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February 15, 1994

7 N. BROWN ST., 3RD FLOOR
RHINELANDER, WI 54501-3161

Mr. Paul Didier
Bureau Director
Wisconsin Department of Natural Resources
Bureau of Solid and Hazardous Waste Management
SW/3
101 South Webster Street
Madison, WI 53702

Dear Mr. Didier:

RE: Crandon Mining Company - Crandon Project
Notification of Intent to Collect Data & A Detailed Scope of Study

With this letter Crandon Mining Company (CMC) is submitting 80 copies of the document titled "*Notification of Intent to Collect Data & A Detailed Scope of Study for the Proposed Crandon Project, Crandon, Wisconsin*" which was prepared by Foth & Van Dyke. An additional 40 copies have been forwarded to the Department's Rhinelander Office.

The document has been prepared in accordance with NR 132.05 as notification to the Department of CMC's intent to collect data in support of an application for a mining permit for its Crandon ore deposit. Included within the document is a review of the existing extensive environmental data base for the project, and a proposed scope of study based on information that is currently available to CMC. In reviewing the document, please note that the project is similar, but smaller, than that proposed in the 1980's.

We are requesting that the Department act in an expeditious manner to schedule the public information hearing as soon as administrative codes will allow. To assist the Department and the public in its review of this document, CMC project team members will be available to answer questions or provide additional information at any time convenient to you.

Sincerely,

Jerome D. Goodrich, Jr.
President

JDG:jcp

Enclosures

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7 N. BROWN ST., 3RD FLOOR
RHINELANDER, WI 54501-3161
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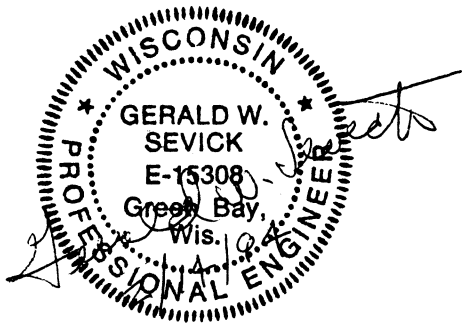
CRANDON FIELD OFFICE
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CRANDON, WI 54520-0336
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Notification of Intent to Collect Data & A Detailed Scope of Study for the Proposed Crandon Project

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1	1	Sokaogon Chippewa Community Arlyn Ackley, Chairman Mole Lake Band Route 1, P.O. Box 625 Crandon, WI 54520-0625



Notification of Intent to Collect Data & A Detailed Scope of Study for the Proposed Crandon Project *Crandon, Wisconsin*

93C049

Prepared for
Crandon Mining Company

Prepared by
Foth & Van Dyke and Associates, Inc.

February 1994

Foth & Van Dyke 1994

2737 S. Ridge Road, P.O. Box 19012, Green Bay, Wisconsin 54307-9012, 414/497-2500, FAX: 414/497-8516

Notification of Intent to Collect Data & A Detailed Scope of Study
Crandon Mining Company

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Appendix C Pertinent Permits
Appendix D Figure 2-2
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1 Introduction

The Crandon deposit was discovered in the mid-1970s using airborne geophysical techniques and exploratory drilling. The deposit is located approximately five miles south of Crandon, Wisconsin.

The size and quality of mineralization has been determined by core holes drilled from the surface. In 1978, Exxon Minerals Company (EMC) submitted to the Wisconsin Department of Natural Resources (WDNR) a Notification of Intent to collect data to support a mining permit application. During the mid-1980s, EMC submitted the following major documents or applications to the WDNR: Environmental Impact Report (EIR), Mine Waste Disposal Facility Feasibility Report, Mine Permit Application, Air Permit Application, Wisconsin Pollutant Discharge Elimination System Permit Application, High Capacity Well Approval Applications, Mine Refuse Disposal Facility Feasibility Report, Chapter 30 and 31 permit applications, and supporting documents. Additional permit applications and plan approvals were submitted by EMC to the Wisconsin Department of Transportation (WDOT) and local units of government, and to the Public Service Commission of Wisconsin (PSC) by Wisconsin Public Service Corporation. In late 1986, the WDNR issued a Final Environmental Impact Statement regarding the proposed project. Also in late 1986, EMC informed the WDNR that it wished to put the permitting process in abeyance due to depressed metal prices.

In the fall of 1993, subsidiaries of Exxon Coal and Minerals Company (formerly EMC) formed a general partnership with subsidiaries of Rio Algom Limited and created Crandon Mining Company (CMC), a Wisconsin general partnership, with the intent to permit and develop the Crandon Project. As described in greater detail in Section 3 of this document, the deposit will be mined and reclaimed in a similar fashion to that proposed in the 1980s, with the exception that the production rate will be reduced by about 25%. The current project will also be modified to meet or exceed current day environmental standards and to incorporate design changes to improve environmental protection.

In order to commence mining operations, numerous environmental, construction, and building permits, etc. from federal, state and local agencies will need to be obtained. The process of obtaining permits is outlined in the various federal, state and local codes and regulations that apply to mining and construction projects in Wisconsin. Two key administrative codes are NR 132 and NR 150.

NR 132 regulates "Metallic Mineral Mining". NR 150 specifies "Environmental Analysis and Review Procedures for WDNR Actions", including environmental assessments for proposed projects and the preparation and review of environmental impact statements (EISs). The proposed Crandon Project would be a "Type I Action", requiring the preparation of an EIS.

The first step in the mine permitting process is the "Notification of Intent to Collect Data". The Notification of Intent (NOI) must contain a description of the proposed project and outline a plan for the collection of data or information intended to be used to support the "Application to Mine". The NOI process involves both regulatory agency and public review through hearings, and is consistent with the issue identification process outlined in NR 150.21.

This NOI contains all of the information that may be required under NR 132.05(2). In preparing the NOI, CMC has included a "Proposed Scope of Study" (SOS) following the

provisions of NR 132.05(7)(a). The combination of the two documents is herein referred to as the CMC NOI/SOS.

The proposed project description represents the current concepts of how the project will be developed and operated. Modifications to the proposed plan will be made in response to environmental, economic and permitting issues raised during the environmental and public review processes.

The following sections contain general project information relating to site location, property ownership, projected date the mine permit application will be submitted to the WDNR, etc.; a detailed description of the project; and details pertaining to the SOS for the project. Included as an appendix to the NOI/SOS is a detailed project quality assurance plan.

Baseline data relating to the project has been collected since the late 1970s. It is CMC's desire to make use of as much of the existing database as possible to fulfill environmental review requirements. Those portions of the database to be carried forward to support the proposed permitting efforts have been carefully selected, and are identified in Section 5, NOI/SOS Files, of this document. Documents listed in Section 5 are hereby made part of the NOI/SOS. Each source document in Section 5 has been assigned a file number (e.g., CMC-NOI-1). Copies of all source documents in the NOI/SOS files have been provided to the WDNR's central office in Madison, WDNR's North Central District Office in Rhinelander, and governmental bodies and libraries in the project vicinity.

The existing database and files for the project are quite extensive. While a detailed review has been completed, it is possible that certain useful existing information will be identified at a later date. If such information is identified, CMC will inform the WDNR and request that the information be added to the project's NOI/SOS files.

In the NOI/SOS references are made to documents in the public domain or in the CMC historical database. Such references are listed by topic and in alphabetical order in Section 6, Bibliography. References are typically called out by author and date (e.g., Rothblatt, 1986) in the text.

The term "data", when used in discussing the NOI/SOS files, relates to "baseline data", and means information collected to define existing conditions prior to the commencement of mining. The existing project files also contain numerous engineering studies and reports. These studies and reports will be used either in part or in total in the preparation of various project permit applications. Such existing studies and reports have not been duplicated at this time or included in the project's NOI/SOS File.

Detailed work plans relating to threatened and endangered species and surface water studies were previously submitted to the WDNR. These studies, titled "*Threatened and Endangered Species Investigations for the Proposed Crandon Project*", November 1993, and "*Surface Water Sampling Quality Assurance Plan for the Proposed Crandon Project*", December 1993, are referenced where appropriate in Section 4, Database and Proposed Scope of Study, of the NOI/SOS narrative. Copies of the narrative of each work plan are included in Appendices A and B, respectively.

Additional ongoing data collection efforts relate to the completion of approximately 13 diamond drill holes to further define the ore deposit and a wetland/lake bed study. Details regarding these two studies are presented in Sections 4.3.6, Geology and Soils, and 4.3.7, Groundwater Characterization, respectively.

Various permits have been obtained to support ongoing data collection work. Copies of these permits are contained in Appendix C.

Certain portions of the proposed scope of study refer to the collection of data and samples from lands not controlled by CMC. To accomplish this, CMC will continue to seek access from various land owners in the area, including the Sokaogon Chippewa Community. If access or needed data cannot be obtained, or is not available from these land owners, best available data and professional judgement will be used in these cases to predict effects of the project, if any.

2 General Project Information

2.1 Name, Address and Telephone Number of Person Submitting Notice of Intent/Scope of Study

Jerome D. Goodrich, Jr., President
Crandon Mining Company
7 North Brown Street, Third Floor
Rhinelander, WI 54501-3161
Phone: (715) 365-1450

Crandon Mining Company is a Wisconsin general partnership formed by subsidiaries of Exxon Coal and Minerals Company, headquartered in Houston, Texas; and subsidiaries of Rio Algom Limited, of Toronto, Ontario.

2.2 Site Location

The CMC ore body is located in Forest County, Wisconsin. The civil land survey location is Section 25, Township 35 North, Range 12 East, Town of Nashville, and Section 30, Township 35 North, Range 13 East, Town of Lincoln. This area is illustrated on Figure 2-1.

The project site is located five miles south of the City of Crandon and two miles east of Highway 55. The site is one-quarter mile north of Little Sand Lake and one mile south of Swamp Creek. Mine surface facilities will be located above and directly north of the ore body. The proposed site layout is shown in Figure 2-2, found in Appendix D.

Access will be from a service road from Highway 55 southeastward to the site. A railroad spur serving the site will be connected northeasterly to the existing Wisconsin Central Limited railroad. The project's tailing management area (TMA) will be located approximately one mile southeast of the mine/mill site.

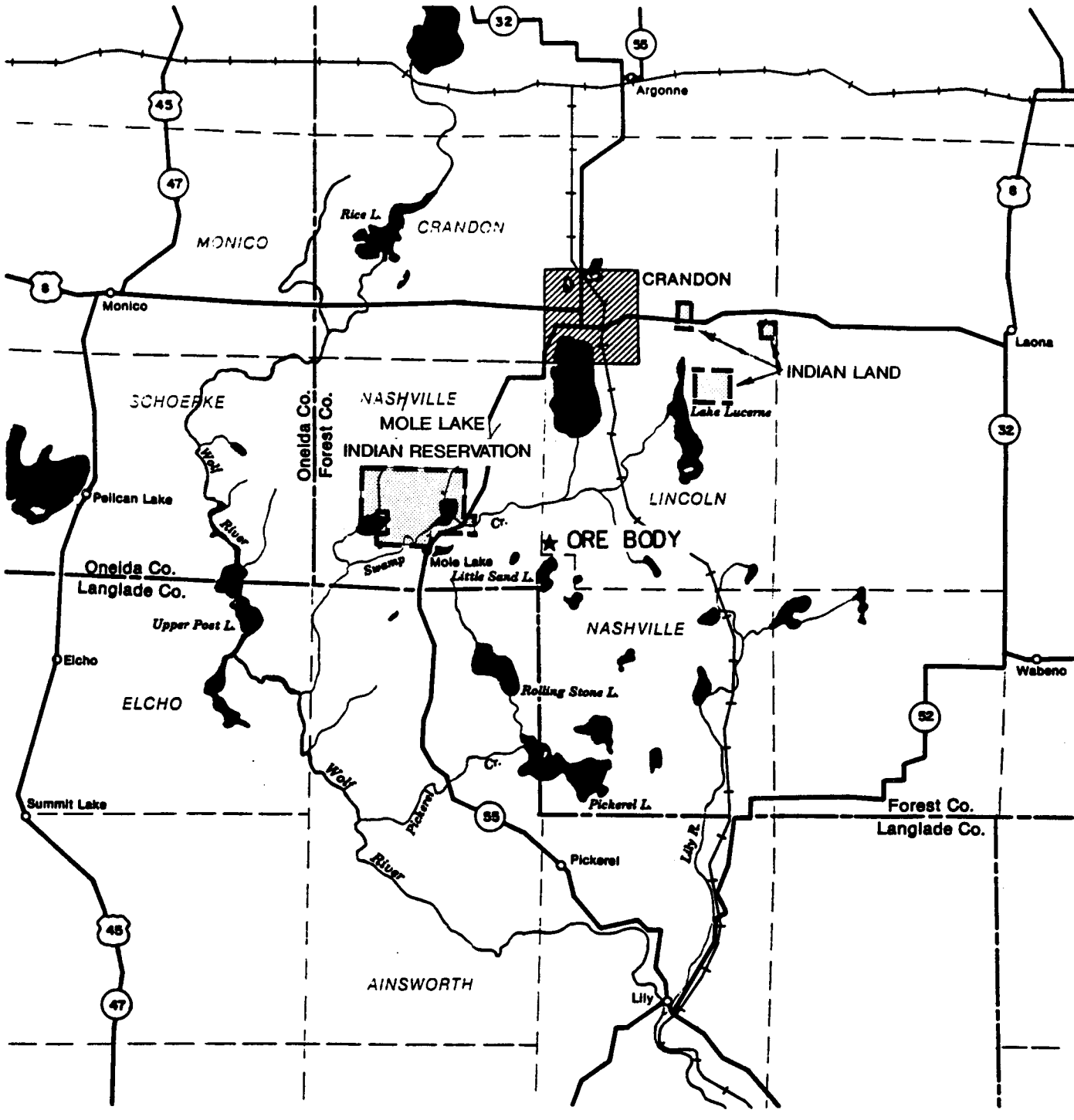
Figure 2-2 (Appendix D) is a site topographic map showing existing site features that are typically on a U.S.G.S. map. The local area shown encompasses the approximate limits of the project's baseline data collection survey area.

2.3 Mine Permit Application Submittal

It is anticipated that the mine permit application for the project will be submitted to the WDNR in the second quarter of 1995.

2.4 Property Ownership

Figure 2-3 is a drawing illustrating Crandon Mining Company's current rights relating to land in and around the project area.



LEGEND

- STATE TRUNK HIGHWAY (55)
- UNITED STATE HIGHWAY (8)
- LAKE
- RAILROAD

Crandon Mining Company

FIGURE 2 - 1

PROJECT LOCATION
CRANDON PROJECT

REVISED	DATE	BY	DESCRIPTION

Scale: AS SHOWN | Date: JANUARY, 1994

Prepared By: Foth & Van Dyke | By: JOW

3c49f1.DGN

93C049 5

Crandon Mining Company

CRANDON BLOCK
FOREST COUNTY, WISCONSIN

- ORE BODY
- FEE PLANT SITE
- PLANT SITE PURCHASE OPTION
- EASEMENT - PERPETUAL
- EASEMENT - OPTIONS
- EASEMENTS - TERM
- FEE S.R. OR M.R. BUFFER ZONE
- M. L. OR OPTION BUFFER ZONE

FEET
0 1000 2000 3000 4000 5000
0 1/4 1/2 3/4 1
MILES

12/2/93	A.T.J/js	R13E T35N S.34(MR & SR)
1/14/94	ATJ/js	MR & SR Revistone
2/7/94	ATJ/js	MR & SR

R 12 E R 13 E

Hwy. 55

MOLE LAKE INDIAN RESERVATION

RICE LAKE

WATER

SWAMP CREEK

OAK LAKE

LITTLE SAND LAKE

DUCK LAKE

DEEP HOLE LAKE

MOLE LAKE

SUBDIV.

WALSH LAKE

KIMBERLY

CLARK LAKE

COOK LAKE

WOODS

SMALL TRACTS

GROUND HEMLOCK LAKE

Town of Lincoln

Forest County

Consolidated Papers

Wisconsin Timber Association

Owens Illinois

LANGLADE COUNTY

FOREST COUNTY

T 35 N
T 34 N

R 12 E R 13 E

FIGURE 2-3

3 Description of the Proposed Project

This section provides a description of the proposed mining project including ore body geology; the mine plan and proposed operations such as ore concentrating and tailings handling; and infrastructure.

3.1 Geology

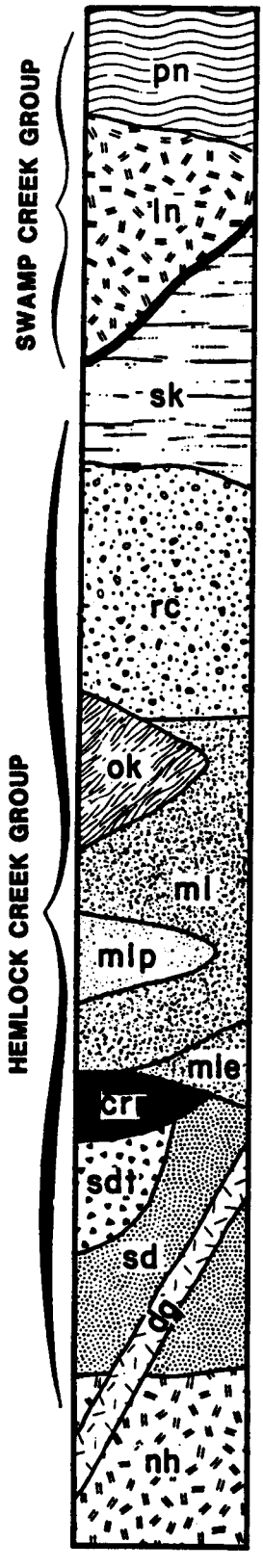
The Crandon deposit contains sulfide ore is of volcanic origin. The minerals were deposited during the PreCambrian era, about 900 to 2500 million years ago. The orebearing deposits were formed on the ocean floor by a volcanic system. Some of the materials deposited by the volcanic system were mineral laden fluids. The mineral laden fluids were heavier than sea water so these fluids accumulated in low spots on the ocean floor near the volcano. Continued accumulation of other volcanic materials and sedimentary rock materials occurred. Later in geologic time, a mountain building phase occurred in the region tilting these layers to a near vertical position and lifting them above the ocean floor. Next, erosion of these rock layers by wind and water occurred. Finally, in the more recent geologic past, these rock layers were covered by unconsolidated materials of glacial origin.

The ore body itself is an enriched zone of these sulfide ore bearing deposits. It is long and tabular with an approximate width of 100 feet and length of 4900 feet. Based on the current level of exploration, the ore body extends to a depth of 2800 feet. It is composed of two distinct mineralizations, zinc ore and copper ore. The zinc ore is primarily composed of sphalerite (zinc sulfide) with interbedded thin layers of pyrite (iron sulfide), chalcopyrite (copper sulfide), and galena (lead sulfide). The copper ore lies statigraphically below the zinc ore deposit, and consists primarily of chalcopyrite, pyrite, and quartz. The interpreted geologic stratigraphy and ore body configuration are shown on Figures 3-1 and 3-2, respectively.

The host rock above and below the ore body consists of a series of volcanic rocks such as tuffs (solidified volcanic ash), debris flows (ocean floor and volcanic-derived sediments), breccia (blocky, angular particles) and lapilli (sand and gravel sized volcanic material). Above the host rock and ore body is a sequence of unconsolidated glacial deposits. The rock in contact with the unconsolidated glacial overburden is weathered in some areas. The amount of weathering varies from staining along fractures of the rock to a reduction of the rock to a clay-like material called saprolite.

The glacial overburden consists of interbedded and intermixed glacial till, which is material deposited directly by the glacier, and glacial outwash deposited by streams emanating from the glacier. Glacial deposits are found in various thicknesses in this area ranging from 75 feet thick to over 250 feet thick.

Groundwater occurs primarily in the glacial materials and to a lesser extent in the upper zones of weathered bedrock. Regional groundwater flow is generally from east to west. A stratified layer of glacial outwash consisting of sands and gravels is the primary aquifer used in the area for local potable water sources. This layer is located below a surficial till layer, and at some locations is separated from the bedrock by a layer of less permeable material which may be a glacial till or a saprolite.



PINE FORMATION (pn)

Predominately a sequence of cherty tuff , argillite and slump breccia.

LINCOLN FORMATION (ln)

Porphyritic flows with minor interflow tuff , chert and argillite.

SKUNK LAKE FORMATION (sk)

Predominately a sequence of cherty tuff , chert , argillite , and slump breccia.

RICE LAKE FORMATION (rc)

A series of volcanic debris flows (blocky chloritic and minor siliceous lapilli and breccia size debris) and eutaxitic ash flows.

OAK LAKE FORMATION (ok)

A sequence of cherty tuff and sericitic tuff.

MOLE LAKE FORMATION (ml)

Predominately a homogenous , chloritic tuff.

PROSPECT MEMBER (mlp)

A volcanic debris flow consisting of siliceous , lapilli size debris.

EAGLE MEMBER (mle)

A volcanic greywacke.

CRANDON FORMATION (cr)

A comprised of sulfide , argillite , argillite , tuff , chert , and dolomite.

SAND LAKE FORMATION (sd)

A volcanic sequence of fine tuffs and minor debris flows.

TOWNSHIP MEMBER (sdt)

A volcanic vent breccia complex consisting of poorly sorted , angular lithic debris.

DUCK LAKE GABBRO (dg)

NASHVILLE FORMATION (nh)

Porphyritic flows.

Crandon Mining Company

FIGURE 3 - 1

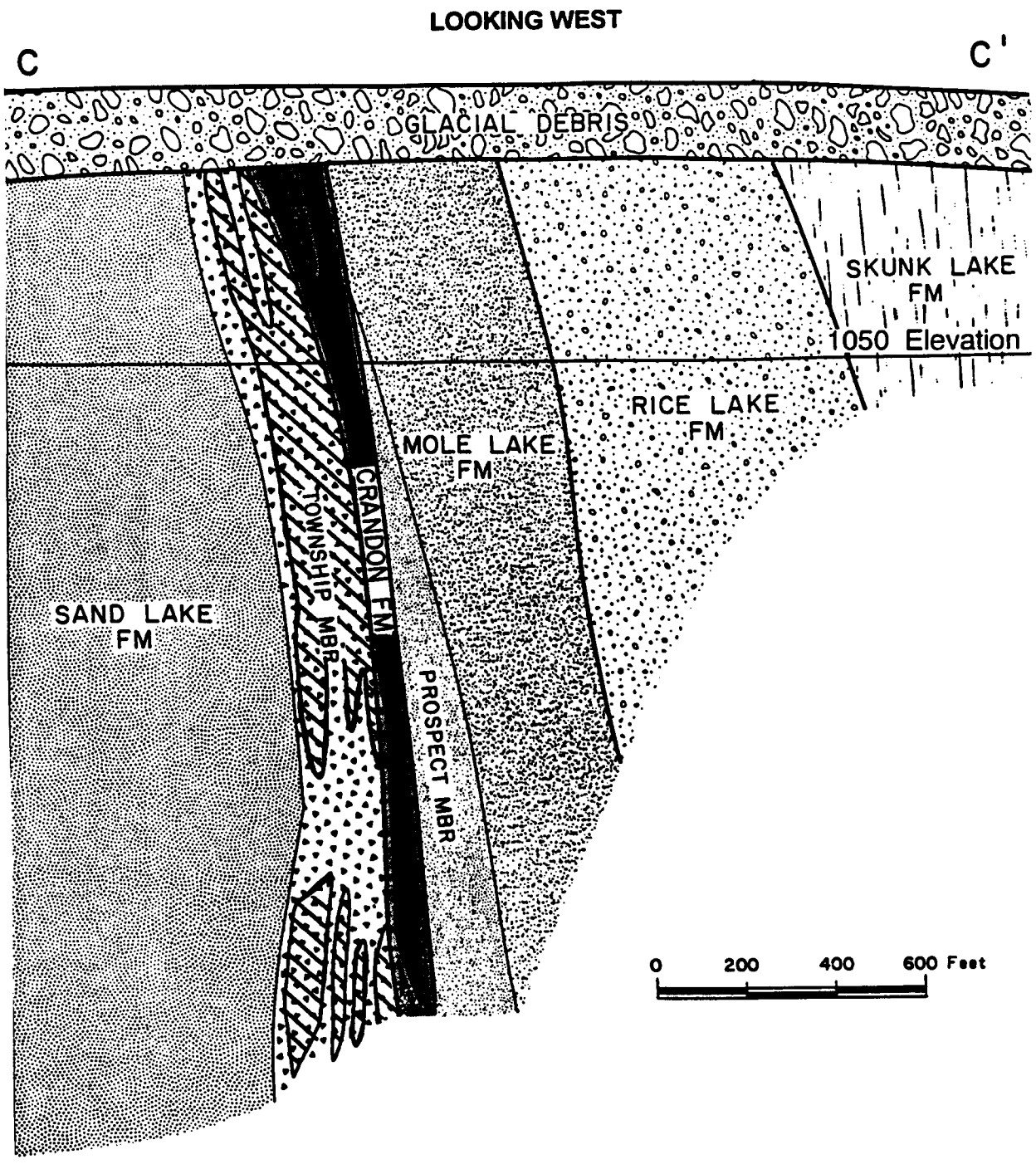
STRATIGRAPHIC COLUMN

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FIGURE 3 - 2
GENERALIZED GEOLOGIC
CROSS SECTION C - C'

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Groundwater inflow into the mine is expected. Previous estimates for the amount of groundwater expected to enter the mine have ranged from less than 1,000 to about 2,000 gallons per minute (GPM). These rates of groundwater inflow are common for underground metal mines, and are not considered an unusually wet operating environment in the mining industry. The groundwater inflow will be re-estimated using more current information and computer models. The majority of groundwater in the immediate vicinity of the mine is expected to be intercepted before entering the mine workings and to be pumped to a treatment facility prior to being released to a surface discharge point.

3.2 Key Project Elements

3.2.1 Mining

3.2.1.1 Mine Layout

The Crandon deposit will be mined by underground mining methods. Open pit mining or underground caving were ruled out as potential mining methods primarily due to the configuration of the ore deposit. The mine will be developed using mechanized blasthole open-stopping with delayed backfill. Below ground accessways will be developed in the bedrock that was deposited above the ore body (called the hanging wall) or in the bedrock that was deposited below the ore body (called the footwall). The ore will then be recovered by the removal of blocks of ore called "stopes".

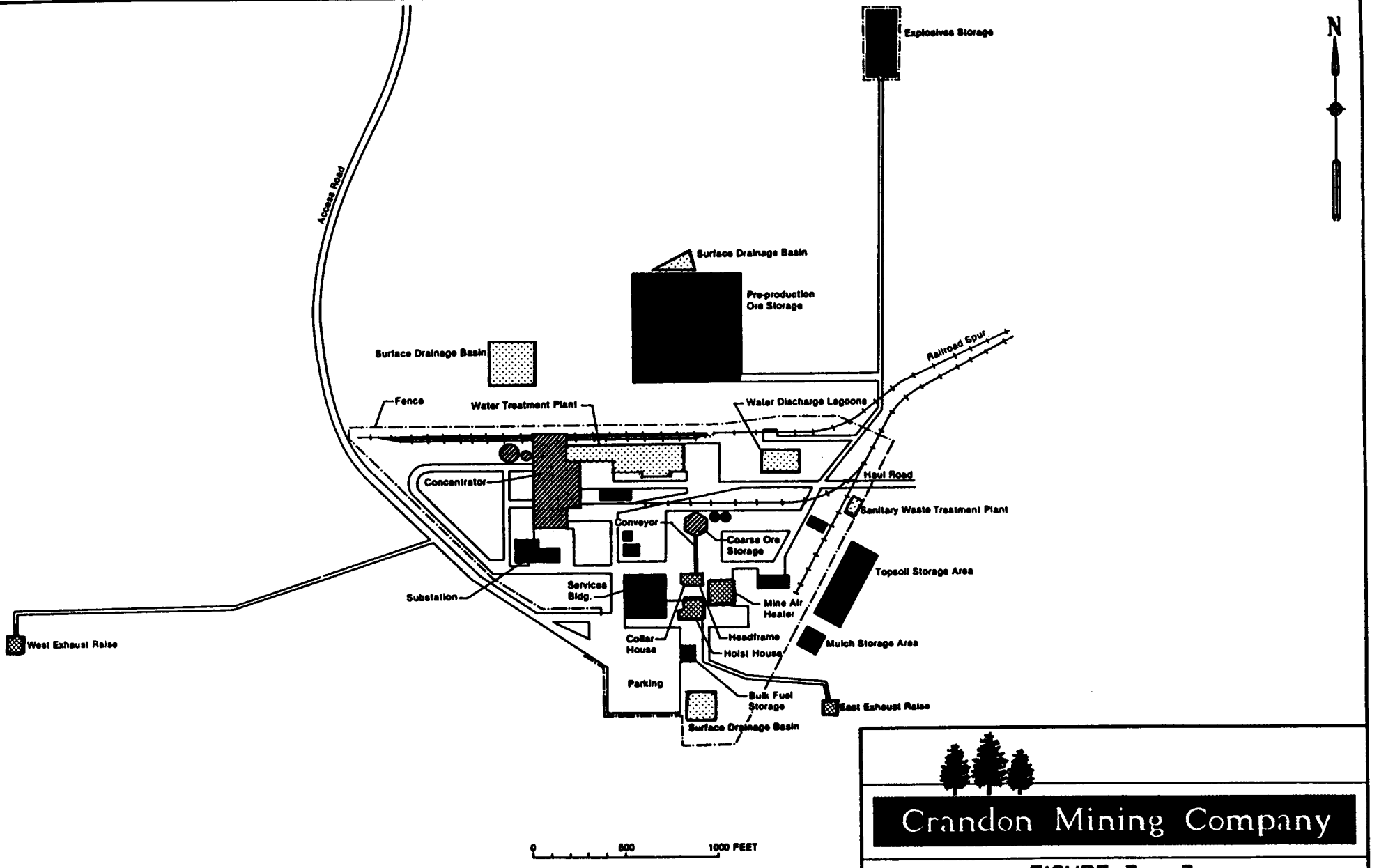
Access into the mine will be through vertical shafts from the surface. One main central shaft and one or two auxiliary shafts are planned. Access to the mine by a decline ramp from the surface was not considered viable because of high construction cost through the unconsolidated glacial materials.

The central shaft will provide primary access for workers, general services, rock hoisting, and serve as the primary fresh air intake opening for the mine. One auxiliary shaft will be used for mine development rock hoisting, and will serve as a mine air exhaust opening and the alternate exit during operations. A second auxiliary shaft may be added later during production to provide for additional mine ventilation.

Facilities on the surface of the mine site will include a service building, an ore concentrating facility, a backfill preparation area, an explosives storage area, a mine wastewater treatment plant, and a headframe for the central shaft. An administration building will provide offices and personnel services areas. A preliminary site layout is illustrated in Figure 3-3.

3.2.1.2 Mine Production

The anticipated rate of production, project life and projected employment requirements are shown on Table 3-1. As with any industrial operation, the life of the facility could change based on economic conditions.



Crandon Mining Company

FIGURE 3 - 3
PRELIMINARY MINE/MILL SITE SURFACES FACILITIES

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Table 3-1

Anticipated Production and Operation Data
Crandon Mining Company NOI/SOS

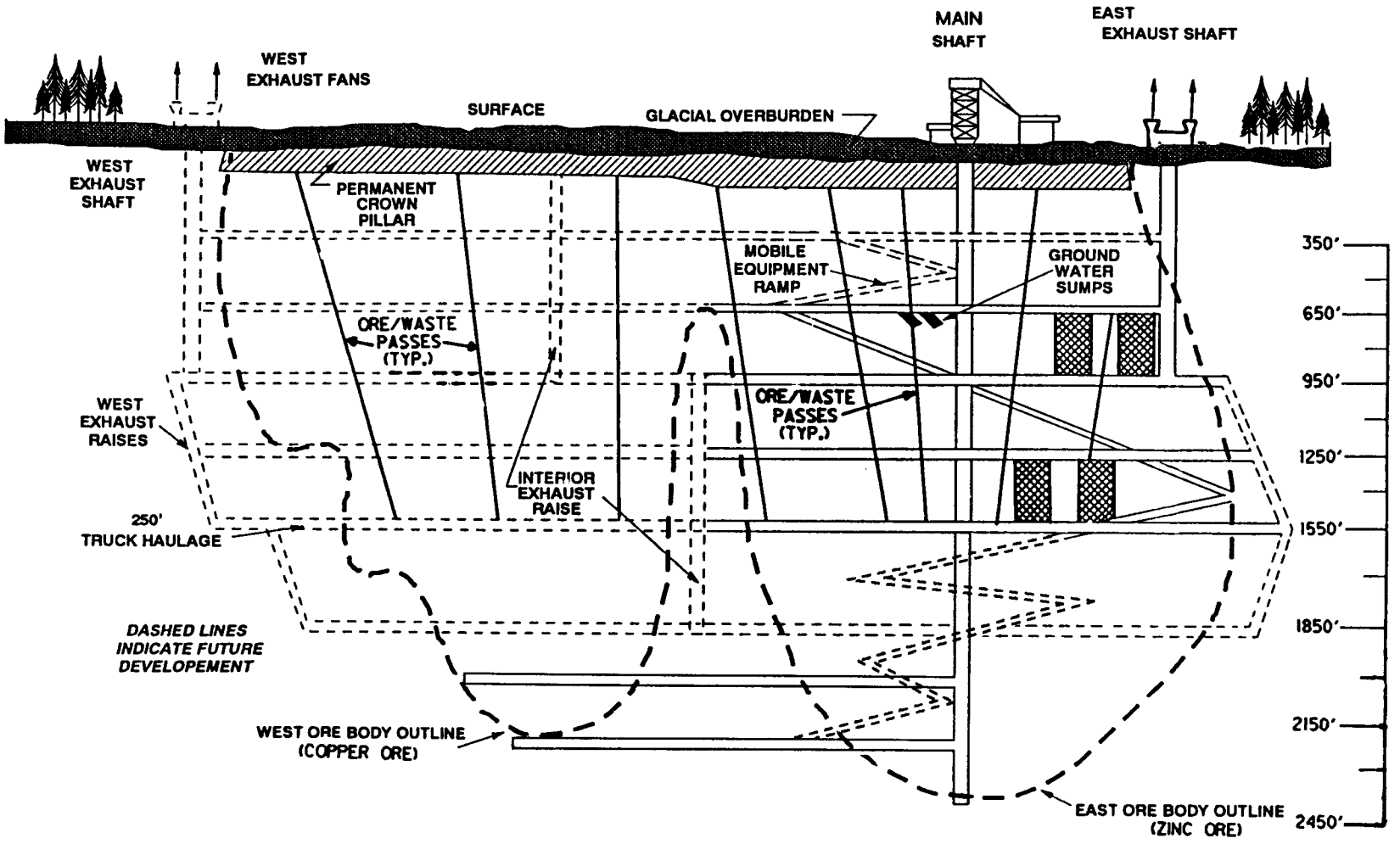
Daily Ore Production	5,500 tons
Annual Ore Production	2,000,000 tons
Total Ore Production	55,000,000 tons
Total Estimated Project Life	35 years
Preproduction	3 years
Mining	28 years
Reclamation	4 years
Production Schedule	5 to 7 days/week
Employment (estimates)	
Peak (during construction)	1,000
Operations	400-500

The blasthole open stoping method of mining is a proven technology that is safe and efficient. The mined stopes are backfilled with waste rock that is derived from the mining of access and haulage ways, tailings material which remains after ore concentration, and cement. The backfilling of the mined stopes provide for long term stability of the mine and maximum ore extraction. This mining technique has been used successfully in mines around the world. Variations of this technique may be used in some areas of the mine depending upon host rock and ore conditions. Rock conditions that may dictate a modification of the mining method include zones where the rock is weathered and less competent, that is, less capable of providing support and strength during mining.

Mine entries, or accessways, will be driven or carved out at 150 to 300 foot vertical intervals. Non-ore or waste rock will be produced during the development of the mine. The waste rock will either be used in the backfill for the mined stopes, as construction material, or disposed on the surface with the tailings that result from ore concentration.

A schematic of the mine layout is shown on Figure 3-4. Removal of the ore on any given vertical level will be accomplished by drilling and blasting the ore in a stope block. The stope blocks are approximately 75 foot wide by 150 foot deep by 300 foot high intervals. These intervals will proceed along the length of the ore body and will be mined in alternating blocks. The backfilling of mined stope blocks provides support for adjacent areas being mined. The proposed alternate sequencing of stope mining is illustrated on Figure 3-5.

The mining sequence removes ore from a stope in the following manner. Holes for blasting are drilled through the ore in the stope. The ore is blasted and transferred to an underground crusher where the ore is reduced to approximately eight inches in size. The ore is then hoisted to the surface and transferred to a covered ore stockpile. Ore is later taken from the stockpile for recovery of the economic minerals in the concentrator building.



Crandon Mining Company

FIGURE 3 - 4
SCHEMATIC LONGITUDINAL SECTION
(LOOKING NORTH)

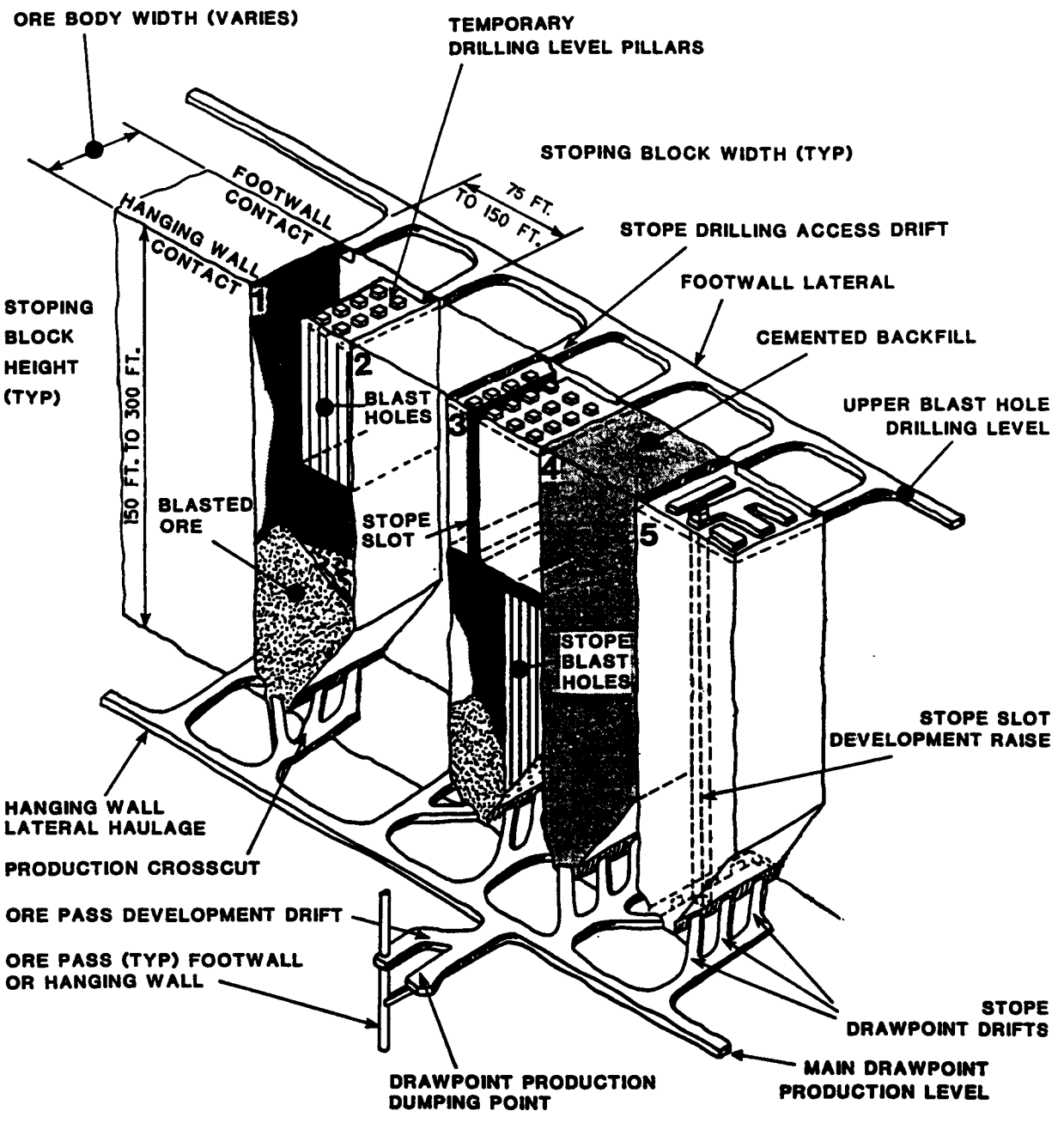
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STOPING BLOCK NO. 1-ACTIVE PRODUCTION-STOPE BLASTING NEARING COMPLETION

STOPING BLOCK NO. 2-ALTERNATE STOPING BLOCK/PILLAR-TO BE MINED AFTER BACKFILLING ADJACENT STOPES

STOPING BLOCK NO. 3-ACTIVE PRODUCTION-INITIAL STAGES OF STOPE BLASTING

STOPING BLOCK NO. 4-DEPLETED STOPE BLOCK-CEMENTED BACKFILL IN PLACE

STOPING BLOCK NO. 5-STOPE BLOCK PARTIALLY DEVELOPED

Crandon Mining Company

FIGURE 3-5

CONCEPTUAL STOPING SEQUENCE

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3.2.1.3 Ore Processing

Ore mined from the Crandon deposit will be physically concentrated at the site by adding water to the crushed ore and grinding it to the size of sand-sized particles or smaller. After grinding, the ore slurry is pumped to a series of circuits that add water and reagents for separating metallic minerals from the waste rock particles (called tailings). During the concentration process, the mineral "floats" to the top of the water and the tailings remain within the water circuit. Different circuits and different reagents are used to concentrate specific individual minerals. A schematic of the ore processing circuits is shown on Figure 3-6. Separate concentrates of zinc, copper and lead minerals will be recovered.

The tailings range in size from coarse sand to very fine particles. The tailings from the mineral separation circuits may be used to backfill the mined-out stopes, or will be sent to settling basins hereafter referred to as the Tailings Management Area (TMA) for settling of the tailings material and removal of the excess water.

In the TMA, the tailings settle to the bottom of the lined basin and clear water rises to the top. Water from the TMA will flow into reclaim water ponds, and then will be pumped to the mill for reuse in the ore processing facility. The ore concentration process, TMA, and reclaim ponds are designed to operate as a closed circuit. The process requires the continuous addition of "make-up" water. Water in this circuit does not require treatment because a discharge does not normally take place. As a contingency measure, the wastewater treatment system will be designed to treat tailings pond waters for discharge, if needed.

3.2.2 Infrastructure

Infrastructure features to support the mining operation include a wastewater treatment system, tailings management facilities, access road, railroad spur, electric power transmission lines, a natural gas pipeline, buildings and storage facilities, etc.

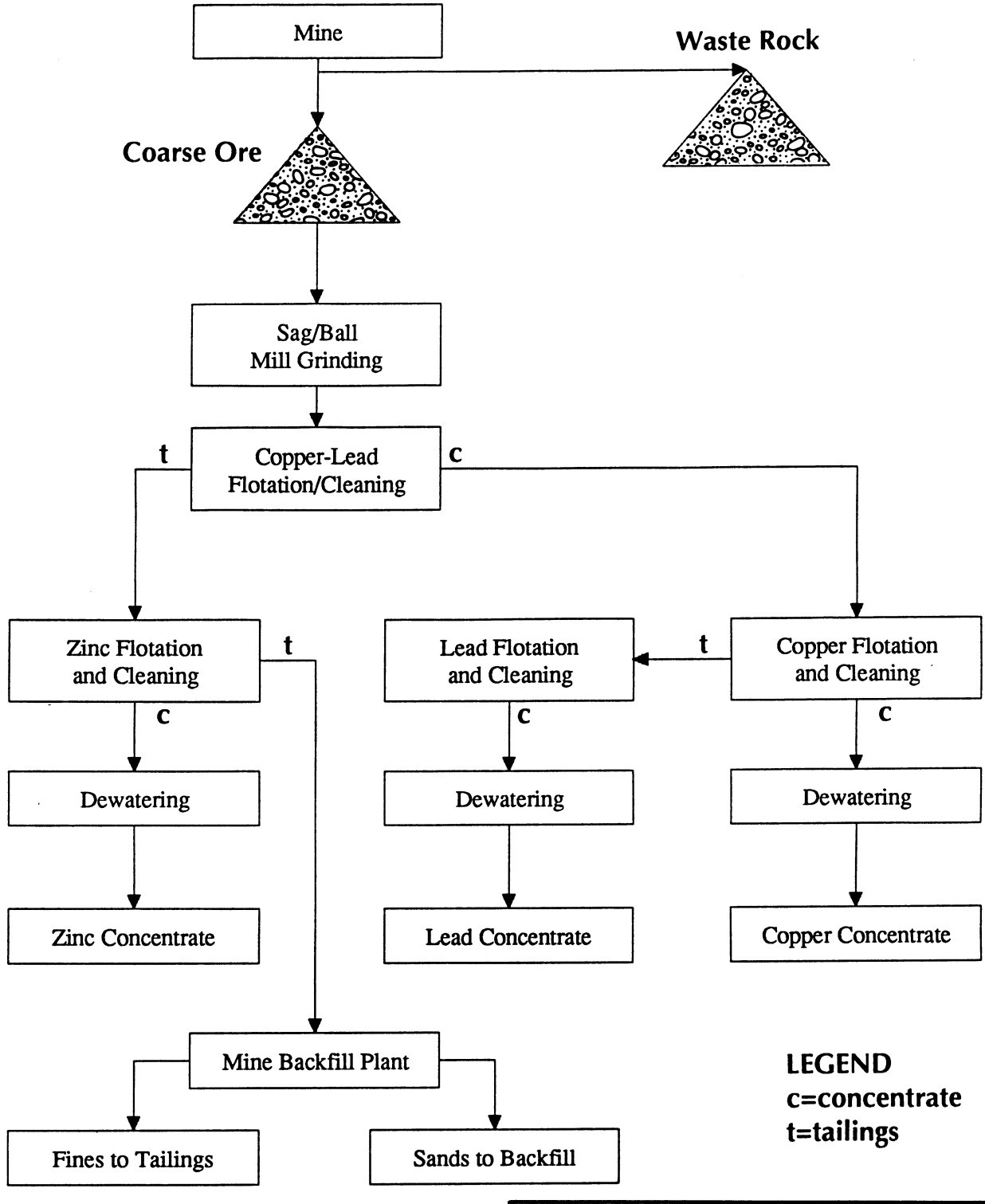
3.2.2.1 Wastewater Treatment

A wastewater treatment plant will be constructed as part of the project facilities. It will treat intercepted groundwater (if so required) and the mine drainage water prior to discharge.

Groundwater is expected to be representative of natural groundwater quality. If the monitoring of this groundwater indicates that the water quality is not suitable for direct discharge, it will be routed through the wastewater treatment plant.

Groundwater that bypasses the interceptor system and comes in contact with mine materials will be commingled with other mine drainage water, such as the water produced as a result of drilling the blast holes. All of these "contact waters" will be routed through the wastewater treatment plant. The mine drainage system is illustrated on Figure 3-7.

The wastewater treatment plant will include a lime and sulfide precipitation system with filtration and pH adjustment. Additional polishing steps, if required, will be evaluated during mine permit preparation. Wastewater treatment solids will be co-disposed with the ore processing tailings in the TMA.



Crandon Mining Company

FIGURE 3-6

CONCENTRATOR PROCESS FLOWSHEET

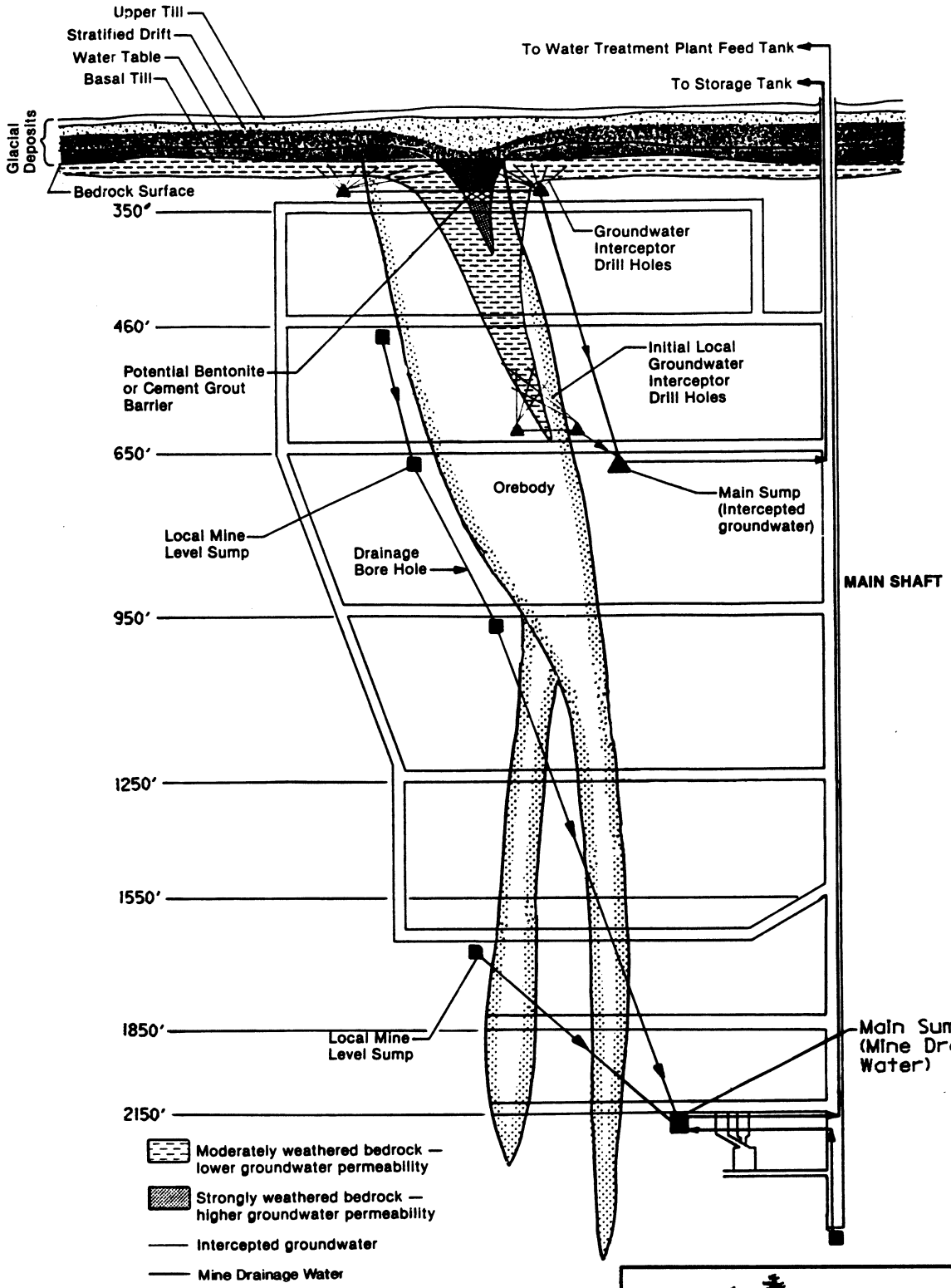
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Crandon Mining Company

FIGURE 3 - 7

MINE DRAINAGE SCHEMATIC

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Treated water from the mine wastewater treatment plant may either be discharged to Swamp Creek via a discharge pipeline installed along the same corridor as envisioned in the 1980s, or discharged to a series of absorption ponds located near the site or in strategic locations to provide mitigation, if needed, due to lowering of the groundwater table in the site vicinity as mining progresses. Selection of a final discharge option will take place during the completion of project environmental studies.

Sanitary wastewater will also be generated at the facility. Sanitary wastewater will be handled separately either through a septic system with an absorption field, or via a package sanitary wastewater treatment plant. If the package system is used, current plans involve discharging the treated effluent to the TMA or reclaim ponds, which are part of the process water recycling loop.

3.2.2.2 Mine Wastes

Mine wastes include tailings, excess mine waste rock, and mine refuse. The principle components of the facility's mine waste management program will include tailing ponds (Tailings Management Area, or TMA), and the reclaim water ponds.

3.2.2.2.1 Tailings Management Area

All tailings produced by ore processing that are not used for mine backfill, mine waste rock not used as mine backfill or for construction, and wastewater treatment sludges will be placed in the TMA. The tailings produced by the ore processing facility will be pumped via pipeline to a series of settling basins. The basins will be lined. Engineering studies to be completed during 1994 will determine the make-up of the liner system. As one basin is filled with tailings, a second basin will be constructed. After the first basin is filled, it will be reclaimed. A potential TMA layout and a conceptual cross-sectional view of one of the TMA basins are illustrated in Figures 3-8 and 3-9.

3.2.2.2.2 Reclaim Ponds

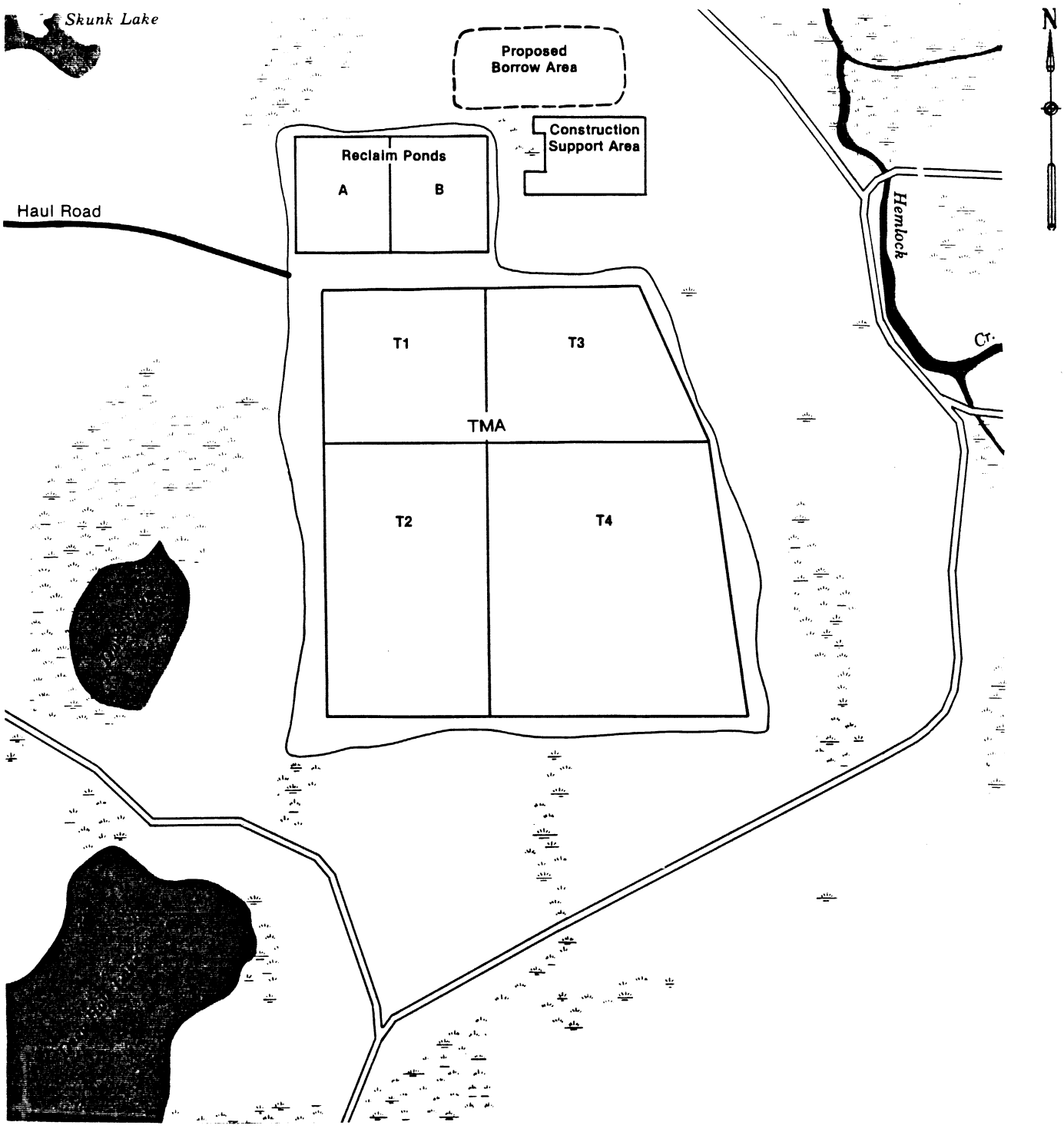
The reclaim ponds will receive water from the TMA. The ponds will be lined with a composite liner. Treated water from the reclaim ponds will be pumped to the ore processing facility for reuse.

3.2.2.2.3 Mine Refuse Management

Disposal options for general refuse generated during the life of the project are currently under review. These options include construction of an on-site landfill, or the use of an existing sanitary landfill in the vicinity of the project.

3.2.2.3 Access Roads

An access road will be constructed from State Highway 55 to the mine/mill site. A haul road will be constructed from the mine/mill site to the TMA. The access road is expected to be approximately three miles long and consist of two lanes of bituminous concrete with gravel shoulders. The TMA access road will be gravel-surfaced. Pipelines for tailings disposal would also be routed adjacent to the haul road.



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FIGURE 3-8

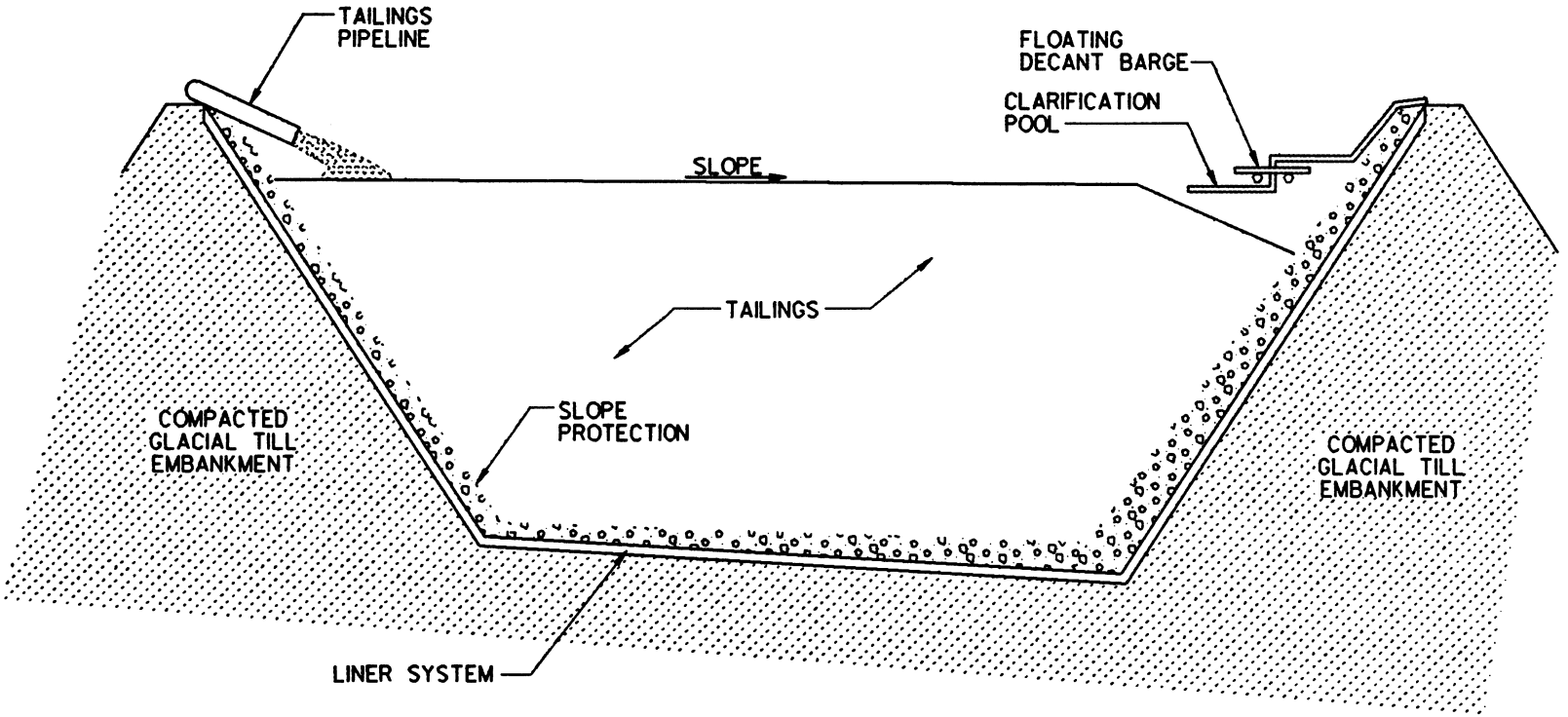
PRELIMINARY TMA AND ADJACENT FACILITIES

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FIGURE 3-9

CONCEPTUAL TAILINGS POND CROSS SECTION

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3.2.2.4 Railroad Spur

A 2.7 mile railroad spur will be constructed from the mine/mill site to the Wisconsin Central Limited Railroad located to the northeast. The spur will consist of a single track along most of its corridor.

3.2.2.5 Utilities

Electrical service to the project site will be provided by Wisconsin Public Service Corporation (WPS). To provide this service, an electric transmission line will be constructed between an existing substation near Monico, Wisconsin, and a new substation at the mine site. The substation near Monico will be upgraded by WPS.

Natural gas service is required for the site's facilities. A pipeline will be constructed from the existing natural gas pipeline located one-half mile north of Crandon, Wisconsin. It will follow existing county roads and the access road into the site.

3.2.2.6 Buildings, Shops and Storage Facilities

Other site facilities will include:

- Administrative offices
- Changehouse facilities
- Sewage treatment plant
- Gate house
- Core logging and storage
- Covered storage area
- Truck weigh scale
- Fencing
- On-site roads
- Area lighting
- Surface maintenance shops
- Potable water supply and distribution system
- Fire project systems
- Lubricant storage
- Bulk fuel storage
- Lay-down areas
- Railroad weigh scale
- Mobile equipment fuel station
- Parking areas

Construction of employee housing is not anticipated at this time. The adequacy of existing available housing will be evaluated as part of the project's socioeconomic study.

3.2.3 Mine Reclamation

Reclamation of the site will occur on an ongoing basis during construction and operation, and as the final phase of the project. After mining, the area will be used for recreation and forestry.

Final reclamation of the mine/mill site will begin after final backfilling. Any open boreholes will be plugged. All removable equipment and materials prone to decay or containing chemical agents potentially harmful to the environment will be removed. The shafts to the mine will be plugged with reinforced concrete caps. Surface facilities may be converted to other uses if possible. If other uses are not feasible, the facilities will be removed, and the site revegetated.

Settling basins and ponds may be drained and reclaimed unless they are part of a wetland restoration plan. Containment structures will be removed. Areas that are regraded to near the original contour will be revegetated. The TMA will be reclaimed by filling phase during its

lifetime. Final closure of the last cell of the TMA will occur late in the sequence of project reclamation.

The wastewater treatment plant and associated pipelines will be removed after they are no longer required. Salvageable equipment will be removed, and scrap and treatment sludges placed in the TMA prior to closure of the final cell. Buried segments of pipelines will be purged and left in place. Above-grade pipelines will be removed. The wastewater treatment plant area and pipeline routes will be graded, revegetated and left for recreational purposes.

On-site mine roads, the access road and the railroad spur will be among the last items to be reclaimed. Reclamation of these features would be dependent upon the final site use. Utilities that service other customers along the route to the mine will be left in place. The portion of the utilities that extend onto the mine site will be removed if above-ground, or remain in service depending upon the final use of the site. Below ground piping may be capped and left in place, if no longer in service.

3.2.4 Risk Assessment/Contingency Planning

A comprehensive risk assessment and contingency plan will be developed for the project and included in the project's mine permit application.

3.2.5 Project Schedule

The project schedule presented below is based on receiving all necessary permits and approvals by November 1, 1996. Estimated key milestones for the project through permitting, construction and start-up are as follows:

Notice of Intent Issued by CMC	1st Quarter 1994
Site Data Collection Completed	1st Quarter 1995
All Permit Applications filed with WDNR	2nd Quarter 1995
FEIS Issued by WDNR	4th Quarter 1995
Master Hearing	2nd Quarter 1996
All Permits Issued	4th Quarter 1996
Construction Completed	4th Quarter 1999
Ore Shipments Started	4th Quarter 1999

It is anticipated that mining of ore will take place over a 28 year period and final site reclamation will be accomplished in four years after mining is complete.

4 Database and Proposed Scope of Study

4.1 Overall Description of Proposed Studies

Presented in Section 4 is an identification of the baseline data collection activities planned by CMC to support all permit applications required for the project. The discussion includes:

- A summary and an evaluation of existing data;
- An identification of additional data requirements;
- A description of specific methods to be used in data collection, data evaluation, and testing and laboratory analysis;
- A description of the format the data will be presented in project reports;
- A tentative schedule for data collection;
- A list of key project personnel;
- A description of the quality assurance measures for obtaining, collecting, generating and evaluating baseline data.

It should be noted that sampling locations listed in the following work plans are subject to securing the necessary land owner agreements for access.

4.2 Quality Assurance Program

The overall quality assurance objectives for the data collection phase of the Crandon Project are to have systems in place to such that:

- The field and laboratory procedures produce representative baseline monitoring results;
- Activities involving sample collection and analysis are performed consistently;
- A process for assessing the quality of baseline data is in place and is utilized;
- The appropriate documentation of baseline monitoring activities is provided for third party review.

To meet the above objectives, an overall detailed Project Quality Assurance Plan (PQAP) has been developed (Appendix E) for Crandon Project baseline data collection activities. This plan presents standard procedures to be implemented and followed during the completion of baseline data collection activities discussed in Section 4.3, Project Work Plans, of this document. Therefore, a detailed discussion of quality assurance and quality control procedures is not necessary in Section 4.3. Project sampling and/or analysis will be conducted in accordance with the methods prescribed in the PQAP. These procedures are intended to meet regulatory requirements applicable to each of the baseline monitoring activities. In reviewing the PQAP, it should be noted that some specific procedures related to certain data collection programs (e.g., Sections 4.3.2.1.3, 4.3.6.3, 4.3.13.3, etc.) have not been included. These procedures will be detailed as part of the work plans referenced in those sections.

The PQAP addresses the following topics, which encompass both field and/or laboratory activities:

- Organization and Responsibility
- Quality Assurance Targets for Precision, Accuracy and Detection Limits for Laboratory Analytical Procedures
- Sampling
- Sample Custody
- Analytical Methods
- Calibration Procedures and Frequency
- Preventive Maintenance
- Quality Control Checks, Routines to Assess Precision and Accuracy and Calculation of Method Detection Limits
- Data Reduction, Validation, and Reporting
- Corrective Actions
- Performance and System Audits
- Quality Assurance Records

4.3 Project Work Plans

4.3.1 Aesthetics

4.3.1.1 Existing Data Summary and Evaluation

In 1982, the Sanborn Group, Inc. prepared a visual impact assessment of the proposed surface facilities. Specific structures addressed included the headframe, tailings pond embankment and the railroad siding. Visibility of the proposed headframe and tailings pond embankments were determined by tethering a helium-filled balloon and allowing it to rise to a known elevation at these locations. The visibility of the proposed railroad siding was determined by placing white styrofoam markers at a height of eight feet spaced at 100 foot intervals. The marker locations were established by field survey. Photographs were then taken from 35 vantage points surrounding the facility selected by the WDNR, EMC, and the Sanborn Group, Inc. The photographs, with an image of the balloon or styrofoam markers at known elevations taken from known distances from the subject, were used to determine visual impact.

Subsequent changes in the design and height of the headframe structure, and changes in the layout and design of the TMA resulted in a need to update the 1982 assessment. Schreiber/ Anderson Associates (Schreiber/Anderson Associates, 1985, CMC-NOI-1) used the photographic documentation compiled by the Sanborn Group, Inc. to revise the visual impact assessment in 1985. The revision was accomplished by simulating the visible portions of the structures on 8" x 10" black and white photographs taken by the Sanborn Group, Inc. at the same 35 vantage points and using the scaling equation technique. This technique recognizes that an object of known size (i.e., the height of the balloon is known) at a known distance in a photograph can be used to establish the size of other objects at the same distance. The Schreiber/Anderson Associates assessment also considered line-of-sight obstructions such as changes in topography and vegetation.

The methods employed in the previous visual impact assessments have not changed, and can be used for similar assessments. The proposed structures will be in the same locations and approximately the same size as described in the 1985 assessment. Further, land use patterns have not changed in the area since 1985. Therefore, no new or additional data will be required.

4.3.2 Air Quality

4.3.2.1 Meteorology and Air Quality

4.3.2.1.1 Existing Data Summary and Evaluation

The air resources database consists of both meteorological and ambient air quality monitoring data. Relevant existing information is found in a 1981 Dames & Moore air quality study (Dames & Moore, 1981). The data contained in the referenced report is applicable. It was previously accepted by the WDNR, and is summarized in Tables 2-15 and 2-17 of the project's 1986 Final Environmental Impact Statement (FEIS) (WDNR, 1986).

Meteorology and air quality monitoring began in March 1977 and continued through December 1978. Monitoring was conducted for meteorological parameters (wind speed, wind direction, temperature, and precipitation) and background concentrations of atmospheric sulfur dioxide (SO_2) and total suspended particulate (TSP) at Station No. 1 (Figure 4-1), which was located upwind from the project site. TSP concentrations were also monitored at two other stations, Station Nos. 2 and 3, located northeast and southeast of the ore body, respectively. In addition, particulate characterization and trace element analyses were conducted on the samples collected at Station No. 1.

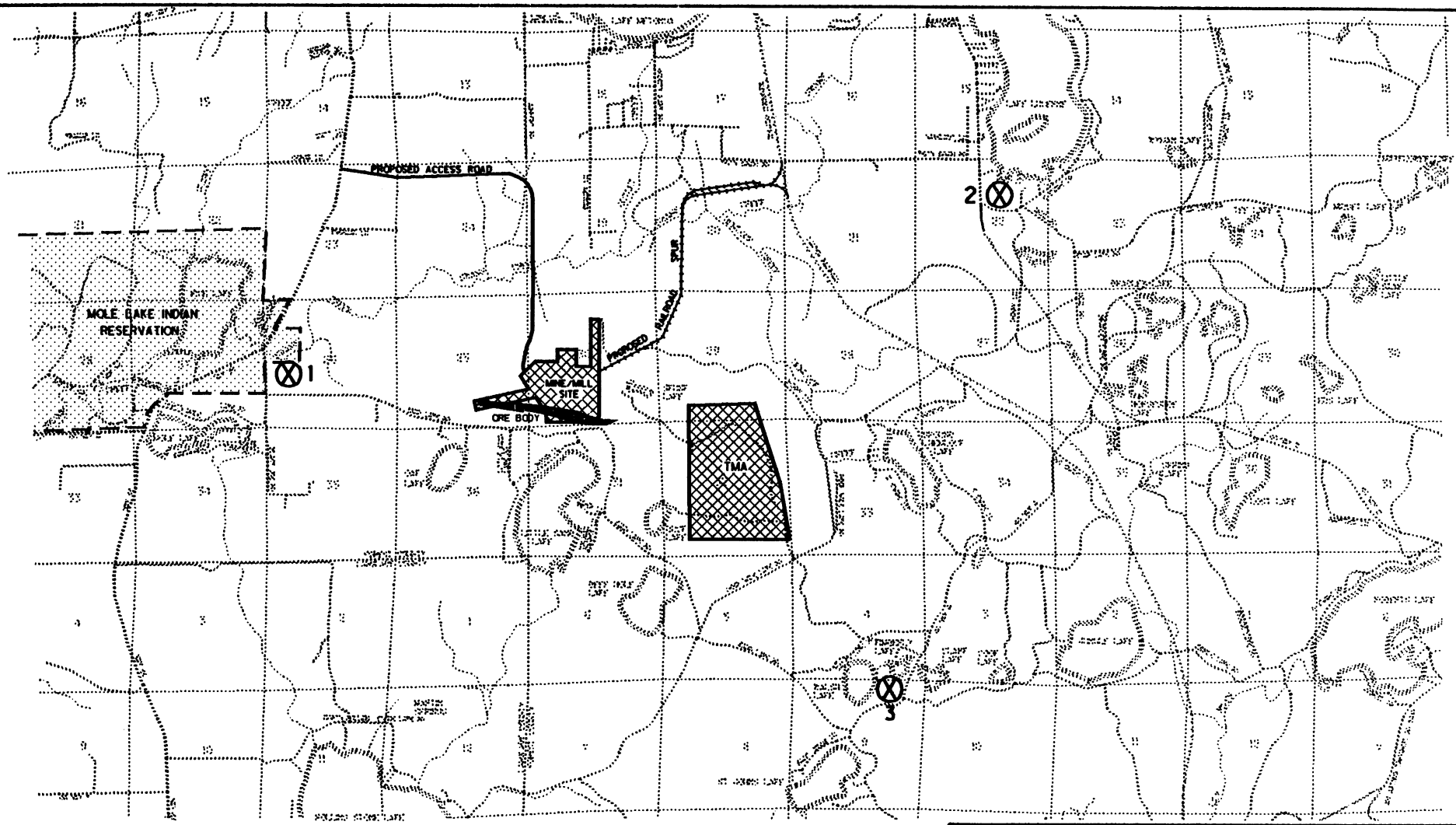
The meteorological parameters were monitored by EMC with continuous recording instruments. The continuous data was reduced to 1-hour averages or, in the case of precipitation, 1-hour totals. Data recovery was 70 percent for wind speed and direction, 78 percent for temperature, and 60 percent for precipitation. The data discussed above has been summarized in a series of wind roses and tables. In addition, information was obtained from the weather station operated at Nicolet College in Rhinelander, which is located 25 miles west-northwest of the environmental study area.

Ambient air sampling for suspended particulate matter was conducted by EMC during the times detailed below using high-volume samplers:

Station No. 1:	April 1977 - December 1978
Station No. 2:	January 1978 - December 1978
Station No. 3:	January 1978 - December 1978

The particulate samplers were operated 24 hours, from midnight to midnight, every third day to coincide with the WDNR's state-wide sampling schedule of every sixth day. Data recovery was 90 percent for Station No. 1, 98 percent for Station No. 2, and 98 percent for Station No. 3.

Results (Dames & Moore, 1981, CMC-NOI-2) of the ambient air particulate matter sampling program are displayed in Table 4-1. Measured concentrations are well below Wisconsin primary and secondary ambient air quality standards for TSP.



LEGEND

⊗¹ AIR MONITORING SITES

REVISED	DATE	BY	DESCRIPTION

Crandon Mining Company

FIGURE 4-1

GENERAL LOCATION OF
AMBIENT AIR MONITORING SITES

Scale:	1" = 6000'	Date:	JANUARY, 1994
Prepared By:	Foth & Van Dyke	By:	JRB

3c49fig13.DGN

93C049 '26

Table 4-1

Total Suspended Particulate Geometric Mean Concentrations ($\mu g/m^3$) At Station Nos. 1, 2, and 3 (April 1977 - December 1978) Crandon Mining Company NOI/SOS

	Station No. 1	Station No. 2	Station No. 3	National Ambient Air Quality Standards	
				Primary	Secondary
Calendar Quarter Averages					
April - June 1977	21.4	--	--	--	--
July - September 1977	17.0	--	--	--	--
October - December 1977	13.2	--	--	--	--
January - March 1978	11.7	10.9	11.5	--	--
April - June 1978	21.4	18.7	25.3	--	--
July - September 1978	19.0	21.0	19.7	--	--
October - December 1978	17.3	16.8	15.8	--	--
Concentrations					
Highest 24-Hour	99	65	74	--	--
Second Highest 24-Hour	72	60	64	150	150
Annual Geometric Mean[a]	16.9	16.4	17.3	50	50

$\mu g/m^3$ = microgram per cubic meter

[a] Calendar year 1978

Twenty percent of the 24 TSP samples collected at Station No. 1 from April 1977 through March 1978 were examined microscopically to identify the types of particulates collected on the filters. The results (Dames & Moore, 1981, CMC-NOI-2) are summarized in Table 4-2.

Table 4-2

Particulate Characterization at Station No. 1 (April 1977 - March 1978) Crandon Mining Company NOI/SOS

	Percent by Area					
	Size < 30 μ m			Size > 30 μ m		
Dates	Mineral	Combustion	Biological	Mineral	Combustion	Biological
April - June 1977	5	1	14	14	2	64
July - September 1977	24	1	39	9	0	28
October - December 1977	60	8	2	27	2	1
January - March 1978	20	17	0	23	8	31
Annual	27	7	14	18	3	31

μ m = micro meter

The TSP samples collected at Station No. 1 from April 1977 through March 1978 were also analyzed for the following trace elements: lead (Pb), zinc (Zn), cadmium (Cd), copper (Cu), mercury (Hg), and arsenic (As). Samples from each calendar quarter were composited for analyses. The results (Dames & Moore, 1981, CMC-NOI-2) are shown in Table 4-3.

Table 4-3

Trace Element Concentrations[1] at Station No. 1 (April 1977 - March 1978) Crandon Mining Company NOI/SOS

Element	Quarters				Annual
	4/77 - 6/77	7/77 - 9/77	10/77 - 12/77	1/78 - 3/78	4/77 - 3/78
Lead	33	17	110	28	47
Zinc	<20	<20	<20	<20	< 20
Cadmium	<3.1	<3.1	<3.1	<3.1	< 3.1
Copper	280	270	150	150	210
Mercury	0.043	0.024	<0.017	<0.017	0.021
Arsenic	0.79	0.66	0.65	1.2	0.82

[1] All concentrations expressed as nanograms per cubic meter (ng/m^3).

Background concentrations of SO_2 were monitored by EMC at Station No. 1 from November 1977 through November 1978 using wet-chemical samplers employing chemical adsorption. None of the SO_2 samples collected indicated that the ambient 24-hour SO_2 concentrations exceeded the lower detection limit (25 microgram per cubic meter [$\mu g/m^3$]) of the system.

A WDNR audit (Chazin, 1980, CMC-NOI-3) validated the TSP, SO_2, and meteorological data. The meteorological and air quality monitoring conducted was reviewed by the WDNR and a majority of the data has been "certified" as being comparable in accuracy to WDNR data. An evaluation of the air monitoring network is included in the WDNR audit (Chazin, 1980, CMC-NOI-3).

4.3.2.1.2 Data Requirements

Based on the proposed estimated emission rates for the project, the project will not be a major source of air pollutants, and, therefore is not expected to require a Prevention of Significant Deterioration (PSD) evaluation. The proposed project's most significant emission level is for particulate matter, with a majority of these emissions being fugitive dust. Under the definition of major source in § 144.30(16), together with the current attainment status in Forest County (for particulate matter), a source with the potential to emit less than 250 tons/year (a mine is not a listed source category), not including fugitives, is a minor source.

Since the estimated emission levels for particulate matter are significantly less than 250 tons/year, it is CMC's conclusion that the source will not be subject to PSD review. This is also the

opinion of USEPA, Region V, based on correspondence from Steve Rothblatt to Don Theiler, WDNR (Rothblatt, 1986, CMC-NOI-4). Therefore, preconstruction monitoring for PSD permitting is not required.

Even though not specifically required by regulations, CMC proposes to re-establish an ambient air monitoring network to update and supplement the historical database.

This network will consist of the following:

1. A meteorological station to continuously monitor and provide hourly averages of wind speed, wind direction, temperature, relative humidity and precipitation.

2. A network of three high-volume air samplers for TSP and one high-volume air sampler for particulate matter less than 10 microns (PM-10). Collected samples will provide 24-hour average concentrations of TSP and PM-10.

   In addition, selected filters will be analyzed for the following substances:

Antimony	Manganese
Arsenic	Mercury
Beryllium	Nickel
Cadmium	Selenium
Chromium	Silver
Cobalt	Tin
Copper	Uranium
Iron	Zinc
Lead	

A microscopic analysis to determine size distribution and particle shape will also be performed on the selected filters.

Estimated emission rates for the SO_2 from mining operations, as listed in the 1986 FEIS (WDNR, 1986), are shown below. Actual rates for the currently proposed project are expected to be lower since the project has been downsized from the original plan.

Phase	SO_2 Emissions (ton/year)
Construction	13.2
Operation	37.1
Reclamation	0.3

Since Forest County is classified as an attainment area for SO_2, an emission level less than 250 tons/year makes the project a minor source for SO_2, and thereby no PSD review is required.

Background SO_2 levels provided by the WDNR for the Crandon area are shown below.

Averaging Period	Background Level	NAAQs*
3 hour	143.9 $\mu g/m^3$	1,300[1]
24 hour	39.0 $\mu g/m^3$	365[2]
Annual	10.4 $\mu g/m^3$	80[2]

* National Ambient Air Quality Standards
[1] Secondary Standard
[2] Primary Standard

The above background levels for SO_2 are the most recent (1993) values complied by the WDNR. They represent an average of several years of highest and second highest values recorded at a WDNR ambient air sampling station located in Wisconsin Rapids. Values for SO_2 concentrations are expected to be representative for large areas since SO_2 acts like an aerosol and disperses somewhat uniformly.

Using the above SO_2 background levels along with predicted ambient air increases calculated by WDNR (WDNR, 1986) modeling of the proposed project, the following table was compiled.

Concentrations ($\mu g/m^3$)

Averaging Period	Background	CMC Impact	Projected Total	NAAQs
3 hour	143.9	73.7	217.6	1,300[1]
24 hour	39.0	29.2	68.2	365[2]
Annual	10.4	0.1	10.5	80[2]

[1] Secondary Standard
[2] Primary Standard

Based on the above evaluation, the relatively low quantities of expected SO_2 emissions from the project, and the small project impacts on ambient air quality levels, SO_2 monitoring is not being proposed.

4.3.2.1.3 Methodology

Three sampling sites will be used to collect the data discussed above. It is proposed that the same site areas used by EMC in the late 1970s be used in the new sampling program. These sites were originally approved by the WDNR and were selected from several potential locations using the following criteria:

- Relatively flat terrain;
- Accessibility for installation and servicing of equipment;
- Availability of electric power;

- More than 100 feet from unpaved roads; and
- Lack of vertical obstructions.

Based upon previous air dispersion modeling, predominant wind directions, and a site visit, CMC, Foth & Van Dyke and the WDNR have determined the location of the three ambient air monitoring sites. Site selection was based on USEPA siting criteria as described in the *Ambient Monitoring Guidelines for PSD* (USEPA, 1987), as well as WDNR requirements. On February 3, 1994, personnel from the WDNR Air Monitoring Section visited the sites and assisted in selection of the three monitoring locations.

Station No. 1 is about two miles west of the ore body and is located in an open field approximately 200 feet north of a paved road (Sand Lake Road). The open field extends at least 650 feet in the south through north sectors surrounding Station No. 1. To the south is Sand Lake Road and an open field beyond the road. To the east and southeast, there are short, widely spaced trees approximately 35 feet from the station and a house and farm buildings with trees approximately 200 to 250 feet from the station. To the north-northeast, about 300 feet from the station, lies an open field with dense trees beyond. To the west-southwest, about ½ mile from the site, is an unused pallet factory.

The meteorological station sensors will be located on a 10-meter (33 feet) tower located approximately 100 feet north of Sand Lake Road. The rain gauge will be located 10 feet northeast of the tower. Platforms will support the TSP and PM10 high volume particulate samplers such that the minimum height of the filter is seven feet above ground level. The TSP sampler will be located approximately 175 feet north of Sand Lake Road, and the PM10 sampler will be located approximately 200 feet north of Sand Lake Road. The meteorological station and TSP and PM10 samplers will all be located approximately 60 feet east of the fence line.

Site No. 2 is approximately 3½ miles northeast of the ore body and is located in an open field approximately 1,150 feet south of the intersection of Keith Siding Road and just east of County Highway W. There is an open field both north and south of the site. The northern boundary is bordered by a dense tree line (approximately 75 feet from the site). There is a residence to the southwest of the site. Further south, approximately 700 feet, is East Shore Drive. Beyond the road is another residence and an open field. To the west is a stand of thin trees, approximately 200 feet from the sampling station. To the northeast lies Lake Lucerne.

The TSP high volume sampler will be located on a platform such that the minimum height of the filter is seven feet above ground level. The sampler will be located 75 feet south of the north property line, and approximately 200 feet west of County Highway W.

Site No. 3 is approximately 3½ miles southeast of the ore body and is located on an elevated tract of land 300 feet east of County Road Q at the junction of Little Sand Lake Road. The surrounding area is densely forested.

The TSP high volume sampler will be located on a platform such that the minimum height of the filter is seven feet above ground level. The sampler will be located on an elevated logging road in a 60 foot radius clearing to the dripline of the nearest trees. Access to the logging road will be barricaded at County Road Q.

All sampling sites were evaluated for compliance with United States Environmental Protection Agency (USEPA) guidelines contained in *Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD)* (USEPA, 1987), and in accordance with WDNR requirements.

It is planned that the high-volume air samplers operate every third day so representative periods can be characterized. The meteorological sampling will be conducted daily and on a continuous basis. This sampling program will be conducted for a total of 12 months, and begin in March of 1994. At the conclusion of six months of sampling, if no significant levels are discovered, CMC will request WDNR approval to sample every sixth day for the last six months of particulate sampling.

After two months of particulate sampling, separate composites of filter material from each site will be prepared for analysis to characterize for the metallic components previously listed and particle size distribution and shape.

A quality assurance/quality control (QA/QC) program for the air monitoring and meteorological data collection will be developed by CMC for WDNR approval prior to implementation of the data collection program. The plan will include, at a minimum:

- Project Description
- Organization and Responsibility
- Quality Assurance Targets for Precision, Accuracy, and Method Detection Limits
- Sampling Procedures
- Sample Custody
- Analytical Methods
- Calibration Procedures and Frequency
- Preventative Maintenance
- Quality Control Checks
- Data Reduction and Reporting
- Corrective Actions
- System and Performance Audits
- Quality Assurance Records

4.3.2.1.4 Data Presentation Format

Air quality monitoring information will be presented in standard formats, including wind rose, tabular summaries, two dimensional isopleths, etc.

In order to allow the WDNR to actively participate in the collection and analysis of the data, monthly summaries of the raw data will be submitted as soon as available. A final report on the completed sampling program will be included in the project's Environmental Impact Report (EIR).

4.3.2.1.5 Schedule for Data Collection

Field data collection is proposed to be initiated in March, 1994. It is anticipated that the particulate matter (TSP and PM10) samplers and meteorological tower will commence operation at the same time. The project's air QA/QC plan will be forwarded to the WDNR in February, 1994 for review and comment.

4.3.2.2 Ambient Air Quality Impact Assessment

4.3.2.2.1 Existing Data Summary and Evaluation

To predict the ambient air quality impact of the project operations, dispersion modeling analysis was performed by both EMC (EMC, 1985) and the WDNR (WDNR, 1986).

The modeling conducted by EMC was in support of the revised air pollution control permit application dated December of 1985. Pertinent modeling parameters are detailed below:

- Models Used:

  USEPA Industrial Source Complex Short Term (ISCST) for all pollutants of concern except nitrogen oxides (NO_X).

  USEPA Industrial Source Complex Long Term (ISCLT) for NO_X, in order to calculate an annual average concentration.

- Meteorological Databases Used:

  1977 hourly surface data from a National Weather Service (NWS) monitoring location at Eau Claire, Wisconsin and NWS upper air data from St. Cloud, Minnesota was used for particulate modeling.

  1979 Quinnesec, Michigan, and Green Bay, Wisconsin meteorological data was used for SO_2 and NO_X modeling.

The modeling was conducted for the 18th year of the project. This corresponds to the largest predicted particulate emission rates during project operations due to construction of a tailings pond.

Modeling included an additional evaluation which added temporary mobile source emissions to the stationary source emissions and still demonstrated compliance with National Ambient Air Quality Standards (NAAQS) (USEPA, 40 CFR 50). A summary (EMC, 1985) of modeling results is shown from the earlier work in Table 4-4.

Table 4-4

ISC Model Predicted Concentrations for the Project at the Modeling Boundary (All Concentrations in ug/m^3) Crandon Mining Company NOI/SOS

	Predicted Concentration from Crandon Project		Background Concentration	Summed Concentration		National Ambient Air Quality Standards	
						Primary[a]	Secondary[a]
Sulfur Dioxide (SO_2)							
Annual	0.1[b]	(2.1)[c]	25.0	25.1	(27.1)	80	--
24-Hour	1.8	(25.0)	25.0	26.8	(50.0)	365	--
3-Hour	7.1	(186.0)	25.0	32.1	(211.0)	--	1,300
Particulate Matter (TSP)							
Annual		4.3	17.9		22.2	50(e)	50(e)
24-Hour		28.9	77.0		105.9	150(e)	150(e)
Nitrogen Dioxide (NO_x)							
Annual		3.8	19.4		23.2	100	100
Carbon Monoxide (CO)							
8-Hour		1,802.5	N/A[d]		1,802.5	10,000	--
1-Hour		2,025.3	N/A		2,025.3	40,000	--
Hydrocarbons (HC)							
3-Hour		47.1	N/A		47.1	160	--
Lead (Pb)							
3-Month Average		0.01	N/A		0.01	1.5	1.5

ISC = Industrial Source Complex
ug/m^3 = micrograms per cubic meter

[a] All short-term limits (24-hour and less) can be exceeded once a year.
[b] Stationary sources only.
[c] Includes temporary mobile source emissions and are the second-highest predicted concentrations.
[d] N/A = Not applicable.
[e] PM-10 Standards

An air quality analysis was also completed by the WDNR in early 1986 as part of the permit application review and generation of the Preliminary Determination (WDNR, 1986). Modeling details are as follows:

- Models Used:

  USEPA ISCST for short term modeling.

  USEPA ISCLT for long term modeling.

- Meteorological Databases Used:

  1977 hourly surface data from Eau Claire, Wisconsin with corresponding Green Bay, Wisconsin upper air data (for both short and long term analysis).

WDNR (WDNR, 1986) modeling included the second year of operation as well as the 18th year. The results (EMC, 1985) demonstrated compliance with NAAQS (USEPA, 40 CFR 50) as detailed in Table 4-5 below.

Table 4-5

Ambient Air Quality Impacts
Crandon Mining Company NOI/SOS

		Maximum Concentration Due to EMC Sources			Total Concentration		National Ambient Air Quality Standards	
Pollutant	Period	Construction	Operation	Background	Construction	Operation	Primary	Secondary
TSP	24-hour	23.5	31.0	77.0	100.5	108.0	150	150
	Annual	7.1	9.3	17.9	25.0	27.2	50	50
SO_2	3-hour	**	73.7	25.0	**	98.7	No standard	1,300
	24-hour	**	29.2	25.0	**	54.2	365	No Standard
	Annual	1.5	0.1	25.0	26.5	25.1	80	No Standard
NO_X	Annual	0.11	0.17	19.4	19.5	20.6	100	100
CO	1-hour	**	5,205.0	0.0	**	5,205.0	40,000	40,000
	8-hour	**	179.0	0.0	**	179.0	10,000	10,000
Lead	Calendar Quarter	**	0.002	0.0	**	0.002	1.5	No Standard

** No air quality modeling done due to insignificant emission rates.

TSP = total suspended particulates
SO_2 = sulfur dioxide
NO_X = nitrogen oxides
CO = carbon monoxide

Concentrations are given in micrograms per cubic meter (ug/m^3).

4.3.2.2.2 Data Requirements

Since the time period when the original dispersion modeling was conducted, changes have occurred to the proposed project as well as the dispersion model programs and meteorological databases. For these reasons, CMC proposes to perform a new air quality analysis employing current parameters and methods.

General details of the dispersion modeling plan are listed below:

- Models:

  USEPA ISCST2 for short and long term modeling.

- Meteorological database:

  5 years (1982-86) of surface data from Eau Claire, Wisconsin along with 5 years (1982-86) of upper air data from Green Bay, Wisconsin. These are understood to be the latest acceptable databases for the study area.

- Conduct analysis during period of time resulting in the maximum emission rate at both construction and operation phases.

4.3.2.2.3 Methodology

Dispersion modeling will be conducted in accordance with WDNR guidelines and in compliance with USEPA guidance contained in *Guideline on Air Quality Models (Revised)* (USEPA, 1986). Prior to initiating modeling work, a detailed modeling protocol will be submitted to the WDNR for approval. This document will address the following points:

- Model Selection
- Emission Inventory
- Source of Meteorological Data
- Receptor Grid Design
- Building Wake Effects
- Urban/Rural Classification
- Modeling Runs
- Program Control Parameters
- Selection of Averaging Times

4.3.2.2.4 Data Presentation Format

Results of the dispersion modeling along with background information, assumptions, and inputs will be included as part of the project's air pollution control permit application and as part of the project's EIR. Data will be displayed in graphs, charts and included in supporting appendices.

4.3.2.2.5 Schedule for Data Collection

The work plan for dispersion modeling is anticipated to be submitted to the WDNR in the summer of 1994. Dispersion modeling is anticipated to be initiated in the summer or early fall of 1994.

4.3.2.3 Key Project Personnel

Mark DiFonzo, Manager of Air Quality with Foth & Van Dyke, will be responsible for sampling and modeling work. Particle sizing and distribution analysis will be conducted by John E. Thresher, Jr. of Thresher & Son, Inc. Mr. DiFonzo has been actively involved in air quality studies, air permitting, dispersion modeling and the design of combustion and air pollution control systems over his 18 year career. Mr. Thresher of Thresher & Son, Inc., and has been

involved in soil investigations, soil absorption studies, waste characterization studies, etc. over his 30 year career.

4.3.3 Archeology

4.3.3.1 Existing Data Summary and Evaluation

An inventory and assessment of 3760 acres covering the project site and the surrounding area was conducted by Beloit College in 1977 and 1978 (Salzer & Birmingham, 1978, CMC-NOI-5). The literature search and on-site survey suggested that no significant archeological sites would be impacted by the proposed mine/mill facility and TMA construction. While the authors noted that older buildings were in the project area, they concluded that they were not qualified to render an opinion regarding the historical significance of these structures.

Based on a review of the Beloit College report (Salzer & Birmingham, 1978, CMC-NOI-5), the State Historical Society of Wisconsin (Dexter, 1980, CMC-NOI-6) determined that the sampling methods used by Beloit College were adequate and concurred with the conclusions reached. It was recommended that the buildings noted by Beloit College researchers by evaluated by a qualified architectural historian.

Subsequent to the Beloit College work, Great Lakes Archaeological Research Center, Inc. (GLARC) (GLARC, 1982a, 1982b, 1983, CMC-NOI-7, CMC-NOI-8, and CMC-NOI-9, respectively) inventoried 1,079 acres including portions of the project site, the access corridor and the wastewater discharge pipeline corridor. In addition, as recommended by the State Historical Society, the MacDonald and Mack Partnership evaluated the buildings discovered in the study area.

As with the Beloit College report, the GLARC and MacDonald and Mack Partnership reports were reviewed by the State Historical Society of Wisconsin (Dexter, 1982, and Green, 1982, CMC-NOI-10 and CMC-NOI-11, respectively). The State Historical Society of Wisconsin concurred with the authors who concluded that only two prehistoric sites existed in the area that could be considered eligible for the National Register of Historic Places. Both of these sites were located east of Oak Lake and as such would not be impacted by proposed project construction or operation.

4.3.3.2 Data Requirements

CMC has contacted the State Historical Society of Wisconsin (Foth & Van Dyke, January 4, 1994, CMC-NOI-12) to obtain comments regarding the Crandon Project and associated facilities as currently proposed. On January 19, 1994, Mr. Richard Dexter of the State Historical Society of Wisconsin responded (Dexter, 1994, CMC-NOI-13) to CMC's request with a recommendation that, due to the amount of time that has passed since the previous archaeological surveys were conducted, a summary report be prepared that identifies those sites which were discovered in the previous surveys. He went on to recommend that the previous determinations regarding inclusion in the National Register of Historic Places be updated. Further, consideration of traditional cultural properties was also recommended.

4.3.3.3 Methodology

A listing of archaeological sites, burial sites, and potential significant historic structures reported in the above-referenced studies will be created. Each of the identified sites will be evaluated to determine if the previous determinations regarding the significance of the these sites is current. Additionally, the *Guidelines for Evaluating and Documenting Traditional Cultural Properties* (National Register Bulletin #38) will be followed to evaluate potential traditional cultural resources that may exist. Contacts will be made with local Native Americans to obtain data regarding traditional cultural resources in the vicinity of the proposed mine facility.

4.3.3.4 Data Presentation Format

Reported archaeological sites, burial sites, and potentially historic structures will be listed and described in tabular form. Locations will be plotted on a map of the area. A written narrative will be developed for inclusion with developed graphics in the project's EIR.

4.3.3.5 Schedule for Data Collection

The summary study will be completed by mid to late spring 1994.

4.3.3.6 Key Project Personnel

Archaeological work will be performed by the Great Lakes Archaeological Research Center, Inc. (GLARC), Milwaukee, Wisconsin. Dr. John D. Richards, Senior Research Associate with GLARC, will manage the work. Dr. Richards has 18 years experience conducting archaeological and historical surveys in northern Wisconsin.

4.3.4 Biological Environment

4.3.4.1 Existing Data Summary and Evaluation

4.3.4.1.1 Terrestrial Biology

The majority of the historic terrestrial biology data is contained in *Terrestrial Ecology Study Baseline Conditions and Study Methodology* (Dames & Moore, 1981, CMC-NOI-14). This report was reviewed by the WDNR and subsequently revised, forming the basis for the terrestrial biology sections of the 1985 *Environmental Impact Report*. Field surveys for the 1981 report were conducted in 1977 and 1978 to document the flora and fauna in the environmental study area (Dames & Moore, 1981, CMC-NOI-14). The terrestrial ecology program was designed to identify and describe the major terrestrial communities in the vicinity of the proposed project. The program included mapping and characterizing plant communities; collection of vegetation samples for heavy metal analysis; and inventorying mammals, birds, and herptofauna based on information compiled by the WDNR and through on-site surveys. A discussion of each follows.

Vegetation

The vegetation types in the environmental study area were mapped using color aerial photographs dated April 1976 and color infrared aerial photographs dated June 1978. Vegetation was classified into the following types: northern hardwood, swamp conifer, shrub swamp, bog, marsh, old field, clearcut, and agricultural. Interpretation of the aerial photographs was verified through on-site reconnaissance. The minimum type sizes mapped were approximately 40 acres and 10 acres, for the larger environmental study area and both the mine/mill and TMA sites, respectively.

The composition and importance of the major vegetation types the environmental study area were determined through quantitative sampling along five transects representing stands of northern hardwood, aspen/birch, and swamp conifer. In addition, qualitative observations and plant collecting for the purpose of identifying threatened and endangered or otherwise important plant species was conducted within the study area that will be directly affected by the proposed project.

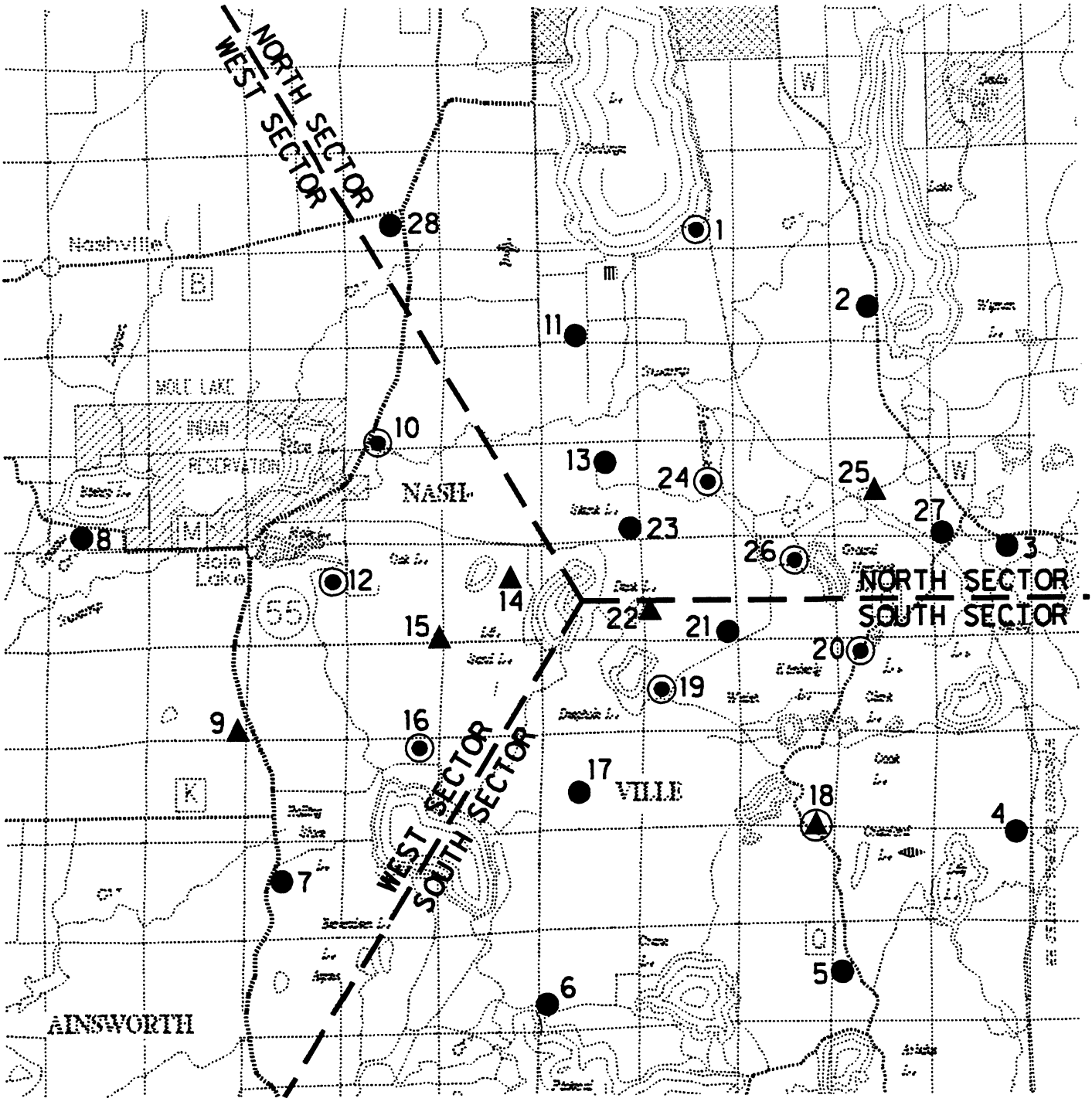
Three plant species, one from each of the three major taxonomic groups of vascular plants (Gymnosperms, Monocotyledons, and Dicotyledons) were collected in June 1978 (EMC, 1985a, CMC-NOI-15) at 27 locations in the environmental study area for analysis of manganese, zinc, cadmium, copper, arsenic, lead, mercury, cobalt, and total chromium. These included balsam fir, red raspberry, and Pennsylvania sedge. For each species, samples were collected at six locations (Figure 4-2) for separate analysis. The environmental study area was then divided into three sectors: north, south, and west, with respect to the predominant wind directions. Composite samples of each species, from each of the sample locations within each of the sectors, were then analyzed (Figure 4-2).

To define and appraise the forest crop, a forest inventory study was conducted in the immediate project area in the early 1980's. Since the forest has matured since this study was completed, the previous forest inventory will need to be updated.

The vegetation mapping is approximately 15 years old, and will need to be updated. Due to the numerous additions and deletions to the state and federal lists of threatened and endangered species, the previous work conducted in this regard needs to be updated. The plant tissue analysis results from the previous studies are considered valid, contingent upon verification sampling.

Mammals, Birds, Herptofauna

The previous studies (EMC, 1985a, CMC-NOI-15) relied on information from the WDNR for black bear (*Ursus americanus*), and medium-sized mammals such as beaver (*Castor canadensis*), otter (*Lutra canadensis*), bobcat (*Lynx rufus*), marten (*Martes americana*), and squirrel (*Sciurus spp.*) The white-tailed deer was given special consideration and was censused along 36 - 0.25-mile transects in the site area in 1977 using the deer trail count method. Small mammals (i.e., mice, shrews, voles) were sampled using snap traps in August 1977 and 1978. At least four traplines (15 trap stations 30 feet apart with two mouse traps and one rat trap baited with peanut butter or dryrolled oats) were set in each of the three major plant communities. Two trap lines were set in an old field and bog. Birds were censused seasonally in 1977 and 1978 including;



LEGEND

- CIRCLED SITES AS SHOWN ARE THOSE PROPOSED FOR 1994 VERIFICATION SAMPLING
- MATERIAL COLLECTED IN 1978 USED FOR COMPOSITE SAMPLE
- MATERIAL COLLECTED IN 1978 USED FOR INDIVIDUAL AND COMPOSITE SAMPLE
- COMPOSITE SECTOR BOUNDARY

NOTE: NO SAMPLES WERE COLLECTED AT LOCATION 17 DUE TO INACCESSABILITY.

BASE MAP REFERENCE: WISCONSIN DEPARTMENT OF TRANSPORTATION, JANUARY, 1978. FOREST CO. AND LANGLADE CO. HIGHWAY MAPS.

REVISED	DATE	BY	DESCRIPTION

Crandon Mining Company

FIGURE 4-2

GENERAL LOCATION OF VEGETATION SAMPLES FOR HEAVY METAL ANALYSIS IN THE ENVIRONMENTAL STUDY AREA

Scale:	1" = 8000'	Date:	FEBRUARY, 1994
Prepared By:	Foth & Van Dyke	By:	JRB

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drumming ruffed grouse counts, migratory waterfowl surveys, waterfowl brood counts, and songbird surveys along transects, and also by using a variable width strip method. The presence and relative abundance of reptiles and amphibians was determined through search and seize methods (i.e., turning logs, debris, leaf litter, etc.) as well as spring surveys for singing amphibians. A specific study to document the distribution and relative abundance of spotted salamanders in an eight county area of northern Wisconsin was conducted by Dames & Moore (Dames & Moore, 1979, CMC-NOI-16).

Previous studies of mammals, birds, and herptofauna provide a comprehensive overview of the wildlife populations in the environmental study area surrounding the proposed facility. This data base will be heavily relied upon for purposes of generally describing the fauna of the environmental study area. However, as with the vegetation, work conducted previously regarding threatened and endangered species will need to be updated.

4.3.4.1.2 Aquatic Biology

The majority of the historic aquatic biological data is contained in a Dames & Moore (Dames & Moore, 1982, CMC-NOI-17) report and several documents prepared by Ecological Analysts, Inc. These and several support documents prepared by Dames & Moore and others were used extensively for the preparation of the 1985 EIR. These studies include data on the following groups:

- Phytoplankton (Dames & Moore, 1978, CMC-NOI-18)
- Zooplankton (Dames & Moore, 1978, CMC-NOI-18)
- Aquatic macroinvertebrates (EMC, 1984a, CMC-NOI-19)
- Fish (EMC, 1985b, CMC-NOI-20)
- Fish and macroinvertebrate tissue analysis (EMC, 1985b, CMC-NOI-20)
- Habitat characterization of portions of Swamp and Hemlock Creeks (Ecological Analysts, 1983, EMC, 1984b, CMC-NOI-21 and CMC-NOI-22, respectively)
- Swamp and Pickerel Creek basin studies (EMC, 1985c and 1985d, CMC-NOI-23 and CMC-NOI-24, respectively)

The main document containing aquatic biologic studies is the Dames & Moore (Dames & Moore, 1982, CMC-NOI-17) report. This document contains all the data from field studies conducted in 1977 and 1978 including information on plankton, macroinvertebrates, fish, and aquatic plants. It also provides a physical description of the Swamp and Pickerel Creek Chains including adjacent portions of the Wolf River.

