Crandon Project Section 404 permit application : addendum 1 : 93C049. 1995

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Crandon Mining Company

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

July 20, 1995

Mr. David L. Ballman, Ecologist
U.S. Army Corps of Engineers
St. Paul District
190 Fifth Street East
St. Paul, MN 55101

Mr. Bill Tans
Wisconsin Department of Natural Resources
Bureau of Environmental Analysis and Review
P.O. Box 9721
Madison, WI 53707

Dear Mr. Ballman and Mr. Tans:

RE: Crandon Project - *Section 404 Permit Application - Addendum 1*

Crandon Mining Company (CMC) is pleased to file the enclosed document titled *Section 404 Permit Application - Addendum 1* for the Crandon Project. On July 7, 1994 CMC filed a Section 404 Permit Application for the project in order to initiate district activities associated with the review of the proposed project pursuant to Section 404 of the Clean Water Act.

The July 7, 1994 submittal included information regarding the proposed project current at that time as well as relevant sections of the 1985 Environmental Impact Report (EIR). Since that submittal, CMC has modified the project and completed a number of studies to update the previous EIR. This submittal provides updated project information and the following documentation as required by the Section 404(b)(1) Guidelines:

- Alternatives analysis;
- Description of wetlands of the study area;
- Measures to avoid/minimize wetland impacts;
- Unavoidable impacts; and
- Wetland compensation.

Please note when reviewing the addendum that CMC has determined that the project will directly impact approximately 29.5 acres of wetland, which is approximately 1.4 percent of the wetlands in the study area. This is a substantial reduction from the project as proposed in the 1980's. The reduction is the result of CMC's work to avoid and minimize wetland impacts. CMC believes that the location and design of project facilities will create the least overall environmental impacts and also minimize direct impact to wetlands.

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To mitigate the direct and indirect wetland impacts of the project, CMC proposes to develop a wetland mitigation site encompassing approximately 57 acres. A discussion of the development of this site and its wetland functional values is also contained in the addendum.

We request that the St. Paul District begin its review of the addendum as soon as practicable and that a conference be set to discuss the addendum and project schedule. We suggest that WDNR be included in these discussions.

If you or your staff have any questions regarding the addendum, please contact me at (715) 365-1450.

Sincerely,

Jerome D. Goodrich, Jr.
President
Crandon Mining Company

JG:mld

Attachment

[MLD2]93C049

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Crandon Project Section 404
Permit Application

Addendum 1

93C049

Prepared for
Crandon Mining Company
Rhinelander, Wisconsin

Prepared by
Foth & Van Dyke and Associates Inc.

July 1995

Crandon Mining Company
Section 404 Permit Application

Executive Summary

Introduction

Crandon Mining Company has applied to the U.S. Army Corps of Engineers for a wetlands permit needed for building and operating the proposed Crandon zinc and copper mine. The permit procedure, required under Section 404 of the Federal Clean Water Act, is designed to make sure the company preserves wetlands to the maximum extent possible and replaces any wetlands directly affected by mine facilities.

All told, the Crandon Project will result in a gain of high-quality wetland acreage in the Fox-Wolf River Watershed, in which the mine site is planned to be located. As now designed, the facilities will directly impact 29.5 acres of wetlands. This represents:

- Less than half the 65.4 acres that would have been directly affected under the original mine plan prepared in the 1980s.
- Less than 1.4 percent of the wetlands in an 18.3-square mile study area around the mine site.

To replace the 29.5 acres, CMC will restore 57 acres of wetlands on a farm in Shawano and Oconto counties that used to be a natural wetland. This restored wetland acreage is enough to replace both wetlands affected directly by mine facilities and other wetlands that may be affected indirectly, such as by lower groundwater levels in the immediate area of the mine. The following summary explains the steps CMC has taken to preserve and replace wetlands.

Mapping and Ranking Wetlands

Some wetlands are more important than others in terms of their value to the environment. Under federal law, high-quality wetlands must receive first priority in wetland protection. If a project will disturb high-quality wetlands, then replacement wetlands must also be of high quality.

In an extensive survey of wetlands in an 18.3-square mile area around the mine site, CMC mapped 2,145 acres of wetlands and assigned values to 174 wetland parcels based on their importance for such purposes as:

- Plant and wildlife habitat
- Stormwater and floodwater storage
- Groundwater recharge
- Water quality maintenance
- Recreation
- Scenery
- Education

This process helped CMC minimize impacts on wetlands, preserve the most important wetland values, and choose an appropriate site for wetland replacement.

Preserving Wetlands

Federal and state laws require CMC to design the mine for the smallest possible effect on wetlands. To reduce wetlands directly affected from 65.4 to 29.5 acres, CMC changed the size, shape and location of project facilities. The biggest reduction came from redesigning the tailings management area (TMA) by:

- Reducing the overall size
- Adjusting the shape
- Moving the location to the north
- Changing the basin slopes and embankments

These and other changes to the TMA saved 35.91 acres of wetlands. The following table shows how mine facilities will affect wetlands under the current design, compared with the previous design.

Minimizing Wetland Disturbance

	Acres of Wetland Directly Affected	
Project Facilities	Previous Design	Current Design
Plant Site	0.0	0.28
TMA and Reclaim Pond	57.7	21.79
Access Road	3.2	3.91
Railroad Spur	3.9	3.05
TMA Access Road and Tailings Pipeline Corridor	0.6	0.47
TOTAL	**65.4**	**29.5**

Replacing Wetlands

Under a wetland replacement formula used by the Wisconsin Department of Transportation, CMC would need to create 35.29 acres of wetlands which is a ratio of 1.2 new acres for each acre directly impacted by the mine project. CMC plans to create 57 acres, a ratio of 1.9 to 1, which is 58 percent more than dictated by the formula.

The primary goal of wetland replacement is to create, within the same watershed, wetlands of similar quality to those directly affected by the project. Because there were no lands suitable for wetland restoration in the immediate area of the mine, CMC conducted an extensive search within a 50-mile radius. After screening 180 parcels of land and giving 35 of these a closer evaluation, CMC chose a portion of a farm straddling the border between Shawano and Oconto counties. This parcel was a natural wetland until it was drained years ago for farming. CMC rated this site as best for wetland restoration because:

- It is large enough.
- It lies in the Fox-Wolf River Watershed.
- It has wetland-type soils that readily will support native wetland plants.
- It has groundwater close to the surface and is bordered by drainage ditches that can be dammed to restore wetland conditions.

CMC studies show that the land will revert to a high-quality wetland within a few years after it is flooded. Already, water collects on the site in spring, and it is used by migrating and breeding waterfowl such as mallard ducks, wood ducks, and Canada Geese. The site is nearly surrounded by wetlands, and wetland plants grow along drainage ditches and on lands that border it. These plants will naturally reseed the area. CMC will accelerate the process by tilling and reseeding portions of the land.

CMC will develop the site by regulating water levels to help establish the desired mix of wetland plants. To prove that the restoration project has been successful, CMC will monitor the site for five to ten years, submitting reports to the Corps of Engineers every two years.

When restoration is complete, the wetland will be a diverse community with three kinds of wetland habitat: 36 acres of shallow marsh, 13 acres of wet meadow, and eight acres of deep marsh. Ultimately, CMC intends to turn the property over to a public entity for permanent use as a natural conservancy area.

Wetland Replacement

	New Wetland Acreage	Replacement Ratio
Amount Recommended Under Wisconsin Department of Transportation Formula	35.29	1.2 to 1
Amount Planned by CMC	57	1.9 to 1

Crandon Mining Company
Section 404 Permit Application

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Tables

Figures

(Note: Figures for the Section 404 Permit Application are located at the end of the text, following page 61.)

Appendices

1 Introduction

A permit application and supplementary information for a Water Regulatory Permit and Approval (Form 3500-53, Rev. 9-89) was submitted by Crandon Mining Company (CMC) on July 7, 1994 to the U.S. Army Corps of Engineers (USCOE) St. Paul District (Moe, 1994). Copies of the permit application were provided at that time to the Wisconsin Department of Natural Resources (WDNR) and other interested parties. The July 7, 1994 submittal included information regarding the proposed project that was current at that time as well as relevant sections of the project's 1985 Environmental Impact Report. Since that time, CMC has modified the proposed project and completed a number of studies to update the previous Environmental Impact Report. This submittal provides updated project information as well as the following supporting documentation required by the Section 404(b)(1) Guidelines:

- Alternatives analysis
- Description of wetlands of the study area
- Measures to avoid/minimize wetland impacts
- Unavoidable impacts
- Wetland compensation

In addition to this document, numerous related permitting documents have been or will be submitted to the USCOE, WDNR and other interested parties relating to the Crandon Project. To avoid duplication, information contained in those documents is, in a number of cases, referenced in this addendum.

2 Description of the Proposed Action

The main elements of the Crandon Project consist of an underground mine; ore concentrating facilities; water treatment facilities; a tailings management area; a water discharge pipeline and ancillary facilities such as an access road, a railroad spur line, and service and support facilities. An extensive description of the project is included in the Mine Permit Application. Following is a brief overview describing the entire project. The overview discusses the location of the mining facilities, the geology of the ore body, the mining process and the major project components which will be developed to operate and reclaim the proposed project in a manner which protects public health, safety, and the environment. The relative location of the project is shown on Figure 2-1.

The anticipated rate of production, project life and projected employment requirements for the project are shown in Table 2-1. As with any industrial operation, the life of the facility could change based on economic conditions.

Table 2-1

Anticipated Production and Operation Data

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	7 days/week
Employment (estimates)	
Construction (Peak)	750
Operations	402-526

Prepared by: PAE
Checked by: JWS

Within this section there are numerous references to the "project area", "mine site", "plant site" and the "tailings management area". These terms have specific meanings as follows.

- Project Area - The project area is defined by the boundaries delineated on Figure 2-2.
- Mine Site - The mine site is defined by the limits of disturbance of project facilities within the project area.
- Plant Site - The plant site is generally defined as the area within the mine site that includes all mining, processing, concentrating, water treatment, administrative, and

storage facilities; portions of the railroad spur in the vicinity of the plant site; portions of the access road in the vicinity of the plant site; ventilation raises; and the project's water supply well and its accompanying pipeline corridor. The plant site also includes all surface water runoff and storage basins constructed in its vicinity.

- Tailings Management Area (TMA) - The "TMA" is defined as the area within the "mine site" that includes the project's four tailings cells and berms, the reclaim pond, the tailings and reclaim water pipeline and access road corridors, and contiguous borrow and storage areas. The TMA also includes all surface water drainage facilities constructed in its vicinity.

Two additional areas located outside of the project area include the narrow corridor from the intersection of the site access road and State Trunk Highway (STH) 55 to the Wisconsin River in which the project's treated water discharge line is to be located, and the project's wetland mitigation site located off-site in Shawano and Oconto Counties. Design information for the discharge pipeline to the Wisconsin River is included as part of the water treatment system engineering report prepared pursuant to Wisconsin Administrative Codes. Design information relative to the wetland mitigation site is included as part of this addendum. For completeness the description of the environmental aspects associated with these areas are included in the project's EIR.

The boundaries of the project area, plant site and TMA are shown on Figure 2-2. The plant site and the TMA are approximately 128 acres and 355 acres in size, respectively. The total area of disturbance, including the access road and railroad spur, is approximately 550 acres.

2.1 Site Location

The Crandon 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. The project area is located five miles south of the City of Crandon and two miles east of STH 55 and the Mole Lake Indian Reservation. The plant site is approximately one-quarter mile north of Little Sand Lake and one mile south of Swamp Creek. The primary mine surface facilities, e.g., plant site, will be located north of the ore body. The proposed plant site layout is shown in Figure 2-3. Access to the plant site will be along a new access road from STH 55 northwest of the site. A railroad spur line serving the site will be connected northeasterly to the existing Wisconsin Central Limited Railroad. The project's TMA will be located approximately one mile southeast of the plant site.

The project area shown in Figure 2-2 includes those portions of property which CMC has purchased, leased, optioned for purchase or obtained by easements for use in the development of the plant site, TMA, access roads, railroad spur line and buffer areas.

2.2 Geology

The Crandon deposit is composed of two distinct mineralization types, zinc ore and copper ore. The minerals were deposited during the Precambrian era, about 900 to 2,500 million years ago. The deposit was formed at and just below the ocean floor by mineral bearing fluids of volcanic origin. Some of the material deposited by this volcanic system was sulfide minerals which accumulated in low spots on the ocean floor. Continued accumulation of other volcanic materials and sediments occurred which buried the sulfide deposit. Deep burial, 33,000 to 50,000 feet, resulted in lithification and metamorphism which hardened and solidified both the host rock and the sulfide deposit over time. Later, a mountain building phase occurred in the region, tilting the volcanic layers and the deposit to a near vertical position. Thereafter, the deposit may have been covered by younger sediments, however weathering and erosion have removed these later rocks. The more recent geological process which has affected the deposit is related to Pleistocene glaciation which left the bedrock buried under unconsolidated glacial overburden deposits.

The Crandon ore body is long and tabular with an approximate width of 100 feet, north-south, and a strike length of 4,900 feet, east-west. Based on the results of drilling, the ore body extends to an approximate depth of 2,200 feet. The interpreted geologic stratigraphy and ore body configuration are shown on Figures 2-4 and 2-5 respectively.

The bedrock in the hanging wall and in the footwall of the ore body consists of a series of fragmental volcanic rocks, fine tuffs (solidified volcanic ash), debris flow (ocean floor and volcanic-derived sediments), breccia (blocky, angular particles), lapilli tuffs (gravel sized volcanic material) and flows. Overlying the bedrock is a sequence of unconsolidated glacial sands, clays, and gravels. The rock in contact with the unconsolidated glacial overburden is weathered to varying degrees. The amount of weathering ranges from simple staining to extreme weathering near the surface which reduced the rock to a clay-like material called massive saprolite. The glacial overburden consists of interbedded and co-mingled glacial till, which is material deposited directly by the glacier, and glacial outwash deposited by streams emanating from the glacier. These glacial deposits are found in various thicknesses in the area ranging from 75 feet to over 250 feet thick.

2.3 Key Project Elements

2.3.1 Mine Development

Access to the mine will be through a main production/service shaft located north of the ore body. The first of two ventilation shafts will be located east of this main production shaft. Underground lateral development drifts will access the ore body from the main shaft at 300 foot vertical intervals. These level development drifts are designed to provide access to the ore body. The lateral extent of a mine level at a given point in time will depend upon the need for access to mining blocks, ore passes, and ventilation raises. A schematic longitudinal section showing a typical main level plan is shown on Figure 2-6.

An underground ramp will also connect mine levels to allow for movement of mobile equipment, supplies, and personnel throughout the mine. This centrally-located ramp is also shown schematically on Figure 2-6.

Mine development will be divided into the following phases:

1) Site preparation and the sinking of the main production shaft and the east ventilation shaft. This phase is expected to take 18 months to complete.

2) The development of the underground ore handling and crushing system, the development of the dewatering system, lateral development into the ore horizons and

development of the initial mining blocks (stopes). An internal mobile equipment access ramp will connect the main production ore levels. This phase of mine development is also expected to take 18 months to complete.

As shown on Figure 2-6, mine development and production will begin in areas chosen to avoid weathered bedrock which are expected to be the primary conduits for water inflow into the mine workings.

2.3.1.1 Phase I Development

Phase I development primarily includes simultaneous construction of two vertical shafts in the hanging wall rocks. Each shaft will be concrete lined through the overburden and the weathered subcrop rock. Collar construction through the glacial overburden will include stabilization and hydraulic control by ground freezing or other suitable techniques, followed by the excavation and concrete lining of the shaft into bedrock. If required, inert grout will be pumped under pressure through holes in the collar into the rock and glacial formations to provide a watertight seal. When the collar section of the main shaft and east ventilation shaft are completed, a headframe structure will be erected over each shaft. Conventional shaft sinking by drilling and blasting techniques will then commence at the main shaft and the east shaft concurrently.

During shaft development, it is estimated that the drainage water from both shaft sinkings will be controlled to less than ten gallons per minute (gpm) by grouting. All shaft water will be pumped to the surface water storage ponds.

2.3.1.2 Phase II Development

Because the east shaft is smaller than the main shaft, it will be completed sooner. Upon its completion, horizontal level development will consist of driving a horizontal opening in the hanging wall rock to connect the east shaft to the main shaft (Figure 2-6). After the two shafts are connected, level development can commence to access the ore body.

The underground ore handling facilities will be constructed near the main production shaft during this period. These facilities will consist of: (a) coarse ore and waste rock storage bins, (b) crusher facilities, (c) ore handling systems, and (d) a loadout facility.

2.3.2 Mine Operations

Level development from the main production shaft to the stoping areas will be driven at 300-foot vertical intervals. The primary mining method will be blasthole open stoping with delayed backfill. However, other mechanized variations, such as sublevel mining or cut-and-fill stoping methods may also be used. Stopes (Figure 2-7) will average approximately 300 feet high by 75 feet long, and will vary with the width of the ore body. Ore will be drilled in a stoping block, then blasted and removed. Top hammer or down-the-hole drills will be used to drill approximately four to six inch diameter blastholes on approximately 12-foot by 12-foot center spacing for production stope blasting. Broken ore will be removed from the drawpoints at the bottom of each stope using mechanized mining equipment which will then transfer the ore to the crushing level below by means of ore pass raises. Primary crushed ore, at a top size of eight inches, will be conveyed to a skip loading pocket and hoisted to the surface.

A typical stope will contain approximately 250,000 tons of ore. At a 2,000,000-ton annual production rate, approximately eight stopes will be mined out each year, which exposes less than five percent of the footwall and hanging wall area of the ore body at any one time. Exact production parameters will be based on the grade of the ore in the mined stope; the mechanical characteristics of the rock in the stoping block; and the potential for inflow of water.

A permanent bridge, or crown pillar, of bedrock directly beneath the glacial overburden will be purposely excluded from mining activity. This bedrock barrier, averaging approximately 100 feet thick, along with the routine backfilling of mined-out stopes, will maintain surface stability and prevent subsidence.

In the uppermost mine levels where the ore and host rock may have been moderately weakened by surficial weathering, mechanized cut-and-fill mining may be employed. This method is commonly used by the industry and involves removal of horizontal lifts of ore of variable thicknesses. The void created by each horizontal mining pass is backfilled prior to mining the next upper lift. Less than 10 percent of the ore body may require use of this mining method.

The planned mining methods provide for backfilling all stopes following ore extraction. These practices, combined with the fact that five to 10 percent of the potentially minable ore will be left in place as pillars throughout the mine, will provide perpetual stability of the mine area bedrock and glacial overburden. Backfilling will also result in the reduction of pathways for water migration as mining progresses.

Mine backfilling will begin with the start of milling operations and after the first stope is depleted. The backfill will consist of mill tailings 10 to 15 micron or greater in size, supplemented with coarse waste rock retained underground. Uncemented tailings backfill will have a hydraulic conductivity on the order of 0.028 feet per day. The hydraulic conductivity of cemented tailings backfill will be lower. Backfill slurry containing approximately 60 to 70 percent solids will be pumped underground through boreholes fitted with distribution pipes. The backfilling operations will normally be conducted to coincide with the mining schedule.

Waste rock material from mine development will be used in the stope backfilling process and will be placed before or during the placement of hydraulic tailings fill. The hydraulically-placed fill will flow into and fill the voids between the rock fragments.

Cement will be added to the backfill when needed to provide stability so that the column of fill will stand unsupported and enable complete removal of the ore in the adjacent stope. Approximately one-third to one-half of the total backfill placed in the mine will contain cement.

2.3.3 Mine Dewatering and Groundwater Inflow Control

Groundwater inflow will vary during the different stages of mine construction and operation. The proposed mining plan for the Crandon Project avoids entry into weathered zones during the initial operations, therefore deferring maximum and steady state inflow rates. During the initial operations, groundwater inflow is expected to be minimal and localized, occurring through isolated bedrock fractures that have limited capacity to move water. During this period, exploration holes will be advanced into the weathered bedrock areas to dewater them. The water removed in this fashion will primarily be stored water which will be withdrawn at rates that can be effectively managed at the project's water treatment plant. A more detailed description of this process follows.

As mine development progresses upward from the original mining areas (Figure 2-6), diamond drilling techniques will be used to identify active underground water courses prior to advancing the mine face. Diamond drill holes will be used throughout the mine to drain stored water. Flows encountered on the uppermost active mine level will be captured by interceptor drill holes and contained to avoid contamination by mining operations on levels below and to reduce pumping head. A conceptual cross-section of the groundwater interceptor system showing the collection methodology is presented in Figure 2-8. Standard rock grouting techniques, typically using neat cement, may also be used for local inflow control during the early mine years to limit total mine pumpage.

Typically, groundwater interception holes will form conical fans in the weathered rock above the development openings, thus increasing the radius of the drains. As is common practice in other mines, the drill hole collars will be fitted with valves to allow controlled water removal.

Groundwater collected from exploration drilling or other drill holes placed specifically for inflow interception will be routed directly to a clean water sump and pump station near the main shaft in the upper mine level. The collected groundwater will typically be pumped to the water treatment plant on the surface. However, a portion of the water may be retained underground for distribution as mine utility water.

Groundwater seepage that is not captured by the interceptor system will infiltrate the mine workings and ultimately be recovered in the main sumps along with the mine potable, utility and backfill drainage water. Normal mine drainage collection will begin on each mine level where groundwater seepage, utility water and backfill drainage will be ditched to small local sumps excavated in the drift wall. Decant water from the local mine level sumps will be piped or drained through boreholes or ditched to the main mine sumps located adjacent to the production shaft at the lowest level.

The main mine sumps and pump station will generally be arranged as indicated on Figure 2-9. Sumps will consist of downgrade excavations in the wall rock adjacent to the pump station. These will function as pumping reservoirs with an outlet end bulkhead containing the pump suction pipes.

2.3.4 Ore Processing

Ore mined from the Crandon deposit will be physically concentrated at the plant site by adding water to the crushed ore and grinding it to the size of fine sand particles. After grinding, the ore slurry will be pumped to a series of flotation circuits where reagents are added for separating metallic minerals from the ground-up ore. During this process, minerals will be selectively "floated" to the top of the flotation cells and removed. The remaining material, which is called tailings, will be either used as backfill in the mine or hydraulically transported to the TMA. Different flotation circuits require different reagents to concentrate specific individual minerals. A schematic of the ore processing circuits is shown on Figure 2-10. Separate concentrates of zinc, copper and lead minerals will be recovered by the flotation process. The concentrate from these processes will be thickened and filtered to an eight to 10 percent moisture content.

The tailings will range in size from sand to very fine particles. The coarser tailings from the mineral separation circuits will be used to backfill the mined-out stopes. The finer fraction will be sent to the TMA.

In the TMA, the tailings will settle to the bottom of the lined basin. Excess water will then be pumped from the TMA basin to a reclaim pond for reuse in the ore processing facility. The ore concentration process, TMA, and reclaim pond are designed to operate as a closed circuit. The concentration process normally requires the continuous addition of "makeup" water. Water in this circuit will not require treatment because a discharge will not normally take place. The water treatment system will be designed to treat tailings pond waters for discharge, if necessary.

2.4 Infrastructure

Infrastructure features to support the mine and milling operations include a water treatment plant, ore and waste rock storage facilities, mining waste management facilities, access road, railroad spur line, electric power transmission lines, a natural gas pipeline, a treated water discharge pipeline, and ancillary buildings and storage facilities. A discussion of each follows.

2.4.1 Water Treatment

A water treatment plant will be constructed as part of the project facilities. It will treat mine water and, if needed, process water prior to discharge. Intercepted 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 water treatment plant. Groundwater that bypasses the interceptor system and comes in contact with mining activities will be commingled with other mine drainage water, such as the water used to cool the drill bits while drilling the blast holes. All of these "contact waters" will be routed through the water treatment plant.

The water treatment plant will include a lime and sulfide precipitation system with filtration and pH adjustment. Treatment solids from this facility will be placed along with the ore processing tailings in the TMA. Mine water will be treated to meet WDNR Water Quality Standards before being discharged to the Wisconsin River via a discharge pipeline installed primarily along the U.S. Route 8 corridor (Figure 2-11).

The treatment system is designed with two holding ponds to retain the treated water so it can be sampled prior to discharge. This will ensure all water meets discharge standards, prior to discharge.

Sanitary water will also be generated at the facility. Sanitary water will be handled separately through a package sanitary water treatment plant. The treated effluent from this plant will be pumped to the TMA.

2.4.2 Mining Waste Management

Crandon Project mining wastes will include waste rock, tailings, refuse, water treatment plant solids, and laboratory wastes.

Over 50 percent of the waste rock generated by the project will be left in the mine to be used as backfill for mined-out stopes. Limited quantities of waste rock will be brought to the surface during preproduction and managed as discussed in Section 2.4.3 below. As discussed in Section 2.4.4 below, approximately 50 percent of the tailings generated by the project will be returned to the mine as backfill, with the remaining 50 percent placed in the TMA.

During the mining operations on-site laboratories will be used to conduct metallurgical testing for mining grade control and for production quality assurance testing related to milling operations. Wastes generated from the performance of these tests will be placed in the TMA. Approximately 900 cubic yards of general refuse such as office wastes will be generated at the facility each year during the 35 years of construction, operation and reclamation. The reclaimable portion of this waste will be recycled in accordance with state law. The remaining waste materials will be disposed of by a contractor in an approved off-site landfill.

Solids will be generated from the treatment of project generated waters. These solids will be placed in the TMA with the tailings.

2.4.3 Preproduction Ore/Waste Rock Storage Areas

Two storage areas will be located to the north of the main production shaft to store ore and waste rock hoisted to the surface during pre-production mine development. Prior to the commencement of underground crushing and the start of mill operations, approximately 1,050,000 tons of uncrushed ore and waste rock of a maximum size of 24-inches will be placed on the two separate areas. One storage facility which will be lined will be used to store approximately 350,000 tons of ore and about 100,000 tons of Type II waste rock. The remaining 600,000 tons of Type I waste rock will be deposited on an unlined area located east of the lined storage area. Type I waste rock is material that has a very low potential to leach, while Type II waste rock has a higher leaching potential. The lined area is designated as the preproduction ore storage area on Figure 2-3. The unlined area is referred to as the construction material storage area on the same figure. Both storage areas have been designed to accommodate the maximum potential amount of waste rock and ore hoisted from underground during the preproduction period and will occupy a total area of approximately 18 acres.

For the preproduction ore storage area a central ridge will divide the facility on its north-south axis. Each side of the lined pad will slope away from the center. The pad will be bounded by berms with runoff collection ditches which will route water to a lined water storage basin. The base of the pre-production ore storage area will consist of a compacted layer of existing soil overlain by a geomembrane liner. A till cushion will be placed over the geomembrane. Water from this area will be drained to a water storage basin. The location of the basin is sized to hold the volume of water from a 25-year, 24-hour storm event. Water from this basin will be either pumped to the TMA for use in ore processing or to the project's water treatment plant.

The base of the construction material storage area will consist of a compacted layer of existing on-site soil. The base will be sloped to drain toward another of the site's surface water runoff basins. Water from this runoff basin will be discharged to natural site drainage ways. Following commencement of mill operations, the ore stored in the preproduction storage area will be processed. Type II waste rock stored in this area will be hauled by truck to the TMA for disposal or for use as riprap for TMA internal sidewalls. Type I waste rock will be used as construction material.

2.4.4 Tailings Management Area

All tailings produced by ore processing that are not used for mine backfill, hoisted Type II waste rock, water treatment plant solids and the small amount of laboratory wastes will be placed in the TMA. The TMA has been designed to provide long-term, environmentally-safe containment. Tailings and treatment plant solids will be pumped to the TMA through a high density polyethylene (HDPE) pipeline. Waste rock will be transported to the TMA by truck.

As shown on Figures 2-12 and 2-13, the TMA will consist of four cells, each of which will be lined and include a leachate collection system. The four cells, referred to as TMA1 through TMA4 will each be constructed and operated in two stages. TMA1 and TMA2 are designed to contain the tailings from processing the zinc ore. TMA3 and TMA4 will be used for the copper ore tailings. The approximate capacities and site lives for each cell are shown in Table 2-2.

Table 2-2

Approximate Tailings Management Area Capacity

TMA Cell	Capacity (in millions of cubic yards)	Approximate Site Life (years)
TMA 1	4.0	6
TMA 2	7.8	10
TMA 3	3.9	6
TMA 4	4.8	6
Total	20.5	28

Prepared by: PAE
Checked by: JWS

TMA cell construction and operation will first involve constructing and filling Stage 1 of TMA1. As the tailings in Stage 1 approach the design elevation, Stage 2 of TMA1 will be built. When approximately one to two years of capacity remain in TMA1, construction of Stage 1 for TMA2 will begin. When TMA1 is full, tailings placement in TMA2 will start. After consolidation, reclamation of TMA1 will begin, while filling in TMA2 progresses. The same process will continue for TMA3 and TMA4.

The tailings slurry will be transported from the concentrator building to the TMA through an approximate 16-inch inside diameter HDPE aboveground pipeline. The location of the pipeline is shown on Figure 2-2. The pipeline will lie above ground in a lined ditch. A 22-foot wide access road will be located next to the pipeline for service and maintenance. Pumps used for pumping the tailings slurry in the pipe will be located in the concentrator building. The pipeline ditch will be sloped to lined sumps located at the plant site and approximately midway between the plant site and the TMA to collect tailings and water in the event of leakage or to provide storage if the pipe must be drained.

The tailings slurry will be deposited in the active TMA cell using spigots. The spigot discharge point(s) will be regularly moved around the inner perimeter of the active cell to facilitate even distribution of tailings and to keep the tailings saturated. The excess water that drains from the slurry after the tailings have settled will flow to an area in the center of the cell and will be pumped to the reclaim pond. Water in the reclaim pond will be retained for a short time and then pumped to the mill for reuse in the process circuit. The tailings operating system is designed to maximize tailings density.

The TMA cells have been designed to meet the standards contained in applicable state statues and administrative codes which are written to protect the public health and welfare. Key TMA design features include:

- An average 43-foot separation from the base of the TMA to groundwater.
- A minimum 1,250-foot separation from the nearest lake or stream.
- A composite liner consisting of a low-permeability soil member and a geomembrane liner.
- A leachate collection system over the bottom of each cell and partially up the interior sidewalls of each cell.
- A reclaimed final cover consisting of the following components from top to bottom.
    - topsoil
    - rooting layer
    - drainage layer
    - geomembrane liner
    - low permeability soil liner
    - grading layer
- Surface water control structures designed to accommodate a 100-year, 24-hour storm event.

2.4.5 Access Roads

A site access road will be constructed from STH 55 to the plant site. A second access road will be constructed from the plant site to the TMA. The site access road will be approximately three miles long and consist of bituminous concrete with gravel shoulders. The treated water discharge line will be buried in the right-of-way of the site access road. The TMA access road will be approximately one mile long and will be gravel-surfaced. Pipelines for tailings disposal and reclaim water will be sited adjacent to the TMA access road in a lined ditch.

2.4.6 Railroad Spur

A 2.7-mile railroad spur line will be constructed from the plant site to the Wisconsin Central Limited Railroad located to the northeast. The spur line will consist of a single track along most of its corridor. A side track will be located near the point where the spur line connects with the main railroad line. The sidetrack will be used for switching and rail car staging. The spur line will be used to bring cement, lime and other materials to the plant, and to ship concentrates to market. Concentrate will be shipped in enclosed cars or containers.

2.4.7 Utilities

Electrical service to the project site will be provided by Wisconsin Public Service Corporation (WPSC) by an electric transmission line constructed between an existing substation near Monico, Wisconsin, and a new substation to be located at the plant site. The substation near Monico will be upgraded by WPSC as part of the extension of electrical power for the project.

The WPSC area distribution system, which will likely be located near the south end of Lake Metonga, will supply natural gas for the project via a pipeline installed to the plant site. The pipeline route will follow existing county roads, cross Swamp Creek north of the plant site, and then follow the main plant access road into the site.

2.4.8 Other Facilities

In addition to the project elements discussed above other site facilities as listed below will be constructed and used as part of the project:

- Administrative offices
- Changehouse facilities
- Explosive storage areas
- 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 protection systems
- Lubricant storage
- Bulk fuel storage
- Lay-down areas
- Railroad weigh scale
- Mobile equipment fuel station
- Parking areas
- Material storage areas

2.4.9 Surface Water Controls

Precipitation falling within the limits of the plant site will be collected and directed to one of a number of water storage basins. Contact runoff will be directed to the water treatment plant or to the TMA. Non-contact runoff will be directed to existing natural drainage features after passing through runoff basins. Precipitation falling within the TMA will co-mingle with process water and become part of the water used in the mill circuit. Some of the surface water drainage originating from outside the active mining area will be intercepted by a series of drainage swales and directed to existing natural drainage features.

2.4.10 Wetland Mitigation

Although mine facilities have been designed to minimize impacts on wetlands, as part of project construction activities, approximately 29.5 acres of wetlands will be either excavated or filled. To compensate, CMC will develop replacement wetlands on a site located in Shawano and Oconto Counties. The selected site is in an area that was originally wetlands, but was converted to cropland. The establishment of the compensation site involves reconverting it from cropland back to wetlands. Section 8 of this report contains a detailed discussion of the proposed compensation site.

2.4.11 Mine Reclamation

Topsoil will be salvaged and stored from all disturbed areas for use in reclamation activities. Reclamation of the mining 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 forestry and as open green space. During construction, disturbed soil areas will be revegetated on a continual basis such that wind and water erosion potential is significantly reduced. These areas will either be temporarily reclaimed or finally reclaimed depending upon their location relative to future construction activities.

Final reclamation of the plant site will begin after completion of mining. All open boreholes will be sealed in compliance with applicable regulations. Salvageable equipment from the mine will be brought to surface. Any equipment left underground will have potentially harmful fluids removed. The shafts to the mine will be sealed with reinforced concrete plugs. Surface facilities may be converted to other uses if possible. If other uses are not feasible, those facilities will be removed. The site area will be regraded and revegetated. Settling basins and ponds will be drained and the area reclaimed. Containment structures will be removed. Disturbed areas will be regraded and revegetated. The TMA will be reclaimed in phases during its lifetime. Final closure of the last cell of the TMA will occur late in the sequence of project reclamation.

The water treatment plant and associated pipelines will be removed after they are no longer required. Salvageable equipment will be transported off-site. Scrap and treatment solids will be 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 water treatment plant area and pipeline routes will be graded and revegetated.

On-site roads, the plant site access road and the railroad spur line will be among the last items to be reclaimed. Reclamation of these features would be dependent upon the final site use. If no future use is anticipated, the construction materials will be removed. Bituminous pavement will be salvaged for use elsewhere, if possible, or placed in the TMA. Rail will be salvaged. The areas will be regraded and revegetated.

Utilities that service other customers along the route to the plant site will be left in place. The portion of the utilities that extend onto the plant site will be removed if above ground, or remain in service depending upon the final use of the site. Below ground piping will be flushed as required, capped and left in place, if no longer in service.

3 Project Purpose

The purpose of the Crandon Project is to develop an underground mine to facilitate the extraction of zinc and copper ore for on-site benefication prior to the transport of the resulting concentrates outside Wisconsin for further processing. Given that the location of the ore body is fixed and that it is necessary for technological, logistical, economic and environmental reasons to locate surface facilities near the ore body, flexibility in locating Crandon Project surface facilities is significantly reduced in comparison to other non-mining projects. Within these constraints, CMC believes that the location and design of project facilities will create the least overall environmental impacts and also minimize direct impacts to wetlands.

4 Alternatives Analysis

A detailed alternatives analysis for the project has been conducted and is included in Section 4 of the project's 1995 Environmental Impact Report. The analysis, which is incorporated into this addendum by reference, addresses alternatives identified and evaluated for major project features. As demonstrated in that analysis, CMC does not believe that there are any practicable alternatives to its proposal which would result in further avoidance or minimization of impacts to wetlands.

5 Study Area Wetlands

The purpose of this section is to present data regarding the current condition of wetlands in the area surrounding the proposed Crandon Project site. The wetland studies were conducted to satisfy the requirements of Section 404 of the Clean Water Act and Wisconsin Administrative Code (WAC) NR 132. Field and laboratory methods are described in Section 5.1, followed by a summary of the wetland types identified in Section 5.2. Ecological relationships between the study area wetlands and wetlands existing in the region are discussed in Section 5.3, while hydrological relationships are addressed in Section 5.4.

5.1 Field and Laboratory Methods

Wetland studies were begun in the early 1980s by Normandeau Associates, Inc. and Interdisciplinary Environmental Planning, Inc. (IEP). Wetlands in the study area were mapped and characterized, and the wetland's functional values were assessed. This work was validated and updated by Foth & Van Dyke for the purposes of incorporation into the project's May 1995 Environmental Impact Report (Foth & Van Dyke, 1995a).

The wetland study area is defined as an approximate 18.3 square mile area surrounding the Crandon Project site (Figure 5-1). Study methods employed by previous investigators, as well as the current studies by Foth & Van Dyke, are described below. Methods are divided into two categories: 1) wetland mapping, delineation, and characterization, and 2) wetland functional analyses.

5.1.1 Wetland Mapping, Characterization, and Delineation

In 1981 and 1982, assessments were conducted on wetlands existing on the CMC property that were larger than 0.25 acres. The assessment included wetlands in an approximate 9.4 square mile area encompassing the plant site, two alternative TMA sites, the access road corridor, and the railroad spur corridor (Normandeau Associates, Inc. and IEP, 1982a,b,c,d). IEP evaluated additional wetlands in 1983 in a larger study area than that used in 1981 and 1982 (IEP, 1983). In total, the two assessments mapped and evaluated the functional values of the wetlands in an approximate 18.3 square mile study area.

Wetlands were originally mapped at a scale of 1 inch = 400 feet by stereoscopic interpretation of 1976 to 1981 aerial photography. 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 (Normandeau Associates, Inc. and IEP, 1982a,d).

Quantitative studies of plants and wildlife communities were conducted in wetlands representative of the different types of wetlands existing in the study area (e.g., scrub/shrub, emergent/wet meadow, bog, etc.). 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 layer). A relative importance index was computed for each species in each strata (Normandeau Associates, Inc. and IEP, 1982a).

Herptofauna, mammals and avifauna were inventoried in representative wetlands. In general, the survey for reptiles and amphibians noted all individuals seen or heard during each phase of the field work from April to June. Spotted salamanders were intensively sampled using pitfall traps and drift fences. Two representative areas of each wetland type were selected for bird census. A line transect and one listening station were established. All bird species seen or heard were recorded. 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 (Normandeau Associates, Inc. and IEP, 1982a).

Fugro-McClelland, Inc. mapped additional wetlands, typically less than 0.25 acres in size, in the plant site and TMA areas in 1992. Similar procedures to those described for the 1981/1982 work were followed.

In August 1994, Foth & Van Dyke delineated wetlands 5, P2, F64, F65 and M3 in accordance with the 1987 *U.S. Corps of Engineers Wetland Delineation Manual.* The purpose of this delineation was to select a subsample of wetlands to validate the work conducted by Normandeau Associates, Inc. and IEP Inc. in the early 1980s for consistency with the 1987 USCOE Manual (USCOE, 1987) mapping methods. These wetlands, totaling approximately 25 percent of previously delineated wetlands in the area of planned disturbance, were delineated, flagged, and a horizontal control survey was conducted to allow for the production of a wetland boundary map which could be directly compared with the wetland map prepared by the previous investigators. The results of this verification evaluation are described in Section 5.2.

In November 1994 as part of investigating alternative sites for wastewater discharge absorption ponds, Foth & Van Dyke delineated a 0.26 acre wetland located to the northwest of the plant site. This wetland, referred to as Wetland 22, is located in an area that was clear-cut by a third party since the previous wetland studies were conducted in the early 1980s. Wetland 22 is situated upgradient of a logging road that appears to have impeded the natural flow through a drainage swale, thereby creating conditions suitable for the formation of this small wetland. A letter (Moe, 1995) discussing the delineation of this wetland is provided in Appendix A.

5.1.2 Wetland Functional Assessment Methods

The functional values of 158 wetlands in the study area were assessed by Normandeau Associates Inc. and Interdisciplinary Environmental Planning, Inc. in the early 1980s (Normandeau Associates, Inc. and IEP, 1982 a through d; IEP, 1983). The functional values of 16 additional wetlands were assessed by Fugro-McClelland in 1995. The wetland functions considered, as required by WAC NR 132, included the following:

1. Biological
2. Hydrologic Support
3. Groundwater
4. Storm and Floodwater Storage
5. Shoreline Protection
6. Water Quality Maintenance
7. Cultural/Economic
8. Recreational
9. Aesthetics
10. Educational

A separate model, representing each of the above wetland functions, was used to provide a score for each of the ten functions for each modeled wetland. The individual scores from each model were then weighted and summed to provide an overall wetland functional value ranking for each wetland. The biological and hydrological functions (i.e., hydrologic support, groundwater, storm and flood water storage, shoreline protection, and water quality maintenance) were considered of equal importance and each was weighted 40 percent. The remaining 20 percent was divided equally among the cultural/economic, recreational, aesthetics and educational function. The final ranking was based on a scale of 0 to 100, with 100 the highest possible ranking. Assessment methodology is described in detail in Appendix B.

5.2 Wetland Characterization/Classification

In total, approximately 2145 acres of wetland have been mapped within an approximate 18.3 square mile (11,711 acres) area surrounding the proposed mine facility. As a result, 256 individual wetlands were mapped as shown on Figure 5-1. Out of that number, 174 wetlands were greater than 0.25 acres or existed in areas where potential direct impacts are expected to occur. A functional values assessment was conducted for each such wetland (i.e., the named wetlands [e.g., W1] shown on Figure 5-1). All 256 wetlands were habitat typed (Figure 5-2). In a WDNR correspondence/memorandum dated September 15, 1994 from Dave Siebert, it was indicated that WDNR field staff evaluated the wetland work completed in the 1980's and were satisfied with the mapped wetland boundaries (Siebert, 1994). A copy of this memorandum is included in Appendix A. Further, based on the 1994 Foth & Van Dyke validation of the previous wetland mapping, it is concluded that the wetland mapping/characterization work performed by Normandeau and Associates, Inc. and IEP (1982a through d and 1983) is a conservative representation of the wetlands in the entire study area and may have overestimated the acreage by up to 13 percent (Appendix C).

Table 5-1 provides a summary of the wetlands existing in the study area by wetland habitat type reflecting current updated information. Table 5-2 presents a comprehensive listing of all wetlands in the study area, including dominant wetland habitat type and acreage. The results of the wetland functional analysis are presented in Appendix D.

Table 5-1

Summary of Wetlands Existing Within the Study Area and Limits of Project Facilities

Wetland Habitat Type	Study Area[1] (acres)
Aquatic Bed	5
Emergent/Wet Meadow	192
Shrub Swamp	274
Conifer Swamp	1,306
Deciduous Swamp	193
Bog	175
Total	2,145

[1] Within the 18.3 square mile study area.

Prepared by: RFS
Checked by: AWZ

Table 5-2

Study Area Wetland Vegetation Types and Sizes

Wetland ID	Dominant Vegetation Type (1)	Total Acres
A1	SM	0.74
A2	CS	2.15
A3	DS	1.11
B1	SW	0.01
B2	CS	5.19
B3	DS	1.5
B4	CS	20.54
B5	CS	0.55
B8	DS	0.48
D1	CS	4.39
D2	SW	0.09
D3	DS	1.61
D4	CS	17.15
D4A	DS	1.84
D5	B	0.9
D8	DS	0.78
D18	DS	0.94
F1	SW	3.9
F2	SM	20.3
F4	CS	3.81
F5	CS	3.32
F6	SW	0.02
F7	SM	20.46
F8	DS	0.9
F9	CS	7.74
F10	CS	9.02
F11	CS	18.37
F12	SM	15.12
F13	CS	1.35
F15	DS	36.47
F16	B	8.81
F17	DS	1.75
F18	CS	56.34
F19	SM	9.21
F21	SM	1.35
F22	DS	2.21

Table 5-2 *(Continued)*

Wetland ID	Dominant Vegetation Type (1)	Total Acres
F23	SM	4.46
F24	SW	0.01
F25	DS	4.08
F26	SW	0.12
F27	DS	3.44
F28	B	59.69
F29	SS	3.16
F30	SW	0.02
F31	CS	6.45
F32	DS	0.68
F33	DS	1.82
F34	DS	0.45
F35	CS	2.17
F36	DS	1.36
F37	SM	15.72
F38	SW	0.09
F39	SS	5.92
F40	SM	7.9
F42	SS	0.44
F43	B	1.33
F45	B	0.65
F46	DS	3.36
F48	CS	0.53
F50	DS	0.59
F51	DS	0.45
F52	B	2.91
F53	CS	13.93
F54	B	0.93
F55	DS	0.52
F57	DS	6.22
F58	SM	0.4
F60	DS	31.76
F61	DS	2.03
F62	DS	8.27
F63	CS	9.68
F64	B	4.62
F65	SS	2.16
F66	CS	16.27

Table 5-2 *(Continued)*

Wetland ID	Dominant Vegetation Type (1)	Total Acres
F69	DS	1.38
F70	DS	2.44
F72	DS	4.29
F81	SM	0.33
F86	DS	0.46
F87	DS	0.74
F90	AB	0.23
F114	SM	0.52
F116	CS	0.79
F119	CS	1.11
F121	CS	0.48
F122	DS	0.61
F122A	SS	0.46
F125	SS	0.87
F126	SM	1.45
F127	DS	1
G1	DS	0.37
H1	CS	18.62
I1	DS	0.64
J1	DS	0.52
K1	SW	0.13
K2	DS	5.17
K3	CS	12.52
K4	SS	0.8
K5	B	1.3
L1	DS	0.97
M1	SS	1.09
M2	SW	0.3
M3	DS	4.51
M4	DS	1.37
M5	CS	1.83
M5A	CS	0.09
YM6	DS	0.62
N1	SS	0.71
O1	CS	113.85
O3	DS	2.22
P1	DS	2.75
P2	CS	18.09

Table 5-2 *(Continued)*

Wetland ID	Dominant Vegetation Type (1)	Total Acres
R1	DS	4.93
R1A	DS	7.15
R3	SM	19.08
R5	CS	10.43
R7	DS	1.52
R7A	SS	2.72
R8	SS	1.92
T1	B	1.66
T2	B	1.74
T3	SS	0.32
T4	CS	199.02
T5	CS	1.64
Z1	SM	7.38
Z2	SM	15.6
Z3	SM	2.04
Z4	SM	1.45
Z5	SM	19.34
Z6	CS	44.68
Z7	DS	3.89
Z8	DS	2.78
Z9	CS	9.54
Z10	DS	20.93
Z11	CS	26.18
Z12	SS	6.9
Z13	SS	4.08
Z14	CS	75.28
Z15	CS	9.89
Z16	CS	33.79
Z17	SM	3.35
Z18	DS	9.59
Z19	CS	3.53
Z20	SM	42.36
Z21	CS	3.54
Z22	SM	22.7
Z23	CS	226.96
Z24	CS	4.02
Z25	SS	16.26
Z26	B	2.86

Table 5-2 *(Continued)*

Wetland ID	Dominant Vegetation Type (1)	Total Acres
W1	CS	436.64
W2	CS	78.47
1	SS	0.67
2	DS	0.65
3	SM	0.71
4	SS	1.98
5	SM	0.28
6	SM	0.16
7	CS	0.2
8	CS	0.27
9	SM	0.19
10	CS	1.41
11	DS	0.72
12	DS	0.11
13	DS	0.07
14	DS	0.06
15	DS	0.14
16	DS	0.1
17	DS	0.54
18	CS	1.51
19	DS	0.13
20	DS	1.85
21	SM	0.07
22	SM	0.26
Other Mapped Wetlands in Study Area	Various	52.52

(1) SM = Emergent marsh/wet meadow.
CS = Coniferous Swamp.
DS = Deciduous Swamp.
B = Bog.
SS = Shrub Swamp.
AB = Aquatic Bed
SW = Streamside Wetland. These may contain components of each of the above listed vegetation types.

Prepared by: RFS
Checked by: AWZ

5.3 Ecological Relationships

To assess the significance of the wetland types occurring in the study area surrounding the proposed Crandon Project site, a comparison was drawn between the frequency of occurrence of each wetland type in the study area with the frequency of occurrence of wetland types in the region (Normandeau Associates, Inc. and IEP, 1982 a through d; IEP, 1983). The larger evaluated region is defined as the Fox-Wolf River Watershed above the town of Langlade as shown in Figure 5-3. Regional wetland acreage and habitat interpretations were based on stereoscopic analysis of aerial photographs dated July 1979 obtained from the WDNR (Normandeau Associates, Inc. and IEP, 1982a). The results of this comparison are presented in Table 5-3. The representation of a given wetland type in the study area versus the total wetland area for the region provides an indication of the regional distribution of the wetland types identified.

Wetlands are a common landscape feature in the region. Based on the results of Normandeau Associates Inc. and IEP (1982 a through d and 1983), wetlands comprise approximately 20 percent of the total land area of the larger region. Conifer swamp is the most common wetland type in the region followed by deciduous swamp, shrub swamp, bog, marsh and finally, aquatic bed.

The relationship between the frequency of wetland occurrence in the study area and that of the region is proportional to the relationship between the overall size of the study area and the size of the region (Table 5-3). The study area comprises approximately 3.9 percent of the region while the study area wetlands comprise approximately 3.5 percent of the regional wetlands. In other words, the study area contains an average quantity of wetland for the region in which it is located.

Table 5-3

Frequency of Occurrence of Wetland Types in the Study Area Versus the Region

Wetland Type	Estimated Area of Wetlands in the Region[1]	Area of Wetlands as a Percentage of the Total Regional Area	Acreage of Wetlands in the Study Area[2]	Study Area Wetlands as a Percentage of the Total Study Area	Study Area Wetlands as a Percentage of the Regional Area Wetlands[3]
Scrub/Shrub	10,083	3.3	274	2.3	2.7
Bog	4,800	1.6	175	1.5	3.6
Aquatic Bed	785	0.3	5	<0.1	0.6
Deciduous Swamp	15,940	5.3	193	1.6	1.2
Conifer Swamp	25,873	8.6	1306	11.2	5.0
Emergent Marsh/Wet Meadow	3,174	1.0	192	1.6	6.1
Total	60,655	20.1	2145	18.3	3.5

[1] Total land area of Fox-Wolf River Watershed: 301,900 acres.

[2] Total land area of the study area: 11,711 acres.

[3] This column is not additive since the denominator is not constant.

Source: *Adapted from Table 6.5-1 in Normandeau Associates Inc. and IEP, 1982a and Table 5.4-1 in IEP, 1983.*

Prepared by: RFS
Checked by: AWZ

5.4 Hydrologic Relationships

The proposed Crandon Project site and surrounding study area are located in the Fox-Wolf River watershed which is part of the Lake Michigan drainage basin. Surface water hydrology is controlled by an average annual rainfall of 30.36 inches (Foth & Van Dyke, 1995a). It is also controlled by the surface soils, topography, vegetation, land use, and seasonal temperature variations.

The study area is located at or near the top of the watershed for a number of small creeks. The surface area contributing to the wetlands within the study area is generally small, with the exception of the wetlands along Swamp and Hemlock Creeks, thus the surface water budgets of the study area wetlands are relatively low. Relatively permeable surface soils in the wooded uplands result in very little runoff except during snowmelt and during above average rainfall events.

There are numerous wetlands located in upland areas of the study area situated in small isolated basins with no defined surface water outlet. The exception to this are the riparian wetlands along Swamp Creek, Pickerel Creek, Hemlock Creek and those surrounding and feeding the five wetland study area lakes.

Wetlands can be classified as either discharge or recharge wetlands based on their relationship with the groundwater system. A detailed discussion of the classification of wetlands in the study area is presented in the May 1995 Crandon Project Environmental Impact Report (Foth & Van Dyke, 1995a).

6 Wetland Avoidance/Minimization of Disturbance

As depicted in the project's 1986 Environmental Impact Statement (WDNR, 1986) and in Table 6-1, project facilities as proposed in 1986 consisting of the plant site, TMA and water reclaim ponds, access road, TMA access road, and railroad spur would have resulted in approximately 65.4 acres of direct wetland impact. The original configuration of the surface facilities as presented in the 1986 Environmental Impact Statement (WDNR, 1986), was further evaluated in 1994 and 1995 by CMC in an effort to further avoid and/or minimize wetland impacts associated with the proposed surface facilities. As a result of that work, the project as currently proposed will directly impact only 29.5 acres as shown in Table 6-1. A discussion of the adjustments made in the project to decrease overall direct wetland impacts is presented in the following paragraphs.

Table 6-1

Minimization of Wetland Disturbance

	Area of Wetland Disturbance	
Project Facilities	Previous Project[1]	Current Project[2]
Plant Site	0.0[3]	0.28
TMA and Reclaim Pond	57.7	21.79
Access Road	3.2	3.91
TMA Access Road/Tailings Transport Pipeline Corridor	0.6	0.47
Railroad Spur	3.9	3.05
Total	65.4	29.5

[1] WDNR, 1986 FEIS

[2] Foth & Van Dyke

[3] Value reported in 1986 FEIS. Based upon further review the area of wetland disturbance for the plant site as outlined in the 1980's would have been approximately 7.64 acres.

Prepared by: PAE
Checked by: RFS

6.1 Plant Site

The following concepts were incorporated into the design of the currently proposed plant site to minimize impacts to wetlands:

- The services building, concentrator building and wastewater treatment plant were moved closer together. This revision reduced the overall size of the plant site area and resulted in less disturbance area.

- The west ventilation shaft was relocated closer to the main shaft. This resulted in a reduction in wetland impacts by eliminating the need to construct a road across wetland 4 and wetland R8 west of the plant site.

- Internal to the plant site, the railroad spur alignment was adjusted and one railroad spur within the plant site was eliminated. This resulted in a reduction in the overall disturbance area and avoided wetland 11 north of the rail spur.

- The alignment of the road accessing the explosives storage area was adjusted to avoid disturbing wetlands 11 and O3.

The revisions described above have resulted in a decreased plant site footprint. As shown on Figure 6-1, this smaller plant site is generally at the same location as that proposed in 1986. Based on the current assessment of wetland impacts for the 1986 plant site footprint, the current footprint results in an overall reduction in plant site wetland impacts of 7.36 acres.

6.2 Tailings Management Area and Water Reclaim Pond

The following concepts were incorporated into the currently proposed design of the TMA to reduce the overall size of the facility and reduce impacts to wetlands:

- External features such as construction staging areas, borrow areas and other surface facilities external to the TMA cells have been eliminated or minimized and relocated to avoid additional wetlands.

- Interior slopes of 3:1 are proposed as opposed to the previously proposed 4:1 slopes. The 3:1 slopes which provide a more efficient use of space helped reduce the size of the TMA.

- A reduction in estimated mineable reserves resulted in the need for a smaller TMA.

- A two percent cell base slope design incorporates a high-point across the center of each cell resulting in a greater volume for a given area which helps reduce the size of the TMA.

- The number of water reclaim ponds and the capacity required at the TMA have been substantially reduced. Previously, two reclaim ponds approximately 60 acres in size were proposed. The current design incorporates one pond approximately five acres in size at the TMA site. In addition, a second waste storage pond is proposed to be sited at the plant site.

- The interior and exterior berm widths have been optimized to reduce the size of the total footprint of the TMA.

The revisions described above have resulted in a reduced TMA footprint. This in turn, provided an opportunity to shift the location of the TMA to further avoid wetlands. The 1986 footprint, as shown in Figure 6-2, resulted in 57.7 acres of direct wetland impact. An alternative footprint, as shown in Figure 6-3, was developed which shifted the TMA north from the 1986 footprint, and would have resulted in 32.25 acres of direct wetland impact. A further shifting of the TMA northward resulted in the preferred alternative TMA footprint as shown in Figure 6-4. The preferred alternative TMA footprint avoids wetlands F15, F28, 18, 19, 20, F27, F64, F65 and the majority of F66. As shown in Figure 6-1 the 1995 preferred TMA footprint results in 21.79 acres of direct wetland impact. The preferred alternative results in a 35.91 acre reduction in wetland impacts over the 1986 design.

6.3 Access Road

Access road construction as currently proposed (Figure 6-5) will result in 3.91 acres of wetland disturbance. This is an increase of 0.71 acres over the previously proposed project. The increase is due to the need for a slightly wider construction corridor to accommodate utility installation.

6.4 TMA Access Road/Tailings Pipeline Corridor

As shown on Figure 6-6 the TMA access road/pipeline corridor was designed such that it crosses only wetland F11. The access road/pipeline corridor design has been narrowed to a minimum cross section through this wetland to reduce the amount of wetland disturbance. Figure 6-7 shows a cross section of the TMA access road/pipeline corridor.

The design consideration discussed above resulted in a reduced TMA access road/pipeline corridor width. This in turn, reduces the amount of wetland impact. In addition, the location of the wetland F11 crossing was adjusted slightly from the 1986 alignment (Figure 6-6). The original alignment would have resulted in a 0.6 acre direct wetland impact. The combination of the current design considerations with the locational considerations resulted in a reduction of wetland impact to 0.47 acres. As a result the currently proposed TMA access road/pipeline corridor reduces direct impacts to wetlands by 0.13 acres.

6.5 Railroad Spur

The following concepts were incorporated into the currently proposed design of the railroad spur (Figure 6-8) to reduce overall impact to wetlands:

- Elimination of the southern railroad spur connection to the Wisconsin Central Limited Railroad route near Keith's Siding Road to avoid wetland T2 entirely.

- Modifying the curve of the north railroad spur connection to the Wisconsin Central Limited Railroad route near Keith's Siding Road to avoid wetland T1 entirely.

- Shifting the alignment of the railroad to the east to avoid Wetland O1.

As originally proposed, the railroad spur resulted in a 3.9 acre direct wetland impact. The wetland impact was reduced to 3.05 acres as a result of the design considerations listed above. The proposed alternative has resulted in a reduction of 0.85 acres of wetland impact.

7 Unavoidable Impacts

The following discussion of wetland impacts has been divided into three sections; direct impacts, temporary impacts and indirect impacts. Direct impacts are defined as the physical loss of wetland habitat resulting from filling or excavating. Temporary impacts are short-term in nature and will not result in permanent, direct wetland impacts. Indirect impacts are defined as secondary impacts that may occur either as a result of the direct impact (eg., increases or decreases in hydrologic inputs to downgradient wetlands) or through other actions associated with the construction or operation of the proposed mine (eg., groundwater drawdown).

7.1 Direct Impacts

Of the wetlands that were mapped, inventoried, and evaluated in the study area, 25 will be affected through partial or total reduction in size during construction of the plant site, TMA and reclaim pond, access road, TMA access road/tailings pipeline corridor, and railroad spur. Figure 5-1 illustrates the relationship of potentially affected wetlands to the proposed project facilities. The reduction in wetland acreage due to project implementation will not occur simultaneously but will occur in phases over a period of several years. These phases are described in Section 2 of this report. For the purposes of this impact assessment, however, these phases are treated collectively.

As described in Table 7-1 the 25 affected wetlands include 0.61 acres of emergent marsh, 3.12 acres of shrub swamp, 9.79 acres of deciduous swamp, 15.92 acres of coniferous swamp, and 0.06 acres of bog. Impacts to these wetlands were assessed on the basis of the raw unnormalized scores that were calculated for each of the 174 wetlands in the Wetland Function Model described in Appendix B. The scores associated with those wetlands that will be directly impacted are presented in Table 7-2. The Wetland Function Model was not applied to the three unnamed wetlands due to their small size.

Table 7-1

Acreages of Wetland Types Removed During Project Construction

	Wetland Types					
Wetland No.	Emergent Marsh	Shrub Swamp	Deciduous Swamp	Coniferous Swamp	Bog	Total Area Impacted
Plant Site						
5	0.28					0.28
Subtotal Plant Site	0.28					0.28
Tailings Management Area						
F30[1]			0.02			0.02
F31			2.16	4.29		6.45
F32			0.68			0.68
F81	0.33					0.33
16			0.10			0.10
F33			1.82			1.82
17			0.54			0.54
M4			0.73			0.73
M3			1.56	1.60		3.16
F66		2.54		4.22		6.76
Unnamed (3)			1.0			1.0
Subtotal TMA	0.33	2.54	8.61	10.11		21.59
Reclaim Pond						
14			0.06			0.06
15			0.14			0.14
Subtotal Reclaim Pond			0.20			0.20

Table 7-1 *(Continued)*

	Wetland Types					
Wetland No.	Emergent Marsh	Shrub Swamp	Deciduous Swamp	Coniferous Swamp	Bog	Total Area Impacted
Access Road Corridor						
W1				2.40		2.40
W2		0.16				0.16
Z6				0.44		0.44
Z7			0.33			0.33
Z9			0.58			0.58
Subtotal Access Road Corridor		.16	0.91	2.84		3.91
TMA Access Road/Tailings Pipeline Corridor						
F11				0.40		0.40
13			0.07			0.07
Subtotal TMA Access Road/Tailings Pipeline Corridor			0.07	0.40		0.47
Railroad Spur Corridor						
T1					0.06	0.06
T4		0.42		2.57		2.99
Subtotal Railroad Spur Corridor		0.42		2.57	0.06	3.05
TOTAL	0.61	3.12	9.79	15.92	0.06	29.50

[1] Wetland F30 is classified as a "streamside wetland" (SW) in Table 5-2. The impacted portion of this wetland is dominated by deciduous swamp.

Prepared by: RFS
Checked by: BDH

Table 7-2

Unnormalized Functional Values Model Results for Wetlands Directly Impacted by the Crandon Project

Wetland No.	Biological	Hydrologic Support	Groundwater	Storm and Flood Water Storage	Shoreline Protection	Water Quality Maintenance	Cultural/ Economic	Recreational	Aesthetics	Education	Total
Z7	79	41	56	72	7	51	19	25	19	7	376
Z6	95	58	61	103	0	75	57	42	34	18	543
Z9	102	52	59	95	19	70	51	38	28	10	524
W2	102	57	56	96	19	79	51	38	31	10	539
W1	101	59	64	99	19	79	51	42	31	10	555
5	53	40	29	87	0	60	31	20	31	10	361
F11	78	48	42	100	0	73	57	42	31	15	486
13	44	8	33	86	0	58	37	24	31	15	336
14	47	12	33	86	0	56	37	28	31	15	345
15	44	8	33	86	0	58	37	24	31	15	336
F30	53	22	30	56	4	36	11	21	27	7	267
F31	83	48	31	98	0	69	51	38	34	10	462
F32	53	8	29	91	0	63	31	20	28	7	330
F81	58	20	29	77	4	50	17	24	37	15	331
16	48	8	33	86	0	58	31	24	31	15	334
F33	52	39	32	82	0	54	39	26	28	7	359

Table 7-2 *(Continued)*

Wetland No.	Biological	Hydrologic Support	Groundwater	Storm and Flood Water Storage	Shoreline Protection	Water Quality Maintenance	Cultural/ Economic	Recreational	Aesthetics	Education	Total
17	60	8	33	90	0	61	31	20	34	10	347
M3	73	44	28	98	0	68	39	31	31	10	422
M4	57	8	29	85	0	59	31	23	36	7	335
F66	94	48	33	99	0	68	51	38	31	10	472
T1	72	12	53	94	0	66	37	28	45	15	422
T4	118	65	62	96	17	84	54	55	37	14	602
Model Range (1)	29-158	6-67	20-68	29-123	0-32	18-98	11-87	10-71	9-66	7-24	142-794
Model Mean (1)	93	36	44	76	17	58	54	40	37	15	470

Note: Functional values were not assessed for the three unnamed wetlands due to their small size.
(1) Model range and mean for all 174 wetlands accessed in the study area.

Prepared by: RFS
Checked by: PAE

The range of model scores for the 174 wetlands in the study area was 142-794 and the mean was 470. Wetlands with model scores higher than the actual mean were considered to be more important in function than other wetlands in the study area. Therefore, in this evaluation, the relative impact of the project on wetlands is considered to be greater to a higher scoring wetland when compared to another wetland with a lower model score. The wetland functions considered included: biological, hydrologic support, groundwater, storm and flood water storage, shoreline protection, water quality maintenance, cultural/economic, recreational, aesthetics and education. A discussion of the direct impacts resulting from each of the proposed surface facilities are presented in the following paragraphs.

7.1.1 Plant Site

The proposed plant site will result in direct impacts to wetland 5. This 0.28 acre isolated depression will be totally filled. Due to wetland 5's very small size and isolated nature, it has a low potential to provide valuable wetland functions and, therefore, scored below average at 361.

7.1.2 Tailings Management Area

Wetlands F30, F31, F32, F81, 16, 17, F33, M4, M3, F66 and three unnamed wetlands will be directly impacted by the proposed TMA.

7.1.2.1 Wetland F30

Wetland F30 was previously classified as a "streamside" wetland. This wetland, totaling 0.02 acres, is a poorly defined channel through a wet deciduous forest connecting wetland F31 to F29. Wetland F30 scored below the model mean for all functional values with a total score of 267. This wetland will be totally filled.

7.1.2.2 Wetland F31

Wetland F31 consists of approximately 4.29 and 2.16 acres of coniferous and deciduous swamp, respectively, and will be totally filled as a result of the construction of the TMA. This wetland is situated in a semi-closed basin at the uppermost point in a chain of wetlands that ultimately drain to Duck Lake. Wetland F31 outlets through wetland F30 into wetland F29 which is directly connected to the wetland system surrounding Duck Lake. From a functional values standpoint, wetland F31 was scored as average for wetlands in the study area with a total score of 462. This wetland scored above the model mean for hydrologic support, storm and floodwater storage, and water quality maintenance. The position of wetland F31 at the headwaters of a series of hydrologically connected wetlands is the primary reason for the high scores in these functions. All other functions were scored below the model mean.

7.1.2.3 Wetlands 16, 17, M4, F32, F33, F81

Each of these wetlands, as well as three unnamed wetlands within the boundaries of the proposed TMA, share a number of characteristics and are therefore discussed together. With the exception of wetland M4, all of these wetlands will be entirely filled resulting in a direct impact of 5.2 acres as a result of the construction of the TMA. Approximately 0.64 acres of wetland M4 will remain. These wetlands are all small, ranging in size from less than one-tenth of one acre to 1.81 acres. With the exception of a small area of marsh (0.33 acres) in wetland

F81, these wetlands are classified as deciduous swamp. All of these wetlands scored below the Wetland Functional Model mean (Table 7-2). Average to slightly above average scores for the storm and flood water storage function, however, were calculated for wetlands F32, F81, F33 and M4. These wetlands are depressions in the upper reaches of their watershed and therefore have capacity to store stormwaters prior to discharge to downgradient waterbodies or wetlands. Wetland F32 and M4 also received slightly above average scores for the Water Quality Maintenance function. With the exception of the functional values associated with wetland M4, these functional values will be lost. The capacity of wetland M4 to provide wetland functional values will be reduced as a result of project construction. Details are provided in Section 7.3.

7.1.2.4 Wetland M3

Wetland M3 is one of three wetlands (including M1 and M2) in a connected system that flows into Hemlock Creek. The TMA will directly impact 3.16 acres (70%) of this 4.51 acre mixed deciduous/coniferous forested wetland. The impacted portion is dominated by lowland conifers. This wetland occurs at the top of the watershed and intermittently contributes flow to wetland M2, M1 and ultimately Hemlock Creek. The total Functional Model score for this wetland is 422 which is slightly below the model mean. Above average scores, however, were assessed for the hydrologic support, storm and flood water storage and water quality maintenance functions due to this wetland's position at the top of the watershed and its storage capacity. The capacity of wetland M3 to continue to provide these wetland functional values will be reduced as a result of project construction. Details are provided in Section 7.3.

7.1.2.5 Wetland F66

Wetland F66 is the uppermost wetland in a series of connected wetlands that ultimately drain into Deep Hole Lake. This wetland is predominantly a conifer swamp. The construction of the TMA will result in the filling of 6.7 acres (41%) of this 16.27 acre wetland. The total Wetland Functional Model score for wetland F66 was 472 which is slightly above the model mean. This wetland is surrounded by mixed northern forest, contains favorable edge and life form variability, and is part of a wetland corridor extending from Deep Hole Lake approximately 1.5 miles to the northeast. As such, the biological function was assigned a score above the model mean. The hydrologic support, storm and flood water storage and water quality maintenance functions were also scored above average largely based on this wetland's relative large size and juxtaposition at the uppermost point in a series of connected wetlands. The filling of slightly less than one-half of this wetland will reduce its capacity to continue to provide these functional values. The biological function will be impaired as a result of direct habitat loss. The reduction in size of this wetland will also reduce its capacity to provide the hydrologic support, storm and floodwater storage and water quality maintenance functions. Details are provided in Section 7.3.

7.1.3 Reclaim Pond

Wetlands 14 and 15 will be excavated and filled, respectively, by the proposed reclaim pond construction resulting in a total direct wetland impact of 0.2 acres. These deciduous forested wetlands are both located in isolated depressions with no inlet or outlet. Due to their very small size these wetlands have a low capacity to provide valuable wetland functions and therefore, as shown in Table 7-2, scored below average.

7.1.4 Access Road

The proposed access road will traverse Wetlands Z7, Z6, Z9, W2 and W1 resulting in a direct impact of 3.9 acres.

7.1.4.1 Wetland Z7

Wetland Z7 consists of a 3.89 acre linear strip of deciduous swamp bordering an ephemeral stream. The total wetland functional value score for this wetland was below the model average (Table 7-2). Structural variability, vegetative interspersion and amount of edge habitat are low in this wetland resulting in a below average biological function score. The isolation of this wetland resulted in below average scores for the cultural/economic, recreational, aesthetics and education functions. Low storage capacity and a relative low water balance resulted in low hydrology function scores. The proposed access road will cross this wetland at one point resulting in a direct impact of 0.33 acres (8.5%) of wetland. Due to the relative small size of the direct impact to this wetland, the loss to wetland functional values associated with the proposed access road crossing are expected to be negligible.

7.1.4.2 Wetlands Z6 and Z9

Wetlands Z6 and Z9 are both mixed coniferous/deciduous forested wetlands contiguous with, and upgradient of wetland W2. Small ephemeral streams flow in and out of these wetlands. Wetland Z6 totals 44.68 acres. Wetland Z9 totals 9.54 acres. Both wetlands have high total wetland functional value scores with individual high scores for the biological and all of the watershed functions. The proposed access road will result in a direct impact to 0.44 (1%) and 0.58 (6.1%) acres of wetlands Z6 and Z9, respectively. The loss to wetland functional values associated with the proposed access road crossings are expected to be negligible. The watershed functions will be maintained through the installation of culverts sized to accommodate existing and expected flows. Due to the relative small size of the direct impacts to these wetlands, the biologic functions should not be impaired.

7.1.4.3 Wetland W2

Wetland W2 is a 78.47 acre conifer swamp contiguous with, and upstream of, Wetland W1. Two small intermittent tributaries to Swamp Creek flow through wetland W2. A small shrub swamp component exists along these streams. The total wetland functional value score for this wetland was well above the model average at 539. The vegetative characteristics of this wetland provide good wildlife habitat and opportunities for socio-cultural uses. A large water storage capacity exists and the wetland also provides a buffer to waters flowing to Swamp Creek.

The proposed access road will cross this wetland at its narrowest point at a location characterized as shrub swamp. A total of 0.16 acres (0.2%) of this wetland will be directly impacted. No significant impact to wetland functional values are expected due to this impact.

7.1.4.4 Wetland W1

Wetland W1 is a 436.64 acre wetland located largely within the floodplain and adjacent riparian zone associated with Swamp Creek. This wetland is predominantly a conifer swamp with a variable width shrub swamp and marsh component along the immediate Swamp Creek floodplain. For many of the same reasons stated for wetland W2, this wetland was assigned a total wetland functional value score well above average at 555. Four State Special Concern plants, including sheathed sedge (*Carex vaginata*), sparse-flowered sedge (*C. tenuiflora*), northern black currant (*Ribes hudsonianus*), and American yew (*Taxus canadensis*) were observed throughout the portions of this wetland dominated by conifers. Mountain cranberry (*Vaccinium vitus-idaea*), a State Endangered plant, was observed in an opening of alder within the conifer swamp matrix in the southwestern portion of this wetland.

The proposed access road will cross this wetland, bridging across Swamp Creek, resulting in the filling of 2.40 acres (0.54%). None of the above listed plant species were observed in this portion of Wetland W1. Due to the relative small size of the direct impact to this wetland, the loss to wetland functional values associated with the proposed access road crossing are expected to be negligible.

7.1.5 TMA Access Road/Tailings Pipeline Corridor

The construction of the TMA access road/tailings pipeline corridor will result in the filling of 0.47 acres of wetland comprising a 0.40 acre portion of wetland F11, and wetland 13 in its entirety. Wetland 13 possesses the same characteristics and functional values as Wetlands 14 and 15 described above.

The construction of the TMA access road will result in clearing a corridor through the 18.37 acre F11 wetland. This wetland is classified as a conifer swamp and is hydrologically connected to wetland F10 by a poorly defined channel and ultimately drains into Little Sand Lake. This hydrologic connection coupled with the wetland's relative large size and dominant wetland class resulted in an above average total Wetland Functional Model score (Table 7-2). The hydrologic support, storm and flood water storage and water quality maintenance functions all scored above average. This wetland also scored above average for the cultural/economic and recreational functions because of the dominant wetland class, large size and location adjacent to a public roadway (i.e., Sand Lake Road). The TMA access road/tailings pipeline corridor will be constructed in such a way as to allow water to pass at a rate and frequency equal to the existing conditions. Further, since only two percent of this wetland will be impacted, the functional values of this wetland should be retained.

7.1.6 Railroad Spur

Wetland T1 and T4 will be impacted by the proposed railroad spur resulting in a total of 3.05 acres of.

7.1.6.1 Wetland T1

Wetland T1 is a 1.66 acre bog located in an isolated depression bounded by Keith Siding Road to the north, the Wisconsin Central Limited Railroad to the east and agricultural lands to the south and west. This wetland's total wetland functional value score of 422 is slightly below the model mean. The biological function potential is reduced due to its location adjacent to two transportation corridors and the fact that this wetland is, in effect, an island in an agricultural matrix. This location, however, resulted in an above average score for the aesthetic function. Only 0.06 acres of the eastern edge of this wetland will be directly impacted. Although it will be reduced in size, its most significant function (i.e., aesthetics) should remain intact.

7.1.6.2 Wetland T4

Wetland T4 is a 199.02 acre conifer swamp within the floodplain of Swamp Creek and two small tributaries to Swamp Creek. The total wetland functional value score of 602 for this wetland is one of the ten highest scores for wetlands in the study area. This wetland is surrounded by mixed northern hardwood forest and contains a high variety of plant species and a large amount of edge habitat. It provides a water quality buffer to Swamp Creek and is also part of a contiguous wetland corridor along Swamp Creek extending nearly from Swamp Creek's origin in Lake Lucerne to STH 55. The location adjacent to Swamp Creek also adds value to the recreational, aesthetic, and educations functions of this wetland.

Wetland T4 will be crossed by the proposed railroad spur three times, resulting in a direct impact of 2.99 acres (1.5 percent) of the total wetland area. No significant impacts to wetland functional values are expected.

7.1.7 Direct Impact Summary

A total of 29.5 acres, representing portions of 25 wetlands, will be directly impacted as a result of the proposed action. The 29.5 acres represent approximately 1.4 percent of the wetlands in the study area. These wetlands include 0.61, 3.12, 9.79, 15.92 and 0.06 acres of emergent marsh, shrub swamp, deciduous swamp, coniferous swamp and bog, respectively. Wetlands F33, 17, 16, F31, F81, F32, 5, 13, 14, and 15 will be entirely filled or excavated. Only portions of the remaining 15 wetlands will be impacted.

Each individual impacted wetland represents a unique set of associated functional values (Table 7-2). However, the project's overall impact to wetland functional values cannot be easily assessed by an individual wetland's functional value scores. Each wetland is variable in size, degree of impact, and potential to provide each of the 10 assessed functional values.

Since the scores associated with each of the 10 functions are not directly comparable (i.e., each of the 10 functional models resulted in ranges of scores unique to that model), the scores for each function were assigned a rank of "high", "medium" or "low" values corresponding to a 3, 2, or 1, respectively. To determine which of the 10 functional values is the most important to the wetland acreage directly impacted, the modified functional value scores for each function and each wetland were weighted by the percent of total impact each individual wetland represents. The weighted scores for each wetland function were then summed to determine which wetland function will be impacted to the greatest degree. The results are presented in Table 7-3. The greatest functional loss to wetlands associated with the proposed action will be to storm and floodwater storage followed by the water quality and hydrologic support functions. Wetlands F66, F31, M3 and T4 represented the greatest direct impacts (i.e., 22.9, 21.9, 10.7 and 10.1 percent of the total wetland impact, respectively) and, therefore, contributed the most to these results.

The product of the above analysis is the data that will be used in the design of the wetland compensation site.

Table 7-3

Weighted Functional Value Model Results for Wetlands Directly Impacted by the Crandon Project

Wetland No.	Percent of Total Impact	Biological		Hydrologic Support		Groundwater		Storm and Flood Water Storage		Shoreline Protection		Water Quality Maintenance		Cultural and Economic		Recreational		Aesthetics		Education	
		Rank(1)	Weighted	Rank	Weighted	Rank	Weighted	Rank	Weighted	Rank	Weighted	Rank	Weighted	Rank	Weighted	Rank	Weighted	Rank	Weighted	Rank	Weighted
Z7	1.1	2	2.2	2	2.2	2	2.2	2	2.2	1	1.1	2	2.2	1	1.1	1	1.1	1	1.1	1	1.1
Z6	1.5	2	3	3	4.5	3	4.5	3	4.5	0	0	3	4.5	2	3	2	3	2	3	2	3
Z9	2	2	4	2	4	3	6	3	6	2	4	2	4	2	4	2	4	2	4	2	4
W2	0.5	2	1	3	1.5	2	1	3	1.5	2	1	3	1.5	2	1	2	1	2	1	2	1
W1	8.1	2	16.2	3	24.3	3	24.3	3	24.3	2	16.2	3	24.3	2	16.2	2	16.2	2	16.2	2	16.2
5	0.9	1	0.9	1	0.9	1	0.9	1	0.9	0	0	1	0.9	1	0.9	1	0.9	1	0.9	1	0.9
F11	1.3	2	2.6	2	2.6	2	2.6	3	3.9	0	0	3	3.9	2	2.6	2	2.6	2	2.6	2	2.6
13	0.2	1	0.2	1	0.2	1	0.2	1	0.2	0	0	1	0.2	1	0.2	1	0.2	1	0.2	1	0.2
14	0.2	1	0.2	1	0.2	1	0.2	1	0.2	0	0	1	0.2	1	0.2	1	0.2	1	0.2	1	0.2
15	0.5	1	0.5	1	0.5	1	0.5	1	0.5	0	0	1	0.5	1	0.5	1	0.5	1	0.5	1	0.5
F30	0.1	1	0.1	2	0.2	1	0.1	1	0.1	1	0.1	1	0.1	1	0.1	1	0.1	1	0.1	1	0.1
F31	21.9	2	43.8	2	43.8	2	43.8	3	65.7	0	0	2	43.8	2	43.8	2	43.8	2	43.8	2	43.8
F32	2.3	1	2.3	1	2.3	2	4.6	3	6.9	0	0	2	4.6	1	2.3	1	2.3	1	2.3	1	2.3
F81	1.1	1	1.1	2	2.2	2	2.2	2	2.2	1	1.1	2	2.2	1	1.1	1	1.1	2	2.2	2	2.2
16	0.3	1	0.3	1	0.3	1	0.3	0	0	0	0	1	0.3	1	0.3	1	0.3	1	0.3	1	0.3
F33	6.2	1	6.2	2	12.4	2	12.4	2	12.4	0	0	2	12.4	2	12.4	1	6.2	1	6.2	1	6.2
17	1.8	1	1.8	1	1.8	1	1.8	0	0	0	0	1	1.8	1	1.8	1	1.8	1	1.8	1	1.8
M3	10.7	2	21.4	2	21.4	1	10.7	3	32.1	0	0	2	21.4	2	21.4	2	21.4	2	21.4	2	21.4
M4	2.5	1	2.5	1	2.5	2	5	2	5	0	0	2	5	1	2.5	1	2.5	2	5	1	2.5
F66	22.9	2	45.8	2	45.8	2	45.8	3	68.7	0	0	2	45.8	2	45.8	2	45.8	2	45.8	2	45.8
T1	0.2	2	0.4	1	0.2	1	0.2	3	0.6	0	0	2	0.4	1	0.2	1	0.2	3	0.6	2	0.4
T4	10.1	3	30.3	3	30.3	3	30.3	3	30.3	2	20.2	3	30.3	2	20.2	3	30.3	2	20.2	2	20.2
			186.80		204.10		199.6		268.2		42.7		210.3		181.6		185.5		179.4		176.7

Note: Functional values were not assessed for the three unnamed wetlands due to their small size.
(1) 0 = function not applicable, 1 = low, 2 = medium, 3 = high

Prepared by: RFS
Checked by: BDH

7.2 Temporary Impacts

As noted in Section 6.3 above, 0.71 acres of wetlands will be temporarily disturbed as part of the construction of the Wisconsin River wastewater discharge pipeline in the access road corridor. As part of pipeline installation, the temporarily disturbed wetlands will be restored through grading to near original contours and through seeding and implementation of erosion control procedures as specified in Section 4.10 of the Crandon Project's May 1995 Mine Permit Application (Foth & Van Dyke, 1995b). The disturbed wetland areas are expected to recover within a few years to near original condition.

In addition, temporary wetland disturbance will result due to the installation of the proposed Wisconsin River wastewater discharge pipeline beyond the access road corridor and as part of electric transmission line installation. These impacts will be similar to those described in the above paragraph. Wetland recovery in a short period of time is also expected for these temporary disturbances. Wetland impacts resulting from the construction of the Wisconsin River wastewater discharge pipeline are described in the Appendix 3-2 of the May 1995 Environmental Impact Report (Foth & Van Dyke, 1995a). Wetland impacts relating to installation of the electric transmission line are being addressed by the Wisconsin Public Service Commission as part of its environmental assessment of Wisconsin Public Service Corporation's application for a Certificate of Public Convenience and Necessity.

7.3 Indirect Impacts

Potential indirect impacts may include surface water impacts associated with changes in certain wetland's watersheds relating to clearing and grading, the construction of surface facilities, etc. and impacts associated with changes to groundwater levels. These impacts are discussed in Section 4 of the Crandon Project's Environmental Impact Report (Foth & Van Dyke, 1995a).

8 Wetland Compensation

As described in Section 7.0, the proposed Crandon Project will directly impact 29.5 acres of wetlands. The greatest functional loss will be to the hydrologic functions (i.e. storm and flood water storage, water quality maintenance and hydrologic support). To compensate for this impact, CMC has developed a wetland mitigation plan. The goal of the proposed plan is to restore or create a sufficient quantity of wetlands with the same or greater functional values as those lost as a result of the proposed action in order to off-set direct wetland impacts at the project site. A description of the search for a compensation site meeting this goal is presented below followed by a description of the proposed compensation site, the site design, establishment of a replacement ratio based on the proposed site characteristics, a maintenance plan, and a monitoring plan.

8.1 Compensation Site Search and Alternatives Analysis

8.1.1 On-Site Alternatives

The lands that CMC currently owns or has rights to in Forest and Langlade Counties are all contiguous with, or in the immediate vicinity of the proposed mine site and are all almost entirely forested. No drained wetlands, prior converted cropland, or non-wetland areas with hydric soils exist on these lands. As such, no on-site opportunities exist for wetland restoration. A number of on-site alternatives have, however, been evaluated for wetland creation. For example, opportunities for wetland creation in conjunction with the construction of the access road and railroad spur have been evaluated. The access road and railroad spur cross many small drainage basins and low lying areas which could be considered potentially suitable for wetland creation. The prime feature considered was the existence of a drainage area tributary which would be large enough to support a wetland. The proposed access road crosses six drainage basins while the proposed railroad spur crosses two. All but one of the drainage basins (i.e., the western most basin along the access road) contain wetlands that would have to be altered or destroyed to create additional wetland acreage. Further, based on the results of model runs of each basin using TR-55 for a 1-inch rainfall, a 1-year frequency rainfall, and a 2-year frequency rainfall, it was found that none of these basins could generate surface water runoff in sufficient quantities to sustain a wetland. In general, this factor makes wetland creation in the immediate vicinity of the proposed Crandon Project site very difficult.

8.1.2 Off-Site Alternatives

Priority in compensation site selection was given to those lands immediately adjacent to the proposed mine site; however, the location of the mine site in the northern forest region of Wisconsin necessitated that the search area be expanded to include agricultural lands not prominent in the immediate site area or to the north of the site. The search area was generally confined to that area within a 50-mile radius of the proposed mine site. The following criteria were applied to the off-site compensation site search:

- Potential sites should be located as close to Crandon, Wisconsin as possible and preferably within the Fox-Wolf River drainage basin. However, sites anywhere in Forest, Langlade, Oneida, Oconto, Marinette, and Shawano Counties, within the Lake Michigan watershed and north of the Tension Zone would be considered eligible for consideration.

- High priority sites would be those that would restore previously drained or otherwise modified wetlands. Sites containing prior converted cropland, therefore, would be given preference.

- Sites should contain hydric or poorly drained soils.

- Sites should have an existing surface water source and/or groundwater should be within approximately three feet of the ground surface. Sites with a natural tendency towards flooding would be preferable.

- Site topography should be relatively flat and, therefore, conducive to minimal earthwork to either intercept groundwater or construct low head embankments.

- Potential sites should be larger than 20 acres with no upper limit on size.

- Preference should be given to sites that are, or will be, in public ownership and for which long-term maintenance requirements would be minimal.

The initial step in the off-site compensation site search involved the development of a mailer that was sent to 20 government officials with responsibilities for management of lands within a four county area surrounding the Crandon Project site. The mailer and mailing list are reproduced in Appendix E. The mailer sought information that may be available regarding potential compensation sites that may meet the above described criteria. The mailer was sent out July 15, 1994. Follow-up phone calls were made after approximately two weeks. A number of the contacted individuals responded, although the majority offered suggestions for enhancement of existing wetlands (i.e., conversion of existing wetland habitat into another wetland habitat type), dredging projects in existing streams or open water areas, or impoundment projects resulting in large areas of open water greater than six feet deep. These types of projects were generally considered undesirable from the standpoint of matching lost or impaired wetland functional values at the Crandon Project site.

Concurrent with the above described effort, a separate effort was initiated involving a review of available information including county soil surveys, Soil Conservation Service (SCS) wetland inventory maps, aerial photography, county plat books and USGS 1:24,000 topographic maps. This effort began within the Fox-Wolf River basin within 25 miles of the site and was then progressively expanded to a 50 mile radius around the site in all counties and drainage basins existing within that region (Figure 8-1).

A preliminary screening of potential sites was followed by a determination of the owner's willingness to sell, an evaluation of the site, and finally a site visit to verify the suitability of the site. The preliminary screening consisted of the following:

- Examine SCS wetland inventory maps for prior converted cropland or converted wetlands.
- Examine SCS county soil survey maps for areas of poorly drained or hydric soils.

- Examine USGS topographic maps of the area to determine if the terrain lends itself to cost-effective wetland restoration or creation.

Table 8-1 *(Continued)*

Site Number	Township	Range	Section	Soils	Hydrology	Watershed	Suitable Acres	Distance From CMC Site	Combined Score
18	T27N	R15E	28	5	4	5	1	1	16
19	T31N	R10E	5	4	1	1	2	3	11
20	T30N	R10E	29	5	5	1	1	2	14
21	T30N	R7E	12	5	5	1	3	1	15
22	T32N	R10E	16	4	3	1	1	3	12
23	T32N	R10E	14	4	2	1	1	3	11
24	T32N	R11E	18	1	1	1	1	3	7
25	T30N	R9E	2	5	4	1	2	2	14
26	T35N	R13E	17	1	1	1	1	4	8
27	T32N	R11E	31	3	2	1	1	3	10
28	T32N	R9E	20	4	3	1	1	3	12
29	T35N	R13E	8	4	3	3	1	4	15
30	T35N	R11E	23	4	3	3	1	4	15
31	T30N	R9E	15	5	5	1	1	2	14
32	T32N	R10E	32	1	1	1	1	3	7
33	T32N	R9E	26	3	2	1	1	3	10
34	T30N	R18E	3/4/31	5	5	4	5	1	20
35	T32N	R10E	5	4	4	1	1	3	13

Prepared by: AWZ
Checked by: RFS

8.2 Proposed Wetland Compensation Site

Following the selection of site 9 as the preferred wetland compensation site, work began to develop a site specific plan to convert the site into replacement wetlands. A discussion of that work and presentation of the proposed site design follows.

8.2.1 Existing Environment

As shown in Figure 8-2 the property on which the proposed wetland restoration site is located straddles the Oconto-Shawano County line north of Shawano Lake. The southern portion of the property is located in the N1/2, NE 1/4, Section 5, T 27 N, R 17 E, Town of Washington, Shawano County, Wisconsin, and the northern part is located in the S1/2, SE 1/4, Section 32, T 28 N, R 17 E, Town of Underhill, Oconto County, Wisconsin. The property is situated within an agricultural field and comprises approximately 129 acres. As shown on Figure 8-2, topography within the property is virtually flat with no significant local relief. The northern portion of the property, however, is marked by the presence of barely discernible, eroded rises which appear to be sandier than surrounding soils.

The proposed compensation site or project area is approximately 57 acres in size. As shown on Figure 8-2 it is located in the approximate center of the 129 acre property boundary. A topographic survey of the site and surrounding area was conducted. The topographic map generated as a result of that survey is shown on Figure 8-3. The map shows that the area ranges in elevation from approximately 818.5 feet to just over 820 feet mean sea level (MSL). The surveyed area also consists of a series of north-south and east-west drainage ditches at lower elevations.

Site soils are mapped as Cormant loamy fine sand on 0-1 percent slopes. Cormant soils are deep, poorly drained soils which formed on sandy outwash plains and glacial lake plains. These soils are subject to periodic ponding. Also present are pockets of Markey and Seelyville soils. These soils are deep, poorly drained mucks which formed on outwash plains from decomposing herbaceous plants and other organic matter. The Markey and Seelyville soils commonly include peaty, organic pedons exceeding 50 inches in depth (Gundlach et al 1982). All three soils are listed in the Hydric Soils List for Shawano County (Otter, 1990).

An on-site soils investigation was conducted on April 7, 1995 consisting of the advancement of four borings by splitspoon to log the surficial soils within the surveyed area. The location of the borings is shown in Figure 8-3. Logs of these borings are included in Appendix F. The borings revealed a one to two foot thick organic layer overlying a relatively thin silty sand layer overlying sands. Water levels in all borings appeared to be at approximately two feet below the ground surface. This is in close agreement with water levels in adjacent ditches.

Current land use is agricultural. According to the Oconto County Natural Resources Conservation Service (Schulz, 1995) these lands are classified as Prior Converted Cropland. Prior to being farmed, the project area was likely part of an extensive wetland currently occupying portions of Sections 31 and 32 immediately to the northwest. The property has been partially drained by construction of several interconnected drainage ditches. A north-south ditch, beginning approximately 0.7 miles to the north of the site and ultimately discharging into Duchess Creek downstream from the site, parallels the western border of the site. Water levels in this ditch are controlled by a stop-log outlet control structure located in the southwest corner of the site (Figure 8-3). Two east-west ditches connected to the north-south ditch exist along the northern and southern boundaries of the surveyed area. A third east-west ditch also connected to the north-south ditch exists in the central portion of the surveyed area. A single ditch draining agricultural lands to the northwest, also enters the north-south ditch just below the point where the central ditch connects to the north-south ditch.

Based on the observed location of the groundwater table and the lack of vegetation on the bottom of the ditches, it appears that the ditches intercept groundwater. Flow in the ditches across the majority of the property is to the west and south. A divide exists resulting in flow to the east and north in the northeastern corner of the surveyed area. Several surface ditches and drains have been installed along the southern boundary of the surveyed area. These channel surface water off the area into the southernmost east-west ditch. Several outlet pipes were observed in this ditch. Although no site plans exist, the current landowner reports that portions of the site have been tiled.

Wisconsin Wetland Inventory Maps of the site and surrounding area show wetlands nearly surrounding the site, with the exception of two bordering agricultural areas; one to the north of the northeast quarter of the site and one to the west of the northwest quarter of the site. The surrounding wetlands largely consist of deciduous forested wetlands dominated by an overstory of red maple (*Acer rubrum*) and quaking aspen (*Populus tremuloides*) with an understory of willows (*Salix sp.*) alder (*Alnus rugosa*), reed canary grass (*Phalaris arundinacea*) and Canada bluejoint grass (*Calamagrostis canadensis*). Scrub/shrub wetlands dominated by willows and alder with some localized areas of emergent marsh also exist.

A partial list of the plants existing at the site is presented in Table 8-2. This list was compiled during a site visit on May 16, 1995, prior to the emergence of all of site vegetation. The project site had been plowed the day before the site visit so the species listed in Table 8-2 represent those species occupying the ditches and the periphery of the project site.

Table 8-2

Compensation Site Existing Plant List

Scientific Name	Common Name	Wetland Indicator Status
Alnus rugusa	alder	OBL
Asclepias syriaca	common milkweed	—
Betula papyrifera	paper birch	FACU+
Carex lacustris	lake sedge	OBL
Carex stricta	hummock sedge	OBL
Cornus stolonifera	red osier dogwood	FACW
Calamagrostis canadensis	blue joint	OBL
Eleocharis sp.	spike rush	FACW/OBL
Equisetum hyemale	common scouring rush	FACW-
Equisetum arvense	common horsetail	FAC

Table 8-2 *(Continued)*

Scientific Name	Common Name	Wetland Indicator Status
Equisetum variegatum	variegated scouring rush	FACW
Equisetum fluviatile	water horsetail	OBL
Erigeron annuus	daisy fleabane	FAC-
Eupatorium maculatum	joe-pye weed	OBL
Fragaria sp.	strawberry	—
Geum sp.	avens	—
Hypericum sp.	St. John's wort	—
Iris virginica	blue flag iris	OBL
Juncus effusus	soft rush	OBL
Juncus tenuis	path rush	FAC
Lycopus sp.	—	—
Phalaris arundinacea	reed canary grass	FACW+
Poa annua	speargrass	FAC-
Populus tremuloides	quaking aspen	FAC
Populus balsamifera	balsam poplar	FACW
Potentilla norvegica	rough cinquefoil	FAC
Prunus sp.	cherry	—
Ranunculus sceleratus	corsed crowfoot	OBL
Rubus strigosus	red raspberry	—
Salix petiolaris	meadow willow	FACW+
Scirpus atrovirens	green bulrush	OBL
Setaria glauca	foxtail	FAC
Solidago canadensis	Canada goldenrod	FACU
Spiraea alba	meadowsweet	FACW+
Verbascum thapsus	common mullein	—
Veronica peregrina	purslane speedwell	FACW+

OBL - obligate wetland plants - plants that almost always occur in wetlands.
FACW - facultative wetlands plants - plants that usually occur in wetlands.
FAC - facultative plants - plants with a similar likelihood of occurring in both wetlands and uplands.
FACU - facultative upland plants - plants that occur sometimes in wetlands but occur more often in uplands.

"+" indicates a preference of the plant toward wetter conditions.
"-" indicates a preference of the plant toward drier conditions.
— No status

Prepared by: RFS
Checked by: BDH

The current landowner has grown mint on the site for a number of years and continues to do so. At the time of the site visit, however, the crop had not yet emerged. The site periphery is occupied by a number of wetland and opportunistic weedy plant species. As indicated in Table 8-2, approximately 85 percent of the observed plants are wetland species (i.e., FAC or greater). Wetter areas of the site periphery, particularly along the southern and northern east-west ditches and the southern portion of the north-south ditch, are dominated by willows (*Salix sp.*), lake sedge (*Carex lacustris*) and reed canary grass (*Phalaris arundinacea*). Variegated scouring rush (*Equisetum verigatum*), a State Special Concern Species, dominates the area immediately above the ordinary high water mark on the north shore of the central east-west ditch. Cattails (*Typha sp.*) dominate isolated portions of the ditches. Rooted vegetation was generally lacking on the ditch bottoms. This, however, may not be the case later in the season.

In general, the plant list is indicative of an area that has been drained and disturbed. Wetland species persist along the site periphery and in the ditches. The opportunistic weedy species occupy the upper edges of the ditches and the drier portions of the site.

Based on observations in April and May, 1995, the site is used heavily by migrating and breeding waterfowl and other wetland dependant wildlife in the spring. Numerous mallards, wood ducks, and Canada geese were observed resting on ponded areas of the site. Sand hill cranes and whistling swans were also observed. A mink was observed along the central east-west ditch. On May 16, 1995, several breeding pairs of mallards and wood ducks were observed on the ditches. The site as presently configured appears to have limited wildlife habitat value during the remainder of the year. During the summer season, the site is maintained in agricultural use (i.e., planted in mint). The ditches provide limited habitat for some wetland dependant wildlife during this time of the year. During the winter the site is devoid of vegetation and provides little, if any, habitat value. Due to the current agricultural use of the site, it does not appear to contain habitat suitable for any state or federally listed species. The site ditches, however, could potentially provide marginal habitat for blanding's turtles, a state threatened species known to occur in Shawano County.

Great Lakes Archaeological Research Center (GLARC) conducted a cultural resources survey of the site in April 1995 (Richards, 1995). The survey included an archival and literature search, a systematic surface survey and limited shovel probing. The surface survey revealed two chipped stone projectile points in the northwest corner of the surveyed area adjacent to the south bank of the northern-most east/west ditch. Additional investigation, including soil test pits, in this area did not reveal additional artifacts. A copy of the survey report is included in Appendix G. The survey concluded that since no ground disturbing activity is planned in the immediate vicinity of the newly discovered archaeological site, project development should have no effect on the located archaeological deposit.

8.2.2 Replacement Ratio

The Wisconsin Department of Transportation (WisDOT), in their Wetland Mitigation Banking Technical Guideline (1993), developed a schedule of replacement ratios for wetland losses in cooperation with the Wisconsin Department of Natural Resources, U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, and the Federal Highway Administration. These guidelines, contained in Appendix H, were followed regarding replacement ratios for the Crandon Project because specific guidelines developed by the USCOE do not exist.

The WisDOT system involves:

> "ratios of replacement in a factor system using the factors Drainage Area, Floristic Province, Wetland Type, and a factor based on professional discretion. Replacement within limits specified by these factors assumes wetland function replacement. Replacement outside the limits are considered off-site or out-of-kind or both and is discouraged by requiring a larger replacement ratio."

The "base" replacement ratio is 1:1 and would apply to a project where both the impact and mitigation site are in the same drainage area and floristic province, the replacement wetland type is the same as the impacted wetland type and there is a high level of confidence that the mitigation project will be successful. Wetland losses replaced outside designated areas and /or by different wetland types are assessed by a variable schedule of increments, which will cause the replacement ratio to be greater than 1:1, but not exceed 3:1.

