  0054
            units mmol/l
            pH    6.87
            pe    2.93
            density     1
            temp  11.2
            redox pe
            Ca    8.233532
            Mg    4.936241
            Na    1.478904E-03
            K     0.3069054
            Fe    9.84957E-03
            Mn    0.1310521
            Ba    4.295908E-04
            Alkalinity  8.310385  as HCO3
```

```
    S      10.09828
SOLUTION 46  14B-Apr-00  Ca-Mg-SO4-HCO3  0046
    units mmol/l
    pH     6.43
    pe     5.09
    density     1
    temp  14.2
    redox pe
    Ca     14.97006
    Mg     6.1703
    Na     1.130927E-03
    K      0.5882353
    Fe     1.074499E-03
    Mn     0.4004368
    Cl     1.184667
    Alkalinity  9.654471  as HCO3
    S      15.61589
    Zn     5.660089E-02
SOLUTION 53  14C-Apr-00  Ca-Mg-SO4-HCO3  0053
    units mmol/l
    pH     6.65
    pe     1.56
    density     1
    temp  11.9
    redox pe
    Ca     7.235528
    Mg     2.097902
    Na     4.088734E-04
    K      0.1943734
    Fe     0.232808
    Mn     6.552603E-02
    Cl     0.9308098
    Alkalinity  8.88408  as HCO3
    S      4.580661
    Zn     2.753557E-02
SOLUTION 58  5P-Jul-99   Ca-Mg            0058
    units mmol/l
    pH     6.91
    pe     1.08
    density     1
    temp  15.9
    redox pe
    Ca     1.297405
    Mg     0.8638421
    Na     3.914746E-04
    K      0.2071611
    Fe     9.670487E-04
    Mn     9.282854E-04
    Ba     4.659968E-04
    Alkalinity  6.507343  as HCO3
    S      7.599734E-02
END
-------------------------------------------
Beginning of initial solution calculations.
-------------------------------------------

Initial solution 18.    13B-Apr-00  Ca-Mg-SO4-HCO3  0018

-----------------------------Solution composition------------------------
-------

      Elements            Molality       Moles

      Alkalinity        1.297e-02   1.297e-02
```

```
        Ca                  1.577e-02   1.577e-02
        Cl                  9.903e-04   9.903e-04
        Fe                  4.850e-06   4.850e-06
        K                   2.181e-04   2.181e-04
        Mg                  6.190e-03   6.190e-03
        Mn                  5.843e-04   5.843e-04
        Na                  1.178e-06   1.178e-06
        S                   1.567e-02   1.567e-02

----------------------------Description of solution--------------------
-------

                                       pH  =   6.630
                                       pe  =   4.110
                        Activity of water  =   0.999
                           Ionic strength  =   5.954e-02
                       Mass of water (kg)  =   1.000e+00
                    Total carbon (mol/kg)  =   1.974e-02
                       Total CO2 (mol/kg)  =   1.974e-02
                      Temperature (deg C)  =   8.700
                  Electrical balance (eq)  =   1.918e-05
                               Iterations  =   9
                                  Total H  = 1.110253e+02
                                  Total O  = 5.562130e+01

----------------------------Distribution of species--------------------
-------

                                                        Log       Log
Log
      Species              Molality    Activity   Molality  Activity
Gamma

      H+                   2.758e-07   2.344e-07    -6.559    -6.630    -
0.071
      OH-                  1.381e-08   1.110e-08    -7.860    -7.955    -
0..095
      H2O                  5.551e+01   9.991e-01     0.000     0.000
0.000
C(4)               1.974e-02
      HCO3-                1.192e-02   9.802e-03    -1.924    -2.009    -
0.085
      CO2                  6.792e-03   6.886e-03    -2.168    -2.162
0.006
      CaHCO3+              5.522e-04   4.543e-04    -3.258    -3.343    -
0.085
      MgHCO3+              2.849e-04   2.323e-04    -3.545    -3.634    -
0.089
      MnHCO3+              1.612e-04   1.315e-04    -3.793    -3.881    -
0.089
      MnCO3                1.543e-05   1.565e-05    -4.812    -4.806
0.006
      CaCO3                9.069e-06   9.194e-06    -5.042    -5.036
0.006
      CO3-2                2.857e-06   1.309e-06    -5.544    -5.883    -
0.339
      MgCO3                2.028e-06   2.056e-06    -5.693    -5.687
0.006
      FeHCO3+              1.475e-06   1.203e-06    -5.831    -5.920    -
0.089
      FeCO3                3.800e-08   3.853e-08    -7.420    -7.414
0.006
      NaHCO3               5.109e-09   5.180e-09    -8.292    -8.286
0.006
```

| | | | | | | |
|---|---|---|---|---|---|---|
| | NaCO3- | 1.177e-11 | 9.597e-12 | -10.929 | -11.018 | -0.089 |
| Ca | | 1.577e-02 | | | | |
| | Ca+2 | 1.125e-02 | 5.179e-03 | -1.949 | -2.286 | -0.337 |
| | CaSO4 | 3.955e-03 | 4.010e-03 | -2.403 | -2.397 | 0.006 |
| | CaHCO3+ | 5.522e-04 | 4.543e-04 | -3.258 | -3.343 | -0.085 |
| | CaCO3 | 9.069e-06 | 9.194e-06 | -5.042 | -5.036 | 0.006 |
| | CaOH+ | 4.491e-09 | 3.663e-09 | -8.348 | -8.436 | -0.089 |
| Cl | | 9.903e-04 | | | | |
| | Cl- | 9.897e-04 | 7.973e-04 | -3.004 | -3.098 | -0.094 |
| | MnCl+ | 5.994e-07 | 4.888e-07 | -6.222 | -6.311 | -0.089 |
| | FeCl+ | 1.656e-09 | 1.351e-09 | -8.781 | -8.869 | -0.089 |
| | MnCl2 | 1.678e-10 | 1.701e-10 | -9.775 | -9.769 | 0.006 |
| | MnCl3- | 4.581e-14 | 3.736e-14 | -13.339 | -13.428 | -0.089 |
| | FeCl+2 | 1.849e-17 | 8.182e-18 | -16.733 | -17.087 | -0.354 |
| | FeCl2+ | 6.171e-20 | 5.033e-20 | -19.210 | -19.298 | -0.089 |
| | FeCl3 | 3.958e-24 | 4.013e-24 | -23.403 | -23.397 | 0.006 |
| Fe(2) | | 4.844e-06 | | | | |
| | Fe+2 | 2.613e-06 | 1.227e-06 | -5.583 | -5.911 | -0.328 |
| | FeHCO3+ | 1.475e-06 | 1.203e-06 | -5.831 | -5.920 | -0.089 |
| | FeSO4 | 7.160e-07 | 7.259e-07 | -6.145 | -6.139 | 0.006 |
| | FeCO3 | 3.800e-08 | 3.853e-08 | -7.420 | -7.414 | 0.006 |
| | FeCl+ | 1.656e-09 | 1.351e-09 | -8.781 | -8.869 | -0.089 |
| | FeOH+ | 5.592e-10 | 4.560e-10 | -9.252 | -9.341 | -0.089 |
| | FeHSO4+ | 1.351e-12 | 1.102e-12 | -11.869 | -11.958 | -0.089 |
| | Fe(HS)2 | 0.000e+00 | 0.000e+00 | -114.348 | -114.342 | 0.006 |
| | Fe(HS)3- | 0.000e+00 | 0.000e+00 | -170.906 | -170.995 | -0.089 |
| Fe(3) | | 6.379e-09 | | | | |
| | Fe(OH)2+ | 5.266e-09 | 4.295e-09 | -8.278 | -8.367 | -0.089 |
| | Fe(OH)3 | 1.097e-09 | 1.112e-09 | -8.960 | -8.954 | 0.006 |
| | FeOH+2 | 1.323e-11 | 5.853e-12 | -10.878 | -11.233 | -0.354 |
| | Fe(OH)4- | 2.651e-12 | 2.162e-12 | -11.577 | -11.665 | -0.089 |
| | FeSO4+ | 2.456e-14 | 2.003e-14 | -13.610 | -13.698 | -0.089 |
| | Fe+3 | 2.537e-15 | 5.870e-16 | -14.596 | -15.231 | -0.636 |
| | Fe(SO4)2- | 2.290e-15 | 1.868e-15 | -14.640 | -14.729 | -0.089 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | FeCl+2 | | 1.849e-17 | 8.182e-18 | -16.733 | -17.087 | -0.354 |
| | FeCl2+ | | 6.171e-20 | 5.033e-20 | -19.210 | -19.298 | -0.089 |
| | Fe2(OH)2+4 | | 4.907e-20 | 1.880e-21 | -19.309 | -20.726 | -1.417 |
| | FeHSO4+2 | | 2.992e-20 | 1.324e-20 | -19.524 | -19.878 | -0.354 |
| | FeCl3 | | 3.958e-24 | 4.013e-24 | -23.403 | -23.397 | 0.006 |
| | Fe3(OH)4+5 | | 1.354e-24 | 8.281e-27 | -23.868 | -26.082 | -2.214 |
| H(0) | | 4.818e-25 | | | | | |
| | H2 | | 2.409e-25 | 2.442e-25 | -24.618 | -24.612 | 0.006 |
| K | | 2.181e-04 | | | | | |
| | K+ | | 2.126e-04 | 1.713e-04 | -3.672 | -3.766 | -0.094 |
| | KSO4- | | 5.442e-06 | 4.438e-06 | -5.264 | -5.353 | -0.089 |
| | KOH | | 2.497e-12 | 2.531e-12 | -11.603 | -11.597 | 0.006 |
| Mg | | 6.190e-03 | | | | | |
| | Mg+2 | | 4.473e-03 | 2.115e-03 | -2.349 | -2.675 | -0.325 |
| | MgSO4 | | 1.430e-03 | 1.450e-03 | -2.845 | -2.839 | 0.006 |
| | MgHCO3+ | | 2.849e-04 | 2.323e-04 | -3.545 | -3.634 | -0.089 |
| | MgCO3 | | 2.028e-06 | 2.056e-06 | -5.693 | -5.687 | 0.006 |
| | MgOH+ | | 8.457e-09 | 6.897e-09 | -8.073 | -8.161 | -0.089 |
| Mn(2) | | 5.843e-04 | | | | | |
| | Mn+2 | | 3.204e-04 | 1.505e-04 | -3.494 | -3.822 | -0.328 |
| | MnHCO3+ | | 1.612e-04 | 1.315e-04 | -3.793 | -3.881 | -0.089 |
| | MnSO4 | | 8.661e-05 | 8.781e-05 | -4.062 | -4.056 | 0.006 |
| | MnCO3 | | 1.543e-05 | 1.565e-05 | -4.812 | -4.806 | 0.006 |
| | MnCl+ | | 5.994e-07 | 4.888e-07 | -6.222 | -6.311 | -0.089 |
| | MnOH+ | | 4.958e-09 | 4.043e-09 | -8.305 | -8.393 | -0.089 |
| | MnCl2 | | 1.678e-10 | 1.701e-10 | -9.775 | -9.769 | 0.006 |
| | MnCl3- | | 4.581e-14 | 3.736e-14 | -13.339 | -13.428 | -0.089 |
| Mn(3) | | 3.025e-26 | | | | | |
| | Mn+3 | | 3.025e-26 | 4.829e-27 | -25.519 | -26.316 | -0.797 |
| Na | | 1.178e-06 | | | | | |
| | Na+ | | 1.149e-06 | 9.397e-07 | -5.940 | -6.027 | -0.087 |
| | NaSO4- | | 2.360e-08 | 1.925e-08 | -7.627 | -7.716 | -0.089 |
| | NaHCO3 | | 5.109e-09 | 5.180e-09 | -8.292 | -8.286 | 0.006 |
| | NaCO3- | | 1.177e-11 | 9.597e-12 | -10.929 | -11.018 | -0.089 |
| | NaOH | | 2.610e-14 | 2.646e-14 | -13.583 | -13.577 | 0.006 |

| | | | | | | |
|---|---|---|---|---|---|---|
| O(0) | | 0.000e+00 | | | | |
| | O2 | 0.000e+00 | 0.000e+00 | -48.840 | -48.835 | 0.006 |
| S(-2) | | 0.000e+00 | | | | |
| | H2S | 0.000e+00 | 0.000e+00 | -58.108 | -58.102 | 0.006 |
| | HS- | 0.000e+00 | 0.000e+00 | -58.595 | -58.690 | -0.095 |
| | S-2 | 0.000e+00 | 0.000e+00 | -65.144 | -65.491 | -0.347 |
| | Fe(HS)2 | 0.000e+00 | 0.000e+00 | -114.348 | -114.342 | 0.006 |
| | Fe(HS)3- | 0.000e+00 | 0.000e+00 | -170.906 | -170.995 | -0.089 |
| S(6) | | 1.567e-02 | | | | |
| | SO4-2 | 1.019e-02 | 4.559e-03 | -1.992 | -2.341 | -0.349 |
| | CaSO4 | 3.955e-03 | 4.010e-03 | -2.403 | -2.397 | 0.006 |
| | MgSO4 | 1.430e-03 | 1.450e-03 | -2.845 | -2.839 | 0.006 |
| | MnSO4 | 8.661e-05 | 8.781e-05 | -4.062 | -4.056 | 0.006 |
| | KSO4- | 5.442e-06 | 4.438e-06 | -5.264 | -5.353 | -0.089 |
| | FeSO4 | 7.160e-07 | 7.259e-07 | -6.145 | -6.139 | 0.006 |
| | HSO4- | 9.157e-08 | 7.468e-08 | -7.038 | -7.127 | -0.089 |
| | NaSO4- | 2.360e-08 | 1.925e-08 | -7.627 | -7.716 | -0.089 |
| | FeHSO4+ | 1.351e-12 | 1.102e-12 | -11.869 | -11.958 | -0.089 |
| | FeSO4+ | 2.456e-14 | 2.003e-14 | -13.610 | -13.698 | -0.089 |
| | Fe(SO4)2- | 2.290e-15 | 1.868e-15 | -14.640 | -14.729 | -0..089 |
| | FeHSO4+2 | 2.992e-20 | 1.324e-20 | -19.524 | -19.878 | -0.354 |

-----------------------------Saturation indices------------------------------

| Phase | SI | log IAP | log KT | |
|---|---|---|---|---|
| Anhydrite | -0.29 | -4.63 | -4.34 | CaSO4 |
| Aragonite | 0.08 | -8.17 | -8.25 | CaCO3 |
| Calcite | 0.24 | -8.17 | -8.41 | CaCO3 |
| CO2(g) | -0.91 | -19.14 | -18.23 | CO2 |
| Dolomite | -0.04 | -16.73 | -16.69 | CaMg(CO3)2 |
| Fe(OH)3(a) | -0.23 | 18.09 | 18.32 | Fe(OH)3 |
| FeS(ppt) | -54.06 | -94.17 | -40.11 | FeS |
| Goethite | 5.66 | 18.09 | 12.43 | FeOOH |
| Gypsum | -0.03 | -4.63 | -4.59 | CaSO4:2H2O |
| H2(g) | -21.54 | -21.48 | 0.06 | H2 |
| H2S(g) | -57.30 | -101.52 | -44.22 | H2S |
| Hausmannite | -15.51 | 49.79 | 65.30 | Mn3O4 |
| Hematite | 12.02 | 36.18 | 24.16 | Fe2O3 |
| Jarosite-K | -6.48 | 25.93 | 32.41 | KFe3(SO4)2(OH)6 |
| Mackinawite | -53.32 | -94.17 | -40.85 | FeS |
| Manganite | -5.16 | 20.18 | 25.34 | MnOOH |
| Melanterite | -5.83 | -8.25 | -2.43 | FeSO4:7H2O |
| O2(g) | -45.95 | 42.96 | 88.91 | O2 |
| Pyrite | -82.85 | -174.21 | -91.36 | FeS2 |

| | | | | |
|---|---|---|---|---|
| Pyrochroite | -5.76 | 9.44 | 15.20 | Mn(OH)2 |
| Pyrolusite | -13.22 | 30.92 | 44.14 | MnO2 |
| Rhodochrosite | 1.36 | -9.71 | -11.07 | MnCO3 |
| Siderite | -1.01 | -11.79 | -10.78 | FeCO3 |
| Sulfur | -41.91 | -80.04 | -38.13 | S |

Initial solution 24. 13C-Apr-00 Ca-Mg-SO4-HCO3 0024

-----------------------------Solution composition-----------------------------

| Elements | Molality | Moles |
|---|---|---|
| Alkalinity | 9.339e-03 | 9.339e-03 |
| Ca | 1.477e-02 | 1.477e-02 |
| Cl | 1.415e-03 | 1.415e-03 |
| Fe | 2.874e-05 | 2.874e-05 |
| K | 6.414e-04 | 6.414e-04 |
| Mg | 7.015e-03 | 7.015e-03 |
| Mn | 1.424e-04 | 1.424e-04 |
| Na | 1.484e-06 | 1.484e-06 |
| S | 1.775e-02 | 1.775e-02 |
| Zn | 9.361e-06 | 9.361e-06 |

-----------------------------Description of solution-----------------------------

| | | |
|---|---|---|
| pH | = | 6.730 |
| pe | = | 3.170 |
| Activity of water | = | 0.999 |
| Ionic strength | = | 5.984e-02 |
| Mass of water (kg) | = | 1.000e+00 |
| Total carbon (mol/kg) | = | 1.327e-02 |
| Total CO2 (mol/kg) | = | 1.327e-02 |
| Temperature (deg C) | = | 8.500 |
| Electrical balance (eq) | = | -1.694e-03 |
| Iterations | = | 8 |
| Total H | = | 1.110217e+02 |
| Total O | = | 5.561309e+01 |

-----------------------------Distribution of species-----------------------------

| Species | Molality | Activity | Log Molality | Log Activity | Log Gamma |
|---|---|---|---|---|---|
| H+ | 2.191e-07 | 1.862e-07 | -6.659 | -6.730 | -0.071 |
| OH- | 1.708e-08 | 1.372e-08 | -7.768 | -7.863 | -0.095 |
| H2O | 5.551e+01 | 9.992e-01 | 0.000 | 0.000 | 0.000 |
| C(4) | 1.327e-02 | | | | |
| HCO3- | 8.673e-03 | 7.133e-03 | -2.062 | -2.147 | -0.085 |
| CO2 | 3.944e-03 | 3.999e-03 | -2.404 | -2.398 | 0.006 |
| CaHCO3+ | 3.639e-04 | 2.992e-04 | -3.439 | -3.524 | -0.085 |
| MgHCO3+ | 2.300e-04 | 1.875e-04 | -3.638 | -3.727 | -0.089 |
| MnHCO3+ | 3.026e-05 | 2.467e-05 | -4.519 | -4.608 | - |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0.089 | | | | | | | |
| | CaCO3 | | 7.513e-06 | 7.617e-06 | -5.124 | -5.118 | |
| 0.006 | | | | | | | |
| | FeHCO3+ | | 6.784e-06 | 5.531e-06 | -5.169 | -5.257 | - |
| 0.089 | | | | | | | |
| | MnCO3 | | 3.623e-06 | 3.674e-06 | -5.441 | -5.435 | |
| 0.006 | | | | | | | |
| | CO3-2 | | 2.605e-06 | 1.192e-06 | -5.584 | -5.924 | - |
| 0.340 | | | | | | | |
| | ZnHCO3+ | | 2.166e-06 | 1.766e-06 | -5.664 | -5.753 | - |
| 0.089 | | | | | | | |
| | MgCO3 | | 2.042e-06 | 2.071e-06 | -5.690 | -5.684 | |
| 0.006 | | | | | | | |
| | ZnCO3 | | 4.613e-07 | 4.677e-07 | -6.336 | -6.330 | |
| 0.006 | | | | | | | |
| | FeCO3 | | 2.186e-07 | 2.217e-07 | -6.660 | -6.654 | |
| 0.006 | | | | | | | |
| | Zn(CO3)2-2 | | 2.697e-08 | 1.192e-08 | -7.569 | -7.924 | - |
| 0.355 | | | | | | | |
| | NaHCO3 | | 4.672e-09 | 4.737e-09 | -8.331 | -8.325 | |
| 0.006 | | | | | | | |
| | NaCO3- | | 1.332e-11 | 1.086e-11 | -10.876 | -10.964 | - |
| 0.089 | | | | | | | |
| Ca | | 1.477e-02 | | | | | |
| | Ca+2 | | 1.026e-02 | 4.715e-03 | -1.989 | -2.326 | - |
| 0.337 | | | | | | | |
| | CaSO4 | | 4.138e-03 | 4.196e-03 | -2.383 | -2.377 | |
| 0.006 | | | | | | | |
| | CaHCO3+ | | 3.639e-04 | 2.992e-04 | -3.439 | -3.524 | - |
| 0.085 | | | | | | | |
| | CaCO3 | | 7.513e-06 | 7.617e-06 | -5.124 | -5.118 | |
| 0.006 | | | | | | | |
| | CaOH+ | | 5.150e-09 | 4.199e-09 | -8.288 | -8.377 | - |
| 0.089 | | | | | | | |
| Cl | | 1.415e-03 | | | | | |
| | Cl- | | 1.414e-03 | 1.139e-03 | -2.849 | -2.943 | - |
| 0.094 | | | | | | | |
| | MnCl+ | | 2.208e-07 | 1.801e-07 | -6.656 | -6.745 | - |
| 0.089 | | | | | | | |
| | FeCl+ | | 1.495e-08 | 1.219e-08 | -7.825 | -7.914 | - |
| 0.089 | | | | | | | |
| | ZnCl+ | | 3.424e-09 | 2.791e-09 | -8.466 | -8.554 | - |
| 0.089 | | | | | | | |
| | MnCl2 | | 8.830e-11 | 8.953e-11 | -10.054 | -10.048 | |
| 0.006 | | | | | | | |
| | ZnCl2 | | 3.061e-12 | 3.104e-12 | -11.514 | -11.508 | |
| 0.006 | | | | | | | |
| | MnCl3- | | 3.445e-14 | 2.809e-14 | -13.463 | -13.552 | - |
| 0.089 | | | | | | | |
| | ZnCl3- | | 4.381e-15 | 3.572e-15 | -14.358 | -14.447 | - |
| 0.089 | | | | | | | |
| | FeCl+2 | | 1.882e-17 | 8.316e-18 | -16.725 | -17.080 | - |
| 0.355 | | | | | | | |
| | ZnCl4-2 | | 4.018e-18 | 1.775e-18 | -17.396 | -17.751 | - |
| 0.355 | | | | | | | |
| | FeCl2+ | | 9.028e-20 | 7.361e-20 | -19.044 | -19.133 | - |
| 0.089 | | | | | | | |
| | FeCl3 | | 8.269e-24 | 8.384e-24 | -23.083 | -23.077 | |
| 0.006 | | | | | | | |
| Fe(2) | | 2.874e-05 | | | | | |
| | Fe+2 | | 1.653e-05 | 7.754e-06 | -4.782 | -5.110 | - |
| 0.329 | | | | | | | |
| | FeHCO3+ | | 6.784e-06 | 5.531e-06 | -5.169 | -5.257 | - |
| 0.089 | | | | | | | |

```
          FeSO4               5.188e-06   5.260e-06    -5.285     -5.279
0.006
          FeCO3               2.186e-07   2.217e-07    -6.660     -6.654
0.006
          FeCl+               1.495e-08   1.219e-08    -7.825     -7.914     -
0.089
          FeOH+               4.375e-09   3.567e-09    -8.359     -8.448     -
0.089
          FeHSO4+             7.783e-12   6.345e-12   -11.109    -11.198     -
0.089
          Fe(HS)2             0.000e+00   0.000e+00  -100.118   -100.112
0.006
          Fe(HS)3-            0.000e+00   0.000e+00  -149.963   -150.051     -
0.089
Fe(3)              7.391e-09
          Fe(OH)2+            5.855e-09   4.774e-09    -8.232     -8.321     -
0.089
          Fe(OH)3             1.520e-09   1.541e-09    -8.818     -8.812
0.006
          FeOH+2              1.179e-11   5.211e-12   -10.928    -11.283     -
0.355
          Fe(OH)4-            4.584e-12   3.738e-12   -11.339    -11.427     -
0.089
          FeSO4+              2.017e-14   1.645e-14   -13.695    -13.784     -
0.089
          Fe(SO4)2-           2.164e-15   1.765e-15   -14.665    -14.753     -
0.089
          Fe+3                1.821e-15   4.206e-16   -14.740    -15.376     -
0.636
          FeCl+2              1.882e-17   8.316e-18   -16.725    -17.080     -
0.355
          FeCl2+              9.028e-20   7.361e-20   -19.044    -19.133     -
0.089
          Fe2(OH)2+4          3.944e-20   1.504e-21   -19.404    -20.823     -
1.419
          FeHSO4+2            1.956e-20   8.645e-21   -19.709    -20.063     -
0.355
          FeCl3               8.269e-24   8.384e-24   -23.083    -23.077
0.006
          Fe3(OH)4+5          1.238e-24   7.517e-27   -23.907    -26.124     -
2.217
H(0)               2.307e-23
          H2                  1.154e-23   1.170e-23   -22.938    -22.932
0.006
K                  6.414e-04
          K+                  6.231e-04   5.017e-04    -3.205     -3.300     -
0.094
          KSO4-               1.831e-05   1.493e-05    -4.737     -4.826     -
0.089
          KOH                 9.207e-12   9.335e-12   -11.036    -11.030
0.006
Mg                 7.015e-03
          Mg+2                4.967e-03   2.346e-03    -2.304     -2.630     -
0.326
          MgSO4               1.816e-03   1.841e-03    -2.741     -2.735
0.006
          MgHCO3+             2.300e-04   1.875e-04    -3.638     -3.727     -
0.089
          MgCO3               2.042e-06   2.071e-06    -5.690     -5.684
0.006
          MgOH+               1.158e-08   9.440e-09    -7.936     -8.025     -
0.089
Mn(2)              1.424e-04
          Mn+2                8.270e-05   3.881e-05    -4.082     -4.411     -
```

| | | | | | | |
|---|---|---|---|---|---|---|
| 0.329 | | | | | | |
| | MnHCO3+ | 3.026e-05 | 2.467e-05 | -4.519 | -4.608 | - |
| 0.089 | | | | | | |
| | MnSO4 | 2.561e-05 | 2.596e-05 | -4.592 | -4.586 | |
| 0.006 | | | | | | |
| | MnCO3 | 3.623e-06 | 3.674e-06 | -5.441 | -5.435 | |
| 0.006 | | | | | | |
| | MnCl+ | 2.208e-07 | 1.801e-07 | -6.656 | -6.745 | - |
| 0.089 | | | | | | |
| | MnOH+ | 1.581e-09 | 1.289e-09 | -8.801 | -8.890 | - |
| 0.089 | | | | | | |
| | MnCl2 | 8.830e-11 | 8.953e-11 | -10.054 | -10.048 | |
| 0.006 | | | | | | |
| | MnCl3- | 3.445e-14 | 2.809e-14 | -13.463 | -13.552 | - |
| 0.089 | | | | | | |
| Mn(3) | 8.690e-28 | | | | | |
| | Mn+3 | 8.690e-28 | 1.384e-28 | -27.061 | -27.859 | - |
| 0.798 | | | | | | |
| Na | 1.484e-06 | | | | | |
| | Na+ | 1.445e-06 | 1.181e-06 | -5.840 | -5.928 | - |
| 0.088 | | | | | | |
| | NaSO4- | 3.411e-08 | 2.781e-08 | -7.467 | -7.556 | - |
| 0.089 | | | | | | |
| | NaHCO3 | 4.672e-09 | 4.737e-09 | -8.331 | -8.325 | |
| 0.006 | | | | | | |
| | NaCO3- | 1.332e-11 | 1.086e-11 | -10.876 | -10.964 | - |
| 0.089 | | | | | | |
| | NaOH | 4.129e-14 | 4.186e-14 | -13.384 | -13.378 | |
| 0.006 | | | | | | |
| O(0) | 0.000e+00 | | | | | |
| | O2 | 0.000e+00 | 0.000e+00 | -52.275 | -52.269 | |
| 0.006 | | | | | | |
| S(-2) | 0.000e+00 | | | | | |
| | H2S | 0.000e+00 | 0.000e+00 | -51.490 | -51.484 | |
| 0.006 | | | | | | |
| | HS- | 0.000e+00 | 0.000e+00 | -51.881 | -51.976 | - |
| 0.095 | | | | | | |
| | S-2 | 0.000e+00 | 0.000e+00 | -58.336 | -58.684 | - |
| 0.347 | | | | | | |
| | Fe(HS)2 | 0.000e+00 | 0.000e+00 | -100.118 | -100.112 | |
| 0.006 | | | | | | |
| | Fe(HS)3- | 0.000e+00 | 0.000e+00 | -149.963 | -150.051 | - |
| 0.089 | | | | | | |
| S(6) | 1.775e-02 | | | | | |
| | SO4-2 | 1.175e-02 | 5.250e-03 | -1.930 | -2.280 | - |
| 0.350 | | | | | | |
| | CaSO4 | 4.138e-03 | 4.196e-03 | -2.383 | -2.377 | |
| 0.006 | | | | | | |
| | MgSO4 | 1.816e-03 | 1.841e-03 | -2.741 | -2.735 | |
| 0.006 | | | | | | |
| | MnSO4 | 2.561e-05 | 2.596e-05 | -4.592 | -4.586 | |
| 0.006 | | | | | | |
| | KSO4- | 1.831e-05 | 1.493e-05 | -4.737 | -4.826 | - |
| 0.089 | | | | | | |
| | FeSO4 | 5.188e-06 | 5.260e-06 | -5.285 | -5.279 | |
| 0.006 | | | | | | |
| | ZnSO4 | 2.087e-06 | 2.116e-06 | -5.680 | -5.674 | |
| 0.006 | | | | | | |
| | Zn(SO4)2-2 | 2.338e-07 | 1.033e-07 | -6.631 | -6.986 | - |
| 0.355 | | | | | | |
| | HSO4- | 8.348e-08 | 6.807e-08 | -7.078 | -7.167 | - |
| 0.089 | | | | | | |
| | NaSO4- | 3.411e-08 | 2.781e-08 | -7.467 | -7.556 | - |
| 0.089 | | | | | | |

```
        FeHSO4+            7.783e-12   6.345e-12   -11.109   -11.198    -
0.089
        FeSO4+             2.017e-14   1.645e-14   -13.695   -13.784    -
0.089
        Fe(SO4)2-          2.164e-15   1.765e-15   -14.665   -14.753    -
0.089
        FeHSO4+2           1.956e-20   8.645e-21   -19.709   -20.063    -
0.355
Zn                   9.361e-06
        Zn+2               4.377e-06   1.967e-06    -5.359    -5.706    -
0.347
        ZnHCO3+            2.166e-06   1.766e-06    -5.664    -5.753    -
0.089
        ZnSO4              2.087e-06   2.116e-06    -5.680    -5.674
0.006
        ZnCO3              4.613e-07   4.677e-07    -6.336    -6.330
0.006
        Zn(SO4)2-2         2.338e-07   1.033e-07    -6.631    -6.986    -
0.355
        Zn(CO3)2-2         2.697e-08   1.192e-08    -7.569    -7.924    -
0.355
        ZnOH+              3.773e-09   3.076e-09    -8.423    -8.512    -
0.089
        ZnCl+              3.424e-09   2.791e-09    -8.466    -8.554    -
0.089
        Zn(OH)2            7.032e-10   7.130e-10    -9.153    -9.147
0.006
        ZnCl2              3.061e-12   3.104e-12   -11.514   -11.508
0.006
        Zn(OH)3-           1.484e-14   1.210e-14   -13.829   -13.917    -
0.089
        ZnCl3-             4.381e-15   3.572e-15   -14.358   -14.447    -
0.089
        ZnCl4-2            4.018e-18   1.775e-18   -17.396   -17.751    -
0.355
        Zn(OH)4-2          2.328e-20   1.029e-20   -19.633   -19.988    -
0.355

----------------------------Saturation indices-------------------------
-------

        Phase              SI log IAP  log KT

        Anhydrite         -0.27   -4.61   -4.34  CaSO4
        Aragonite          0.00   -8.25   -8.25  CaCO3
        Calcite            0.15   -8.25   -8.41  CaCO3
        CO2(g)            -1.15  -19.38  -18.23  CO2
        Dolomite          -0.12  -16.80  -16.68  CaMg(CO3)2
        Fe(OH)3(a)        -0.08   18.25   18.33  Fe(OH)3
        FeS(ppt)         -46.44  -86.59  -40.15  FeS
        Goethite           5.81   18.25   12.44  FeOOH
        Gypsum            -0.01   -4.61   -4.59  CaSO4:2H2O
        H2(g)            -19.86  -19.80    0.06  H2
        H2S(g)           -50.68  -94.94  -44.25  H2S
        Hausmannite      -18.41   46.95   65.35  Mn3O4
        Hematite          12.31   36.50   24.19  Fe2O3
        Jarosite-K        -5.74   26.70   32.44  KFe3(SO4)2(OH)6
        Mackinawite      -45.71  -86.59  -40.88  FeS
        Manganite         -6.39   18.95   25.34  MnOOH
        Melanterite       -4.96   -7.39   -2.43  FeSO4:7H2O
        O2(g)            -49.39   39.60   88.99  O2
        Pyrite           -70.30 -161.73  -91.43  FeS2
        Pyrochroite       -6.15    9.05   15.20  Mn(OH)2
        Pyrolusite       -15.33   28.85   44.18  MnO2
```

| | | | | |
|---|---|---|---|---|
| Rhodochrosite | 0.73 | -10.33 | -11.07 | MnCO3 |
| Siderite | -0.25 | -11.03 | -10.78 | FeCO3 |
| Smithsonite | -1.82 | -11.63 | -9.81 | ZnCO3 |
| Sphalerite | -38.98 | -87.18 | -48.20 | ZnS |
| Sulfur | -36.97 | -75.14 | -38.16 | S |
| Zn(OH)2(e) | -3.75 | 7.75 | 11.50 | Zn(OH)2 |

Initial solution 46. 14B-Apr-00 Ca-Mg-SO4-HCO3 0046

----------------------------Solution composition-----------------------------

| Elements | Molality | Moles |
|---|---|---|
| Alkalinity | 9.683e-03 | 9.683e-03 |
| Ca | 1.501e-02 | 1.501e-02 |
| Cl | 1.188e-03 | 1.188e-03 |
| Fe | 1.078e-06 | 1.078e-06 |
| K | 5.900e-04 | 5.900e-04 |
| Mg | 6.188e-03 | 6.188e-03 |
| Mn | 4.016e-04 | 4.016e-04 |
| Na | 1.134e-06 | 1.134e-06 |
| S | 1.566e-02 | 1.566e-02 |
| Zn | 5.677e-05 | 5.677e-05 |

----------------------------Description of solution----------------------------

pH = 6.430
pe = 5.090
Activity of water = 0.999
Ionic strength = 5.613e-02
Mass of water (kg) = 1.000e+00
Total carbon (mol/kg) = 1.683e-02
Total CO2 (mol/kg) = 1.683e-02
Temperature (deg C) = 14.200
Electrical balance (eq) = 1.720e-03
Iterations = 9
Total H = 1.110221e+02
Total O = 5.561219e+01

----------------------------Distribution of species----------------------------

| Species | Molality | Activity | Log Molality | Log Activity | Log Gamma |
|---|---|---|---|---|---|
| H+ | 4.364e-07 | 3.715e-07 | -6.360 | -6.430 | -0.070 |
| OH- | 1.405e-08 | 1.133e-08 | -7.852 | -7.946 | -0.093 |
| H2O | 5.551e+01 | 9.992e-01 | 0.000 | 0.000 | 0.000 |
| C(4) 1.683e-02 | | | | | |
| HCO3- | 8.885e-03 | 7.328e-03 | -2.051 | -2.135 | -0.084 |
| CO2 | 7.164e-03 | 7.257e-03 | -2.145 | -2.139 | 0.006 |
| CaHCO3+ | 4.537e-04 | 3.742e-04 | -3.343 | -3.427 | -0.084 |
| MgHCO3+ | 2.101e-04 | 1.718e-04 | -3.678 | -3.765 | -0.087 |

| | | | | | |
|---|---|---|---|---|---|
| MnHCO3+ | 8.889e-05 | 7.268e-05 | -4.051 | -4.139 | -0.087 |
| ZnHCO3+ | 1.416e-05 | 1.158e-05 | -4.849 | -4.936 | -0.087 |
| MnCO3 | 6.285e-06 | 6.367e-06 | -5.202 | -5.196 | 0.006 |
| CaCO3 | 4.967e-06 | 5.031e-06 | -5.304 | -5.298 | 0.006 |
| ZnCO3 | 1.781e-06 | 1.804e-06 | -5.749 | -5.744 | 0.006 |
| CO3-2 | 1.556e-06 | 7.203e-07 | -5.808 | -6.142 | -0.335 |
| MgCO3 | 1.193e-06 | 1.208e-06 | -5.923 | -5.918 | 0.006 |
| FeHCO3+ | 2.598e-07 | 2.124e-07 | -6.585 | -6.673 | -0.087 |
| Zn(CO3)2-2 | 6.216e-08 | 2.778e-08 | -7.207 | -7.556 | -0.350 |
| FeCO3 | 4.944e-09 | 5.008e-09 | -8.306 | -8.300 | 0.006 |
| NaHCO3 | 3.692e-09 | 3.740e-09 | -8.433 | -8.427 | 0.006 |
| NaCO3- | 8.460e-12 | 6.917e-12 | -11.073 | -11.160 | -0.087 |
| Ca | 1.501e-02 | | | | |
| Ca+2 | 1.060e-02 | 4.929e-03 | -1.975 | -2.307 | -0.333 |
| CaSO4 | 3.951e-03 | 4.002e-03 | -2.403 | -2.398 | 0.006 |
| CaHCO3+ | 4.537e-04 | 3.742e-04 | -3.343 | -3.427 | -0.084 |
| CaCO3 | 4.967e-06 | 5.031e-06 | -5.304 | -5.298 | 0.006 |
| CaOH+ | 2.690e-09 | 2.200e-09 | -8.570 | -8.658 | -0.087 |
| Cl | 1.188e-03 | | | | |
| Cl- | 1.188e-03 | 9.598e-04 | -2.925 | -3.018 | -0.092 |
| MnCl+ | 5.322e-07 | 4.351e-07 | -6.274 | -6.361 | -0.087 |
| ZnCl+ | 2.419e-08 | 1.978e-08 | -7.616 | -7.704 | -0.087 |
| FeCl+ | 4.697e-10 | 3.840e-10 | -9.328 | -9.416 | -0.087 |
| MnCl2 | 1.800e-10 | 1.823e-10 | -9.745 | -9.739 | 0.006 |
| ZnCl2 | 1.876e-11 | 1.901e-11 | -10.727 | -10.721 | 0.006 |
| MnCl3- | 5.894e-14 | 4.819e-14 | -13.230 | -13.317 | -0.087 |
| ZnCl3- | 2.341e-14 | 1.914e-14 | -13.631 | -13.718 | -0.087 |
| FeCl+2 | 8.380e-17 | 3.745e-17 | -16.077 | -16.427 | -0.350 |
| ZnCl4-2 | 1.885e-17 | 8.424e-18 | -16.725 | -17.074 | -0.350 |
| FeCl2+ | 2.801e-19 | 2.290e-19 | -18.553 | -18.640 | -0.087 |
| FeCl3 | 2.170e-23 | 2.198e-23 | -22.664 | -22.658 | 0.006 |
| Fe(2) | 1.064e-06 | | | | |
| Fe+2 | 6.111e-07 | 2.899e-07 | -6.214 | -6.538 | -0.324 |
| FeHCO3+ | 2.598e-07 | 2.124e-07 | -6.585 | -6.673 | - |

```
0.087
          FeSO4              1.873e-07   1.898e-07    -6.727    -6.722
0.006
          FeCO3              4.944e-09   5.008e-09    -8.306    -8.300
0.006
          FeCl+              4.697e-10   3.840e-10    -9.328    -9.416     -
0.087
          FeOH+              1.305e-10   1.067e-10    -9.884    -9.972     -
0.087
          FeHSO4+            5.557e-13   4.543e-13   -12.255   -12.343     -
0.087
          Fe(HS)2            0.000e+00   0.000e+00  -128.847  -128.841
0.006
          Fe(HS)3-           0.000e+00   0.000e+00  -192.344  -192.431     -
0.087
Fe(3)               1.384e-08
          Fe(OH)2+           1.178e-08   9.632e-09    -7.929    -8.016     -
0.087
          Fe(OH)3            2.021e-09   2.047e-09    -8.694    -8.689
0.006
          FeOH+2             3.702e-11   1.654e-11   -10.432   -10.781     -
0.350
          Fe(OH)4-           3.915e-12   3.201e-12   -11.407   -11.495     -
0.087
          FeSO4+             8.715e-14   7.125e-14   -13.060   -13.147     -
0.087
          Fe(SO4)2-          8.246e-15   6.742e-15   -14.084   -14.171     -
0.087
          Fe+3               7.846e-15   1.843e-15   -14.105   -14.734     -
0.629
          FeCl+2             8.380e-17   3.745e-17   -16.077   -16.427     -
0.350
          Fe2(OH)2+4         2.935e-19   1.171e-20   -18.532   -19.932     -
1.399
          FeCl2+             2.801e-19   2.290e-19   -18.553   -18.640     -
0.087
          FeHSO4+2           1.624e-19   7.256e-20   -18.790   -19.139     -
0.350
          FeCl3              2.170e-23   2.198e-23   -22.664   -22.658
0.006
          Fe3(OH)4+5         1.017e-23   6.624e-26   -22.993   -25.179     -
2.186
H(0)                1.309e-26
          H2                 6.546e-27   6.631e-27   -26.184   -26.178
0.006
K                   5.900e-04
          K+                 5.742e-04   4.641e-04    -3.241    -3.333     -
0.092
          KSO4-              1.574e-05   1.287e-05    -4.803    -4.890     -
0.087
          KOH                4.272e-12   4.328e-12   -11.369   -11.364
0.006
Mg                  6.188e-03
          Mg+2               4.351e-03   2.075e-03    -2.361    -2.683     -
0.322
          MgSO4              1.626e-03   1.647e-03    -2.789    -2.783
0.006
          MgHCO3+            2.101e-04   1.718e-04    -3.678    -3.765     -
0.087
          MgCO3              1.193e-06   1.208e-06    -5.923    -5.918
0.006
          MgOH+              9.010e-09   7.366e-09    -8.045    -8.133     -
0.087
Mn(2)               4.016e-04
```

| | | | | | |
|---|---|---|---|---|---|
| Mn+2 | 2.346e-04 | 1.113e-04 | -3.630 | -3.954 | -0.324 |
| MnHCO3+ | 8.889e-05 | 7.268e-05 | -4.051 | -4.139 | -0.087 |
| MnSO4 | 7.128e-05 | 7.221e-05 | -4.147 | -4.141 | 0.006 |
| MnCO3 | 6.285e-06 | 6.367e-06 | -5.202 | -5.196 | 0.006 |
| MnCl+ | 5.322e-07 | 4.351e-07 | -6.274 | -6.361 | -0.087 |
| MnOH+ | 3.774e-09 | 3.086e-09 | -8.423 | -8.511 | -0.087 |
| MnCl2 | 1.800e-10 | 1.823e-10 | -9.745 | -9.739 | 0.006 |
| MnCl3- | 5.894e-14 | 4.819e-14 | -13.230 | -13.317 | -0.087 |
| Mn(3) | 5.043e-25 | | | | |
| Mn+3 | 5.043e-25 | 8.235e-26 | -24.297 | -25.084 | -0.787 |
| Na | 1.134e-06 | | | | |
| Na+ | 1.107e-06 | 9.075e-07 | -5.956 | -6.042 | -0.086 |
| NaSO4- | 2.341e-08 | 1.914e-08 | -7.631 | -7.718 | -0.087 |
| NaHCO3 | 3.692e-09 | 3.740e-09 | -8.433 | -8.427 | 0.006 |
| NaCO3- | 8.460e-12 | 6.917e-12 | -11.073 | -11.160 | -0.087 |
| NaOH | 1.592e-14 | 1.612e-14 | -13.798 | -13.793 | 0.006 |
| O(0) | 0.000e+00 | | | | |
| O2 | 0.000e+00 | 0.000e+00 | -43.720 | -43.714 | 0.006 |
| S(-2) | 0.000e+00 | | | | |
| H2S | 0.000e+00 | 0.000e+00 | -64.922 | -64.917 | 0.006 |
| HS- | 0.000e+00 | 0.000e+00 | -65.533 | -65.627 | -0.093 |
| S-2 | 0.000e+00 | 0.000e+00 | -72.106 | -72.448 | -0.342 |
| Fe(HS)2 | 0.000e+00 | 0.000e+00 | -128.847 | -128.841 | 0.006 |
| Fe(HS)3- | 0.000e+00 | 0.000e+00 | -192.344 | -192.431 | -0.087 |
| S(6) | 1.566e-02 | | | | |
| SO4-2 | 9.983e-03 | 4.519e-03 | -2.001 | -2.345 | -0.344 |
| CaSO4 | 3.951e-03 | 4.002e-03 | -2.403 | -2.398 | 0.006 |
| MgSO4 | 1.626e-03 | 1.647e-03 | -2.789 | -2.783 | 0.006 |
| MnSO4 | 7.128e-05 | 7.221e-05 | -4.147 | -4.141 | 0.006 |
| KSO4- | 1.574e-05 | 1.287e-05 | -4.803 | -4.890 | -0.087 |
| ZnSO4 | 1.204e-05 | 1.220e-05 | -4.919 | -4.914 | 0.006 |
| Zn(SO4)2-2 | 1.093e-06 | 4.883e-07 | -5.962 | -6.311 | -0.350 |
| FeSO4 | 1.873e-07 | 1.898e-07 | -6.727 | -6.722 | 0.006 |
| HSO4- | 1.594e-07 | 1.304e-07 | -6.797 | -6.885 | -0.087 |
| NaSO4- | 2.341e-08 | 1.914e-08 | -7.631 | -7.718 | - |

0.087
FeHSO4+ 5.557e-13 4.543e-13 -12.255 -12.343 -
0.087
FeSO4+ 8.715e-14 7.125e-14 -13.060 -13.147 -
0.087
Fe(SO4)2- 8.246e-15 6.742e-15 -14.084 -14.171 -
0.087
FeHSO4+2 1.624e-19 7.256e-20 -18.790 -19.139 -
0.350
Zn 5.677e-05
Zn+2 2.759e-05 1.255e-05 -4.559 -4.901 -
0.342
ZnHCO3+ 1.416e-05 1.158e-05 -4.849 -4.936 -
0.087
ZnSO4 1.204e-05 1.220e-05 -4.919 -4.914
0.006
ZnCO3 1.781e-06 1.804e-06 -5.749 -5.744
0.006
Zn(SO4)2-2 1.093e-06 4.883e-07 -5.962 -6.311 -
0.350
Zn(CO3)2-2 6.216e-08 2.778e-08 -7.207 -7.556 -
0.350
ZnCl+ 2.419e-08 1.978e-08 -7.616 -7.704 -
0.087
ZnOH+ 1.935e-08 1.582e-08 -7.713 -7.801 -
0.087
Zn(OH)2 1.128e-09 1.143e-09 -8.948 -8.942
0.006
ZnCl2 1.876e-11 1.901e-11 -10.727 -10.721
0.006
ZnCl3- 2.341e-14 1.914e-14 -13.631 -13.718 -
0.087
Zn(OH)3- 1.189e-14 9.718e-15 -13.925 -14.012 -
0.087
ZnCl4-2 1.885e-17 8.424e-18 -16.725 -17.074 -
0.350
Zn(OH)4-2 9.268e-21 4.142e-21 -20.033 -20.383 -
0.350

------------------------------Saturation indices-------------------------------

| Phase | SI | log IAP | log KT | |
|---|---|---|---|---|
| Anhydrite | -0.32 | -4.65 | -4.33 | CaSO4 |
| Aragonite | -0.17 | -8.45 | -8.27 | CaCO3 |
| Calcite | -0.02 | -8.45 | -8.43 | CaCO3 |
| CO2(g) | -0.81 | -19.00 | -18.19 | CO2 |
| Dolomite | -0.45 | -17.28 | -16.83 | CaMg(CO3)2 |
| Fe(OH)3(a) | -0.34 | 17.84 | 18.18 | Fe(OH)3 |
| FeS(ppt) | -61.82 | -101.04 | -39.22 | FeS |
| Goethite | 5.55 | 17.84 | 12.29 | FeOOH |
| Gypsum | -0.07 | -4.65 | -4.59 | CaSO4:2H2O |
| H2(g) | -23.08 | -23.04 | 0.04 | H2 |
| H2S(g) | -64.05 | -107.36 | -43.32 | H2S |
| Hausmannite | -14.04 | 49.76 | 63.80 | Mn3O4 |
| Hematite | 12.27 | 35.68 | 23.42 | Fe2O3 |
| Jarosite-K | -5.30 | 26.21 | 31.51 | KFe3(SO4)2(OH)6 |
| Mackinawite | -61.09 | -101.04 | -39.95 | FeS |
| Manganite | -4.91 | 20.43 | 25.34 | MnOOH |
| Melanterite | -6.54 | -8.89 | -2.35 | FeSO4:7H2O |
| O2(g) | -40.80 | 46.08 | 86.88 | O2 |
| Pyrite | -95.96 | -185.36 | -89.40 | FeS2 |
| Pyrochroite | -6.29 | 8.91 | 15.20 | Mn(OH)2 |

| | | | | |
|---|---|---|---|---|
| Pyrolusite | -11.23 | 31.95 | 43.17 | MnO2 |
| Rhodochrosite | 0.99 | -10.10 | -11.09 | MnCO3 |
| Siderite | -1.86 | -12.68 | -10.82 | FeCO3 |
| Smithsonite | -1.16 | -11.04 | -9.88 | ZnCO3 |
| Sphalerite | -52.25 | -99.40 | -47.15 | ZnS |
| Sulfur | -47.02 | -84.32 | -37.30 | S |
| Zn(OH)2(e) | -3.54 | 7.96 | 11.50 | Zn(OH)2 |

Initial solution 53. 14C-Apr-00 Ca-Mg-SO4-HCO3 0053

-----------------------------Solution composition-----------------------------

| Elements | Molality | Moles |
|---|---|---|
| Alkalinity | 8.896e-03 | 8.896e-03 |
| Ca | 7.246e-03 | 7.246e-03 |
| Cl | 9.321e-04 | 9.321e-04 |
| Fe | 2.331e-04 | 2.331e-04 |
| K | 1.946e-04 | 1.946e-04 |
| Mg | 2.101e-03 | 2.101e-03 |
| Mn | 6.562e-05 | 6.562e-05 |
| Na | 4.094e-07 | 4.094e-07 |
| S | 4.587e-03 | 4.587e-03 |
| Zn | 2.757e-05 | 2.757e-05 |

----------------------------Description of solution----------------------------

pH = 6.650
pe = 1.560
Activity of water = 1.000
Ionic strength = 2.722e-02
Mass of water (kg) = 1.000e+00
Total carbon (mol/kg) = 1.339e-02
Total CO2 (mol/kg) = 1.339e-02
Temperature (deg C) = 11.900
Electrical balance (eq) = 5.379e-04
Iterations = 8
Total H = 1.110213e+02
Total O = 5.556023e+01

----------------------------Distribution of species----------------------------

| Species | Molality | Activity | Log Molality | Log Activity | Log Gamma |
|---|---|---|---|---|---|
| H+ | 2.544e-07 | 2.239e-07 | -6.595 | -6.650 | -0.055 |
| OH- | 1.810e-08 | 1.544e-08 | -7.742 | -7.811 | -0.069 |
| H2O | 5.551e+01 | 9.995e-01 | 0.000 | 0.000 | 0.000 |
| C(4) | 1.339e-02 | | | | |
| HCO3- | 8.410e-03 | 7.262e-03 | -2.075 | -2.139 | -0.064 |
| CO2 | 4.508e-03 | 4.536e-03 | -2.346 | -2.343 | 0.003 |
| CaHCO3+ | 2.718e-04 | 2.347e-04 | -3.566 | -3.630 | -0.064 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | MgHCO3+ | | 9.259e-05 | 7.943e-05 | -4.033 | -4.100 | -0.067 |
| | FeHCO3+ | | 6.820e-05 | 5.851e-05 | -4.166 | -4.233 | -0.067 |
| | MnHCO3+ | | 1.730e-05 | 1.484e-05 | -4.762 | -4.829 | -0.067 |
| | ZnHCO3+ | | 8.392e-06 | 7.199e-06 | -5.076 | -5.143 | -0.067 |
| | CaCO3 | | 5.065e-06 | 5.097e-06 | -5.295 | -5.293 | 0.003 |
| | FeCO3 | | 2.138e-06 | 2.151e-06 | -5.670 | -5.667 | 0.003 |
| | MnCO3 | | 2.014e-06 | 2.027e-06 | -5.696 | -5.693 | 0.003 |
| | CO3-2 | | 2.003e-06 | 1.113e-06 | -5.698 | -5.953 | -0.255 |
| | ZnCO3 | | 1.738e-06 | 1.749e-06 | -5.760 | -5.757 | 0.003 |
| | MgCO3 | | 8.395e-07 | 8.448e-07 | -6.076 | -6.073 | 0.003 |
| | Zn(CO3)2-2 | | 7.685e-08 | 4.162e-08 | -7.114 | -7.381 | -0.266 |
| | NaHCO3 | | 1.412e-09 | 1.421e-09 | -8.850 | -8.848 | 0.003 |
| | NaCO3- | | 4.212e-12 | 3.613e-12 | -11.376 | -11.442 | -0.067 |
| Ca | | 7.246e-03 | | | | | |
| | Ca+2 | | 5.942e-03 | 3.304e-03 | -2.226 | -2.481 | -0.255 |
| | CaSO4 | | 1.027e-03 | 1.033e-03 | -2.988 | -2.986 | 0.003 |
| | CaHCO3+ | | 2.718e-04 | 2.347e-04 | -3.566 | -3.630 | -0.064 |
| | CaCO3 | | 5.065e-06 | 5.097e-06 | -5.295 | -5.293 | 0.003 |
| | CaOH+ | | 2.853e-09 | 2.448e-09 | -8.545 | -8.611 | -0.067 |
| Cl | | 9.321e-04 | | | | | |
| | Cl- | | 9.319e-04 | 7.953e-04 | -3.031 | -3.099 | -0.069 |
| | FeCl+ | | 1.031e-07 | 8.845e-08 | -6.987 | -7.053 | -0.067 |
| | MnCl+ | | 8.658e-08 | 7.427e-08 | -7.063 | -7.129 | -0.067 |
| | ZnCl+ | | 1.074e-08 | 9.211e-09 | -7.969 | -8.036 | -0.067 |
| | MnCl2 | | 2.562e-11 | 2.578e-11 | -10.591 | -10.589 | 0.003 |
| | ZnCl2 | | 7.214e-12 | 7.260e-12 | -11.142 | -11.139 | 0.003 |
| | ZnCl3- | | 6.955e-15 | 5.967e-15 | -14.158 | -14.224 | -0.067 |
| | MnCl3- | | 6.583e-15 | 5.648e-15 | -14.182 | -14.248 | -0.067 |
| | ZnCl4-2 | | 3.939e-18 | 2.133e-18 | -17.405 | -17.671 | -0.266 |
| | FeCl+2 | | 3.787e-18 | 2.051e-18 | -17.422 | -17.688 | -0.266 |
| | FeCl2+ | | 1.311e-20 | 1.125e-20 | -19.882 | -19.949 | -0.067 |
| | FeCl3 | | 8.890e-25 | 8.946e-25 | -24.051 | -24.048 | 0.003 |
| Fe(2) | | 2.331e-04 | | | | | |
| | Fe+2 | | 1.429e-04 | 8.057e-05 | -3.845 | -4.094 | - |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0.249 | | | | | | | |
| | FeHCO3+ | | 6.820e-05 | 5.851e-05 | -4.166 | -4.233 | - |
| 0.067 | | | | | | | |
| | FeSO4 | | 1.975e-05 | 1.987e-05 | -4.705 | -4.702 | |
| 0.003 | | | | | | | |
| | FeCO3 | | 2.138e-06 | 2.151e-06 | -5.670 | -5.667 | |
| 0.003 | | | | | | | |
| | FeCl+ | | 1.031e-07 | 8.845e-08 | -6.987 | -7.053 | - |
| 0.067 | | | | | | | |
| | FeOH+ | | 4.763e-08 | 4.086e-08 | -7.322 | -7.389 | - |
| 0.067 | | | | | | | |
| | FeHSO4+ | | 3.344e-11 | 2.869e-11 | -10.476 | -10.542 | - |
| 0.067 | | | | | | | |
| | Fe(HS)2 | | 0.000e+00 | 0.000e+00 | -73.952 | -73.949 | |
| 0.003 | | | | | | | |
| | Fe(HS)3- | | 0.000e+00 | 0.000e+00 | -111.248 | -111.314 | - |
| 0.067 | | | | | | | |
| Fe(3) | | 2.212e-09 | | | | | |
| | Fe(OH)2+ | | 1.739e-09 | 1.492e-09 | -8.760 | -8.826 | - |
| 0.067 | | | | | | | |
| | Fe(OH)3 | | 4.692e-10 | 4.722e-10 | -9.329 | -9.326 | |
| 0.003 | | | | | | | |
| | FeOH+2 | | 3.132e-12 | 1.696e-12 | -11.504 | -11.770 | - |
| 0.266 | | | | | | | |
| | Fe(OH)4- | | 1.292e-12 | 1.108e-12 | -11.889 | -11.955 | - |
| 0.067 | | | | | | | |
| | FeSO4+ | | 2.217e-15 | 1.902e-15 | -14.654 | -14.721 | - |
| 0.067 | | | | | | | |
| | Fe+3 | | 4.160e-16 | 1.319e-16 | -15.381 | -15.880 | - |
| 0.499 | | | | | | | |
| | Fe(SO4)2- | | 8.192e-17 | 7.028e-17 | -16.087 | -16.153 | - |
| 0.067 | | | | | | | |
| | FeCl+2 | | 3.787e-18 | 2.051e-18 | -17.422 | -17.688 | - |
| 0.266 | | | | | | | |
| | FeCl2+ | | 1.311e-20 | 1.125e-20 | -19.882 | -19.949 | - |
| 0.067 | | | | | | | |
| | FeHSO4+2 | | 2.177e-21 | 1.179e-21 | -20.662 | -20.928 | - |
| 0.266 | | | | | | | |
| | Fe2(OH)2+4 | | 1.586e-21 | 1.365e-22 | -20.800 | -21.865 | - |
| 1.065 | | | | | | | |
| | FeCl3 | | 8.890e-25 | 8.946e-25 | -24.051 | -24.048 | |
| 0.003 | | | | | | | |
| | Fe3(OH)4+5 | | 6.954e-27 | 1.506e-28 | -26.158 | -27.822 | - |
| 1.664 | | | | | | | |
| H(0) | | 5.527e-20 | | | | | |
| | H2 | | 2.763e-20 | 2.781e-20 | -19.559 | -19.556 | |
| 0.003 | | | | | | | |
| K | | 1.946e-04 | | | | | |
| | K+ | | 1.926e-04 | 1.644e-04 | -3.715 | -3.784 | - |
| 0.069 | | | | | | | |
| | KSO4- | | 2.030e-06 | 1.741e-06 | -5.693 | -5.759 | - |
| 0.067 | | | | | | | |
| | KOH | | 2.529e-12 | 2.545e-12 | -11.597 | -11.594 | |
| 0.003 | | | | | | | |
| Mg | | 2.101e-03 | | | | | |
| | Mg+2 | | 1.724e-03 | 9.725e-04 | -2.764 | -3.012 | - |
| 0.249 | | | | | | | |
| | MgSO4 | | 2.836e-04 | 2.854e-04 | -3.547 | -3.545 | |
| 0.003 | | | | | | | |
| | MgHCO3+ | | 9.259e-05 | 7.943e-05 | -4.033 | -4.100 | - |
| 0.067 | | | | | | | |
| | MgCO3 | | 8.395e-07 | 8.448e-07 | -6.076 | -6.073 | |
| 0.003 | | | | | | | |
| | MgOH+ | | 5.332e-09 | 4.574e-09 | -8.273 | -8.340 | - |