On Swamp Creek a one year study (Ecological Analysts, 1983, CMC-NOI-21) conducted from April 1982 through 1983 concentrated on the ecology of fish and benthic macroinvertebrates and documentation of habitat and flow conditions upstream and downstream of the proposed site for the Crandon Project surface water discharge pipe. Similar habitat surveys with biological assessments were conducted (EMC, 1984b, CMC-NOI-22) on Hemlock Creek. Two habitat surveys were also conducted in 1985 on Pickerel Creek, Creek 11-4, Creek 12-9, and Hoffman Springs. A one day collection effort for drifting macroinvertebrates was conducted in May 1984 on an unidentified portion of Swamp Creek.

Trace metal analyses (i.e., manganese, zinc, cadmium, copper, arsenic, lead, mercury, cobalt, and total chromium) on the tissues of selected aquatic macrophytes, benthic organisms, and fish from

the Swamp Creek and Pickerel Creek drainages were performed in 1977 (EMC, 1985b, CMC-NOI-20). Sample locations are shown in a Dames & Moore (Dames & Moore, 1983, CMC-NOI-25) report. Aquatic macrophytes sampled included bur reed, cattail, water lily, pipewort, spike rush, and wild rice. Composite samples were collected along the shoreline from Rice Lake, Swamp Creek Station E, Oak Lake, and Little Sand Lake. A wild rice sample was collected from Rice Lake and analyzed separately. Benthic organisms including crayfish, dragonflies, nymphs, snails, leeches, stoneflies, mayflies, dobson flies, and caddisflies were collected in conjunction with qualitative benthos collections. Benthos were sampled at Rice Lake, Swamp Creek Stations D and E, Oak Lake, and Little Sand Lake. Except for crayfish from Rice Lake, benthic organisms were placed whole in a separate plastic bag for each station and analyzed as a composite sample for that station. Crayfish from Rice Lake were analyzed separately. The fish species and tissues analyzed for each sampling station are summarized in Table 4-6. Tissue analysis results from the previous studies for all organisms sampled is representative of background values expected in natural systems similar to northern Wisconsin.

The aquatic biologic studies and assessments were comprehensive. However, they were conducted in the late 1970s and early 1980s, and since that time the list of threatened and endangered species has changed. Therefore, additional studies should be completed to address the current list of threatened and endangered species.

Table 4-6

Determination of Trace Metals in Fish Tissues Collected from Water Bodies in the Environmental Study Area in 1978 Crandon Mining Company NOI/SOS

Location Station	Month of Collection	Number of Individuals that Comprised the Sample	Species	Tissue Analyzed
Swamp Creek Drainage Basin				
Rice Lake	August	25	Black bullhead	muscle
Hemlock Creek				
Station A-1	August	24	White sucker	muscle
Swamp Creek				
Station D	May	21	White sucker	whole fish
Station D	August	7	Mottled sculpin	whole fish
Oak Creek	August	25	Yellow perch	muscle
Pickerel Creek Drainage Basin				
Rolling Stone Lake	May	20	Yellow perch	muscle
	August	26	Yellow perch	muscle
Pickerel Creek M-5	August	25	Yellow perch	muscle
Creek 12-9 M-1	August	5	Yellow perch	muscle
Creek 11-4 M-3	August	25	Redbelly dace	whole fish
Little Sand Lake	August	20	Yellow perch	muscle
Little Sand Lake	August	1*	Yellow perch	muscle
Duck Lake	May	20	Yellow perch	muscle
	August	25	Yellow perch	muscle
Deep Hole Lake	August	25	Yellow perch	muscle

* Twenty-three yellow perch were analyzed individually.

Source: Final Environmental Impact Report, Volume II, Table 2.5-6, 1985.

4.3.4.2 Data Requirements

The majority of the previous work regarding threatened and endangered species should be updated. As such, collection of new data targeting those species that are currently listed, or proposed for listing, as state or federally threatened, endangered, or special concern species will be necessary. It will also be necessary to update the vegetation cover maps that were prepared based on 1977 and 1978 aerial photography. An updated forest inventory is also proposed. A limited number of vegetation and aquatic organism tissue samples will also be collected for verification of previously collected data.

4.3.4.3 Methodology

Previous vegetation mapping will be verified using current aerial photography obtained in November 1993 consisting of 1 inch = 660 feet color stereo aerial photography of the environmental study area, and 1 inch = 400 feet color stereo aerial photography coverage of the Swamp Creek and Wolf River corridors. A second flight in spring of 1994 will duplicate the coverage of November, 1993. The forest inventory will focus on the project areas where surface activities will take place. Standard forestry procedures will be employed to evaluate the forest timber crop composition and value.

Methods proposed for the collection of data regarding threatened and endangered plant and animal species are presented in the *Work Plan for Threatened and Endangered Species Investigations for the Proposed Crandon Mine* (Foth & Van Dyke, 1993) provided in Appendix A. Study procedures, sample locations, objectives, and sampling schedules are presented for each of the following groups:

Terrestrial	**Aquatic**
Plants	Fish
Mammals	Aquatic Macroinvertebrates
Birds	Mollucks
Amphibians and Reptiles	
Lepidoptera	

Implementation of this work plan will involve a comprehensive survey of all major habitat types in the environmental study area. The previous vegetation mapping, species inventories, and habitat characterizations will be verified and updated in conjunction with the field surveys proposed in the work plan.

Metal analyses will be performed on tissue samples of both terrestrial and aquatic vegetation and aquatic organisms for verification of the previous results. As with the previous samples, these samples will be analyzed for manganese, zinc, cadmium, copper, arsenic, lead, mercury, cobalt, and total chromium. The plant species to be sampled include balsam fir (*Abies balsamea*), red raspberry (*Rubus idaeus*), and Pennsylvania sedge (*Carex pennsylvanica*). Samples will be collected from three sites in each of the previously defined study area sectors (i.e., north, south, west) for individual and composite analysis for each of the sectors. A total of nine individual samples will be collected for each of the three species. Vegetation samples will be collected from sites 10, 12, and 16 in the west sector, site 1, 24, and 26 in the north sector, and sites 18, 19 and 20 in the south sector (Figure 4-2).

Samples of aquatic macrophytes, benthic macroinvertebrates and fish will also be collected for verification of the previous metal analysis results. Verification samples will be collected from a total of five sites including: Swamp Creek upstream and downstream of the proposed wastewater discharge; Little Sand Lake; and the Wolf River upstream and downstream of its confluence with Swamp Creek. These samples will be collected during the aquatic threatened and endangered species surveys. Methods for the collection of benthic macroinvertebrates and fish are described in the *Work Plan for Threatened and Endangered Species Investigations for the Proposed Crandon Mine* (Foth & Van Dyke, 1993).

To be consistent with the previous work, yellow perch (*Perca flavesceus*) greater than six inches will be targeted for analysis. If yellow perch are not available, other fish species will be selected based on relative abundance. If possible, a total of 10 fish will be collected from each of the five sample sites. The fish, once captured, will be immediately placed in a live well or in a cooler with ice for subsequent field processing at the end of the day. For each fish, the fillets will be removed (with the skin left on) and placed in individual polyethylene bags. The fillets from each fish will be analyzed for mercury. The livers will be removed from the fish and placed in a single polyethylene bag for a composite sample to be analyzed for manganese, zinc, cadmium, copper, arsenic, lead, cobalt, and total chromium. The field-processed samples will be placed on ice in a cooler for transport to the laboratory within 24 hours of collection.

Crayfish is targeted as the aquatic macroinvertebrate organism for metal analysis. Whole body composites, including the exoskeleton, will be made of 10 or more adult crayfish collected from each site. If an insufficient sample is available after a reasonable effort, the tests will be run on the sample that is available. Crayfish will be placed in polyethylene bags in a cooler with ice for transport to the laboratory within 24 hours of collection.

Aquatic macrophytes will be collected manually from the shoreline and shallow areas at each sample location. Lower portions of the main stalks of larger species (eg., bur reed, cattail, water lily) and the entire plant above the substrate of smaller species (eg., pipewort, spike rush) will be collected. In addition to the sample locations described above, a sample of wild rice will also be collected from Rice Lake and Swamp Creek upstream of State Trunk Highway 55, if available. A one-gallon bag will be filled at each site for the sample. The samples will be placed on ice in a cooler for transport to the laboratory within 24 hours of collection. Samples will be rinsed with distilled water in the field to remove sediment particles attached to the plants, except for wild rice, which will be analyzed separately. Aquatic macrophyte samples will be placed in a single polyethylene bag and analyzed as a composite.

4.3.4.4 Data Presentation Format

Vegetation mapping will be based on the interpretation of the 1 inch = 660 feet and 1 inch = 400 feet aerial photography. Cover types will be transferred onto a base map of the environmental study area. The data presentation format for threatened and endangered species data is specified in the *Work Plan for Threatened and Endangered Species Investigations for the Proposed Crandon Mine* (Foth & Van Dyke, 1993). Data collected from the forest inventory and tissue verification analyses will be presented in tabular and graphic formats. A separate report will be prepared for the forest inventory and included as an appendix to the project's EIR. A written text summarizing tissue verification work will be included in the project's EIR.

4.3.4.5 Schedule for Data Collection

A tentative field collection schedule for threatened and endangered species is presented in Appendix A. Aerial photography was obtained in November 1993. Another flight of the environmental study area is proposed in the spring of 1994 during the first emergence of leaves. The forest inventory will be conducted in the late winter of 1994. Samples for tissue analyses will be collected in early summer, 1994.

4.3.4.6 Key Project Personnel

The biological programs will be conducted through the cooperative efforts of Foth & Van Dyke and a number of state and nationally known experts in the various specific biological disciplines. Tim Weyenberg, Ronald Steg, and William West will form the key Foth & Van Dyke team with support from Robert Howe, Thomas Erdman, Gary Fewless, Gary Casper, Kenneth Tennessen, Gregory Seegert and Donald Helms. Experience summaries of each of the individuals, including their role in the program, are provided in the following paragraphs.

Tim Weyenberg. Mr. Weyenberg will serve as overall task manager for the biological programs providing oversight and quality control. Mr. Weyenberg is a Certified Professional Ecologist with over 22 years of experience. He previously managed a similar program for the Kennecott Flambeau Project and has managed over 50 environmental report/impact statements for mines, power plants, water resource projects, wetland developments, etc.

Ronald Steg. Mr. Steg will be responsible for the day to day management and oversight of the terrestrial biologic programs, including the supervision of field activities, coordination of project team activities and assembly of required reports. Mr. Steg has over 10 years of experience in the field of biology and impact assessment, with a specific focus on wetland ecology.

William West. Mr. West will act as Mr. Steg's counterpart, with responsibility for the day to day management and oversight of the aquatic biologic programs. Mr. West is an aquatic biologist with 18 years of experience, and has recently served in a similar role for the Kennecott Flambeau Project.

Dr. Robert Howe. Dr. Howe will oversee and supervise all of the biological field studies conducted by University of Wisconsin Green Bay (UWGB) faculty and students. Before assuming his current position on the UWGB faculty, Dr. Howe was Program Coordinator and Zoologist for the Natural Heritage Inventory Program in Iowa, a parallel with Wisconsin's Natural Heritage Program in the WDNR's Bureau of Endangered Resources.

Gregory Seegert. Mr. Seegert is an senior scientist at EA Engineering Associates, Inc., Deerfield, Illinois. His areas of special expertise are aquatic toxicology and aquatic ecology. In his 20 years experience in these areas, Mr. Seegert has conducted studies throughout the Midwest and much of the East and Southeast. He is a recognized expert on the effects of water chlorination on aquatic life, and works regularly with the private sector and regulatory agencies in designing and implementing bioassay and biological studies. His main contribution to this project will be in the area of fish studies. Mr. Seegert conducted much of the original fish studies completed for the Crandon Project throughout the 1970s and 1980s.

Dr. Kenneth Tennessen. Dr. Tennessen specializes in aquatic entomology. He is currently employed with the Tennessee Valley Authority in Alabama. Dr. Tennessen will provide expertise in the broad category of aquatic macroinvertebrate investigations and in the specific category of Odonata investigations. His career includes 17 years research on identification and ecology of aquatic insects, including evaluation of effects of environmental disturbance on aquatic insects.

Donald Helms. Mr. Helms of Helms & Associates, Bellevue, Iowa, will provide expertise in the area of mussel identification and enumeration. Mr. Helms has over 25 years experience in aquatic research and consulting in the Midwest, primarily concentrating on the Mississippi and Ohio River systems. Since 1986, Mr. Helms has specialized in projects involving the ecology of mussels, particularly in conducting mussel surveys.

Thomas Erdman. Mr. Erdman will assist the project team in the proposed mammal and bird programs. Mr. Erdman, Associate Curator of the Richter Museum of Natural History, is well known for his research on raptor populations in northeastern Wisconsin. As part of his responsibilities, Mr. Erdman maintains one of the largest reference collection of mammals, birds, amphibians and reptiles in Wisconsin. He is past president of the Wisconsin Society for Ornithology and currently directs the Little Suamico Ornithological Station, a facility which was founded 23 years ago. Mr. Erdman has authored or co-authored many articles and notes on raptors and colonial waterbirds in the Green Bay area.

Gary Fewless. Mr. Fewless will assist the project team in the proposed plant and butterfly programs. He is currently Assistant Curator of the UWGB Richter Museum and is co-organizer of an annual butterfly survey in the Nicolet National Forest and has offered University Extension courses on butterflies. He is also one of northern Wisconsin's leading field botanists.

Gary Casper. Mr. Casper will assist the project team in the proposed reptile and amphibian programs. He is currently producing an atlas of amphibian and reptile distribution in Wisconsin for the Milwaukee Public Museum. He has conducted field work throughout Wisconsin and works cooperatively with the WDNR. The huge database being compiled for the atlas project has provided a strong background in species distributions and habitat requirements.

4.3.5 Blasting, Vibration and Seismicity

4.3.5.1 Existing Data Summary and Evaluation

U.S.G.S. publications (Algermissen, et al., 1991 and Howard, et al., 1978) indicate that the project site is relatively inactive with the peak ground accelerations in the lithified rock not likely to exceed 0.05 times the acceleration due to gravity (only 10% probability in 250 years). Also, there are no faults in the project vicinity which have been active in the holocene period. Therefore, earthquake impacts on the project are not a concern.

Blasting is expected to occur during the sinking of shafts, as well as during active mining operations. Similar mining operations have been studied extensively, and extensive observational and analytical data on the effects of blasting are available in the literature. Proposed blasting activities at the Crandon Project site and assessments of potential impacts on the ground surface have been previously presented to WDNR in a July 31, 1984 report (EMC, 1984). Also in December 1985, a report titled "*Supplemental Information on the Seismic Effects of Mine Blasting Practices*" (EMC, 1985, CMC-NOI-26) was prepared. These documents include data which shows that during anticipated blasting activities, the estimated impacts at a half-mile radius from the mine will be well within DILHR regulations. Details of a proposed preblast survey in accordance with NR 132.07(5) are also included in the documents.

4.3.5.2 Data Requirements

In view of the information that already exists, current baseline information on ambient ground vibrations in the vicinity of the mine site should be obtained at this time.

4.3.5.3 Methodology

The survey of background vibration levels will be accomplished at both the nearest residential locations and the nearest communities. These measurements will include reading of peak particle velocities in three mutually perpendicular directions. An on-site reconnaissance of the project site will be made to select four to six locations for the survey. Data will be collected at each location by continuously recording ground vibrations for a period of four hours. Readings will be taken during daylight hours. A portable seismograph will be used to collect data.

4.3.5.4 Data Presentation Format

The data will be presented using tables, maps, graphs, figures, computer printouts and narrative text to report baseline monitoring results and to assess the impact of blasting on the surrounding environment. The blasting assessment will be included in the project's EIR.

4.3.5.5 Schedule for Field Data Collection

Field data collection for the background vibration survey will occur in June and July of 1994.

4.3.5.6 Key Project Personnel

Data gathering on baseline vibrations will be directed by Dr. Nandu Paruvakat, P.E. of Foth & Van Dyke, who has a degree in Earthquake (Civil) Engineering. Over his 25 year career he has used blasts in exploration engineering and has evaluated blast effects on structures, fills, liquefaction, etc.

4.3.6 Geology and Soils

4.3.6.1 Existing Data Summary and Evaluation

A generalized description of the geology of the site is provided in Section 3.1, Geology. This section of the NOI/SOS provides greater detail on site geology that are particularly relevant to the project.

The Crandon deposit has been described in detail in the professional literature by May and Schmidt (1982), Lambe and Rowe (1986) and Rowe and Hite (1992). To avoid confusion on the part of the non-geologists reviewing the work on this project, the Crandon ore body will be described as containing a zinc zone and a copper zone. These zones are defined as:

Zinc - Greater than 50% sulfides by weight and containing economically significant amounts of zinc

Copper - Less than 50% sulfides by weight, of any origin, and containing economically significant amounts of copper

The zinc ore is a major conformable mineralized zone which contains economically significant amounts of zinc. It also contains minor amounts of copper and lead, and trace amounts of silver and gold.

The copper zone mineralization cross cuts the non-mineralized footwall rocks and zinc zone. This nonconformable mineralized zone is younger, and formed by different processes. It contains economically significant amounts of either copper-bearing minerals with milky white quartz, or, less commonly, variable proportions of zinc- and copper-bearing minerals. The zone also contains minor amounts of lead and silver.

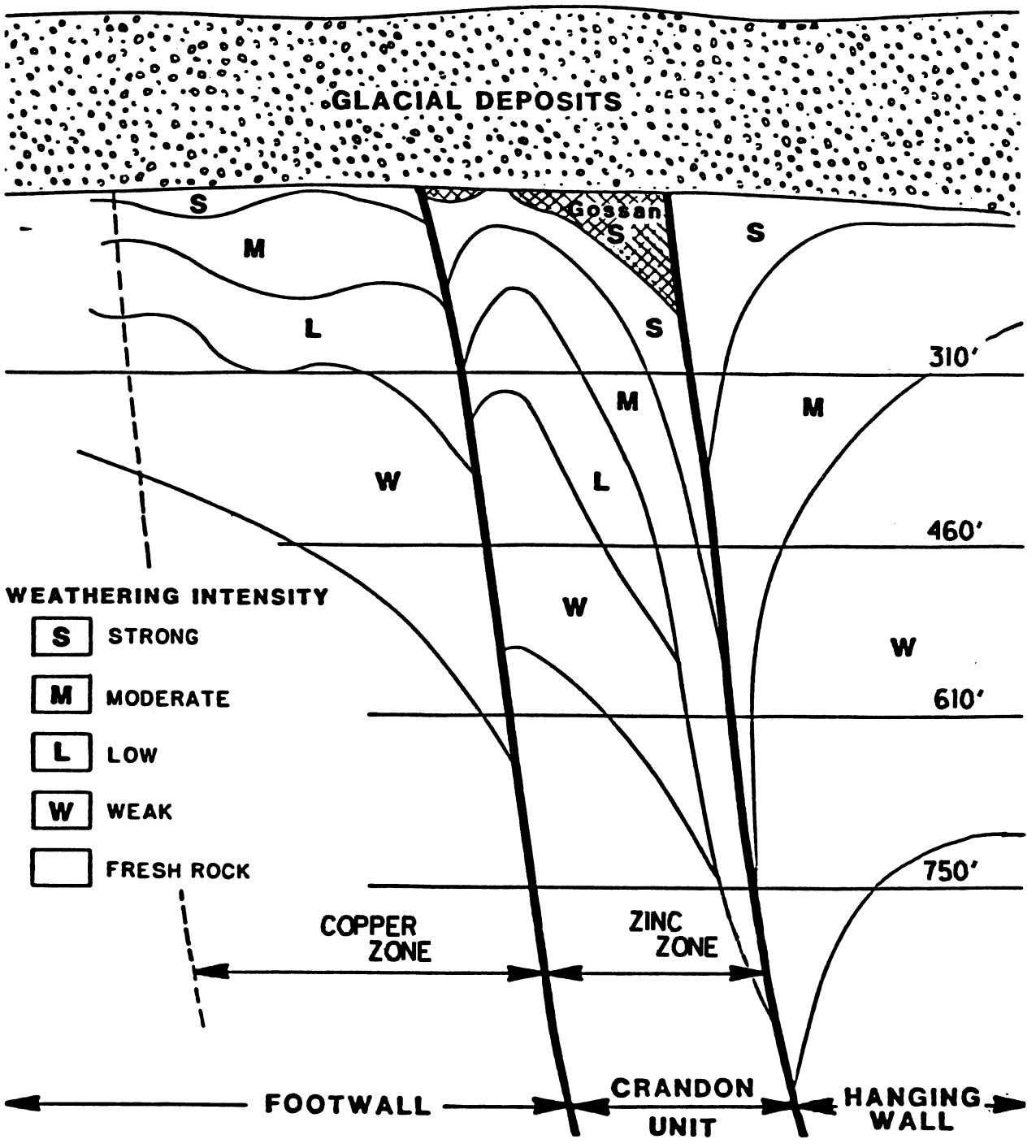
The two mineralized zones of the Crandon deposit are nearly parallel and tabloid in shape. The larger of the two zones is a zinc zone which contains large amounts of pyrite (iron sulfide) and sphalerite (zinc sulfide). The smaller of the two zones is a copper zone containing important amounts of pyrite and chalcopyrite (copper-iron sulfide). Both zones contain small amounts of galena (lead sulfide). In addition, trace amounts of: arsenopyrite (iron-arsenic sulfide), tetrahedrite (copper-iron arsenic-antimony sulfide), pyrrhotite (iron sulfide), chalcocite and covellite (copper sulfides), bornite (copper-iron sulfide), native silver, native copper, and, electrum (gold-silver metal) are found in both zones. The main sulfide gangue (waste) mineral in both zones is pyrite.

The deposit is covered with a blanket of unconsolidated glacial sediments of varying thickness. There are no outcrops of the ore body, or associated lithologies, at or near the site. The size, shape, mineralogy and economic value of the ore body has been delineated by the description of recovered rock cores and assays of selected samples. These data are sufficient for assessing environmental effects that mining the deposit might produce.

The upper surface elevation of the ore body is somewhat higher than most of the surrounding bedrock elevations. This suggests that the ore body may be more resistive to physical weathering than the surrounding rocks. The ore body has been altered by processes associated with percolating groundwater which have weathered the deposit. The destructive processes, which are mainly chemical weathering processes, include: oxidation of sulfide minerals; leaching of sulfide minerals, argillization (development of clay minerals at the expense of existing minerals, especially feldspars); and, fracturing. The intensity, or degree of weathering varies over the site but is most intensely recorded at the ore body, especially along its northern, or hanging wall, boundary. Figure 4-3 shows a generalized weathering profile of the Crandon deposit rocks.

The weathering that the ore body and the rock immediately adjacent to it have been subjected to has several important consequences to mining. Weathering weakens the rock and may limit the quantity of ore that can be removed from the deposit. As a result of weathering effects, a crown pillar at the top of the ore body will be left in place and not mined to provide for the longterm stabilization of the bedrock and overlying glacial sediments.

A layer of saprolite, varying in thickness and extent, has been developed in the upper portion of the crystalline rocks. Saprolite is a soil-like material that inhibits the movement of groundwater, and is a result of intensive in-situ chemical weathering of bedrock. A special case of saprolite, known as gossan, develops from intense weathering of sulfide ore bodies. Saprolites vary widely in composition and texture and vary from clay to silt to clayey or silty sand. They generally have hydraulic conductivities considerably less than granular unconsolidated sediments. In addition, saprolites are often thick, and may form a layer that could be resistive to groundwater migration.



Crandon Mining Company

FIGURE 4-3

GENERALIZED WEATHERING PROFILE OF CRANDON DEPOSIT ROCKS

Scale: NOT TO SCALE	Date: JANUARY, 1994
Prepared By: Foth & Van Dyke	By: JRB

REVISED	DATE	BY	DESCRIPTION

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The saprolite and/or crystalline bedrock is covered with a blanket of overburden approximately 100 to 150 feet thick. Most of the overburden consists of sand, silt and clay materials, considered to be of glacial till and outwash origin. Overburden samples recovered during the exploratory and environmental drilling programs have been used to define the stratigraphy of these unconsolidated units. A thorough compilation and interpretation of the unconsolidated materials at the site was conducted (STS Consultants, Ltd., 1984a and 1984b, CMC-NOI-27 and CMC-NOI-28, respectively).

An initial review of overburden data suggests that saprolite may be more extensive at the site than previously reported and that some, or all, of the fine grained basal till and/or the deep fine grained lacustrine deposits may be saprolites. A more extensive saprolite layer could limit groundwater inflow into the ore body during mining and could also effect the shape and extent of the groundwater drawdown envelope surrounding the active mine. An inspection of the preserved overburden samples, and a limited re-interpretation of the existing data base, will be made to determine the thickness and extent of the saprolite layer. If necessary, a limited number of additional soil borings could be constructed at the site to verify the findings of the evaluation, and to better define the saprolite layer.

The characterization of the overburden at the Crandon Project site was initiated in the 1970s and continued through the mid-1980s. Characterization was accomplished through both field and laboratory work. Field work consisted of gathering data through soil borings, test pits, the completion of diamond drill coring, geophysical logging, etc. Laboratory testing included grain size analyses, permeability tests, carbonate fraction tests, etc. This work was completed as part of site subsurface investigations to collect bedrock and unconsolidated geologic information and information pertaining to the hydrogeology of the site. A detailed discussion of the specific work that was done is presented in Section 4.3.7, Groundwater Characterization. An overview of the surficial geology of the site is discussed below.

As shown in Figure 4-4, Appendix F, the main concentrations of soil characterization work were performed in the vicinity of the ore body and in the area of the proposed TMA. The surficial geology within 1,200 feet of the limit of the area in which the TMA is planned to be located has been determined from data derived from constructing 108 soil borings and 61 soil test pits. Twenty six of the borings were extended to the upper surface of the bedrock. Monitoring wells were installed in 97 of the soil borings.

Surficial geology near the mine site has been characterized from the data derived from constructing 90 soil borings and 13 soil test pits. Monitoring wells were installed in 46 of the soil borings.

Surficial geology at the mine and TMA sites consists of five types of glacial deposit, generally ranging from 100 to 150 feet in total thickness. These deposits include: 1) glacial till at the land surface; 2) coarse grained glacial outwash (drift); 3) fine grained glacial outwash (drift); 4) basal till; and, 5) small amounts of lacustrine deposits.

Glacial till found at the surface consists of a well graded (poorly sorted) mixture of silt, sand, gravel and cobbles with a trace of clay (less than 10%). It is generally described as a slightly silty, fine to medium sand grading to silty fine to coarse sand. These deposits are extensive at the site and form many of the upland areas.

The coarse grained outwash (drift) is composed of well sorted, silty, fine to medium sand to well graded sand and gravel. Samples of this stratigraphic unit often exhibit layering.

The fine grained glacial outwash (drift) is characterized by well sorted, uniformly graded, fine grained materials. This unit generally consists of fine sands with lesser amounts of silty fine sand and fine sandy silt. Similar to the coarse grained outwash, samples of the fine grained outwash stratigraphic unit often exhibit layering, typical of outwash deposits. The two outwash units are generally more permeable than the other surficial geologic units and form the primary aquifer at the site.

A relatively thin (less than 30 feet thick) layer of material was found in contact with the bedrock in most of the deep borings. This material has been described as either a: 1) basal till; 2) buried ancient lacustrine deposits; or 3) saprolite. The basal till has been differentiated from the surface till based on color and soil texture. The basal till is generally reddish brown and finer grained than the brown, coarser grained surface till. It generally ranges from a silty fine to coarse sand, to a fine to coarse silty sand.

The buried ancient lacustrine deposits are relatively fine grained and usually contain conspicuous layering. The layering is generally fine and consists of bands of very fine sand, silt and/or clay. These layered sequences, when distinguished, have been interpreted as varves. Varves are considered to be lacustrine (lake) deposits that contain rhythmically alternating layering which has formed from seasonal or annual fluctuations in sediment deposition.

Diamond drill coring was conducted to determine the size and extent of the ore body and the nature of the surrounding crystalline rocks. General descriptions of the unconsolidated (glacial) sediments overlaying the crystalline rocks are contained in the diamond drill core logs. Saprolitic material has been described as reddish brown, fine grained silty clay to clayey silt with sandy layers. Saprolites are considered to have formed from intense weathering of crystalline rock in which the by-products of that weathering, secondary minerals such as clays and iron oxides, remain in contact with the weathering crystalline rock. This is in contrast with till and lacustrine deposits which are composed of materials that have been deposited in an area removed from the weathering site in which the sediments were produced.

It is possible that all three units in contact with bedrock in various locations at the site exist as described. However, the descriptions of all three materials would be typical for a saprolite. The identification and distribution of these materials, especially those in contact with the upper surface of the ore body, can be important due to the differences in hydrologic properties of the three materials.

No evidence of mineralization was observed in the overburden. A thorough geochemical survey of the surficial (pedogenic) soils at the mine site was conducted by BHP Minerals in 1993 (BHP Minerals, 1993, CMC-NOI-29). Concentrations of 33 elements in samples collected from 222 locations were determined.

4.3.6.2 Data Requirements

Given the extent of geologic characterization at the site and the fact that data gathering and interpretive techniques have not changed over the intervening years, no additional characterization of site geology is necessary to support the project's permitting process.

Additional data regarding the existence and extent of the saprolite is necessary to form an accurate estimate of its hydrologic properties at the mine site. A preliminary study of the basal overburden samples stored in Rhinelander will be conducted. If the saprolite layer should appear to be more extensive than previously reported, it may be necessary to complete a limited number of soil borings to verify the findings of the preliminary study, and to conduct additional tests on fresh samples.

4.3.6.3 Methodology

The preliminary saprolite study will include a comprehensive investigation of the existing soil samples stored at the CMC warehouse in Rhinelander, and an evaluation of the site boring logs. The purpose of the study is to determine if the existing descriptions and interpretations of the materials in contact with bedrock are internally consistent, and the previously described distribution of the materials is accurate. If the past work is deemed acceptable, the results of the preliminary study will be incorporated in the EIR. If the study concludes that additional work should be conducted to verify or amplify the results of the preliminary study, a work plan summarizing the results of the study and containing a description of the proposed work will be presented to WDNR for review.

4.3.6.4 Data Presentation Formats

All data and interpretations will be presented in drawing, tabular and graphical formats as warranted. The accompanying text will detail the study and will provide an interpretation of the results. Data and text will be presented in the project's EIR.

4.3.6.5 Schedule for Data Collection

The preliminary saprolite study will be conducted during February 1994. If additional work is deemed necessary to confirm the results of the study, a schedule for its performance will be included in the work plan referenced in Section 4.3.6.3, Methodology.

4.3.6.6 Key Project Personnel

John E. Thresher, Jr. of Thresher & Son, Inc. will be in charge of the saprolite study. Mr. Thresher, a Ph.C. soil scientist, has conducted similar studies for other mining projects. He has over 30 years experience working on a variety of projects relating to geochemistry.

Lanette L. Altenbach and Stephen V. Donohue of Foth & Van Dyke will assist Mr. Thresher in this work. Ms. Altenbach is a geological engineer with eight years experience relating to geological and hydrogeological investigations. Mr. Donohue is a hydrogeologist specializing in hydrogeological characterization studies and the application of groundwater models to groundwater flow projects.

4.3.7 Groundwater Characterization

4.3.7.1 Existing Data Summary and Evaluation

Hydrogeologic characterization of the Crandon project site was initiated in the late 1970s and continued through the mid-1980s. Regular groundwater level readings have been collected through the present.

In 1978, Dames & Moore (Dames & Moore, 1978) summarized investigative work performed in 1977 and 1978. The data obtained during these efforts included the installation of the DMB series of monitoring wells. These wells were used to identify the different unconsolidated glacial materials, the occurrence of groundwater within the different glacial units, and the interrelationship between the various lakes and streams encompassed by the project area. Chemical analyses were presented for seven of the DMB series wells. The analytes included metals and indicator parameters such as pH, alkalinity, hardness, total dissolved solids, and conductivity.

In 1979, Golder Associates (Golder Associates, 1979, CMC-NOI-30) prepared a report that consisted solely of sieve analysis curves generated from the analysis of soil samples collected from the G40 and G41 series of soil borings and monitoring wells. These data are complete for the selected borings and are incorporated into the NOI/SOS database. These data were part of a multi-year study performed by Golder Associates for the siting of a tailings management area. The data were included in the Golder Associates interpretations, and are discussed below under the Golder, 1982.

In September 1981, Golder Associates (Golder Associates, 1981a, CMC-NOI-31) prepared a report on the "Groundwater Potentiometric Contours" for the Crandon project area. This series of groundwater contour maps included water levels collected jointly by Golder Associates and Dames & Moore from each of their respective well networks. These maps were used to perform an evaluation of the hydrogeologic flow regime within the study area. In October 1981, Golder Associates (Golder Associates, 1981b, CMC-NOI-32) provided a hydrogeologic characterization of the study area. Soil testing included in the report related to the evaluation of potential areas for tailings disposal.

A 1982 Dames & Moore report (Dames & Moore, 1982, CMC-NOI-33) discusses the results of the installation of 96 soil borings and 78 piezometers. Groundwater level and quality data were collected. Soil samples were collected and tested for grain size analysis. Groundwater contour maps and geologic cross sections were prepared. The results of a Golder Associates pump test and EMC borehole permeability tests were discussed. An assessment of groundwater use within Forest, Langlade, and Oneida counties was presented. Groundwater quality testing included indicator parameters (pH, temperature, specific conductance), inorganics (TDS, COD, alkalinity, phosphorus, etc), anions (e.g. chloride, cyanide, nitrate, fluoride, etc), and cations (e.g. aluminum, barium iron, copper, lead, zinc, etc).

Dames & Moore (1982) concluded that groundwater primarily occurred in the unconsolidated glacial deposits, under water table conditions, and that groundwater flow primarily mirrored surface topography. Dames & Moore also concluded that based on work by EMC and Camp, Dresser & McKee (CDM, 1982a, CMC-NOI-34), groundwater flow within the bedrock occurred

primarily in fractures and in weathered zones, primarily near the top of the bedrock. Other Dames & Moore conclusions discussed groundwater interactions with surface streams and lakes.

During 1981 and 1982, CDM (CDM, 1982a, CMC-NOI-34) conducted investigations into the permeability and interconnection of the bedrock and overlying saturated glacial sediments. These investigations included the installation of soil borings for lithologic testing and wells for pump testing and water level monitoring. During the installation of the soil borings and wells, borehole geophysical testing was performed as an aid in identifying subzones within the glacial sediments and to evaluate the overburden bedrock interface for a lower permeability layer. The borehole geophysical logs were presented in a February, 1982 CDM (CDM, 1982b, CMC-NOI-35) report, and copies of the logs are included in the NOI/SOS database. Soil samples were collected for sieve analysis, and the results of those analyses were included in the CDM August 1981 (CDM, 1981a, CMC-NOI-36) report are included in the NOI/SOS database. The CDM studies were performed to aid in the evaluation of the amount of groundwater that could potentially enter the mine.

The CDM pump tests were reported in a 1982 report which concluded that evidence existed for a hydrologic connection between the glacial overburden and the upper fractured bedrock based on water levels that were nearly equal and similarities in groundwater quality. However, the shape of the area influenced by the pump test was oblong along the length (strike) of the ore body. A lower permeability zone was identified across the ore body area and is referred to as a "resistive layer". CDM concluded that the resistive layer included a clay rich, basal till. Also included as part of the CDM pump tests was the pumping of two exploration boreholes. Water quality samples were collected from these boreholes during and after pumping. These data are incorporated into the NOI/SOS database (CMC-NOI-34) as representative of bedrock groundwater quality at the depths from which the samples were collected.

In late 1982, Golder Associates (Golder Associates, 1982, CMC-NOI-37) prepared a more comprehensive report that reviewed work by other consultants including Dames & Moore, ore body drilling by EMC, ore body borings and pump tests by CDM, and included the results of additional geotechnical and hydrogeologic characterizations performed by Golder Associates.

The 1982 Golder Associates report provides a description of the bedrock geology and its formation, and characterizes the types and occurrences of the glacial deposits. The glacial deposits include till (both near the surface and immediately overlying the bedrock), coarse and fine sand stratified drift, outwash deposits, and lacustrine deposits. Groundwater levels were measured in the wells, and the study determined that for the majority of the study area, groundwater occurs under water table conditions across the site and has approximately the same potentiometric head throughout the thickness of the aquifer. The flow direction was mapped by the preparation of groundwater contour maps. The groundwater contour maps illustrate that the groundwater elevations parallel a topographically high area located to the east and southeast of the ore body. Groundwater flows radially away from this high area. Across much of the study area, groundwater flow is predominantly to the west and southwest. To the east and north of the topographically higher area, flow occurs to the east toward Hemlock Creek and to the north toward Swamp Creek. Hemlock and Swamp Creeks were characterized as groundwater discharge areas.

The 1982 Golder Associates report discusses permeability data obtained from pump tests performed by Dames & Moore (Dames & Moore, 1978) in May 1977, by themselves (Golder

Associates, 1981b, CMC-NOI-32), and by CDM (CDM, 1982a, CMC-NOI-34) in November 1981. Additional information regarding permeabilities in the various unconsolidated materials was obtained through soil testing programs by Dames & Moore and Golder Associates, as well as slug tests performed on individual wells installed by each of the consultants.

The 1982 Golder Associates report also provided a study of the surface water occurrence in the study area and its relationship to groundwater. The various lakes encompassed within the study area were evaluated for their hydrogeologic characteristics and relationship to groundwater in the area.

In 1984, STS Consultants, Ltd. (STS Consultants, Ltd., 1984a and 1984b, CMC-NOI-27 and CMC-NOI-28, respectively) completed a hydrogeological study update for the Crandon Project. The STS hydrogeological update was intended to respond to WDNR comments that the area proposed for tailings management required additional information for all sides of the facility due to the radial groundwater flow pattern in the area and for evaluation of in-situ horizontal and vertical permeability. This study included three series of soils borings and/or well installations. Sixteen EX series of borings were drilled to bedrock and all of these borings were completed as wells and piezometers. Each of the borings had multiple, individual well completions (two or three, two-inch well screens and casings), with each well within the boring completed with a screened gravel-packed interval separated from the next individual well screen by bentonite grout. Soil samples were collected from the EX series of soil borings for grain size analyses and water content determination. Slug tests (rising and falling head tests) were performed to evaluate vertical hydraulic gradients. Borehole geophysical logging (on six of the EX borings) was performed to provide additional information for lithological correlation between boreholes.

Fifteen RP series soil borings were drilled for evaluation of a reclaim pond area just to the north of the proposed tailings management area. Seven WP series wells were installed as shallow wells in groundwater discharge areas to evaluate hydrogeologic characteristics in these environments.

The STS Consultants, Ltd. report compared the results of their testing program and reevaluated previously obtained hydrogeologic data from other consultants to further refine the interpretation of the hydrogeologic setting in the proposed area for tailings management. A summary of the permeabilities of the different glacial units derived from the STS Consultants, Inc. study is shown on Table 4-7.

Other data collected during the studies that were not included in the reports described above includes raw data from the STS slug tests, additional boring logs and grain size analyses, and water level data collected throughout the early 1980s to the present. These data are shown on Table 4-8, and are incorporated into the NOI/SOS database as referenced in the table.

Groundwater use in the Crandon project area was studied by Dames & Moore in 1982 (Dames & Moore, 1982, CMC-NOI-33) and by Northern Lake Services, Inc. (NLS) in 1984 (Northern Lake Service, 1984, CMC-NOI-38). The NLS study collected detailed data for the list of groundwater users obtained by Dames & Moore in 1982. The data collected by NLS was obtained from public sources such as the Wisconsin Geologic and Natural History Survey, and from contact with the well owners through written survey responses or verbal communications. The report contains a summary data sheet with well information for each well owner contacted and maps showing the locations of the wells included in the report.

Table 4-7
Field Permeability Test Data
Crandon Mining Company NOI/SOS

Geologic Unit	Number of Tests	Range, cm/sec.	Arthimetic Mean, cm/sec.	Geometric Mean, cm/sec.	Standard Deviation cm/sec.
Coarse drift	15	1×10^{-2} to 1×10^{-3}	4×10^{-3}	3×10^{-3}	3×10^{-3}
Fine drift	12	6×10^{-3} to 7×10^{-4}	2×10^{-3}	1×10^{-3}	7×10^{-4}
Till	10	3×10^{-3} to 9×10^{-6}	6×10^{-4}	2×10^{-4}	9×10^{-4}
Basal till	7	9×10^{-4} to 9×10^{-5}	4×10^{-4}	3×10^{-4}	3×10^{-4}
Lacustrine*	4	5×10^{-4} to 1×10^{-5}	2×10^{-4}	9×10^{-5}	2×10^{-4}

* These values are representative only for glacial lacustrine deposits and not for the recent deposits under Little Sand, Skunk, Oak, Deep Hole and Duck Lakes.

Table 4-8

Existing Hydrogeologic Characterization Data
Crandon Mining Company NOI/SOS

Reference	Data	Date	NOI/SOS File Listing
STS Consultants, Ltd.	Field Boring Logs and Well Completion Data	1984c	CMC-NOI-40
STS Consultants, Ltd.	Grain Size Analysis	1984d	CMC-NOI-41
Camp, Dresser & McKee	Geophysical Logs	1981b	CMC-NOI-42
Memo from L.N. Blair to R.A. Landers	Water Analysis from Hole 213	1/8/81	CMC-NOI-44
Memo from L.N. Blair to R.A. Landers	Laboratory Analysis Results from Water Samples from Hole 213	7/10/81	CMC-NOI-45
STS Consultants, Ltd.	Boring Logs	1984e	CMC-NOI-46
STS Consultants, Ltd.	Field Permeability Test Summary and Composite Gradation Curves	1984f	CMC-NOI-47
Letters from David L. Rastetter to Dr. Kenneth J. Stimpfl	Water Level Measurements	8/1/79, 9/5/79	CMC-NOI-48
Memo from J.E. Grimes to C.E. Fowler	Piezometer Surface Elevations	12/4/81	CMC-NOI-49
Memo from D.E. Kincaid to J.E. Grimes	Piezometer Readings	11/16/81	CMC-NOI-49
Memo from D.E. Kincaid to C.C. Schroeder	Piezometer Readings	3/1/82	CMC-NOI-49
Memos from D.E. Kincaid to C.C. Schroeder	Piezometer Readings	1/24-27/83 4/25-26/83 7/18-19/83 10/18-20/83	CMC-NOI-49
Memos from D.E. Kincaid to C.C. Schroeder	Piezometer Readings	1/84-11/84 5/85-11/85 2/86- 8/86 11/10/86	CMC-NOI-49
Letter from Roger G. Rowe to Mr. Nile Ostenso, WDNR	Aquifer Transmissivity with Attachments	7/19/85	CMC-NOI-50
STS Consultants, Ltd.	Single Well Hydraulic Conductivity Tests, Field Permeability Test Data and Composite Gradation Curves	1984g	CMC-NOI-51
Letter from Robert M. Krill, WDNR to Mr. Joseph A. DeMarte	Private Water Well Survey with Attachments	5/17/84	CMC-NOI-52
Golder Associates	Water Level Data	1982b	CMC-NOI-53
Memo from R.A. Landers to E.R. May	Crandon Mine Hydrology - Design of Phase 2 Tests	1/30/81	CMC-NOI-54
Memo from R.A. Landers to E.R. May	Results of Crandon Phase 1 - Mine Hydrology Tests	1/30/81	CMC-NOI-55
STS Consultants, Ltd.	Slug Test	1982a	CMC-NOI-56
Soil Testing Services	Grain Size Analyses and Boring Logs	3/78 - 1/80	CMC-NOI-57
Camp, Dresser & McKee	Grain Size Analyses	12/81	CMC-NOI-58

Reference	Data	Date	NOI/SOS File Listing
STS Consultants, Ltd.	Field Boring Logs and Well Completion Data	1984h	CMC-NOI-59
D.E. Kincaid	Water Level Readings	8/86 - 9/93	CMC-NOI-60
D.E. Kincaid	Weekly Lake Gage Reports	4/87 - 10/93	CMC-NOI-61
EMC, EIR, Appendix 2.2B	Boring Logs	1985a	CMC-NOI-63
EMC, EIR, Appendix 2.3A	Piezometer Data	1985b	CMC-NOI-64
EMC, EIR, Appendix 2.3E	Field Permeability Tests	1985c	CMC-NOI-65
EMC, EIR, Appendix 2.3F	Lab Permeability Tests	1985d	CMC-NOI-66
EMC, EIR, Appendix 2.3G	Well Inventory	1985e	CMC-NOI-67
STS Consultants, Ltd.	Test Pit Logs and Soil Test Data	1985	CMC-NOI-69
Soil Testing Services	Vent Shaft Soil Report	1978	CMC-NOI-135
Soil Testing Services	Surface Facilities Soils Report	1980	CMC-NOI-136

The permeability of the bedrock was characterized in a 1984 report prepared by Roger Rowe of EMC (Rowe, 1984, CMC-NOI-39). This report reviewed and summarized data collected by EMC and its consultants during previous studies. Discussed in the report were: bedrock geology and morphology; bedrock weathering; the basal overburden unit that exhibited lower permeability, and the components of this unit; bedrock permeability; and bedrock water quality. The various discussions are supported by work previously performed and the data are included as appendices to the bedrock permeability report.

The bedrock permeability report concluded the following:

- *that the bedrock is moderately fractured near the top of rock, but that the number and frequency of fractures decrease with depth.*

- *that the weathering of the rock can serve to raise bedrock permeability by creating more open area for groundwater flow, and that weathering can lower bedrock groundwater flow because some of the fractures become "plugged" with the clays produced by weathering. No single feature could therefore be used to classify bedrock permeability zones. The evaluation of bedrock permeability relies on the integration of many factors.*

- *that a barrier which reduced groundwater flow existed at the bedrock-overburden interface. This area was termed the "resistive layer" and was composed of till, low permeability basal tills, strongly weathered clay-rick material, and weathered or unweathered low permeability bedrock.*

- *that groundwater quality in the upper bedrock (approximately the upper 1500 feet) was similar in characteristics to the groundwater found in the overlying glacial overburden.*

- *that groundwater quality found at depth (below 1500 feet deep) within the bedrock was found to contain high concentrations of total dissolved solids and chlorides typical of waters in an environment of little groundwater circulation that also may include water trapped in the rocks during their emplacement.*

- *that significant circulation of groundwater within the bedrock will not occur after closure of the mine because the crown pillar will be undisturbed and the potentiometric head will return to its pre-mining state (equal to the potentiometric head in the overburden).*

A large number of soil borings, test pits, and monitoring wells have been performed over the study area, with greater concentrations of study at the mine/mill site and the proposed area for tailings management. Many of the previous works contain geologic and hydrogeologic cross sections which are all similar but contain minor differences due to refinements in interpretations that took place as the base of knowledge expanded. These various studies do provide a comprehensive evaluation of the nature and occurrence of groundwater and aquifer materials present within the study area. A map showing the location of previous subsurface investigations consisting of soil borings, test pits, monitoring wells and piezometers is shown on Figure 4-4, which is included as Appendix F.

Groundwater quality data was summarized in the 1985 EIR (EMC, 1985f and 1985g). The data contained in Appendix 2.3C and 2.3D (CMC-NOI-70 and CMC-NOI-71, respectively) of that report are incorporated into the NOI/SOS database. The groundwater quality data were summarized on a table in the EIR which is reproduced in this report (in part) as Table 4-9. These data show the range of concentrations of some of the tested parameters and the lack of detection of other parameters, such as cobalt and silver.

Table 4-9

Summary of Groundwater Quality for Principal Aquifers in the Environmental Study Area* Crandon Mining Company NOI/SOS

Parameter	Units	Range	Mean (x)	Standard Deviation	Number of Samples
Field temperature	°C	3.0 - 12.0	7.1	1.8[a]	220
Total laboratory alkalinity	mg/ℓ[b]	14 - 453	123	50	234
Total field alkalinity	mg/ℓ[b]	11 - 487	127	53	221
Specific conductance	μmhos/cm	50 - 1,300	237	107	235
Field conductivity	μmhos/cm[c]	29 - 1,150	178	92	218
Laboratory pH	standard units	6.09 - 11.02	7.6	0.69	204
Field pH	standard units	5.5 - 12.2	7.7	1.0	222
Total hardness	mg/ℓ[b]	16 - 452	125	53	236
Total dissolved solids	mg/ℓ	14 - 836	166	84	235
Chemical oxygen demand	mg/ℓ	<1 - 365	<29	<56	143
Total phosphorus (P)	mg/ℓ	<0.01 - 0.84	<0.06	<0.10	135

Parameter	Units	Range	Mean (x)	Standard Deviation	Number of Samples
Anions					
Arsenic	mg/ℓ	<0.001 - 0.004	<0.001	<0.001	236
Chloride	mg/ℓ	<1 - 78	<4	<10	236
Cyanide, total	mg/ℓ	<0.001 - 0.004	<0.001	<0.001	236
Fluoride	mg/ℓ	<0.12 - 0.57	<0.20	<0.09	142
Nitrate nitrogen (N)	mg/ℓ	<0.01 - 11.0	<0.37	<1.04	235
Phosphate (PO_4)	mg/ℓ	<0.01 - 0.31	<0.06	<0.06	101
Sulfate	mg/ℓ	<1 - 86	<9	<9	232
Cations					
Aluminum	mg/ℓ	<0.01 - 9.09	<0.53	<1.12	169
Barium	mg/ℓ	<0.01 - 0.24	<0.02	<0.03	142
Cadmium	mg/ℓ	<0.001 - 0.015	<0.002	<0.002	169
Calcium	mg/ℓ	4.9 - 92.4	29.8	12.6	94
Chromium, total	mg/ℓ	<0.001 - 0.021	<0.002	<0.003	169
Cobalt	mg/ℓ	<0.01	<0.01	0	169
Copper	mg/ℓ	<0.001 - 0.09	<0.007	<0.011	232
Iron	mg/ℓ	<0.01 - 38.9	<1.74	<4.34	236
Lead	mg/ℓ	<0.01 - 0.10	<0.01	<0.01	235
Magnesium	mg/ℓ	0.279 - 29.6	12.00	5.12	169
Manganese	mg/ℓ	<0.001 - 10.2	<0.423	<0.989	236
Mercury	mg/ℓ	<0.0001 - 0.0010	<0.0001	<0.0001	169
Molybdenum	mg/ℓ	<0.01 - 0.03	<0.01	<0.01	169
Nickel	mg/ℓ	<0.01 - 0.04	<0.01	<0.01	169
Selenium	mg/ℓ	<0.001 - 0.001	<0.001	0	142
Silver	mg/ℓ	<0.001	<0.001	0	142
Zinc	mg/ℓ	<0.001 - 2.60	<0.052	<0.214	235

[a] Reflects seasonal temperature variation.
[b] All alkalinity and hardness values listed in text are as $CaCO_3$, although the "as $CaCO_3$" hasbeen eliminated to make the text more readable.
[c] Varies with temperature (USEPA, 1976).

* Table derived from the 1985 EMC Environmental Impact Report (EMC, 1985)

4.3.7.2 Data Requirements

4.3.7.2.1 Regional Hydrogeology

Groundwater levels have been collected quarterly since 1984, from the list of wells presented in Table 4-10. Groundwater contour drawings are illustrated on Figures 4-5, 4-6, 4-7 and 4-8. Figure 4-5 is a Golder Associates 1982 drawing, photographically reduced. The remaining three figures were prepared from water levels taken in September 1991, June 1992 and March 1993. Water level measurements have been and will be collected on a quarterly basis from the existing wells shown on Figure 4-9. The newly proposed wells will be included in the quarterly groundwater level measurement program to provide continuing data to be used with groundwater modeling and the continuing characterization of the regional groundwater system. The groundwater contours map prepared for 1991, 1992 and 1993 illustrate groundwater contours very similar to those presented by previous consultants. In general, the area just southeast of the mine/mill site is topographically higher and the groundwater contours reflect this topography. Groundwater flow is predominantly toward the west within the study area, with minor components of flow toward the northwest and southwest. Radial groundwater flow does occur from the topographic high. As a result, groundwater does flow toward Hemlock Creek in the

Table 4-10

Wells Used for Groundwater Levels From 1984 to 1993
Crandon Mining Company NOI/SOS

2-inch wells

DMA-12	CDM-16*	EX-4BU	EX-10AL	WP-5U
DMA-18	G40-S17	EX-4BL	EX-10AU*	WP-5L
DMA-19	G40-Y21*	EX-5CL	EX-12AL	WP-4L
DMA-20	G41-H9	EX-8AL	EX-12AU	WP-4U
DMA-48	G41-A23	EX-8AU	EX-12BL	
DMB- 4	G41-H18B	EX-8BL	EX-12BU	
DMB- 6	G41-K13	EX-8BU[a]	EX-13BL	
DMB-10	G41-E22	EX-9AL	EX-13BU	
DMB-23	G41-E17*	EX-9AU*	EX-14AU	
DMS- 1	G41-E19A	EX-9BL*	EX-14AL	
		EX-9BU	EX-14BU	
			EX-14BL	
			EX-15BL	
			EX-16AL	
			EX-16AU	
			EX-16BL	

½ inch to 1 inch wells

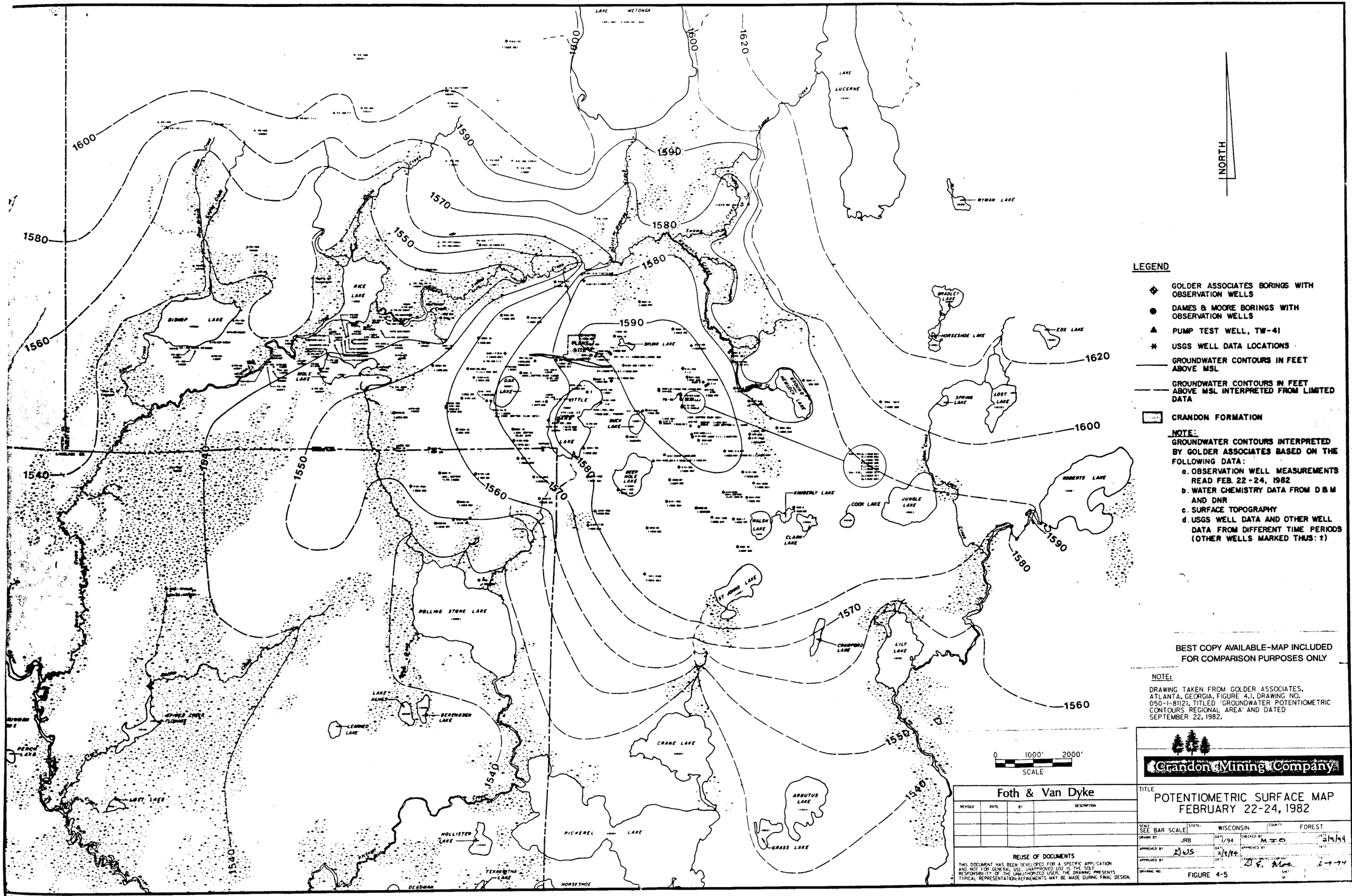
DMI-2U
DMI-2L
DW-3L
DW-1A*
DW-1L*
DW-1U*

8 inch well

TW-1

* Wells with obstructions noted during a December 1993 well inspection survey. Two other wells, G40-L23 and DMA-31 were in the monitoring program but are unable to be located in the field.

[a] well dry



LEGEND

- GOLDER ASSOCIATES BORINGS WITH OBSERVATION WELLS
- DAMES & MOORE BORINGS WITH OBSERVATION WELLS
- PUMP TEST WELL, TW-4I
- USGS WELL DATA LOCATIONS
- GROUNDWATER CONTOURS IN FEET ABOVE MSL
- GROUNDWATER CONTOURS IN FEET ABOVE MSL INTERPRETED FROM LIMITED DATA
- CRANDON FORMATION

NOTE:
GROUNDWATER CONTOURS INTERPRETED BY GOLDER ASSOCIATES BASED ON THE FOLLOWING DATA:

a. OBSERVATION WELL MEASUREMENTS READ FEB. 22-24, 1982
b. WATER CHEMISTRY DATA FROM D&M AND DNR
c. SURFACE TOPOGRAPHY
d. USGS WELL DATA AND OTHER WELL DATA FROM DIFFERENT TIME PERIODS (OTHER WELLS MARKED THUS: †)

BEST COPY AVAILABLE-MAP INCLUDED FOR COMPARISON PURPOSES ONLY

NOTE:
DRAWING TAKEN FROM GOLDER ASSOCIATES, ATLANTA, GEORGIA, FIGURE 4.1, DRAWING NO. 050-1-81121, TITLED 'GROUNDWATER POTENTIOMETRIC CONTOURS REGIONAL AREA' AND DATED SEPTEMBER 22, 1982.

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

REUSE OF DOCUMENTS
THIS DOCUMENT HAS BEEN DEVELOPED FOR A SPECIFIC APPLICATION AND NOT FOR GENERAL USE. UNAPPROVED USE IS THE SOLE RESPONSIBILITY OF THE UNAUTHORIZED USER. THE DRAWING PRESENTS TYPICAL REPRESENTATION. REFINEMENTS MAY BE MADE DURING FINAL DESIGN.

Crandon Mining Company

TITLE
POTENTIOMETRIC SURFACE MAP
FEBRUARY 22-24, 1982

SCALE: SEE BAR SCALE	STATE: WISCONSIN	COUNTY: FOREST	
DRAWN BY: JRB	DATE: 1/94	CHECKED BY: M.J.O.	DATE: 2/9/94
APPROVED BY: D.W.S.	DATE: 2/9/94	APPROVED BY:	DATE:
APPROVED BY:	DATE:	PROJECT MGR.: D.S. Moe	COMPANY: 2-7-94
DRAWING NO.: FIGURE 4-5		SHT:	

2,270,000 E | 2,275,000 E | 2,280,000 E | 2,285,000 E | 2,290,000 E

125,000 N | 120,000 N | 115,000 N | 110,000 N

N

LEGEND

EX-5CL 1573.95 — MONITORING WELL LOCATION, NUMBER AND GROUNDWATER ELEVATION

—— 1570 —— POTENTIOMETRIC SURFACE CONTOUR FEET ABOVE MSL

------ 1580 ---- INFERRED POTENTIOMETRIC SURFACE CONTOUR FEET ABOVE MSL

NOTES:

1. TOPOGRAPHIC BASE MAP PREPARED FROM 7.5' U.S.G.S. ETAK BASE MAPS; MOLE LAKE, LAKE LUCERNE, CRANDON AND ROBERTS LAKE.
2. HORIZONTAL DATUM BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM NORTH ZONE.
3. CONTOUR INTERVAL = 20 FEET.
4. WELLS WITH DESIGNATION "EX" HAVE MULTIPLE WELLS (WITH THE SAME LETTER DESIGNATION) PER BOREHOLE. WELLS WITH THE SAME "EX" NUMBER BUT A DIFFERENT LETTER ARE IN ANOTHER BOREHOLE WITHIN 10 FEET.

   FOR EXAMPLE:

   EX-9BU, EX-9BL } ARE IN SAME BOREHOLE

   EX-9AU, EX-9AL } ARE IN SAME BOREHOLE AND WITHIN 10 FEET OF THE "B" PAIR LISTED ABOVE
5. LAKE LEVELS MEASURED ON SEPTEMBER 16, 1991
6. LAKE ELEVATIONS BASED UPON 1991 SURVEY OF LAKE STAFF GAGES.
7. (A) - G40-L23 AND G40-Y21 CAN NOT BE LOCATED IN THE FIELD.

   (B) - WELL THAT WAS OBSTRUCTED OR DAMAGED AS NOTED DURING THE DECEMBER, 1993 WELL INSPECTION SURVEY. IN SOME WELLS, THE DAMAGE DOES NOT PREVENT THE COLLECTION OF WATER LEVELS. THE SURFACE & ANNULAR SPACE SEALS ON THE DAMAGED WELLS APPEAR TO STILL BE FUNCTIONAL.

0 1000' 2000'
SCALE

Crandon Mining Company

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REVISED	DATE	BY	DESCRIPTION

REUSE OF DOCUMENTS

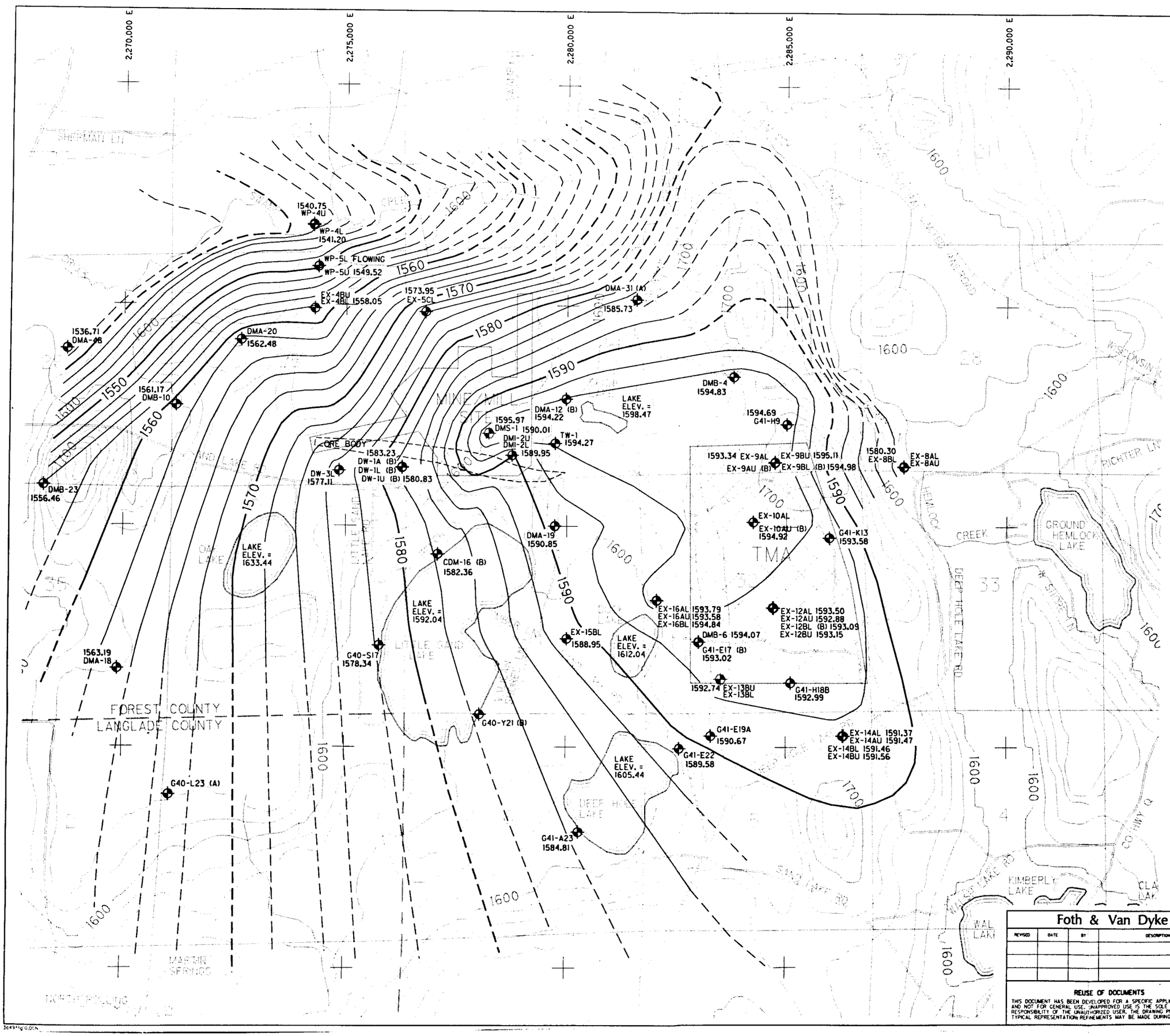
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TITLE: POTENTIOMETRIC SURFACE MAP SEPTEMBER, 1991

SCALE: SEE BAR SCALE	STATE: WISCONSIN	COUNTY: FOREST	
DRAWN BY: JRB	DATE: JAN, '94	CHECKED BY: M.J.O.	DATE: 2/9/94
APPROVED BY: DWS	DATE: 2/9/94	APPROVED BY	DATE
APPROVED BY	DATE	CRANDON MINING COMPANY: D.S. Moe	DATE: 2-7-94
DRAWING NO.	FIGURE 4-6	SHEET 1 OF 1	REVISION A

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LEGEND

EX-5CL 1573.95 — MONITORING WELL LOCATION, NUMBER AND GROUNDWATER ELEVATION

—— 1570 —— POTENTIOMETRIC SURFACE CONTOUR FEET ABOVE MSL

------ 1580 ---- INFERRED POTENTIOMETRIC SURFACE CONTOUR FEET ABOVE MSL

NOTES:

1. TOPOGRAPHIC BASE MAP PREPARED FROM 7.5' U.S.G.S. ETAK BASE MAPS: MOLE LAKE, LAKE LUCERNE, CRANDON AND ROBERTS LAKE.
2. HORIZONTAL DATUM BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM NORTH ZONE.
3. CONTOUR INTERVAL = 20 FEET.
4. WELLS WITH DESIGNATION "EX" HAVE MULTIPLE WELLS (WITH THE SAME LETTER DESIGNATION) PER BOREHOLE. WELLS WITH THE SAME "EX" NUMBER BUT A DIFFERENT LETTER ARE IN ANOTHER BOREHOLE WITHIN 10 FEET.

   FOR EXAMPLE:

   EX-9BU, EX-9BL } ARE IN SAME BOREHOLE

   EX-9AU, EX-9AL } ARE IN SAME BOREHOLE AND WITHIN 10 FEET OF THE "B" PAIR LISTED ABOVE
5. LAKE LEVELS MEASURED IN JUNE, 1992.
6. LAKE ELEVATIONS BASED UPON 1991 SURVEY OF LAKE STAFF GAGES.
7. (A) - G40-L23 AND G40-Y21 CAN NOT BE LOCATED IN THE FIELD.

   (B) - WELL THAT WAS OBSTRUCTED OR DAMAGED AS NOTED DURING THE DECEMBER, 1993 WELL INSPECTION SURVEY. IN SOME WELLS, THE DAMAGE DOES NOT PREVENT THE COLLECTION OF WATER LEVELS. THE SURFACE & ANNULAR SPACE SEALS ON THE DAMAGED WELLS APPEAR TO STILL BE FUNCTIONAL.

0 1000' 2000'
SCALE

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REVISED	DATE	BY	DESCRIPTION

REUSE OF DOCUMENTS

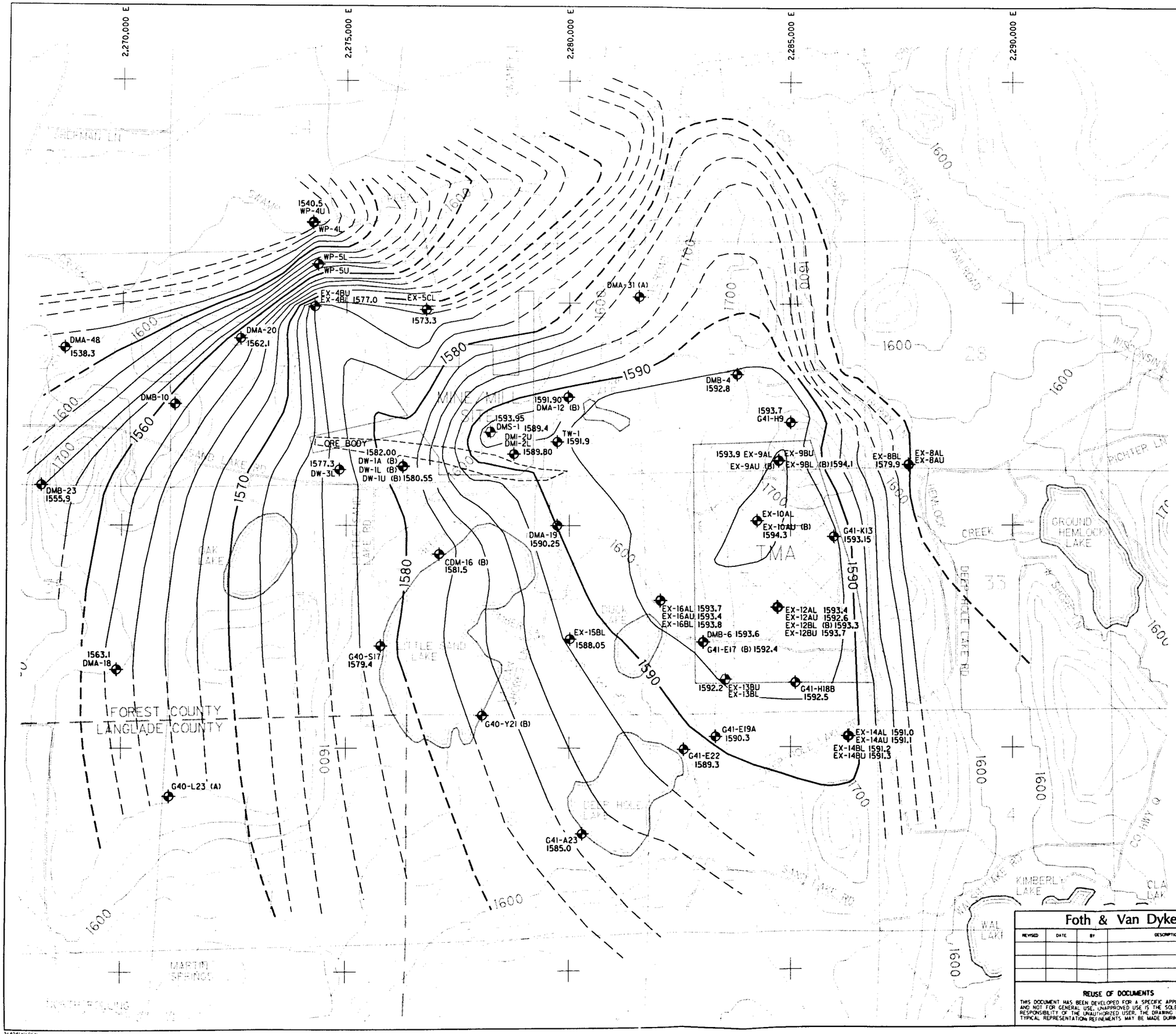
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TITLE
POTENTIOMETRIC SURFACE MAP
JUNE, 1992

SCALE: SEE BAR SCALE	STATE: WISCONSIN	COUNTY: FOREST	
DRAWN BY: JRB	DATE: JAN. '94	CHECKED BY: M.S.D.	DATE: 2/9/94
APPROVED BY: [signature]	DATE: 2/9/94	APPROVED BY:	DATE:
APPROVED BY:	DATE:	CRANDON MINING COMPANY: [signature]	DATE: 2-9-94
DRAWING NO.	FIGURE 4-7	SHEET OF	

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LEGEND

EX-5CL 1573.3 — MONITORING WELL LOCATION, NUMBER AND GROUNDWATER ELEVATION

—— 1570 —— POTENTIOMETRIC SURFACE CONTOUR FEET ABOVE MSL

------ 1580 ---- INFERRED POTENTIOMETRIC SURFACE CONTOUR FEET ABOVE MSL

NOTES:

1. TOPOGRAPHIC BASE MAP PREPARED FROM 7.5' U.S.G.S. ETAK BASE MAPS: MOLE LAKE, LAKE LUCERNE, CRANDON AND ROBERTS LAKE.
2. HORIZONTAL DATUM BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM NORTH ZONE.
3. CONTOUR INTERVAL = 20 FEET.
4. WELLS WITH DESIGNATION "EX" HAVE MULTIPLE WELLS (WITH THE SAME LETTER DESIGNATION) PER BOREHOLE. WELLS WITH THE SAME "EX" NUMBER BUT A DIFFERENT LETTER ARE IN ANOTHER BOREHOLE WITHIN 10 FEET.

   FOR EXAMPLE:

   EX-9BU } ARE IN SAME BOREHOLE
   EX-9BL }

   EX-9AU } ARE IN SAME BOREHOLE AND WITHIN
   EX-9AL } 10 FEET OF THE "B" PAIR LISTED ABOVE

5. (A) - G40-L23 AND G40-Y21 CAN NOT BE LOCATED IN THE FIELD.

   (B) - WELL THAT WAS OBSTRUCTED OR DAMAGED AS NOTED DURING THE DECEMBER, 1993 WELL INSPECTION SURVEY. IN SOME WELLS, THE DAMAGE DOES NOT PREVENT THE COLLECTION OF WATER LEVELS. THE SURFACE & ANNULAR SPACE SEALS ON THE DAMAGED WELLS APPEAR TO STILL BE FUNCTIONAL.

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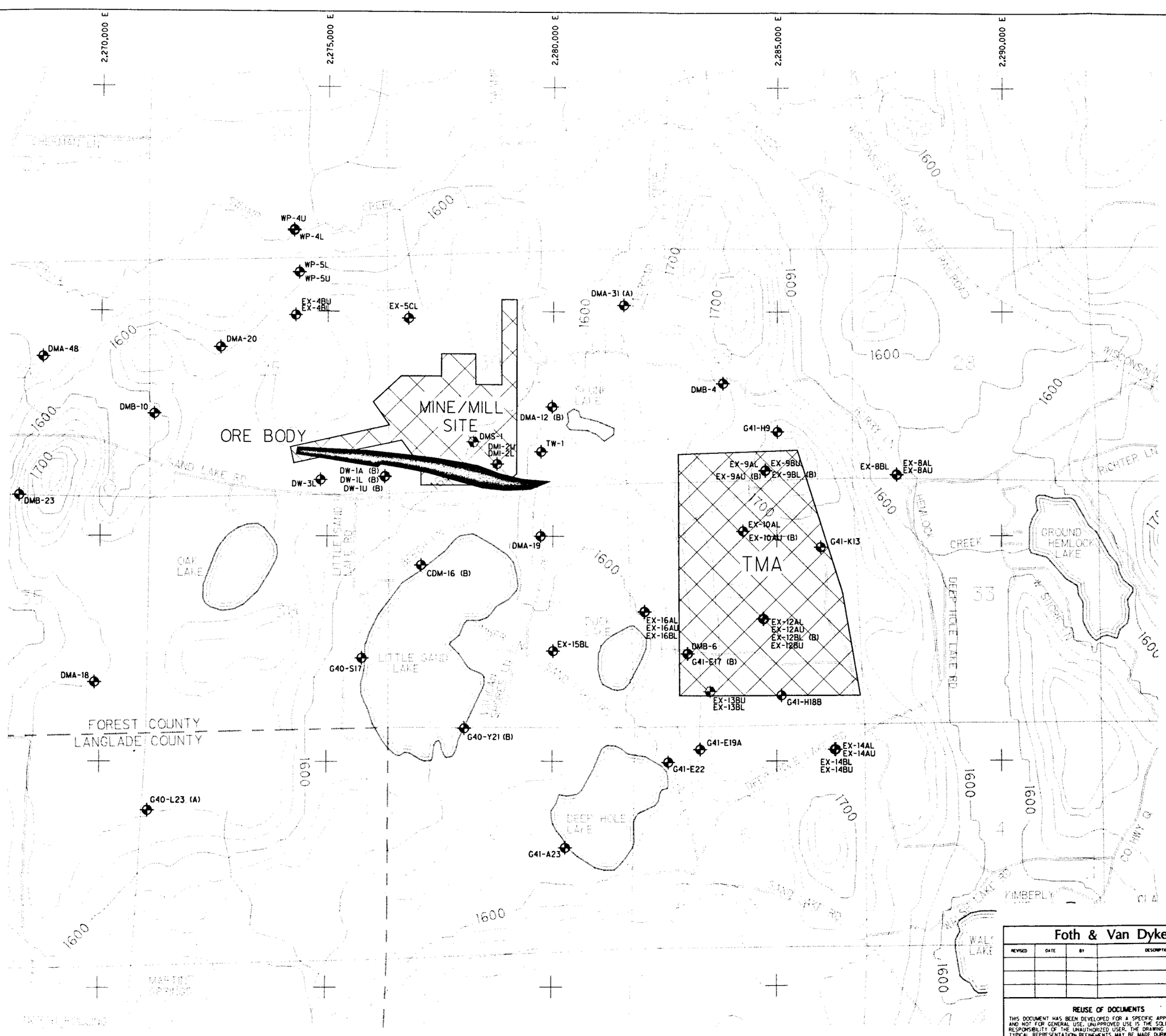
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TITLE
POTENTIOMETRIC SURFACE MAP MARCH, 1993

SCALE SEE BAR SCALE	STATE WISCONSIN	COUNTY FOREST	
DRAWN BY JRB	DATE JAN. '94	CHECKED BY M.J.O.	DATE 2/9/94
APPROVED BY JWS	DATE 2/9/94	APPROVED BY	DATE
APPROVED BY	DATE	CRANDON MINING COMPANY	DATE 2-9-94
DRAWING NO. FIGURE 4-8		SHT. 1 OF 1	

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3C495FIG1.DGN



LEGEND

EX-5AL — MONITORING WELL LOCATION, NUMBER AND GROUNDWATER LOCATION

NOTES:

1. TOPOGRAPHIC BASE MAP PREPARED FROM 7.5' U.S.G.S. 'ETAK BASE MAPS: MOLE LAKE, LAKE LUCERNE, CRANDON AND ROBERTS LAKE.
2. HORIZONTAL DATUM BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM NORTH ZONE.
3. CONTOUR INTERVAL = 20 FEET.
4. WELLS WITH DESIGNATION "EX" HAVE 2 WELLS (WITH THE SAME LETTER DESIGNATION) PER BOREHOLE. WELLS WITH THE SAME "EX" NUMBER BUT A DIFFERENT LETTER ARE IN ANOTHER BOREHOLE WITHIN 10 FEET.

   FOR EXAMPLE:

   EX-9BU } ARE IN SAME BOREHOLE
   EX-9BL }

   EX-9AU } ARE IN SAME BOREHOLE AND WITHIN
   EX-9AL } 10 FEET OF THE "B" PAIR LISTED ABOVE

5. (A) - G40-L23 AND DMA-31 CAN NOT BE LOCATED IN THE FIELD.

   (B) - WELL THAT WAS OBSTRUCTED OR DAMAGED AS NOTED DURING THE DECEMBER, 1993 WELL INSPECTION SURVEY. IN SOME WELLS, THE DAMAGE DOES NOT PREVENT THE COLLECTION OF WATER LEVELS. THE SURFACE & ANNULAR SPACE SEALS ON THE DAMAGED WELLS APPEAR TO STILL BE FUNCTIONAL.

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TITLE

WATER LEVEL WELL LOCATION MAP

SCALE: SEE BAR SCALE	STATE: WISCONSIN	COUNTY: FOREST	
DRAWN BY: JRB	DATE: JAN. '94	CHECKED BY: M.S.O.	DATE: 2/9/94
APPROVED BY: MSOS	DATE: 2/9/94	APPROVED BY:	DATE:
APPROVED BY:	DATE:	CRANDON MINING COMPANY: J. Moe	DATE: 2-9-94

DRAWING NO.: FIGURE 4-9 — SHEET: — OF: — REVISION NO.:

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east and Swamp Creek to the north, both previously identified as groundwater discharge areas.

The existing hydrogeologic cross sections will be reevaluated for use in the groundwater model. Since a 3-dimensional groundwater model is proposed (see Section 4.3.8, Groundwater Modeling), additional detail may be incorporated into the cross sections so that the changes in permeabilities may be used in the model to obtain both horizontal and vertical representations of the groundwater system at the project site. Any addition or changes to the cross sections for the purpose of increasing the accuracy of the groundwater model will represent minor refinements to the previous regional hydrogeologic interpretation.

4.3.7.2.2 Lake Bed and Wetland Characterization

To quantify potential surface water impacts, it is necessary to understand the hydraulic relationships between surface water bodies and the glacial aquifer. A number of previous studies have characterized the hydraulic relationship between area lakes and the glacial aquifer. STS Consultants, Ltd. (STS Consultants, Ltd., 1982b, 1984a, 1984b, 1984i and 1986, CMC-NOI-72, CMC-NOI-27, CMC-NOI-28, CMC-NOI-73 and CMC-NOI-74, respectively) characterized the hydraulic conductivity of the lake beds and wetlands associated with Little Sand, Duck, Deep Hole, Skunk and Oak Lakes. These studies provided estimates of the hydraulic conductivity of lake bed material. Additional lake bed studies will build upon this database and provide an updated assessment of lake bed hydrogeologic characteristics. A main objective of the hydrogeologic studies will be to quantify potential impacts to surface water bodies due to mine dewatering activities and associated drawdown of the water table present in the overburden.

With regard to wetlands, data exists on the hydraulic relationships between area wetlands and the glacial aquifer. Further data on hydraulic conductivity of wetland substrates is required to evaluate, via the groundwater model, groundwater drawdown impacts to wetlands. Additional field work will be conducted to evaluate hydrogeologic characteristics of selected area wetlands. The methodology for lake bed and wetland field studies are described under Methodology.

4.3.7.2.3 Baseline Monitoring

Groundwater quality was evaluated for the Crandon study area during the mid-1980s permitting effort. Data were gathered from 44 wells scattered across the site. Many of the wells have been abandoned. The previous data did characterize groundwater across the study site (horizontal characterization) as well as compare groundwater quality at different depths (vertical characterization).

Although many of the methods used previously for analysis of the groundwater are nearly the same, 15 years have passed since these data were collected and changes in a dynamic system such as groundwater may have occurred. Therefore, validation of baseline groundwater quality is necessary.

Validation of baseline groundwater quality will concentrate on the mine/mill site and the TMA because these are the areas with the potential to impact groundwater quality. Additionally, validation of groundwater quality should, at this time, concentrate on specific zones within the groundwater regime. The specific zones and proposed reasons for choosing these zones are:

- *at the water table interface, because this is the first contact that water recharging the aquifer has with groundwater;*

- *at the top of the outwash sand and gravel, because this is the zone with the highest horizontal permeability;*

- *and, for the mine/mill site, since the aquifer is thin and the water table occurs in the outwash, at the water table interface and the till immediately above the bedrock. These two zones will provide groundwater quality data about the groundwater that will provide inflow to the mine.*

The baseline groundwater validation for the TMA will include two existing water table monitoring wells, four existing piezometers, plus the addition of six new water table wells and four new piezometers. Validation of groundwater quality at the mine/mill site will be accomplished by the monitoring of three new water table wells, two new piezometers, and one existing piezometer (DMS-1).

The wells proposed for baseline groundwater quality validation are shown on Figure 4-10 and listed on Table 4-11 below. The existing wells proposed for use were completed prior to the promulgation of NR 141. NR 141 governs the installation, development and abandonment of monitoring wells. Although the existing well completions differ from NR 141 requirements, the monitoring well completions are technically sound in design. A comparison of NR 141 to the existing well completions is included as Table 4-12. The STS Consultants, Ltd. EX wells were completed two wells per borehole under previous WDNR approval. The well screen length and annular space seals are not expected to impact groundwater quality.

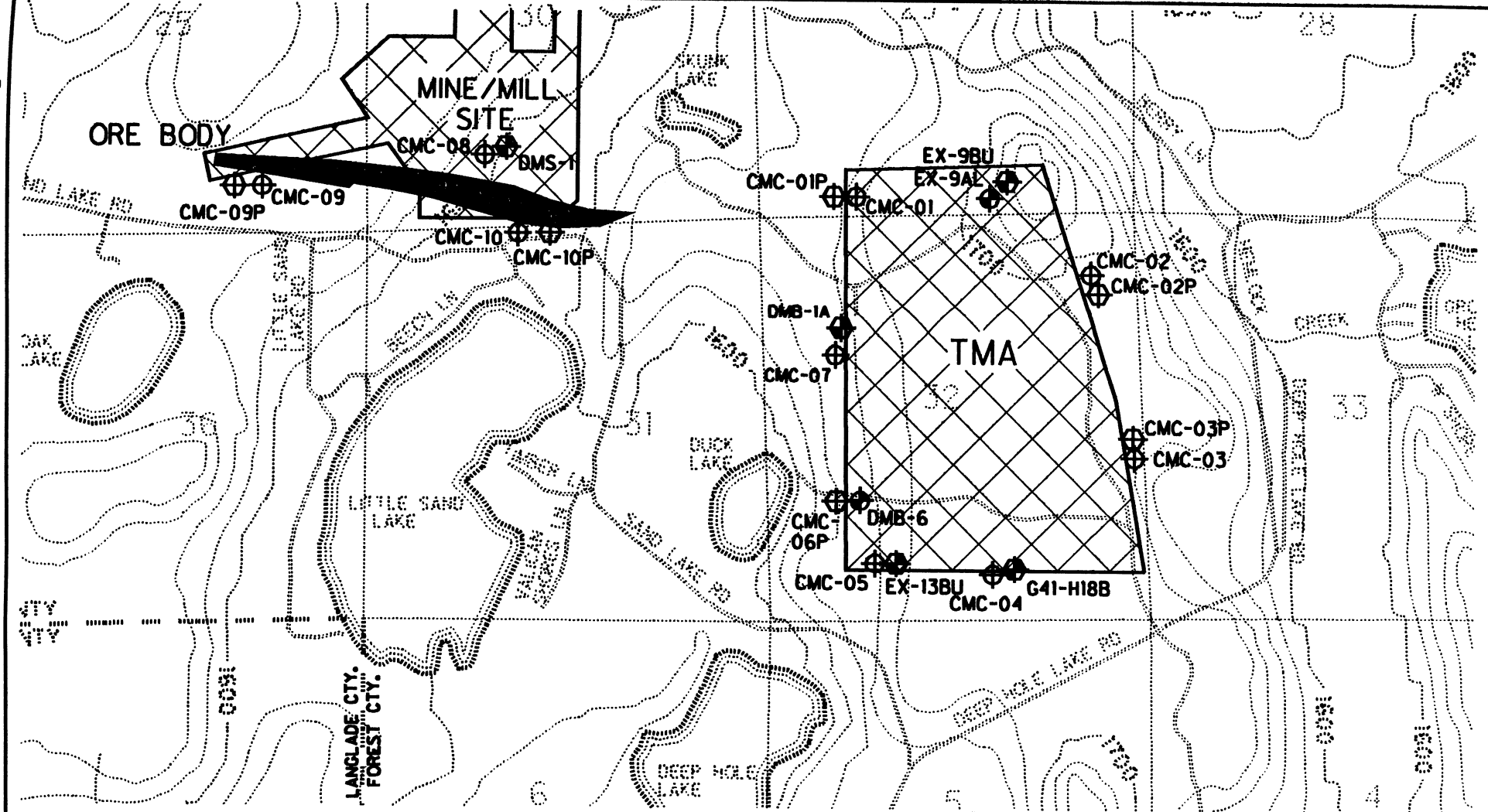
4.3.7.2.4 Private Water Wells

Updated information for private water wells in the study area will include new inquiries of the sources used previously; the WDNR, the USGS, and from the private home owners. Private wells within 1200 feet, if any, of the mine/mill site and the TMA will have background water quality collected from those wells twice, one month apart for the same parameters described for baseline monitoring in the Methodology section.

4.3.7.3 Methodology

4.3.7.3.1 Monitoring Well Installation

Monitoring wells will be installed in the locations shown on Figure 4-10. The wells will be drilled by a mud rotary method with drill hole sizes as required by Wisconsin Administrative Code NR 141. The wells will be constructed and developed in accordance with NR 141 using 15 foot screens for water table wells, and five foot screens for piezometers. The wells will be developed and surveyed according to NR 141. The boring log and well completion and development details will be provided on WDNR forms. The newly installed monitoring wells will be slug-tested. The slug tests will be analyzed via the method described by Bouwer & Rice (1976) and Bouwer (1989).



LEGEND

- CMC-07P — PROPOSED PIEZOMETER
- DMB-1A — EXISTING PIEZOMETER
- CMC-01 — PROPOSED WELL
- EX-9A,B — EXISTING WELLS TO BE USED IN MONITORING PLAN

N

NOTE:
PAIRS OF WELLS SHOWN WILL BE WITHIN 10 FEET OF EACH OTHER.

REVISED	DATE	BY	DESCRIPTION

Crandon Mining Company

FIGURE 4-10

PROPOSED MONITORING WELLS (NEW AND EXISTING) FOR BASELINE GROUNDWATER QUALITY VALIDATION

Scale:	1" = 2000'	Date:	JANUARY, 1994
Prepared By:	Foth & Van Dyke	By:	JRB

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Table 4-11

Baseline Groundwater Quality Validation
Proposed Wells
Crandon Mining Company NOI/SOS

Well	Formation to be Monitored	Approximate Depth in Feet[a]	Screen Length in Feet	Existing (E) or New (N)
TMA				
CMC-01	water table	75	15	N
CMC-01P	upper outwash	190	5	N
EX-9BU	water table	115	20	E
EX-9AL	upper outwash	187	3	E
CMC-02	water table	85	15	N
CMC-02P	upper outwash	190	5	N
CMC-03	water table	80	15	N
CMC-03P	upper outwash	170	5	N
CMC-04	water table	110	15	N
G41-H18B[b]	outwash	147	10	E
CMC-05	water table	90	15	N
EX-13BU	outwash	141	3	E
DMB-6	water table	75.5	10	E
CMC-06P	upper outwash	150	5	N
CMC-07	water table	50	15	N
DMB-1A[b]	outwash	69	10	E
Mine/Mill				
CMC-08	outwash	65	15	N
DMS-1	till above bedrock	95	10	E
CMC-09	outwash	50	15	N
CMC-09P	till above bedrock	100	5	N
CMC-10	outwash	50	15	N
CMC-10P	till above bedrock	100	5	N

[a] for existing wells approximate depth is top of well screen
[b] subject to field inspection of well condition

Table 4-12

Comparison of Existing Wells to NR 141
Crandon Mining Company NOI/SOS

NR 141	EX-9BU	EX-9AL	G41-H18B	EX-13BU	DMS-1	DMB-6	DMB-1A
Total Depth-Borehole (Ft)	192	280	288	193	128	86	79.4
Total Depth-Well (Ft)	135	278	157	144	105	85.5	79
Borehole Diameter (In)	6.25	6.25	[B]	6.25	6	6	6
Well Casing (In)	2	2	2	2	2	2	2
Well Casting Material	Sch 40 PVC	Sch 40 PVC	PVC[A]	Sch 40 PVC	PVC[A]	PVC[A]	PVC[A]
Well Screen Length (Ft)	20	3	10	3	10	10	10
Well Screen Material	PVC	PVC	PVC	PVC	PVC	PVC	PVC - 2 in
Screen Size	#20 Slot	#20 Slot	[C]	#20 Slot	[C]	[C]	[C]
Filter Pack	Pea Gravel 2 Ft Below Screen 30 Ft at Screen	Pea Gravel 2 Ft Below Screen 5 Ft at Screen	Pea Gravel 131 Ft Below Screen 17 Ft at Screen	Pea Gravel 2 Ft Below Screen 9 Ft at Screen	55 ft sand	Gravel Pack 23.9 Ft	Gravel Pack 49 Ft
Filter Pack Seal	17 Ft Bentonite Slurry	27 Ft Bentonite Slurry	3 Ft Bentonite Slurry	7 Ft Bentonite Slurry	none	7.8 Ft Sand 3.8 Ft Bentonite	6 Ft Sand
Annular Space Seal	88 Ft Cement Bentonite Grout	7 In Pea Gravel 10 Ft Bentonite Slurry 231 Ft Cement/Bentonite Grout	137 Ft Grout	28 Ft Cement/Bentonite Grout 16 Ft Pea Gravel 7 Ft Bentonite Slurry 128 Cement/Bentonite Grout	Soft Grout	50 Ft Grout	24 Ft Grout
Ground Surface Seal	Cement/Bentonite Grout	Cement/Bentonite Grout	Grout	Cement/Bentonite Grout	Grout	Grout	Grout
Note	EX-9BL and EX-9BL are in common borehole	EX-9AL and EX-9AU are in common borehole.		EX-13BL and EX-BL are in a common borehole.			

[A] Schedule of PVC not noted on borelog by installer.
[B] Borehole diameter not noted on drill log.
[C] Screen slot size not noted on drill log.

4.3.7.3.2 Lake Bed and Wetland Characterization

The proposed field work described in the following sections is designed to provide additional data to assess the hydrogeologic characteristics of lake beds and wetlands.

Lake Bed Studies

Previous field studies identified that Little Sand, Duck, Deep Hole and Skunk Lake as the lakes that are most likely to be impacted by mine dewatering activities (STS 1982b, 1984i, Dames & Moore, 1985, CMC-NOI-72, CMC-NOI-73 and CMC-NOI-75, respectively). Previous studies concluded that Oak Lake is completely perched, and thus will not be impacted by mine dewatering activities. Consequently, lake bed studies will be limited to Little Sand, Duck, Deep Hole and Skunk Lakes.

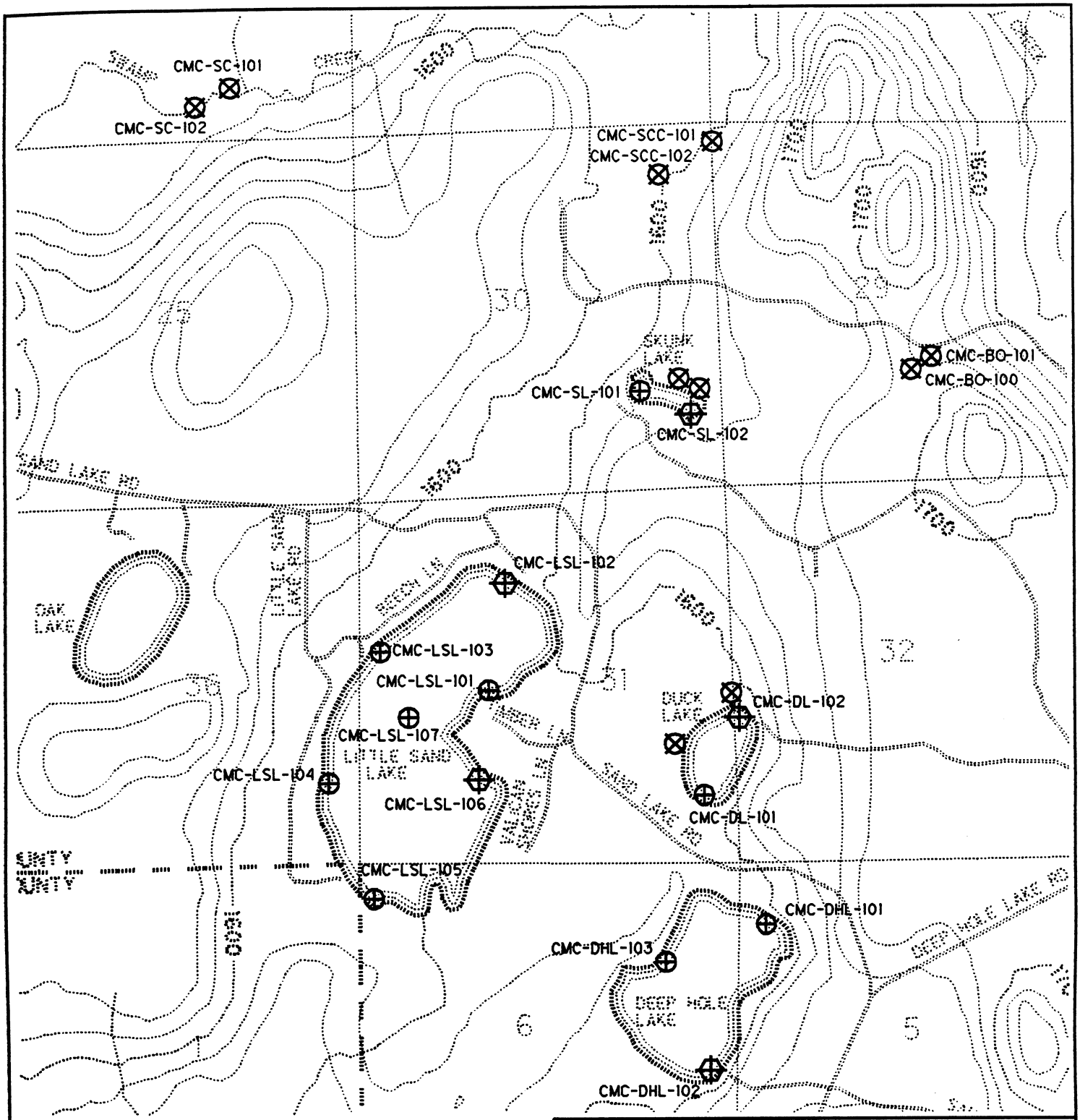
In general, lake bed studies will consist of borings through the lake beds along the perimeter of the lakes. For each boring, undisturbed soil samples will be collected from each major hydrostratigraphic unit encountered down to the top of the glacial aquifer. Lab permeability tests will be run on representative lacustrine soil samples collected from each boring. Lab permeability tests will provide an assessment of the vertical hydraulic conductivity of the lake beds.

At a limited number of boring locations, piezometers will be installed in the lake bed and main glacial aquifer. Hydraulic gradients measured with these piezometers and boring log data will define the hydraulic relations between the lakes and the main glacial aquifer. Slug tests will be performed on each piezometer to assess the in-situ hydraulic conductivity of the lake beds and underlying glacial drift aquifer. Slug tests will be analyzed via the method described by Bouwer & Rice (1976) and Bouwer (1989).

Figure 4-11 shows the locations of proposed lake bed borings and piezometer nests. For Little Sand Lake, borings will be conducted at up to seven locations with well nests installed at two of these boring locations. Up to three borings will be conducted on Deep Hole Lake with a well nest installed at one location. Up to two borings will be conducted on Duck Lake with a well nest installed at one location. Likewise, up to two borings will be conducted on Skunk Lake with a well nest installed at one location. The drilling program will be conducted during the winter months when the lakes are frozen so as to allow the boring locations to be accessed by a conventional drilling rig. All well nests will be abandoned before the end of the winter. The exact number of borings and well installations will depend on field conditions and ice thickness. The final number of borings and well installations will not exceed the number that are described above.

Geophysical studies will be performed to provide a detailed map of the horizontal and vertical extent of lake bed material. Several surface geophysical methods are available to delineate the thickness and horizontal extent of lake bed material. These methods include electromagnetic (EM) and seismic reflection surveys.

EM surveys and/or seismic surveys will be used to prepare a detailed map of the horizontal and vertical extent of lake bed deposits. This information, along with lab permeability and slug test data obtained from the boring program described above, will provide quantitative data on important hydrogeologic characteristics that control lake seepage. This



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⊗	PROPOSED WETLAND DRILLING LOCATION
⊕ CMC-LSL-104	PROPOSED SOIL BORING
⊕ CMC-LSL-102	PROPOSED PIEZOMETER NEST

REVISED	DATE	BY	DESCRIPTION

Crandon Mining Company

FIGURE 4-11

PROPOSED LAKEBED & WETLAND BORING LOCATION MAP

Scale:	1" = 2000'	Date:	JANUARY, 1994
Prepared By:	Foth & Van Dyke	By:	JRB

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information will be used in the groundwater model to provide estimates of lake bed permeability. Variability in the hydraulic conductivity of the lake bed along with calibration data from the groundwater model will be used to estimate probable ranges of lake bed hydraulic conductivity. The resulting probable ranges of hydraulic conductivity will in turn be used in the prediction phase of the groundwater modeling studies to assess probable ranges of lake level impacts induced by mine dewatering.

Wetland Hydraulic Studies

Wetland hydrogeologic studies will be similar to lake bed studies proposed above. As described in Section 4.3.18, there are likely to be three hydrogeologic classes of wetlands that exist within the study area. These are classified as follows:

1. perched wetlands that will not be affected by drawdown of the water table;

2. seepage wetlands that are continuously saturated from the wetland substrate down to the glacial aquifer and may be affected by mine dewatering; and

3. water table wetlands associated with discharge points, such as Swamp and Hemlock Creek that may be affected by mine dewatering.

Wetlands associated with Duck Lake, Skunk Lake, Swamp Creek, Bur Oak Swamp and Swamp Creek Cedars will be investigated to confirm this interpretation and to provide data for use in the groundwater model described in Section 4.3.8. Figure 4-11 also shows the wetland areas that will be investigated.

The wetland investigations will consist of completing borings at up to two locations within each wetland boundary. At each boring location, undisturbed soil samples will be collected from each major hydrostratigraphic unit down to the top of the glacial drift aquifer or to the top of any unsaturated zone, whichever comes first. At one boring location per wetland, a well nest will be installed in the wetland substrate and the glacial drift aquifer. Lab permeability tests will be conducted on an undisturbed soil sample from each boring, and slug tests will be performed on each piezometer according to the method described by Bouwer & Rice (1976) and Bouwer (1989).

Water level measurements from the piezometers will be used to assess the hydraulic relationship of the wetland to the groundwater (i.e., perched, seepage, or water table wetland) and the hydraulic conductivity data will be used to provide estimates of hydraulic conductivity inputs for the groundwater model. Piezometers will be left in place for a period of one year and will be used for water level measurements only.

4.3.7.3.3 Baseline Monitoring

Baseline groundwater monitoring will consist of the collection of water level data and the collection of groundwater quality data and groundwater quality data. Water level data will be collected from the previously installed wells which have been monitored from the submittal of the EIR in 1985 to the present and from the proposed new wells. These wells are listed on Table 4-10 and Table 4-11.

Groundwater quality data will be collected from two specific areas within the study area. The first area is the mine/mill site. The second area is the circumference of the proposed tailings management area (TMA). The proposed wells will monitor each of the identified hydrogeologic zones described previously.

Groundwater will be collected and analyzed monthly for the parameters shown on Table 4-13 for up to eight consecutive months. This baseline study will be used to validate the characterization of the groundwater quality within the study area and to provide an estimate of the range of concentrations for introduction into the groundwater solute transport model.

Validation of groundwater quality will be performed by initially tabulating the data followed by cumulative statistics (mean, standard deviation, etc.). Upon completion of the collection of groundwater quality data, the 1994 data set will be compared to the data set shown on Table 4-9. Statistical analyses will be applied to the 1978 and 1994 data sets for evaluation of trends within each data set and comparison of significant difference between the two data sets. Based on the distribution of the data, appropriate statistical tests, either parametric or non-parametric, will be used. These methods will be used to assess whether changes have occurred in groundwater quality during the past 15 years in the study area.

4.3.7.3.4 Private Water Wells

The update of private water wells information will begin with a review of WDNR and Wisconsin Geologic and Natural History Survey files to identify private water well construction information submitted to these agencies since the collection of the previous project data (CMC-NOI-38). Verification of the existing data will be obtained by mailing a questionnaire to well owners within the areas previously surveyed (CMC-NOI-38). Previous responders to the questionnaire will be asked to note if any maintenance or changes to their well system has occurred. Maintenance or changes may include; relining the well, deepening the well, pump replacement, etc. Well owners new to the database will be asked for information about their well system, such as the date the well was installed, the depth of the well, the type of pump, and the well's location on the property. Attempts will be made to contact the owners not responding to the questionnaire by telephone or in person.

4.3.7.4 Data Presentation Format

Text addressing groundwater characterization of the project site and raw field and laboratory data will be presented in the body of the project's EIR and in its appendices. Data will be summarized on tables, maps, cross-sections, and graphs as appropriate.

Soil borings drilled for the installation of monitoring wells will be logged and the log will be presented on WDNR Form 4400-122 in an appendix to the project's EIR. The monitoring well completions and well development will be documented on WDNR Form 4400-113A and -113B and also included as an appendix to the EIR. In addition, a summary of all wells (both existing and newly installed wells) used for this study will be tabulated on WDNR Form 4400-89, the Well Inventory Form (WIF). These summaries will be provided to the WDNR.

Table 4-13

Proposed Baseline Groundwater Quality Validation Parameters
Crandon Mining Company NOI/SOS

Field Measured Parameters	Laboratory Analyzed Parameters	
Specific Conductance	Total Alkalinity	Antimony
pH	Total Hardness	Aluminum
Temperature	COD	Arsenic
	Fluoride	Barium
	Kjeldahl (N)	Cadmium
	Nitrite + Nitrate	Calcium
	Chloride	Chromium
	Sulfate	Cobalt
	Cyanide (total)	Copper
	TDS	Iron
		Lead
		Magnesium
		Manganese
		Mercury
		Molybdenum
		Nickel
		Selenium
		Silver
		Zinc

4.3.7.5 Schedule for Data Collection

Quarterly groundwater level data collection has been ongoing and will continue. Lake bed and wetland drilling will take place between January and March 1994.

Monitoring wells needed for baseline monitoring will be installed in late winter 1994 so that baseline monitoring can start in March 1994. The wells will be developed shortly after installation, and allowed to equilibrate for approximately two weeks prior to the collection of the initial rounds of groundwater samples. Baseline monitoring validation will begin approximately two weeks after the newly installed wells are developed. The private water well work will be conducted during the summer of 1994.

4.3.7.6 Key Project Personnel

Lanette L. Altenbach, a Senior Hydrogeologist with Foth & Van Dyke, will coordinate the hydrogeologic studies, monitoring well installations and baseline monitoring. Stephen V. Donohue will coordinate field and data analysis activities associated with the collection of additional characterization data for groundwater modeling. Ms. Altenbach is a geological engineer with eight years experience relating to geological and hydrogeological investigations. Mr. Donohue is a hydrogeologist specializing in hydrogeological characterization studies and the application of groundwater models to groundwater flow projects.

4.3.8 Groundwater Modeling

4.3.8.1 Existing Data Summary and Evaluation

Four separate groundwater modeling studies were conducted by various consultants and agencies for the Crandon Project in the early to mid-1980s. Each of these models focused on specific aspects of the hydrogeologic system and mining associated activities. These may be divided into the categories of mine dewatering, regional drawdown and lake impacts, and solute transport. A discussion of each category follows.

4.3.8.1.1 Mine Dewatering

Prickett and Associates (1984) developed a three-dimensional groundwater flow model of the proposed mine workings. The purpose of this model was to compute the amount of leakage from the glacial drift aquifer as a result of the dewatering activities used for the mine. A modified version of the PLASM (Prickett and Lonnquist, 1971) code was used for all simulations. This code is a finite difference program for computing groundwater flow in fully saturated porous media. The model covered a 1640 ft by 5250 ft area consisting of the immediate vicinity of the ore body and extended vertically from the glacial drift aquifer to approximately 1150 ft below land surface. This area was represented by a five row by 16 column by 12 layer grid. From this model, computed flow rates into the mine were input to the regional groundwater flow model described in Section 4.3.8.1.2, Regional Drawdown and Lake Impacts, to determine drawdown in the glacial drift aquifer.