Drainage areas have been grouped into three major drainage basins: Lake Superior; Mississippi River, which includes the St. Croix, Chippewa, Trempealeau, Wisconsin, Rock-Fox-Des Plaines River systems; and Lake Michigan, which includes Lake Michigan and the Fox-Wolf and Menominee-Oconto-Peshtigo River systems. Both the Crandon Project site and the proposed proposed compensation site are located in the Fox-Wolf River system within the Lake Michigan drainage basin.

The State of Wisconsin contains two distinct Floristic Provinces, the prairie-forest province in the south and the northern hardwoods province in the north (Curtis, 1959). The two provinces are separated by a narrow band or zone containing vegetational elements common to both provinces called the tension zone. Both the Crandon Project site and the proposed compensation site are located in the northern hardwoods floristic province.

The wetland types to be filled or excavated as a result of the Crandon Project are listed in Table 7-1. As discussed below the replacement wetland will be composed of a combination of shallow marsh, deep marsh and wet meadow which will result in an incremental increase over the base 1:1 compensation ratio.

The compensation ratio was estimated using Table 3C in Appendix H. The incremental values under the column "Floristic Province (In)" and "Drainage Area (In)" were added to the base 1:1 compensation ratio for each wetland type listed in Table 7-1 as shown below:

(0.61 acres shallow marsh) * (0.0 increment for shallow marsh + 1.0) = 0.61 acres
(3.12 acres scrub/shrub) * (0.2 increment for shallow marsh + 1.0) = 3.74 acres
(25.71 acres wooded swamp) * (0.2 increment for shallow marsh + 1.0) = 30.85 acres
(0.06 acres bog) * (0.5 increment for shallow marsh + 1.0) = 0.09 acres

Total required compensation acreage = 35.29

The compensation ratio, following the WisDOT guidelines, can be calculated by dividing the total required acreage by the acreage of impacted wetlands. The resulting Crandon Project ratio is 1.2:1.

The proposed compensation site development plan described below involves the development of approximately 57 acres of high quality wetlands which will provide an actual replacement ratio of approximately 1.9:1. This replacement ratio is over 58% greater than the calculated replacement ratio using WisDOT guidance. The additional wetland restoration above that calculated using WisDOT guidance has been incorporated into the compensation plan to compensate for potential indirect wetland impacts as described in Section 7.3 of this report and for unknown future potential effects that could result from the project.

8.2.3 Proposed Design

The primary goal of the proposed compensation plan is to replace the wetland functions and values that would be unavoidably lost due to the construction and operation of the proposed Crandon Project. The accomplishment of this goal through the design of the replacement site is discussed below.

8.2.3.1 Site Grading Design

The existing surveyed area is very flat ranging from approximately 818.5 feet MSL to 821 feet MSL (Figure 8-3). The elevation of the top surface of CTH R is approximately 822 feet MSL. The highpoint of the site exists in the northwest corner with the lowest areas other than the ditch bottoms occurring in the southwest and east-central portions of the site.

The proposed site grading plan calls for the excavation of approximately 66,900 cubic yards of soil to provide open water areas and a moisture gradient across the approximate southern two-thirds of the surveyed area (Figure 8-4). The proposed excavation will take advantage of the existing topography by focusing on the lowest areas of the site. The eastern third of the central east-west ditch will be filled to prohibit water from exiting to the north and east across County Trunk Highway (CTH) R. The north-south ditch will be plugged just to the south of the intersection of this ditch with the central east-west ditch, but before the ditch draining an area to the northwest drains into the north-south ditch. Surface waters will enter the site through the north-south ditch, flow to the east in the central east-west ditch, flow south through the site and then west to the proposed outlet structure located in the southwest portion of the surveyed area. This plan results in a flow through system which optimizes the pollutant removal efficiency of the system and reduces the potential for problems associated with stagnant water. The excess excavated material will be deposited on the eastern two-thirds of the existing agricultural field to the north of the site (Figure 8-4). Site construction will be completed in accordance with the erosion control procedures outlined in Section 4.10 of the Project's Mine Permit Application (Foth & Van Dyke, 1995b).

8.2.3.2 Hydrology

Based on information obtained through on-site soil borings and water levels observed in ditches flowing along the periphery of the site, it appears that the groundwater table is currently approximately two feet below land surface or at an approximate elevation of 817 feet MSL. The water table across the site has been lowered by the ditches as well as a series of drainage tiles reported to exist by the current landowner. To restore the wetland hydrology at this site, the north-south and central east-west ditch will be plugged and an outlet control structure will be placed in the southwest corner of the site.

The outlet control structure will initially consist of a three foot wide stop-log weir with a minimum and maximum elevation of 816 and 818.9 feet MSL, respectively (Figure 8-5). With this structure, the water level can be fluctuated by up to 2.9 feet by removing or installing the desired width stop log(s). A 40 foot wide emergency spillway at an elevation of 819.6 feet is also proposed to allow flood waters to exit the site before potential backwaters reach CTH R. The proposed normal pool elevation is 818.9 feet. Design and supporting hydrologic modeling information is provided in Appendix I. The response of the system to a 1-year, 2-year, 10-year and 100-year 24-hour storm event with the outlet control set at elevations 818.9 (i.e., normal pool elevation) are presented in Table 8-3. Associated backwater impacts upstream will be minimal and will follow proper regulatory requirements.

Table 8-3

Proposed CMC Compensation Site Hydrologic Response

Storm Event	Rainfall (inches)	Water Surface Elevation at the Outlet
1-year	1	819.01
2-year	2	819.31
10-year	3.3	819.68
100-year	5.0	820.11

Prepared by: MDL
Checked by: RFS

The proposed design calls for a flow through system which results in maximum water contact with the wetland vegetation and a retention time sufficient to settle out a large percentage of any pollutants that may be entrained in influent stormwaters. Approximately 42 acre-feet of stormwater storage is available above the normal pool elevation of 818.9 feet MSL. Further, this design provides a variety of water depths across the site including open water areas, areas with saturated soils, and areas that will be intermittently saturated. This will result in the interspersion of several different wetland habitat types. As shown on Figure 8-6 the proposed design will result in approximately 36 acres of shallow marsh, approximately 13 acres of wet meadow and approximately eight acres of deep marsh.

8.2.3.3 Substrate

All three soil types existing at the site are listed as hydric soils (Otter, 1990) and will provide a suitable substrate for the proposed compensation site. The site soils generally consist of an approximate two-foot highly organic layer overlying sands. As a result of the excavation, the sand layer will be exposed below an elevation of approximately 817 feet MSL.

8.2.3.4 Revegetation

The site was previously a wetland and wetlands nearly surround the site. Table 8-2 indicates that a prevalence of wetland vegetation already exists along the site periphery and in the site ditches.

These factors coupled with a site design that provides for the control of water levels between approximately 819.6 MSL and the top of the groundwater surface, which is estimated to be at approximately 817 feet MSL, offer an ideal opportunity for natural revegetation.

Water level adjustment has been found to be an effective means of both controlling nuisance vegetation as well as stimulating new vegetative growth (Fredrickson, 1982). As such, the portion of the site below an elevation of approximately 819.6 feet will be allowed to revegetate naturally, relying on the seedbank remaining in the site soils and the adjacent wetlands as a source of plant material.

It is anticipated that construction of the site will be completed by late summer in the year in which it takes place. At the completion of construction the outlet structure will be set to allow maximum flooding during the fall and winter periods. A gradual drawdown is proposed beginning the following May to stimulate germination of the existing seedbank. Water levels will be maintained at approximately 817 feet until germination occurs. At this point water levels will be raised and maintained at adequate depths to preclude terrestrial species, yet not impair the growth of wetland species. The proposed normal pool elevation is 818.9 feet. During the first growing season, this elevation will be maintained based on the growth of the vegetation.

The seedbank, in areas of the site above the elevation where water level adjustment can effectively control invasive plant species (i.e., above 819.6), will be supplemented by seeding (Figure 8-6). A mixture of oats and annual rye will be planted at a rate of 80 and 100 pounds per acre, respectively to establish a temporary cover crop at the completion of construction to control erosion. The following spring, during the maximum drawdown period, these areas will be tilled and reseeded with the wet meadow seed mixture presented in Table 8-4.

Table 8-4

Wet Meadow Seed Mixture

Grasses and Sedges:

- Canada bluejoint grass *(Calamagrostis canadensis)*
- Prairie cord-grass *(Spartina pectinata)*[1]
- Big bluestem *(Andropogon gerardii)*
- Switch grass *(Panicum virgatum)*[2]
- Green bulrush *(Scirpus atrovirens)*
- Fox Sedge *(Carex vuplinoidea)*

Forbs:

- Swamp Milkweed *(Ascelepias incarnata)*
- Angelica *(Angelica atropurpurea)*
- Blue vervain *(Verbena hastata)*
- New England aster *(Aster novae-angliae)*
- Marsh aster *(Aster simplex)*
- Joe-pye weed *(Eupatorium maculatum)*

Source: Eggers, 1992.

Checked by: RFS

The shallow and deep marsh areas will be maintained in the desired condition over time through water level controls. The wet meadow habitat type will not be maintained, but will be allowed to succeed naturally. Based on the existing condition of the surrounding wetlands, this portion of the site will likely be encroached by willows and alders and progress into a shrub swamp over time. The area to the north where the excess soil will be deposited will be used for agricultural or other compatible purposes.

8.2.3.5 Maintenance

Due to the relatively simple site design, maintenance activities will largely be limited to water level adjustment as described above to establish the desired wetland vegetation. Once the desired vegetation has been established, the stop-log weir will be replaced with a permanent weir with an elevation of 818.9 feet MSL. The bypass spillway will not be affected as part of weir replacement. It is anticipated that the permanent weir will be installed between years five and ten after wetland development to provide sufficient time for vegetation to take hold. During the time the stop-log weir is in place periodic drawdowns and/or inundation may be required to develop a healthy vegetative community.

8.2.4 Construction Schedule

The proposed wetland mitigation project will be constructed during the construction phase of the proposed mine site prior to the beginning of mine operations. Construction of the wetland site will begin in the summer and end in late summer or early fall. The current agricultural use of the site will be maintained until construction begins. Although construction will be completed in less than one year, it is anticipated that up to four years will be required to establish a fully functional wetland system.

8.2.5 Long-Term Use

CMC intends to convey the site to local governments or a private conservatory group and leave the proposed wetland compensation site dedicated in perpetuity for use as a natural conservatory area.

8.2.6 Monitoring Plan

8.2.6.1 Baseline Monitoring Plan

Baseline biological monitoring will be conducted for one year prior to the construction of the compensation site. Monitoring will include three frog calling surveys (early spring, late spring and early summer) following the Wisconsin Department of Natural Resources Bureau of Endangered Resources Frog and Toad Survey guidelines (WDNR, 1986). This will provide an indication of the current use of the site by herptiles and can later be used as a baseline for evaluating the success of the compensation site. Migratory water bird and waterfowl surveys will be conducted once in the spring and the fall of the year. A waterfowl brood count will be conducted in early summer.

A site visit during the late July or early August period will be conducted to develop a complete plant list for the site. This information will be used to fine-tune the site revegetation plan.

8.2.6.2 Post-Construction Monitoring Plan

The primary goal of the proposed restoration project is to establish a functioning wetland system that compensates for the loss of functions and values of the wetlands impacted by the Crandon Project. The purpose of the monitoring plan is to measure the success of the proposed restoration. For the purposes of this monitoring plan, success of the proposed restoration will be achieved if a functioning wetland system has been created. A qualitative set of performance standards will be established to evaluate success. If an answer of yes is obtained to the following two questions, it will be assumed that a functioning wetland system has been restored:

- Has wetland hydrology (i.e., as defined by the 1987 *U.S. Army Corps of Engineers Wetland Delineation Manual* [USCOE, 1987]) been established across a minimum of 36 acres of the site?
- Has a dominance of wetland vegetation been established on at least 36 acres of the site?

The proposed compensation site was historically a wetland and is currently adjacent to existing wetlands. If the hydrology and wetland vegetation have been reestablished and are comparable to adjacent wetlands, it can be assumed that a functioning wetland has been successfully restored. Unlike many mitigation projects, the success of this mitigation project will not be measured on the diversity of wetland vegetation but on the functions that the wetland provides. However, this monitoring plan is designed to identify invasions of nuisance vegetation (e.g., purple loose strife) which will be addressed in the maintenance plan.

As part of the proposed design, adequate retention time, water depths, and storage volume are provided to enhance hydrologic support functions. Water levels will be monitored to ensure that the site meets the design standards. The biological functions will be assessed through comparison of wildlife observations from the baseline monitoring program to those obtained during the monitoring program. If documented use of the site by wetland dependent wildlife occurs, the site will be considered a success. Birds and herptiles will be the indicator species.

The specific elements of the monitoring plan are listed below:

- All plant species, along with their estimated relative frequency and percent cover, will be identified bi-annually by using plots measuring 10 feet by 10 feet with at least one representative plot located in each of the habitat types within the compensation site. The location of each plot shall be identified on a plan view site drawing. Vegetation surveys will be conducted between July 1 and September 30 of every other year.
- A vegetation cover type map will be prepared based on the results of the vegetation surveys.
- Photographs will be taken at the time of the vegetation surveys at each sample site. Additionally, a set of fixed-point panoramic photographs will be taken at pre-established locations.

- A staff gauge will be installed upstream of the outlet structure and monitored monthly between April and October.

- Groundwater levels will be monitored at a frequency similar to that used for the ditches by three piezometers located around the periphery of the site.

- Frog call surveys will be conducted three times every other year following the guidelines of the Wisconsin Frog and Toad Call Survey (WDNR, 1986).

- Migratory bird and waterfowl surveys will be conducted once in the spring and the fall of every other year. Waterfowl brood counts will be conducted every other year in early summer.

- Qualitative observations for wildlife will be made during each monitoring visit to the site. Records will be maintained regarding the species encountered, activity and number of the species.

Bi-annual reports will be submitted to the USCOE by December 31, beginning after the first growing season following completion of site construction. The bi-annual reports will summarize monitoring performed during the year. The reports will assess the state of the compensation wetland at the end of the monitoring period and contain a discussion relating to the two questions referenced above that will be used to define if a successful wetland system has been created. Once a determination is made that a successful wetland system has been created, monitoring will continue for one additional year to confirm the determination. Upon documentation of the confirmation in the subsequent years annual report, the permanent weir structure will be installed at the site and monitoring and reporting will cease. It is anticipated that the cessation will occur between years five and 10 after site construction is completed.

9 References

Adamus, Paul R., ARA Inc., Ellis J. Clarain, R. Daniel Smith, and Richard E. Young, 1987. *Wetland Evaluation Technique*. U.S. Army Corps of Engineers.

Curtis, John T., 1959. *The Vegetation of Wisconsin*. The University of Wisconsin Press.

Eggers, 1992. *Compensatory Wetland Mitigation: Some Problems and Suggestions for Corrective Measures*. U.S. Army Corps of Engineers.

Foth & Van Dyke, May 1995a. *Environmental Impact Report for the Crandon Project*.

Foth & Van Dyke, May 1995b. *Mine Permit Application for the Crandon Project*.

Fredrickson, 1982. *Management of Seasonally Flooded Impoundments for Wildlife*. United States Department of the Interior. Fish and Wildlife Service.

Gundlach, et al., 1982. Soil Survey of Shawano County, Wisconsin. United States Department of Agriculture, Washington, D.C.

Interdisciplinary Environmental Planning, Inc., 1983. Supplemental Wetland Assessment Report. CMC-NOI-164.

Mitsch & Gosselink, 1986. *Wetlands*. Van Nostrand Reinhold. New York.

Moe, Don, July 7, 1994. Crandon Project Section 404 Permit Application.

Moe, Don, September 1994. Correspondence to James Bauer, WDNR.

Moe, Don, January, 1995. Correspondence to Dave Siebert, WDNR.

Normandeau Associates, Inc. and Interdisciplinary Environmental Planning, Inc., 1982a. *Wetlands Assessment Report.* CMC-NOI-160.

Normandeau Associates, Inc. and Interdisciplinary Environmental Planning, Inc., 1982b. *Wetlands Assessment Inventory Reports.* CMC-NOI-161.

Normandeau Associates, Inc. and Interdisciplinary Environmental Planning, Inc., 1982c. *Wetlands Assessment Appendices.* CMC-NOI-162.

Normandeau Associates, Inc. and Interdisciplinary Environmental Planning, Inc., 1982d. *Wetlands Assessment Maps.* CMC-NOI-163.

Otter, 1990. Hydric Soils List for Shawano County. Shawano County Soil Conservation Service.

Richards, John D., April 1995. Technical Memorandum to Jerry W. Sevick, Foth & Van Dyke. *Crandon Project: Archaeological Survey of Proposed 150 Acre Wetland Mitigation Site in Oconto and Shawano Counties, Wisconsin*. Great Lakes Archaeological Research Center, Inc.

Schulz, D., Oconto County Natural Resources Conservation Service, April 1995. Personal communication regarding wetland classifications.

Siebert, Dave, WDNR, September 15, 1994. Correspondence Memorandum to Bill Tans, WDNR.

U.S. Army Corps of Engineers, 1987. Wetland Delineation Manual.

Wisconsin Department of Natural Resources/Public Service Commission, 1986. *Final Environmental Impact Statement, Exxon Coal and Minerals Co. Zinc-Copper Mine, Crandon, Wisconsin.*

Wisconsin Department of Natural Resources, April, 1986. *Frog and Toad Survey Guidelines.* Field Data Sheet. Form 1700-3.

Wisconsin Department of Transportation, 1993. *Wetland Mitigation Banking Technical Guideline.*

FIGURES FOR SECTION 404 PERMIT APPLICATION

NOTES:

1. BASE MAP DERIVED FROM COUNTY MAPS PREPARED BY THE WISCONSIN DEPARTMENT OF TRANSPORTATION.
2. ORE BODY OUTLINE IS REPRESENTATIVE OF THE SUBCROP AT THE BASE OF THE OVERBURDEN.
3. ADDITIONAL POTAWATOMI LANDS LOCATED TO THE EAST OF MAP COVERAGE.

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

CHECKED BY:	JKS1	DATE: MAY '95
APPROVED BY:	PAE	DATE: MAY '95
APPROVED BY:	GWS	DATE: MAY '95

Crandon Mining Company

FIGURE 2-1
SITE LOCATION

Scale: 0 5000' 10,000'
Date: MAY, 1995
Prepared By: Foth & Van Dyke
By: BSH

93C049

/d3/d1/users/jprl/3c49ml3.dgn

NOTES:

1. TOPOGRAPHIC BASE MAP DIGITIZED FROM 1" = 1000' SCALE, 5' CONTOUR INTERVAL MAP PREPARED BY AERO-METRIC ENGINEERING, INC., SHEBOYGAN, WISCONSIN. DATE OF PHOTOGRAPHY APRIL 28, 1976.
2. HORIZONTAL DATUM BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM - NORTH ZONE.
3. VERTICAL DATUM BASED ON MEAN SEA LEVEL DATUM. CONTOUR INTERVAL IS 25 FEET.
4. COUNTY AND TOWNSHIP LINES DIGITIZED FROM 7.5' SERIES USGS MAPS.
5. ORE BODY OUTLINE IS REPRESENTATIVE OF THE SUBCROP AT THE BASE OF THE OVERBURDEN.

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

CHECKED BY:	JKS1	DATE: MAY '95
APPROVED BY:	PAE	DATE: MAY '95
APPROVED BY:	GWS	DATE: MAY '95

Crandon Mining Company

FIGURE 2-2
PROJECT AREA

Scale: 0 1000' 2000'
Date: MAY, 1995
Prepared By: Foth & Van Dyke
By: JRB

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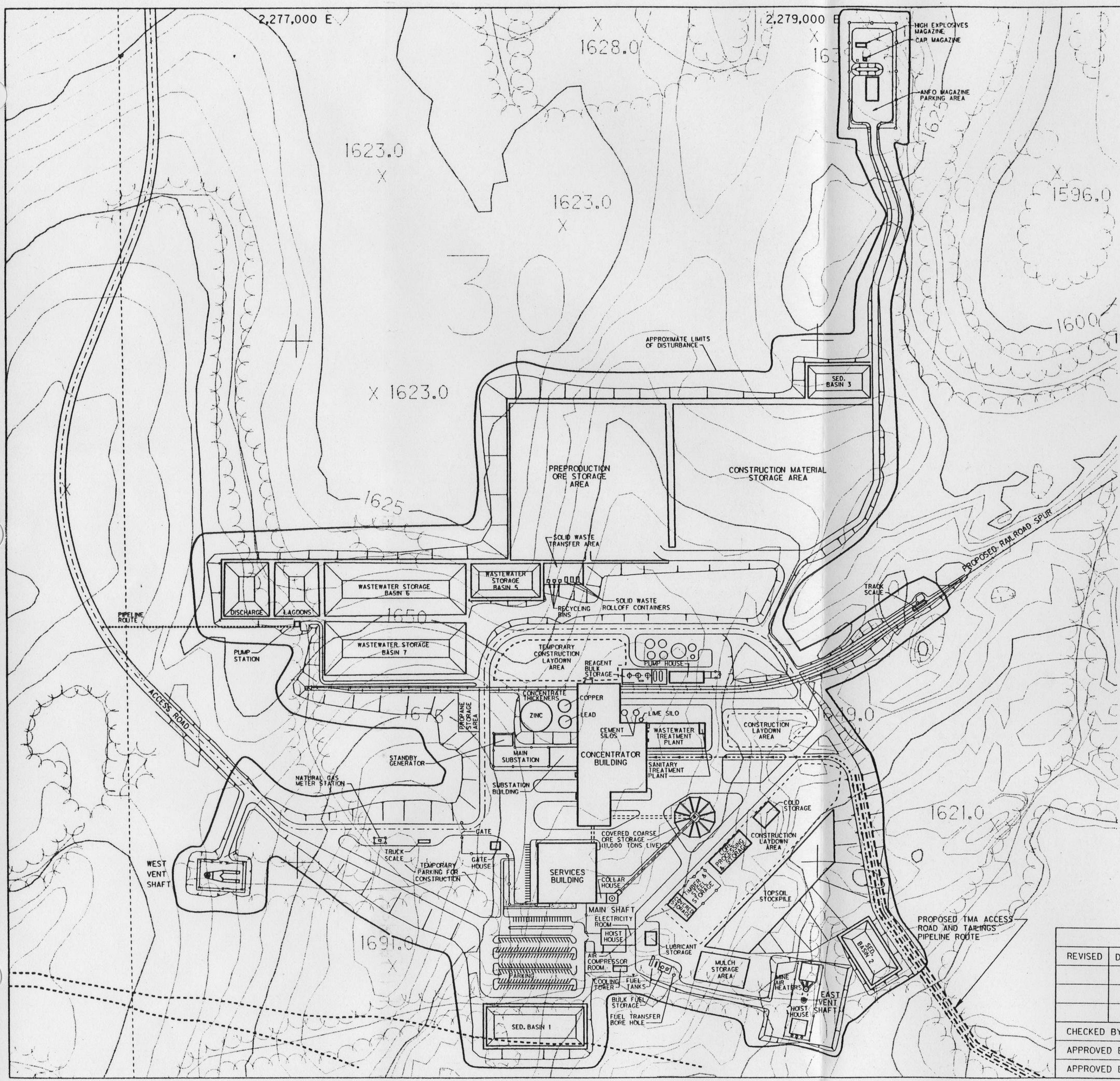
93C049



N

LEGEND

	LAKES
	STREAMS
	EXISTING ROAD
—1675—	EXISTING CONTOUR
x1692.0	SPOT ELEVATION
-----------	SECTION LINE
	ORE BODY

NOTES:

1. TOPOGRAPHIC BASE MAP DIGITIZED FROM 1"=1000' SCALE, 5' CONTOUR INTERVAL MAP PREPARED BY AERO-METRIC ENGINEERING, INC., SHEBOYGAN, WISCONSIN. DATE OF PHOTOGRAPHY APRIL 28, 1976.
2. HORIZONTAL DATUM BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM - NORTH ZONE.
3. VERTICAL DATUM BASED ON MEAN SEA LEVEL DATUM. CONTOUR INTERVAL IS FIVE FEET.
4. COUNTY AND TOWNSHIP LINES DIGITIZED FROM 7.5' SERIES USGS MAPS.

SCALE
0 200' 400'

TYPICAL REPRESENTATION: REFINEMENTS MAY BE MADE PRIOR TO CONSTRUCTION.

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

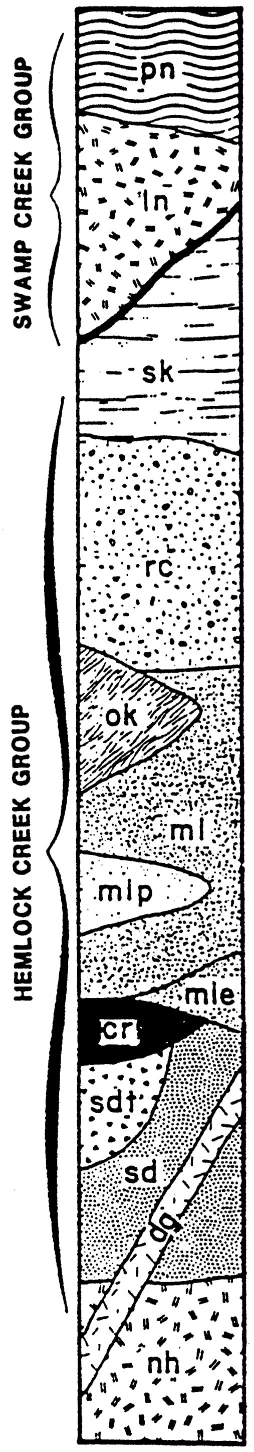
CHECKED BY: JKS1 DATE: MAY.'95
APPROVED BY: PAE DATE: MAY.'95
APPROVED BY: JWS DATE: MAY.'95

Crandon Mining Company

FIGURE 2-3
PLANT SITE LAYOUT

Scale: SEE BAR SCALE
Date: MAY, 1995
Prepared By: Foth & Van Dyke
By: JRB2

93C049



PINE FORMATION (pn)
Cherty tuff and argillite.

LINCOLN FORMATION (ln)
Quartz porphyritic rhyolite flows with minor interflow tuff, chert and argillite.

SKUNK LAKE FORMATION (sk)
Predominantly fine to coarse ash chert tuff, some cherty and very minor argillite.

RICE LAKE FORMATION (rc)
Volcanic debris flows (blocky chloritic and minor siliceous lapilli and breccia size debris) and eutaxitic ash flows, some chert.

OAK LAKE FORMATION (ok)
Sequence of cherty tuff and sericitic tuff.

MOLE LAKE FORMATION (ml)
Predominantly mafic ash tuff.

PROSPECT MEMBER (mlp)
Volcanic debris flow consisting of siliceous, lapilli size debris.

EAGLE MEMBER (mle)
Volcanic greywacke.

CRANDON FORMATION (cr)
Laminated, bedded & replacement sulfides (zinc ore) interbedded with pyritic argillite, pyritic felsic tuff and chert.

SAND LAKE FORMATION (sd)
Sequence of fine felsic tuffs and minor felsic debris & lava flows.

TOWNSHIP MEMBER (sdt)
Volcanic vent breccia affected by multiple stage hydrothermal alteration and sulfide enrichment.

NASHVILLE FORMATION (nh)
Feldspar porphyritic mafic flows.

DUCK LAKE GABBRO (dg)
Fresh, 2 pyroxene gabbro.
Cross cuts nh and sd.

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

CHECKED BY: JKS1	DATE: APR.'95	
APPROVED BY: PAE	DATE: APR.'95	
APPROVED BY: GWS	DATE: APR.'95	

Crandon Mining Company

FIGURE 2-4
STRATIGRAPHIC COLUMN

Scale: NOT TO SCALE
Date: MARCH, 1995
Prepared By: Foth & Van Dyke
By: BSH

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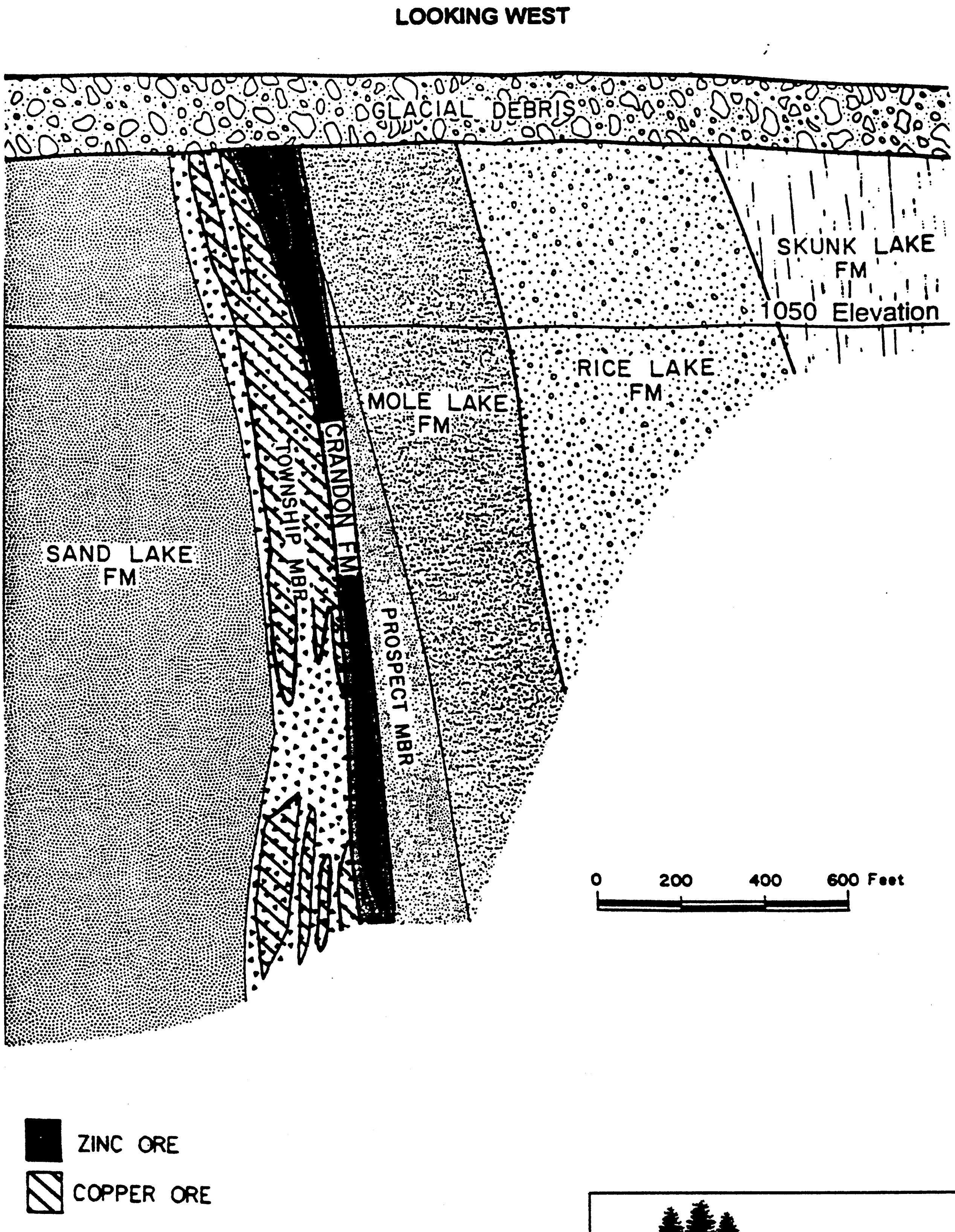

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

CHECKED BY:	JKS1	DATE: APR.'95
APPROVED BY:	PAE	DATE: APR.'95
APPROVED BY:	GWS	DATE: APR.'95

Crandon Mining Company

FIGURE 2-5

GENERALIZED GEOLOGIC CROSS SECTION C-C'

Scale: AS SHOWN		Date: MARCH, 1995	
Prepared By: Foth & Van Dyke			By: BSH

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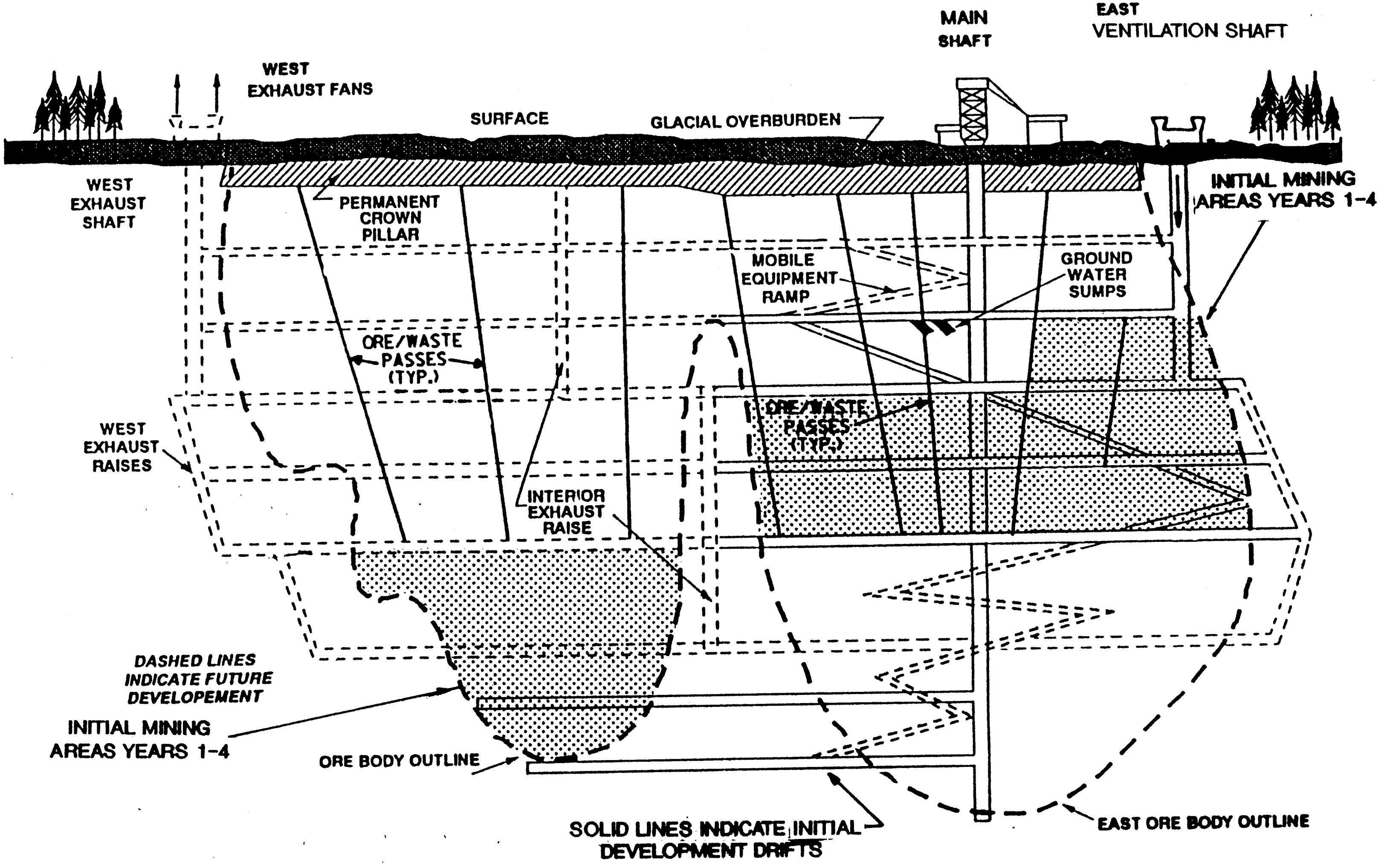


Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

CHECKED BY:	JKSI	DATE:	APR.'95
APPROVED BY:	PAE	DATE:	APR.'95
APPROVED BY:	GWS	DATE:	APR.'95

Crandon Mining Company

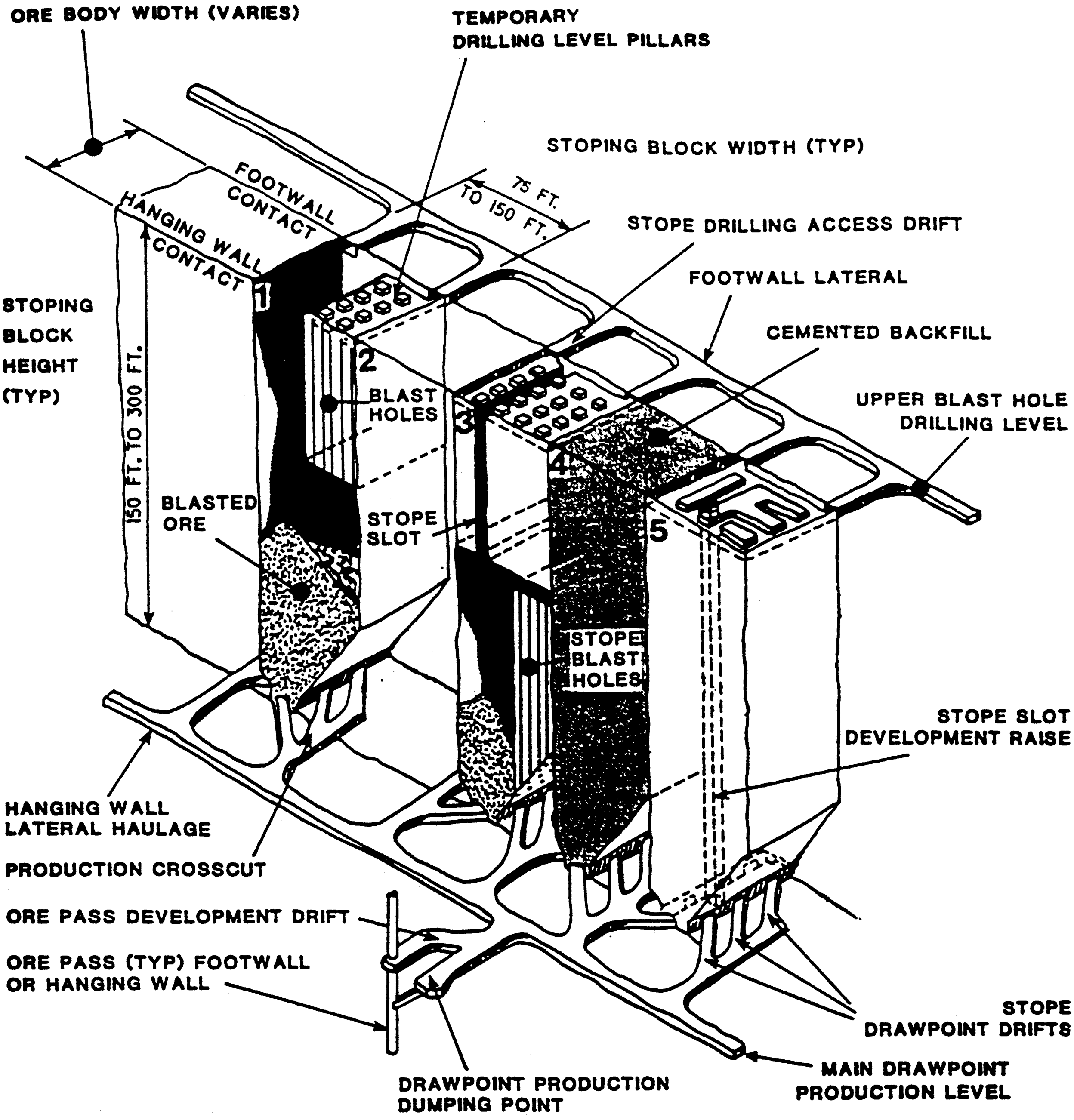
FIGURE 2-6

SCHEMATIC LONGITUDINAL SECTON
(LOOKING NORTH)

Scale: NOT TO SCALE Date: MARCH, 1995

Prepared By: Foth & Van Dyke By: BSH

93C049



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

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

CHECKED BY: JKS1 DATE: APR.'95
APPROVED BY: PAE DATE: APR.'95
APPROVED BY: GWS DATE: APR.'95

Crandon Mining Company

FIGURE 2-7
CONCEPTUAL STOPING SEQUENCE

Scale: NOT TO SCALE Date: MARCH, 1995
Prepared By: Foth & Van Dyke By: BSH

93C049

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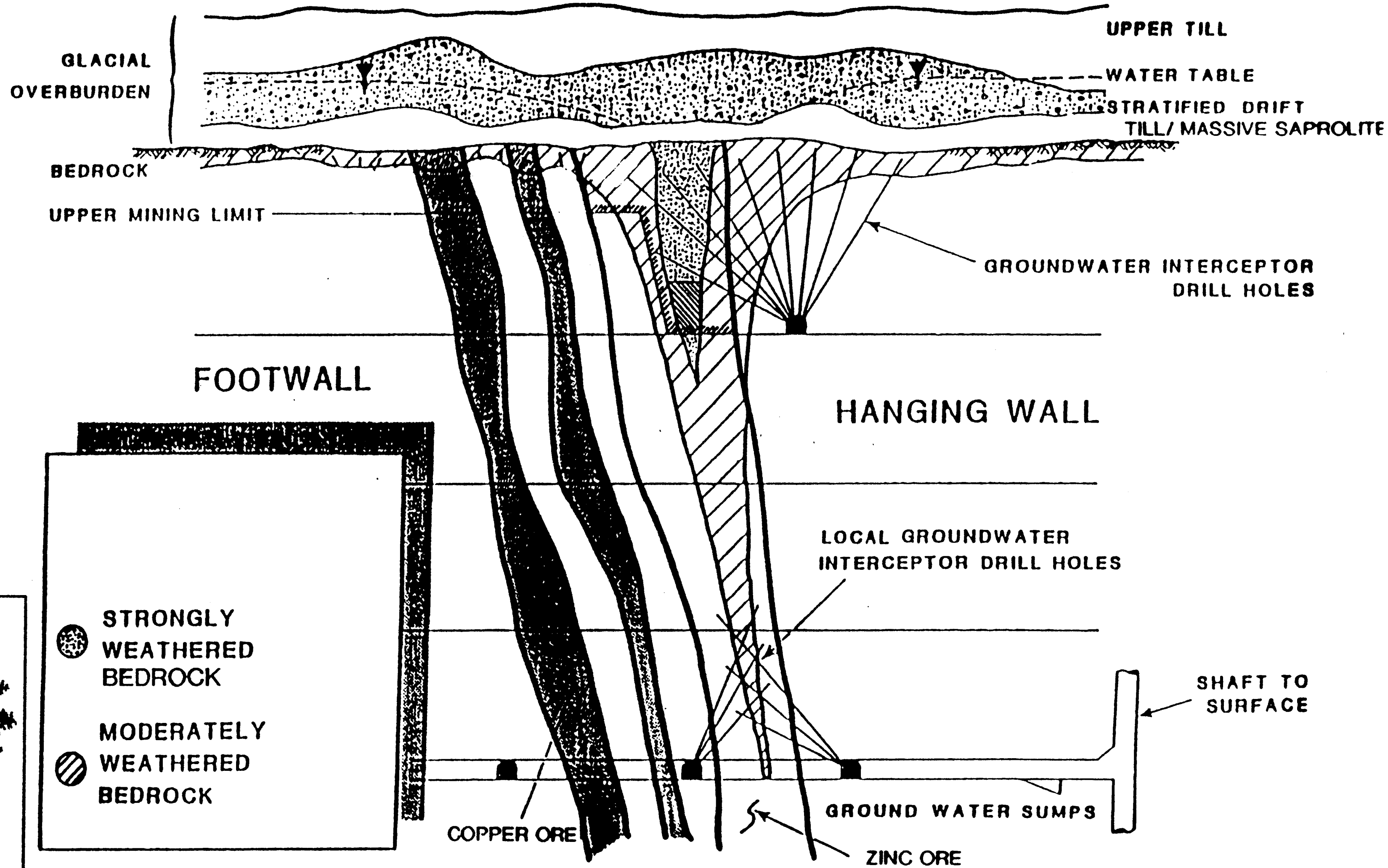

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

CHECKED BY: JKSI DATE: APRIL '95

APPROVED BY: PAE DATE: APRIL '95

APPROVED BY: GWS DATE: APRIL '95

Crandon Mining Company

FIGURE 2-8

GROUNDWATER INTERCEPTOR SYSTEM
(CONCEPTUAL CROSS SECTION)

Scale: AS SHOWN

Date: MARCH, 1995

Prepared By: Foth & Van Dyke

By: BSH

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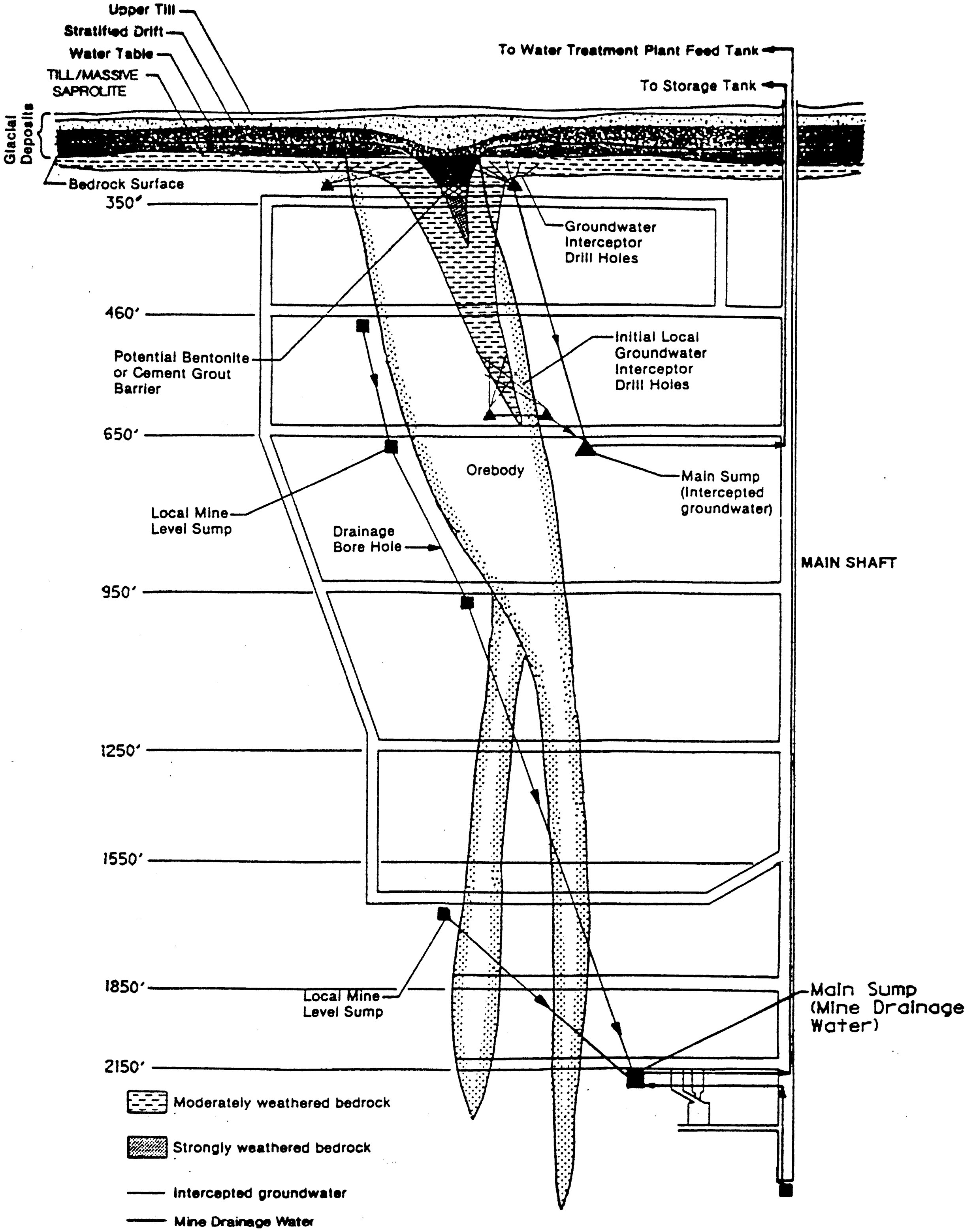


Foth & Van Dyke

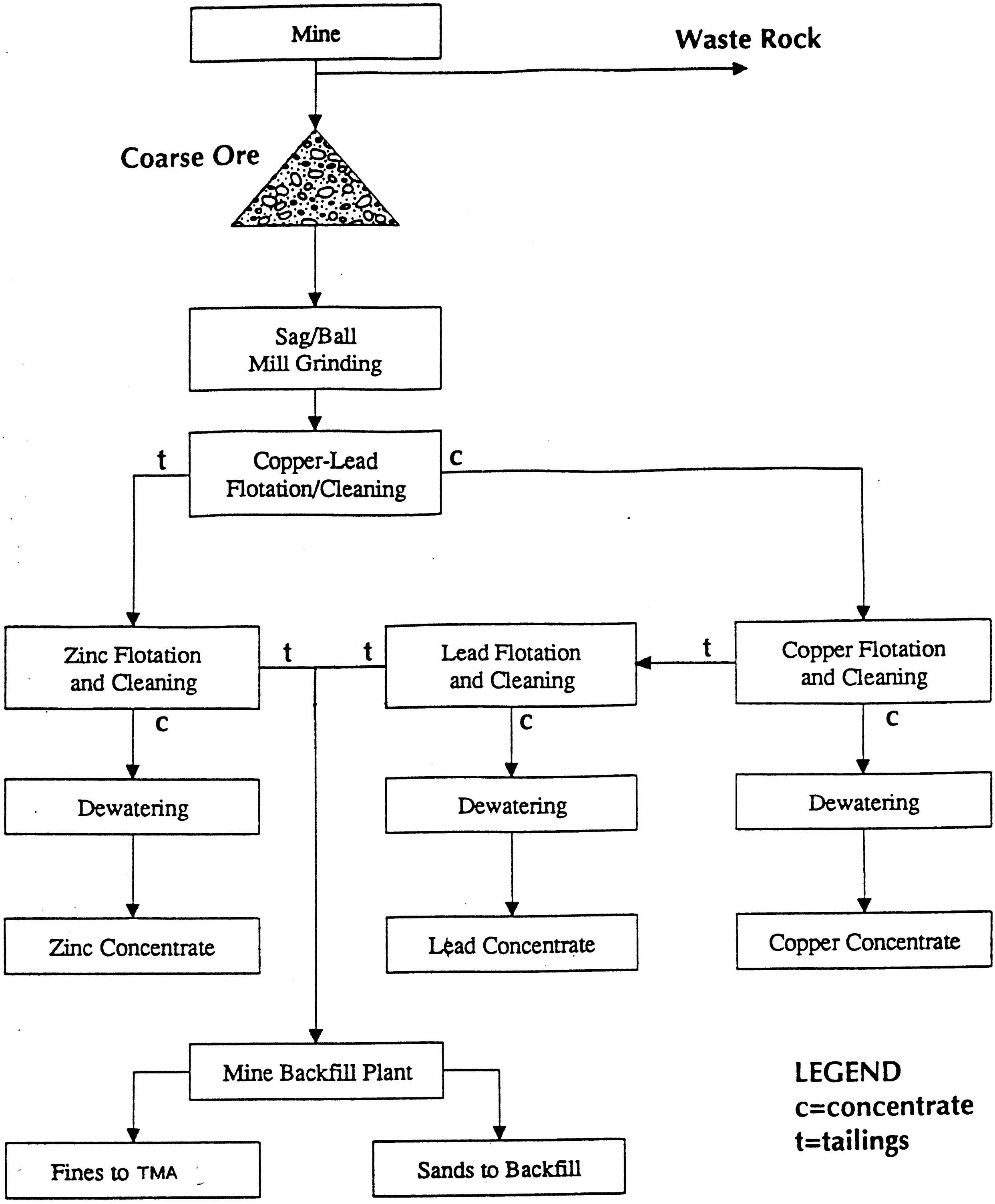
REVISED	DATE	BY	DESCRIPTION

CHECKED BY: JKSI DATE: APR.'95
APPROVED BY: PAE DATE: APR.'95
APPROVED BY: GWS DATE: APR.'95

Crandon Mining Company

FIGURE 2-9
MINE DRAINAGE SCHEMATIC

Scale: NOT TO SCALE
Date: MARCH, 1995
Prepared By: Foth & Van Dyke
By: BSH



Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

CHECKED BY:	JKSI	DATE:	APR.'95
APPROVED BY:	PAE	DATE:	APR.'95
APPROVED BY:	GWS	DATE:	APR.'95

Crandon Mining Company

FIGURE 2-10
CONCENTRATOR PROCESS FLOWSHEET

Scale: NOT TO SCALE Date: MARCH, 1995

Prepared By: Foth & Van Dyke By: BSH

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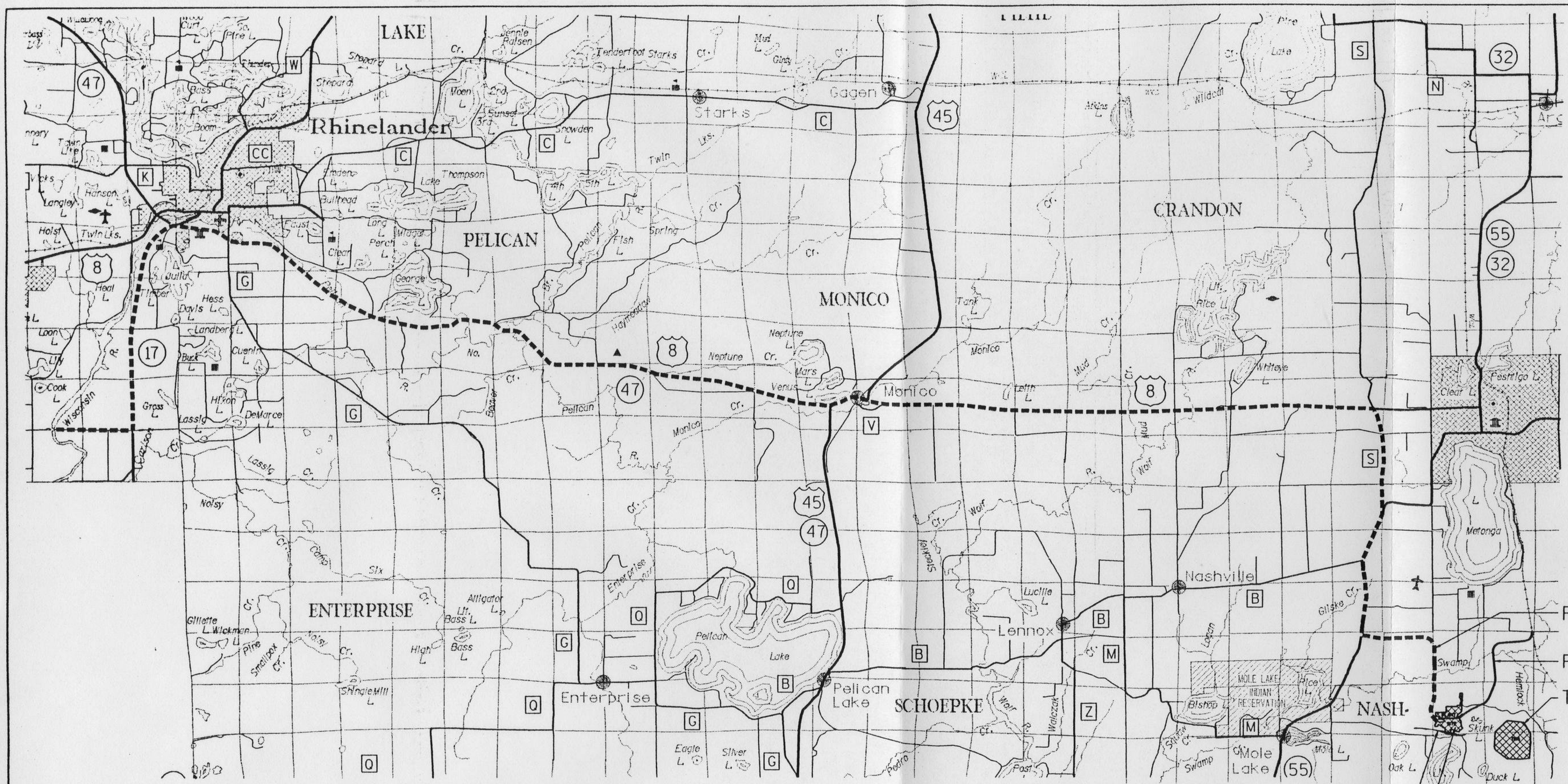

PROPOSED ACCESS ROAD

PROPOSED RAILROAD SPUR

TAILINGS MANAGEMENT AREA

ORE BODY

PLANT SITE

N

LEGEND

- U.S. OR STATE HWY
- COUNTY TRUNK ROAD
- TOWN ROAD
- SECTION LINE
- 8 U.S. HWY NO.
- 47 STATE HWY NO.
- W COUNTY HIGHWAY LETTER
- PROPOSED WASTEWATER PIPELINE

NOTES:

1. BASE MAP DERIVED FROM COUNTY MAPS PREPARED BY THE WISCONSIN DEPARTMENT OF TRANSPORTATION.
2. ORE BODY OUTLINE IS REPRESENTATIVE OF THE SUBCROP AT THE BASE OF THE OVERBURDEN.

TYPICAL REPRESENTATION: REFINEMENTS MAY BE MADE PRIOR TO CONSTRUCTION.

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

CHECKED BY:	JKS1	DATE:	MAY.'95
APPROVED BY:	PAE	DATE:	MAY.'95
APPROVED BY:	GWS	DATE:	MAY.'95

Crandon Mining Company

FIGURE 2-11

PROPOSED PIPELINE ROUTE FOR WISCONSIN RIVER DISCHARGE

Scale: 0 6000' 12,000' Date: MAY, 1995

Prepared By: Foth & Van Dyke By: GAM

93C049

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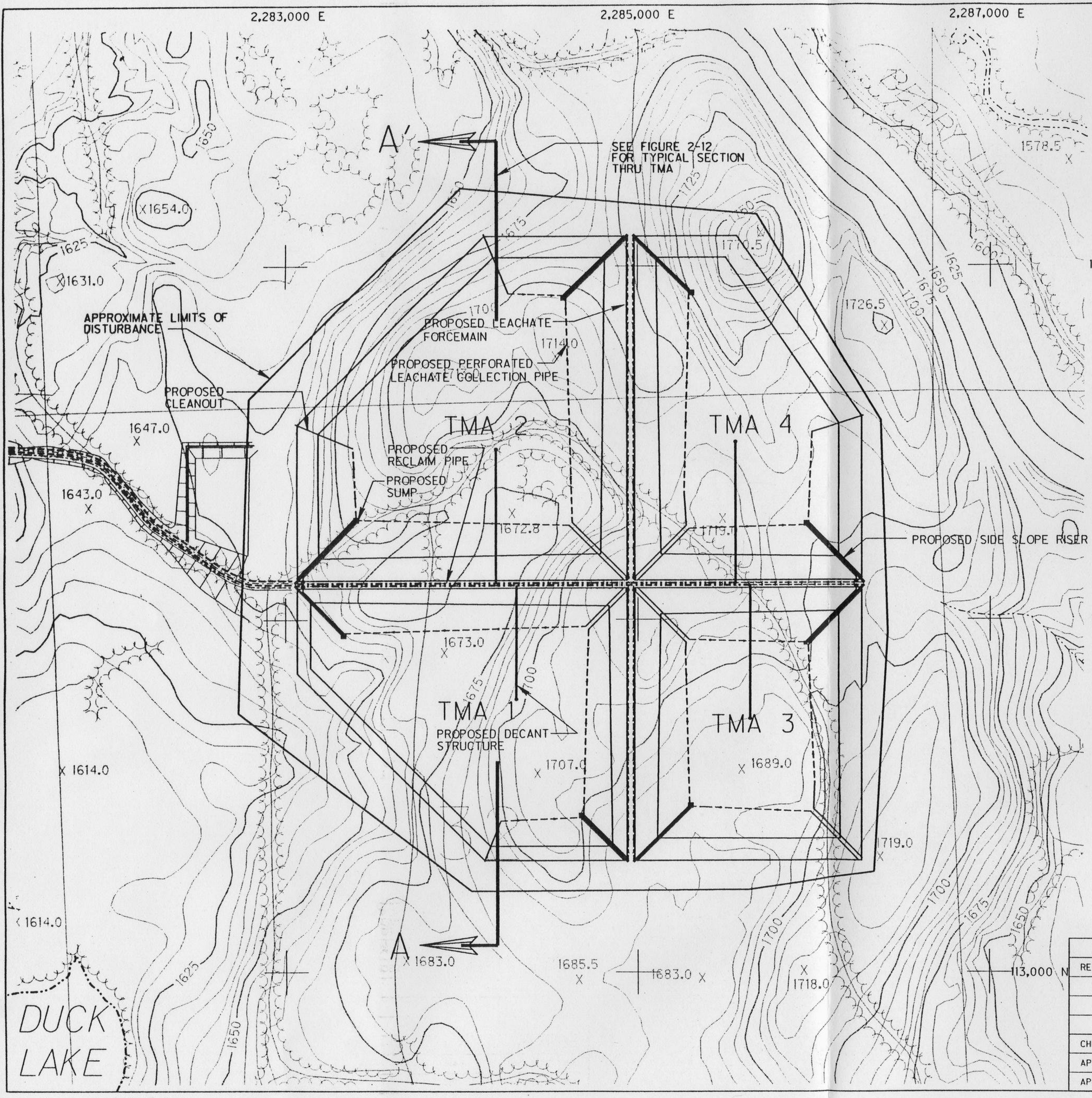


LEGEND

⬭	LAKES
-·-·-	STREAMS
═	EXISTING ROAD
—1675—	EXISTING CONTOUR
x 1692.0	SPOT ELEVATION
———	SECTION LINE
TMA	APPROXIMATE LIMITS OF DISTURBANCE

N

NOTES:

1. TOPOGRAPHIC BASE MAP DIGITIZED FROM 1"=1000' SCALE, 5' CONTOUR INTERVAL MAP PREPARED BY AERO-METRIC ENGINEERING, INC., SHEBOYGAN, WISCONSIN. DATE OF PHOTOGRAPHY APRIL 28, 1976.
2. HORIZONTAL DATUM BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM - NORTH ZONE.
3. VERTICAL DATUM BASED ON MEAN SEA LEVEL DATUM. CONTOUR INTERVAL IS FIVE FEET.
4. COUNTY AND TOWNSHIP LINES DIGITIZED FROM 7.5' SERIES USGS MAPS.

SCALE
0 300' 600'

TYPICAL REPRESENTATION: REFINEMENTS MAY BE MADE PRIOR TO CONSTRUCTION.

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

CHECKED BY: JKSI DATE: MAY.'95
APPROVED BY: PAE DATE: MAY.'95
APPROVED BY: GWS DATE: MAY.'95

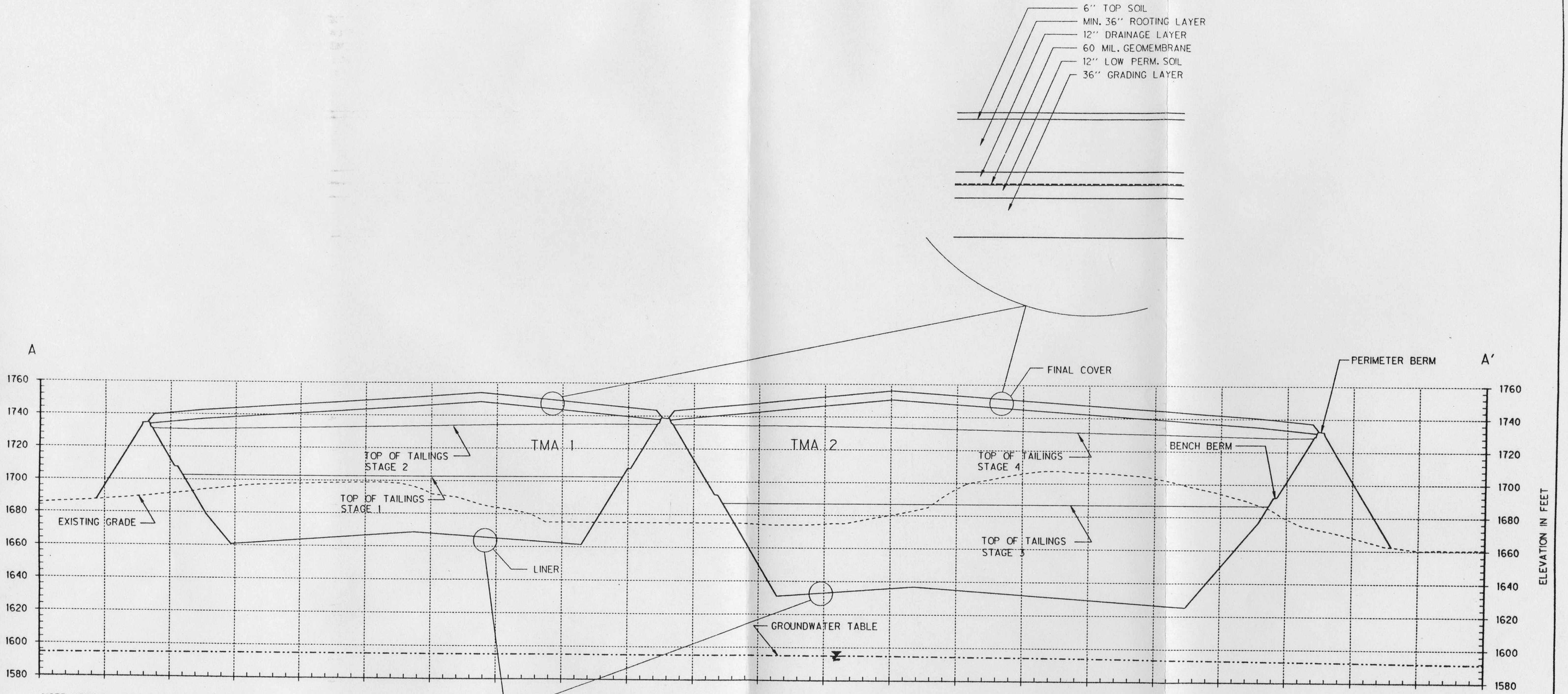
Crandon Mining Company

FIGURE 2-12

PROPOSED TMA LAYOUT

Scale: AS SHOWN Date: MAY, 1995
Prepared By: Foth & Van Dyke By: MRS

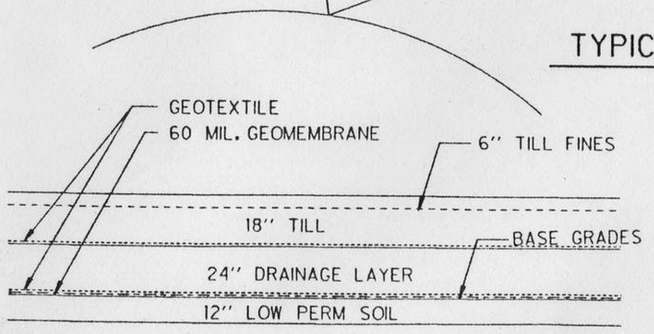
93C049

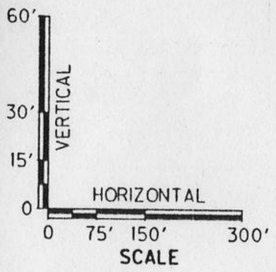


NOTE: VERTICAL SCALE IS EXAGGERATED

TYPICAL CROSS SECTION A-A' THROUGH TMA

NOT TO SCALE





TYPICAL REPRESENTATION:
REFINEMENTS MAY BE MADE
PRIOR TO CONSTRUCTION.

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

CHECKED BY:	JKS1	DATE: MAY '95
APPROVED BY:	PAE	DATE: MAY '95
APPROVED BY:	GWS	DATE: MAY '95

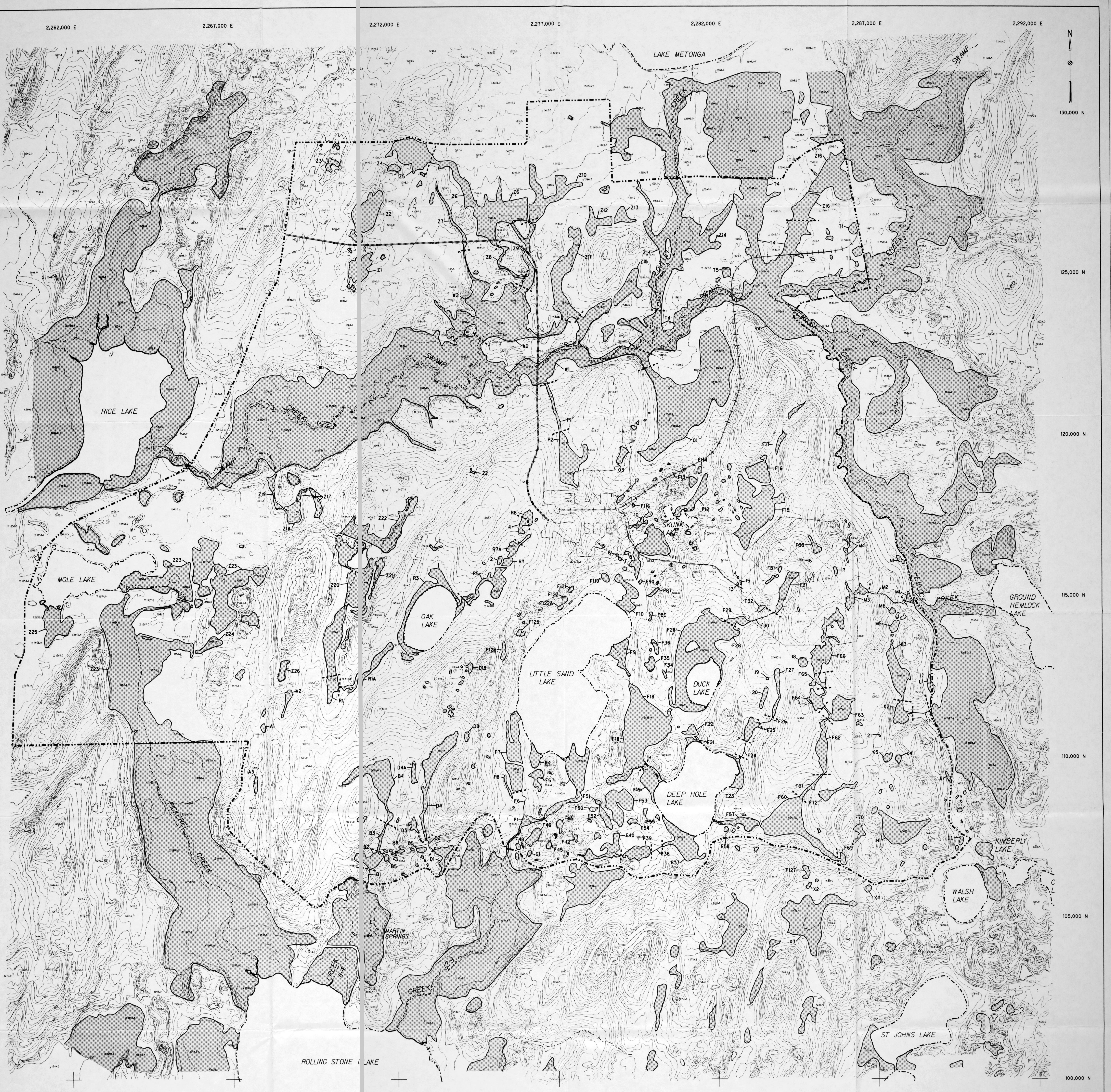
Crandon Mining Company

FIGURE 2-13
TYPICAL CROSS SECTION
THROUGH TMA

Scale:	AS SHOWN	Date:	MAY, 1995
Prepared By:	Foth & Van Dyke	By:	MRS

/d3/d1/users/jprl/3c49m7.dgn

93C049



LEGEND

	LAKES
	STREAMS
	EXISTING ROAD
—1675—	EXISTING CONTOUR
1692.0 X	SPOT ELEVATION
	PROPOSED ACCESS ROAD
	PROPOSED RAILROAD SPUR
☒	PROPOSED FACILITIES
F16	WETLAND IDENTIFICATION
	WETLAND DIVIDER
	WETLAND STUDY BOUNDARY WETLANDS WITHIN THIS BOUNDARY BASED ON NORMANDEAU ASSOCIATES, INC., AND INTERDISCIPLINARY ENVIRONMENTAL PLANNING, INC. 1983. WETLANDS OUTSIDE THIS BOUNDARY BASED ON AERIAL PHOTOGRAPHIC INTERPRETATION BY FOTH & VAN DYKE IN 1995.

NOTES:

1. TOPOGRAPHIC BASE MAP DIGITIZED FROM 1"=1000' SCALE, 5' CONTOUR INTERVAL MAP PREPARED BY AERO-METRIC ENGINEERING, INC., SHEBOYGAN, WISCONSIN. DATE OF PHOTOGRAPHY APRIL 28, 1976.
2. HORIZONTAL DATUM BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM - NORTH ZONE.
3. VERTICAL DATUM BASED ON MEAN SEA LEVEL DATUM. CONTOUR INTERVAL IS FIVE FEET.

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

CHECKED BY:	JKS1	DATE: JULY'95
APPROVED BY:	RFS	DATE: JULY'95
APPROVED BY:	GWS	DATE: JULY'95

Crandon Mining Company

FIGURE 5-1

STUDY AREA WETLANDS

Scale: 1" = 1000'

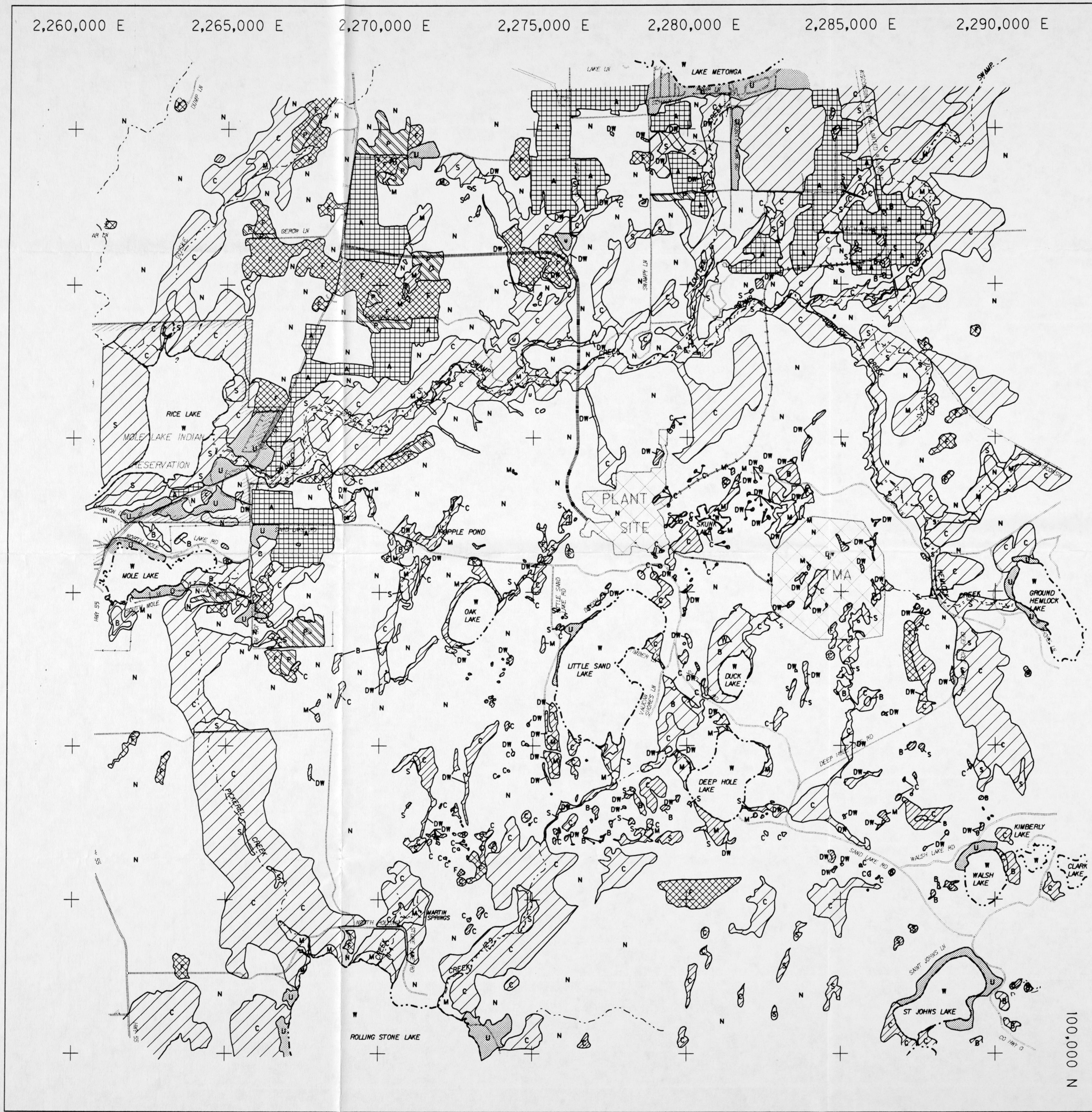
Date: JULY, 1995

Prepared By: Foth & Van Dyke

By: BSH

93C049

/d3/dl/users/jprl/4c57zl2.dgn
07/17/95 jprl



LEGEND

LAKES

STREAMS

EXISTING ROAD

PROPOSED ACCESS ROAD

PROPOSED RAILROAD SPUR

PROPOSED FACILITIES

VEGETATION CLASSIFICATIONS

B = BOGS
C = SWAMP CONIFERS
DW = DECIDUOUS FORESTED WETLANDS
M = MARSHES
S = SHRUB WETLANDS

F = FIELDS AND UPLAND OPENINGS (INCLUDING TREES < 10' IN HEIGHT)

A = AGRICULTURAL LANDS

P = PINE PLANTATIONS

N = NORTHERN HARDWOOD FORESTS (INCLUDING > 10' IN HEIGHT)

OTHER LAND CLASSIFICATIONS

W = OPEN WATER

U = URBAN, RESIDENTIAL OR DEVELOPED AREAS

NOTES:

1. BASE MAP DIGITIZED FROM 1'' = 1000' SCALE, MAP PREPARED BY AERO-METRIC ENGINEERING, INC., SHEBOYGAN, WISCONSIN. DATE OF PHOTOGRAPHY APRIL 28, 1976.
2. HORIZONTAL DATUM BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM - NORTH ZONE.
3. COUNTY AND TOWNSHIP LINES DIGITIZED FROM 7.5' SERIES USGS MAPS.

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

CHECKED BY: JKS1 DATE: JULY'95
APPROVED BY: RFS DATE: JULY'95
APPROVED BY: GWS DATE: JULY'95

Crandon Mining Company

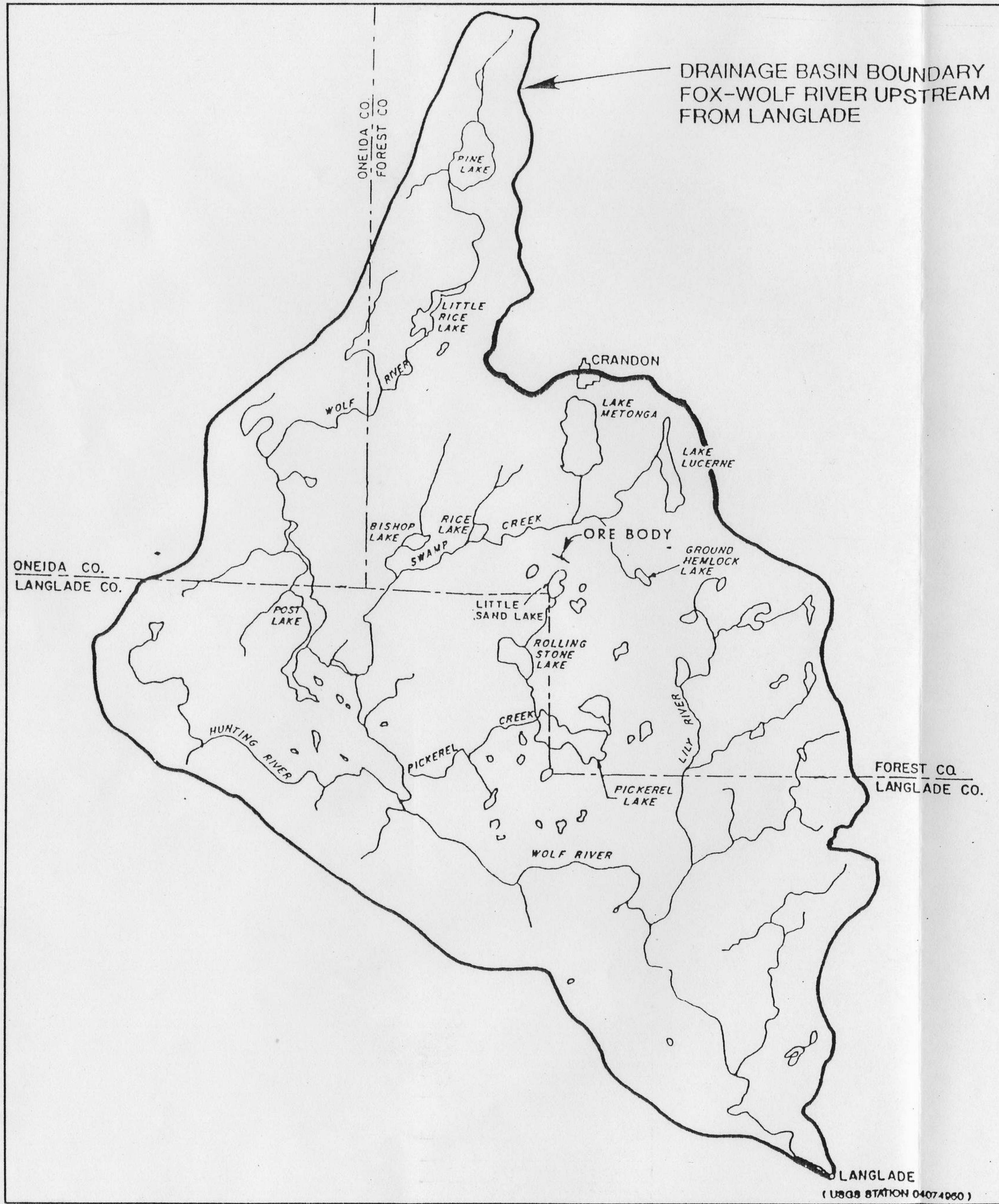
FIGURE 5-2

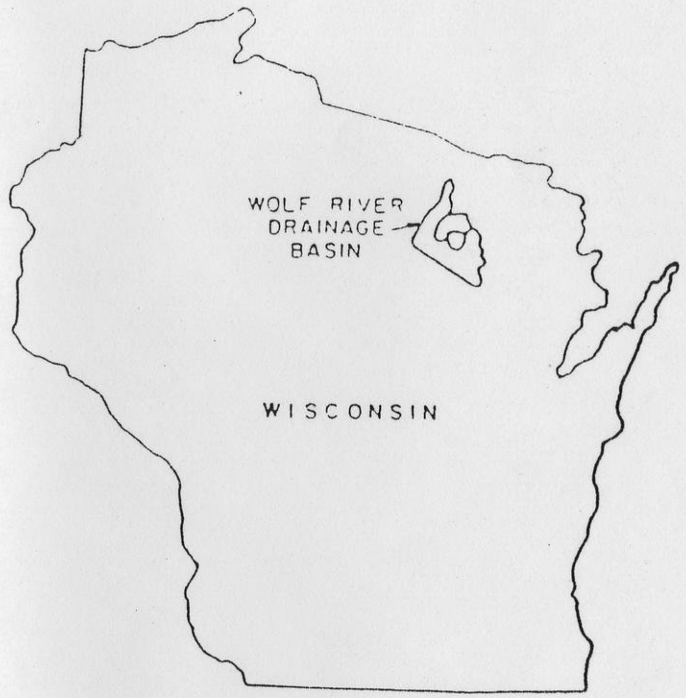
STUDY AREA VEGETATION MAP

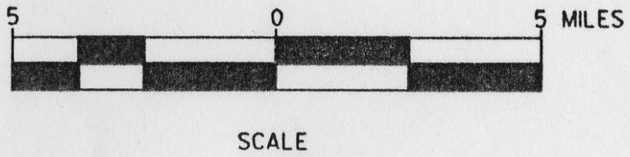
Scale: 0 1750' 3500'
Date: JULY, 1995
Prepared By: **Foth & Van Dyke**
By: JPR1

93C049

/d3/dl/users/jprl/4c57zl6.dgn







Foth & Van Dyke

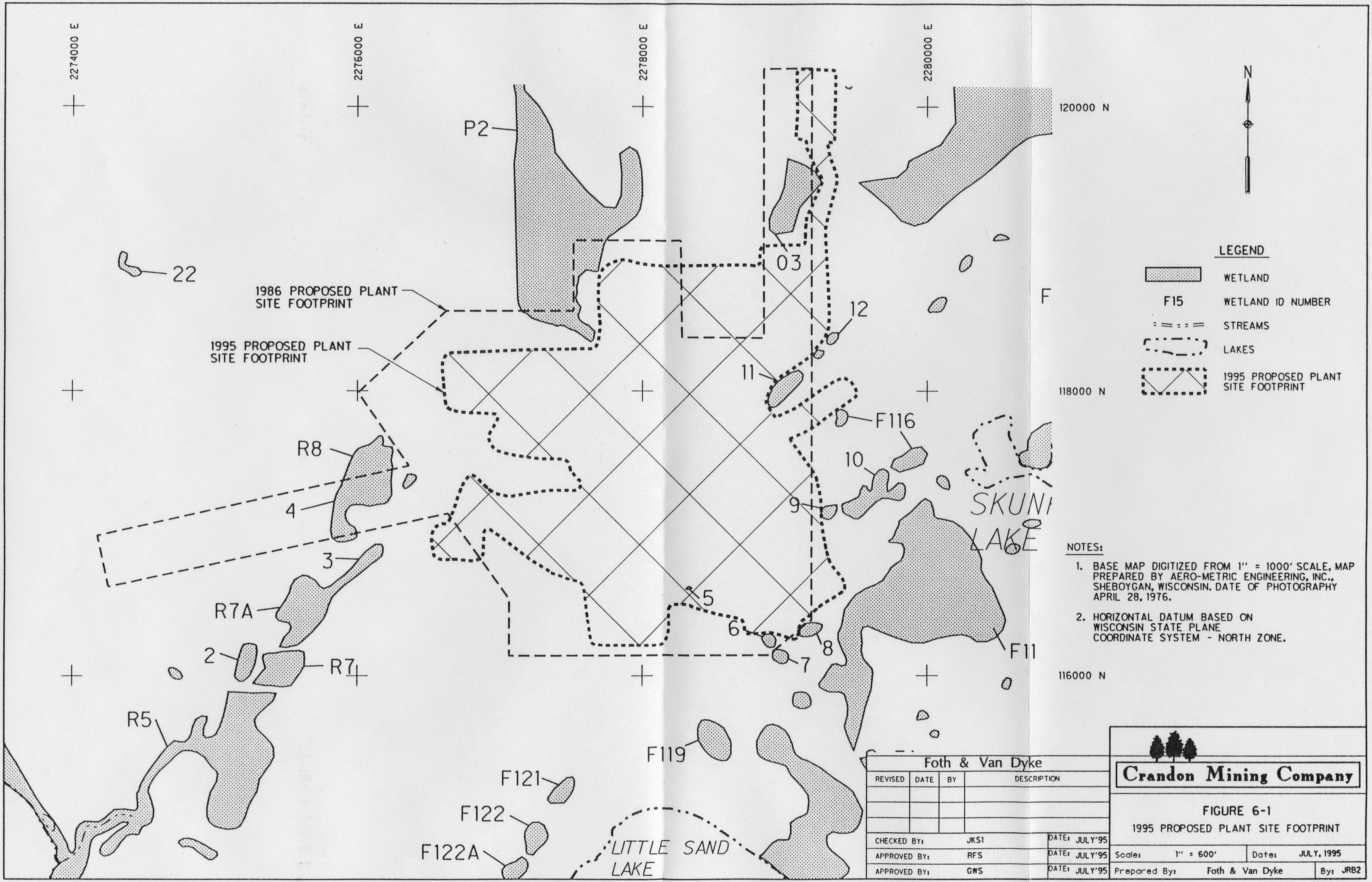
REVISED	DATE	BY	DESCRIPTION

CHECKED BY:	JKS1	DATE:	JULY'95
APPROVED BY:	RFS	DATE:	JULY'95
APPROVED BY:	GWS	DATE:	JULY'95

Crandon Mining Company

FIGURE 5-3
FOX-WOLF RIVER WATERSHED

Scale: AS SHOWN		Date: JULY, 1995	
Prepared By: Foth & Van Dyke		By: BSH	



NOTES:

1. BASE MAP DIGITIZED FROM 1" = 1000' SCALE, MAP PREPARED BY AERO-METRIC ENGINEERING, INC., SHEBOYGAN, WISCONSIN. DATE OF PHOTOGRAPHY APRIL 28, 1976.
2. HORIZONTAL DATUM BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM - NORTH ZONE.

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

CHECKED BY: JKS1 DATE: JULY'95
APPROVED BY: RFS DATE: JULY'95
APPROVED BY: GWS DATE: JULY'95

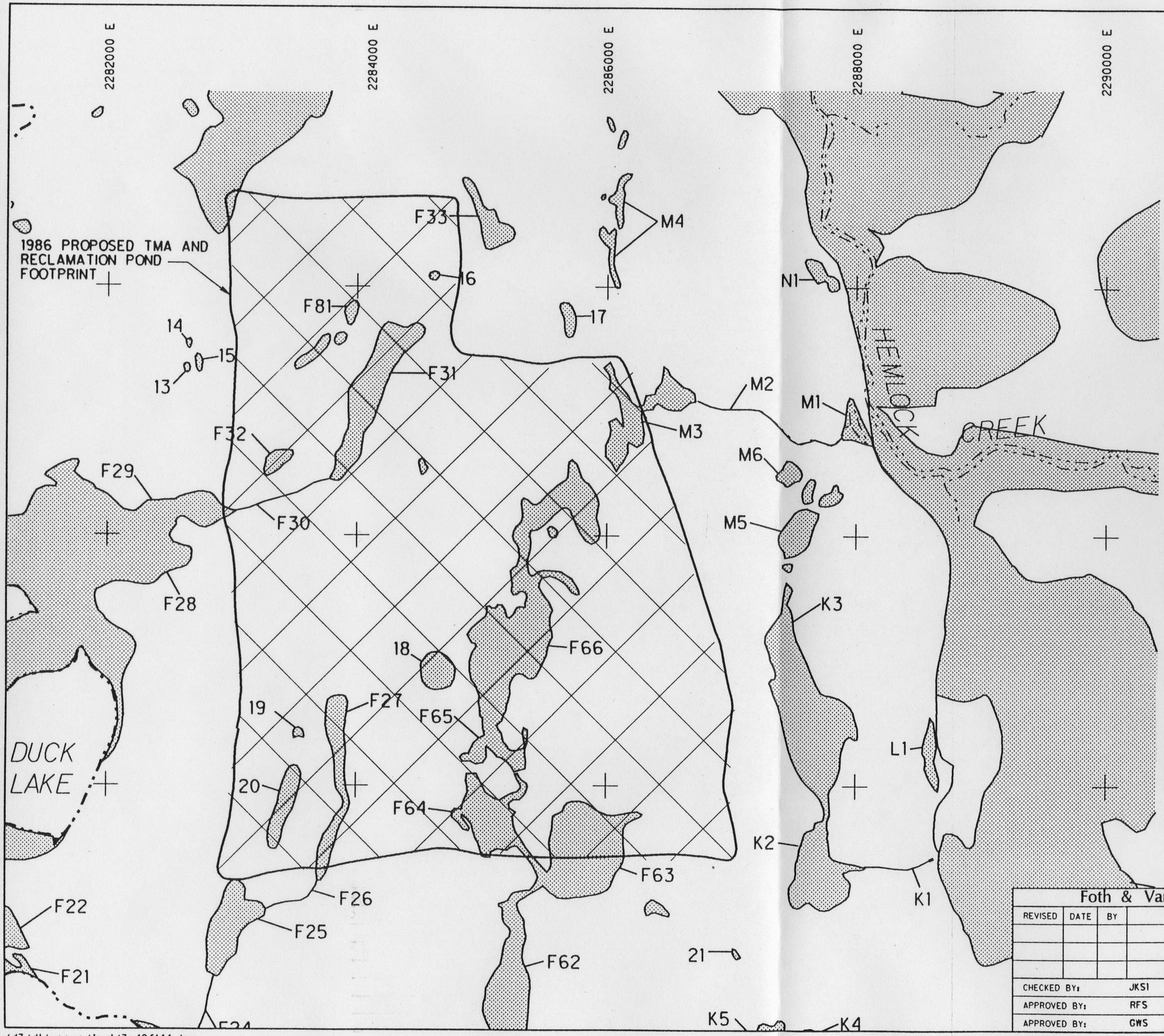
Crandon Mining Company

FIGURE 6-1
1995 PROPOSED PLANT SITE FOOTPRINT

Scale: 1" = 600' Date: JULY, 1995
Prepared By: Foth & Van Dyke By: JRB2

93C049

/d3/dl/users/jprl/3c49f142.dgn



NOTES:

1. BASE MAP DIGITIZED FROM 1" = 1000' SCALE, MAP PREPARED BY AERO-METRIC ENGINEERING, INC., SHEBOYGAN, WISCONSIN. DATE OF PHOTOGRAPHY APRIL 28, 1976.
2. HORIZONTAL DATUM BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM - NORTH ZONE.

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

CHECKED BY:	JKS1	DATE:	JULY'95
APPROVED BY:	RFS	DATE:	JULY'95
APPROVED BY:	GWS	DATE:	JULY'95

Crandon Mining Company

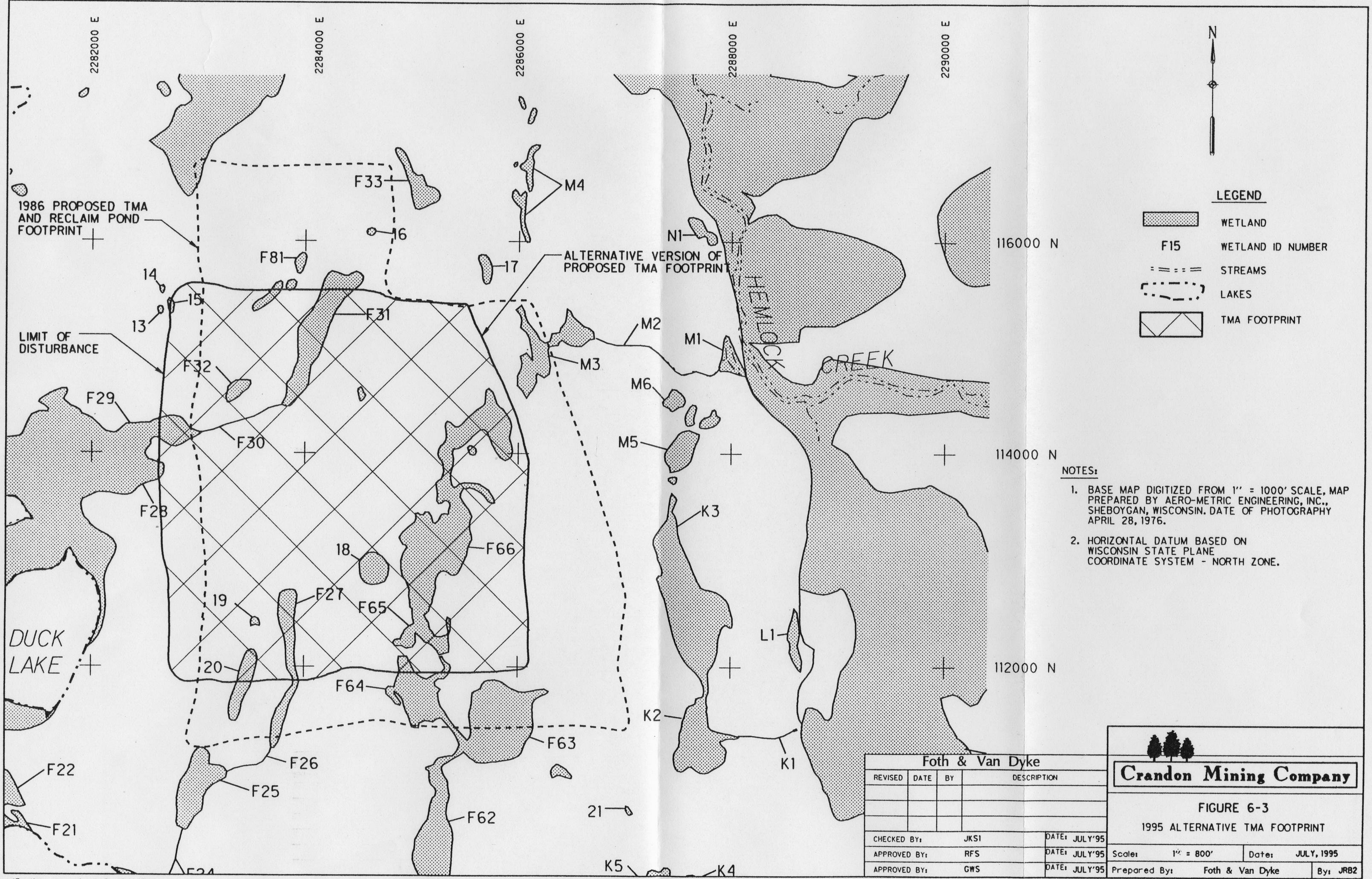
FIGURE 6-2

1986 PROPOSED TMA FOOTPRINT

Scale: 1" = 800'
Date: JULY, 1995
Prepared By: Foth & Van Dyke
By: JRB2

93C049

/d3/dl/users/jprl/3c49f144.dgn



NOTES:

1. BASE MAP DIGITIZED FROM 1" = 1000' SCALE, MAP PREPARED BY AERO-METRIC ENGINEERING, INC., SHEBOYGAN, WISCONSIN. DATE OF PHOTOGRAPHY APRIL 28, 1976.
2. HORIZONTAL DATUM BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM - NORTH ZONE.