```
0.067
Mn(2)            6.562e-05
     Mn+2              4.066e-05   2.293e-05    -4.391    -4.640    -
0.249
     MnHCO3+           1.730e-05   1.484e-05    -4.762    -4.829    -
0.067
     MnSO4             5.558e-06   5.593e-06    -5.255    -5.252
0.003
     MnCO3             2.014e-06   2.027e-06    -5.696    -5.693
0.003
     MnCl+             8.658e-08   7.427e-08    -7.063    -7.129    -
0.067
     MnOH+             1.004e-09   8.611e-10    -8.998    -9.065    -
0.067
     MnCl2             2.562e-11   2.578e-11   -10.591   -10.589
0.003
     MnCl3-            6.583e-15   5.648e-15   -14.182   -14.248    -
0.067
Mn(3)            1.382e-29
     Mn+3              1.382e-29   3.477e-30   -28.860   -29.459    -
0.599
Na               4.094e-07
     Na+               4.047e-07   3.479e-07    -6.393    -6.459    -
0.066
     NaSO4-            3.320e-09   2.848e-09    -8.479    -8.545    -
0.067
     NaHCO3            1.412e-09   1.421e-09    -8.850    -8.848
0.003
     NaCO3-            4.212e-12   3.613e-12   -11.376   -11.442    -
0.067
     NaOH              1.020e-14   1.026e-14   -13.991   -13.989
0.003
O(0)             0.000e+00
     O2                0.000e+00   0.000e+00   -57.784   -57.781
0.003
S(-2)            1.774e-39
     H2S               1.310e-39   1.318e-39   -38.883   -38.880
0.003
     HS-               4.643e-40   3.958e-40   -39.333   -39.403    -
0.069
     S-2               0.000e+00   0.000e+00   -45.819   -46.078    -
0.259
     Fe(HS)2           0.000e+00   0.000e+00   -73.952   -73.949
0.003
     Fe(HS)3-          0.000e+00   0.000e+00  -111.248  -111.314    -
0.067
S(6)             4.587e-03
     SO4-2             3.246e-03   1.782e-03    -2.489    -2.749    -
0.260
     CaSO4             1.027e-03   1.033e-03    -2.988    -2.986
0.003
     MgSO4             2.836e-04   2.854e-04    -3.547    -3.545
0.003
     FeSO4             1.975e-05   1.987e-05    -4.705    -4.702
0.003
     MnSO4             5.558e-06   5.593e-06    -5.255    -5.252
0.003
     ZnSO4             2.941e-06   2.960e-06    -5.531    -5.529
0.003
     KSO4-             2.030e-06   1.741e-06    -5.693    -5.759    -
0.067
     Zn(SO4)2-2        8.795e-08   4.763e-08    -7.056    -7.322    -
0.266
     HSO4-             3.452e-08   2.962e-08    -7.462    -7.528    -
```

```
0.067
   NaSO4-            3.320e-09   2.848e-09    -8.479    -8.545    -
0.067
   FeHSO4+           3.344e-11   2.869e-11   -10.476   -10.542    -
0.067
   FeSO4+            2.217e-15   1.902e-15   -14.654   -14.721    -
0.067
   Fe(SO4)2-         8.192e-17   7.028e-17   -16.087   -16.153    -
0.067
   FeHSO4+2          2.177e-21   1.179e-21   -20.662   -20.928    -
0.266
Zn              2.757e-05
   Zn+2              1.431e-05   7.874e-06    -4.844    -5.104    -
0.259
   ZnHCO3+           8.392e-06   7.199e-06    -5.076    -5.143    -
0.067
   ZnSO4             2.941e-06   2.960e-06    -5.531    -5.529
0.003
   ZnCO3             1.738e-06   1.749e-06    -5.760    -5.757
0.003
   Zn(SO4)2-2        8.795e-08   4.763e-08    -7.056    -7.322    -
0.266
   Zn(CO3)2-2        7.685e-08   4.162e-08    -7.114    -7.381    -
0.266
   ZnOH+             1.589e-08   1.363e-08    -7.799    -7.865    -
0.067
   ZnCl+             1.074e-08   9.211e-09    -7.969    -8.036    -
0.067
   Zn(OH)2           1.964e-09   1.976e-09    -8.707    -8.704
0.003
   ZnCl2             7.214e-12   7.260e-12   -11.142   -11.139
0.003
   Zn(OH)3-          3.252e-14   2.790e-14   -13.488   -13.554    -
0.067
   ZnCl3-            6.955e-15   5.967e-15   -14.158   -14.224    -
0.067
   ZnCl4-2           3.939e-18   2.133e-18   -17.405   -17.671    -
0.266
   Zn(OH)4-2         3.645e-20   1.974e-20   -19.438   -19.705    -
0.266

----------------------------Saturation indices-----------------------
-------
```

| Phase | SI | log IAP | log KT | |
|---|---|---|---|---|
| Anhydrite | -0.90 | -5.23 | -4.33 | CaSO4 |
| Aragonite | -0.17 | -8.43 | -8.26 | CaCO3 |
| Calcite | -0.02 | -8.43 | -8.42 | CaCO3 |
| CO2(g) | -1.05 | -19.25 | -18.21 | CO2 |
| Dolomite | -0.63 | -17.40 | -16.77 | CaMg(CO3)2 |
| Fe(OH)3(a) | -0.82 | 17.42 | 18.24 | Fe(OH)3 |
| FeS(ppt) | -32.93 | -72.52 | -39.59 | FeS |
| Goethite | 5.07 | 17.42 | 12.35 | FeOOH |
| Gypsum | -0.64 | -5.23 | -4.59 | CaSO4:2H2O |
| H2(g) | -16.47 | -16.42 | 0.05 | H2 |
| H2S(g) | -38.04 | -81.73 | -43.69 | H2S |
| Hausmannite | -22.02 | 42.40 | 64.42 | Mn3O4 |
| Hematite | 11.11 | 34.83 | 23.72 | Fe2O3 |
| Jarosite-K | -8.87 | 23.01 | 31.88 | KFe3(SO4)2(OH)6 |
| Mackinawite | -32.20 | -72.52 | -40.32 | FeS |
| Manganite | -8.47 | 16.87 | 25.34 | MnOOH |
| Melanterite | -4.46 | -6.84 | -2.38 | FeSO4:7H2O |
| O2(g) | -54.88 | 32.84 | 87.72 | O2 |

| | | | | |
|---|---|---|---|---|
| Pyrite | -47.62 | -137.83 | -90.21 | FeS2 |
| Pyrochroite | -6.54 | 8.66 | 15.20 | Mn(OH)2 |
| Pyrolusite | -18.49 | 25.08 | 43.57 | MnO2 |
| Rhodochrosite | 0.49 | -10.59 | -11.08 | MnCO3 |
| Siderite | 0.76 | -10.05 | -10.81 | FeCO3 |
| Smithsonite | -1.20 | -11.06 | -9.85 | ZnCO3 |
| Sphalerite | -25.96 | -73.53 | -47.57 | ZnS |
| Sulfur | -27.66 | -65.31 | -37.65 | S |
| Zn(OH)2(e) | -3.30 | 8.20 | 11.50 | Zn(OH)2 |

Initial solution 54.    14A-Apr-00  Ca-Mg-SO4-HCO3  0054

----------------------------Solution composition-----------------------------

| Elements | Molality | Moles |
|---|---|---|
| Alkalinity | 8.327e-03 | 8.327e-03 |
| Ba | 4.304e-07 | 4.304e-07 |
| Ca | 8.250e-03 | 8.250e-03 |
| Fe | 9.869e-06 | 9.869e-06 |
| K | 3.075e-04 | 3.075e-04 |
| Mg | 4.946e-03 | 4.946e-03 |
| Mn | 1.313e-04 | 1.313e-04 |
| Na | 1.482e-06 | 1.482e-06 |
| S | 1.012e-02 | 1.012e-02 |

----------------------------Description of solution-----------------------------

pH = 6.870
pe = 2.930
Activity of water = 0.999
Ionic strength = 3.811e-02
Mass of water (kg) = 1.000e+00
Total carbon (mol/kg) = 1.083e-02
Total CO2 (mol/kg) = 1.083e-02
Temperature (deg C) = 11.200
Electrical balance (eq) = -1.579e-03
Iterations = 9
Total H = 1.110207e+02
Total O = 5.557665e+01

----------------------------Distribution of species-----------------------------

| Species | | Molality | Activity | Log Molality | Log Activity | Log Gamma |
|---|---|---|---|---|---|---|
| H+ | | 1.555e-07 | 1.349e-07 | -6.808 | -6.870 | -0.062 |
| OH- | | 2.894e-08 | 2.410e-08 | -7.538 | -7.618 | -0.080 |
| H2O | | 5.551e+01 | 9.995e-01 | 0.000 | 0.000 | 0.000 |
| Ba | 4.304e-07 | | | | | |
| Ba+2 | | 2.238e-07 | 1.134e-07 | -6.650 | -6.945 | -0.295 |
| BaSO4 | | 2.010e-07 | 2.028e-07 | -6.697 | -6.693 | 0.004 |
| BaHCO3+ | | 5.571e-09 | 4.680e-09 | -8.254 | -8.330 | -0.076 |

```
        BaCO3               7.299e-11   7.364e-11   -10.137    -10.133
0.004
        BaOH+               3.389e-14   2.847e-14   -13.470    -13.546     -
0.076
C(4)                1.083e-02
        HCO3-               7.852e-03   6.647e-03    -2.105     -2.177     -
0.072
        CO2                 2.517e-03   2.540e-03    -2.599     -2.595
0.004
        CaHCO3+             2.357e-04   1.995e-04    -3.628     -3.700     -
0.072
        MgHCO3+             1.711e-04   1.438e-04    -3.767     -3.842     -
0.076
        MnHCO3+             2.871e-05   2.412e-05    -4.542     -4.618     -
0.076
        CaCO3               7.081e-06   7.143e-06    -5.150     -5.146
0.004
        MnCO3               5.315e-06   5.362e-06    -5.274     -5.271
0.004
        CO3-2               3.230e-06   1.658e-06    -5.491     -5.780     -
0.290
        MgCO3               2.443e-06   2.464e-06    -5.612     -5.608
0.004
        FeHCO3+             2.419e-06   2.032e-06    -5.616     -5.692     -
0.076
        FeCO3               1.205e-07   1.216e-07    -6.919     -6.915
0.004
        BaHCO3+             5.571e-09   4.680e-09    -8.254     -8.330     -
0.076
        NaHCO3              4.534e-09   4.574e-09    -8.343     -8.340
0.004
        BaCO3               7.299e-11   7.364e-11   -10.137    -10.133
0.004
        NaCO3-              2.168e-11   1.821e-11   -10.664    -10.740     -
0.076
Ca                  8.250e-03
        Ca+2                6.080e-03   3.126e-03    -2.216     -2.505     -
0.289
        CaSO4               1.927e-03   1.944e-03    -2.715     -2.711
0.004
        CaHCO3+             2.357e-04   1.995e-04    -3.628     -3.700     -
0.072
        CaCO3               7.081e-06   7.143e-06    -5.150     -5.146
0.004
        CaOH+               4.576e-09   3.844e-09    -8.340     -8.415     -
0.076
Fe(2)               9.863e-06
        Fe+2                5.846e-06   3.057e-06    -5.233     -5.515     -
0.282
        FeHCO3+             2.419e-06   2.032e-06    -5.616     -5.692     -
0.076
        FeSO4               1.475e-06   1.488e-06    -5.831     -5.827
0.004
        FeCO3               1.205e-07   1.216e-07    -6.919     -6.915
0.004
        FeOH+               2.892e-09   2.429e-09    -8.539     -8.615     -
0.076
        FeHSO4+             1.542e-12   1.296e-12   -11.812    -11.888     -
0.076
        Fe(HS)2             0.000e+00   0.000e+00  -100.423   -100.419
0.004
        Fe(HS)3-            0.000e+00   0.000e+00  -150.234   -150.310     -
0.076
Fe(3)               5.521e-09
```

| | | | | | | |
|---|---|---|---|---|---|---|
| | Fe(OH)2+ | | 3.871e-09 | 3.252e-09 | -8.412 | -8.488 | -0.076 |
| | Fe(OH)3 | | 1.638e-09 | 1.652e-09 | -8.786 | -8.782 | 0.004 |
| | Fe(OH)4- | | 7.429e-12 | 6.241e-12 | -11.129 | -11.205 | -0.076 |
| | FeOH+2 | | 4.608e-12 | 2.295e-12 | -11.336 | -11.639 | -0.303 |
| | FeSO4+ | | 3.801e-15 | 3.193e-15 | -14.420 | -14.496 | -0.076 |
| | Fe+3 | | 4.051e-16 | 1.124e-16 | -15.392 | -15.949 | -0.557 |
| | Fe(SO4)2- | | 2.804e-16 | 2.355e-16 | -15.552 | -15.628 | -0.076 |
| | Fe2(OH)2+4 | | 4.192e-21 | 2.577e-22 | -20.378 | -21.589 | -1.211 |
| | FeHSO4+2 | | 2.404e-21 | 1.197e-21 | -20.619 | -20.922 | -0.303 |
| | Fe3(OH)4+5 | | 5.197e-26 | 6.655e-28 | -25.284 | -27.177 | -1.893 |
| H(0) | | 3.649e-23 | | | | | |
| | H2 | | 1.825e-23 | 1.841e-23 | -22.739 | -22.735 | 0.004 |
| K | | 3.075e-04 | | | | | |
| | K+ | | 3.012e-04 | 2.511e-04 | -3.521 | -3.600 | -0.079 |
| | KSO4- | | 6.280e-06 | 5.275e-06 | -5.202 | -5.278 | -0.076 |
| | KOH | | 6.395e-12 | 6.452e-12 | -11.194 | -11.190 | 0.004 |
| Mg | | 4.946e-03 | | | | | |
| | Mg+2 | | 3.673e-03 | 1.925e-03 | -2.435 | -2.716 | -0.281 |
| | MgSO4 | | 1.099e-03 | 1.109e-03 | -2.959 | -2.955 | 0.004 |
| | MgHCO3+ | | 1.711e-04 | 1.438e-04 | -3.767 | -3.842 | -0.076 |
| | MgCO3 | | 2.443e-06 | 2.464e-06 | -5.612 | -5.608 | 0.004 |
| | MgOH+ | | 1.669e-08 | 1.402e-08 | -7.778 | -7.853 | -0.076 |
| Mn(2) | | 1.313e-04 | | | | | |
| | Mn+2 | | 7.785e-05 | 4.071e-05 | -4.109 | -4.390 | -0.282 |
| | MnHCO3+ | | 2.871e-05 | 2.412e-05 | -4.542 | -4.618 | -0.076 |
| | MnSO4 | | 1.943e-05 | 1.960e-05 | -4.712 | -4.708 | 0.004 |
| | MnCO3 | | 5.315e-06 | 5.362e-06 | -5.274 | -5.271 | 0.004 |
| | MnOH+ | | 2.837e-09 | 2.384e-09 | -8.547 | -8.623 | -0.076 |
| Mn(3) | | 6.212e-28 | | | | | |
| | Mn+3 | | 6.212e-28 | 1.294e-28 | -27.207 | -27.888 | -0.681 |
| Na | | 1.482e-06 | | | | | |
| | Na+ | | 1.453e-06 | 1.224e-06 | -5.838 | -5.912 | -0.075 |
| | NaSO4- | | 2.377e-08 | 1.996e-08 | -7.624 | -7.700 | -0.076 |
| | NaHCO3 | | 4.534e-09 | 4.574e-09 | -8.343 | -8.340 | 0.004 |
| | NaCO3- | | 2.168e-11 | 1.821e-11 | -10.664 | -10.740 | -0.076 |

```
        NaOH                 5.939e-14   5.991e-14   -13.226    -13.223
 0.004
O(0)                 0.000e+00
        O2                   0.000e+00   0.000e+00   -51.679    -51.675
 0.004
S(-2)                0.000e+00
        H2S                  0.000e+00   0.000e+00   -51.619    -51.615
 0.004
        HS-                  0.000e+00   0.000e+00   -51.848    -51.927     -
0.080
        S-2                  0.000e+00   0.000e+00   -58.111    -58.406     -
0.295
        Fe(HS)2              0.000e+00   0.000e+00  -100.423   -100.419
 0.004
        Fe(HS)3-             0.000e+00   0.000e+00  -150.234   -150.310     -
0.076
S(6)                 1.012e-02
        SO4-2                7.064e-03   3.568e-03    -2.151     -2.448     -
0.297
        CaSO4                1.927e-03   1.944e-03    -2.715     -2.711
 0.004
        MgSO4                1.099e-03   1.109e-03    -2.959     -2.955
 0.004
        MnSO4                1.943e-05   1.960e-05    -4.712     -4.708
 0.004
        KSO4-                6.280e-06   5.275e-06    -5.202     -5.278     -
0.076
        FeSO4                1.475e-06   1.488e-06    -5.831     -5.827
 0.004
        BaSO4                2.010e-07   2.028e-07    -6.697     -6.693
 0.004
        HSO4-                4.197e-08   3.525e-08    -7.377     -7.453     -
0.076
        NaSO4-               2.377e-08   1.996e-08    -7.624     -7.700     -
0.076
        FeHSO4+              1.542e-12   1.296e-12   -11.812    -11.888     -
0.076
        FeSO4+               3.801e-15   3.193e-15   -14.420    -14.496     -
0.076
        Fe(SO4)2-            2.804e-16   2.355e-16   -15.552    -15.628     -
0.076
        FeHSO4+2             2.404e-21   1.197e-21   -20.619    -20.922     -
0.303

------------------------------Saturation indices------------------------
-------

        Phase               SI log IAP  log KT

        Anhydrite        -0.62   -4.95   -4.33  CaSO4
        Aragonite        -0.02   -8.29   -8.26  CaCO3
        Barite            0.83   -9.39  -10.22  BaSO4
        Calcite           0.13   -8.29   -8.41  CaCO3
        CO2(g)           -1.31  -19.52  -18.21  CO2
        Dolomite         -0.03  -16.78  -16.75  CaMg(CO3)2
        Fe(OH)3(a)       -0.23   18.02   18.26  Fe(OH)3
        FeS(ppt)        -46.66  -86.36  -39.70  FeS
        Goethite          5.66   18.02   12.36  FeOOH
        Gypsum           -0.36   -4.95   -4.59  CaSO4:2H2O
        H2(g)           -19.65  -19.60    0.05  H2
        H2S(g)          -50.78  -94.59  -43.81  H2S
        Hausmannite     -16.96   47.65   64.61  Mn3O4
        Hematite         12.23   36.05   23.82  Fe2O3
        Jarosite-K       -7.03   24.97   32.00  KFe3(SO4)2(OH)6
```

| | | | | |
|---|---|---|---|---|
| Mackinawite | -45.92 | -86.36 | -40.44 | FeS |
| Manganite | -6.19 | 19.15 | 25.34 | MnOOH |
| Melanterite | -5.57 | -7.96 | -2.39 | FeSO4:7H2O |
| O2(g) | -48.78 | 39.20 | 87.98 | O2 |
| Pyrite | -70.89 | -161.35 | -90.46 | FeS2 |
| Pyrochroite | -5.85 | 9.35 | 15.20 | Mn(OH)2 |
| Pyrolusite | -14.75 | 28.95 | 43.70 | MnO2 |
| Rhodochrosite | 0.91 | -10.17 | -11.08 | MnCO3 |
| Siderite | -0.49 | -11.30 | -10.80 | FeCO3 |
| Sulfur | -37.23 | -74.99 | -37.75 | S |
| Witherite | -4.10 | -12.73 | -8.62 | BaCO3 |

Initial solution 58.    5P-Jul-99    Ca-Mg    0058

----------------------------Solution composition-----------------------------

| Elements | Molality | Moles |
|---|---|---|
| Alkalinity | 6.511e-03 | 6.511e-03 |
| Ba | 4.662e-07 | 4.662e-07 |
| Ca | 1.298e-03 | 1.298e-03 |
| Fe | 9.675e-07 | 9.675e-07 |
| K | 2.073e-04 | 2.073e-04 |
| Mg | 8.643e-04 | 8.643e-04 |
| Mn | 9.287e-07 | 9.287e-07 |
| Na | 3.917e-07 | 3.917e-07 |
| S | 7.603e-05 | 7.603e-05 |

----------------------------Description of solution----------------------------

| | | |
|---|---|---|
| pH | = | 6.910 |
| pe | = | 1.080 |
| Activity of water | = | 1.000 |
| Ionic strength | = | 7.581e-03 |
| Mass of water (kg) | = | 1.000e+00 |
| Total carbon (mol/kg) | = | 8.363e-03 |
| Total CO2 (mol/kg) | = | 8.363e-03 |
| Temperature (deg C) | = | 15.900 |
| Electrical balance (eq) | = | -2.126e-03 |
| Iterations | = | 10 |
| Total H | = | 1.110189e+02 |
| Total O | = | 5.552975e+01 |

----------------------------Distribution of species----------------------------

| Species | | Molality | Activity | Log Molality | Log Activity | Log Gamma |
|---|---|---|---|---|---|---|
| H+ | | 1.333e-07 | 1.230e-07 | -6.875 | -6.910 | -0.035 |
| OH- | | 4.328e-08 | 3.950e-08 | -7.364 | -7.403 | -0.040 |
| H2O | | 5.551e+01 | 9.998e-01 | 0.000 | 0.000 | 0.000 |
| Ba | 4.662e-07 | | | | | |
| Ba+2 | | 4.445e-07 | 3.125e-07 | -6.352 | -6.505 | -0.153 |
| BaHCO3+ | | 1.443e-08 | 1.319e-08 | -7.841 | -7.880 | -0.039 |

| | | | | | |
|---|---|---|---|---|---|
| BaSO4 | 7.037e-09 | 7.049e-09 | -8.153 | -8.152 | 0.001 |
| BaCO3 | 2.441e-10 | 2.445e-10 | -9.612 | -9.612 | 0.001 |
| BaOH+ | 9.416e-14 | 8.606e-14 | -13.026 | -13.065 | -0.039 |
| C(4) | 8.363e-03 | | | | |
| HCO3- | 6.397e-03 | 5.862e-03 | -2.194 | -2.232 | -0.038 |
| CO2 | 1.858e-03 | 1.861e-03 | -2.731 | -2.730 | 0.001 |
| CaHCO3+ | 5.972e-05 | 5.473e-05 | -4.224 | -4.262 | -0.038 |
| MgHCO3+ | 4.207e-05 | 3.845e-05 | -4.376 | -4.415 | -0.039 |
| CO3-2 | 2.577e-06 | 1.818e-06 | -5.589 | -5.740 | -0.152 |
| CaCO3 | 2.274e-06 | 2.278e-06 | -5.643 | -5.643 | 0.001 |
| MgCO3 | 8.714e-07 | 8.729e-07 | -6.060 | -6.059 | 0.001 |
| FeHCO3+ | 2.950e-07 | 2.697e-07 | -6.530 | -6.569 | -0.039 |
| MnHCO3+ | 2.489e-07 | 2.275e-07 | -6.604 | -6.643 | -0.039 |
| MnCO3 | 6.278e-08 | 6.289e-08 | -7.202 | -7.201 | 0.001 |
| FeCO3 | 2.003e-08 | 2.006e-08 | -7.698 | -7.698 | 0.001 |
| BaHCO3+ | 1.443e-08 | 1.319e-08 | -7.841 | -7.880 | -0.039 |
| NaHCO3 | 1.175e-09 | 1.177e-09 | -8.930 | -8.929 | 0.001 |
| BaCO3 | 2.441e-10 | 2.445e-10 | -9.612 | -9.612 | 0.001 |
| NaCO3- | 8.240e-12 | 7.531e-12 | -11.084 | -11.123 | -0.039 |
| Ca | 1.298e-03 | | | | |
| Ca+2 | 1.229e-03 | 8.665e-04 | -2.910 | -3.062 | -0.152 |
| CaHCO3+ | 5.972e-05 | 5.473e-05 | -4.224 | -4.262 | -0.038 |
| CaSO4 | 7.116e-06 | 7.128e-06 | -5.148 | -5.147 | 0.001 |
| CaCO3 | 2.274e-06 | 2.278e-06 | -5.643 | -5.643 | 0.001 |
| CaOH+ | 1.279e-09 | 1.169e-09 | -8.893 | -8.932 | -0.039 |
| Fe(2) | 9.675e-07 | | | | |
| Fe+2 | 6.487e-07 | 4.600e-07 | -6.188 | -6.337 | -0.149 |
| FeHCO3+ | 2.950e-07 | 2.697e-07 | -6.530 | -6.569 | -0.039 |
| FeCO3 | 2.003e-08 | 2.006e-08 | -7.698 | -7.698 | 0.001 |
| FeSO4 | 3.096e-09 | 3.101e-09 | -8.509 | -8.509 | 0.001 |
| FeOH+ | 6.414e-10 | 5.862e-10 | -9.193 | -9.232 | -0.039 |
| FeHSO4+ | 2.691e-15 | 2.460e-15 | -14.570 | -14.609 | -0.039 |
| Fe(HS)2 | 0.000e+00 | 0.000e+00 | -77.665 | -77.664 | 0.001 |
| Fe(HS)3- | 0.000e+00 | 0.000e+00 | -115.727 | -115.766 | - |

```
0.039
Fe(3)              3.222e-11
         Fe(OH)2+           1.966e-11    1.797e-11    -10.706    -10.745     -
0.039
         Fe(OH)3            1.248e-11    1.250e-11    -10.904    -10.903
0.001
         Fe(OH)4-           6.950e-14    6.352e-14    -13.158    -13.197     -
0.039
         FeOH+2             1.366e-14    9.534e-15    -13.864    -14.021     -
0.156
         Fe+3               6.493e-19    3.158e-19    -18.188    -18.501     -
0.313
         FeSO4+             1.385e-19    1.266e-19    -18.859    -18.898     -
0.039
         Fe(SO4)2-          1.315e-22    1.202e-22    -21.881    -21.920     -
0.039
         FeHSO4+2           6.078e-26    4.241e-26    -25.216    -25.372     -
0.156
         Fe2(OH)2+4         1.520e-26    3.606e-27    -25.818    -26.443     -
0.625
         Fe3(OH)4+5         3.049e-34    3.220e-35    -33.516    -34.492     -
0.976
H(0)               1.513e-19
         H2                 7.567e-20    7.581e-20    -19.121    -19.120
0.001
K                  2.073e-04
         K+                 2.072e-04    1.891e-04     -3.684     -3.723     -
0.040
         KSO4-              5.850e-08    5.347e-08     -7.233     -7.272     -
0.039
         KOH                5.320e-12    5.330e-12    -11.274    -11.273
0.001
Mg                 8.643e-04
         Mg+2               8.165e-04    5.786e-04     -3.088     -3.238     -
0.150
         MgHCO3+            4.207e-05    3.845e-05     -4.376     -4.415     -
0.039
         MgSO4              4.785e-06    4.793e-06     -5.320     -5.319
0.001
         MgCO3              8.714e-07    8.729e-07     -6.060     -6.059
0.001
         MgOH+              8.002e-09    7.314e-09     -8.097     -8.136     -
0.039
Mn(2)              9.287e-07
         Mn+2               6.141e-07    4.354e-07     -6.212     -6.361     -
0.149
         MnHCO3+            2.489e-07    2.275e-07     -6.604     -6.643     -
0.039
         MnCO3              6.278e-08    6.289e-08     -7.202     -7.201
0.001
         MnSO4              2.909e-09    2.914e-09     -8.536     -8.536
0.001
         MnOH+              4.630e-11    4.232e-11    -10.334    -10.373     -
0.039
Mn(3)              9.227e-32
         Mn+3               9.227e-32    4.107e-32    -31.035    -31.386     -
0.351
Na                 3.917e-07
         Na+                3.904e-07    3.571e-07     -6.408     -6.447     -
0.039
         NaHCO3             1.175e-09    1.177e-09     -8.930     -8.929
0.001
         NaSO4-             8.305e-11    7.591e-11    -10.081    -10.120     -
0.039
```

```
        NaCO3-              8.240e-12   7.531e-12   -11.084    -11.123     -
0.039
        NaOH                1.914e-14   1.918e-14   -13.718    -13.717
0.001
O(0)                0.000e+00
        O2                  0.000e+00   0.000e+00   -57.231    -57.231
0.001
S(-2)               1.167e-40
        H2S                 1.167e-40   1.169e-40   -39.933    -39.932
0.001
        HS-                 0.000e+00   0.000e+00   -40.099    -40.139     -
0.040
        S-2                 0.000e+00   0.000e+00   -46.273    -46.426     -
0.153
        Fe(HS)2             0.000e+00   0.000e+00   -77.665    -77.664
0.001
        Fe(HS)3-            0.000e+00   0.000e+00  -115.727   -115.766     -
0.039
S(6)                7.603e-05
        SO4-2               6.406e-05   4.501e-05    -4.193     -4.347     -
0.153
        CaSO4               7.116e-06   7.128e-06    -5.148     -5.147
0.001
        MgSO4               4.785e-06   4.793e-06    -5.320     -5.319
0.001
        KSO4-               5.850e-08   5.347e-08    -7.233     -7.272     -
0.039
        BaSO4               7.037e-09   7.049e-09    -8.153     -8.152
0.001
        FeSO4               3.096e-09   3.101e-09    -8.509     -8.509
0.001
        MnSO4               2.909e-09   2.914e-09    -8.536     -8.536
0.001
        HSO4-               4.866e-10   4.448e-10    -9.313     -9.352     -
0.039
        NaSO4-              8.305e-11   7.591e-11   -10.081    -10.120     -
0.039
        FeHSO4+             2.691e-15   2.460e-15   -14.570    -14.609     -
0.039
        FeSO4+              1.385e-19   1.266e-19   -18.859    -18.898     -
0.039
        Fe(SO4)2-           1.315e-22   1.202e-22   -21.881    -21.920     -
0.039
        FeHSO4+2            6.078e-26   4.241e-26   -25.216    -25.372     -
0.156

------------------------------Saturation indices------------------------
-------

        Phase               SI log IAP  log KT

        Anhydrite        -3.07   -7.41   -4.34  CaSO4
        Aragonite        -0.52   -8.80   -8.28  CaCO3
        Barite           -0.72  -10.85  -10.13  BaSO4
        Calcite          -0.37   -8.80   -8.43  CaCO3
        CO2(g)           -1.38  -19.56  -18.18  CO2
        Dolomite         -0.91  -17.78  -16.87  CaMg(CO3)2
        Fe(OH)3(a)       -2.66   15.47   18.13  Fe(OH)3
        FeS(ppt)        -35.65  -74.60  -38.95  FeS
        Goethite          3.23   15.47   12.24  FeOOH
        Gypsum           -2.83   -7.41   -4.58  CaSO4:2H2O
        H2(g)           -16.01  -15.98    0.03  H2
        H2S(g)          -39.04  -82.09  -43.05  H2S
        Hausmannite     -25.00   38.36   63.35  Mn3O4
```

```
          Hematite            7.75    30.95    23.19  Fe2O3
          Jarosite-K        -17.97    13.27    31.24  KFe3(SO4)2(OH)6
          Mackinawite       -34.92   -74.60   -39.69  FeS
          Manganite          -9.89    15.45    25.34  MnOOH
          Melanterite        -8.36   -10.68    -2.33  FeSO4:7H2O
          O2(g)             -54.31    31.96    86.27  O2
          Pyrite            -51.89  -140.71   -88.82  FeS2
          Pyrochroite        -7.74     7.46    15.20  Mn(OH)2
          Pyrolusite        -19.44    23.44    42.88  MnO2
          Rhodochrosite      -1.00   -12.10   -11.10  MnCO3
          Siderite           -1.24   -12.08   -10.83  FeCO3
          Sulfur            -29.05   -66.11   -37.05  S
          Witherite          -3.65   -12.25    -8.59  BaCO3

------------------
End of simulation.
------------------

------------------------------------
Reading input data for simulation 2.
------------------------------------

      END
------------------
End of simulation.
------------------

------------------------------------
Reading input data for simulation 3.
------------------------------------

      END
------------------
End of simulation.
------------------

------------------------------------
Reading input data for simulation 4.
------------------------------------

      END
------------------
End of simulation.
------------------

------------------------------------
Reading input data for simulation 5.
------------------------------------

-----------
End of run.
-----------
```

# Attachment 3

## PHREEQ-C Runs with Decreasing $CO_2$

---

Reading data base.

---

```
SOLUTION_MASTER_SPECIES
SOLUTION_SPECIES
PHASES
EXCHANGE_MASTER_SPECIES
EXCHANGE_SPECIES
SURFACE_MASTER_SPECIES
SURFACE_SPECIES
END
```

---

Reading input data for simulation 1.

---