4.3.8.1.2 Regional Drawdown and Lake Impacts

Golder Associates (1982b) developed a groundwater impact screening model intended to aid in determining the optimum site design and location of the TMA. The model was regional in extent, covering approximately 18 square miles. The model was two-dimensional and used a finite difference grid consisting of 41 rows by 28 columns. Both groundwater flow and solute transport from the TMA were simulated. A modification of the Random Walk code (Prickett, et al., 1981) was used.

D'Appalonia (1985) developed an areal two-dimensional groundwater flow model of the stratified drift aquifer within the entire site area. The model was used to assess drawdown of the potentiometric surface resulting from mine inflow and provided information to evaluate changes in discharges to and from lakes and streams. This model was also used to simulate the steady-state migration of chemical constituents from potential TMA seepage (see Section 4.3.8.1.3, Solute Transport). Model simulations were made using the GEOFLOW finite element computer code developed by D'Appalonia (1983). The 22 square mile site area was modeled using a finite element grid consisting of 1153 quadrilateral elements with 1227 nodes. Boundary conditions for the model were: Swamp Creek to the north, Hemlock Creek and Ground Hemlock Lake to the east, Crane Lake and Pickerel Lake to the south, and Rolling Stone Lake, Pickerel Creek, and a portion of Rice Lake to the west.

The U.S. Geological Survey, working in cooperation with the WDNR (Krug et al., 1987), used the drawdowns derived from the D'Appalonia model to formulate a water-budget model to predict lake-stage and lake outflow changes for four lakes in the study area.

4.3.8.1.3 Solute Transport

The model described in Section 4.3.8.1.2, Regional Drawdown and Lake Impacts, developed by D'Appalonia (1985) was also used to simulate migration of chemical constituents from potential TMA seepage. A normalized concentration was assumed to infiltrate the TMA area and the resulting plume was modeled through time to steady state. This model assumed complete vertical mixing within the aquifer thickness.

A cross-sectional model was also developed by D'Appalonia (1985) to address the vertical variation in concentrations resulting from constituent entry to the top of the saturated zone and variations in aquifer hydrologic and dispersive properties. The finite element code GEOFLOW was also used in that application. The cross section ran approximately in a northeasterly direction from Rolling Stone Lake to 4500 ft beyond Hemlock Creek. A finite element grid consisting of 122 elements horizontally and 9 elements vertically was used.

A one-dimensional vertical model was also developed by D'Appalonia (1985) to determine the concentration and timing for contaminant entry to the water-table. Partially saturated conditions were simulated in the till. The results of this model were used as input to the cross-sectional model.

The U.S. Geological Survey, working in cooperation with the WDNR, developed a cross-sectional model to assess contaminant concentrations resulting from seepage at the TMA.

4.3.8.1.4 Summary

Overall, four distinct hydrogeologic and surface water models were used to evaluate mine inflow rates, drawdown in the glacial aquifer, lake and stream impacts, and groundwater transport of sulfate from the mine waste disposal facility. At the time these modeling studies were completed, four separate models were required, since one comprehensive model with capabilities to evaluate all the potential hydrologic impacts associated with mine operations was not available. Current state-of-the-art groundwater models now have the capabilities to quantitatively evaluate these potential impacts through use of a single comprehensive groundwater model. For this reason, a revised groundwater model and assessment of potential impacts and potential mitigation measures is necessary. The data requirements and methodology are described in Sections 4.3.8.2 and 4.3.8.3 below.

4.3.8.2 Data Requirements

A substantial volume of regional and site data that was collected in the 1970s and 1980s will be relied upon in the new model construction. Where appropriate, new state-of-the-art data analysis techniques will be used to reinterpret existing data. For example, the Geographic Information System (GIS) will be used to more accurately define stream elevations based on digitized contour maps. Based on the review of the existing database, it would be desirable to obtain selected additional data to support the new modeling work. This data collection is discussed below. It should be noted that during model construction and initial conceptual model runs, a need for additional data may become apparent, and appropriate additional field programs may be proposed. At the current time though, field work beyond that discussed below is not anticipated.

An initial review of the documents indicates three areas where additional data may be required. These are the hydraulic conductivity of the resistive layer, the hydraulic connection of lakes to the aquifer and the hydraulic connection of wetlands to the aquifer. The permeability of the resistive layer is characterized as being a function of several factors: weathering of the bedrock, heterogeneity in the aquifer, and vertical anisotropy of the aquifer. Examination of existing boring logs and cuttings may provide relative spatial variability of hydraulic conductivity in the resistive layer. Additional evaluation of the resistive layer may be required to further quantify its hydraulic conductivity. The conceptual model runs and sensitivity analysis will aid to determine if additional data are required.

The hydraulic connection of the lakes to the aquifer has been estimated from laboratory permeability tests on cores from within the lakes, water budget calculations, numerical modeling, and hydraulic testing on wells within wetlands. Model sensitivity analyses may indicate that additional hydraulic testing of lake bed sediments may be required. Additional investigations to further quantify the hydraulic connection of lakes to the aquifer and to fill these anticipated data requirements are described in Section 4.3.7.3.2, Lake Bed and Wetland Characterization.

4.3.8.2.1 Data to be Used in Model

Table 4-14 presents the significant regional and site data relied upon in the previous models that would be available for incorporation into a more current model. This table is organized to indicate data requirements of the MODFLOW model, which will be used in the flow application. Presentation in this fashion provides a checklist of the data needs that are fulfilled with existing data. A description of the data available for each MODFLOW package to be used in this application is summarized below.

The BASIC package defines the boundary conditions of the model. Data used to establish the boundary conditions includes geologic maps to outline extent of units and historic water level, precipitation, and pumping data to characterize how the flow system responds to stresses. Furthermore, USGS stream gaging data and site-specific stream studies may be used to qualitatively determine the type of boundary the streams pose. For example, the U.S. Geological Survey collected daily stream discharge at two Swamp Creek locations and surface water elevations at numerous lakes (EMC, 1985, Appendix 2.4B and 2.4C, CMC-NOI-76 and CMC-NOI-77, respectively).

Starting heads are provided in the BASIC package. These heads are essentially starting points for the iterative solution. However, boundaries of specified head need true representative values because they remain constant in the iterative history. Such information exists in the available database or will be collected as part of proposed surface water studies.

The BLOCK CENTERED FLOW Package defines the hydrostratigraphy of the flow system, namely the unit elevations, thicknesses, and conductances. Elevations of the stratigraphic units are interpreted from geologic cross sections, isopach maps, structural elevation maps, geologic logs, and geophysical logs. These data are primarily presented in Golder, 1982a, CMC-NOI-37, Rowe, 1984, CMC-NOI-39, STS 1984a, CMC-NOI-27, STS, 1984b, CMC-NOI-28, CDM, 1982a, CMC-NOI-34, CDM, 1982b, CMC-NOI-35, EMC, 1985, Appendices 2.2A and 2.2B, CMC-NOI-78 and CMC-NOI-63, respectively.

Horizontal and vertical hydraulic conductivity data of the glacial overburden and ore body have been estimated with lab permeability tests, slug tests, and aquifer tests. Bedrock/ore body permeability data was collected by Dames & Moore (Dames & Moore, 1978, CMC-NOI-82) using injection with packers. Three pumping tests were performed by CDM (CDM, 1982a, CMC-NOI-34) which estimated the bedrock properties, the glacial overburden properties, and the hydraulic connection between the two across the resistive layer. Golder Associates (Golder Associates, 1981, CMC-NOI-80) performed a pump test in the vicinity of the TMA which measured the hydraulic characteristics of the glacial aquifer. STS Consultants, Ltd. (STS Consultants, Ltd. 1984a and 1984b, CMC-NOI-27

Table 4-14

Model Data Availability
Crandon Mining Company NOI/SOS

MODFLOW Package	Model Input	Reference	NOI/SOS File Listing
Basic	Boundary Conditions	Dames & Moore (1985)	CMC-NOI-75
		EMC, EIR Appendix 2.4B (1985e)	CMC-NOI-76
		EMC, EIR Appendix 2.4C (1985f)	CMC-NOI-77
	Starting Heads	EMC, EIR Appendix 2.4B (1985e)	CMC-NOI-76
		EMC, EIR Appendix 2.4C (1985f)	CMC-NOI-77
		Golder (1982a)	CMC-NOI-37
		Rowe (1984)	CMC-NOI-39
		STS (1984a and 1984b)	CMC-NOI-27 & 28
		USGS Topographic Maps	
Block Centered Flow	Stratigraphic Elevations	Rowe (1984)	CMC-NOI-39
		Rowe (1985)	CMC-NOI-79
		STS (1984a and 1984b)	CMC-NOI-27 & 28
		CDM (1981)	CMC-NOI-36
		Golder (1979)	CMC-NOI-30
		CDM (1982b)	CMC-NOI-35
		EMC, EIR Appendix 2.3E (1985c)	CMC-NOI-65
		EMC, EIR Appenix 2.3F (1985d)	CMC-NOI-66
	Horizontal Hydraulic Conductivities	Golder (1981, 1982a)	CMC-NOI-80 & 37
		Rowe (1984)	CMC-NOI-39
		STS (1984a and 1984b)	CMC-NOI-27 & 28
		CDM (1982a)	CMC-NOI-34
		Dames & Moore (1978)	CMC-NOI-82
	Vertical Hydraulic Conductivities	Golder (1981)	CMC-NOI-80
	Storage Coefficient	Golder (1981, 1982a)	CMC-NOI-80 & 37
Well	Existing Well Locations and Rates	U.S. Geological Survey	
Recharge	Precipitation	National Weather Service	
	Pan Evaporation	National Weather Service	
	Evapotranspiration	USGS	
	Infiltration	Soil Conservation Service U.S. Department of Agriculture	
Stream Flow Routing	Stream Location	USGS Topographic Maps	
	Stream Depth	USGS Topographic Maps	
	Stream Sediment Thickness and Hydraulic Conductivity	EMC, EIR Appendix 2.3H (1985h)	CMC-NOI-84

Table 4-14 (continued)

MODFLOW Package	Model Input	Reference	NOI/SOS File Listing
Stream Flow Routing	Stream Flow Rates	EMC, EIR Appendix 2.4A (1985i) EMC, EIR Appendix 2.4C (1985f) EMC, EIR Appendix 2.4J (1985j) EMC, EIR Appendix 2.4K (1985k) EMC, EIR Appendix 2.4L (1985l)	CMC-NOI-85 CMC-NOI-77 CMC-NOI-86 CMC-NOI-87 CMC-NOI-88
	Stream Characteristics	EMC, EIR Appendix 2.3H (1985h)	CMC-NOI-84
	Stream Slope	USGS Topographic Maps	
	Proposed Stream Augmentation		
Lake Stage	Lake Location	USGS Topographic Maps	
	Lake Stage	Dames & Moore (1985) EMC, EIR Appendix 2.4B (1985e) EMC, EIR Appendix 2.4I (1985m)	CMC-NOI-75 CMC-NOI-76 CMC-NOI-89
	Lake Bed Characteristics	Dames & Moore (1985) STS (1982b, 1984i)	CMC-NOI-75 CMC-NOI-72 & 73
	Surface Inflows	Dames & Moore (1985)	CMC-NOI-75
	Lake Surface Evaporation	Dames & Moore (1985) USGS	CMC-NOI-75
Drain	Wetland Location	See Wetlands NOI/SOS File Listing USGS Topographic Maps	See Wetlands NOI/SOS Filing Listing
	Wetland Elevation	Set Wetlands NOI/SOS File Listing STS (1986) USGS Topographic Maps	See Wetlands NOI/SOS File Listing CMC-NOI-74
	Wetland Characteristics	See Wetlands NOI/SOS File Listing STS (1986) USGS Topographic Maps	See Wetlands NOI/SOS File Listing CMC-NOI-74

and CMC-NOI-28, respectively) performed slug tests on 85 piezometers, wells, and well points and categorized the glacial overburden into five distinct units. Additionally, hundreds of lithologic descriptions and grain size analyses are available for qualitative assessments of permeability. Storage coefficients that characterize the transient response of the aquifer to stress such as pumping may be derived directly from aquifer tests of the bedrock (Dames & Moore, 1978, CMC-NOI-82) or glacial overburden (Golder Associates, 1981, CMC-NOI-80) (CDM 1982a, CMC-NOI-34), or they may be derived indirectly from lithologic logs.

Existing and future use stresses are incorporated in the WELL Package. Available data for existing pumping wells may be available from a homeowner survey. The U.S. Geological Survey supplied water level data from private wells (Golder Associates, 1982a, CMC-NOI-37) which identifies potential withdrawal locations for domestic use. Proposed pumping well locations will be reevaluated.

Water supplied to the groundwater system by infiltration is input with the RECHARGE Package. This component of the water balance may be estimated from subtracting evapotranspiration and runoff from precipitation. Historic precipitation records covering 1941 to 1981 from a station in Rhinelander, Wisconsin, and pan evaporation data from a station at Rainbow Reservoir (located 42 miles northwest of the site) covering the period 1948 to 1953 were presented in Dames & Moore (Dames & Moore, 1985, CMC-NOI-75). These records were used to separate wet, dry and average years for lake water balances. Average annual evapotranspiration rates will be obtained from the U.S. Geological station in Langlade County, Wisconsin. Accurate estimates of infiltration may additionally require information on soil type, ground cover, and slope that could be available in maps and reports by the Soil Conservation Service or the U.S. Department of Agriculture.

Flowing surface water bodies (e.g., creeks, streams) that may not function as fixed boundaries are simulated through the STREAM FLOW ROUTING Package which calculates and tracks the flow into and out of streams. Topographic maps by the U.S. Geological Survey provide the location and approximate bottom elevations and slope of the streams. Stream elevations and flow rates have already been estimated at approximately 14 U.S. Geological Survey and site-specific gaging stations (EMC, 1985, Appendix 2.3H and 2.4A, CMC-NOI-84 and CMC-NOI-85, respectively). Estimates of stream sediment thickness and hydraulic conductivity, as well as stream roughness characteristics, will be described in field notes from proposed field visits. Stream bottom material is also described at 33 sampling points (EMC, 1985h, Appendix 2.3H, CMC-NOI-84).

The LAKE STAGE Package is similar to the previously described package. It defines the seepage into and out of surface water bodies and adjusts stage based on a net accumulation. Therefore, the LAKE STAGE package is amenable to simulating the response of lakes due to mine operations. Data available for the LAKE STAGE package includes lake locations from U.S. Geological Survey topographic maps, lake stage data from U.S. Geological Survey topographic maps and lake gaging stations (EMC, 1985e, Appendix 2.4B, CMC-NOI-76), and lake surface evaporation data (pan evaporation data collected from a U.S. Geological Survey station at Rainbow Reservoir), and lake bottom thickness and permeability (STS Consultants, Ltd., 1982b and 1984i, CMC-NOI-72 and CMC-NOI-73, respectively) (Dames & Moore, 1985, CMC-NOI-75). Historic surface

inflows for a flow budget analysis has been provided by Dames & Moore (Dames & Moore, 1985, CMC-NOI-75). Data availability varies from lake to lake.

The wetlands are best represented using the DRAIN or Lake Package. Previously compiled wetland assessment and mapping data will provide the wetland locations and elevations (Section 4.3.18, Wetlands). Site-specific wetland surveys that included borings, groundwater level measurements, and hydraulic conductivity tests to characterize the hydraulic characteristics and connection of the wetland to the aquifer system will be relied upon for model input.

4.3.8.3 Methodology

4.3.8.3.1 Computer Models and Analysis Programs

Two primary simulation models will be used for this task. MODFLOW (McDonald and Harbaugh, 1988) will be used to model regional groundwater flow and to assess quantity of mine water inflow. Several recently developed packages for MODFLOW will be used to model specific features of this site and to facilitate the modeling process. The code FTWORK (Faust, et al, 1990) will simulate contaminant transport from the TMA.

MODFLOW is a three-dimensional finite-difference groundwater flow model developed by the U. S. Geological Survey. It is widely used, well tested, extensively documented, and publicly available. MODFLOW uses a block-centered discretization of the flow domain. Resulting linear finite-difference groundwater flow equations are solved using iterative solution techniques. The program allows variable grid spacing, variable layer thicknesses, and a heterogeneous distribution of aquifer parameters. MODFLOW simulates unconfined, confined, or a combination of unconfined and confined layers. Boundary conditions include specified head, specified flux, and head dependent flux. MODFLOW also has packages for simulating the effects of internal stresses such as recharge, wells, drains,and rivers. Either steady-state or transient conditions can be simulated.

Several recently developed packages for MODFLOW will be utilized in this project. The PCG2 package (Hill, 1990) will be used to solve the finite difference equations. This solution technique has been found to be faster and more stable than the standard solution techniques included in the original MODFLOW. Simulation of a falling water table, desaturation of grid blocks, and resaturation of grid blocks is accomplished more accurately than in the original code with the newly developed BCF2 package (McDonald, et al., 1991). The streamflow routing package (Prudic, 1988) allows a more accurate technique of accounting for stream depletion than was present in the standard river package of MODFLOW or through the use of specified head cells. Another surface water package, the lake stage module (Cheng and Anderson, 1993) will be used to model groundwater/lake interactions. This package allows direct simulation of changes to lake elevation as a result of lowered groundwater levels, changes in stream inflows, and/or evaporation. Finally, the calibration process and analysis of calibration validity will be greatly enhanced through the use of the parameter estimation techniques found in MODFLOW-P (Hill, 1991).

FTWORK is public domain software, and will be used for all simulations involving solute transport. This code was developed for the Westinghouse Savannah River Company to

simulate groundwater flow and contaminant transport at Department of Energy sites. FTWORK has been benchmarked against several flow and transport models and analytic solutions (Sims, et al. 1989). The code has been applied to several investigations at the Savannah River Site and the Paducah Gaseous Diffusion Plant. Recently it was accepted by the Illinois Environmental Protection Agency (IEPA) with the successful permitting of a landfill expansion. FTWORK is a three-dimensional finite difference model for simulating flow and solute transport processes in fully saturated porous media. It provides an alternative to more comprehensive models such as SWIFT II (Reeves, et al., 1986) or HST3D (Kipp, 1987) which consider heat flow processes, density dependence, deformation, etc. FTWORK is consistent with the MODFLOW model in terms of equation and finite difference formulation, allowing transfer of input data between the two models. Although FTWORK is capable of solving both the flow and transport aspects of this problem, we have chosen MODFLOW to serve as the basis for the regional model. This is because MODFLOW is more familiar to regulatory staff and the general public, has superior preprocessing capabilities available, and is more efficient. Processes considered for solute transport include dispersion, a linear or non-linear equilibrium isotherm, dilution, and first-order decay.

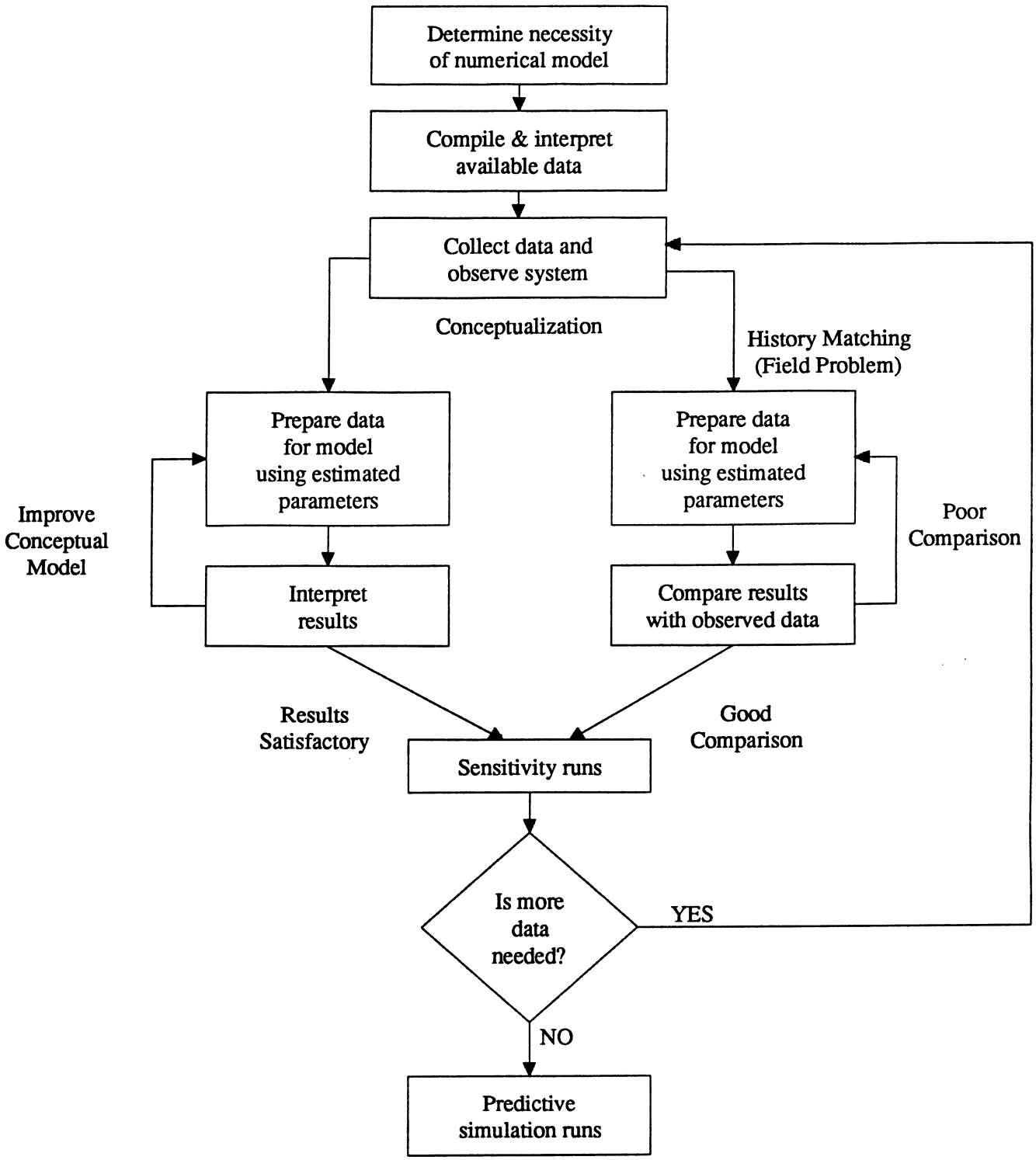
All data for the models will be converted to digital form. This will, in turn, be entered into the models using Geographic Information System (GIS) techniques. Rules for assignment of attributes to grid cells will be developed and adhered to. This allows a documented and reproducible modeling approach as well as eliminating errors that standard preprocessing techniques are prone to. The ArcINFO GIS system will be used with a link to MODFLOW and FTWORK called GWZOOM (GeoTrans, 1993). GWZOOM allows telescoping to localized areas of interest, such as the TMA, and regridding the models with minimal effort. GIS work will be performed on a SUN work station. All model simulations will be conducted on IBM compatible 486 personal computers.

4.3.8.3.2 Analysis Procedure

The generalized procedure for a groundwater modeling investigation is diagramed in the flowchart shown in Figure 4-12 (Mercer and Faust, 1981). Each step of the procedure is described below. Further detail on how specific aspects of the modeling will be handled are given in the subsections that follow this discussion.

Determine necessity of numerical model. It has already been determined that a revised numerical model of this site is desirable. The site hydrogeology is too complex to be represented by an analytical solution or through a suite of analytical techniques. In addition, the questions that the model must answer involve prediction of a number of interrelated features. Given model needs, a three-dimensional model is most appropriate for this application. Such a model will allow incorporation of lower permeability layers, zonation of aquifer parameters, and better computation of lake interaction.

Compile and interpret available data. A significant amount of data exists for this site, including a number of previously developed models. A preliminary screening of all the data has been made to determine which data are of sufficient quality to use in the current model. The screening has involved some interpretation. Further interpretation will be conducted as the conceptual model development continues. As part of the modelling work, data will be compiled into electronic databases and spreadsheets (Quattro Pro,



Crandon Mining Company

FIGURE 4-12

DIAGRAM SHOWING HYDROGEOLOGIC MODEL USE

REVISED	DATE	BY	DESCRIPTION

Scale: NO SCALE | Date: JANUARY 1994

Prepared By: Foth & Van Dyke | By: JRB

3c49figs.DGN

Excel, Paradox, Foxpro) to facilitate searches for specific features and for graphical purposes. Digital maps will be developed to assess the spatial distribution of data.

Collect data and observe system. A variety of time variant data have been collected at the site since the previous models were developed. These data includes water levels, precipitation, lake levels, and groundwater quality. These data indicate that significant changes to the system have not occurred since the previous work.

Prepare data for model using estimated parameters: Conceptualization branch. Two branches are shown on the flowchart (Figure 4-12), one for conceptualization and one for history matching. Both branches will be used in this effort. The conceptualization branch will be used initially, followed by the history matching branch. The conceptualization branch will allow testing of theories about the system, including alternative representations of boundary conditions, model grid and layering, and aquifer parameters. Data will be prepared for input to the model through the GWZOOM software. Basic parameters, such as number of grid nodes, are selected by the user. Spatially varying hydrostratigraphic, hydrographic, and hydraulic parameter data are assigned to model grid cells through contouring and interpolation techniques. A set of rules for assignment of each parameter is established thereby eliminating many qualitative decisions. The procedure is therefore documented and can be easily reproduced.

Interpret results: Conceptualization branch. The model will be run an undetermined number of times to improve the understanding of the system and to test alternative hypotheses. The performance standard for these conceptual runs will be somewhat qualitative: whether or not the numerical model adequately represents the conceptual model. A steady-state simulation for a relatively current time interval will be used as the basis for these simulations.

Sensitivity runs: Conceptualization branch. The runs described above will constitute an informal sensitivity analysis that will be adequate for this part of the study. The uncertainty associated with various boundary conditions, modeling assumptions, and parameter values can be assessed and the importance of more accurate quantification of these can be determined. A sensitivity simulation involving a potential stress on the system from mine operation will also be made at this time to determine how the model is affected when stressed.

Evaluation of additional data needs: Conceptualization branch. Conclusions from the model set-up and sensitivity runs may indicate a potential need for the collection of additional field data.

Prepare data for model using estimated parameters: History matching branch. The history matching branch will build upon the model developed within the conceptualization branch by refinement of parameter estimates. At this stage in the analysis, the model boundary conditions and configuration (layering, number of nodes, etc) have been established from the conceptualization branch. Furthermore, a range for value and variability of the hydraulic parameters will also be known. Preparation of data for input to the model will therefore not be extensive because most of these activities will have been covered as a part of the prior conceptualization exercise. Additional data that may have been collected as a

part of the conceptualization exercise and data from the field studies proposed in Section 4.3.7.3.2, Lake Bed and Wetland Characterization will be incorporated here.

Compare results with observed data: History matching branch. This step will involve calibrating the model until a satisfactory match of observed to modeled conditions is achieved. This is similar to the procedure followed in the conceptualization mode, except the standards of performance will be quantitatively based. Comparison will be made between modeled and observed hydraulic heads, hydraulic gradients, stream base flow, and lake levels. The history matching procedure will involve matching a recent steady-state condition as the basic calibration, a prior steady-state condition involving different calibration targets as a verification, and a transient simulation to verify that time-variant phenomenon and parameters are handled properly. The MODFLOW-P program for parameter estimation will be used to achieve the best match.

Sensitivity runs: History matching branch. The adequacy of the model will be tested in the sensitivity runs. Rather than conducting a series of runs where parameters are independently varied, model sensitivity will be determined from the MODFLOW-P sensitivity coefficients and parameter correlation data. This provides a more complete evaluation of model adequacy.

Evaluation of additional data needs: History matching branch. The results of the history matching and sensitivity analysis could indicate additional data are required. This is a remote possibility, however, because the conceptualization branch will have been carried through to sensitivity analysis.

Predictive simulation runs. The model will be used as a predictive tool once it has been calibrated and verified against an independent set of data and a transient event. Predictive simulations that will be made include: the effect on regional water-levels and streamflows and localized lake levels as a result of mine dewatering, the rebound of regional water-levels and localized lake levels as a result of cessation of mine dewatering, contaminant transport as a result of seepage from the TMA, and any mitigative schemes deemed necessary. Sensitivity simulations will be conducted on selected predictions to bracket the effect of parameter uncertainty.

Mine Inflow/Dewatering Calculations

Various methods will be assessed to incorporate the outflow from the stratified drift aquifer to the mine. Two options exist for representing it in the regional model: implicitly as a leakance term (drain or general head boundary) or explicitly as a discharge well with rates calculated from another analytical technique.

Representation of the mine as a leakance term makes use of two findings by Prickett and Associates (1984). These are: 1) that the discharge from the aquifer system is based primarily on the difference between the stratified drift aquifer hydraulic head and the elevation of the base of the resistive layer as well as the hydraulic conductivity of the resistive layer, and 2) that a steady-state condition where this relationship holds is achieved relatively rapidly as an unsaturated zone develops below the resistive layer. Use of this method requires development of a conductance term for each grid node overlying the ore body. The conductance will be based on the degree of weathering documented in Rowe

(Rowe, 1984, CMC-NOI-39), Dames & Moore (Dames & Moore, 1978, CMC-NOI-82) and CDM (CDM, 1982b, CMC-NOI-35). A limited calibration/verification of this method can be achieved by matching modeled results to the drawdowns observed in the stratified drift aquifer resulting from the pump test documented by CDM (CDM, 1982a, CMC-NOI-34). An advantage of this method is that the mine is incorporated implicitly in the model; no other models or calculations are required to represent the mine outflow. A potential disadvantage is that mine response time may be faster in the model than observed in the field because this method assumes a steady state condition is achieved instantaneously in the mine.

Another alternative is to represent the mine explicitly as a series of discharge wells. This method is similar to that used by D'Appalonia (1985). Well discharge rates for input to the model may be computed by a simple Darcy relationship as described above or by a complex numerical model of the mine similar to the one developed by Prickett and Associates (1984). The advantages of using a numerical model of the mine are that the transient response and the extent of dewatering and unsaturated conditions underlying the resistive layer may be better accounted for than by implicit representation. Disadvantages include the uncertainty of using what is essentially a saturated zone model to represent unsaturated or partially saturated conditions. There is virtually no difference in accuracy whether mine discharge is computed by a Darcy relationship and input as a well or if it is computed implicitly by the model as a leakance term. Sensitivity runs will be conducted to determine which method is the most suitable for the overall modeling process.

Lake Interaction

The lake stage package developed by Cheng and Anderson (1993) will be used to represent potential changes in lake elevations resulting from mining operations. This package incorporates many of the methods used in the prior analysis by the U.S.G.S. and WDNR. The lake stage package computes a water budget for each lake for each time period. Potential outflows include evaporation, surface water discharge, and groundwater seepage. Potential inflows include precipitation, surface water inflow, and groundwater seepage. Any difference between inflow and outflow represents a change in storage of the lake, which in turn is reflected by a change in lake stage. An advantage of the lake stage package is that the lakes are implicitly represented in the model. No additional programs or calculations are required for iterative input to the model.

The lake stage package will be incorporated into the regional groundwater flow model. The model grid will be designed to have fine spacing in the immediate vicinity of major lakes such as Little Sand Lake. This will allow accurate definition of lake geometry, zonation of lake bed conductivities, and computation of hydraulic gradients.

Section 4.3.7.3.2, Lake Bed and Wetland Characterization, describes the lake bed studies that are proposed to more quantitatively assess lake bed hydrogeologic characteristics. Preliminary model simulations may indicate that additional lake bed studies may be required.

Solute Transport

A submodel of the regional model will be used to model migration of contaminants as the result of potential seepage from the TMA. A submodel will be necessary to obtain greater grid resolution arealy and vertically than present in the regional model. This is required for accuracy as well as to ensure a stable and convergent solution. Peclet and Courant criteria (Huyakorn and Pinder, 1985) will be adhered to in determining the spatial and time discretization. The model will encompass the area between the TMA and the nearest receptor, as defined by the shortest transit time to a discharge point determined from a particle tracking analysis.

The magnitude and location of potential seepage will be determined by analyses performed for waste characterization. Simulations will be based on normalized concentrations, which can later be scaled to represent actual input concentrations. Unsaturated zone modeling described in Section 4.3.13, TMA, will be used to determine the time at which constituents enter the water table and whether one or several steady-state flow fields are required. Because a steady-state flow field is expected to be used, a fully mobile solute will be simulated. Time can then be scaled according to retardation of the constituents being studied. Porosities will be based on D'Appalonia (1985). Dispersivities will be based on transit distance and field values from similar aquifer materials.

4.3.8.4 Data Presentation Format

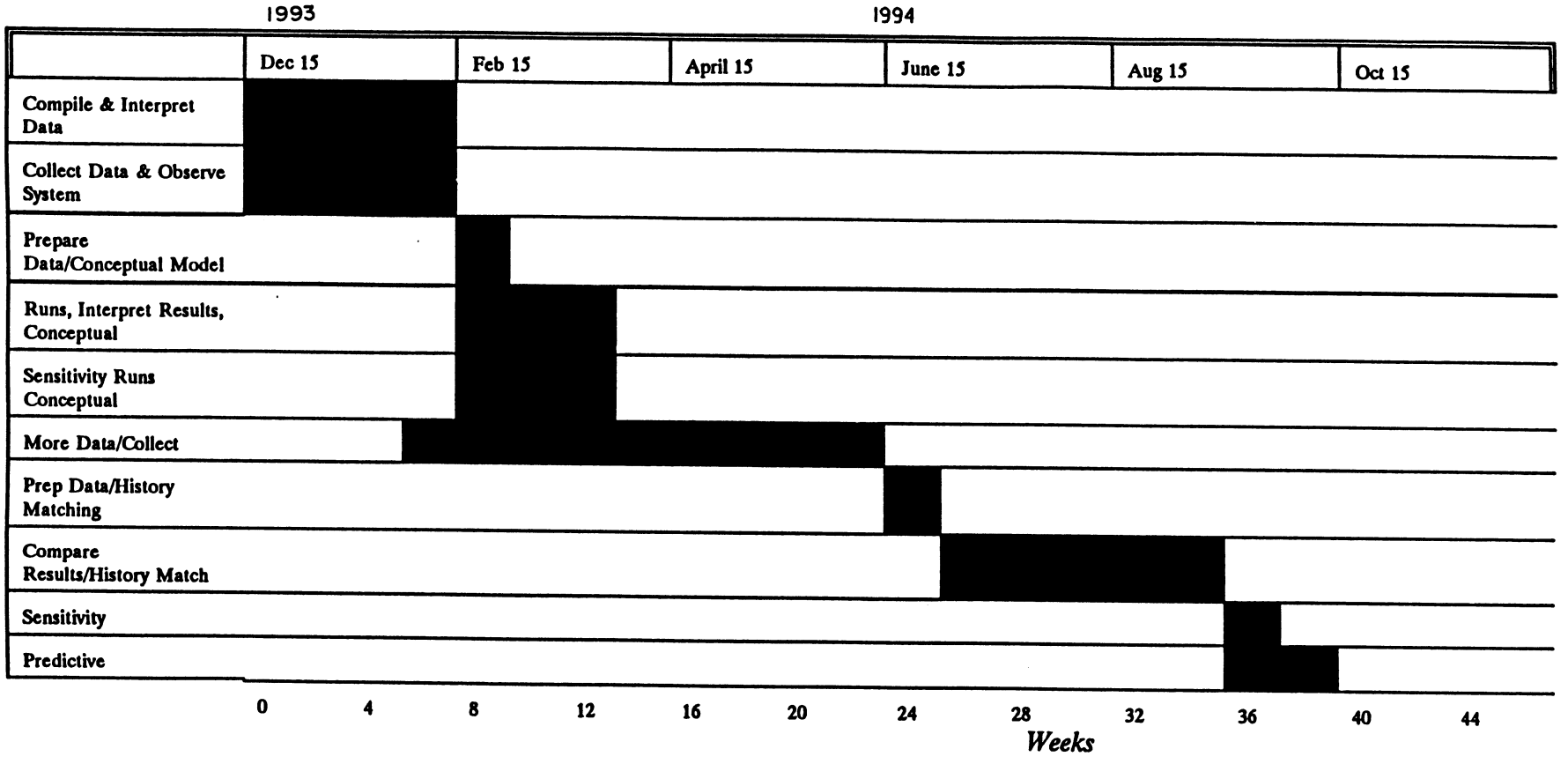
A report on all modeling activities, including development of the conceptual model, documentation of input parameters, parameter assignment rules, and results of the calibration/verification, sensitivity analysis, and predictive simulations, will be developed. Included in this document will be maps showing distribution of spatial data such as boundary conditions, discretization unit thicknesses, unit elevations, hydraulic parameters, modeled hydraulic heads, and modeled solute concentrations. Tables of pertinent numerical data, such as calibration residuals, lake decline, stream flow diversion, and mass balances, will also be a part of this document.

Progress reports, in the form of technical memorandums, will be prepared at key points in the project. These will be submitted to WDNR and followed by oral presentations. The purpose of these meetings will be to keep WDNR informed on the progress of the modeling and to address any concerns prior to advancing to the next stage of modeling.

Model data sets for key simulations will be submitted to WDNR at significant project junctures. The version of the MODFLOW code which is utilized, including recent packages, will be provided to WDNR. In addition, FTWORK will also be supplied to WDNR.

4.3.8.5 Schedule for Groundwater Modeling

The schedule for the modeling task, including report, memorandum, and progress meetings is presented in Figure 4-13.



Crandon Mining Company

FIGURE 4-13

HYDROGEOLOGIC MODELING SCHEDULE

REVISED	DATE	BY	DESCRIPTION

Scale: NOT TO SCALE | Date: JANUARY, 1994

Prepared By: Foth & Van Dyke | By: JRB

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4.3.8.6 Key Project Personnel

Key staff for the groundwater modeling task include personnel from Foth and Van Dyke and GeoTrans, Inc. These are: from GeoTrans, Mr. Peter F. Andersen, Mr. R. Todd Hagemeyer, Dr. James W. Mercer, and Dr. Charles R. Faust; and from Foth & Van Dyke, Stephen V. Donohue and Dr. Xiangxue Cheng. Brief biographical sketches and descriptions of each individuals role in the project are given below.

Peter F. Andersen. Mr. Andersen will serve as task manager for groundwater modeling and will be the primary contact at GeoTrans, Inc. As Vice President and principal engineer at GeoTrans, Inc., he will be actively involved with and will oversee the development of all models. He will be present at all technical meetings with WDNR. Mr. Andersen has over 15 years of experience in the field of groundwater hydrology and specializes in the application of groundwater modeling to water resource and contaminant transport problems. He has taught groundwater modeling at the International Ground Water Modeling Center, several government agencies (USEPA, Corps of Engineers, etc), and commercial clients and authored a recent USEPA publication on the application of MODFLOW to groundwater problems.

R. Todd Hagemeyer. Mr. Hagemeyer, a senior hydrogeologist at Geotrans, Inc., will be involved with the groundwater modeling on a day-to-day basis. He will participate in the development of the conceptual model, preparation of data input to the model, model calibration, sensitivity analysis, and predictive runs. Mr. Hagemeyer has over nine years of experience in hydrogeology.

Dr. James W. Mercer. Dr. Mercer, who is President and the principal hydrogeologist of GeoTrans, Inc., will be the Quality Assurance reviewer for this task. He will review all progress memorandums and reports for technical accuracy and completeness prior to delivery to WDNR. Dr. Mercer has over 22 years of experience in the field of hydrogeology, having worked with the U. S. Geological Survey for eight years and as president of GeoTrans, Inc. for 14 years. He has served as the secretary of Water Resources Research and is an advisor to the National Science Foundation.

Dr. Charles R. Faust. Dr. Faust, Executive Vice President and principal hydrogeologist of GeoTrans, Inc., will be a technical advisor for this project. He will provide input to major decisions encountered during the modeling process. He has over 22 years of experience in the field of hydrogeology and is the primary developer of the FTWORK code.

Stephen V. Donohue. Mr. Donohue, a hydrogeologist at Foth & Van Dyke, will be continuously involved in the model development and will be the primary contact at Foth & Van Dyke. Mr. Donohue will provide input on development of the conceptual model, calibration, sensitivity analysis, and predictive runs. Mr. Donohue, in consultation with the project team, will direct the hydrogeologic characterization studies that are proposed for the model. Mr. Donohue has experience in hydrogeologic characterization studies and the application of groundwater models to groundwater flow problems.

Dr. Xiangxue Cheng. Dr. Cheng, a hydrogeologist at Foth & Van Dyke, will be involved in the groundwater modeling studies on a continuous basis. For his Ph.D. dissertation, Dr. Cheng conducted numerical modeling and field studies for over three years to investigate

the impacts of climate change on the lake and groundwater systems in Vilas County in northern Wisconsin. While at the University of Wisconsin-Madison, Dr. Cheng developed the lake package for the widely used U.S. Geological Survey MODFLOW code.

4.3.9 Noise

4.3.9.1 Existing Data Summary and Evaluation

Previous noise studies included the collection of background sound level data and an assessment of noise impacts associated with the construction and operation of the mine and associated facilities as envisioned at this time. The data base regarding both the background noise monitoring and impact assessment are discussed separately in the following paragraphs.

Background Noise Level Data

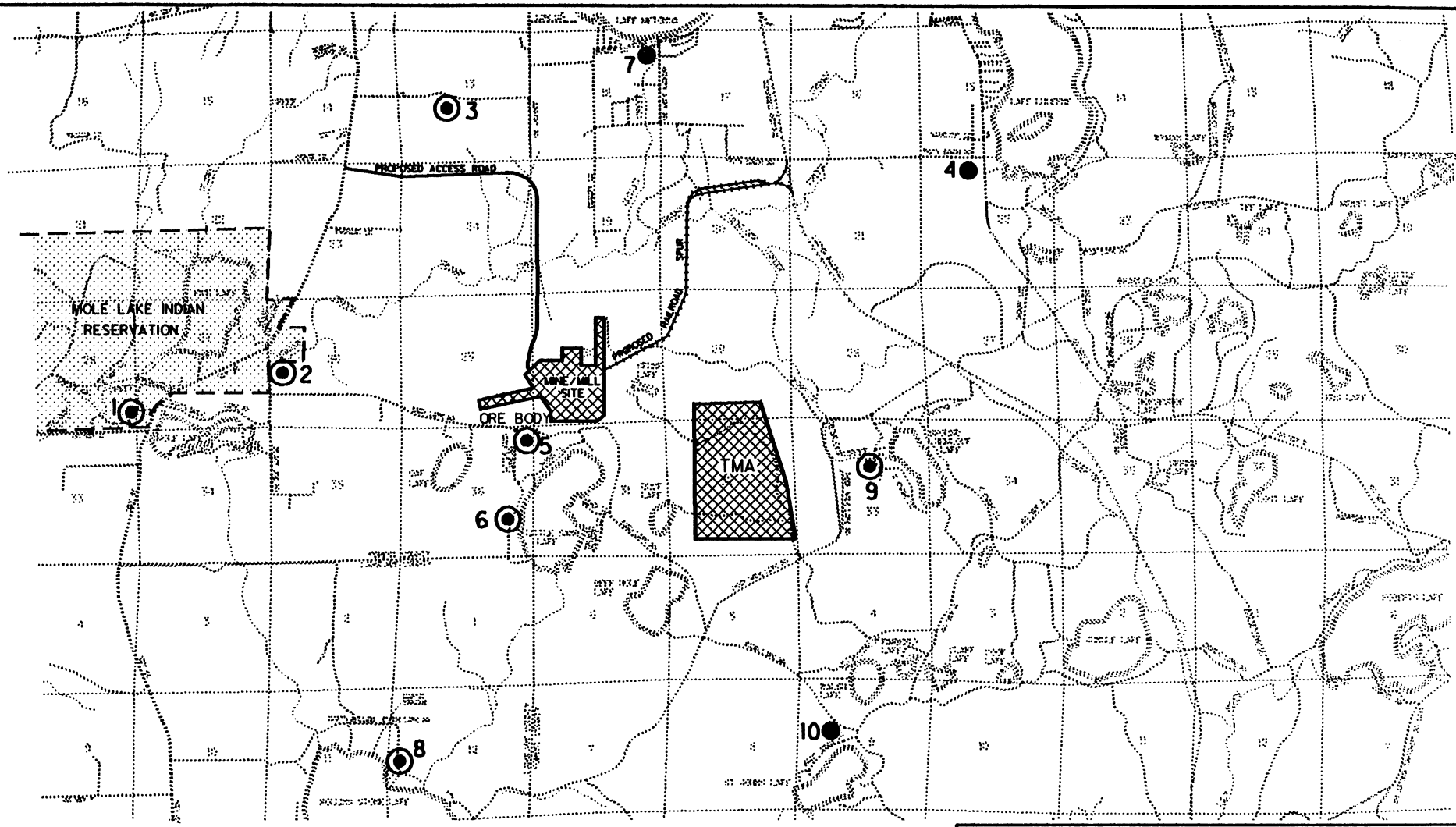
Background noise level data were previously collected at sites potentially impacted by construction and operation of the mine facility. Data were collected in March and July of both 1977 and 1983 to represent winter (leaf-off) and summer (leaf-on) conditions (Dames & Moore, 1981 and EMC, 1985a, 1985b and 1985c, CMC-NOI-90, CMC-NOI-91, CMC-NOI-92, and CMC-NOI-93, respectively). A total of 10 sites were monitored; six in 1977 and four in 1983. Sound levels were recorded three times a day during the daytime (7 a.m. to 6 p.m.), evening (6 p.m. to 10 p.m.), and night (10 p.m. to 7 a.m.). Each monitoring event lasted from 16 to 20 minutes. The previous monitoring locations are shown in Figure 4-14.

The background data was collected using currently accepted standard procedures. Current conditions related to noise generation are very similar to previous study periods. As such, contingent upon the verification procedures discussed below, these data are considered valid and representative of current background noise conditions in the vicinity of the proposed mine.

Noise Impact Assessment

The noise impact assessment methods and results are described in a Dames & Moore, 1984 (Dames & Moore, 1984, CMC-NOI-94) study and an EMC (EMC, 1984, CMC-NOI-95) letter to WDNR. Mine facility construction and operation noise emissions were extrapolated to noise-sensitive areas using a hemispherical dispersion model where noise levels were decreased over distance from the source according to the inverse square law. The model also considered natural attenuation (by atmosphere, trees, grass, etc.) which was based on actual measured values of attenuation across the site. The noise impact assessment was a worst-case analysis because it was assumed that noise sources were located at the closest possible point to each of the noise-sensitive receptors.

Collection and evaluation methods employed in the previous noise impact analysis have not changed significantly. Currently planned construction activities will be phased similarly to, and will be of the same magnitude, or smaller than, the previous proposal. Some of the construction equipment used today may be somewhat quieter than in the late 1970s and early 1980s; however, much of the equipment in use today is greater than 20 years old.



LEGEND

- ● 4 PREVIOUS NOISE SURVEY LOCATION
- ◉ 3 PROPOSED VERIFICATION NOISE SURVEY LOCATION

REVISED	DATE	BY	DESCRIPTION

Crandon Mining Company

FIGURE 4-14

GENERAL LOCATION OF NOISE SAMPLING SITES

Scale:	1" = 6000'	Date:	JANUARY, 1994
Prepared By:	Foth & Van Dyke	By:	JRB

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Therefore, for the construction phase, the previously conducted noise impact assessment is considered valid. The same analysis methods were employed for the mine facility operation phase as for the construction phase. Since the proposed operations are the same or smaller than previously described, the results of the previous analysis are considered valid. Therefore no additional impact modeling is required.

4.3.9.2 Data Requirements

Given the passage of between 11 to 17 years since the collection of previous baseline noise data, baseline sound level monitoring data should be collected to verify previous work.

4.3.9.3 Methodology

Current conditions related to noise generation (eg., land use, traffic, activity patterns, etc.), with the exception of the area around Mole Lake, are very similar to previous study periods. As such, it is unlikely that sound levels have changed significantly, either increasing or decreasing, since the previous baseline data was collected. Therefore, verification monitoring is most important at those sites where moderate impacts were previously predicted. A moderate impact is defined by the International Organization for Standards as an increase of 5 to 10 decibels over baseline levels, resulting in potential sporadic to widespread complaints. Increases or decreases become more important at these sites in that a small increase or decrease in baseline noise levels may result in a change in the impact status at that site (i.e., no impact versus impact).

The proposed verification monitoring program is based on a review of the previously predicted impact results summarized in WDNR's 1986 FEIS (WDNR, 1986). All locations where increases were previously predicted in the "moderate" range will be included in the verification monitoring program. The proposed verification monitoring locations and schedule for sampling is presented in Table 4-15. Monitoring locations are shown in Figure 4-14. Both previously monitored sites located in Mole Lake (Locations 1 and 2) are included in the program to determine if land use changes in this community (i.e., operation of the casinos) have resulted in changes in the baseline noise levels.

Table 4-15

Proposed Noise Monitoring Locations and Schedule Crandon Mining Company NOI/SOS

Monitoring Location	Proposed Monitoring Period*			
	March, 1994		July, 1994	
	Day	Night	Day	Night
1 - Mole Lake School	X	X	X	X
2 - Mole Lake Community Center	X	X	X	X
3 - Mihalko Residence	X	X		
5 - CMC Field Office	X	X	X	X
6 - Webb Residence	X	X	X	X
8 - Rolling Stone Lake	X	X	X	X
9 - Ground Hemlock Lake	X			X

* Day 7 a.m. to 6 p.m., night 10 p.m. to 7 a.m.

Background noise level data will be collected using a Bruel & Kjaer Precision Integrating Sound Level Meter Type 2230 coupled with a Type 2317 recorder. Calibration will be conducted with a Type 4230 Sound Level Calibrator producing a nominal sound pressure level of 94 dB. Noise levels will be monitored for a period of 16 to 21 minutes at each location. The microphone will be located four to five feet above the ground, and at least 12 feet from any large reflecting plane. During the data recording period, meteorological parameters will also be recorded, including; wet and dry bulb temperatures, barometric pressure, wind speed, and wind direction. Monitoring will be postponed if the humidity exceeds 95 percent or the wind speed is greater than 12 miles per hour.

4.3.9.4 Data Presentation Format

Noise monitoring sites will be indicated on a map. Summary noise data will be presented in tabular form. A text describing the monitoring program and its results will be included in the project's EIR. Supporting field documentation and the copies of the raw data (i.e., strip charts) will be presented in an appendix to the EIR.

4.3.9.5 Schedule for Data Collection

Verification baseline noise monitoring will be performed as indicated in Table 4-15 when no other on-site activities are proposed that would result in a source of noise not typical to the area.

4.3.9.6 Key Project Personnel

Mr. Ronald F. Steg of Foth & Van Dyke will be responsible for the collection and evaluation of noise data. Mr. Steg has 10 years experience conducting environmental studies relating to water resources, wetlands, mitigation, resource management alternative identification, noise, transportation and utility systems, etc.

4.3.10 Site Topography

A wide variety of topographic maps and drawings currently exist for the site and study area. These range from maps produced by the United States Geological Survey (U.S.G.S.), which are readily available to the public, to numerous topographic maps produced for the project by EMC. These later maps include lake bathymetric maps, aerial photographic contour maps, and orthophotographic contour maps. The maps have been produced in a variety of scales, at a variety of contour intervals and in both the English and the metric systems. The maps were typically produced between 1976 and 1982. The aerial contour maps were produced using stereo plotting techniques from aerial photography.

Vertical control for the maps are tied to U.S.G.S. datum. Horizontal control is based on the State Plan Coordinate System, north zone. Currently, CMC is evaluating three options relating to the development of a topographic existing conditions (base) map for use in the preparation of permit applications. These options consist of the following:

- using existing 1976 or 1978 contour maps to develop the project's topographic base map;
- generate a new site topographic map using new aerial photography; and
- using a combination of existing and new mapping to develop the project's topographic base map.

Existing maps meet the needs for project permitting activities. The final decision between the three options will be based on a determination of the mapping needs related to the preparation of both final design and construction drawings. The topographic base map for the project will have a scale no greater than 1:3,600 with a contour interval of five feet or less.

4.3.11 Socioeconomics

4.3.11.1 Existing Data Summary and Evaluation

Most of the existing socioeconomic reports from the 1970s and early 1980s are outdated and not applicable to an impact assessment of the current project. New information from existing sources will need to be obtained as described in the following sections. A report prepared by the Denver Research Institute (Denver Research Institute, 1986) offers a framework for evaluating the socioeconomic aspects of the project. With the input of new data, the methods and assessments contained in this document will provide the framework for the planned socioeconomic work.

4.3.11.2 Data Requirements

4.3.11.2.1 Population

Although the proposed mine project is smaller in size than the one proposed during the early 1980s, an increase in local population can be expected. To estimate what this increase will be, as well as assess the impact of the population gain on the affected governmental units, population data are required for the following three areas. These three areas are referred to as the study area, the Rhinelander area, and the Antigo area. The study area includes the City and Town of Crandon; Lincoln, Nashville and Elcho Townships; and the Sokaogon Chippewa Community. The Rhinelander area includes the City of Rhinelander and Crescent, Newbold, Pelican and Pine Lake Townships, and the Antigo area includes the City and Town of Antigo.

In addition to population, information on potentially affected civil divisions will be needed in order to obtain demographic parameters necessary to analyze the proposed project's impact on such factors.

4.3.11.2.2 Zoning

The planning area falls under the jurisdiction of the Forest County Zoning Ordinance. The planning area is located in Lincoln and Nashville Townships in Forest County. The height of the head frame is subject to regulation by the City of Crandon.

4.3.11.2.3 Land Use

The most recent land use inventories, aerial photographs and topographic maps of Lincoln and Nashville Townships, and Forest, Langlade and Oneida Counties need to be acquired. The most recent land use inventories of Forest, Langlade and Oneida Counties are maintained by North Central Regional Planning Commission (NCRPC).

North Central Regional Planning Commission data on recent land use statistics and maps of Forest, Langlade and Oneida Counties and the areas surrounding the project site will be needed to identify changes that have occurred in order to update the existing database.

4.3.11.2.4 Employment and Income

Employment data by activity will be required and should be compiled for Forest, Langlade and Oneida Counties, as well as the State of Wisconsin. This information should be used to analyze the distribution and composition of the labor force, as well as to identify major employers in the local economic base. Employment and payroll data for the proposed project during both the construction phase and the actual operation of the mine will be necessary. Unemployment rates and other work force data will be required for Forest, Langlade and Oneida Counties and the State of Wisconsin for comparison purposes. This data should include a breakdown of the labor force by sex, occupation and wage levels.

Income data, including Medium Household Income (MHI), Adjusted Gross Income Per Capita (AGIPC) and percent of population with income at or below the poverty level will be needed for Forest, Langlade and Oneida Counties, as well as for the State of Wisconsin.

Estimates of the value of various supplies and services expected to be purchased locally for the operation over the course of the project will be required. Updated information compiled by the Wisconsin Department of Revenue (WDOR) in a report titled "Taxes, Aids and Shared Taxes" should be gathered.

4.3.11.2.5 Taxes and Revenue

Property tax data for civil divisions in Forest, Langlade and Oneida Counties will be required. This will include all local, state, county and school taxes. Tax rates for the affected taxing jurisdictions over the past seven years should be reviewed, and projections for future collections should be estimated. The U.S. Internal Revenue Service can provide Federal Income Tax figures and Federal Excise Tax information and data. Information and data on State payments to localities will be needed from the Wisconsin Department of Revenue (WDOR), as well as other State agencies such as the Department of Transportation, Department of Administration and Department of Natural Resources. Two other sources of information for taxes and revenue are the Wisconsin League of Municipalities and the Wisconsin Taxpayers Alliance. Both organizations should be requested to provide updated information.

4.3.11.2.6 Housing

Employees of the proposed project that must reside at or near the project site will have several alternatives for housing:

- buy or rent vacant housing
- build new housing
- convert seasonal housing
- occupy temporary housing

The study should evaluate demand for housing for three areas; the project area, Rhinelander area and the Antigo area. The study should estimate demand for housing by each of the three geographic areas, as well as quantify the available housing stock by type of units. Since there are many housing units in the study area which lack services generally associated with habitability, the study should attempt to separate these from the houses that are in good condition. The underlying question to be addressed is whether the existing housing stock is adequate in quality and quantity to accommodate in-migration of additional population.

4.3.11.2.7 Native Americans

There should be an analysis of the project's impacts on the Sokaogon Chippewa Community and Forest County Potawatomi which are located in Forest County. Project impacts on the Menominee Reservation should be evaluated as it relates to tourism on the Wolf River watershed.

4.3.11.2.8 Tourism

Data should be collected on the tourism industry in Forest, Langlade and Oneida Counties. This information will attempt to quantify the importance of tourism on the study area economy.

4.3.11.2.9 Premature Shutdown of the Mine

Besides evaluating socioeconomic impacts assuming full term life of the mine, data should be gathered and evaluated under the assumption that the mine is closed prematurely.

4.3.11.2.10 School Districts

Information should be collected on school districts which serve the population of the tri-county area. Statistics on capacity and enrollment should be collected to determine available capacity. Information on existing property tax levies for school district operation should be collected as well.

4.3.11.3 Methodology

4.3.11.3.1 Population

Population change in both absolute and relative terms will be determined for the State of Wisconsin, the project area, Rhinelander area and Antigo area over the past several decades. Anticipated populations for the four areas over the next 40 years will be considered.

Based on expected mine employment figures, the impact on the affected municipalities during both the construction and mine operation periods, as well as following the scheduled shutdown of the operation, will be assessed. This information, coupled with population projections, will be used to determine whether or not existing public facilities and services, housing, etc. will be sufficient to handle the expected project-related change.

Basic demographic data, such as median age and age distribution, will be studied for the affected governmental units and compared to state norms. The impact of the proposed project on such information will then be considered. The population increase resulting from the proposed project may lower the median age in the community somewhat. This slight change in age distribution would alter slightly the economic conditions in the area, and to some degree change public facilities and services that are needed by residents.

4.3.11.3.2 Zoning

The existing zoning ordinance(s) will be systematically examined and evaluated in terms of the existing and proposed land use in the planning area.

4.3.11.3.3 Land Use

The existing land use will be broken down into three areas: CMC holdings; Lincoln and Nashville Townships; and Forest, Langlade and Oneida Counties. These categories, in turn, will be broken down into general land use classifications based on acreages and the percent totals of each classification. An example of some of the classifications would be wetland, agriculture, residential, commercial, transportation and industrial. This information will be important when analyzing the impacts of the project on surrounding land uses, as well as on projecting future land use after mining is complete.

4.3.11.3.4 Employment and Income

Existing economic conditions for Forest, Langlade and Oneida Counties and the State of Wisconsin will be established. Analysis of employment by industry for each economy will characterize the State, and the tri-county area. This will identify what the critical and dominating economic activities presently are at each level. A comparison of Forest, Langlade and Oneida Counties to similar state entities, as well as Wisconsin figures, will help to identify unique aspects of the local economy.

Labor force data, including unemployment figures, will be compiled for Forest, Langlade and Oneida Counties, and compared to other Wisconsin Counties and State figures to further characterize the local economy. This portion of the analysis will include a breakdown of the work force by such categories as sex, occupation and income.

Income characteristics for Forest, Langlade and Oneida Counties will also be explored, including Medium Household Income, Adjusted Gross Income Per Capita and percent of persons at or below poverty level.

The study will also address the possibility of employment upgrades. While the project will attract new employees from outside the area, it is also expected to provide job opportunities for local residents. The study will assess the impact the project will have on local wage rates as well as training and upgrade opportunities for the existing work force in the study area.

An employment multiplier will be calculated for Forest, Langlade and Oneida Counties to determine how many new jobs will result from mine employment in other sectors of the local economy. The effect of this new employment (mine employment and other) on unemployment and other labor factors will then be analyzed. Impacts on the retail sector of the local economy will be evaluated as well. This effort will address anticipated increases in retail spending.

Impact of the proposed Crandon Project on local and state economies during construction, mine operation and shutdown phases will be assessed. The probability that mine permitting and operation will cause some supplies and services to be purchased locally also will be analyzed for its impacts on the local economy.

4.3.11.3.5 Taxes and Revenue

Personal property tax has undergone considerable change in Wisconsin over the past several years. These taxes will be investigated and impacts, if any, reported.

Sales, use and excise taxes for Forest County and the State of Wisconsin will be obtained. The impact of the Crandon Project on local and state economies during the construction and operation periods will be assessed based on county and statewide averages.

In Wisconsin, a net proceeds occupation tax exists for mined copper-bearing ores and concentrates. The amount assessed on the Crandon Project during its operating life, and the distribution of this tax among local entities and the state, and its benefit to these taxing jurisdictions, will be analyzed. According to the Bureau of Local Fiscal Policy for the Wisconsin Department of Revenue, there is a model available to estimate net proceeds tax income. The Department of Revenue has indicated a willingness to provide technical assistance on the project. They will provide the model so that calculations for net proceeds tax estimation can be performed.

Fiscal impacts related to the cost of providing police, fire, emergency care and road maintenance will be evaluated. This assessment will also include an evaluation of the current capacity of public service systems (e.g., sewage treatment plants).

The impact of the project on shared revenue and state and federal grant and aid programs to local entities will be evaluated and reported. This will include shared taxes, payments to school districts and counties, and other various aids and grants.

Local agreement negotiations will be initiated in the near future. These negotiations could have an impact on the evaluation of taxes and revenue. When negotiations are complete, the terms of the agreement will be incorporated in the socioeconomic report.

Based on past and current tax rates for the affected taxing jurisdictions, an estimate for future property tax collections for the Crandon Project will be made. The distribution of this revenue to each taxing jurisdiction plus the resulting impact will then be assessed. The affected taxing jurisdictions are the local school district and vocational school, affected counties, local townships, and the State of Wisconsin.

The impact of the project in terms of personal income tax during both the construction period and the operating life will be estimated. This will involve the estimated average yearly salary of direct employees on the project, plus the estimated average of each salary for jobs created by the project in other sectors of the local economy.

Sales, use and excise tax impact can be estimated as a percentage of personal income tax collected. Percentages are available for Forest, Langlade and Oneida Counties, as well as the State of Wisconsin. This percentage is applied to the personal income tax amount collected in order to calculate a dollar impact.

Using current state tax rates, the impact of the project in terms of corporate tax to the State will be estimated on a per annum and total basis. Production tax will be estimated by applying current production tax rates to the projected production of the proposed mine.

4.3.11.3.6 Housing

In order to evaluate potential impacts on local housing stocks, the study will estimate the number and percentage of new employees who will move within commuting distance of the project site. The next task will be to break down the quantity and quality of available housing between Forest, Langlade and Oneida counties. It is then possible to evaluate how new employees for the project will respond to available housing choices. The study will estimate the number of vacant housing units available for rental or purchase, the available property for building new housing units, seasonal housing units which can be converted, as well as opportunities for temporary housing. The housing evaluation will also attempt to quantify available housing units which are not suitable for occupancy and which are not worth the cost of necessary upgrades.

Statistical data sources will include 1990 Census Summary File 3A, Housing 201 Report prepared by the Wisconsin Department of Development, as well as information available at the local level.

4.3.11.3.7 Native Americans

In order to evaluate project impacts on the Sokaogan Chippewa Community and Forest County Potawatomi, off-reservation gathering activities, employment and cultural values will be evaluated. Efforts will be made to collect information on gaming casinos operated by the tribes.

4.3.11.3.8 Tourism

Once data has been collected on the tourism industry in the study area, the potential impact this project could have on tourism will be evaluated. Seasonal changes in tourism demand will be evaluated as they relate to potential impacts caused by the project.

4.3.11.3.9 Premature Shutdown of the Project

Besides evaluating socioeconomic impacts assuming full term life of the project, the socioeconomic impacts of the project assuming premature closure will be evaluated. Similar methodologies as those employed assuming the project operates full term will be used. These methodologies will include evaluation of employment, economic base, housing, population, etc., as it would be impacted by a premature shutdown of the mine.

4.3.11.3.10 School Districts

The existing enrollment of school districts serving Forest, Langlade and Oneida counties will be evaluated. Available capacity will be calculated, as well as anticipated facility expenditures with and without the project. Property tax levies for school district operation will be evaluated to determine potential impacts.

4.3.11.4 Data Presentation Format

Data and analysis results will be presented in tabular and graphic formats. A written text will be developed to discuss study methodologies and its conclusions. The text and data will be incorporated into the project's EIR.

4.3.11.5 Schedule for Data Collection

Gathering of the socioeconomic data will occur during 1994.

4.3.11.6 Key Project Personnel

The evaluation of socioeconomic aspects will be conducted by Dr. Jack Huddleston and Ronald P. Van Straten of Foth & Van Dyke.

Dr. Huddleston is a professor of Urban and Regional Planning at the University of Wisconsin-Madison. Before joining the University of Wisconsin, Dr. Huddleston worked for the Wisconsin Department of Revenue as Chief of Local Fiscal Policy Analysis. He has conducted extensive socioeconomic research on a variety of projects throughout Wisconsin.

Mr. Van Straten has eight years experience working on economic research-related projects, including economic base analysis, regional economic modeling, and a variety of economic development projects. Mr. Van Straten has extensive experience working with small communities throughout Wisconsin to assist in developing businesses that create jobs and expand the local economic base.

4.3.12 Surface Water

Topics of discussion under this category fall into five subcategories: 1) surface water and sediments; 2) ordinary high water mark; 3) surface water quality modeling; 4) surface water mitigation; and 5) floodplains. Each subcategory is addressed on an individual basis below.

4.3.12.1 Water Quality/Sediments

4.3.12.1.1 Existing Data Summary and Evaluation

Data collection and technical studies for the project's surface water monitoring program will be related to 1) WPDES permitting, 2) background surface water quality, and 3) surface water sediments. A considerable amount of data has been collected over the past 15 years for the surface waters within the area of the proposed project. This information is available in the documents listed in Table 4-16.

Given changes in regulations since existing water and sediment chemistry data was collected, it is not possible to reference past data to a laboratory certified under NR 149 of the Wisconsin Administrative Code. Also, for certain parameters, the detection limits for the methods of analysis used in the past are higher than those needed for current studies.

Table 4-16

Previous Surface Water Data
Crandon Mining Company NOI/SOS

	Reference	NOI/SOS File Listing
Stream Flow and Lake Gage	EMC, EIR (1985i) (Appendix 2.4A)	CMC-NOI-85
	EMC, EIR (1985e) (Appendix 2.4B)	CMC-NOI-76
	EMC, EIR (1985f) (Appendix 2.4C)	CMC-NOI-77
	EMC, EIR (1985m) (Appendix 2.4I)	CMC-NOI-89
	EMC, EIR (1985j) (Appendix 2.4J)	CMC-NOI-86
	EMC, EIR (1985k) (Appendix 2.4K)	CMC-NOI-87
	EMC, EIR (1985l) (Appendix 2.4L)	CMC-NOI-88
	Simon, D. Correspondence (1986)	CMC-NOI-96
	U.S.G.S. Survey Data (1985-1986)	CMC-NOI-97
	Kincaid, D.E., 1985a Water Levels	CMC-NOI-98
	Martin, R. Correspondence (1986)	CMC-NOI-99
	Read, R. Correspondence (1986)	CMC-NOI-100
	Dames & Moore (1978)	CMC-NOI-108
	George, J. Correspondence (1985)	CMC-NOI-109
	U.S.G.S. Survey Data (1985-1986)	CMC-NOI-110
	Krug, W. Correspondence (1986)	CMC-NOI-102
	Simon, D. Correspondence (1985)	CMC-NOI-103
	Simon, D. Correspondence (1986)	CMC-NOI-111
	Hansen, B. Correspondence (1985)	CMC-NOI-105
	WDNR Lake Surveys (1984)	CMC-NOI-107
	Krug, W. Correspondence (1984)	CMC-NOI-112
	Kincaid, D.E. Correspondence (1990)	CMC-NOI-114
	Foltz, S. Correspondence (1991)	CMC-NOI-113
	Kincaid, D.E., Water Level Readings	CMC-NOI-60
	EMC (1980)	CMC-NOI-132

	Reference	NOI/SOS File Listing
	Ecological Analysis, Inc. (1983)	CMC-NOI-115
	Ecological Analysis, Inc. (1984b)	CMC-NOI-116
	Ecological Analysis, Inc. (1985)	CMC-NOI-117
	Fish & Wildlife Service, et al. (1982)	
Study Area Surface Water Quality	EMC, EIR (1985n) (Appendix 2.4D)	CMC-NOI-118
	EMC, EIR (1985o) (Appendix 2.4F)	CMC-NOI-119
	EMC, EIR (1985p) (Appendix 2.4G)	CMC-NOI-120
	EMC, EIR (1985q) (Appendix 2.4H)	CMC-NOI-121
	Aqualab, Inc. (1979-1980)	CMC-NOI-122
	Young, R. Correspondence (1982)	CMC-NOI-123
	Blair L.N. Correspondence (1980)	CMC-NOI-124
	EMC (1980)	CMC-NOI-132
	Ecological Analysis, Inc. (1983)	CMC-NOI-115
	Ecological Analysis, Inc. (1984b)	CMC-NOI-116
	Ecological Analysis, Inc. (1985)	CMC-NOI-117
	Baker, B.J. Correspondence (1984)	CMC-NOI-125
	Fish & Wildlife Service, et al. (1982)	
Mitigation	Bochert, L.H. Correspondence (1986)	CMC-NOI-126
	Baker, B.J. Correspondence (1985)	CMC-NOI-127
	EA Science and Technology (1986)	CMC-NOI-129
Sediment	EMC, EIR (1985r) (Appendix 2.4E)	CMC-NOI-130
OHW	WDNR Lake Surveys (1984)	CMC-NOI-107
Floodplain	Foth & Van Dyke (1982a)	CMC-NOI-133
	Foth & Van Dyke (1982b)	CMC-NOI-134

However, past water chemistry data does have value in that it provides a good reference to conditions that exist at the time of collection. Therefore, this data will be used to identify trends that may have occurred since its original collection.

Flow monitoring methods have not changed in the past 20 years. As a result, existing data will be used for environmental studies and as part of project permit applications. Since the

time that the original permitting efforts ceased additional monitoring of lake levels has been conducted on a regular basis by both EMC and CMC employees. This data has been compiled and is referenced in Table 4-16.

4.3.12.1.2 Data Requirements

The need for surface water data is driven by a number of factors. The establishment of a baseline for the project is the most important of these factors. Baseline data will be used to model stream quality, develop effluent limits for the WPDES discharge permit, identify 100 year floodplain areas, provide data for the groundwater modeling efforts and set goals for mitigation in the event that the groundwater modeling program predicts impacts which must be mitigated.

Surface water/sediment data needed for this project includes stream flow measurements and morphological characteristics, lake level measurements, and water and sediment quality data for the streams and lakes associated with the project.

4.3.12.1.3 Methodology

Data Collection for Surface Water Quality

Surface water data collection falls into two categories. The first relates to the Wolf River and Swamp Creek. The second relates to lakes and other creeks in the vicinity of the site. Wolf River and Swamp Creek data collection activities have commenced. A work plan identifying sampling locations, parameters, sample collection procedures, analytical methodologies, etc. has been previously submitted to the WDNR in the document titled *Surface Water Sampling Quality Assurance Plan for the Crandon Project, Crandon, Wisconsin*, 1993. This document is included in Appendix B to this report. Additional surface water data collection relating to area lakes and other creeks is planned. The combined points where surface water data collection will take place is outlined in Table 4-17, which lists all the proposed surface water sampling sites and the proposed monitoring schedule. Figure 4-15 shows the approximate location of all collection sites, with the exception of sites SG-V, SG-Y and SG-CC. The location of these sites can be found in Figure 6-1 in Appendix B.

Table 4-17

Surface Water Monitoring Schedule
Crandon Mining Company NOI/SOS

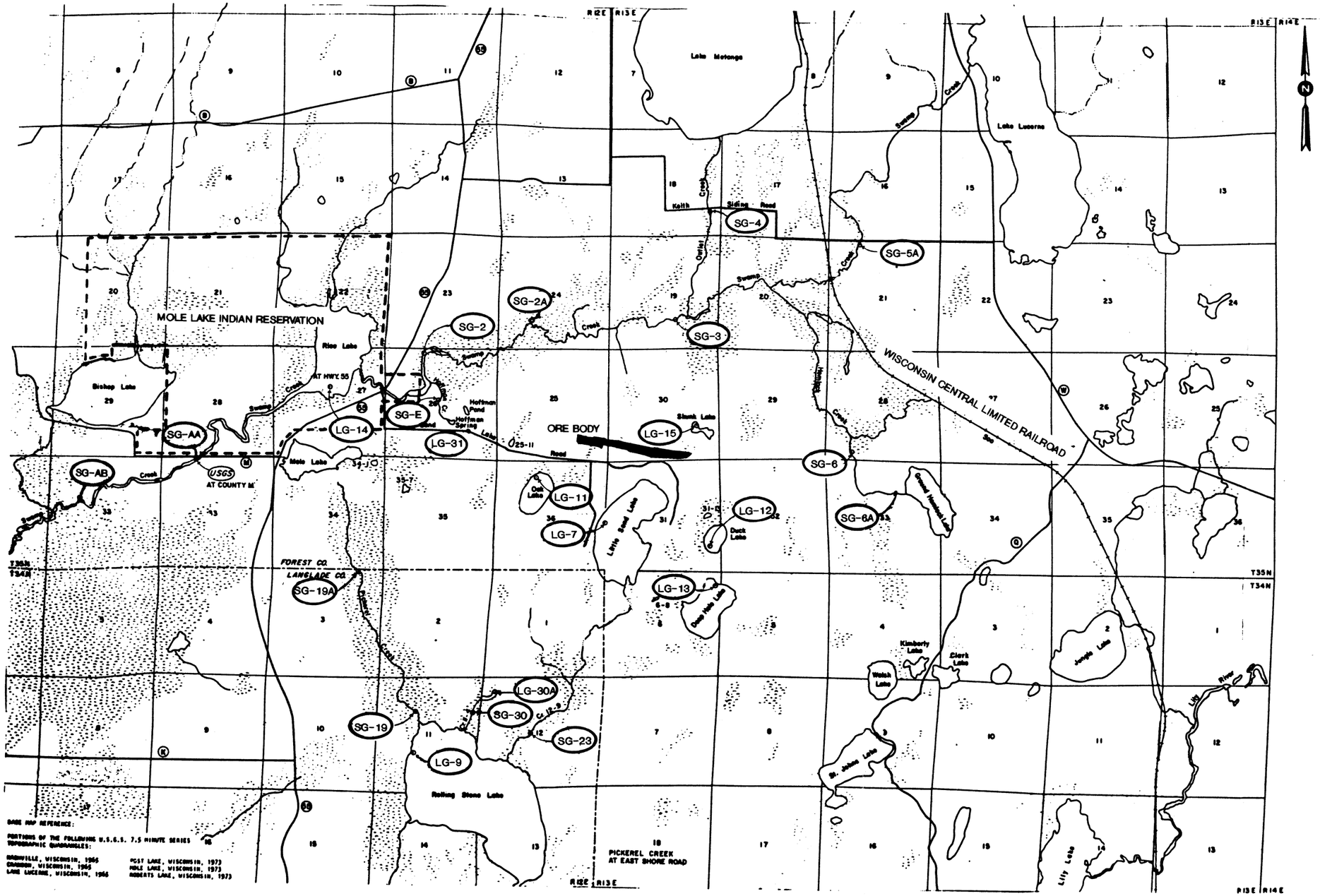
Surface Water	Site ID	Monthly Sample	Quarterly Sample	Low Level Metals	Standard Metals	Monitor Flow[3]	Monitor Level[3]
Swamp Creek	SG-2	(1)		(2)		X	
Swamp Creek	SG-2A					X	
Swamp Creek	SG-3	(1)		(2)		X	
Swamp Creek	SG-5A		X		X	X	
Swamp Creek	SG-AB	X		X		X	
Swamp Creek	SG-AA					X	
Swamp Creek	SG-V	X		X		X	
Wolf River	SG-Y	X		X		X	
Wolf River	SG-CC	X		X		X	
Pickerel Creek	SG-19	(1)		(2)		X	
Pickerel Creek	SG-19A					X	
Hemlock Creek	SG-6	(1)		(2)		X	
Hemlock Creek	SG-6A					X	
Creek 11-4	SG-30	(1)		(2)		X	
Creek 12-9	SG-23	(1)		(2)		X	
Hoffman Creek	SG-E	(1)		(2)		X	
Outlet Creek	SG-4		X		X	X	
Martin Springs	LG-30A						X
Hoffman Springs	LG-31						X
Skunk Lake	LG-15	(1)		(2)			X

Surface Water	Site ID	Monthly Sample	Quarterly Sample	Low Level Metals	Standard Metals	Monitor Flow[3]	Monitor Level[3]
Duck Lake	LG-12	(1)		(2)			X
Deep Hole Lake	LG-13	(1)		(2)			X
Little Sand Lake	LG-7	(1)		(2)			X
Rice Lake	LG-14		X		X		X
Oak Lake	LG-11	(1)		(2)			X
Rolling Stone Lake	LG-9		X		X		X

(1) If groundwater modeling demonstrates that no mitigation will be required for this site, monthly sampling will be changed to quarterly sampling.

(2) If groundwater modeling demonstrates that no mitigation will be required for this site, low level analyses for metals will be changed to standard detection levels.

(3) Stream flow measurements and lake level measurements will be taken monthly.



BASE MAP REFERENCE:

PORTIONS OF THE FOLLOWING U.S.G.S. 7.5 MINUTE SERIES TOPOGRAPHIC QUADRANGLES:

BRADVILLE, WISCONSIN, 1966
CRANDON, WISCONSIN, 1966
LAKE LUCERNE, WISCONSIN, 1966
POST LAKE, WISCONSIN, 1973
MOLE LAKE, WISCONSIN, 1973
ROBERTS LAKE, WISCONSIN, 1973

LEGEND

	WETLAND
	STREAM
o SG	LOCATION OF STREAM GAGE
o LG	LOCATION OF LAKE GAGE
⊙ USGS	LOCATION OF USGS STREAM GAGE
31-13	WISCONSIN DNR IDENTIFICATION CODE FOR UNNAMED LAKES
Cr 12-9	WISCONSIN DNR IDENTIFICATION CODE FOR UNNAMED STREAMS
(35)	BLACKTOP ROAD

NOTES:

1. STREAM DISCHARGE MEASUREMENTS ONLY WERE TAKEN AT SGA, SGC, SGD, AND SGF.
2. SAMPLING LOCATIONS, SG-V, SG-Y AND SG-CC CAN BE LOCATED BY REFERING TO FIGURE 6-1 IN APPENDIX B.

0 1 MILE

REVISED	DATE	BY	DESCRIPTION

Crandon Mining Company

FIGURE 4-15

SURFACE WATER MONITORING STATIONS

Scale:	1" = 1 MILE	Date:	JANUARY 1994
Prepared By:	Foth & Van Dyke	By:	JRB

3c49figs.DGN

93C049

Test parameters for surface water quality work for all locations listed in Table 4-17 are specified in Appendices B and E. The methodology to be used for analytical work are also contained in Appendices B and E. Sample collection and flow monitoring methods will be consistent with those methods identified in Appendices B and E.

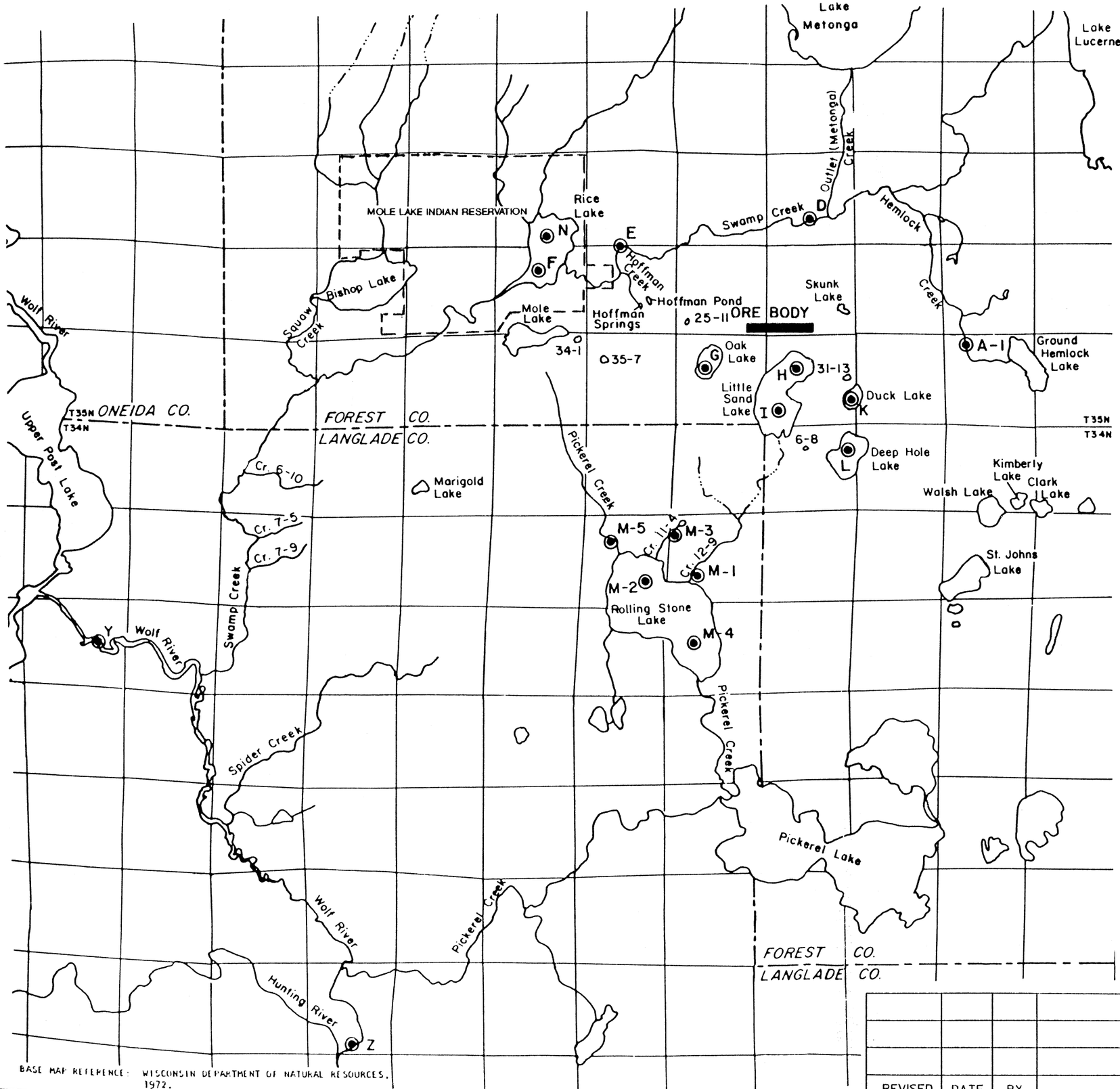
Data Collection for Surface Water Sediments

For confirmation of the data collected in the previous surface water sediment studies which were presented in the EMC EIR (EMC, 1985r, CMC-NOI-130), and to document current conditions, sediment samples will be collected from the sites identified in Table 4-18. Figure 4-16 shows the location of all collection sites.

Table 4-18

Surface Water Sediment Sampling Sites
Crandon Mining Company NOI/SOS

Surface Water	Sampling Station
Swamp Creek	D
Swamp Creek	E
Hemlock Creek	A-1
Rice Lake	F
Rice Lake	N
Oak Lake	G
12-9 Creek	M-1
11-4 Creek	M-3
Pickerel Creek	M-5
Rolling Stone Lake	M-2
Rolling Stone Lake	M-4
Deep Hole Lake	L
Duck Lake	K
Little Sand Lake	H
Little Sand Lake	I
Wolf River	Y
Wolf River	Z



LEGEND

- STREAM
- 25-11 — WISCONSIN DNR IDENTIFICATION CODE FOR UNNAMED LAKES
- Cr. 11-4 — WISCONSIN DNR IDENTIFICATION CODE FOR UNNAMED STREAMS
- WATER AND BOTTOM SEDIMENT CHEMISTRY SAMPLING STATION

BASE MAP REFERENCE: WISCONSIN DEPARTMENT OF NATURAL RESOURCES, 1972.

REVISED	DATE	BY	DESCRIPTION

Crandon Mining Company

FIGURE 4-16

PROPOSED BOTTOM SEDIMENT SAMPLING LOCATIONS

Scale:	1" = 1 MILE	Date:	JANUARY 1994
Prepared By:	Foth & Van Dyke	By:	JRB

3c49figs.DGN

93C049

Because of the diversity of sediment characteristics, sampling methods will vary. Specific depth of samples and equipment to be used will depend on site conditions. It is intended to sample the upper one foot of sediment to determine background characteristics. A non-metallic sampler such as a coring tube will be used to collect the sample. If stratification of sediments are visually observed, samples will be collected from the top layer of sediment for independent analyses. Stratification will be noted in the field reports.

A single sample will be collected from each of the sediment sites. Two duplicate samples will be collected for quality control purposes at sites selected at the time of sampling. A total of 19 sediment samples will be collected. The parameters to be analyzed are those listed in Table 4-19.

Table 4-19

Sediment Sample Parameters
Crandon Mining Company NOI/SOS

Aluminum	Magnesium	Thallium
Antimony	Manganese	Total Solids
Arsenic	Manganese, total	Total Volatile Solids
Barium	Mercury	Zinc
Beryllium	Molybdenum	
Boron	Nickel	
Cadmium	Nitrogen-Organic	
Calcium	Nitrogen, Kjeldahl	
Chloride	Oil and Grease	
Chromium, total	pH	
Copper	Phosphorus, total	
Cyanide	Potassium	
Fluoride	Selenium	
Iron, total	Silver	
Lead	Sodium	

4.3.12.1.4 Data Presentation Format

Water quality and flow information will be presented in graphic and tabular form. The presentation format will also include drawings showing sample collection points. A narrative discussing the work performed and interpretations of the data will be included in the EIR produced for the project.

4.3.12.1.5 Schedule for Data Collection

Surface water sampling and flow monitoring programs began in November, 1993, and will continue on a monthly basis, or as noted in the text above, for a period of at least one year. Sediment sampling will be conducted at various times of the year. Lake sediment samples will likely be collected when ice cover is on the lakes and stream sediment sampling will be conducted during open water periods.

4.3.12.2 Ordinary High Water Mark

4.3.12.2.1 Existing Data Summary and Evaluation

A considerable amount of data was collected for the previous EMC project to establish Ordinary High Water marks (OHW). The data was accepted as part of previous project activities. No significant changes in OHW's or OHW delineation techniques have occurred over the intervening years, therefore a need does not exist to perform additional field studies regarding OHWs. Available OHW information is referenced in Table 4-16.

4.3.12.2.2 Data Requirements

No additional data will be collected for the purposes of establishing OHWs within the study area.

4.3.12.3 Surface Water Quality Modeling

Surface water quality modeling was performed to support previous project permitting efforts. Changes in regulatory requirements relating to effluent limitations result in the need to use new modeling techniques for the development of WPDES permit limits that will apply to the project. Inputs to the model are both existing data and that to be collected as described above.

Modeling will consist of mass balance calculations under a variety of flow situations. Modeling for the permit application will typically include maximum discharge from the project associated with seven-day, 10-year low flow condition (Q7,10). However, because the effluent limits will be based on background water quality, additional considerations to flow based effluent limits will be evaluated. The relationship between stream flow and water quality may vary between low flow and high flow conditions. Some surface waters experience the poorest water quality under low flow conditions while others may experience the poorest water quality under high flow conditions. This may result in the application of an alternative method of computing discharge limits to the project. Mass balance calculations will be completed on a spread sheet format with graphics created to

illustrate the relationships and impacts. Various statistical evaluations will be completed to examine the data.

Model results will be presented in tabular and graphic form, using a PC-based spread sheet. Written text will accompany the data to clarify the methodology and logic behind the evaluations. Data and text will be presented in the project's EIR.

A preliminary evaluation of the data will be completed after approximately six months of surface water data collection. This preliminary evaluation will be used to determine the preliminary effluent limits for wastewater discharges. The final evaluation will be completed and presented in the project's EIR.

4.3.12.4 Surface Water Mitigation

Data collection and technical studies for the project's surface water mitigation program will be driven by other areas of evaluation including; groundwater modeling, surface water studies and wastewater treatment evaluations.

The need for mitigation to supplement flow in streams and lakes will be determined based on the results of the groundwater modeling program. If mitigation is necessary, techniques to be used to accomplish it will be developed based on the data collected from groundwater modeling work, surface water studies, biological studies, wastewater treatment evaluations, etc. The development of the various work plans for groundwater modeling, biological studies, surface water studies, wastewater studies, etc., has taken into consideration the collection of data that would be needed to support either or both mitigation methodologies.

Mitigation will be addressed once groundwater modeling work has generated enough information to quantify if, and to what degree, impacts may occur on area surface waters. As currently planned, this information will become available in late summer in 1994. This evaluation, if conducted, will be presented in report form identifying individual water resources that need to be mitigated. Data will be presented in tabular and graphic form, utilizing a PC based spread sheet. Written text will accompany the data to clarify the methodology and logic behind the evaluations. Drawings, where appropriate, will accompany the text to illustrate the location of planned mitigation activities, and to illustrate mitigation methods. The final evaluation will be completed and presented in the project's EIR.

4.3.12.5 Floodplain Considerations

4.3.12.5.1 Existing Data Summary and Evaluation

A Floodplain Study for Forest County is available. The only floodplain defined in the county study in the vicinity of the project is Lake Metonga and its outlet. Other nearby floodplain evaluations known to exist (as listed in the WDNR floodplain information clearinghouse publication, "Wisconsin Floodplain Management - Community Status Report" dated August 3, 1993) relate to a site on Gliske Creek (west of STH "55"), and a roadway and railroad bridge over Swamp Creek just north of the mine/mill site.

The floodplain evaluations on Swamp Creek were completed in October of 1986 and submitted to the WDNR by the WDOT. These evaluations are the bridge/floodplain work completed during the previous mine permitting activities for crossing Swamp Creek with the mine's access road and railroad service spur. As public documents, this information is available for use as part of current project permitting work.

4.3.12.5.2 Data Requirements

Based on topographic mapping and field investigation, the proposed mining activities will remain separated from any floodplains. The previously completed floodplain work is sufficient to meet project needs.

4.3.12.5.3 Data Presentation Format

Drawings will be used in the project's EIR to illustrate the location of floodplains relevant to the project. A short text will be included in the EIR addressing the floodplain issue.

4.3.12.6 Key Project Personnel

Mr. Gerald J. Berg of Foth & Van Dyke will manage the surface water program. Mr. Berg has over 20 years experience in the fields of surface water and wastewater treatment studies. In his career he has also managed a laboratory and, in 1986, was named Laboratorian of the Year by the Wisconsin Laboratory Association. Mr. Berg will be assisted in his activities by Messrs. William M. West, Ronald F. Steg, Stephen G. Lehrke, and Michael D. Liebman, P.E., all of Foth & Van Dyke.

Mr. West is a liminologist and wastewater treatment specialist with over 16 years of experience in the areas of surface water studies, bioassays, industrial pretreatment, etc. Mr. Steg is a water resource specialist with 10 years experience in the areas of water resource studies, wetland studies mitigation, resource management alternative studies, noise studies, etc.

Stephen G. Lehrke is an environmental statistician with experience in the areas of data management, sampling designs, statistical comparisons, trend analyses, statistical modeling, etc. Michael D. Liebman is a registered professional engineer specializing in civil and water resources engineering. His areas of expertise relate to stormwater management and permitting, hydraulic sizing for bridges and culverts, water resource studies, etc.

4.3.13 Tailings Management Area

The Tailings Management Area (TMA) described in the 1986 FEIS was previously referred to by the name Mine Waste Disposal Facility (MWDF). The 1986 facility consisted of four basins (two small and two large) that were proposed to be lined with a composite consisting of a filter fabric, a granular soil underdrain, and a base material of bentonite amended soil. Tailings material (fine or mixed coarse tailings and fine rock particles) were to be slurried and pumped to the TMA. The plan of operation for the TMA specified that excess water would be continually removed from the TMA and the tailings would return to a moist, unsaturated condition prior to covering and reclamation. The wastewater treatment sludge will be placed in the ponds with the tailings.

The site for the TMA was selected after a detailed evaluation of a number of candidate sites. The site selection was reviewed by the WDNR (Schuff, 1984, CMC-NOI-167) with the Department concluding that the proposed site "is a viable site which can preferably be developed into an environmentally acceptable disposal facility if adequate engineering design and construction of the site is accomplished."

The number, configuration, depositional method and liner system of the TMA basins will be reappraised as part of planned project engineering studies which will also consider:

1. The type of material(s) to be used in the liner system;

2. The compatibility of the liner system with the hydraulic conditions that will exist, and the leachate that will be generated within the TMA;

3. Soil breakthrough and moisture retention for the undisturbed soils beneath the TMA; and,

4. Unsaturated flow and contaminant transport of fluids potentially emanating from the TMA.

4.3.13.1 Existing Data Summary and Evaluation

Data regarding the performance and compatibility of low permeability synthetic materials exists in the professional literature and in manufacturer's specifications. This body of information is suitable for use in the selection of liner materials for the TMA facility.

The soils at the site have been extensively studied in the past (STS, 1984a and 1984b, CMC-NOI-27 and CMC-NOI-28, respectively). Based on these studies, it is unlikely that significant quantities of low permeability soil exists at the site. Identification of low permeability soils for potential use as a soil component of a liner system, if soil is to be used in lieu of a bentonite amended soil, is needed.

Bentonite amended native granular soils have been extensively tested with regard to their physical characteristics (STS, 1984c, 1985a, 1985b and Smith, 1986, CMC-NOI-137, CMC-NOI-138, CMC-NOI-139, and CMC-NOI-140, respectively).

4.3.13.2 Data Requirements

Final decisions regarding data needs and data collection techniques will be made after the completion of initial tasks relating to the planned engineering studies. At that time, a detailed work plan identifying specific data collection efforts will be prepared and submitted to the WDNR. Initial engineering studies to evaluate the TMA design will commence in March 1994. As currently envisioned, the work plan identifying TMA data needs will be submitted to the WDNR in early to mid-spring 1994.

4.3.13.3 Key Project Personnel

Nandu Paruvakat, Ph.D., P.E. of Foth & Van Dyke will manage the design of the TMA, the preparation of the engineering report and plan of operation, and the compatibility

evaluation of the synthetic low permeability liner. Dr. Paruvakat is a geotechnical engineer that, over his 20 year career, has performed similar evaluations and prepared similar documents for related projects. Dr. Paruvakat will be assisted by John E. Thresher, Jr. Mr. Thresher is president of Thresher & Son, Inc. As a Ph.C. soil scientist, Mr. Thresher has been involved in soil investigations, soil absorption studies, waste characterization studies, etc. over his 30 year career. Mr. Thresher will be in charge of the field and laboratory studies of the soil materials, and will also conduct the unsaturated flow and contaminant transport modelling.

4.3.14 Transportation

4.3.14.1 Existing Data Summary and Evaluation

Proposed transportation facilities include both a site access road for vehicular traffic such as employee autos, buses, and trucks for delivery of supplies, and a railroad access to facilitate the movement of concentrates to, and receipt of supplies from, the Wisconsin Central Limited Railroad approximately 2.7 miles east of the facility. Past transportation studies relate to corridor studies, soils studies and preliminary engineering reports. Corridor studies (Inman-Foltz, 1979 and Fowler, 1977, CMC-NOI-141 and CMC-NOI-142, respectively) and soils work (Soil Testing Services of Wisconsin, Inc., 1981, CMC-NOI-143) contain information relevant to environmental studies. A 1982 EMC report (EMC, 1982, CMC-NOI-144) presents a summary of the rail and access roadway corridor siting sequence.

4.3.14.2 Data Requirements

The previous studies and associated data are approximately 15 years old. As a result, it will be necessary to collect updated traffic data for the existing roadways that may be used by traffic entering and exiting the mine facility. Updated data regarding the physical condition of these roadways as well as the Wisconsin Central Limited Railroad will also be required.

4.3.14.3 Methodology

The Wisconsin Department of Transportation (WDOT) and the Wisconsin Central Limited Railroad will be contacted directly to obtain available information regarding roadway and rail condition information as well as traffic data for the roadways. Traffic volume data (average daily traffic and peak hourly traffic), including all turning movements, will be required for the following roadway segments:

- STH 55 at the intersection with Sand Lake Road to determine the traffic volume on STH 55 in the vicinity of the proposed access road as well as on Sand Lake Road.

- North intersection of STH 55 and STH 8 in Crandon to determine the traffic volume on STH 8 to and from the west and on STH 55/STH 32 to and from the north.

- South intersection of STH 55 and STH 8 to determine the traffic volume on STH 8 to and from the east.

If current traffic data is not available from WDOT, traffic counts will be conducted at these locations.

4.3.14.4 Data Presentation Format

All data will be presented in tabular format accompanied by a narrative description. The data and narrative will be included in the project's EIR.

4.3.14.5 Schedule for Data Collection

Data will be collected in late winter or spring of 1994.

4.3.14.6 Key Project Personnel

Mr. Ronald F. Steg of Foth & Van Dyke will be responsible for the collection and evaluation of transportation data. Mr. Steg has 10 years experience conducting environmental studies relating to water resources, wetlands, mitigation, resource management alternative identification, noise, transportation and utility systems, etc.

4.3.15 Utilities

4.3.15.1 Existing Data Summary Evaluation

Data on utility systems that will support the proposed project include descriptive information on electricity and natural gas systems to be provided by the utility companies themselves. The electric utility is Wisconsin Public Services Corporation (WPS). Natural gas will be provided by WPS and the ANR Pipeline Company. On-site utilities, which include electrical and gas distribution and storage for diesel fuel, are addressed in Section 3, Project Description.

4.3.15.2 Data Requirements

Updated information on the current status of electrical and gas utility systems will be obtained from the utility companies. They are directly responsible for delivering the necessary services to the Crandon Project and are currently working on siting, design and regulatory approvals for the facilities to delivery electricity and natural gas to the site. These activities are subject to environmental review and approval by the Wisconsin Public Service Commission and the WDNR. Therefore, the Scope of Study for the proposed project will not include data gathering or evaluation studies regarding utilities. However, the results of the utility company studies will be available for use in the environmental review process for the Crandon Project.

4.3.16 Waste Characterization

4.3.16.1 Existing Data Summary and Evaluation

An exploration drilling program was conducted at the site during the late 1970s and early 1980s. Additional limited drilling began during November, 1993. Most of the geologic data gathered to date consists of drill logs and assays of the mineralized zones and rock units surrounding these zones. This data has been used to construct the stratigraphy at the site and to define the distribution and limits of the ore body and non-mineralized lithologies. Figure 4-17 is a geologic cross-section showing the distribution of sulfur within the vicinity of the ore body and the underground facilities. As seen in the figure, the highest concentrations of sulfur are adjacent to the ore body. The concentration of sulfur decreases rapidly away from the ore body which is typical of mineralized stratabound deposits. The tightly limited distribution of sulfur in the geologic units separates the potential waste rock that will be produced during the mining operation into high sulfur-content and low sulfur-content waste rock. Waste rock containing more than 1% total sulfur is termed high sulfur-content waste rock. Waste rock containing less than 1% total sulfur is termed low sulfur-content waste rock.

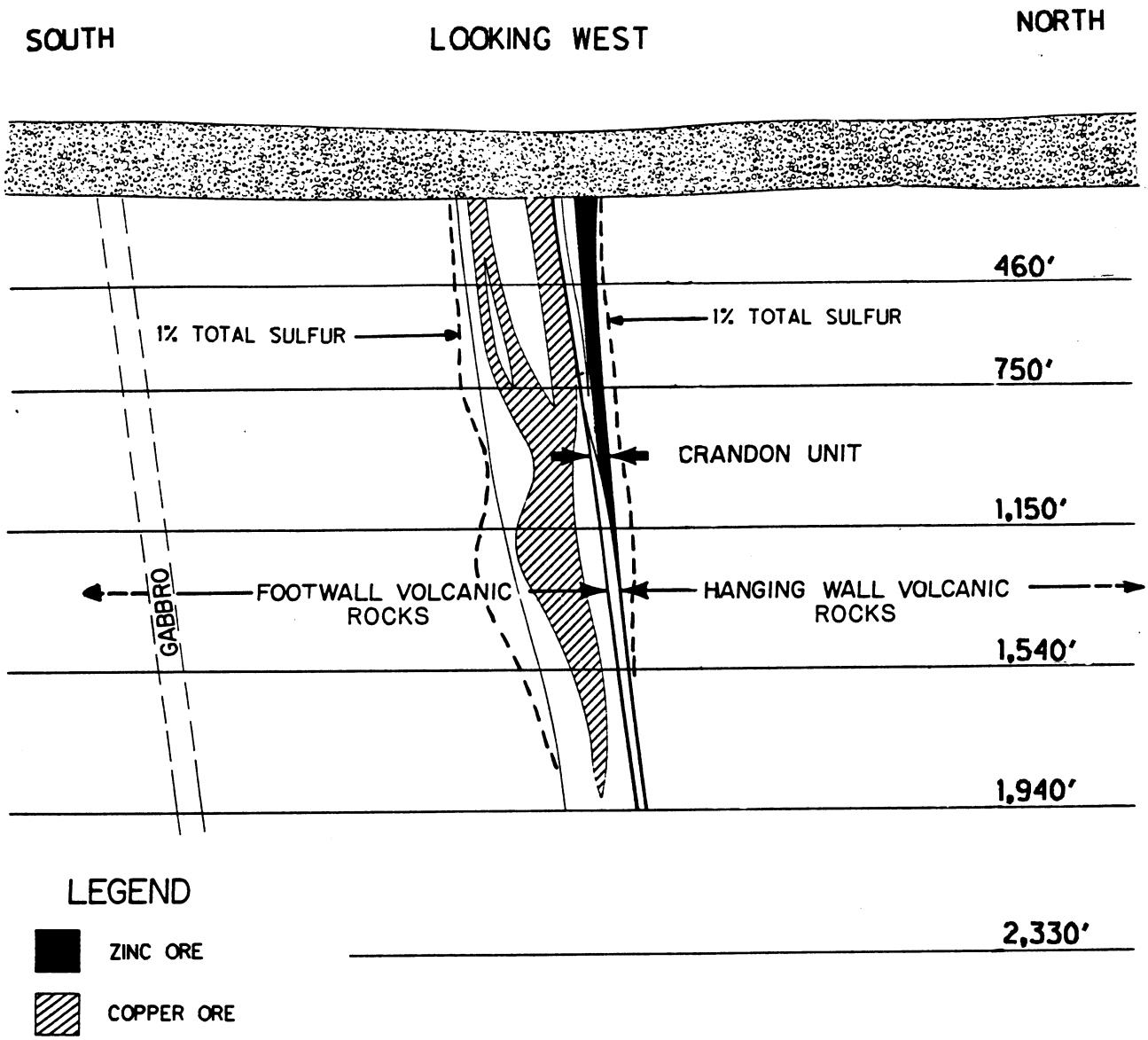
Petrographic analyses of selected samples from the mineralized and unmineralized rocks have been conducted to determine the mineral composition and distribution within the rocks.

A layer of saprolite, of varying thickness and extent, has developed in the upper portion of the crystalline rocks. The saprolite and/or crystalline bedrock is covered with a blanket of overburden approximately 100-150 feet thick. Most of the overburden consists of sand, silt and clay materials, considered to be of glacial till and outwash origin. Overburden samples recovered during the exploratory and environmental drilling programs have been used to define the stratigraphy of these unconsolidated units. No evidence of mineralization was found in any of the recovered unconsolidated samples.

An underground mine has been proposed for the recovery of the ore. Ore will be removed from the Crandon Formation by stoping. The grade of the metals in the ore is too low to permit direct shipment of crushed ore to a smelter. The mine facilities will therefore include a primary beneficiation process known as flotation, wherein the metallic minerals will be physically concentrated prior to shipment to a smelter.

Seven wastes will be generated during the development of the mine, its operation, and concentration of the ore. These wastes will include: 1) low sulfur-content waste rock; 2) high sulfur-content waste rock; 3) fine tailings; 4) backfill sands (coarse tailings); 5) wastewater treatment sludge; and, 6) reclaim pond sludge; and 7) overburden.

Most of the low sulfur-content waste rock will be generated during the construction of the shafts and levels of the mine. It is anticipated that this waste rock will be used in the construction of above grade facilities. Properties of a composite sample representing a small population of low sulfur-content waste rock were characterized by BC Research (1982a and 1982b, CMC-NOI-145 and CMC-NOI-146, respectively).



Crandon Mining Company

FIGURE 4-17

GENERALIZED CROSS SECTION SHOWING THE ORE ZONED AND THE 1% TOTAL SULFUR ISOGRADIENT

Scale: NOT TO SCALE	Date: JANUARY, 1994
Prepared By: Foth & Van Dyke	By: JRB

REVISED	DATE	BY	DESCRIPTION

3c49f1.DGN

Most of the high sulfur-content waste rock will be generated during the recovery of the ore. Most of this material will be used to backfill the stopes after the ore is recovered. Part of the high sulfur-content waste rock will be temporarily stored above grade on a lined site until it can be used for erosion control in the interior of the tailings ponds. Properties of several composites of high sulfur-content waste rock were also characterized by BC Research (1982a and 1982b, CMC-NOI-145 and CMC-NOI-146, respectively).

The method used by BC Research to estimate the acid producing potential of the waste rock composites is a currently accepted method. The results of their tests indicated that waste rock containing more than one percent pyritic-sulfur would likely be acid producing. Small and variable quantities of carbonate minerals (mainly calcite) are found within the rock units at the site (Nimjee, 1979 and Rowe, 1980, CMC-NOI-147 and CMC-NOI-148, respectively). Waste rock created from the carbonate-bearing rocks would be expected to have enhanced acid neutralization capacities.

BC Research evaluated the quality of leachate resulting from column leaching tests performed on the waste rock composites. Some of the methods used to test the leachate are currently acceptable. These methods include: sulfate, pH, conductivity and temperature. The detection limits for most of the past leachate metal analyses were greater than those currently acceptable, especially for arsenic, antimony, cadmium, mercury, and, selenium (BC Research, 1982a, CMC-NOI-145). Therefore, additional testing is required.

Extraction Procedure (EP) toxicity tests were performed on all of the waste rock composites by BC Research. This test is a currently acceptable test used to determine if a material will leach under acidic conditions. The results of the tests indicated that the leachable metal concentrations derived during the tests were lower than current state and federal threshold limits as defined by 40 CFR 261 (BC Research, 1982a, CMC-NOI-145). The most commonly used method currently to determine if a substance will leach is the TCPL method. This method is considerably more accurate for the determination of leachable volatile organic compounds (not an issue of concern for this project), but provides similar results to the EP toxicity test for metals. Although the method to determine leachability has changed from EP Toxicity to TCLP, the two methods produce similar results for metals analyses. Therefore, the previously collected data are still valid, and no additional testing is required.

During backfilling, high sulfur-content and low sulfur content waste rock will be placed in the empty stopes. The stopes will then be filled with tailings. Part of the stopes will receive either coarse tailings mixed with normal Portland cement (NPC) or thickened whole tailings materials with NPC. The remaining stopes will receive either of these cemented materials at the base and/or the top of the stopes as needed. The central parts of these stopes will be backfilled with uncemented tailings materials. Cementitious backfilling of the stopes will increase rock stability while decreasing the permeability of the backfilled zones. Waste rock testing will be needed to evaluate the leaching characteristics of the different potential mixtures that will actually be placed within the mine during the backfilling process.

Tailings materials will be generated as a result of the primary beneficiation of the ore at the site. The permanent disposal of tailings materials will occur both in the mine and in

the TMA. Both wastewater treatment facility and reclaim pond sludges will be co-disposed with the tailings materials in the TMA.