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

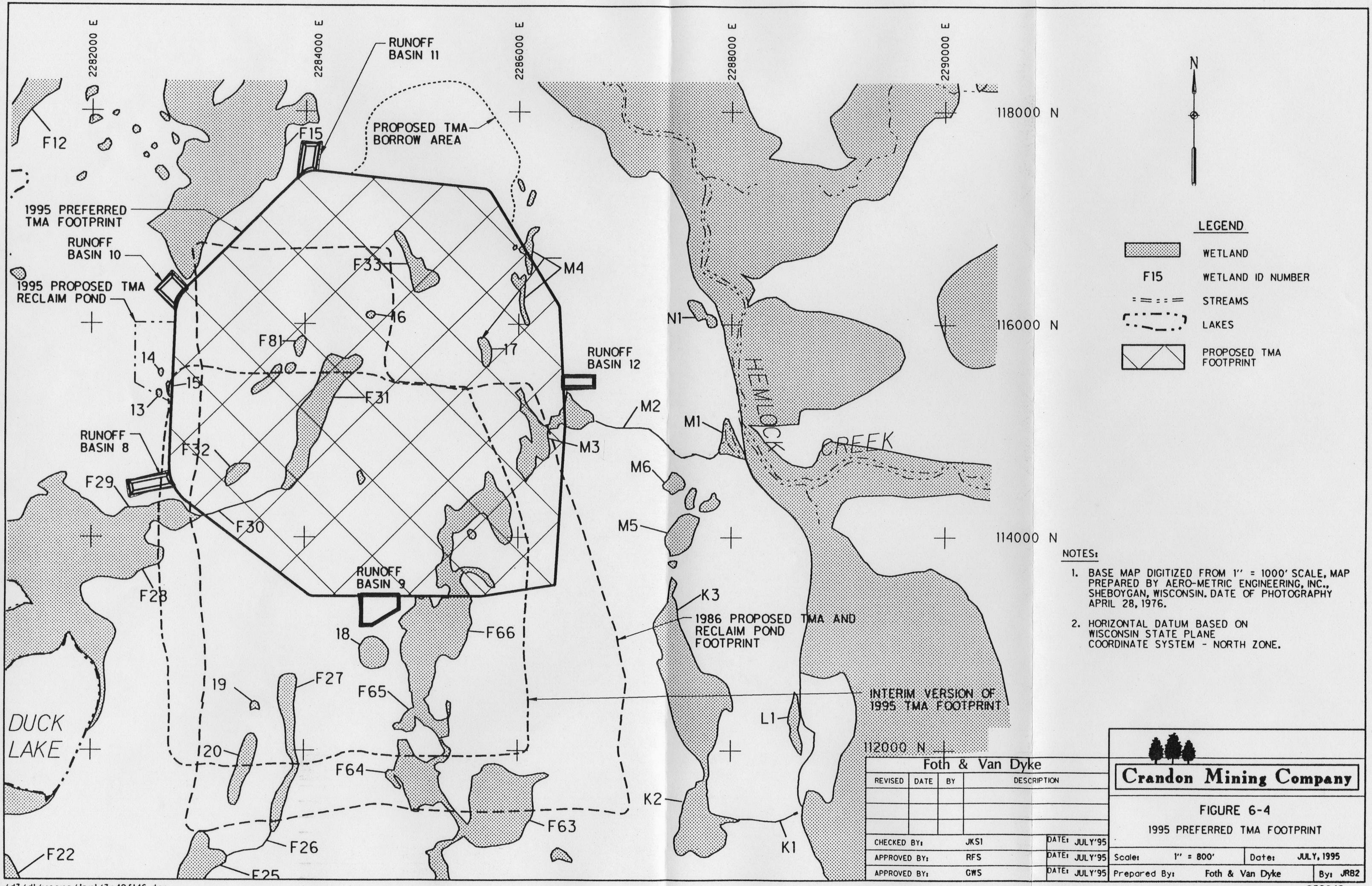
CHECKED BY:	JKS1	DATE:	JULY'95
APPROVED BY:	RFS	DATE:	JULY'95
APPROVED BY:	GWS	DATE:	JULY'95

Crandon Mining Company

FIGURE 6-3

1995 ALTERNATIVE TMA FOOTPRINT

Scale: 1" = 800'		Date:	JULY, 1995
Prepared By:	Foth & Van Dyke	By:	JRB2



NOTES:

1. BASE MAP DIGITIZED FROM 1" = 1000' SCALE, MAP PREPARED BY AERO-METRIC ENGINEERING, INC., SHEBOYGAN, WISCONSIN. DATE OF PHOTOGRAPHY APRIL 28, 1976.
2. HORIZONTAL DATUM BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM - NORTH ZONE.

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

CHECKED BY:	JKS1	DATE:	JULY'95
APPROVED BY:	RFS	DATE:	JULY'95
APPROVED BY:	GWS	DATE:	JULY'95

Crandon Mining Company

FIGURE 6-4

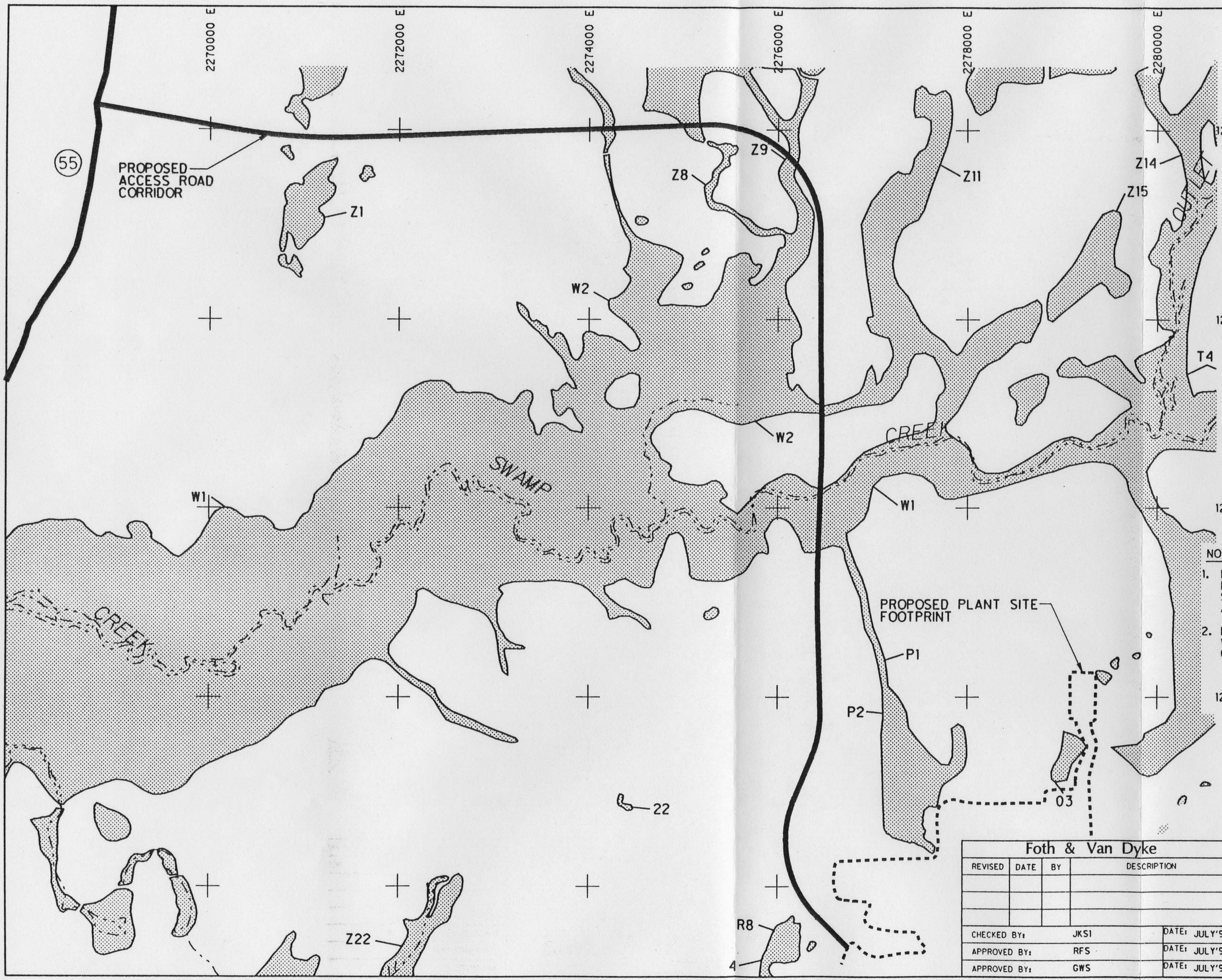
1995 PREFERRED TMA FOOTPRINT

Scale: 1" = 800' Date: JULY, 1995

Prepared By: Foth & Van Dyke By: JRB2

/d3/dl/users/jprl/3c49f146.dgn

93C049



LEGEND

▨	WETLAND
W2	WETLAND ID NUMBER
═ ═ ∙ ∙ ═ ═	STREAMS
⬭	LAKES
━━━	PROPOSED ACCESS ROAD CORRIDOR

NOTES:

1. BASE MAP DIGITIZED FROM 1" = 1000' SCALE, MAP PREPARED BY AERO-METRIC ENGINEERING, INC., SHEBOYGAN, WISCONSIN. DATE OF PHOTOGRAPHY APRIL 28, 1976.
2. HORIZONTAL DATUM BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM - NORTH ZONE.

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

CHECKED BY:	JKS1	DATE:	JULY'95
APPROVED BY:	RFS	DATE:	JULY'95
APPROVED BY:	GWS	DATE:	JULY'95

Crandon Mining Company

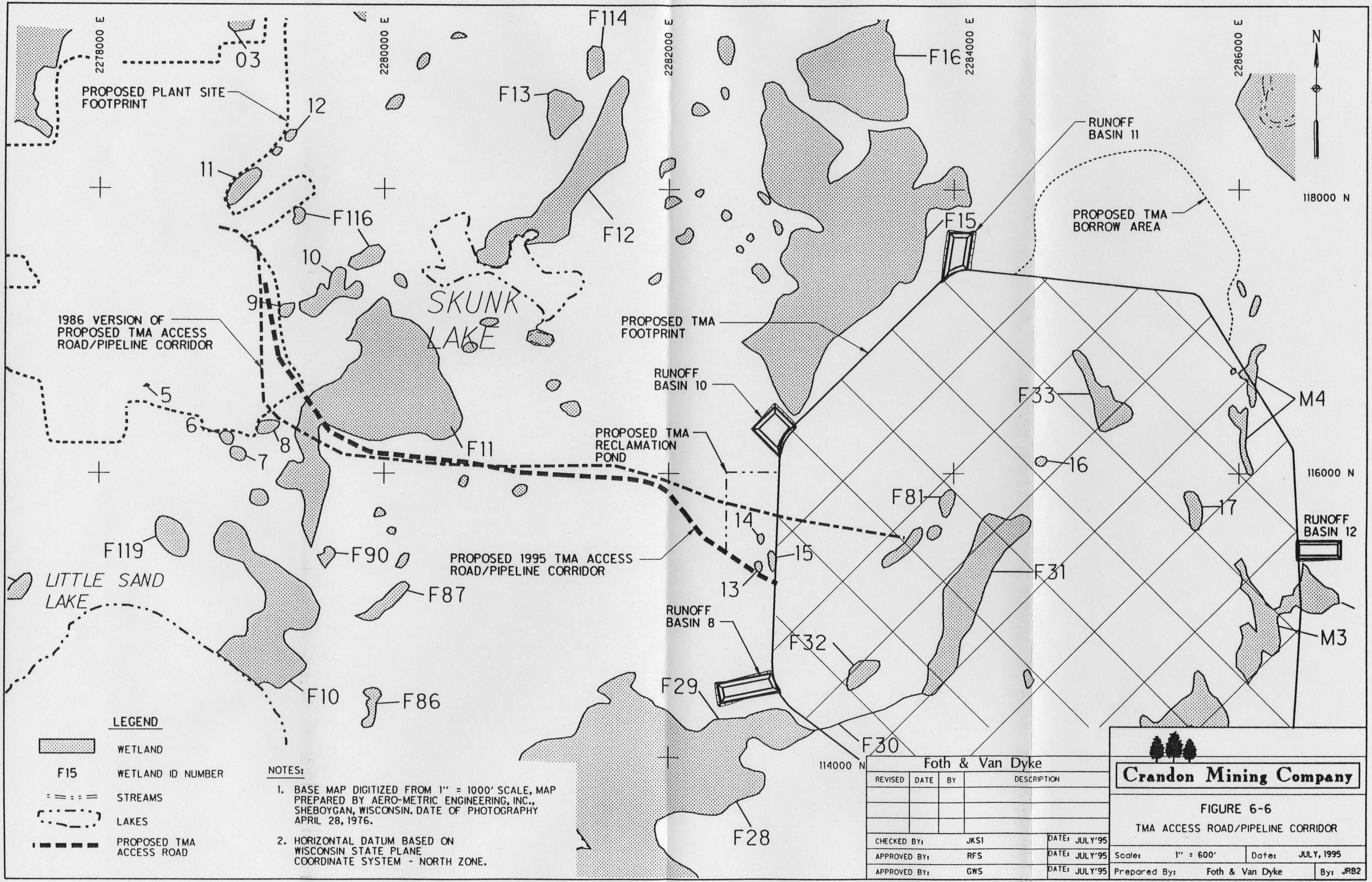
FIGURE 6-5

ACCESS ROAD CORRIDOR

Scale:	1" = 1000'	Date:	JULY, 1995
Prepared By:	Foth & Van Dyke	By:	JRB2

93C049

/d3/dl/users/jprl/3c49f151.dgn



NOTES:

1. BASE MAP DIGITIZED FROM 1" = 1000' SCALE, MAP PREPARED BY AERO-METRIC ENGINEERING, INC., SHEBOYGAN, WISCONSIN. DATE OF PHOTOGRAPHY APRIL 28, 1976.
2. HORIZONTAL DATUM BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM - NORTH ZONE.

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

CHECKED BY:	JKS1	DATE: JULY'95
APPROVED BY:	RFS	DATE: JULY'95
APPROVED BY:	GWS	DATE: JULY'95

Crandon Mining Company

FIGURE 6-6

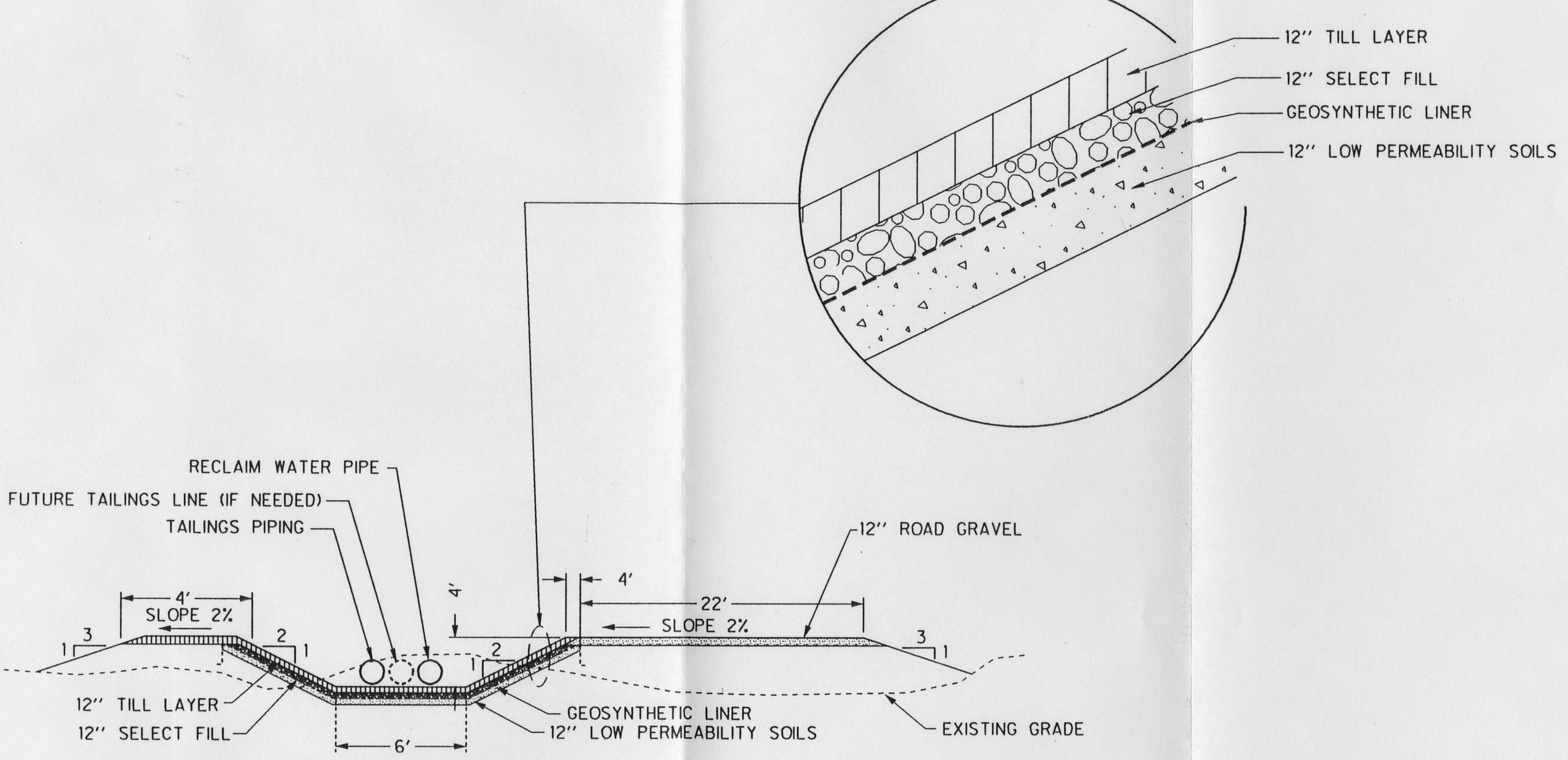
TMA ACCESS ROAD/PIPELINE CORRIDOR

Scale: 1" = 600'   Date: JULY, 1995

Prepared By: Foth & Van Dyke   By: JRB2

93C049

/d3/dl/users/jprl/3c49f140.dgn



TYPICAL SECTION

NOT TO SCALE

TYPICAL REPRESENTATION:
REFINEMENTS MAY BE MADE
PRIOR TO CONSTRUCTION.

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

CHECKED BY: JKS1	DATE: JULY'95	
APPROVED BY: RFS	DATE: JULY'95	
APPROVED BY: GWS	DATE: JULY'95	

Crandon Mining Company

FIGURE 6-7

TYPICAL SECTION THROUGH
TMA ACCESS ROAD / PIPELINE CORRIDOR

Scale: AS SHOWN
Date: JULY, 1995
Prepared By: Foth & Van Dyke
By: JOW

/d3/dl/users/jprl/4c56f5l.dgn

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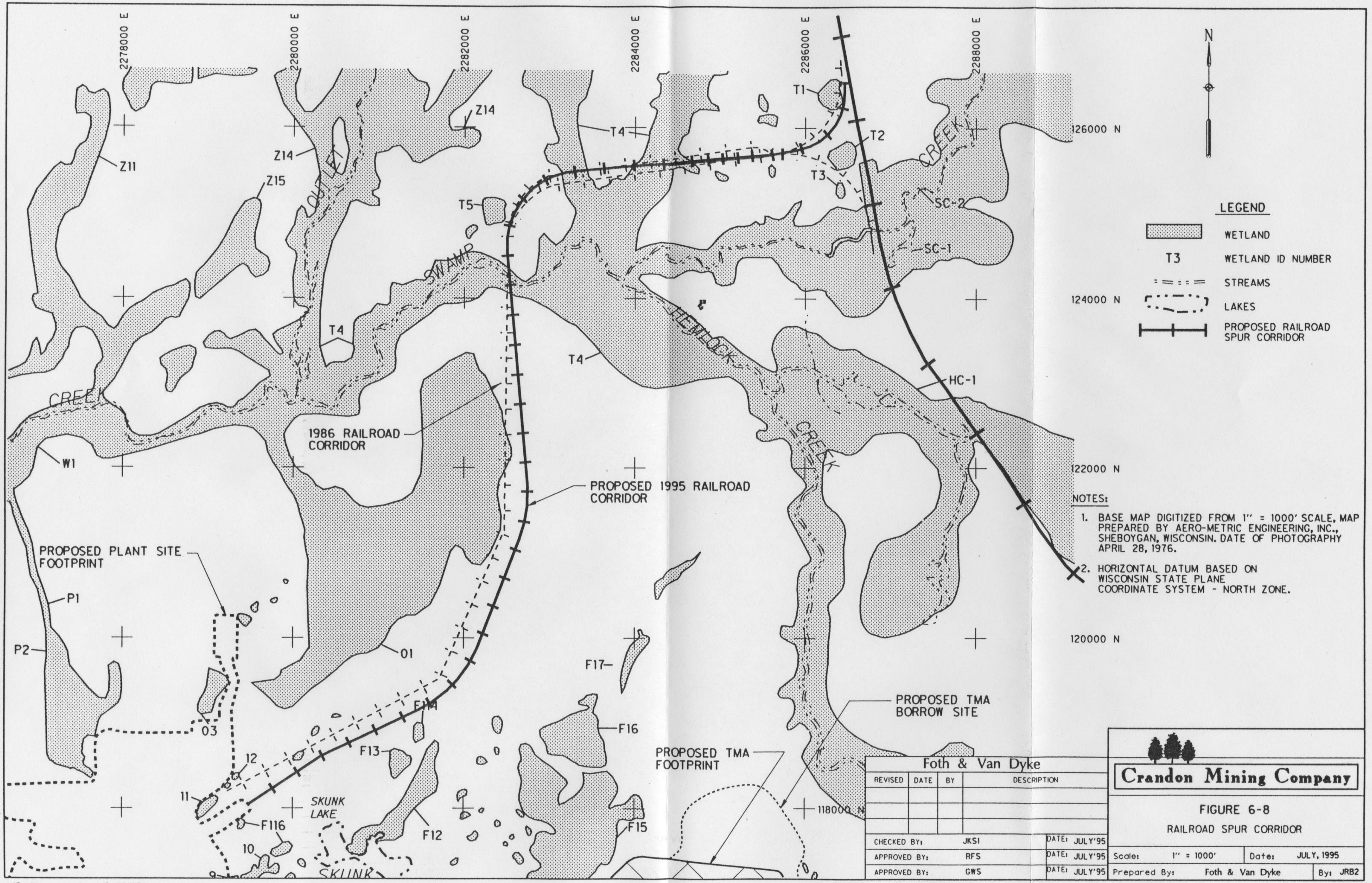

NOTES:

1. BASE MAP DIGITIZED FROM 1" = 1000' SCALE, MAP PREPARED BY AERO-METRIC ENGINEERING, INC., SHEBOYGAN, WISCONSIN. DATE OF PHOTOGRAPHY APRIL 28, 1976.
2. HORIZONTAL DATUM BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM - NORTH ZONE.

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

CHECKED BY: JKS1 DATE: JULY'95
APPROVED BY: RFS DATE: JULY'95
APPROVED BY: GWS DATE: JULY'95

Crandon Mining Company

FIGURE 6-8

RAILROAD SPUR CORRIDOR

Scale: 1" = 1000' Date: JULY, 1995
Prepared By: Foth & Van Dyke By: JRB2

/d3/dl/users/jprl/3c49f139.dgn

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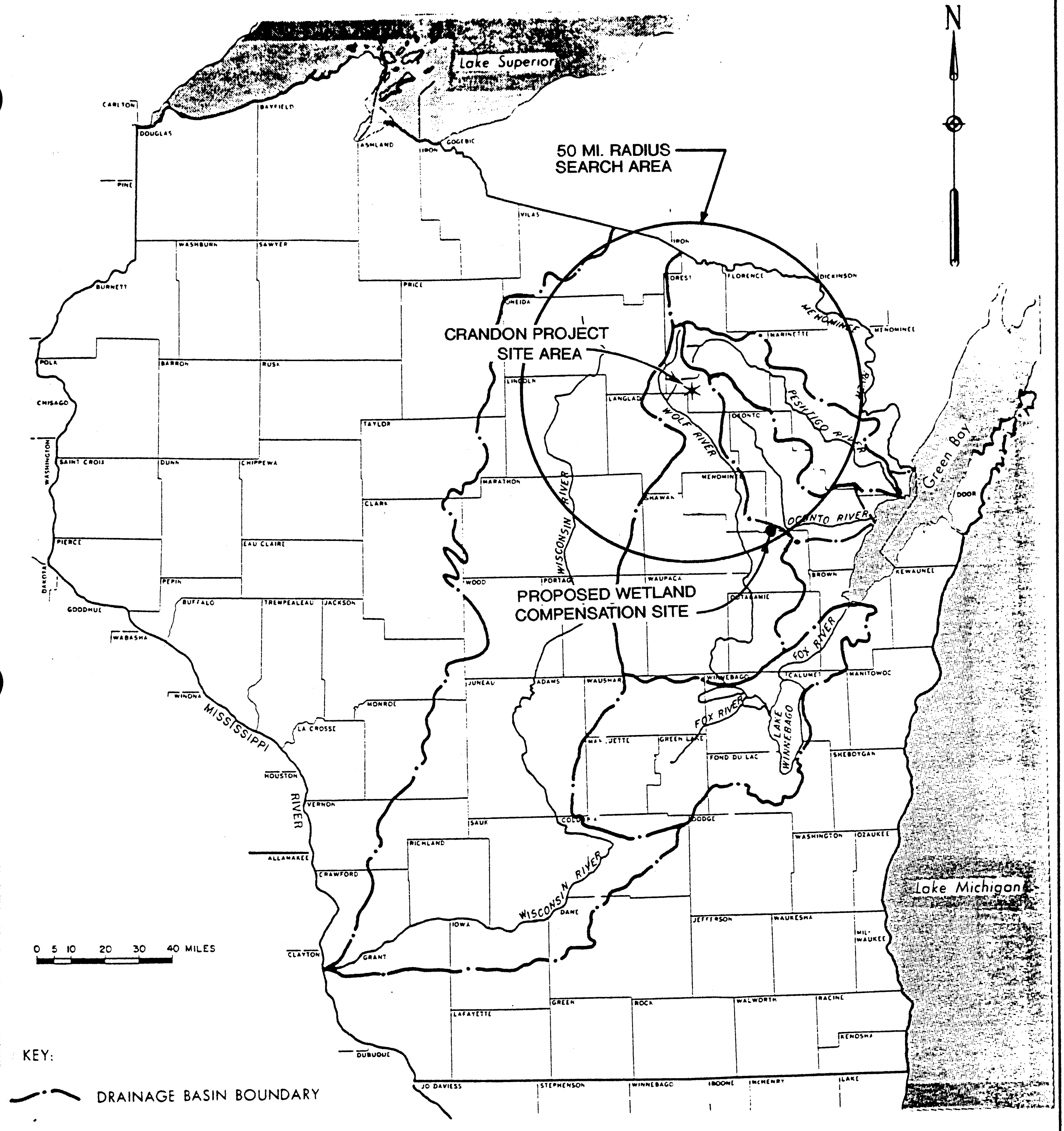

SOURCE: 1985, ENVIRONMENTAL IMPACT REPORT.

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

CHECKED BY:	JKS1	DATE: JULY'95
APPROVED BY:	RFS	DATE: JULY'95
APPROVED BY:	GWS	DATE: JULY'95

Crandon Mining Company

FIGURE 8-1
WETLAND COMPENSATION SITE
SEARCH AREA

Scale:	AS SHOWN	Date:	JULY 1995
Prepared By:	Foth & Van Dyke	By:	KMP

/d3/dl/users/jprl/4c58f3.dgn

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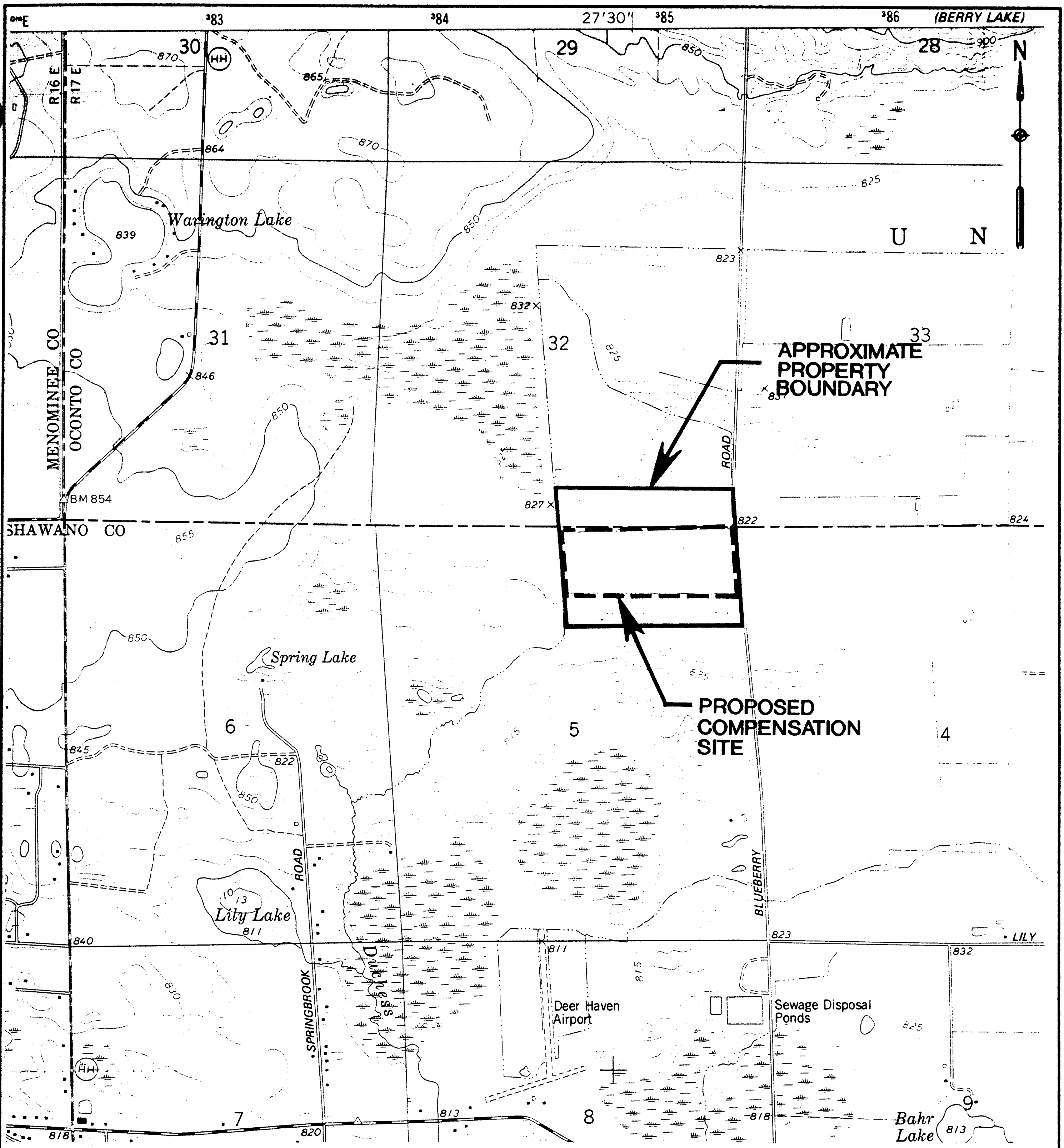


SOURCE: U.S.G.S. 7.5 MINUTE TOPOGRAPHIC
QUADRANGLE - CECIL, 1974
OCONTO & SHAWANO COUNTY, WISCONSIN

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

CHECKED BY:	JKS1	DATE: JULY'95
APPROVED BY:	RFS	DATE: JULY'95
APPROVED BY:	GWS	DATE: JULY'95

Crandon Mining Company

FIGURE 8-2

WETLAND COMPENSATION SITE LOCATION

Scale: 0 1000' 2000'

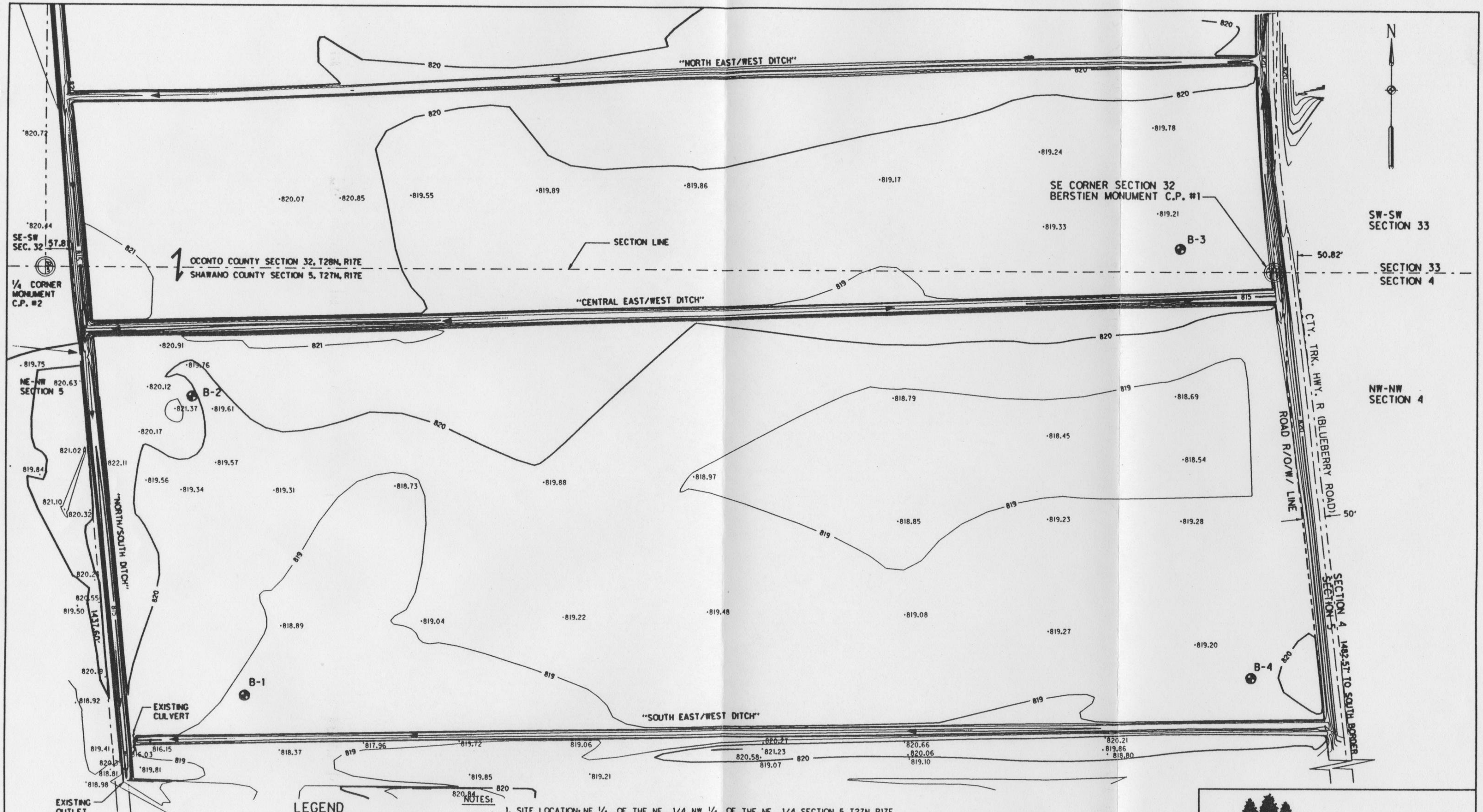
Date: JULY, 1995

Prepared By: Foth & Van Dyke

By: JOW

/d3/dl/users/jprl/4c55f7.dgn

93C049



LEGEND

·819.04	EXISTING SPOT ELEVATION
—815—	EXISTING CONTOUR
● B-1	SOIL BORING LOCATIONS
←	EXISTING SURFACE WATER FLOW
— · —	SECTION LINE
— - —	APPROXIMATE CENTERLINE OF ROAD

NOTES:

1. SITE LOCATION: NE 1/4 OF THE NE 1/4, NW 1/4 OF THE NE 1/4, SECTION 5 T27N, R17E, TOWN OF WASHINGTON, SHAWANO COUNTY, AND SE 1/4 OF THE SE 1/4, SW 1/4 OF THE SE 1/4 SECTION 32, T28N, R17E, TOWN OF UNDERHILL, OCONTO COUNTY, WISCONSIN.
2. BASE MAP PREPARED FROM TOPOGRAPHIC SURVEY BY FOTH & VAN DYKE. DATE OF SURVEY - MARCH, 1995.
3. ELEVATIONS BASED OFF OF SPOT ELEVATION FROM 'CECIL' 7.5 MINUTE SERIES USGS MAP (1974). CONTOUR INTERVAL IS ONE FOOT.
4. HORIZONTAL DATUM BASED ON SITE GRID SYSTEM USING SOUTH 1/4 CORNER SECTION 32, T29N, R17E AS 10,000 N , 10,000 E (CP #2) AND THE SE CORNER SECTION 32 AS 10,000 N , 12,663.52 E (CP #1).
5. PROPERTY LINES REPRESENTED ON THIS MAP ARE DERIVED FROM FIELD SURVEY MADE BY FOTH & VAN DYKE DURING MARCH, 1995 USING SECTION BREAKDOWN INFORMATION FURNISHED BY NORDIN & ASSOCIATES, SHAWANO, WISCONSIN.

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

CHECKED BY:	JKSI	DATE: JULY '95
APPROVED BY:	RFS	DATE: JULY '95
APPROVED BY:	GWS	DATE: JULY '95

Crandon Mining Company

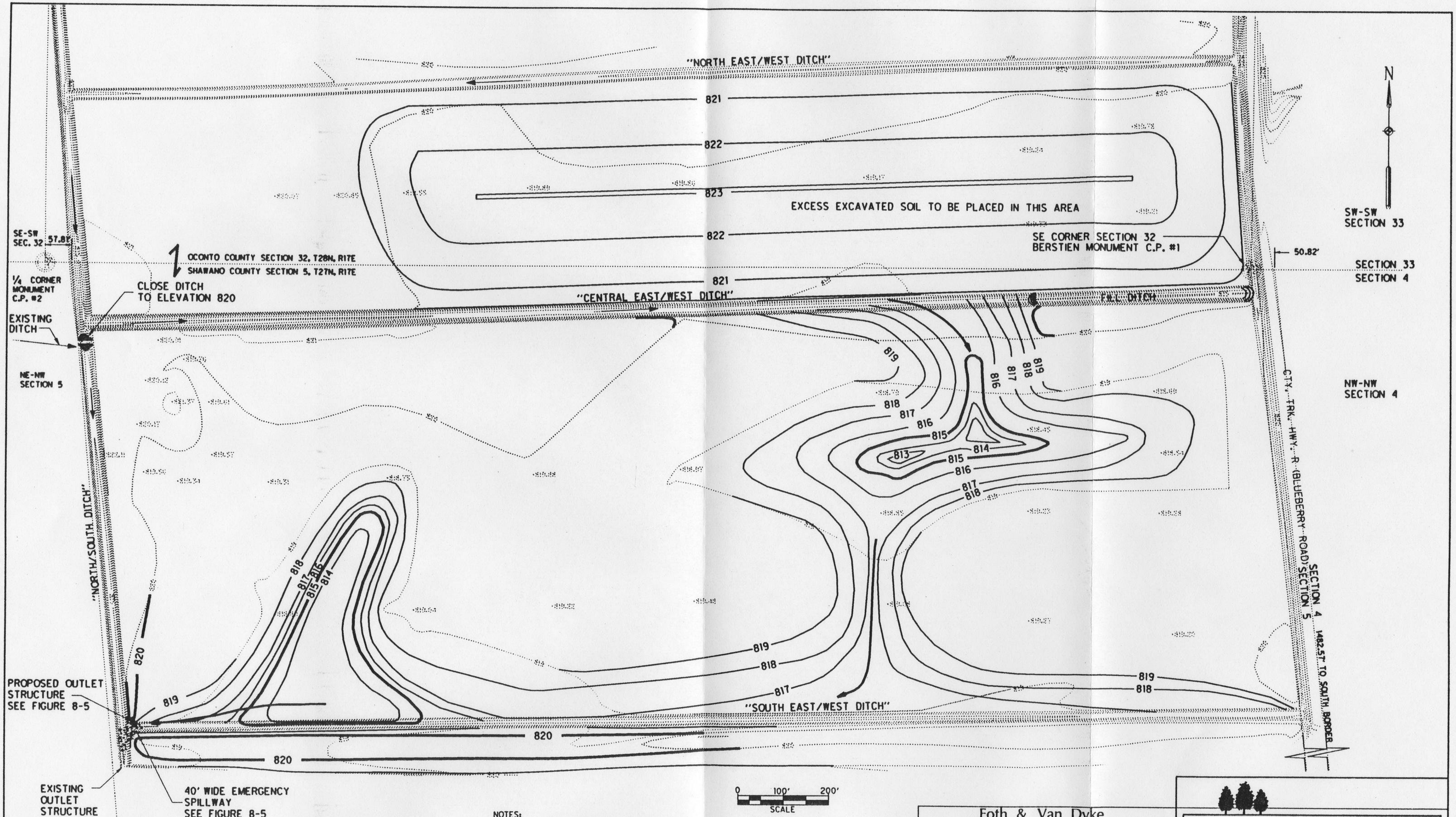
FIGURE 8-3

WETLAND COMPENSATION
SITE EXISTING TOPOGRAPHY

Scale: 0 100' 200'
Date: JULY, 1995
Prepared By: Foth & Van Dyke
By: JRB2

93C049

/d3/d1/users/jprl/4c55f6.dgn



SOUTH PROPERTY LINE

NORTH LINE OF SOUTH 660' OF
NE 1/4 SECTION 32,
T27N, R17E

LEGEND

··	EXISTING SPOT ELEVATION
·· 815 ··	EXISTING CONTOUR
— 815 —	PROPOSED CONTOUR
←	DIRECTION OF WATER FLOW
········	SECTION LINE

NOTES:

1. BASE MAP PREPARED FROM TOPOGRAPHIC SURVEY BY FOTH & VAN DYKE. DATE OF SURVEY - MARCH, 1995.
2. ELEVATIONS BASED OFF OF SPOT ELEVATION FROM 'CECIL' 7.5 MINUTE SERIES USGS MAP (1974). CONTOUR INTERVAL IS ONE FOOT.
3. HORIZONTAL DATUM BASED ON SITE GRID SYSTEM USING SOUTH 1/4 CORNER SECTION 32, T29N, R17E AS 10,000 N ,10,000 E (CP #2) AND THE SE CORNER SECTION 32 AS 10,000 N ,12,663.52 E (CP #1).

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

CHECKED BY:	JKS1	DATE: JULY '95
APPROVED BY:	RFS	DATE: JULY '95
APPROVED BY:	GWS	DATE: JULY '95

Crandon Mining Company

FIGURE 8-4
WETLAND COMPENSATION
SITE GRADING PLAN

Scale: AS SHOWN		Date: JULY, 1995	
Prepared By:	Foth & Van Dyke		By: JRB2

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93C049

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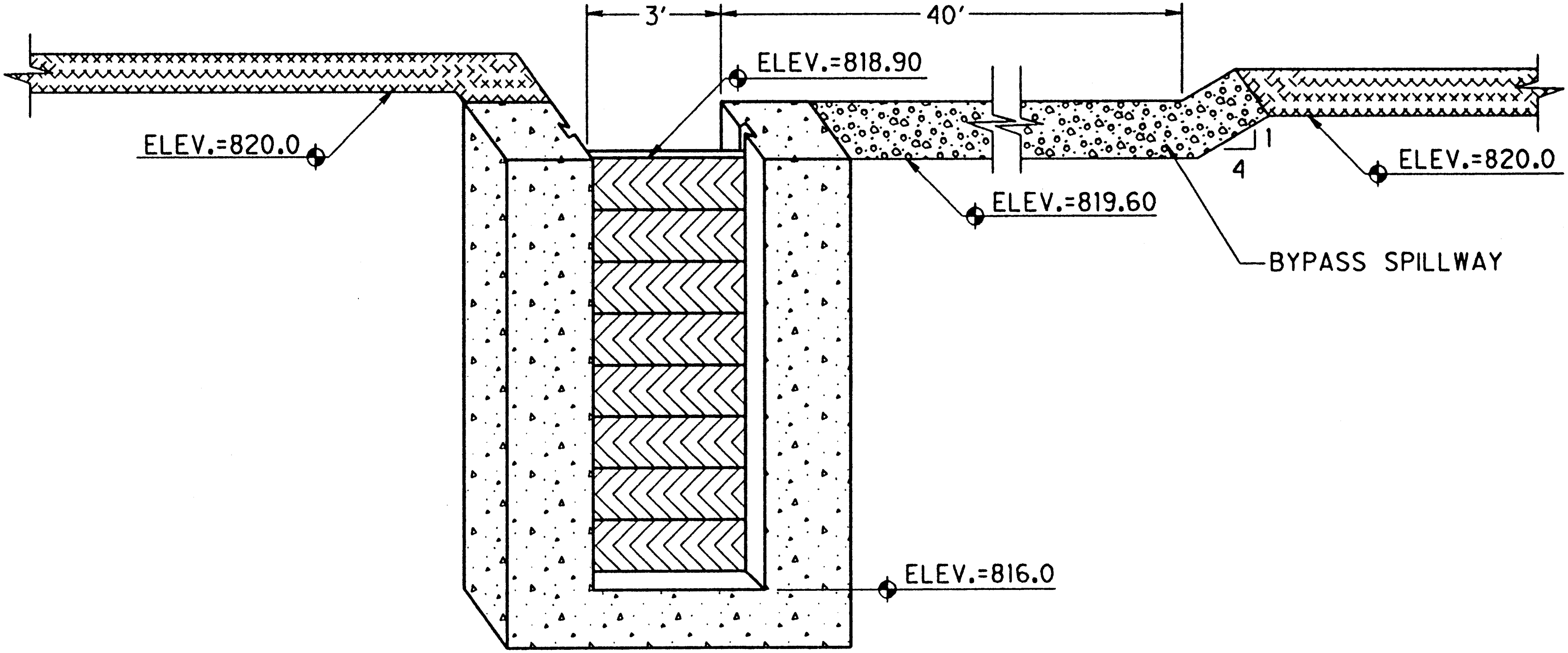


Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

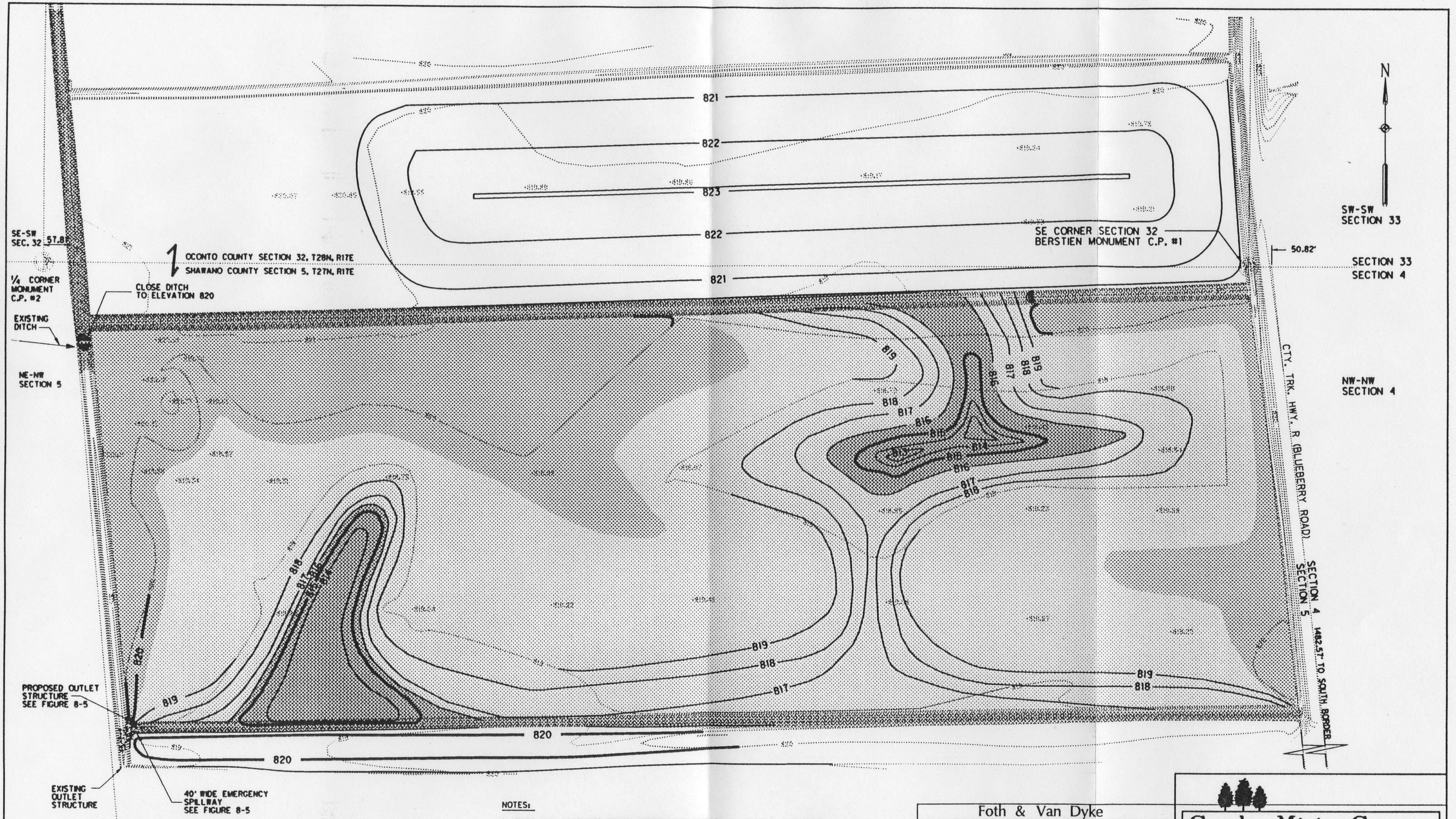
CHECKED BY:	JKS1	DATE: JULY'95
APPROVED BY:	RFS	DATE: JULY'95
APPROVED BY:	GWS	DATE: JULY'95

Crandon Mining Company

FIGURE 8-5
WETLAND COMPENSATION SITE OUTLET STRUCTURE

Scale:	NOT TO SCALE	Date:	JULY, 1995
Prepared By:	Foth & Van Dyke	By:	JOW

93C049



LEGEND

·815.64	EXISTING SPOT ELEVATION
········815········	EXISTING CONTOUR
—815—	PROPOSED CONTOUR
←	DIRECTION OF WATER FLOW
················	SECTION LINE
▩	DEEP MARSH - APPROX. 8 ACRES
▨	WET MEADOW - APPROX. 13 ACRES
░	SHALLOW MARSH - APPROX. 36 ACRES

NOTES:

1. BASE MAP PREPARED FROM TOPOGRAPHIC SURVEY BY FOTH & VAN DYKE. DATE OF SURVEY - MARCH, 1995.
2. ELEVATIONS BASED OFF OF SPOT ELEVATION FROM 'CECIL' 7.5 MINUTE SERIES USGS MAP (1974). CONTOUR INTERVAL IS ONE FOOT.
3. HORIZONTAL DATUM BASED ON SITE GRID SYSTEM USING SOUTH 1/4 CORNER SECTION 32, T29N, R17E AS 10,000 N , 10,000 E (CP #2) AND THE SE CORNER SECTION 32 AS 10,000 N , 12,663.52 E (CP #1).

0 100' 200'
SCALE

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

CHECKED BY:	JKS1	DATE: JULY '95
APPROVED BY:	RFS	DATE: JULY '95
APPROVED BY:	GWS	DATE: JULY '95

Crandon Mining Company

FIGURE 8-6
WETLAND COMPENSATION
SITE VEGETATION PLAN

Scale: AS SHOWN
Date: JULY, 1995
Prepared By: Foth & Van Dyke
By: JRB2

c:\cadwork\4c55f2.3d

93C049

Appendix A

Relevant Technical Memoranda and Regulatory Agency Correspondence

CORRESPONDENCE/MEMORANDUM State of Wisconsin

DATE: September 15, 1994 **FILE REF:** 1600

TO: Bill Tans- EA/6

FROM: Dave Siebert- EA/6

SUBJECT: Crandon Mine Proposal- Wetland delineation verification

On September 8, 1994, you, Tom Portle (SW/3), and I accompanied Dave Ballman of the Corps of Engineers on a site visit to look at recent delineation work done by Foth and Van Dyke. Ron Steg, from Foth and Van Dyke, led the tour to the delineation sites. The purpose of the visit was for the Corps to review the delineation work and to "verify" its accuracy.

It is my understanding that in the early 80's wetlands on and near the site were delineated and mapped. WDNR staff field evaluated the determinations and were satisfied with the mapped boundaries. Since that time, the federal government has adopted formal manuals for delineation of jurisdictional wetlands (the 1987 Corps Manual is the one in use now). As such, Dave Ballman requested that the mining company re-delineate the wetlands using the latest methodology.

The Corps and Crandon Mining Co. came to an agreement that rather than re-delineate all the wetlands, they would do the work for a representative subset of wetlands first. Foth and Van Dyke selected 5 wetland areas (shown on the attached map), representing approximately 25% of the total wetland acreage to be affected by the proposed project, and proceeded to flag the boundaries.

The next step will be to survey in the boundaries and overlay that data with the original delineation work. Based on the results of that exercise, the Corps will decide whether the delineation under the 87 Manual is close to the previous work, whether the "error" observed should be applied to the total acreage figures for the project (i.e. if the total acreage now delineated is greater than the previous work by 5%, then add 5% to the total acres originally proposed to be affected), or whether future delineation work will be necessary. It is my opinion that this approach seems reasonable.

During the site visit, we looked at boundary flagging for wetlands F64, F65, M3, #5, and P2. Based on the site visit, it is my opinion that the delineation work was acceptable. There were a few areas, for example F65, where the wetland area contained numerous small "islands" of upland. To be conservative and to avoid the need to flag and survey "out" the upland islands, Foth and Van Dyke included these areas within the wetland boundary.

The delineation work for these 5 sites was technically sound. I look forward to reviewing the overlay mapping to compare this delineation work with that done in the early 80's.

Attachment

cc: Don Moe- Crandon Mining Co.
Dave Ballman- COE- St. Paul

FILE MAIN PLA
Sub ST
Sub DNR-VE
Keywords

Crandon Mining Company

January 9, 1995

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

Dave Siebert
Wisconsin Department of Natural Resources
101 South Webster Street
P.O. Box 7921
Madison, WI 53707-7921

Dear Mr. Siebert:

RE: Crandon Project - Wetland Mapping

This is a follow-up to the November 11, 1994 letter regarding a previously unmapped wetland in the southeast quarter of the northeast quarter of Section 25, T35N, R12E. A wetland assessment was conducted at that location by Ron Steg of Foth & Van Dyke on November 17, 1994. An area of 0.26 acres of wetland was delineated according to the guidelines in the 1987 *Corps of Engineers Wetland Delineation Manual.* This wetland is located in an opening in an aspen stand upgradient and parallel to an old logging road likely constructed approximately 10 to 15 years ago. The vegetation is dominated by wool grass (*Scirpus cyperinus*) and Canada blue joint grass (*Calamagrostis canadensis*). This small transitional wetland is located in a natural swale with mineral soils underlain by a layer of tight clay below a depth of approximately 12 to 18 inches. The old logging road appears to have impeded the natural flow through this swale resulting in slightly more moisture than may have previously existed at this site prior to logging the area.

The location and delineation of the 0.26 acre wetland in relation to other nearby project delineated wetlands is shown on Figure 1. The 0.26 acre wetland is referred to as wetland 22 on the figure. Wetland field data sheets are provided in Attachment 1. Wetland 22 will be included in all future Crandon Mining Company wetland mapping, and will be considered in the Crandon Project environmental review process.

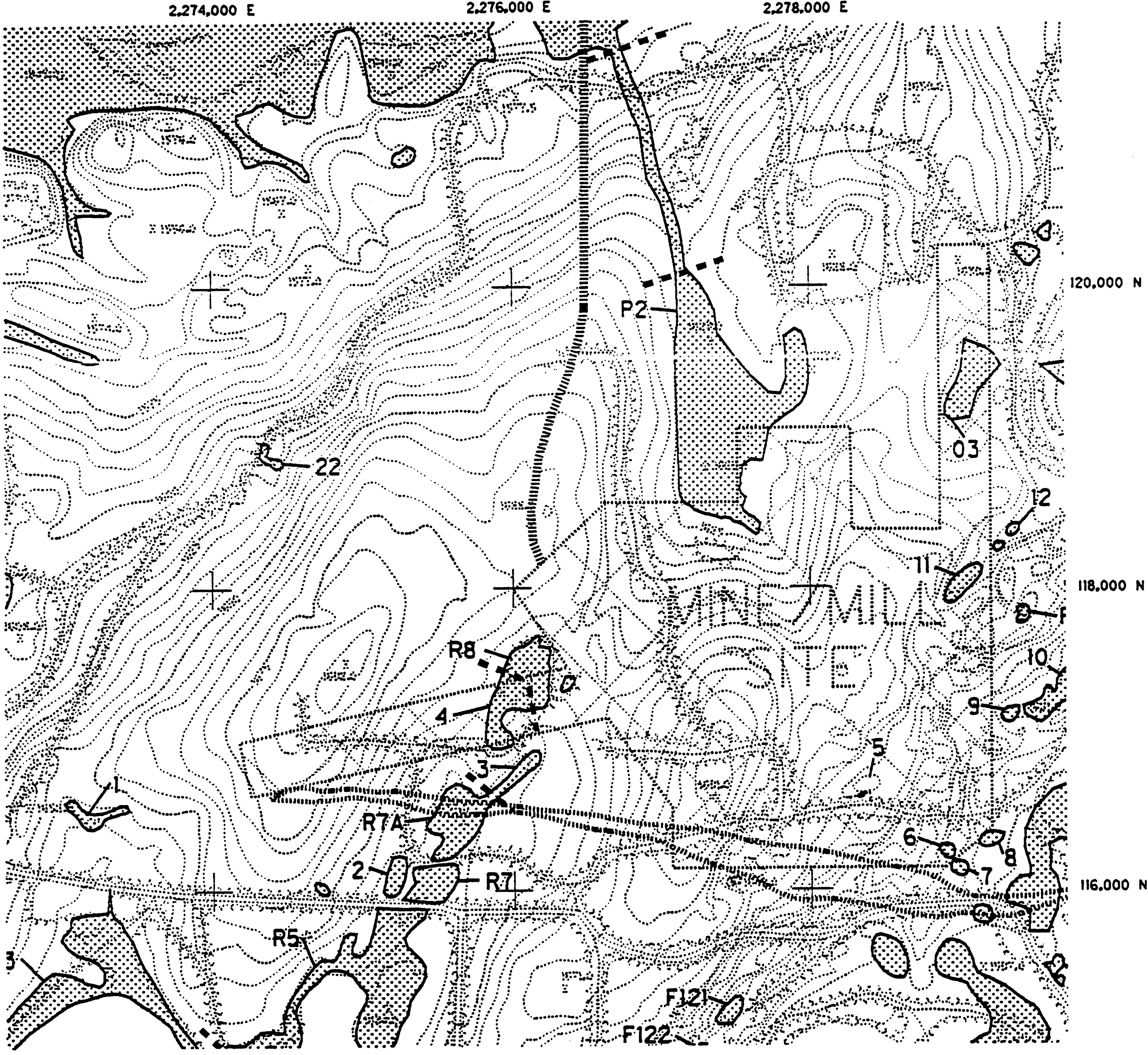
Please feel free to call me at (715) 365-1450 or Mr. Steg at (414) 497-2500 if you have any questions or comments.

Sincerely,

D. E. Moe

Don Moe
Technical/Permitting Manager

DM:jcp
Attachment
cc w/attach.: Bill Tans, WDNR
Archie Wilson, WDNR
Larry Lynch, WDNR
Robert Jaeger, Bureau of Indian Affairs
Al Milham, Forest County Potawatomi
Arlyn Ackley, Sokaogon Chippewa Community
Glen Miller, Menominee Indian Tribe of Wisconsin
M. Catherine Condon, Greene, Meyer & McElroy
David Kee, USEPA-Air Division (A18J)
David Ballman, USCOE
Jerry Sevick, Foth & Van Dyke
Tim Weyenberg, Foth & Van Dyke
Garret Hollands, Fugro-McClelland



NOTES:

1. APPROXIMATE SITE AREA: PART OF SECTION 25 T35N, R12E, TOWN OF NASHVILLE AND PART OF SECTIONS 29, 30 AND 32, T35N, R13E, TOWN OF LINCOLN, FOREST COUNTY, WISCONSIN.
2. TOPOGRAPHIC BASE MAP DIGITIZED FROM 1" = 1000' SCALE. 5' CONTOUR INTERVAL MAP PREPARED BY AERO-METRIC ENGINEERING, INC., SHEBOYGAN, WISCONSIN. DATE OF PHOTOGRAPHY APRIL 28, 1976.
3. HORIZONTAL DATUM BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM - NORTH ZONE.
4. VERTICAL DATUM BASED ON MEAN SEA LEVEL DATUM. CONTOUR INTERVAL IS FIVE FEET.
5. COUNTY AND TOWNSHIP LINES DIGITIZED FROM 7.5' SERIES USGS MAPS.

LEGEND

P2	WETLAND IDENTIFICATION
▬ ▬ ▬ ▬	WETLAND DIVIDER
▨	WETLANDS MAPPING BASED ON NORMANDEAU ASSOCIATES, INC. AND INTERDISCIPLINARY ENVIROMENTAL PLANNING, INC., 1992 AND INTERDISCIPLINARY ENVIRONMENTAL PLANNING, INC., 1983

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

CHECKED BY:	JKS	DATE:	JAN.'95
APPROVED BY:	RFS	DATE:	JAN.'95
APPROVED BY:	GWS	DATE:	JAN.'95

Crandon Mining Company

FIGURE 1

WETLAND MAP

Scale:	1" = 1000'	Date:	DEC. 1994
Prepared By:	Foth & Van Dyke	By:	JRB

93C049

c:\cadwork\4c55f3.dgn

Attachment 1

Wetland Field Data Sheets

Data Form
Routine Wetland Determination
(1987 COE Wetlands Delineation Manual)

Project/Site:	Crandon Project Site	Date: 11/17/94
Applicant/Owner:	Crandon Mining Company	County: Forest
Investigator:	Ron Steg	State: WI

Do Normal Circumstances exist on the site? [✓ Yes] No	Wetland ID: 22
Is the site significantly disturbed (Atypical Situation)? Yes [✓ No]	Transect ID:
Is the area a potential Problem Area? Yes [✓ No] (If needed, explain on reverse.)	Plot ID: 1C

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Rubus trigosus*	herb	FACW-	9.		
2. *R. allegheniensis*	herb	FACU+	10.		
3. *Populus balsamifera*	tree	FACW	11.		
4. *Betula papyrifera*	tree	FACU+	12.		
5. *Abies balsamea*	tree	FACW	13.		
6. *Tilia americana*	tree	FACU	14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC). < 50%

* = dominant species

Remarks:

HYDROLOGY

_____ Recorded Data (Describe in Remarks):

☐ Stream, Lake or Tide Gauge
☐ Aerial Photographs
☐ Other

__X__ No Recorded Data Available

Wetland Hydrology Indicators:
☐ Water Stained/Silt Covered Leaves
☐ Drift Lines
☐ High Water Marks
☐ Sand/Silt Deposits
☐ Swollen Tree Bases
☐ Exposed Roots
☐ Periodically Flooded Channels/Depressions

Field Observations:
Depth of Surface Water __NA__ (in.)
Depth of Free Water in Pit __NA__ (in.)
Depth of Saturated Soil __NA__ (in.)

Remarks: no indicators

Map Unit Name *
(Series and Phase):

Drainage Class: *

Field Observations Confirm Mapped Type? Yes No

Profile Description:

Depth (inches)	Matrix Color (Munsel Notation)	Mottle Colors (Munsel Notation)	Mottle Abundance	Soil Texture/ Type
0-4"	10 YR 2/3		None	Loam
4-18"	10 YR 4/3		None	Sand

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic Odor
- ☐ Aquic Moisture Regime
- ☐ Reducing Conditions
- ☐ Gleyed or Low Chroma
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soil
- ☐ Organic Streaking in Sandy Soil
- ☐ Listed on Local Hydric Soils List
- ☐ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

Remarks: bright soil, sandy, no hydric indicators

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes [✓ No]
Wetland Hydrology Present? Yes [✓ No]
Hydric Soils Present? Yes [✓ No]

Is this Sampling Point Within a Wetland? Yes [✓ No]

Remarks:

* Forest County soil survey not complete.

Data Form
Routine Wetland Determination
(1987 COE Wetlands Delineation Manual)

Project/Site:	Crandon Project Site	Date: 11/17/94
Applicant/Owner:	Crandon Mining Company	County: Forest
Investigator:	Ron Steg	State: WI

Do Normal Circumstances exist on the site? [✓ Yes] No	Wetland ID: 22
Is the site significantly disturbed (Atypical Situation)? Yes [✓ No]	Transect ID:
Is the area a potential Problem Area? Yes [✓ No] (If needed, explain on reverse.)	Plot ID: 1B

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Rubus trigosus*	herb	FACW-	9.		
2. *Lycopodium obscurum*	herb	FACU	10.		
3. *Acer saccharum*	tree	FACU	11.		
4. *Rubus alleyheniensis*	herb	FACU+	12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC). < 25%

* = dominant species

Remarks:

HYDROLOGY

____ Recorded Data (Describe in Remarks):

☐ Stream, Lake or Tide Gauge
☐ Aerial Photographs
☐ Other

_X_ No Recorded Data Available

Wetland Hydrology Indicators:

☐ Water Stained/Silt Covered Leaves
☐ Drift Lines
☐ High Water Marks
☐ Sand/Silt Deposits
☐ Swollen Tree Bases
☐ Exposed Roots
☐ Periodically Flooded Channels/Depressions

Field Observations:

Depth of Surface Water _NA_ (in.)
Depth of Free Water in Pit _NA_ (in.)
Depth of Saturated Soil _NA_ (in.)

Remarks: sloping topography, no hydrology indicators

Map Unit Name *
(Series and Phase):

Drainage Class: *

Field Observations Confirm Mapped Type? Yes No

Profile Description:

Depth (inches)	Matrix Color (Munsel Notation)	Mottle Colors (Munsel Notation)	Mottle Abundance	Soil Texture/ Type
0-4"	10 YR 2/3		None	Loam
4-18"	10 YR 4/3		None	Sand

Hydric Soil Indicators:

☐ Histosol
☐ Histic Epipedon
☐ Sulfidic Odor
☐ Aquic Moisture Regime
☐ Reducing Conditions
☐ Gleyed or Low Chroma
☐ Concretions
☐ High Organic Content in Surface Layer in Sandy Soil
☐ Organic Streaking in Sandy Soil
☐ Listed on Local Hydric Soils List
☐ Listed on National Hydric Soils List
☐ Other (Explain in Remarks)

Remarks: no hydric indicators

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes [✓ No]
Wetland Hydrology Present? Yes [✓ No]
Hydric Soils Present? Yes [✓ No]

Is this Sampling Point Within a Wetland? Yes [✓ No]

Remarks: marginal, transitional, disturbed

* Forest County soil survey not complete.

Data Form
Routine Wetland Determination
(1987 COE Wetlands Delineation Manual)

Project/Site:	Crandon Project Site	Date: 11/17/94
Applicant/Owner:	Crandon Mining Company	County: Forest
Investigator:	Ron Steg	State: WI

Do Normal Circumstances exist on the site?	[✓ Yes] No	Wetland ID: 22
Is the site significantly disturbed (Atypical Situation)?	Yes [✓ No]	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes [✓ No]	Plot ID: 1A

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Scirpus cyperinus**	herb	OBL	9.		
2. *Calamogrostis canadensis**	herb	OBC	10.		
3.			11.		
4.			12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC). 100%

* = dominant species

Remarks: small area of wetland vegetation within an opening in young aspen stand

HYDROLOGY

____ Recorded Data (Describe in Remarks):

- ☐ Stream, Lake or Tide Gauge
- ☐ Aerial Photographs
- ☐ Other

__X__ No Recorded Data Available

Wetland Hydrology Indicators:

- ☐ Water Stained/Silt Covered Leaves
- ☐ Drift Lines
- ☐ High Water Marks
- ☐ Sand/Silt Deposits
- ☐ Swollen Tree Bases
- ☐ Exposed Roots
- ☒ Periodically Flooded Channels/Depressions

Field Observations:

Depth of Surface Water 2 (in.)
Depth of Free Water in Pit ____ (in.)
Depth of Saturated Soil ____ (in.)

Remarks: old logging road appears to have impeded flow through natural drainage swale

Map Unit Name (Series and Phase): *

Drainage Class: *

Field Observations Confirm Mapped Type? Yes No

Profile Description:

Depth (inches)	Matrix Color (Munsel Notation)	Mottle Colors (Munsel Notation)	Mottle Abundance	Soil Texture/ Type
0-4"	10 YR 3/3		None	Sandy Loam
4-12"	10 YR 4/3	10 YR 6/6	Minor	Loam
12-18"	10 YR 5/1	10 YR 6/6	Moderate	Stiff Clay

Hydric Soil Indicators:

☐ Histosol
☐ Histic Epipedon
☐ Sulfidic Odor
☐ Aquic Moisture Regime
☐ Reducing Conditions
☒ Gleyed or Low Chroma

☐ Concretions
☐ High Organic Content in Surface Layer in Sandy Soil
☐ Organic Streaking in Sandy Soil
☐ Listed on Local Hydric Soils List
☐ Listed on National Hydric Soils List
☐ Other (Explain in Remarks)

Remarks: area appears to be underlain by a stiff clay at a depth of ≈12-18 inches

WETLAND DETERMINATION

Hydrophytic Vegetation Present? [✓ Yes] No
Wetland Hydrology Present? [✓ Yes] No
Hydric Soils Present? [✓ Yes] No

Is this Sampling Point Within a Wetland? [✓ Yes] No

Remarks: very small, marginal, disturbed site

* Forest County soil survey not complete.

Appendix B

Description of Wetland Functional Models

PREFACE

The information presented in this appendix addresses the specific assumptions that were used by the investigators to arrive at the various element weights and condition weights illustrated on Table E-1 through E-10. The precedence for assigning numerical wetland element values to assess wetland functions was established by Golet and Larson (1974) and expanded by Reppert et al. (1979). These authors followed established environmental planning principles such as those put forth by McHarg (1969). This approach has been used in numerous Environmental Impact Statements for state and Federal agencies.

The models apply to all wetlands, with only one exception. The Shoreline Protection function model (Table E-5) only applies to those wetlands which border on a lake or stream. Many wetlands in the study area do not border on a lake or stream and have no shoreline protection function.

DESCRIPTION OF WETLAND FUNCTIONAL MODELS

1.0 BIOLOGICAL FUNCTION MODEL

The Biological Function Model was based on the wildlife habitat models developed by Fried (1973) and Golet and Larson (1974) and has been modified to address the specific considerations presented under "Biological Functions" in NR 132.06 of the Wisconsin Administrative Code (Table E-1). The elements that comprise this model were selected to evaluate those wetland features known to determine "the kinds, numbers and relative abundance" of animal species, "wildlife production and use", "short- and long-term importance of the wetlands to both aquatic and terrestrial species" and "specialized wetland functions essential for an organism to complete its life cycle requirements such as cover, spawning, feeding and the like." In general, life form (growth form or habit) and arrangement of the vegetatio were the most important considerations in this model. Classical works by MacArthur and MacArthur (1961) and Weller and Spatcher (1965) have demonstrated the key role of vegetation in determining wildlife production and variety. Porter (1981) recognized the key role that the wetland-upland transition zone played in wildlife habitat.

Vegetative density was used as an expression of biomass, which served as an indicator of "net primary production of plant communities." Pratt and Andrews (1981) indicated that wetlands are naturally very productive habitats often nutrient sinks, and that their biomass represents a large potential energy source. Other elements were less directly used; surface water connection, for example, was an indicator of the "kinds and amount of organic material transported to other aquatic systems as a potential energy

Table E-1. Biological Function Model.

Elements	Element Weight	Condition Weight	Conditions
Unique Fisheries[a]	NA[b]	NA	Present
		NA	Not Present
Presence of Endangered or Threatened Species[a]	NA	NA	Present
		NA	Not Present
Dominant Wetland Class	5	1	Stream or brookside wetland
		0	Open fresh water
		4	Deep fresh marsh (aquatic bed)
		5	Shallow fresh marsh
		5	Yearly flooded floodplain
		2	Wet meadow
		4	Shrub swamp
		2	Wooded swamp (deciduous)
		4	Wooded swamp (coniferous)
		3	Bog
Number of Wetland Classes (Richness)	4	5	>5
		4	4
		3	3
		2	2
		1	1
Number of Wetland Subclasses (Richness)	3	5	>10
		4	6-9
		3	4-5
		2	2-3
		1	1
Vegetative Interspersion	4	3	High
		2	Moderate
		1	Low

[a] = Preemptive Factors
[b] = Not applicable

Table E-1. (continued)

Elements	Element Weight	Condition Weight	Conditions
Surrounding Habitat	3	3	>90% of two or more of listed types
		2	50-90% of one or more: 90% of one
		1	<50% of one ore more of listed
Water/Cover Ratio (Cover Typed)	3	4	26-75% scattered
		2	26-75% peripheral
		3	75% or <25% scattered
		1	100% cover: >75% or <25% peripheral
Number of Plant Species (Vegetative Species Richness)	2	1	Low
		2	Medium
		3	High
Proportion of Wildlife Food Plants	1	1	Low
		2	Moderate
		3	High
Vegetative Density	2	3	High
		2	Moderate
		1	Low
Wetland Juxtaposition	3	3	Highly favorable
		2	Moderately favorable
		0	Unfavorable
Hydrological Position (Groundwater Connection)	2	1	Perched wetland
		4	Water table wetland
		3	Water table/artesian wetland
		3	Artesian wetland
Water Level Fluctuation	1	2	Low
		1	Vernal pool
		0	High

Table E-1. (continued)

Elements	Element Weight	Condition Weight	Conditions
Surface Water Connection	1	1	Connected to a small stream
		2	Connected to a river
		3	Connected to a lake
		4	Connected to a combination
		0	Not connected
Percent Wetland Bordering on Open Water	4	1	<33%
		2	34-66%
		3	67-100%
		0	Does not border
Size	5	3	Large ≥ 4.6 acres
		2	Medium 1.1-4.5 acres
		1	Small ≤ 1.0 acres
		Range 29-158	
		Mean 93	

source for consumer organisms in those systems." In aggregate, the elements of this model constituted an evaluation system designed to assess the maximum potential of a wetland for biological production and variety. Each of these elements is described in Table E-1.

1.1 PREEMPTIVE FACTORS

Wetlands bordering a water body that supports unique commercial or recreational fisheries, or which provide habitat for or are frequented by threatened or endangered species were immediately identified for more thorough analysis.

1.2 DOMINANT WETLAND CLASS

As a result of the important role vegetation life form plays in determining wildlife habitat value, Dominant Wetland Class was accorded a weighting of five. Some wetland classes have a higher value than others for wildlife species diversity and production rate because of the differences in vegetative life form and water depth and permanence. Shallow marsh, for example, was one of the most valuable classes because of the habitat provided for nesting birds and various mammals, particularly muskrats. This class was also assigned a value of five. Yearly flooded floodplain was also a very valuable class because of its importance as nesting habitat for many wetland animals, particularly waterfowl, and from its importance as a waterfowl feeding area during migration. This class was also assigned a value of five. A steep-sided stream or brookside wetland, on the other hand was one of the least valuable classes because of the poor development of wetland functions essential for an organism to complete its life cycle requirements; therefore, this class was assigned a value of one. The weights assigned to the remaining classes in this element are presented in Table E-1.

1.3 NUMBER OF WETLAND CLASSES (RICHNESS)

As the number of wetland classes increases so does the variety of plant life forms which, in turn, increases the potential for wildlife species diversity (Weller and Spatcher, 1965). This was one of the most important wetland features in determining kinds, numbers and relative abundances of wildlife species, and wildlife production and use; therefore, this element was assigned a weight of four. The weight assigned to the condition increased or decreased depending on the number of wetland classes comprising the wetland (Table E-1).

1.4 NUMBER OF WETLAND SUBCLASSES (RICHNESS)

This element was a refinement of "Number of Wetland Classes" in assessing the potential for wildlife species diversity. As the number of subclasses increases so do those features important in the life cycles of many wildlife species, such as cover and food, which increases the kinds and numbers of wildlife that can be supported in an area. Differences among subclasses are probably less important than differences among classes with respect to increases in wildlife habitat variety (Golet and Larson, 1974); therefore this element was assigned a weight of three. The weight assigned to the condition increased or decreased depending on the number of subclasses present (Table E-1).

1.5 VEGETATIVE INTERSPERSION

As stated above, wildlife density and species diversity are primarily a function of vegetative life form variety and arrangement. Since most species of wildlife require more than one life form of vegetation, wildlife population density and species diversity were closely related to the length and number of different kinds of edge. As vegetative interspersion increases, wildlife production and use, and overall biological production improves. Because of its importance in the model, this element was accorded a weight of 4. The conditions were weighted on a descending scale from high to low (Table E-1).

1.6 SURROUNDING HABITAT

The habitat surrounding a wetland is an important factor affecting its wildlife production since the life cycle requirement of many species is satisfied partly in wetlands and partly in uplands. Many waterfowl and other wildlife depend upon surroundings such as hay fields, corn, and oak forests for food and nesting cover. The nature of the surrounding habitat also determines which upland wildlife are likely to utilize the wetland. Marshes, for example, provide cover for pheasants and cottontail rabbits. Uplands also provide a buffer against human disturbance, a frequent deterrent to successful breeding, and wetlands bordered by agriculture, forest land and abandoned open land have a higher wildlife support capacity than those surrounded by industry, housing or outdoor recreation. Based on its role in determining the importance of a wetland to both aquatic and terrestrial species this element was assigned a weight of 3. The listed types in the three conditions refer to agriculture, forest land and abandoned open land (Table E-1).

1.7 WATER/COVER RATIO (COVER TYPE)

The relative proportion of vegetative cover and open water in a wetland is a very important factor affecting the kinds, numbers and relative abundance of wildlife species. Investigators have found that maximum numbers and species diversity of wetland wildlife occurred where a water/cover ratio of 50:50 was attained (Weller and Spatcher, 1965). Wetlands having nearly total cover or total open water were less valuable than wetlands with nearly equal proportions of each. The degree of water/cover interspersion was also an important factor affecting value. Scattered cover, or cover interspersed with water was a more valuable condition than peripheral cover or water because of the greater edge which results (Delacour, 1964). Based on its role in determining wildlife production and use, this element was assigned a weight of 3. The weight assigned to the condition was related to both the ratio of cover to open water and the degree of interspersion (Table E-1).

1.8 PLANT SPECIES VARIETY

As the number of different plant species in a wetland increases, so also does the species diversity of invertebrate fauna supported by the vegetation. This is directly related to the food available to certain wildlife species and life stages, and is therefore an indicator of wildlife production. Also, some wildlife, including certain waterfowl, tend to be plant species specific with regard to placement of nests (Delacour, 1964) or in selection of plant foods. Thus, although life form plays a more important role in wildlife production and use of a wetland, plant species variety is also a contributing factor. As plant species variety increases the potential of the wetland to provide specialized functions essential for some wildlife to complete their life cycle requirements also improves. Because of its secondary role in determining wildlife production and use, this element was assigned a weight of 2. The condition (high, medium, low) was chosen using best professional judgement, based on comparing the kinds of plant species inventoried in a unit area of a given wetland to those found in the same unit areas of other wetlands in the study area (Table E-1).

1.9 PROPORTION OF WILDLIFE FOOD PLANTS

This element is a direct indicator of wildlife production and use, and of the degree of expression of those wetland functions which are essential for wildlife to fulfill their feeding requirements. Some plant species provide food for only a short time, but this is often during critical periods in wildlife cycles such as during annual migrations or before the onset of winter. Other plant species produce structures that supply food over winter. Both kinds of food production along with other factors, such as quantity produced, were considered in the analysis of plant food availability. Since vegetative structure plays a greater role in wildlife production and use than do the edible parts of plants, this element was assigned a weight of 1. It was included, however, to distinguish wetlands in which plant food production was particularly high so that when it occurred the contribution of such a condition to the overall assessment could be added. The condition (high, medium, low) was chosen following the field inventory, and was based on the food value of each species listed on the wetland inventory report (Martin et al., 1961) and its relative abundance (Table E-1).

1.10 VEGETATIVE DENSITY

Vegetative density is an expression of biomass or standing crop, which can serve as an index of net primary production of plant communities depending upon age of the wetland. During early wetland stages, such as shallow marsh and shrub swamp, high density is much more directly related to high primary production than in a mature wetland stage, such as wooded swamp. In the latter type, a large quantity of biomass may be represented in the vegetative structure while net annual primary production is very low. Moreover, in the younger stages a higher proportion of the primary production is in the form of edible structures that can be utilized by wildlife for food. However, in all stages, high plant density provides more breeding, resting and escape cover so that higher wildlife densities per unit area can be accommodated. Vegetative density, therefore, can serve both as an index of primary production and an indicator of potential numbers and relative abundance of wildlife species (Smith, 1980). Based on its contribution to the overall wildlife support value of a wetland, this element was assigned a weight of 2 (Table E-1).

1.11 WETLAND JUXTAPOSITION

Wildlife production and use in a wetland is generally higher if it is located near other wetlands, particularly those of a different class or with different subclasses. This value improves if the wetlands are connected by streams which provide cover and travelways to permit wetland wildlife to move safely between wetlands. This element becomes less important in large, diversified wetlands in which life cycle requirements can be met without travelling to other wetlands. Based on its contribution to wildlife production and use, wetland juxtaposition was assigned a weighting of 3. The condition in which other wetlands were nearby and connected by streams was highly favorable and was accorded a weight of 3; if wetlands were nearby but not connected, the condition was moderately favorable and was given a weight of 2. Isolated wetlands received no value for wetland juxtaposition (Table E-1).

1.12 HYDROLOGIC POSITION (GROUND-WATER CONNECTION)

The position of a wetland with respect to ground water determines its longevity, water level fluctuation and nutrient level. Productivity rates of wetland plants are closely related to nutrient availability and abundance. Local aquifer (perched) wetlands have shorter longevity, lower nutrient levels, less diverse vegetation and greater water level fluctuation when compared with those connected to the main aquifer (Bay 1967). In wetlands connected to the main aquifer, water level is relatively constant and the abundance and availability of nutrients is higher because of ground water movement through the wetland soils. As a result, plant productivity rates are higher and wildlife production and use is greater. In general, main aquifer wetlands potentially have a greater short- and long-term importance to wildlife than local aquifer wetlands. In comparison with the contributions of other elements in the model, hydrologic position was assigned a weight of 2. The level of discrimination between water table/ artesian wetlands and artesian wetlands was not important with respect to those wetland functions relevant to wildlife cycles, and both were assigned a weight of 3 (Table E-1).

1.13 WATER LEVEL FLUCTUATION

The magnitude of water level fluctuation in a wetland has a direct effect on wildlife production and use. Wide fluctuations adversely affect a large variety of wildlife species. High water may destroy nests and young, and low water may expose the nests to predators. Although the contribution of this element to the model was considerably less than that of other elements (an assigned weight of 1), water level fluctuation was a consideration that affected the ability of a wetland to fulfill wildlife requirements and was part of the overall evaluation. Since low water fluctuation was the preferred condition it was assigned a weight of 2. Wetlands with a high water level fluctuation receive no rating for this element (Table E-1).

1.14 PERCENT OF WETLAND BORDERING OPEN WATER

The value of a wetland with respect to wildlife support is greater if associated with a stream, river or lake than if isolated. Open water provides habitat for waterfowl during migration and during the breeding season, as well as for other wildlife, such as otter and raccoons. The greater the percentage of wetland edge bordering open water, the higher the numbers and kinds of wildlife that will utilize the wetland. Because of the importance of this element in determining wildlife production and use, it was accorded a weight of 4. The weights assigned the conditions varied with the percent of wetland bordering open water (Table E-1).

1.15 SURFACE WATER CONNECTION

The kind of open water connected to a wetland influences wildlife production and use as well as the transport of organic material to other aquatic systems. Although some small streams, particularly those bordering marshes, may provide some habitat for waterfowl broods and other wildlife, the spectrum of aquatic and terrestrial wildlife which are able to fulfill certain life cycle requirements is greater in wetlands bordered by rivers and lakes. Thus, rivers, lakes and particularly combinations of riparian and lake habitats greatly improve wildlife production in the wetlands they border. In general, rivers are more important than small streams with respect to the transport of organic material because of the higher predictability of surface water flow during summer months. Overall however, the kind of surface water connection was less important than the percentage of bordering wetland edge; therefore, this element was assigned a weight of 1. The weight assigned to the conditions varied with the kind of water body and with combinations receiving the heaviest weighting (Table E-1).

1.16 SIZE

In general, as wetland size increases so does its value for wildlife production and use. Greater size results in greater insulation from human disturbance on the periphery. Also, habitat variety tends to improve with increased size, so that a large wetland would be more likely to fulfill all of a species life cycle requirements than a small wetland. Large wetlands are valuable as waterfowl feeding and resting areas during migration. Moreover, the factors which determine longevity such as permanence of the water table and watershed size were correlated with large wetland size. As a result of the important role of this element in determining the kinds and numbers of wildlife supported by the wetland, it was accorded a weight of 5. The weight assigned to the condition was directly related to size (Table E-1).

2.0 WATERSHED FUNCTION MODELS

Watershed functions, as defined in proposed Wisconsin NR 132 consist of five separate functions; hydrologic support, ground-water, storm and floodwater storage, shoreline protection, and water quality maintenance functions. The following text describes the models for these functions.

2.1 HYDROLOGIC SUPPORT FUNCTION MODEL

Water resides in wetlands for a limited time; that is, some water is always passing through a wetland. Water leaves wetlands by evaporation-transpiration, recharge to the ground-water system or as surface water outflow to downstream areas (Winter, 1981a). The ability of a vegetative wetland to discharge surface water to downstream surface waterbodies, streams, lakes and other vegetated wetlands, is important in maintaining the chemical and physical integrity of downstream aquatic ecosystems.

The Hydrologic Support Function Model (Table E-2) is designed to assess the "Hydrologic Support Function" of a wetland defined in the Wisconsin Administrative Code, NR 132, by inventorying those physical elements which in combination allow a wetland to function so that it controls the quantity and quality of water that it discharges to downstream waterbodies. These physical elements defined in NR 132 include location, topographic position, areal extent (size), degree of connection, hydrologic regime, water chemistry, velocity, water depth, fluctuation patterns, water renewal rate and temporal pattern.

It is difficult to separate wetland functions into specific definitions. The functions ascribed to wetlands are highly interrelated. For

Table E-2. Hydrologic Support Function Model.

Elements	Element Weight	Condition Weight	Conditions
Size	4	3	Large $\geq$ 4.6 acres
		2	Moderate 1.1-4.5 acres
		1	Small $\leq$ 1.0 acres
Topographic Configuration	1	3	Semi-closed basin
		2	Valley
		1	Hillside
		0	Closed basin
Dominant Hydrologic Type	5	1	Condition 1
		2	Condition 2
		3	Condition 3
		4	Condition 4
		5	Condition 5
		0	Condition 6
Water Level Fluctuation	2	2	Low
		1	High
Outlet	4	2	Perennial Outlet
		1	Ephemeral Outlet
		1	Groundwater Outflow
		0	Absent
Inlet	1	2	Perennial
		1	Ephemeral
		0	Absent
Percent Wetland[a] Bordering on Open Water	4	1	<33%
		2	34-66%
		3	67-100%
		0	Does not border

Range 6-66[b]
Mean 36

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[a] Applies only to those wetlands with an outlet.

[b] Total value for one inlet and one outlet only.

example, the hydrologic support function is closely related to the prevention of pollution and stormwater storage functions. In other words, these two wetland functions, in part, control the quantity and quality of water passed down stream. Thus, when assessing the hydrologic support function of a wetland, one must assess, in part, the wetland's stormwater storage and prevention of pollution function. Reppert et al. (1979) define a method to determine the hydrologic support functions of wetlands, but emphasize flushing rates as opposed to frequency of flooding. No consideration is given for base water flow maintenance.

According to NR 132 (Wisconsin Administrative Code), there is a correlation between specific wetland physical elements such as "location" and "topographic position" and a physical condition such as hydrologic "degree of connection". The hydrologic support function model includes those physical elements which give rise to a particular wetland functioning "to maintain the hydrologic characteristics, and thereby the physical and chemical integrity of an entire aquatic ecosystem." These elements are listed in the model (Table E-2).

2.1.1 Size

The size of a wetland was considered to be a critical element in the hydrological support function and was given a weight of 4. The larger a wetland, the more potential it has to contribute to the "hydrologic regime" of downstream receiving hydrologic systems. If all other inventory elements were equal between two wetlands except size, the larger wetland should better support the hydrological regime (Table E-2).

2.1.2 Topographic Configuration

Particular topographic wetland configurations dictate the "temporal pattern" or the "frequency of inundation" potential of a wetland. They also, in turn, control "water velocity" and the "ability of the water to carry suspended particulate matter." "Water depth, fluctuation patterns" and water "renewal rates" are also controlled in part by the topographic configuration. The topographic configuration, which slows the flow of water (reduces water velocity), and controls temporal patterns was considered most beneficial to the hydrologic support function of a wetland. This situation was defined as a semi-closed basin and it was given a condition weight of 3. Valleys and hillsides, respectively, were considered to be less beneficial. The element weight given to topographic configuration was low (1) since it was considered not to be as important as other elements (Table E-2).

2.1.3 Dominant Hydrologic Type

Dominant hydrologic type is used to describe the residence time of water in a wetland, travel time for a drop of water moving through a wetland. The more time a drop of water spends in the wetland, the greater its chance to interact with the physical elements of the wetland. This is a measure of the "living filter" function of a wetland which controls water chemistry to include "ionic composition" and "oxygen saturation." Each hydrologic type predicts potential water "velocity", "fluctuation patterns", "flooding" and "renewal rates". These factors control the quantity, quality and "temporal pattern" of water leaving the wetland. The conditions representative of the highest residence times were assumed to be the most valuable. Those reflecting low residence times were assumed to have low values (Table E-2).

2.1.4 Water Level Fluctuation

Water level fluctuation is a measure of the rise and fall of water in a wetland, its "frequency of inundation and its regularity or predictability." Wetlands with low water level fluctuations were assumed to be indicative of a complex set of wetland elements that control and regulate (smooth out) surface water flows. Wetlands with high water level fluctuations were assumed to be indicative of more extreme "flashy" and uneven surface water flows. Wetlands which exhibit the most control of water movement generally have small water level fluctuations and better store and release water. This maintains downstream base water flows, which, in turn, supports aquatic ecosystems (Table E-2).

2.1.5 Outflow

The outflow element was assigned a weight of 4 since it was critical to insuring that a wetland contributes to and supports other aquatic ecosystems. The greater the outflow, the more the wetland supports "renewal rates", "water depth", water chemistry and fluctuation patterns. Another important factor is that the outlet establishes the "degree of connection with other wetlands and water bodies." Perennial wetlands were given the highest condition weight (2) while ephemeral and groundwater (soil interflow) outlets were each given a weight of 1 (Table E-2).

2.1.6 Inflow

The type of inflowing water, whether perennial or ephemeral, determines, in part, the amount of water available for hydrologic support.

This element was considered to be less important than the outlet and was given an element weight of 2. Perennial inlets were weighted higher (2) than ephemeral ones (1) (Table E-2).

2.1.7 Wetland Shoreline as a Percent of Total Lake Shoreline or Wetland Edge

The amount of contact or edge that a vegetative wetland has with a surface water body (pond, lake or stream) was assumed to be a critical element for the wetland to support the "hydrologic regime" of an aquatic ecosystem and was assigned an element weight of 4 (Table E-2). This percentage was determined by measuring the total length of lake or pond edge and then measuring the length of edge between the individual wetland and the lake or pond. For example, the length of the stream section passing through the wetland was compared with the total circumference of the wetland/upland boundary. Measurements were made using the orthophoto map (Scale: 1 inch = 400 feet) and the appropriate box was checked on the wetland inventory report.

2.2 GROUND-WATER FUNCTION MODEL

The ground-water function of a wetland may better be termed the "ground-water support function", since this function is directed towards a wetland's ability to recharge underlying aquifers. Wetlands in a recharge condition pass accumulated surface water and direct precipitation from the wetland soil downward into an aquifer. Many wetlands seasonally alternate between recharge and discharge. Even perched (local aquifer) wetlands may be partly recharging a deep underlying main aquifer by slow seepage. Winter (1981b) described the geohydrologic scientific uncertainties in estimating the water balance of lakes and wetlands. The potential for some ground-water recharge, however small, appears to be common to most wetlands. Thus, in developing the ground-water function model, it was assumed that all wetlands have some recharge potential and only those elements that enhance this potential were included in the model (Table E-3).

2.2.1 Surficial Geology

Surficial geology controls recharge and was assigned an element weight of 3. Those wetlands that occurred in till areas had the least potential for recharge since till was the most impermeable surficial geologic deposit in the study area. Stratified sand and gravel was the most permeable and thus offered the most recharge potential. Fine sand and gravel and alluvium had intermediate permeabilities and intermediate recharge potential. Condition weights were accordingly assigned (Table E-3).

Table E-3. Ground-water Function Model.

Elements	Element Weight	Condition Weight	Conditions
Surficial Geology	3	1	Till
		4	Stratified sand and gravel
		3	Stratified fine sand and silt
		2	Alluvium
Organic Material	2	3	Absent
		2	High permeability
		1	Low permeability
Hydrologic Position	5	2	Perched wetland
		4	Water table wetland
		2	Water table/artesian wetland
		1	Artesian wetland
Transmissivity Aquifer	4	1	Low <10,000 gal/day/ft
		2	Mod. 10,000-40,000 gal/day/ft
		3	High >40,000 gal/day/ft
Inlet	1	1	Absent
		3	Perennial
		2	Ephemeral
Outlet	2	3	Absent
		2	Perennial
		1	Ephemeral
Size	3	3	Large $\leq$ 4.6 acres
		2	Medium 1.1-4.5 acres
		1	Small $\geq$ 1.0 acres
		Range 20-68[a]	
		Mean 44	

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[a] Total value for one inlet and one outlet only. Some wetlands may have more than one inlet or outlet but the range above is for wetlands with only one inlet and one outlet.

2.2.2 Organic Material

Organic material has a low vertical permeability and retards movement of surface water from a wetland to the underlying groundwater system. Some organic materials have higher permeabilities than others and allow greater recharge. Wetlands with little organic material would have the greatest recharge potential since the organic material "liner" is reduced. The organic material inventory elements were weighted using these assumptions (Table E-3).

2.2.3 Hydrologic Position

The hydrologic position element was considered the best measure of a wetland's recharge potential and was given the highest element weight (5). A water table (main aquifer) wetland was considered to be the best hydrogeologic situation for recharge and was assigned a condition weight of 4. Perched (local aquifer) hydrogeologic situations had the potential for slow recharge and were given a weight of 2. Water table/artesian wetlands have some recharge potential but are more commonly discharge areas. They were given a weight of 2 while artesian wetlands are almost always in a discharge condition and were given a weight of 1 (Table E-3).

2.2.4 Transmissivity of Aquifer

The aquifer is the receptor of recharge and transmissivity is a measure of the value of an aquifer for water withdrawal, ground-water movement, and possible discharge to down-gradient aquatic ecosystems. It is used to define the hydrologic characteristics of an associated aquifer. The larger the transmissivity of an aquifer the more valuable will be the recharge of overlying wetlands. Because of its importance to the aquifer this element was assigned a weight of 4 (Table E-3).

2.2.5 Inlet

The inlet characteristics define, in part, the amount of surface water flowing into a wetland which may recharge the underlying aquifer. Perennial inlet conditions were given a higher weight (3) than ephemeral (2) because of the continuous water flow into the wetland and the potential to recharge the aquifer. The inlet element was assigned a weight of 1 (Table E-3).

2.2.6 Outlet

The amount of water leaving a wetland could provide an estimate of the recharge function of a wetland. A wetland receiving inflowing surface water but having no outlet, forces water to leave the wetland by recharge or evapotranspiration. A wetland having a perennial outlet, is constantly losing potential recharge water and may also be indicative of a discharge wetland. Thus, the highest inventory condition weight (3) was assigned to wetlands with no outlet and the lowest (1) to wetlands having an ephemeral outlet (Table E-3).

2.2.7 Size

The size of a wetland can be used to measure its potential recharge value. When other conditions are held equal, the larger a wetland, the greater its recharge potential. Large wetlands were weighted 3, medium 2 and small 1 (Table E-3).

2.3 STORM AND FLOODWATER STORAGE FUNCTION MODEL

The value of wetlands for control of storm waters and prevention of downstream flooding has been recognized by numerous investigators (Coleman and Kline, 1977). Wetlands may contain many natural resources which intercept, retain, and detain inflowing storm waters so that the outflow hydrograph has less of a peak and a greater time of concentration than the inflow hydrograph. How wetlands function to control storm water is a complex topic (Novitzki, 1978; Larson, 1981; and Reppert, 1981). One concept is to treat a wetland simplistically as a designed flood control device and apply standard hydrologic engineering approaches to estimating the wetland's flood storage volume as has been practiced by the Department of Environmental Quality Engineering in Massachusetts. Another concept is to examine the wetland as a complex ecosystem and assess the various elements of that ecosystem as to their ability to store water and retard water flows during periods of flood or storm discharge (Coleman and Kline, 1977). To meet the criteria presented in NR 132 (Wisconsin Administrative Code) the latter concept was used and the following model (Table E-4) was developed.

2.3.1 Dominant Wetland Class

Wetland vegetation has the potential for reducing the energy of inflowing storm water and retaining water. Those wetland classes which have the highest potential for primary production were also assumed to have the highest stem density to reduce flood water energy and to remove water by evapotranspiration. The inventory conditions shallow fresh marsh, wooded swamp and shrub swamp were assumed to be high primary production

Table E-4. Storm and Flood Water Storage Function Model.