```
SOLUTION 27  13C-Apr-00  Ca-Mg-SO4-HCO3  0024
        units         mmol/l
        pH 6.73 Calcite 0.0
        pe                  4
        density             1
        temp                4
        redox        pe
        Ca           14.72056
        Mg           6.993007
        Na           1.48E-03
        K            0.639386
        Fe           2.87E-02
        Mn           0.141973
        Cl           1.410318
        Alkalinity   9.31  as HCO3
        S            17.69801
        Zn           9.33E-03
SOLUTION 28  13C-Apr-00  Ca-Mg-SO4-HCO3  0024
        units         mmol/l
        pH 6.73 Calcite 0.0
        pe                  4
        density             1
        temp                4
        redox        pe
        Ca           14.72056
        Mg           6.993007
        Na           1.48E-03
        K            0.639386
        Fe           2.87E-02
        Mn           0.141973
        Cl           1.410318
        Alkalinity   5  as HCO3
        S            17.69801
        Zn           9.33E-03
SOLUTION 29  13C-Apr-00  Ca-Mg-SO4-HCO3  0024
```

| | |
|---|---|
| units | mmol/l |
| pH 6.73 Calcite 0.0 | |
| pe | 4 |
| density | 1 |
| temp | 4 |
| redox | pe |
| Ca | 14.72056 |
| Mg | 6.993007 |
| Na | 1.48E-03 |
| K | 0.639386 |
| Fe | 2.87E-02 |
| Mn | 0.141973 |
| Cl | 1.410318 |
| Alkalinity | 1 as HCO3 |
| S | 17.69801 |
| Zn | 9.33E-03 |

END

----------------------------------------

Beginning of initial solution calculations.

----------------------------------------

Initial solut 13C-Apr-00 Ca-Mg-SO4-HCO3 0024

----------------------------Solution composition----------------------------

| Elements | Molality | Moles |
|---|---|---|
| Alkalinity | 9.339e-03 | 9.339e-03 |
| Ca | 1.477e-02 | 1.477e-02 |
| Cl | 1.415e-03 | 1.415e-03 |
| Fe | 2.874e-05 | 2.874e-05 |
| K | 6.414e-04 | 6.414e-04 |
| Mg | 7.015e-03 | 7.015e-03 |
| Mn | 1.424e-04 | 1.424e-04 |
| Na | 1.484e-06 | 1.484e-06 |
| S | 1.775e-02 | 1.775e-02 |
| Zn | 9.361e-06 | 9.361e-06 |

----------------------------Description of solution----------------------------

pH = 6.643 Equilibrium with Calcite
pe = 4.000
Activity of water = 0.999
Ionic strength = 6.081e-02
Mass of water (kg) = 1.000e+00
Total carbon (mol/kg) = 1.476e-02
Total CO2 (mol/kg) = 1.476e-02
Temperature (deg C) = 4.000
Electrical balance (eq) = -1.694e-03
Iterations = 8
Total H = 1.110217e+02

Total O = 5.561607e+01

----------------------------Distribution of species----------------------------

| | Species | Molality | Activity | Log Molality | Log Activity | Log Gamma |
|---|---|---|---|---|---|---|
| | H+ | 2.676e-07 | 2.274e-07 | -6.572 | -6.643 | -0.071 |
| | OH- | 9.217e-09 | 7.405e-09 | -8.035 | -8.130 | -0.095 |
| | H2O | 5.551e+01 | 9.991e-01 | 0.000 | 0.000 | 0.000 |
| C(4) | 1.476e-02 | | | | | |
| | HCO3- | 8.718e-03 | 7.170e-03 | -2.060 | -2.145 | -0.085 |
| | CO2 | 5.427e-03 | 5.504e-03 | -2.265 | -2.259 | 0.006 |
| | CaHCO3+ | 3.198e-04 | 2.630e-04 | -3.495 | -3.580 | -0.085 |
| | MgHCO3+ | 2.378e-04 | 1.939e-04 | -3.624 | -3.712 | -0.089 |
| | MnHCO3+ | 3.103e-05 | 2.530e-05 | -4.508 | -4.597 | -0.089 |
| | FeHCO3+ | 6.914e-06 | 5.637e-06 | -5.160 | -5.249 | -0.089 |
| | CaCO3 | 5.384e-06 | 5.460e-06 | -5.269 | -5.263 | 0.006 |
| | MnCO3 | 2.640e-06 | 2.677e-06 | -5.578 | -5.572 | 0.006 |
| | ZnHCO3+ | 2.218e-06 | 1.808e-06 | -5.654 | -5.743 | -0.089 |
| | CO3-2 | 1.861e-06 | 8.512e-07 | -5.730 | -6.070 | -0.340 |
| | MgCO3 | 1.400e-06 | 1.420e-06 | -5.854 | -5.848 | 0.006 |
| | ZnCO3 | 3.355e-07 | 3.403e-07 | -6.474 | -6.468 | 0.006 |
| | FeCO3 | 1.583e-07 | 1.606e-07 | -6.800 | -6.794 | 0.006 |
| | Zn(CO3)2-2 | 1.401e-08 | 6.192e-09 | -7.854 | -8.208 | -0.355 |
| | NaHCO3 | 4.696e-09 | 4.762e-09 | -8.328 | -8.322 | 0.006 |
| | NaCO3- | 7.348e-12 | 5.991e-12 | -11.134 | -11.222 | -0.089 |
| Ca | 1.477e-02 | | | | | |
| | Ca+2 | 1.038e-02 | 4.771e-03 | -1.984 | -2.321 | -0.337 |
| | CaSO4 | 4.065e-03 | 4.122e-03 | -2.391 | -2.385 | 0.006 |
| | CaHCO3+ | 3.198e-04 | 2.630e-04 | -3.495 | -3.580 | -0.085 |
| | CaCO3 | 5.384e-06 | 5.460e-06 | -5.269 | -5.263 | 0.006 |
| | CaOH+ | 4.266e-09 | 3.478e-09 | -8.370 | -8.459 | -0.089 |
| Cl | 1.415e-03 | | | | | |
| | Cl- | 1.414e-03 | 1.139e-03 | -2.849 | -2.944 | -0.094 |
| | MnCl+ | 2.253e-07 | 1.837e-07 | -6.647 | -6.736 | -0.089 |
| | FeCl+ | 1.516e-08 | 1.236e-08 | -7.819 | -7.908 | -0.089 |
| | ZnCl+ | 2.781e-09 | 2.268e-09 | -8.556 | -8.644 | -0.089 |
| | MnCl2 | 9.005e-11 | 9.132e-11 | -10.046 | -10.039 | 0.006 |
| | ZnCl2 | 2.435e-12 | 2.470e-12 | -11.613 | -11.607 | 0.006 |
| | MnCl3- | 3.513e-14 | 2.864e-14 | -13.454 | -13.543 | -0.089 |
| | ZnCl3- | 3.380e-15 | 2.756e-15 | -14.471 | -14.560 | -0.089 |
| | FeCl+2 | 8.278e-17 | 3.659e-17 | -16.082 | -16.437 | -0.355 |
| | ZnCl4-2 | 2.975e-18 | 1.315e-18 | -17.527 | -17.881 | -0.355 |
| | FeCl2+ | 4.672e-19 | 3.810e-19 | -18.330 | -18.419 | -0.089 |
| | FeCl3 | 4.279e-23 | 4.339e-23 | -22.369 | -22.363 | 0.006 |
| Fe(2) | 2.873e-05 | | | | | |
| | Fe+2 | 1.676e-05 | 7.863e-06 | -4.776 | -5.104 | -0.329 |
| | FeHCO3+ | 6.914e-06 | 5.637e-06 | -5.160 | -5.249 | -0.089 |
| | FeSO4 | 4.879e-06 | 4.948e-06 | -5.312 | -5.306 | 0.006 |
| | FeCO3 | 1.583e-07 | 1.606e-07 | -6.800 | -6.794 | 0.006 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | FeCl+ | 1.516e-08 | 1.236e-08 | -7.819 | -7.908 | -0.089 |
| | FeOH+ | 2.477e-09 | 2.020e-09 | -8.606 | -8.695 | -0.089 |
| | FeHSO4+ | 9.054e-12 | 7.383e-12 | -11.043 | -11.132 | -0.089 |
| | Fe(HS)2 | 0.000e+00 | 0.000e+00 | -110.298 | -110.292 | 0.006 |
| | Fe(HS)3- | 0.000e+00 | 0.000e+00 | -165.235 | -165.323 | -0.089 |
| Fe(3) | 1.452e-08 | | | | | |
| | Fe(OH)2+ | 1.237e-08 | 1.009e-08 | -7.908 | -7.996 | -0.089 |
| | Fe(OH)3 | 2.103e-09 | 2.133e-09 | -8.677 | -8.671 | 0.006 |
| | FeOH+2 | 3.695e-11 | 1.634e-11 | -10.432 | -10.787 | -0.355 |
| | Fe(OH)4- | 4.227e-12 | 3.447e-12 | -11.374 | -11.463 | -0.089 |
| | FeSO4+ | 9.498e-14 | 7.745e-14 | -13.022 | -13.111 | -0.089 |
| | Fe(SO4)2- | 1.018e-14 | 8.297e-15 | -13.992 | -14.081 | -0.089 |
| | Fe+3 | 9.422e-15 | 2.178e-15 | -14.026 | -14.662 | -0.636 |
| | FeCl+2 | 8.278e-17 | 3.659e-17 | -16.082 | -16.437 | -0.355 |
| | Fe2(OH)2+4 | 4.784e-19 | 1.827e-20 | -18.320 | -19.738 | -1.418 |
| | FeCl2+ | 4.672e-19 | 3.810e-19 | -18.330 | -18.419 | -0.089 |
| | FeHSO4+2 | 1.162e-19 | 5.136e-20 | -18.935 | -19.289 | -0.355 |
| | Fe3(OH)4+5 | 5.088e-23 | 3.096e-25 | -22.293 | -24.509 | -2.216 |
| | FeCl3 | 4.279e-23 | 4.339e-23 | -22.369 | -22.363 | 0.006 |
| H(0) | 7.620e-25 | | | | | |
| | H2 | 3.810e-25 | 3.864e-25 | -24.419 | -24.413 | 0.006 |
| K | 6.414e-04 | | | | | |
| | K+ | 6.239e-04 | 5.023e-04 | -3.205 | -3.299 | -0.094 |
| | KSO4- | 1.749e-05 | 1.426e-05 | -4.757 | -4.846 | -0.089 |
| | KOH | 7.546e-12 | 7.652e-12 | -11.122 | -11.116 | 0.006 |
| Mg | 7.015e-03 | | | | | |
| | Mg+2 | 5.108e-03 | 2.413e-03 | -2.292 | -2.617 | -0.326 |
| | MgSO4 | 1.667e-03 | 1.691e-03 | -2.778 | -2.772 | 0.006 |
| | MgHCO3+ | 2.378e-04 | 1.939e-04 | -3.624 | -3.712 | -0.089 |
| | MgCO3 | 1.400e-06 | 1.420e-06 | -5.854 | -5.848 | 0.006 |
| | MgOH+ | 6.139e-09 | 5.005e-09 | -8.212 | -8.301 | -0.089 |
| Mn(2) | 1.424e-04 | | | | | |
| | Mn+2 | 8.439e-05 | 3.959e-05 | -4.074 | -4.402 | -0.329 |
| | MnHCO3+ | 3.103e-05 | 2.530e-05 | -4.508 | -4.597 | -0.089 |
| | MnSO4 | 2.413e-05 | 2.447e-05 | -4.617 | -4.611 | 0.006 |
| | MnCO3 | 2.640e-06 | 2.677e-06 | -5.578 | -5.572 | 0.006 |
| | MnCl+ | 2.253e-07 | 1.837e-07 | -6.647 | -6.736 | -0.089 |
| | MnOH+ | 8.695e-10 | 7.090e-10 | -9.061 | -9.149 | -0.089 |
| | MnCl2 | 9.005e-11 | 9.132e-11 | -10.046 | -10.039 | 0.006 |
| | MnCl3- | 3.513e-14 | 2.864e-14 | -13.454 | -13.543 | -0.089 |
| Mn(3) | 2.834e-27 | | | | | |
| | Mn+3 | 2.834e-27 | 4.516e-28 | -26.548 | -27.345 | -0.798 |
| Na | 1.484e-06 | | | | | |
| | Na+ | 1.445e-06 | 1.181e-06 | -5.840 | -5.928 | -0.088 |
| | NaSO4- | 3.365e-08 | 2.744e-08 | -7.473 | -7.562 | -0.089 |
| | NaHCO3 | 4.696e-09 | 4.762e-09 | -8.328 | -8.322 | 0.006 |
| | NaCO3- | 7.348e-12 | 5.991e-12 | -11.134 | -11.222 | -0.089 |
| | NaOH | 3.381e-14 | 3.429e-14 | -13.471 | -13.465 | 0.006 |
| O(0) | 0.000e+00 | | | | | |
| | O2 | 0.000e+00 | 0.000e+00 | -51.000 | -50.994 | 0.006 |
| S(-2) | 0.000e+00 | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| | H2S | 0.000e+00 | 0.000e+00 | -56.430 | -56.423 | 0.006 |
| | HS- | 0.000e+00 | 0.000e+00 | -56.974 | -57.069 | -0.095 |
| | S-2 | 0.000e+00 | 0.000e+00 | -63.668 | -64.016 | -0.347 |
| | Fe(HS)2 | 0.000e+00 | 0.000e+00 | -110.298 | -110.292 | 0.006 |
| | Fe(HS)3- | 0.000e+00 | 0.000e+00 | -165.235 | -165.323 | -0.089 |
| S(6) | 1.775e-02 | | | | | |
| | SO4-2 | 1.197e-02 | 5.348e-03 | -1.922 | -2.272 | -0.350 |
| | CaSO4 | 4.065e-03 | 4.122e-03 | -2.391 | -2.385 | 0.006 |
| | MgSO4 | 1.667e-03 | 1.691e-03 | -2.778 | -2.772 | 0.006 |
| | MnSO4 | 2.413e-05 | 2.447e-05 | -4.617 | -4.611 | 0.006 |
| | KSO4- | 1.749e-05 | 1.426e-05 | -4.757 | -4.846 | -0.089 |
| | FeSO4 | 4.879e-06 | 4.948e-06 | -5.312 | -5.306 | 0.006 |
| | ZnSO4 | 2.082e-06 | 2.111e-06 | -5.682 | -5.676 | 0.006 |
| | Zn(SO4)2-2 | 2.470e-07 | 1.092e-07 | -6.607 | -6.962 | -0.355 |
| | HSO4- | 9.578e-08 | 7.810e-08 | -7.019 | -7.107 | -0.089 |
| | NaSO4- | 3.365e-08 | 2.744e-08 | -7.473 | -7.562 | -0.089 |
| | FeHSO4+ | 9.054e-12 | 7.383e-12 | -11.043 | -11.132 | -0.089 |
| | FeSO4+ | 9.498e-14 | 7.745e-14 | -13.022 | -13.111 | -0.089 |
| | Fe(SO4)2- | 1.018e-14 | 8.297e-15 | -13.992 | -14.081 | -0.089 |
| | FeHSO4+2 | 1.162e-19 | 5.136e-20 | -18.935 | -19.289 | -0.355 |
| Zn | 9.361e-06 | | | | | |
| | Zn+2 | 4.459e-06 | 2.003e-06 | -5.351 | -5.698 | -0.347 |
| | ZnHCO3+ | 2.218e-06 | 1.808e-06 | -5.654 | -5.743 | -0.089 |
| | ZnSO4 | 2.082e-06 | 2.111e-06 | -5.682 | -5.676 | 0.006 |
| | ZnCO3 | 3.355e-07 | 3.403e-07 | -6.474 | -6.468 | 0.006 |
| | Zn(SO4)2-2 | 2.470e-07 | 1.092e-07 | -6.607 | -6.962 | -0.355 |
| | Zn(CO3)2-2 | 1.401e-08 | 6.192e-09 | -7.854 | -8.208 | -0.355 |
| | ZnCl+ | 2.781e-09 | 2.268e-09 | -8.556 | -8.644 | -0.089 |
| | ZnOH+ | 2.133e-09 | 1.739e-09 | -8.671 | -8.760 | -0.089 |
| | Zn(OH)2 | 4.800e-10 | 4.868e-10 | -9.319 | -9.313 | 0.006 |
| | ZnCl2 | 2.435e-12 | 2.470e-12 | -11.613 | -11.607 | 0.006 |
| | Zn(OH)3- | 8.294e-15 | 6.763e-15 | -14.081 | -14.170 | -0.089 |
| | ZnCl3- | 3.380e-15 | 2.756e-15 | -14.471 | -14.560 | -0.089 |
| | ZnCl4-2 | 2.975e-18 | 1.315e-18 | -17.527 | -17.881 | -0.355 |
| | Zn(OH)4-2 | 1.065e-20 | 4.709e-21 | -19.973 | -20.327 | -0.355 |

------------------------Saturation indices------------------------

| Phase | SI | log IAP | log KT | |
|---|---|---|---|---|
| Anhydrite | -0.24 | -4.59 | -4.35 | CaSO4 |
| Aragonite | -0.16 | -8.39 | -8.23 | CaCO3 |
| Calcite | 0.00 | -8.39 | -8.39 | CaCO3 |
| CO2(g) | -1.08 | -19.36 | -18.27 | CO2 |
| Dolomite | -0.51 | -17.08 | -16.57 | CaMg(CO3)2 |
| Fe(OH)3(a) | 0.38 | 18.82 | 18.45 | Fe(OH)3 |
| FeS(ppt) | -51.61 | -92.52 | -40.91 | FeS |
| Goethite | 6.27 | 18.82 | 12.56 | FeOOH |
| Gypsum | 0.01 | -4.59 | -4.60 | CaSO4:2H2O |
| H2(g) | -21.36 | -21.29 | 0.07 | H2 |
| H2S(g) | -55.68 | -100.70 | -45.02 | H2S |

| | | | | |
|---|---|---|---|---|
| Hausmannite | -18.68 | 47.94 | 66.62 | Mn3O4 |
| Hematite | 12.83 | 37.65 | 24.82 | Fe2O3 |
| Jarosite-K | -4.50 | 28.70 | 33.20 | KFe3(SO4)2(OH)6 |
| Mackinawite | -50.88 | -92.52 | -41.64 | FeS |
| Manganite | -5.81 | 19.53 | 25.34 | MnOOH |
| Melanterite | -4.88 | -7.38 | -2.50 | FeSO4:7H2O |
| O2(g) | -48.14 | 42.57 | 90.71 | O2 |
| Pyrite | -78.85 | -171.94 | -93.09 | FeS2 |
| Pyrochroite | -6.32 | 8.88 | 15.20 | Mn(OH)2 |
| Pyrolusite | -14.83 | 30.17 | 45.00 | MnO2 |
| Rhodochrosite | 0.58 | -10.47 | -11.05 | MnCO3 |
| Siderite | -0.42 | -11.17 | -10.75 | FeCO3 |
| Smithsonite | -2.01 | -11.77 | -9.76 | ZnCO3 |
| Sphalerite | -44.05 | -93.11 | -49.07 | ZnS |
| Sulfur | -40.55 | -79.42 | -38.87 | S |
| Zn(OH)2(e) | -3.91 | 7.59 | 11.50 | Zn(OH)2 |

Initial solut 13C-Apr-00 Ca-Mg-SO4-HCO3 0024 •

----------------------------Solution composition----------------------------

| Elements | Molality | Moles |
|---|---|---|
| Alkalinity | 5.014e-03 | 5.014e-03 |
| Ca | 1.476e-02 | 1.476e-02 |
| Cl | 1.414e-03 | 1.414e-03 |
| Fe | 2.874e-05 | 2.874e-05 |
| K | 6.412e-04 | 6.412e-04 |
| Mg | 7.013e-03 | 7.013e-03 |
| Mn | 1.424e-04 | 1.424e-04 |
| Na | 1.483e-06 | 1.483e-06 |
| S | 1.775e-02 | 1.775e-02 |
| Zn | 9.358e-06 | 9.358e-06 |

----------------------------Description of solution----------------------------

pH = 6.907 Equilibrium with Calcite
pe = 4.000
Activity of water = 0.999
Ionic strength = 5.872e-02
Mass of water (kg) = 1.000e+00
Total carbon (mol/kg) = 6.588e-03
Total CO2 (mol/kg) = 6.588e-03
Temperature (deg C) = 4.000
Electrical balance (eq) = 2.629e-03
Iterations = 11
Total H = 1.110174e+02
Total O = 5.559539e+01

----------------------------Distribution of species----------------------------

| | Species | Molality | Activity | Log Molality | Log Activity | Log Gamma |
|---|---|---|---|---|---|---|
| | H+ | 1.456e-07 | 1.239e-07 | -6.837 | -6.907 | -0.070 |
| | OH- | 1.687e-08 | 1.359e-08 | -7.773 | -7.867 | -0.094 |
| | H2O | 5.551e+01 | 9.993e-01 | 0.000 | 0.000 | 0.000 |
| C(4) | 6.588e-03 | | | | | |
| | HCO3- | 4.662e-03 | 3.843e-03 | -2.331 | -2.415 | -0.084 |
| | CO2 | 1.586e-03 | 1.607e-03 | -2.800 | -2.794 | 0.006 |
| | CaHCO3+ | 1.738e-04 | 1.433e-04 | -3.760 | -3.844 | -0.084 |
| | MgHCO3+ | 1.299e-04 | 1.062e-04 | -3.886 | -3.974 | -0.088 |
| | MnHCO3+ | 1.857e-05 | 1.518e-05 | -4.731 | -4.819 | -0.088 |
| | CaCO3 | 5.386e-06 | 5.460e-06 | -5.269 | -5.263 | 0.006 |
| | FeHCO3+ | 4.179e-06 | 3.416e-06 | -5.379 | -5.466 | -0.088 |
| | MnCO3 | 2.909e-06 | 2.948e-06 | -5.536 | -5.530 | 0.006 |
| | CO3-2 | 1.814e-06 | 8.376e-07 | -5.741 | -6.077 | -0.336 |
| | MgCO3 | 1.409e-06 | 1.428e-06 | -5.851 | -5.845 | 0.006 |
| | ZnHCO3+ | 1.340e-06 | 1.095e-06 | -5.873 | -5.960 | -0.088 |
| | ZnCO3 | 3.733e-07 | 3.784e-07 | -6.428 | -6.422 | 0.006 |
| | FeCO3 | 1.762e-07 | 1.786e-07 | -6.754 | -6.748 | 0.006 |
| | Zn(CO3)2-2 | 1.518e-08 | 6.776e-09 | -7.819 | -8.169 | -0.350 |
| | NaHCO3 | 2.528e-09 | 2.562e-09 | -8.597 | -8.591 | 0.006 |
| | NaCO3- | 7.239e-12 | 5.917e-12 | -11.140 | -11.228 | -0.088 |
| Ca | 1.476e-02 | | | | | |
| | Ca+2 | 1.045e-02 | 4.848e-03 | -1.981 | -2.314 | -0.333 |
| | CaSO4 | 4.135e-03 | 4.191e-03 | -2.384 | -2.378 | 0.006 |
| | CaHCO3+ | 1.738e-04 | 1.433e-04 | -3.760 | -3.844 | -0.084 |
| | CaCO3 | 5.386e-06 | 5.460e-06 | -5.269 | -5.263 | 0.006 |
| | CaOH+ | 7.939e-09 | 6.489e-09 | -8.100 | -8.188 | -0.088 |
| Cl | 1.414e-03 | | | | | |
| | Cl- | 1.414e-03 | 1.142e-03 | -2.850 | -2.942 | -0.093 |
| | MnCl+ | 2.522e-07 | 2.061e-07 | -6.598 | -6.686 | -0.088 |
| | FeCl+ | 1.714e-08 | 1.401e-08 | -7.766 | -7.854 | -0.088 |
| | ZnCl+ | 3.143e-09 | 2.569e-09 | -8.503 | -8.590 | -0.088 |
| | MnCl2 | 1.014e-10 | 1.027e-10 | -9.994 | -9.988 | 0.006 |
| | ZnCl2 | 2.768e-12 | 2.805e-12 | -11.558 | -11.552 | 0.006 |
| | MnCl3- | 3.953e-14 | 3.231e-14 | -13.403 | -13.491 | -0.088 |
| | ZnCl3- | 3.840e-15 | 3.139e-15 | -14.416 | -14.503 | -0.088 |
| | FeCl+2 | 9.291e-17 | 4.147e-17 | -16.032 | -16.382 | -0.350 |
| | ZnCl4-2 | 3.364e-18 | 1.502e-18 | -17.473 | -17.823 | -0.350 |
| | FeCl2+ | 5.296e-19 | 4.329e-19 | -18.276 | -18.364 | -0.088 |
| | FeCl3 | 4.877e-23 | 4.943e-23 | -22.312 | -22.306 | 0.006 |
| Fe(2) | 2.867e-05 | | | | | |
| | Fe+2 | 1.878e-05 | 8.888e-06 | -4.726 | -5.051 | -0.325 |
| | FeSO4 | 5.520e-06 | 5.595e-06 | -5.258 | -5.252 | 0.006 |
| | FeHCO3+ | 4.179e-06 | 3.416e-06 | -5.379 | -5.466 | -0.088 |
| | FeCO3 | 1.762e-07 | 1.786e-07 | -6.754 | -6.748 | 0.006 |
| | FeCl+ | 1.714e-08 | 1.401e-08 | -7.766 | -7.854 | -0.088 |
| | FeOH+ | 5.127e-09 | 4.191e-09 | -8.290 | -8.378 | -0.088 |
| | FeHSO4+ | 5.564e-12 | 4.548e-12 | -11.255 | -11.342 | -0.088 |
| | Fe(HS)2 | 0.000e+00 | 0.000e+00 | -114.993 | -114.987 | 0.006 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Fe(HS)3- | 0.000e+00 | 0.000e+00 | -172.305 | -172.392 | -0.088 |
| Fe(3) | 6.187e-08 | | | | | |
| | Fe(OH)2+ | 4.702e-08 | 3.843e-08 | -7.328 | -7.415 | -0.088 |
| | Fe(OH)3 | 1.472e-08 | 1.492e-08 | -7.832 | -7.826 | 0.006 |
| | FeOH+2 | 7.594e-11 | 3.390e-11 | -10.120 | -10.470 | -0.350 |
| | Fe(OH)4- | 5.415e-11 | 4.426e-11 | -10.266 | -10.354 | -0.088 |
| | FeSO4+ | 1.071e-13 | 8.758e-14 | -12.970 | -13.058 | -0.088 |
| | Fe(SO4)2- | 1.148e-14 | 9.386e-15 | -13.940 | -14.028 | -0.088 |
| | Fe+3 | 1.049e-14 | 2.461e-15 | -13.979 | -14.609 | -0.630 |
| | FeCl+2 | 9.291e-17 | 4.147e-17 | -16.032 | -16.382 | -0.350 |
| | Fe2(OH)2+4 | 1.982e-18 | 7.867e-20 | -17.703 | -19.104 | -1.401 |
| | FeCl2+ | 5.296e-19 | 4.329e-19 | -18.276 | -18.364 | -0.088 |
| | FeHSO4+2 | 7.088e-20 | 3.164e-20 | -19.149 | -19.500 | -0.350 |
| | Fe3(OH)4+5 | 7.856e-22 | 5.080e-24 | -21.105 | -23.294 | -2.189 |
| | FeCl3 | 4.877e-23 | 4.943e-23 | -22.312 | -22.306 | 0.006 |
| H(0) | 2.263e-25 | | | | | |
| | H2 | 1.131e-25 | 1.147e-25 | -24.946 | -24.941 | 0.006 |
| K | 6.412e-04 | | | | | |
| | K+ | 6.237e-04 | 5.036e-04 | -3.205 | -3.298 | -0.093 |
| | KSO4- | 1.750e-05 | 1.431e-05 | -4.757 | -4.844 | -0.088 |
| | KOH | 1.390e-11 | 1.408e-11 | -10.857 | -10.851 | 0.006 |
| Mg | 7.013e-03 | | | | | |
| | Mg+2 | 5.176e-03 | 2.466e-03 | -2.286 | -2.608 | -0.322 |
| | MgSO4 | 1.705e-03 | 1.729e-03 | -2.768 | -2.762 | 0.006 |
| | MgHCO3+ | 1.299e-04 | 1.062e-04 | -3.886 | -3.974 | -0.088 |
| | MgCO3 | 1.409e-06 | 1.428e-06 | -5.851 | -5.845 | 0.006 |
| | MgOH+ | 1.149e-08 | 9.390e-09 | -7.940 | -8.027 | -0.088 |
| Mn(2) | 1.424e-04 | | | | | |
| | Mn+2 | 9.361e-05 | 4.431e-05 | -4.029 | -4.353 | -0.325 |
| | MnSO4 | 2.703e-05 | 2.740e-05 | -4.568 | -4.562 | 0.006 |
| | MnHCO3+ | 1.857e-05 | 1.518e-05 | -4.731 | -4.819 | -0.088 |
| | MnCO3 | 2.909e-06 | 2.948e-06 | -5.536 | -5.530 | 0.006 |
| | MnCl+ | 2.522e-07 | 2.061e-07 | -6.598 | -6.686 | -0.088 |
| | MnOH+ | 1.782e-09 | 1.457e-09 | -8.749 | -8.837 | -0.088 |
| | MnCl2 | 1.014e-10 | 1.027e-10 | -9.994 | -9.988 | 0.006 |
| | MnCl3- | 3.953e-14 | 3.231e-14 | -13.403 | -13.491 | -0.088 |
| Mn(3) | 3.103e-27 | | | | | |
| | Mn+3 | 3.103e-27 | 5.054e-28 | -26.508 | -27.296 | -0.788 |
| Na | 1.483e-06 | | | | | |
| | Na+ | 1.447e-06 | 1.186e-06 | -5.840 | -5.926 | -0.087 |
| | NaSO4- | 3.370e-08 | 2.755e-08 | -7.472 | -7.560 | -0.088 |
| | NaHCO3 | 2.528e-09 | 2.562e-09 | -8.597 | -8.591 | 0.006 |
| | NaCO3- | 7.239e-12 | 5.917e-12 | -11.140 | -11.228 | -0.088 |
| | NaOH | 6.233e-14 | 6.317e-14 | -13.205 | -13.199 | 0.006 |
| O(0) | 0.000e+00 | | | | | |
| | O2 | 0.000e+00 | 0.000e+00 | -49.945 | -49.939 | 0.006 |
| S(-2) | 0.000e+00 | | | | | |
| | H2S | 0.000e+00 | 0.000e+00 | -59.067 | -59.061 | 0.006 |
| | HS- | 0.000e+00 | 0.000e+00 | -59.349 | -59.443 | -0.094 |
| | S-2 | 0.000e+00 | 0.000e+00 | -65.783 | -66.126 | -0.343 |
| | Fe(HS)2 | 0.000e+00 | 0.000e+00 | -114.993 | -114.987 | 0.006 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Fe(HS)3- | 0.000e+00 | 0.000e+00 | -172.305 | -172.392 | -0.088 |
| S(6) | 1.775e-02 | | | | | |
| | SO4-2 | 1.186e-02 | 5.350e-03 | -1.926 | -2.272 | -0.346 |
| | CaSO4 | 4.135e-03 | 4.191e-03 | -2.384 | -2.378 | 0.006 |
| | MgSO4 | 1.705e-03 | 1.729e-03 | -2.768 | -2.762 | 0.006 |
| | MnSO4 | 2.703e-05 | 2.740e-05 | -4.568 | -4.562 | 0.006 |
| | KSO4- | 1.750e-05 | 1.431e-05 | -4.757 | -4.844 | -0.088 |
| | FeSO4 | 5.520e-06 | 5.595e-06 | -5.258 | -5.252 | 0.006 |
| | ZnSO4 | 2.354e-06 | 2.386e-06 | -5.628 | -5.622 | 0.006 |
| | Zn(SO4)2-2 | 2.767e-07 | 1.235e-07 | -6.558 | -6.908 | -0.350 |
| | HSO4- | 5.207e-08 | 4.256e-08 | -7.283 | -7.371 | -0.088 |
| | NaSO4- | 3.370e-08 | 2.755e-08 | -7.472 | -7.560 | -0.088 |
| | FeHSO4+ | 5.564e-12 | 4.548e-12 | -11.255 | -11.342 | -0.088 |
| | FeSO4+ | 1.071e-13 | 8.758e-14 | -12.970 | -13.058 | -0.088 |
| | Fe(SO4)2- | 1.148e-14 | 9.386e-15 | -13.940 | -14.028 | -0.088 |
| | FeHSO4+2 | 7.088e-20 | 3.164e-20 | -19.149 | -19.500 | -0.350 |
| Zn | 9.358e-06 | | | | | |
| | Zn+2 | 4.989e-06 | 2.264e-06 | -5.302 | -5.645 | -0.343 |
| | ZnSO4 | 2.354e-06 | 2.386e-06 | -5.628 | -5.622 | 0.006 |
| | ZnHCO3+ | 1.340e-06 | 1.095e-06 | -5.873 | -5.960 | -0.088 |
| | ZnCO3 | 3.733e-07 | 3.784e-07 | -6.428 | -6.422 | 0.006 |
| | Zn(SO4)2-2 | 2.767e-07 | 1.235e-07 | -6.558 | -6.908 | -0.350 |
| | Zn(CO3)2-2 | 1.518e-08 | 6.776e-09 | -7.819 | -8.169 | -0.350 |
| | ZnOH+ | 4.414e-09 | 3.608e-09 | -8.355 | -8.443 | -0.088 |
| | ZnCl+ | 3.143e-09 | 2.569e-09 | -8.503 | -8.590 | -0.088 |
| | Zn(OH)2 | 1.829e-09 | 1.854e-09 | -8.738 | -8.732 | 0.006 |
| | ZnCl2 | 2.768e-12 | 2.805e-12 | -11.558 | -11.552 | 0.006 |
| | Zn(OH)3- | 5.785e-14 | 4.729e-14 | -13.238 | -13.325 | -0.088 |
| | ZnCl3- | 3.840e-15 | 3.139e-15 | -14.416 | -14.503 | -0.088 |
| | ZnCl4-2 | 3.364e-18 | 1.502e-18 | -17.473 | -17.823 | -0.350 |
| | Zn(OH)4-2 | 1.354e-19 | 6.045e-20 | -18.868 | -19.219 | -0.350 |

----------------------------Saturation indices----------------------------

| Phase | SI | log IAP | log KT | |
|---|---|---|---|---|
| Anhydrite | -0.24 | -4.59 | -4.35 | CaSO4 |
| Aragonite | -0.16 | -8.39 | -8.23 | CaCO3 |
| Calcite | 0.00 | -8.39 | -8.39 | CaCO3 |
| CO2(g) | -1.62 | -19.89 | -18.27 | CO2 |
| Dolomite | -0.51 | -17.08 | -16.57 | CaMg(CO3)2 |
| Fe(OH)3(a) | 1.22 | 19.67 | 18.45 | Fe(OH)3 |
| FeS(ppt) | -53.67 | -94.58 | -40.91 | FeS |
| Goethite | 7.11 | 19.67 | 12.56 | FeOOH |
| Gypsum | 0.02 | -4.59 | -4.60 | CaSO4:2H2O |
| H2(g) | -21.89 | -21.81 | 0.07 | H2 |
| H2S(g) | -58.32 | -103.34 | -45.02 | H2S |
| Hausmannite | -16.43 | 50.19 | 66.62 | Mn3O4 |
| Hematite | 14.52 | 39.34 | 24.82 | Fe2O3 |
| Jarosite-K | -2.76 | 30.45 | 33.20 | KFe3(SO4)2(OH)6 |
| Mackinawite | -52.94 | -94.58 | -41.64 | FeS |

| | | | | |
|---|---|---|---|---|
| Manganite | -4.97 | 20.37 | 25.34 | MnOOH |
| Melanterite | -4.82 | -7.32 | -2.50 | FeSO4:7H2O |
| O2(g) | -47.08 | 43.63 | 90.71 | O2 |