The fine tailings materials have been characterized regarding their acid production potential and leachability under aerobic conditions (Colorado School of Mines, 1982, CMC-NOI-149). The methods used to characterize the fine tailings essentially meet current laboratory standards. Testing of the tailings under anoxic conditions and testing of the anticipated co-disposed materials need to be conducted.

Physical characterization of the coarse tailings materials (backfill sands) have been conducted. One test measured the heat of reaction generated by the reaction of these materials (and also with fine tailings materials) with water (Spira, 1981, CMC-NOI-150). The results of the tests indicate that backfilling the stopes containing broken and crushed waste rock with a cementitious tailings slurry will be a slightly exothermic process.

Permeability and rock mechanics tests were conducted on various tailings fractions with and without additives to evaluate the properties of cemented and non-cemented backfilled wastes. The tests were performed with tailings materials (Smith, 1986 and Dames & Moore, 1978, CMC-NOI-140 and CMC-NOI-151, respectively). The results showed that tailings materials mixed with normal Portland cement (NPC) at a ratio of 10:1 (tails:NPC) produced the best overall reduction in permeability in the tailings for the greatest increase in rock strength. Testing of tailings material slurried into backfilled waste rock needs to be performed.

An evaluation of the characteristics of a wastewater treatment sludge was conducted. Much of this sludge characterization was conducted on synthesized, or estimated sludges based upon a CH2M Hill water model. The worst case wastewater that the proposed facility will treat will be the mine drainage water that will be formed by water contacting freshly exposed sulfide-bearing rocks and highly weathered rocks containing iron- and aluminum-bearing colloids. Therefore, wastewater treatment sludge characterization should be performed on material derived from wastewater generated by leaching materials that will result in the production of water similar to mine drainage water.

The reclaim pond sludge will be similar in characteristics to the tailings plus wastewater treatment sludge. Therefore, no production of a reclaim pond sludge, nor separate characterization of the sludge, is considered necessary.

Since the proposed mine will be an underground operation, little overburden material will be disturbed or displaced during the proposed mining operation. Therefore, testing of the overburden material was not conducted. No testing of the overburden material is deemed necessary.

Extensive radiological analyses have been performed on the fine tailings, ore and waste rock. The results of the chemical and radiation tests, conducted and verified by several organizations, showed that these materials contain less uranium, thorium and radium, and have lower radioactivity, than nearby unmineralized crystalline rock (Hazelton, 1981 and 1981b, CMC-NOI-152 and CMC-NOI-153, respectively). Additional radiological analyses are not necessary.

Thin sections of selected ore and waste rock samples were prepared and examined by optical microscopy for the presence of asbestiform minerals. This work, which was verified by Wisconsin Geological and Natural History Survey (Ostrom, 1982, CMC-NOI-154), found no asbestiform minerals in the analyzed samples. Samples of fine tailings material were examined by transmission electron microscopy by a laboratory recommended by WDNR. No asbestiform minerals were found in the fine tailings material (Yamate, 1984a and Yamate, 1984b, CMC-NOI-155 and CMC-NOI-156, respectively). No further evaluation of asbestiform minerals in the waste materials is needed.

The above mentioned thin sections were also used to verify the core descriptions of the various geologic rock units, and to determine the content of the minerals within these rocks (Schmidt, 1976, CMC-NOI-157).

Subsamples of ore, ore concentrates and tailings material, originally collected and analyzed approximately 15 years ago (CMC, 1992, CMC-NOI-158), were analyzed for their total sulfur and sulfate concentrations in 1992 to determine the long term stability of the sulfide minerals within these materials. The proportion of sulfate-sulfur to total sulfur was used as a measure of the degradation of the sulfide minerals within these materials. The results of these analyses indicate that the coarser grained ore samples were only slightly degraded during this time interval. Larger proportions of sulfate-sulfur to total sulfur were found in the fine grained ore concentrates and tailings samples (Hanks, 1992, CMC-NOI-159). The results of these analyses indicate that the use of waste rock samples collected in the past in the proposed testing program would produce results nearly identical to those that would be produced if fresh waste rock were used.

4.3.16.2 Data Requirements

The testing of the waste materials will be conducted under conditions approximating those under which the individual materials will be used or disposed of at the site. The low sulfur-content waste rock will be leached under alternating wet and dry conditions to determine what, if any, impact the storage and usage of the this material above grade will have on the surficial environment.

The ore composite and mixtures of fine tailings material plus wastewater treatment sludge and the mixed fine and coarse tailings materials plus wastewater treatment sludge will be leached under aerobic saturated conditions to determine what, if any, impact that these materials in the form of fugitive dusts will have on the aquatic environment near the site.

Composites of materials to be backfilled in the mine need to be tested under anoxic saturated conditions. A low sulfur-content waste rock also needs to be tested under these conditions without the added mixture of tailings materials. The results of this testing will be used to determine what, if any, impact these materials will have upon groundwater when the mine is resaturated. Duplicate sets of the two cemented composites need to be tested for compressive strength and permeability.

The acid production potential of the two waste rock composites will be determined. In addition, the acid production potential of each of the low sulfur-content waste rock stratigraphic units used to produce the low sulfur-content waste rock composite will be determined.

The existing data and mining plan have been used extensively in the design of the waste characterization program. Additional data will be incorporated into the design and final definition of the physical setting of the site as it becomes available.

4.3.16.3 Methodology

WDNR personnel will be invited to observe and verify the collection of core samples from the CMC storage facility in Rhinelander and the processing and testing of samples at Foth & Van Dyke in Green Bay and at Lakefield Laboratories in Lakefield, Ontario.

4.3.16.3.1 Sampling Locations

Waste rock samples will be obtained from the diamond drill cores recovered during the past and present exploration programs. These samples are either stored in Rhinelander or are being obtained at the site near Crandon.

4.3.16.3.2 Sampling Techniques

Selected samples will be collected and preserved to minimize chemical and physical degradation. Preservation of diamond drill core samples will be accomplished by placing the samples in heavy weight plastic bags and shipping them to the laboratories where the testing will be performed. Preservation of the crushed and ground materials will be accomplished by placing the samples in polyethylene bottles and shipping them to the laboratories where the testing will be performed.

4.3.16.3.3 Compositing Schemes

The material that will be used to form the two ore composites will be acquired from some of the diamond drill cores currently being obtained. The materials from these cores will be used of ore recovery benchtesting by Lakefield Laboratories. Based upon the results of the initial benchtesting, Lakefield will form two or three master ore composites for final testing and process optimization. The materials that will be used to form the master ore concentrates, and the fine tailings and coarse tailings materials composites that will be produced during the processing of the master composites will be acquired from Lakefield Laboratories following the processing of the ore samples.

The material that will be used to form the two low sulfur-content waste rock composites will be acquired from core selected to represent the variety and relative abundance of the various lithologies expected to be removed from the mine during initial construction. The samples will be collected from the stored cores, and where possible, from the cores presently being recovered.

The material that will be used to form the high sulfur-content waste rock composite will be acquired from core that will represent the variety and spatial distribution of these materials adjacent to the ore body. All of these materials will have a sulfur content exceeding 2%. The samples will be collected from the cores currently being recovered where possible. The remainder of these samples will be collected from the stored cores.

The material that will be used to form the composite for the simulation of mine drainage water will be formed from high sulfur-content waste rock and highly weathered waste rock containing abundant clays and iron- and aluminum-bearing colloids. The high sulfur-content waste rock samples will have sulfur contents greater than 4% total sulfur. Samples will be collected from the cores currently being recovered where possible. The remainder of the samples will be collected from the stored cores. Leachate derived from the interaction between groundwater and this composite will be used in the wastewater treatment bench test studies.

A portion of the high sulfer-content waste rock composites will be used to form two composites containing either coarse tailings material or thickened whole tailings materials. Additional composites will be formed containing both tailings materials mixed with NPC. As currently planned, the ratio of either tailings materials to NPC will be 10:1.

The production and separation of tailings material into coarse and fine sized fractions will be conducted by Lakefield Laboratories during the metallurgical benchtesting program. The proportions of the size fractions will represent the average coarse to fine tailings that will be expected to be produced during the mining operation. Whole tailings materials will be produced by combining the two fractions using the determined proportion.

The wastewater treatment sludge that will be used in the simulation of the tailings pond environment will be acquired from the wastewater treatment bench test studies.

4.3.16.3.4 Laboratory Analyses

The bulk chemical composition of the following composited materials will be determined: 1) low sulfur-content waste rock; 2) high sulfur-content waste rock; 3) ore; 4) ore concentrate; 5) fine tailings materials; 6) coarse tailings material; 7) the mixed waste rock composite that will be used for the simulation of mine drainage water; and, 8) wastewater treatment sludge. These eight composites will be digested and the following parameters will be quantified:

Aluminum	Copper	Silicon
Antimony	Gold	Silver
Arsenic	Iron	Sodium
Barium	Lead	Sulfur
Beryllium	Magnesium	Tellurium
Bismuth	Manganese	Thallium
Cadmium	Mercury	Tin
Calcium	Molybdenum	Titanium
Carbon (Total)	Nickel	Uranium
Chromium	Potassium	Zinc
Cobalt	Selenium	

The alternating wet and dry leaching of four composited materials (low sulfur-content waste rock, ore, fine tailings material plus wastewater treatment sludge, and, mixed fine and coarse tailings material plus wastewater treatment sludge) will consist of a maximum of 16 cycles made up of one day of saturation followed by three days of free drainage. The composited samples will be contained in columns during the testing. The columns

containing waste rock and ore composites will be leached with deionized water. The columns containing tailings materials will be leached with a mixture of deionized water and spent flotation liquors. Specific electrical conductivity, temperature and pH will be measured in the leachate during each cycle. Sampling of the leachate will proceed until it becomes evident that the wastes have reached an approximate equilibrium with the leachate. Leachate samples will be collected, as necessary, following cycles 1, 2, 4, 8 and 16. The following parameters will be quantified in the cycle one, two and four leachate collected from each composite. In addition, the leachate collected from the columns containing tailings materials will be tested for cyanide.

Aluminum	Copper	Silver
Antimony	Iron	Sodium
Arsenic	Lead	Sulfate
Barium	Magnesium	Tellurium
Beryllium	Manganese	Thallium
Bismuth	Mercury	Tin
Cadmium	Molybdenum	Titanium
Calcium	Nickel	Uranium
Chromium	Potassium	Zinc
Cobalt	Selenium	

The aerobic saturated leaching of the ore composite, fine tailings material plus wastewater treatment sludge and mixed fine and coarse tailings materials plus wastewater treatment sludge will be conducted in columns. The column containing the ore composite will be leached with deionized water. The columns containing tailings material will be leached with a mixture of deionized water and spent flotation liquors. The tops of the columns will be open to the atmosphere. Sampling of the leachate will proceed until it becomes evident that the wastes have reached an approximate equilibrium with the leachate. Leachate samples will be collected, as necessary, following 1, 2, 4, 8, 16, 32, 64, and 128 days of leaching. Additional deionized water will be added to each leaching column following the collection of sample aliquots to maintain a constant solid to liquid ratio. Specific electrical conductivity, temperature and pH will be measured in all leachate samples collected. The above listed parameters will be quantitated in the leachate samples collected.

Anoxic saturated leaching of: 1) the high sulfur-content waste rock; 2) high sulfur-content waste rock plus coarse tailings material; 3) high sulfur-content waste rock plus coarse tailings and NPC; 4) high sulfur-content waste rock plus thickened whole tailings materials, and 5) high sulfur-content waste rock plus thickened whole tailings material and NPC will be conducted in columns with groundwater collected at the site. The columns will be sparged with nitrogen gas during the leaching experiments to achieve anoxic conditions. One set of the composites containing cement will be solidified and broken into smaller pieces and loaded into the columns prior to commencing the experiments. Sampling of the leachate will proceed until it becomes evident that the wastes have reached an approximate equilibrium with the leachate. Leachate samples will be collected, as necessary, following 1, 2, 4, 8, 16, 32, 64, and, 128 days of leaching. Additional groundwater from the site will be added to each column following the collection of sample aliquots to maintain a constant solid to liquid ratio. Specific electrical conductivity, temperature and pH will be measured in all leachate samples collected. The above listed parameters will be quantitated in the leachate samples collected.

Each leachate sample will be digested prior to analysis without filtering. Previously collected data from this project, and experience with similar materials, has shown that many of the listed parameters will not be detected in the leachate samples. It is proposed that if a parameter is not detected after three rounds of analyses that further analysis for that particular parameter be terminated. In addition, if a previously detected parameter is no longer detected in two consecutive analyses, further analysis for that parameter should also be terminated.

Based on the results of the past EMC studies, and other studies conducted on similar materials, the following list of parameters will likely be determined on all leachate samples:

Calcium	Magnesium	Sulfate
Iron	Manganese	

The acid production potential of the two waste rock composites and of each of the low sulfur-content waste rock lithologies will be determined using the BC Research method (CMC-NOI-146).

Petrographic thin section analyses will be prepared from a representative portion of each of the waste rock and ore subsamples and from the coarse tailings. These analyses will be used to determine the mineralogical composition and variability of the coarse grained wastes and ore.

Each of the second set of cemented backfill samples will be tested for the following physical properties: 1) porosity; 2) permeability; 3) dry density; 4) unconfined strength (compression); and 5) confirmed strength (compression).

4.3.16.4 Data Presentation Format

All data and interpretations will be presented in drawing, tabular and graphical formats as warranted. The accompanying text will detail the locations and methods used in the study and will provide an interpretation of the results. A discussion of the waste characterization program and its results will be presented in the project's EIR.

4.3.16.5 Schedule for Data Collection

The drilling and recovery of new rock cores began during November, 1993. A copy of the exploration permit for this drilling is included in Appendix C. The recovered cores will be split and shipped to Lakefield Laboratories as they are recovered, beginning in January 1994. Lakefield Laboratories will crush the ore and float the resulting pulp to collect both ore concentrate and tailings materials. Subsamples of the crushed ore, ore concentrate and tailings materials will be collected by Lakefield Laboratories from each processed ore sample. Representative samples will be shipped to Foth & Van Dyke where the waste characterization tests will be performed.

A sampling plan for the waste rock samples that will be used in the waste characterization and wastewater treatment bench test studies will be prepared and submitted to WDNR in April 1994. This plan will include the proposed sample locations and distribution, lithologic data and percent total sulfur of the proposed core sample intervals.

The low and high sulfur-bearing waste rock samples and the mixed waste rock sample for wastewater treatment bench testing, will be collected from the existing cores stored in Rhinelander, during May 1994. These samples will be shipped to Foth & Van Dyke where composites of the low and high sulfur-bearing waste rock and the mixed waste rock will be prepared and tested.

It is expected that all testing, analyses and interpretations of these samples will be completed within approximately ten months of the completion of the sampling.

4.3.16.6 Key Project Personnel

John E. Thresher, Jr. of Thresher & Son, Inc. will be in charge of the field work, sampling scheme, sample preparation, and the interpretation of the results of the study. Mr. Thresher, a Ph.C. soil scientist, has conducted similar studies for other mining projects. He has over 30 years experience working on a variety of projects relating to geochemistry.

4.3.17 Water Management

4.3.17.1 Existing Data Summary and Evaluation

Numerous studies were conducted during previous permitting work during the early and mid-1980s relating to wastewater treatment. Given that wastewater treatment regulations have changed, and that the mine water balance has changed due to the reduction in ore processing rate, a new wastewater treatment engineering report will be completed for the project. Data required to complete this report will be generated as part of the studies identified in this document.

4.3.17.2 Data Requirements

The mine and ore processing activities will generate five sources of wastewater which will be handled and/or treated prior to reuse or release. These areas include:

- Mine Drainage Water
- Intercepted Groundwater
- Stormwater
- Ore Processing/Tailings Water
- Sanitary Wastewater

Mine drainage water has the potential to carry soluble metals. This water will be isolated and treated in a chemical/physical treatment process. Intercepted groundwater will be handled separately from the mine drainage water and will be treated in a chemical/physical process, if required.

The stormwater will be collected from surface drainage areas that do not pose a threat to contaminate the water with dissolved metals. The water from these areas will be handled through conventional sedimentation basins.

The processing of the ore will require water which will be carried out with the tailings to the TMA. This water will be collected in lined ponds for treatment by sedimentation and

then returned to the ore processing facility for reuse. As described in Section 3, Project Description, the ore processing system is a closed loop net consumer of water. As a contingency measure, the wastewater treatment facility will be designed to treat tailings pond waters.

The work force at the mine will generate sanitary wastewater. Alternative methods will be evaluated for treatment and disposal of this wastewater.

Alternative technology for treating the mine drainage water will be evaluated concurrently with surface water studies. Because surface water quantity and quality data will be used to establish effluent limits, preliminary calculations will be needed to project the approximate limits that will be included in the project's discharge permit. Some of the surface water data will be available at the midpoint of the evaluation of treatment technologies. This information will be given to the WDNR and preliminary effluent limits can be developed. The preliminary effluent limits will be used to complete the technology review and prepare a final engineering report.

An engineering report identifying how each of the issues identified above is to be addressed is needed.

4.3.17.3 Methodology

Various studies are planned relating to wastewater treatment. The studies and proposed methodologies are discussed below.

4.3.17.3.1 Mine/Mill Water and Chemical Balances

A water and chemical balance for both the mine and the mill processes will be completed. A water balance flow sheet will be prepared to illustrate the relationship of the processes. Other study areas such as waste characterization and groundwater modeling will impact the balance and will be taken into consideration when completing a mass balance for the project. The balance will address both volume and mass parameters. This section of the evaluation will also address pollution prevention and water management practices.

The previous project proposed treatment of mill process water. This treatment step was intended to reduce scaling problems within the ore processing system. Currently, facilities operating without such treatment have found that scaling can best be handled through routine equipment maintenance. Also, because the ore processing and tailings management program are a net consumer of water, make-up water, either from precipitation or from freshwater input into the process, will reduce scaling potential. The elimination of this treatment process is a step towards pollution prevention and water management. Details relating to the suitability of the proposed wastewater management techniques for the ore processing system will be generated through the evaluation and presented in the final engineering report.

4.3.17.3.2 Metals Removal Process Evaluation

An evaluation of the alternative water treatment options will be driven by effluent limitations, production rates and hydrogeologic modeling. Effluent limitations will be

impacted by the classification of the Wolf River as an "Outstanding Resource Water" under NR 102 and the application of NR 207 of the Wisconsin Administrative Code which requires the establishment of effluent limits equal to background water quality. Other codes which will have the potential to impact effluent limits include NR 105, NR 106, NR 132, NR 140, NR 182, NR 214 and NR 270.

The treatment technologies for the metals removal process which will be evaluated as a part of the study and discussed in the engineering report include; alternative lime and sulfide precipitation processes, chemical coagulation alternatives, solids removal processes, neutralization, alternative reagents, reagent dosage optimization, reverse osmosis, ion exchange and filtration.

The technical evaluations will include the survey of similar facilities as well as pilot studies to determine the ability of the selected treatment option to meet effluent limitations on a consistent basis. The pilot study will be completed in conjunction with the waste characterization studies. This information will be provided to the WDNR as a part of the final engineering report.

4.3.17.3.3 Pilot Studies

A pilot test will be completed to evaluate the lime/sulfide treatment process, either as a single stage reaction or as separate reactions, followed by dual media filtration. The test will use water generated during leach testing of the material associated with the mine. The material which, through the waste characterization process most closely represents the water which will be treated, will be used for the test.

Treatment of the intercepted groundwater may be needed prior to discharge. If the lime/sulfide treatment process is needed, samples of groundwater taken from on-site groundwater monitoring wells will be subjected to the pilot studies identified in this section.

As part of the pilot study other technologies may also be evaluated. The preliminary evaluations will drive further pilot treatment study needs.

At the current time, the lime/sulfide treatment technology in one of a number of combinations that appears to be the treatment method most likely to be used for metals removal. A brief discussion of the pilot test procedure for this process is presented below. As the preliminary evaluation is completed, the pilot testing methods will be modified to reflect changes in the proposed treatment technology. Before changes or modifications to the pilot study are made, contacts will be initiated with the WDNR for review and concurrence.

The WDNR will be notified prior to beginning the pilot testing procedure. This will allow for scheduled observations of the pilot study. Split sample will be made available to WDNR if additional raw materials are available for the completion of the study.

Step 1

Water will be generated through the waste characterization process. Refer to Section 4.3.16, Waste Characterization, for a discussion of the waste characterization process.

The first evaluation will be to determine which pH produces the most efficient wastewater treatment. Three precipitation steps will be completed at pHs of 9.0, 9.5 and 10.0. This pH range has typically been used effectively in metals removal processes. The sample will be allowed to react with the lime for a period of 10 minutes. The samples will then be filtered to determine the fraction of metals which remain in solution. While filtering does not precisely reflect the actual treatment process, this step is simply evaluating the ability to complex soluble metals with hydroxide to form an insoluble precipitate. Steps 2 and 3 will be used to evaluate gravity separation and filtration in the pilot study. The raw sample and the three filtered samples, a total of 4 samples, will be analyzed for the parameters listed in Table 4-20.

The approximate volume of sample that will be needed to complete these analyses will be seven liters per test run. This will require an initial volume of raw water of 28 liters to complete this step.

Quantity control procedures for sample handling, chain of custody, preservatives, etc., can be found in the Quality Assurance Section of the NOI/SOS submittal. These procedures will be used throughout the pilot study.

The list of parameters in Table 4-20 is based on NR 105 and NR 140 standards. Additional parameters were included to further characterize the wastewater. If the waste characterization process identifies further elements or compounds of concern, they will be added to Table 4-20. Parameters not included in Table 4-20, but that are present in NR 105 and NR 140, are not going to be present in the raw wastewater. These include parameters such as chlorine and various organic compounds.

Table 4-20

Analytical Parameters for the Wastewater Treatment Pilot Study Crandon Mining Company NOI/SOS

Alkalinity (as $CaCO_3$)	Color	Odor
Aluminum	Copper	pH
Ammonia Nitrogen	Cyanide	Phosphorus, total
Antimony	Fluoride	Potassium
Arsenic	Hardness (as $CaCO_3$)	Selenium
Barium	Iron, total	Silver
Beryllium	Lead	Sodium
Biochemical Oxygen Demand	Magnesium	Sulfate
Boron	Mangense	Sulfide
Cadmium	Mercury	Thallium
Calcium	Molybdenem	Total Dissolved Solids
Chemical Oxygen Demand	Nickel	Total Kjeldahl Nitrogen
Chloride	Nitrate + Nitrite Nitrogen	Zinc
Chromium, total		

*Low level methods performed by Battelle Marine Sciences Laboratory

Step 2

After the optimum lime dosage rate is identified in Step 1, the sulfide dosage rate will be evaluated. A raw water sample will be treated with the optimum lime dosage and allowed to settle for one hour. The supernatant will then be used to evaluate the sulfide treatment process. Again, three dosage levels of sulfide will be evaluated. Stoichiometric calculations will be completed to determine the dosage required for the effluent quality generated from the lime treatment alone. The pilot study will reflect proposed sulfide contact time, approximately five to ten minutes. The samples will then be filtered to determine the fraction of metals which remain in solution. Again, the intent of this step is

to evaluate the ability of sulfide to complex metals and take them out of solution. Process filtration steps will be evaluated in Step 3 of the pilot study.

A sample of supernatant from the lime treated sample and three sulfide treated/filtered samples for a total of four samples will be tested. The list of parameters in Step 1 will be tested in these samples. However, the list of parameters will be evaluated for potential reduction. If the lime treatment process has satisfied the effluent requirements or if the raw sample contained elements below the level of concern, they will not be analyzed in Step 2. Actual sample volumes will be based on the analytical procedures needed to complete this step.

Step 3

Following Steps 1 and 2, the dosage for lime and sulfide should be optimized. The next part of the pilot study will be to evaluate the efficiency of gravity settling and dual media filtration. To do this, a batch of water will be treated and allowed to settle in the sequence and duration identified in the preliminary evaluation. The effluent will then be fed to a pilot scale dual media filter, allowing sufficient volume exchanges such that a representative sample is obtained. The following samples will be collected in this process.

1. For quality control purposes, a sample blank will be obtained from the filter prior to introduction of the test water.

2. A raw water sample will be collected prior to treatment for total metal analysis.

3. A sample will be collected after the lime/sulfide treatment step for laboratory filtration. This is intended to evaluate the concentration of soluble metals as a comparison to the total metal content following the dual media filtration.

4. An effluent sample from the filter will be collected after at least three volumes of treated water have displaced the laboratory grade water used to prepare the filter.

As with Step 2, the list of parameters in Step 3 will be evaluated for potential reduction. However, only those parameters that have concentrations below the level of concern in the raw water will be eliminated from the testing protocol. Actual sample volumes will be based on the analytical procedures needed to complete this step.

Step 4

If the treatment steps identified in Steps 1, 2 and 3 do not produce an effluent capable of meeting new effluent limits, Step 3 will be repeated with enough sample for further evaluation of proposed treatment technologies. This additional evaluation may include the use of additional chemicals or physical treatment processes. Until the evaluation of alternate treatment technologies and the development of preliminary effluent limits are completed, this step cannot be discussed in more detail. Prior to proceeding with any modifications to the pilot study, the proposed modifications will be presented to the

WDNR for review and concurrence. At this point in time, the raw water sample, the final effluent sample and a sample collected after additional treatment processes will be tested.

Step 5

The final step in the pilot scale evaluation will be to generate enough sample to complete an acute and chronic bioassay. The treatment process which generates an effluent with suitable chemical specific quality will be repeated to generate enough sample for the bioassays. For quality control purposes, the chemical specific parameters will be analyzed again on the raw water and fully treated sample.

Step 6

The solids generated from the lime/sulfide treatment process in Step 3 will be analyzed for the parameters listed in Table 4-21.

Table 4-21

Analytical Parameters for Pilot Study Solids
Crandon Mining Company NOI/SOS

Aluminum	Iron	Thallium
Antimony	Lead	Total Solids
Arsenic	Magnesium	Total Suspended Solids
Barium	Manganese	Zinc
Beryllium	Mercury	
Boron	Molybdenum	
Cadmium	Nickel	
Calcium	Phosphorus, total	
Chloride	Potassium	
Chromium, total	Selenium	
Copper	Silver	
Cyanide	Sodium	
Fluoride	Sulfur	

Parameters that were not evident in the raw water analyses may show up in the solids as treatment technology will concentrate metals in the solids. If the treatment process is altered, the pilot testing protocol will also be altered to mirror the full scale treatment processes. The procedures used and results obtained from the pilot study will be presented in a section in the wastewater treatment engineering report.

4.3.17.3.4 Stormwater

Stormwater control and management will be an important part of the site evaluation. Stormwater runoff can be classified into two areas: contact and non-contact stormwater. Contact stormwater will have the potential to carry elements which will require removal prior to discharge. Of particular concern for contact stormwater is the dissolved metal content. Contact stormwater will be handled either through the tailings management area or through the water treatment system for the mine drainage water. Stormwater which does not come in contact with materials which pose a threat to the environment will be handled through conventional sedimentation basins.

An engineering evaluation will be conducted to correctly size the containment and conveyance structures for all stormwater. The sedimentation ponds will be designed to comply with NR 213.

4.3.17.3.5 Ore Processing/Tailings Water

Ore processing will require the use of water for conveyance and the separation of materials. This water will be discharged to a tailings management area. At this structure, free water will flow back to a retention basin for sedimentation and storage prior to reuse. The ore processing system will be a net consumer of water, therefore water from this process will not require treatment. Through the evaluation of the water balance, if excess stormwater is identified which will require disposal through alternate means, this water will be treated in the mine wastewater treatment system. This potential will be evaluated under Section 4.3.17.3.1, Mine/Mill Water and Chemical Balances, and Section 4.3.17.3.2, Metals Removal Process Evaluation.

The development of a Mine/Mill Water and Chemical Balances identified in Section 4.3.17.3.1 will generate data for incorporation into an evaluation of options for the water reclaim system. The parameters that will impact this evaluation include both water demand characteristics and water generation rates. These issues will be evaluated on both a long and short term basis addressing areas such as peak and average hourly, daily and monthly demands for water as compared to the rate at which water is generated through the tailings disposal process. It is possible that during mine reclamation, tailings water will be treated and discharged from the mine wastewater treatment system. Treatment technologies suitable for this wastewater will be evaluated as a part of the final engineering report. The pilot studies listed under Section 4.3.17.3.3 will evaluate treatment of tailings water.

The engineering report will address the sizing and physical structure of the conveyance and containment system for compliance with NR 213.

4.3.17.3.6 Sanitary Wastewater

Sanitary wastewater will be generated at the mine and ore processing site. This water will require treatment and disposal. The alternative treatment systems which will be evaluated for the sanitary wastewater include; alternative mechanical treatment plant options, septic system with discharge to a soil seepage system, and stabilization lagoons. Treatment technologies will be in compliance with the appropriate Wisconsin Administrative Codes.

Alternative discharge locations will also be addressed including the possibility of water reuse in the ore process facility.

4.3.17.3.7 Intercepted Groundwater

The mine plan will incorporate measures to intercept groundwater before it enters the mine workings and comes in contact with materials which can cause contamination. This will be accomplished by installing groundwater drainage holes in the upper level mine entries as shown in Figure 3-7. Depending on the natural quality of this water, direct discharge or discharge following treatment are considerations which will be addressed in the engineering evaluation and presented in the final engineering report.

The groundwater quality from the approximate location of the intercept system will be documented as discussed in Section 4.3.7, Groundwater Characterization. Monitoring wells CMC 08, 09 and 10 will be used to evaluate the need for additional treatment. If necessary, the groundwater will be subjected to the pilot studies presented in Section 4.3.17.3.3.

4.3.17.3.8 Alternate Discharge Locations

Proposed discharge locations for the treated mine wastewater will be evaluated as a part of the engineering report. These will include discharge to Swamp Creek below Rice Lake, use of discharge wastewaters to mitigate potential surface water impacts, use of discharge water to mitigate potential groundwater drawdown impacts, discharge to absorption ponds, and other alternatives that might be indicated during the study period.

If the evaluation indicates that discharge to absorption ponds or the use of discharge wastewater to mitigate potential groundwater drawdown or surface water impacts are viable alternatives, soil studies will be conducted. The studies will involve the selection of discharge sites. At each site, approximately eight to 12 test pits will be dug by backhoe to a depth of 20-25 feet. The soil profile in the test pits will be logged and samples collected for laboratory analysis. A detailed work plan showing the proposed areas of investigation and the locations of test pits will be presented to WDNR prior to commencement of work. The work plan will include a summary of the known geology for each site and the methods by which the soils will be evaluated in the field and tested in the laboratory. Also, the work plan will identify the program to be implemented to characterize groundwater at the site(s) selected for the land application of wastewaters. The work plan will explain how the groundwater model will address inputs into the groundwater regime resulting from land application of wastewaters.

The findings of the alternative discharge locations evaluation will be presented in the engineering report.

4.3.17.3.9 Economic Evaluation

An economic evaluation of treatment options will be completed. This evaluation will address capital and operational cost considerations.

4.3.17.4 Data Presentation Format

An engineering report will be developed to allow for issuance of the necessary permits including a WPDES discharge permit. The report will contain the results of the various evaluations and pilot study work identified above. Data will be presented in tabular and graphic form within the report. Conceptual engineering drawings will be included to illustrate the significant features of the selected treatment systems. Prior to construction, final plans and specifications will be prepared for the wastewater treatment processes and submitted to the WDNR for approval.

4.3.17.5 Schedule for Data Collection

Portions of the water management evaluation will begin in February, 1994. Tailings will be generated through laboratory evaluation of collected ore samples. When the tailings samples are generated, the pilot studies for the wastewater treatment process will commence. It is anticipated the work involved with the water management portion of the project will take approximately one year to complete.

4.3.17.6 Key Project Personnel

Mr. Gerald J. Berg, of Foth & Van Dyke, will manage the surface water program. Mr. Berg has over 20 years experience in the areas of wastewater treatment and surface water studies. He has experience working with mine water and the lime/sulfide treatment process. He will be assisted by Mr. Philip Korth, P.E., and Mr. William West, also of Foth & Van Dyke. Mr. John E. Thresher, Jr. will also assist in the generation of water through the waste characterization portion of the study, and will conduct the soil survey and testing for the absorption ponds. Mr. Korth is a registered professional engineer with experience in the area of wastewater treatment system design. Mr. West is a limnologist and wastewater treatment specialist with over 16 years of experience in the areas of surface water studies, bioassays, industrial pretreatment, etc. Mr. Thresher is president of Thresher & Son, Inc. As a Ph.C. soil scientist, Mr. Thresher has been involved in soil investigations, soil absorption studies, waste characterization studies, etc. over his career.

4.3.18 Wetlands

4.3.18.1 Existing Data Summary and Evaluation

Existing Data Summary

Numerous wetland studies for the project were conducted in the 1980s and 1990s. A discussion of each, in chronological order, is presented below.

Normandeau Associates, Inc. and Interdisciplinary Environmental Planning, Inc. (IEP) (Normandeau, 1982a, 1982b, 1982c, 1982d and Interdisciplinary, 1983, CMC-NOI-160, CMC-NOI-161, CMC-NOI-162, CMC-NOI-163 and CMC-NOI-164, respectively) conducted an assessment of the wetlands existing within a 9.4 square mile area encompassing the mine/mill site, two alternative TMAs, the access road corridor, and the railroad spur corridor. This assessment mapped and evaluated the functional values of wetlands within the study area. Field studies inventoried and mapped 127 wetlands larger

than 0.25 acres. Semi-quantitative numerical evaluation models for wetland functions were developed based on information in NR 132 and the literature. Of the 127 inventoried wetlands in the study area, 46 were considered special interest wetlands because of their relationship to proposed project activities.

Quantitative studies of plant and wildlife communities were conducted in wetlands representative of the different types of special interest wetlands existing in the study area. Plant communities were sampled during the spring at three representative areas within each wetland type. Vegetation was sampled on points at fixed intervals along transects. Each plot was divided into three vertical strata (i.e., overstory, intermediate strata, herbaceous plants). A relative importance index was computed for each species in each strata.

Herptofauna, mammals, and avifauna were inventoried in representative wetlands. In general, the survey for reptiles and amphibians noted all individuals seen or heard during all phases of the field work from April to June 1981. Spotted salamanders were intensively sampled using pitfall traps and drift fences. Two representative areas of each wetland type were selected for bird census. Line transects and one listening station were established. All bird species seen or heard were recorded. As with the birds, two representative areas in each of the wetland types were trapped for small and medium-sized mammals. Captures in each area were summarized by species and expressed in numbers caught per 100 trap nights.

Wetlands in the study area were classified using the U.S. Fish and Wildlife Service national classification of wetlands and deepwater habitats. Wetlands were mapped at a scale of 1 inch = 400 feet by stereoscopic interpretation of 1976 to 1981 aerial photography. Wetland maps included: 1) the wetland/upland vegetative boundary; 2) vegetative subtypes; 3) topography; and 4) location of surface water interconnections. Each mapped wetland was visited during the field surveys. When discrepancies were noted, the aerial photography was stereoscopically reviewed in the field and corrections were made to the map.

A supplemental wetland evaluation of 31 additional wetlands using the same procedures as described above was conducted in 1983 (IEP) (Interdisciplinary, 1983, CMC-NOI-164). In total, the two assessments mapped and evaluated the functional values of 158 wetlands in a 12 square mile area. In 1992 Fugro McClelland, Inc. (CMC-NOI-165) mapped wetlands in the mine/mill and TMA areas that were less than 0.25 acre in size. These smaller sites have been added to the wetland inventory.

To determine the potential impact of the proposed mine on the inventoried wetlands, IEP (Interdisciplinary, 1982, CMC-NOI-166) conducted an analysis of the change in each wetland's hydrology. The primary purpose of this analysis was to predict the relative change in the water balance of perched and water table wetlands potentially caused by the proposed project. To accomplish this, the wetlands within the environmental study area were divided into "perched" wetlands and "water table" wetlands based on surficial geologic conditions at the site. Water table wetlands were assumed to be those wetlands associated with high permeability glaciofluvial sand and gravel and assumed to be connected to the main groundwater aquifer. These included wetlands T1 through T4, W1, W2, Z1 through Z19, and Z23 (Figure 1.0-2 [Interdisciplinary, 1983, CMC-NOI-164]). The remaining

wetlands were assumed to be perched, i.e., located in very low permeable glacial till or separated from the groundwater by an unsaturated zone.

A perched wetland water balance computer model (Interdisciplinary, 1982, CMC-NOI-166) was developed to evaluate inflow and outflow of water to these types of wetlands. Changes in Swamp Creek discharge and predicted groundwater drawdown values were used to evaluate the effects on water table wetlands.

Data Evaluation

All wetlands within the study area, including the mine/mill facility area, TMA and rail and roadway access areas, were mapped and the functional values were assessed in accordance with NR 132. Characteristics of the vegetation and wildlife communities were assessed. Potential impacts, driven by predicted changes in the wetland's water balance, were assessed. The previous wetland assessment and mapping studies as referenced above comprise a comprehensive wetland data base that is acceptable for use because it meets or exceeds current standards.

As described above, previous investigators grouped the wetlands within the environmental study area into perched wetlands and water table wetlands. A review of wetland maps, water table maps, and information regarding the surficial geology of the study area indicate that this classification system may be further refined to facilitate an updated assessment of the hydrologic impacts to the wetlands. Therefore, it is proposed that wetlands within the environmental study area be grouped into three classes based on their hydrogeologic setting: perched wetlands, seepage wetlands, and discharge wetlands. Perched wetlands are defined as those that are separated from the underlying aquifer by a confining layer or located within very low permeability substrates, resulting in a nearly complete separation from the water table aquifer. Drawdown affects associated with dewatering the mine will not have an impact on these wetlands and the previously used method of hydrologic impact analysis will be relied upon for future evaluations (Interdisciplinary, 1982, CMC-NOI-166).

Seepage wetlands will be defined as those that are underlain by a low permeability glacial till but are hydraulically connected with the water table aquifer. Although drawdown affects will likely be less than the predicted drawdown affects in the underlying aquifer, these impacts will be considered in evaluating the hydrologic impact to this class of wetland (see Section 4.3.8, Groundwater Modeling).

Discharge wetlands will be defined as those that are largely groundwater fed wetlands and exist primarily along Swamp Creek, Pickerel Creek, and the lower reaches of the associated tributary streams. The results of the hydrologic modeling (see Section 4.3.8, Groundwater Modeling) will be incorporated into the hydrologic impact analysis of these wetlands.

4.3.18.2 Data Requirements

No additional wetland assessments are required. The previously determined wetland boundary determinations will be verified to determine if they have changed over time. Additional data will be required to refine the definition of the hydrogeologic relationship between selected wetlands and the groundwater system to facilitate the grouping of the

wetlands existing within the environmental study area into one of the three classes described above.

4.3.18.3 Methodology

Wetland boundary verification will be accomplished through the comparison of November 1993 (i.e., leaf-off, no snow cover) and spring 1994 (to be acquired during early leaf emergence) color aerial photography with the existing wetland maps. Field verification will resolve any discrepancies noted. This effort will result in an update of wetland boundaries in the entire study area.

As described above, the hydrogeological modeling that will be conducted may result in an updated evaluation of impacts to water table wetlands. Data produced by the current proposed hydrogeologic modeling effort will provide input to the evaluation of impact to the seepage and discharge wetlands.

A field investigation program has been designed to confirm the hydrogeologic status of project wetlands. Hydrogeologic investigations in five wetlands representing each of the three wetland classes (i.e., perched, etc.) are described in detail in Section 4.3.7, Groundwater Characterization. Wetland F15, the Bur Oak Swamp (Interdisciplinary, 1983, CMC-NOI-164) will represent the perched class of wetlands because of its proximity to the proposed mine facility and its significance as a natural area. Wetlands associated with Duck Lake (Wetland F28) and Skunk Lake (Wetland F12) will represent the seepage wetlands because of their close proximity to the mine facility. Wetland O1, part of the Swamp Creek Cedars natural area, will also be included for additional hydrogeologic investigation. Wetland W1, along the Swamp Creek floodplain, will represent the discharge class of wetlands. A detailed description of the field methods is presented in Section 4.3.7, Groundwater Characterization. This field data will be used in combination with existing topographic and groundwater surface elevation data, boring logs, and other geologic information of the environmental study area to group wetlands into the three classes.

4.3.18.4 Data Presentation Format

Given the extent and completeness of existing work, it is not necessary to complete new wetland assessments. The Data presentation format for the wetland hydrologic data is presented in Section 4.3.7, Groundwater Characterization.

4.3.18.5 Schedule for Data Collection

The schedule for the proposed wetland hydrogeological studies is presented in Section 4.3.7, Groundwater Characterization. Verification of the wetland mapping will be conducted in early to mid-summer, 1994.

4.3.18.6 Key Project Personnel

Wetland evaluations will be conducted through the cooperative efforts of Foth & Van Dyke and Fugro McClelland, Inc. Tim Weyenberg and Ronald Steg will be

the key Foth & Van Dyke staff members, while Garrett Hollands will represent Fugro McClelland, Inc.

Mr. Weyenberg will serve as overall manager for the wetlands programs providing oversight and quality control. Mr. Weyenberg is a Certified Professional Ecologist with over 22 years of experience. He previously managed a similar program for the Kennecott Flambeau Project and has managed over 50 environmental report/impact statements for mines, power plants, water resource projects, wetland developments, etc.

Mr. Steg of Foth & Van Dyke will be responsible for the collection and evaluation of wetland data. Mr. Steg has 10 years experience conducting environmental studies relating to water resources, wetlands, mitigation, resource management alternative identification, noise, transportation and utility systems, etc.

Mr. Hollands is a senior geologist and Vice President of Fugro McClelland, Inc. He has extensive experience relating to wetland delineation, wetland studies and wetland mitigation.

5 NOI/SOS File Listing

Aesthetics

CMC-NOI-1 Schreiber/Anderson Associates, 1985. *Visual Impact Assessment.* (Entire Document)

Ambient Air Quality Monitoring

CMC-NOI-2 Dames & Moore, May, 1981. *Meteorology and Air Quality Study and Study Methods.* (Entire Document)

CMC-NOI-3 Chazin, Julian, November, 1980. Correspondence to Marie Stewart.

CMC-NOI-4 Rothblatt, Steve, June 23, 1986. Correspondence from USEPA to WDNR.

Archaeology

CMC-NOI-5 Salzer, Robert J. and Robert A. Birmingham, 1978. *Archaeological Research in the Potential Exxon Minerals Company USA Mining Area of Forest and Langlade Counties, Wisconsin.* (Entire Document)

CMC-NOI-6 Dexter, Richard W., February 28, 1980. Correspondence to Ms. Marie Stewart.

CMC-NOI-7 Great Lakes Archaeological Research Center, Inc., 1982a. *Archaeological Inventory and Evaluation of Exxon Minerals Company Crandon Project Site, in Forest and Langlade Counties, Wisconsin.* (Entire Document)

CMC-NOI-8 Great Lakes Archaeological Research Center, Inc., 1982b. *Archaeological Inventory and Evaluation of Exxon Minerals Company Crandon Project Site, in Forest and Langlade Counties, Wisconsin, Addendum - May 1982.* (Entire Document)

CMC-NOI-9 Great Lakes Archaeological Research Center, Inc., 1983. *Archaeological Inventory and Evaluation of Exxon Minerals Company Crandon Project Site, in Forest and Langlade Counties, Wisconsin, Addendum - June 1983.* (Entire Document)

CMC-NOI-10 Dexter, Richard W., May 1982. Correspondence to Robert H. Ramharter.

CMC-NOI-11 Green, William, July 1982. Correspondence to Robert H. Ramharter.

CMC-NOI-12 Foth & Van Dyke, January 4, 1994. Correspondence to the State Historical Society of Wisconsin.

CMC-NOI-13 Dexter, Richard W., January 19, 1994. Correspondence to Foth & Van Dyke.

Biology

CMC-NOI-14 Dames & Moore, 1981. *Terrestrial Ecology Study Baseline Conditions and Study Methods.* (Entire Document)

CMC-NOI-15 EMC, 1985a. *Environmental Impact Report*, Section 2.6. (Entire Section)

CMC-NOI-16 Dames & Moore, 1979. *A Survey of the Distribution and Relative Abundance of Spotted Salamanders in a Portion of Northern Wisconsin.* (Entire Document)

CMC-NOI-17 Dames & Moore, 1982. *Aquatic Ecology Study and Study Methods.* (Entire Document)

CMC-NOI-18 Dames & Moore, 1978. *Interim Phytoplankton and Zooplankton Data Report.* (Entire Document)

CMC-NOI-19 EMC, 1984a. *Density and Percent Occurrences of Drifting Macroinvertebrates Collection from Swamp Creek.* (Entire Document)

CMC-NOI-20 EMC, 1985b. *Environmental Impact Report*, Section 2.5 and Appendices. (Entire Section)

CMC-NOI-21 Ecological Analysts, Inc., 1983. *Aquatic Biology of Swamp Creek - Final Report.* (Entire Document)

CMC-NOI-22 EMC, 1984b. *Hemlock Creek Riffle/Habitat Survey.* (Entire Document)

CMC-NOI-23 EMC, 1985c. *Qualitative Habitat Surveys of 4 Streams in the Crandon Project Study Area.* (Entire Document)

CMC-NOI-24 EMC, 1985. *Qualitative Habitat Surveys of 4 Streams in the Crandon Project Study Area.* (Entire Document)

CMC-NOI-25 Dames & Moore, 1983. *Aquatic Ecology Sampling Stations.* (Entire Document)

Blasting, Vibration and Seismicity

CMC-NOI-26 EMC, 1985. *Supplemental Information on the Seismic Effects of Mine Blasting Practices.* (Entire Document)

Geology and Soils

CMC-NOI-27 STS Consultants, Ltd., 1984a. *Hydrogeologic Study Update for the Crandon Project.* Vol. I. (Entire Document)

CMC-NOI-28 STS Consultants, Ltd. 1984b. *Hydrogeologic Study Update for the Crandon Project.* Vol. II. (Entire Document)

CMC-NOI-29 BHP Minerals International, Inc., August, 1993. Letter from M.L. Nebel of BHP Minerals International, Inc. to K. Barrett of EMC Coal and Minerals Co.

Groundwater Characterization

CMC-NOI-27 STS Consultants, Ltd., 1984a. Hydrogeologic Study Update for the Crandon Project. Vol. I. (Entire Document)

CMC-NOI-28 STS Consultants, Ltd. 1984b. *Hydrogeologic Study Update for the Crandon Project*. Vol. II. (Entire Document)

CMC-NOI-30 Golder Associates, 1979. *Grain Size Distribution.* (Entire Document)

CMC-NOI-31 Golder Associates, 1981a. *Groundwater Potentiometric Contours, Crandon Project*. (Entire Document)

CMC-NOI-32 Golder Associates, 1981b. *Geotechnical Review, Crandon Project Waste Disposal System, Project Report 2.* (Volume 1, Entire Report, and Soil Test Data from Volume 2 with map)

CMC-NOI-33 Dames & Moore, 1982. *Groundwater Study and Study Methods*. (Entire Document)

CMC-NOI-34 Camp, Dresser & McKee, 1982a. *Mine Hydrology Test Data Analysis.* (Entire Document)

CMC-NOI-35 Camp, Dresser & McKee, 1982b. *Geophysical Logging and Interpretation.* (Entire Document)

CMC-NOI-36 Camp, Dresser & McKee, 1981a. *Sieve Analysis Curves.* (Entire Document)

CMC-NOI-37 Golder Associates, 1982a. *Geohydrologic Characterizations, Crandon Project*. (Entire Document)

CMC-NOI-38 Northern Lake Service, Inc., 1984. Private Water Well Survey. (Entire Document)

CMC-NOI-39 Rowe, Roger, 1984. *Bedrock Permeability.* (Entire Document).

CMC-NOI-40 STS Consultants, Ltd., 1984c. Field Boring Logs and Well Completion Data.

CMC-NOI-41 STS Consultants, Ltd., 1984d. Grain Size Analysis.

CMC-NOI-42 Camp, Dresser & McKee, 1981b. Geophysical Logs.

CMC-NOI-43 Not used.

CMC-NOI-44 Blair, Lewis N., January 1981. Correspondence to R.A. Landers, water analysis from Hole 213.

CMC-NOI-45 Blair, Lewis N., July 1981. Correspondence to R.A. Landers, laboratory analysis results from water samples from Hole 213.

CMC-NOI-46 STS Consultants, Ltd., 1984e. Boring Logs.

CMC-NOI-47 STS Consultants, Ltd., 1984f. Field Permeability Test Summary and Composite Gradation Curves.

CMC-NOI-48 Rastetter, David L., August - September 1979. Correspondence to Dr. Kenneth J. Stimpfl, water level measurements.

CMC-NOI-49 Grimes, J.E., December 1981. Correspondence to C.E. Fowler, piezometric surface elevations.

CMC-NOI-49 Kincaid, D.E., November 1981. Correspondence to J.E. Grimes, piezometer readings.

CMC-NOI-49 Kincaid, D.E., March 1982. Correspondence to C.C. Schroeder, piezometer readings.

CMC-NOI-49 Kincaid, D.E., January 1983, April 1983, July 1983, October 1983. Correspondence to C.C. Schroeder, piezometer readings.

CMC-NOI-49 Kincaid, D.E.. Correspondence to C.C. Schroeder, piezometer readings from 1/84 - 11/84 and 1/24-27/84.

CMC-NOI-49 Kincaid, D.E., 1985. Piezometer readings from 5/85 - 11/85.

CMC-NOI-49 Kincaid, D.E., 1986. Piezometer readings from 2/86 - 8/86.

CMC-NOI-49 Kincaid, D.E., 1986. Piezometer readings from 11/10/86.

CMC-NOI-50 Rowe, Roger G., July 1985. Correspondence to Nile Ostenso, WDNR, aquifer transmissivity with attachments.

CMC-NOI-51 STS Consultants, Ltd., 1984g. Single Well Hydraulic Conductivity Tests, Field Permeability Test Data and Composite Gradation Curves.

CMC-NOI-52 Krill, Robert M., May 1984. Correspondence Joe A. DeMarte, private water well survey with attachments.

CMC-NOI-53 Golder Associates, 1982b. Water Level Data.

CMC-NOI-54 Landers, R.A., January 1981. Correspondence to E.R. May, Crandon Mine hydrology-design of Phase 2 Tests.

CMC-NOI-55 Landers, R.A., January 1981. Correspondence to E.R. May, results of Crandon Phase 1 - mine hydrology tests.

CMC-NOI-56 STS Consultants, Ltd., 1982a. Slug Test.

CMC-NOI-57 Soil Testing Services of Wisconsin, Inc., March 1978 - January 1980. Grain Size Analyses and Boring Logs.

CMC-NOI-58 Camp, Dresser & McKee, December 1981. Grain Size Analyses.

CMC-NOI-59 STS Consultants, Ltd., 1984h. Field Boring Logs and Well Completion Data.

CMC-NOI-60 Kincaid, D.E. Water Level Elevations.

CMC-NOI-61 Kincaid, D.E. Weekly Lake Gage Reports.

CMC-NOI-62 Not used.

CMC-NOI-63 EMC, 1985a. *Environmental Impact Report*, Appendix 2.2B.

CMC-NOI-64 EMC, 1985b. *Environmental Impact Report*, Appendix 2.3A.

CMC-NOI-65 EMC, 1985c. *Environmental Impact Report*, Appendix 2.3E.

CMC-NOI-66 EMC, 1985d. *Environmental Impact Report*, Appendix 2.3F.

CMC-NOI-67 EMC, 1985e. *Environmental Impact Report*, Appendix 2.3G.

CMC-NOI-68 Not used.

CMC-NOI-69 STS Consultants, Ltd., 1985. Test Pit Logs and Soil Test Data.

CMC-NOI-70 EMC, 1985f. *Environmental Impact Report*, Appendix 2.3C.

CMC-NOI-71 EMC, 1985g. *Environmental Impact Report*, Appendix 2.3D.

CMC-NOI-72 STS Consultants, Ltd., 1982b. *Soil Boring and Laboratory Test Results of the Little Sand Lake Drilling Project.* (Entire Document)

CMC-NOI-73 STS Consultants, Ltd., 1984i. *Lake Sediment Sampling, Duck, Skunk, Oak, and Deep Hole Lakes.* (Entire Document)

CMC-NOI-74 STS Consultants, Ltd., 1986. *Duck Lake and Skunk Lake Wetland Installation.* (Entire Document)

CMC-NOI-75 Dames & Moore, 1985. *Hydraulic Relations Between Little Sand, Oak, Duck, Skunk, and Deep Hole Lakes and the Main Ground Water Aquifer.* (Entire Document)

CMC-NOI-135 Soil Testing Services of Wisconsin, Inc., 1978. *Subsurface Exploration and Laboratory Testing for Two Ventilation Shaft Sites at the Crandon Mine Project in Crandon, Wisconsin.* (Entire Document)

CMC-NOI-136 Soil Testing Services of Wisconsin, Inc., 1980. *Subsurface Exploration for the Proposed Surface Facilities and Access Shaft Collar Associated with the Prospecting Project at the Exxon Mine Development in Crandon, Wisconsin.* (Entire Document plus Addendum)

Groundwater Modeling

CMC-NOI-27 STS Consultants, Ltd., 1984a. *Hydrogeologic Study Update for the Crandon Project, Vol. I.* (Entire Document)

CMC-NOI-28 STS Consultants, Ltd., 1984b. *Hydrogeologic Study Update for the Crandon Project, Vol. II.* (Entire Document)

CMC-NOI-30 Golder Associates, 1979. *Grain Size Distribution.* (Entire Document)

CMC-NOI-34 Camp, Dresser & McKee, 1982a. *Mine Hydrology Test Data Analysis.* (Entire Document)

CMC-NOI-35 Camp, Dresser, & McKee, 1982b. *Geophysical Logging and Interpretation* (Entire Document)

CMC-NOI-36 Camp, Dresser & McKee, 1981a. *Sieve Analysis Curves.* (Entire Document)

CMC-NOI-37 Golder Associates, 1982a. *Geohydrologic Characterization, Crandon Project.* (Entire Document)

CMC-NOI-39	Rowe, 1984. *Bedrock Permeability*. (Entire Document)
CMC-NOI-63	EMC, 1985a. *Environmental Impact Report*, Appendix 2.2B. (Entire Appendix)
CMC-NOI-64	EMC, 1985b. *Environmental Impact Report*, Appendix 2.3A. (Entire Appendix)
CMC-NOI-65	EMC, 1985c. *Environmental Impact Report*, Appendix 2.3E. (Entire Appendix)
CMC-NOI-66	EMC, 1985d. *Environmental Impact Report*, Appendix 2.3F. (Entire Appendix)
CMC-NOI-72	STS Consultants, Ltd., 1982b. *Soil Boring and Laboratory Test Results of the Little Sand Lake Drilling Project.* (Entire Document)
CMC-NOI-73	STS Consultants, Ltd., 1984i. *Lake Sediment Sampling, Duck, Skunk, Oak, and Deep Hole Lakes.* (Entire Document)
CMC-NOI-74	STS Consultants, Ltd., 1986. *Duck Lake and Skunk Lake Wetland Installation.* (Entire Document)
CMC-NOI-75	Dames & Moore, 1985. *Hydraulic Relations Between Little Sand, Oak, Duck, Skunk, and Deep Hole Lakes and the Main Ground Water Aquifer.* (Entire Document)
CMC-NOI-76	EMC, 1985e. *Environmental Impact Report*, Appendix 2.4B. (Entire Appendix)
CMC-NOI-77	EMC, 1985f. *Environmental Impact Report*, Appendix 2.4C. (Entire Appendix)
CMC-NOI-78	EMC, 1985g. *Environmental Impact Report*, Appendix 2.2A. (Entire Appendix)
CMC-NOI-79	Rowe, April, 1985. *Deep Hanging Wall Fracturing Report.* (Entire Document)
CMC-NOI-80	Golder Associates, 1981. *Pump Test and Analyses*. (Entire Document)
CMC-NOI-81	Not used.
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Appendix A

Threatened and Endangered Species Investigations for the Proposed Crandon Project November 1993

(The following is the narrative from the above-referenced report. Appendices for this document are not reproduced here.)

Crandon Mining Company

Threatened and Endangered Species Investigations for the Proposed Crandon Project *Crandon, Wisconsin*

Scope ID: 93C049

Prepared by
Foth & Van Dyke and Associates Inc.

Under the Direction of

Tim Weyenberg

Ron Steg

Bill West

November 1993

Work Plan for Threatened and Endangered Species Investigations for the Proposed Crandon Project Crandon, Wisconsin

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Appendix

Appendix A Resumes

1 Introduction

Crandon Mining Company is interested in updating the existing database for the proposed Crandon Project in order to evaluate the project based on current information. One area of information that needs updating for the project study area is the occurrence and status of those unique biological communities and rare species that are identified on the Wisconsin Heritage Inventory working list as possibly occurring in the region.

It is the intent of this work plan to present the methodologies for updating the available information on the study area pertaining to the occurrence of these communities and species. It is the objective of these work plans to provide methodology that will allow the WDNR to accept the results as adequate under NR 132 should Crandon Mining Company issue a Notice of Intent for this project.

Individual work plans are presented for each of the following groups:

Terrestrial	**Aquatic**
Plants	Fish
Mammals	Aquatic Macroinvertebrates
Birds	Mussels
Amphibians and Reptiles	
Lepidoptera	

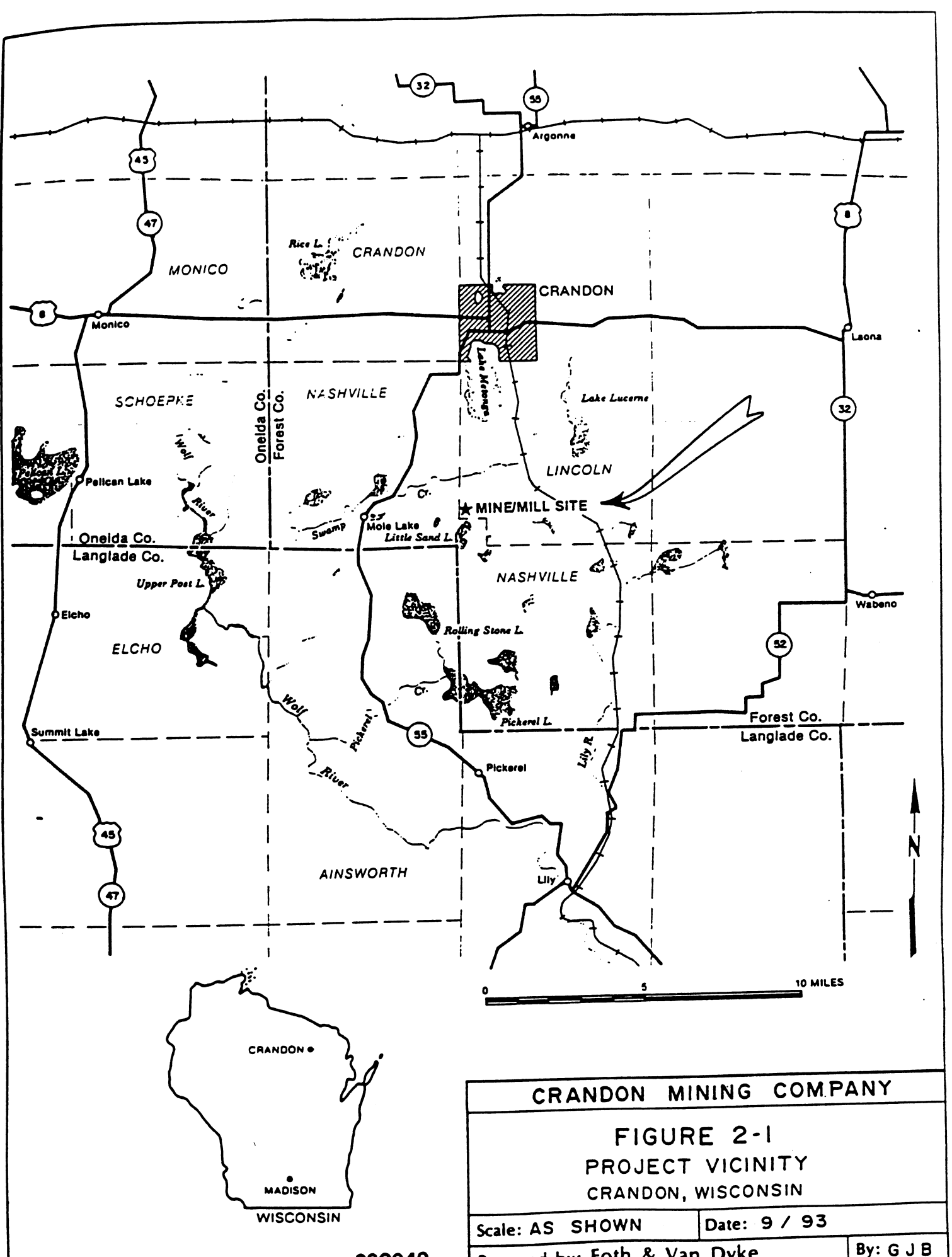
Separating the work plans by group will facilitate review and implementation.

2 Overview of Study Area

The site is located in Forest County, Wisconsin, approximately five miles south of Crandon (Figure 2-1). The mine site itself will occupy approximately 865 acres, including access roads, utility corridors, water discharge lines and the railroad spur corridor. Of this total, approximately 10% is wetlands, 85% is in various stages of northern hardwood forest succession, and the remaining 5% is agricultural or otherwise open land.

The primary surface water system in the area of the site is the Swamp Creek/Hemlock Creek system, which drains the eastern and northern portions of the site. A number of lakes and northern wetlands (Figure 2-2) occur on the project area, and the Pickerel Creek system drains the project area to the south. The actual studies will focus primarily on the 865 acre project site. However, habitats adjacent to the project site that may harbor populations of state or federally listed species that may rely on the project site, or potentially be affected by the proposed project, will also be included in the investigation. This larger area is referred to as the study area.

Field collections will be made under Scientific Collectors permits issued to Foth & Van Dyke's principal investigators by the WDNR. All conditions of these permits will be incorporated into the work plans once they are issued. Applications have been made to the WDNR for these permits.



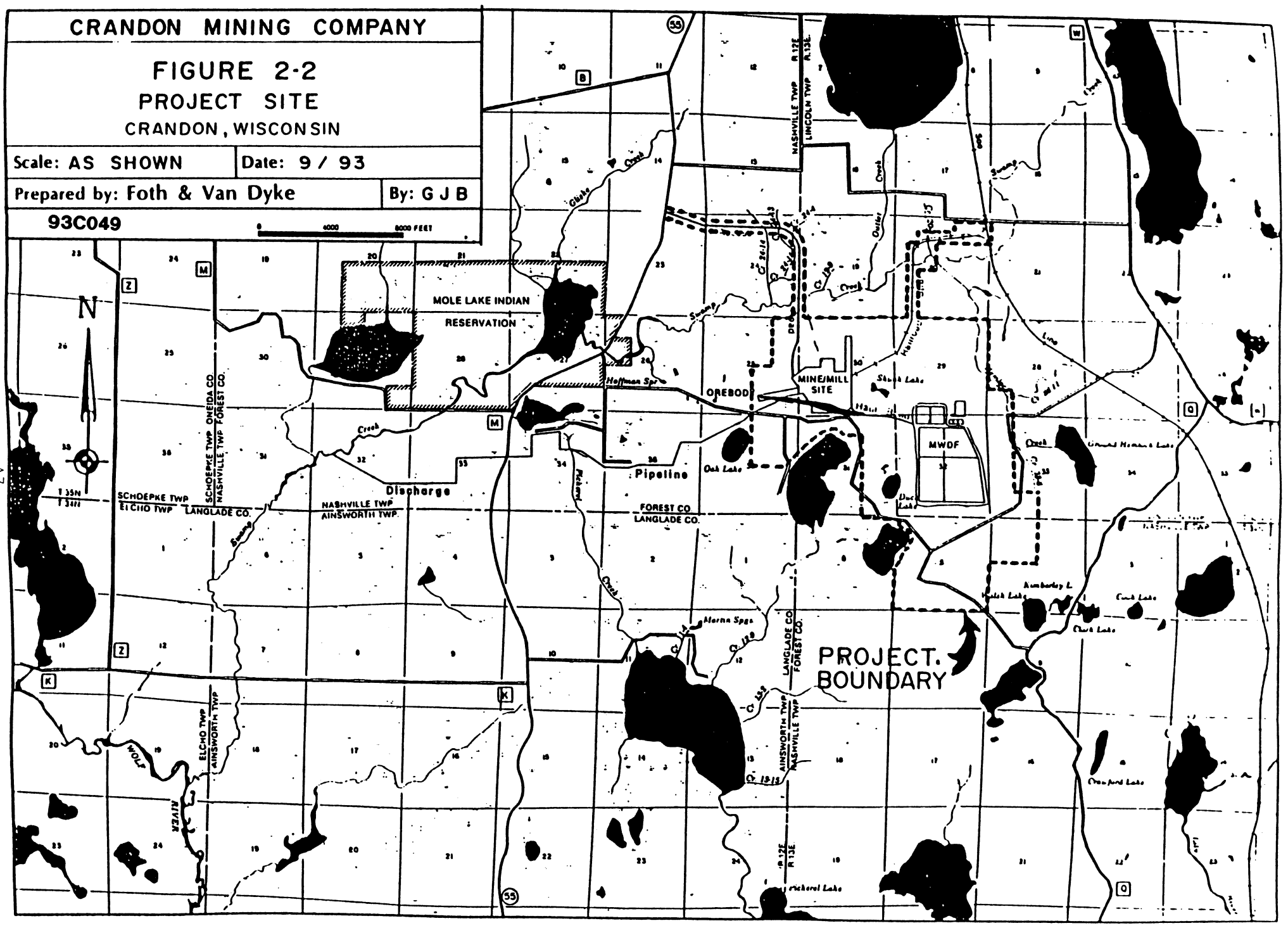
CRANDON MINING COMPANY		
FIGURE 2-1 PROJECT VICINITY CRANDON, WISCONSIN		
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FIGURE 2-2
PROJECT SITE
CRANDON, WISCONSIN

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3 General Comments

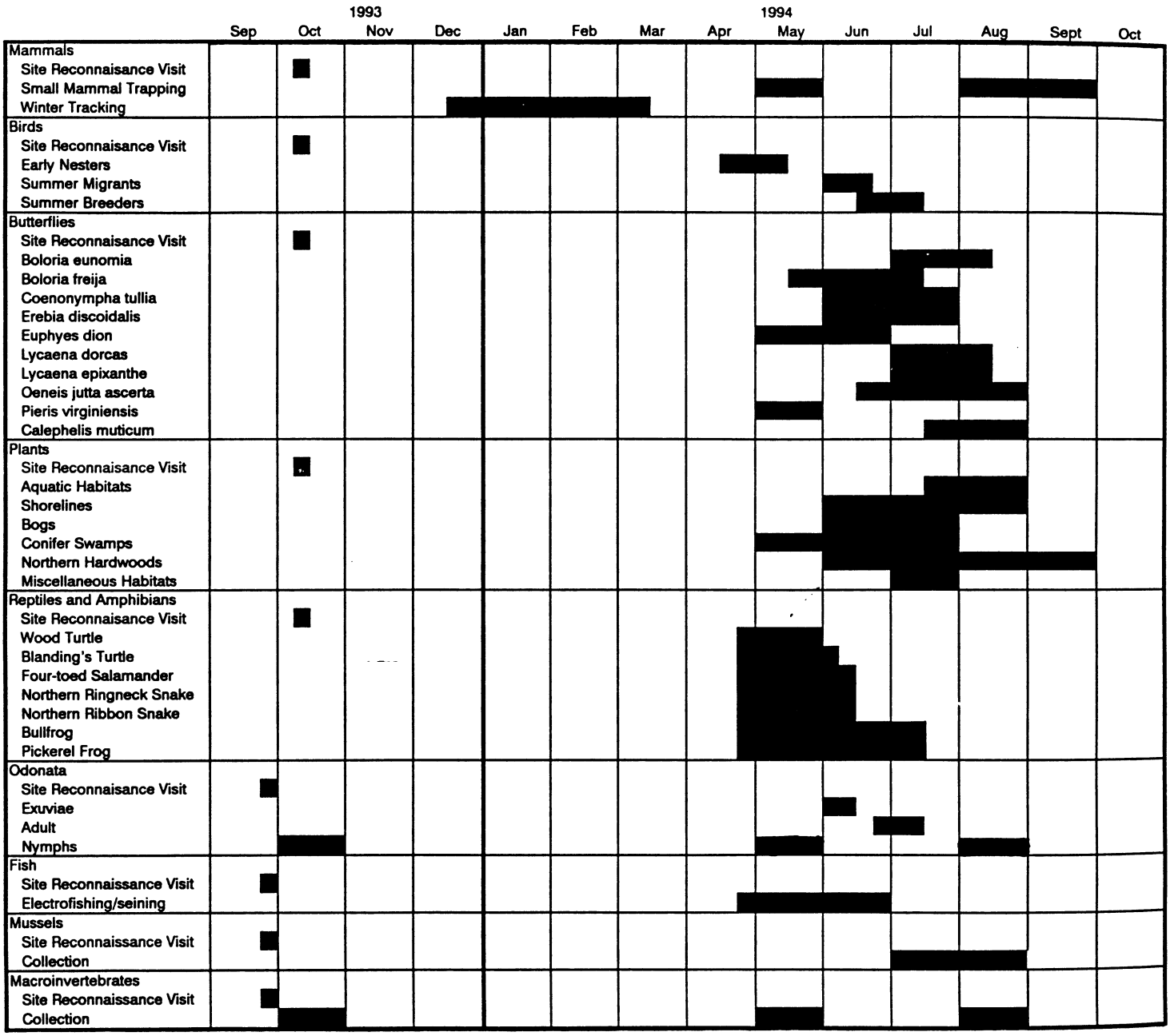
Each following work plan describes the specific objectives of the plan, presents a proposed methodology and schedule, and also provides other related, pertinent information. Specificity as to timing, sampling locations and methodologies varies among the individual plans, because the knowledge of study area's habitats and micro habitats and life history information for individual species or groupings varies. Foth & Van Dyke will be coordinating and managing this effort with the assistance of a team of specialists. Resumes for all of the key members are presented in Appendix A. A tentative work schedule is presented in Figure 3-1.

Figure 3-1

Crandon Mining Company

Threatened and Endangered Species Survey

Tentative Field Schedule



September 28, 1993 **93C049** Foth & Van Dyke

4 Introduction to Terrestrial Section of Work Plan

The terrestrial sections of the work plan address mammals, birds, amphibians and reptiles and lepidopterans. Other terrestrial invertebrates will be collected as part of the Odonata and amphibian/reptile investigations. A general habitat map is presented as Figure 4-1.

4.1 Work Plan for Mammals

4.1.1 Objective

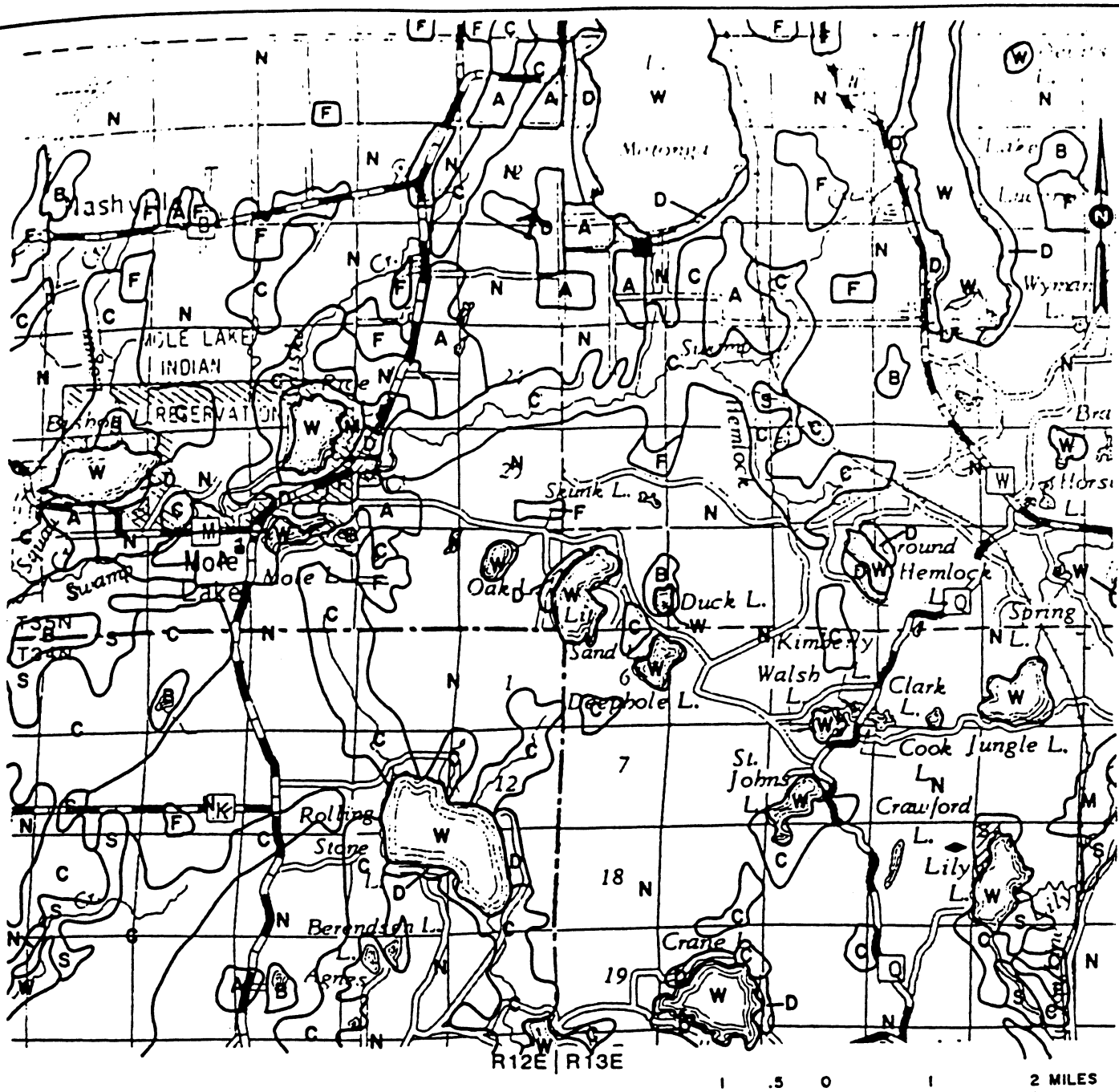
The objective of the work plan is aimed at documenting the status of rare mammal species in the vicinity of the Crandon Project site. Previous inventories by Dames and Moore, Inc. (1981) have documented at least 29 mammals species, including tracks of bobcats, a species identified as "special concern" by the Bureau of Endangered Resources of the WDNR. The goal will be to focus on species that were not adequately surveyed by the previous work and to document areas of concentration (if any exist) of bobcat and pine marten, while relying on existing information about the occurrence or absence of timber wolf from this area.

4.1.2 Target Species

Target Species	Common Name	Wisconsin Status
Canis lupus	Timber Wolf	Endangered
Lynx canadensis	Lynx	Endangered
Lynx rufus	Bobcat	Rule
Martes americana	Pine Marten	Endangered
Pitymys pinetorum	Northern Pine Mouse	Special Concern
Sorex arcticus	Arctic Shrew	Special Concern
Sorex hoyi	Thompson's Pygmy Shrew	Special Concern
Sorex palustris	Water Shrew	None
Napaeozapus insignis	Woodland Jumping Mouse	None

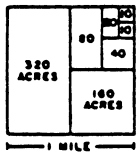
4.1.3 Methods

Other sources, particularly the WDNR, will be utilized for up-to-date information about gray wolves in the study area. Tracking surveys will be carried out during winter 1993-1994 to identify areas of use by bobcat and marten/fisher. Approximately ten miles of drivable roads are distributed throughout the potential impact area. Tracking samples will consist of fixed-length (0.5 km) transects located in selected habitats within or near the potential impact area (Figure 4-2), primarily, but not exclusively, along accessible roads and trails. The tracking surveys will be conducted within one to two days of fresh snowfalls during the period between December 15 and March 15. Trackers will use metric "hip-chains" to standardize transect length. Observers will record all significant mammal tracks as well as notable tracks along trails en route to the



KEY:

N	NORTHERN HARDWOOD (INCLUDING ASPEN/BIRCH)
C	SWAMP CONIFER
S	SHRUB SWAMP
B	BOG
M	MARSH
D	URBAN OR DEVELOPED
F	OLD FIELD AND CLEARCUT
A	AGRICULTURE
W	WATER



NOTE: MINIMUM SIZE DELINEATED IS 16.2 HECTARES (40 ACRES)

BASE MAP REFERENCE: WISCONSIN DEPARTMENT OF TRANSPORTATION, JANUARY, 1978. FOREST CO. AND LANGLADE CO. HIGHWAY MAPS.

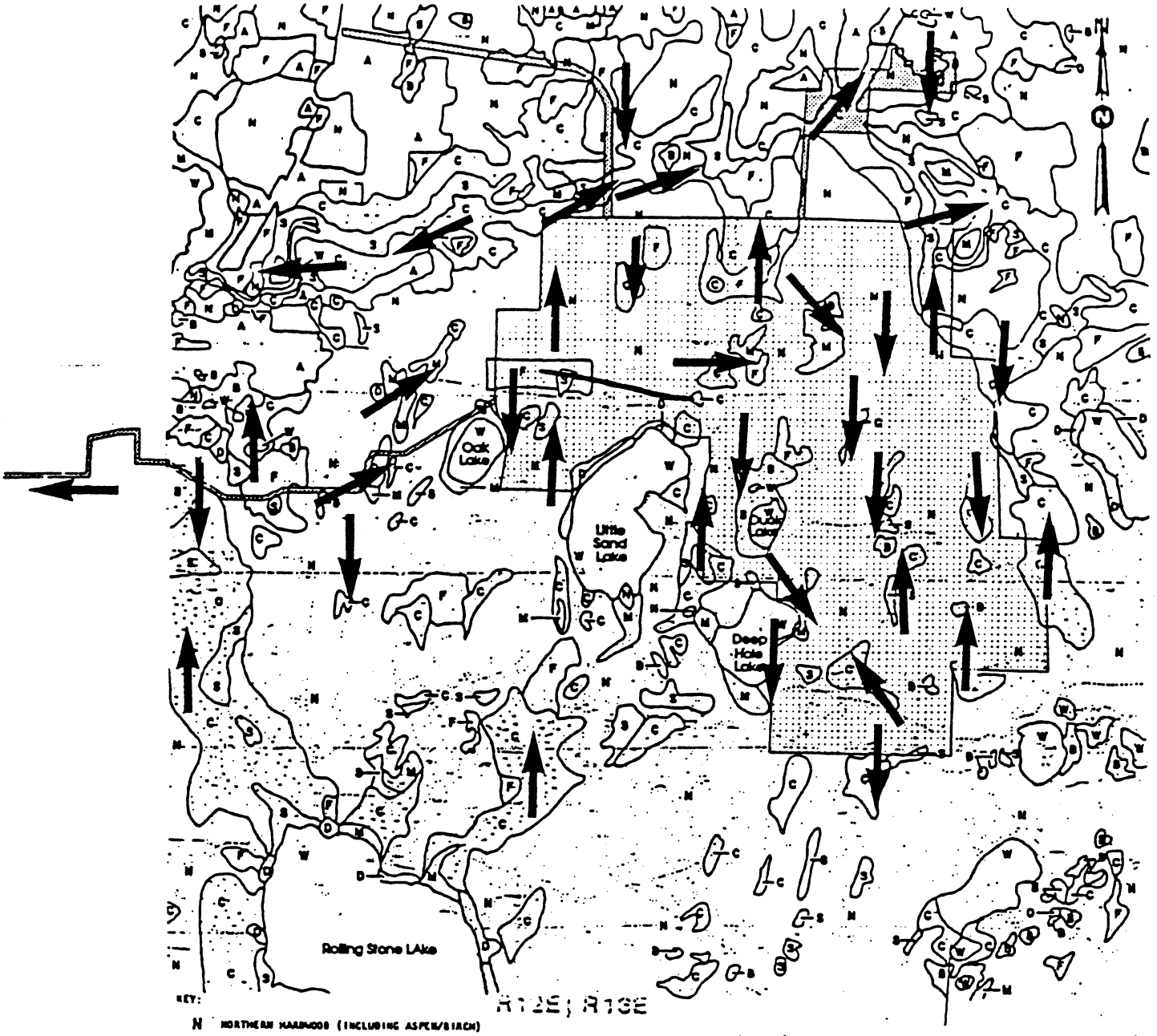
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FIGURE 4-1
VEGETATION OF THE ENVIRONMENTAL STUDY AREA

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Tentative distribution of 30 mammal tracking routes at the Exxon mine site near Crandon, WI. Each route will be sampled once shortly after snowfall during the period December 15 - March 15. An additional 10 routes will be established later along roads and trails. Routes cover all major habitats but emphasize lowland conifers, where bobcats are most likely to occur.



NOTE:
MINIMUM TYPE SIZE DELINEATED IS APPROXIMATELY 4 HECTARES (10 ACRES) EXCEPT FOR WETLANDS WHICH ARE DELINEATED TO APPROXIMATELY 1 HECTARE (2.5 ACRES).

BASE MAP REFERENCE:
PORTIONS OF THE FOLLOWING U.S.G.S. 7.5 MINUTE SERIES: CRANDON, WISCONSIN, 1965; LAKE LUCERNE, WISCONSIN, 1973; AND ROBERTS LAKE, WISCONSIN, 1973.

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FIGURE 4-2

PROPOSED
MAMMAL TRACKING ROUTES

Scale: AS SHOWN	Date: 9 / 93
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appointed transect areas. The systematic sampling scheme will allow us to identify critical areas that may be important for protection during construction and design of roads and other facilities.

The tracking surveys may be supplemented by live trapping for pine marten if the tracking surveys indicate areas of marten activity. John Gilbert of the Great Lakes Indian Fish and Wildlife Commission and the WDNR will be consulted to implement trapping methods that are the most effective for verifying the presence or absence of pine marten activity.

Depending upon the level of pine marten activity indicated by the tracking effort, a maximum of 30 to 40 live traps will be monitored for mid-size carnivores. We propose to monitor each trap for 10 days for a total of 300 to 400 trap nights. Martens and fishers that are collected will be marked with a non-toxic paint or dye and released near the trap site.

The second emphasis of the mammal survey will be the monitoring of pitfall traps for rare shrews (*Sorex hoyi* and *S. articus*) and *Microtus (Pitymys) pinetorum*, "special concern" species whose Wisconsin status is poorly known. Trap units will consist of 8 pitfall traps (sunken "coffee can" containers filled with approximately 2 cm of water) along a 10 m (long) x 0.5 m (high) "drift fence" of aluminum flashing. If time permits, additional traps will be placed in the vicinity of the drift fence. Trap units will be established in all habitats and monitored for a one week period during August, September, October, November, if weather permits, and possibly May of 1994. After one week, the materials will be moved to another location. Pitfall traps are known to be effective for shrews and semi-fossorial rodents like *P. pinetorum*. In addition, they also will capture terrestrial arthropods (especially beetles), amphibians, and reptiles which may be of interest in the biological assessment.

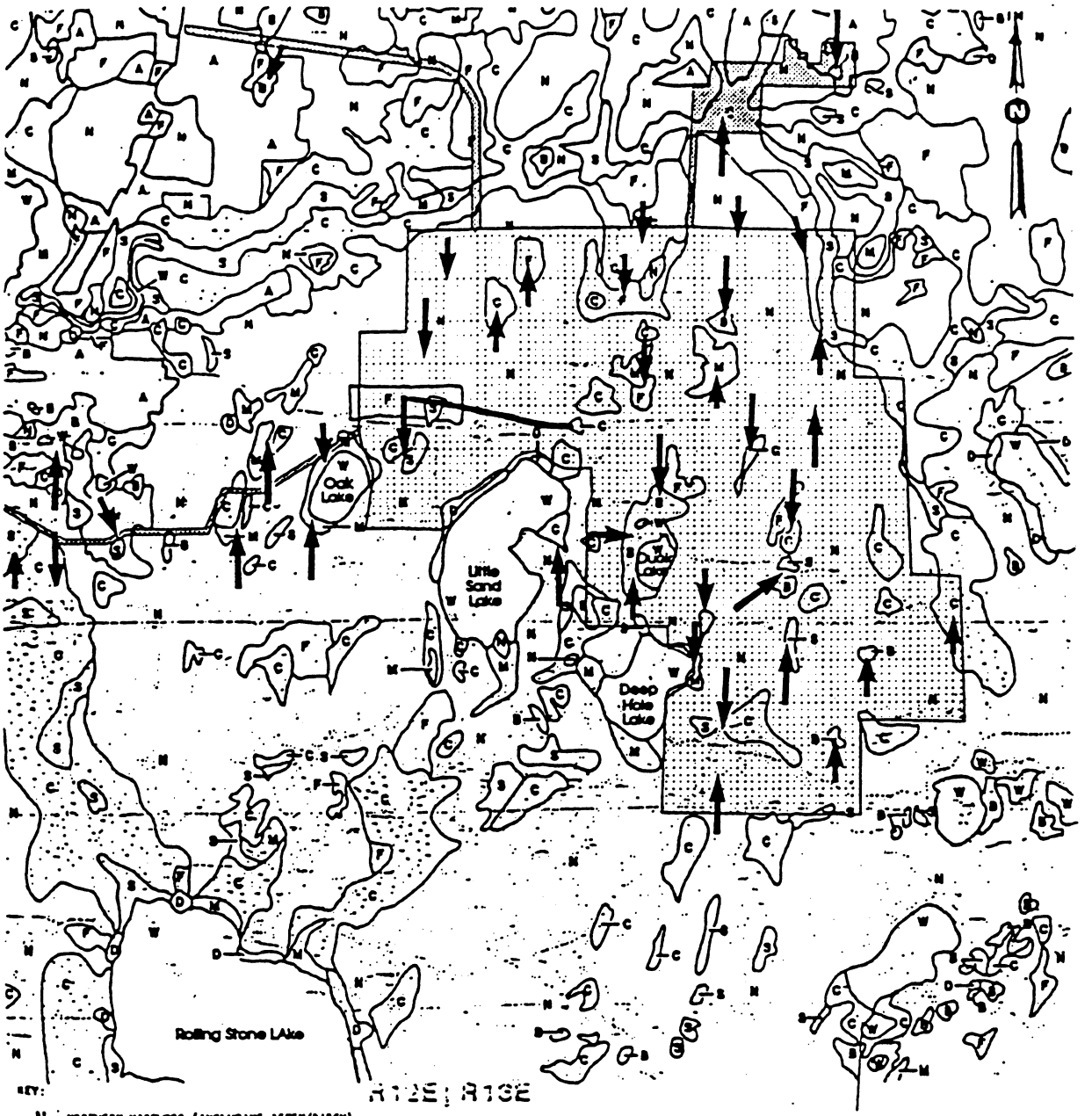
At least 40 trap units will be established (five at any given time) covering all major habitat types, but with an emphasis on bogs, conifer swamps and other special habitats (Figure 4-3). One crew of two field workers will work full time establishing new field trap units (approximately one per day), while another observer will monitor the five operating units daily.

In addition, two trapping sites each will be selected for the water shrew and the woodland jumping mouse. One site will be selected within, or adjacent to, the proposed mine/mill facility boundaries, and one within, or adjacent to, the mine waste disposal facility boundaries. For the woodland jumping mouse, the focus will be on old growth hemlock or pine forest, hemlock/pine/hardwood transitional forest, or old growth hardwood forest. The focus for the water shrew will be along water courses in the area. Museum Special or live traps will be utilized, setting approximately 100 traps per site for a ten day period in August, September, or possibly May, 1994.

4.1.4 Disposition of Specimens

All specimens will be deposited in the Richter Natural History Museum of the University of Wisconsin-Green Bay, where reference materials are available for identification of all target mammals. Skulls of all shrews (and whole specimens, where possible) will be preserved for the purpose of documentation.

Tentative distribution of 40 pitfall trap units designed to capture shrews and terrestrial invertebrates. Each trap unit will consist of a 10 m drift fence with 4 pitfall traps located along each side. Additional pitfall traps and snap traps will be placed in the same vicinity. Traps will be monitored for one week, after which the materials will be moved to a new location. All major habitats are covered, but efforts are focused on ecotones and wet habitats such as bogs, lowland conifer forest, and riparian corridors.



NOTE:
MINIMUM TYPE SIZE DELINEATED IS APPROXIMATELY 4 HECTARES (10 ACRES) EXCEPT FOR WETLANDS WHICH ARE DELINEATED TO APPROXIMATELY 1 HECTARE (2.5 ACRES).

BASE MAP REFERENCE:
PORTIONS OF THE FOLLOWING U.S.G.S. 7.5 MINUTE SERIES: CRANDON, WISCONSIN, 1965; LAKE LUCERNE, WISCONSIN, 1973; AND ROBERTS LAKE, WISCONSIN, 1973.

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FIGURE 4-3
PROPOSED
MAMMAL TRAP SITES

Scale: AS SHOWN | Date: 9 / 93

Prepared by: Foth & Van Dyke | By: G J B

4.1.5 Habitat Assessment

Vegetation in the vicinity of each track transect and trap line will be described by visual estimates of percent cover by major canopy trees, understory trees and shrubs. Other simple estimates of percent canopy cover, average canopy tree diameter and percent shrub cover will further characterize the point, while sacrificing little time and effort.

4.1.6 Personnel and Schedule

Tracking surveys will commence as soon as snow conditions dictate during winter 1993-1994. Field workers will consist of experienced undergraduates and graduate students at UWGB, including Andrew Zovnic, James Broetzman, Joel Whitehouse, Steve Petzke, Denise Friedrick, Brian Henrickson, Dan Goltz, Lynn White, and perhaps several others. All of these students have taken a course in mammalogy and have considerable field experience. Field work will attempt to be completed at times of excellent snow conditions; hence, a large number of observers will permit the coverage of many transects during these periods.

Pitfall traps will be established and monitored by these same workers. This work will involve more extended periods of field work, and the bulk of the work effort is expected to take place during this time. Field work will be designed and supervised by Dr. Robert Howe and Thomas Erdman.

4.1.7 Quality Assurance

Selection of trained wildlife biologists to participate in the effort will assure proper site selection and identification. Voucher specimens and other documentation will be provided to the WDNR for further verification. Field events will be scheduled and the WDNR advised well enough ahead of time such that the WDNR personnel will be able to participate as they wish.

4.2 Work Plan for Birds

4.2.1 Objective

The objective of the work plan is aimed at documenting the status of rare bird species in the vicinity of the Crandon Project site. Previous inventories by Dames and Moore, Inc. (1981) have documented the general character of the site's avifauna; our purpose will be to search more specifically for species that are legally protected and species that have been identified on the working list by the Bureau of Endangered Resources of the WDNR. Since the Dames and Moore survey, new species have been added to the state working list, and broader concerns about the decline of neotropical migrant songbirds (e.g., Terborgh, 1990) and the effects of global warming (reference) justify a new evaluation of bird species which might be affected by the mining operations.

4.2.2 Target Species

Target Species	Common Name	Wisconsin Status
*Accipiter gentilis**	Northern Goshawk	Rule
Ammodramus leconteii	LeConte's Sparrow	Rule
Anas rubripes	American Black Duck	Rule
*Asio otus**	Long-eared Owl	Rule
Botaurus lentiginosus	American Bittern	Rule
Bucephala clangula	Common Goldeneye	Rule
*Buteo lineatus**	Red-shouldered Hawk	Threatened
Carduelis pinus	Pine Siskin	Rule
Catharus ustulatus	Swainson's Thrush	Rule
Chlidonias niger	Black Tern	Rule
Circus cyaneus	Northern Harrier	Rule
Cistothorus platensis	Sedge Wren	Rule
Coccoth vespertinus	Evening Grosbeak	Rule
*Coturn noveboracensis**	Yellow Rail	Rule
Dendragapus canadensis	Spruce Grouse	Rule
Dendroica cerulea	Cerulean Warbler	Threatened
Dendroica fusca	Blackburnian Warbler	Rule
*Dendroica tigrina**	Cape May Warbler	Rule
Empidonax flaviventris	Yellow-belly Flycatcher	Rule
Falco columbarius	Merlin	Rule
Haliaeetus leucocephalus	Bald Eagle	Threatened
Nycticorax nycticorax	Black-crowned Night Heron	Rule
*Oporornis agilis**	Connecticut Warbler	Rule
Pandion haliaetus	Osprey	Threatened
*Parus hudsonicus**	Boreal Chickadee	Rule
Perisoreus canadensis	Gray Jay	Rule
Picoides arcticus	Black-backed Woodpecker	Rule
*Protonotaria citrea**	Prothonotary Warbler	Rule
Regulus calendula	Ruby-crowned Kinglet	Rule

Target Species	Common Name	Wisconsin Status
Sterna forsteri	Forster's Tern	Endangered
*Strix nebulosa**	Great Gray Owl	Rule
Vermivora peregrina	Tennessee Warbler	Rule

* Searches for these species will be augmented by playback recordings.

In addition to the birds listed, the work plan also includes searching for and documenting records of several other uncommon or declining species like common and red-breasted mergansers and lesser scaup (listed as species of concern by the WDNR), Canada and golden-winged warblers (considered to be declining on a global scale). Also, for goshawks and red-shouldered hawks, the study area will be surveyed for sticknests and perching posts during leaf-off conditions in late April and early May. Note that no special effort is designed to search for bald eagles and osprey, as monitoring reports already available from the WDNR will be used.

4.2.3 Methods

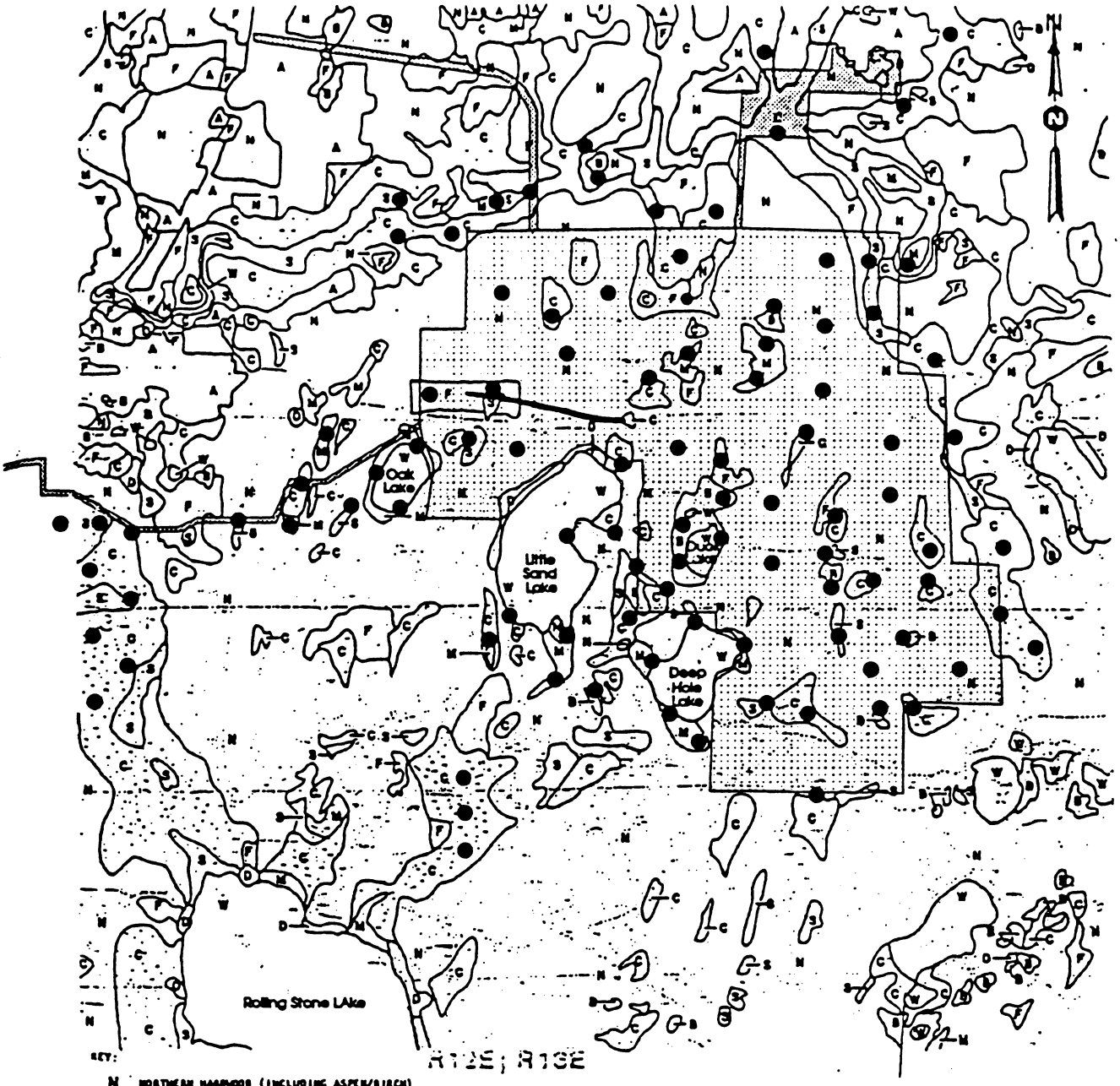
Because so many bird species are listed on the Heritage Inventory "working list", we propose to conduct bird surveys throughout the area that will be affected by mining operations. Even some species (e.g., Canadian warbler) that are not currently listed are likely to be given more attention in the future if populations continue to decline (James 1993). Our sampling scheme will provide quantitative data on all species.

Primary sampling units will consist of five-minute stationary point counts (Ralph, et al. *in press*) distributed approximately 1,200 feet apart along linear transects, themselves 1,200 feet apart. Point counts are desirable because they are quantitative, repeatable and comparable to numerous other studies of bird populations in the Great Lakes Region (e.g., Neimi, et al. 1991, Howe, et al, *in press*). Records of birds observed between census points contribute further to the search for rare species localities. Approximately 100 points will be sampled in the study area (Figure 4-4). Each point will be visited three times: 1) in late April and early May for early nesters such as northern goshawk, spruce grouse and black-backed woodpecker; 2) in early June for summer migrants, such as Cerulean warbler, Blackburnian warbler, Cape May warbler, and others; and 3) late June or early July to verify breeding status of summer breeders.

Sample points will be located independently of habitat type in order to provide a comprehensive survey of the study area, and to incorporate ecotonal or transitional habitats that might be important for species like Connecticut warbler, ruby-crowned kinglet and northern harrier. Count points will be conducted between first light (¼ - ½ hour before sunrise) and approximately 10:00 a.m.

In addition to point surveys, custom-made playback recordings will be used to attract target species in selected habitat types (see 4.2.2). A digitalized compact disc recording of birds in the Nicolet National Forest has been prepared by the Cornell Laboratory of Ornithology, and is available to make custom-made sequences of target bird studies at the Crandon Project site. We will use the recordings additionally to verify detections of rare species at the systematic survey

Tentative distribution of 100 sampling points for target bird species at the Exxon mine site near Crandon, WI. Each point will be sampled three times, once during early spring and twice during summer. Configuration of points is designed to emphasize habitats where target species are most likely to occur. For example, 39 of the 100 points are located within or adjacent to lowland conifers, where boreal species such as Spruce Grouse, Gray Jay, Boreal Chickadee, Great Gray Owl, and others are most likely to occur. Base map is taken from an environmental assessment of this site by Dames and Moore (1981).



NOTE:
MINIMUM TYPE SIZE DELINEATED IS APPROXIMATELY 4 HECTARES (10 ACRES) EXCEPT FOR WETLANDS WHICH ARE DELINEATED TO APPROXIMATELY 1 HECTARE (2.5 ACRES).

BASE MAP REFERENCE:
PORTIONS OF THE FOLLOWING U.S.G.S. 7.5 MINUTE SERIES: CRANDON, WISCONSIN, 1965; LAKE LUCERNE, WISCONSIN, 1973; AND ROBERTS LAKE, WISCONSIN, 1973.

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FIGURE 4-4

PROPOSED SAMPLING POINTS FOR TARGET BIRD SPECIES

Scale: AS SHOWN	Date: 9 / 93
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points. Tape recordings will be played at all times of the day, although owl calls will be played during evening and night hours. After playing the recording, the observer will wait at least five minutes to listen for responses.

An observer skilled at orienteering can cover at least four points each morning during summer (although fewer might be possible in deep conifer swamps). Approximately two points per day will be covered during spring. Point counts will be followed by playback recordings aimed at attracting individual target species (e.g., northern goshawk, Cerulean warbler). The search for target species also will involve careful observations between census points for signs, such as the characteristic "bark-peeling" of black-backed woodpecker, nests, and raptor pellets or prey remains.

A significant fraction of the sites will be established at special sites of interest, such as the edges of lakes, wetlands and watercourses. These special survey points (Figure 4-4) will help ensure that areas sensitive or target habitats are adequately covered. The larger wetlands and lakes will be sampled by canoe whenever possible.

4.2.4 Habitat Assessment

The vegetation at each sampling point will be described by visual estimates of percent cover by major canopy trees, understory trees, and shrubs. Other simple estimates of percent canopy cover, average canopy cover tree diameter, and percent shrub cover will further characterize the point, while sacrificing little time and effort. These results, when coupled with the bird census data, will improve predictions about the consequences of mining operations on the local avifauna. Site-specific consequence of the extensive bird point surveys is the fact that observers will systematically traverse virtually the entire area of impact. The presence of more "eyes and ears" will help improve the odds of seeing uncommon and inconspicuous species of their taxonomic groups.

4.2.5 Personnel

Point counts and playback recordings will be carried out by Thomas Erdman, Associate Curator of the Richter Museum of Natural History, Andrew Zovnic, a master's degree candidate at UWGB, and Dr. Robert Howe, Professor at UWGB. Each of these individuals are trained ornithologists who have extensive experience with northern Wisconsin birds. Others, including Steve Petzke, a graduate student working on the effects of gypsy moths on bird populations, and Dan Goltz, part of Howe's field team working on birds of old-growth forest in northern Wisconsin, may be involved with parts of the bird inventory. Dr. Howe will oversee the project and, along with Thomas Erdman, will help verify significant field records by visiting points where target species were observed.

4.2.6 Quality Assurance

Selection of trained wildlife biologist to participate in the effort will assure proper site selection and identification. Documentation and field notes will be provided to the WDNR for further verification. Field events will be schedule and the WDNR advised well enough ahead of time such that the WDNR personnel will be able to participate as they wish.

4.3 Work Plan for Amphibians and Reptiles

4.3.1 Objective

The objective of the work plan is to provide documentation regarding the presence and/or status of reptiles and amphibians that are included in the Heritage Inventory working list in the area of the Crandon Project. Survey methods for reptiles and amphibians are never 100 percent reliable, due to technical difficulties in finding animals that remain inactive for long periods of time and spend much of the year hiding underground. Further, survey methods are often only conclusive if species are found (i.e., negative results may mean that the species are absent, or that they did not turn up with the survey methods employed). This plan proposes an approach designed to make a reasonable effort to find species if they are present and provide sufficient documentation of study methods and findings to interpret negative results.

This plan will likely evolve and change as it is implemented. For example, if target species are found, subsequent surveys may be reduced in scope, as it may be possible to extrapolate from sites where species were actually observed to surrounding habitat based on habitat quality.

4.3.2 Target Species

Target Species	Common Name	Wisconsin Status
Clemmys insculpta	Wood Turtle	Threatened
Emydoidia blandingii	Blanding's Turtle	Threatened
Diadophis punctatus edwardsii	Northern Ringneck Snake	Special Concern
Thamnophis sauritus	Northern Ribbon Snake	Endangered
Rana catesbeiana	Bullfrog	Rule
Rana palustris	Pickerel Frog	Special Concern
Hemidactylium scutatum	Four-toed Salamander	Proposed State Special Concern

4.3.3 Study Area

The primary study area for amphibians and reptiles is the project area which could potentially be physically altered as a result of the proposed mining activities. However, certain peripheral areas in Forest and Langlade Counties, Wisconsin are potentially affected by the project, and are included for study in this plan. A site location map is presented in Figure 4-3. Initial sampling locations are discussed in the following section.

4.3.4 Methods and Schedule

Target species specific survey methods and observation/collection schedules are presented in the following paragraphs. As reptile and amphibian activity is very seasonal and can be affected by unusual weather conditions, time "windows" are provided herein rather than specific survey dates.

Wood Turtle - Wood turtles are typically found in streams in wooded areas and fields adjacent to streams in summer. They are mostly terrestrial in summer and hibernate in banks or bottoms of streams in winter. Nest sites are in open, sunny areas in well drained, sandy or gravelly soil.

Surveys will include walking/canoeing appropriate streams in late April and May when the turtles are likely to be concentrated in these habitats and investigation of potential nesting sites. Potential nesting sites will be sought within approximately 200 yards of streams within the primary study area during fall 1993 site reconnaissance visits. Identified potential sites will be visited in the spring during the nesting period (mid-June) to look for predated nest sites and/or egg remains. Where predation and/or egg remains are evidenced, surveys will be conducted at least three times in the evening hours during peak nesting period in an attempt to conclusively identify the nesting species. For the purpose of this work plan, it is assumed that the following streams within the study area will be surveyed (Figure 4-5):

Wolf River - approximately 1.5 miles upstream and downstream of the confluence with Swamp Creek.

Swamp Creek - from approximately 0.5 miles upstream of SOO Line Railroad to its confluence with the Wolf River.

Squaw Creek - from Bishop Lake to confluence with Swamp Creek.

Outlet Creek - from Lake Metonga to its confluence with Swamp Creek.

Hemlock Creek - from Ground Hemlock Lake to its confluence with Swamp Creek.

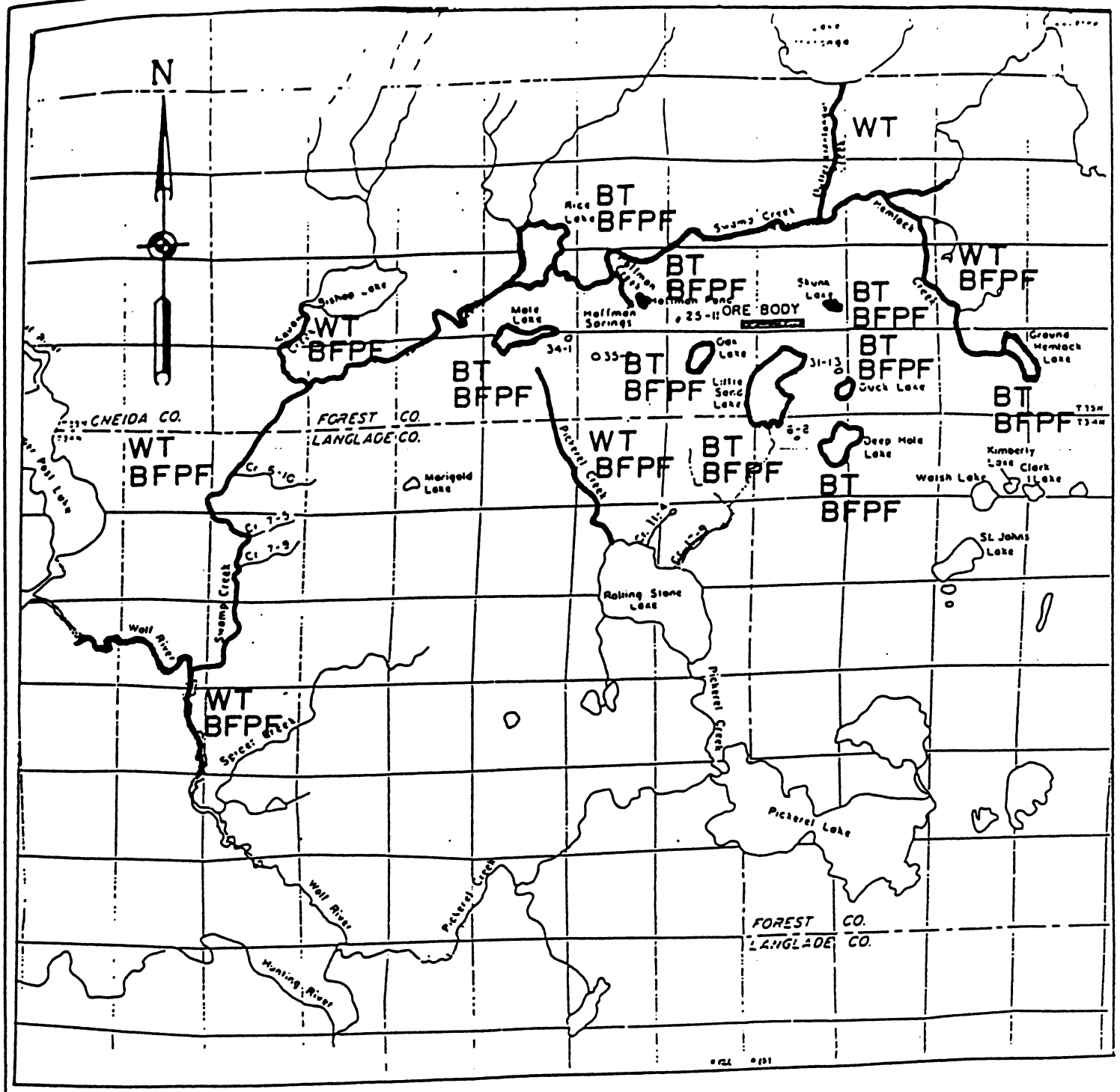
Pickerel Creek - entire stream upstream of Rolling Stone Lake.