Elements	Element Weight	Condition Weight	Conditions
Dominant Wetland Class	2	1	Stream or brookside wetland
		1	Open fresh water
		2	Deep fresh marsh (aquatic bed)
		4	Shallow fresh marsh
		4	Yearly flooded floodplain
		3	Wet meadow
		5	Shrub swamp
		4	Wooded swamp
		3	Bog
Percent Open Water	2	3	0-33%
		2	34-66%
		1	67-95%
		0	96-100%
Vegetative Density	4	3	High
		2	Moderate
		1	Low
Topographic Configuration	2	4	Closed basin
		3	Semi-closed basin
		2	Valley
		1	Hillside
Topographic Position in Watershed	3	3	Upper
		2	Intermediate
		1	Lower
Surficial Material of Watershed	2	4	Till
		1	Stratified sand and gravel
		3	Stratified fine sand and silt
		2	Alluvium

Table E-4. (continued)

Elements	Element Weight	Condition Weight	Conditions
Surficial Geologic Materials of Wetland Banks	2	1	Till
		4	Stratified sand and gravel
		2	Stratified fine sand and silt
		3	Alluvium
Organic Material	1	2	High permeability
		1	Low permeability
		0	Absent
Dominant Hydrologic Type	5	1	Condition 1
		2	Condition 2
		3	Condition 3
		4	Condition 4
		5	Condition 5
		6	Condition 6
Hydrologic Connection	4	1	Not part of riparian system
		2	Part of riparian system
Water Level Fluctuation	3	2	High
		1	Low
Inlet	1	2	Perennial
		1	Ephemeral
		0	Absent
Outlet	1	1	Perennial
		2	Ephemeral
		0	Absent
Size	4	3	Large ≥ 4.6 acres
		2	Medium 1.1-4.5 acres
		1	Small ≤ 1.0 acres
		Range 29-123[a]	
		Mean 76	

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[a] Total value for one inlet and one outlet only. Some wetlands may have more than one inlet or outlet but the range above is for wetlands with only one inlet and one outlet.

vegetative communities and were assigned high condition weights. This element was given a weight of 2. This element also was considered to be a measure of the substrates' texture (vegetative structure), the material over which flood water must flow (Table E-4).

2.3.2 Percent Open Water

The percent open water element addresses the considerations of "previous degree of saturation" and wetland vegetation. Wetlands with large amounts of open water (67-95 percent) are predominantly saturated and have high amounts of surface water discharge. Also, there is little stem density to slow down flood water. This inventory condition was assigned a weight of 1 in comparison to a wetland with little area (0-30 percent) of open water (3) (Table E-4).

2.3.3 Vegetative Density

Vegetative density is an important criterion since it retards inflowing storm water. Some wetlands of the same dominant class may have different densities and thus different abilities to control floods. It was also considered to be an estimate of substrate texture. Since stem density was considered to be one of the most important vegetative elements it was given a weight of 4. Condition weight reflects an increase in flood control value corresponding to an increase in stem density (Low = 1, High = 3) (Table E-4).

2.3.4 Topographic Configuration

The topographic configuration element is a measure of the "basin shape" (Bureau of Reclamation, 1977). Basins with shapes similar to flood control dams, such as closed basins and semi-closed basins were given high condition weights, 4 and 3, respectively. These topographic shapes have the highest potential for retardation near the outlet so that the basin can fill with water. Valleys and hillsides have little if any potential for holding water, but they have the potential for channel storage (valley) or water spreading (hillsides) (Table E-4).

2.3.5 Topographic Position in Watershed

The location of a wetland in a stream's watershed was considered to influence the ability or importance of the wetland in controlling flooding. Wetlands near the top of the watershed were considered to be important since they are the first to receive runoff (they have the shortest times of concentration). As a result they absorb the initial hydrologic shock generated by a runoff event. Without wetlands high in the watershed, lower sections of the stream would have higher flood peaks and a shorter time of concentration. As a result, the element weight assigned was moderate (3) and condition weights were correlated with watershed locations (upper 3, lower 1) (Table E-4).

2.3.6 Surficial Geological Materials

Impervious surficial geologic materials of the watershed permit greater surface water discharge which results in higher peak discharges.

Those wetlands occurring in high surface water runoff potential watersheds are more important in controlling floods than those in low surface water drainage potential watersheds. Till has a high surface water discharge potential, while permeable sand and gravel has a low potential and the condition weights reflect this relationship (Till - 4, stratified sand and gravel - 1) (Table E-4).

2.3.7 Surficial Geologic Materials of Wetland Embankments

As water rises in a wetland because of rapidly inflowing surface water, the water level in the wetland may become higher than the groundwater table in the surrounding embankments. If this condition continued for sufficient time, water would infiltrate from the wetland through the embankments and cause a rise in the water table. The more permeable the wetland embankments, the greater the potential for them to store flood waters (bank storage). Impermeable till has little storage potential whereas permeable sand and gravel has a high storage potential and the condition weights (1 to 4) reflect this relationship (Table E-4).

2.3.8 Organic Materials[3]

Some flood water storage may occur in wetland organic soils that are not saturated. High permeability wetland soils have larger porosities and a greater potential for drying than do low permeability soils and were assigned a higher condition weight (2 versus 1). This element was not weighted high (1) because organic soils are anaerobic due to water saturation and are seldom "dry" or unsaturated (Table E-4).

2.3.9 Dominant Hydrologic Type

Dominant hydrologic type was considered to be the most important element and was given the highest weight (5). This element is a measure of the potential length of time (retention time) that a drop of water spends in a wetland. Hydrologic Condition 1 is a high gradient rushing stream passing water through the wetlands as rapidly as possible and has the least impact on reducing peak surface water discharges and the lowest floodwater storage potential since it is not a topographically flat area. Hydrologic Condition 6, a closed depression with no outlet, stores water which enters and has the highest flood control potential; therefore, it was given a condition weight of 6 (Table E-4).

2.3.10 Hydrologic Connection

This element received a high weighting (4) since it was believed that a wetland must be part of a riparian system in order to protect downstream areas from flooding. Isolated wetlands also serve a flood control function by retention of water and not passing it downstream; however, they were not believed to play as important a role in flood control as wetlands connected to a riparian system. Isolated wetlands have a similar flood control value to isolated upland closed basins. However, it is only when a vegetated wetland occurs as part of a riparian system that the role of the vegetation and soils play an important role in reducing flood flows and providing flood storage.

2.3.11 Water Level Fluctuation

A high water level fluctuation observed in a wetland indicates that the wetland is functioning to store floodwaters. This condition was assigned an element weight of 3 and condition weights of 2 and 1 (Table E-4).

2.3.12 Inlet

The amount and frequency of water flowing into a wetland are partly controlled by its inlet. The greater the volume of inflowing water the more important becomes the function of a wetland in controlling that water. A wetland could have all the components necessary to control storm water, but if it is seldom required to do so, it has less value than a wetland which frequently receives large amounts of water. Thus, a perennial inlet was assigned a weight of 2 and an ephemeral inlet 1 (Table E-4).

2.3.13 Outlet

The outlet of a wetland partially controls the amount of floodwater that can be stored in the wetland. An ephemeral outlet was assumed to have higher water storage capacity than a perennial outlet. In addition, a perennial outlet may indicate continuous saturation of wetland soils, while ephemeral outlets could indicate that the wetland soils may become dry during parts of the year. Thus, an ephemeral outlet was assigned a weight of 2 and a perennial outlet a weight of 1 (Table E-4).

2.3.14 Size

If all other elements were equal between two wetlands, it was assumed that the larger wetland would have a greater potential to control flooding than a smaller one. As a result, large wetlands (>1.8 ha [4.6 acres]) were assigned a weight of 3, medium 2, and small 1 (Table E-4).

2.4 SHORELINE PROTECTION FUNCTION MODEL

When wetlands are adjacent to a lake or a stream channel, they buffer the wave and current energy of these water bodies and protect upland ecosystems and valuable residential, commercial and industrial acreage. Such wetlands have preemptive value as shown in Table E-5 along with the other elements required for this model.

2.4.1 Vegetative Density

Vegetative density affords protection of shorelines by providing plant stems which reduce water flow rates and thus decrease erosive energy. Plant stems also prevent debris and ice from battering the shoreline. The higher the vegetation stem density, the greater the shoreline protection (Table E-5).

2.4.2 Dominant Wetland Class

The shoreline buffering capacity of a wetland is in part a reflection of the strength of the plant stems to resist water flow, floating debris and ice. Also, the type of vegetation present determines the strength of the root mat for erosion control. Wetland classes with poorly rooted floating communities and non-woody stems were assumed to offer little shoreline buffering capacity, such as a deep marsh which was assigned a condition weight of 1. On the other hand, a shrub swamp or wooded swamp containing strong plant stems and thick root mats securely attached to the soil were considered to have a high shoreline buffering capacity and were assigned a weight of 4. Other classes were intermediate in value (Table E-5).

Table E-5. Shoreline Protection Function Model.

Elements	Element Weight	Condition Weight	Conditions
Wetland Borders[a] Lake or Stream	NA[b]	NA	Yes
		NA	No
Vegetative Density	2	3	High
		2	Moderate
		1	Low
Dominant Wetland Class	3	0	Open fresh water
		0	Stream and brookside
		1	Deep fresh marsh (aquatic bed)
		2	Shallow fresh marsh
		4	Yearly floodplain
		1	Wet meadow
		4	Shrub swamp
		4	Wood swamp
		3	Bog
Surficial Material Underlying Wetland	1	2	Till
		1	Stratified sand and gravel
		4	Stratified fine sand and silt
		3	Alluvium
Fetch (Lakes only)	4	2	Over 2000 ft.
		1	Under 2000 ft.
Depth of Lake	1	2	Deep 6 ft.
		1	Shallow 6 ft.
		Range 3-32 Mean 17	

[a] preemptive

[b] = not applicable

2.4.3 Surficial Material Underlying a Wetland

Some wetlands overlie surficial geologic materials which are very difficult to erode. A wetland located upon easily erodable materials such as fine sand and silt have a greater protective function than wetlands located on more difficult materials to erode such as stratified sand and gravel. Condition weights were assigned accordingly (Table E-5).

2.4.4 Fetch

Fetch is a measure of the length of open lake water across which wind may blow to generate waves. In general, a long fetch will create a high wave. A fetch of >609.6 m (2000 feet) was considered large, <609.6 m was considered small. Large fetch was assigned a condition weight of 2 while small fetch was assigned a weight of 1. Fetch was considered the most important element and was weighted 4 (Table E-5).

2.4.5 Depth of Lake

Large waves are created in deep lakes with a long fetch. A shallow lake with a long fetch will not generate waves as high as will a deep lake with an equally long fetch. Wave energy is primarily a result of wave height. The depth of a lake is generally given an element weight equal to that of fetch. However, it was not since all the study area lakes are shallow and capable of generating only small waves. Fetch in this case is more important than depth in determining wave height (Table E-5).

2.5 WATER QUALITY MAINTENANCE FUNCTION MODEL

According to Wisconsin Administrative Code, NR 132, "wetlands may degrade, inactivate, or store materials such as heavy metals, sediments, nutrients, and organic compounds that would otherwise drain into waterways." This function is best defined as the ability of a wetland to abate inflowing pollutants and to discharge cleaner water. In the Massachusetts Wetlands Protection Act (Massachusetts General Laws 131-40) this function is defined as the prevention of pollution value of a wetland. It has also been referred to as the wetland's "living-filter" function.

Wetlands may act as "living-filters" removing floatable and sinkable debris, suspended solids, dissolved solids, nutrients and chemical compounds, both natural and manmade by a variety of methods including physical filtering, sedimentation, nutrient uptake, adsorption, and absorption (Burton, 1981; Davis et al., 1981; Kadlec, 1981; and Oberts, 1981).

The following model (Table E-6) has been developed to assess the pollution abatement function by using the nine criteria set forth in NR 132:

1) density and distribution of plants;
2) area, depth and basin shape;
3) hydrologic regime;
4) physical, chemical and biological properties of the water and soil;
5) relationship of wetland size to watershed size;
6) the number and size of other wetlands remaining in the watershed;
7) topography of the watershed;

Table E-6. Water Quality Maintenance Function Model.

Elements	Element Weight	Condition Weight	Conditions
Dominant Wetland Class	4	1	Stream or brookside wetland
		0	Open fresh water
		3	Deep fresh marsh (aquatic bed)
		4	Shallow fresh marsh
		4	Yearly floodplain
		3	Wet meadow
		4	Shrub swamp
		2	Wooded swamp
		2	Bog
Percent Open Water	1	3	0-33%
		2	34-66%
		1	67-95%
		0	96-100%
Vegetative Density	3	3	High
		2	Moderate
		1	Low
Topographic Configuration	3	4	Closed basin
		3	Semi-closed basin
		2	Valley
		1	Hillside
Topographic Position in Watershed	2	1	Upper
		2	Intermediate
		3	Lower
Organic Material	1	1	High permeability
		2	Low permeability
		0	Absent

Table E-6. (continued)

Elements	Element Weight	Condition Weight	Conditions
Dominant Hydrologic Type	4	1	Condition 1
		2	Condition 2
		3	Condition 3
		4	Condition 4
		5	Condition 5
		6	Condition 6
Hydrologic Connection	2	1	Not part of riparian system
		2	Part of riparian system
Inlet	2	2	Perennial
		1	Ephemeral
		0	Absent
Outlet	3	2	Perennial
		1	Ephemeral
		0	Absent
Size	4	3	Large $\geq$ 4.6 acres
		2	Moderate 1.1-4.5 acres
		1	Small $\leq$ 1.0 acres
		Range 18-98 [a]	
		Mean 58	

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[a] Total value for one inlet and one outlet only. Some wetlands may have more than one inlet or outlet but the range above is only for wetlands with one inlet and one outlet.

8) position of the wetland relative to springs, lakes rivers and other waters; and

9) land use practices and trends within the watershed, or the likelihood of nutrient, sediment or toxin loads increasing.

2.5.1 Dominant Wetland Class

The dominant wetland class defines the type of vegetative community that may act as a "living-filter". This element was considered to be important and was weighted 4. Some types of wetlands are assumed to have better physical filtering and nutrient uptake than others. Shallow fresh marsh, shrub swamp and yearly floodplain were considered to be the best "living-filters" and were assigned a weight of 4. The stream or brookside wetland offered the least amount of potential for interaction of water with vegetation and was weighted the lowest (1). Other classes were weighted intermediate (Table E-6).

2.5.2 Percent Open Water

The lesser the amount of open water, the more the contact between water and the vegetative community. Those wetlands having little open water will function best since their water is in contact with the largest percentage of wetland plants. Those wetlands having 0-30 percent open water were considered the best and were given a weight of 3. Those having large amounts of open water, 67-95 percent, were weighted 1 (Table E-6).

2.5.3 Vegetative Density

Densely vegetated wetlands provide a high rate of physical filtering and nutrient uptake and were given a weight of 3. Wetlands with low vegetative density have the least potential for physical filtering and nutrient uptake and were weighted 1. This element was considered important in assessing the pollution abatement function and was assigned a weight of 3 (Table E-6).

2.5.4 Topographic Configuration

Topographic configuration is a description of the "basin shape" and the "topography of the watershed." The topographic configuration relates to the potential for the wetland to act as a trap for inflowing pollutants. The best pollutant trap is a closed basin which does not release any water to a downstream ecosystem, and was weighted the highest (4). A hillside offers the least ability to trap pollutants and was weighted the lowest (1) (Table E-6).

2.5.5 Topographic Position in Watershed

This element refers to the "relationship of wetland size to watershed size" and the "number and size of other wetlands remaining in the watershed." It was assumed that wetlands lower in the watershed will have larger watersheds than wetlands higher in the watershed. Thus, such wetlands will receive a larger volume of water for renovation. Also, wetlands low in the watershed will have fewer wetlands below them to further renovate polluted water. For these reasons, wetlands lower in the watershed were assigned a higher weight (3) and those higher in the watershed a low weight (1) (Table E-6).

2.5.6 Organic Material

Organic material has the potential to remove pollutants by adsorption and absorption. Organic soils also act as habitat for bacteria which are important in nutrient cycling. The lower the permeability of an organic material, the larger the number of molecular attachment sites available for absorption and adsorption. Also, water will pass more slowly through organic soil, offering a longer period of time for trapping and retaining pollutants before they pass downstream. Low permeability materials were assigned a condition weight of 2 and high permeability materials a weight of 1 (Table E-6).

2.5.7 Dominant Hydrologic Type

Dominant hydrologic type refers to the residence time of water in a wetland or the amount of time required for a drop of water to move through a wetland. The longer a drop of water spends in the wetland, the greater its chances to interact with the "living-filter" function of the wetland. Those conditions that have the highest residence times were considered to have the greatest function. Those with lowest residence times were considered to have the least function. Appendix C, Section 4.3 defines the various dominant hydrologic types in detail. Hydrologic Condition 6 was considered to be the best pollutant trap since it allows nothing to pass downstream. Hydrologic Conditions 4 and 5 have slightly different residence times, but are very similar and were assigned equal weights (4). Condition 1, a rushing stream, does little to remove pollutants and was given a weight of 1 (Table E-6).

2.5.8 Hydrologic Connection

The hydrologic connection defines the "position of the wetland within the watershed" relative to springs, lakes, rivers and other waters. Basically a wetland is either located above other aquatic ecosystems and protects them by pollution abatement function or it does not. If it is not part of a riparian system, it can not directly protect downstream ecosystems and was weighted the lowest (1). If it is part of a riparian system, it protects downstream ecosystems and was assigned a weight of 2 (Table E-6).

2.5.9 Inlet

Since perennial inlets have water flow continuously, they have the potential to continuously add polluted water to the wetland. Wetlands having perennial inlets could have the potential to renovate inflowing water continuously and were considered more valuable than wetlands having ephemeral inlets. Perennial inlets were assigned a weight of 2 and ephemeral inlets were weighted 1 (Table E-6).

2.5.10 Outlet

The outlet character of a wetland is an important element in the hydrologic regime. An important function of a wetlands' hydrologic regime is to maintain downstream ecosystems by maintaining base water flow, which decreases pollution by dilution, maintains water chemistry and temperature, and provides water volumes for aquatic habitats. Perennial outlets have more of a potential to provide clean downstream water than do ephemeral outlets and were weighted higher (2); ephemeral outlets were weighted lower (1) (Table E-6).

2.5.11 Size

When other elements are equal, the larger the wetland the greater will be its prevention of pollution function. This element was weighted high (4) since the potential quantity of pollutants entering a wetland either naturally or man-induced, is difficult to predict. Larger wetlands should be able to renovate a larger quantity of polluted water. Large wetlands (>1.8 ha [4.6 acres]) were assigned a weight of 3, moderate size wetlands 2 and small wetlands 1 (Table E-6).

In the study area, all wetlands were considered to have an equal "likelihood of nutrient, sediment or toxin loads increasing" so the pollution abatement function model would not be biased towards potential Crandon Project activities.

3.0 CULTURAL AND ECONOMIC FUNCTION MODEL

In attempting to model wetland cultural values, it became apparent that the cultural heritage of people in the vicinity of the proposed Crandon Project was not readily definable in terms of model elements and that such a model would not be an adequate evaluation of all possible relevant considerations. For this reason, it was decided that major cultural considerations would be identified by contacting appropriate information sources and making a qualitative assessment of wetland cultural values. The wetland functions that give rise to economic value, on the other hand, were much more readily identified in terms of model elements. The elements which were considered to be most important in determining economic function are presented in Table E-7.

3.1 DOMINANT WETLAND CLASS

Dominant wetland class has a direct bearing on whether commercial products are present such as wild rice, furbearers or game fish that have the potential to contribute to the economic base of the region. Because of its important role in the model, this element was assigned a weight of 4. The weighting was high for classes having high potential for producing cash crops such as wooded swamps, which very often contain some harvestable timber, or marshes which provide habitat for commercial crops and game species. Conversely, the weighting was low for classes that seldom produce economically viable crops, such as shrub swamps (Table E-7).

Table E-7. Cultural and Economic Function Model.

Elements	Element Weight	Condition Weight	Conditions
Dominant Wetland Class	4	0	Stream or brookside
		0	Open fresh water
		4	Deep fresh marsh
		4	Shallow fresh marsh
		0	Yearly flooded floodplain
		2	Wet meadow
		3	Shrub swamp
		5	Wooded swamp (deciduous)
		6	Wooded swamp (coniferous)
		3	Bog
Access	3	3	Within 100' of road
		2	Access by passable waterway
		1	Isolated
Size	8	3	Large ≥ 4.6 acres
		2	Medium 1.1-4.5 acres
		1	Small ≤ 1.0 acres
		Range 11-87 Mean 54	

3.2 ACCESS

Access to wetlands having a potential cash crop is a factor in the wetlands' economic value, but its importance as an element in the model was less than that of the other 2 elements, which determine the presence and extent of the resource. Moreover, if the cash crop has a major value, access will be developed when a decision has been made to harvest. Based on the above, this element was assigned a weight of 3; the weight assigned the condition increases with ease of access (Table E-7).

3.3 SIZE

Size of a wetland containing a potential cash crop is as important a factor in determining economic viability of the resource as actual presence of the crop. Size is directly related to total yield of the harvest, which has a direct bearing on both the decision to harvest and cash return. It was determined that this element should have the same maximum possible score as "Dominant Wetland Class" and it was assigned a weight of 8; the large size category was weighted 3 (Table E-7).

4.0 RECREATIONAL FUNCTION MODEL

The elements in this model are very similar to the criteria used by Bedford et al. (1974) to assess the recreational value of wetlands in Dane County, Wisconsin (Table E-8).

4.1 DOMINANT WETLAND CLASS

Dominant wetland class directly affects the potential for hunting, trapping, fishing and nature study. Wetland classes differ with respect to wildlife species diversity, and net primary production; shallow marsh provides habitat for songbirds and certain mammals, coniferous swamps provide winter yards for deer, and aquatic beds provide habitat for warm water fish species. Based on its role in determining recreational value this element was assigned a weight of 3 and the weights assigned to each class varied with its importance as wildlife habitat (Table E-8).

4.2 PERCENT OPEN WATER

Percent open water is an important element, since it affects recreational potential in several ways. Open water provides opportunities for boating and fishing, as well as providing an added habitat element for both game and non-game wildlife. Based on its role in this model, this element was assigned a weight of 3. The weight assigned to the condition increased with percent open water, the optimum condition being between two-thirds and complete open water (Table E-8).

Table E-8. Recreational Function Model.

Elements	Element Weight	Condition Weight	Conditions
Dominant Wetland Class	3	0	Stream or brookside
		0	Open fresh water
		6	Deep fresh marsh
		5	Shallow fresh marsh
		0	Yearly flooded floodplain
		0	Wet meadow
		2	Shrub swamp
		2	Wooded swamp (deciduous)
		3	Wooded swamp (coniferous)
		2	Bog
Percent Open Water	3	1	0-33%
		2	34-66%
		3	67-95%
		0	96-100%
Surface Water Association	4	1	Connected to a small stream
		2	Connected to a river
		3	Connected to a lake
		4	Connected to a combination
		0	Not connected
Access to Public	2	3	Within 100' of road
		2	Access by passable waterway
		1	Isolated
Size	4	3	Large $\geq$ 4.6 acres
		2	Medium 1.1-4.5 acres
		1	Small $\leq$ 1.0 acres
Legal Access	2	2	Yes
		1	No

Table E-8. (continued)

Elements	Element Weight	Condition Weight	Conditions
Output From Biological Function Model	3	3	High
		2	Moderate
		1	Low
		Range 10-71	
		Mean 40	

4.3 SURFACE WATER CONNECTION

Connection of a wetland to a surface water body is the most important factor affecting recreational potential, since without a surface water connection the recreational benefits associated with open water discussed above are absent from the wetland. Surface water connection directly influences wildlife and finfish production, an important factor affecting recreational potential. Because of its importance in determining recreational potential of a wetland this element was assigned a weight of 4. The weight accorded to the condition is related to the type of connection and the recreational benefits associated with each, a combination of lake and riparian system being the most ideal (Table E-8).

4.4 PUBLIC ACCESS

Although access to a wetland is a factor in its recreational potential, this element was considered to be less important than others in the model. In fact, in a wetland affording good hunting and fishing opportunities isolation may be an enhancement to those sportsmen willing to make their own access. Based on the above, this element was assigned a weight of 2. The weight assigned to the condition increased with ease of access (Table E-8).

4.5 SIZE

Size is a very important element since it directly influences recreational carrying capacity of a wetland. Larger wetlands support a greater variety and density of wildlife, and afford more opportunities for recreational activities associated with wetlands such as canoeing, nature study and hunting. Because of its important role in this model, size was accorded a weight of 5, the weight assigned to the condition varying directly with size (Table E-8).

4.6 LEGAL ACCESS

Ownership status determines whether a wetland is legally accessible; the broad categories of ownership are public, private and Native American. As with Public Access, this element was much less important than those functional elements which actually determine recreational potential because ownership and legal access status can both change. Accordingly, "Legal Access" was assigned a weight of 2 (Table E-8).

4.7 OUTPUT FROM BIOLOGICAL FUNCTION MODEL

Since the potential of a wetland for biological production and variety determines whether it might provide habitat for or be productive of species of recreational, cultural or economic interest, this was an important consideration in determining recreational potential. The contribution of this element to the recreational model was included by assigning one of three conditions using the output from the biological function model. As a result of the importance of this output to the recreational model, it was assigned a weight of 3 (Table E-8).

5.0 AESTHETICS FUNCTION MODEL

5.1 DOMINANT WETLAND CLASS

Dominant wetland class was important in determining the aesthetic value of a wetland. Certain wetland classes have higher visual appeal than others. For example, floating mats of vegetation such as occur in a bog or an aquatic bed are highly attractive; shrub swamps and most deciduous swamps, on the other hand, provide very shallow vistas and little visual relief, therefore, their contributions to the aesthetics of a wetland were considered to be minimal. This element was assigned a weight of 4 and the weights assigned to the wetland classes varied with their visual appeal (Table E-9).

5.2 NUMBER OF WETLAND SUBCLASSES (RICHNESS)

Subclass richness is a measure of the variety of plant form and arrangement. Where this factor was rated high the wetland was also rated high in visual richness and aesthetic appeal. This element was assigned a weight of 3, and the weights assigned to the conditions varied with the number of different wetland subclasses (Table E-9).

5.3 PERCENT OPEN WATER

Open water is an important factor contributing to the aesthetic appeal of a wetland, and this element was assigned a weighting of 4. The aesthetic appeal improves as percent open water increases with an optimum occurring for most people at around 95 percent. Up to this point, sufficient

Table E-9. Aesthetic Function Model.

Elements	Element Weight	Condition Weight	Conditions
Dominant Wetland Class	4	0	Stream or brookside wetland
		0	Open fresh water
		5	Deep fresh marsh
		4	Shallow fresh marsh
		0	Yearly flooded floodplain
		0	Wet meadow
		2	Shrub swamp
		3	Wooded swamp (deciduous)
		3	Wooded swamp (coniferous)
		5	Bog
Number of Subclasses (Richness)	3	4	6-9
		3	4-5
		2	2-3
		1	1
Percent Open Water	4	1	0-33%
		3	34-66%
		4	67-95%
		0	96-100%
Access to Public	3	3	Within 100' of road
		2	Access by passable waterway
		1	Isolated
Local Scarcity	3	1	<200' to nearest similar type
		2	201-1000' to nearest similar type
		3	>1000' to nearest similar type
		Range 9-66 Mean 37	

vegetation is present to provide visual relief but as percent vegetation diminishes to zero, visual richness declines (Table E-9).

5.4 ACCESS

Access to a view of a wetland is certainly a factor contributing to its aesthetic value. If access was limited, appreciation of the wetland's aesthetic attributes was considered to be minimal. However, access may be created to provide visual access to a particularly appealing view, therefore, this factor was not as important as the functional components "Dominant Wetland Class" and "Percent Open Water," in determining the aesthetic value of a wetland. The weight assigned to this element was 3, and the weights assigned to the conditions varied with ease of access (Table E-9).

5.5 LOCAL SCARCITY

Visual relief is a factor in the aesthetic value of a wetland. Where a particular wetland type was commonly distributed over the landscape, visual relief was considered to be low; but where a type was quite rare, relief was given a heavy weighting. This element was assigned a weight of 3 and weights assigned to the conditions varied depending on the commonness of the wetland type as a landscape element (Table E-9).

6.0 EDUCATIONAL FUNCTION MODEL

There exists such a variety of elements to the processes of education that no system can be developed that foresees all future educational opportunities and directions. This model was designed to include present educational uses and trends at various age and professional levels of education.

6.1 NUMBER OF WETLAND SUBCLASSES (RICHNESS)

This element is a measure of the variety of vegetative life forms available for study in a wetland. As the number of subclasses increases the opportunity becomes greater to observe natural history phenomena compared to a similar sized wetland of lower plant form variability and therefore, having less edge, lower interspersion and fewer wildlife. Based on the above, this element was assigned a weight of 3; the weight assigned to the conditions varies with the number of subclasses as presented in Table E-10.

6.2 PUBLIC ACCESS

Wetlands affording public access permit larger numbers of people to study wetland processes and observe plant and animal life cycle interactions than do isolated wetlands. Because access was considered important in terms of the educational value of a wetland, this element was assigned a weight of 4, and the weights assigned to the conditions varied with ease of access (Table E-10).

Table E-10. Educational Function Model.

Elements	Element Weight	Condition Weight	Conditions
Subclass Richness (Lateral Diversity)	3	4	6-9
		3	4-5
		2	2-3
		1	1
Access to Public	4	3	Within 100 ft. of road
		2	Access by passable waterway
		1	Isolated
		Range 7-24 Mean 15	

LITERATURE CITED

Bay, R.R. 1967. Ground water and vegetation in two peat bogs in northern Minnesota. Ecology 48(2):308-310.

Bedford, B.L., E.H. Zimmerman, and J.H. Zimmerman. 1974. The Wetlands of Dane County, Wisconsin. Report prepared for the Dane County Regional Planning Commission in cooperation with the Wisc. Dept. Natural Resources. 581 pp.

Bureau of Reclamation, 1977. Design of small dams -- a water resources technical publication. U.S. Dept. of Interior, Bureau of Reclamation.

Burton, T. M. 1981. The effects of riverine marshes on water quality. In: B. Richardson (ed). Selected proceedings of the Midwest Conference on Wetland Values and Management. Minnesota Water Planning Board, Minneapolis, Minn.

Coleman, J., and E. Kline. 1977. A guide to understanding and administering the Massachusetts Wetlands Protection Act. Massachusetts Audubon Society, Lincoln, MA 01773.

Davis, C. B., A. C. van der Valk, and C. E. Beer. 1981. Prairie pothole marshes as traps for nitrogen and phosphorus in agricultural runoff. In. B. Richardson (ed.). Selected Proceedings of the Midwest Conference on Wetland Values and Management. Minnesota Water Planning Board, Minneapolis, Minn.

Delacour, J. ed. 1964. The waterfowl of the world. Country life ltd. London.

Fried, E. 1973. Priority rating of wetlands for acquisition. Bureau of Wildlife, N.Y.S. Dept. of Env. Cons. Unpublished Report.

Golet, F.C. and J.S. Larson. 1974. Classification of freshwater wetlands in the glaciated northeast. Bur. Sport Fish. and Wildl. Res. Publ. 116. Washington. 56 pp.

Kadlec, R.H. 1981. How natural wetlands treat wastewater. In: B. Richardson (ed). Selected proceedings of the Midwest Conference on Wetland Values and Management. Minnesota Water Planning Board, Minneapolis, Minn.

Larson, C.L. 1981. Effects of wetland drainage on surface runoff. In: B. Richardson (ed.). Selected proceedings of the Midwest Conference on Wetland Values and Management. Minnesota Water Planning Board, Minneapolis, Minn.

MacArthur, R.H. and J.W. MacArthur. 1961. Bird species diversity. Ecology. 42:594-598.

Martin, A.C., H.S. Zim and A.L. Nelson. 1961. American Wildlife and Plants: A guide to wildlife food habits. Dover Pub., Inc., N.Y.

McHarg, Ian. 1969. Design with nature. Doubleday, Garden City, N.Y.

Novitzki, R.P. 1978. Hydrology of the Nevin Wetland near Madison, Wisconsin. U.S. Geol. Survey Water Resources Investigations 78-48.

Oberts, C.L. 1981. Impacts of wetlands on watershed water quality. In: B. Richardson (ed.). Selected Proceedings of the Midwest Conference on Wetland Values and Management. Minnesota Water Planning Board, Minneapolis, Minn.

Porter, B. 1981. The wetland edge as a community and its value to wildlife. In: B. Richardson (ed.). Selected proceedings of the Midwest Conference on Wetland Values and Management. Minnesota Water Planning Board, Minneapolis, Minn.

Pratt, D.C. and N.J. Andrews. 1981. Research in biomass/special energy crop production in wetlands. In: B. Richardson (ed.). Selected Proceedings of the Midwest Conference on Wetland Values and Management. Minnesota Water Planning Board, Minneapolis, Minn.

Reppert, T. 1981. Wetland Values, concepts and methods for wetland evaluation In: B. Richardson (ed.). Selected Proceedings of the Midwest Conference on Wetland Values and Management. Minnesota Water Planning Board, Minneapolis, Minn.

___________, W.R. Sigleo, E. Stakhiz, L. Messman and C. Meyers. 1979. Wetland values -- concepts and methods for wetland evaluation. Institute for water resoruces, U.S. Army Corps of Engineers Res. Rpt. 79-R1.

Smith, R.L. 1980. Ecology and Field Biology. Third Edition. Harper & Row Pub.

Weller, M.W., and C.S. Spatcher. 1965. Role of habitat in the distribution and abundance of marsh birds. Special Rpt. No. 43. Iowa Agric. and Home Econ. Exp. Sta., Iowa State Uiv. of Science and Tech., Ames, Iowa. 31 pp.

Winter T.C. 1981a. The hydrology of prairie lakes and wetlands. In: B. Richardson (ed.). Selected Proceedings of the Midwest Conference on Wetland Values and Management. Minnesota Water Planning Board, Minneapolis, Minn.

Winter, T.C. 1981b. Uncertainties in estimating the water balance of lakes. Water Resources Bulletin Vol. 17, No. 1. American Water Resources Association.

Appendix C

1994 Wetland Verification Delineation

Crandon Mining Company

March 22, 1995

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

David Ballman
Ecologist, U.S. Army Corps of Engineer
St. Paul District
190 Fifth Street East
St. Paul, MN 55101

RE: Crandon Project - Wetland Verification Delineation

Dear Mr. Ballman:

The Crandon Project wetland delineation ~~verification has been completed as per the procedures outlined~~ in the July 21, 1994 letter previously sent to you. Subsequent to the September 8, 1994, field meeting at the Crandon project site, at which time flagged wetland boundaries were validated by you and the Wisconsin Department of Natural Resources, the planned wetlands horizontal-control survey was completed.

A comparison between the wetland delineation completed in the early 1980s and the August 1994 verification is provided in the attached technical memorandum. The conclusion of the comparison is that the wetland delineation work performed in the 1980's by Normandeau and Associates, Inc. and Interdisciplinary Environmental Planning, Inc. is an accurate representation of the wetlands in the entire study area.

This completes our verification study of the wetlands in the vicinity of the Crandon Project site. If you have any questions regarding our work please feel free to call me at (715) 365-1450 or Ron Steg of Foth & Van Dyke at (414) 497-2500.

Sincerely,

Don Moe

D. E. Moe

Technical/Permitting Manager

DM:mkj:jcp
Attachments

cc: Bill Tans, WDNR
Archie Wilson, WDNR
Larry Lynch, WDNR
Robert Jaeger, Bureau of Indian Affairs
Al Milham, Forest County Potawatomi
Arlyn Ackley, Sokaogon Chippewa Community
John Teller, Menominee Indian Tribe of Wisconsin
M. Catherine Condon, Greene, Meyer & McElroy
David Kee, USEPA-Air Division (A18J)
Jerry Sevick, Foth & Van Dyke
Garrett Hollands, Fugro-McClelland
Tim Weyenberg, Foth & Van Dyke

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Foth & Van Dyke
Memorandum

March 21, 1995

TO: Jerry Sevick, Foth & Van Dyke

CC: Don Moe, Crandon Mining Company
Tim Weyenberg, Foth & Van Dyke
Garrett Hollands, Fugro-McClelland
Master File

FR: Brad Helmandollar, Foth & Van Dyke BDH
Ron Steg, Foth & Van Dyke

RE: Crandon Mining Company - Wetland Delineation Verification

In response to discussions with the U.S. Army Corps of Engineers (USCOE) and the Wisconsin Department of Natural Resources (WDNR), Foth & Van Dyke developed a plan to verify the boundaries of wetlands in the Crandon Mining Company (CMC) study area. The plan was outlined in a letter to David Ballman, USCOE, issued on July 21, 1994 (Attachment 1).

The approach for verifying the boundaries of wetlands existing in the CMC study area, as mapped by previous investigators (Normandeau Associates, Inc. and Interdisciplinary Environmental Planning, Inc., 1982, CMC-NOI-164), consisted of field delineation of approximately 25% of the wetlands existing in the mine/mill site and TMA configurations current at that time. This delineation was to be followed by completion of a horizontal control survey of the delineated wetlands and creation of a wetland boundary map at the same scale as the previously prepared wetland maps. Verification was then to be accomplished through direct comparison between the two maps. Details regarding the implementation of the approach and the results of the work are presented in the following paragraphs.

On August 24 and 25, 1994, Ron Steg and Brad Helmandollar of Foth & Van Dyke conducted delineation work on six wetlands on the Crandon Project site, designated as Wetlands P2, 5, M3, F64, F65 and F66. Wetlands 5, M3, F64 and F65 were delineated in their entirety. Only that portion of Wetland P2 existing within the mine/mill site was delineated. Wetland F66 was not considered in the July 21, 1994 work plan, however, based on field conditions observed at the time of the site visit, the southern portion of this wetland was delineated. Wetlands P2 and 5 are located within the proposed mine/mill site. The remaining wetlands, M3, F64, F65 and F66, are located within the proposed TMA. The boundaries of these wetlands were delineated with black and red striped survey tape. Field data forms are provided in Attachment 2.

On September 8, 1994, representatives of CMC and Foth & Van Dyke met with representatives of the USCOE and the WDNR to conduct a field review of the delineated wetland boundaries. The group was unanimously in agreement with the Foth & Van Dyke wetland boundary determination.

On September 28, 1994, Foth & Van Dyke surveyors were taken to and shown the boundaries for all delineated wetlands. In the days that followed a horizontal control survey was completed. The survey information was then downloaded into Foth & Van Dyke's CADD system so the coordinates could be plotted on the existing wetland maps. As Wetlands F66 and P2 were not delineated in their entirety, the surveyed wetland boundary was tied into the previous wetland boundary based on interpretation of May 1993 aerial photography, followed by field verification on August 27, 1994. Figures 1A and 1B provide a comparison of the August 1994 and previously mapped wetland boundaries.

Table 1 presents a comparison between the August 1994 wetland verification work to previously mapped wetlands. The configuration of the boundary of Wetland F65 is somewhat different than previously mapped. The August 1994 mapping resulted in a westerly shift in the connection between wetlands F65 and F66, however the overall size of these two wetlands remains very close to the previously mapped acreage. Wetland 5, as mapped in August 1994, is considerably smaller than previously mapped and is shifted approximately 50 feet to the south. The configuration of the remaining wetlands mapped in 1994 is much the same as the previous mapping. The resultant acreage from the 1994 delineation is approximately 13 percent less than the previous mapping. If this approximation is extrapolated to the entire study area, the previous wetland mapping represents a slight over estimate of the actual wetland acreage in the study area.

Based on the 1994 verification work, botanical surveys of the entire study area conducted by the Foth & Van Dyke botany team, and a review of fall 1993 and spring 1994 aerial photography of the study area, it is concluded that the wetland delineation work performed by Normandeau and Associates, Inc. and Interdisciplinary Environmental Planning, Inc. is an accurate representation of the wetlands in the entire study area and may have actually overestimated the acreage by up to 13 percent.

Please note that since the field verification work was completed, the configuration of both the mine/mill site and TMA have changed somewhat as work on the project's environmental impact report and permit applications has progressed. For consistency and to avoid confusion, the location and configuration of both the mine/mill site and TMA shown on the attached figures are those that were used to develop the wetland delineation work plan. The fact that the mine/mill site and TMA locations and configurations have changed slightly since the work plan was developed does not affect the results and conclusions of the work addressed in this memorandum.

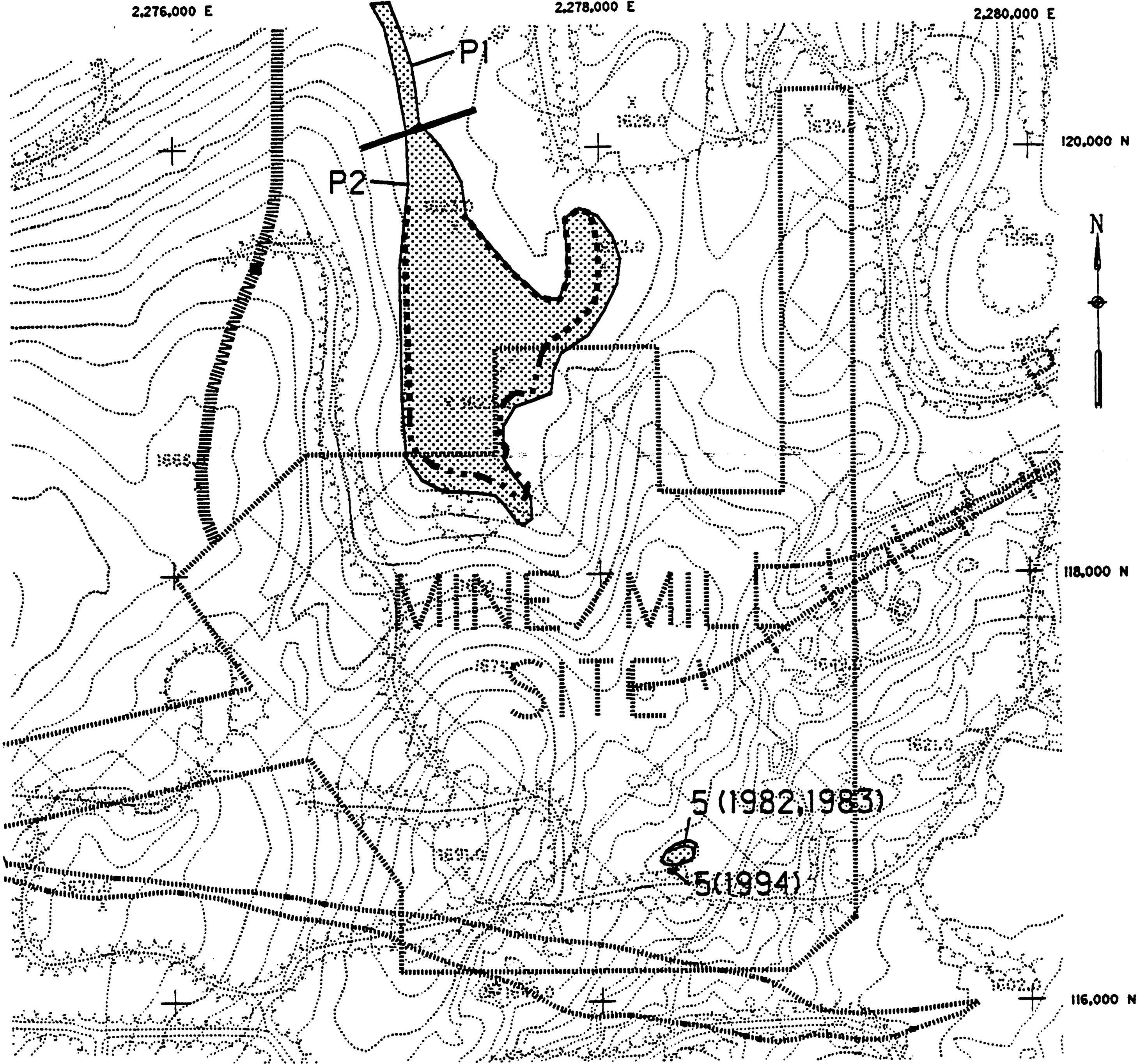
Table 1

Comparison of Wetland Acreage from August 1994 Verification Work to Previous Mapping Work

Crandon Project

Wetland	Acreage August 1994 Mapping	Acreage Previous Mapping
5	0.01	0.28
M3	4.50	5.52
F64	4.50	5.21
F65	2.40	2.36
F66	16.10	17.07
P2	18.00	21.91
Total	**45.51**	**52.35**

Prepared by: BDH
Checked by: RFS



LEGEND

P2	WETLAND IDENTIFICATION
━━━━	WETLAND DIVIDER
▪ ▪ ▪ ▪ ▪ ▪	WETLAND BOUNDARY DETERMINED BY FOTH & VAN DYKE IN 1994 BASED ON REVIEW OF AERIAL PHOTOGRAHY AND FIELD RECONNAISSANCE
▬ ▪ ▪ ▬	WETLAND BOUNDARY BASED ON FIELD DELINEATION AND HORIZONTAL CONTROL SURVEY IN 1994 BY FOTH & VAN DYKE
▨	WETLANDS MAPPING BASED ON NORMANDEAU ASSOCIATES, INC. AND INTERDISCIPLINARY ENVIROMENTAL PLANNING, INC., 1982 AND INTERDISCIPLINARY ENVIRONMENTAL PLANNING, INC., 1983

NOTES:

1. APPROXIMATE SITE AREA: PART OF SECTION 25, T35N, R12E, TOWN OF NASHVILLE AND PART OF SECTIONS 29, 30 AND 32, T35N, R13E, TOWN OF LINCOLN, FOREST COUNTY, WISCONSIN.
2. TOPOGRAPHIC BASE MAP DIGITIZED FROM 1" = 1000' SCALE, 5' CONTOUR INTERVAL MAP PREPARED BY AERO-METRIC ENGINEERING, INC., SHEBOYGAN, WISCONSIN. DATE OF PHOTOGRAPHY APRIL 28, 1976.
3. HORIZONTAL DATUM BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM - NORTH ZONE.
4. VERTICAL DATUM BASED ON MEAN SEA LEVEL DATUM. CONTOUR INTERVAL IS FIVE FEET.
5. COUNTY AND TOWNSHIP LINES DIGITIZED FROM 7.5' SERIES USGS MAPS.

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

CHECKED BY:	JKSI	DATE: JAN. '95
APPROVED BY:	RFS	DATE: JAN. '95
APPROVED BY:	GWS	DATE: JAN. '95

Crandon Mining Company

FIGURE 1A

WETLAND VERIFICATION DELINEATION RESULTS

Scale:	1" = 700'	Date:	JANUARY 1995
Prepared By:	Foth & Van Dyke	By:	JRB

93C049

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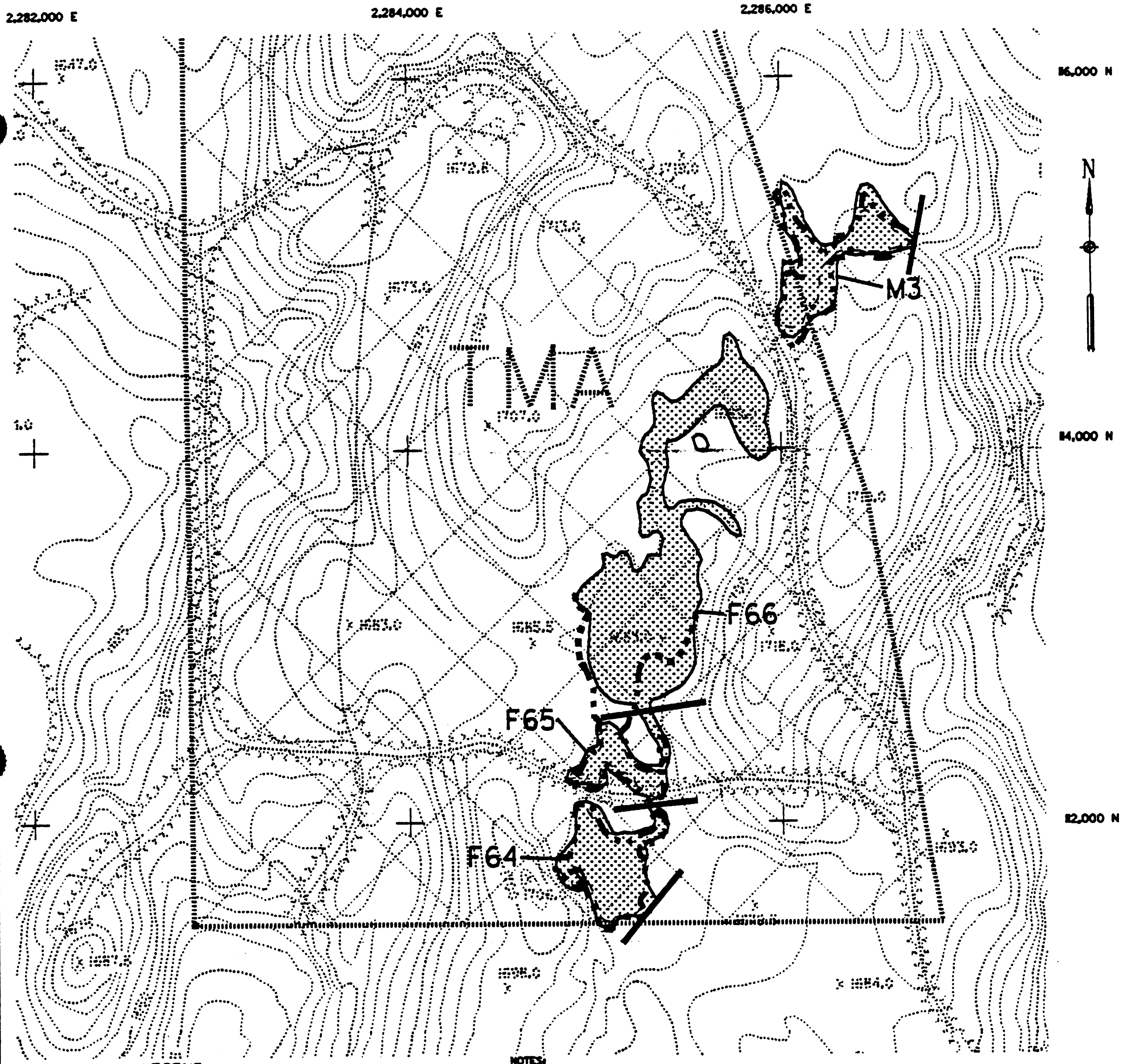

LEGEND

F66	WETLAND IDENTIFICATION
▬▬▬	WETLAND DIVIDER
■ ■ ■ ■ ■ ■	WETLAND BOUNDARY DETERMINED BY FOTH & VAN DYKE IN 1994 BASED ON REVIEW OF AERIAL PHOTOGRAHY AND FIELD RECONNAISSANCE
▬ ■ ■ ▬	WETLAND BOUNDARY BASED ON FIELD DELINEATION AND HORIZONTAL CONTROL SURVEY IN 1994 BY FOTH & VAN DYKE
▨	WETLANDS MAPPING BASED ON NORMANDEAU ASSOCIATES, INC. AND INTERDISCIPLINARY ENVIROMENTAL PLANNING, INC., 1982 AND INTERDISCIPLINARY ENVIRONMENTAL PLANNING, INC., 1983

NOTES:

1. APPROXIMATE SITE AREA: PART OF SECTION 25, T35N, R12E, TOWN OF NASHVILLE AND PART OF SECTIONS 29, 30 AND 32, T35N, R13E, TOWN OF LINCOLN, FOREST COUNTY, WISCONSIN.
2. TOPOGRAPHIC BASE MAP DIGITIZED FROM 1" = 1000' SCALE, 5' CONTOUR INTERVAL MAP PREPARED BY AERO-METRIC ENGINEERING, INC., SHEBOYGAN, WISCONSIN. DATE OF PHOTOGRAPHY APRIL 28, 1976.
3. HORIZONTAL DATUM BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM - NORTH ZONE.
4. VERTICAL DATUM BASED ON MEAN SEA LEVEL DATUM. CONTOUR INTERVAL IS FIVE FEET.
5. COUNTY AND TOWNSHIP LINES DIGITIZED FROM 7.5' SERIES USGS MAPS.

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

CHECKED BY:	JKS1	DATE:	JAN.'95
APPROVED BY:	RFS	DATE:	JAN.'95
APPROVED BY:	GWS	DATE:	JAN.'95

Crandon Mining Company

FIGURE 1B

WETLAND VERIFICATION DELINEATION RESULTS

Scale:	1" = 800'	Date:	JANUARY 1995		
Prepared By:	Foth & Van Dyke			By:	JRB

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93C049

Attachment 1

Crandon Mining Company

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

July 21, 1994

David Ballman
Ecologist, U.S. Army Corps of Engineers
St. Paul District
190 Fifth Street East
St. Paul, MN 55101

Dear Mr. Ballman:

RE: Wetland Verification Delineation - Crandon Project

This letter is provided in response to your site review and subsequent telephone conversation recommending that Crandon Mining Company (CMC) conduct a "verification" study to confirm the accuracy of wetland delineation conducted in the 1980s.

Wetlands existing in the environmental study area were mapped previously by Normandeau Associates, Inc., Interdisciplinary Environmental Planning, Inc., and Fugro-McClelland. Mapping procedures were consistent with standard wetland mapping practices existing at the time the work was conducted. Based on conversations with the St. Paul District of the U.S. Army Corps of Engineers, CMC proposes verification delineation and mapping of approximately one-quarter of the wetland acreage existing within the boundaries of the direct impact area of the project. Portions of eight and 12 wetlands exist within the mine/mill site and tailings management area, respectively (Table 1). As noted on the table, CMC proposes to delineate and map wetlands 5 and P2 in the mine/mill site, and wetlands F65, F64 and M3 in the TMA.

Wetlands will be delineated using the routine wetland determination method described in the 1987 Corps of Engineers Wetland Delineation Manual. Wetland boundaries will be flagged with labeled and numbered survey tape. Following the delineation, a horizontal control survey will provide the data necessary to map the wetlands onto Foth & Van Dyke's base map of the area.

After the wetlands are flagged, we will notify you so a field assessment can be conducted by your staff. The verification of the delineation of these wetland areas is also being conducted to provide the WDNR with information they need for their verification that wetland boundaries/acreage have not appreciably changed since the previous studies were completed.

This work will be scheduled in August, 1994. The results of the work will be summarized in a letter report, including a wetland map, to be submitted within three weeks of the completion of the field activities.

We look forward to your comments on this verification activity.

Sincerely,

D. E. Moe

Don Moe
Technical/Permitting Manager

DEM:jcp

Attachment

cc: Bill Tans, WDNR
Archie Wilson, WDNR
Larry Lynch, WDNR
Robert Jaeger, Bureau of Indian Affairs
Al Milham, Forest County Potawatomi
Arlyn Ackley, Sokaogon Chippewa Community
Glen Miller, Menominee Tribe
David Kee, USEPA-Air Division (A18J)
Jerry Sevick, Foth & Van Dyke

Table 1
Wetlands in the Mine/Mill Site and Tailings Management Area
Crandon Mining Company

Wetland ID	Total Wetland Acres[1]	Wetland Acres w/in Site[2]
Mine/Mill Site		
R8	1.8	0.3
#4	0.2	0.2
#5	0.3	0.3
#6	0.2	0.2
#9	0.2	0.2
#11	0.6	0.6
#12	0.1	0.1
P2	20.8	1.4
Total Mine/Mill	24.2	3.3
TMA		
F27	4.2	3.7
F31	6.0	2.3
F32	0.6	0.5
F63	9.6	2.6
F64	4.5	4.2
F65	2.5	2.5
F66	16.2	16.2
F31	6.0	2.3
M3	4.2	1.7
#18	1.2	1.2
#19	0.1	0.1
#20	1.0	1.0
Total TMA	56.1	38.3

Note: CMC proposes to delineate and map wetlands 5 and P2 in the mine/mill site, and wetlands F65, F64, and M3 in the TMA.

---

[1] Acreage taken from Table 1 - Letter dated March 25, 1994 to Mr. Michael F. O'Keefe

[2] Preliminary acreage estimate based on planimetry.

Attachment 2

Data Form
Routine Wetland Determination
(1987 COE Wetlands Delineation Manual)

Project/Site:	Crandon Mine Site	Date: 8/25/94
Applicant/Owner:	Crandon Mining Company	County: Forest
Investigator:	Ron Steg/Brad Helmandollar	State: WI

Do Normal Circumstances exist on the site?	[✓ Yes] No	Wetland ID: M3
Is the site significantly disturbed (Atypical Situation)?	Yes [✓ No]	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes [✓ No]	Plot ID: 1A

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Acer saccharum* *	trees	FACU	9. *Viola spp.*	herb	
2. *Tsuga canadensis*	tree	FACU	10. *Aster macrophyllus*	herb	N/A
3. *Abies balsamen*	tree	FACW	11.		
4. *Betula papyrifera*	tree	FACU+	12.		
5. *Balleghaniensis*	tree	FAC	13.		
6. *Acer saccharum*	shrub	FACU	14.		
7. *Lycopodium obscurum* *	herbs	FACU	15.		
8. *Lycopodium annotonum*	herbs	FAC	16.		

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC). < 50%

* = dominant species

Remarks:

HYDROLOGY

____ Recorded Data (Describe in Remarks):

☐ Stream, Lake or Tide Gauge
☐ Aerial Photographs
☐ Other

X No Recorded Data Available

Wetland Hydrology Indicators:

☐ Water Stained/Silt Covered Leaves
☐ Drift Lines
☐ High Water Marks
☐ Sand/Silt Deposits
☐ Swollen Tree Bases
☐ Exposed Roots
☐ Periodically Flooded Channels/Depressions

Field Observations:

Depth of Surface Water NA (in.)
Depth of Free Water in Pit NA (in.)
Depth of Saturated Soil NA (in.)

Remarks: No hydrology indicators

Map Unit Name (Series and Phase): *

Drainage Class: *

Field Observations Confirm Mapped Type? Yes No

Profile Description:

Depth (inches)	Matrix Color (Munsel Notation)	Mottle Colors (Munsel Notation)	Mottle Abundance	Soil Texture/ Type
0-8"	10 YR 3/6			sandy loam
8-24"	10 YR 4/4			sandy loam

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic Odor
- ☐ Aquic Moisture Regime
- ☐ Reducing Conditions
- ☐ Gleyed or Low Chroma
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soil
- ☐ Organic Streaking in Sandy Soil
- ☐ Listed on Local Hydric Soils List
- ☐ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

Remarks: No hydric indicators

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes [✓ No]
Wetland Hydrology Present? Yes [✓ No]
Hydric Soils Present? Yes [✓ No]

Is this Sampling Point Within a Wetland? Yes [✓ No]

Remarks:

* Forest County Soil Survey Not Complete

Data Form
Routine Wetland Determination
(1987 COE Wetlands Delineation Manual)

Project/Site:	Crandon Mine Site	Date: 8/25/94
Applicant/Owner:	Crandon Mining Company	County: Forest
Investigator:	Ron Steg/Brad Helmandollar	State: WI

Do Normal Circumstances exist on the site?	[✓ Yes] No	Wetland ID: M3
Is the site significantly disturbed (Atypical Situation)?	Yes [✓ No]	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes [✓ No]	Plot ID: 1B

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Acer rubrum* *	tree	FAC	9. *Dryopteris spp.*	herb	
2. *Betula alleghaniensis*	tree	FAC	10. *Cornus canadensus*	herb	FAC
3. *Populus tremuloides* *	tree	FAC	11. *Osmonda cinnamomea*	herb	FACW
4. *Acer rubrum*	shrub	FAC	12.		
5. *Betula alleghaniensis*	shrub	FAC	13.		
6. *Abies balsamea*	shrub	FACW	14.		
7. *Picea mariana*	shrub	FACW	15.		
8. *Sphagnum magellanicum*	herb	OBL	16.		

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC). 100%

* = dominant species

Remarks:

HYDROLOGY

_____ Recorded Data (Describe in Remarks):

☐ Stream, Lake or Tide Gauge
☐ Aerial Photographs
☐ Other

_X_ No Recorded Data Available

Wetland Hydrology Indicators:

☒ Water Stained/Silt Covered Leaves
☐ Drift Lines
☐ High Water Marks
☐ Sand/Silt Deposits
☐ Swollen Tree Bases
☐ Exposed Roots
☒ Periodically Flooded Channels/Depressions

Field Observations:
Depth of Surface Water _NA_ (in.)
Depth of Free Water in Pit _NA_ (in.)
Depth of Saturated Soil _NA_ (in.)

Remarks:

Map Unit Name * (Series and Phase):

Drainage Class: *

Field Observations Confirm Mapped Type? Yes No

Profile Description:

Depth (inches)	Matrix Color (Munsel Notation)	Mottle Colors (Munsel Notation)	Mottle Abundance	Soil Texture/ Type
0-10"	10 YR 2/1			organic
10-20"	10 YR 2/1			organic
20-24"	2.5 YR 5/2	7.5 YR 4/6		silt loam

Hydric Soil Indicators:

☐ Histosol
☒ Histic Epipedon
☐ Sulfidic Odor
☐ Aquic Moisture Regime
☐ Reducing Conditions
☐ Gleyed or Low Chroma

☐ Concretions
☐ High Organic Content in Surface Layer in Sandy Soil
☐ Organic Streaking in Sandy Soil
☒ Listed on Local Hydric Soils List
☐ Listed on National Hydric Soils List
☐ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? [✓ Yes] No
Wetland Hydrology Present? [✓ Yes] No
Hydric Soils Present? [✓ Yes] No

Is this Sampling Point Within a Wetland? [✓ Yes] No

Remarks:

* Forest County Soil Survey Not Complete

Data Form
Routine Wetland Determination
(1987 COE Wetlands Delineation Manual)

Project/Site:	Crandon Mine Site	Date:	8/24/94
Applicant/Owner:	Crandon Mining Company	County:	Forest
Investigator:	Ron Steg/Brad Helmandollar	State:	WI

Do Normal Circumstances exist on the site?	[✓ Yes] No	Wetland ID:	M3
Is the site significantly disturbed (Atypical Situation)?	Yes [✓ No]	Transect ID:	
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes [✓ No]	Plot ID:	2A

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Acer rubrum* *	tree	FAC	9. *Aralia nudicaulis*	herb	FACU
2. *Popolus tremuloides* *	tree	FAC	10. *Coptis trifola*	herb	FACW
3. *Betula alleghaniensis*	tree	FAC	11. *Lycopodium locidolom*	herb	FAC+
4. *Prunus serotina*	tree	FACU	12. *Cornus canadensis*	herb	FAC
5. *Abies balsamea*	shrub	FACW	13. *Dryopteris spp.*	herb	
6. *Acer saccharum*	shrub	FACU	14.		
7. *Acer rubrum*	shrub	FAC	15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC). < 50%

* = dominant species

Remarks:

HYDROLOGY

______ Recorded Data (Describe in Remarks):

- ☐ Stream, Lake or Tide Gauge
- ☐ Aerial Photographs
- ☐ Other

X No Recorded Data Available

Wetland Hydrology Indicators:

- ☐ Water Stained/Silt Covered Leaves
- ☐ Drift Lines
- ☐ High Water Marks
- ☐ Sand/Silt Deposits
- ☐ Swollen Tree Bases
- ☐ Exposed Roots
- ☐ Periodically Flooded Channels/Depressions

Field Observations:

Depth of Surface Water NA (in.)
Depth of Free Water in Pit NA (in.)
Depth of Saturated Soil NA (in.)

Remarks: Sloping topography toward wetland
No indicators or wetland hydrology

Map Unit Name * (Series and Phase):	Drainage Class: * Field Observations Confirm Mapped Type? Yes No

Profile Description:

Depth (inches)	Matrix Color (Munsel Notation)	Mottle Colors (Munsel Notation)	Mottle Abundance	Soil Texture/ Type
0-20"	10 YR 3/6			sandy loam

Hydric Soil Indicators:

☐ Histosol
☐ Histic Epipedon
☐ Sulfidic Odor
☐ Aquic Moisture Regime
☐ Reducing Conditions
☐ Gleyed or Low Chroma

☐ Concretions
☐ High Organic Content in Surface Layer in Sandy Soil
☐ Organic Streaking in Sandy Soil
☐ Listed on Local Hydric Soils List
☐ Listed on National Hydric Soils List
☐ Other (Explain in Remarks)

Remarks: No hydric indicators

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes [✓ No]
Wetland Hydrology Present? Yes [✓ No]
Hydric Soils Present? Yes [✓ No]

Is this Sampling Point Within a Wetland? Yes [✓ No]

Remarks: Plot located adjacent to Flag 15

* Forest County Soil Survey Not Complete

Data Form
Routine Wetland Determination
(1987 COE Wetlands Delineation Manual)

Project/Site: Crandon Mine Site
Date: 8/24/94
Applicant/Owner: Crandon Mining Company
County: Forest
Investigator: Ron Steg/Brad Helmandollar
State: WI

Do Normal Circumstances exist on the site? [✓ Yes] No
Wetland ID: M3
Is the site significantly disturbed (Atypical Situation)? Yes [✓ No]
Transect ID:
Is the area a potential Problem Area? Yes [✓ No]
(If needed, explain on reverse.)
Plot ID: 2B

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Acer rubrum* *	tree	FAC	9.		
2. *Populus tremuloides* *	tree	FAC	10.		
3. *Acer rubrum*	shrub	FAC	11.		
4. *Dryopterus spp.*	herb		12.		
5. *Lycopdium obscurum*	herb	FACU	13.		
6. *Coptis trifola*	herb	FACW	14.		
7. *Lycopodium annotinum*	herb	FAC	15.		
8. *Acer saccharum*	herb	FACU	16.		

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC). 75%

* = dominant species

Remarks:

HYDROLOGY

____ Recorded Data (Describe in Remarks):

☐ Stream, Lake or Tide Gauge
☐ Aerial Photographs
☐ Other

_X_ No Recorded Data Available

Wetland Hydrology Indicators:
☒ Water Stained/Silt Covered Leaves
☐ Drift Lines
☐ High Water Marks
☐ Sand/Silt Deposits
☐ Swollen Tree Bases
☐ Exposed Roots
☒ Periodically Flooded Channels/Depressions

Field Observations:
Depth of Surface Water _NA_ (in.)
Depth of Free Water in Pit _NA_ (in.)
Depth of Saturated Soil _NA_ (in.)

Remarks:

Map Unit Name *
(Series and Phase):

Drainage Class: *

Field Observations Confirm Mapped Type? Yes No

Profile Description:

Depth (inches)	Matrix Color (Munsel Notation)	Mottle Colors (Munsel Notation)	Mottle Abundance	Soil Texture/ Type
0-24"	10 YR 7/2	10 YR 5/8	minor	clay loam

Hydric Soil Indicators:

☐ Histosol
☐ Histic Epipedon
☐ Sulfidic Odor
☐ Aquic Moisture Regime
☐ Reducing Conditions
☒ Gleyed or [✓ Low Chroma]

☐ Concretions
☐ High Organic Content in Surface Layer in Sandy Soil
☐ Organic Streaking in Sandy Soil
☐ Listed on Local Hydric Soils List
☐ Listed on National Hydric Soils List
☐ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? [✓ Yes] No
Wetland Hydrology Present? [✓ Yes] No
Hydric Soils Present? [✓ Yes] No

Is this Sampling Point Within a Wetland? [✓ Yes] No

Remarks:

* Forest County Soil Survey Not Complete

Data Form
Routine Wetland Determination
(1987 COE Wetlands Delineation Manual)

Project/Site:	Crandon Mine Site	Date: 8/25/94
Applicant/Owner:	Crandon Mining Company	County: Forest
Investigator:	Ron Steg/Brad Helmandollar	State: WI

Do Normal Circumstances exist on the site?	[✓ Yes] No	Wetland ID: M3
Is the site significantly disturbed (Atypical Situation)?	Yes [✓ No]	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes [✓ No]	Plot ID: 2C

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Acer rubrum* *	tree	FAC	9. *Sphagnum spp.*	herb	OBL
2. *Betula alleghaniensis*	tree	FAC	10.		
3. *Tsuga canadensis*	tree	FACU+	11.		
4. *Populus tremuloides*	tree	FAC	12.		
5. *Acer rubrum*	shrub	FAC	13.		
6. *Betula alleghaniensis*	shrub	FAC	14.		
7. *Dryopteris Spp*	herb		15.		
8. *Trientalis borealis*	herb	FAC+	16.		

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC). 90%

* = dominant species

Remarks:

HYDROLOGY

______ Recorded Data (Describe in Remarks):

☐ Stream, Lake or Tide Gauge
☐ Aerial Photographs
☐ Other

_X_ No Recorded Data Available

Wetland Hydrology Indicators:

☒ Water Stained/Silt Covered Leaves
☐ Drift Lines
☐ High Water Marks
☐ Sand/Silt Deposits
☐ Swollen Tree Bases
☒ Exposed Roots
☒ Periodically Flooded Channels/Depressions

Field Observations:

Depth of Surface Water _NA_ (in.)
Depth of Free Water in Pit _NA_ (in.)
Depth of Saturated Soil _NA_ (in.)

Remarks:

Map Unit Name *
(Series and Phase):

Drainage Class: *

Field Observations Confirm Mapped Type? Yes No

Profile Description:

Depth (inches)	Matrix Color (Munsel Notation)	Mottle Colors (Munsel Notation)	Mottle Abundance	Soil Texture/ Type
0-24"	7.5 YR 6/2	7.5 YR 5/8	moderate	sandy loam

Hydric Soil Indicators:

☐ Histosol
☐ Histic Epipedon
☐ Sulfidic Odor
☐ Aquic Moisture Regime
☐ Reducing Conditions
☒ Gleyed or [✓ Low Chroma]
☐ Concretions
☐ High Organic Content in Surface Layer in Sandy Soil
☐ Organic Streaking in Sandy Soil
☐ Listed on Local Hydric Soils List
☐ Listed on National Hydric Soils List
☐ Other (Explain in Remarks)

Remarks: Basis-mottles and low chroma

WETLAND DETERMINATION

Hydrophytic Vegetation Present? [✓ Yes] No
Wetland Hydrology Present? [✓ Yes] No
Hydric Soils Present? [✓ Yes] No

Is this Sampling Point Within a Wetland? [✓ Yes] No

Remarks: Basis - edge of sphagnom, clear topography
Plot located adjacent to Flag 15

* Forest County Soil Survey Not Complete

57 Flags Total

Data Form
Routine Wetland Determination
(1987 COE Wetlands Delineation Manual)

Project/Site:	Crandon Mine Site	Date: 8/25/94
Applicant/Owner:	Crandon Mining Company	County: Forest
Investigator:	Ron Steg/Brad Helmandollar	State: WI

Do Normal Circumstances exist on the site?	[✓ Yes] No	Wetland ID: M3
Is the site significantly disturbed (Atypical Situation)?	Yes [✓ No]	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes [✓ No]	Plot ID: 2D

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Tsuga canadensis* *	tree	FACU+	9. *Triantalis borealis*	herbs	FAC+
2. *Betula alleghaniensis*	tree	FAC	10. *Streptopus roseus*	herb	FAC
3. *Populus tremuloides*	tree	FAC	11. *Clintonia borealis*	herbs	FAC+
4. *Acer rubrum*	tree	FAC	12. *Aralia nudicaulis*	herbs	FACU
5. *Acer saccharum*	tree	FACU	13.		
6. *Acer rubrum* *	shrub	FAC	14.		
7. *Acer saccharum*	shrub	FACU	15.		
8. *Dryoptens spp*	herb		16.		

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC). < 50%

* = dominant species

Remarks: Hemlock is the dominant plant species

HYDROLOGY

___ Recorded Data (Describe in Remarks):

☐ Stream, Lake or Tide Gauge
☐ Aerial Photographs
☐ Other

_X_ No Recorded Data Available

Wetland Hydrology Indicators:

☐ Water Stained/Silt Covered Leaves
☐ Drift Lines
☐ High Water Marks
☐ Sand/Silt Deposits
☐ Swollen Tree Bases
☐ Exposed Roots
☐ Periodically Flooded Channels/Depressions

Field Observations:

Depth of Surface Water _NA_ (in.)
Depth of Free Water in Pit _NA_ (in.)
Depth of Saturated Soil _NA_ (in.)

Remarks: No indication of hydrology

Map Unit Name * (Series and Phase):	Drainage Class: * Field Observations Confirm Mapped Type? Yes No

Profile Description:

Depth (inches)	Matrix Color (Munsel Notation)	Mottle Colors (Munsel Notation)	Mottle Abundance	Soil Texture/ Type
0-24"	10 YR 6/4			silty-loam

Hydric Soil Indicators:

☐ Histosol
☐ Histic Epipedon
☐ Sulfidic Odor
☐ Aquic Moisture Regime
☐ Reducing Conditions
☐ Gleyed or Low Chroma

☐ Concretions
☐ High Organic Content in Surface Layer in Sandy Soil
☐ Organic Streaking in Sandy Soil
☐ Listed on Local Hydric Soils List
☐ Listed on National Hydric Soils List
☐ Other (Explain in Remarks)

Remarks: No indication of hydric soils

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes [✓ No] Wetland Hydrology Present? Yes [✓ No] Hydric Soils Present? Yes [✓ No]	Is this Sampling Point Within a Wetland? Yes [✓ No]

Remarks: Plot located adjacent to Flag 57

* Forest County Soil Survey Not Complete

Data Form
Routine Wetland Determination
(1987 COE Wetlands Delineation Manual)

Project/Site:	Crandon Mine Site	Date: 8/25/94
Applicant/Owner:	Crandon Mining Company	County: Forest
Investigator:	Ron Steg/Brad Helmandollar	State: WI

Do Normal Circumstances exist on the site?	Yes	No	Wetland ID: M3
Is the site significantly disturbed (Atypical Situation)?	Yes	No	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes	No	Plot ID: 3A

VEGETATION

Dominant Plant Species	~~Stratum~~	~~Indicator~~	~~Dominant Plant Species~~	~~Stratum~~	Indicator
1. *Acer saccharum*	tree	FACU	9. *Dryopteris Spp.*	herb	
2. *Tsuga canadensis*	tree	FACU+	10. *Acer saccarinum*	sapling	FACU
3. *Betula alleghaniensis*	tree	FAC	11.		
4. *Abies balsamea*	tree	FACW	12.		
5. *Acer saccharum*	shrub	FACU	13.		
6. *Ulmus americana*	shrub	FALW-	14.		
7. *Lycopodium obscurum*	shrub	FALU	15.		
8. *Aralia nudicaulis*	shrub	FACU	16.		

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC). * = dominant species

Remarks:

HYDROLOGY

____ Recorded Data (Describe in Remarks):

☐ Stream, Lake or Tide Gauge
☐ Aerial Photographs
☐ Other

_X_ No Recorded Data Available

Wetland Hydrology Indicators:

☐ Water Stained/Silt Covered Leaves
☐ Drift Lines
☐ High Water Marks
☐ Sand/Silt Deposits
☐ Swollen Tree Bases
☐ Exposed Roots
☐ Periodically Flooded Channels/Depressions

Field Observations:

Depth of Surface Water _NA_ (in.)
Depth of Free Water in Pit _NA_ (in.)
Depth of Saturated Soil _NA_ (in.)

Remarks:

Map Unit Name * (Series and Phase):	Drainage Class: * Field Observations Confirm Mapped Type? Yes No

Profile Description:

Depth (inches)	Matrix Color (Munsel Notation)	Mottle Colors (Munsel Notation)	Mottle Abundance	Soil Texture/ Type
0-4"				Organic
4-12"	7.5 YR 6/8			Sandy Loam
12-24"	10 YR 6/4			Sandy Loam

Hydric Soil Indicators:

☐ Histosol
☐ Histic Epipedon
☐ Sulfidic Odor
☐ Aquic Moisture Regime
☐ Reducing Conditions
☐ Gleyed or Low Chroma

☐ Concretions
☐ High Organic Content in Surface Layer in Sandy Soil
☐ Organic Streaking in Sandy Soil
☐ Listed on Local Hydric Soils List
☐ Listed on National Hydric Soils List
☐ Other (Explain in Remarks)

Remarks: No hydric indicators

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes [✓ No]
Wetland Hydrology Present? Yes [✓ No]
Hydric Soils Present? Yes [✓ No]

Is this Sampling Point Within a Wetland? Yes [✓ No]

Remarks:

* Forest County Soil Survey Not Complete

Data Form
Routine Wetland Determination
(1987 COE Wetlands Delineation Manual)

Project/Site:	Crandon Mine Site	Date: 8/25/94
Applicant/Owner:	Crandon Mining Company	County: Forest
Investigator:	Ron Steg/Brad Helmandollar	State: WI

Do Normal Circumstances exist on the site? [✓ Yes] No	Wetland ID: M3
Is the site significantly disturbed (Atypical Situation)? Yes [✓ No]	Transect ID:
Is the area a potential Problem Area? Yes [✓ No] (If needed, explain on reverse.)	Plot ID: 3B

VEGETATION

Dominant Plant Species	Stratum	~~Indicator~~	~~Dominant Plant Species~~	Stratum	Indicator
1. *Fraxinus nigra* *	tree	FACW+	9. *Dryopteris Spp.*		
2. *Betula alleghaniensis*	tree	FAC	10. *Impatiens capensis*	herb	FACW
3. *Populus tremuloides*	tree	FAC	11. *Scutellaria Spp.*		
4. *Ulmus americana*	tree	FACW-	12.		
5. *Fraxinus nigra*	shrub	FACW+	13.		
6. *Nemopanthis mucronata*	shrub	OBL	14.		
7. *Betula alleghaniensis*	shrub	FAC	15.		
8. *Calamogrostis canadensis*	herb	OBL	16.		

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC). 100%

* = dominant species

Remarks:

HYDROLOGY

____ Recorded Data (Describe in Remarks):

☐ Stream, Lake or Tide Gauge
☐ Aerial Photographs
☐ Other

_X_ No Recorded Data Available

Wetland Hydrology Indicators:
☐ Water Stained/Silt Covered Leaves
☐ Drift Lines
☐ High Water Marks
☐ Sand/Silt Deposits
☐ Swollen Tree Bases
☐ Exposed Roots
☐ Periodically Flooded Channels/Depressions

Field Observations:
Depth of Surface Water _NA_ (in.)
Depth of Free Water in Pit _NA_ (in.)
Depth of Saturated Soil _NA_ (in.)

Remarks: Sloping topography

Map Unit Name * (Series and Phase):	Drainage Class: * Field Observations Confirm Mapped Type? Yes No

Profile Description:

Depth (inches)	Matrix Color (Munsel Notation)	Mottle Colors (Munsel Notation)	Mottle Abundance	Soil Texture/ Type
0-4"				O.M.
4-24"	10 YR 5/1			

Hydric Soil Indicators:

☐ Histosol

☐ Histic Epipedon

☐ Sulfidic Odor

☐ Aquic Moisture Regime

☐ Reducing Conditions

☒ Gleyed or [✓ Low Chroma]

☐ Concretions

☐ High Organic Content in Surface Layer in Sandy Soil

☐ Organic Streaking in Sandy Soil

☐ Listed on Local Hydric Soils List

☐ Listed on National Hydric Soils List

☐ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? [✓ Yes] No
Wetland Hydrology Present? [✓ Yes] No
Hydric Soils Present? [✓ Yes] No

Is this Sampling Point Within a Wetland? [✓ Yes] No

Remarks:

* Forest County Soil Survey Not Complete

Data Form
Routine Wetland Determination
(1987 COE Wetlands Delineation Manual)

Project/Site:	Crandon Mine Site	Date: 8/25/94
Applicant/Owner:	Crandon Mining Company	County: Forest
Investigator:	Ron Steg/Brad Helmandollar	State: WI

Do Normal Circumstances exist on the site?	[✓ Yes] No	Wetland ID: F64
Is the site significantly disturbed (Atypical Situation)?	Yes [✓ No]	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes [✓ No]	Plot ID: 1A

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Betula alleghaniensis*	tree	FAC	9.		
2. *Acer saccharum* *	tree	FACU	10.		
3. *Abies balsamea*	tree	FACW	11.		
4. *Abies balsamea* *	shrub	FAC	12.		
5. *Acer saccarinum*	shrub	FACU	13.		
6. *Aralia nudicaulis*	herb	FACU	14.		
7. *Lycopodium obscurum*	herb	FACU	15.		
8. *Lycopodium claratum*	herb	FAC	16.		

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC). < 50%

* = dominant species

Remarks:

HYDROLOGY

____ Recorded Data (Describe in Remarks):

- ☐ Stream, Lake or Tide Gauge
- ☐ Aerial Photographs
- ☐ Other

__X__ No Recorded Data Available

Wetland Hydrology Indicators:

- ☐ Water Stained/Silt Covered Leaves
- ☐ Drift Lines
- ☐ High Water Marks
- ☐ Sand/Silt Deposits
- ☐ Swollen Tree Bases
- ☐ Exposed Roots
- ☐ Periodically Flooded Channels

Field Observations:

Depth of Surface Water __NA__ (in.)
Depth of Free Water in Pit __NA__ (in.)
Depth of Saturated Soil __NA__ (in.)

Remarks:

Map Unit Name (Series and Phase): *

Drainage Class: *

Field Observations Confirm Mapped Type? Yes No

Profile Description:

Depth (inches)	Matrix Color (Munsel Notation)	Mottle Colors (Munsel Notation)	Mottle Abundance	Soil Texture/ Type
0-24"	7.5 YR 5/8			sandy loam

Hydric Soil Indicators:

☐ Histosol
☐ Histic Epipedon
☐ Sulfidic Odor
☐ Aquic Moisture Regime
☐ Reducing Conditions
☐ Gleyed or Low Chroma

☐ Concretions
☐ High Organic Content in Surface Layer in Sandy Soil
☐ Organic Streaking in Sandy Soil
☐ Listed on Local Hydric Soils List
☐ Listed on National Hydric Soils List
☐ Other (Explain in Remarks)

Remarks: No hydric indicators

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes [✓ No]
Wetland Hydrology Present? Yes [✓ No]
Hydric Soils Present? Yes [✓ No]

Is this Sampling Point Within a Wetland? Yes [✓ No]

Remarks:

* Forest County Soil Survey Not Complete

Data Form
Routine Wetland Determination
(1987 COE Wetlands Delineation Manual)

Project/Site:	Crandon Mine Site	Date: 8/25/94
Applicant/Owner:	Crandon Mining Company	County: Forest
Investigator:	Ron Steg/Brad Helmandollar	State: WI

Do Normal Circumstances exist on the site?	[✓ Yes] No	Wetland ID: F64
Is the site significantly disturbed (Atypical Situation)?	Yes [✓ No]	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes [✓ No]	Plot ID: 1B

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Acer rubrum* *	tree	FAC	9.		
2. *Betula alleghaniensis*	tree	FAC	10.		
3. *Carex intumescens* *	herb	FACW+	11.		
4. *Bidens connata*	herb	OBL	12.		
5. *Scotilaria lateriflora*	herb	OBL	13.		
6. *Sphagnum magellanicum*			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC). 100%

* = dominant species

Remarks: Trees and saplings only around periphery

HYDROLOGY

______ Recorded Data (Describe in Remarks):

☐ Stream, Lake or Tide Gauge
☐ Aerial Photographs
☐ Other

__X__ No Recorded Data Available

Wetland Hydrology Indicators:

☒ Water Stained/Silt Covered Leaves
☐ Drift Lines
☒ High Water Marks
☐ Sand/Silt Deposits
☐ Swollen Tree Bases
☐ Exposed Roots
☐ Periodically Flooded Channels/Depressions

Field Observations:

Depth of Surface Water __1__ (in.)
Depth of Free Water in Pit __0__ (in.)
Depth of Saturated Soil __0__ (in.)

Remarks: Plot located in a periodically flooded depression

Map Unit Name *
(Series and Phase):

Drainage Class: *

Field Observations Confirm Mapped Type? Yes No

Profile Description:

Depth (inches)	Matrix Color (Munsel Notation)	Mottle Colors (Munsel Notation)	Mottle Abundance	Soil Texture/ Type
0-10"	5 Y 5/1			wet sand
0-20"	10 YR 4/4			silty clay

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic Odor
- ☐ Aquic Moisture Regime
- ☐ Reducing Conditions
- ☒ [✓ Gleyed] or Low Chroma
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soil
- ☐ Organic Streaking in Sandy Soil
- ☐ Listed on Local Hydric Soils List
- ☐ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? [✓ Yes] No
Wetland Hydrology Present? [✓ Yes] No
Hydric Soils Present? [✓ Yes] No

Is this Sampling Point Within a Wetland? [✓ Yes] No

Remarks:

* Forest County Soil Survey Not Complete

Data Form
Routine Wetland Determination
(1987 COE Wetlands Delineation Manual)

Project/Site:	Crandon Mine Site	Date: 8/25/94
Applicant/Owner:	Crandon Mining Company	County: Forest
Investigator:	Ron Steg/Brad Helmandollar	State: WI

Do Normal Circumstances exist on the site?	[✓ Yes] No	Wetland ID: F64
Is the site significantly disturbed (Atypical Situation)?	Yes [✓ No]	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes [✓ No]	Plot ID: 1C

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Larix larcina* *	tree	FACW	9.		
2. *Picea mariana* *	tree	FACW	10.		
3. *Chamaedaphne calycalata*	shrub	OBL	11.		
4. *Pilea moriana*	shrub	FACW	12.		
5. *Larix larcina*	shrub	FACW	13.		
6. *Sphagrum spp.*	herb	OBL	14.		
7. *Carex spp.*	herb		15.		
8. *Iris versicolor*	herb	OBL	16.		

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC). 100%

* = dominant species

Remarks:

HYDROLOGY

____ Recorded Data (Describe in Remarks):

☐ Stream, Lake or Tide Gauge
☐ Aerial Photographs
☐ Other

_X_ No Recorded Data Available

Wetland Hydrology Indicators:
☐ Water Stained/Silt Covered Leaves
☐ Drift Lines
☐ High Water Marks
☐ Sand/Silt Deposits
☐ Swollen Tree Bases
☐ Exposed Roots
☐ Periodically Flooded Channels/Depressions

Field Observations:
Depth of Surface Water _NA_ (in.)
Depth of Free Water in Pit _0_ (in.)
Depth of Saturated Soil _0_ (in.)

Remarks: Landscape position clearly indicates hydrology

Map Unit Name *
(Series and Phase):

Drainage Class: *

Field Observations Confirm Mapped Type? Yes No

Profile Description:

Depth (inches)	Matrix Color (Munsel Notation)	Mottle Colors (Munsel Notation)	Mottle Abundance	Soil Texture/ Type
0-24"				peat

Hydric Soil Indicators:

☒ Histosol
☐ Histic Epipedon
☐ Sulfidic Odor
☐ Aquic Moisture Regime
☐ Reducing Conditions
☐ Gleyed or Low Chroma

☐ Concretions
☐ High Organic Content in Surface Layer in Sandy Soil
☐ Organic Streaking in Sandy Soil
☐ Listed on Local Hydric Soils List
☐ Listed on National Hydric Soils List
☐ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? [✓ Yes] No
Wetland Hydrology Present? [✓ Yes] No
Hydric Soils Present? [✓ Yes] No

Is this Sampling Point Within a Wetland? [✓ Yes] No

Remarks:

* Forest County Soil Survey Not Complete

Data Form
Routine Wetland Determination
(1987 COE Wetlands Delineation Manual)

Project/Site:	Crandon Mine Site	Date: 8/25/94
Applicant/Owner:	Crandon Mining Company	County: Forest
Investigator:	Ron Steg/Brad Helmandollar	State: WI

Do Normal Circumstances exist on the site? [✓ Yes] No	Wetland ID: F65
Is the site significantly disturbed (Atypical Situation)? Yes [✓ No]	Transect ID:
Is the area a potential Problem Area? Yes [✓ No] (If needed, explain on reverse.)	Plot ID: 1A

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Acer saccharum* *	tree	FACU	9.		
2. *Populus tremuloides*	tree	FAC	10.		
3. *Fraxinus nigra*	tree	FACW+	11.		
4. *Abies balsamea*	shrub	FACW	12.		
5. *Acer saccharum* *	shrub	FACU	13.		
6. *Lycopodium obscurum*	herb	FACU	14.		
7. *Athyrium Felix-femina*	herb	FAC	15.		
8. *Aralia nudicaulis*	herb	FACU	16.		

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC). < 50%

* = dominant species

Remarks: Dominants are upland plants

HYDROLOGY

_____ Recorded Data (Describe in Remarks):

- ☐ Stream, Lake or Tide Gauge
- ☐ Aerial Photographs
- ☐ Other

_X_ No Recorded Data Available

Wetland Hydrology Indicators:

- ☐ Water Stained/Silt Covered Leaves
- ☐ Drift Lines
- ☐ High Water Marks
- ☐ Sand/Silt Deposits
- ☐ Swollen Tree Bases
- ☐ Exposed Roots
- ☐ Periodically Flooded Channels/Depressions

Field Observations:

Depth of Surface Water _NA_ (in.)
Depth of Free Water in Pit _NA_ (in.)
Depth of Saturated Soil _NA_ (in.)

Remarks: Sloping topography

Map Unit Name *
(Series and Phase):

Drainage Class: *

Field Observations Confirm Mapped Type? Yes No

Profile Description:

Depth (inches)	Matrix Color (Munsel Notation)	Mottle Colors (Munsel Notation)	Mottle Abundance	Soil Texture/ Type
0-24"	10 YR 3/6			sandy loam

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic Odor
- ☐ Aquic Moisture Regime
- ☐ Reducing Conditions
- ☐ Gleyed or Low Chroma
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soil
- ☐ Organic Streaking in Sandy Soil
- ☐ Listed on Local Hydric Soils List
- ☐ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

Remarks: No indicators of hydric soils

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes [✓ No]
Wetland Hydrology Present? Yes [✓ No]
Hydric Soils Present? Yes [✓ No]

Is this Sampling Point Within a Wetland? Yes [✓ No]

Remarks:

* Forest County Soil Survey Not Complete

Data Form
Routine Wetland Determination
(1987 COE Wetlands Delineation Manual)

Project/Site:	Crandon Mine Site	Date: 8/25/94
Applicant/Owner:	Crandon Mining Company	County: Forest
Investigator:	Ron Steg/Brad Helmandollar	State: WI

Do Normal Circumstances exist on the site? [✓ Yes] No	Wetland ID: F65
Is the site significantly disturbed (Atypical Situation)? Yes [✓ No]	Transect ID:
Is the area a potential Problem Area? Yes [✓ No] (If needed, explain on reverse.)	Plot ID: 1B

VEGETATION

Dominant Plant Species	~~Stratum~~	~~Indicator~~	~~Dominant Plant Species~~	~~Stratum~~	Indicator
1. *Fraxinus nigra* *	tree	FACW+	9. *Dryopteris spinulosa*	herb	FACW
2. *Acer rubrum* *	tree	FAC	10.		
3. *Betula alleghaniensis*	tree	FAC	11.		
4. *Abies balsamea*	tree	FACW	12.		
5. *Abies balsamea*	shrub	FACW	13.		
6. *Nemopanthus mucronatus*	shrub	OBL	14.		
7. *Scutilaria laterafolia*	herb	OBL	15.		
8. *Sphagnum* spp.	herb	OBL	16.		

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC). 100%

* = dominant species

Remarks:

HYDROLOGY

_____ Recorded Data (Describe in Remarks):

☐ Stream, Lake or Tide Gauge
☐ Aerial Photographs
☐ Other

X No Recorded Data Available

Wetland Hydrology Indicators:
☒ Water Stained/Silt Covered Leaves
☐ Drift Lines
☐ High Water Marks
☐ Sand/Silt Deposits
☐ Swollen Tree Bases
☐ Exposed Roots
☒ Periodically Flooded Channels/Depressions

Field Observations:
Depth of Surface Water NA (in.)
Depth of Free Water in Pit NA (in.)
Depth of Saturated Soil NA (in.)

Remarks:

Map Unit Name * (Series and Phase):	Drainage Class: * Field Observations Confirm Mapped Type? Yes No

Profile Description:

Depth (inches)	Matrix Color (Munsel Notation)	Mottle Colors (Munsel Notation)	Mottle Abundance	Soil Texture/ Type
0-8"	2.5 Y 4/2			silty loam
8-24"	10 YR 5/8	2.5 Y 5/2		silty loam

Hydric Soil Indicators:

☐ Histosol
☐ Histic Epipedon
☐ Sulfidic Odor
☐ Aquic Moisture Regime
☐ Reducing Conditions
☒ Gleyed or [✓ Low Chroma]

☐ Concretions
☐ High Organic Content in Surface Layer in Sandy Soil
☐ Organic Streaking in Sandy Soil
☐ Listed on Local Hydric Soils List
☐ Listed on National Hydric Soils List
☐ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? [✓ Yes] No
Wetland Hydrology Present? [✓ Yes] No
Hydric Soils Present? [✓ Yes] No

Is this Sampling Point Within a Wetland? [✓ Yes] No

Remarks:

* Forest County Survey Not Complete

Data Form
Routine Wetland Determination
(1987 COE Wetlands Delineation Manual)

Project/Site: Crandon Mine Site	Date: 8/25/94
Applicant/Owner: Crandon Mining Company	County: Forest
Investigator: Ron Steg/Brad Helmandollar	State: WI

Do Normal Circumstances exist on the site? [✓ Yes] No	Wetland ID: F65
Is the site significantly disturbed (Atypical Situation)? Yes [✓ No]	Transect ID:
Is the area a potential Problem Area? Yes [✓ No] (If needed, explain on reverse.)	Plot ID: 1C

VEGETATION

Dominant Plant Species	Stratum	Indicator	~~Dominant Plant Species~~	~~Stratum~~	Indicator
1. *Acer rubrum* *	tree	FAC	9.		
2. *Populus tremuloides*	tree	FAC	10.		
3. *Salix spp.* *	shrub		11.		
4. *Acer rubrum*	shrub	FAC	12.		
5. *Spirea alba*	herb	FACW+	13.		
6. *Sphagnum spp.*	herb	OBL	14.		
7. *Scirpus cyperinus*	herb	OBL	15.		
8. *Calamagrostis canadensis*	herb	OBL	16.		

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC). 100%

* = dominant species

Remarks:

HYDROLOGY

_____ Recorded Data (Describe in Remarks):

- ☐ Stream, Lake or Tide Gauge
- ☐ Aerial Photographs
- ☐ Other

X No Recorded Data Available

Wetland Hydrology Indicators:

- ☒ Water Stained/Silt Covered Leaves
- ☐ Drift Lines
- ☐ High Water Marks
- ☐ Sand/Silt Deposits
- ☐ Swollen Tree Bases
- ☐ Exposed Roots
- ☒ Periodically Flooded Channels/Depressions

Field Observations:

Depth of Surface Water NA (in.)
Depth of Free Water in Pit NA (in.)
Depth of Saturated Soil NA (in.)

Remarks:

Map Unit Name *
(Series and Phase):

Drainage Class: *

Field Observations Confirm Mapped Type? Yes No

Profile Description:

Depth (inches)	Matrix Color (Munsel Notation)	Mottle Colors (Munsel Notation)	Mottle Abundance	Soil Texture/ Type
0-6"	2.5 YR 3/2			silty loam
6-24"	10 YR 4/6	5 Y 5/1	moderate	silty loam

Hydric Soil Indicators:

☐ Histosol
☐ Histic Epipedon
☐ Sulfidic Odor
☐ Aquic Moisture Regime
☐ Reducing Conditions
☒ Gleyed or [✓ Low Chroma]

☐ Concretions
☐ High Organic Content in Surface Layer in Sandy Soil
☐ Organic Streaking in Sandy Soil
☐ Listed on Local Hydric Soils List
☐ Listed on National Hydric Soils List
☐ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? [✓ Yes] No
Wetland Hydrology Present? [✓ Yes] No
Hydric Soils Present? [✓ Yes] No

Is this Sampling Point Within a Wetland? [✓ Yes] No

Remarks: Plot located adjacent to Flag 50

* Forest County Soil Survey Not Complete

Data Form
Routine Wetland Determination
(1987 COE Wetlands Delineation Manual)

Project/Site:	Crandon Mine Site	Date: 8/25/94
Applicant/Owner:	Crandon Mining Company	County: Forest
Investigator:	Ron Steg/Brad Helmandollar	State: WI

Do Normal Circumstances exist on the site? [✓ Yes] No	Wetland ID: F65
Is the site significantly disturbed (Atypical Situation)? Yes [✓ No]	Transect ID:
Is the area a potential Problem Area? Yes [✓ No] (If needed, explain on reverse.)	Plot ID: 2A

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Acer saccharum* *	tree	FACU	9. *Lycopdium obscurum*	herb	FACU
2. *Populus tremuloides*	tree	FAC	10. *Triantalis borealis*	herb	FAC+
3. *Acer rubrum*	tree	FAC	11.		
4. *Fraxinus americana*	shrub	FACU	12.		
5. *Abies balsamea*	shrub	FACW	13.		
6. *Acer saccharum* *	shrub	FACU	14.		
7. *Fraxinus nigra*	shrub	FACW+	15.		
8. *Aralia nudicaulis*	herb	FACU	16.		

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC). 50%

* = dominant species

Remarks: The dominant plants are upland plants

HYDROLOGY

_____ Recorded Data (Describe in Remarks):

☐ Stream, Lake or Tide Gauge
☐ Aerial Photographs
☐ Other

_X_ No Recorded Data Available

Wetland Hydrology Indicators:
☐ Water Stained/Silt Covered Leaves
☐ Drift Lines
☐ High Water Marks
☐ Sand/Silt Deposits
☐ Swollen Tree Bases
☐ Exposed Roots
☐ Periodically Flooded Channels/Depressions

Field Observations:
Depth of Surface Water _NA_ (in.)
Depth of Free Water in Pit _NA_ (in.)
Depth of Saturated Soil _NA_ (in.)

Remarks: Topography sloping towards wetland

Map Unit Name (Series and Phase): *

Drainage Class: *

Field Observations Confirm Mapped Type? Yes No

Profile Description:

Depth (inches)	Matrix Color (Munsel Notation)	Mottle Colors (Munsel Notation)	Mottle Abundance	Soil Texture/ Type
0-10"	10 YR 4/2			sandy loam
10-18"	10 YR 3/4			sandy loam

Hydric Soil Indicators:

☐ Histosol

☐ Histic Epipedon

☐ Sulfidic Odor

☐ Aquic Moisture Regime

☐ Reducing Conditions

☐ Gleyed or Low Chroma

☐ Concretions

☐ High Organic Content in Surface Layer in Sandy Soil

☐ Organic Streaking in Sandy Soil

☐ Listed on Local Hydric Soils List

☐ Listed on National Hydric Soils List

☐ Other (Explain in Remarks)

Remarks: No hydric soil indicators

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes [✓ No]

Wetland Hydrology Present? Yes [✓ No]

Hydric Soils Present? Yes [✓ No]

Is this Sampling Point Within a Wetland? Yes [✓ No]

Remarks:

* Forest County Soil Survey Not Complete

Data Form
Routine Wetland Determination
(1987 COE Wetlands Delineation Manual)

Project/Site:	Crandon Mine Site	Date: 8/25/94
Applicant/Owner:	Crandon Mining Company	County: Forest
Investigator:	Ron Steg/Brad Helmandollar	State: WI

Do Normal Circumstances exist on the site? [✓ Yes] No	Wetland ID: F65
Is the site significantly disturbed (Atypical Situation)? Yes [✓ No]	Transect ID:
Is the area a potential Problem Area? Yes [✓ No] (If needed, explain on reverse.)	Plot ID: 2B

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Acer rubrum* *	tree	FAC	9. *Scutilaria lateraflora*	herb	OBL
2. *Betula alleghaniensis*	tree	FAC	10.		
3. *Populus tremuloides*	tree	FAL	11.		
4. *Abies balsamea*	tree	FACW	12.		
5. *Acer rubrum* *	shrub	FAC	13.		
6. *Betula alleghaniensis*	shrub	FAC	14.		
7. *Abies balsamea*	shrub	FACW	15.		
8. *Spagnum spp.*	herb	OBL	16.		