| Pyrite | -83.02 | -176.10 | -93.09 | FeS2 |
| Pyrochroite | -5.74 | 9.46 | 15.20 | Mn(OH)2 |
| Pyrolusite | -13.72 | 31.27 | 45.00 | MnO2 |
| Rhodochrosite | 0.62 | -10.43 | -11.05 | MnCO3 |
| Siderite | -0.38 | -11.13 | -10.75 | FeCO3 |
| Smithsonite | -1.96 | -11.72 | -9.76 | ZnCO3 |
| Sphalerite | -46.10 | -95.17 | -49.07 | ZnS |
| Sulfur | -42.66 | -81.53 | -38.87 | S |
| Zn(OH)2(e) | -3.33 | 8.17 | 11.50 | Zn(OH)2 |

Initial solut 13C-Apr-00 Ca-Mg-SO4-HCO3 0024 •

-----------------------------Solution composition-----------------------------

| Elements | Molality | Moles |
|---|---|---|
| Alkalinity | 1.003e-03 | 1.003e-03 |
| Ca | 1.476e-02 | 1.476e-02 |
| Cl | 1.414e-03 | 1.414e-03 |
| Fe | 2.873e-05 | 2.873e-05 |
| K | 6.411e-04 | 6.411e-04 |
| Mg | 7.011e-03 | 7.011e-03 |
| Mn | 1.423e-04 | 1.423e-04 |
| Na | 1.483e-06 | 1.483e-06 |
| S | 1.774e-02 | 1.774e-02 |
| Zn | 9.356e-06 | 9.356e-06 |

-----------------------------Description of solution-----------------------------

pH = 7.609 Equilibrium with Calcite
pe = 4.000
Activity of water = 0.999
Ionic strength = 5.679e-02
Mass of water (kg) = 1.000e+00
Total carbon (mol/kg) = 1.050e-03
Total CO2 (mol/kg) = 1.050e-03
Temperature (deg C) = 4.000
Electrical balance (eq) = 6.636e-03
Iterations = 9
Total H = 1.110134e+02
Total O = 5.558029e+01

-----------------------------Distribution of species-----------------------------

| Species | Molality | Activity | Log Molality | Log Activity | Gamma |
|---|---|---|---|---|---|
| OH- | 8.470e-08 | 6.845e-08 | -7.072 | -7.165 | -0.093 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | H+ | 2.887e-08 | 2.461e-08 | -7.540 | -7.609 | -0.069 |
| | H2O | 5.551e+01 | 9.994e-01 | 0.000 | 0.000 | 0.000 |
| C(4) | 1.050e-03 | | | | | |
| | HCO3- | 9.100e-04 | 7.518e-04 | -3.041 | -3.124 | -0.083 |
| | CO2 | 6.163e-05 | 6.244e-05 | -4.210 | -4.205 | 0.006 |
| | CaHCO3+ | 3.444e-05 | 2.846e-05 | -4.463 | -4.546 | -0.083 |
| | MgHCO3+ | 2.589e-05 | 2.121e-05 | -4.587 | -4.674 | -0.087 |
| | CaCO3 | 5.389e-06 | 5.460e-06 | -5.269 | -5.263 | 0.006 |
| | MnHCO3+ | 4.074e-06 | 3.338e-06 | -5.390 | -5.477 | -0.087 |
| | MnCO3 | 3.221e-06 | 3.264e-06 | -5.492 | -5.486 | 0.006 |
| | CO3-2 | 1.770e-06 | 8.249e-07 | -5.752 | -6.084 | -0.332 |
| | MgCO3 | 1.417e-06 | 1.435e-06 | -5.849 | -5.843 | 0.006 |
| | FeHCO3+ | 8.286e-07 | 6.789e-07 | -6.082 | -6.168 | -0.087 |
| | ZnCO3 | 4.152e-07 | 4.206e-07 | -6.382 | -6.376 | 0.006 |
| | ZnHCO3+ | 2.952e-07 | 2.419e-07 | -6.530 | -6.616 | -0.087 |
| | FeCO3 | 1.764e-07 | 1.787e-07 | -6.754 | -6.748 | 0.006 |
| | Zn(CO3)2-2 | 1.646e-08 | 7.418e-09 | -7.783 | -8.130 | -0.346 |
| | NaHCO3 | 4.964e-10 | 5.029e-10 | -9.304 | -9.298 | 0.006 |
| | NaCO3- | 7.137e-12 | 5.847e-12 | -11.147 | -11.233 | -0.087 |
| Ca | 1.476e-02 | | | | | |
| | Ca+2 | 1.052e-02 | 4.923e-03 | -1.978 | -2.308 | -0.330 |
| | CaSO4 | 4.201e-03 | 4.257e-03 | -2.377 | -2.371 | 0.006 |
| | CaHCO3+ | 3.444e-05 | 2.846e-05 | -4.463 | -4.546 | -0.083 |
| | CaCO3 | 5.389e-06 | 5.460e-06 | -5.269 | -5.263 | 0.006 |
| | CaOH+ | 4.050e-08 | 3.318e-08 | -7.393 | -7.479 | -0.087 |
| Cl | 1.414e-03 | | | | | |
| | Cl- | 1.414e-03 | 1.145e-03 | -2.850 | -2.941 | -0.092 |
| | MnCl+ | 2.835e-07 | 2.323e-07 | -6.547 | -6.634 | -0.087 |
| | FeCl+ | 1.742e-08 | 1.427e-08 | -7.759 | -7.846 | -0.087 |
| | ZnCl+ | 3.549e-09 | 2.908e-09 | -8.450 | -8.536 | -0.087 |
| | MnCl2 | 1.146e-10 | 1.161e-10 | -9.941 | -9.935 | 0.006 |
| | ZnCl2 | 3.141e-12 | 3.183e-12 | -11.503 | -11.497 | 0.006 |
| | MnCl3- | 4.467e-14 | 3.660e-14 | -13.350 | -13.437 | -0.087 |
| | ZnCl3- | 4.357e-15 | 3.570e-15 | -14.361 | -14.447 | -0.087 |
| | FeCl+2 | 9.376e-17 | 4.224e-17 | -16.028 | -16.374 | -0.346 |
| | ZnCl4-2 | 3.801e-18 | 1.712e-18 | -17.420 | -17.766 | -0.346 |
| | FeCl2+ | 5.395e-19 | 4.420e-19 | -18.268 | -18.355 | -0.087 |
| | FeCl3 | 4.994e-23 | 5.060e-23 | -22.302 | -22.296 | 0.006 |
| Fe(2) | 2.557e-05 | | | | | |
| | Fe+2 | 1.891e-05 | 9.030e-06 | -4.723 | -5.044 | -0.321 |
| | FeSO4 | 5.612e-06 | 5.685e-06 | -5.251 | -5.245 | 0.006 |
| | FeHCO3+ | 8.286e-07 | 6.789e-07 | -6.082 | -6.168 | -0.087 |
| | FeCO3 | 1.764e-07 | 1.787e-07 | -6.754 | -6.748 | 0.006 |
| | FeOH+ | 2.617e-08 | 2.144e-08 | -7.582 | -7.669 | -0.087 |
| | FeCl+ | 1.742e-08 | 1.427e-08 | -7.759 | -7.846 | -0.087 |
| | FeHSO4+ | 1.121e-12 | 9.180e-13 | -11.951 | -12.037 | -0.087 |
| | Fe(HS)2 | 0.000e+00 | 0.000e+00 | -127.621 | -127.615 | 0.006 |
| | Fe(HS)3- | 0.000e+00 | 0.000e+00 | -191.252 | -191.338 | -0.087 |
| Fe(3) | 3.153e-06 | | | | | |
| | Fe(OH)3 | 1.909e-06 | 1.934e-06 | -5.719 | -5.713 | 0.006 |
| | Fe(OH)2+ | 1.208e-06 | 9.899e-07 | -5.918 | -6.004 | -0.087 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Fe(OH)4- | 3.527e-08 | 2.890e-08 | -7.453 | -7.539 | -0.087 |
| | FeOH+2 | 3.849e-10 | 1.734e-10 | -9.415 | -9.761 | -0.346 |
| | FeSO4+ | 1.086e-13 | 8.900e-14 | -12.964 | -13.051 | -0.087 |
| | Fe(SO4)2- | 1.164e-14 | 9.540e-15 | -13.934 | -14.020 | -0.087 |
| | Fe+3 | 1.051e-14 | 2.501e-15 | -13.978 | -14.602 | -0.624 |
| | FeCl+2 | 9.376e-17 | 4.224e-17 | -16.028 | -16.374 | -0.346 |
| | Fe2(OH)2+4 | 4.997e-17 | 2.059e-18 | -16.301 | -17.686 | -1.385 |
| | FeCl2+ | 5.395e-19 | 4.420e-19 | -18.268 | -18.355 | -0.087 |
| | Fe3(OH)4+5 | 4.997e-19 | 3.423e-21 | -18.301 | -20.466 | -2.164 |
| | FeHSO4+2 | 1.417e-20 | 6.386e-21 | -19.848 | -20.195 | -0.346 |
| | FeCl3 | 4.994e-23 | 5.060e-23 | -22.302 | -22.296 | 0.006 |
| H(0) | 8.931e-27 | | | | | |
| | H2 | 4.466e-27 | 4.524e-27 | -26.350 | -26.344 | 0.006 |
| K | 6.411e-04 | | | | | |
| | K+ | 6.235e-04 | 5.049e-04 | -3.205 | -3.297 | -0.092 |
| | KSO4- | 1.751e-05 | 1.435e-05 | -4.757 | -4.843 | -0.087 |
| | KOH | 7.017e-11 | 7.109e-11 | -10.154 | -10.148 | 0.006 |
| Mg | 7.011e-03 | | | | | |
| | Mg+2 | 5.242e-03 | 2.518e-03 | -2.281 | -2.599 | -0.318 |
| | MgSO4 | 1.742e-03 | 1.765e-03 | -2.759 | -2.753 | 0.006 |
| | MgHCO3+ | 2.589e-05 | 2.121e-05 | -4.587 | -4.674 | -0.087 |
| | MgCO3 | 1.417e-06 | 1.435e-06 | -5.849 | -5.843 | 0.006 |
| | MgOH+ | 5.891e-08 | 4.827e-08 | -7.230 | -7.316 | -0.087 |
| Mn(2) | 1.423e-04 | | | | | |
| | Mn+2 | 1.043e-04 | 4.981e-05 | -3.982 | -4.303 | -0.321 |
| | MnSO4 | 3.041e-05 | 3.081e-05 | -4.517 | -4.511 | 0.006 |
| | MnHCO3+ | 4.074e-06 | 3.338e-06 | -5.390 | -5.477 | -0.087 |
| | MnCO3 | 3.221e-06 | 3.264e-06 | -5.492 | -5.486 | 0.006 |
| | MnCl+ | 2.835e-07 | 2.323e-07 | -6.547 | -6.634 | -0.087 |
| | MnOH+ | 1.006e-08 | 8.245e-09 | -7.997 | -8.084 | -0.087 |
| | MnCl2 | 1.146e-10 | 1.161e-10 | -9.941 | -9.935 | 0.006 |
| | MnCl3- | 4.467e-14 | 3.660e-14 | -13.350 | -13.437 | -0.087 |
| Mn(3) | 3.416e-27 | | | | | |
| | Mn+3 | 3.416e-27 | 5.681e-28 | -26.466 | -27.246 | -0.779 |
| Na | 1.483e-06 | | | | | |
| | Na+ | 1.449e-06 | 1.190e-06 | -5.839 | -5.925 | -0.086 |
| | NaSO4- | 3.375e-08 | 2.765e-08 | -7.472 | -7.558 | -0.087 |
| | NaHCO3 | 4.964e-10 | 5.029e-10 | -9.304 | -9.298 | 0.006 |
| | NaCO3- | 7.137e-12 | 5.847e-12 | -11.147 | -11.233 | -0.087 |
| | NaOH | 3.150e-13 | 3.192e-13 | -12.502 | -12.496 | 0.006 |
| O(0) | 0.000e+00 | | | | | |
| | O2 | 0.000e+00 | 0.000e+00 | -47.137 | -47.131 | 0.006 |
| S(-2) | 0.000e+00 | | | | | |
| | HS- | 0.000e+00 | 0.000e+00 | -65.668 | -65.760 | -0.093 |
| | H2S | 0.000e+00 | 0.000e+00 | -66.087 | -66.081 | 0.006 |
| | S-2 | 0.000e+00 | 0.000e+00 | -71.402 | -71.741 | -0.339 |
| | Fe(HS)2 | 0.000e+00 | 0.000e+00 | -127.621 | -127.615 | 0.006 |
| | Fe(HS)3- | 0.000e+00 | 0.000e+00 | -191.252 | -191.338 | -0.087 |
| S(6) | 1.774e-02 | | | | | |
| | SO4-2 | 1.174e-02 | 5.352e-03 | -1.930 | -2.272 | -0.341 |
| | CaSO4 | 4.201e-03 | 4.257e-03 | -2.377 | -2.371 | 0.006 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | MgSO4 | 1.742e-03 | 1.765e-03 | -2.759 | -2.753 | 0.006 |
| | MnSO4 | 3.041e-05 | 3.081e-05 | -4.517 | -4.511 | 0.006 |
| | KSO4- | 1.751e-05 | 1.435e-05 | -4.757 | -4.843 | -0.087 |
| | FeSO4 | 5.612e-06 | 5.685e-06 | -5.251 | -5.245 | 0.006 |
| | ZnSO4 | 2.659e-06 | 2.694e-06 | -5.575 | -5.570 | 0.006 |
| | Zn(SO4)2-2 | 3.096e-07 | 1.395e-07 | -6.509 | -6.856 | -0.346 |
| | NaSO4- | 3.375e-08 | 2.765e-08 | -7.472 | -7.558 | -0.087 |
| | HSO4- | 1.032e-08 | 8.456e-09 | -7.986 | -8.073 | -0.087 |
| | FeHSO4+ | 1.121e-12 | 9.180e-13 | -11.951 | -12.037 | -0.087 |
| | FeSO4+ | 1.086e-13 | 8.900e-14 | -12.964 | -13.051 | -0.087 |
| | Fe(SO4)2- | 1.164e-14 | 9.540e-15 | -13.934 | -14.020 | -0.087 |
| | FeHSO4+2 | 1.417e-20 | 6.386e-21 | -19.848 | -20.195 | -0.346 |
| Zn | 9.356e-06 | | | | | |
| | Zn+2 | 5.579e-06 | 2.556e-06 | -5.253 | -5.592 | -0.339 |
| | ZnSO4 | 2.659e-06 | 2.694e-06 | -5.575 | -5.570 | 0.006 |
| | ZnCO3 | 4.152e-07 | 4.206e-07 | -6.382 | -6.376 | 0.006 |
| | Zn(SO4)2-2 | 3.096e-07 | 1.395e-07 | -6.509 | -6.856 | -0.346 |
| | ZnHCO3+ | 2.952e-07 | 2.419e-07 | -6.530 | -6.616 | -0.087 |
| | Zn(OH)2 | 5.237e-08 | 5.306e-08 | -7.281 | -7.275 | 0.006 |
| | ZnOH+ | 2.503e-08 | 2.051e-08 | -7.602 | -7.688 | -0.087 |
| | Zn(CO3)2-2 | 1.646e-08 | 7.418e-09 | -7.783 | -8.130 | -0.346 |
| | ZnCl+ | 3.549e-09 | 2.908e-09 | -8.450 | -8.536 | -0.087 |
| | Zn(OH)3- | 8.316e-12 | 6.814e-12 | -11.080 | -11.167 | -0.087 |
| | ZnCl2 | 3.141e-12 | 3.183e-12 | -11.503 | -11.497 | 0.006 |
| | ZnCl3- | 4.357e-15 | 3.570e-15 | -14.361 | -14.447 | -0.087 |
| | Zn(OH)4-2 | 9.733e-17 | 4.385e-17 | -16.012 | -16.358 | -0.346 |
| | ZnCl4-2 | 3.801e-18 | 1.712e-18 | -17.420 | -17.766 | -0.346 |

----------------------------Saturation indices----------------------------

| Phase | SI | log IAP | log KT | |
|---|---|---|---|---|
| Anhydrite | -0.23 | -4.58 | -4.35 | CaSO4 |
| Aragonite | -0.16 | -8.39 | -8.23 | CaCO3 |
| Calcite | 0.00 | -8.39 | -8.39 | CaCO3 |
| CO2(g) | -3.03 | -21.30 | -18.27 | CO2 |
| Dolomite | -0.51 | -17.07 | -16.57 | CaMg(CO3)2 |
| Fe(OH)3(a) | 3.33 | 21.78 | 18.45 | Fe(OH)3 |
| FeS(ppt) | -59.28 | -100.19 | -40.91 | FeS |
| Goethite | 9.22 | 21.78 | 12.56 | FeOOH |
| Gypsum | 0.02 | -4.58 | -4.60 | CaSO4:2H2O |
| H2(g) | -23.29 | -23.22 | 0.07 | H2 |
| H2S(g) | -65.34 | -110.36 | -45.02 | H2S |
| Hausmannite | -10.66 | 55.96 | 66.62 | Mn3O4 |
| Hematite | 18.74 | 43.56 | 24.82 | Fe2O3 |
| Jarosite-K | 1.48 | 34.68 | 33.20 | KFe3(SO4)2(OH)6 |
| Mackinawite | -58.55 | -100.19 | -41.64 | FeS |
| Manganite | -2.82 | 22.52 | 25.34 | MnOOH |
| Melanterite | -4.82 | -7.32 | -2.50 | FeSO4:7H2O |
| O2(g) | -44.27 | 46.44 | 90.71 | O2 |
| Pyrite | -94.24 | -187.33 | -93.09 | FeS2 |

| | | | | |
|---|---|---|---|---|
| Pyrochroite | -4.29 | 10.91 | 15.20 | Mn(OH)2 |
| Pyrolusite | -10.86 | 34.13 | 45.00 | MnO2 |
| Rhodochrosite | 0.66 | -10.39 | -11.05 | MnCO3 |
| Siderite | -0.38 | -11.13 | -10.75 | FeCO3 |
| Smithsonite | -1.92 | -11.68 | -9.76 | ZnCO3 |
| Sphalerite | -51.67 | -100.73 | -49.07 | ZnS |
| Sulfur | -48.27 | -87.14 | -38.87 | S |
| Zn(OH)2(e) | -1.88 | 9.62 | 11.50 | Zn(OH)2 |

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End of simulation.

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Reading input data for simulation 2.

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End of run.

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# Appendix B

# Foth & Van Dyke
# Memorandum

January 26, 2001

TO: Jana Murphy, Flambeau Mining Co.

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

FR: Steve Lehrke, Foth & Van Dyke SL

RE: Flambeau Mining Company - 2000 Annual Report Groundwater and Surface Water Trends

## Background

The groundwater and surface water sample results collected between July of 1991 and November of 2000 for the 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 onsite. 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.

Groundwater concentration trends of the in-pit wells were also statistically analyzed, and included as Attachment 4. The in-pit wells are MW-1013, MW-1013A, MW-1013B, MW-1013C, MW-1014, MW-1014A, MW-1014B, and MW-1014C. This is the first trend analysis completed for these wells.

## 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 November 2000. This test indicates whether any general increasing or decreasing trends have 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, 2 and 4 to properly evaluate trend conditions. 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[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 2000, 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 1999 Annual Report. The trend graphs given in Attachment 1 should be reviewed carefully in addition to the Mann-Kendall results to interpret current trends in MW-1000PR, due to the rebound of water elevation which began during the second half of 1997. Significant increases in the conductivity, and in the concentrations of alkalinity, hardness, manganese, sulfate and TDS took place during 1998. Iron concentrations began increasing in this well during 1999. Hardness, Manganese, Sulfate and TDS concentrations have since stabilized and even decreased somewhat. Copper concentrations in MW-1000PR increased to a high in July 1999, but have since decreased to non-detectable levels.

The results of the Mann-Kendall tests are as follows:

| Well | Parameter | Trend |
|---|---|---|
| MW-1000PR | Sulfate | Increasing |
| | TDS | Increasing |
| MW-1002 | Copper | Decreasing |

[1]Gilbert, R.O., 1987. "Statistical Methods for Environmental Pollution Monitoring", Van Nostrand Reinhold, New York.

| Well | Parameter | Trend |
|---|---|---|
| MW-1004P | Hardness | Decreasing |
| | Iron | Decreasing |
| | Manganese | Decreasing |
| | Sulfate | Increasing |
| MW-1004S | pH | Decreasing |
| | Copper | Decreasing |
| | Sulfate | Increasing |
| MW-1005 | Conductivity | Decreasing |
| | Alkalinity | Decreasing |
| | Hardness | Decreasing |
| | TDS | Decreasing |
| MW-1005P | Alkalinity | Decreasing |
| | Copper | Decreasing |
| | Hardness | Decreasing |
| | Iron | Decreasing |
| | Manganese | Decreasing |
| | Sulfate | Increasing |
| MW-1005S | Hardness | Decreasing |
| MW-1010P | Conductivity | Decreasing |
| | Alkalinity | Decreasing |

Note that with the exception of the trends observed in MW-1000PR, and the trend of sulfate in MW-1004P, MW-1004S, and MW-1005P, all trends detected by the Mann-Kendall test are decreasing. In addition, the increasing trend of sulfate in MW-1004P and MW-1005P has reversed over the last two years, and is now at non-detectable levels. Even though sulfate in MW-1004S has continued to increase over the last year, actual increases in concentration are very small. The concentrations of iron and manganese in MW-1004P remain generally consistent after sharply decreasing in 1993. Iron concentrations in MW-1005P also de during 1993 and remained historically low, however, with a single elevated occurrence October 1999.

The decreasing trend of pH in MW-1004S as indicated by the Mann-Kendall test is influenced by the higher pH values which occurred prior to July 1994. Since then, the trend of pH in this well has been relatively consistent.

Few trends are evident in the results collected to date of the in-pit wells. Those indicated by the Mann-Kendall test (Attachment 4) include increasing trends of manganese in MW-1013B and iron in MW-1013C, and a decreasing trend of conductivity in MW-1014C. Although not indicated by the Mann-Kendall test, a decreasing trend of iron in MW-1014C is also evident.

Very few trends were noted for the surface water samples. Slightly decreasing trends of aluminum and selenium were noted by the Mann-Kendall tests for SW-1 and for copper in SW-1 and SW-2. Note that 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.

Recovery of groundwater elevations in MW-1000PR seem to have stabilized during the end of 1998 and remain so throughout 2000. Recovery of groundwater elevations continue in MW-1001, MW-1001G, MW-1001P, MW-1003, PZ-S3 and ST-9-23. Additional wells in which groundwater elevations seem to have stabilized after rebounding during 1997 include MW-1010P, MW-1003P, MW-1004, MW-1004P, MW-1004S, OW-42, PZ-S1, and PZ-R1.

## Conclusions

Parameter concentrations of hardness, manganese, sulfate and TDS in MW-1000PR seem to have stabilized correspondingly with the stabilization of groundwater elevations. Concentrations of alkalinity and iron in this well have yet to stabilize since groundwater elevation recovery. Other trends noted for parameter concentrations in MW-1002, MW-1004P, MW-1004S, MW-1005, MW-1005P, MW-1005S and MW-1010P are mainly decreasing, with the exception of an increasing trend of sulfate in MW-1004S with very small increases in concentration.

Only a small number of trends were observed for the in-pit wells. These were increasing trends of manganese in MW-1013B and iron in MW-1013C, and decreasing trends of conductivity and iron in MW-1014C. The sample sizes in these wells are still relatively small to test for overall trends.

Only a small number of decreasing trends were noted for the surface water samples.

## Table 1A

### Groundwater Quality Results, Summary Statistics and Trend Analysis
### July 1991 Through October 2000

| 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 |

# Table 1A

## Groundwater Quality Results, Summary Statistics and Trend Analysis
## July 1991 Through October 2000

| 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 | < 0.0005 | 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 | < 0.0005 | 0.0027 | 0.0003 |
| 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 | < 0.0005 | 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 | < 0.0005 | 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 | < 0.0005 | 0.0034 | 0.0009 |
| 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 |

## Table 1A

**Groundwater Quality Results, Summary Statistics and Trend Analysis**
**July 1991 Through October 2000**

| 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 | 0.001 | 0.0016 | < 0.0007 | 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 | 0.0004 | 0.0014 | 0.0001 | 0.001 | 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 | < 0.0007 | < 0.0007 | < 0.0007 | < 0.0007 | < 0.0005 | < 0.0005 | 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 | 0.0001 | < 0.0002 | < 0.0002 | 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 | 0.0003 | 0.0007 | 0.0003 | 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 |

# Table 1A

## Groundwater Quality Results, Summary Statistics and Trend Analysis
## July 1991 Through October 2000

| Well/Parameter | Units | Jul-97 | Oct-97 | Jan-98 | Apr-98 | Jul-98 | Oct-98 | Jan-99 | Apr-99 |
|---|---|---|---|---|---|---|---|---|---|
| **MW-1000P-R** | | | | | | | | | |
| Conductivity(Field) | umhos | 107.1 | 132 | 576 | 888 | 1097 | 1338 | 1293 | 1319 |
| pH(Field) | S.U. | 6.72 | 6.55 | 6.47 | 6.69 | 6.28 | 6.24 | 6.15 | 6.2 |
| Alkalinity | mg/l | 33 | 40 | 54 | 93 | 71 | 100 | 120 | 120 |
| Copper | mg/l | 0.029 | 0.034 | 0.04 | 0.098 | 0.066 | 0.053 | 0.037 | 0.054 |
| Hardness | mg/l | 39 | 45 | 110 | 470 | 480 | 570 | 760 | 740 |
| Iron | mg/l | 0.0079 | 0.0044 | 0.0061 | 0.044 | 0.076 | 0.012 | 1.2 | 1.2 |
| Manganese | mg/l | 0.061 | 0.11 | 0.49 | 3 | 1.8 | 2 | 4.8 | 5.3 |
| Sulfate | mg/l | 7.8 | 5.9 | 180 | 310 | 350 | 480 | 560 | 440 |
| TDS | mg/l | 110 | 82 | 96 | 770 | 250 | 960 | 1200 | 1300 |
| **MW-1002** | | | | | | | | | |
| Conductivity(Field) | umhos | 118.4 | 114 | 109.8 | 131.7 | 124.8 | 158 | 142.9 | 160 |
| pH(Field) | S.U. | 6.38 | 6.02 | 7.15 | 7.32 | 6.55 | 7.13 | 7.29 | 6.6 |
| Alkalinity | mg/l | 30 | 40 | 40 | 30 | 44 | 52 | 54 | 52 |
| Copper | mg/l | 0.0013 | 0.00086 | 0.0014 | 0.00086 | 0.0009 | 0.00056 | < 0.00054 | 0.00051 |
| Hardness | mg/l | 45 | 46 | 47 | 37 | 50 | 57 | 60 | 59 |
| Iron | mg/l | 0.0087 | 0.003 | 0.034 | 0.05 | 0.0077 | 0.0096 | 0.012 | 0.0018 |
| Manganese | mg/l | 0.0008 | 0.00052 | 0.00026 | 0.0017 | 0.00092 | 0.0004 | 0.00071 | < 0.00041 |
| Sulfate | mg/l | 6.6 | 6 | 7.6 | < 5 | 8.2 | 6.9 | 8.3 | 7.3 |
| TDS | mg/l | 88 | 76 | 82 | 89 | 100 | 120 | 92 | 72 |
| **MW-1002G** | | | | | | | | | |
| Conductivity(Field) | umhos | 271 | 228 | 218 | 245 | 215 | 194 | 215 | 248 |
| pH(Field) | S.U. | 6.51 | 6.35 | 6.85 | 6.97 | 6.81 | 7 | 6.54 | 6.5 |
| Alkalinity | mg/l | 78 | 88 | 82 | 75 | 82 | 76 | 85 | 85 |
| Copper | mg/l | 0.00054 | 0.00054 | < 0.00054 | < 0.00054 | 0.00069 | < 0.00054 | < 0.00054 | < 0.00047 |
| Hardness | mg/l | 100 | 98 | 100 | 98 | 93 | 97 | 97 | 95 |
| Iron | mg/l | 0.0051 | 0.001 | 0.0034 | 0.0047 | 0.0038 | < 0.001 | 0.0035 | < 0.001 |
| Manganese | mg/l | 0.00018 | 0.00018 | < 0.00018 | 0.00021 | < 0.00018 | < 0.00018 | 0.00024 | < 0.00041 |
| Sulfate | mg/l | 9.3 | 7.8 | 12 | 11 | 13 | 13 | 11 | 9.8 |
| TDS | mg/l | 200 | 160 | 150 | 180 | 180 | 120 | 160 | 100 |
| **MW-1004P** | | | | | | | | | |
| Conductivity(Field) | umhos | 277 | 349 | 271 | 303 | 292 | 327 | 267 | 294 |
| pH(Field) | S.U. | 6.94 | 6.91 | 7.13 | 7.41 | 7.08 | 7.06 | 7.47 | 6.7 |
| Alkalinity | mg/l | 140 | 150 | 150 | 96 | 160 | 140 | 160 | 160 |
| Copper | mg/l | 0.014 | 0.04 | 0.027 | 0.02 | 0.01 | 0.005 | 0.0026 | 0.0032 |
| Hardness | mg/l | 140 | 140 | 140 | 130 | 130 | 140 | 140 | 130 |
| Iron | mg/l | 0.0035 | 0.0047 | 0.012 | 0.0064 | 0.0077 | 0.0094 | 0.007 | 0.0066 |
| Manganese | mg/l | 0.012 | 0.01 | 0.012 | 0.0099 | 0.032 | 0.012 | 0.012 | 0.009 |
| Sulfate | mg/l | 6.5 | 5.3 | 8.8 | 8.5 | 9.2 | 8.6 | 7.6 | 6.6 |
| TDS | mg/l | 200 | 120 | 140 | 170 | 220 | 150 | 140 | 140 |
| **MW-1004S** | | | | | | | | | |
| Conductivity(Field) | umhos | 202 | 201 | 140.1 | 164.6 | 162.3 | 324 | 141.8 | 157 |
| pH(Field) | S.U. | 6.36 | 6.13 | 6.6 | 7.97 | 6.5 | 6.29 | 6.59 | 6.1 |
| Alkalinity | mg/l | 55 | 58 | 48 | 47 | 40 | 48 | 44 | 46 |
| Copper | mg/l | 0.002 | 0.0016 | 0.0016 | 0.00092 | 0.0014 | 0.0011 | 0.0006 | 0.0017 |
| Hardness | mg/l | 64 | 75 | 58 | 60 | 60 | 60 | 59 | 60 |
| Iron | mg/l | 0.0091 | 0.0057 | 0.0027 | 0.0049 | 0.0054 | 0.0029 | 0.005 | 0.0037 |
| Manganese | mg/l | 0.00038 | 0.00093 | 0.0003 | 0.00052 | 0.00029 | 0.00045 | 0.00062 | 0.00087 |