Additionally, some waters bordering the study area may be included for wood turtle surveys if records exist for them, or if potential nesting or feeding areas on-site may attract turtles into the study area.

Blanding's Turtle - Blanding's turtles prefer marshes, ponds, swamps, bogs, lake shallows, and slow moving rivers with soft bottoms and aquatic vegetation. These turtles are sometimes observed basking on sunny days and occasionally leave water and move overland, particularly during the nesting season and response to rains. They overwinter in mud or debris at the bottom of waterbodies.

Wetlands and shallow open water areas associated with the following lakes will be evaluated: Rice Lake, Mole Lake, Oak Lake, Little Sand Lake, Deep Hole Lake, Duck Lake, Skunk Lake, Hoffman Pond and Ground Hemlock Lake (Figure 4-5). Of the areas determined to be suitable habitat, a representative sample will be chosen for visual searches for basking turtles on 3 days from mid-April to June under appropriate weather conditions. Areas of emergent vegitation will also be surveyed for hatchlings and juveniles.

In addition, live trapping is proposed in wetlands associated with the above listed lakes. Two trap sites will be selected in each of the above mentioned lakes containing suitable habitat. Traps will be set for approximately 20 consecutive days in late May or June. All traps will be checked daily by



LEGEND

WT . WOOD TURTLE

BT . BLANDINGS TURTLE

BFPF. BULL FROG & PICKEREL FROG

CRANDON MINING COMPANY

FIGURE 4-5

PROPOSED SAMPLE SITES
REPTILES AND AMPHIBIANS

Scale: NONE	Date: 9 / 93
Prepared by: Foth & Van Dyke	By: G J B

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a trained biologist or field technician. Traps will consist of baited hoop nets, with a mesh size of approximately 3 inches, staked to keep part of the trap above the water line.

Four-toed Salamander, Northern Ringneck Snake, and Northern Ribbon Snake - Four-toed salamanders occur in mossy micro-habitats in association with springs, spring creeks and spring-fed bogs in northern mesic and southern mesic forest associations and spring-fed conifer swamps, where they live within moist moss. In Michigan, they are most common in shady, undisturbed forest with shallow ponds edged with moss and rotting logs (Harding, J.H. & J.A. Holman. Michigan Frogs, Toads, and Salamanders. 1992. Michigan State University Museum). Northern ringneck snakes live in moist deciduous forests, where they spend most of their time underground or within ground litter, under rocks and logs, and within rotten logs.

In Wisconsin, the northern ribbon snake has been found only in open sphagnum bogs, where they forage on the bog mat, or shoreline.

Surveys for these species will be conducted concurrently and will include searching and seizing (e.g., turning over logs, etc.) in moist deciduous and mixed forest and around edges of sphagnum bogs. Because of the large amount of potential habitat for these species in the study area (i.e., 41,888 acres of deciduous forest, 8,937 acres of swamp conifer, and 525 acres of bog - see Figure 4-1), and lack of reliable survey methods for these species, only a representative sample of habitat will be surveyed. Six sampling locations will be chosen; however, due to the specific habitat requirements within such a large area of potential habitat, and the proposed survey methods, specific sample locations will be selected based on a systematic field survey of the study area and information received from individuals with specific local information regarding snake and salamander sightings. The public (baitshops, fishermen, biology teachers, natural resource personnel, nature centers, etc.) will be solicited for information regarding potential sightings, locations of nesting sites, location of snake dens, and other first hand information that may potentially allow for a more focused field effort. Surveys will be conducted in late April to Mid-June. Approximately 6 days will be scheduled for this effort.

Bullfrog and Pickerel Frog - Bullfrogs are found in ponds, swamps, lakes, reservoirs, marshes, stream margins, and occasionally ephemeral waters. Permanent water is needed for breeding since tadpoles require two to four years to develop.

Pickerel frogs prefer cool, densely canopied mesic forests near cold spring water and remain close to bodies of water throughout the summer.

Surveys for these species will be conducted concurrently and will involve searching and seizing along lakeshores and streams (including those areas described for the Blanding's turtle and the wood turtle) through deciduous forest and wet meadows, dipnetting for larvae, and listening for frog calls (Figure 4-5). As with the above species group, due to the large amount of potential habitat in the study area, only a representative sample of habitat will be surveyed in late April, May, and June. Frog call surveys will be conducted during the following time periods and water temperature conditions: water temperature 50°F, April 15-30; water temperature 60°F, May 20-June 5; and water temperature 70°F, July 1-15. Five sampling locations will be chosen based on habitat inspection, record review and results of public inquires towards frog sightings. Approximately 5 days will be scheduled for this effort.

4.3.5 Disposition of Specimens

Adults or larvae (live specimens) of endangered, threatened, or species of concern will be identified in the field, recorded, and released. A summary report of all activities and findings will be prepared. Significant observations will be recorded on film and/or tape recorded (i.e., frog calls). The report will list all species encountered and if threatened, endangered, or species of concern are found, the number of specimens and the exact location at which they were collected will be provided to the WDNR.

Photographs documenting significant species occurrence or new county records as well as any specimens collected will be deposited at the Milwaukee Public Museum. Specimen locations will be limited to amphibian larvae and any roadkills or other casualties encountered that are deemed salvageable. Protected species will be documented with photographs. Foth & Van Dyke will obtain a Wisconsin Endangered Species Permit for this project, to allow trapping and handling of specimens.

4.3.6 Personnel

Gary Casper of Casper Consulting will act as the project herpetologist. Infield collections will be conducted by Gary Casper. Foth & Van Dyke will provide one or two field personnel to assist in the field work. Trapping efforts will be coordinated by Foth & Van Dyke.

4.3.7 Quality Assurance

Specific collection schedules will be provided to the WDNR one month prior to the proposed initiation of an individual work plan. Voucher specimens will be made available to WDNR personnel for verification purposes. The WDNR is encouraged to participate in the sampling effort as their time permits.

4.4 Work Plan for Lepidoptera

4.4.1 Objective

The objective of this work plan is to inventory and assess rare butterfly populations at the site of the proposed Crandon Project. A previous biological assessment (Dames and Moore, 1981) did not address this taxon because at the time no invertebrates were listed under Wisconsin's endangered species regulations. Since the earlier study, however, several terrestrial invertebrates have been identified on the Heritage Inventory working list. For many of these, including some butterflies, statewide distributions are not well documented, and life histories themselves are poorly described.

The WDNR's Bureau of Endangered Resources has identified 10 butterfly species of "Special Concern" known to occur at or near the proposed mine site. Added to this list should be the state threatened swamp metalmark (*Calephelis mutica*), which reaches the northern limit of its range in Wisconsin and could potentially be present at the proposed mine site. The goal of this work plan is be to conduct an inventory of butterflies in target habitats (see 4.4.2) that are likely to yield one or more of these 11 species.

4.4.2 Target Species

The following lists rare butterfly species which might occur at the proposed mine site based on their published habitat preferences and larval host species requirements. Information was obtained from Scott (1986).

Species	Habitat (Host Plant)	Flight
Boloria eunomia	bogs, tundra (*Viola palustris* + *salix spp.*)	July - Early August
Boloria freija	bogs (*Vaccinium, Arctostaphylos*)	Late May - Early July
Boloria frigga	shrub/willow bogs (*Salix, Betula*)	June - July
Coenonympha tullia	woodland, meadows (grasses)	June - July
Erebia discoidalis	open sphagnum bogs (grasses)	May - June
Euphyes dion	sedge meadows (*Scirpus, Carex*)	July - Early August
Lycaena dorcas	bogs, marshes (*Potentilla*)	July - Early August
Lycaena epixanthe	cranberry bogs (*Vaccinium*)	Late June - August
Oeneis jutta ascerta	spruce bogs, tamarack bogs (*Carex, Eriophorm* +)	June - July*
Pieris virginiensis	deciduous woods (*Dentarla* + others)	May
Calephelis mutica	bogs, wet meadows (*Cirsium muticum*)	Mid July - August

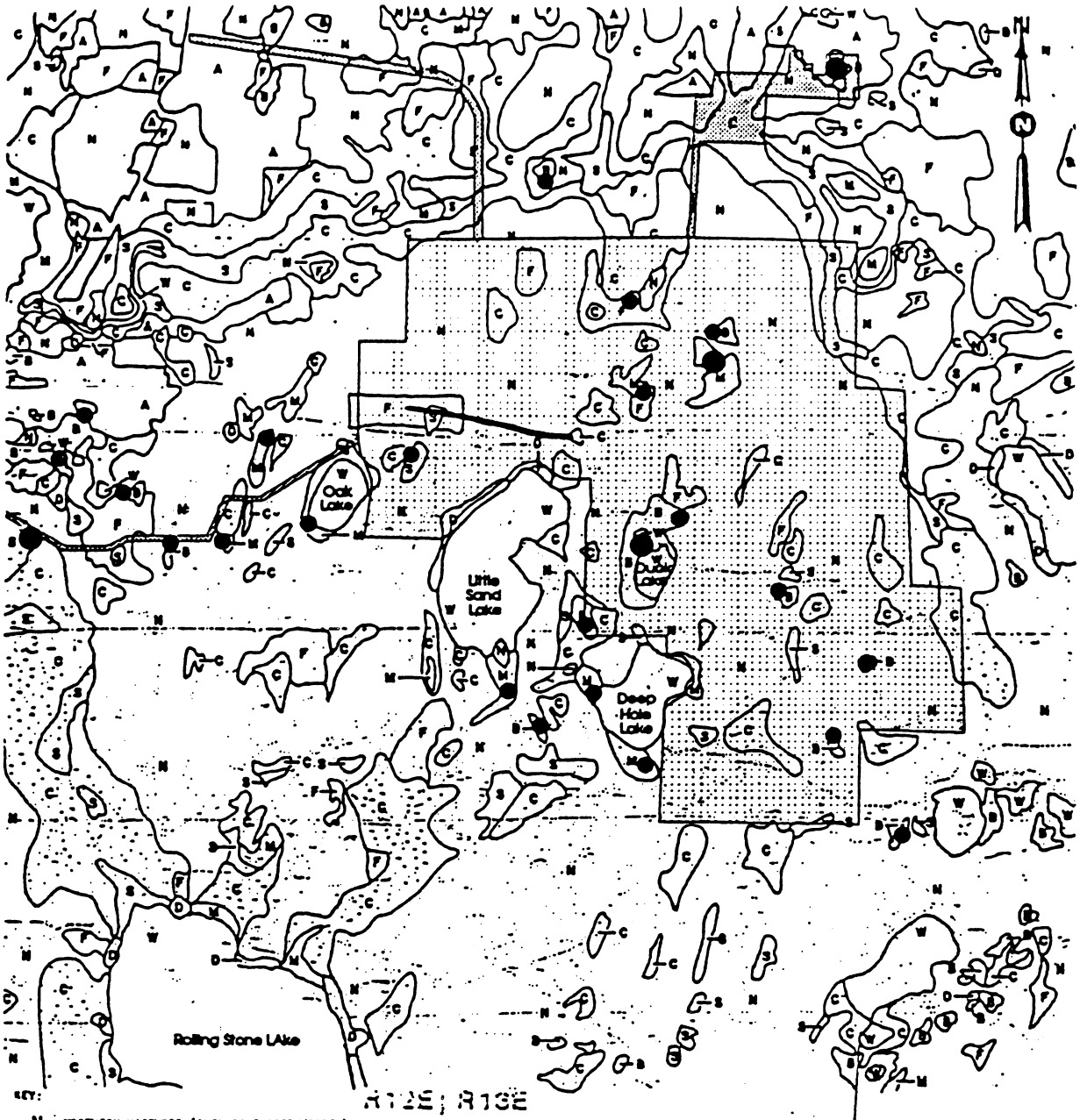
* This species is biennial and primarily flies in odd years; surveys will be conducted in 1995.

4.4.3 Methods

Butterflies will be sampled during specific expeditions timed to correspond with the flight periods of target species listed above. Field teams will move through designated habitats (e.g., bogs) as a group. Butterflies will be captured with standard sweep nets, and either identified and released, or collected for lab identification. Voucher specimens will be "pinched", collected and folded in envelopes for later processing. No more than two specimens will be taken for any species, preferably males. (If possible, a smaller number will be collected.) Specimens will be mounted and preserved in the invertebrate collection of UWGB's Richter Natural History Museum.

The butterfly inventories will need to be closely coordinated with plant inventories in order to most efficiently identify sites where larval host plants are known to occur. Clearly, a major emphasis of the field surveys will be bogs and other wetlands, primary habitat for all but two of the 11 target species. Thirty sampling localities have been identified (Figure 4-6), more than one-third of which occur in bogs or habitats adjacent to bogs. Samples will be needed during May in the northern hardwoods forest to search for *Pieris virginiensis*. All other target species are present as adults during June, July or August. The sampling periods will be conducted during this period.

Tentative distribution of 20 sampling areas for target butterfly species at the Exxon mine site near Crandon, WI. Each area will be sampled by teams of observes during June - early August. Some areas will be sampled twice to insure adequate coverage of later flying species. Separate surveys for the early flying *Pieris virginiensis* will be conducted along trails and in deciduous forests.



KEY:

- N NORTHERN HARDWOOD (INCLUDING ASPEN/BIRCH)
- C SWAMP CONIFER
- S SHRUB SWAMP
- B BOG
- M MARSH
- D URBAN OR DEVELOPED
- F OLD FIELD AND CLEARCUT
- A AGRICULTURE
- W WATER

NOTE:
MINIMUM TYPE SIZE DELINEATED IS APPROXIMATELY 4 HECTARES (10 ACRES) EXCEPT FOR WETLANDS WHICH ARE DELINEATED TO APPROXIMATELY 1 HECTARE (2.5 ACRES).

BASE MAP REFERENCE:
PORTIONS OF THE FOLLOWING U.S.G.S. 7.5 MINUTE SERIES: CRANDON, WISCONSIN, 1965; LAKE LUCERNE, WISCONSIN, 1973; AND ROBERTS LAKE, WISCONSIN, 1973.

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FIGURE 4-6

PROPOSED BUTTERFLY SAMPLING LOCATIONS

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Prepared by: Foth & Van Dyke	By: G J B

4.4.4 Personnel

Butterfly expeditions will be led by Gary Fewless, Dr. Robert Howe, and Joel Trick, a graduate of UWGB's Master's Degree program in Science and Environmental Policy. Other participants in the butterfly expeditions will be field researchers from other areas of this investigation, including bird researchers and botanists.

4.5 Work Plan for Plants

This workplan describes activities planned to locate Wisconsin endangered, threatened and special concern species of vascular plants on the Crandon Project site near Crandon Wisconsin.

4.5.1 Methods

The most likely habitats for the target species have been identified from examination of current aerial photographs and from previous field work for the Crandon Project site. Early field work will examine these sites to determine their appropriateness and to resolve questions on sites not clearly identifiable from the photos. Subsequent field work will involve thorough searches and collections of the appropriate habitats at dates consistent with the known phenology of the individual species.

The following habitats and species potentially to be found within each can be identified at this time. The lists include all endangered, threatened and concern species identified by the Wisconsin Department of Natural Resources as known or potentially present in this area. Conifer swamps and aquatic habitats outside of the project site that are associated with Hemlock Creek, Swamp Creek and Rice Lake and the area of entry of Swamp Creek into the Wolf River will also be examined.

4.5.2 Habitat Assessment

Aquatic habitats. *Armoracia aquatica, Littorella americana, Myriophyllum farwellii, Potamogeton confervoides, P. pulcher, P. vaginatus, P. vaseyi, Ranunculus gmelinii,* and *Utricularia purpurea* will be restricted to the aquatic habitats. These species will be best searched for after mid-July when the pondweeds are mature and *Ranunculus gmelinii* is still in flower. Much of the search will be conducted from canoe or boat, but examination of streams and associated pools and ponds will probably require hip boots or waders. *Littorella americana* usually grows submersed and sterile on the lake bottoms and flowers only when water levels fall sufficiently to expose the plants. Fortunately, it usually grows in shallow water and should be found by searching the margins of lakes by canoe. Particularly good sites might be searched or verified by "snorkeling" in somewhat deeper water. *Armoracia aquatica* is very rare in Wisconsin, but its presence is usually readily observed late in the year when large numbers of its highly distinctive leaves are broken from the stems and advertise its presence over a wider area.

Shorelines. Although associated with the aquatic habitats this category seems worthy of note. *Carex garberi, C. lenticularis, Eleocharis robbinsii,* and *Rhynchospora fusca* are generally associated with shoreline areas and *Platanthera flava* and *Botrychium ternatum* are also sometimes found in moist, grassy lakeside areas. The *Carex* species and *Platanthera flava* should be searched for in June when they are in flower. *Rhynchospora fusca* and *Eleocharis robbinsii* are best identified in July or August and *Botrychium ternatum,* although identifiable earlier, is very difficult to find before mid-August.

Bogs. *Arethusa bulbosa* and *Platanthera dilatata* are generally species of bogs. *Arethusa* flowers mostly in June and *Platanthera dilatata* in June and July. Some of the aquatic species described earlier prefer bog lakes and might also fall into this category. The bog lakes within the area will be searched for the aquatic species.

Conifer Swamps. The conifer swamps provide habitat for the largest number of rare species in this area, including: *Amerorchis rotundifolia, Calypso bulbosa, Cardamine pratensis, Carex gynocrates, C. tenuifolia, C. vaginata, Cypripedium arietinum, C. reginae, Epilobium palustre, Pyrola minor, Ribes hudsonianum and Valeriana sitchensis*. These species are best searched for by "sweeping" appropriate sites with several persons closely spaced. The searchers must be fully familiar with the rather large number of species, several of which are quite small and inconspicuous. Not all are likely to be found at the same site, but together they will occupy most of the conifer swamp habitat, ranging from the most complete canopy areas on somewhat drier micro-habitats (*Calypso*), to the wettest (*Cardamine*) and in canopy openings (*Ribes* and *Valeriana*). These sites should be searched, once in May or perhaps very early June for *Calypso* and *Cypripedium arietinum*, in mid to late June for the *Carex* species, *Ribes hudsonianum*, and *Valeriana sitchensis*, and again in July for *Amerorchis rotundifolia*, and *Epilobium palustre*. The other species will fall in one or both of the later periods.

Northern Hardwoods. This category would also include mixed hardwood/conifers. The following species are found in this habitat: *Botrychium mormo, B. oneidense, Carex formosa, Dryopteris expansa, Melica smithii, Polystichum braunii, Ribes oxyacanthoides, Tiarella cordifolia* and *Viola novae-angliae*. Most of these species could be searched for in June. *Carex formosa* can also be identified later and *Polystichum braunii* and *Dryopteris expansa* can be identified throughout the summer. Searches for *Botrychium mormo* and *B. oneidense* are best performed late in the summer or even into September.

Miscellaneous habitats. *Leucophysalis grandiflora* and *Penstemon pallidus* prefer dry, sandy sites with full or nearly full sunlight. No knowledge of any appropriate habitat on the site is known at this time, but initial field work will include identifying such sites for later searches. *Platanthera hookeri, P. orbiculata* seem to prefer northern dry, coniferous forest or mixed forests, although *P. hookeri* also occupies swamps or mesic forests. Searches for both can be accomplished in July. *Botrychium lunaria* occurs under coniferous forests near Lake Michigan in Door County, but elsewhere in its range it grows in grassy habitats.

4.5.3 Collection and Disposition of Vouchers

Preceding the summer field work a permit for the collection of Wisconsin endangered and threatened species must be acquired from the Department of Natural Resources. If endangered, threatened or concern species are encountered in populations of sufficient size, vouchers will be collected and prepared for disposition to the UW-Green Bay Herbarium with duplicates to UW-Madison. If populations are too small to permit the taking of vouchers, photographs of the plants will be taken.

4.5.4 Personnel

The vascular plant work plan will be directed by Gary Fewless, Associate Curator of the University of Wisconsin Green Bay Herbarium, with assistance from botanists and graduate and undergraduate students with experience in working with the plants of northeastern Wisconsin, and by personnel of Foth and Van Dyke as available.

4.5.5 Quality Assurance

Selection of trained wildlife biologist to participate in the effort will assure proper site selection and identification. Voucher specimens and other documentation will be provided to the WDNR for further verification. Field events will be schedule and the WDNR advised well enough ahead of time such that the WDNR personnel will be able to participate as they wish.

5 Introduction to Aquatic Section of Work Plan

The aquatic sections of the study include work plans for mussels, fish, aquatic macroinvertebrates and Odonata. The development of the work plans took into consideration of potential effects of the mine on organisms which may be both proximal and distal to the project area. Proximal considerations include the potential effects associated with possible dewatering and recharge activities. These effects may impact streams and lakes in the immediate vicinity of the mine. Distal considerations include the potential effects of mine activities associated with a discharge. These effects may impact streams at the discharge location (Swamp Creek) and streams downstream of Swamp Creek (Wolf River).

The work plans which are designed to document the status of potential threatened, endangered, and/or species of concern in or within the impact area of the mine project, have been developed based on information provided by past studies, review of the Wisconsin Heritage Inventory, and professional judgement.

5.1 Work Plan for Fish

5.1.1 Objective of the Work Plan

The objective of this work plan is to provide documentation regarding the presence and current status of fish species of concern as identified in the Wisconsin Heritage Inventory in the study area. Documentation will be provided by an evaluation of existing records of habitats and fish encountered in previous studies, an evaluation of known species distribution, and actual field surveys. Specific methods at specific collection sites will be deployed to maximize the potential for collection of the target species and will vary according to physical habitat at each site.

5.1.2 Target Species

Efforts to collect target species will be concentrated in the spring and early summer for most fish, though some species may be successfully collected throughout the summer to fall. The preliminary list of species which have the potential for occurring in the area of the Crandon Project project are:

Target Species	Common Name	Wisconsin Status
Moxostoma carinatum	River redhorse	Threatened
Moxostoma valenciennesi	Greater redhorse	Threatened
Notropis anogenus	Pugnose shiner	Threatened
Notropis texanus	Weed Shiner	Special Concern
Opsopoeodus emiliae	Pugnose minnow	Special Concern
Etheostoma microperca	Least darter	Special Concern

The two species of redhorse will, if present, in all probability be restricted to the Wolf River. Historical data (1) does not list these two species as having a local presence. However, earlier records do not differentiate between the several species of redhorse and one or both of these target species may be present.

The four minnows and darters listed prefer pool habitat which is represented in the project area by slow stream areas and lakes. The weed shiner is more typically a stream resident while the pugnose minnow, pugnose shiner, and the least darter prefer slower steams and lake habitat. The project area has not been thoroughly searched for these species. There are no known records of any of the four species from the study area, and literature suggests that the project area is at or out of the range for these species. Of these four species, the least darter has the most potential for being encountered based on known distribution. Possibly because of its size and life history, the least darter could have been missed in previous studies.

Two additional species of fish which appear on the Wisconsin Heritage List as species of concern include the pirate perch (*Aphredoderus sayanus*) and lake herring (*Coregonus artedi*). Neither of these species are expected to be found in the study area. The range of the pirate perch is far outside the study area for this project. Lakes within the study area are considered to be too shallow to support the lake herring. Consequently neither of these two species will be specifically searched for as part of this work plan.

Most of the streams of the Swamp Creek and Pickerel Chains in close proximity of the project area were sampled in the 1980's and no currently listed threatened or endangered species were found from these streams at that time. These streams, including Swamp Creek, Hemlock Creek, Pickerel Creek, and Cr. 12-9 will be sampled once to document comparative conditions and results per the 1980 data. Sampling will occur in May or June 1994. Sampling for the least darter will be conducted early in the spring/summer. In the northern parts of its range the adult least darters may die after breeding in May (one year life cycle). Mid to late summer sampling may miss the least darter because the juveniles will pass through the seine.

5.1.3 Methodology

Target species of fish which may be found in the study area will be sought using boom shocking, pram shocking, backpack electrofishing, and seining techniques. Since most of the streams in the study area are small, boom shocking will be limited to the Wolf River above and below the confluence with Swamp Creek and lakes on the Swamp and Pickerel Creek chains. Shocking with a portable pram or backpack electrofishing and seining will be used for all smaller streams.

The boat mounted electroshocker will be used on the Wolf River and lakes which have a boat landing. The shocker is powered by a 240 volt, 4000 watt Kohler generator controlled by a Coffelt Model VVP-15 pulser. Output is 3-4 amps and about 320 volts at 80 pulses per second and 40 percent pulse width. Output will be adjusted to obtain maximum efficiency depending on the conductivity of the water.

Pram electrofishing, backpack electrofishing, and seining collection techniques will be used in streams in the project area where the boat shocker cannot be used. Pram electrofishing is similar to boat electrofishing except that the generator is mounted in a pram which can be towed by field personnel. The 2000 watt Coffelt 2C generator supplies current to hand-held electrodes. On small streams one electrode is used while two electrodes can be used on larger streams. A crew of three will be used when both electrodes are in use. One person is used to guide and direct the pram. The backpack electroshocker is powered by a Coffelt BPC.

Two sizes of seines will be used. On larger streams and in slow areas, 20 - 30 foot seines will be used while 10 - 15 foot seines will be used in faster or smaller stream segments. Both seines will be a mesh size of 3/16 inch.

Up to five sites will be sampled on Swamp Creek (Figure 5-1). Swamp Creek will be sampled to obtain upstream and downstream documentation of fish at the location of proposed outfall discharges. Smaller tributary streams will be sampled at one to two sites, the number and location depending on habitat diversity and previous records of species diversity.

Lakes in close proximity to the project site have not been sampled for a considerable period of time. Two sampling events will be planned for Little Sand, Oak, Duck, Deep Hole, and Skunk Lakes. These sampling events will be conducted in May and June 1994.

Lakes peripheral to the study area (Rolling Stone Lake) will be sampled once in June 1994. Approximately two hours time will be devoted to shocking each of the lakes. This amount of time will allow the boat shocker to make one pass around the shore of the smaller lakes. Where shallow areas are encountered in the lake, seine hauls will supplement the shocking effort.

The Wolf River will hold the most potential for locating target species if they are present. Some of the target species do occur in the lower Wolf River basin (1) and there is the potential that they may occur in the Wolf River in the area of the project. The Wolf River will be sampled twice at locations both above and below the confluence with Swamp Creek. The first survey of the Wolf River will occur in late April or early to mid-May 1994 depending on river stage. The second survey will be conducted in June 1994.

Since habitats and activity patterns overlap, it is estimated that habitats for the species can be investigated in four weeks of sampling assuming the time frame is discontinuous and may extend from April to the end of June.

5.1.4 Personnel

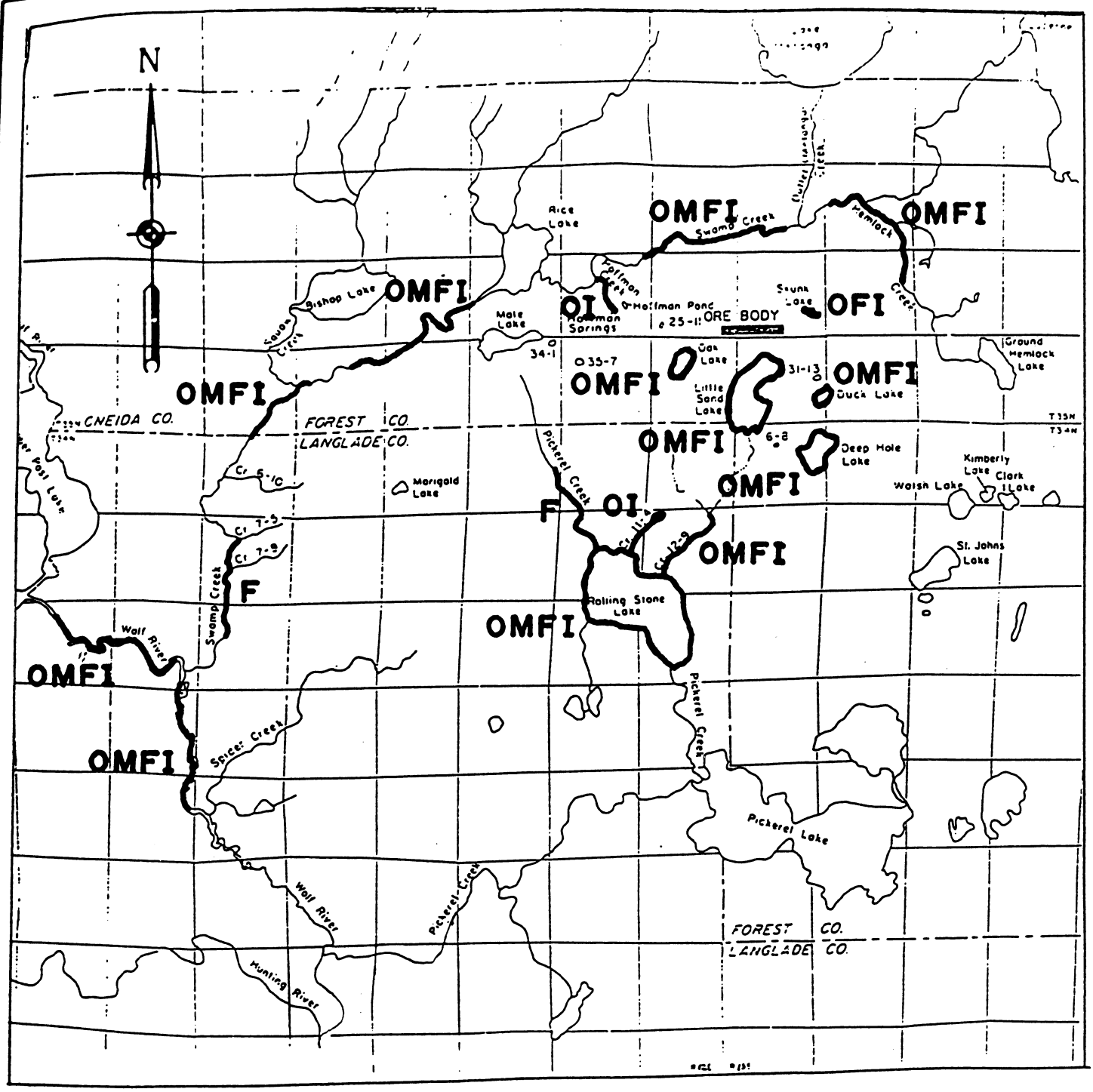
Infield collections will be conducted by Dr. Greg Seegert of EA Associates. He will be assisted in the collection efforts by an experienced biologist from EA. Foth & Van Dyke will provide one or two field personnel to assist in the field work. Two people will be available where seining is required.

5.1.5 Reports

An annual summary report of all activities and findings will be prepared. The report will list all species encountered and if threatened, endangered, or species of concern are found, the number of specimens and the exact location at which they were surveyed and/or collected will be provided. If a target species is encountered, WDNR will be notified as soon as possible.

5.1.6 Disposition of Specimens

All fish collected will be weighed, measured and the number recorded in field logs. Representative specimens of endangered, threatened, or species of concern will be identified, recorded and released in the field. Voucher specimens of fish will be identified by Dr. Greg Seegert, preserved, and deposited per requirements of the WDNR Scientific Collector's permits. All work to be conducted



LEGEND

O - ODONATA

M - MUSSELS

F - FISH

I - MACROINVERTEBRATE

93C049

CRANDON MINING COMPANY		
FIGURE 5-1 PROPOSED SAMPLE SITES AQUATIC WORK PLAN CRANDON, WISCONSIN		
Scale: NONE	Date: 9 / 93	
Prepared by: Foth & Van Dyke		By: G J B

under this work plan will be authorized by a current threatened and endangered species collectors permit issued by the WDNR. Disposition of specimens will be carried out as directed by the permit.

5.1.7 Quality Assurance

Following preliminary taxonomic identification, specimens will be provided to the WDNR for verification. Specific collection schedules will be provided to the WDNR one month prior to the proposed initiation of each field event. The WDNR will be encouraged to participate in the sampling effort as their time permits.

5.2 Work Plan for Mussels

5.2.1 Objective

The objective of this activity is to document the occurrence (non-occurrence) and status of species of listed threatened and endangered mussels or those listed as species of concern in the Wisconsin Heritage Inventory.

5.2.2 Targeted Species

The following is a species "working list" for which this work plan has been developed.

Target Species	Common Name	Wisconsin Status
Quadrula fragosa	Winged mapleleaf	Endangered
Epioblasma triquetra	Snuffbox	Endangered
Cyclonaias tuberculata	Purple wartyback	Endangered
Plethobasus cyphyus	Bullhead	Endangered
Simpsonaias ambigua	Salamander mussel	Threatened
Alasmidonta viridis	Slippershell	Threatened
Quadrula metanevra	Monkeyface	Threatened
Tritogonia verrucosa	Buckhorn	Threatened
Venustraconcha ellipsiformis	Ellipse	Threatened
Leptodea leptodon	Scaleshell	Special Concern
Alasmidonta marginata	Elktoe	Special Concern
Anodonta cataracta cataracta	Eastern floater	Special Concern
Anodonta cataracta marginata	Gaspe floater	Special Concern
Elliptio complanata	Atlantic elliptio	Special Concern
Lasmigona compressa	Creek heelsplitter	Special Concern
Pleurobema sintoxia	Round pigtoe	Special Concern

5.2.3 Methods for the Collection of Mussels

The Crandon Project Site is located within the upper Wolf River drainage basin. Streams which occur in close proximity of the mine make up portions of what is known as the Swamp and Pickerel Creek chains. Both of these chains flow into the Wolf River south of Crandon, Wisconsin.

Previous macroinvertebrate studies by Dames & Moore (1977, 1978) indicate that only a few species of mussels were encountered in the study area. None of the currently listed (list current January 1993) threatened and endangered species were identified from previous studies. However, previous methods were not specific to survey mussels, nor has an extensive search for threatened and endangered species of mussels ever been conducted within this study area. Mussels classified as threatened and endangered have been found in the lower Wolf River and have the potential to be encountered in the upper Wolf River basin and perhaps the Swamp Creek and Pickerel Creek chains as well.

Collection efforts will concentrate on the Wolf River, Swamp Creek, and Pickerel Creek. Because of deeper waters located on some stretches of the Wolf River and possibly Swamp Creek, divers will be required to accomplish the collections at these locations. A minimum of two beds of mussels will be located and sampled on the Wolf River, one each above and below the confluence with Swamp Creek. Since the presence of mussels in Swamp Creek and Pickerel Creek may be dependent on recruitment from Wolf River, preliminary findings on the Wolf River may direct or require revisions in collection activities planned for Swamp and Pickerel Creek. Three stream locations will be sampled on Swamp Creek - one each above and below the intended mine discharge, and one adjacent to the mine. Depending on the findings, an additional location may be established on the lower reach of Hemlock Creek prior to its confluence with Swamp Creek. If distinct beds are not located, a stretch of river approximately 300 feet will be surveyed using divers. A minimum of two full days of investigation will be spent at each of these locations, unless mussels are encountered. Prior to sampling, a general stream reconnaissance via canoe will spot sample the entire stretch of Swamp Creek from Hemlock Creek to the Wolf River. If areas of mussel concentration are found, they will be added to the sampling locations.

A "bed" of mussels may consist of an area of several feet in length or, depending on substrate and other conditions, 300 feet or more in length. If defined beds are located, collectors will randomly pick 20 mussels and place them in a mesh bag or several mesh bags. The mesh bags will be brought to shore, remaining submerged, where a taxonomist will identify the mussels. Collectors will repeat this procedure picking 20 mussels at a time until no new species are found for six replicate picking efforts. If insufficient mussels are encountered within a bed to accomplish this protocol, then the collectors will continue to search for four hours in lieu of completing the six replicate collections.

The search for mussels, specifically the salamander mussel, will involve looking under large, flat rocks including rocks greater than 12 inches in diameter where such stream areas occur.

In addition to general reconnaissance and hand picking techniques described above, bank searches will also be conducted. Field technicians will walk designated sections of the river looking for shells which may lie in the shallows or which other animals may have left along the bank. These findings will be documented and will supplement the instream picking technique.

5.2.4 Disposition of Specimens

Live specimens of mussels which have been identified will be returned to the approximate location of their finding and replaced with proper alignment to substrate and flow. Voucher specimens will be retained per requirements of a Wisconsin Department of Natural Resources collector's permit.

5.2.5 Personnel

The mussel investigation will be carried out by Don Helms of Helms & Associates, Bellevue, Iowa. He will be assisted when required by a team of divers or by aquatic field technicians. Taxonomic identification and field reports will be provided by Don Helms. Mussel collection will be conducted in the summer of 1994 pending approval of this work plan.

5.2.6 Quality Assurance

Following preliminary taxonomic identification, species verification will be completed by the WDNR. Specific collection schedules will be provided to the WDNR one month prior to the proposed initiation of an individual work plan. The WDNR is encouraged to participate in the sampling effort as their time permits.

5.3 Work Plan for Macroinvertebrates

5.3.1 Objective

This work plan presents activities to be conducted in the vicinity of the Crandon Project to determine the presence and/or status of macroinvertebrate species listed on the Wisconsin Heritage Inventory List of threatened & endangered species. Dragonflies (Odonata) are separated from the other arthropod in this work plan because distinct methods are proposed for this group.

5.3.2 Species Working List

The following working list organizes the target list under the preferred general collection technique. However, any of the techniques is suitable for the collection of each of the listed species. Species which may be collected equally well by more than one technique are listed within several tables presented below. During the general macroinvertebrate collection time periods it is assumed that resident Odonata specimens will also be collected.

Exuviae collection technique:

Target Species	Common Name	Wisconsin Status
Gomphus lineatifrons	Splendid clubtail	Special Concern
Gomphus ventricosus	Skillet clubtail	Special Concern
Gomphus viridifrons	Green-faced clubtail	Special Concern
Gomphus quadricolor	Rapids clubtail	Special Concern

Target Species	Common Name	Wisconsin Status
Gomphus graslinellus	Pronghorned clubtail	Special Concern
Ophiogomphus aspersus	Brook snaketail	Special Concern
Ophiogomphus carolus	Riffle snaketail	Special Concern
Ophiogomphus anomalus	Extra-striped snaketail	Endangered
Ophiogomphus howei	Pygmy snaketail	Endangered
Stylurus amnicola	Riverine clubtail	Special Concern
Stylurus scudderi	Zebra clubtail	Special Concern

Observation of Adult Specimens (Odonata):

Target Species	Common Name	Wisconsin Status
Aeshna clepsydra	Mottled darner	Special Concern
Aeshna eremita	Lake darner	Special Concern
Aeshna tuberculifera	Black-tipped darner	Special Concern
Coenagrion interrogatum	Subarctic bluet	Special Concern
Cordulegaster obliqua	Arrowhead spiketail	Special Concern
Aeshna verticalis	Green-striped darner	Special Concern
Gomphaeshna furcillata		Special Concern
Libellula incesta	Slaty skimmer	Special Concern
Nannothemis bella	Elfin skimmer	Special Concern
Nasiaeschna pentacantha	Cyrano darner	Special Concern
Somatochlora forcipata	Forcipate emerald	Special Concern
Somatochlora franklini	Delicate emerald	Special Concern
Somatochlora incurvata	Warpaint emerald	Special Concern
Somatochlora kennedyi	Kennedy's emerald	Special Concern
Somatochlora tenebrosa	Clamp-tipped emerald	Special Concern
Sympetrum danae	Black meadowhawk	Special Concern
Williamsonia fletcheri	Ebony bog haunter	Special Concern

Instream Sampling for Odonata Nymphs:

Target Species	Common Name	Wisconsin Status
Cordulegaster obliqua	Arrowhead spiketail	Special Concern
Naiaeschna pentacantha	Cyrano darner	Special Concern
Meuracordulia yamaskanensis	Stygian shadowfly	Special Concern
Ophiogomphus aspersus	Brook snaketail	Special Concern
Stylogomphus albistylus	Least clubtail	Special Concern
Cordulegaster diastatops	Delta-spotted spiketail	Special Concern

Instream Collection of Non-Odonata Macroinvertebrates:

Target Species	Common Name	Wisconsin Status
Acanthametropus pecatonica	Pecatonica river mayfly	Endangered
Anepeorus simplex	A flat-headed mayfly	Endangered
Attaneuria ruralis	A stonefly	Special Concern
Dolania americana	American sand burying mayfly	Special Concern
Homoeoneuria ammophila	A mayfly	Special Concern
Hydroperla crosbyi	A stonefly	Special Concern
Lepidostoma libum	A bizarre caddisfly	Special Concern
Lepidostoma vernale	A bizarre caddisfly	Special Concern
Macdunnoa persimplex	A mayfly	Special Concern
Paracloeodes minutum	A small mayfly	Special Concern
Soyedina vallicularia	A stonefly	Special Concern
Stenelmus knobeli	Knobel's riffle beetle	Special Concern
Stenelmus douglasensis	Douglas riffle beetle	Special Concern
Triaenodes dopsius	A longnose casemaker caddisfly	Special Concern
Zealeuctra narfi	A rolled-winged winter stonefly	Special Concern

5.3.3 Methods for the Collection of Dragonflies

The field investigators will employ three techniques for collecting dragonflies, including collection of exuviae from shoreline habitats, observation and collection of adult specimens, and instream sampling. Depending on the species of Odonata, one collection technique may be more suited than the other for obtaining information on potential species. For instance, the gomphid dragonflies will be most easily sampled by the collection of exuviae. Exuviae can be found along the banks of streams and lakes and on vegetation or other objects immediately after adults have emerged from the water body. Because of their relative size, members of the genus *Somatochlora* are best surveyed as adults. The exuviae is a casing of a dragonfly which is left behind when the dragonfly emerges as an adult.

In general, all Odonata may be collected using instream sampling techniques in the fall and early spring while most species are in the late instars or at pre-emergence stages. It should be noted that instream sampling techniques may underestimate the numbers of organisms present and may miss some populations altogether. The collection of exuviae is a good technique for obtaining specimens which are uncommon or rare in an area and for determining relative species abundance.

Sites for sampling will be located on portions of Swamp Creek, Hemlock Creek, Wolf River, Pickerel Creek, Cr. 12-9, and the following lakes: Oak, Little Sand, Duck, Skunk, Deep Hole, and Rolling Stone. Refer to Figure 5-1 for general locations of sampling sites.

It is proposed to collect exuviae in the spring/early summer. A field reconnaissance may be required to determine the specific timing of emergence. Typically in northern Wisconsin, emergence will occur in late May or the first two weeks of June for the gomphids, although one gomphid (*Stylurus scudderi*) does not emerge until the second week of July. Exuviae will be collected from selected areas of streams and lakes. Depending on exuviae abundance, 150 to 300 foot segments of stream (or lakeshore) will be searched intensely. Both sides of the stream will be searched. All specimens will be collected within the collection area.

Three areas will be sampled on Swamp Creek - one north of the mine site, and one each upstream and downstream of the proposed discharge point. Two areas will be located and sampled on the Wolf River, one each upstream and downstream of the confluence with Swamp Creek. All other flowing tributary streams will have one to two sampling areas, the number dependent on habitat diversity. Two sampling locations are planned for each lake. Approximately two weeks will be utilized for the collection of exuviae in these locations. The reporting of exuviae will be qualitative. Where practical, attempts will be made to quantify species. Collections will be directed by, and species verification will be completed by Dr. Ken Tennessen of TVA, Florence, Alabama.

Dragonfly nymphs will be collected using instream techniques in the late fall of the year or in the spring prior to emergence using a combination of kick nets and surber samplers. Drift nets and sweep nets may also be used if it is deemed that the site conditions suggest that these techniques are appropriate.

5.3.4 General Macroinvertebrate Collections

Aquatic macroinvertebrates other than Odonata included on the target list may be encountered in the area of the project. A search for these species will be conducted in early spring, late summer and late fall of the year, beginning in October of 1993. Areas which will be targeted for field

investigation will include lakes and streams local to proposed mining activities as well as streams which may be impacted by mining discharges (see Figure 5-1). Some organisms such as the nymphs of Ephemeroptera and Plecoptera as well as the larvae of Trichoptera and Coleoptera generally cannot be identified to species. Therefore, sampling for adults using UV light traps and sweep netting will be conducted during the specific known flight seasons of the target species. Qualitative instream sampling efforts will include the use of dip nets to hand pick a section of stream selected from the general areas depicted on Figure 5-1 to represent a cross section of all available micro-habitats in the stream (i.e.,pools, riffles, detrital masses in slackwater, cut banks with overhanging cover, snags, and various bottom types). Each micro-habitat will be sampled by two biologists hand picking for no less than 30 minutes, or until a five minute period produces no new species, whichever is the longest period.

In addition, a riffle area in each site will be sampled using a surber sampler. Triplicate samples will be taken at each site during each season. Pools with soft bottom substrates will be sampled using an Ekman dredge to assure collection of infamerals forms. Triplicates will be taken at each location. Samples will be washed through a surber net (mesh size 600-800) and preserved in formalin. If members of the genera considered to be endangered are found, then the search for adults of those species would be conducted in the summer of 1994. Sampling locations for the general macroinvertebrate collections and Odonata nymphs are the same as those described for the exuviae collection. Dr. Tennessen will provide specimen verification.

5.3.5 Disposition of Specimens

Nymphs, larvae, or adults (live specimens) of listed species will be identified in the field, recorded, and released. Only voucher specimens will be retained for documentation. Voucher specimens of live organisms as well as exuviae of Odonata will be identified by Dr. Ken Tennessen and saved and deposited per requirements of the WDNR scientific collector's permit. All work to be conducted under this work plan will be authorized by a current threatened and endangered species collectors permit issued by the WDNR. Disposition of specimens will be carried out as directed by the permit.

5.3.6 Personnel

The Odonata and general macroinvertebrate work plan will be led by Dr. Ken Tennessen with assistance from trained aquatic biologists. General macroinvertebrate collections will commence in the fall of 1993, pending approval of the work plan. The general macroinvertebrate collections not initiated in the fall of 1993 will be conducted in 1994. Odonata collections will commence in the spring/summer of 1994. Odonata collections will be directed by Dr. Ken Tennessen.

5.3.7 Quality Assurance

Following preliminary taxonomic identification, vouchers will be provided to the WDNR for verification. Specific collection schedules will be provided to the WDNR one month prior to the proposed initiation of an individual work plan. The WDNR is encouraged to allow their representatives to participate in the sampling effort as their time permits.

Appendix B

Surface Water Sampling Quality Assurance Plan for the Proposed Crandon Project December 1993

(The following is the narrative from the above-referenced report. Appendices for this document are not reproduced here.)

Crandon Mining Company

Surface Water Sampling Quality Assurance Plan
Prepared for the
Proposed Crandon Project
Crandon, Wisconsin

Scope ID: 93C049

Prepared by
Foth & Van Dyke and Associates Inc.

Under the Direction of

Gerald J. Berg
Project Manager

Russell T. Janeshek
Project QA Officer

Barbara Bowman
Laboratory QA Officer

December 1993

Surface Water Sampling Quality Assurance Plan
Prepared for the Proposed Crandon Project
Crandon, Wisconsin

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3 Project Description

Since the Crandon Project was suspended in 1986, the Wolf River has been classified as an Outstanding Resource Water, which invokes some antidegradation requirements. All surface water discharges from the 1986 proposed project would ultimately flow into the Wolf River by way of Swamp Creek, and the previous impact assessments predicted some very minor changes to Wolf River water quality. NR 106 allows natural variations in water quality to be considered in determining compliance under this rule. Crandon Mining Company (CMC) desires to begin data collection to evaluate natural variation of parameters that may be affected by the Project's discharge.

Water quality will be monitored at two locations in the Wolf River and at two locations in lower Swamp Creek. Flow will be monitored on a monthly basis. Surface water samples (one at each location) will be collected on a monthly basis and analyzed at a Wisconsin-certified laboratory for the list of analytes specified in Table 5-2 of this plan. Additional samples may be collected during unusual stream flow conditions, such as following a rain event.

The purpose of this document is to provide a quality assurance plan for the collection, preservation, transportation and analysis of these surface water samples. Adherence to the plan described herein will result in data that can be used by CMC as well as government agencies in the evaluation of the natural variation of water quality within the Wolf River and Swamp Creek.

4 Organization and Responsibility

This section of the quality assurance plan will describe the organization and responsibilities for field operations and laboratory operations.

4.1 Field Operations

Field monitoring and sample collection activities will be performed by representatives of Foth & Van Dyke and CMC (see Figure 4-1). Field operations will generally consist of the following:

- flow measurement
- sample procurement and ancillary activities
- sample preservation
- measurement of sample characteristics
- sample documentation and recordkeeping
- sample shipment to the laboratory for analysis.

The field operations staff structure is shown on Figure 4-1. The key field operations positions are shown along with lines of authority. Individual members of the project team are responsible for project quality control activities on a day-to-day basis. A quality assurance officer is assigned to the project and is responsible to assure that:

- Appropriate project QC protocol is used.
- Project records are maintained in accordance with this plan and/or standard operation procedures.
- The intent of this quality assurance/quality control plan is carried out as described.

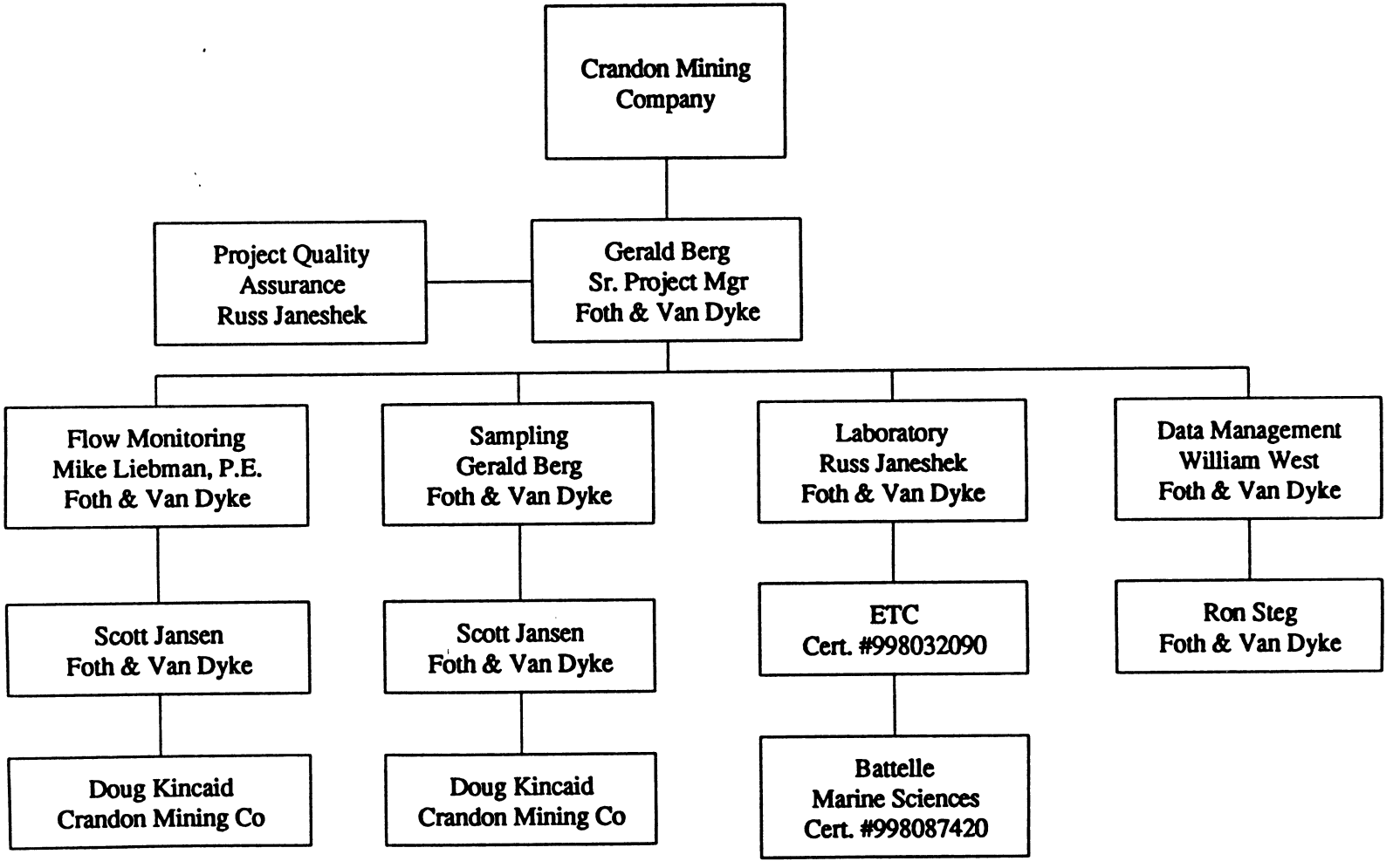
4.2 Laboratory Operations

Laboratory analytical activities will be performed by ETC, a division of APBI Environmental Sciences Group, Inc. (ETC) and their subcontractor, Battelle Marine Sciences Laboratory (Battelle).

A copy of ETC's quality assurance plan is also included in Appendix A. It is required that ETC undertake their analytical activities in accordance with the requirements of their quality assurance plan.

Figure 4-1

Organizational Chart
Surface Water Sampling Work



5 Quality Assurance Targets for Precision, Accuracy, and Method Detection Limits

The purpose of quality assurance objectives is to define the precision and accuracy targets as well as the method detection limits which will be used for both laboratory and field measurement data.

All measurements must be made such that results are representative of the media and conditions being measured. Unless otherwise specified, data will be calculated and reported in consistent units from one sampling event to the next.

Data quality objectives for accuracy and precision for each measurement parameter will be based on the measurement system employed and the requirements specified by regulation (if any).

Quality assurance objectives for field measurement data are found in Table 5-1, while those for laboratory data are found in Table 5-2.

Table 5-1

Field Measurement Data
Quality Assurance Objectives

Component	Matrix	Analytical Method*	Precision (SD)	Accuracy
Conductance	Water	EPA 120.1	±6%	N/A
pH	Water	EPA 150.1	±0.1%	N/A
Dissolved Oxygen	Water	EPA 360.1	N/A	N/A
Temperature	Water	EPA 170.1	±10%	N/A
Flow	Water	(1)	N/A	N/A

* Methods for Chemical Analysis of Water and Wastes, USEPA March 1983

N/A = Not Applicable

1 Measurement of cross-sectional area and velocity will be taken to establish a stage/discharge rating table. WDNR Draft document "Guidance on Stream Gaging for WPDES Permits" will be referenced where applicable. A copy of this document is included in Appendix B.

Table 5-2

Laboratory Measurement Data
Quality Assurance Objectives

Parameter	Analytical Method[1]	Precision Targets	Accuracy Targets	TDL
Alkalinity	EPA310.1	25	80-120	5 mg/l
Bicarbonate	EPA310.1	25	80-120	5 mg/l
Biochemical Oxygen Demand (5 day)	EPA405.1	25	80-120	2 mg/l
Carbonate	EPA310.1	25	80-120	5 mg/l
Chemical Oxygen Demand	EPA410.4	25	80-120	20 mg/l
Chloride	EPA9056	25	80-120	0.5 mg/l
Cyanide	EPA9010	25	80-120	0.02 mg/l
Fluoride	EPA340.2	25	80-120	0.1 mg/l
Hardness	EPA130.2	25	80-120	5 mg/l
Nitrogen-Ammonia	EPA350.2	25	80-120	0.1 mg/l
Nitrogen-Nitrate	EPA9056	25	80-120	0.5 mg/l
Nitrogen, Kjeldahal	EPA351.3	25	80-120	0.2 mg/l
Oil and Grease	EPA413.2	25	80-120	1 mg/l
pH	EPA150.1	25	N/A	0.1 SU
Turbidity	EPA180.1	25	80-120	0.5 NTU
Phosphorus (Soluble)	EPA365.3	25	80-120	0.05 mg/l
Phosphorus (Total)	EPA365.3	25	80-120	0.05 mg/l
Modified SAR	Calculation	N/A	N/A	N/A
Sulfate	EPA9056	25	80-120	1 mg/l
Cations (Sum)	Calculation	25	80-120	N/A
Anions (Sum)	Calculation	25	80-120	N/A
Cation Anion Balance	Calculation	N/A	N/A	N/A
Total Dissolved Solids	EPA160.1	25	N/A	5 mg/l
Total Suspended Solids	EPA160.2	25	N/A	5 mg/l

Table 5-2 (*Cont.*)

Parameter	Analytical Method[1]	Precision Targets	Accuracy Targets	TDL
Boron	EPA200.7	25	75-125	0.1 mg/l
Calcium	EPA200.7	25	75-125	1 mg/l
Aluminum	*	25	75-125	0.2 µg/l
Arsenic	EPA206.2	25	75-125	0.005 mg/l
Barium	EPA200.7	25	75-125	0.04 mg/l
Cadmium	*	25	75-125	0.004 µg/l
Copper	*	25	75-125	0.04 µg/l
Iron	EPA200.7	25	75-125	0.05 mg/l
Iron (Total)	EPA200.7	25	75-125	0.05 mg/l
Lead	*	25	75-125	0.05 µg/l
Manganese	EPA200.7	25	75-125	0.01 mg/l
Manganese (Total)	EPA200.7	25	75-125	0.01 mg/l
Mercury	*	25	75-125	0.05 ng/l
Molybdenum	EPA200.7	25	75-125	0.02 mg/l
Selenium	EPA270.2	25	75-125	0.005 mg/l
Silver	EPA200.7	25	75-125	0.01 mg/l
Zinc	*	25	75-125	0.03 µg/l
Chromium (Total)	EPA200.7	25	75-125	0.03 mg/l
Beryllium	EPA200.7	25	75-125	0.01 mg/l
Thallium	EPA279.2	25	75-125	0.005 mg/l
Nickel	EPA200.7	25	75-125	0.03 mg/l
Antimony	EPA204.2	25	75-125	0.005 mg/l
Magnesium	EPA200.7	25	75-125	1.0 mg/l
Potassium	EPA200.7	25	75-125	1.0 mg/l
Sodium	EPA200.7	25	75-125	1.0 mg/l

TDL = Target Detection Limit
* = Low Level Methods Performed by Battelle Marine Science Laboratory
N/A = Detection limit not applicable

(1) Methods referenced are taken from USEPA - 600/4-79-020 Rev. 1983 Methods for the Chemical Analysis of Water and Wastes.

6 Sampling Procedures

6.1 Sampling Capabilities

The intent of the specific sampling protocol is to assure that accurate low level metal concentrations can be measured for surface waters.

6.2 Sampling Equipment

Two samples will be collected from each location. The first procedure will be used for low level detection limits for the following parameters:

Aluminum	Lead
Cadmium	Mercury
Copper	Zinc

This sampling procedure is presented in Appendix C, "Recommendations for Trace Element Analysis of Natural Waters".

The other samples will be collected by submergence of a glass or plastic receptacle or with the use of a Kemmerer water sampler for the analysis of other chemical constituents (not low level metals). The equipment needed for the sampling procedure is as follows.

6.2.1 Clothing

- Waders that are clean or dedicated to the sampling program
- Non-metallic boat if sampling is to be done from a boat
- Clean outdoor clothing, a wind breaker or Tyvek suit which covers the head
- Shoulder length polyethylene gloves

6.2.2 Sampling Device

Two sampling devices are available for holding the teflon sample bottles. The attached report "Recommendations for Trace Element Analysis of Natural Waters" illustrates these devices. In the discussion with Dave Webb, WDNR, he indicated that the pole sampler would be the most likely system for stream sampling if one is used at all. He indicated that the sampling devices are not a necessity for small stream sampling.

6.2.3 Sampling Bottles

The sampling bottles must be carefully prepared. The laboratory completing the low level element analyses will supply the sample bottles and preservatives. The attached report "Recommendations for Trace Element Analysis of Natural Waters" has a description for the recommended cleaning methods. It should be noted that this procedure is not a regulatory procedure and the laboratory completing the analyses may have a modification to this method. It will be necessary for the laboratory to fully document their method of cleaning and provide the necessary justification for their specific method. The sample containers and preservative vials must be double bagged in the laboratory prior to sending them into the field. The sample bottles should be pre-labeled to allow for easy sampling and documentation.

6.2.4 Shipping Containers

The shipping containers shall be capable of being sealed for security purposes. They must also be capable of maintaining samples at the proper temperature while in shipment.

6.2.5 Miscellaneous Sampling Equipment

Extra plastic should be brought to the site to be used to create a clean area for the introduction of the preservatives into the sample. This may be limited to a ground cloth if there is very little wind. If the potential for airborne contaminants exists, an glove box should be used to prevent contamination.

6.3 Sampling Considerations

The intent of the detailed sampling procedure is to assure that no additional contamination is introduced to the sample(s) prior to analysis. It is the responsibility of the sample collection team to continuously look for potential sources of contamination and eliminate them. Each site will present its own unique set of conditions that must be addressed. It is not possible to develop written text which will answer all the questions for each site. The following is a description of the steps typically taken leading up to the sampling, the actual sampling and the steps taken after the sample is collected.

6.3.1 Equipment Preparation

The primary concern for the equipment is cleanliness. If waders, clothing and the equipment is soiled it may lead to contamination of the sample. Outer garments and equipment used in this study should be dedicated to the project. If the equipment or clothing becomes soiled and is unable to be cleaned it must be replaced.

The actual sample bottles, preservatives and other associated equipment will be supplied by the laboratory. The laboratory is responsible for proper preparation of the equipment. The sample bottles and other equipment will be sealed in plastic bags which have been cleaned in the laboratory. These bags must not be opened until the team is at the site and ready for sample collection.

6.3.2 Site Reconnaissance

When the sampling team arrives at the site, their first assignment is to note any unusual conditions that may impact the water chemistry of the stream. The sampling location should not be moved unless such conditions dictate that a move is required. If a sampling site needs to be moved because of stream conditions, the sample shall be collected as close to the original sampling location as possible, yet upstream from any unnatural sources of contamination. Any information associated with this site inspection shall be logged in the field book and brought to the project managers attention as soon as possible.

6.3.3 Site Preparation

A clean area for the sample handling shall be established by laying down a ground cloth (plastic). The sample bottles and preservatives, both double bagged, shall be made ready for use. It is advisable to use the sample cooler as a bench to work off of. This should also be made clean with the use of a sheet of plastic. If wind conditions are unfavorable, the glove box shall be set up and prepared for use. The sampling gloves and equipment will then be brought to the clean area and readied for use.

6.3.4 Personnel Preparation

The sampling program will require at a minimum, two team members. One will act as the sampler, the second will assist.

The sampler shall put on the waders (if sampling is not to be done from a boat) and the clean outer garments. One set of shoulder length gloves will be put on by both the assistant and the sampler. A second set of shoulder length gloves will be put on by the sampler. After the gloves are put on, the team members must only touch clean items. If the sampler touches anything that is not clean such as the ground or vegetation while entering the steam, the outer pair of gloves shall be removed and replaced with a clean set of gloves. If the assistant has to leave the clean area, a new pair of gloves shall be put on when returning.

6.3.5 Sampling Procedure

It is the intent to collect all of the low level metals samples by hand with a gloved person. Because of the flowing and relatively shallow stream conditions. The gloved sampling technique will offer the quality needed and also be the most practical.

The assistant shall pick up a double bagged sample bottle and open the outer bag. The sampler shall reach into the outer bag and open the inner bag, removing the sample bottle. The cap for the sample bottle shall remain securely closed until the actual sample is to be collected.

The sampler will enter the water from a down stream location to assure that any disturbed bottom sediments will flow away from the sampling location. The sampler will move upstream and position their body to allow for collection of the sample upstream from their body. The sample bottle will then be lowered into the water to a depth of approximately 2/3 of the stream depth. Once the sample bottle is in position, the cap can be removed and the sample bottle allowed to fill. The sample bottle will then be recapped and brought out of the water.

At no time will the sample bottle be allowed to pass through the surface of the water with out the cap being securely closed. The sample bottle will then be opened and emptied downstream from the sampling location. The bottle will again be closed. This process will be repeated twice to assure rinsing of the sample bottle with the desired water to be sampled.

The third time a sample is collected the sample bottle should be filled to approximately 90% of the volume. This will allow for the introduction of the preservative without spilling. The sampler shall exit the stream, again moving down stream to maintain the integrity of the sampling site. The sampler will then go to the clean area and set the sample bottle into the glove box or a secure area. The assistant will then open the outer bag for the preservative vials

allowing the sampler to reach in and open the inner bag removing the proper preservative. The vile will not be opened until the sample bottle and vile are in a secure area. The sample bottle cap will then be removed, placing the cap in a clean area where no contamination can be introduced. The vile will then be opened and the preservative will be put into the sample. Both bottles will then be capped again. The sample bottle will then be placed into the inner bag of the double bag system and the inner bag will be closed by the sampler. This bag and bottle will then be put into the outer bag and closed by the assistant. This bottle will then be put into the cooler and iced. This procedure will be repeated as often as necessary to obtain adequate sample volumes.

6.4 Field Equipment Decontamination and Cleaning Procedures

6.4.1 In-House Cleaning Procedures

Equipment that is transported to the field shall be pre-cleaned and ready to use. Sufficient clean equipment shall be available such that the amount of field cleaning is minimized.

Equipment is cleaned prior to transportation to the site according to the following:

1. Soak in hot tap water and Alconox® (or equivalent) or in the case of nutrients, Liquinox^{R} to loosen any particles.
2. Scrub with a soft brush if necessary.
3. Rinse thoroughly with hot tap water.
4. Triple rinse with deionized water from a documented source.
5. Rinse thoroughly with analyte-free water.
6. Allow to air dry.
7. Wrap to prevent contamination during storage and transportation.

If the equipment has been heavily contaminated with oils, greases or other difficult-to-remove substances, steps 1-4 may be repeated. As an alternative procedure in these instances, the equipment may be rinsed with pesticide grade acetone or hexane in an attempt to remove these substances. Another option would be to steam clean the equipment prior to step 1. If these procedures are ineffective, consideration will be given to removing the equipment from service or using it in a less sensitive situation.

6.4.2 In-Field Cleaning Procedures

When field cleaning is necessary, the following procedures will be used:

1. Wash with Alconox® (or equivalent) or in the case of nutrients, Liquinox® (or equivalent).
2. Scrub with a soft brush, if necessary.
3. Rinse thoroughly with tap water from a documented source.
4. Rinse with deionized water from a documented source.
5. Rinse with analyte-free water from a documented source (if available).

If further sampling is to be performed, the sampling equipment will be rinsed with analyte-free water immediately after use.

6.4.3 Field Instrument Decontamination Procedures

Field instrumentation is generally decontaminated as follows:

1. Wash with water and appropriate soap solution.
2. Rinse with tap water.
3. Rinse with deionized water.
4. Allow to air dry as long as possible.

6.4.4 Lanyards/Measuring Tapes Decontamination Procedures

Decontamination procedures to be followed for lanyards and measuring tapes are:

1. Wash with water and the appropriate detergent.
2. Rinse with tap water.
3. Rinse with deionized water.

6.4.5 Analyte-free Water Storage Container Decontamination Procedures

New containers will be decontaminated as follows:

1. Wash with detergent and hot tap water.
2. Rinse with hot tap water.
3. Rinse with tap water.
4. Rinse with deionized water.
5. Rinse with organic-free water.

6.4.6 Decontamination Documentation

Records of the procedures used to clean equipment used shall be maintained as part of the equipment file. This documentation will include the actual method of cleaning, the date of cleaning, the person performing the cleaning, and any quality control activities to demonstrate adequate decontamination.

This documentation will be recorded in the field notebook when equipment is decontaminated in the field and in the equipment service/maintenance record when cleaned in-house.

6.5 Sampling Containers

Sample containers will be provided by the laboratory. The laboratory will provide new containers for samples and shall be able to substantiate the source of containers used on the project.

6.5.1 Sample Bottle Check Procedure

Upon receipt of new sample bottles, all bottles are immediately capped to prevent contamination. Each box of bottles is then assigned a specific lot number. A random sampling is taken from every lot and analyzed for the parameters specific to that bottle. Bottle checks with the proper preservative added are filled with distilled and deionized water and allowed to sit for a minimum of one day before analysis. The analysis to run on specific bottle sizes are shown in Table 6-1.

Table 6-1

Bottle Check Parameters

Bottle Size	Preservative	Parameter
30 ml	H_2S0_4, pH<2	C.O.D.
60 ml	Non-pres.	Chloride Conductivity Sulfate
60 ml	H_2S0_4, pH<2	C.O.D. TKN N+N
60 ml	$HN0_3$, pH<2	Metals* Hardness
125 ml	Non-pres.	Chloride Conductivity Sulfate
125 ml	$HN0_3$, pH<2	Metals* Hardness
250 ml	Non-pres.	Chloride Conductivity Sulfate
250 ml	H_2S0_4, pH<2	TKN N+N Phosphorus
250 ml	$HN0_3$, pH<2	Metals*
500 ml	Non-pres.	Fluoride
500 ml	$HN0_3$, pH<2	Metals*
625 ml	$HN0_3$, pH<2	Mercury
960 ml	NaOH, pH>12	Cyanide
960 ml	Non-pres.	Chloride Conductivity Sulfate
960 ml	$HN0_3$, pH<2	Metals
500 ml Glass	H_2SO_4, pH<2	Oil & Grease

* Metals include the following parameters: Cadmium, Calcium, Chromium, Copper, Iron, Magnesium, Manganese, Zinc.

If bottles are contaminated, new bottle checks will be set up to confirm the presence of contamination, and the contaminated lot will be washed in the appropriate manner to remove contamination. If contamination cannot be removed, the lot will be discarded.

Example of contamination removal: Ammonia is found in a bottle check and it is determined that the lot is contaminated. Bottles would be triple rinsed with distilled water. These bottles would be analyzed for ammonia to determine if distilled water rinsing has removed the contamination. If ammonia was absent from these rinsed bottles, then the distilled water rinsing would be the acceptable method of removal.

Any treatment of bottles to remove a contaminant is recorded. Records are kept on the dates specific lots of bottles are used, and the test results for that lot.

6.6 Sampling Protocols

Described within this section of the QA/QC plan are those procedures which will be used to collect samples from the Wolf River and Swamp Creek.

6.6.1 Sampling Locations

Surface water quality samples and flow monitoring will be collected at four locations as shown in Figure 6-1. A description of each location is as follows:

- **Upstream Wolf River (Y)**

  The upstream Wolf River sampling and flow monitoring site is located at Lat. 45°, 25' 50", Long. 89°, 04' 27", Section 14, T34N, R11E.

- **Downstream Wolf River (CC)**

  The downstream Wolf River sampling and flow monitoring site is located at Lat. 45°, 24' 47", Long. 89°, 03' 00", Section 24, T34N, R11E.

- **Upstream Swamp Creek (AB and AA)**

  The upstream sample for Swamp Creek will be collected at Lat. 45°, 28' 24", Long. 89°, 01' 14", Section 32, T35N, R12E (Site AB). The flow monitoring for this site (Site AA) will be taken at the USGS Gaging Station 04074548 located at the CTH "M" bridge, Lat. 45°, 28' 46", Long. 88°, 59' 52", Section 33, T35N, R12E.

  Site AB (sampling site) is selected because this is the proposed discharge point for the 1986 proposed project. Site AA (flow monitoring) is selected because of its history as a USGS gaging station. Variation in flow between these two sites is considered to be insignificant.

- **Downstream Swamp Creek (V)**

  The downstream Swamp Creek sampling and flow monitoring site is located at Lat. 45°, 26' 23", Long. 89°, 02' 02", Section 7, T34N, R12E CTH "K".

N

LEGEND

SAMPLING LOCATION

A

ONEIDA COUNTY
FOREST COUNTY

M

Bishop L.

MOLE LAKE
RESERVATION

INDIAN

NASH-

Mole L.

Squaw Cr.

Swamp

AA

Mole
Lake

AB

55

Oak L.

ONEIDA COUNTY
LANGLADE COUNTY

FOREST COUNTY
LANGLADE COUNTY

Cr.

Z

6

Post L.

ELCHO

Mud Cr.

V

K

Y

Wamin L.

Swamp

Cr.

Rolling
Stone
L.

Berendsen L.

Lower
Post L.

Aninnan
L.

CC

Spider

L.
Agnes

AINSWORTH

B19

SURFACE WATER SAMPLING LOCATIONS		
CRANDON MINING COMPANY		
LANGLADE AND FOREST COUNTY, WISCONSIN		
DATE: 12/93	**Foth & Van Dyke**	FIGURE 6-1

6.6.2 Surface Water Sampling Schedule

Samples will be collected on a monthly basis from November 29, 1993 and will continue until weather conditions render the validity of the samples in doubt. Additional sampling may be collected during unusual stream flow conditions, such as following a rain event.

6.6.3 Special Collection Procedures for Specific Parameter Types

Typical sampling procedures are detailed in Section 6.3.5. The following categories of parameters have specific sampling techniques and considerations which must be followed to collect unbiased, uncontaminated samples:

6.6.3.1 Non-Low-Level Metals Sampling

New plastic containers will be used for sampling of general water chemistry and other metals not requiring low level detection. Adequate HNO_3 will be added per liter of sample to reduce the pH to below 2.0 to keep metals in solution. If dissolved metals are to be measured, the sample will be filtered through a 0.45 micron membrane filter prior to acidification.

6.6.3.2 Cyanide Sampling

Cyanide is very reactive and unstable. Cyanide will be analyzed as soon as possible after collection. The sample container must be polyethylene or glass. The currently approved method (Standard Methods) is being rewritten due to some inaccuracies in the method language. To deal with the interferences from chlorine, or other oxidants, sufficient ascorbic acid will be added to the sample upon collection. To deal with sulfide interferences, the easiest solution is to analyze the preserved sample within 24 hours.

6.7 Split Samples

Split samples, when required, are to be taken from consecutive samples collected from the same stream location.

6.8 Sample Documentation

Personnel shall use only bound field logbooks for the maintenance of field records. Other bound logbooks, such as bound surveyors logbooks, are acceptable so long as pages cannot be removed without tearing them out.

A log book will be dedicated to this project. The field technician's name, project name, and project code will be entered on the inside of the front cover of the logbook. All entries will be dated and time of entry recorded. At the end of each day's activity, or entry of a particular event if appropriate, the field technician will draw a diagonal line at the conclusion of the entry and initial indicating the conclusion of the entry or the day's activity.

All aspects of sample collection and handling as well as visual observations shall be documented in the field logbooks. All sample collection equipment (where appropriate), field analytical equipment, and equipment utilized to make physical measurements shall be identified in the field logbooks. All calculations, results, and calibration data for field sampling, field analytical, and

field physical measurement equipment shall also be recorded in the field logbooks. All field analyses and measurements must be traceable to the specific piece of field equipment utilized and to the field investigator collecting the sample, making the measurement, or analyses.

All entries in field logbooks shall be dated, shall be legible, and shall contain accurate and inclusive documentation of an individual's project activities. Since field records are the basis for later written reports, language will be objective, factual, and free of personal feelings or other terminology which might prove inappropriate. Once completed, these field logbooks become accountable documents and must be maintained as part of project files.

6.9 Sample Preservation

Table 6-2 indicates the parameter, container type, minimum sample volume, preservation requirements and holding times.

Those samples requiring thermal preservation will be cooled with wet ice to reduce/maintain the sample container environment at 4°C. The ice should be wetted ice that is in full contact with the sample containers. (Blue ice is not acceptable.) For samples which require pH adjustment as a means of preservation, ETC will provide sample containers with preservatives and sufficient additional preservative from the same source such that the field sampler can add additional preservatives if necessary. The pH of the sample will be checked by removing an aliquot of the sample, checking the pH with pH paper and adjusting the pH by adding additional preservative (if necessary). If equipment blanks are to be collected, the same amount of acid is added to the blank as to the sample.

The pH checking procedure will be done on all samples for each parameter on the first sampling event at a given site. For subsequent sampling events at the same site, only one sample from each parameter need be checked. Documentation of the pH verification will be done in the field notebook.

If the samples arrive at the laboratory with water and ice remaining in the cooler, the laboratory can assume that the sample temperature is 4°C. If no ice remains, the laboratory shall make a temperature reading and record the temperature reading.

Table 6-2

Sample Container, Preservation Methods, Holding Times

Parameter	Sample Container Type	Volume (ml)	Preservative[2][3]	Holding Time[4]
Alkalinity	P, G	100	cool, 4°C	14 dy
Bicarbonate Alkalinity	P, G	100	cool, 4°C	14 dy
Carbonate Alkalinity	P, G	100	cool, 4°C	14 dy
Biochemical Oxygen Demand (5-day)	P, G	250	cool, 4°C	48 hr
Chemical Oxygen Demand	P, G	100	H_2SO_4,pH<2	28 dy
Chloride	P, G	50	none	28 dy
Cyanide	P, G	1000	NaOH,pH>12[1]	14 dy
Fluoride	P, G	300	none	28 dy
Hardness	P, G	100	HNO_3,pH<2 cool, 4°C	6 mo.
Nitrogen				
Ammonia	P, G	500	H_2SO_4,pH<2 cool, 4°C	28 dy
Kjeldahl	P, G	500	H_2SO_4,pH<2 cool, 4°C	28 dy
Nitrate	P, G	50	cool, 4°C	48 hr
Oil & Grease	G	1000	H_2SO_4,pH<2 cool, 4°C	28 dy
pH	P, G	25	none	immediate
Phosphorous				
total	P, G	100	H_2SO_4,pH<2 cool, 4°C	24 hr
soluble	P, G	100	Filter on site H_2SO_4, pH<2 cool, 4°C	24 hr
Solids				
total	P, G	100	cool, 4°C	7 dy
suspended	P, G	100	cool, 4°C	7 dy
dissolved	P, G	100	cool, 4°C	7 dy
Sulfate	P, G	100	cool, 4°C	28 dy
Turbidity	P, G	100	cool, 4°C	48 hr

Parameter	Sample Container Type	Volume (ml)	Preservative[2][3]	Holding Time[4]
Metals				
total	P	2000	HNO_3, pH <2	6 mo
dissolved	P	2000	filter on site HNO_3, pH <2	6 mo
Mercury	P	500	HNO_3, pH <2	28 dy

P = Plastic
G = Glass
PE = Pre-extraction
C = Completion

(1) If residual chlorine is present, 0.6 gm ascorbic acid will be added; if sulfide is present, samples must be pretreated in the field or must be shipped unpreserved at 4°C to the laboratory for analysis within 24 hours.

(2) Sample preservation will be performed immediately upon sample collection. For composite chemical samples, each aliquot will be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then chemical samples may be preserved by maintaining at 4°C until compositing and sample splitting is completed.

(3) When any sample is to be shipped by common carrier or sent through the United States Mails, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172). The person offering such material for transportation is responsible for ensuring such compliance. For the preservation requirements of Table II, the Office of the Hazardous Materials, Materials Transportation Bureau, Department of Transportation has determined that the Hazardous Materials Regulations do not apply to the following materials: Hydrochloric acid (HCl) in water solutions at concentrations of 0.04 percent by weight or less (pH about 1.96 or greater); Nitric acid (HNO_3) in water solutions at concentrations of 0.15 percent by weight or less (pH about 1.62 or greater); Sulfuric acid (H_2SO_4) in water solutions at concentrations of 0.35 percent by weight or less (pH about 1.15 or greater); and Sodium hydroxide (NaOH) in water solutions at concentrations of 0.080 percent by weight or less (pH about 12.30 or less).

(4) Samples will be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid. Some samples may not be stable for the maximum time period given in the table. A permittee, or monitoring laboratory, is obligated to hold the sample for a shorter time if knowledge exists to show that this is necessary to maintain sample stability. See § 136.3(e) for details.

6.10 Sample Dispatch

Sample containers are transferred from field storage containers to insulated shipping containers for delivering to the laboratory. The sample containers, within the shipping container, are placed such that individual sample containers are not touching each other and there is no movement of sample containers. Samples requiring thermal preservation are stored with wet ice. The wet ice is packaged such that sample container labels do not become wet and unglued during shipment. Fiberglass strapping tape is used to seal the containers along with numbered seals to insure sample security. Containers are appropriately labelled for shipment.

Shipping containers are delivered to the laboratory by the sampling team, shipped via courier or shipped via common carrier to the laboratory for analysis. Copies of the chain-of-custody form and any shipping forms accompany the samples. The laboratory will be notified in advance of the forthcoming shipment.

6.11 Analyte-Free Water

Analyte-free water is defined as water in which all interferences and analytes of interest are below detection limits. Analyte-free water is typically obtained from the subcontracted laboratory. Analyte-free water will be used for preparation of blanks and for the final decontamination rinse (see section 6.3). Blanks of analyte-free water are submitted for analysis to document the reliability and "purity" of the analyte-free water source(s).

6.12 Flow Monitoring

For each monitoring location on the Wolf River and the upstream location for Swamp Creek, a reach of stream has been chosen with characteristics conducive to steady-state hydraulics. Detailed stream cross-sections will be surveyed along this reach, and slope, roughness, and other hydraulic characteristics will be verified. From this information, a stage discharge curve will be constructed and run to obtain a stage/discharge relationship at the measurement point.

The monitoring location for lower Swamp Creek will utilize standard formulae for pipe hydraulics. These calculations will be verified through velocity measurements and the cross-sectional area will be measured.

The most critical task necessary for accurate flow monitoring is calibration of the hydraulic backwater model. In order to calibrate this model, detailed depth and velocity measurements will be taken across the entire stream section. An electromagnetic probe-type velocity meter will be used to provide reliable velocity measurement across the channel. Incremental velocities and depths (areas) will then be used to calculate incremental flows, which, in total, give total flow across the section. Velocity measurement will be taken each time a sample is collected during the 1993 sampling period. By periodically estimating these flows under different flow regimes (high flow, low flow, etc.), a fairly reliable model can be created from which a stage/discharge rating table may be constructed.

7 Sample Custody

A Chain-of-Custody form (Figure 7-1 or equivalent) will be used to document sample possession from the time the sample bottles leave the laboratory until they are received back at the laboratory. Each time custody of a sample is transferred, the new sample custodian will sign the form and will document the time and date. A sample will be considered in custody if it is:

- In one's actual possession.
- In view, after being in physical possession.
- Locked so that no one can tamper with it, after having been in one's physical possession.
- In a secured area, restricted to authorized personnel.

Upon receipt of samples in the laboratory, the Chain-of-Custody form will be checked and signed. A copy of the form will be retained by the laboratory and the remaining copy returned to the sampling team.

Procedures for preparing and shipping samples will conform with labelling and packing requirements of the United States Department of Transportation.

While awaiting screening or packaging, samples will be stored on wet ice in coolers. Preservatives are added to collected samples such that the physical and/or chemical alterations are minimized. Preservatives must be added immediately upon sample collection. The preservative added will be documented on the Chain-of-Custody form in the "analyses required" or "remarks" portion of the form. If samples cannot be shipped on the same day that they are collected, packaging will be delayed until the following morning so that the samples can be shipped with a full load of ice. These samples will be stored on wet ice in coolers and kept in a secure area.

Each time the custody of the samples is relinquished to another individual (or to the laboratory), the date, time, and items transferred are noted on the Chain-of-Custody form. After the samples have been packaged for shipping, the custody will be transferred to a team member who will ship the coolers via overnight courier. Upon shipment, the laboratory will be notified that the sample shipment is scheduled to arrive.

7.1 Laboratory Arrangements

Samples for analysis will be shipped to ETC in Santa Rosa, California and Battelle Marine Sciences in Sequin, Washington.

7.2 Laboratory Processing of Samples

Procedures for the receipt and logging of samples by the laboratory are addressed in their individual quality assurance plan (Appendices A and D). The following minimum requirements will be used by ETC and Battelle.

7.2.1 Receipt of Samples by Laboratory

Upon receipt of samples at ETC and Battelle, the following, at a minimum, shall take place:

- Place the samples in adequate laboratory cold storage. This is generally accomplished by placing the samples in a refrigerator or cold storage room where the temperature is maintained at 4°C. Daily readings of calibrated thermometer are used to verify temperatures present in the refrigerator or cold room.

- Enter the following information to the laboratory sample log-in system:

  - Assigned laboratory numbers.
  - Project name.
  - General sample status (temperature, seal).
  - Sample pH.
  - Date and time received in laboratory.
  - Storage location.
  - Chain-of-Custody number.

ETC

CHAIN-OF-CUSTODY RECORD

Form 0019
Field Technical Services
Rev. 08/90

No. 96883

Environmental Testing and Certification Corp. • 284 Raritan Center Parkway • Edison, NJ 08818 • 908-225-6700

COMPANY	FACILITY/SITE
PROJECT CONTACT	TELEPHONE NO.

ITEM NO.	ETC JOB #	SOURCE CODE	SAMPLE POINT	START DATE YY/MM/DD	START TIME
1					
2					
3					
4					
5					
6					
7	B27				
8					
9					

Source Codes:
Well .... (W) Outfall ..... (O)
Soil .... (S) River/Stream .... (R)
Bottom Sediment ..... (B)
Generation Point ..... (G)
Surface Impoundment ..... (I)
Treatment Facility ..... (T)
Leachate Collection Sys ..... (C)
Lake/Ocean ..... (L)
Other ..... (X)
Specify _____

NUMBER OF CONTAINERS

FILT. (Y/N)
PRESERV.
ANALYSIS REQUIRED

LEGEND FOR PRESERVATIVE
0 - NONE
1 - HCL
2 - HNO_3
3 - H_2SO_4
4 - $Na_2SO_3 + H_2SO_4$

SAMPLER OBSERVATIONS	LAB OBSERVATIONS

CHAIN OF CUSTODY CHRONICLE

1. Shuttle Opened By: (print) _____ Date: _____ Time: _____
   Signature: _____ Seal #: _____ Intact: _____

2. I have received these materials in good condition from the above person.
   Name: _____ Signature _____
   Date: _____ Time: _____ Remarks: _____

3. I have received these materials in good condition from the above person.
   Name: _____ Signature _____
   Date: _____ Time: _____ Remarks: _____

4. Shuttle Sealed By: (print) _____ Date: _____ Time: _____
   Signature _____ Seal #: _____ Intact: _____

REMARKS

SAMPLER'S SIGNATURE

LAB USE ONLY Opened By: _____ Date: _____ Time: _____
SHUTTLE # _____ TEMP. °C _____ SEAL # _____ COND. _____

Figure 7-1

LAB COPY

7.2.2 Laboratory Storage of Samples

The primary considerations for sample storage are:

- Maintenance of prescribed temperature, if required, which is typically 4°C.
- Proper preservation to ensure integrity of samples until samples are analyzed.
- Security of the laboratory and the samples.

All extraction and chemical analyses of samples of a given project will conform to the holding times and be maintained at the temperatures given in Table 6-3. Placement of samples in the proper storage environment is the responsibility of ETC and Battelle.

7.3 Sample Disposal

Samples will be disposed of thirty days after providing written documentation of the analysis, samples, extracts, and digestates are handled, stored, and/or disposed in accordance with the individual laboratory's procedure in that regard, and within applicable State and/or Federal regulations.

7.4 Documentation

Project sampling activities will be documented by keeping a written record of daily sampling activities and implementing the Chain-of-Custody procedures described in this portion of the QAP. The information documented will incorporate that which is specified in Section 7.4.2 of the plan, at a minimum. This will provide for the integrity of data by tracking and documenting samples from the time they are collected by the sampling team through receipt at the laboratory.

7.4.1 Sample Numbering System

A sample numbering system will be used to identify each sample. This numbering system will provide a tracking procedure to allow retrieval of information about a particular sample and assure that each sample is uniquely numbered. The sample identification numbers will be composed of four components, which are described below.

7.4.1.1 Sample Type

Each sample type collected during the sampling program will be identified by a two-digit alpha code. For this project, the following sample type designation will be used:

- SW - Surface water

7.4.1.2 Sample Location

An alpha code will be used to indicate the specific sampling location at the site.
For this project, the following sampling location designations will be used:

- Y Upstream Wolf River (Section 14, T34N, R11E).
- CC Downstream Wolf River (Section 24, T34N, R11E).
- V Downstream Swamp Creek (at Highway K, Section 7, T34N, R12E).
- AB Upstream Swamp Creek (Section 32, T35N, R12E).

7.4.1.3 Sample Number

A two-digit number will be used to consecutively number sequential samples taken at a specific sampling location. QC samples shall be prepared and numbered uniquely. Duplicate and split samples shall be numbered using the same designation as the original sample (i.e., if original sample is SWY-01, duplicate is SWY-02 and split SWY-03). A record of the QA/QC identification numbers will be maintained by the sampling technician(s) in the project log book.

7.4.2 Sample Collection Data

Sample collection data will be obtained in the field for each sample acquired. Collection data for samples will be documented in the field notebook.

7.4.3 Sample Labelling

Sample labels must contain sufficient information to uniquely identify the sample in the absence of other documentation. This will include at a minimum:

- Project number.
- Unique sample number.
- Sample location (and depth, if applicable).
- Sampling date and time.
- Individual collecting the sample (signature).
- Grab or composite.
- Preservation method employed (if any).

7.4.4 Field Notebook

A bound field notebook with prenumbered pages will be used to record field analytical sampling results. The notebook will be completed in indelible ink and will include a record of:

- Water sampling field parameters (i.e., temperature, specific conductance and pH).
- Sample identification numbers, and date/time of collection, location and description.
- Sample preservation documentation.
- Instrument adjustments (calibrations) performed in the field.
- Statements pertaining to any problems encountered.
- Weather/site conditions.
- Individuals collecting samples and field supervisor's signature.

Mistakes in the notebook will be crossed through with a single line, initialed and dated.

7.4.5 Common Carrier Shipments

Samples will be shipped to the laboratory using common carriers. A copy of the shipping documents which are completed in order to ship samples with a carrier will be maintained as part of the project file in order to demonstrate sample custody.

8 Analytical Methods

The field reading methodologies to be taken or analytical methods to be performed are specified in the tables which follow.

8.1 Field Operations

Methods to be used for field operations are listed in Table 8-1.

8.2 Laboratory Operations

Analytical methods to be used at ETC and Battelle are listed in Table 5-2.

Table 8-1

Field Methodologies

Parameter	Method	MDL	EPA Methods*
pH	Meter/Electrode	0.1	150.1
Conductance	Meter	1 μmho	120.1
Temperature	Thermometer/ Meter	0.1°C	170.1
Dissolved Oxygen	Meter/Electrode	0.1 mg/l	360.1
Flow	Electromagnetic Velocity Meter	0.02 ft/sec.	N/A

* Methods for Chemical Analysis of Water and Wastes USEPA, March 1983

9 Calibration Procedures and Frequency

9.1 Field Instrumentation

Field instrumentation used to obtain the field measurement data listed in Table 5-1 are listed in Table 9-1. In addition, the equipment used to obtain samples for laboratory analysis are listed in Table 9-1.

9.1.1 Standard Receipt and Traceability

Standards for pH and conductivity measurements will be purchased commercially as certified standards. All standards and/or standard sources will be dated upon receipt and stored under recommended conditions until the expiration date (if any). Any documentation accompanying the standards will be retained in a file as part of the calibration record.

9.1.2 Standard Sources

Standard sources are listed in Table 9-2.

9.1.3 Instrument Calibration

Procedures for calibration of field instruments are listed in Table 9-3.

9.1.4 Calibration Documentation

Documentation of field calibration activities must be included in the field notebook and may be included on the field sheet (if a field sheet has been developed for the field activity being performed). If an instrument does not meet calibration acceptance criteria it shall not be used.

9.2 Laboratory Instruments

Laboratory instruments will be calibrated at the frequency and according to procedures described in ETC's quality assurance plan (Appendix A) and Battelle's quality assurance plan (Appendix D).

Table 9-1
Field Instrumentation and Sampling Equipment

Instrument/Equipment Name	Manufacturer	Model. No.	Field Data
Kemmerer Water Sampler	Wildco Supply Co.	1520-C20	N/A
Flow Meter	Monteduro-Whitney	PVM-2A	flow
pH	Corning	Checkmate 90	pH
Dissolved Oxygen	Corning	Checkmate 90	dissolved oxygen
Conductivity	Corning	Checkmate 90	conductivity
Temperature	Corning	Checkmate 90	temperature

Table 9-2
Standard Sources

Instrument Group	Standard Source	How Received	Storage
pH meter	commercial lab supplier	pH buffer solutions	room temperature
conductivity meter	commercial lab supplier	standardized solutions	room temperature

Table 9-3
Field Instrument Calibration

Instrument Group	Calibration Type	No. of Standards	Frequency	Acceptance Criteria[1]
pH meter	before use	2 levels	daily	<0.05 unit
	continuous	2 levels	hourly	<0.05 unit
conductivity meter	before use	2 conc	daily	NA
DO meter	before use	sat. air	daily	<0.1 mg/L
	continuous use	sat. air	twice/day	<0.1 mg/L
		Winkler titration	twice/year	NA
temperature	before use	field grade thermometer	daily	<0.1°C
	continuous	NIST certified thermometer	annually	<0.1°C
flow meter	before use	N/A	daily	N/A

[1] Deviation from standard calibration.

10 Preventative Maintenance

The result of any equipment/instrument readings depends on the inherent accuracy and proper operation, use and function of the instrument. It is essential that the equipment/instruments operate under optimum conditions at all times. Each equipment/instrument user is expected to be familiar with the manufacturer's operations manual on each instrument and routinely performs various service checks.

Each equipment/instrument is calibrated according to the manufacturer's instructions. A maintenance log will be maintained for each instrument. This log will include the following (at a minimum):

- Instrument description.
- Manufacturer, model number and serial number.
- Name, address, and telephone number of company which services item.
- Type of service policy.
- Timing and frequency of routine maintenance, servicing and calibration.

Routine field preventative maintenance procedures are found on Table 10-1. Routine laboratory preventative maintenance procedures for ETC are found in Appendix A (see also Table 10-2) and for Battelle are found in Appendix D.

Table 10-1

Routine Field Preventative Maintenance

Instrument/ Equipment Type	Activity	Frequency
pH meter	- rinse electrodes with pH 7 buffer	after each reading
	- immerse electrodes in an appropriate solution consistent with manufacturers instructions.	when not in use
	- clean electrodes with mild acid or alcohol solution.	when needed or at least monthly
	- maintain liquid level in electrode (if appropriate).	when needed or at least monthly
	- check batteries	before each use
	- clean equipment	as needed or at least at the end of each day in which equipment is used.
conductivity meter	- rinse probe w/deionized water	after each reading
	- check batteries	before each use
	- replatenize probe	as needed
	- clean equipment	as needed or at least at the end of each day in which equipment is used
DO meter	- change probe membrane	as needed or at least annually
	- check batteries	before each use
	- clean gold cathode	as needed or at least annually
	- clean equipment	as needed or at least at the end of each day in which equipment is used
thermometer	- clean thermometer	- as needed or at least monthly
	- check batteries	- before each use
	- clean equipment	- as needed or at least at the end of each day in which equipment is used
flow meter	- check batteries	- as needed or at least monthly
	- clean equipment	- before each use
		- as needed or at least at the end of each day in which equipment is used

Critical spare parts are stocked where frequent failure or routine wear warrant. Unexpected downtime is unavoidably encountered at times due to equipment failure. In such instances, a protocol will be followed in which steps are taken to either correct the problem and resume measurements, or otherwise ensure that samples are properly analyzed within allowable holding time.

10.1 Field Preventative Maintenance

The following contingency plan has been established in the event of equipment malfunction. The steps are carried out in sequence until the analysis of still-valid samples is ensured, or provisions are made for resampling.

1. Attempt is made by field technician to correct the problem immediately, by referencing available service information. Samples are returned to proper storage during trouble-shooting.

2. Project manager is apprised that an equipment malfunction is disrupting normal field sampling activities. Attempts which are made to correct failure are described.

3. Project manager decides whether or not to involve outside servicing. This decision is based upon the nature of the problem and the availability of service assistance and parts.

4. Project manager assesses time required to restore proper equipment function in relation to remaining sample-holding time.

5. Project manager selects an approved alternate analytical method, if possible, which will permit completion of field activities within applicable time limits (if any).

6. Project manager makes arrangements with another equipment source to complete the field measurements within remaining holding time and by approved methodology.

7. Client is notified by project manager to advise of problem and determine course of action.

10.2 Laboratory Preventative Maintenance

Routine maintenance activities for ETC's laboratory instruments are described in Appendix A and for Battelle's in Appendix D.

10.3 Documentation

Routine maintenance procedures will be documented with checklists, and charts for recording maintenance activities will be kept for each instrument. Records of non-routine repairs will be maintained in permanent files.

Table 10-2

Laboratory Preventative Maintenance

Instrument	Activity	Frequency
ICP	Change pump tubing	Once/week
	Clean nebulizer tips	Once/week
	Change oil in vacuum	Once/year
	Clean torch	As required
	Replace water filters	As required
Conductivity Bridge	Clean conductivity cell	As needed
	Re-platenize electrodes	As needed
DO Meter	Change probe membrane	As needed
	Clean gold cathode	As needed
pH Meter	Inspect electrode junction for air bubbles	Daily
	Check for blocked junction	Daily
	Clean or recondition pH bulb	Daily
Analytical Balances	Clean pans and compartment	After every use
	Check accuracy	Annually (on contract)
Incubators/Refrigerators	Check temperature	Daily
	Check Freon® level/leaks	Annually
Ovens	Check temperature	Daily

11 Quality Control Checks

11.1 Field QC Checks

Field quality control checks are described below.

11.1.1 Equipment Blank

If equipment is cleaned in the field, one equipment blank for each matrix group will be collected and analyzed on the field-decontaminated equipment. If no equipment is cleaned, then one equipment blank that is prepared on-site on the precleaned equipment will be collected and analyzed for each matrix group.

11.1.2 QC Checks on Field Measurements

At least one duplicate measurement will be made for every 10 field measurements.

11.2 Laboratory QC Checks

11.2.1 Method Reagent Blanks

A method reagent blank is a blank of an approximate analyte-free matrix that is processed (digested, extracted, etc.) and analyzed with a specified sample set. Method reagent blanks will be prepared and analyzed at a rate of one per sample set, or five percent, whichever is greater.

11.2.2 Matrix Spikes

Matrix spikes are environmental samples selected from a set (not blanks) that are fortified to a known and validated concentration of analyte(s) before sample preparation. The concentration of each analyte in the spiking solution will be approximately at a level between three times the MDL and the mid-point of the calibration curve.

At least one matrix spike in a sample set (or five percent, whichever is greater), with common matrices will be prepared and analyzed using the specified method. If a set contains samples of different matrices, matrix spikes will be prepared and analyzed for each matrix type.

11.2.3 Quality Control Check Samples

Quality control check samples (reference materials) are samples obtained from an independent source for which the level(s) of analytes have been validated. These samples are prepared and analyzed with a sample set of similar matrix. Quality control check samples will be used when available. If not available, the spiked blank taken through the entire method will be used.

11.2.4 Quality Control Check Standards

Quality control check standards are standard solutions from a source other than normal calibration standards that are certified and traceable. These standards are used to check the accuracy of a calibration curve.

QC check standards will be analyzed at a continuing frequency equivalent to five percent of the samples in the analytical set (i.e., one every 20 samples).

11.3 Routine Procedures to Assess Precision and Accuracy

The results of the instrument readings or laboratory results (as appropriate) will be used to evaluate precision and accuracy.

11.3.1 Evaluation of Field Analytical Precision

To determine the precision of the field measurements taken, a routine program of duplicate measurements will be used to calculate the relative percent difference (RPD) to assess the degree of precision associated with field measurement systems.

The RPD is defined as:

$$\% \ RPD = \frac{\frac{|D_1 - D_2|}{D_1 + D_2}}{2} \ x \ 100\%$$

where RPD = relative percent difference
D_1 = first measurement value
D_2 = second measurement value

11.3.2 Evaluation of Field Analytical Accuracy

To determine the accuracy of the field sampling methods used, a routine program of evaluating the results of an observed measurement of a check standard against the true concentration of such a standard shall be used. The result of these evaluations will be used to calculate percent recovery (percent R).

The percent R is defined as:

$$\% \ R = \frac{observed}{true} \ x \ 100\%$$

11.3.3 Evaluation of Field Completeness

Completeness is defined as the percentage of valid data obtained as judged by the data quality objectives compared to the total amount of data required to be collected. Completeness is calculated for each field measurement/analysis in the following manner:

$$C = V/D \times 100$$

where C = percent completeness
V = number of valid sample measurements/results
D = number of total sample measurements/results required

It is expected that at least 95 percent of the determinations will be complete. Certain sample types may require different levels of completeness, which will be identified in specific project plans.

11.3.4 Evaluation of Laboratory Analytical Precision (ETC)

These procedures are described in Appendix A.

11.3.5 Evaluation of Laboratory Analytical Accuracy (ETC)

These procedures are described in Appendix A.

11.3.6 Evaluation of Battelle's Precision and Accuracy

These procedures are described in Appendix D.

12 Data Reduction, Validation and Reporting

12.1 Data Reduction

The field technician/lab analyst will be responsible for reading charts and/or interpreting instrument output and raw concentration data. Standard curves, determined by linear regression of standard concentration with peak height (or equivalent output), will be used to calculate sample concentrations. Other parameters (e.g., sample dilution, sample weight, extract volume) will be factored in, to arrive at corrected concentration values. Field measurement data will also be entered into spreadsheets for tabulation and analysis. Data entry will be performed by the analyst, technicians, or project managers. It will be the responsibility of each project manager to insure that data are entered accurately and on time.

12.2 Data Validation

12.2.1 Data Integrity

Field technicians/lab analysts and, ultimately, project managers, will be responsible for the following tasks associated with checking data integrity:

- Checking raw data entries and calculations.
- Checking sample preparation log books.
- Checking analytical log books.
- Checking calibration integrity.

These tasks apply to both field measurements and laboratory analyses.

13 Corrective Actions

A nonconformance is any procedure, event, reading or measurement which is outside the limits established for field or laboratory operations.

As a result of a nonconformance, whether identified by the project quality control officer, by the sampling technician, or by an auditor, a corrective action shall be implemented. Any one of the individuals indicated above can initiate a corrective action, if necessary.

Corrective actions are generally of two kinds:

- Immediate, to recalibrate or repair nonconforming equipment. The need for such an action will most frequently be identified by the field technician.
- Long-term, to eliminate causes of nonconformance and to minimize the possibility of their recurrence. These are usually system-related issues that may be identified as the result of quality control reports associated with one or more projects.

Field corrective action procedures are detailed in Table 13-1. Laboratory corrective action procedures are detailed in Appendix A with recommended laboratory corrective actions indicated on Table 13-2.

A corrective action consists of an evaluation of a nonconforming situation that threatens the outcome of a procedure, event, reading or measurement. Upon recognition of the problem, the field/lab technician will review his procedure for apparent errors, recalibrate the instrument used for measurement and remeasure.

Table 13-1

Recommended Field Corrective Actions

QC Activity	Acceptance Criteria	Recommended Corrective Action
Instrument Zero	Must zero	Reset zero: if same response, determine cause.
Initial Calibration	Standard concentration $\pm$5% of expected value	Reanalyze standards; if still unacceptable, use new standards. If equipment malfunctions, notify project manager.
QC Check Standard	$\pm$ 5% of expected value	Reanalyze standard; if still unacceptable, use new standards. If equipment malfunctions, notify project manager.
Continuing Calibration (cc)	$\pm$ 5% of expected values	Reanalyze standard; if unacceptable, recalibrate equipment and rerun samples from last cc standard check. If equipment malfunctions, notify project manager.

Table 13-2

Recommended Laboratory Corrective Action

EPA Method*	QC Procedure	Frequency	Acceptance Criteria	Corrective Action	Comments
200.7/6010 ICP	1. Initial 2-point calibration	1. Each 8-hour shift.	1. Manufacturer's specification; high standard must be >10xPQL.	1. Return before samples.	
	2. ICV/CCV	2. Initial, every 10 samples, end of run.	2. 90-110% of expected value.	2. Rerun before samples.	
	3. ICB/CCB	3. Initial, every 10 samples, end of run.	3. ±PQL	3. Rerun before samples.	
	4. Interference Check A and AB (ICA and ICAB)	4. Each 8-hour shift and end of run.	4. 80-120% of expected value.	4. Rerun before samples.	
	5. CRI Standard	5. Each 8-hour shift and end of run.	5. Report only.	5. None.	
	6. Method Blank	6. Each batch of ≤20.	6. Results <PQL for target analytes, <x5 PQL for common lab contaminants.	6. Correct cause of interference, redigest, rerun batch.	
	7. Blank Spike	7. Each batch of ≤20.	7. Table 3.1 (Appendix A).	7. Check MS and MSD. If both are out, redigest, rerun batch.	
	8. MS/MSD	8. Each batch of ≤20.	8. Table 3.1 (Appendix A).	8. Check blank spike, if okay, and RPD within limits, matrix interference suspect; report.	
200 Series/7000 Series GFAA	1. Initial 4-point or 5-point calibration.	1. Each day of analysis.	1. Coefficient ≥0.995.	1. Rerun before samples.	Number of points in calibration curve dependent on instrumentation used.
	2. ICV/CCV	2. Initial, every 10 samples, end of run.	2. 85-115% of expected value.	2. Rerun before samples.	
	3. ICB/CCB	3. Initial, every 10 samples, end of run.	3. ±PQL	3. Rerun before samples.	
	4. CRA Standard	4. Initial.	4. Report only.	4. None.	
	5. Method Blank	5. Each batch of ≤20.	5. Results <PQL for target analytes, <x5 PQL for common lab contaminants.	5. Correct cause of interference, redigest, rerun batch.	
	6. Blank Spike	6. Each batch of ≤20.	6. Table 3.1 (Appendix A).	6. Check MS and MSD. If both are out, redigest, rerun batch.	
	7. MS/MSD	7. Each batch of ≤20.	7. Table 3.1 (Appendix A).	7. Check blank spike, if okay, and RPD within limits, matrix interference suspect; report.	