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC). 100%

* = dominant species

Remarks:

HYDROLOGY

_____ Recorded Data (Describe in Remarks):

☐ Stream, Lake or Tide Gauge
☐ Aerial Photographs
☐ Other

__X__ No Recorded Data Available

Wetland Hydrology Indicators:

☒ Water Stained/Silt Covered Leaves
☐ Drift Lines
☐ High Water Marks
☐ Sand/Silt Deposits
☐ Swollen Tree Bases
☒ Exposed Roots
☒ Periodically Flooded Channels/depressions

Field Observations:

Depth of Surface Water NA (in.)
Depth of Free Water in Pit NA (in.)
Depth of Saturated Soil NA (in.)

Remarks:

Map Unit Name *
(Series and Phase):

Drainage Class: *

Field Observations Confirm Mapped Type? Yes No

Profile Description:

Depth (inches)	Matrix Color (Munsel Notation)	Mottle Colors (Munsel Notation)	Mottle Abundance	Soil Texture/ Type
0-10"	2.5 yr 4/2			
10-24"	2.5 yr 5/2	10 yr 4/6	moderate	sandy loam

Hydric Soil Indicators:

☐ Histosol
☐ Histic Epipedon
☐ Sulfidic Odor
☐ Aquic Moisture Regime
☐ Reducing Conditions
☒ Gleyed or [✓ Low Chroma]
☐ Concretions
☐ High Organic Content in Surface Layer in Sandy Soil
☐ Organic Streaking in Sandy Soil
☐ Listed on Local Hydric Soils List
☐ Listed on National Hydric Soils List
☐ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? [✓ Yes] No
Wetland Hydrology Present? [✓ Yes] No
Hydric Soils Present? [✓ Yes] No

Is this Sampling Point Within a Wetland? [✓ Yes] No

Remarks:

* Forest County Soil Survey Not Complete

Data Form
Routine Wetland Determination
(1987 COE Wetlands Delineation Manual)

Project/Site:	Crandon Mine Site	Date: 8/25/94
Applicant/Owner:	Crandon Mining Company	County: Forest
Investigator:	Ron Steg/Brad Helmandollar	State: WI

Do Normal Circumstances exist on the site? [✓ Yes] No	Wetland ID: F65
Is the site significantly disturbed (Atypical Situation)? Yes [✓ No]	Transect ID:
Is the area a potential Problem Area? Yes [✓ No] (If needed, explain on reverse.)	Plot ID: 3A

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Quercus rubra*	tree	FACU	9.		
2. *Acer saccharum* *	tree	FACU	10.		
3. *Populus tremuloides*	tree	FAC	11.		
4. *Abies balsamea*	tree	FACU	12.		
5. *Acer saccharum* *	shrub	FACU	13.		
6. *Betula alleghaniensis*	shrub	FAC	14.		
7. *Lycopodium obscurum*	herb	FACU	15.		
8. *Triantulis borealis*	herb	FAC+	16.		

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC). 30%

* = dominant species

Remarks:

HYDROLOGY

_____ Recorded Data (Describe in Remarks):

- ☐ Stream, Lake or Tide Gauge
- ☐ Aerial Photographs
- ☐ Other

_X_ No Recorded Data Available

Wetland Hydrology Indicators:

- ☐ Water Stained/Silt Covered Leaves
- ☐ Drift Lines
- ☐ High Water Marks
- ☐ Sand/Silt Deposits
- ☐ Swollen Tree Bases
- ☐ Exposed Roots
- ☐ Periodically Flooded Channels

Field Observations:

Depth of Surface Water NA (in.)
Depth of Free Water in Pit NA (in.)
Depth of Saturated Soil NA (in.)

Remarks: No indicators of wetland hydrology

Map Unit Name *
(Series and Phase):

Drainage Class: *

Field Observations Confirm Mapped Type? Yes No

Profile Description:

Depth (inches)	Matrix Color (Munsel Notation)	Mottle Colors (Munsel Notation)	Mottle Abundance	Soil Texture/ Type
0-8"	10 yr 5/2			sandy loam
8-15"	10 yr 4/6			sandy loam

Hydric Soil Indicators:

☐ Histosol
☐ Histic Epipedon
☐ Sulfidic Odor
☐ Aquic Moisture Regime
☐ Reducing Conditions
☐ Gleyed or Low Chroma

☐ Concretions
☐ High Organic Content in Surface Layer in Sandy Soil
☐ Organic Streaking in Sandy Soil
☐ Listed on Local Hydric Soils List
☐ Listed on National Hydric Soils List
☐ Other (Explain in Remarks)

Remarks: No indicators of hydric soils

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes [✓ No]
Wetland Hydrology Present? Yes [✓ No]
Hydric Soils Present? Yes [✓ No]

Is this Sampling Point Within a Wetland? Yes [✓ No]

Remarks: No indication of water
Plot located west of Flag 32

* Forest County Soil Survey Not Complete

Data Form
Routine Wetland Determination
(1987 COE Wetlands Delineation Manual)

Project/Site: Crandon Mine Site
Date: 8/25/94
Applicant/Owner: Crandon Mining Company
County: Forest
Investigator: Ron Steg/Brad Helmandollar
State: WI

Do Normal Circumstances exist on the site? [✓ Yes] No
Wetland ID: F65
Is the site significantly disturbed (Atypical Situation)? Yes [✓ No]
Transect ID:
Is the area a potential Problem Area? Yes [✓ No]
(If needed, explain on reverse.)
Plot ID: 3B

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Betula alleghaniensis* *	tree	FAC	9. *Scutilaria lateraflora*	herb	OBL
2. *Acer rubrum* *	tree	FAC	10. *Coptis trifolia*	tree	FACW
3. *Tsuga canadensis*	tree	FACU+	11. *Viola spp*		
4. *Fraxinus nigra*	tree	FACW+	12.		
5. *Betula alleghaniensis* *	shrub	FAC	13.		
6. *Acer rubrum* *	shrub	FAC	14.		
7. *Fraxinus nigra*	shrub	FACW+	15.		
8. *Spagnum spp.*	herb	OBL	16.		

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC). 90%

* = dominant species

Remarks:

HYDROLOGY

______ Recorded Data (Describe in Remarks):

☐ Stream, Lake or Tide Gauge
☐ Aerial Photographs
☐ Other

_X_ No Recorded Data Available

Wetland Hydrology Indicators:
☒ Water Stained/Silt Covered Leaves
☐ Drift Lines
☐ High Water Marks
☐ Sand/Silt Deposits
☐ Swollen Tree Bases
☐ Exposed Roots
☒ Periodically Flooded Channels/Depressions

Field Observations:
Depth of Surface Water _NA_ (in.)
Depth of Free Water in Pit _NA_ (in.)
Depth of Saturated Soil _NA_ (in.)

Remarks:

Map Unit Name (Series and Phase): *

Drainage Class: *

Field Observations Confirm Mapped Type? Yes No

Profile Description:

Depth (inches)	Matrix Color (Munsel Notation)	Mottle Colors (Munsel Notation)	Mottle Abundance	Soil Texture/ Type
0-2"	leaf litter			
2-6"	2.5 yr 4/2			sandy loam
6-20"	2.5 yr 4/2	10 yr 4/6		
20-24"	10 yr 4/4	10 yr 4/6		sandy loam

Hydric Soil Indicators:

☐ Histosol
☐ Histic Epipedon
☐ Sulfidic Odor
☐ Aquic Moisture Regime
☐ Reducing Conditions
☒ Gleyed or [✓ Low Chroma]
☐ Concretions
☐ High Organic Content in Surface Layer in Sandy Soil
☐ Organic Streaking in Sandy Soil
☐ Listed on Local Hydric Soils List
☐ Listed on National Hydric Soils List
☐ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? [✓ Yes] No
Wetland Hydrology Present? [✓ Yes] No
Hydric Soils Present? [✓ Yes] No

Is this Sampling Point Within a Wetland? [✓ Yes] No

Remarks: Plot located adjacent to Flags 32 and 33

* Forest County Soil Survey Not Yet Complete

Data Form
Routine Wetland Determination
(1987 COE Wetlands Delineation Manual)

Project/Site:	Crandon Mine Site	Date: 8/25/94
Applicant/Owner:	Crandon Mining Company	County: Forest
Investigator:	Ron Steg/Brad Helmandollar	State: WI

Do Normal Circumstances exist on the site? [✓ Yes] No	Wetland ID: F65
Is the site significantly disturbed (Atypical Situation)? Yes [✓ No]	Transect ID:
Is the area a potential Problem Area? Yes [✓ No] (If needed, explain on reverse.)	Plot ID: 4A

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Acer rubrum* *	tree	FAC	9. *Aralia nudicaulis*	herb	FACU
2. *Tsuga canadensis*	tree	FACU+	10. *Viola spp.*	herb	
3. *Abies balsamea*	tree	FACW	11. *Triantalis borealis*	herb	FAC+
4. *Populus tremuloides*	tree	FAC	12.		
5. *Abies balsamea* *	shrub	FACW	13.		
6. *Acer rubrum*	shrub	FAC	14.		
7. *Lycopodium annotinum*	herb	FAC	15.		
8. *Lycopodium obscurum*	herb	FACU	16.		

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC). 50%

* = dominant species

Remarks:

HYDROLOGY

_____ Recorded Data (Describe in Remarks):

☐ Stream, Lake or Tide Gauge
☐ Aerial Photographs
☐ Other

_X_ No Recorded Data Available

Wetland Hydrology Indicators:
☐ Water Stained/Silt Covered Leaves
☐ Drift Lines
☐ High Water Marks
☐ Sand/Silt Deposits
☐ Swollen Tree Bases
☐ Exposed Roots
☐ Periodically Flooded Channels/Depressions

Field Observations:
Depth of Surface Water _NA_ (in.)
Depth of Free Water in Pit _NA_ (in.)
Depth of Saturated Soil _NA_ (in.)

Remarks: No indication of hydrology

Map Unit Name * (Series and Phase):	Drainage Class: * Field Observations Confirm Mapped Type? Yes No

Profile Description:

Depth (inches)	Matrix Color (Munsel Notation)	Mottle Colors (Munsel Notation)	Mottle Abundance	Soil Texture/ Type
0-8"	7.5 yr 4/4			sandy loam
8-24"	10 yr 4/4			sandy loam

Hydric Soil Indicators:

☐ Histosol

☐ Histic Epipedon

☐ Sulfidic Odor

☐ Aquic Moisture Regime

☐ Reducing Conditions

☐ Gleyed or Low Chroma

☐ Concretions

☐ High Organic Content in Surface Layer in Sandy Soil

☐ Organic Streaking in Sandy Soil

☐ Listed on Local Hydric Soils List

☐ Listed on National Hydric Soils List

☐ Other (Explain in Remarks)

Remarks: No indications of hydric soils

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes [✓ No]
Wetland Hydrology Present? Yes [✓ No]
Hydric Soils Present? Yes [✓ No]

Is this Sampling Point Within a Wetland? Yes [✓ No]

Remarks: Vegetation marginally hydrophytic-no indication of hydrology or hydric soils
Plot located east of Flag 36

* Forest County Soil Survey Not Complete

Data Form
Routine Wetland Determination
(1987 COE Wetlands Delineation Manual)

Project/Site:	Crandon Mine Site	Date: 8/25/94
Applicant/Owner:	Crandon Mining Company	County: Forest
Investigator:	Ron Steg/Brad Helmandollar	State: WI

Do Normal Circumstances exist on the site? [✓ Yes] No	Wetland ID: F65
Is the site significantly disturbed (Atypical Situation)? Yes [✓ No]	Transect ID:
Is the area a potential Problem Area? Yes [✓ No] (If needed, explain on reverse.)	Plot ID: 4B

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Tsuga canadensis*	tree	FACU+	9. *Coptis trifolia*	herb	FACW
2. *Betula alleghaniensis* *	tree	FAC	10. *Carex spp.*	herb	
3. *Acer rubrum* *	tree	FAC	11. *Lycopus americanus*	herb	OBL
4. *Betula alleghaniensis* *	shrub	FAC	12.		
5. *Picea mariana*	shrub	FACW	13.		
6. *Acer rubrum*	shrub	FAC	14.		
7. *Ilex verticillata*	shrub	FACW	15.		
8. *Sphagnum spp.*	herb	OBL	16.		

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC). 90%

* = dominant species

Remarks:

HYDROLOGY

_____ Recorded Data (Describe in Remarks):

☐ Stream, Lake or Tide Gauge
☐ Aerial Photographs
☐ Other

X No Recorded Data Available

Wetland Hydrology Indicators:

☐ Water Stained/Silt Covered Leaves
☐ Drift Lines
☐ High Water Marks
☐ Sand/Silt Deposits
☐ Swollen Tree Bases
☐ Exposed Roots
☐ Periodically Flooded Channels/Depressions

Field Observations:

Depth of Surface Water N/A (in.)
Depth of Free Water in Pit N/A (in.)
Depth of Saturated Soil 4 (in.)

Remarks: Clear presence of hydrology

Map Unit Name (Series and Phase): *

Drainage Class: *

Field Observations Confirm Mapped Type? Yes No

Profile Description:

Depth (inches)	Matrix Color (Munsel Notation)	Mottle Colors (Munsel Notation)	Mottle Abundance	Soil Texture/ Type
0-4"	black			sandy loam
4-15"	2.5 YR 5/2			wet/sandy loam
15-24"	10 YR 6/2	7.5 yr 5/8		wet/sandy loam

Hydric Soil Indicators:

☐ Histosol
☐ Histic Epipedon
☐ Sulfidic Odor
☐ Aquic Moisture Regime
☐ Reducing Conditions
☒ Gleyed [✓ or Low Chroma]

☐ Concretions
☐ High Organic Content in Surface Layer in Sandy Soil
☐ Organic Streaking in Sandy Soil
☐ Listed on Local Hydric Soils List
☐ Listed on National Hydric Soils List
☐ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? [✓ Yes] No
Wetland Hydrology Present? [✓ Yes] No
Hydric Soils Present? [✓ Yes] No

Is this Sampling Point Within a Wetland? [✓ Yes] No

Remarks: Plot located west of Flag 36

* Forest County Soil Survey Not Complete

Data Form
Routine Wetland Determination
(1987 COE Wetlands Delineation Manual)

Project/Site:	Crandon Mine Site	Date: 8/25/94
Applicant/Owner:	Crandon Mining Company	County: Forest
Investigator:	Ron Steg/Brad Helmandollar	State: WI

Do Normal Circumstances exist on the site?	[✓ Yes] No	Wetland ID: P2
Is the site significantly disturbed (Atypical Situation)?	Yes [✓ No]	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes [✓ No]	Plot ID: 1A (at Flag No. 1)

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Abies balsamea* *	tree	FACW	9. *Aralia nudicaulis* *	herb	FACU
2. *Populus tremoloides* *	tree	FAC	10. *Cornus canadensis*	herb	FAC
3. *Acer rubrum* *	tree	FAC	11. *Lycopodium anatinum*	herb	FAC
4. *Acer saccharum* *	shrub	FACU	12.		
5. *Acer rubrum*	shrub	FAC	13.		
6. *Betula papyrifero*	shrub	FACU+	14.		
7. *Aster macrophyllus*	herb		15.		
8. *Athyrium Felix-femina*	herb	FAC	16.		

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC). < 50%

* = dominant species

Remarks:

HYDROLOGY

___ Recorded Data (Describe in Remarks):

☐ Stream, Lake or Tide Gauge
☐ Aerial Photographs
☐ Other

_X_ No Recorded Data Available

Wetland Hydrology Indicators:
☐ Water Stained/Silt Covered Leaves
☐ Drift Lines
☐ High Water Marks
☐ Sand/Silt Deposits
☐ Swollen Tree Bases
☐ Exposed Roots
☐ Periodically Flooded Channels/Depressions

Field Observations:
Depth of Surface Water _NA_ (in.)
Depth of Free Water in Pit _NA_ (in.)
Depth of Saturated Soil _NA_ (in.)

Remarks: No indication of wetland hydrology

Map Unit Name *
(Series and Phase):

Drainage Class: *

Field Observations Confirm Mapped Type? Yes No

Profile Description:

Depth (inches)	Matrix Color (Munsel Notation)	Mottle Colors (Munsel Notation)	Mottle Abundance	Soil Texture/ Type

Hydric Soil Indicators:

☐ Histosol
☐ Histic Epipedon
☐ Sulfidic Odor
☐ Aquic Moisture Regime
☐ Reducing Conditions
☐ Gleyed or Low Chroma
☐ Concretions
☐ High Organic Content in Surface Layer in Sandy Soil
☐ Organic Streaking in Sandy Soil
☐ Listed on Local Hydric Soils List
☐ Listed on National Hydric Soils List
☐ Other (Explain in Remarks)

Remarks: Too rocky to get a soil sample.

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes [✓ No]
Wetland Hydrology Present? Yes [✓ No]
Hydric Soils Present? Yes [✓ No]

Is this Sampling Point Within a Wetland? Yes [✓ No]

Remarks: Plot located at Flag 1

* Forest County Soil Survey Not Complete

Data Form
Routine Wetland Determination
(1987 COE Wetlands Delineation Manual)

Project/Site:	Crandon Mine Site	Date: 8/25/94
Applicant/Owner:	Crandon Mining Company	County: Forest
Investigator:	Ron Steg/Brad Helmandollar	State: WI

Do Normal Circumstances exist on the site?	[✓ Yes] No	Wetland ID: P2
Is the site significantly disturbed (Atypical Situation)?	Yes [✓ No]	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes [✓ No]	Plot ID: 1B

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Thuja occidentelis* *	tree	FACW	9. *Osmunda claytoniana*	herb	OBL
2. *Populus tremuloides*	tree	FAC	10. *Abies balsamea*	tree	FACW
3. *Picea mariana* *	tree	FACW	11.		
4. *Acer rubrum*	shrub	FAC	12.		
5. *Alnus rugosa*	shrub	OBL	13.		
6. *Ilex verticillata*	shrub	FACW	14.		
7. *Cornus canadensus*	herb	FAC	15.		
8. *Sphagnum spp.*	herb	OBL	16.		

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC). 100%

* = dominant species

Remarks:

HYDROLOGY

_____ Recorded Data (Describe in Remarks):

☐ Stream, Lake or Tide Gauge
☐ Aerial Photographs
☐ Other

__X__ No Recorded Data Available

Wetland Hydrology Indicators:
☐ Water Stained/Silt Covered Leaves
☐ Drift Lines
☐ High Water Marks
☐ Sand/Silt Deposits
☐ Swollen Tree Bases
☐ Exposed Roots
☒ Periodically Flooded Channels/Depressions

Field Observations:
Depth of Surface Water _NA_ (in.)
Depth of Free Water in Pit _NA_ (in.)
Depth of Saturated Soil _NA_ (in.)

Remarks: Hydrology clearly evidenced by topographic position

Map Unit Name * (Series and Phase):

Drainage Class: *

Field Observations Confirm Mapped Type? Yes No

Profile Description:

Depth (inches)	Matrix Color (Munsel Notation)	Mottle Colors (Munsel Notation)	Mottle Abundance	Soil Texture/ Type
0-24"	10 YR 7/2	10 yr 6/8	minor	silt loam

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic Odor
- ☐ Aquic Moisture Regime
- ☐ Reducing Conditions
- ☒ Gleyed or [✓ Low Chroma]
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soil
- ☐ Organic Streaking in Sandy Soil
- ☐ Listed on Local Hydric Soils List
- ☐ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? [✓ Yes] No
Wetland Hydrology Present? [✓ Yes] No
Hydric Soils Present? [✓ Yes] No

Is this Sampling Point Within a Wetland? [✓ Yes] No

Remarks:

* Forest County Soil Survey Not Complete

Data Form
Routine Wetland Determination
(1987 COE Wetlands Delineation Manual)

Project/Site:	Crandon Mine Site	Date: 8/25/94
Applicant/Owner:	Crandon Mining Company	County: Forest
Investigator:	Ron Steg/Brad Helmandollar	State: WI

Do Normal Circumstances exist on the site?	[✓ Yes] No	Wetland ID: P2
Is the site significantly disturbed (Atypical Situation)?	Yes [✓ No]	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes [✓ No]	Plot ID: 2A

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Populus tremuloides* *	tree	FAC	9. *Osmunda claytoniana*	herb	FAC+
2. *Betula papyrifera* *	tree	FACU	10.		
3. *Abies balsamen*	tree	FACW	11.		
4. *Acer rubrum*	shrub	FAC	12.		
5. *Acer saccarinum*	shrub	FACU	13.		
6. *Rubus occidentalis*	herb		14.		
7. *Lycopodium obscurum*	herb	FACU	15.		
8. *Coptis trifolia*	herb	FACW	16.		

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC). < 50%

* = dominant species

Remarks:

HYDROLOGY

___ Recorded Data (Describe in Remarks):

☐ Stream, Lake or Tide Gauge
☐ Aerial Photographs
☐ Other

_✓_ No Recorded Data Available

Wetland Hydrology Indicators:
☐ Water Stained/Silt Covered Leaves
☐ Drift Lines
☐ High Water Marks
☐ Sand/Silt Deposits
☐ Swollen Tree Bases
☐ Exposed Roots
☐ Periodically Flooded Channels/Depressions

Field Observations:
Depth of Surface Water NA (in.)
Depth of Free Water in Pit NA (in.)
Depth of Saturated Soil NA (in.)

Remarks: No indicators of wetland hydrology

Map Unit Name (Series and Phase): *

Drainage Class: *

Field Observations Confirm Mapped Type? Yes No

Profile Description:

Depth (inches)	Matrix Color (Munsel Notation)	Mottle Colors (Munsel Notation)	Mottle Abundance	Soil Texture/ Type
0-24"	10 YR 6/8			silt loam

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic Odor
- ☐ Aquic Moisture Regime
- ☐ Reducing Conditions
- ☐ Gleyed or Low Chroma
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soil
- ☐ Organic Streaking in Sandy Soil
- ☐ Listed on Local Hydric Soils List
- ☐ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

Remarks: No hydric indicators

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes [✓ No]
Wetland Hydrology Present? Yes [✓ No]
Hydric Soils Present? Yes [✓ No]

Is this Sampling Point Within a Wetland? Yes [✓ No]

Remarks:

* Forest County Soil Survey Not Complete

Data Form
Routine Wetland Determination
(1987 COE Wetlands Delineation Manual)

Project/Site:	Crandon Mine Site	Date: 8/25/94
Applicant/Owner:	Crandon Mining Company	County: Forest
Investigator:	Ron Steg/Brad Helmandollar	State: WI

Do Normal Circumstances exist on the site?	Yes	No	Wetland ID: P2
Is the site significantly disturbed (Atypical Situation)?	Yes	No	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes	No	Plot ID: 2B

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Picea mariana*	tree	FACW	9. *Calamagrostis canadensis*	herb	OBL
2. *Populus tremuloides* *	tree	FAC	10. *Lycopus ameriсonus*	herb	OBL
3. *Thuja occidentalis*	tree	FACW	11.		
4. *Acer rubrum*	shrub	FAC	12.		
5. *Ilex verticilluta*	shrub	FACW+	13.		
6. *Alnus rugosa*	shrub	OBL	14.		
7. *Vaccinium myrtilloides*	shrub	FACW-	15.		
8. *Sphagnum spp.*	herb		16.		

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC). 100%

* = dominant species

Remarks:

HYDROLOGY

_____ Recorded Data (Describe in Remarks):

☐ Stream, Lake or Tide Gauge
☐ Aerial Photographs
☐ Other

_X_ No Recorded Data Available

Wetland Hydrology Indicators:
☐ Water Stained/Silt Covered Leaves
☐ Drift Lines
☐ High Water Marks
☐ Sand/Silt Deposits
☐ Swollen Tree Bases
☐ Exposed Roots
☒ Periodically Flooded Channels/Depressions

Field Observations:
Depth of Surface Water _NA_ (in.)
Depth of Free Water in Pit _NA_ (in.)
Depth of Saturated Soil _NA_ (in.)

Remarks: Hydrology clearly evidenced by topography

Map Unit Name *
(Series and Phase):

Drainage Class: *

Field Observations Confirm Mapped Type? Yes No

Profile Description:

Depth (inches)	Matrix Color (Munsel Notation)	Mottle Colors (Munsel Notation)	Mottle Abundance	Soil Texture/ Type
0-4"	black			organic
4-14"	10 YR 7/2	10 YR 6/8	minor	silt loam

Hydric Soil Indicators:

- ☐ Histosol
- ☐ Histic Epipedon
- ☐ Sulfidic Odor
- ☐ Aquic Moisture Regime
- ☐ Reducing Conditions
- ☒ Gleyed or [✓ Low Chroma]
- ☐ Concretions
- ☐ High Organic Content in Surface Layer in Sandy Soil
- ☐ Organic Streaking in Sandy Soil
- ☐ Listed on Local Hydric Soils List
- ☐ Listed on National Hydric Soils List
- ☐ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? [✓ Yes] No
Wetland Hydrology Present? [✓ Yes] No
Hydric Soils Present? [✓ Yes] No

Is this Sampling Point Within a Wetland? [✓ Yes] No

Remarks: Plot located adjacent to Flag 14

* Forest County Soil Survey Not Complete

Data Form
Routine Wetland Determination
(1987 COE Wetlands Delineation Manual)

Project/Site:	Crandon Mine Site	Date: 8/25/94
Applicant/Owner:	Crandon Mining Company	County: Forest
Investigator:	Ron Steg/Brad Helmandollar	State: WI

Do Normal Circumstances exist on the site? [✓ Yes] No	Wetland ID: P2
Is the site significantly disturbed (Atypical Situation)? Yes [✓ No]	Transect ID:
Is the area a potential Problem Area? Yes [✓ No] (If needed, explain on reverse.)	Plot ID: 3A

VEGETATION

Dominant Plant Species	Stratum	Indicator	~~Dominant Plant Species~~	Stratum	Indicator
1. *Abies balsamea*	tree	FACW	9. *Rubus idaeus*	herb	FACU+
2. *Populus tremloides* *	tree	FAC	10. *Clintonia borealis*	herb	FAC+
3. *Betula papyrifera*	tree	FACU	11. *Acer rubrum*	tree	FAC
4. *Corylus americana*	shrub	FACU	12.		
5. *Acer rubrum*	shrub	FAC	13.		
6. *Lycopodium obscurum*	herb	FACU	14.		
7. *Cornus canadensis*	herb	FAC	15.		
8. *Athyrium Filix-femina*	herb	FAC	16.		

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC). 60%

* = dominant species

Remarks:

HYDROLOGY

____ Recorded Data (Describe in Remarks):

☐ Stream, Lake or Tide Gauge
☐ Aerial Photographs
☐ Other

_X_ No Recorded Data Available

Wetland Hydrology Indicators:
☐ Water Stained/Silt Covered Leaves
☐ Drift Lines
☐ High Water Marks
☐ Sand/Silt Deposits
☐ Swollen Tree Bases
☐ Exposed Roots
☐ Periodically Flooded Channels

Field Observations:
Depth of Surface Water _NA_ (in.)
Depth of Free Water in Pit _NA_ (in.)
Depth of Saturated Soil _NA_ (in.)

Remarks: Topography sloping towards wetland
No hydrology indicators present

Map Unit Name * (Series and Phase):	Drainage Class: * Field Observations Confirm Mapped Type? Yes No

Profile Description:

Depth (inches)	Matrix Color (Munsel Notation)	Mottle Colors (Munsel Notation)	Mottle Abundance	Soil Texture/ Type
0-24	10 YR 6/4	10 YR 5/8	minor	silty loam/ stoney

Hydric Soil Indicators:

☐ Histosol

☐ Histic Epipedon

☐ Sulfidic Odor

☐ Aquic Moisture Regime

☐ Reducing Conditions

☐ Gleyed or Low Chroma

☐ Concretions

☐ High Organic Content in Surface Layer in Sandy Soil

☐ Organic Streaking in Sandy Soil

☐ Listed on Local Hydric Soils List

☐ Listed on National Hydric Soils List

☐ Other (Explain in Remarks)

Remarks: Very stoney soil-no hydric indicators

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes [✓ No]
Wetland Hydrology Present? Yes [✓ No]
Hydric Soils Present? Yes [✓ No]

Is this Sampling Point Within a Wetland? Yes [✓ No]

Remarks:

* Forest County Soil Survey Not Complete

Data Form
Routine Wetland Determination
(1987 COE Wetlands Delineation Manual)

Project/Site:	Crandon Mine Site	Date: 8/25/94
Applicant/Owner:	Crandon Mining Company	County: Forest
Investigator:	Ron Steg/Brad Helmandollar	State: WI

Do Normal Circumstances exist on the site? [✓ Yes] No	Wetland ID: P2
Is the site significantly disturbed (Atypical Situation)? Yes [✓ No]	Transect ID:
Is the area a potential Problem Area? Yes [✓ No] (If needed, explain on reverse.)	Plot ID: 3B

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Populus tremuloides*	tree	FACW	9. *Cornus canadensis*	herb	FAC
2. *Thuja occidentalis* *	tree	FACW	10. *Sphagnum spp.* *	herb	OBL
3. *Picea mariana*	tree	FACW	11.		
4. *Abies balsamea*	tree	FACW	12.		
5. *Acer rubrum*	shrub	FAC	13.		
6. *Alnus rugosa*	shrub	OBL	14.		
7. *Ilex vertillata*	shrub	FACW+	15.		
8. *Vaccinium myrtilloides*	shrub	FACW -	16.		

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC). 100%

* = dominant species

Remarks:

HYDROLOGY

____ Recorded Data (Describe in Remarks):

☐ Stream, Lake or Tide Gauge
☐ Aerial Photographs
☐ Other

_X_ No Recorded Data Available

Wetland Hydrology Indicators:
☒ Water Stained/Silt Covered Leaves
☐ Drift Lines
☐ High Water Marks
☐ Sand/Silt Deposits
☐ Swollen Tree Bases
☐ Exposed Roots
☒ Periodically Flooded Channels/Depressions

Field Observations:
Depth of Surface Water _NA_ (in.)
Depth of Free Water in Pit _NA_ (in.)
Depth of Saturated Soil _NA_ (in.)

Remarks:

Map Unit Name *
(Series and Phase):

Drainage Class: *

Field Observations Confirm Mapped Type? Yes No

Profile Description:

Depth (inches)	Matrix Color (Munsel Notation)	Mottle Colors (Munsel Notation)	Mottle Abundance	Soil Texture/ Type
	too rocky to advance soil probe			

Hydric Soil Indicators:

☐ Histosol
☐ Histic Epipedon
☐ Sulfidic Odor
☐ Aquic Moisture Regime
☐ Reducing Conditions
☐ Gleyed or Low Chroma
☐ Concretions
☐ High Organic Content in Surface Layer in Sandy Soil
☐ Organic Streaking in Sandy Soil
☐ Listed on Local Hydric Soils List
☐ Listed on National Hydric Soils List
☐ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? [✓ Yes] No
Wetland Hydrology Present? [✓ Yes] No
Hydric Soils Present? Yes No

Is this Sampling Point Within a Wetland? [✓ Yes] No

Remarks: Plot is located adjacent to Flag 35
Hydric soils assumed based on vegetation, hydrology and landscape position

* Forest County Soil Survey Not Complete

Appendix D

Normalized Results of 10 Functional Models for Wetlands for the Study Area

Appendix 3.10-4 Table 1

Normalized Results of 10 Functional Models for 127 Wetlands in the Study Area

	FUNCTIONAL MODELS										
Wetland No.	Biological Function	Hydrologic Support Function	Groundwater Function	Storm and Floodwater Storage Function	Shoreline Protection Function	Water Quality Maintenance Function	Cultural and Economic Function	Recreational Function	Aesthetics Function	Education Function	Total
A1	14.00	0.24	1.28	4.72	0.00	4.48	1.75	1.80	2.30	0.90	31.47
A2	10.80	3.60	2.24	4.24	0.00	3.04	3.50	1.40	1.95	0.00	30.77
A3	6.40	0.64	2.24	4.96	0.00	3.92	3.05	1.15	1.95	0.00	24.31
B1	8.40	2.80	3.12	2.40	0.00	2.56	0.00	1.05	1.60	0.00	21.93
B2*	20.80	5.12	3.52	5.52	0.00	5.52	4.35	2.45	1.65	0.90	49.83
B3*	13.20	2.72	3.12	3.44	2.32	2.64	3.05	1.90	2.00	0.00	34.49
B4*	19.60	4.56	1.84	5.68	0.00	4.48	4.35	2.45	1.95	0.90	45.81
B5*	14.40	0.24	2.80	4.96	0.00	4.56	2.60	1.50	1.40	0.00	32.46
B8*	8.80	0.24	2.56	4.08	0.00	4.00	2.15	1.25	2.10	0.00	25.18
D1*	22.00	5.12	3.20	5.60	3.68	5.28	5.00	2.77	2.45	3.25	58.35
D2	6.00	1.76	2.64	2.32	0.00	1.36	0.00	1.30	1.95	0.00	17.33
D3*	11.20	4.08	1.44	5.36	0.00	4.08	3.05	1.65	1.65	0.00	32.51
D4*	19.60	4.40	1.52	5.76	0.00	4.56	4.35	2.45	1.95	0.90	45.49
D4A*	0.00	0.64	1.68	5.36	0.00	4.32	3.05	1.30	1.65	0.00	28.00
D5*	8.00	0.24	2.80	4.96	0.00	3.92	1.30	1.00	2.65	0.00	24.87
D8*	8.80	0.24	1.52	4.64	0.00	3.52	2.15	1.25	2.10	0.00	24.22
D18	6.00	0.24	1.52	4.80	0.00	3.68	2.15	0.80	1.40	0.00	20.59
F1	16.80	3.76	4.80	2.64	0.00	3.28	1.75	2.20	1.95	0.90	38.08
F2	31.60	5.30	4.80	4.24	1.04	5.28	3.50	4.00	2.55	0.90	63.23
F4	21.20	4.96	2.96	5.36	3.68	4.80	3.50	2.60	1.65	0.90	51.61
F5	16.00	0.64	3.20	5.44	0.00	4.24	4.15	1.95	1.95	2.35	39.92
F6	8.40	4.08	2.08	3.92	0.00	3.76	0.00	0.80	0.90	0.00	23.94
F7	22.00	1.86	2.80	5.76	0.00	5.76	3.50	2.45	2.55	0.90	47.58
F8	9.60	0.24	2.56	4.48	0.00	3.92	2.15	1.00	1.95	0.90	26.80
F9	21.60	4.96	3.68	4.96	6.32	4.64	4.65	3.40	2.20	2.05	58.46
F10*	22.40	5.52	3.52	6.08	7.04	5.12	4.35	3.30	1.65	0.90	59.88
F11*	15.20	4.56	3.12	5.76	0.00	4.88	5.00	2.60	1.95	2.35	45.42
F12	24.00	1.52	3.68	6.16	3.36	5.60	3.50	3.40	2.00	0.90	54.12
F13*	12.80	0.64	3.20	5.76	0.00	4.56	3.50	1.40	1.95	0.00	33.81

Prepared by: MDJ
Checked by: GGH

Appendix 3.10-4 Table 1

Normalized Results of 10 Functional Models for 127 Wetlands in the Study Area

	FUNCTIONAL MODELS										
Wetland No.	Biological Function	Hydrologic Function	Groundwater Function	Storm and Floodwater Storage Function	Shoreline Protection Function	Water Quality Maintenance Function	Cultural Economic Function	Recreational Function	Aesthetics Function	Education Function	Total
F15	20.80	1.44	3.68	5.60	0.00	4.32	4.55	2.20	2.45	3.25	48.29
F16	15.50	1.12	3.68	6.16	0.00	4.64	3.70	2.20	3.40	3.25	43.65
F17	9.20	0.64	1.68	5.36	0.00	4.32	3.05	1.30	1.65	0.00	27.20
F18	20.80	5.12	3.68	5.68	0.00	5.28	4.35	2.30	1.95	0.90	50.06
F19	23.60	5.60	3.68	5.52	4.64	6.08	3.80	4.45	3.60	2.05	63.02
F21	12.00	5.12	2.80	5.36	4.64	5.76	3.25	3.80	3.05	3.25	59.03
F22	8.80	4.08	2.64	4.80	0.00	4.00	3.70	1.80	2.45	2.35	34.62
F23*	23.20	6.04	3.36	6.32	4.64	6.32	3.50	3.80	2.55	0.90	60.63
F24	8.40	2.24	2.08	3.28	0.00	2.56	0.65	1.25	1.85	2.35	24.66
F25*	12.80	4.24	1.52	5.52	0.00	4.72	3.70	1.80	2.70	3.25	40.25
F26	7.20	2.14	1.44	2.40	0.00	1.68	0.00	0.65	0.60	0.00	16.11
F27*	8.80	4.08	1.44	5.04	0.00	3.84	3.70	1.80	2.70	3.25	34.65
F28*	25.00	5.92	3.20	6.08	4.32	4.96	3.05	2.45	3.30	0.90	59.18
F29*	20.40	4.08	1.28	5.44	0.00	5.28	2.15	1.70	1.60	0.90	42.83
F30	7.60	1.76	1.44	2.24	0.00	1.60	0.00	0.90	1.60	0.00	17.14
F31*	16.80	4.46	1.52	5.60	0.00	4.56	4.35	2.30	2.20	0.90	42.79
F32*	7.60	0.24	1.28	5.04	0.00	4.00	2.15	0.80	1.65	0.00	22.76
F33	7.20	3.60	1.68	4.32	0.00	3.20	3.05	1.30	1.65	0.00	26.00
F34	7.60	0.32	1.28	4.24	0.00	2.96	2.15	0.80	1.65	0.00	19.00
F35	16.40	0.64	2.00	5.76	0.00	4.56	4.15	1.95	2.20	2.35	40.01
F36	10.40	0.72	1.68	4.56	0.00	3.28	3.70	1.50	2.20	2.35	30.39
F37	28.70	6.40	3.76	5.60	4.00	6.08	3.80	4.20	2.55	2.05	67.14
F38	7.60	2.48	2.08	2.48	0.00	2.16	0.00	0.90	1.60	0.00	19.30
F39	18.80	4.64	2.96	5.92	0.00	5.84	3.05	2.05	1.05	0.00	44.31
F40	25.30	4.64	3.20	5.28	0.00	5.68	4.15	2.90	2.55	3.25	56.95
F42	11.20	0.24	2.96	5.04	0.00	4.64	1.30	1.05	2.00	0.00	28.03
F43	10.80	0.64	3.20	5.60	0.00	4.56	2.15	1.15	2.35	0.00	30.45
F45	12.40	0.24	2.80	4.96	0.00	3.92	1.30	0.80	2.65	0.90	29.97
F46	12.00	0.64	3.20	5.44	0.00	4.24	4.15	1.90	1.95	2.35	35.87

Prepared by: MDJ
Checked by: GGH

Appendix 3.10-4 Table 1

Normalized Results of 10 Functional Models for 127 Wetlands in the Study Area

FUNCTIONAL MODELS											
Wetland No.	Biological Function	Hydrologic Support Function	Groundwater Function	Storm and Floodwater Storage Function	Shoreline Protection Function	Water Quality Maintenance Function	Cultural and Economic Function	Recreational Function	Aesthetics Function	Education Function	Total
F48	10.40	0.24	2.80	5.44	0.00	4.16	2.60	1.25	1.40	0.00	28.29
F50	7.20	0.24	2.80	5.12	0.00	3.92	2.15	0.80	1.65	0.00	23.88
F51	8.00	0.24	2.80	4.48	0.00	3.44	2.15	1.30	2.45	0.00	24.86
F52	16.40	0.72	3.36	6.08	0.00	4.88	2.15	1.70	2.65	0.90	38.84
F53	17.20	4.56	3.12	6.08	0.00	4.72	4.35	2.30	1.40	0.00	43.73
F54	13.20	0.64	3.20	5.60	0.00	4.56	2.15	1.15	2.10	0.00	32.60
F55	7.60	0.24	2.56	4.40	0.00	3.52	2.15	1.30	2.70	0.00	24.47
F57*	21.60	5.84	2.96	5.36	3.68	5.04	3.90	3.05	2.20	0.90	54.53
F58	15.5	0.24	2.56	4.32	0.00	4.56	2.40	2.40	3.50	3.25	38.73
F60*	20.00	4.64	2.00	5.84	0.00	5.04	5.00	2.60	2.70	3.25	51.07
F61*	8.80	3.36	1.28	4.48	0.00	3.68	3.70	1.80	1.95	2.35	31.40
F62*	14.40	4.56	1.68	5.28	0.00	4.64	4.55	2.40	2.45	3.25	43.21
F63*	18.80	5.12	2.00	5.84	0.00	5.04	4.35	3.20	1.95	0.90	46.30
F64*	15.20	5.12	2.00	5.68	0.00	5.04	3.05	2.05	2.65	0.00	40.79
F65*	20.80	4.64	1.52	5.36	0.00	5.28	2.15	1.70	1.60	0.90	43.95
F66*	20.00	4.56	1.84	5.68	0.00	4.48	4.35	2.30	1.95	0.90	46.06
F69*	9.20	4.08	1.44	5.36	0.00	4.08	3.70	1.80	2.20	2.35	34.21
F70*	13.60	0.96	1.68	5.20	0.00	4.08	3.05	1.40	1.65	0.90	32.52
F72*	8.80	0.72	1.68	4.88	0.00	3.52	3.05	1.15	1.65	0.00	25.45
F81*	8.80	1.52	1.28	3.92	0.00	2.88	0.65	1.15	2.45	2.35	25.00
F86	7.60	0.24	2.56	5.52	0.00	4.00	2.85	1.15	2.20	2.35	28.47
F87	7.60	0.24	2.56	5.52	0.00	4.00	2.85	1.15	2.20	2.35	28.47
F90	7.20	1.52	3.12	3.60	0.00	2.88	0.65	1.15	2.45	2.35	24.92
F114*	17.60	0.24	5.04	4.56	0.00	4.32	2.40	2.40	3.25	3.25	43.06
F116	8.80	0.24	3.92	5.44	0.00	4.16	2.60	1.05	1.65	0.00	27.86
F119	13.60	0.64	3.20	5.44	0.00	4.24	4.15	1.95	2.20	3.25	38.67
F121	7.60	0.24	2.80	5.12	0.00	3.92	2.15	0.80	1.40	0.00	24.03
F122	6.80	0.24	2.80	5.12	0.00	3.92	2.85	1.15	1.95	2.35	27.18
F122A	14.40	0.24	2.80	4.80	0.00	4.24	1.95	1.65	3.05	3.25	36.38

Prepared by: MDJ
Checked by: GGH

Appendix 3.10-4 Table 1

Normalized Results of 10 Functional Models for 127 Wetlands in the Study Area

FUNCTIONAL MODELS											
Wetland No.	Biological Function	Hydrologic Support Function	Groundwater Function	Storm and Floodwater Storage Function	Shoreline Protection Function	Water Quality Maintenance Function	Cultural and Economic Function	Recreational Function	Aesthetics Function	Education Function	Total
F125	10.80	0.24	2.80	4.64	0.00	4.16	1.95	1.65	3.40	3.25	32.89
F126	11.60	0.64	3.20	5.92	0.00	4.96	2.60	1.60	2.00	0.00	32.52
F127	12.80	0.00	1.28	4.80	0.00	3.68	2.15	1.05	2.10	0.00	27.86
G1	6.80	0.24	2.80	5.12	0.00	3.92	2.15	1.00	1.65	0.00	23.68
H1	17.60	1.12	2.40	6.16	0.00	4.88	4.35	1.95	1.95	0.90	41.31
I1	14.40	0.24	2.56	4.88	0.00	3.92	2.85	1.65	2.90	3.25	36.65
J1	4.80	0.24	2.56	4.88	0.00	3.52	2.15	1.30	3.00	0.00	22.45
K1	10.80	1.76	1.44	2.48	0.00	2.16	0.65	1.00	1.65	3.25	25.19
K2	17.20	4.64	2.00	5.84	0.00	5.04	5.00	2.60	2.45	3.25	48.02
K3	14.80	4.56	1.52	5.92	0.00	4.80	5.00	2.60	2.20	2.35	43.75
K4	11.60	0.24	1.52	4.80	0.00	4.24	1.95	1.40	3.05	3.25	32.05
K5	9.60	0.24	1.52	5.28	0.00	4.16	1.95	1.15	3.15	2.35	29.40
M1	11.60	4.24	1.12	4.96	0.00	5.60	1.95	1.80	2.10	2.35	35.72
M2	8.80	1.76	1.44	2.56	0.00	1.84	0.00	0.90	1.30	0.00	18.60
M3*	13.60	4.08	1.12	5.60	0.00	4.48	3.05	1.70	1.95	0.90	36.48
M4	8.80	0.24	1.28	4.56	0.00	3.68	2.15	1.05	2.35	0.00	24.11
M5	16.00	4.08	1.44	5.36	0.00	4.08	4.15	2.30	2.45	3.25	43.11
M6	11.20	3.68	0.96	4.24	0.00	3.84	2.15	1.15	1.65	0.00	28.87
N1	15.60	0.24	2.56	5.04	0.00	4.96	1.95	1.65	3.05	3.25	38.30
O1*	18.80	5.12	3.20	5.44	0.00	5.60	4.35	2.45	2.20	0.90	48.06
O3	11.20	4.08	2.40	5.76	0.00	4.16	3.70	1.95	2.45	2.35	38.05
P1	13.60	3.28	2.24	3.68	3.36	3.68	3.05	1.70	1.95	0.00	36.54
P2*	17.20	4.56	1.84	6.08	0.00	4.72	4.35	2.30	1.95	0.00	43.00
R1*	13.60	4.56	2.96	5.52	0.00	4.48	3.90	2.05	1.65	0.90	39.62
R1A*	16.00	4.96	2.96	5.28	3.04	4.64	3.90	2.05	1.40	0.00	44.23
R3	26.80	5.92	2.96	5.44	1.04	5.60	3.80	4.20	2.80	2.05	60.61
R5	24.40	5.42	3.20	5.84	3.04	4.56	5.00	2.60	3.00	4.10	61.16
R7	10.40	4.08	2.40	5.76	0.00	4.16	3.70	1.80	2.45	2.35	37.10
R7A	17.20	0.64	3.20	6.48	0.00	5.28	2.85	1.70	1.85	2.35	41.55

Prepared by: MDJ
Checked by: GGH

Appendix 3.10-4 Table 1

Normalized Results of 10 Functional Models for 127 Wetlands in the Study Area

	FUNCTIONAL MODELS										
Wetland No.	Biological Function	Hydrologic Support Function	Groundwater Function	Storm and Floodwater Storage Function	Shoreline Protection Function	Water Quality Maintenance Function	Cultural and Economic Function	Recreational Function	Aesthetics Function	Education Function	Total
R8*	14.00	0.64	2.00	5.92	0.00	5.28	2.85	1.70	1.85	2.35	36.59
T1*	13.20	0.64	4.64	5.28	0.00	4.24	2.85	1.50	3.15	2.35	37.85
T2*	20.00	0.64	4.64	5.60	0.00	4.56	2.85	1.70	2.90	3.25	46.14
T3*	16.00	0.24	4.24	5.28	0.00	4.64	1.95	1.40	1.60	2.35	37.70
T4*	27.60	6.40	5.88	5.44	3.04	5.90	4.65	3.70	2.45	2.05	67.11
T5	15.20	0.64	2.96	5.36	0.00	4.32	3.50	1.65	1.95	0.00	35.58
W1*	22.40	5.32	6.16	5.68	3.68	5.44	4.35	2.60	1.95	0.90	58.48
W2*	22.80	5.52	5.04	5.44	3.68	5.44	4.35	2.30	1.95	0.90	57.42
X2	12.00	0.24	1.28	4.88	0.00	3.92	2.15	1.05	2.10	0.00	27.62
X3	20.00	4.56	1.84	5.68	0.00	4.48	4.35	2.30	2.20	0.90	46.31
X4	10.80	0.24	1.28	5.36	0.00	4.96	1.75	1.55	2.30	0.00	28.24

*wetlands of special interest

Prepared by: MDJ
Checked by: GGH

Appendix 3.10-4 Table 2

Normalized Results of 10 Functional Models for 23 Wetlands

		FUNCTIONAL MODELS										
Wetland No.	Wetland Type	Biological Function	Hydrologic Support Function	Groundwater Function	Storm and Floodwater Storage Function	Shoreline Protection Function	Water Quality Maintenance Function	Cultural and Economic Function	Recreational Function	Aesthetics Function	Education Function	Total
Z1	SM	53	14	70	77	0	70	70	54	46	18	472
Z2	SM	47	14	70	77	0	70	70	49	46	0	443
Z3	SM	23	8	65	70	0	61	35	13	18	0	293
Z4	SM	33	8	65	70	0	61	35	18	18	0	308
Z5	SM	49	68	63	76	0	68	83	62	51	47	567
Z6	CS	51	68	61	71	0	56	100	57	44	65	573
Z7	DS	39	49	63	44	0	37	17	25	18	0	292
Z8	DS	37	55	56	50	0	43	17	25	18	0	301
Z9	CS	57	65	68	67	46	58	87	51	33	18	550
Z10	DS	56	57	63	76	0	59	91	52	49	82	585
Z11	CS	46	55	63	69	0	52	100	52	39	47	523
Z12	SS	48	19	70	79	0	70	74	41	32	47	480
Z13	SS	41	8	65	74	0	66	57	34	32	47	424
Z14	CS	62	81	70	62	38	58	100	57	49	65	642
Z15	CS	47	14	70	72	0	58	100	46	39	47	493
Z16	CS	59	14	70	77	0	61	100	51	49	65	546
Z17	SM	71	62	59	65	13	59	96	69	86	18	575
Z18	DS	47	81	68	68	38	63	91	48	44	65	613
Z19	CS	46	73	65	69	0	64	70	39	39	18	483
Z20	SM	60	16	56	71	0	77	126	70	77	65	640
Z21	CS	34	8	51	68	0	53	83	39	49	65	469
Z22	SM	64	24	54	77	0	70	126	70	82	82	670
Z23	CS	50	81	68	71	38	61	87	66	39	0	561

SM-shallow marsh, SS-shrub swamp, DS-deciduous swamp, CS-conifer swamp

Prepared by: MDJ
Checke[illegible]: GGH

Appendix 3.10-4 Table 3

Normalized Results of 10 Functional Wetland Assessment Models for 20 Wetlands in the Plant Site

	FUNCTIONAL MODELS										
Wetland No.	Biological Function	Hydrologic Support Function	Groundwate Function	Storm and Floodwater Storage Function	Shoreline Protection Function	Water Quality Maintenance Function	Cultural and Economic Function	Recreational Function	Aesthetics Function	Education Function	Total
1	10.9	0.3	2.2	5.4	0.0	5.1	0.8	0.8	1.6	0.9	28
2	9.6	4.3	1.5	5.1	0.0	4.1	1.3	1.5	1.9	2.4	32
3	Part of R7A	-	-	-	-	-	-	-	-	-	-
4	Part of R8	-	-	-	-	-	-	-	-	-	-
5	7.4	4.5	1.5	4.9	0.0	4.2	1.3	0.8	1.9	0.9	28
6	7.1	4.5	1.5	4.4	0.0	3.6	1.3	0.8	1.4	0.0	25
7	10.2	0.0	1.5	5.3	0.0	4.5	1.6	1.1	1.4	0.0	26
8	12.1	0.3	2.2	4.9	0.0	4.0	1.6	1.1	1.7	0.9	29
9	16.4	4.5	0.8	5.2	0.0	5.1	1.4	2.5	3.1	3.2	42
10	16.4	5.2	1.8	6.0	0.0	5.1	2.5	2.3	1.9	2.4	44
11	7.8	0.8	2.7	5.5	0.0	4.7	1.8	1.1	1.7	0.0	26
12	5.9	0.3	2.2	4.9	0.0	4.0	1.3	0.8	1.7	0.0	21
13	4.7	0.3	2.2	4.9	0.0	4.0	1.7	1.1	1.9	2.4	23
14	5.6	0.8	2.2	4.9	0.0	3.8	1.7	1.5	1.9	2.4	25
15	4.7	0.3	2.2	4.9	0.0	4.0	1.7	1.1	1.9	2.4	23
16	5.9	0.3	2.2	4.9	0.0	4.0	1.3	1.1	1.9	2.4	24
17	9.6	0.3	2.2	5.2	0.0	4.3	1.3	0.8	2.2	0.9	27
18	13.3	0.9	2.3	5.5	0.0	4.3	2.1	1.4	1.4	0.0	31
19	10.5	0.3	2.2	5.0	0.0	4.8	1.2	1.1	1.8	2.4	29
20	9.0	1.1	2.7	5.2	0.0	4.1	2.2	1.5	2.2	2.4	30
21	4.3	0.3	2.2	4.9	0.0	4.0	1.7	1.1	2.5	2.4	23
22	4.7	0.3	2.2	4.7	0.0	4.4	0.9	0.7	0.8	2.4	21

Prepared by: LDB
Checked by: GGH

Appendix E

Wetland Compensation Site Search Information Request Mailing List and Relevant Correspondence

CRANDON PROJECT
WETLAND COMPENSATION SITE SEARCH MAILING LIST

JANET SMITH
GREEN BAY FIELD OFFICE
US FISH & WILDLIFE SERVICE
1015 CHALLENGER COURT
GREEN BAY WI 54311-8331

KENNETH SLOAN
FORESTRY SUPERVISOR
WDNR RANGER STATION
HIGHWAY 17
PO BOX 576
RHINELANDER WI 54501

MICHAEL SOHASKY
COUNTY FOREST ADMINISTRATOR
LANGLADE COUNTY FORESTRY
DEPARTMENT
FAIRGROUNDS
BOX 460
ANTIGO WI 54409

JOHN B HESS
WDNR RANGER STATION
PO BOX 371
CRANDON WI 54520

TODD C MCCOURT
WDNR RANGER STATION
PO BOX 96
OCONTO FALLS WI 54154

RON ECKSTEIN
WILDLIFE BIOLOGIST
WDNR RANGER STATION
PO BOX 576
RHINELANDER WI 54501

CARL MCILQUHAM
WILDLIFE MANAGER
PO BOX 310
ANTIGO WI 54409

JON O JACKSON
OFFICE OF ENVIRONMENTAL ANALYSIS
WISCONSIN DEPARTMENT OF
TRANSPORTATION
ROOM 951, HILL FARMS OFFICE BUILDING
4802 SHEBOYGAN AVENUE
PO BOX 7916
MADISON WI 53707

SUE VAP
NICOLET FOREST RANGER
US FOREST SERVICE
LAONA RANGER STATION
LAONA WI 54541

HARLEY ERBS
REGIONAL VICE PRESIDENT
TROUT UNLIMITED
15 ISLEVIEW DRIVE
RHINELANDER WI 54501

WILLIAM RICHIE
REGIONAL DIRECTOR
DUCKS UNLIMITED
1568 HILL CIRCLE DRIVE
ST GERMAINE WI 54558

JOHN HUFF
WILDLIFE MANAGER
WISCONSIN DEPARTMENT OF NATURAL
RESOURCES
647 LAKELAND ROAD
SHAWANO WI 54166

CHARLES FLEISCHMAN
LAND AND FOREST AGENT
OCONTO COUNTY COURTHOUSE
300 WASHINGTON STREET
OCONTO WI 54153-1621

KATHRYN GORICHAN
SOIL CONSERVATION SERVICE
72 ACKLEY STREET ROOM 3
ANTIGO WI 54409-2405

DAVID ZIOLKOWSKI
FOREST COUNTY COURTHOUSE
200 E MADISON STREET
CRANDON WI 54520-1414

RICHARD ROLLMAN
COUNTY FOREST ADMINISTRATOR
ONEIDA COUNTY COURTHOUSE
COURTHOUSE SQUARE
PO BOX 400
RHINELANDER WI 54501

DIRECTOR
FORESTRY AND PARKS DEPARTMENT
LANGLADE COUNTY COURTHOUSE
ANTIGO WI 54409

PETE LINDGREN
SOIL CONSERVATION SERVICE
3375 AIRPORT ROAD
RHINELANDER WI 54501

RHODA SPENCER
ASCS
300 S LAKE AVENUE
CRANDON WI 54520

JAMES LUKAS
COUNTY EXECUTIVE DIRECTOR
AGRICULTURAL STABILIZATION
CONSERVATION SERVICE
111 ARBUTUS AVENUE
OCONTO WI 54153

Crandon Mining Company

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

July 15, 1994

Dear

Crandon Mining Company (CMC) is proposing to develop a mining project at a site approximately 5 miles south of the city of Crandon, Wisconsin. If the mining project moves into construction, approximately 80 acres of wetlands will be modified. As part of the permitting process, a compensation program will need to be developed that will replace the functional uses and values of those wetlands.

We are seeking wetland restoration and development projects that CMC could participate in as part of this mitigation program. Potential projects should meet the following criteria:

1. The wetland projects should have high value for wildlife and be constructed such that they will require minimal or no maintenance over time.

2. Mitigation sites should be located as close to Crandon, Wisconsin, as possible. However, sites anywhere in Forest, Langlade, Oneida or Oconto Counties may prove to be feasible for compensation.

3. High priority sites are those that will restore previously drained or otherwise modified wetlands. Restoration sites could include agricultural lands that have been drained, wetlands that have been dried up due to drainage programs, or sites otherwise modified by man's activity that could be restored to a wetland status.

4. Mitigation sites will preferably be larger than 20 acres. At this time there is no upper limit to the size of any single contiguous wetland mitigation site.

5. Potential mitigation sites that are already planned, or for which preliminary feasibility work has been done, will be preferred. However, potential projects that have had no planning to date will also be considered.

6. Preference will be given to sites that are, or will be, in public ownership and for which there is a long-term commitment to maintenance.

RHINELANDER BUSINESS OFFICE
7 N. BROWN ST., 3RD FLOOR
RHINELANDER, WI 54501-3161
TEL.: (715) 365-1450 FAX: (715) 365-1457

CRANDON FIELD OFFICE
P.O. BOX 336 104 W. MADISON
CRANDON, WI 54520-0336
TEL.: (715) 478-3393 FAX: (715) 478-3641

We are interested in learning about and discussing with you any potential sites you may be aware of that meet some or all of the above criteria. We expect to identify potential alternative mitigation sites before August 15, 1994.

If you are aware of any potential sites that would become feasible or further enhanced by outside funding, or if you would like clarification on any of the above criteria or the intent of this letter, please give me a call at 715-365-1450 or call either Tim Weyenberg or Ron Steg with Foth & Van Dyke at 414-497-2500. We would be happy to discuss your project with you and, if appropriate, arrange a site visit.

Sincerely,

D. E. Moe

Don Moe
Technical/Permitting Manager

cc: Tim Weyenberg, Foth & Van Dyke
Ron Steg, Foth & Van Dyke
Jerry Sevick, Foth & Van Dyke
U.S. Forest Service
U.S. Environmental Protection Agency
U.S. Army Corps of Engineers

Appendix F

Wetland Compensation Site Soil Boring Logs

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 1

Facility/Project Name Garrity Farms - Wetland Compensation Site	License/Permit/Monitoring Number Not Applicable	Boring Number B-1

Boring Drilled by (Firm name and name of crew chief) Dan Zielowzowski/Randy Rudtke Boart Longyear	Date Started 04/07/95	Date Completed 04/07/95	Drilling Method 2" Split Spoon (Continuous Sampling)

DNR Facility Well No. —	WI Unique Well No. —	Common Well Name —	Final Static Water Level Not Measured	Surface Elevation ~819	Borehole Diameter 2.5 inches

Boring Location (See Figure 8-3)
State Plane ____ N, ____ E S/C/N Lat
NW 1/4 of NE 1/4 of Section 5, T27N, R17E Long

Local Grid Location (if applicable)
____ N ____ E
Feet ____ S Feet ____ W

County Shawano	DNR County Code	Civil Town/City/or Village Cecil

SAMPLE									Soil Properties					
No.	Rec (in)	Blow Counts	Depth in Feet	Soil/Rock description and geologic origin for each major unit	USCS	Graph Log	Well Diag	PID/FID	Std Pntr	Mst Cont	Liq Lim	Plas Lim	P 200	RQD/Comm
1	18	3/3		0-1.6 Black (10 YR 2/1) organic topsoil (silty sand muck) mod. coarse blocky structure, frozen, roots and organic fibers	OL									
		10/3	1	1.6-1.8 Dark grey (5 Y 4/1) silty sand with fibrous organic material, weak fine blocky structure, v. damp, soft, minor clay	SM									
2	21	5/7	2	1.8-4.0 Grey (5 Y 5/1) fine sand with silt, minor organics, structureless wet, loose	SP-SM									
		5/5	3											
3	20	2/2	4	4.0-8.0 Grey brown (2.5 Y 4/2) fine sand with minor organics, structureless wet, loose, minor stratification	SP									
		1/1	5											
4	18	1/2	6	(6-8) as above	SP									
		3/3	7											
			8											
				E.O.B. 8'										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature Erik A. Silvola (REM)	Firm Foth & Van Dyke

This form is authorized by Chapters 114.147 and 162, Wis. Stats. Completion of this report is mandatory.
Penalties: Forfeit not less than $10 nor more then $5,000 for each violation. Fined not less than $10 or more than $100 or imprisoned not less than 30 days, or both for each violation. Each day of continued violation is a separate offense, pursuant to ss 114.06, Wis. Stats.

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 1

Facility/Project Name: Garrity Farms - Wetland Compensation Site
License/Permit/Monitoring Number: Not Applicable
Boring Number: B-2
Boring Drilled by (Firm name and name of crew chief): Dan Zielowzowski/Randy Rudtke
Boart Longyear
Date Started: 04/07/95
Date Completed: 04/07/95
Drilling Method: 2" Split Spoon (Continuous Sampling)
DNR Facility Well No.: —
WI Unique Well No.: —
Common Well Name: —
Final Static Water Level: Not Measured
Surface Elevation: ~821
Borehole Diameter: 2.5 inches
Boring Location (See Figure 8-3)
State Plane ____ N, ____ E S/C/N Lat
NW 1/4 of NE 1/4 of Section 5, T27N, R17E Long
Local Grid Location (if applicable)
____ N ____ E
Feet ____ S Feet ____ W
County: Shawano
DNR County Code:
Civil Town/City/or Village: Cecil

SAMPLE									Soil Properties					
No.	Rec (in)	Blow Counts	Depth in Feet	Soil/Rock description and geologic origin for each major unit	USCS	Graph Log	Well Diag	PID/FID	Std Pntr	Mst Cont	Liq Lim	Plas Lim	P 200	RQD/ Comm
1	22	2/2		0-1.6 Dark brown (10 YR 2/2) organic topsoil (silty sand) mod., med. blocky structure, frozen, roots	OL									
		11/9	1	1.1-2.2 Grey-brown (2.5 Y 3/3) silty sand with minor clay and organics, weak, fine blocky structure, damp, soft	SM									
2	20	4/4	2	2.2-8.0 Brown (10 YR 5/4) brown fine sand with minor silt, structureless wet, loose weak stratification	SP									
		5/5	3											
3	23	5/4	4	(4-6) as above with minor organics and occasional silt lenses	SP SM									
		5/5	5											
4	19	2/2	6	(6-8) as above, less silt, sand is coarser	SP									
		2/1	7											
			8											
				E.O.B. 8'										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Erik A. Silvola (REM)

Firm: Foth & Van Dyke

This form is authorized by Chapters 114.147 and 162, Wis. Stats. Completion of this report is mandatory.
Penalties: Forfeit not less than $10 nor more then $5,000 for each violation. Fined not less than $10 or more than $100 or imprisoned not less than 30 days, or both for each violation. Each day of continued violation is a separate offense, pursuant to ss 114.06, Wis. Stats.

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 1

Facility/Project Name: Garrity Farms - Wetland Compensation Site
License/Permit/Monitoring Number: Not Applicable
Boring Number: B-3

Boring Drilled by (Firm name and name of crew chief): Dan Zielowzowski/Randy Rudtke, Boart Longyear
Date Started: 04/07/95
Date Completed: 04/07/95
Drilling Method: 2" Split Spoon (Continuous Sampling)

DNR Facility Well No.: —
WI Unique Well No.: —
Common Well Name: —
Final Static Water Level: Not Measured
Surface Elevation: ~821
Borehole Diameter: 2.5 inches

Boring Location (See Figure 8-3)
State Plane ____ N, ____ E S/C/N
Lat
Long
SE 1/4 of SE 1/4 of Section 32, T28N, R17E

Local Grid Location (if applicable)
____ N ____ E
Feet ____ S Feet ____ W

County: Shawano
DNR County Code:
Civil Town/City/or Village: Cecil

SAMPLE									Soil Properties					
No.	Rec (in)	Blow Counts	Depth in Feet	Soil/Rock description and geologic origin for each major unit	USCS	Graph Log	Well Diag	PID/FID	Std Pntr	Mst Cont	Liq Lim	Plas Lim	P 200	RQD/Comm
1	23	1/1		0-2.0 Black (10 YR 2/1) organic topsoil (silty sand muck) frozen, mod. med blocky structure, clay in lower 1'	OL									
		1/6	1											
2	20	5/5	2	2.0-6.0 Lt. brown (10 YR 6/4) fine-med. sand with silt, structureless wet, loose, weak stratification minor silt lenses	SP SM									
		4/5	3											
3	18	4/8	4	(4-6) as above, less silt	SP									
		8/7	5											
4	18	3/4	6	(6-8) Brown (10 YR 6/6) very fine sand with silt, weak, fine platy structure, wet, very soft	SP SM									
		7/6	7											
			8											
				E.O.B. 8'										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Erik A. Silvola (REM)
Firm: Foth & Van Dyke

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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 1

Facility/Project Name: Garrity Farms - Wetland Compensation Site
License/Permit/Monitoring Number: Not Applicable
Boring Number: B-4

Boring Drilled by (Firm name and name of crew chief): Dan Zielowzowski/Randy Rudtke, Boart Longyear
Date Started: 04/07/95
Date Completed: 04/07/95
Drilling Method: 2" Split Spoon (Continuous Sampling)

DNR Facility Well No.: —
WI Unique Well No.: —
Common Well Name: —
Final Static Water Level: Not Measured
Surface Elevation: ~819
Borehole Diameter: 2.5 inches

Boring Location (See Figure 8-3)
State Plane ____ N, ____ E S/C/N
Lat
Long
NE 1/4 of NE 1/4 of Section 5, T27N, R17E

Local Grid Location (if applicable)
____ N ____ E
Feet ____ S Feet ____ W

County: Shawano
DNR County Code:
Civil Town/City/or Village: Cecil

SAMPLE									Soil Properties					
No.	Rec (in)	Blow Counts	Depth in Feet	Soil/Rock description and geologic origin for each major unit	USCS	Graph Log	Well Diag	PID/FID	Std Pntr	Mst Cont	Liq Lim	Plas Lim	P 200	RQD/ Comm
1	22	1/2		0-1 Dark brown (10 YR 3/2) organic topsoil (silty sand) mod. med. blocky structure damp, frozen	OL									
		9/7	1	1.0-2.0 Dark brown (10 YR 3/4) silty sand with organics, weak fine blocky structure, frozen	SM									
2	20	5/5	2	2.0-2.5 Brown (10 YR 5/4) fine sand structureless, wet, loose	SP									
		7/9	3	2.5-4.0 Brown (10 YR 5/4) sandy silt to silty sand, weak fine platy structure wet, soft, weak stratification	ML-SM									
3	18	8/7	4	4.0-8.0 Brown (10 YR 4/4) very silty sand with minor clay, massive wet, soft	SM									
		6/8	5											
4	19	7/9	6	(6-8) as above, less silt and clay	SM-SP									
		8/8	7											
			8											
				E.O.B. 8'										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Erik A. Silvola (REM)
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Appendix G

Archaeological Survey for the Wetland Mitigation Site

GREAT LAKES ARCHAEOLOGICAL RESEARCH CENTER

TECHNICAL MEMORANDUM

DATE: 19 April 1995

TO: Jerry Sevick, Foth & Van Dyke

CC: Don Moe, Crandon Mining Company

FR: John D. Richards, Great Lakes Archaeological Research Center

RE: Crandon Project: Archaeological Survey of a Proposed 150 Acre Wetland Mitigation Site In Oconto and Shawano Counties, Wisconsin

1.0 Introduction

Per Foth & Van Dyke's request, Great Lakes Archaeological Research Center Inc. (GLARC) conducted a cultural resource survey of a proposed wetland mitigation site in Oconto and Shawano Counties, Wisconsin. The wetland mitigation project is being undertaken by Crandon Mining Company to compensate for the loss of wetlands associated with development of the Crandon Project.

The proposed site of the wetland mitigation is located in an area which has not been previously subjected to archaeological survey. Typically, Wisconsin's State Historic Preservation Officer (SHPO) requires that potential wetland mitigation sites be subjected to an archaeological reconnaissance prior to development. Consequently, GLARC designed and implemented an archaeological survey to accomplish this work.

2.0 Summary of Available Information

Previous studies pertinent to the Project Area include GLARC's recent survey of portions of the Wolf River in nearby Menominee County (Richards and Mier 1992) and Barrett and Skinner's (1932) survey of archaeological resources in Oconto and Shawano Counties. These reports are listed in Appendix A. A project map detailing project boundaries and showing areas surveyed is provided in Appendix B.

3.0 Description of Project Area

The proposed wetland mitigation site straddles the Oconto-Shawano County Line north of Shawano Lake. The southern portion of the parcel is located in T 27 N, R 17 E, Sec 5, N1/2, NE 1/4, Washington Township, Shawano County and the northern part is located in T 28 N, R 17 E, Sec 32, S 1/2, SE 1/4, Underhill Township, Oconto County. The project area is situated within an agricultural field comprising approximately 150 acres. Topography is virtually flat with no significant local relief present. However, the northern portion of the property is marked by the scattered presence of barely discernible, eroded rises which appear to be sandier than the surrounding soils.

Project soils are mapped as Cormant loamy fine sand on 0-1 percent slopes. Cormant soils are deep, poorly drained soils which formed on sandy outwash plains and glacial lake plains. These soils are subject to periodic ponding. Also present are pockets of Markey and Seelyville soils. These soils are deep, poorly drained mucks which formed on outwash plains from decomposing herbaceous plants and other organic matter. The Markey and Seelyville soils commonly include peaty, organic pedons exceeding 50 inches (19.6 cm) in depth (Gundlach et al 1982; Roberts et al. 1988).

Current landuse is agricultural. Prior to being farmed, the project area was likely part of an extensive wetland currently occupying portions of Sections 31 and 32 immediately northeast of the project area. At the time of the survey, the property had been partially drained by construction of several interconnected drainage ditches which channel water southwestward into Duchess Creek. An east-west ditch paralleling the northern border of the project area appears to represent a post-1974 addition to this drainage system since the feature does not appear on the 1974 Cecil, Wisconsin USGS quad map. The property reportedly supports a perennial mint crop which is turned under in the Fall and allowed to regenerate each Spring.

4.0 Methodology

4.1 Archival and Literature Search

Pre-field research entailed a comprehensive review of the data housed at Great Lakes Archaeological Research Center, Inc., at regional libraries and historical societies, and at Madison, Wisconsin. Archives and serial file systems were also searched for site-specific information. Published literature sources consulted include: *The Wisconsin Archeologist,* a quarterly journal published since 1901; *The Wisconsin Magazine of History,* the journal of the State Historical Society of Wisconsin; *The Wisconsin Historical Collections* consisting of 20 volumes published between the years 1903 and 1920; and the *Bulletin of the Public Museum of the City of Milwaukee*, several of which detail archaeological investigations conducted in various Wisconsin localities.

Unpublished sources subjected to scrutiny are represented by four different formats: (I) serial entry files; (2) map files; (3) manuscript files; and (4) archaeological survey reports. Two serial file systems were consulted. The first of these is the Wisconsin Archaeological Site Codification File, copies of which are housed at the Anthropology Section, Milwaukee Public Museum and the Museum Division, State Historical Society of Wisconsin. This file consists of an inventory of previously reported archaeological sites from both historic and prehistoric times and provides information relating to site locations, cultural affiliation, artifacts, and literature sources. The second file consulted is the Historic Preservation Division inventory file housed at the Historic Preservation Division, State Historical Society of Wisconsin. This file includes both archaeological sites and standing structures that have been identified as possessing architectural and/or historical significance.

Several map files were reviewed. They include: (I) The Charles E. Brown Archaeological Atlas; (2) the Government Land Office survey records; (3) the Trygg map files; and (4) local plat and deed maps. The Charles E. Brown Archaeological Atlas provides the locations of sites on county plat maps. The prehistoric and historic sites include camps, villages, mounds, springs, rock art, workshops, quarries, cemeteries, trails and various other types of archaeological manifestations reported to Brown during his long tenure as editor of *The*

Wisconsin Archeologist and as an employee of the State Historical Society of Wisconsin. The Government Land Office records consist of plats and survey notes that may provide information regarding presettlement vegetation, topography, and aquatic features, all important variables in determining potential site locations. In addition, dependent on the interests of individual land surveyors, cultural information such as the locations of Indian trails, camps and villages, maple sugar processing stations ("sugar bushes"), pioneer settlements, and early industrial improvements such as mills, roads, and early homes and farmsteads are frequently noted on these maps. Both map files are housed at the Archives Division, State Historical Society of Wisconsin and the latter is available on microfilm at various repositories.

The Trygg map file is a privately published composite of the GLO land survey records. While the Trygg maps are less detailed in scale than the GLO plats, the file is an important source for understanding the chronology and magnitude of regional development during the late historic period (ca. 1850). Finally, early plats and topographic maps were reviewed to assess historical settlement and development of the project environs.

Manuscript files investigated include the Charles E. Brown manuscript files and the State Archaeologist's county files. Both of these are housed at the Museum Division, State Historical Society of Wisconsin. The Brown manuscripts consist of 50 years of notes, correspondence, sketches, maps, and other data relating to historic and prehistoric archaeological sites. The county files include reports (unpublished), photographs, sketch maps, letters, and information derived from the Museum's highway archaeology program.

4.2 Field Investigations

Archaeological survey utilized the techniques of visual inspection, systematic surface collection, and shovel probing.

4.2.1 Simple Visual Inspection

This technique is commonly employed to provide an initial assessment of the project area. Attempts are made to identify those portions of the project area not surveyable by conventional means. All of the project area was subjected to visual inspection.

4.2.2 Systematic Surface Survey

In localities where the earth's surface is not obscured by vegetation (where more than 20% of the surface was exposed) traditional pedestrian survey or surface collection can be employed. Survey crews simply traverse the project area along predetermined transects spaced 5.0 to 10.0 m apart. Artifact concentrations are noted, recovery locations are marked with survey flags and the distribution of cultural debris plotted on scaled field maps. Data from carefully controlled surface survey provides a useful indicator of the boundaries of an archaeological site as well as the distribution of artifacts within the site limits. All of the project area was subjected to systematic surface survey.

4.2.3 Shovel Probing

Shovel probing is a technique utilized to sample areas where the earth’s surface is masked by vegetation (less than 20% surface visibility). It is a labor-intensive technique which results in only a small fraction of the site area being sampled for cultural remains and thus has limitations. In spite of these limitations, shovel probing is a cost-effective technique for small tracts where vegetation, recent fill, or sediments mask older surfaces. The technique consists of digging a series of small excavation units placed along predetermined transects, or in grids, of 15 meter intervals. Intervals are decreased to 10 meters in areas adjacent to water bodies. Pits of approximately 35-45 centimeters in diameter are excavated and the spoil is screened through a 1/4” mesh hardware cloth to determine the presence or absence of cultural debris. Depth is usually restricted to 35 to 40 cm below the surface. However, excavation is typically carried through the plow zone or modern A horizon and into the underlying B horizon. Upon examination of the stratigraphy and inspection of the screen contents, the pits are immediately backfilled. Shovel probing was utilized to document soil horizonation and to spot check selected locales for the presence of undisturbed subsurface soils or archaeological deposits.

5.0 Survey Results

5.1 Archival Research

Results of the archival research indicate that no previously reported archaeological sites are located within or adjacent to the project area. A historic period Indian trail (Brown n.d.) is reported approximately 1-1/2 miles northwest of the project area in portions of Sections 30 and 31, Oconto County. In addition, the northeast shore of Shawano Lake, located approximately 2-1/2 miles south of the project area, harbors dense concentrations of prehistoric and historic archaeological sites. The proximity of these resources relative to the project area suggests that the region in general is characterized by a high potential to harbor archaeological sites. However, the landscape position of the project area restricts potential prehistoric utilization to areas coincident with the perimeter or near perimeter of the proposed wetland development.

5.2 Systematic Surface Survey

Ground visibility over most of the project area was close to 100%. However, about 15% of the total project area was characterized by ground visibility of approximately 75%. Ground visibility over 10% of the property ranged between 30% and 50%. Survey transect spacing was set at 5.0 m intervals. A total of two artifacts were recovered during the survey. Both items represent fragments of chipped stone projectile points. One fragment (95.0046.1) is manufactured of white quartz and the other specimen (95.0046.2) was produced from locally available poor grade chert. Both artifacts were recovered within a 10 m area near the northern boundary of the project area adjacent to the south bank of an east-west drainage ditch. This location is also near an example of the low, sandy, eroded rises described above. Both point fragments are suggestive of contracting stemmed forms commonly associated with Early and Middle Woodland occupations of the area (Green et al. 1986). The chert point (95.0046.2) resembles an informal biface type sometimes referred to as a "Sheboygan Knife" (Richards et al. 1993). Illustrations of each point are shown in Figure 1.

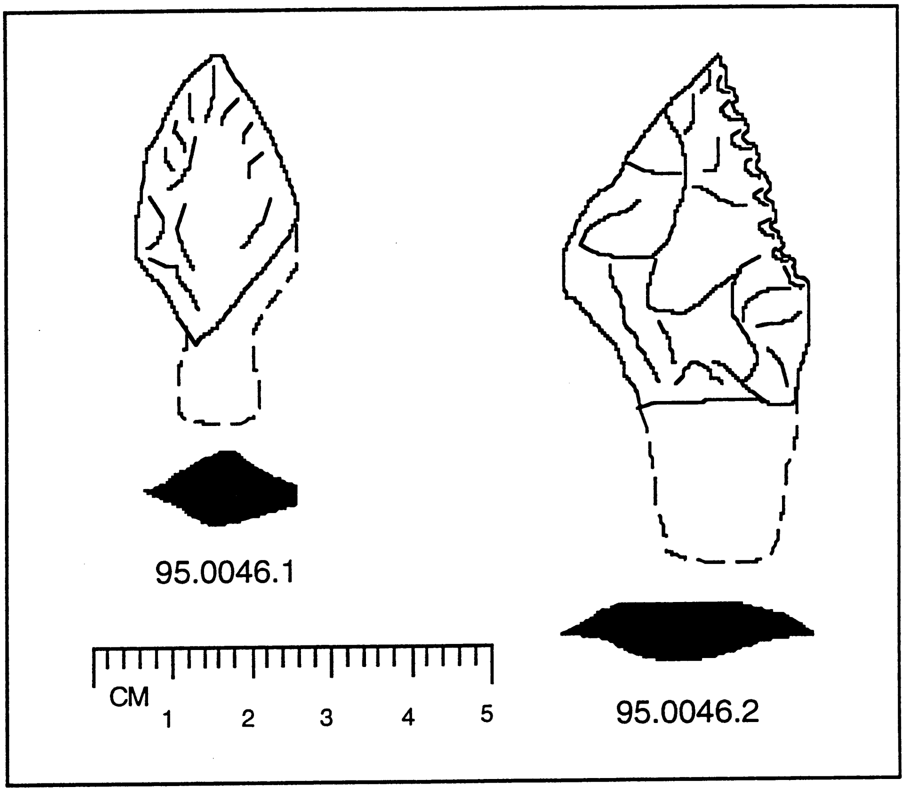


Figure 1: Projectile point fragments from the project area

5.3 Soil Test Pits

Soil test pits were selectively located within the project area to provide data on soil horizonation and to test for additional artifacts adjacent to the locations of each of the point fragments. In general, the soil profiles documented in each of the three locales chosen exhibit an organically enriched Ap horizon occasionally containing wooden debris underlain by a structureless sand unit. The underlying sand unit is typically saturated. Location of each soil test pit is shown in Appendix B. Profiles are illustrated in Appendix C. No archaeological materials were recovered from the soil test pits within the project area.

6.0 Conclusions

Results of the archaeological investigation indicate that a prehistoric archaeological site is located within the project area, near the northern limits of project development. The absence of associated artifactual debris such as lithic debitage, pottery, or fire-cracked rock, suggests that the site is neither extensive nor representative of an intensive occupation. The site location near what would have been the the northern margin of the former wetland, adjacent to a low rise, suggests an occupation directed toward exploitation of wetland resources. Agricultural activity has disturbed the upper 30-40 cm of soil. However, the presence of peat-bearing soils suggest the possibility that the recovered tools may be associated with buried archaeological and/or paleontological deposits incorporated in near shore peats formed during the time that the project area was an active wetland. Alternatively, the site location may have been associated with an occupation of the low rise noted earlier. In this case, it is unlikely that substantial archaeological deposits remain below the present, plow-truncated surface.

7.0 Recommendations

Currently, no ground disturbing activities are planned in the immediate vicinity of the newly discovered archaeological site. Consequently, project development should have no affect on any archaeological deposits present. If future project development involves ground disturbance coincident with the location of the archaeological site, additional archaeological investigations are warranted in order to determine the potential significance of any remaining archaeological deposits.

If the archaeological site is to be disturbed by project development a coordinated program of geoarchaeological studies supplemented by limited archaeological testing should be implemented. The focus of these investigations should be: (1) An accurate reconstruction of the project area environment prior to European settlement; (2) the potential of the project area land forms to harbor archaeological deposits; and (3) archaeological testing centered on the locations from which the recovered artifacts were collected.

APPENDIX A

ARCHIVAL SOURCES CONSULTED

Barrett, S.A., and Alanson Skinner

1932 Certain Mounds and Village Sites in Shawano and Oconto Counties, Wisconsin. *Milwaukee Public Museum Publications in Anthropology* 10(5):401-552.

Brown, Charles E.

n.d. Atlas on file at the State Historical Society of Wisconsin, Madison. Manuscripts (1937).

Green, William, James B. Stoltman and Alice B. Kehoe (editor)

1986 *Introduction to Wisconsin Archaeology*. The Wisconsin Archeological Society, 67(3-4).

Grundlach, Howard F., John E. Campbell, Terry J. Huffman, William L. Kowalski, Raymond L. Newbury, and David C. Roberts

1982 *Soil Survey of Shawano County, Wisconsin*. United States Department of Agriculture, Washington, D.C.

Richards, John D., David F. Overstreet, and Patricia B. Richards

1993 *Archaeological Investigations in the Sheboygan River Watershed, 1990-1993* Great Lakes Archaeological Research Center, Inc. Reports of Investigations No. 327.

Richards, Patricia B., and Lawrence Mier

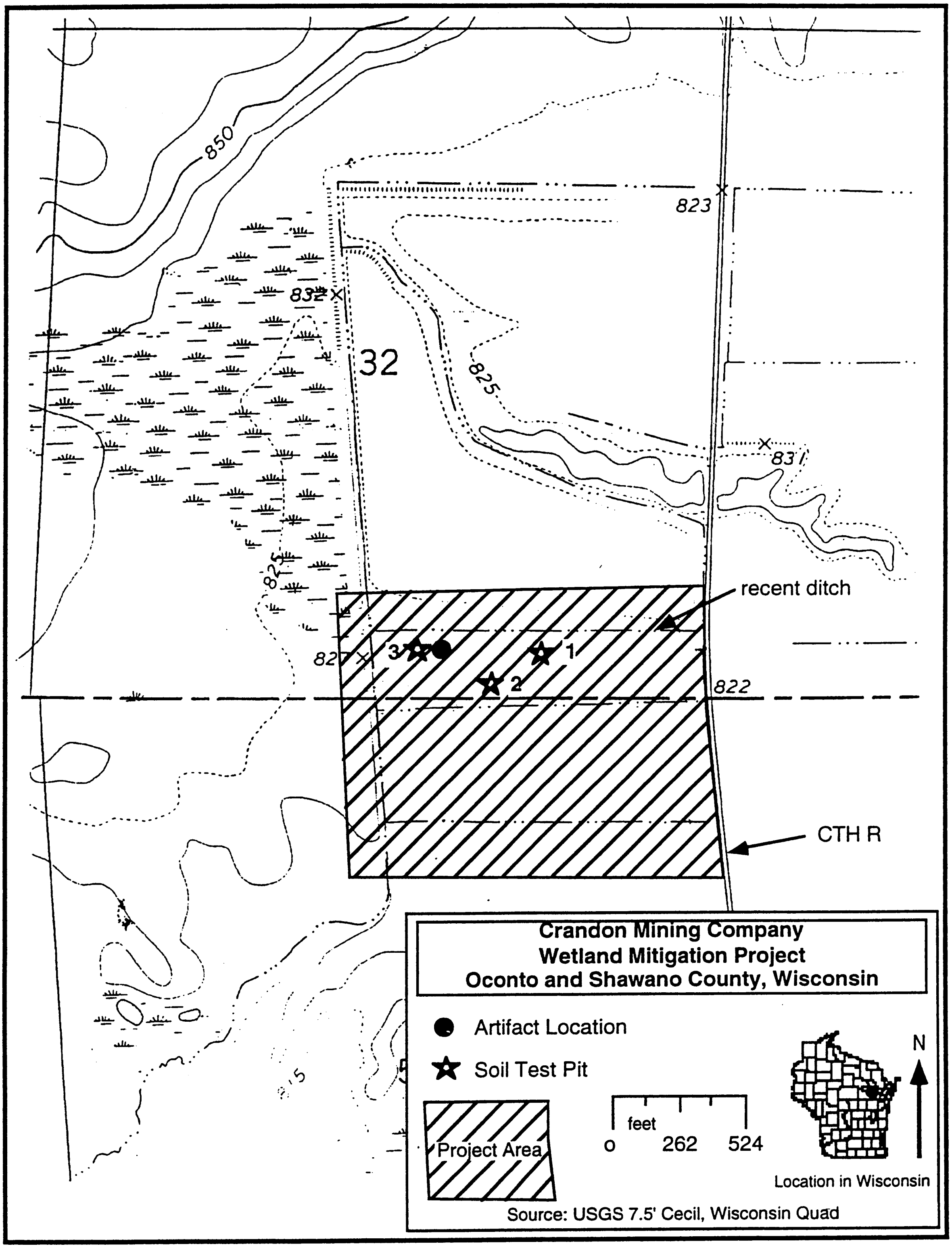
1992 Archaeological Reconnaissance and Phase I Archaeological Survey of the Wolf River, Menominee Indian Reservation Shawano Hydroelectric Project. Great Lakes Archaeological Research Center, Inc. Reports of Investigations No. 290.

Roberts, David C., John E. Campbell, and Terry L. Kroll

1988 *Soil Survey of Oconto County, Wisconsin*. United States Department of Agriculture, Washington, D.C.

APPENDIX B

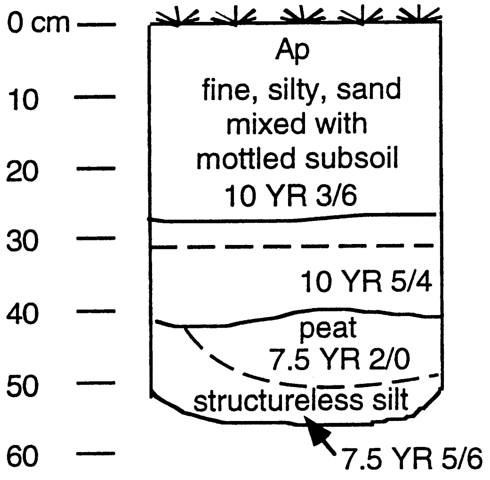
TOPOGRAPHIC MAP ILLUSTRATING SURVEY LOCATION



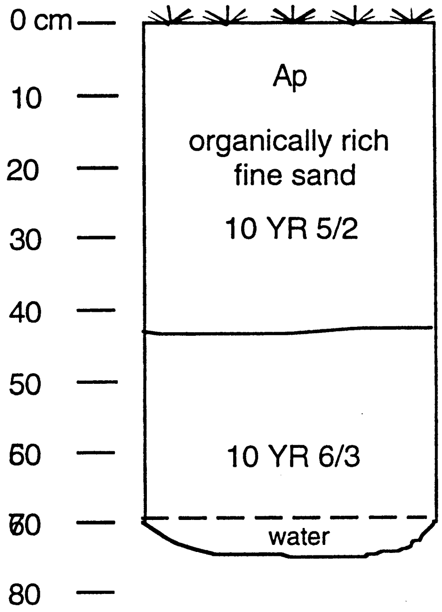
Source: USGS 7.5' Cecil, Wisconsin Quad

APPENDIX C

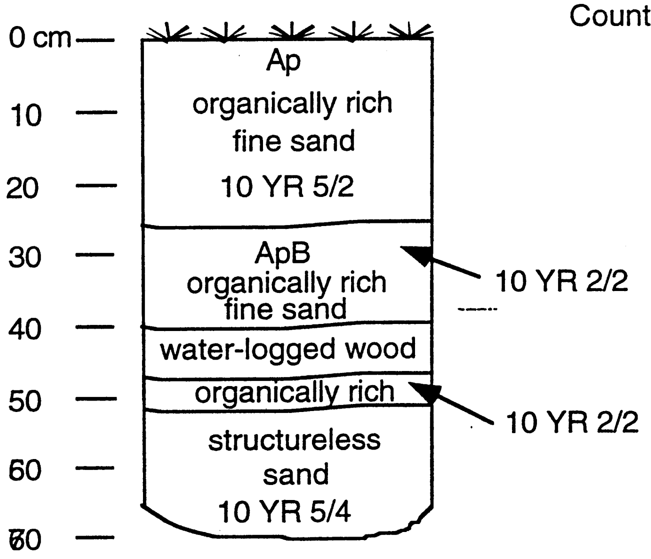
PROJECT AREA SOIL PROFILES



Soil Test Pit 1
Crandon Mining Company
Wetland Mitigation Site
Oconto and Shawano
County, Wisconsin



Soil Test Pit 2
Crandon Mining Company
Wetland Mitigation Site
Oconto and Shawano
County, Wisconsin



Soil Test Pit 3
Crandon Mining Company
Wetland Mitigation Site
Oconto and Shawano
County, Wisconsin

Appendix H

Wisconsin Department of Transportation Wetland Mitigation Banking Technical Guidelines

Wisconsin Department of Transportation

Wetland Mitigation Banking Technical Guideline

In cooperation with:

Wisconsin Department of Natural Resources
U.S. Army Corps of Engineers
U.S. Environmental Protection Agency
U.S. Fish & Wildlife Service
Federal Highway Administration

July 1993

CONTENTS

Wetland Mitigation Banking Technical Guideline

INTERAGENCY COORDINATION AGREEMENT

WETLAND MITIGATION BANKING TECHNICAL GUIDELINES FOR WiDOT PROJECTS

We are pleased to note that the Wisconsin Department of Natural Resources and the Wisconsin Department of Transportation have officially concurred in the use of mitigation banking technical guidelines to address wetland impacts associated with Wisconsin Department of Transportation (WiDOT) projects.

The development of these guidelines by a Federal/State interagency task force was initiated approximately three years ago. The numerous meetings and intense discussions on this issue have produced an agreement which reflects a philosophy and procedural approach that is consistent with the wetland protection goals of the Clean Water Act.

Accordingly, it is the desire of the Federal agencies to endorse this agreement so that both Federal and State agencies are in harmony with respect to wetland mitigation banking for WiDOT projects. Further, by endorsing this agreement, the respective Federal agencies agree to active participation on the Interagency Overview Committee, and make a firm commitment to maintain the cooperative spirit that made possible the establishment of these guidelines.

APPROVED:

Frederic R. Ross Administrator, Division of Highways Wisconsin Department of Transportation	July 7, 1993 Date
Jac Lawton Jaclyn D. Lawton Environmental Programs Engineer Wisconsin Division Federal Highways Administration	July 20, 1993 Date
Ben A. Wopat Ben A. Wopat Chief, Regulatory Branch U.S. Army Corps of Engineers St. Paul District	20 July 93 Date
Sue Elstad Douglas Ehorn for Chief, Wetland & Watersheds Section U.S. Environmental Protection Agency Region V	July 20, 1993 Date
Janet M. Smith Janet Smith Supervisor, Green Bay Field Office U.S. Fish and Wildlife Service	July 20, 1993 Date

June 1, 1993

Wisconsin Department of Transportation
Wetland Mitigation Banking Technical Guideline.

Introduction.

The Wisconsin state policy on wetland mitigation banking for Wisconsin Department of Transportation (DOT) is established through the amendment to the cooperative agreement (COA) between DOT and the state Department of Natural Resources (DNR) regarding compensatory wetland mitigation (Appendix A). The amendment is applicable under Wis Stats 30.12 (4) and allows for a program of wetland compensatory mitigation banking for DOT activities carried out under the established liaison procedure.

The concept and policy of wetland mitigation banking has been agreed upon within the state of Wisconsin for DOT projects. The **purpose of this guideline is** to establish the liaison and gain the participation of the appropriate federal regulatory, resource and supporting agencies in a statewide program of wetland compensatory mitigation banking with the state agencies. The federal agencies include: The Army Corps of Engineers, the U.S. EPA, the U.S. Fish & Wildlife Service and the FHWA.

Wetland mitigation banking for DOT projects was established within Wisconsin by signature to the DOT/DNR COA amendment by the secretaries of DOT and DNR. Federal participation in Wisconsin statewide mitigation banking will be established by letter of concurrence with procedure contained in this technical guideline by each participating federal agency. The statewide mitigation banking program will not be established unless all federal participating agencies concur. The sponsor of this wetland mitigation bank is the Division of Highways, Wisconsin Department of Transportation. The bank may be used by any entity within DOT which supervises projects under the DOT/DNR Cooperative Agreement.
The operation and maintenance of the DOT wetland mitigation bank will be reviewed by an <u>Interagency Overview Committee (IOC)</u>. The IOC will be composed of a representative from the Corps, U.S. EPA, U.S. Fish & Wildlife Service, FHWA, Wisconsin DNR and DOT. Specific activities of the IOC are outlined under Operational Criteria item 8.

For definitions of special terms used in this guideline, refer to the glossary of terms beginning on page 13.

Background.

Mitigation or measures to minimize harm was defined for the purpose of the implementation of the <u>National Environmental Policy Act (NEPA)</u> 40 CFR 1508.20. Under this definition mitigation includes avoiding and minimizing impacts or reducing impact by preservation and maintenance operations, as well as rectifying through restoring or compensating for the impact by replacement of resource lost.

Executive Order 11990, Protection of Wetlands (1977) directed federal agencies to provide leadership to minimize loss and destruction of wetlands. In response to and in accordance with E.O. 11990 the U.S. DOT revised a 1975 DOT order on wetland preservation and issued DOT 5660.1A, which directed "new construction located in wetlands shall be avoided unless there is no practicable alternative to the construction and the proposed action includes all practicable measures to minimize harm to wetlands which may result from such construction."

The establishment of a mitigation bank for DOT projects is in conformance with NEPA mitigation guidelines and with Executive and DOT Orders provided there are no other practical project alternatives.

The 404(b)(1) Guidelines of the Clean Water Act have a goal of restoring and maintaining aquatic resources. The guidelines are mandated for the 404 permit process. After all practicable measures have been taken to avoid the aquatic resource followed by planning to minimize the impact to the resource that can not be avoided, compensation for the unavoidable loss may be required. A DOT project is any state or local project supervised by the Wisconsin Department of Transportation.

"Appropriate and practicable compensatory mitigation is required for unavoidable adverse impacts which remain after all appropriate and practicable minimization has been required" (Army/EPA MOA Concerning the Determination of Mitigation under Section 404(b)(1) Guidelines, 1990). According to the MOA, mitigation banking "may be an acceptable form of compensatory mitigation under specific criteria designed to ensure an environmentally successful bank." Concurrence with specific criteria developed by DOT as the bank proponent by all affected agencies should ensure participation by those agencies.

Operational Criteria.

1. **Geographic.** The area to be served by the wetland mitigation bank will be the 72 counties of Wisconsin. The bank sites of the mitigation bank will be associated with hydrologic units delineated by the U.S. Geological Survey. The surface waters of the State drain into Lakes Superior or Michigan or to the Mississippi River. These three major drainage basins will form the major geographic areas of the bank. It is anticipated that wetland losses occurring within the three basins would be debited to bank sites within those areas without an increase in replacement ratio and if unavoidable wetland losses can not be compensated on-site.

The three major drainage basins in Wisconsin are further subdivided into 10 watersheds (accounting units) and 48 subwatersheds (cataloging units). The movement of debited wetland losses from one watershed to another will be permitted and is discussed under Evaluation Procedure (item 4).

2. **Bank Life**. The mitigation bank should always maintain a positive acre balance (DOT/DNR COA Amendment). This balance will be reviewed at least annually by the IOC. If a deficit condition arises statewide use of the bank will be temporarily suspended by the IOC until a positive balance is attained. Long term and sustained deficit may result in dissolution of the bank if factors causing chronic deficits can not be resolved.

Under surplus credit condition the bank will exist as long as there is unused credit. Individual bank sites will be available for use by the bank until all available creditable acres have been expended on the site.

Bank sites will be purchased or leased. Purchased sites will be either retained by DOT or donated to DNR, another public entity (e.g. U.S. Fish and Wildlife Service, a County) or to a private entity (e.g. Nature Conservancy) dedicated to natural resource protection. Leased sites will be retained by the land owner, but the property will be deed restricted so that wetland restoration or creation will not be subject to future developments that convert the restored wetland to other uses. The objective in public or private ownership is to protect wetland restorations or creations and maintain them as wetlands in perpetuity.

Arrangements for future operation and maintenance for each bank site will be agreed to by the bank sponsor (DOT) and the potential future owner on a site-by-site basis. The agreement will become part of the bank site record and available for review by the IOC. The final decision will reside with DOT whether a bank site will be retained by DOT or to whom a bank site will be transferred. DOT will seek interagency concurrence for sites retained in private ownership.

3. **Project Applicability Criteria**. The projects eligible for the mitigation banking process are those where all **reasonable** measures to avoid, minimize and rectify harm have already been taken, on-site or near-site compensation is not feasible or practical and the loss of the wetland is unavoidable. Potentially eligible projects will be designated by DOT at the project level in the highway district. These projects will qualify for the process if they conform to the operational criteria of this guideline. All debit/credit transactions to the wetland mitigation bank are subject to review by the IOC. A formal review will be conducted annually. Other reviews may be conducted upon request by any member of the IOC.