| Sulfate | mg/l | 8 | 15 | 11 | 10 | 13 | 14 | 11 | 10 |
| TDS | mg/l | 130 | 100 | 120 | 140 | 140 | 98 | 120 | 82 |

## Table 1A

### Groundwater Quality Results, Summary Statistics and Trend Analysis
### July 1991 Through October 2000

| Well/Parameter | Units | Jul-99 | Oct-99 | Jan-00 | Apr-00 | Jul-00 | Oct-00 |
|---|---|---|---|---|---|---|---|
| **MW-1000P-R** | | | | | | | |
| Conductivity(Field) | umhos | 1310 | 1400 | 1300 | 1274 | 1200 | 1189 |
| pH(Field) | S.U. | 6.1 | 6.7 | 6.3 | 6.9 | 6.3 | 6.2 |
| Alkalinity | mg/l | 130 | 130 | 140 | 140 | 140 | 170 |
| Copper | mg/l | 0.13 | 0.017 | 0.0019 | 0.019 | 0.0073 | < 0.0026 |
| Hardness | mg/l | 770 | 760 | 670 | 720 | 710 | 680 |
| Iron | mg/l | 3.3 | 3.6 | 4.4 | 3.4 | 2.3 | 6.6 |
| Manganese | mg/l | 5.4 | 5.2 | 4.1 | 3.8 | 5 | 4.2 |
| Sulfate | mg/l | 380 | 680 | 610 | 560 | 550 | 460 |
| TDS | mg/l | 1300 | 1100 | 1000 | 920 | 930 | 1100 |
| **MW-1002** | | | | | | | |
| Conductivity(Field) | umhos | 149 | 140 | 170 | 166 | 160 | 125 |
| pH(Field) | S.U. | 6.7 | 7 | 6.9 | 6.8 | 6.7 | 6.4 |
| Alkalinity | mg/l | 50 | 46 | 57 | 55 | 52 | 47 |
| Copper | mg/l | < 0.0047 | < 0.00047 | < 0.00047 | 0.00091 | < 0.00053 | < 0.0005 |
| Hardness | mg/l | 58 | 51 | 65 | 67 | 66 | 58 |
| Iron | mg/l | 0.0027 | 0.029 | < 0.001 | 0.0039 | < 0.005 | < 0.005 |
| Manganese | mg/l | < 0.00041 | < 0.00041 | < 0.00041 | < 0.00041 | < 0.002 | < 0.002 |
| Sulfate | mg/l | 5.9 | 6.9 | 5.6 | 5.2 | 5.7 | 5.7 |
| TDS | mg/l | 110 | 91 | 110 | 98 | 110 | 120 |
| **MW-1002G** | | | | | | | |
| Conductivity(Field) | umhos | 227 | 240 | 240 | 239 | 220 | 223 |
| pH(Field) | S.U. | 7 | 7.2 | 7.1 | 6.8 | 6.6 | 6.6 |
| Alkalinity | mg/l | 84 | 87 | 87 | 89 | 90 | 89 |
| Copper | mg/l | < 0.0047 | < 0.00047 | < 0.00047 | < 0.0006 | < 0.00053 | < 0.0005 |
| Hardness | mg/l | 100 | 100 | 98 | 100 | 110 | 110 |
| Iron | mg/l | 0.0022 | 0.0061 | 0.0031 | 0.0027 | < 0.005 | < 0.005 |
| Manganese | mg/l | < 0.00041 | < 0.00041 | < 0.00041 | < 0.00041 | < 0.002 | < 0.002 |
| Sulfate | mg/l | 11 | 12 | 12 | 11 | 12 | 12 |
| TDS | mg/l | 180 | 150 | 120 | 140 | 160 | 150 |
| **MW-1004P** | | | | | | | |
| Conductivity(Field) | umhos | 308 | 320 | 310 | 293 | 300 | 284 |
| pH(Field) | S.U. | 7.1 | 7.4 | 6.7 | 6.9 | 6.3 | 7.2 |
| Alkalinity | mg/l | 160 | 160 | 160 | 160 | 160 | 160 |
| Copper | mg/l | < 0.0069 | 0.0019 | < 0.00047 | 0.0017 | 0.00065 | 0.0008 |
| Hardness | mg/l | 140 | 140 | 130 | 140 | 150 | 140 |
| Iron | mg/l | 0.014 | 0.014 | 0.085 | 0.012 | 0.0086 | 0.008 |
| Manganese | mg/l | 0.01 | 0.0081 | 0.056 | 0.0079 | 0.022 | 0.016 |
| Sulfate | mg/l | 3 | 2.8 | < 5 | < 5 | < 5 | < 5 |
| TDS | mg/l | 180 | 180 | 150 | 170 | 160 | 200 |
| **MW-1004S** | | | | | | | |
| Conductivity(Field) | umhos | 158 | 160 | 160 | 156 | 150 | 134 |
| pH(Field) | S.U. | 5.9 | 6.5 | 6.7 | 6.9 | 6.6 | 6 |
| Alkalinity | mg/l | 40 | 41 | 43 | 42 | 41 | 35 |
| Copper | mg/l | < 0.0069 | 0.00083 | < 0.00047 | 0.0013 | 0.0012 | 0.001 |
| Hardness | mg/l | 59 | 57 | 59 | 56 | 61 | 58 |
| Iron | mg/l | 0.0068 | 0.0089 | 0.0051 | 0.0027 | < 0.005 | < 0.005 |
| Manganese | mg/l | 0.0023 | 0.00063 | 0.00065 | < 0.00041 | < 0.002 | < 0.002 |
| Sulfate | mg/l | 10 | 15 | 16 | 15 | 16 | 18 |
| TDS | mg/l | 100 | 84 | 110 | 98 | 100 | 130 |

# Table 1A

## Groundwater Quality Results, Summary Statistics and Trend Analysis
## July 1991 Through October 2000

| 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 |



Prepared By: SGL Checked By: JBH1

# Table 1A

## Groundwater Quality Results, Summary Statistics and Trend Analysis
## July 1991 Through October 2000

| Well/Parameter | Units | Jul-93 | Oct-93 | Jan-94 | Apr-94 | Jul-94 | Oct-94 | Jan-95 | Apr-95 |
|---|---|---|---|---|---|---|---|---|---|
| **MW-1005** | | | | | | | | | |
| Conductivity(Field) | umhos | 1,10 | 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 | < 0.0005 | 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 | < 0.0005 | < 0.0007 |
| 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 2000

| 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 | < 0.0007 | < 0.0007 | < 0.0007 | < 0.0007 | < 0.0005 | 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 | < 0.0007 | < 0.0007 | 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 | < 0.0007 | < 0.0007 | < 0.0007 | < 0.0007 | < 0.0005 | 0.0006 | 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 |

## Table 1A

## Groundwater Quality Results, Summary Statistics and Trend Analysis
## July 1991 Through October 2000

| Well/Parameter | Units | Jul-97 | Oct-97 | Jan-98 | Apr-98 | Jul-98 | Oct-98 | Jan-99 | Apr-99 |
|---|---|---|---|---|---|---|---|---|---|
| MW-1005 | | | | | | | | | |
| Conductivity(Field) | umhos | 755 | 804 | 782 | 725 | 644 | 724 | 598 | 596 |
| pH(Field) | S.U. | 6.22 | 6 | 6.1 | 6.06 | 6.16 | 6.12 | 6.21 | 6.3 |
| Alkalinity | mg/l | 63 | 77 | 71 | 69 | 130 | 65 | 74 | 69 |
| Copper | mg/l | 0.0059 | 0.00054 | < 0.00054 | < 0.00054 | < 0.00054 | < 0.00054 | < 0.00054 | < 0.00047 |
| Hardness | mg/l | 300 | 280 | 260 | 250 | 240 | 250 | 230 | 200 |
| Iron | mg/l | 29 | 23 | 21 | 21 | 17 | 19 | 20 | 20 |
| Manganese | mg/l | 0.8 | 0.59 | 0.49 | 0.5 | 0.4 | 0.46 | 0.47 | 0.48 |
| Sulfate | mg/l | 12 | 10 | 14 | 13 | 16 | 17 | 12 | 11 |
| TDS | mg/l | 220 | 510 | 490 | 440 | 440 | 430 | 370 | 430 |
| MW-1005P | | | | | | | | | |
| Conductivity(Field) | umhos | 448 | 505 | 456 | 461 | 458 | 477 | 449 | 464 |
| pH(Field) | S.U. | 7.03 | 6.9 | 7.06 | 7.36 | 7.01 | 6.96 | 7.6 | 7 |
| Alkalinity | mg/l | 240 | 240 | 250 | 240 | 260 | 230 | 250 | 250 |
| Copper | mg/l | 0.002 | 0.00054 | 0.00073 | 0.0011 | < 0.00054 | 0.0019 | < 0.00054 | 0.0011 |
| Hardness | mg/l | 230 | 230 | 220 | 210 | 220 | 220 | 220 | 210 |
| Iron | mg/l | 0.087 | 0.17 | 0.41 | 0.077 | 0.34 | 0.17 | 0.066 | 0.049 |
| Manganese | mg/l | 0.066 | 0.062 | 0.072 | 0.029 | 0.1 | 0.063 | 0.027 | 0.023 |
| Sulfate | mg/l | 6.7 | 5 | 11 | 9.6 | 12 | 9.4 | 7.8 | 7.8 |
| TDS | mg/l | 280 | 260 | 270 | 280 | 270 | 250 | 250 | 230 |
| MW-1005S | | | | | | | | | |
| Conductivity(Field) | umhos | 689 | 351 | 313 | 332 | 305 | 327 | 319 | 297 |
| pH(Field) | S.U. | 6.83 | 6.77 | 7.09 | 7.19 | 6.7 | 6.82 | 6.87 | 7 |
| Alkalinity | mg/l | 140 | 150 | 170 | 140 | 160 | 150 | 170 | 160 |
| Copper | mg/l | 0.00071 | 0.00054 | < 0.00054 | < 0.00054 | 0.011 | < 0.00054 | < 0.00054 | < 0.00047 |
| Hardness | mg/l | 150 | 150 | 120 | 140 | 150 | 150 | 150 | 140 |
| Iron | mg/l | 4 | 4.2 | 3.3 | 4.2 | 3.9 | 3.9 | 4 | 4.1 |
| Manganese | mg/l | 0.2 | 0.21 | 0.17 | 0.2 | 0.2 | 0.21 | 0.2 | 0.21 |
| Sulfate | mg/l | 9.8 | 6.2 | 11 | 11 | 15 | 13 | 8.9 | 8.6 |
| TDS | mg/l | 260 | 190 | 200 | 250 | 230 | 180 | 180 | 210 |
| MW-1010P | | | | | | | | | |
| Conductivity(Field) | umhos | 295 | 303 | 284 | 294 | 284 | 309 | 288 | 284 |
| pH(Field) | S.U. | 7.25 | 7.03 | 7.4 | 7.64 | 7.24 | 7.53 | 7.01 | 7.1 |
| Alkalinity | mg/l | 130 | 140 | 140 | 130 | 150 | 130 | 140 | 160 |
| Copper | mg/l | 0.048 | 0.03 | 0.026 | 0.019 | 0.027 | 0.02 | 0.024 | 0.012 |
| Hardness | mg/l | 140 | 140 | 130 | 130 | 130 | 130 | 130 | 140 |
| Iron | mg/l | 0.001 | 0.001 | < 0.001 | 0.0034 | 0.0034 | < 0.001 | 0.0046 | 0.019 |
| Manganese | mg/l | 0.026 | 0.029 | 0.029 | 0.043 | 0.029 | 0.022 | 0.02 | 0.067 |
| Sulfate | mg/l | 7 | 5.1 | 9.2 | 5.6 | 11 | 8.6 | 8.3 | 7.6 |
| TDS | mg/l | 170 | 170 | 190 | 170 | 160 | 190 | 170 | 140 |

## Table 1A

### Groundwater Quality Results, Summary Statistics and Trend Analysis July 1991 Through October 2000

| Well/Parameter | Units | Jul-99 | Oct-99 | Jan-00 | Apr-00 | Jul-00 | Oct-00 |
|---|---|---|---|---|---|---|---|
| **MW-1005** | | | | | | | |
| Conductivity(Field) | umhos | 603 | 570 | 600 | 598 | 520 | 530 |
| pH(Field) | S.U. | 6.2 | 6.5 | 6.8 | 6.8 | 6.6 | 6.2 |
| Alkalinity | mg/l | 65 | 65 | 85 | 66 | 64 | 58 |
| Copper | mg/l | < 0.0047 | < 0.00047 | < 0.00047 | < 0.00067 | 0.0007 | 0.0006 |
| Hardness | mg/l | 200 | 190 | 200 | 190 | 210 | 190 |
| Iron | mg/l | 19 | 18 | 16 | 18 | 20 | 17 |
| Manganese | mg/l | 0.46 | 0.41 | 0.53 | 0.41 | 0.6 | 0.39 |
| Sulfate | mg/l | 12 | 17 | 16 | 13 | 15 | 15 |
| TDS | mg/l | 530 | 400 | 300 | 400 | 470 | 430 |
| **MW-1005P** | | | | | | | |
| Conductivity(Field) | umhos | 501 | 460 | 480 | 483 | 460 | 448 |
| pH(Field) | S.U. | 6.9 | 7.3 | 6.7 | 7.3 | 6.5 | 7.3 |
| Alkalinity | mg/l | 240 | 240 | 250 | 250 | 250 | 240 |
| Copper | mg/l | < 0.0047 | < 0.00047 | < 0.00047 | < 0.0006 | < 0.00053 | 0.0007 |
| Hardness | mg/l | 220 | 220 | 200 | 220 | 230 | 220 |
| Iron | mg/l | 0.054 | 0.97 | 0.14 | 0.37 | 0.058 | 0.13 |
| Manganese | mg/l | 0.051 | 0.088 | 0.047 | 0.08 | 0.075 | 0.038 |
| Sulfate | mg/l | 7.3 | < 1.5 | < 5 | < 5 | < 5 | < 5 |
| TDS | mg/l | 250 | 260 | 280 | 220 | 290 | 260 |
| **MW-1005S** | | | | | | | |
| Conductivity(Field) | umhos | 331 | 320 | 380 | 354 | 330 | 330 |
| pH(Field) | S.U. | 6.7 | 7 | 6.7 | 7 | 6.5 | 7.3 |
| Alkalinity | mg/l | 160 | 160 | 170 | 170 | 170 | 170 |
| Copper | mg/l | < 0.0047 | < 0.00047 | < 0.00047 | < 0.0006 | < 0.00053 | < 0.0005 |
| Hardness | mg/l | 150 | 150 | 150 | 150 | 170 | 160 |
| Iron | mg/l | 4.3 | 4.1 | 3.9 | 4.2 | 4.6 | 4.3 |
| Manganese | mg/l | 0.22 | 0.21 | 0.21 | 0.22 | 0.24 | 0.22 |
| Sulfate | mg/l | 9.5 | 5.6 | < 5 | < 5 | < 5 | < 5 |
| TDS | mg/l | 240 | 210 | 210 | 230 | 200 | 210 |
| **MW-1010P** | | | | | | | |
| Conductivity(Field) | umhos | 296 | 300 | 280 | 283 | 290 | 268 |
| pH(Field) | S.U. | 7.2 | 7.6 | 6.8 | 7.1 | 6.5 | 7.5 |
| Alkalinity | mg/l | 150 | 150 | 140 | 140 | 140 | 150 |
| Copper | mg/l | 0.012 | 0.0035 | 0.0022 | 0.0099 | 0.014 | 0.0043 |
| Hardness | mg/l | 140 | 140 | 130 | 150 | 140 | 140 |
| Iron | mg/l | 0.0074 | 0.0096 | 0.017 | 0.0066 | < 0.025 | 0.41 |
| Manganese | mg/l | 0.059 | 0.065 | 0.039 | 0.024 | 0.026 | 0.25 |
| Sulfate | mg/l | 5.5 | 5.3 | < 5 | < 5 | < 5 | < 5 |
| TDS | mg/l | 200 | 170 | 130 | 140 | 190 | 220 |

## Table 2A

### Surface Water Quality Results, Summary Statistics and Trend Analysis
### July 1991 Through October 2000

| 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 |
| Iron | mg/l | | | | | | | | |
| Lead | mg/l | 0.0012 | < 0.003 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | 0.001 |
| Manganese | mg/l | | | | | | | | |
| 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 |
| Sulfate | mg/l | | | | | | | | |
| 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 |
| Iron | mg/l | | | | | | | | |
| Lead | mg/l | 0.0012 | < 0.003 | 0.001 | < 0.001 | 0.003 | < 0.001 | < 0.001 | < 0.001 |
| Manganese | mg/l | | | | | | | | |
| 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 |
| Sulfate | mg/l | | | | | | | | |
| 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 |

## Table 2A

### Surface Water Quality Results, Summary Statistics and Trend Analysis
### July 1991 Through October 2000

| 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 | < 0.0003 | < 0.0003 |
| Cadmium | mg/l | < 0.0008 | < 0.0006 | < 0.0002 | 0.0004 | < 0.0002 | < 0.0008 | < 0.0005 | 0.0002 |
| Chromium | mg/l | < 0.002 | 0.004 | < 0.001 | 0.0018 | 0.0018 | 0.0025 | < 0.0006 | 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 |
| Iron | mg/l | | | | | | | | |
| Lead | mg/l | < 0.005 | < 0.001 | < 0.001 | 0.01 | 0.0025 | 0.0011 | < 0.0008 | 0.0045 |
| Manganese | mg/l | | | | | | | | |
| 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 |
| Sulfate | mg/l | | | | | | | | |
| 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 | 0.0002 | < 0.0008 | < 0.0005 | < 0.0016 |
| Chromium | mg/l | 0.0021 | 0.004 | < 0.001 | 0.0019 | 0.0023 | 0.0037 | < 0.0006 | 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 |
| Iron | mg/l | | | | | | | | |
| Lead | mg/l | < 0.005 | < 0.001 | < 0.001 | < 0.001 | 0.0014 | 0.0015 | 0.0097 | 0.0061 |
| Manganese | mg/l | | | | | | | | |
| 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 | < 0.0009 | 0.0018 |
| Sulfate | mg/l | | | | | | | | |
| 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 |

## Table 2A

## Surface Water Quality Results, Summary Statistics and Trend Analysis
## July 1991 Through October 2000

| 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 | 0.0001 | < 8.3E-05 | < 8.3E-05 | 0.0002 | < 8.3E-05 | < 8.3E-05 | < 8.3E-05 |
| Cadmium | mg/l | < 0.0002 | 0.0002 | 0.0004 | < 0.0002 | 0.0002 | 0.0003 | < 0.00016 | < 0.00016 |
| Chromium | mg/l | < 0.0006 | 0.0014 | 0.0013 | < 9.3E-06 | 0.0014 | < 0.0006 | 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 |
| Iron | mg/l | | | | | | | | |
| Lead | mg/l | < 0.002 | 0.0082 | 0.01 | < 0.002 | 0.0027 | < 0.002 | 0.0023 | < 0.002 |
| Manganese | mg/l | | | | | | | | |
| Mercury | mg/l | < 9.5E-05 | < 9.5E-05 | < 9.5E-05 | < 9.5E-05 | 0.0007 | < 6.7E-05 | < 6.7E-05 | < 6.7E-05 |
| Nickel | mg/l | < 0.0008 | 0.0026 | < 0.0008 | < 0.0008 | 0.0008 | < 0.0008 | < 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 |
| Sulfate | mg/l | | | | | | | | |
| 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 | 0.0001 | < 8.3E-05 | < 8.3E-05 | 0.0001 | < 8.3E-05 | < 8.3E-05 | < 8.3E-05 |
| Cadmium | mg/l | < 0.0002 | 0.0003 | < 0.0002 | < 0.0002 | < 0.0002 | 0.0003 | 0.00016 | 0.00016 |
| Chromium | mg/l | < 0.0006 | 0.002 | 0.0014 | < 9.3E-06 | 0.0012 | < 0.0006 | 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 |
| Iron | mg/l | | | | | | | | |
| Lead | mg/l | < 0.002 | 0.0083 | 0.0096 | < 0.002 | 0.0026 | 0.0022 | 0.0021 | < 0.002 |
| Manganese | mg/l | | | | | | | | |
| 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 | < 0.0008 | < 0.0008 | < 0.0008 | < 0.0008 | < 0.0008 | < 0.0008 | < 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 |
| Sulfate | mg/l | | | | | | | | |
| 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 |

# Table 2A

## Surface Water Quality Results, Summary Statistics and Trend Analysis
## July 1991 Through October 2000

| Station/Parameter | Units | Jul-97 | Oct-97 | Jan-98 | Apr-98 | Jul-98 | Oct-98 | Jan-99 | Mar-99 |
|---|---|---|---|---|---|---|---|---|---|
| **SW-1** | | | | | | | | | |
| Conductivity(Field) | umhos | 96.1 | 107.6 | 136.3 | 110 | 130 | | | 166.7 |
| pH(Field) | S.U. | 7.25 | 7.27 | 7.63 | 7 | 8.7 | | | 7.3 |
| Aluminum | mg/l | 0.085 | 0.11 | 0.036 | 0.065 | < 0.025 | | | 0.085 |
| Arsenic | mg/l | < 0.0014 | < 0.0014 | < 0.0018 | < 0.0018 | < 0.0018 | | | < 0.003 |
| Beryllium | mg/l | 0.00011 | < 8.3E-05 | < 8.3E-05 | < 8.3E-05 | < 8.3E-05 | | | < 0.00015 |
| Cadmium | mg/l | < 0.00016 | < 0.00016 | 0.0002 | < 0.00016 | < 0.00016 | | | < 0.00031 |
| Chromium | mg/l | 0.0011 | < 0.00061 | < 0.00061 | < 0.00061 | 0.0011 | | | 0.00078 |
| Chromium IV | mg/l | < 0.0036 | < 0.0036 | 0.006 | < 0.0036 | < 0.0036 | | | < 0.0036 |
| Copper | mg/l | < 0.0017 | 0.0022 | 0.0076 | < 0.0017 | < 0.0017 | | | 0.00074 |
| Diss O2 | mg/l | 6 | 6.9 | 8.7 | 8.5 | 8.2 | | | 9.3 |
| Hardness | mg/l | 35 | 39 | 46 | 29 | 41 | | | 58 |
| Iron | mg/l | | | | | | | | |
| Lead | mg/l | < 0.002 | < 0.002 | < 0.002 | < 0.002 | < 0.002 | | | < 0.0024 |
| Manganese | mg/l | | | | | | | | |
| Mercury | mg/l | < 5E-05 | < 5E-05 | < 5E-05 | 0.00033 | < 5E-05 | | | < 5E-05 |
| Nickel | mg/l | < 0.00075 | < 0.00075 | 0.0019 | 0.001 | < 0.00075 | | | < 0.001 |
| Selenium | mg/l | < 0.0016 | < 0.0016 | < 0.0016 | < 0.0016 | < 0.0016 | | | < 0.0016 |
| Silver | mg/l | < 0.0011 | 0.0011 | < 0.0011 | < 0.0011 | < 0.0011 | | | < 0.00047 |
| Sulfate | mg/l | | | | | | | | |
| Sulfide | mg/l | < 2 | < 2 | < 2 | < 2 | < 2 | | | < 2 |
| TDS | mg/l | 94 | 72 | 84 | 71 | 70 | | | 110 |
| TSS | mg/l | 4 | 5 | < 1 | 6 | 6 | | | 8 |
| Zinc | mg/l | < 0.012 | < 0.012 | 0.043 | < 0.012 | < 0.012 | | | < 0.012 |
| **SW-2** | | | | | | | | | |
| Conductivity(Field) | umhos | 106.8 | 113.8 | 167.9 | 97 | 160 | | | 159.6 |
| pH(Field) | S.U. | 7.25 | 7.44 | 7.32 | 7 | 8.3 | | | 7.7 |
| Aluminum | mg/l | 0.08 | 0.072 | 0.074 | 0.057 | 0.12 | | | 0.094 |
| Arsenic | mg/l | < 0.0014 | < 0.0014 | < 0.0018 | 0.0043 | < 0.0018 | | | < 0.003 |
| Beryllium | mg/l | 0.00023 | < 8.3E-05 | < 8.3E-05 | < 8.3E-05 | 0.00021 | | | < 0.00015 |
| Cadmium | mg/l | < 0.00016 | < 0.00016 | 0.00023 | < 0.00016 | < 0.00016 | | | < 0.00031 |
| Chromium | mg/l | 0.0012 | 0.0014 | 0.0032 | < 0.00061 | 0.0016 | | | < 0.00062 |
| Chromium IV | mg/l | < 0.0036 | < 0.0036 | 0.005 | < 0.0036 | < 0.0036 | | | 0.005 |
| Copper | mg/l | < 0.0017 | < 0.0017 | 0.012 | < 0.0017 | < 0.0017 | | | < 0.0006 |
| Diss O2 | mg/l | 6.1 | 8.1 | 8.5 | 8.7 | 8.6 | | | 9.7 |
| Hardness | mg/l | 37 | 40 | 49 | 28 | 52 | | | 57 |
| Iron | mg/l | | | | | | | | |
| Lead | mg/l | < 0.002 | < 0.002 | 0.0021 | < 0.002 | 0.002 | | | < 0.0024 |
| Manganese | mg/l | | | | | | | | |
| Mercury | mg/l | < 5E-05 | < 5E-05 | 6E-05 | 0.00013 | < 5E-05 | | | < 5E-05 |
| Nickel | mg/l | 0.0011 | < 0.00075 | 0.0037 | 0.0013 | < 0.00075 | | | < 0.001 |
| Selenium | mg/l | < 0.0016 | < 0.0016 | 0.0026 | 0.004 | < 0.0016 | | | < 0.0016 |
| Silver | mg/l | < 0.0011 | < 0.0011 | < 0.0011 | < 0.0011 | < 0.0011 | | | < 0.00047 |
| Sulfate | mg/l | | | | | | | | |
| Sulfide | mg/l | < 2 | < 2 | < 2 | < 2 | < 2 | | | < 2 |
| TDS | mg/l | 99 | 80 | 92 | 88 | 70 | | | 110 |
| TSS | mg/l | 3 | < 1 | 3 | 5 | 12 | | | 11 |
| Zinc | mg/l | < 0.012 | < 0.012 | 0.089 | < 0.012 | < 0.012 | | | < 0.012 |

(Unfiltered?

# Table 2A

## Surface Water Quality Results, Summary Statistics and Trend Analysis
## July 1991 Through October 2000

| Station/Parameter | Units | Apr-99 | Nov-99 | Jan-00 | Apr-00 | Jun-00 | Nov-00 |
|---|---|---|---|---|---|---|---|
| **SW-1** | | | | | | | |
| Conductivity(Field) | umhos | 119.3 | 144 | | | 120 | 126 |
| pH(Field) | S.U. | 7.63 | 8.4 | | | 6.5 | 8 |
| Aluminum | mg/l | 0.075 | | | | 0.042 | |
| Arsenic | mg/l | < 0.003 | | | | < 0.003 | |
| Beryllium | mg/l | < 0.00015 | | | | < 0.00015 | |
| Cadmium | mg/l | < 0.00031 | | | | < 0.00031 | |
| Chromium | mg/l | < 0.00062 | | | | 0.00092 | |
| Chromium IV | mg/l | < 0.0036 | | | | < 0.018 | |
| Copper | mg/l | < 0.0006 | < 0.0006 | | | 0.00094 | < 0.0012 |
| Diss O2 | mg/l | 7.8 | 7.5 | | | 6.3 | 11.5 |
| Hardness | mg/l | 43 | 50 | | | 38 | 50 |
| Iron | mg/l | | 0.34 | | | 0.36 | 0.48 |
| Lead | mg/l | < 0.0024 | | | | < 0.0024 | |
| Manganese | mg/l | | 0.042 | | | 0.06 | 0.056 |
| Mercury | mg/l | < 5E-05 | | | | < 5E-05 | |
| Nickel | mg/l | < 0.001 | | | | < 0.001 | |
| Selenium | mg/l | < 0.0016 | | | | < 0.0017 | |
| Silver | mg/l | < 0.00047 | | | | < 0.00047 | |
| Sulfate | mg/l | | 7.7 | | | 5.2 | 8.6 |
| Sulfide | mg/l | < 2 | | | | | |
| TDS | mg/l | 78 | 38 | | | 180 | |
| TSS | mg/l | 5 | 3 | | | < 1 | |
| Zinc | mg/l | < 0.012 | < 0.012 | | | < 0.012 | < 0.012 |
| **SW-2** | | | | | | | |
| Conductivity(Field) | umhos | 124.7 | 139 | | | 120 | 125 |
| pH(Field) | S.U. | 7 | 8.3 | | | 5.5 | 7.6 |
| Aluminum | mg/l | 0.077 | | | | 0.16 | |
| Arsenic | mg/l | < 0.003 | | | | < 0.003 | |
| Beryllium | mg/l | < 0.00015 | | | | < 0.00015 | |
| Cadmium | mg/l | < 0.00031 | | | | < 0.00031 | |
| Chromium | mg/l | < 0.00062 | | | | 0.0013 | |
| Chromium IV | mg/l | < 0.0036 | | | | < 0.018 | |
| Copper | mg/l | < 0.0006 | < 0.0006 | | | 0.0013 | < 0.0012 |
| Diss O2 | mg/l | 7.5 | 7.3 | | | 7.5 | 11.5 |
| Hardness | mg/l | 44 | 48 | | | 40 | 49 |
| Iron | mg/l | | 0.34 | | | 0.54 | 0.46 |
| Lead | mg/l | < 0.0024 | | | | < 0.0024 | |
| Manganese | mg/l | | 0.038 | | | 0.089 | 0.053 |
| Mercury | mg/l | < 5E-05 | | | | < 5E-05 | |
| Nickel | mg/l | < 0.001 | | | | 0.0016 | |
| Selenium | mg/l | < 0.0016 | | | | < 0.0017 | |
| Silver | mg/l | < 0.00047 | | | | < 0.00047 | |
| Sulfate | mg/l | | 7.9 | | | 5.2 | 8.4 |
| Sulfide | mg/l | < 2 | | | | | |
| TDS | mg/l | 79 | 28 | | | 85 | |
| TSS | mg/l | 4 | 4 | | | 10 | |
| Zinc | mg/l | < 0.012 | < 0.012 | | | < 0.012 | < 0.012 |

Table 1B

## Groundwater Quality Results, Summary Statistics and Trend Analysis

| Well/Parameter | Total Detections | # Of Samples Included In Trend Test(*) | Mann-Kendall S | p-Level | |
|---|---|---|---|---|---|
| **MW-1000P-R** | | | | | |
| Conductivity(Field) | 38 | 38 | 140 | 0.08 | — |
| pH(Field) | 38 | 38 | -201 | 0.012 | — |
| Alkalinity | 38 | 38 | 138 | 0.085 | |
| Copper | 31 | 38 | 182 | 0.022 | — |
| Hardness | 38 | 38 | 156 | 0.051 | |
| Iron | 37 | 37 | -2 | 0.99 | |
| Manganese | 38 | 38 | 83 | 0.304 | |
| Sulfate | 35 | 38 | 287 | 0.006 | + - |
| TDS | 38 | 38 | 210 | 0.008 | + - |
| **MW-1002** | | | | | |
| Conductivity(Field) | 38 | 38 | 40 | 0.627 | |
| pH(Field) | 38 | 38 | -67 | 0.41 | |
| Alkalinity | 38 | 38 | 39 | 0.636 | |
| Copper | 16 | 23 | -102 | 0.007 | - |
| Hardness | 38 | 38 | -18 | 0.832 | |
| Iron | 24 | 26 | -58 | 0.212 | |
| Manganese | 20 | 20 | -52 | 0.098 | |
| Sulfate | 32 | 38 | -24 | 0.774 | |
| TDS | 38 | 38 | -13 | 0.88 | |
| **MW-1002G** | | | | | |
| Conductivity(Field) | 38 | 38 | -158 | 0.048 | |
| pH(Field) | 38 | 38 | -43 | 0.6 | |
| Alkalinity | 38 | 38 | 54 | 0.508 | |
| Copper | 6 | 23 | -71 | 0.064 | |
| Hardness | 38 | 38 | -167 | 0.036 | |
| Iron | 19 | 23 | -39 | 0.32 | |
| Manganese | 9 | 18 | 32 | 0.245 | |
| Sulfate | 37 | 38 | 33 | 0.69 | |
| TDS | 38 | 38 | -104 | 0.197 | |
| **MW-1004P** | | | | | |
| Conductivity(Field) | 38 | 38 | -88 | 0.276 | |
| pH(Field) | 38 | 38 | -110 | 0.172 | |
| Alkalinity | 38 | 38 | -194 | 0.015 | |
| Copper | 23 | 25 | -81 | 0.06 | |
| Hardness | 38 | 38 | -282 | 0.006 | - |
| Iron | 36 | 36 | -307 | 0 | - |
| Manganese | 37 | 38 | -373 | 0.006 | - |
| Sulfate | 27 | 27 | 134 | 0.005 | + |
| TDS | 38 | 38 | -137 | 0.088 | |
| **MW-1004S** | | | | | |
| Conductivity(Field) | 38 | 38 | -1 | 1 | |
| pH(Field) | 38 | 38 | -249 | 0.006 | - |
| Alkalinity | 38 | 38 | -177 | 0.026 | |
| Copper | 23 | 24 | -175 | 0 | - |
| Hardness | 38 | 38 | -24 | 0.774 | |
| Iron | 23 | 23 | 8 | 0.85 | |
| Manganese | 21 | 23 | -17 | 0.676 | |
| Sulfate | 34 | 38 | 267 | 0.006 | + |