Table 13-2 (*Continued*)

EPA Method*	QC Procedure	Frequency	Acceptance Criteria	Corrective Action	Comments
	3. Blank Spike	3. Each batch of ≤20.	3. Table 3.1 (Appendix A).	3. Check MS and MSD. If both are out, rerun batch.	
	4. MS/MSD	4. Each batch of ≤20.	4. Table 3.1 (Appendix A).	4. Check blank spike, if okay, and RPD within limits, matrix interference suspect; report.	
180.1 Turbidity Meter	1. Three-point calibration (primary).	1. Once per batch.	1. Within 5% of expected.	1. Rerun before samples.	
	2. Three-point calibration (secondary).	2. Once per batch.	2. Within 5% of expected.	2. Rerun before samples.	
Balances	1. Weigh S-weight.	1. Daily.	1. Manufacturer's criteria (inside notebook).	1. Call for balance service.	
	2. Contract service.	2. Yearly.	2. Manufacturer's criteria.	2. Repair balance or remove from use.	
Refrigerators	1. Temperature reading.	1. Daily.	1. 4°C ±2 for refrigerators, 15°C ±2 for freezers.	1. Replace.	
S-Weights	1. Calibrated against NIST weights.	1. Yearly.	1. ASTM Method S-weight standard.	1. Remove from use.	
Thermometers	1. Lab therm. calibrated against NIST.	1. Yearly.	1. Must compare with expected temperature.	1. Note correction on thermometer tag.	
	2. NIST calibrated.	2. Yearly.	2. Must compare with expected temperature.	2. Use corrected temperature when calibrating lab thermometers.	

*Please see Table 6.1 for cross-reference of parameters and EPA method numbers. This table describes most commonly-used methods used at ETC-Santa Rosa. For methods not given, please contact the laboratory for specific criteria.

ABBREVIATIONS:

CCB = Continuing Calibration Blank
CCV = Continuing Calibration Verification
CRA = Standard at Level of Contract Required Detection Limits for GFAA
CRI = Standard at Level of Contract Required Detection Limits for ICP
GFAA = Graphite Furnace Atomic Absorption
IC = Ion Chromatograph
PQL = Practical Quantitation Limit
ICB = Initial Calibration Blank
ICP = Inductively Coupled Plasma
ICV = Initial Calibration Verification
MS = Matrix Spike
MSD = Matrix Spike Duplicate
RPD = Relative Percent Difference
UV/Vis Spec = Ultraviolet/Visible Spectrophotometer
ASTM = American Society for Testing and Materials

Table 13-2 (*Continued*)

EPA Method*	QC Procedure	Frequency	Acceptance Criteria	Corrective Action	Comments
365.3, 410.4, 9010, 9038 UV/Vis Spec	1. Initial 5-point calibration.	1. Initial, when CCV fails.	1. Correlation coefficient ≥0.995.	1. Rerun before samples.	
	2. ICV/CCV	2. Initial, every 10 samples.	2. 90-110% of expected value.	2. Rerun 5-point curve before samples.	
	3. ICB/CCB	3. Initial, every 10 samples.	3. ±PQL	3. Rerun before samples.	
	4. Method Blank	4. Each batch of ≤20.	4. Results <PQL.	4. Correct cause of interference, rerun batch.	
	5. Blank Spike	5. Each batch of ≤20.	5. Table 3.1 (Appendix A).	5. Check MS and MSD. If both are out, rerun batch.	
	6. MS/MSD	6. Each batch of ≤20.	6. Table 3.1 (Appendix A).	6. Check blank spike, if okay, and RPD within limits, matrix interference suspect; report.	
300.0, 9056 IC	1. Initial 5-point calibration.	1. Quarterly.	1. Correlation coefficient ≥0.995.	1. Rerun before samples.	
	2. ICV/CCV	2. Initial, every 10 samples, end of run.	2. 90-110% of expected value.	2. Rerun before samples.	
	3. ICB/CCB	3. Initial, every 10 samples, end of run.	3. ±PQL	3. Rerun before samples.	
	4. Method Blank	4. Each batch of ≤20.	4. Results <PQL	4. Correct cause of interference, rerun batch.	
	5. Blank Spike	5. Each batch of ≤20.	5. Table 3.1 (Appendix A).	5. Check MS and MSD. If both are out, rerun batch.	
	6. MS/MSD	6. Each batch of ≤20.	6. Table 3.1 (Appendix A).	6. Check blank spike, if okay, and RPD within limits, matrix interference suspect; report.	
150.1, 9040, 9045 pH Meter	1. Three buffers to calibrate, 4-7 and 7-10, 5-point for F.	1. Daily.	1. Manufacturer's specification, >0.995 correlation coefficient for F.	1. Rerun before samples.	
	2. Replicates.	2. Each batch of ≤20.	2. Table 3.1 (Appendix A).	2. Rerun batch	
130.2, 310.1, 350.2, 351.3 Std Sol'n	1. H_2SO_4, NaOH Standardization.	1. Once per batch.	1. Within 5% of expected.	1. Re-prepare standard, re-standardize, rerun batch.	
	2. Method Blank	2. Each batch of ≤20.	2. Results <PQL.	2. Correct cause of error, rerun batch.	

If this does not result in correction of the problem, the field technician/lab analyst will bring the problem to the attention of the project manager who will determine the proper correction action. If significant time or costs are involved, the project manager will contact the client for approval of the corrective action indicated. An investigation as to the causes and solutions will be undertaken at the direction of the Foth & Van Dyke quality assurance officer. The corrective action will be incorporated into the appropriate procedures to minimize the possibility of recurrence.

In either case, occurrence of the problem, corrective action taken and verification of problem resolution must be documented. Documentation of the corrective action will be made in the field/lab log book.

14 Performance and System Audits

14.1 Systems Audits

A system audit determines that each element within an activity is functioning appropriately and is within the guidelines specified by the QA plan. These types of audits will be conducted on field sampling, preservation, shipping and equipment calibration/cleaning procedures by the project quality control officer. These audits will be conducted during the life of this project. If this project lasts more than one year, such audits will be performed at least once annually. A systems audit will include a review of the sampling/analysis plan, sample collection/measurement methods, sampling protocol, field chain-of-custody procedures, field documentation methods and sample identification methods.

14.2 Performance Audits

These types of audits may be conducted on field or laboratory activities. Foth & Van Dyke reserves the right to audit laboratories used for analyses on a regular basis or if there are inappropriate trends in the laboratory data, major changes in personnel, and/or discrepancies in quality control samples. These audits will be conducted at the request of and under the supervision of the Foth & Van Dyke quality assurance officer.

15 Quality Assurance Records

Records shall be maintained to provide evidence of quality assurance activities. All activities which indicate an out-of-control situation will be evaluated. Corrective action taken will be documented. This documentation will be in the project log book (field records) or in formal memos, letters, or notifications which are part of the project file.

Appendix C

Pertinent Permits

State of Wisconsin
Department of Natural Resources
Box 7921
Madison, Wisconsin 53707

PERMIT FOR ENDANGERED AND THREATENED SPECIES
Form 1700-2 Rev. 3-90

The below named person is authorized by the Wisconsin Department of Natural Resources, pursuant to section 29.415, Wis. Stats., and chapter NR 27, Wis. Adm. Code, to conduct a survey of all listed macroinvertebrates (type of activity) for zoological, educational or scientific purposes, or propagation for preservation.

		DNR Permit Number: 315	DNR Metal Tag Number:
Permittee's Name: William M. West		Date DNR Permit Issued: October 21, 1993	Date DNR Permit Expires: December 31, 1994
Street or Route: 2737 S. Ridge Rd., P.O. Box 19012		Federal Permit Number:	Date Federal Permit Expires:
City, State, Zip Code: Green Bay, WI 54307-9012		County(ies) of Activity: Forest/Langlade	Telephone Number (incl. area code): 414/497-2500
Date of Birth (month-day-year): 5/16/51	Color of Eyes: Blue	Color of Hair: Blond	Weight: 170 lbs.	Height: 5' 8"

Name and Number of Specimens or Description of Item

Conduct surveys for Endangered and Threatened species of aquatic macroinvertebrates per the specifications of the work plans agreed to at the CMC/WDNR meeting of October 14, 1993 in Rhinelander, WI.

Source of Species or Item: Swamp and Pickerel Creek chains; Wolf River	Where Species or Item Will Be Kept: Voucher specimens will be held temporarily for identification, then forwarded to Bill Smith, WDNR.
Method of Taking and/or Transporting: Per approved work plan.	During the Following Period of Time: October 1993 - December 1994; permit to be renewed annually.

Purpose of Obtaining or Collecting

To determine the presence or absence and relative abundance of Endangered and Threatened species, and special concern species in the area of the Crandon Mine Site and zone of influence.

Final Disposition of Specimens

Live specimens will be identified and where possible, returned to the location found. Damaged specimens or voucher specimens should be preserved and sent to Bill Smith, Bureau of Endangered Resources.

Scientific Qualification of Permittee

M.S. Limnology

Additional Conditions of This Permit

SEE ATTACHED PAGE 2 WHICH IS A PART OF THIS PERMIT.

I hereby certify that I have read, am familiar, and agree to comply with the regulations described herein. This permit is not transferable and must be exhibited to any authorized agent of the Department of Natural Resources on demand.

State of Wisconsin Department of Natural Resources For the Secretary By Charles M. Pils	Permittee's Signature William M West

Additional Conditions of this Permit:

1. This permit is not valid unless signed by both parties.

2. Permittee is required to provide on site supervision of all work activities conducted under the authority of this permit.

3. In addition to reporting requirements specified in the approved work plans, an annual report for the Endangered/Threatened Species Permit is required by January 15, 1994 and for each year thereafter that the permit is in effect. A notice and report form will be mailed to you, and should be returned directly to the Bureau of Endangered Resources, P.O. Box 7921, Madison, WI 53707.

4. SUBPERMITTEE: Ken Tennessen

State of Wisconsin
Department of Natural Resources

SCIENTIFIC COLLECTORS PERMIT
Form 9400-380 4-88

The below named person is authorized by the Wisconsin Department of Natural Resources, pursuant to section 29.17, Wis. Stats., and section NR 19.11, Wis. Adm. Code, to collect for scientific purposes only. The permit authority may cover migratory birds, but may not be exercised without an appropriate federal permit issued by the U.S. Fish and Wildlife Service.

Permittee's Name	Agency or Organization	
William M. West	Foth & Van Dyke	
Street or Route	Federal Permit No. (if any)	Date Federal Permit Expires
P.O. Box 19012		
City, State, Zip Code	Telephone Number (include area code)	
Green Bay, Wisconsin 54307-9012	Business 414-497-2500	Home 414-730-0684

Date of Birth (M-D-Y)	Color Eyes	Color Hair	Weight	Height	Sex
May 16, 1951	Blue	Blond	170	5' 8"	[X] Male [ ] Female

Species, Age or Size Class*, and Number of Specimens or Description of Items to be Collected:

Aquatic Macroinvertebrates
Odonata
Mussels

*For game fish and panfish species list young-of-year separately from larger length range

Purpose for Collecting	Where Specimens or Items Will be Kept for Study
Determine presence/absence of threatened, endangered, or species of concern in area of Crandon Mine site or zone of influence.	Mussels returned to stream. Voucher specimens at UW-Green Bay
Method(s) of Collecting	**Collection Period**
Boomshocking, pram shocking, backpack electrofishing & seining for smaller streams; boat mounted electroshocker on Wolf River & lakes with a boat landing.	1993

Location of Collecting Site(s) - County for all sites; waters for aquatic collections and civil township for all others

Forest/Langlade Counties - Swamp and Pickerel Creek Chains, Wolf River

Final Disposition of Specimens or Items

Live specimens keyed and released; voucher specimens kept at UW-Green Bay herbarium.

Special Conditions of this Permit

NOTIFY County Warden prior to any collection. Forest County - Rick Koch, (715)674-7020
Langlade County - Bill Lazarz, (715)627-4317

Individuals included in this permit: Ken Tennessen
Don Helms
Ron Steg

DNR Fish Manager, Max Johnson, P.O. Box 310, Antigo, WI 54409, (715)627-4317, is to be kept informed of location by providing name of water body and quarter section, section, township, range and date of survey 24 hours prior to start of activity for work in the Langlade County area.

I hereby certify that I have read, am familiar and agree to comply with the regulations described herein. This permit is not transferable and must be exhibited to any authorized agent of the Department of Natural Resources on demand. An annual report is due by January 10 of each year.

Permittee's Signature (Permit Valid Only When Signed)	Date Signed
William M West	10/27/93

DNR Permit Number	Date DNR Permit Number
SCP-NC-49-93	October 7, 1993
	Date DNR Permit Expires: December 31, 1993

State of Wisconsin
Department of Natural Resources
FOR THE SECRETARY
By A. E. Lawrence Date Signed 10/25/93

cc: Bureau of Research, Madison
District Headquarters, Rhinelander
Archie Wilson, Rhinelander
Area Warden-Woodruff, Antigo
Area Fish Manager-Woodruff, Antigo

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES
George E. Meyer, Secretary
Box 7921
Madison, Wisconsin 53707
TELEFAX NO. 608-267-3579
TDD NO. 608-267-6897

October 27, 1993

File Ref : 2720-1

Mr. Don Moe, Technical/Permitting Manager
Crandon Mining Company
P. O. Box 856
7 North Brown Street
Rhinelander, WI 54501-0856

Dear Mr. Moe:

Enclosed is the Metallic Mineral Exploration License issued to your firm by the Department of Natural Resources, pursuant to ss. 144.80 to 144.94, Wis. Stats., and Chapter NR 130, Wisconsin Administrative Code. The license is effective for the period October 27, 1993 through June 30, 1994.

Sincerely,

Gordon H. Reinke

Gordon H. Reinke, Coordinator
Mine Reclamation Unit
Bureau of Solid and Hazardous Waste Management

LJL:pc
Enc.
cc: T. Evans - WGNHS(applic. & license)
K. Markart - NCD

State of Wisconsin
Dept. of Natural Resources

METALLIC MINERAL EXPLORATION LICENSE

ISSUED TO:

FOR THE PERIOD:
October 27, 1993 through June 30, 1994

Crandon Mining Company
P. O. Box 856
7 North Brown Street
Rhinelander, WI 54501-0856

Metallic Mineral Exploration conducted by the Licensee in Wisconsin shall be in compliance with and is subject to the restrictions and penalties provided in Chapter NR 130, Wisconsin Administrative Code, and Sections 144.80 to 144.94, Wisconsin Statutes.

LICENSE NUMBER 37

DATE OF ISSUANCE October 27, 1993

George E. Meyer

GEORGE E. MEYER, SECRETARY
DEPARTMENT OF NATURAL RESOURCES

WISCONSIN
DEPT. OF NATURAL RESOURCES

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

101 South Webster Street
Box 7921
Madison, Wisconsin 53707
TELEPHONE 608-266-2621
TELEFAX 608-267-3579
TDD 608-267-6897

PLEASE READ CAREFULLY
AND COMPLY WITH
THE CONDITIONS OF APPROVAL

November 8, 1993 File Number: 21-3-0001

Mr. K. W. Collison
Crandon Mining Company
P.O. Box 336
Crandon, WI 54520

SUBJECT: Conditional Approval for Temporary Well Reactivation, Forest County, Wisconsin

Dear Mr Collison:

The Division for Environmental Quality, Bureau of Water Supply, has reviewed the letter you submitted on November 1, 1993. Your letter proposes the temporary activation of Crandon Mining Company wells 1 and 2 for the purpose of providing drilling water for the drilling of about 13 test holes on the Mineral Company property. We further understand that this test boring drilling is expected to be conducted over the next 6 months, after which the temporary pumps will be removed and wells resealed with the watertight, locking caps.

Both 8 inch diameter, steel cased, wells are expected to be fitted with 25 gallon per minute maximum capacity, submersible pumps to provide as much as 50 gallons per minute (cumulative flow) on an intermittent basis for the test boring drilling operations. The wells are located as noted in the following table:

Well #	Location	Civil Town, County
001	NE¼ SE¼ S30 T35N R13E	Lincoln, Forest
002	SE¼ SE¼ S25 T35N R12E	Nashville, Forest

Because the operation of the two existing, low capacity, non-potable water supply are not expected to influence groundwater availability to any public utility well, the proposed temporary operation of both wells is hereby approved, as described in this approval, subject to the conditions noted below. Approval by the Department does not relieve the property owner or well operator of any liability which may result from injury or damage suffered by any person upon operation of the wells.

1. A sign stating "WATER FROM THIS WELL SHALL NOT BE USED FOR HUMAN CONSUMPTION OR FOR THE WASHING OR PREPARATION OF FOOD PRODUCTS" shall be posted at the site of each well and maintained in a legible condition during test boring operations.

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2. If the discharge piping of either well is not continuously pressurized, an Underwriter's Laboratory (UL) approved check valve and an air-vacuum relief valve shall be installed in the pump discharge pipe of the affected well near the pump.

3. A Department approved model of a vented, vermin-proof well cap conforming to the requirements of Section 112.30, Wis. Adm. Code shall be fitted to each well, at the time the well is operational for test boring operations.

4. Upon completion of the test boring operations, both low capacity supply wells shall be temporarily abandoned with the placement of locking, water-tight steel capping plates. The completion of this work shall be reported to the DNR Bureau of Water Supply (P.O. Box 7921, Madison WI 53707) within 30 days of completing the test boring work.

If you believe that you have a right to challenge this decision, you should know that Wisconsin statutes and administrative rules establish time periods within which requests to review Department decisions must be filed. For judicial review of a decision pursuant to sections 227.52 and 227.53, Stats., you have 30 days after the decision is mailed, or otherwise served by the Department, to file your petition with the appropriate circuit court and serve the petition on the Department. Such a petition for judicial review must name the Department of Natural Resources as the respondent.

To request a contested case hearing pursuant to section 227.42, Stats., you have 30 days after the decision is mailed, or otherwise served by the Department, to serve a petition for hearing on the Secretary of the Department of Natural Resources. The filing of a request for a contested case hearing is not a prerequisite for judicial review and does not extend the 30 day period for filing a petition for judicial review. This notice is provided pursuant to section 227.48(2), Stats.

STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES
For the Secretary:

James F. Scharch, P.E.
Private Water Supply Section

William T. Rock, P.E., Chief
Private Water Supply Section
Bureau of Water Supply

Enclosure: Approved Wellhead Equipment Catalog

cc: North Central District
WGS - Roger Peters
Bill TAns - EA/6

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
180 E. KELLOGG BLVD., ROOM 1421
ST. PAUL, MINNESOTA 55101-1479

January 20, 1994

REPLY TO
ATTENTION OF
Construction-Operations
Regulatory (94-02119-NW-MOK)

Mr. Ronald F. Steg
Foth & Van Dyke
2737 S. Ridge Road
PO Box 19012
Green Bay, Wisconsin 54307-9012

Dear Mr. Steg:

We have reviewed the information provided us about a project of the Crandon Mining Company to install temporary monitoring wells and soil borings in lakes and wetlands (see Enclosure 1 and 2).

This work is eligible for authorization by a Department of the Army nationwide permit referenced below and described in the enclosures, provided the enclosed conditions are followed. Also, the Wisconsin Department of Natural Resources (WDNR) shall be allowed reasonable entry and access to inspect any discharge for compliance with applicable state laws. You should notify the WDNR within five days prior to, and again five days following the discharge.

This determination covers only your project as described in the attached enclosures. If the design, location, or purpose of the project is changed, you should contact us to make sure the work would not result in a violation of Federal law.

It is your responsibility to ensure that the work complies with the terms of this letter and the enclosures AND TO OBTAIN ALL REQUIRED STATE AND LOCAL PERMITS AND APPROVALS BEFORE YOU PROCEED WITH THE WORK.

If you have any questions, contact Mike O'Keefe in our Stevens Point (Plover) office at (715) 345-7911.

Sincerely,

Ben Wopat
Chief, Regulatory Branch
Construction-Operations Division

Enclosures
Nationwide permit conditions

Determination: 33 CFR 330-App. A, Nationwide permit number (5) & (6)
Copy furnished to:
Mr. Jack Smith, WDNR-Woodruff office, Woodruff, WI
Mr. Don Moe, Crandon Mining Company, Rhinelander, WI

Item 5: Wetland Drilling Locations

	Township	Waterway	County	Township	Range	Section
[a]Duck Lake Wetland						
CMC-DL-103	Lincoln	Duck Lake	Forest	35N	13E	SE1/4, Sec 31
CMC-DL-104	Lincoln	Duck Lake	Forest	35N	13E	NE1/4, Sec 31
[a]Skunk Lake Wetland						
CMC-SL-103	Lincoln	Skunk Lake	Forest	35N	13E	SE1/4, Sec 30
CMC-SL-104	Lincoln	Skunk Lake	Forest	35N	13E	SE1/4, Sec 30
[a]Swamp Creek						
CMC-SC-101	Nashville	Swamp Creek	Forest	35N	12E	SW1/4, Sec 24
CMC-SC-102	Nashville	Swamp Creek	Forest	35N	12E	SW1/4, Sec 24
[a,b]Swamp Creek Cedars						
CMC-SCC-101	Lincoln	Swamp Creek	Forest	35N	13E	NE1/4, Sec 30
CMC-SCC-102	Lincoln	Swamp Creek	Forest	35N	13E	NE1/4, Sec 30
[a,b]Bur Oak Swamp						
CMC-BO-101	Lincoln	None	Forest	35N	13E	SW1/4, Sec 29
CMC-BO-102	Lincoln	None	Forest	35N	13E	SW1/4, Sec 29

[a]Exact locations to be selected based on field conditions and site reconnaissance visit.
[b]Are not within 500 feet of ordinary high water mark of any waterway.

Item 5: Lake Bed Drilling Location

	Township	Waterway	County	Township	Range	Section
CMC-LSL-101	Lincoln	Little Sand Lake	Forest	35N	13E	SE1/4, NW1/4, Sec 31
CMC-LSL-102	Lincoln	Little Sand Lake	Forest	35N	13E	NE1/4, NW1/4, Sec 31
CMC-LSL-103	Lincoln	Little Sand Lake	Forest	35N	13E	SW1/4, NW1/4, Sec 31
CMC-LSL-104	Nashville	Little Sand Lake	Forest	35N	12E	NE1/4, SE1/4, Sec 36
CMC-LSL-105	Lincoln	Little Sand Lake	Forest	34N	13E	NW1/4, NW1/4, Sec 6
CMC-LSL-106	Lincoln	Little Sand Lake	Forest	35N	13E	SE1/4,SW1/4, Sec 31
CMC-LSL-107	Lincoln	Little Sand Lake	Forest	35N	13E	NW1/4, SW1/4, Sec 31
CMC-DHL-101	Lincoln	Deep Hole Lake	Forest	34N	13E	NW1/4, NW1/4, Sec 5
CMC-DHL-102	Lincoln	Deep Hole Lake	Forest	34N	13E	NE1/4, SE1/4, Sec 6
CMC-DHL-103	Lincoln	Deep Hole Lake	Forest	34N	13E	SW1/4, NE1/4, Sec 6
CMC-DL-101	Lincoln	Duck Lake	Forest	35N	13E	SE1/4, SE1/4, Sec 31
CMC-DL-102	Lincoln	Duck Lake	Forest	35N	13E	NW1/4, SW1/4, Sec 32
CMC-SL-101	Lincoln	Skunk Lake	Forest	35N	13	NW1/4, SE1/4, Sec 30
CMC-SL-102	Lincoln	Skunk Lake	Forest	35N	13	NE1/4, SE1/4, Sec 30

B. Nationwide Permit

5. Scientific Measurement Devices. Staff gages, tide gages, water recording devices, water quality testing and improvement devices and similar structures. Small weirs and flumes constructed primarily to record water quantity and velocity are also authorized provided the discharge is limited to 25 cubic yards and further for discharges of 10 to 25 cubic yards provided the permittee notifies the District Engineer in accordance with "Notification" general condition. (Sections 10 and 404)

REGIONAL CONDITIONS FOR THE STATE OF WISCONSIN:

A. If WDNR permits or approvals are required for the entire project; or coordination is in accordance with established WDNR/WDOT liaison procedures, the work is authorized by this nationwide permit.

B. If WDNR permits or approvals are NOT required for the entire project; or coordination in accordance with established WDNR/WDOT liaison procedures is NOT required, all excavated or dredged material shall be confined to containers or hauled to an upland site. Temporary stockpiling is not allowed under this NWP.

Construction-Operations
Regulatory (94-02119-NW-MOK)

Enclosure

B. Nationwide Permit

6. Survey Activities. Survey activities including core sampling, seismic exploratory operations, and plugging of seismic shot holes and other exploratory-type bore holes. Drilling and the discharge of excavated material from test wells for oil and gas exploration is not authorized by this nationwide permit; the plugging of such wells is authorized. Fill placed for roads, pads, and other similar activities is not authorized by this nationwide permit. The discharge of drilling muds and cuttings may require a permit under Section 402 of the Clean Water Act. (Sections 10 and 404)

WISCONSIN
DEPT. OF NATURAL RESOURCES

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Woodruff Area Headquarters
8770 Hwy J
Woodruff, Wisconsin 54568
TELEPHONE 715-356-5211
TELEFAX 715-358-2352

George E. Meyer
Secretary

February 1, 1994

File Ref: 3-NC-94-3005

Crandon Mining Company
P.O. Box 856
Rhinelander, WI 54501-0856

Dear Mining Company:

Enclosed are three copies of a contract authorizing you to conduct lakebed drillings in Forest County.

One copy is for your records, one is to be retained at the site of the project, and the other is to be signed by you as applicant, agreeing to the terms of the contract, notarized, and returned to this office.

Please read this dredging contract carefully as the Department will require strict compliance with all provisions therein. We call your attention especially to paragraph 9 of the contract relative to the restrictions of the disposal of the material.

If the project is not completed by the expiration date of March 1, 1994, an extension may be requested from the area office. This request must be made prior to the contract expiration date.

Please notify the Department not less than five days before dredging begins and again when completed. This may be done by contacting me. Please use the enclosed postcards for this purpose.

Sincerely,

NORTH CENTRAL DISTRICT

Jack A. Smith
Water Management Specialist

JAS:lw
\WZ\DREDGECV.WZ
Enclosures

cc: Dale Lang, Rhinelander District Office

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Crandon Mining Company
P.O. Box 856
Rhinelander, WI 54501-0856

CONTRACT 3-NC-94-3005

Crandon Mining Company has been granted a contract according to Section 30.20, Wis. Stats., to conduct lakebed and wetland drilling for hydrologic investigations in Forest County in the locations listed below, subject to the following conditions:

LOCATION	TOWNSHIP	WATERWAY	TWN	RANGE	SECTION
CMC-DL-103	LINCOLN	DUCK LAKE WETLAND	35N	13E	NE¼ SE¼ SEC 31
CMC-CL-104	LINCOLN	DUCK LAKE WETLAND	35N	13E	NE¼ SE¼ SEC 31
CMC-SL-103	LINCOLN	SKUNK LAKE WETLAND	35N	13E	NE¼ SE¼ SEC 30
CMC-SL-104	LINCOLN	SKUNK LAKE WETLAND	35N	13E	NE¼ SE¼ SEC 30
CMC-SC-101	NASHVILLE	SWAMP CREEK WETLAND	35N	12E	SE¼ SW¼ SEC 24
CMC-SC-102	NASHVILLE	SWAMP CREEK WETLAND	35N	12E	SE¼ SW¼ SEC 24
CMC-LSL-101	LINCOLN	LITTLE SAND LAKE	35N	13E	SE¼ NW¼ SEC 31
CMC-LSL-102	LINCOLN	LITTLE SAND LAKE	35N	13E	NE¼ NW¼ SEC 31
CMC-LSL-103	LINCOLN	LITTLE SAND LAKE	35N	13E	SW¼ NW¼ SEC 31
CMC-LSL-104	NASHVILLE	LITTLE SAND LAKE	35N	12E	NE¼ SE¼ SEC 36
CMC-LSL-105	LINCOLN	LITTLE SAND LAKE	34N	13E	NW¼ NW¼ SEC 6
CMC-LSL-106	LINCOLN	LITTLE SAND LAKE	35N	13E	SE¼ SW¼ SEC 31
CMC-LSL-107	LINCOLN	LITTLE SAND LAKE	35N	13E	NW¼ SW¼ SEC 31
CMC-DHL-101	LINCOLN	DEEP HOLE LAKE	34N	13E	NW¼ NW¼ SEC 5
CMC-DHL-102	LINCOLN	DEEP HOLE LAKE	34N	13E	NE¼ SE¼ SEC 6
CMC-DHL-103	LINCOLN	DEEP HOLE LAKE	34N	13E	SW¼ NE¼ SEC 6
CMC-DL-101	LINCOLN	DUCK LAKE	35N	13E	SE¼ SE¼ SEC 31
CMC-DL-102	LINCOLN	DUCK LAKE	35N	13E	NW¼ SW¼ SEC 32
CMC-SL-101	LINCOLN	SKUNK LAKE	35N	13E	NW¼ SE¼ SEC 30
CMC-SL-102	LINCOLN	SKUNK LAKE	35N	13E	NE¼ SE¼ SEC 30

1. This contract expires on March 1, 1994; osprey nests located in the vicinity of several drilling locations. No construction may begin or continue after this date unless a new contract or contract extension is granted in writing by the Department.

2. You must complete this project according to the plans you submitted. If you wish to make changes in the project, you must submit your new plans to the Department. The Department then must approve the changes in writing before you start or continue your project.

3. You are responsible for obtaining any permit or approval required for your project under other State Statutes, Administrative Codes or by municipal, town or county zoning ordinances and by the U.S. Army Corps of Engineers before starting your project.

4. You must allow free and unlimited access to your project site at any time to any Department employee who is investigating the project's construction, operation or maintenance.

5. The Department may change or revoke this contract if the project obstructs navigation or becomes detrimental to the public interest.

6. Your accepting this contract and beginning the project means that you have read, understand and agree to follow all conditions of this contract.

7. You must provide a copy of this contract to your contractor and keep a copy at the project site at all times until the project has been completed.

8. You must notify Jack Smith, 8770 Hwy J, Woodruff, WI 54568, in writing at least five days before starting your project and again five days after completing it.

9. You must place all of the removed materials in the upland location shown on your application. None of the removed materials may be deposited or stored upon any part of the bed of the waterway below the ordinary high-water mark or in any wetland.

10. You are only allowed to dredge in the locations shown on your application.

11. You must perform the removal under the direction of the Department if it becomes necessary to protect the navigable waters involved.

12. The removal of vegetative cover and exposure of bare ground must be restricted to the minimum amount necessary for construction. Areas of exposed soil must be protected from erosion by seeding and mulching, riprap, sodding, diversion of surface runoff, installation of straw bales or silt screens, construction of settling basins, or similar methods as soon as possible after removal of the original ground cover and before construction is completed.

13. You must contain all drilling fluids and cuttings in a closed system to ensure that no adverse environmental impacts to the lakes or adjacent wetlands result from your dredging activities.

14. You must clearly mark any obstructions above the ice or wetland surface with reflectorized ribbon or tape placed on a tripod no less than 3½ feet above the surface.

15. This permit has been issued with the understanding that any construction equipment used is the right size to do the job, and can be brought to and removed from the project's site without unreasonable harm to vegetative cover or fish or wildlife habitat. This permit may be rescinded or revoked if the Department determines that the conditions of this permit have not been followed or if it finds the activity to be detrimental to the public interest.

16. You must comply with Section 16.765, Wisconsin Statutes, the provisions of which shall be deemed to incorporated herein the same as if copied herein in full. Subsection 2(a) thereof requires that:

(2)(a) In connection with the performance of work under this contract, the contractor agrees not to discriminate against any employe or applicant for employment because of age, race, religion, color, handicap, sex, physical conditions, developmental disability as defined in s. 51.434(1) or national origin. This provision shall include, but not be limited to the following: employment, upgrading, demotion or transfer, recruitment or recruitment advertising, layoff or termination, rates of pay or other forms of compensation, and selection for training, including apprenticeship. The contractor further agrees to take affirmative action to ensure equal employment opportunities for persons with physical disabilities. The contractor agrees to post in conspicuous places, available for employees and applicants for employment, notices to be provided by the contracting officer setting forth the provision of the non-discrimination clause.

FINDINGS OF FACT (These are the facts which the Department considered in making its decision.)

1. The project is as described in the permit and plans, and the project site has been investigated by Department staff.

2. The proposed project will not adversely affect water quality, will not increase water pollution in surface waters and will not cause environmental pollution as defined in Section 144.01(3), Wisconsin Statutes, if the dredging is done in accordance with the plans submitted.

3. The Department has determined that the grant or denial of this permit would not be a major state action significantly affecting the quality of the human environment.

4. The proposed project will not adversely impact wetlands as defined in Section NR 103 Wisconsin Administrative Code.

5. The Department has complied with the requirements of ch. NR 150 and s. 1.11, Stats.

6. Consistent with social, economic, and other essential considerations, the Department has adopted all practical means to avoid or minimize environmental harm.

7. The Department of Natural Resources and the applicant have completed all procedural requirements and the project as permitted will comply with all applicable requirements of s. 30.20, Stats., and Chapters NR 102, 103, 115, 116, 150, 180, 346, and 347, Wis. Adm. Code.

CONCLUSIONS OF LAW (These are the legal reasons why the Department can issue your permit.)

1. The Department has authority under the above indicated Statutes and administrative rules, to issue a permit for the construction and maintenance of this project.

2. The proposed project is in conformance with Section NR 103, Wisconsin Administrative Code.

3. The Department has complied with Section 1.11, Statues, and Chapter NR 150.

If you believe that you have a right to challenge this decision, you should know that Wisconsin statutes and administrative rules establish time periods within which requests to review Department decisions must be filed.

To request a contested case hearing pursuant to Section 227.42, Stats., you have 30 days after the decision is mailed, or otherwise served by the Department, to serve a petition for hearing on the Secretary of the Department of Natural Resources. The filing of a request for a contested case hearing is not a prerequisite for judicial review and does not extend the 30-day period for filing a petition for judicial review.

This notice is provided pursuant to Section 227.48(2), Stats.

STATE OF WISCONSIN DEPARTMENT OF NATURAL RESOURCES
For the Secretary

February 1, 1996

Jack A. Smith
Water Management Specialist
8770 Hwy J
Woodruff, WI 54568
(715)358-9214

\WZ\DREDGE.WZ

By the Applicant:

Date 2/1/94

Subscribed and sworn to before me this
1st day of February 1994.

Notary Public, State of Wisconsin
My commission 9/17/95

LOIS L. GODAWA NOTARY PUBLIC State of Wisconsin

cc: Dale Lang, Water Regulation & Zoning Supervisor, Rhinelander
Dawn Schmidt, Forest County Zoning Administrator
U. S. Corps of Engineers
R. Koch, Warden
Woodruff Area Headquarters
Foth & Van Dyke, P.O. Box 19012, Green Bay, WI 54307-9012, Contractor
Public Intervenor, P.O. Box 7857, Madison, WI 53707
GLIFWC, P.O. Box 9, Odanah, WI 54861
Tribal Chair, Potawatomi Tribe, Tribal Hall, Box 346, Crandon, WI 54520
Tribal Chair, Mole Lake Sokaogan Band, Rt. 1 Box 625, Crandon, WI 54520

Original and copies of this document were deposited for mailing to the addressee and indicated copies at the US mail at Woodruff, Wisconsin, on 2-1-94, by Linda Winters.

There are no Department permits required for the following locations:

LOCATION	TOWNSHIP	WATERWAY	TWN	RANGE	SECTION
CMC-SCC-101	LINCOLN	SWAMP CREEK CEDARS	35N	13E	NE¼ SEC 30
CMC-SCC-102	LINCOLN	SWAMP CREEK CEDARS	35N	13E	NE¼ SEC 30
CMC-BO-101	LINCOLN	BUR OAK SWAMP	35N	13E	SW¼ SEC 29
CMC-BO-102	LINCOLN	BUR OAK SWAMP	35N	13E	SW¼ SEC 29

State of Wisconsin
Department of Natural Resources

SCIENTIFIC COLLECTORS PERMIT
Form 9400-380 4-88

The below named person is authorized by the Wisconsin Department of Natural Resources, pursuant to section 29.17, Wis. Stats., and section NR 19.11, Wis. Adm. Code, to collect for scientific purposes only. The permit authority may cover migratory birds, but may not be exercised without an appropriate federal permit issued by the U.S. Fish and Wildlife Service.

Permittee's Name	Agency or Organization	
William M. West	Foth & Van Dyke	
Street or Route	Federal Permit No. (if any)	Date Federal Permit Expires
P.O. Box 19012		
City, State, Zip Code	Telephone Number (include area code)	
Green Bay, Wisconsin 54307-9012	Business 414-497-2500	Home 414-730-0684

Date of Birth (M-D-Y)	Color Eyes	Color Hair	Weight	Height	Sex
May 16, 1951	Blue	Blond	170	5'8"	[X] Male [ ] Female

Species, Age or Size Class*, and Number of Specimens or Description of Items to be Collected:

Aquatic macroinvertebrates; Odonata; Mussels; Fish

*For game fish and panfish species list young-of-year separately from larger length range

Purpose for Collecting	Where Specimens or Items Will be Kept for Study
-Determine presence/absence of threated, endangered or species of concern in area of Crandon mine site or zone of influence	Mussels returned to stream; Voucher specimens - WDNR, Madison, Otherwise inverts at UWGB; Fish at EA Ass. reference collection
Method(s) of Collecting -Boomshocking, pram shocking, backpack electrofishing & seining for smaller streams; boat mounted electroshocker on Wolf River & lakes with a boat landing.	Collection Period 1994

Location of Collecting Site(s) - County for all sites; waters for aquatic collections and civil township for all others

Forest/Langlade Counties - Swamp and Pickerel Creek Chains, Wolf River

Final Disposition of Specimens or Items

Live specimens keyed and released. Voucher specimens sent to WDNR, ALSO UWGB herbarium or EA Associates fish reference collection.

Special Conditions of this Permit

NOTIFY County Warden prior to any collection. Forest County - Rick Koch, (715)674-7020
Langlade County - Bill Lazarz, (715)62704317

Individuals included in this permit: Ken Tennessen
Don Helms
Greg Seegert

DNR Fish Manager, Max Johnson, P.O. Box 310, Antigo, WI 54409, (715)627-4317, is to be kept informed of location by providing name of water body and quarter section, section, township, range and date of survey 24 hours prior to start of activity for work in the Langlade County area.

I hereby certify that I have read, am familiar and agree to comply with the regulations described herein. This permit is not transferable and must be exhibited to any authorized agent of the Department of Natural Resources on demand. An annual report is due by January 10 of each year.

Permittee's Signature (Permit Valid Only When Signed)	Date Signed
W. M. West	2/1/94

DNR Permit Number	Date DNR Permit Number
	February 1, 1994
SCP-NC-23-94	Date DNR Permit Expires
	December 31, 1994

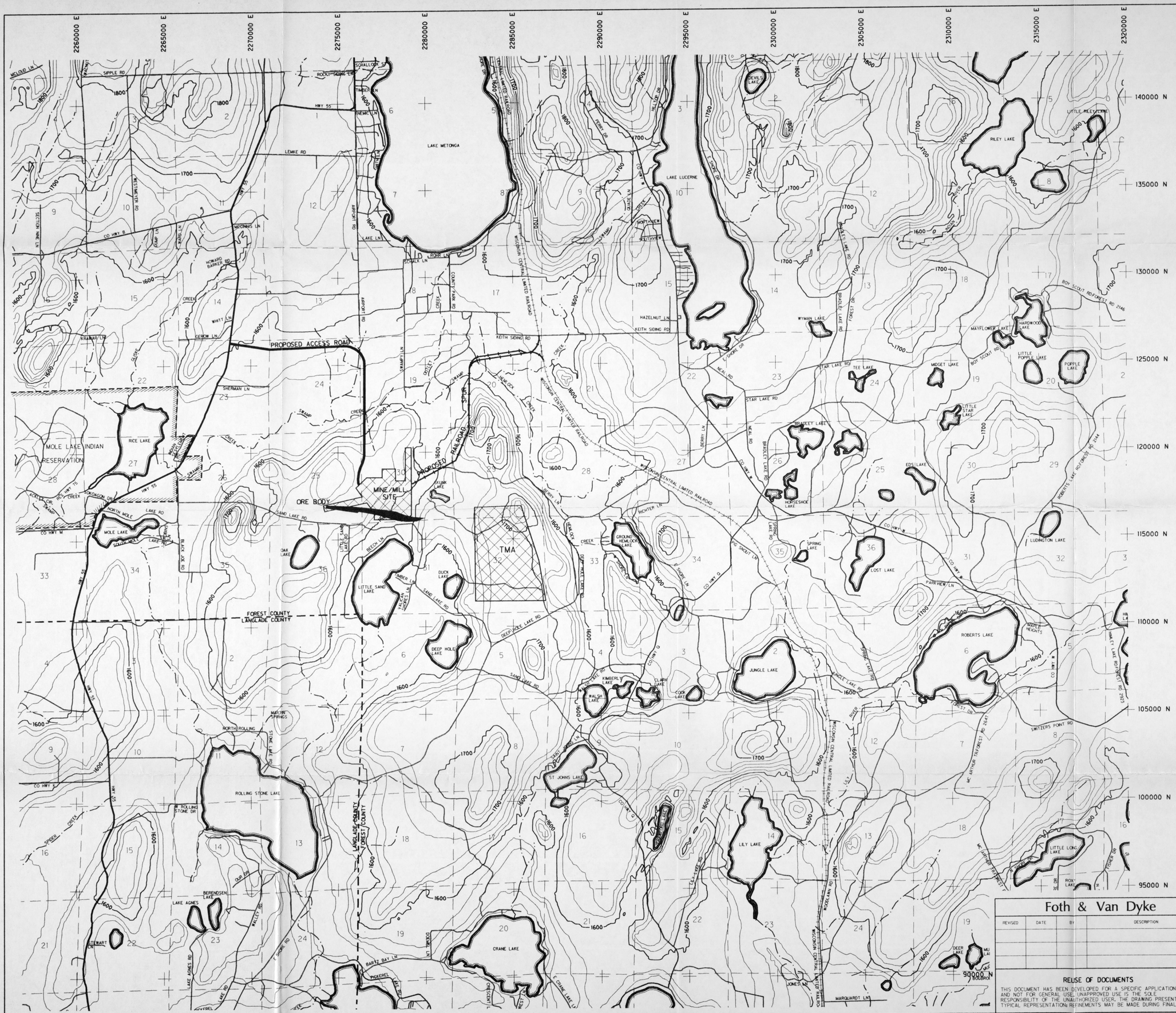
State of Wisconsin
Department of Natural Resources
FOR THE SECRETARY

By A. E. Lawrence Date Signed 2/1/94

cc: Bureau of Research, Madison
District Headquarters, Rhinelander
Archie Wilson, Rhinelander
Area Warden-Woodruff, Antigo
Area Fish Manager-Woodruff, Antigo

Appendix D

Figure 2-2



N

LEGEND

- EXISTING CONTOUR (1600)
- EXISTING RIVER, STREAM OR CREEK
- EXISTING LAKE
- EXISTING HIGHWAY (HWY 55)
- EXISTING ROAD
- EXISTING RAILROAD

NOTES:

1. TOPOGRAPHIC BASE MAP PREPARED FROM 7.5' U.S.G.S. ETAK BASE MAPS: MOLE LAKE, LAKE LUCERNE, CRANDON AND ROBERTS LAKE.
2. HORIZONTAL DATUM BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM NORTH ZONE.
3. CONTOUR INTERVAL = 20 FEET.
4. INDIVIDUAL POTAWATOMI TRIBAL LANDS LOCATED NORTH AND EAST OF THE PROPOSED SITE ARE NOT SHOWN.

Crandon Mining Company

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

TITLE

SITE TOPOGRAPHY

SCALE 1" = 2500'	STATE: WISCONSIN		COUNTY FOREST		
DRAWN BY JRB	DATE JAN. '94	CHECKED BY M.J.D.		DATE 2/9/94	
APPROVED BY	DATE	APPROVED BY		DATE	
APPROVED BY DWS	DATE 2/10/94	CRANDON MINING COMPANY D.E. Moe		DATE 2-11-94	
DRAWING NO. FIGURE 2-2		SHEET OF		REVISION NO.	

REUSE OF DOCUMENTS

THIS DOCUMENT HAS BEEN DEVELOPED FOR A SPECIFIC APPLICATION AND NOT FOR GENERAL USE. UNAPPROVED USE IS THE SOLE RESPONSIBILITY OF THE UNAUTHORIZED USER. THE DRAWING PRESENTS TYPICAL REPRESENTATION; REFINEMENTS MAY BE MADE DURING FINAL DESIGN.

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Appendix E

Project Quality Assurance Plan

Crandon Mining Company

Project Quality Assurance Plan
Prepared for the
Proposed Crandon Project
Crandon, Wisconsin

Scope ID: 93C049

Prepared by
Foth & Van Dyke and Associates Inc.

Under the Direction of

Russell T. Janeshek
Project QA Officer

Gerald W. Sevick, P.E.
Project Manager

February 1994

Project Quality Assurance Plan
Prepared for the Proposed Crandon Project

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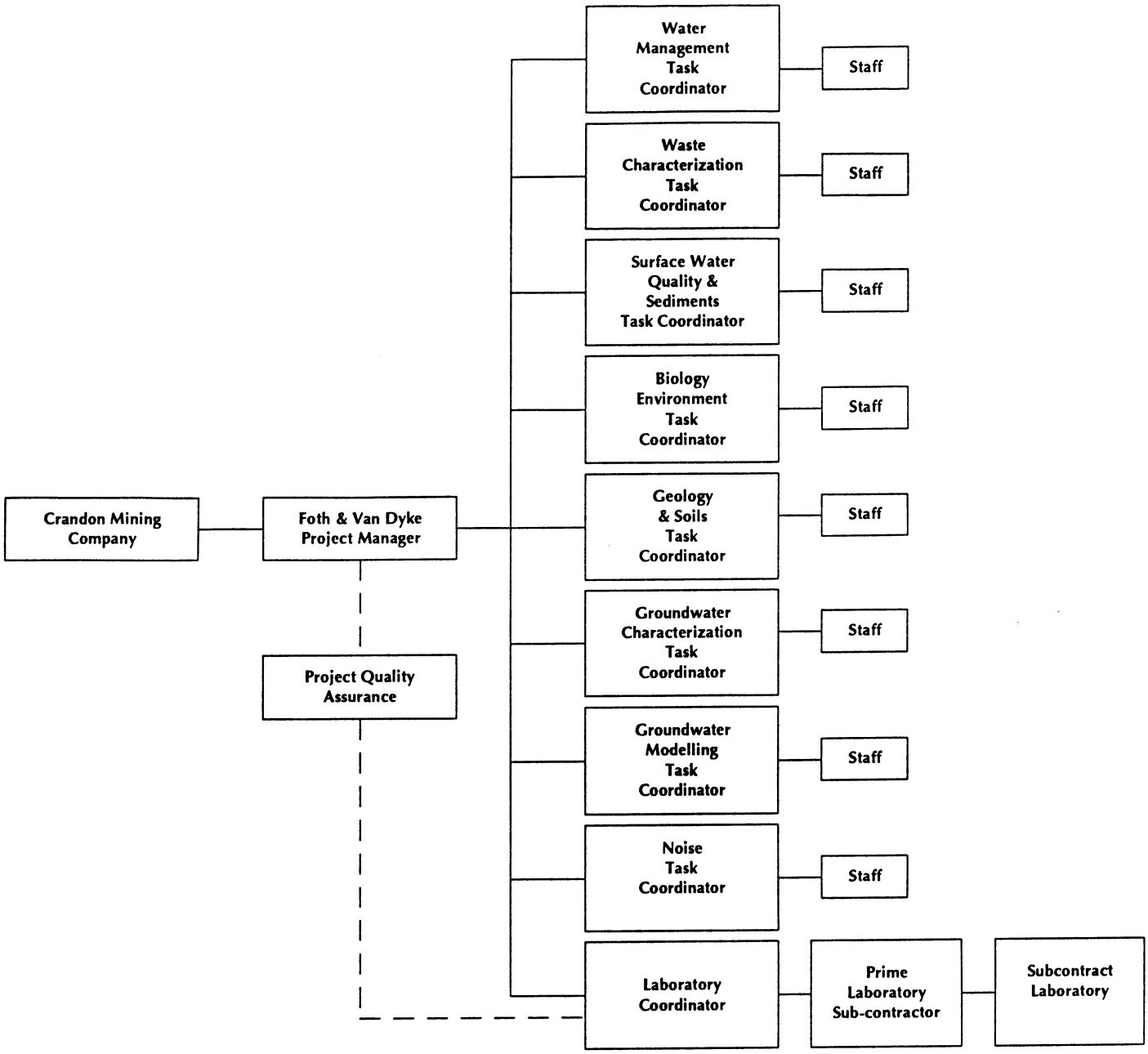
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Appendix B Tissue Sample Digestion Methods

3 Quality Assurance Program Description

This Project Quality Assurance Plan (PQAP) was developed as an integral part of the Notice of Intent/Scope of Study (NOI/SOS) activities for Crandon Mining Company's (CMC) Crandon Project. The intent of this PQAP is to facilitate the collection of baseline data in support of NOI/SOS activities using a quality control/quality assurance (QA/QC) plan that will provide data of high quality which will allow appropriate regulatory agencies to issue the required permits to construct and operate the CMC mining facilities.

4 Organization and Responsibility

Project organization and responsibility is shown on Figure 4-1.



Crandon Mining Company

FIGURE 4-1

PROJECT ORGANIZATION AND RESPONSIBILITY

REVISED	DATE	BY	DESCRIPTION	E8

Scale: NO SCALE | Date: FEBRUARY 1994

Prepared By: Foth & Van Dyke | By: JRB

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93C049

5 Quality Assurance Targets for Precision, Accuracy and Detection Limits

The purpose of quality assurance objectives is to define precision and accuracy targets, as well as to define the target detection limits, which will be used for both the generation of laboratory analytical data and field measurement data.

All measurements need to be made such that results are representative of the media (air, water, biota, etc.) and the conditions being measured. Unless otherwise specified, data will be calculated and/or reported in consistent units from one sampling event to the next. Metals results for solid samples, i.e., tissue, sediment and soil, will be reported on a dry-weight basis.

Data quality objectives for accuracy and precision for each measurement parameter will be based on the measurement system employed and the requirements of this plan.

Quality assurance objectives for field measurement data are found in Table 5-1, while those for laboratory data are found in Tables 5-2 through 5-10.

Table 5-1

Quality Assurance Objectives for Field Measurement Data
Crandon Mining Company NOI/SOS/PQAP

Parameter	Matrix	Analytical Method References	Precision Targets	Accuracy Targets	Target Detection Limit
Groundwater elevation	Water	N/A	N/A	N/A	0.01 ft
Conductivity	Water	120.1(A)	20	---	1 μmho/cm
pH	Water	150.1(A)	20	---	0.15U
Color	Water	(B)	N/A	N/A	N/A
Odor	Water	(B)	N/A	N/A	N/A
Turbidity	Water	(B)	N/A	N/A	N/A

E10

(A) Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020, Revised March 1983.

(B) Ref: Groundwater Sampling Procedures PUBL-WR-168
Color: Note against a white background.
Odor: Wave hand over sample container and note distinct smell.
Turbidity: Comment on level of turbidity, e.g., cloudy, turbid, clear.

N/A: Not Applicable

ft = feet

μmho/cm = micromohrs per centimeter

Table 5-2

Quality Assurance Targets
Terrestrial Biology
Crandon Mining Company NOI/SOS/PQAP

Component	Method Reference	Matrix	Precision Targets	Accuracy Targets	TPQL (μg/kg)
Arsenic	WI620.2[a]/EPA206.2	TB	25	75-125	100
Cadmium	WI620.2[a]/EPA200.7	TB	25	75-125	40
Chromium	WI620.2[a]/EPA200.7	TB	25	75-125	100
Copper	WI620.2[a]/EPA200.7	TB	25	75-125	100
Mercury	WI540.2[b]/EPA245.1	TB	25	75-125	50
Lead	WI620.2[a]/EPA239.2	TB	25	75-125	50
Zinc	WI620.2[a]/EPA200.7	TB	25	75-125	200
Manganese	WI620.2[a]/EPA200.7	TB	25	75-125	50
Cobalt	WI620.2[a]/EPA200.7	TB	25	75-125	200

[a] This method is included in Appendix B. For digestion, covered beakers on hot plates at 95°C will be used in lieu of block digester and tubes.

[b] This method is included in Appendix B. For digestion, the alternate method procedure outlined in the method will be used. BOD bottles in a 95°C water bath will be used in lieu of block digester and tubes.

μg/kg = microgram/kilogram

TB = Terrestrial Biological Tissue

TPQL = Target Practical Quantitation Limit

EPA references either *Methods for Chemical Analysis of Water and Wastes*, USEPA 600/4-79-020, Revised March 1983, or *Test Methods for Evaluating Solid Waste* (SW846) USEPA, September, 1986.

Table 5-3

Quality Assurance Targets
Aquatic Biology
Crandon Mining Company NOI/SOS/PQAP

Component	Method Reference	Matrix	Precision Targets	Accuracy Targets	TPQL (µg/kg)
Arsenic	WI620.2[a]/EPA206.2	AB	25	75-125	100
Cadmium	WI620.2[a]/EPA200.7	AB	25	75-125	40
Chromium	WI620.2[a]/EPA200.7	AB	25	75-125	100
Copper	WI620.2[a]/EPA200.7	AB	25	75-125	100
Mercury	WI540.2[b]/EPA245.1	AB	25	75-125	50
Lead	WI620.2[a]/EPA239.2	AB	25	75-125	50
Zinc	WI620.2[a]/EPA200.7	AB	25	75-125	200
Manganese	WI620.2[a]/EPA200.7	AB	25	75-125	50
Cobalt	WI620.2[a]/EPA200.7	AB	25	75-125	200

[a] This method is included in Appendix B. For digestion, covered beakers on hot plates at 95°C will be used in lieu of block digester and tubes.

[b] This method is included in Appendix B. For digestion, the alternate method procedure outlined in the method will be used. BOD bottles in a 95°C water bath will be used in lieu of block digester and tubes.

µg/kg = micrograms per kilogram

TB = Aquatic Biological Tissue

TPQL = Target Practical Quantitation Limit

EPA references either *Methods for Chemical Analysis of Water and Wastes*, USEPA 600/4-79-020, Revised March 1983, or *Test Methods for Evaluating Solid Waste* (SW846) USEPA, September, 1986.

Table 5-4

Quality Assurance Targets
Groundwater
Crandon Mining Company NOI/SOS/PQAP

Component	Method Reference	Matrix	Precision Targets	Accuracy Targets	TPQL (mg/L)
Chloride	EPA 300.0	GW	25	80-120	0.5
Nitrate	EPA 300.0	GW	25	80-120	0.5
Nitrate + Nitrite	EPA 300.0	GW	25	80-120	0.5
Sulfate	EPA 300.0	GW	25	80-120	1
Total Alkalinity	EPA 310.1	GW	25	80-120	5
Total Hardness	EPA 130.2	GW	25	80-120	5
Chemical Oxygen Demand	EPA 410.4	GW	25	80-120	20
Cyanide, total	EPA 9010	GW	25	80-120	0.02
Fluoride, probe	EPA 340.2	GW	25	80-120	0.1
Nitrogen, total Kjeldahl	EPA 351.3	GW	25	80-120	0.2
Solids, total dissolved	EPA 160.1	GW	25	N/A	5
Arsenic	EPA 7050/206.2	GW	25	75-125	0.005
Cadmium	EPA 7131/213.2	GW	25	75-125	0.001
Chromium	EPA 7191/218.2	GW	25	75-125	0.005
Lead	EPA 7421/239.2	GW	25	75-125	0.001
Selenium	EPA 7740/270.2	GW	25	75-125	0.005
Antimony	EPA 6010/200.7	GW	25	75-125	0.2
Aluminum	EPA 6010/200.7	GW	25	75-120	0.05
Barium	EPA 6010/200.7	GW	25	75-125	0.01
Calcium	EPA 6010/200.7	GW	25	75-125	1
Cobalt	EPA 6010/200.7	GW	25	75-125	0.01
Copper	EPA 6010/200.7	GW	25	75-125	0.03

Component	Method Reference	Matrix	Precision Targets	Accuracy Targets	TPQL (mg/L)
Iron	EPA 6010/200.7	GW	25	75-125	0.05
Magnesium	EPA 6010/200.7	GW	25	75-125	0.5
Manganese	EPA 6010/200.7	GW	25	75-125	0.01
Molybdenum	EPA 6010/200.7	GW	25	75-125	0.02
Nickel	EPA 6010/200.7	GW	25	75-125	0.03
Silver	EPA 6010/200.7	GW	25	75-125	0.01
Zinc	EPA 6010/200.7	GW	25	75-125	0.02
Mercury by Cold Vapor	EPA 7470/245.3	GW	25	75-125	0.0002

GW = Groundwater

N/A = Not Applicable

TPQL = Target Practical Quantitation Limits

mg/l - milligrams per liter

EPA references either *Methods for Chemical Analysis of Water and Wastes*, USEPA 600/4-79-020, Revised March 1983, or *Test Methods for Evaluating Solid Waste* (SW846) USEPA, September, 1986.

Table 5-5

Quality Assurance Targets
Surface Water Sediment
Crandon Mining Company NOI/SOS/PQAP

Component	Method Reference	Matrix	Precision Targets	Accuracy Targets	TDL (mg/kg)
Chloride	EPA 9252	SW Sed.	25	80-120	1
Cyanide	EPA 9010	SW Sed.	25	80-120	0.5
Fluoride	EPA 340.2	SW Sed.	25	80-120	0.5
Nitrogen-Organic	EPA 350.2	SW Sed.	25	80-120	50
Nitrogen-Kjeldahl	EPA 351.3	SW Sed.	25	80-120	50
Oil and Grease	EPA 413.2	SW Sed.	25	75-125	50
pH	EPA 150.1	SW Sed.	25	N/A	0.1 SU
Phosphorous (total)	EPA 365.3	SW Sed.	25	80-120	5
Total Solids	SM 209F	SW Sed.	25	N/A	1%
Total Volatile Solids	SM 209F	SW Sed.	25	N/A	10
Boron	EPA 6010	SW Sed.	25	75-125	10
Calcium	EPA 6010	SW Sed.	25	75-125	100
Aluminum	EPA 6010	SW Sed.	25	75-125	20
Arsenic	EPA 7060	SW Sed.	25	75-125	5
Barium	EPA 6010	SW Sed.	25	75-125	4
Cadmium	EPA 6010	SW Sed.	25	75-125	1
Copper	EPA 6010	SW Sed.	25	75-125	3
Iron (total)	EPA 6010	SW Sed.	25	75-125	5
Lead	EPA 7421	SW Sed.	25	75-125	0.1
Manganese	EPA 6010	SW Sed.	25	75-125	1
Manganese (total)	EPA 6010	SW Sed.	25	75-125	1
Mercury	EPA 7471	SW Sed.	25	75-125	1
Molybdenum	EPA 6010	SW Sed.	25	75-125	0.1
Selenium	EPA 7740	SW Sed.	25	75-125	2

Component	Method Reference	Matrix	Precision Targets	Accuracy Targets	TDL (mg/kg)
Silver	EPA 6010	SW Sed.	25	75-125	5
Zinc	EPA 6010	SW Sed.	25	75-125	1
Chromium (total)	EPA 6010	SW Sed.	25	75-125	2
Beryllium	EPA 6010	SW Sed.	25	75-125	3
Thallium	EPA 7841	SW Sed.	25	75-125	1
Nickel	EPA 6010	SW Sed.	25	75-125	7.5
Antimony	EPA 6010	SW Sed.	25	75-125	3
Magnesium	EPA 6010	SW Sed.	25	75-125	5
Potassium	EPA 6010	SW Sed.	25	75-125	100
Sodium	EPA 6010	SW Sed.	25	75-125	100

SW Sed. = Surface Water Sediment

TDL = Target Detection Limit

SU = Standard Units

mg/kg = milligrams per kilogram

SM references the *Standard Methods for the Examination of Water and Wastewater.*

EPA references either *Methods for Chemical Analysis of Water and Wastes*, USEPA 600/4-79-020, Revised March 1983, or *Test Methods for Evaluating Solid Waste* (SW846) USEPA, September, 1986.

Table 5-6

Quality Assurance Targets
Waste Characterization Bulk Chemical Composition
Crandon Mining Company NOI/SOS/PQAP

Component	Method Reference	Matrix	Precision Targets	Accuracy Targets	TDL (mg/kg)
Aluminum	EPA 3050/6010	BCC	25	75-125	20
Antimony	EPA 3050/6010	BCC	25	75-125	5
Arsenic	EPA 3050/7060	BCC	25	75-125	5
Calcium	EPA 3050/6010	BCC	25	75-125	100
Beryllium	EPA 3050/6010	BCC	25	75-125	0.5
Cadmium	EPA 3050/6010	BCC	25	75-125	1.0
Copper	EPA 3050/6010	BCC	25	75-125	3.0
Chromium	EPA 3050/6010	BCC	25	75-125	2.0
Cobalt	EPA 3050/6010	BCC	25	75-125	1.0
Manganese	EPA 3050/6010	BCC	25	75-125	1.0
Iron	EPA 3050/6010	BCC	25	75-125	5.0
Lead	EPA 3050/6010	BCC	25	75-125	5.0
Nickel	EPA 3050/6010	BCC	25	75-125	3.0
Magnesium	EPA 3050/6010	BCC	25	75-125	50.0
Mercury	EPA 7471	BCC	25	75-125	0.1
Molybdenum	EPA 3050/6010	BCC	25	75-125	2.0
Silver	EPA 3050/6010	BCC	25	75-125	1.0
Potassium	EPA 3050/6010	BCC	25	75-125	100.0
Selenium	EPA 3050/7740	BCC	25	75-125	5.0
Tin	EPA 3050/6010	BCC	25	75-125	50.0
Sodium	EPA 3050/6010	BCC	25	75-125	100.0
Total Sulfur	EPA 5050/9038	BCC	25	80-120	100.0
Thallium	EPA 3050/6010	BCC	25	75-125	5.0
Titanium	EPA 3050/6010	BCC	25	75-125	5.0
Uranium	EPA 908.1	BCC	N/A	N/A	0.001

Component	Method Reference	Matrix	Precision Targets	Accuracy Targets	TDL (mg/kg)
Barium	EPA 3050/6010	BCC	25	75-125	1.00
Bismuth	*	BCC	*	*	*
Carbon (total)	EPA/Kahn	BCC	10	90-110	0.1%
Gold	*	BCC	*	*	*
Silicon	*	BCC	*	*	*
Tellurium	*	BCC	*	*	*
Zinc	EPA 6010	BCC	25	75-125	1

BCC = Bulk Chemical Composition

TDL = Target Detection Limit

N/A = Not Applicable

mg/kg = milligrams per kilogram

EPA references either *Methods for Chemical Analysis of Water and Wastes*, USEPA 600/4-79-020, Revised March 1983, or *Test Methods for Evaluating Solid Waste* (SW846) USEPA, September, 1986.

* = Quality Assurance Targets for these compounds will be submitted to the WDNR at a later date.

Table 5-7

Quality Assurance Targets
Waste Characterization Leachate
Crandon Mining Company NOI/SOS/PQAP

Component	Method Reference	Matrix	Precision Targets	Accuracy Targets	TDL (mg/L)
Aluminum	EPA 3015/6010	WC-L	25	75-125	0.2
Antimony	EPA 3015/6010	WC-L	25	75-125	0.05
Cadmium	EPA 3015/6010	WC-L	25	75-125	0.01
Copper	EPA 3015/6010	WC-L	25	75-125	0.03
Beryllium	EPA 3015/6010	WC-L	25	75-125	0.005
Cobalt	EPA 3015/6010	WC-L	25	75-125	0.01
Manganese	EPA 3015/6010	WC-L	25	75-125	0.01
Chromium	EPA 3015/6010	WC-L	25	75-125	0.02
Lead	EPA 3015/6010	WC-L	25	75-125	0.05
Nickel	EPA 3015/6010	WC-L	25	75-125	0.03
Iron	EPA 3015/6010	WC-L	25	75-125	0.05
Molybdenum	EPA 3015/6010	WC-L	25	75-125	0.02
Silver	EPA 3015/6010	WC-L	25	75-125	0.01
Magnesium	EPA 3015/6010	WC-L	25	75-125	0.5
Mercury	EPA 7470	WC-L	25	75-125	0.0002
Tin	EPA 3015/6010	WC-L	25	75-125	0.5
Potassium	EPA 3015/6010	WC-L	25	75-125	1.00
Selenium	EPA 3015/7740	WC-L	25	75-125	0.01
Thallium	EPA 3015/6010	WC-L	25	75-125	0.05
Sodium	EPA 3015/6010	WC-L	25	75-125	1.0
Sulfate	EPA 300.0	WC-L	25	80-120	1.0
Titanium	EPA 3015/6010	WC-L	25	75-125	0.01
Uranium	EPA 908.1	WC-L	N/A	N/A	0.001
Barium	EPA 3015/6010	WC-L	25	75-125	0.01
Arsenic	EPA 3015/7060	WC-L	25	75-125	0.01

Component	Method Reference	Matrix	Precision Targets	Accuracy Targets	TDL (mg/L)
Calcium	EPA 3015/6010	WC-L	25	75-125	1.0
Cyanide	EPA 9010	WC-L	25	80-120	0.02
Bismuth	*	WC-L	*	*	*
Tellurium	*	WC-L	*	*	*
Zinc	EPA 3015/6010	WC-L	25	75-125	0.02

WC-L = Waste Characterization-Leachate

TDL = Target Detection Limit

mg/L = milligrams per liter

EPA references either *Methods for Chemical Analysis of Water and Wastes*, USEPA 600/4-79-020, Revised March 1983, or *Test Methods for Evaluating Solid Waste* (SW846) USEPA, September, 1986.

* = Quality Assurance Targets for these compounds will be submitted to the WDNR at a later date.

Table 5-8

Quality Assurance Targets
Wastewater Treatment Filtrate
Crandon Mining Company NOI/SOS/PQAP

Component	Method Reference	Matrix	Precision Targets	Accuracy Targets	TDL (mg/L)
Alkalinity	EPA 310.1	WTF	25	80-120	5.0
Chloride	EPA 300.0	WTF	25	80-120	0.5
Fluoride	EPA 340.2	WTF	25	80-120	0.1
Ammonia (as N)	EPA 350.2	WTF	25	80-120	0.1
Nitrite & Nitrate (as N)	EPA 300.0	WTF	25	80-120	0.5
Total Phosphorous	EPA 365.3	WTF	25	80-120	0.05
Total Dissolved Solids	EPA 160.1	WTF	25	N/A	5.0
Calcium	EPA 3015/6010	WTF	25	75-125	1.0
Arsenic	EPA 3015/7060	WTF	25	75-125	0.01
Cadmium	*	WTF	25	75-125	0.004 $\mu g/\ell$
Iron	EPA 3015/6010	WTF	25	75-125	0.05
Manganese	EPA 3015/6010	WTF	25	75-125	0.01
Molybdenum	EPA 3015/6010	WTF	25	75-125	0.02
Silver	EPA 3015/6010	WTF	25	75-125	0.01
Chromium	EPA 3015/6010	WTF	25	75-125	0.02
Thallium	EPA 3015/6010	WTF	25	75-125	0.05
Antimony	EPA 3015/6010	WTF	25	75-125	0.05
Potassium	EPA 3015/6010	WTF	25	75-125	1.0
COD	EPA 410.4	WTF	25	80-120	20
Cyanide	EPA 9010	WTF	25	80-120	0.02
Hardness	EPA 130.2	WTF	25	N/A	5.0
pH	EPA 9040	WTF	25	N/A	0.1 SU
Sulfate	EPA 300.0	WTF	25	80-120	1.0
Boron	EPA 3015/6010	WTF	25	75-125	0.1

Component	Method Reference	Matrix	Precision Targets	Accuracy Targets	TDL (mg/L)
Aluminum	*	WTF	25	75-125	0.2 µg/ℓ
Barium	EPA 3015/6010	WTF	25	75-125	0.01
Copper	*	WTF	25	75-125	0.04 µg/ℓ
Lead	*	WTF	25	75-125	0.05 µg/ℓ
Mercury	*	WTF	25	75-125	0.05 ng/ℓ
Selenium	EPA 3015/7740	WTF	25	75-125	0.01
Zinc	*	WTF	25	75-125	0.03 µg/ℓ
Beryllium	EPA 3015/6010	WTF	25	75-125	0.05
Nickel	EPA 3015/6010	WTF	25	75-125	0.03
Magnesium	EPA 3015/6010	WTF	25	75-125	0.5
Sodium	EPA 3015/6010	WTF	25	75-125	1.0
BOD_5	EPA 405.1	WTF	25	80-120	2
TKN	EPA 351.3	WTF	25	80-120	0.2
Sulfide	EPA 376.2	WTF	32	28-160	0.1

WTF = Wastewater Treatment Filtrate

TDL = Target Detection Limit

SU = Standard Units

mg/L = milligrams per liter

µg/ℓ = micrograms per liter

ng/ℓ = nanograms per liter

* = Low level method based on Recommendations for Trace Element Analyses of Natural Waters.

EPA references either *Methods for Chemical Analysis of Water and Wastes*, USEPA 600/4-79-020, Revised March 1983, or *Test Methods for Evaluating Solid Waste* (SW846) USEPA, September, 1986.

Table 5-9

Quality Assurance Targets
Wastewater Treatment Solids
Crandon Mining Company NOI/SOS/PQAP

Component	Method Reference	Matrix	Precision Targets	Accuracy Targets	TDL (mg/kg)
Chloride	EPA 9252	WTS	25	80-120	5.0
Fluoride	EPA 340.2	WTS	25	80-120	0.2
Sulfur	EPA 5050/9038	WTS	25	80-120	100.0
Total Solids	SM 209F	WTS	25	N/A	0.1%
Calcium	EPA 3050/6010	WTS	25	75-125	100.0
Arsenic	EPA 3050/7060	WTS	25	75-125	5.0
Cadmium	EPA 3050/6010	WTS	25	75-125	1.0
Iron	EPA 3050/6010	WTS	25	75-125	5.0
Manganese	EPA 3050/6010	WTS	25	75-125	1.0
Molybdenum	EPA 3050/6010	WTS	25	75-125	2.0
Cyanide	EPA 9010	WTS	25	75-125	0.5
Total Phosphorous	EPA 365.3	WTS	25	75-125	0.1
Total Suspended Solids	EPA 160.2	WTS	25	75-125	5.0
Boron	EPA 3050/6010	WTS	25	75-125	10.0
Aluminum	EPA 3050/6010	WTS	25	75-125	20.0
Barium	EPA 3050/6010	WTS	25	75-125	1.0
Copper	EPA 3050/6010	WTS	25	75-125	3.0
Lead	EPA 3050/6010	WTS	25	75-125	5.0
Mercury	EPA 7471	WTS	25	75-125	0.1
Selenium	EPA 3050/7740	WTS	25	75-125	5.0
Silver	EPA 3050/6010	WTS	25	75-125	1.0
Chromium	EPA 3050/6010	WTS	25	75-125	2.0
Thallium	EPA 3050/6010	WTS	25	75-125	5.0
Antimony	EPA 3050/6010	WTS	25	75-125	5.0

Component	Method Reference	Matrix	Precision Targets	Accuracy Targets	TDL (mg/kg)
Potassium	EPA 3050/6010	WTS	25	75-125	100.0
Zinc	EPA 3050/6010	WTS	25	75-125	2.00
Beryllium	EPA 3050/6010	WTS	25	75-125	0.5
Nickel	EPA 3050/6010	WTS	25	75-125	3.0
Magnesium	EPA 3050/6010	WTS	25	75-125	50.0
Sodium	EPA 3050/6010	WTS	25	75-125	100.0

WTS = Wastewater Treatment Solids

TDL = Target Detection Limit

mg/kg = milligrams per kilogram

SM = Reference Standard Methods for the Examination of Water and Wastewater.

EPA references either *Methods for Chemical Analysis of Water and Wastes*, USEPA 600/4-79-020, Revised March 1983, or *Test Methods for Evaluating Solid Waste* (SW846) USEPA, September, 1986.

Table 5-10

Quality Assurance Targets
Surface Water Quality*
Crandon Mining Company NOI/SOS/PQAP

Parameter	Reference	Matrix	Precision Targets	Accuracy Targets	TDL (mg/ℓ)
Aluminum	EPA 6010	SW	25	75-125	0.2
Cadmium	EPA 6010	SW	25	75-125	0.01
Copper	EPA 6010	SW	25	75-125	0.03
Lead	EPA 6010	SW	25	75-125	0.05
Mercury	EPA 7470	SW	25	75-125	0.0002
Zinc	EPA 6010	SW	25	75-125	0.02

* Selected sites only. See Table 4-17 of the NOI/SOS.

SW = Surface Water

TDL = Target Detection Limit

mg/ℓ = milligrams per liter

EPA references either *Methods for Chemical Analysis of Water and Wastes*, USEPA 600/4-79-020, Revised March 1983, or *Test Methods for Evaluating Solid Waste* (SW846) USEPA, September, 1986.

6 Project Activities

6.1 Terrestrial Biology

6.1.1 Sampling Protocols

The species of vegetation to be sampled will include balsam fir, red raspberry and Pennsylvania sedge. A total of nine individual samples will be collected for each of the three species. Samples will be collected from the following: sites 10, 12 and 16 in the west sector; sites 1,24 and 26 in the north sector; and sites 18, 19 and 20 in the south sector. These sites are illustrated on Figure 4-2 in the NOI/SOS.

Field studies, including winter mammal tracking, small and mid-size mammal trapping, bird censuses, herptilogical surveys, butterfly surveys, etc., will be included as part of the biological programs. Reference markers, consisting of numbered metal tags, will be placed in strategic locations along roadways throughout the environmental study area. The location of the reference markers will be indicated on a base map of the environmental study area and will provide a baseline from which to locate mammal tracking transects, bird point count sites, etc. in the field. To avoid confusion in the field, a master list of sample sites will be developed for each of the terrestrial biology programs, including directions to each of the sites from one or more of the reference markers. Finally, the reference markers will be used in conjunction with handheld LORAN units to locate terrestrial biologic sample sites to provide repeatability and to document locations of specific rare plant or animal sightings. All of the terrestrial biologic sample sites will be located by coordinates.

6.1.2 Analytical Methods

Vegetation samples will be analyzed for manganese, zinc, cadmium, copper, arsenic, lead, mercury, cobalt and total chromium using the methods specified in Table 5-2.

6.1.3 Sample Documentation

A terrestrial biology field log will be maintained. A summary of field activities, including names of all individuals involved and their specific field assignment, a summary of the day's activities, and a brief description of any significant finds, will be entered into the log for each day spent in the field. Specific field forms will be developed for each of the tasks to provide consistent field notations among the individuals working on the task. A mammal survey form is illustrated in Figure
6-1. A field notebook will be maintained as described in Section 7.2 in addition to the data collection on the mammal survey form.

A sample numbering system will be used to identify each sample. The numbering system will provide a tracking procedure to allow retrieval of information about a particular sample and result for each sample being uniquely numbered.

Mammal Survey Form

Site:_____ Date:_____ Observer(s):_____

Start Time	End Time	Map Code	Direction (N = 0°)	Location Description

Number	Species	Distance	Habitat
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Number	Species	Distance	Habitat
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			
38			
39			
40			

Distance	Species	Habitat	Notes

NOTE:
FORM REDUCED FOR FIGURE.
FORMS USED FOR DOCUMENTATION
WILL BE 8.5 X 11 INCHES.

REVISED	DATE	BY	DESCRIPTION

E27

Crandon Mining Company

FIGURE 6-1
MAMMAL SURVEY FORM

Scale: NO SCALE | Date: FEBRUARY 1994
Prepared By: Foth & Van Dyke | By: JRB

3c49form.DGN

Vegetation samples will be labelled according to the following scheme:

CMC-TBN-BF	North Sector	Balsam Fir
CMC-TBN-RR	North Sector	Red Raspberry
CMC-TBN-PS	North Sector	Pennsylvania Sedge
CMC-TBW-BF	West Sector	Balsam Fir
CMC-TBW-RR	West Sector	Red Raspberry
CMC-TBW-PS	West Sector	Pennsylvania Sedge
CMC-TBS-BF	South Sector	Balsam Fir
CMC-TBS-BF	South Sector	Red Raspberry
CMC-TBS-BF	South Sector	Pennsylvania Sedge

Chain of custody procedures will be followed to document sample custody from time of collection until arrival at the laboratory. These procedures are described in detail in Section 7. Errors in documents will be deleted by crossing through the mistaken information with a single line, initialling and dating by the person making the change.

6.1.4 Quality Control

Team leaders, consisting of one or more individuals with senior level experience in the discipline in which the field activities are involved, will be assigned for each field task. These individuals will supervise field activities and will be available for verification of any potentially significant finds. Significant finds will be photo documented in the field. Voucher specimens will be collected where appropriate (see November 1993 *Work Plan for Threatened and Endangered Species Investigations for the Proposed Crandon Project*), and maintained for species verification at the University of Wisconsin, Green Bay Ricter Museum (i.e., plants, small mammals, butterflies) and the Milwaukee Public Museum (i.e., reptiles and amphibians).

6.2 Aquatic Biology

6.2.1 Sampling Protocols

Samples of aquatic macrophytes, benthic macroinvertebrates and fish will be collected for metals analysis. Samples will be collected in Swamp Creek, upstream and downstream of the potential wastewater discharge point, in Little Sand Lake, and the Wolf River, upstream and downstream of its confluence with Swamp Creek.

Methods for the collection of benthic macroinvertebrates and fish are described in the *Work Plan for Threatened and Endangered Species Investigations for the Proposed Crandon Project*, November 1993. Aquatic macrophytes will be collected manually from the shoreline and shallow areas at each sample location.

6.2.2 Analytical Methods

To be consistent with previous work, yellow perch (greater than six inches) will be targeted for analysis. Other fish species will be selected based on relative abundance, if yellow perch are not available. If possible, a total of 10 fish will be collected from each of the five sample sites. The fish, once captured, will be immediately placed in a live well or in a cooler with ice for subsequent field processing at the end of the day. For each fish, the fillets will be removed (with the skin left on) and placed in individual polyethylene bags. The fillets from each fish will be analyzed for mercury. The livers will be removed from the fish and placed in a single polyethylene bag for a composite sample to be analyzed for manganese, zinc, cadmium, copper, arsenic, lead, cobalt, and total chromium. The field-processed samples will be placed on ice in a cooler for transport to the laboratory within 24 hours of collection.

Benthic macroinvertebrate samples will be whole body crayfish composites, including the exoskeleton. The composite sample will be made of 10 or more adult crayfish, collected from each site. If an insufficient sample is available after a reasonable effort, the tests will be run on the sample that is available. Crayfish will be placed in polyethylene bags in a cooler with ice for transport to the laboratory within 24 hours of collection.

For macrophytes, the lower portions of the main stalks of larger species (e.g., bur reed, cattail, water lily) and the entire plant above the substrate of smaller species (e.g., pipewort, spike rush) will be collected. In addition to the sample locations described above, a sample of wild rice will also be collected from Rice Lake and Swamp Creek upstream of State Trunk Highway 55, if available. Samples will be rinsed with distilled water in the field to remove sediment particles attached to the plants. With the exception of the wild rice sample, which will be analyzed separately, these samples will be placed in a single polyethylene bag and analyzed as a composite. A one-gallon bag will be filled at each site to form the sample. The samples will be placed on ice in a cooler for transport to the laboratory within 24 hours of collection.

All aquatic biological samples will be analyzed using the methods specified in Table 5-3.

6.2.3 Sample Documentation

An aquatic biology field log will be maintained. A summary of field activities, including names of all individuals involved and their specific field assignment, a summary of the day's activities, and a brief description of any significant finds, will be entered into the log for each day spent in the field. A field notebook will be maintained as described in Section 7.2.

A sample numbering system will be used to identify each sample. The numbering system will provide a tracking procedure to allow retrieval of information about a particular sample and result in each sample being uniquely numbered.

Aquatic biological samples will be labelled according to the following scheme:

CMC-AB-SC-501	Swamp Creek	upstream
CMC-AB-SC-502	Swamp Creek	downstream
CMC-AB-WR-301	Wolf River	upstream
CMC-AB-WR-302	Wolf River	downstream

CMC-AB-SC	Little Sand Lake
CMC-AB-RL	Rice Lake
CMC-AB-SC55	Swamp Creek W Hwy. 55

Chain of custody procedures will be followed to document sample custody from time of collection until arrival at the laboratory. These procedures are described in Section 7.

Errors in documents will be deleted by crossing through the mistaken information with a single line, initialling and dating by the person making the change.

6.2.4 Quality Control

Team leaders, consisting of one or more individuals with senior level experience in the discipline in which the field activities are involved, will be assigned for each field task. These individuals will supervise field activities and will be available for verification of any potentially significant finds. Significant finds will be photo documented in the field. Voucher specimens will be collected where appropriate (see November 1993 *Work Plan for Threatened and Endangered Species Investigations for the Proposed Crandon Project*), and maintained for species verification at the University of Wisconsin, Green Bay Ricter Museum (i.e., plants, small mammals, butterflies) and the Milwaukee Public Museum (i.e., reptiles and amphibians).

6.3 Geology and Soils

6.3.1 Sampling Protocols

Collection of soil samples and review of the site's geology is done by either invasive techniques such as drilling or digging; or by non-invasive techniques such as geophysics. Both types of techniques may be employed at the site for the collection of additional information. Geophysical work would be performed by a specialty subcontractor who will provide their quality control procedures prior to performance of work at the site. Drilling of boreholes or digging of test pits will also be performed at the site for the collection of soil samples. Test pits are generally limited to the upper 20 feet and are used in areas where shallow soil sampling and larger quantities of soil for testing are required. The drilling of boreholes will be used for deeper soil and rock sampling.

6.3.1.1 Soil Boring Installation

Drilling equipment will be steam cleaned off-site prior to beginning drilling activities to remove oil and grease. Drilling and soil sampling will be performed using standard ASTM methods. Drilling will consist of conventional rotary and hollow stem auger drilling methods (ASTM D2113 and D1452). To begin a drill hole for rotary or diamond core drilling, steel casing will be driven into the ground to provide a means to recirculate drilling fluids and contain drilling fluids and cuttings. Rotary drilling will be performed with a standard tricone bit. The bit and drill rod will be inserted into the steel casing and then advanced into the ground.

Drilling fluids will be circulated from a holding tub at the surface down through the drill rod and out the tricone bit. The drilling fluids will then suspend the soil cuttings and circulate up

through the steel casing to the surface where it will empty back into a holding tub. This closed system will contain the drilling fluids and cuttings and prevent them from being discharged at the surface. The drilling fluids will conform to standards promulgated under NR 141 of the Wis. Adm. Code. Threaded joints on the steel casing will be sealed with teflon tape to minimize the loss of drilling fluids though joints in the casing.

The soils will be sampled ahead of the drill bit or augers by standard thin walled tube (ASTM 1587, *Thin-Walled Tube Sampling of Soils*) and split spoon sampling techniques (ASTM D1586, *Penetration Test and Split Barrel Sampling of Soils*). Soils will be logged in the field using to the Unified Soil Classification System (USCS) in accordance with ASTM D2488, *Description and Identification of Soils (Visual Manual Procedures)*. Soil boring logs will be prepared on standard Wisconsin Department of Natural Resources (WDNR) forms.

6.3.2 Analytical Methods

Representative soil samples may be collected and analyzed for particle size distribution (ASTM D422, *Particle Size Analysis of Soils*), liquid limit and plastic index (ASTM D4318) and classified according to ASTM D2487, *Classification of Soils for Engineering Purposes.*

6.3.3 Sample Documentation

A sample numbering system will be used to identify each sample. This numbering system will provide a tracking procedure to allow retrieval of information about a particular sample and result for each sample being uniquely numbered. The sample identification numbers will be composed of three components, which are described below:

Each sample type collected during the sampling program will be identified by a three-digit and a two-digit alpha code to signify work performed during the 1994 data collection in support of mine permitting. These digits will be:

- CMC-SB - Soil Boring
- CMC-TP - Test Pit

A two-digit number will be used to indicate the specific sampling location at the site. These numbers will be sequential starting with -01.

The depth interval of the sample will be included in the sample number behind a slash (/) inserted after the two-digit location number. An example of a full sample number is:

CMC-SB-01/10-12

This number then shows that the sample was soil boring, at location number 1, with a depth of the sample being 10 to 12 feet below grade.

QC samples shall be prepared and numbered uniquely. Duplicate and split samples shall be numbered using the same designation as the original sample (i.e., if original sample is CMC-SB01/10-12, duplicate is CMC-SB01-01/10-12A and split CMC-SB01/10-12B).

A record of the QA/QC identification numbers will be maintained in the project note book. Field note books are discussed in Section 7.2.

Project sampling activities will be documented by keeping a written record of daily sampling activities and implementing the Chain-of-Custody procedures described in this portion of the PQAP. The information documented will incorporate that which is specified in Section 7 of the plan. This will provide for the integrity of data by tracking and documenting samples from the time they are collected by the sampling team through receipt at the laboratory. Errors in all documents will be deleted by crossing through the mistaken information with a single line, initialling and dating by the person making the change.

6.3.4 Quality Control

WDNR forms for soil boring logs will be used to record the details of the soils encountered during either drilling or the digging of test pits. This form 4400-122 is illustrated on Figure 6-2. The form will be completed in the field by the geologist performing the interpretation. For final reporting the log will be typed and verified by the logger against the original handwritten field notes. The logs will then be reviewed by the technical coordinator prior to inclusion in any report.

6.4 Groundwater Characterization

Groundwater characterization will include the installation of monitoring wells and piezometers, the collection of groundwater level data, the collection of groundwater for analysis, and other tasks associated with the interpretation of the data collected during the previously mentioned activities. Specific protocols for the activities supporting these data collections are described next, in addition to the descriptions of groundwater level and sample collection.

6.4.1 Sampling Protocols

6.4.1.1 Monitoring Well and Piezometer Installation

Monitoring well and piezometer installation will be managed by first drilling a borehole, sampling the soil, and logging the soils, in the manner described in Section 6.3, Geology and Soils. One borehole per well nest location will be split spoon sampled at five foot intervals according to ASTM D1586. The deepest borehole of a two-well well nest will be sampled, or in the case of a single well installation, the one well will be split spoon sampled. Once the desired depth of the monitoring well or piezometer has been reached, the well will be completed inside the hollow stem augers, if that method of drilling was used. If mud rotary drilling was used, the drilling mud will be circulated and thinned prior to installation of the well, and the well will be installed with the steel conductor casing still place.

State of Wisconsin
Department of Natural Resources

Route to: Solid Waste, Emergency Response, Wastewater, Haz. Waste, Underground Tanks, Water Resources, Other

SOIL BORING LOG INFORMATION
Form 4400-122 7-91

Page 1 of

Facility/Project Name	License/Permit/Monitoring Number	Boring Number

Boring Drilled by (Firm name and name of crew chief)	Date Started	Date Completed	Drilling Method
	MM/DD/YY	MM/DD/YY	

DNR Facility Well No.	WI Unique Well No.	Common Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter

Boring Location
State Plane ___ N, ___ E S/C/N
___ 1/4 of ___ 1/4 of Section ___, T ___ N, R ___ E/W
Lat
Long

Local Grid Location (if applicable)
___ Feet ___ N ___ S
___ Feet ___ E ___ W

County | DNR County Code | Civil Town/City/or Village

SAMPLE No.	SAMPLE Rec (in)	Blow Counts	Depth in Feet	Soil/rock description and geologic origin for each major unit	USCS	Graph Log	Well Diag	PID/ FID	Soil Properties: Std Pntr	Mst Cont	Liq Lim	Plas Lim	P 200	RQD/ Comm
			--											
			--											
			--											

The wells will be installed and constructed in accordance with NR 141 of the Wis. Adm. Code. Monitoring wells and piezometers will be constructed with two inch diameter PVC using schedule 40 for shallow wells and schedule 80 for deep wells. Monitoring wells and piezometers will be constructed with 10 slot PVC screens. Monitoring well screens will be 15 feet in length and piezometers will be from one to five feet in length. The shorter length piezometer screens are planned for the lake bed investigation program. The PVC riser will extend about three feet above the ground surface and will be protected by a locking steel casing. Well construction will be documented on WDNR form 4400-113A. This form is illustrated on Figure 6-3.

After the well casing and screen are placed in the borehole, a well sorted silica based sand and gravel will be added to the borehole to form the filter pack around the well screen. The filter pack will extend from six inches below the well screen to two feet above the well screen. Two feet of fine silica sand will than be placed on top of the filter pack. A five foot bentonite seal consisting of 3/8-inch chipped bentonite or bentonite pellets will be placed on top of the fine sand. A bentonite slurry or 3/8-inch chipped bentonite will be used to seal the remainder of the annular space. After the well is set a protective steel casing will be placed over the well and sealed with a concrete surface seal. Special construction for the lake bed and wetland wells are described in the NOI/SOS section for Lake Bed and Wetland Characterization. The PVC riser will be fitted with a friction fitted cap. A steel cap will be placed over the protective casing and locked. The protective casing will be marked with florescent orange paint.

All wells will be developed in accordance with NR 141 of the Wis. Adm. Code. Well development will be documented on WDNR form 4400-113B which is shown on Figure 6-4.

6.4.1.2 Groundwater Quality Sample Collection Procedures

Sampling procedures will be consistent with those published in the WDNR PUBL WR-153-87, *Groundwater Sampling Procedures Guideline.*

Prior to purging, the depth to water is first determined by an electronic water level indicator whose procedure is described in Section 6.4.1.2.1. The well is then purged such that the purging will "pull" water from the aquifer into the screened area of the well and up through the casing.

Prior to sample collection, each well will be purged by removing four times the volume of water in the monitoring well or until the well is dewatered, whichever comes first. The wells will be purged with a dedicated PVC bailer or a Grundfos® stainless steel submersible pump. In the piezometers, water will be drawn from above the screen in the uppermost part of the water column such that fresh water from the screen moves upward.

Subsequent to purging, samples will be removed with either the dedicated PVC bailer or the Grundfos® submersible pump if appropriate for the parameter being collected. Sampling shall follow purging by no more than six hours for wells which recover quickly. For slowly recovering wells, sampling must be completed within ten hours of purging. In no case will wells be sampled after ten hours have elapsed following the purging event.

State of Wisconsin
Department of Natural Resources

Route to: Solid Waste ☐ Haz. Waste ☐ Wastewater ☐
Env. Response & Repair ☐ Underground Tanks ☐ Other ☐ _____

MONITORING WELL CONSTRUCTION
Form 4400-113A Rev. 4-90

Facility/Project Name	Local Grid Location of Well: ___ ft. ☐N ☐S ___ ft. ☐E ☐W	Well Name
Facility License, Permit or Monitoring Number	Grid Origin Location: Lat. ___ Long. ___ or	Wis. Unique Well Number / DNR Well Number
Type of Well: Water Table Observation Well ☐ 11; Piezometer ☐ 12	St. Plane ___ ft. N, ___ ft. E.	Date Well Installed: m m / d d / y y
Distance Well Is From Waste/Source Boundary: ___ ft.	Section Location of Waste/Source: ___ 1/4 of ___ 1/4 of Sec. ___, T. ___ N, R. ___ ☐E ☐W	Well Installed By: (Person's Name and Firm)
Is Well A Point of Enforcement Std. Application? ☐ Yes ☐ No	Location of Well Relative to Waste/Source: u ☐ Upgradient; s ☐ Sidegradient; d ☐ Downgradient; n ☐ Not Known	

A. Protective pipe, top elevation _____ ft. MSL
B. Well casing, top elevation _____ ft. MSL
C. Land surface elevation _____ ft. MSL
D. Surface seal, bottom _____ ft. MSL or _____ ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☐
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis attached? ☐ Yes ☐ No

14. Drilling method used: Rotary ☐ 50; Hollow Stem Auger ☐ 41; Other ☐ ___ _____

15. Drilling fluid used: Water ☐ 02; Air ☐ 01; Drilling Mud ☐ 03; None ☐ 99

16. Drilling additives used? ☐ Yes ☐ No
Describe _____

17. Source of water (attach analysis): _____

E. Bentonite seal, top _____ ft. MSL or _____ ft.
F. Fine sand, top _____ ft. MSL or _____ ft.
G. Filter pack, top _____ ft. MSL or _____ ft.
H. Screen joint, top _____ ft. MSL or _____ ft.
I. Well bottom _____ ft. MSL or _____ ft.
J. Filter pack, bottom _____ ft. MSL or _____ ft.
K. Borehole, bottom _____ ft. MSL or _____ ft.
L. Borehole, diameter ___.___ in.
M. O.D. well casing ___.___ in.
N. I.D. well casing ___.___ in.



1. Cap and lock? ☐ Yes ☐ No
2. Protective cover pipe:
a. Inside diameter: ___.___ in.
b. Length: ___.___ ft.
c. Material: Steel ☐ 04; Other ☐ ___ _____
d. Additional protection? ☐ Yes ☐ No
If yes, describe: _____
3. Surface seal: Bentonite ☐ 30; Concrete ☐ 01; Other ☐ ___ _____
4. Material between well casing and protective pipe: Bentonite ☐ 30; Annular space seal ☐ ___; Other ☐ ___ _____
5. Annular space seal: a. Granular Bentonite ☐ 33
b. _____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐ 35
c. _____ Lbs/gal mud weight . . . . . Bentonite slurry ☐ 31
d. _____ % Bentonite . . . . . Bentonite-cement grout ☐ 50
e. _____ Ft^3 volume added for any of the above
f. How installed: Tremie ☐ 01; Tremie pumped ☐ 02; Gravity ☐ 08
6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐ 1/4 in. ☐ 3/8 in. ☐ 1/2 in. Bentonite pellets ☐ 32
c. _____ Other ☐ ___
7. Fine sand material: Manufacturer, product name & mesh size
a. _____ ___
b. Volume added _____ ft^3
8. Filter pack material: Manufacturer, product name and mesh size
a. _____ ___
b. Volume added _____ ft^3
9. Well casing: Flush threaded PVC schedule 40 ☐ 23; Flush threaded PVC schedule 80 ☐ 24; Other ☐ ___ _____
10. Screen material: _____ ___
a. Screen type: Factory cut ☐ 11; Continuous slot ☐ 01; Other ☐ ___ _____
b. Manufacturer _____
c. Slot size: 0.___ in.
d. Slotted length: ___.___ ft.
11. Backfill material (below filter pack): None ☐ 14; Other ☐ ___ _____

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature _____ Firm _____

Please complete both sides of this form and return to the appropriate DNR office listed at the top of this form as required by chs. 144, 147 and 160, Wis. Stats., and ch. NR 141, Wis. Ad. Code. In accordance with ch.144, Wis Stats., failure to file this form may result in a forfeiture of not less than $10, nor more than $5000 for each day of violation. In accordance with ch. 147, Wis. Stats., failure to file this form may result in a forfeiture of not more than $10,000 for each day of violation. NOTE: Shaded areas are for DNR use only. See instructions for more information including where the completed form should be sent.

NOTE:
FORM REDUCED FOR FIGURE.
FORMS USED FOR DOCUMENTATION
WILL BE 8.5 X 11 INCHES.

Crandon Mining Company

FIGURE 6-3
WDNR MONITORING WELL CONSTRUCTION FORM
FORM 4400-113A

Scale: NO SCALE | Date: FEBRUARY 1994
Prepared By: Foth & Van Dyke | By: JRB

REVISED	DATE	BY	DESCRIPTION	E35

3c49form.DGN

93C049

State of Wisconsin
Department of Natural Resources

MONITORING WELL DEVELOPMENT
Form 4400-113B Rev. 4-90

Route to: Solid Waste ☐ Haz. Waste ☐ Wastewater ☐
Env. Response & Repair ☐ Underground Tanks ☐ Other ☐ _____

Facility/Project Name	County Name	Well Name

Facility License, Permit or Monitoring Number	County Code	Wis. Unique Well Number	DNR Well Number
_ _ _ _ _ _ _	_ _		

1. Can this well be purged dry? ☐ Yes ☐ No

2. Well development method
- surged with bailer and bailed ☐ 41
- surged with bailer and pumped ☐ 61
- surged with block and bailed ☐ 42
- surged with block and pumped ☐ 62
- surged with block, bailed and pumped ☐ 70
- compressed air ☐ 20
- bailed only ☐ 10
- pumped only ☐ 51
- pumped slowly ☐ 50
- Other _____ ☐ [redacted]

3. Time spent developing well _ _ _ _ min.

4. Depth of well (from top of well casing) _ _ _ . _ ft.

5. Inside diameter of well _ _ . _ _ in.

6. Volume of water in filter pack and well casing _ _ _ . _ gal.

7. Volume of water removed from well _ _ _ . _ gal.

8. Volume of water added (if any) _ _ _ . _ gal.

9. Source of water added _____

10. Analysis performed on water added? ☐ Yes ☐ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. _ _ _ . _ _ ft.	_ _ _ . _ _ ft.
Date	b. m m / d d / y y	m m / d d / y y
Time	c. _ _ : _ _ ☐ a.m. ☐ p.m.	_ _ : _ _ ☐ a.m. ☐ p.m.
12. Sediment in well bottom	_ _ . _ inches	_ _ . _ inches
13. Water clarity	Clear ☐ 10 Turbid ☐ 15 (Describe)	Clear ☐ 20 Turbid ☐ 25 (Describe)
Fill in if drilling fluids were used and well is at solid waste facility:		
14. Total suspended solids	_ _ _ _ . _ mg/l	_ _ _ _ . _ mg/l
15. COD	_ _ _ _ . _ mg/l	_ _ _ _ . _ mg/l

16. Additional comments on development:

Well developed by: Person's Name and Firm

Name: _____

Firm: _____

I hereby certify that the above information is true and correct to the best of my knowledge.

Signature: _____

Print Initials: _____

Firm: _____

NOTE: Shaded areas are for DNR use only. See instructions for more information including a list of county codes.

NOTE:
FORM REDUCED FOR FIGURE.
FORMS USED FOR DOCUMENTATION
WILL BE 8.5 X 11 INCHES.

Crandon Mining Company

FIGURE 6-4

WDNR MONITORING WELL DEVELOPMENT FORM
FORM 4400-113B

REVISED	DATE	BY	DESCRIPTION	E36

Scale: NO SCALE | Date: FEBRUARY 1994

Prepared By: Foth & Van Dyke | By: JRB

3c49form.DGN

Water samples will be poured from the bailer, or from the pump tubing, into containers specifically prepared for the given parameter(s). Metal sample aliquots will be filtered in the field prior to acidification. These samples will be passed through a 0.45-micron membrane. Filtering of samples is described in Section 6.4.1.2.2.

Documentation of purging and sampling activities shall be accomplished by using the Groundwater Monitoring Field Form illustrated on Figure 6-5.

When collecting samples for trace contaminants and/or metals, all equipment used shall be cleaned and/or decontaminated. Blanks should be collected to determine the adequacy of cleaning. Samples for purgeable organic analyses shall be collected with bailers.

If fuel-powered units are used in groundwater sampling activities, those units shall be placed away from and down wind of any site activities (i.e., purging, sampling decontamination). It is also recommended that the individual who handles such equipment be a different individual than the one who actually conducts the sampling (if possible).

Any dedicated equipment (except for dedicated pump systems that are never removed from the well) will be stored off-site between sampling events. Decontamination activities will also be performed on the equipment followed by storage precautions to minimize contamination between sampling events.

When duplicate samples are to be collected, they shall be collected by sampling from successively collected sample volumes. Split samples, when collected, are to be taken from consecutive sample volumes from the same device or by mixing in an intermediate vessel. This sample should be portioned into two or more containers from a single sample container. Portioning assumes adequate mixing to assure "split samples" are identical.

6.4.1.2.1 Water Level Measurement

To measure the static water level with an electric water level indicator, the procedure below will be followed:

- Rinse the sounder cable off with distilled water. Shake off all excess water.
- Test the unit to assure that it is functional.
- Slowly unreel the cable into the well until the beeping sound can be heard.
- Slowly raise and lower the cable to the point when the beeping just begins to sound. Note the measurement and repeat raising and lowering until three consecutive measurements are the same. This is the static water level.
- Read the depth measurement on the tape to the nearest one-hundredth foot.
- Rinse the water level indicator off with distilled water after reeling the cable back onto the spool. Shake off all excess water.

GROUNDWATER MONITORING FIELD FORM

PURGING PHASE

WELL I.D.	DATE	TIME	DEPTH TO SWL (FT.)	TOTAL DEPTH (FT.)	LENGTH WATER COL.(FT.)	LENGTH OF SAND PACK(FT.)	RECEIVALS TO PURGE 4 VOLS.	AMOUNT PURGED (GAL.)	DEPTH TO SWL AFTER PURGE (FT.)

SAMPLING PHASE

DATE	TIME	PH	SPEC. COND. AT 25C	TEMP. (C)	COLOR BEFORE FILTER	COLOR AFTER FILTER	ODOR	TURB BEFORE FILTER	TURB AFTER FILTER	# OF FILTERS	VOLUME FILTERED (GAL)

TEMPERATURE/WEATHER CONDITIONS:

EQUIPMENT USED:

OTHER REMARKS:

CASING I.D. (INCHES)	GAL./FT./CASING	BOREHOLE DIA.(INCHES)	GAL/FT/WELL VOLUME (V1+V2)
1.25	0.06	4	.24
1.25	0.06	6	.48
1.5	0.09	4	.26
1.5	0.09	6	.50
2	0.16	6	0.55
2	0.16	8	0.89
2	0.16	10	1.33
4	0.65	8	1.23
4	0.65	10	1.67
4	0.65	12	2.21
6	1.47	10	2.23
6	1.47	12	2.76
6	1.47	14	3.40

SITE NAME: _____ SCOPE I.D.: _____

PERSONNEL: _____ CLIENT: _____

_____ PROJECT: _____

PREPARED BY: _____ DATE: _____

CHECKED BY: _____ DATE: _____

Foth & Van Dyke

FORM EES017 (Rev 3/93)

NOTE:
FORM REDUCED FOR FIGURE.
FORMS USED FOR DOCUMENTATION
WILL BE 8.5 X 11 INCHES.

REVISED	DATE	BY	DESCRIPTION

E38

Crandon Mining Company

FIGURE 6-5

GROUNDWATER MONITORING FIELD FORM

Scale: NO SCALE | Date: FEBRUARY 1994

Prepared By: Foth & Van Dyke | By: JRB

3c49form.DGN

93C049

6.4.1.2.2 Field Filtration

When sampling with a pump, an in-line 0.45 micron filter will be used to filter water samples in the field. If groundwater samples are collected with a bailer, the alternative field filtering procedure to be used is described below:

- Set up the filtering apparatus.
- Place a 0.45 micron membrane filter on the apparatus (using tweezers). If the sample contains a lot of sediment, use a pre-filter to prevent clogging.
- Flush a minimum of 500 ml of reagent grade water through the filtering apparatus before filtering the sample.
- Pump the sample through the filter and discard at least the first 150 ml (if there is enough extra volume).
- Collect the remaining volume of sample needed in the sample containers.
- Remove the filter membrane (and the pre-filter if used) after the sample is collected and discard. DO NOT REUSE FILTER PAPER FOR ANOTHER SAMPLE.
- Flush the filtering apparatus and o-ring with 500 ml reagent grade water.
- Reassemble the filtering apparatus for next sample.

6.4.1.3 Cleaning/Decontamination Procedures

Sufficient clean equipment should be transported to the field such that field cleaning is minimized. Equipment that is transported to the field shall be precleaned and ready to use.

Equipment is to be cleaned prior to transportation to the site according to the following scheme:

- Wash with hot, soapy water.
- Scrub with brush (if necessary).
- Rinse thoroughly with tap water.
- Rinse thoroughly with deionized water.
- Air dry completely.
- Store in a manner to minimize contamination.

If in-field decontamination is necessary, the following procedure is to be used:

- Wash thoroughly with Alconox® and water from a documented source using a brush (if necessary) to remove heavy contamination.
- Rinse with water from a documented source.
- Rinse with deionized water from a documented source.
- Allow equipment to air dry.

6.4.2 Analytical Methods

The following is a list of drinking water parameters for which groundwater samples will be taken and analyzed:

Field Measured Parameters

pH
Specific Conductance
Temperature

Conductivity, pH and temperature readings will be performed at the well head.

Laboratory Measured Parameters

Total alkalinity	Arsenic
TDS	Barium
COD	Cadmium
Chloride	Chromium
Cyanide	Copper
Sulfate	Iron
Nitrate	Lead
Kjeldahl Nitrogen	Manganese
Nitrate + Nitrite	Mercury
Fluoride	Selenium
Calcium	Silver
Magnesium	Molybdenum
Zinc	Cobalt
Aluminum	Antimony
Total hardness	

The analytical methods, target practical quantitation limits and QC measures are indicated on Table 5-4.

The following parameters will not be monitored because they are not commonly related to mining operations, are not naturally occurring, and are not expected to be present in groundwater at the site because of current land use practices.

Color
Corrosivity
Foaming Agents MBAS
Odor
Turbidity
Coliform Bacteria
Trihalomethanes
Volatile Organic Compounds
Semi-Volatile Organic Compounds
Pesticides/Herbicides
Acrylamide

Asbestos
Hydrogen Sulfide

6.4.3 Sample Documentation

Field observations of color, odor and turbidity will also be noted. Field log sheets will be maintained by the field sampler. During the groundwater monitoring program the field sampler will do a verification of the integrity of the wells and, if necessary, perform minor maintenance.

The following data is also included on the groundwater monitoring field form illustrated on Figure 6-5:

- Water table depth
- Calculation used for well volume purged
- Amount of water purged
- Date/time well purged
- pH, temperature, conductivity of the groundwater by well
- Use of fuel powered units
- Equipment used for purging/sampling

Monitoring wells and piezometers will be labeled with a three-digit alpha code particular to this project which is CMC. The remainder of the well label will consist of a two digit numeric code starting with 01. Piezometers will be labeled with a P after the numeric code. An example of these labels are:

Monitoring well	CMC-01
Piezometer	CMC-01P

Groundwater samples will be labeled using their respective well labels. Tracking successive sampling events will be done by the date of analysis.

6.4.4 Quality Control

6.4.4.1 Equipment Blanks

At least one equipment blank on clean sampling equipment will be submitted for each sampling event and analyzed for each analyte group (to include all matrices). The blank will be prepared in the field before sampling begins by filling or rinsing the precleaned equipment with analyte-free water, filling the appropriate container(s) and preserving and documenting in the same manner as the collected samples. Suitable blanks for analyte groups of interest will be submitted and analyzed for each type of equipment to be used in sampling.

If equipment is cleaned on site, then additional equipment blanks will be collected and analyzed for each equipment group at a rate of one blank or five percent of the equipment sets that must be cleaned, whichever is greater. These blanks will be collected and analyzed for all types of matrices.

6.4.4.2 Field Duplicates

During each independent sampling event, at least one sample or 10% of the samples, whichever is greater, will be collected in duplicate for analysis. This requirement applies to each and all parameter groups and matrices that are sampled.

6.4.4.3 Quality Control for Field Measurements

At least one duplicate measurement will be made for every ten field measurements to evaluate precision. QC check standards (from a different source and with a different value than the calibration standards used) will be analyzed at a frequency of 5% to evaluate accuracy.

6.4.4.4 General Requirements

All blanks required must be preserved, documented and transported in the same manner as the samples they are associated with.

6.5 Noise

6.5.1 Monitoring Protocol

The proposed verification monitoring program is based on a review of the previously predicted impact results summarized in WDNR's 1986 *Final Environmental Impact Statement*. Those locations where increases were previously predicted in the "moderate" range will be included in the verification monitoring program.

6.5.2 Monitoring Methodology

Nine locations have been selected for noise verification monitoring. Both previously monitored sites located in Mole Lake (Locations 1 and 2) are included in the program to determine if land use changes in this community (i.e., operation of the casinos) have resulted in changes in the baseline noise levels.

Noise levels will be monitored for a period of 16 to 21 minutes at each location. The microphone will be located four to five feet above the ground, and at least 12 feet from any large reflecting plane. Monitoring will be postponed if the humidity exceeds 95 percent or the wind speed is greater than 12 miles per hour.

6.5.3 Monitoring Documentation

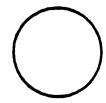
During the data recording period, meteorological parameters will also be recorded, including; wet and dry bulb temperatures, barometric pressure, wind speed, and wind direction using the noise data collection form (Figure 6-6). A field notebook will be maintained as described in Section 7.2 in addition to the data collection form.