The first considerations on mitigation will be given to avoiding and then minimizing wetland loss. For unavoidable losses where compensation is recommended, first consideration will be given to restoration opportunities within the highway right-of-way or near the location of wetland loss. Near-site opportunities for wetland compensation are those within 2.5 miles of either side of the alignment. This provides a five mile search corridor covering the project alignment.

If no reasonable opportunities are available on-site or near-site, second consideration may be given to an off-site wetland restoration. Off-site restoration for compensating unavoidable wetland loss will be considered for the mitigation banking process.

4. **Evaluation Procedure.** Ratios of replacement in the DOT/DNR COA Amendment (Appendix A) are based on the uncertainty of completely establishing the hydrologic regime for project specific wetland restoration or creation projects. Once wetland hydrology and persistent hydroperiod have been established and the risk eliminated the ratio of replacement is one acre replacement for each acre lost. For high risk projects where wetland loss is concurrent with wetland replacement, the initial replacement ratio may be as high as two acres replacement for each acre lost. Since bank sites are established as wetlands before becoming part of the statewide bank, debits from bank sites will be a minimum acre for acre.

According to the 1990 Memorandum of Agreement between the U.S. EPA and the Corps of Engineers on determination of mitigation under the Clean Water Act section 404(b)(1) guidelines, the objective of mitigation for unavoidable wetland losses is to provide functional replacement (sec. III B), i.e. replacement of wetland function.

Since there is uncertainty in the precision of existing methodologies to measure wetland function and some disagreement in using functional wetland assessment methods for evaluation in wetland mitigation banking, arbitrary ratio schedules have been proposed as surrogates for functional wetland replacement. Staff of EPA Region V and the Corps St Paul district have made the assumption that the highest probability of success for replacing the wetland functions and values lost is to compensate in-kind, acre for acre, close to the area of wetland loss (on-site is the first choice, within the same subwatershed the next choice, followed by site choices more distant from the site where loss has occurred).

Where the credit for compensation is in equal acres and wetland type within minimum defined area, the ratio of replacement is acre for acre. If replacement of wetland loss is by a different wetland type or into a different geographical area or both, the debit will be permitted, but the ratio of replacement may be higher and according to a specified schedule described within this section and in Appendix 3C.

Two methods are offered in the EPA/Corps Generic Mitigation

Banking Program Under Section 404 (Wopat and Rockwell, 1991) to develop a schedule of replacement ratios for wetland debits that are out-of-kind and off-site. One suggested method based on historic trends of wetland loss with the intent to replace those categories of wetland that have received greatest losses. A second method is based on interagency agreement to a schedule of replacement factors.

Information needed to develop a system based on loss trends is not currently available in sufficient detail. The greatest concentrations of wetlands in the state occur in the glaciated region, which represents ~~almost two-thirds of the state's area.~~ Agricultural drainage is given as the cause for most of the wetland loss and it is assumed that the wetland types drained consist primarily of wet and sedge meadows, low prairies and shallow and deep marshes. According to information compiled by WDNR on drainage districts (Johnson, 1976), the greatest area for these activities were from the south-central to the northeastern part of the state. Currently drained agricultural land provides the greatest potential for wetland restoration and the opportunity to replace wetlands that were historically lost over large areas.

Since sufficient information is not currently available to develop a complete system of replacement ratios based on loss trends at this time, an interim factor system will be used until a <u>loss trend</u> system is developed or it is decided that the interim system is sufficient to continue operating as the standard. The concept of loss trend is proposed under a factor "professional discretion", which is defined below.

Ratios of replacement in a factor system are derived using the factors <u>Drainage Area</u>, <u>Floristic Province</u>, <u>Wetland Type</u> and a factor based on professional discretion. Replacement within limits specified by these factors assumes wetland function replacement. Replacement outside the limits are considered off-site or out-of-kind or both and is discouraged by requiring a larger replacement ratio.

<u>Drainage area</u> is defined according to the hydrologic units mapped by USGS (1974). For the purpose of this wetland mitigation bank the hydrologic units are grouped into three major drainage areas (Appendix C, Fig. 1C). These drainage areas correspond to "Geographic Area" cited in the DOT/DNR cooperative amendment (Appendix A) and include:

1) Lake Superior,

2) Mississippi River, which includes the St Croix, Chippewa, Trempealeau, Wisconsin, Rock-Fox-Des Plaines river systems,

3) Lake Michigan, which includes Lake Michigan, Fox-Wolf and Menomimee-Oconto-Peshtigo river systems.

If a wetland loss in one drainage area is replaced at a bank site in a second, the added increment is 0.5 acre. The professional discretion factor may reduce or increase the increment. Since the base ratio is 1.0 to 1.0 (replacement to loss), the final replacement ratio would be 1.0 to 1.5 provided no other increments are added from other factors.

Floristic Province is used as a substitute for ecoregion as defined by Omernik and Gallant (1988) or Wells (1988). It has long been recognized (Curtis, 1959) that a tension zone divides Wisconsin into two floristic provinces, which lie north and south of a vegetational zone. It is felt that these two provinces may best represent the ecoregional differences in the state. For purposes of the mitigation bank system, the two provinces are divided along county lines within the band of the tension zone (Appendix C, Fig. 1C).

If a wetland loss on one side of the tension zone is debited to a bank site on the other side of the tension zone, the added increment is one acre, unless the professional discretion factor is employed to reduce it.

Wetland Type is based on a modification of the classification of Shaw and Fredine (1956) and consists of the nine types given in Table 1C (Appendix C). Application of replacement ratio increments is variable and depends on the perceived importance of each type. Specific replacement ratio increments by type are given in Appendix C (Table 2C).

Wetland type may change in time. In general, the intent is to develop wetland bank sites for passive management. Without active management the wetland type at time of establishment may succeed to a different wetland type. For example, a meadow without periodic burning may succeed to shrub wetland or a shrub wetland later subjected to long duration inundation should succeed to a shallow or deep marsh. It is suggested that if a portion of a wetland bank site or the entire bank site was established originally to yield a specific type and remains that type through the first few seasons then it will be given credit as that type for the duration of the bank site.

A table giving increments for compensation ratios for combined factors; Floristic Province, Drainage Area and Wetland Type is provided in Table 3C (Appendix C). These increments when added to the floor of one will give the final replacement side of the replacement/loss compensation ratio. The replacement side can be modified by the following "professional discretion" factor provided the compensation ratio does not fall below 1:1.

Professional Discretion factor corresponds to the "site specific factor" of Wopat and Rockwell (1991), which gives the intent of this factor to provide ".... additional latitude in determining the compensational ratio will allow the mitigation bank to take advantage of unique circumstances and to arrive at a beneficial compensatory mitigation situation where a rigid ratio system might otherwise not have allowed this to occur." For the purposes of this mitigation bank system the range given for this factor is - 0.5 to + 0.5.

Some example applications of this factor are:

- 0.5, if wetland type lost is abundant on a statewide basis and the compensation wetland type at the bank site is unique or represents restoration of wetlands that have been lost historically on large scale. For example, degraded wet meadows adjacent to highways or bridge approaches that are lost to highway improvement or bridge replacement projects, but replaced by restored wetlands previously drained for agriculture would receive a 0.5 acre reduction in debit.

- 0.5, if wetland lost and bank site are geographically close, but fall just to either side of Drainage Area or Floristic Province boundaries.

+ 0.5, if the wetland unavoidably lost is rare ecologically or hydrologically unique (e.g. a Fen).

Other examples will become apparent as experience is gained with operating the bank.

Some wetland types are considered sensitive and have been assigned a critical status by resource agencies and society. These wetlands are commonly referred to as "red flag" wetlands. Such wetlands may possess one or more of the following characteristics:

1. Wetland is unique to its locality.
2. Wetland is ecologically unique. In Wisconsin these include fens and wild rice producing wetlands.
3. A resource agency has placed a nationwide emphasis on its protection. In Wisconsin these would include those riparian forested wetlands that are identified as "bottomland hardwoods" by the U.S. Fish and Wildlife Service.
4. Presence or use by federal or state threatened or endangered species.
5. Public or private expenditure has been made to restore, protect or ecologically manage the wetland on either public or private land.
6. Wetland is on a listing of historic places or archeological sites.

The debit of wetland loss of "red flag" wetlands will be determined by the IOC on a case by case basis.

5. Bank Credit, Debit and Accounting Procedures.

Basically there are three categories of wetland compensation projects; project specific, project specific with a surplus and bank developed. Project specific wetland compensation projects are those that are developed for a particular highway or bridge project and the amount of wetland compensation is equal to the amount needed for the project. For those project specific compensation projects that establish surplus acres, the surplus acres become a bank site. Bank developed sites may be independent of specific highway projects and are established in advance of known wetland losses.

The compensation ratios given in the DOT/DNR Cooperative Agreement amendment and those developed under the federal generic mitigation guideline to accommodate off-site and out-of-kind replacement are applied to these compensation project categories.

If project specific or surplus generating project specific projects produce restored wetlands that are established prior to wetland losses, the ratio of replacement is one acre restored/created for one acre lost (1:1). If these types of projects are restored at the same time or shortly after the wetland losses then the ratios of replacement can be 1.5:1 to 2:1 based on risk assessment.

Bank developed compensation projects and the surplus from project specific projects are pre-established wetlands and the 1:1 ratio is applied to all losses that are within floristic province, drainage area and wetland type. Additions to the floor of 1:1 replacement are based on the criteria discussed in item 4 above and detailed in Appendix C.

Accounting and reporting. Reports on wetland mitigation bank statewide status will be submitted to member agencies of the IOC at a minimum of one per year. Current status of the mitigation bank in regional areas is open to review at any time upon request. Information contained in reports shall contain at a minimum: Location of wetland loss (DOT Highway/Bridge project, County), wetland acres lost by wetland type, location of wetland replacement (bank site) and rate of replacement in acres by wetland type. Reports will be due on December 31 each year. Table 1D (Appendix D) provides the basic format for statewide reporting.

6. **Bank Site Establishment.** Wetland mitigation bank sites will be established for DOT wetland mitigation bank in different areas of the state. The process for bank site establishment is given in Appendix B. The ability to acquire restorable sites will depend on a private land owner's willingness to sell or lease in perpetuity the land identified for a bank site. Use of public land will be bound by agreements among the public agencies.

A DOT interdisciplinary science and engineering team should be established to assist in the development of plans and specifications for wetland restoration and creation. This Wetland Technical Team will assist the district project staff and environmental coordinator in bank site and project specific developments, monitoring and critique. Use of this team will be on the premise that a well planned and executed project will be less likely to require remediation and rectification.

The essential science fields for this team are hydrogeology, surface water hydrology, wetland ecology and geomorphology. Basic civil engineering fulfills the engineering needs.

Staff can be allocated to the team as needed and is dependent on the needs of the project. The team should have at its disposal or access to at least one:

Hydrogeologist
Hydrologist
Wetland Ecologist
Geomorphologist
Soil Scientist
Landscape Architect
Civil Engineer

Currently (1992) the fields of civil engineering, landscape architecture, wetland ecology, soil science and geomorphology are available in DOT. The field of hydrogeology is needed. Surface hydrology may be acquired through civil engineers in DOT with that experience.

This team should maintain contact with resource agencies such as WDNR, Soil Conservation Service, U.S. Geological Survey, U.S. Fish & Wildlife Service, State Geological Survey, Corps of Engineers and U.S. EPA.

7. **Bank Site Development and Maintenance.** This section refers to the development and maintenance of the physical and biological attributes of bank sites.

In the context of compensatory wetland mitigation the obligation of DOT is to compensate by means of wetland restoration and creation for wetlands lost due to DOT facility development. Development of specific wetland habitat features for wildlife management is not required to compensate for wetland loss. Habitat features at the mitigation site should be determined and agreed to in the mitigation planning process and specified in the plan. Objectives based on wetland function at bank sites are determined by the mitigation plan.

Credit of each site should be based on the establishment of those attributes that define a wetland, i.e. wetland hydrology, hydric soils and hydrophytic vegetation. First consideration will be given to wetland hydrology and evidence of a persistent hydroperiod. For site developments consideration will be given to establishing a diversity of wetland vegetational types, but not to the extent that such developments are inappropriate for the hydrogeomorphological potential of the site. Recommendations from resource agencies will be sought, considered and concurrence reached in bank site selection and development.

In the development of plans for bank sites emphasis will be placed on projects that result in low operational and maintenance costs (DOT/DNR COA). Facilities that require passive management are encouraged. Future operations and maintenance of a site will be part of plan development.

Based on experience so far gained, wetland restoration of drained wetlands is the preferred technique for bank site development. Larger sites provide an economy of scale and represents an efficient use of public funds. The greatest potential for finding sites with these characteristics is in the state's glaciated region, particularly from south-central to northeastern areas of the state. The lowest potential is found in the driftless areas in the southwestern part of the state and areas of low agricultural development in northeastern and northcentral Wisconsin.

8. **Bank Management and Reporting Responsibility.** The purpose of this section is to define the organizational structure necessary to carry out the functions of the DOT Wetland Mitigation Bank and associated wetland compensatory mitigation projects. Components of the organization have responsibility to provide interagency communication and coordination, supervise accounting for the statewide system and provide a mechanism to resolve procedural as well as technical problems. Organizational components of the DOT statewide mitigation bank will consist of three entities: the IOC, a DOT wetland bank coordination team and a DOT wetland interdisciplinary design team (see section 6).

Interagency Overview Committee (IOC). This interagency work group will be responsible for reviewing wetland bank credit and debit reporting and whether specific projects meet the project applicability criteria outlined in section 3. Elevation of any issues requiring administrative resolution will be referred to the appropriate supervisory level of each member agency.

The IOC will be available to monitor bank sites by means of data and field reviews. This should assure that bank sites have been established as wetlands. The IOC will receive assistance from the DOT Interdisciplinary Design Team in making determinations and formulating solutions. Only bank sites established as wetlands are creditable under the mitigation bank system.

Each agency will be represented equally on the IOC. During IOC deliberations several individuals from each agencies may be present, but each agency will have one vote. Passage of any transactions put before the IOC should be by unanimous consent of the members.

The membership of the IOC will include representatives from U.S. EPA, Corps of Engineers, U.S. Fish & Wildlife Service, FHWA, Wisconsin DNR and DOT. Bank operations will be conducted by staff within the Division of Highways (DOT). The member representing DOT on the IOC will be drawn from OEA. Transportation District environmental staff will be available for assistance for DOT on the IOC. The district environmental staff will be responsible for local accounting and a minimum of one member should be present at each IOC meeting.

DOT Wetland Mitigation Bank Coordination Team. The purpose of this work group is to ensure the intra-agency coordinated operation of the DOT bank functions statewide. The team will establish an interaction between the central office and transportation district offices to resolve problems in site selection, acquisition, development, monitoring and reporting. It is not necessary that these groups meet as teams, but that an effective communication network is established between the statewide entity and the local entity for each function and where there is overlap of function.

The primary elements of the group are environmental, design and real estate. Since GIS is planned as a part of reporting, the central office and district GIS staff will be associated with this team. Communications to construction, materials and maintenance functions can be conducted through design and environmental members.

A team of the primary components will be established in the central office with one member being drawn from OEA, Real Estate and design or district planning. Each district will have a comparable team composed of the district environmental coordinator and at least one member determined by the district and representing both real estate and design. Teams will work together and with GIS staff on an as need basis.

Agency Obligations.

The wetland mitigation bank for DOT projects requires the participation of several public agencies. Included are the Wisconsin Departments of Transportation and Natural Resources and the federal agencies, Army Corps of Engineers, U.S. EPA, U.S. Fish & Wildlife Service and Federal Highway Administration.

In general, DOT (DOH) as the project sponsor will develop bank sites, while all other agencies through their concurrence will support the use of these sites for compensatory wetland mitigation under the section 404 guidelines, NEPA, Executive Order 11990, the Fish and Wildlife Coordination Act and the state DOT/DNR COA compensatory wetland mitigation amendment.

Specific obligations and responsibilities of each agency are as follows:

DOT has been assigned the responsibility by the state to provide and adequate, safe and economical transportation system for the people and the commerce of the state. Programs and plans for transportation facility development have been established for specific improvement projects. These projects can cause unavoidable losses to the waters of the United States including wetlands and other special aquatic sites.

DOT with assistance from resource agencies will find and identify potential bank sites. Once a potential site has been located and concurrence has been made on the feasibility of its restoration to a wetland, DOT will:

* Acquire the site from a willing seller.
* ~~Determine and arrange for future ownership of the site.~~
* Prepare reports and plans for developing the site. Emphasis will be placed on strong and comprehensive plan development.
* Develop cost estimates and specifications for construction, landscape operations and follow-up contingencies identified in plans.
* Supervise construction.
* To conduct or arrange for follow-up monitoring according to terms specified in site plans.
* Remediate construction deficiencies.
* Establish in coordination with the regulatory and resource agencies the limits and size of the restored wetland. This may be done using approved federal agency procedures of Wetland Delineation.
* Where a bank site is under a lease agreement with a private entity, DOT will insure the long term protection, maintenance and remediation of bank sites.

DOT will be responsible for maintaining mitigation bank accounting and generating reports for the IOC.

WDNR. WDNR has the responsibility to protect and manage the natural resources of the state. Obligations of DNR to wetland mitigation banking for DOT projects is established through the DOT/DNR COA amendment (Appendix A) and in procedures for wetland mitigation bank site establishment (Appendix B). WDNR will make available a representative for the IOC.

Corps of Engineers. The Corps administers the regulatory program under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899. In the construction of transportation projects Section 404 and/or Section 10 permits are required for the discharge of dredge and fill material into waters of the United States and any work done in Navigable Waters of the United States. The Corps will make available a representative for the IOC.

U.S. EPA. The U.S. EPA has the responsibility to require that all activities needing a permit under Section 404 of the Clean Water Act fully comply with all applicable parts of the Guidelines to Section 404, known as the 404 (b)(1) Guidelines. In addition, if the project is subject to the National Environmental Policy Act, it is EPA's responsibility to require compliance to that Act. The EPA will make available a representative for the IOC.

U.S. Fish & Wildlife Service. The Service is responsible for conserving and protecting fish and wildlife and their habitats for the benefit of people through federal programs relating to migratory birds, endangered species, certain marine mammals, inland sport fisheries and specific fishery and wildlife research activities. Replacement of wetland habitat values is consistent with that agency's goals and responsibilities. The Service has the responsibility to provide consultation pursuant to the Fish and Wildlife Coordination Act. The Service will make available a representative for the IOC.

Federal Highway Administration. The role of FHWA is to approve project federal aid funding. In carrying out this responsibility, FHWA will assure coordination activities are carried out with regulatory and resource agencies to the extent necessary to secure compliance with the National Environmental Policy Act and executive orders for protection of natural resources. FHWA will make available a representative for the IOC.

References.

Curtis, J.T. 1959. Vegetation of Wisconsin. University of Wisconsin Press, Madison, Wi. 657 pp.

Henrick, E.W. and D.N. Daniel. Drainage Area Data for Wisconsin Streams. U.S. Geological Survey Open-File Report 83-933.

Johnson, C.D. 1976. Wetland Use in Wisconsin. Report by Wisconsin Department of Natural Resources. 48 pp.

Omernik, J.M. and A.L. Gallant. 1988. Ecoregions of the Upper Midwest States. U.S. EPA Environmental Research Laboratory. EPA/600/3-88/037. 56 PP.

Page, R.W. and L.S. Wilcher. 1990. Memorandum of Agreement between the Environmental Protection Agency and the Department of the Army Concerning the Determination of Mitigation under the Clean Water Act Section 404(b)(1) Guidelines. 6 pp.

Shaw, S.P. and C.G. Fredine. 1956. Wetlands of the United States. U.S. Fish and Wildlife Service. Cir. 39. 67 pp.

Short, C. 1988. Mitigation Banking. U.S. Fish and Wildlife Service. Biological Report 88 (41).

USGS. 1974. Hydrologic Unit Map- 1974. Wisconsin. United States Department of Interior Geologic Survey. 1 p.

Wells, J.R. 1978. The Minnesota Wetland Evaluation Methodology for North Central United States. 1st ed. St. Paul District U.S. Army Corps of Engineers. 97 pp. Appendices.

Wopat, B. and T.L. Rockwell, 1991. Generic Mitigation Banking Program under Section 404. Corps of Engineers, St Paul District and U.S. EPA Region V Mitigation Banking Guideline. Minnesota and Wisconsin Mitigation Banking Workgroup. 7 pp. Appendices.

Wisconsin Department of Transportation. 1988. Patrick Lake Wetland Mitigation Bank for Transportation District 1 Wisconsin Department of Transportation Highway Projects. Plan and procedure. 17 pp.

Glossary of Terms.

[Refer to the DNR/DOT COA Amendment (Appendix A) for the definitions for the terms: <u>Compensation</u>, <u>Creation</u>, <u>Mitigation</u>, <u>Mitigation Banking</u>, <u>Restoration</u>, <u>Unavoidable Wetland Loss</u>, <u>Wisconsin State</u> definition of <u>Wetland</u>]

Compensation Project Types:

<u>Bank Developed</u>: Wetland mitigation project that establishes wetland for the purpose of developing a wetland mitigation bank site irrespective to and in advance of any specific facilities development projects.

<u>Project Specific</u>: Wetland mitigation project that compensates for the amount of wetland loss of a specific facility development project, i.e. the amount of wetland established compensates only for wetland loss due to the facilities project.

<u>Project Specific with Surplus</u>: Wetland mitigation project that compensates for more than the wetland loss of a specific facility development project, i.e. the amount of wetland established exceeds that needed for the facility development projects. Surplus acres by wetland type are produced.

Degraded Wetland: Wetland that has been exposed to deleterious activities such as excessive use as pasture, agricultural cultivation, over exposure to urban effects or stormwater runoff to the extent that its natural characteristics have been severely compromised and where wetland function has been substantially reduced.

Enhancement: Refers to increasing one or more functions of an existing wetland by means of management techniques, which increases and improves function, but does change wetland type. For example, use of prescribed burning, weed control and seeding to establish a wet prairie on a reed canary grass and shrubby wet meadow.

Exchange: Conversion of one wetland type for another. For example, impoundment of surface water onto an existing sedge meadow to establish a shallow to deep marsh.

In-Kind Replacement: Wetland loss replaced with wetland from a compensation project of the same or similar type.

Near-Site Replacement: Replacement opportunity for wetland compensation within a five mile corridor centered over the highway project alignment.

Off-Site Replacement: Wetland replacement located away from the project site, generally outside the project's local watershed.

On-Site Replacement: Wetland replacement located in the general proximity of the project site within the same local watershed. These replacements are often contiguous to the highway project.

Out-of-Kind Replacement: Wetland loss replaced with wetland from a compensation project of a different type.

Preservation: Acquisition of existing wetland for the purpose of protection.

Remediation: Action taken to correct unforeseen deficiencies in a wetland compensation project. The action may take the form of correcting planned construction methods incorrectly installed or not installed, repairing installed facilities through maintenance operations, or ,if on-site remediation is not possible, the resulting debit can be transferred to a bank site through the bank process.

Riparian Wetland: A wetland adjacent to a river, stream or lake that is periodically flooded.

Vernal Pool: A seasonally flooded non-riparian wetland found in topographical depressions, i.e. seasonally flooded basins isolated from the tributary system. They are usually small (less than a few acres) in size.

Watershed: A drainage area or basin that contributes surface and ground water to a stream, river, lake or isolated wetland basin.
The term can be used interchangeably with <u>drainage basin</u> or <u>contributing area</u>.

Wetland: Wetlands are those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands include swamps, marshes, bogs and similar areas [40 CFR 230.3 (t)].

Wetlands are those areas that are inundated by surface or ground water with a frequency sufficient to support and under normal circumstances does or would support a prevalence of vegetative or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction. [Executive Order 11990].

Wetland Mitigation Bank: A system of accounting for wetland loss and compensation, which can include one to many wetland mitigation bank sites.

Wetland Mitigation Bank Site: A wetland compensation site containing wetland credit acres and types from bank developed wetland restoration/creation projects or surplus acres from the wetland compensation projects of specific DOT facility development projects.

APPENDIX A

Amendment to the Cooperative Agreement between DNR and DOT on Compensatory Wetland Mitigation

COMPENSATORY MITIGATION POLICY FOR UNAVOIDABLE WETLAND LOSSES RESULTING FROM STATE TRANSPORTATION ACTIVITIES

an amendment to the Interagency Cooperative
Agreement between the

WISCONSIN DEPARTMENT OF NATURAL RESOURCES

and the

WISCONSIN DEPARTMENT OF TRANSPORTATION

PURPOSE AND APPLICABILITY

The purpose of this document is to provide mutual departmental policy and procedures for seeking compensatory mitigation for unavoidable wetland losses resulting from state transportation activities. It is appropriate for staff to apply this policy to any activity subject to the Interagency Cooperative Agreement (ICA) between the Wisconsin Departments of Natural Resources and Transportation (DNR, DOT). This applicability is inclusive of the Chapter 30.12(4), Wis. Stats., the Department of Transportation permit exemption and requirement of interdepartmental coordination of environmental protection measures pertaining to structures and fills in navigable waters of the State. It is also applicable to DOT airport, railroad, and port/harbor projects that are covered under the ICA.[1] Both non-emergency, new construction and maintenance construction activities are covered under this policy.

STATEMENT OF POLICY.

The public missions of the Department of Natural Resources -- to protect, manage and enhance the state's natural resources, and that of the Department of Transportation -- to provide the people of Wisconsin with a safe and efficient network of transportation facilities, have resulted in the need to devise a way to accommodate both. In most cases, coordinated transportation/natural resource planning should result in the avoidance or minimization of wetland impacts to a great extent. Locational factors often place constraints on siting alternatives for transportation facilities because of the linear nature of much transportation development and the requirement for specific standards of design for safety reasons; therefore transportation projects sometimes result in wetland losses that cannot be avoided.

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[1] It is understood that the local or private sponsor of an airport, railroad, or port/harbor must obtain all appropriate regulatory permits notwithstanding the provisions of this policy.

The DOT will consider compensatory wetland mitigation in the priority order of restoration and creation, for the unavoidable loss of wetland resulting from transportation construction and maintenance activities funded all or in part by the DOT.

A system of mitigation banking shall be established to deal equitably with cumulative wetland losses resulting from transportation projects.

POLICY GUIDANCE ON MITIGATION

Natural Resources Board Policy (NR 1.95, Admin. Code) regarding wetland preservation, protection, and management shall be followed in concert with this policy. Environmental evaluation of transportation projects involving wetlands must conform to the standards of NR 1.95(5)(a). Staff should take special note of NR 1.95(6)(f), which prohibits DNR staff from "...recognizing the conveyance of land (or other consideration) to local units of government, the state of Wisconsin or the federal government as off-setting the adverse impacts of the proposal and shall consider the net effects of the action by itself."

After wetland impacts related to the proposed transportation project have been avoided and minimized to the maximum extent practical, DNR and DOT staff shall use the following guidance in order to compensate for unavoidable wetland losses:

1. The goal of compensatory mitigation is no net wetland loss.

2. Preference shall be given to compensatory mitigation that restores former or marginal wetlands, followed by creation of new wetlands where it is technically feasible to do so.

3. Compensation for wetland acres lost shall be based on an evaluation of both primary (direct) and secondary (indirect) impacts. Secondary impacts are those effects which are caused by the project but occur later in time but are still reasonably foreseeable (for example, drainage changes resulting from the project). Adjacent private land use developments are not secondary impacts under this policy.

4. As a general rule, compensatory mitigation should be planned based on replacement of the acreage of the impacted wetlands at the following ratios (replacement acreage:acreage lost):

    1.0:1.0, where wetland acreage losses are applied to an established mitigation bank at the time of loss;

    1.5:1.0, where wetland acreage losses are mitigated as part of a concurrent transportation project design <u>and</u> where both DNR and DOT staff concur that there is a high probability of success of the mitigation[2];

2.0:1.0, where wetland losses are mitigated as part of a concurrent transportation project design and where both DNR and DOT staff concur that there is not a high probability of success of the mitigation[3].

These ratio's may be modified to compensate for out-of-kind replacement (see Technical Guidelines). ~~Minimum replacement will be at 1:1.~~

5. Preference should be given for compensatory mitigation accomplished in the vicinity of the impacted area. Where such opportunities are not present or practical, in-watershed opportunities should be explored.

6. Preference shall be given to locating compensatory mitigation projects on lands not presently under DNR ownership.

7. Provision for long-term protection must be made for all mitigated efforts, including who will own the mitigation site, and who will be responsible for long-term management.

8. In formulating compensatory mitigation plans, preference should be given for techniques that result in low operation and maintenance costs.

9. Compensatory mitigation should be accomplished in concert with, or prior to, the construction of the transportation project.

10. Compensatory mitigation projects may include a long-term "effectiveness" monitoring program that establishes baseline conditions, goals and objectives, and a plan of study that will allow an evaluation of the mitigation effort. The extent of monitoring necessary should be determined by DOT/DNR staff in the development of the mitigation plan. Monitoring programs should be of enough specific detail to allow them to be used as performance standards of mitigation efficacy. Provision of monitoring program funding should be included as part of mitigation costs, and should be of a sufficient amount to provide monitoring for up to five years past construction of the mitigation project. Compliance monitoring should be accomplished on all projects. Effectiveness monitoring normally should be provided on mitigation banking projects that are on sites of

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[2] Suggested staff guidance for such so-called "low risk" mitigation is wetland restorations (e.g., removing or blocking drainage structures) where it is deemed likely that former hydrology can be reestablished, and wetland creations that are extensions or enlargements of an existing wetland basin.

[3] Suggested staff guidance for such so-called "high risk" situations is wetland creations where there is uncertainty about the ability to sustain hydrologic conditions needed for wetland establishment (for example, isolated excavated basins), and wetland restorations where there are limitations to restoring the hydrology or other wetland conditions formerly present.

sufficient size and character to advance the knowledge of wetland restoration and creation. Selection of such sites will be made by mutual agreement of DOT and DNR staff.

11. Any compensatory mitigation proposal shall include coordination with the United States Fish and Wildlife Service, Environmental Protection Agency, Army Corps of Engineers, and Federal Highway Administration to facilitate interagency coordination and participation (see Technical Guideline). Interagency conflicts regarding appropriate compensatory mitigation will be resolved through established conflict resolution mechanisms prior to construction of the transportation project.

    Where federal mitigation policy indicates more extensive mitigation is warranted than is required by this agreement, federal requirements will prevail, unless such federal mitigation is determined by DNR and DOT staff to be technically unfeasible, inconsistent with the spirit of this agreement or NR 1.95 (Admin. Code), or requires an unwarranted management or financial commitment by the state of Wisconsin.

POLICY GUIDANCE ON MITIGATION BANKING

It shall be the Departments' policy to utilize a mitigation banking system to compensate for unavoidable wetland losses. The following guidance specific to mitigation banking is to be utilized.

1. A mutually agreed upon mitigation banking accounting procedure will be used by DNR and DOT. The currency for the mitigation bank will be based on area and is further developed in the Technical Guideline.

2. The mitigation bank should always maintain a positive balance.

3. Preference should be given to limiting mitigation banking transactions to the geographical area in which the impacts occur. The limits and scale of geographical area (acres) are given in the Technical Guideline.

4. Transfers of project-specific wetland losses may be made to mitigation bank sites that may exist around the state by mutual agreement of DOT and DNR staff and the participating federal agencies (see Technical Guideline).

5. Mitigation banking areas shall be selected based on their restoration or creation potential, and should be of a size and nature to possess wetland functions and values when complete.

DEFINITIONS USED IN THIS POLICY

Compensation --	Wetland restoration or creation (or combination thereof) that results in a size-equivalent wetland(s) to the one(s) taken, resulting in no net loss of wetland acres.
Creation --	Establishment of a wetland on a site that was never before a wetland.
Mitigation --	As used in this agreement, compensation for unavoidable wetland losses resulting from a state transportation development or maintenance activity. To be applied after avoidance and minimization of wetland resources has been achieved to the most practical extent.
Mitigation banking --	A program mutually established by the Departments of Transportation and Natural Resources, with concurrence and oversight by the appropriate federal agencies, that permits unavoidable wetland losses to be debited to a prior-established and constructed wetland mitigation bank site.
Restoration --	Reestablishment of a wetland on a site that was once a wetland or rehabilitation of a degraded wetland. Degraded wetlands are wetlands altered by human or other activities to the point where wetland function has been substantially reduced.
Unavoidable wetland loss --	An impact to a wetland that occurs as the result of no other feasible project alternative.
Wetland --	As defined in Section 23.32, Wis. Stats., "an area where water is at, near, or above the land surface long enough to be capable of supporting aquatic or hydrophytic vegetation and which has soils indicative of wet conditions."

APPENDIX AA

Amendment to the Cooperative Agreement between DNR and DOT on Compensatory Wetland Mitigation

COMPENSATORY MITIGATION POLICY FOR UNAVOIDABLE WETLAND LOSSES RESULTING FROM STATE TRANSPORTATION ACTIVITIES

an amendment to the Interagency Cooperative
Agreement between the

WISCONSIN DEPARTMENT OF NATURAL RESOURCES

and the

WISCONSIN DEPARTMENT OF TRANSPORTATION

PURPOSE AND APPLICABILITY

The purpose of this document is to provide mutual departmental policy and procedures for seeking compensatory mitigation for unavoidable wetland losses resulting from state transportation activities. It is appropriate for staff to apply this policy to any activity subject to the Interagency Cooperative Agreement (ICA) between the Wisconsin Departments of Natural Resources and Transportation (DNR, DOT). This applicability is inclusive of the Chapter 30.12(4), Wis. Stats., the Department of Transportation permit exemption and requirement of interdepartmental coordination of environmental protection measures pertaining to structures and fills in navigable waters of the State. It is also applicable to DOT airport, railroad, and port/harbor projects that are covered under the ICA.[1] Both non-emergency, new construction and maintenance construction activities are covered under this policy.

STATEMENT OF POLICY

The public missions of the Department of Natural Resources -- to protect, manage and enhance the state's natural resources, and that of the Department of Transportation -- to provide the people of Wisconsin with a safe and efficient network of transportation facilities, have resulted in the need to devise a way to accommodate both. In most cases, coordinated transportation/natural resource planning should result in the avoidance or minimization of wetland impacts to a great extent. Locational factors often place constraints on siting alternatives for

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[1] It is understood that the local or private sponsor of an airport, railroad, or port/harbor must obtain all appropriate regulatory permits notwithstanding the provisions of this policy.

transportation facilities because of the linear nature of much transportation development and the requirement for specific standards of design for safety reasons; therefore transportation projects sometimes result in wetland losses that cannot be avoided.

The DOT will consider compensatory wetland mitigation in the priority order of restoration and creation, for the unavoidable loss of wetland resulting from transportation construction and maintenance activities funded all or in part by the DOT.

A system of mitigation banking shall be established to deal equitably with cumulative wetland losses resulting from transportation projects.

POLICY GUIDANCE ON MITIGATION

Natural Resources Board Policy (NR 1.95, Admin. Code) regarding wetland preservation, protection, and management shall be followed in concert with this policy. Environmental evaluation of transportation projects involving wetlands must conform to the standards of NR 1.95(5)(a). Staff should take special note of NR 1.95(6)(f), which prohibits DNR staff from "...recognizing the conveyance of land (or other consideration) to local units of government, the state of Wisconsin or the federal government as off-setting the adverse impacts of the proposal and shall consider the net effects of the action by itself."

After wetland impacts related to the proposed transportation project have been avoided and minimized to the maximum extent practical, DNR and DOT staff shall use the following guidance in order to compensate for unavoidable wetland losses:

1. The goal of compensatory mitigation is no net loss of wetland acreage.

2. Preference shall be given to compensatory mitigation that restores former or marginal wetlands, followed by creation of new wetlands where it is technically feasible to do so.

3. Compensation for wetland acres lost shall be based on an evaluation of both primary (direct) and secondary (indirect) impacts. Secondary impacts are those effects which are caused by the project but occur later in time but are still reasonably foreseeable (for example, drainage changes resulting from the project). Adjacent private land use developments are not secondary impacts under this policy.

4. As a general rule, compensatory mitigation should be planned based on replacement of the acreage of the impacted wetlands at the following ratios (replacement acreage:acreage lost):

   1.0:1.0, where wetland acreage losses are applied to an established mitigation bank at the time of loss;

   1.5:1.0, where wetland acreage losses are mitigated as part of a concurrent transportation project design <u>and</u> where both DNR and DOT staff concur that there is a high probability of success of the mitigation[2];

   2.0:1.0, where wetland losses are mitigated as part of a concurrent transportation project design <u>and</u> where both DNR and DOT staff concur that there is <u>not</u> a high probability of success of the mitigation[3].

5. Preference should be given for compensatory mitigation accomplished in the vicinity of the impacted area. Where such opportunities are not present or practical, in-watershed opportunities should be explored.

6. Preference shall be given to locating compensatory mitigation projects on lands not presently under DNR ownership.

7. Provision for long-term protection must be made for all mitigated efforts, including who will own the mitigation site, and who will be responsible for long-term management.

8. In formulating compensatory mitigation plans, preference should be given for techniques that result in low operation and maintenance costs.

9. Compensatory mitigation should be accomplished in concert

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[2] Suggested staff guidance for such so-called "low risk" mitigation is <u>wetland</u> <u>restorations</u> (e.g., removing or blocking drainage structures) where it is deemed likely that former hydrology can be reestablished, and <u>wetland</u> <u>creations</u> that are extensions or enlargements of an existing wetland basin.

[3] Suggested staff guidance for such so-called "high risk" situations is <u>wetland</u> <u>creations</u> where there is uncertainty about the ability to sustain hydrologic conditions needed for wetland establishment (for example, isolated excavated basins), and <u>wetland</u> <u>restorations</u> where there are limitations to restoring the hydrology or other wetland conditions formerly present.

with, or prior to, the construction of the transportation project.

10. Compensatory mitigation projects may include a long-term "effectiveness" monitoring program that establishes baseline conditions, goals and objectives, and a plan of study that will allow an evaluation of the mitigation effort. The extent of monitoring necessary should be determined by DOT/DNR staff in the development of the mitigation plan. Monitoring programs should be of enough specific detail to allow them to be used as performance standards of mitigation efficacy. Provision of monitoring program funding should be included as part of mitigation costs, and should be of a sufficient amount to provide monitoring for up to five years past construction of the mitigation project. Compliance monitoring should be accomplished on all projects. Effectiveness monitoring normally should be provided on mitigation banking projects that are on sites of sufficient size and character to advance the knowledge of wetland restoration and creation. Selection of such sites will be made by mutual agreement of DOT and DNR staff.

11. Any compensatory mitigation proposal shall include contacts with the United States Fish and Wildlife Service, Environmental Protection Agency, Army Corps of Engineers, and Federal Highway Administration to facilitate interagency coordination and cooperation. Interagency conflicts regarding appropriate compensatory mitigation will be resolved through established conflict resolution mechanisms prior to construction of the transportation project.

    Where federal mitigation policy indicates more extensive mitigation is warranted than is required by this agreement, federal requirements will prevail, unless such federal mitigation is determined by DNR and DOT staff to be technically unfeasible, inconsistent with the spirit of this agreement or NR 1.95 (Admin. Code), or requires an unwarranted management or financial commitment by the state of Wisconsin.

POLICY GUIDANCE ON MITIGATION BANKING

It shall be the Departments' policy to utilize a mitigation banking system to compensate for unavoidable wetland losses. The following guidance specific to mitigation banking is to be utilized.

1. A mutually agreed upon mitigation banking accounting procedure will be used by DNR and DOT. The currency for the mitigation

bank will be bank-acres.

2. The mitigation bank should always maintain a positive acre-balance.

3. Preference should be given to limiting mitigation banking transactions to the geographical area in which the impacts occur.

4. Transfers of project-specific wetland losses may be made to mitigation banks that may exist around the state by mutual agreement of DOT and DNR staff.

5. Mitigation banking areas shall be selected based on their restoration or creation potential, and should be of a size and nature to possess wetland functions and values when complete.

DEFINITIONS USED IN THIS POLICY

Compensation -- Wetland restoration or creation (or combination thereof) that results in a size-equivalent wetland(s) to the one(s) taken, resulting in no net loss of wetland acres.

Creation -- Establishment of a wetland on a site that was never before a wetland.

Mitigation -- As used in this agreement, compensation for unavoidable wetland losses resulting from a state transportation development or maintenance activity. To be applied after avoidance and minimization of wetland resources has been achieved to the most practical extent.

Mitigation banking -- A program mutually established by the Departments of Transportation and Natural Resources that permits unavoidable wetland losses to be credited to a prior-established and constructed wetland area referred to as a "mitigation bank".

Restoration -- Reestablishment of a wetland on a site that was once a wetland or rehabilitation of a marginal wetland. Marginal wetlands are wetlands altered by human or other activities to the point where the site no longer functions as a wetland.

Unavoidable wetland loss -- An impact to a wetland that occurs as the result of no other feasible project alternative.

Wetland -- As defined in Section 23.32, Wis. Stats., "an area where water is at, near, or above the land surface long enough to be capable of supporting aquatic or hydrophytic vegetation and which has soils indicative of wet conditions."

Wisconsin Department of Natural Resources

CD Besadny

C. D. Besadny, Secretary

11-7-90

Date

Wisconsin Department of Transportation

Ronald R Fiedler

Ronald F. Fiedler, Secretary

10/30/90

Date

APPENDIX B

Bank Site Establishment

APPENDIX B

Wetland Mitigation Bank Site Establishment and Process

A wetland mitigation bank will be used to compensate for unavoidable wetland losses caused by a Department of Transportation project where the sequence of mitigation steps of Avoid, Minimize and Compensate on-site have been followed in that order. All reasonable efforts to **avoid** wetland loss will be made before minimization and compensation are considered. The mitigation bank process will be integrated into the DOT Facilities Development Process. Applicable elements of this process can be used for compensational mitigation projects that are not banks. This process is established under the DOT/DNR Cooperative Agreement amendment on wetland mitigation.

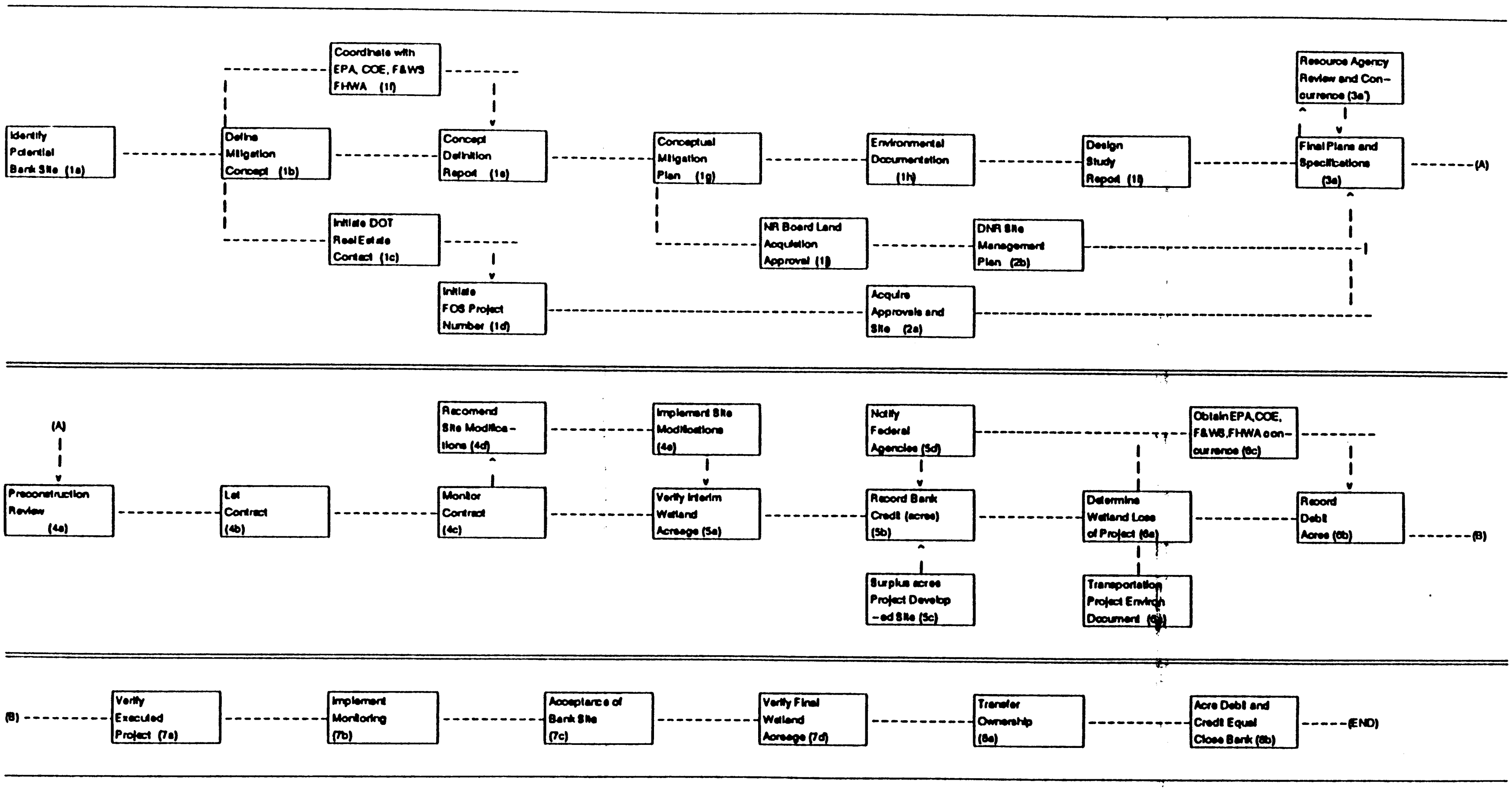
Bank Process.

Bank Project Stage	Action (Responsibility)
1. Site Selection	(a) Identify potential bank site from preestablished inventory and field review (DNR/DOT). Determination of site potential is based initially on the level of risk in site restoration and creation (DNR/DOT). Make preliminary archeological determination (DOT). (b) Define mitigation concept based on initial assessment of identified site. This assessment should provide topological, geological and hydrological evidence that the site has the potential to support a wetland (DOT/DNR assist). Make preliminary determination of future site ownership (DOT/DNR). (c) DOT real estate initiate contact with landowner. Determine feasibility of purchase (DOT). (d) Initiate a FOS project number (DOT). (e) Prepare and submit Concept Definition Report (DOT). (f) Coordinate with EPA, COE, FWS, FHWA on mitigation concept and request review and comment (DOT/DNR assist). (g) Develop conceptual mitigation plan. Plan is to include location, size (acres), restoration/creation objective, anticipated hydrology, wetland type, disposition of special features, monitoring plan based on objective.

	Determine future management and if future operation and management costs will apply (DOT/DNR assist). (h) Prepare and submit Environmental Documentation (DOT). (i) Prepare and submit Design Study Report (DOT). (j) DNR future ownership. Obtain Natural Resource Board approval to accept the bank site if needed (DNR).
2. Site Acquisition	(a) Survey site, prepare plat and initiate real estate process. Acquire funding approvals for real estate acquisition and estimated costs for monitoring program (DOT). (b) DNR develop site management plan if land to be owned by DNR (DNR/DOT review).
3. Detailed Design Phase	(a) Final mitigation plan. Prepare plans and specifications based on interagency concurrence on conceptual plan (DOT prepare/resource agency review). (b) Obtain interagency concurrence (DOT).
4. Site Construction	(a) Preconstruction review process (DOT/DNR). (b) Let contract (DOT). (c) Monitor construction and contractor (DOT lead/DNR assist). (d) Recommend site modifications within scope of plan (DNR/DOT review). (e) Implement site modifications (DOT). (f) Determine bank site wetland acreage (DOT).
5. Open Bank (Credit)	(a) Verify interim wetland acreage of bank site (DNR lead/DOT assist). (b) Record bank credit (acres), site criteria, wetland type and functions (DOT). (c) Transfer surplus acres from a Transportation project developed site as credit to the closest bank developed site (DOT/DNR). (d) Notify federal agencies (DOT).
6. Debit Bank	(a) Delineate project wetlands (DOT). Determine unavoidable wetland acre loss (debit) (DOT).

	Document presence or absence of on-site wetland compensation opportunities (DOT). Provide rationale for not using an on-site opportunity (DOT). Follow process on compensation for loss defined in wetland mitigation amendment to the Cooperative Agreement (DOT/DNR). (b) Identify wetland bank to be debited. Record debit based on acres of wetland loss due to individual transportation projects. Record wetland type and function lost (DOT). (c) Coordinate with and obtain concurrence from EPA, COE, FWS, FHWA (DOT/DNR assist).
7. Monitoring	(a) Verify that plans and specifications for bank site have been executed (DOT/DNR concur). (b) Implement monitoring activities agreed upon and stated in conceptual plan (DOT/DNR concur). (c) Determination of restored or created wetland bank site after a monitoring period of not less than one growing season and not to exceed five seasons. Determine if remedial measures are needed and implement the measures required (DOT/DNR concur). (d) Evaluate bank site and make final wetland acreage determination (DOT/DNR concur). (e) Monitoring will be conducted whether the transfer is to DNR, another public entity, or under a lease agreement with a private entity. Under private lease agreements DOT will monitor and maintain the agreement in perpetuity.
8. Close Bank	(a) Transfer ownership to entity agreed upon during preliminary planning stage (DOT). (b) Close bank when wetland acres lost (debits) assessed to the bank equal the wetland acre credit. Close project account (DOT).

Wetland Mitigation Bank Process



APPENDIX C

Compensation Ratios

Appendix C

For the purposes of this wetland mitigation bank, the replacement of wetland function is assumed if the replacement of wetland loss occurs within the floristic province, major drainage area and by wetland type. Under these conditions the replacement ratio is one acre of replacement for one acre lost (1:1). A 1:1 ratio represents the floor for wetland compensation. Wetland losses replaced outside designated areas and/or by different wetland types are assessed by a variable schedule of increments, which will cause the replacement ratio to be greater than 1:1, but not exceed 3:1. These increased ratios do not produce ratio generated surpluses (see discussion under item 5 of Guideline).

Floristic province and drainage area boundaries for this bank are given in figure 1C.

Nine wetland types are defined for this wetland mitigation bank (Table 1C) and can be placed into four major groups: Riparian, palustrine emergent, palustrine shrub/forested and bog. In terms of hydrogeomorphology and stage of ecological succession these appear to be natural groupings. Based on these groupings the interrelationship between out-of-kind replacement by type and increments of increase for replacement ratios is given in Table 2C.

It should be noted that degraded conditions may occur for wetlands lost to DOT projects, but should not at Bank sites. It is assumed that bank sites will not be exposed to the outside influences of degradation.

Degradation in wetlands lost can be caused by agricultural practices such as pasturing, haying and crop cultivation. Wetlands in the early stages of regeneration from tillage can be regarded as degraded. Surface water run-off from urban and highway development can cause degradation by sediment loading and poor water quality.

Evidence of degrading influences on riparian emergent, wet and sedge meadow and wet prairie could be vegetational community dominated by reed canary grass and stinging nettle. For riparian shrub/forest, shrub or wooded swamps the resulting vegetational community composition could include an overstory of box elder, a shrub layer of buckthorn or honeysuckle and a reed canary grass herb layer. Degraded aquatic bed may be indicated by turbid water, low density of rooted vegetation and evidence of excessive run off.

Shallow and deep marshes do not seem to be subjected to degradation to the same degree that meadows do, in terms of cultivation and pasturing, but can be degraded by introduction of aggressive exotics (e.g. purple loosestrife, Lythrum salicaria) and degraded water sources such as urban stormwater runoff.

An integration of compensation ratio increments by floristic province, drainage area and wetland type is given in Table 3C. Given the wetland lost and the replacement wetland at the bank site, replacement ratio can be obtained by adding the increment to 1.0. For example, shallow marsh acres lost are replaced by shallow marsh acres at a bank site (increment=0.0). The bank site is within the same floristic province (increment=0.0), but outside the drainage area (increment=0.5). Therefore, if there is no modification base on professional discretion, the replacement ratio is 1.5:1.

EXAMPLES Using Table 3C

1. Undegraded riparian forested wetland [RPF(N)] replaced by wet meadow (M) within the drainage area and within the floristic province. No professional discretion applied. Increment is 0.5 (third row, third column). Compensation ratio is 1.5:1 (acres).

2. Undegraded riparian forested wetland [RPF(N)] replaced by shallow marsh (SM) outside the drainage area and outside the floristic province. No professional discretion applied. Increment is 2.0 (third row, sixth column). Compensation ratio is 3.0:1 (acres).

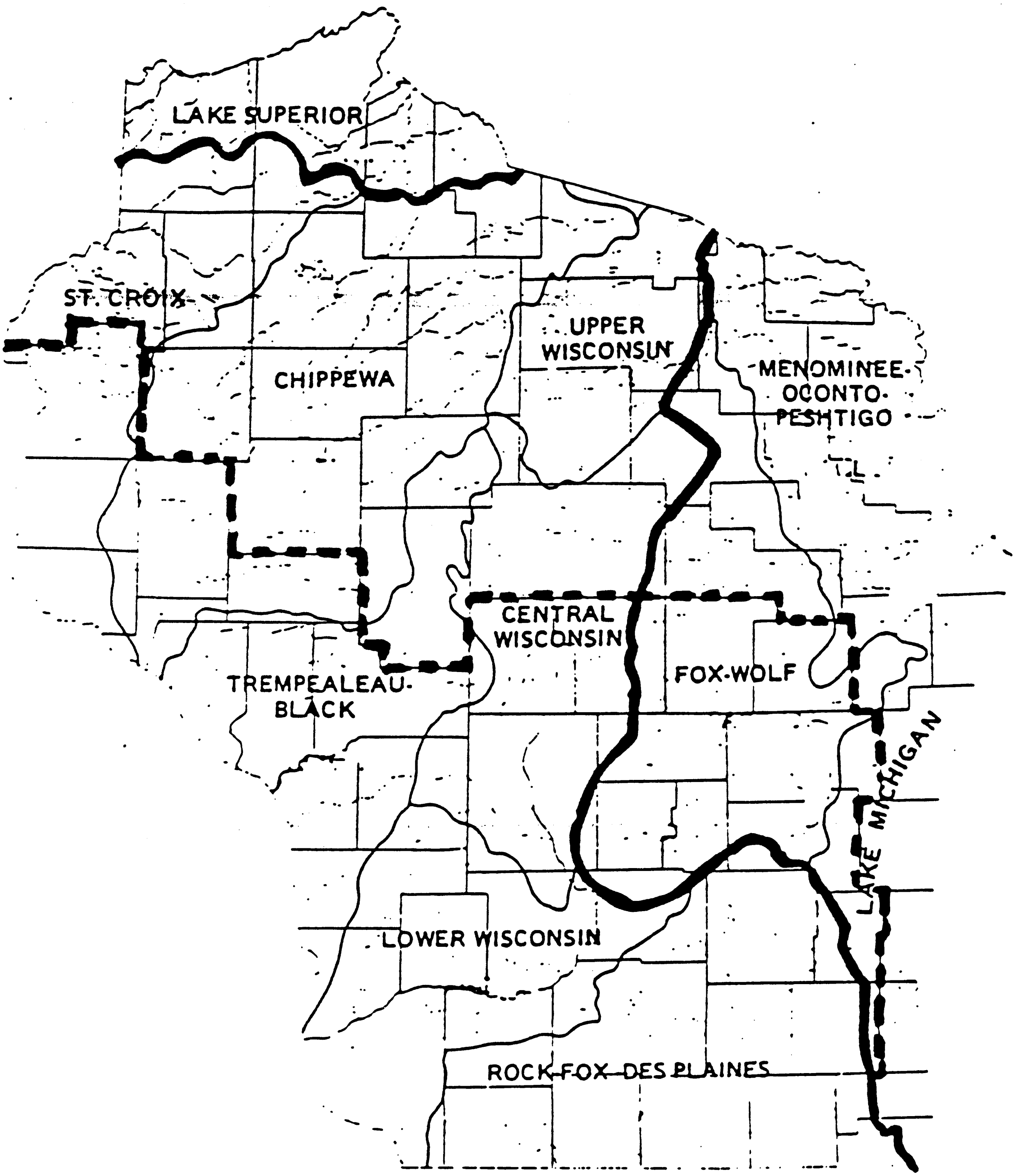
3. Degraded riparian forested wetland [RPF(D)] replaced by shallow marsh (SM) within the drainage area, but outside the floristic province. Professional discretion factor applied, since site of wetland loss is relatively near the floristic province boundary. Increment is 1.1 (row 11, column 5) minus 0.5 (professional discretion). Compensation ratio is 1.6:1 (acres).

4. Undegraded sedge meadow [M(N)] replaced by wet meadow (M) outside the drainage area, but inside the floristic province. Professional discretion not applied. Increment is 0.5 (row 15, column 4). Compensation ratio is 1.5:1 (acres).

5. Degraded shrub swamp [SS(D)] replaced by wet meadow (M) inside the drainage area, but outside the floristic province. Professional discretion applied (- 0.5) based on the replacement wetland being in a category of wetland types that have been historically lost in large amounts. Increment is 1.0 (row 27, column 5) minus 0.5 (professional discretion), giving a 0.5 increment to be added to the floor of 1.0 acres. Compensation ratio is 1.5:1 (acres).

6. Bog replaced by shallow marsh (SM) outside the drainage area and outside the floristic province. Professional discretion applied (-0.5) since the bogs in the area of wetland loss are abundant and the replacement wetland represents a wetland type that was historically lost in the area of replacement. Increment is 2.0 (row 6, column 31) minus 0.5 (professional discretion). Compensation ratio is 2.5:1, giving a 1.5 increment to be added to the floor of 1.0 acre.

Figure 1C. Boundry Delineation of Floristic Province and Three Major Drainage Basins.



Floristic Province Boundry ▬ ▬ ▬ ▬ ▬

Table 1C. Proposed Wetland Type Classification for Wisconsin Wetland Mitigation Banks.

Cir39 Classification	Wetland Type Bank Site *	Examples of Vegetational Community Types
1A Seasonally flooded basin or flat	Riparian wetland (RPF) (wooded)	Floodplain Forest (includes Bottomland Hardwood forests **), Riparian Shrub Carr and Alder Thickets
1B Seasonally flooded basin or flat	Riparian wetland (RPE) (emergent)	Riparian Wet and Sedge Meadows, Bars and Mudflats
2 Inland fresh meadow	Wet Meadow (M)	Wet Meadow, Wet/Wet Mesic Prairie, Sedge Meadow, Vernal pools, (also includes Fens **)
3 Inland shallow fresh marsh	Shallow Marsh (SM)	Emergent Aquatic
4 Inland deep fresh marsh	Deep Marsh (DM)	Emergent and Submergent Aquatic
5 Inland open fresh water	Aquatic Bed (AB)	Submergent Aquatic, Aquatic Bed (depth less than 3 Meters)
6 Shrub swamp	Shrub Scrub (SS)	Shrub Carr, Alder Thicket
7 Wooded swamp	Wooded Swamp (WS) (Forested Wetland)	Wet/Wet-Mesic Deciduous Forests White Cedar Swamps
8 Bog	Bog (Bog)	Open Bog, Forested Bog

* Wetland types used for purposes of this bank system.
These should be refered to by name or by acronym (e.g. RPF, SM, AB, etc.)

** Red flag wetlands

Table 2C. Increments (acres)* for Replacement by Wetland Type.

	Bank Site Wetland Types			
Wetland Type Lost	RPF (N)	RPE (N)	M,AB(N) SM,DM	SS,WS (N)
RPF(N)**	0.0	0.2	0.5	0.3
RPE(N)	0.1	0.0	0.3	0.2
RPF/E(D)***	0.0	0.0	0.1	0.1
M(N),SM, DM,AB(N)	0.1	0.1	0.0	0.2
SS,WS(N)	0.1	0.2	0.2	0.0
M,AB(D), SM,DM	0.0	0.0	0.0	0.0
SS,WS(D)	0.0	0.0	0.0	0.0
BOG	0.5	0.5	0.5	0.5

* Increment added to minimum replacement of 1.0 acre.
** (N): Wetland is not degraded.
*** (D): Wetland is degraded.

Table 3C. Compensation ratio increments* by floristic province, drainage area, and wetland type. **

Wetland Type Lost	Bank Site Type	Floristic Province (In)		Floristic Province (Out)	
		Drainage Area (In)	Drainage Area (Out)	Drainage Area (In)	Drainage Area (Out)
RPF(N)	RPF	0.0	0.5	1.0	1.5
	RPE	0.2	0.7	1.2	1.7
	M,AB,SM,DM	0.5	1.0	1.5	2.0
	SS,WS	0.3	0.8	1.3	1.8
RPE(N)	RPE	0.1	0.6	1.1	1.6
	RPE	0.0	0.5	1.0	1.5
	M,AB,SM,DM	0.3	0.8	1.3	1.8
	SS,WS	0.2	0.7	1.2	1.7
RPF/E(D)	RPF	0.0	0.5	1.0	1.5
	RPE	0.0	0.5	1.0	1.5
	M,AB,SM,DM	0.1	0.6	1.1	1.6
	SS,WS	0.1	0.6	1.1	1.6
M(N),SM, DM,AB(N)	RPF	0.1	0.6	1.1	1.6
	RPE	0.1	0.6	1.1	1.6
	M,AB,SM,DM	0.0	0.5	1.0	1.5
	SS,WS	0.2	0.7	1.2	1.7
SS,WS(N)	RPF	0.1	0.6	1.1	1.6
	RPE	0.2	0.7	1.2	1.7
	M,AB,SM,DM	0.2	0.7	1.2	1.7
	SS,WS	0.0	0.5	1.0	1.5
M,AB(D) SM,DM	RPF	0.0	0.5	1.0	1.5
	RPE	0.0	0.5	1.0	1.5
	M,AB,SM,DM	0.0	0.5	1.0	1.5
	SS,WS	0.0	0.5	1.0	1.5
SS,WS(D)	RPF	0.0	0.5	1.0	1.5
	RPE	0.0	0.5	1.0	1.5
	M,AB,SM,DM	0.0	0.5	1.0	1.5
	SS,WS	0.0	0.5	1.0	1.5
BOG	RPF	0.5	1.0	1.5	2.0
	RPE	0.5	1.0	1.5	2.0
	M,AB,SM,DM	0.5	1.0	1.5	2.0
	SS,WS	0.5	1.0	1.5	2.0

* Increments (acres) are added to 1.0 to give the replacement component of a compensation ratio.

** See Tables 1C and 2C for defined abreviations.

APPENDIX D

Wetland Mitigation Bank Reporting

APPENDIX D

Wetland Mitigation Bank Report

Format for report to IOC is under development. A hypothetical example is given in Table 1D.

District 3 Planning is investigating and developing a GIS application. Example tables attached. Map not attached.

Table 1D. Hypothetical Example of Wetland Mitigation Bank Site Report for WDOT Wetland Mitigation Bank.

WETLAND MITIGATION BANK ACCOUNTING FOR LOWER WISCONSIN RIVER WATERSHED
ROXBURY BANK SITE, COLUMBIA COUNTY

INITIAL BANK SITE TOTAL AREA=189 ACRES
INITAL BANK SITE COMPOSITION BY TYPE
M=55, SM=60, DM=54, AB=20 (acres)

PROJECT LOCATION			WETLAND TYPE LOST	ACRES LOST	RF *	DEBIT ACRES	ACRE BALANCE BY TYPE				TOTAL ACRE BALANCE
COUNTY	PROJ_ID	HWY					M	SM	DM	AB	
							55.00	60.00	54.00	20.00	189.00
DANE	11110500	151	M	12.50	1.0	12.50	42.50				176.50
			SS(N)	10.00	1.2	12.00		48.00			164.50
			RPF(N)	3.50	1.5	5.25			48.75		159.25
DANE	10020000	51	M	6.20	1.0	6.20	36.30				153.05
			SS(N)	2.00	1.2	2.40		45.60			150.65
GREEN	10030000	11	M	4.00	1.0	4.00	32.30				146.65
			SM	2.50	1.0	2.50		43.10			144.15
			AB	1.50	1.0	1.50				18.50	142.65
			SS(N)	3.25	1.2	3.90			44.85		138.75
			RPF(D)	2.75	1.1	3.03		40.08			135.73
ROCK	10040000	59	M	0.90	1.0	0.90	31.40				134.83
DODGE	10050000	16	M	4.00	1.0	4.00	27.40				130.83
			SS(N)	2.00	1.2	2.40		37.68			128.42
			RPF(N)	1.50	1.5	2.25			42.60		126.17
LINCOLN	70000500	109	BOG	10.00	2.5	25.00		12.68			101.17
			RPF(N)	3.60	2.5	9.00			33.60		92.17
DOUGLAS	11980102	53	SS(N)	6.00	2.7	16.20			17.40		75.97
SAUK	10006000	12	SS(D)	5.00	1.0	5.00	22.40				70.97

* Replacement Factor (multiplied by acres lost gives debit acres)

DISTRICT 3
TABLE

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  0.45 ACRES WITHDRAWN BY DNR
  0.00 ACRES WITHDRAWN BY COE


0631-03-01     HOPKINS SITE
PROJECT MAKING WITHDRAWAL:6210-07-71
DATE OF 404 PERMIT:10/23/92
GREEN LAKE - BERLIN
STH 049     GREEN LAKECOUNTY
  0.24 ACRES WITHDRAWN BY DNR
  0.24 ACRES WITHDRAWN BY COE


0631-03-01     HOPKINS SITE
PROJECT MAKING WITHDRAWAL:6499-04-00
DATE OF 404 PERMIT:03/12/93
DUCK CREEK BRIDGE AND APPROACHES
LCL         OUTAGAMIE COUNTY
  0.30 ACRES WITHDRAWN BY DNR
  0.30 ACRES WITHDRAWN BY COE


0631-03-01     HOPKINS SITE
PROJECT MAKING WITHDRAWAL:6693-00-71
DATE OF 404 PERMIT:  /  /
MOUNTAIN DR. BRIDGE AND APPROACHES
LCL         MARATHON  COUNTY
  0.30 ACRES WITHDRAWN BY DNR
  0.30 ACRES WITHDRAWN BY COE


0631-03-01     HOPKINS SITE
PROJECT MAKING WITHDRAWAL:6693-01-71
DATE OF 404 PERMIT:  /  /
BOBSIDING RD. BRIDGE AND APPROACHES
LCL         MARATHON  COUNTY
  0.30 ACRES WITHDRAWN BY DNR
  0.30 ACRES WITHDRAWN BY COE


0631-03-01     HOPKINS SITE
PROJECT MAKING WITHDRAWAL:6844-10-71
DATE OF 404 PERMIT:  /  /
WALL ST. BRIDGE AND APPROACHES
CTH E       KEWAUNEE  COUNTY
  0.06 ACRES WITHDRAWN BY DNR
  0.06 ACRES WITHDRAWN BY COE


0631-03-01     HOPKINS SITE
PROJECT MAKING WITHDRAWAL:6885-00-71
DATE OF 404 PERMIT:  /  /
MC NINCH RD. BRIDGE AND APPROACHES
LCL         WAUPACA   COUNTY
  0.03 ACRES WITHDRAWN BY DNR
  0.03 ACRES WITHDRAWN BY COE
```

DISTRICT 3
TABLE

```
1150-17-00
ABRAMS - OCONTO
USH 41      OCONTO        COUNTY

DATE OF 404 PERMIT  3/ 1/92

   WETLAND TYPE AND ACRES LOST

RIPARIAN-WOODED       0.00
RIPARIAN-EMERGENT     0.00
WET MEADOW            0.46
SHALLOW MARSH         0.00
DEEP MARSH            0.00
OPEN WATER            0.00
SHRUB SCRUB           0.00
WOODED SWAMP         45.54
BOG                   0.00
UNSPECIFIED           0.00

MITIGATED -  ON SITE


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


1150-17-00
ABRAMS - OCONTO
USH 41      OCONTO        COUNTY

DATE OF 404 PERMIT  3/ 1/92

   WETLAND TYPE AND ACRES LOST

RIPARIAN-WOODED       0.00
RIPARIAN-EMERGENT     0.00
WET MEADOW            0.46
SHALLOW MARSH         0.00
DEEP MARSH            0.00
OPEN WATER            0.00
SHRUB SCRUB           0.00
WOODED SWAMP         45.54
BOG                   0.00
UNSPECIFIED           0.00

MITIGATED -  SIKMA SITE


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


1451-13-00
KOS OVERHEAD - MANITOWOC/GUNS RD. - IH 43
USH 141     BROWN         COUNTY

DATE OF 404 PERMIT 0 /0 /
```

Appendix I

Crandon Project Wetland Compensation Site Surface Water Hydrologic Assessment

Foth & Van Dyke
Technical Memorandum

June 17, 1995

TO: Jerry Sevick, Foth & Van Dyke

CC: Don Moe, Crandon Mining Company
Ron Steg, Foth & Van Dyke
Master File

FR: Mike Liebman and Steve Birr, Foth & Van Dyke MDL SRB

RE: Crandon Project Wetland Compensation Site
Surface Water Hydrologic Assessment

1 Introduction

A wetland compensation site for the Crandon project has been selected. This memorandum presents a discussion of the site's surface water hydrology considering both existing and proposed conditions. The proposed conditions relate to the development of an approximate 57 acre wetland focusing on replacing storm and flood storage, water quality maintenance and hydrologic support functions.

2 Watershed Characteristics

2.1 Existing Environment

As shown in Figure 1 the property on which the proposed wetland restoration site is located straddles the Oconto-Shawano County line north of Shawano Lake. The southern portion of the property is located in the N1/2, NE 1/4, Section 5, T 27 N, R 17 E, Town of Washington, Shawano County, Wisconsin, and the northern part is located in the S1/2, SE 1/4, Section 32, T 28 N, R 17 E, Town of Underhill, Oconto County, Wisconsin. The property is situated within an agricultural field and comprises approximately 129 acres. As shown on Figure 1, topography within the property is virtually flat with no significant local relief. The northern portion of the property, however, is marked by the presence of barely discernible, eroded rises which appear to be sandier than surrounding soils.

The proposed compensation site or project area is approximately 57 acres in size. As shown on Figure 1 it is located in the approximate center of the 129 acre property boundary. A topographic survey of the site and surrounding area was conducted. The topographic map generated as a result of that survey is shown on Figure 2. The map shows that the area ranges in elevation from approximately 818.5 feet to just over 820 feet mean sea level (MSL). The surveyed area also consists of a series of north-south and east-west drainage ditches at lower elevations.

Site soils are mapped as Cormant loamy fine sand on 0-1 percent slopes. Cormant soils are deep, poorly drained soils which formed on sandy outwash plains and glacial lake plains. These soils are subject to periodic ponding. Also present are pockets of Markey and Seelyville soils. These soils are deep, poorly drained mucks which formed on outwash plains from decomposing herbaceous plants and other organic matter. The Markey and Seelyville soils commonly include peaty, organic pedons exceeding 50 inches in depth (Gundlach et al., 1982). All three soils are listed in the Hydric Soils List for Shawano County (Otter, 1990).

Current land use is agricultural. According to the Oconto County Natural Resources Conservation Service (Schulz, 1995) these lands are classified as Prior Converted Cropland. Prior to being farmed, the project area was likely part of an extensive wetland currently occupying portions of Sections 31 and 32 immediately to the northwest. The property has been partially drained by construction of several interconnected drainage ditches. A north-south ditch, beginning approximately 0.7 miles to the north of the site and ultimately discharging into Duchess Creek downstream from the site, parallels the western border of the site. Water levels in this ditch are controlled by a stop-log outlet control structure located in the southwest corner of the site (Figure 2). Two east-west ditches connected to the north-south ditch exist along the northern and southern boundaries of the surveyed area. A third east-west ditch also connected to the north-south ditch exists in the central portion of the surveyed area. A single ditch draining agricultural lands to the northwest, also enters the north-south ditch just below the point where the central ditch connects to the north-south ditch.

Based on the observed location of the groundwater table and the lack of vegetation on the bottom of the ditches, it appears that the ditches intercept groundwater. Flow in the ditches across the majority of the property is to the west and south. A divide exists resulting in flow to the east and north in the northeastern corner of the surveyed area. Several surface ditches and drains have been installed along the southern boundary of the surveyed area. These drains channel surface water off the area into the southernmost east-west ditch. Several outlet pipes were observed in this ditch. Although no site plans exist, the current landowner reports that portions of the site have been tiled.

Because of the very flat topography and dense vegetative cover, it is difficult to precisely define the boundaries of the drainage basin serving the proposed wetland compensation site. To address this issue, maximum and minimum effective watersheds were defined for use in the assessment of site hydrology based on a review of the USGS 7.5 minute topographic map of the site and surrounding area (Cecil, Wisconsin Quadrangle, 1974). The "maximum" watershed tributary to the site is shown in Figure 3. The "maximum" watershed would generate the largest volume of runoff and represents the potential maximum case for peak flow generation. As shown in Figure 3, this watershed has been divided into four sub-basins based on topography and land use characteristics. As will be discussed later in this memorandum, the agricultural sub-basin was further divided for analysis purposes into on-site and off-site sub-basins. The "minimum" watershed includes only the two "agricultural" sub-basins. The "minimum" watershed would generate the smallest possible volume of runoff and represents the minimum case for the wetland compensation site water budget analysis.

2.2 Water Balance (Long-Term Wetland Hydrology)

2.2.1 General Discussion

The method used for evaluation of the long-term wetland compensation site hydrology was a water balance analysis. This method was chosen to evaluate annual runoff to the site which includes the spring snowmelt/runoff component which is a major source of upland drainage area runoff to the wetlands. The analysis focuses on monthly water budgets based on monthly averages of climatological data from the nearby Shawano meteorological station which are summed to develop annual totals.

The water balance model is an expanded and modified model based on the mathematical methods of Soil Conservation Service (1972) and Thornthwaite and Mather (1957). The governing equation is based on a mass balance principle, i.e., the available moisture equals initial moisture and the sum of monthly inflow quantities (precipitation and snowmelt, discharge from upstream drainage areas, etc.) minus outflow quantities (percolation to groundwater, evapotranspiration, etc.). The water balance model uses climatological records of the National Oceanic and Atmospheric Administration (NOAA) weather station at Shawano from 1961 to 1990.

Monthly climatic records, evapotranspiration data, and the baseline data made up the input files for the water balance model. The climatic records include precipitation, temperature, and open-water evaporation. The evapotranspiration data file includes the consumptive use coefficient (derived for each land cover type) and daylight hours. The consumptive use coefficient, daylight hours, and temperature are then combined to yield potential evapotranspiration. The baseline data file includes soil moisture limit, wetland area, upland area, open water area, direct drainage area, and inflowing wetland identification numbers.

Seasonal and annual average water discharge rates and monthly water balances are the outputs from the water balance model.

2.2.2 Model Development

The water balance program was initially developed for analysis of the water balance related to irrigation of agricultural lands. The model was modified by the Wisconsin Department of Natural Resources (WDNR) for use in evaluating the top surface of sanitary landfills in the State of Wisconsin (WDNR, 1985). The computer model was based on procedures developed initially in the 1940's and the early 50's by Thornthwaite and Mather in the Laboratory of Climatology. The procedures were calibrated by field measurement of deep percolation at specific test sites situated at various, diverse, and world-wide locations.

The WDNR water balance model was written in BASIC for an IBM-PC computer. The computer model uses a series of input files to provide automatic reference of 30 years of climatological data, including monthly average temperature and precipitation for 101 NOAA weather stations throughout the State of Wisconsin. Either the nearest NOAA station or a weighted (based on distance from the site) average among nearby weather stations can be used for the site climatological data. The input files also include index values (I) for monthly average temperature and a latitude correction factor for computing daylight hours. The index values and daylight hours are used in computing potential evapotranspiration.

Monthly surface runoff is computed based on the input runoff coefficient and precipitation. The monthly snowfall can be accumulated during months with average temperatures below 32°F. The accumulated snowpack can then be allowed to melt during months with average temperature above 32°F. Infiltration is calculated as the difference between precipitation and runoff. The difference between infiltration and actual evapotranspiration (and moisture change) is net percolation.

The WDNR water balance model was chosen for this study because it can compute all of the hydrologic components for a typical drainage basin. Because the WDNR's purpose for the final water balance model was to analyze water balance for the top surface of sanitary landfills, a number of modifications were needed for the purpose of this wetland impact assessment.

Surface runoff or "run-on" is an important component of the wetland water balance. Modifications were made to the WDNR's water balance model so that the runoff from an upstream drainage area is received as an inflow component for the downstream wetland. The cumulative runoff, which equals the sum of runoff from upstream areas and its own specific drainage area, is then calculated and tabulated.

The WDNR's water balance model code was modified so that output can be re-directed into an ASCII file rather than to a printer/plotter. If this were not done, the output would be available in hard copies only and no output file(s) would be saved. This modification also allows the analyst to print output only when it is needed, which eliminates unnecessary printouts.

There are many input parameters that needed to be analyzed before calculations could be made. These parameters were chosen from tables found in credible documents and from field observation and scientific and engineering experience.

The water balance program allows use of climatological data from the five closest NOAA weather stations with an option to average the available data from all five or choose the closest weather station. The closest weather station was chosen to achieve the best results. This NOAA weather station (Shawano) is approximately 10 miles from the proposed site.

The model offers two runoff analysis options. Option 1 calls for allowing runoff to occur monthly for each precipitation quantity. Option 2 calls for accumulating a snow pack for a springmelt event. Option 2 was selected to give a more accurate value of runoff in the north central Wisconsin area. In setting the format for computing Option 2, the timing of how the snowmelt event will occur in spring must be defined. The amount of snowmelt that occurs each month is specified by a percentage input. A spring melt of 60% in March, and 40% in April was specified.

The next input parameter involves runoff coefficients. The following table lists the runoff coefficients that were used in the analysis.

Table 1

Runoff Coefficients

Land Slope	Upland Areas		Wetland Area		Agricultural Area*	
	Normal	Frozen	Normal	Frozen	Normal	Frozen
<2%	.05	.35	.05	.35	.08	.50

* Wetland area coefficients were used on those agricultural lands to be converted to wetlands for the proposed condition.

Prepared by: SRB
Checked by: MDL

These coefficients were obtained from a combination of Tables 5.5 and 5.6 of the *Design and Construction of Urban Stormwater Management System* (1992) which is published by the American Society of Civil Engineers and Table 3-1 of McGraw-Hill's *Water-Resources Engineering* (Linsley and Franzini, 1992). Also, these values were adjusted to take into account the frozen months and highly wooded topography based on experience, judgement and discussions in *Handbook of Snow* edited by the University of Saskatchewan (Grey and Male, 1981).

The maximum available moisture value is the next option in the program where the user must choose from two methods. The first method calls for entering the available moisture into the water balance. The second method calls for calculating the available moisture based on: a) root zone depth; and, b) the stratigraphy of the upper soil system. Method 2 was chosen to take into account the different soils in the area.

There are two available moisture menus to assist the user in selecting values. The first is the SCS typical chart, and the other is the EPA/1975 chart. The SCS typical chart was chosen based on familiarity. In computing the moisture capacity, one root zone depth was used. Two soil layers were determined to exist in the root zone of the upland areas and wetland areas. Three soil layers were determined to exist in the agricultural area. The following table shows what soil layers, depths and moisture percentages were used in the analysis.

Table 2

Available Moisture Data

Soil Layer	Upland Area	Wetland Area	Agricultural Area
1	12" Sandy Loam 10% Moisture	12" Peaty Topsoil 30% Moisture	12" Peaty Topsoil 25% Moisture*
2	36" Silty Sand 8% Moisture	36" Peaty Topsoil 30% Moisture	12" Peaty Topsoil 20% Moisture*
3			12" Silty Sand 8% Moisture

* 100% moisture was used on those agricultural lands to be converted to wetlands for the proposed condition.

Prepared by: SRB
Checked by: MDL

These values were obtained from the SCS method (the program lists a table of moisture levels based on soil type from which to choose appropriate values).

After entering these data values, the program requires input for some additional information including the following:

1. Name of Basin - Names of basins were determined from locations and present land uses.
2. Area of Basin (in acres) - calculated from 1" = 2000' scale USGS mapping.
3. Upgradient Inflow - For this parameter, if an upgradient drainage basin has potential to discharge runoff to this basin, the program took the previous calculated runoff and accumulated it with the present drainage basin.

The water balance model, with the modifications and assumptions discussed was used to evaluate the existing water balance at the site.

2.2.3 Model Results

The hydrologic water balance under existing conditions was determined for selected basins within the drainage basin of the projected wetland site. Both maximum and minimum basin areas as defined in Section 2.1 were considered in the analysis. The results are shown in the following table.

Table 3

Basin Runoff Under Existing Conditions

Drainage Basin	Maximum Basin Area	Annual Runoff in Ac-Ft		Minimum Basin Area	Annual Runoff in Ac-Ft	
		Basin	Cumulative		Basin	Cumulative
Upland North	30.3 Ac	6.7	6.7	0	0	0
Wetland	157.0 Ac	34.5	41.2	0	0	0
Upland South	52.3 Ac	11.5	52.7	0	0	0
Agricultural (off-site)	54.2 Ac	18.1	70.8	54.2 Ac	18.1	18.1
Agricultural (on-site)	50.5 Ac	16.8	87.6	50.5 Ac	16.8	34.9

Prepared by: SRB
Checked by: MDL

The program calculated the Upland North Area runoff first, and then calculated the wetland runoff separate from the upland area, and then tallied the total (cumulative) runoff. Runoff from Upland South Area was calculated (and totaled) followed by the remaining agricultural area that exists in the drainage basin. These runoff values were then accumulated to give a total annual basin runoff, under maximum conditions, of 87.6 acre/ft. For the minimum drainage basin area the total annual basin runoff is 34.9 ac-ft.

For the proposed wetland compensation site (agricultural on-site basin), the runoff characteristics will be different than those used in the above analysis. A subsequent evaluation was performed modelling the changed conditions. The minimum case annual runoff for these conditions would be 29.2 ac-ft.

The computer output for the water balance analyses is included as Appendix A.

2.3 Peak Flow Evaluation (Short-Term Wetland Hydrology)

To determine existing peak flow rates from the drainage basin, the hydrologic analysis method utilizing SCS TR-55 software was used. Runoff curve numbers were determined from soil and land cover types. The results of this analysis are presented in detail in Appendix B and summarized below.

Table 4

Existing Peak Flow Rates Under Maximum Basin Conditions

		Storm Event			
Sub area	Area	1-Inch	2-Year	10-Year	100-Year
Upland North	30.3 Ac.	1 cfs	4 cfs	4 cfs	8 cfs
Wetland	157.0 Ac.	4 cfs	53 cfs	137 cfs	271 cfs
Upland South	52.3 Ac.	1 cfs	19 cfs	48 cfs	93 cfs
Agricultural	104.7 Ac.	2 cfs	20 cfs	164 cfs	320 cfs
TOTAL:	344.3 Ac.	8 cfs	96 cfs	353 cfs	692 cfs

Prepared by: SRB
Checked by: MDL

These peak runoff flow estimates help describe the hydrology for this drainage basin and provide the basis to develop desirable hydraulics at the compensation site.

3 Proposed Hydraulics

Since a large part of the modeled drainage basin's runoff is generated from the northwest that flows in the north-south ditch, this ditch will be bermed at a point just south of the central east-west ditch. With this berm in place, flow from the upper tributary basins will be diverted to the central east-west ditch. This ditch will be filled in the northeast corner of the site to divert water into the wetland site. Runoff will flow through the restoration site and ultimately through an outlet structure located in the southwest corner of the site. A three foot stop-log weir outlet structure set at 818.9 feet with a 40 foot emergency spillway set at 819.6 feet will act as the control outlet structure. Existing contours along with berming just within the perimeter of the site will set the maximum elevation at 820.00 feet. An added feature of this outlet structure is that the weir (stop-log) elevation may be lowered by removing several stop-leg sections. This will allow the wetland area to be drained during development, if desired.

The Haestad Methods POND2 (Glazner, 1989) software package was used to route a 1 inch, 2-year, 10-year, and 100-year storm event through this structure. The computer output from this modelling effort is presented in Appendix C. The results are summarized below.

Table 5

Water Surface Elevations Under Maximum Conditions

Storm Event	Rainfall (inches)	Water Surface Elevation at the Outlet
1-inch	1	819.01
2-year	2	819.31
10-year	3.3	819.68
100-year	5.0	820.11

Prepared by: MDL
Checked by: RFS

4 Proposed Hydrology

The total water storage volume available in the restoration site (see Appendix D) at the proposed normal pool elevation (818.9 feet) is 68.9 acre-feet. Groundwater will fill the proposed site up to the existing groundwater surface elevation (i.e., approximately 817 feet). The remaining volume required to fill the restoration site to the normal pool elevation (52.61 acre-feet) will need to be supplied by surface water sources. The results of the existing condition water balance evaluation showed that the cumulative runoff under minimum case conditions will equal 34.9 acre-feet per year. Under the maximum and minimum case conditions, it will take approximately 0.6 to 1.5 years to attain the proposed normal pool elevation, somewhat longer if nominal downstream flow is maintained. The annual runoff will easily maintain this water level after a full pond is achieved.

The outlet structure will have the ability to fluctuate backwater during peak runoff events which fits the needs and capabilities of a wetland area. To avoid overtopping any nearby roads, the existing ditches along with the emergency spillway will handle any water flows that exceed the 820 foot elevation.

5 Summary

The results of this analysis indicate that, even under minimum case conditions, the watershed serving the proposed wetland restoration site generates sufficient surface water flows to support the proposed action. The proposed outlet structure provides the flexibility to manipulate the water surface elevation of the site during site establishment. It also provides for the passage of flooding events without causing negative impacts to adjacent lands.

6 References

American Society of Civil Engineers, *Design and Construction of Urban Stormwater Management Systems*, 1992 by ASCE.

Glazner, Michael K., *POND2 - Detention Pond Design and Analysis*, 1989 by Haestad Methods, Inc.

Gray, D.M. and D.H. Male, *Handbook of Snow*, 1981 by Pergamon Press Canada Ltd.

Gundlach, et al., 1982. Soil Survey of Shawano County, Wisconsin. United States Department of Agriculture, Washington, D.C.

Linsley and Franzini, *Water Resources Engineering*, Second Edition, 1972 by McGraw-Hill, Inc.

Otter, 1990. Hydric Soils List for Shawano County. Shawano County Soil Conservation Service.

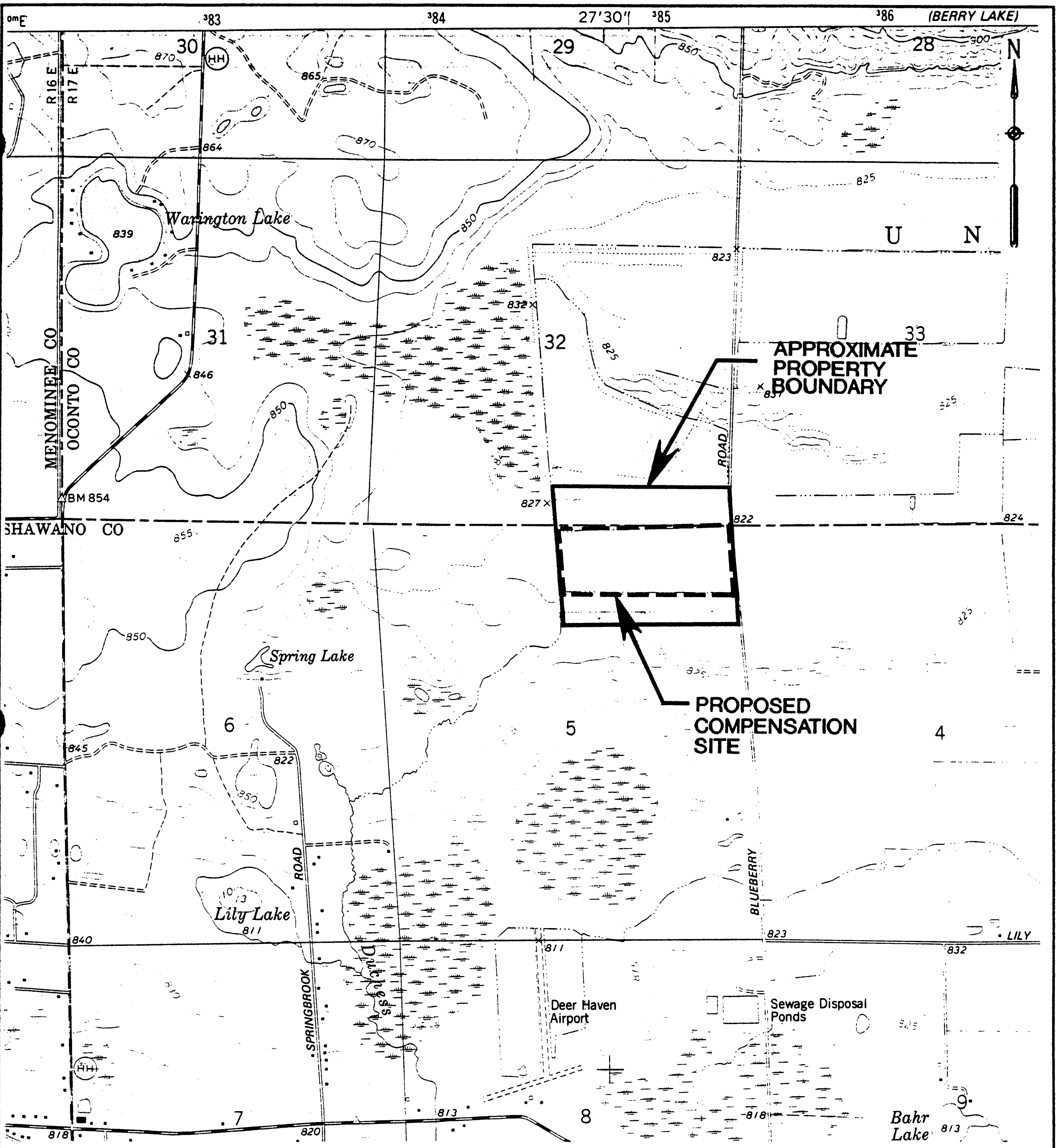
Schulz, D., Oconto County Natural Resources Conservation Service, April 1995. Personal communication regarding wetland classifications.

State of Wisconsin Department of Natural Resources Bureau of Solid Waste Management (WDNR), 1985. *Water Balance Analysis Program For: IBM-PC Micro-Computer*. 68p.

Thornthwaite, C.W., Mather, J.R., *Instructions and Tables for Computing Potential Evapotranspiration and Water Balance*, Publications in Climatology, Volume X, No. 3, 1957.

USDA Soil Conservation Service, Hydrology. Section 4 in *National Engineering Handbook*, August 1972.

USDA Soil Conservation Service, *Technical Release 55-Urban Hydrology for Small Watersheds*, TR-55, Second Edition, June 1986.



SOURCE: U.S.G.S. 7.5 MINUTE TOPOGRAPHIC
QUADRANGLE - CECIL, 1974
OCONTO & SHAWANO COUNTY, WISCONSIN

Foth & Van Dyke

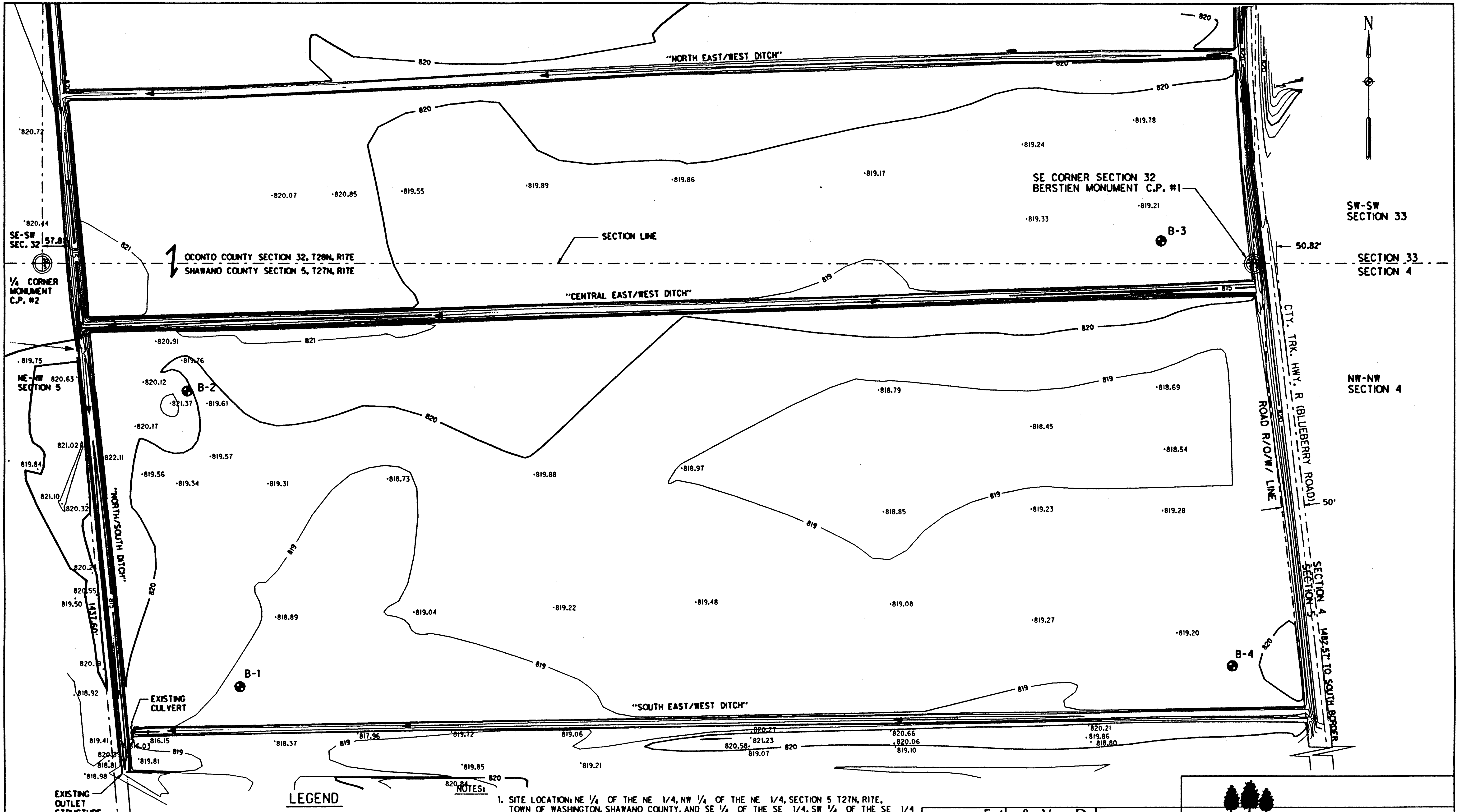
REVISED	DATE	BY	DESCRIPTION

CHECKED BY:	JKS1	DATE:	JULY'95
APPROVED BY:	RFS	DATE:	JULY'95
APPROVED BY:	GWS	DATE:	JULY'95

Crandon Mining Company

FIGURE 1
WETLAND COMPENSATION SITE LOCATION

Scale: 0 1000' 2000'
Date: JULY, 1995
Prepared By: Foth & Van Dyke
By: JOW



SOUTH PROPERTY LINE

NORTH LINE OF SOUTH 660' OF
NE ¼ SECTION 32,
T27N, R17E

LEGEND

·819.04	EXISTING SPOT ELEVATION
—815—	EXISTING CONTOUR
● B-1	SOIL BORING LOCATIONS
←———	EXISTING SURFACE WATER FLOW
— · — · —	SECTION LINE
—— — ——	APPROXIMATE CENTERLINE OF ROAD

NOTES:

1. SITE LOCATION: NE ¼ OF THE NE 1/4, NW ¼ OF THE NE 1/4, SECTION 5 T27N, R17E, TOWN OF WASHINGTON, SHAWANO COUNTY, AND SE ¼ OF THE SE 1/4, SW ¼ OF THE SE 1/4 SECTION 32, T28N, R17E, TOWN OF UNDERHILL, OCONTO COUNTY, WISCONSIN.
2. BASE MAP PREPARED FROM TOPOGRAPHIC SURVEY BY FOTH & VAN DYKE. DATE OF SURVEY - MARCH, 1995.
3. ELEVATIONS BASED OFF OF SPOT ELEVATION FROM 'CECIL' 7.5 MINUTE SERIES USGS MAP (1974). CONTOUR INTERVAL IS ONE FOOT.
4. HORIZONTAL DATUM BASED ON SITE GRID SYSTEM USING SOUTH ¼ CORNER SECTION 32, T29N, R17E AS 10,000 N , 10,000 E (CP #2) AND THE SE CORNER SECTION 32 AS 10,000 N , 12,663.52 E (CP #1).
5. PROPERTY LINES REPRESENTED ON THIS MAP ARE DERIVED FROM FIELD SURVEY MADE BY FOTH & VAN DYKE DURING MARCH, 1995 USING SECTION BREAKDOWN INFORMATION FURNISHED BY NORDIN & ASSOCIATES, SHAWANO, WISCONSIN.

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

CHECKED BY:	JKS1	DATE: JULY '95
APPROVED BY:	RFS	DATE: JULY '95
APPROVED BY:	GWS	DATE: JULY '95

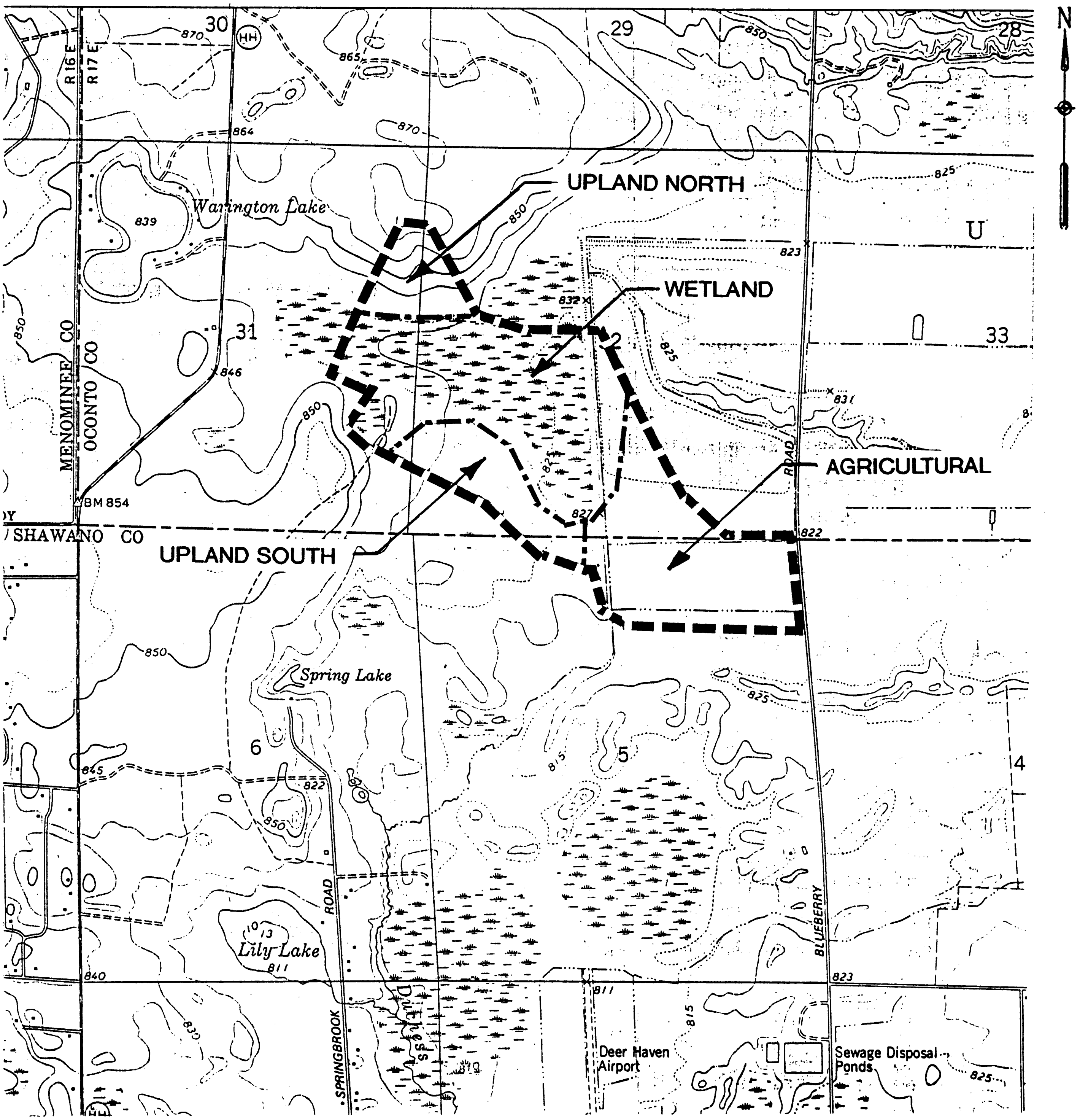
Crandon Mining Company

FIGURE 2

WETLAND COMPENSATION
SITE EXISTING TOPOGRAPHY

Scale: 0 100' 200'
Date: JULY, 1995
Prepared By: Foth & Van Dyke
By: JRB2

/d3/dl/users/jprl/4c55f6a.dgn



SOURCE: U.S.G.S. 7.5 MINUTE TOPOGRAPHIC
QUADRANGLE - CECIL, 1974
OCONTO & SHAWANO COUNTY, WISCONSIN

Foth & Van Dyke

REVISED	DATE	BY	DESCRIPTION

CHECKED BY:	JKSI	DATE: JULY '95
APPROVED BY:	MDL	DATE: JULY '95
APPROVED BY:	GWS	DATE: JULY '95

Crandon Mining Company

FIGURE 3

WETLAND COMPENSATION CONTRIBUTING WATERSHED AND LAND USE

Scale: 0 1000' 2000'

Date: JULY, 1995

Prepared By: Foth & Van Dyke

By: JOW

Appendix A

Water Balance Program Analysis

```
****************************************************************************************************
*                                                                                                  *
*                                     WATER BALANCE PROGRAM                                        *
*                                                                                                  *
*                            FOTH & VAN DYKE AND ASSOCIATES, INC.                                  *
*                                                                                                  *
****************************************************************************************************

    DRAINAGE BASIN NAME: UPLAND NORTH                    DRAINAGE BASIN AREA:     30.30 ACRES

                                   JAN   FEB   MAR   APR   MAY   JUN   JUL   AUG   SEP   OCT   NOV   DEC    ANNUAL

TEMPERATURE (F)                   14.6  18.8  29.4  44.7  56.7  65.7  70.2  67.8  59.2  49.1  34.3  21.1
MONTHLY i VALUES                  0.00  0.00  0.00  1.68  4.60  7.38  8.92  8.09  5.34  2.64  0.12  0.00    38.77
UNADJUSTED POT. EVAPO-TRANSP.     0.00  0.00  0.00  0.04  0.08  0.12  0.13  0.12  0.09  0.05  0.00  0.00
LATITUDE CORRECTION (r)           24.0  24.3  30.6  33.8  38.3  38.7  39.0  36.2  31.2  28.2  23.7  22.5
POTENTIAL EVAPO-TRANSPIRATION     0.00  0.00  0.00  1.35  3.06  4.64  5.06  4.34  2.80  1.41  0.00  0.00
PRECIPITATION                     1.30  1.20  1.95  3.04  3.69  3.67  3.42  3.77  3.55  2.37  1.87  1.49    31.32
CUMULATIVE SNOW PACK (IN)         2.79  3.99  2.37  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  1.49
CORRECTED EQUIV. PRECIP. (IN)     0.00  0.00  3.57  5.41  3.69  3.67  3.42  3.77  3.55  2.37  1.87  0.00
RUNOFF COEFFICIENT                0.35  0.35  0.35  0.05  0.05  0.05  0.05  0.05  0.05  0.05  0.05  0.35
MONTHLY RUNOFF (IN)               0.00  0.00  1.25  0.27  0.18  0.18  0.17  0.19  0.18  0.12  0.09  0.00     2.64
INFILTRATION (IN)                 0.00  0.00  2.32  5.14  3.51  3.49  3.25  3.58  3.37  2.25  1.78  0.00
INFILTRATION MINUS PET (IN)       0.00  0.00  2.32  3.79  0.45 -1.15 -1.81 -0.76  0.57  0.84  1.78  0.00
ACCUMULATED WATER LOSS (IN)       0.00  0.00  0.00  0.00  0.00 -1.15 -2.96 -3.72  0.00  0.00  0.00  0.00
SOIL MOISTURE STORAGE (IN)        4.08  4.08  4.08  4.08  4.08  3.05  1.94  1.60  2.17  3.01  4.08  4.08
MONTHLY MOISTURE CHANGE (IN)      0.00  0.00  0.00  0.00  0.00 -1.03 -1.12 -0.34  0.57  0.84  1.07  0.00
ACTUAL EVAPO-TRANSP. (IN)         0.00  0.00  0.00  1.35  3.06  4.51  4.37  3.92  2.80  1.41  0.00  0.00    21.42
NET PERCOLATION (IN)              0.00  0.00  2.32  3.79  0.45  0.00  0.00  0.00  0.00  0.00  0.71  0.00     7.27
DRAINAGE BASIN RUNOFF (ACRE-FT)   0.00  0.00  3.15  0.68  0.47  0.46  0.43  0.48  0.45  0.30  0.24  0.00     6.66
CUMUL. BASIN RUNOFF (ACRE-FT)     0.00  0.00  3.15  0.68  0.47  0.46  0.43  0.48  0.45  0.30  0.24  0.00     6.66

NOTE: THE FOLLOWING CONDITIONS WERE USED IN COMPUTING THIS WATER BALANCE (PER THORNTHWAITE & MATHER / EPA 1975 METHODS).