| TDS | 38 | 38 | -69 | 0.396 | |

Table 1B

## Groundwater Quality Results, Summary Statistics and Trend Analysis

| Well/Parameter | Total Detections | # Of Samples Included In Trend Test(*) | Mann-Kendall S | p-Level | |
|---|---|---|---|---|---|
| MW-1005 | | | | | |
| Conductivity(Field) | 38 | 38 | -399 | 0.006 | - |
| pH(Field) | 38 | 38 | 19 | 0.822 | |
| Alkalinity | 38 | 38 | -357 | 0.006 | - |
| Copper | 8 | 23 | -23 | 0.566 | |
| Hardness | 38 | 38 | -558 | 0.006 | - |
| Iron | 38 | 38 | -126 | 0.117 | |
| Manganese | 38 | 38 | -79 | 0.33 | |
| Sulfate | 38 | 38 | -139 | 0.082 | |
| TDS | 38 | 38 | -320 | 0.006 | - |
| MW-1005P | | | | | |
| Conductivity(Field) | 38 | 38 | 26 | 0.755 | |
| pH(Field) | 38 | 38 | -74 | 0.361 | |
| Alkalinity | 38 | 38 | -244 | 0.006 | - |
| Copper | 15 | 23 | -122 | 0 | - |
| Hardness | 38 | 38 | -249 | 0.006 | - |
| Iron | 38 | 38 | -272 | 0.006 | - |
| Manganese | 38 | 38 | -309 | 0.006 | - |
| Sulfate | 19 | 23 | 128 | 0 | + |
| TDS | 38 | 38 | -178 | 0.025 | |
| MW-1005S | | | | | |
| Conductivity(Field) | 38 | 38 | -124 | 0.123 | |
| pH(Field) | 38 | 38 | -199 | 0.012 | |
| Alkalinity | 38 | 38 | -122 | 0.129 | |
| Copper | 6 | 23 | -52 | 0.18 | |
| Hardness | 38 | 38 | -259 | 0.006 | - |
| Iron | 38 | 38 | 143 | 0.074 | |
| Manganese | 38 | 38 | 34 | 0.681 | |
| Sulfate | 28 | 38 | 64 | 0.431 | |
| TDS | 37 | 38 | 17 | 0.842 | |
| MW-1010P | | | | | |
| Conductivity(Field) | 38 | 38 | -283 | 0.006 | - |
| pH(Field) | 38 | 38 | -105 | 0.192 | |
| Alkalinity | 38 | 38 | -260 | 0.006 | - |
| Copper | 25 | 25 | -81 | 0.06 | |
| Hardness | 38 | 38 | -29 | 0.726 | |
| Iron | 23 | 26 | 13 | 0.794 | |
| Manganese | 38 | 38 | -126 | 0.117 | |
| Sulfate | 31 | 31 | -8 | 0.906 | |
| TDS | 38 | 38 | -277 | 0.006 | - |

+ : 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 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.

**Table 2B**

**Surface Water Quality Results, Summary Statistics and Trend Analysis**

| Station/Parameter | Total Detections | # Of Samples Included In Trend Test(*) | Mann-Kendall S | p-Level | |
|---|---|---|---|---|---|
| SW-1 | | | | | |
| Conductivity(Field) | 34 | 34 | 138 | 0.042 | |
| pH(Field) | 34 | 34 | 73 | 0.288 | |
| Aluminum | 29 | 31 | -179 | 0.002 | - |
| Arsenic | 1 | 32 | 72 | 0.252 | |
| Beryllium | 3 | 16 | 17 | 0.478 | |
| Cadmium | 10 | 28 | -109 | 0.032 | |
| Chromium | 16 | 30 | -100 | 0.077 | |
| Chromium IV | 5 | 24 | -15 | 0.72 | |
| Copper | 18 | 21 | -104 | 0.002 | - |
| Diss O2 | 34 | 34 | -107 | 0.116 | |
| Hardness | 34 | 34 | -80 | 0.244 | |
| Iron | | | | No Test Performed | |
| Lead | 10 | 27 | -6 | 0.918 | |
| Manganese | | | | No Test Performed | |
| Mercury | 2 | 32 | 31 | 0.629 | |
| Nickel | 5 | 16 | 16 | 0.506 | |
| Selenium | 3 | 32 | -161 | 0.009 | - |
| Silver | 4 | 31 | 78 | 0.192 | |
| Sulfate | | | | No Test Performed | |
| Sulfide | 0 | 20 | 0 | 1 | |
| TDS | 33 | 33 | -39 | 0.559 | |
| TSS | 21 | 33 | 7 | 0.926 | |
| Zinc | 14 | 34 | -65 | 0.346 | |
| SW-2 | | | | | |
| Conductivity(Field) | 34 | 34 | 108 | 0.113 | |
| pH(Field) | 34 | 34 | -1 | 1 | |
| Aluminum | 30 | 31 | -94 | 0.114 | |
| Arsenic | 3 | 32 | -91 | 0.145 | |
| Beryllium | 8 | 20 | -45 | 0.155 | |
| Cadmium | 6 | 27 | -12 | 0.82 | |
| Chromium | 19 | 32 | -26 | 0.688 | |
| Chromium IV | 5 | 24 | -2 | 0.98 | |
| Copper | 15 | 33 | -173 | 0.007 | - |
| Diss O2 | 34 | 34 | -97 | 0.156 | |
| Hardness | 34 | 34 | -40 | 0.566 | |
| Iron | | | | No Test Performed | |
| Lead | 14 | 27 | 35 | 0.482 | |
| Manganese | | | | No Test Performed | |
| Mercury | 2 | 18 | -53 | 0.048 | |
| Nickel | 5 | 16 | 41 | 0.071 | |
| Selenium | 2 | 32 | 45 | 0.478 | |
| Silver | 3 | 32 | -30 | 0.64 | |
| Sulfate | | | | No Test Performed | |
| Sulfide | 0 | 20 | 0 | 1 | |
| TDS | 33 | 33 | -123 | 0.058 | |
| TSS | 21 | 33 | 84 | 0.2 | |
| Zinc | 16 | 18 | 59 | 0.026 | |

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

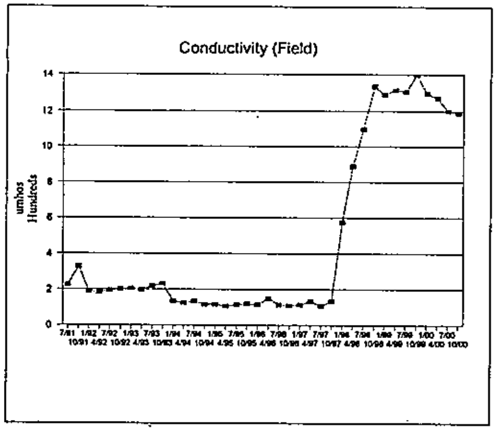
(*) If the value of a sample is below the detection limit, three situations apply:
1) If the detection limit is equal to or less than the minimum detected value, the result is replaced with zero.
2) If the detection limit is greater than the minimum detected value, but less than or equal to two times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

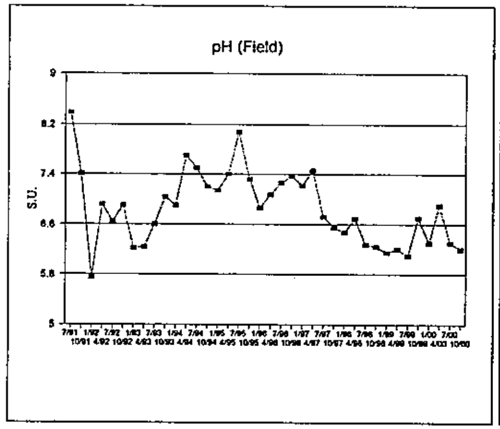
# Attachment 1

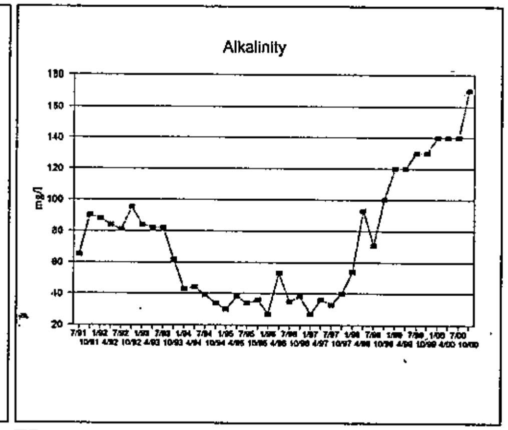
# Trend Graphs (Groundwater)

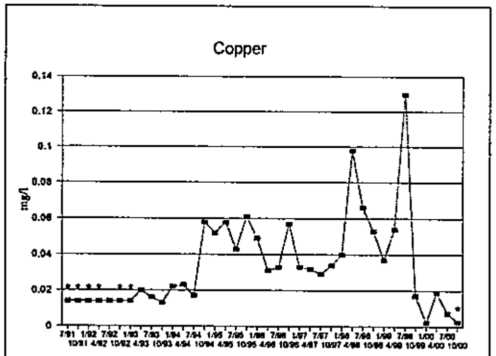
# Flambeau Mining Company
# Groundwater Quality Results

## MW-1000P-R

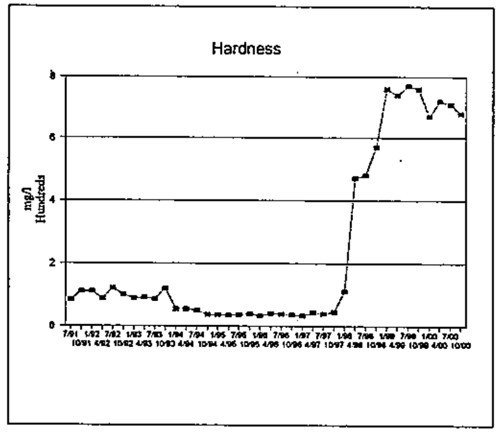


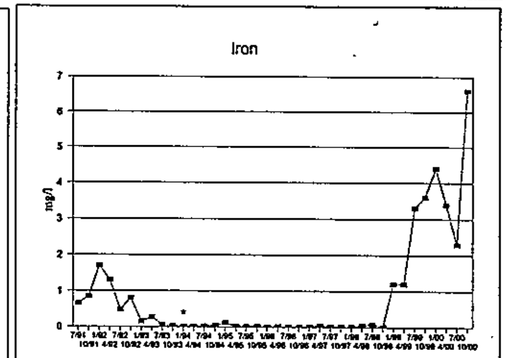



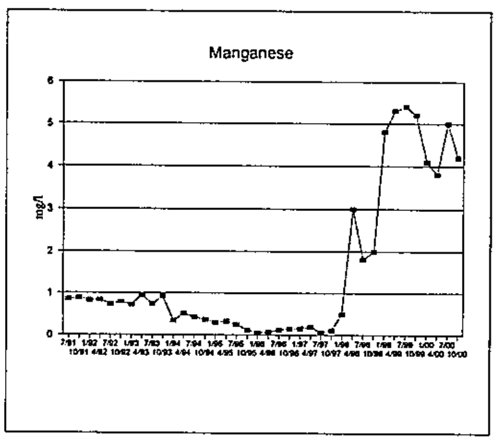



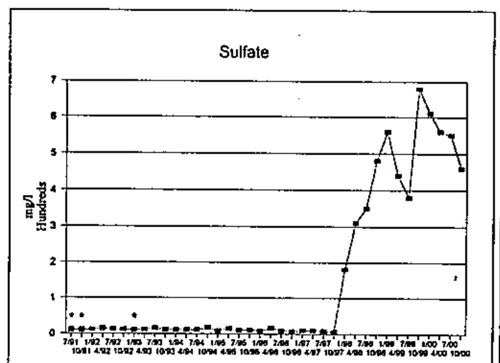

* Compound Not Detected, Value = Detection Limit



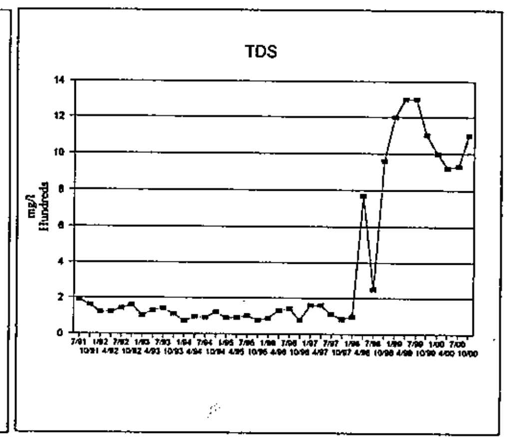




* Compound Not Detected, Value = Detection Limit



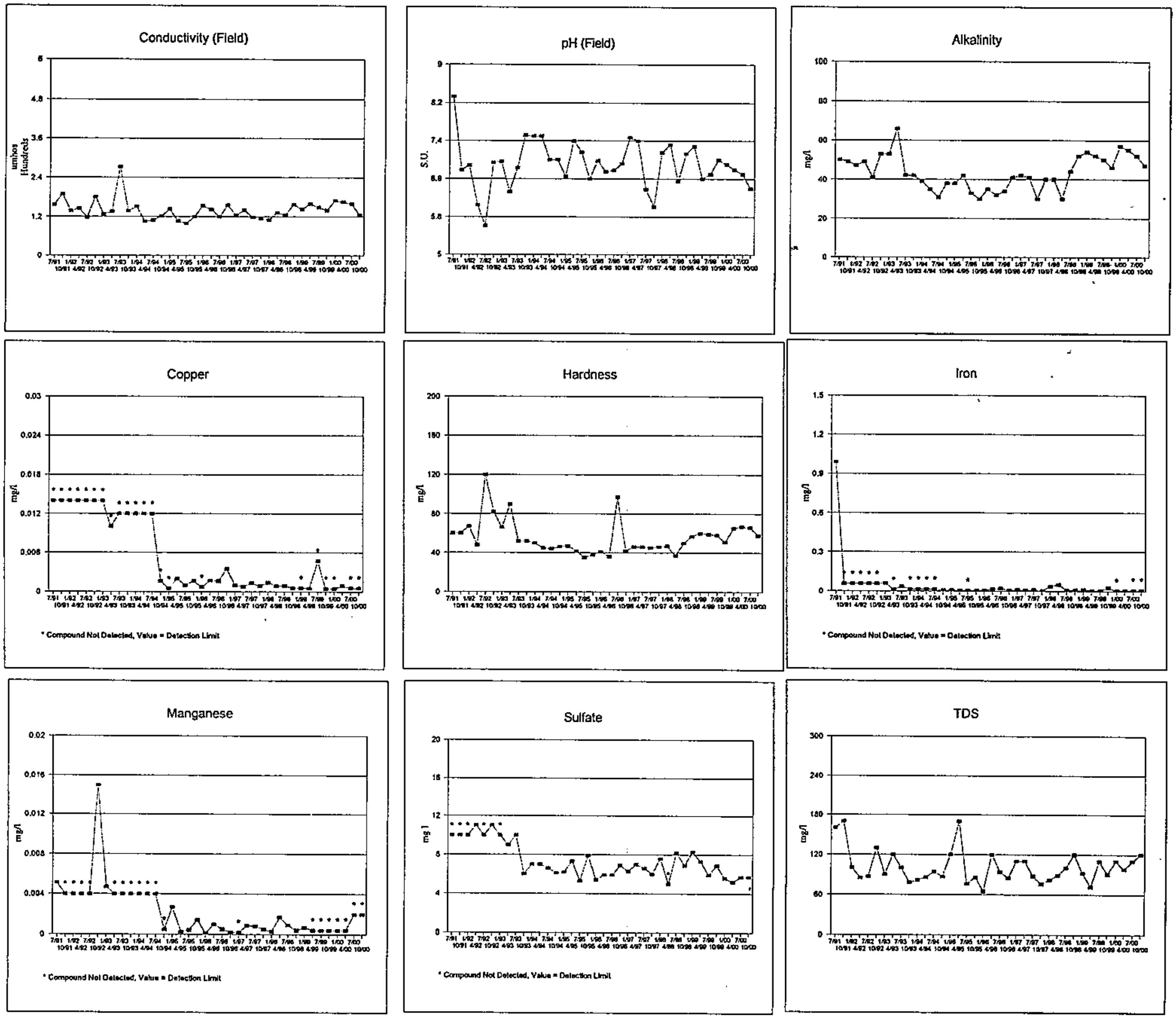

* Compound Not Detected, Value = Detection Limit




Prepared By: SGL Checked By: JBH1

# Flambeau Mining Company
# Groundwater Quality Results

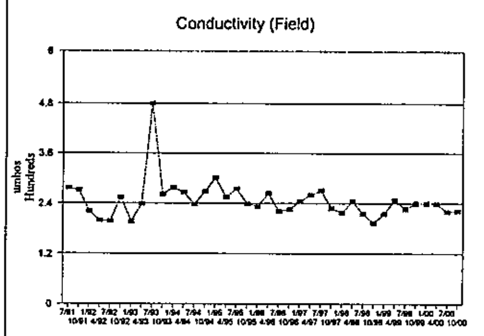
## MW-1002

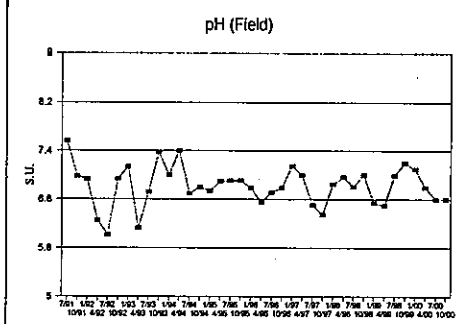


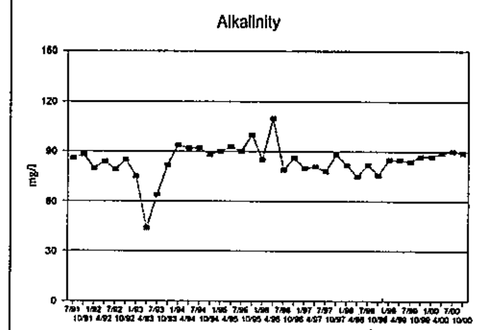

Prepared By: SGL Checked By: JBH1

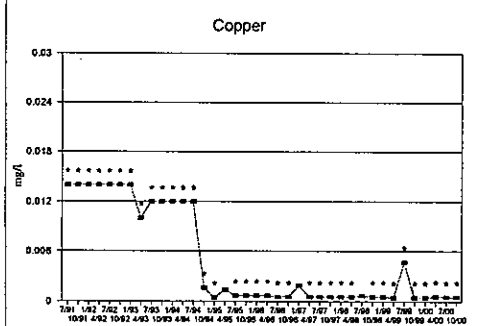
# Flambeau Mining Company
# Groundwater Quality Results

## MW-1002G

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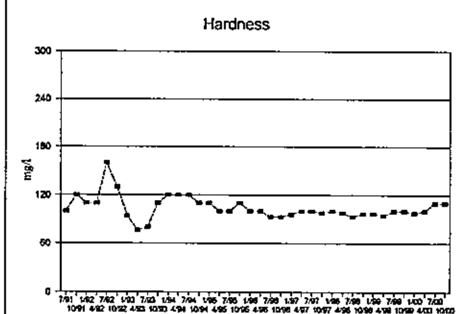


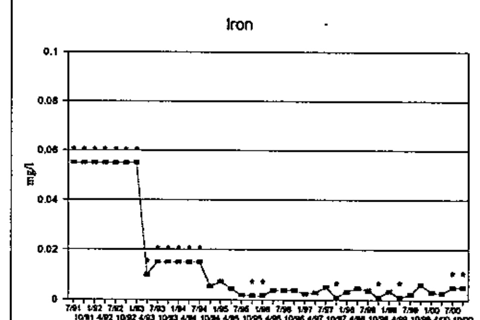


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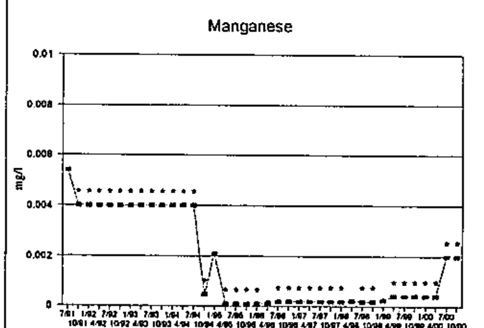


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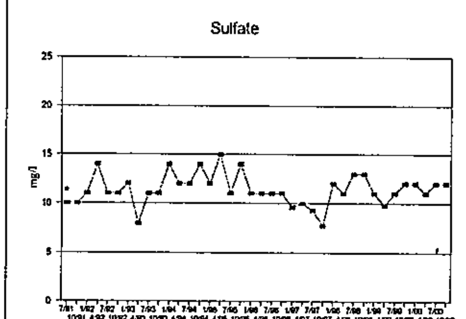


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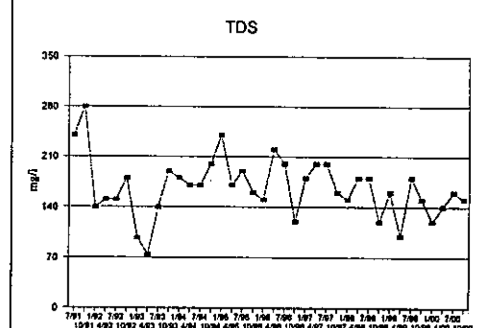
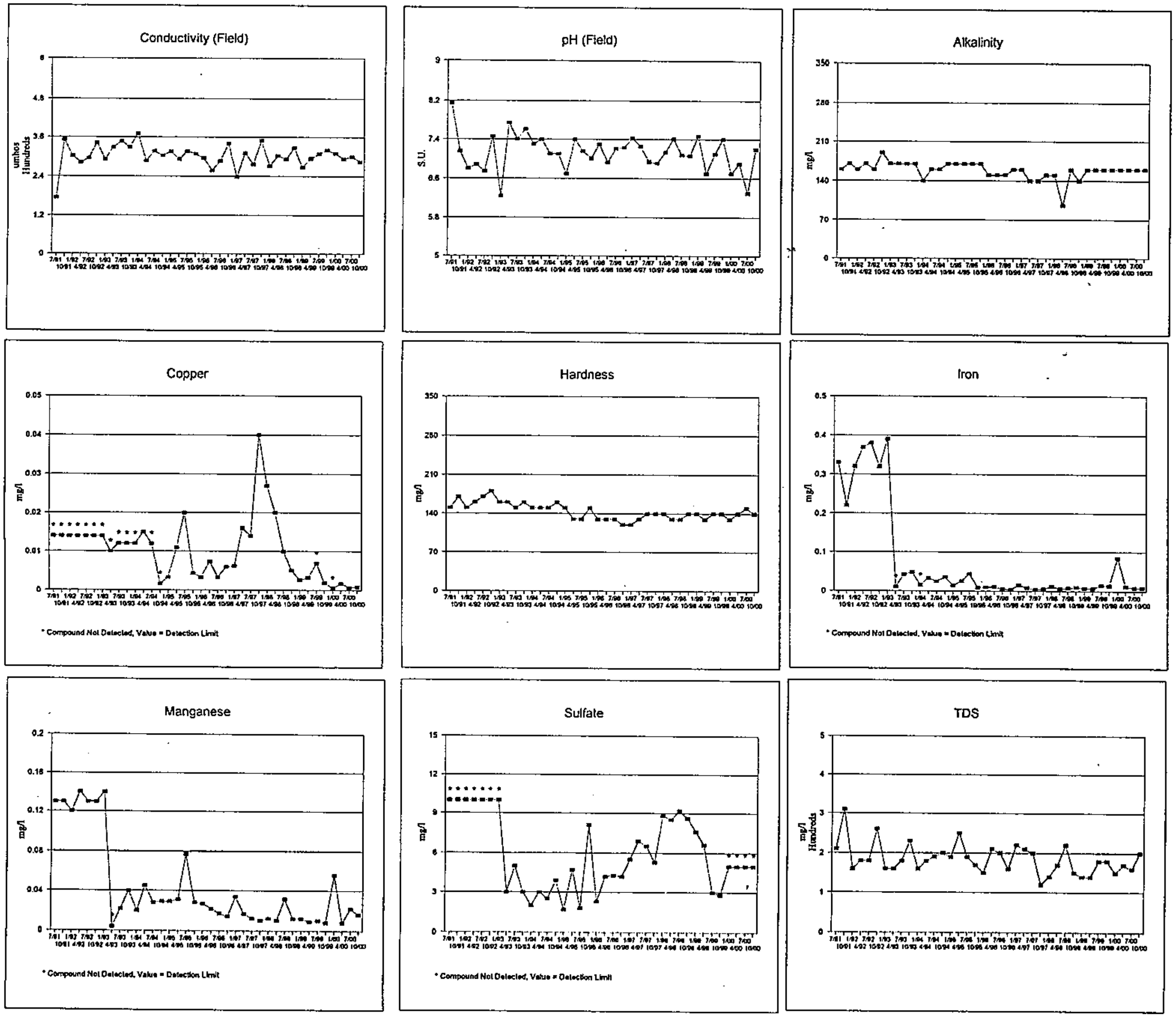



Prepared By: SGL Checked By: JBH1

# Flambeau Mining Company
# Groundwater Quality Results

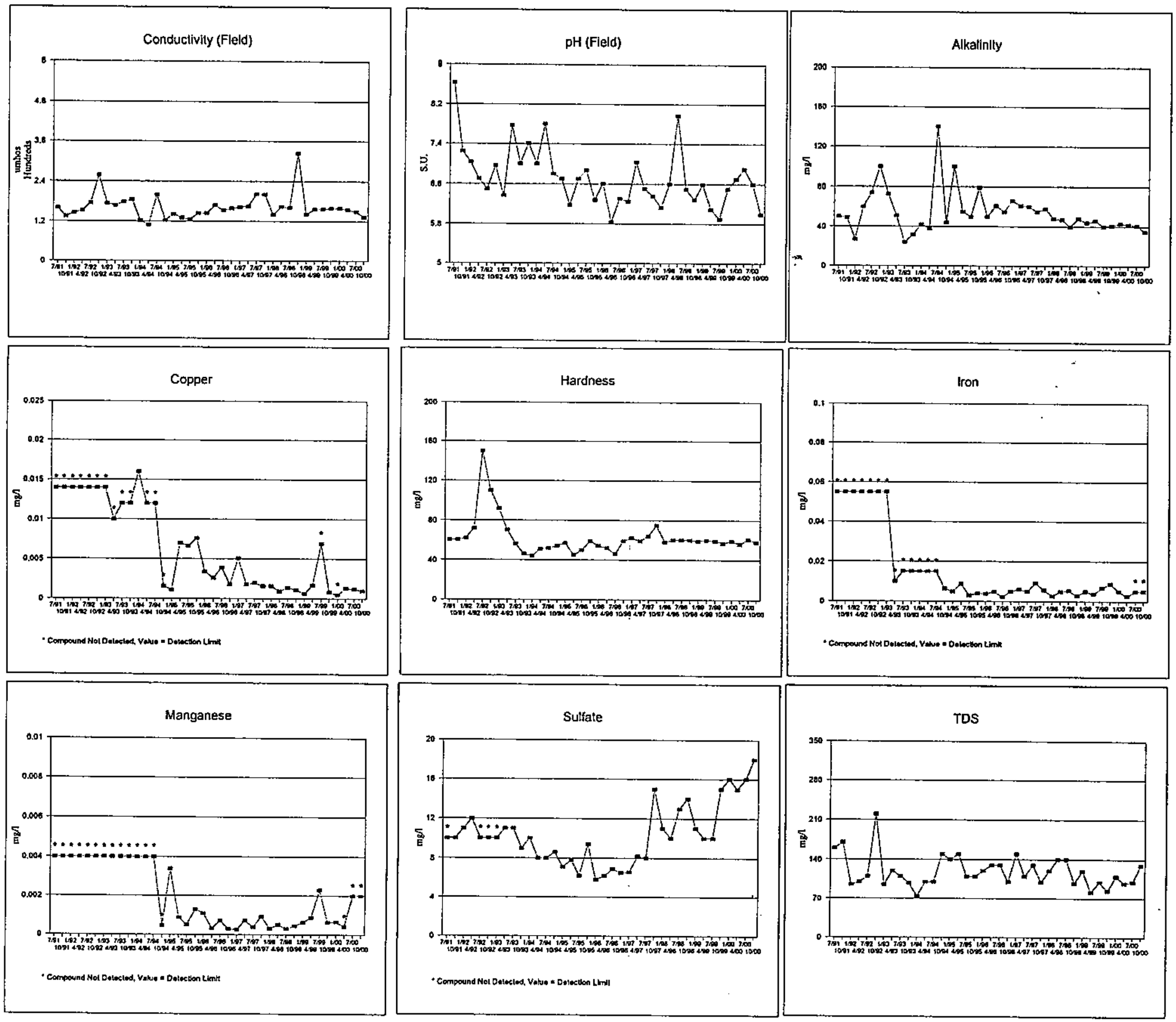
## MW-1004P




Prepared By: SGL Checked By: JBH1

# Flambeau Mining Company
# Groundwater Quality Results

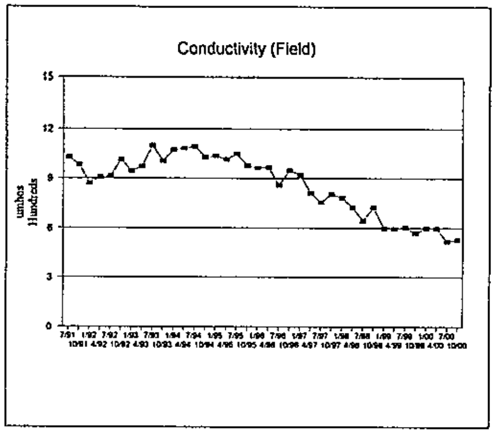
## MW-1004S

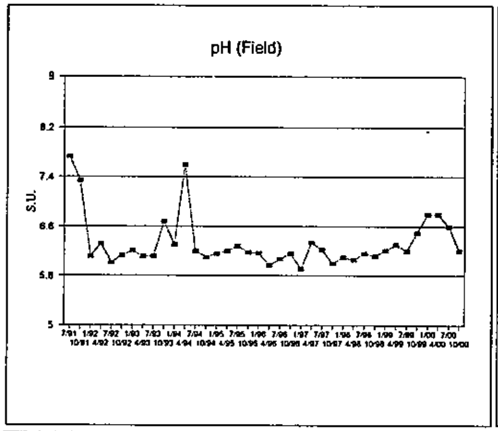


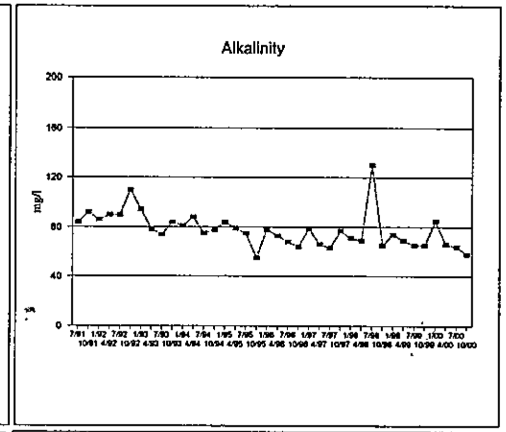

Prepared By: SGL Checked By: JBH1

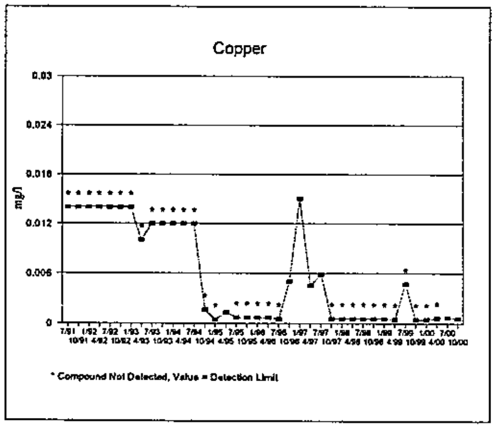
# Flambeau Mining Company
# Groundwater Quality Results

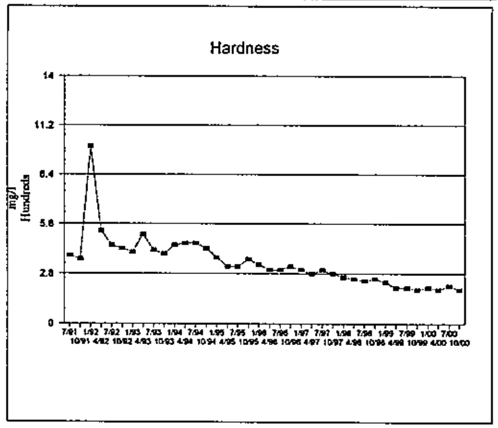
## MW-1005

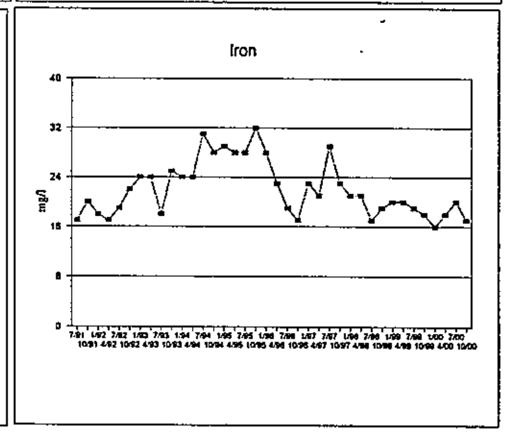


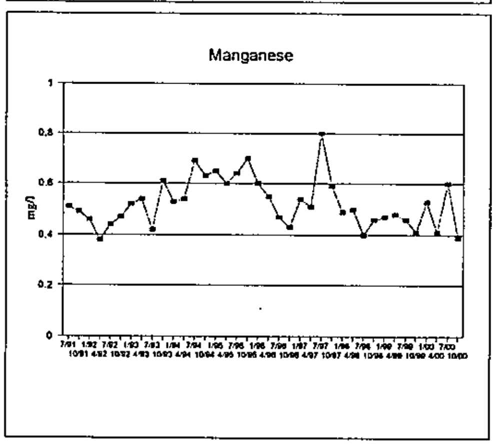



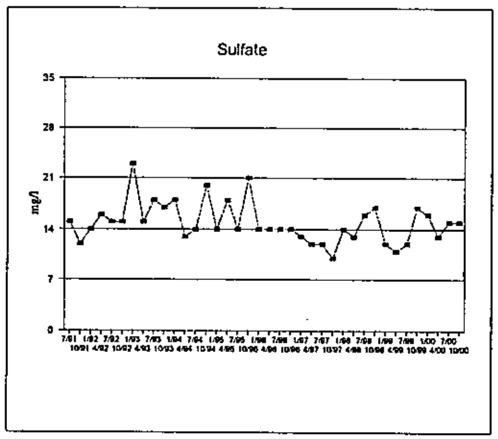



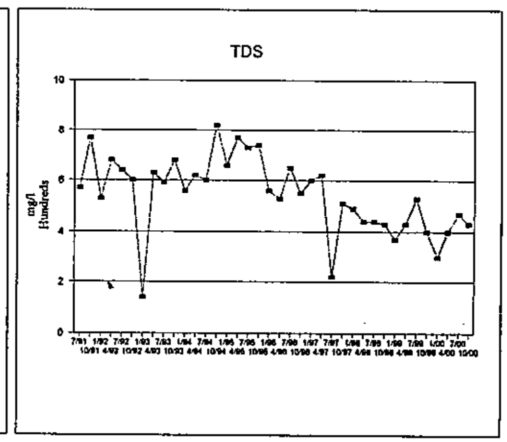



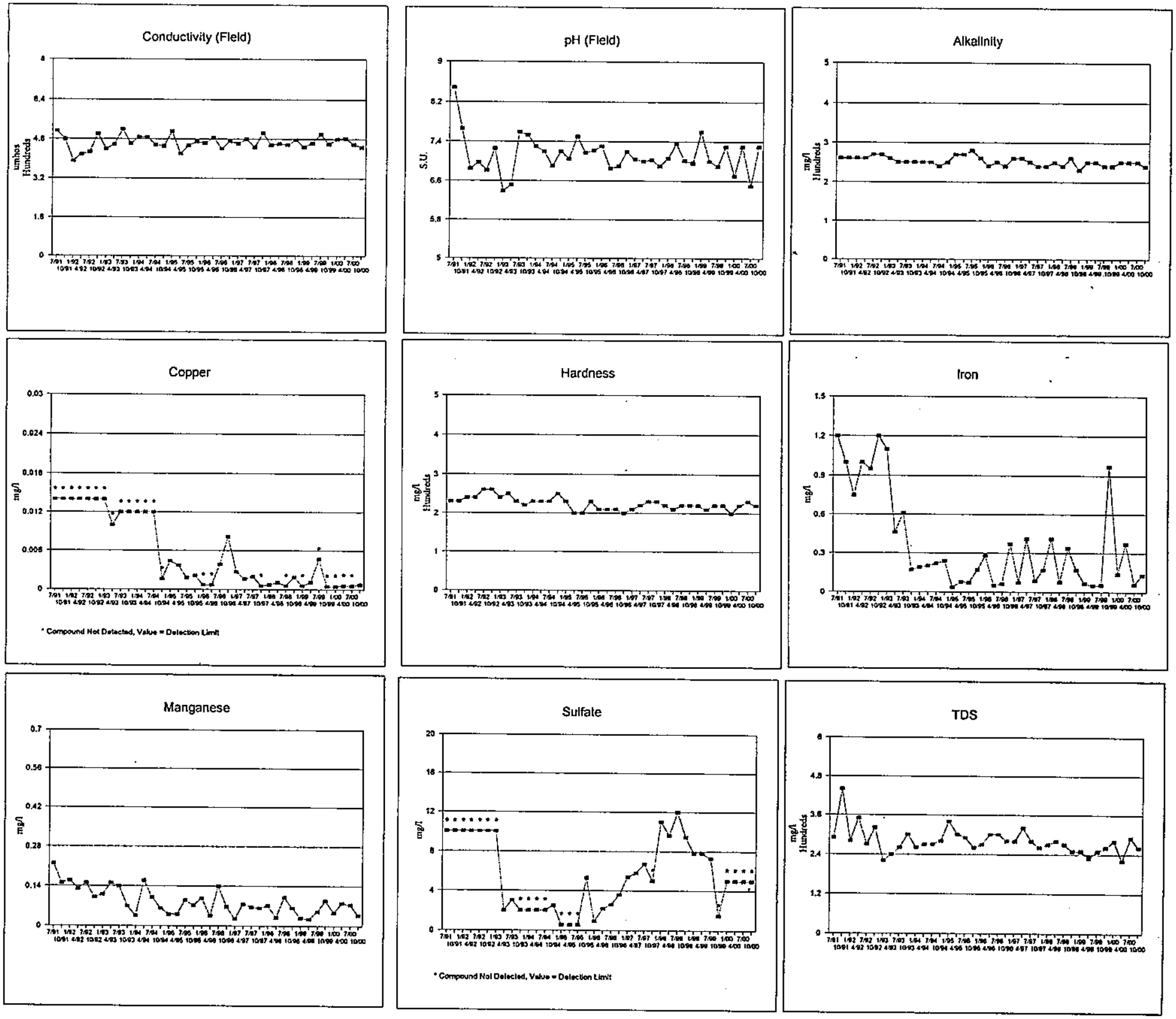




Prepared By: SGL Checked By: JBH1

# Flambeau Mining Company
# Groundwater Quality Results

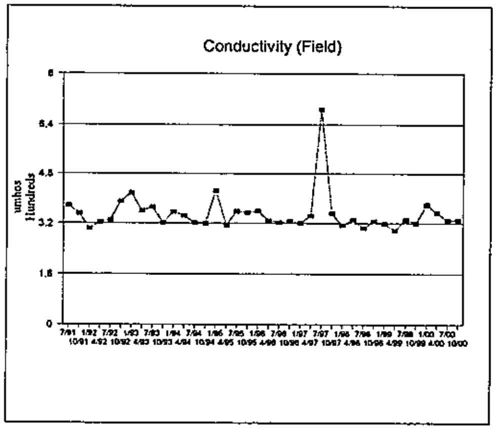
## MW-1005P

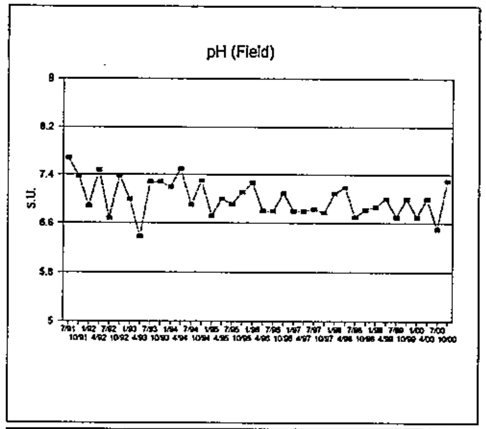


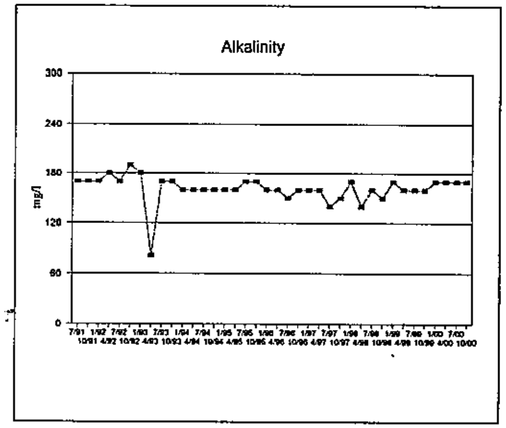

Prepared By: SGL Checked By: JBH1

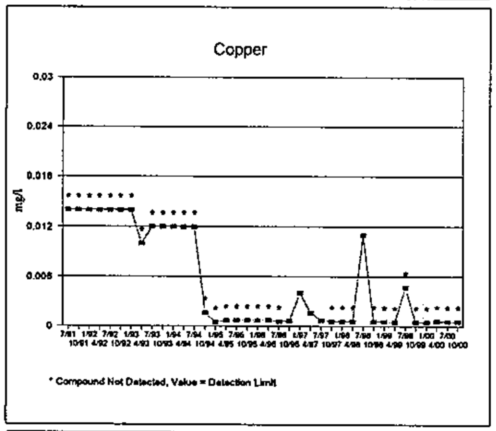
Flambeau Mining Company
Groundwater Quality Results

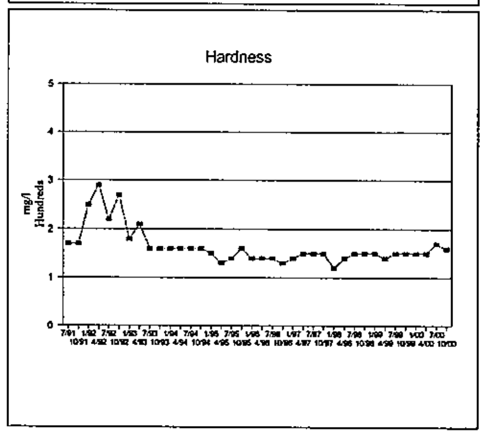
MW-1005S

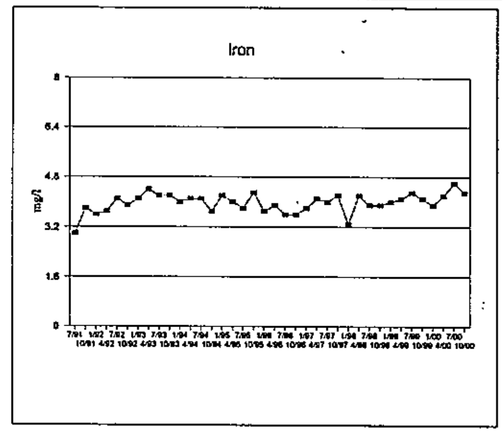


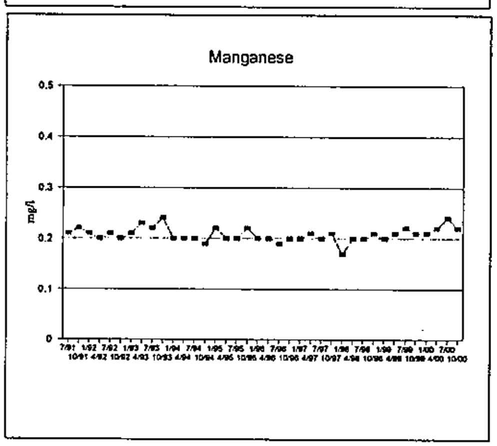



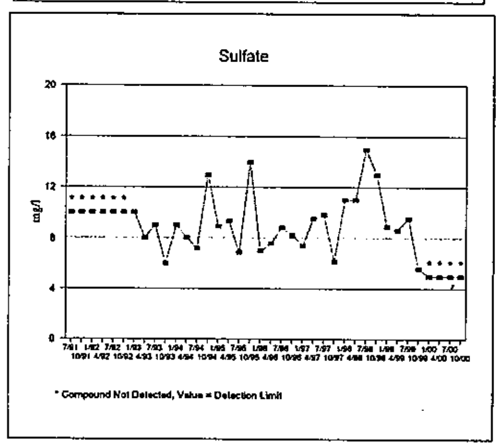



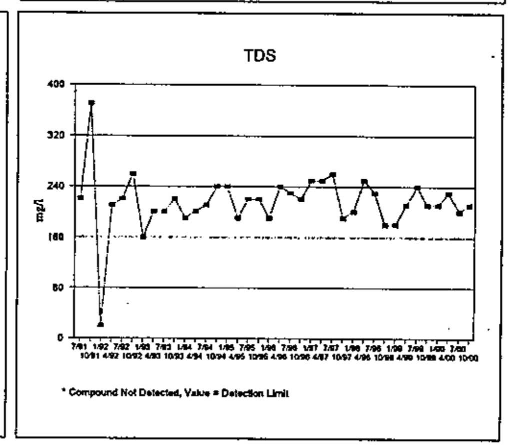



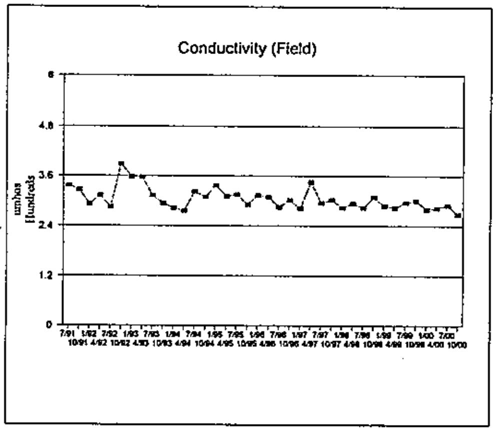



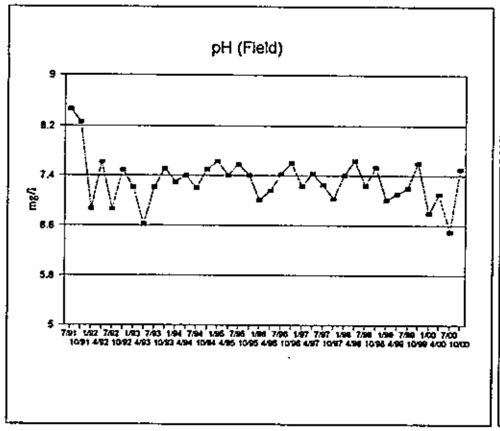



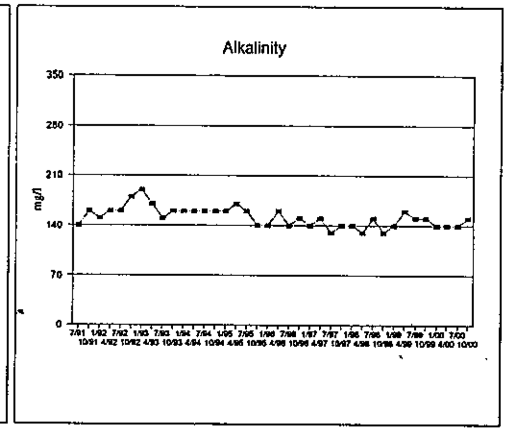

Prepared By: SGL Checked By: JBH1

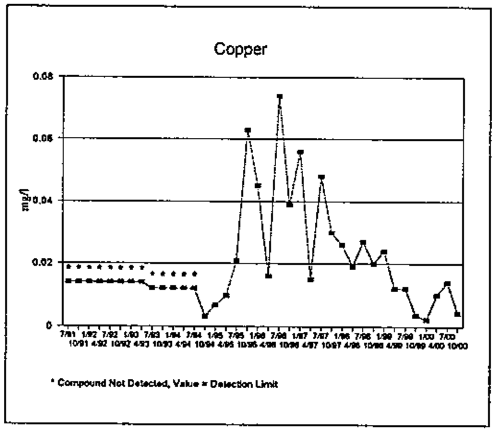
Flambeau Mining Company
Groundwater Quality Results

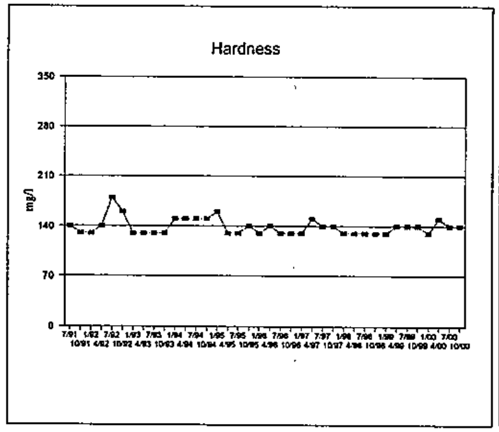
MW-1010P

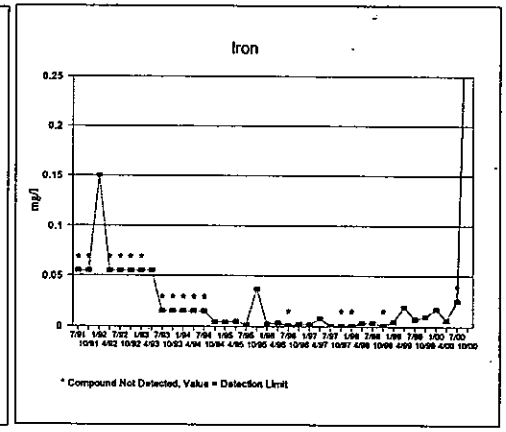


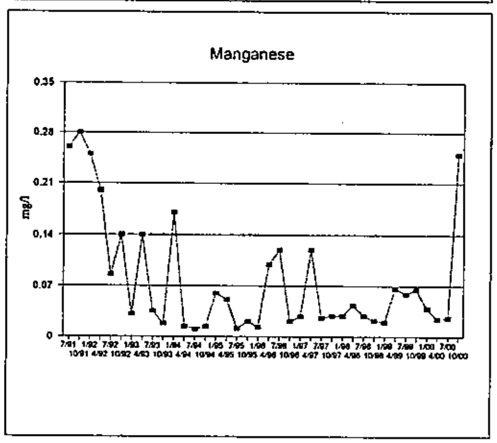



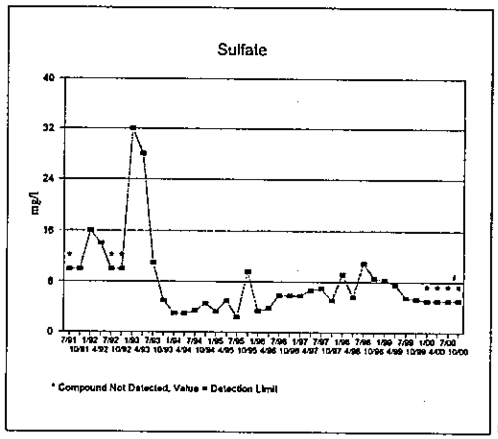



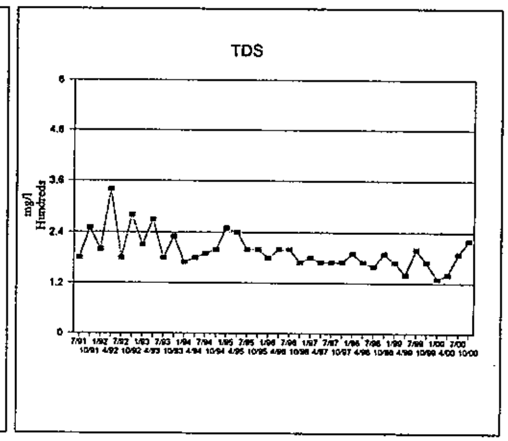



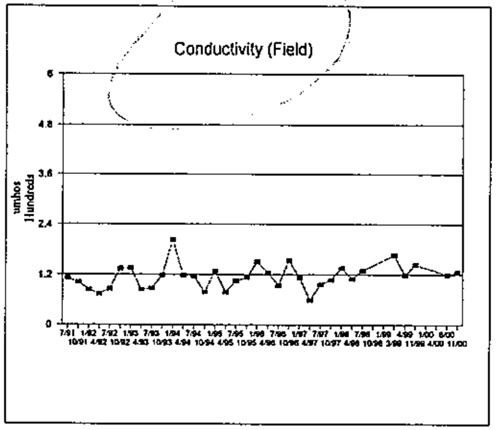

Prepared By: SGL Checked By: JBH1

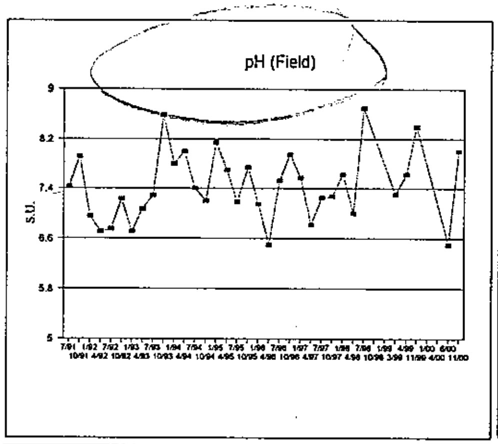
# Attachment 2

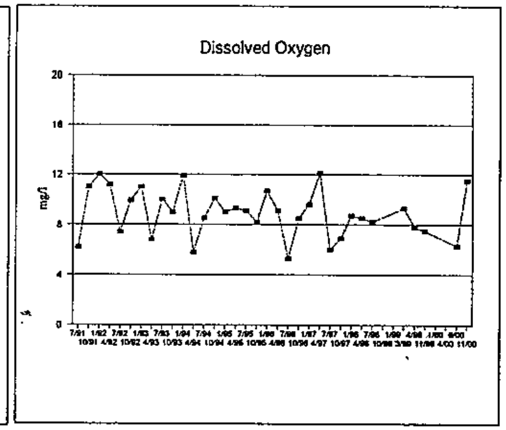
## Surface Water Trend Plots

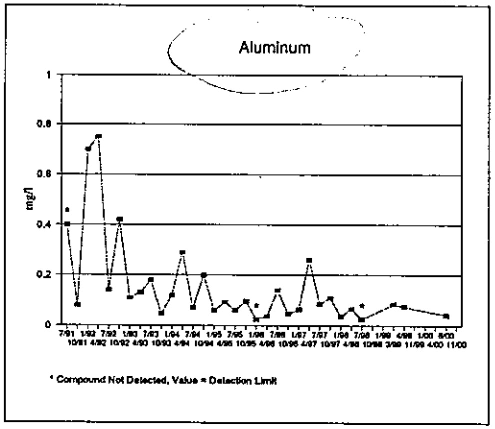
# Flambeau Mining Company
# Surface Water Quality Results

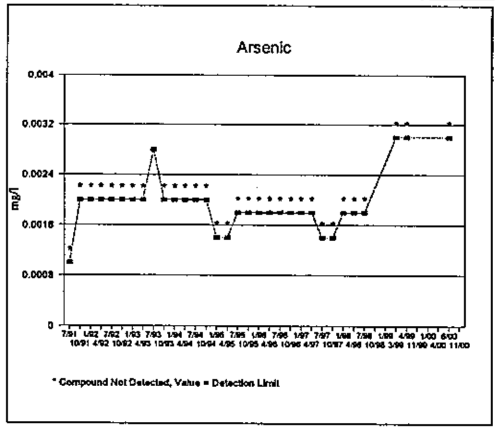
## SW-1 (Upstream)

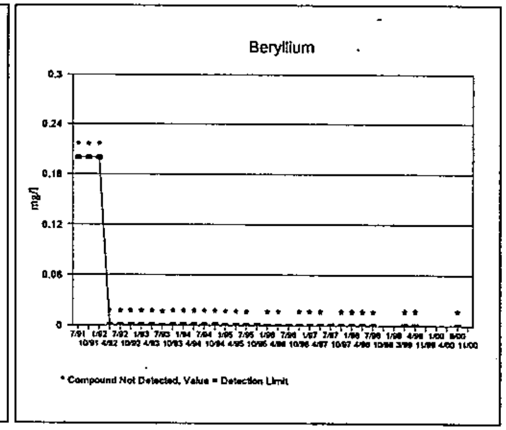


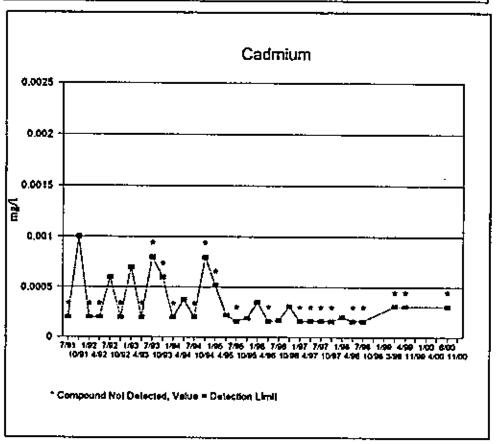



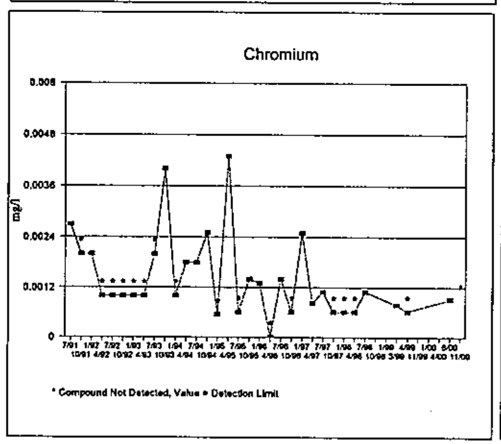



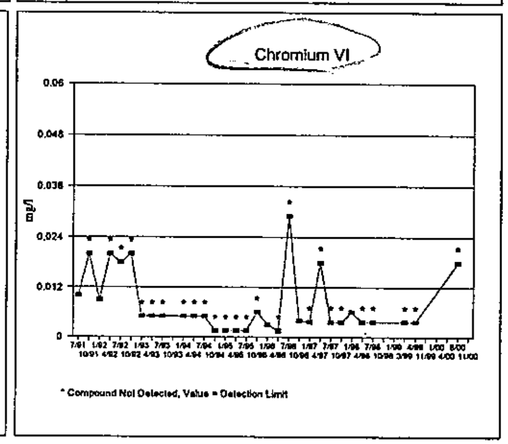



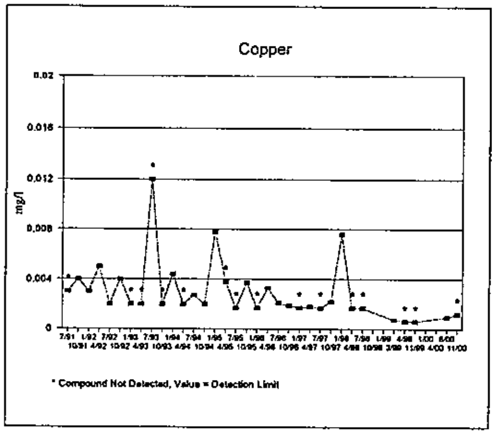



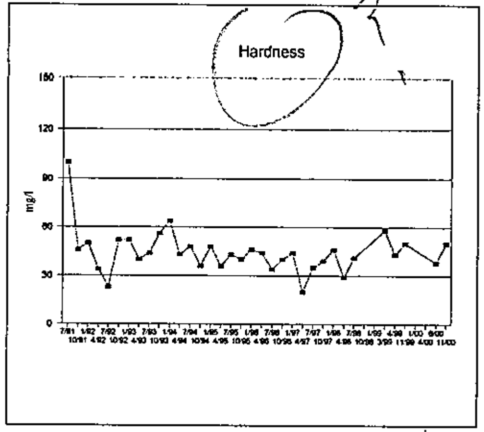



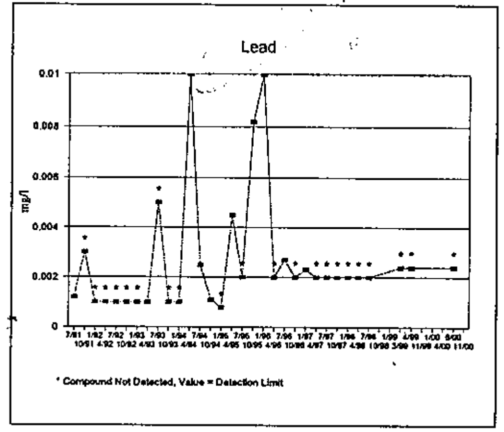

Prepared By: SGL Checked By: JBH1

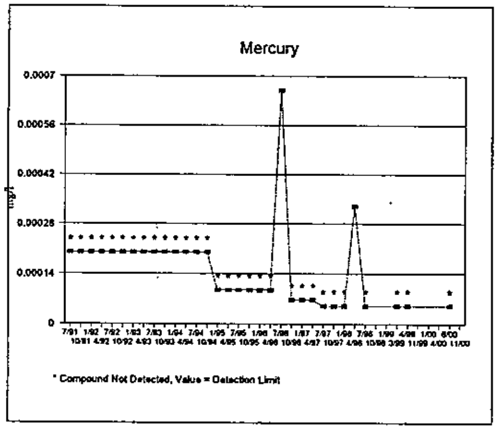
# Flambeau Mining Company
# Surface Water Quality Results

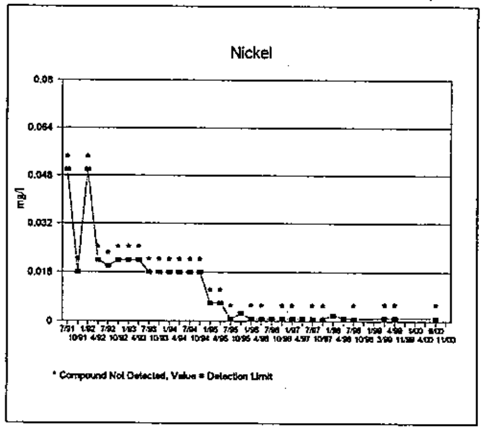
## SW-1 (Upstream)

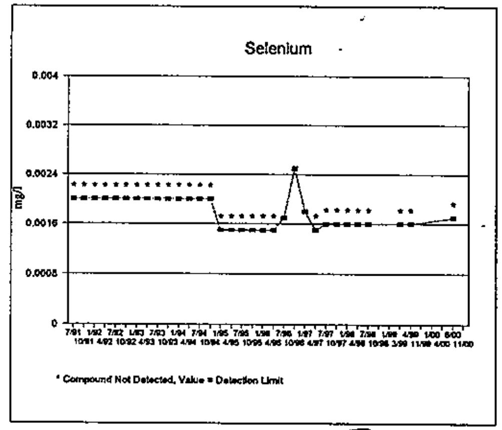


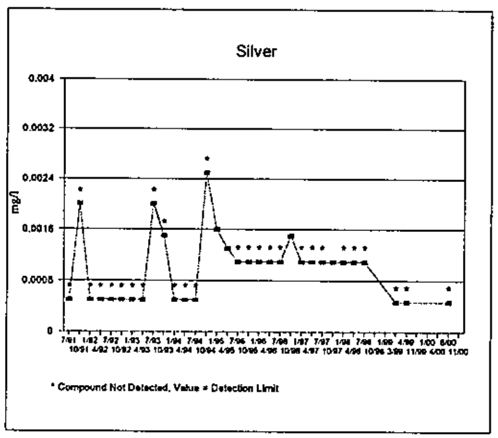



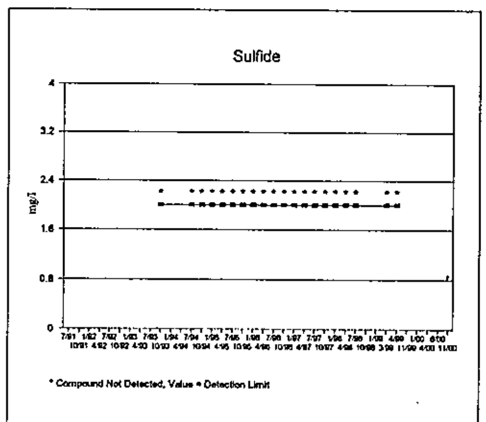



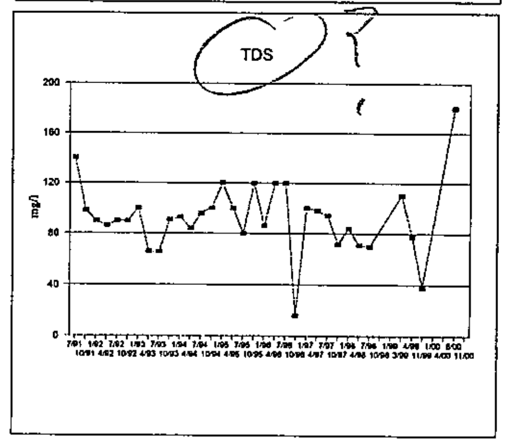



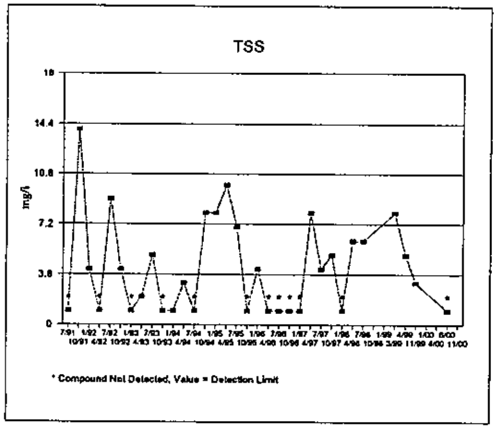



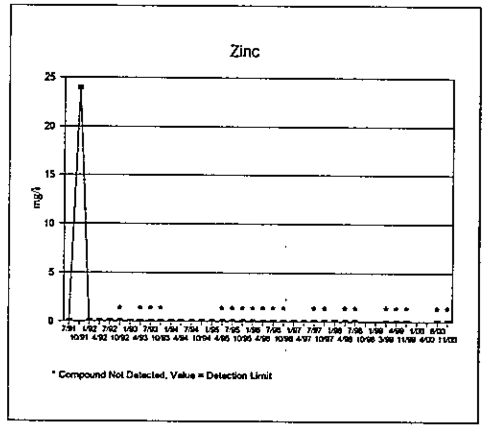




Prepared By: SGL Checked By: JBH1

Flambeau Mining Company
Surface Water Quality Results

SW-1 (Upstream)

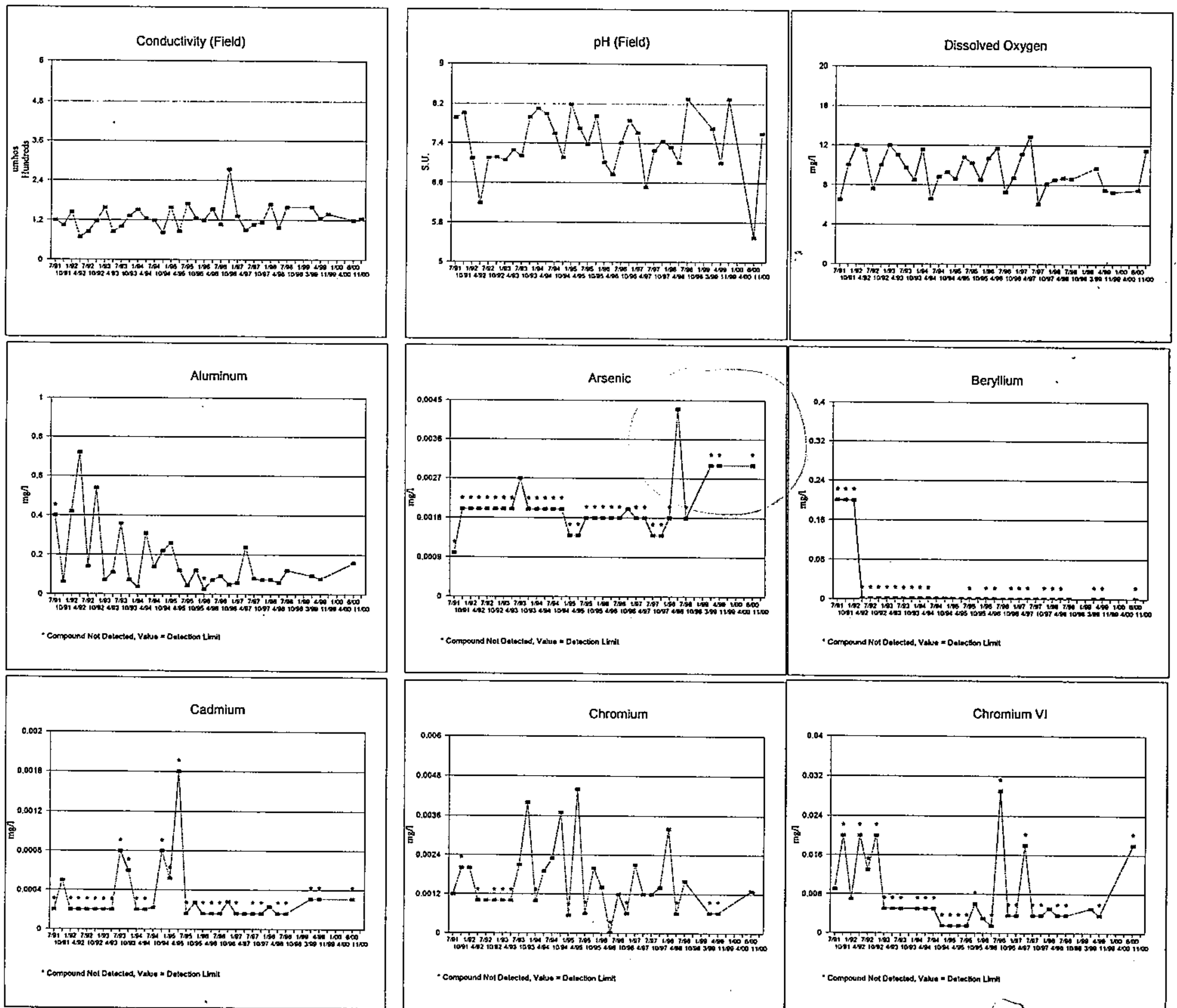



Prepared By: SGL Checked By: JBH1

# Flambeau Mining Company
# Surface Water Quality Results

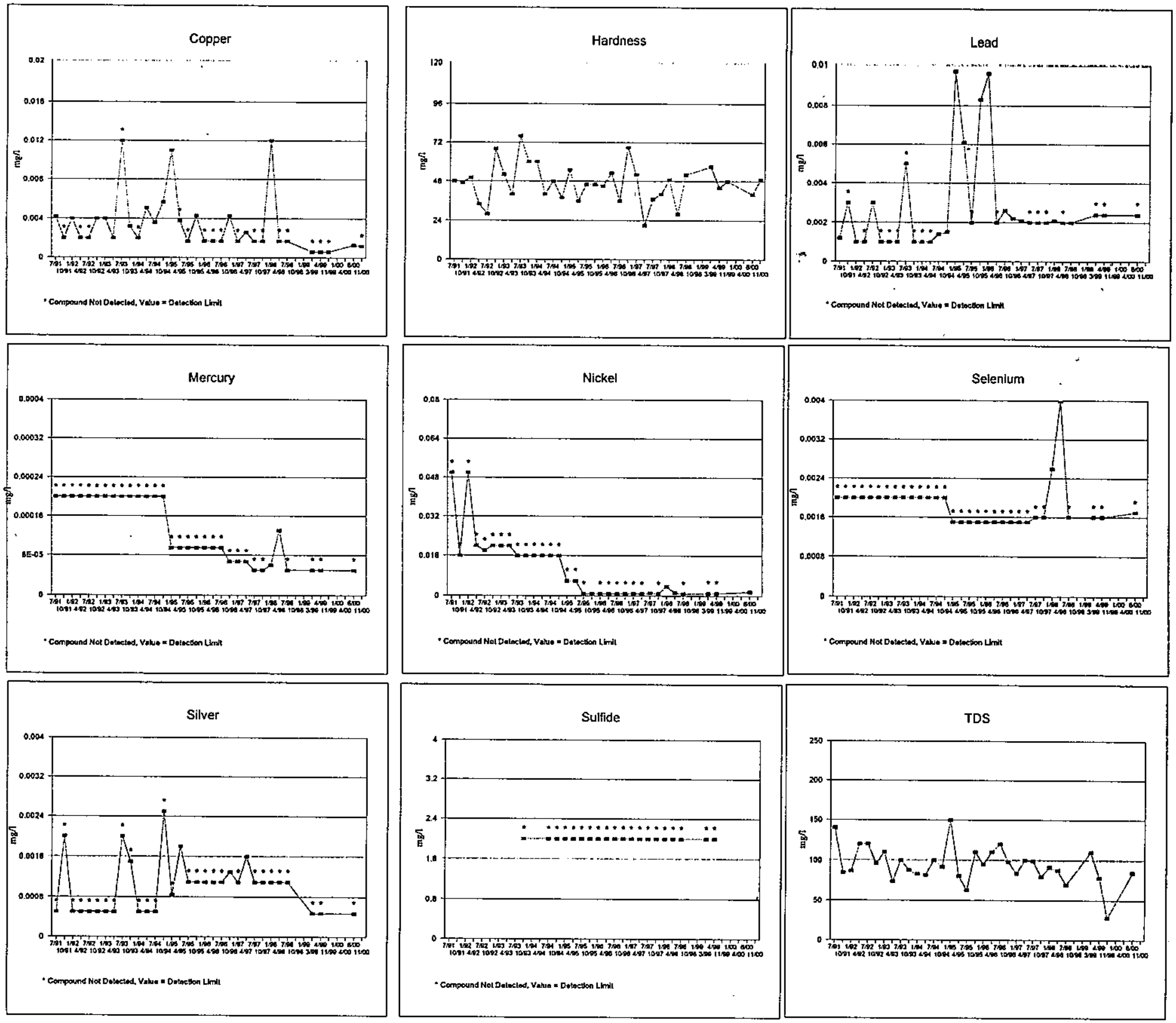
## SW-2 (Downstream)




Prepared By: SGL Checked By: JBH1

# Flambeau Mining Company
# Surface Water Quality Results

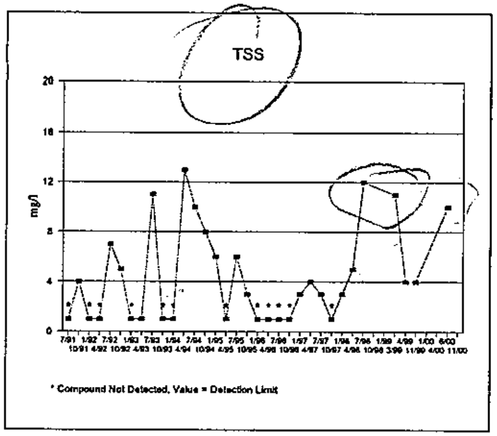
## SW-2 (Downstream)

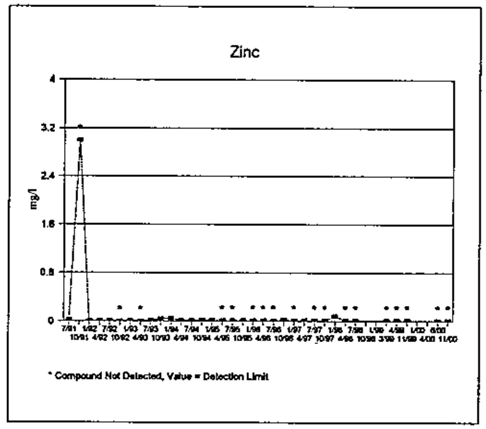



Prepared By: SGL Checked By: JBH1

# Flambeau Mining Company
# Surface Water Quality Results

## SW-2 (Downstream)



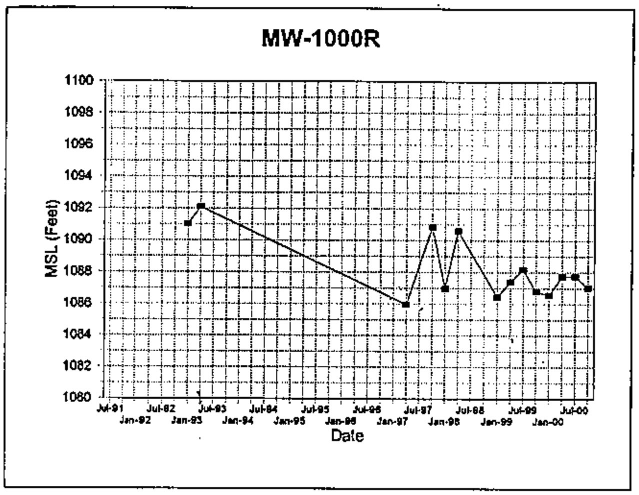

Prepared By: SGL Checked By: JBH1

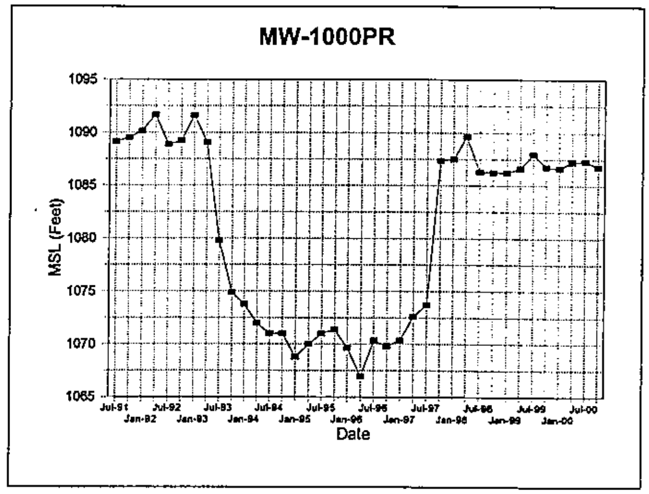
# Attachment 3

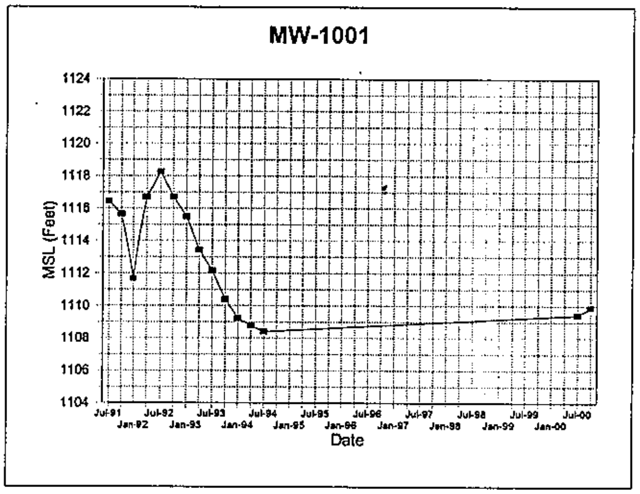
# Hydrographs

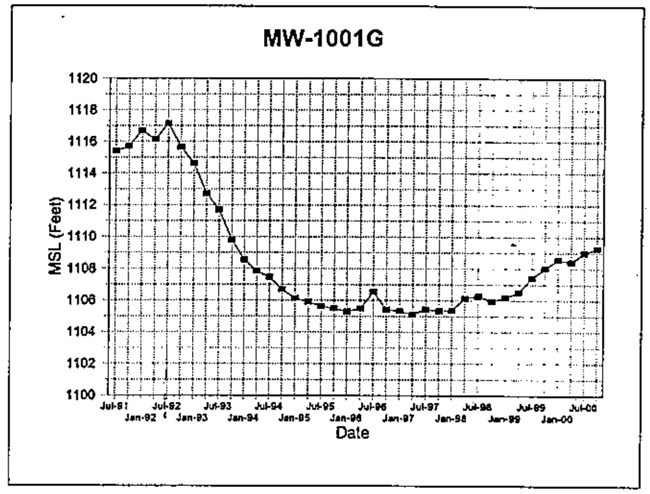
# Flambeau Mining Company

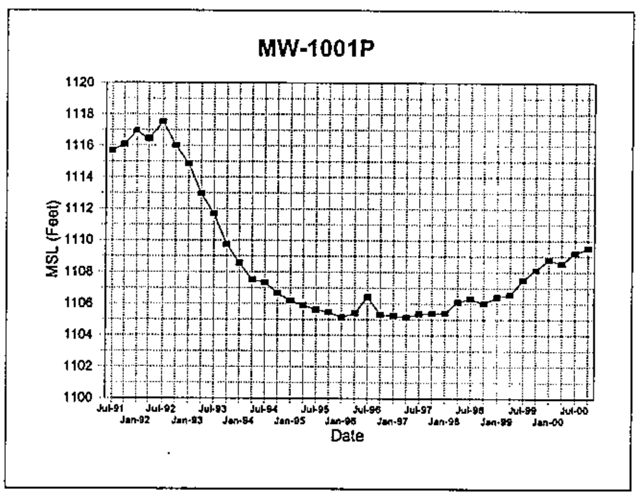
## Groundwater Elevation Results

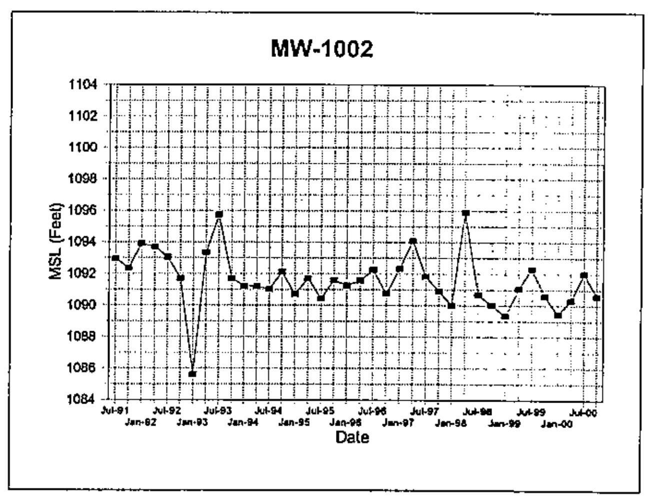


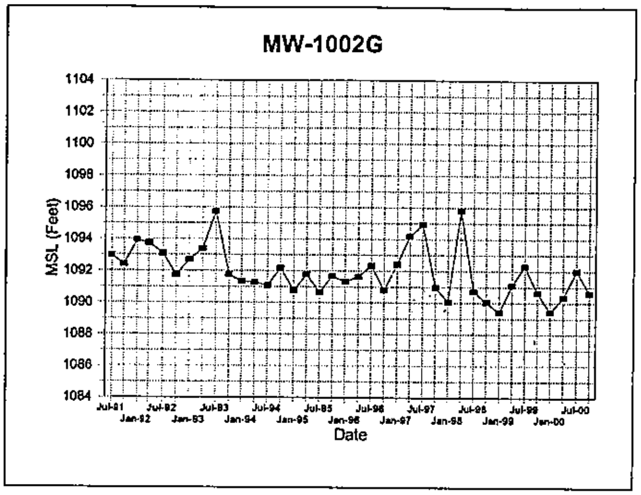



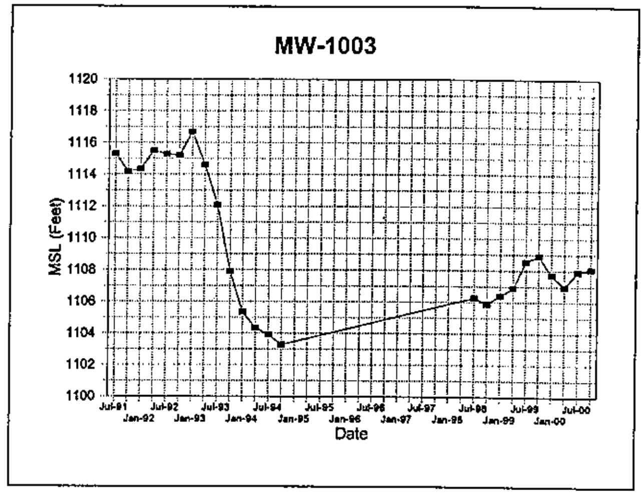



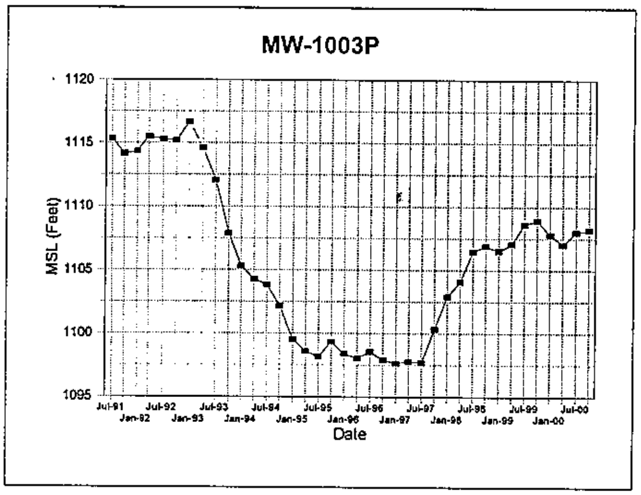


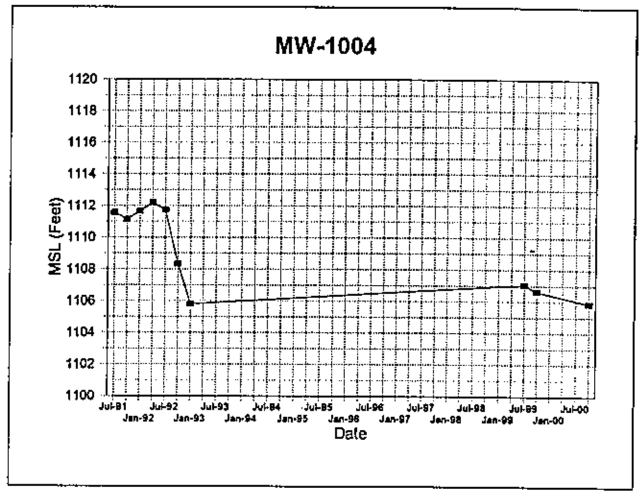

Prepared By: SGL Checked By: JBH1

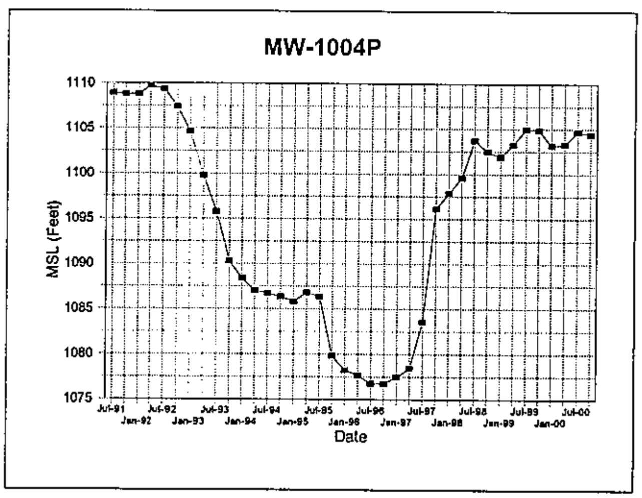
# Groundwater Elevation Results

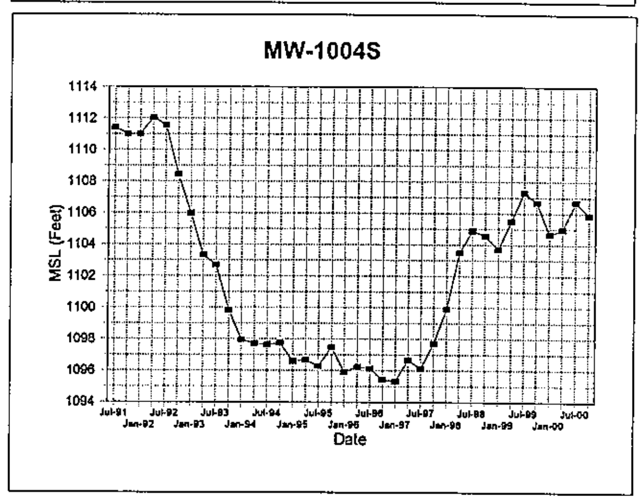


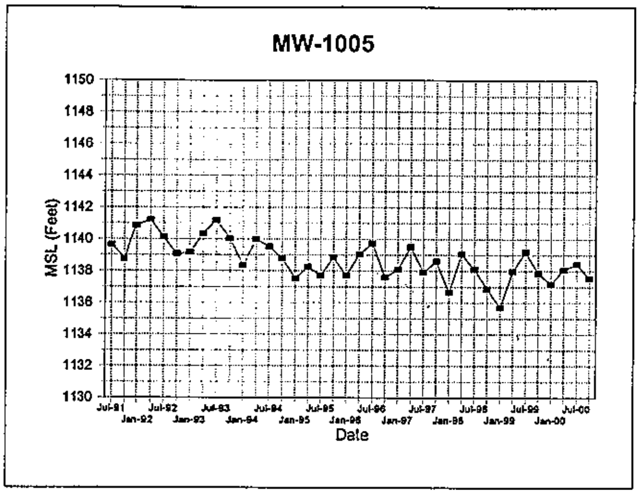



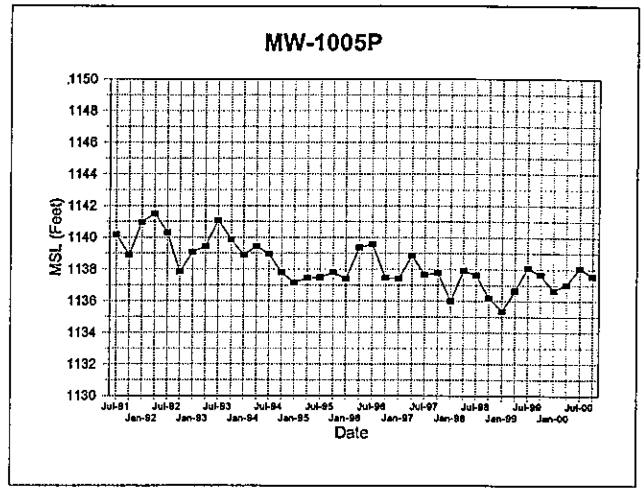


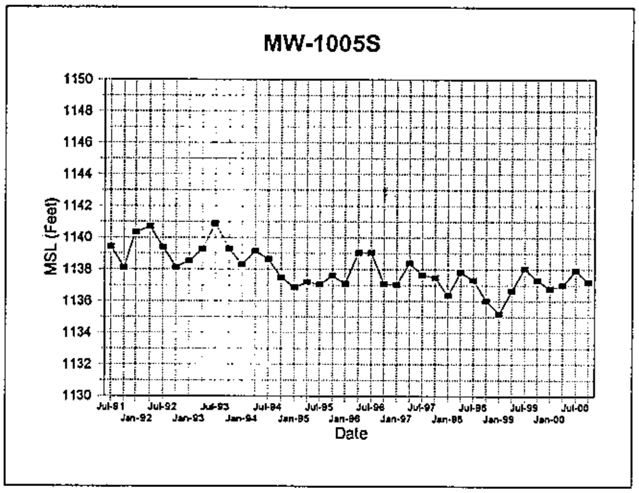

Prepared By: SGL Checked By: JBH1

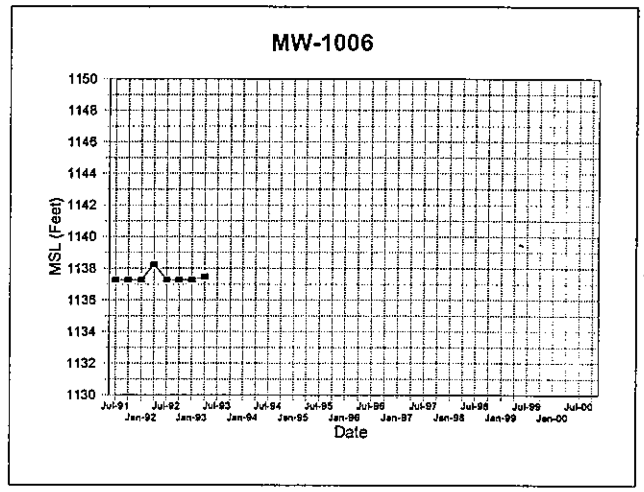
# Flambeau Mining Company

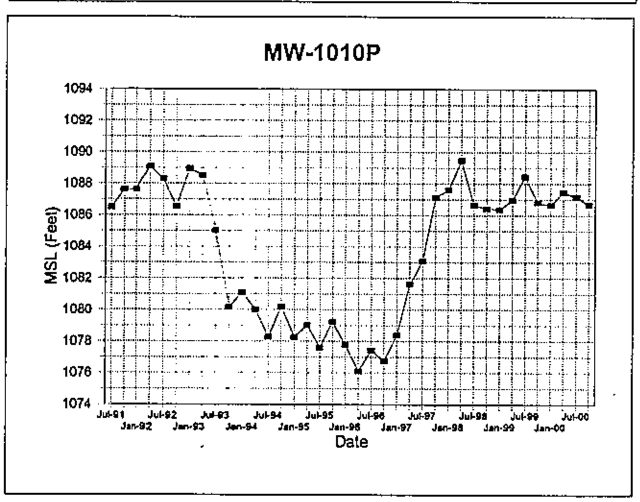
## Groundwater Elevation Results

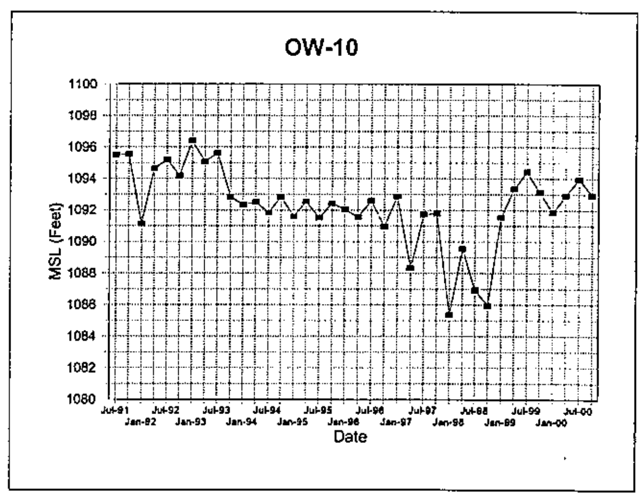


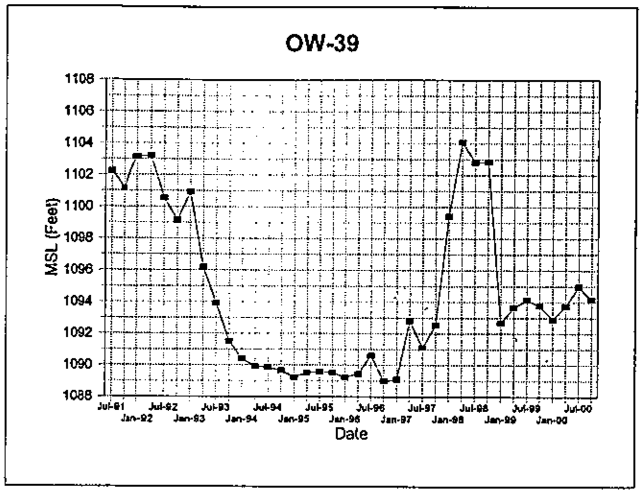



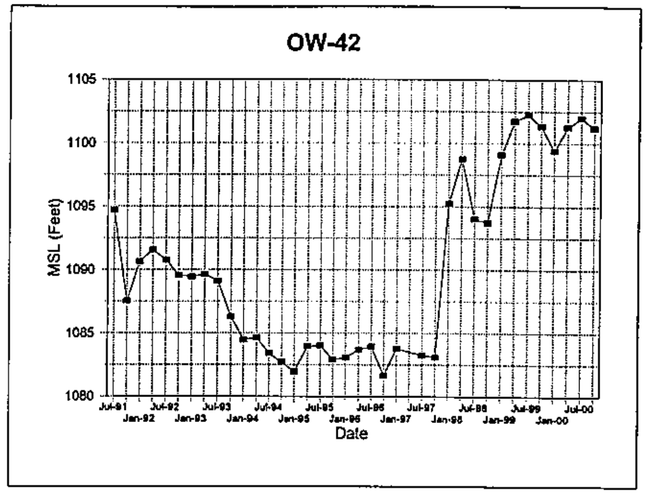


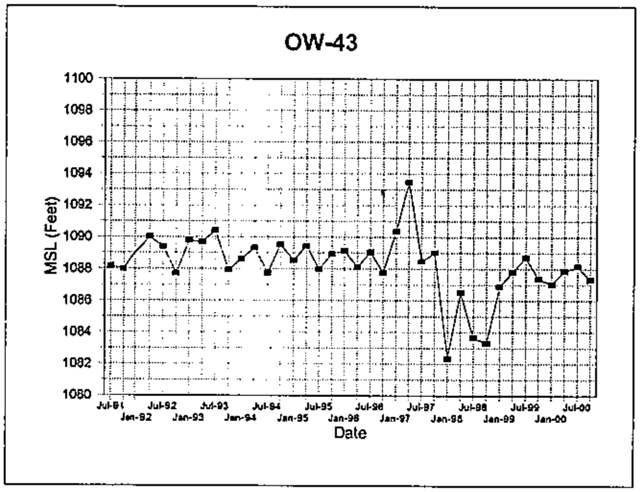

Prepared By: SGL Checked By: JBH1

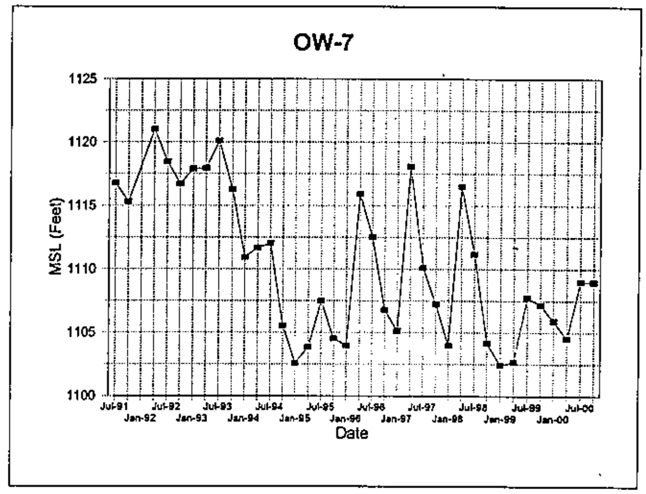
# Flambeau Mining Company

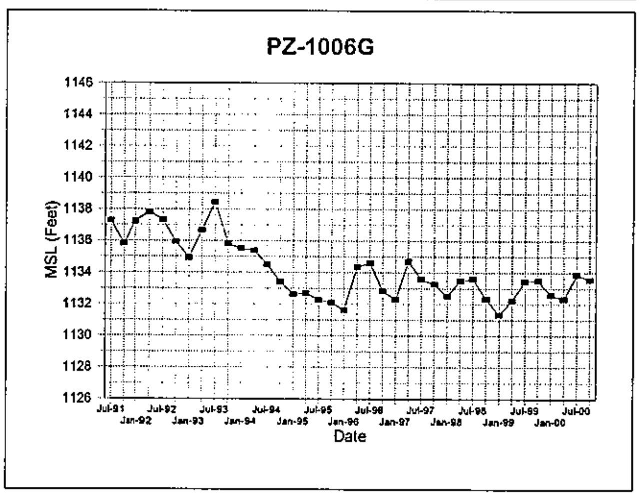
## Groundwater Elevation Results

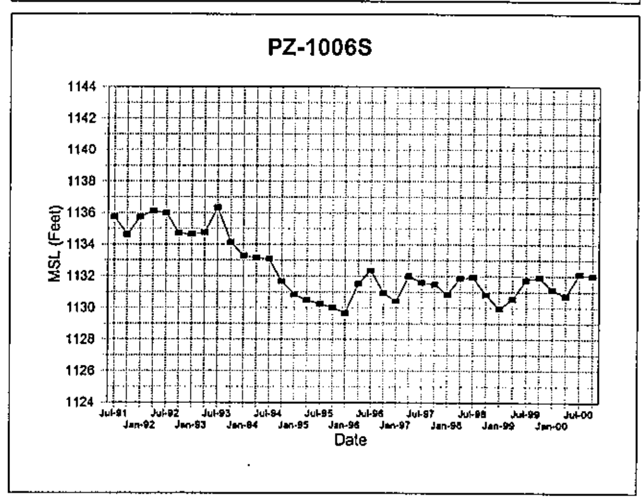


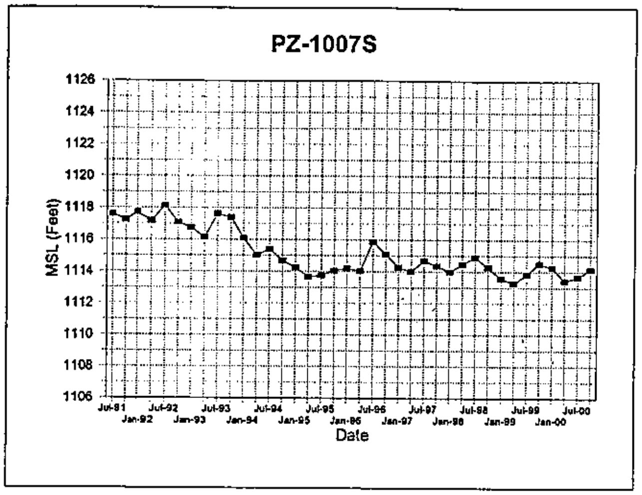



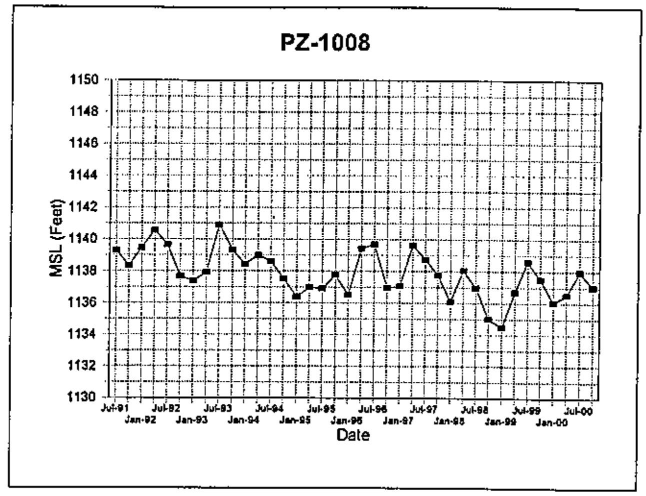


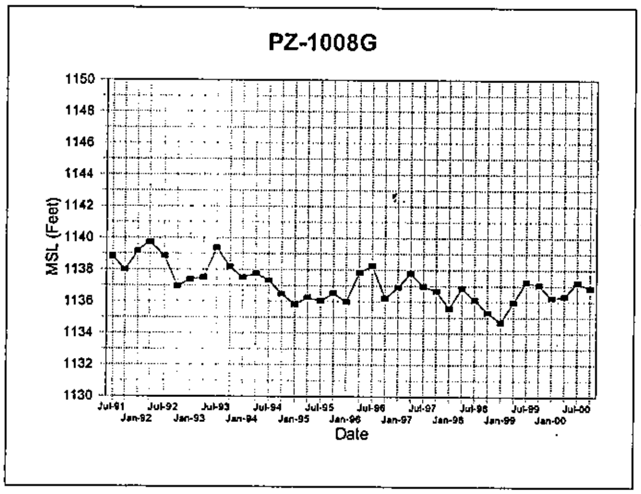

Prepared By: SGL Checked By: JBH1

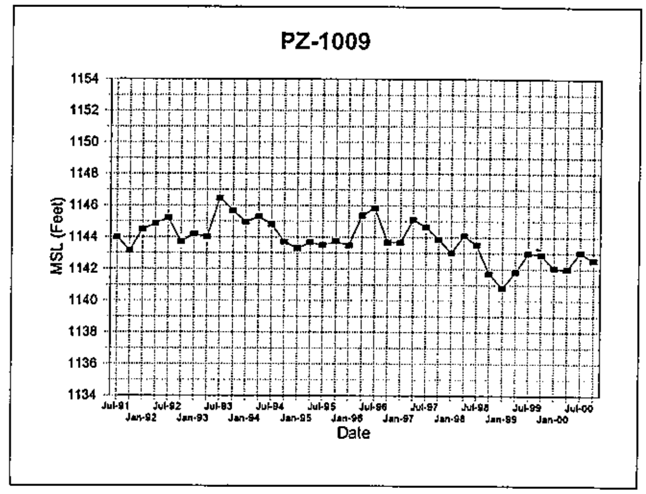
# Flambeau Mining Company

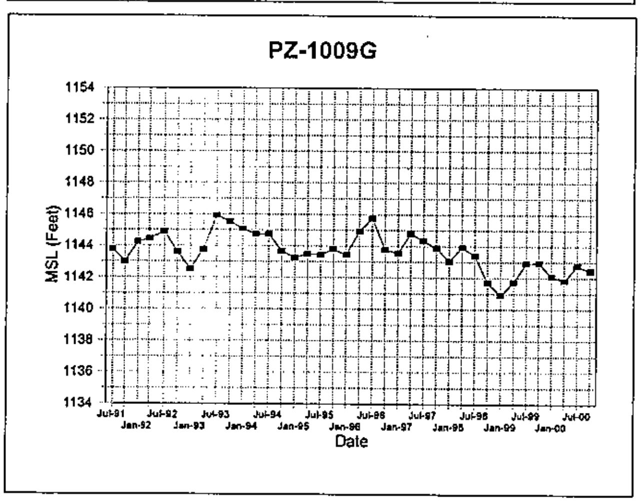
## Groundwater Elevation Results

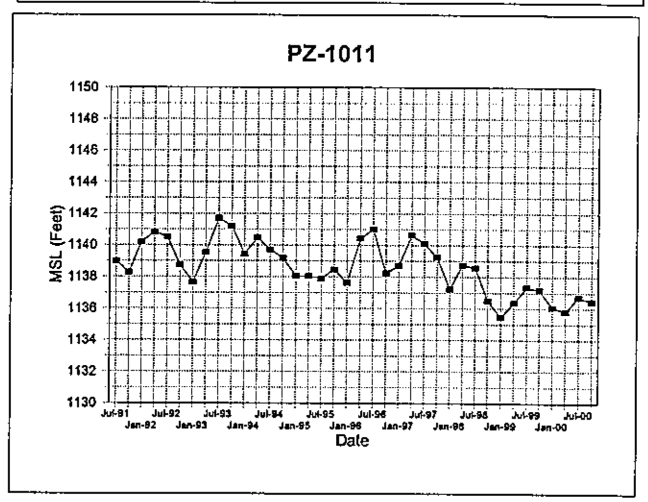


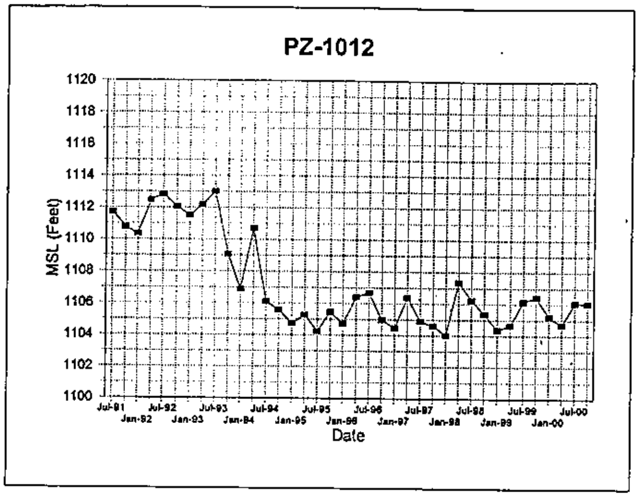



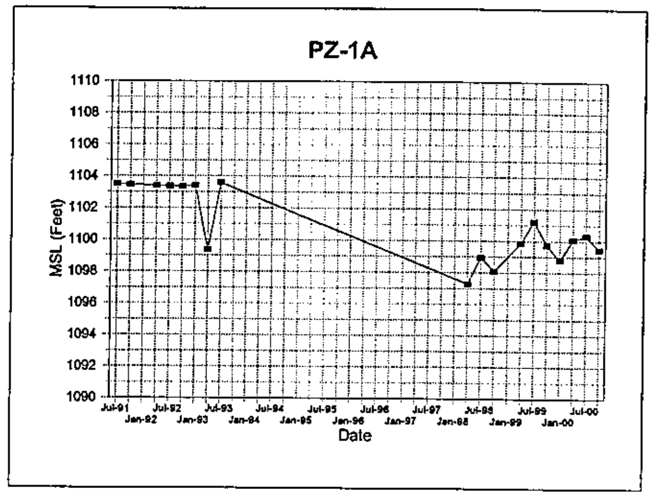



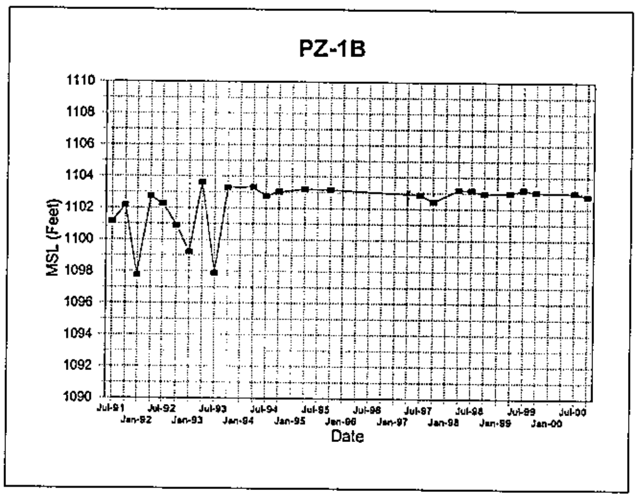


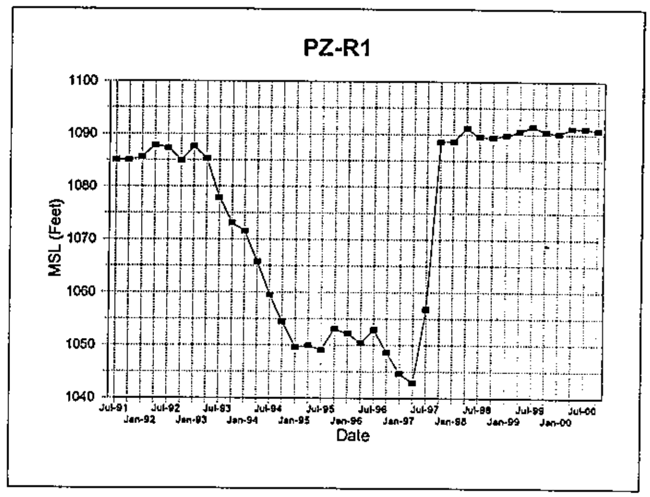

Prepared By: SGL Checked By: JBH1

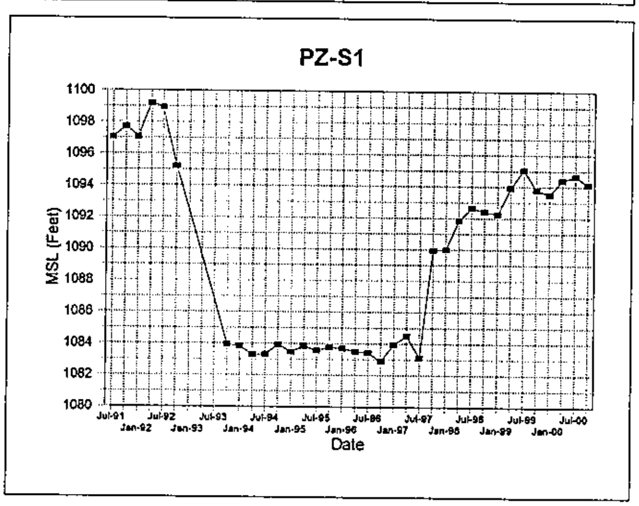
# Groundwater Elevation Results

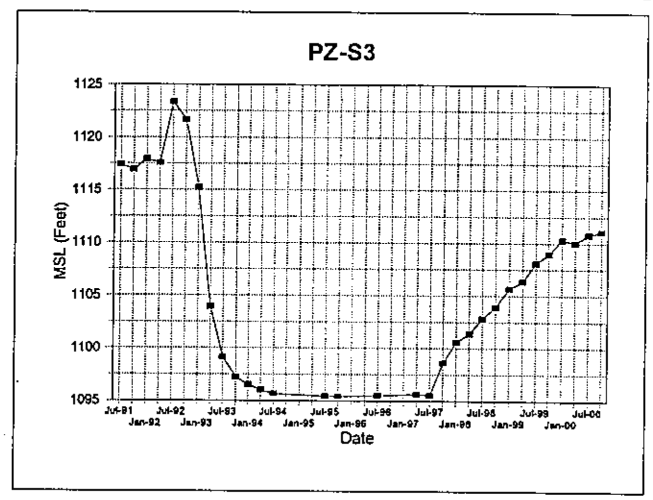


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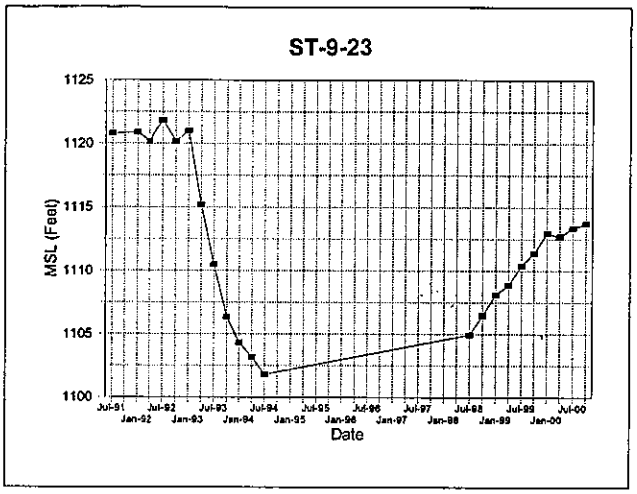
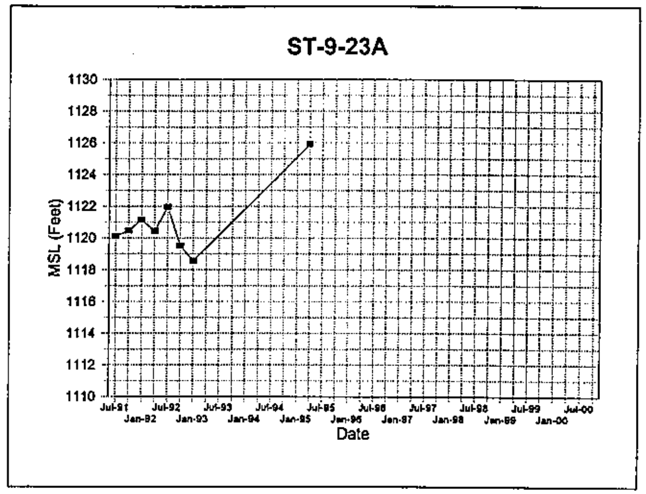
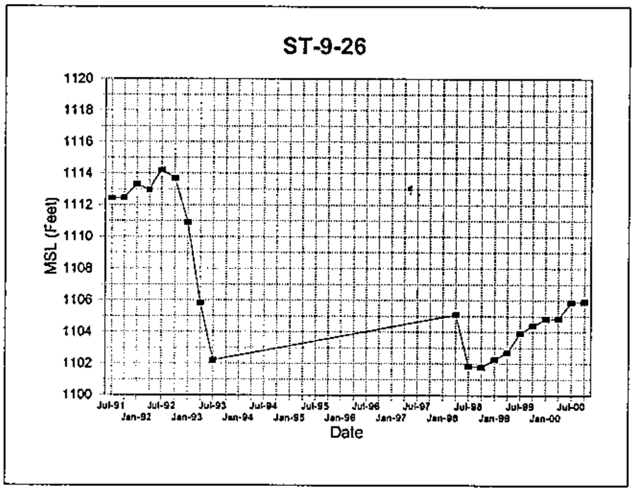
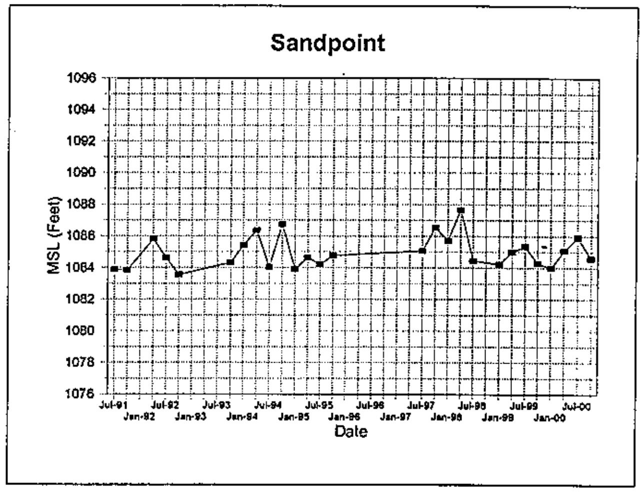
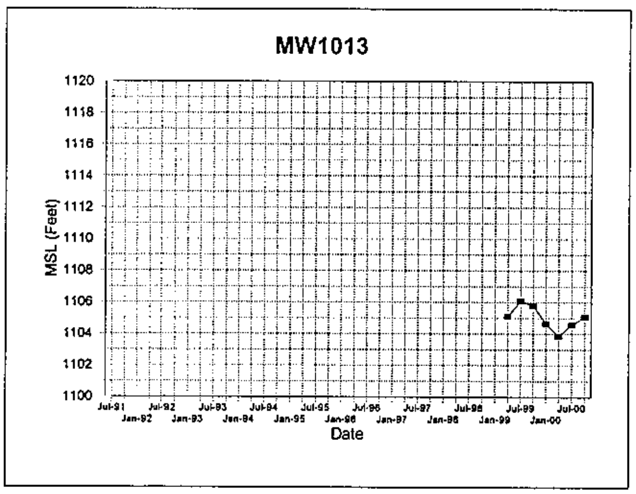
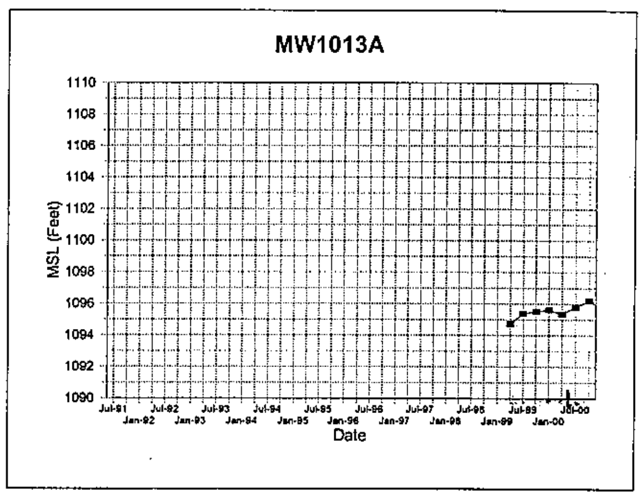


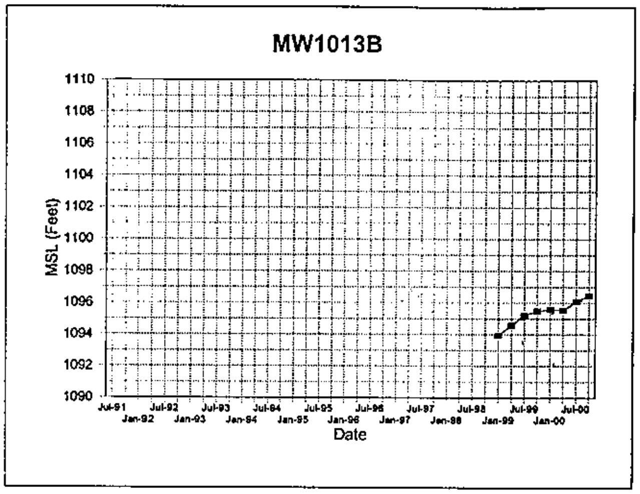



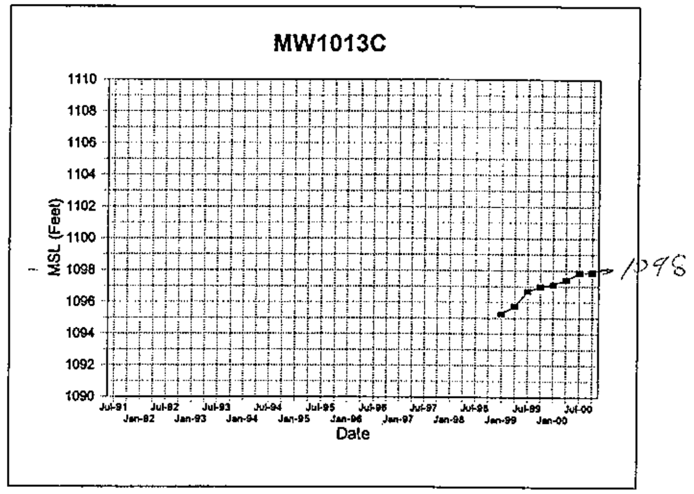



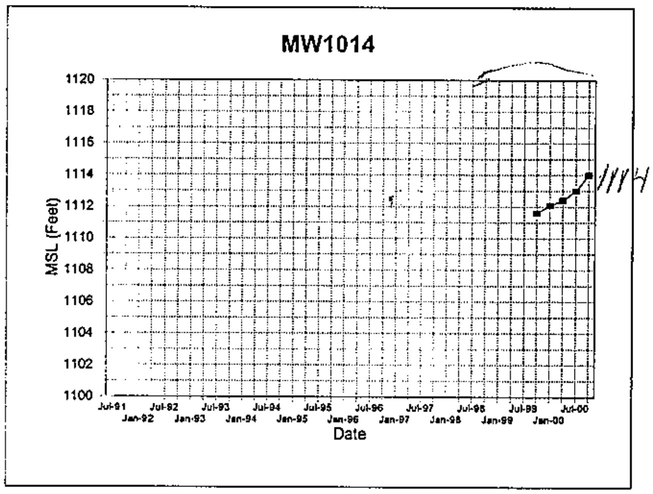



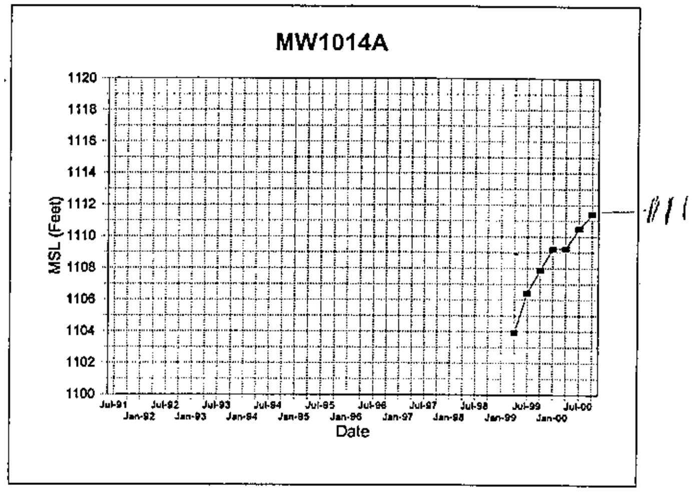



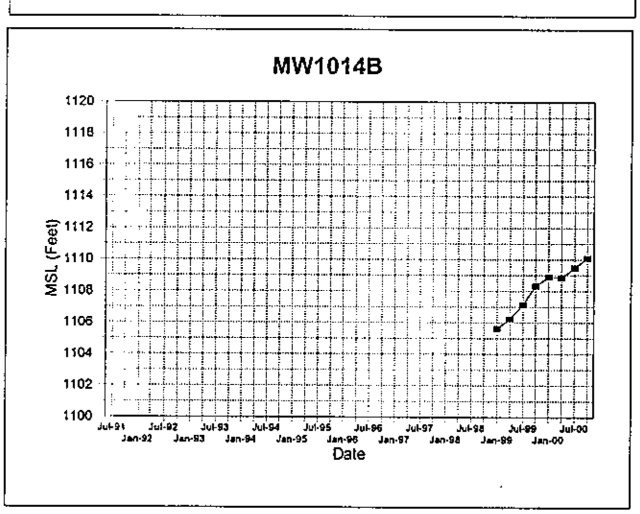
## Groundwater Elevation Results

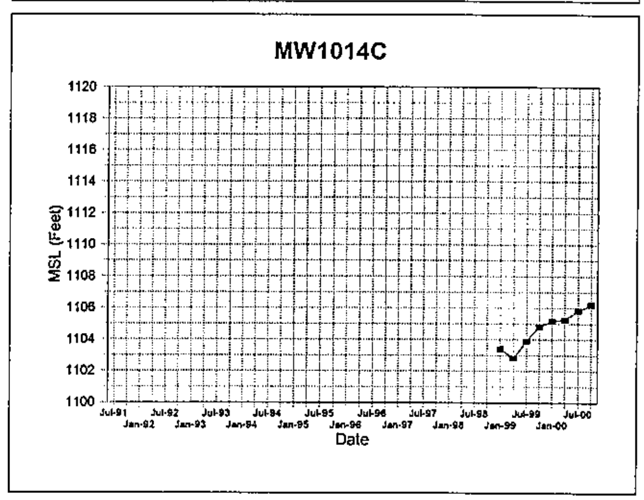





Prepared By: SGL Checked By: JBH1

# Attachment 4

## Trend Results In-Pit Wells

## Summary Statistics and Trend Results (In-Pit Wells)
## February 1999 - November 2000

| | | MW-1013 | | | | MW-1013A | | | | MW-1013B | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total Samples | Percent Detects | Mann-Kendall S | p-Level | Total Samples | Percent Detects | Mann-Kendall S | p-Level | Total Samples | Percent Detects | Mann-Kendall S | p-Level | |
| Alk | (mg/l) | 0 | NA | NA | NA | 0 | NA | NA | NA | 8 | 100% | -1 | 0.952 | |
| As | (ug/l) | 0 | NA | NA | NA | 0 | NA | NA | NA | 5 | 40% | 1 | 1 | |
| Ba | (ug/l) | 0 | NA | NA | NA | 0 | NA | NA | NA | 5 | 0% | 0 | 1 | |
| Cd | (ug/l) | 0 | NA | NA | NA | 0 | NA | NA | NA | 5 | 0% | 0 | 1 | |
| Ca | (mg/l) | 0 | NA | NA | NA | 0 | NA | NA | NA | 5 | 100% | 3 | 0.65 | |
| Cl | (mg/l) | 0 | NA | NA | NA | 0 | NA | NA | NA | 5 | 80% | -5 | 0.359 | |
| Cr | (ug/l) | 0 | NA | NA | NA | 0 | NA | NA | NA | 5 | 80% | -4 | 0.484 | |
| Cu | (ug/l) | 0 | NA | NA | NA | 0 | NA | NA | NA | 8 | 63% | -13 | 0.143 | |
| Hard | (mg/l) | 0 | NA | NA | NA | 0 | NA | NA | NA | 8 | 100% | -7 | 0.473 | |
| Fe | (mg/l) | 0 | NA | NA | NA | 0 | NA | NA | NA | 8 | 88% | 4 | 0.72 | |
| Pb | (ug/l) | 0 | NA | NA | NA | 0 | NA | NA | NA | 5 | 0% | 0 | 1 | |
| Mg | (mg/l) | 0 | NA | NA | NA | 0 | NA | NA | NA | 5 | 100% | 4 | 0.484 | |
| Mn | (ug/l) | 0 | NA | NA | NA | 0 | NA | NA | NA | 8 | 100% | 21 | 0.009 | + |
| Hg | (ug/l) | 0 | NA | NA | NA | 0 | NA | NA | NA | 5 | 0% | 0 | 1 | |
| Field pH | (s.u.) | 0 | NA | NA | NA | 0 | NA | NA | NA | 8 | 100% | 7 | 0.473 | |
| K | (ug/l) | 0 | NA | NA | NA | 0 | NA | NA | NA | 5 | 100% | 2 | 0.816 | |
| Se | (ug/l) | 0 | NA | NA | NA | 0 | NA | NA | NA | 5 | 20% | -4 | 0.484 | |
| Ag | (ug/l) | 0 | NA | NA | NA | 0 | NA | NA | NA | 5 | 0% | 0 | 1 | |
| Na | (mg/l) | 0 | NA | NA | NA | 0 | NA | NA | NA | 5 | 100% | 0 | 1 | |
| TDS | (mg/l) | 0 | NA | NA | NA | 0 | NA | NA | NA | 8 | 100% | -8 | 0.398 | |
| Sulf | (mg/l) | 0 | NA | NA | NA | 0 | NA | NA | NA | 8 | 100% | 3 | 0.812 | |
| Zn | (ug/l) | 0 | NA | NA | NA | 0 | NA | NA | NA | 6 | 0% | 0 | 1 | |
| Field Cond | (umho) | 0 | NA | NA | NA | 0 | NA | NA | NA | 8 | 100% | -9 | 0.337 | |

+ : Implies Statistically Increasing Trend
- : Implies Statistically Decreasing Trend
NA: Not Applicable

# Summary Statistics and Trend Results (In-Pit Wells)
## February 1999 - November 2000

| | | MW-1013C | | | | | MW-1014 | | | | MW-1014A | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total Samples | Percent Detects | Mann-Kendall S | p-Level | | Total Samples | Percent Detects | Mann-Kendall S | p-Level | Total Samples | Percent Detects | Mann-Kendall S | p-Level |
| Alk | (mg/l) | 8 | 100% | 13 | 0.143 | | 0 | NA | NA | NA | 3 | 100% | NA | NA |
| As | (ug/l) | 5 | 40% | -3 | 0.65 | | 0 | NA | NA | NA | 2 | 50% | NA | NA |
| Ba | (ug/l) | 5 | 0% | 0 | 1 | | 0 | NA | NA | NA | 2 | 100% | NA | NA |
| Cd | (ug/l) | 5 | 20% | 0 | 1 | | 0 | NA | NA | NA | 2 | 0% | NA | NA |
| Ca | (mg/l) | 5 | 100% | 4 | 0.484 | | 0 | NA | NA | NA | 2 | 100% | NA | NA |
| Cl | (mg/l) | 5 | 100% | 3 | 0.65 | | 0 | NA | NA | NA | 2 | 0% | NA | NA |
| Cr | (ug/l) | 5 | 20% | -2 | 0.816 | | 0 | NA | NA | NA | 2 | 50% | NA | NA |
| Cu | (ug/l) | 8 | 50% | -18 | 0.032 | | 0 | NA | NA | NA | 3 | 0% | NA | NA |
| Hard | (mg/l) | 8 | 100% | 11 | 0.227 | | 0 | NA | NA | NA | 3 | 100% | NA | NA |
| Fe | (mg/l) | 8 | 100% | 23 | 0.003 | + | 0 | NA | NA | NA | 3 | 100% | NA | NA |
| Pb | (ug/l) | 5 | 0% | 0 | 1 | | 0 | NA | NA | NA | 2 | 0% | NA | NA |
| Mg | (mg/l) | 5 | 100% | 7 | 0.159 | | 0 | NA | NA | NA | 2 | 100% | NA | NA |
| Mn | (ug/l) | 8 | 100% | 17 | 0.047 | | 0 | NA | NA | NA | 3 | 100% | NA | NA |
| Hg | (ug/l) | 5 | 0% | 0 | 1 | | 0 | NA | NA | NA | 2 | 0% | NA | NA |
| Field pH | (s.u.) | 8 | 100% | 3 | 0.812 | | 0 | NA | NA | NA | 3 | 100% | NA | NA |
| K | (ug/l) | 5 | 100% | 1 | 1 | | 0 | NA | NA | NA | 2 | 100% | NA | NA |
| Se | (ug/l) | 5 | 20% | -4 | 0.484 | | 0 | NA | NA | NA | 2 | 0% | NA | NA |
| Ag | (ug/l) | 5 | 20% | 0 | 1 | | 0 | NA | NA | NA | 2 | 0% | NA | NA |
| Na | (mg/l) | 5 | 100% | 4 | 0.484 | | 0 | NA | NA | NA | 2 | 100% | NA | NA |
| TDS | (mg/l) | 8 | 100% | 3 | 0.812 | | 0 | NA | NA | NA | 3 | 100% | NA | NA |
| Sulf | (mg/l) | 8 | 100% | 4 | 0.72 | | 0 | NA | NA | NA | 3 | 100% | NA | NA |
| Zn | (ug/l) | 6 | 100% | -12 | 0.036 | | 0 | NA | NA | NA | 3 | 0% | NA | NA |
| Field Cond | (umho) | 8 | 100% | 6 | 0.548 | | 0 | NA | NA | NA | 3 | 100% | NA | NA |

+ : Implies Statistically Increasing Trend
- : Implies Statistically Decreasing Trend
NA: Not Applicable

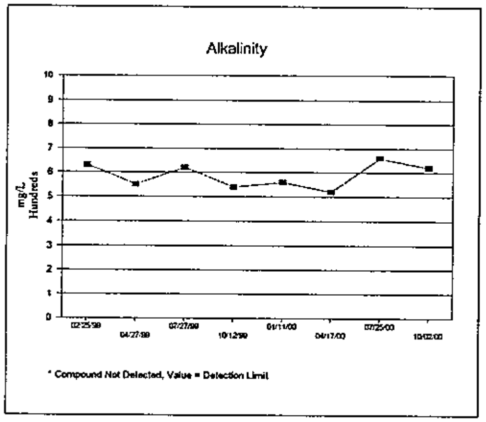
## Summary Statistics and Trend Results (In-Pit Wells)
### February 1999 - November 2000

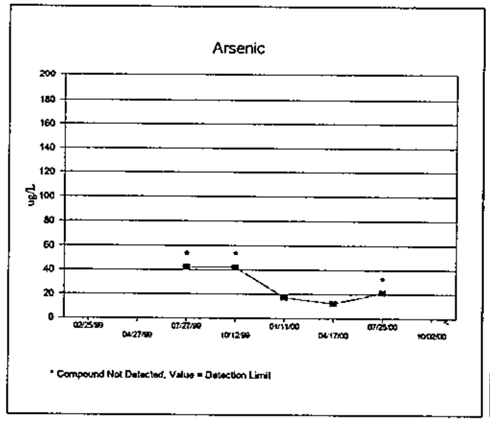
| | | MW-1014B | | | | MW-1014C | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Total Samples | Percent Detects | Mann-Kendall S | p-Level | Total Samples | Percent Detects | Mann-Kendall S | p-Level |
| Alk | (mg/l) | 8 | 100% | 3 | 0.812 | 8 | 100% | 3 | 0.812 |
| As | (ug/l) | 5 | 20% | -4 | 0.484 | 5 | 40% | 7 | 0.159 |
| Ba | (ug/l) | 5 | 0% | 0 | 1 | 5 | 20% | 0 | 1 |
| Cd | (ug/l) | 5 | 100% | -7 | 0.159 | 5 | 0% | 0 | 1 |
| Ca | (mg/l) | 5 | 100% | 1 | 1 | 5 | 100% | -2 | 0.816 |
| Cl | (mg/l) | 5 | 80% | -6 | 0.234 | 5 | 100% | 5 | 0.359 |
| Cr | (ug/l) | 5 | 40% | -7 | 0.159 | 5 | 20% | 4 | 0.484 |
| Cu | (ug/l) | 8 | 100% | -11 | 0.227 | 8 | 13% | -3 | 0.812 |
| Hard | (mg/l) | 8 | 100% | 9 | 0.337 | 8 | 100% | -16 | 0.062 |
| Fe | (mg/l) | 8 | 50% | -14 | 0.108 | 8 | 100% | -17 | 0.047 |
| Pb | (ug/l) | 5 | 0% | 0 | 1 | 5 | 0% | 0 | 1 |
| Mg | (mg/l) | 5 | 100% | -1 | 1 | 5 | 100% | -3 | 0.65 |
| Mn | (ug/l) | 8 | 100% | -15 | 0.085 | 8 | 100% | -20 | 0.014 |
| Hg | (ug/l) | 5 | 0% | 0 | 1 | 5 | 0% | 0 | 1 |
| Field pH | (s.u.) | 8 | 100% | 7 | 0.473 | 8 | 100% | 10 | 0.276 |
| K | (ug/l) | 5 | 100% | 0 | 1 | 5 | 100% | 6 | 0.234 |
| Se | (ug/l) | 5 | 60% | -5 | 0.359 | 5 | 40% | -3 | 0.65 |
| Ag | (ug/l) | 5 | 0% | 0 | 1 | 5 | 0% | 0 | 1 |
| Na | (mg/l) | 5 | 100% | 0 | 1 | 5 | 100% | 1 | 1 |
| TDS | (mg/l) | 8 | 100% | -5 | 0.634 | 8 | 100% | 6 | 0.548 |
| Sulf | (mg/l) | 8 | 100% | 12 | 0.178 | 8 | 100% | -1 | 0.952 |
| Zn | (ug/l) | 6 | 100% | -8 | 0.204 | 6 | 100% | -12 | 0.036 |
| Field Cond | (umho) | 8 | 100% | -3 | 0.812 | 8 | 100% | -22 | 0.004 |

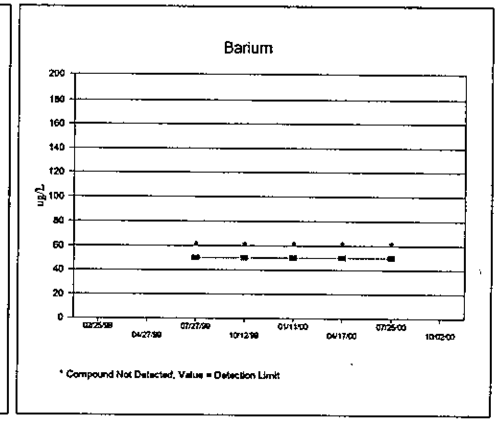
+ : Implies Statistically Increasing Trend
- : Implies Statistically Decreasing Trend
NA: Not Applicable

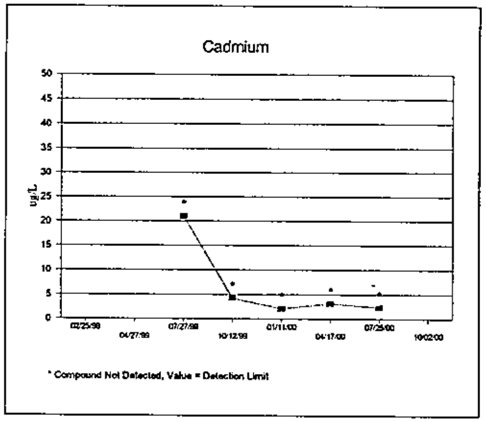
Flambeau Mining Company
Groundwater Quality Results

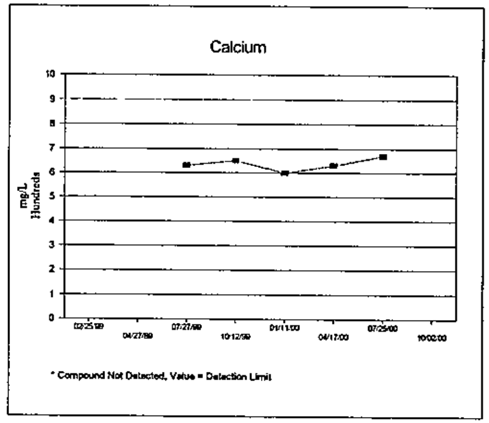
MW-1013B

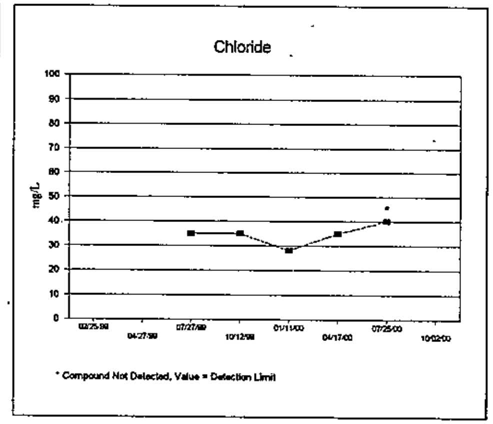


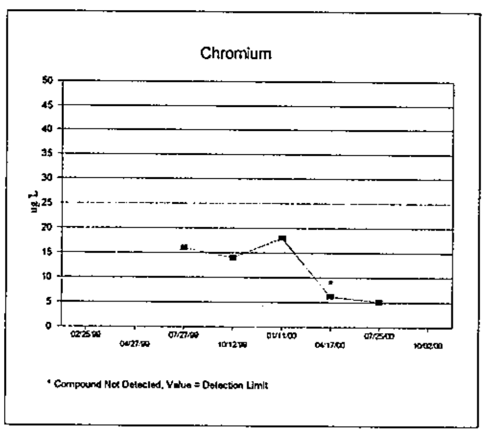



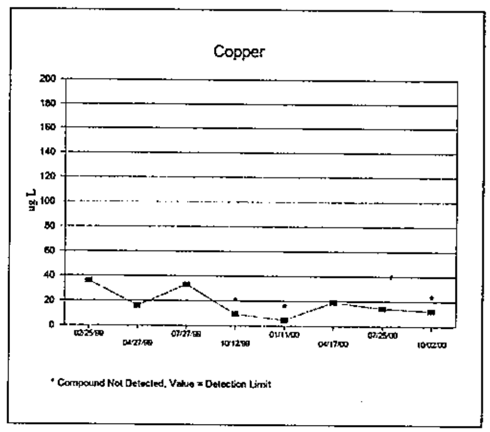



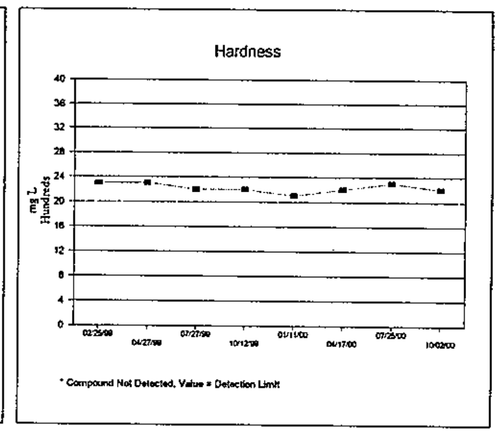



Flambeau Mining Company
Groundwater Quality Results

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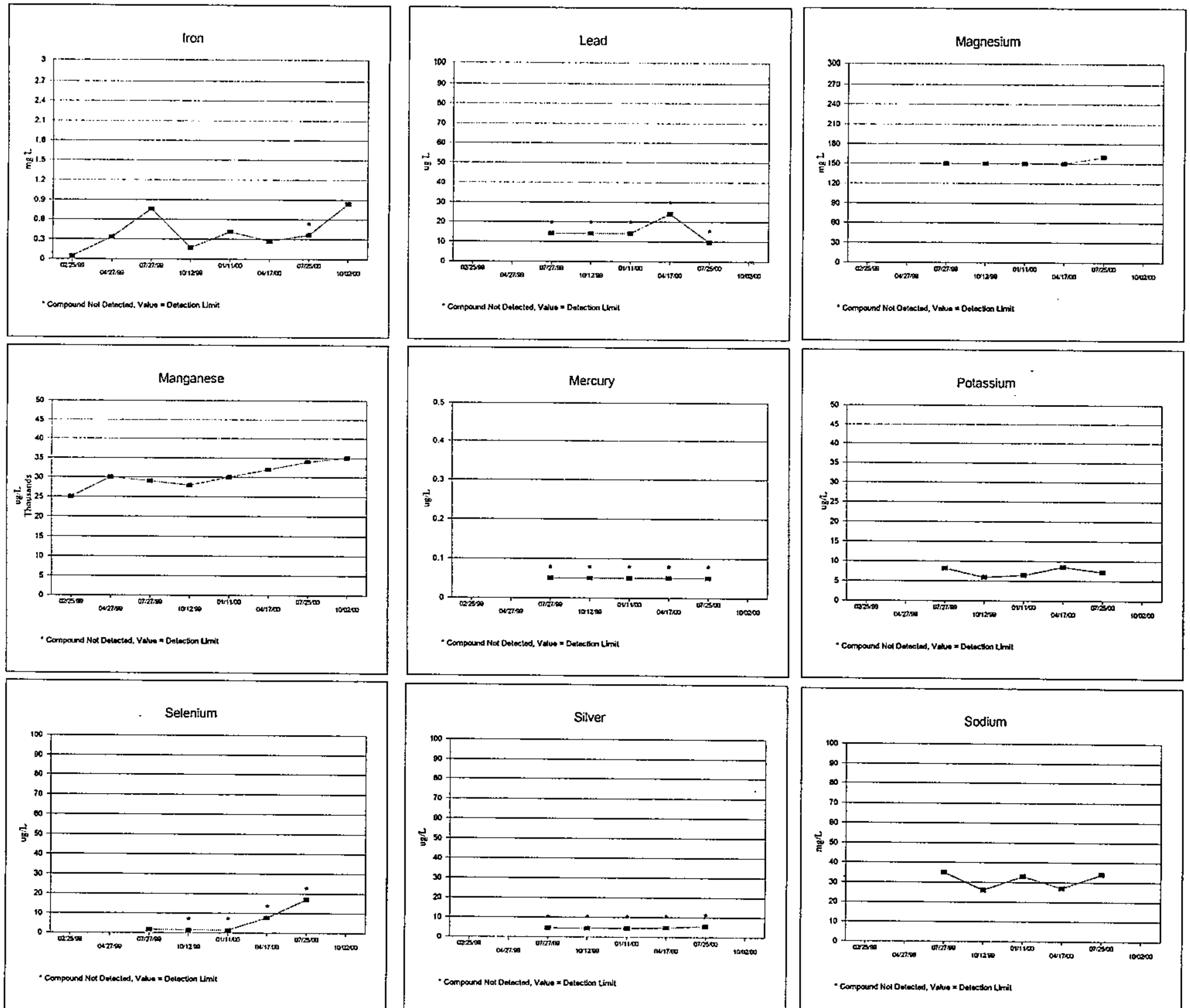
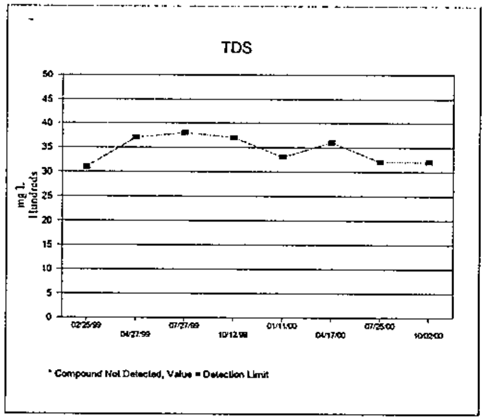
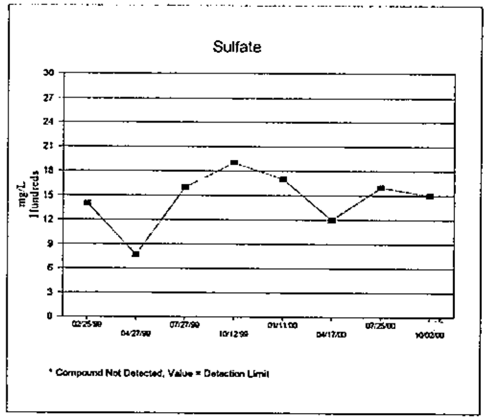
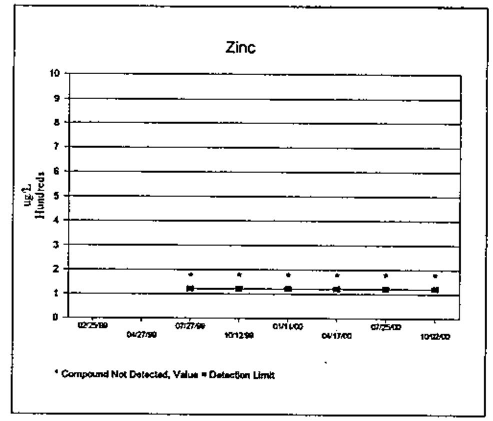


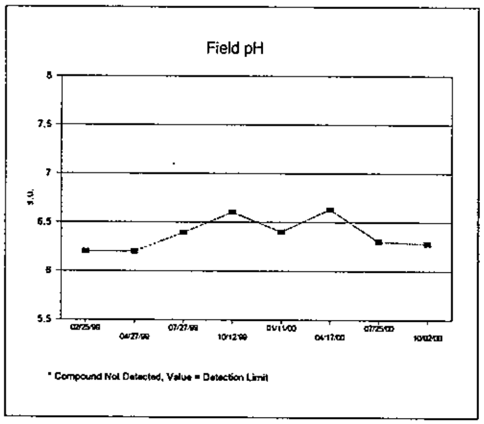
## Flambeau Mining Company
## Groundwater Quality Results

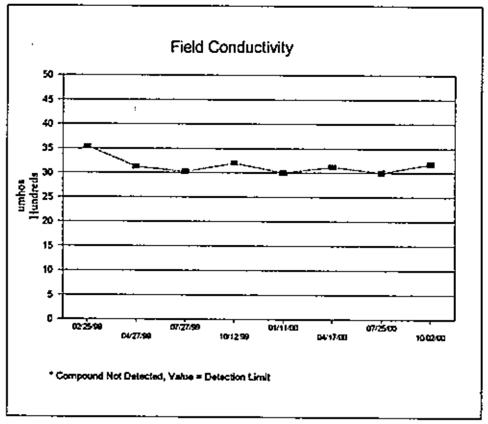
### MW-1013B



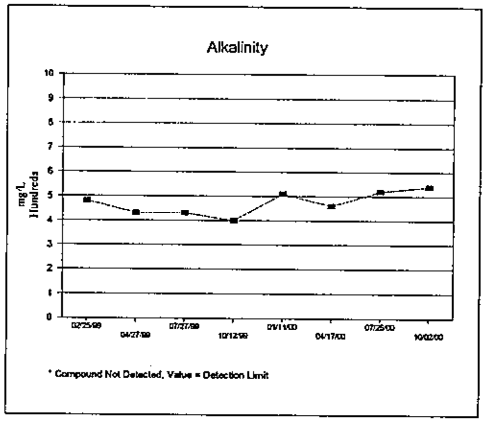



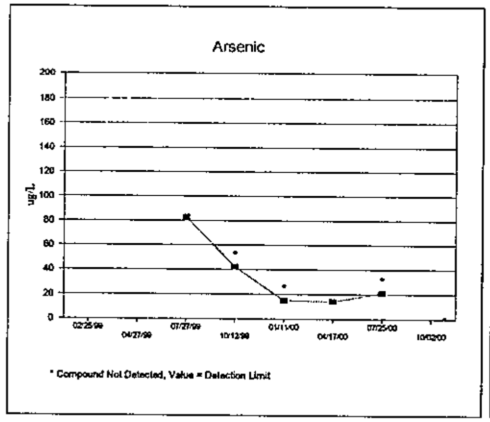



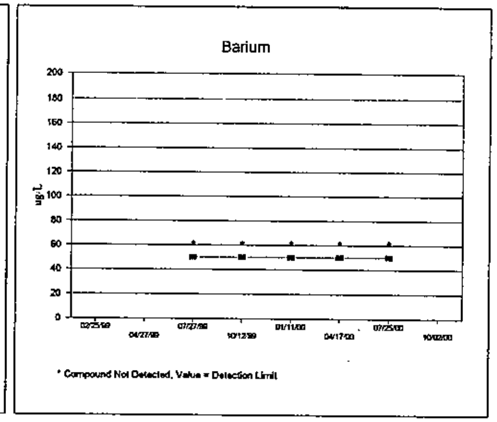



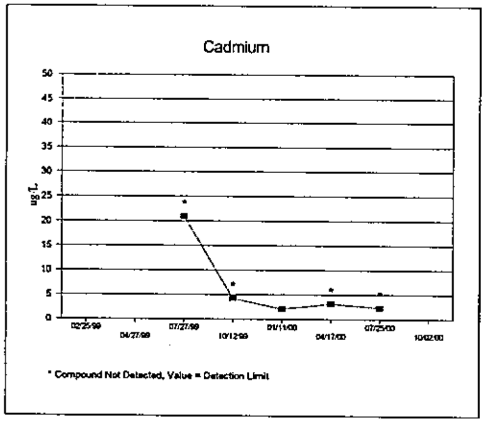
# Flambeau Mining Company
# Groundwater Quality Results

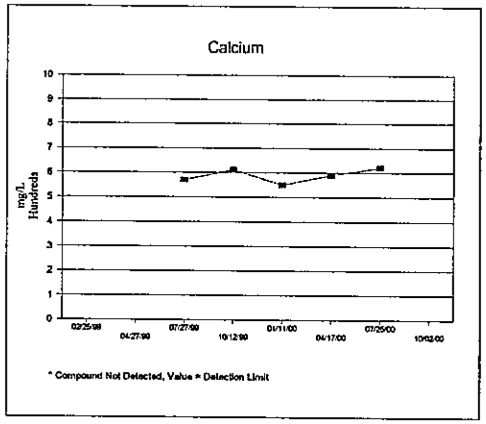
## MW-1013C

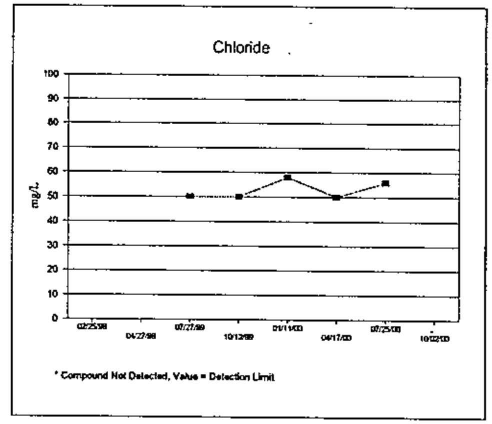


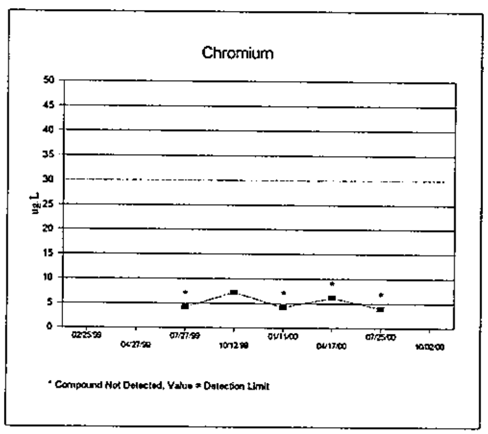



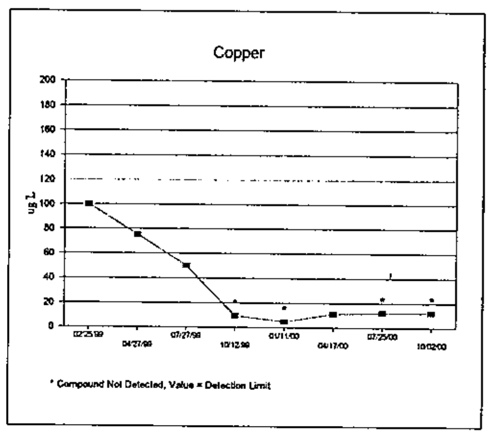



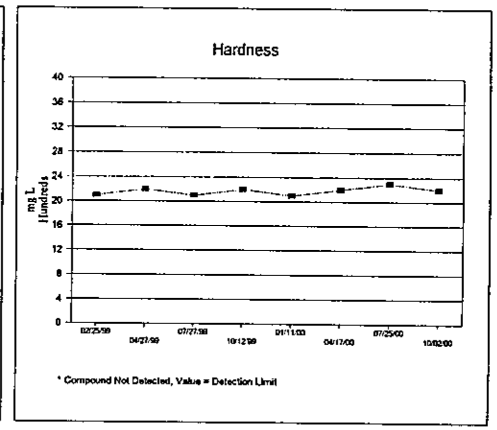



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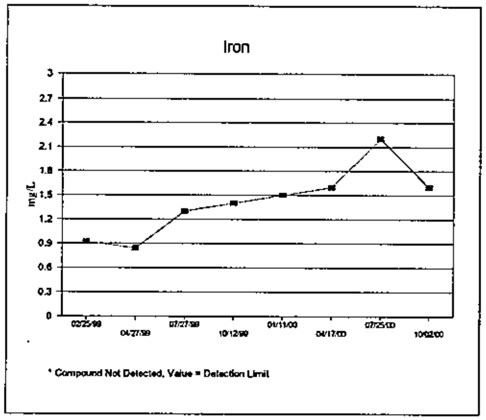
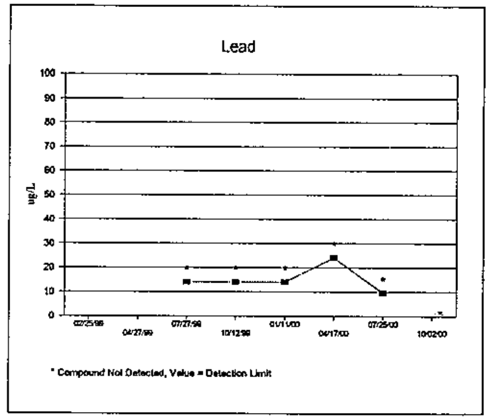
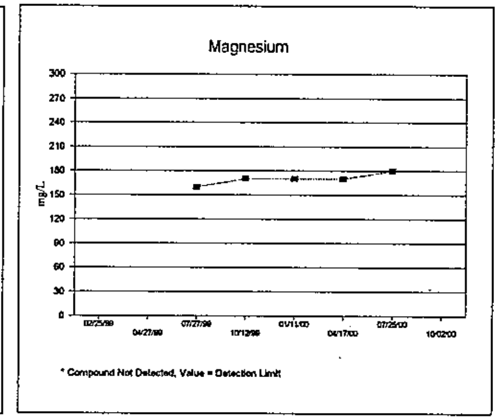
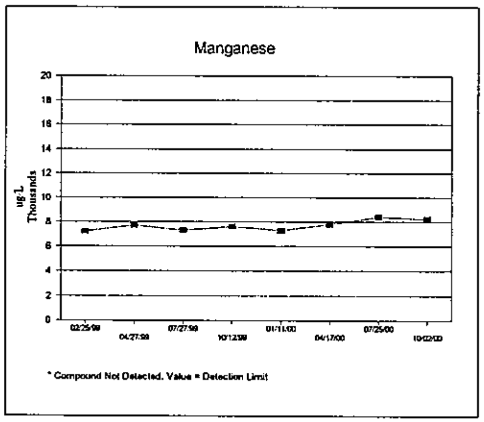
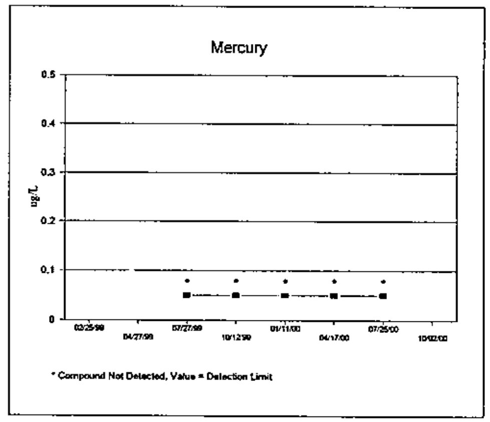
MW-1013C

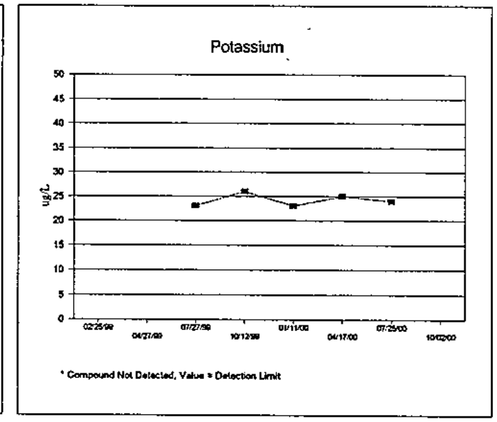


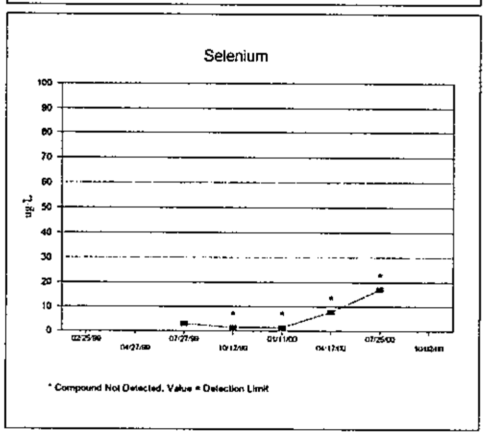



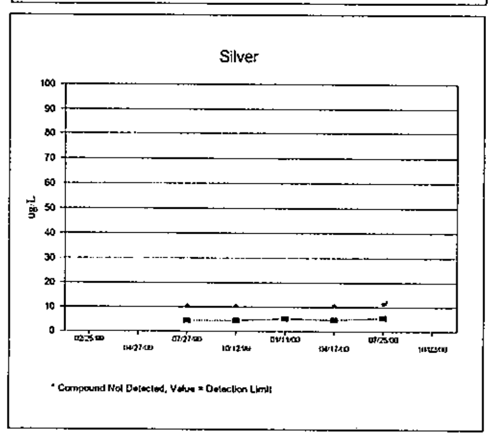



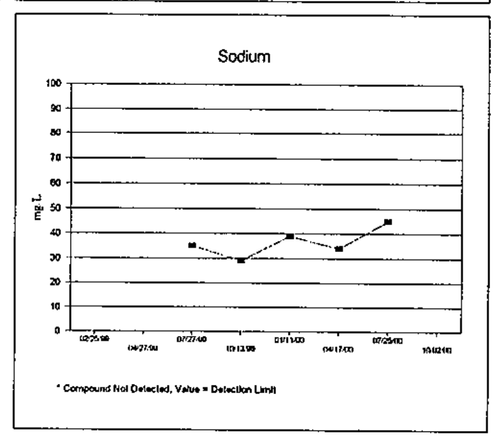



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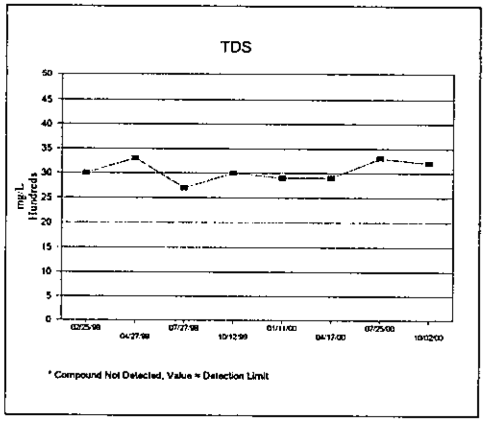


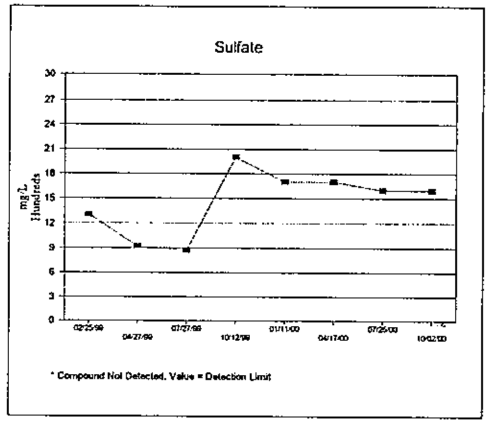


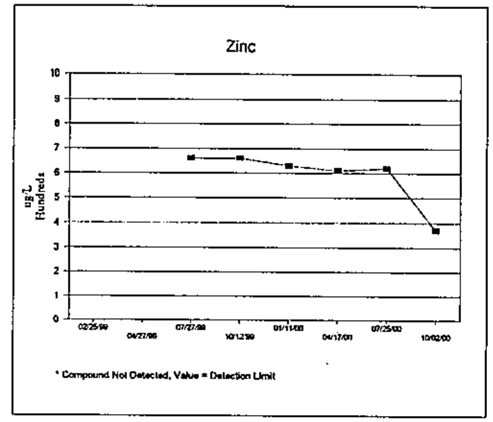


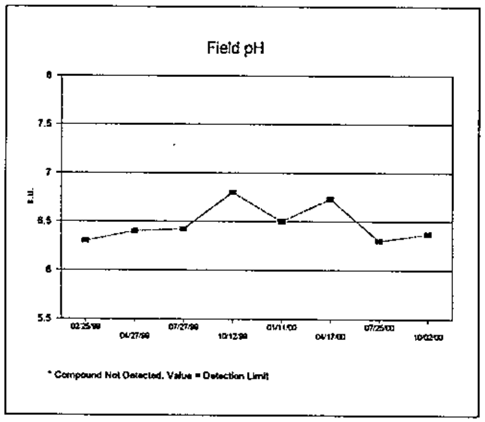


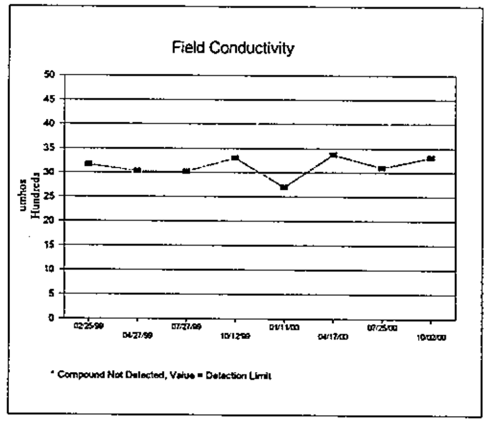

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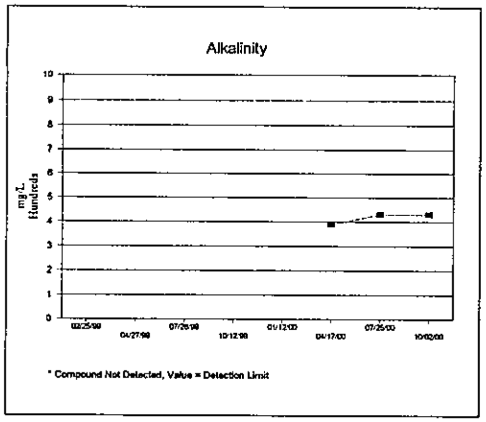
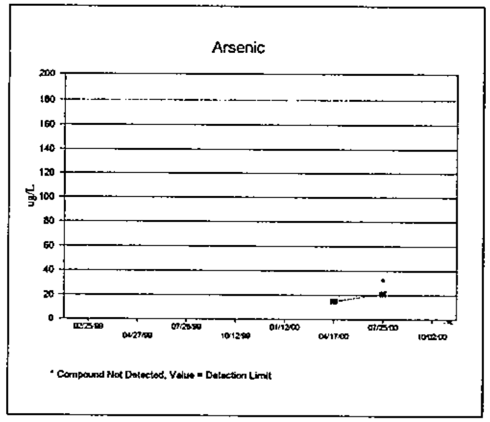
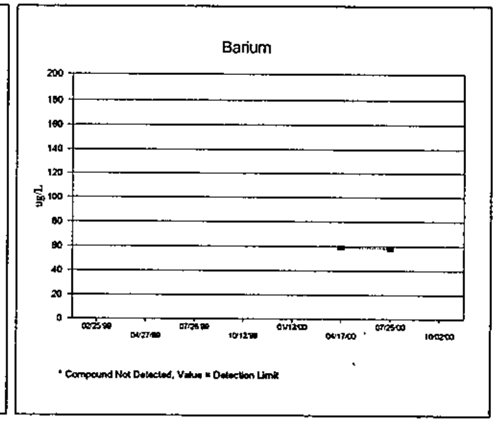
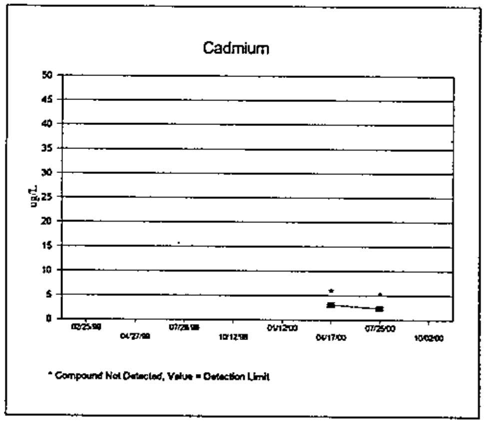
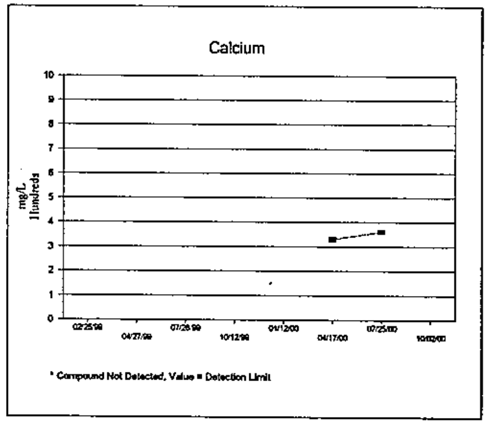
MW-1014A

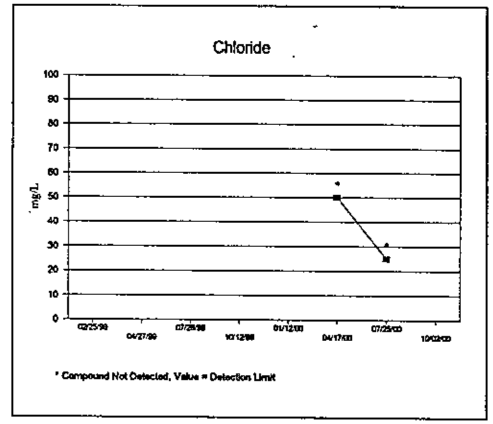


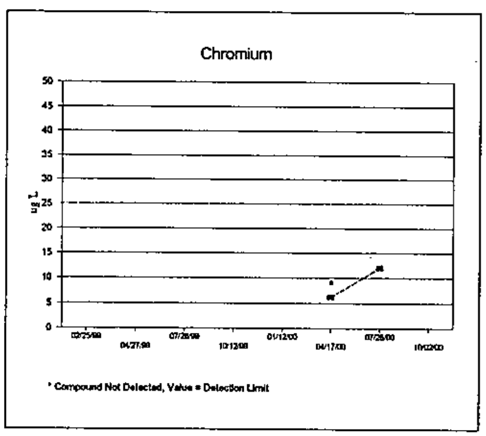



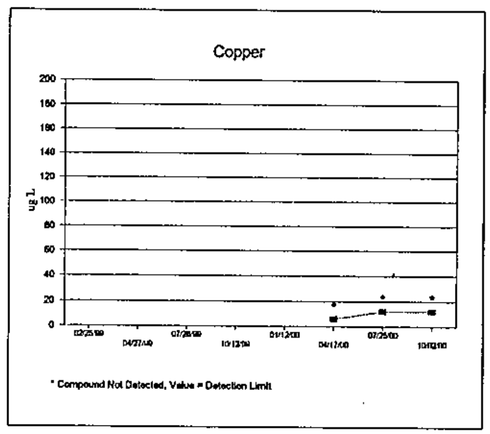



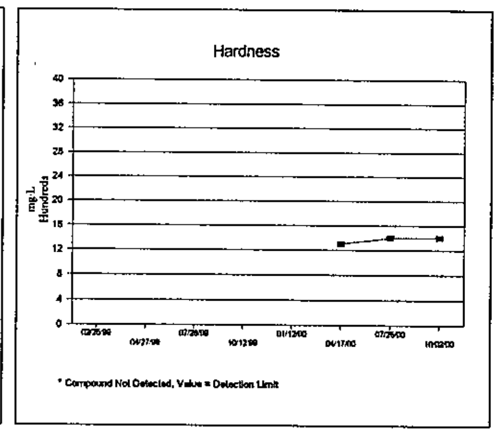



Flambeau Mining Company
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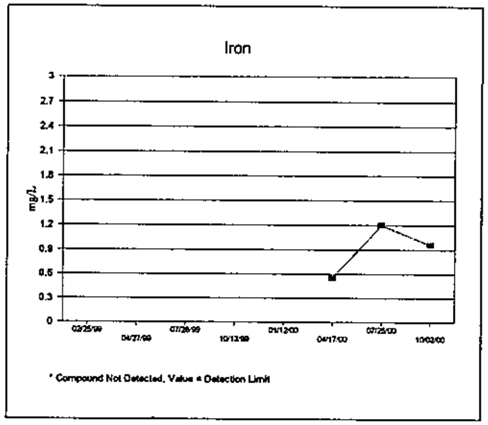


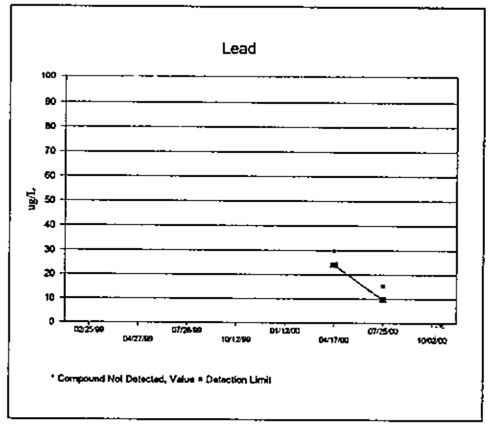


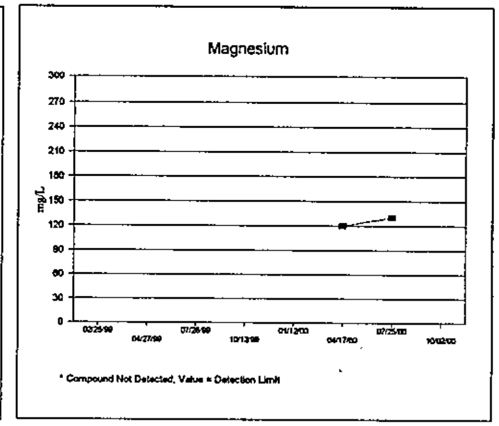


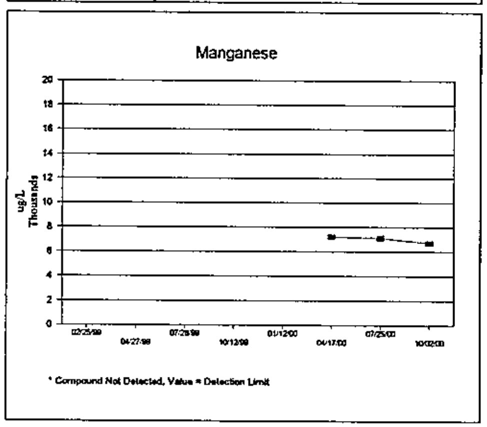


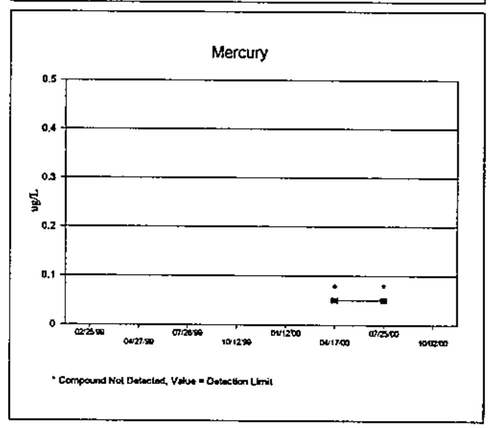


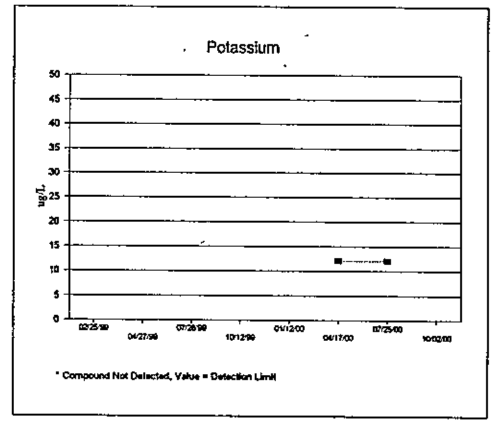


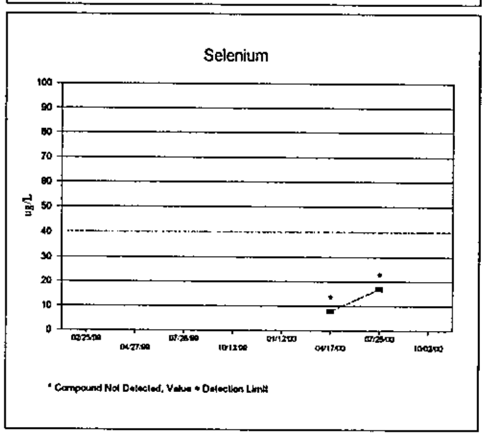


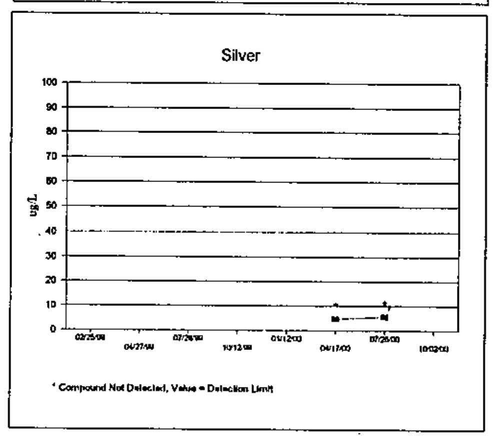


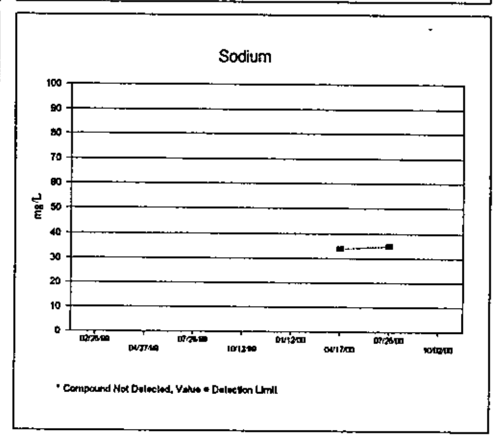

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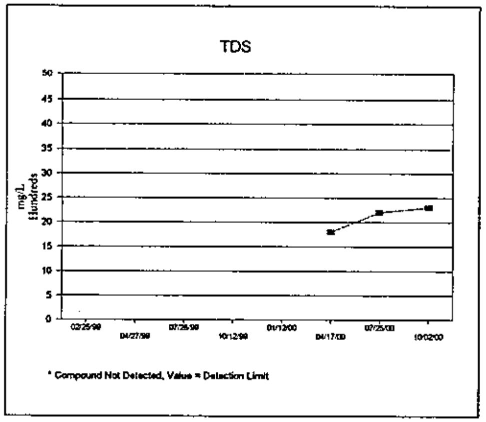
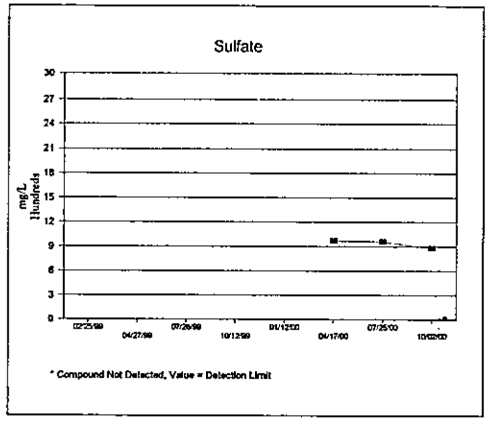
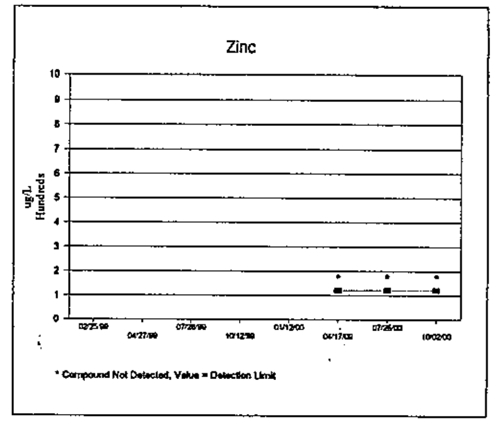
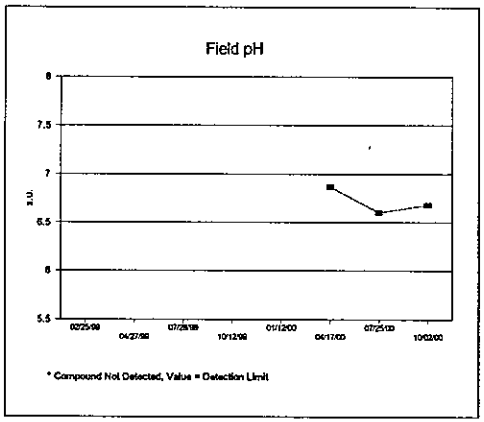
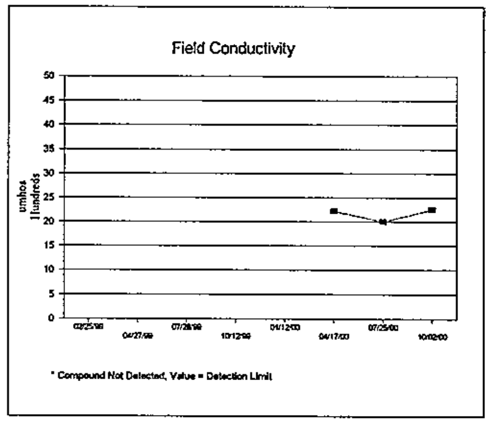
### MW-1014A



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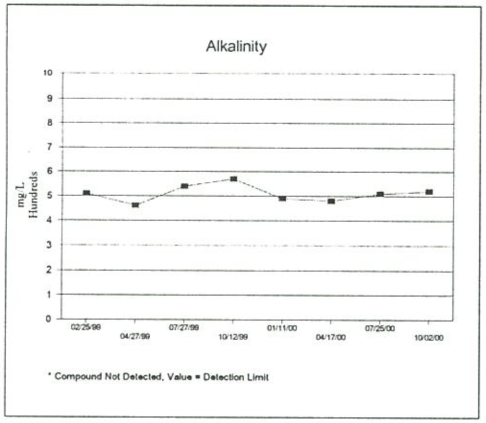
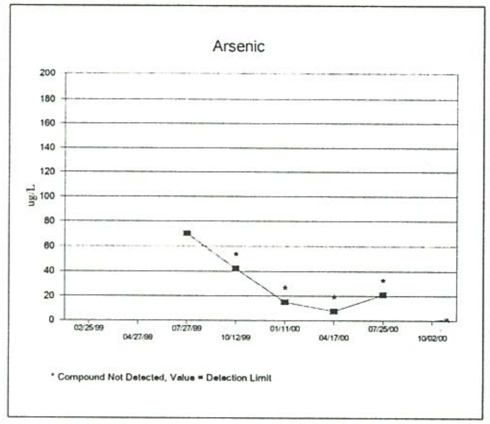
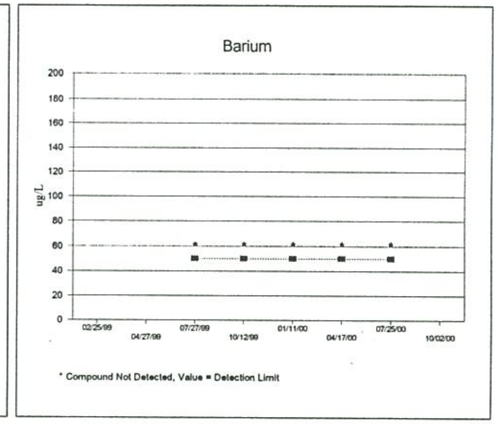