Noise Notes

Notes by			Date	Project Number	
Type of Noise	Steady	Transient		Impulse	Tones

Instrumentation (type/serial number)

Sketch of measurement site



Time of measurement _____ am pm Duration of measurement _____hrs _____mins

Weather conditions

Temperature _____Wind speed _____Wind direction _____

Barometric pressure _____Relative humidity _____

Noise sources during measurement

Readings Time Min Max Leq SEL

Settings

Peak ☐	RMS ☐		☐ Ref
Imp ☐	Fast ☐	Slow ☐	☐ Operate
Frontal ☐			☐ Test
Random ☐			☐ A
Out ☐	In ☐		☐ C
			☐ Lin ⌐
			☐ Lin

Meter settings Calibrated? _____Bat check? _____Wind screen? _____Leq (FSD) range? _____

Notes

NOTE:
FORM REDUCED FOR FIGURE.
FORMS USED FOR DOCUMENTATION
WILL BE 8.5 X 11 INCHES.

REVISED	DATE	BY	DESCRIPTION

E43

Crandon Mining Company

FIGURE 6-6

NOISE DATA COLLECTION FORM

Scale: NO SCALE Date: FEBRUARY 1994

Prepared By: Foth & Van Dyke By: JRB

3c49form.DGN

6.5.4 Quality Control

Calibration will be conducted with a Type 4230 Sound Level Calibrator producing a nominal sound pressure level of 94 dB.

6.6 Surface Water Sediments

6.6.1 Sampling Protocols

Sediment samples will be collected at 17 locations to confirm the previous data which was collected and to document current conditions. The intent is to sample the upper one foot of sediment to determine background characteristics, although site conditions may dictate sampling depths. A non-metallic sampler will be used to collect the sample. If stratification of sediments is evident, samples will be collected from the top layer of sediment for independent analysis.

6.6.2 Analytical Methods

The analytical methods to be used to analyze these sediment samples are indicated in Table 5-6.

6.6.3 Sample Documentation

A sample numbering system will be used to identify each sample. This numbering system will provide a tracking procedure to allow retrieval of information about a particulate sample and result in
each sample being uniquely numbered. The sample identification number will be composed of three components, which are described below:

Sediment samples will be designated CMC-SWS-(sampling station ID)

The sampling station ID can be a single alpha digit or a single alpha digit followed by a numeric digit, i.e.:

CMC-SWS-D
or
CMC-SWS-A-1

Quality control samples shall be uniquely numbered. Duplicate samples shall be named using the same designation as the original sample followed by an A. For example, duplicates for the sampling locations listed above would be designated

CMC-SWS-DA
and
CMC-SWS-A-1A

A record of the QA/QC identification numbers will be maintained in the project note book. Field note books are discussed in Section 7.2.

Project sampling activities will be documented by keeping a written record of daily sampling activities and implementing the Chain-of-Custody procedures described in the PQAP. The

information documented will incorporate that which is specified in Section 7 of the plan. This will provide for the integrity of data by tracking and documenting samples from the time they are collected by the sampling team through receipt at the laboratory. Errors in documents will be deleted by crossing through the mistaken information with a single line, initialling and dating by the person making the change.

6.6.4 Quality Control

Two duplicate samples will be collected for quality control purposes at sites selected at the time of sampling.

6.7 Waste Characterization

6.7.1 Sampling Protocols

The testing of the waste materials will be conducted under conditions approximating those under which the individual materials will be used or disposed of at the site. The low sulfur-content waste rock will be leached under alternating wet and dry conditions to determine what, if any, impact the storage and usage of the this material above grade will have on the surficial environment. Other combinations of waste rock, tailings, sludge and normal Portland cement will be tested under varied conditions as specified in the sampling and testing plan that will be submitted to the WDNR during the spring of 1994.

The acid production potential of the two waste rock composites will be determined. In addition, the acid production potential of each of the low sulfur-content waste rock stratigraphic units used to produce the low sulfur-content waste rock composite will be determined.

Waste rock samples will be obtained from the diamond drill cores recovered during the past and present exploration programs. These samples are either stored in Rhinelander or are being obtained at the site near Crandon.

6.7.2 Analytical Methods

Selected samples will be collected and preserved to minimize chemical and physical degradation. Preservation of diamond drill core samples will be accomplished by placing the samples in heavy weight plastic bags and shipping them to the laboratories where the testing will be performed. Preservation of the crushed and ground materials will be accomplished by placing the samples in polyethylene bottles and shipping them to the laboratories where the testing will be performed.

The material that will be used to form the ore composite will be acquired from some of the diamond drill cores currently being obtained. The materials from these cores will be used for ore recovery benchtesting by Lakefield Laboratories. Based upon the results of the initial benchtesting, Lakefield Laboratories will form two or three master ore composites for final testing and process optimization. The materials that will be used to form the master ore concentrates, and the fine tailings and coarse tailings materials composites that will be produced during the processing of the master composites will be acquired from Lakefield Laboratories following the processing of the ore samples.

The laboratory analyses to be performed are described in detail in Section 4.3.16 of the NOI/SOS and are included in Table 5-6 and 5-7.

6.7.3 Sample Documentation

A sample numbering system will be used to identify each sample. The numbering system will provide a tracking procedure to allow retrieval of information about a particular sample and result in a sample which is uniquely numbered.

Bulk chemical composition samples will be designated according to the following scheme:

CMC-BCC-01 COMP	low sulfur waste rock
CMC-BCC-02 COMP	high sulfur waste rock
CMC-BCC-03 COMP	ore
CMC-BCC-04 COMP	ore concentrate
CMC-BCC-05 COMP	fine tailings
CMC-BCC-06 COMP	coarse tailings
CMC-BCC-07 COMP	mixed waste rock
CMC-BCC-08 COMP	wastewater treatment sludge

Alternative wet and dry leaching samples will be named according to the following scheme:

CMC-WCL-WD-01-(cycle)	low sulfur waste rock
CMC-WCL-WD-03-(cycle)	ore
CMC-WCL-WD-09-(cycle)	fine tailings + wastewater treatment sludge
CMC-WCL-WD-10-(cycle)	mixed fine and coarse tailings + wastewater treatment sludge

Aerobic saturated leaching samples will be named according to the following scheme:

CMC-WCL-RS03-(cycle)	ore
CMC-WCL-RS09-(cycle)	fine tailings + wastewater sludge
CMC-WCL-RS10-(cycle)	mixed fine and coarse tailings + wastewater sludge

Anoxic saturated leaching samples will be named according to the following scheme:

CMC-WCL-AS02-(cycle)	high sulfur waste rock
CMC-WCL-AS11-(cycle)	high sulfur waste rock + coarse tailings
CMC-WCL-AS12-(cycle)	high sulfur waste rock + coarse tailings + NPC
CMC-WCL-AS13-(cycle)	high sulfur waste rock + thickened whole tailings
CMC-WCL-AS14-(cycle)	high sulfur waste rock + thickened whole tailings + NPC
CMC-WCL-AS15-(cycle)	low sulfur waste rock

Activities will be documented by keeping a written record of daily sampling activities and implementing the Chain-of-Custody procedures described in this portion of the PQAP. The information documented will incorporate that which is specified in Section 7 of the plan. This will provide for the integrity of data by tracking and documenting samples from the time they are collected by the sampling team through receipt at the laboratory. Errors in documents will be deleted by crossing through the mistaken information with a single line, initialling and dating by the person making the change.

6.7.4 Quality Control

Specific Quality Control requirements will be specified in the waste characterization sampling and testing plan that will be submitted to the WDNR in the spring of 1994.

6.8 Water Management

6.8.1 Sampling Protocols

A pilot test will be completed to evaluate the lime/sulfide treatment process, either as a single stage reaction or as separate reactions, followed by dual media filtration. The test will use water generated during leach testing of the material associated with the mine. The material which, through the waste characterization process most closely represents the water which will be treated, will be used for the test.

If wells are used to intercept groundwater prior to seepage into the mine, treatment may be needed prior to discharge. If the lime/sulfide treatment process is needed, samples of groundwater will be subjected to the pilot studies. The selection of wells for collecting these samples will be based on the location of the proposed intercept system.

As part of the pilot study other technologies may also be evaluated. The preliminary evaluations will drive further pilot treatment study needs.

At the current time, the lime/sulfide treatment technology is one of a number of combinations that appears to be the treatment method most likely to be used for metals removal. A brief discussion of the pilot test procedure for this process is presented in Section 4.3.17.3.3 of the NOI/SOS. As the preliminary evaluation is completed, the pilot testing methods will be modified to reflect changes in the proposed treatment technology. Split sample will be made available to WDNR if additional raw materials are available for the completion of the study.

6.8.2 Analytical Methods

The analytical methods to be employed on these pilot plant samples are described in Tables 5-8 and 5-9.

6.8.3 Sample Documentation

A sample number system will be used to identify each sample. The numbering system will provide a tracking procedure to allow retrieval of information about a particular sample and result in a sample which is uniquely numbered. Water management samples will be numbered as follows:

CMC-WM-pH 9.0
CMC-WM-pH 9.5
CMC-WM-pH 10
CMC-WM-01-RAW

The samples associated with sulfide treatment will be named as follows:

CMC-WM-02 RAW
CMC-WM-S1
CMC-WM-S2
CMC-WM-S3

The samples associated with gravity settling and dual media filtration will be named as follows:

CMC-WM-03 RAW	
CMC-WM-FSB	sample blank
CMC-WM-FLF	laboratory filtrate
CMC-WM-FEF	effluent

The samples associated with further treatment will be named as follows:

CMC-WM-04 RAW	
CMC-WM-FT EF	final treatment effluent
CMC-WM-FT AT	additional treatment

The samples associated with pilot study solids will be named:

CMC-WM-WTS

Activities will be documented by keeping a written record of daily sampling activities and implementing the Chain-of-Custody procedures described in this portion of the PQAP. The information documented will incorporate that which is specified in Section 7 of the plan. This will provide for the integrity of data by tracking and documenting samples from the time they are collected by the sampling team through receipt at the laboratory. Errors in documents will be deleted by crossing through the mistaken information with a single line, initialling and dating by the person making the change.

6.8.4 Quality Control

Quality control samples associated with this task are specified within the protocols outlined in Section 4.3.17 of the NOI/SOS.

6.9 Surface Water Quality

Surface water sampling protocols, analytical methodology and quality control/quality assurance procedures are specified in the *Surface Water Sampling Quality Assurance Plan for the Proposed Crandon Project*, December 1993. Surface water sampling locations are identified in Table 4-17 of the NOI/SOS that were not included in the December 1993 surface water sampling plan. Analytical methods for these additional sites are either included in the December 1993 plan, or are shown in Table 5-10.

6.10 Air Quality

The sampling protocols, analytical methodology and quality control/quality assurance procedures will be specified in the document titled *Ambient Air Monitoring Quality Assurance/Quality Control Plan for the Proposed Crandon Project*. This document will be submitted to the WDNR in February 1994.

6.11 Tailings Management Area

Sampling protocols, analytical methodologies and quality assurance procedures which will be used for samples collected as part of the studies associated with the tailings management area will be specified within the work plan which will be developed for that task at a later date.

6.12 Sample Preservation

Table 6-1 indicates the parameter, container type, minimum sample volume, preservation requirements and holding times applicable to Crandon Project data collection activities. Appendix A contains additional information regarding this topic. This table also includes parameters not currently planned for analysis, but which are commonly associated with environmental studies.

Those samples requiring thermal preservation will be cooled with wet ice to reduce/maintain the sample container environment at 4°C. The ice should be wet ice that is in full contact with the sample containers (blue ice is not acceptable). For samples which require pH adjustment as a means of preservation, ETC will provide sample containers with preservatives and sufficient additional preservatives from the same source such that the field sampler can add additional preservatives if necessary. The pH of the sample will be checked by removing an aliquot of the sample, checking the pH with pH paper and adjusting the pH by adding additional preservative (if necessary). If equipment blanks are to be collected, the same amount of acid is added to the blank as to the sample.

The pH checking procedure will be done on all samples for each parameter on the first sampling event at a given site. For subsequent sampling events at the same site, only one sample from each parameter need be checked. Documentation of the pH verification will be done in the field notebook.

If the samples arrive at the laboratory with water and ice remaining in the cooler, the laboratory can assume that the sample temperature is 4°C. If no ice remains, the laboratory shall take and record a temperature reading.

Table 6-1

Sample Containers, Preservation Methods, Holding Times
Crandon Mining Company NOI/SOS/PQAP

Component	Container Type	Matrix	Minimum Sample Volume (Aq in ml) (Solid in gm)	Preservative	Holding Time
Chloride	P, G	Aq	100	none required	28 dy
	P, G	Solid	50	none required	28 dy
Nitrate	P, G	Aq	500	cool, 4°C	48 hr
Nitrate + Nitrite	P, G	Aq	500	cool, 4°C H_2SO_4,pH<2	28 dy
Sulfate	P, G	Aq	150	cool, 4°C	28 dy
Total Alkalinity	P, G	Aq	100	cool, 4° C	14 dy
Chemical Oxygen Demand	P, G	Aq	120	cool, 4°C H_2SO_4,pH<2	28 dy
Cyanide, Total	P, G	Aq	1000	cool, 4°C, NaOH, pH>12	14 dy
	P, G	Solid	50	cool, 4°C	14 dy
Fluoride	P	Aq	100	none required	28 dy
	P	Solid	100	none required	28 dy
Total Kjeldahl Nitrogen	P, G	Aq	500	cool, 4°C, H_2SO_4,pH<2	28 dy
		Solid	50	cool, 4°C	28 dy
Total Dissolved Solids	P, G	Aq	150	cool, 4°C	7 dy
Total Hardness	P, G	Aq	100	HNO_3, pH<2	6 mo
Nitrogen, Organic	P, G	Solid	100	cool, 4°C	28 dy
Oil and Grease	G	Solid	100	cool, 4°C	28 dy
T Phosphorus	P, G	Aq	100	cool, 4°C, H_2SO_4,pH<2	28 dy
	P, G	Solid	50	cool, 4°C	28 dy
Total Solids	P, G	Solid	50	cool, 4°C	7dy
Total Volatile Solids	P, G	Solid	50	cool, 4°C	7 dy
Ammonia	P, G	Aq	500	cool, 4°C, H_2SO_4,pH<2	28 dy
BOD_5	P, G	Aq	500	cool, 4°C	48 hr
Sulfide	P, G	Aq	500	cool, 4°C, ZnOAc+NaOH, pH>9	7 dy

Table 6-1 (cont.)

Component	Container Type	Matrix	Minimum Sample Volume (Aq in ml) (Solid in gm)	Preservative	Holding Time
Sulfur	P, G	Solid	50	cool, 4°C	none specified
Total Suspended Solids	P, G	Solid	50	cool, 4°C	7 dy
Carbon (total)	G	Solid	20	cool, 4°C	none specified
Boron	P, G	Aq	1000	HNO_3, pH<2	6 mo
	P, G	Solid	200	cool, 4°C	6 mo
Calcium	P, G	Aq	1000	HNO_3, pH<2	6 mo
	P, G	Solid	200	cool, 4°C	6 mo
Aluminum	P, G	Aq	1000	HNO_3,pH<2	6 mo
	P, G	Solid	200	cool, 4°C	6 mo
Arsenic	P, G	Aq	1000	HNO_3,pH<2	6 mo
	P, G	Solid	200	cool, 4°C	6 mo
	P	Tissue	25	frozen	180 dy
Barium	P, G	Aq	1000	HNO_3,pH<2	6 mo
	P, G	Solid	200	cool, 4°C	6 mo
Cadmium	P, G	Aq	1000	HNO_3, pH<2	6 mo
	P, G	Solid	200	cool, 4°C	6 mo
	P	Tissue	25	frozen	180 dy
Copper	P, G	Aq	1000	HNO_3, pH<2	6 mo
	P, G	Solid	200	cool, 4°C	6 mo
		Tissue	25	frozen	180 dy
Iron	P, G	Aq	1000	HNO_3, pH<2	6 mo
	P, G	Solid	200	cool, 4°C	6 mo
Lead	P, G	Aq	1000	HNO_3, pH<2	6 mo
	P, G	Solid	200	cool, 4°C	6 mo
	P	Tissue	25	frozen	180 dy
Manganese	P, G	Aq	1000	HNO_3, pH<2	6 mo
	P, G	Solid	200	cool, 4°C	6 mo
		Tissue	25	frozen	180 dy
Mercury	P, G	Aq	1000	HNO_3, pH<2	28 dy
	P, G	Solid	200	cool, 4°C	28 dy
	P	Tissue	5	frozen	28 dy
Molybdenum	P, G	Aq	1000	HNO_3, pH<2	6 mo
	P, G	Solid	200	cool, 4°C	6 mo

Table 6-1 (cont.)

Component	Container Type	Matrix	Minimum Sample Volume (Aq in ml) (Solid in gm)	Preservative	Holding Time
Selenium	P, G	Aq	1000	HNO_3, pH<2	6 mo
	P, G	Solid	200	cool, 4°C	6 mo
Silver	P, G	Aq	1000	HNO_3, pH<2	6 mo
	P, G	Solid	200	cool, 4°C	6 mo
Zinc	P, G	Aq	1000	HNO_3, pH<2	6 mo
	P, G	Solid	200	cool, 4°C	6 mo
	P	Tissue	25	frozen	180 dy
Chromium	P, G	Aq	1000	HNO_3, pH<2	6 mo
	P, G	Solid	200	cool, 4°C	6 mo
	P	Tissue	25	frozen	180 dy
Beryllium	P, G	Aq	1000	HNO_3, pH<2	6 mo
	P, G	Solid	200	cool, 4°C	6 mo
Thallium	P, G	Aq	1000	HNO_3, pH<2	6 mo
	P, G	Solid	200	cool, 4°C	6 mo
Nickel	P, G	Aq	1000	HNO_3, pH<2	6 mo
	P, G	Solid	200	cool, 4°C	6 mo
Antimony	P, G	Aq	1000	HNO_3, pH<2	6 mo
	P, G	Solid	200	cool, 4°C	6 mo
Magnesium	P, G	Aq	1000	HNO_3, pH<2	6 mo
	P, G	Solid	200	cool, 4°C	6 mo
Potassium	P, G	Aq	1000	HNO_3, pH<2	6 mo
	P, G	Solid	200	cool, 4°C	6 mo
Sodium	P, G	Aq	1000	HNO_3, pH<2	6 mo
	P, G	Solid	200	cool, 4°C	6 mo
Cobalt	P, G	Aq	1000	HNO_3, pH<2	6 mo
	P, G	Solid	200	cool, 4°C	6 mo
	P	Tissue	25	frozen	180 dy
Tin	P, G	Aq	1000	HNO_3, pH<2	6 mo
	P, G	Solid	200	cool, 4°C	6 mo
Sodium	P, G	Aq	1000	HNO_3, pH<2	6 mo
	P, G	Solid	200	cool, 4°C	6 mo
Titanium	P, G	Aq	1000	HNO_3, pH<2	6 mo
	P, G	Solid	200	cool, 4°C	6 mo
Uranium	P, G	Aq	500	none required	6 mo
	P, G	Solid	20	none required	6 mo
Bismuth	P, G	Aq	1000	HNO_3, pH<2	6 mo
	P, G	Solid	200	cool, 4°C	6 mo

Component	Container Type	Matrix	Minimum Sample Volume (Aq in ml) (Solid in gm)	Preservative	Holding Time
Gold	P, G	Solid	200	cool, 4° C	6 mo
Silicon	P, G	Solid	200	cool, 4°C	6 mo
Tellurium	P, G	Aq	1000	HNO_3, pH<2	6 mo
	P, G	Solid	200	cool, 4°C	6 mo

P = plastic
G = glass
Aq = aqueous (groundwater, surface water, filtrate)

6.13 Sample Dispatch

Sample containers are transferred from field storage containers to insulated shipping containers for delivering to the laboratory. The sample containers, within the shipping container, are placed such that individual sample containers are not touching each other and there is no movement of sample containers. If VOC sample containers are to be packed in a shipping container, multiple vials from the same sampling point are placed into individual Ziploc™ bags. Samples requiring thermal preservation are stored with wet ice. The wet ice is packaged such that sample container labels do not become wet and unglued during shipment. Fiberglass strapping tape is used to seal the containers. Containers are appropriately labelled for shipment.

Shipping containers are delivered to the laboratory by the sampling team or shipped via courier or common carrier to the laboratory for analysis. Copies of the chain-of-custody form and any shipping forms must accompany the samples. The laboratory should be notified in advance of the forthcoming shipment.

7 Sample Custody

The Chain-of-Custody form (Figure 7-1) will be used to document sample possession from the time the sample bottles leave the laboratory until they are received back at the laboratory. Each time custody of a sample is transferred, the new custodian will sign the form and will document the time and date. A sample will be considered in custody if it is:

- In one's actual possession.
- In view, after being in physical possession.
- Locked so that no one can tamper with it, after having been in one's physical possession.
- In a secured area, restricted to authorized personnel.

Procedures for preparing and shipping samples will conform with labeling and packing requirements of the United States Department of Transportation.

While awaiting screening or packaging, those samples which must be kept cool will be stored on wet ice in coolers. Preservatives, when required by method or regulation, are added to collected samples such that the physical and/or chemical alterations are minimized. Preservatives must be added immediately upon sample collection. The preservative added will be documented on the chain-of-custody form in the "analyses required" or "remarks" portion of the form. If samples cannot be shipped on the same day that they are collected, packaging will be delayed until the following morning so that the samples can be shipped properly preserved.

Each time the custody of the samples is relinquished to another individual (or to the laboratory), the date, time and items transferred are noted on the chain-of-custody form. After the samples have been packaged for shipping, the custody will be transferred to a team member who will ship the coolers via overnight courier. Upon shipment, the laboratory will be notified that the sample shipment is scheduled to arrive.

Upon receipt of samples in the laboratory, the Chain-of-Custody form will be checked and signed. A copy of the form will be retained by the laboratory and the remaining copy returned to the sampling team.

7.1 Laboratory Arrangements

Foth & Van Dyke will send samples for analysis to one of the following laboratories:

ETC - Edison, NJ
ETC - Santa Rosa, CA
Battelle Marine Science - Sequim, WA
Northern Lake Service, Inc. - Crandon, WI

3c49form.DGN

NOTE:
FORM REDUCED FOR FIGURE.
FORMS USED FOR DOCUMENTATION
WILL BE 8.5 X 11 INCHES.

REVISED	DATE	BY	DESCRIPTION
			E55

ETC

CHAIN-OF-CUSTODY RECORD

Form 0019
Field Technical Services
Rev. 11/91

No. 113003

Environmental Testing and Certification Corp. • 284 Raritan Center Parkway • Edison, NJ 08818 • 908-225-6700

COMPANY | FACILITY/SITE

PROJECT CONTACT | TELEPHONE NO.

ITEM NO	ETC JOB #	SOURCE CODE	SAMPLE POINT	START DATE YY/MM/DD	START TIME
1					
2					
3					
4					
5					
6					
7					
8					
9					

Source Codes:
Well .... (W) Outfall ..... (O)
Soil .... (S) River/Stream .... (R)
Bottom Sediment ..... (B)
Generation Point ..... (G)
Surface Impoundment ..... (I)
Treatment Facility ..... (T)
Leachate Collection Sys ..... (C)
Lake/Ocean ..... (L)
Other ..... (X)
Specify _____

NUMBER OF CONTAINERS

FILT. (Y/N)
PRESERV.
ANALYSIS REQUIRED

LEGEND FOR PRESERVATIVE
0 - NONE
1 - HCL
2 - HNO_3
3 - H_2SO_4
4 - $Na_2SO_3 + H_2SO_4$

SAMPLER OBSERVATIONS	LAB OBSERVATIONS

CHAIN OF CUSTODY CHRONICLE

1 Shuttle Opened By: (print) _____ Date: _____ Time: _____
Signature _____ Seal #: _____ Intact: _____

2 I have received these materials in good condition from the above person
Name: _____ Signature _____
Date: _____ Time: _____ Remarks: _____

3 I have received these materials in good condition from the above person
Name: _____ Signature _____
Date: _____ Time: _____ Remarks: _____

4 Shuttle Sealed By: (print) _____ Date: _____ Time: _____
Signature _____ Seal #: _____ Intact: _____

LAB USE ONLY Opened By: _____ Date: _____ Time: _____
SHUTTLE # _____ TEMP. °C _____ SEAL # _____ COND. _____

REMARKS

SAMPLER'S SIGNATURE

Crandon Mining Company

FIGURE 7-1
CHAIN OF CUSTODY RECORD

Prepared By:	Scale:	Date:	By:
Foth & Van Dyke	NO SCALE	FEBRUARY 1994	JRB

93C049

When ETC designates a subcontractor lab for a particular analysis or set of analyses, samples may be shipped directly to that designated laboratory.

7.1.1 Laboratory Processing of Samples

Procedures for the receipt and logging of samples by the laboratory are addressed in their individual approved quality assurance plans (Appendix A). The following minimum requirements will be expected of those laboratories which are used for sample analysis on this project.

7.1.2 Receipt of Samples by Laboratory

Upon receipt of samples at the laboratory, the following, at a minimum, shall take place:

- Examine all samples and determine if proper temperature has been maintained during shipment. If samples have been damaged during shipment, the remaining samples will be carefully examined to determine whether they were affected. Any samples affected will be considered damaged. It will be noted on the Chain-of-Custody form and reported to laboratory management that specific samples were damaged and that the samples were removed from the sampling program.

  Field personnel will be notified as soon as possible that samples were damaged.

- Compare samples received against those listed on the Chain-of-Custody and any analysis request forms which may be used. Any discrepancies are to be reported immediately to the project manager.

- Verify that sample holding times (if specified) have not been exceeded.

- Sign and date the Chain-of-Custody and associated analysis request forms (if any).

- Verify temperature of samples, if thermal preservation is required. If the sample was shipped in ice and solid ice is still present, report the sample as "received on ice". If the ice used to ship the sample has melted, then the temperature of the melt water may be substituted as the sample temperature.

- Verify pH of samples, if acidic or basic preservation is required. If the samples have been unpreserved, the project manager will be notified so that a decision regarding resampling can be made.

- Assign laboratory number to each sample.

- Place the samples in adequate laboratory storage. If cold storage is required, this is generally accomplished by placing the samples in a refrigerator or cold storage room where the temperature is maintained at 4°C. A maximum-minimum thermometer or thermomograph is used to verify temperatures present in the refrigerator or cold room.

- Enter the following information in the laboratory sample log-in system:

  - Assigned laboratory numbers
  - Project name
  - General sample status (temperature, seal)
  - Sample pH
  - Date received in laboratory
  - Storage location
  - Chain-of-Custody number

7.1.3 Laboratory Storage of Samples

The primary considerations for sample storage are:

- Maintenance of prescribed temperature, if required, which is typically four degrees Celsius.

- Proper preservation to ensure integrity of samples until samples are analyzed.

- Security of the laboratory and the samples.

All extraction and chemical analyses of samples for the project will conform to the holding times and be maintained at the temperatures given in Table 6-1. Placement of samples in the proper storage environment is the responsibility of the laboratory.

7.1.4 Sample Disposal

After the testing program is completed, samples, extracts, and digestates are handled, stored, and/or disposed in accordance with the individual laboratory's procedure in that regard, and within applicable State and/or Federal regulations.

7.2 Field Notebooks

Personnel shall use only bound field log books for the maintenance of field records. Other bound log books such as bound surveyors log books, are acceptable as long as pages cannot be removed without tearing them out.

A log book should be dedicated to an individual project. The field technician's name, project name, and project code should be entered on the inside of the front cover of the log book. Entries should be dated and time of entry recorded. At the end of each day's activity, or entry of a particular event if appropriate, the field technician should draw a diagonal line at the conclusion of the entry and initial indicating the conclusion of the entry or the day's activity.

Aspects of the sample collection and handling, as well as visual observations, shall be documented in the field log books. Sample collection equipment (where appropriate), field analytical equipment, and equipment used to make physical measurements shall be identified in the field log books. Calculations, results, and calibration data for field sampling, field analytical, and field physical measurement equipment shall also be recorded

in the field log books. Field analyses and measurements must be traceable to the specific piece of field equipment used and to the field investigator collecting the sample, making the measurement, or performing the analysis.

Entries in field log books shall be dated, shall be legible, and shall contain accurate and inclusive documentation of an individual's project activities. Since field records are the basis for later written reports, language should be objective, factual, and free of personal feelings or other terminology which might prove inappropriate. Once completed, these field log books become accountable documents and must be maintained as part of the project files.

A bound field notebook with prenumbered pages will be used to record field activities. A separate field notebook will be issued and used for each activity (i.e., groundwater sampling, surface water sampling, etc.). The notebook will be completed in indelible ink and will include a record of:

- Field instrument readings.
- Sample identification numbers, and time/date of collection, location, and description.
- Sample preservation documentation.
- Instrument adjustments (calibrations) performed in the field.
- Statements pertaining to any problems encountered.
- Weather/site conditions.
- Individuals collecting samples.

Mistakes in the notebook will be crossed through with a single line, initialled and dated.

7.3 Common Carrier Shipments

7.3.1 Shipments Within the Continental United States

Samples may be shipped to the laboratory using common carriers. A copy of the shipping documents which are completed in order to ship samples with a carrier will be maintained as part of the project file in order to demonstrate sample custody. The chain-of-custody will also reflect that a common carrier was used for sample transport. The name of the common carrier used will be entered in the "remarks" or "comments" section of the chain-of-custody. When coolers are shipped via common carrier, strapping tape is to be wrapped perpendicular to the cooler openings.

7.3.2 International Shipments

Samples may be shipped to the laboratory using common carriers. A copy of the shipping documents which are completed in order to ship samples with a carrier will be maintained as part of the project file in order to demonstrate sample custody. The chain-of-custody will also reflect that a common carrier was used for sample transport. The common carrier will deliver the sample to a custom house broker familiar with the handling of environmental samples. An agent of the brokerage will be present when the samples are inspected by customs agents so that the integrity of the samples are maintained. Upon clearance, the common carrier will then complete the delivery to the laboratory.

8 Analytical Methods

The field methodologies to be employed or analytical methods to be performed are specified in the tables which follow.

8.1 Field Operations

Methods to be used for field operations are listed in Table 8-1.

Table 8-1

Field Methodologies
Crandon Mining Company NOI/SOS/PQAP

Parameter	Method	MDL	Standards Methods 17th Edition	Methods*
pH	Meter/Electrode	0.1	4500-H+	150.1/9040
Conductivity	Meter	1 μmho	2510	120.1/9050
Temperature	Thermometer/Meter	0.1 C	2550	170.1/NA
Dissolved Oxygen	Meter/Electrode	0.1 mg/L	NA	360.1/NA
Flow	Electromagnetic Velocity Meter	0.02 ft/sec	NA	NA

* Format used refers to:

Method for Chemical Analysis of Water and Wastes USEPA March 1983/*Test Methods for Evaluating Solid Waste (SW846)* USEPA September 1986.

N/A = Not Applicable

8.2 Laboratory Operations

Analytical methods to be used by ETC and its subcontractors are listed in Tables 5-2 through 5-10.

9 Calibration Procedures and Frequency

9.1 Field Instrumentation

Field instrumentation used to measure the components listed in Table 5-1 are listed in Table 9-1.

Table 9-1

Sampling Equipment
Crandon Mining Company NOI/SOS/PQAP

Instrument Name	Manufacturer	Model Number	Analytical Components
Checkmate	Corning, Inc.	M90	pH, specific conductance, dissolved oxygen, temperature
Water Level Indicator	QED, Inc.	6000	Water Levels
Flow Meter	Monteduro-Whitney	PVM-2A	Flow

9.1.1 Standard Receipt and Traceability

Standards for pH and conductivity measurements will be purchased commercially as certified standards. All standards and/or standard sources will be dated upon receipt and stored under recommended conditions until the expiration date (if any). Any documentation accompanying the standards will be retained in a file as part of the calibration record.

9.1.2 Standard Sources

Standard sources are listed in Table 9-2.

Table 9-2

Standard Sources
Crandon Mining Company NOI/SOS/PQAP

Instrument Group	Standard Source	How Received	Storage
pH meter	Commercial Lab Supplier	pH Buffer Solutions	Room Temperature
Conductivity Meter	Commercial Lab Supplier	Standardized Solutions	Room Temperature

9.1.3 Instrument Calibration

Procedures for calibration of field instruments are listed in Table 9-3.

Table 9-3

Field Instrument Calibration
Crandon Mining Company NOI/SOS/PQAP

Instrument	Number of Standards Initial Calibration	Acceptance/ Rejection Criteria (Initial)	Frequency	Number of Standards Continual Calibration	Acceptance/ Rejection Criteria (Continuing)	Frequency
pH meter	2	±0.1 SU	Daily prior to use or failure of continuing calibration.	1	Reading within 5% of known value.	Initial and every ten samples.
Conductivity Meter	1	±1%	Daily prior to use of failure of continuing calibration.	1	Reading within 5% of known value.	Initial and every ten samples.
Thermometer	N/A	±0.1°C	Yearly	N/A	N/A	N/A
DO Meter	N/A	<0.1 mg/L	Daily prior to use or failure of continuing calibration.	1	Reading less than 0.1 mg/L	Initial and twice per day.

N/A = Not Applicable

9.1.4 Calibration Documentation

Documentation of calibration activities must be included in the field notebook and may be included on the field sheet (if a field sheet has been developed for the field activity being performed). If an instrument does not meet calibration acceptance criteria it shall not be used.

9.2 Laboratory Instrumentation

Laboratory instrumentation used to analyze the components in Tables 5-2 through 5-9 are listed in Table 7.1 of ETC's quality assurance plan (Appendix A).

9.2.1 Standard Sources

The standard sources used by the laboratory are listed in Section 7.2 of the laboratory QA plan (Appendix A).

9.2.2 Instrument Calibration

Procedures for calibration of laboratory instruments are found in Table 7.2 of the laboratory QA plan (Appendix A).

9.2.3 Calibration Documentation

Documentation of calibration activities is detailed in ETC's quality assurance plan (Appendix A).

10 Preventative Maintenance

10.1 Routine Maintenance Activities

The result of instrument readings depends on the inherent accuracy and proper operations, use, and function of the instrument. It is essential that the instruments operate under optimum conditions at all times. Each equipment/instrument user is expected to be familiar with the manufacturer's operations manual for each instrument. Each instrument is to be calibrated (at a minimum) according to the manufacturers instructions. Routine preventative maintenance activities for field instruments are listed in Table 10-1. Those for laboratory instruments are listed in Appendix A.

10.2 Documentation of Preventive Maintenance Activities

Routine maintenance activities will be documented in the equipment maintenance log provided for each instrument. The log includes the following:

- Instrument/equipment type.
- Manufacturer, model number, serial number.
- Name, address, telephone number of company which services item.
- Type of service policy.
- Timing and frequency of routine maintenance servicing.

Where preventative maintenance procedures are performed, such procedures shall be documented.

10.3 Contingency Plans

Critical spare parts are stocked where frequent failure or routine wear warrant. Unexpected downtime is unavoidably encountered at times due to equipment failure. In such instances, a protocol should be followed in which steps are taken to either correct the problem and resume measurements, or otherwise provide that samples are properly analyzed within allowable holding times. The following contingency plan has been established in the event of equipment malfunction. The steps are carried out in sequence until the analysis of still-valid samples is provided, or provisions are made for resampling.

1. Attempt is made by field/lab technician to correct the problem immediately, by referencing available service information. Samples are returned to proper storage during troubleshooting.

2. Sampling coordinator/lab supervisor is appraised that an equipment malfunction is disrupting normal field sampling activities. Attempts made to correct failure are described.

Table 10-1

Routine Preventative Maintenance
Crandon Mining Company NOI/SOS/PQAP

Instrument/Equipment Type	Activity	Frequency
pH Meter	- Rinse electrodes with deionized water.	After each reading.
	- Immerse electrodes in an appropriate solution consistent with manufacturers instructions.	When not in use.
	- Clean electrodes with mild acid or alcohol solution.	When needed or at least monthly.
	- Maintain liquid level in electrode (if appropriate).	When needed or at least monthly.
	- Check batteries.	Before each use.
	- Clean equipment.	As needed or at least at the end of each day in which equipment is used.
Conductivity Meter	- Rinse probe w/deionized water.	After each reading.
	- Check batteries.	Before each use.
	- Replatenize probe.	As needed.
	- Clean equipment.	As needed or at least at the end of each day in which equipment is used.
DO meter	- Change probe membrane.	As needed or at least annually.
	- Check batteries.	Before each use.
	- Clean gold cathode.	As needed or at least annually.
	- Clean equipment.	As needed or at least at the end of each day in which equipment is used.
Temperature	- Clean temperature probe.	As needed or at least monthly.
	- Check batteries.	Before each use.
	- Clean equipment.	As needed or at least at the end of each day in which equipment is used.

3. Sampling coordinator/lab supervisor decides whether or not to involve outside servicing. This decision is based on the nature of the problem and availability of service assistance and parts.

4. Sampling coordinator/lab supervisor assesses time required to restore proper equipment function in relation to remaining sample holding time.

5. Sampling coordinator/lab supervisor assesses options if proper equipment function cannot be restored. These options include equipment rental, obtaining equipment from other offices, equipment from other consultants, and/or laboratory, or emergency repair of equipment.

If none of the options in Step 5 are viable, client is notified by Project Manager to advise of problem and course of action.

11 Routines to Assess Data Precision, Accuracy and Completeness

11.1 Procedures to Assess Data Precision, Accuracy, and Completeness

11.1.1 Field Measurements

Field data will be assessed by the Quality Control (QC) officer. The QC officer will review the field results for compliance with the established QC criteria that are specified in this quality assurance plan. Accuracy of the field measurements will be assessed using daily instrument calibration, calibration check, and analysis of blanks. Precision will be assessed on the basis of reproduceability by multiple readings of a single sample. Data completeness will be calculated as follows:

$$Completeness = \frac{Valid\ Data\ Obtained}{Total\ Data\ Planned} \times 100$$

11.1.2 Laboratory Data

Laboratory results will be assessed for compliance with required precision, accuracy, completeness, and sensitivity as follows:

11.1.2.1 Precision

Precision of laboratory analysis will be assessed by comparing the analytical results between matrix spike/matrix spike duplicate (MS/MSD) for organic analysis, and laboratory duplicate analyses for inorganic analysis. The relative percent difference (%RPD) will be calculated for each pair of duplicate analysis using the following equation:

$$\%RPD = \frac{S - D}{(S + D)/2} X\ 100$$

Where: S = First sample value (original or MS value)
D = Second sample value (duplicate or MSD value)

11.1.2.2 Accuracy

Accuracy of laboratory results will be assessed for compliance with the established QC criteria that are described in Section 5 of the PQAP using the analytical results of method blanks, reagent/preparation blank, matrix spike/matrix spike duplicate samples, field blanks, and bottle blanks. The percent recovery (%R) of matrix spike samples will be calculated as indicated below:

$$\%R = \frac{A - B}{C} \times 100$$

Where: A = The analyte concentration determined experimentally from the spike sample.
B = The background level determined by a separate analysis of the unspiked sample.
C = The amount of the spike added.

11.1.2.3 Completeness

The data completeness of laboratory analyses results will be assessed for compliance with the amount of data required by each task. The completeness is calculated using the equation in Section 11.1.1.

11.1.2.4 Sensitivity

The achievement of method detection limits depends on instrumental sensitivity and matrix effects. Therefore, it is important to monitor the instrumental sensitivity to ensure the data quality through constant instrument performance. The instrumental sensitivity will be monitored through the analysis of method blank, calibration check sample, and laboratory control samples, etc.

12 Data Reduction, Validation and Reporting

12.1 Data Reduction

The field technician/sampler is responsible for instrument readings or interpreting instrument output and providing raw concentration data to the project manager. Field measurement data will be entered onto the appropriate field form (with appropriate references to the form in the field log book) or into the field log book. Calculations performed will be noted such that such can be validated.

12.2 Data Validation

12.2.1 Data Integrity

Technicians, their direct supervisors, and ultimately the project managers, will be responsible for the following tasks associated with checking data integrity:

- Checking raw data entries and calculations.
- Checking sample preparation log books.
- Checking analytical log books.
- Checking calibration integrity.
- Checking internal chain-of-custody.

Some or all of these tasks apply to both field measurements and laboratory analyses.

12.2.2 Data Validation

12.2.2.1 Field and Laboratory Activities

It will be the responsibility of the lab analyst or field technician to properly perform routine QC checks and to identify and report out of control situations. The project quality assurance officer will be responsible for verification of QC checks and resolution of any out-of-control situations.

12.2.2.2 Project Data

The project quality assurance officer will be responsible for reviewing overall project data before submission. Key areas of review include field and laboratory QC data, review of supporting documentation and review of data for any obvious anomalous values.

12.3 Data Storage

Raw and processed data will be stored on computer disks and/or hard copy. Computer files will be backed-up on separate disks stored in a different location than the original files. Data hard copies, along with strip charts and instrument printouts, will be labelled and stored. Field, laboratory, sample preparation and analytical log books will also be stored. Archived data will be stored in such a manner that records are easily accessed. Records will be maintained for a minimum of three years.

12.4 Data Reporting

Data entry will be performed by the field technician/sampler or project manager (or his designee). The project coordinator will be responsible for checking data entry. The project quality control officer and project manager will be responsible to determine that data on the final report are correct, by performing an informal audit of measurement, data entry and data reduction procedures.

13 Corrective Actions

A nonconformance is any procedure, event, reading or measurement which exceeds the QA targets and/or calibration criteria and/or QC checks required for field operations or laboratory operations.

As a result of a nonconformance, whether identified by the project quality control officer, by the sampling technician, or by an auditor, a corrective action shall be implemented. Any one of the individuals indicated above as well as the Foth & Van Dyke quality assurance officer, can initiate a corrective action, if necessary.

Corrective actions are generally of two kinds:

- Immediate, to recalibrate or repair nonconforming equipment. The need for such an action will most frequently be identified by the field technician.

- Long-term, to eliminate causes of nonconformance and to minimize the possibility of their recurrence. These are usually system related issues that may be identified as the result of quality control reports associated with one or more projects.

Field corrective action procedures are detailed in Table 13-1. Laboratory corrective action procedures are detailed in Table 13-2.

Depending on the nature of the problem, the corrective action employed may be formal or informal. An informal corrective action consists of an evaluation of a nonconforming situation that threatens the outcome of a procedure, event, reading or measurement. Upon recognition of the problem, the field/lab technician will review his procedure for apparent errors, recalibrate the instrument used for measurement and remeasure.

If this does not result in correction of the problem, the field/lab technician will bring the problem to the attention of the appropriate supervisor/manager who will aid in determining the proper corrective action. The corrective action will be incorporated into the appropriate procedures to minimize the possibility of recurrence. If significant time or costs are involved, the manager will alert the project manager and project quality assurance officer.

A formal corrective action typically results from an audit of a number of projects where similar non-conformances are recurring. In either case, occurrence of the problem, corrective action taken and verification of problem resolution must be documented. Documentation of corrective action will be made in the field/lab log book. Documentation of corrective actions will be in memos or forms developed for this purpose.

Table 13-1

Recommended Field Corrective Actions
Crandon Mining Company NOI/SOS/PQAP

QC Activity	Acceptance Criteria	Recommended Corrective Action
Instrument Zero	Must zero	Reset zero: if same response, determine cause.
Initial Calibration	Standard concentration ±5% of expected value	Reanalyze standards; if still unacceptable, remake standards. If equipment malfunctions, notify manager.
QC Check Standard	±5% of expected value	Reanalyze standard; if still unacceptable, remake standards or use new standards. If equipment malfunctions, notify manager.
Continuing Calibration (cc)	±5% of expected values	Reanalyze standard; if unacceptable, recalibrate equipment and rerun samples from last cc standard check. If equipment malfunctions, notify manager.

Table 13-2

Recommended Laboratory Corrective Actions
Crandon Mining Company NOI/SOS/PQAP

QC Activity	Acceptance Criteria	Recommended Corrective Action
Initial Instrument Blank	Instrument response >MDL response	Prepare another blank. If same response, determine cause of contamination: reagents, environment, instrument equipment failure, etc.
Initial Calibration Standards	Coefficient of variation >acceptable limit or standard concentration value (*) deviation from value	Reanalyze standards. If still unacceptable, then remake standards.
QC Check Standard	(*) Deviation from value	Reanalyze standard. If still unacceptable, then remake standards, or use new primary standards if necessary.
Continuing Calibration	(*) Deviation from value	Reanalyze standard. If still unacceptable, then recalibrate and rerun samples from the last cc standard check.
Method Blank	>MDL	Reanalyze blank. If still positive, determine source of contamination. If necessary, reprocess (i.e., digest or extract) sample set.

* ±10% for metals analyses.
  ±20% for wet lab/nonmetals analyses.
  ±15% for organic analyses

14 Performance and System Audits

14.1 Systems Audits

A systems audit determines that each element within an activity is functioning appropriately and is within the guidelines specified by the QA plan. These types of audits will be conducted on field sampling, preservation, shipping and equipment calibration/cleaning procedures, as well as on laboratory deliverables, by the project quality control officer. These audits will be conducted periodically during the life of this project. Such audits will be performed at least once annually.

14.2 Performance Audits

These types of audits may be conducted on field or laboratory activities. Foth & Van Dyke reserves the right to audit laboratories used for analyses on a regular basis or if there are inappropriate trends in the laboratory data, major changes in personnel, and/or discrepancies in quality control samples. These audits will be conducted at the request of and under the supervision of the project quality assurance officer.

15 Quality Assurance Records

Records shall be maintained to provide evidence of quality assurance activities. Activities which indicate an out-of-control situation will be evaluated. Corrective action taken will be documented. This documentation will be in the project log book (field/lab records) or in formal memos, letters, or notifications which are part of the project file.

Quality assurance records will be found in the project files or in the files of the quality assurance department. Access to these files will be restricted to selected project personnel.

These files will be maintained in quality assurance files for a minimum period of three years from the date of completion of the project. After three years, a decision will be made by the project QA officer in consultation with the project manager, as to the ultimate disposition of these records.

Appendix A

ETC Quality Assurance Plan

LABORATORY
QUALITY ASSURANCE PLAN

Prepared for

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1.0 STATEMENT OF POLICY AND ETHICAL COMMITMENT

1.1 Introduction

ETC - Santa is a wholly owned subsidiary of Applied Bioscience International, Inc. (APBI) of East Millstone, New Jersey. The ETC Corp. network of analytical laboratories includes six facilities: ETC - Edison in Edison, New Jersey, ETC - Santa Rosa in Santa Rosa, California, ETC - Gulf South in New Orleans, Louisiana, ETC - Mid-Pacific in Mountain View, California, ETC - Northwest in Redmond, Washington, and ETC - Houston in Houston Texas. ETC - Santa Rosa is referenced generically throughout this text as ETC.

This Quality Assurance Plan is a statement of the ETC procedures used to manage the laboratory's quality assurance program. It reflects the necessary specifications to assure accuracy, precision, completeness, representativeness and comparability on all tasks within the laboratory. The purpose of this document is to assure that data of the highest known quality are being reported by ETC.

This Quality Assurance Plan is prepared using the "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans" EPA-600/4-83-004, February 1983 (QAMS-005/80) and the Florida DER Manual for Preparing QA Plans as guidelines. This document has been prepared to describe ongoing laboratory operations for routine analysis performed at ETC. As such, the material contained within is subject to change. Changes may be based on procedural system modification geared towards operational process and quality improvements. Quality Assurance Project Plans are developed from this document and are geared to meet specific project requirements and objectives. This document is reviewed and updated annually.

1.2 Statement of Policy and Ethical Commitment

ETC - Santa Rosa is committed to providing the highest quality of analytical and data management services to meet the needs of our clients while satisfying the requirements of various state and federal regulatory communities. This document details the protocols and procedures utilized by this laboratory with emphasis on the Quality Assurance/Quality Control (QA/QC) requirements based on EPA guidelines for the analysis of multimedia samples for a broad range of inorganic and organic contaminants.

ETC's objective is to consistently produce analytical data which is of known quality and meets the quality objectives of the methods and the data user. This will enable the data use to make rational, confident, cost effective decisions on the assessment and resolution of environmental problems.

1.3 ETC Code of Ethics

ETC Corp. provides analytical chemistry on environmental matters to the regulated community. The data the company produces provides the foundation for determining the risk presented by a chemical pollutant to human health and the environment. The environmental laboratory business is dependent upon the accurate portrayal of environmental chemistry data. This process is reliant upon a high level of scientific and personal ethics. Accordingly, ETC has adapted the following ethical code which each employee is expected to adhere to:

To search for scientific truths by use of the scientific method.

To be faithful and incorruptible, respecting confidence, advising honesty.

To maintain professional integrity as an individual.

To place the public welfare above any considerations of self-interest recognizing and responding to community concerns.

To present services in a confidential, honest, and forthright manner.

To produce results that are accurate and defensible.

To comply with all pertinent federal, state and local laws and regulations as it relates to his or her practice.

To provide employees with guidelines and an understanding of the ethical and quality standards required to work in this industry.

1.4 ETC CORP. ETHICAL CONDUCT AGREEMENT

I. I understand the high ethical standards required of me with regard to the duties I perform and the data I report in connection with my employment at ETC.

II. I have received formal instruction on the code of ethics that has been adapted by ETC and agree to comply with these requirements.

III. I also agree to the following:

A. I shall not intentionally report data values which are not the actual values observed or measured.

B. I shall not intentionally modify data values unless the

modification can be technically justified though a measurable analytical process.

C. I shall not intentionally report dates and times of data analysis that are not the true and actual times the data analysis was conducted.

D. I shall not condone any accidental or intentional reporting of unauthentic data by other employees and immediately report it's occurrence to by superiors.

E. I shall immediately report any accidental reporting of inauthentic data by myself to my superiors.

_____
(signature)

_____
(date)

2.0 ORGANIZATION AND RESPONSIBILITY

2.1 The ETC organization includes laboratory operations, marketing and quality assurance staff. The structure allows close, coordinated interactions and promotes the common goals of successful project management and quality data.

The ETC organizational structure is presented in Figure 2.1. This organizational chart shows the line-staff relationships within the laboratory. The laboratory operations is divided into two distinct analytical departments, organic and inorganic analysis. The program management department has direct interaction with the operations of the laboratory to facilitate modification within the operations of the laboratory to meet the changing needs of the clientele. The Quality Assurance Officer has direct line reporting to the Laboratory Director to facilitate modifications within operations of the laboratory to meet the changing requirements from regulators, and also has a reporting line to the Corporate Quality Assurance Director for guidance and to separate the goals of Quality Assurance from the goals of Operations.

2.2 Key Individual Responsibilities

The specific responsibilities for key individuals to maintain the Quality Assurance program are summarized in the following subsections.

2.2.1 Laboratory Director

The Laboratory Director has overall responsibility for the quality, production, cost control, laboratory personnel management, and adherence to project schedules. The overall management responsibility involves the following items:

a) Implemention of the Quality Assurance Program;

b) Ultimate implemention of Correction Action Procedures;

c) Schedule and execution of all project testing programs;

d) Adherence to delivery schedules;

e) Deliverable reports;

f) Subcontractor work if required;

g) Project/contract cost control and accounting;

h) Task performance of key personnel.

2.2.2 Quality Assurance Officer

The Quality Assurance Officer (QAO) is responsible for monitoring the quality of laboratory work and taking appropriate actions to ensure that quality standards are being met. The QAO reports directly to the Laboratory Director in reviewing the work of teams and individuals. The QAO is responsible for the following:

a) Serving as the official organization contact for all QA matters. For example: QA project implementation, sampling and analytical methodologies, field and laboratory audits, management and data quality audits, performance evaluations and QC studies, etc;

b) Preparing and overseeing the preparation of the laboratory QA/QC plan;

c) Reviewing, evaluating and approving QA project plans prior to federal and/or state regulatory agency review and evaluation;

d) Establishing QC procedures, providing control samples and setting warning and action limits for every test or parameter to standardize laboratory operations for quality performance;

e) Monitoring compliance with the laboratory's QAP by:

1. Reviewing QC related activities and documentation for completeness in accordance with the QAP;

2. Identifying and referring any instances in which the QA objectives are not being met to groupleaders and Department Mangers for remedial and/or corrective action;

3. Following up on the remedial and/or corrective action to assure that QC objectives are being met;

f) Serving as the laboratory point-of-contact for the exchange of QA/QC information with the authority to approve, along with the Laboratory Director, the release of QA/QC information;

g) Providing input for all on-site QA/QC inspections;

h) Coordinating a corrective action plan in response to deficiencies identified during laboratory inspections;

i) Identifying trends as noted from review of laboratory control charts and communicating the information to the appropriate laboratory personnel;

j) Providing the Laboratory Director with reports of laboratory QC performance, based on Corrective Action Reports, Certification information, PE sample results, and other QA documentation.

2.2.3 Program Manager

The Program Manager(s) provides supervision and maintenance of project files, data entries into the computer system upon receipt of samples and quality review of the final data deliverables. The Program Manager reports directly to the Laboratory Director and is responsible for:

a) Acting as liaison between client's program needs and laboratory staff;

b) Serving as liaison (along with QAO) between the laboratory and other internal/external organizations or organizational subunits;

c) Ensuring that the laboratory's performance meets the requirements of all client specific contracts;

d) Assisting the QAO in implementing any audits necessitated by contractual agreements;

e) Providing coordination of any requests for information on sample status, invoice question of general project status;

f) Serving as the focal point for client services reporting of any changes in QA project documents and activities.

2.2.4 Laboratory Department Managers

The laboratory is divided into two analytical departments, each headed by a Department Manager (DM). The DMs have primary responsibility for the technical quality of all data generated within their respective sections. In addition they are responsible for the adherence

to delivery schedules, management and utilization of manpower and the technical aspects of all Standard Operating Procedures (SOPs). The DMs report directly to the Laboratory Director and are also responsible for:

a) The implementation of remedial/corrective action as developed by the QAO;

b) The implementation of all new analytical equipment including new operating procedures, preventative maintenance and service agreements;

c) Monitoring the quality/quantity of all reagents, standards, calibration materials, glassware, solvents and instrumentation used in the analytical process;

d) Scheduling workloads in each individual department to assure compliance with regulated holding times and adherence to established delivery schedules;

e) Reviewing data interpretation and quantitation for completeness and accuracy;

f) Checking to ensure that the data package includes all required analytical and quality control results, raw data and lab chronicles and meets all client commitments;

g) Assuring that qualified personnel are provided with initial and continued training, as necessary, for proper performance of the analytical work.

2.2.5 Analysts and Group Leaders

The Analysts and Group Leaders report to the Laboratory Department Manager and are responsible for:

a) Analysis of raw data as well as the calculations, interpretation and quantitation of the data;

b) Checking the accompanying Quality Control data against the appropriate criteria;

In addition to the above, Group Leaders are responsible for the following:

c) Initial reviewing of data interpretation and quantitation for completeness and accuracy;

d) Initial checking to ensure that the data package includes all required analytical and quality control results, raw data and lab chronicles (signatures and dates).

3.0 QUALITY ASSURANCE OBJECTIVES (PRECISION, ACCURACY AND PQLs)

The quality assurance objectives are found in Table 3.1. Cross references for preparation methods may be found in Table 3.2.

4.0 SAMPLING PROCEDURES

4.1 Field Support

ETC provides shipping containers, custody documents, custody seals, sample bottles, labels, chemical preservatives for water samples, "blue ice" packs to maintain thermal preservation, and trip and field blanks to support field sampling events. Table 4.1 lists sample container types, preservatives and holding times. ETC can provide sample pick up and delivery services to its clients.

Upon receipt of the field samples at the laboratory, ETC verifies that they have been sampled and maintained according to preservation requirements and that sample storage conditions do not contribute to the presence of test analytes in the samples In the event that any irregularity is noted, the client will be contacted by ETC to discuss the problem.

4.2 ETC Shipping Containers - Sample Shuttles, Coolers

The ETC provides shipping containers (coolers or the specially developed ETC Sample Shuttle™) for the transport of environmental samples from the field to the laboratory. The Sample Shuttle is a rugged carrying case lined with insulating polyurethane. Insulating sleeves with pre-formed slots hold the sample bottles. The shuttle can be locked from the outside. Chain-of-custody seals (locks or tape) and forms, employed for each shipping container packed at ETC, ensure complete documentation and provide evidence of unbroken custody of the container contents. Copies of the seals used are listed int he Appendix in Figure 4.2. The containers meet or exceed all protocol requirements (i.e.,DOT, USEPA, ASTM) for shipping. See figure 4.3 in the Appendix.

4.3 Preservation

ETC provides the necessary chemical preservatives and "blue ice" pack (at pre-frozen or ambient temperatures, as per the client's needs) in the shipping containers. High quality reagent grade chemical preservatives are used. It is the responsibility of those collecting the samples to properly use these materials and ensure that proper preservation techniques are performed and preservative requirements are met. ETC recommends that all sample containers be chilled with ice after collection and prior to shipment. Upon receipt of samples at the laboratory, the temperature of each Shuttle is measured and recorded on the chain of custody documents.

4.4 Sample Bottles

ETC provides vendor-prepared sample containers in the shuttles for sample collection. The containers are cleaned according to EPA recommended wash procedures by the manufacturer and arrive at ETC packed with a wash certificate and bottle labels in custody sealed cases. Glassware and plasticware are cleaned using the appropriate procedure as follows:

4.4.1 Cleaning Procedure A:

a) Bottles, liners and caps are washed in laboratory-grade, nonphosphate detergent;
b) Rinsed 3 times with distilled water;
c) Rinsed with 1:1 nitric acid;
d) Rinsed 3 times with ASTM Type 1 organic-free water;
e) Oven-dried for 1 hour;
f) Rinsed with hexane;
g) Oven-dried for 1 hour.

4.4.2 Cleaning Procedure B:

a) Vials, septa and caps are washed in laboratory-grade, nonphosphate detergent;
b) Rinsed 3 times with distilled;
c) Rinsed 3 times with ASTM Type 1 organic-free water;
d) Oven-dried for 1 hour.

4.4.3 Cleaning Procedure C:

a) Bottles, liners and caps are washed in laboratory-grade, nonphosphate detergent;
b) Rinsed 3 times with distilled water;
c) Rinsed with 1:1 nitric acid;
d) Rinsed 3 times with ASTM Type 1 organic-free water;
e) Air-dried.

5.0 SAMPLE CUSTODY

5.1 Receipt of Samples

5.1.1 Samples are received daily (Monday - Saturday) from commercial carriers, clients, or ETC courier. Samples may be received in either ETC Shuttles or in client provided containers.

5.1.2 Upon receipt of samples at ETC, the shuttle seal is inspected, a temperature reading is taken and noted on the chain of custody (COC), along with the date, time, seal number, and signature of receiver. Sample containers are checked against COC (See ETC Figure 5.1) using the form in Figure 5.2 Sample Receiving Log-in Check List. The COC is signed by the ETC personnel receiving the samples at the laboratory.

5.2 Sample Log-in and Lab identification

5.2.1 An order form is filled out and samples are ordered/logged onto the Laboratory Information Management System (LIMS). See Figure 5.3 for Order Form. Each sample is assigned a unique laboratory number starting with two alpha characters and ending with a 4-digit number (e.g.,ME1234). Each sample is also assigned computer-coded analysis types (ATYPES) at the time of login. Sample date, due date, client facility account numbers and codes are also assigned. Any project specific notes are also entered.

5.2.2 Sample container labels are generated. Sample containers are labeled as appropriate. See Figure 5.4 for example of labels. Any sample aliquots for preservation and/or subcontracting are split off, using a fume hood.

5.2.3 The COC is referenced with the joblink number(s) assigned sequentially by the LIMS. A project file is generated including the order form, original COC, and a computer generated order acknowledgement. The project file folder is labeled with the facility code, joblink number, laboratory sample number(s) and due date. See Figure 5.4 for the file folder label.

5.3 Sample Storage and Security

5.3.1 All samples are placed in designated cold storage area(s). All samples except high level organics and VOA's are stored in Refrigerator #1. All VOA's except high level organics are stored in Refrigerator #6. Refrigerators #1 and #6 are locked when sample receipt personnel

are not on duty. All exits are kept locked to the outside except the front reception area which is open during business hours, 8am - 5pm only.

5.3.2 High level organic samples are stored in Refrigerator #12 to prevent cross contamination with other samples for trace organic analysis.

5.3.3 Sample Check-out logs are maintained at each storage refrigerator. Samples are kept in order by sample number, and may be checked-out by analysts for weighing subsamples. They are promptly returned after subsamples are taken. Check-out documentation includes container identifation, date/time checked-out, date/time checked-in, and initials. Samples are considered in legal custody of the person during the check out period.

5.4 Sample Tracking

5.4.1 Schedules are printed nightly of work logged-in or still outstanding from the previous day. Department Managers are responsible for tracking samples and work for their departments. The types of sample status tracking used in the LIMS are given in Table 5.5.

5.4.2 An example of a daily Lab Sample Control Report is given in Figure 5.6.

5.5 Sample Disposition

5.5.1 Samples are kept in cold storage for 40 days after the report is issued. Samples are kept another 60 days in ambient storage. After samples have been kept 60 days at ambient storage, they are disposed of according to Sample Disposal procedures outlined in the ETC Health and Safety Manual.

5.6 Sample Subcontracting

5.6.1 Samples requiring subcontracting are determined by project managers ahead of time. Chain-of-custody forms are prepared for samples subcontracted, copies are maintained on file by subcontractor and in individual joblink files. Any work subcontracted in clearly noted on reports giving the name of the lab performing the work.

5.7 Data Archival

5.7.1 Data is kept on-site for 10 years in secure storage. Only authorized personnel may retreive archived data.

5.8 Electronic data

5.8.1 The LIMS is secured by limited access requiring passward to enter. The various levels of accessibility are as follows:

a) Access to the HP3000 is controlled by user names and accounts which are set up for each new employee and removed when an employee leaves. A user name and account passwords allow an employee to log on to the HP3000.

b) Privileges on the HP3000 are granted separately for each user name and account. These privileges are kept as restrictive as possible. Most employees are not able to alter files outside of their user name and account.

c) Access to the Database is controlled by passwords known only by the General Manager and System Manager.

d) Access to the LIMS is provided through a set of menus and a user ID. The user ID is used to limit access to order entry and data review. There is also an audit trail that shows shich parts of the menu system were used by each employee.

5.8.2 Electronic deliverable backup discs are kept in controlled-atmosphere storage for 10 years. Only authorized personnel may retreive archived data.

6.0 ANALYTICAL PROCEDURES

6.1 Methodologies

ETC uses approved USEPA methodologies for all analyses, if available and applicable. The deliverables included in the reports are based upon the level of report deliverable requires and the quality assurance requirements of the methods performed. Analytical results and quality assurance protocols are based on the following methods and guidelines:

"Test Methods for Evaluating Solid Waste," USEPA, SW-846 Third Edition, Revision 1, July 1992;

"Methods for Chemical Analysis of Water and Wastes," EPA 600/4-79-020, EMSL, March, 1983;

"Methods of Organic Chemical Analysis of Municipal and Industrial Wastewater," Federal Register Vol. 49, No. 209, October 1984;

"Standard Methods for the Examination of Water and Wastewater," 14th, 15th, 16th, 17th and 18th Editions;

"Methods for the Determination of Nonconventional Pesticides in Municipal and Industrial Wastewater," EPA 821 RR-92-002 April 1992;

"Manual of Analytical Methods for the Analysis of Pesticides in Humans and Environmental Samples," EPA 600/8-80-038, June, 1980;

"Handbook of Analytical Quality Control in Water and Wastewater Laboratories," EPA 600/4-79-019, March, 1979;

In addition to performing these standard methods and procedures, ETC has the capability of performing client or project specific modified methods. See Table 6.1 for a complete listing of methods used at ETC - Santa Rosa.

6.2 Laboratory Glassware

Class A volumetric glassware is used by the laboratory for measuring trace constituents in both inorganic and organic analysis. Laboratory contamination is minimized through implementation of a glassware and labware cleaning procedure. The procedure ensures the removal of all traces of parameters of interest and contaminants that could interfere with analysis. The procedure includes:

6.2.1 Phosphate free detergent;

6.2.2 Triple rinsing with DI water;

6.2.3 Baking at a minimum of 445° C for four hours, when required or needed;

6.2.4 Further acid rinsing with a 20% HNO_2 followed by triple rinsing with DI water for metals analysis;

6.2.5 Further solvent rinsing for organic analysis, as needed.

6.3 Supplies and Reagents

6.3.1 Control of materials, reagents, standards, and solvents used in the analysis are maintained. The identity, purity, shelf-life, source, tests to be conducted for quality and purity, storage and handling procedures, and replacement dates are factors that are considered in making purchase requisitions.

6.3.2 Materials, reagents, solvents and gases are carefully selected to meet specifications as prescribed by the method for an analysis. In storage, these items are protected from degradation and contamination through conformance to storage requirements according to the manufacturer's directions and/or individual method of analysis.

6.3.3 Solvents used for extraction are pre-analyzed to determine impurities that might interfere with the analytes of interest. Standards and reagents are dated upon receipt, and the date of expiration recorded. This procedure establishes the order of use and eliminates the possibility of exceeding shelf life.

7.0 CALIBRATION

7.1 Instrument calibration

Information on performance of equipment is obtained before a purchase request is made. Service availability for installation specifications are considered in purchases negotiations. Ultimate approval for such purchases is made by the Laboratory Director. When the instrument/equipment is installed, an internal calibration is made on the instrument to meet manufacturer's specification.

Instrument calibration is a mandatory requirement of performing quantitative analytical methodology. The laboratory must meet method criteria for instrument calibration and calibration verification before proceeding with sample analysis. Table 7.1 lists equipment used at ETC - Santa Rosa. Table 7.2 includes the routine calibration and criteria for the most commonly used methods in the laboratory.

7.2 Standards Traceability

EPA-certified, NIST, and A2LA-certified standards are used wherever possible.

8.0 EQUIPMENT AND PREVENTATIVE MAINTENANCE

To assure a good laboratory quality assurance program in the procurement of equipment and supplies, ETC has established criteria and specifications for the purchase of important pieces of equipment. Factors such as cost, volume of work, ease of operation, ability to interact with the LIM system, inherent accuracy, expected equipment lifetime, length and condition of warranties or service contracts, expected downtime and repair costs are considered in the process of selection. The increased usage of electronic analytical instruments has improved the quality and quantity of data and has increased productivity.

Before any purchases are made, purchase requisition orders and requests are checked, verified and approved by the Department Managers.

8.1 Preventative Maintenance Procedures

ETC maintains maintenance contracts on the major instrumentation in the laboratory. The laboratory performs routine maintenance to prevent instrument malfunction and minimize downtime, and to optimize instrument capabilities.

8.1.1 Preventative Maintenance

The schedule of preventative or routine maintenance checks are outlined within the specific equipment operator's manuals and in the analytical procedures performed. It is the responsibility of both the analyst and the department manager to ensure the checks are completed according to the schedule developed and maintained for each instrument. See Table 8.1 for preventative maintenance schedules for major instruments at ETC.

8.1.2 Replacement Parts

The laboratory maintains an inventory of replacement parts for analytical instruments. This enables ETC analysts to perform routine maintenance and repair of instruments as needed.

8.1.3 Instrument Backup

For all major analysis (GC, GCMS, ICP, GFAA) more than one instrument may be used for appropriate analysis. For organic analysis, three gas chromatograph/mass spectrometers are maintained for semi-volatiles work, two for volatile work, and over 16 gas chromatographs are available and convertable to needed analysis. In the Inorganics

Department, two ICPs are available, one serving primarily as backup. Two graphite furnace atomic absorption spectometers are available, and two mercury analyzer setups are also available. This helps to reduce backlog buildup and possility of missed hold times.

8.1.3 Record Keeping and Preventative Maintenance Logbooks

Criteria for instrument maintenance is based on instrument performance. Failure of instruments to perform according to stated methodologies and criteria limits drives the need for daily maintenance. For each instrument, a logbook is kept to record the problems as well as the maintenance required. Routine maintenance checks by service engineers as well as maintenance performed by laboratory staff is recorded in the instrument logbook.

9.0 QUALITY CONTROL CHECKS AND ROUTINE PROCEDURES TO ASSESS PRECISION, ACCURACY AND METHOD DETECTION LIMITS

9.1 Quality Control Checks

The responsibility for the internal analytical quality control checks rests with the laboratory analyst. The type, frequency and acceptance criteria of the checks performed are based upon the reference analytical methodology employed and client or project requirements. In cases where the project required method does not address these critical issues, ETC may recommend that quality control protocols be established on a per method basis to meet the intended data quality objectives of the project.

The following descriptions present a summary of quality control samples that are used routinely for ETC projects. These data are compiled and are used both by the QA department and project staff to monitor analytical data. Table 7.1 list specific criteria for acceptance for these control checks.

9.1.1 Instrument Quality Control Checks

CALIBRATION CHECK STANDARD - A mid-range concentration standard made up of target compounds to determine if instrument calibration is stable. It is run at the beginning of a run (called Initial Calibration Verification, ICV) and every 10 samples (called Continuing Calibration Verification, CCV). Relative percent difference from the initial calibration curve is determined and compared to established limits.

CALIBRATION BLANK - A volume of ASTM type I water or instrument-purity grade solvent matrix matched with the calibration standards. The calibration blank is a zero standard and is used for instrument calibration.

METHOD SPECIFIC CALIBRATION STANDARDS - This includes Interference Check Standards for ICP, Endrin/DDT Breakdown Check Standards for Method 8080, Tuning standards for GCMS. These are run at method prescribed frequencies.

9.1.2 Batch Quality Control Checks

METHOD BLANK - An artificial sample designed to monitor the introduction of artifacts into the laboratory process. The blank is taken through the appropriate steps of the process and analyzed with each laboratory defined batch of samples (of up to a maximum of 20 samples per batch), or at the method required frequency.

BLANK SPIKE - Standard reference materials spiked into reagent grade water or other blank material and carried through the entire preparation and/or analytical process to verify and demonstrate method performance. One spiked blank is analyzed with each laboratory defined batch of samples (of up to a maximum of 20 samples per batch), or at the method required frequency.

MATRIX SPIKE - A client sample spiked with standard reference materials and carried through the entire preparation and/or analytical process to evaluate sample matrix effects on analyte recovery and accuracy. A matrix spike is analyzed with each batch of samples (up to a maximum of 20 samples per batch), or at the method required frequency.

MATRIX SPIKE DUPLICATE - A client sample which is split, spike with standard reference materials, and carried through the entire preparation and/or analytical process as a replicate sample to evaluate sample matrix effects on analyte recovery and accuracy as well as laboratory reproducibility and precision. A matrix spike duplicate is analyzed with each batch of samples (of up to a maximum of 20 samples per batch), or at the method required frequency.

SAMPLES DUPLICATE - A client sample which is split and carried through the entire preparation and/or analytical process as a replicate sample to evaluate laboratory reproducibility and precision. A sample duplicate is analyzed instead of a matrix spike duplicate at the request of a client or for methods where matrix spikes are impractical, e.g. pH and % moisture and analyzted with each appropriate batch.

9.1.3 Sample Quality Control Checks

INTERNAL STANDARDS - Compounds that possess similar chemical and physical properties to the target analytes. These compounds are added to samples or extracts prior to analysis, and used as retention and response reference points and to verify instrument performance. Internal standards are evaluated as specified in the GC and GC/MS analytical methods.

SURROGATES - Compounds that possess similar chemical and physical properties to the target analytes. These compounds are added to each sample to check for matrix effects or other difficulties related to method application. Surrogates and recovery limits are used and reported as specified in the organic methods.

9.1.4 Reagent Checks

STANDARDS VERIFICATION CHECKS - Newly-prepared standards (surrogate, internal, calibration, spiking) are checked prior to use.

SOLVENT LOT CHECKS - Solvents used for extraction are checked for purity prior to use.

9.1.5 External Quality Control Checks

TRIP BLANK - Analyte free reagent grade water prepared by the laboratory, shipped with the bottle order, and analyzed with the samples to detect possible contamination during transport. Used as required by specific project plans. One trip blank is used per shipping container.

FIELD BLANK - Reagent grade water provided by the laboratory that is transferred on-site to an additional clean sample container to evaluate the environmental or procedural effects of a sampling event; used to determine if contamination occurred during field sampling. The field blank is analyzed upon request of the client or project directors.

BLIND QC CHECKS - Blind samples provided to check accuracy of method. See also Section 12.1, Internal Performance Audits. Additional blind QC check samples may be ordered from companies such as APG (Analytical Products Group) or ERA (Environmental Research Associates) to check method performance.

9.2 Routine Methods Used to Assess Precision and Accuracy

9.2.1 Accuracy is defined as the degree of agreement of a measured value with the true or expected value.

Accuracy is calculated as follows:

$$R = \frac{(X-T)}{K} \times 100$$

where:
R = %Recovery = Accuracy
X = Analytical result from the spiked sample
T = Analytical result from the unspiked sample
K = Known addition of the spiked compound

9.2.2 Standard Deviation (Sp) is used to determine the variation among

several recovery samples, and establish upper and lower warning and control limits. Standard Deviation is calculated as follows:

$$Sp = \sqrt{\frac{\sum (Ri - R)^2}{(n - 1)}}$$

where:
Sp = Standard deviation of % recovery
Ri = Observed value
R = Mean or average of all observations
n = Number of observations

9.2.3 Control Limits are created to determine the acceptable range of analyte recovery and are used in comparison with the actual spike recovery results. Control Limits are calculated as follows:

UCL = X + 3Sp
LCL = X - 3Sp
UWL = X + 2Sp
LWL = X - 2Sp

where:
UCL = Upper Control Limit
LCL = Lower Control Limit
UWL = Upper Warning Limit
LWL = Lower Warning Limit
Sp = Standard Deviation

9.2.4 Precision is defined as the reproduceability or degree of agreement among replicate measurements of the same quantity.

Precision is calculated as follows:

$$RPD = \frac{|A - B|}{(A + B)/2} \times 100$$

where:
RPD = Relative Percent Difference
A = Replicate value 1
B = Replicate value 2

The objective of the laboratory concerning precision is to meet or exceed the criteria specified in an analytical methodology. Precision measurements are performed for each parameter according to the specifications of the particular method employed. For each type of replicate sample and MS/MSD pair, precision control charts can be developed. Upper warning and control limits are established according to the requirements of methodology. In the absence of published control criteria, the Standard Deviation formula is used to determine the variation among RPD values and establish upper warning and control limits. The formula used for calculation is the same as in section 9.2.2,except that in this case:

Sp = Standard deviation of RPD values
Ri = Observed RPD
R = Mean or average of all observations
n = Number of observations

Control limits are calculated as follows:

UCL = 0 + 3Sp
UWL = 0 + 2Sp

where:

UCL = Upper Control Limit
UWL = Upper Warning Limit
Sp = Standard deviation of RPD values

9.2.5 Completeness is defined as the percentage of valid data obtained from a measurement system.

9.2.6 Representativeness is defined as the degree to which the data accurately represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition.

9.2.7 Comparability is defined as the confidence with which one data set can be compared to another.

9.3 Control Charts

Control charts can be generated from the Laboratory Information Management (LIM) System. The LIM system utilizes a program that monitors all quality control check samples for most parameters analyzed by the laboratory. The compounds that are spiked into the samples are monitored for percent recovery and relative percent difference between the duplicate spikes. The following parameters are utilized at ETC:

9.3.1 Quality Control Spikes (QCS) to monitor the base performance of an analytical procedure;

9.3.2 Matrix Spikes to monitor the analytical performance;

9.3.3 Surrogate Spikes to monitor the preparation efficiency;

9.3.4 Relative Percent Difference between replicate matrix spikes to monitor the precision for the analytical procedure.

The control charting program that ETC utilizes is supported by the LIM system and will allow for monitoring and flagging of all out of compliance data at the instrument system level. The control charts monitor the laboratory

performance verses that specified by the analytical method.

Control charts are printed whenever control limits are recalculated. Control limits are recalculated every six months to one year, depending on the frequency of the analysis.

9.4 Method Detection Limits and Practical Quantitation Limits

Method Detection Limit Studies are performed annually for all analysis according to 40 CFR Part 136 Appendix B. Practical Quantitation Limits are set to meet all instrument MDLs and are verified by running a standard at approximately the expected PQLs. Practical Quantitation Limits are typically 2 to 5 times the MDL for water samples, and calculated from the water MDLs for soil samples.

10.0 DATA REDUCTION, VALIDATION AND REPORTING

Data reduction, validation and reporting describes the processes that result in the delivery of quantitative analytical data to the data user. These processes include calculation of raw data into final concentration units, reviewing results for accuracy and assembly of the report contents for delivery to the data user. The following describes procedures employed at ETC for translating raw analytical data into accurate, completed sample reports and data storage.

10.1 Data Integrity and Validation

10.1.1 Data Integrity

The integrity of sample identification is checked in Sample receipt. Sample receipt also maintains internal chain-of-custody.

All organic or inorganic data generated by the analytical laboratories are reviewed by the analyst. This data reviewer must:

a) Verify initial calibration and continuing calibration results, that runlog IDs match printed IDs, calibration factors have been correctly updated for sample calculation.

b) Verify digestion/extraction/leachate benchsheets identify correct sample IDs, that the sample weight or volume has been entered correctly into all calculations, that the sample was extracted before hold time.

c) Verify raw data entries and calculation of each sample and QC sample. Verify dates and IDs are correct.

d) Verify instrument runlogs or sample benchsheets that dates, times, ID files, sample IDs are correct.

After review, the analyst transmits the results from the instrument computer system to the HP3000, ETC's computerized data base from which the summary tables are generated. The automatic transmission of the data eliminates the possibility of transcription errors occurring during data entry. A copy of the actual report to be sent to the client is printed and reviewed at this time by the analyst.

The analyst is responsible for the assembly of quality control batch file (batch cover sheet, preparation bench sheets, summary sheets and raw data for calibration curves, continuing calibration verifications, QC Batch reports printed from LIMS, surrogate reports and raw data for

method blank, QC spike, matrix spike and matrix spike duplicate, nonconformance/corrective action reports.) and the assembly of sample raw data files by joblink (batch cover sheet, batch report printed from LIMS, samples reports and surrogates printed from LIMS, sample raw data).

10.1.2 Data Validation

Initial data validation is done by the analyst. Sample and QC checks are compared to established criteria. See Table 7.2 for QC criteria checked for most analysis performed at ETC - Santa Rosa. Data is evaluated in terms of both single samples and sets of samples. See Table 10.1 for matrix of data set acceptability.

The completed batch and sample data packages are transferred to a Senior Staff Scientist or Department Manager for a second complete review of the use of proper methodology and detection limits, compliance to quality control protocol and criteria, presence and completeness of laboratory chronicles (signatures and dates), and accuracy of calculations and data quantitation. The Department Manager has the ultimate responsibility for the final data review of all data generated by the department.

The completed Batch Data Package is transferred to the QC Officer who performs a QC audit for the following: compliance to quality control protocol and criteria, presence and completeness of laboratory chronicles (signatures and dates), and accuracy of calculations and data quantitation.

10.1.3 Project Data Evaluation

The completed package of sample raw data and printed detail reports is reviewed by the project managers for project specific concerns and how the data interrelates as a whole.

10.1.4 Subcontract Lab Data Validation

Samples subcontracted to other labs for work undergo initial review and data entry by the project manager. The entered data is reviewed by the QA Officer before it is released.

10.2 Data Reporting

10.2.1 A summary of sample identifications, lab identification numbers, and

method description and numbers is prepared, along with an executive summary prepared by the program manager describing condition at receipt and any comments about the data, including any quality control outliers. A draft report is assembled and submitted to report production where it is copied on letterhead and submitted to the Laboratory Director for final review and signature. A copy of a typical final report is given in Figure 10.2.

10.2.2 Report Production logs out the finalized report to the laboratory courier or commercial carrier.

10.3 Data Archive

The original hard-copy documentation is maintained and archived as follows:

10.3.1 Final Client Report, Chain of Custody and Field Documentation - original documentation is filed numerically according to the ETC joblink number. The joblink number is traceable to the date of sample receipt.

10.3.2 QC Batch Data Package - any additional laboratory data which substantiates the final reported results, but are not report deliverables, are maintained by assigned QC batch number and separated by departments: organics, metals, and conventionals.

10.3.3 Raw Data - Instrument summaries, maintenance logs, calibration reports, tuning reports, diagnostic reports and any other notebooks are archived by date and description.

10.3.4 Data System Files - Hard copy reports and tapes are maintained by date. Systems are backed up daily, weekly, and monthly.

10.3.5 Download hardcopy files - all downloaded data is printed and archived and maintained by client and year.

The files are given an ETC - Santa Rosa archive box number, which is entered into a spreedsheet. Locations are assigned to each box and maintained in a limited access area within ETC. The spreadsheet allows for sorting by type, range, or date for quick retrieval for ETC and/or client review. The files are routinely held for a minimum of ten years and may be held longer to comply with client or contract requirements.

The information retained for long term storage includes all sample reports which are delivered to clients, any raw data stored on magnetic media, raw data which cannot be stored on magnetic media, and processed QC data not

reported to the client. ETC retains raw data produced during the analysis of any sample to ensure that all steps in the analytical process can be traced and verified if necessary long after the analysis has been completed and the results reported to the client. Data archiving and storage is managed by the Quality Assurance Officer, who controls the access to stored information.

All information retained at the laboratory facility is stored in secured areas on-site at the laboratory or off-site at a commercial document storage facility equipped with a professional security system. All electronic data is stored on-site at the laboratory or off-site at a commercial document storage facility equipped with a professional security system and a controlled environment suitable for storage or magnetic media.

11.0 CORRECTIVE ACTION

Corrective action is defined as those actions necessary to place any operational process or analytical system back into its performance specification. It is the objective of the laboratory to implement appropriate corrective action when and where necessary in an effective and timely manner.

Corrective actions are initiated at all operational levels within the laboratory, involving analysts, their management, and the quality assurance group in both formal and informal procedures. Analysts are responsible for taking routine informal corrective actions described in the methods. Corrective actions are also initiated externally through project management personnel in local, state, or federal agencies and private sector clients. In each case, after an assessment of the issue, appropriate steps are taken to correct the situation and prevent it from occurring again.

Depending on the severity, corrective actions may be taken at the analyst level, department level, or within the entire laboratory. ETC recognizes the importance of corrective action to maintain a high quality program. In this light, data are reviewed for completeness, accuracy, precision and compliance with analytical method quality control and project specifications during the data generation and reporting process.

In general, there are three major types of corrective actions which are initiated at ETC:

11.1 Correction of Sample Problems

Individual samples or matrix problems are usually handled within the analytical laboratory. Corrective actions may include re-preparation and re-analysis, clean-ups, dilutions or matrix modifications. All actions taken are documented with the analytical results. See Table 7.1 for corrective action for each type of analysis.

11.2 Correction of Sample Batch Problems

An entire batch of samples may require corrective action if quality control criteria are not met. See Table 7.1 for corrective action for each type of analysis. Laboratory managers are involved in the decisions for actions which may include re-analysis, re-extraction, etc. The Quality Assurance Officer may review both sets of data as applicable to determine if the problems have been resolved. The corrective action is identified and documented through the use of Corrective Action Report Form, see Figure 11.1.

11.3 Correction of Systematic Problems

Those problems of a procedural nature are handled by the laboratory managers and Quality Assurance Officer. Major operational changes are made only after approval of the Laboratory Director.

When a situation or issue is identified that requires a corrective action, it is investigated and evaluated using processes that address the requirements for the specific non-conformance found. In a case where there is a lack of existing requirements that may be applied, identification of the requirements is included in the corrective action plan. The corrective action is identified and documented through use of the Corrective Action Report Form.

In the event that any corrective actions are needed because the data quality is in question above and beyond those actions stipulated in the analytical methods, the client will be contacted by ETC to discuss the problem.

12.0 PERFORMANCE AND SYSTEMS AUDITS

12.1 System Audits

12.1.1 Internal Systems Audits

Internal audits are performed quarterly by the QA Officer. Deficiencies are reported to the General Manager and Department Manager. A sample of the checklist used for internal audits is given in Figure 12.1

12.1.2 External System Audits

Externals audits are conducted on the approximate schedules listed below:

California Department of Health Services	Every 2 years
New Jersey DEP	Yearly
Army Corp of Engineers	Every 18 months
State of Utah	Every 2 years
State of Washington	Every 2 years
State of Wisconsin	Every 2 years

A summary of the certifications maintained by parameter are given in Tables 12.2 and 12.3. External audits are hosted by the QA Officer, and reports of the audit are issued to all ETC - Santa Rosa staff. The QA Officer is responsible for submitting responses on a timely manner.

Clients are welcome to audit the lab as needed. Responses are prepared by the QA Officer.

12.1 Internal Performance Audits

ETC subcontracts ASI for quarterly double blind internal performance audits. The QA Officer is responsible for conducting the audit, distributing the results and preparing corrective action responses for not acceptable results.

12.2 External Performance Audits

External Performance Audits are conducted by the use of the following

interlaboratory checks:

EPA Water Pollution Performance Evaluation	Every 6 months
Department of the Army Performance Evaluation	per contract

13.0 QUALITY ASSURANCE REPORTS

The objective of the ETC quality assurance program is to insure that an operational system is in place which enables management to (1) assess analytical performance and take corrective action as necessary to affect process development and (2) determine the quality level of all data produced within the laboratory system. An essential component of the system is the communication pathways and feedback mechanisms which insure that management obtains quality information promptly and consistently. To achieve this objective, ETC employs informal and formal reporting processes to insure that management is informed of operational quality. This information enables ETC to take corrective action promptly when required.

The reporting occurs in several different forms. The Quality Assurance Officer meets three times per week with upper management to discuss possible quality assurance problems and proposed solutions, laboratory performance, upcoming audits, certification programs, and past audit performances.

Monthly written status reports are given to upper management which include a status update of all quality assurance programs and pertinent quality assurance issues within the laboratory.

As required, internal departmental audit reports are written which include observations and suggestions for corrective action procedures. A list of all the corrective action procedures written during the month are included in the written status report.

FIGURE 2.1 ETC - SANTA ROSA ORGANIZATIONAL STRUCTURE

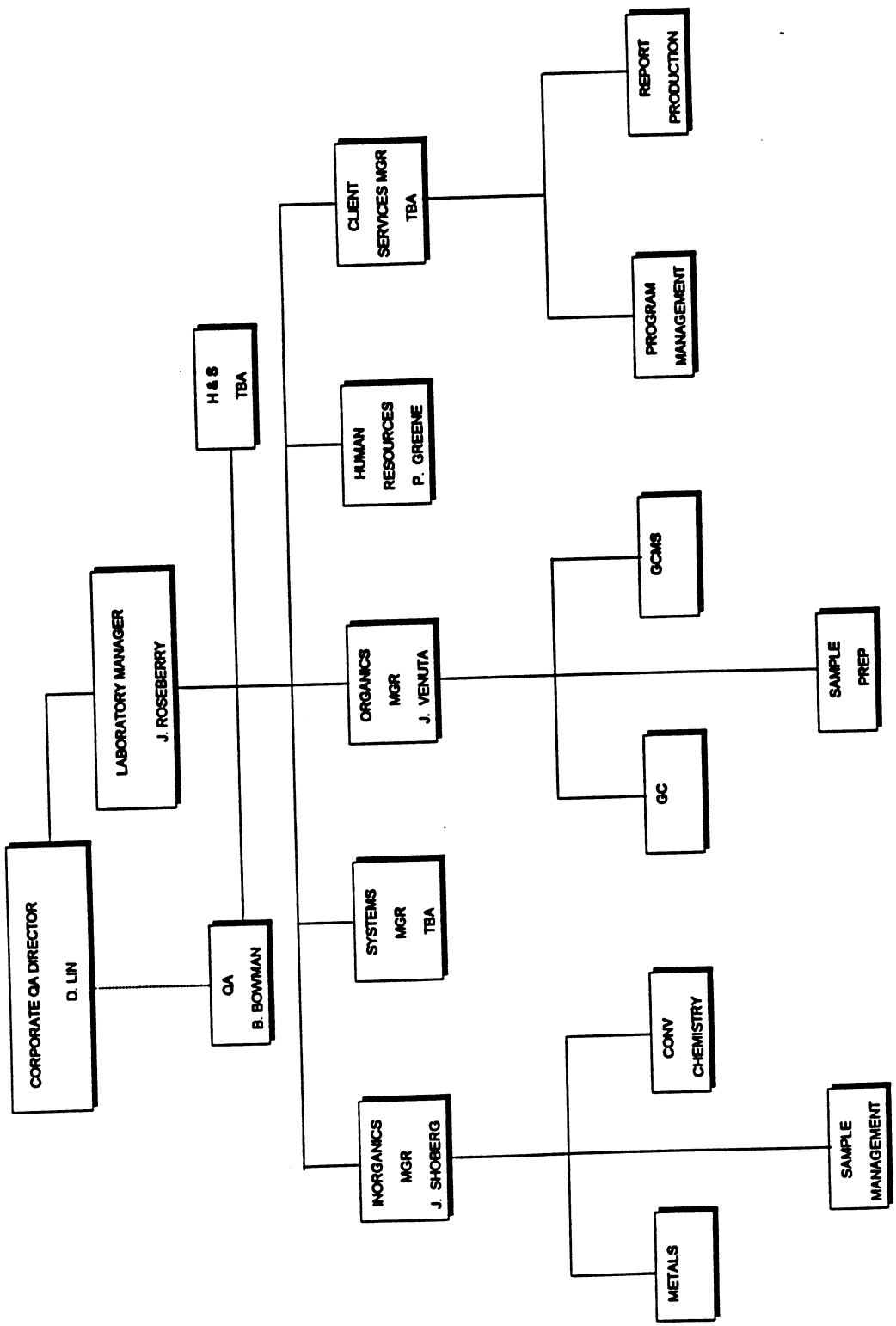


TABLE 3.1 PRECISION, ACCURACY, AND PQL OBJECTIVES

Analysis/Parameter	EPA Method	PQL - Aqueous a)	Aqueous Spike % Recovery Limits	Aqueous RPD Limits	PQL - Solid b)	Solid Spike % Recovery Limits	Solid RPD Limits	Blank Spike % Recovery Limits (AQ)	Blank Spike % Recovery Limits (SO)
Metals by GFAA									
Antimony	7041/204.2	0.005 mg/L	75 - 125	25	1 mg/kg	75 - 125	25	80 - 120	80 - 120
Arsenic	7050/206.2	0.005 mg/L	75 - 125	25	5 mg/kg	75 - 125	25	80 - 120	80 - 120
Cadmium	7131/213.2	0.001 mg/L	75 - 125	25	1 mg/kg	75 - 125	25	80 - 120	80 - 120
Chromium	7191/218.2	0.005 mg/L	75 - 125	25	1 mg/kg	75 - 125	25	80 - 120	80 - 120
Lead	7421/239.2	0.001 mg/L	75 - 125	25	0.1 mg/kg	75 - 125	25	80 - 120	80 - 120
Selenium	7740/270.2	0.005 mg/L	75 - 125	25	5 mg/kg	75 - 125	25	80 - 120	80 - 120
Thallium	7841/279.2	0.005 mg/L	75 - 125	25	1 mg/kg	75 - 125	25	80 - 120	80 - 120
Metals by ICP	6010/200.7								
Aluminum		0.2 mg/L	75 - 125	25	20 mg/kg	75 - 125	25	80 - 120	80 - 120
Antimony		0.05 mg/L	75 - 125	25	5 mg/kg	75 - 125	25	80 - 120	80 - 120
Barium		0.01 mg/L	75 - 125	25	1 mg/kg	75 - 125	25	80 - 120	80 - 120
Beryllium		0.005 mg/L	75 - 125	25	0.5 mg/kg	75 - 125	25	80 - 120	80 - 120
Boron		0.1 mg/L	75 - 125	25	10 mg/kg	75 - 125	25	80 - 120	80 - 120
Cadmium		0.01 mg/L	75 - 125	25	1 mg/kg	75 - 125	25	80 - 120	80 - 120
Calcium		1 mg/L	75 - 125	25	100 mg/kg	75 - 125	25	80 - 120	80 - 120
Chromium		0.02 mg/L	75 - 125	25	2 mg/kg	75 - 125	25	80 - 120	80 - 120
Cobalt		0.01 mg/L	75 - 125	25	1 mg/kg	75 - 125	25	80 - 120	80 - 120
Copper		0.03 mg/L	75 - 125	25	3 mg/kg	75 - 125	25	80 - 120	80 - 120
Iron		0.05 mg/L	75 - 125	25	5 mg/kg	75 - 125	25	80 - 120	80 - 120
Lead		0.05 mg/L	75 - 125	25	5 mg/kg	75 - 125	25	80 - 120	80 - 120
Magnesium		0.5 mg/L	75 - 125	25	50 mg/kg	75 - 125	25	80 - 120	80 - 120
Manganese		0.01 mg/L	75 - 125	25	1 mg/kg	75 - 125	25	80 - 120	80 - 120

AQ = Aqueous = Surface water, Leachate, Wastewater, Groundwater
NA = Not applicable

SO = Solids = Bulk chemical, Treatment Solids, Sediments
TBD = To be determined

TABLE 3.1 PRECISION, ACCURACY, AND PQL OBJECTIVES

Analysis/Parameter	EPA Method	PQL - Aqueous a)	Aqueous Spike % Recovery Limits	Aqueous RPD Limits	PQL - Solid b)	Solid Spike % Recovery Limits	Solid RPD Limits	Blank Spike % Recovery Limits (AQ)	Blank Spike % Recovery Limits (SO)
Molybdenum		0.02 mg/L	75 - 125	25	2 mg/kg	75 - 125	25	80 - 120	80 - 120
Nickel		0.03 mg/L	75 - 125	25	3 mg/kg	75 - 125	25	80 - 120	80 - 120
Potassium		1 mg/L	75 - 125	25	100 mg/kg	75 - 125	25	80 - 120	80 - 120
Silica		0.5 mg/L	75 - 125	25	50 mg/kg	75 - 125	25	80 - 120	80 - 120
Silver		0.01 mg/L	75 - 125	25	1 mg/kg	75 - 125	25	80 - 120	80 - 120
Sodium		1 mg/L	75 - 125	25	100 mg/kg	75 - 125	25	80 - 120	80 - 120
Thallium		0.05 mg/L	75 - 125	25	5 mg/kg	75 - 125	25	80 - 120	80 - 120
Tin		0.5 mg/L	75 - 125	25	50 mg/kg	75 - 125	25	80 - 120	80 - 120
Titanium		0.01 mg/L	75 - 125	25	5 mg/kg	75 - 125	25	80 - 120	80 - 120
Zinc		0.02 mg/L	75 - 125	25	2 mg/kg	75 - 125	25	80 - 120	80 - 120
Uranium	908.1	0.001 mg/L	75 - 125	25	0.001 mg/kg	75 - 125	25	NA	NA
Mercury by Cold Vapor	7471 7470/245.1	0.0002 mg/L	75 - 125	25	0.1 mg/kg	75 - 125	25	75 - 120	75 - 125
Metals by Wisconsin Trace Methods	ICP/MS, CVAA								
Aluminum		0.2 ug/L	75 - 125	25				75 - 125	
Cadmium		0.004 ug/L	75 - 125	25				75 - 125	
Copper		0.04 ug/L	75 - 125	25				75 - 125	
Lead		0.05 ug/L	75 - 125	25				75 - 125	
Mercury		0.05 ng/L	75 - 125	25				75 - 125	
Zinc		0.03 ug/L	75 - 125	25				75 - 125	
Metals - Terrestrial/Aquatic Tissue									
Arsenic	620.2/7060				0.5 mg/kg	75 - 125	25		80 - 120
Cadmium	620.2/7131				1 mg/kg	75 - 125	25		80 - 120

AQ = Aqueous = Surface water, Leachate, Wastewater, Groundwater
NA = Not applicable

SO = Solids = Bulk chemical, Treatment Solids, Sediments
TBD = To be determined

TABLE 3.1 PRECISION, ACCURACY, AND PQL OBJECTIVES

Analysis/Parameter	EPA Method	PQL - Aqueous a)	Aqueous Spike % Recovery Limits	Aqueous RPD Limits	PQL - Solid b)	Solid Spike % Recovery Limits	Solid RPD Limits	Blank Spike % Recovery Limits (AQ)	Blank Spike % Recovery Limits (SO)
Chromium	620.2/7191				1 mg/kg	75 - 125	25		80 - 120
Copper	620.2/6010				1 mg/kg	75 - 125	25		80 - 120
Mercury	620.2/7471				0.08 mg/kg	75 - 125	25		80 - 120
Lead	620.2/7421				0.5 mg/kg	75 - 125	25		80 - 120
Zinc	620.2/6010				2 mg/kg	75 - 125	25		80 - 120
Metals - Air Filters	NIOSH 7300m								
Arsenic					TBD	75 - 125	25		80 - 120
Antimony					TBD	75 - 125	25		80 - 120
Barium					TBD	75 - 125	25		80 - 120
Beryllium					TBD	75 - 125	25		80 - 120
Cadmium					TBD	75 - 125	25		80 - 120
Chromium					TBD	75 - 125	25		80 - 120
Cobalt					TBD	75 - 125	25		80 - 120
Copper					TBD	75 - 125	25		80 - 120
Lead					TBD	75 - 125	25		80 - 120
Manganese					TBD	75 - 125	25		80 - 120
Mercury					TBD	75 - 125	25		80 - 120
Moybdenum					TBD	75 - 125	25		80 - 120
Nickel					TBD	75 - 125	25		80 - 120
Phosphorus					TBD	75 - 125	25		80 - 120
Selenium					TBD	75 - 125	25		80 - 120
Thallium					TBD	75 - 125	25		80 - 120
Tin					TBD	75 - 125	25		80 - 120

AQ = Aqueous = Surface water, Leachate, Wastewater, Groundwater
NA = Not applicable

SO = Solids = Bulk chemical, Treatment Solids, Sediments
TBD = To be determined

TABLE 3.1 PRECISION, ACCURACY, AND PQL OBJECTIVES

Analysis/Parameter / EPA Method	PQL - Aqueous a)	Aqueous Spike % Recovery Limits	Aqueous RPD Limits	PQL - Solid b)	Solid Spike % Recovery Limits	Solid RPD Limits	Blank Spike % Recovery Limits (AQ)	Blank Spike % Recovery Limits (SO)
Zinc				TBD	75 - 125	25		80 - 120

Notes:

a) Aqueous samples digested by EPA method 3015 (Microwave)
b) Solid samples digested by EPA method 3050

AQ = Aqueous = Surface water, Leachate, Wastewater, Groundwater
NA = Not applicable

SO = Solids = Bulk chemical, Treatment Solids, Sediments
TBD = To be determined

TABLE 3.1 PRECISION, ACCURACY, AND PQL OBJECTIVES

Analysis/Parameter	EPA Method	PQL - Aqueous	Aqueous Spike % Recovery Limits	Aqueous RPD Limits	PQL - Solids	Solid Spike % Recovery Limits	Solid RPD Limits	Blank Spike % Recovery Limits (AQ)	Blank Spike % Recovery Limits (SO)
Anions by IC	300.0								
Chloride		0.5 mg/L	80 - 120	25				80 - 120	
Nitrate + Nitrite as N		0.5 mg/L	80 - 120	25				80 - 120	
Sulfate		1 mg/L	80 - 120	25				80 - 120	
Alkalinity	310.1								
Total Alkalinity		5 mg/L	80 - 120	25				80 - 120	
Bicarbonate Alkalinity		5 mg/L	80 - 120	25				80 - 120	
Carbonate Alkalinity		5 mg/L	80 - 120	25				80 - 120	
Asbestos	TEM	7M F/L	TBA	TBA					
BOD	405.1	2 mg/L	80 - 120	25				80 - 120	
Chemical Oxygen Demand	410.4	20 mg/L	80 - 120	25				80 - 120	
Chloride, titrimetric	9252	0.5 mg/L	80 - 120	25	5 mg/kg 1 mg/kg a)	80 - 120	25	80 - 120	80 - 120
Conductivity	9050	10 umhos	NA	25				NA	
Cyanide, Total	9010	0.02 mg/L	80 - 120	25	0.5 mg/kg	75 - 125	25	80 - 120	75 - 125
Fluoride, probe	340.2	0.1 mg/L	80 - 120	25	0.2 mg/kg	80 - 120	25	80 - 120	80 - 120
Hardness	130.2	5 mg/L	80 - 120	25	5 mg/kg	NA	NA	80 - 120	80 - 120
MBAS	SM16 - 512B	0.02 mg/L	70 - 130	25				80 - 120	
Nitrate, cadmium reduction	352.1	0.5 mg/L	80 - 120	25				80 - 120	
Nitrogen, Ammonia, titration	350.2	0.1 mg/L	80 - 120	25	50 mg/kg	80 - 120	25	80 - 120	80 - 120
Nitrogen, Total Kjeldahl	351.3	0.2 mg/L	80 - 120	25	50 mg/kg	80 - 120	25	80 - 120	80 - 120
Oil and Grease	413.2	1 mg/L	80 - 120	25	50 mg/kg	75 - 125	25	80 - 120	75 - 125
pH	9040/9045/150.1	0.1 STD	NA	25	0.1 STD	NA	25	NA	NA

AQ = Aqueous = Surface water, Leachate, Wastewater, Groundwater
NA = Not Applicable

SO = Solids = Bulk chemical, Treatment Solids, Sediments
TBD = To be detemined

TABLE 3.1 PRECISION, ACCURACY, AND PQL OBJECTIVES

Analysis/Parameter	EPA Method	PQL - Aqueous	Aqueous Spike % Recovery Limits	Aqueous RPD Limits	PQL - Solids	Solid Spike % Recovery Limits	Solid RPD Limits	Blank Spike % Recovery Limits (AQ)	Blank Spike % Recovery Limits (SO)
Phosphorus, Soluble	365.3	0.05 mg/L	60 - 120	25				60 - 120	
Phosphorus, Total	365.3	0.05 mg/L	60 - 120	25	5 mg/kg	75 - 125	25	60 - 120	60 - 120
Radiological									
Gross alpha	900.0	TBD							
Gross beta	900.0	TBD							
Radium 220	903.1	0.001 mg/L							
Radium 228	903.1	0.001 mg/L							
Solids, Total	SM 209F				0.1%	NA	25		NA
Solids, Total Dissolved	160.1	5 mg/L	NA	25					
Solids, Total Suspended	160.2	5 mg/L	NA	25					
Solids, Total Volatile	160.4				10 mg/kg	NA	25		NA
Sulfate, turbidimetric	9038	5 mg/L	80 - 120	25	100 mg/kg	80 - 120	25	80 - 120	80 - 120
Sulfur, Total	5030/9056				100 mg/kg	80 - 120	25		80 - 120
Turbidity	180.1	0.5 NTU	80 - 120	25					

Notes:

a) Sediment detection limit

AQ = Aqueous = Surface water, Leachate, Wastewater, Groundwater
NA = Not Applicable

SO = Solids = Bulk chemical, Treatment Solids, Sediments
TBD = To be detemined

TABLE 3.1 PRECISION, ACCURACY, AND PQL OBJECTIVES

Analysis/Parameter	EPA Method	PQL - Groundwater	Groundwater Spike % Recovery Limits	Groundwater RPD Limits	Blank Spike % Recovery Limits (AQ)
Volatile Organics by GC/ELCD/FID	8021				
Benzene		0.5 ug/L	82 - 118	30	82 - 118
Bromobenzene		0.5 ug/L	70 - 130	30	70 - 130
Bromochloromethane		0.5 ug/L	50 - 150	30	50 - 150
Bromodichloromethane		0.5 ug/L	80 - 122	30	80 - 122
Bromoform		0.5 ug/L	59 - 143	30	59 - 143
Bromomethane		0.5 ug/L	50 - 150	30	50 - 150
n-Butylbenzene		0.5 ug/L	70 - 130	30	70 - 130
sec-Butylbenzene		0.5 ug/L	70 - 130	30	70 - 130
tert-Butylbenzene		0.5 ug/L	70 - 130	30	70 - 130
Carbon tetrachloride		0.5 ug/L	50 - 152	30	50 - 152
Chlorobenzene		0.5 ug/L	80 - 116	30	80 - 116
Chloroethane		0.5 ug/L	65 - 143	30	65 - 143
Chloroform		0.5 ug/L	53 - 149	30	53 - 149
Chloromethane		0.5 ug/L	D - 217	30	D - 217
2-Chlorotoluene		0.5 ug/L	70 - 130	30	70 - 130
4-Chlorotoluene		0.5 ug/L	70 - 130	30	70 - 130
1,2-Dibromo-3-chloropropane		0.5 ug/L	50 - 150	30	50 - 150
Dibromomethane		0.5 ug/L	50 - 150	30	50 - 150
Dibromochloromethane		0.5 ug/L	73 - 127	30	73 - 127
1,2-Dichlorobenzene		0.5 ug/L	78 - 120	30	78 - 120
1,3-Dichlorobenzene		0.5 ug/L	85 - 115	30	85 - 115
1,4-Dichlorobenzene		0.5 ug/L	82 - 118	30	82 - 118
Dichlorodifluoromethane		0.5 ug/L	7 - 157	30	7 - 157
1,1-Dichloroethane		0.5 ug/L	80 - 128	30	80 - 128
1,2-Dichloroethane		0.5 ug/L	67- 139	30	67- 139
1,1-Dichloroethene		0.5 ug/L	51 - 159	30	51 - 159
cis-1,2-Dichloroethene		0.5 ug/L	85 - 121	30	85 - 121
trans-1,2-Dichloroethene		0.5 ug/L	84 - 120	30	84 - 120
Dichloromethane		0.5 ug/L	50 - 150	30	50 - 150
1,2-Dichloropropane		0.5 ug/L	83 - 125	30	83 - 125

SS = Surrogate Standard

TABLE 3.1 PRECISION, ACCURACY, AND PQL OBJECTIVES

Analysis/Parameter / EPA Method	PQL - Groundwater	Groundwater Spike % Recovery Limits	Groundwater RPD Limits	Blank Spike % Recovery Limits (AQ)
1,3-Dichloropropane	0.5 ug/L	50 - 150	30	50 - 150
2,2-Dichloropropane	0.5 ug/L	50 - 150	30	50 - 150
1,1-Dichloropropene	0.5 ug/L	50 - 150	30	50 - 150
1,3-Dichloropropene, Total	0.5 ug/L	84 - 120	30	84 - 120
Ethyl benzene	0.5 ug/L	74 - 122	30	74 - 122
Ethylene dibromide	0.5 ug/L	70 - 130	30	70 - 130
Hexachlorobutadiene	0.5 ug/L	50 - 150	30	50 - 150
p-Isopropyltoluene	0.5 ug/L	70 - 130	30	70 - 130
Naphthalene	0.5 ug/L	50 - 150	30	50 - 150
n-Propylbenzene	0.5 ug/L	50 - 150	30	50 - 150
Styrene	0.5 ug/L	70 - 130	30	70 - 130
1,1,1,2-Tetrachloroethane	0.5 ug/L	70 - 130	30	70 - 130
1,1,2,2-Tetrachloroethane	0.5 ug/L	75 - 141	30	75 - 141
Tetrachloroethene	0.5 ug/L	73 - 133	30	73 - 133
Toluene	0.5 ug/L	79 - 115	30	79 - 115
1,2,3-Trichlorobenzene	0.5 ug/L	70 - 130	30	70 - 130
1,2,4-Trichlorobenzene	0.5 u/gl	70 - 130	30	70 - 130
1,1,1-Trichloroethane	0.5 ug/L	77 - 131	30	77 - 131
1,1,2-Trichloroethane	0.5 ug/L	82 - 130	30	82 - 130
Trichlorofluoromethane	0.5 ug/L	68 - 140	30	68 - 140
1,2,3-Trichloropropane	0.5 ug/L	50 - 150	30	50 - 150
1,2,4-Trimethylbenzene	0.5 ug/L	50 - 150	30	50 - 150
1,3,5-Trimethylbenzene	0.5 ug/L	50 - 150	30	50 - 150
Xylenes, Total	0.5 ug/L	75 - 125	30	75 - 125
Bromochloromethane (SS)		72 - 132		
1-Chloro-2-fluorobenzene (SS)		65 - 125		
Bromofluorobenzene (SS)		80 - 122		
Pesticides and PCBs by GC/ECD 8080				
Aldrin	0.1 ug/L	12 - 162	33	12 - 162
Chlordane	0.1 ug/L			
Dieldrin	0.1 ug/L	39 -171	31	39 -171

SS = Surrogate Standard

TABLE 3.1 PRECISION, ACCURACY, AND PQL OBJECTIVES

Analysis/Parameter	EPA Method	PQL - Groundwater	Groundwater Spike % Recovery Limits	Groundwater RPD Limits	Blank Spike % Recovery Limits (AQ)
Heptachlor		0.1 ug/L	29 - 149	21	29 - 149
Heptachlor epoxide		0.1 ug/L	25 - 169	28	25 - 169
Methoxychlor		0.1 ug/L	17 - 179	34	17 - 179
Toxaphene		2 ug/L			
PCB-1016		1 ug/L			
PCB-1221		2 ug/L			
PCB-1232		2 ug/L			
PCB-1242		1 ug/L			
PCB-1248		1 ug/L			
PCB-1254		1 ug/L			
PCB-1260		1 ug/L	8 - 128	50	8 - 128
Total PCBs		1 ug/L	8 - 128	50	8 - 128
Dibutylchlorendate (SS)			54 - 130		
Pentachloronitrobenzene (SS)			75 - 141		
Decachlorobiphenyl (SS)			50 - 150		
Organophosphorous Pesticides by GC/NPD	8140M/8141M				
Alachlor		2 ug/L	50 - 150	50	50 - 150
1,3-Dimethyl-2-nitrobenzene (SS)			50 - 150		
Chlorinated Herbicides by GC/ECD	8150/8151				
2,4-D		1 ug/L	D - 153	27	D - 153
2,4,5-TP (Silvex)		0.5 ug/L	D - 136	30	D - 136
Dalapon		1 ug/L	50 - 150	50	50 - 150
Dicamba		0.5 ug/L	50 - 150	50	50 - 150
Dinoseb		0.5 ug/L	50 - 150	50	50 - 150
Picloram		1 ug/L	50 - 150	50	50 - 150
2,4-Dichlorophenylacetic acid (SS)			50 - 122		
N-Methylcarbmoyloximes and N-Methylcarbamates	531.1				
Aldacarb		0.5 ug/L	40 - 160	30	40 - 160
Aldacarb sulfone		0.4 ug/L	40 - 160	30	40 - 160

SS = Surrogate Standard

TABLE 3.1 PRECISION, ACCURACY, AND PQL OBJECTIVES

Analysis/Parameter	EPA Method	PQL - Groundwater	Groundwater Spike % Recovery Limits	Groundwater RPD Limits	Blank Spike % Recovery Limits (AQ)
Aldicarb sulfoxide		0.5 ug/L	40 - 160	30	40 - 160
Carbaryl		1 ug/L	40 - 160	30	40 - 160
Carbofuran		0.9 ug/L	40 - 160	30	40 - 160
3-Hydroxycarbofuran		1 ug/L	40 - 160	30	40 - 160
Methomyl		0.5 ug/L	40 - 160	30	40 - 160
Oxamyl		1 ug/L	40 - 160	30	40 - 160
(SS)			TBD		
Glyphosate a)	547	6 ug/L	50 - 150	30	50 - 150
Endothall a)	548	9 ug/L	50 - 150	30	50 - 150
Diquat a)	549	0.4 ug/L	50 - 150	30	50 - 150
Nitrogen-Phosphorus Pesticides	507				
Butachlor		0.1 ug/L	50 - 150	30	50 - 150
Metolachlor		0.1 ug/L	50 - 150	30	50 - 150
Metribuzin		0.1 ug/L	50 - 150	30	50 - 150
Propachlor		0.1 ug/L	50 - 150	30	50 - 150
(SS)			TBD		
Triazine Pesticides	619				
Atrazine		1 ug/L	50 - 150	30	50 - 150
Simazine		1 ug/L	50 - 150	30	50 - 150
(SS)			TBD		

NOTES:

a) Surrogate standards and limits to be determined.