 1   THE PROPOSED SITE HAS BEEN ESTIMATED TO BE AT 44.81 DEGREES NORTH LATITUDE.
 2   THE NOTED RELATIVE SITE LOCATION WAS REFERENCED FOR ATMOSPHERIC DATA BASED UPON THE NEAREST NOAA STATION(S)
     ( 1 SHAWANO WHICH IS 9.3 MILES WSW THE SITE LOCATION).
 3   THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) DATA FOR PRECIPITATION AND TEMPERATURE, FOR THE YEARS
     1961 THROUGH 1990 FOR THE STATION NOTED IN ITEM 2, HAS BEEN USED IN THIS ANALYSIS.
 4   UNADJUSTED POTENTIAL EVAPO-TRANSPIRATION VALUES HAVE BEEN CALCULATED USING THE EQUATION DEVELOPED BY THORNTHWAITE
     & MATHER AND NOT EPA/1975 TABLE 3 WHICH VARIES AS MUCH AS 0.01 FROM THE DEFINING EQUATION.
 5   A SNOW PACK (IN EQUIVALENT INCHES OF RAINFALL) IS ACCUMULATED FOR EACH SUB 32 DEGREE FAHRENHEIT MONTH FROM OCTOBER
     THROUGH SEPTEMBER. THE TOTAL SNOW PACK IS THEN DISPERSED AS EQUIVALENT PRECIPITATION DURING A SPRING MELT EVENT,
     STARTING WHEN TEMPERATURES APPROACH 32 DEGREES.
 6   THE CORRECTED EQUIVALENT PRECIPITATION IS THE SUM OF THE MONTHLY PRECIPITATION MINUS THE AMOUNT ADDED TO THE
     ACCUMULATED SNOW PACK PLUS THE ESTIMATED MONTHLY SNOW MELT.
 7   RUNOFF COEFFICIENTS HAVE BEEN SELECTED PER CHOW, FENN, ET AL. FOR THE TOPSOIL TYPE AND SLOPE SPECIFIC TO THIS
     DRAINAGE BASIN.  THE SURFACE SLOPE WHICH HAS BEEN ESTIMATED AS .007 FEET PER FOOT.
 8   SELECTING AVAILABLE MOISTURE VALUES FROM THE RANGE OF VALUES RECORDED BY SCS, THE FOLLOWING FINAL COVER
     SYSTEM HAS BEEN ANALYZED:    THE ROOT ZONE HAS BEEN ESTIMATED AT;  48  INCHES
                                  THE FINAL COVER WAS SET AT; 12 INCHES OF SANDY LOAM WITH 10 % AVAILABLE MOISTURE
                                                              36 INCHES OF SAND WITH 8 % AVAILABLE MOISTURE
 9   FOR MONTHS WHEN POTENTIAL EVAPO-TRANSPIRATION EXCEEDS INFILTRATION, THE MOISTURE STORAGE VALUES ARE COMPUTED BY
     THE EQUATION USED TO GENERATE EPA/1975 TABLES 11 THROUGH 22. THE VALUES DO NOT MATCH THE EQUATION VALUES AT
     ALL POINTS. THESE VARIATIONS DON'T AFFECT THE  MONTHLY MOISTURE CHANGE VALUES BY MORE THAN 0.01.
10   ALL COMPUTED TABLE VALUES HAVE BEEN ROUNDED TO THE NEAREST 0.01 FOR PRINTING FORMAT. COMPUTER STORAGE ACCURACY OF
     THESE VALUES, RESULTS IN AN ANNUAL TOTAL PERCOLATION VALUE ACCURACY OF PLUS OR MINUS 0.05.
11   THIS CODE WAS ADAPTED FROM THE CODE BY J. F. SCHARCH OF THE WISCONSIN DEPARTMENT OF NATURAL RESOURCES (1985).
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*                                     WATER BALANCE PROGRAM                                     *
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*                           FOTH & VAN DYKE AND ASSOCIATES, INC.                                *
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     DRAINAGE BASIN NAME: WETLAND                        DRAINAGE BASIN AREA:   157.02 ACRES

                                   JAN   FEB   MAR   APR   MAY   JUN   JUL   AUG   SEP   OCT   NOV   DEC   ANNUAL

TEMPERATURE (F)                   14.6  18.8  29.4  44.7  56.7  65.7  70.2  67.8  59.2  49.1  34.3  21.1
MONTHLY i VALUES                  0.00  0.00  0.00  1.68  4.60  7.38  8.92  8.09  5.34  2.64  0.12  0.00    38.77
UNADJUSTED POT. EVAPO-TRANSP.     0.00  0.00  0.00  0.04  0.08  0.12  0.13  0.12  0.09  0.05  0.00  0.00
LATITUDE CORRECTION (r)           24.0  24.3  30.6  33.8  38.3  38.7  39.0  36.2  31.2  28.2  23.7  22.5
POTENTIAL EVAPO-TRANSPIRATION     0.00  0.00  0.00  1.35  3.06  4.64  5.06  4.34  2.80  1.41  0.00  0.00
PRECIPITATION                     1.30  1.20  1.95  3.04  3.69  3.67  3.42  3.77  3.55  2.37  1.87  1.49    31.32
CUMULATIVE SNOW PACK (IN)         2.79  3.99  2.37  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  1.49
CORRECTED EQUIV. PRECIP. (IN)     0.00  0.00  3.57  5.41  3.69  3.67  3.42  3.77  3.55  2.37  1.87  0.00
RUNOFF COEFFICIENT                0.35  0.35  0.35  0.05  0.05  0.05  0.05  0.05  0.05  0.05  0.05  0.30
MONTHLY RUNOFF (IN)               0.00  0.00  1.25  0.27  0.18  0.18  0.17  0.19  0.18  0.12  0.09  0.00     2.64
INFILTRATION (IN)                 0.00  0.00  2.32  5.14  3.51  3.49  3.25  3.58  3.37  2.25  1.78  0.00
INFILTRATION MINUS PET (IN)       0.00  0.00  2.32  3.79  0.45 -1.15 -1.81 -0.76  0.57  0.84  1.78  0.00
ACCUMULATED WATER LOSS (IN)       0.00  0.00  0.00  0.00  0.00 -1.15 -2.96 -3.72  0.00  0.00  0.00  0.00
SOIL MOISTURE STORAGE (IN)       14.31 14.31 14.40 14.40 14.40 13.29 11.72 11.12 11.69 12.53 14.31 14.31
MONTHLY MOISTURE CHANGE (IN)      0.00  0.00  0.09  0.00  0.00 -1.11 -1.57 -0.60  0.57  0.84  1.78  0.00
ACTUAL EVAPO-TRANSP. (IN)         0.00  0.00  0.00  1.35  3.06  4.60  4.82  4.18  2.80  1.41  0.00  0.00    22.22
NET PERCOLATION (IN)              0.00  0.00  2.23  3.79  0.45  0.00  0.00  0.00 -0.00 -0.00  0.00  0.00     6.47
DRAINAGE BASIN RUNOFF (ACRE-FT)   0.00  0.00 16.35  3.54  2.41  2.40  2.24  2.47  2.32  1.55  1.22  0.00    34.51
CUMUL. BASIN RUNOFF (ACRE-FT)     0.00  0.00 19.50  4.22  2.88  2.86  2.67  2.95  2.77  1.85  1.46  0.00    41.17

NOTE: THE FOLLOWING CONDITIONS WERE USED IN COMPUTING THIS WATER BALANCE (PER THORNTHWAITE & MATHER / EPA 1975 METHODS).

 1   THE PROPOSED SITE HAS BEEN ESTIMATED TO BE AT 44.81 DEGREES NORTH LATITUDE.
 2   THE NOTED RELATIVE SITE LOCATION WAS REFERENCED FOR ATMOSPHERIC DATA BASED UPON THE NEAREST NOAA STATION(S)
     ( 1 SHAWANO WHICH IS 9.3 MILES WSW THE SITE LOCATION).
 3   THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) DATA FOR PRECIPITATION AND TEMPERATURE, FOR THE YEARS
     1961 THROUGH 1990 FOR THE STATION NOTED IN ITEM 2, HAS BEEN USED IN THIS ANALYSIS.
 4   UNADJUSTED POTENTIAL EVAPO-TRANSPIRATION VALUES HAVE BEEN CALCULATED USING THE EQUATION DEVELOPED BY THORNTHWAITE
     & MATHER AND NOT EPA/1975 TABLE 3 WHICH VARIES AS MUCH AS 0.01 FROM THE DEFINING EQUATION.
 5   A SNOW PACK (IN EQUIVALENT INCHES OF RAINFALL) IS ACCUMULATED FOR EACH SUB 32 DEGREE FAHRENHEIT MONTH FROM OCTOBER
     THROUGH SEPTEMBER. THE TOTAL SNOW PACK IS THEN DISPERSED AS EQUIVALENT PRECIPITATION DURING A SPRING MELT EVENT,
     STARTING WHEN TEMPERATURES APPROACH 32 DEGREES.
 6   THE CORRECTED EQUIVALENT PRECIPITATION IS THE SUM OF THE MONTHLY PRECIPITATION MINUS THE AMOUNT ADDED TO THE
     ACCUMULATED SNOW PACK PLUS THE ESTIMATED MONTHLY SNOW MELT.
 7   RUNOFF COEFFICIENTS HAVE BEEN SELECTED PER CHOW, FENN, ET AL. FOR THE TOPSOIL TYPE AND SLOPE SPECIFIC TO THIS
     DRAINAGE BASIN.  THE SURFACE SLOPE WHICH HAS BEEN ESTIMATED AS .002 FEET PER FOOT.
 8   SELECTING AVAILABLE MOISTURE VALUES FROM THE RANGE OF VALUES RECORDED BY SCS, THE FOLLOWING FINAL COVER
     SYSTEM HAS BEEN ANALYZED:   THE ROOT ZONE HAS BEEN ESTIMATED AT;  48  INCHES
                                 THE FINAL COVER WAS SET AT; 12 INCHES OF ORGANIC TOPSOIL WITH 30 % AVAILABLE MOISTURE
                                                             36 INCHES OF ORGANIC TOPSOIL WITH 30 % AVAILABLE MOISTURE

 9   FOR MONTHS WHEN POTENTIAL EVAPO-TRANSPIRATION EXCEEDS INFILTRATION, THE MOISTURE STORAGE VALUES ARE COMPUTED BY
     THE EQUATION USED TO GENERATE EPA/1975 TABLES 11 THROUGH 22. THE VALUES DO NOT MATCH THE EQUATION VALUES AT
     ALL POINTS. THESE VARIATIONS DON'T AFFECT THE  MONTHLY MOISTURE CHANGE VALUES BY MORE THAN 0.01.
10   ALL COMPUTED TABLE VALUES HAVE BEEN ROUNDED TO THE NEAREST 0.01 FOR PRINTING FORMAT. COMPUTER STORAGE ACCURACY OF
     THESE VALUES, RESULTS IN AN ANNUAL TOTAL PERCOLATION VALUE ACCURACY OF PLUS OR MINUS 0.05.
11   THIS CODE WAS ADAPTED FROM THE CODE BY J. F. SCHARCH OF THE WISCONSIN DEPARTMENT OF NATURAL RESOURCES (1985).
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*                                     WATER BALANCE PROGRAM                                         *
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*                         FOTH & VAN DYKE AND ASSOCIATES, INC.                                      *
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    DRAINAGE BASIN NAME: UPLAND SOUTH                    DRAINAGE BASIN AREA:    52.34 ACRES

                                  JAN   FEB   MAR   APR   MAY   JUN   JUL   AUG   SEP   OCT   NOV   DEC   ANNUAL

TEMPERATURE (F)                   14.6  18.8  29.4  44.7  56.7  65.7  70.2  67.8  59.2  49.1  34.3  21.1
MONTHLY i VALUES                  0.00  0.00  0.00  1.68  4.60  7.38  8.92  8.09  5.34  2.64  0.12  0.00   38.77
UNADJUSTED POT. EVAPO-TRANSP.     0.00  0.00  0.00  0.04  0.08  0.12  0.13  0.12  0.09  0.05  0.00  0.00
LATITUDE CORRECTION (r)           24.0  24.3  30.6  33.8  38.3  38.7  39.0  36.2  31.2  28.2  23.7  22.5
POTENTIAL EVAPO-TRANSPIRATION     0.00  0.00  0.00  1.35  3.06  4.64  5.06  4.34  2.80  1.41  0.00  0.00
PRECIPITATION                     1.30  1.20  1.95  3.04  3.69  3.67  3.42  3.77  3.55  2.37  1.87  1.49   31.32
CUMULATIVE SNOW PACK (IN)         2.79  3.99  2.37  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  1.49
CORRECTED EQUIV. PRECIP. (IN)     0.00  0.00  3.57  5.41  3.69  3:67  3.42  3.77  3.55  2.37  1.87  0.00
RUNOFF COEFFICIENT                0.35  0.35  0.35  0.05  0.05  0.05  0.05  0.05  0.05  0.05  0.05  0.35
MONTHLY RUNOFF (IN)               0.00  0.00  1.25  0.27  0.18  0.18  0.17  0.19  0.18  0.12  0.09  0.00    2.64
INFILTRATION (IN)                 0.00  0.00  2.32  5.14  3.51  3.49  3.25  3.58  3.37  2.25  1.78  0.00
INFILTRATION MINUS PET (IN)       0.00  0.00  2.32  3.79  0.45 -1.15 -1.81 -0.76  0.57  0.84  1.78  0.00
ACCUMULATED WATER LOSS (IN)       0.00  0.00  0.00  0.00  0.00 -1.15 -2.96 -3.72  0.00  0.00  0.00  0.00
SOIL MOISTURE STORAGE (IN)        4.08  4.08  4.08  4.08  4.08  3.05  1.94  1.60  2.17  3.01  4.08  4.08
MONTHLY MOISTURE CHANGE (IN)      0.00  0.00  0.00  0.00  0.00 -1.03 -1.12 -0.34  0.57  0.84  1.07  0.00
ACTUAL EVAPO-TRANSP. (IN)         0.00  0.00  0.00  1.35  3.06  4.51  4.37  3.92  2.80  1.41  0.00  0.00   21.42
NET PERCOLATION (IN)              0.00  0.00  2.32  3.79  0.45  0.00  0.00  0.00  0.00  0.00  0.71  0.00    7.27
DRAINAGE BASIN RUNOFF (ACRE-FT)   0.00  0.00  5.45  1.18  0.80  0.80  0.75  0.82  0.77  0.52  0.41  0.00   11.50
CUMUL. BASIN RUNOFF (ACRE-FT)     0.00  0.00 24.95  5.40  3.68  3.66  3.42  3.77  3.54  2.37  1.87  0.00   52.67

NOTE: THE FOLLOWING CONDITIONS WERE USED IN COMPUTING THIS WATER BALANCE (PER THORNTHWAITE & MATHER / EPA 1975 METHODS).

 1   THE PROPOSED SITE HAS BEEN ESTIMATED TO BE AT 44.81 DEGREES NORTH LATITUDE.
 2   THE NOTED RELATIVE SITE LOCATION WAS REFERENCED FOR ATMOSPHERIC DATA BASED UPON THE NEAREST NOAA STATION(S)
     ( 1 SHAWANO WHICH IS 9.3 MILES WSW THE SITE LOCATION).
 3   THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) DATA FOR PRECIPITATION AND TEMPERATURE, FOR THE YEARS
     1961 THROUGH 1990 FOR THE STATION NOTED IN ITEM 2, HAS BEEN USED IN THIS ANALYSIS.
 4   UNADJUSTED POTENTIAL EVAPO-TRANSPIRATION VALUES HAVE BEEN CALCULATED USING THE EQUATION DEVELOPED BY THORNTHWAITE
     & MATHER AND NOT EPA/1975 TABLE 3 WHICH VARIES AS MUCH AS 0.01 FROM THE DEFINING EQUATION.
 5   A SNOW PACK (IN EQUIVALENT INCHES OF RAINFALL) IS ACCUMULATED FOR EACH SUB 32 DEGREE FAHRENHEIT MONTH FROM OCTOBER
     THROUGH SEPTEMBER. THE TOTAL SNOW PACK IS THEN DISPERSED AS EQUIVALENT PRECIPITATION DURING A SPRING MELT EVENT,
     STARTING WHEN TEMPERATURES APPROACH 32 DEGREES.
 6   THE CORRECTED EQUIVALENT PRECIPITATION IS THE SUM OF THE MONTHLY PRECIPITATION MINUS THE AMOUNT ADDED TO THE
     ACCUMULATED SNOW PACK PLUS THE ESTIMATED MONTHLY SNOW MELT.
 7   RUNOFF COEFFICIENTS HAVE BEEN SELECTED PER CHOW, FENN, ET AL. FOR THE TOPSOIL TYPE AND SLOPE SPECIFIC TO THIS
     DRAINAGE BASIN.  THE SURFACE SLOPE WHICH HAS BEEN ESTIMATED AS .007 FEET PER FOOT.
 8   SELECTING AVAILABLE MOISTURE VALUES FROM THE RANGE OF VALUES RECORDED BY SCS, THE FOLLOWING FINAL COVER
     SYSTEM HAS BEEN ANALYZED:     THE ROOT ZONE HAS BEEN ESTIMATED AT;  48  INCHES
                                   THE FINAL COVER WAS SET AT; 12 INCHES OF SANDY LOAM WITH 10 % AVAILABLE MOISTURE
                                                               36 INCHES OF SAND WITH 8 % AVAILABLE MOISTURE
 9   FOR MONTHS WHEN POTENTIAL EVAPO-TRANSPIRATION EXCEEDS INFILTRATION, THE MOISTURE STORAGE VALUES ARE COMPUTED BY
     THE EQUATION USED TO GENERATE EPA/1975 TABLES 11 THROUGH 22. THE VALUES DO NOT MATCH THE EQUATION VALUES AT
     ALL POINTS. THESE VARIATIONS DON'T AFFECT THE  MONTHLY MOISTURE CHANGE VALUES BY MORE THAN 0.01.
10   ALL COMPUTED TABLE VALUES HAVE BEEN ROUNDED TO THE NEAREST 0.01 FOR PRINTING FORMAT. COMPUTER STORAGE ACCURACY OF
     THESE VALUES, RESULTS IN AN ANNUAL TOTAL PERCOLATION VALUE ACCURACY OF PLUS OR MINUS 0.05.
11   THIS CODE WAS ADAPTED FROM THE CODE BY J. F. SCHARCH OF THE WISCONSIN DEPARTMENT OF NATURAL RESOURCES (1985).
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*                                   WATER BALANCE PROGRAM                                       *
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*                           FOTH & VAN DYKE AND ASSOCIATES, INC.                                *
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   DRAINAGE BASIN NAME: OFF-SITE AGRICULTURAL                    DRAINAGE BASIN AREA:    54.17 ACRES

                                  JAN   FEB   MAR   APR   MAY   JUN   JUL   AUG   SEP   OCT   NOV   DEC   ANNUAL

TEMPERATURE (F)                   14.6  18.8  29.4  44.7  56.7  65.7  70.2  67.8  59.2  49.1  34.3  21.1
MONTHLY i VALUES                  0.00  0.00  0.00  1.68  4.60  7.38  8.92  8.09  5.34  2.64  0.12  0.00   38.77
UNADJUSTED POT. EVAPO-TRANSP.     0.00  0.00  0.00  0.04  0.08  0.12  0.13  0.12  0.09  0.05  0.00  0.00
LATITUDE CORRECTION (r)           24.0  24.3  30.6  33.8  38.3  38.7  39.0  36.2  31.2  28.2  23.7  22.5
POTENTIAL EVAPO-TRANSPIRATION     0.00  0.00  0.00  1.35  3.06  4.64  5.06  4.34  2.80  1.41  0.00  0.00
PRECIPITATION                     1.30  1.20  1.95  3.04  3.69  3.67  3.42  3.77  3.55  2.37  1.87  1.49   31.32
CUMULATIVE SNOW PACK (IN)         2.79  3.99  2.37  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  1.49
CORRECTED EQUIV. PRECIP. (IN)     0.00  0.00  3.57  5.41  3.69  3.67  3.42  3.77  3.55  2.37  1.87  0.00
RUNOFF COEFFICIENT                0.50  0.50  0.50  0.08  0.08  0.08  0.08  0.08  0.08  0.08  0.08  0.50
MONTHLY RUNOFF (IN)               0.00  0.00  1.79  0.43  0.30  0.29  0.27  0.30  0.28  0.19  0.15  0.00    4.01
INFILTRATION (IN)                 0.00  0.00  1.79  4.98  3.39  3.38  3.15  3.47  3.27  2.18  1.72  0.00
INFILTRATION MINUS PET (IN)       0.00  0.00  1.79  3.63  0.33 -1.26 -1.91 -0.87  0.47  0.77  1.72  0.00
ACCUMULATED WATER LOSS (IN)       0.00  0.00  0.00  0.00  0.00 -1.26 -3.18 -4.05  0.00  0.00  0.00  0.00
SOIL MOISTURE STORAGE (IN)        6.31  6.31  6.36  6.36  6.36  5.21  3.85  3.36  3.82  4.59  6.31  6.31
MONTHLY MOISTURE CHANGE (IN)      0.00  0.00  0.05  0.00  0.00 -1.15 -1.36 -0.50  0.47  0.77  1.72  0.00
ACTUAL EVAPO-TRANSP. (IN)         0.00  0.00  0.00  1.35  3.06  4.53  4.50  3.96  2.80  1.41  0.00  0.00   21.61
NET PERCOLATION (IN)              0.00  0.00  1.74  3.63  0.33  0.00  0.00  0.00  0.00 -0.00  0.00  0.00    5.70
DRAINAGE BASIN RUNOFF (ACRE-FT)   0.00  0.00  8.06  1.95  1.33  1.33  1.24  1.36  1.28  0.86  0.68  0.00   18.08
CUMUL. BASIN RUNOFF (ACRE-FT)     0.00  0.00 33.01  7.35  5.01  4.99  4.66  5.13  4.82  3.23  2.55  0.00   70.75

NOTE: THE FOLLOWING CONDITIONS WERE USED IN COMPUTING THIS WATER BALANCE (PER THORNTHWAITE & MATHER / EPA 1975 METHODS).

 1   THE PROPOSED SITE HAS BEEN ESTIMATED TO BE AT 44.81 DEGREES NORTH LATITUDE.
 2   THE NOTED RELATIVE SITE LOCATION WAS REFERENCED FOR ATMOSPHERIC DATA BASED UPON THE NEAREST NOAA STATION(S)
     ( 1 SHAWANO WHICH IS 9.3 MILES WSW THE SITE LOCATION).
 3   THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) DATA FOR PRECIPITATION AND TEMPERATURE, FOR THE YEARS
     1961 THROUGH 1990 FOR THE STATION NOTED IN ITEM 2, HAS BEEN USED IN THIS ANALYSIS.
 4   UNADJUSTED POTENTIAL EVAPO-TRANSPIRATION VALUES HAVE BEEN CALCULATED USING THE EQUATION DEVELOPED BY THORNTHWAITE
     & MATHER AND NOT EPA/1975 TABLE 3 WHICH VARIES AS MUCH AS 0.01 FROM THE DEFINING EQUATION.
 5   A SNOW PACK (IN EQUIVALENT INCHES OF RAINFALL) IS ACCUMULATED FOR EACH SUB 32 DEGREE FAHRENHEIT MONTH FROM OCTOBER
     THROUGH SEPTEMBER. THE TOTAL SNOW PACK IS THEN DISPERSED AS EQUIVALENT PRECIPITATION DURING A SPRING MELT EVENT,
     STARTING WHEN TEMPERATURES APPROACH 32 DEGREES.
 6   THE CORRECTED EQUIVALENT PRECIPITATION IS THE SUM OF THE MONTHLY PRECIPITATION MINUS THE AMOUNT ADDED TO THE
     ACCUMULATED SNOW PACK PLUS THE ESTIMATED MONTHLY SNOW MELT.
 7   RUNOFF COEFFICIENTS HAVE BEEN SELECTED PER CHOW, FENN, ET AL. FOR THE TOPSOIL TYPE AND SLOPE SPECIFIC TO THIS
     DRAINAGE BASIN.  THE SURFACE SLOPE WHICH HAS BEEN ESTIMATED AS .002 FEET PER FOOT.
 8   SELECTING AVAILABLE MOISTURE VALUES FROM THE RANGE OF VALUES RECORDED BY SCS, THE FOLLOWING FINAL COVER
     SYSTEM HAS BEEN ANALYZED:    THE ROOT ZONE HAS BEEN ESTIMATED AT;  36  INCHES
                                  THE FINAL COVER WAS SET AT; 12 INCHES OF ORGANIC TOPSOIL WITH 25 % AVAILABLE MOISTURE
                                                              12 INCHES OF ORGANIC TOPSOIL WITH 20 % AVAILABLE MOISTURE
                                                              12 INCHES OF SILTY SAND WITH 8 % AVAILABLE MOISTURE
 9   FOR MONTHS WHEN POTENTIAL EVAPO-TRANSPIRATION EXCEEDS INFILTRATION, THE MOISTURE STORAGE VALUES ARE COMPUTED BY
     THE EQUATION USED TO GENERATE EPA/1975 TABLES 11 THROUGH 22. THE VALUES DO NOT MATCH THE EQUATION VALUES AT
     ALL POINTS. THESE VARIATIONS DON'T AFFECT THE  MONTHLY MOISTURE CHANGE VALUES BY MORE THAN 0.01.
10   ALL COMPUTED TABLE VALUES HAVE BEEN ROUNDED TO THE NEAREST 0.01 FOR PRINTING FORMAT. COMPUTER STORAGE ACCURACY OF
     THESE VALUES, RESULTS IN AN ANNUAL TOTAL PERCOLATION VALUE ACCURACY OF PLUS OR MINUS 0.05.
11   THIS CODE WAS ADAPTED FROM THE CODE BY J. F. SCHARCH OF THE WISCONSIN DEPARTMENT OF NATURAL RESOURCES (1985).
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**************************************************************************************************
*                                                                                                *
*                                   WATER BALANCE PROGRAM                                        *
*                                                                                                *
*                           FOTH & VAN DYKE AND ASSOCIATES, INC.                                 *
*                                                                                                *
**************************************************************************************************

     DRAINAGE BASIN NAME: ON-SITE AGRICULTURAL                    DRAINAGE BASIN AREA:    50.51 ACRES

                                      JAN   FEB   MAR   APR   MAY   JUN   JUL   AUG   SEP   OCT   NOV   DEC   ANNUAL

TEMPERATURE (F)                       14.6  18.8  29.4  44.7  56.7  65.7  70.2  67.8  59.2  49.1  34.3  21.1
MONTHLY i VALUES                      0.00  0.00  0.00  1.68  4.60  7.38  8.92  8.09  5.34  2.64  0.12  0.00   38.77
UNADJUSTED POT. EVAPO-TRANSP.         0.00  0.00  0.00  0.04  0.08  0.12  0.13  0.12  0.09  0.05  0.00  0.00
LATITUDE CORRECTION (r)               24.0  24.3  30.6  33.8  38.3  38.7  39.0  36.2  31.2  28.2  23.7  22.5
POTENTIAL EVAPO-TRANSPIRATION         0.00  0.00  0.00  1.35  3.06  4.64  5.06  4.34  2.80  1.41  0.00  0.00
PRECIPITATION                         1.30  1.20  1.95  3.04  3.69  3.67  3.42  3.77  3.55  2.37  1.87  1.49   31.32
CUMULATIVE SNOW PACK (IN)             2.79  3.99  2.37  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  1.49
CORRECTED EQUIV. PRECIP. (IN)         0.00  0.00  3.57  5.41  3.69  3.67  3.42  3.77  3.55  2.37  1.87  0.00
RUNOFF COEFFICIENT                    0.50  0.50  0.50  0.08  0.08  0.08  0.08  0.08  0.08  0.08  0.08  0.50
MONTHLY RUNOFF (IN)                   0.00  0.00  1.79  0.43  0.30  0.29  0.27  0.30  0.28  0.19  0.15  0.00    4.01
INFILTRATION (IN)                     0.00  0.00  1.79  4.98  3.39  3.38  3.15  3.47  3.27  2.18  1.72  0.00
INFILTRATION MINUS PET (IN)           0.00  0.00  1.79  3.63  0.33 -1.26 -1.91 -0.87  0.47  0.77  1.72  0.00
ACCUMULATED WATER LOSS (IN)           0.00  0.00  0.00  0.00  0.00 -1.26 -3.18 -4.05  0.00  0.00  0.00  0.00
SOIL MOISTURE STORAGE (IN)            6.31  6.31  6.36  6.36  6.36  5.21  3.85  3.36  3.82  4.59  6.31  6.31
MONTHLY MOISTURE CHANGE (IN)          0.00  0.00  0.05  0.00  0.00 -1.15 -1.36 -0.50  0.47  0.77  1.72  0.00
ACTUAL EVAPO-TRANSP. (IN)             0.00  0.00  0.00  1.35  3.06  4.53  4.50  3.96  2.80  1.41  0.00  0.00   21.61
NET PERCOLATION (IN)                  0.00  0.00  1.74  3.63  0.33  0.00  0.00  0.00  0.00 -0.00  0.00  0.00    5.70
DRAINAGE BASIN RUNOFF (ACRE-FT)       0.00  0.00  7.51  1.82  1.24  1.24  1.15  1.27  1.20  0.80  0.63  0.00   16.86
CUMUL. BASIN RUNOFF (ACRE-FT)         0.00  0.00 40.52  9.17  6.25  6.23  5.81  6.40  6.02  4.03  3.18  0.00   87.61

NOTE: THE FOLLOWING CONDITIONS WERE USED IN COMPUTING THIS WATER BALANCE (PER THORNTHWAITE & MATHER / EPA 1975 METHODS).

 1   THE PROPOSED SITE HAS BEEN ESTIMATED TO BE AT 44.81 DEGREES NORTH LATITUDE.
 2   THE NOTED RELATIVE SITE LOCATION WAS REFERENCED FOR ATMOSPHERIC DATA BASED UPON THE NEAREST NOAA STATION(S)
     ( 1 SHAWANO WHICH IS 9.3 MILES WSW THE SITE LOCATION).
 3   THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) DATA FOR PRECIPITATION AND TEMPERATURE, FOR THE YEARS
     1961 THROUGH 1990 FOR THE STATION NOTED IN ITEM 2, HAS BEEN USED IN THIS ANALYSIS.
 4   UNADJUSTED POTENTIAL EVAPO-TRANSPIRATION VALUES HAVE BEEN CALCULATED USING THE EQUATION DEVELOPED BY THORNTHWAITE
     & MATHER AND NOT EPA/1975 TABLE 3 WHICH VARIES AS MUCH AS 0.01 FROM THE DEFINING EQUATION.
 5   A SNOW PACK (IN EQUIVALENT INCHES OF RAINFALL) IS ACCUMULATED FOR EACH SUB 32 DEGREE FAHRENHEIT MONTH FROM OCTOBER
     THROUGH SEPTEMBER. THE TOTAL SNOW PACK IS THEN DISPERSED AS EQUIVALENT PRECIPITATION DURING A SPRING MELT EVENT,
     STARTING WHEN TEMPERATURES APPROACH 32 DEGREES.
 6   THE CORRECTED EQUIVALENT PRECIPITATION IS THE SUM OF THE MONTHLY PRECIPITATION MINUS THE AMOUNT ADDED TO THE
     ACCUMULATED SNOW PACK PLUS THE ESTIMATED MONTHLY SNOW MELT.
 7   RUNOFF COEFFICIENTS HAVE BEEN SELECTED PER CHOW, FENN, ET AL. FOR THE TOPSOIL TYPE AND SLOPE SPECIFIC TO THIS
     DRAINAGE BASIN.  THE SURFACE SLOPE WHICH HAS BEEN ESTIMATED AS .002 FEET PER FOOT.
 8   SELECTING AVAILABLE MOISTURE VALUES FROM THE RANGE OF VALUES RECORDED BY SCS, THE FOLLOWING FINAL COVER
     SYSTEM HAS BEEN ANALYZED:    THE ROOT ZONE HAS BEEN ESTIMATED AT;  36  INCHES
                                  THE FINAL COVER WAS SET AT; 12 INCHES OF ORGANIC TOPSOIL WITH 25 % AVAILABLE MOISTURE
                                                              12 INCHES OF ORGANIC TOPSOIL WITH 20 % AVAILABLE MOISTURE
                                                              12 INCHES OF SILTY SAND WITH 8 % AVAILABLE MOISTURE
 9   FOR MONTHS WHEN POTENTIAL EVAPO-TRANSPIRATION EXCEEDS INFILTRATION, THE MOISTURE STORAGE VALUES ARE COMPUTED BY
     THE EQUATION USED TO GENERATE EPA/1975 TABLES 11 THROUGH 22. THE VALUES DO NOT MATCH THE EQUATION VALUES AT
     ALL POINTS. THESE VARIATIONS DON'T AFFECT THE  MONTHLY MOISTURE CHANGE VALUES BY MORE THAN 0.01.
10   ALL COMPUTED TABLE VALUES HAVE BEEN ROUNDED TO THE NEAREST 0.01 FOR PRINTING FORMAT. COMPUTER STORAGE ACCURACY OF
     THESE VALUES, RESULTS IN AN ANNUAL TOTAL PERCOLATION VALUE ACCURACY OF PLUS OR MINUS 0.05.
11   THIS CODE WAS ADAPTED FROM THE CODE BY J. F. SCHARCH OF THE WISCONSIN DEPARTMENT OF NATURAL RESOURCES (1985).
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*                                                                                                  *
*                                      WATER BALANCE PROGRAM                                       *
*                                                                                                  *
*                               FOTH & VAN DYKE AND ASSOCIATES, INC.                               *
*                                                                                                  *
****************************************************************************************************

     DRAINAGE BASIN NAME: OFF-SITE PROPOSED 100%                 DRAINAGE BASIN AREA:     54.17 ACRES

                                   JAN   FEB   MAR   APR   MAY   JUN   JUL   AUG   SEP   OCT   NOV   DEC    ANNUAL

TEMPERATURE (F)                   14.6  18.8  29.4  44.7  56.7  65.7  70.2  67.8  59.2  49.1  34.3  21.1
MONTHLY i VALUES                  0.00  0.00  0.00  1.68  4.60  7.38  8.92  8.09  5.34  2.64  0.12  0.00    38.77
UNADJUSTED POT. EVAPO-TRANSP.     0.00  0.00  0.00  0.04  0.08  0.12  0.13  0.12  0.09  0.05  0.00  0.00
LATITUDE CORRECTION (r)           24.0  24.3  30.6  33.8  38.3  38.7  39.0  36.2  31.2  28.2  23.7  22.5
POTENTIAL EVAPO-TRANSPIRATION     0.00  0.00  0.00  1.35  3.06  4.64  5.06  4.34  2.80  1.41  0.00  0.00
PRECIPITATION                     1.30  1.20  1.95  3.04  3.69  3.67  3.42  3.77  3.55  2.37  1.87  1.49    31.32
CUMULATIVE SNOW PACK (IN)         2.79  3.99  2.37  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  1.49
CORRECTED EQUIV. PRECIP. (IN)     0.00  0.00  3.57  5.41  3.69  3.67  3.42  3.77  3.55  2.37  1.87  0.00
RUNOFF COEFFICIENT                0.50  0.50  0.50  0.08  0.08  0.08  0.08  0.08  0.08  0.08  0.08  0.50
MONTHLY RUNOFF (IN)               0.00  0.00  1.79  0.43  0.30  0.29  0.27  0.30  0.28  0.19  0.15  0.00     4.01
INFILTRATION (IN)                 0.00  0.00  1.79  4.98  3.39  3.38  3.15  3.47  3.27  2.18  1.72  0.00
INFILTRATION MINUS PET (IN)       0.00  0.00  1.79  3.63  0.33 -1.26 -1.91 -0.87  0.47  0.77  1.72  0.00
ACCUMULATED WATER LOSS (IN)       0.00  0.00  0.00  0.00  0.00 -1.26 -3.18 -4.05  0.00  0.00  0.00  0.00
SOIL MOISTURE STORAGE (IN)       24.18 24.18 24.96 24.96 24.96 23.73 21.98 21.22 21.69 22.46 24.18 24.18
MONTHLY MOISTURE CHANGE (IN)      0.00  0.00  0.78  0.00  0.00 -1.23 -1.75 -0.75  0.47  0.77  1.72  0.00
ACTUAL EVAPO-TRANSP. (IN)         0.00  0.00  0.00  1.35  3.06  4.61  4.90  4.22  2.80  1.41  0.00  0.00    22.35
NET PERCOLATION (IN)              0.00  0.00  1.00  3.63  0.33  0.00  0.00  0.00  0.00  0.00  0.00  0.00     4.97
DRAINAGE BASIN RUNOFF (ACRE-FT)   0.00  0.00  8.06  1.95  1.33  1.33  1.24  1.36  1.28  0.86  0.68  0.00    18.08
CUMUL. BASIN RUNOFF (ACRE-FT)     0.00  0.00  8.06  1.95  1.33  1.33  1.24  1.36  1.28  0.86  0.68  0.00    18.08

NOTE: THE FOLLOWING CONDITIONS WERE USED IN COMPUTING THIS WATER BALANCE (PER THORNTHWAITE & MATHER / EPA 1975 METHODS).

  1   THE PROPOSED SITE HAS BEEN ESTIMATED TO BE AT 44.81 DEGREES NORTH LATITUDE.
  2   THE NOTED RELATIVE SITE LOCATION WAS REFERENCED FOR ATMOSPHERIC DATA BASED UPON THE NEAREST NOAA STATION(S)
      ( 1 SHAWANO WHICH IS 9.3 MILES WSW THE SITE LOCATION).
  3   THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) DATA FOR PRECIPITATION AND TEMPERATURE, FOR THE YEARS
      1961 THROUGH 1990 FOR THE STATION NOTED IN ITEM 2, HAS BEEN USED IN THIS ANALYSIS.
  4   UNADJUSTED POTENTIAL EVAPO-TRANSPIRATION VALUES HAVE BEEN CALCULATED USING THE EQUATION DEVELOPED BY THORNTHWAITE
      & MATHER AND NOT EPA/1975 TABLE 3 WHICH VARIES AS MUCH AS 0.01 FROM THE DEFINING EQUATION.
  5   A SNOW PACK (IN EQUIVALENT INCHES OF RAINFALL) IS ACCUMULATED FOR EACH SUB 32 DEGREE FAHRENHEIT MONTH FROM OCTOBER
      THROUGH SEPTEMBER. THE TOTAL SNOW PACK IS THEN DISPERSED AS EQUIVALENT PRECIPITATION DURING A SPRING MELT EVENT,
      STARTING WHEN TEMPERATURES APPROACH 32 DEGREES.
  6   THE CORRECTED EQUIVALENT PRECIPITATION IS THE SUM OF THE MONTHLY PRECIPITATION MINUS THE AMOUNT ADDED TO THE
      ACCUMULATED SNOW PACK PLUS THE ESTIMATED MONTHLY SNOW MELT.
  7   RUNOFF COEFFICIENTS HAVE BEEN SELECTED PER CHOW, FENN, ET AL. FOR THE TOPSOIL TYPE AND SLOPE SPECIFIC TO THIS
      DRAINAGE BASIN.  THE SURFACE SLOPE WHICH HAS BEEN ESTIMATED AS .002 FEET PER FOOT.
  8   SELECTING AVAILABLE MOISTURE VALUES FROM THE RANGE OF VALUES RECORDED BY SCS, THE FOLLOWING FINAL COVER
      SYSTEM HAS BEEN ANALYZED:    THE ROOT ZONE HAS BEEN ESTIMATED AT;  36  INCHES
                                   THE FINAL COVER WAS SET AT; 12 INCHES OF ORGANIC TOPSOIL WITH 100 % AVAILABLE MOISTURE
                                                               12 INCHES OF ORGANIC TOPSOIL WITH 100 % AVAILABLE MOISTURE
                                                               12 INCHES OF SILTY SAND WITH 8 % AVAILABLE MOISTURE

  9   FOR MONTHS WHEN POTENTIAL EVAPO-TRANSPIRATION EXCEEDS INFILTRATION, THE MOISTURE STORAGE VALUES ARE COMPUTED BY
      THE EQUATION USED TO GENERATE EPA/1975 TABLES 11 THROUGH 22. THE VALUES DO NOT MATCH THE EQUATION VALUES AT
      ALL POINTS. THESE VARIATIONS DON'T AFFECT THE  MONTHLY MOISTURE CHANGE VALUES BY MORE THAN 0.01.
 10   ALL COMPUTED TABLE VALUES HAVE BEEN ROUNDED TO THE NEAREST 0.01 FOR PRINTING FORMAT. COMPUTER STORAGE ACCURACY OF
      THESE VALUES, RESULTS IN AN ANNUAL TOTAL PERCOLATION VALUE ACCURACY OF PLUS OR MINUS 0.05.
 11   THIS CODE WAS ADAPTED FROM THE CODE BY J. F. SCHARCH OF THE WISCONSIN DEPARTMENT OF NATURAL RESOURCES (1985).
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*                                                                                               *
*                                   WATER BALANCE PROGRAM                                       *
*                                                                                               *
*                          FOTH & VAN DYKE AND ASSOCIATES, INC.                                 *
*                                                                                               *
*************************************************************************************************

   DRAINAGE BASIN NAME: ON-SITE PROPOSED 100%            DRAINAGE BASIN AREA:    50.51 ACRES

                                 JAN   FEB   MAR   APR   MAY   JUN   JUL   AUG   SEP   OCT   NOV   DEC   ANNUAL

TEMPERATURE (F)                 14.6  18.8  29.4  44.7  56.7  65.7  70.2  67.8  59.2  49.1  34.3  21.1
MONTHLY i VALUES                0.00  0.00  0.00  1.68  4.60  7.38  8.92  8.09  5.34  2.64  0.12  0.00   38.77
UNADJUSTED POT. EVAPO-TRANSP.   0.00  0.00  0.00  0.04  0.08  0.12  0.13  0.12  0.09  0.05  0.00  0.00
LATITUDE CORRECTION (r)         24.0  24.3  30.6  33.8  38.3  38.7  39.0  36.2  31.2  28.2  23.7  22.5
POTENTIAL EVAPO-TRANSPIRATION   0.00  0.00  0.00  1.35  3.06  4.64  5.06  4.34  2.80  1.41  0.00  0.00
PRECIPITATION                   1.30  1.20  1.95  3.04  3.69  3.67  3.42  3.77  3.55  2.37  1.87  1.49   31.32
CUMULATIVE SNOW PACK (IN)       2.79  3.99  2.37  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  1.49
CORRECTED EQUIV. PRECIP. (IN)   0.00  0.00  3.57  5.41  3.69  3.67  3.42  3.77  3.55  2.37  1.87  0.00
RUNOFF COEFFICIENT              0.35  0.35  0.35  0.05  0.05  0.05  0.05  0.05  0.05  0.05  0.05  0.35
MONTHLY RUNOFF (IN)             0.00  0.00  1.25  0.27  0.18  0.18  0.17  0.19  0.18  0.12  0.09  0.00    2.64
INFILTRATION (IN)               0.00  0.00  2.32  5.14  3.51  3.49  3.25  3.58  3.37  2.25  1.78  0.00
INFILTRATION MINUS PET (IN)     0.00  0.00  2.32  3.79  0.45 -1.15 -1.81 -0.76  0.57  0.84  1.78  0.00
ACCUMULATED WATER LOSS (IN)     0.00  0.00  0.00  0.00  0.00 -1.15 -2.96 -3.72  0.00  0.00  0.00  0.00
SOIL MOISTURE STORAGE (IN)     24.69 24.69 24.96 24.96 24.96 23.83 22.16 21.50 22.07 22.92 24.69 24.69
MONTHLY MOISTURE CHANGE (IN)    0.00  0.00  0.27  0.00  0.00 -1.13 -1.67 -0.66  0.57  0.84  1.78  0.00
ACTUAL EVAPO-TRANSP. (IN)       0.00  0.00  0.00  1.35  3.06  4.61  4.92  4.24  2.80  1.41  0.00  0.00   22.40
NET PERCOLATION (IN)            0.00  0.00  2.05  3.79  0.45  0.00  0.00  0.00 -0.00  0.00 -0.00  0.00    6.29
DRAINAGE BASIN RUNOFF (ACRE-FT) 0.00  0.00  5.26  1.14  0.78  0.77  0.72  0.79  0.75  0.50  0.39  0.00   11.10
CUMUL. BASIN RUNOFF (ACRE-FT)   0.00  0.00 13.32  3.09  2.11  2.10  1.96  2.15  2.03  1.36  1.07  0.00   29.18

NOTE: THE FOLLOWING CONDITIONS WERE USED IN COMPUTING THIS WATER BALANCE (PER THORNTHWAITE & MATHER / EPA 1975 METHODS).

 1   THE PROPOSED SITE HAS BEEN ESTIMATED TO BE AT 44.81 DEGREES NORTH LATITUDE.
 2   THE NOTED RELATIVE SITE LOCATION WAS REFERENCED FOR ATMOSPHERIC DATA BASED UPON THE NEAREST NOAA STATION(S)
     ( 1 SHAWANO WHICH IS 9.3 MILES WSW THE SITE LOCATION).
 3   THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) DATA FOR PRECIPITATION AND TEMPERATURE, FOR THE YEARS
     1961 THROUGH 1990 FOR THE STATION NOTED IN ITEM 2, HAS BEEN USED IN THIS ANALYSIS.
 4   UNADJUSTED POTENTIAL EVAPO-TRANSPIRATION VALUES HAVE BEEN CALCULATED USING THE EQUATION DEVELOPED BY THORNTHWAITE
     & MATHER AND NOT EPA/1975 TABLE 3 WHICH VARIES AS MUCH AS 0.01 FROM THE DEFINING EQUATION.
 5   A SNOW PACK (IN EQUIVALENT INCHES OF RAINFALL) IS ACCUMULATED FOR EACH SUB 32 DEGREE FAHRENHEIT MONTH FROM OCTOBER
     THROUGH SEPTEMBER. THE TOTAL SNOW PACK IS THEN DISPERSED AS EQUIVALENT PRECIPITATION DURING A SPRING MELT EVENT,
     STARTING WHEN TEMPERATURES APPROACH 32 DEGREES.
 6   THE CORRECTED EQUIVALENT PRECIPITATION IS THE SUM OF THE MONTHLY PRECIPITATION MINUS THE AMOUNT ADDED TO THE
     ACCUMULATED SNOW PACK PLUS THE ESTIMATED MONTHLY SNOW MELT.
 7   RUNOFF COEFFICIENTS HAVE BEEN SELECTED PER CHOW, FENN, ET AL. FOR THE TOPSOIL TYPE AND SLOPE SPECIFIC TO THIS
     DRAINAGE BASIN.  THE SURFACE SLOPE WHICH HAS BEEN ESTIMATED AS .002 FEET PER FOOT.
 8   SELECTING AVAILABLE MOISTURE VALUES FROM THE RANGE OF VALUES RECORDED BY SCS, THE FOLLOWING FINAL COVER
     SYSTEM HAS BEEN ANALYZED:     THE ROOT ZONE HAS BEEN ESTIMATED AT;  36  INCHES
                                   THE FINAL COVER WAS SET AT; 12 INCHES OF ORGANIC TOPSOIL WITH 100 % AVAILABLE MOISTURE
                                                               12 INCHES OF ORGANIC TOPSOIL WITH 100 % AVAILABLE MOISTURE
                                                               12 INCHES OF SILTY SAND WITH 8 % AVAILABLE MOISTURE
 9   FOR MONTHS WHEN POTENTIAL EVAPO-TRANSPIRATION EXCEEDS INFILTRATION, THE MOISTURE STORAGE VALUES ARE COMPUTED BY
     THE EQUATION USED TO GENERATE EPA/1975 TABLES 11 THROUGH 22. THE VALUES DO NOT MATCH THE EQUATION VALUES AT
     ALL POINTS. THESE VARIATIONS DON'T AFFECT THE  MONTHLY MOISTURE CHANGE VALUES BY MORE THAN 0.01.
10   ALL COMPUTED TABLE VALUES HAVE BEEN ROUNDED TO THE NEAREST 0.01 FOR PRINTING FORMAT. COMPUTER STORAGE ACCURACY OF
     THESE VALUES, RESULTS IN AN ANNUAL TOTAL PERCOLATION VALUE ACCURACY OF PLUS OR MINUS 0.05.
11   THIS CODE WAS ADAPTED FROM THE CODE BY J. F. SCHARCH OF THE WISCONSIN DEPARTMENT OF NATURAL RESOURCES (1985).
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Appendix B

QTR-55 Tabulation:
1 Inch Rainfall Event
2-Year Event
10-Year Event
100-Year Event

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Quick TR-55 Version: 5.46 S/N: 1315430197                     Page 1

                       TR-55 TABULAR HYDROGRAPH METHOD
                            Type II  Distribution
                           (24 hr. Duration Storm)

                      Executed:  07-17-1995  11:44:44
               Watershed file: --> SHAW1   .WSD
               Hydrograph file: --> SHAW1   .HYD

                           CRANDON MINING COMPANY
                         FOTH AND VAN DYKE    93C049
          WETLAND COMPENSATION: SHAWANO COUNTY                  5/95
                            1-INCH  STORM EVENT


              >>>> Input Parameters Used to Compute Hydrograph <<<<
------------------------------------------------------------------------------
 Subarea          AREA     CN      Tc     * Tt    Precip. |  Runoff     Ia/p
Description      (acres)          (hrs)   (hrs)    (in)   |   (in)  input/used
------------------------------------------------------------------------------

WETLAND          157.02   79.0    0.50    0.10    1.00    |   0.07    .53  .50
UPLAND NORTH      30.30   80.0    0.30    0.75    1.00    |   0.08    .5   .50
AGRICULTURAL     104.68   80.0    0.30    0.00    1.00    |   0.08    .5   .50
UPLAND SOUTH      52.34   80.0    0.50    0.10    1.00    |   0.08    .5   .50
------------------------------------------------------------------------------
* Travel time from subarea outfall to composite watershed outfall point.
                 Total area = 344.34 acres  or  0.5380 sq.mi
                         Peak discharge =  8 cfs

              WARNING: Drainage areas of two or more subareas
                       differ by a factor of 5 or greater.



              >>>> Computer Modifications of Input Parameters <<<<<
------------------------------------------------------------------------------
                   Input Values     Rounded Values     Ia/p
 Subarea            Tc    * Tt       Tc    * Tt    Interpolated       Ia/p
Description        (hr)    (hr)     (hr)    (hr)     (Yes/No)       Messages
------------------------------------------------------------------------------
WETLAND            0.61    0.10     0.50    0.10       No       Computed Ia/p > .5
UPLAND NORTH       0.21    0.83     0.30    0.75       No              --
AGRICULTURAL       0.28    0.00     0.30    0.00       No              --
UPLAND SOUTH       0.61    0.10     0.50    0.10       No              --
------------------------------------------------------------------------------
 * Travel time from subarea outfall to composite watershed outfall point.
```

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                TR-55 TABULAR HYDROGRAPH METHOD
                     Type II  Distribution
                    (24 hr. Duration Storm)

                Executed:  07-17-1995  11:44:44
      Watershed file:  --> SHAW1    .WSD
      Hydrograph file: --> SHAW1    .HYD

                     CRANDON MINING COMPANY
                  FOTH AND VAN DYKE     93C049
        WETLAND COMPENSATION: SHAWANO COUNTY                   5/95
                      1-INCH  STORM EVENT


             >>>> Summary of Subarea Times to Peak <<<<

                          Peak Discharge at   Time to Peak at
                          Composite Outfall   Composite Outfall
          Subarea               (cfs)               (hrs)
       --------------     --------------      ------------
       WETLAND                   4                12.7
       UPLAND NORTH              1                12.8
       AGRICULTURAL              4                12.3
       UPLAND SOUTH              1                12.5
       --------------     --------------      ------------
     Composite Watershed         8                12.8
```

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Quick TR-55 Version: 5.46 S/N: 1315430197                    Page 3

                      TR-55 TABULAR HYDROGRAPH METHOD
                           Type II  Distribution
                          (24 hr. Duration Storm)

                      Executed:  07-17-1995  11:44:44
               Watershed file:  --> SHAW1   .WSD
               Hydrograph file: --> SHAW1   .HYD

                           CRANDON MINING COMPANY
                         FOTH AND VAN DYKE    93C049
             WETLAND COMPENSATION: SHAWANO COUNTY                  5/95
                            1-INCH  STORM EVENT


                      Composite Hydrograph Summary (cfs)
----------------------------------------------------------------------
  Subarea       11.0   11.3   11.6   11.9   12.0   12.1   12.2   12.3   12.4
 Description     hr     hr     hr     hr     hr     hr     hr     hr     hr
----------------------------------------------------------------------
WETLAND           0      0      0      0      0      0      0      0      1
UPLAND NORTH      0      0      0      0      0      0      0      0      0
AGRICULTURAL      0      0      0      0      0      0      2      4      4
UPLAND SOUTH      0      0      0      0      0      0      0      0      0
----------------------------------------------------------------------
Total (cfs)       0      0      0      0      0      0      2      4      5


----------------------------------------------------------------------
  Subarea       12.5   12.6   12.7   12.8   13.0   13.2   13.4   13.6   13.8
 Description     hr     hr     hr     hr     hr     hr     hr     hr     hr
----------------------------------------------------------------------
WETLAND           2      3      4      4      3      2      2      2      2
UPLAND NORTH      0      0      0      1      1      1      1      0      0
AGRICULTURAL      3      2      2      2      1      1      1      1      1
UPLAND SOUTH      1      1      1      1      1      1      1      1      1
----------------------------------------------------------------------
Total (cfs)       6      6      7      8      6      5      5      4      4
```

```
                    TR-55 TABULAR HYDROGRAPH METHOD
                          Type II  Distribution
                         (24 hr. Duration Storm)

                     Executed:  07-17-1995  11:44:44
                Watershed file:  --> SHAW1    .WSD
                Hydrograph file: --> SHAW1    .HYD

                          CRANDON MINING COMPANY
                       FOTH AND VAN DYKE    93C049
            WETLAND COMPENSATION: SHAWANO COUNTY                    5/95
                           1-INCH  STORM EVENT


                    Composite Hydrograph Summary (cfs)
------------------------------------------------------------------------------
   Subarea       14.0   14.3   14.6   15.0   15.5   16.0   16.5   17.0   17.5
 Description      hr     hr     hr     hr     hr     hr     hr     hr     hr
------------------------------------------------------------------------------
WETLAND            1      1      1      1      1      1      1      1      1
UPLAND NORTH       0      0      0      0      0      0      0      0      0
AGRICULTURAL       1      1      1      1      1      1      1      1      1
UPLAND SOUTH       1      0      0      0      0      0      0      0      0
------------------------------------------------------------------------------
Total (cfs)        3      2      2      2      2      2      2      2      2



------------------------------------------------------------------------------
   Subarea       18.0   19.0   20.0   22.0   26.0
 Description      hr     hr     hr     hr     hr
------------------------------------------------------------------------------
WETLAND            1      1      1      0      0
UPLAND NORTH       0      0      0      0      0
AGRICULTURAL       1      0      0      0      0
UPLAND SOUTH       0      0      0      0      0
------------------------------------------------------------------------------
Total (cfs)        2      1      1      0      0
```

```
                    TR-55 TABULAR HYDROGRAPH METHOD
                         Type II  Distribution
                        (24 hr. Duration Storm)

                    Executed:  07-17-1995  11:44:44
          Watershed file:  --> SHAW1   .WSD
          Hydrograph file: --> SHAW1   .HYD

                         CRANDON MINING COMPANY
                      FOTH AND VAN DYKE    93C049
      WETLAND COMPENSATION: SHAWANO COUNTY                    5/95
                          1-INCH  STORM EVENT


               Time         Flow              Time         Flow
               (hrs)        (cfs)             (hrs)        (cfs)
               -----------------              -----------------
               11.0            0              14.8            2
               11.1            0              14.9            2
               11.2            0              15.0            2
               11.3            0              15.1            2
               11.4            0              15.2            2
               11.5            0              15.3            2
               11.6            0              15.4            2
               11.7            0              15.5            2
               11.8            0              15.6            2
               11.9            0              15.7            2
               12.0            0              15.8            2
               12.1            0              15.9            2
               12.2            2              16.0            2
               12.3            4              16.1            2
               12.4            5              16.2            2
               12.5            6              16.3            2
               12.6            6              16.4            2
               12.7            7              16.5            2
               12.8            8              16.6            2
               12.9            7              16.7            2
               13.0            6              16.8            2
               13.1            6              16.9            2
               13.2            5              17.0            2
               13.3            5              17.1            2
               13.4            5              17.2            2
               13.5            5              17.3            2
               13.6            4              17.4            2
               13.7            4              17.5            2
               13.8            4              17.6            2
               13.9            4              17.7            2
               14.0            3              17.8            2
               14.1            3              17.9            2
               14.2            2              18.0            2
               14.3            2              18.1            2
               14.4            2              18.2            2
               14.5            2              18.3            2
               14.6            2              18.4            2
```

```
                 TR-55 TABULAR HYDROGRAPH METHOD
                      Type II  Distribution
                    (24 hr. Duration Storm)

                 Executed:  07-17-1995  11:44:44
        Watershed file:  --> SHAW1   .WSD
        Hydrograph file: --> SHAW1   .HYD

                     CRANDON MINING COMPANY
                   FOTH AND VAN DYKE    93C049
     WETLAND COMPENSATION: SHAWANO COUNTY                   5/95
                      1-INCH  STORM EVENT



            Time        Flow             Time        Flow
            (hrs)       (cfs)            (hrs)       (cfs)
            -----------------            -----------------
            18.6          1              22.4          0
            18.7          1              22.5          0
            18.8          1              22.6          0
            18.9          1              22.7          0
            19.0          1              22.8          0
            19.1          1              22.9          0
            19.2          1              23.0          0
            19.3          1              23.1          0
            19.4          1              23.2          0
            19.5          1              23.3          0
            19.6          1              23.4          0
            19.7          1              23.5          0
            19.8          1              23.6          0
            19.9          1              23.7          0
            20.0          1              23.8          0
            20.1          1              23.9          0
            20.2          1              24.0          0
            20.3          1              24.1          0
            20.4          1              24.2          0
            20.5          1              24.3          0
            20.6          1              24.4          0
            20.7          1              24.5          0
            20.8          1              24.6          0
            20.9          1              24.7          0
            21.0          0              24.8          0
            21.1          0              24.9          0
            21.2          0              25.0          0
            21.3          0              25.1          0
            21.4          0              25.2          0
            21.5          0              25.3          0
            21.6          0              25.4          0
            21.7          0              25.5          0
            21.8          0              25.6          0
            21.9          0              25.7          0
            22.0          0              25.8          0
            22.1          0              25.9          0
            22.2          0
            22.3          0
```

```
Quick TR-55 Version: 5.46 S/N: 1315430197                    Page 1

                     TR-55 TABULAR HYDROGRAPH METHOD
                          Type II  Distribution
                         (24 hr. Duration Storm)

                     Executed:  06-19-1995  12:09:50
             Watershed file:  --> SHAWANO .WSD
             Hydrograph file: --> SHAWANO .HYD

                          CRANDON MINING COMPANY
                        FOTH AND VAN DYKE    93C049
          WETLAND COMPENSATION: SHAWANO COUNTY                 5/95
                           2  YEAR STORM EVENT


             >>>> Input Parameters Used to Compute Hydrograph <<<<
------------------------------------------------------------------------
  Subarea          AREA     CN      Tc     * Tt    Precip. | Runoff    Ia/p
 Description      (acres)          (hrs)   (hrs)    (in)   |  (in)  input/used
------------------------------------------------------------------------
 WETLAND          157.02   79.0    0.50    0.10    2.00    |  0.52   .27  .30
 UPLAND NORTH      30.30   80.0    0.30    0.75    2.00    |  0.56   .25  .30
 AGRICULTURAL     104.68   80.0    0.30    0.00    2.00    |  0.56   .25  .30
 UPLAND SOUTH      52.34   80.0    0.50    0.10    2.00    |  0.56   .25  .30
------------------------------------------------------------------------
 * Travel time from subarea outfall to composite watershed outfall point.
                Total area = 344.34 acres  or  0.5380 sq.mi
                         Peak discharge =  96 cfs

             WARNING: Drainage areas of two or more subareas
                      differ by a factor of 5 or greater.



            >>>> Computer Modifications of Input Parameters <<<<<
------------------------------------------------------------------------
                 Input Values    Rounded Values     Ia/p
  Subarea        Tc     * Tt      Tc     * Tt   Interpolated      Ia/p
 Description    (hr)    (hr)     (hr)    (hr)    (Yes/No)       Messages
------------------------------------------------------------------------
WETLAND          0.61   0.10     0.50    0.10       No              --
UPLAND NORTH     0.21   0.83     0.30    0.75       No              --
AGRICULTURAL     0.28   0.00     0.30    0.00       No              --
UPLAND SOUTH     0.61   0.10     0.50    0.10       No              --
------------------------------------------------------------------------
 * Travel time from subarea outfall to composite watershed outfall point.
```

```
Quick TR-55 Version: 5.46 S/N: 1315430197                  Page 2

                  TR-55 TABULAR HYDROGRAPH METHOD
                       Type II  Distribution
                      (24 hr. Duration Storm)

                  Executed:  06-19-1995  12:09:50
          Watershed file:  --> SHAWANO .WSD
          Hydrograph file: --> SHAWANO .HYD

                       CRANDON MINING COMPANY
                     FOTH AND VAN DYKE    93C049
      WETLAND COMPENSATION: SHAWANO COUNTY                   5/95
                        2  YEAR STORM EVENT


              >>>> Summary of Subarea Times to Peak <<<<

                            Peak Discharge at  Time to Peak at
                            Composite Outfall  Composite Outfall
            Subarea               (cfs)              (hrs)
          --------------     --------------     ------------
          WETLAND                   53                 12.6
          UPLAND NORTH               9                 13.0
          AGRICULTURAL              53                 12.3
          UPLAND SOUTH              19                 12.6
          --------------     --------------     ------------
        Composite Watershed         96                 12.6
```

```
                         TR-55 TABULAR HYDROGRAPH METHOD
                              Type II  Distribution
                             (24 hr. Duration Storm)

                         Executed:  06-19-1995  12:09:50
                   Watershed file:  --> SHAWANO .WSD
                   Hydrograph file: --> SHAWANO .HYD

                               CRANDON MINING COMPANY
                             FOTH AND VAN DYKE    93C049
              WETLAND COMPENSATION: SHAWANO COUNTY                    5/95
                                2  YEAR STORM EVENT


                         Composite Hydrograph Summary (cfs)
-----------------------------------------------------------------------------
  Subarea       11.0   11.3   11.6   11.9   12.0   12.1   12.2   12.3   12.4
 Description     hr     hr     hr     hr     hr     hr     hr     hr     hr
-----------------------------------------------------------------------------
WETLAND           0      0      0      0      0      1      5     15     32
UPLAND NORTH      0      0      0      0      0      0      0      0      1
AGRICULTURAL      0      0      0      1      6     23     48     53     42
UPLAND SOUTH      0      0      0      0      0      0      2      5     11
-----------------------------------------------------------------------------
Total (cfs)       0      0      0      1      6     24     55     73     86



-----------------------------------------------------------------------------
  Subarea       12.5   12.6   12.7   12.8   13.0   13.2   13.4   13.6   13.8
 Description     hr     hr     hr     hr     hr     hr     hr     hr     hr
-----------------------------------------------------------------------------
WETLAND          47     53     50     42     28     19     14     12     10
UPLAND NORTH      2      4      6      8      9      7      5      4      3
AGRICULTURAL     28     20     16     13     10      8      7      6      6
UPLAND SOUTH     17     19     18     15     10      7      5      4      4
-----------------------------------------------------------------------------
Total (cfs)      94     96     90     78     57     41     31     26     23
```

```
                     TR-55 TABULAR HYDROGRAPH METHOD
                          Type II  Distribution
                         (24 hr. Duration Storm)

                     Executed:  06-19-1995  12:09:50
               Watershed file:  --> SHAWANO .WSD
               Hydrograph file: --> SHAWANO .HYD

                          CRANDON MINING COMPANY
                        FOTH AND VAN DYKE    93C049
          WETLAND COMPENSATION: SHAWANO COUNTY                  5/95
                           2  YEAR STORM EVENT


                    Composite Hydrograph Summary (cfs)
-----------------------------------------------------------------------------
  Subarea        14.0   14.3   14.6   15.0   15.5   16.0   16.5   17.0   17.5
 Description      hr     hr     hr     hr     hr     hr     hr     hr     hr
-----------------------------------------------------------------------------
WETLAND            9      8      7      6      5      5      4      4      4
UPLAND NORTH       2      2      2      1      1      1      1      1      1
AGRICULTURAL       5      5      4      4      4      3      3      3      3
UPLAND SOUTH       3      3      2      2      2      2      2      1      1
-----------------------------------------------------------------------------
Total (cfs)       19     18     15     13     12     11     10      9      9



-----------------------------------------------------------------------------
  Subarea        18.0   19.0   20.0   22.0   26.0
 Description      hr     hr     hr     hr     hr
-----------------------------------------------------------------------------
WETLAND            4      3      3      2      0
UPLAND NORTH       1      1      1      1      0
AGRICULTURAL       3      2      2      2      0
UPLAND SOUTH       1      1      1      1      0
-----------------------------------------------------------------------------
Total (cfs)        9      7      7      6      0
```

```
                   TR-55 TABULAR HYDROGRAPH METHOD
                        Type II  Distribution
                       (24 hr. Duration Storm)

                   Executed:  06-19-1995  12:09:50
         Watershed file:  --> SHAWANO .WSD
         Hydrograph file: --> SHAWANO .HYD

                        CRANDON MINING COMPANY
                     FOTH AND VAN DYKE    93C049
       WETLAND COMPENSATION: SHAWANO COUNTY                    5/95
                         2  YEAR STORM EVENT



            Time        Flow             Time        Flow
            (hrs)       (cfs)            (hrs)       (cfs)
            -----------------            -----------------
            11.0           0             14.8          14
            11.1           0             14.9          14
            11.2           0             15.0          13
            11.3           0             15.1          13
            11.4           0             15.2          13
            11.5           0             15.3          12
            11.6           0             15.4          12
            11.7           0             15.5          12
            11.8           1             15.6          12
            11.9           1             15.7          12
            12.0           6             15.8          11
            12.1          24             15.9          11
            12.2          55             16.0          11
            12.3          73             16.1          11
            12.4          86             16.2          11
            12.5          94             16.3          10
            12.6          96             16.4          10
            12.7          90             16.5          10
            12.8          78             16.6          10
            12.9          67             16.7          10
            13.0          57             16.8           9
            13.1          49             16.9           9
            13.2          41             17.0           9
            13.3          36             17.1           9
            13.4          31             17.2           9
            13.5          29             17.3           9
            13.6          26             17.4           9
            13.7          24             17.5           9
            13.8          23             17.6           9
            13.9          21             17.7           9
            14.0          19             17.8           9
            14.1          19             17.9           9
            14.2          18             18.0           9
            14.3          18             18.1           9
            14.4          17             18.2           9
            14.5          16             18.3           8
            14.6          15             18.4           8
```

```
                    TR-55 TABULAR HYDROGRAPH METHOD
                        Type II  Distribution
                       (24 hr. Duration Storm)

                    Executed:  06-19-1995  12:09:50
              Watershed file:  --> SHAWANO .WSD
              Hydrograph file: --> SHAWANO .HYD

                        CRANDON MINING COMPANY
                     FOTH AND VAN DYKE    93C049
          WETLAND COMPENSATION: SHAWANO COUNTY                 5/95
                         2  YEAR STORM EVENT


                Time        Flow             Time        Flow
                (hrs)       (cfs)            (hrs)       (cfs)
                -----------------            -----------------
                18.6           8             22.4           5
                18.7           8             22.5           5
                18.8           7             22.6           5
                18.9           7             22.7           5
                19.0           7             22.8           5
                19.1           7             22.9           5
                19.2           7             23.0           4
                19.3           7             23.1           4
                19.4           7             23.2           4
                19.5           7             23.3           4
                19.6           7             23.4           4
                19.7           7             23.5           4
                19.8           7             23.6           4
                19.9           7             23.7           3
                20.0           7             23.8           3
                20.1           7             23.9           3
                20.2           7             24.0           3
                20.3           7             24.1           3
                20.4           7             24.2           3
                20.5           7             24.3           3
                20.6           7             24.4           2
                20.7           7             24.5           2
                20.8           7             24.6           2
                20.9           7             24.7           2
                21.0           6             24.8           2
                21.1           6             24.9           2
                21.2           6             25.0           2
                21.3           6             25.1           1
                21.4           6             25.2           1
                21.5           6             25.3           1
                21.6           6             25.4           1
                21.7           6             25.5           1
                21.8           6             25.6           1
                21.9           6             25.7           0
                22.0           6             25.8           0
                22.1           6             25.9           0
                22.2           6
                22.3           6
```

```
Quick TR-55 Version: 5.46 S/N: 1315430197                    Page 1

                    TR-55 TABULAR HYDROGRAPH METHOD
                         Type II  Distribution
                        (24 hr. Duration Storm)

                    Executed:  06-19-1995  12:13:36
            Watershed file:  --> SHAW10   .WSD
            Hydrograph file: --> SHAW10   .HYD

                         CRANDON MINING COMPANY
                       FOTH AND VAN DYKE    93C049
        WETLAND COMPENSATION: SHAWANO COUNTY                  5/95
                          10 YEAR STORM EVENT


           >>>> Input Parameters Used to Compute Hydrograph <<<<
------------------------------------------------------------------------
  Subarea         AREA      CN      Tc     * Tt    Precip. | Runoff    Ia/p
Description      (acres)           (hrs)   (hrs)    (in)   |  (in)  input/used
------------------------------------------------------------------------
WETLAND          157.02    79.0    0.50    0.10    3.30    |  1.41   .16  .10
UPLAND NORTH      30.30    80.0    0.30    0.75    3.30    |  1.48   .15  .10
AGRICULTURAL     104.68    80.0    0.30    0.00    3.30    |  1.48   .15  .10
UPLAND SOUTH      52.34    80.0    0.50    0.10    3.30    |  1.48   .15  .10
------------------------------------------------------------------------
* Travel time from subarea outfall to composite watershed outfall point.
             Total area = 344.34 acres  or  0.5380 sq.mi
                      Peak discharge =  353 cfs

           WARNING: Drainage areas of two or more subareas
                    differ by a factor of 5 or greater.




           >>>> Computer Modifications of Input Parameters <<<<<
------------------------------------------------------------------------
                 Input Values      Rounded Values     Ia/p
  Subarea         Tc     * Tt       Tc     * Tt   Interpolated      Ia/p
Description      (hr)    (hr)      (hr)    (hr)    (Yes/No)       Messages
------------------------------------------------------------------------
WETLAND          0.61    0.10      0.50    0.10       No              --
UPLAND NORTH     0.21    0.83      0.30    0.75       No              --
AGRICULTURAL     0.28    0.00      0.30    0.00       No              --
UPLAND SOUTH     0.61    0.10      0.50    0.10       No              --
------------------------------------------------------------------------
* Travel time from subarea outfall to composite watershed outfall point.
```

```
Quick TR-55 Version: 5.46 S/N: 1315430197                        Page 2

                    TR-55 TABULAR HYDROGRAPH METHOD
                          Type II  Distribution
                        (24 hr. Duration Storm)

                    Executed:  06-19-1995  12:13:36
            Watershed file:  --> SHAW10  .WSD
            Hydrograph file: --> SHAW10  .HYD

                        CRANDON MINING COMPANY
                      FOTH AND VAN DYKE    93C049
      WETLAND COMPENSATION: SHAWANO COUNTY                      5/95
                         10 YEAR STORM EVENT


                 >>>> Summary of Subarea Times to Peak <<<<

                          Peak Discharge at  Time to Peak at
                          Composite Outfall  Composite Outfall
            Subarea             (cfs)              (hrs)
          --------------    --------------     ------------
          WETLAND                173               12.5
          UPLAND NORTH            29               12.8
          AGRICULTURAL           164               12.2
          UPLAND SOUTH            60               12.5
          --------------    --------------     ------------
        Composite Watershed      353               12.3
```

```
Quick TR-55 Version: 5.46 S/N: 1315430197                    Page 3

                    TR-55 TABULAR HYDROGRAPH METHOD
                         Type II  Distribution
                        (24 hr. Duration Storm)

                    Executed:  06-19-1995  12:13:36
          Watershed file: --> SHAW10  .WSD
          Hydrograph file: --> SHAW10  .HYD

                         CRANDON MINING COMPANY
                      FOTH AND VAN DYKE    93C049
       WETLAND COMPENSATION: SHAWANO COUNTY                  5/95
                          10 YEAR STORM EVENT


                   Composite Hydrograph Summary (cfs)
-----------------------------------------------------------------------------
  Subarea      11.0   11.3   11.6   11.9   12.0   12.1   12.2   12.3   12.4
 Description    hr     hr     hr     hr     hr     hr     hr     hr     hr
-----------------------------------------------------------------------------
WETLAND          6      8     10     18     28     48     87    137    167
UPLAND NORTH     1      1      1      2      2      2      3      4      7
AGRICULTURAL     5      7     10     29     57    108    164    164    111
UPLAND SOUTH     2      3      4      6     10     17     31     48     59
-----------------------------------------------------------------------------
Total (cfs)     14     19     25     55     97    175    285    353    344


-----------------------------------------------------------------------------
  Subarea      12.5   12.6   12.7   12.8   13.0   13.2   13.4   13.6   13.8
 Description    hr     hr     hr     hr     hr     hr     hr     hr     hr
-----------------------------------------------------------------------------
WETLAND        173    150    119     92     56     37     28     22     19
UPLAND NORTH    11     18     24     29     28     21     14      9      6
AGRICULTURAL    69     47     35     28     19     16     14     12     11
UPLAND SOUTH    60     53     42     32     20     13     10      8      7
-----------------------------------------------------------------------------
Total (cfs)    313    268    220    181    123     87     66     51     43
```

```
                    TR-55 TABULAR HYDROGRAPH METHOD
                         Type II  Distribution
                        (24 hr. Duration Storm)

                    Executed:  06-19-1995  12:13:36
              Watershed file:  --> SHAW10  .WSD
              Hydrograph file: --> SHAW10  .HYD

                         CRANDON MINING COMPANY
                       FOTH AND VAN DYKE    93C049
          WETLAND COMPENSATION: SHAWANO COUNTY                  5/95
                          10 YEAR STORM EVENT


                    Composite Hydrograph Summary (cfs)
----------------------------------------------------------------------
  Subarea        14.0   14.3   14.6   15.0   15.5   16.0   16.5   17.0   17.5
 Description      hr     hr     hr     hr     hr     hr     hr     hr     hr
----------------------------------------------------------------------
WETLAND           17     15     12     11     10      9      8      7      7
UPLAND NORTH       5      4      3      3      2      2      2      2      1
AGRICULTURAL      10      9      8      8      7      6      5      5      5
UPLAND SOUTH       6      5      4      4      4      3      3      3      2
----------------------------------------------------------------------
Total (cfs)       38     33     27     26     23     20     18     17     15



----------------------------------------------------------------------
  Subarea        18.0   19.0   20.0   22.0   26.0
 Description      hr     hr     hr     hr     hr
----------------------------------------------------------------------
WETLAND            7      6      5      4      0
UPLAND NORTH       1      1      1      1      0
AGRICULTURAL       4      4      3      3      0
UPLAND SOUTH       2      2      2      1      0
----------------------------------------------------------------------
Total (cfs)       14     13     11      9      0
```

```
                  TR-55 TABULAR HYDROGRAPH METHOD
                       Type II  Distribution
                      (24 hr. Duration Storm)

                  Executed:  06-19-1995  12:13:36
         Watershed file:  --> SHAW10   .WSD
         Hydrograph file: --> SHAW10   .HYD

                      CRANDON MINING COMPANY
                    FOTH AND VAN DYKE    93C049
       WETLAND COMPENSATION: SHAWANO COUNTY                 5/95
                       10 YEAR STORM EVENT


            Time        Flow              Time        Flow
            (hrs)       (cfs)             (hrs)       (cfs)
            -----------------             -----------------
            11.0          14              14.8          26
            11.1          16              14.9          26
            11.2          17              15.0          26
            11.3          19              15.1          25
            11.4          21              15.2          25
            11.5          23              15.3          24
            11.6          25              15.4          24
            11.7          35              15.5          23
            11.8          45              15.6          22
            11.9          55              15.7          22
            12.0          97              15.8          21
            12.1         175              15.9          21
            12.2         285              16.0          20
            12.3         353              16.1          20
            12.4         344              16.2          19
            12.5         313              16.3          19
            12.6         268              16.4          18
            12.7         220              16.5          18
            12.8         181              16.6          18
            12.9         152              16.7          18
            13.0         123              16.8          17
            13.1         105              16.9          17
            13.2          87              17.0          17
            13.3          76              17.1          17
            13.4          66              17.2          16
            13.5          59              17.3          16
            13.6          51              17.4          15
            13.7          47              17.5          15
            13.8          43              17.6          15
            13.9          40              17.7          15
            14.0          38              17.8          14
            14.1          36              17.9          14
            14.2          35              18.0          14
            14.3          33              18.1          14
            14.4          31              18.2          14
            14.5          29              18.3          14
            14.6          27              18.4          14
```

```
                 TR-55 TABULAR HYDROGRAPH METHOD
                      Type II  Distribution
                     (24 hr. Duration Storm)

                 Executed:  06-19-1995  12:13:36
            Watershed file:  --> SHAW10   .WSD
            Hydrograph file: --> SHAW10   .HYD

                      CRANDON MINING COMPANY
                    FOTH AND VAN DYKE    93C049
        WETLAND COMPENSATION: SHAWANO COUNTY                5/95
                       10 YEAR STORM EVENT



              Time         Flow               Time         Flow
              (hrs)        (cfs)              (hrs)        (cfs)
              -----------------               -----------------
              18.6           13               22.4            8
              18.7           13               22.5            8
              18.8           13               22.6            8
              18.9           13               22.7            7
              19.0           13               22.8            7
              19.1           13               22.9            7
              19.2           13               23.0            7
              19.3           12               23.1            7
              19.4           12               23.2            6
              19.5           12               23.3            6
              19.6           12               23.4            6
              19.7           12               23.5            6
              19.8           11               23.6            5
              19.9           11               23.7            5
              20.0           11               23.8            5
              20.1           11               23.9            5
              20.2           11               24.0            4
              20.3           11               24.1            4
              20.4           11               24.2            4
              20.5           10               24.3            4
              20.6           10               24.4            4
              20.7           10               24.5            3
              20.8           10               24.6            3
              20.9           10               24.7            3
              21.0           10               24.8            3
              21.1           10               24.9            2
              21.2           10               25.0            2
              21.3           10               25.1            2
              21.4           10               25.2            2
              21.5           10               25.3            2
              21.6            9               25.4            1
              21.7            9               25.5            1
              21.8            9               25.6            1
              21.9            9               25.7            1
              22.0            9               25.8            0
              22.1            9               25.9            0
              22.2            9
              22.3            8
```

```
Quick TR-55 Version: 5.46 S/N: 1315430197                           Page 1

                       TR-55 TABULAR HYDROGRAPH METHOD
                            Type II  Distribution
                           (24 hr. Duration Storm)

                       Executed:  06-19-1995  12:39:17
               Watershed file:  --> SHAW100 .WSD
               Hydrograph file: --> SHAW100 .HYD

                            CRANDON MINING COMPANY
                          FOTH AND VAN DYKE    93C049
         WETLAND COMPENSATION: SHAWANO COUNTY                      5/95
                             100-YR  STORM EVENT


              >>>> Input Parameters Used to Compute Hydrograph <<<<
-----------------------------------------------------------------------------
  Subarea          AREA      CN      Tc     * Tt    Precip. | Runoff    Ia/p
Description       (acres)           (hrs)   (hrs)    (in)   |  (in)  input/used
-----------------------------------------------------------------------------
WETLAND           157.02    79.0    0.50    0.10    5.00   |  2.80   .11  .10
UPLAND NORTH       30.30    80.0    0.30    0.75    5.00   |  2.89   .1   .10
AGRICULTURAL      104.68    80.0    0.30    0.00    5.00   |  2.89   .1   .10
UPLAND SOUTH       52.34    80.0    0.50    0.10    5.00   |  2.89   .1   .10
-----------------------------------------------------------------------------
 * Travel time from subarea outfall to composite watershed outfall point.
                Total area = 344.34 acres  or  0.5380 sq.mi
                          Peak discharge =  692 cfs

              WARNING: Drainage areas of two or more subareas
                       differ by a factor of 5 or greater.