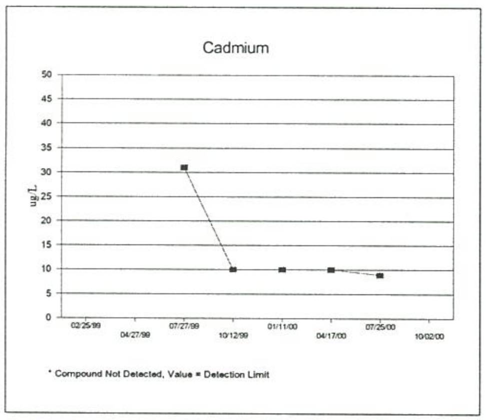
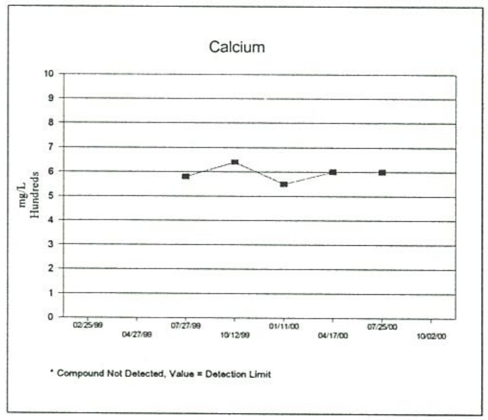
MW-1014B

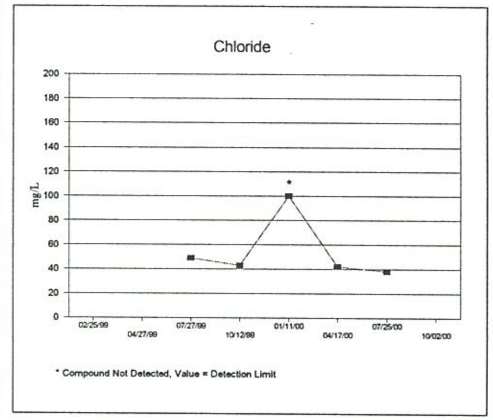


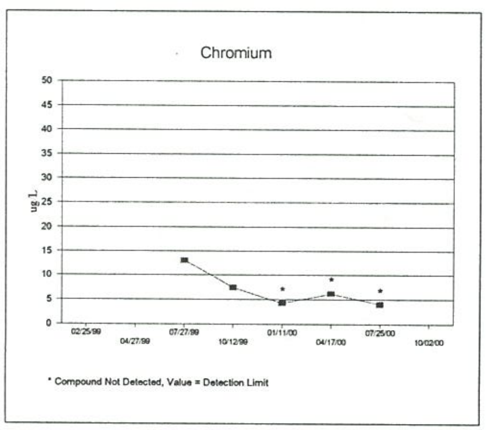



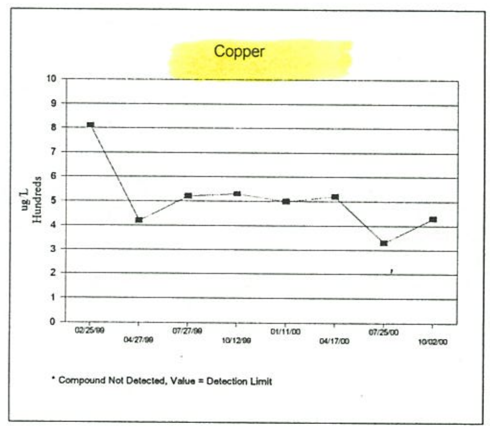



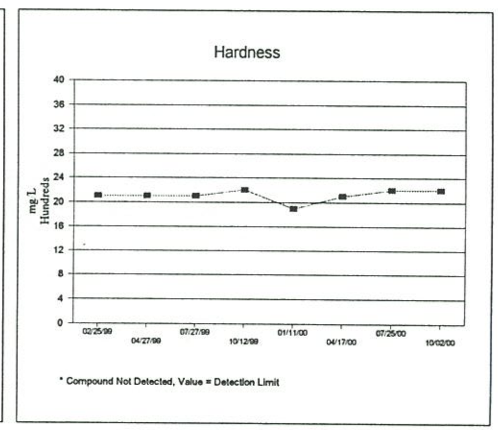



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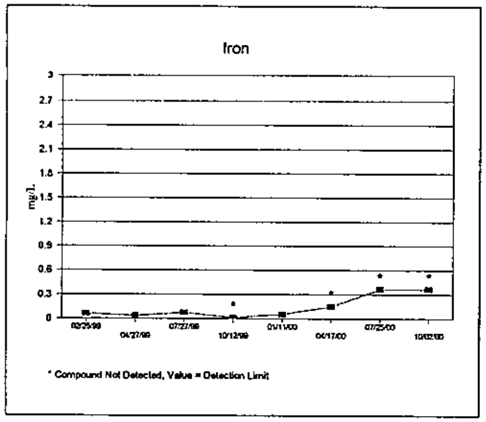


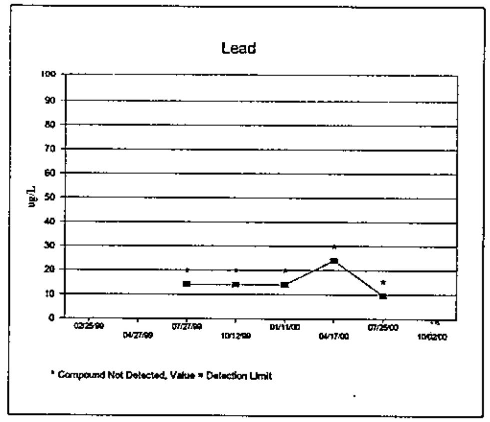


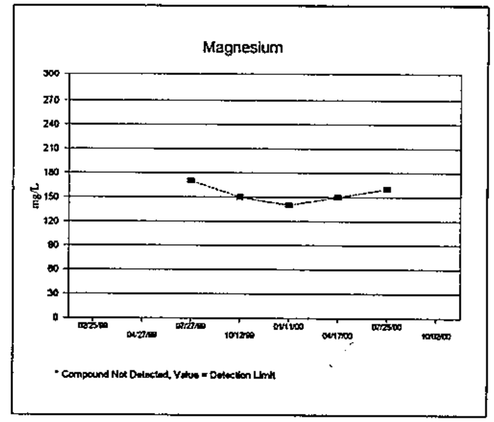


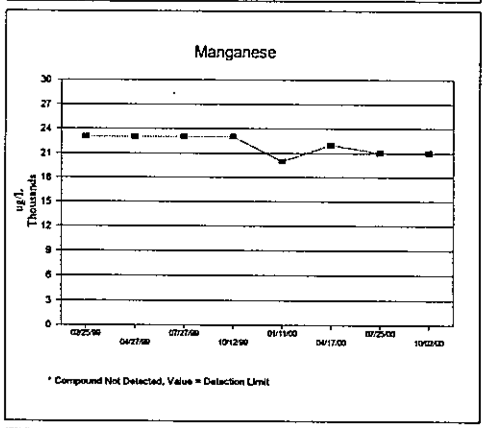


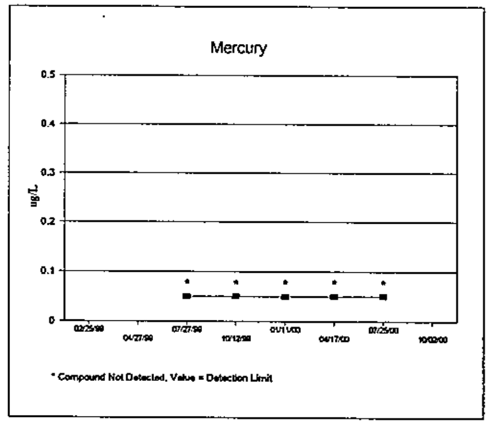


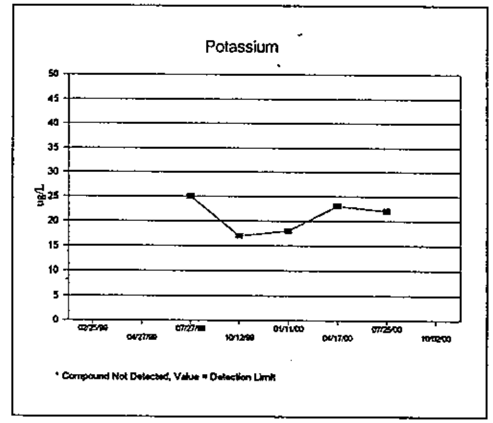


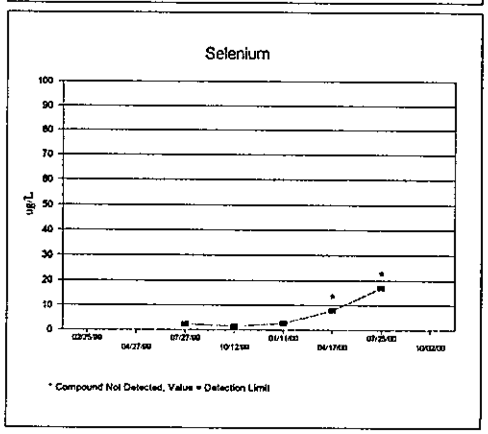


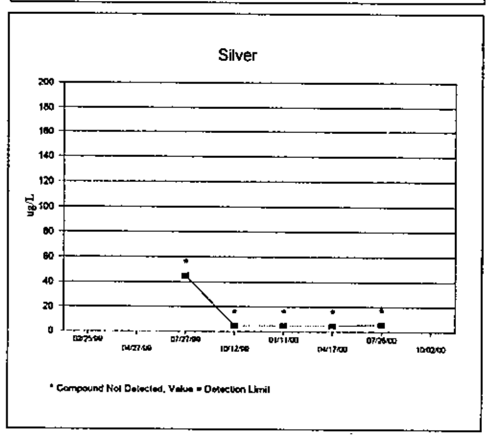


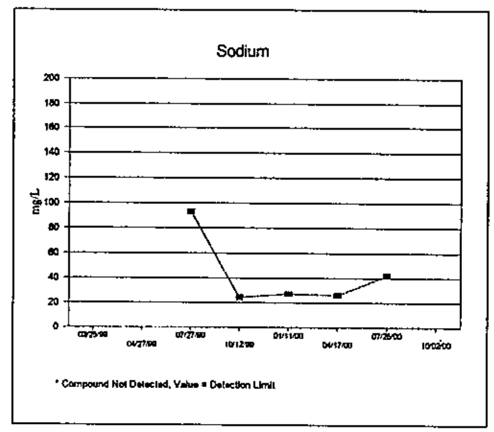

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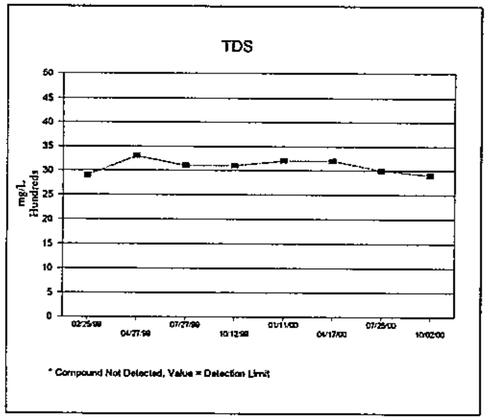
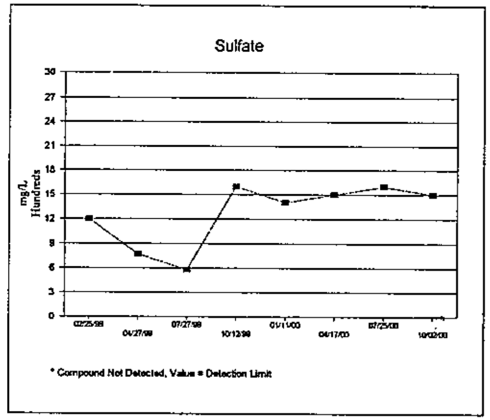
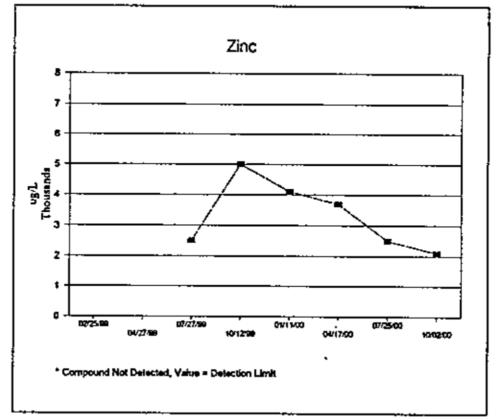
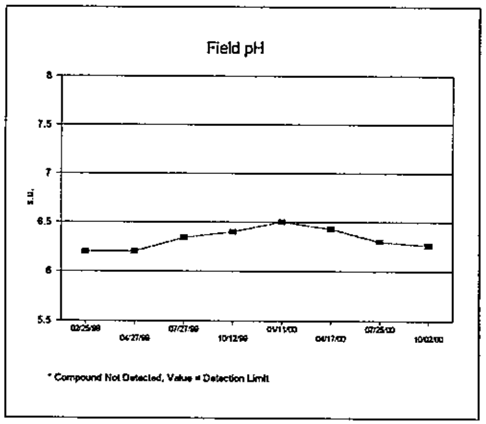
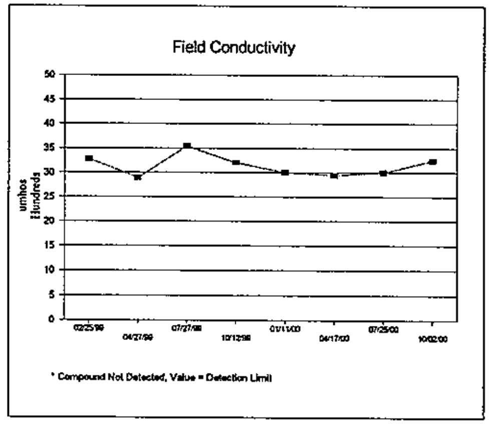
MW-1014B



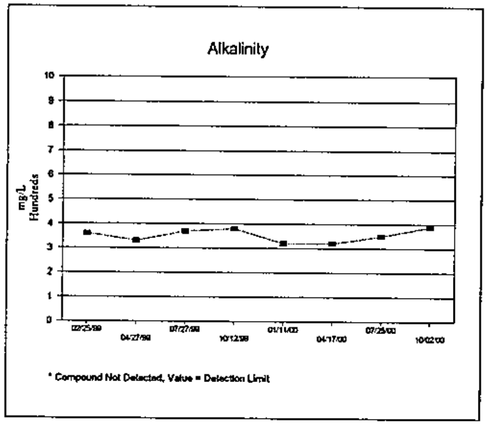



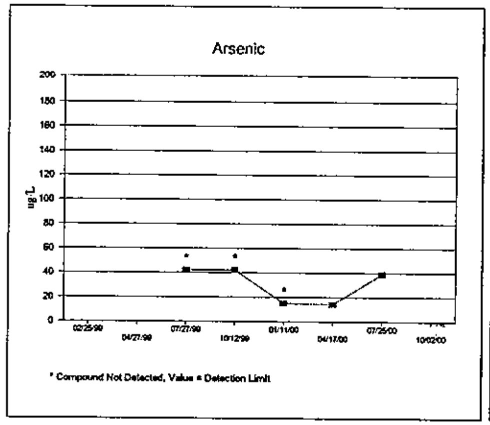



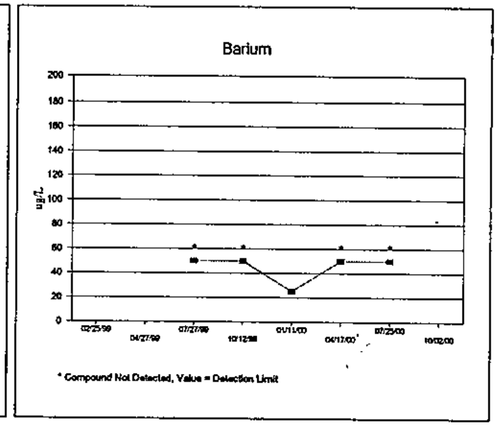



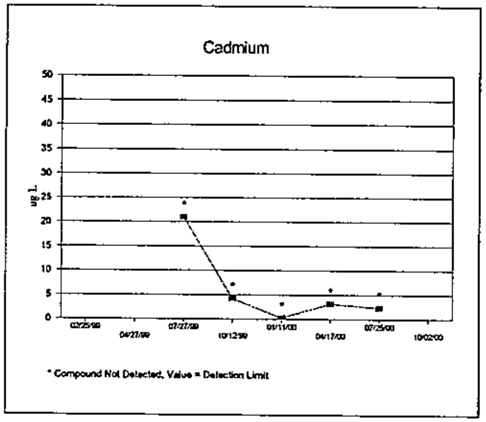
Flambeau Mining Company
Groundwater Quality Results

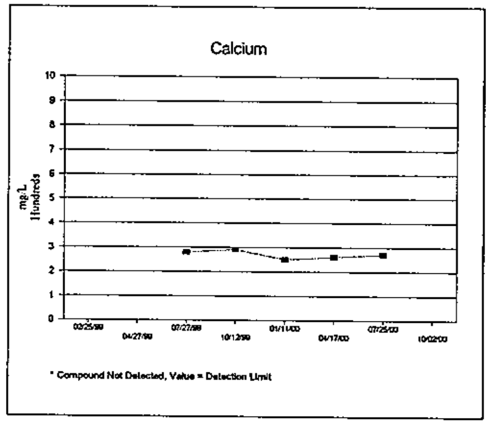
MW-1014C

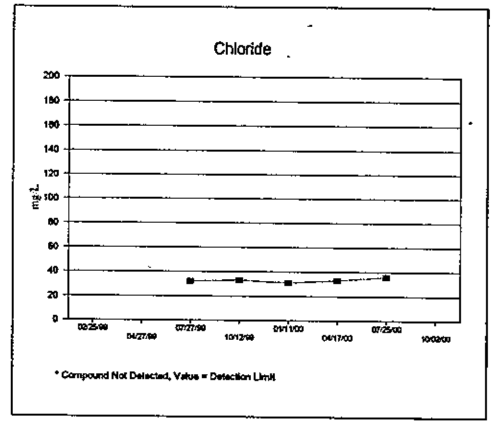


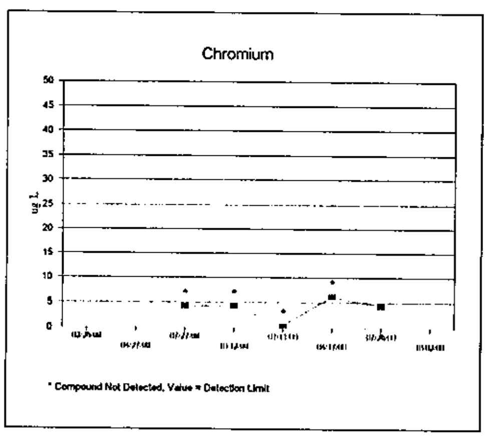



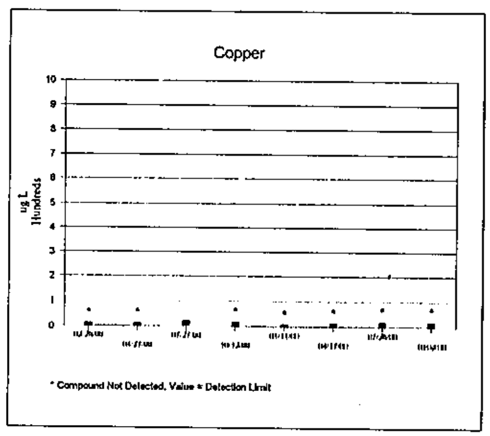



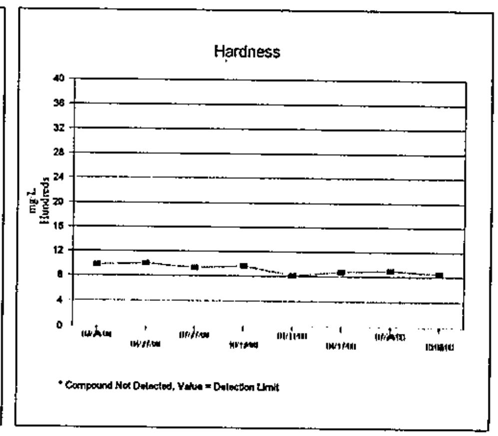



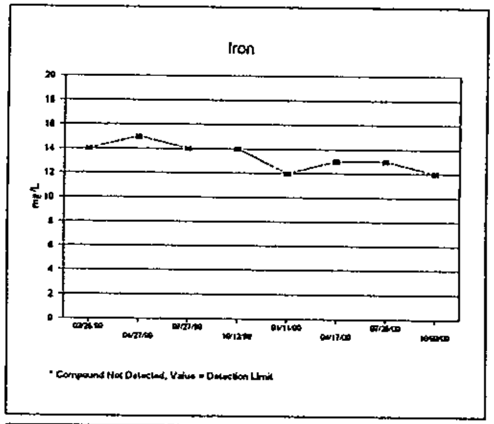



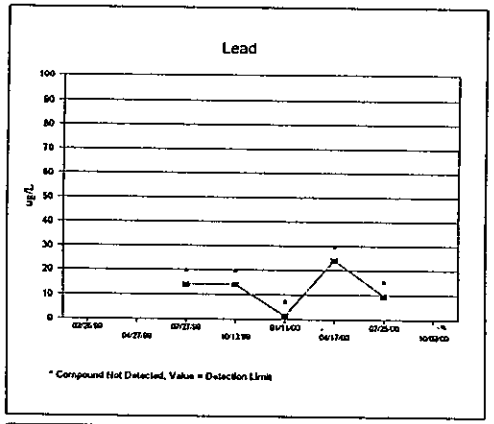



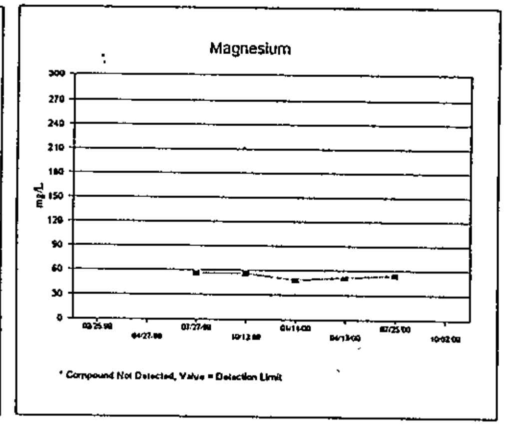



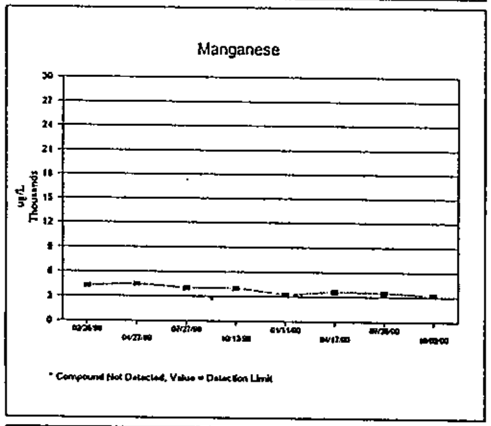
Flambeau Mining Company
Groundwater Quality Results

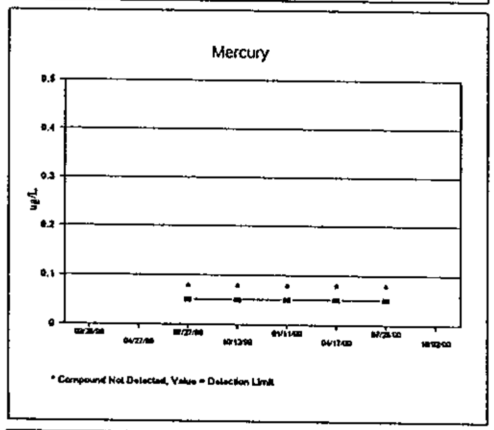
MW-1014C

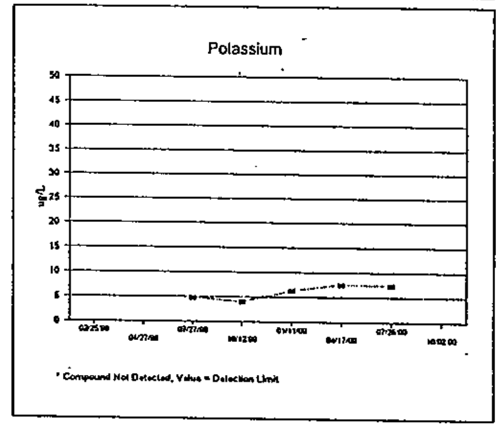


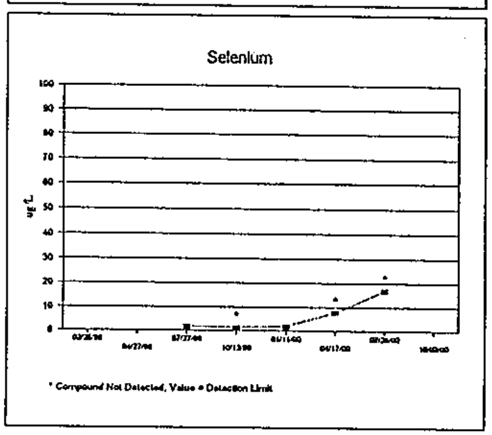



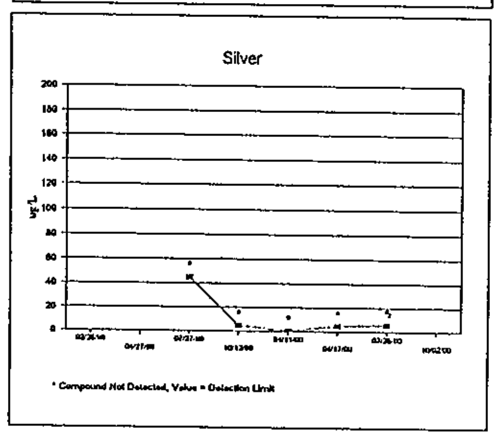



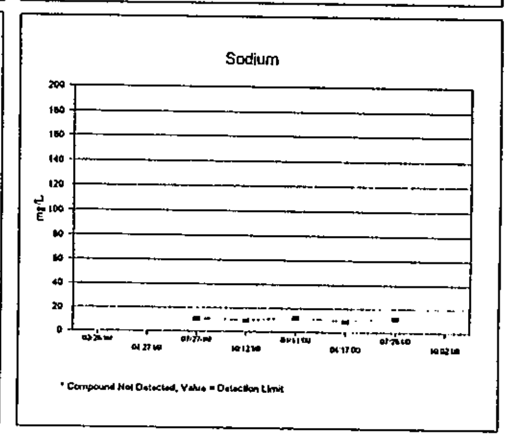



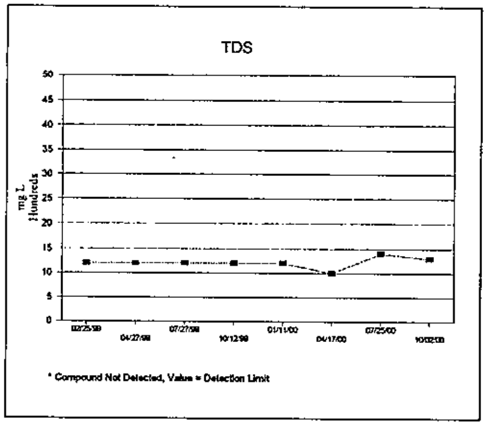



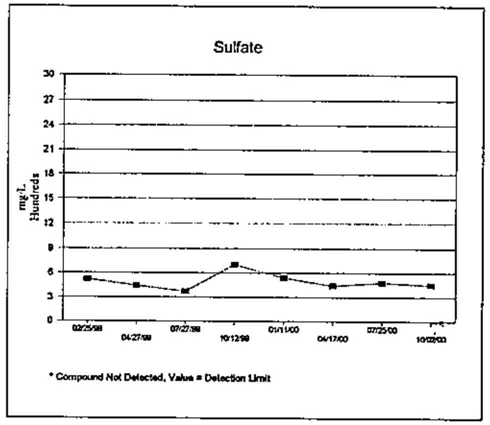



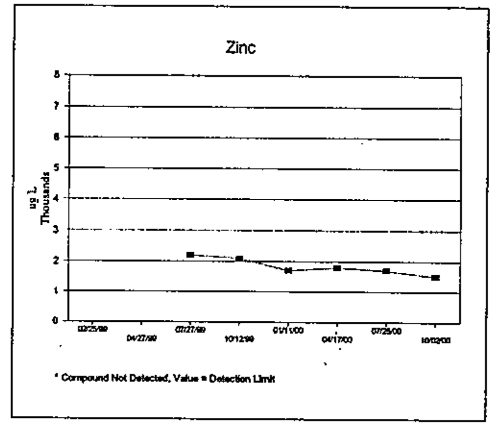



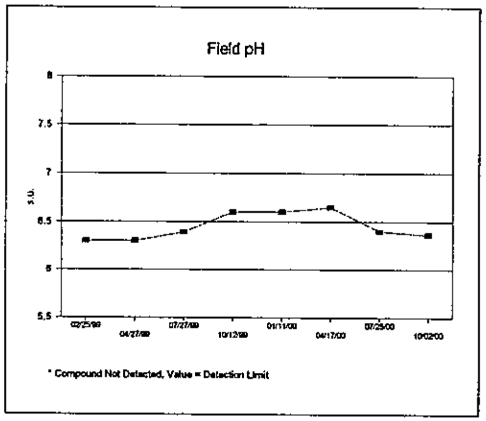
Flambeau Mining Company
Groundwater Quality Results

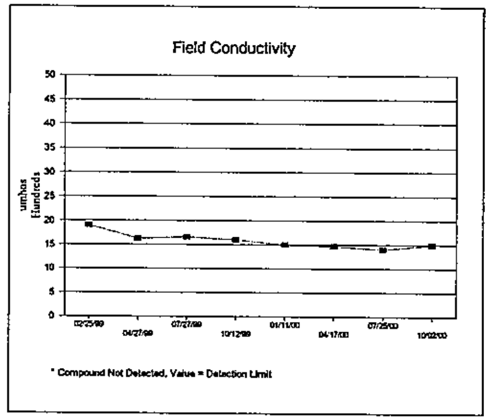
MW-1014C



# Appendix C

**Blue Iris Environmental, Inc.**
**Memorandum**

October 11, 2000

TO: Jana Murphy, Flambeau Mining Company

FR: Bill West, Blue Iris Environmental, Inc.

RE: Report on Activities Associated with 2000 Sediment Sampling , Flambeau River, Ladysmith, Wisconsin

## Introduction

On June 12, 2000, Bill West of Blue Iris Environmental, 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 (Site S-1) was above the reclaimed Flambeau Mine Site and located at the Blackberry Lane access. The second location was downstream of mining site 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 2000 were the same locations sampled in 1993 through 1999 and are shown on Figure 1.

Sediment sample jars were retrieved from the Flambeau River on August 29 after slightly more than 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 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 1/4-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 29, 2000. 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 types of sediments which were typical of previous years. On an average, the upstream samples contained more sediment than in the past which has been atypical of several of the past years except during years during which high flows were observed. There was also a greater amount of collected sediment in the downstream jars, however, sediment particulate size in the downstream jars was observed to be smaller than those observed in upstream samples.

Because of the higher flow witnessed in 2000, one might expect more substrate in each of the jars but a lower percent volatile suspended solids. The lower volatile fraction would be expected based on a lower percentage of biological matter versus inorganic matter collected over the exposure period. The data appears to bear this out.

Sediment levels are shown in Figure 2 and 3 representing samples from Blackberry Lane and Sister's Farm respectively. Figure 4 shows a side by side comparison of the upstream sample with the downstream sample. As noted earlier and in previous annual reports, the upstream sample at Blackberry Lane usually contains a higher amount of small sized grit and pebble, especially in years of high flow. In contrast, the downstream sample at Sister's Farm contains some grit but a higher percentage of smaller sized particles including silty deposition. This condition at Sister's Farm may have more to do with sample site location where the site is characterized by a long sweeping outside bank which has some susceptibility to erosion.

Both sets of jars were colonized by the immature forms of caddisfly.

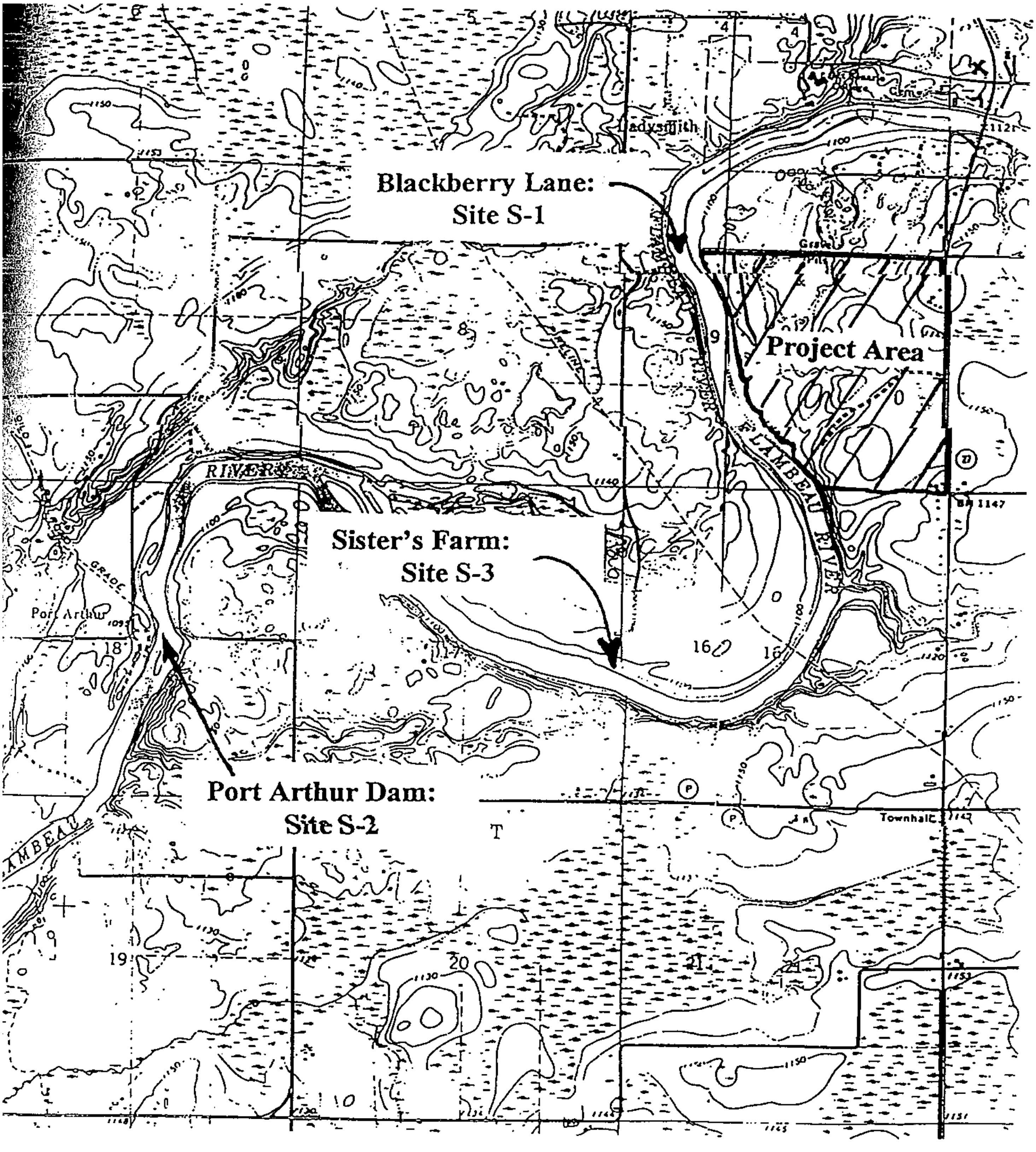
**Results**

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 ten years of sediment analysis indicate that, in general, no increase or decrease in parameter concentration in sediments is occurring. Data from 2000 compare very favorably with data collected in 1999. Moreover, downstream samples continue to compare favorably with upstream sediment samples indicating no impacts due to mine activities.

The data from the sieve analysis is consistent with the observations made during sample collection. That is, there was a higher amount of pebble and sand in the upstream sample while there was a higher amount of silt in the downstream sample. The downstream sample had more than three times the amount of volatile matter on a percentage basis as the upstream sample which again was predictable based on the observations at the time of collection.




| Flambeau Mining Company | |
|---|---|
| Figure 1<br>Flambeau River Sediment<br>Collection Locations | |
| Scale: None | Date: 10/99 |


Figure 2. Sediment Samples Obtained at Blackberry Lane.


Figure 3. Sediment Samples Obtained at Sister's Farm
White line indicates sediment level.

Figure 4 - Sediment Samples Comparison of Sediment Composition
Blackberry Lane (left) with Sister's Farm (right)

Table 1
Flambeau River Sediment Sampling Results
1991 - 2000

| Parameter (mg/kg) | Sample Location/Number | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Blackberry Lane (S-1) | | | | | | | | | |
| | 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-1-09 (1999) | S-1-00 (2000) |
| Silver | <1.2 | <1.1 | 0.057 | <0.21 | <0.05 | <0.57 | <0.70 | <0.043 | <0.068 | <0.16 |
| Aluminum | 3800 | 3300 | 4000 | 3900 | 2900 | 1900 | 2100 | 1900 | 2700 | 2900 |
| Arsenic | 2.2 | 2.2 | 1.4 | <4.2 | <0.41 | 1.6 | <0.87 | 1.1 | <0.71> | <0.73 |
| Cadmium | <0.7 | <0.6 | <0.06 | <0.42 | <0.03 | 0.72 | 1.2 | 1.2 | 1.4 | 1.7 |
| Chromium | 11.0 | 10.0 | 11 | 10 | 4.4 | 4.1 | 5.6 | 5.3 | 7.7 | 7.3 |
| Copper | 7.3 | 6.0 | 7.0 | 5.8 | 6.4 | 5.8 | 5.3 | 4.9 | 7.0 | 6.0 |
| Iron | 18000 | 16000 | 15000 | 11000 | 4800 | 6800 | 6500 | 7900 | 12000 | 13000 |
| Mercury | 0.1 | <0.1 | <0.045 | <0.04 | <0.02 | <0.02 | <0.024> | <0.013 | <0.0070> | <0.078 |
| Manganese | 1900 | 1000 | 1300 | 1500 | 600 | 510 | 700 | 1100 | 1500 | 1100 |
| Nickel | 5.8 | 6.1 | 8.4 | 7.4 | 6.1 | 6.1 | 2.2 | 4.4 | 6.7 | 6.6 |
| Lead | 6.0 | 5.8 | 8.5 | 3.3 | 3.3 | <2.2 | <5.1> | 5.1 | 7.8 | <6.9> |
| Selenium | 0.4 | <0.4 | <0.32 | 4.2 | <0.44 | <0.28 | <1.0 | <0.37 | <0.54 | <0.59 |
| Zinc | 47.0 | 33.0 | 38 | 34 | 18 | 19 | 20 | 18 | 28 | 23 |
| Total Solids% | 73.0 | 78.6 | 79.2 | NA | 76.7 | 74.9 | 72.6 | 41.7 | 74.9 | 78.7 |
| Total Vol. Solids % | 1.8 | 1.6 | 0.77 | NA | <2 | <2 | <2 | 6.7 | <2 | <2 |
| Field Temp. C | 25.0 | 16.2 | 15.0 | NA | 25.0 | 27.0 | 18.9 | 22.8 | 26.1 | 17.8 |

NA = Data Not Available
Data from Site S-1 is referenced by Sample ID#238863, Site S-3 is represented by Sample ID#238864
Data appearing in brackets (< >) was reported as observed between the level of detection (LOD) and level of quantitation (LOQ)

Prepared by: WMW
Checked by: BJW

| Table 1 (cont) | Sample Location/Number | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Port Arthur Dam (S-2) Sister's Farm( S-3) | | | | | | | | | | |
| Parameter (mg/kg) | 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) | S-3-09 (1999) | S-3-00 (2000) |
| Silver | <1.1 | <2.6 | 0.086 | 0.58 | <0.08 | 0.04 | <0.56 | <0.40 | <0.044 | <0.058 | <0.17 |
| Aluminum | 4000 | 12000 | 1500.0 | 4400 | 4000 | 3600 | 2500 | 2400 | 2000 | 3000 | 3200 |
| Arsenic | 1.5 | 4.1 | <0.55 | 0.71 | <1.6 | 1.5 | <0.45 | <0.71 | <0.94> | <0.90> | <0.67 |
| Cadmium | 0.6 | <1.4 | <0.055 | 0.11 | 0.13 | 0.085 | 0.64 | 0.70 | 1.0 | 1.1 | 1.1 |
| Chromium | 13.0 | 24.0 | 23.8 | 9.6 | 10 | 6.6 | 6.3 | 6.1 | 5.6 | 8.0 | 7.8 |
| Copper | 7.2 | 24.0 | 2.1 | 6.7 | 7.1 | 7.0 | 8.2 | 6.7 | 6.1 | 7.7 | 6.4 |
| Iron | 16000 | 25000 | 3100 | 8200 | 7700 | 7300 | 6700 | 7900 | 6300 | 9300 | 18000 |
| Mercury | 0.1 | <0.3 | <0.057 | <0.07 | <0.03 | <0.06 | <0.02 | <0.059> | <0.042> | 0.029 | <0.060> |
| Manganese | 1600 | 570 | 610 | 830 | 860 | 780 | 840 | 910 | 910 | 830 | 680 |
| Nickel | 7.3 | 12.0 | 1.7 | 6.5 | 6.2 | 5.0 | 5.7 | 3.0 | 3.1 | 5.7 | 5.7 |
| Lead | 6.9 | 20.0 | 2.6 | 8.3 | 7.8 | 7.5 | 9.0 | 6.4 | 5.9 | 11 | <8.9> |
| Selenium | 0.4 | <0.9 | <0.28 | <0.26 | <1.6 | <0.27 | 1.4 | <0.95> | <0.37 | <0.54 | <0.54 |
| Zinc | 45.0 | 79.0 | 9.6 | 33 | 46 | 26 | 28 | 24 | 21 | 34 | 30 |
| Total Solids% | 76.8 | 35.0 | 32 | 56 | NA | 44.8 | 49.8 | 30.6 | 24.5 | 45.9 | 52.6 |
| Total Vol. Solids % | 2.5 | 12.0 | 5.8 | 6.24 | NA | 6.9 | 5.5 | 11 | 15 | 6.0 | 6.0 |
| Field Temp. C | 25.0 | 15.8 | 15.5 | 15.5 | NA | 25.0 | 27.0 | 19.4 | 22.8 | 26.1 | 17.8 |

# Appendix 1

## Laboratory Data for Sediment Analysis
## Flambeau Mining Project, 1999

**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# 56175
NLS CUST# 90830

Client: Blue Iris Environmental Inc
Attn: Bill West
N5811 12 Corners Road
Black Creek, WI 54106

Project Description: Flambeau Mining Co.

**Sample ID: FMC-SED-A1/A4** NLS#: 238863
Ref. Line 1 of COC 45323 Description: FMC-SED-A1/A4
Collected: 08/28/00 Received: 09/01/00 Reported: 10/13/00

| Parameter | Result | Units | LOD | LOQ | Method | Analyzed | Lab |
|---|---|---|---|---|---|---|---|
| Aluminum, tot. as Al | 2900 | mg/Kg WWB | 0.57 | 2.0 | SW846 6010 | 09/26/00 | 721026460 |
| Arsenic, tot. as As by furnace AAS | ND | mg/Kg WWB | 0.73 | 2.5 | SW846 7060 | 09/18/00 | 721026460 |
| Cadmium, tot. as Cd | 1.7 | mg/Kg WWB | 0.11 | 0.42 | SW846 6010 | 09/21/00 | 721026460 |
| Chromium, tot. as Cr | 7.3 | mg/Kg WWB | 0.30 | 1.2 | SW846 6010 | 09/21/00 | 721026460 |
| Copper, tot. as Cu | 6.0 | mg/Kg WWB | 0.10 | 0.40 | SW846 6010 | 09/21/00 | 721026460 |
| Iron, tot. as Fe | 13000 | mg/Kg WWB | 0.76 | 3.0 | SW846 6010 | 09/22/00 | 721026460 |
| Lead, tot. as Pb | < 6.9 > | mg/Kg WWB | 2.7 | 11 | SW846 6010 | 09/21/00 | 721026460 |
| Manganese, tot. as Mn | 1100 | mg/Kg WWB | 1.6 | 6.3 | SW846 6010 | 10/03/00 | 721026460 |
| Mercury, total as Hg on solids | ND | mg/Kg WWB | 0.078 | 0.25 | SW846 7470A | 09/21/00 | 721026460 |
| Nickel, tot. as Ni | 6.6 | mg/Kg WWB | 0.33 | 1.3 | SW846 6010 | 09/21/00 | 721026460 |
| Selenium, tot. as Se by furnace AAS | ND | mg/Kg WWB | 0.59 | 2.1 | SW846 7740 | 09/14/00 | 721026460 |
| Silver, tot. as Ag | ND | mg/Kg WWB | 0.16 | 0.61 | SW846 6010 | 09/21/00 | 721026460 |
| Solids, total on solids | 78.7 | % | 0.10 | | ASTM D2216 | 09/07/00 | 721026460 |
| Solids, tot. volatile | ND | % DWB | 2.0 | | EPA 160.4 | 09/04/00 | 721026460 |
| Zinc, tot. as Zn | 23 | mg/Kg WWB | 0.20 | 0.20 | SW846 6010 | 09/21/00 | 721026460 |
| Metals digestion - total (soil/sludge) ICP | yes | | | | SW846 3050 | 09/14/00 | 721026460 |
| Metals digestion - total (soil/sludge) furnace | yes | | | | SW846 3050 | 09/14/00 | 721026460 |
| Sieve test | see attached | | | | ASTM C136/C117 | 09/11/00 | 737105930 |

**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: 5  NLS PROJECT# 56175
NLS CUST# 90830

Client: Blue Iris Environmental Inc
Attn: Bill West
N5811 12 Corners Road
Black Creek, WI 54106

Project Description: Flambeau Mining Co.

**Sample ID: FMC-SED-B1/B4** **NLS#: 238864**
Ref. Line 5 of COC 45323 Description: FMC-SED-B1/B4
Collected: 08/28/00 Received: 09/01/00 Reported: 10/13/00

| Parameter | Result | Units | LOD | LOQ | Method | Analyzed | Lab |
|---|---|---|---|---|---|---|---|
| Aluminum, tot. as Al | 3200 | mg/Kg WWB | 0.61 | 2.2 | SW846 6010 | 09/26/00 | 721026460 |
| Arsenic, tot. as As by furnace AAS | ND | mg/Kg WWB | 0.67 | 2.3 | SW846 7060 | 09/18/00 | 721026460 |
| Cadmium, tot. as Cd | 1.1 | mg/Kg WWB | 0.11 | 0.45 | SW846 6010 | 09/21/00 | 721026460 |
| Chromium, tot. as Cr | 7.8 | mg/Kg WWB | 0.32 | 1.3 | SW846 6010 | 09/21/00 | 721026460 |
| Copper, tot. as Cu | 6.4 | mg/Kg WWB | 0.11 | 0.43 | SW846 6010 | 09/21/00 | 721026460 |
| Iron, tot. as Fe | 18000 | mg/Kg DWB | 1.6 | 6.2 | SW846 6010 | 09/22/00 | 721026460 |
| Lead, tot. as Pb | < 8.9 > | mg/Kg WWB | 2.9 | 12 | SW846 6010 | 09/21/00 | 721026460 |
| Manganese, tot. as Mn | 680 | mg/Kg WWB | 1.7 | 6.8 | SW846 6010 | 10/03/00 | 721026460 |
| Mercury, total as Hg on solids | < 0.060 > | mg/Kg WWB | 0.052 | 0.17 | SW846 7470A | 09/21/00 | 721026460 |
| Nickel, tot. as Ni | 5.7 | mg/Kg WWB | 0.36 | 1.4 | SW846 6010 | 09/21/00 | 721026460 |
| Selenium, tot. as Se by furnace AAS | ND | mg/Kg WWB | 0.54 | 1.9 | SW846 7740 | 09/14/00 | 721026460 |
| Silver, tot. as Ag | ND | mg/Kg WWB | 0.17 | 0.66 | SW846 6010 | 09/21/00 | 721026460 |
| Solids, total on solids | 52.6 | % | 0.10 | | ASTM D2216 | 09/07/00 | 721026460 |
| Solids, tot. volatile | 6.0 | % DWB | 2.0 | | EPA 160.4 | 09/04/00 | 721026460 |
| Zinc, tot. as Zn | 30 | mg/Kg WWB | 0.22 | 0.22 | SW846 6010 | 09/21/00 | 721026460 |
| Metals digestion - total (soil/sludge) ICP | yes | | | | SW846 3050 | 09/14/00 | 721026460 |
| Metals digestion - total (soil/sludge) furnace | yes | | | | SW846 3050 | 09/14/00 | 721026460 |
| Sieve test | see attached | | | | ASTM C136/C117 | 09/11/00 | 737105930 |

MAXIM TECHNOLOGIES INC

Maxim Technologies, Inc.
555 South 72nd Avenue
Wausau, WI 54401
Telephone: (715) 845-4100
FAX: (715) 842-0381

# REPORT OF SIEVE ANALYSIS OF SOIL

**CLIENT:** NORTHERN LAKES SERVICE
STEVE CRUPI
400 NORTH LAKE AVENUE
CRANDON, WI 54520

**PROJECT:** LABORATORY ANALYSIS OF SOIL

PROJECT NO.: 9910570
REPORT NO.: W83782
DATE OF SERVICE: 9/11/2000
AUTHORIZATION: S0-356
REPORT DATE: 9/12/2000

**SERVICES:** This report represents the results of our analysis on two samples received in our laboratory on 9-7-2000 from Northern Lakes Services (P.O.#S0-356).

## REPORT OF TESTS

METHODOLOGY -

The soil samples were subjected to Mechanical Analysis ASTM:C136/C117.

RESULTS - See attached graph for gradation curves.

| Sieve Size | Percent Passing Lab #238864 | Percent Passing Lab #238863 |
|---|---|---|
| 3/8" | 100 | 100 |
| #4 | 100 | 95.3 |
| #10 | 100 | 75.5 |
| #40 | 98.2 | 11.5 |
| #100 | 66.1 | 0.9 |
| #200 | 16.9 | 0.3 |

REMARKS -

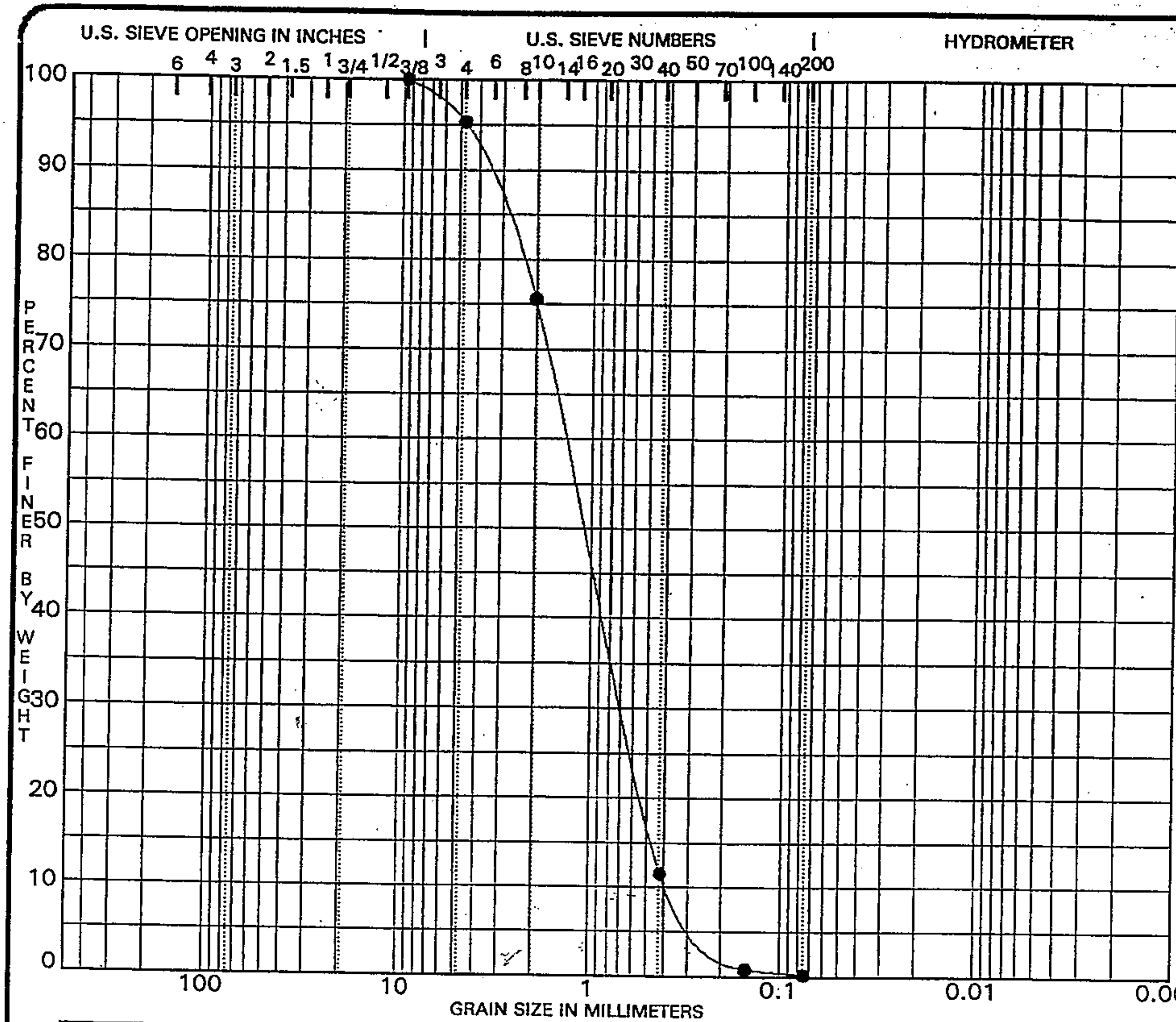
The samples were consumed in the testing.

**Technician:** ERIC DOBBE
ENGINEERING TECHNICIAN

**Report Distribution:**
(1) NORTHERN LAKES SERVICE

MAXIM TECHNOLOGIES INC.

PAUL MICHLIG
CME SUPERVISOR




| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| Specimen Identification | | | Classification | MC% | LL | PL | PI | Cc | Cu |
|---|---|---|---|---|---|---|---|---|---|
| ● | 238863 | 0.0 | POORLY GRADED SAND SP | | | | | 0.88 | 3.7 |

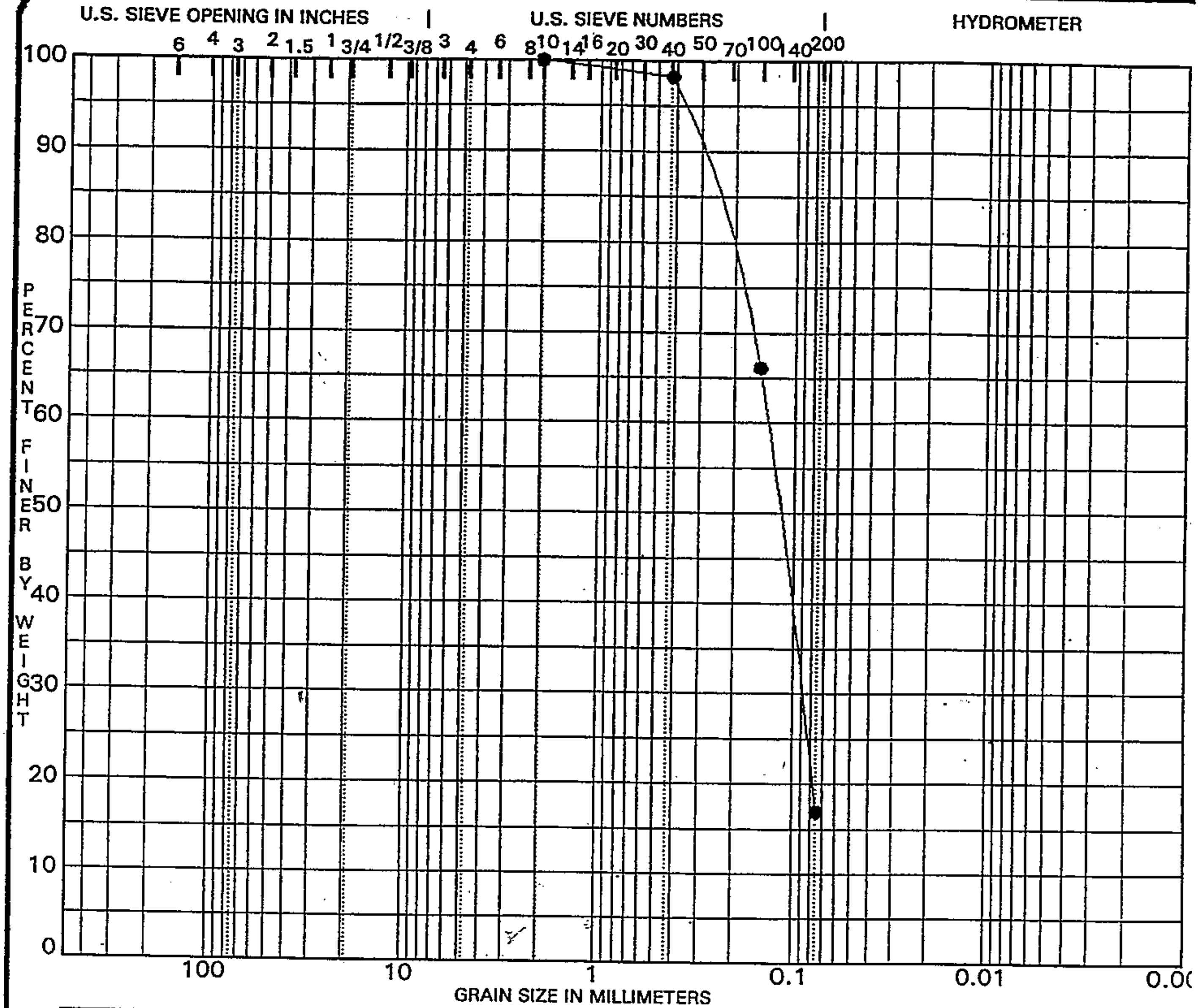
| Specimen Identification | | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Silt | %Clay |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 238863 | 0.0 | 9.50 | 1.37 | 0.665 | 0.3668 | 4.7 | 95.0 | 0.3 | |

PROJECT NORTHEN LAKES SEVICES 400 NORTH LAKE AVENUE, CRANDON WI. 54520

JOB NO. 9910570
DATE 9/18/00

# GRADATION CURVES

**MAXIM TECHNOLOGIES, INC.**
555 SOUTH 72ND AVENUE WAUSAU, WI




| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| Specimen Identification | | Classification | MC% | LL | PL | PI | Cc | Cu |
|---|---|---|---|---|---|---|---|---|
| ● 238864 | 0.0 | | | | | | | |

| Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Silt | %Clay |
|---|---|---|---|---|---|---|---|---|---|
| ● 238864 | 0.0 | 2.00 | 0.14 | 0.090 | | 0.0 | 83.1 | 16.9 | |

PROJECT NORTHEN LAKES SEVICES 400 NORTH LAKE AVENUE, CRANDON WI. 54520

JOB NO. 9910570
DATE 9/18/00

# GRADATION CURVES

MAXIM TECHNOLOGIES, INC.
555 SOUTH 72ND AVENUE WAUSAU, WI

# Appendix D

**Blue Iris Environmental, Inc.**
**Memorandum**

October 10, 2000

TO: Jana Murphy, Flambeau Mining Company

FR: Bill West, Blue Iris Environmental, Inc.

RE: Report on Activities Associated with 2000 Fish Sampling
Flambeau River, Ladysmith, Wisconsin

## Introduction

On August 29 and 30, 2000, representatives of EA Associates, Deerfield, Illinois and Blue Iris Environmental, Inc., 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 29, 2000 and on the Ladysmith Flowage on August 30, 2000. Approximately 40-45% of the workable shoreline of the Thornapple Flowage was sampled (6.6 hours of energized time). Weather conditions at the initiation of the collection period included a clear sky with a temperature in the lower 60s (°F). Initial water conditions included a temperature of 23.5 °C, dissolved oxygen of 8.6 mg/L, and conductivity of 108 umhs/cm (all measurements taken near the boat ramp prior to sampling).

Approximately 40-45% of the workable shoreline of the Ladysmith Flowage was sampled (5.0 hours of energized time). Weather conditions at the initiation of the collection period included a partly cloudy sky, air temperature in the low 60s (°F) and a slight breeze. Initial water conditions included a temperature of 23.0 °C, dissolved oxygen of 8.3 mg/L, and conductivity of 108 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. Walleye which met the criteria for length were set aside in tubs of ice water for further processing. Walleye 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 walleye 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 Blue Iris Environmental, Inc. 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 2000) 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.

Blue Iris Environmental, Inc. 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 2000. 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 2000**

| ID No. | Length (mm) | Weight (g) | Sex | Age |
|---|---|---|---|---|
| | | **Thornapple Flowage** | | |
| WE-TA-01 | 297 | 185 | U* | 2+ |
| WE-TA-02 | 333 | 275 | M | 3+ |
| WE-TA-03 | 375 | 410 | F | 4+ |
| WE-TA-04 | 380 | 435 | F | 4+ |
| WE-TA-05 | 382 | 470 | F | 4+ |
| WE-TA-06 | 384 | 475 | M | 4+ |
| WE-TA-07 | 387 | 495 | F | 4+ |
| WE-TA-08 | 410 | 590 | M | 4+ |
| WE-TA-09 | 444 | 715 | F | 5+ |
| | | **Ladysmith Flowage** | | |
| WE-LS-01 | 285 | 160 | U | 2+ |
| WE-LS-02 | 312 | 210 | F | 2+ |
| WE-LS-03 | 336 | 330 | F | 3+ |
| WE-LS-04 | 353 | 345 | M | 3+ |
| WE-LS-05 | 369 | 415 | M | 3+ |
| WE-LS-06 | 370 | 475 | M | 3+ |
| WE-LS-07 | 403 | 610 | F | 4+ |
| WE-LS-08 | 444 | 725 | F | 5+ |
| WE-LS-09 | 445 | 750 | F | 5+ |

*U=unsexed, M=male, F=female

Prepared by: WMW
Checked by: BJW

## Table 2

**Fish Species Observed**
**Flambeau River, Ladysmith, Wisconsin**
**August 2000**

| Fish Species | Thornapple* Flowage | Ladysmith* Flowage |
|---|---|---|
| Northern pike | C | C |
| Muskellunge | C | P |
| Silver redhorse | C | C |
| Golden redhorse | P | --- |
| Walleye | A | A |
| Burbot | --- | P |
| White sucker | P | --- |
| Rock bass | A | A |
| Smallmouth bass | A | C |
| Yellow perch | C | C |
| Shorthead redhorse | P | P |
| Pumpkinseed sunfish | P | --- |
| Bluegill | P | P |
| Northern hog sucker | P | --- |
| Golden shiner | P | --- |
| Black bullhead | --- | P |
| Lamprey sp. | --- | P |

* A=Abundant
C=Common
P=Present
— not found

Prepared by: WMW
Checked by: BJW

## Table 3

**Stomach Analysis of Walleye**
**Flambeau River, Ladysmith, Wisconsin**
**August 2000**

| Sample ID | Percent Full | Type of Content | General Comment |
|---|---|---|---|
| WE-TA-01 | 100% | Undiscernable matter | Mostly digested |
| WE-TA-02 | Empty | None | None |
| WE-TA-03 | 60% | Part of crayfish | Mostly digested |
| WE-TA-04 | Empty | None | None |
| WE-TA-05 | 100% | Small mammal | Mostly digested; hair and tail remain |
| WE-TA-06 | 30% | Part of crayfish | Mostly digested |
| WE-TA-07 | 70% | 1 minnow | Mostly digested |
| WE-TA-08 | Empty | None | None |
| WE-TA-09 | Empty | None | None |
| WE-LS-01 | Empty | None | None |
| WE-LS-02 | Empty | None | None |
| WE-LS-03 | 100% | 1 crayfish | Intact, no digestion |
| WE-LS-04 | 60% | 1 minnow | Mostly digested |
| WE-LS-05 | 100% | 2 crayfish | Intact, no digestion |
| WE-LS-06 | 10% | Undiscernable matter | Mostly digested |
| WE-LS-07 | 100% | 1 minnow | Mostly digested |
| WE-LS-08 | Empty | None | None |
| WE-LS-09 | 80% | 2 minnows; some eel grass | Mostly digested |

**Table 4**
**Fish Tissue Analysis**
**Flambeau River, Ladysmith, Wisconsin**
**Mercury 1991 - 2000 (mg/kg)**

| Fish ID No. | Year | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
| **Thornapple Flowage** | | | | | | | | | | |
| WE-TA-01 | 0.09 | 0.78 | 0.40 | 0.10 | 0.08 | 0.12 | 0.16 | <0.24> | <0.054 | <0.14> |
| WE-TA-02 | 1.00 | 0.55 | 0.40 | 0.18 | 0.10 | 0.09 | 0.13 | <0.13> | <0.074> | <0.18> |
| WE-TA-03 | 0.60 | 0.59 | 0.20 | 0.19 | 0.09 | 0.19 | 0.15 | <0.24> | 0.22 | <0.19> |
| WE-TA-04 | 0.80 | 0.52 | 0.48 | 0.21 | 0.13 | 0.13 | 0.66 | <0.24> | <0.12> | <0.10 |
| WE-TA-05 | 0.40 | 0.68 | 0.39 | 0.37 | 0.12 | 0.16 | <0.072> | <0.20> | <0.11> | <0.16> |
| WE-TA-06 | 0.70 | 0.76 | 0.33 | 0.88 | 0.12 | 0.19 | 0.14 | 0.29 | 0.37 | <0.19> |
| WE-TA-07 | 0.60 | 0.44 | 1.10 | 0.59 | 0.14 | 0.35 | 0.14 | <0.19> | <0.11> | <0.19> |
| WE-TA-08 | 0.80 | 0.47 | 0.63 | 0.29 | 0.13 | 0.23 | 0.14 | <0.20> | <0.040> | <0.12> |
| WE-TA-09 | 0.60 | 0.38 | 0.91 | 0.32 | 0.13 | 0.19 | 0.52 | <0.22> | <0.14> | 0.51 |
| Average Concentration | 0.71 | 0.57 | 0.54 | 0.35 | 0.12 | 0.17 | 0.20 | 0.22 | 0.14 | 0.20 |