SS = Surrogate Standard

TABLE 3.1 PRECISION, ACCURACY, AND PQL OBJECTIVES

Analysis/Parameter	EPA Method	PQL - Groundwater	Groundwater Spike % Recovery Limits	Groundwater RPD Limits	Blank Spike % Recovery Limits (AQ)
Volatile Organics by GC/MS	8260				
Acrylamide		50 ug/L	70 - 130	30	70 - 130
Epichlorohydrin		50 ug/L	70 - 130	30	70 - 130
Trichloroethene		1 ug/L	70 - 130	30	70 - 130
Vinyl chloride		2 ug/L	70 - 130	30	70 - 130
Bromofluorobenzene (SS)			90 - 108		90 - 108
1,2-Dichloroethane-d4 (SS)			83 - 119		83 - 119
Toluene-d8 (SS)			87 - 111		87 - 111
Semivolatile Organics by GC/MS	8270				
Benzo(a)pyrene		5 ug/L	17 - 163	30	17 - 163
Diethylhexyl adipate		10 ug/L	40 - 160	30	40 - 160
Diethyl phthalate		10 ug/L	D - 114	30	D - 114
Hexachlorobenzene		10 ug/L	D - 152	30	D - 152
Hexachlorocyclopentadiene		10 ug/L	60 - 140	30	60 - 140
Pentachlorophenol		20 ug/L	2 - 176	30	2 - 176
2-Fluorobiphenyl (SS)			43 - 116		43 - 116
Nitrobenzene-d5 (SS)			35 - 114		35 - 114
Terphenyl-d14 (SS)			33 - 141		33 - 141
2-Fluorophenol (SS)			21 - 100		21 - 100
Phenol-d6 (SS)			10 - 94		10 - 94
2,4,6-Tribromophenol (SS)			10 - 123		10 - 123
Dioxins and Dibenzofurans	8280				
2,3,7,8-TCDD		0.01 ug/L	50 - 150	30	50 - 150
^{13}C-2,3,7,8-TCDD (IS)			50 - 150		50 - 150

SS = Surrogate Standard
IS = Internal Standard

TABLE 3.2 SAMPLE PREPARATION METHODS

SAMPLE PREP METHOD NUMBER	DESCRIPTION	MATRIX	APPLIED TO THESE METHODS:
3005	Acid Digestion, total recoverable, for ICP	Water	6010
3010	Acid Digestion, total, for ICP	Water	6010
3015	Microwave Digestion, total, for ICP	Water	6010
3020	Acid Digestion, for GFAA	Water	7000 series GFAA
3050	Acid Digestion, total	Soil, Hazardous Waste	6010
3510	Separatory Funnel Extraction	Water	8080, 8140M, 8270
3520	Liquid/Liquid Extraction	Water	8080, 8140M, 8270
8150	Separatory Funnel extraction/derivatization	Water	8150
3260	Fluorosil Cleanup	Water, Soil	8080, 8270
ASTM	Acid Cleanup	Soil, Hazardous Waste	8080 PCB's only
5030/Low level	5-mL Purge and trap	Water, Soil	8021
5030/Low level	25-mL Heated Purge and trap	Water, Soil	8260
5030/Med level	Methanol extraction, Purge and Trap	Soil, Hazardous Waste	8021, 8260

TABLE 4.1 SAMPLE CONTAINER TYPES, PRESERVATION, AND HOLDING TIMES

PARAMETER	MINIMUM VOLUME	ETC SUPPLIED CONTAINERS	PRESERVATION	MAXIMUM HOLDING TIME
VOLATILES ORGANICS				
Concentrated Waste Samples	10 g	8-oz. widemouth glass jar with Teflon liner	None	14 Days
Liquid Samples No Residual Chlorine Present	40 mL	2 x 40-mL vials with Teflon lined septum caps	4 drops conc. HCl, Cool, 4°C	14 Days
Residual Chlorine Present	40 mL	2 x 40-mL vials with Teflon lined septum caps	4 drops conc. HCl, Cool, 4°C, $Na_2S_2O_3$	14 Days
Acrolein and Acrylonitrile	40 mL	2 x 40-mL vials with Teflon lined septum caps	Adjust to pH 4-5, Cool, 4°C	14 Days
Soil/Sediments and Sludges	10 g	4-oz (120-mL) widemouth glass with Teflon liner	Cool, 4°C	14 Days
SEMI-VOLATILE ORGANICS				
Concentrated Waste Samples	10 g	8-oz. widemouth glass with Teflon liner	None	14 days to extract, 40 days after extraction
Liquid Samples No Residual Chlorine Present	1 L	2 x 1-liter amber glass with Teflon liner	Cool, 4°C	7 days to extract, 40 days after extraction
Liquid Samples Residual Chlorine Present	1 L	2 x 1-liter amber glass with Teflon liner	Add 2 mL 10% $Na_2S_2O_3$ per liter, Cool, 4°C	7 days to extract, 40 days after extraction
Soil/Sediments and Sludges	10 g	8-oz. widemouth glass with glass with Teflon liner	Cool, 4°C	14 days to extract, 40 days after extraction
PARAMETER	**MINIMUM VOLUME**	**ETC SUPPLIED CONTAINER**	**PRESERVATION**	**MAXIMUM HOLDING TIME**
Coliform, fecal and total	120 mL	Sterile, Plastic or glass	Cool, 4°C, 0.008% $Na_2S_2O_3$	6 hours
Fecal streptococci	120 mL	Sterile, Plastic or glass	Cool, 4°C, 0.008% $Na_2S_2O_3$	6 hours
Bioassay, percent survival/LC50	5 gal	5-gal cubitainer	Cool, 4°C	24 hours
Bioassay, hazardous waste	100 g	8-oz. widemouth glass jar with Teflon liner	Cool, 4°C	None recommended
Acidity	100 mL	Plastic or glass	Cool, 4°C	14 days
Alkalinity	100 mL	Plastic or glass	Cool, 4°C	14 days
Ammonia	500 mL	Plastic or glass	Cool, 4°C, H_2SO_4 to pH<2	28 days
Biochemical oxygen demand	500 mL	Plastic or glass	Cool, 4°C	48 hours

a) $Na_2S_2O_3$ added when chlorine present in sample.
b) Soil samples do not require pH adjustment.

TABLE 4.1 SAMPLE CONTAINER TYPES, PRESERVATION, AND HOLDING TIMES

PARAMETER	MINIMUM VOLUME	ETC SUPPLIED CONTAINER	PRESERVATION	MAXIMUM HOLDING TIME
Biochemical oxygen demand, carbonaceous	500 mL	Plastic or glass	Cool, 4°C	48 hours
Bromide	100 mL	Plastic or glass	None required	28 days
Chemical oxygen demand	120 mL	Plastic or glass	Cool, 4°C, H_2SO_4,to pH<2	28 days
Chloride	100 mL	Plastic or glass	None required	28 days
Chlorine, total residual	100 mL	Plastic or glass	None required	Analyze immediately
Color	1 L	Plastic or glass	Cool, 4°C	48 hours
Cyanide, total and amenable to chlorination	1 L	Plastic or glass	Cool, 4°°C, NaOH to pH>12, 0.6g ascorbic acid	14 days
Fluoride	100 mL	Plastic	None required	28 days
Hardness	100 mL	Plastic or glass	HNO_3 to pH<2, H_2SO_4 to pH<2	6 months
Hydrogen ion (pH)	50 mL	Plastic or glass	None required	Analyze immediately
Kjeldahl and organic nitrogen	500 mL	Plastic or glass	Cool, 4°C, H_2SO_4 to pH<2	28 days
Chromium VI	500 mL	Plastic or glass	Cool, 4°C	24 hours
Mercury	1 L	Plastic or glass	HNO_3, to pH<2	28 days
Metals, except Cr^{+6} and Hg	1 L	Plastic or glass	HNO_3, to pH<2	6 months
Nitrate	500 mL	Plastic or glass	Cool, 4°C	48 hours
Nitrate+nitrite	500 mL	Plastic or glass	Cool, 4°C, H_2SO_4 to pH<2	28 hours
Nitrite	500 mL	Plastic or glass	Cool, 4°C	48 hours
Oil and grease	1 L	Glass	Cool, 4°C, H_2SO_4 to pH<2	28 days
Organic Carbon	100 mL	Plastic or glass	Cool, 4°°C, HCl or H_2SO_4 to pH<2	28 days
Orthophosphate	100 mL	Plastic or glass	Filter immediately, cool, 4°C	48 hours
Oxygen, Dissolved Probe	300 mL	300 ml BOD bottle and top	None required	Analyze immediately
Winkler	300 mL	300 ml BOD bottle and top	Fix on site and store in dark	8 hours
Phenols	1 L	Glass only	Cool, 4°C,H_2SO_4 to pH<2	28 days

a) $Na_2S_2O_3$ added when chlorine present in sample.
b) Soil samples do not require pH adjustment.

TABLE 4.1 SAMPLE CONTAINER TYPES, PRESERVATION, AND HOLDING TIMES

PARAMETER	MINIMUM VOLUME	ETC SUPPLIED CONTAINER	PRESERVATION	MAXIMUM HOLDING TIME
Phosphorus (elemental)	100 mL	Glass	Cool, 4°C	48 hours
Phosphorus, total	100 mL	Plastic or glass	Cool, 4°C, H_2SO_4 to pH<2	28 days
Residue, total	150 mL	Plastic or glass	Cool, 4°C	7 days
Residue, Filterable	150 mL	Plastic or glass	Cool, 4°C	7 days
Residue, Nonfilterable (TSS)	150 mL	Plastic or glass	Cool, 4°C	7 days
Residue, Settleable	2 L	Plastic or glass	Cool, 4°C	48 hours
Residue, volatile	150 mL	Plastic or glass	Cool, 4°C	7 days
Silica	100 mL	Plastic	Cool, 4°C	28 days
Specific conductance	120 mL	Plastic or glass	Cool, 4°C	28 days
Sulfate	150 mL	Plastic or glass	Cool, 4°C	28 days
Sulfide	500 mL	Plastic or glass	Cool, 4°C, add zinc acetate plus sodium hydroxide to pH>9	7 days
Sulfite	150 mL	Plastic or glass	None required	Analyze immediately
Surfactants	1 L	Plastic or glass	Cool, 4°C	48 hours
Temperature (of ice chest or shuttle)	40 mL	40-mL vial with water	--	Analyze immediately
Total organic halogens	250 mL	Glass, Teflon-lined cap	Cool, 4°C, H_2SO_4 to pH<2	7 days
Turbidity	500 mL	Plastic or glass	Cool, 4°C	48 hours
Purgeable Halocarbons	40 mL/10 g	2 x 40-mL vials with Teflon lined septum caps; 8 oz. widemouth jar	Cool, 4°C a)	14 days
Purgeable aromatic hydrocarbons	40 mL/10 g	2 x 40-mL vials with Teflon lined septum caps; 8 oz. widemouth jar	Cool, 4°C, HCl to pH 2 a) b)	14 days
Acrolein and acrylonitrile	40 mL/10 g	2 x 40-mL vials with Teflon lined septum caps; 8 oz. widemouth jar	Cool, 4°C, Adjust pH to 4-5 a) b)	14 days
Phenols	1 L/50 g	2 x 1-liter amber glass with Teflon liner; 8 oz. widemouth jar	Cool, 4°C a)	Water 7; Soil 14 days to extract, 40 days after extraction

a) $Na_2S_2O_3$ added when chlorine present in sample.
b) Soil samples do not require pH adjustment.

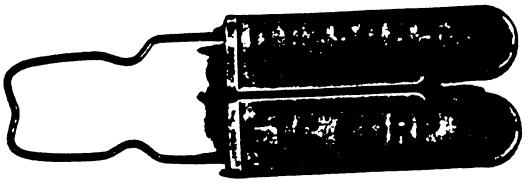
TABLE 4.1 SAMPLE CONTAINER TYPES, PRESERVATION, AND HOLDING TIMES

PARAMETER	MINIMUM VOLUME	ETC SUPPLIED CONTAINER	PRESERVATION	MAXIMUM HOLDING TIME
Benzidines	1 L/50 g	2 x 1-liter amber glass with Teflon liner; 8 oz. widemouth jar	Cool, 4°C	Water 7; Soil 14 days to extract, 40 days after extraction
Phthalate esters	1 L/50 g	2 x 1-liter amber glass with Teflon liner; 8 oz. widemouth jar	Cool, 4°C	Water 7; Soil 14 days to extract, 40 days after extraction
Nitrosamines	1 L/50 g	2 x 1-liter amber glass with Teflon liner; 8 oz. widemouth jar	Cool, 4°C, store in dark a)	Water 7; Soil 14 days to extract, 40 days after extraction
PCBs, acrylonitrile	1 L/50 g	2 x 1-liter amber glass with Teflon liner; 8 oz. widemouth jar	Cool, 4°C	Water 7; Soil 14 days to extract, 40 days after extraction
Nitroaromatics and isophorone	1 L/50 g	2 x 1-liter amber glass with Teflon liner; 8 oz. widemouth jar	Cool, 4°C, store in dark	Water 7; Soil 14 days to extract, 40 days after extraction
Pesticides	1 L/50 g	2 x 1-liter amber glass with Teflon liner; 8 oz. widemouth jar	Cool, 4°C, pH 5-9 b)	Water 7; Soil 14 days to extract, 40 days after extraction
Polynuclear aromatic hydrocarbons	1 L/50 g	2 x 1-liter amber glass with Teflon liner; 8 oz. widemouth jar	Cool, 4°C, store in dark	Water 7; Soil 14 days to extract, 40 days after extraction
Haloethers	1 L/50 g	2 x 1-liter amber glass with Teflon liner; 8 oz. widemouth jar	Cool, 4°C a)	Water 7; Soil 14 days to extract, 40 days after extraction
Chlorinated hydrocarbons	1 L/75 g	2 x 1-liter amber glass with Teflon liner; 8 oz. widemouth jar	Cool, 4°C	Water 7; Soil 14 days to extract, 40 days after extraction
Herbicides	1 L/75 g	2 x 1-liter amber glass with Teflon liner; 8 oz. widemouth jar	Cool, 4°C	Water 7; Soil 14 days to extract, 40 days after extraction
TCDD	1 L/50 g	2 x 1-liter amber glass with Teflon liner; 8 oz. widemouth jar	Cool, 4°C a)	Water 7; Soil 14 days to extract, 40 days after extraction
Alpha, beta and radium	1 L	Plastic or glass	HNO_3 to pH<2	6 months

a) $Na_2S_2O_3$ added when chlorine present in sample.
b) Soil samples do not require pH adjustment.

FIGURE 4.2 CHAIN OF CUSTODY SEALS

CHAIN OF CUSTODY LOCK



CHAIN OF CUSTODY TAPE

FIGURE 4.3 ETC SAMPLE SHUTTLE™

The ETC Shuttle™ is a uniquely engineered and patented shipping container that has been designed to meet and exceed EPA and State protocols for shipping, chemical and thermal preservation of analytical samples. The container can be locked and sealed to ensure sample integrity during both transport and sampling.

Features include;

- A rugged and waterproof outer container that withstands varying field conditions.
- Polyurethane foam insulation for dependable thermal performance.
- Chain of Custody locks and numbered seals preserve sample integrity.
- Customized coolant to sustain required EPA temperature controls.
- Chain of Custody and Field parameter forms to document sampling event.
- Polyethylene modular sleeve designed to prevent bottle breakage during shipment.
- Pre-labeled, pre-configured bottles specific for each sampling event.
- Pre-measured preservatives are attached to bottles with color coded instructions to insure proper protocols are followed.
- Return shipping labels and custody seals to provide rapid *correct* return of samples to the lab.

WITH ETC'S SAMPLE SHUTTLE™ CHAIN OF CUSTODY BEGINS IN THE LABORATORY, PRIOR TO SHIPMENT INTO THE FIELD.

The Shuttle is configured at the lab to provide all the correct sample containers needed for the analysis ordered. All sample containers used by ETC meet the criteria stated in the appropriate analytical methodology, for size of container, material composition and required preservatives.

ETC provides you with three part *chain of custody* and *field parameter* forms which provide the mechanism to document the chronological evidence of the possession of the sampling event.

ETC SHUTTLES™ ARE SHIPPED TO A CLIENT CONTAINING A UNIQUE CONFIGURATION TO SPECIFICALLY MEET THE NEEDS OF A MONITORING PROGRAM AND THE ANALYTICAL REQUIREMENTS.

Shuttles can be sent to any client requesting analytical services from ETC.

The analytical requirements, in conjunction with the sampling schedule, determine the number of shuttles required by a specific project or monitoring program.

Shuttles can be shipped by either UPS or an express overnight delivery service for a nominal fee, which ever is indicated by the client. Shuttles can be shipped to *any location* as long as UPS or the express delivery services can make a delivery.

FOR INTERNATIONAL SHIPMENTS,

ETC holds a USDA permit which allows for the expeditious shipment of the ETC Sample Shuttle™ through U.S. Customs. Use of this permit will insure environmental samples arrive at ETC within the required holding times and temperature controlled protocols.

FIGURE 4.3 ETC SAMPLE SHUTTLE™

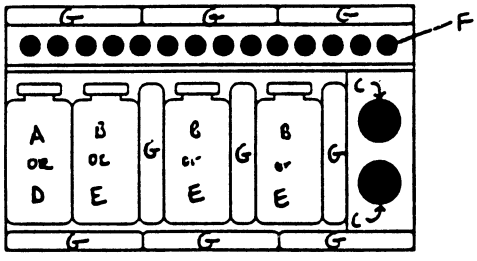
Sample Shuttle Instructions
Please read carefully before sampling

1. Freeze the shuttle ice pack at least 24 hours before sampling.

2. Break the black seal on the shuttle hasp. Open shuttle and remove the plastic bag which contains: Chain-of-Custody Form (CC1), Field Information From (CC2), return shipping label, clear blank seals, and one black ETC seal for resealing the shuttle after sampling.

3. Examine the Chain-of-Custody (CC1) form and the Field Information (CC2) form carefully These must be filled out and returned for accurate processing of your sample. Note any relevant observation on the Forms. If you have questions, please call the Client Service Department.

4. Unpack bottles and ice packs. Freeze the ice packs prior to sampling. (NOTE the order of packing. The shuttle should be repacked exactly as received. This prevents bottle breakage and sample freezing from occurring.)



A. 1 Liter Plastic Bottle
B. 1 Liter Amber Bottle
C. 125 ml Amber Bottle
D. 500 ml Plastic Bottle
E. 500 ml Amber Bottle
F. 40 ml Vial
G. Ice Packs

5. Each bottle is labeled with an ETC number (e.g. D1234), and the analysis to be performed (TOC, VOA, EXTBL, Metals, CN). Match the type of analysis and quantity of bottle against the Chain-of-Custody form. Be sure all bottles used for a single sample point have the same ETC number. Preservatives have been provided for bottles requiring them.

6. After sampling and repacking shuttle place all completed forms in the plastic bag and replace in shuttle.

7. Insert the black seal in one of the outside latches and lock.

8. When Emergency of Express analysis are requested, call ETC Client Service Department, and give the following information: a) Carrier, b) Airbill number, c) Arrival date, and d) Number of Shuttles.

SAMPLING NOTES

- For TOX (Total Organic Halides), fill the bottle, leaving no headspace (no air bubbles).

- For all metals analysis the preservative in the vial must be added to the bottle after sampling.

- Indicate on CC1 whether sample has been filtered.

FIGURE 5.1 CHAIN OF CUSTODY RECORD

Figure 5.1
Date 01-05-94
Page 1 of 1

ETC

CHAIN-OF-CUSTODY RECORD

Form 0019
Field Technical Services
Rev. 08/90

No. 96884

Environmental Testing and Certification Corp. • 284 Raritan Center Parkway • Edison, NJ 08818 • 908-225-6700

COMPANY	FACILITY/SITE
PROJECT CONTACT	TELEPHONE NO.

ITEM NO	ETC JOB #	SOURCE CODE	SAMPLE POINT	START DATE YY/MM/DD	START TIME
1					
2					
3					
4					
5					
6					
7					
8					
9					

Source Codes:
Well .... (W) Outfall ..... (O)
Soil .... (S) River/Stream .... (R)
Bottom Sediment ..... (B)
Generation Point ..... (G)
Surface Impoundment ..... (I)
Treatment Facility ..... (T)
Leachate Collection Sys ..... (C)
Lake/Ocean ..... (L)
Other ..... (X)
Specify _____

NUMBER OF CONTAINERS

FILT. (Y/N)
PRESERV.
ANALYSIS REQUIRED

LEGEND FOR PRESERVATIVE
0 - NONE
1 - HCL
2 - HNO_3
3 - H_2SO_4
4 - $Na_2SO_3 + H_2SO_4$

SAMPLER OBSERVATIONS	LAB OBSERVATIONS

CHAIN OF CUSTODY CHRONICLE

1. Shuttle Opened By: (print) _____ Date: _____ Time: _____
   Signature: _____ Seal #: _____ Intact: _____
2. I have received these materials in good condition from the above person
   Name: _____ Signature _____
   Date: _____ Time: _____ Remarks: _____
3. I have received these materials in good condition from the above person.
   Name: _____ Signature _____
   Date: _____ Time: _____ Remarks: _____
4. Shuttle Sealed By: (print) _____ Date: _____ Time: _____
   Signature _____ Seal #: _____ Intact: _____

LAB USE ONLY Opened By: _____ Date: _____ Time: _____
SHUTTLE # _____ TEMP. °C _____ SEAL # _____ COND. _____ pH _____

REMARKS

SAMPLER'S SIGNATURE

LAB COPY

FIGURE 5.2 SAMPLE RECEIVING: LOG-IN CHECK LIST

ETC Santa Rosa

SANTA ROSA LABORATORY
SAMPLE RECEIVING: LOG-IN CHECK LIST

CLIENT: _____ DATE: _____ JOBLINK: _____

SAMPLE POINT ID(s): _____

SAMPLE RECEIVING CHECK LIST: (CHECK ALL THAT APPLY)

1) Custody Seal(s) ☐ Present ☐ Intact ☐ Absent ☐ Broken

2) Custody Seal #(s): _____

3) Air Bill #(s): _____

4) Chain-of-Custody: ☐ Present ☐ Absent #(s): _____

☐ Complete ☐ Incomplete #(s): _____

5) Temperature: _____ °C Corr Value ± _____ Therm #: _____

☐ Within Range (4 ± 2°C) ☐ Outside Range : _____

6) Sample Container(s): ☐ Intact ☐ Broken #(s) : _____

7) Cap(s): ☐ Intact ☐ Missing #(s) : _____

☐ Cracked #(s): _____

☐ Broken #(s): _____

8) Sample Volume: ☐ Sufficient ☐ Insufficient #(s) / Tests: _____

9) Label(s): ☐ Intact ☐ Missing / Illegible #(s): _____

10) COC vs. Container Labels ☐ Match ☐ Do not match: _____

11) Preservative: ☐ Correct ☐ Incorrect pH (#s): _____

12) Sampling Date(s): ☐ Present ☐ Absent/Incorrect #(s): _____

13) Matrix: ☐ Correct ☐ Incorrect #(s): _____

14) Other: _____

15) Air Bubbles ≥ 1/8" #(s) _____

16) Sample Receiving Completed: Comments: _____

(Signature / Date) _____

17) Sample Log-In Review: (Signature / Date) _____

PROBLEM RESOLUTION (INITIAL & DATE)

1) ☐ Program Manager Verbally Informed: (Date) _____

2) ☐ Client Informed: (Date) _____

3) ☐ Include in Executive Summary: (Date) _____

4) ☐ Sample(s) Placed on Hold: (Date) _____

5) ☐ Sample(s) Processed Per Contract or Pre-arrangement: _____

6) ☐ Resample Requested: _____

Program Manager: _____ (initials) _____ (date) ☐ Y ☐ N (received?)

Copy / Comments: _____

FIGURE 5.3 ORDER ENTRY/LOG-IN FORM

ETC

ORDER FORM

ACCT # _____ Due:

Facility Code: _____ TAT:

Contact: _____ Phone: _____

PO#: _____ FAX: _____

Joblink: _____ Received: _____

MF _____ - MF _____ WF _____ Ordered: _____

# OF JOBS	SAMPLING DATE	A-TYPE	PRICE	SAMPLE ID

COMMENTS

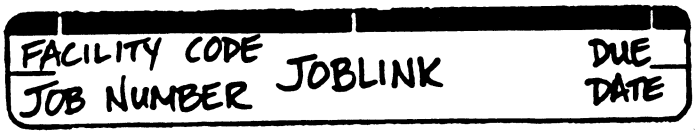
ORDER ENTRY	INVOICE

REVIEWED BY: _____ EDIT(S): _____

COMMENTS:

FIGURE 5.4 FILE FOLDER AND SAMPLE CONTAINER LABELS

FILE FOLDER LABEL



SAMPLE CONTAINER LABEL

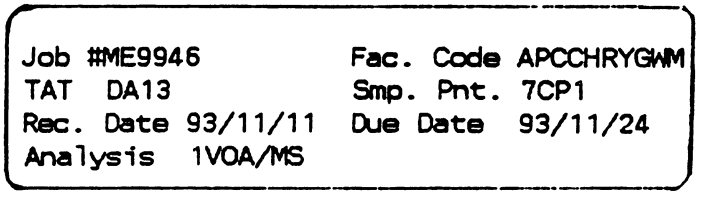


FIGURE 5.6 LAB SAMPLE CONTROL REPORT

TUE, JAN 11, 1994, 12:41 AM PAGE 1

ALL atypes, AA costcenter(s) Date last updated: 94/01/11 at 00:30
ETC/Santa Rosa **LAB SAMPLE CONTROL REPORT (CS05AD)**
Sorted by: DUEDATE, ACCOUNT, JOBNUMBER

Job No / <BekJob> / Facility	LogLink Xrnd / JobLink Team / SmpPnt	Due Date / Rec Date / Price	Hold Date	Src/Sent Locations	Atype	GeBatch	SP	MS	GC	AA	CV	PR	DN
Acctid: 1237071 FOTH & VAN DYKE													
MF1541-01	808458 DA15	94/01/06	94/01/17	MULT/BATT	1CD/I	s				S1222		NEED	
	810178 ST/ST	(93/12/22)	94/01/17	MULT/BATT	1CU/I	s				S1222		NEED	
FVDGRNBCNC	AB	300.00	94/01/17	MULT/BATT	1PB/I	s				S1222		NEED	
			94/01/17	MULT/BATT	1HG/CV	s				S1222		NEED	
			94/01/17	MULT/BATT	1ZN/I	s				S1222		NEED	
			94/01/17	MULT/BATT	1AL/I	s				S1222		NEED	
/SEE PROJECT-SPECIFIC METHODS/DLS./ /SEE SPECS. FOR CALCULATED PARAMETERS./ /TASK NUMBER 5.13 SURFACE WATERS./**/													
MF1542-01	808458 DA15	94/01/06	94/01/17	MULT/BATT	1CD/I	s				S1222		NEED	
	810178 ST/ST	(93/12/22)	94/01/17	MULT/BATT	1CU/I	s				S1222		NEED	
FVDGRNBCNC	V	300.00	94/01/17	MULT/BATT	1PB/I	s				S1222		NEED	
			94/01/17	MULT/BATT	1HG/CV	s				S1222		NEED	
			94/01/17	MULT/BATT	1ZN/I	s				S1222		NEED	
			94/01/17	MULT/BATT	1AL/I	s				S1222		NEED	
/SEE PROJECT-SPECIFIC METHODS/DLS./ /SEE SPECS. FOR CALCULATED PARAMETERS./ /TASK NUMBER 5.13 SURFACE WATERS./**/													
MF1543-01	808458 DA15	94/01/06	94/01/17	MULT/BATT	1CD/I	s				S1222		NEED	
	810178 ST/ST	(93/12/22)	94/01/17	MULT/BATT	1CU/I	s				S1222		NEED	
FVDGRNBCNC	Y	300.00	94/01/17	MULT/BATT	1PB/I	s				S1222		NEED	
			94/01/17	MULT/BATT	1HG/CV	s				S1222		NEED	
			94/01/17	MULT/BATT	1ZN/I	s				S1222		NEED	
			94/01/17	MULT/BATT	1AL/I	s				S1222		NEED	
/SEE PROJECT-SPECIFIC METHODS/DLS./ /SEE SPECS. FOR CALCULATED PARAMETERS./ /TASK NUMBER 5.13 SURFACE WATERS./**/													
MF1544-01	808458 DA15	94/01/06	94/01/17	MULT/BATT	1CD/I	s				S1222		NEED	
	810178 ST/ST	(93/12/22)	94/01/17	MULT/BATT	1CU/I	s				S1222		NEED	
FVDGRNBCNC	CC	300.00	94/01/17	MULT/BATT	1PB/I	s				S1222		NEED	
			94/01/17	MULT/BATT	1HG/CV	s				S1222		NEED	
			94/01/17	MULT/BATT	1ZN/I	s				S1222		NEED	
			94/01/17	MULT/BATT	1AL/I	s				S1222		NEED	
/SEE PROJECT-SPECIFIC METHODS/DLS./ /SEE SPECS. FOR CALCULATED PARAMETERS./ /TASK NUMBER 5.13 SURFACE WATERS./**/													
MF1545-01	808458 DA15	94/01/06	94/01/17	MULT/BATT	1CD/I	s				S1222		NEED	
	810178 ST/ST	(93/12/22)	94/01/17	MULT/BATT	1CU/I	s				S1222		NEED	
FVDGRNBCNC	CC-2	300.00	94/01/17	MULT/BATT	1PB/I	s				S1222		NEED	
			94/01/17	MULT/BATT	1HG/CV	s				S1222		NEED	
			94/01/17	MULT/BATT	1ZN/I	s				S1222		NEED	
			94/01/17	MULT/BATT	1AL/I	s				S1222		NEED	
/SEE PROJECT-SPECIFIC METHODS/DLS./ /SEE SPECS. FOR CALCULATED PARAMETERS./ /TASK NUMBER 5.13 SURFACE WATERS./**/													
---------- FVDGRNBCNC Facility Total: 5		1,500.00											
Account Daily Total: 5		1,500.00											
Daily Totals for 94/01/06 Jobcount: 5		1,500.00					0	0	0	30	0	30	0
Acctid: 1728083 UNOCAL CHEMICAL DIVISION													
MF1660-01	808480 DA11	94/01/10	93/11/29	MULT/	1CAN/MET					****		****	
	810208 ET/ET	(93/12/30)	93/12/27	MULT/	1AS/G	QG32581				NEED		NEED	
UCDRODEHZW	CONTROOMCW	238.00	93/12/27	MULT/	1HG/CV	QM32581				NEED		NEED	

TABLE 6.1 ETC - SANTA ROSA TEST METHODS

PARAMETER	EPA SW-846 Third Edition July 1992	EPA 600/4-79-020 EPA 600/4-82/057	Standard Methods 17th Edition	ASTM
VOLATILE ORGANIC METHODS BY GC OR GC/MS:				
Halogenated Volatile Organics	5030A/8010A	601	--	--
Aromatic Volatile Organics	5030A/8020	602	--	--
Volatile Fuel Hydrocarbons/Gasoline Range	5030A/8015Mod a)	--	--	--
GC/MS Volatile Organics	8240A/8260	624	--	--
EXTRACTABLE ORGANIC METHODS BY GC OR GC/MS:				
Separatory Funnel Extraction	3510A	--	--	--
Continuous Liquid/Liquid Extraction	3520A	--	--	--
Soxhlet Extraction	3540A	--	--	--
Sonication Extraction	3550A	--	--	--
Waste Dilution	3580	--	--	--
Phenols	8040A b)	604	--	--
Phthalate Esters	8060 b)	606	--	--
Nitrosamines	8070 b)	607	--	--
Organochlorine Pesticides	8080 b)	608	--	--
Polynuclear Aromatic Hydrocarbons	8270A b)	625	--	--
Chlorinated Hydrocarbons	8120 b)	612	--	--
Organophosphorus Pesticides	8140/8041 b)	614	--	--
Chlorinated Herbicides	8150A	--	--	--
Extractable Fuel Hydrocarbons/Diesel Range	8015 Mod b),a)	--	--	--
GC/MS Semivolatile Organics	8270A b)	625	--	--
LEACHATE EXTRACTION METHODS:				
TCLP Extraction	1311	--	--	--
EP Tox Extraction	1310A	--	--	--
CAM WET Extraction	c)	--	--	--

TABLE 6.1 ETC - SANTA ROSA TEST METHODS

PARAMETER	EPA SW-846 Third Edition July 1992	EPA 600/4-79-020 EPA 600/4-82/057	Standard Methods 17th Edition	ASTM
METALS METHODS:				
Dissolved Metals Prepartion	3005A	200	--	--
Total metals digestion - ICP	3010A	200	--	--
Total Metals Digestion - GFAA	3020A	200	--	--
Total Metals Digestion - Solids	3050A	--	--	--
Aluminum	6010A	200.7/202.2	--	--
Antimony	6010A/7041	200.7/204.2	--	--
Arsenic	6010A/7060	200.7/206.2	--	--
Barium	6010A/7081	200.7	--	--
Beryllium	6010A/7091	200.7/210.2	--	--
Cadmium	6010A/7131	200.7/213.2	--	--
Calcium	6010A	200.7	--	--
Chromium	6010A/7191	200.7/218.2	--	--
Cobalt	6010A/7201	200.7	--	--
Iron	6010A	200.7	--	--
Copper	6010A/7211	200.7/220.2	--	--
Lead	6010A/7421	200.7/239.2	--	--
Magnesium	6010A	200.7	--	--
Manganese	6010A	200.7	--	--
Mercury	7470/7471	245.1	--	--
Molybdenum	6010A/7481	200.7	--	--
Nickel	6010A	200.7/249.2	--	--
Potassium	6010A	200.7	--	--
Selenium	6010A/7740	200.7/270.2	--	--
Silver	6010A/7761	200.7/272.2	--	--
Sodium	6010A	200.7	--	--
Thallium	6010A/7841	200.7/279.2	--	--
Titanium	6010A	200.7	--	--
Vanadium	6010A/7911	200.7	--	--
Zinc	6010A	200.7	--	--

TABLE 6.1 ETC - SANTA ROSA TEST METHODS

PARAMETER	EPA SW-846 Third Edition July 1992	EPA 600/4-79-020 EPA 600/4-82/057	Standard Methods 17th Edition	ASTM
CONVENTIONAL WET METHODS:				
Acidity	--	305.1	--	--
Alkalinity	--	310.1	--	--
Ash	--	--	--	D482
BTU	--	--	--	D240
Chloride	9252/9056	325.3/300.0 d)	--	--
Chemical Oxygen Demand	--	410.4	--	--
Corrosivity	1110	--	--	--
Cyanide, Reactive	7.3.3.2/9010A	--	--	--
Cyanide, Total and Amenable to Chlorination	9010A	335.2/335.1	--	--
Hexavalent Chromium	7196A e)	--	--	--
Density	--	--	2520 C 2710 F	--
Fluoride	--	340.2/300.0 d)	--	--
Hardness	--	130.2	--	--
Ignitability, Pensky-Martin	1010	--	--	--
Moisture	--	--	2540 B	--
Ammonia	--	350.2	--	--
Nitrate	9056	352.1/300.0 d)	--	--
Nitrite	9056	354.1/300.0 d)	--	--
Nitrogen, Total Kjeldahl	--	351.3	--	--
Oil & Grease, Extraction Method for Sludge Samples	9071	--	--	--
Oil & Grease, Total Recoverable, Gravimetric	9070	413.1	--	--
Oil & Grease, Total Recoverable, by IR	9070	413.2	--	--
Petroleum Hydrocarbons, Total Recoverable	--	418.1	--	--
Paint Filter Liquids	9095	--	--	--
pH	9040/9045	150.1	--	--
Phenolics, Total Recoverable	9065	420.1	--	--
Phosphate, Ortho-	9056	365.3/300.0 d)	--	--
Phosphorous, Total	9056	365.3	--	--
Salinity	--	--	2520	--

TABLE 6.1 ETC - SANTA ROSA TEST METHODS

PARAMETER	EPA SW-846 Third Edition July 1992	EPA 600/4-79-020 EPA 600/4-82/057	Standard Methods 17th Edition	ASTM
Specific Conductance	9050	120.1	--	--
Sulfate	9038	375.4/300.0 d)	--	--
Solids, Total	--	160.3	2540 B	--
Solids, Total Dissolved	--	160.1	2540 C	--
Solids, Total Suspended	--	160.2	2540 D	--
Solids, Total Settleable	--	160.5	2540 F	--
Solids, Total Volatile	--	160.4	2540 E,G	--
Solids, Volatile Suspended	--	160.4	2540 E,G	--
Sulfide, Reactive	7.3.4.2/9030A	--	--	--
Sulfide, Total	9030A	--	--	--
Sulfur	5050/9038 f)	--	--	--
Temperature	--	170.1	--	--
Total Organic Carbon	9060	415.1	--	--
Total Suspended Particulates	g)	--	--	--
Turbidity	--	180.1	--	--
Total Halogens	5050/9252 f)	--	--	D808

a) California LUFT Manual methods, alternately, other state requirements: Alaska, Washington, Wisconson DRO/GRO (Gasoline Range Organics/Diesel Range Organics) methods may be used.
b) Method must be preceded by extraction method 3510, 3520, 3540, 3550, or 3580 (waste dilution).
c) Title 22, California Code of Regulations, Section 66261, Appendix II.
d) Method 300.0, by ion chromatograph has not yet been approved for CWA analysis in 40 CFR part 136.2..
e) Method 3060, from SW-846 Second Edition, is used for soil digests.
f) Method 5050 is part of Proposed Update II, November 1992.
g) NIOSH Method 0500.

TABLE 7.1 ETC - SANTA ROSA EQUIPMENT LIST

INSTRUMENT	MANUFACTURER	MODEL	YEAR ACQUIRED	SERIAL #
GC/MS (P&T)	HEWLETT PACKARD	5995	1990	2413A00508
GC/MS	HEWLETT PACKARD	5890A (GC) 5970 (MSD)	1986 1986	2623A08475 2623A01328
GC/MS (P&T)	HEWLETT PACKARD	5890A (GC) 5970 (MSD)	1991 1991	2843A21140 2905A11730
GC/MS	HEWLETT PACKARD	5890 II (GC) 5970B (MSD)	1991 1991	3033A31770 3004A12715
GC/MS	HEWLETT PACKARD	5890II (GC) 5970 (MSD)	1992 1992	3108A34489 3034A12967
'M' GC (ECD/NPD)	HEWLETT PACKARD	5890	1991	2750A14787
'D' GC (ECD/FID)	HEWLETT PACKARD	5890	1992	2750A17756
'G' GC (ELCD/FID)	HEWLETT PACKARD	5890	1991	2750A16570
'N' GC (ECD)	HEWLETT PACKARD	5890	1987	2643A11620
'B' GC (ECD/NPD)	HEWLETT PACKARD	5890	1987	2728A14106
'A' GC (ELCD/PID)	HEWLETT PACKARD	5890	1987	2643A11030
'C' GC (FID)	VARIAN	3700	1981	3740-9215
'E' GC (FID/PID)	VARIAN	3300	1985	3300-2689
GC (FID/FID)	HEWLETT PACKARD	5890 II	1993	3310A49125
GC (FID)	HEWLETT PACKARD	5890 II	1993	3310A47239
ECD	HEWLETT PACKARD	-	1992	L7765
ECD	HEWLETT PACKARD	-	1987	F1667
ECD	HEWLETT PACKARD	-	1991	L3053
ECD	VARIAN	-	1986	A3523
ECD	VARIAN	-	1987	A6378
ECD	VARIAN	-	1986	A4776
NPD	HEWLETT PACKARD	5890	1992	A2487
NPD	HEWLETT PACKARD	5890	1990	-
ELCD	OI	4420	1985	539-6-324
ELCD	OI	4420	1985	225-2-8603
ELCD/PID	OI	PI-52	1991	720045
ELCD/PID	OI	PI-52	1989	04697
PID	TRACOR	703	1990	864301
FID	VARIAN	3300	1981	-
FID	VARIAN	3400	1986	-
FID	VARIAN	3700	1990	-

TABLE 7.1 ETC - SANTA ROSA EQUIPMENT LIST

INSTRUMENT	MANUFACTURER	MODEL	YEAR ACQUIRED	SERIAL #
FID	HEWLETT PACKARD	5890	1989	-
P&T AUTOSAMPLER	TEKMAR	ALS 2016	-	91298032
P&T AUTOSAMPLER	TEKMAR	ALS 2016	-	872655008
P&T AUTOSAMPLER	TEKMAR	ALS 2016	-	91031003
P&T AUTOSAMPLER	TEKMAR	ALS 2016	-	-
P&T AUTOSAMPLER	TEKMAR	ALS 2016	-	-
P&T AUTOSAMPLER AUTOSAMPLER CONTROL	OI	- 4560	1993 1993	329235 -
HPLC	HEWLETT-PACKARD	1050	1993	3033A00266 3107A00701 3019G00746
FLUORESCENCE DETECTOR (HPLC)	HEWLETT-PACKARD	1046A	1993	3016G01541
GFAA	VARIAN	SPECTRA AA-30	1990	5111622
GFAA	VARIAN	ZEEMAN AA400Z	1989	90111167
GFAA	PERKIN ELMER	PEZ5100PC	1991	136701
ICP - AES	LEEMAN LAB	PS-1	1986	291A
ICP - AES	THERMAL JARREL ASH	12943200 6100E	1990	15090
VIS SPECTROPHOTOMETER	MILTON ROY	SPEC 200	1985	3221191033
UV SPECTROPHOTOMETER	MILTON ROY	SPEC 200	1985	3322123056
FTIR	MATSON	2020	1987	890609
UV SPECTROPHOTOMETER	VARIAN	DMS-80	1985	9011081
VIS SPECTROPHOTOMETER	HACH	DR3000	1985	870701253
ION CHROMATOGRAPH	DIONEX	DX-300	1991	914804
TOC	DOHRMAN	DOHRMAN 80	1985	-
BALANCE	FISHER	7224DA	1987	23867
BALANCE	SARTORIUS	2432	1987	2803056
BALANCE	METTLER	AE100	1987	D81492
BALANCE	TOLEDO	2020-0003	1987	7101878-77R
BALANCE	SARTORIUS	B3100S	1989	40030010
BALANCE	SARTORIUS	B3100S	1989	40080062A
BALANCE	METTLER	AJ100	1990	H60638
BALANCE	SARTORIUS	BA4100S	1993	30804889
CONDUCTANCE METER	YSI SCIENTIFIC	YSI 32	1985	3704
TURBIDIMETER	HF SCIENTIFIC	DRT 100B	1985	18913

TABLE 7.1 ETC - SANTA ROSA EQUIPMENT LIST

INSTRUMENT	MANUFACTURER	MODEL	YEAR ACQUIRED	SERIAL #
pH/ION METER	FISHER	ACCUMET 925	1989	10500174
pH METER	FISHER	ACCUMET 825 MP	1989	2138
BOMB CALIMETER	PARR	BOMB 1261	1987	338
ION SELECTIVE ELECTRODES	VARIOUS	-	-	-
OVEN	PRECISION	16	1987	21-AP/2
OVEN	FISHER	IOSTEMP 500	1990	91200527
OVEN	FISHER	IOSTEMP 200 G	1987	000046-C
OVEN	PRECISION	2	1985	22-AN/3
OVEN	VWR	1510E	1990	000012-C
GPC	ABC	AUTOVAP AS2000	1991	AS0139118-9118
CENTRIFUGE	FISHER	CENTRIFIC 225	1985	3858
CENTRIFUGE	DAMON	HN-SII	1987	285510455
WATERBATH	BLUE M	MW-1130A-1	1990	MW-1648
WATERBATH	BLUE M	MW-1120A-1	1990	MW-6031
WATERBATH	BLUE M	MW-1120A-1	1990	MW-6035
NEVAP	ORGANOMOTOR	111	1990	8801
NEVAP	ORGANOMOTOR	111	1990	7189

TABLE 7.2 QC FREQUENCY, CRITERIA, AND CORRECTIVE ACTION

EPA METHOD*	QC PROCEDURE	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	COMMENTS
8021 GC	1. Initial 5-point Calibration	1. Initial instrument/column; when CCV fails	1. RSD < 20% for all target compounds except gases	1. Rerun before samples	Internal Standard limits 50-200% of RF for last curve. Both columns fully calibrated, used interchangeably. Capillary column method.
	2. ICV/CCV	2. Initial, every 10 samples	2. RPD < 15% from last 5-point cal all target compounds except gases	2. Rerun 5-point curve before samples	
	3. Method Blank	3. Each batch of ≤ 20	3. Results < PQL for target analytes, < x5 PQL for common lab contaminants ($MeCl_2$)	3. Correct cause of interference, rerun batch.	
	4. Blank Spike	4. Each batch of ≤ 20	4. Table 3.1	4. Check MS and MSD. If both are out, rerun batch.	
	5. MS/MSD	5. Each batch of ≤ 20	5. Table 3.1	5. Check blank spike, if okay, and RPD within limits, matrix interference suspect; report.	
	6. Surrogate Spike	6. Each Sample	6. Table 3.1	6. Rerun sample. If still out, matrix intereference suspect; report.	
8080 Single Pesti-cides GC	1. Initial 5-point Calibration	1. Initial instrument/column; when CCV fails	1. RSD < 20% for all target compounds	1. Rerun before samples	Internal standard limits 50-200% of RF for last curve. Both columns fully calibrated, used interchangeably.
	2. ICV/CCV	2. Initial, every 10 samples	2. RPD < 15% from last 5-point cal all target compounds	2. Rerun 5-point curve before samples	
	3. DDT/Endrin degredation check	3. Once per day of analysis	3. DDT/Endrin degradation < 20%	3. Change column	
	4. Method Blank	4. Each batch of ≤ 20	4. Results < PQL for target analytes	4. Correct cause of interference, Re-extract, re-run batch.	
	5. Blank Spike	5. Each batch of ≤ 20	5. Table 3.1	5. Check MS and MSD. If both are out, Re-extract, re-run batch.	
	6. MS/MSD	6. Each batch of ≤ 20	6. Table 3.1	6. Check blank spike, if okay, and RPD within limits, matrix interference suspect; report.	
	7. Surrogate Spike	7. Each Sample	7. Table 3.1	7. Re-extract, re-run sample. If still out, matrix intereference suspect; report.	

TABLE 7.1 QC FREQUENCY, CRITERIA, AND CORRECTIVE ACTION

EPA METHOD*	QC PROCEDURE	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	COMMENTS
8080 PCBs Chlordane Toxaphene GC	1. Initial 5-point with 7 cogeners/isomers quantified.	1. Initial instrument/column; when CCV fails	1. RSD < 20% for 5 or more cogeners/isomers	1. Rerun before samples	Internal standard limits 50-200% of RF for last curve. Both columns fully calibrated, used interchangeably. Capillary column method.
	2. ICV/CCV	2. Initial, every 10 samples	2. RPD < 15% for 5 or more cogeners/isomers	2. Rerun 5-point curve before samples	
	3. Method Blank	3. Each batch of ≤ 20	3. Results < PQL for target analytes	3. Correct cause of interference, Re-extract, re-run batch.	
	4. Blank Spike	4. Each batch of ≤ 20	4. Table 3.1	4. Check MS and MSD. If both are out, Re-extract, re-run batch.	
	5. MS/MSD	5. Each batch of ≤ 20	5. Table 3.1	5. Check blank spike, if okay, and RPD within limits, matrix interference suspect; report.	
	6. Surrogate Spike	6. Each Sample	6. Table 3.1	6. Re-extract, re-run sample. If still out, matrix intereference suspect; report.	
8140M 507 531.1 547 548 549 619 GC	1. Initial 5-point Calibration	1. Initial instrument/column; when CCV fails	1. RSD < 20% for all target compounds	1. Rerun before samples	Internal standard limits 50-200% of RF for last curve. Both columns fully calibrated. Capillary column method.
	2. ICV/CCV	2. Initial, every 10 samples	2. RPD < 15% from last 5-point cal all target compounds	2. Rerun 5-point curve before samples	
	3. Method Blank	3. Each batch of ≤ 20	3. Results < PQL for target analytes	3. Correct cause of interference, Re-extract, re-run batch.	
	4. Blank Spike	4. Each batch of ≤ 20	4. Table 3.1	4. Check MS and MSD. If both are out, Re-extract, re-run batch.	
	5. MS/MSD	5. Each batch of ≤ 20	5. Table 3.1	5. Check blank spike, if okay, and RPD within limits, matrix interference suspect; report.	
	6. Surrogate Spike	6. Each Sample	6. Table 3.1	6. Re-extract, re-run sample. If still out, matrix intereference suspect; report.	

TABLE 7.2 QC FREQUENCY, CRITERIA, AND CORRECTIVE ACTION

EPA METHOD*	QC PROCEDURE	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	COMMENTS
8150 GC	1. Initial 5-point Calibration	1. Initial instrument/column; when CCV fails	1. RSD < 20% for all target compounds	1. Rerun before samples	Internal standard limits 50-200% of RF for last curve. Both columns fully calibrated. Capillary column method. Extracts may be rederivatized if Blank Spike, MS, MSD, or surrogates fail.
	2. ICV/CCV	2. Initial, every 10 samples	2. RPD < 15% from last 5-point cal all target compounds	2. Rerun 5-point before samples	
	3. Method Blank	3. Each batch of ≤ 20	3. Results < PQL for target analytes, < x5 PQL for common lab contaminants	3. Correct cause of interference, Re-extract, re-run batch.	
	4. Blank Spike	4. Each batch of ≤ 20	4. Table 3.1	4. Check MS and MSD. If both are out, Re-extract, re-run batch.	
	5. MS/MSD	5. Each batch of ≤ 20	5. Table 3.1	5. Check blank spike, if okay, and RPD within limits, matrix interference suspect; report.	
	6. Surrogate Spike	6. Each Sample	6. Table 3.1	6. Re-extract, re-run sample. If still out, matrix intereference suspect; report.	
8260 GC/MS	1. Initial 5-point Calibration	1. Initial instrument/column; when CCV fails	1. RSD < 30% CCCs, RF >0.3 for SPCCs	1. Rerun before samples	Internal standard limits 50-200% of average RF of last 5-point; RT ± 30 sec from last CCV. Capillary column method. Refrigerator blanks run daily.
	2. ICV/CCV	2. Initial, every 12 hr	2. CCC RFs < 25% RPD of last 5-point cal, SPCC > 0.3 RF	2. Rerun 5-point before samples	
	3. BFB tune	3. Initial, every 12 hr	3. Abundance criteria all okay	3. Rerun before samples	
	4. Method Blank	4. Each batch of ≤ 20	4. Results < PQL for target analytes, < x5 PQL for common lab contaminants ($MeCl_2$)	4. Correct cause of interference, rerun batch.	
	5. Blank Spike	5. Each batch of ≤ 20	5. Table 3.1	5. Check MS and MSD. If both are out, rerun batch.	
	6. MS/MSD	6. Each batch of ≤ 20	6. Table 3.1	6. Check blank spike, if okay, and RPD within limits, matrix interference suspect; report.	
	7. Surrogate Spike	7. Each Sample	7. Table 3.1, two out of three surrogates must be within limits	7. Rerun sample. If still out, matrix intereference suspect; report.	

TABLE 7.1 QC FREQUENCY, CRITERIA, AND CORRECTIVE ACTION

EPA METHOD*	QC PROCEDURE	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	COMMENTS
8270 GC/MS	1. Initial 5-point Calibration	1. Initial instrument/column; when CCV fails	1. RSD < 30% CCCs, RF >0.05 for SPCCs	1. Rerun before samples	Internal standard limits 50-200% of average RF of last 5-point; RT ± 30 sec from last CCV.
	2. ICV/CCV	2. Initial, every 12 hr	2. CCC RFs < 25% RPD of last 5-point cal, SPCC > 0.05 RF	2. Rerun 5-point before samples	
	3. DFTPP tune	3. Initial, every 12 hr	3. Abundance criteria all okay	3. Rerun before samples	
	4. Method Blank	4. Each batch of ≤ 20	4. Results < PQL for target analytes, < x5 PQL for common lab contaminants (phthalates)	4. Correct cause of interference, rerun batch.	
	5. Blank Spike	5. Each batch of ≤ 20	5. Table 3.1	5. Check MS and MSD. If both are out, rerun batch.	
	6. MS/MSD	6. Each batch of ≤ 20	6. Table 3.1	6. Check blank spike, if okay, and RPD within limits, matrix interference suspect; report.	
	7. Surrogate Spike	7. Each Sample	7. Table 3.1, two out of three acid surrogates and two out of three B/N surrogates must be within limits	7. Rerun sample. If still out, matrix intereference suspect; report.	
200.7 6010 ICP	1. Initial 2-point calibration	1. Each 8 hour shift	1. Manufacturer's specification; high standard must be > 10x PQL	1. Rerun before samples	
	2. ICV/CCV	2. Initial, every 10 samples, end of run	2. 90-110% of expected value	2. Rerun before samples	
	3. ICB/CCB	3. Initial, every 10 samples, end of run	3. ± PQL	3. Rerun before samples	
	4. Interference Check A and AB (ICA and ICAB)	4. Each 8 hour shift and end of run	4. 80-120% of expected value	4. Rerun before samples	
	5. CRI Standard	5. Each 8 hour shift and end of run	5. Report only	5. None	
	6. Method Blank	6. Each batch of ≤ 20	6. Results < PQL for target analytes, < x5 PQL for common lab contaminants	6. Correct cause of interference, redigest, rerun batch.	
	7. Blank Spike	7. Each batch of ≤ 20	7. Table 3.1	7. Check MS and MSD. If both are out, redigest, rerun batch.	
	8. MS/MSD	8. Each batch of ≤ 20	8. Table 3.1	8. Check blank spike, if okay, and RPD within limits, matrix interference suspect; report.	

TABLE 7.2 QC FREQUENCY, CRITERIA, AND CORRECTIVE ACTION

EPA METHOD*	QC PROCEDURE	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	COMMENTS
200 series 7000 series GFAA	1. Initial 4-point or 5-point calibration	1. Each day of analysis	1. Coefficient $\geq$ 0.995	1. Rerun before samples	Number of points in calibration curve dependent on instrumentation used.
	2. ICV/CCV	2. Initial, every 10 samples, end of run	2. 85-115% of expected value	2. Rerun before samples	
	3. ICB/CCB	3. Initial, every 10 samples, end of run	3. $\pm$ PQL	3. Rerun before samples	
	4. CRA Standard	4. Each day of analysis	4. Report only	4. None	
	5. Method Blank	5. Each batch of $\leq$ 20	5. Results < PQL for target analytes, < x5 PQL for common lab contaminants	5. Correct cause of interference, redigest, rerun batch.	
	6. Blank Spike	6. Each batch of $\leq$ 20	6. Table 3.1	6. Check MS and MSD. If both are out, redigest, rerun batch.	
	7. MS/MSD	7. Each batch of $\leq$ 20	7. Table 3.1	7. Check blank spike, if okay, and RPD within limits, matrix interference suspect; report.	
245.1 7470 7471 CVAA	1. Initial 5-point calibration	1. Each day of analysis	1. Coefficient $\geq$ 0.995	1. Rerun before samples	
	2. ICV/CCV	2. Initial, every 10 samples	2. 85-115% of expected value	2. Rerun before samples	
	3. Method Blank	3. Each batch of $\leq$ 20	3. Results < PQL	3. Correct cause of interference, redigest, rerun batch.	
	4. Blank Spike	4. Each batch of $\leq$ 20	4. Table 3.1	4. Check MS and MSD. If both are out, redigest, rerun batch.	
	5. MS/MSD	5. Each batch of $\leq$ 20	5. Table 3.1	5. Check blank spike, if okay, and RPD within limits, matrix interference suspect; report.	

TABLE 7.1 QC FREQUENCY, CRITERIA, AND CORRECTIVE ACTION

EPA METHOD*	QC PROCEDURE	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	COMMENTS
9010 365.3 410.4 UV/Vis Spec	1. Initial 5-point calibration	1. Initial, when CCV fails.	1. Correlation coefficient $\geq$ 0.995	1. Rerun before samples	
	2. ICV/CCV	2. Initial, every 10 samples	2. 90 - 110% of expected value	2. Rerun 5-point curve before samples	
	3. ICB/CCB	3. Initial, every 10 samples	3. $\pm$ PQL	3. Rerun before samples	
	4. Method Blank	4. Each batch of $\leq$ 20	4. Results < PQL	4. Correct cause of interference, rerun batch.	
	5. Blank Spike	5. Each batch of $\leq$ 20	5. Table 3.1	5. Check MS and MSD. If both are out, rerun batch.	
	6. MS/MSD	6. Each batch of $\leq$ 20	6. Table 3.1	6. Check blank spike, if okay, and RPD within limits, matrix interference suspect; report.	
413.2 FTIR	1. Initial 5-point calibration	1. Quarterly	1. Correlation coefficient $\geq$ 0.995	1. Rerun before samples	
	2. Two point verification	2. Once per batch	2. 95 - 105% of expected value	2. Rerun before samples	
	3. ICB/CCB	3. Initial, every 10 samples	3. $\pm$ PQL	3. Rerun before samples	
	4. Method Blank	4. Each batch of $\leq$ 20	4. Results < PQL	4. Correct cause of interference, rerun batch.	
	5. Blank Spike	5. Each batch of $\leq$ 20	5. Table 3.1	5. Check MS and MSD. If both are out, rerun batch.	
	6. MS/MSD	6. Each batch of $\leq$ 20	6. Table 3.1	6. Check blank spike, if okay, and RPD within limits, matrix interference suspect; report.	

TABLE 7.2 QC FREQUENCY, CRITERIA, AND CORRECTIVE ACTION

EPA METHOD*	QC PROCEDURE	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	COMMENTS
300.0 IC	1. Initial 5-point calibration	1. Quarterly	1. Correlation coefficient $\geq$ 0.995	1. Rerun before samples	
	2. ICV/CCV	2. Initial, every 10 samples, end of run	2. 90-110% of expected value	2. Rerun before samples	
	3. ICB/CCB	3. Initial, every 10 samples, end of run	3. $\pm$ PQL	3. Rerun before samples	
	4. Method Blank	4. Each batch of $\leq$ 20	4. Results < PQL	4. Correct cause of interference, rerun batch.	
	5. Blank Spike	5. Each batch of $\leq$ 20	5. Table 3.1	5. Check MS and MSD. If both are out, rerun batch.	
	6. MS/MSD	6. Each batch of $\leq$ 20	6. Table 3.1	6. Check blank spike, if okay, and RPD within limits, matrix interference suspect; report.	
120.1 Cond Meter	1. 1-point calibration with NIST std.	1. Once per batch	1. 98 - 102% expected value	1. Adust instrument, rerun before samples	Bracket 2-point verification as necessary.
	2. 2-point verification	2. Once per batch	2. 90 - 110% of expected value	2. Rerun calibration before samples	
	3. Method Blank	3. Each batch $\leq$ 20	3. Results < PQL	3. Correct cause of interference, rerun batch	
	4. Replicates	4. Each batch $\leq$ 20	4. Table 3.1	4. Rerun replicates	
150.1 9040 9045 pH meter	1. 3 buffers to calibrate, 4-7 and 7-10, 5-point for F^-	1. Daily	1. Manufacturer's specification, >0.995 correlation coefficient for F^-	1. Rerun before samples	
	2. Replicates	2. Each batch $\leq$ 20	2. Table 3.1	2. Rerun batch	
130.2 310.1 350.2 351.3 Std Sol'n	1. H_2SO_4, NaOH Standardization	1. Once per batch	1. Within 5% of expected	1. Reprepare standard, restandardize, rerun batch	
	2. Method Blank	2. Each batch of $\leq$ 20	2. Results < PQL	2. Correct cause of error, rerun batch.	
	3. Blank Spike	3. Each batch of $\leq$ 20	3. Table 3.1	3. Check MS and MSD. If both are out, rerun batch.	
	4. MS/MSD	4. Each batch of $\leq$ 20	4. Table 3.1	4. Check blank spike, if okay, and RPD within limits, matrix interference suspect; report.	

TABLE 7.1 QC FREQUENCY, CRITERIA, AND CORRECTIVE ACTION

EPA METHOD*	QC PROCEDURE	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION	COMMENTS
180.1 Turbidity Meter	1. 3-point calibration (primary)	1. Once per batch	1. Within 5% of expected	1. Rerun before samples	
	2. 3-point calibration (secondary)	2. Once per batch	2. Within 5% of expected	2. Rerun before samples	
Balances	1. Weigh S-weight	1. Daily	1. Manufacturer's criteria (inside notebook)	1. Call for balance service	
	2. Contract service	2. Yearly	2. Manufacturer's criteria	1. Repair balance or remove from use	
Refrigerators; Freezers	1. Temperature Reading	1. Daily	1. 4°C ± 2 for refrigerators, -15°C ± 2 for freezers	1. Defrost if necessary, call for service, move items to correct temperature	
S-Weights	1. Calibrated against NIST weights	1. Yearly	1. ASTM Method S-weight standard	1. Remove from use	
Thermometers	1. Lab therm. calibrated against NIST	1. Yearly	1. Must compare with expected temperature	1. Note correction on thermometer tag	
	2. NIST calibrated	2. Yearly	2. Must compare with expected temperature	2. Use corrected temperature when calibrating lab thermometers	

* Please see Table 6.1 for cross reference of parameters and EPA method numbers. This table describes most commonly used methods used at ETC - Santa Rosa. For methods not given, please contact the labortory for specific criteria.

ABBREVIATIONS:

BFB = Bromofluorobenzene
B/N = Base/Neutral
CCB = Continuing Calibration Blank
CCC = Calibration Check Compounds (GC/MS)
CCV = Continuing Calibration Verification
CRA = Standard at level of Contract Required Detection Limits for GFAA
CRI = Standard at level of Contract Required Detection Limits for ICP
CVAA = Cold Vapor Atomic Absorption
DFTPP = Decafluorotriphenylphosphine
FTIR = Fourier Transformation Infra-Red
GC = Gas Chromatogram
GC/MS = Gas Chromatogram/Mass Spectrophotometer
GFAA = Graphite Furnace Atomic Absorption
IC = Ion Chromatograph
ICB = Initial Calibration Blank
ICP = Inductively Coupled Plasma
ICV = Initial Calibration Verification
MS = Matrix Spike
MSD = Matrix Spike Duplicate
RSD = Relative Standard Deviation (in percent)
RPD = Relative percent difference
SPCC = System Performance Check Compounds (GC/MS)
UV/Vis Spec = Ultraviolet/Visible Spectrophotometer

TABLE 8.1 ETC - SANTA ROSA INSTRUMENT MAINTENANCE

INSTRUMENT	MAINTENANCE PROCEDURE	FREQUENCY
GC	1. Clip and/or change columns 2. Change liners 3. Change septums 4. Replace bead in NPD detector 5. Change transfer line in ELCD 6. Clean ELCD cell	As needed
	1. Clean PID lamps 2. Change traps on P&T systems	Monthly
	1. Replace nickel tubes on ELCD	Quarterly
	1. Clean and perform wipe test on ECDs 2. Change resins on ELCD detectors 3. Clean FIDs	Semi-annually
	1. Change cartridges and traps on gas lines 2. Vacuum dust from boards 3. Check electronics 4. Call for contract service preventative maintenance	Yearly
GC/MS	1. Clip and/or replace columns 2. Change liners 3. Change septums	As needed
	1. Check oil in mechanical pump 2. Run autotune and file final report in permanent log book	Weekly
	1. Check and refill calibration vial with PFFBA	Quarterly
	1. Clean source 2. Change oil in mechanical pump	Semi-annually
	1. Vacuum dust from grills of the two fans 2. Change oil in turbomolecular pump 3. Check electronics 4. Call fro contract service preventative maintanance	Yearly
ICP	1. Check that the nebulizer is producing a fine dense mist withou sputtering, and that droplets are not forming on the spray chamber walls. Clean nebulizer and spray changer if necessary. 2. Check the peristalic pump tubing. Replace if worn. 3. Keep the instrument and autosampler clean. Wipe up spills immediately. Brush-off or vacuum dust. 4. Clean and lubricate the autosampler traverse rods.	Daily
	1. Dissassemble and clean the nebulizer, spray chamber, and torch assembly. 2. Clean the cooling fan dust screens. 3. Check the cooling water level. Fill if necessary.	Weekly
	1. Clean and lubricate the peristaltic pump rollers. 2. Vacuum the recirculating pump's air intake screen. 3. Clean the instrument and autosampler thoroughly with spray cleaner and sponge.	Monthly
	1. Drain and refil vacuum pump oil. 2. Drain and refill cooling water. 3. Replace torch and/or nebulizer if necessary. 4. Check and clean optics of possible.	Quarterly
	1. Call for contract service preventative maintenance.	Yearly

TABLE 8.1 ETC - SANTA ROSA INSTRUMENT MAINTENANCE

INSTRUMENT	MAINTENANCE PROCEDURE	FREQUENCY
GFAA	1. Check tube condition. Replace if necessary. 2. Keep the instrument and autosampler clean. Wipe up spills immediately. Brush-off or vacuum dust. 3. Clean the work head with cotton tipped applicator and D.I. water. 4. Check sample delivery tube tip for proper "beading" effect. Snip end or replace if necessary.	Daily
	1. Clean windows in optical path. 2. Check the cooling water level. Fill if necessary.	Weekly
	1. Clean the instrument and autosampler thoroughly with spray cleaner and sponge. 2. Vacuum dust from cooling fans on instrument and computer.	Monthly
	1. Drain and refill cooling water. 2. Replace electrodes.	Quarterly
	1. Call for contract service preventative maintenance.	Yearly
UV/Vis Spec	Clean and/or replace parts	As needed
FTIR	Clean and/or replace parts	As needed
Ion Chromatograph	Clean and/or replace parts	As needed
TOC	Clean and/or replace parts	As needed
Conductance meter	Clean and/or replace parts	As needed
Turbidimeter	Clean and/or replace parts	As needed
pH/Ion meter	Clean and/or replace parts	As needed
pH meter	Clean and/or replace parts	As needed

ABBREVIATIONS:

ECD = Electron Capture Detector
ELCD = Electolytic Conductivity Detector (Hall detector)
FTIR = Fourier Transformation Infra-red Spectrophotometer
GC = Gas Chromatograph
GC/MS = Gas Chromatograph/Mass Spectrometer
GFAA = Graphite Furnace Atomic Absorption
ICP = Inductively Coupled Plasma
NPD = Nitrogen/Phosphorous-specific Detector
PID = Photoionization Detector
TOC = Total Organic Carbon analyzer
UV/Vis Spec = Ultraviolet/Visable Spectrophotometer

TABLE 10.1 DATA VALIDATION

LEVEL OF VALIDATION	QUALITY CONTROL CHECKS	EVALUATION FOR ACCEPTING DATA ACCORDING TO CRITERIA IN TABLE 7.1
I. Instrument run validation	Initial calibration Calibration verifications Calibration blanks Interference check Endrin/DDT check Tunes	No data is acceptable after failed QC, problem must be corrected and QC rerun until acceptable.
II. Batch validation	Method Blank	If all samples are ND, point incidence, data reportable. For sample results > 10 x method blank result, data reportable. For all others, batch data not acceptable.
	QC Spike	Batch data not acceptable unless recovery is marginally above upper limits and all samples are ND.
	Matrix Spike	If QC spike is acceptable and RPDs are acceptable, matrix interference is suspect and data is reported. If samples are soils, heterogeneity may be suspect. For others, batch data not acceptable.
	Matrix Spike Duplicate Replicate	If sample is soil and spike recoveries are within limits, heterogeneity is suspect, data is reportable. If sample matrix is aqueous batch data is not acceptable.
III. Sample validation (all analysis types)	Holding times Preservative	See Table 4.1. Sample results not acceptable if improper preservative is used or if it is extracted and/or analyzed out of regulator-established hold time.
IV. Sample validation (organic analysis)	Internal Standards Surrogates	Sample data may be acceptable if matrix interference can be shown by repeatable results or similar effects with matrix spikes. For other samples, data not acceptable.

FIGURE 10.2 SAMPLE REPORT

ETC
Santa Rosa

An ETC Laboratory

320 Tesconi Circle

Suite G

Santa Rosa, CA
95401

Telephone
(707) 544-5570

Facsimile
(707) 544-4906

DECEMBER 29, 1993

CLIENT: XYZ ENGINEERING
320 TESCONI CIRCLE, SUITE G
SANTA ROSA CA 95401

ATTENTION: JOE GROUNDWATER

JOBLINK: 810000
PROJECT: MAIN SITE

ANALYSIS

EPA METHOD 8020 - AROMATIC VOLATILE ORGANICS

SAMPLE NUMBER	SAMPLE POINT	SAMPLE MATRIX	SAMPLE DATE	DATE IN LAB
MF0000	MW-1	LIQUID	12-27-93	12-28-93

This report is "PROPRIETARY AND CONFIDENTIAL" and delivered to, and intended for the exclusive use of the above named client only. ETC. a Division of APBI Environmental Sciences Group Inc, assumes no responsibility or liability for the reliance hereon or use hereof by anyone other than the above named client.

A division of
APBI Environmental
Sciences Group, Inc.

Jennifer L. Roseberry, General Manager

Date

FIGURE 10.2 SAMPLE REPORT

XYZ ENGINEERING
DECEMBER 29, 1993
810000

PAGE 2 OF 3

SAMPLE MATRIX: LIQUID

Parameter	EPA Prep Method	EPA Analysis Method
Aromatic Volatile Organics	5030	8020

ns

FIGURE 10.2 SAMPLE REPORT

XYZ ENGINEERING
28 DECEMBER 1993

EXECUTIVE SUMMARY
ETC JOBLINK 810000

One aqueous sample was collected on 27 December 1993 under the direction of XYZ Engineering and submitted to ETC-Santa Rosa via Federal Express. The sample arrived 28 December 1993 under Chain of Custody Record number 96884. The shuttle temperature was 3°C upon receipt at the laboratory. The sample was analyzed as specified on the preceding page.

Pam P. Manager, Program Manager

Date

FIGURE 10.2 SAMPLE REPORT

TABLE 1: QUANTITATIVE RESULTS DATA

EPA METHOD 8020 - AROMATIC VOLATILE ORGANICS (AR12)

Chain of Custody Data Required for ETC Data Management Summary Reports

MF0000	XYZ ENGINEERING	MW-1	931227	810000
ETC Sample No.	*Company*	*Facility*	*Sample Point*	*Date*	*Joblink*

	Results						
Compound	Sample Concen. ug/L	Report DL ug/L	Blank Concen. ug/L	Batch #	Prep Date	Analysis Date	
1,2-Dichlorobenzene	ND	.500	ND	QX31475	931229	931229	
1,3-Dichlorobenzene	ND	.500	ND	QX31475	931229	931229	
1,4-Dichlorobenzene	ND	.500	ND	QX31475	931229	931229	
Benzene	ND	.500	ND	QX31475	931229	931229	
Chlorobenzene	ND	.500	ND	QX31475	931229	931229	
Ethylbenzene	ND	.500	ND	QX31475	931229	931229	
Toluene	ND	.500	ND	QX31475	931229	931229	
m+p-Xylenes	ND	.500	ND	QX31475	931229	931229	
o-Xylene	ND	.500	ND	QX31475	931229	931229	

FIGURE 10.2 SAMPLE REPORT

TABLE 2: METHOD PERFORMANCE DATA

SURROGATE

Chain of Custody Data Required for ETC Data Management Summary Reports

ETC Sample No.	Company	Facility	Sample Point	Date	Joblink
MF0000	XYZ ENGINEERING		MW-1	931227	810000

Compound	Amount added ug/L	% Recovery	Control Limits Lower	Control Limits Upper
VOLATILE FRACTION (GC)				
Bromochloromethane	-	-	-	-
Bromofluorobenzene	10	101	71	131
4-Bromofluorobenzene	-	-	-	-
1-Chloro-2-fluorobenzene	10	109	78	126
EXTRACTABLE FRACTION (GC)				
2,4,6-Tribromophenol	-	-	-	-
Dibutylchlorendate	-	-	-	-
Pentachloronitrobenzene	-	-	-	-
Decachlorobiphenyl	-	-	-	-
2,4-Dichlorophenylacetic acid	-	-	-	-
1,3-Dimethyl-2-nitrobenzene	-	-	-	-
Pentacosane	-	-	-	-
N-Nitrosodiethylamine	-	-	-	-

FIGURE 10.2 SAMPLE REPORT

TABLE 1: QUALITY ASSURANCE DATA

EPA METHOD 8020 - AROMATIC VOLATILE ORGANICS (AR12)

Chain of Custody Data Required for ETC Data Management Summary Reports

See Below

ETC Batch No.

Compound	QC Blank and Spiked Data			QC Matrix Spike			QC Duplicate			
	Blank Concen. mg/L	Concen. Added mg/L	% Recov	Unspiked Sample mg/L	Concen. Added mg/L	% Recov	First mg/L	Second mg/L	RPD	Batch #
1,2-Dichlorobenzene	ND	.010	103	ND	.010	101	.010	.010	.6	QX31475
1,3-Dichlorobenzene	ND	.010	101	ND	.010	101	.010	.010	.1	QX31475
1,4-Dichlorobenzene	ND	.010	103	ND	.010	107	.011	.011	4	QX31475
Benzene	ND	.010	101	ND	.010	96	.01	.01	3	QX31475
Chlorobenzene	ND	.010	100	ND	.010	95	.01	.01	4	QX31475
Ethylbenzene	ND	.010	103	ND	.010	98	.01	.010	2	QX31475
Toluene	ND	.010	101	.002	.010	99	.012	.012	1	QX31475
m+p-Xylenes	ND	.020	102	ND	.020	98	.020	.020	.05	QX31475
o-Xylene	ND	.010	99	ND	.010	103	.010	.011	2	QX31475

FIGURE 10.2 SAMPLE REPORT

ETC

CHAIN-OF-CUSTODY RECORD

Form 0019
Field Technical Services
Rev. 08/90

810000

No. 96884

Environmental Testing and Certification Corp. • 284 Raritan Center Parkway • Edison, NJ 08818 • 908-225-6700

COMPANY: XYZ Engineering
FACILITY/SITE: MAIN SITE
PROJECT CONTACT: Joe Groundwater
TELEPHONE NO.: (707) 544-5570

ITEM NO.	ETC JOB #	SOURCE CODE	SAMPLE POINT	START DATE YY/MM/DD	START TIME
1		W	MW-11	12-27-93	1410
2					
3					
4					
5					
6					
7					
8					
9					

Source Codes:
Well .... (W) Outfall ..... (O)
Soil .... (S) River/Stream .... (R)
Bottom Sediment ..... (B)
Generation Point ..... (G)
Surface Impoundment ..... (I)
Treatment Facility ..... (T)
Leachate Collection Sys ..... (C)
Lake/Ocean ..... (L)
Other ..... (X)
Specify _____

NUMBER OF CONTAINERS	FILT. (Y/N)	PRESERV.	ANALYSIS REQUIRED: 8020	SAMPLER OBSERVATIONS	LAB OBSERVATIONS
2	Y	1	X		

LEGEND FOR PRESERVATIVE
0 - NONE
1 - HCL
2 - HNO_3
3 - H_2SO_4
4 - Na_2SO_3 + H_2SO_4

CHAIN OF CUSTODY CHRONICLE

1. Shuttle Opened By: (print) Joe Manager Date: 12-26-93 Time: 1230
   Signature: Joe Manager Seal #: 123456 Intact: yes
2. I have received these materials in good condition from the above person
   Name: Joe Groundwater Signature: Joe Groundwater
   Date: 12-27-93 Time: 0830 Remarks:
3. I have received these materials in good condition from the above person.
   Name: _____ Signature _____
   Date: _____ Time: _____ Remarks: _____
4. Shuttle Sealed By: (print) Joe Groundwater Date: 12-27-93 Time: 1630
   Signature: Joe Groundwater Seal #: 123457 Intact: yes

LAB USE ONLY Opened By: Sam Receipt Date: 12-28-93 Time: 1030
SHUTTLE # _____ TEMP. °C 3 SEAL # 123457 COND. Okay

REMARKS

SAMPLER'S SIGNATURE: Joe Groundwater

FIGURE 11.1 CORRECTIVE ACTION REPORT FORM

ETC - SANTA ROSA LABORATORY LOG #: S_____

NONCONFORMANCE / CORRECTIVE ACTION REPORT

Q BATCH #:_____ DATE:_____
JOB(s) #:_____ INITIATOR:_____
JOBLINK(s) #:_____ FACILITY CODE:_____
TEST / METHOD:_____

NONCONFORMING EVENT:_____

INVOLVED LABORATORY DEPARTMENT:_____

CORRECTIVE ACTION TAKEN: _____

CORRECTIVE ACTION INITIATED BY: _____ DATE: _____

VERIFIED BY:

_____ DATE:_____
TEAM LEADER (AS APPROPRIATE)

_____ DATE:_____
DEPARTMENT MANAGER (AS APPROPRIATE)

VERIFIED BY:

_____ DATE:_____
QUALITY ASSURANCE OFFICER

ORIGINAL - QUALITY ASSURANCE OFFICER; COPIES - PROJECT MANAGER, FILE(QBATCH)

TABLE 12.2 ACCREDITATION AND CERTIFICATE LIST - ETC SANTA ROSA

AGENCY	CATAGORIES	CERTIFICATE #
STATE OF CALIFORNIA	WASTEWATER AND HAZARDOUS WASTE	1462
STATE OF NEW JERSEY	WASTEWATER	44944
STATE OF ALASKA	UST PROGRAM*	--
STATE OF UTAH	HAZARDOUS WASTE	E-154
STATE OF WASHINGTON	WASTEWATER AND GROUNDWATER	C109
STATE OF WISCONSIN	WASTEWATER AND GROUNDWATER	998032090
DEPARTMENT OF THE ARMY	WASTEWATER AND HAZARDOUS WASTE	--
LOS ANGELES COUNTY SANITATION DISTRICT	WASTEWATER AND HAZARDOUS WASTE	10168
SONOMA COUNTY DEPARTMENT OF AGRICULTURE	PERMIT FOR SOILS FROM FOREIGN AND DOMESTIC SOURCES	S-2557
US DEPARTMENT OF AGRICULTURE	PERMIT FOR SOILS FROM FOREIGN AND DOMESTIC SOURCES	S-2557

* Applied status. Laboratory Accreditation Program not fully developed

FIGURE 12.1 INTERNAL AUDIT CHECKLIST EXAMPLE

Performed by:_____ Date:_____

Audited Item	YES	NO	Comments
A. SAMPLE RECEIPT/MANAGEMENT			
1. Refrigerators #1 and #6 monitored correctly? (That is daily, corrected, and corrective action initiated when outside prescribed limits?)			
2. Refrigerators #1 and #6 secured between 5p - 8a?			
3. Preservative checked on incoming samples?			
4. Temperature checked on incoming coolers/shuttles?			
5. Samples not left unattended on counter during login?			
6. Sample receipt procedure and preservative table posted in sample receipt area? SOPs available for sample receipt personnel?			
7. Thermometers in refrigerators and for cooler checks free from separated mercury and labeled with calibration within 1 year, corrections indicated?			
8. Area generally neat, without unnecessary debris on floors or benches?			
B. TCLP ROOM			
1. Balances #2 and #3 calibrated with 1 and 1000 g S-weight each day of use? Yearly calibration visible and current?			
2. S-weights numbers correspond to balance logs, last calibration visible and within one year?			
3. Refrigerators #12, #15A, and 15B monitored correctly? (That is daily, corrected, and corrective action initiated when outside prescribed limits?)			
4. Thermometers in refrigerators free from separated mercury and labeled with calibration within 1 year, corrections indicated?			
5. Reagents labeled with name, date prepped, date expired? No expired standards on shelves/refrigerators?			
6. Area generally neat, without unnecessary debris on floors or benches?			
C. SAMPLE PREP - CONCENTRATOR AND GLP AREA			
1. Balances #2 and #3 calibrated with 1 and 1000 g S-weight each day of use? Yearly calibration visible and current?			
2. S-weights numbers correspond to balance logs, last calibration visible and within one year?			
3. Refrigerators #5 and #8 monitored correctly? (That is daily, corrected, and corrective action initiated when outside prescribed limits?)			
4. Reagents labeled with name, date prepped, date expired? No expired standards on shelves/refrigerators?			
5. SOPs current and available for all sample prep methods and general analytical methods?			
6. Hoods monitored? Sash at correct level?			
7. Area generally neat, without unnecessary debris on floors or benches?			

TABLE 12.3 CERTIFIED PARAMETERS BY AGENCY FOR ETC - SANTA ROSA

AGENCY	CA	NJ	UT	WA	WI	DOA
EXPIRATION	3/31/95	6/30/94	8/6/94	4/22/94	6/30/94	7/29/94
MATRIX	WW/HZ	WW	HW	WW/GW	WW/GW	WW/HW
PARAMETER						
ORGANIC ANALYSIS						
Halogenated Volatile Organics	X a)	A	X	X	X	X
Nonhalogenated Volatile Organics	X		X			
Gas & Diesel	X			X		X
Aromatic Volatile Organics	X a)	A	X	X	X	X
Acrolein and Acrylonitrile	X				X	
Phenols	X					
Organochlorine Pesticides	X	A	X	X	X	X
Polychlorinated Biphenyls (PCBs)	X	A	X	X	X	X
Nitroaromatics & Cyclic Ketones	X				X	
Chlorinated Hydrocarbons	X				X	
Organophosphorous Pesticides	X b)				X	
Chlorinated Herbicides	X			X		X
Triazine Pesticides (Method 619)	X					
GC/MS Volatile Organics	X c)	A	X	X	X	X
GC/MS Semivolatile Organics	X	A	X	X	X	X
METALS						
Aluminum	I	I	I	I	X	X
Antimony	G/I	G/I	G d)	I	X	X
Arsenic	G/I	G	G/I d)	G	X	X
Barium	I	I	G/I	I	X	X
Beryllium	I	I	G/I d)	I	X	X
Boron	I				X	
Cadmium	G/I	I	G/I d)	I	X	X
Calcium	I	I	I	I	X	X
Chromium	G/I	I	G/I d)	I	X	X
Cobalt	I	I	G/I d)	I	X	X
Copper	G/I	I	G/I d)	I	X	X
Iron	I	I	I d)	I	X	X
Lead	G/I	G/I	G/I d)	I	X	X
Magnesium	I	I	I	I	X	

TABLE 12.3 CERTIFIED PARAMETERS BY AGENCY FOR ETC - SANTA ROSA

AGENCY	CA	NJ	UT	WA	WI	DOA
EXPIRATION	3/31/95	6/30/94	8/6/94	4/22/94	6/30/94	7/29/94
MATRIX	WW/HZ	WW	HW	WW/GW	WW/GW	WW/HW
PARAMETER						
Manganese	I	I	G/I d)	I	X	X
Mercury	X	X	X d)	X	X	X
Molybdenum	I	I	G/I d)		X	X
Nickel	G/I	I	I	I	X	X
Potassium	I	I	I	I		X
Selenium	G/I	G	G/I d)	G	X	X
Silver	G/I	I	G/I d)	I	X	X
Sodium	I	I	I	I	X	X
Thallium	G/I	G/I	G/I d)	I	X	X
Titanium	I					
Vanadium	I	I	G/I d)	I	X	X
Zinc	I	I	I d)	I	X	X
WET CHEMISTRY						
Acidity	X	X			X	
Alkalinity	X	X			X	
Ash						
Bromide	X					
Chloride	X	X e)	X	X	X	X f)
Cyanide, Total & Ammenable	X	X	X	X	X	X
Cyanide, Reactive	X	X	X		X	
Chemical Oxygen Demand	X				X	
Corrosivity	X		X			
Chromium (+6)	X	X				
Fluoride	X	X e)		X	X	X f)
Hardness	X	X			X	
Ignitability	X		X		X	
Nitrate	X	X e)	X	X	X	X f)
Nitrite	X	X e)			X	X f)
Nitrogen, Ammonia	X	X			X	
Nitrogen, Total Kjeldahl	X	X			X	
Oil & Grease	X	X	X d)			

TABLE 12.3 CERTIFIED PARAMETERS BY AGENCY FOR ETC - SANTA ROSA

AGENCY	CA	NJ	UT	WA	WI	DOA
EXPIRATION	3/31/95	6/30/94	8/6/94	4/22/94	6/30/94	7/29/94
MATRIX	WW/HZ	WW	HW	WW/GW	WW/GW	WW/HW
PARAMETER						
pH	X	X	X			
Phenols	X	X	X		X	
Orthophosphate	X	X				X f)
Phosphorous, Total	X	X				
Silica	X					
Specific Cunductance	X	X	X			
Solids, Total	X	X			X	
Solids, Total Dissolved	X	X			X	
Solids, Total Suspended	X	X			X	
Solids, Total Settleable	X	X				
Solids, Total Volatile	X	X			X	
Solids, Volatile Suspended						
Sulfide, Reactive	X		X		X	
Sulfide, Total	X	X				
Sulfate	X	X e)	X	X	X	X f)
Sulfite	X					
Total Organic Carbon	X	X	X	X	X	X
Total Petroleum Hydrocarbons	X			X		X
Turbidity	X	X				
ADDITIONAL PREP METHODS						
TCLP Extraction	X		X		X	
California WET	X					
EP Tox	X				X	

ABBREVIATIONS:

CA = State of California Department of Health Services ELAP
NJ = State of New Jersey Department of Environmental Protection and Energy
UT = State of Utah Department of Health
WA = State of Washington Department of Ecology
WI = State of Wisconsin Department of Natural Resources
DOA = Department of the Army
WW = Wastewater
HZ = Hazardous Waste
GW = Ground Water
I = Inductively Coupled Plasma (Methods 6010 or 200.7)
G = Graphite Furnace Atomic Absorption (200 or 7000 series methods)
X = Certified Parameters
A = Applied status only

TABLE 12.3 CERTIFIED PARAMETERS BY AGENCY FOR ETC - SANTA ROSA

NOTES:

a) 8010 or 8020 and 8021
b) 8140 and 8141
c) Both 5 ml and 25 ml purge (8240 and 8260)
d) Provisional certification
e) For New Jersey, Method 300.0 is not an approved method for analysis.
f) For DOA, anions by IC only.

APPENDIX A
SUBCONTRACT LABS USED FOR FOTH & VAN DYKE PROJECTS

SUBCONTRACT LABORATORY	TYPICAL SUBCONTRACTED ANALYSIS	CERT #	EXP. DATE	ETC AUDIT
Battelle Marine Sciences Laboratory 1529 West Sequim Bay Road Sequim, WA 98382 (206) 681-3650 QA - Robert Cuello	State of Wisconsin trace metals analysis	WA - C043 (Reciprocity with Wisconson) WI - Pending	08/27/94	11/19/93
Core Laboratories 420 West First Street Casper, WY 82601 (307) 266-4592 QA - Don Ukele	Radiological methods: Gross alpha, Gross beta, Radium, Uranium	WI - No catagories in Wisconsin at this time		QA Manual audit only
Environmental Health Laboratories 110 S. Hill Street South Bend, IN 46617 (219) 233-4777 QA - Jeff Brown	Drinking water methods (500 series organics)	WI - 999766900	12/31/94	QA Manual audit only
ETC - Edison 284 Raritan Center Parkway, P.O. Box 7808 Edison, NJ 08818 (908) 225-6700 QA - Sonia Cordova	Dioxin	WI - 999464070	10/31/94	QA Manual audit only
Northern Lake Service, Inc. 400 North Lake Ave. Crandon, WI 54520-1286 (715) 478-2777 QA - W. J. Nosek, Jr.	BOD, MBAS, Color, Odor	WI - 712026460	06/30/94	QA Manual audit only
Princeton Testing Labs 3490 US Route 1, Princeton Service Center Princeton, NJ 08540 (800) 548-8378 QA - Alan Volk	Asbestos	WI - No catagory in Wisconsin at this time.		QA Manual audit only
Warzyn One Science Court, PO Box 5385 Madison, WI 53705-0385 (608) 231-4747 QA - Chris Wautlet	BOD, MBAS, Color, Odor	WI - 113138399	06/30/94	QA Manual audit only

NOTE:

QA Manuals will be reviewed and kept on hand for all subcontract laboratories. Copies of the Manuals are available on request.

Appendix B

Tissue Sample Digestion Methods

Method 540.2

Digestion Method for Mercury in Nonaqueous Samples

1. **Scope and Application**
   1.1 This digestion procedure is applicable for the preparation of tissue, sediments, sludges and other solid samples for the analysis of mercury by cold vapor atomic absorption spectroscopy (Method 540.1).

2. **Summary of Method**
   2.1 Portions of samples are weighed into test tubes and digested in a block digester with a sulfuric-nitric acid mixture with the additional aid of hydrogen peroxide. Potassium permanganate is added to the cooled tubes to ensure complete oxidation and to remove aromatic and nitrogen compounds that could interfere during the photometric measurement.

3. **Sample Handling and Preservation**
   3.1 Tissue samples are homogenized and frozen by the DNR personnel. Some tissues may require further homoganizing using a Waring blender.

   3.2 Solid samples are ground or dried by Method 100.1 or 700.1.

4. **Interferences**
   4.1 The same types of interferences that may occur in water samples are also possible in tissue and solid samples. (See Method 540.1)

5. **Apparatus**
   5.1 Technicon BD-40 Aluminum Block Digester Heating Unit.

   5.2 Technicon pyrex partial reflux test tubes (20 x 152 mm) calibrated at 50 mL. Rinse with stannous chloride solution (6.6) followed by five or more Milli-Q water rinsings.

   5.3 Hangar granules, micro (Catalog #136-CC, Hangar Co., Philadelphia, PA). Rinse with stannous chloride solution (6.6) followed by five or more Milli-Q water rinsings.

   5.4 Balance, top loading, weighing to nearest 0.01 g.

6. **Reagents**
   6.1 Concantrated acids, suitable for trace metals analysis, such as Baker Instra-Analyzed grade from J. T. Baker

Chemical Co., Philipsburg, NJ.

6.1.1 Nitric acid

6.1.2 Sulfuric acid

6.1.3 Hydrochloric acid

6.2 Digestion mixture: Prepare by adding 200 mL nitric acid (6.1.1) to 800 mL sulfuric acid (6.1.2) and mixing thoroughly.

6.3 Milli-Q (MQ) water (ASTM type I water), Millipore Corp., Bedford, MA.

6.4 Potassium permanganate, 5% W/V: Prepare by dissolving 25 g $KMnO_4$ in 500 mL MQ water.

6.5 Hydroxylamine solution: Prepare by dissolving 60 g hydroxylamine sulfate and 60 g sodium chloride in 500 mL MQ water.

6.6 Stannous chloride solution: Prepare by dissolving 200 g $SnCl_2 \cdot 2H_2O$ (suitable for Hg determination grade) in 1 liter 1:1 hydrochloric acid (6.1.3).

6.7 Hydrogen peroxide, 30%, procured from commercial vendor.

6.8 Stock mercury standard, 1000 mg/L, NIST traceable. Procure from commercial vendor.

6.8.1 Working standard solution: Prepare by successively diluting the stock standard (6.8) to obtain a 0.10 µg/mL solution in 1% HCl. Add 1-2 granules of $K_2Cr_2O_7$ as a preservative.

6.9 Stock organic mercury standard 1000 ng Hg/L as methylmercury chloride. Procure from commercial vendor (such as Alfa Products, Danvers, MA.).

6.9.1 Working spike solution: Prepare by successively diluting the stock organic standard (6.9) to obtain a 0.10 µg/mL solution in 1% HCl. Verify concentration against mercury chloride standard (6.8.1) by digesting at least seven replicates of spike solution by Method 540.3.

7. Procedure

7.1 Weigh samples directly into digester tubes.

7.1.1 For fish and animal tissue, mix mostly thawed sample with a spatula and weigh out 0.75 ± 0.10 g. Some types of animal tissue may only work with 0.55 ± 0.05 g.

7.1.2 For non-RCRA solids, weigh out 0.25 ± 0.05 g of sample that has been prepared by Method 100.1.

7.1.3 For RCRA samples, weigh out an amount of homogenized wet sample equivalent to approximately 0.25 g dry weight. This requires a knowledge or estimate of the percent moisture.

7.2 Duplicate 10% of the samples and any new or unusual samples.

7.3 Spike 5% of the samples and any new or unusual samples. For low level tissue samples and solids add 1.0 mL of working spike solution (6.9.1). For tissue samples add 2.0 mL of working spike solution (6.9.1).

7.4 Prepare separate tubes for a blank, standards and initial calibration verification sample.

7.4.1 For low level tissue and solids, use 0.0, 0.2, 0.5, 1.0 and 1.5 mL of working standard 6.8.1.

7.4.2 For tissue, use 0.0, 0.5, 1.0, 2.0 and 3.0 mL of working standard 6.8.1.

7.4.3 Prepare an initial calibration verification sample by pipetting 1.5 mL of working spike 6.9.1.

7.5 Add 12.5 mL of digestion mixture (6.2) to each tube. For solid samples, add an additional 2.5 mL HNO_3.

7.6 Vortex all the tubes. Some tubes may have portions of sample adhering to the tube wall which need to be wetted with acid by carefully tipping the tubes until the digestion solution covers that portion of sample.

7.7 Cover the tubes (individually with parafilm or as a group with wax paper) and allow to stand overnight.

7.8 Add 0.5 mL 30% H_2O_2 dropwise and vortex. Since this reaction can be quite vigorous, it is recommended that tubes be vortexed while adding the H_2O_2.

7.9 Repeat the 0.5 mL 30% H_2O_2 addition three more times for a total of 2.0 mL.

7.10 Place tubes in a cold block digester and start the following program: Low Temp = 120°C, Low Temp Time = 1.5 hours, High Temp = 265°C and Total Cycle Time = 3.25 hours. Leave the front and back covers off for the first hour to ensure refluxing occurs. At the end of the cycle, there should be persistent white fumes.

7.11 Remove the tubes, allow to air cool for 10 minutes and place in a cool water bath (approximately 18°C) for 30 minutes. Digestates should be completely clear after cooling. A brown or tan digestate indicates insufficient oxidant was present and mercury loss may have occurred. Redigest those samples using smaller weights if possible. (If sample will not work with this digestion, use the alternate digestion procedure Step 8.)

7.12 Add 2.0 mL potassium permanganate solution (6.4) to each tube, vortex and return to the bath. Add extra 2.0 mL aliquots of potassium permanganate solution as required until the purple color persists for 15 minutes. Allow the tubes to cool overnight (or at least 30 minutes).

7.13 To each tube add 20 mL MQ water to prevent frothing and 2.0 mL hydroxylamine solution (6.6) to reduce the excess permanganate. Mix by vortexing and dilute to the 50 mL mark.

7.14 Analyze by Method 540.1.

8. Alternate Digestion Procedure

8.1 Weigh out samples and prepare standards as in 7.1, 7.2, 7.3 and 7.4.

8.2 Add 2.5 ml 1:1 HNO_3 and 7.5 mL 1:1 HCl to each tube and vortex.

8.3 Heat in the block digester at 95°C for 2 minutes and cool.

8.4 Add 10 mL MQ water and 15 mL potassium permanganate solution to each tube, vortex and return to the 95°C

block digester for 30 minutes.

8.5 Cool, add 5.0 mL MQ and 5.0 mL hydroxylamine solution and vortex. Caution: Chlorine gas is evolved during this addition. Dilute to the 50 mL mark.

8.6 Analyze by Method 540.1.

9. Precision and Accuracy

9.1 The accuracy and precision of the method was evaluated using National Bureau of Standards reference materials with certified concentrations of mercury. In addition, the precision was further evaluated by running one fish sample 21 times on different days. The results are shown in the following table.

		This Method				
Sample Material	Certified Value µg/g	µg/g (Mean value)	Range	# of Runs	CH_3HgCl Spike Recovery Average	Relative Std. Deviation
NBS Orchard Leaves	0.155±0.015	0.148±0.037	.127-.192	13	95.9%	12.4%
NBS Fly Ash	0.14±0.01	0.12±0.033	.10-.143	7	88.9%	14.3%
NBS Bovine Liver	0.016±0.002	0.017±0.005	.014-.023	15	90.5%	14.3%
Carp Tissue	Not Applicable	0.131±0.028	.116-.144	21	96.0%	6.6%

9.2 Using this method, the reporting limit is 0.03 µg/g for tissue, 0.01 µg/g for low level tissue and 0.02 mg/kg for solids.

10. References

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Inorganic Chemistry Unit
Revised, February 1993

METHOD 620.2

Digestion Method for Metals in Tissue by Inductively Coupled Plasma Spectroscopy

Also applicable for GFAA

1. Scope and Application

   1.1 This method is applicable for the digestion of fish and animal tissue for the analysis of cadmium, chromium, copper, lead, nickel and zinc by inductively coupled plasma spectroscopy (ICP). This procedure may be applicable to other metals.

2. Summary of Method

   2.1 Portions of well-homogenized tissue are digested in nitric acid with the periodic addition of hydrogen peroxide.

3. Sample Handling and Preservation

   3.1 Fish and animal tissue samples are collected, homogenized and frozen by the Department of Natural Resources personnel before transporting to the Lab of Hygiene.

   3.2 Samples are kept frozen until needed.

   3.3 Samples can be re-homogenized if necessary.

4. Apparatus and Materials

   4.1 Test tubes calibrated at 50 mL

   4.2 Technicon BD40 Block Digestor

   4.3 Balance, top loading, weighing to nearest 0.01 g

   4.4 Whatman No. 542 filter paper or equivalent

   4.5 Funnels

5. Reagents

   5.1 Nitric Acid (concentrated), Baker Insta-Analyzed (J. T. Baker Chemical Co., Philipsburg, NJ)

   5.2 Milli-Q water (ASTM Type I Water)

5.3 Hydrogen Peroxide, 30%

5.4 Mixed stock standard solutions: Procure certified Mixed Standard Solutions from commercial vendors or mix certified 1000 ppm single element standards to obtain appropriate solutions.

6. Procedure

6.1 Remove tissues from the freezer and allow to thaw to near room temperature.

6.2 Weigh 5.0 to 5.5 g (to nearest 0.01 g) into acid rinsed test tubes. Prepare a blank and three standards using the Mixed Stock Standard Solutions (5.4). Duplicate 10% and spike 5% of the samples.

6.3 Add 5.0 mL concentrated HNO_3 to all tubes. Add Milli-Q water to the blank and standards to the approximate level of liquid in the sample tubes.

6.4 Place the tubes in the block digestor and heat at 95°C until the tissue is mostly dissolved leaving a layer of fat on top of the liquid. This should take approximately one hour.

6.5 Add 2.5 mL 30% H_2O_2 to the tubes, vortex and continue heating. (It is not necessary to cool tubes to add H_2O_2.)

6.6 Repeat the 2.5 mL H_2O_2 additions at half hour intervals until a total of 10 mL H_2O_2 has been added.

6.7 30 minutes after the final H_2O_2 addition, remove the tubes from the block digestor and allow to cool to near room temperature.

6.8 Cool the tubes to near 4°C.

6.9 Filter the digestates through Whatman No. 542 filter paper, dilute to 50 mL with Milli-Q water and mix thoroughly.

6.10 Analyze by ICP calibrating with either the digested standards or undigested standards prepared in 10% HNO_3.

7. Quality Control

7.1 See the Quality Control Section of Method 400.1 of this manual.

7.2 Precision and accuracy data are available in the Inorganic Chemistry Unit Quality Assurance Manual.

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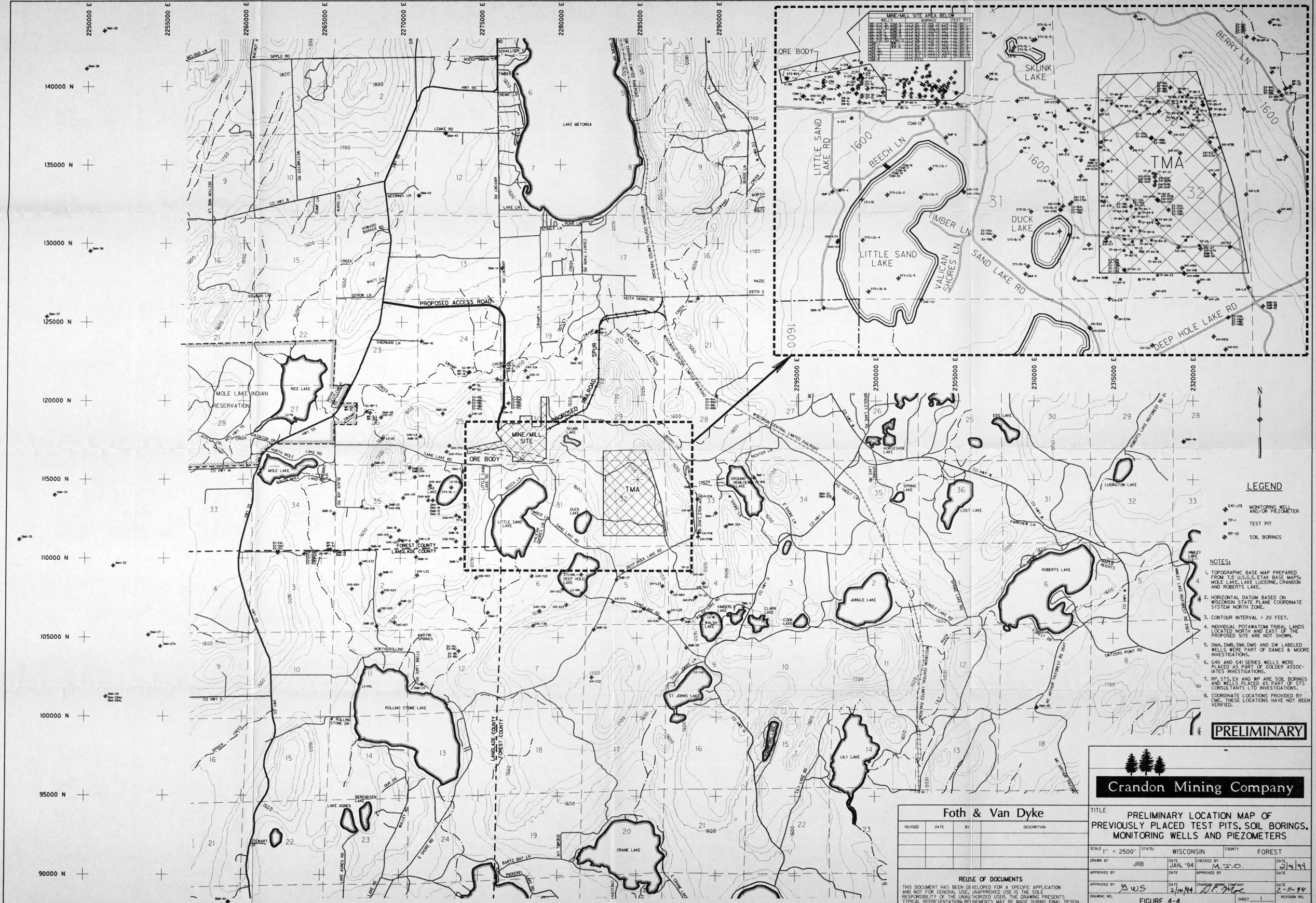
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Inorganic Chemistry Unit
February, 1991

[redacted]

Appendix F

Figure 4-4



Crandon Mining Company

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

REUSE OF DOCUMENTS

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TITLE: PRELIMINARY LOCATION MAP OF PREVIOUSLY PLACED TEST PITS, SOIL BORINGS, MONITORING WELLS AND PIEZOMETERS

SCALE 1" = 2500'	STATE: WISCONSIN	COUNTY: FOREST	
DRAWN BY: JRB	DATE: JAN. '94	CHECKED BY: M.J.O.	DATE: 2/9/94
APPROVED BY	DATE	APPROVED BY	DATE
APPROVED BY: DWS	DATE: 2/10/94	CRANDON MINING COMPANY	DATE: 2-11-94
DRAWING NO.	FIGURE 4-4	SHEET 1 OF 1	REVISION NO.

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02/10/94 dec

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