              >>>> Computer Modifications of Input Parameters <<<<<
-----------------------------------------------------------------------------
                  Input Values     Rounded Values     Ia/p
  Subarea          Tc     * Tt      Tc     * Tt   Interpolated        Ia/p
Description       (hr)    (hr)     (hr)    (hr)     (Yes/No)        Messages
-----------------------------------------------------------------------------
WETLAND           0.61    0.10     0.50    0.10       No               --
UPLAND NORTH      0.21    0.83     0.30    0.75       No               --
AGRICULTURAL      0.28    0.00     0.30    0.00       No               --
UPLAND SOUTH      0.61    0.10     0.50    0.10       No               --
-----------------------------------------------------------------------------
 * Travel time from subarea outfall to composite watershed outfall point.
```

```
                    TR-55 TABULAR HYDROGRAPH METHOD
                         Type II  Distribution
                        (24 hr. Duration Storm)

                    Executed:  06-19-1995  12:39:17
              Watershed file:  --> SHAW100 .WSD
              Hydrograph file: --> SHAW100 .HYD

                        CRANDON MINING COMPANY
                      FOTH AND VAN DYKE    93C049
          WETLAND COMPENSATION: SHAWANO COUNTY                  5/95
                         100-YR  STORM EVENT



                >>>> Summary of Subarea Times to Peak <<<<

                               Peak Discharge at  Time to Peak at
                               Composite Outfall  Composite Outfall
                  Subarea            (cfs)              (hrs)
              --------------    --------------     ------------
              WETLAND                 343                12.5
              UPLAND NORTH             57                12.8
              AGRICULTURAL            320                12.2
              UPLAND SOUTH            118                12.5
              --------------    --------------     ------------
             Composite Watershed      692                12.3
```

```
                    TR-55 TABULAR HYDROGRAPH METHOD
                         Type II  Distribution
                        (24 hr. Duration Storm)

                    Executed:  06-19-1995  12:39:17
              Watershed file: --> SHAW100 .WSD
              Hydrograph file: --> SHAW100 .HYD

                         CRANDON MINING COMPANY
                       FOTH AND VAN DYKE    93C049
            WETLAND COMPENSATION: SHAWANO COUNTY                  5/95
                          100-YR  STORM EVENT


                    Composite Hydrograph Summary (cfs)
-----------------------------------------------------------------------------
  Subarea       11.0   11.3   11.6   11.9   12.0   12.1   12.2   12.3   12.4
 Description     hr     hr     hr     hr     hr     hr     hr     hr     hr
-----------------------------------------------------------------------------
WETLAND          11     15     21     35     55     96    173    271    332
UPLAND NORTH      2      2      3      4      4      5      6      8     13
AGRICULTURAL      9     13     19     56    111    211    320    320    217
UPLAND SOUTH      4      5      7     12     19     33     60     93    114
-----------------------------------------------------------------------------
Total (cfs)      26     35     50    107    189    345    559    692    676


-----------------------------------------------------------------------------
  Subarea       12.5   12.6   12.7   12.8   13.0   13.2   13.4   13.6   13.8
 Description     hr     hr     hr     hr     hr     hr     hr     hr     hr
-----------------------------------------------------------------------------
WETLAND         343    298    236    182    111     74     55     45     38
UPLAND NORTH     22     34     46     57     54     41     27     18     12
AGRICULTURAL    134     93     69     54     38     31     27     24     22
UPLAND SOUTH    118    103     81     63     38     26     19     15     13
-----------------------------------------------------------------------------
Total (cfs)     617    528    432    356    241    172    128    102     85
```

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Quick TR-55 Version: 5.46 S/N: 1315430197                    Page 4

                    TR-55 TABULAR HYDROGRAPH METHOD
                         Type II  Distribution
                        (24 hr. Duration Storm)

                    Executed:  06-19-1995  12:39:17
             Watershed file:  --> SHAW100 .WSD
             Hydrograph file: --> SHAW100 .HYD

                         CRANDON MINING COMPANY
                       FOTH AND VAN DYKE    93C049
          WETLAND COMPENSATION: SHAWANO COUNTY                   5/95
                          100-YR  STORM EVENT


                    Composite Hydrograph Summary (cfs)
---------------------------------------------------------------------------
  Subarea        14.0   14.3   14.6   15.0   15.5   16.0   16.5   17.0   17.5
 Description      hr     hr     hr     hr     hr     hr     hr     hr     hr
---------------------------------------------------------------------------
WETLAND           34     29     25     23     20     18     16     14     14
UPLAND NORTH       9      7      6      5      4      4      4      3      3
AGRICULTURAL      20     17     16     15     13     11     10      9      9
UPLAND SOUTH      12     10      9      8      7      6      5      5      5
---------------------------------------------------------------------------
Total (cfs)       75     63     56     51     44     39     35     31     31



---------------------------------------------------------------------------
  Subarea        18.0   19.0   20.0   22.0   26.0
 Description      hr     hr     hr     hr     hr
---------------------------------------------------------------------------
WETLAND           13     11     10      8      0
UPLAND NORTH       3      2      2      2      0
AGRICULTURAL       9      8      6      6      0
UPLAND SOUTH       4      4      3      3      0
---------------------------------------------------------------------------
Total (cfs)       29     25     21     19      0
```

```
                  TR-55 TABULAR HYDROGRAPH METHOD
                       Type II  Distribution
                      (24 hr. Duration Storm)

                  Executed:  06-19-1995  12:39:17
             Watershed file:  --> SHAW100 .WSD
             Hydrograph file: --> SHAW100 .HYD

                       CRANDON MINING COMPANY
                     FOTH AND VAN DYKE    93C049
           WETLAND COMPENSATION: SHAWANO COUNTY                 5/95
                        100-YR  STORM EVENT



               Time        Flow            Time        Flow
               (hrs)       (cfs)           (hrs)       (cfs)
               -----------------           -----------------
               11.0          26            14.8          54
               11.1          29            14.9          52
               11.2          32            15.0          51
               11.3          35            15.1          50
               11.4          40            15.2          48
               11.5          45            15.3          47
               11.6          50            15.4          45
               11.7          69            15.5          44
               11.8          88            15.6          43
               11.9         107            15.7          42
               12.0         189            15.8          41
               12.1         345            15.9          40
               12.2         559            16.0          39
               12.3         692            16.1          38
               12.4         676            16.2          37
               12.5         617            16.3          37
               12.6         528            16.4          36
               12.7         432            16.5          35
               12.8         356            16.6          34
               12.9         298            16.7          33
               13.0         241            16.8          33
               13.1         206            16.9          32
               13.2         172            17.0          31
               13.3         150            17.1          31
               13.4         128            17.2          31
               13.5         115            17.3          31
               13.6         102            17.4          31
               13.7          93            17.5          31
               13.8          85            17.6          31
               13.9          80            17.7          30
               14.0          75            17.8          30
               14.1          71            17.9          29
               14.2          67            18.0          29
               14.3          63            18.1          29
               14.4          61            18.2          28
               14.5          58            18.3          28
               14.6          56            18.4          27
```

```
                 TR-55 TABULAR HYDROGRAPH METHOD
                      Type II  Distribution
                     (24 hr. Duration Storm)

                 Executed:  06-19-1995  12:39:17
      Watershed file:  --> SHAW100 .WSD
      Hydrograph file: --> SHAW100 .HYD

                      CRANDON MINING COMPANY
                    FOTH AND VAN DYKE    93C049
   WETLAND COMPENSATION: SHAWANO COUNTY                     5/95
                       100-YR  STORM EVENT



         Time        Flow               Time        Flow
         (hrs)       (cfs)              (hrs)       (cfs)
         -----------------              -----------------
         18.6          27               22.4          17
         18.7          26               22.5          17
         18.8          26               22.6          16
         18.9          25               22.7          16
         19.0          25               22.8          15
         19.1          25               22.9          15
         19.2          24               23.0          14
         19.3          24               23.1          14
         19.4          23               23.2          13
         19.5          23               23.3          13
         19.6          23               23.4          12
         19.7          22               23.5          12
         19.8          22               23.6          11
         19.9          21               23.7          11
         20.0          21               23.8          10
         20.1          21               23.9          10
         20.2          21               24.0          10
         20.3          21               24.1           9
         20.4          21               24.2           9
         20.5          20               24.3           8
         20.6          20               24.4           8
         20.7          20               24.5           7
         20.8          20               24.6           7
         20.9          20               24.7           6
         21.0          20               24.8           6
         21.1          20               24.9           5
         21.2          20               25.0           5
         21.3          20               25.1           4
         21.4          20               25.2           4
         21.5          20               25.3           3
         21.6          19               25.4           3
         21.7          19               25.5           2
         21.8          19               25.6           2
         21.9          19               25.7           1
         22.0          19               25.8           1
         22.1          19               25.9           0
         22.2          18
         22.3          18
```

Appendix C

POND2 Tabulation:
1 Inch Rainfall Event
2-Year Event
10-Year Event
100-Year Event

```
POND-2 Version: 5.16 S/N: 1295130172                          Page 1
EXECUTED: 07-15-1995   11:36:57

   **********************************************************************
   *                                                                    *
   * CRANDON MINING COMPANY          93C049          FOTH & VAN DYKE    *
   *       WETLAND COMPENSATION: SHAWANO COUNTY            5/95         *
   *                   3 FOOT BLOCK-LOG WEIR OUTLET                     *
   *                        1-INCH STORM EVENT                          *
   *                                                                    *
   **********************************************************************

      Inflow Hydrograph: SHAW1   .HYD
      Rating Table file: SHAWET3 .PND

      ----INITIAL CONDITIONS----
      Elevation =   811.00 ft
      Outflow   =     0.00 cfs
      Storage   =     0.00 ac-ft

                                            INTERMEDIATE ROUTING
               GIVEN POND DATA                  COMPUTATIONS
      ------------------------------       -------------------------
     |ELEVATION| OUTFLOW |  STORAGE |      |    2S/t    |  2S/t  + 0  |
     |  (ft)   |  (cfs)  |  (ac-ft) |      |    (cfs)   |    (cfs)    |
     |---------|---------|----------|      |------------|-------------|
     | 811.00  |    0.0  |    0.000|       |        0.0 |         0.0 |
     | 811.50  |    0.0  |    0.001|       |        0.3 |         0.3 |
     | 812.00  |    0.0  |    0.002|       |        0.6 |         0.6 |
     | 812.50  |    0.0  |    0.003|       |        0.8 |         0.8 |
     | 813.00  |    0.0  |    0.005|       |        1.1 |         1.1 |
     | 813.50  |    0.0  |    0.006|       |        1.4 |         1.4 |
     | 814.00  |    0.0  |    0.007|       |        1.7 |         1.7 |
     | 814.50  |    0.0  |    0.008|       |        1.9 |         1.9 |
     | 815.00  |    0.0  |    0.009|       |        2.2 |         2.2 |
     | 815.50  |    0.0  |    0.010|       |        2.5 |         2.5 |
     | 816.00  |    0.0  |    0.011|       |        2.8 |         2.8 |
     | 816.50  |    0.0  |    0.013|       |        3.1 |         3.1 |
     | 817.00  |    0.0  |    0.014|       |        3.3 |         3.3 |
     | 817.50  |    0.0  |    0.015|       |        3.6 |         3.6 |
     | 818.00  |    0.0  |    0.016|       |        3.9 |         3.9 |
     | 818.50  |    0.0  |    0.017|       |        4.2 |         4.2 |
     | 819.00  |    0.3  |    1.169|       |      282.8 |       283.1 |
     | 819.50  |    4.3  |   20.171|       |     4881.4 |      4885.7 |
     | 820.00  |   41.2  |   43.197|       |    10453.6 |     10494.8 |
     | 820.50  |  122.4  |   68.766|       |    16641.5 |     16763.9 |
     | 821.00  |  230.7  |   95.003|       |    22990.7 |     23221.4 |
     | 821.50  |  361.3  |  121.914|       |    29503.2 |     29864.5 |
      ------------------------------       -------------------------

                      Time increment (t) = 0.100 hrs.
```

```
POND-2 Version: 5.16 S/N: 1295130172                    Page 2
EXECUTED: 07-15-1995   11:36:57

Pond File:            SHAWET3 .PND
Inflow Hydrograph:    SHAW1   .HYD
Outflow Hydrograph: OUT     .HYD

INFLOW HYDROGRAPH                    ROUTING COMPUTATIONS
------------------      ---------------------------------------------------------
| TIME  |  INFLOW |     |  I1+I2  |  2S/t - O  |  2S/t + O  | OUTFLOW |ELEVATION|
| (hrs) |  (cfs)  |     |  (cfs)  |   (cfs)    |   (cfs)    |  (cfs)  |  (ft)   |
|-------|---------|     |---------|------------|------------|---------|---------|
| 11.000 |    0.00|     |  -----  |       0.0 |         0.0|    0.00 |  811.00 |
| 11.100 |    0.00|     |     0.0 |       0.0 |         0.0|    0.00 |  811.00 |
| 11.200 |    0.00|     |     0.0 |       0.0 |         0.0|    0.00 |  811.00 |
| 11.300 |    0.00|     |     0.0 |       0.0 |         0.0|    0.00 |  811.00 |
| 11.400 |    0.00|     |     0.0 |       0.0 |         0.0|    0.00 |  811.00 |
| 11.500 |    0.00|     |     0.0 |       0.0 |         0.0|    0.00 |  811.00 |
| 11.600 |    0.00|     |     0.0 |       0.0 |         0.0|    0.00 |  811.00 |
| 11.700 |    0.00|     |     0.0 |       0.0 |         0.0|    0.00 |  811.00 |
| 11.800 |    0.00|     |     0.0 |       0.0 |         0.0|    0.00 |  811.00 |
| 11.900 |    0.00|     |     0.0 |       0.0 |         0.0|    0.00 |  811.00 |
| 12.000 |    0.00|     |     0.0 |       0.0 |         0.0|    0.00 |  811.00 |
| 12.100 |    0.00|     |     0.0 |       0.0 |         0.0|    0.00 |  811.00 |
| 12.200 |    2.00|     |     2.0 |       2.0 |         2.0|    0.00 |  814.60 |
| 12.300 |    4.00|     |     6.0 |       8.0 |         8.0|    0.00 |  818.51 |
| 12.400 |    5.00|     |     9.0 |      17.0 |        17.0|    0.01 |  818.52 |
| 12.500 |    6.00|     |    11.0 |      27.9 |        28.0|    0.03 |  818.54 |
| 12.600 |    6.00|     |    12.0 |      39.8 |        39.9|    0.04 |  818.56 |
| 12.700 |    7.00|     |    13.0 |      52.7 |        52.8|    0.05 |  818.59 |
| 12.800 |    8.00|     |    15.0 |      67.6 |        67.7|    0.07 |  818.61 |
| 12.900 |    7.00|     |    15.0 |      82.4 |        82.6|    0.08 |  818.64 |
| 13.000 |    6.00|     |    13.0 |      95.2 |        95.4|    0.10 |  818.66 |
| 13.100 |    6.00|     |    12.0 |     107.0 |       107.2|    0.11 |  818.68 |
| 13.200 |    5.00|     |    11.0 |     117.8 |       118.0|    0.12 |  818.70 |
| 13.300 |    5.00|     |    10.0 |     127.5 |       127.8|    0.13 |  818.72 |
| 13.400 |    5.00|     |    10.0 |     137.2 |       137.5|    0.14 |  818.74 |
| 13.500 |    5.00|     |    10.0 |     146.9 |       147.2|    0.15 |  818.76 |
| 13.600 |    4.00|     |     9.0 |     155.6 |       155.9|    0.16 |  818.77 |
| 13.700 |    4.00|     |     8.0 |     163.2 |       163.6|    0.17 |  818.79 |
| 13.800 |    4.00|     |     8.0 |     170.9 |       171.2|    0.18 |  818.80 |
| 13.900 |    4.00|     |     8.0 |     178.5 |       178.9|    0.19 |  818.81 |
| 14.000 |    3.00|     |     7.0 |     185.1 |       185.5|    0.20 |  818.83 |
| 14.100 |    3.00|     |     6.0 |     190.7 |       191.1|    0.20 |  818.84 |
| 14.200 |    2.00|     |     5.0 |     195.3 |       195.7|    0.21 |  818.84 |
| 14.300 |    2.00|     |     4.0 |     198.9 |       199.3|    0.21 |  818.85 |
| 14.400 |    2.00|     |     4.0 |     202.4 |       202.9|    0.21 |  818.86 |
| 14.500 |    2.00|     |     4.0 |     206.0 |       206.4|    0.22 |  818.86 |
| 14.600 |    2.00|     |     4.0 |     209.6 |       210.0|    0.22 |  818.87 |
| 14.700 |    2.00|     |     4.0 |     213.1 |       213.6|    0.23 |  818.88 |
| 14.800 |    2.00|     |     4.0 |     216.7 |       217.1|    0.23 |  818.88 |
| 14.900 |    2.00|     |     4.0 |     220.2 |       220.7|    0.23 |  818.89 |
| 15.000 |    2.00|     |     4.0 |     223.7 |       224.2|    0.24 |  818.89 |
| 15.100 |    2.00|     |     4.0 |     227.2 |       227.7|    0.24 |  818.90 |
| 15.200 |    2.00|     |     4.0 |     230.8 |       231.2|    0.24 |  818.91 |
| 15.300 |    2.00|     |     4.0 |     234.3 |       234.8|    0.25 |  818.91 |
| 15.400 |    2.00|     |     4.0 |     237.8 |       238.3|    0.25 |  818.92 |
------------------      ---------------------------------------------------------
```

```
POND-2 Version: 5.16 S/N: 1295130172                        Page 3
EXECUTED: 07-15-1995    11:36:57

Pond File:            SHAWET3 .PND
Inflow Hydrograph:    SHAW1   .HYD
Outflow Hydrograph:   OUT     .HYD

INFLOW HYDROGRAPH                   ROUTING COMPUTATIONS
-----------------     ----------------------------------------------------------
| TIME   | INFLOW  |  | I1+I2   | 2S/t - O   | 2S/t + O   | OUTFLOW |ELEVATION|
| (hrs)  | (cfs)   |  | (cfs)   | (cfs)      | (cfs)      | (cfs)   | (ft)    |
|--------|---------|  |---------|------------|------------|---------|---------|
| 15.500 |     2.00|  |     4.0 |      241.2 |      241.8|    0.26 |  818.93 |
| 15.600 |     2.00|  |     4.0 |      244.7 |      245.2|    0.26 |  818.93 |
| 15.700 |     2.00|  |     4.0 |      248.2 |      248.7|    0.26 |  818.94 |
| 15.800 |     2.00|  |     4.0 |      251.7 |      252.2|    0.27 |  818.94 |
| 15.900 |     2.00|  |     4.0 |      255.1 |      255.7|    0.27 |  818.95 |
| 16.000 |     2.00|  |     4.0 |      258.6 |      259.1|    0.27 |  818.96 |
| 16.100 |     2.00|  |     4.0 |      262.0 |      262.6|    0.28 |  818.96 |
| 16.200 |     2.00|  |     4.0 |      265.5 |      266.0|    0.28 |  818.97 |
| 16.300 |     2.00|  |     4.0 |      268.9 |      269.5|    0.29 |  818.98 |
| 16.400 |     2.00|  |     4.0 |      272.3 |      272.9|    0.29 |  818.98 |
| 16.500 |     2.00|  |     4.0 |      275.7 |      276.3|    0.29 |  818.99 |
| 16.600 |     2.00|  |     4.0 |      279.1 |      279.7|    0.30 |  818.99 |
| 16.700 |     2.00|  |     4.0 |      282.5 |      283.1|    0.30 |  819.00 |
| 16.800 |     2.00|  |     4.0 |      285.9 |      286.5|    0.30 |  819.00 |
| 16.900 |     2.00|  |     4.0 |      289.3 |      289.9|    0.31 |  819.00 |
| 17.000 |     2.00|  |     4.0 |      292.7 |      293.3|    0.31 |  819.00 |
| 17.100 |     2.00|  |     4.0 |      296.1 |      296.7|    0.31 |  819.00 |
| 17.200 |     2.00|  |     4.0 |      299.4 |      300.1|    0.31 |  819.00 |
| 17.300 |     2.00|  |     4.0 |      302.8 |      303.4|    0.32 |  819.00 |
| 17.400 |     2.00|  |     4.0 |      306.2 |      306.8|    0.32 |  819.00 |
| 17.500 |     2.00|  |     4.0 |      309.5 |      310.2|    0.32 |  819.00 |
| 17.600 |     2.00|  |     4.0 |      312.9 |      313.5|    0.33 |  819.00 |
| 17.700 |     2.00|  |     4.0 |      316.2 |      316.9|    0.33 |  819.00 |
| 17.800 |     2.00|  |     4.0 |      319.5 |      320.2|    0.33 |  819.00 |
| 17.900 |     2.00|  |     4.0 |      322.9 |      323.5|    0.34 |  819.00 |
| 18.000 |     2.00|  |     4.0 |      326.2 |      326.9|    0.34 |  819.00 |
| 18.100 |     2.00|  |     4.0 |      329.5 |      330.2|    0.34 |  819.01 |
| 18.200 |     2.00|  |     4.0 |      332.8 |      333.5|    0.34 |  819.01 |
| 18.300 |     2.00|  |     4.0 |      336.1 |      336.8|    0.35 |  819.01 |
| 18.400 |     2.00|  |     4.0 |      339.4 |      340.1|    0.35 |  819.01 |
| 18.500 |     2.00|  |     4.0 |      342.7 |      343.4|    0.35 |  819.01 |
| 18.600 |     1.00|  |     3.0 |      345.0 |      345.7|    0.35 |  819.01 |
| 18.700 |     1.00|  |     2.0 |      346.3 |      347.0|    0.36 |  819.01 |
| 18.800 |     1.00|  |     2.0 |      347.6 |      348.3|    0.36 |  819.01 |
| 18.900 |     1.00|  |     2.0 |      348.9 |      349.6|    0.36 |  819.01 |
| 19.000 |     1.00|  |     2.0 |      350.2 |      350.9|    0.36 |  819.01 |
| 19.100 |     1.00|  |     2.0 |      351.4 |      352.2|    0.36 |  819.01 |
| 19.200 |     1.00|  |     2.0 |      352.7 |      353.4|    0.36 |  819.01 |
| 19.300 |     1.00|  |     2.0 |      354.0 |      354.7|    0.36 |  819.01 |
| 19.400 |     1.00|  |     2.0 |      355.3 |      356.0|    0.36 |  819.01 |
| 19.500 |     1.00|  |     2.0 |      356.5 |      357.3|    0.36 |  819.01 |
| 19.600 |     1.00|  |     2.0 |      357.8 |      358.5|    0.37 |  819.01 |
| 19.700 |     1.00|  |     2.0 |      359.1 |      359.8|    0.37 |  819.01 |
| 19.800 |     1.00|  |     2.0 |      360.3 |      361.1|    0.37 |  819.01 |
| 19.900 |     1.00|  |     2.0 |      361.6 |      362.3|    0.37 |  819.01 |
| 20.000 |     1.00|  |     2.0 |      362.9 |      363.6|    0.37 |  819.01 |
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```

```
POND-2 Version: 5.16 S/N: 1295130172                       Page 4
EXECUTED: 07-15-1995   11:36:57

Pond File:           SHAWET3 .PND
Inflow Hydrograph:   SHAW1   .HYD
Outflow Hydrograph:  OUT     .HYD

INFLOW HYDROGRAPH                     ROUTING COMPUTATIONS
------------------    --------------------------------------------------------
| TIME   | INFLOW  |  | I1+I2   | 2S/t - O   | 2S/t + O  | OUTFLOW |ELEVATION|
| (hrs)  | (cfs)   |  | (cfs)   |  (cfs)     |  (cfs)    | (cfs)   |  (ft)   |
|--------|---------|  |---------|------------|-----------|---------|---------|
| 20.100 |     1.00|  |     2.0 |      364.1 |      364.9|   0.37  |  819.01 |
| 20.200 |     1.00|  |     2.0 |      365.4 |      366.1|   0.37  |  819.01 |
| 20.300 |     1.00|  |     2.0 |      366.6 |      367.4|   0.37  |  819.01 |
| 20.400 |     1.00|  |     2.0 |      367.9 |      368.6|   0.37  |  819.01 |
| 20.500 |     1.00|  |     2.0 |      369.1 |      369.9|   0.38  |  819.01 |
| 20.600 |     1.00|  |     2.0 |      370.4 |      371.1|   0.38  |  819.01 |
| 20.700 |     1.00|  |     2.0 |      371.6 |      372.4|   0.38  |  819.01 |
| 20.800 |     1.00|  |     2.0 |      372.9 |      373.6|   0.38  |  819.01 |
| 20.900 |     1.00|  |     2.0 |      374.1 |      374.9|   0.38  |  819.01 |
| 21.000 |     0.00|  |     1.0 |      374.3 |      375.1|   0.38  |  819.01 |
| 21.100 |     0.00|  |     0.0 |      373.6 |      374.3|   0.38  |  819.01 |
| 21.200 |     0.00|  |     0.0 |      372.8 |      373.6|   0.38  |  819.01 |
| 21.300 |     0.00|  |     0.0 |      372.1 |      372.8|   0.38  |  819.01 |
| 21.400 |     0.00|  |     0.0 |      371.3 |      372.1|   0.38  |  819.01 |
| 21.500 |     0.00|  |     0.0 |      370.6 |      371.3|   0.38  |  819.01 |
| 21.600 |     0.00|  |     0.0 |      369.8 |      370.6|   0.38  |  819.01 |
| 21.700 |     0.00|  |     0.0 |      369.1 |      369.8|   0.38  |  819.01 |
| 21.800 |     0.00|  |     0.0 |      368.3 |      369.1|   0.37  |  819.01 |
| 21.900 |     0.00|  |     0.0 |      367.6 |      368.3|   0.37  |  819.01 |
| 22.000 |     0.00|  |     0.0 |      366.8 |      367.6|   0.37  |  819.01 |
| 22.100 |     0.00|  |     0.0 |      366.1 |      366.8|   0.37  |  819.01 |
| 22.200 |     0.00|  |     0.0 |      365.3 |      366.1|   0.37  |  819.01 |
| 22.300 |     0.00|  |     0.0 |      364.6 |      365.3|   0.37  |  819.01 |
| 22.400 |     0.00|  |     0.0 |      363.8 |      364.6|   0.37  |  819.01 |
| 22.500 |     0.00|  |     0.0 |      363.1 |      363.8|   0.37  |  819.01 |
| 22.600 |     0.00|  |     0.0 |      362.4 |      363.1|   0.37  |  819.01 |
| 22.700 |     0.00|  |     0.0 |      361.6 |      362.4|   0.37  |  819.01 |
| 22.800 |     0.00|  |     0.0 |      360.9 |      361.6|   0.37  |  819.01 |
| 22.900 |     0.00|  |     0.0 |      360.2 |      360.9|   0.37  |  819.01 |
| 23.000 |     0.00|  |     0.0 |      359.4 |      360.2|   0.37  |  819.01 |
| 23.100 |     0.00|  |     0.0 |      358.7 |      359.4|   0.37  |  819.01 |
| 23.200 |     0.00|  |     0.0 |      358.0 |      358.7|   0.37  |  819.01 |
| 23.300 |     0.00|  |     0.0 |      357.2 |      358.0|   0.37  |  819.01 |
| 23.400 |     0.00|  |     0.0 |      356.5 |      357.2|   0.36  |  819.01 |
| 23.500 |     0.00|  |     0.0 |      355.8 |      356.5|   0.36  |  819.01 |
| 23.600 |     0.00|  |     0.0 |      355.0 |      355.8|   0.36  |  819.01 |
| 23.700 |     0.00|  |     0.0 |      354.3 |      355.0|   0.36  |  819.01 |
| 23.800 |     0.00|  |     0.0 |      353.6 |      354.3|   0.36  |  819.01 |
| 23.900 |     0.00|  |     0.0 |      352.9 |      353.6|   0.36  |  819.01 |
| 24.000 |     0.00|  |     0.0 |      352.1 |      352.9|   0.36  |  819.01 |
| 24.100 |     0.00|  |     0.0 |      351.4 |      352.1|   0.36  |  819.01 |
| 24.200 |     0.00|  |     0.0 |      350.7 |      351.4|   0.36  |  819.01 |
| 24.300 |     0.00|  |     0.0 |      350.0 |      350.7|   0.36  |  819.01 |
| 24.400 |     0.00|  |     0.0 |      349.3 |      350.0|   0.36  |  819.01 |
| 24.500 |     0.00|  |     0.0 |      348.6 |      349.3|   0.36  |  819.01 |
| 24.600 |     0.00|  |     0.0 |      347.8 |      348.6|   0.36  |  819.01 |
------------------    --------------------------------------------------------
```

```
POND-2 Version: 5.16 S/N: 1295130172                        Page 5
EXECUTED: 07-15-1995   11:36:57

Pond File:           SHAWET3 .PND
Inflow Hydrograph:   SHAW1   .HYD
Outflow Hydrograph:  OUT     .HYD

INFLOW HYDROGRAPH                     ROUTING COMPUTATIONS
------------------    --------------------------------------------------------
| TIME   | INFLOW  |  | I1+I2   | 2S/t - O   | 2S/t + O  | OUTFLOW |ELEVATION|
| (hrs)  | (cfs)   |  | (cfs)   |  (cfs)     |  (cfs)    | (cfs)   |  (ft)   |
|--------|---------|  |---------|------------|-----------|---------|---------|
| 24.700 |     0.00|  |     0.0 |     347.1  |     347.8|    0.36 |  819.01 |
| 24.800 |     0.00|  |     0.0 |     346.4  |     347.1|    0.36 |  819.01 |
| 24.900 |     0.00|  |     0.0 |     345.7  |     346.4|    0.36 |  819.01 |
| 25.000 |     0.00|  |     0.0 |     345.0  |     345.7|    0.35 |  819.01 |
| 25.100 |     0.00|  |     0.0 |     344.3  |     345.0|    0.35 |  819.01 |
| 25.200 |     0.00|  |     0.0 |     343.6  |     344.3|    0.35 |  819.01 |
| 25.300 |     0.00|  |     0.0 |     342.9  |     343.6|    0.35 |  819.01 |
| 25.400 |     0.00|  |     0.0 |     342.2  |     342.9|    0.35 |  819.01 |
| 25.500 |     0.00|  |     0.0 |     341.5  |     342.2|    0.35 |  819.01 |
| 25.600 |     0.00|  |     0.0 |     340.8  |     341.5|    0.35 |  819.01 |
| 25.700 |     0.00|  |     0.0 |     340.1  |     340.8|    0.35 |  819.01 |
| 25.800 |     0.00|  |     0.0 |     339.4  |     340.1|    0.35 |  819.01 |
| 25.900 |     0.00|  |     0.0 |     338.7  |     339.4|    0.35 |  819.01 |
 -----------------    --------------------------------------------------------
```

```
****************** SUMMARY OF ROUTING COMPUTATIONS ******************

Pond File:           SHAWET3 .PND
Inflow Hydrograph:   SHAW1   .HYD
Outflow Hydrograph:  OUT     .HYD


Starting Pond W.S. Elevation =   811.00 ft


        ***** Summary of Peak Outflow and Peak Elevation *****

                   Peak Inflow    =     8.00 cfs
                   Peak Outflow   =     0.38 cfs
                   Peak Elevation =   819.01 ft


          ***** Summary of Approximate Peak Storage *****

               Initial Storage        =     0.00 ac-ft
               Peak Storage From Storm =    1.55 ac-ft
                                          ---------------
               Total Storage in Pond  =     1.55 ac-ft
```

```
      Pond File:          SHAWET3 .PND
      Inflow Hydrograph:  SHAW1   .HYD
      Outflow Hydrograph: OUT     .HYD
                                                       EXECUTED: 07-15-1995
      Peak Inflow    =     8.00 cfs                                11:36:57
      Peak Outflow   =     0.38 cfs
      Peak Elevation =   819.01 ft

                                                                 Flow (cfs)
      0.0   1.0   2.0   3.0   4.0   5.0   6.0   7.0   8.0   9.0  10.0  11.0
      .------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-
      |
12.1 -|x
      |x     *
12.2 -|x           *
      |x                 *
12.3 -|x                       *
      |x                          *
12.4 -|x                             *
      |x                                *
12.5 -|x                                   *
      |x                                   *
12.6 -|x                                   *
      |x                                      *
12.7 -|x                                         *
      |x                                            *
12.8 -|x                                               *
      |x                                            *
12.9 -|x                                         *
      | x                                     *
13.0 -| x                                  *
      | x                                  *
13.1 -| x                                  *
      | x                               *
13.2 -| x                            *
      | x                            *
13.3 -| x                            *
      | x                            *
13.4 -| x                            *
      | x                            *
13.5 -| x                            *
      | x                         *
13.6 -| x                      *
      | x                      *
13.7 -| x                      *
      | x                      *
13.8 -| x                      *
      | x                      *
13.9 -| x                      *
      | x                   *
14.0 -| x                *
      |
    TIME
    (hrs)

  *  File:  SHAW1   .HYD   Qmax =     8.0 cfs
  x  File:  OUT     .HYD   Qmax =     0.4 cfs
```

```
POND-2 Version: 5.16 S/N: 1295130172                          Page 1
EXECUTED: 06-01-1995   10:19:45

   *******************************************************************
   *                                                                 *
   * CRANDON MINING COMPANY          93C049          FOTH & VAN DYKE *
   *      WETLAND COMPENSATION: SHAWANO COUNTY           5/95        *
   *                3 FOOT BLOCK-LOG WEIR OUTLET                     *
   *                                                                 *
   *                                                                 *
   *******************************************************************

      Inflow Hydrograph: SHAWANO .HYD
      Rating Table file: SHAWET3 .PND

      ----INITIAL CONDITIONS----
      Elevation =   811.00 ft
      Outflow   =     0.00 cfs
      Storage   =     0.00 ac-ft

                                              INTERMEDIATE ROUTING
              GIVEN POND DATA                     COMPUTATIONS
      -----------------------------         -------------------------
     |ELEVATION| OUTFLOW | STORAGE |        |    2S/t    |  2S/t  + 0  |
     |  (ft)   |  (cfs)  | (ac-ft) |        |    (cfs)   |    (cfs)    |
     |---------|---------|---------|        |------------|-------------|
     | 811.00  |    0.0  |   0.000 |        |        0.0 |         0.0 |
     | 811.50  |    0.0  |   0.001 |        |        0.3 |         0.3 |
     | 812.00  |    0.0  |   0.002 |        |        0.6 |         0.6 |
     | 812.50  |    0.0  |   0.003 |        |        0.8 |         0.8 |
     | 813.00  |    0.0  |   0.005 |        |        1.1 |         1.1 |
     | 813.50  |    0.0  |   0.006 |        |        1.4 |         1.4 |
     | 814.00  |    0.0  |   0.007 |        |        1.7 |         1.7 |
     | 814.50  |    0.0  |   0.008 |        |        1.9 |         1.9 |
     | 815.00  |    0.0  |   0.009 |        |        2.2 |         2.2 |
     | 815.50  |    0.0  |   0.010 |        |        2.5 |         2.5 |
     | 816.00  |    0.0  |   0.011 |        |        2.8 |         2.8 |
     | 816.50  |    0.0  |   0.013 |        |        3.1 |         3.1 |
     | 817.00  |    0.0  |   0.014 |        |        3.3 |         3.3 |
     | 817.50  |    0.0  |   0.015 |        |        3.6 |         3.6 |
     | 818.00  |    0.0  |   0.016 |        |        3.9 |         3.9 |
     | 818.50  |    0.0  |   0.017 |        |        4.2 |         4.2 |
     | 819.00  |    0.3  |   1.169 |        |      282.8 |       283.1 |
     | 819.50  |    4.3  |  20.171 |        |     4881.4 |      4885.7 |
     | 820.00  |   42.0  |  43.197 |        |    10453.6 |     10495.6 |
      -----------------------------         -------------------------

                     Time increment (t) = 0.100 hrs.
```

```
POND-2 Version: 5.16 S/N: 1295130172                         Page 2
EXECUTED: 06-01-1995   10:19:45

Pond File:           SHAWET3 .PND
Inflow Hydrograph:   SHAWANO .HYD
Outflow Hydrograph:  OUT     .HYD

 INFLOW HYDROGRAPH                   ROUTING COMPUTATIONS
 ------------------   ------------------------------------------------------
| TIME   | INFLOW |  | I1+I2   | 2S/t - O   | 2S/t + O | OUTFLOW |ELEVATION|
| (hrs)  | (cfs)  |  | (cfs)   |   (cfs)    |  (cfs)   |  (cfs)  |  (ft)   |
|--------|--------|  |---------|------------|----------|---------|---------|
| 11.000 |   0.00|  |  -----  |        0.0 |       0.0|   0.00  |  811.00 |
| 11.100 |   0.00|  |    0.0  |        0.0 |       0.0|   0.00  |  811.00 |
| 11.200 |   0.00|  |    0.0  |        0.0 |       0.0|   0.00  |  811.00 |
| 11.300 |   0.00|  |    0.0  |        0.0 |       0.0|   0.00  |  811.00 |
| 11.400 |   0.00|  |    0.0  |        0.0 |       0.0|   0.00  |  811.00 |
| 11.500 |   0.00|  |    0.0  |        0.0 |       0.0|   0.00  |  811.00 |
| 11.600 |   0.00|  |    0.0  |        0.0 |       0.0|   0.00  |  811.00 |
| 11.700 |   0.00|  |    0.0  |        0.0 |       0.0|   0.00  |  811.00 |
| 11.800 |   1.00|  |    1.0  |        1.0 |       1.0|   0.00  |  812.80 |
| 11.900 |   1.00|  |    2.0  |        3.0 |       3.0|   0.00  |  816.40 |
| 12.000 |   6.00|  |    7.0  |       10.0 |      10.0|   0.01  |  818.51 |
| 12.100 |  24.00|  |   30.0  |       39.9 |      40.0|   0.04  |  818.56 |
| 12.200 |  55.00|  |   79.0  |      118.7 |     118.9|   0.12  |  818.71 |
| 12.300 |  73.00|  |  128.0  |      246.1 |     246.7|   0.26  |  818.93 |
| 12.400 |  86.00|  |  159.0  |      404.3 |     405.1|   0.41  |  819.01 |
| 12.500 |  94.00|  |  180.0  |      583.2 |     584.3|   0.56  |  819.03 |
| 12.600 |  96.00|  |  190.0  |      771.8 |     773.2|   0.73  |  819.05 |
| 12.700 |  90.00|  |  186.0  |      956.0 |     957.8|   0.89  |  819.07 |
| 12.800 |  78.00|  |  168.0  |     1121.9 |    1124.0|   1.03  |  819.09 |
| 12.900 |  67.00|  |  145.0  |     1264.6 |    1266.9|   1.16  |  819.11 |
| 13.000 |  57.00|  |  124.0  |     1386.1 |    1388.6|   1.26  |  819.12 |
| 13.100 |  49.00|  |  106.0  |     1489.4 |    1492.1|   1.35  |  819.13 |
| 13.200 |  41.00|  |   90.0  |     1576.5 |    1579.4|   1.43  |  819.14 |
| 13.300 |  36.00|  |   77.0  |     1650.6 |    1653.5|   1.49  |  819.15 |
| 13.400 |  31.00|  |   67.0  |     1714.5 |    1717.6|   1.55  |  819.16 |
| 13.500 |  29.00|  |   60.0  |     1771.3 |    1774.5|   1.60  |  819.16 |
| 13.600 |  26.00|  |   55.0  |     1823.0 |    1826.3|   1.64  |  819.17 |
| 13.700 |  24.00|  |   50.0  |     1869.6 |    1873.0|   1.68  |  819.17 |
| 13.800 |  23.00|  |   47.0  |     1913.2 |    1916.6|   1.72  |  819.18 |
| 13.900 |  21.00|  |   44.0  |     1953.7 |    1957.2|   1.75  |  819.18 |
| 14.000 |  19.00|  |   40.0  |     1990.1 |    1993.7|   1.79  |  819.19 |
| 14.100 |  19.00|  |   38.0  |     2024.5 |    2028.1|   1.82  |  819.19 |
| 14.200 |  18.00|  |   37.0  |     2057.8 |    2061.5|   1.85  |  819.19 |
| 14.300 |  18.00|  |   36.0  |     2090.0 |    2093.8|   1.87  |  819.20 |
| 14.400 |  17.00|  |   35.0  |     2121.2 |    2125.0|   1.90  |  819.20 |
| 14.500 |  16.00|  |   33.0  |     2150.4 |    2154.2|   1.93  |  819.20 |
| 14.600 |  15.00|  |   31.0  |     2177.5 |    2181.4|   1.95  |  819.21 |
| 14.700 |  14.00|  |   29.0  |     2202.5 |    2206.5|   1.97  |  819.21 |
| 14.800 |  14.00|  |   28.0  |     2226.5 |    2230.5|   1.99  |  819.21 |
| 14.900 |  14.00|  |   28.0  |     2250.5 |    2254.5|   2.01  |  819.21 |
| 15.000 |  13.00|  |   27.0  |     2273.5 |    2277.5|   2.03  |  819.22 |
| 15.100 |  13.00|  |   26.0  |     2295.3 |    2299.5|   2.05  |  819.22 |
| 15.200 |  13.00|  |   26.0  |     2317.2 |    2321.3|   2.07  |  819.22 |
| 15.300 |  12.00|  |   25.0  |     2338.0 |    2342.2|   2.09  |  819.22 |
| 15.400 |  12.00|  |   24.0  |     2357.8 |    2362.0|   2.11  |  819.23 |
 ------------------   ------------------------------------------------------
```

```
POND-2 Version: 5.16 S/N: 1295130172                        Page 3
EXECUTED: 06-01-1995   10:19:45

Pond File:            SHAWET3 .PND
Inflow Hydrograph:    SHAWANO .HYD
Outflow Hydrograph:  OUT      .HYD

INFLOW HYDROGRAPH                     ROUTING COMPUTATIONS
------------------    ---------------------------------------------------------
| TIME   | INFLOW |   | I1+I2  |  2S/t - O  |  2S/t + O | OUTFLOW |ELEVATION|
| (hrs)  | (cfs)  |   | (cfs)  |   (cfs)    |   (cfs)   |  (cfs)  |  (ft)   |
|--------|---------|  |---------|------------|-----------|---------|---------|
| 15.500 |   12.00|   |   24.0 |     2377.6 |     2381.8|    2.12 |  819.23 |
| 15.600 |   12.00|   |   24.0 |     2397.3 |     2401.6|    2.14 |  819.23 |
| 15.700 |   12.00|   |   24.0 |     2417.0 |     2421.3|    2.16 |  819.23 |
| 15.800 |   11.00|   |   23.0 |     2435.6 |     2440.0|    2.17 |  819.23 |
| 15.900 |   11.00|   |   22.0 |     2453.2 |     2457.6|    2.19 |  819.24 |
| 16.000 |   11.00|   |   22.0 |     2470.8 |     2475.2|    2.21 |  819.24 |
| 16.100 |   11.00|   |   22.0 |     2488.4 |     2492.8|    2.22 |  819.24 |
| 16.200 |   11.00|   |   22.0 |     2505.9 |     2510.4|    2.24 |  819.24 |
| 16.300 |   10.00|   |   21.0 |     2522.4 |     2526.9|    2.25 |  819.24 |
| 16.400 |   10.00|   |   20.0 |     2537.9 |     2542.4|    2.26 |  819.25 |
| 16.500 |   10.00|   |   20.0 |     2553.3 |     2557.9|    2.28 |  819.25 |
| 16.600 |   10.00|   |   20.0 |     2568.8 |     2573.3|    2.29 |  819.25 |
| 16.700 |   10.00|   |   20.0 |     2584.1 |     2588.8|    2.30 |  819.25 |
| 16.800 |    9.00|   |   19.0 |     2598.5 |     2603.1|    2.32 |  819.25 |
| 16.900 |    9.00|   |   18.0 |     2611.9 |     2616.5|    2.33 |  819.25 |
| 17.000 |    9.00|   |   18.0 |     2625.2 |     2629.9|    2.34 |  819.25 |
| 17.100 |    9.00|   |   18.0 |     2638.5 |     2643.2|    2.35 |  819.26 |
| 17.200 |    9.00|   |   18.0 |     2651.8 |     2656.5|    2.36 |  819.26 |
| 17.300 |    9.00|   |   18.0 |     2665.0 |     2669.8|    2.37 |  819.26 |
| 17.400 |    9.00|   |   18.0 |     2678.2 |     2683.0|    2.39 |  819.26 |
| 17.500 |    9.00|   |   18.0 |     2691.4 |     2696.2|    2.40 |  819.26 |
| 17.600 |    9.00|   |   18.0 |     2704.6 |     2709.4|    2.41 |  819.26 |
| 17.700 |    9.00|   |   18.0 |     2717.8 |     2722.6|    2.42 |  819.27 |
| 17.800 |    9.00|   |   18.0 |     2730.9 |     2735.8|    2.43 |  819.27 |
| 17.900 |    9.00|   |   18.0 |     2744.0 |     2748.9|    2.44 |  819.27 |
| 18.000 |    9.00|   |   18.0 |     2757.1 |     2762.0|    2.45 |  819.27 |
| 18.100 |    9.00|   |   18.0 |     2770.2 |     2775.1|    2.47 |  819.27 |
| 18.200 |    9.00|   |   18.0 |     2783.2 |     2788.2|    2.48 |  819.27 |
| 18.300 |    8.00|   |   17.0 |     2795.3 |     2800.2|    2.49 |  819.27 |
| 18.400 |    8.00|   |   16.0 |     2806.3 |     2811.3|    2.50 |  819.27 |
| 18.500 |    8.00|   |   16.0 |     2817.3 |     2822.3|    2.51 |  819.28 |
| 18.600 |    8.00|   |   16.0 |     2828.2 |     2833.3|    2.52 |  819.28 |
| 18.700 |    8.00|   |   16.0 |     2839.2 |     2844.2|    2.53 |  819.28 |
| 18.800 |    7.00|   |   15.0 |     2849.1 |     2854.2|    2.53 |  819.28 |
| 18.900 |    7.00|   |   14.0 |     2858.0 |     2863.1|    2.54 |  819.28 |
| 19.000 |    7.00|   |   14.0 |     2866.9 |     2872.0|    2.55 |  819.28 |
| 19.100 |    7.00|   |   14.0 |     2875.8 |     2880.9|    2.56 |  819.28 |
| 19.200 |    7.00|   |   14.0 |     2884.7 |     2889.8|    2.57 |  819.28 |
| 19.300 |    7.00|   |   14.0 |     2893.5 |     2898.7|    2.57 |  819.28 |
| 19.400 |    7.00|   |   14.0 |     2902.4 |     2907.5|    2.58 |  819.29 |
| 19.500 |    7.00|   |   14.0 |     2911.2 |     2916.4|    2.59 |  819.29 |
| 19.600 |    7.00|   |   14.0 |     2920.0 |     2925.2|    2.60 |  819.29 |
| 19.700 |    7.00|   |   14.0 |     2928.8 |     2934.0|    2.60 |  819.29 |
| 19.800 |    7.00|   |   14.0 |     2937.6 |     2942.8|    2.61 |  819.29 |
| 19.900 |    7.00|   |   14.0 |     2946.3 |     2951.6|    2.62 |  819.29 |
| 20.000 |    7.00|   |   14.0 |     2955.1 |     2960.3|    2.63 |  819.29 |
------------------    ---------------------------------------------------------
```

```
POND-2 Version: 5.16 S/N: 1295130172                          Page 4
EXECUTED: 06-01-1995   10:19:45

Pond File:            SHAWET3 .PND
Inflow Hydrograph:    SHAWANO .HYD
Outflow Hydrograph: OUT      .HYD

INFLOW HYDROGRAPH                   ROUTING COMPUTATIONS
------------------   ------------------------------------------------------
| TIME  | INFLOW |   | I1+I2 | 2S/t - O  | 2S/t + O | OUTFLOW |ELEVATION|
| (hrs) | (cfs)  |   | (cfs) |  (cfs)    |  (cfs)   | (cfs)   |  (ft)   |
|-------|--------|   |-------|-----------|----------|---------|---------|
| 20.100 |   7.00|   |  14.0 |  2963.8 |   2969.1|   2.63 |  819.29 |
| 20.200 |   7.00|   |  14.0 |  2972.5 |   2977.8|   2.64 |  819.29 |
| 20.300 |   7.00|   |  14.0 |  2981.2 |   2986.5|   2.65 |  819.29 |
| 20.400 |   7.00|   |  14.0 |  2989.9 |   2995.2|   2.66 |  819.29 |
| 20.500 |   7.00|   |  14.0 |  2998.6 |   3003.9|   2.66 |  819.30 |
| 20.600 |   7.00|   |  14.0 |  3007.2 |   3012.6|   2.67 |  819.30 |
| 20.700 |   7.00|   |  14.0 |  3015.9 |   3021.2|   2.68 |  819.30 |
| 20.800 |   7.00|   |  14.0 |  3024.5 |   3029.9|   2.69 |  819.30 |
| 20.900 |   7.00|   |  14.0 |  3033.1 |   3038.5|   2.69 |  819.30 |
| 21.000 |   6.00|   |  13.0 |  3040.7 |   3046.1|   2.70 |  819.30 |
| 21.100 |   6.00|   |  12.0 |  3047.3 |   3052.7|   2.71 |  819.30 |
| 21.200 |   6.00|   |  12.0 |  3053.9 |   3059.3|   2.71 |  819.30 |
| 21.300 |   6.00|   |  12.0 |  3060.4 |   3065.9|   2.72 |  819.30 |
| 21.400 |   6.00|   |  12.0 |  3067.0 |   3072.4|   2.72 |  819.30 |
| 21.500 |   6.00|   |  12.0 |  3073.5 |   3079.0|   2.73 |  819.30 |
| 21.600 |   6.00|   |  12.0 |  3080.1 |   3085.5|   2.74 |  819.30 |
| 21.700 |   6.00|   |  12.0 |  3086.6 |   3092.1|   2.74 |  819.31 |
| 21.800 |   6.00|   |  12.0 |  3093.1 |   3098.6|   2.75 |  819.31 |
| 21.900 |   6.00|   |  12.0 |  3099.6 |   3105.1|   2.75 |  819.31 |
| 22.000 |   6.00|   |  12.0 |  3106.1 |   3111.6|   2.76 |  819.31 |
| 22.100 |   6.00|   |  12.0 |  3112.5 |   3118.1|   2.76 |  819.31 |
| 22.200 |   6.00|   |  12.0 |  3119.0 |   3124.5|   2.77 |  819.31 |
| 22.300 |   6.00|   |  12.0 |  3125.4 |   3131.0|   2.78 |  819.31 |
| 22.400 |   5.00|   |  11.0 |  3130.9 |   3136.4|   2.78 |  819.31 |
| 22.500 |   5.00|   |  10.0 |  3135.3 |   3140.9|   2.78 |  819.31 |
| 22.600 |   5.00|   |  10.0 |  3139.7 |   3145.3|   2.79 |  819.31 |
| 22.700 |   5.00|   |  10.0 |  3144.2 |   3149.7|   2.79 |  819.31 |
| 22.800 |   5.00|   |  10.0 |  3148.6 |   3154.2|   2.80 |  819.31 |
| 22.900 |   5.00|   |  10.0 |  3153.0 |   3158.6|   2.80 |  819.31 |
| 23.000 |   4.00|   |   9.0 |  3156.4 |   3162.0|   2.80 |  819.31 |
| 23.100 |   4.00|   |   8.0 |  3158.8 |   3164.4|   2.80 |  819.31 |
| 23.200 |   4.00|   |   8.0 |  3161.1 |   3166.8|   2.81 |  819.31 |
| 23.300 |   4.00|   |   8.0 |  3163.5 |   3169.1|   2.81 |  819.31 |
| 23.400 |   4.00|   |   8.0 |  3165.9 |   3171.5|   2.81 |  819.31 |
| 23.500 |   4.00|   |   8.0 |  3168.3 |   3173.9|   2.81 |  819.31 |
| 23.600 |   4.00|   |   8.0 |  3170.7 |   3176.3|   2.81 |  819.31 |
| 23.700 |   3.00|   |   7.0 |  3172.0 |   3177.7|   2.82 |  819.31 |
| 23.800 |   3.00|   |   6.0 |  3172.4 |   3178.0|   2.82 |  819.31 |
| 23.900 |   3.00|   |   6.0 |  3172.8 |   3178.4|   2.82 |  819.31 |
| 24.000 |   3.00|   |   6.0 |  3173.1 |   3178.8|   2.82 |  819.31 |
| 24.100 |   3.00|   |   6.0 |  3173.5 |   3179.1|   2.82 |  819.31 |
| 24.200 |   3.00|   |   6.0 |  3173.9 |   3179.5|   2.82 |  819.31 |
| 24.300 |   3.00|   |   6.0 |  3174.2 |   3179.9|   2.82 |  819.31 |
| 24.400 |   2.00|   |   5.0 |  3173.6 |   3179.2|   2.82 |  819.31 |
| 24.500 |   2.00|   |   4.0 |  3172.0 |   3177.6|   2.82 |  819.31 |
| 24.600 |   2.00|   |   4.0 |  3170.3 |   3176.0|   2.81 |  819.31 |
------------------   ------------------------------------------------------
```

```
POND-2 Version: 5.16 S/N: 1295130172                          Page 5
EXECUTED: 06-01-1995    10:19:45

Pond File:           SHAWET3 .PND
Inflow Hydrograph:   SHAWANO .HYD
Outflow Hydrograph:  OUT     .HYD

INFLOW HYDROGRAPH                        ROUTING COMPUTATIONS
 ------------------     ------------------------------------------------------
| TIME   | INFLOW  |   | I1+I2   |  2S/t - O  |  2S/t + O | OUTFLOW |ELEVATION|
| (hrs)  | (cfs)   |   | (cfs)   |   (cfs)    |   (cfs)   | (cfs)   |  (ft)   |
|--------|---------|   |---------|------------|-----------|---------|---------|
| 24.700 |     2.00|   |     4.0 |     3168.7 |     3174.3|    2.81 |  819.31 |
| 24.800 |     2.00|   |     4.0 |     3167.1 |     3172.7|    2.81 |  819.31 |
| 24.900 |     2.00|   |     4.0 |     3165.5 |     3171.1|    2.81 |  819.31 |
| 25.000 |     2.00|   |     4.0 |     3163.8 |     3169.5|    2.81 |  819.31 |
| 25.100 |     1.00|   |     3.0 |     3161.2 |     3166.8|    2.81 |  819.31 |
| 25.200 |     1.00|   |     2.0 |     3157.6 |     3163.2|    2.80 |  819.31 |
| 25.300 |     1.00|   |     2.0 |     3154.0 |     3159.6|    2.80 |  819.31 |
| 25.400 |     1.00|   |     2.0 |     3150.4 |     3156.0|    2.80 |  819.31 |
| 25.500 |     1.00|   |     2.0 |     3146.8 |     3152.4|    2.79 |  819.31 |
| 25.600 |     1.00|   |     2.0 |     3143.3 |     3148.8|    2.79 |  819.31 |
| 25.700 |     0.00|   |     1.0 |     3138.7 |     3144.3|    2.79 |  819.31 |
| 25.800 |     0.00|   |     0.0 |     3133.1 |     3138.7|    2.78 |  819.31 |
| 25.900 |     0.00|   |     0.0 |     3127.6 |     3133.1|    2.78 |  819.31 |
 ----------------       ------------------------------------------------------
```

```
******************* SUMMARY OF ROUTING COMPUTATIONS ******************

Pond File:           SHAWET3 .PND
Inflow Hydrograph:   SHAWANO .HYD
Outflow Hydrograph:  OUT     .HYD


Starting Pond W.S. Elevation =   811.00 ft


         ***** Summary of Peak Outflow and Peak Elevation *****

                      Peak Inflow    =    96.00 cfs
                      Peak Outflow   =     2.82 cfs
                      Peak Elevation =   819.31 ft


           ***** Summary of Approximate Peak Storage *****

               Initial Storage         =      0.00 ac-ft
               Peak Storage From Storm =     13.13 ac-ft
                                           ---------------
               Total Storage in Pond   =     13.13 ac-ft
```

```
     POND-2 Version: 5.16 S/N: 1295130172                      Page 7

     Pond File:          SHAWET3 .PND
     Inflow Hydrograph:  SHAWANO .HYD
     Outflow Hydrograph: OUT     .HYD
                                                      EXECUTED: 06-01-1995
     Peak Inflow    =    96.00 cfs                            10:19:45
     Peak Outflow   =     2.82 cfs
     Peak Elevation =   819.31 ft

                                                                 Flow (cfs)
      0.0  10.0  20.0  30.0  40.0  50.0  60.0  70.0  80.0  90.0 100.0 110.0
      .------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-
      |
11.8 -|x*
      |x*
11.9 -|x*
      |x *
12.0 -|x   *
      |x        *
12.1 -|x             *
      |x                       *
12.2 -|x                                *
      |x                                     *
12.3 -|x                                           *
      |x                                               *
12.4 -|x                                                   *
      |x                                                     *
12.5 -|x                                                       *
      |x                                                        *
12.6 -|x                                                         *
      |x                                                       *
12.7 -| x                                                    *
      | x                                                *
12.8 -| x                                             *
      | x                                         *
12.9 -| x                                      *
      | x                                   *
13.0 -| x                                *
      | x                              *
13.1 -| x                           *
      | x                         *
13.2 -| x                       *
      | x                     *
13.3 -| x                    *
      | x                  *
13.4 -| x                 *
      | x                *
13.5 -| x               *
      | x               *
13.6 -| x              *
      | x             *
13.7 -| x            *
      |
     TIME
     (hrs)

   * File:  SHAWANO .HYD   Qmax =    96.0 cfs
   x File:  OUT     .HYD   Qmax =     2.8 cfs
```

```
POND-2 Version: 5.16 S/N: 1295130172                        Page 1
EXECUTED: 06-01-1995   10:26:48

    ************************************************************************
    *                                                                      *
    * CRANDON MINING COMPANY           93C049          FOTH & VAN DYKE     *
    *       WETLAND COMPENSATION: SHAWANO COUNTY            5/95           *
    *                     3 FOOT BLOCK-LOG WEIR OUTLET                     *
    *                        10-YEAR STORM EVENT                           *
    *                                                                      *
    ************************************************************************

       Inflow Hydrograph: SHAW10  .HYD
       Rating Table file: SHAWET3 .PND

       ----INITIAL CONDITIONS----
       Elevation =   811.00 ft
       Outflow   =     0.00 cfs
       Storage   =     0.00 ac-ft

                                                 INTERMEDIATE ROUTING
                GIVEN POND DATA                       COMPUTATIONS
        -----------------------------           -------------------------
       |ELEVATION| OUTFLOW | STORAGE |         |    2S/t    |  2S/t  + O  |
       |  (ft)   |  (cfs)  | (ac-ft) |         |   (cfs)    |    (cfs)    |
       |---------|---------|---------|         |------------|-------------|
       | 811.00  |    0.0  |   0.000|          |       0.0  |         0.0 |
       | 811.50  |    0.0  |   0.001|          |       0.3  |         0.3 |
       | 812.00  |    0.0  |   0.002|          |       0.6  |         0.6 |
       | 812.50  |    0.0  |   0.003|          |       0.8  |         0.8 |
       | 813.00  |    0.0  |   0.005|          |       1.1  |         1.1 |
       | 813.50  |    0.0  |   0.006|          |       1.4  |         1.4 |
       | 814.00  |    0.0  |   0.007|          |       1.7  |         1.7 |
       | 814.50  |    0.0  |   0.008|          |       1.9  |         1.9 |
       | 815.00  |    0.0  |   0.009|          |       2.2  |         2.2 |
       | 815.50  |    0.0  |   0.010|          |       2.5  |         2.5 |
       | 816.00  |    0.0  |   0.011|          |       2.8  |         2.8 |
       | 816.50  |    0.0  |   0.013|          |       3.1  |         3.1 |
       | 817.00  |    0.0  |   0.014|          |       3.3  |         3.3 |
       | 817.50  |    0.0  |   0.015|          |       3.6  |         3.6 |
       | 818.00  |    0.0  |   0.016|          |       3.9  |         3.9 |
       | 818.50  |    0.0  |   0.017|          |       4.2  |         4.2 |
       | 819.00  |    0.3  |   1.169|          |     282.8  |       283.1 |
       | 819.50  |    4.3  |  20.171|          |    4881.4  |      4885.7 |
       | 820.00  |   42.0  |  43.197|          |   10453.6  |     10495.6 |
        -----------------------------           -------------------------

                      Time increment (t) = 0.100 hrs.
```

```
POND-2 Version: 5.16 S/N: 1295130172                          Page 2
EXECUTED: 06-01-1995   10:26:48

Pond File:           SHAWET3 .PND
Inflow Hydrograph:   SHAW10  .HYD
Outflow Hydrograph: OUT      .HYD

INFLOW HYDROGRAPH                       ROUTING COMPUTATIONS
------------------    ------------------------------------------------------
| TIME   | INFLOW  |  | I1+I2   |  2S/t - O  |  2S/t + O | OUTFLOW |ELEVATION|
| (hrs)  | (cfs)   |  | (cfs)   |   (cfs)    |   (cfs)   | (cfs)   |  (ft)   |
|--------|---------|  |---------|------------|-----------|---------|---------|
| 11.000 |    14.00|  |  -----  |        0.0 |        0.0|    0.00 |  811.00 |
| 11.100 |    16.00|  |    30.0 |       29.9 |       30.0|    0.03 |  818.55 |
| 11.200 |    17.00|  |    33.0 |       62.8 |       62.9|    0.06 |  818.61 |
| 11.300 |    19.00|  |    36.0 |       98.6 |       98.8|    0.10 |  818.67 |
| 11.400 |    21.00|  |    40.0 |      138.3 |      138.6|    0.14 |  818.74 |
| 11.500 |    23.00|  |    44.0 |      181.9 |      182.3|    0.19 |  818.82 |
| 11.600 |    25.00|  |    48.0 |      229.5 |      229.9|    0.24 |  818.90 |
| 11.700 |    35.00|  |    60.0 |      288.8 |      289.5|    0.31 |  819.00 |
| 11.800 |    45.00|  |    80.0 |      368.1 |      368.8|    0.37 |  819.01 |
| 11.900 |    55.00|  |   100.0 |      467.2 |      468.1|    0.46 |  819.02 |
| 12.000 |    97.00|  |   152.0 |      618.0 |      619.2|    0.59 |  819.04 |
| 12.100 |   175.00|  |   272.0 |      888.3 |      890.0|    0.83 |  819.07 |
| 12.200 |   285.00|  |   460.0 |     1345.9 |     1348.3|    1.23 |  819.12 |
| 12.300 |   353.00|  |   638.0 |     1980.3 |     1983.9|    1.78 |  819.18 |
| 12.400 |   344.00|  |   697.0 |     2672.6 |     2677.3|    2.38 |  819.26 |
| 12.500 |   313.00|  |   657.0 |     3323.7 |     3329.6|    2.95 |  819.33 |
| 12.600 |   268.00|  |   581.0 |     3897.8 |     3904.7|    3.45 |  819.39 |
| 12.700 |   220.00|  |   488.0 |     4378.0 |     4385.8|    3.87 |  819.45 |
| 12.800 |   181.00|  |   401.0 |     4770.6 |     4779.0|    4.21 |  819.49 |
| 12.900 |   152.00|  |   333.0 |     5092.1 |     5103.6|    5.76 |  819.52 |
| 13.000 |   123.00|  |   275.0 |     5352.0 |     5367.1|    7.53 |  819.54 |
| 13.100 |   105.00|  |   228.0 |     5562.1 |     5580.0|    8.97 |  819.56 |
| 13.200 |    87.00|  |   192.0 |     5733.8 |     5754.1|   10.14 |  819.58 |
| 13.300 |    76.00|  |   163.0 |     5874.6 |     5896.8|   11.09 |  819.59 |
| 13.400 |    66.00|  |   142.0 |     5992.8 |     6016.6|   11.90 |  819.60 |
| 13.500 |    59.00|  |   125.0 |     6092.7 |     6117.8|   12.58 |  819.61 |
| 13.600 |    51.00|  |   110.0 |     6176.4 |     6202.7|   13.15 |  819.62 |
| 13.700 |    47.00|  |    98.0 |     6247.1 |     6274.4|   13.63 |  819.62 |
| 13.800 |    43.00|  |    90.0 |     6309.0 |     6337.1|   14.05 |  819.63 |
| 13.900 |    40.00|  |    83.0 |     6363.2 |     6392.0|   14.42 |  819.63 |
| 14.000 |    38.00|  |    78.0 |     6411.7 |     6441.2|   14.75 |  819.64 |
| 14.100 |    36.00|  |    74.0 |     6455.6 |     6485.7|   15.05 |  819.64 |
| 14.200 |    35.00|  |    71.0 |     6495.9 |     6526.6|   15.33 |  819.65 |
| 14.300 |    33.00|  |    68.0 |     6532.7 |     6563.9|   15.58 |  819.65 |
| 14.400 |    31.00|  |    64.0 |     6565.1 |     6596.7|   15.80 |  819.65 |
| 14.500 |    29.00|  |    60.0 |     6593.2 |     6625.1|   15.99 |  819.66 |
| 14.600 |    27.00|  |    56.0 |     6616.9 |     6649.2|   16.15 |  819.66 |
| 14.700 |    27.00|  |    54.0 |     6638.3 |     6670.9|   16.30 |  819.66 |
| 14.800 |    26.00|  |    53.0 |     6658.4 |     6691.3|   16.43 |  819.66 |
| 14.900 |    26.00|  |    52.0 |     6677.3 |     6710.4|   16.56 |  819.66 |
| 15.000 |    26.00|  |    52.0 |     6695.9 |     6729.3|   16.69 |  819.66 |
| 15.100 |    25.00|  |    51.0 |     6713.3 |     6746.9|   16.81 |  819.67 |
| 15.200 |    25.00|  |    50.0 |     6729.5 |     6763.3|   16.92 |  819.67 |
| 15.300 |    24.00|  |    49.0 |     6744.4 |     6778.5|   17.02 |  819.67 |
| 15.400 |    24.00|  |    48.0 |     6758.2 |     6792.4|   17.11 |  819.67 |
------------------    ------------------------------------------------------
```

```
POND-2 Version: 5.16 S/N: 1295130172                           Page 3
EXECUTED: 06-01-1995   10:26:48

Pond File:           SHAWET3 .PND
Inflow Hydrograph:   SHAW10  .HYD
Outflow Hydrograph:  OUT     .HYD

INFLOW HYDROGRAPH                   ROUTING COMPUTATIONS

------------------    ---------------------------------------------------
| TIME  | INFLOW |    | I1+I2 | 2S/t - O  | 2S/t + O | OUTFLOW |ELEVATION|
| (hrs) | (cfs)  |    | (cfs) |   (cfs)   |  (cfs)   |  (cfs)  |  (ft)   |
|-------|--------|    |-------|-----------|----------|---------|---------|
| 15.500 |  23.00|    |  47.0 |   6770.8  |   6805.2|  17.20  | 819.67  |
| 15.600 |  22.00|    |  45.0 |   6781.2  |   6815.8|  17.27  | 819.67  |
| 15.700 |  22.00|    |  44.0 |   6790.6  |   6825.2|  17.33  | 819.67  |
| 15.800 |  21.00|    |  43.0 |   6798.8  |   6833.6|  17.39  | 819.67  |
| 15.900 |  21.00|    |  42.0 |   6805.9  |   6840.8|  17.44  | 819.67  |
| 16.000 |  20.00|    |  41.0 |   6812.0  |   6846.9|  17.48  | 819.67  |
| 16.100 |  20.00|    |  40.0 |   6816.9  |   6852.0|  17.51  | 819.68  |
| 16.200 |  19.00|    |  39.0 |   6820.9  |   6855.9|  17.54  | 819.68  |
| 16.300 |  19.00|    |  38.0 |   6823.7  |   6858.9|  17.56  | 819.68  |
| 16.400 |  18.00|    |  37.0 |   6825.6  |   6860.7|  17.57  | 819.68  |
| 16.500 |  18.00|    |  36.0 |   6826.4  |   6861.6|  17.58  | 819.68  |
| 16.600 |  18.00|    |  36.0 |   6827.3  |   6862.4|  17.58  | 819.68  |
| 16.700 |  18.00|    |  36.0 |   6828.1  |   6863.3|  17.59  | 819.68  |
| 16.800 |  17.00|    |  35.0 |   6827.9  |   6863.1|  17.59  | 819.68  |
| 16.900 |  17.00|    |  34.0 |   6826.7  |   6861.9|  17.58  | 819.68  |
| 17.000 |  17.00|    |  34.0 |   6825.6  |   6860.7|  17.57  | 819.68  |
| 17.100 |  17.00|    |  34.0 |   6824.5  |   6859.6|  17.57  | 819.68  |
| 17.200 |  16.00|    |  33.0 |   6822.4  |   6857.5|  17.55  | 819.68  |
| 17.300 |  16.00|    |  32.0 |   6819.3  |   6854.4|  17.53  | 819.68  |
| 17.400 |  15.00|    |  31.0 |   6815.3  |   6850.3|  17.50  | 819.68  |
| 17.500 |  15.00|    |  30.0 |   6810.4  |   6845.3|  17.47  | 819.67  |
| 17.600 |  15.00|    |  30.0 |   6805.5  |   6840.4|  17.44  | 819.67  |
| 17.700 |  15.00|    |  30.0 |   6800.7  |   6835.5|  17.40  | 819.67  |
| 17.800 |  14.00|    |  29.0 |   6795.0  |   6829.7|  17.36  | 819.67  |
| 17.900 |  14.00|    |  28.0 |   6788.3  |   6823.0|  17.32  | 819.67  |
| 18.000 |  14.00|    |  28.0 |   6781.8  |   6816.3|  17.27  | 819.67  |
| 18.100 |  14.00|    |  28.0 |   6775.3  |   6809.8|  17.23  | 819.67  |
| 18.200 |  14.00|    |  28.0 |   6768.9  |   6803.3|  17.19  | 819.67  |
| 18.300 |  14.00|    |  28.0 |   6762.7  |   6796.9|  17.14  | 819.67  |
| 18.400 |  14.00|    |  28.0 |   6756.4  |   6790.7|  17.10  | 819.67  |
| 18.500 |  14.00|    |  28.0 |   6750.3  |   6784.4|  17.06  | 819.67  |
| 18.600 |  13.00|    |  27.0 |   6743.3  |   6777.3|  17.01  | 819.67  |
| 18.700 |  13.00|    |  26.0 |   6735.4  |   6769.3|  16.96  | 819.67  |
| 18.800 |  13.00|    |  26.0 |   6727.6  |   6761.4|  16.90  | 819.67  |
| 18.900 |  13.00|    |  26.0 |   6719.9  |   6753.6|  16.85  | 819.67  |
| 19.000 |  13.00|    |  26.0 |   6712.3  |   6745.9|  16.80  | 819.67  |
| 19.100 |  13.00|    |  26.0 |   6704.8  |   6738.3|  16.75  | 819.67  |
| 19.200 |  13.00|    |  26.0 |   6697.4  |   6730.8|  16.70  | 819.66  |
| 19.300 |  12.00|    |  25.0 |   6689.1  |   6722.4|  16.64  | 819.66  |
| 19.400 |  12.00|    |  24.0 |   6679.9  |   6713.1|  16.58  | 819.66  |
| 19.500 |  12.00|    |  24.0 |   6670.9  |   6703.9|  16.52  | 819.66  |
| 19.600 |  12.00|    |  24.0 |   6662.0  |   6694.9|  16.46  | 819.66  |
| 19.700 |  12.00|    |  24.0 |   6653.2  |   6686.0|  16.40  | 819.66  |
| 19.800 |  11.00|    |  23.0 |   6643.5  |   6676.2|  16.33  | 819.66  |
| 19.900 |  11.00|    |  22.0 |   6633.0  |   6665.5|  16.26  | 819.66  |
| 20.000 |  11.00|    |  22.0 |   6622.6  |   6655.0|  16.19  | 819.66  |
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```

```
POND-2 Version: 5.16 S/N: 1295130172                        Page 4
EXECUTED: 06-01-1995   10:26:48

Pond File:           SHAWET3 .PND
Inflow Hydrograph:   SHAW10  .HYD
Outflow Hydrograph:  OUT     .HYD

INFLOW HYDROGRAPH                      ROUTING COMPUTATIONS
------------------     -----------------------------------------------------
| TIME  | INFLOW |    | I1+I2 | 2S/t - O  |  2S/t + O | OUTFLOW |ELEVATION|
| (hrs) | (cfs)  |    | (cfs) |   (cfs)   |   (cfs)   |  (cfs)  |  (ft)   |
|--------|---------|  |---------|------------|-----------|---------|---------|
| 20.100 |   11.00|  |    22.0 |     6612.4 |    6644.6|   16.12 |  819.66 |
| 20.200 |   11.00|  |    22.0 |     6602.3 |    6634.4|   16.05 |  819.66 |
| 20.300 |   11.00|  |    22.0 |     6592.3 |    6624.3|   15.98 |  819.65 |
| 20.400 |   11.00|  |    22.0 |     6582.5 |    6614.3|   15.92 |  819.65 |
| 20.500 |   10.00|  |    21.0 |     6571.8 |    6603.5|   15.84 |  819.65 |
| 20.600 |   10.00|  |    20.0 |     6560.2 |    6591.8|   15.77 |  819.65 |
| 20.700 |   10.00|  |    20.0 |     6548.9 |    6580.2|   15.69 |  819.65 |
| 20.800 |   10.00|  |    20.0 |     6537.7 |    6568.9|   15.61 |  819.65 |
| 20.900 |   10.00|  |    20.0 |     6526.6 |    6557.7|   15.54 |  819.65 |
| 21.000 |   10.00|  |    20.0 |     6515.7 |    6546.6|   15.46 |  819.65 |
| 21.100 |   10.00|  |    20.0 |     6504.9 |    6535.7|   15.39 |  819.65 |
| 21.200 |   10.00|  |    20.0 |     6494.3 |    6524.9|   15.32 |  819.65 |
| 21.300 |   10.00|  |    20.0 |     6483.8 |    6514.3|   15.24 |  819.65 |
| 21.400 |   10.00|  |    20.0 |     6473.4 |    6503.8|   15.17 |  819.64 |
| 21.500 |   10.00|  |    20.0 |     6463.2 |    6493.4|   15.10 |  819.64 |
| 21.600 |    9.00|  |    19.0 |     6452.1 |    6482.2|   15.03 |  819.64 |
| 21.700 |    9.00|  |    18.0 |     6440.3 |    6470.1|   14.95 |  819.64 |
| 21.800 |    9.00|  |    18.0 |     6428.5 |    6458.3|   14.87 |  819.64 |
| 21.900 |    9.00|  |    18.0 |     6416.9 |    6446.5|   14.79 |  819.64 |
| 22.000 |    9.00|  |    18.0 |     6405.5 |    6434.9|   14.71 |  819.64 |
| 22.100 |    9.00|  |    18.0 |     6394.2 |    6423.5|   14.63 |  819.64 |
| 22.200 |    9.00|  |    18.0 |     6383.1 |    6412.2|   14.56 |  819.64 |
| 22.300 |    8.00|  |    17.0 |     6371.2 |    6400.1|   14.48 |  819.63 |
| 22.400 |    8.00|  |    16.0 |     6358.4 |    6387.2|   14.39 |  819.63 |
| 22.500 |    8.00|  |    16.0 |     6345.8 |    6374.4|   14.30 |  819.63 |
| 22.600 |    8.00|  |    16.0 |     6333.3 |    6361.8|   14.22 |  819.63 |
| 22.700 |    7.00|  |    15.0 |     6320.1 |    6348.3|   14.13 |  819.63 |
| 22.800 |    7.00|  |    14.0 |     6306.0 |    6334.1|   14.03 |  819.63 |
| 22.900 |    7.00|  |    14.0 |     6292.1 |    6320.0|   13.94 |  819.63 |
| 23.000 |    7.00|  |    14.0 |     6278.5 |    6306.1|   13.85 |  819.63 |
| 23.100 |    7.00|  |    14.0 |     6264.9 |    6292.5|   13.75 |  819.63 |
| 23.200 |    6.00|  |    13.0 |     6250.6 |    6277.9|   13.66 |  819.62 |
| 23.300 |    6.00|  |    12.0 |     6235.5 |    6262.6|   13.55 |  819.62 |
| 23.400 |    6.00|  |    12.0 |     6220.6 |    6247.5|   13.45 |  819.62 |
| 23.500 |    6.00|  |    12.0 |     6205.9 |    6232.6|   13.35 |  819.62 |
| 23.600 |    5.00|  |    11.0 |     6190.4 |    6216.9|   13.25 |  819.62 |
| 23.700 |    5.00|  |    10.0 |     6174.2 |    6200.4|   13.14 |  819.62 |
| 23.800 |    5.00|  |    10.0 |     6158.1 |    6184.2|   13.03 |  819.62 |
| 23.900 |    5.00|  |    10.0 |     6142.3 |    6168.1|   12.92 |  819.61 |
| 24.000 |    4.00|  |     9.0 |     6125.7 |    6151.3|   12.80 |  819.61 |
| 24.100 |    4.00|  |     8.0 |     6108.3 |    6133.7|   12.69 |  819.61 |
| 24.200 |    4.00|  |     8.0 |     6091.2 |    6116.3|   12.57 |  819.61 |
| 24.300 |    4.00|  |     8.0 |     6074.2 |    6099.2|   12.45 |  819.61 |
| 24.400 |    4.00|  |     8.0 |     6057.6 |    6082.2|   12.34 |  819.61 |
| 24.500 |    3.00|  |     7.0 |     6040.1 |    6064.6|   12.22 |  819.61 |
| 24.600 |    3.00|  |     6.0 |     6021.9 |    6046.1|   12.10 |  819.60 |
------------------     -----------------------------------------------------
```

```
Pond File:           SHAWET3 .PND
Inflow Hydrograph:   SHAW10  .HYD
Outflow Hydrograph:  OUT     .HYD

 INFLOW HYDROGRAPH                  ROUTING COMPUTATIONS
 ------------------    ------------------------------------------------------
| TIME   | INFLOW  |  | I1+I2   |  2S/t - O  |  2S/t + O | OUTFLOW |ELEVATION|
| (hrs)  | (cfs)   |  | (cfs)   |   (cfs)    |   (cfs)   | (cfs)   |  (ft)   |
|--------|---------|  |---------|------------|-----------|---------|---------|
| 24.700 |     3.00|  |     6.0 |     6004.0 |     6027.9|   11.98 |  819.60 |
| 24.800 |     3.00|  |     6.0 |     5986.3 |     6010.0|   11.86 |  819.60 |
| 24.900 |     2.00|  |     5.0 |     5967.8 |     5991.3|   11.73 |  819.60 |
| 25.000 |     2.00|  |     4.0 |     5948.6 |     5971.8|   11.60 |  819.60 |
| 25.100 |     2.00|  |     4.0 |     5929.7 |     5952.6|   11.47 |  819.60 |
| 25.200 |     2.00|  |     4.0 |     5911.0 |     5933.7|   11.34 |  819.59 |
| 25.300 |     2.00|  |     4.0 |     5892.5 |     5915.0|   11.22 |  819.59 |
| 25.400 |     1.00|  |     3.0 |     5873.4 |     5895.5|   11.09 |  819.59 |
| 25.500 |     1.00|  |     2.0 |     5853.5 |     5875.4|   10.95 |  819.59 |
| 25.600 |     1.00|  |     2.0 |     5833.8 |     5855.5|   10.82 |  819.59 |
| 25.700 |     1.00|  |     2.0 |     5814.5 |     5835.8|   10.68 |  819.58 |
| 25.800 |     0.00|  |     1.0 |     5794.4 |     5815.5|   10.55 |  819.58 |
| 25.900 |     0.00|  |     0.0 |     5773.6 |     5794.4|   10.41 |  819.58 |
 -----------------     ------------------------------------------------------
```

```
******************* SUMMARY OF ROUTING COMPUTATIONS ******************

Pond File:           SHAWET3 .PND
Inflow Hydrograph:   SHAW10  .HYD
Outflow Hydrograph:  OUT     .HYD


Starting Pond W.S. Elevation =   811.00 ft


         ***** Summary of Peak Outflow and Peak Elevation *****

                      Peak Inflow    =   353.00 cfs
                      Peak Outflow   =    17.59 cfs
                      Peak Elevation =   819.68 ft


           ***** Summary of Approximate Peak Storage *****

               Initial Storage         =      0.00 ac-ft
               Peak Storage From Storm =     28.29 ac-ft
                                           ---------------
               Total Storage in Pond   =     28.29 ac-ft


        Warning: Inflow hydrograph truncated on left side.
```

```
      POND-2 Version: 5.16 S/N: 1295130172                      Page 7

      Pond File:          SHAWET3 .PND
      Inflow Hydrograph:  SHAW10  .HYD
      Outflow Hydrograph: OUT     .HYD
                                                       EXECUTED: 06-01-1995
      Peak Inflow    =   353.00 cfs                                10:26:48
      Peak Outflow   =    17.59 cfs
      Peak Elevation =   819.68 ft

                                                                 Flow (cfs)
        0    40    80   120   160   200   240   280   320   360   400   440
      .------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-
      |
11.5 -|x  *
      |x   *
11.6 -|x   *
      |x    *
11.7 -|x    *
      |x     *
11.8 -|x      *
      |x       *
11.9 -|x       *
      |x          *
12.0 -|x              *
      |x                   *
12.1 -|x                         *
      |x                                  *
12.2 -|x                                          *
      |x                                               *
12.3 -|x                                                    *
      |x                                                   *
12.4 -|x                                                   *
      |x                                                *
12.5 -|x                                              *
      |x                                           *
12.6 -| x                                      *
      | x                                   *
12.7 -| x                               *
      | x                            *
12.8 -| x                         *
      | x                       *
12.9 -| x                     *
      | x                   *
13.0 -| x                *
      | x               *
13.1 -| x              *
      | x            *
13.2 -|  x          *
      |  x         *
13.3 -|  x        *
      |  x        *
13.4 -|  x       *
      |
    TIME
    (hrs)

  *  File:  SHAW10  .HYD   Qmax =    353.0 cfs
  x  File:  OUT     .HYD   Qmax =     17.6 cfs
```

```
POND-2 Version: 5.16 S/N: 1295130172                              Page 1
EXECUTED: 06-19-1995   12:51:09

   **********************************************************************
   *                                                                    *
   * CRANDON MINING COMPANY          93C049          FOTH & VAN DYKE   *
   *      WETLAND COMPENSATION: SHAWANO COUNTY             5/95         *
   *                   3 FOOT BLOCK-LOG WEIR OUTLET                     *
   *                       100-YEAR STORM EVENT                         *
   *                                                                    *
   **********************************************************************

      Inflow Hydrograph: SHAW100 .HYD
      Rating Table file: SHAWET3 .PND

      ----INITIAL CONDITIONS----
      Elevation =   811.00 ft
      Outflow   =     0.00 cfs
      Storage   =     0.00 ac-ft

                                                 INTERMEDIATE ROUTING
               GIVEN POND DATA                       COMPUTATIONS
      ------------------------------         -------------------------
      |ELEVATION| OUTFLOW |  STORAGE |       |    2S/t    |   2S/t  + 0  |
      |  (ft)   |  (cfs)  |  (ac-ft) |       |   (cfs)    |    (cfs)     |
      |---------|---------|----------|       |------------|--------------|
      | 811.00  |    0.0  |    0.000|       |        0.0 |         0.0 |
      | 811.50  |    0.0  |    0.001|       |        0.3 |         0.3 |
      | 812.00  |    0.0  |    0.002|       |        0.6 |         0.6 |
      | 812.50  |    0.0  |    0.003|       |        0.8 |         0.8 |
      | 813.00  |    0.0  |    0.005|       |        1.1 |         1.1 |
      | 813.50  |    0.0  |    0.006|       |        1.4 |         1.4 |
      | 814.00  |    0.0  |    0.007|       |        1.7 |         1.7 |
      | 814.50  |    0.0  |    0.008|       |        1.9 |         1.9 |
      | 815.00  |    0.0  |    0.009|       |        2.2 |         2.2 |
      | 815.50  |    0.0  |    0.010|       |        2.5 |         2.5 |
      | 816.00  |    0.0  |    0.011|       |        2.8 |         2.8 |
      | 816.50  |    0.0  |    0.013|       |        3.1 |         3.1 |
      | 817.00  |    0.0  |    0.014|       |        3.3 |         3.3 |
      | 817.50  |    0.0  |    0.015|       |        3.6 |         3.6 |
      | 818.00  |    0.0  |    0.016|       |        3.9 |         3.9 |
      | 818.50  |    0.0  |    0.017|       |        4.2 |         4.2 |
      | 819.00  |    0.3  |    1.169|       |      282.8 |       283.1 |
      | 819.50  |    4.3  |   20.171|       |     4881.4 |      4885.7 |
      | 820.00  |   41.2  |   43.197|       |    10453.6 |     10494.8 |
      | 820.50  |  122.4  |   68.766|       |    16641.5 |     16763.9 |
      | 821.00  |  230.7  |   95.003|       |    22990.7 |     23221.4 |
      | 821.50  |  361.3  |  121.914|       |    29503.2 |     29864.5 |
      ------------------------------         -------------------------

                       Time increment (t) = 0.100 hrs.
```

```
POND-2 Version: 5.16 S/N: 1295130172                        Page 2
EXECUTED: 06-19-1995   12:51:09

Pond File:            SHAWET3 .PND
Inflow Hydrograph:    SHAW100 .HYD
Outflow Hydrograph:   OUT     .HYD

INFLOW HYDROGRAPH                  ROUTING COMPUTATIONS
------------------    ------------------------------------------------------
| TIME   | INFLOW |   |  I1+I2   |  2S/t - O  |  2S/t + O | OUTFLOW |ELEVATION|
| (hrs)  | (cfs)  |   |  (cfs)   |   (cfs)    |   (cfs)   |  (cfs)  |  (ft)   |
|--------|---------|  |----------|------------|-----------|---------|---------|
| 11.000 |   26.00|   |  -----   |       0.0  |       0.0|   0.00  | 811.00  |
| 11.100 |   29.00|   |    55.0  |      54.9  |      55.0|   0.05  | 818.59  |
| 11.200 |   32.00|   |    61.0  |     115.7  |     115.9|   0.12  | 818.70  |
| 11.300 |   35.00|   |    67.0  |     182.3  |     182.7|   0.19  | 818.82  |
| 11.400 |   40.00|   |    75.0  |     256.7  |     257.3|   0.27  | 818.95  |
| 11.500 |   45.00|   |    85.0  |     341.0  |     341.7|   0.35  | 819.01  |
| 11.600 |   50.00|   |    95.0  |     435.2  |     436.0|   0.43  | 819.02  |
| 11.700 |   69.00|   |   119.0  |     553.1  |     554.2|   0.54  | 819.03  |
| 11.800 |   88.00|   |   157.0  |     708.7  |     710.1|   0.67  | 819.05  |
| 11.900 |  107.00|   |   195.0  |     902.1  |     903.7|   0.84  | 819.07  |
| 12.000 |  189.00|   |   296.0  |    1195.9  |    1198.1|   1.10  | 819.10  |
| 12.100 |  345.00|   |   534.0  |    1726.8  |    1729.9|   1.56  | 819.16  |
| 12.200 |  559.00|   |   904.0  |    2626.1  |    2630.8|   2.34  | 819.26  |
| 12.300 |  692.00|   |  1251.0  |    3870.2  |    3877.1|   3.42  | 819.39  |
| 12.400 |  676.00|   |  1368.0  |    5225.0  |    5238.2|   6.62  | 819.53  |
| 12.500 |  617.00|   |  1293.0  |    6487.9  |    6518.0|  15.04  | 819.65  |
| 12.600 |  528.00|   |  1145.0  |    7588.2  |    7632.9|  22.37  | 819.74  |
| 12.700 |  432.00|   |   960.0  |    8491.4  |    8548.2|  28.39  | 819.83  |
| 12.800 |  356.00|   |   788.0  |    9213.0  |    9279.4|  33.20  | 819.89  |
| 12.900 |  298.00|   |   654.0  |    9792.8  |    9867.0|  37.07  | 819.94  |
| 13.000 |  241.00|   |   539.0  |   10251.6  |   10331.8|  40.13  | 819.99  |
| 13.100 |  206.00|   |   447.0  |   10610.9  |   10698.6|  43.84  | 820.02  |
| 13.200 |  172.00|   |   378.0  |   10893.7  |   10988.9|  47.60  | 820.04  |
| 13.300 |  150.00|   |   322.0  |   11114.6  |   11215.7|  50.54  | 820.06  |
| 13.400 |  128.00|   |   278.0  |   11287.0  |   11392.6|  52.83  | 820.07  |
| 13.500 |  115.00|   |   243.0  |   11420.7  |   11530.0|  54.61  | 820.08  |
| 13.600 |  102.00|   |   217.0  |   11525.7  |   11637.7|  56.00  | 820.09  |
| 13.700 |   93.00|   |   195.0  |   11606.6  |   11720.7|  57.08  | 820.10  |
| 13.800 |   85.00|   |   178.0  |   11668.8  |   11784.6|  57.91  | 820.10  |
| 13.900 |   80.00|   |   165.0  |   11716.7  |   11833.8|  58.54  | 820.11  |
| 14.000 |   75.00|   |   155.0  |   11753.6  |   11871.7|  59.03  | 820.11  |
| 14.100 |   71.00|   |   146.0  |   11780.8  |   11899.6|  59.40  | 820.11  |
| 14.200 |   67.00|   |   138.0  |   11799.5  |   11918.8|  59.64  | 820.11  |
| 14.300 |   63.00|   |   130.0  |   11810.0  |   11929.5|  59.78  | 820.11  |
| 14.400 |   61.00|   |   124.0  |   11814.3  |   11934.0|  59.84  | 820.11  |
| 14.500 |   58.00|   |   119.0  |   11813.6  |   11933.3|  59.83  | 820.11  |
| 14.600 |   56.00|   |   114.0  |   11808.1  |   11927.6|  59.76  | 820.11  |
| 14.700 |   55.00|   |   111.0  |   11799.8  |   11919.1|  59.65  | 820.11  |
| 14.800 |   54.00|   |   109.0  |   11789.8  |   11908.8|  59.52  | 820.11  |
| 14.900 |   52.00|   |   106.0  |   11777.1  |   11895.8|  59.35  | 820.11  |
| 15.000 |   51.00|   |   103.0  |   11761.8  |   11880.1|  59.14  | 820.11  |
| 15.100 |   50.00|   |   101.0  |   11745.0  |   11862.8|  58.92  | 820.11  |
| 15.200 |   48.00|   |    98.0  |   11725.6  |   11843.0|  58.66  | 820.11  |
| 15.300 |   47.00|   |    95.0  |   11703.9  |   11820.6|  58.37  | 820.11  |
| 15.400 |   45.00|   |    92.0  |   11679.8  |   11795.9|  58.05  | 820.10  |
------------------    ------------------------------------------------------
```

```
POND-2 Version: 5.16 S/N: 1295130172                          Page 3
EXECUTED: 06-19-1995   12:51:09

Pond File:           SHAWET3 .PND
Inflow Hydrograph:   SHAW100 .HYD
Outflow Hydrograph:  OUT     .HYD

INFLOW HYDROGRAPH                      ROUTING COMPUTATIONS
-----------------      -----------------------------------------------------------
| TIME   | INFLOW  |   |  I1+I2  |  2S/t - O  |  2S/t + O | OUTFLOW |ELEVATION|
| (hrs)  | (cfs)   |   |  (cfs)  |   (cfs)    |   (cfs)   |  (cfs)  |  (ft)   |
|--------|---------|   |---------|------------|-----------|---------|---------|
| 15.500 |    44.00|   |    89.0 |    11653.4 |    11768.8|   57.70 |  820.10 |
| 15.600 |    43.00|   |    87.0 |    11625.7 |    11740.4|   57.33 |  820.10 |
| 15.700 |    42.00|   |    85.0 |    11596.8 |    11710.7|   56.95 |  820.10 |
| 15.800 |    41.00|   |    83.0 |    11566.7 |    11679.8|   56.55 |  820.09 |
| 15.900 |    40.00|   |    81.0 |    11535.4 |    11647.7|   56.13 |  820.09 |
| 16.000 |    39.00|   |    79.0 |    11503.0 |    11614.4|   55.70 |  820.09 |
| 16.100 |    38.00|   |    77.0 |    11469.5 |    11580.0|   55.26 |  820.09 |
| 16.200 |    37.00|   |    75.0 |    11434.9 |    11544.5|   54.80 |  820.08 |
| 16.300 |    37.00|   |    74.0 |    11400.3 |    11508.9|   54.34 |  820.08 |
| 16.400 |    36.00|   |    73.0 |    11365.5 |    11473.3|   53.87 |  820.08 |
| 16.500 |    35.00|   |    71.0 |    11329.7 |    11436.5|   53.40 |  820.08 |
| 16.600 |    34.00|   |    69.0 |    11292.9 |    11398.7|   52.91 |  820.07 |
| 16.700 |    33.00|   |    67.0 |    11255.1 |    11359.9|   52.41 |  820.07 |
| 16.800 |    33.00|   |    66.0 |    11217.3 |    11321.1|   51.90 |  820.07 |
| 16.900 |    32.00|   |    65.0 |    11179.5 |    11282.3|   51.40 |  820.06 |
| 17.000 |    31.00|   |    63.0 |    11140.7 |    11242.5|   50.88 |  820.06 |
| 17.100 |    31.00|   |    62.0 |    11102.0 |    11202.7|   50.37 |  820.06 |
| 17.200 |    31.00|   |    62.0 |    11064.2 |    11164.0|   49.87 |  820.05 |
| 17.300 |    31.00|   |    62.0 |    11027.5 |    11126.2|   49.38 |  820.05 |
| 17.400 |    31.00|   |    62.0 |    10991.7 |    11089.5|   48.90 |  820.05 |
| 17.500 |    31.00|   |    62.0 |    10956.8 |    11053.7|   48.44 |  820.04 |
| 17.600 |    31.00|   |    62.0 |    10922.8 |    11018.8|   47.99 |  820.04 |
| 17.700 |    30.00|   |    61.0 |    10888.7 |    10983.8|   47.53 |  820.04 |
| 17.800 |    30.00|   |    60.0 |    10854.6 |    10948.7|   47.08 |  820.04 |
| 17.900 |    29.00|   |    59.0 |    10820.3 |    10913.6|   46.62 |  820.03 |
| 18.000 |    29.00|   |    58.0 |    10786.0 |    10878.3|   46.17 |  820.03 |
| 18.100 |    29.00|   |    58.0 |    10752.6 |    10844.0|   45.72 |  820.03 |
| 18.200 |    28.00|   |    57.0 |    10719.0 |    10809.6|   45.28 |  820.03 |
| 18.300 |    28.00|   |    56.0 |    10685.3 |    10775.0|   44.83 |  820.02 |
| 18.400 |    27.00|   |    55.0 |    10651.6 |    10740.3|   44.38 |  820.02 |
| 18.500 |    27.00|   |    54.0 |    10617.7 |    10705.6|   43.93 |  820.02 |
| 18.600 |    27.00|   |    54.0 |    10584.7 |    10671.7|   43.49 |  820.01 |
| 18.700 |    26.00|   |    53.0 |    10551.6 |    10637.7|   43.05 |  820.01 |
| 18.800 |    26.00|   |    52.0 |    10518.4 |    10603.6|   42.61 |  820.01 |
| 18.900 |    25.00|   |    51.0 |    10485.1 |    10569.4|   42.17 |  820.01 |
| 19.000 |    25.00|   |    50.0 |    10451.6 |    10535.1|   41.72 |  820.00 |
| 19.100 |    25.00|   |    50.0 |    10419.1 |    10501.6|   41.29 |  820.00 |
| 19.200 |    24.00|   |    49.0 |    10386.0 |    10468.1|   41.02 |  820.00 |
| 19.300 |    24.00|   |    48.0 |    10352.4 |    10434.0|   40.80 |  819.99 |
| 19.400 |    23.00|   |    47.0 |    10318.3 |    10399.4|   40.57 |  819.99 |
| 19.500 |    23.00|   |    46.0 |    10283.6 |    10364.3|   40.34 |  819.99 |
| 19.600 |    23.00|   |    46.0 |    10249.4 |    10329.6|   40.11 |  819.99 |
| 19.700 |    22.00|   |    45.0 |    10214.6 |    10294.4|   39.88 |  819.98 |
| 19.800 |    22.00|   |    44.0 |    10179.3 |    10258.6|   39.65 |  819.98 |
| 19.900 |    21.00|   |    43.0 |    10143.5 |    10222.3|   39.41 |  819.98 |
| 20.000 |    21.00|   |    42.0 |    10107.1 |    10185.5|   39.17 |  819.97 |
-----------------      -----------------------------------------------------------
```

```
POND-2 Version: 5.16 S/N: 1295130172                         Page 4
EXECUTED: 06-19-1995   12:51:09

Pond File:           SHAWET3 .PND
Inflow Hydrograph:   SHAW100 .HYD
Outflow Hydrograph:  OUT     .HYD

INFLOW HYDROGRAPH                    ROUTING COMPUTATIONS
------------------    ---------------------------------------------------------
| TIME   | INFLOW |   |  I1+I2  |  2S/t - O  |  2S/t + O | OUTFLOW |ELEVATION|
| (hrs)  | (cfs)  |   |  (cfs)  |   (cfs)    |   (cfs)   |  (cfs)  |  (ft)   |
|--------|--------|   |---------|------------|-----------|---------|---------|
| 20.100 |   21.00|   |    42.0 |    10071.3 |    10149.1|   38.93 |  819.97 |
| 20.200 |   21.00|   |    42.0 |    10035.9 |    10113.3|   38.69 |  819.97 |
| 20.300 |   21.00|   |    42.0 |    10001.0 |    10077.9|   38.46 |  819.96 |
| 20.400 |   21.00|   |    42.0 |     9966.5 |    10043.0|   38.23 |  819.96 |
| 20.500 |   20.00|   |    41.0 |     9931.6 |    10007.5|   37.99 |  819.96 |
| 20.600 |   20.00|   |    40.0 |     9896.0 |     9971.6|   37.76 |  819.95 |
| 20.700 |   20.00|   |    40.0 |     9861.0 |     9936.0|   37.52 |  819.95 |
| 20.800 |   20.00|   |    40.0 |     9826.4 |     9901.0|   37.29 |  819.95 |
| 20.900 |   20.00|   |    40.0 |     9792.3 |     9866.4|   37.07 |  819.94 |
| 21.000 |   20.00|   |    40.0 |     9758.6 |     9832.3|   36.84 |  819.94 |
| 21.100 |   20.00|   |    40.0 |     9725.3 |     9798.6|   36.62 |  819.94 |
| 21.200 |   20.00|   |    40.0 |     9692.5 |     9765.3|   36.40 |  819.93 |
| 21.300 |   20.00|   |    40.0 |     9660.2 |     9732.5|   36.19 |  819.93 |
| 21.400 |   20.00|   |    40.0 |     9628.2 |     9700.2|   35.97 |  819.93 |
| 21.500 |   20.00|   |    40.0 |     9596.7 |     9668.2|   35.76 |  819.93 |
| 21.600 |   19.00|   |    39.0 |     9564.6 |     9635.7|   35.55 |  819.92 |
| 21.700 |   19.00|   |    38.0 |     9531.9 |     9602.6|   35.33 |  819.92 |
| 21.800 |   19.00|   |    38.0 |     9499.7 |     9569.9|   35.12 |  819.92 |
| 21.900 |   19.00|   |    38.0 |     9467.9 |     9537.7|   34.90 |  819.91 |
| 22.000 |   19.00|   |    38.0 |     9436.5 |     9505.9|   34.69 |  819.91 |
| 22.100 |   19.00|   |    38.0 |     9405.5 |     9474.5|   34.49 |  819.91 |
| 22.200 |   18.00|   |    37.0 |     9374.0 |     9442.5|   34.28 |  819.91 |
| 22.300 |   18.00|   |    36.0 |     9341.9 |     9410.0|   34.06 |  819.90 |
| 22.400 |   17.00|   |    35.0 |     9309.2 |     9376.9|   33.85 |  819.90 |
| 22.500 |   17.00|   |    34.0 |     9275.9 |     9343.2|   33.62 |  819.90 |
| 22.600 |   16.00|   |    33.0 |     9242.1 |     9308.9|   33.40 |  819.89 |
| 22.700 |   16.00|   |    32.0 |     9207.8 |     9274.1|   33.17 |  819.89 |
| 22.800 |   15.00|   |    31.0 |     9172.9 |     9238.8|   32.94 |  819.89 |
| 22.900 |   15.00|   |    30.0 |     9137.5 |     9202.9|   32.70 |  819.88 |
| 23.000 |   14.00|   |    29.0 |     9101.6 |     9166.5|   32.46 |  819.88 |
| 23.100 |   14.00|   |    28.0 |     9065.1 |     9129.6|   32.22 |  819.88 |
| 23.200 |   13.00|   |    27.0 |     9028.2 |     9092.1|   31.97 |  819.87 |
| 23.300 |   13.00|   |    26.0 |     8990.8 |     9054.2|   31.72 |  819.87 |
| 23.400 |   12.00|   |    25.0 |     8952.8 |     9015.8|   31.47 |  819.87 |
| 23.500 |   12.00|   |    24.0 |     8914.4 |     8976.8|   31.21 |  819.86 |
| 23.600 |   11.00|   |    23.0 |     8875.5 |     8937.4|   30.95 |  819.86 |
| 23.700 |   11.00|   |    22.0 |     8836.1 |     8897.5|   30.69 |  819.86 |
| 23.800 |   10.00|   |    21.0 |     8796.2 |     8857.1|   30.43 |  819.85 |
| 23.900 |   10.00|   |    20.0 |     8755.9 |     8816.2|   30.16 |  819.85 |
| 24.000 |   10.00|   |    20.0 |     8716.1 |     8775.9|   29.89 |  819.85 |
| 24.100 |    9.00|   |    19.0 |     8675.9 |     8735.1|   29.62 |  819.84 |
| 24.200 |    9.00|   |    18.0 |     8635.2 |     8693.9|   29.35 |  819.84 |
| 24.300 |    8.00|   |    17.0 |     8594.0 |     8652.2|   29.08 |  819.84 |
| 24.400 |    8.00|   |    16.0 |     8552.4 |     8610.0|   28.80 |  819.83 |
| 24.500 |    7.00|   |    15.0 |     8510.4 |     8567.4|   28.52 |  819.83 |
| 24.600 |    7.00|   |    14.0 |     8467.9 |     8524.4|   28.24 |  819.82 |
------------------    ---------------------------------------------------------
```

```
Pond File:           SHAWET3 .PND
Inflow Hydrograph:   SHAW100 .HYD
Outflow Hydrograph: OUT      .HYD

INFLOW HYDROGRAPH                     ROUTING COMPUTATIONS
-----------------      -----------------------------------------------------
| TIME   | INFLOW |   | I1+I2   | 2S/t - O   | 2S/t + O  | OUTFLOW |ELEVATION|
| (hrs)  | (cfs)  |   | (cfs)   |  (cfs)     |  (cfs)    | (cfs)   |  (ft)   |
|--------|--------|   |---------|------------|-----------|---------|---------|
| 24.700 |   6.00|   |   13.0  |    8425.0  |    8480.9|  27.95  | 819.82  |
| 24.800 |   6.00|   |   12.0  |    8381.7  |    8437.0|  27.66  | 819.82  |
| 24.900 |   5.00|   |   11.0  |    8337.9  |    8392.7|  27.37  | 819.81  |
| 25.000 |   5.00|   |   10.0  |    8293.8  |    8347.9|  27.08  | 819.81  |
| 25.100 |   4.00|   |    9.0  |    8249.2  |    8302.8|  26.78  | 819.80  |
| 25.200 |   4.00|   |    8.0  |    8204.3  |    8257.2|  26.48  | 819.80  |
| 25.300 |   3.00|   |    7.0  |    8158.9  |    8211.3|  26.18  | 819.80  |
| 25.400 |   3.00|   |    6.0  |    8113.2  |    8164.9|  25.87  | 819.79  |
| 25.500 |   2.00|   |    5.0  |    8067.0  |    8118.2|  25.57  | 819.79  |
| 25.600 |   2.00|   |    4.0  |    8020.5  |    8071.0|  25.26  | 819.78  |
| 25.700 |   1.00|   |    3.0  |    7973.6  |    8023.5|  24.94  | 819.78  |
| 25.800 |   1.00|   |    2.0  |    7926.4  |    7975.6|  24.63  | 819.78  |
| 25.900 |   0.00|   |    1.0  |    7878.8  |    7927.4|  24.31  | 819.77  |
----------------       -----------------------------------------------------
```

```
****************** SUMMARY OF ROUTING COMPUTATIONS ******************

Pond File:           SHAWET3 .PND
Inflow Hydrograph:   SHAW100 .HYD
Outflow Hydrograph: OUT     .HYD


Starting Pond W.S. Elevation =   811.00 ft


         ***** Summary of Peak Outflow and Peak Elevation *****

                     Peak Inflow    =   692.00 cfs
                     Peak Outflow   =    59.84 cfs
                     Peak Elevation =   820.11 ft


          ***** Summary of Approximate Peak Storage *****

               Initial Storage         =     0.00 ac-ft
               Peak Storage From Storm =    49.07 ac-ft
                                          --------------
               Total Storage in Pond   =    49.07 ac-ft


        Warning: Inflow hydrograph truncated on left side.
```

```
POND-2 Version: 5.16 S/N: 1295130172                        Page 7

Pond File:          SHAWET3 .PND
Inflow Hydrograph:  SHAW100 .HYD
Outflow Hydrograph: OUT     .HYD
                                                  EXECUTED: 06-19-1995
Peak Inflow    =   692.00 cfs                               12:51:09
Peak Outflow   =    59.84 cfs
Peak Elevation =   820.11 ft

                                                           Flow (cfs)
        0    70   140   210   280   350   420   490   560   630   700   770
      .------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-
      |
11.5 -|x   *
      |x   *
11.6 -|x   *
      |x    *
11.7 -|x     *
      |x      *
11.8 -|x       *
      |x       *
11.9 -|x        *
      |x             *
12.0 -|x                *
      |x                       *
12.1 -|x                              *
      |x                                       *
12.2 -|x                                                *
      |x                                                      *
12.3 -|x                                                           *
      |x                                                           *
12.4 -| x                                                         *
      | x                                                      *
12.5 -| x                                                    *
      |  x                                               *
12.6 -|  x                                           *
      |  x                                       *
12.7 -|  x                                   *
      |   x                               *
12.8 -|   x                            *
      |   x                         *
12.9 -|   x                       *
      |   x                    *
13.0 -|   x                  *
      |    x               *
13.1 -|    x              *
      |    x            *
13.2 -|    x           *
      |    x          *
13.3 -|    x         *
      |    x        *
13.4 -|     x      *
      |
     TIME
     (hrs)

   *  File:  SHAW100 .HYD   Qmax =   692.0 cfs
   x  File:  OUT     .HYD   Qmax =    59.8 cfs
```

Appendix D

Wetland Compensation Volume Table

```
POND-2 Version: 5.16
S/N: 1295130172

       CRANDON MINING COMPANY                   FOTH & VAN DYKE
            WETLAND COMPENSATION: SHAWANO COUNTY     5/95



                         CALCULATED    06-21-1995    14:05:06
                         DISK FILE: SHAWET2 .VOL


                         Planimeter scale: 1 inch = 100 ft.

                                                              *
Elevation  Planimeter   Area  A1+A2+sqr(A1*A2)          Volume   Volume Sum
  (ft)      (sq.in.)  (acres)     (acres)             (acre-ft)  (acre-ft)
---------------------------------------------------------------------------
  811.00       0.01     0.00       0.00                   0.00       0.00
  818.90       0.01     0.00       0.01                   0.02       0.02
  819.00     149.15    34.24      34.52                   1.15       1.17
  820.01     220.01    50.51     126.33                  42.53      43.70
  822.00     243.40    55.88     159.51                 105.81     149.51

 *  Incremental volume computed by the Conic Method for Reservoir Volumes.
```

```
POND-2 Version: 5.16
S/N: 1295130172

       CRANDON MINING COMPANY                  FOTH & VAN DYKE
            WETLAND COMPENSATION: SHAWANO COUNTY      5/95



                       CALCULATED     06-01-1995     10:19:07
                       DISK FILE: SHAWET2 .VOL


                       Planimeter scale: 1 inch = 100 ft.

                                                          *
Elevation   Planimeter    Area   A1+A2+sqr(A1*A2)      Volume    Volume Sum
   (ft)      (sq.in.)   (acres)      (acres)          (acre-ft)   (acre-ft)
----------------------------------------------------------------------------
   811.00      0.01       0.00        0.00               0.00        0.00
   818.90      0.01       0.00        0.01               0.02        0.02
   819.00    149.15      34.24       34.52               1.15        1.17
   820.01    220.01      50.51      126.33              42.53       43.70

 *  Incremental volume computed by the Conic Method for Reservoir Volumes.
```

```
POND-2 Version: 5.16
S/N: 1295130172

        CRANDON MINING COMPANY                      FOTH & VAN DYKE
             WETLAND COMPENSATION: SHAWANO COUNTY     5/95



                        CALCULATED    06-01-1995     10:18:38
                        DISK FILE: SHAWANO .VOL


                        Planimeter scale: 1 inch = 100 ft.

                                                          *
Elevation  Planimeter   Area   A1+A2+sqr(A1*A2)        Volume    Volume Sum
  (ft)      (sq.in.)   (acres)      (acres)            (acre-ft)  (acre-ft)
--------------------------------------------------------------------------
   811.00      0.01      0.00        0.00                 0.00       0.00
   812.00      1.13      0.26        0.29                 0.10       0.10
   813.00      2.62      0.60        1.26                 0.42       0.51
   814.00      5.27      1.21        2.66                 0.89       1.40
   815.00      8.17      1.88        4.59                 1.53       2.93
   816.00     16.93      3.89        8.46                 2.82       5.75
   817.00     83.17     19.09       31.59                10.53      16.28
   818.00    113.78     26.12       67.55                22.52      38.80
   819.00    149.15     34.24       90.27                30.09      68.89
   820.00    220.01     50.51      126.33                42.11     111.00

 *  Incremental volume computed by the Conic Method for Reservoir Volumes.
```