| **Ladysmith Flowage** | | | | | | | | | | |
| WE-LS-01 | 0.90 | 0.99 | 0.68 | 0.35 | 0.19 | 0.17 | <0.079> | <0.20> | <0.046> | 0.94 |
| WE-LS-02 | 0.80 | 0.94 | 0.67 | 0.45 | 0.12 | 0.23 | 0.25 | 0.27 | 0.13 | <0.27> |
| WE-LS-03 | 0.80 | 0.79 | 0.55 | 0.31 | 0.18 | 0.44 | 0.34 | <0.19> | <0.066> | <0.16> |
| WE-LS-04 | 0.70 | 0.85 | 0.44 | 0.25 | 0.16 | 0.27 | 0.16 | 0.27 | 0.20 | <0.10> |
| WE-LS-05 | 0.90 | 0.81 | 0.81 | 0.53 | 0.15 | 0.30 | 0.12 | 0.29 | 0.15 | <0.18> |
| WE-LS-06 | 0.60 | 0.91 | 0.66 | 0.35 | 0.15 | 0.50 | 0.34 | 0.34 | 0.18 | <0.27> |
| WE-LS-07 | 0.80 | 0.82 | 0.71 | 0.25 | 0.29 | 0.40 | 0.32 | 0.33 | 0.19 | <0.25> |
| WE-LS-08 | 0.60 | 0.96 | 0.76 | 0.18 | 0.25 | 0.38 | 0.22 | 0.31 | <0.14> | <0.27> |
| WE-LS-09 | 0.60 | 0.55 | 0.77 | 0.31 | 0.29 | 0.38 | 0.26 | 0.50 | <0.10> | <0.27> |
| Average Concentration | 0.67 | 0.84 | 0.67 | 0.33 | 0.20 | 0.34 | 0.20 | 0.30 | 0.13 | 0.30 |

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

Prepared by: WMW
Checked by: BJW

## Table 5

### Metals Analysis of Walleye Liver
### Flambeau River, Ladysmith, Wisconsin
### 1991 - 2000 (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 |
| WE-TA-1-9 1999 | 0.20 | <0.11 | 46 | 0.69 | <0.74 | 28 | 5.0 | <0.047> | <0.30 | <0.62> | <0.13> | 110 | 1.4 |
| WE-TA-1-9 2000 | 0.21 | <0.14 | 48 | <0.54> | <1.3 | 30 | <0.90> | 0.36 | <0.37 | <0.34> | <0.11> | 130 | 2.0 |

Table 5 (cont)

| Sample ID | Cd | Cr | Cu | Ni | Pb | Zn | Al | Hg | As | Se | Ag | Fe | Mn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **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 |
| WE-LS-1-9 1999 | 0.23 | <0.23> | 25 | <0.43> | <0.75 | 23 | 4.5 | 0.11 | <0.31 | <0.75> | <0.037 | 79 | 2.1 |
| WE-LS-1-9 2000 | 0.20 | <0.14 | 32 | <0.61> | <1.3 | 25 | <0.59> | <0.23> | <0.37 | <0.30 | <0.10> | 92 | 1.7 |

Data for the Thornapple Flowage have sample ID#238884,Data for the Ladysmith Flowage have sample ID#238874
Data in appearing brackets (< >) were observed in concentrations between the level of detection (LOD) and level of quantitation (LOQ)

Prepared by: WMW
Checked by: BJW

*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
# 2000

**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# 56175
NLS CUST# 90830

Client: Blue Iris Environmental Inc
Attn: Bill West
N5811 12 Corners Road
Black Creek, WI 54106

Project Description: Flambeau Mining Co.

**Sample ID: WE-LS-01** NLS#: 238865
Ref. Line 1 of COC 45324 Description: WE-LS-01
Collected: 08/29/00 Received: 09/01/00 Reported: 10/13/00

| Parameter | Result | Units | LOD | LOQ | Method | Analyzed | Lab |
|---|---|---|---|---|---|---|---|
| Mercury (Tissue) by CVAA | 0.94 | mg/Kg WWB | 0.10 | 0.32 | SW846 7470 | 09/26/00 | 721026460 |

**Sample ID: WE-LS-02** NLS#: 238866
Ref. Line 2 of COC 45324 Description: WE-LS-02
Collected: 08/29/00 Received: 09/01/00 Reported: 10/13/00

| Parameter | Result | Units | LOD | LOQ | Method | Analyzed | Lab |
|---|---|---|---|---|---|---|---|
| Mercury (Tissue) by CVAA | < 0.27 > | mg/Kg WWB | 0.10 | 0.32 | SW846 7470 | 09/26/00 | 721026460 |

**Sample ID: WE-LS-03** NLS#: 238867
Ref. Line 3 of COC 45324 Description: WE-LS-03
Collected: 08/29/00 Received: 09/01/00 Reported: 10/13/00

| Parameter | Result | Units | LOD | LOQ | Method | Analyzed | Lab |
|---|---|---|---|---|---|---|---|
| Mercury (Tissue) by CVAA | < 0.16 > | mg/Kg WWB | 0.10 | 0.32 | SW846 7470 | 09/26/00 | 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# 56175
NLS CUST# 90830

Client: Blue Iris Environmental Inc
Attn: Bill West
N5811 12 Corners Road
Black Creek, WI 54106

Project Description: Flambeau Mining Co.

**Sample ID: WE-LS-04** **NLS#: 238868**
Ref. Line 4 of COC 45324 Description: WE-LS-04
Collected: 08/29/00 Received: 09/01/00 Reported: 10/13/00

| Parameter | Result | Units | LOD | LOQ | Method | Analyzed | Lab |
|---|---|---|---|---|---|---|---|
| Mercury (Tissue) by CVAA | < 0.10 > | mg/Kg WWB | 0.10 | 0.32 | SW846 7470 | 09/26/00 | 721026460 |

**Sample ID: WE-LS-05** **NLS#: 238869**
Ref. Line 5 of COC 45324 Description: WE-LS-05
Collected: 08/29/00 Received: 09/01/00 Reported: 10/13/00

| Parameter | Result | Units | LOD | LOQ | Method | Analyzed | Lab |
|---|---|---|---|---|---|---|---|
| Mercury (Tissue) by CVAA | < 0.18 > | mg/Kg WWB | 0.10 | 0.32 | SW846 7470 | 09/26/00 | 721026460 |

**Sample ID: WE-LS-06** **NLS#: 238870**
Ref. Line 6 of COC 45324 Description: WE-LS-06
Collected: 08/29/00 Received: 09/01/00 Reported: 10/13/00

| Parameter | Result | Units | LOD | LOQ | Method | Analyzed | Lab |
|---|---|---|---|---|---|---|---|
| Mercury (Tissue) by CVAA | < 0.27 > | mg/Kg WWB | 0.10 | 0.32 | SW846 7470 | 09/26/00 | 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# 56175
NLS CUST# 90830

Client: Blue Iris Environmental Inc
Attn: Bill West
N5811 12 Corners Road
Black Creek, WI 54106

Project Description: Flambeau Mining Co.

**Sample ID: WE-LS-07** **NLS#: 238871**
Ref. Line 7 of COC 45324 Description: WE-LS-07
Collected: 08/29/00 Received: 09/01/00 Reported: 10/13/00

| Parameter | Result | Units | LOD | LOQ | Method | Analyzed | Lab |
|---|---|---|---|---|---|---|---|
| Mercury (Tissue) by CVAA | < 0.25 > | mg/Kg WWB | 0.10 | 0.32 | SW846 7470 | 09/26/00 | 721026460 |

**Sample ID: WE-LS-08** **NLS#: 238872**
Ref. Line 8 of COC 45324 Description: WE-LS-08
Collected: 08/29/00 Received: 09/01/00 Reported: 10/13/00

| Parameter | Result | Units | LOD | LOQ | Method | Analyzed | Lab |
|---|---|---|---|---|---|---|---|
| Mercury (Tissue) by CVAA | < 0.27 > | mg/Kg WWB | 0.10 | 0.32 | SW846 7470 | 09/26/00 | 721026460 |

**Sample ID: WE-LS-09** **NLS#: 238873**
Ref. Line 9 of COC 45324 Description: WE-LS-09
Collected: 08/29/00 Received: 09/01/00 Reported: 10/13/00

| Parameter | Result | Units | LOD | LOQ | Method | Analyzed | Lab |
|---|---|---|---|---|---|---|---|
| Mercury (Tissue) by CVAA | < 0.27 > | mg/Kg WWB | 0.10 | 0.32 | SW846 7470 | 09/26/00 | 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# 56175
NLS CUST# 90830

Client: Blue Iris Environmental Inc
Attn: Bill West
N5811 12 Corners Road
Black Creek, WI 54106

Project Description: Flambeau Mining Co.

**Sample ID: WE-LS-(1-9)** **NLS#: 238874**
Ref. Line 10 of COC 45324 Description: WE-LS-(1-9)
Collected: 08/29/00 Received: 09/01/00 Reported: 10/13/00

| Parameter | Result | Units | LOD | LOQ | Method | Analyzed | Lab |
|---|---|---|---|---|---|---|---|
| Aluminum, tot. as Al | < 0.59 > | mg/Kg WWB | 0.27 | 0.95 | SW846 6010 | 09/26/00 | 721026460 |
| Arsenic, tot. as As by furnace AAS | ND | mg/Kg WWB | 0.37 | 1.3 | SW846 7060 | 09/26/00 | 721026460 |
| Cadmium, tot. as Cd | 0.20 | mg/Kg WWB | 0.050 | 0.20 | SW846 6010 | 09/27/00 | 721026460 |
| Chromium, tot. as Cr | ND | mg/Kg WWB | 0.14 | 0.56 | SW846 6010 | 09/27/00 | 721026460 |
| Copper, tot. as Cu | 32 | mg/Kg WWB | 0.048 | 0.19 | SW846 6010 | 09/27/00 | 721026460 |
| Iron, tot. as Fe | 92 | mg/Kg WWB | 0.36 | 1.4 | SW846 6010 | 10/09/00 | 721026460 |
| Lead, tot. as Pb | ND | mg/Kg WWB | 1.3 | 5.0 | SW846 6010 | 10/04/00 | 721026460 |
| Manganese, tot. as Mn | 1.7 | mg/Kg WWB | 0.076 | 0.30 | SW846 6010 | 10/03/00 | 721026460 |
| Mercury (Tissue) by CVAA | < 0.23 > | mg/Kg WWB | 0.10 | 0.32 | SW846 7470 | 09/26/00 | 721026460 |
| Nickel, tot. as Ni | < 0.61 > | mg/Kg WWB | 0.16 | 0.62 | SW846 6010 | 09/27/00 | 721026460 |
| Selenium, tot. as Se by furnace AAS | ND | mg/Kg WWB | 0.30 | 1.0 | SW846 7740 | 10/01/00 | 721026460 |
| Silver, tot. as Ag | < 0.10 > | mg/Kg WWB | 0.074 | 0.29 | SW846 6010 | 10/06/00 | 721026460 |
| Zinc, tot. as Zn | 25 | mg/Kg WWB | 0.094 | 0.094 | SW846 6010 | 09/27/00 | 721026460 |
| Metals digestion - total (soil/sludge) ICP | yes | | | | SW846 3050 | 09/26/00 | 721026460 |
| Metals digestion - total (soil/sludge) furnace | yes | | | | SW846 3050 | 09/26/00 | 721026460 |

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WIS. LAB CERT. NO. 721026460

# ANALYTICAL REPORT

 NLS PROJECT# 56175

NLS CUST# 90830

Client: Blue Iris Environmental Inc
Attn: Bill West
N5811 12 Corners Road
Black Creek, WI 54106

Project Description: Flambeau Mining Co.

Sample ID: WE-TA-01 NLS#: 238875
Ref. Line 1 of COC 45325 Description: WE-TA-01
Collected: 08/30/00 Received: 09/01/00 Reported: 10/13/00

| Parameter | Result | Units | LOD | LOQ | Method | Analyzed | Lab |
|---|---|---|---|---|---|---|---|
| Mercury (Tissue) by CVAA | < 0.14 > | mg/Kg WWB | 0.10 | 0.32 | SW846 7470 | 09/26/00 | 721026460 |

Sample ID: WE-TA-02 NLS#: 238876
Ref. Line 2 of COC 45325 Description: WE-TA-02
Collected: 08/30/00 Received: 09/01/00 Reported: 10/13/00

| Parameter | Result | Units | LOD | LOQ | Method | Analyzed | Lab |
|---|---|---|---|---|---|---|---|
| Mercury (Tissue) by CVAA | < 0.18 > | mg/Kg WWB | 0.10 | 0.32 | SW846 7470 | 09/26/00 | 721026460 |

Sample ID: WE-TA-03 NLS#: 238877
Ref. Line 3 of COC 45325 Description: WE-TA-03
Collected: 08/30/00 Received: 09/01/00 Reported: 10/13/00

| Parameter | Result | Units | LOD | LOQ | Method | Analyzed | Lab |
|---|---|---|---|---|---|---|---|
| Mercury (Tissue) by CVAA | < 0.19 > | mg/Kg WWB | 0.10 | 0.32 | SW846 7470 | 09/26/00 | 721026460 |

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WIS. LAB CERT. NO. 721026460

# ANALYTICAL REPORT

 NLS PROJECT# 56175

NLS CUST# 90830

Client: Blue Iris Environmental Inc
Attn: Bill West
N5811 12 Corners Road
Black Creek, WI 54106

?roject Description: Flambeau Mining Co.

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**Sample ID: WE-TA-04** NLS#: 238878
Ref. Line 4 of COC 45325 Description: WE-TA-04
Collected: 08/30/00 Received: 09/01/00 Reported: 10/13/00

| Parameter | Result | Units | LOD | LOQ | Method | Analyzed | Lab |
|---|---|---|---|---|---|---|---|
| ıercury (Tissue) by CVAA | ND | mg/Kg WWB | 0.10 | 0.32 | SW846 7470 | 09/26/00 | 721026460 |

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**Sample ID: WE-TA-05** NLS#: 238879
Ref. Line 5 of COC 45325 Description: WE-TA-05
Collected: 08/30/00 Received: 09/01/00 Reported: 10/13/00

| Parameter | Result | Units | LOD | LOQ | Method | Analyzed | Lab |
|---|---|---|---|---|---|---|---|
| ıercury (Tissue) by CVAA | < 0.16 > | mg/Kg WWB | 0.10 | 0.32 | SW846 7470 | 09/26/00 | 721026460 |

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**Sample ID: WE-TA-06** NLS#: 238880
Ref. Line 6 of COC 45325 Description: WE-TA-06
Collected: 08/30/00 Received: 09/01/00 Reported: 10/13/00

| Parameter | Result | Units | LOD | LOQ | Method | Analyzed | Lab |
|---|---|---|---|---|---|---|---|
| ıercury (Tissue) by CVAA | < 0.19 > | mg/Kg WWB | 0.10 | 0.32 | SW846 7470 | 09/26/00 | 721026460 |

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WIS. LAB CERT. NO. 721026460

# ANALYTICAL REPORT

 NLS PROJECT# 56175
NLS CUST# 90830

Client: Blue Iris Environmental Inc
Attn: Bill West
N5811 12 Corners Road
Black Creek, WI 54106

Project Description: Flambeau Mining Co.

**Sample ID: WE-TA-07** NLS#: 238881
Ref. Line 7 of COC 45325 Description: WE-TA-07
Collected: 08/30/00 Received: 09/01/00 Reported: 10/13/00

| Parameter | Result | Units | LOD | LOQ | Method | Analyzed | Lab |
|---|---|---|---|---|---|---|---|
| Mercury (Tissue) by CVAA | < 0.19 > | mg/Kg WWB | 0.10 | 0.32 | SW846 7470 | 09/26/00 | 721026460 |

**Sample ID: WE-TA-08** NLS#: 238882
Ref. Line 8 of COC 45325 Description: WE-TA-08
Collected: 08/30/00 Received: 09/01/00 Reported: 10/13/00

| Parameter | Result | Units | LOD | LOQ | Method | Analyzed | Lab |
|---|---|---|---|---|---|---|---|
| Mercury (Tissue) by CVAA | < 0.12 > | mg/Kg WWB | 0.10 | 0.32 | SW846 7470 | 09/26/00 | 721026460 |

**Sample ID: WE-TA-09** NLS#: 238883
Ref. Line 9 of COC 45325 Description: WE-TA-09
Collected: 08/30/00 Received: 09/01/00 Reported: 10/13/00

| Parameter | Result | Units | LOD | LOQ | Method | Analyzed | Lab |
|---|---|---|---|---|---|---|---|
| Mercury (Tissue) by CVAA | 0.51 | mg/Kg WWB | 0.10 | 0.32 | SW846 7470 | 09/26/00 | 721026460 |

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# ANALYTICAL REPORT

PAGE: 13 NLS PROJECT# 56175

NLS CUST# 90830

Client: Blue Iris Environmental Inc
Attn: Bill West
N5811 12 Corners Road
Black Creek, WI 54106

Project Description: Flambeau Mining Co.

Sample ID: We-TA-(1-9) NLS#: 238884
Ref. Line 10 of COC 45325 Description: We-TA-(1-9)
Collected: 08/30/00 Received: 09/01/00 Reported: 10/13/00

| arameter | Result | Units | LOD | LOQ | Method | Analyzed | Lab |
|---|---|---|---|---|---|---|---|
| luminum, tot. as Al | < 0.90 > | mg/Kg WWB | 0.27 | 0.96 | SW846 6010 | 09/26/00 | 721026460 |
| rsenic, tot. as As by furnace AAS | ND | mg/Kg WWB | 0.37 | 1.3 | SW846 7060 | 09/26/00 | 721026460 |
| admium, tot. as Cd | 0.21 | mg/Kg WWB | 0.051 | 0.20 | SW846 6010 | 09/27/00 | 721026460 |
| hromium, tot. as Cr | ND | mg/Kg WWB | 0.14 | 0.56 | SW846 6010 | 09/27/00 | 721026460 |
| opper, tot. as Cu | 48 | mg/Kg WWB | 0.048 | 0.19 | SW846 6010 | 09/27/00 | 721026460 |
| ron, tot. as Fe | 130 | mg/Kg WWB | 0.36 | 1.4 | SW846 6010 | 10/09/00 | 721026460 |
| ead, tot. as Pb | ND | mg/Kg WWB | 1.3 | 5.1 | SW846 6010 | 10/04/00 | 721026460 |
| anganese, tot. as Mn | 2.0 | mg/Kg WWB | 0.077 | 0.30 | SW846 6010 | 10/03/00 | 721026460 |
| ercury (Tissue) by CVAA | 0.36 | mg/Kg WWB | 0.10 | 0.32 | SW846 7470 | 09/26/00 | 721026460 |
| ickel, tot. as Ni | < 0.54 > | mg/Kg WWB | 0.16 | 0.62 | SW846 6010 | 09/27/00 | 721026460 |
| elenium, tot. as Se by furnace AAS | < 0.34 > | mg/Kg WWB | 0.29 | 1.0 | SW846 7740 | 10/01/00 | 721026460 |
| ilver, tot. as Ag | < 0.11 > | mg/Kg WWB | 0.074 | 0.29 | SW846 6010 | 10/06/00 | 721026460 |
| inc, tot. as Zn | 30 | mg/Kg WWB | 0.095 | 0.095 | SW846 6010 | 09/27/00 | 721026460 |
| etals digestion - total (soil/sludge) ICP | yes | | | | SW846 3050 | 09/26/00 | 721026460 |
| etals digestion - total (soil/sludge) furnace | yes | | | | SW846 3050 | 09/26/00 | 721026460 |

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

OD = Limit of Detection
WB = Dry Weight Basis

LOQ = Limit of Quantitation
NA = Not Applicable

ND = Not Detected
%DWB = (mg/kg DWB)/10000

Reviewed by:

Authorized by:

R. T. Krueger
Laboratory Manager

# Appendix E

Blue Iris Environmental, Inc.
Memorandum

October 25, 2000

TO: Jana Murphy

FR: Bill West, Blue Iris Environmental, Inc.

RE: Report of Activities Conducted in 2000 Associated with Collection and Analysis of Crayfish from the Flambeau River, Ladysmith, Wisconsin

**Introduction**

On August 29, 2000, Bill West of Blue Iris Environmental, Inc., 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 now reclaimed Flambeau Mine Site. 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 | 1:00 p.m. - 3:00 p.m. | 30 |
| Port Arthur Dam | 9:00 a.m. - 11:00 a.m. | 30 |
| Meadowbrook Creek | 11:00 a.m. - 1:00 p.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**

Water levels in the Flambeau River in the early portion of the summer of 2000 were fairly high. Water levels toward the later part of summer including the window during which the crayfish were collected were considered normal to slightly low. Water level in the river on the day of collection was about a foot below bank stage at all three locations. Water temperature during the collection was 20.6 °C at Blackberry Lane, 18.9 °C at Meadowbrook Creek and 17.7 °C at Port Arthur Dam.

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 - 2000

| 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 |
| 1999 | <0.049 | <0.24> | 12 | <0.17> | <0.80 | 10 | 36 | <0.027 | <0.28 | <0.32 | <0.040 |
| 2000 | <0.063 | <0.18 | 8.8 | <0.20 | <1.6 | 9.4 | 11 | <0.10 | <0.42 | <0.34 | <0.093 |

**Crayfish Metals Analysis (cont)**

| Sample ID | Cadmium | Chromium | Copper | Nickel | Lead | Zinc | Aluminum | Mercury | Arsenic | Selenium | Silver |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **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 | <0.1 |
| 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 |
| 1999 | <0.047 | <0.11 | 13 | <0.20> | <0.76 | 8.6 | 14 | <0.027 | <0.23 | <0.26 | <0.038 |
| 2000 | <0.056 | <0.36> | 21 | <0.36> | <1.4 | 14 | 18 | <0.10 | <0.49> | <0.34 | <0.082 |

**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 |
| 1999 | <0.048 | <0.12 | 14 | <0.15 | <0.78 | 8.9 | 17 | <0.027 | <0.27 | <0.31 | <0.039 |
| 2000 | <0.062 | <0.25> | 16 | <0.29> | <1.6 | 12 | 25 | <0.10 | <0.37 | <0.30 | <0.091 |

Data for Blackberry Lane is represented by Sample ID#238860, Meadowbrook Creek by ID#238861, and Port Arthur Dam by ID#238862
Data appearing in brackets (<>) fall between the level of detection (LOD) and level of quantitation (LOQ)

Prepared by: WMW
Checked by: BJW

Appendix 1

**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# 56175
NLS CUST# 90830

Client: Blue Iris Environmental Inc
Attn: Bill West
N5811 12 Corners Road
Black Creek, WI 54106

Project Description: Flambeau Mining Co.

**Sample ID: FMC-CR-BBL** NLS#: 238860
Ref. Line 1 of COC 45322 Description: FMC-CR-BBL
Collected: 08/29/00 Received: 09/01/00 Reported: 10/13/00

| Parameter | Result | Units | LOD | LOQ | Method | Analyzed | Lab |
|---|---|---|---|---|---|---|---|
| Aluminum, tot. as Al | 11 | mg/Kg WWB | 0.34 | 1.2 | SW846 6010 | 10/13/00 | 721026460 |
| Arsenic, tot. as As by furnace AAS | ND | mg/Kg WWB | 0.42 | 1.5 | SW846 7060 | 09/26/00 | 721026460 |
| Cadmium, tot. as Cd | ND | mg/Kg WWB | 0.063 | 0.25 | SW846 6010 | 09/27/00 | 721026460 |
| Chromium, tot. as Cr | ND | mg/Kg WWB | 0.18 | 0.70 | SW846 6010 | 09/27/00 | 721026460 |
| Copper, tot. as Cu | 8.8 | mg/Kg WWB | 0.060 | 0.24 | SW846 6010 | 09/27/00 | 721026460 |
| Lead, tot. as Pb | ND | mg/Kg WWB | 1.6 | 6.4 | SW846 6010 | 10/04/00 | 721026460 |
| Mercury (Tissue) by CVAA | ND | mg/Kg WWB | 0.10 | 0.32 | SW846 7470 | 09/26/00 | 721026460 |
| Nickel, tot. as Ni | ND | mg/Kg WWB | 0.20 | 0.78 | SW846 6010 | 09/27/00 | 721026460 |
| Selenium, tot. as Se by furnace AAS | ND | mg/Kg WWB | 0.34 | 1.2 | SW846 7740 | 10/01/00 | 721026460 |
| Silver, tot. as Ag | ND | mg/Kg WWB | 0.093 | 0.37 | SW846 6010 | 10/06/00 | 721026460 |
| Zinc, tot. as Zn | 9.4 | mg/Kg WWB | 0.12 | 0.12 | SW846 6010 | 09/27/00 | 721026460 |
| Metals digestion - total (soil/sludge) ICP | yes | | | | SW846 3050 | 09/26/00 | 721026460 |
| Metals digestion - total (soil/sludge) furnace | yes | | | | SW846 3050 | 09/26/00 | 721026460 |

EPA Solid Waste

**NORTHERN LAKE SERVICE, INC.**
Analytical Laboratory and Environmental Services
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Tel:(715)478-2777 Fax:(715)478-3060

WIS. LAB CERT. NO. 721026460

# ANALYTICAL REPORT



NLS PROJECT# 56175
NLS CUST# 90830

Client: Blue Iris Environmental Inc
Attn: Bill West
N5811 12 Corners Road
Black Creek, WI 54106

Project Description: Flambeau Mining Co.

**Sample ID: FMC-CR-MBC** **NLS#: 238861**
Ref. Line 2 of COC 45322 Description: FMC-CR-MBC
Collected: 08/29/00 Received: 09/01/00 Reported: 10/13/00

| Parameter | Result | Units | LOD | LOQ | Method | Analyzed | Lab |
|---|---|---|---|---|---|---|---|
| Aluminum, tot. as Al | 18 | mg/Kg WWB | 0.30 | 1.1 | SW846 6010 | 09/26/00 | 721026460 |
| Arsenic, tot. as As by furnace AAS | < 0.49 > | mg/Kg WWB | 0.42 | 1.4 | SW846 7060 | 09/26/00 | 721026460 |
| Cadmium, tot. as Cd | ND | mg/Kg WWB | 0.056 | 0.22 | SW846 6010 | 09/27/00 | 721026460 |
| Chromium, tot. as Cr | < 0.36 > | mg/Kg WWB | 0.16 | 0.62 | SW846 6010 | 09/27/00 | 721026460 |
| Copper, tot. as Cu | 21 | mg/Kg WWB | 0.054 | 0.21 | SW846 6010 | 09/27/00 | 721026460 |
| Lead, tot. as Pb | ND | mg/Kg WWB | 1.4 | 5.6 | SW846 6010 | 10/04/00 | 721026460 |
| Mercury (Tissue) by CVAA | ND | mg/Kg WWB | 0.10 | 0.32 | SW846 7470 | 09/26/00 | 721026460 |
| Nickel, tot. as Ni | < 0.36 > | mg/Kg WWB | 0.18 | 0.69 | SW846 6010 | 09/27/00 | 721026460 |
| Selenium, tot. as Se by furnace AAS | ND | mg/Kg WWB | 0.34 | 1.2 | SW846 7740 | 10/01/00 | 721026460 |
| Silver, tot. as Ag | ND | mg/Kg WWB | 0.082 | 0.32 | SW846 6010 | 10/06/00 | 721026460 |
| Zinc, tot. as Zn | 14 | mg/Kg WWB | 0.11 | 0.11 | SW846 6010 | 09/27/00 | 721026460 |
| Metals digestion - total (soil/sludge) ICP | yes | | | | SW846 3050 | 09/26/00 | 721026460 |
| Metals digestion - total (soil/sludge) furnace | yes | | | | SW846 3050 | 09/26/00 | 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# 56175
NLS CUST# 90830

Client: Blue Iris Environmental Inc
Attn: Bill West
N5811 12 Corners Road
Black Creek, WI 54106

Project Description: Flambeau Mining Co.

**Sample ID: FMC-CR-PAD NLS#: 238862**
Ref. Line 3 of COC 45322 Description: FMC-CR-PAD
Collected: 08/29/00 Received: 09/01/00 Reported: 10/13/00

| Parameter | Result | Units | LOD | LOQ | Method | Analyzed | Lab |
|---|---|---|---|---|---|---|---|
| Aluminum, tot. as Al | 25 | mg/Kg WWB | 0.33 | 1.2 | SW846 6010 | 09/26/00 | 721026460 |
| Arsenic, tot. as As by furnace AAS | ND | mg/Kg WWB | 0.37 | 1.3 | SW846 7060 | 09/26/00 | 721026460 |
| Cadmium, tot. as Cd | ND | mg/Kg WWB | 0.062 | 0.24 | SW846 6010 | 09/27/00 | 721026460 |
| Chromium, tot. as Cr | < 0.25 > | mg/Kg WWB | 0.17 | 0.68 | SW846 6010 | 09/27/00 | 721026460 |
| Copper, tot. as Cu | 16 | mg/Kg WWB | 0.059 | 0.23 | SW846 6010 | 09/27/00 | 721026460 |
| Lead, tot. as Pb | ND | mg/Kg WWB | 1.6 | 6.2 | SW846 6010 | 10/04/00 | 721026460 |
| Mercury (Tissue) by CVAA | ND | mg/Kg WWB | 0.10 | 0.32 | SW846 7470 | 09/26/00 | 721026460 |
| Nickel, tot. as Ni | < 0.29 > | mg/Kg WWB | 0.19 | 0.76 | SW846 6010 | 09/27/00 | 721026460 |
| Selenium, tot. as Se by furnace AAS | ND | mg/Kg WWB | 0.30 | 1.1 | SW846 7740 | 10/01/00 | 721026460 |
| Silver, tot. as Ag | ND | mg/Kg WWB | 0.091 | 0.36 | SW846 6010 | 10/06/00 | 721026460 |
| Zinc, tot. as Zn | 12 | mg/Kg WWB | 0.12 | 0.12 | SW846 6010 | 09/27/00 | 721026460 |
| Metals digestion - total (soil/sludge) ICP | yes | | | | SW846 3050 | 09/26/00 | 721026460 |
| Metals digestion - total (soil/sludge) furnace | yes | | | | SW846 3050 | 09/26/00 | 721026460 |